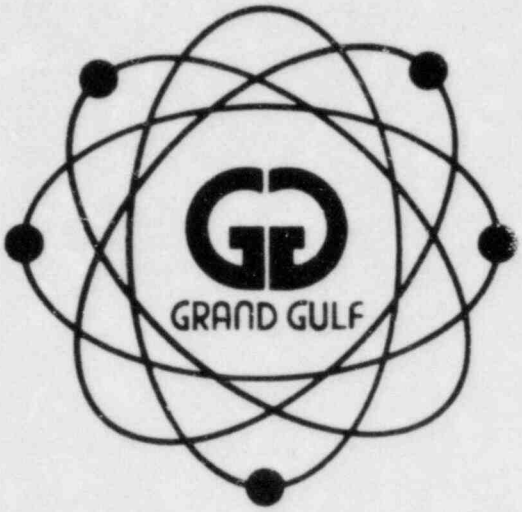
FINAL ENVIRONMENTAL REPORT



GRAND GULF
NUCLEAR STATION
UNITS 1 AND 2

MISSISSIPPI POWER & LIGHT COMPANY

MIDDLE SOUTH ENERGY, INC.

MIDDLE SOUTH UTILITIES SYSTEM

VOLUME 1

8304210058 811231
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SUMMARY TABLE OF CONTENTS

CHAPTER 1.0

PURPOSE OF THE PROPOSED FACILITY AND ASSOCIATED TRANSMISSION

		Page
1.1	SYSTEM DEMAND AND RELIABILITY	1.1-1
1.2	OTHER OBJECTIVES	1.2-1
1.3	CONSEQUENCES OF DELAY	1.3-1

CHAPTER 2.0

THE SITE AND ENVIRONMENTAL INTERFACES

2.1	GEOGRAPHY AND DEMOGRAPHY	2.1-1
2.2	ECOLOGY	2.2-1
2.3	METEOROLOGY	2.3-1
2.4	HYDROLOGY	2.4-1
2.5	GEOLOGICAL SUMMARY	2.5-1
2.6	REGIONAL HISTORIC, ARCHEOLOGICAL, ARCHITECTURAL, SCENIC, CULTURAL, AND NATURAL FEATURES	2.6-1
2.7	NOISE	2.7-1

CHAPTER 3.0

THE STATION

3.1	EXTERNAL APPEARANCE	3.1-1
3.2	REACTOR AND STEAM ELECTRIC SYSTEM	3.2-1
3.3	STATION WATER USE	3.3-1
3.4	HEAT DISSIPATION SYSTEM	3.4-1
3.5	RADWASTE SYSTEMS AND SOURCE TERMS	3.5-1
3.6	CHEMICAL AND BIOCIDE WASTES	3.6-1

SUMMARY TABLE OF CONTENTS (Cont.)

		Page
3.7	SANITARY AND OTHER WASTE SYSTEMS	3.7-1
3.8	REPORTING OF RADIOACTIVE MATERIAL MOVEMENT	3.8-1
3.9	TRANSMISSION FACILITIES	3.9-1
	CHAPTER 4.0	
	ENVIRONMENTAL EFFECTS OF SITE PREPARATION, STATION CONSTRUCTION, AND TRANSMISSION FACILITIES CONSTRUCTION	
4.1	SITE PREPARATION AND STATION CONSTRUCTION	4.1-1
4.2	TRANSMISSION FACILITIES CONSTRUCTION	4.2-1
4.3	RESOURCES COMMITTED	4.3-1
4.4	RADIOACTIVITY	4.4-1
4.5	CONSTRUCTION IMPACT CONTROL PROGRAM	4.5-1
	CHAPTER 5.0	
	ENVIRONMENTAL EFFECTS OF STATION OPERATION	
5.1	EFFECTS OF OPERATION OF HEAT DISSIPATION SYSTEM	5.1-1
5.2	RADIOLOGICAL IMPACT FROM ROUTINE OPERATION	5.2-1
5.3	EFFECTS OF CHEMICAL AND BIOCIDE DISCHARGES	5.3-1
5.4	EFFECTS OF SANITARY WASTE DISCHARGES	5.4-1
5.5	EFFECTS OF OPERATION AND MAINTENANCE OF THE TRANSMISSION SYSTEMS	5.5-1
5.6	OTHER EFFECTS	5.6-1
5.7	RESOURCES COMMITTED	5.7-1
5.8	DECOMMISSIONING AND DISMANTLING	5.8-1

SUMMARY TABLE OF CONTENTS (Cont.)

Page

CHAPTER 6.0

EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

6.1	PREOPERATIONAL ENVIRONMENTAL PROGRAMS	6.1-1
6.2	PROPOSED OPERATIONAL MONITORING PROGRAMS	6.2-1
6.3	RELATED ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAMS	6.3-1
6.4	PREOPERATIONAL ENVIRONMENTAL RADIOLOGICAL MONITORING DATA	6.4-1

CHAPTER 7.0

ENVIRONMENTAL EFFECTS OF ACCIDENTS

7.1	STATION ACCIDENTS INVOLVING RADIOACTIVITY	7.1-1
7.2	TRANSPORTATION ACCIDENTS INVOLVING RADIOACTIVITY	7.2-1
7.3	OTHER ACCIDENTS	7.3-1

CHAPTER 8.0

ECONOMIC AND SOCIAL EFFECTS OF STATION CONSTRUCTION AND OPERATION

8.1	BENEFITS	8.1-1
8.2	COSTS	8.2-1

CHAPTER 9.0

ALTERNATIVE ENERGY SOURCES AND SITES

9.1	ALTERNATIVES NOT REQUIRING THE CREATION OF NEW GENERATING CAPACITY	9.1-1
9.2	ALTERNATIVES REQUIRING THE CREATION OF NEW GENERATING CAPACITY	9.2-1
9.3	COST EFFECTIVENESS ANALYSIS OF CANDIDATE SITE-PLANT ALTERNATIVES	9.3-1
9.4	COSTS OF ALTERNATIVE POWER GENERATION METHODS	9.4-1

GG
ER

SUMMARY TABLE OF CONTENTS (Cont.)

		Page
	CHAPTER 10.0	
	STATION DESIGN ALTERNATIVES	
10.1	CIRCULATING COOLING WATER SYSTEM	10.1-3
10.2	INTAKE SYSTEM	10.2-1
10.3	DISCHARGE SYSTEM	10.3-1
10.4	CHEMICAL WASTE TREATMENT	10.4-1
10.5	BIOCIDE TREATMENT	10.5-1
10.6	SANITARY WASTE SYSTEM	10.6-1
10.7	LIQUID RADWASTE SYSTEM ALTERNATIVES	10.7-1
10.8	GASEOUS RADWASTE SYSTEM ALTERNATIVES	10.8-1
10.9	TRANSMISSION FACILITIES	10.9-1
10.10	OTHER SYSTEMS	10.10-1
	CHAPTER 11.0	
	SUMMARY COST-BENEFIT ANALYSIS	
11.1	BENEFITS	
11.2	COSTS	
11.3	CONCLUSION	
	CHAPTER 12.0	
	ENVIRONMENTAL APPROVALS AND CONSULTATION	
	CHAPTER 13.0	
	REFERENCES	

PAGE REVISION INDEX

A dash in the amendment column means that the page is a part of the initial issue of the ER and has not been revised to date.

Page	Amendment
SUMMARY OF TABLE OF CONTENTS	
i	-
ii	-
iii	-
iv	-
QUESTIONS AND RESPONSES TABLE OF CONTENTS	
Q&R-i	5
Q&R-ii	5
PAGE REVISION INDEX	
1	8
2	8
3	8
4	8
5	8
6	8
7	8
8	8
9	8
10	8
11	8
12	8
13	8
14	8
15	8
16	8
17	8
18	8
19	8
20	8
21	8
22	8
23	8
24	8

GG
ER

CHAPTER 1

PAGE REVISION INDEX

Page	Amendment
1-i	1
1-ii	1
1-iii	1
1-iv	-
1.1-1	1
1.1-2	1
1.1-3	1
1.1-4	1
1.1-5	1
1.1-6	1
1.1-7	1
1.1-7a	1
1.1-7b	1
1.1-8	1
1.1-9	-
1.1-10	1
1.1-11	-
1.1-12	-
1.1-13	1
1.1-14	1
Table 1.1.1	1
Table 1.1.2	1
Table 1.1.3	1
Table 1.1.4	1
Table 1.1.5	1
Table 1.1.6	1
Table 1.1.7	1
Table 1.1.8	1
Table 1.1.9	1
Table 1.1.10	1
Table 1.1.11	
Sht. 1	-
Sht. 2	-
Table 1.1.12	
Sht. 1	1
Sht. 2	1
Table 1.1.13	
Sht. 1	1
Sht. 2	1
Table 1.1.14	1
Table 1.1.15	1
Table 1.1.16	
Sht. 1	1
Sht. 2	1
Table 1.1.17	1
Table 1.1.18	
Sht. 1	1
Sht. 2	1
Sht. 3	1
Table 1.1.19	
Sht. 1	1
Sht. 2	1
Fig. 1.1-1	-
Fig. 1.1-2	-
Fig. 1.1-3	1
Fig. 1.1-4	1
Fig. 1.1-5	1
Fig. 1.1-6	1
Appendix A	
1.1A-1	-
1.1A-2	-
1.1A-3	-
1.1A-4	-
1.1A-5	-
1.1A-6	-
1.1A-7	-
1.1A-8	-
1.1A-9	-
1.1A-10	-
1.1A-11	-
1.1A-12	-
1.1A-13	-
1.1A-14	-
1.1A-15	-
1.1A-16	-
1.1A-17	-
1.1A-18	-
1.1A-19	-
1.1A-20	-
1.1A-21	-
1.1A-22	-
1.1A-23	-
1.1A-24	-
1.1A-25	-
1.1A-26	-
1.1A-27	-
1.1A-28	-
1.1A-29	-
1.1A-30	-
1.1A-31	-
1.1A-32	-
1.1A-33	-
1.1A-34	-
1.1A-35	-
1.2-1	-
1.3-1	1
Table 1.3.1	1
Table 1.3.2	1

GG
ER

CHAPTER 2

PAGE REVISION INDEX

Page	Amendment	Page	Amendment	Page	Amendment
2-i	1	2.1-16	1	Table 2.1.24	-
2-ii	-	2.1-17	-	Table 2.1.25	-
2-iii	-	2.1-18	-	Table 2.1.26	-
2-iv	1	2.1-19	-	Table 2.1.27	-
2-v	-	2.1-20	-	Table 2.1.28	-
2-vi	-	2.1-21	-	Table 2.1.29	-
2-vii	-	2.1-22	-	Table 2.1.30	-
2-viii	-	2.1-23	-	Table 2.1.31	-
2-ix	-	Table 2.1.1		Table 2.1.32	-
2-x	-	Sht. 1	-	Table 2.1.33	-
2-xi	-	Sht. 2	-	Table 2.1.34	-
2-xii	-	Sht. 3	-	Table 2.1.35	-
2-xiii	-	Sht. 4	-	Table 2.1.36	-
2-xiv	-	Table 2.1.2		Table 2.1.37	-
2-xv	-	Sht. 1	-	Table 2.1.38	-
2-xvi	-	Sht. 2	-	Table 2.1.39	-
2-xvii	-	Sht. 3	-	Table 2.1.40	-
2-xviii	-	Table 2.1.3		Table 2.1.41	-
2-xix	-	Sht. 1	-	Table 2.1.42	-
2-xx	-	Sht. 2	-	Table 2.1.43	-
2-xxi	-	Sht. 3	-	Table 2.1.44	-
2-xxii	-	Sht. 4	-	Table 2.1.45	-
2-xxiii	-	Table 2.1.4		Table 2.1.46	-
2-xxiv	5	Sht. 1	-	Table 2.1.47	-
2-xxv	-	Sht. 2	-	Table 2.1.48	-
2-xxvi	-	Sht. 3	-	Table 2.1.49	-
2-xxvii	5	Table 2.1.5	-	Table 2.1.50	-
2-xxviii	6	Table 2.1.6	-	Table 2.1.51	-
2-xxix	-	Table 2.1.7	-	Table 2.1.52	-
2.1-1	5	Table 2.1.8	-	Table 2.1.53	-
2.1-1a	5	Table 2.1.9	-	Table 2.1.54	-
2.1-2	-	Table 2.1.10	-	Table 2.1.55	-
2.1-3	-	Table 2.1.11	-	Table 2.1.56	-
2.1-4	-	Table 2.1.12	-	Table 2.1.57	-
2.1-5	-	Table 2.1.13	-	Table 2.1.58	-
2.1-6	-	Table 2.1.14	-	Table 2.1.59	-
2.1-7	-	Table 2.1.15	-	Table 2.1.60	-
2.1-8	5	Table 2.1.16	-	Table 2.1.61	-
2.1-9	-	Table 2.1.17	-	Table 2.1.62	-
2.1-10	-	Table 2.1.18	-	Table 2.1.63	-
2.1-11	-	Table 2.1.19	-	Table 2.1.64	-
2.1-12	-	Table 2.1.20	-	Table 2.1.65	-
2.1-13	-	Table 2.1.21	-	Table 2.1.66	-
2.1-14	-	Table 2.1.22	-	Table 2.1.67	-
2.1-15	1	Table 2.1.23	-	Table 2.1.68	-

CHAPTER 2

PAGE REVISION INDEX (CONT'D)

Page	Amendment	Page	Amendment	Page	Amendment
Table 2.1.69	-	2.2-35	-	2.2-80	-
Table 2.1.70	-	2.2-36	-	2.2-81	-
Table 2.1.71		2.2-37	-	2.2-82	-
Sht. 1	-	2.2-38	-	2.2-83	-
Sht. 2	-	2.2-39	-	2.2-84	-
Table 2.1.72	-	2.2-40	-	Fig. 2.2-1	-
Fig. 2.1-1	-	2.2-41	-	Fig. 2.2-2	-
Fig. 2.1-2	-	2.2-42	-	Fig. 2.2-3	-
Fig. 2.1-3	-	2.2-43	-	Fig. 2.2-4	-
Fig. 2.1-4	-	2.2-44	-	Fig. 2.2-5	-
Fig. 2.1-5	-	2.2-45	-	Fig. 2.2-6	-
2.2-1	-	2.2-46	-	Fig. 2.2-7	-
2.2-2	-	2.2-47	-	Fig. 2.2-8	-
2.2-3	-	2.2-48	-	Fig. 2.2-9	-
2.2-4	-	2.2-49	-	Fig. 2.2-10	-
2.2-5	-	2.2-50	-	Fig. 2.2-11	-
2.2-6	-	2.2-51	-	Fig. 2.2-12	-
2.2-7	-	2.2-52	-	Fig. 2.2-13	-
2.2-8	-	2.2-53	-	2.3-1	-
2.2-9	-	2.2-54	-	2.3-2	-
2.2-10	-	2.2-55	-	2.3-3	-
2.2-11	-	2.2-56	-	2.3-4	-
2.2-12	-	2.2-57	-	2.3-5	-
2.2-13	-	2.2-58	-	2.3-6	-
2.2-14	-	2.2-59	-	2.3-7	-
2.2-15	-	2.2-60	-	2.3-8	-
2.2-16	-	2.2-61	-	2.3-9	-
2.2-17	-	2.2-62	-	2.3-10	-
2.2-18	-	2.2-63	-	2.3-11	-
2.2-19	-	2.2-64	-	2.3-12	-
2.2-20	-	2.2-65	-	2.3-13	-
2.2-21	-	2.2-66	-	2.3-14	-
2.2-22	-	2.2-67	-	2.3-15	-
2.2-23	-	2.2-68	-	2.3-16	-
2.2-24	-	2.2-69	-	2.3-17	-
2.2-25	-	2.2-70	-	2.3-18	-
2.2-26	-	2.2-71	-	2.3-19	-
2.2-27	-	2.2-72	-	2.3-20	-
2.2-28	-	2.2-73	-	2.3-21	-
2.2-29	-	2.2-74	-	2.3-22	-
2.2-30	-	2.2-75	-	2.3-23	-
2.2-31	-	2.2-76	-	2.3-24	-
2.2-32	-	2.2-77	-	2.3-25	-
2.2-33	-	2.2-78	-	Table 2.3.1	-
2.2-34	-	2.2-79	-	Table 2.3.2	-

CHAPTER 2

PAGE REVISION INDEX (CONT'D)

Page	Amendment	Page	Amendment	Page	Amendment
Table 2.3.3	-	Table 2.3.48	-	Sht. 6	-
Table 2.3.4	-	Table 2.3.49	-	Sht. 7	-
Table 2.3.5	-	Table 2.3.50	-	Sht. 8	-
Table 2.3.6	-	Table 2.3.51	-	Sht. 9	-
Table 2.3.7	-	Table 2.3.52	-	Table 2.3.61	
Table 2.3.8	-	Table 2.3.53	-	Sht. 1	-
Table 2.3.9	-	Table 2.3.54	-	Sht. 2	-
Table 2.3.10	-	Table 2.3.55	-	Sht. 3	-
Table 2.3.11	-	Table 2.3.56	-	Sht. 4	-
Table 2.3.12	-	Table 2.3.57		Sht. 5	-
Table 2.3.13	-	Sht. 1	-	Sht. 6	-
Table 2.3.14	-	Sht. 2	-	Sht. 7	-
Table 2.3.15	-	Sht. 3	-	Sht. 8	-
Table 2.3.16	-	Sht. 4	-	Sht. 9	-
Table 2.3.17	-	Sht. 5	-	Table 2.3.62	-
Table 2.3.18	-	Sht. 6	-	Table 2.3.63	-
Table 2.3.19	-	Sht. 7	-	Table 2.3.64	-
Table 2.3.20	-	Sht. 8	-	Table 2.3.65	-
Table 2.3.21	-	Sht. 9	-	Table 2.3.66	-
Table 2.3.22	-	Table 2.3.58		Table 2.3.67	-
Table 2.3.23	-	Sht. 1	-	Table 2.3.68	-
Table 2.3.24	-	Sht. 2	-	Table 2.3.69	-
Table 2.3.25	-	Sht. 3	-	Table 2.3.70	-
Table 2.3.26	-	Sht. 4	-	Table 2.3.71	-
Table 2.3.27	-	Sht. 5	-	Table 2.3.72	-
Table 2.3.28	-	Sht. 6	-	Table 2.3.73	-
Table 2.3.29	-	Sht. 7	-	Table 2.3.74	-
Table 2.3.30	-	Sht. 8	-	Table 2.3.75	-
Table 2.3.31	-	Sht. 9	-	Table 2.3.76	-
Table 2.3.32	-	Table 2.3.59		Table 2.3.77	-
Table 2.3.33	-	Sht. 1	-	Table 2.3.78	-
Table 2.3.34	-	Sht. 2	-	Table 2.3.79	-
Table 2.3.35	-	Sht. 3	-	Table 2.3.80	-
Table 2.3.36	-	Sht. 4	-	Table 2.3.81	-
Table 2.3.37	-	Sht. 5	-	Table 2.3.82	-
Table 2.3.38	-	Sht. 6	-	Table 2.3.83	-
Table 2.3.39	-	Sht. 7	-	Table 2.3.84	-
Table 2.3.40	-	Sht. 8	-	Table 2.3.85	-
Table 2.3.41	-	Sht. 9	-	Table 2.3.86	-
Table 2.3.42	-	Table 2.3.60		Table 2.3.87	-
Table 2.3.43	-	Sht. 1	-	Table 2.3.88	-
Table 2.3.44	-	Sht. 2	-	Table 2.3.89	-
Table 2.3.45	-	Sht. 3	-	Table 2.3.90	-
Table 2.3.46	-	Sht. 4	-	Table 2.3.91	-
Table 2.3.47	-	Sht. 5	-	Table 2.3.92	-

CHAPTER 2

PAGE REVISION INDEX (CONT'D)

Page	Amendment	Page	Amendment	Page	Amendment
Table 2.3.93	-	Table 2.3.128D	-	Fig. 2.3-5	-
Table 2.3.94	-	Table 2.3.128E	-	Fig. 2.3-6	-
Table 2.3.95	-	Table 2.3.128F	-	Fig. 2.3-7	-
Table 2.3.96	-	Table 2.3.128G	-	Fig. 2.3-8	-
Table 2.3.97	-	Table 2.3.129A	-	Fig. 2.3-9	-
Table 2.3.98	-	Table 2.3.129B	-	Fig. 2.3-10	-
Table 2.3.99	-	Table 2.3.129C	-	2.4-1	-
Table 2.3.100	-	Table 2.3.129D	-	2.4-2	5
Table 2.3.101	-	Table 2.3.129E	-	2.4-3	5
Table 2.3.102	-	Table 2.3.129F	-	2.4-4	1
Table 2.3.103	-	Table 2.3.130	-	2.5-5	1
Table 2.3.104	-	Table 2.3.131	-	2.4-6	5
Table 2.3.105	-	Table 2.3.132	-	2.4-7	1
Table 2.3.106	-	Table 2.3.133	-	2.4-8	1
Table 2.3.107	-	Table 2.3.134	-	2.4-9	1
Table 2.3.108	-	Table 2.3.135	-	2.4-10	5
Table 2.3.109	-	Table 2.3.136	-	2.4-11	6
Table 2.3.110	-	Table 2.3.137	-	Table 2.4.1	-
Table 2.3.111	-	Table 2.3.138	-	Table 2.4.2	-
Table 2.3.112	-	Table 2.3.139	-	Table 2.4.3	
Table 2.3.113	-	Table 2.3.140	-	Sht. 1	5
Table 2.3.114	-	Table 2.3.141	-	Sht. 2	5
Table 2.3.115	-	Table 2.3.142	-	Table 2.4.4	5
Table 2.3.116	-	Table 2.3.143	-	Table 2.4.5	-
Table 2.3.117	-	Table 2.3.144	-	Table 2.4.6	-
Table 2.3.118	-	Table 2.3.145	-	Table 2.4.7	5
Table 2.3.119	-	Table 2.3.146	-	Table 2.4.8	-
Table 2.3.120	-	Table 2.3.147	-	Table 2.4.9	-
Table 2.3.121	-	Table 2.3.148	-	Table 2.4.10	-
Table 2.3.122	-	Table 2.3.149	-	Table 2.4.11	-
Table 2.3.123	-	Table 2.3.150	-	Table 2.4.12	
Table 2.3.124	-	Table 2.3.151	-	Sht. 1	-
Table 2.3.125	-	Table 2.3.152	-	Sht. 2	-
Table 2.3.126	-	Table 2.3.153	-	Table 2.4.13	-
Table 2.3.127A	-	Table 2.3.154	-	Table 2.4.14	-
Table 2.3.127B	-	Table 2.3.155	-	Table 2.4.15	-
Table 2.3.127C	-	Table 2.3.156	-	Fig. 2.4-1	-
Table 2.3.127D	-	Table 2.3.157	-	Fig. 2.4-2	5
Table 2.3.127E	-	Table 2.3.158	-	Fig. 2.4-3	-
Table 2.3.127F	-	Table 2.3.159	-	Fig. 2.4-4	-
Table 2.3.127G	-	Table 2.3.160	-	Fig. 2.4-5	-
Table 2.3.127H	-	Fig. 2.3-1	-	Fig. 2.4-6	-
Table 2.3.128A	-	Fig. 2.3-2	-	Fig. 2.4-7	-
Table 2.3.128B	-	Fig. 2.3-3	-	Fig. 2.4-8	-
Table 2.3.128C	-	Fig. 2.3-4	-	Fig. 2.4-9	-

CHAPTER 2

PAGE REVISION INDEX (CONT'D)

Page	Amendment
Fig. 2.4-10	-
Fig. 2.4-11	
Sht. 1	-
Sht. 2	-
Sht. 3	-
Sht. 4	-
Sht. 5	-
Fig. 2.4-12	-
Fig. 2.4-13	-
Fig. 2.4-14	-
Fig. 2.4-15	6
2.5-1	-
2.5-2	-
2.5-3	-
2.5-4	-
Fig. 2.5-1	-
Fig. 2.5-2	-
Fig. 2.5-3	-
Fig. 2.5-4	-
2.6-1	-
2.6-2	-
2.6-3	-
Fig. 2.6-1	-
2.7-1	-
2.7-2	-
2.7-3	-
2.7-4	-
2.7-5	-
2.7-6	-
2.7-7	-
2.7-8	-
Table 2.7.1	-
Fig. 2.7-1	-
Fig. 2.7-2	-
Fig. 2.7-3	-
Fig. 2.7-4	-
Fig. 2.7-5	-
Fig. 2.7-6	-
Fig. 2.7-7	-
Fig. 2.7-8	-
Fig. 2.7-9	-
Fig. 2.7-10	-

CHAPTER 3

PAGE REVISION INDEX

Page	Amendment	Page	Amendment	Page	Amendment
3-i	1	3.5-9	-	Sht. 3	-
3-ii	-	3.5-10	-	Table 3.6.3a	
3-iii	7	3.5-11	-	Sht. 1	5
3-iv	1	3.5-12	-	Sht. 2	5
3-v	5	3.5-13	-	Table 3.6.3b	
3-vi	-	3.5-14	-	Sht. 1	5
3-vii	-	3.5-15	-	Sht. 2	5
3-viii	-	Table 3.5.1		Table 3.6.4	
3.1-1	-	Sht. 1	-	Sht. 1	-
3.1-2	-	Sht. 2	-	Sht. 2	-
Fig. 3.1-1	-	Sht. 3	-	Table 3.6.5	
3.2-1	-	Sht. 4	-	Sht. 1	-
3.2-2	-	Sht. 5	-	Sht. 2	-
3.2-3	-	Sht. 6	-	Fig. 3.6-1	-
Fig. 3.2-1	-	Table 3.5.2	-	3.7-1	-
3.3-1	5	Table 3.5.3		3.7-2	-
3.3-2	1	Sht. 1	-	3.7-3	1
3.3-3	5	Sht. 2	-	3.7-4	1
Table 3.3.1		Table 3.5.4		Table 3.7.1	-
Sht. 1	5	Sht. 1	-	3.8-1	-
Sht. 2	5	Sht. 2	-	3.9-1	-
Table 3.3.2	-	Table 3.5.5	-	3.9-2	-
Fig. 3.3-1	5	Table 3.5.6	-	3.9-3	-
3.4-1	5	Fig. 3.5-1	-	3.9-4	1
3.4-2	-	Fig. 3.5-2	-	3.9-4a	1
3.4-3	5	Fig. 3.5-3	-	3.9-5	-
3.4-4	5	Fig. 3.5-4	-	3.9-6	1
3.4-5	5	Fig. 3.5-5	-	3.9-6a	1
Table 3.4.1	-	3.6-1	7	3.9-7	-
Table 3.4.2	5	3.6-2	7	3.9-8	1
Table 3.4.3	5	3.6-3	7	3.9-8a	1
Table 3.4.4	5	3.6-4	7	3.9-9	-
Fig. 3.4-1	5	3.6-4a	7	3.9-10	-
Fig. 3.4-2	-	3.6-5	5	3.9-11	-
Fig. 3.4-3	-	3.6-6	5	3.9-12	-
Fig. 3.4-4	-	3.6-7	7	3.9-13	-
Fig. 3.4-5	-	3.6-8	7	3.9-14	5
3.5-1	-	Table 3.6.1		Table 3.9.1	-
3.5-2	-	Sht. 1	7	Table 3.9.2	-
3.5-3	-	Sht. 2	7	Table 3.9.3	-
3.5-4	-	Sht. 2a	7	Table 3.9.4	-
3.5-5	-	Sht. 3	-	Fig. 3.9-1	-
3.5-6	-	Sht. 4	7	Fig. 3.9-2	-
3.5-7	-	Table 3.6.2		Fig. 3.9-3	-
3.5-8	-	Sht. 1	-	Fig. 3.9-4	-
		Sht. 2	-		

CHAPTER 3

PAGE REVISION INDEX (CONT'D)

Page	Amendment
Fig. 3.9-5	-
Fig. 3.9-6	-
Fig. 3.9-7	-
Fig. 3.9-8	-

GG
ER

CHAPTER 4

PAGE REVISION INDEX

Page	Amendment	Page	Amendment
4-i	-	Appendix A	
4-ii	1	4.5A-1	-
4-iii	-	4.5A-2	-
4-iv	-	4.5A-3	-
4.1-1	5	4.5A-4	-
4.1-2	-	4.5A-5	-
4.1-3	-	4.5A-6	-
4.1-4	-	4.5A-7	-
4.1-5	-	4.5A-8	-
4.1-6	-	4.5A-9	-
4.1-7	-	4.5A-10	-
4.1-8	-	4.5A-11	-
4.1-9	-	4.5A-12	-
4.1-10	-	4.5A-13	-
4.1-11	-	4.5A-14	-
4.1-12	-		
4.1-13	-		
4.1-14	-		
4.1-15	-		
4.1-16	1		
4.1-16a	1		
4.1-17	5		
4.1-18	-		
4.1-19	-		
4.1-20	-		
4.1-21	-		
4.1-22	-		
4.1-23	-		
4.1-24	-		
4.1-25	-		
4.1-26	1		
Table 4.1.1	5		
Table 4.1.2	-		
Fig. 4.1-1	-		
Fig. 4.1-2	-		
Fig. 4.1-3	-		
Fig. 4.1-4	-		
Fig. 4.1-5	-		
4.2-1	-		
4.2-2	-		
4.2-3	1		
4.2-4	1		
4.3-1	-		
4.4-1	-		
4.5-1	-		

CHAPTER 5

PAGE REVISION INDEX

Page	Amendment
5-i	5
5-ia	5
5-ii	5
5-iii	5
5-iv	1
5-v	5
5-vi	7
5-vii	5
5.1-1	5
5.1-2	5
5.1-3	5
5.1-4	5
5.1-5	5
5.1-6	5
5.1-7	5
5.1-8	5
5.1-9	5
5.1-10	5
5.1-11	5
5.1-12	5
5.1-13	5
5.1-13a	5
5.1-13b	5
5.1-13c	5
5.1-14	-
5.1-15	-
5.1-16	-
5.1-17	-
5.1-18	-
5.1-19	-
5.1-20	5
5.1-21	5
5.1-22	5
5.1-23	5
5.1-24	5
5.1-25	5
Table 5.1.1a	5
Table 5.1.1b	5
Table 5.1.2a	5
Table 5.1.2b	5
Table 5.1.3	-
Table 5.1.4	
Sht. 1	-
Sht. 2	-
Sht. 3	-
Sht. 4	-
Sht. 5	-
Table 5.1.5	-
Table 5.1.6	-
Table 5.1.7	-
Table 5.1.8	-
Table 5.1.9	-
Table 5.1.10	-
Table 5.1.11	5
Table 5.1.12	5
Table 5.1.13	5
Table 5.1.14	5
Table 5.1.15	5
Table 5.1.16	5
Table 5.1.17	5
Table 5.1.18	5
Table 5.1.19	5
Table 5.1.20	5
Table 5.1.21	5
Table 5.1.22	5
Table 5.1.23	5
Table 5.1.24	1
Fig. 5.1-1	5
Fig. 5.1-2	5
Fig. 5.1-3	5
Fig. 5.1-4	5
Fig. 5.1-5	5
Fig. 5.1-6	5
Fig. 5.1-7	5
Fig. 5.1-8	5
Fig. 5.1-8a	5
Fig. 5.1-9	-
Appendix A	
5.1A-1	5
5.1A-2	5
5.1A-3	5
Appendix B	
5.1B-1	5
5.2-1	-
5.2-2	-
5.2-3	-
5.2-4	-
5.2-5	-
5.2-6	-
5.2-7	-
5.2-8	-
5.2-9	-
5.2-10	-
5.2-11	-
Table 5.2.1	-
Table 5.2.2	-
Table 5.2.3	-
Table 5.2.4	-
Table 5.2.5	-
Table 5.2.6	-
Table 5.2.7	-
Table 5.2.8	-
Table 5.2.9	-
Fig. 5.2-1	-
Fig. 5.2-2	-
Appendix A	
5.2A-1	-
5.2A-2	-
5.2A-3	-
5.2A-4	-
Table 5.2A.1	
Sht. 1	-
Sht. 2	-
Sht. 3	-
Fig. 5.2A-1	-
5.3-1	5
5.3-2	5
5.3-3	5
5.3-4	5
5.3-5	5
5.3-6	5
5.3-7	5
5.3-8	5
5.3-9	5
5.3-10	5
5.3-11	5
Table 5.3.1	7
Table 5.3.1a	5
Table 5.3.1b	5
Table 5.3.2	5
Table 5.3.3	5
Table 5.3.4	5
Table 5.3.5	5
Table 5.3.6	5
Appendix A	
5.3A-1	-

CHAPTER 5

PAGE REVISION INDEX (CONT'D)

Page	Amendment
5.4-1	-
Table 5.4.1	-
5.5-1	-
5.5-2	1
5.5-3	1
5.5-4	1
5.6-1	1
5.6-2	1
5.6-3	1
5.7-1	-
5.8-1	-
5.8-2	-

CHAPTER 6

PAGE REVISION INDEX

Page	Amendment
6-i	-
6-ii	-
6-iii	-
6-iv	-
6-v	-
6-vi	2
6-vii	2
6.1-1	-
6.1-2	-
6.1-3	-
6.1-4	-
6.1-5	-
6.1-6	-
6.1-7	-
6.1-8	-
6.1-9	-
6.1-10	-
6.1-11	8
6.1-12	8
6.1-13	8
6.1-13a	8
6.1-13b	8
6.1-14	-
6.1-15	-
6.1-16	-
6.1-17	-
6.1-18	-
6.1-19	-
6.1-20	5
6.1-21	5
6.1-22	5
6.1-23	5
6.1-24	-
6.1-25	-
6.1-26	-
6.1-27	-
6.1-28	2
6.1-29	8
6.1-30	2
6.1-31	2
6.1-32	2
Table 6.1.1	
Sht. 1	-
Sht. 2	-
Table 6.1.2	
Sht. 1	-
Sht. 2	-
Table 6.1.3	
Sht. 1	-
Sht. 2	-
Table 6.1.4	
Sht. 1	-
Sht. 2	-
Table 6.1.5	-
Table 6.1.6	-
Table 6.1.7	
Sht. 1	-
Sht. 2	-
Table 6.1.8	
Sht. 1	-
Sht. 2	-
Table 6.1.9	
Sht. 1	8
Sht. 2	8
Sht. 3	8
Table 6.1.10	-
Table 6.1.11	-
Table 6.1.12	-
Table 6.1.13	-
Table 6.1.14	-
Table 6.1.15	-
Table 6.1.16	-
Table 6.1.17	-
Table 6.1.18	-
Table 6.1.19	-
Table 6.1.20	-
Table 6.1.21	-
Table 6.1.22	-
Table 6.1.23	-
Table 6.1.24	-
Table 6.1.25	-
Table 6.1.26	-
Table 6.1.27	-
Table 6.1.28	-
Table 6.1.29	-
Table 6.1.30	
Sht. 1	-
Sht. 2	5
Table 6.1.31	5
Fig. 6.1-1	-
Fig. 6.1-2	-
Fig. 6.1-3	-
Fig. 6.1-4	-
Fig. 6.1-5	-
Fig. 6.1-6	-
6.2-1	-
6.3-1	-
6.4-1	2
Table 6.4.1	
Sht. 1	2
Sht. 2	2
Sht. 3	2
Table 6.4.2	2
Table 6.4.3	2
Table 6.4.4	2
Table 6.4.5	2
Table 6.4.6	2
Table 6.4.7	2
Table 6.4.8	2
Table 6.4.9	2
Table 6.4.10	2
Table 6.4.11	2
Table 6.4.12	2
Table 6.4.13	2
Table 6.4.14	2
Table 6.4.15	2
Table 6.4.16	2
Table 6.4.17	
Sht. 1	2
Sht. 2	2
Fig. 6.4-1	2
Fig. 6.4-2	2
Fig. 6.4-3	2

GG
ER

CHAPTER 7

PAGE REVISION INDEX

Page	Amendment
7-i	-
7-ii	-
7-iii	-
7.1-1	-
7.1-2	-
7.1-3	-
7.1-4	-
7.1-5	-
7.1-6	-
7.1-7	-
7.1-8	-
7.1-9	-
Table 7.1.1	-
Table 7.1.2	-
Table 7.1.3	-
Table 7.1.4	
Sht. 1	-
Sht. 2	-
Sht. 3	-
7.2-1	-
7.3-1	-
Table 7.3.1	-

GG
ER

CHAPTER 8

PAGE REVISION INDEX

Page	Amendment	Page	Amendment	Page	Amendment
8-i	1	8.1A-26	-	8.1A-71	-
8-ii	-	8.1A-27	-	8.1A-72	-
8-iii	-	8.1A-28	-	8.1A-73	-
8.1-1	-	8.1A-29	-	8.1A-74	-
8.1-2	1	8.1A-30	-	8.1A-75	-
8.1-3	5	8.1A-31	-	8.1A-76	-
8.1-4	5	8.1A-32	-	8.1A-77	-
8.1-5	1	8.1A-33	-	8.1A-78	-
8.1-6	1	8.1A-34	-	8.1A-79	-
8.1-7	1	8.1A-35	-	8.1A-80	-
8.1-8	1	8.1A-36	-	8.1A-81	-
8.1-9	1	8.1A-37	-	8.1A-82	-
8.1-10	1	8.1A-38	-	8.1A-83	-
Table 8.1.1	-	8.1A-39	-	8.1A-84	-
Table 8.1.2	-	8.1A-40	-	8.1A-85	-
Table 8.1.3	-	8.1A-41	-	8.1A-86	-
Table 8.1.4	-	8.1A-42	-	8.1A-87	-
Table 8.1.5	-	8.1A-43	-	8.2-1	-
Fig. 8.1-1	-	8.1A-44	-	8.2-2	-
Appendix A		8.1A-45	-		
8.1A-1	-	8.1A-46	-		
8.1A-2	-	8.1A-47	-		
8.1A-3	-	8.1A-48	-		
8.1A-4	-	8.1A-49	-		
8.1A-5	-	8.1A-50	-		
8.1A-6	-	8.1A-51	-		
8.1A-7	-	8.1A-52	-		
8.1A-8	5	8.1A-53	-		
8.1A-9	5	8.1A-54	-		
8.1A-10	-	8.1A-55	-		
8.1A-11	-	8.1A-56	-		
8.1A-12	-	8.1A-57	-		
8.1A-13	-	8.1A-58	-		
8.1A-14	-	8.1A-59	-		
8.1A-15	-	8.1A-60	-		
8.1A-16	-	8.1A-61	-		
8.1A-17	-	8.1A-62	-		
8.1A-18	-	8.1A-63	-		
8.1A-19	-	8.1A-64	-		
8.1A-20	-	8.1A-65	-		
8.1A-21	-	8.1A-66	-		
8.1A-22	-	8.1A-67	-		
8.1A-23	-	8.1A-68	-		
8.1A-24	-	8.1A-69	-		
8.1A-25	-	8.1A-70	-		

GG
ER

CHAPTER 9

PAGE REVISION INDEX

Page	Amendment
9-i	1
9-ii	-
9.1-1	-
9.2-1	-
9.2-2	1
9.2-3	1
9.2-4	-
9.2-5	-
Table 9.2.1	1
Table 9.2.2	-
9.3-1	1
9.3-2	1
Table 9.3.1	-
Table 9.3.2	1
9.4-1	-
Table 9.4.1	-
Table 9.4.2	-
Table 9.4.3	-
Table 9.4.4	-

GG
ER

CHAPTER 10

PAGE REVISION INDEX

Page	Amendment	Page	Amendment
10-i	-	Fig. 10.3-3	-
10-ii	-	Appendix A	
10-iii	-	10.3A-1	-
10-iv	-	10.3A-2	-
10-v	-	10.3A-3	-
10-vi	-	Table 10.3A-1	-
10.1-1	-	Table 10.3A-2	-
10.1-2	-	10.4-1	-
10.1-3	-	10.4-2	-
10.1-4	-	10.4-3	-
10.1-5	-	10.4-4	-
10.1-6	-	10.5-1	-
Table 10.1.1	-	10.5-2	-
Table 10.1.2		10.5-3	-
Sht. 1	-	10.5-4	-
Sht. 2	-	10.5-5	-
Sht. 3	-	10.5-6	-
Table 10.1.3	-	10.5-7	-
Table 10.1.4	-	Table 10.5.1	-
Fig. 10.1-1	-	10.6-1	-
Fig. 10.1-2	-	10.6-2	-
Fig. 10.1-3	-	10.6-3	-
Fig. 10.1-4	-	10.7-1	-
10.2-1	-	10.8-1	-
10.2-2	-	10.9-1	-
10.2-3	-	10.9-2	-
10.2-4	-	Table 10.9.1	-
10.2-5	-	Fig. 10.9-1	-
10.2-6	-	10.10-1	-
10.2-7	-		
Table 10.2.1	-		
Table 10.2.2	-		
Fig. 10.2-1	-		
Fig. 10.2-2	-		
Fig. 10.2-3	-		
Fig. 10.2-4	-		
10.3-1	-		
10.3-2	-		
10.3-3	-		
10.3-4	-		
10.3-5	-		
Table 10.3.1	-		
Table 10.3.2	-		
Fig. 10.3-1	-		
Fig. 10.3-2	-		

GG
ER

CHAPTER 11

PAGE REVISION INDEX

Page	Amendment
11-i	-
11-ii	-
11.1-1	1
11.1-2	-
11.2-1	-
11.2-2	-
Table 11.2.1	
Sht. 1	-
Sht. 2	-
Sht. 3	-
Sht. 4	-
Sht. 5	-
11.3-1	-

GG
ER

CHAPTER 12

PAGE REVISION INDEX

Page	Amendment
12-1	-
12.1-1	-
12.2-1	-
12.2-2	-
12.3-1	-
12.4-1	-
12.5-1	-
12.6-1	-
12.6-2	-
12.7-1	-

GG
ER

CHAPTER 13

PAGE REVISION INDEX

Page	Amendment
13-1	-
13-2	-
13-3	-
13-4	-
13-5	-
13-6	-
13-7	-
13-8	-
13-9	-
13-10	-
13-11	-
13-12	-
13-13	-
13-14	-
13-15	-
13-16	-
13-17	-
13-18	-
13-19	-
13-20	-
13-21	-
13-22	-
13-23	-
13-24	-
13-25	-
13-26	-
13-27	-
13-28	-

QUESTIONS AND RESPONSES

PAGE REVISION INDEX

Page	Amendment	Page	Amendment	Page	Amendment
Q&R 1.1-1	1	40	-	Location Map	-
Q&R 1.1-2	1	41	-	II-1 (001)	-
Fuel Estimating Program		Q&R 8.1-1	1	II-2 (001)	-
1	-	Q&R 1.1-3	1	II-3 (001)	-
2	-	Q&R 1.1-4	1	II-4 (001)	-
3	-	Q&R 8.1-2	1	II-5 (001)	-
4	-	Q&R 8.1-3	1	II-6 (001)	-
5	-	Q&R 4.1-1	1	II-7 (001)	-
6	-	Table 300.7.1		II-8 (001)	-
7	-	Sht. 1	1	II-9 (001)	-
8	-	Sht. 2	1	II-1 (002)	-
9	-	Sht. 3	1	II-2 (002)	-
10	-	Sht. 4	1	II-3 (002)	-
11	-	Sht. 5	1	II-4 (002)	-
12	-	Sht. 6	1	II-5 (002)	-
13	-	Sht. 7	1	II-6 (002)	-
14	-	Sht. 8	1	II-7 (002)	-
15	-	Q&R 3.9-1	1	II-8 (002)	-
16	-	Q&R 2.1-1	1	II-9 (002)	-
17	-	Q&R 2.2-1	1	II-1 (003)	-
18	-	Q&R 2.4-1	1	II-2 (003)	-
19	-	Q&R 3.3-1	1	II-3 (003)	-
20	-	Q&R 3.7-1	1	II-4 (003)	-
21	-	Q&R 5.1-1	1	II-5 (003)	-
22	-	Q&R 8.1-4	1	II-6 (003)	-
23	-	Q&R 1.1-5	1	II-7 (003)	-
24	-	Q&R 5.1-2	1	II-8 (003)	-
25	-	Q&R 2.2-2	1	II-9 (003)	-
26	-	Q&R 2.2-3	1	II-1 (004)	-
27	-	Q&R 3.6-1	1	II-2 (004)	-
28	-	Q&R 3.6-2	1	II-3 (004)	-
29	-	Q&R 4.2-1	1	II-4 (004)	-
30	-	Q&R 5.3-1	1	II-5 (004)	-
31	-	Q&R 5.6-1	1	II-6 (004)	-
32	-	Q&R 6.1-1	1	II-7 (004)	-
33	-	Q&R 12.2-1	1	II-8 (004)	-
34	-	Cover Letter		II-9 (004)	-
35	-	NPDES Permit Application	-	II-1 (005)	-
36	-	I-1	-	II-2 (005)	-
37	-	I-2	-	II-3 (005)	-
38	-	I-3	-	II-4 (005)	-
39	-	Fig. 3.3-1	-	II-5 (005)	-
				II-6 (005)	-
				II-7 (005)	-
				II-8 (005)	-

QUESTIONS AND RESPONSES

PAGE REVISION INDEX (CONT'D)

Page	Amendment	Page	Amendment	Page	Amendment
II-9 (005)	-	Q&R 2.4-5	3	Q&R 1.1-6	3
II-1 (006)	-	Q&R 11.1-1	3	Q&R 8.1-7	3
II-2 (006)	-	Q&R 11.1-2	3	Q&R 8.1-8	3
II-3 (006)	-	Q&R 4.1-2	3	Q&R 2.1-3	5
II-4 (006)	-	Q&R 4.2-3	3	Q&R 2.1-4	5
II-5 (006)	-	Q&R 5.5-3	3	Q&R 8.1-9	5
II-6 (006)	-	Q&R 5.3-2	5	Q&R 8.1-10	5
II-7 (006)	-	Q&R 5.3-3	5	Q&R 8.1-11	5
II-8 (006)	-	Table 1	-	Q&R 2.6-1	3
II-9 (006)	-	Table 2	-	Q&R 2.6-2	3
II-1 (007)	-	Table 3	-	Q&R 2.6-3	3
II-2 (007)	-	Fig. 1	-	Q&R 2.1-2	1
II-3 (007)	-	Q&R 12.2-2	5	Q&R 2.4-2	1
II-4 (007)	-	State of Mississippi		Q&R 2.4-3	1
II-5 (007)	-	Water Pollution		Q&R 3.3-2	1
II-6 (007)	-	Control Permit		Q&R 3.3-3	1
II-7 (007)	-	1	-	Q&R 3.3-4	1
II-8 (007)	-	2	-	Q&R 3.4-1	1
II-9 (007)	-	3	-	Q&R 2.4-10	5
II-1 (008)	-	4	-	Q&R 2.4-11	5
II-2 (008)	-	5	-	Q&R 2.4-12	5
II-3 (008)	-	6	-	Q&R 2.4-13	5
II-4 (008)	-	7	-	Q&P 2.4-14	5
II-5 (008)	-	8	-	Q&R 2.4-15	5
II-6 (008)	-	9	-	Q&R 2.4-16	5
II-7 (008)	-	10	-	Table 371.07.1	5
II-8 (008)	-	11	-	Table 371.07.2	
II-9 (008)	-	12	-	Sht. 1	5
II-1 (009)	-	13	-	Sht. 2	5
II-2 (009)	-	14	-	Sht. 3	5
II-3 (009)	-	15	-	Fig. 371.07-1	5
II-4 (009)	-	16	-	Fig. 371.07-2	5
II-5 (009)	-	17	-	Fig. 371.07-3	5
II-6 (009)	-	18	-	Fig. 371.07-4	5
II-7 (009)	-	19	-	Fig. 371.07-5	5
II-8 (009)	-	20	-	Fig. 371.07-6	5
II-9 (009)	-	21	-	Fig. 371.07-7	5
Q&R 3.6-3	3	Q&R 8.1-5	3	Fig. 371.07-8	5
Q&R 3.6-4	3	Q&R 8.1-6	3	Fig. 371.07-9	5
Q&R 2.2-4	3	Q&R 9.4-1	3	Fig. 371.07-10	5
Q&R 4.2-2	3	Q&R 9.4-2	3	Fig. 371.07-11	5
Q&R 5.5-1	3	Q&R 9.4-3	3	Appendix 317.07-A	
Q&R 5.5-2	3	Q&R 9.2-1	3	2.4C-1	-
Q&R 2.4-4	3			2.4C-2	-
Q&R 4.5-1	3				

QUESTIONS AND RESPONSES

PAGE REVISION INDEX (CONT'D)

Page	Amendment	Page	Amendment	Page	Amendment
2.4C-3	-	2.4C-48	-	2.4C-93	-
2.4C-4	-	2.4C-49	-	2.4C-94	-
2.4C-5	-	2.4C-50	-	2.4C-95	-
2.4C-6	-	2.4C-51	-	2.4C-96	-
2.4C-7	-	2.4C-52	-	2.4C-97	-
2.4C-8	-	2.4C-53	-	2.4C-98	-
2.4C-9	-	2.4C-54	-	2.4C-99	-
2.4C-10	-	2.4C-55	-	2.4C-100	-
2.4C-11	-	2.4C-56	-	2.4C-101	-
2.4C-12	-	2.4C-57	-	2.4C-102	-
2.4C-13	-	2.4C-58	-	2.4C-103	-
2.4C-14	-	2.4C-59	-	2.4C-104	-
2.4C-15	-	2.4C-60	-	2.4C-105	-
2.4C-16	-	2.4C-61	-	2.4C-106	-
2.4C-17	-	2.4C-62	-	2.4C-107	-
2.4C-18	-	2.4C-63	-	2.4C-108	-
2.4C-19	-	2.4C-64	-	2.4C-109	-
2.4C-20	-	2.4C-65	-	2.4C-110	-
2.4C-21	-	2.4C-66	-	2.4C-111	-
2.4C-22	-	2.4C-67	-	2.4C-112	-
2.4C-23	-	2.4C-68	-	2.4C-113	-
2.4C-24	-	2.4C-69	-	2.4C-114	-
2.4C-25	-	2.4C-70	-	2.4C-115	-
2.4C-26	-	2.4C-71	-	2.4C-116	-
2.4C-27	-	2.4C-72	-	2.4C-117	-
2.4C-28	-	2.4C-73	-	2.4C-118	-
2.4C-29	-	2.4C-74	-	2.4C-119	-
2.4C-30	-	2.4C-75	-	2.4C-120	-
2.4C-31	-	2.4C-76	-	2.4C-121	-
2.4C-32	-	2.4C-77	-	2.4C-122	-
2.4C-33	-	2.4C-78	-	2.4C-123	-
2.4C-34	-	2.4C-79	-	2.4C-124	-
2.4C-35	-	2.4C-80	-	Q&R 2.3-1	1
2.4C-36	-	2.4C-81	-	Q&R 2.3-2	1
2.4C-37	-	2.4C-82	-	Fig. 372.1-1	1
2.4C-38	-	2.4C-83	-	Fig. 372.1-2	1
2.4C-39	-	2.4C-84	-	Fig. 372.1-3	1
2.4C-40	-	2.4C-85	-	Fig. 372.1-4	1
2.4C-41	-	2.4C-86	-	Fig. 372.1-5	1
2.4C-42	-	2.4C-87	-	Q&R 2.3-3	1
2.4C-43	-	2.4C-88	-	Q&R 2.3-4	1
2.4C-44	-	2.4C-89	-	Fig. 372.2-1	1
2.4C-45	-	2.4C-90	-	Fig. 372.2-2	1
2.4C-46	-	2.4C-91	-	Q&R 2.3-5	1
2.4C-47	-	2.4C-92	-	Table 372.3.1	1

QUESTIONS AND RESPONSES

PAGE REVISION INDEX (CONT'D)

Page	Amendment	Page	Amendment
Q&R 5.2-1	1	Fig. 372.5-8	1
Q&R 5.2-2	1	Fig. 372.5-9	1
Q&R 5.2-3	1	Q&R 6.1-5	1
Q&R 6.1-2	1	Q&R 6.1-6	1
Q&R 6.1-3	1	Q&R 6.1-7	1
Q&R 6.1-4	1	Q&R 3.7-2	5
Table 372.5.1	1	Q&R 3.7-3	5
Table 372.5.2	1	Q&R 3.7-4	5
Table 372.5.3	1	Q&R 2.4-6	4
Table 372.5.4	1	Q&R 2.4-7	4
Table 372.5.5	1	Q&R 4.1-3	4
Table 372.5.6	1	Q&R 2.4-8	4
Table 372.5.7	1	Q&R 2.4-9	4
Table 372.5.8	1	Q&R 10.2-1	4
Table 372.5.9	1	Q&R 10.2-2	4
Table 372.5.10	1	Fig. 1	4
Table 372.5.11	1	Fig. 2	4
Table 372.5.12	1		
Table 372.5.13	1		
Table 372.5.14	1		
Table 372.5.15	1		
Table 372.5.16	1		
Table 372.5.17	1		
Table 372.5.18	1		
Table 372.5.19	1		
Table 372.5.20	1		
Table 372.5.21	1		
Table 372.5.22	1		
Table 372.5.23	1		
Table 372.5.24	1		
Table 372.5.25	1		
Table 372.5.26	1		
Table 372.5.27	1		
Table 372.5.28	1		
Table 372.5.29	1		
Table 372.5.30	1		
Table 372.5.31	1		
Fig. 372.5-1	1		
Fig. 372.5-2	1		
Fig. 372.5-3	1		
Fig. 372.5-4	1		
Fig. 372.5-5	1		
Fig. 372.5-6	1		
Fig. 372.5-7	1		

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CHAPTER 1.0

PURPOSE OF THE PROPOSED FACILITY AND ASSOCIATED TRANSMISSION

TABLE OF CONTENTS

		Page
1.1	SYSTEM DEMAND AND RELIABILITY	1.1-1
	1.1.1 The Middle South Utilities System	1.1-1
	1.1.2 Conservation Programs Within the Middle South Utilities System	1.1-3
	1.1.3 Load Characteristics	1.1-4
	1.1.3.1 Load Analysis	1.1-4
	1.1.3.1.1 Peak Demand	1.1-4
	1.1.3.1.2 Energy Requirements	1.1-4
	1.1.3.1.3 Energy and Demand Growth	1.1-5
	1.1.3.1.4 Load Factor	1.1-7
	1.1.3.2 Demand Projections	1.1-7a |1
	1.1.3.3 Power Exchanges	1.1-9
	1.1.4 System Capacity	1.1-9
	1.1.5 Reserve Margin	1.1-11
	1.1.6 External Supporting Studies	1.1-14
	1.1.7 References	1.1-14
	Appendix A - Reports to Federal Power Commission	1.1A-1
1.2	OTHER OBJECTIVES	1.2-1
1.3	CONSEQUENCES OF DELAY	1.3-1

LIST OF TABLES

Table No.	Title
1.1.1	Middle South Utilities System Actual Annual Peak Load
1.1.2	Middle South Utilities System Projected Annual Peak Load
1.1.3	Middle South Utilities System Annual Energy
1.1.4	Middle South Utilities System Annual Energy Estimates 1978-1988 |1
1.1.5	Middle South Utilities System Energy Sales
1.1.6	Middle South Utilities System Peak Load
1.1.7	Middle South Utilities System Actual Energy Sales
1.1.8	Middle South Utilities System Forecast Energy Sales
1.1.9	Middle South Utilities System Net Energy For Load
1.1.10	Middle South Utilities System Power Exchanges at Time of Annual Peak Demand
1.1.11	Middle South Utilities System Generating Stations
1.1.12	Middle South Utilities System Load and Capability Forecast
1.1.13	Middle South Utilities System Unit Capabilities in MW
1.1.14	Middle South Utilities System Actual Load and Capability (Summary - 1972 through 1978) |1
1.1.15	Middle South Utilities System Load and Capability Forecast (Summary 1979 through 1993) |1

LIST OF TABLES (Cont.)

Table No.	Title	
1.1.16	Southwest Power Pool Analysis of Predicted Capability Load vs Actual - Summer Peak Period	
1.1.17	Southwest Power Pool Estimated Resources, Demand and Margin for the 1 to 10 Year Period	
1.1.18	Mississippi Power and Light Company - Economic Model - Historical Annual Values of Forecasted Variables - 1960 to 1976 (Sheets 1 through 3)	1
1.1.19	Mississippi Power and Light Company - Economic Model - Annual Values of Forecasted Variables - 1977 to 1990 (Sheets 1 and 2)	
1.3.1	Capability Reserve Margin with Assumed Delay of Grand Gulf Unit 1 (1250 MW)	
1.3.2	Capability Reserve Margin with Assumed Delay of Grand Gulf Unit 2 (1250 MW)	

LIST OF FIGURES

Figure No.	Title
1.1-1	National Electric Reliability Council Regions
1.1-2	The Middle South Utilities System
1.1-3	Middle South Utilities System - Actual and Forecast Annual Peak Load
1.1-4	Middle South Utilities System - Actual and Forecast Annual Energy Consumption
1.1-5	Middle South Utilities System - Load Duration Curves 1981 - 1986
1.1-6	Middle South Utilities System Actual and Forecast Annual Peak and Energy

CHAPTER 1.0 PURPOSE OF THE PROPOSED FACILITY AND ASSOCIATED TRANSMISSION

1.1 SYSTEM DEMAND AND RELIABILITY

1.1.1 The Middle South Utilities System

Mississippi Power & Light Company is one of five operating companies of the Middle South Utilities (MSU) System. The MSU System provides electric service to customers in portions of Missouri, Arkansas, Mississippi, and Louisiana. The MSU System functions in a manner that provides the advantages of a power pool for each of its five operating company members. Planning for the development and operation of its generation and major transmission facilities is done on a system-wide basis. This enables the MSU System to supply the combined electric load of its customers more efficiently, economically, and reliably than if each company planned and operated solely on its own. Since power planning is based on the bulk power system, the purpose of Grand Gulf Nuclear Station Units 1 and 2 and its associated transmission is discussed in terms of the MSU System.

The MSU System is a part of the Southwest Power Pool (SPP), one of nine regional reliability councils that constitute the National Electric Reliability Council (NERC). The SPP provides electric service to loads in Kansas, Oklahoma, Arkansas, and Louisiana and in parts of New Mexico, Texas, Missouri, and Mississippi. There are 37 member systems in the SPP. Four of the systems are members of both Mid-America Interpool Network (MAIN) and SPP and report their resource data to MAIN for inclusion in its response to FPC Order 383-3. The SPP response to Order 383-3, therefore, includes resource data from 33 of its 37 member systems and, in addition, includes data from five small non-member municipalities and 10 other non-member systems, each with 25 MW or more of generating capacity. In all, 46 interconnected systems within the SPP region are included in the SPP response to FPC Order 383-3. Figure 1.1-1 shows the region included within the SPP and its relationship to the other NERC regions.

There were 1,433,130 retail and 166 wholesale electric customers being served by the MSU System at the end of 1977. Power for the MSU System load was generated by 65 generating units at 24 generating stations. The generating stations were interconnected by an extensive transmission network to 869 substations. By the end of 1977, there were 9477 pole miles of transmission at all voltages, including 993 miles operating at 500 kV. In addition, there were 57 transmission ties between the MSU System and neighboring utility systems. Customer load was distributed from the transmission substations via an extensive distribution system that included 63,020 miles of distribution feeders. Figure 1.1-2 shows the MSU System bulk power

generation, transmission and substation facilities, and transmission interconnections as they existed January 1, 1978.

It is anticipated that by 1981, when the first unit of Grand Gulf Nuclear Station is scheduled to begin operations, the annual peak electrical load of the MSU System will have increased to 13,249 MW; its energy requirements will have increased to 67,669,930 MWh; and its net usable owned capacity will have increased to 14,120 MW. Compared to 1976, this will represent a 3904 MW increase in peak load and a 2919 MW increase in net usable owned capacity. The energy increase will be 21,899,168 MWh, about 48 percent greater than the 1976 comsumption. Taking into account leased capacity, in addition to firm purchases and sales, total capability will exceed load responsibility by 2660 MW. The 1250 MW unit represents 30 percent of the capacity additions planned through 1981 and 47 percent of the MSU System's reserve capacity at the time of its first peak load season.

It is anticipated that by 1984, when the second unit of Grand Gulf Nuclear Station is scheduled to begin operation, the annual peak electrical load of the MSU System will have increased to 16,345 MW; its energy requirements will have increased to 83,945,737 MWh; and its net usable owned capacity will have increased to 17,084 MW. Compared to 1976, this will represent a 7000 MW increase in peak load and a 5883 MW increase in net usable owned capacity. The energy increase will be 38,174,975 MWh, about 83 percent greater than the 1976 consumption. Taking into account leased capacity, in addition to firm purchases and sales, total capability will exceed load responsibility by 2584 MW. The 1250 MW unit represents 20 percent of the capacity additions planned through 1984 and 48 percent of the MSU System's reserve capacity at the time of its first peak load season.

By 1981, it is anticipated that the net usable owned capability in the SPP will be 57,216 MW. Taking into account all scheduled imports and exports, the total available capability will be 57,786 MW. The expected peak demand during this period will be 47,083 MW, and the margin of total available capability over peak demand will be 10,634 MW. Compared to 1976, peak demand will have increased 13,319 MW, and net usable owned capability will have increased 15,202 MW. The first generating unit at Grand Gulf Nuclear Station will represent 8.2 percent of the SPP's capacity increase and over 11.7 percent of the reserve margin at the time of the 1981 summer peak.

By 1984, it is anticipated that the net usable owned capability in the SPP will be 68,706 MW. Taking into account all scheduled imports and exports, the total available capability will be 69,786 MW. The expected peak demand during this period will be 56,357 MW, and the margin of total available capability over peak demand will be 13,370 MW. Compared to 1976, peak demand will

have increased 22,593 MW, and net usable owned capability will have increased 26,692 MW. The second generating unit at Grand Gulf Nuclear Station will represent 4.7 percent of the SPP's capacity increase and over 9.4 percent of the reserve margin at the time of the 1984 summer peak. 1

1.1.2 Conservation Programs Within the Middle South Utilities System

In the area of energy conservation, the five operating companies of the MSU System have embarked on a number of programs involving: advertising campaigns, innovative rate designs, load management techniques, and promotion of energy saving construction methods, among others. Advertising campaigns educating consumers in the wise and efficient use of electricity have been initiated. Topics of such campaigns include: the electric heat pump, guides to selecting efficient air conditioning units, energy usage associated with home thermostat settings, benefits of proper insulation, and others.

Many of the companies are participating in "zip up" energy conservation programs that assist consumers in improving the energy efficiency of their homes. To participate in this program, a homeowner fills out a questionnaire concerning his house characteristics and energy usage. The company then analyzes the answers with the aid of a computer and provides the homeowner with methods in which he can reduce energy consumption in his home (e.g., add insulation; install double glazed windows; etc.). Ranges of costs and savings associated with implementing these energy saving features are also provided, thus furnishing the customer with the expected pay-back period for the various recommended improvements.

The development of an Energy Efficient Electric Home was undertaken by MSU System personnel, in conjunction with architects, builders, government agencies, and universities. Construction methods were developed that can save a homeowner up to 65 percent in electric energy costs. Manuals were prepared describing the methods used in constructing such a home, and these have been distributed to the construction industry.

Two of the MSU System companies, Arkansas Power & Light Company and Mississippi Power & Light Company, are experimenting with management of the residential air conditioner load. During peak periods, air conditioning compressors are remotely shut off for short periods of time in order to reduce peak demand. To date, Arkansas Power & Light Company has filed a special rate for any residential customer wishing this type of service. Mississippi Power & Light Company is still conducting the experiment.

Other forms of load management have been proposed or experimented with. These include: time-of-day rates, seasonal rates, and storage cooling. By 1985, it is hoped that these and other load

management techniques will significantly affect the MSU System peak and load factor.

1.1.3 Load Characteristics

1.1.3.1 Load Analysis

1.1.3.1.1 Peak Demand

The MSU System has, for many years, experienced its annual peak demand in the summer. The annual peak of each of its operating companies occurs during the 4-month summer period, starting with June and extending through September, with the majority of these peaks occurring either in July or August. A second peak, not as clearly defined, and usually only 65 to 70 percent of the summer peak occurs in the December - January period.

In 1975, for the first time in 20 years, the annual peak occurred in early September. This late peak is not attributed to changes in load characteristics. Instead, it is felt that unusual weather conditions that were fairly widespread throughout the MSU System service area prevented the peak from occurring in July or August and caused it, instead, although lower than predicted, to occur in September. In 1976, 1977, and 1978, weather conditions returned more nearly to normal, and the annual peaks occurred in July and August, respectively. | 1

The companies normally reach their summer annual peak load demand at nearly, but not exactly, the same time. The MSU System peak that results is, therefore, somewhat lower than the non-coincident peak, the sum of the individual company peaks. The diversity factor is generally very close to 99 percent, indicating relatively slight diversity.

The past annual peak load demands of the MSU System operating companies, and of the entire MSU System, are shown on Table 1.1.1 for the period 1965 through 1978. Forecasted annual peak load demands are shown on Table 1.1.2 for 1979 through 1993. | 1

1.1.3.1.2 Energy Requirements

Annual energy consumption is the sum of monthly energy requirements. The minimum monthly energy requirement most often occurs in February and is on the order of 6.5 to 7.0 percent of the annual requirement. There normally follows a gradual increase in monthly consumption, with the maximum usage occurring in July and August. During each of these 2 months, 10.5 to 11.0 percent of the MSU System's annual energy is consumed. This maximum usage period is then followed by gradually decreasing consumption to the following February.

The MSU System's energy consumption includes sales to ultimate customers, sales at wholesale for resale, energy for company use,

and lost or unaccounted for energy. The latter category includes transmission and distribution system losses and, generally, is on the order of 7 to 8 percent of the total of net generation and the net of interchange purchases and sales. Power plant auxiliary usage consumes another 4 to 5 percent of total energy.

The past annual energy requirements of each of the operating companies, and of the entire MSU System, for the period 1965 through 1977 are shown on Table 1.1.3. The energy requirements are shown as "Net Energy for System Load," "Sales for Resale in Area," and "Net Energy for Area Load." Forecasted MSU System energy consumption for 1978 through 1988, equivalent to "Net Energy for Area Load," is shown on Table 1.1.4.

In all categories tabulated on Tables 1.1.3 and 1.1.4, the energy requirements include, in addition to energy sales, energy for company use, losses, and unaccounted for energy. "Net Energy for System Load" refers to usage and losses associated with the MSU System's ultimate customers. "Net Energy for Area Load" includes all energy utilized in the area, including that for customers supplied at wholesale. "Net Energy for Area Load" is the sum of "Net Energy for System Load" and "Sales for Resale in Area."

The composition of energy sales by customer class is shown on Table 1.1.5. Sales to ultimate customers are separated into residential, commercial, industrial, and governmental classes. Sales for resale account for the remainder of sales. Sales for resale, in this tabulation, are a combination of sales at wholesale for resale and consumption within the service area, and sales to other utilities for resale and consumption outside the service area.

1.1.3.1.3 Energy and Demand Growth

During the period following World War II, the nation's electric utility industry experienced steady electrical load growth. By 1973, however, there began a general awakening to the growing energy crisis and fuel shortage. This awakening had comparatively little effect on the 1973 electrical load, but in the next 2 years, the effect was severe. Essentially no growth was experienced in electrical load during 1974 or 1975 in most areas of the nation, including the area served by the MSU System.

The fuel situation worsened considerably in 1973 when interstate pipeline companies failed to deliver natural gas in quantities called for by long-term contracts. As a result, a shift to available alternate fuels began. For predominately gas-burning utilities, such as the operating companies of the MSU System, the shift was to larger and larger quantities of oil. The oil embargo and resulting oil shortage during this same period greatly increased oil prices, and in turn, greatly increased electricity prices. The net result, including the effect of conscious customer efforts at energy conservation and a poor

economic climate in general, was a period of no electrical load growth.

Fuel costs and fuel availability, construction lead times and construction costs, interest rates, inflation, and other factors that increased electricity prices, and consequently decreased load growth, appear to be beginning to stabilize. If so, once again, a stable pattern of load growth can be expected to emerge. However, new growth rates of both peak load and energy that differ from previously experienced trends are expected, and somewhat lessened electrical load growth rates are now being forecast.

Growth rates in the MSU System service area and, in fact, in the surrounding region, have in the past exceeded the rate of growth experienced by the United States as a whole. Growth trends exhibited by the MSU System, as compared to those of the continental United States during the 8-year period beginning with 1965, are illustrated by the following:

	1965	1973	Increase (Percent)	Rate (Percent)
Total Electric Utility Industry: (Ref. 1)				
Installed Capacity (MW)	228,900	415,500	81.5	7.7
Annual Peak (MW)	186,300	343,900	84.6	8.0
Elec. Energy Output (kWh x 10^6)	1,060,100	1,868,800	76.3	7.3
Ultimate Customers (x 10^3)	65,600	78,500	19.7	2.3
Middle South Utilities System:				
Installed Capacity (MW)	3,621	9,141	152	12.3
Annual Peak (MW)	3,762	7,972	112	9.8
Elec. Energy Output (kWh x 10^6)	18,538	40,025	116	10.1
Ultimate Customers (x 10^3)	1,017	1,309	28.7	3.2

Peak load grew in the MSU System area, between 1965 and 1973, at an average rate of 9.8 percent per year, while for the United States, it grew at an 8.0 percent rate during the same period. Energy output grew at a 10.1 percent rate in the MSU System area, while it was growing at a 7.3 percent rate in the United States as a whole. Thus, peak load and energy increased at rates of 1.8 percent and 2.8 percent faster in the MSU System area than in the United States in this time period. 1

Between 1973 and 1977, peak load grew in the MSU System area at an average rate of 5.2 percent per year, while for the United States, it grew at an average rate of 3.5 percent per year. The diminished growth rates for both the United States and MSU between 1973 and 1977 reflect the "no-growth" pattern of 1974 and 1975. However, it is apparent that electrical load is still growing at a faster rate for the MSU System compared to the total United States. 1

To better visualize the relationships between current forecasts and actual experience, both for damand and energy requirements, MSU System demands are plotted in Figure 1.1-3 and energy requirements in Figure 1.1-4. These curves clearly illustrate the "no-growth" 1974 and 1975 period in which energy growth was practically nil in both years, while peak load grew slightly in 1974 and declined slightly in 1975. Additionally, the 1973 peak, probably largely due to weather, was below what would normally be expected. The small apparent growth in 1974 would have appeared even smaller had 1973 been a normal weather year.

In 1976, demand trends, especially in the industrial sector, returned to a more normal pattern. As a result, peak demand and energy requirements increased at rates comparable to those experienced before the "no-growth" period. Peak load increased 9.9 percent, while energy requirements increased 12.1 percent.

In 1977, peak demand increased 4.7 percent. Although this is only one-half of the increase experienced in 1976, a general strengthening of economic activity is still indicated. Much of this reduction in peak demand growth is due to the fact that while 1976 is being compared to a year of relatively poor economic activity, 1977 is being compared to a year of more "normal" activity. Even though peak demand growth was cut in half for 1977, the increase in energy requirements for 1977, 11.6 percent, is not unlike that experienced in 1976. 1

In 1978 peak demand increased 8.9 percent, indicating a continuing strengthening of economic activity. Energy requirements are expected to increase at 8.0 percent. 1

A discussion of projected peak demand and energy growth is contained in subsection 1.1.3.2.

1.1.3.1.4 Load Factor

Based upon current projections of annual peak load and energy consumption for the 1981 through 1983 period, it is expected that the annual MSU System load factor will be very nearly 58 percent. 1 Similar data for the 1984 through 1986 period yields an annual load factor of about 59 percent. 1 In Figure 1.1-5, load duration curves that are typical for the MSU System, and would yield annual load factors of 58 percent and 59 percent, are shown. 1

1.1.3.2 Demand Projections

Annual peak load and energy consumption are independently forecast by each of the five operating companies. Traditionally, these forecasts were primarily based on historical data, with modifications for any major new loads and weather normalization. However, in the past few years, it has been found that historical trends are no longer as good indicators of future trends as they were in the past.

Recognizing the importance of more accurate peak load and energy forecasts, the MSU System has developed, along with a consultant-Data Resources, Inc., sophisticated econometric models for this very purpose.

The forecasting methodology in use employs the use of multiple-equation regression models that yield quantitative estimates of the likelihood of future events based on detailed past and current information. An illustration of regression analysis is that one is making inferences about a variable based upon information about separate and distinct variables.

The economic growth and the use of energy are rigidly tied together. To plan for future energy needs, one must closely examine the underlying economic forces which create energy demands. After careful consideration of the determinants for energy growth invarious economic sectors, an econometric model can be developed. The model then captures the crucial linkages between the sector's activity and the kilowatt-hour sales, providing the user with a structural framework for forecasting. The model produces a forecast of sales for each of the sectors consistent with an economic outlook.

In arriving at a forecast, the model utilizes information and forecasts of the U.S. Economy, the National Energy Market, the Service Area Economy, Local Weather Conditions, and even Company Policy.

Since the economic fortune of the service area depends on the economic fortunes of the U.S. Economy, the starting input is a macroeconomic forecast of the U.S. Economy. This forecast is used as input to the service area model to produce a forecast of the energy sales. In the economic sector, the five major areas of analysis are employment growth in both manufacturing and non-manufacturing, inflation rates of wages and prices, growth in income, changing demographics with respect to both population growth and changing age makeup, and housing activity. These five areas are highly interdependent. Annual values of historical and forecasted variables are shown in Tables 1.1.18 through 1.1.22.

Nonprice conservation was addressed in several sectors of the forecasting models but only "held in" or proved significant in but a few pieces of the model. This variable was looked at during the 1973-74 timeframe, when the other variables could not satisfactorily explain the decrease in energy usage. However, this conservation did not persist and was not anticipated to continue in the forecast.

Price-related conservation, being a much more realizable variable, was most often significant in history and could be included in the forecast period.

The substitution of electricity for other fuels, as well as labor, was addressed in the forecasting models. For example, in the industrial sector, electricity is primarily a factor input to production. Consequently, the modeling approach was to prove that there is a proportional relationship between production and consumption. Realizing that this relationship changes over time, due to numerous things such as fuel or labor substitution, additional predictors were included to represent these effects. The relative price of electricity to alternate fuels was included to capture the consumer's ability to choose between alternate fuels or labor (wages) as a substitution for electricity.

Substitution of solar energy for electricity was not included into the forecasting methodology, since there had been no history of solar substitution.

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Figure 1.1-6 is a plot of "Actual and Forecast Annual Peak and Energy" for the MSU System. The plot is on semi-logarithmic paper, so that an exponential growth trend appears and can be plotted as a straight line. The historical growth experienced prior to 1974 has been extended on the figure to illustrate the decreased growth rates of both peak and energy that are now projected.

It is not anticipated that growth rates of either peak load or energy will return to their previous values during the current forecast period. It is anticipated, though, that the growth rates in the MSU System service area will be somewhat greater than average United States electric utility growth rates. From 1979 through 1993, peak load is expected to increase at approximately 6.1 percent per year, 3.7 percent slower than it increased between 1965 and 1973. Through 1988, energy consumption of the MSU System is expected to increase at 6.9 percent per year. This represents a 3.2 percent per year decrease in the energy growth rate experienced through 1973. |1 |1

Monthly data showing actual MSU System peak demand and forecast MSU System peak demand are tabulated on Table 1.1.6. The peak forecast is made on an annual basis only, and the historical relationship of monthly to annual peaks was used to establish monthly peak forecasts. During the period covered by Table 1.1.6, there were numerous instances of the peak forecast of one or more of the operating companies being adjusted. An (*) by the forecast figure indicates the start of monthly peaks based upon a revised MSU System annual peak.

Monthly data showing actual MSU System energy sales are tabulated on Table 1.1.7, and forecast system energy sales are tabulated on Table 1.1.8. The sales are broken down into those to Ultimate Customers and those to Public Utilities. The latter are sales for resale, some to customers in the service area, some to customers out of the area. These two tables of energy sales show energy as billed, as opposed to how it is actually consumed by the MSU System. Table 1.1.9 shows the latter and also includes the energy for losses, MSU System use, and unaccounted for energy.

Reports were supplied to the FPC, in accordance with FPC Order 496, by each of the MSU System's five operating companies.

A copy of each company's report is included in Appendix A to this section.

1.1.3.3 Power Exchanges

Past and projected net power exchanges at the time of the annual MSU System peak demand are shown on Table 1.1.10. The total exchange power received, sent out, and the resulting net exchange power are tabulated.

The historical data shows that, since 1965, the MSU System's power exchange at the time of the annual peak has almost always resulted in a substantial net input to the MSU System. (Only during 1968 and 1976, was this not the case.) The forecast power exchanges show that a substantial net input is also expected in future years.

In this tabulation, the total power received is the result of combining all inputs to the MSU System, exclusive of those from owned capability. These power inputs include purchases from other utilities with and without reserves, diversity exchanges, energy payback transactions, and leased capacity.

In actual planning of the MSU System, these transactions are not considered or handled in this manner. Instead, those exchanges that are not backed up by capacity reserves, for example, a leased unit, are netted with MSU System owned capability. The result is considered "total capability." Those exchanges that are backed up with capacity reserves are netted with the MSU System load, the result determining "load responsibility."

1.1.4 System Capacity

The operating companies of the MSU System observe and subscribe to "Reliability Criteria for the Planning, Operation, and Design of the Middle South Utilities System." These criteria include sections on "Principles of Generation Planning" and "Principles of Transmission Planning."

The systems of the SPP, similarly, observe and subscribe to certain minimum planning criteria, as set forth in "Southwest Power Pool Planning Criteria Guide I." This criteria, too, includes sections on "Principles of Generation Planning" and "Principles of Transmission Planning."

Historically, capacity additions to the MSU System have been planned and scheduled to maintain a minimum margin of reserves over load responsibility equal to the largest of either 16 percent of the annual peak load responsibility or the sum of the capability of the largest generating unit and one-half of the capability of the next largest unit. These criteria for capacity additions are unchanged.

The assurance of having adequate generating capacity depends, in part, on the availability of an adequate and reliable fuel supply. This, too, is covered by both the MSU System and the SPP criteria previously referred to. Recent developments have clearly established that neither gas nor oil can or should be counted on as reliable and assured fuel for future base load units. Only coal and nuclear fuels appear as reasonable alternatives for fueling future base load units, and present plans are based upon these two fuels.

The capabilities of existing MSU System plants, plant type, and location are shown on Table 1.1.11. These capabilities are based upon unlimited availability of each unit's primary fuel. Capacity additions and retirements that are planned through 1993 are shown on Table 1.1.12. 1

MSU System and SPP capabilities, both existing and planned, at the time of the annual peak demand are tabulated in Tables 1.1.14 through 1.1.17. While MSU System data for the period 1972 through 1993 is shown, SPP data is shown for the 1971 through 1987 period. 1

Table 1.1.13 shows the capabilities of existing units and unit additions planned through 1981. Each unit's fuel type and its capability on each of its fuels are listed. Also, its assumed dependable capability during each month of the year is shown. In the case of gas units capable of burning oil as an alternate fuel, the dependable capability takes into consideration the effect of assumed gas curtailment and substitution of fuel oil.

Categorization of generating units, as to function, is to some extent an arbitrary determination, at least as far as base load and intermediate categories are concerned. All such units on the MSU System were purchased originally for base load operation. As newer base load units are added, the capacity factor of older, less efficient units declines, and ultimately, within their capabilities to operate, these units are cycled, their capacity factor continuing to decline, until eventually they reach retirement age.

The gas turbine units, the diesel unit, and the relatively small amount of hydro capacity can be categorized as peaking capacity. By year-end 1977, this amounted to 400 MW of capacity. 1

The nuclear units, in-service and planned, are definitely intended for base load operation, as are future coal units. Similarly, it is likely that existing units in the 500 MW and 750 MW classes should be considered as base load units. There are, at present, five units rated at close to 500 MW each and three rated close to 750 MW each. These units, plus the two 411 MW Waterford units, comprise the base load capacity of the MSU System.

As time progresses, some of the above base load units will operate at declining capacity factors and will ultimately be considered as intermediate type units, to the extent that they are capable of operating in cycling duty. All of the other units, those below 500 MW in capacity (except Waterford No. 1 and No. 2), should presently be considered as intermediate type units.

1.1.5 Reserve Margin

A system's reserve margin is the excess of its total capability over its load responsibility. Its total capability is the sum of the capability of each of its installed units, plus its non-firm purchases, minus its non-firm sales. Its load responsibility is the sum of its peak load and firm sales, less its firm purchases. Non-firm, in the sense used here, refers to transactions that do not include reserves. That is, the selling party does not provide reserves that would normally be associated with a load of the magnitude of the transaction. Firm, in the sense used here, refers to transactions that do include reserves provided by the selling party. An example of a non-firm transaction is the lease of all or part of a specific unit, in which the capacity included in the transaction is available only when the leased unit is actually in operation.

"Reliability Criteria for the Planning, Operation, and Design of the Middle South Utilities System," as mentioned earlier, includes principles for planning generating capacity additions, including the following:

Planning of capacity additions must provide that the total generating capacity available to the MSU System be such as to exceed the predicted annual peak load responsibility by an amount equal to the largest of:

a. 16 percent of the annual peak load responsibility, or

b. the sum of the capability of the largest generating unit and one-half of the capability of the next larger unit.

Reserve margin is the excess of capability over load. Load forecast error and equipment forced outages are to be expected, as has been amply demonstrated by history. So, a reserve margin must be provided that is sufficient to increase to acceptable levels the probability that load will be supplied on a continuous basis.

For practical purposes, there is only one way that capability can unintentionally and unexpectedly be changed, and that is downward. It can be and is decreased almost continuously to values below its maximum value by total or partial unit forced outages. Load responsibility, on the other hand, is subject to

variation in either direction as a result of peak load forecast error. The net result is that reserve margin may increase only because of too high a load estimate, but it may decrease, or disappear altogether, because of either too low a load forecast or excessive forced capacity outages, or both.

The criteria that have been established for planning generation additions are based upon historical experience. Reserves have been provided on the MSU System, as called for by the criteria, and history has demonstrated that the reliability of the bulk power system has been adequate but not excessive. Consequently, it has been concluded that it is desirable, from a reliability viewpoint, to provide reserves in the future that are equivalent to those planned in the past.

The loss of load probability method (LOLP) is a method for calculating the number of occurrences of load exceeding capacity. Actually, the number of occurrences in which reserve capacity is zero or less is calculated. The name given this widely-known technique is unfortunate, in that it implies that load will be dropped. Such is not necessarily the case, however, since it is likely that resources not included in the calculation are available and can be called upon. External capacity available through interconnections is an example.

The LOLP method is not generally used or thought of as an absolute measure of reliability. It is, instead, used as a method of comparing alternate plans. It permits the formulation of plans that are equivalent from a reliability viewpoint, so that more logical and meaningful economic comparisons of the plans can be made.

Interconnections and their effects on reliability are not normally included in LOLP studies. It is assumed that emergency import capability provided by the MSU System's interconnections, while certainly beneficial, would be essentially the same and equally beneficial in any and all generation expansion plans considered for any given point in time. While interconnections are not normally included in LOLP studies made for comparison of capacity addition plans, the MSU System's criteria does state that "...there shall be no greater dependence upon interconnections with adjacent areas than is agreed to by said areas or is deemed prudent by good engineering judgement."

Interconnections are not included as capacity in studies of capacity additions, simply because interconnections are not capacity and cannot be substituted for it. If excess capacity is available within the interconnected system, then interconnections can provide immediate emergency assistance to the extent of their transfer capabilities and to the extent of the excess capacity online. Also, in the event that the emergency is prolonged, interconnections afford the opportunity to negotiate for and

schedule capacity and energy that will be available as excess during the expected emergency period.

The transmission system, including interconnections and internal transmission, must be planned to handle all normally scheduled transactions and, additionally, to simultaneously handle any except the less probable transmission and/or generation contingencies that might occur. Interchange capability in excess of normal transactions, sometimes referred to as the MSU System's incremental transfer capability, should be capable of importing power at least equal to the maximum planned-for capability outage that might occur within the MSU System. Also, this incremental capability should permit exporting any excess generating capability the MSU System might have available at the time of an emergency external to the MSU System. It is felt that the MSU System's transmission capabilities will exceed these requirements during the time period being considered.

Table 1.1.14 is a summary of the MSU System actual load and capability for the 1972 through 1978 period, while Table 1.1.15 contains similar forecast information for the 1979 through 1993 period. Both summaries show the load and capability situation for the MSU System at the time of annual peak demand. The forecast information includes the capacity additions and retirements shown in Table 1.1.12 and the annual peak load demand shown in Table 1.1.2. Tables 1.1.16 and 1.1.17 contain similar information for the SPP during the 1971 through 1987 period. 1

These summaries indicate that in 1981, with the inclusion of Grand Gulf Unit 1, the MSU System will have reserves of 2660 MW, and the SPP will have reserves of 10,634 MW. Without Grand Gulf Unit 1, the MSU System would have only 1410 MW of reserves, 11 percent of load responsibility, and the SPP would have 9304 MW of reserves, 19.9 percent of demand requirements. Table 1.3.1 gives the MSU System and SPP reserves through 1983 without Grand Gulf Unit 1. 1

In 1984, with the inclusion of Grand Gulf Unit 2, the summaries indicate that the MSU System will have reserves of 2584 MW, and the SPP will have reserves of 13,370 MW. Without Grand Gulf Unit 2, the MSU System would have reserves of only 1334 MW, 8.4 percent of load responsibility, and the SPP would have reserves of 12,120 MW, 21.5 percent of demand requirements. Table 1.3.2 gives the MSU System and SPP reserves through 1986 without Grand Gulf Unit 2. 1

Generation maintenance throughout the MSU System is scheduled with the intent of levelizing reserve margins at more or less a constant percentage of load responsibility each week during the maintenance season, September 16 through May 14. No maintenance is scheduled during the peak demand season, May 15 through September 15.

Unexpected forced outages cause the maintenance schedule to be constantly revised. Many times, an outage on one unit will prevent others from coming off for maintenance because of reserve requirement limitations. In some instances, when a unit is forced out, maintenance work planned for later in the year is done ahead of schedule, since the generator is out of service anyway.

1.1.6 External Supporting Studies

The "Southwest Power Pool Planning Criteria Guide 2" is included in its entirety in the annual report by the SPP to FPC under Order 383-3. The criteria states in part that, with respect to generating capacity additions, "...Generating capacity available to each Group in the Southwest Power Pool shall be such that the capacity available shall exceed the predicted annual peak load obligation by a margin of 15 percent, or as an alternative, a probability study made so as to ensure that the probability of load exceeding capacity available to such Group shall not be greater than one occurrence in ten years, provided that in no case shall the reserve be less than the peak load obligation by 12 percent."

Formal studies concerning the adequacy of the MSU System's reserve capacity have not been necessary, since the criteria of the MSU System is more demanding with respect to reserve capacity than is the criteria of the SPP. Even though financial considerations have caused the MSU System to delay, and in certain instances to cancel, previously planned capacity additions, reserve capacity planned for the year of initial operation of Grand Gulf Unit 2, 1984, is 16.2 percent of load responsibility, which exceeds the 15 percent minimum reserve required by the SPP. If only this minimum reserve requirement were satisfied, the MSU System would need reserves of 2396 MW, instead of the 2584 MW presently planned. In either case, Grand Gulf Unit 2 is crucial to the MSU System's reliability, since it accounts for almost 50 percent of the reserve margin. |1 |1 |1

In 1984, the planned reserve margin for the SPP is 23.7 percent of demand requirements. (Demand requirements are usually higher than the peak load obligation mentioned in the Southwest Power Pool Planning Criteria. Therefore, these are conservative estimates.) If only the minimum reserve requirement were satisfied, the SPP would need reserves of 8454 MW, instead of the 13,370 MW presently planned. |1 |1

1.1.7 References

1. "EEI Statistical Year Book of the Electrical Utility Industry for 1973."

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TABLE 1.1.1

MIDDLE SOUTH UTILITIES SYSTEM

ACTUAL ANNUAL PEAK LOAD (MW)

COMPANY	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
ARKANSAS	1,470	1,616	1,652	1,829	2,054	2,142	2,392	2,607	2,744	3,049	2,868	3,242	3,336	3,654
ARK.-MO.	128	150	146	177	203	216	223	271	284	307	326	344	344	328
LOUISIANA	942	1,156	1,284	1,494	1,779	1,872	2,096	2,389	2,563	2,692	2,883	3,180	3,515	3,852
MISSISSIPPI	788	887	924	1,005	1,176	1,238	1,343	1,476	1,565	1,640	1,642	1,733	1,776	1,901
NOPSI	595	675	609	729	822	810	837	908	936	869	915	917	965	967
SUM	3,923	4,484	4,695	5,234	6,034	6,278	6,891	7,651	8,092	8,557	8,634	9,416	9,936	10,702
MSU SYSTEM	3,762	4,343	4,593	5,110	5,924	6,148	6,818	7,622	7,972	8,532	8,504	9,345	9,780	10,648

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TABLE 1.1.2

MIDDLE SOUTH UTILITIES SYSTEM
PROJECTED ANNUAL PEAK LOAD (MW)

COMPANY	1979	1980	1981	1982	1983	1984	1985	1986	1987
ARKANSAS	3895	4419	4764	5252	5677	6085	6543	6991	7465
ARKANSAS-MISSOURI	337	359	384	409	437	464	491	516	543
LOUISIANA	4421	4447	4822	5241	5680	6119	6556	6975	7459
MISSISSIPPI	2065	2172	2279	2383	2491	2601	2710	2824	2943
NOPSI	1035	1087	1134	1177	1210	1241	1270	1299	1330
SUM	11753	12484	13383	14462	15495	16510	17570	18605	19740
FORECAST WITH 1% DIVERSITY	11635	12359	13249	14317	15340	16345	17394	18419	19543

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COMPANY	1988	1989	1990	1991	1992	1993
ARKANSAS	7956	8450	8977	9351	9743	10150
ARKANSAS-MISSOURI	569	598	629	661	695	730
LOUISIANA	7961	8469	8997	9546	10119	10726
MISSISSIPPI	3061	3176	3292	3414	3540	3671
NOPSI	1362	1395	1429	1464	1500	1537
SUM	20909	22088	23324	24436	25597	26614
FORECAST WITH 1% DIVERSITY	20700	21867	23091	24192	25341	26546

Amend. 1 3/79

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TABLE 1.1.3

MIDDLE SOUTH UTILITIES SYSTEM
ANNUAL ENERGY
(MWh)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
NET ENERGY FOR SYSTEM LOAD:													
ARKANSAS	6634244	7158493	7657199	8427853	9087713	9592131	10128858	11145611	11760120	11831133	10651042	12127300	13639019
ARKANSAS-MISSOURI						1032928	1069313	1144598	1218323	1237684	1307578	1390085	1514171
LOUISIANA	4324106	5333462	6378305	7550499	8627613	9253208	9996738	11637091	12532244	12980804	14017978	16128008	18112050
MISSISSIPPI	3182605	3460671	3683075	4040130	4465079	4916978	5279192	5813963	6393797	6312955	6590919	6931042	7527643
NOPSI	2577852	2979727	3096189	3417655	3631822	3789832	3965096	4351803	4441085	4233876	4359503	4466462	4304203
MIDDLE SOUTH UTILITIES SYSTEM	16718807	18937711	20826588	23436137	25812227	28585077*	30439197*	34093066	36345569	36596452	36927020	41042897	45597086
SALES FOR RESALE IN AREA:													
ARKANSAS	900034	830472	692907	812298	919538	1032402	1167677	1421926	1701867	1817794	2131093	2366746	2795984
ARKANSAS-MISSOURI						27085	29452	46471	104118	108457	119352	134937	148469
LOUISIANA	371545	425832	465994	528020	615069	690873	742863	823258	885051	916802	1028785	1161517	1326625
MISSISSIPPI	547959	601110	659025	765835	860845	959651	966016	1089350	988351	938207	990313	1064666	1217042
NOPSI	0	0	0	0	0	0	0	0	0	0	0	0	0
MIDDLE SOUTH UTILITIES SYSTEM	1819538	1857414	1817926	2106153	2395452	2710011*	2906008*	3381005	3679387	3781260	4269543	4727866	5488130
NET ENERGY FOR AREA LOAD:													
ARKANSAS	7534278	7988965	8350107	9240150	10007251	10624533	11296535	12567537	13461987	13648927	12782135	14494046	16435013
ARKANSAS-MISSOURI						1060013	1098765	1191069	1322441	1346141	1426930	1525022	1662640
LOUISIANA	4695650	5759294	6844299	8078519	9242682	9944081	10739601	12460349	13417295	13897606	15046763	17289525	19433675
MISSISSIPPI	3730564	4061781	4342100	4805966	5325924	5876629	6245208	6903313	7382148	7251162	7581232	7995708	8744655
NOPSI	2577853	2979727	3096189	3417655	3631822	3789832	3965096	4351803	4441085	4233876	4359503	4466462	4804203
MIDDLE SOUTH UTILITIES SYSTEM	18538345	20795125	22644514	25542290	28207679	31295088*	33345205*	37474071	40024956	40377712	41196563	45770762	51085216

NOTE: 1. Energy data is from FPC Form 12, Schedule 14, Col. 8, Col. 6 - 5, Col. 9.
2. Underlined data has been corrected.
3. Company totals were corrected for assumed losses in 1966 and 1967 and are less than MSU System total.
4. (*) Indicates the addition of Arkansas-Missouri to original data in 1970 and 1971.

Amend. 1 3/79

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TABLE 1.1.4

MIDDLE SOUTH UTILITIES SYSTEM
ANNUAL ENERGY ESTIMATES
1978 - 1988
(MEGAWATT - HOURS)

	APL	AMP	LPL	MPL	NOPSI	MSU
1978*	17,665,450	1,583,013	21,605,450	9,390,149	4,929,726	55,173,788
1979	18,472,083	1,509,744	24,608,055	9,361,000	5,103,228	50,054,110
1980	20,566,418	1,607,000	26,519,107	9,866,000	5,343,964	63,902,489
1981	22,295,756	1,716,000	27,727,738	10,369,000	5,561,436	67,669,930
1982	24,392,903	1,816,000	30,238,009	10,856,000	5,754,549	73,057,461
1983	25,384,453	1,932,000	32,979,416	11,367,000	5,901,932	78,564,801
1984	28,279,852	2,044,000	35,712,059	11,871,000	6,038,826	83,945,737
1985	30,349,103	2,148,000	38,484,598	12,385,000	6,165,038	89,521,739
1986	32,442,929	2,247,000	41,214,629	12,890,000	5,286,094	95,080,652
1987	34,521,084	2.350,000	44,294,922	13,423,000	5,416,032	101,005,038
1988	36,708,858	2,458,000	47,567,779	13,959,000	6,533,648	107,247,285
AVERAGE COMPOUND GROWTH FOR THE TEN-YEAR PERIOD	7.6%	4.5%	8.2%	4.1%	2.9%	6.9%

*Nine months actual and three months estimated.

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TABLE 1.1.5

MIDDLE SOUTH UTILITIES SYSTEM
ENERGY SALES

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
ENERGY SALES (millions of kwh):													
Residential	4,388	4,949	5,350	6,297	7,191	8,005	8,808	10,281	11,261	11,012	11,042	12,233	13,853
Commercial	2,992	3,238	3,541	3,937	4,336	4,762	5,215	5,834	6,364	6,370	6,907	7,241	7,972
Industrial	6,980	8,142	9,126	10,118	10,873	11,268	12,029	13,520	14,531	14,966	13,620	16,832	18,712
Governmental	872	965	1,034	1,114	1,183	1,222	1,256	1,340	1,398	1,335	1,444	1,522	1,651
Total to Ultimate Customers	15,232	17,294	19,051	21,466	23,583	25,257	27,308	30,975	33,554	33,683	33,913	37,828	42,188
Sales for Resale	1,939	2,213	2,117	3,505	6,153	7,275	7,829	6,834	4,309	4,096	4,830	5,130	6,289
Total Electric Energy Sales	17,171	19,507	21,168	24,971	29,736	32,532	35,137	37,809	37,863	37,779	38,743	42,958	48,477
ENERGY SALES (percent)													
Residential	26	25	25	25	24	24	25	27	30	29	31	28	29
Commercial	17	17	17	16	15	15	15	15	17	17	18	17	16
Industrial	41	42	43	41	36	35	34	36	38	40	35	39	39
Governmental	5	5	5	4	4	4	4	4	4	3	4	4	3
Total to Ultimate Customers	89	89	90	86	79	78	78	82	89	89	88	88	87
Sales for Resale	11	11	10	14	21	22	22	18	11	11	12	12	13
Total Electric Energy Sales	100	100	100	100	100	100	100	100	100	100	100	100	100

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Amend. 1 3/79

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TABLE 1.1.6

MIDDLE SOUTH UTILITIES SYSTEM
PEAK LOAD
(MW)

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1972												
Actual	4558	4572	4395	5073	6295	7130	7313	7622	7285	6071	5118	5011
Forecast	4980	4980	4980	5516	6512	7662	7662	7696*	7696	6479*	5335	5488
1973												
Actual	5137	5138	4855	5087	6188	7543	7972	7781	7285	7101	5344	5477
Forecast	5459	5459	5291	6047	7155*	8418	8418	8418	8418	7155	6061	5893
1974												
Actual	5239	5241	4924	5343	7230	7829	8532	7986	6889	5633	5369	5525
Forecast	5892*	5892	5711	6527	7705	9065	9065	9065	9065	7705	6527	6345
1975												
Actual	5590	5394	5465	5659	7178	7697	8133	8223	8504	6438	5515	6097
Forecast	6180*	6180	5989	6845	8081	9078*	9078	9078	9078	7716	6536	6355
1976												
Actual	6207	5621	5413	6129	6432	8422	9345	9006	7900	7096	6690	6543
Forecast	6195*	6129*	5847	6766*	8004	9529	9529	9529	9529	7814	6670	6575
1977												
Actual	6960	6518	6175	6274	8851	9494	9780	9653	9366	8438	6668	6932
Forecast	6664*	6693*	6389	6997*	8620	10141	10028*	10028	9780	8117	6994	7042
1978												
Actual**	7429	7219	6556	6686	8979	10269	10386	10648	9943	7942	7114	-
Forecast	7135	7135	6810	7459	9182*	10802	10802	10802	10802	8966	7669	7777

* Denotes start of revised forecast data.
** Through November

Amend. 1 3/79

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TABLE 1.1.7

MIDDLE SOUTH UTILITIES SYSTEM
ACTUAL ENERGY SALES
(kWh x 10^6)

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1972 Actual:												
Ultimate Customers	2202	2156	2111	2135	2247	2700	3108	3216	3322	2996	2443	2325
Public Utilities	504	453	437	448	437	630	765	828	937	539	457	399
Total	2706	2609	2548	2583	2684	3330	3873	4044	4259	3535	2900	2724
1973 Actual:												
Ultimate Customers	2529	2370	2315	2285	2355	2833	3413	3539	3476	3145	2784	2510
Public Utilities	427	380	347	267	236	287	419	519	454	365	306	301
Total	2956	2750	2662	2552	2591	3120	3832	4058	3930	3510	3090	2811
1974 Actual:												
Ultimate Customers	2608	2385	2359	2393	2577	3056	3268	3599	3449	2842	2598	2549
Public Utilities	324	297	261	244	267	367	405	499	549	388	290	304
Total	2932	2682	2620	2637	2844	3423	3673	4098	3998	3230	2888	2853
1975 Actual:												
Ultimate Customers	2663	2520	2411	2385	2479	2978	3329	3497	3541	2883	2695	2532
Public Utilities	311	300	287	298	339	426	532	663	546	366	364	398
Total	2974	2820	2698	2683	2818	3404	3861	4160	4087	3249	3059	2930
1976 Actual:												
Ultimate Customers	2812	2633	2598	2682	2881	3056	3657	4060	3927	3417	3004	3101
Public Utilities	391	384	314	323	320	367	494	572	556	533	452	424
Total	3203	3017	2912	3005	3201	3423	4151	4632	4483	3950	3456	3525
1977 Actual:												
Ultimate Customers	3285	3093	2959	2985	3090	3821	4332	4334	4228	3810	3099	3152
Public Utilities	472	448	350	349	389	559	771	744	709	553	441	503
Total	3757	3541	3309	3334	3479	4380	5103	5078	4937	4363	3540	3655

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Amend. 1 3/79

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TABLE 1.1.8

MIDDLE SOUTH UTILITIES SYSTEM
FORECAST ENERGY SALES
(kWh x 10^6)

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1972 Forecast:												
Ultimate Customers	2230	2151	2134	2110	2251	2628	3144	3233	3184	2773	2369	2284
Public Utilities	535	513	508	465	477	535	619	635	599	547	541	545
Total	2765	2664	2642	2575	2728	3163	3763	3868	3783	3320	2910	2829
1973 Forecast:												
Ultimate Customers	2409	2338	2319	2309	2458	2908	3424	3545	3451	3043	2606	2500
Public Utilities	520	511	502	503	480	588	702	716	694	629	600	617
Total	2929	2849	2821	2812	2938	3496	4126	4261	4145	3672	3206	3117
1974 Forecast:												
Ultimate Customers	2606	2503	2473	2436	2614	3088	3654	3796	3738	3333	2851	2719
Public Utilities	385	368	290	287	318	370	445	481	588	376	314	324
Total	2991	2871	2763	2723	2932	3458	4099	4277	4326	3709	3165	3043
1975 Forecast:												
Ultimate Customers	2749	2629	2595	2599	2771	3284	3765	3980	3926	3587	3196	2977
Public Utilities	315	318	285	280	285	385	437	535	518	433	358	340
Total	3064	2947	3880	2879	3056	3669	4202	4515	4444	4020	3554	3317
1976 Forecast:												
Ultimate Customers	2749	2660	2585	2608	2750	3241	3750	3960	3830	3391	2948	2835
Public Utilities	652	566	488	394	489	648	612	651	679	502	460	469
Total	3401	3226	3073	3002	3239	3889	4362	4611	4509	3893	3408	3304
1977 Forecast:												
Ultimate Customers	3273	3070	3007	2975	3115	3579	4186	4418	4311	3720	3297	3239
Public Utilities	238	227	239	262	273	322	352	373	358	282	252	244
Total	3511	3317	3246	3237	3388	3901	4530	4719	4669	4002	3549	3483

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TABLE 1.1.9

MIDDLE SOUTH UTILITIES SYSTEM
NET ENERGY FOR LOAD
(kWh x 1000)

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	
1972														
Actual	2636968	2451341	2563584	2589092	3076923	3669481	3831144	4120504	3732360	3078106	2802662	2921906	37474071	
Forecast (2/29/72)	2720581	2449832	2621246	2616391	3082830	3614623	4012720	4000770	3506696	3082456	2766518	2870337	37345000	
1973														
Actual	2952436	2643499	2774171	2682254	3154557	3885232	4439778	4281362	3739704	3524938	2952720	2994306	40024956	
Forecast (1/18/73)	2981896	2685139	2873017	2867696	3378937	3961808	4398143	4385045	3843515	3378527	3032243	3146034	40932000	
1974														
Actual	3015071	2681219	2906864	2867868	3585364	3751189	4489204	4283254	3386463	3187454	3033383	3190377	40377712	
Forecast	3141030	2828437	3026341	3020736	3559260	4173238	4632859	4619061	4048631	3558829	3194064	3313928	43116414	
1975														
Actual	3147096	2775221	3025633	2862269	3461080	3941099	4398300	4354764	3592913	3289849	3080402	3267937	41196563	1
Forecast	3188544	2875957	3102460	3024591	3641830	4184640	4659648	4779226	4382068	3915525	3603640	3628173	44986302	
1976														
Actual	3346804	3002689	3242516	3276105	3567509	4217636	4955809	4930231	4133242	3666722	3644343	3787156	45770762	1
Forecast (1/20/76)	3226539	2975439	3200712	3163498	3709580	4239656	4940061	4864722	4159045	3800593	3367192	3499289	45154326	
1977														
Actual	4044753	3372191	3637574	3532903	4363488	5106250	5407346	5278955	4799999	3897242	3681285	3963230	51085216	1
Forecast (1/24/77)	3800209	3427629	3631945	3548287	4140881	4764720	5503410	5416189	4593948	4179453	3729055	3942455	50678181	

Amend. 1 3/79

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TABLE 1.1.10

MIDDLE SOUTH UTILITIES SYSTEM
POWER EXCHANGES AT TIME OF ANNUAL PEAK DEMAND
(MW)

Year	Total Received	Total Sent	Net Received
1965	475	0	475
1966	664	10	654
1967	570	0	570
1968	622	703	(81)
1969	1400	596	804
1970	952	519	433
1971	1415	734	681
1972	1818	766	1052
1973	1237	375	862
1974	1700	60	1640
1975	811	721	90
1976	1041	1175	(134)
1977	1565	1069	496
1978	2549	825	1724
1979	1328	0	1328
1980	1657	0	1657
1981	1789	0	1789
1982	1760	0	1760
1983	2008	0	2008
1984	1845	0	1845
1985	2126	0	2126
1986	2363	0	2363
1987	2463	0	2463
1988	2744	0	2744
1989	2829	0	2829
1990	3029	0	3029
1991	3130	0	3130
1992	3231	0	3231
1993	3332	0	3332

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Amend. 1 3/79

TABLE 1.1.11

MIDDLE SOUTH UTILITIES SYSTEM

GENERATING STATIONS

Location and Type of Plant	Net Capability MW*
Steam Turbine (Fossil-Fueled):	
Lake Catherine-Malvern, Arkansas	756
Cecil Lynch-North Little Rock, Arkansas	239
Harvey Couch-Stamps, Arkansas	161
Hamilton Moses-Forrest City, Arkansas	144
Robert E. Ritchie-Helena, Arkansas	900
Sterlington-Sterlington, Louisiana	471**
Ninemile Point-near New Orleans, Louisiana	1,827
Little Gypsy-Montz, Louisiana	1,253
Waterford-Killona, Louisiana	822
Rex Brown-Jackson, Mississippi	390
Natchez-Natchez, Mississippi	73
Delta-near Cleveland, Mississippi	207
Baxter Wilson-Vicksburg, Mississippi	1,321
Gerald Andrus-Greenville, Mississippi	761
Market Street-New Orleans, Louisiana	103
A. B. Paterson-New Orleans, Louisiana	233
Michoud-New Orleans, Louisiana	906
Jim Hill-Campbell, Missouri	35
New Madrid (leased capacity)-New Madrid, Missouri	116
Steam Turbine (Nuclear):	
Arkansas Nuclear One-Russellville, Arkansas	836
Hydro:	
Carpenter-Hot Springs, Arkansas	59
Remmel-Malvern, Arkansas	10

* "Net Capability" as used herein is the present dependable load carrying ability of the station, as demonstrated under actual operating conditions based on the primary fuel which each station was designed to utilize.

** Includes 203 MW Combined Cycle (Gas/Oil-Fired). Steam Turbine part of the plant (268 MW) includes 44 MW gas-fired only.

TABLE 1.1.11 (Cont.)

Gas Turbine and Internal Combustion Engines:

Blytheville (leased)-Blytheville, Arkansas	188
Mabelvale-Mabelvale, Arkansas	73
Cecil Lynch-North Little Rock, Arkansas	6
Robert E. Ritchie-Helena, Arkansas	18
Buras-Buras, Louisiana	19
Rex Brown-Jackson, Mississippi	11
A. B. Paterson-New Orleans, Louisiana	16
Total	11,954

TABLE 1.1.12

MIDDLE SOUTH SYSTEM
LOAD AND CAPABILITY FORECAST

ADDITIONS				RETIREMENTS			
YEAR	UNIT NAME	MONTH	MW	YEAR	UNIT NAME	MONTH	MW
1978	ARK NUC 2	DECEMBER	912				
1980	W.BLUFF 1	JUNE	420				
1981	W.BLUFF 2	MAY	420	1981	LYNCH 1	DEC 31st	35
	WATERFRD 3	NOVEMBER	1110		COUCH 1	DEC 31st	30
	GR.GULF 1*	APRIL	1250				
				1982	MARKET 11	DEC 31st	36
					MARKET 12	DEC 31st	36
					MARKET 13	DEC 31st	31
1983	INDEPEND 1	JANUARY	420	1983	LYNCH 2	DEC 31st	74
	AP 1PEAK83	JANUARY	50		STERLING 5	DEC 31st	44
	LP 2PEAK83	JANUARY	100				
	NP 1PEAK83	JANUARY	50				
1984	AP 3PEAK84	JANUARY	100	1984	L.CATH 1	DEC 31st	52
	LP 3PEAK84	JANUARY	50		L.CATH 2	DEC 31st	51
	NP 2PEAK84	JANUARY	50				
	NP 1PEAK84	JANUARY	50				
	GR.GULF 2*	JANUARY	1250				
1985	INDEPEND 2	JANUARY	420	1985	MOSES 1	DEC 31st	72
	MP COAL 1	JANUARY	700		MOSES 2	DEC 31st	72
1986	COAL 6 APL	JANUARY	420				
	COAL 7 LPL	JANUARY	700				
1987	AP 7PEAK87	JANUARY	200	1987	L.CATH 3	DEC 31st	106
	LP 7PEAK87	JANUARY	200		A.B.PAT 1	DEC 31st	46
	MP 3PEAK87	JANUARY	50				
	COAL 8 MP*	JANUARY	700				
1988	AM 1PEAK88	JANUARY	50	1988	LYNCH 3	DEC 31st	130
	COAL 9 AP*	JANUARY	420		COUCH 2	DEC 31st	131
	COAL10 LP*	JANUARY	700		A.B.PAT 2	DEC 31st	44
1989	AP 8PEAK89	JANUARY	50				
	LP 9PEAK89	JANUARY	100				
	NP 2PEAK89	JANUARY	50				
	COAL11 UA*	JANUARY	700				
	COAL12 UA*	JANUARY	700				
1990	NUC. 6 UA*	JANUARY	1200	1990	NINEMILE 1	DEC 31st	74
					A.B.PAT 3	DEC 31st	56
1991	COAL13 UA*	JANUARY	700	1991	A.B.PAT 4	DEC 31st	87
	COAL14 UA*	JANUARY	700				

Amend. 1 3/79

TABLE 1.1.12 (Cont.)

MIDDLE SOUTH SYSTEM
LOAD AND CAPABILITY FORECAST

ADDITIONS				RETIREMENTS				
YEAR	UNIT NAME	MONTH	MW	YEAR	UNIT NAME	MONTH	MW	
1992	NUC. 7 UA*	JANUARY	1200	1992	MICHOUD 1	DEC 31st	114	
1993	AP10PEAK93	JANUARY	100	1993	NINEMILE 2	DEC 31st	107	1
	LP11PEAK93	JANUARY	100					
	MP 4PEAK93	JANUARY	50					
	NUC. 8 UA*	JANUARY	1200					
9/7/78	CASE NUMBER 1							

TABLE 1.1.13

MIDDLE SOUTH SYSTEM
UNIT CAPABILITIES IN MW

YEAR 1981

UNIT	NON-COINCIDENT CAPABILITY					COINCIDENT MONTHLY UNIT GEN. CAP.--WITH ASSUMED FUEL CONSTRAINTS											
	GAS	OIL	COAL	HYDRO	NUCLEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
APL																	
LYNCH 1	35	28	0	0	0	28	28	28	28	28	28	28	28	28	28	28	28
LYNCH 2	74	55	0	0	0	55	55	55	55	55	55	55	55	55	55	55	55
LYNCH 3	130	130	0	0	0	130	130	130	130	130	130	130	130	130	130	130	130
LYNCH 4	0	6	0	0	0	6	6	6	6	6	6	6	6	6	6	6	6
COUCH 1	30	25	0	0	0	25	25	25	25	25	25	25	25	25	25	25	25
COUCH 2	131	120	0	0	0	122	122	122	122	122	122	122	122	122	122	122	122
L. CATH 1	52	45	0	0	0	45	45	45	45	45	45	45	45	45	45	45	45
L. CATH 2	51	44	0	0	0	44	44	44	44	44	44	44	44	44	44	44	44
L. CATH 3	106	90	0	0	0	90	90	90	90	90	90	90	90	90	90	90	90
L. CATH 4	547	459	0	0	0	436	436	436	436	436	436	436	436	436	436	436	436
MABEL 1	18	15	0	0	0	15	15	15	15	15	15	15	15	15	15	15	15
MABEL 2	19	15	0	0	0	15	15	15	15	15	15	15	15	15	15	15	15
MABEL 3	18	15	0	0	0	15	15	15	15	15	15	15	15	15	15	15	15
MABEL 4	18	15	0	0	0	15	15	15	15	15	15	15	15	15	15	15	15
MOSES 1	72	63	0	0	0	63	63	63	63	63	63	63	63	63	63	63	63
MOSES 2	72	63	0	0	0	63	63	63	63	63	63	63	63	63	63	63	63
RITCHIE 1	356	310	0	0	0	295	295	295	295	295	295	295	295	295	295	295	295
RITCHIE 2	544	510	0	0	0	485	485	485	485	485	485	485	485	485	485	485	485
RITCHIE 3	18	15	0	0	0	15	15	15	15	15	15	15	15	15	15	15	15
CARP 1-2	0	0	0	59	0	59	59	59	59	59	59	59	59	59	59	59	59
REMMEL 1-3	0	0	0	10	0	10	10	10	10	10	10	10	10	10	10	10	10
ARK NUC 1	0	0	0	0	836	836	836	836	836	836	836	836	836	836	836	836	836
ARK NUC 2	0	0	0	0	912	912	912	912	912	912	912	912	912	912	912	912	912
W. BLUFF 1	0	0	420	0	0	420	420	420	420	420	420	420	420	420	420	420	420
W. BLUFF 2	0	0	420	0	0	0	0	0	0	420	420	420	420	420	420	420	420
		3137		69	1748	4199	4199	4199	4199	4199	4619	4619	4619	4619	4619	4619	4619
AMP																	
JIM MILL 1	33	35	0	0	0	35	35	35	35	35	35	35	35	35	35	35	35
BLYTH #1-3	0	188	0	0	0	188	188	188	188	188	188	188	188	188	188	188	188
		223		0	0	223	223	223	223	223	223	223	223	223	223	223	223
LPL																	
BURAS 8	19	19	0	0	0	19	19	19	19	19	19	19	19	19	19	19	19
STERLING 5	44	0	0	0	0	44	44	44	44	44	44	44	44	44	44	44	44
STERLING 6	224	210	0	0	0	210	210	210	210	210	210	210	210	210	210	210	210
STERLING 7	203	203	0	0	0	203	203	203	203	203	203	203	203	203	203	203	203
NINEMILE 1	74	70	0	0	0	70	70	70	70	70	70	70	70	70	70	70	70
NINEMILE 2	107	90	0	0	0	90	90	90	90	90	90	90	90	90	90	90	90
NINEMILE 3	135	125	0	0	0	125	125	125	125	125	125	125	125	125	125	125	125
NINEMILE 4	748	700	0	0	0	700	700	700	725	725	725	725	725	725	725	700	700
NINEMILE 5	763	700	0	0	0	725	725	725	740	740	740	740	740	740	740	725	725

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Amend. 1 3/79

TABLE 1.1.13 (Cont.)

MIDDLE SOUTH SYSTEM
UNIT CAPABILITIES IN MW

UNIT	NON-COINCIDENT CAPABILITY					COINCIDENT MONTHLY UNIT GEN. CAP.--WITH ASSUMED FUEL CONSTRAINTS											
	GAS	OIL	COAL	HYDRO	NUCLEAR	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
GYPSY 1	244	210	0	0	0	244	244	244	244	244	244	244	244	244	244	244	244
GYPSY 2	436	380	0	0	0	380	380	380	380	380	380	380	380	380	380	380	380
GYPSY 3	573	510	0	0	0	510	510	510	573	573	537	573	753	573	573	510	510
WATERFRD 1	411	411	0	0	0	411	411	411	411	411	411	411	411	411	411	411	411
WATERFRD 2	411	411	0	0	0	411	411	411	411	411	411	411	411	411	411	411	411
WATERFRD 3	0	0	0	0	1110	0	0	0	0	0	0	0	0	0	0	1110	1110
		4392		0	1110	4142	4142	4142	4245	4245	4245	4245	4245	4245	4245	5252	5252
MPL																	
REX BRWN 1	36	0	0	0	0	36	36	36	36	36	36	36	36	36	36	36	36
REX BRWN 2	47	0	0	0	0	47	47	47	47	47	47	47	47	47	47	47	47
REX BRWN 3	76	69	0	0	0	69	69	69	69	69	69	69	69	69	69	69	69
REX BRWN 4	231	210	0	0	0	210	210	210	210	210	210	210	210	210	210	210	210
REX BRWN 5	0	11	0	0	0	11	11	11	11	11	11	11	11	11	11	11	11
NATCHEX 1	73	73	0	0	0	73	73	73	73	73	73	73	73	73	73	73	73
DELTA 1	104	95	0	0	0	95	95	95	95	95	95	95	95	95	95	95	95
DELTA 2	103	95	0	0	0	95	95	95	95	95	95	95	95	95	95	95	95
B.WILSON 1	550	525	0	0	0	525	525	525	525	525	525	525	525	525	525	525	525
B. WILSON 2	771	650	0	0	0	650	650	650	650	650	650	650	650	650	650	650	650
ANDRUS 1	0	761	0	0	0	761	761	761	761	761	761	761	761	761	761	761	761
		2736		0	0	2572	2572	2572	2572	2572	2572	2572	2752	2572	2572	2572	2572
NOPS																	
MICHOUD 1	113	114	0	0	0	114	114	114	114	114	114	114	114	114	114	114	114
MICHOUD 2	244	244	0	0	0	244	244	244	244	244	244	244	244	244	244	244	244
MICHOUD 3	548	525	0	0	0	525	525	525	525	525	525	525	525	525	525	525	525
A.B.PAT 1	46	46	0	0	0	46	46	46	46	46	46	46	46	46	46	46	46
A.B.PAT 2	44	42	0	0	0	42	42	42	42	42	42	42	42	42	42	42	42
A.B.PAT 3	56	55	0	0	0	55	55	55	55	55	55	55	55	55	55	55	55
A.B.PAT 4	87	80	0	0	0	80	80	80	80	80	80	80	80	80	80	80	80
A.B.PAT 5	0	16	0	0	0	16	16	16	16	16	16	16	16	16	16	16	16
MARKET 11	36	31	0	0	0	31	31	31	31	31	31	31	31	31	31	31	31
MARKET 12	36	31	0	0	0	31	31	31	31	31	31	31	31	31	31	31	31
MARKET 13	31	27	0	0	0	27	27	27	27	27	27	27	27	27	27	27	27
		1258	0	0	0	1211	1211	1211	1211	1211	1211	1211	1211	1211	1211	1211	1211
MSE																	
GR.GULF 1#	0	0	0	0	1250	0	0	0	1250	1250	1250	1250	1250	1250	1250	1250	1250
		0		0	1250	0	0	0	1250	1250	1250	1250	1250	1250	1250	1250	1250
SYSTEM TOTALS		11773		69	4108	12347	12347	12347	13700	14120	14120	14120	14120	14120	14120	15127	15127

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TABLE 1.1.14

MIDDLE SOUTH UTILITIES SYSTEM
ACTUAL LOAD AND CAPCBILITY
SUMMARY - 1972 through 1978

		1972	1973	1974	1975	1976	1977	1978	
1.	Capability without curtailment	8308	9128	9810	11392	11825	11838	11838	
2.	Capability with assumed curtailment	8308	8592	9393	10908	11201	11014	11084	
3.	Purchases without reserves	612	509	631	305	305	356	616	
4.	Total capability (2 + 3)	8920	9101	10024	11213	11506	11370	11710	
5.	System maximum hourly load	7622	7972	8532	8504	9345	9780	10648	
6.	Firm sales with reserves	631	25	37	196	34	35	0	1
7.	Firm purchases with reserves	684	704	718	711	700	703	736	
8.	Load responsibility (5 + 6 - 7)	7569	7293	7851	7989	8679	9112	9112	
9.	Margin in excess of load (4 - 8)	1351	1808	2173	3224	2827	2258	1798	
10.	Planned reserve*	1217	1238	1341	1370	1418	1498	1611	
11.	Percent margin in excess of load (9/8)	17.8	24.8	27.7	40.4	32.6	24.8	18.1	
12.	Capability in excess of planned reserve	134	570	832	1854	1409	760	787	

* 16% of planned load responsibility. This is not the same as the actual load responsibility shown in Line 8, since the estimated and actual System peaks always differ.

TABLE 1.1.15

MIDDLE SOUTH UTILITIES SYSTEM
LOAD AND CAPABILITY FORECAST FOR MSU
SUMMARY - 1979-1993

		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1.	Capability W/O Curtailment	12750	13170	14840	15885	16402	17784	18801	19777	20927	21945
2.	Capability W/Assumed Curtailment	12030	12450	14120	15177	15708	17084	18075	19006	20156	21190
3.	Purchases W/O Reserves	603	1013	1266	1237	1484	1471	1751	1987	2087	2367
4.	Total Capability (2+3)	12633	13463	15386	16414	17192	18555	19826	20993	22243	23557
5.	System Maximum Hourly Load	11635	12359	13249	14317	15340	16345	17394	18419	19543	20700
6.	Firm Sales W/Reserves	0	0	0	0	0	0	0	0	0	0
7.	Firm Purchases W/Reserves	725	644	523	523	524	374	375	376	376	377
8.	Load Responsibility (5+6-7)	10910	11715	12726	13794	14816	15971	17019	18043	19167	20323
9.	Margin in Excess of Load (4-8)	1723	1748	2660	2620	2376	2584	2807	2350	3076	3234
10.	Planned Reserve (16.0% of Line 8)	1746	1874	2036	2207	2371	2555	2723	2887	3067	3252
11.	PCNT Margin in Excess of Load (9/8)	15.8	14.9	20.9	19.0	16.0	16.2	16.5	16.3	16.0	15.9
12.	Cap. in Excess of Planned Reserve	-23	-126	624	413	5	29	84	63	9	-18

		1989	1990	1991	1992	1993
1.	Capability W/O Curtailment	23240	24440	25710	26823	28159
2.	Capability W/Assumed Curtailment	22496	23696	24971	26091	27427
3.	Purchases W/O Reserves	2451	2651	2751	2851	2951
4.	Total Capability (2+3)	24947	26347	27722	28942	30378
5.	System Maximum Hourly Load	21867	23091	24192	25341	26546
6.	Firm Sales W/Reserves	0	0	0	0	0
7.	Firm Purchases W/Reserves	378	378	379	380	381
8.	Load Responsibility (5+6-7)	21489	22713	23813	24961	26165
9.	Margin in Excess of Load (4-8)	3458	3634	3909	3981	4213
10.	Planned Reserve (16.0% of Line 8)	3438	3634	3810	3994	4186
11.	PCNT Margin in Excess of Load (9/8)	16.1	16.0	16.4	15.9	16.1
12.	Cap. in Excess of Planned Reserve	20	0	99	-13	27

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9/7/78 Case Number 1

TABLE 1.1.16

SOUTHWEST POWER POOL[1]
ANALYSIS OF PREDICTED CAPABILITY
LOAD VS. ACTUAL - SUMMER PEAK PERIOD (MW)

ITEM	1971 Forecast 4-1-71*	1971 Actual	1972 Forecast 4-1-72**	1972 Actual	1973 Forecast 4-1-73	1973 Actual	1974 Forecast 4-1-74	1974 Actual
1. Net Dependable Capability	27502	27502	32002	32002	34765	34738	38474	36198
2. All Scheduled Purchases	4410	4410	5567	5567	5809	5726	6206	6206
3. All Scheduled Sales	4169	4169	4734	4734	3839	4332	4112	4112
4. Total Resources (1+2-3)	27743	27743	32835	32835	36735	36132	40568	38292
5. Inoperable Capability	---	---	---	---	---	---	---	---
6. Operable Resources (4-5)	27743	27743	32835	32835	36735	36132	40568	38292
7. Peak Hour Demand	23653	22187	27896	27552	30568	29367	32711	32078
8. Interruptible Demand	---	---	---	---	---	---	---	---
9. Demand Requirements (7-8)	23653	22187	27896	27552	30568	29367	32711	32078
10. Gross Margin (6-9)	4090	5556	4939	5283	6167	6765	7857	6214
11. Unavailable Capacity								
a. Scheduled Outages	111	150	92	375	67	78	745	748
b. Forced Outages	---	1570	---	950	---	3735	---	1626
c. Fuel Limited	---	---	59	25	---	258	---	---
Total	111	1720	151	1350	67	4071	745	2374
12. Net Margin (10-11)	3979	3836	4788	3933	6100	2694	7112	3840
13. Net Margin in % of Item 9	16.8	17.3	17.2	14.3	20.0	9.2	21.7	12.0

1 As forecasted in April 1 reports to F.P.C. under Docket R-362.
* Revised 6/28/71.
** Revised 5/1/72.

TABLE 1.1.16 (Cont.)

SOUTHWEST POWER POOL[1]
ANALYSIS OF PREDICTED CAPABILITY
LOAD VS. ACTUAL - SUMMER PEAK PERIOD (MW)

ITEM	1975 Forecast 4-1-75	1975 Actual	1976 Forecast 4-1-76	1976 Actual	1977 Forecast 4-1-77	1977 Actual	1978 Forecast 4-1-78	1978 Actual
1. Net Dependable Capability	41309	40644	42199	42014	44846	43739	46487	46457
2. All Scheduled Purchases	2084	2084	2464	2464	2164	7457	5411	8688
3. All Scheduled Sales	678	678	1320	1320	879	6258	3704	4343
4. Total Resources (1+2-3)	42715	42050	43343	43158	46131	44938	48194	50802
5. Inoperable Capability	---	---	---	---	---	549	135	304
6. Operable Resources (4-5)	42715	42050	43343	43158	46131	44389	48059	50498
7. Peak Hour Demand	34735	32200	35307	33764	37090	36847	38946	39191
8. Interruptible Demand	---	---	---	---	---	35	---	---
9. Demand Requirements (7-8)	34735	32200	35307	33764	37090	36812	38946	39191
10. Gross Margin (6-9)	7980	9850	8036	9394	9041	7577	9113	11307
11. Unavailable Capacity								
a. Scheduled Outages	377	1326	20	2353	---	600	44	---
b. Forced Outages	---	1457	---	1190	---	3958	---	---
c. Fuel Limited	---	---	---	---	---	---	---	---
Total	377	2783	20	3543	0	4558	44	5720
12. Net Margin (10-11)	7603	7067	8016	5851	9041	3019	9069	5587
13. Net Margin in % of Item 9	21.9	21.9	22.7	17.3	27.4	8.2	23.3	14.3

1 As forecasted in April 1 reports to F.P.C. under Docket R-362.

TABLE 1.1.17

SOUTHWEST POWER POOL

ESTIMATED RESOURCES, DEMAND AND MARGIN FOR THE 1 TO 10 YEAR PERIOD

SUMMARY

SYSTEM GROUP		RESOURCES IN MW						DEMAND IN MW			MARGIN IN MW			
		NET CAPABILITY	SCHEDULED IMPORTS	SCHEDULED EXPORTS	TOTAL RESOURCE	INOPERABLE CAPABILITY	OPERABLE OPERABLE RESOURCES	PEAK HOUR DEMAND	INTERRUPTIBLE DEMAND	DEMAND REQUIREMENTS	MARGIN	SCHEDULED OUTAGE	ADJUSTED MARGIN	
1979	SUMMER PK.	48867	5279	3460	58686	135	50551	41461	0	41461	9090	44	9046	
1979	WINTER PK.	48341	3717	4414	48644	57	48587	29452	0	29452	19135	3102	16033	
1980	SUMMER PK.	53682	5037	4123	54596	69	54527	44307	0	44307	10220	44	10176	
1980	WINTER PK.	54042	3875	4671	53246	57	53189	31559	0	31559	21630	3119	18511	
1981	SUMMER PK.	57229	4597	4027	57869	69	57800	47083	0	47083	10717	83	10634	
1981	WINTER PK.	57048	3835	4570	56313	57	56256	33626	0	33626	22630	4168	18462	
1982	SUMMER PK.	60567	4294	3431	61430	114	61316	50063	0	50063	11253	60	11193	1
1982	WINTER PK.	60656	3502	3973	60185	69	60116	35696	0	35696	24420	4131	20289	
1983	SUMMER PK.	63413	5669	4388	64694	59	64635	53141	0	53141	11494	0	11494	
1983	WINTER PK.	64644	4677	4778	64543	69	64474	37896	0	37896	26578	0	26578	
1984	SUMMER PK.	68706	5044	3964	69786	59	69727	56357	0	56357	13370	0	13370	
1984	WINTER PK.	68465	4252	4498	68219	69	68150	40241	0	40241	27909	0	27909	
1985	SUMMER PK.	71681	5371	3938	73114	59	73055	59807	0	59807	13248	0	13248	
1985	WINTER PK.	71763	4579	4465	71877	49	71828	42767	0	42767	29061	0	29061	
1986	SUMMER PK.	76831	5248	3758	78321	59	78262	63382	0	63382	14880	0	14880	
1986	WINTER PK.	77590	4456	4278	77768	49	77719	45280	0	45280	32439	0	32439	
1987	SUMMER PK.	80861	5388	3806	82443	59	82284	66991	0	66991	15393	0	15393	
1987	WINTER PK.	88455	4596	4321	80730	49	80681	48017	0	48017	32664	0	32664	

Amend. 1 3/79

TABLE 1.1.18

MISSISSIPPI POWER & LIGHT COMPANY
ECONOMIC MODEL
HISTORICAL ANNUAL VALUES OF FORECASTED VARIABLES
1960 TO 1976

		1960	1961	1962	1963	1964	1965	1966
EMPLOYMENT (THOUSANDS OF EMPLOYEES)								
SIC	INDUSTRY							
20	FOODS		8.242	8.140	8.279	2.461	8.493	8.701
22	TEXTILES		3.280	3.378	3.360	3.348	3.606	3.716
23	APPAREL		6.677	7.593	8.600	2.647	9.008	9.578
24	LUMBER AND WOOD		8.731	8.468	8.545	9.813	10.044	9.823
25	FURNITURE AND FIXTURES		2.402	2.757	3.040	3.245	3.414	4.626
26	PAPER AND PRODUCTS		2.559	2.646	2.730	2.335	2.095	2.244
2729	PRINTING, PUBLISHING, AND PETROLEUM		1.485	1.445	1.397	1.403	1.406	1.488
28	CHEMICALS		1.170	1.175	1.210	1.215	1.276	1.280
30	RUBBER AND PLASTICS		1.331	1.524	1.637	1.680	1.768	1.951
31	LEATHER AND PRODUCTS		0.126	0.150	0.132	0.129	0.176	0.237
32	STONE, CLAY, AND GLASS		2.491	2.542	2.576	2.480	2.522	2.720
33	PRIMARY METALS		0.279	0.310	0.266	0.293	0.353	0.420
34	FABRICATED METALS		1.466	1.959	2.559	2.879	3.165	3.651
35	NONELECTRICAL MACHINERY		1.561	1.797	2.015	2.481	3.595	4.460
36	ELECTRICAL MACHINERY		1.980	2.224	2.374	3.111	3.962	4.691
37	TRANSPORTATION EQUIPMENT		1.283	1.407	1.625	1.791	1.619	1.805
3869	INSTRUMENTS AND MISCELLANEOUS		0.040	0.042	0.045	0.058	1.138	2.793
MANUFACTURING - TOTAL			45.101	47.556	50.411	53.327	57.663	64.185
	CONSTRUCTION		8.417	7.932	8.263	8.789	12.077	12.637
	FINANCE, INSURANCE, AND REAL ESTATE		7.810	8.495	8.943	9.109	9.385	9.841
	GOVERNMENT		43.936	46.511	48.628	49.524	51.723	54.533
	TRANS., COMM., UTILITIES		12.770	13.143	13.299	13.611	13.819	13.701
	SERVICES		22.589	24.441	26.249	27.773	28.621	29.816
	TRADE		42.211	43.116	44.818	46.117	47.204	49.015
	MINING						2.847	2.807
NONMANUFACTURING - TOTAL							165.676	172.351
NONAGRICULTURAL - TOTAL			205.276	214.265	324.084	232.075	245.110	259.193
INCOME, WAGES, AND POPULATION								
TOTAL PERSONAL INCOME (000000'S)		1,415.261	1,549.826	1,532.821	1,721.324	1,810.825	1,965.817	2,156.270
PER CAPITA PERSONAL INCOME		1,223.94	1,326.56	1,296.78	1,456.74	1,539.56	1,675.92	1,852.76
AVERAGE HOURLY EARNINGS - MFG.		1.522	1.560	1.635	1.688	1.764	1.823	1.904
POPULATION (000'S)		1,156.213	1,168.219	1,181.994	1,181.669	1,176.225	1,173.013	1,163.875

301.9

Amend. 1 3/79

TABLE 1.1.18

MISSISSIPPI POWER & LIGHT COMPANY
ECONOMIC MODEL
HISTORICAL ANNUAL VALUES OF FORECASTED VARIABLES
1960 to 1976

SIC	INDUSTRY	1967	1968	1969	1970	1971	1972
EMPLOYMENT (THOUSANDS OF EMPLOYEES)							
20	FOODS	8.909	9.050	9.194	9.513	9.689	9.726
22	TEXTILES	3.657	3.918	4.366	5.059	3.806	4.436
23	APPAREL	10.349	10.872	10.794	11.173	12.732	13.659
24	LUMBER AND WOOD	9.845	9.517	9.869	10.098	9.513	10.081
25	FURNITURE AND FIXTURES	5.575	5.862	6.049	5.561	5.334	5.980
26	PAPER AND PRODUCTS	2.507	2.989	3.373	3.675	3.695	3.761
2729	PRINTING, PUBLISHING, AND PETROLEUM	1.518	1.587	1.567	1.612	1.614	1.652
28	CHEMICALS	1.412	1.587	1.691	1.857	1.968	1.768
30	RUBBER AND PLASTICS	2.130	2.896	2.619	2.799	2.808	2.976
31	LEATHER AND PRODUCTS	0.290	0.313	0.289	0.269	0.302	0.308
32	STONE, CLAY, AND GLASS	2.698	2.587	2.773	2.706	3.147	3.318
33	PRIMARY METALS	0.432	0.500	0.725	0.913	0.822	0.724
34	FABRICATED METALS	3.948	4.581	4.730	4.785	4.749	5.268
35	NONELECTRICAL MACHINERY	4.510	4.460	4.778	4.963	5.012	5.876
36	ELECTRICAL MACHINERY	5.154	5.334	5.442	5.674	6.182	7.139
37	TRANSPORTATION EQUIPMENT	2.107	2.405	2.500	2.680	2.975	3.204
3869	INSTRUMENTS AND MISCELLANEOUS	3.168	2.666	2.728	2.670	2.401	2.459
MANUFACTURING - TOTAL		68.210	70.726	73.509	76.009	76.840	82.913
	CONSTRUCTION	11.505	11.822	11.875	11.839	12.791	14.931
	FINANCE, INSURANCE, AND REAL ESTATE	10.517	11.062	11.504	12.037	12.669	13.245
	GOVERNMENT	57.226	60.052	61.903	64.018	67.365	68.020
	TRANS., COMM., UTILITIES	14.387	14.685	14.978	15.232	17.022	17.300
	SERVICES	31.805	34.177	36.645	38.825	41.967	43.767
	TRADE	49.891	51.097	53.156	54.705	58.105	60.943
	MINING	2.760	2.885	2.768	2.735	2.642	2.629
NONMANUFACTURING - TOTAL		178.030	185.800	192.833	198.789	212.450	220.634
NONAGRICULTURAL - TOTAL		269.690	281.272	292.381	302.205	316.490	331.529
INCOME, WAGES, AND POPULATION							
TOTAL PERSONAL INCOME (000000'S)		2,362.512	2,547.710	2,747.278	2,968.809	3,246.556	3,604.813
PER CAPITA PERSONAL INCOME		2,056.34	2,832.28	2,417.75	2,624.56	2,859.01	3,164.71
AVERAGE HOURLY EARNINGS - MFG.		2.035	2.227	2.327	2.426	2.575	2.767
POPULATION (000'S)		1,148.925	1,141.331	1,136.307	1,131.184	1,135.921	1,136.981

301.9

TABLE 1.1.18

MISSISSIPPI POWER & LIGHT COMPANY
ECONOMIC MODEL
HISTORICAL ANNUAL VALUES OF FORECASTED VARIABLES
1960 TO 1976

		1973	1974	1975	1976	
EMPLOYMENT (THOUSANDS OF EMPLOYEES)						
SIC	INDUSTRY					
20	FOODS	9.570	10.189	9.857	10.211	
22	TEXTILES	4.148	3.824	3.417	3.631	
23	APPAREL	14.597	14.213	12.530	13.850	
24	LUMBER AND WOOD	10.322	10.257	8.381	9.012	
25	FURNITURE AND FIXTURES	6.235	5.754	4.782	4.968	
26	PAPER AND PRODUCTS	3.767	3.767	3.980	3.447	
2729	PRINTING, PUBLISHING, AND PETROLEUM	1.766	1.930	1.958	2.038	
28	CHEMICALS	2.007	2.307	2.372	3.420	
30	RUBBER AND PLASTICS	2.687	3.320	2.870	3.167	
31	LEATHER AND RPODUCTS	1.218	0.364	0.263	0.358	
32	STONE, CLAY, AND GLASS	3.575	3.567	3.271	3.936	
33	PRIMARY METALS	0.736	0.842	0.936	1.344	
34	FABRICATED METALS	5.732	5.415	4.444	4.568	
35	NONELECTRICAL MACHINERY	6.149	6.597	5.895	5.876	
36	ELECTRICAL MACHINERY	8.663	9.807	7.571	7.535	
37	TRANSPORTATION EQUIPMENT	3.776	3.486	3.517	4.003	
3869	INSTRUMENTS AND MISCELLANEOUS	2.381	3.194	1.759	2.470	
MANUFACTURING - TOTAL		87.330	87.833	77.900	82.828	301.9
	CONSTRUCTION	18.751	18.102	16.726	16.733	
	FINANCE, INSURANCE, AND REAL ESTATE	14.160	14.828	15.372	15.806	
	GOVERNMENT	71.182	71.293	74.118	78.009	
	TRANS., COMM., UTILITIES	18.789	19.241	16.656	12.462	
	SERVICES	48.197	50.797	52.182	55.008	
	TRADE	65.449	69.043	67.611	71.152	
	MINING	3.180	3.078	3.239	3.614	
NONMANUFACTURING - TOTAL		239.708	247.383	247.904	258.784	
NONAGRICULTURAL - TOTAL		356.294	364.218	355.450	341.612	
INCOME, WAGES, AND POPULATION						
TOTAL PERSONAL INCOME (000000'S)		4,219.076	4,468.019	4,764.203	5,741.377	
PER CAPITA PERSONAL INCOME		3,642.01	3,229.80	4,063.99	4,538.01	
AVERAGE HOURLY EARNINGS - MFG.		2.947	3.182	3.552	3.827	
POPULATION (000'S)		1,158.281	1,166.625	1,172.250	1,177.005	

TABLE 1.1.19

MISSISSIPPI POWER & LIGHT COMPANY
ECONOMIC MODEL
ANNUAL VALUES OF FORECASTED VARIABLES
1977 TO 1990

SIC	INDUSTRY	1977	1978	1979	1980	1981	1982	1983
EMPLOYMENT (THOUSANDS OF EMPLOYEES)								
20	FOODS	10.315	10.616	10.819	10.975	11.133	11.245	11.332
22	TEXTILES	3.686	3.792	3.821	3.977	4.136	4.283	4.434
23	APPAREL	14.328	14.504	14.669	15.169	15.827	16.248	16.670
24	LUMBER AND WOOD	9.796	10.301	10.388	10.605	10.875	10.964	11.066
25	FURNITURE AND FIXTURES	4.785	5.058	5.177	5.311	5.505	5.646	5.806
26	PAPER AND PRODUCTS	3.467	3.595	3.696	3.809	3.923	4.030	4.138
2729	PRINTING, PUBLISHING, AND PETROLEUM	2.067	2.113	2.158	2.203	2.248	2.288	2.324
28	CHEMICALS	2.463	2.583	2.636	2.742	2.831	2.892	2.942
30	RUBBER AND PLASTICS	3.369	3.440	3.479	3.592	3.665	3.724	3.807
31	LEATHER AND PRODUCTS	0.347	0.335	0.320	0.333	0.331	0.328	0.327
32	STONE, CLAY, AND GLASS	4.050	4.211	4.242	4.349	4.476	4.627	4.632
33	PRIMARY METALS	1.449	1.509	1.542	1.561	1.579	1.593	1.607
34	FABRICATED METALS	4.644	4.783	4.942	5.076	5.284	5.424	5.522
35	NONELECTRICAL MACHINERY	5.944	6.157	6.405	6.771	7.123	7.441	7.737
36	ELECTRICAL MACHINERY	7.746	8.010	7.972	8.400	8.611	9.221	9.726
37	TRANSPORTATION EQUIPMENT	4.065	4.318	4.418	4.421	4.448	4.506	4.638
3869	INSTRUMENTS AND MISCELLANEOUS	2.620	2.737	2.209	2.926	3.015	3.095	3.173
MANUFACTURING - TOTAL		85.141	88.065	89.397	92.224	95.214	97.557	100.082
	CONSTRUCTION	16.943	17.376	17.464	17.851	18.545	19.316	20.149
	FINANCE, INSURANCE, AND REAL ESTATE	16.558	17.294	17.987	18.665	19.312	19.896	20.458
	GOVERNMENT	78.824	80.527	82.726	85.150	87.761	90.444	93.061
	TRANS., COMM., UTILITIES	18.954	19.337	19.665	19.985	20.267	20.628	21.028
	SERVICES	57.655	59.968	62.223	64.457	66.519	68.781	71.207
	TRADE	72.648	74.541	75.852	77.534	79.202	80.106	80.992
	MINING	3.708	3.817	3.901	3.979	4.061	4.145	4.244
NONMANUFACTURING - TOTAL		265.289	272.859	279.818	287.621	295.686	303.315	311.139
NONAGRICULTURAL - TOTAL		350.426	360.923	369.215	379.845	390.899	400.871	411.220
INCOME, WAGES, AND POPULATION								
TOTAL PERSONAL INCOME (000000'S)		5,905.638	6,442.956	7,011.172	7,675.227	9,415.865	9,179.195	9,996.691
PER CAPITA PERSONAL INCOME		4,994.43	5,418.23	5,861.99	6,376.53	6,944.30	7,518.76	8,123.68
AVERAGE HOURLY EARNINGS - MFG.		4.137	4.483	4.758	5.106	5.483	5.578	6.284
POPULATION (000'S)		1,182.400	1,189.082	1,195.995	1,303.613	1,211.856	1,220.722	1,230.501

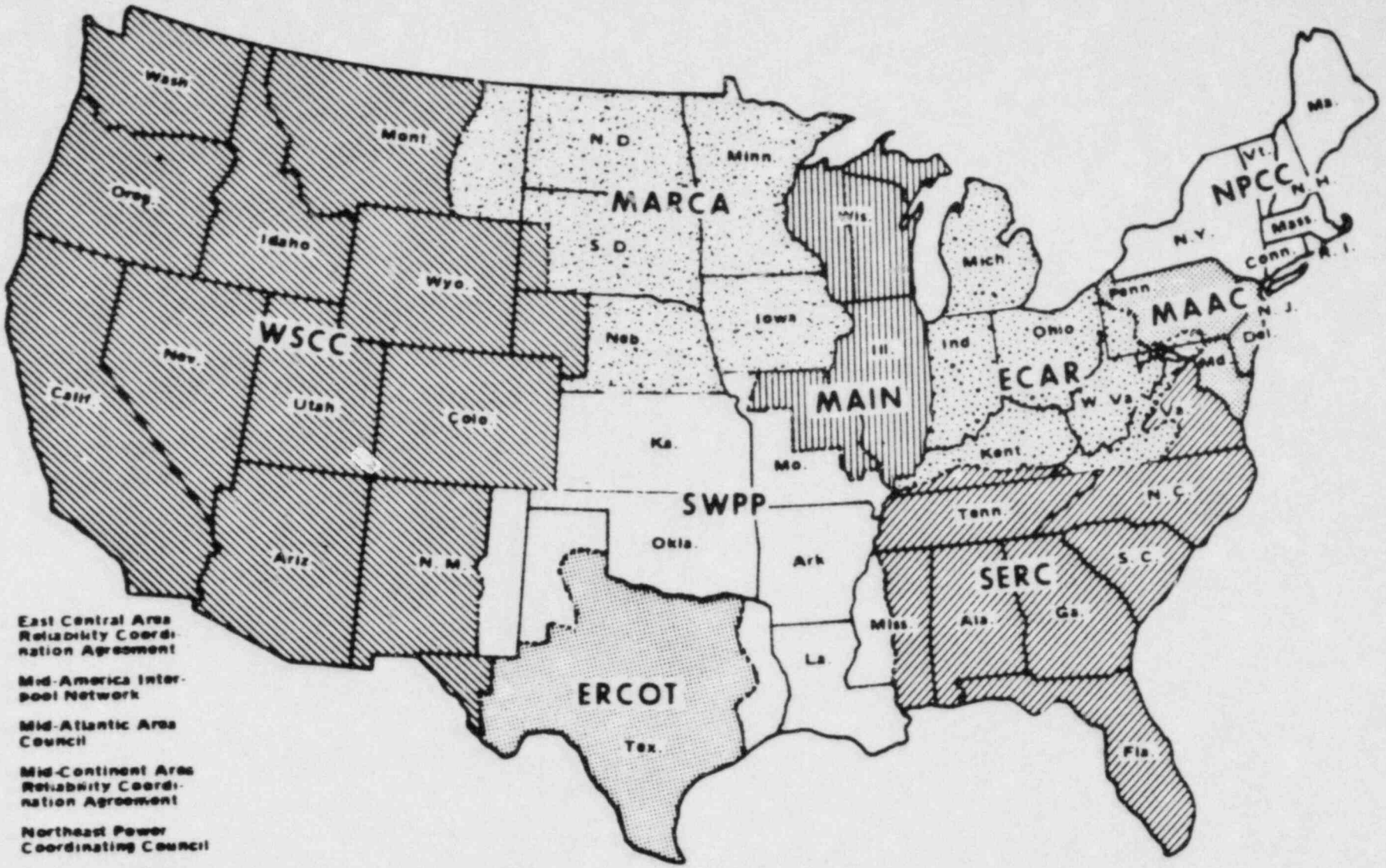
301.9

TABLE 1.1.19 (Cont.)

MISSISSIPPI POWER & LIGHT COMPANY
ECONOMIC MODEL
ANNUAL VALUES OF FORECASTED VARIABLES
1977 TO 1990

		1984	1985	1986	1987	1988	1989	1990
EMPLOYMENT (THOUSANDS OF EMPLOYEES)								
SIC	INDUSTRY							
20	FOODS	11.404	11.449	11.477	11.490	11.476	11.486	11.381
22	TEXTILES	4.569	4.687	4.795	4.891	4.974	5.036	5.095
23	APPAREL	17.169	17.887	18.280	18.872	19.493	19.982	20.398
24	LUMBER AND WOOD	11.134	11.094	11.008	10.869	10.732	10.592	10.428
25	FURNITURE AND FIXTURES	5.998	6.207	6.431	6.625	6.767	6.850	6.952
26	PAPER AND PRODUCTS	4.243	4.340	4.433	4.519	4.597	4.668	4.733
2729	PRINTING, PUBLISHING, AND PETROLEUM	2.355	2.383	2.409	2.432	2.454	2.474	2.492
28	CHEMICALS	2.997	3.045	3.069	3.098	3.156	3.211	3.281
30	RUBBER AND PLASTICS	3.893	3.976	4.063	4.152	4.241	4.335	4.437
31	LEATHER AND PRODUCTS	0.324	0.321	0.317	0.313	0.309	0.298	0.292
32	STONE, CLAY, AND GLASS	5.059	5.246	5.367	5.517	5.657	5.799	5.928
33	PRIMARY METALS	1.614	1.619	1.624	1.632	1.648	1.669	1.687
34	FABRICATED METALS	5.575	5.632	5.713	5.754	5.766	5.851	5.892
35	NONELECTRICAL MACHINERY	8.021	8.289	8.640	8.997	9.291	9.572	9.882
36	ELECTRICAL MACHINERY	10.239	10.645	11.046	11.446	11.800	12.189	12.688
37	TRANSPORTATION EQUIPMENT	4.814	4.998	5.176	5.368	5.547	5.719	5.894
3869	INSTRUMENTS AND MISCELLANEOUS	3.249	3.307	3.367	3.432	3.495	3.552	3.612
MANUFACTURING - TOTAL		102.655	104.924	107.236	109.422	111.402	113.235	115.062
	CONSTRUCTION	20.910	21.502	21.945	22.210	22.335	22.355	22.232
	FINANCE, INSURANCE, AND REAL ESTATE	20.996	21.532	22.072	22.632	23.168	23.655	24.139
	GOVERNMENT	95.496	98.098	100.812	103.632	106.412	109.054	111.619
	TRANS., COMM., UTILITIES	21.452	21.879	22.306	22.742	23.174	23.595	24.005
	SERVICES	73.672	76.178	78.717	81.344	84.030	86.720	89.371
	TRADE	81.972	83.146	84.686	86.435	88.124	89.668	91.178
	MINING	4.363	4.478	4.566	4.628	4.675	4.709	4.724
NONMANUFACTURING - TOTAL		318.860	326.814	335.105	343.622	351.917	359.755	367.268
NONAGRICULTURAL - TOTAL		421.516	431.737	442.340	453.043	463.318	472.989	482.329
INCOME, WAGES, AND POPULATION								
TOTAL PERSONAL INCOME (000000'S)		10,867.623	11,786.741	12,775.695	13,827.840	14,936.434	16,096.951	17,380.769
PER CAPITA PERSONAL INCOME		8,756.48	9,410.21	10,100.23	10,820.39	11,564.19	12,326.84	13,116.28
AVERAGE HOURLY EARNINGS - MFG.		6.707	7.151	7.616	8.105	8.618	9.154	9.712
POPULATION (000'S)		1,241.031	1,252.482	1,264.822	1,277.872	1,291.540	1,305.774	1,320.483

301.9



ECAR - East Central Area Reliability Coordination Agreement

MAIN - Mid-America Interpool Network

MAAC - Mid-Atlantic Area Council

MARCA - Mid-Continent Area Reliability Coordination Agreement

NPCC - Northeast Power Coordinating Council

SERC - Southeastern Electric Reliability Council

SWPP - Southwest Power Pool

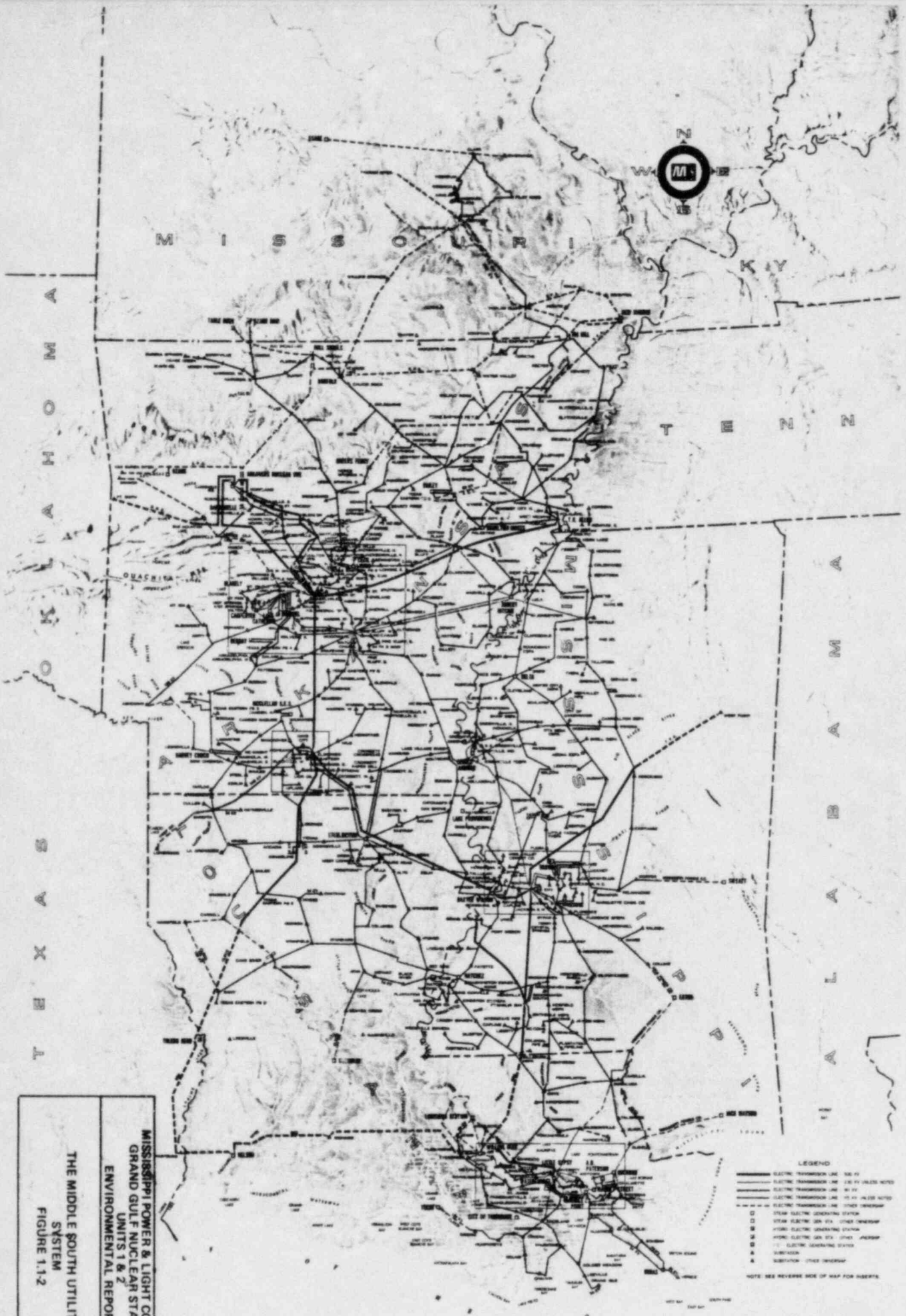
ERCOT - Electric Reliability Council of Texas

WSCC - Western Systems Coordinating Council

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

NATIONAL ELECTRIC
RELIABILITY COUNCIL REGIONS

FIGURE 1.1-1



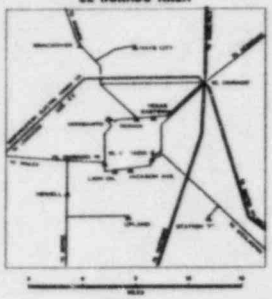
THE MIDDLE SOUTH UTILITIES SYSTEM

ARKANSAS POWER & LIGHT CO. • ARKANSAS MISSOURI POWER CO. • LOUISIANA POWER & LIGHT CO.
MISSISSIPPI POWER & LIGHT CO. • NEW ORLEANS PUBLIC SERVICE INC. • MIDDLE SOUTH SERVICES INC.

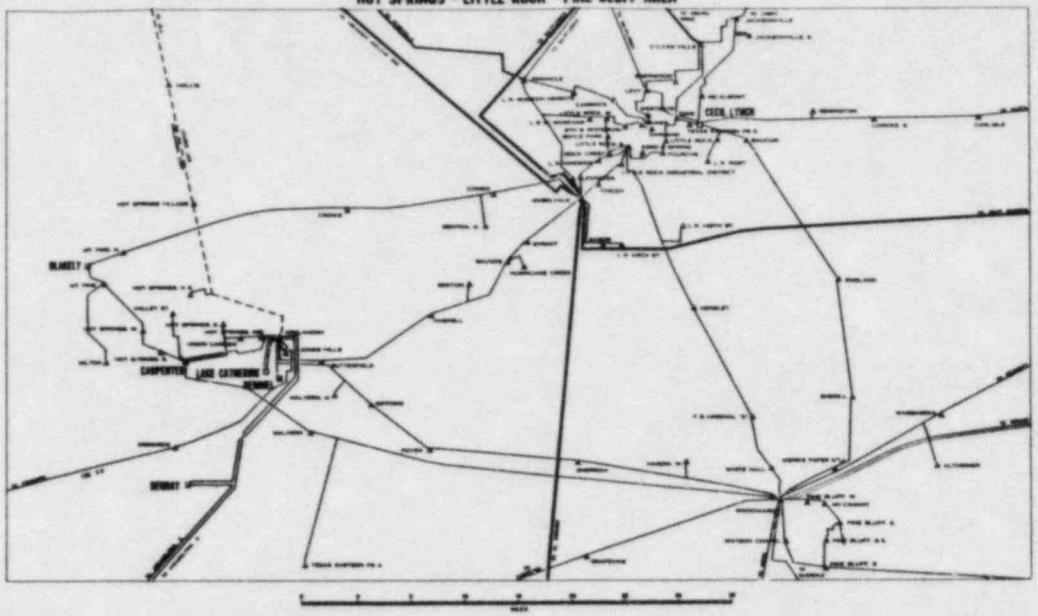
MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

THE MIDDLE SOUTH UTILITIES SYSTEM
FIGURE 1.1-2

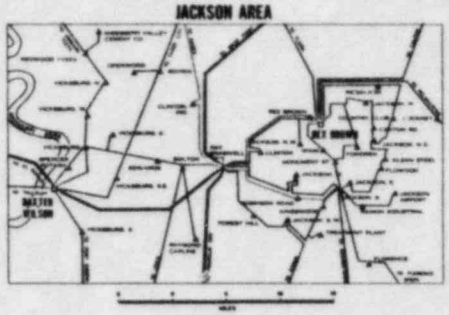
EL DORADO AREA



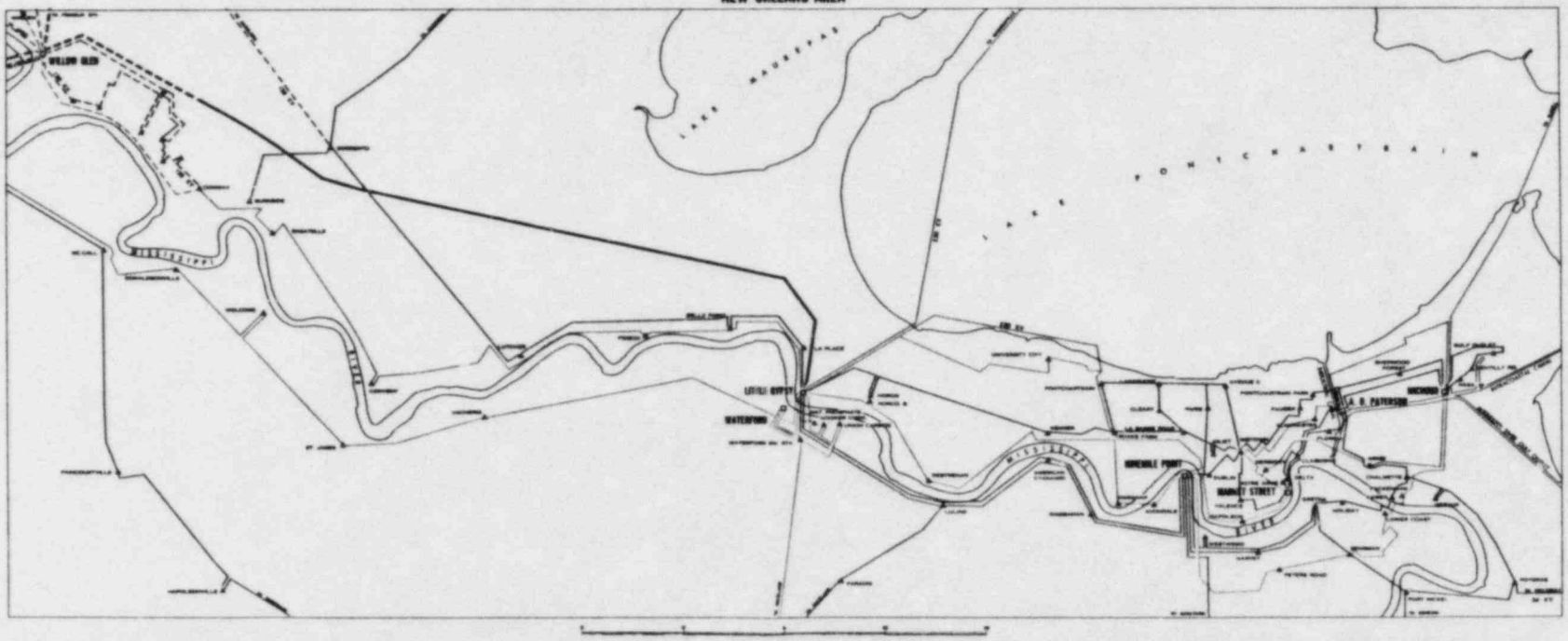
HOT SPRINGS - LITTLE ROCK - PINE BLUFF AREA

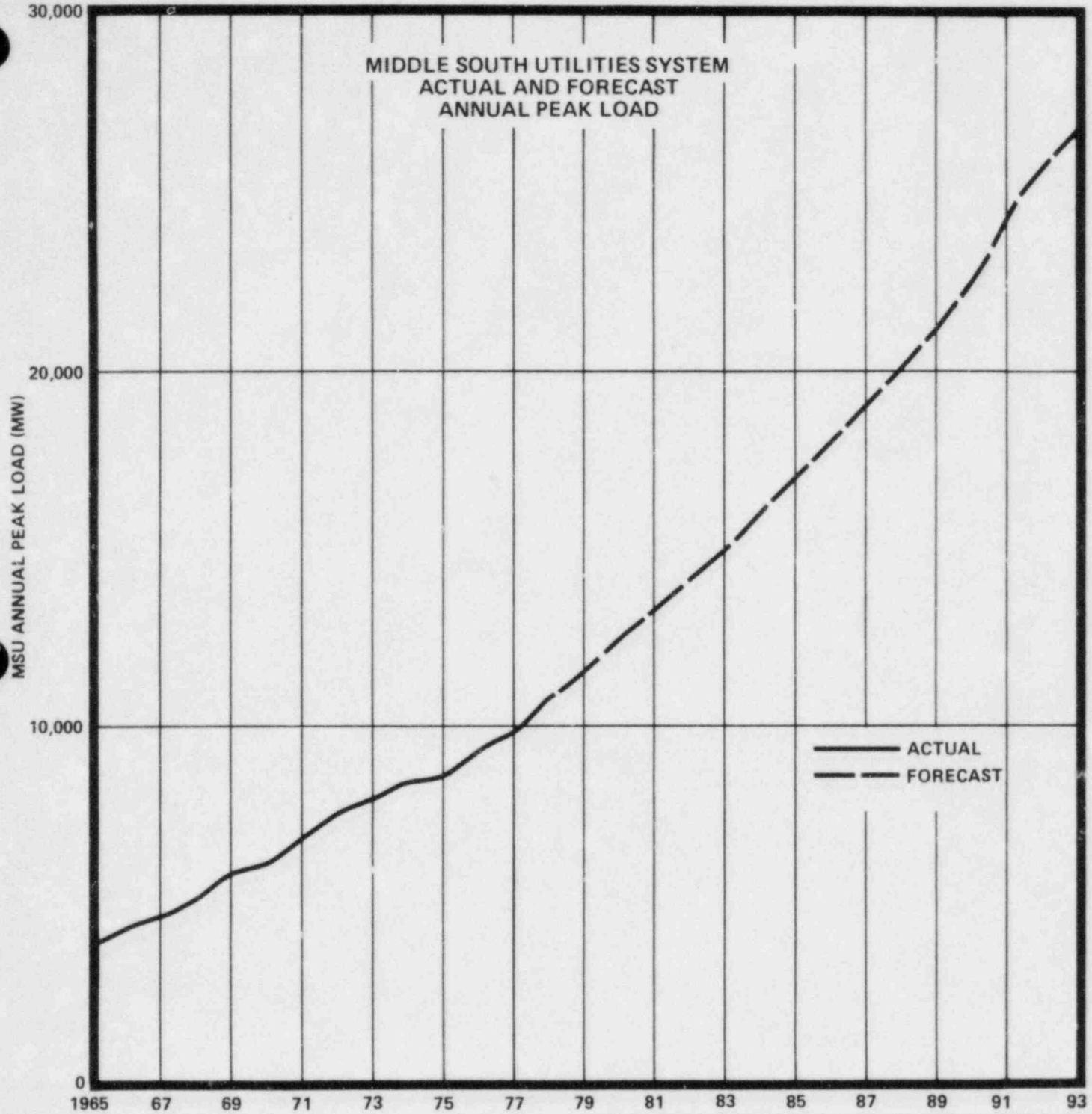


JACKSON AREA



NEW ORLEANS AREA



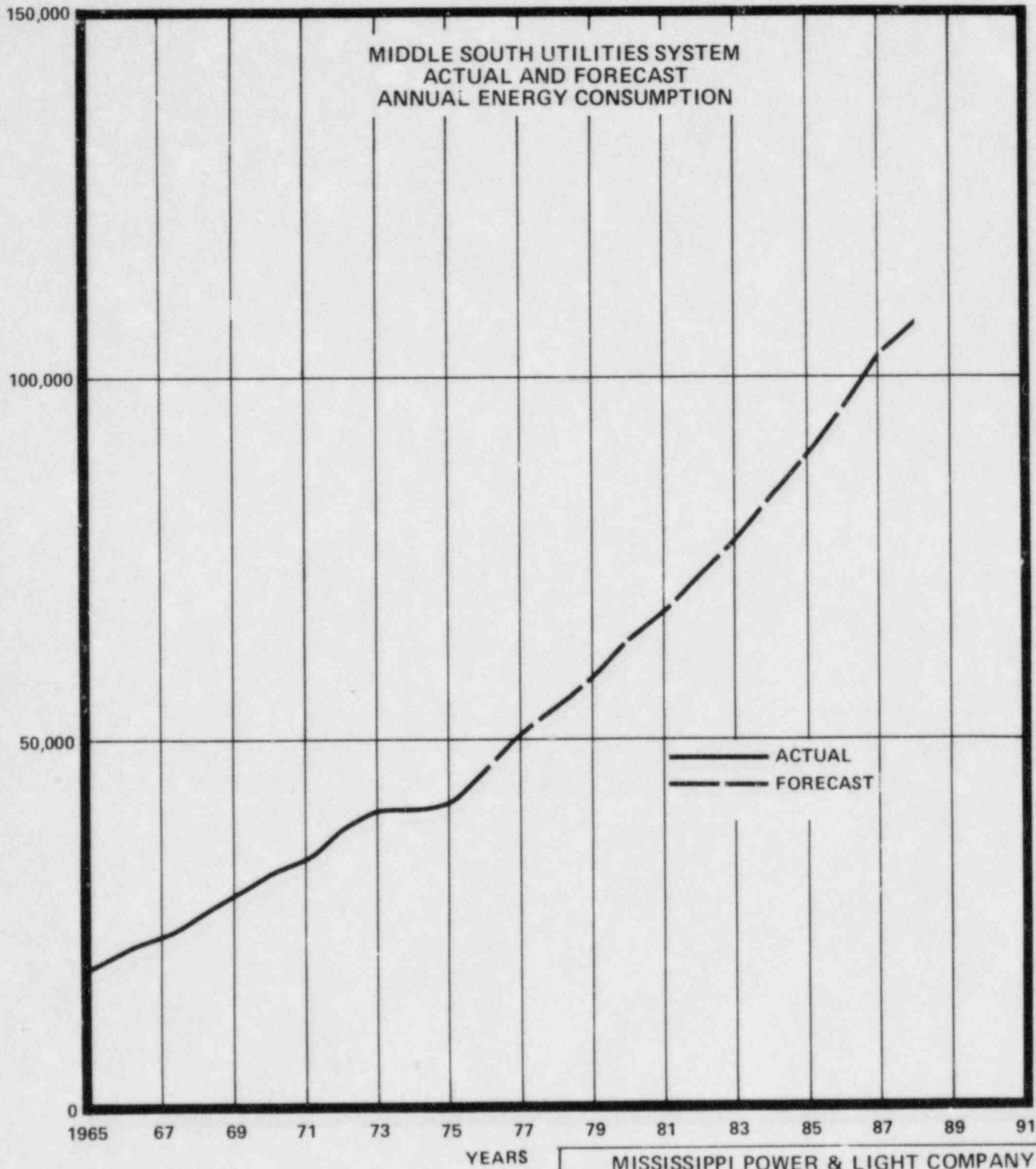


MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

MIDDLE SOUTH UTILITIES SYSTEM
ACTUAL AND FORECAST ANNUAL
PEAK LOAD

FIGURE 1.1-3

Amend. 1 3/79

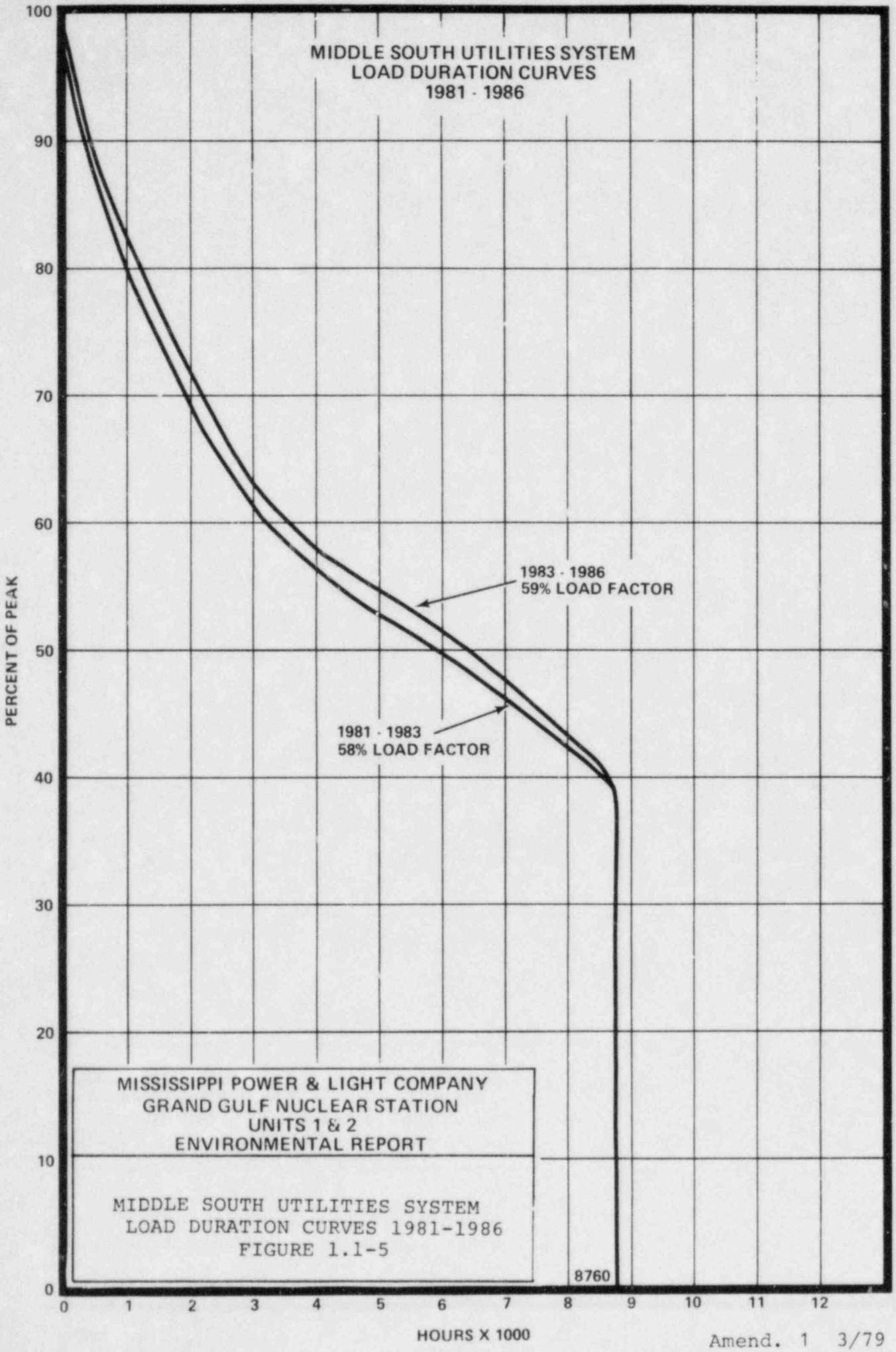


MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

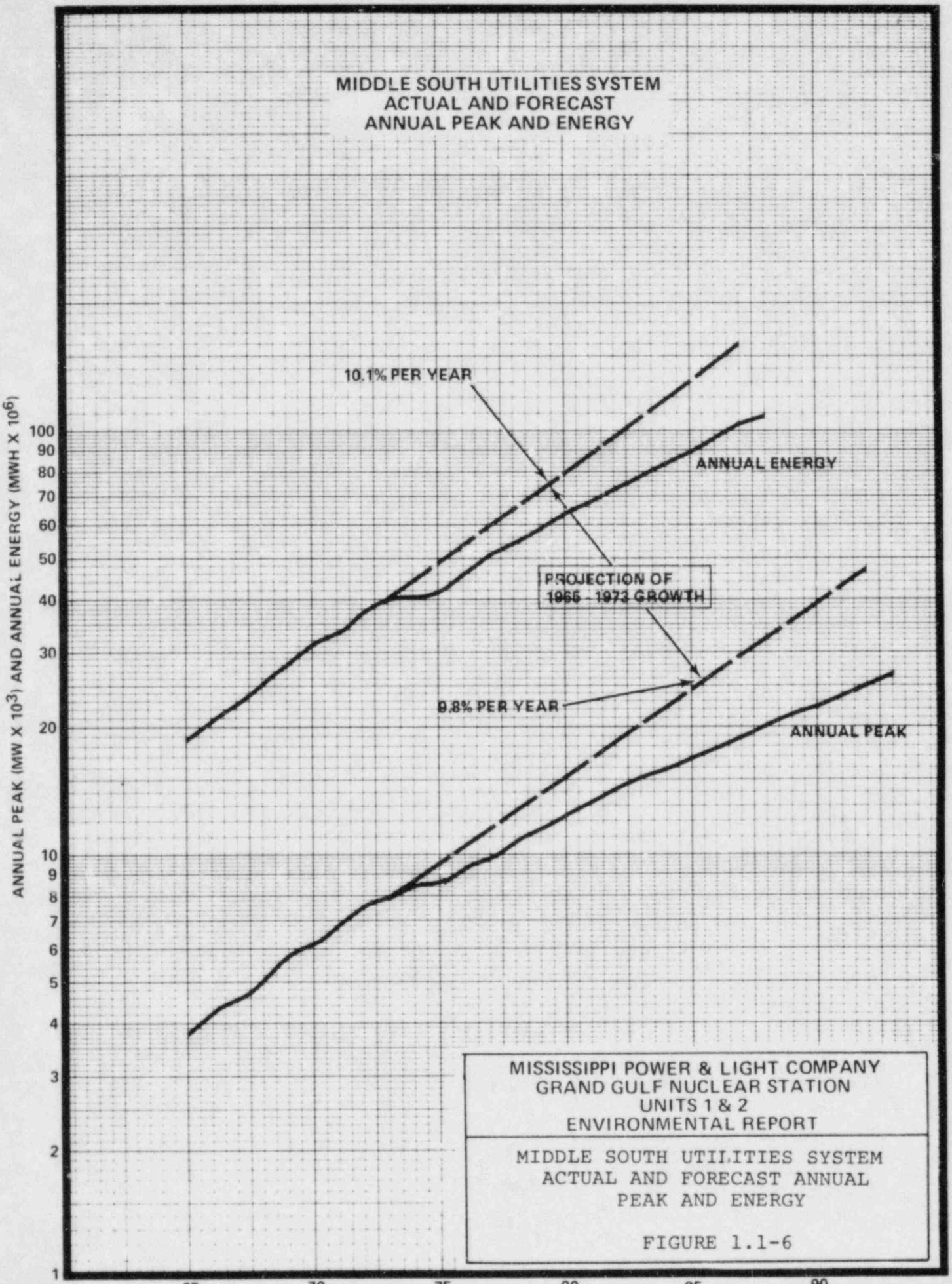
MIDDLE SOUTH UTILITIES SYSTEM
ACTUAL AND FORECAST ANNUAL
ENERGY COMSUMPTION

FIGURE 1.1-4

Amend. 1 3/79


MIDDLE SOUTH UTILITIES SYSTEM
LOAD DURATION CURVES
1981 - 1986
PERCENT OF PEAK
100
90
80
70
60
50
40
30
20
10
0
1983 - 1986
59% LOAD FACTOR
1981 - 1983
58% LOAD FACTOR
0
1
2
3
4
5
6
7
8
9
10
11
12
8760
HOURS X 1000
MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT
MIDDLE SOUTH UTILITIES SYSTEM
LOAD DURATION CURVES 1981-1986
FIGURE 1.1-5

Amend. 1 3/79



MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

MIDDLE SOUTH UTILITIES SYSTEM
ACTUAL AND FORECAST ANNUAL
PEAK AND ENERGY

FIGURE 1.1-6

Amend. 1 3/79

REPORTS TO FEDERAL POWER COMMISSION

APPENDIX A

ARKANSAS POWER & LIGHT COMPANY
9th & LOUISIANA STREETS • LITTLE ROCK, ARKANSAS 72203 • (501) 372-4311

December 14, 1973

ARCH P. PETTIT
Senior Vice President

Federal Power Commission
441 "G" Street, N. W.
Washington, D.C. 20426

Attention: Mr. Kenneth F. Plumb, Secretary

Gentlemen:

Re: Docket No. RM-74-7
Order No. 496

Enclosed, in duplicate, is completed FPC Form 19 (Energy Report Form) for Arkansas Power & Light Company, which Form is filed pursuant to Order No. 496, issued November 29, 1973. Because of the filing deadline set forth in Order No. 496, the figures set forth in Form 19 are, of necessity, merely the best estimates which could be completed from existing information.

It must be realized that the interrelation of energy use is an involved process and that the effects of curtailment in one area of use can have an effect upon other areas of use, and is, at best, unpredictable with any degree of accuracy. For example, the elimination of a nighttime athletic event will result in a saving of energy for that particular use. The people who would have attended such an event, however, will be somewhere else and will be otherwise engaged, with the very strong probability that they will, as an aggregate, consume more energy than the athletic event would have consumed. The probability is, then, that the aggregate energy use for these particular hours would be increased.

It must also be noted that voluntary curtailment in commercial and industrial applications may, in some cases, work contrary to its purpose. For example, there exists the possibility that in buildings with some types of ducted air systems, the thermostat reduction may occasion increases in energy consumption unless a

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MIDDLE SOUTH SERVICES, INC.
ENGINEERING DEPARTMENT

1.1A-1

thorough analysis of the system is made and extensive readjustment of the system operating characteristics is accomplished. In these cases, the further possibility exists that, without the addition of controls and some modification of the system, the reduction in energy consumption cannot be realized.

Not only are there these large and unpredictable interrelations between the various uses of electric energy, but there is also a definite interface between electric and other forms of energy such as natural gas, LP gas and fuel oil. For example, the generation of heat in a space by lighting is lost when lighting use is curtailed and, regardless of thermostat setting, thus results in increased heating fuel consumption. Further, in some types of ducted air systems for heating and cooling, the reduction of thermostat settings may result in a savings of heating fuel while at the same time activating cooling equipment or increasing the use of cooling equipment, thus increasing the aggregate energy consumption.

It is urged that a stronger, more concentrated conservation effort on the part of the gas industry, particularly gas distribution companies, be pursued in the area of residential and commercial fields which might well keep industry from having to reduce production and lay off personnel.

Internally, the Arkansas Power & Light Company has and is making a concentrated effort toward conservation. The steps taken in this direction are:

1. Discontinuation at all offices, plants, substations and other properties of all outdoor night lighting except that minimum amount considered essential at power plants for operating safety and security purposes and that amount at other properties considered essential to security purposes.

2. The reduction of all heating levels in Company offices, plants and other properties to a level not exceeding 68° in the daytime, with additional night setbacks where practical, considering the use of the structure during night hours.

3. A concentrated effort to reduce automotive travel to the essential minimum and to encourage car pooling among employees.

4. The establishment and enforcement of Company speed limits for all Company owned vehicular transportation and encouragement of employees to recognize the President's request for reduced speed limits when traveling in personal vehicles.

External to the Company's owned operation and its employees, the Arkansas Power & Light Company has and is engaged in a campaign of advertising directed toward the necessity of energy conservation and providing information to its customers as to the methods and ways in which energy may be conserved. This campaign is carried out through the mass media of newspaper, radio and television.

Further, the Company's representatives have been and are calling on commercial, industrial, government and municipal customers to inform these customers of the provisions of the Company's "Contingency Emergency Power Conservation and Curtailment Plan" and to assist these customers in a survey of their facilities to determine what loads can be discontinued from service and for what periods of time, and to assist these customers in determining where voluntary curtailments may be carried out and, if necessary, where further load reduction can be accomplished in an orderly manner, with the least detriment to the customer's operating capability. In these calls, customers with ducted air systems which might increase in energy consumption due to temperature setbacks are being encouraged to seek professional analysis and advice of their system for maximum energy reduction.

We will continue to advise our customers on methods of conservation and urge them to reduce all nonessential use.

Yours very truly,

Arch P Pettit

Arch P. Pettit
Senior Vice President

APP:jb

Enclosure

RESPONDING UTILITY */ **Arkansas Power & Light Company**

Line No.			1973 DEC.	1974 JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	13 Mo TOTAL
1	I. Projected net system generation by months prior to conservation efforts proposed by this order. (MWH)		1,064,616	1,122,970	1,024,003	1,083,744	1,017,419	1,115,120	1,420,340	1,563,150	1,580,834	1,359,604	1,201,852	1,133,621	1,170,965	15,858,238
2	II. Projected net energy generation from combustion turbines and internal combustion engines by months prior to conservation efforts proposed by this order. (MWH) Note 1		0	0	0	0	0	0	0	0	0	0	0	0	0	0
	III. Projected monthly reductions that may result from the following conservation procedures:															
3	1. Curtailment of non-essential heating and lighting load at utility-owned power plants and office facilities. Note 2	a.	520	545	520	470	370	345	520	545	545	470	345	470	520	6185
4		b.														0
5	2. Curtailment of non-essential generating station auxiliaries at power plants. Note 3	a.	179	179	179	179	179	179	179	179	179	179	179	179	179	2327
6		b.														0
7	3. Appeals to large commercial and industrial customers to curtail non-essential use. Note 4	a.	8030	8330	8034	8234	6700	7125	8451	14088	14651	11796	10542	7652	10426	124059
8		b.														0

a. Total energy saved. (MWH)
b. Amount of energy in "a" which is normally supplied by combustion turbines and internal combustion engines. (MWH)

*/ GENERAL INSTRUCTION - Where the reporting electric utility projects short-falls of fuel availability for its generating resources which will necessitate electric power and energy reductions of greater than 10 percent (e.g., 15, 20 or 25 percent), the Emergency Report Form shall be completed so as to reflect (a) the various stages of projected fuel availability up to the most adverse foreseable projections at the time of completing the form, (b) the variations (if any) in the order of the steps which the reporting utility proposes to implement in carrying out its electric contingency planning. The reporting utility shall relate the reported actions to any contingency planning procedures which the reporting utility has submitted to the Federal Power Commission or state public service commissions pursuant to Federal Power Commission Order No. 445, this Commissions January 24, 1973, emergency letter questionnaire or otherwise, individually or through a reliability council. The Commission requests the use of manifold copies of pages of the Emergency Report Form by each reporting utility to supply, for its system, the electric conservation, contingency planning procedures and load reduction steps under varying assumptions, as may be projected by the reporting utility. The Emergency Report Form shall be filed in duplicate.

EMERGENCY ACTION FOR CONSERVATION OF PETROLEUM AND NATURAL GAS

Arkansas Power & Light Company

Line No.			1973 DEC.	1974 JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	13 Mo. TOTAL
9	4. Appeals to the public to curtail non-essential use	a.	5120	5404	5214	4659	2135	1864	5856	13051	14203	8733	5976	2056	5120	79391
10		b.														0
	Note 4															
11	5. Interuption of contractually interruptible load.	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12		b.														
	Note 5															
13	6. Reduction of system voltage.	a.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14		b.														
	Note 6															
15	7. Reduction in use of electricity by governmental entities due to reductions or changes of usage in governmental facilities, buildings, street illumination, or others.	a.	1291	1381	1262	1211	1278	1196	1409	1473	1521	1528	1395	1284	1290	17519
16		b.														0
	Note 7															
17	8. Reduction of hours of operation of commercial centers.	a.	4212	4422	4212	4338	4248	4635	5667	6735	7092	6768	5814	4848	4653	67644
18		b.														0
	Note 8															
19	9. Reduction of use by industrial customers whose output is not essential to the public health and safty.	a.	13890	13908	13116	13950	13688	14112	14730	15081	15090	14676	14958	14808	14562	186569
20		b.														0
	Note 9															
21	10. Elimination of outdoor nighttime sporting events.	a.	86	36	66	89	30	182	331	528	385	272	288	248	86	2627
22		b.														0
23	11. Elimination of outdoor commercial advertising display.	a.	4080	4080	4080	4080	4080	4080	4080	4080	4080	4080	4080	4080	4080	53040
24		b.														
25	12. Other (identify)	a.	4275	4275	4247	3993	2605	2620	3677	6583	6986	6946	5786	3127	4498	59618
26	Note 10	b.														0

NOTES: It is recognized the savings envisioned by use of item 7 through 11 would reflect prior governmental action in many instances authorizing or mandating the changed conditions producing the savings.

Arkansas Power & Light Company

ne o.			1973 DEC	1974 JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	13 Mo TOTAL
	IV. State the amount of oil in barrels and natural gas in Mcf which may be saved through the following measures:															
1	1. Optimizing use of coal-fired generation within the utility's system.	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3		c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Note 11															
4	2. Engaging in inter-company and inter-area transfers in order to maximize the use of coal-fired capacity.	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6		c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Note 12															
7	3. Modifying operating reserve policy to permit combustion turbines and internal combustion engines to be considered as reserve when shut down.	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9		c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Note 13															
10	4. Other (identify)	a.														
11		b.														
12		c.														

a. Total bbls. of residual oil
b. Total bbls. of distillate oil
c. Total volumes of natural gas in Mcf at 14.73 psia

ARKANSAS POWER & LIGHT COMPANY

FOOTNOTES TO FPC FORM 19

Note 1 (Line 2)

The Arkansas Power & Light Company presently has installed 91 megawatts of combustion turbine generation and 6 megawatts of internal combustion engine generation. Based on our latest studies, this generating capability will not be used under normal operating conditions. We expect these units to be used only in the event of forced outages on steam units within the Middle South System. For this reason, no generation is projected on this class of generation.

This class of generation will, however, be operated periodically for short periods for purposes of testing to assure reliability.

Note 2 (Line 3)

This reduction has been implemented.

Note 3 (Line 5)

This reduction has been implemented. The megawatt hours of reduced generation listed here are the results of curtailment of both nonessential generating station auxiliaries at power plants and the reduction of lighting at plant facilities.

The megawatt hours used by power plant auxiliaries and power plant lighting are not included in the projected net system generation listed on Line 1 above.

Note 4 (Line 7 and Line 9)

The Company, in all media, radio, television and newspaper, is urging this voluntary curtailment.

Note 5 (Line 11)

The Company has no contractually interruptible loads except to the extent that all loads may be temporarily interrupted pursuant to provisions of the "Contingency

Emergency Power Conservation and Curtailment Plan" section of the Company's Service Regulations as filed with, and approved by, the Arkansas Public Service Commission.

Note 6 (Line 13)

The amount of energy conservation due to voltage reduction is unknown. Tests are now being run by the Arkansas Power & Light Company and other companies of Middle South System to determine the amount of energy, if any, that will be conserved by this method of System operation.

Note 7 (Line 15)

This reduction has been placed in implementation by Federal, State and local installations, as requested by the President and the State of Arkansas.

Note 8 (Line 17)

The amount of reduction in megawatt hours of consumption which can be saved by reducing the hours of operation of commercial centers could vary widely, depending upon:

1. The final definition placed on commercial centers which affect the type, number and size of businesses involved.

2. The number of hours by which the defined commercial center's operation was reduced.

3. The time of day during which the defined commercial center's operation was suspended.

4. The choice of reduction of operation by curtailing hours per day versus curtailing days per week.

The estimate of total reduction of consumption listed on Line 17 is not additive in total with the reduction shown on Line 7, since the curtailment by voluntary action of some part of this load is already foreseen and reported on Line 7.

Note 9 (Line 19)

The reduction of consumption listed on Line 19 may vary depending upon the definition of industry which is not essential to public health and safety.

Assuming that 12% of the industrial consumption is in industry which might be classified as nonessential to public health and safety, and that such customers would be reduced in operation by 25%, there would be an overall reduction of 3% in projected industrial consumption.

The estimate of total reduction of consumption listed on Line 9 is not additive in total with the reductions shown on Line 7, since the curtailment by voluntary action of some part of this load is already foreseen and reported on Line 7 and is considered in this estimated reduction.

Note 10 (Line 25)

The foregoing figures do not include information pertaining to reduction in use by customers of municipal and co-operative electric systems which systems are supplied with electric energy generated by the Company. It is assumed that such systems will make their own responses to Order 496. Figures shown on Line 25 are based on the assumption that the reductions experienced by the utilities served from our generation will parallel those of the Company.

Note 11 (Question IV) (Line 1)

There are no coal fired plants on the Middle South Utilities System.

Note 12 (Question IV) (Line 4)

At this time, the System operator has been unable to secure commitments for energy from any of the adjoining systems that use coal as a primary fuel.

Note 13 (Question IV) (Line 7)

The combustion turbines and internal combustion engines are expected to be used only in the event of forced outages on steam units within the Middle South System and are, therefore, already considered as reserves when shut down.

ARKANSAS-MISSOURI POWER COMPANY
405 W. PARK ST. • BLYTHEVILLE, ARKANSAS 72315 • (501) 763-6621
MIDDLE SOUTH SERVICES, INC.
ENGINEERING DEPARTMENT

T. J. WRIGHT
DIRECTOR
ENGINEERING AND PLANNING

RECEIVED
DEC 20 1973

December 12, 1973

Mr. Kenneth F. Plumb, Secretary
Federal Power Commission
441 G Street, N. W.
Washington, D. C. 20426

Reference: Docket No. RM-74-7
Order No. 496

Dear Mr. Plumb:

In response to the aforementioned docket and order, Arkansas-Missouri Power Company submits the attached FPC Form No. 19 and states that the following actions have been undertaken prior to this order in an effort to curtail electric energy consumption:

Mr. Frank G. Smith, Jr., President of Arkansas-Missouri Power Company and its subsidiary, Associated Natural Gas Company, announced in a news release dated November 13, 1973, support for President Richard M. Nixon's proposals to conserve energy in "Operation Independence." He also stated the following steps to be undertaken to effect immediate reductions in the consumption of electric power and energy internally to the utility and ultimate consumers served by it. These steps are as follows:

1. All officers, department heads, district and local managers, and key personnel should see that all thermostats in all company offices be set no higher than 68 degrees during the heating season.

2. All unnecessary lighting in company offices, storerooms, and substations should be reduced.

3. The lights should be turned off when work is not being conducted, such as during lunch hours.

1.1A-10

4. Christmas decorations requiring electric lights will be eliminated.

5. Through the news media, we are presently publicizing ways and means by which our customers can reduce the usage of electric energy.

6. Handout literature is available to our customers that further explains how our consumers can conserve energy.

In compiling the information required in FPC Form No. 19, the following interpretations were utilized.

Item	Line	Interpretation
I	1	Net system generation was interpreted to mean net system requirements. This meaning was coordinated with the other Operating Companies within the Middle South Utilities System to assure total MS system generation would equal total individual MS Companies' net requirements.
III-2	5	All requirements are projected to be generated by plants operated by others.
III-6	13	Due to extensive utilization of line regulators, reduction of voltage level highly impracticable.
III-9	19	Public health and safety was interpreted to include economic health and safety.

If any additional information or clarifications should be necessary, please contact us.

Very truly yours,

T. J. Wright

TJW:eb

Enclosure

cc: Richard M. Merriman, Esq., Reid & Priest
Mr. Frank G. Smith, Jr.
Mr. R. M. Jamison

RESPONDING UTILITY: */

Line No.		1973 DEC.	1974 JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1	I. Projected net system generation by months prior to conservation efforts proposed by this order. (MWH)	109,760	105,648	110,936	101,108	97,697	103,111	118,489	136,354	144,281	139,096	125,552	116,027	112,641	1521,500
2	II. Projected net energy generation from combustion turbines and internal combustion engines by months prior to conservation efforts proposed by this order. (MWH)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	III. Projected monthly reductions that may result from the following conservation procedures:														
3	1. Curtailment of non-essential heating and lighting load at utility-owned power plants and office facilities. a.	25	25	20	20	20	25	30	25	25	25	25	25	25	315
4	b.														
5	2. Curtailment of non-essential generating station auxiliaries at power plants. a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	b.														
7	3. Appeals to large commercial and industrial customers to curtail non-essential use. a.	850	929	936	912	897	754	804	831	1049	646	1122	975	1302	12007
8	b.														

a. Total energy saved. (MWH)
b. Amount of energy in "a" which is normally supplied by combustion turbines and internal combustion engines. (MWH)

*/ GENERAL INSTRUCTION - Where the reporting electric utility projects short-falls of fuel availability for its generating resources which will necessitate electric power and energy reductions of greater than 10 percent (e.g., 15, 20 or 25 percent), the Emergency Report Form shall be completed so as to reflect (a) the various stages of projected fuel availability up to the most adverse forseeable projections at the time of completing the form, (b) the variations (if any) in the order of the steps which the reporting utility proposes to implement in carrying out its electric contingency planning. The reporting utility shall relate the reported actions to any contingency planning procedures which the reporting utility has submitted to the Federal Power Commission or state public service commissions pursuant to Federal Power Commission Order No. 445, this Commissions January 24, 1973, emergency letter questionnaire or otherwise, individually or through a reliability council. The Commission requests the use of manifold copies of pages of the Emergency Report Form by each reporting utility to supply, for its system, the electric conservation, contingency planning procedures and load reduction steps under varying assumptions, as may be projected by the reporting utility. The Emergency Report Form shall be filed in duplicate.

EMERGENCY ACTION FOR CONSERVATION OF PETROLEUM AND NATURAL GAS

Line No.			1973 DEC.	1974 JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
9	4. Appeals to the public to curtail non-essential use	a.	1050	1095	1077	1065	852	923	1051	1594	1846	1979	1603	1099	1015	16249
10		b.														
11	5. Interuption of contractually interruptible load.	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12		b.														
13	6. Reduction of system voltage.	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14		b.														
15	7. Reduction in use of electricity by governmental entities due to reductions or changes of usage in governmental facilities, buildings, street illumination, or others.	a.	30	31	44	36	67	40	47	49	39	33	36	27	44	523
16		b.														
17	8. Reduction of hours of operation of commercial centers.	a.		No major commercial centers												
18		b.														
19	9. Reduction of use by industrial customers whose output is not essential to the public health and safty.	a.	275	291	256	281	289	240	241	228	287	150	326	303	410	3607
20		b.														
21	10. Elimination of outdoor nighttime sporting events.	a.	0	0	0	0	100	95	95	100	90	140	135	145	0	900
22		b.														
23	11. Elimination of outdoor commercial advertising display.	a.	325	325	325	325	325	250	250	250	250	250	250	325	325	3775
24		b.														
25	12. Other (identify)	a.														
26		b.														

NOTE: It is recognized the savings envisioned by use of item 7 through 11 would reflect prior governmental action in many instances authorizing or mandating the changed conditions producing the savings.

Line No.			1973	1974											
			DEC	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
	IV. State the amount of oil in barrels and natural gas in Mcf which may be saved through the following measures:															
1	1. Optimizing use of coal-fired generation within the utility's system.	a.	0	46100	33500	45100	43200	46100	43200	45100	46100	43200	45100	43200	46100	543000
2		b.														
3		c.														
4	2. Engaging in inter-company and inter-area transfers in order to maximize the use of coal-fired capacity.	a.	Unable to secure any commitments at this time.													
5		b.														
6		c.														
7	3. Modifying operating reserve policy to permit combustion turbines and internal combustion engines to be considered as reserve when shut down.	a.	Already considered as such.													
8		b.														
9		c.														
10	4. Other (identify)	a.														
11		b.														
12		c.														

a. Total bbls. of residual oil
b. Total bbls. of distillate oil
c. Total volumes of natural gas in Mcf at 14.73 psia

Mr. Jordan

LOUISIANA POWER & LIGHT / 142 DELARONDE STREET • NEW ORLEANS, LOUISIANA 70114

MIDDLE SOUTH UTILITIES SYSTEM

December 14, 1973

Federal Power Commission
441 G Street, N. W.
Washington, D.C. 20426

Attention: Mr. Kenneth F. Plumb, Secretary

Re: FPC Docket No. RM-74-7 Order No. 496
Emergency Actions For Conservation Of Petroleum
And Natural Gas Fuel Resources By Electric Utilities
FPC Form No. 19

Gentlemen:

We are filing this date in duplicate Louisiana Power & Light Company's reply to Paragraph "C" of FPC Order No. 496 and FPC Form No. 19.

Sincerely,

W. C. Montgomery
Director of Rates & Research

WCM:KS

cc: Louisiana Public Service Commission
With Enclosures

bc: With Enclosures
Mr. E. A. Rodrigue
Mr. J. M. Wyatt
Mr. J. H. Erwin
Mr. R. J Meyer
Mr. G. F. Delery
Mr. O. K. LeBlanc
Mr. D. L. Aswell
Mr. A. P. Carter
Mr. R. M. Merriman
Mr. W. Dunham Crawford, EEI
Mr. F. W. Lewis
Mr. Reeves Ritchie
Mr. F. G. Smith
Mr. William McCollam, Jr.
Mr. D. C. Lutken

REPLY TO FEDERAL POWER COMMISSION ORDER NO. 496,
DOCKET NO. RM-74-7 ISSUED NOVEMBER 29, 1973

Part (C). Page 7 of the Commission Order is as follows:

(C) Each Class A and B electric utility, as referred to above, shall advise the Commission within 15 days hereof of the specific steps which it has undertaken to effect immediate reductions in the consumption of electric power and energy internally to the utility, other utilities or ultimate consumers served by it, and immediate reduction in the consumption of petroleum and natural gas used by it for electric generation purposes.

Specific Steps Undertaken by Louisiana Power & Light Company (LP&L) to Effect Immediate Reduction in the Consumption of Electric Power and Energy Internally:

November 21, 1973

The President of Louisiana Power & Light Company issued instructions to all LP&L supervisors to take the following steps immediately:

1. All unnecessary lighting, including decorative lighting, is to be turned off. Necessary lighting, in offices, etc., is to be used frugally and is to be turned off during all hours when not neccessary, such as lunch hour, closing time, weekends, and holidays. This does not apply to lighting needed for operations and security.

2. All heating thermostats should be lowered to 68 degrees. Heating in seldom-used areas should either be cut off altogether, or reduced to as low a temperature as is necessary to maintain the minimum temperature required by equipment, etc. that may be located in subject space.

3. Cooling thermostats should be set no lower than 78 degrees.

4. Any and all other uses of electricity not essential to LP&L operations should be eliminated.

5. A 50 MPH maximum speed limit should be observed by persons driving Company vehicles or personal vehicles on Company business (except in genuine emergencies).

6. No trip should be made unless it is "really necessary."

7. To the maximum extent possible, "car pooling" should be arranged to maximize the use of vehicles and simultaneously minimize "miles driven."

The President requested in his letter that individual employees follow the same guidelines as far as their personal lives are concerned.

November 29, 1973

Twelve recommendations on "Optimizing the Uses of Energy for Lighting" prepared by the Illuminating Engineering Society and published in the October 1973 issue of Lighting Design & Application were sent to all supervisors having responsibility for operation and maintenance of Company buildings. The supervisors were asked to follow these recommendations during the current energy crisis.

December 4, 1973

The Manager of the Corporate Services Department for Louisiana Power & Light Company issued the following additional instructions to conserve electric energy within the LP&L organization:

1. Reduce the Foot Candle level of illumination in all offices.

2. Cut down on the level of illumination in lobbys, meeting rooms, hallways, and rest rooms where it can be done without adversely affecting operations, safety or security.

Specific Steps Undertaken by Louisiana Power & Light Company to Effect Immediate Reduction in the Consumption of Electric Power and Energy Used by the Ultimate Consumer:

For some time prior to F. P. C. Order No. 496, Louisiana Power & Light Company has been promoting the wise and efficient use of electricity among its customers. This effort has been especially directed to air conditioning and electric heating, informing customers how they can get the most out of their heating and cooling dollars through the use of proper insulation, reasonable thermostat settings, and other similar suggestions.

Some specific examples include:

March/April, 1973

Newspaper advertisements and radio and television commercials offered a free booklet on making wise and efficient use of electric heating.

June, 1973

Twenty thousand (20,000) copies of booklet on "Consumer Tips on Using Electric Energy" printed for free distribution to customers.

July, 1973

Louisiana Power & Light Company's bill insert "Louisiana Highlights," which is sent monthly to all customers, offered the booklet "Consumer Tips on Using Electric Energy" free to any customer.

October, 1973

Newspaper advertisements and radio and television commercials repeated the offer of a free booklet on making wise and efficient use of electric heating.

Bill insert "Louisiana Highlights" to all customers again featured booklet "Consumer Tips on Using Electric Energy" free to any customer.

November, 1973

Louisiana Power & Light Company cancelled immediately, as of November 12, 1973 all advertising which tended to promote additional use of electricity. This included:

1. All television commercials which promote various uses of electricity.
2. All radio commercials advertising additional uses of electricity.
3. All newspaper advertising promoting additional uses of electricity.
4. Discontinued the use of truck posters promoting additional uses of electricity. These had been used on Louisiana Power & Light Company vehicles.

Second printing of 40,000 copies of "Consumer Tips on Using Electric Energy" for free distribution to customers.

All promotional programs were discontinued as of November 19, 1973, including the Gold Medallion Home Program and other programs designed to encourage the use of electricity.

December, 1973

Production of a special booklet directed primarily to high school home economics students. This booklet will feature recipes using small appliances, and includes ideas on conserving energy. It will be available January, 1974.

Suggestions on energy conservation included in monthly bill insert "Louisiana Highlights," mailed to all customers.

December 1973 Continued

The winter issue of the Company magazine "Profit Builder" distributed to industry allies, including appliance dealers, appliance distributors, newspaper editors and others, urges them to advise their customers in ways to conserve electricity. Magazine to be published January, 1974.

Third printing of "Consumer Tips on Using Electric Energy" for free distribution to customers.

Bill insert "Louisiana Highlights" to all customers featured booklet "Consumer Tips on Using Electric Energy" free to any customer.

Summary

LP&L representatives, who have been counselling with our customers on how to use electricity wisely and more efficiently, are now placing more emphasis than ever before on energy conservation.

LP&L newspaper advertisements, as well as our television and radio commercials, have urged the wise and efficient use of energy. They are now also emphasizing the saving of energy as well.

RESPONDING UTILITY 1/

Line No.			1973 DEC.	1974 JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1	I. Projected net system generation by months prior to conservation efforts proposed by this order. (MWH)		1,057,929	1,031,987	937,983	1,067,635	1,052,965	1,305,401	1,473,592	1,628,532	1,644,787	1,540,051	1,278,884	1,133,490	1,193,50[illegible]	14354,83[illegible]
2	II. Projected net energy generation from combustion turbines and internal combustion engines by months prior to conservation efforts proposed by this order. (MWH)		26,000	69,900	63,100	24,800	49,300	69,400	67,700	68,800	69,900	67,600	69,900	40,600	61,000	748,000
	III. Projected monthly reductions that may result from the following conservation procedures:															
3	1. Curtailment of non-essential heating and lighting load at utility-owned power plants and office facilities.	a.	1,062	1,154	1,156	932	916	940	961	969	967	971	936	919	1,179	13,062
4		b.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	2. Curtailment of non-essential generating station auxiliaries at power plants.	a.	8	8	8	-	-	-	-	-	-	-	-	-	8	32
6		b.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	3. Appeals to large commercial and industrial customers to curtail non-essential use.	a.	21,926	22,908	21,188	24,517	24,570	28,362	28,542	27,306	27,252	25,715	23,252	23,731	26,777	296,026
8		b.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9																

a. Total energy saved. (MWH)
b. Amount of energy in "a" which is normally supplied by combustion turbines and internal combustion engines. (MWH)

1/ GENERAL INSTRUCTION - Where the reporting electric utility projects short-falls of fuel availability for its generating resources which will necessitate electric power and energy reductions of greater than 10 percent (e.g., 15, 20 or 25 percent), the Emergency Report Form shall be completed so as to reflect (a) the various stages of projected fuel availability up to the most adverse forseeable projections at the time of completing the form, (b) the variations (if any) in the order of the steps which the reporting utility proposes to implement in carrying out its electric contingency planning. The reporting utility shall relate the reported actions to any contingency planning procedures which the reporting utility has submitted to the Federal Power Commission or state public service commissions pursuant to Federal Power Commission Order No. 445, this Commissions January 24, 1973, emergency letter questionnaire or otherwise, individually or through a reliability council. The Commission requests the use of manifold copies of pages of the Emergency Report Form by each reporting utility to supply, for its system, the electric conservation, contingency planning procedures and load reduction steps under varying assumptions, as may be projected by the reporting utility. The Emergency Report Form shall be filed in duplicate.

Line No.			1973 DEC.	1974 JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
9	4. Appeals to the public to curtail non-essential use	a.	18,373	20340	18,055	17377	16,920	21,936	31,974	45,513	47,509	47827	39,779	25413	20,013	371,027
10		b.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	5. Interuption of contractually interruptible load.	a.	None													
12		b.	None													None
																None
13	6. Reduction of system voltage.	a.	None													None
14		b.	None													None
15	7. Reduction in use of electricity by governmental entities due to reductions or changes of usage in governmental facilities, buildings, street illumination, or others.	a.	1,236	1,278	1,306	1,270	1,271	1,347	1,429	1,502	1,564	1,510	1,446	1,376	1,305	17,544
16		b.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17	8. Reduction of hours of operation of commercial centers.	a.	12,977	12,744	11,709	12,973	12,884	15,732	17,810	19,832	20,026	19,078	16,298	14,326	14,573	190,265
18		b.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	9. Reduction of use by industrial customers whose output is not essential to the public health and safty.	a.	37,304	37,385	35,732	37,000	37,553	40,178	42,868	44,580	45,373	44,671	42,139	41,183	41,810	527,773
20		b.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	10. Elimination of outdoor nighttime sporting events.	a.	200	200	200	200	200	200	200	200	200	200	200	200	200	2,600
22		b.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	11. Elimination of outdoor commercial advertising display.	a.	5,750	5,740	5,582	5,505	5,644	6,419	7,370	8,511	8,577	8,816	8,414	7,051	6,32	84,70
24		b.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	12. Other (identify) a. Sales for Resale	a.	3,433	3,659	3,553	3,07	3,028	3,271	4,379	5,447	5,040	5,755	4,873	3,83	3,942	54,361
26		b.	-	-	-	-	-	-	-	-	-	-	-	-	-	-

NOTE: It is recognized the savings envisioned by use of item 7 through 11 would reflect prior governmental action in many instances authorizing or mandating the changed conditions producing the savings.

$\frac{160,341}{1,635,465} = 9.8\%$

Line No.			1973 DEC	1974 JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
	IV. State the amount of oil in barrels and natural gas in Mcf which may be saved through the following measures:															
1	1. Optimizing use of coal-fired generation within the utility's system.	a.	None													None
2		b.	None													None
3		c.	None													None
4	2. Engaging in inter-company and inter-area transfers in order to maximize the use of coal-fired capacity.	a.	Unable to secure any commitment at this time.													
5		b.	Unable to secure any commitment at this time.													
6		c.	Unable to secure any commitment at this time.													
7	3. Modifying operating reserve policy to permit combustion turbines and internal combustion engines to be considered as reserve when shut down.	a.	Considered as reserve at this time.													
8		b.	Considered as reserve at this time.													
9		c.	Considered as reserve at this time.													
10	4. Other (identify)	a.														
11		b.														
12		c.														

a. Total bbls. of residual oil
b. Total bbls. of distillate oil
c. Total volumes of natural gas in Mcf at 14.73 psia

MISSISSIPPI POWER & LIGHT COMPANY
Helping Build Mississippi
P. O. BOX 1640, JACKSON, MISSISSIPPI 39205

DONALD C. LUTKEN
PRESIDENT

December 14, 1973

Federal Power Commission
Washington, D. C. 20426

Subject: ORDER NUMBER 496

EMERGENCY ACTIONS FOR CONSERVATION OF PETROLEUM AND NATURAL GAS FUEL RESOURCES BY ELECTRIC UTILITIES

In compliance with the Commission's orders contained in Order Number 496, we are attaching the completed energy report form, FPC Form Number 19.

The following data is submitted in answer to Paragraph C, Page 7 of Order 496.

(1) Mississippi Power & Light Company began internal conservation of electric energy in January 1973 by reducing noncritical lighting at its generating plants, substations, and offices.

(2) Advertising in all media (newspaper, TV, radio, billboards) has been, since December 1972, devoted to conservation messages on electric energy (applicable to other forms of energy). (Samples attached).

(3) Following President Nixon's TV report of November 7, 1973, MP&L President Donald Lutken announced on TV and in newspaper advertising (sample attached) that "MP&L supports the National Energy Conservation Program." Reprints have been and are being distributed to our customers. (Sample attached).

(4) On November 9, 1973 MP&L President, Mr. Lutken, notified our employees to take specific steps to conserve energy in our buildings, transportation, and all operations. (Sample attached). He urged personal involvement in energy conservation in their homes and transportation.

(5) The lighting has been eliminated on all outdoor advertising billboards which MP&L is using to communicate with its customers.

(6) Our President, Mr. Lutken, and his management staff conducted a meeting on November 13, 1973 with all managerial and marketing personnel to update them on the total energy picture, to restate our Company's support of the National Energy Conservation Program, and presented a broad outline of a conservation and contingency plan to conserve energy.

(7) On November 14, 1973, all of the Electric Power Associations and municipalities which MP&L serve on a wholesale basis were invited to a meeting to cover the subjects discussed in item number 6.

(8) Mississippi Power & Light Company is presently making telephone and personal contacts with all of its large commercial and industrial customers to request them to implement conservation measures. We are discussing methods of reducing electric energy use with the least economic impact. We are attempting to determine incremental reductions which can be achieved without forcing a complete closing of the commercial or industrial facilities.

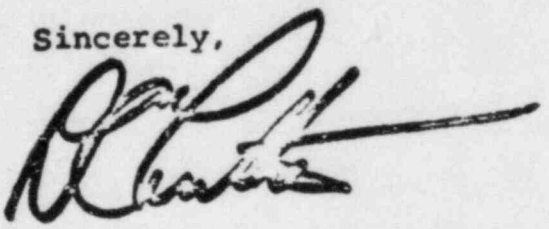
(9) Bumper stickers, window stickers, and lapel stickers have been produced with the message "HELP US SAVE ENERGY," and distributed to Company personnel. Bumper stickers are displayed on all MP&L vehicles. They are made available to others upon request. (Samples attached).

Immediate reduction in the consumption of petroleum and natural gas used by Mississippi Power & Light Company for electric generation purposes is being achieved.

Steps have been taken in all power plants to reduce non-essential station electrical use. The lighting load has been reduced by leaving off all lights that are not absolutely needed for operation and safety. This includes plant operating areas, office buildings and substations. The heating and cooling load has been reduced by maintaining all thermostats approximately 6 degrees from normal setting. Station auxiliary use has been reduced by removing from service equipment not absolutely needed for generation.

This includes such items as half-capacity condensate pumps, boiler feed pumps, and circulating water pumps during operating periods with generation below one-half nameplate ratings.

Sincerely,



sw

bcs: Messrs. F. W. Lewis
Reeves Ritchie
E. A. Rodrique
William McCollam, Jr.
F. G. Smith
J. H. Box
H. Q. Pray

RESPONDING UTILITY */

Appendix
Sheet 1
FPC Form No. 19

Line No.		1973 DEC.	1974 JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
1	I. Projected net system generation by months prior to conservation efforts proposed by this order. (MWH) * See Note Below	539,000	559,700	566,900	529,800	529,700	537,200	649,000	745,500	782,800	752,900	648,700	604,000	581,800	7,997,000
2	II. Projected net energy generation from combustion turbines and internal combustion engines by months prior to conservation efforts proposed by this order. (MWH)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	III. Projected monthly reductions that may result from the following conservation procedures:														
3	1. Curtailment of non-essential heating and lighting load at utility-owned power plants and office facilities. a.	398	416	380	377	335	355	349	380	371	363	340	350	398	4812
4	b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	2. Curtailment of non-essential generating station auxiliaries at power plants. a.	6,170	5,200	4,720	5200	5040	2040	1,950	2010	2010	1,980	2070	5040	5,200	48,630
6	b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	3. Appeals to large commercial and industrial customers to curtail non-essential use. a.	15,400	15,400	15,400	15400	16,400	21,100	23,100	24,100	24,130	23,100	22,100	15,400	15,400	246,400
8	b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0

a. Total energy saved. (MWH)
b. Amount of energy in "a" which is normally supplied by combustion turbines and internal combustion engines. (MWH)

*/ GENERAL INSTRUCTION - Where the reporting electric utility projects short-falls of fuel availability for its generating resources which will necessitate electric power and energy reductions of greater than 10 percent (e.g., 15, 20 or 25 percent), the Emergency Report Form shall be completed so as to reflect (a) the various stages of projected fuel availability up To the most adverse forseeable projections at the time of completing the form, (b) the variations (if any) in the order of the steps which the reporting utility proposes to implement in carrying out its electric contingency planning. The reporting utility shall relate the reported actions to any contingency planning procedures which the reporting utility has submitted to the Federal Power Commission or state public service commissions pursuant to Federal Power Commission Order No. 445, this Commissions January 24, 1973, emergency letter questionnaire or otherwise, individually or through a reliability council. The Commission requests the use of manifold copies of pages of the Emergency Report Form by each reporting utility to supply, for its system, the electric conservation, contingency planning procedures and load reduction steps under varying assumptions, as may be projected by the reporting utility. The Emergency Report Form shall be filed in duplicate.

* Note (Line No. 1) - Net after deduction for losses

Line No.			1973 DEC.	1974 JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
9	4. Appeals to the public to curtail non-essential use	a.	8,160	11,440	9,780	7,720	5,160	5,300	10,940	19,980	22,120	14,960	15,100	8,340	8,160	147,160
10		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	5. Interuption of contractually interruptible load.	a.	We	have	no	interruptible	load.									
12		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	6. Reduction of system voltage.	a.	Quantities	not known.	MSU Companies	are running	tests to	determine	if appreciable	savings can be	achieved					
14		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	7. Reduction in use of electricity by governmental entities due to reductions or changes of usage in governmental facilities, buildings, street illumination, or others.	a.	1,180	1,090	1120	1,090	1,160	1,170	1,250	1,380	1,390	1,390	1,510	1,270	1,180	16,180
16		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	8. Reduction of hours of operation of commercial centers.	a.	360	360	360	360	360	360	360	360	360	360	360	360	360	4,680
18		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	9. Reduction of use by industrial customers whose output is not essential to the public health and safty.	a.	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	9,500	123,500
20		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	10. Elimination of outdoor nighttime sporting events.	a.	134	57	56	64	137	209	448	1,016	173	317	313	353	134	3,411
22		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	11. Elimination of outdoor commercial advertising display.	a.	7,420	7,420	7,420	7,420	7,420	7,420	7,420	7,420	7,420	7,420	7,420	7,420	7,420	96,460
24		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	12. Other (identify) * See Note Below	a.	7,778	7,780	7,820	7,360	7,360	7,470	8,640	10,370	10,890	10,470	9,020	8,400	8,090	111,478
26		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0

NOTE: It is recognized the savings envisioned by use of item 7 through 11 would reflect prior governmental action in many instances authorizing or mandating the changed conditions producing the savings.

* Note (Line No. 25) - Figures shown are based on the assumption that the reductions experienced by Electric Power Associations and Wholesale Municipalities will parallel t... ...r Co...

Line No.			1973 DEC	1974 JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
	IV. State the amount of oil in barrels and natural gas in Mcf which may be saved through the following measures:															
1	1. Optimizing use of coal-fired generation within the utility's system.	a.														0
2		b.	Does not apply - No coal fired generation													0
3		c.														0
4	2. Engaging in inter-company and inter-area transfers * in order to maximize the use of coal-fired capacity.	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6		c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	3. Modifying operating reserve ** policy to permit combustion turbines and internal combustion engines to be considered as reserve when shut down.	a.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8		b.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9		c.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	4. Other (identify)	a.														
11		b.														
12		c.														

a. Total bbls. of residual oil
b. Total bbls. of distillate oil
c. Total volumes of natural gas in Mcf at 14.73 psia

* Unable to secure commitments at this time

** These units already considered as reserves.

MISSISSIPPI POWER & LIGHT COMPANY
Helping Build Mississippi
P. O. BOX 1640, JACKSON, MISSISSIPPI 39205

DONALD C. LUTKEN
PRESIDENT

November 9, 1973

DEPARTMENT HEADS
DIVISION MANAGERS
PLANT SUPERINTENDENTS
MANAGERS

Gentlemen:

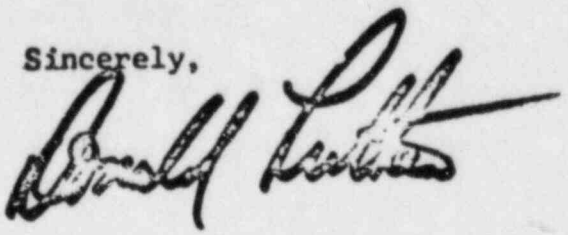
As was pointed out by President Nixon in his talk last Wednesday night, our nation's energy demands have begun to exceed available supplies. President Nixon announced a national energy conservation program and we are pledging the company's cooperation in this program.

Attached you will find an outline of steps that we will take to conserve energy in our buildings and in our transportation operations. We ask that you put these recommendations into practice immediately and continue to use them until further notice.

We also ask that all employees be informed of these conservation measures and request that they take similar steps to conserve energy in their homes and travels.

Your help is necessary if this program is to be successful.

Sincerely,



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Attachment

CONSERVATION OF ENERGY

Buildings

1. Reduce temperatures in all heated office areas to a maximum of 68 degrees. Do not use portable electric space heaters.

2. Reduce temperatures in storeroom and warehouse areas, that are heated, to a maximum of 55 degrees.

3. Cut off all outside lighting except that which is absolutely essential. Sign lights, canopy lights and other non-essential lights must be turned off.

4. Cut off all inside lighting except that which is necessary during working hours and that which is absolutely essential during non-working hours.

5. During cooling season, do not reduce temperatures below 80 degrees in air conditioned areas.

6. Set water heater thermostats back to 120 degrees.

7. Use no Christmas office lighting. Decorate trees, etc., without use of lights.

8. Maintain heating and cooling systems to insure most efficient operation.

9. Check insulation of heated areas and be sure we are getting maximum benefit from heat used.

10. Clean lighting fixtures to get maximum benefit from lights used.

Transportation

1. Reduce speed to a maximum of 50 miles per hour.

2. Discontinue the idling of engines when not in use.

3. Keep vehicles properly tuned.

4. Keep tires properly inflated.

5. Use slow acceleration and deceleration on starts and stops. Do not "race" engine.

6. Reduce weight by removing all tools and material from service trucks, line trucks, and other vehicles that is not absolutely essential.

7. For service trucks, assign service orders and service work so that minimum travel will be required. Also assign work so that duplicate trips will not be made to the same area.

8. Do not use extra vehicles that are not required to perform the job assignment.

9. Travel in groups rather than in individual vehicles wherever possible.

10. Set a goal of reducing mileage by 10% below the same period last year.

NEW ORLEANS PUBLIC SERVICE INC.

POST OFFICE BOX 60340

NEW ORLEANS, LOUISIANA 70160

W. C. NELSON
VICE PRESIDENT
&
GENERAL COUNSEL

AREA CODE 504 586-2210
317 BARONNE STREET

December 12, 1973

AIRMAIL

RECEIVED
DEC 19 1973
MIDDLE SOUTH SERVICES, INC.
ENGINEERING DEPARTMENT

Kenneth F. Plumb, Esquire
Secretary
Federal Power Commission
Washington, D. C. 20426

Dear Mr. Plumb:

RE: Docket No. RI-74-7

As required by Order No. 496, attached for filing by New Orleans Public Service Inc. are three copies of completed F.P.C. Form No. 19.

In response to ordering paragraph (C) of Order No. 496, the following are the steps taken by the Company to effect reduction in the consumption of electric energy for its own use and for use by ultimate consumers:

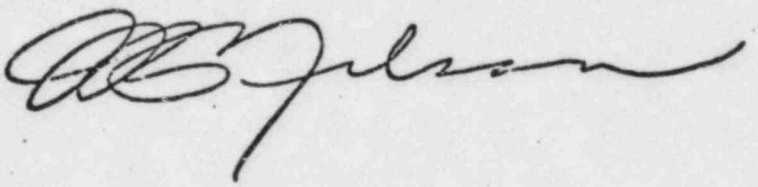
1. New Orleans Public Service Inc., via the communications media, consisting of television, radio, newspapers and house journals, has appealed to the general public in the City of New Orleans to reduce their consumption of electric energy by eliminating unnecessary and decorative lighting, by adjusting thermostat settings, by improving insulation and weather stripping, etc., and by curtailing voluntarily other usage of electricity. A joint appeal to the public was made by the President of the Company and the Mayor of the City of New Orleans along these lines.

2. Internally, instructions have been issued to all Company employees to eliminate all exterior lighting on Company facilities other than that needed for security purposes and to reduce levels and turn off unnecessary lighting in Company offices at all times. Heating and cooling requirements are being reduced and vehicular fuel is being conserved.

3. A careful survey has been made of the use of power plant auxiliaries to be sure that no unnecessary use was involved. Investigation of our generation operations has indicated that we are doing everything possible to improve the efficiency of generation. It should be pointed out, however, that the need for conversion to oil as boiler fuel, brought on by the shortage of natural gas, is resulting in a material increase in power plant auxiliary equipment loads.

Please indicate the date accepted for filing on the attached copy of this letter and return it to me in the enclosed stamped self-addressed envelope.

Yours very truly,



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Appendix 1
Sheet 1 of 3
FPC Form No. 19

RESPONDING UTILITY */ NEW ORLEANS PUBLIC SERVICE INC. **

Line No.		1973 DEC.	1974 JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	13 mos. TOTAL
1	I. Projected net system generation by months prior to conservation efforts proposed by this order. (MWH)	289,000	284,000	269,000	303,000	329,000	436,000	498,000	540,000	538,000	483,000	387,000	309,000	304,000	4,969,000
2	II. Projected net energy generation from combustion turbines and internal combustion engines by months prior to conservation efforts proposed by this order. (MWH)														0
	III. Projected monthly reductions that may result from the following conservation procedures:														
3	1. Curtailment of non-essential heating and lighting load at utility-owned power plants and office facilities. a.	654	641	590	631	668	723	709	798	733	730	689	631	651	8,848
4	b.														0
5	2. Curtailment of non-essential generating station auxiliaries at power plants. a.														0
6	b.														0
7	3. Appeals to large commercial and industrial customers to curtail non-essential use. a.	3,095	2,984	2,973	3,096	3,279	3,467	3,725	3,901	3,945	4,063	3,674	3,413	3,351	44,956
8	b.														

a. Total energy saved. (MWH)
b. Amount of energy in "a" which is normally supplied by combustion turbines and internal combustion engines. (MWH)

*/ GENERAL INSTRUCTION - Where the reporting electric utility projects short-falls of fuel availability for its generating resources which will necessitate electric power and energy reductions of greater than 10 percent (e.g., 15, 20 or 25 percent), the Emergency Report Form shall be completed so as to reflect (a) the various stages of projected fuel availability up to the most adverse forseeable projections at the time of completing the form, (b) the variations (if any) in the order of the steps which the reporting utility proposes to implement in carrying out its electric contingency planning. The reporting utility shall relate the reported actions to any contingency planning procedures which the reporting utility has submitted to the Federal Power Commission or state public service commissions pursuant to Federal Power Commission Order No. 445, this Commissions January 24, 1973, emergency letter questionnaire or otherwise, individually or through a reliability council. The Commission requests the use of manifold copies of pages of the Emergency Report Form by each reporting utility to supply, for its system, the electric conservation, contingency planning procedures and load reduction steps under varying assumptions, as may be projected by the reporting utility. The Emergency Report Form shall be filed in duplicate.

** Note: The reductions shown under Item III of the form represent the Company's best estimate of reductions which might realistically be obtained by the listed categories of curtailment.

Line No.			1973 DEC.	1974 JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	13 mos. TOTAL
9	4. Appeals to the public to curtail non-essential use	a.	6,005	6,045	5,930	6,030	6,520	8,110	10,890	12,700	12,955	12,890	10,730	7,580	6,325	112,710
10		b.														0
11	5. Interuption of contractually interruptible load.	a.														0
12		b.														
13	6. Reduction of system voltage.	a.														0
14		b.														
15	7. Reduction in use of electricity by governmental entities due to reductions or changes of usage in governmental facilities, buildings, street illumination, or others.	a.	2,810	2,755	2,750	2,800	2,830	3,065	3,225	3,480	3,575	3,545	3,245	3,055	2,995	40,130
16		b.														0
17	8. Reduction of hours of operation of commercial centers.	a.	7,260	7,010	7,040	7,300	7,685	8,725	9,850	10,600	10,830	11,029	9,900	8,235	7,650	113,110
18		b.														0
19	9. Reduction of use by industrial customers whose output is not essential to the public health and safty.	a.	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	65,000
20		b.														0
21	10. Elimination of outdoor nighttime sporting events.	a.	350	350	350	350	350	350	350	350	350	350	350	350	350	4,550
22		b.														0
23	11. Elimination of outdoor commercial advertising display.	a.	650	650	650	650	650	650	650	650	650	650	650	650	650	8,450
24		b.														0
25	12. Other (Identify)	a.														0
26		b.														0

NOTE: It is recognized the savings envisioned by use of item 7 through 11 would reflect prior governmental action in many instances authorizing or mandating the changed conditions producing the savings.

Line No.			1973 DEC	1974 JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
	IV. State the amount of oil in barrels and natural gas in Mcf which may be saved through the following measures:															
1	1. Optimizing use of coal-fired generation within the utility's system.	a.														0
2		b.														0
3		c.														0
4	2. Engaging in inter-company and inter-area transfers in order to maximize the use of coal-fired capacity.	a.														0
5		b.														0
6		c.														0
7	3. Modifying operating reserve policy to permit combustion turbines and internal combustion engines to be considered as reserve when shut down. *	a.														0
8		b.														0
9		c.														0
10	4. Other (identify)	a.														0
11		b.														0
12		c.														0

a. Total bbls. of residual oil
b. Total bbls. of distillate oil
c. Total volumes of natural gas in Mcf at 14.73 psia

* This practice currently being observed.

1.2 OTHER OBJECTIVES

Grand Gulf Nuclear Station does not provide for meeting any objectives other than the generation of electrical energy for distribution and sale by the MSU System.

1.3 CONSEQUENCES OF DELAY

Mississippi Power & Light Company, under existing laws at various levels of government, has the responsibility and obligation to supply electricity to meet the demands in its service area and must, therefore, plan to satisfy the forecast demand for its services. The effects of delays in commercial operation, of both units of Grand Gulf Nuclear Station are shown in Tables 1.3.1 and 1.3.2. The reserve margins of both the MSU System and the SPP that result from no delay and from delays of 1, 2, and 3 years are tabulated. In each case, it is assumed that no action is taken to increase capacity by means not included in present plans.

For the MSU System, Table 1.3.1 shows that delays of 1, 2, and 3 years in the commercial operation of Grand Gulf Unit 1 will reduce the MSU System reserve margins to 11.1 percent (1981), 9.9 percent (1982), and 7.6 percent (1983), respectively. All reserve margins are, therefore, reduced below the planned 16 percent. If Grand Gulf Unit 1 is delayed 3 years, the reserve margin in 1983 will be 1126 MW, which is only 16 MW greater than the largest unit that would be online (Waterford No. 3). Failure of this unit would lower MSU System capacity dangerously close to peak demand. Table 1.3.1 also contains similar information for the SPP. | 1 | 1

Table 1.3.2 shows that, for the MSU System, delays of 1, 2, and 3 years in the commercial operation of Grand Gulf Unit 2 will reduce the MSU System reserve margin to 8.3 percent (1984), 9.1 percent (1985), and 9.4 percent (1986), respectively. Again, all reserve margins are less than the planned 16 percent. If Grand Gulf Unit 2 is delayed at least 1 year, the reserve margin in 1984 will be 1334 MW, which is only 84 MW greater than the largest unit that would be on line (Grand Gulf Unit 1). Failure of this unit would lower MSU System capacity dangerously close to peak demand. Table 1.3.2 also contains similar information for the SPP. | 1 | 1

In addition to jeopardizing reliability, delays in commercial operation of either unit at Grand Gulf Nuclear Station would substantially increase the MSU System's oil requirements. This increased reliance on oil would be contrary to the United States' objective of decreasing dependence on oil. Of course, any increase in oil requirements would also bring with it a dramatic increase in the cost of electric energy (see Section 9.3).

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TABLE 1.3.1

CAPABILITY RESERVE MARGIN
WITH ASSUMED DELAY OF
GRAND GULF UNIT 1 (1250 MW)

Middle South Utilities System	RESERVE MARGIN								
Years Delayed	0		1		2		3		
	(MW)	(%)	(MW)	(%)	(MW)	(%)	(MW)	(%)	
1981	2,660	20.9	1,410	11.1	1,410	11.1	1,410	11.1	
1982	2,620	19.0	2,620	19.0	1,370	9.9	1,370	9.9	1
1983	2,376	16.0	2,376	16.0	2,376	16.0	1,126	7.6	
1984	2,584	16.2	2,584	16.2	2,584	16.2	2,584	16.2	

Southwest Power Pool	RESERVE MARGIN								
Years Delayed	0		1		2		3		
	(MW)	(%)	(MW)	(%)	(MW)	(%)	(MW)	(%)	
1981	10,634	22.6	9,384	19.9	9,384	19.9	9,384	19.9	
1982	11,193	22.4	11,193	22.4	9,943	19.9	9,943	19.9	1
1983	11,494	21.6	11,494	21.6	11,494	21.6	10,244	19.3	
1984	13,370	23.7	13,370	23.7	13,370	23.7	13,370	23.7	

Amend. 1 3/79

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TABLE 1.3.2

CAPABILITY RESERVE MARGIN
WITH ASSUMED DELAY OF
GRAND GULF UNIT 2 (1250 MW)

Middle South Utilities System

Years Delayed	RESERVE MARGIN								
	0		1		2		3		
	(MW)	(%)	(MW)	(%)	(MW)	(%)	(MW)	(%)	
1984	2,584	16.2	1,334	8.3	1,334	8.3	1,334	8.3	
1985	2,807	16.5	2,807	16.5	1,557	9.1	1,557	9.1	
1986	2,950	16.3	2,950	16.3	2,950	16.3	1,700	9.4	1
1987	3,076	16.0	3,076	16.0	3,076	16.0	3,076	16.0	

Southwest Power Pool

Years Delayed	RESERVE MARGIN								
	0		1		2		3		
	(MW)	(%)	(MW)	(%)	(MW)	(%)	(MW)	(%)	
1984	13,370	23.7	12,120	21.5	12,120	21.5	12,120	21.5	
1985	13,248	22.1	13,248	22.1	11,998	20.1	11,998	20.1	
1986	14,880	23,5	14,880	23.5	14,880	23.5	13.630	21.5	1
1987	15,393	23.0	15,393	23.0	15,393	23.0	15,393	23.0	

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CHAPTER 2

THE SITE AND ENVIRONMENTAL INTERFACES

TABLE OF CONTENTS

		Page
2.1	GEOGRAPHY AND DEMOGRAPHY	2.1-1
	2.1.1 Site Location and Description	2.1-1
	2.1.1.1 Specification of Location	2.1-1
	2.1.1.2 Site Area	2.1-1
	2.1.1.3 Boundaries for Establishing Effluent Release Limits	2.1-2
	2.1.2 Population Distribution	2.1-2
	2.1.2.1 Population Within 10 Miles	2.1-4
	2.1.2.2 Population Between 10 and 50 Miles	2.1-4
	2.1.2.3 Transient Population	2.1-4
	2.1.2.3.1 Seasonal Variation	2.1-4
	2.1.2.3.2 Daily Variation	2.1-6
	2.1.3 Uses of Adjacent Lands and Waters	2.1-8
	2.1.3.1 Land Use of the Site and Immediate Environs	2.1-8
	2.1.3.2 Present and Projected Land Use Within 5 Miles	2.1-8
	2.1.3.2.1 Residential	2.1-8
	2.1.3.2.2 Agricultural	2.1-9
	2.1.3.2.3 Forestry	2.1-9
	2.1.3.2.4 Industrial	2.1-9
	2.1.3.2.5 Recreation	2.1-10
	2.1.3.2.6 Transportation	2.1-10
	2.1.3.3 Agricultural Production	2.1-11
	2.1.3.3.1 Vegetable and Crop Production	2.1-12
	2.1.3.3.2 Milk Production	2.1-13
	2.1.3.3.3 Meat Production	2.1-13
	2.1.3.4 Fishing and Hunting Activities Within 50 Miles	2.1-14
	2.1.3.5 Coordination of Station Activities With Outside Land Use	2.1-15
	2.1.3.6 Surface and Ground Water Use	2.1-16 |1
	2.1.4 References	2.1-16
2.2	ECOLOGY	2.2-1
	2.2.1 Introduction	2.2-1
	2.2.2 Terrestrial Ecology	2.2-1
	2.2.2.1 Summary	2.2-1

TABLE OF CONTENTS (Cont.)

	Page
2.2.2.2 Vegetation	2.2-2
2.2.2.2.1 Forest Overstory	2.2-3
2.2.2.2.2 Understory Vegetation	2.2-4
2.2.2.2.3 Forest Midstory	2.2-7
2.2.2.3 Birds	2.2-8
2.2.2.3.1 Avian Fauna of the Forest Communities	2.2-9
2.2.2.3.2 Avian Fauna of the Field-Forest Ecotone	2.2-10
2.2.2.3.3 Avian Fauna of Hamilton and Gin Lakes	2.2-10
2.2.2.3.4 Vultures, Hawks and Falcons	2.2-13
2.2.2.3.5 Owls	2.2-14
2.2.2.3.6 Blackbirds	2.2-15
2.2.2.3.7 Upland Game Birds	2.2-15
2.2.2.4 Mammals	2.2-16
2.2.2.4.1 Small Mammals	2.2-17
2.2.2.4.2 Larger Mammals	2.2-20
2.2.2.5 Reptiles and Amphibians	2.2-24
2.2.2.5.1 Reptiles	2.2-25
2.2.2.5.2 Amphibians	2.2-27
2.2.2.6 Disease and Pest Infestations in Flora and Wildlife	2.2-27
2.2.2.6.1 Flora	2.2-27
2.2.2.6.2 Wildlife	2.2-29
2.2.2.7 Endangered or Threatened Terrestrial Species	2.2-30
2.2.3 Aquatic Ecology	2.2-31
2.2.3.1 Summary	2.2-31
2.2.3.2 Fishes	2.2-32
2.2.3.2.1 Species Collected	2.2-34
2.2.3.2.2 Adult Fish Assemblage - Mississippi and Big Black Rivers	2.2-37
2.2.3.2.3 Larval Fish Assemblage - Mississippi River	2.2-48
2.2.3.2.4 Adult Fish Assemblage - Hamilton and Gin Lakes	2.2-51
2.2.3.2.5 Adult Fish Assemblage - Site Stream A	2.2-52
2.2.3.2.6 Adult Fish Assemblage - Bluff Ponds	2.2-53
2.2.3.2.7 Creel Census	2.2-55
2.2.3.3 Benthic Macroinvertebrates	2.2-57
2.2.3.3.1 Mississippi and Big Black Rivers	2.2-58
2.2.3.3.2 Hamilton and Gin Lakes	2.2-64
2.2.3.4 Plankton	2.2-66
2.2.3.4.1 Introduction	2.2-66
2.2.3.4.2 Mississippi River	2.2-68

TABLE OF CONTENTS (Cont.)

		Page
2.2.3.4.3	Big Black River	2.2-70
2.2.3.4.4	Hamilton Lake	2.2-71
2.2.3.4.5	Gin Lake	2.2-74
2.2.3.5	Lake Periphyton and Macrophyton	2.2-75
2.2.3.5.1	Periphyton	2.2-75
2.2.3.5.2	Macrophyton	2.2-76
2.2.3.6	Disease and Pest Infestations in Fish	2.2-76
2.2.3.7	Endangered or Threatened Fish Species	2.2-78
2.2.4	References	2.2-80
2.3	METEOROLOGY	2.3-1
2.3.1	Regional Climatology	2.3-1
2.3.1.1	General Climate	2.3-1
2.3.1.2	Regional Meteorological Conditions for Design and Operating Bases	2.3-3
2.3.1.2.1	Severe Weather Phenomena	2.3-3
2.3.1.2.2	Probable Maximum Annual Frequency and Duration of Freezing Rain	2.3-5
2.3.1.2.3	Probable Maximum Annual Frequency and Duration of Dust Storms	2.3-6
2.3.1.2.4	Estimated Weight of the 100-Year Return Snowpack	2.3-7
2.3.1.2.5	Estimated Weight of the 48-Hour Probable Maximum Winter Precipitation	2.3-8
2.3.1.2.6	100-Year Return Period Fastest Mile of Wind	2.3-9
2.3.2	Local Meteorology	2.3-10
2.3.2.1	Normal and Extreme Values of Meteorological Parameters	2.3-10
2.3.2.1.1	Winds	2.3-10
2.3.2.1.2	Air Temperature	2.3-12
2.3.2.1.3	Atmospheric Water Vapor	2.3-13
2.3.2.1.4	Precipitation	2.3-14
2.3.2.1.5	Fog and Smog	2.3-16
2.3.2.1.6	Atmospheric Stability	2.3-18
2.3.2.1.7	Mixing Heights	2.3-21
2.3.2.2	Potential Influence of the Plant and Its Facilities on Local Meteorology	2.3-22
2.3.2.2.1	Effects of Heat Dissipation System	2.3-22
2.3.2.2.2	Topographical Description	2.3-22
2.3.3	References	2.3-22

TABLE OF CONTENTS (Cont.)

		Page	
2.4	HYDROLOGY	2.4-1	
	2.4.1 Introduction	2.4-1	
	2.4.2 Surface Water Hydrology	2.4-1	
	2.4.2.1 Mississippi River	2.4-1	
	2.4.2.2 Local Streams	2.4-4	
	2.4.2.3 Local Lakes	2.4-4	
	2.4.3 Physical Properties of Surface Waters	2.4-5	
	2.4.3.1 Flow Velocity	2.4-5	
	2.4.3.2 Water Temperature	2.4-6	1
	2.4.4 Water Quality	2.4-6	
	2.4.5 Ground Water	2.4-7	1
	2.4.5.1 Regional Conditions	2.4-7	1
	2.4.5.2 Plant Site Conditions	2.4-7	
	2.4.5.3 Ground Water Withdrawals and Use	2.4-8	
	2.4.5.4 Ground Water Levels and Movements	2.4-9	
	2.4.5.5 Ground Water Quality	2.4-10	
	2.4.6 References	2.4-11	
2.5	GEOLOGICAL SUMMARY	2.5-1	
	2.5.1 General	2.5-1	
	2.5.2 Geologic Investigation Program	2.5-1	
	2.5.3 Stratigraphy	2.5-1	
	2.5.3.1 Quaternary Deposits	2.5-2	
	2.5.3.2 Tertiary Deposits	2.5-2	
	2.5.4 Structure	2.5-3	
	2.5.4.1 Regional Dip	2.5-3	
	2.5.4.2 Salt Domes	2.5-3	
	2.5.4.3 Faults	2.5-4	
	2.5.5 Petroleum Production	2.5-4	
2.6	REGIONAL, HISTORIC, ARCHEOLOGICAL, ARCHITECTURAL, SCENIC, CULTURAL AND NATURAL FEATURES	2.6-1	
	2.6.1 References	2.6-2	

TABLE OF CONTENTS (Cont.)

		Page
2.7	NOISE	2.7-1
	2.7.1 Monitoring Locations and Schedule	2.7-1
	2.7.1.1 Ambient Background Noise Survey	2.7-1
	2.7.1.2 Construction Noise Surveys	2.7-1
	2.7.1.2.1 Survey No. 1 (June 5-6, 1974)	2.7-2
	2.7.1.2.2 Survey No. 2 (August 27-30, 1974)	2.7-2
	2.7.1.2.3 Survey No. 3 (October 16-18, 1974)	2.7-2
	2.7.1.2.4 Survey No. 4 (December 9-10, 1974)	2.7-2
	2.7.1.2.5 Survey No. 5 (February 25-27, 1975)	2 7-2
	2.7.2 Equipment	2.7-2
	2.7.3 Monitoring Procedure	2.7-3
	2.7.3.1 Ambient Background Noise Survey	2.7-3
	2.7.3.2 Construction Noise Surveys	2.7-3
	2.7.4 Method of Data Analysis	2.7-3
	2.7.5 Interpretation of Results	2.7-4
	2.7.5.1 Ambient Background Noise Survey	2.7-4
	2.7.5.2 Construction Noise Surveys	2.7-4
	2.7.5.2.1 Survey No. 1	2.7-4
	2.7.5.2.2 Survey No. 2	2.7-6
	2.7.5.2.3 Survey No. 3	2.7-6
	2.7.5.2.4 Survey No. 4	2.7-6
	2.7.5.2.5 Survey No. 5	2.7-7
	2.7.6 Conclusions	2.7-7
	2.7.6.1 Ambient Background Noise Survey	2.7-7
	2.7.6.2 Construction Noise Surveys	2.7-7
	2.7.6.2.1 Survey No. 1	2.7-7
	2.7.6.2.2 Survey No. 2	2.7-8
	2.7.6.2.3 Survey No. 3	2.7-8
	2.7.6.2.4 Survey No. 4	2.7-8
	2.7.6.2.5 Survey No. 5	2.7-8
	2.7.6.3 Evaluation of Noise-Level Effects	2.7-8

LIST OF TABLES

Table No.	Title
2.1.1	Resident Population Distribution By Sector and Radial Distance Out to 10 Miles
2.1.2	Age Distribution by Sector and Radial Distance Out to 10 Miles for the Year 2000
2.1.3	Resident Population Distribution by Sector and Radial Distance Between 10 and 50 Miles
2.1.4	Age Distribution by Sector and Radial Distance Out to 50 Miles for the Year 2000
2.1.5	Yearly Attendance 1972-1976 Grand Gulf Military Park
2.1.6	Monthly Attendance in 1976 Grand Gulf Military Park
2.1.7	Nearest Vegetable Garden Greater Than 500 Square Feet Within the 5-Mile Radius
2.1.8	Non-Commercial Dairy Cows Within the 5-Mile Radius
2.1.9	Nearest Residence Within the 5-Mile Radius
2.1.10	Nearest Site Boundary in Each Sector
2.1.11	Milk Goats Within the 5-Mile Radius
2.1.12	Total Acreage Per Radial Distance From Reactor Per Sector
2.1.13	Total Production of Leafy Vegetables for Commercial Use Within 10 Miles in Kilograms Per Year
2.1.14	Total Production of Non-Leafy Vegetables for Commercial Use Within 10 Miles in Kilograms Per Year
2.1.15	Production Percentage of Rootlike Vegetables for Commercial Use Within 10 Miles

LIST OF TABLES (Cont.)

Table No.	Title
2.1.16	Percentage of Surface Area Covered by Vegetables for Commercial Use Within 10 Miles
2.1.17	Total Production of Leafy Vegetables for Commercial Use Between 10 and 50 Miles in Kilograms Per Year
2.1.18	Total Production of Non-Leafy Vegetables for Commercial Use Between 10 and 50 Miles in Kilograms Per Year
2.1.19	Production Percentage of Rootlike Vegetables for Commercial Use Between 10 and 50 Miles
2.1.20	Percentage of Surface Area Covered by Vegetables for Commercial Use Between 10 and 50 Miles
2.1.21	Vegetable Yield in Kilograms/m^2
2.1.22	Dry to Wet Ratio of Vegetables
2.1.23	Total Number of Acres of Soybeans Within 10 Miles
2.1.24	Total Soybean Production Within 10 Miles in Kilograms Per Year
2.1.25	Percentage of Surface Area Covered by Soybeans Within 10 Miles
2.1.26	Total Number of Acres of Soybeans Between 10 and 50 Miles
2.1.27	Total Soybean Production Between 10 and 50 Miles in Kilograms Per Year
2.1.28	Percentage of Surface Covered by Soybeans Between 10 and 50 Miles
2.1.29	Total Number of Acres of Corn Within 10 Miles
2.1.30	Total Production of Corn in Kilograms Per Year Within 10 Miles

LIST OF TABLES (Cont.)

Table No.	Title
2.1.31	Percentage of Surface Area Covered by Corn Within 10 Miles
2.1.32	Total Number of Acres of Corn Between 10 and 50 Miles
2.1.33	Total Production of Corn in Kilograms Per Year Between 10 and 50 Miles
2.1.34	Percentage of Surface Area Covered by Corn Between 10 and 50 Miles
2.1.35	Total Acres of Wheat Within 10 Miles
2.1.36	Total Acres of Wheat Between 10 and 50 Miles
2.1.37	Total Wheat Production in Kilograms/Year Between 10 and 50 Miles
2.1.38	Percentage of Surface Area Covered by Wheat Between 10 and 50 Miles
2.1.39	Total Number of Acres of Rice Within 10 Miles
2.1.40	Total Number of Acres of Rice Between 10 and 50 Miles
2.1.41	Total Production of Rice Between 10 and 50 Miles in Kilograms Per Year
2.1.42	Percentage of Surface Area Covered by Rice Between 10 and 50 Miles
2.1.43	Yield of Crops Grown Within 50 Miles in Kilograms/m^2
2.1.44	Milk Production from Commercial Dairies Between 10 and 50 Miles in Liters Per Year
2.1.45	Number of Head of Beef Cattle Within 10 Miles to be Sold Locally for Human Consumption
2.1.46	Beef Production in Kilograms Per Year Within 10 Miles to be Sold Locally for Human Consumption

LIST OF TABLES (Cont.)

Table No.	Title
2.1.47	Total Number of Head of Beef Cattle Between 10 and 50 Miles
2.1.48	Total Beef Weight Gain in Kilograms Per Year Between 10 and 50 Miles
2.1.49	Number of Head of Swine Within 10 Miles
2.1.50	Pork Production in Kilograms Per Year Within 10 Miles
2.1.51	Number of Head of Swine Between 10 and 50 Miles
2.1.52	Total Pork Weight Gain in Kilograms Per Year Between 10 and 50 Miles
2.1.53	Total Meat Production in Kilograms Per Year Within 10 Miles for Local Human Consumption
2.1.54	Total Beef and Swine Weight Gain in Kilograms Per Year Between 10 and 50 Miles
2.1.55	Beef Slaughter Production Between 10 and 50 Miles in Kilograms Per Year
2.1.56	Pork Slaughter Production in Kilograms Per Year Between 10 and 50 Miles
2.1.57	Annual Atmospheric Humidity for Louisiana
2.1.58	Annual Atmospheric Humidity for Mississippi
2.1.59	Winter Supplementary Diet of Cattle
2.1.60	Pasture Grass Densities
2.1.61	Pasture Grass Yields
2.1.62	Pasture Grass Dry to Wet Ratio
2.1.63	Total Number of Acres of Pastureland Within 10 Miles

LIST OF TABLES (Cont.)

Table No.	Title
2.1.64	Percentage of Surface Area Covered by Pastureland Within 10 Miles
2.1.65	Total Number of Acres of Pastureland Between 10 and 50 Miles
2.1.66	Percentage of Surface Area Covered by Pastureland Between 10 and 50 Miles
2.1.67	Total Kilograms of Commercial Fish Catch From Mississippi River Within 100-Mile Study Area for Year 1976
2.1.68	Mississippi Deer Kills for 1976-1977
2.1.69	Louisiana Deer Kills for 1975-1976
2.1.70	Deer Kill in Kilograms Per Year Within 5 Miles
2.1.71	Monthly Surface and Ground Water Use Within the 50 Mile Study Area in Million Gallons Per Month
2.1.72	Users of Mississippi River Water
2.3.1	Resultant Wind
2.3.2	Temperature Means and Extremes (F) at Municipal Airport, Jackson, Mississippi
2.3.3	Temperature Means and Extremes at Post Office Building, Vicksburg, Mississippi
2.3.4	Mean Relative Humidity at Municipal Airport, Jackson and Post Office Building, Vicksburg
2.3.5	Wet and Dry Bulb Temperatures (F) for Cooling Equipment Design
2.3.6	Frequency of Tropical Cyclones (By Months) Along the Middle Gulf Coast

LIST OF TABLES (Cont.)

Table No.	Title
2.3.7	Average Number of Days With Thunderstorms in the Site Region
2.3.8	Mean Ventilation Rates* By Month Jackson, Mississippi
2.3.9	Occurrence of Freezing Rain or Drizzle at Jackson, Mississippi
2.3.10	Number and Duration of Discrete Occurrences of Freezing Rain at Jackson, Mississippi 1955 Through 1964
2.3.11	Monthly Summary of Occurrences of Ice Storms at Jackson, Mississippi 1955 Through 1964
2.3.12	Annual Summary of Occurrences of Ice Storms at Jackson, Mississippi 1955 Through 1964
2.3.13	Occurrence of Dust, Blowing Dust or Blowing Sand at Jackson, Mississippi 1955 Through 1964
2.3.14	Number and Duration of Discrete Occurrences of Dust, Blowing Dust or Blowing Sand at Jackson, Mississippi 1955 Through 1964
2.3.15	Monthly Summary of Occurrences of Dust, Blowing Dust or Blowing Sand at Jackson, Mississippi 1955 Through 1964
2.3.16	Annual Summary of Occurrences of Dust, Blowing Dust or Blowing Sand at Jackson, Mississippi 1955 Through 1964
2.3.17	Total Maximum Winter Precipitation Jackson, Mississippi
2.3.18	Percentage Frequency of Wind Direction and Speed Municipal Airport, Jackson, Mississippi Length of Record - 10 Years January

LIST OF TABLES (Cont.)

Table No.	Title
2.3.19	Percentage Frequency of Wind Direction and Speed Municipal Airport, Jackson, Mississippi Length of Record - 10 Years February
2.3.20	Percentage Frequency of Wind Direction and Speed Municipal Airport, Jackson, Mississippi Length of Record - 10 Years March
2.3.21	Percentage Frequency of Wind Direction and Speed Municipal Airport, Jackson, Mississippi Length of Record - 10 Years April
2.3.22	Percentage Frequency of Wind Direction and Speed Municipal Airport, Jackson, Mississippi Length of Record - 10 Years May
2.3.23	Percentage Frequency of Wind Direction and Speed Municipal Airport, Jackson, Mississippi Length of Record - 10 Years June
2.3.24	Percentage Frequency of Wind Direction and Speed Municipal Airport, Jackson, Mississippi Length of Record - 10 Years July
2.3.25	Percentage Frequency of Wind Direction and Speed Municipal Airport, Jackson, Mississippi Length of Record - 10 Years August
2.3.26	Percentage Frequency of Wind Direction and Speed Municipal Airport, Jackson, Mississippi Length of Record - 10 Years September
2.3.27	Percentage Frequency of Wind Direction and Speed Municipal Airport, Jackson, Mississippi Length of Record - 10 Years October

LIST OF TABLES (Cont.)

Table No.	Title
2.3.28	Percentage Frequency of Wind Direction and Speed Municipal Airport, Jackson, Mississippi Length of Record - 10 Years November
2.3.29	Percentage Frequency of Wind Direction and Speed Municipal Airport, Jackson, Mississippi Length of Record - 10 Years December
2.3.30	Percentage Frequency of Wind Direction and Speed Municipal Airport, Jackson, Mississippi Length of Record - 10 Years Annual
2.3.31	Percentage Frequency of Wind Direction and Speed at Grand Gulf Site Period of Record - August 1972 to July 1973
2.3.32	Percentage Frequency of Wind Direction and Speed Municipal Airport, Jackson, Mississippi Period of Record - August 1972 to July 1973
2.3.33	Percentage Frequency of Wind Direction and Speed at Grand Gulf Site Period of Record - August 1972 to July 1974
2.3.34	Relative Frequency of Hourly Observations of Wind Direction and Speed, January, Grand Gulf, Mississippi, August 1972 - July 1974
2.3.35	Relative Frequency of Hourly Observations of Wind Direction and Speed, February, Grand Gulf, Mississippi, August 1972 - July 1974
2.3.36	Relative Frequency of Hourly Observations of Wind Direction and Speed, March, Grand Gulf, Mississippi, August 1972 - July 1974
2.3.37	Relative Frequency of Hourly Observations of Wind Direction and Speed, April, Grand Gulf, Mississippi, August 1972 - July 1974

LIST OF TABLES (Cont.)

Table No.	Title
2.3.38	Relative Frequency of Hourly Observations of Wind Direction and Speed, May, Grand Gulf, Mississippi, August 1972 - July 1974
2.3.39	Relative Frequency of Hourly Observations of Wind Direction and Speed, June, Grand Gulf, Mississippi, August 1972 - July 1974
2.3.40	Relative Frequency of Hourly Observations of Wind Direction and Speed, July, Grand Gulf, Mississippi, August 1972 - July 1974
2.3.41	Relative Frequency of Hourly Observations of Wind Direction and Speed, August, Grand Gulf, Mississippi, August 1972 - July 1974
2.3.42	Relative Frequency of Hourly Observations of Wind Direction and Speed, September, Grand Gulf, Mississippi, August 1972 - July 1974
2.3.43	Relative Frequency of Hourly Observations of Wind Direction and Speed, October, Grand Gulf, Mississippi, August 1972 - July 1974
2.3.44	Relative Frequency of Hourly Observations of Wind Direction and Speed, November, Grand Gulf, Mississippi, August 1972 - July 1974
2.3.45	Relative Frequency of Hourly Observations of Wind Direction and Speed, December, Grand Gulf, Mississippi, August 1972 - July 1974
2.3.46	Maximum Number of Consecutive Hours With Wind From a Single Sector (22.5°) at Jackson, Mississippi
2.3.47	Maximum Number of Consecutive Hours With Wind From Three Adjacent Sectors (67.5°) at Jackson, Mississippi
2.3.48	Maximum Number of Consecutive Hours With Wind From Five Adjacent Sectors (112.5°) at Jackson, Mississippi

LIST OF TABLES (Cont.)

Table No.	Title
2.3.49	Maximum Number of Consecutive Hours With Wind From a Single Sector (22.5°) at Grand Gulf Site
2.3.50	Maximum Number of Consecutive Hours With Wind From Three Adjacent Sectors (67.5°) at Grand Gulf Site
2.3.51	Maximum Number of Consecutive Hours With Wind From Five Adjacent Sectors (112.5°) at Grand Gulf Site
2.3.52	Comparison of Maximum Wind Persistence at Grand Gulf Site and at Jackson, Mississippi
2.3.53	Maximum Number of Consecutive Hours With Wind From a Single Sector, by Month, at Jackson, Mississippi 1955 Through 1964
2.3.54	Average Number of Occurrences of Extreme Temperatures at Municipal Airport, Jackson and Vicksburg Post Office Building
2.3.55	Temperature Means and Extremes (F) at Grand Gulf (GG) and Jackson, Ms (J) August 1973 - July 1974
2.3.56	Temperature Means and Extremes (F) at Grand Gulf (GG) and Jackson, Mississippi (J) August 1972 - July 1973
2.3.57	Annual Frequency Distribution of Saturation Deficit Versus Wind Speed by Sector at Jackson
2.3.58	Spring Season Frequency Distribution of Saturation Deficit Versus Wind Speed by Sector at Jackson, Mississippi, 1955-1964
2.3.59	Summer Season Frequency Distribution of Saturation Deficit Versus Wind Speed by Sector at Jackson, Mississippi, 1955-1964
2.3.60	Fall Season Frequency Distribution of Saturation Deficit Versus Wind Speed by Sector at Jackson, Mississippi, 1955-1964

LIST OF TABLES (Cont.)

Table No.	Title
2.3.61	Winter Season Frequency Distribution of Saturation Deficit Versus Wind Speed by Sector at Jackson, Mississippi 1955-1964
2.3.62	Precipitation Means and Extremes (Inches) at Vicksburg, Mississippi
2.3.63	Precipitation Measurements at Grand Gulf, Mississippi
2.3.64	Monthly Precipitation Amounts and Hours With Precipitation at the Grand Gulf Site, Jackson, Ms, and Alexandria, La
2.3.65	Rainfall Rate Frequency Distribution at Grand Gulf, Ms
2.3.66	Rainfall Rate Frequency Distribution at Jackson, Ms
2.3.67	Rainfall Rate Frequency Distribution at Alexandria, La
2.3.68	Annual Rainfall Rate Frequency Distribution at Grand Gulf, Ms
2.3.69	Annual Rainfall Rate Frequency Distribution at Jackson, Ms
2.3.70	Annual Rainfall Rate Frequency Distribution at Alexandria, La
2.3.71	Estimated Maximum Point Precipitation Amounts (Inches) for Selected Durations and Recurrence Intervals Grand Gulf, Mississippi
2.3.72	Maximum Observed Short Period Precipitation (in.) Vicksburg, Mississippi
2.3.73	Percent of Total Observations (By Months) of Indicated Wind Directions and Precipitation, Jackson, Mississippi
2.3.74	Frequency Distribution Jan from 1972 to 1976 Station: GGNS PCPN Winroses
2.3.75	Frequency Distribution Feb From 1972 to 1976 Station: GGNS PCPN Winroses

LIST OF TABLES (Cont.)

Table No.	Title
2.3.76	Frequency Distribution Mar From 1972 to 1976 Station: GGNS PCPN Winroses
2.3.77	Frequency Distribution Apr From 1972 to 1976 Station: GGNS PCPN Winroses
2.3.78	Frequency Distribution May From 1972 to 1976 Station: GGNS PCPN Winroses
2.3.79	Frequency Distribution Jun From 1972 to 1976 Station: GGNS PCPN Winroses
2.3.80	Frequency Distribution Jul From 1972 to 1976 Station: GGNS PCPN Winroses
2.3.81	Frequency Distribution Aug From 1972 to 1976 Station: GGNS PCPN Winroses
2.3.82	Frequency Distribution Sep From 1972 to 1976 Station: GGNS PCPN Winroses
2.3.83	Frequency Distribution Oct From 1972 to 1976 Station: GGNS PCPN Winroses
2.3.84	Frequency Distribution Nov From 1972 to 1976 Station: GGNS PCPN Winroses
2.3.85	Frequency Distribution Dec From 1972 to 1976 Station: GGNS PCPN Winroses
2.3.86	Frequency Distribution 1972 to 1976 Station: GGNS PCPN Winroses
2.3.87	Frequency Distribution Jan From 1972 to 1976 Station: Jan, Ms PCPN Roses
2.3.88	Frequency Distribution Feb From 1972 to 1976 Station: Jan, Ms PCPN Roses
2.3.89	Frequency Distribution Mar From 1972 to 1976 Station: Jan, Ms PCPN Roses
2.3.90	Frequency Distribution Apr From 1972 to 1976 Station: Jan, Ms PCPN Roses
2.3.91	Frequency Distribution May From 1972 to 1976 Station: Jan, Ms PCPN Roses

LIST OF TABLES (Cont.)

Table No.	Title
2.3.92	Frequency Distribution Jun From 1972 to 1976 Station: Jan, Ms PCPN Roses
2.3.93	Frequency Distribution Jul From 1972 to 1976 Station: Jan, Ms PCPN Roses
2.3.94	Frequency Distribution Aug From 1972 to 1976 Station: Jan, Ms PCPN Roses
2.3.95	Frequency Distribution Sep From 1972 to 1976 Station: Jan, Ms PCPN Roses
2.3.96	Frequency Distribution Oct From 1972 to 1976 Station: Jan, Ms PCPN Roses
2.3.97	Frequency Distribution Nov From 1972 to 1976 Station: Jan, Ms PCPN Roses
2.3.98	Frequency Distribution Dec From 1972 to 1976 Station: Jan, Ms PCPN Roses
2.3.99	Frequency Distribution 1972 to 1976 Station: Jan, Ms PCPN Roses
2.3.100	Frequency Distribution Jan From 1972 to 1976 Station: Alx, La PCPN Roses
2.3.101	Frequency Distribution Feb From 1972 to 1976 Station: Alx, La PCPN Roses
2.3.102	Frequency Distribution Mar From 1972 to 1976 Station: Alx, La PCPN Roses
2.3.103	Frequency Distribution Apr From 1972 to 1976 Station: Alx, La PCPN Roses
2.3.104	Frequency Distribution May From 1972 to 1976 Station: Alx, La PCPN Roses
2.3.105	Frequency Distribution Jun From 1972 to 1976 Station: Alx, La PCPN Roses
2.3.106	Frequency Distribution Jul From 1972 to 1976 Station: Alx, La PCPN Roses
2.3.107	Frequency Distribution Aug From 1972 to 1976 Station: Alx, La PCPN Roses

LIST OF TABLES (Cont.)

Table No.	Title
2.3.108	Frequency Distribution Sep From 1972 to 1976 Station: Alx, La PCPN Roses
2.3.109	Frequency Distribution Oct From 1972 to 1976 Station: Alx, La PCPN Roses
2.3.110	Frequency Distribution Nov From 1972 to 1976 Station: Alx, La PCPN Roses
2.3.111	Frequency Distribution Dec From 1972 to 1976 Station: Alx, La PCPN Roses
2.3.112	Frequency Distribution 1972 to 1976 Station: Alx, La PCPN Roses
2.3.113	Monthly and Annual Mean Number of Days With Heavy Fog Jackson, Mississippi and Baton Rouge, Louisiana
2.3.114	Monthly and Annual Percentage Frequency of Occurrence of Visibility Restricted With Moderate Fog
2.3.115	Occurrence of Fog (Including Smog) at Jackson, Mississippi 1955 Through 1964
2.3.116	Number and Duration of Discrete Occurrences of Fog (Including Smog) at Jackson, Mississippi 1955 Through 1964
2.3.117	Monthly Summary of Occurrences of Fog (Including Smog) at Jackson, Mississippi 1955 Through 1964
2.3.118	Annual Occurrences of Fog (Including Smog) at Jackson, Mississippi 1955 Through 1964
2.3.119	Occurrence of Heavy Fog or Heavy Smog at Jackson, Mississippi 1955 Through 1964
2.3.120	Number and Duration of Occurrences of Heavy Fog or Heavy Smog at Jackson, Mississippi 1955-1964
2.3.121	Monthly Summary of Occurrences of Heavy Fog or Heavy Smog at Jackson, Mississippi

LIST OF TABLES (Cont.)

Table No.	Title
2.3.122	Annual Summary of Occurrences of Heavy Smog at Jackson, Mississippi
2.3.123	Occurrence of Smog at Jackson, Mississippi 1955 Through 1964
2.3.124	Number and Duration of Discrete Occurrences of Smog at Jackson, Mississippi 1955 Through 1964
2.3.125	Monthly Summary of Occurrences of Smog at Jackson, Mississippi 1955-1964
2.3.126	Annual Summary of Occurrences of Smog at Jackson, Mississippi 1955-1964
2.3.127A	Frequency Distribution for Pasquill Stability Class A
2.3.127B	Frequency Distribution for Pasquill Stability Class B
2.3.127C	Frequency Distribution for Pasquill Stability Class C
2.3.127D	Frequency Distribution for Pasquill Stability Class D
2.3.127E	Frequency Distribution for Pasquill Stability Class E
2.3.127F	Frequency Distribution for Pasquill Stability Class F
2.3.127G	Frequency Distribution for Pasquill Stability Class G
2.3.127H	Frequency Distribution
2.3.128A	Joint Frequency Distribution of Wind Direction and Wind Speeds for Pasquill Stability Class A Municipal Airport, Jackson, Mississippi

LIST OF TABLES (Cont.)

Table No.	Title
2.3.128B	Joint Frequency Distribution of Wind Direction and Wind Speeds for Pasquill Stability Class B Municipal Airport, Jackson, Mississippi
2.3.128C	Joint Frequency Distribution of Wind Direction and Wind Speeds for Pasquill Stability Class C Municipal Airport, Jackson, Mississippi
2.3.128D	Joint Frequency Distribution of Wind Direction and Wind Speeds for Pasquill Stability Class D Municipal Airport, Jackson, Mississippi
2.3.128E	Joint Frequency Distribution of Wind Direction and Wind Speeds for Pasquill Stability Class E Municipal Airport, Jackson, Mississippi
2.3.128F	Joint Frequency Distribution of Wind Direction and Wind Speeds for Pasquill Stability Class F Municipal Airport, Jackson, Mississippi
2.3.128G	Joint Frequency Distribution of Wind Direction and Wind Speeds for Pasquill Stability Class G Municipal Airport, Jackson, Mississippi
2.3.129A	Joint Frequency Distribution of Wind Direction and Wind Speeds for Pasquill Stability Class A Municipal Airport, Jackson, Mississippi (1965-1969)
2.3.129B	Joint Frequency Distribution of Wind Direction and Wind Speeds for Pasquill Stability Class B Municipal Airport, Jackson, Mississippi (1965-1969)
2.3.129C	Joint Frequency Distribution of Wind Direction and Wind Speeds for Pasquill Stability Class C Municipal Airport, Jackson, Mississippi (1965-1969)

LIST OF TABLES (Cont.)

Table No.	Title
2.3.129D	Joint Frequency Distribution of Wind Direction and Wind Speeds for Pasquill Stability Class D Municipal Airport, Jackson, Mississippi (1965-1969)
2.3.129E	Joint Frequency Distribution of Wind Direction and Wind Speeds for Pasquill Stability Class E Municipal Airport, Jackson, Mississippi (1965-1969)
2.3.129F	Joint Frequency Distribution of Wind Direction and Wind Speeds for Pasquill Stability Class F Municipal Airport, Jackson, Mississippi (1965-1969)
2.3.130	Percentage Frequency Distribution of Pasquill Stability Classes, Grand Gulf, Mississippi
2.3.131	Number of Inversion Occurrences During January at Jackson, Mississippi
2.3.132	Number of Inversion Occurrences During February at Jackson, Mississippi
2.3.133	Number of Inversion Occurrences During March at Jackson, Mississippi
2.3.134	Number of Inversion Occurrences During April at Jackson, Mississippi
2.3.135	Number of Inversion Occurrences During May at Jackson, Mississippi
2.3.136	Number of Inversion Occurrences During June at Jackson, Mississippi
2.3.137	Number of Inversion Occurrences During July at Jackson, Mississippi
2.3.138	Number of Inversion Occurrences During August at Jackson, Mississippi
2.3.139	Number of Inversion Occurrences During September at Jackson, Mississippi

LIST OF TABLES (Cont.)

Table No.	Title
2.3.140	Number of Inversion Occurrences During October at Jackson, Mississippi
2.3.141	Number of Inversion Occurrences During November at Jackson, Mississippi
2.3.142	Number of Inversion Occurrences During December at Jackson, Mississippi
2.3.143	Mean Number of Inversion Occurrences During 1955-1964 at Jackson, Mississippi
2.3.144	Percent of Hours With Inversion at Jackson, Mississippi
2.3.145	Number of Inversion Occurrences During January at Grand Gulf Site
2.3.146	Number of Inversion Occurrences During February at Grand Gulf Site
2.3.147	Number of Inversion Occurrences During March at Grand Gulf Site
2.3.148	Number of Inversion Occurrences During April at Grand Gulf Site
2.3.149	Number of Inversion Occurrences During May at Grand Gulf Site
2.3.150	Number of Inversion Occurrences During June at Grand Gulf Site
2.3.151	Number of Inversion Occurrences During July at Grand Gulf Site
2.3.152	Number of Inversion Occurrences During August at Grand Gulf Site
2.3.153	Number of Inversion Occurrences During September at Grand Gulf Site
2.3.154	Number of Inversion Occurrences During October at Grand Gulf Site
2.3.155	Number of Inversion Occurrences During November at Grand Gulf Site

LIST OF TABLES (Cont.)

Table No.	Title
2.3.156	Number of Inversion Occurrences During December at Grand Gulf Site
2.3.157	Number of Inversion Occurrences at Grand Gulf Site
2.3.158	Percent of Hours With Inversion at Grand Gulf Site
2.3.159	Average Mixing Heights and Wind Speeds for Jackson, Mississippi
2.3.160	Mean Daily Mixing Depths by Month
2.4.1	Flood Discharge at Key Locations on Mississippi River During Six Highest Floods of Record
2.4.2	Observed Mean Discharge, 1000 cfs, at Vicksburg, Miss.
2.4.3	Minimum Daily Flows and Stages Observed on Mississippi River Vicksburg, Mississippi 1932-1979
2.4.4	Low-Flow Values, CFS, for 1, 7 and 30 Days for Selected Return Periods for Mississippi River at Vicksburg, Mississippi
2.4.5	Maximum Discharges of Stream Draining Basin A
2.4.6	Velocity, Discharge, and Water Surface Elevations for Mississippi River at Site
2.4.7	Ranges of Water Temperatures for Mississippi River at Vicksburg, Mississippi
2.4.8	Chemical Analyses of Water From the Mississippi River Near St. Francisville, Louisiana
2.4.9	Summary of Water Quality Parameters for Mississippi River at Grand Gulf November 1972 Through November 1973

LIST OF TABLES (Cont.)

Table No.	Title
2.4.10	Permeability Test Results
2.4.11	Site Hydrogeologic Parameters
2.4.12	Water-Use Survey, Vicinity of Site
2.4.13	Piezometer Inventory
2.4.14	Observation Well Inventory
2.4.15	Results of Chemical Analyses of Water Samples
2.7.1	Primary Activities Occurring During Each of the Construction Noise Surveys

LIST OF FIGURES

Figure No.	Title
2.1-1	Site and Yard Work Site Plan
2.1-2	Plot Plan
2.1-3	General Area Map
2.1-4	Site Vicinity Map
2.1-5	Site Area and Adjacent Land Uses
2.2-1	Vegetation Sampling Location
2.2-2	Overstory Vegetation Type Map
2.2-3	Understory Vegetation Type Map Summer
2.2-4	Understory Vegetation Type Map Winter
2.2-5	Understory Vegetation Type Map Spring
2.2-6	Avian Census Location
2.2-7	Mammalian Sampling and Census Locations
2.2-8	Areas of Suspected Vegetation Stress Determined from Color Infrared
2.2-9	Mississippi and Big Black Rivers Sampling and Survey Locations
2.2-10	Hamilton and Gin Lakes Sampling Locations
2.2-11	Electrofishing Sampling Locations During Flood Conditions
2.2-12	Stream and Pond Sampling and Gaging Locations
2.2-13	Mean Surface Current Velocity at Mississippi River Stations
2.3-1	Annual Wind Rose Jackson Mississippi
2.3-2	Annual Wind Rose August 1972 - July 1973

LIST OF FIGURES (Cont.)

Figure No.	Title
2.3-3	Comparison of Wind Directions and Speeds at Grand Gulf, Miss., 1972-74 and at Jackson, Miss., 1960-1964
2.3-4	Comparison of Temperature and Extremes (F) at Grand Gulf, Miss., August 1972 - July 1973, August 1973 - July 1974
2.3-5	Annual Precipitation Wind Rose (Percent of Total Observations) Jackson, Mississippi
2.3-6	Low Speed Wind Rose August 1972 - July 1973
2.3-7	Comparison of Wind Direction and Slow Speeds (7 MPH) at Grand Gulf, Miss., Under Stable Atmospheric Conditions, 1973-1974, 1972-1973
2.3-8	Topographic Profiles
2.3-9	Topographic Profiles
2.3-10	Topographic Plan of Area Within 5 Miles of Plant
2.4-1	Regional Topography
2.4-2	Hydrographic Details of the Mississippi River at Grand Gulf 5
2.4-3	Channel Cross Sections of the Mississippi River in the Vicinity of the Discharge Structure
2.4-4	Water Surface Profiles for High Flows on the Mississippi River
2.4-5	Rating Curve for the Mississippi River at Grand Gulf Site
2.4-6	Local Drainage Basins
2.4-7	Vertical Temperature Profile Mississippi River February 19, 1973

LIST OF FIGURES (Cont.)

Figure No.	Title
2.4-8	Locations of Velocity and Temperature Measurements
2.4-9	Site Hydrologic Features (Normal Conditions)
2.4-10	Water Well Location
2.4-11	Hydrographs of Wells and Piezometers
2.4-12	Hydrographs of Mississippi River, Gin Lake and Hamilton Lake
2.4-13	Site Hydrologic Features (Flood Conditions May 1973)
2.4-14	Hydrogeologic Cross Section A-A[1]
2.4-15	Hydrographs of Hamilton Lake and Observation Wells F-4 and F-6 During Pump Tests 6
2.5-1	Regional Physiographic Map
2.5-2	Local Geologic Map
2.5-3	Geologic Section, Adams County Through Warren County, Mississippi
2.5-4	Contour Map of the Glendon Limestone of Claiborne County
2.6-1	Artist's Concept of Grand Gulf Nuclear Station
2.7-1	Ambient Noise Monitoring Station Locations
2.7-2	Diel Variations db(A) Background Noise Levels
2.7-3	Comparison of Median (L_{50}) dB(A) Noise Levels Between July 1973 and June 1974 Surveys
2.7-4	Variation of dB(A) Noise Levels With Time During the Construction Noise Survey, June 1974

LIST OF FIGURES (Cont.)

Figure No.	Title
2.7-5	Variation of dB(A) Noise Levels With Time During the Ambient Background Noise Survey, July 1973
2.7-6	Overall Mean Octave Band Levels During the July 1973 and June 1974 Surveys
2.7-7	Comparison of Median (L_{50}) dB(A) Noise Levels Between July 1973 and August 1974 Surveys
2.7-8	Comparison of Median (L_{50}) dB(A) Noise Levels Between July 1973 and October 1974 Surveys
2.7-9	Comparison of Median (L_{50}) dB(A) Noise Levels Between July 1973 and December 1974 Surveys
2.7-10	Comparison of Median (L_{50}) dB(A) Noise Levels Between July 1973 and February 1975 Surveys

CHAPTER 2.0 THE SITE AND ENVIRONMENTAL INTERFACES

2.1 GEOGRAPHY AND DEMOGRAPHY

2.1.1 Site Location and Description

2.1.1.1 Specification of Location

Centerline coordinates between the Unit 1 and 2 reactors are 91° 2' 53" longitude and 32° 0' 27" latitude. The Universal Transverse Mercator (UTM) coordinates are N3, 542, 550 meters and, E684, 360 meters.

The Grand Gulf Nuclear Station is located in Claiborne County, Mississippi. The site is on the east bank of the Mississippi River, approximately 25 miles south of Vicksburg, Mississippi and 37 miles north-northeast of Natchez, Mississippi. The Grand Gulf Military Park borders a portion of the north side of the property and the community of Grand Gulf is approximately 1.5 miles to the north. The town of Port Gibson is about 6 miles southeast of the site. Two lakes, Hamilton Lake and Gin Lake, are located in the western portion of the site. These lakes were once the channel of the Mississippi River and average about 5 to 7 feet deep.

Figure 2.1-1 shows the location of significant plant facilities with respect to the property boundary. The site and its environs consist primarily of woodlands and farms and are about equally divided between two physiographic regions. The western half of the site is in the Mississippi Alluvial Valley; the eastern half is in the Loess or Bluff Hills. The elevation of the site varies between 60 and 80 feet above mean sea level in the Mississippi Alluvial Valley whereas the Loess Hills portion varies from 80 to more than 200 feet above mean sea level.

2.1.1.2 Site Area

The property line shown on Figure 2.1-1 encompasses the 2376 acres originally purchased by Mississippi Power & Light Company. However, due to erosion activity of the Mississippi River along the western boundary of the site, this acreage figure will continually decrease until the river bank from the barge slip to the north boundary of the site undergoes stabilization through the Corps of Engineers shoreline modification program. The present acreage figure for the site due to erosion is 2300 acres. This figure will be referenced throughout this Environmental Report as the official site acreage. 5

The site boundary is the same as the property line except in the southwest and west-southwest sectors as shown in Figure 2.1-1. A 2-acre residential property within the southwest sector is privately owned.

There are no industrial, commercial, institutional, or residential structures within the site boundary.

The boundary lines of the plant exclusion area (as defined in 10 CFR 100) are shown in Figure 2.1-2. The boundary consists of semicircles drawn from the center of each containment joined by tangent straight lines. The minimum distance from each reactor

to the exclusion area boundary is 696 meters. This is the closest distance from the center of the Unit 1 containment to the property line.

There are no railroads or waterways that traverse the site. A county road runs through the site in the south-southeast, south, south-southwest, and southwest sectors. An unpaved county road provides access to Hamilton and Gin Lakes and the Mississippi River from the Port Gibson - Grand Gulf Road.

2.1.1.3 Boundaries for Establishing Effluent Release Limits

The boundary lines of the restricted area (as defined in 10 CFR 20) are the same as the site boundary defined in subsection 2.1.1.2. The east edge of the Mississippi River is the western boundary of the site.

Access to the restricted area will be allowed for recreational purposes and use of the county roads.

Distances from plant effluent release points to the nearest site boundary are given in the table on Figure 2.1-2. Distances to the nearest site boundary in each of the 16 sectors are given in Table 2.1.10.

2.1.2 Population Distribution

The area within 50 miles of the Grand Gulf Nuclear Station includes all or parts of 25 counties and parishes in Mississippi and Louisiana. A general area map and a site vicinity map are shown in Figures 2.1-3 and 2.1-4, respectively.

For each area thus formed by the concentric circles and radial lines, both the resident population for 1970 and the projected resident population for each decade through the year 2020 were calculated.

For the 1970 population distribution within 5 miles of the site, an average value of 3.6 persons per house was used to convert house counts to population. The average value was based on 1970 census data for the surrounding area. House counts were taken from a 1967 Claiborne County highway map. For the area beyond 5 miles from the station, 1970 census data were used to develop the 1970 population distribution.

Population projections were based on the 1971 Department of Commerce, Office of Business Economics (OBE) population projection studies (U. S. Dept. of Com. 1968, 1972; DeGraff, 1972, Lyle, 1972). These projection studies were prepared by OBE for comprehensive planning, management and development of the Nation's water and related resources.

The OBE population projections were based primarily on a study of the historical economic activity for various regions in the United States beginning in 1929 and then projecting from these historical trends to predict future growth patterns through the year 2020 (U. S. Dept. of Com., 1971). There are eight broad assumptions underlying the OBE projections. They are as follows:

a. A general decline in fertility rate.

b. Reasonably full employment will prevail.

c. Future economy is considered to be free of disruptive effects of foreign conflict.

d. Stability will be maintained in the conduct of international trade.

e. Continued technological progress.

f. Continued development of new products within existing industrial system.

g. Continued growth in output within existing industrial system can be achieved with environmental balance.

h. Factors influencing historical trends will continue into the future.

Simplified, the steps used by OBE in projecting population consist of the following:

a. Estimate the future Gross National Product of the Nation.

b. Allocate the projected GNP to the various regions and counties in the Country according to employment by industry and earnings.

c. Determine the regional population on the basis of projected regional employment.

OBE population projections for each decade in the period of 1970 through 2020 were obtained by county in Mississippi and for OBE "economic areas" in Louisiana. A growth rate was computed for each county and parish from the OBE data. Projected population for each population sector was computed by applying the appropriate growth rate to the 1970 population. In areas where there is no resident population, e.g. lakes and marshes, these areas were assumed to remain uninhabited for the next 50 years (Ref. 1 through 11).

2.1.2.1 Population Within 10 Miles

Table 2.1.1 presents the resident population for 1970 and the projected resident population through the year 2020. Age distribution for the year 2000 is presented in Table 2.1.2. The year 2000 was determined to be the midpoint of the station operating life. Age distribution was calculated by percentages as follows:

Age Distribution

0-1	years	2 percent
1-11	years	16 percent
11-18	years	11 percent
>18	years	71 percent

2.1.2.2 Population Between 10 and 50 Miles

Table 2.1.3 presents the resident population for 1970 and the projected resident population through the year 2020. Age distribution for the year 2000 is presented in Table 2.1.4. The year 2000 was determined to be the midpoint of the station operating life. Age distribution was calculated by percentages as follows:

Age Distribution

0-1	years	2 percent
1-11	years	16 percent
11-18	years	11 percent
>18	years	71 percent

2.1.2.3 Transient Population

2.1.2.3.1 Seasonal Variation

a. Grand Gulf Military Park

The Grand Gulf Military Park is located approximately 1.5 miles north of the reactor location and is contiguous to the site property. The park had approximately 123,444 visitors in 1976. During the summer, the park is open from 8:30 am to 8:30 pm, while during the winter months the park is open from 8:30 am to 5:30 pm. School groups, Boy Scouts, YMCA groups, and others use Grand Gulf Military Park for field trips and nature studies. Most people visit the park on Sundays, with Saturday second in attendance. The park is most heavily populated during the months of June and July. Table 2.1.5 tabulates the number of visitors to the park since 1971. Table 2.1.6 tabulates the number of park visitors each month in 1976. The park has two permanent residents (Ref. 12).

b. Warner YMCA Camp

The Warner YMCA Camp consists of 108 acres of land located approximately 3.5 miles northeast of the site. The camp has two permanent residents and facilities to serve a maximum of 125 individuals. During the summer, a total of 1300 to 1600 people attend the camp: approximately 650 people from March-June, 460 from June-August, and 550 from August-November. The average daily attendance is approximately 100 (Ref. 13).

c. Lake Claiborne Development and Recreational Area

Lake Claiborne, Inc., is a private development with residential and recreational facilities. It is located approximately 3.5 miles east of the site. There are 25 permanent and 31 seasonal homes on the lake with at least 10 more permanent homes expected by the end of 1978. Lake Claiborne, Inc., has a total of 450 family memberships; families who have access to the lake and picnic area. A maximum of 200 people use these facilities on a summer weekend (Ref. 14).

d. Lake Bruin State Park

Lake Bruin State Park consists of 45 acres located on the shore of Lake Bruin approximately 9.5 miles west of the site. From May 15 to Labor Day, the park has approximately 200,000 visitors (Ref. 15).

e. Natchez Trace Parkway

The Natchez Trace Parkway passes within about 6 miles of the site, but no developed facilities exist in the study area.

f. Hunting Camps

There are 22 hunting camps within the 5-mile radius of the site. Nineteen camps are located in Mississippi and three in Louisiana. These camps are primarily used for deer hunting although they are commodious for and employed by sportsmen who enjoy other types of hunting as well as sport fishing. Deer season traditionally opens early in October for archery and late November for guns. The season continues through early January. The greatest number of hunters are invariably present on the first day of gun season which is approximately November 20 (November 19 in 1977). A total of 675 hunters are customarily in attendance at the 22 camps for the first day of the gun season. After the opening weekend, about

70 percent of the first day's total remain at the camps for the remainder of the season (Ref. 16).

g. Sport Fishing

Sport fishing is not as popular as hunting. Within the study area, the portion contiguous to the site property in Louisiana is fished more heavily than that in Mississippi. The Conservation Officer estimates that the number of people fishing in the Louisiana area is more than twice that of the Mississippi area. Most fishing occurs in May, June and July, with Saturday the busiest day of the week. As many as 200 fishermen may be within the 5-mile radius on Saturdays during the months noted above.

2.1.2.3.2 Daily Variation

The daily variation is due primarily to employment and schools. In 1976, 1064 people resided within the 5-mile radius of the study area. Of these, 297 were employed and 160 attended school outside the 5-mile radius. There were 290 people working and 1711 people attending school within the 5-mile radius coming from outside. Therefore, there were seven people leaving the area daily for employment and 1551 entering the area for school. There is a net population gain of 1544 in the study area from 8:00 am to 5:00 pm during the school year. It can be concluded that the population within the 5-mile radius during the workday is 2608 people during the 9-month school year and 1057 during the remainder of the year.

Within the 5- to 10-mile area, approximately 6181 people presently reside. The center of employment and educational activity within this area is the town of Port Gibson. Approximately 695 students attended school in the 5- to 10-mile southeast sector of the study area. As previously mentioned, 1711 people attend school in the 4- to 5-mile southeast sector. Within the corporate limits of Port Gibson, 2406 students attend school during the 9-month school year. Approximately 1694 of the residents within the area are employed. During work hours, approximately 456 people work within Port Gibson at major manufacturing plants. Approximately 170 leave the 5- to 10-mile area for employment in St. Joseph and Newellton, Louisiana. Other employment opportunities within Port Gibson in commercial, finance, services, etc., employ approximately 1360 people. A decrease of approximately 50 people occurs during the work week within the 5- to 10-mile radius (Ref. 17, 18, 19). There are people who reside outside of the study area but work occasionally within its limits. The following are descriptions of those in this classification:

a. An Illinois Central Gulf Railroad freight train passes within 2.7 miles of the site twice daily. The train

runs from Vicksburg to Harrison, then turns and returns to Vicksburg. The train carries a crew of five. No plans are indicated to expand the Vicksburg-Harrison line. In the event of an emergency on the main line to New Orleans, traffic would be routed on the Vicksburg-Harrison line (Ref. 20).

b. The Delta Queen, a paddle wheel tour boat, passes the site twice weekly on the Mississippi River from October 1 through January 1; also from February 1 through May. The Delta Queen's full complement is 192 passengers and 75 crew members. No alteration in schedule was indicated (Ref. 21).

The Mississippi Queen, another paddle wheel tour boat operated by the same company as the Delta Queen, also passes the site twice weekly on the Mississippi River. The Mississippi Queen operates through the entire year at least to 1979. The Mississippi Queen's full complement is 500 passengers and 140 crew members (Ref. 21).

River tours are also conducted on the Jefferson Davis, a cabin cruiser based in Vicksburg. It has a capacity of about 100 people. The Jefferson Davis does not pass the site at this time, nor are any plans to pass the site indicated (Ref. 22).

c. There are three primary forest product companies who own and lease land within the study area. Anderson-Tully has one rover and 15 logging crews. Grief Brothers has 10 logging crews, and International Paper Company has five rovers and 15 logging crews. These individuals do not work exclusively within the 5-mile radius, but are occasionally present.

d. The Corps of Engineers, Vicksburg District, does not have anyone working within the 5-mile radius permanently. If the need should arise, the Corps may have as many as 400 people working in the area temporarily. This temporary work usually requires only a few days to complete.

e. There is some commercial fishing within the study area (subsection 2.1.3.4). Most of this occurs on the Mississippi River and its backwaters, but some takes place on the Big Black River and Little Bayou Pierre. There are approximately 20 fishermen who occasionally fish within the area (Ref. 16).

f. There is an average of 20 barge tows passing the site each day. The crew for each tow averages 10 people.

g. There are four churches within the 5-mile study area. On Sunday mornings, a total of 290 people attend these churches and on special occasions, such as weddings or funerals, this figure tends to be higher. The churches are also used on Wednesday evenings, but fewer people attend at this time.

2.1.3 Uses of Adjacent Lands and Waters

2.1.3.1 Land Use of the Site and Immediate Environs

The site area is located within prime deer hunting country. A total of 2300 acres is owned by Mississippi Power & Light Company for the site. There will be 94 acres fenced in the immediate plant area with an additional 37 acres set aside for permanent utilization. The other 2169 acres of the site are available for wildlife. No hunting with guns is allowed; however, limited bow hunting for deer was allowed during the 1980 to 1981 season. This 2169 acres is an excellent habitat area for Mississippi wildlife and could possibly be used as a wildlife refuge. Two lakes, Hamilton and Gin, are on the site. These lakes are used for sport fishing, and the plant should have no effect on sport fishing in these lakes during operation. Figure 2.1-5 illustrates the site area and surrounding land uses. 5

The location of the nearest vegetable gardens, milk cows, residences, site boundaries, and milk goats are presented in Tables 2.1.7, 2.1.8, 2.1.9, 2.1.10, and 2.1.11.

The milk cow is not part of a dairy operation. The milk is consumed by the family which owns the cow. No milk goats were found within the 5-mile radius study area (Ref. 23,24).

2.1.3.2 Present and Projected Land Use Within 5 Miles

2.1.3.2.1 Residential

The area within the 5-mile radius is rural, with the exception of the 4- to 5-mile southeast section. This southeast section includes a portion of the town of Port Gibson. The total population of the 5-mile area in 1970 was 2086 with 59 percent of the population within the 4- to 5-mile southeast area. The projected population for the year 2020 is 2484 with 59 percent of the population within the 4- to 5-mile southeast section. The rural housing is single family dwellings with no significant residential development expected due to the small projected increase in population. No significant increase in residential development is expected in the town of Port Gibson. The small increase in housing to meet the demand as the population increases is expected to be mainly single family dwellings.

2.1.3.2.2 Agricultural

Some land within the 5-mile area is utilized for agricultural purposes. The major agricultural products are soybeans, corn, cotton, and livestock. Approximately 10 percent of the 5-mile area is used for pastures and croplands.

In the Mississippi portion of the study area the trend is toward larger, but fewer, farms with more land devoted to livestock and commercial forests. In the Louisiana portion, cotton and soybeans will continue to be the primary crops. The areas that are not protected by the levee will remain in commercial forests.

2.1.3.2.3 Forestry

The majority of the land within the 5-mile radius area is utilized for commercial forests. The forests are almost entirely hardwoods and are considered to be one of the prime hardwood areas of the South. The commercial forests have been over harvested within the area and this trend is expected to continue. By the year 2000, a 25 percent decrease in U. S. commercial forest land is expected, however, the Mississippi Forestry Commission feels that the decrease within the study area will be much less.

2.1.3.2.4 Industrial

No industrial development has occurred in the Louisiana portion of the 5-mile study area. It is unlikely that any industrial development will take place in that area. A large part is undesirable for industrial use as it is not protected by the Mississippi River levee and the small portion that is protected is very fertile, delta farmland.

A small amount of industrial development has occurred in the 4- to 5-mile southeast sector. These industries are located at Port Gibson and provide most of the manufacturing employment for the area.

Industrial development efforts are largely directed toward the Mississippi side of the Mississippi River southwest of the site. The Claiborne County Port Commission plans to develop a small port on the Mississippi River with adjoining property zoned for industrial use. The Port Commission then intends to increase the size and facilities of the port as the industrial need expands. Other areas for development are being considered, but the major thrust will be concentrated in the river area south of the site (Ref. 25).

2.1.3.2.5 Recreation

a. Grand Gulf Military Park

The Grand Gulf Military Park is located approximately 1.5 miles north of the reactor location and is contiguous to the site property. This park is the only formal recreation facility existing or predicted within the study area. The Grand Gulf Military Monument Commission plans to increase the recreational facilities by developing overnight camp sites, expanding the park's boundaries to the river, developing other nature trails, constructing a small craft harbor, and rebuilding portions of old Grand Gulf. If the Commission is successful in their plans, the population of the park will be increased. This increase will be dependent upon the success of the Commission as well as the extent and capacity of these facilities (Ref. 12).

b. Hunting

Prime deer country exists within the study area. As a result, 22 hunting camps are located within this 5-mile area. Hunting occurs mainly in the southern and western portions of the area, especially on the lands adjacent to the Mississippi River. It is not expected that the hunting pressures will increase significantly since club memberships are limited (Ref. 16).

c. Sport Fishing

Sport fishing occurs on Hamilton and Gin Lakes, the Mississippi River, and the lakes and bayous on the Louisiana side. A substantial part of sport fishing is on the Louisiana side. As many as 200 fishermen may be within the 5-mile radius on Saturdays during May, June, and July. Sport fishing is expected to remain at its present level over the next several years (Ref. 16).

2.1.3.2.6 Transportation

a. Railroads

The Illinois Central Gulf Railroad is located 2.7 miles from the site. No routing changes are anticipated, however, a spur track leading to the proposed river port is in the Port Commission's plans (Ref. 20).

b. Air

There is no existing general aviation type airport within the study area. Port Gibson is listed in the 1970-1975 Mississippi Airport Plan as a community needing this type of airport. Four possible sites have been considered with two being within the 5-mile study area. One site is 0.5 mile north of Port Gibson and the other is at the proposed river port. However, due to the limited funds presently available for airport construction, plans for the airport have been cancelled (Ref. 26).

c. Highways and Streets

The major highway transportation route within the study area is U. S. Highway 61. Other roads within the area are rural county roads. The Claiborne County Board of Supervisors is expected to maintain and improve these county roads. The roads leading to the Grand Gulf Military Park are expected to be upgraded. However, the improvement and upgrading of county roads depends on the availability of funds.

The only major, predictable change that can be foreseen within the 5-mile area is the conversion of U. S. Highway 61 into a four-lane road. This project has been approved by the Mississippi Legislature, but will probably not be completed for 10 to 15 years. This project is dependent upon the availability of state highway funds.

d. Other

No additional wildlife preserves, governmental facilities, unique natural environments, scenic areas, or unusual sites exist within the study area. After construction, the remaining 2046 acres of the site may be used as a wildlife refuge since it will be an excellent habitat for Mississippi wildlife.

2.1.3.3 Agricultural Production

Table 2.1.12 presents the acreage of each sector within the 50-mile radius. Tables 2.1.13 through 2.1.56 present data on the amount, yield, and production of vegetables, crops, and meat within the 50-mile study area. Crops, milk, and meat production data in the 10-mile radius were obtained from extension personnel but were verified by ground reconnaissance. The annual atmospheric humidities for Louisiana and Mississippi are presented in Tables 2.1.57 and 2.1.58 (Ref. 27, 28).

2.1.3.3.1 Vegetable and Crop Production

Vegetable and crop acreages according to the sectors were obtained from extension personnel in the parishes and counties (Ref. 29 through 79). Vegetable and crop yields were obtained from state officials and publications (Ref. 80 through 85). Crop production data were obtained using 1976 yields applied to 1977 acreages.

Tables 2.1.21 and 2.1.43 present the yields for the various vegetables and crops grown within the study area. Table 2.1.22 presents the dry to wet ratio of vegetables grown within the area (Ref. 86).

Vegetable and crop production data were calculated by the following equation:

#Acres X bushels/acre X lbs/bushel
X 453g/lb X 1Kg/1000 g

The production of leafy vegetables, non-leafy vegetables (Ref. 87) and various crops were calculated for each sector. The various crops grown within the study area are corn, soybeans, wheat, and rice. Data concerning production, number of acres, and percentage of sector surface area covered by the particular crop of vegetable are presented in tables as follows:

Leafy vegetables	- Tables 2.1.13 and 2.1.17
Non-Leafy vegetables	- Tables 2.1.14 and 2.1.18
Percentage of rootlike vegetables	- Tables 2.1.15 and 2.1.19
Vegetable surface area percentage	- Tables 2.1.16 and 2.1.20
Soybeans	- Tables 2.1.23 through 2.1.28
Corn	- Tables 2.1.29 through 2.1.34
Wheat	- Tables 2.1.35 through 2.1.38
Rice	- Tables 2.1.39 through 2.1.42

The percentages of production of rootlike vegetables were calculated by the following equation:

$$\frac{\text{Total Kg of Rootlike Vegetables (Ref. 91)}}{\text{Total Kg of Non-leafy Vegetables}} \times 100$$

The vegetables are distributed locally by roadside stands, local grocery stores, and individual markets. A small percentage of the vegetables may be distributed outside the study area if the market inside the area is filled.

Crops grown within the area are corn, wheat, soybeans, and rice. Rice is sold outside the study area to processing plants. After processing the rice is distributed through national markets. Corn and wheat produced in the area are distributed locally

within the study area. Soybeans are distributed both locally and nationally (Ref. 29 through 54).

The duration of the growing season is divided into a warm and a cold season as follows:

Warm Season - March 15th to November 15th
Cold Season - August 1st to May 30th

The majority of vegetables and crops are grown during the warm season (Ref. 39).

2.1.3.3.2 Milk Production

Commercial dairy cows were located by contacting appropriate state officials (Ref. 29 through 54, 88, 89).

No commercial dairy cows were found within the 10-mile radius. Total milk production was calculated by the following equation:

$$\frac{\#\text{Head} \times 12{,}905 \text{ lbs milk/cow}}{8.6 \text{ lbs/gallon} \times 1 \text{ gallon}/3.8\text{L}}$$

The number of pounds of milk produced per year per cow, 12,905, is the southern regional average (Ref. 89). The conversion factor of 8.6 pounds milk/gallon was obtained from the Mississippi State Department of Agriculture, Weights and Measures Division. The raw milk is sold to dairy processing plants. There it is processed to finished products of milk, butter, ice cream, cheese, and other related dairy products. These products are then placed on the food market and distributed according to demand. Only one milk processing plant was found in the area, The Milk House, located at Winnsboro, Louisiana (Ref. 90, 91). The duration of the dairy season is 305 days per year per cow. The 60 days of the year the cow is in her "dry period" varies according to each dairy farmer's discretion (Ref. 39).

2.1.3.3.3 Meat Production

Three meat production categories were investigated. These categories are pork, beef, and poultry. Extension personnel were contacted and publications examined (Ref. 28 through 54, 88, 92) to determine the amount of production in these areas. No commercial poultry operations were found. Several beef and swine farming operations are located in the area. However, with both the beef and pork operations, farmers usually bring the cattle and swine up to a certain weight. After this weight is obtained the beef cattle and swine are sold to other farmers who operate feedlots where the animals are grain fed until slaughter weight is obtained. The markets for the beef and swine are national. To determine the amount of beef and pork that is grown,

slaughtered, and consumed in the study area, meat processing plants located in the study area were contacted (Ref. 93 through 100).

It was determined from these sources that the slaughtered beef and swine are purchased from local growers and local sales. The processed meat is distributed locally through grocery stores, meat markets, and custom slaughters. Data was obtained from the plant operators and state officials on the amount of swine and beef slaughtered per year (Ref. 93 through 100). Tables 2.1.55 and 2.1.56 present beef and pork slaughter production data. No slaughter houses were found within the 10-mile radius.

Beef cattle and swine farming operations, as previously mentioned, occur within the 50-mile radius. The number of beef cattle and swine were obtained for each sector (Ref. 29 through 54, 88, 92). An average weight gain per year of 365 pounds per cow and 50 pounds per swine were used to calculate the beef and pork production in each sector as presented in Tables 2.1.46, 2.1.48, 2.1.50, and 2.1.52. The number of head of beef cattle and swine in each sector are presented in Tables 2.1.45, 2.1.47, 2.1.49, and 2.1.51. The total meat production of beef and swine is presented in Table 2.1.53.

Cattle in the study area graze all year. Spring and summer grazing is on pastures usually planted in Bermuda, Bahalia, and Dallis grasses. Winter grazing grasses are rye, clover, sorghum sudan, and wheat oats. The diet is supplemented in the winter with hay, cottonseed meal, corn silage, and cottonseed hulls. Table 2.1.59 presents the amount of the winter supplementary diets (Ref. 31). No fraction of the animal feed is considered rootlike (Ref. 101). Tables 2.1.60, 2.1.61, and 2.1.62 present pasture grass densities, yields, and dry to wet ratios (Ref. 31, 101). The total number of acres of pasture were obtained from extension personnel and are presented in Tables 2.1.63 and 2.1.65 (Ref. 29 through 54). The percentages of surface area covered by pastureland are presented in Tables 2.1.64 and 2.1.66.

2.1.3.4 Fishing and Hunting Activities Within 50 Miles

Commercial fishing within the study area occurs mainly on the Mississippi River. Commercial fishing is not a highly active industry in the area. Extensive data on catches within the study area are unavailable since commercial fishing in the area is not a developed industry. Table 2.1.67 presents data on the past catches of 1976 from the Mississippi River within the study area. The data for the past catches were calculated by multiplying the number of pounds per river mile that were landed in Mississippi and Louisiana by 50, the approximate number of river miles within the study area. The number of pounds per river mile were calculated by dividing the total pounds landed in each state by the river miles in each state (Ref. 102, 103).

Projected catches are unavailable from the area. No commercial fish farms were found within the area.

Boat launching sites giving access to the Mississippi River are limited within the Grand Gulf vicinity. Access at St. Joseph, Claiborne County Ferry Landing and the Karmac Ferry crossing on the Big Black River is approximately 11 miles by water from Grand Gulf. Most fishermen find these accesses inconvenient and more time consuming than the lower Grand Gulf landing. This landing is accessible by both land and water. However, during flood periods, the lower Grand Gulf landing can be inaccessible. The success a fisherman can have in this area is dependent on the fluctuations of the river stage. During periods of stable or falling river stages, a fisherman should have good results (Ref. 104).

Information on sport fishing within the 50-mile area is restricted to data obtained from a creel census performed on and near the site during the GGNS baseline environmental studies. During this census, sport fishing was recorded frequently from April through August 1973 for the Mississippi and Big Black Rivers, Hamilton Lake, and Gin Lake. 301.2

Hunting occurs within the 50-mile area with deer being the primary game hunted. Tables 2.1.68 and 2.1.69 present data on deer kills for each of the 25 counties/parishes within the area (Ref. 105, 106). Small game and waterfowl are not hunted extensively in the area. No data is available on the amount of game consumed locally, since all hunting club members are not residents of the area and hunters from other areas of the state utilize the area. However, due to the problem of transporting freshly killed meat long distances, it can be concluded that the majority of the game is killed by local residents. Table 2.1.70 presents deer productions within the 5-mile radius. Deer production was calculated by obtaining an average deer slaughter weight from the Mississippi State Game and Fish Commission and the number of head killed within Claiborne County and Tensas Parish. Since deer are not confined to a particular area, the production for each acre was assumed to be equal. The deer kill seasons used for production calculations were 1975-1976 for Tensas Parish and 1976-1977 for Claiborne County.

2.1.3.5 Coordination of Station Activities With Outside Land Use

The site is located in a rural area with no conflict with present land use. A railroad spur to the plant site presently exists, and no need for other spurs is anticipated. No new or future roadways are anticipated within the 5-mile radius. Excellent access to the plant site already exists from public roads. Agricultural, recreational, and residential land use should remain unaffected by the station activities.

2.1.3.6 Surface and Ground Water Use

Table 2.1.71 presents data on ground water and surface water use within the 50-mile area. No significant increase in the amount of ground water use is anticipated (Ref. 107 through 110.)

The main surface water use in the area is on the Mississippi River. The Mississippi River is utilized mainly for transportation. Some fishing and recreational use of the river is made within the study area. The other surface waters in the area are numerous lakes, bayous, and freshwater streams. These are utilized mainly for recreation, sport fishing, and wildlife.

Table 2.1.72 lists water intake users of the Mississippi River (Ref. 111). The nearest downstream user of Mississippi River water where a portion of the intake is used as a potable water supply is The Dow Chemical Company plant, located approximately 197 miles from the station discharge.

No significant effect on regional water supplies will occur through the station use or regional use due to the abundance of ground water and surface water resources within the area.

2.1.4 References

1. "General Highway Map, Claiborne County," Mississippi Highway Department, 1976.

2. "Count Population by Enumeration District-Mississippi," U. S. Census Bureau, 1970.

3. "Master Enumeration List - Louisiana," U. S. Census Bureau, 1970.

4. "Final Population Counts - Mississippi," U. S. Census Bureau, PC (V1)-26, 1970.

5. "Final Population Counts - Louisiana," U. S. Census Bureau, PC (V1)-20, 1970.

6. "General Highway Maps - By Parish," Louisiana Department of Highways, 1962-1967.

7. "General Highway Maps, By County," Mississippi State Highway Department, 1962-1967.

8. "Population Projections - OBE Areas 134, 135, and 138," U. S. Department of Commerce, Bureau of Economic Analysis, 1968.

9. "Population Projections - OBE Areas 132 - 139," U. S. Department of Commerce, Bureau of Economic Analysis, 1968.

10. Henry L. DeGraff, Chief, Regional Economics Division, Bureau of Economic Analysis, personal communications; Washington, D. C., February, 1972.

11. C. V. Lyle, Chief, Regional Economist, Economic Analysis Office, personal communications; Atlanta, Georgia, March, 1972.

12. Woodrow Wilson, Park Manager, Grand Gulf Military Monument Commission, personal communications; Grand Gulf, Mississippi, August, 1977.

13. Wes Stevens, Warner YMCA Camp Director, personal communications, Vicksburg, Mississippi, August, 1977.

14. Earl Moore, Lake Claiborne, Inc., personal communication; Port Gibson, Mississippi, August, 1977.

15. Mrs. Woodrow Bowman, Lake Bruin State Park, personal communications; St. Joseph, Louisiana, August, 1977.

16. Joseph D. Price, Jr., Conservation Officer, Claiborne County, personal communications; Port Gibson, Mississippi, August, 1977.

17. "Public School Enrollment, 1976-77," State Department of Education, Jackson, Mississippi, 1977.

18. "Louisiana School Directory, Session 1976-1977," State Department of Education, Baton Rouge, Louisiana.

19. "Labor Market Data," Mississippi Employment Security Commission, July, 1977.

20. David L. Gibson, Assistant to the Superintendent, Illinois Central Gulf Railroad, Vicksburg Office, personal communications; Vicksburg, Mississippi, August, 1977.

21. Pat Wingerter, Operations Manager, Delta Queen Steamboat Company, personal communications; New Orleans, Louisiana, August, 1977.

22. Lenore Barkley, Direct[illegible]sburg Hospitality House, personal communicatio[illegible]burg, Mississippi, August, 1977.

23. Alfred R. Smith, Claiborne County Agent, personal communications; August 10, 1977.

24. Charles. B. Jones, Tensas Parish Agent, personal communications; August 25, 1977.

25. "Socioeconomic Impact of Grand Gulf Nuclear Station," compiled by Recon, Inc. for Mississippi Power & Light Company, August 1977.

26. Charles Prouty, Airport Planning Division, FAA, District Office, Jackson, Mississippi, 969-4628, personal communications by Henry Ramsey, August 12, 1977.

27. National Oceanic and Atmospheric Administration, "Climate of Louisiana," National Climatic Center, Asheville, N. C., December, 1976.

28. National Oceanic and Atmospheric Administration, "Climate of Mississippi," National Climatic Center, Asheville, N. C., March, 1977.

29. Charles Wells, Adams County Agent, personal communications, August-October, 1977.

30. William D. Craft, Amite County Agent, personal communications, August-October, 1977.

31. Alfred R. Smith, Claiborne County Agent, personal communications, August-October, 1977.

32. Wiley Ray, Copiah County Agent, personal communications, August-October, 1977.

33. John Monroe, Franklin County Agent, personal communications, August-October, 1977.

34. Charles Estus, Hinds County Agent, personal communications, August-October, 1977.

35. James McVeil, Issaquena County Agent, personal communications, August-October, 1977.

36. Julius Mann, Jefferson County Agent, personal communications, August-October, 1977.

37. Travis Tedlock, Lincoln County Agent, personal communications, August-October, 1977.

38. Buck Coates, Madison County Agent, personal communications, August-October, 1977.

39. Robert Barker, Rankin County Agent, personal communications, August-October, 1977.

40. Benjamin. F. Corbin, Sharkey County Agent, personal communications, August-October, 1977.

41. Sam Dyar, Simpson County Agent, personal communications, August-October, 1977.

42. Hunter George, Warren County Agent, personal communications, August-October, 1977.

43. John R. Date, Jr., Wilkinson County Agent, personal communications, August-October, 1977.

44. Rick Lange, Yazoo County Agent, personal communications, August-October, 1977.

45. Thomas Breland, Hinds County ASC, personal communications, August-October, 1977.

46. Donald Hollis, Caldwell Parish Agent, personal communications, August-October, 1977.

47. Rodney Ewing, Catahoula Parish Agent, personal communications, August-October, 1977.

48. Joe. W. Milby, Concordia Parish Agent, personal communications, August-October, 1977.

49. Sidney Reech, East Carroll Parish Agent, personal communications, August-October, 1977.

50. Austin Johnson, Franklin Parish Agent, personal communications, August-October, 1977.

51. Buck Roby, Madison Parish Agent, personal communications, August-October, 1977.

52. Basil Doles, Richland Parish Agent, personal communications, August-October, 1977.

53. Charles James, Tensas Parish Agent, personal communications, August-October, 1977.

54. Jessie Peterson, West Carroll Parish Agent, personal communications, August-October, 1977.

55. "General Highway Map, Adams County," Mississippi Highway Department, 1967.

56. "General Highway Map, Amite County," Mississippi Highway Department, 1969.

57. "General Highway Map, Claiborne County," Mississippi Highway Department, 1976.

58. "General Highway Map, Copiah County," Mississippi Highway Department, 1976.

59. "General Highway Map, Franklin County," Mississippi Highway Department, 1967.

60. "General Highway Map, Hinds County," Mississippi Highway Department, 1974.

61. "General Highway Map, Issaquena County," Mississippi Highway Department, 1971.

62. "General Highway Map, Jefferson County," Mississippi Highway Department, 1976.

63. "General Highway Map, Lincoln County," Mississippi Highway Department, 1969.

64. "General Highway Map, Madison County," Mississippi Highway Department, 1975.

65. "General Highway Map, Rankin County," Mississippi Highway Department, 1974.

66. "General Highway Map, Sharkey County," Mississippi Highway Department, 1972.

67. "General Highway Map, Simpson County," Mississippi Highway Department, 1967.

68. "General Highway Map, Warren County," Mississippi Highway Department, 1967.

69. "General Highway Map, Wilkinson County," Mississippi Highway Department, 1969.

70. "General Highway Map, Yazoo County," Mississippi Highway Department, 1970.

71. "General Highway Map, Caldwell Parish," Louisiana Highway Department, 1971.

72. "General Highway Map, Catahoula Parish," Louisiana Highway Department, 1971.

73. "General Highway Map, Concordia Parish," Louisiana Highway Department, 1971.

74. "General Highway Map, East Carroll Parish," Louisiana Highway Department, 1973.

75. "General Highway Map, Franklin Parish," Louisiana Highway Department, 1971.

76. "General Highway Map, Madison Parish," Louisiana Highway Department, 1972.

77. "General Highway Map, Richland Parish," Louisiana Highway Department, 1971.

78. "General Highway Map, Tensas Parish," Louisiana Highway Department, 1972.

79. "General Highway Map, West Carroll Parish," Louisiana Highway Department, 1973.

80. "Rice, County Estimates," Mississippi Crop and Livestock Reporting Service, Mississippi Department of Agriculture, 1976.

81. "Wheat, County Estimates," Mississippi Crop and Livestock Reporting Service, Mississippi Department of Agriculture, 1976.

82. "Corn, County Estimates," Mississippi Crop and Livestock Reporting Service, Mississippi Department of Agriculture, 1976.

83. "Soybeans, County Estimates," Mississippi Crop and Livestock Reporting Service, Mississippi Department of Agriculture, 1976.

84. "Parish Estimates of Cotton, Corn, Soybeans, and Vegetables," Louisiana Crop and Livestock Reporting Service, Louisiana Department of Agriculture, 1977.

85. Ted Pullin, Extension Service, Mississippi Department of Agriculture, personal communications, August-October, 1977.

86. "Nutritive Value of American Foods," Agricultural Handbook No. 456, United States Department of Agriculture.

87. J. Mike Cannon, Extension Service, Louisiana Department of Agriculture, personal communications, August, 1977.

88. "Livestock County Estimates," Mississippi Crop and Livestock Reporting Service, Mississippi Department of Agriculture, 1977.

89. "1976 Report on Production Testing," The Louisiana Dairy Herd Improvement Records Committee and The Louisiana Animal Breeding Cooperative, LSU Cooperative Extension Service, 1976.

90. "Louisiana Directory of Manufacturers," Department of Commerce and Industry, State of Louisiana, 1972.

91. "Mississippi Directory of Manufacturers, 1977," Mississippi Research and Development Center, Jackson, Mississippi, 1976.

92. "Louisiana 1974 Census of Agriculture," U. S. Department of Commerce, Louisiana Department of Agriculture, 1976.

93. Freddie Passbach, Jr., Passbach Meats, Inc., Natchez, Mississippi, personal communications, August-October, 1977.

94. Thomas W. Jones, Lincoln County Slaughter House, Brookhaven, Mississippi, personal communications, August-October, 1977.

95. Roger Jones, Hinds Junior College Cold Storage, Raymond, Mississippi, personal communications, August-October, 1977.

96. Danny Smith, County Meat Market, Brookhaven, Mississippi, personal communications, August-October, 1977.

97. Jack Wilson, Wilson Slaughter House, Crystal Springs, Mississippi, personal communications, August-October, 1977.

98. James Meadows, Meat Inspector Division, Mississippi Department of Agriculture, personal communications, August-October, 1977.

99. Bobby Durr, Meat Grading and Inspection, Louisiana Department of Agriculture, personal communications, August-October, 1977.

100. Linda Doiga, Meat Grading and Inspection, Louisiana Department of Agriculture, personal communications, August-October, 1977.

101. Kelton Anderson, Mississippi Extension Service, Mississippi State University, personal communications, August-October, 1977.

102. "Summary of Operating Units and Landings, Mississippi River and Tributaries Within Louisiana, 1976," National Marine Fisheries Service.

103. "Summary of Operating Units and Landings, Mississippi River and Tributaries, Within Mississippi, 1976," National Marine Fisheries Service.

104. "Environmental Field Measurements Programs, Final Report," Grand Gulf Nuclear Station Units 1 and 2, 1973, Mississippi Power & Light Company.

105. "1975-1976 Deer Kill Survey," Louisiana Wildlife and Fisheries Commission, Baton Rouge, Louisiana.

106. "Mississippi 1976-1977 Deer Kill," Mississippi Game and Fish Commission, Jackson, Mississippi.

107. "Water Use In Mississippi, 1975," Water Resources Investigations, Open File Report No. 76-125, U. S. Geological Survey.

108. Jack W. Pepper, Mississippi Board of Water Commissioners, personal communications, September, 1977.

109. James E. Rogers, Water Resources Division, U. S. Geological Survey, Alexandria, Louisiana, personal communications, August, 1977.

110. Merrick S. Whitfield, Water Resources Division, U. S. G. S. Alexandria, Louisiana, personal communications, September, 1977.

111. "Lower Mississippi River Basin Water Quality Management Plan, State of Louisiana," Louisiana Stream Control Commission, Prepared by Burke and Associates, Inc., New Orleans, La., June 1973.

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TABLE 2.1.1

RESIDENT POPULATION DISTRIBUTION BY SECTOR AND
RADIAL DISTANCE OUT TO 10 MILES

		Radial Distance From Reactor (Miles)						
Sector	Year	0-1	1-2	2-3	3-4	4-5	5-10	10-Mile Total
NNE	1970	11	11	0	0	0	115	137
	1980	11	11	0	0	0	123	145
	1990	11	11	0	0	0	131	153
	2000	12	12	0	0	0	141	165
	2010	13	13	0	0	0	149	175
	2020	13	13	0	0	0	162	188
NE	1970	4	4	4	11	65	288	376
	1980	4	4	4	11	64	302	389
	1990	4	4	4	11	68	322	413
	2000	4	4	4	12	71	344	439
	2010	5	5	5	13	74	364	466
	2020	5	5	5	13	77	392	497
ENE	1970	0	0	18	7	29	298	352
	1980	0	0	18	7	29	295	349
	1990	0	0	19	7	30	310	366
	2000	0	0	20	8	32	325	385
	2010	0	0	21	8	33	340	402
	2020	0	0	21	8	35	355	419
E	1970	4	22	40	47	47	274	434
	1980	4	22	40	47	47	271	431
	1990	4	23	42	49	49	285	452
	2000	4	24	44	51	51	299	473
	2010	5	25	46	54	54	312	496
	2020	5	26	48	56	56	326	517

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TABLE 2.1.1 (Cont.)

Sector	Year	Radial Distance From Reactor (Miles) 0-1	1-2	2-3	3-4	4-5	5-10	10-Mile Total
ESE	1970	7	7	28	0	191	232	465
	1980	7	7	28	0	189	230	461
	1990	7	7	29	0	199	241	483
	2000	8	8	31	0	208	253	508
	2010	8	8	32	0	218	264	530
	2020	8	8	34	0	227	276	553
SE	1970	0	4	7	40	1,224	1,676	2,951
	1980	0	4	7	40	1,213	1,659	2,923
	1990	0	4	7	42	1,273	1,743	3,069
	2000	0	4	8	44	1,334	1,827	3,217
	2010	0	5	8	46	1,395	1,911	3,365
	2020	0	5	8	48	1,457	1,994	3,512
SSE	1970	3	7	0	32	83	579	704
	1980	3	7	0	32	82	573	697
	1990	3	7	0	33	86	602	731
	2000	3	8	0	35	90	631	767
	2010	3	8	0	36	95	660	802
	2020	4	8	0	38	99	689	838
S	1970	0	4	0	4	0	309	317
	1980	0	4	0	4	0	306	314
	1990	0	4	0	4	0	321	329
	2000	0	4	0	4	0	337	345
	2010	0	5	0	5	0	352	362
	2020	0	5	0	5	0	368	378
SSW	1970	0	4	4	0	0	453	461
	1980	0	4	4	0	0	448	456
	1990	0	4	4	0	0	471	479
	2000	0	4	4	0	0	494	502
	2010	0	5	5	0	0	516	526
	2020	0	5	5	0	0	539	549

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TABLE 2.1.1 (Cont.)

Sector	Year	Radial Distance From Reactor (Miles) 0-1	1-2	2-3	3-4	4-5	5-10	10-Mile Total
SW	1970	4	0	0	0	0	291	295
	1980	4	0	0	0	0	288	292
	1990	4	0	0	0	0	303	307
	2000	4	0	0	0	0	317	321
	2010	5	0	0	0	0	332	337
	2020	5	0	0	0	0	346	351
WSW	1970	0	0	0	0	0	122	122
	1980	0	0	0	0	0	122	122
	1990	0	0	0	0	0	129	129
	2000	0	0	0	0	0	138	138
	2010	0	0	0	0	0	149	149
	2020	0	0	0	0	0	161	161
W	1970	0	0	0	0	0	218	218
	1980	0	0	0	0	0	218	218
	1990	0	0	0	0	0	231	231
	2000	0	0	0	0	0	246	246
	2010	0	0	0	0	0	266	266
	2020	0	0	0	0	0	288	288
WNW	1970	0	0	0	0	4	78	82
	1980	0	0	0	0	4	78	82
	1990	0	0	0	0	4	83	87
	2000	0	0	0	0	5	88	93
	2010	0	0	0	0	5	95	100
	2020	0	0	0	0	5	103	108
NW	1970	7	0	0	0	0	151	158
	1980	7	0	0	0	0	151	158
	1990	7	0	0	0	0	160	167
	2000	8	0	0	0	0	171	179
	2010	8	0	0	0	0	184	192
	2020	8	0	0	0	0	199	207

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TABLE 2.1.1 (Cont.)

Sector	Year	Radial Distance From Reactor (Miles) 0-1	1-2	2-3	3-4	4-5	5-10	10-Mile Total
NNW	1970	7	18	0	0	0	75	100
	1980	7	18	0	0	0	75	100
	1990	7	19	0	0	0	80	106
	2000	8	20	0	0	0	85	113
	2010	8	21	0	0	0	92	121
	2020	8	21	0	0	0	99	128
N	1970	4	58	11	0	0	0	73
	1980	4	57	11	0	0	0	72
	1990	4	60	11	0	0	0	75
	2000	4	63	12	0	0	0	79
	2010	5	66	13	0	0	0	84
	2020	5	69	13	0	0	0	87
GRAND TOTALS	1970	51	139	112	141	1,643	5,159	7,245
	1980	51	138	112	141	1,628	5,139	7,209
	1990	51	143	116	146	1,709	5,412	7,577
	2000	55	151	123	154	1,791	5,696	7,970
	2010	60	161	130	162	1,874	5,986	,373
	2020	61	165	134	168	1,956	6,297	8,781

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TABLE 2.1.2

AGE DISTRIBUTION BY SECTOR AND RADIAL DISTANCE
OUT TO 10 MILES FOR THE YEAR 2000

	Radial Distance From Reactor (Miles)						
Sector	0-1	1-2	2-3	3-4	4-5	5-10	10-Mile Total
NNE, Total Pop	12	12	0	0	0	141	165
0-1 yrs	0	0	0	0	0	3	3
1-10 yrs	2	2	0	0	0	22	26
11-18 yrs	1	1	0	0	0	16	18
>-18 yrs	9	9	0	0	0	100	118
NE, Total Pop	4	4	4	12	71	344	439
0-1 yrs	0	0	0	0	2	7	9
1-10 yrs	1	1	1	2	11	55	71
11-18 yrs	0	0	0	1	8	38	47
>-18 yrs	3	3	3	9	50	244	312
ENE, Total Pop	0	0	20	8	32	325	385
0-1 yrs	0	0	1	0	0	6	7
1-10 yrs	0	0	3	1	5	52	61
11-18 yrs	0	0	2	1	4	36	43
>-18 yrs	0	0	14	6	23	231	274
E, Total Pop	4	24	44	51	51	299	473
0-1 yrs	0	0	1	1	1	6	9
1-10 yrs	1	4	7	8	8	48	76
11-18 yrs	0	3	5	6	6	33	53
>-18 yrs	3	17	31	36	36	212	335
ESE, Total Pop	8	8	31	0	208	253	508
0-1 yrs	0	0	1	0	4	5	10
1-10 yrs	1	1	5	0	33	40	80
11-18 yrs	1	1	3	0	23	28	56
>-18 yrs	6	6	22	0	148	180	362
SE, Total Pop	0	4	8	44	1334	1827	3217
0-1 yrs	0	0	0	1	27	37	65
1-10 yrs	0	1	1	7	213	292	514
11-18 yrs	0	0	1	5	147	201	354
>-18 yrs	0	3	6	31	947	1297	2284

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TABLE 2.1.2 (Cont.)

	Radial Distance From Reactor (Miles)						
Sector	0-1	1-2	2-3	3-4	4-5	5-10	10-Mile Total
SSE, Total Pop	3	8	0	35	90	631	767
0-1 yrs	0	0	0	1	2	13	16
1-10 yrs	1	1	0	5	14	101	122
11-18 yrs	0	1	0	4	10	69	84
>-18 yrs	2	6	0	25	64	448	545
S, Total Pop	0	4	0	4	0	337	345
0-1 yrs	0	0	0	0	0	7	7
1-10 yrs	0	1	0	1	0	54	56
10-18 yrs	0	0	0	0	0	37	37
>-18 yrs	0	3	0	3	0	239	245
SSW, Total Pop	0	4	4	0	0	494	502
0-1 yrs	0	0	0	0	0	10	10
1-10 yrs	0	1	1	0	0	79	81
10-18 yrs	0	0	0	0	0	54	54
>-18 yrs	0	3	3	0	0	351	357
SW, Total Pop	4	0	0	0	0	291	295
0-1 yrs	0	0	0	0	0	6	6
1-10 yrs	1	0	0	0	0	46	47
11-18 yrs	0	0	0	0	0	32	32
>-18 yrs	3	0	0	0	0	207	210
WSW, Total Pop	0	0	0	0	0	122	122
0-1 yrs	0	0	0	0	0	2	2
1-10 yrs	0	0	0	0	0	20	20
11-18 yrs	0	0	0	0	0	13	13
>-18 yrs	0	0	0	0	0	87	87
W, Total Pop	0	0	0	0	0	218	218
0-1 yrs	0	0	0	0	0	4	4
1-10 yrs	0	0	0	0	0	35	35
11-18 yrs	0	0	0	0	0	24	24
>-18 yrs	0	0	0	0	0	155	155

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TABLE 2.1.2 (Cont.)

	Radial Distance From Reactor (Miles)						
Sector	0-1	1-2	2-3	3-4	4-5	5-10	10-Miles Total
WNW, Total Pop	0	0	0	0	4	78	82
0-1 yrs	0	0	0	0	0	2	2
1-10 yrs	0	0	0	0	1	12	13
11-18 yrs	0	0	0	0	0	9	9
>-18 yrs	0	0	0	0	3	55	58
NW, Total Pop	8	0	0	0	0	171	179
0-1 yrs	0	0	0	0	0	3	3
1-10 yrs	1	0	0	0	0	27	28
11-18 yrs	1	0	0	0	0	19	20
>-18 yrs	6	0	0	0	0	122	128
NNW, Total Pop	8	20	0	0	0	85	113
0-1 yrs	0	1	0	0	0	2	3
1-10 yrs	1	3	0	0	0	14	18
11-18 yrs	1	2	0	0	0	9	12
>-18 yrs	6	14	0	0	0	60	80
N, Total Pop	4	63	12	0	0	0	79
0-1 yrs	0	1	0	0	0	0	1
1-10 yrs	1	10	2	0	0	0	13
11-18 yrs	0	7	1	0	0	0	8
>-18 yrs	3	45	9	0	0	0	57

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TABLE 2.1.3

RESIDENT POPULATION DISTRIBUTION BY SECTOR AND
RADIAL DISTANCE BETWEEN 10 AND 50 MILES

		Radial Distance from Reactor (Miles)					
Sector	Year	10-Mile Total	10-20	20-30	30-40	40-50	50-Mile Total
NNE	1970	137	2,434	31,873	2,758	1,061	38,263
	1980	145	2,629	34,404	2,971	1,050	41,199
	1990	153	2,821	36,942	3,187	1,093	44,196
	2000	165	3,039	39,796	3,431	1,141	47,572
	2010	175	3,233	42,334	3,648	1,184	50,574
	2020	188	3,523	46,137	3,973	1,251	55,072
NE	1970	376	1,766	5,142	3,322	3,289	13,895
	1980	389	1,907	5,598	3,871	3,776	15,541
	1990	413	2,049	6,625	4,421	4,285	17,793
	2000	439	2,207	6,53	5,032	4,850	19,066
	2010	466	2,349	7,038	6,006	5,764	21,623
	2020	497	2,561	7,729	7,000	6,687	24,474
ENE	1970	352	327	2,924	3,495	8,230	15,328
	1980	349	324	3,442	4,124	9,711	17,950
	1990	366	340	3,962	4,753	11,192	20,613
	2000	385	356	4,540	5,452	12,839	23,572
	2010	402	373	5,492	6,606	15,555	28,428
	2020	419	390	6,445	7,759	18,271	33,284
E	1970	434	657	1,582	3,734	10,387	16,794
	1980	431	651	1,550	3,929	10,967	17,528
	1990	452	683	1,925	4,151	11,626	18,837
	2000	473	717	2,117	4,393	12,347	20,047
	2010	496	749	2,440	4,810	13,554	22,049
	2020	517	782	2,762	5,228	14,772	24,061

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TABLE 2.1.3 (Cont.)

Sector	Year	Radial Distance from Reactor (Miles) 10-Mile Total	10-20	20-30	30-40	40-50	50-Mile Total
ESE	1970	465	841	655	5,244	7,942	15,147
	1980	461	833	660	5,296	8,021	15,271
	1990	483	875	676	5,401	8,180	15,615
	2000	508	916	691	5,506	8,358	15,979
	2010	530	959	719	5,716	8,695	16,619
	2020	553	1,001	746	5,926	9,060	17,286
SE	1970	2,951	782	796	1,940	16,815	23,284
	1980	2,923	772	774	1,932	16,966	23,367
	1990	3,069	807	791	1,967	17,300	23,934
	2000	3,217	840	807	2,029	17,967	24,860
	2010	3,365	874	829	2,126	18,969	26,163
	2020	3,512	908	851	2,265	20,471	28,007
SSE	1970	704	1,355	751	2,535	2,629	7,974
	1980	697	1,323	729	2,214	2,299	7,262
	1990	731	1,346	729	2,214	2,301	7,321
	2000	767	1,369	729	2,214	2,304	7,383
	2010	802	1,392	729	2,214	2,309	7,446
	2020	838	1,415	729	2,214	2,317	7,513
S	1970	317	1,386	3,369	1,960	1,795	8,827
	1980	314	1,345	3,264	1,734	1,665	8,322
	1990	329	1,345	3,264	1,746	1,662	8,346
	2000	345	1,345	3,264	1,758	1,688	8,400
	2010	362	1,345	3,264	1,774	1,723	8,468
	2020	378	1,345	3,264	1,795	1,768	8,550
SSW	1970	461	1,238	2,110	31,504	3,487	38,800
	1980	456	1,207	2,117	33,709	3,712	41,201
	1990	479	1,222	2,176	36,230	3,966	44,073
	2000	502	1,237	2,229	38,750	4,220	46,938
	2010	526	1,251	2,306	42,215	4,569	50,867
	2020	549	1,266	2,405	46,626	5,013	55,859

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TABLE 2.1.3 (Cont.)

Sector	Year	Radial Distance from Reactor (Miles) 10-Mile Total	10-20	20-30	30-40	40-50	50-Mile Total
SW	1970	295	824	2,482	15,869	4,177	23,647
	1980	292	822	2,529	17,600	4,632	25,875
	1990	307	867	2,694	19,335	5,078	28,281
	2000	321	917	2,881	21,535	5,665	31,319
	2010	337	981	3,126	24,213	6,368	35,025
	2020	351	1,050	3,402	27,005	7,115	38,973
WSW	1970	122	1,838	888	2,334	2,691	7,873
	1980	122	1,838	888	2,358	2,731	7,937
	1990	129	1,948	941	2,510	2,912	8,440
	2000	138	2,077	1,003	2,689	3,125	9,032
	2010	149	2,242	1,083	2,917	3,397	9,788
	2020	161	2,426	1,172	3,168	3,695	10,622
W	1970	218	436	568	5,939	3,824	10,985
	1980	218	436	568	5,939	3,824	10,985
	1990	231	462	602	6,295	4,053	11,643
	2000	246	493	642	6,711	4,321	12,413
	2010	266	532	693	7,246	4,665	13,402
	2020	288	576	750	7,839	5,048	14,501
WNW	1970	82	2,100	645	6,971	8,242	18,040
	1980	82	2,100	645	6,971	8,242	18,040
	1990	87	2,226	684	7,389	8,737	19,123
	2000	93	2,373	729	7,877	9,314	20,386
	2010	100	2,562	787	8,505	10,055	22,009
	2020	108	2,772	851	9,202	10,879	23,812
NW	1970	158	423	206	2,681	7,413	10,831
	1980	158	423	206	2,681	7,413	10,881
	1990	167	448	218	2,842	7,858	11,533
	2000	179	478	233	3,030	8,377	12,297
	2010	192	516	251	3,271	9,044	13,274
	2020	207	549	272	3,539	9,785	14,352

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TABLE 2.1.3 (Cont.)

Sector	Year	Radial Distance from Reactor (Miles) 10-Mile Total	10-20	20-30	30-40	40-50	50-Mile Total
NNW	1970	100	145	10,660	993	3,670	15,568
	1980	100	148	10,660	993	3,670	15,571
	1990	106	156	11,300	1,053	3,890	16,505
	2000	113	164	12,046	1,122	4,147	17,592
	2010	121	173	13,005	1,212	4,477	18,988
	2020	128	184	14,071	1,311	4,844	20,538
N	1970	73	247	1,354	885	1,449	4,008
	1980	72	247	1,358	907	1,402	3,986
	1990	75	262	1,441	965	1,465	4,208
	2000	79	279	1,538	1,033	1,534	4,463
	2010	84	301	1,658	1,109	1,622	4,774
	2020	87	326	1,794	1,204	1,729	5,140
GRAND TOTALS	1970	7,245	16,799	66,005	92,164	87,101	269,314
	1980	7,209	17,005	69,392	97,229	90,081	280,916
	1990	7,577	17,857	74,970	104,459	95,598	300,461
	2000	7,970	18,807	79,783	112,562	102,197	321,319
	2010	8,373	19,832	85,754	123,588	111,950	349,497
	2020	8,781	21,074	93,380	136,104	122,705	382,044

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TABLE 2.1.4

AGE DISTRIBUTION BY SECTOR AND RADIAL DISTANCE
OUT TO 50 MILES FOR THE YEAR 2000

	Radial Distance From Reactor (Miles)					
Sector	0-10	10-20	20-30	30-40	40-50	50-Mile Total
NNE, Total Pop	165	3039	39796	3431	1141	47572
0-1 yrs	4	61	796	69	23	953
1-10 yrs	26	486	6367	549	182	7610
11-18 yrs	18	334	4378	377	126	5233
>-18 yrs	117	2158	28255	2436	810	33776
NE, Total Pop	439	2207	6538	5032	4850	19066
0-1 yrs	9	44	131	100	97	381
1-10 yrs	70	353	1046	805	776	3050
11-18 yrs	48	243	719	554	534	2098
>-18 yrs	312	1567	4642	3573	3443	13537
ENE, Total Pop	385	356	4540	5452	12839	23572
0-1 yrs	8	7	91	109	257	472
1-10 yrs	62	57	727	872	2054	3772
11-18 yrs	42	39	499	600	1412	2673
>-18 yrs	273	253	3223	3871	9116	16736
E, Total Pop	473	717	2117	4393	12347	20047
0-1 yrs	9	14	42	88	247	400
1-10 yrs	76	115	339	703	1976	3209
11-18 yrs	52	79	233	483	1358	2205
>-18 yrs	336	509	1503	3119	8766	14233
ESE, Total Pop	508	916	691	5506	8358	15979
0-1 yrs	10	18	14	110	167	319
1-10 yrs	81	147	110	881	1337	2556
11-18 yrs	56	101	76	606	920	1759
>-18 yrs	361	650	491	3909	5934	11345
SE, Total Pop	3217	840	807	2029	17967	24860
0-1 yrs	64	17	16	41	359	497
1-10 yrs	515	134	129	325	2875	3978
11-18 yrs	354	92	89	223	1976	2734
>-18 yrs	2284	597	573	1440	12757	17651

TABLE 2.1.4 (Cont.)

Sector	Radial Distance From Reactor (Miles) 0-10	10-20	20-30	30-40	40-50	50-Mile Total
SSE, Total Pop	767	1369	729	2214	2304	7383
0-1 yrs	15	27	15	44	46	147
1-10 yrs	123	219	116	354	369	1181
11-18 yrs	84	151	80	244	253	812
>-18 yrs	545	972	518	1572	1636	5243
S, Total Pop	345	1345	3264	1758	1688	8400
0-1 yrs	7	27	66	35	34	169
1-10 yrs	55	215	522	282	270	1344
11-18 yrs	38	148	359	193	186	924
>-18 yrs	245	955	2317	1248	1198	5963
SSW, Total Pop	502	1237	2229	38750	4220	46938
0-1 yrs	10	25	45	775	85	940
1-10 yrs	80	198	356	6200	675	7509
11-18 yrs	55	136	245	4263	464	5163
>-18 yrs	375	878	1583	27512	2996	33326
SW, Total Pop	321	917	2881	21535	5665	31319
0-1 yrs	7	18	57	430	113	625
1-10 yrs	51	147	461	3446	907	5012
11-18 yrs	35	101	317	2369	623	3445
>-18 yrs	228	651	2046	15290	4022	22237
WSW, Total Pop	138	2077	1003	2689	3125	9032
0-1 yrs	3	42	20	54	62	181
1-10 yrs	22	332	161	430	500	1445
11-18 yrs	15	228	110	296	344	993
>-18 yrs	98	1475	712	1909	2219	6511
W, Total Pop	246	493	642	6711	4321	12413
0-1 yrs	5	10	13	134	87	249
1-10 yrs	39	79	103	1074	691	1986
11-18 yrs	27	54	70	738	475	1364
>-18 yrs	175	350	456	4765	3068	8814

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TABLE 2.1.4 (Cont.)

	Radial Distance From Reactor (Miles)					
Sector	0-10	10-20	20-30	30-40	40-50	50-Mile Total
WNW, Total Pop	93	2373	729	7877	9314	20386
0-1 yrs	2	47	14	158	186	407
1-10 yrs	15	380	117	1260	1490	3262
11-18 yrs	10	261	80	866	1025	2242
>-18 yrs	66	1685	518	5593	6613	14475
NW, Total Pop	179	478	233	3030	8377	12297
0-1 yrs	3	10	5	61	168	265
1-10 yrs	29	76	37	385	1340	1967
11-18 yrs	20	53	26	333	921	1353
>-18 yrs	127	339	165	2151	5948	8730
NNW, Total Pop	113	164	12046	1122	4147	17592
0-1 yrs	3	4	241	22	83	353
1-10 yrs	18	26	1927	180	664	2815
11-18 yrs	12	18	1325	123	456	1934
>-18 yrs	80	116	8553	797	2944	12686
N, Total Pop	79	279	1538	1033	1534	4463
0-1 yrs	1	5	31	21	31	89
1-10 yrs	13	45	246	165	245	714
11-18 yrs	9	31	169	114	169	492
>-18 yrs	56	198	1092	733	1089	3168

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TABLE 2.1.5

YEARLY ATTENDANCE
1972 - 1976
GRAND GULF MILITARY PARK

Year	Attendance
1972	75,310
1973	85,116
1974	89,210
1975	103,920
1976	123,444

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TABLE 2.1.6

MONTHLY ATTENDANCE IN 1976
GRAND GULF MILITARY PARK

MONTH	ATTENDANCE	PER CENT OF TOTAL
January	3,718	3.01
February	3,646	2.95
March	11,790	9.55
April	12,356	10.01
May	13,606	11.02
June	14,046	11.38
July	14,828	12.01
August	11,711	9.49
September	11,133	9.02
October	10,827	8.77
November	9,357	7.58
December	6,426	5.21
Total	123,444	100.00

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TABLE 2.1.7

NEAREST VEGETABLE GARDEN GREATER THAN 500
SQUARE FEET WITHIN THE 5-MILE RADIUS

SECTOR	DISTANCE (Miles)
NNE	1.5
NE	---
ENE	3.0
E	1.5
ESE	2.75
SE	---
SSE	---
S	---
SSW	---
SW	---
WSW	---
W	---
WNW	---
NW	---
NNW	---
N	1.75

Source: Data determined by ground reconnaissance.

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TABLE 2.1.8

NON-COMMERCIAL DAIRY COWS WITHIN THE 5-MILE RADIUS

SECTOR	NUMBER OF COWS	DISTANCE (MILES)
NNE	0	---
NE	0	---
ENE	0	---
E	1	5.0
ESE	0	---
SE	0	---
SSE	0	---
S	0	---
SSW	0	---
SW	0	---
WSW	0	---
W	0	---
WNW	0	---
NW	0	---
NNW	0	---
N	0	---

Sources: Claiborne County Agent, R. Smith, 1977, Personal Communication, August 10, 1977.

Tensas Parish Agent, C. B. James, 1977, Personal Communication, August 25, 1977.

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TABLE 2.1.9

NEAREST RESIDENCE WITHIN THE 5-MILE RADIUS

SECTOR	DISTANCE (Meters)
NNE	1446
NE	1062
ENE	4300
E	986
ESE	4000
SE	3300
SSE	1696
S	1766
SSW	3725
SW	1432
WSW	--
W	--
WNW	6437
NW	--
NNW	1741
N	1485

Source: Data determined by use of aerial photographs and ground-truth reconnaissance.

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TABLE 2.1.10

NEAREST SITE BOUNDARY IN EACH SECTOR*

Sector	Distance	
	Miles	Meters
NNE	0.66	1062
NE	0.63	1014
ENE	0.63	1014
E	0.55	885
ESE	0.55	885
SE	0.51	821
SSE	0.46	740
S	0.61	982
SSW	0.65	1046
SW	0.85	1368
WSW	1.07	1722
W	1.14	1835
WNW	1.34	2157
NW	1.37	2205
NNW	1.02	1642
N	0.79	1271

*Measured from the midpoint of a line joining the centers of the two reactors.

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TABLE 2.1.11

MILK GOATS WITHIN THE 5-MILE RADIUS

SECTOR	NUMBER OF MILK GOATS	DISTANCE
NNE	0	---
NE	0	---
ENE	0	---
E	0	---
ESE	0	---
SE	0	---
SSE	0	---
S	0	---
SSW	0	---
SW	0	---
WSW	0	---
W	0	---
WNW	0	---
NW	0	---
NNW	0	---
N	0	---

Source: Data determined by ground reconnaissance.

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TABLE 2.1.12

TOTAL ACREAGE PER RADIAL DISTANCE
FROM REACTOR PER SECTOR

Radial Distance From Reactor Miles	Total Acreage per Sector
0-1	128
1-2	371.2
2-3	633.6
3-4	876.8
4-5	1132.8
5-10	9420.3
10-20	37676.8
20-30	62784.0
30-40	87936.0
40-50	113024.0

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TABLE 2.1.13

TOTAL PRODUCTION OF LEAFY VEGETABLES FOR COMMERCIAL USE WITHIN 10 MILES IN KILOGRAMS PER YEAR

Radial Distance From Reactor (Miles)

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	0
NE	0	0	0	0	0	0
ENE	0	0	0	0	0	0
E	0	0	0	0	0	0
ESE	0	0	0	0	0	0
SE	0	0	0	0	0	0
SSE	0	0	0	0	0	0
S	0	0	0	0	0	0
SSW	0	0	0	0	0	0
SW	0	0	0	0	0	0
WSW	0	0	0	0	0	0
W	0	0	0	0	0	0
WNW	0	0	0	0	0	0
NW	0	0	0	0	0	0
NNW	0	0	0	0	0	0
N	0	0	0	0	0	0

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TABLE 2.1.14

TOTAL PRODUCTION OF NON-LEAFY VEGETABLES FOR COMMERCIAL USE WITHIN 10 MILES IN KILOGRAMS PER YEAR

Radial Distance From Reactor (Miles)

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	0
NE	0	0	0	0	0	0
ENE	0	0	0	0	0	0
E	0	0	0	0	0	0
ESE	0	0	0	0	0	6350
SE	0	0	0	0	0	15501
SSE	0	0	0	0	0	1270
S	0	0	0	0	0	3171
SSW	0	0	0	0	0	0
SW	0	0	0	0	0	0
WSW	0	0	0	0	0	0
W	0	0	0	0	0	0
WNW	0	0	0	0	0	0
NW	0	0	0	0	0	0
NNW	0	0	0	0	0	0
N	0	0	0	0	0	0

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TABLE 2.1.15

PRODUCTION PERCENTAGE OF ROOTLIKE VEGETABLES FOR COMMERCIAL USE WITHIN 10 MILES

Radial Distance From Reactor (Miles)

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	0
NE	0	0	0	0	0	0
ENE	0	0	0	0	0	0
E	0	0	0	0	0	0
ESE	0	0	0	0	0	0
SE	0	0	0	0	0	0
SSE	0	0	0	0	0	0
S	0	0	0	0	0	0
SSW	0	0	0	0	0	0
SW	0	0	0	0	0	0
WSW	0	0	0	0	0	0
W	0	0	0	0	0	0
WNW	0	0	0	0	0	0
NW	0	0	0	0	0	0
NNW	0	0	0	0	0	0
N	0	0	0	0	0	0

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TABLE 2.1.16

PERCENTAGE OF SURFACE AREA COVERED BY VEGETABLES FOR COMMERCIAL USE WITHIN 10 MILES

Radial Distance From Reactor (Miles)

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	0
NE	0	0	0	0	0	0
ENE	0	0	0	0	0	0
E	0	0	0	0	0	0
ESE	0	0	0	0	0	0.1
SE	0	0	0	0	0	0.1
SSE	0	0	0	0	0	0.1
S	0	0	0	0	0	0.1
SSW	0	0	0	0	0	0
SW	0	0	0	0	0	0
WSW	0	0	0	0	0	0
W	0	0	0	0	0	0
WNW	0	0	0	0	0	0
NW	0	0	0	0	0	0
NNW	0	0	0	0	0	0
N	0	0	0	0	0	0

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TABLE 2.1.17

TOTAL PRODUCTION OF LEAFY VEGETABLES FOR COMMERCIAL USE BETWEEN 10 AND 50 MILES IN KILOGRAMS PER YEAR

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	0	0	0	
NE	0	0	0	0
ENE	0	0	0	0
E	0	2721	0	191646
ESE	0	0	2721	4808
SE	0	0	0	0
SSE	0	0	0	0
S	0	0	0	0
SSW	0	0	0	0
SW	0	0	0	0
WSW	0	0	0	0
W	0	0	0	0
WNW	0	0	0	0
NW	0	0	0	0
NNW	0	0	0	0
N	0	0	0	0

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TABLE 2.1.18

TOTAL PRODUCTION OF NON-LEAFY VEGETABLES FOR COMMERCIAL USE BETWEEN 10 AND 50 MILES IN KILOGRAMS PER YEAR

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	19051	9072	33403	0
NE	0	0	0	0
ENE	0	0	0	0
E	172368	64502	0	788357
ESE	66044	0	387011	529133
SE	66044	0	3152	136080
SSE	0	0	3152	2177
S	0	0	0	24403
SSW	0	0	0	0
SW	0	0	0	0
WSW	0	0	0	0
W	0	0	0	0
WNW	0	0	0	0
NW	0	0	0	28667
NNW	0	0	0	716688
N	0	0	0	0

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TABLE 2.1.19

PRODUCTION PERCENTAGE OF ROOTLIKE VEGETABLES
FOR COMMERCIAL USE BETWEEN 10 AND 50 MILES

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	100	100	0	0
NE	0	0	0	0
ENE	0	0	0	0
E	63	29	0	29
ESE	0	0	29	29
SE	0	0	0	7
SSE	0	0	0	10
S	0	0	0	10
SSW	0	0	0	0
SW	0	0	0	0
WSW	0	0	0	0
W	0	0	0	0
WNW	0	0	0	0
NW	0	0	0	10
NNW	0	0	0	10
N	0	0	0	0

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TABLE 2.1.20

PERCENTAGE OF SURFACE AREA COVERED BY VEGETABLES
FOR COMMERCIAL USE BETWEEN 10 AND 50 MILES

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	0.1	0.1	0.1	0
NE	0	0	0	0
ENE	0	0	0	0
E	0.1	0.1	0	0.7
ESE	0.1	0	0.1	0.5
SE	0.1	0	0.1	0.3
SSE	0	0	0.5	0.1
S	0	0	0	0.6
SSW	0	0	0	0
SW	0	0	0	0
WSW	0	0	0	0
W	0	0	0	0
WNW	0	0	0	0
NW	0	0	0	0
NNW	0	0	0	0.3
N	0	0	0	0.2

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TABLE 2.1.21

VEGETABLE YIELD IN KILOGRAMS/m^2

Vegetable	Yield
Beans, Green	0.67
Beans, Lima	0.52
Cabbage	1.57
Cantaloupe	1.02
Collards	1.22
Corn, Sweet	0.49
Cucumbers	1.40
Eggplant	1.48
Mustard	1.22
Okra	0.47
Onions	1.40
Peas	0.28
Pepper, Bell	1.01
Pepper, Hot	0.45
Pepper, Pimiento	0.45
Potatoes, Irish	1.68
Potatoes, Sweet	1.68
Pumpkins	Data Not Available
Spinach	1.22
Squash	1.23
Tomatoes	1.74
Turnips	1.22
Watermelon	0.90

Source: Ref. 85

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TABLE 2.1.22

DRY TO WET RATIO OF VEGETABLES

VEGETABLES	RATIO, DRY TO WET	
Beans, Green	9.9:100	
Beans, Lima	32.5:100	
Cabbage	7.6:100	
Cantaloupe	8.8:100	
Collards	14.7:100[1]	13.1:100[2]
Corn, Sweet	27.3:100[3]	23.5:100[4]
Cucumbers	4.9:100	
Eggplant	5.7:100	
Mustard	10.5:100	
Okra	11.1:100	
Onions	10.9:100	
Peas	22.0:100	
Pepper, Bell	6.6:100	
Pepper, Hot	6.1:100	
Pepper, Pimiento	7.6:100	
Potatoes, Irish	20.2:100	
Potatoes, Sweet	29.4:100	
Pumpkins	9.8:100	
Spinach	9.3:100	
Squash	6.0:100	
Tomatoes	6.5:100	
Turnips	8.5:100	
Watermelon	7.4:100	

[1]Without Stems

[2]With Stems

[3]With Cob, Cob 45% Refuse

[4]Cut Off Cob

Source: Nutritive Value Of American Foods, Agriculture Handbook No. 456, United States Department of Agriculture.

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TABLE 2.1.23

TOTAL NUMBER OF ACRES OF SOYBEANS WITHIN 10 MILES

Radial Distance From Reactor (Miles)

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	150
NE	0	0	0	0	0	0
ENE	0	0	0	0	0	1178
E	0	0	0	220	550	2355
ESE	0	0	0	220	300	2355
SE	0	50	64	0	0	1884
SSE	0	0	200	150	0	200
S	0	0	0	0	0	0
SSW	0	0	0	0	0	250
SW	0	0	0	0	0	250
WSW	0	0	0	0	0	784
W	0	0	0	0	160	4187
WNW	0	0	0	0	0	6920
NW	0	0	0	0	0	2740
NNW	0	100	100	0	0	600
N	0	16	90	300	0	1920

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TABLE 2.1.24

TOTAL SOYBEAN PRODUCTION WITHIN
10 MILES IN KILOGRAMS PER YEAR

Radial Distance From Reactor (Miles)

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	93,351
NE	0	0	0	0	0	0
ENE	0	0	0	0	0	733,116
E	0	0	0	136,915	342,287	1,465,609
ESE	0	0	0	136,915	186.702	1,465,609
SE	0	31,117	39,830	0	0	1,172,487
SSE	0	0	124,468	93,351	0	124,468
S	0	0	0	0	0	0
SSW	0	0	0	0	0	155,585
SW	0	0	0	0	0	155,585
WSW	0	0	0	0	0	487,914
W	0	0	0	0	99,574	2,605,734
WNW	0	0	0	0	0	4,306,587
NW	0	0	0	0	0	1,705,209
NNW	0	62,233	62,233	0	0	373,404
N	0	9,957	56,011	186,702	0	1,194,891

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TABLE 2.1.25

PERCENTAGE OF SURFACE AREA COVERED
BY SOYBEANS WITHIN 10 MILES

Radial Distance From Reactor (Miles)

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	1.6
NE	0	0	0	0	0	0
ENE	0	0	0	0	0	12.5
E	0	0	0	25.1	48.6	25
ESE	0	0	0	25.1	26.5	25
SE	0	13.5	10.1	0	0	20
SSE	0	0	31.6	17.1	0	2.1
S	0	0	0	0	0	0
SSW	0	0	0	0	0	2.6
SW	0	0	0	0	0	2.6
WSW	0	0	0	0	0	8.3
W	0	0	0	0	14.1	44.4
WNW	0	0	0	0	0	73.4
NW	0	0	0	0	0	29.1
NNW	0	26.9	15.8	0	0	6.4
N	0	4.3	14.2	34.2	0	20.4

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TABLE 2.1.26

TOTAL NUMBER OF ACRES OF SOYBEANS
BETWEEN 10 AND 50 MILES

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	8800	2700	15000	33600
NE	1368	2550	4150	6650
ENE	2480	6000	12000	7000
E	2480	2500	1000	5200
ESE	2480	100	5000	3000
SE	1500	2000	550	2100
SSE	2000	2000	2100	2700
S	5000	4075	1600	2200
SSW	2000	5000	2000	3500
SW	4740	22192	54000	37700
WSW	22292	27554	75000	50000
W	14044	42040	27000	30600
WNW	25360	26690	50000	33500
NW	33176	45780	40000	27000
NNW	30923	40000	50000	58000
N	500	56000	18500	29500

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TABLE 2.1.27

TOTAL SOYBEAN PRODUCTION BETWEEN
10 AND 50 MILES IN KILOGRAMS PER YEAR

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	5,476,585	1,680,318	9,335,100	20,910,624
NE	851,360	1,586,967	2,582,711	4,138,561
ENE	1,543,401	3,734,040	7,468,080	4,356,380
E	1,543,401	1,555,850	622,340	3,236,158
ESE	1,543,401	62,234	3,111,700	1,867,020
SE	933,509	1,244,678	342,287	1,306,914
SSE	1,244,678	1,244,678	1,306,914	1,680,318
S	3,111,696	2,536,036	995,744	1,369,148
SSW	1,244,678	3,111,700	1,244,678	2,178,190
SW	2,949,888	13,810,969	33,606,360	23,462,218
WSW	13,873,203	17,147,956	46,675,440	31,117,000
W	8,740,143	26,163,174	16,803,180	19,043,504
WNW	15,782,542	16,610,255	31,117,000	20,848,390
NW	20,646,752	28,490,725	24,893,600	16,803,180
NNW	23,845,680	24,893,600	31,117,000	36,095,720
N	311,170	34,851,040	11,513,290	18,359,030

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TABLE 2.1.28

PERCENTAGE OF SURFACE COVERED
BY SOYBEANS BETWEEN 10 AND 50 MILES

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	23.4	4.3	17.0	29.7
NE	3.6	4.1	4.7	5.9
ENE	6.6	9.6	13.6	6.2
E	6.6	4.0	1.1	4.6
ESE	6.6	0.2	5.7	2.6
SE	4.0	3.2	0.6	1.8
SSE	5.3	3.2	2.4	2.4
S	13.3	6.5	1.8	1.9
SSW	5.3	8.0	2.3	3.1
SW	12.6	46.5	61.4	33.4
WSW	59.2	43.9	85.3	44.2
W	37.3	67.0	30.7	27.1
WNW	67.3	42.5	56.8	29.6
NW	88.0	72.9	45.5	23.9
NNW	82.1	63.7	56.8	51.3
N	1.3	89.2	21.0	26.1

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TABLE 2.1.29

TOTAL NUMBER OF ACRES
OF CORN WITHIN 10 MILES

Radial Distance From Reactor (Miles)

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	25
NE	0	0	0	0	0	0
ENE	0	0	0	0	0	0
E	0	0	100	200	0	300
ESE	0	0	0	100	0	0
SE	0	0	0	0	0	0
SSE	0	0	0	0	0	0
S	0	0	0	0	0	0
SSW	0	0	0	0	0	0
SW	0	0	0	0	0	0
WSW	0	0	0	0	0	0
W	0	0	0	0	0	60
WNW	0	0	0	0	0	0
NW	0	0	0	0	0	0
NNW	0	0	0	0	0	0
N	25	0	0	0	0	0

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TABLE 2.1.30

TOTAL PRODUCTION OF CORN IN KILOGRAMS
PER YEAR WITHIN 10 MILES

	Radial Distance From Reactor (Miles)					
SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	36,959
NE	0	0	0	0	0	0
ENE	0	0	0	0	0	0
E	0	0	147,837	295,675	0	443,512
ESE	0	0	0	147,837	0	0
SE	0	0	0	0	0	0
SSE	0	0	0	0	0	0
S	0	0	0	0	0	0
SSW	0	0	0	0	0	0
SW	0	0	0	0	0	0
WSW	0	0	0	0	0	0
W	0	0	0	0	0	88,702
WNW	0	0	0	0	0	0
NW	0	0	0	0	0	0
NNW	0	0	0	0	0	0
N	36,959	0	0	0	0	0

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TABLE 2.1.31

PERCENTAGE OF SURFACE AREA
COVERED BY CORN WITHIN 10 MILES

Radial Distance From Reactor (Miles)

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	0.3
NE	0	0	0	0	0	0
ENE	0	0	0	0	0	0
E	0	0	15.8	22.8	0	3.2
ESE	0	0	0	11.4	0	0
SE	0	0	0	0	0	0
SSE	0	0	0	0	0	0
S	0	0	0	0	0	0
SSW	0	0	0	0	0	0
SW	0	0	0	0	0	0
WSW	0	0	0	0	0	0
W	0	0	0	0	0	0.6
WNW	0	0	0	0	0	0
NW	0	0	0	0	0	0
NNW	0	0	0	0	0	0
N	19.5	0	0	0	0	0

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TABLE 2.1.32

TOTAL NUMBER OF ACRES OF CORN
BETWEEN 10 AND 50 MILES

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	20	60	100	200
NE	515	180	1525	2830
ENE	650	700	2500	2500
E	650	0	200	200
ESE	650	200	0	4200
SE	300	0	560	1700
SSE	0	250	245	240
S	50	140	100	400
SSW	50	150	300	150
SW	100	150	0	210
WSW	50	500	300	400
W	0	400	600	600
WNW	0	400	1500	500
NW	0	0	400	20
NNW	200	0	0	300
N	1000	1000	600	0

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TABLE 2.1.33

TOTAL PRODUCTION OF CORN IN KILOGRAMS
PER YEAR BETWEEN 10 AND 50 MILES

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	29,567	88,702	147,837	295,675
NE	761,362	266,107	2,254,519	4,183,795
ENE	960,943	1,034,861	3,695,933	3,695,933
E	960,943	0	295,675	295,675
ESE	960,943	295,675	0	6,209,167
SE	443,512	0	827,889	2,513,234
SSE	0	369,593	362,201	354,810
S	73,919	206,972	147,837	591,349
SSW	73,919	221,756	443,512	221,756
SW	147,837	221,756	0	310,458
WSW	88,702	739,187	443,512	591,349
W	0	591,349	887,024	887,024
WNW	0	591,349	2,217,550	739,187
NW	0	0	591,349	29,567
NNW	295,675	0	0	443,512
N	1,478,373	1,478,373	887,024	0

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TABLE 2.1.34

PERCENTAGE OF SURFACE AREA COVERED BY CORN BETWEEN 10 AND 50 MILES

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	0.05	0.1	0.1	0.2
NE	1.4	0.3	1.7	2.5
ENE	1.7	1.1	2.8	2.2
E	1.7	0	0.2	0.2
ESE	1.7	0.3	0	3.7
SE	0.8	0	0.6	1.5
SSE	0	0.4	0.3	0.2
S	0.1	0.2	0.1	0.4
SSW	0.1	0.2	0.3	0.1
SW	0.3	0.2	0	0.2
WSW	0.1	0.8	0.3	0.4
W	0	0.6	0.7	0.5
WNW	0	0.6	1.7	0.4
NW	0	0	0.4	0.02
NNW	0.5	0	0	0.3
N	2.6	1.6	0.7	0

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TABLE 2.1.35

TOTAL ACRES OF WHEAT WITHIN 10 MILES

Radial Distance From Reactor (Miles)

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	0
NE	0	0	0	0	0	0
ENE	0	0	0	0	0	0
E	0	0	0	0	0	0
ESE	0	0	0	0	0	0
SE	0	0	0	0	0	0
SSE	0	0	0	0	0	0
S	0	0	0	0	0	0
SSW	0	0	0	0	0	0
SW	0	0	0	0	0	0
WSW	0	0	0	0	0	0
W	0	0	0	0	0	0
WNW	0	0	0	0	0	0
NW	0	0	0	0	0	0
NNW	0	0	0	0	0	0
N	0	0	0	0	0	0

GG
ER

TABLE 2.1.36

TOTAL ACRES OF WHEAT BETWEEN 10 AND 50 MILES

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	50	150	350	275
NE	0	100	250	0
ENE	0	0	0	0
E	0	0	0	0
ESE	0	0	0	0
SE	0	0	0	0
SSE	0	0	0	0
S	0	200	0	0
SSW	0	250	540	650
SW	0	0	0	60
WSW	0	0	500	200
W	0	0	500	200
WNW	0	0	0	0
NW	0	0	0	300
NNW	0	500	1500	2500
N	500	200	11000	500

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ER

TABLE 2.1.37

TOTAL WHEAT PRODUCTION IN KILOGRAMS/YEAR BETWEEN 10 AND 50 MILES

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	35517	106551	248618	195343
NE	0	71034	177584	0
ENE	0	0	0	0
E	0	0	0	0
ESE	0	0	0	0
SE	0	0	0	0
SSE	0	0	0	0
S	0	142068	0	0
SSW	0	177584	383582	461719
SW	0	0	0	42620
WSW	0	0	355169	142068
W	0	0	355169	142068
WNW	0	0	0	0
NW	0	0	0	213101
NNW	0	355169	1065506	1775844
N	355169	142068	7813714	355169

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ER

TABLE 2.1.38

PERCENTAGE OF SURFACE AREA COVERED
BY WHEAT BETWEEN 10 AND 50 MILES

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	0.1	0.2	0.4	0.2
NE	0	0.2	0.3	0
ENE	0	0	0	0
E	0	0	0	0
ESE	0	0	0	0
SE	0	0	0	0
SSE	0	0	0	0
S	0	0.3	0	0
SSW	0	0.4	0.6	0.6
SW	0	0	0	0.05
WSW	0	0	0.6	0.2
W	0	0	0.6	0.2
WNW	0	0	0	0
NW	0	0	0	0.3
NNW	0	0.8	1.7	2.2
N	1.3	0.3	12.5	0.4

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ER

TABLE 2.1.39

TOTAL NUMBER OF ACRES OF RICE WITHIN 10 MILES

Radial Distance From Reactor (Miles)

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	0
NE	0	0	0	0	0	0
ENE	0	0	0	0	0	0
E	0	0	0	0	0	0
ESE	0	0	0	0	0	0
SE	0	0	0	0	0	0
SSE	0	0	0	0	0	0
S	0	0	0	0	0	0
SSW	0	0	0	0	0	0
SW	0	0	0	0	0	0
WSW	0	0	0	0	0	0
W	0	0	0	0	0	0
WNW	0	0	0	0	0	0
NW	0	0	0	0	0	0
NNW	0	0	0	0	0	0
N	0	0	0	0	0	0

GG
ER

TABLE 2.1.40

TOTAL NUMBER OF ACRES OF RICE BETWEEN 10 AND 50 MILES

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	0	0	0	0
NE	0	0	0	0
ENE	0	0	0	0
E	0	0	0	0
ESE	0	0	0	0
SE	0	0	0	0
SSE	0	0	0	0
S	0	0	0	0
SSW	0	0	0	0
SW	0	0	0	0
WSW	0	0	0	0
W	180	0	0	0
WNW	0	300	0	0
NW	0	0	0	0
NNW	0	0	0	0
N	0	0	0	0

GC
ER

TABLE 2.1.41

TOTAL PRODUCTION OF RICE BETWEEN 10 AND 50 MILES IN KILOGRAMS PER YEAR

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	0	0	0	0
NE	0	0	0	0
ENE	0	0	0	0
E	0	0	0	0
ESE	0	0	0	0
SE	0	0	0	0
SSE	0	0	0	0
S	0	0	0	0
SSW	0	0	0	0
SW	0	0	0	0
WSW	0	0	0	0
W	342187	0	0	0
WNW	0	570311	0	0
NW	0	0	0	0
NNW	0	0	0	0
N	0	0	0	0

GG
ER

TABLE 2.1.42

PERCENTAGE OF SURFACE AREA COVERED BY RICE BETWEEN 10 AND 50 MILES

	Radial Distance From Reactor (Miles)			
SECTOR	10-20	20-30	30-40	40-50
NNE	0	0	0	0
NE	0	0	0	0
ENE	0	0	0	0
E	0	0	0	0
ESE	0	0	0	0
SE	0	0	0	0
SSE	0	0	0	0
S	0	0	0	0
SSW	0	0	0	0
SW	0	0	0	0
WSW	0	0	0	0
W	0.5	0	0	0
WNW	0	0.5	0	0
NW	0	0	0	0
NNW	0	0	0	0
N	0	0	0	0

GG
ER

TABLE 2.1.43

YIELD OF CROPS GROWN WITHIN
50 MILES IN KILOGRAMS/m^2

Crop	Yield, Kg/m^2
Corn	0.36
Wheat	0.18
Soybeans	0.15
Rice	0.47

GG
ER

TABLE 2.1.44

MILK PRODUCTION FROM COMMERCIAL DAIRIES BETWEEN
10 AND 50 MILES IN LITERS PER YEAR

	Radial Distance From Reactor (Miles)			
SECTOR	10-20	20-30	30-40	40-50
NNE	0	0	0	0
NE	0	285,114	285,114	285,114
ENE	0	285,114	570,228	570,228
E	0	724,190	724,190	724,190
ESE	0	1,459,783	1,459,783	1,459,783
SE	0	290,816	855,342	9,978,990
SSE	0	0	570,228	570,228
S	285,114	285,114	855,342	0
SSW	1,425,570	285,114	285,114	285,114
SW	0	0	0	0
WSW	0	0	342,137	826,831
W	0	1,283,013	1,283,013	1,283,013
WNW	0	0	1,283,013	2,280,912
NW	0	0	0	2,280,912
NNW	0	0	0	570,228
N	0	0	0	0

GG
ER

TABLE 2.1.45

NUMBER OF HEAD OF BEEF CATTLE WITHIN 10 MILES
TO BE SOLD LOCALLY FOR HUMAN CONSUMPTION

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	17
NE	0	0	0	0	0	33
ENE	0	0	0	0	58	50
E	0	0	0	0	50	67
ESE	0	0	0	0	100	67
SE	0	0	0	0	0	0
SSE	0	0	0	0	67	0
S	0	0	0	0	50	0
SSW	0	0	0	0	0	0
SW	0	0	0	0	0	0
WSW	0	0	0	0	0	0
W	0	0	0	0	13	0
WNW	0	0	0	0	67	0
NW	0	0	0	0	0	67
NNW	0	0	0	0	0	0
N	0	0	0	0	17	0

GG
ER

TABLE 2.1.46

BEEF PRODUCTION IN KILOGRAMS PER YEAR WITHIN 10 MILES
TO BE SOLD LOCALLY FOR HUMAN CONSUMPTION

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	2814
NE	0	0	0	0	0	5464
ENE	0	0	0	0	9603	8278
E	0	0	0	0	8278	11093
ESE	0	0	0	0	16556	11093
SE	0	0	0	0	0	0
SSE	0	0	0	0	11093	0
S	0	0	0	0	8278	0
SSW	0	0	0	0	0	0
SW	0	0	0	0	0	0
WSW	0	0	0	0	0	0
W	0	0	0	0	2152	0
WNW	0	0	0	0	11093	0
NW	0	0	0	0	0	11093
NNW	0	0	0	0	0	0
N	0	0	0	0	2814	0

GG
ER

TABLE 2.1.47

TOTAL NUMBER OF HEAD OF BEEF CATTLE BETWEEN 10 AND 50 MILES

SECTOR	10-20	20-30	30-40	40-50
NNE	0	0	333	433
NE	1067	4067	7067	8500
ENE	2000	6000	12000	12000
E	2000	4667	7667	7667
ESE	2000	5667	5000	5833
SE	2000	2333	333	6667
SSE	2667	2000	1333	4167
S	2667	2000	3333	167
SSW	2667	2000	4000	3433
SW	733	167	1333	1000
WSW	1167	567	1867	2667
W	153	900	1833	1767
WNW	533	1233	1667	3533
NW	450	400	500	2767
NNW	833	667	1000	3667
N	250	333	667	667

GG
ER

TABLE 2.1.48

TOTAL BEEF WEIGHT GAIN IN KILOGRAMS
PER YEAR BETWEEN 10 AND 50 MILES

SECTOR	10-20	20-30	30-40	40-50
NNE	0	0	55133	71689
NE	176657	673349	1170041	1407294
ENE	331128	993384	1986768	1986768
E	331128	772687	1269379	1269379
ESE	331128	938251	827820	965735
SE	331128	386261	55133	1103815
SSE	441559	331128	220697	689905
S	441559	331128	551824	27649
SSW	441559	331128	662256	568381
SW	121358	27649	220697	165564
WSW	193213	93375	309108	441559
W	25332	149008	303479	292552
WNW	88246	204140	275995	584938
NW	75000	66226	82782	458116
NNW	137915	110431	165564	607123
N	41391	55133	110431	110431

GG
ER

TABLE 2.1.49

NUMBER OF HEAD OF SWINE WITHIN 10 MILES

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	0
NE	0	0	0	0	85	0
ENE	0	0	0	0	0	0
E	0	0	0	0	0	0
ESE	0	0	0	0	0	0
SE	0	0	0	0	0	3400
SSE	0	0	0	0	0	0
S	0	0	0	0	0	0
SSW	0	0	0	0	68	0
SW	0	0	0	0	0	0
WSW	0	0	0	0	0	0
W	0	0	0	0	0	0
WNW	0	0	0	0	0	0
NW	0	0	0	0	0	0
NNW	0	0	0	0	0	0
N	0	0	0	0	0	0

GG
ER

TABLE 2.1.50

PORK PRODUCTION IN KILOGRAMS PER YEAR WITHIN 10 MILES

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	0
NE	0	0	0	0	1925	0
ENE	0	0	0	0	0	0
E	0	0	0	0	0	0
ESE	0	0	0	0	0	0
SE	0	0	0	0	0	77112
SSE	0	0	0	0	0	0
S	0	0	0	0	0	0
SSW	0	0	0	0	1540	0
SW	0	0	0	0	0	0
WSW	0	0	0	0	0	0
W	0	0	0	0	0	0
WNW	0	0	0	0	0	0
NW	0	0	0	0	0	0
NNW	0	0	0	0	0	0
N	0	0	0	0	0	0

GG
ER

TABLE 2.1.51

NUMBER OF HEAD OF SWINE BETWEEN 10 AND 50 MILES

SECTOR	10-20	20-30	30-40	40-50
NNE	738	1738	738	738
NE	738	2038	2038	2038
ENE	0	2600	2600	2600
E	3400	1814	1814	1814
ESE	3400	514	514	514
SE	0	257	257	650
SSE	387	387	0	350
S	387	387	352	0
SSW	387	387	1300	1300
SW	387	387	0	260
WSW	803	803	758	1516
W	803	1024	221	979
WNW	803	1727	221	550
NW	0	430	221	450
NNW	0	430	430	2400
N	0	430	0	250

GG
ER

TABLE 2.1.52

TOTAL PORK WEIGHT GAIN IN KILOGRAMS
PER YEAR BETWEEN 10 AND 50 MILES

SECTOR	10-20	20-30	30-40	40-50
NNE	16738	39418	16738	16738
NE	16738	46222	46222	46222
ENE	0	58968	58968	58968
E	77112	41142	41142	41142
ESE	77112	11658	11658	11658
SE	0	5829	5829	14742
SSE	8777	8777	0	7938
S	8777	8777	7938	0
SSW	8777	8777	29484	29484
SW	8777	8777	0	5897
WSW	18212	18212	17191	34383
W	18212	23224	5012	22204
WNW	18212	39168	5012	12474
NW	0	9752	5012	10206
NNW	0	9752	9752	54432
N	0	9752	0	5670

GG
ER

TABLE 2.1.53

TOTAL MEAT PRODUCTION IN KILOGRAMS PER YEAR
WITHIN 10 MILES FOR LOCAL HUMAN CONSUMPTION

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	2814
NE	0	0	0	0	1925	5464
ENE	0	0	0	0	9603	8278
E	0	0	0	0	8278	11093
ESE	0	0	0	0	16556	11093
SE	0	0	0	0	0	0
SSE	0	0	0	0	12633	77112
S	0	0	0	0	8278	0
SSW	0	0	0	0	0	0
SW	0	0	0	0	0	0
WSW	0	0	0	0	0	0
W	0	0	0	0	2152	0
WNW	0	0	0	0	11093	0
NW	0	0	0	0	0	11093
NNW	0	0	0	0	0	0
N	0	0	0	0	2814	0

GG
ER

TABLE 2.1.54

TOTAL BEEF AND SWINE WEIGHT GAIN IN KILOGRAMS
PER YEAR BETWEEN 10 AND 50 MILES

SECTOR	10-20	20-30	30-40	40-50
NNE	16738	39418	71871	88427
NE	193395	719571	1216263	1453516
ENE	331128	1052352	2045736	2045736
E	408240	813829	1310521	1310521
ESE	408240	949909	839478	977393
SE	331128	44090	60962	1118557
SSE	450336	339905	220697	697843
S	450336	339905	559762	27649
SSW	450336	339905	691740	597835
SW	130135	36426	220697	171461
WSW	211425	111066	326299	475942
W	43544	172232	308491	314756
WNW	106458	243308	281007	597412
NW	75000	75978	87794	468322
NNW	137915	120183	175316	661555
N	41391	64885	110431	116101

GG
ER

TABLE 2.1.55

BEEF SLAUGHTER PRODUCTION BETWEEN
10 AND 50 MILES IN KILOGRAMS PER YEAR

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	0	0	0	0
NE	0	0	0	0
ENE	0	0	0	270,979
E	0	0	0	176,904
ESE	0	0	0	0
SE	0	0	0	678,132
SSE	0	0	0	0
S	0	0	0	0
SSW	0	0	0	589,680
SW	0	0	0	0
WSW	0	0	0	138,677
W	0	0	0	27,461
WNW	0	0	0	35,957
NW	0	0	0	43,455
NNW	0	0	0	50,532
N	0	0	0	0

GG
ER

TABLE 2.1.56

PORK SLAUGHTER PRODUCTION IN KILOGRAMS
PER YEAR BETWEEN 10 AND 50 MILES

SECTOR	10-20	20-30	30-40	40-50
NNE	0	0	0	0
NE	0	0	0	0
ENE	0	0	0	0
E	0	0	0	14152
ESE	0	0	0	0
SE	0	0	0	19596
SSE	0	0	0	0
S	0	0	0	0
SSW	0	0	0	23587
SW	0	0	0	0
WSW	0	0	0	4220
W	0	0	0	12086
WNW	0	0	0	13364
NW	0	0	0	4990
NNW	0	0	0	10045
N	0	0	0	0

GG
ER

TABLE 2.1.57

ANNUAL ATMOSPHERIC HUMIDITY FOR LOUISIANA

SITE: ALEXANDRIA, LOUISIANA
ESTER FIELD

YEAR: 1975

MONTH	RELATIVE HUMIDITY, PERCENT LOCAL TIME			
	00	0600	1200	1800
January	87	88	67	74
February	85	88	58	63
March	87	89	57	58
April	89	92	58	60
May	92	94	57	62
June	94	96	58	64
July	94	96	61	68
August	93	96	59	69
September	92	95	62	73
October	91	93	54	75
November	90	91	58	78
December	86	89	66	78
Yearly Average	90	92	60	69

Source: National Oceanic and Atmospheric Administration, Climate of Louisiana, National Climatic Center, Asheville, N.C., December 1976.

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TABLE 2.1.58

ANNUAL ATMOSPHERIC HUMIDITY FOR MISSISSIPPI

SITE: JACKSON, MISSISSIPPI

YEAR: 1975

MONTH	RELATIVE HUMIDITY, PERCENT LOCAL TIME			
	00	0600	1200	1800
JANUARY	84	87	66	72
FEBRUARY	82	86	59	63
MARCH	82	87	57	58
APRIL	84	90	57	60
MAY	87	91	56	61
JUNE	86	90	55	60
JULY	89	93	59	66
AUGUST	90	94	60	70
SEPTEMBER	90	94	60	72
OCTOBER	89	93	54	73
NOVEMBER	87	91	58	74
DECEMBER	85	89	66	77
YEARLY AVERAGE	86	90	59	67

Source: National Oceanic and Atmospheric Administration, Climate of Mississippi, National Climatic Center, Asheville, N. C., March 1977

TABLE 2.1.59

WINTER SUPPLEMENTARY DIET OF CATTLE

DIET	NUMBER OF POUNDS/DAY
Hay	18
Cottonseed Meal	2
Cottonseed Hulls	2
Corn Silage	30

Source: Refs. 31 and 101

GG
ER

TABLE 2.1.60

PASTURE GRASS DENSITIES

GRASS TYPE	DENSITY, Kg/m^2
Dry Meadow Sorghum Sudan	0.84
Dry Meadow Grain Winter Grazing	0.67
Rye Grass	0.58
Bermuda	0.54
Dallis	0.44
Bahalia	0.40

Source: Refs. 31 and 101

GG
ER

TABLE 2.1.61

PASTURE GRASS YIELDS

GRASS TYPE	YIELD, Kg/m^2
Bermuda	1.68
Rye	0.22
Johnson	1.68

Source: Refs. 31 and 101

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TABLE 2.1.62

PASTURE GRASS DRY TO WET RATIO

PASTURE GRASS	DRY TO WET RATIO
Bermuda	1:5
Rye	9.2:10
Johnson	1:10
Dallas	1:5
Bahalia	1:5
Clover	9.2:10
Oats	9.2:10
Barley	9.2:10

Source: Refs. 31 and 101

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TABLE 2.1.63

TOTAL NUMBER OF ACRES OF PASTURELAND WITHIN 10 MILES

Radial Distance From Reactor (Miles)

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	50
NE	0	0	0	0	0	100
ENE	0	0	0	0	175	150
E	0	0	0	0	150	200
ESE	0	0	0	0	300	200
SE	15	100	0	0	0	0
SSE	70	100	0	0	200	0
S	70	0	150	0	150	0
SSW	50	0	0	0	0	0
SW	0	0	0	0	0	0
WSW	0	0	0	0	0	0
W	0	0	0	0	40	0
WNW	0	0	0	0	200	0
NW	0	0	0	0	0	200
NNW	0	0	0	0	0	0
N	0	0	0	0	50	0

GG
ER

TABLE 2.1.64

PERCENTAGE OF SURFACE AREA COVERED BY PASTURELAND WITHIN 10 MILES

Radial Distance From Reactor (Miles

SECTOR	0-1	1-2	2-3	3-4	4-5	5-10
NNE	0	0	0	0	0	0.5
NE	0	0	0	0	0	1.1
ENE	0	0	0	0	15.4	1.6
E	0	0	0	0	13.2	2.1
ESE	0	0	0	0	26.5	2.1
SE	11.7	26.9	0	0	0	0
SSE	54.7	26.9	0	0	17.6	0
S	54.7	0	23.7	0	13.2	0
SSW	39.1	0	0	0	0	0
SW	0	0	0	0	0	0
WSW	0	0	0	0	0	0
W	0	0	0	0	3.5	0
WNW	0	0	0	0	17.6	0
NW	0	0	0	0	0	2.1
NNW	0	0	0	0	0	0
N	0	0	0	0	4.4	0

GG
ER

TABLE 2.1.65

TOTAL NUMBER OF ACRES OF PASTURELAND BETWEEN 10 AND 50 MILES

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	0	0	1000	1300
NE	3200	12200	21200	25500
ENE	6000	18000	36000	36000
E	6000	14000	23000	23000
ESE	6000	17000	15000	17500
SE	6000	7000	10000	20000
SSE	8000	6000	4000	12500
S	8000	6000	10000	500
SSW	8000	6000	12000	10300
SW	2200	500	4000	3000
WSW	3500	1700	5600	8000
W	460	2700	5500	5300
WNW	1600	3700	5000	10600
NW	1350	1200	1500	8300
NNW	2500	2000	3000	11000
N	750	1000	2000	2000

GG
ER

TABLE 2.1.66

PERCENTAGE OF SURFACE AREA COVERED
BY PASTURELAND BETWEEN 10 AND 50 MILES

Radial Distance From Reactor (Miles)

SECTOR	10-20	20-30	30-40	40-50
NNE	0	0	1.1	1.1
NE	8.5	19.4	24.1	22.6
ENE	15.9	28.7	40.9	31.8
E	15.9	22.3	26.2	20.3
ESE	15.9	27.1	17.0	15.5
SE	15.9	11.1	11.4	17.7
SSE	21.2	9.6	4.5	11.0
S	21.2	9.6	11.4	0.4
SSW	21.2	9.6	13.6	9.1
SW	5.8	0.8	4.5	2.6
WSW	9.3	2.7	6.4	7.1
W	1.2	4.3	6.2	4.7
WNW	4.2	5.9	5.7	9.4
NW	3.6	1.9	1.7	7.3
NNW	6.6	3.2	3.4	9.7
N	2.0	1.6	2.3	1.8

GG
ER

TABLE 2.1.67

TOTAL KILOGRAMS OF COMMERCIAL FISH CATCH FROM MISSISSIPPI RIVER WITHIN 100-MILE STUDY AREA FOR YEAR 1976

Species	Kilograms
Bowfin	1826.87
Buffalo Fish	202117.90
Burbot	0
Carp	71134.38
Catfish and Bullheads	113136.90
Chubs	0
Crappie	0
Garfish	8380.26
Gizzard Shad	0
Mooneye	0
Paddlefish	589.68
Quillback	0
Shad	22171.97
Sheepshead	27109.40
Shovelnose Sturgeon	0
Sucker (Mullet)	0
White Bass	0
Yellow Perch	0
Yellow Pike	0
Crawfish	2766.96
Shrimp	743.90
Mussel Shells	0
Pearls and Slugs	0
Baby Turtles	0
Snapping Turtles	635.04
Soft Shell Turtles	0
Frogs	607.82
Spoonbill	7461.72

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ER

TABLE 2.1.68

MISSISSIPPI DEER KILLS FOR 1976-1977

County	Number of Head Killed
Adams	669
Amite	316
Claiborne	2034
Copiah	981
Franklin	238
Hinds	285
Issaquena	1155
Jefferson	1434
Lincoln	84
Madison	284
Rankin	253
Sharkey	425
Simpson	212
Warren	1325
Wilkinson	1891
Yazoo	117

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TABLE 2.1.69

LOUISIANA DEER KILLS FOR 1975-1976

Parish	Number of Head Killed
Caldwell	2516
Catahoula	777
Concordia	3583
East Carroll	1151
Franklin	308
Madison	2966
Richland	700
Tensas	4765
West Carroll	49

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ER

TABLE 2.1.70

DEER KILL IN KILOGRAMS PER YEAR WITHIN 5 MILES

Radial Distance From Reactor (Miles)

SECTOR	0-1	1-2	2-3	3-4	4-5
NNE	19.2	55.68	95.04	131.52	169.92
NE	19.2	55.68	95.04	131.52	169.92
ENE	19.2	55.68	95.04	131.52	169.92
E	19.2	55.68	95.04	131.52	169.92
ESE	19.2	55.68	95.04	131.52	169.92
SE	19.2	55.68	95.04	131.52	169.92
SSE	19.2	55.68	95.04	131.52	169.92
S	19.2	55.68	95.04	131.52	169.92
SSW	19.2	55.68	95.04	131.52	169.92
SW	19.2	55.68	95.04	131.52	169.92
WSW	19.2	96.51	164.74	227.97	294.53
W	19.2	96.51	164.74	227.97	294.53
WNW	19.2	96.51	164.74	227.97	294.53
NW	19.2	96.51	164.74	227.97	294.53
NNW	19.2	96.51	164.74	227.97	294.53
N	19.2	55.68	95.04	131.52	169.92

GG
ER

TABLE 2.1.71

MONTHLY SURFACE AND GROUND WATER USE WITHIN
THE 50-MILE STUDY AREA IN MILLION GALLONS PER MONTH

County Or Parish	Public Supply		Domestic		Industrial		Irrigation		Livestock	
	GW	SW	GW	SW	GW	SW	GW	SW	GW	SW
Adams County	1.41	0	120.21	0	1347.9	129	C	21.84	2.28	3.45
Amite County	0.84	0	30.9	0	19.5	0	0	0	7.2	11.25
Claiborne County	8.76	0	26.85	0	11.13	0	0	0	4.11	6.15
Copiah County	21.48	0	57.18	0	47.07	0	0	0	6.69	10.02
Franklin County	1.26	0	13.5	0	0	0	0	0	1.83	2.73
Hinds County	3.16	367.08	169.71	364.41	246.39	0	0	0	14.25	21.36
Issaquena County	0	0	2.82	0	0	0	50.88	11.19	1.32	2.01
Jefferson County	0.42	0	15.39	0	0.87	0	0	0	2.94	4.38
Lincoln County	2.19	0	55.86	0	0.24	0	0	0	6.81	10.23
Madison County	14.37	0	97.56	0	11.52	0	0	0	10.5	15.78
Rankin County	8.22	0	105.66	0	40.68	0	0	0	7.62	11.43
Sharkey County	.09	0	14.46	0	4.32	0	403.68	88.59	0.9	6.81
Simpson County	1.62	0	48.69	0	3.9	0	0	0	6.06	9.09

GG
ER

TABLE 2.1.71 (Cont.)

County Or Parish	Public Supply		Domestic		Industrial		Irrigation		Livestock	
	GW	SW	GW	SW	GW	SW	GW	SW	GW	SW
Warren County	83.58	0	138.3	0	17.91	19236.63	0	0	3.96	5.97
Wilkinson County	0.42	0	12.6	0	0.03	0	0	0	5.31	7.95
Yazoo County	2.16	0	61.86	0	552	0	205.74	48.18	7.26	10.92
Caldwell Parish	19.05	0	1.44	0	0	0	0.3	0	0.57	3.15
Catahoula Parish	25.02	0	4.35	0	0	53.4	22.77	0	0.21	1.83
East Carroll Parish	32.61	0	2.76	0	0.63	9.0	392.16	86.85	0.93	0.12
Franklin Parish	40.5	0	10.86	0	9.03	0	315.6	20.1	1.71	9.78
Madison Parish	29.94	0	2.7	0	1.035	0	234.36	65.64	2.43	0.42
Richland Parish	41.88	0	8.7	0	210.0	0	902.34	150.0	8.25	0.9
West Carroll Parish	23.4	0	0.15	0	17.61	0	153.12	140.67	3.06	0.78
Concordia Parish	57.0	0	1.8	0	0	0	0	0	6.6	0.3
Tensas Parish	19.2	0.6	3.0	0	14.4	4.2	51.0	0	1.2	0

GG
ER

TABLE 2.1.72

USERS OF MISSISSIPPI RIVER WATER

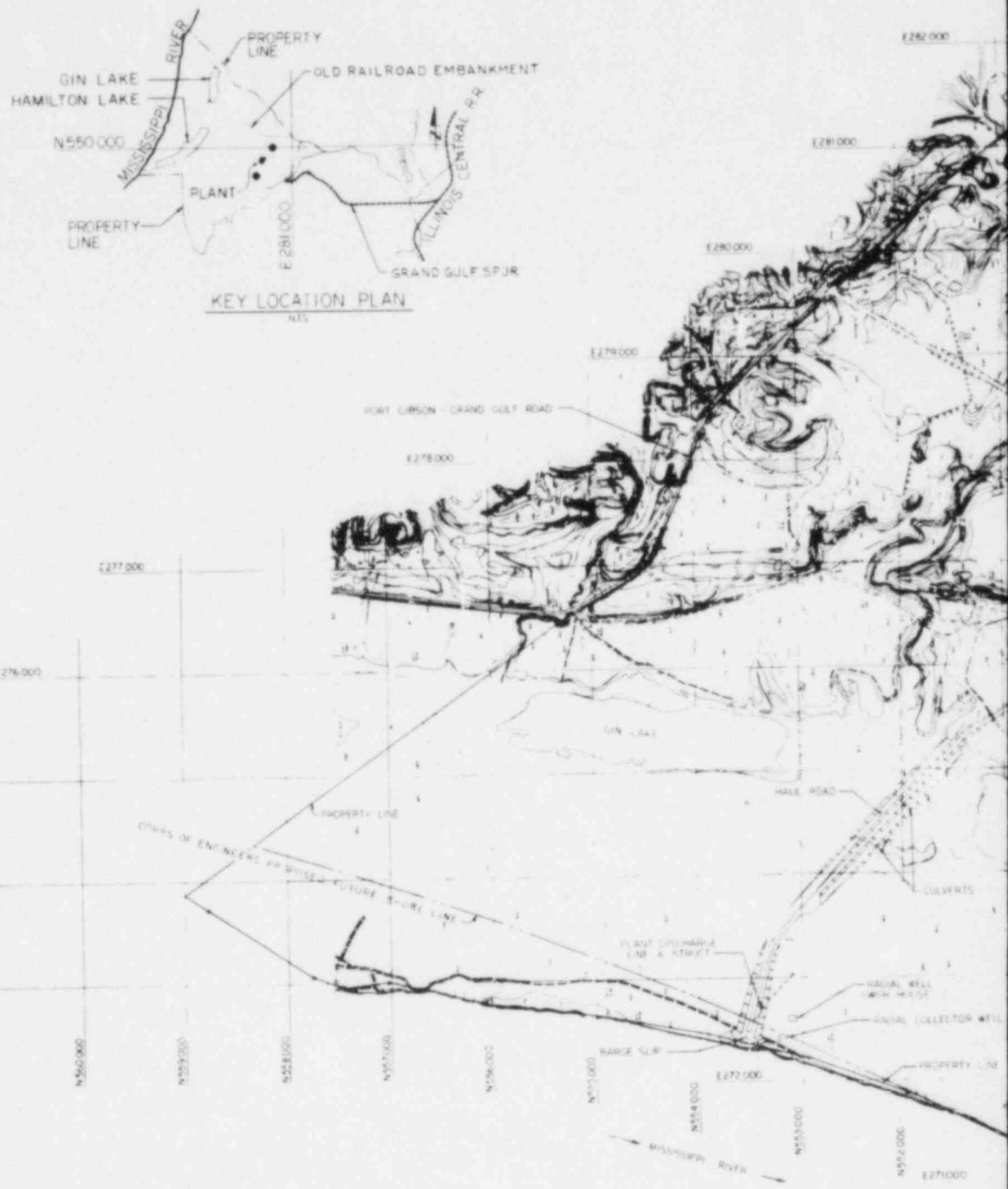
Company	Location, river mi above Head of Passes	Average Daily Intake Flows,[1] mgd
Crown-Zellerbach Corp., St. Francisville, La.	260.4	35.02
Kaiser Aluminum & Chemical Corp., Baton Rouge, La.	234.0	38.16
Stauffer Chemical Co., Baton Rouge, La.	233.7	2.74
Gulf States Utilities Co., Baton Rouge, La.	233.1	6.79
Ethyl Corp., Baton Rouge, La.	233.1	11.50
Enjay Chemical Co., Baton Rouge, La.	232.3	18.70
Allied Chemical Co., Baton Rouge, La.	231.8	59.00
Humble Oil & Refining Co., Baton Rouge, La.	231.6	68.75
Cargo Carriers, Inc., Port Allen, La.	227.9	7.92
*The Dow Chemical Corp., Plaquemine, La.	209.0	615.20

From wells Tom Joffrion
Pubb Rel Managers
P.O. 150
Plaquemine LA 70764

2450 in round no
500 contract maint people day people

* First downstream user (potable water of 500 to 600 gpm) of Mississippi River water.

1. Source: Reference 111.


PROPERTY LINE
OLD RAILROAD EMBANKMENT
GIN LAKE
HAMILTON LAKE
MISSISSIPPI RIVER
N550,000
PLANT
PROPERTY LINE
E 281,000
ILLINOIS CENTRAL RR
GRAND GULF SPUR
KEY LOCATION PLAN
NTS
E282,000
E281,000
E280,000
E279,000
PORT GIBSON - GRAND GULF ROAD
E278,000
E277,000
E276,000
E275,000
E274,000
E273,000
GIN LAKE
HAUL ROAD
PROPERTY LINE
CULVERTS
RADIAL WELL
RADIAL COLLECTOR WELL
BARGE SLIP
PROPERTY LINE
E272,000
Mississippi River
E271,000
N561,000
N560,000
N559,000
N558,000
N557,000
N556,000
N555,000
N554,000
N553,000
N552,000

MISSISSIPPI POWER & LIGHT COMPANY
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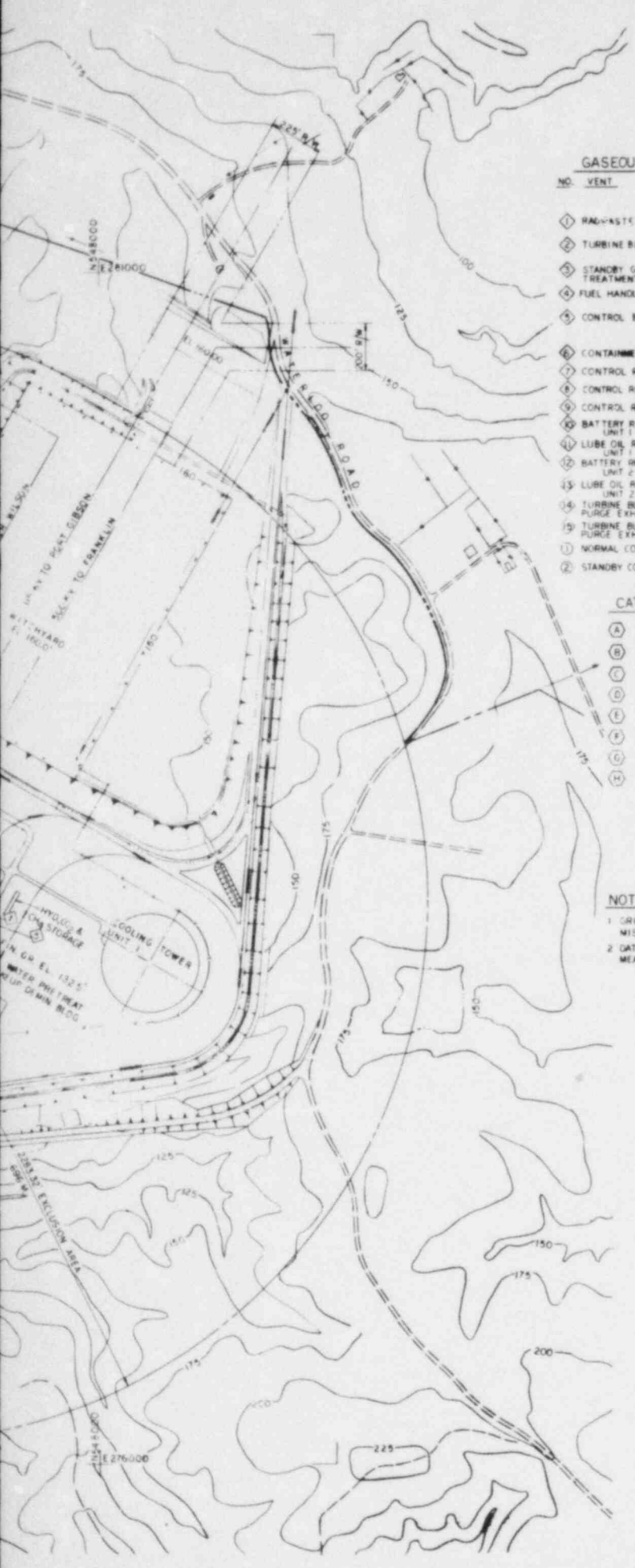
SITE AND YARD WORK
SITE PLAN
FIGURE 2.1-1

EL 281000
RAILROAD EASEMENT
FILL TO EL 160.00
FILL TO EL 160.00
FIN FL EL 132.5
FINISH EL 132.5
UNIT 2
UNIT 1
LAYDOWN AREA
GRADE EL 155.0 ±
EL 76000
PSW DISCH LINE
PSW SUPPLY LINE



GASEOUS EFFLUENT RELEASE POINTS

NO.	VENT	MIN. DISTANCE TO BOUNDARY LINE	RELEASE ELEV.
1	RADWASTE BLDG.	2030 ± FT.	EL. 164.0'
2	TURBINE BLDG.	2090 ± FT.	EL. 232.0'
3	STANDBY GAS TREATMENT	2350 ± FT.	EL. 272.0'
4	FUEL HANDLING AREA	2340 ± FT.	EL. 272.0'
5	CONTROL BLDG.	2350 ± FT.	EL. 195.0'
6	CONTAINMENT	2240 ± FT.	EL. 193.0'
7	CONTROL ROOM	2420 ± FT.	EL. 195.0'
8	CONTROL RM. PURGE	2420 ± FT.	EL. 195.0'
9	CONTROL RM. UTIL. EXH.	2420 ± FT.	EL. 195.0'
10	BATTERY RM. EXH. UNIT 1	2030 ± FT.	EL. 170.0'
11	LUBE OIL RM. EXH. UNIT 1	2160 ± FT.	EL. 143.0'
12	BATTERY RM. EXH. UNIT 2	2320 ± FT.	EL. 156.0'
13	LUBE OIL RM. EXH. UNIT 2	2500 ± FT.	EL. 141.0'
14	TURBINE BLDG. SMOKE PURGE EXH. UNIT 1	1990 ± FT.	EL. 190.0'
15	TURBINE BLDG. SMOKE PURGE EXH. UNIT 2	2540 ± FT.	EL. 186.0'
1	NORMAL CONTROL RM. O/A INTAKE		EL. 208.0'
2	STANDBY CONTROL RM. O/A INTAKE		EL. 139.0'

CATEGORY I STRUCTURES

- (A) CONTAINMENT STRUCTURE
- (B) AUXILIARY BUILDING
- (C) MAIN STEAM PIPE CHASE
- (D) DIESEL GENERATOR BUILDING
- (E) DIESEL GEN. FUEL OIL STORAGE TANK
- (F) CONTROL BUILDING
- (G) CONDENSATE STORAGE TANK
- (H) STANDBY SERVICE WATER COOLING TOWER BASIN

NOTES

1. GRID COORDINATES SHOWN ARE BASED ON MISSISSIPPI COORDINATE SYSTEM, WEST ZONE.
2. DATUM FOR ELEVATIONS SHOWN IS MEAN SEA LEVEL EL. 0.0'.

200 0 200 400
FEET

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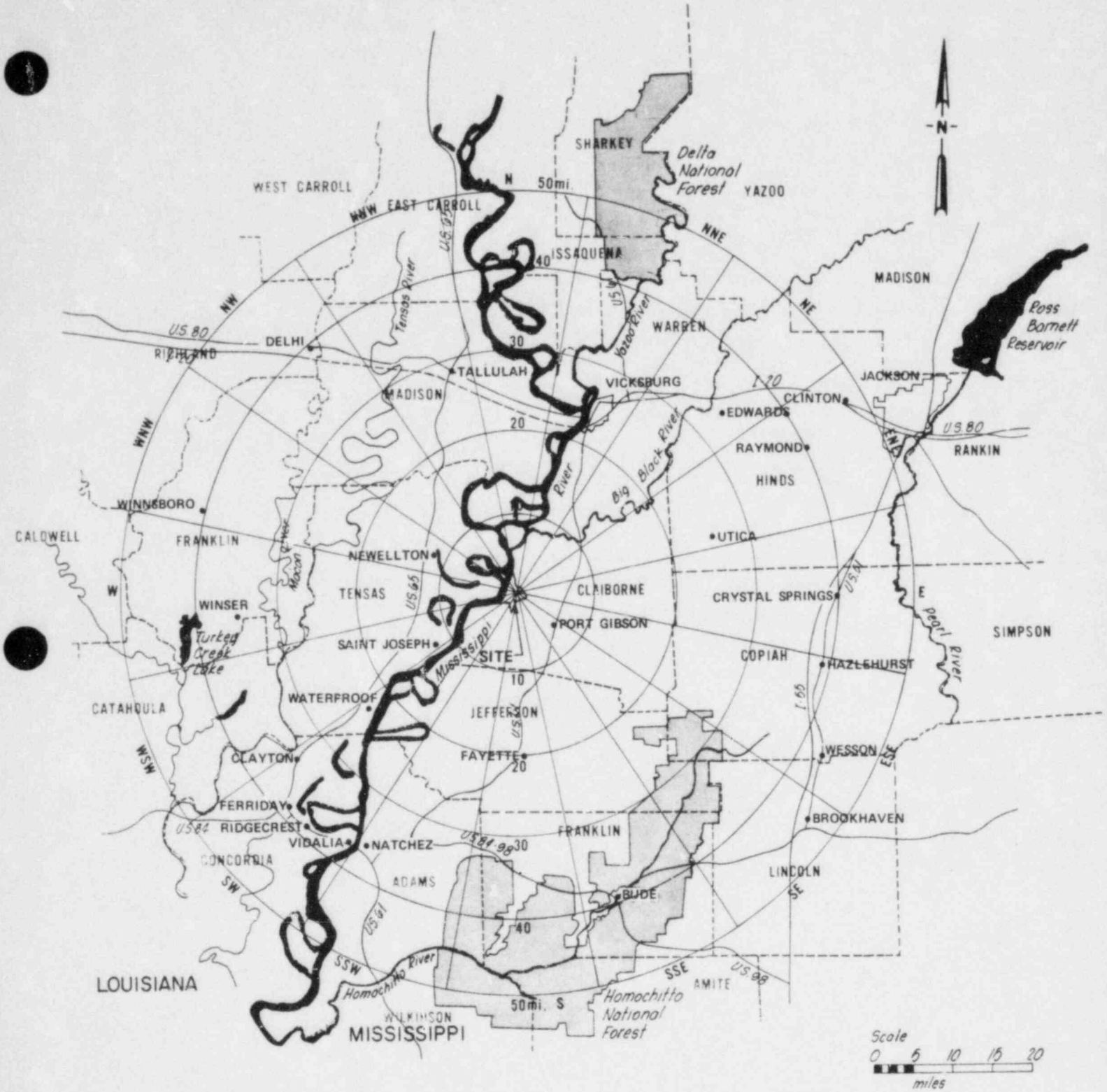
PLOT PLAN

FIGURE 2.1-2



SOURCE: Official highway map - Louisiana (1970)
Official highway map - Mississippi (1971)

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GENERAL AREA MAP

FIGURE 2.1-3

LEGEND

SITE BOUNDARY

RESIDENTIAL AREA

SOURCE: General highway maps (1962) - Claiborne County and Tensas Parish

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SITE VICINITY MAP

FIGURE 2.1-4

LEGEND

- LEVEE
- SCHOOL
- HUNTING CAMP
- (Y) YMCA CAMP
- † CHURCH
- CF COMMERCIAL FISHING AREA
- SF SPORT FISHING AREA
- SITE BOUNDARY

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SITE AREA AND ADJACENT
LAND USES

FIGURE 2.1-5

2.2 ECOLOGY

2.2.1 Introduction

Preconstruction terrestrial and aquatic ecological field measurements were taken by a 12-man biological staff stationed on the Grand Gulf Nuclear Station site from June 1972 through August 1973. During this period seasonal measurements were taken of vegetation, mammals, birds, reptiles, amphibians, and insect pest infestations on and near the site and of fishes, benthos, plankton and water quality in the two onsite oxbow lakes and adjacent Mississippi and Big Black Rivers. Since August 1973, a full time biologist responsible for the conduct of the Environmental Protection Program Respecting Construction, including construction monitoring, has been stationed at the site.

This section provides a summary of all pertinent terrestrial and aquatic ecological field data and historical information that has been collected since the inception of the preconstruction environmental field measurements programs in 1972. More detailed presentations of the preconstruction field data are contained in the Environmental Field Measurements Programs: Interim Report (July 1973), Interim Report 2 (October 1973), Final Report (December 1973) and Supplementary Report (May 1974). Detailed descriptions of the field data and laboratory procedures used during the preconstruction studies are presented in the Environmental Report, Construction Permit Stage, Amendment 2, Item 22, March 1973.

2.2.2 Terrestrial Ecology

2.2.2.1 Summary

The Grand Gulf site has two general edaphic types, loessial bluffs and alluvial river bottomlands, each supporting a different plant community. These plant communities provide habitats that meet the vital requirements of the varied fauna present on the site. Periodic flooding of the Mississippi River onto the bottomlands results in the deposition of nutrient-rich materials. As a result of these nutrient additions, the bottomlands are more productive[1] than the loessial bluffs (Refs. 1 and 2). This inundation, however, creates an unstable environment, particularly for the vegetation; the bottomland plant community, consequently, contains fewer species than does the loessial bluff plant community.

Because of the presence of forests and fields in both the loessial bluffs and the river bottomlands, the site contains four principal terrestrial habitats: loessial bluff deciduous hardwood forest, loessial bluff fields, bottomland deciduous hardwood forest, and bottomland fields.

The forest communities are the largest habitat and prior to initiation of construction covered approximately 1785 acres (80 percent)

[1] More productive in the sense that a given area of bottomland can support a greater density of animals compared to an equal area of loessial bluff.

of the 2330-acre site (on June 19, 1974, 164 acres of bottomland were donated to the Grand Gulf Military Park). Of this, approximately 775 acres are loessial bluff forest and about 1010 acres are bottomland forest. Two oxbow lakes, Hamilton and Gin, are present on the site and cover about 110 acres in the bottomlands. Approximately 150 acres of the bottomland forest is shrub swamp dominated by black willow and swamp privet. This shrub swamp is located around the periphery of Hamilton and Gin Lakes but is most extensive at the northern end of Gin Lake. Most of the land west of the lakes is periodically flooded and supports bottomland hardwoods and herbaceous vegetation. No marsh community[2], however, is present on the site.

Field studies have resulted in the documentation of the occurence on the Grand Gulf site of at least 420 species of woody and herbaceous plants, 140 species of birds, 31 species of mammals, 34 species of reptiles, and 14 species of amphibians.

Construction activities have resulted in the clearing of approximately 465 acres of which about 75 percent (350 acres) was forested (274 acres of bluff forest and 76 acres of bottomland forest).

One endangered species, the American alligator (Alligator mississipiensis) is present in the oxbow lakes on the site.

2.2.2.2 Vegetation

Systematic sampling of the forest overstory was conducted in 0.1-acre plots and the understory vegetation was sampled in mil-acre (0.001-acre) plots. Sample plots were established at 5-chain intervals (330 feet) along parallel transect lines spaced approximately 1000 feet apart. Vegetation sampling locations are shown in Figure 2.2-1.

During 1972 and 1973, seasonal sampling and continuous collection indicated that at least 420 species of vascular plants representing 285 genera and 105 families occurred on the Grand Gulf site. Sixty-four species (15 percent of the total) were trees. With the exception of three species, all trees occurring on the site were deciduous. The species composition of understory vegetation growing on the site varied seasonally with the largest number of plants occurring during the summer.

None of the species found growing on the site were listed in the "Report on Endangered and Threatened Plant Species of the United States" that was published by the U.S. Fish and Wildlife Service in the July 1, 1975 Federal Register or on the proposed list of "Endangered and Threatened Plant Species" published in the June 16, 1976 Federal Register.

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[2] The existence of a marsh community is determined by the presence of indicative vegetation such as bulrushes, spike rushes, cattails or reeds.

2.2.2.2.1 Forest Overstory

Two forest types occur on the site: bottomland deciduous hardwood and loessial bluff deciduous hardwood. The bottomland hardwood forest covered approximately 1010 acres (43 percent of the site) along the east bank of the Mississippi River. The bluff hardwood forest covered approximately 775 acres (33 percent of the site) east of and adjacent to the bottomland forest. A type map showing the preconstruction distribution of the dominant species comprising the forest overstory is presented in Figure 2.2-2.

a. Bottomland Forest

Twenty-seven tree species were identified in the bottomland forest. Sampling indicated a density of approximately 146 trees per acre and a total basal area of about 61 square feet per acre. Sugarberry (Celtis laevigata), pecans (Carya spp.), green ash (Fraxinus Pennsylvanica), black willow (Salix nigra), swamp privet (Forestiera acuminata), and box elder (Acer Negundo) were the dominant species. These trees comprised approximately 79 percent of the total basal area and about 84 percent of the total number of trees. Swamp privet was the only dominant tree species that is not commercially valuable (Ref. 3).

Four species of trees observed in the bottomlands but not encountered in sampling were catalpa (Catalpa bignonioides), mimosa (Albizzia Julibrissin), sandbar willow (Salix interior), and tupelo gum (Nyssa sylvatica). The catalpa and mimosa trees were found growing near a house and had probably been planted as ornamentals. As its name implies, sandbar willow grows on sandbars along river and stream banks; onsite, a few specimens of this species occurred along the banks of the Mississippi River. Only a single specimen of tupelo gum, a species commonly occurring in the Mississippi River bottomlands, was observed on the site. This species is intolerant of shade and cannot compete with other bottomland trees. It typically occurs on very wet sites where most other species cannot survive.

b. Bluff Forest

Forty-six tree species were identified in the bluff forest. Included in this total are fig (Ficus Carica), a fruit tree found growing near a house, trifoliate orange (Pancirus trifoliata), herclules club (Aralia spinosa), osage orange (Maclura pomifera), prickly ash (Zanthoxylum Clava-Herculis), redbud (Cercis canadensis), and American holly (Ilex opaca). These latter species may be considered as either shrubs or small trees. All specimens of these species encountered onsite were shrub size.

Sampling indicated a density of approximately 161 trees per acre and a total basal area of about 86 square feet per acre. In the bluff forest, sweetgum (Liquidambar Stryaciflua), water oak (Quercus nigra), southern red oak (Quercus falcata), American elm (Ulmus americana), and hickories (Carya spp.) were the dominant species. These trees comprised approximately 63 percent of the total basal area and about 58 percent of the total number of trees. All of these species are commercially valuable (Ref. 3).

Six species of trees observed in the bluff forest but not encountered in the sample plots were willow oak (Quercus Phellos), yellow chestnut oak (Quercus Muehlenbergii), slippery elm (Ulmus rubra), red maple (Acer rubrum), empress tree (Paulownia tormentosa)[3] and shortleaf pine (Pinus echinata). These species were present in limited numbers and constituted only a minor portion of the bluff forest overstory.

2.2.2.2.2 Understory Vegetation

Inventories of understory vegetation were conducted in July and August 1972 (summer season), January and February 1973 (winter season), and May 1973 (spring season) using systematic sampling methods (sampling locations are shown in Figure 2.2-1). All plants occurring in sample plots were identified to genus or species with the exception of the grasses and sedges which were identified to family. Due to flooding by the Mississippi River, the bottomlands were only partially sampled in January and February and were not sampled in May.

During summer sampling, 162 plant taxa were recorded. Of this total, 25 occurred exclusively in the bottomlands and 50 occurred exclusively in the bluffs. Only 78 taxa were recorded during winter sampling; 11 taxa occurred exclusively in the bottomlands and 22 occurred exclusively in the bluffs. In spring sampling, 148 taxa were recorded in the bluffs. The reduction of plant taxa from 162 identified in the summer sampling period to 78 identified in the winter sampling period resulted primarily from the seasonal retrogression of summer annuals and dormant perennials. The subsequent regrowth of the perennials and the growth of spring and some summer annuals was reflected in the increase from 78 taxa identified in January and February to 148 identified in May. If flooding had not prohibited spring sampling in the bottomlands, the number of taxa recorded in the May sampling would have been greater (Ref. 4).

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[3] This species is an ornamental tree that has been introduced from Asia and was probably planted on the site.

Type maps of the seasonally dominant understory vegetation are presented in Figures 2.2-3 through 2.2-5.

a. Bottomlands

Ninety-seven plant taxa were recorded during sampling of the bottomland understory vegetation conducted in July and August 1972. The following plants were most abundant and comprised 59 percent of all understory cover: asters (Aster spp.), buckvine (Ampelopsis arborea), dewberries (Rubus spp.), grasses (Poaceae), sugarberry (Celtis laevigata), poison ivy (Rhus radicans), false nettle (Boehmeria cylindrica), Johnson grass (Sorghum halepense), trumpet creeper (Campsis radicans) and ladies eardrops (Brunnichia cirrhosa). References 4 and 5 reported that the same taxa comprised 51 percent of all understory cover (117 taxa sampled) in the summer on a similar bottomland hardwood area (Durango Hunting Club) located adjacent to the east bank of the Mississippi River about 20 miles south-southwest of the Grand Gulf site.

In the January and February 1973 sampling, the number of identified bottomland taxa decreased from 97 to 48. The most abundant taxa (73 percent of all understory vegetation cover) were asters, dewberries, grasses, nemophila (Nemophila microcalyx), sedges, daisy fleabane (Erigeron spp.), vetches, (Vicia spp.), violets (Viola spp.), chickweed (Stellaria spp.), and bedstraw (Galium spp.) These same taxa[4] comprised 72 percent of all understory cover occurring on Durango during the winter of 1972 (Ref. 4).

Due to flooding of the bottomlands, no sampling could be conducted during the spring. However, the Durango study indicated that asters, dewberries, grasses, sugarberry, and poison ivy are the most abundant understory vegetation occurring in the bottomlands during the spring and comprise about 33 percent of all understory cover (Ref. 4).

Dewberries, asters, and grasses were dominant taxa in all seasons sampled at Grand Gulf and Durango. At Grand Gulf, these taxa comprised 26 percent of all bottomland summer understory cover and 44 percent of all bottomland winter understory cover. The increase in the cover of these taxa in the winter was due to a decrease in the cover of other taxa.

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[4] Except nemophila and chickweed which did not occur on Durango study plots in this season.

Large fields and forest openings occupied approximately 10 percent of the bottomland area and supported plant taxa that ordinarily did not occur in the forested areas. Dominant field taxa in the summer (8 percent of all the bottomland understory cover) were Johnson grass, sumpweed (Iva annua), balloon vine (Cardiospermum Halicacabum), and golden rod (Solidago altissima). In the winter, the dominant field taxa (6 percent of all the bottomland understory cover) were henbit (Lamium amplexicaule), cranesbill (Geranium spp.), clover (Trifolium spp.), goldenrod, and dock (Rumex crispus).

b. Loessial Bluffs

During July and August 1972, 114 plant taxa were recorded in the sampling of the loessial bluff understory vegetation. The following plants were most abundant and comprised 60 percent of all understory cover: switchcane (Arundinaria tecta), grasses, poison ivy, Japanese honeysuckle (Lonicera japonica), winged elm (Ulmus alata), sedges, oaks (Quercus spp.) asters, rattan (Berchemia scandens), and green briars (Smilax spp.)

In the January and February 1973 sampling, the number of identified bluff understory taxa decreased from 114 to 60. The most abundant taxa (70 percent of all understory vegetation cover) were switchcane, Japanese honeysuckle, grasses, sedges, asters, nemophila, oaks, haircap moss (Family Musci), crossvine (Bignonia capreolata), and violet (Viola spp.).

In the May 1973 sampling, 148 understory taxa were recorded. This was an increase of about 147 percent over the total number of taxa recorded in the winter (60) and a 30 percent increase over the number of taxa recorded in the summer (114). The large number of taxa recorded in the spring resulted from the presence of many short-lived spring annuals. The most abundant taxa (52 percent of all understory vegetation cover) were poison ivy, switchcane, Japanese honeysuckle, grasses, spreading bladder fern (Cystopteris fragilis), sedges, winged elm, Virginia creeper (Parthenocissus quinquefolia), rattan, and oaks.

Switchcane, grasses, Japanese honeysuckle, sedges and oaks[5] were dominant in all seasons. These taxa comprised 42 percent of all bluff summer understory cover,

[5] Small oaks growing close to the ground were somewhat protected from wind and cold and most of their leaves stayed green during the winter.

51 percent of all bluff winter understory cover, and 28 percent of all bluff spring understory cover. The changes in the cover of these taxa resulted from seasonal retrogression and recrudescense of other plant taxa.

Large field and forest openings occupied approximately 15 percent of the bluff area and supported plant taxa that ordinarily did not occur in the forested areas. Dominant field taxa in summer (3 percent of all the bluff understory cover) were goldenrod, sida (Sida rhombifolia), goatweed (Croton capitatus), mare's tail (Erigeron canadensis), butterfly pea (Centrosema virginianum), and dog-fennel (Eupatorium capillifolium). In the winter, the dominant field taxa (4 percent of all the bluff understory cover) were clover, chickweed, dog-fennel, henbit, dock and cranesbill. Dominant field taxa in the spring (4 percent of all the bluff understory cover) were low hop clover (Trifolium dubium), goldenrod, cranesbill, and dog-fennel. Dog-fennel was a dominant in the field in all seasons.

2.2.2.2.3 Forest Midstory

Eleven ligneous or woody vines which were common in the forest understory and midstory on the site are listed below:

Buckvine	(Ampelopsis arborea)
Rattan	(Berchemia scandens)
Cross-vine	(Bignonia capreolata)
Red-berried moonseed	(Cocculus carolinus)
Greenbrier	(Smilax spp.)
Japanese honeysuckle	(Lonicera japonica)
Virginia creeper	(Parthenocissus quinquefolia)
Kudzu	(Pueraria lobata
Poison ivy	(Rhus radicans)
Wild grape	(Vitis spp.)

With the exception of Kudzu, which grows exclusively in the bluffs, all of these taxa occurred in both the bottomlands and the bluffs. Sampling and field observations indicated that buckvine, red-berried moonseed, trumpet creeper, and Virginia creeper were more abundant in the bottomlands: cross-vine, Japanese honeysuckle, poison ivy and rattan were more abundant in the bluffs; and greenbrier and wild grape were equally abundant in the bluffs and bottomlands.

Kudzu is a perennial vine that was introduced into Mississippi from Asia to assist in controlling erosion. It has stems up to 60 feet long and frequently chokes out young forest trees. On site, it was most abundant on severely eroded bluffs and along roadsides; it had probably been planted in these locations to control erosion.

Two additional plant taxa commonly occurring in the bottomland and bluff forest midstory were Spanish moss (Tillandsia usneoides) and American mistletoe (Phoradendron flavescens). Spanish moss is an epiphyte[6] which clings to the branches of trees. American mistletoe is a parasite that grows on trees and absorbs water and minerals directly from its host. Although it is epiphytic, Spanish moss occasionally causes damage to supporting trees because it may become saturated with rain water during severe storms and cause branches to break. Field observations indicated that Spanish moss and American mistletoe were most abundant in the bluff forest.

2.2.2.3 Birds

Field observations using several different systematic methods were employed to inventory birds on the site. A monthly census of birds was made from observation stations established on Hamilton and Gin Lakes, at the Grand Gulf Military Park observation tower, and on the east bank of the Mississippi River. Bimonthly censuses were conducted in 40-acre plots located in the bluff and bottomland forest communities. Birds occurring along two 300-foot-wide belt transects which traversed all habitats on the site, and along approximately 16,100 feet of field edge in both the bottomlands (8000 feet) and bluffs (8100 feet) were also censused bimonthly. Census locations are shown in Figure 2.2-6.

One hundred and forty avian species have been observed on or near the Grand Gulf site. Review of range maps presented in Reference 6 indicated that, with the exception of two species, the white ibis (Eudocimus albus) and Louisiana heron (Hydrannassa tricolor), all observed species regularly occur in the area. On the basis of seasonal occurrence information presented in Reference 6, of the 140 species recorded 44 (31 percent) are permanent residents in the area; 44 (31 percent) are resident only during the spring and summer: 20 (14 percent) occur only during spring and fall migration; and 32 (23 percent) are resident in the area only during the winter.

None of the observed species have been designated as endangered or threatened by the U. S. Fish and Wildlife Service (Ref. 7). However, 15 of the observed species have been declining in numbers and concern has been expressed about the future of these species (Ref. 8). These species are listed below:

White ibis	(Eudocimus albus)
Sharp-shinned hawk	(Accipiter striatus)
Red-shouldered hawk	(Buteo lineatus)
Marsh hawk	(Circus cyaneus)
Osprey	(Pandion haliaetus)
American kestrel	(Falco sparverius
Yellow-billed cuckoo	(Coccyzus americanus)
Barn owl	(Tyto alba)

[6] An epiphyte is a plant that derives its moisture and nutrients from the air and rain and usually grows on another plant.

Common nighthawk	(Chordeiles minor)
Red-headed woodpecker	(Melanerpes erythrocephalus)
Hairy woodpecker	(Dendrocopus villosus)
Purple martin	(Progne subis)
Loggerhead shrike	(Lanius ludovicianus)
Yellow warbler	(Dendroica petechia)
Yellow breasted chat	(Icteria virens)

2.2.2.3.1 Avian Fauna of the Forest Communities

Censuses[7] indicated that the cardinal (Cardinalis cardinlis), Carolina wren (Thryothorus ludovicianus), Carolina chickadee (Parus carolinensis), blue jay (Cyanocitta cristata), rufous-sided towhee (Piplio erythropthalmus), and red-bellied woodpecker (Centurus carolinus) were common[8], permanent residents in both the loessial bluff and bottomland forest communities. One permanent resident, the tufted titmouse (Parus bicolor), was common only in the loessial bluff forest. The brown thrasher (Taxostoma rufum), another permanent resident, was common only between October and April when large numbers evidently wintered on the site.

Common winter residents on the site were the white-throated sparrow (Zonotricia albicollis), robin (Turdus migratorius), yellow-shafted flicker (Colaptes auratus), ruby-crowned kinglet (Regulus calendula), myrtle warbler (Dendroica coronata), and yellow-bellied sapsucker (Sphyrapicus varius). All of these species were common in both the loessial bluff and bottomland forest communities. The myrtle warbler, however, was much more numerous in the bottomland forest.

Common summer residents on the site were the white-eyed vireo (Vireo griseus), red-eyed vireo (Vireo olivaceus), parula warbler (Parula americana), hooded warbler (Wilsonia citrina), prothonotary warbler (Protonotaria citrea), worm-eating warbler (Helmitheros vermivorus), Acadian flycatcher (Empidonax virescens), indigo bunting (Passerina cyanea), and yellow-billed cuckoo (Coccyzus americanus). The red-eyed vireo, parula warbler and worm-eating warbler primarily inhabited the loessial bluff forest; the prothonotary warbler, white-eyed vireo, hooded warbler, Acadian flycatcher, and yellow-billed cuckoo were abundant in both the bottomland and loessial bluff forest.

The cardinal, blue jay, rufous-sided towhee, and white-throated sparrow subsist largely on seeds and fruits; the robin, brown thrasher, red-bellied woodpecker, yellow-bellied sapsucker, and Carolina chickadee are normally omnivorous; and the vireos, warblers, yellow-billed cuckoo, tufted titmouse, and Acadian flycatcher are primarily insectivorous.

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[7] Census, as used in this report, refers only to a count or talley of birds observed and does not imply that all individuals present were recorded.

[8] Common i defined herein as more than ten individuals per 100 acres.

2.2.2.3.2. Avian Fauna of the Field-Forest Ecotone

Avian species occurring within 50 feet of the edge of a field were considered to inhabit the field-forest ecotone. Species primarily inhabiting the field edge, that were permanent residents on the site, included the mourning dove (Zenaidura macroura), bobwhite (Colinus virginianus), red-winged blackbird (Agelaius phoeniceus), mockingbird (Mimus polyglottos), and loggerhead shrike (Lanius ludovicianus). Mourning doves were most numerous during the winter months when as many as 100 to 200 were observed feeding on the seeds of a variety of weed species growing along roadsides and in old fields.

Bobwhite, loggerhead shrikes, and mockingbirds are most numerous in areas that are predominantly fields with scattered woodlots. Since the Grand Gulf site is mostly wooded, these species were present in limited numbers. The red-winged blackbird commonly occurred along field edges throughout the year.

Field-edge species resident on the site only during the winter included the white-throated sparrow, fox sparrow, (Passerella iliaca), lark sparrow (Chondestes grammacus), and field sparrow (Spizella pusilla). Of these species, the white-throated sparrow was the most abundant with an average of 10.7 birds occurring along every 100 feet of field edge in the December 1972 census.

Species resident in the field edge only during the summer included the indigo bunting, painted bunting (Passerine ciris), yellow-breasted chat (Icteria virens), yellowthroat (Geothlypis thrichas), rough-winged swallow (Stelgidopteryx ruficollis), and orchard oriole (Icterus spurius). Only the indigo bunting and yellow-breasted chat occurred commonly. Occasionally, 200 to 300 rough-winged swallows were observed perched on powerlines traversing fields adjacent to Hamilton and Gin Lakes.

During migration, the brown-headed cowbird (Molothrus ater) and American goldfinch (Spinus tristis) were particularly abundant along field edges. With the exception of the rough-winged swallow, field-edge species largely subsist on plant seeds.

2.2.2.3.3 Avian Fauna of Hamilton and Gin Lakes

The following species of water-dependent birds were observed on Hamilton and/or Gin Lakes:

Water Birds

Anhinga	(Anhinga anhinga)
Great blue heron	(Ardea herodias)
Little blue heron	(Florida caerulea)
Green heron	(Butorides virescens)
Louisiana heron	(Hydranassa tricolor)
Cattle egret	(Bubulcus ibis)
Common egret	(Casmerodius albus)

White ibis	(Eudocimus albus)
Wood ibis	(Mycteria americana)
American coot	(Fulica americana)
Pied-billed grebe	(Podilymbus podiceps)
Belted kingfisher	(Megaceryle alcyon)

Waterfowl

Wood duck	(Aix sponsa)
Mallard	(Anas platyrhynchos)
Canvasback	(Aythya valisineria)
Gadwall	(Anas strepera)
Pintail	(Anas acuta)
Blue-winged teal	(Anas discors)
Green-winged teal	(Anas carolinensis)

Of these species, only the wood duck, great blue heron, and belted kingfisher are permanent residents in this section of Mississippi. With the exception of the American coot and the pied-billed grebe, the remaining species of water birds are primarily summer residents. The American coot, the pied-billed grebe and the remaining species of waterfowl occur in the area only during the fall, winter, and early spring. The water birds are carnivorous, normally feeding on a variety of fish, reptiles and amphibians whereas the waterfowl are omnivorous, subsisting on a variety of aquatic invertebrates and seeds and leaves of aquatic and terrestrial plants.

Utilization of the lakes by water-dependent species was seasonal. During the summer and early fall of 1972 and late spring of 1973, fewer than ten individuals of any single species were concurrently observed on the lakes. During the summer of 1973, however, about 300 little blue herons and about 100 cattle egrets and common egrets were observed at dusk flying over the lakes in a southerly direction. The herons and egrets were evidently flying to a roosting area located south of the site near Bayou Pierre. Most of these birds came from areas north of the site and only a small number (generally less than 10) were observed on Hamilton and Gin Lakes at the same time.

Lack of utilization of the lakes by water-dependent birds during the summer was not unusual since, with the exception of anhinga, kingfisher and wood duck, the habitat requirements of all water-dependent birds observed at Grand Gulf during the summer are more readily fulfilled by shallow marshes and ponds (water depth less than two feet) than by lakes.

The wood duck is a common permanent resident of the oxbow lakes occurring along the Mississippi River bottomlands. It nests in tree cavities and raises its young in brush-covered portions of the oxbow lakes. Since the bottomlands of the Grand Gulf site contained these basic elements (trees with cavities and oxbow

lakes), special efforts were devoted to evaluating the importance of the lakes to wood duck production by using observational and trapping techniques in 1972 and 1973. Only one brood of wood ducks was observed on the lakes during the entire summer of 1972 and none were seen during the spring and summer of 1973. No wood ducks were captured in baited floating traps placed in brush-covered sections of the lakes during August and September 1972. The apparent lack of utilization of the lakes by wood ducks during the summer period can probably be attributed to the scarcity of submerged or emergent aquatic vascular plants, except for the duckweed species Lemna minor and Spirodela polyrhiza.

Wood duck utilization of the lakes increased noticeably in October 1972 when approximately 200 wood ducks roosted each evening in the north end of Gin Lake. In November, at the height of fall migration, the estimated number of roosting wood ducks increased to over 600. From late December 1972 through February 1973, the number of wood ducks estimated to be using Hamilton and Gin Lakes fluctuated between 50 and 300. This fluctuation in wood duck numbers is probably attributable to the creation of additional roosting and feeding habitat in nearby areas as a result of flooding of bottom-land areas by the Mississippi River.

Beginning in late November and continuing through February, periodic concentrations of several hundred to several thousand mallards and a few gadwall and green-winged teal were observed feeding in flooded soybean fields adjacent to the northern boundary of the Grand Gulf site. After feeding, many of these ducks utilized flooded areas on and near the site for resting.

During the winter of 1972-73 a few American coot (estimated to number less than 10) wintered on Hamilton and Gin Lakes. During the preconstruction study period, most wintering waterfowl left the Grand Gulf area by mid-March, at which time the summer-resident herons and egrets began to return. Migrating blue-winged teal were periodically noted feeding in flooded fields adjacent to Hamilton and Gin Lakes during the latter part of March and April 1973. By May 1973 all wintering and migrating water-dependent species had departed from the area and all summer-resident species had returned.

Nest searches were conducted during March, May and June 1973 to determine if any heron, egret or anhinga rookeries existed on the site and to survey the extent of onsite wood duck nesting. No rookeries were found and only one wood duck nest was located on March 28. This wood duck nest was subsequently inundated by the rising waters of the flooding Mississippi River.

Two additional species, the prothonotary warbler and the rough-winged swallow, commonly occur in the vicinity of the lakes during the summer. The prothonotary warbler also nests in tree cavities. During May, five prothonotary warbler nests were found in cavities

of willow trees growing near Hamilton and Gin Lakes. The rough-winged swallow is an adaptable species that will use any type of cavity for nesting; however, it prefers to nest in burrows which it excavates in steep river banks. In the Grand Gulf area, rough-winged swallow nests were often located in the cut sides of steep bluff slopes that resulted from the construction of local roads. Insects in the vicinity of the lakes provided food for the insectivorous swallows and prothonotary warbler. Both species winter in Central America and occur on the site only during the spring and summer.

2.2.2.3.4 Vultures, Hawks and Falcons

The following species were observed on the site:

Black vulture	(Coragyps atratus)
Turkey vulture	(Carthartes aura)
Red-tailed hawk	(Buteo jamaicensis)
Red-shouldered hawk	(Buteo lineatus)
Broad-winged hawk	(Buteo platypterus)
American kestrel	(Falco sparverius)
Marsh hawk	(Circus cyaneus)
Sharp-shinned hawk	(Accipiter striatus)
Mississippi kite	(Ictinia misisippiensis)

Black and turkey vultures were permanent residents on the site. The black vulture was more abundant than was the turkey vulture. Very few turkey vultures were observed during the winter months. Both species are carrion eaters and were often seen scavenging along roadsides. The largest number of vultures seen on the site was on July 5, 1973 when 25 black and 5 turkey vultures were attracted to the Gin Lake boat landing by fish remains left by fishermen. A similar concentration of vultures occurred on January 16, 1973, at the end of the deer season, when 25 black vultures and 1 turkey vulture were attracted to deer remains left at the Mississippi-Arkansas Hunting Camp located on the Grand Gulf site. On April 30, a black vulture was flushed from its nest in the loessial bluff forest at the interface of the bluffs and bottomlands. The nest, which was just a depression on the ground, was subsequently flooded and abandoned.

The red-tailed hawk and red-shouldered hawk were permanent residents on the site; the broad-winged hawk was resident on the site only during the summer; and the marsh hawk, American kestrel and sharp-shinned hawk occurred on the site only during migration. The broad-winged hawk and red-tailed hawk were the most abundant of the hawks. With the exception of the marsh hawk (an inhabitant of grasslands and marshes), woodlands and wooded margins are the preferred habitat for all the hawks observed. Hawks are carnivorous and feed on a variety of small mammals, other birds, and occasionally reptiles and amphibians.

The Mississippi kite was abundant in the Grand Gulf area and was observed on the site from April until September. Kites subsist almost entirely on insects: during July 1972, as many as 35 individuals were observed soaring over the fields on the site consuming insects. The largest breeding populations of the Mississippi kite in the United States occur along the Lower Mississippi River valley; the kite nests in tall trees, particularly cottonwood, growing along stream bottoms. No Mississippi kite nests were found on the site although potential nesting habitats were thoroughly searched in May and June of 1973. The migration habits of the Mississippi kite are not well defined; however, it is believed to winter in southern Texas and Mexico (Ref. 9). Most Mississippi kites were gone from the Grand Gulf area by the end of August, presumably migrating to their wintering grounds.

On May 11, 1973, an osprey was observed on the western (Louisiana) bank of the Mississippi River about 2 miles southwest of the site. This individual was probably migrating north. This was the only osprey observed in the area during the study period from June 1972 through August 1973.

2.2.2.3.5 Owls

During the preconstruction study period, great horned (Bubo virginianus), screech (Otus asio), barn (Tyto alba), and barred owls (Strix varia) were observed on or near the site. All of these species are permanent residents in this section of Mississippi (Ref. 6).

A pair of great horned owls were present on Middle Ground Island from the summer of 1972 until the island was inundated in April 1973. The ready availability of a source of food provided by the thousands of blackbirds that roosted on the island may have attracted the owls to the island.

The occurrence of screech owls on the site was sporadic. The species was recorded in September, October, November and December 1972 and July 1973. The screech owl generally inhabits orchards and small woodlots rather than heavily wooded areas such as those occurring on most of the Grand Gulf site. The largest number of screech owls noted on the site was three in September 1972.

A single barn owl was observed on the site in July 1973. This species hunts mice and rats in marshes and fields; it nests in barns, abandoned buildings and tree cavities.

The barred owl was abundant on the site. A spring census of owl calls indicated that approximately six barred owls were present in the bluff forest on the site and an additional seven inhabited woodlands adjacent to the site. Additional barred owls were present in the bottomland forest; because of flooding, however, the bottomlands could not be censused.

Owls are carnivorous, feeding largely on small mammals. Normally owls are nocturnal, inhabiting secluded woodlands during the day and hunting along forest edges and fields at night.

2.2.2.3.6 Blackbirds

A blackbird roost was located on Middle Ground Island in the Mississippi River just northwest of the site. Blackbirds left the roost at dawn and flew to Mississippi and Louisiana to feed, returning to the island at dusk. The majority of the birds using the roost were common grackles (Quiscalus quiscula), although starlings (Sturnus vulgaris) and red-winged blackbirds (Agelaius phoeniceus) also used it. Most of the blackbirds flew over the Grand Gulf site to agricultural areas which provided an abundance of food (seeds and insects). When the mast crop matured during the latter part of September, however, large numbers of blackbirds were observed feeding in oak trees on the site.

Monthly estimates of the number of birds leaving the roost and flying to the Mississippi[9] side of the river indicated that the number of roosting birds declined about 85 percent between August (90,000 birds) and October (14,000 birds) of 1972. As fall progressed in 1972, however, the number of blackbirds using the roost increased tremendously until a peak was reached in December 1972 when an estimated 500,000 birds were observed flying from the island to Mississippi. The January and February 1973 estimates showed a decrease to a wintering population of approximately 250,000 birds. March 1973 estimates indicated a further decrease to 123,000 birds. The island was inundated during April, May and most of June 1973 and only the top 15 to 20 feet of trees growing on the island was available to the roosting blackbirds. Consequently, the blackbird counts dropped sharply to 2000 to 3000. By July 1973, the floodwaters had receded and the estimated number of blackbirds leaving the island increased to 10,000.

2.2.2.3.7 Upland Game Birds

Species of upland game birds occurring on the site were woodcock (Philohela minor), mourning dove (Zenaidura macroura), bobwhite (Colinus virginianus), and wild turkey (Meleagris gallopavo). The woodcock is a migratory species, breeding in the northeastern and north central United States and Canada and wintering primarily in Louisiana (Ref. 10). Woodcock are crepuscular, resting in protective woodlands during the day and flying at twilight to fields to feed on earthworms and other soil invertebrates. Spotlight surveys of fields indicated that only a few woodcock were wintering on the site in 1972-73. The maximum number of woodcock counted during any survey was seven.

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[9] Estimates were not made of the number of blackbirds flying to Louisiana.

The mourning dove, bobwhite, and wild turkey were all permanent residents on the site; the mourning dove was also the most abundant of the upland game species. During preconstruction studies, it reached its highest numbers in December 1972 when up to 200 doves were frequently observed feeding on seeds of weeds in the bottomland fields.

During 1972-73 only a few bobwhite (estimated to number less than 100) were present on the largely wooded Grand Gulf site. Bobwhite become most abundant in agricultural areas containing an interspersion of fields and small woodlots. This species is omnivorous, feeding on seeds, fruits, plant buds, and insects.

Although the Grand Gulf site contained suitable wild turkey habitat (hardwood forest), only two wild turkeys were observed on the site. Both turkeys were seen during the spring of 1973 and may have been displaced by flooding of the Big Black River bottomlands (north of the site) which are reported to support a sizeable turkey population (Ref. 11). The wild turkey inhabits mature forests and is omnivorous, consuming seeds, mast, fruits, plant buds, and insects. In recent years, the range and numbers of this species have been increasing throughout Mississippi, including Claiborne County (Ref. 11). There was no known upland game bird hunting conducted on the site during the 1972 hunting season. Since the site did not support a sizeable upland game bird population, hunting of upland game birds was not a significant recreational activity on the site.

2.2.2.4 Mammals

Field data on mammals were gathered by direct field observations, hunter bag checks, trapping, censusing squirrel nests, nightlight counts, and tallying road kills. The location of mammalian sampling plots and nightlighting routes are shown in Figure 2.2-7.

Thirty-three mammalian species were observed on the Grand Gulf site. None of the observed mammals have been designated as endangered or threatened by the U.S. Fish and Wildlife Service (Ref. 7). However, black bear (Ursus americanus), a species listed as threatened by both the Mississippi Game and Fish Commission (Ref. 12) and the Mississippi Natural Heritage Program (Ref. 13), have been seen on the site four times since February 1977. In addition, bear tracks and other sign have been observed in the bottomlands just south of the Grand Gulf property line. This species is discussed further in Section 2.2.2.7.

A cougar (Felis concolor), was observed crossing Grand Gulf road near the northeast corner of the site on June 17, 1973. According to Reference 14, there are no authenticated records[10] of cougar occurring in Mississippi during this century. However, reports

[10] An authenticated record normally requires the collection of the animal for verification of identification by a mammalian taxonomist.

of cougar sightings, particularly from the Pascagoula Swamp region of George and Jackson counties (in southeastern Mississippi), occur periodically. No other cougar sightings were made in the Grand Gulf area, nor was any cougar sign, such as tracks or scats, encountered during the preconstruction studies. The cougar may have been temporarily displaced from a remote section of the Mississippi River bottomlands by the 1973 spring flood. No sightings have been reported in the Grand Gulf area since 1973.

At least 25 free-ranging dogs were present in the Grand Gulf area during preconstruction studies and were occasionally observed chasing deer. However, no deer are known to have been killed by these dogs.

2.2.2.4.1 Small Mammals

Small mammals, as identified in this report, include mice, shrews, moles, voles and rats. Some small mammal species are herbivores, subsisting entirely on plants; others are insectivores, subsisting largely on invertebrates; and others are omnivores, consuming both plant and animal matter. Small mammals are a major source of food for larger carnivorous animals such as owls, hawks, foxes and snakes. They are an important pathway for energy flow through terrestrial ecosystems, with the population density of larger carnivorous species often fluctuating with density fluctuations of small mammal populations. These variations can result from environmental factors such as food, weather, and cover which influence mortality, natality, emigration, and immigration of population (Ref 15). The existence and abundance of animal species in any locality is also dependent on environmental changes wrought by man. Population densities of these small mammals inhabiting fields or open areas in forested regions are highly dependent upon land use practices of man. Populations generally reach highest densities in recently abandoned or unused fields. In the south, small mammal populations normally reach highest densities in the fall or winter (Ref. 16).

The habitat preferences, ecological distribution, and species composition of small mammals on the Grand Gulf site were determined by saturation trapping in the following habitats:

Grand Gulf Island forest
Bottomland forest (east of Hamilton Lake)
Bottomland fields
Loessial bluff forest
Loessial bluff fields

Trapping was conducted in the various habitats[11] during the fall (October and November 1972), winter (January and February 1973),

[11] Due to flooding, Grand Gulf Island was not trapped in the winter and spring; the bottomland forest and fields were not trapped in the spring.

spring (May and June 1973) and summer (July and August 1973). The following 10 small mammal species were collected during these trapping periods:

White-footed mouse	(Peromyscus leucopus)
Cotton mouse	(Peromyscus gossypinus)
House mouse	(Mus musculus)
Fulvous harvest mouse	(Reithrodontomys fulvescens)
Golden mouse	(Ochrotomys noutalli)
Pine vole	(Pityms pinetorium)
Shorttail shrew	(Blarina brevicauda)
Least shrew	(Cryptotis parva)
Hispid cotton rat	(Sigmodon hispidus)
Rice rat	(Oryzomys palustris)

Three additional small mammal species occurring on the site but not collected in traps were the eastern mole (Scalopus aquaticus), eastern woodrat (Neotoma floridana) and Norway rat (Rattus norvegicus).[12] The eastern mole is a tunneling mammal whose residence on the site was indicated by the presence of raised tunnels of earth in pastures and fields. The presence of woodrats was indicated by large stick and leaf nests located in wooded portions of the site that supported a dense understory growth. One Norway rat was collected in a hunting camp.

The shorttail shrew, cotton mouse, golden mouse, and white-footed mouse inhabited wooded areas; whereas, the hispid cotton rat, rice rat, house mouse, fulvous harvest mouse, pine vole, and least shrew inhabited fields or large openings within the forest. All of the species collected were expected to inhabit the site and, based on information presented in Reference 14, were a typical representation of the species composition of small mammals occurring in similar habitats of southwest Mississippi.

The number of small mammals collected varied considerably among seasons. This variation was expected inasmuch as considerable seasonal and yearly variation typically occurs in small mammal populations (Ref. 16). The number of small mammals collected in the bluff forest was 7 in the fall, 3 in the winter, 18 in the spring, and 10 in the summer. In the bottomland forest, 6 small mammals were collected in the fall, 10 in the winter, and 1 in the summer. In the loessial bluff fields, 20 small mammals were collected in the fall, 15 in the winter, 2 in the spring, and 5 in the summer. In the bottomland fields, 52 were collected in the fall, 19 in the winter, and 12 in the summer.

A reduction in small mammal densities occurred between fall and winter in all habitats except in the bottomland forest east of

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[12] The special museum traps used to collect small mammals were not capable of capturing the relatively large woodrat. The eastern mole seldom occurs on the ground surface and the Norway rat is chiefly an inhabitant of buildings and dumps.

Hamilton Lake where an increase occurred. The increase of small mammals in the bottomland forest could have resulted from a concentration of individuals displaced by inundation of the bottomland forest adjacent to the area sampled. The large number of small mammals collected in the bottomland fields during fall trapping is probably attributable to the following factors:

a. The loessial bluff fields had been grazed by cattle during the spring of 1972, and therefore, did not support as dense a growth of vegetation as did the bottomland fields. This thicker growth created more cover in the bottomland fields, thus resulting in better habitat for field-dwelling small mammals.

b. Of the 30 hispid cotton rats collected in the bottomland fields, 22 were juveniles, indicating that trapping probably occurred during a period of dispersal of juvenile hispid cotton rats.

The 1973 spring trapping, which could only be conducted in the bluffs because the Mississippi River had flooded the bottomlands, indicated that the number of small mammals in the loessial bluff forest habitat had increased over the number present during the winter; the number in the bluff field habitat, however, had decreased. During summer trapping, the opposite trend occurred; the number of small mammals decreased in the forest habitat and increased in the field habitat. The results of trapping in the field habitat during both spring and summer periods, however, are probably not a true indication of small mammal numbers in the loessial bluff fields because ants stripped the bait off most of the traps.

In an effort to evaluate the potential large scale migration of small mammals from the bottomlands to the bluffs because of the extensive bottomland flooding, some limited small mammal trapping was conducted at the interface of the loessial bluffs with the bottomlands during the periods April 10 through 13 and May 15 through 18, 1973. During these two trapping periods, six small mammals were captured in two quarter-acre sample plots located in forest habitat and nine small mammals were captured in one quarter-acre sample plot located in field habitat. Compared to the results of previous trapping, these data do not indicate that large number of small mammals migrated from the bottomlands to the adjacent bluffs as the floodwaters rose. When the floodwaters receded in June, selective small mammal trapping was conducted in order to evaluate the repopulation of the bottomlands by small mammals. Trapping results indicated that house mice were quickly repopulating the fields as the floodwaters receded. Between June 21 and July 10, 13 house mice, 2 hispid cotton rats, and 1 white-footed mouse were captured in the bottomland fields. The sparsity of the ground cover may account for the capture of only two hispid cotton rats and no fulvous harvest mice or least shrews, species which were

previously collected in the fields during fall and winter trappings. The most significant information obtained from these data is the following: although the bottomland fields had been completely inundated from late March through late June 1973, some small mammal species repopulated the field habitats almost immediately after the floodwaters receded.

Similar trapping was conducted in the bottomland forest east of Hamilton Lake from June 26 through July 23 and in the Grand Gulf Island forest from July 11 through July 23, 1973. Only three small mammals (one house mouse, one cotton mouse, and one shorttail shrew) were captured in the forest east of Hamilton Lake and none were captured in the Grand Gulf Island forest. These trapping data indicate that the rate of repopulation of the bottomland forests by small mammals was much less than that of the bottomland fields. The regrowth of ground cover in the forest proceeded at a slower rate than it did in the fields. The greater sparsity of ground cover in the forest may account for the apparent slowness of small mammals to repopulate the forest habitat. These trapping data also suggest that very few, if any, small mammals of the bottomland forest were able to survive the duration of the flood by living in trees. The cotton mouse and golden mouse, two species inhabiting the bottomland forest prior to the flood, are partially arborial and could have been expected to survive in trees for the duration of the flood provided they could obtain sufficient food to sustain themselves. A paper providing an in-depth analysis of the effect of the flooding on the small mammal population has been published by the Mississippi Academy of Science (Ref. 17).

Scheduled small mammal trapping in the bottomlands was resumed in the summer season (August 1 through 8, 1973). Twelve small mammals (five species) were captured in the field habitat, one was captured in the forest habitat west of Hamilton Lake, and none were captured in the Grand Gulf Island forest. During winter trapping, 19 small mammals were captured in the bottomland fields and 10 were captured in the bottomland forest east of Hamilton Lake. The summer trapping data indicate that small mammal populations in the bottomland fields were recovering from the effects of the prolonged flood; whereas, the small mammal populations in the bottomland forest habitats apparently were not.

The probability of capturing small mammals did not remain constant during the sampling periods because heavy rainfall tripped the traps on several occasions. Consequently, no valid estimate of small mammal population density can be calculated on a per-acre-basis. The data do indicate, however, the relative abundance of small mammals inhabiting the various habitats on the site and can serve as an index of abundance for future sampling.

2.2.2.4.2 Larger Mammals

In comparison to small mammals, the larger mammals are generally more difficult to inventory. Attempts to determine the relative

abundance of the larger mammals inhabiting the Grand Gulf site were only partially successful even though a variety of techniques were employed. Direct field observations, line trapping, hunter bag checks, nightlight counts, and a tally of road kills indicated that the following species of larger mammals commonly occurred in the Grand Gulf area:

Eastern chipmunk	(Tamias striatus)
Gray squirrel	(Sciurus carolinensis)
Fox squirrel	(Sciurus niger)
Cottontail rabbit	(Sylvilagus floridanus)
Swamp rabbit	(Sylvilagus aquaticus)
Beaver	(Castor canadensis)
Raccoon	(Procyon lotor)
Oppossum	(Didelphis marsupialis)
Armadillo	(Dasypus novemcinctus)
Striped skunk	(Mephitis mephitis)
Gray fox	(Urocyon cinereoargenteus)
Red fox	(Vulpes fulva)
Bobcat	(Lynx rufus)
Whitetail deer	(Odocoileus virginianus)

Censuses of squirrel nests occurring along vegetation transects (see Figure 2.2-1) were conducted in the bottomland and loessial bluff forests. In the fall of 1972, mean nest density (standard deviation) per 100 acres varied from 189 (40) in the bottomland forest to 218 (62) in the loessial bluff forest. Reference 18 reported a ratio of 1.09, 1.09 and 1.10 nests per squirrel over the course of a three-year study conducted in a hardwood forest in West Virginia. Assuming a similar situation existed at Grand Gulf, there were approximately 170 squirrels per 100 acres in the bottomland forest and 200 squirrels per 100 acres in the loessial bluff forest prior to the 1972 hunting season.

A systematic survey of the backwaters of Hamilton and Gin Lakes indicated that three active beaver lodges were present on the site in 1972 (Figure 2.2-7). On the basis of Reference 19 determination of 5.1 beavers per lodge, approximately 15 to 20 beaver were living in Hamilton and Gin Lakes. Beaver are considered "pests" in Mississippi and a bounty is offered for killing them. During the course of the field studies, three beaver were know to have been shot by private citizens.

Attempts to determine the density of rabbits and opossums on the site using live trapping were unsuccessful. No rabbits and only eight opossums were captured. All opossums were ear tagged and released; no marked opossums, however, were recaptured in subsequent trapping.[13] The lack of trapping success was attributed to the availability of natural foods which made it difficult to

[13] All opossums were captured in February 1973 in a 33-acre sample plot established in the bottomland forest. This area was subsequently flooded by the Mississippi River.

lure rabbits and opossums into the baited traps. Hunter bag checks did not provide sufficient data to indicate rabbit densities.[14] Nightlight counts also failed to provide sufficient data to estimate rabbit densities.

Attempts to census predatory mammals were based on the use of tape-recorded prey calls to attract the predators. During a three-month period from September through November 1972, the prey calls were played periodically at night from blinds and tree stands located in fields and large forest openings in the loessial bluffs and bottomlands. Although sign and field observations indicated the presence of predatory mammals, none were attracted by the calls. Since the technique did not prove effective in counting predatory mammals, the program was discontinued.

A nightlight census was conducted on a biweekly basis to count nocturnal mammals. This technique did not provide sufficient information to develop an index of species abundance. It did, however, serve to document the presence of several species on the site.

Hunter bag checks for small game were conducted for five consecutive weekends beginning the weekend of October 14-15, when the 1972 squirrel season opened, and continuing through the weekend of November 11-12, 1972. When the 1972-73 deer season (gun) opened on November 18, hunters in the Grand Gulf area ceased active hunting of small game. During the period that the game bags were checked, the mean hunting effort was 25.4 man-days per weekend with a range of 46 man-days on October 14-15 to 12 man-days on October 28-29 and November 11-12.

Bag checks indicated that squirrels were the only small game actively hunted in the Grand Gulf area. Of 277 squirrels counted in the hunter bags, 164 (59 percent) were gray squirrels and 113 (41 percent) were fox squirrels. Three of the grey squirrels examined were of the uncommon melanistic (black) color phase. Most of the gray squirrels were harvested in the loessial bluff forest, while most of the fox squirrels were harvested in the bottomland forest or near field edges. Generally, the gray squirrel inhabits wooded areas with heavy understory; the fox squirrel, however, inhabits small woodlots and wooded areas with light understory growth (Ref. 20).

The whitetail deer was the largest mammal and most heavily hunted game animal occurring on the Grand Gulf site. Field observations and nightlight counts indicated that deer regularly moved back and forth between the loessial bluff and bottomland forests. During the 1973 spring flood, deer were forced from the bottomlands into the loessial bluffs. The displacement of deer from the bottomlands

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[14] Only four rabbits were recorded in weekend bag checks conducted from October 14 to November 12, 1972.

did not appear to cause an overbrowsing of the loessial bluff understory vegetation. Field observations indicated that deer were numerous on the site. Insufficient data were obtained to accurately estimate their density; however, review of the literature indicates that bottomland hardwood forests of the lower Mississippi Valley typically support a carrying capacity of one deer per 10 to 12 acres and upland (bluff) hardwood forests typically support one deer per 18 to 20 acres (Ref. 21).

During the 1972-73 hunting season, approximately 200 individuals hunted in the Grand Gulf area and killed an estimated 100 deer. Eighty-seven deer were examined and the age and sex recorded at four hunting camps on or adjacent to the Grand Gulf site. All deer examined appeared to be in excellent physical condition. Antlered deer (bucks) could be legally shot on 29 days, whereas antlerless deer (does and fawns) could be legally shot only on 5 days. Of the deer examined, 94 percent of the males and 91 percent of the females were 2.5 years old or less. These age data indicate that there is heavy hunting pressure exerted on the deer population in the vicinity of the site and most deer are being shot within three years of birth. According to Mississippi Game and Fish Commission game biologist Mr. Wendell Neal (Ref. 22), hunting pressure of this nature is not unusual in areas adjacent to the Mississippi River and the deer population is generally able to sustain the heavy annual harvest.

Deer hunting has not been permitted on the site since the beginning of construction in 1974. Hunting pressure, however, has remained heavy in the areas adjacent to the site. Deer kill data for Claiborne County compiled by the Mississippi Game and Fish Commission indicate that the deer harvest in the county has ranged from 1076 to 2034 between the 1972-73 and 1976-77 hunting seasons. Specifically, the total deer kill in the county each hunting season was as follows:

Year	Number
1972-73	1550
1973-74	1076
1974-75	1080
1975-76	1655
1976-77	2034

Deer are herbivorous and obtain their food by browsing on vegetation growing within 6 feet of the ground. The species composition of vegetation growing in an area varies seasonally (see subsection 2.2.2.2); consequently, the types and amounts of vegetation consumed by deer also vary seasonally. An intensive study of the food habits of deer inhabiting a bottomland hardwood

forest about 20 miles south-southwest of the Grand Gulf site was conducted by Murphy (Ref. 23). Some pertinent results of Murphy's study[15] which illustrate the seasonality of deer food habits are described below:

a. Summer

Aster, buckvine, dewberry, grass, sugarberry, poison ivy, and trumpet creeper comprised 46 percent of all available food plants and constituted 68 percent of all food plants consumed by deer. These species comprised 48 percent of all forage available in the Grand Gulf bottomlands. Aster and trumpet creeper were the most important summer food plants; they comprised 48 percent of all forage consumed.

b. Winter

Aster, dewberry, grass, sedge, daisy fleabane, vetch, and violet comprised 69 percent of all food plants available and constituted 97 percent of all food plants consumed by deer. These species comprised 61 percent of all forage available in the Grand Gulf bottomlands. Dewberry was the most important winter food plant; it comprised 86 percent of all forage consumed.

c. Spring

Aster, dewberry, sugarberry, poison ivy, and grass comprised 43 percent of all food plants available and constituted 68 percent of all food plants consumed by deer. Due to flooding, the Grand Gulf bottomlands could not be sampled during the spring. Aster and dewberry were the most important spring food plants; they comprised 60 percent of all forage consumed.

2.2.2.5 Reptiles and Amphibians

Information on reptiles and amphibians was compiled by tallying road kills, periodic field collection, and sampling in conjunction with fish sampling.

Thirty-four reptilian species and 14 amphibian species were collected or observed on the Grand Gulf site in 1972-73. With the exception of the American alligator (Alligator mississipiensis), none of the reptiles or amphibians occurring in the Grand Gulf area have been designated as rare and endangered by the U. S. Fish and Wildlife Service (Ref. 7).

[15] Food availability was determined by estimating ground cover; the amount and taxa of food eaten was determined by estimating and recording evidence of feeding on individual plants.

Field collections[16] and observations indicated that the following 19 reptilian and 8 amphibian species commonly occurred in the Grand Gulf area:

Reptiles

Ground skink	(Lygosoma laterale)
Green anole	(Anolis carolinensis)
Black racer	(Coluber constrictor)
Diamond-backed water snake	(Natrix rhombifera)
Common water snake	(Natrix sipedon)
Garter snake	(Thamnophis sirtalis)
Mud snake	(Farancia abacura)
Hognose snake	(Heterodon platyrhinos)
Gray rat snake	(Elaphe obsoleta)
Speckled kingsnake	(Lampropeltis getulus)
Copperhead	(Agkistrodon contortrix)
Cottonmouth	(Agkistrodon piscivorus)
Red-eared turtle	(Pseudemys scripta)
Three-toed box turtle	(Terrapene carolina)
Stinkpot	(Sternothaerus odoratus)
Mississippi map turtle	(Graptemys kohni)
False map turtle	(Graptemys pseudogeographica)
Southern painted turtle	(Chrysemys picta)
Slider	(Pseudemys concinna)

Amphibians

American toad	(Bufo americanus)
Fowler's toad	(Bufo woodhousei fowleri)
Spring peeper	(Hyla crucifer)
Upland chorus frog	(Pseudacris triseriata)
Gray tree frog	(Hyla versicolor)
Leopard frog	(Rana pipiens)
Bullfrog	(Rana catesbeiana)
Bronze frog	(Rana clamitans)

Reptiles and amphibians are found in both aquatic and terrestrial habitats. Since they are poikilotherms[17], reptiles and amphibians occurring in Mississippi are only active from spring through fall, becoming dormant in the winter.

2.2.2.5.1 Reptiles

Generally, reptiles of the Lower Mississippi Valley breed during the spring and early summer and young are produced from July to October (Ref. 24). The American alligator and all of the lizards and

[16] Most specimens were captured alive, taxonomically identified, and released.

[17] Poikilotherms are animals whose body temperature varies with the temperature of their environment.

turtles of the region are oviparous[18], while the snakes may be either oviparous or ovoviviparous.[19] Literature review of the food habits of reptiles observed on the site (Refs. 25, 26, and 27) indicates that the lizards are primarily insectivorous, although all consume a variety of other invertebrates including snails, spiders and millipedes; the turtles are omnivorous, feeding on plants, fish, carrion and invertebrates; the snakes are carnivorous, consuming a variety of reptiles, amphibians, birds, small mammals and fish; and the alligator is carnivorous, feeding on insects and crustaceans as a juvenile, and larger animals, such as fish, snakes and mammals, as an adult.

Field collections indicated that the red-eared turtle, three-toed box turtle, and stinkpot were the most abundant turtles on the site. Reference 24 notes that aquatic turtles normally become inactive when the water temperature drops below 50 F (10 C). Aquatic turtles on the Grand Gulf site were generally inactive from mid-November through late February. During this period, the mean surface water temperature of Hamilton and Gin Lakes and the Mississippi and Big Black Rivers was below 10 C. Mean surface water temperatures rose above 10 C in March, at which time aquatic turtles become active. The terrestrial box turtle was also generally inactive from December to March. During this period, mean weekly air temperature in the Grand Gulf area was generally less than 10 C. The mean weekly air temperature rose about 10 C in March and the activity of box turtles increased noticeably.

Red-eared turtles, snapping turtles, sliders, and stinkpots dug nests and laid eggs in fields adjacent to Hamilton and Gin Lakes beginning in the latter part of May and continuing through June. Egg deposition began shortly after floodwaters started receding from the bottomlands.

Twenty-five water snakes (representing five species of Natrix[20]) were collected from stockponds, Hamilton and Gin Lakes, and the flooded bottomlands. The majority were collected between May 16 and June 30, 1973 from shallow pools of water that were created by the gradual draining of floodwaters from the bottomlands. Many small fish (largely Centrarchidae (sunfishes) and Cyprinidae (minnows)) were trapped in the pools and apparently attracted the piscivorous water snakes. Of the 25 water snakes collected, 10 were common (broad-banded) water snakes, and 9 were diamond-backed water snakes.

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[18] Oviparous animals are those which produce offspring from eggs hatched outside the female's body.

[19] Ovoviviparous animals are those which produce offspring from eggs hatched within the female's body.

[20] Species of water snakes collected were the green water snake (Natrix cyclopion), diamond-backed water snake (Natrix rhombifera), yellow-bellied water snake (Natrix erythrogaster), common water snake (Natrix sipedon), and Graham's water snake (Natrix grahami).

Collection of terrestrial snakes and field observations indicated that the gray rat snake, speckled kingsnake, black racer, and eastern hognose snake were the most common terrestrial snakes on the site. Field observations indicated that terrestrial snakes were generally inactive from December 1972 until early March 1973. During this period, the mean weekly air temperature was normally less than 10 C.

The American alligator, an endangered species, has been observed on or near the Grand Gulf site since May 1973. Prior to May 1973, no alligators had been observed on the site; one alligator had been sighted, however, on the bank of the Big Black River in September 1972. The occurrence of alligators on the site beginning in May 1973 may have resulted from a displacement of alligators from the Big Black River and/or nearby oxbow lakes by the 1973 spring flood. Four alligators were observed during a September 1975 survey of Hamilton and Gin Lakes. One was seen in Hamilton Lake in September 1976, and two were seen in Gin Lake in July 1977. In November 1974 one alligator was found dead (shot) in Hamilton Lake.

2.2.2.5.2 Amphibians

Amphibians of the Lower Mississippi Valley normally breed during the later winter-spring period, although occasional breeding by toads may occur during any part of the year (Ref. 24). Breeding activity[21] of frogs and toads was observed on the site from January to May 1973, with a peak occurring in late February and March. No observations of salamander breeding were made.

Literature review of amphibian food habits (Ref. 27) indicates that the adult forms of all amphibian species occurring at Grand Gulf are carnivorous and primarily insectivorous. However, the larval form of frogs and toads (tadpoles) subsist largely on microscopic plants.

The American toad and Fowler's toad were abundant in all terrestrial habitats. The spade foot toad was only collected in the loessial bluff forest. Frogs inhabited the lakes, streams and stockponds, with the bronze frog being the most abundant. Of the salamanders, the amphiuma and the lesser siren were collected only in the flooded bottomlands near Hamilton and Gin Lakes. The mole salamander and slimy salamander were collected only in the loessial bluff forest.

2.2.2.6 Disease and Pest Infestations in Flora and Wildlife

2.2.2.6.1 Flora

Plants and trees are afflicted by a variety of diseases which may cause severe injury and occasionally death to affected vegetation.

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[21] Observations of breeding activity were based on the vociferous calling of males.

Additionally, plants and trees support thousands of insect species which occasionally become so abundant that severe injury or death is inflicted on host plants in a large geographic area.

Review of literature and contacts with Mr. Robert Morris (Ref. 28), Dr. Richard Collins, (Ref. 29), and Mr. Jack Coley, (Ref. 30), indicated that there are no serious disease or pest infestations currently (1976) occurring in epidemic proportions in the Grand Gulf region.

Mr. Morris and Dr. Collins (Ref. 28 and 29) noted the following:

a. During 1974, plantations of young sycamore trees in the Grand Gulf and New Roads, Louisiana vicinity developed lethal cankers caused by a complex of fungii.

b. During the summer and fall of 1974, oak trees in Mississippi, Louisiana, and Arkansas were defoliated by the yellow-necked caterpillar and the orange-striped oakworm.

c. During 1975 in Mississippi, Louisiana, and Arkansas oak declines occurred as a result of a complex of diseases with insect involvement which caused the death of oak trees.

d. During the 1972 growing season, southern red oaks in southwest Mississippi exhibited an uncharacteristic upward cupping or curling of their leaves. This leaf curling malady has not recurred since 1972. The cause of this leaf curling has not been determined; preliminary results of a study of the affliction by the Mississippi Forestry Commission, however, indicated growth of the afflicted trees was not affected.

e. Currently, the Homochitto National Forest is afflicted with a southern pine beetle (Dendroctonus frontalis).

Some disease or pest infestations that were observed on the Grand Gulf site during the preconstruction studies were:

Disease or Pest Infestation	Host Vegetation
Southern pine beetle	Loblolly pine
Ips engraver beetle (Ips spp.)	Loblolly pine
Tent caterpillar (Malacosms disstri)	Pecans

Rust-type fungi	Loblolly pine, dewberry and wood sorrel
Gall-producing insects of the order Hymenoptera and the family Chalididae	Southern red oak

An airborne remote-sensing survey utilizing infrared photography was conducted on October 2, 1972 to document baseline, preconstruction information concerning vegetation assemblages on and adjacent to the Grand Gulf site, and to delineate areas of suspected existing stress or disease within these vegetation assemblages. Areas of suspected vegetation stress are shown in Figure 2.2-8; the larger areas of suspected stressed foliage occurred in swampy, high-moisture areas. Areas of suspected vegetational stress located on or near the site were at the northern end of Grand Gulf Island and in the Alligator Bayou area adjacent to the southwest boundary of the site.

Subsequent inspection of these two areas by an entomologist and a plant pathologist did not reveal any heavy insect pest or plant disease infestations. In the Alligator Bayou area, some nuttall oak (Quercus nuttallii) trees were dead or dying as a result of increased water levels in the area caused by the impoundment of a small stream by beaver dams.

2.2.2.6.2 Wildlife

Wild animals are normally subject to various kinds of diseases and serve as hosts for numerous parasites. In natural communities there will normally exist a variety of viruses, bacteria, protozoans, and parasites of higher animal orders to which affected wildlife species have achieved mutual adaptation. Disease and pest infestations in wildlife populations are usually density dependent (i.e., the greater the population density, the higher the level of parasitism and disease).

Review of literature and contacts with Mr. William H. Turcotte, (Ref. 11), Mr. Peter Fusselle, (Ref. 31), and Dr. Annie K. Prestwood, (Ref. 32), indicated that there are no known wildlife diseases or pest infestations currently occurring in epidemic proportions in the Grand Gulf region.

However, Dr. Prestwood (Ref. 32) noted the following:

a. In 1973, high water and food shortages caused severe parasitic infestations (mainly stomach and lung worms) in wildlife. These infestations occurred in Issaquena and Warren Counties in Mississippi and East Carroll, Madison, Tensas, East Baton Rouge, and Iberville parishes in Louisiana.

b. In 1975 there was an epidemic of Hermorrhagic disease in deer of southeast Arkansas.

2.2.2.7 Endangered or Threatened Terrestrial Species

There are no plants, mammals, birds or amphibians which have been designated as endangered or threatened by the U. S. Fish & Wildlife Service (Ref. 7). One endangered reptilian species, the American alligator, occurs in Hamilton and Gin Lakes.

The Mississippi Game and Fish Commission (Ref. 12) and Mississippi Natural Heritage Program (Ref. 13) have listed endangered and threatened species for the state. With the exception of the American alligator (endangered) and black bear (threatened), none of the species on these lists are known to be present on the Grand Gulf site. Species on the lists which could occur in the vicinity of the site (Ref. 6 and 14) are listed below:

Red wolf	(*Canis niger*)
Cougar	(*Felis concolor*)
Southern bald eagle	(*Haliaeetus l. leucocephalus*)
Peregrine falcon	(*Falco peregrinus*)
Osprey	(*Pandion haliaetus*)
Eskimo curlew	(*Numenius borealis*)
Bachman's warbler	(*Vermivora bachmanii*)

The southern bald eagle, peregrine falcon, eskimo curlew, Bachman's warbler, red wolf, eastern cougar, and American alligator have been designated as endangered by the U. S. Fish and Wildlife Service.

The red wolf and puma, are wilderness species which were extirpated from the region as the result of hunting and destruction of habitat. Suitable habitat for these species is present in much of southwest Mississippi including the Grand Gulf area. A summary of the records of Mississippi land mammals (Ref. 14), however, indicated that the last authenticated[22] record of any of these species occurring in this region was in 1946 when a red wolf was collected in Claiborne County.

On June 17, 1973, a cougar was sighted near the northeast corner of the Grand Gulf site. Reference 14 notes that cougar sightings are periodically reported in Mississippi, particularly from the Pascagoula Swamp region of George and Jackson Counties in southeastern Mississippi. No other cougar sightings were made in the Grand Gulf area, nor was any cougar sign such as tracks or scats encountered during field studies. The cougar may have been temporarily displaced from a remote section of the Mississippi River bottomlands by the 1973 spring flood.

Black bear, which had not previously been seen on the Grand Gulf site, were first observed on February 2, 1977, when one was seen near basin A. On February 25, another bear was seen in the same

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[22] An authenticated record normally requires the collection of the animal for verification of identification by a mammalian taxonomist.

locality. Two additional sitings were made in the field in which the meteorological tower is located on March 30, and April 28. While no bears have been seen since April, tracks and other sign were observed in the bottomlands just south of the property line.

The southern bald eagle, osprey, peregrine falcon, and eskimo curlew may occur in this region, particularly along the Mississippi River during migration. The Grand Gulf Nuclear Station Project has consulted with the Mississippi Game and Fish Commission (Ref. 11) and has found that the southern bald eagle was known to nest in the Mississippi River bottomland region north of the Big Black River prior to 1960. In recent years, southern bald eagles have occasionally been sighted around Yucatan Lake, located across the Mississippi River northwest of the site. An osprey was observed on May 11, 1973 on the western (Louisiana) bank of the Mississippi River about 2 miles southwest of the Grand Gulf site. This was the only osprey observed in the area during the entire period of preconstruction field studies (June 1973 through August 1973) and this individual was probably migrating north.

Bachman's warbler is a very rare species that inhabits moist deciduous woodlands, particularly swamp forests. The most recently recorded observations of this species have been in Virginia and South Carolina. Records in the Mississippi Museum of Natural Science, consulted by the Grand Gulf Nuclear Station Project, indicated that the species does not occur in the Grand Gulf area.

According to the Bureau of Sport Fisheries and Wildlife, the present distribution of the American alligator is from Tyrell County, North Carolina to Corpus Christi, Texas, and north in the Mississippi River drainage to Arkansas and southeastern Oklahoma. Prior to the 1973 spring flood, no alligators had been observed on the site, although one had been sighted on the bank of the Big Black River.

Four alligators were counted during a September 1975 survey of the lakes. One was seen in Hamilton Lake in September 1976, and two were seen in Gin Lake in July 1977. One alligator which had been shot and killed was encountered on Hamilton Lake in November 1974.

2.2.3 Aquatic Ecology

2.2.3.1 Summary

The Mississippi River, the Big Black River (a tributary to the Mississippi), and two oxbow lakes, Hamilton and Gin, are the major features of the aquatic environment on and near the Grand Gulf site (see Figure 2.2-9). In addition, five small stock ponds (under 2 acres) and two perennial streams with normally negligible

flow were located on the site. During preconstruction studies in 1972-73, fishes, benthic macroinvertebrates, and plankton were systematically sampled in the two rivers and oxbow lakes and fish sampling was conducted in two stockponds and one of the streams. In addition, periphyton and macrophyton assemblages of the lakes were characterized and sport fishing activities documented.

For purposes of sampling and description, each of the oxbow lakes was treated as a single macrohabitat; the Mississippi River system, however, was divided into backwater, river bank, main channel, and tributary macrohabitats. Sampling was conducted in the reach of the river extending from mile 400 to mile 410 of the Lower Mississippi River.

Backwater habitats in the Mississippi River are located in the slow moving, quiet waters on the inside of large bends, in coves on the leeside of sandbars and islands, in the lower reaches of sluggish tributaries, and in other similar areas. These backwaters are characterized by zero to low velocity current, relatively shallow waters, and loosely consolidated silty clay sediments of low plasticity. They typically support an abundant and productive biologic community of fishes, benthos, and plankton.

In areas of moderate to swift current, banks of the Mississippi River are usually steep and generally composed of consolidated, highly plastic clay. Clay bank stability varies greatly, depending on local soil geology, the amount and type of terrestrial vegetation, and the degree of scouring currents. In areas of stable clay outcroppings, large populations of burrowing mayflies and other invertebrate taxa become established. Where the bank is constantly eroding, however, benthic organisms are unable to establish a stable population.

The tributary macrohabitat as used in this report is the mouth of the Big Black River which alternates between periods of little or no discharge (backwater) and periods of relatively high discharge (tributary). The substrate typically consists of loosely consolidated silty clays of low plasticity. The composition and abundance of the fish, benthic, and plankton populatiors can fluctuate markedly in this type of macrohabitat.

Because of the large area it encompasses, the river channel is the dominant macrohabitat in the site vicinity. This habitat is characterized by deep water, strong (and turbulent) currents, and coarse-grained substrate, typically consisting of gravelly sand sediments. The severity of this habitat imposes restrictions on living organisms. The bottom was found to be virtually non-productive of benthic organisms, and the water column to contain fewer fish than in other macrohabitats.

The oxbow lakes, Hamilton and Gin, are relatively small and shallow. At normal water levels, the surface area of Hamilton Lake covers approximately 70 acres; that of Gin covers approximately 45 acres. In 1973 the mean depth of both lakes was about 5 feet. River-transported sediments, primarily silts and clays, are deposited on the lake bottoms during periodic inundation by Mississippi River floodwaters. These lakes are similar to river backwater in physical characters, with shallow depth, no current, and loosely consolidated, highly plastic clay sediments. They generally support productive biotic assemblages.

The bluff stock ponds, constructed to water cattle stock, are small (0.25 to 0.50 acre each) and unproductive. These ponds were apparently stocked with fish by previous owners and do not appear to have been managed recently. The two streams draining the site bluffs are perennial. Because of their negligible flow, they are not productive fish habitats.

Field studies have resulted in the documentation of occurrence on or near the Grand Gulf site of 86 species of fish, more than 100 plankton taxa, and over 50 benthic macroinvertebrate taxa.

No endangered fish species are known to be present on or near the Grand Gulf site.

2.2.3.2 Fishes

Fish sampling was conducted with various frequencies and intensities in the aquatic systems on and adjacent to the Grand Gulf site from June 1972 through August 1973. The aquatic systems sampled included the Mississippi River (mile 400-410), the mouth of the Big Black River, Hamilton and Gin Lakes, site stream A, and two bluff stock ponds.

Sampling was conducted monthly from September 1972 through August 1973 for 3 to 15 consecutive days at backwater macrohabitat station 1, river bank macrohabitat stations 3, 5, 6, and 8, and tributary macrohabitat station 10 (see Figure 2.2-9) with various mesh sizes of gill, trammel and hoop nets. Sampling of the river channel macrohabitat (between stations 3 and 6) was conducted once in September 1972 and monthly from June through September 1973 with an otter trawl and fish-locating echo sounder. Periodic sampling of the near-shore macrohabitats at stations 1, 3, 6 and 8 was performed with a beach seine. Nektonic larval fish were systematically sampled monthly or semimonthly at river stations 3 and 6 from January through July 1973. Hamilton and Gin Lakes were generally sampled bimonthly with electrofishing gear or gill and trammel nets from June 1972 through August 1973 (see Figures 2.2-10 and 2.2-11). Site stream A was sampled twice and two bluff stock ponds were each sampled once with electrofishing gear during the study period (see Figure 2.2-12). Sport fishing creel and

recreation activities were recorded frequently for the Mississippi and Big Black Rivers, Hamilton Lake, and Gin Lake from April through August 1973. Mississippi River commercial fishing creel census was conducted during January and February 1973.

Sampling with fish nets and electrofishing gear was standardized so that valid comparisons of temporal changes in fish catches among macrohabitats could be made. Each net was set and fished for 24 hours (a net-day) if conditions permitted. River condition, river stage, weather conditions, and equipment problems (e.g., lost, torn or clogged nets) occasionally required modifications of the planned schedule and procedures. Data on fish catches with nets and electrofishing gear were transformed to catch-per-unit-effort bases for comparisons among water bodies and macrohabitats.

Fish diet was characterized in a preliminary study for 13 fish species collected from the river and Hamilton Lake. Reproductive periodicity of river fishes was inferred from spawning condition of adults and from detailed densities of larval fishes. Population density and standing stock estimates of near-shore fishes in the Mississippi River and in site stream A were made using the population removal method of Zippin (Ref. 33). Population density and standing stock estimates in the two bluff stock ponds were made using the Peterson mark-recapture method (Ref. 34); confidence intervals were placed around these estimates using the method suggested by Adams (Ref. 35). Occurrence of fish disease and parasites was recorded during regularly scheduled field collecting activities; data on these occurrences are presented in subsection 2.2.3.6.

2.2.3.2.1 Species Collected

The Lower Mississippi River suffered a catastrophic fish kill from Memphis to the river mouth in 1963-1964. Endrin, a chlorinated hydrocarbon, was demonstrated to be the cause of the heavy mortalities (Ref. 36). The fish population appeared to recover rapidly when the industrial releases of endrin in Memphis were discontinued after 1964. A notable exception to this recovery was the absence of large specimens of long-lived fish (e.g., catfish, buffalo and drum) when the population was surveyed in 1966-1968 by the Lower Mississippi River Technical Assistance Project (Ref. 36).

A total of 86 species (20 families and 42 genera) were collected from the waters on or adjacent to the Grand Gulf site from June 1972 through August 1973. Sixty-nine species were collected from the Mississippi River, which compares favorably with the 69 species collected in a similar study conducted for a proposed nuclear station at St. Francisville, Louisiana, approximately 136 miles downstream in 1972-1973 (Ref. 37).

The results from both of these studies indicate a lower species diversity than was expected prior to commencement of field studies at Grand Gulf, when as many as 110 species had been expected. A survey of the Upper Mississippi River listed 134 species, of which 30 were considered stragglers and not normal inhabitants of the river (Ref. 38). Since fish species diversity generally increases from headwater to river mouth, the original list of 110 species should be a realistic estimate. If so, the endrin kill in the early 1960s may have reduced species diversity by extirpating some species which were highly sensitive to the chlorinated hydrocarbon pesticide.

Although extended flooding tends to disrupt normal habitat distributions of fishes, some distinct patterns in both species diversity and habitat distribution were noted among the water bodies on or adjacent to the Grand Gulf site. The Mississippi River was the most diverse environment, containing several major macrohabitats in the site vicinity (i.e., backwater, river bank, channel, sandbars). This diversity is reflected by fish species distribution: 69 species were collected from the Mississippi River compared to 49 species in the Big Black River.

The following species were collected only in the Mississippi River:

Chestnut lamprey	(Ichthyomyzon castaneus)
Pallid sturgeon	(Scaphirhynchus albus)
Shovelnose sturgeon	(Scaphirhynchus platorynchus)
Goldeye	(Hiodon alosoiaes)
Mooneye	(Hiodon tergisus)
Speckled chub	(Hybopsis aestivalis)
Sicklefin chub	(Hybopsis meeki)
Sauger	(Stizostedion canadense)
Walleye	(Stizostedion vitreum)
Quillback	(Carpiodes cyprinus)
Highfin carpsucker	(Carpiodes velifer)
Lake chubsucker	(Erimyzon sucetta)
Blacktail redhorse	(Moxostoma poecilurum)
Yellow bullhead	(Ictalurus natalis)
Brown bullhead	(Ictalurus nebulosus)
Stonecat	(Noturus flavus)
Tadpole madtom	(Noturus gyrinus)
Freckled madtom	(Noturus nocturnus)
Striped mullet	(Mugil cephalus)

Several of the species collected were distributional records. Identification of a pallid sturgeon specimen (Scaphirhynchus albus, Forbes and Richardson) was confirmed by Bailey (Ref. 39); the specimen has been reposited in the Museum of Zoology, University of Michigan. Prior to this recorded collection, this species was known only from two locations in the entire Mississippi, the mouth of the Missouri River and the Mississippi River at New Orleans.

Two specimens of the sicklefin chub (Hybopsis meeki, Jordan and Evermann) were collected from the intake screens of MP&L's Baxter Wilson Steam Electric Station at Vicksburg. Prior to these collections, this species had never been recorded in the Mississippi River south of the mouth of the Ohio River (Ref. 40). One specimen of a newly described species, Hybopsis winchelli, Clemmer, was also collected from the Mississippi River (Ref. 40).

A number of fish species occurred in both oxbow lakes and in the Mississippi River. Although the lakes are similar morphometrically, Hamilton Lake appears to have a more diverse species composition: 46 species were collected in Hamilton versus 36 in Gin. One possible reason for this difference is the relationship of the lakes to the river. Hamilton Lake has a direct connection through which fish can pass between the river and the lake when the river elevation is above 56 feet msl. However, Gin has no direct connection with the river except during very high river stages (greater than 63 feet msl). Evidence of this interaction was recorded in both the fall of 1972 and the succeeding summer of 1973.

When the river first began flowing into Hamilton Lake (November 7, 1972) at the beginning of the flood, fish were caught on the river side of a trammel net placed in the outfall, indicating movement into the lake from the river. At that time, the stomach of a blue catfish (Ictalurus furcatus) captured in the net was examined. The fish had consumed the mayfly nymphs Hexagenia and Pentagenia. Neither of these mayflies had been previously collected in the lakes, although they had been recorded at river stations. It was inferred that the catfish had been feeding in the river and had subsequently tried to enter the lake.

Large numbers of young-of-the-year paddlefish (Polyodon spathula) were observed[23] in both lakes in July 1973, after the river and lakes were separated. A rise in river stage in early August 1973 again made the river and Hamilton Lake confluent. When these water bodies were subsequently separated, the number of paddlefish had decreased, indicating they were probably recruited to the river population.

Site stream A contained 21 fish species, some of these were indigenous: the striped shiner[24] (Notropis chrysocephalus), bluntnose minnow (Pimephales notatus), creek chub (Semotilus atromaculatus), and redfin darter (Etheostoma whipplei). These four species generally occur in stream environments and have been noted in streams draining the Vicksburg bluffs (Ref.41). The two bluff ponds were low in species diversity: Pond 1 contained bluegill (Lepomis

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[23] Visual observation only; attempts to collect these fish were unsuccessful.

[24] A subspecies of the common shiner (N. cornutus).

macrochirus) and mosquitofish (Gambusia affinis); and Pond 2 had a large population of bluegill and mosquitofish and a few channel catfish (Ictalurus punctatus).

During extensive flooding, such as recorded in the spring of 1973, fish are often displaced from their normal habitat. When the near-shore environment of the Mississippi River was displaced by flooding, in some cases a considerable distance from the river bank, fishes of this habitat apparently moved inland abandoning what had been beaches and sandbars. This movement was indicated by a sharp decrease in the abundance of minnows from before the flood (September 1972) and later during the flood (January, 1973) at two river stations. Fishes of this near-shore environment (e.g., silvery minnow (Hybognathus nuchalis) and emerald shiner (Notropis atherinoides)) were subsequently collected in shallow floodwaters at the base of the bluffs, east of the oxbow lakes. It is possible that normal species-habitat distribution in the Grand Gulf vicinity may be more restricted than that observed during the preconstruction study.

2.2.3.2.2 Adult Fish Assemblage - Mississippi and Big Black Rivers

a. Backwater, River Bank and Channel Habitats

1. Numbers and Weights

Net sampling from September 1972 through August 1973 produced 3710 fish which weighed[25] 5430 pounds. Forty-seven species were collected. Gizzard shad (Dorosoma petenense) were markedly dominant in numbers (37 percent of the total). This species showed marked temporal fluctuations in abundance during the year, varying from 3 to 76 percent in relative numerical abundance. Gizzard shad abundance also varied spatially. From September 1972 through January 1973 and from April through August 1973, they were most abundant in backwater habitat. However, in February very high numbers occurred in the river bank habitat. The appearance of nektonic larval shad in March indicated a possible seasonal spawning movement had occurred in February.

Four other species comprised at least 5 percent (numerically) of the river population: freshwater drum (Aplodinotus grunniens) (10 percent), blue catfish (Ictalarus furcatus) (8 percent), flathead catfish (Pylodictis olivaris) (5 percent),

[25] All weights were taken on live specimens except in September and October 1972. Weights of most specimens collected in August 1973 were estimated from lengths using least square regressions.

and river carpsucker (Carpiodes carpio) (5 percent). The numerical abundance of shovelnose sturgeon (Scaphirhynchus platorhynchus) (3 percent) is noteworthy because numbers of this species have apparently declined significantly in recent years (Ref. 42) and concern has been expressed for survival of the species (Ref. 43). It appears however, that an abundant population may exist in the Grand Gulf vicinity.

Carp (Cyprinus carpio) ranked eleventh in numerical abundance (2 percent of the total). This contrasts to their high abundance in the Upper Mississippi River where they are a dominant commerical fish, exceeded in catch only by buffalo fishes and drum (Ref. 44 and 45). They were also one of the most abundant fish reported from the study conducted in the Mississippi River at Vicksburg during 1966-1968 (Ref. 36).

Fish biomass in the river was more evenly distributed and no one species dominated to the extent seen in numerical abundance. The dominant fish smallmouth buffalo (Ictiobus bubalus) comprised 14 percent of the total biomass. Biomass dominance by this species was largely due to species configuraton; specimens up to 25 pounds were recorded in field collections, and up to 35 pounds were recorded in the commercial fisherman creel census. Flathead catfish (14 percent), gizzard shad (10 percent), freshwater drum (9 percent), and blue catfish (9 percent) ranked next in biomass abundance. Carp (7 percent) were sixth in biomass abundance.

It is probably significant that, with the exception of the gizzard shad, fish of commercial value constituted the first 10 most numerically abundant species in the total catch. This is particularly noteworthy since no attempt was made during field sampling to collect only these species.

2. Habitat Distribution - Spatial

Differences in the five numerically abundant species occurred among backwater (station 1), river bank (stations 3, 5, 6, 8), and tributary (station 10) macrohabitats. Gizzard shad were numerically dominant in all three habitats, ranging from 18 percent in the tributary habitat to a marked dominance of 52 percent in the river bank habitat.

The five most abundant species in the backwater at station 1 were gizzard shad, blue catfish, river carpsucker, freshwater drum, and shovelnose sturgeon. A total of 35 species were collected with nets in this backwater. Eighty-five percent of the backwater fish assemblage was comprised of 10 species, of which two sport species, white crappie (Pomoxis annularis) and black crappie (Pomoxis nigromaculatus) made up 11 percent.

In contrast, of the 34 species collected at river bank habitat stations, the following were most abundant: gizzard shad, freshwater drum, silver chub (Hybopsis storeriana), flathead catfish, and blue catfish. The abundance of silver chub indicates a preference by this minnow for moving water. However, they were more abundant in moderate current than in swift current: 80 percent of the silver chub were collected at stations 5 and 8, while the remaining 20 percent came from stations 3 and 6. Surface current velocities at stations 5 and 8 were lower than those at 3 and 6. In contrast, drum were more abundant on the east side of the river in swifter current; 61 percent of those collected at river bank stations came from stations 3 and 6. Flathead catfish and shortnose gar (Lepisosteus platostomus) (fourth and seventh, respectively) were seasonally abundant at river banks. Flathead catfish were about equally distributed between the east and west banks; 26 of the 29 shortnose gar collected, however, were captured at station 3. Most of these gar were collected in February in hoop nets which also contained large numbers of gizzard shad, indicating the gar may have been preying on the shad. Bigmouth buffalo (Ictiobus cyprinellus), eighth in numerical abundance, were caught primarily in river bank habitat. These catches, considered with catches recorded in commercial fishing creel censuses, indicated a preference by this species for moderate to swift current habitats, unlike the smallmouth buffalo which appeared to frequent backwater.

The fish assemblage of the Big Black River was not easily characterized because of the physical variation which occurred during the study period. The river varied from backwater, to a moderate current stream, to a flooded stream with high current velocity. Based on catches from September 1972 through August 1973, the following species were

most abundant in the Big Black: gizzard shad, shortnose gar, blue catfish, freshwater drum, and smallmouth buffalo. Twenty-eight species were collected. Channel catfish were more abundant in this tributary habitat (4 percent) than in backwater (<0.1 percent). There abundance fluctuated widely throughout the year and was highest in June 1973 during the period that floodwaters were rapidly receding. At this same time, sport fishermen reported high trotline catches of catfish in the floodwaters adjacent to the Big Black River and the two lakes. Fifteen blue suckers (Cycleptus elongatus) were collected in October and November in the Big Black; none were encountered subsequently. Local fishermen report that the Big Black River is the only water body this species inhabits in the Grand Gulf vicinity (Ref. 46). Their distribution appears to be restricted to the Missouri River in the Upper Mississippi River Basin (Ref. 44), and they apparently are not common in the Mississippi River proper.

The fish assemblage of the river channel habitat was the most difficult to characterize because of sampling limitations imposed by physical conditions (e.g., turbulent, swift current; irregular bed configuration; bottom-associated debris). Two trawl efforts on September 13, 1972, in the vicinity of station 6, yielded no fish. Trawling was then discontinued until June 1973 because of flood conditions. Nineteen trawl efforts between June 7 and July 18 yielded a total of 92 fish and 5 river shrimp for a mean catch per effort ($\pm$ standard deviation) of 5.2 $\pm$8.7 organisms.

All the fish collected in June and July were young-of-the-year; the river shrimp were large adults. Gizzard shad and drum were the most common species encountered. These fish were probably being carried downriver by the current and were probably not a resident population of fish. July surface meternet samples indicated an increased density of young-of-the-year shad and drum in larval fish samples. This occurred concurrently with a large increase in rate of impingement of organisms at the Baxter Wilson Steam Electric Station approximately 30 miles up river from Grand Gulf, particularly young-of-the-year shad and drum. Echo sounder traces taken concurrently with the July 18 trawls indicated a concentration of small fish in the upper 10 feet of water. This information suggested that the fish

collected in the trawls may have been near the water surface and captured while the trawl was being played out or retrieved.

A series of echo sounder traces was taken parallel and perpendicular to the current on July 19 in an attempt to determine vertical and horizontal fish distribution. These traces were taken on ranges located between stations 3 and 6. A representative pair of traces were selected for analysis.

Horizontal distribution appeared to be fairly homogenous and approximated an even distribution. Vertical distribution, however, was clumped; highest numbers occurred at the river surface (4 to 10 foot depth) and at the bottom (40 to 50 foot depth), while the 10 to 30 foot depth was virtually devoid of fish traces. One parameter possibly affecting this distribution is water velocity. A line connecting the mean number of traces at each depth interval appeared to approximate a vertical velocity profile. Assuming this is a good approximation, fish distribution could be related to velocity. At highest velocity (20 to 30 foot depth), few fish occur, probably because of their inability to withstand the current. At the surface (4 to 10 foot depth) and bottom (40 to 50 foot depth), current was probably reduced enough so fish could partially maintain a position in the water column.

However, trawl sampling in August 1973 indicated a possible resident population of fish in the channel. Young blue and channel catfish, shovelnose sturgeon, and specimens of four chub species were collected. A similar collection in September 1973 (although with reduced species diversity) strongly indicates these fish were resident in the channel during these 2 months. Current velocities near the bottom of about 1 foot per second, measured on September 25, lend support to this possibility.

The sizes of the fish collected in August and September 1973 suggest a population composed primarily of juvenile fish. However, since larger fish probably easily escaped the trawl and avoided capture, the collections are probably biased toward smaller fish. Because of the presence of these juveniles in the main river channel, it is reasonable to assume that larger and older fish are also present. Also, echo sounder traces indicated the surface population present on July 19, 1973 was considerably reduced in number.

3. Habitat Distribution - Temporal

Temporal fluctuations in fish abundance in various river habitats result from such factors as season (reproductive periodicity), water temperature, photoperiod, behavioral patterns, river stage, and current velocities. Additional variation in sampling results comes from the influence of physical factors (e.g., river stage, current velocities, and debris) on gear efficiency. Variations in gear efficiencies and in fishing efforts with gill, trammel, and hoop nets result in catches which are not directly comparable. Catch-per-unit-effort calculations correct for these variations and express catches on a unit basis (i.e., per net day or 24-hour fishing period). These units can then be compared between time periods and habitats.

Backwater numerical catch per effort was high in the fall of 1972 (station 1 in October, station 10 in November) but decreased to fairly constant levels from November 1972 through June 1973. Catch success at station 1 in August 1973 returned to the level observed in the previous fall. In contrast, river bank catches per effort at stations 3, 6 and 8 were low through January, increased significantly in February, then decreased to former levels in April and June; a small increase occurred in August.

The rather large numerical catches per effort in October and November 1972 at stations 1 and 10 and again in August 1973 at station 1 may be indicative of seasonal increases in fish abundance in backwaters. Concomitantly, fish abundance in river bank habitats also appeared to fluctuate seasonally. The increased abundance in February in the river bank habitat occurred at the same time ripe fish were observed and occurred just prior to the appearance of larval fish in March. Apparently, these fish were participating in movements preparatory to spawning.

Weight catches per effort generally showed a pattern similar to numerical catches. The only exception was the high weight catch and low number catch at station 1 in September 1972. This was due to the collection of several rather large catfish which contributed significantly to the total weight catch. Weight catch per effort in February at river bank stations did not show as large an increase as did numbers because gizzard shad made up most of the

numerical increase. Since the average weight of these shad was only 0.3 pound, their relative contribution to the average weight catch was less than that of several large catfish caught at station 1 in September 1972.

The number of fish species caught per effort was low in all periods at all stations. Lowest (0.04) and highest (2.62) values were recorded in the Big Black River (station 10). The number of species caught per effort does not appear related to either number or weight catch per effort. This was evident both at individual stations and in mean catches for all stations. Although significant fluctuations in both mean number (0.83 to 5.17) and mean weight (1.3 to 9.1 pounds) catches per effort occurred, mean species catch per effort showed little fluctuation (0.53 to 1.53).

4. Diet

Food items consumed by adults of 13 fish species collected from Mississippi River stations 1, 10 and 13[26] and Hamilton Lake, were identified and enumerated.

Data from this preliminary study indicated that threadfin and gizzard shad were an important food source for some fish species. Catfish, crappie, skipjack herring (Alosa chrysochloris), white bass (Morone chrysops), and largemouth bass (Micropterus salmoides) had fed mainly on fish, principally shad. When benthic macroinvertebrates were eaten, some fish species appeared to feed selectively. Flathead and blue catfish at station 1 preyed primarily on mayfly numphs (Hexagenia and Pentagenia) which, although low in relative numerical abundance (ca. 4 percent), comprised approximately one-third of the benthic standing stock at station 1. Crappie and drum, however, cropped primarily dipteran larvae in this backwater. Carp fed on benthic macroinvertebrates (dipteran larvae and bivalves); river carpsuckers fed on cladocerans and diatoms.

Shovelnose sturgeon appeared to feed selectively on benthic organisms in the backwater at station 1. A single specimen collected in November 1972 had consumed primarily tubificid worms, the numerically

[26] Reconnaissance sampling was conducted at station 13 in October 1972; this station was not sampled subsequently. The station was located in a backwater cover on the east bank of the river at about river mile 413.

dominant organism in the benthic assemblage. However, 10 specimens collected in April 1973 had consumed mainly Cryptochironomus (62 percent) of all organisms consumed and dipteran pupae (31 percent). These two taxa comprised less than 1 percent of the benthic organism density in April at station 1.

Results of fish diet analyses generally agreed with those of other published reports, except in the case of the white bass. Chadwich (Ref. 47) reported that white bass from Texas, Iowa and Wisconsin had preyed on fish, insects (mayflies), crustaceans (crayfish), and cladocerans (Daphnia). The white bass examined at Grand Gulf were entirely piscivorous.

Field observations made during net sampling indicated gar are piscivorous, although no stomach content analysis were performed. Gar captured in trammel and gill nets were almost always ensnared by their teeth. Partially eaten net-trapped fish were generally found with these gar. Apparently, the gar became entangled while feeding on net-caught fish. Also, hoop nets at station 3 in February often held 40 to 60 gizzard shad per net. These shad were generally accompanied by several gar, the only time significant numbers of gar were collected at a river bank station.

b. Near-Shore Habitat

1. Species Composition

The near-shore habitat of the Mississippi River was characterized by a variety of substrates and a range of current velocities. At station 1, the dominant near-shore habitat was a large sandbar (towhead) characterized by moderate current velocity and sand substrate on the channel side, and no current and silt-clay substrate on the leeward side from the channel. The depth gradient was gradual. The near-shore habitat at station 8 was also composed on a sandbar with moderate current, coarse, well-graded sand substrate and a shallow depth gradient. In contrast, both stations 3 and 6 were strongly influenced by swift currents which actively eroded the steep clay banks.

The habitat characteristics influenced sampling efficiency, and. consequently, the results obtained. Areas of shallow depth gradient and moderate or no current (stations 1 and 8) were relatively easy to sample. Areas of swift current and steep banks

(stations 3 and 6) were more difficult to sample, and catches may misrepresent the resident population. The data reported for station 3 in this case is an exception, however, because the sample was taken during flood stage (January 1973) at which time the water was outside the river bank and flowing slowly over a shallow gradient, gravel-base boat landing.

Prior to August 1973, the dominant species in catches from all near-shore areas were threadfin shad, emerald shiner, river shiner, silvery minnow, mosquitofish, Mississippi silverside (Menidia audens) and juvenile gizzard shad. Between habitats, however, there were distinct differences in dominant species.

The area of no current and silt-clay substrate at station 1 (essentially a pothole) was dominated by mosquitofish, Mississippi silverside and juvenile gizzard shad. The apparent habitat similarity of the moderate current sandbars at stations 1 and 8 was contradicted by the species composition. At station 1 in September 1972, the two most abundant species were silvery minnow and river shiner. In the same month, threadfin shad and emerald shiners were numerically dominant at station 8, whereas silvery minnows and river shiners ranked third and fourth in abundance. At station 3 in January 1973, river and emerald shiners shared dominance and comprised about 85 percent of the sample.

In August 1973, the fish assemblage in the no current habitat at station 1 was dominated by young-of-the-year threadfin and gizzard shad and by silvery minnows. This species composition was significantly different from that observed in September 1972 when mosquitofish and Mississippi silverside dominated. No mosquitofish were collected in August and Mississippi silverside ranked eighth in abundance. Red shiners (Notropis lutrensis), fourth in abundance, were not present in the sample taken in September 1972.

The fish assemblage in the moderate current habitat at station 1 also changed significantly between September 1972 and August 1973. Young-of-the-year channel catfish and mooneye, and silver chub dominated the August sample. Neither the silver chub nor the mooneye were collected in the previous September. Young-of-the-year drum, fourth in abundance, were also not present in September samples. River shiner (Notropis blennius) second in abundance in September, were not collected at all in August.

Silvery minnow, dominant in September, ranked only fifth in August in numerical abundance. Young-of-the-year white crappie comprised 5 percent of the August sample, perhaps indicating high survival success of that year's class.

In summary, prior to the 1973 flood, the near-shore fish population of sandbars was dominated by threadfin shad, emerald shiners, river shiners and silvery minnows; their numerical rank varied among various microhabitats (i.e., individual sandbars). The single collection from station 6 had too few fish to charaterize the population, except to suggest that total abundance was probably lower in swift current and steep bank habitats than in other near-shore environments of the river.

The near-shore fish assemblage at station 1 changed significantly in dominant species composition between September 1972 and August 1973. The two habitats (no current and moderate current) supported a distinct and different assemblage at both times. High numbers of young-of-the-year channel catfish, mooneye, drum and white crappie indicated strong 1973 year classes. The cause(s) of changes in species composition is (are) unknown; however, a major influence was probably the extensive flood of 1973. The near-shore habitat at station 1 was essentially vacated by fish during the flood. Repopulation of the void after the flood appeared to result in a different near-shore fish assemblage.

2. Population Estimate

The collection from station 3 was not taken in the normal steep bank and swift current habitat. The sample was taken during flood stage at which time the water was outside the river bank and flowing slowly over a shallow-gradient, gravel-base boat landing immediately adjacent to the station. Since it was taken in the immediate vicinity of the near-shore habitat, however, it was considered representative of the local population. The catch at station 3 was less than at station 1 in terms of number of individuals, number of species and total weight. The numerical population estimate ($\pm$ standard deviation) (Ref. 33) for station 1 (246 $\pm$ 3.30 per 0.04 acre) was about twice that for station 3 (140 $\pm$ 1.19 per 0.04 acre). Expressing these estimates on the basis of a hectare of water, station 1 contained 13,494 fish (5463 fish per acre) weighing 66.6 pounds

(26.9 pounds per acre). Station 3 contained 7680 fish (3109 fish per acre) weighing 20.1 pounds (8.1 pounds per acre). Difference in river stage and season may have influenced these density variations, but habitat differences were probably the major factor influencing differing fish abundances.

3. Unusual Observations

From September 1972 through August 1973, 113 shovelnose sturgeon were collected from the Mississippi River. The mean standard length of these fish was 25.8 inches and the mean total weight was 0.99 pounds. Thirty-two (29 percent of the total) of these fish showed some damage to their pectoral fins by rubber bands. These rubber bands were stretched tightly over the fish dorsum and against the pectoral fins. The rubber bands had cut into the fins, or had cut one or both fins completely off at the endoskeleton girdle joint (clethrum). Fins had not regenerated on eight (25 percent) of the damaged specimens, resulting in healed-over stumps on the fish. Regenerated fins were deformed, typically cupped in appearance rather than flat like a normal fin.

The rubber bands were usually 2.4 to 3.9 inches in length (non-stretched) and approximately 0.08 inch in thickness. The origin of the rubber bands is unknown, although municipal discharges are suspected. The density of bands in the river is also unknown; a number of them have been observed on the screens of the intake structure of the Baxter Wilson Steam Electric Station.

The occurrence of rubber bands on sturgeon probably results from its external anatomy which is comprised of spinous dermal plates. The posterior spine orientation makes it difficult, or perhaps impossible, for the fish to rid itself of a rubber band once it has slipped over its body. It is unfortunate that this species, whose numbers are depleted (Ref. 43) should be anatomically adapted to collect rubber bands.

On June 20, 1973, a large number of young-of-the-year bullheads were observed schooling in floodwaters adjacent to Bayou Pierre. At least 50 schools were seen, each probably an individual cohort recently emerged from their nest; the total number was estimated at 50,000. Specimens from several schools were identified as yellow bullheads (Ictalurus natalis). Daily observations indicated that as the floodwater receded, many of these fish were recruited to Bayou Pierre via a small drainage ditch.

2.2.3.2.3 Larval Fish Assemblage - Mississippi River

Fish reproduction in the Grand Gulf vicinity in 1973 was investigated by systematic collections of nektonic larvae at Mississippi River stations 2 and 6.

Low densities of larval fish were first noted in early March. Larvae of seven taxa were collected at that time, indicating some species had commenced spawning. Shad, Mississippi silverside, stoneroller, and mosquitofish larvae were the most abundant species in this early spawning group.

Spawning activity increased significantly by early April. Increased number and taxa of larvae occurred at both stations. Densities generally increased through April and May to a peak in June. Decreased densities from June through mid-July indicated peak spawning activity occurred in April and May. Although major spawning activity appeared to have occurred before July, significant numbers of larvae were encountered as late as July 17. This indicated spawning by some species probably will occur into the fall, although total densities may continue to decrease at a slow rate.

Prior to May 23, nocturnal densities tended to be larger than diurnal densities. After May 23, however, diurnal densities were consistently larger. Although none of these differences were statistically significant[27], they may indicate a trend of increased larval activity in the daytime. If it is assumed many of these larvae were hatched in backwater habitats and swept into the main river by currents, increased diurnal activity would make them more susceptible to this action in the daytime and account for the higher densities. This is not an unreasonable assumption since larvae have been demonstrated to follow diel vertical and horizontal migration patterns in Lake Texoma, a large impoundment reservoir on the Red River (Ref. 48). Larvae in the Mississippi River may also follow similar behavioral patterns.

Differential densities at the two sampling stations are more difficult to explain. Station 3 densities were always greater than those at station 6, except on March 12 when they were equal, albeit quite small. Higher density at station 3 may have resulted partially from drainage out of the bottomlands and oxbow lakes. Since these bottomlands provide abundant cover and vegetation for species whose eggs are adhesive, they were probably a major spawning area. Floodwaters moving through the area would tend to carry larvae into the river. Conversely, currents at station 6 tended to flow from the river into the bottomlands.

Current patterns in the river proper may also have influenced differential densities. Station 6 was located downstream of a clay bank outcropping which deflected much of the current away from the

[27] Tested by Student's "t" test for independent means.

station. However, at station 3 there was no outcropping to deflect the current, and surface velocities were generally greater than those at station 6 (see Figure 2.2-13). These two factors, bottomlands and river current patterns, probably were major factors causing higher densities of larval fish at station 3.

As noted previously, although densities varied between sampling periods, overall density shows a general pattern of increase from March through June and a subsequent decrease through mid-July. Within this time period, however, densities of various taxa fluctuated greatly. Several taxa showed definite periods of reproduction.

Shad, the most abundant taxa throughout much of the period, apparently spawned over an extended period. The major spawning began in early April, peaked in May and June, and extended through July. Some spawning may also have occurred in August, although it appears from the data that a significant amount of spawning probably did not extend beyond mid-July. Drum, however, appeared to spawn over a shorter time period and may have had two major spawning periods. Significant numbers of drum larvae appeared in late May, peaked in June, and decreased sharply by early July. Larvae density increased again in mid-July, indicated another spawning population may have reproduced in late summer.

Starrett (Ref. 49) reported three distinct groups of spawning populations of minnows in the Des Moines River based on "examination of gonads, appearance[28] of young, and literature references". The three groups, as proposed by Starrett, are:

a. Early spawners, i.e. later spring or early summer

b. Intermittent spawners, i.e. through warmer months of the year

c. Late spawners, i.e. late July through August

Starrett also noted that floods and silt appeared to be the major factors reducing reproductive success in the Des Moines River minnow populations. The abundant minnow species were late spawners which reproduced during periods of low water level and reduced silt loads.

The groups proposed by Starrett may apply to the Mississippi River in the Grand Gulf vicinity. Large numbers of minnow larvae were collected in April, essentially late spring in this area. The stoneroller, one of Starrett's early spawners, were collected only on March 12 and April 4. Large numbers of minnow larvae again occurred in June and July, with highest densities occurring

[28] The time young appeared in his samples.

in July. This group may belong to Starrett's late spawner group. Minnow larvae occurred throughout the entire sampling period; some of these could be called intermittent spawners. Since none of these larvae, except the stoneroller, were identified to genus or species, it is difficult to say whether the minnow population around Grand Gulf follows Starrett's proposal. The periodicity of larvae densities strongly suggests, however, that there may be similar reproductive patterns.

Two taxa which were abundant in the river as adults, catfish and suckers were conspicuously absent as larvae. This absence of larvae is probably due to their reproductive behavior. Catfish build shallow depression nests in backwater and the male guards the young until they are strong swimmers (Ref. 50). These young fish are probably able to avoid being swept into the river by currents. Suckers (e.g., buffalo and carpsuckers) typically move into tributaries, sometimes to the headwaters, to spawn (Ref. 50). Since the Grand Gulf collections were made in the main river, it is unlikely that many catfish and sucker larvae would occur.

In summary, major spawning activity of fish started in March and extended at least through July. Peak spawning probably occurred from mid to late May; larval densities were maximum in June. A pattern of diel movements by larvae was inferred from observed differences in diurnal and nocturnal densities. Although none of the differences were statistically significant, a pattern of higher diurnal densities was observed from late May through July. Conversely, prior to late May, a general pattern of higher nocturnal densities occurred. Several taxa-specific reproductive periods were identified. Shad apparently spawned over a period of 4 to 5 months, with maximum spawning occurring in May and June. Drum appeared to spawn over a shorter period; additionally, there were possibly two periods, early and late summer. Minnows appeared to follow three reproductive patterns, similar to those in the Des Moines River. These patterns, early spawners, intermittent spawners and late summer spawners, were inferred from observed periodicities in minnow larvae densities. Reproductive periodicity of catfish and suckers probably cannot be inferred by larval collections in the river; because of their reproductive behavior, the larvae develop into juveniles in backwaters and tributaries before they appear in the river.

The eggs of most freshwater fishes have at least two characteristics: they are demersal (sinking) and adhesive. Eggs are typically spawned in backwaters where they adhere to substrates like vegetation or logs; or they are spawned over gravelbars and sandbars, and adhere to the bottom during development (Ref. 50). The freshwater drum produces eggs which are pelagic in character and develop while floating at or near the water surface (Ref. 45 and 51). The eggs are quite small, ranging from 0.02 to 0.3

inches in Lake Erie drum (Ref. 51). Larval fish collections with a 0.02 inch-mesh plankton net will infrequently collect fish eggs. During the entire study period, a total of 20 fish eggs were collected; a total of 16,596 larvae were collected. The density of these eggs was always less than 0.00003 per cubic foot of water.

2.2.3.2.4 Adult Fish Assemblage - Hamilton and Gin Lakes

Oxbow lakes periodically inundated by Mississippi River floodwater are potentially dynamic systems in comparison to lakes which are closed systems. Population density stresses caused by high year class survival in one year can be balanced by dispersal during annual flooding. The potential for fish populations to readjust should lead to balanced populations over a period of years. The studies conducted at Grand Gulf during 1972-1973 suggest the influence of the Mississippi River on the fish populations of Hamilton and Gin Lakes. A 1-year study is insufficient, however, to indicate long-term trends in river-lake interactions.

Although apparently similar habitats, the lakes appear to have discrete fish fauna. Hamilton Lake collections yielded 46 species while Gin Lake yielded 36 species from June 1972 through August 1973. This higher species number in Hamilton was first indicated in collections made in June 1972 when 26 species were collected in Hamilton and 16 species in Gin.

The presence of more species in Hamilton Lake may be due, in part, to its more frequent connection with the Mississippi through its drainage outfall (as discussed in subsection 2.2.3.2.1). Eight of the species collected only in Hamilton Lake were "stragglers", i.e., species which normally inhabit the river. They included the silver chub, emerald shiner, silverband shiner (Notropis shumardi), weed shiner (Notropis texanus), blacktail shiner (Notropis venustus), bullhead minnow (Pimephales vigilax), blue sucker[29], and yellow bass (Morone mississippiensis). Red shiners, collected only in Gin Lake, were probably also river "stragglers".

Although the total species assemblage was more diverse in Hamilton, gizzard shad, bluegill, threadfin shad, and largemouth bass were dominant in both lakes, comprising about 80 percent of the population. The numerical abundance composition in Gin Lake is based entirely on electrofishing collection; although net sampling was conducted in January and February, the samples were considered too small to be representative. Net sampling efforts in Gin comparable to those in Hamilton may have resulted in similar abundance of gizzard shad and bluegill.

These two species (bluegill and gizzard shad) occupied separate habitats in the lakes. Gizzard shad were the numerically dominant open-water fish in both lakes, comprising about one-quarter of

[29] Apparently restricted to Big Black River in local distribution.

the total population in each lake. Bluegill dominated the shoreline-cover habitat in both Hamilton and Gin and comprised about one-third of the lake population in Gin and one-quarter in Hamilton.

An anomaly between species abundance and sport fishing activities was noted. Crappie (white and black) were never significantly abundant in sampling collections except in August 1973 when they comprised about 5 percent in each lake. However, most of the local fishermen using boats fished primarily for crappie and not largemouth bass, which ranked fourth in abundance in Hamilton and Gin (7 and 6 percent, respectively).

Interaction between fish in the Mississippi River and the oxbow lakes and the influence of river species on lake species composition was demonstrated more clearly in Hamilton Lake, as discussed previously in subsection 2.2.3.2.1. Additionally, in April and May 1973, the silvery minnow (river species) comprised 17 and 2 percent of the lake population, respectively. This species was not collected in the June 1972 sample taken after the 1972 spring flood had subsided and Hamilton Lake was separated from the river.

A fish kill was observed on August 27, 1973 during electrofishing sampling in Hamilton Lake. The fish, which had been dead about 12 to 15 hours, numbered about 200 specimens, and were primarily shad, drum and a few catfish. The kill may have been due to low dissolved oxygen levels. Nocturnal oxygen depletion was noted in both lakes. Although similar dissolved oxygen levels occurred in Gin Lake, no fish kill was observed.

2.2.3.2.5 Adult Fish Assemblage - Site Stream A

Site stream A drains a small watershed of about 2.8 square miles and is characterized by extreme fluctuations in discharge. During period of dry weather, the stream had negligible flow and was characterized by isolated pools within the site boundaries. A significant amount of erosion on the site has generated heavy deposits of loess sediments in the stream bed. Upstream of the site, in the vicinity of fish sampling station 2 (see Figure 2.2-12), significantly less erosion has occurred, and the stream was characterized by alternating gravel-substrate riffles and loessial-sediment pools.

The stream A fish assemblage was characteristic of streams draining loessial bluffs around Vicksburg, Mississippi (Reference 41); fewer species, however, occurred in stream A than in the Vicksburg streams. The intermittent nature of the stream was probably the major factor restricting species composition and population density. Also periodic concentration of fish into pools probably results in heavy predation by the abundant green sunfish (Lepomis cyanellus) and yellow bullheads, effectively reducing population density.

Twenty-one species were collected from stream A. Some of these species were probably not residents, but had entered when river floodwaters backed into the stream basin in March 1973. Species such as largemouth bass, river shiner and warmouth (Lepomis gulosus), normally inhabit the lakes and river in the site vicinity.

The gravel-bottom riffle and silt-bottom pool portion of the stream (station 2) contained seven fish species. Bluntnose minnows and green sunfish were numerically dominant. The population density was estimated (Ref. 33) to be 7230 fish per acre. Estimated standing stock was 79 pounds per acre.

An attempt to estimate population density in the lower portion of stream A (station 1) in March 1973 was unsatisfactory because of high water turbidity and heavy sediment deposits in the stream bed. A total of 167 fish, representing 18 species, was removed for the population estimate. The most abundant species were bluntnose minnow, green sunfish, longear sunfish (Lepomis megalotis), silvery minnor (a river species) and blackspotted topminnow (Fundulus olivaceus). Population density was estimated to be 2901 per acre. Standing stock was estimated to be 63.0 pounds per acre. A density estimate less than one-half that at station 2, however, is of suspect accuracy, particularly since the stream is larger and supports a higher diversity of species at station 1. Although it is true that these two factors do not necessarily result in higher densities, in this case the population estimate at station 1 is believed to be low.

2.2.3.2.6 Adult Fish Assemblage - Bluff Ponds

There are four small (ca. 0.25 to 0.5 acre) stock ponds and a larger pond (ca. 1 to 2 acre) on the site. The location of these ponds precluded natural population by recruitment from either stream A or B. These ponds were apparently stocked with fish by previous owners. Population estimates were made for two of the ponds. Population density and standing stock were estimated by the mark-recapture method (Ref. 34). Confidence limits were placed around these estimates using the method suggested by Adams (Ref. 35).

Bluff Pond 1 (ca. 0.5 acre) contained only bluegill and mosquitofish. The estimates were based on a total catch of 338 bluegill and 51 mosquitofish which weighed a total of 9.02 pounds. Estimated population density and standing stock, with confidence limits (95 percent) in parenthesis, were:

Species	Number of Fish	Standing Stock (lb./acre)
Bluegill		
Per acre	4316 (2214 - 5534)	115.2 (58.9 - 147.3)
Mosquitofish		
Per acre	1096 (410 - 2866)	1.092 (0.407 - 2.850)

These estimates are equivalent to 5412 fish per acre and 116.3 pounds per acre.

The four-to-one ratio of bluegill to mosquitofish indicated an unbalanced population, i.e., one prey (mosquitofish) to four predators (bluegill); as a result, the bluegill were stunted in growth. Mean total length was 3.2 inches compared to a mean total length of 3.7 inches of 581 bluegill collected in Gin Lake, and 3.8 inches for 49 bluegill from Hamilton Lake.

Bluff Pond 2 (ca. 0.25 acre) contained bluegill, mosquitofish, and a few channel catfish. Electrofishing produced 108 bluegill and three channel catfish; the total catch weighed 9.24 pounds. Population density and standing stock estimates, with confidence limits (95 percent) in parenthesis for bluegill were:

	Number of Fish	Standing Stock (lb./acre)
Per acre	1670 (928 - 3867)	41.4 (23.0 - 95.8)

The pond also supported a dense population of mosquitofish. However, most of these fish readily escaped the electrical field, probably because of their small size and the low water conductivity (24 μmhos/cm^2). Although their abundance was noted, no attempt was made to estimate their population since it was not possible to efficiently capture the fish.

Bluegill in Pond 2 were not stunted in growth, probably because of an abundant food supply (mosquitofish). The mean total length of the 108 bluegill was 4.3 inches. Although the bluegill population in Pond 1 appeared stunted in growth, the standing stock was over twice that of Pond 2, largely because of the higher density in Pond 1.

2.2.3.2.7 Creel Census

a. Commercial Fishing

Commercial fisheries in the Grand Gulf reach of the Mississippi River have declined significantly in the past 20 years (Ref. 46). Prior to this decline, active fisheries existed. Fish buyers maintained houseboats in the immediate area to purchase fish directly from fishermen. This practice has been discontinued and fishermen now transport fish to Vicksburg or Natchez for sale to fish markets. The number of fishermen has also apparently declined; estimates, however, are only available for the present. The Grand Gulf Nuclear Station Project contacted Mississippi Game and Fish Commission Game Wardens, Salvo Piazzo (Jefferson County) and B. G. Newman (Adams County), and Louisiana Wildlife and Fisheries Commission Law Enforcement Officer, Captain Vance Herring, for information on local fisheries. Based on those contacts and direct observations of fishing activity in the site vicinity, there may have been 10 to 15 full-time and 30 to 40 part-time commercial fishermen operating between Grand Gulf and Natchez in 1973.

During the study period, one full-time fisherman operated from June 1972 through February 1973 in the immediate site vicinity. Three to five part-time fishermen were also observed. Creel censuses were obtained from the full-time fishermen on 7 different days in January and February. The dominant fish in these catches was the bigmouth buffalo; smallmouth buffalo was the next most frequently caught fish. Freshwater drum, catfishes and paddlefish were also occasionally caught. The average daily catch for all 7 days was 262.5 pounds, worth $131.26 at $.50 per pound (the 1973 price for undressed buffalo and catfish). This fisherman ceased his activities in early March 1973.

b. Sport Fishing

Sport fishing and related recreational activities (i.e., camping and boating) in the Grand Gulf vicinity is seasonal in nature. Stage and duration of annual flooding has a major influence on these activities. From November 1972 through March 1973, little or no sport fishing activity occurred. However, Hamilton Lake, Gin Lake, the Mississippi River, and the Big Black River were used frequently from April through August.

During the period when the 1973 flood crested and receded (April through June), a total of 240 people were recorded on the site water bodies; this was a daily average of 8.6 campers and fisherman (based on 28 observations). A total of 804 fish (mostly catfishes) were recorded on 15 different days. This was an average daily catch of 53.6 fish and an average catch of 6.1 fish per-angler-day. Boat fishermen were primarily fishing for three species of catfishes (blue, channel and flathead) in floodwaters on the forested bottomland. Most fishing was done with baited trotlines; catches for fishermen were as high as 100 catfish per night on this gear. Bank fishermen were primarily fishing for sunfishes (e.g., bluegill, crappie and largemouth bass) and catch success was typically low.

After floodwaters receded (July and August), sport fishing activities with trotlines occurred primarily along the banks of the Mississippi River. Both bank and boat fishing for sunfishes continued in the lakes. A total of 271 people were recorded on the three water bodies; this was a daily average of 5.9 campers and fishermen (based on 46 observations). Catch successes were considerably less than those during the flood period. A total of 53 fish were recorded for an average daily catch of 7.6 fish (based on seven observations) and an average catch of 1.3 fish-per-angler-day, a decrease of 86 percent in catch successes. The decrease was largely due to a sharp decrease in trotline catch success. Trotline catches were periodically very high in the shallow bottomland floodwaters, suggesting possible spawning concentrations of catfishes in these vegetated areas. A maximum of 500 catfish were recorded taken in a 24-hour period by a portion of the fishermen using the flooded bottomlands. After floodwaters receded, trotline fishing along the river banks resulted in lower catches.

Heaviest fishing activity occurred on weekends (including Friday), holidays, and during periods of stable or falling river stage. Observations on fishing pressures suggested fishing success with baited trotlines was related to fluctuations of river stage; catch success apparently increased during periods of stable or falling river stage.

Hamilton Lake, Gin Lake, and the Mississippi River (including the Big Black River) received different fishing pressures. During the flood period, boats were launched at the Gin Lake Landing and at Fort Cobun north of Grand Gulf; Hamilton Lake and Lower Grand Gulf Landings (Hamilton Lake outfall) were inaccessible. During

that period (March 30 through June 30, 1973), 52 percent of the people were recorded at Gin Lake, 37 percent at Fort Cobun, and 12 percent enroute to or from these landings.

By early July, floodwaters had receded and the Fort Cobun Landing (a soybean field) was dry. Concurrently, the Hamilton Lake and Lower Grand Gulf Landings became accessible by vehicle. During July and August, Gin Lake received the greatest fishing pressure; about 50 percent of all observations were recorded on this lake. Hamilton Lake and the Mississippi River each received about 20 percent of the summer recreation activity. Similar fishing and recreation pressures existed on the various water bodies during the entire period from March 30 through August 31, 1973.

The disproportionate usage of Gin Lake was primarily the result of three factors. During the extended flooding, access to Hamilton Lake was difficult and many fishermen used Gin Lake because of its easier accessibility. After the flood, the Hamilton Lake Landing, although accessible, required use of a four-wheel-drive vehicle to launch a boat, whereas, the Gin Lake Landing was easily accessible without such a vehicle. Lastly, local fishermen are generally of the belief that Gin Lake affords better fishing than does Hamilton.

Boat access to the Mississippi River at Fort Cobun is seasonal and occurs only during very high river stages. Most of the year, fishermen camp at the Lower Grand Gulf landing and launch boats there, or on the river bank revetment south of the outfall. This recreation appears to be a popular activity for citizens of the immediate Mississippi counties and a number of "regulars" frequently use the area. The popularity of this landing may stem from the fact that boat launching sites giving access to the Mississippi River in the Grand Gulf vicinity are limited. The alternatives are two: (a.) St. Joseph, Claiborne County Ferry Landing at river mile 394.2, and (b.) the Karnac Ferry crossing on the Big Black River. Both of these alternative launching sites are about 11 miles by water from Grand Gulf, and are less convenient and more time consuming to use than is the Lower Landing.

2.2.3.3 Benthic Macroinvertebrates

Benthic sampling was conducted at various locations in the Mississippi and Big Black Rivers (see Figure 2.2-9) and Hamilton and Gin Lakes (see Figure 2.2-10). River samples were collected

monthly beginning in September 1972 with a Shipek sediment sampler; lake samples were collected monthly beginning in October 1972 with a Ponar bottom grab. Starting in January 1973, drifting benthic macroinvertebrate samples were collected near the water surface at two stations in the Mississippi River using a 1-meter diameter planton net (505-micron mesh). Shrimp were also collected in the Mississippi, generally on a monthly basis, using box traps measuring 4 x 2 x 1 feet. Crayfish were sampled in the bottomland fields adjacent to the lakes in June after the 1973 spring flood receded.

2.2.3.3.1 Mississippi and Big Black Rivers

a. Benthos

The Mississippi River at Grand Gulf consists of several macrohabitats (clay bank, backwater, and main channel) within which a characteristic assemblage of benthic macroinvertebrates are found. A diverse assemblage of benthic organisms was collected at various river stations. Macrohabitats of the river are mainly defined by current velocity and pattern, sediment type, and water depth. Moreover, since the velocity of the overlying water largely determines the gross type of bottom substrate[30], current velocity is probably the "master variable" affecting overall benthic distributional patterns in a river system. Principle benthic macrohabitats in the Mississippi River at Grand Gulf are (1) backwaters, (2) steep, clay river banks, and (3) main channel.

1. Backwater

Backwater macrohabitats in the Mississippi River are located in slow moving, quiet waters on the inside of large bends, in coves on the leeside of sandbars and islands, in the lower reaches of sluggish tributaries, and in other similar areas. In addition, during flood periods, oxbow lakes are confluent with the main river and become backwaters of the river.

Backwater habitats in the Mississippi River system at Grand Gulf (stations 1, 9 and 10; Hamilton and Gin Lakes) are characterized by zero to slow current velocities, relatively shallow waters, and loosely consolidated sediments composed of 85 percent or more silt and clay. Dissolved oxygen near the bottom may become depleted in warmer months when the water is stagnant.

[30] Bottom substrate is the main physical characteristic directly influencing the basic type of benthic assemblage in an area.

Backwater areas account for most benthic production of the river and are major feeding and spawning grounds for many river fishes. Benthic assemblages in backwater macrohabitats typically consist of dipteran larvae (mainly chironomid and phantom midges), tubificid worms and, to a lesser extent, bivalves. Considerable variation occurs in the relative abundance and taxonomic composition of backwater benthos with respect to these dominant groups. Benthic population densities and standing stocks in backwater macrohabitats are relatively large and fluctuate temporally.

The mud flat at station 1 is located in the lee of a towhead on the west bank of the river approximately 5 miles downstream of the Lower Grand Gulf Landing and is bordered to the east by the main river channel. Station 1 was the largest backwater habitat of this type in the study area and is approximately 120 acres in surface area.

The benthic macroinvertebrate assemblage inhabiting the organically rich silt-clay sediments at station 1 was numerically dominated (78 percent) by tubificid worms; chironomid larvae (dipteran) composed most of the remaining benthos. Total benthic densities ranged from a minimum of 540 organisms/m^2 in August 1973 to a maximum of 7670 organisms/m^2 in June 1973. Although numerous fluctuations occurred, a general increase in benthic numbers occurred from September 1972 through June 1973. In July and August, however, total benthic density decreased. Benthic dry weight standing stock ranged from a low of 311 mg/m^2 in August 1973 to a high of 5543 mg/m^2 in April 1973. Tubificid worms and, because of its larger size, the burrowing mayfly (Hexagenia) codominated standing stock on the mud flat from September 1972 through June 1973. However, in July and August, tubificids, leeches, and bivalves were dominant organisms. A general increase in modal population size of Hexagenia was evident for the study period. The importance of the backwater at station 1 as a feeding ground for fishes is readily apparent considering that the estimated total dry weight standing stock of benthic macroinvertebrates on this mudbar was roughly 3 tons in April, the month of maximum standing stock.

Lower reaches of the Big Black River, particularly near its mouth, may be classified as a backwater habitat of the Mississippi River system. In contrast to conditions at station 1, the benthic

macroinvertebrate assemblage at station 10 (1/4 mile up the Big Black from its mouth) was composed mainly of dipteran larvae (principally chironomids) from September through March; subsequently, bivalves and tubificids were numerically dominant. The spring decrease in chironomid numbers probably reflected adult emergence. Total benthos density increased from lows in the fall and winter to spring maxima in March and June. Total densities ranged from 192 organisms/m^2 in September 1972 to 3955 organisms/m^2 in June 1973.

Standing stock of benthos in the Big Black peaked twice during the preconstruction study period: October 1972 at 4096 mg/m^2 and July 1973 at 11 510 mg/m^2. Standing stock values were comparably low from September 1972 through May 1973. Bivalves and tubificids composed most benthic standing stock in the Big Black. Dipteran larvae were important in September and December, and mayfly (Hexagenia) biomass was abundant in November. Like the mud flat at station 1, the Big Black is probably an important feeding ground for bottom-feeding fish since the benthos of this tributary is comparably productive and abundant.

Benthos in the chute on the leeside or western side of Middle Ground Island (station 9) was variable, being alternately backwater and main channel macrohabitats. Spur dikes at the upstream end of the chute divert most river flow to the eastern side of the island during low-flow periods and, consequently, silt-clay sediments build up on the chute bottom during these times. From September through December, low-flow conditions existed and there was little current at station 9. The resulting mud substrate contained populations of benthos during the fall which increased from 75 organisms/m^2 in September to 505 organisms/m^2 in December. Benthos at station 9 was mainly chironomid larvae. Benthic diversity, however, increased at station 9 from two taxa collected in September to 16 taxa collected in November. This marked rise in diversity can probably be attributed to colonization of the bottom by drifting benthic species carried into the chute by rising floodwaters in November. By January, however, river floodwaters had risen to the point that current velocity in the chute became strong enough to scour the bottom free of silt, leaving a sand substrate. Consequently, benthic populations disappeared in January and, as a result of

prolonged flooding, did not become reestablished until July or August 1973. However, in August, as mud built up on the chute bottom due to reduced current velocities, benthos became reestablished at a total density of 17 organisms/m^2.

2. Clay bank

Banks of the Mississippi River are steep and generally composed of various types of consolidated silt and clay. Clay bank stability varies greatly depending on local soil geology, amount and type of terrestrial vegetation, and degree of scouring by currents. Generally, in areas of stable banks, large populations of benthic macroinvertebrates (mainly mayflies) were present, whereas in reaches where the bank was constantly eroding, macroinvertebrates were scarce or non-existent. Extensive removal of stable clay bank habitat in an area by revetment and other river channelization programs causes significant decreases in biological production.

Clay banks of the Mississippi River at Grand Gulf were sampled in four locations, stations 2, 3, 5 and 6 (see Figure 2.2-9). The bank environment at stations 2 and 6 had high current velocities and was comparatively unstable. No benthos was collected at station 2 in September and October 1972, and this station was not sampled after November. Similarly, no organisms were collected at station 6 until March when this station was moved approximately 1/2 mile downstream to a less severe area (station 6). Subsequently, densities of 25, 45 and 5 organisms/m^2 occurred on the bank at station 6 in March, June and August, respectively. These consisted of tubificids, the midges Cryptochironomus and Chaoborus, and the mayfly Pentagenia.

The clay bank at station 5 supported benthic populations of moderate abundance (35 to 125 organisms/m^2) from September through December, 1972. In January, 1973, however, the substrate at station 5 changed from clay to sand as a result of sediment transport by floodwaters, and no benthic organisms were present from January through March. Some colonization occurred in April and May (5 and 45 organisms/m^2), but benthic concentrations dropped to zero again in June, July and August. A variety of organisms including mayflies, bivalves, chironomids, tubificids, and amphipods were collected at station 5.

In contrast to other clay bank areas, the bank in the eddy current at station 3 contained large populations of the burrowing mayflies Pentagenia and Tortopus. Respiratory tubes of these mayflies gave the substrate a "honey combed" appearance. The abundance of Pentagenia and Tortopus made the bank at station 3 one of the most productive habitats for benthos in the river. Benthic densities decreased regularly from a high of 1467 organisms/m^2 in October 1972 to a low of 20 organisms/m^2 in June 1973. Densities began to increase again in July to 875 organisms/m^2 in August. The mayfly Tortopus reappeared, for the first time since November 1972, in July and August 1973 with densities of 50 and 255 organisms/m^2, respectively.

Standing stock levels showed a temporal trend similar to that of densities with a peak of 9073 mg/m^2 in October and low of 16 mg/m^2 in June. The pronounced decrease in mayfly abundance from February through June may be associated with natural mortality, predation, adult emergence, or a combination of these and other factors. Adult mayflies Pentagenia and Tortopus were observed at Grand Gulf from June through early October 1973. Pentagenia size increased during the year. Size structure of the population exhibited modal increases from the 5 to 10 and 10 to 15 mm total length (TL) size classes in September and October 1972, to the 15 to 20 mm (TL) class for November through April, and to the 20 to 25 mm (TL) class in May and June. Mean individual dry weight of Pentagenia also increased from 2.39 mg in September 1972 to 11.64 mg in June 1973, and then decreased to 1.73 mg in August. Recruitment of young-of-the-year organisms was evident in the summer, with subsequent growth of individuals to maturity in the spring.

3. Main Channel

The river channel is the dominant benthic macrohabitat in the Mississippi River in terms of area. Strong currents and coarse sand-gravel sediments at stations 4 and 7 are characteristic of the main channel environment. Thirty-six benthic samples collected at main channel stations in September, October, March, June, July and August contained no macroinvertebrates. This large area is, therefore, considered to have virtually no benthos.

In summary, benthic sampling in the Mississippi River from September 1972 through August 1973 showed that the most productive areas for benthos were the backwater at station 1 and the clay bank at station 3. Backwaters in the chute on the western side of the Middle Ground Island (station 9), except after January, and in the Big Black River (station 10) were also important habitats for benthos, although to a lesser degree than at stations 1 and 3. Areas of clay bank other than at station 3 (i.e., stations 2, 5, 6 and 8) had a depauperate benthic fauna. The main channel environment was apparently devoid of macroinvertebrates.

b. Drifting Benthic Macroinvertebrates

Benthic macroinvertebrates in the Mississippi River and adjacent backwaters regularly exhibit the phenomenon known as benthic drifting. Mean daily benthic drift intensity in the river at stations 3 and 6 was low in January (0.1 organisms/m^3), rose to intermediate levels (0.5 organisms/m^3) from March through May, increased threefold to a pronounced peak of 2.3 organisms/m^3 in early June, and decreased significantly in July. Nocturnal concentrations of drifting macroinvertebrates were typically 1.5 times greater than diurnal concentrations. Mean nocturanl densities of drifting benthos at stations 3 and 6 averaged 1.6 organisms/m^3, ranging from 0.2 to 3.7 organisms/m^3. In contrast, diurnal densities at both stations average only 0.5 organisms/m^3 and ranged from 0.1 to 1.6 organisms/m^3.

Chironomid pupae and larvae of the phanton midge Chaoborus composed a majority of benthic drift; coleopteran larvae, mayfly larvae, and amphipods were also common. A total of 96 taxa of macroinvertebrates were collected in drift samples. Drift intensity was greatest during flooding when river water flowed across backwater areas such as oxbow lakes and the lower reaches of tributaries. It is apparent that the primary source of drifting organisms was not the river channel but these backwaters. The fact that drift intensity declined markedly within a few days after Hamilton and Gin Lakes became separated from the river in late June supports this hypothesis.

Benthic drift in the Mississippi River may be generally classified as the "catastrophic" type in which organisms are physically torn from their normal habitat by strong

currents or other physical forces (Ref. 52). A "behavioral" drift component was also evident from the significant difference in diurnal and noctural drift intensities. For example, Chaoborus is benthic in the daytime but migrates upward into the water column at night. This phantom midge was numerically dominant in Hamilton and Gin Lakes in the fall. As the currents of rising floodwaters increased during late fall and early winter, populations of Chaoborus were depleted because individuals were continually swept from lakes into the river during their daily nocturnal migration into surface waters.

c. Shrimp

River shrimp (Macrobrachium ohione) were seasonally abundant in the Mississippi River at Grand Gulf where they were collected mainly along the river banks. A few shrimp were collected in trawl samples from the open channel. Shrimp catches along the river bank at stations 3 and 6 were moderate in September 1972, but increased to a fall peak in October. Except for one specimen in March, no shrimp were collected from November 1972 through April 1973. Catches again peaked in August to the preconstruction study-period maximum. Catch per unit effort values ranged from 0 to 22.3 shrimp per trap per day. The decline in shrimp catches in November occurred concurrently with a sharp drop in river water temperature to about 7.5 C. Likewise, the spring rise in catches occurred simultaneously with a sharp increase in water temperature to above 20 C. The decline in winter shrimp catches is not believed to reflect a general reduction in population size, but probably results from decreased activity due to cold water temperatures. A few shrimp were taken in beach seine hauls, in hoop nets, electrofishing equipment, and from the intake screens at MP&L's Baxter Wilson Steam Electric Station in Vicksburg during winter months.

One gravid shrimp was collected in early September 1972, but none were subsequently captured until the next May. During May and June all females were gravid. In August, females composed 97 percent of the catch but only 5 percent of the females were gravid. These data strongly suggest that river shrimp spawn in a fairly discrete period in late spring through mid-summer.

2.2.3.3.2 Hamilton and Gin Lakes

a. Benthos

Hamilton and Gin Lakes are relatively shallow, varying from 6 to 30 feet deep depending on the flood stage of the river. Lake bottom sediments are loosely consoli-

dated and composed of over 95 percent silt and clay-size particles, and the organic content of lake sediments is high. Dissolved oxygen depletions occurred near the bottom in the summer of 1973.

Benthic macroinvertebrate assemblages of the oxbow lakes were similar to those of backwater areas in the river proper. Larvae of the phanton midge Chaoborus and various genera of chironomid midges (e.g., Coelotanypus, Procladius, Cryptochironomus, Pentaneura and Tanypus) numerically dominated the lakes in the fall and winter; tubificid worms and bivalves were spring dominants. Several species of aquatic invertebrates not collected by the bottom grab were also common in the lakes. These included the large unionid mussels Carunculinus, Anodonta and Lampsilus, and the large snails Campeloma and Viviparus which occurred sporadically in fairly dense clusters in shallow waters along the lake shore. In addition, whirligig beetles (Gyrinus) and water striders (Notonectidae) occurred frequently on the lake surface. The crayfish Procambarus and grass shrimp Palaemonetes kadiakensis were common in shallow nearshore waters.

Total benthic density exhibited little temporal variation throughout the preconstruction study period in Hamilton Lake. Total density ranged from 1270 to 2920 organisms/m^2. Temporal fluctuations in benthic density were somewhat more pronounced in Gin Lake. Benthic macroinvertebrate abundance peaks in Gin occurred in late fall-early winter, spring and mid-summer. The study-period minimum occurred in late winter. Total benthic density ranged from 987 to 3242 organisms/m^2 in Gin.

In contrast to benthos density, the standing stock of macroinvertebrates in both lakes fluctuated significantly on a temporal basis. Peaks in benthic standing stock were observed in each lake during the spring; biomass had steadily increased from fall minima to spring maxima. Declines in standing stock began in early summer and continued through late summer. Standing stock levels ranged from 252 to 3886 mg/m^2 in Hamilton and from 162 to 3489 mg/m^2 in Gin. Bivalves generally dominated benthic standing stock of both lakes during the spring maximum, but diptera and tubificids were generally most abundant in other months.

b. Crayfish

An abnormally abundant population of crayfish was present along the lakes during the spring of 1973. As floodwaters began to recede in June, large numbers of

crayfish chimneys were observed in the previously inundated fields adjacent to Hamilton and Gin Lakes. The density of active chimneys in seven bottomland fields on and immediately adjacent to the site ranged from 680 to 9110 per acre and averaged 2931 chimneys per acre for all fields combined. As the floodwaters receded from the fields and the subsoils began draining, crayfish were observed to construct new chimneys closer to the waters edge, abandoning their existing chimneys.

Numerous adult crayfish of the genus Procambarus (possibly P. acutus acutus) were observed at night in the fields along the lakes and were collected in commercial quantities by local residents. Crayfish were not as abundant in the site area, however, as they reportedly were along the river near Vicksburg. Minnow seine hauls in ditches and other shallow floodwater areas along the lakes in June contained large numbers of small (0.5 to 2.0 inches total length) juvenile Procambarus. These juveniles were probably hatched in the early spring. The abnormally successful year for crayfish can probably be attributed to the prolonged presence of exceptionally large areas of idea backwater habitat.

2.2.3.4 Plankton

Plankton sampling was conducted at various locations in the Mississippi and Big Black Rivers (see Figure 2.2-9) and Hamilton and Gin Lakes (see Figure 2.2-10) with various frequencies (monthly to semimonthly) and intensities from September 1972 through August 1973. Replicate river samples were collected at stations 1 through 10 prior to December 1972, and subsequently at stations 1, 3, 6 and 10. Throughout the study, sampling was not standardized at specific times of the day because of the logistic problems associated with the sampling of four water bodies. Zooplankton densities were determined from samples obtained with a Clarke-Bumpus sampler (No. 10 mesh net). Phytoplankton densities were determined from whole-water sample. Zooplankton standing stock and phytoplankton standing crop were determined using their densities and biovolume/biomass estimates. Beginning January 1973, an additional measure of phytoplankton standing crop was obtained from chlorophyll-a analysis.

2.2.3.4.1 Introduction

Plankton are organisms that live adrift in nearly all bodies of water from the smallest ponds, to rivers, to the largest lakes and oceans. Plankton may be divided into two broad, distinctly different groups: phytoplankton and zooplankton. Phytoplankton are typically microscopic, photosynthetic, producer organisms that

form the base of the aquatic chain. Aside from their importance as food for larger organisms, phytoplankton are responsible for producing much of the oxygen utilized by all other aquatic life. Oxygen is produced as a by-product of the photosynthetic process in which carbon dioxide is converted into sugar, the basic food-producing function of phytoplankton. The small size of phytoplankton is countered by their great reproductive capability (which frequently exceeds one division per day). Typical subdivisions of freshwater phytoplankton include blue-green algae, green algae, euglenophytes, and diatoms.

Zooplankton are also usually microscopic but are more structurally complex consumer organisms that obtain their nutrition by consuming other zooplankton, phytoplankton, bacteria, and/or detritus. Excluding protozoans (which typically have rapid reproductive rates), zooplankton reproductive rates are much lower than those of phytoplankton (zooplankton development time usually ranges from a few days to a few weeks). As a consequence, total zooplankton densities and frequently, biomass are also much lower in a body of water. Like phytoplankton, zooplankton are themselves important food items for larger aquatic consumers such as fish and aquatic insects. Typical freshwater zooplankton sub-groups include protozoans, rotifers, cladocerans, and copepods in addition to the larvae of usually nonplanktonic organisms such as insects and other invertebrates.

A large river, in contrast with most lakes and oceans, is not a particularly favorable place for an indigenous plankton assemblage, mainly because of the continual, fast, turbulent flow. Plankton by their drifting characteristic are at the mercy of the turbulence. Generally, lakes are not subject to such continual turbulence. Consequently, typical lake plankton are often not well adapted to survival in the Mississippi River with its continual high turbidity and turbulence. The photic zone[31] is very shallow in the Mississippi. Phytoplankton production is therefore limited; consequently, zooplankton production may also be limited. Much production is tied up in the adventitious plankters that have been flooded out of lakes and backwater areas. These include many crustaceans and larval insects in addition to other rotifers, protozoans, and algae.

The river carries plankton far from its point of origin in a few days. Generally speaking, plankton at any given place in a river may be assumed to have originated upstream in tributary streams, lake, and backwater areas. Consequently, in a river, a true drifting community of self-reproducing organisms has no chance to develop except in backwater areas.

The interrelationship between the Mississippi River and its backwaters in the Grand Gulf region, particularly the two oxbow lakes, Hamilton and Gin and its tributary the Big Black River, is well

[31] The zone with sufficient light for photosynthesis.

illustrated in the plankton. During periods of low flow (September through early November 1972 and July through August 1973), plankton associations were distinct in the Mississippi River, Big Black River, Hamilton Lake, and Gin Lake. When the Mississippi River flooded, river plankton strongly influenced plankton density and biomass of the two oxbow lakes and the Big Black River near Grand Gulf.

Except for short periods from late November 1972 through June 1973, the flooding Mississippi continually flushed the two oxbow lakes and backed into the Big Black River. As the flushing began in November, lake species composition and abundance changed dramatically. Mississippi River plankton replaced that of the lakes, and lake plankton abundance declined more than an order of magnitude to values comparable to those of the Mississippi. Plankton associations in all four water bodies during much of the 8-month flood period were similar to each other, producing nearly identical taxa lists, which reflect the sum of various physical-chemical influences on river plankton upstream. Temporal changes in plankton density and biomass, moreover, were also similar, reflecting these same upstream influences.

The Mississippi River influenced the plankton of the other three water bodies far more than the reverse. The effect of the Big Black River, for example, was particularly noticeable on the plankton of the Mississippi during the preconstruction study period only during lowest flows in September 1972 and August 1973. In September, the cladoceran Moina micrura dominated the Big Black zooplankton (97 percent of numerical density) but was absent from the Mississippi above the confluence of the two rivers. Downstream from the confluence, however, M. micrura was present (although only at a density of less than 5 percent of that in the Big Black). Again in August 1973, M. micrura dominated the Big Black (4222 organisms/m^3) but was far less numerous in the Mississippi (84 organisms/m^3).

The lakes, of course, contributed their own plankton to the Mississippi when they were flushed for the first time in mid-November. The comparative influence of the lake plankton on a volume of water as great as the Mississippi is quite small: for example, on November 7, 1972, a volume of water equal to the total volume of both lakes (25 million cubic feet) flowed past Grand Gulf in about 40 seconds with a river flow rate of approximately 0.63 million cfs.

2.2.3.4.2 Mississippi River

Mississippi River zooplankton and phytoplankton exhibited sharply different temporal patterns of abundance during the preconstruction study period. Zooplankton density and standing stock discharges were substantially lower from September through January

than from February through early June and were again lower from late June through August. Phytoplankton density and standing crop discharges, on the other hand, peaked at a study-period maximum in early November and exhibited another peak in late spring. They exhibited low values in the winter and summer.

Mississippi River zooplankton density ranged over two orders of magnitude during the study period from 367 to 44,828 organisms/m^3, while zooplankton standing stock[32] ranged less broadly from 10 to 172 mg/m^3. Discharge density of zooplankton organisms was relatively constant for the period September 1972 through February 1973. During the same period, however, discharge standing stock rose gradually but steadily. Although discharge density peaked abruptly in mid-March, 1973, standing stock did not peak until three weeks later. As was frequently the case, the numerically dominant organisms contributed relatively little to the standing stock. Thus in mid-March, the small, stalked, river protozoan Carchesium sp. was a 93 percent numerical dominant and contributed substantially to the highest numerical zooplankton density measured in any of the four water bodies (44,828 organisms/m^3). In terms of standing stock, however, Carchesium sp. was insignificant, comprising less than 4 percent in mid March. In fact, discharge standing stock peaked in early April at a value more than twice that of mid-March. Moreover, Carchesium sp. had nearly disappeared by early April. Total standing stock reached its peak for the study period in early June (172 mg/m^3). During the study period, and particularly for early April and early June maxima, various Cladocera (Daphnia spp., Ceriodaphnia sp. and Bosmina longirostris) and both cyclopoid and calanoid copepods dominated the standing stock. Of the 46 Mississippi River zooplankton taxa identified during the study period, Bosmina longirostris was particularly characteristic of the Mississippi, being one of the three most abundant river zooplankters on 10 of 16 sampling dates.

A colonial rotifer, Conchiloides sp.[33], was a river dominant during the spring, comprising at least 30 percent of river zooplankton densities in April and May 1973. Previously, Conchiloides sp. had been a dominant zooplankter observed in the lakes prior to flooding. The role of the river in introducing taxa such as Conchiloides sp. into the lakes is discussed in subsection 2.2.3.4.4.

Mississippi River phytoplankton abundance experienced both a fall and a spring bloom, a typical occurrence in many bodies of water. Phytoplankton discharge density and standing crop were highest

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[32] All biomass values are biovolumes that have been converted to wet weights.

[33] Conchiloides sp. is another small, frequently numerically abundant taxon which contributed relatively little to standing stock.

in early November (respectively, 7.6 x 10^{15} cells/minute and 4480 kg/minute), were much lower from December through early May (lowest values of the study period were approached in mid-March - 0.9 x 10^{15} cells/minute and 560 kg/minute), were higher again in early June, and were low in July and August.

Although density and standing crop changed greatly during the study period, the actual species composition changed relatively little. The dominant taxa were centric diatoms. Invariably, either Melosira spp. or Cyclotella spp. dominated the numerical density. In addition, other centric diatoms (Stephanodiscus spp. and Coscinodiscus sp.), pennate diatoms (Asterionella sp., Navicula spp. Nitzschia spp., and Synedra spp.), and euglenoid (Trachelomonas spp.) were frequently important in both numbers and standing crop. An additional 49 phytoplankton genera were identified from the Mississippi during the preconstruction study period. Only rarely did any of these 49 become one of the three dominants.

2.2.3.4.3 Big Black River

Big Black River plankton in the vicinity of Grand Gulf was at times quite distinct from that of the Mississippi River and at other times, indistinguishable. When the Mississippi River stage was low, the Big Black generally had its own characteristic plankton. When the Mississippi River stage was high, the Mississippi backed far into the Big Black and, consequently, influenced plankton composition near the mouth of the Big Black.

During the low-water periods (September 1972 and August 1973), the cladoceran Moina micrura dominated Big Black zooplankton density and standing stock. During these same two months, the Mississippi River had comparatively insignificant populations of M. micrura and, in fact, total zooplankton abundance was several times lower in the Mississippi than in the Big Black.

During high-river stages (November 1972 through June 1973), temporal zooplankton fluctuation patterns of the two rivers were very comparable, suggesting the strong influence of the flooding Mississippi on its tributaries. During that time, species composition was also quite comparable. From November through June, almost invariably at least two of the three dominants were the same for both rivers on a given sample date even though densities may have differed.

In mid-September 1972, Big Black zooplankton exhibited its highest standing stock of the preconstruction study period (332 mg/m^3), with 99 percent due to Moina micrura. Three weeks later, total density and standing stock approached their lowest values for the year (respectively, 314 organisms/m^3 and 11 mg/m^3). From early fall through winter, density and standing stock rose slowly

and steadily. Density peaked for the preconstruction study period in mid-March (9485 organisms/m^3) and again in early June (9302); standing stock peaked in early June, declined sharply by mid-June, but peaked again in July and August. Both the late spring and summer peaks were lower than the previous September peak.

Big Black River phytoplankton density and standing crop were distinctly different than those of the Mississippi from September through January. Big Black phytoplankton abundance was much lower than that of the Mississippi from September through December. In early January, however, Big Black phytoplankton density and standing crop were at their maximum levels (respectively, 2031 million cells/m^3 and 1362 mg/m^3) for the study period and were much higher than those of the Mississippi. At that time, the high Mississippi River stage caused a reduction of flow in the Big Black River for the first time in the study period. This produced the appropriate conditions for a peak in Big Black phytoplankton.

When the Mississippi River backed into the Big Black from February through June, the Big Black River phytoplankton density, standing crop and composition, closely paralleled those of the Mississippi[34]. By mid-July, after the Mississippi stage had fallen, the two rivers again had distinct phytoplankton assemblages. While the Mississippi remained dominated by its characteristic diatoms, the Big Black was dominated by green algae, blue-green algae, and euglenophytes. Over the entire study period, phytoplankton abundance in the Big Black averaged the lowest of the four water bodies. Big Black phytoplankton density ranged from 199 to 2031 million cells/m^3, while standing crop ranged from 70 to 1362 mg/m^3.

2.2.3.4.4 Hamilton Lake

The plankton composition and abundance in Hamilton and Gin Lakes are greatly affected by the frequency and duration of regular flooding by the Mississippi River. When Hamilton and Gin Lakes are separated from the Mississippi, they develop distinct plankton assemblages such as those which occurred from September through early November 1972 and in July and August 1973. When the lakes are flooded (essentially flushed), however, the lake plankton assemblage is closely related to that of the Mississippi; this condition occurred from late November 1972 through June 1973. Occasionally, for brief periods during the flood season, the lakes may be cut off from the river. Consequently, they may develop a distinct plankton assemblage for a short time such as that which occurred in early March 1973.

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[34] Except in mid-March, when the Mississippi fell and no longer backed into the Big Black but still retarded Big Black flow. At that time, a distinct phytoplankton assemblage was observed in the Big Black.

In the fall, Hamilton Lake zooplankton was dominated by a small rotifer, Conchiloides sp., and a cyclopoid copepod, Ergasilus sp., both also characterized Gin Lake zooplankton in the fall. Total zooplankton density and standing stock were generally higher in the fall prior to flooding, lower from November through February, Higher again from March through May, and lower again following renewed separation from the Mississippi from June through August 1973.

Hamilton Lake surface zooplankton density during the study period ranged over an order of magnitude from 369 to 19,060 organisms/m^3, while standing stock ranged from 7 to 417 mg/m^3. Mid-depth density and standing stock ranges were, respectively, 1787 to 23,072 organisms/m^3 and 44 to 235 mg/m^3.

Substantial differences in surface and mid-depth density on a sample date were occasionally measured, particularly in the spring; however, only a few consistent patterns in total density were evident. For instance, in early March 1973 both surface total density and standing stock were more than 75 percent larger than mid-depth values. All major taxa (e.g., rotifers, copepods, and cladocerans) had higher density and standing stocks at the surface than at mid-depth. Total standing stocks, moreover, were also higher at the surface in late March, late April, and early and late May. In early April, mid-May and mid-June, however, total standing stock was, respectively, 13, 17 and 38 percent lower at the surface than at mid-depth. This relationship held for total density through March and April; in May and June, however, surface density was the greater when surface standing stock was the lesser.

The pattern of vertical distribution was more pronounced for Cladocera than it was for total standing stock. For most of the sampling dates, the dominant Cladocera had higher numerical densities near the surface than at mid-depth. Daphnia spp., for instance, were seven times more numerous in early March at the surface than at mid-depth. In late March and late April, Bosmina longirostris were nearly three times more numerous at the surface than at mid-depth.

Vertical distribution in zooplankton has been attributed to various factors such as light, gravity, thermal gradients, and chemical gradients (Ref. 53). Distinct diel vertical plankton movements have been noted in many bodies of water that are typically deep, nonturbulent and not particularly turbid. It has been demonstrated that cladocerans, in particular, migrate away from bright light (Ref. 53). Consequently, in many lakes, Cladocera are more concentrated at deeper levels during the day than near the surface.

Hamilton Lake was shallow in early March 1973, but relatively deep from April through June 1973. Flooding of the lakes by the river produced turbulence and quite turbid conditions; these conditions

hindered the detection of vertical plankton migration. A vertical stratification in Cladocera, however, was often observed; they were generally found to be more concentrated at depths of 3 feet than at 10 feet. Hutchinson (Ref. 53) reports, however, that some plankters will migrate toward a dim light. It is likely that such dim-light-conditions prevailed at the 3-foot depth in the turbid Hamilton Lake water, perhaps explaining the higher concentration of Cladocera near the surface.

The overall temporal pattern of abundance, whether surface or mid-depth, was characterized by abrupt changes. These changes were usually associated with large fluctuations in river stage. When the lake was first flooded in November 1972, following a sharp 20-foot rise in river stage, the preflood numerically dominant Conchiloides sp. abruptly decreased more than an order of magnitude. From November 1972 through February 1973, Hamilton Lake and the Mississippi shared a similar zooplankton association (cyclopoid copepods, Carchesium sp., Asplanchna sp., Brachionus spp. and Bosmina longirostris). In early March, however, when the lake was briefly cut off, cyclopoid copepods and Daphnia spp. increased very sharply in a short period and produced the highest standing stock measured in Hamilton Lake during the study period (417 mg/m^3).

With renewed flooding in mid-March, lake standing stock once again equilibrated with that of the river. At the same time, Conchiloides sp., which had become the river dominant (from an upstream source), also invaded the lakes. Conchiloides sp. had been the lake dominant in the fall (50 to 80 percent of numerical density in September and October). Conchiloides sp. again dominated the lake zooplankton from March through June. This occurrence strongly suggests the influence of Mississippi River plankton on the plankton composition of associated oxbow lakes. If the lakes had been severed from the river in April or May 1973, Conchiloides sp. and other taxa present would have been the innoculum for a renewed lake zooplankton succession[35]. Merely being the dominant taxon in the innoculum, however, would not necessarily suggest continued dominance during succession. Following separation from the Mississippi River, Hamilton Lake zooplankton in July and August, in fact, lacked any Conchiloides sp. and was dominated, respectively, by Diaphanosoma brachyurum and Brachionus angularis. By the end of August, zooplankton density and standing stock were both at study-period lows.

Hamilton Lake phytoplankton was substantially more abundant from September through November and then again in July and August than

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[35] Lake plankton typically undergo a change in species composition throughout the year. Such a succession in a nonflooding lake may be quite similar from year to year. In flooding oxbows, however, species succession is necessarily influenced by those species present when annual flooding ceases.

for the rest of the preconstruction study period. Near-surface[36] total phytoplankton density ranged over two orders of magnitude from 192 to 40,249 million cells/m^3, while standing crop had a similarly broad range from 99 to 27,893 mg/m^3.

Prior to flooding, the important taxa numerically were a small desmid, Selenastrum Westii, and the same two centric diatom genera that dominated the Mississippi, Melosira spp. and Cyclotella spp. In late October, two euglenoids, Euglena sp. and Trachelomonas sp., experienced a large bloom and produced the largest measured standing crop of any of the four water bodies. At the same time that the Hamilton Lake euglenophyte bloom was measured, there was a concurrent sharp decline (66 percent) in total zooplankton standing stock and Ergasilus sp. in particular. It is possible that the euglenophyte bloom caused a detrimental effect on the Ergasilus sp. population in Hamilton Lake, conceivably by depletion of oxygen. After the lake was flooded, total phytoplankton density and standing crop declined dramatically and remained low through June with only relatively minor fluctuations. Centric diatoms, as in the Mississippi River, usually dominated the flooded lake: occasional subdominants included Nitzschia spp., Trachelomonas spp., Synedra spp. and colonial flagellates.

By late July, the lakes had again separated from the Mississippi and developed high phytoplankton densities comparable to those which existed prior to flooding. Selenastrum Westii was again the numerical dominant, while Cyclotella spp. and Melosira spp. continued standing crop dominance. At the end of August, Hamilton Lake total phytoplankton density was at its highest value for the study period. Selenastrum Westii was an 82 percent numerical dominant while a green colonial flagellate and Trachelomonas sp. shared standing crop dominance.

2 2.3.4.5 Gin Lake

Gin Lake plankton density and biomass prior to November 1972 flooding were distinct from those in the other three water bodies. The species composition of Gin Lake plankton, moreover, was also distinct from the two rivers. Species compositions of the two lakes, however, were quite similar. Dominant zooplankton taxa of both lakes were Conchiloides sp., Ergasilus sp. and Diaphanosoma brachyurum. Dominant phytoplankton taxa of both were Selenastrum Westii, Melosira spp., Cyclotella spp., Euglena sp. and Trachelomonas spp.

Both before and after flooding occurred, Gin Lake and Hamilton Lake zooplankton assemblages exhibited similar abrupt changes in density, standing stock, and species composition. For example, between

[36] Mid-depth density and standing crop are discussed only if they differ significantly from near-surface values.

early and late November 1972, total Gin Lake zooplankton density and standing stock declined 86 and 92 percent, respectively. During that period, the Mississippi rose over 20 feet, flooded the lakes and decimated the established Conchiloides sp. and Ergasilus sp. populations. Another abrupt change occurred between late February and early March 1973. Total surface zooplankton density and standing stock increased over 12 times and 17 times, respectively. During that period, the river stage had dropped sharply and the lakes were briefly cut off. Cyclopoid copepods and Daphnia spp. were the dominants. Following renewed flooding, total standing stock, in particular, declined sharply. Zooplankton density continued to fluctuate through the spring, achieving a maximum numerical density in early June (35,672 organisms/m^3) before declining by mid-June. July and August zooplankton densities maintained relatively low values. In fact, in August, Gin Lake total zooplankton density was at its lowest for the study period.

In general, both zooplankton density and standing stock peaked at higher values in Gin Lake than in Hamilton Lake. For example, Gin Lake surface density peaks in early October, early March and early June were, respectively, 41, 27 and 27 percent higher than those in Hamilton Lake. Gin Lake surface standing stock peaks for the same dates were, respectively, 34, 8 and 13 percent higher than those in Hamilton Lake. In fact, comparison of the temporal patterns of total standing stock in both Hamilton and Gin Lakes reveals that the two fluctuated in concert. The pattern for both lakes, whether up or down, was identical on 14 of 16 sampling dates.

Gin Lake phytoplankton density and standing crop were several fold greater before the river flooded than at any time during flooding from December 1972 through June 1973. As happened in Hamilton Lake, Gin Lake phytoplankton density and standing crop increased in July and August to high values comparable to those of early fall 1972. Contrary to the case for zooplankton, Gin Lake phytoplankton density was not consistently greater than that of Hamilton Lake.

2.2.3.5 Lake Periphyton and Macrophyton

2.2.3.5.1 Periphyton

Stands of dead trees occur in the waters along the western and northern perimeters of Hamilton and Gin Lakes. The submerged surfaces of these trees provide substrate for growth of attached algae and invertebrates (periphyton and Aufwuchs). Fall 1972 periphyton, prior to flooding, was dominated by thick mats of filamentous green algae, Rhizoclonium sp. Associated with the Rhizoclonium filaments were numerous species of pennate diatoms (Navicula spp., Cymbella spp., Gomphomena spp.) and the filamentous centric diatom Melosira spp. Dominant fauna in the fall associated with the Aufwuchs were nematodes (Nemata), leeches (Hirudinea) and flatworms (Platyhelminthes).

Periphyton was substantially reduced during the winter partly because the water level fluctuated greatly. During April and May 1973, the filamentous diatoms Melosira granulata and Melosira distans dominated the periphyton which at that time was located in the upper branches of living trees surrounding the lakes. Most of the dead tree substrates were totally submerged and beneath the photic zone.

In July the lakes returned to their pre-flood levels, and the dead tree substrates were dominated by an encrusted sponge mat (Spongillidae). Dense growths of the filamentous green algae Cladophora sp. and Mougeotia sp. occurred where sponge growth was lacking. Pennate diatoms (Navicula spp., Nitzschia spp., Gomphonema spp. and Cymbella spp.), centric diatoms (Melosira spp.), blue-green algae (Oscillatoria spp. and Anabena sp.), euglenophytes (Euglena sp., Phacus sp. and Trachelomonas spp.) and various green algae (Actinastrum sp., Chlamydomonas spp., Closterium sp., Pandorina sp. and Scenedesmus spp.) were among the flora associated with both sponge and algae mats. Invertebrates in the periphyton included crayfish, insects (Chaoborus sp. and Coleoptera larvae), Cladocera (Alona sp.), rotifers (Brachionus spp., Polyarthra sp. and Keratella spp.) and Nemata.

2.2.3.5.2 Macrophyton

Hamilton and Gin Lakes did not support a vascular aquatic plant assemblage of any significance during the preconstruction study period. None of the common vascular plants such as Potamogeton, Elodea, and Myriophyllum were observed. It is possible that extreme annual fluctuation in lake levels due to flooding prevented these rooted plants from becoming established.

The only aquatic plant recorded in the lakes was big duckweed, Spirodela spp. Portions of the northern end of Gin Lake contained a sparse population of this duckweed in the fall of 1972. These floating plants were flushed from the lakes by flooding in November 1972. After floodwaters receded in July 1973, sparse populations again established in both lakes. This cycle of flushing by floodwaters and repopulation following the floods is probably a normal event in the lakes.

2.2.3.6 Disease and Pest Infestations in Fish

Fish generally harbor a number of parasites and pathogenic organisms to which they are mutually adapted. Although these infestations cause stress to varying degrees, depending on condition of the host fish and environmental conditions, mortality due to natural causes (old age) is probably the largest single cause of death in an adult fish population (Ref. 54). Any outbreak of disease required the simultaneous occurrence of three factors:

(a) a susceptible host, (b) the pathogenic organism (e.g., virus, bacteria, parasite), and (c) a predisposing condition (e.g., low oxygen, food shortage, rapid temperature fluctuation, high population density).

Review of pertinent literature and contacts with Dr. Glynn Hoffman (Ref. 55), Dr. Thomas Wellborn, Jr. (Ref. 56), and Mr. Barry Freeman (Ref. 57) indicated that no parasite or infectious disease outbreaks have been recorded in the Lower Mississippi River between 1973 and 1976.

The likelihood of such outbreaks occurring is considered very small since most recorded outbreaks in the Southeast have occurred in fish cultures (e.g., fish farming, fish hatcheries) (Ref. 56). Rogers (Ref. 58) reported that parasites were responsible for 30 percent of the fish kills investigated in the southeastern United States over a 5-year period. Bacteria were responsible for 35 percent of the fish kills during the same period. A parasitic protozoan, Ichthyophthirius, was responsible for a large shad kill in the Coosa River in Alabama (Ref. 59). Such outbreaks are unusual in a natural environment.

During preconstruction studies, incidents of infestation or parasitism were recorded when noticed, either in the field or laboratory. From April through August 1973, systematic observations were made during normal field sampling activities.

Leeches were the most commonly encountered ectoparasite; the majority of these leeches were attached to the fins. Approximately 20 percent of the blue catfish specimens were infested; freshwater drum (9 percent) and channel catfish (4 percent) were also occasionally infested by the ectoparasite.

An infestation by a myxosporidean occurred on blue catfish in April 1973. This parasite's life cycle is direct from one fish to another. While resident in the flesh, the organism is encased in a large cyst, somewhat blister-like in appearance. In April, 23 of 57 blue catfish examined (40 percent) were infested by this parasite. The degree of infestation varied from a single cyst on a fish to almost complete coverage of the body on other fish. By June, the incidence of infestation had decreased to 9 percent when only 4 of 45 fish were observed with cysts. None of the blue catfish collected in August were infested. This ectoparasite was not observed on any other fish species.

Several other pests were noted during the study. A low incidence of occurrence of the parasitic copepod Lernea was observed on bluegill (2 percent), carp (1 percent), and blue catfish (1 percent). Many of the fish collected possessed low numbers of trematodes, Gyrodactylus and/or Dactylogyrus, on the gills; none, however, appeared seriously affected. A few fish bearing the fungus Saprolegnia or Achlya on body lesions were also collected.

Two of these fish, both largemouth buffalo, had extensive body lesions of suspected bacterial origin; both fish appeared stressed by the infections. Tapeworms were common in many of the fish collected. The fish, however, did not appear stressed by the presence of these intestinal parasites. Intestines of several shovelnose sturgeons contained roundworms. With the exception of the two largemouth buffalo, afflicted fish appeared normal. The buffalo, however, were obviously stressed by the severe body infections they carried.

A fish kill of moderate proportions (approximately 200 fish) occurred in Hamilton Lake on August 26 and 27, 1973. The fish were primarily shad, drum, and a few catfish. Although the cause of the kill was undetermined, dissolved oxygen depletion was suspected as the causative agent. Nocturnal dissolved oxygen depletion at the lake bottom was recorded in the summer and stress was probably added by very warm water temperatures (ca. 30 C).

2.2.3.7 Endangered or Threatened Fish Species

There are no fish species which have been designated as endangered or threatened by the U.S. Fish and Wildlife Service (Ref. 7), the Mississippi Game and Fish Commission (Ref. 12) or the Mississippi Natural Heritage Program (Ref. 13) that are known to be resident in waters on or adjacent to the Grand Gulf site. One threatened species, the Bayou darter (Etheostoma rubrum), is endemic to the Bayou Pierre system which drains into the Mississippi about 10 miles south of Grand Gulf.

The Endangered Species Committee of the American Fisheries Society has published a 1971 assessment by states suggesting the status of threatened freshwater fishes in the United States (Ref. 43). Six species have been suggested as threatened in the Mississippi and concern is expressed for their survival. The shovelnose sturgeon, listed as depleted, is the only one of these species expected to occur in the site vicinity (Ref. 42). Shovelnose sturgeon were common, however, in gill and trammel net catches at station 1 in the Mississippi River; 108 specimens were collected: aproximately 20 of these were preserved for further study; the remainder were returned to the river. The shovelnose sturgeon population in the site vicinity appears to be abundant.

Species listed as rare in Louisiana (Ref. 43), which has also been reported as possibly occurring in the Grand Gulf vicinity (Ref. 42), are listed below:

Pallid sturgeon	(Scaphirhynchus albus)
Stoneroller	(Campostoma anomalum)
Bluntnose shiner	(Notropis camurus)
Suckermouth minnow	(Phenacobius mirabilis)
Steel color minnow	(Notropis whipplei)
Bluntnose minnow	(Pimephales notatus)
Rainbow darter	(Etheostoma caeruleum)

Two pallid sturgeon specimens were collected from the Mississippi River at stations 1 and 9 and preserved for verification of the identifications. Confirmation of the specimen identification was made by Dr. Reeve M. Bailey (Ref. 60). One of these specimens has been reposited in the Museum of Zoology, University of Michigan, Catalog No. UMMZ 194245. The pallid sturgeon is currently classified as "status-undetermined" by the Bureau of Sport Fisheries and Wildlife. A status-undetermined species is one that has been suggested as possibly threatened with extinction, but one about which insufficient information exists concerning its abundance and distribution. Results of the Grand Gulf field study indicate a very low abundance of pallid sturgeon in the Grand Gulf vicinity.

The bluntnose minnow and stoneroller were both common in collections from site stream A in February 1972. Two bluntnose minnows were collected at Mississippi River station 1 in August 1973. A few larvae of the stoneroller were collected at station 3 in March 1973 and at station 6 in both March and April 1973.

2.2.4 References

1. Stansky, J. J., 1969. "Deer Habitat Quality of Major Forest Types in the South," In Proceedings of Symposium: White-tailed Deer in the Southern Forest Habitat. Southern Forest Experiment Station, Nacogdoches, Texas, pp. 42-45.

2. Yancey, R. K., 1970. "The Vanishing Delta Hardwoods: Their Wildlife Resources," La. Conservationist, March-April, p. 26.

3. Putnam, J. R., G. M. Furnival and J. S. McKnight, 1960. "Management and Inventory of Southern Hardwoods," Handbook No. 181, U. S. Department of Agriculture, Washington.

4. Murphy, P. K., 1973. Personal Communication. Graduate Student, School of Forestry and Wildlife Management, Louisiana State University, Baton Rouge.

5. Noble, R. E., 1972. Personal Communication. School of Forestry and Wildlife Management, Louisiana State University, Baton Rouge.

6. Robbins, C. S., B. Brunn, and H. S. Zim, 1966. "Birds of North America," Golden Press, New York.

7. U. S. Department of the Interior. 1976. "Endangered and Threatened Wildlife and Plants." Federal Register, Vol. 41 (208): 47180-47198

8. American Birds, 1971. "Announcing the Blue List: An Early Warning System for Birds." American Birds 25(6): 948-949.

9. American Ornithologists' Union, 1957. "Check-list of North American Birds," Port City Press, Inc., Baltimore, Md.

10. Sheldon, W.G., 1971. "The Book of the American Woodcock." University of Massachusetts Press, Amherst.

11. Turcotte, W. H., 1976. Personal Communication. Chief, Game and Fisheries Division, Mississippi Game and Fish Commission, Jackson.

12. Public Notice 1790, April 9, 1975. An order and regulations adopting an official list of endangered or threatened vertebrates in Mississippi, State Game and Fish Commission, Jackson.

13. Mississippi Natural Heritage Program 1977. Special Plant and Animal Lists for the State of Mississippi.

14. Wolfe, J. E., 1971. "Mississippi Land Mammals," Mississippi Game and Fish Commission.

15. Lack, D., 1954. "The Natural Regulations of Animal Numbers," Oxford University Press, London.

16. Golly, F. B., 1962. "Mammals of Georgia," University of Georgia Press, Athens.

17. Hayden, D. C. and W. F. MacCallum, 1976. "Effects of prolonged flooding on small mammal populations in an area of the Lower Mississippi River Valley," J. Miss. Academy of Sci., Vol. XXI: 84-88.

18. Uhlig, H. G., 1956. "The Gray Squirrel in West Virginia." Bulletin 3, West Virginia Conservation Commission, Division of Game Management, Charleston.

19. Brandt, G. W., 1938. "A Study of Beaver Colonies in Michigan." Journal of Mammalogy 19: 139-162.

20. Burt, W. H. and R. P. Grossenheider, 1964. "A field Guide to the Mammals," Houghton Mifflin Company, Boston.

21. Glasgow, L. L. and R. E. Noble, 1971. "The Importance of Bottomland Hardwoods to Wildlife." Proceedings Symposium on Southeastern Hardwoods, U. S. Department Agricultural Forest Service, State and Private Forestry, Atlanta, Ga.: 30-43.

22. Neal, W. A., 1973. Personal Communication, Game Biologist, Mississippi Game and Fish Commission, Jackson.

23. Murphy, P. K., 1974. "The Monthly Availability and Use of Browse Plants by Deer on a Bottomland Hardwood Area in Tensas Parish, Louisiana." M. S. Thesis Submitted to Graduate School, Louisiana State University, Baton Rouge.

24. Conant, R., 1958. "A Field Guide to Reptiles and Amphibians," Houghton Mifflin Company, Boston.

25. Cook, F. A., 1942. "Alligator and Lizards of Mississippi," State Wildlife Museum, Jackson, Mississippi.

26. Cook, F. A., 1954. "Snakes of Mississippi," State Wildlife Museum, Jackson, Mississippi.

27. Klots, E. B., 1966. "New Field Book of Freshwater Life," G. P. Putnam's Sons, New York.

28. Morris, R. C., 1973. Personal Communication. U. S. Department of Agriculture, Southern Forest Experiment Station, Southern Hardwoods Laboratory, Stoneville, Mississippi.

29. Collins, R., 1976. Personal Communication. Mississippi Forestry Commission, Jackson.

30. Coley, J., 1976. Personal communication. Division of Plant Industry, Mississippi Department of Agriculture, Starkville.

31. Fusselle, P., 1976. Personal Communication. Mississippi State Board of Health, Jackson.

32. Prestwood, A. K., 1976. Personal Communication. Southeastern Cooperative Wildlife Disease Study, College of Veterinary Medicine, University of Georgia, Athens.

33. Zippin, C., 1958. "The Removal Method of Population Estimation." Journal of Wildlife Management 22(1): 82-90.

34. Lagler, K. F., 1956. "Freshwater Fishery Biology," Wm. C. Brown Company, Dubuque, Iowa.

35. Adams, L., 1951. "Confidence Limits for the Peterson or Lincoln Index Used in Animal Population Studies." Journal of Wildlife Management 15(1): 13-19.

36. Federal Water Pollution Control Administration, 1969. "Endrin Pollution in the Lower Mississippi River Basin." U. S. Department of Interior, Washington.

37. Guillory, V., 1973. Personal Communication. Graduate Student, Department of Wildlife and Fisheries, Louisiana State University, Baton Rouge.

38. Smith, P. W., A. C. Lopinot and W. L. Pflieber, 1971. "A Distributional Atlas of Upper Mississippi River Fishes." Biological Notes No. 73, Illinois Natural History Survey, Urbana.

39. Bailey, R. M., 1973. Personal Communication, Letter dated September 12, 1973. Curator of Fishes, Museum of Zoology, University of Michigan, Ann Arbor.

40. Clemmer, G., 1973. "Taxonomic Verification on Various Fishes Collected from the Mississippi River in the Area of the Proposed Grand Gulf Nuclear Station." Consultant's Report, Mississippi State University, State College, Mississippi.

41. Hemphill, A. F., 1954. "A Preliminary Survey of Fishes in the Streams Emerging from the Vicksburg Bluffs, Warren County, Mississippi." M. A. Thesis, University of Alabama, Auburn.

42. Cook, F. A., 1959. "Freshwater Fishes in Mississippi," Mississippi Game and Fish Commission, Jackson.

43. Miller, R. R., 1972. "Threatened Freshwater Fishes of the United States." Transactions American Fisheries Society 101(2): 239-252.

44. Barnickol, P. G. and W. C. Starrett, 1951. "Commercial and Sport Fishes of the Mississippi River Between Caruthersville, Missouri, and Dubuque, Iowa." Bulletin of the Illinois Natural History Survey Volume 25(5).

45. Butler, R. L., 1965. "Freshwater Drum, Aplodinotus grunniens, in the Navigational Impoundments of the Upper Mississippi River." Transactions American Fisheries Society 94(4): 339-349.

46. Hayes, C., 1972. Personal Communication. Former Commercial Fisherman, Grand Gulf, Mississippi.

47. Chadwich, H. K., C. E. von Geldren, Jr. and M. L. Johnson, 1966. "White Bass." In: "Inland Fisheries Management," A. Calhoun, Ed., State of California, Resources Agency, Department of Fish and Game, Sacramento: 412-422.

48. Taber, C. A., 1969. "The Distribution and Identification of Larval Fishes in the Buncombe Creek Arm of Lake Texoma with Observations on Spawning Habits and Relative Abundance." Ph.D. Thesis, University of Oklahoma, Norman.

49. Starrett, W. C., 1951. "Some Factors Affecting the Abundance of Minnows in the Des Moines River, Iowa." Ecology 32(1): 13-27.

50 Breder, C. M. and D. E. Rosen, 1966. "Modes of Reproduction in Fishes," T. F. H. Publications, Jersey City, New Jersey.

51. Daiber, F. C., 1953. "Notes on the Spawning Population of the Freshwater Drum (Aplodinotus grunniens, Rafinesque) in Western Lake Erie." American Midland Naturalist 50(1): 159-171.

52. Waters, T. F., 1965. "Interpretation of Invertebrate Drift in Streams." Ecology 46: 327-334.

53. Hutchison, G. E., 1967. "A Treatise on Limnology," Vol. II. "Introduction to Lake Biology and the Limnoplankton," John Wileys and Sons, New York.

54. Ricker, W. E., 1954. "Causes of Death Among Indiana Fishes." Transactions of 10th American Wildlife Conference, American Wildlife Institute, Washington: 267-279.

55. Hoffman, G., 1976. Personal Communication. Parasitologist, U. S. Department of Interior, Fish Farming and Experimental Station, Stuttgart, Arkansas.

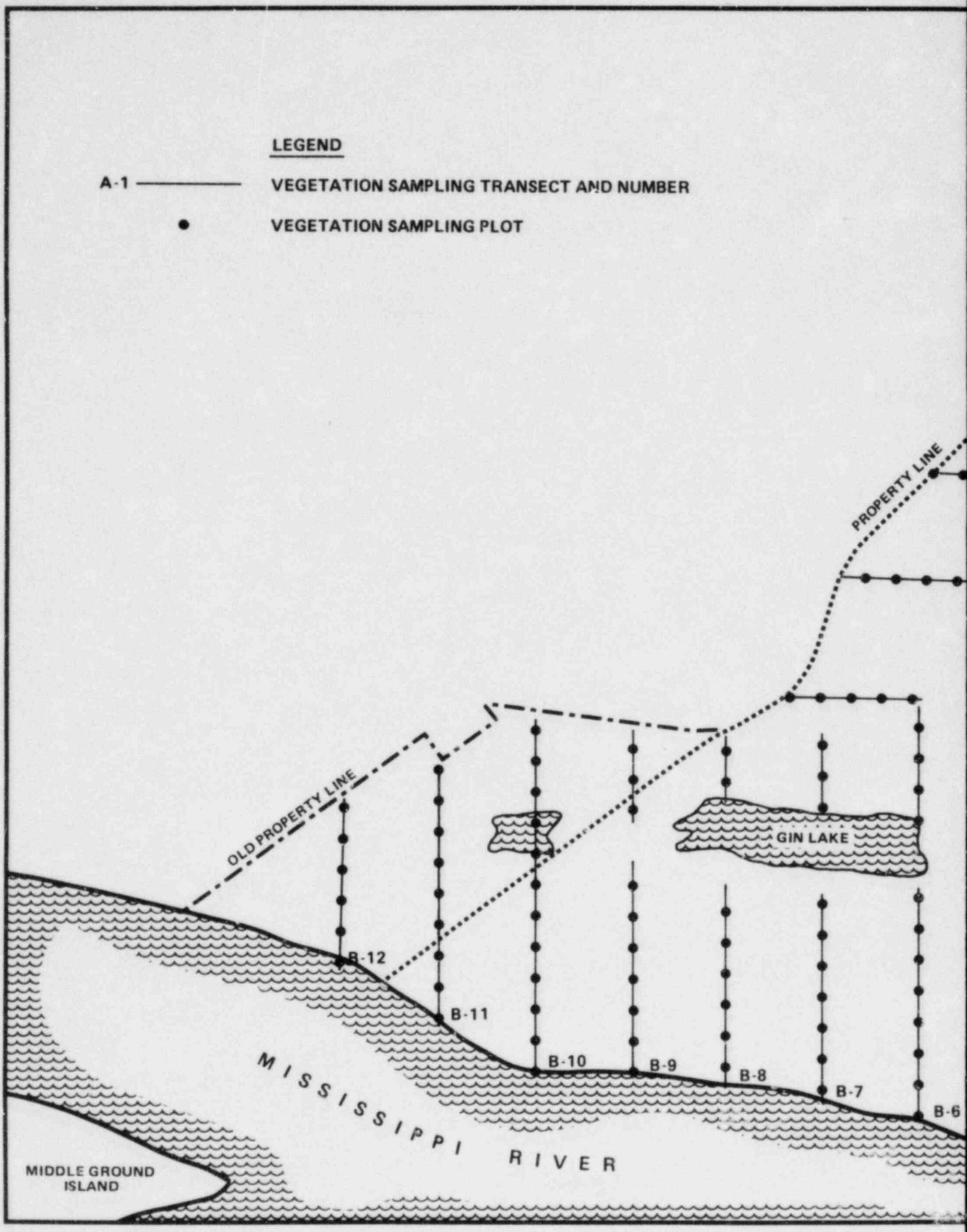
56. Wellborn, T. L., Jr., 1976. Personal Communication. Fish Parasitologist, Agricultural Extension Service, Mississippi State University, State College, Mississippi.

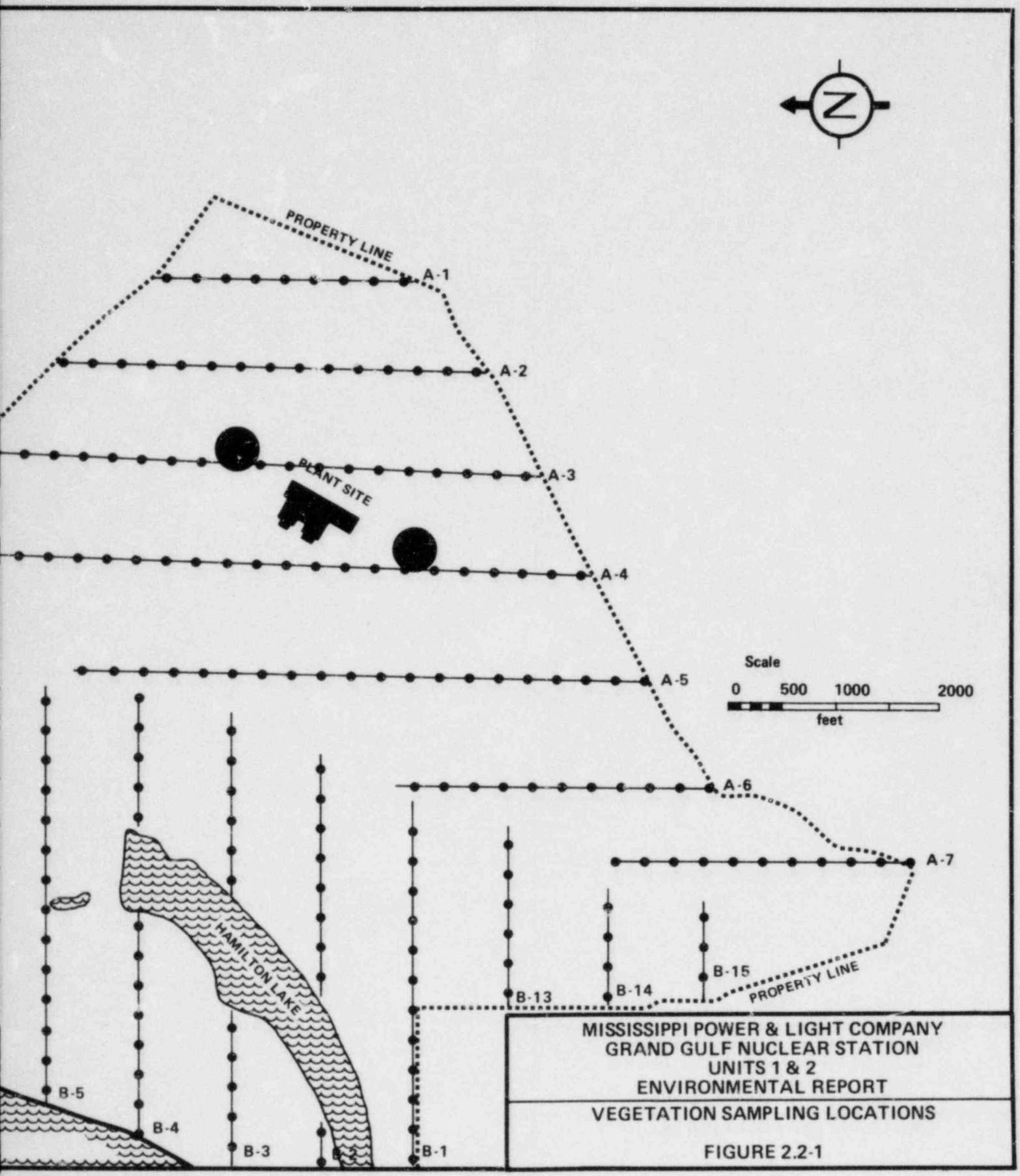
57. Freeman, B. O., 1976. Personal Communication, Chief, Fisheries Division, Mississippi Game and Fish Commission, Jackson.

58. Rogers, W. A., 1969. "A Summary of Fish Disease Cases Received Over a Five-Year Period at the Southeastern Cooperative Fish Disease Laboratory." Presented at 23rd Annual Conference, Southeastern Association of Game and Fish Commissioners, Mobile. (Mimeograph Copy).

59. Allison, R. and H. D. Kelley, 1963. "An Epizootic of Ichthyophthirus multifilies in a River Fish Population." Progressive Fish Culturist 19(2): 58-63.

60. Bailey, R. M. (Chairman), 1970. "A List of Common and Scientific Names of Fishes from the United States and Canada," 3rd Edition. American Fisheries Society, Special Publication No. 6.

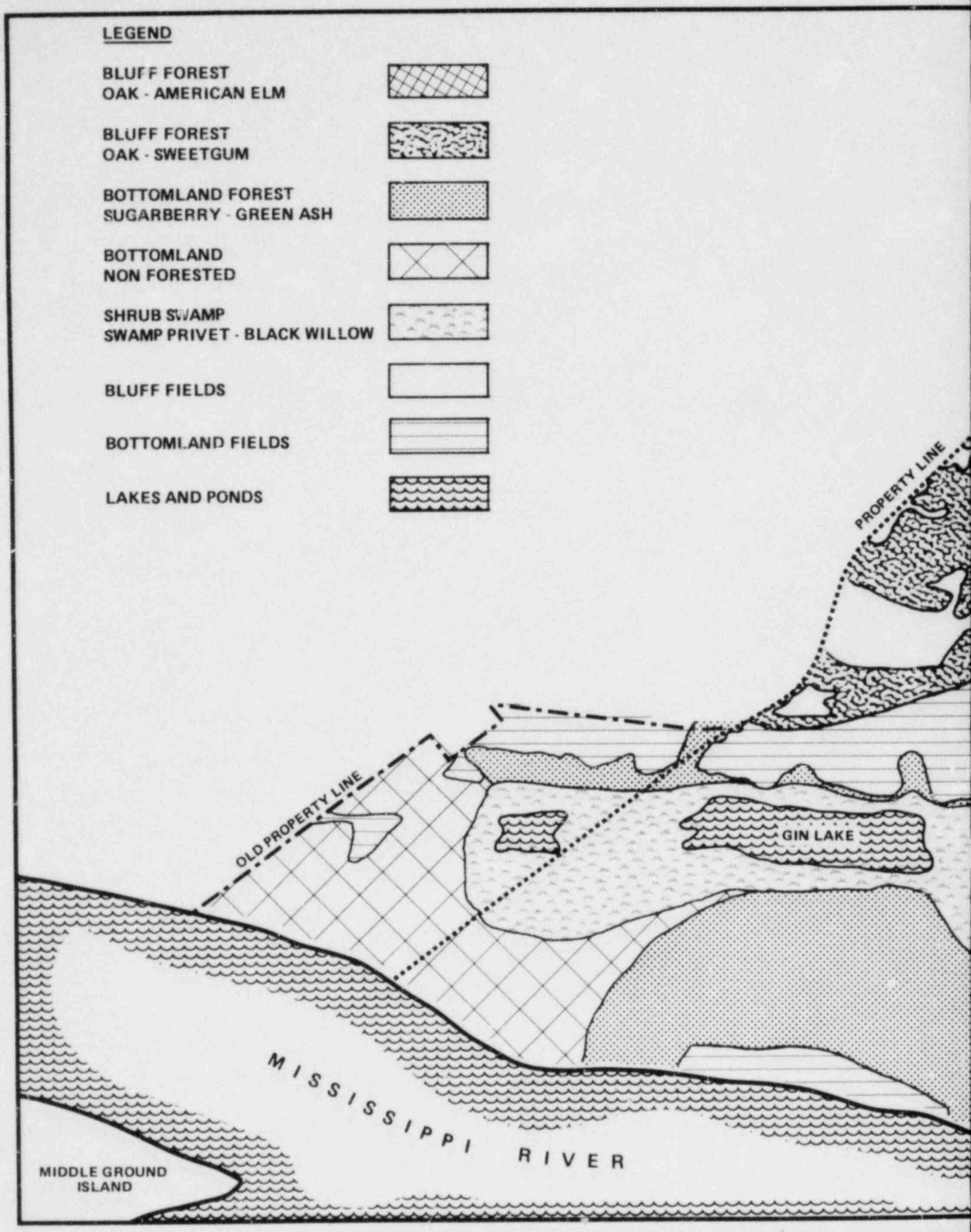

LEGEND
A-1
VEGETATION SAMPLING TRANSECT AND NUMBER
VEGETATION SAMPLING PLOT
PROPERTY LINE
OLD PROPERTY LINE
GIN LAKE
B-12
B-11
B-10
B-9
B-8
B-7
B-6
MISSISSIPPI RIVER
MIDDLE GROUND ISLAND

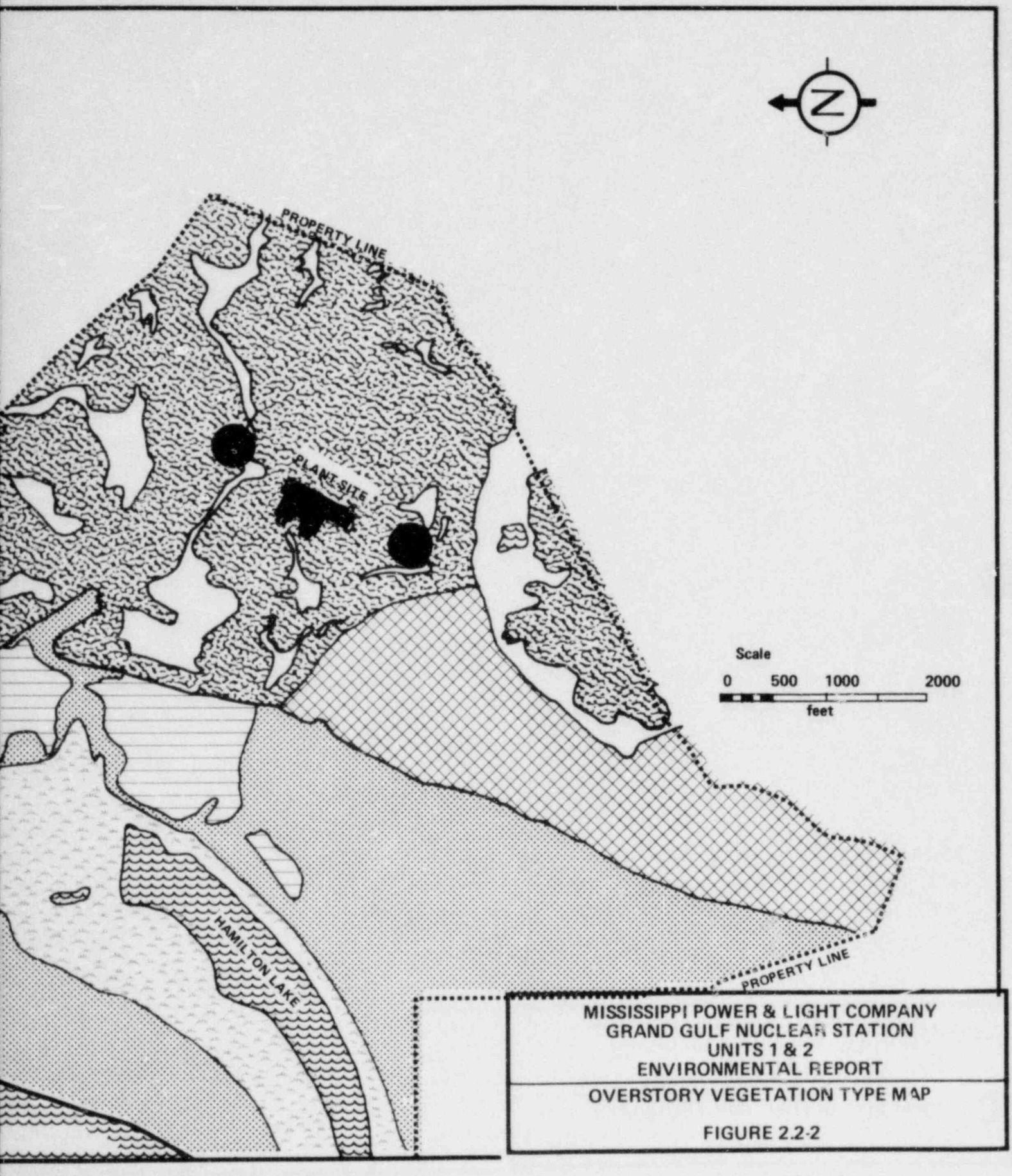


MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

VEGETATION SAMPLING LOCATIONS

FIGURE 2.2-1


LEGEND
BLUFF FOREST
OAK - AMERICAN ELM
BLUFF FOREST
OAK - SWEETGUM
BOTTOMLAND FOREST
SUGARBERRY - GREEN ASH
BOTTOMLAND
NON FORESTED
SHRUB SWAMP
SWAMP PRIVET - BLACK WILLOW
BLUFF FIELDS
BOTTOMLAND FIELDS
LAKES AND PONDS
PROPERTY LINE
OLD PROPERTY LINE
GIN LAKE
MISSISSIPPI RIVER
MIDDLE GROUND
ISLAND



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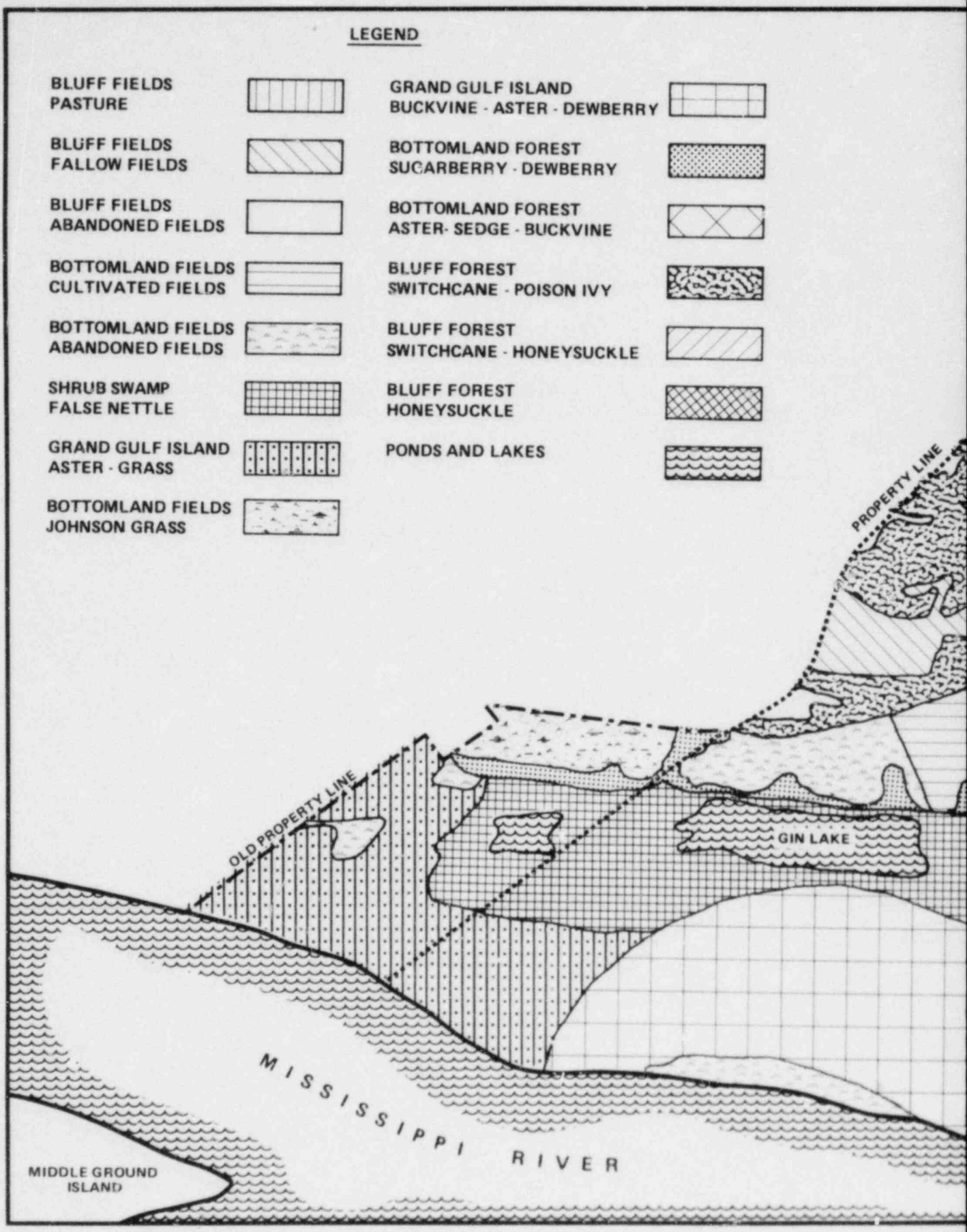
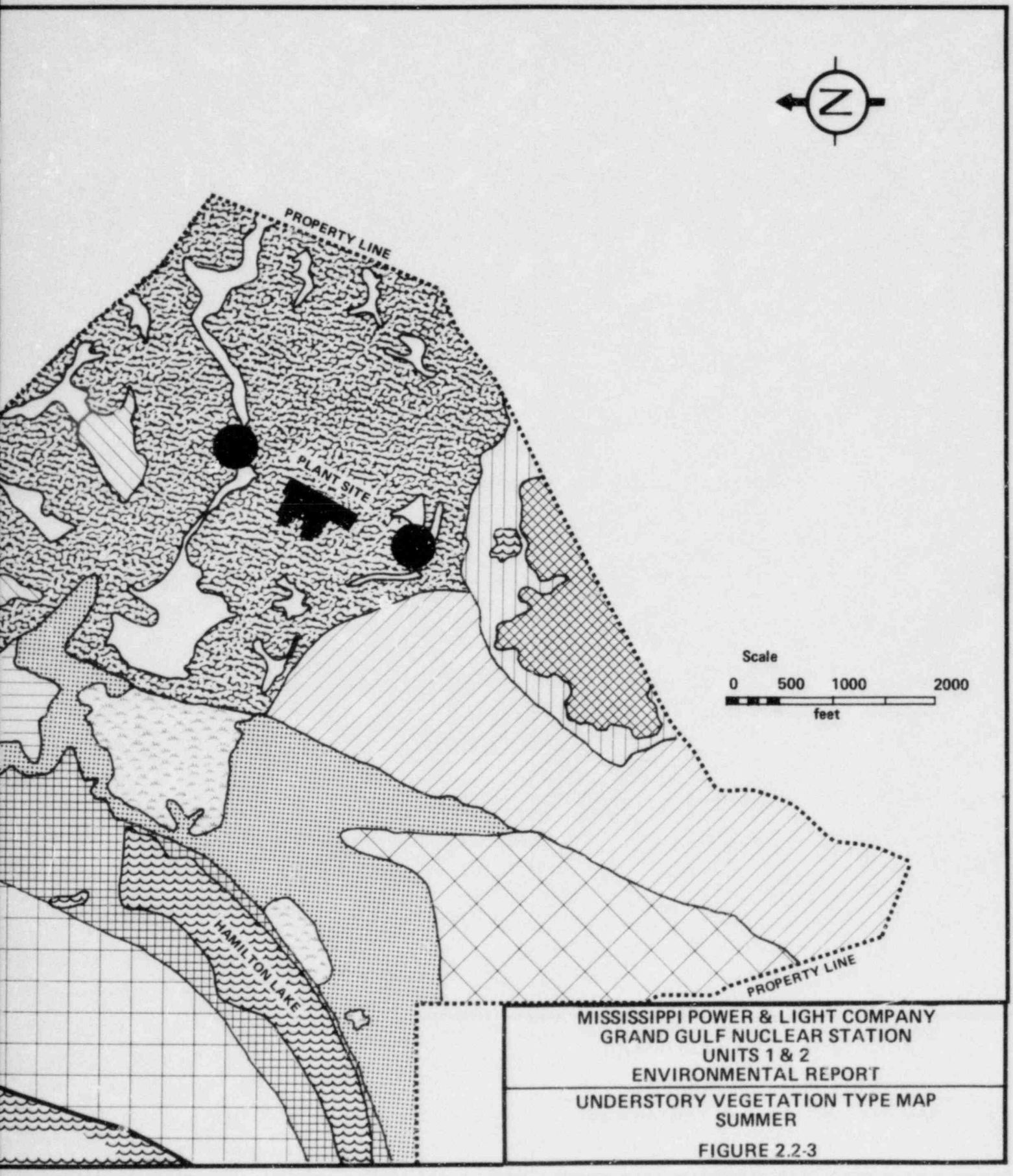
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

OVERSTORY VEGETATION TYPE MAP

FIGURE 2.2-2


LEGEND
BLUFF FIELDS PASTURE
BLUFF FIELDS FALLOW FIELDS
BLUFF FIELDS ABANDONED FIELDS
BOTTOMLAND FIELDS CULTIVATED FIELDS
BOTTOMLAND FIELDS ABANDONED FIELDS
SHRUB SWAMP FALSE NETTLE
GRAND GULF ISLAND ASTER - GRASS
BOTTOMLAND FIELDS JOHNSON GRASS
GRAND GULF ISLAND BUCKVINE - ASTER - DEWBERRY
BOTTOMLAND FOREST SUGARBERRY - DEWBERRY
BOTTOMLAND FOREST ASTER- SEDGE - BUCKVINE
BLUFF FOREST SWITCHCANE - POISON IVY
BLUFF FOREST SWITCHCANE - HONEYSUCKLE
BLUFF FOREST HONEYSUCKLE
PONDS AND LAKES
PROPERTY LINE
OLD PROPERTY LINE
GIN LAKE
MISSISSIPPI RIVER
MIDDLE GROUND ISLAND



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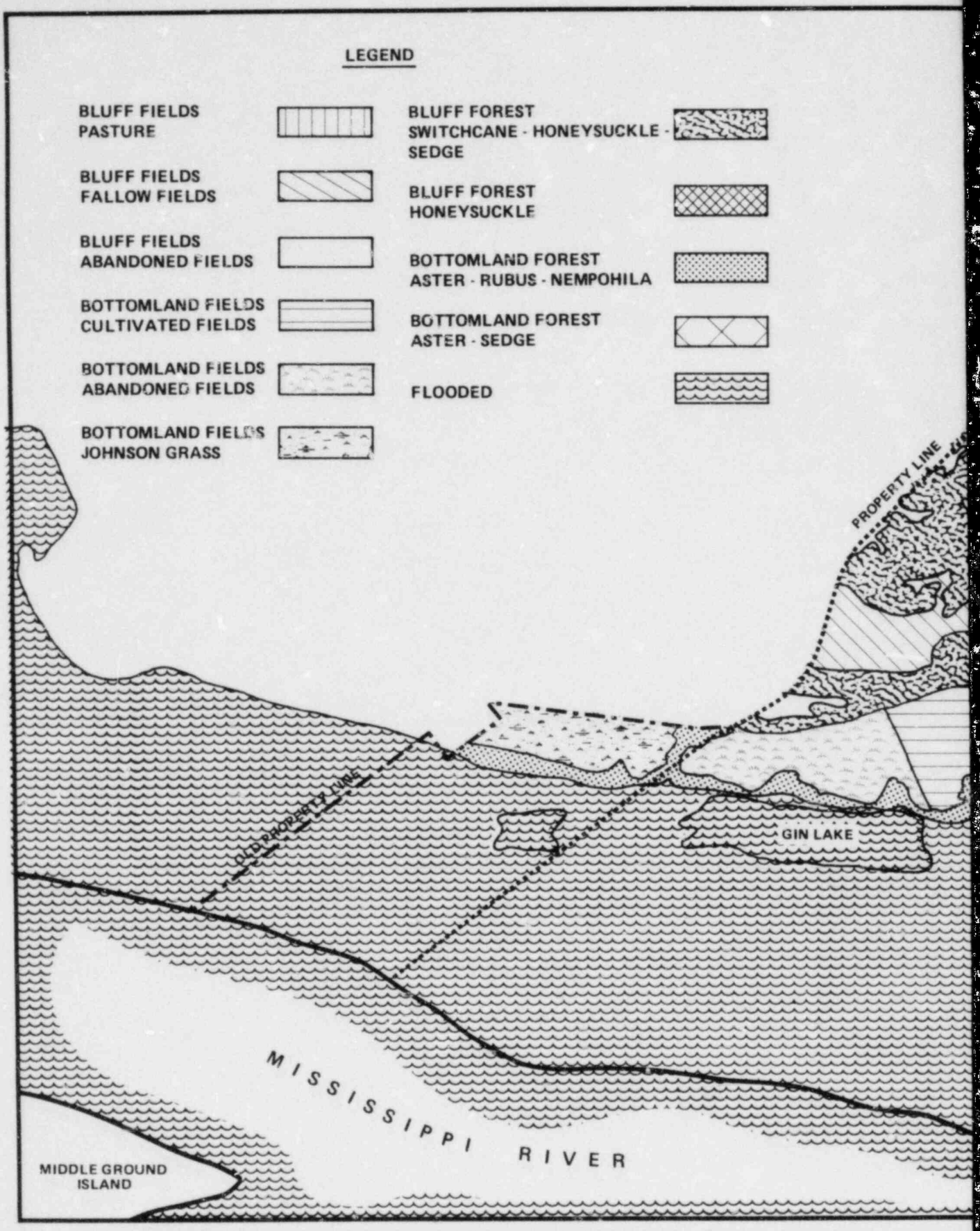
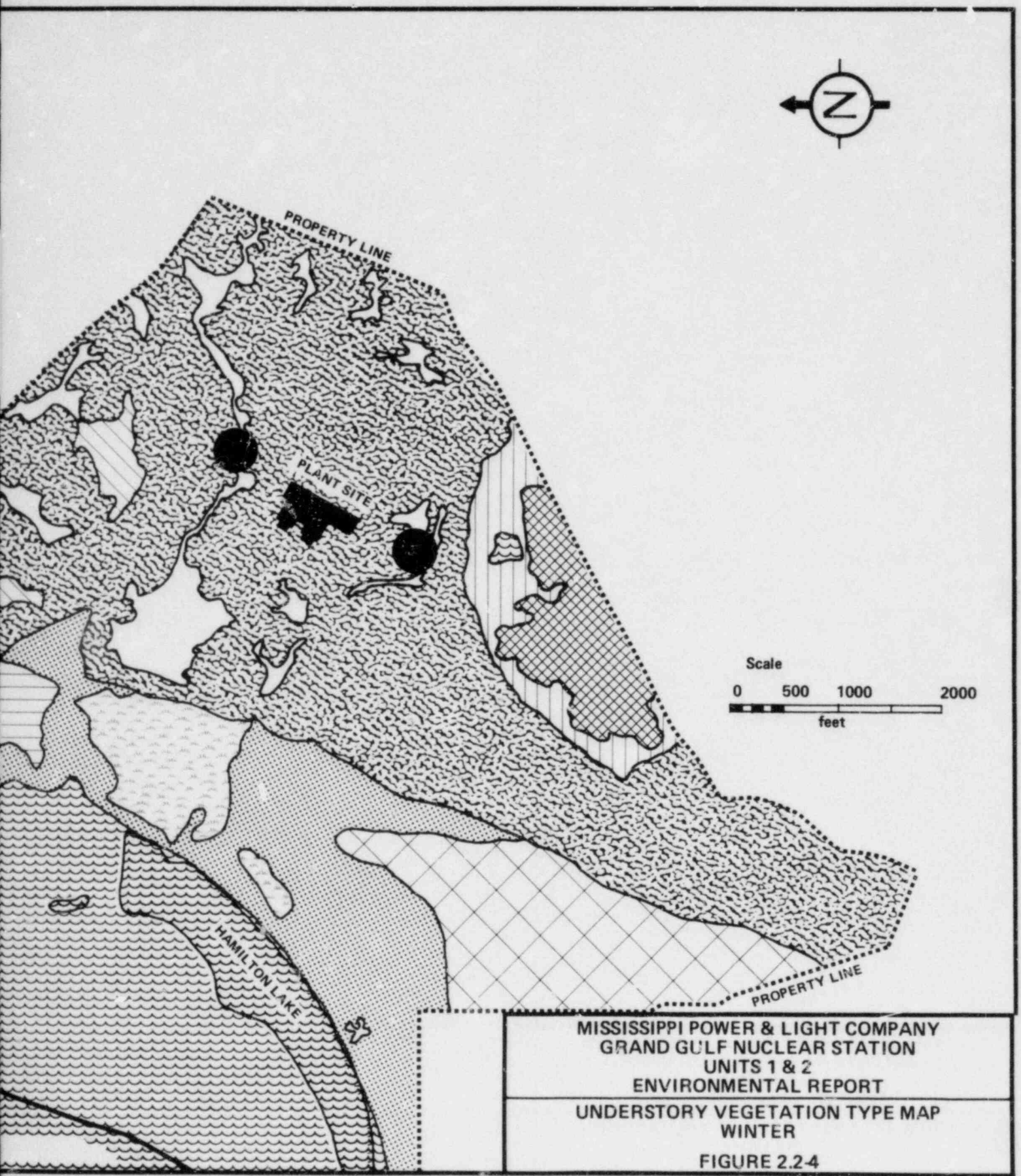
UNITS 1 & 2
ENVIRONMENTAL REPORT

UNDERSTORY VEGETATION TYPE MAP
SUMMER

FIGURE 2.2-3


LEGEND
BLUFF FIELDS PASTURE
BLUFF FIELDS FALLOW FIELDS
BLUFF FIELDS ABANDONED FIELDS
BOTTOMLAND FIELDS CULTIVATED FIELDS
BOTTOMLAND FIELDS ABANDONED FIELDS
BOTTOMLAND FIELDS JOHNSON GRASS
BLUFF FOREST SWITCHCANE - HONEYSUCKLE - SEDGE
BLUFF FOREST HONEYSUCKLE
BOTTOMLAND FOREST ASTER - RUBUS - NEMPOHILA
BOTTOMLAND FOREST ASTER - SEDGE
FLOODED
PROPERTY LINE
OLD PROPERTY LINE
GIN LAKE
MISSISSIPPI RIVER
MIDDLE GROUND ISLAND



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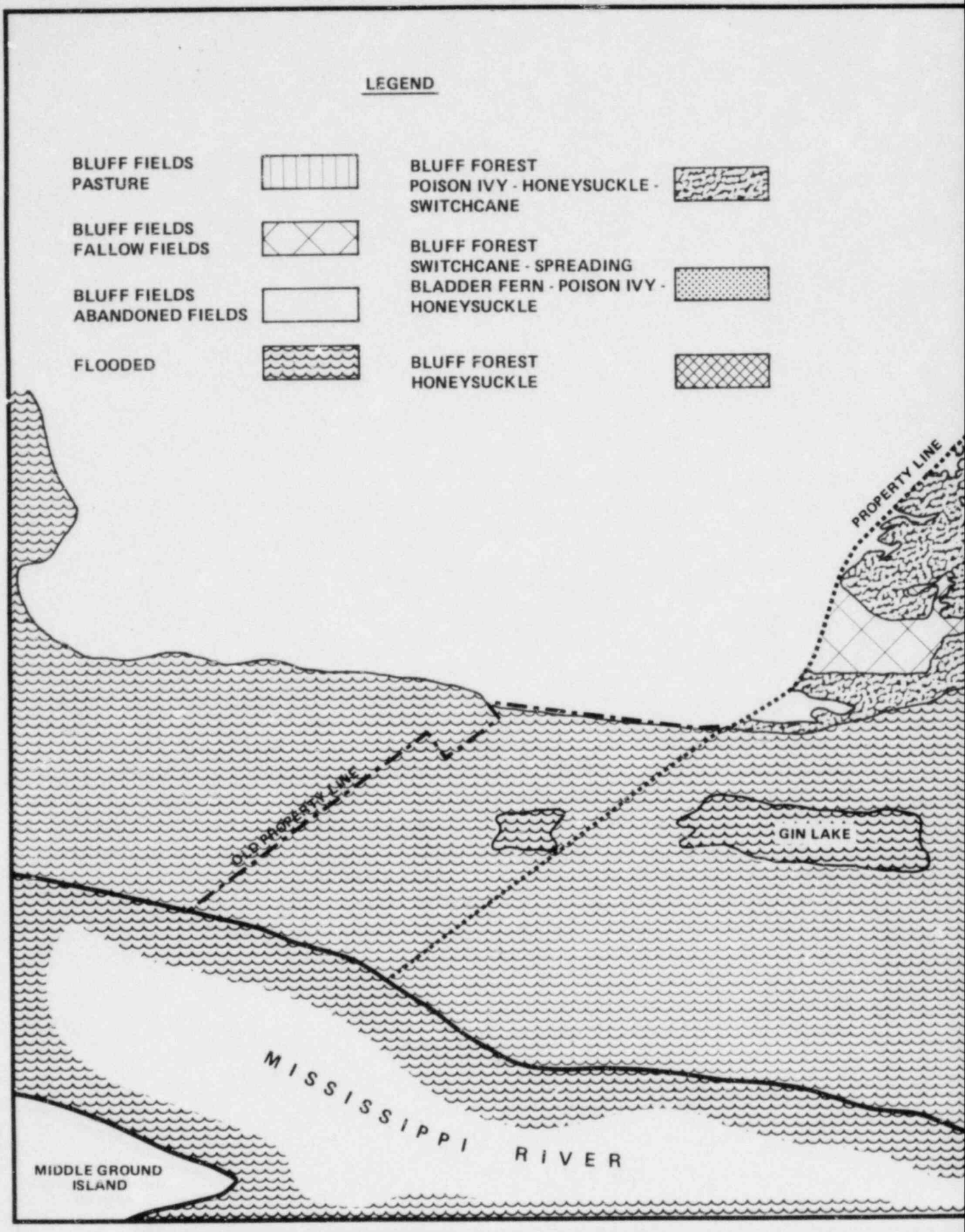
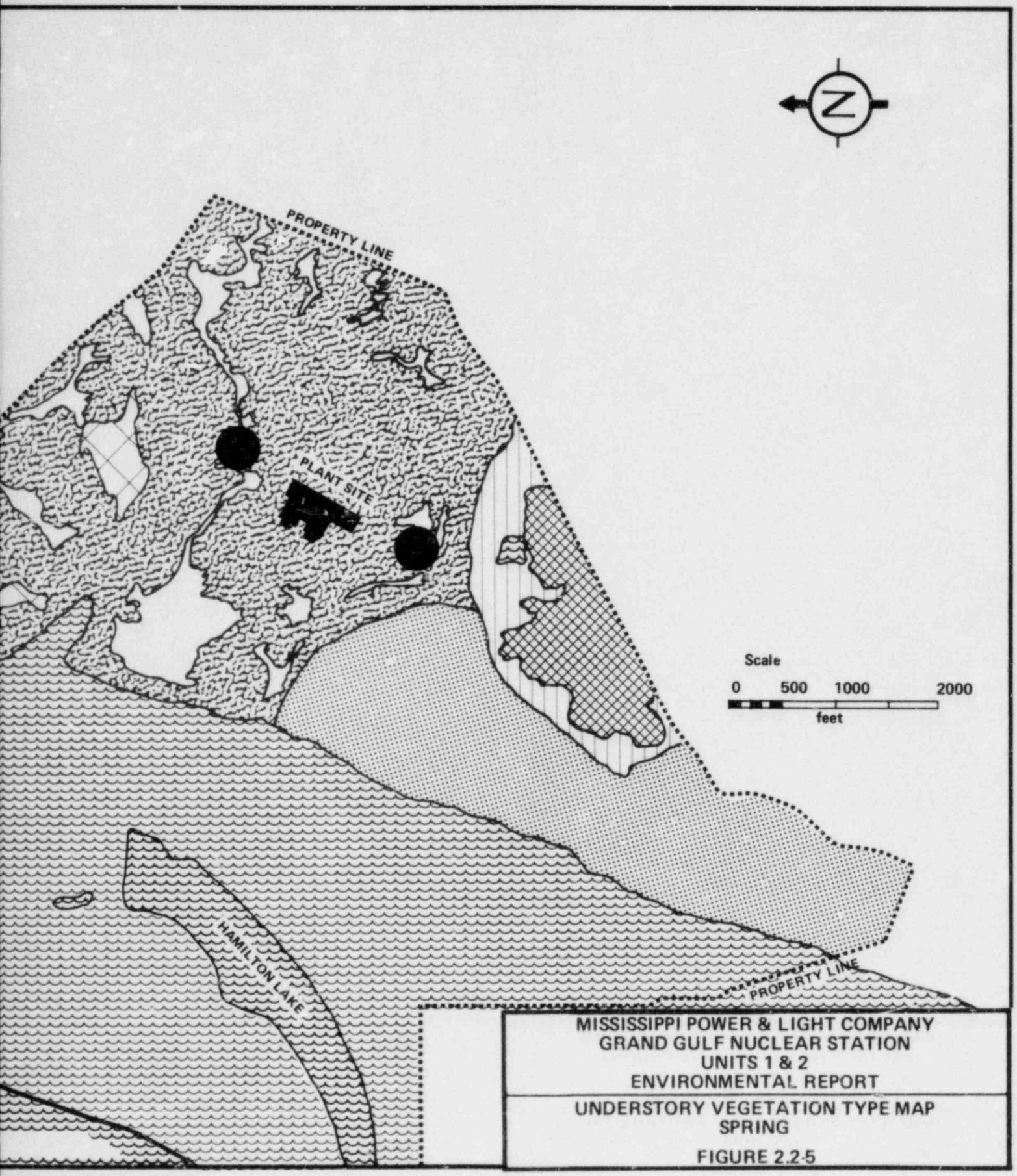
UNITS 1 & 2
ENVIRONMENTAL REPORT

UNDERSTORY VEGETATION TYPE MAP
WINTER

FIGURE 2.2-4


LEGEND
BLUFF FIELDS
PASTURE
BLUFF FIELDS
FALLOW FIELDS
BLUFF FIELDS
ABANDONED FIELDS
FLOODED
BLUFF FOREST
POISON IVY - HONEYSUCKLE - SWITCHCANE
BLUFF FOREST
SWITCHCANE - SPREADING BLADDER FERN - POISON IVY - HONEYSUCKLE
BLUFF FOREST
HONEYSUCKLE
PROPERTY LINE
OLD PROPERTY LINE
GIN LAKE
MISSISSIPPI RIVER
MIDDLE GROUND ISLAND



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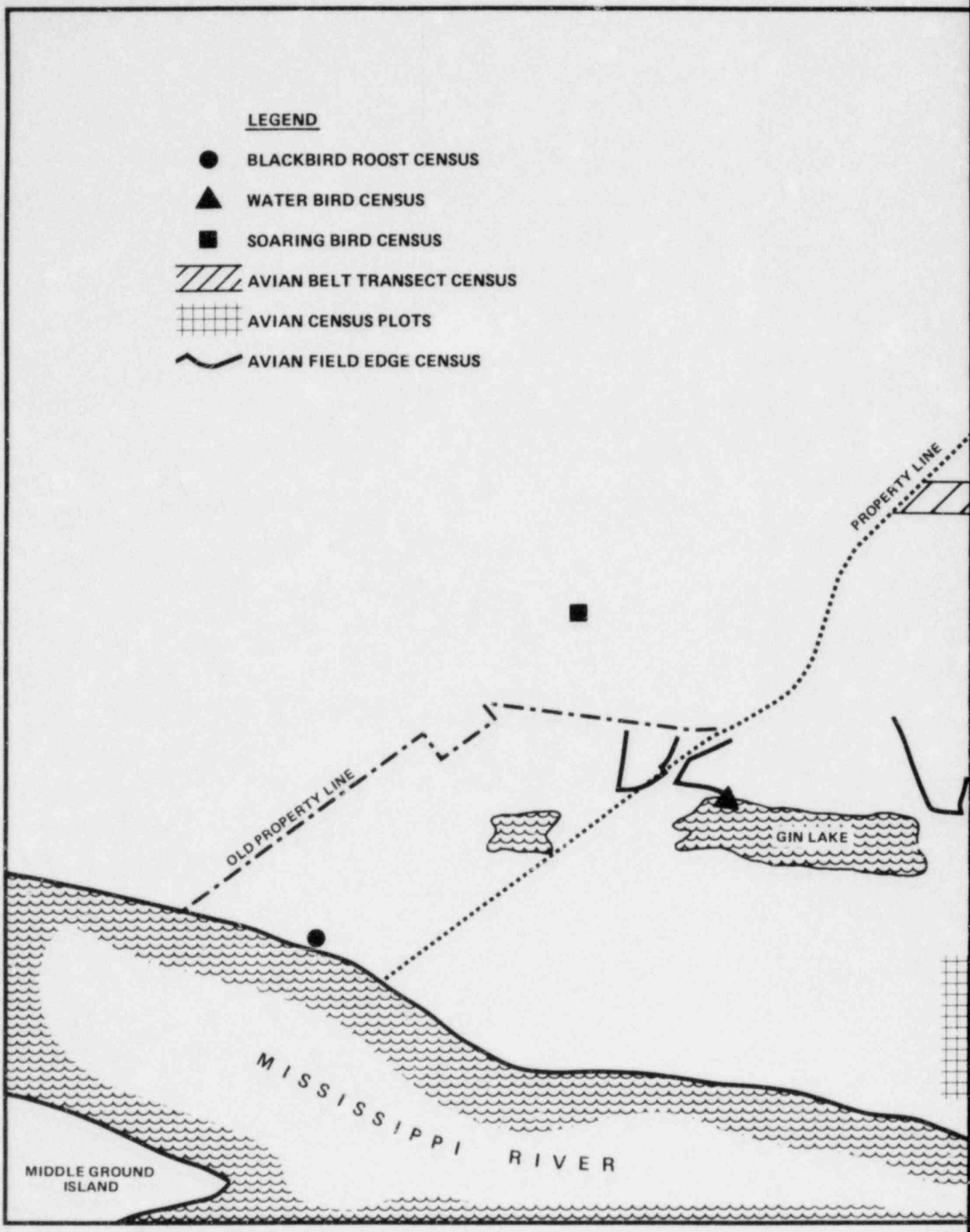
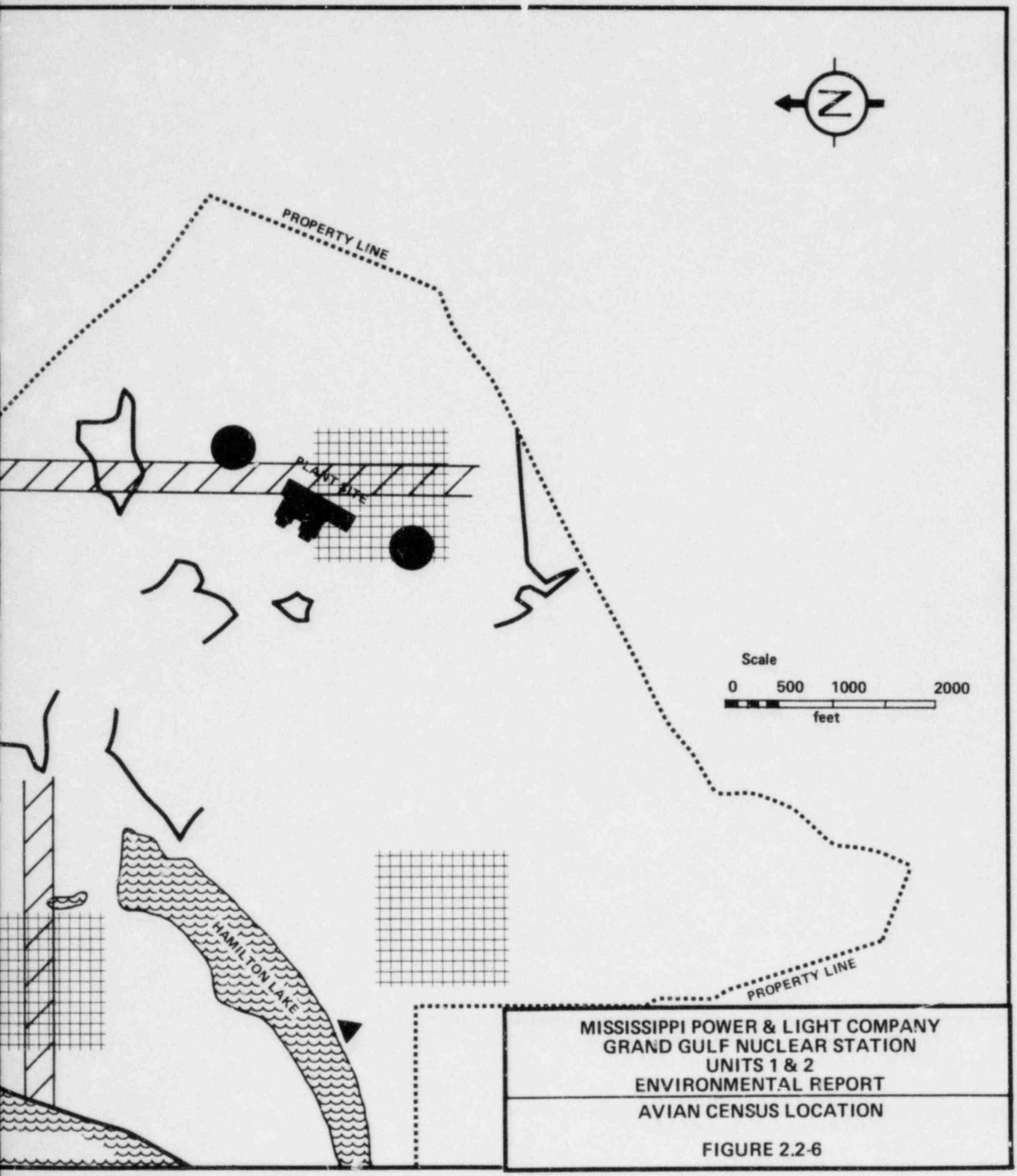
UNITS 1 & 2
ENVIRONMENTAL REPORT

UNDERSTORY VEGETATION TYPE MAP
SPRING

FIGURE 2.2-5


LEGEND
BLACKBIRD ROOST CENSUS
WATER BIRD CENSUS
SOARING BIRD CENSUS
AVIAN BELT TRANSECT CENSUS
AVIAN CENSUS PLOTS
AVIAN FIELD EDGE CENSUS
PROPERTY LINE
OLD PROPERTY LINE
GIN LAKE
MISSISSIPPI RIVER
MIDDLE GROUND ISLAND



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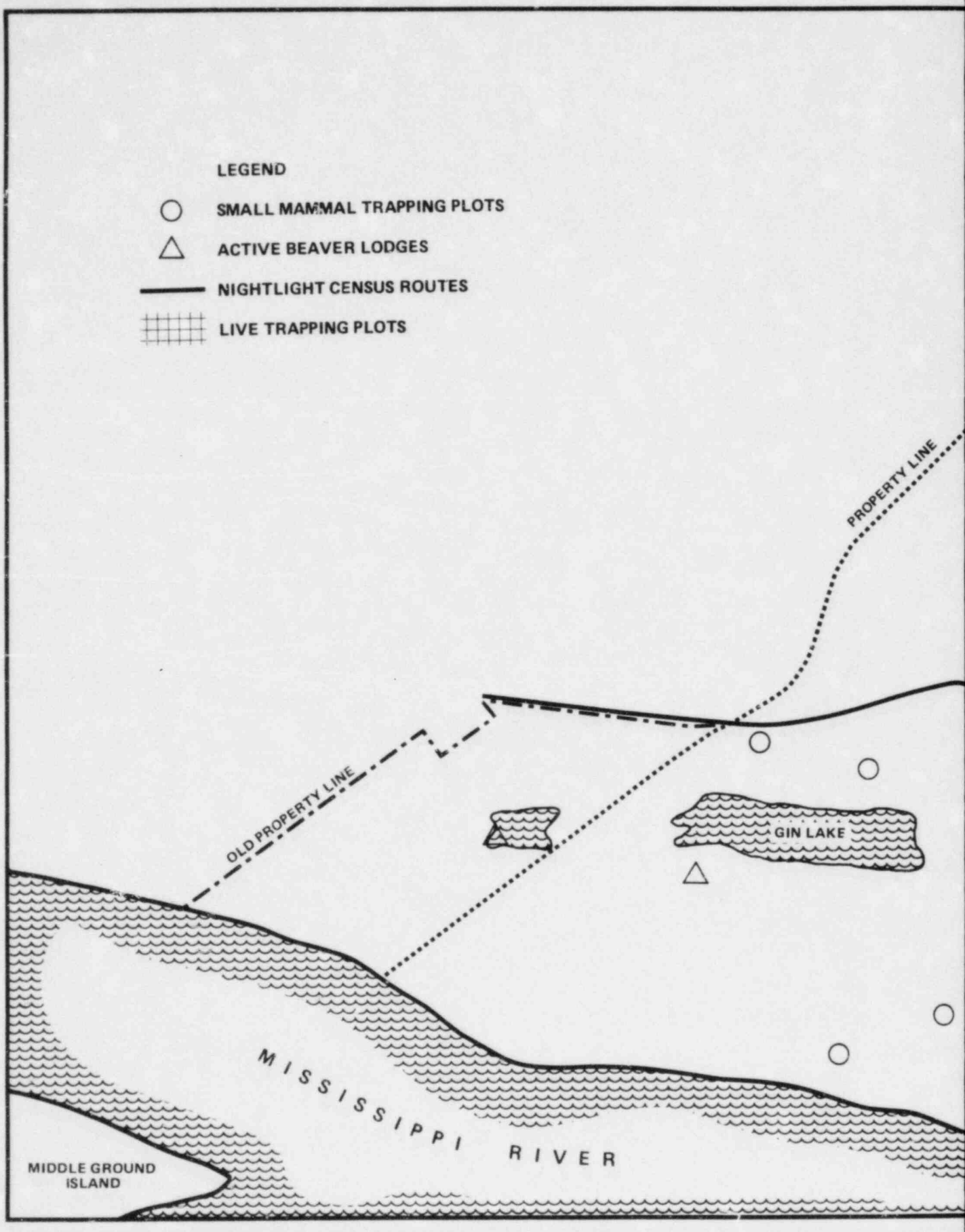
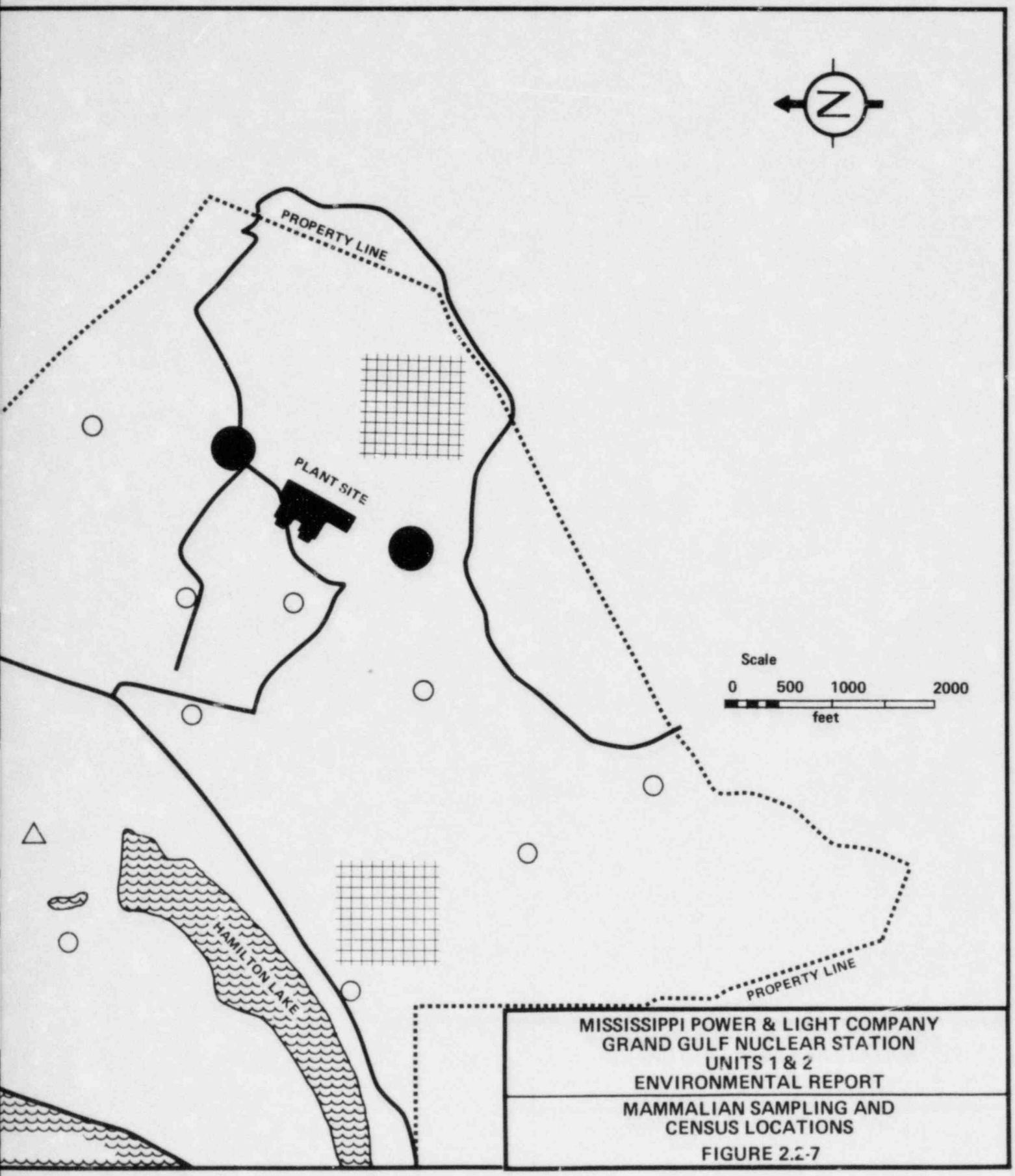
UNITS 1 & 2
ENVIRONMENTAL REPORT

AVIAN CENSUS LOCATION

FIGURE 2.2-6


LEGEND
SMALL MAMMAL TRAPPING PLOTS
ACTIVE BEAVER LODGES
NIGHTLIGHT CENSUS ROUTES
LIVE TRAPPING PLOTS
PROPERTY LINE
OLD PROPERTY LINE
GIN LAKE
MISSISSIPPI RIVER
MIDDLE GROUND ISLAND



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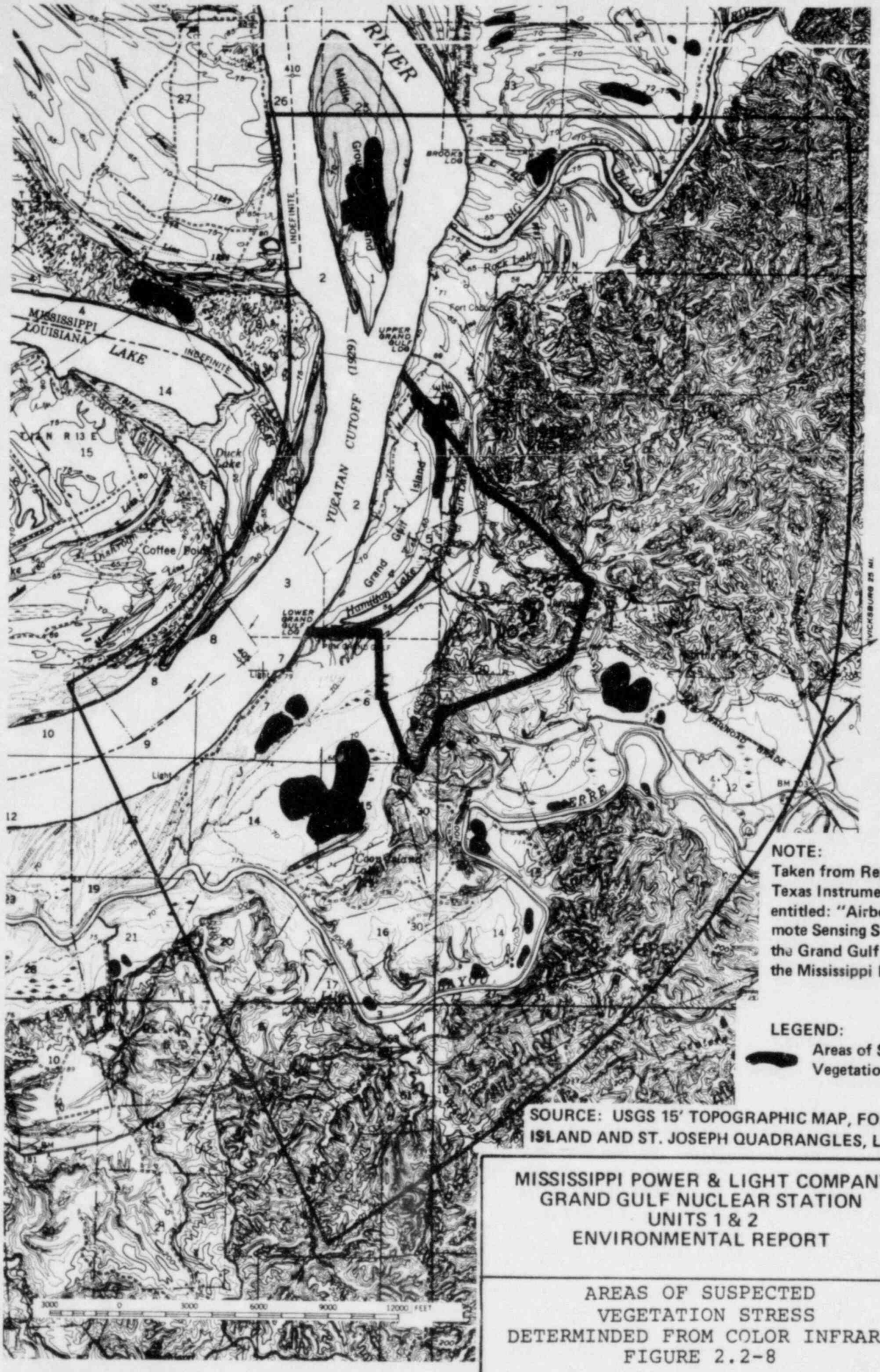
MAMMALIAN SAMPLING AND
CENSUS LOCATIONS

FIGURE 2.2-7



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NOTE:
Taken from Report by Texas Instruments, Inc. entitled: "Airborne Remote Sensing Survey of the Grand Gulf Area on the Mississippi River."

LEGEND:
Areas of Suspected Vegetation Stress.

SOURCE: USGS 15' TOPOGRAPHIC MAP, FOR DAVIS ISLAND AND ST. JOSEPH QUADRANGLES, LA. - MS.

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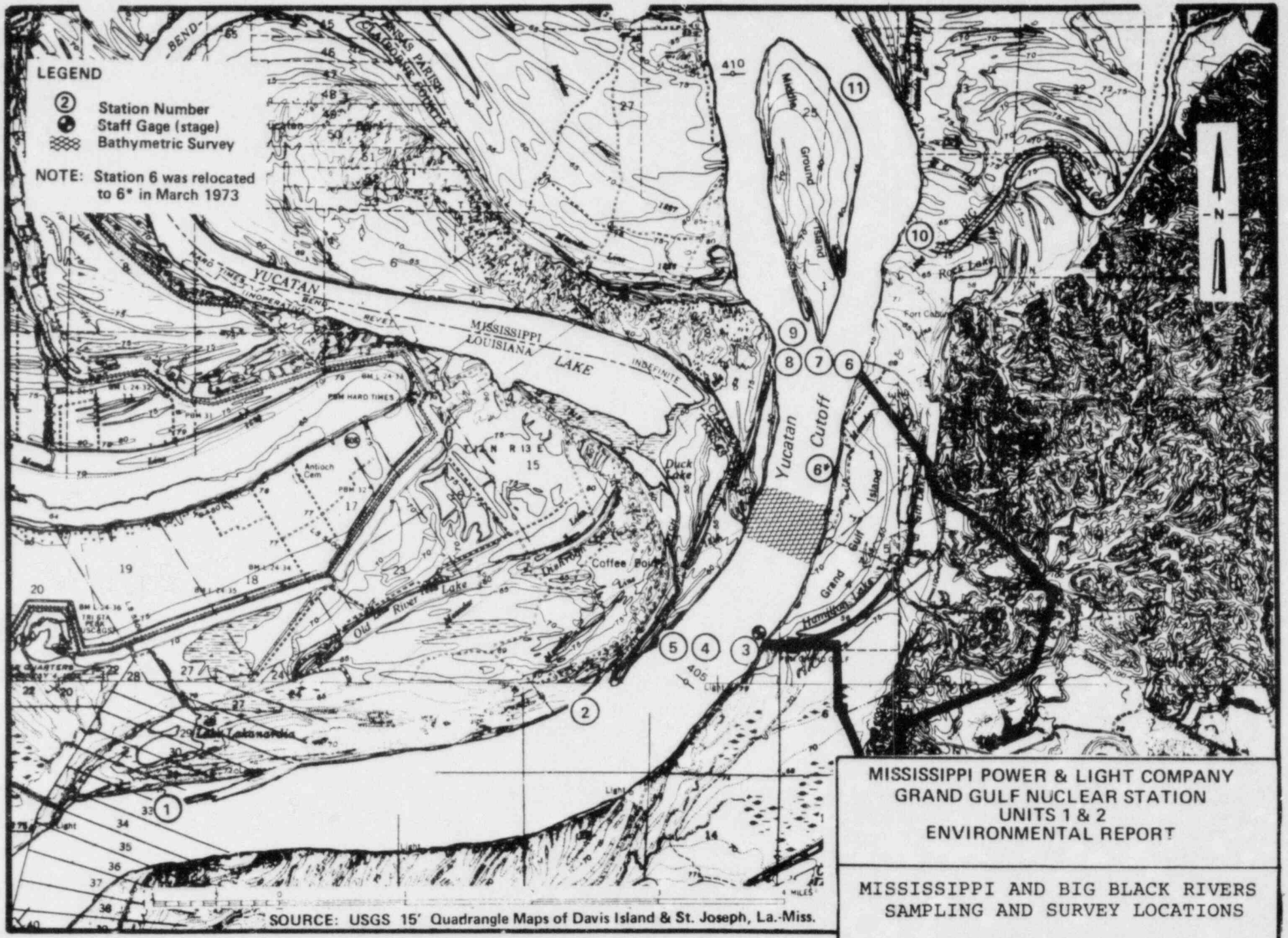
UNITS 1 & 2
ENVIRONMENTAL REPORT

AREAS OF SUSPECTED
VEGETATION STRESS
DETERMINDED FROM COLOR INFRARED
FIGURE 2.2-8



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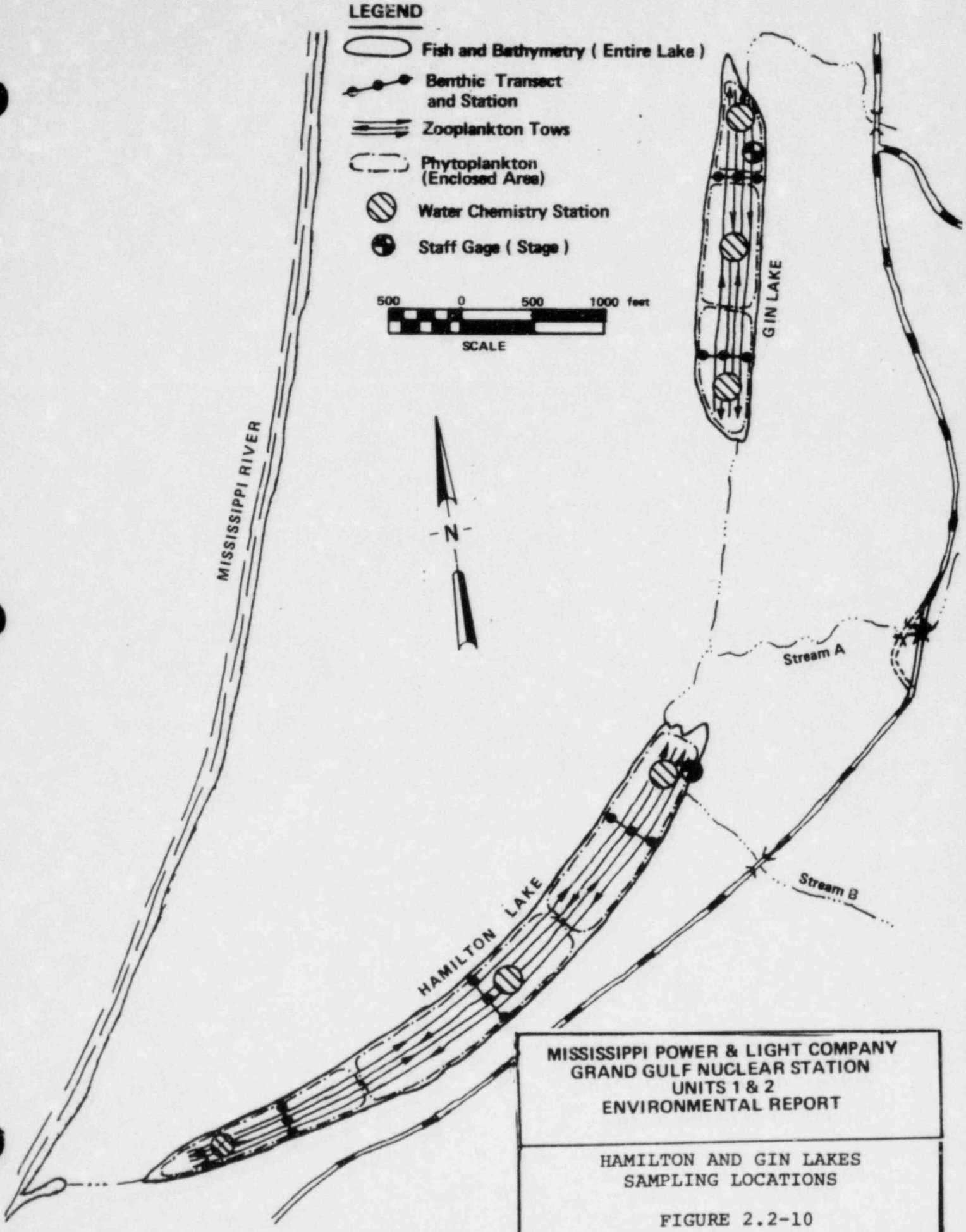
ENVIRONMENTAL REPORT

MISSISSIPPI AND BIG BLACK RIVERS
SAMPLING AND SURVEY LOCATIONS

FIGURE 2.2-9



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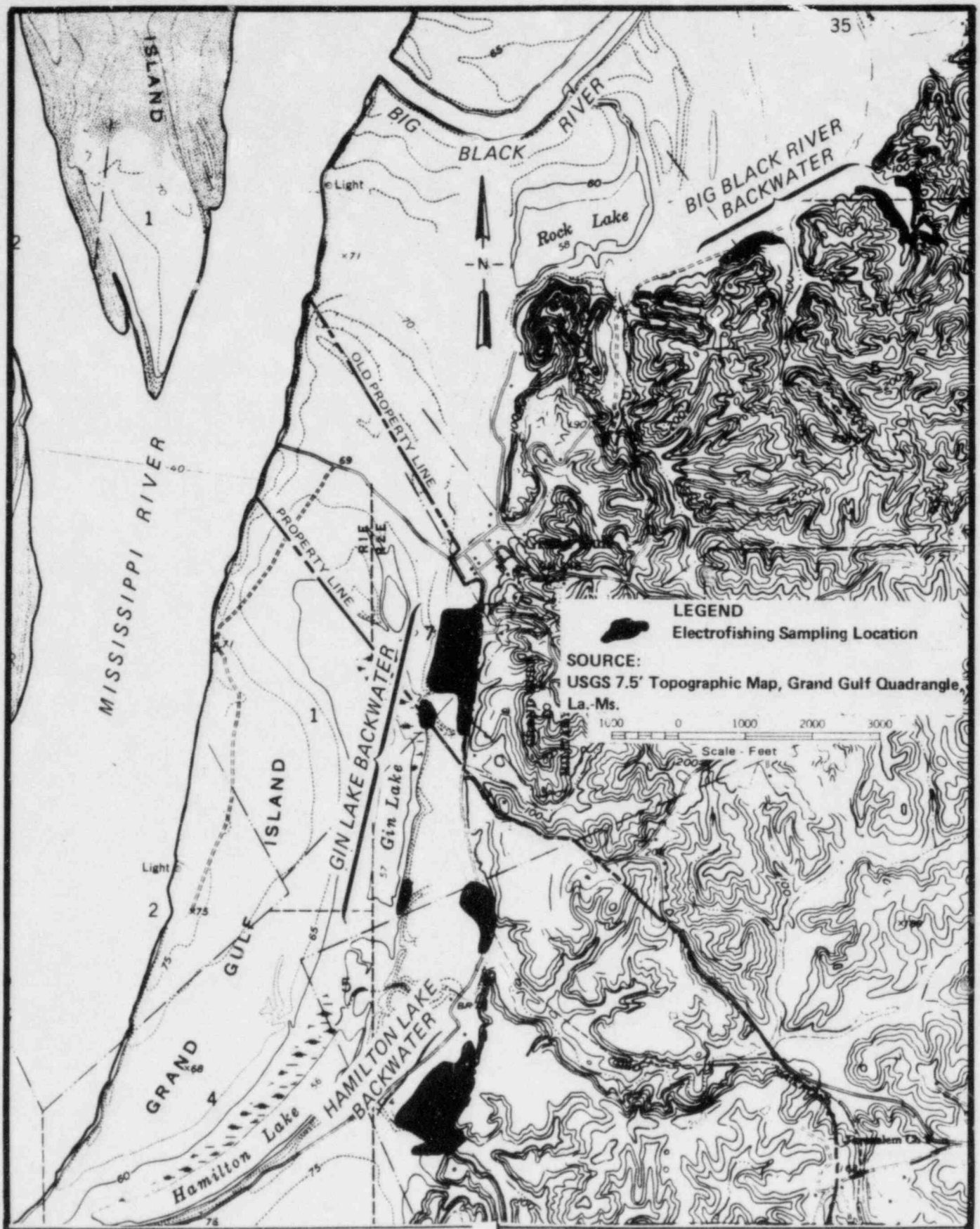
HAMILTON AND GIN LAKES
SAMPLING LOCATIONS

FIGURE 2.2-10



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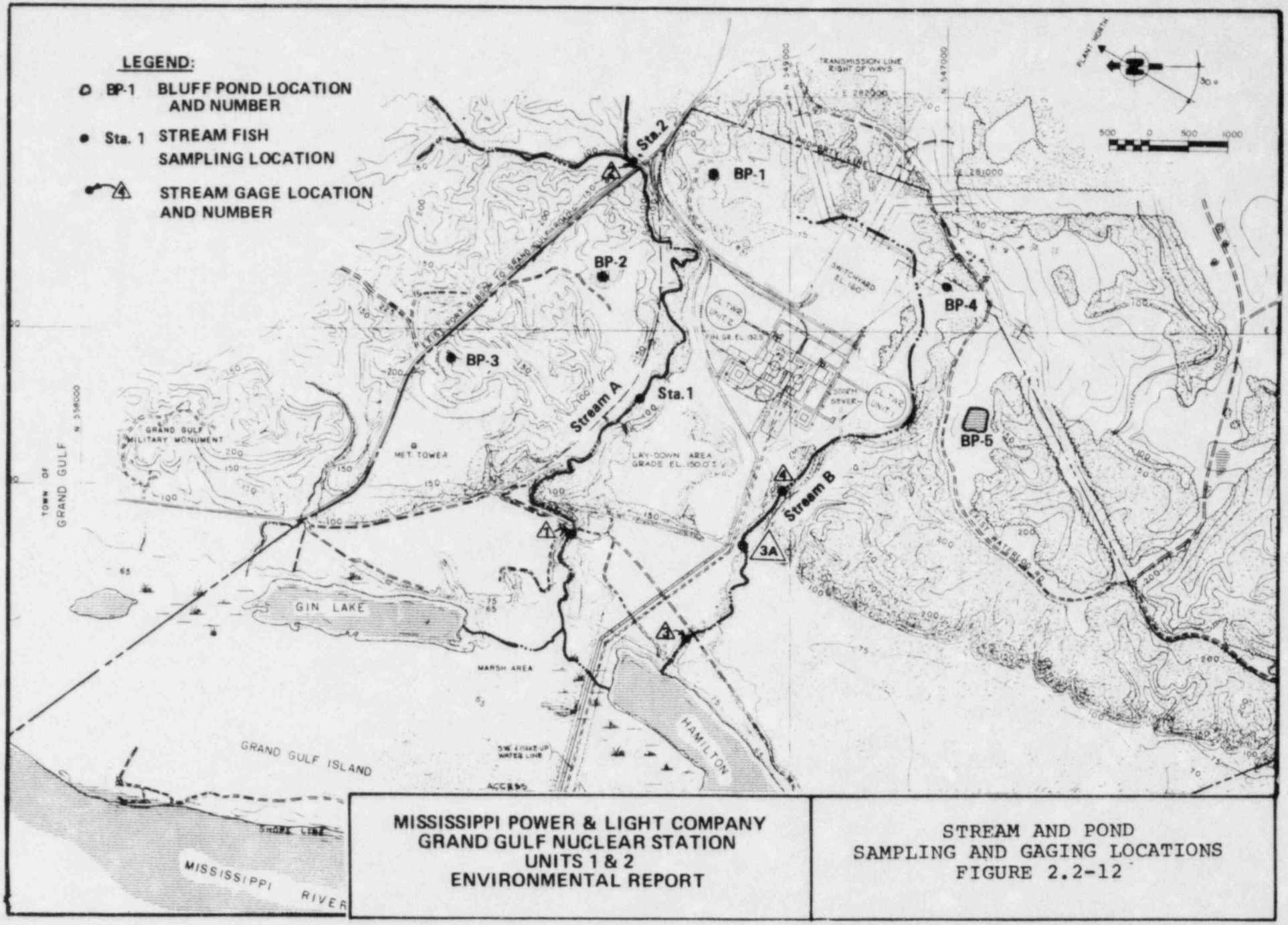
ENVIRONMENTAL REPORT

ELECTROFISHING SAMPLING LOCATIONS
DURING FLOOD CONDITIONS

FIGURE 2.2-11



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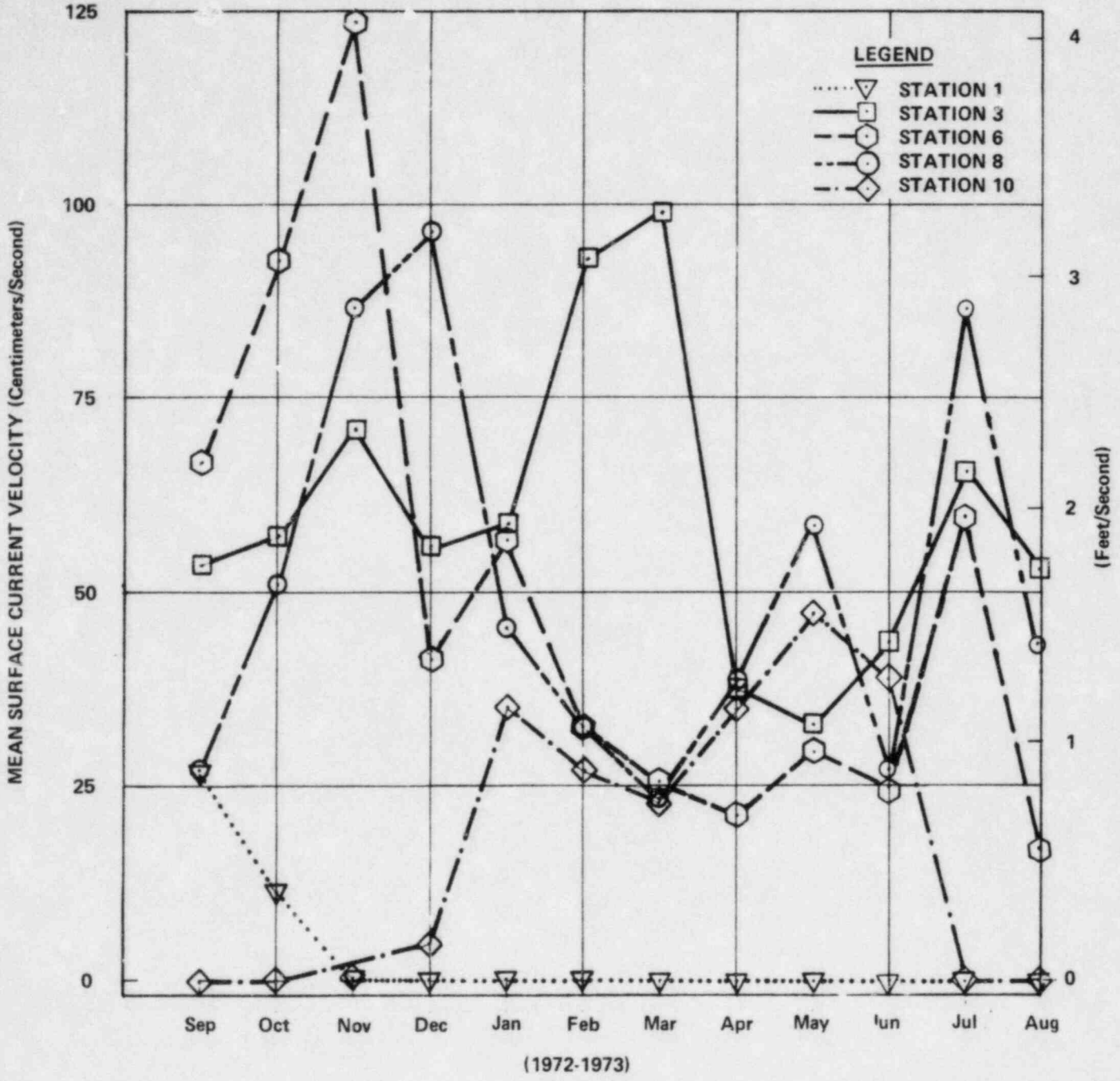
UNITS 1 & 2
ENVIRONMENTAL REPORT

STREAM AND POND
SAMPLING AND GAGING LOCATIONS
FIGURE 2.2-12



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	MEAN SURFACE CURRENT VELOCITY AT MISSISSIPPI RIVER STATIONS FIGURE 2.2-13

2.3 METEOROLOGY

2.3.1 Regional Climatology

2.3.1.1 General Climate

Meteorological measurements were not made prior to 1972 at the Grand Gulf site. Therefore, this description of the general climate of the region is based primarily on climatological records for Vicksburg and Jackson, Mississippi. Topographical considerations and examination of the records indicate that meteorological conditions at both Vicksburg and Jackson are representative of the general climate of the region encompassing the site.

Since Vicksburg is the closer of the two stations and borders the Mississippi River, the tables and figures included are based primarily on Vicksburg data when the period of record and observational procedures are considered adequate. Otherwise, Jackson data are presented.

The climate of southwestern Mississippi is humid and subtropical with a short cold season and a relatively long warm season. The predominant air mass over the region during most of the year is maritime tropical with origins over the Gulf of Mexico. In the winter, occasional southward movements of continental polar air from Canada bring colder and drier air into Mississippi. However, cold spells seldom last over 3 or 4 days.

In summer, the region is almost wholly dominated by the westward extension of the Bermuda High, a subtropical, semipermanent anticyclone. The prevailing southerly winds provide a generous supply of moisture and this, combined with thermal instability, produces frequent afternoon and evening showers and thundershowers over the region. The convective thundershowers of the summer season are more numerous than frontal type thunderstorms. However, the thunderstorms associated with the occasional polar front activity in late winter and early spring are more severe and sometimes produce tornadoes.

Mississippi is south of the average track of winter cyclones, but occasionally one moves over the State. In some winters a succession of such cyclones develops in the Gulf of Mexico or in Texas and moves over or near the State. Also the State is occasionally in the path of tropical storms or hurricanes (Ref. 1).

The general airflow over the region is from the southerly sectors during much of the year, although the prevailing direction may be from one of the northerly sectors during some months. The net air movement can be deduced from the annual resultant wind values for Jackson, Mississippi shown in Table 2.3.1. (Ref. 2).

Annual mean wind speed at Jackson is 7.7 mph with a maximum monthly mean of 9.6 mph in March and a minimum monthly mean of 5.8 mph in August. For Vicksburg the annual mean wind speed is 8.2 mph with a maximum monthly mean of 9.8 mph in January and a minimum monthly mean of 6.6 mph in August. (Refs. 3 and 4.)

The temperature regime of the region can be described by the data shown in Tables 2.3.2 and 2.3.3. These data suggest that the Mississippi River exerts a modifying influence on the air temperatures at locations near the river. The lower maxima and higher minima at Vicksburg as compared to those at Jackson indicate this. The differences cannot be explained by the difference in the years of record used for the two tables; similar differences occur when identical years (1931-1960) of record are used.

Climatic records of humidity in the region are shown in Table 2.3.4. These data show that relative humidity in the region is high throughout the year. Nighttime relative humidities are highest in summer and fall and lowest in winter. Daytime humidities are highest in winter. Seasonal variations are in the vicinity of 5 to 10 percent. On an annual basis, relative humidities below 50 percent occur at Jackson only 19 percent of the time (Ref. 5). Highest relative humidities occur in the early morning hours, averaging greater than 80 percent during all months. Lowest relative humidities occur during early and mid afternoon with noontime averages ranging from the 50's to mid-60's for all months.

Table 2.3.5 presents cooling equipment design wet and dry bulb temperatures for the site. Temperature data collected at Jackson, Mississippi are considered to be representative of the site.

Mean annual precipitation in the region ranges from about 50 inches in northwestern Mississippi to 65 inches in the southeastern part of the State. During the freeze-free season, rainfall ranges from about 24 inches in the northwest to about 37 inches in the southeast, but during winter the precipitation maximum is centered in the northwest with the minimum in the coastal counties. The fall months are the driest of the year.

While snowfall is not of much economic importance, it is not a rare event in Mississippi. During the 60 years from 1898 through 1957, measurable snow or sleet fell on some part of the State in all but 3 years. During these 60 years snow or sleet fell in January in 37 years, in February in 31 years. Along the latitude of the site (about 32 N) snow has fallen in about 30 percent of the years. (Ref. 1.)

Local (site) meteorological conditions are expected to result almost entirely from synoptic-scale atmospheric processes. There is

some evidence of channeling of extremely low level (less than 70 feet above grade) winds with a westerly component into a trajectory along the river. This phenomena should have no effect on dispersion of effluents from the plant since the site is east of the area affected.

2.3.1.2 Regional Meteorological Conditions for Design and Operating Bases

2.3.1.2.1 Severe Weather Phenomena

a. Hurricanes

During the period 1885 to 1975 there were 88 tropical cyclones which affected the Middle Gulf Coast (Louisiana, Mississippi, and Alabama). Of these, 40 (45 percent) were of hurricane intensity and 48 (55 percent) were less than hurricane intensity. Table 2.3.6 presents a monthly breakdown of the 88 cyclones.

Tropical cyclones, including hurricanes, lose strength as they move inland from the coast and the greatest concern for an inland site is possible flooding due to excessive rainfall. The extremes for rainfall presented elsewhere include possible hurricane effects.

The small diameter, extremely intense Camille hurricane (1969), whose center passed less than 10 miles to the east of Jackson Municipal Airport, generated gusts at Jackson of only 67 mph. The top winds in this hurricane at points on the coast were estimated at over 170 mph (Ref. 6).

b. Tornadoes and Waterspouts

Tornadoes do occur in this area. A highly destructive tornado struck Vicksburg in December 1953. The annual average frequency of tornadoes during the years 1953-1962 in the vicinity varied from 1.1 to 1.5 per representative 1-degree square (about 4000 square miles). The estimated mean recurrence interval, using Thom's method, is about 1000 years (Ref. 7).

During the years 1950 through 1975 a total of 73 tornadoes touched down within a circle of 40 nautical miles radius centered on Grand Gulf, Mississippi. Of these, the mean path length was 7.73 miles and the mean path area was 0.43 square miles (Ref. 8). Using the point probability method with these data:

40 nautical miles = 46.06 miles

Total area of circle = $\pi(46.06)^2$ = 6665 sq. mi.

Average annual frequency = 73 ÷ 26 = 2.81

P = (0.43) x (2.81) ÷ 6665 = 0.000181

Mean recurrence interval = $\frac{1}{P}$ = 5525 years.

Waterspouts are similar to tornadoes but they do not form under the same meteorological conditions; they form over water bodies and do, on occasion, cross the coastline and penetrate several kilometers inland (Ref. 9). The water bodies in the vicinity of the Grand Gulf site are not likely to spawn waterspouts.

c. Thunderstorms

Table 2.3.7 presents the thunderstorm data for the region. The data for Vicksburg may be slightly less than actual conditions since the station was not manned 24 hours per day. Thunderstorm occurrences at the plant site are probably best represented by an interpolation between the data for Alexandria and Jackson.

About 56 percent of the thunderstorms in this area occur during the warm months (May-August). This indicates that the majority are air mass thunderstorms.

d. Lightning

Data on lightning stroke density is extremely sparse. Analysis has shown that the density per square mile is approximately one half the number of storm days from the isokeraunic map. This was partially confirmed by a two year count in a region with 27 storm days per year where the average stroke density was approximately 15 strokes per square mile per year (Ref. 10).

The annual mean number of thunderstorm days in the site area is estimated to be 66; therefore it is estimated that the annual lightning stroke density in the Grand Gulf site area is 33 strokes per square mile.

e. Hail

According to Visher (Ref. 11), hail occurs at the site about 2 days per year, with the most probable month of occurrence being April. Hail of a damaging nature occurs infrequently (Ref. 3).

f. High Air Pollution Potential

Atmospheric ventilation data for 1959 through 1962 (Ref. 12) from Jackson, Mississippi were used to determine air pollution potential estimates for the site. A tabu-

lation of daily mixing heights and mixing layer wind speeds for both morning and afternoon was obtained from the National Climatic Center, Asheville, North Carolina.

Table 2.3.8 presents monthly morning and afternoon ventilation data for the 4-year period of record at Jackson.

Morning ventilation is low throughout the year, particularly between June and October. Afternoon ventilation is adequate from February through September, but low from October through January. Based on this, the highest daily air pollution potentials exist from October through January, with October having maximum values, although lowest morning ventilation rates occur in August. Lowest air pollution potentials occur in the spring.

Extended periods of low ventilation rates usually result from stagnating anticyclones. According to Korshover (Ref. 13), in a 35-year period from 1936 through 1970, there were 36 cases of atmospheric stagnation (4 days or more duration) over southwest Mississippi, accounting for a total of 150 days. Atmospheric stagnation may occur during any month, with maximum probability in October and the minimum in March.

2.3.1.2.2 Probable Maximum Annual Frequency and Duration of Freezing Rain

An ice storm (also called glaze ice) is the accretion of ice, generally clear and smooth, formed on exposed objects by the freezing of a film of supercooled water deposited by rain, drizzle, or possibly condensed from supercooled water vapor. The weight of this ice is often sufficient to greatly damage telephone and electric power lines and poles. The ice coating on roads frequently slows down, or even completely paralyzes, transportation and makes movement of personnel and equipment extremely difficult.

Most glaze is the result of freezing rain or drizzle falling on surfaces with temperatures between 25 and 32 F (Ref. 14).

The glaze belt of the United States includes all of the area east of the Rocky Mountains. However, in the southeast and gulf coast sections of the country, below freezing temperatures seldom last more than a few hours after glaze storms (Ref. 14).

The total number of glaze storms reported in the broad general area surrounding the plant site, during the period 1917 through 1953 inclusive, ranged from one to seven. It is estimated that about 30 percent of these caused ice coatings in excess of 0.5 inches in some portions of the area (Ref. 14).

Since the major ice storms usually result from freezing rain or drizzle, the occurrences of these phenomena at Jackson, Mississippi were analyzed for the 10-year period 1955 through 1964. The total hours of either freezing rain or drizzle are shown for each month of the chosen years in Table 2.3.9. The month of January had the largest number of total hours, but December's total was almost as large. The range of the annual totals was from 0 (in half the years) to 46 hours in 1963.

From these data the probable maximum frequency (probability = 0.01) of ice storms in the Grand Gulf area is estimated to be 51/8760, or 0.58 percent on an annual basis.

The total accumulation of ice during an episode of freezing rain is usually directly proportional to the duration of the episode. Table 2.3.10 shows the number and duration of discrete occurrences of freezing rain by month. A discrete occurrence is defined as 1, 2, or more consecutive hours, during which freezing rain or drizzle was reported by the National Weather Service. Table 2.3.10 shows that there was a total of eight discrete occurrences during which the episodes lasted 4 hours or more. The longest episode of the 10 years lasted 9 hours and occurred in December 1963.

Table 2.3.11 summarizes frequency and duration data for ice storms for each month. Table 2.3.12 summarizes frequency and duration data for each of the chosen years. From these data, the probable maximum duration in consecutive hours (probability = 0.01) of freezing precipitation in the Grand Gulf site area is estimated to be 12 hours. However, it is possible that several discrete occurrences may be logged during a period when the dry bulb temperature never exceeds 32 F. Thus, the ice accretion of each occurrence is added to that of the preceding occurrences. This situation prevailed in December 1963 when discrete occurrences of freezing precipitation occurred on the 21st through the 22nd in the following sequence: 1 hour with, 1 hour without, 3 hours with, 3 hours without, 7 hours with, 1 hour without, 9 hours with. The total precipitation for the 2 days was 0.84 inches, but an unknown portion of this was in the form of sleet. The Local Climatological Data publication for this month stated, "Freezing rain and sleet on the 20th and 22nd caused considerable damage to trees and utility lines."

2.3.1.2.3 Probable Maximum Annual Frequency and Duration of Dust Storms

The occurrence of dust, blowing dust, or blowing sand is a comparatively rare phenomena in the Jackson/Grand Gulf area. The hourly weather records for the years 1955 through 1964 were computer processed and the statistics on dust storms were compiled. These statistics are shown in Tables 2.3.13 through 2.3.16. The

total hours of occurrence are shown for each month of each of the 10 years in Table 2.3.13. April had the largest total. From the yearly totals shown in this table, the probable maximum annual frequency (probability = 0.01) of dust storms in the Grand Gulf area is estimated to be 14/8760 or 0.16 percent.

Table 2.3.14 shows the number and duration of discrete occurrences of dust storms by month. A discrete occurrence is defined as 1 hour, or more than 1 consecutive hour, during which dust, blowing dust, or blowing sand was reported by the National Weather Service. There were no occurrences of more than 1 hour during the 10-year period.

Table 2.3.15 summarizes the monthly statistics on the dust storm occurrences and Table 2.3.16 presents a summary of frequency and duration for each of the 10 years. From these data the probable maximum duration (probability = 0.01) of the dust storm in the Grand Gulf area is estimated to be about 2 hours.

2.3.1.2.4 Estimated Weight of the 100-Year Return Snowpack

Snowpack, as used in this section, is defined as a layer of snow and/or ice on the ground surface, and is usually reported daily, in inches, by the National Weather Service at all first order weather stations.

The density of the snowpack varies with age and the conditions to which it has been subjected. Thus, the depth of the snowpack is not a true indication of the pressure which the snowpack exerts on the surface which it covers. A more useful statistic for estimating the snowpack pressure is the water equivalent (in inches) of the snowpack.

To estimate the weight of the 100 year snowpack at the Grand Gulf site, the maximum reported snow and/or ice depths at Jackson, Mississippi during each of the winter seasons 1959-60 through 1974-75 were fitted to the Fisher-Tippett Type 1 distribution using the Lieblein method (Ref. 15). Since a measurable snowpack depth occurred during only 5 of the examined 16 seasons (about one-third), the data from only these seasons were used, and the estimated 33-year return snowpack was considered equivalent to the actual 100-year return snowpack. Thus, the estimated depth of the 100-year return snowpack is 8.5 inches.

Reference 16 states that freshly fallen snow has a snow density (the ratio of the volume of melted water to the original volume of snow) of 0.07 to 0.15, and glacial ice formed from compacted snow has a maximum density of 0.91.

In the Jackson/Grand Gulf area, snow melts and/or evaporates quickly, usually within 48 hours, and before additional snow is

added; thus, the water equivalent of the snowpack can be considered equal to the water equivalent of the falling snow as reported hourly during the snowfall. The data during the period studied indicate that the water equivalent of the maximum snowpacks in the Jackson area was between 0.08 and 0.12 inches of water per inch of snow. Hence, it appears that a conservative estimate of the water equivalent of snowpack in the Grand Gulf site area would be 0.20 inches of water per inch of snowpack. Then, the water equivalent of the 100-year return snowpack would be 8.5 x 0.2 = 1.7 inches of water.

Since 1 cubic inch of water is approximately 0.0361 pounds in weight, a 1-inch water equivalent snowpack would exert a pressure of 5.20 pounds per square foot (0.0361 x 144).

For the 100-year return snowpack, the water equivalent would exert a pressure of 8.84 pounds per square foot (5.2 x 1.7).

2.3.1.2.5 Estimated Weight of the 48-Hour Probable Maximum Winter Precipitation

The observed maximum precipitation amounts (water equivalent) during any consecutive 48-hour period at Jackson, Mississippi for the indicated winter (November through March) seasons is given in Table 2.3.17. The data were analyzed by the Gumbel-Lieblein method described by Thom in Reference 15, with the following results:

Return Period (Years)	Max. 48-Hr. Winter Precip. Water Equivalent (inches)
10	4.60
25	5.50
50	6.15
100	6.80
500	8.20
1000	8.80

Thus, it is estimated that a value of 7.0 inches (water equivalent) is ultra-conservative for the 48-hour probable maximum winter precipitation at the Grand Gulf site, especially since only one of the above maximum values contained a trace of frozen precipitation.

In the unlikely event that the 7.0 inches maximum were entirely frozen precipitation, i.e. there was no runoff, a weight of 36.4 pounds per square foot (0.0361 lbs/in^3 x 7 in x 144 in^2/ft^2) would result.

2.3.1.2.6 100-Year Return Period Fastest Mile of Wind

The records of the National Weather Service for Jackson, Mississippi (Ref. 17) report the fastest mile of wind to be 68 mph. This occurred in 1952. Other records (Ref. 2) show that the height of the wind sensor in 1952 was approximately 46 feet above ground level. Reducing 69 mph from 46 feet to the standard 30-foot level gives a value of 64 mph.

Reference 18 indicates a value of approximately 83 mph for the 100-year return period fastest mile of wind in the Grand Gulf area.

A Gumbel-Lieblein extreme value analysis (Ref. 15) of Jackson wind data, corrected for differences in measurement levels for the years 1960 through 1975, gave a value of 61 mph for the 30-foot level, 100-year return period, fastest mile of wind.

Judging from these three values:	mph
Observed	64
Thom	83
Extreme value analysis	61

The conservative estimate of 83 mph for the fastest mile of wind at 30 feet above ground, 100-year return period, in the Grand Gulf area is used.

In Reference 18, Thom cites the often used power law as a representative estimate of the vertical wind profile. This vertical distribution of the wind velocity is expressed as,

$$u_z = u_{30} \left(\frac{z}{30}\right)^{\frac{1}{n}}$$

Where z is the height above ground, u_z is the wind speed at height z, u_{30} is the wind speed at 30 feet, and n is a constant depending on surface roughness. For the Grand Gulf site the value of n is approximately 7 since the terrain characteristics can be described as being level or slightly rolling land with some obstructions.

In addition to corrections of the basic 30-foot above ground design wind for height of structures it is also necessary to apply corrections for gusts. This is normally done by means of a gust factor (gust velocity ÷ the velocity of the fastest mile of wind). A gust factor of 1.3 is used for gusts of approximately 1-second duration that, in a 90 mph basic wind, would have a

length downwind of about 130 feet. This is adequate for small structures. A gust factor of 1.1 allows for gusts of approximately 10-second duration that, in a 90 mph basic wind, would have a length downwind of about 1300 feet.; this factor is adequate for larger structures having a horizontal dimension, transverse to the wind of about 125 feet. (Ref. 19).

2.3.2 Local Meteorology

2.3.2.1 Normal and Extreme Values of Meteorological Parameters

2.3.2.1.1 Winds

a. Wind Distributions (All Meteorological Conditions)

Surface wind data for Jackson, Mississippi covering 1951 through 1960 (Ref. 20) were used to approximate site wind conditions since sufficient Vicksburg data were not available. On an annual basis, SSE is the most frequent (10.8 percent) wind direction. The wind is from SE through S 27.5 percent of the time. Westerly (WSW-WNW) and easterly (ENE-ESE) winds are least frequent, with frequencies of 11.3 and 11.5 percent, respectively. Calms occur about 8 percent of the time.

Tables 2.3.18 to 2.3.30 present monthly and annual percent frequency distributions jointly for wind directions and speeds, based on a 10-year period of record, for Jackson. Southerly components prevail in spring, summer, and winter, while northerly components prevail in the fall. Figure 2.3-1 presents an annual wind rose based on this 10-year period of record.

Mean hourly wind speed data from 1964 through 1975 show March to have the fastest winds (9.6 mph) and August to have the slowest (5.8 mph). Winds average greater than 8.7 mph from December through April, and 7.9 mph or less from May through November. Mean annual wind speed is 7.7 mph. (Ref. 3).

Figure 2.3-2 presents comparative annual wind roses for Grand Gulf and Jackson based on data observed from August 1972 to July 1973. These figures are based on Tables 2.3.31 and 2.3.32, annual joint frequency distribution tables for Grand Gulf and Jackson, respectively. Wind speeds at Grand Gulf were generally slower than those at Jackson averaging 4.4 mph versus 7.6 mph at Jackson. Wind direction at Grand Gulf was fairly evenly distributed, but with a noticable tendency toward a greater frequency of winds with easterly components. At Jackson, winds from SE through south (34 percent) or

north (10 percent) occurred with a significantly greater frequency than other directions.

Figure 2.3-3 compares the wind roses for the Grand Gulf site (based on 2 years of onsite data from August 1972 to July 1974) and Jackson (based on 5 years of data from January 1960 to December 1964). The latest year for which hourly weather observations for Jackson are readily available on computer tape is 1964.

The similarities between the 10-, 1-, and 5-year wind roses for Jackson (Figures 2.3-1, 2.3-2, and 2.3-3, respectively) indicate that the wind condition in the August 1972 to July 1973 period was representative of long-term normal wind conditions in southwestern Mississippi. Also, the similarity between the 1-year and the 2-year wind roses for the Grand Gulf site (Figures 2.3-2 and 2.3-3, respectively) indicates the annual average wind conditions at the site were similar during both years (see Tables 2.3.31 and 2.3.33) and can be considered representative of long-term wind conditions at the site.

Thus, the similarities and differences between the two wind roses shown in Figure 2.3-3 provide a true comparison of the wind regimes at Grand Gulf and Jackson.

The Jackson data indicate some channeling effect with wind directions giving preference to the NW through NNE and SE through SSW sectors. The directions at Grand Gulf are more evenly distributed. Jackson shows a large percentage (11 percent) of calms to almost none at Grand Gulf. This can be attributed primarily to a higher wind sensor threshold at Jackson and also to the method of observation (hourly average at Grand Gulf versus a virtual instantaneous observation at Jackson). The frequency of higher wind speeds is significantly greater at Jackson than at Grand Gulf.

Monthly relative frequencies of wind direction and speed for the Grand Gulf site are shown in Tables 2.3.34 through 2.3.45.

Monthly and annual joint frequency distributions of wind direction and speed tables, based on three annual data cycles extending from August 1972 through July 1974 and January 1976 through December 1976, are presented in Appendix 2.3A of the FSAR (limited distribution to NRC only).

b. Wind Direction Persistance

Hourly weather observation records from the National Weather Service at Jackson, Mississippi for the years

1955 through 1964 were examined for wind direction persistence. The longest persistence periods from a single sector (22.5 degrees), three adjoining sectors (67.5 degrees), and five adjoining sectors (112.5 degrees) were determined for each sector (and calm) during each year. The results are shown in Tables 2.3.46 through 2.3.48. During the period, the single sector persistence was greatest (29 hours) for the SSE direction. The average maximum persistence (16.5 hours) was also greatest for the SSE direction. For the persistence in three adjoining sectors, the central south sector had the longest period of persistence (97 hours) and the largest average maximum persistence (53.2 hours).

The longest persistence period (182 hours) from five adjoining sectors was shown by the central south sector. This same central sector showed the greatest average maximum persistence (96.4 hours).

Wind persistence data similar to the above are shown in Tables 2.3.49 through 2.3.51 for the Grand Gulf site. The statistics shown in these tables cover a 2-year period from August 1972 through July 1974. Table 2.3.49 shows that the longest single sector persistence period was 55 hours from the NNW sector. The NNW sector had the greatest average maximum persistence with the SE sector having the next greatest.

For the longest persistence in three adjoining sectors, the central NNW sector had the longest period with 101 hours. The central NNW sector had the greatest average maximum persistence. The persistence data for five adjoining sectors (Table 2.3.51) shows the central SSW sector with the longest persistence period (102 hours) and the central NNE sector with the greatest average maximum persistence.

Table 2.2.52 presents a comparison of the maximum persistence periods for Jackson and the Grand Gulf site. The periods of record are different and this may account for the differences in the preferred sectors.

Table 2.3.53 is a monthly breakdown of the maximum wind direction persistence period for each sector at Jackson.

2.3.2.1.2 Air Temperature

Tables 2.3.2 and 2.3.3 show that temperature extremes have ranged from 103 F (June 1969) to 7 F (January 1966 at Jackson) (Ref. 3) and from 101 F (July 1954) to 2 F (January 1962) at

Vicksburg (Ref. 4). Table 2.3.54 shows that Jackson averages 80 days per year with maximum temperatures of 90 F or above while Vicksburg averages only 66. The average number of days per year with minimum temperatures of 32 F or below is 46 for Jackson and 23 for Vicksburg.

These data suggest that the proximity of the Mississippi River to Vicksburg may exert a moderating influence. Therefore, the Vicksburg temperature data may be more representative of the Grand Gulf site. A comparison of Grand Gulf temperatures with Jackson temperatures for coincident periods (Tables 2.3.55 and 2.3.56) confirms the indication that the river moderates the temperatures in its vicinity, especially the daily maximum temperatures.

Figure 2.3-4 compares the mean and extreme temperatures measured at the Grand Gulf site during two annual cycles.

2.3.2.1.3 Atmospheric Water Vapor

Mean relative humidities for four different times of day at Jackson and Vicksburg are shown in Table 2.3.4 (Refs. 3 and 4). All of Mississippi experiences high humidity during much of the year. At Jackson, humidities of 90 percent or higher have occurred at any hour of the day. They are most frequent in the early morning hours. In the summer, at times there develops a combination of high temperatures together with high humidities; this usually builds up progressively for several days and becomes oppressive for 1 or more days. Humidities of less than 50 percent occur on some days each month, usually in the early afternoon hours. Humidities drop under 30 percent on about one-fourth of the October and November days; the number of days with such low humidities diminishes in the other months. In July and August there may be none (Ref. 3). On an annual basis, relative humidities below 50 percent occur only 19 percent of the time and below 30 percent only 3 percent of the time. (Ref. 20).

Table 2.3.5 (Ref. 21) shows cooling equipment design temperatures for the site. The 1 percent design dry bulb of 98 F and the 1 percent design wet bulb of 79 F shown for Jackson are probably best representative of the Grand Gulf site. However, a study (Ref. 22) has shown that although, at least in the mean, the highest wet bulb temperatures are coincident with the highest dry bulb temperatures, in the Grand Gulf region, the highest dew point temperatures (i.e. highest absolute humidity) occur near the middle of the dry bulb temperature range.

The saturation deficit tables (Tables 2.3.57 through 2.3.61) were prepared from 10 years (1955-64) of Jackson hourly weather observations. These tables show the total occurrences for

the 10-year period. Therefore, to arrive at seasonal or annual averages the number of occurrences shown must be divided by 10. Table 2.3.57 shows all occurrences during the 1955-64 period and thus can be used to calculate annual averages. Tables 2.3.58 through 2.3.61 show the total occurrences for the spring, summer, fall, and winter seasons, respectively. Dividing the number of occurrences in these tables by 10 will give seasonal averages. For these tables the seasons were defined as follows:

Spring	March, April, May
Summer	June, July, August
Fall	September, October, November
Winter	December, January, February

2.3.2.1.4 Precipitation

a. Rain

Monthly and annual mean and extreme precipitation amounts for Vicksburg, Mississippi (Ref. 4) are presented in Table 2.3.62[1]. Average monthly precipitation follows a seasonal trend, reaching a maximum in March (5.73 inches) and a minimum in October (2.04 inches). Maximum annual precipitation has been 64.84 inches; the maximum daily amount has been 9.97 inches. The mean number of days per month with measurable precipitation varies between a winter maximum of 11 days and a fall minimum of 5 days. Table 2.3.63 provides comparative data from the Grand Gulf site measured from August 1972 to July 1974.

Monthly precipitation amounts and hours, with precipitation at the Grand Gulf site, Jackson, Mississippi and Alexandria, Louisiana are presented in Table 2.3.64.

Tables 2.3.65 through 2.3.70 provide monthly and annual frequency distribution of rainfall rates at the Grand Gulf site, Jackson, Mississippi and Alexandria, Louisiana. The 36-month period of data used in these tables is August, 1972 through July, 1974 and January, 1976 through December, 1976.

In general, the Jackson and Alexandria data, especially the 3-year average values, appear to be representative of the Grand Gulf area. There are considerable variations between the three locations from month to month, particularly during the summer months. The individual differences reflect the occurrence of heavy shower and thunderstorm activity common in the area.

[1]According to Reference 4, maximum monthly precipitation has been exceeded at least at one other site in the locality with 22.24 inches being reported for April 1974. However, the publication does not indicate the specific location at which this event occurred.

Maximum point precipitation values are given in Table 2.3.71. These were interpolated from the maps of USWB Technical Papers 40 and 49 (Refs. 23 and 24). Table 2.3.72 was taken from Reference 25. It presents maximum observed short-period precipitation data for Vicksburg. A comparison of the two tables suggests that 100-year amounts may have occurred during the period of record (1893-1961) for precipitation amounts for periods of 3-, 6-, 12-, and 24-hour durations.

b. Snow

Annual average snowfall in the Grand Gulf area is estimated to be 1 to 2 inches. This estimate is based on 36 years of record (1930-1966) at Vicksburg (Ref. 4) and 39 years of record (1936-1975) at Jackson (Ref. 3).

During the period of record at Vicksburg, measurable amounts of snow have fallen in November, December, January, and February with trace amounts in March. The maximum monthly amount was 10 inches in February 1960 and this total fell within a 24-hour period. The maximum annual amount was also 10 inches. At another site in the Vicksburg area a total of 10.1 inches of snow fell in January 1919.

During the period of record at Jackson, measurable snow amounts have fallen in the months November through March with a trace in April. The maximum monthly amount of 10.6 inches fell in January 1940 in a 24-hour period. The maximum annual amount was 11.6 inches and occurred in the 1939-1940 season.

c. Precipitation Wind Roses

Table 2.3.73 presents the percentage frequencies of precipitation by wind directions on a monthly and annual basis (Ref. 26), and Figure 2.3-5 shows an annual precipitation wind rose (percentage of the total number of observations) for Jackson, Mississippi.

Annually, precipitation occurs most frequently with winds from southeast through south, with 2.1 percent of all observations having these conditions simultaneously. Precipitation occurs least frequently (0.7 percent of all observations) when winds are from the southwest through west. March is the month with the greatest amount of precipitation; during this month, precipitation occurs most frequently with south-southeasterly winds (1.4 percent of all observations).

Wind speeds during precipitation average 9.1 mph annually and over 7.9 mph (the average annual wind speed) during fall, winter, and spring.

Tables 2.3.74 through 2.3.86 are the monthly and annual precipitation wind roses generated from the 3 years of onsite hourly meteorological data. Similar information for Jackson, Mississippi and Alexandria, Louisiana are presented in Tables 2.3.87 through 2.3.112. The meteorological data for these two stations were obtained from the National Climatic Center. The total number of observations reported are the total number of occurrences of precipitation including trace and drizzle.

2.3.2.1.5 Fog and Smog

An analysis of nearby weather station records for periods up to 23 years indicates that the frequency of natural occurrence of fog varies considerably from year to year and from station to station. Annual variations are a result of differences in frequencies of general meteorological conditions favorable for fog formation (low temperature, high humidity, and boundary layer inversion conditions). Variations by location are attributed to differences in terrain and proximity to large water bodies.

Vicksburg data were considered inadequate as continuous 24-hour observations were not available. Other stations whose data were reviewed included Baton Rouge, Louisiana, Jackson, Greenville AFB, and Greenwood AFB, Mississippi.

The Jackson weather station is located at the Municipal Airport, 45 miles east of the Mississippi River, 5 miles southwest of Ross Barnett Reservoir (50 square miles of water surface), on the west bank of the Pearl River. The Baton Rouge airport weather station is on the east bank of the Mississippi River about 102 miles south of the Grand Gulf site and about 68 miles northeast of the Gulf of Mexico. The Greenville AFB weather station was about seven miles east of the Mississippi River and about 116 miles north of Grand Gulf. The Greenwood AFB weather station was located about 114 miles north-northeast of Grand Gulf, about 53 miles east of the Mississippi River.

Table 2.3.113 presents the average number of days, monthly and annual, on which heavy fog (visibility 1/4 mile) occurs at Jackson and Baton Rouge (26 and 37 days/yr., respectively) (Refs. 3 and 27). The monthly and annual percentage frequencies of heavy fog occurrence at Greenville AFB (Ref. 28) ranged from a winter maximum of 1.6 percent in February to a summer minimum of 0.1 percent in June and July. The average annual frequency was 0.6 percent (53 hours).

Observation of natural fog frequency of moderate fog occurrence (visibility 1/2 mile) at Greenwood AFB, Greenville AFB, and Jackson are presented in Table 2.3.114 (Refs. 20, 28, 29, 30). Moderate fog was observed to occur on an average of 61, 96, and 26 hours annually at Greenwood AFB, Greenville AFB, and Jackson, respectively.

George (Ref. 31), using 5 years of data, showed that maximum frequencies of extensive fog formations over southwestern Mississippi occur in the winter months (in agreement with data presented here). Extensive fog formations are considered to cover at least an area on the order of 50,000 square miles. The mean number of cases of extensive fog formation ranged from winter maxima of seven in January and five in December and February to less than 0.5 cases from April through August.

It appears that the Greenville AFB data are most representative of the Grand Gulf site. The location of Greenville AFB (seven miles east of the Mississippi River) was similar to that of Grand Gulf, but unlike that of Baton Rouge, in that the latter's fog climatology is significantly affected by its proximity to the Gulf of Mexico. Neither Greenwood AFB nor Jackson are similarly located on the Mississippi River.

Based on this, it was concluded that moderate fog occurs about 1 percent (88 hours) of the time at Grand Gulf, and heavy fog occurs about 0.6 percent (53 hours) of the time.

A further analysis of fog and smog occurrences at Jackson was made from 10 years of hourly weather data obtained from the National Climatic Center. The total hours of occurrence of fog and/or smog during the years 1955 through 1964 are shown in Table 2.3.115. The total hours per year ranged from a maximum of 793 to a minimum of 411. The total hours during any given month also varied widely from year to year.

Table 2.3.116 shows the frequency distribution of the number of occurrences of fog and/or smog according to month and duration of the occurrence. Also shown are the duration of the longest occurrence, or episode, and the total number of occurrences for each month. January had the longest single episode (51 hours), and there were only 10 events during the 10-year period which lasted longer than 35 hours.

Table 2.3.117 shows monthly statistics for the fog and/or smog phenomena. This table shows that January has the largest average percentage frequency of occurrence (15.8) and also the longest average duration of the event (9.0 hours). However, an examination of Table 2.3.115 reveals that for any given year the maximum total hours of occurrence may fall in other months. May has the

lowest percentage frequency of occurrence and also the shortest average duration per event. Table 2.3.118 contains the annual statistics on fog and/or smog. During this 10-year period, the average annual percentage frequency of occurrence was 7.9. On an individual yearly basis, the percentage frequency varied from 4.7 in 1955 to 9.1 in 1961.

Tables 2.3.119 through 2.3.122 contain data similar to that discussed above for heavy fog and/or heavy smog (visibility less than 5/16 mile). Based on a 10-year sample (1955 through 1964) the average annual percentage frequency of occurrence of this phenomena is 0.4 with a range from 0.2 to 0.8. The maximum duration of a single event during the period was 10 hours.

Tables 2.3.123 through 2.3.126 show the data for smog only (all intensities) for 1955 through 1964. The average annual percentage frequency of occurrence for this phenomena is 0.6 with a range from 0.3 to 1.0. The maximum duration for a single episode of smog during this period was 11 hours as shown in Table 2.3.126.

2.3.2.1.6 Atmospheric Stability

The meteorological data gathered at the Grand Gulf site have been used to assign hourly stability classifications to the atmosphere in the area. The classifications were assigned according to the definitions set forth in USNRC Regulatory Guide 1.23.

Annual joint frequency distributions of wind speed, wind direction, and stability for the Grand Gulf site and Jackson, Mississippi are presented in Tables 2.3.127 through 2.3.129. Tables for the Grand Gulf site are based on three annual cycles of onsite hourly data, and tables for Jackson are based on periods 1960 to 1964 and 1965 to 1969, 3-hourly observations. The similar annual and monthly joint frequency distributions for the first two individual annual cycles and the composite three annual cycles, respectively, are presented in Appendix 2.3A of the FSAR (limited distribution to NRC only). The similarity of stability conditions at the site during the first two individual annual cycles can be clearly seen from Table 2.3.130.

That these 2 years are representative of long-term wind and stability conditions at the site cannot be proved conclusively because long-term onsite tower observations are not available. Also, stability classifications by the delta-temperature method (applicable to Grand Gulf) and stability classifications by the Pasquill-Turner method (applicable to long-term Jackson, Mississippi data) are not directly comparable. However, conditions which produce anomalies in wind and stability in general cover large areas. Thus, long-term conditions at Jackson can be compared to conditions

at Jackson during one of the annual cycles in question; and, if the chosen annual cycle conditions are representative of the normal, it can be inferred that the conditions at Grand Gulf during the same annual cycle are representative of long-term conditions at the Grand Gulf site.

Since the Jackson meteorological station was relocated 8.5 miles in July 1963 (during the reference period of record), it was deemed appropriate to perform a comparative analysis to determine whether the move has modified the wind-stability distributions to a significant extent.

Joint frequency distributions for Jackson based on 3-hour observations were obtained for the periods 1960 to 1964 and 1965 to 1969. The 1965-1969 distribution is based entirely on data taken after the station was moved.

To first determine the adequacy of joint frequency distributions using 3-hour observations, the summaries using hourly and 3-hourly observations (1960-1964) were compared statistically. If the data were very dissimilar, one would expect a relatively low coefficient of correlation. However, the correlation between the two sets of data was calculated to be nearly perfect ($r = 0.996$). The data sets consisted of frequency of occurrence of each wind direction in each stability class (16 directions x 7 stability classes = 112 data points in each set). The limit of significance at the 99.9 percent level of confidence, according to Brooks and Carruthers (Ref. 32), is less than 0.324. Therefore, distributions obtained using a 3-hourly summary should not be significantly different from an hourly summary.

Three-hourly joint frequency distributions for 1960 to 1964 and 1964 to 1969 were then compared to evaluate the effect, if any, relocation has had on wind and stability class frequencies. A cursory inspection of the data suggest that the period 1960 to 1964 was more conservative. The mean wind speed for the earlier period was lower (6.0 knots to 6.8 knots), which can be associated with a greater frequency of A and G stability classes. During the period 1965 to 1969, higher frequencies of Class D stability were evident, associated with the higher mean wind speeds. Despite these differences, which are probably due to variations in long-term synoptic scale circulation, the correlation coefficient for the paired distributions was 0.948. One can be at least 99.9 percent certain that the two periods are highly correlated and that correlation is not due to chance. Therefore, it is concluded that relocation of the Jackson meteorological station has not caused a significant biasing of frequency distributions; data from either period should be representative of the climatology for Jackson, Mississippi.

A comparison of the data from Jackson for the August 1972 through July 1973 period with the 1960-1964 Jackson data reveals

a very close relationship in wind direction and stability distributions.

Using the same technique as was used in comparing the 1960-64 data with the 1965-69 data, a correlation coefficient of 0.90 was derived. This highly significant correlation (99.9 percent confidence level) leads to the conclusion that meteorological conditions during the period August 1972 through July 1973 were quite representative of climatology at Jackson, Mississippi. This conclusion is reinforced by good relationships observed between other meteorological parameters for the current Jackson data and data from the historical record (wind speeds: 7.6 mph vs. 7.1 mph; temperatures, average maximum 76.4 vs. 77.0 F; average minimum 54.8 vs. 53.9 F; and daily mean 65.6 vs. 65.6 F).

This same correlation technique was applied to a comparison of August 1972-July 1973 data from Grand Gulf to the Jackson data for the same time period in an attempt to confirm the validity of earlier usage of historical Jackson data to approximate site meteorology. The resulting correlation coefficient was 0.54, somewhat below that derived from comparing current Jackson data to historical Jackson data, but still above the 99.9 percent confidence level.

In order to assess the validity of this correlation, it is necessary to consider at least two factors: topographical influences on both wind direction and stability, and different methods of determining stability for the two data sets. The latter factor listed was considered the most critical to the question of whether it is scientifically reasonable to compare the two data sets in this manner. There are weaknesses in both methods for stability classification. The Pasquill-Turner method is an approximation based on related parameters (solar angle, cloud cover, ceiling height, and wind speed) while the delta-temperature method is a direct measurement, in a relatively shallow layer of the atmosphere, of temperature variation with height. To answer this question, the distribution of wind speeds by direction and stability class was compared between the two stations. Since stability classification at Jackson is based, in part, on wind speed, a correlation of dependent data at one station (Jackson wind speeds) versus independent data at the other (Grand Gulf wind speeds) should provide an indication of whether the correlation of frequencies of occurrence is valid. The resulting correlation coefficient, for wind speeds distributed by wind direction and stability class, was 0.53, again above the 99.9 percent confidence level. It is concluded that the correlation of frequencies of occurrence of wind direction by stability class between the Grand Gulf and Jackson data is valid and that a strong relationship exists between the two data sets.

The differences in topography at Grand Gulf as related to that at Jackson do cause some differences in both wind direction

and stability, particularly during low wind speed conditions. Figure 2.3-6 presents annual low-speed (less than 5.5 mph) wind directional frequencies for Grand Gulf and Jackson based on the period August 1972 to July 1973. The Jackson data varied very little from the wind rose based on all winds. The Grand Gulf data showed a significant peak in winds from the east and east-northeast. This is presumably due to the early morning drainage winds which flow from the bluffs west of the site down to the river valley. The same (or similar) topographical influences will affect diffusion of any radioactive gases released from the Grand Gulf Nuclear Station.

As has been shown, meteorological parameters observed during the August 1972 through July 1973 time period are representative of regional climatology. It is therefore concluded that the best estimate of meteorological conditions that will occur during the operating life of the Grand Gulf Nuclear Station may be obtained by using the data measured at Grand Gulf (and included in this report) during the period August 1972-July 1974 and January 1976-December 1976.

Figure 2.3-7 shows inversion wind roses for the two annual (August 1972 to July 1973 and August 1973 to July 1974) data cycles. The two roses shown are remarkably similar, and, for reasons discussed above, are believed to be representative of the long-term conditions at the site.

Tables 2.3.131 through 2.3.142 are presented to indicate the monthly frequency and persistence of inversions in Jackson, Mississippi. These tables were prepared from hourly surface observations for the years 1955 through 1964. The tables show the number of discrete periods when inversion conditions (Pasquill-Turner method of calculation resulted in either E, F, or G stability) existed 1 hour, or 2 or more consecutive hours. Short periods contained within a longer period are not considered as discrete occurrences. These tables show the data for each of the 10 years in order to show the variations from year to year. They also show the monthly mean distribution calculated from the 10 years.

The monthly means are summarized in Tables 2.3.143 and 2.3.144 and they have been added to give an annual mean.

Tables 2.3.145 through 2.3.158 show similar inversion data for the Grand Gulf site. These inversion occurrences were determined from E, F, or G stability classifications resulting from onsite delta-temperature measurements. The periods covered by the data are August 1972 through July 1974 and January 1976 through December 1976.

2.3.2.1.7 Mixing Heights

Seasonal and annual mixing heights for Jackson, Mississippi are shown in Table 2.3.159. These are from Holzworth's study (Ref. 33).

Average mixing heights in the mornings are lowest during the fall, but the average wind speed for fall mornings is a little higher than for summer mornings. The winter season has the lowest afternoon average mixing height.

Table 2.3.160 presents monthly morning and afternoon mixing height data for the 4-year period of record at Jackson.

2.3.2.2 Potential Influence of the Plant and Its Facilities on Local Meteorology

2.3.2.2.1 Effects of Heat Dissipation System

Operation of Grand Gulf Nuclear Station will modify the local climatology. The effects of the natural draft cooling towers and blowdown discharge on the local meteorological environment are presented in Subsection 5.1.4.

2.3.2.2.2 Topographical Description

The station lies about 7300 feet east of the Mississippi River, about 132.5 feet above mean sea level. The town of Port Gibson, Mississippi lies about 5 miles to the southeast, the town of St. Joseph, Louisiana lies about 13 miles to the southwest, and the Big Black River empties into the Mississippi River about 3 miles to the north.

The surrounding terrain is generally hilly and wooded to the south and east, with several hilltops over 350 feet above mean sea level to the south. To the north and west, the terrain is generally flat and wooded, lying less than 100 feet above mean sea level. Numerous lakes of various sizes and isolated marshes dot the landscape. There is a rather abrupt (irregular) 100- to 200-foot rise in terrain approximately 1 mile east of the river bank. Figures 2.3-8 to 2.3-10 present topographic cross sections and a site area map.

According to Regulatory Guide 1.3, credit for elevated release of contaminants is given only if the release point is at a height of at least 2.5 times the height of the tallest nearby structure that could affect dispersion. Since discussion of effects of topography on diffusion estimates is required only for elevated releases, and the Grand Gulf Nuclear Station, as planned, does not qualify for elevated release, these effects have not been estimated.

2.3.3 References

1. "Climatography of the United States No. 60-22, Climates of the States, Mississippi," U. S. Department of Commerce, Weather Bureau, 1959.

2. "Local Climatological Data, Annual Summary with Comparative Data, Jackson, Mississippi," U. S. Department of Commerce, 1965-1975.

3. "Local Climatological Data, Annual Summary with Comparative Data, Jackson, Mississippi," U. S. Department of Commerce, NOAA, 1975.

4. "Local Climatological Data, Annual Summary with Comparative Data, Vicksburg, Mississippi," U. S. Department of Commerce, ESSA, 1966.

5. "Climatography of the United States No. 82-22, Summary of Hourly Observations, Jackson, Mississippi, 1951-1960," U. S. Department of Commerce, Weather Bureau, 1963.

6. "Report on Hurricane Camille," U. S. Army Corps of Engineers, Mobile District, May 1970.

7. Thom, H. C. S., "Tornado Probabilities," Monthly Weather Review, Vol. 91, October-December 1963, pp 730-736.

8. Grand Gulf, Mississippi area tornado summary provided by the National Severe Storms Forecast Center, Kansas City, Missouri, May 1976.

9. Draft "Safety Guide on Meteorology - Extreme Meteorological Conditions in Nuclear Power Plant Siting," International Atomic Energy Agency, April 1976.

10. Malone, T. F., (Editor), "Compendium of Meteorology," American Meteorological Society, Boston, Massachusetts, 1951.

11. Visher, S. S., "Climatic Atlas of the United States," Harvard University Press, Cambridge, Massachusetts, 1966, p. 403.

12. "Tabulation III - Daily Mixing Depth and Average Wind Speed, Jackson, Mississippi (1959-62)," U. S. Department of Commerce, ESSA, National Weather Records Center, 1968.

13. Korshover, Julius, "Climatology of Stagnating Anticyclones East of the Rocky Mountains, 1936-1970," NOAA Technical Memorandum ERL ARL-34, U. S. Department of Commerce, 1971.

14. Bennett, Ivan, "Glaze: Its Meteorology and Climatology, Geographical Distribution, and Economic Effects," Headquartermaster Research and Engineering Command, U. S. Army, Quartermaster Research and Engineering Center, Environmental Protection Research Division, Natick, Massachusetts, March 1959.

15. Thom, H. C. S., "Some Methods of Climatological Analysis," WMO Technical Note No. 81. Secretariat of the World Meteorological Organization, Geneva, Switzerland, 1966.

16. Huschke, Ralph E., Ed., "Glossary of Meteorology," American Meteorological Society, Boston, Massachusetts, 1959.

17. "Climatic Atlas of the United States," U. S. Department of Commerce, 1968.

18. Thom, H. C. S., "New Distributions of Extreme Winds in the United States," Journal of the Structural Division, Proceedings of the American Society of Civil Engineers, Vol. 94, No. ST 7, pp 1787-1801, 1968.

19. Task Committee on Wind Forces, "Wind Forces on Structures," Paper 3269, Reprinted From Transactions, Vol. 126, Part II 1961, ASCE 1962.

20. "Climatography of the United States No. 82-22, Summary of Hourly Observations for Jackson, Mississippi, 1951-1960," U. S. Department of Commerce, Weather Bureau, 1963.

21. Fluor Products Company, "Evaluated Weather Data for Cooling Equipment Design, Addendum No. 1." Ecodyne Corporation, P. O. Box 1267, Santa Rosa, California, 52 pp., 1964.

22. Bailey, Desmond T., "A Wet-Bulb Climatology of the United States," (Ph. D) dissertation, Cornell University, Ithaca, New York, 1976.

23. Hershfield, David M., "Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years," U. S. Weather Bureau Technical Paper 40, Washington, D. C., 1961.

24. Miller, John F., "Two to Ten Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States," U. S. Weather Bureau Technical Paper 49, Washington, D. C., 1964.

25. Jennings, A. H., "Maximum Recorded United States Point Rainfall for 5 Minutes to 24 Hours at 296 First Order Stations," U. S. Weather Bureau Technical Paper 2, Washington, D. C., 1963.

26. "Precipitation and Non-Precipitation Winds for Jackson, Mississippi (1955-1964)," U. S. Department of Commerce, NOAA, National Climatic Center, 1972.

27. "Local Climatological Data, Annual Summary with Comparative Data for Baton Rouge, Louisiana," U. S. Department of Commerce, NOAA, 1974.

28. "Uniform Summary of Weather Observations, Part A, Greenville AFB, Mississippi," Department of the Air Force, National Climatic Center, February 1942 - June 1960, less April-July 1945, and February 1946-March 1953.

29. "Summary of Mean Percentages, Greenwood AFB, Mississippi," U. S. Department of Commerce, Weather Bureau, May 1938 - December 1941.

30. "Summary of Monthly Percentages, Greenwood AFB, Mississippi," National Climatic Center, February 1943 - October 1945.

31. George, J. J., "The Prediction of Very Low Ceilings and Fogs," Eastern Air Lines, Inc., Meteorology Department, Atlanta, Georgia, Scientific Report No. 1, 1958.

32. Brooks, C. E. P., and N. Carruthers, "Handbook of Statistical Methods in Meteorology," London, H.M.S.O., 1953.

33. Holzworth, George C., "Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States," Environmental Protection Agency, Research Triangle Park, North Carolina, January 1972.

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TABLE 2.3.1

RESULTANT WIND

JACKSON, MISSISSIPPI

Year	Direction (degrees)	Speed (mph)
1965	140	1.5
1966	100	1.1
1967	260	2.5
1968	150	0.7
1969	090	1.1
1970	170	1.1
1971	150	1.1
1972	150	0.7
1973	160	1.5
1974	180	1.6
1975	160	1.3
Mean	146	1.2

NOTE: From Reference 2.

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TABLE 2.3.2

TEMPERATURE MEANS AND EXTREMES (F)
AT MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
[YEARS OF RECORD: NORMALS, 1941-70; EXTREMES, 1964-75]

	Normals			Extremes			
Month	Daily Max.	Daily Min.	Monthly Mean	Record Max.	Year	Record Min.	Year
Jan	58.4	35.8	47.1	82	1972	7	1966
Feb	61.7	37.8	49.8	82	1972	11	1970
Mar	68.7	43.4	56.1	88	1974	18	1968
Apr	78.2	53.1	65.7	92	1970	30	1971
May	85.0	60.4	72.7	99	1964	38	1971
Jun	91.0	67.7	79.4	103	1969	49	1972
Jul	92.7	70.6	81.7	102	1970	51	1967
Aug	92.6	69.8	81.2	99	1972	55	1966
Sep	88.0	64.0	76.0	98	1972	35	1967
Oct	80.1	51.5	65.8	91	1972	30	1968
Nov	68.5	42.0	55.3	88	1971	17	1966
Dec	60.5	37.3	48.9	81	1971	14	1966
Annual	77.1	52.8	65.0	103	1969	7	1966

NOTE: Annual extremes have been exceeded at other sites in the locality as follows: Highest --- 107°F in July 1930
Lowest --- -5°F in January 1940

SOURCE: Local Climatological Data, Annual Summary with Comparative Data for Jackson, Mississippi. U. S. Department of Commerce, NOAA, 1975.

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TABLE 2.3.3

TEMPERATURE MEANS AND EXTREMES (F)
AT POST OFFICE BUILDING, VICKSBURG, MISSISSIPPI --
[YEARS OF RECORD: NORMALS, 1931-60; EXTREMES, 1938-66]

	Normals			Extremes			
Month	Daily Max.	Daily Min.	Monthly Mean	Record Max.	Year	Record Min.	Year
Jan	57.4	40.5	49.0	81	1949	2	1962
Feb	60.6	42.9	51.8	82	1957	6	1951
Mar	67.1	48.1	57.6	88	1946	17	1943
Apr	75.1	56.2	65.7	90	1958	36	1957
May	82.7	64.0	73.4	95	1951	43	1954
Jun	88.7	70.7	79.7	99	1953	55	1946
Jul	90.4	73.2	81.8	101	1954	64	1943
Aug	90.6	72.7	81.7	101	1943	59	1963
Sep	85.9	67.2	76.6	99	1951	41	1942
Oct	77.4	57.6	67.5	93	1954	31	1952
Nov	65.8	46.6	56.2	85	1955	20	1959
Dec	58.7	41.9	50.3	82	1951	9	1962
Annual	75.0	56.8	65.9	101	1954	2	1962

NOTE: Annual extremes have been exceeded at other sites in the locality as follows: Highest --- 104°F in September 1925
Lowest --- -1°F in February 1899

SOURCE: Local Climatological Data, Annual Summary with Comparative Data for Vicksburg, Mississippi. U. S. Department of Commerce, ESSA, 1966.

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TABLE 2.3.4

MEAN RELATIVE HUMIDITY AT MUNICIPAL AIRPORT,
JACKSON AND POST OFFICE BUILDING, VICKSBURG

	Relative Humidity (%)							
	0000 CST		0600 CST		1200 CST		1800 CST	
Month	J*	V*	J	V	J	V	J	V
Jan	84	84	87	83	66	62	72	70
Feb	82	84	86	84	59	61	63	67
Mar	82	83	87	84	57	56	58	60
Apr	84	87	90	89	57	57	60	63
May	87	91	91	90	56	57	61	65
Jun	86	93	90	91	55	59	60	69
Jul	89	93	93	93	59	62	66	71
Aug	90	92	94	93	60	59	70	72
Sep	90	91	94	92	60	56	72	74
Oct	89	92	93	91	54	52	73	76
Nov	87	89	91	88	58	55	74	74
Dec	85	86	89	86	66	61	77	73
Annual	86	89	90	89	59	58	67	70

*Length of Record: Jackson (J) - 12 years
Vicksburg (V) - 0000 CST, 9 years;
Other times, 12 years

SOURCES: (a) Local Climatological Data, Annual Summary with Comparative Data for Jackson, Mississippi. U. S. Department of Commerce, NOAA, 1975.

(b) Same for Vicksburg, Mississippi. U. S. Department of Commerce, ESSA, 1966.

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TABLE 2.3.5

WET AND DRY BULB TEMPERATURES (F)
FOR COOLING EQUIPMENT DESIGN

Parameter		Jackson MS
Winter (Dec - Feb)		
Median Annual Extreme Minimum Dry Bulb	°	17
99% Dry Bulb	°	21
97 1/2 % Dry Bulb	°	24
Summer (Jun - Sep)		
Design Dry Bulb		
1%	°	98
2 1/2%	°	96
5%	°	94
Design Wet Bulb		
1%	°	79*
2 1/2%	°	78
5%	°	78

NOTES: (1) The Median Annual Extreme Minimum Dry Bulb will be equalled or exceeded during one-half of the years.

(2) Percentage temperatures are those that are equalled or exceeded during the indicated percentage of the hours during the season.

SOURCE: Fluor Products Company 1964. "Evaluated Weather Data For Cooling Equipment Design, Addendum No. 1." Ecodyne Corporation, P. O. Box 1267, Santa Rosa, California, 52 pp. (Ref. 21)

* Design point for both circulatory water cooling tower and ultimate heat sink cooling tower

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TABLE 2.3.6

FREQUENCY OF TROPICAL CYCLONES (BY MONTHS)
ALONG THE MIDDLE GULF COAST

(Based on a 91-Year Record Ending in 1975)

Month	Hurricane Intensity	Less Than Hurricane Intensity	Monthly Total	% of Total
May	0	1	1	1
Jun	4	6	10	11
Jul	1	5	6	7
Aug	7	11	18	21
Sep	23	19	42	48
Oct	5	5	10	11
Nov	0	1	1	1
Total	40	48	88	100

SOURCES: Dunn, Gordon E. and Banner I. Miller - "Atlantic Hurricanes," Louisiana State University Press, 1960.

"Tropical Cyclones of the North Atlantic Ocean." U.S. Department of Commerce Weather Bureau Technical Paper No. 55.

"North Atlantic Tropical Cyclones," U. S. Department of Commerce, NOAA's Climatological Data, National Summary, 1972.

'Atlantic Hurricane Seasons of 1973, 1974 and 1975.' Weatherwise, Vol. 27, No. 1; Vol. 28, No. 1; Vol. 29, No. 1.

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TABLE 2.3.7

AVERAGE NUMBER OF DAYS WITH
THUNDERSTORMS IN THE SITE REGION

	Vicksburg MS	Jackson MS	Baton Rouge LA	Alexandria LA
Jan	2	2	2	3
Feb	3	3	3	3
Mar	6	6	4	5
Apr	6	5	5	5
May	7	7	6	6
Jun	9	8	9	8
Jul	11	12	16	13
Aug	8	11	12	11
Sep	4	5	7	6
Oct	2	1	2	2
Nov	2	2	2	3
Dec	2	3	3	3
Annual	62	65	70	68
Length of Record	27	12	23	14
(Years)	1938-64	1964-75	1952-74	1961-74

SOURCES: "Local Climatological Data, Annual Summary with Comparative Data,
(1) Vicksburg, Mississippi, 1966
(2) Jackson, Mississippi, 1975
(3) Baton Rouge, Louisiana, 1974
(4) Alexandria, Louisiana, 1974,"
U. S. Department of Commerce.

TABLE 2.3.8

MEAN VENTILATION RATES* BY MONTH

JACKSON, MISSISSIPPI

Length of Record - 4 Years

	Morning (m^3/sec)	Afternoon (m^3/sec)	Mean (m^3/sec)
Jan	3327	4321	3824
Feb	3260	6426	4843
Mar	3482	8374	5928
Apr	3206	9387	6297
May	2626	8844	5735
Jun	1948	7536	4742
Jul	1474	7413	4444
Aug	1325	6959	4142
Sep	1762	7168	4465
Oct	1725	5795	3760
Nov	2358	5829	4094
Dec	2394	5418	3906

*Ventilation rate is numerically equal to the product of the mixing height and the average wind speed within the mixing layer.

SOURCE: "Tabulation III - Daily Mixing Depth and Average Wind Speed, Jackson, Mississippi, (1959-1962)," U. S. Department of Commerce, ESSA, National Weather Records Center, 1968.

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TABLE 2.3.9

OCCURRENCE OF FREEZING RAIN OR DRIZZLE
AT JACKSON, MISSISSIPPI
1955 THROUGH 1964 (10 YEARS)

	Total Hours of Occurrence Per Month												
Year	J	F	M	A	M	J	J	A	S	O	N	D	Year
1955	-	-	-	-	-	-	-	-	-	-	-	-	0
1956	-	-	-	-	-	-	-	-	-	-	-	-	0
1957	-	-	-	-	-	-	-	-	-	-	-	-	0
1958	-	5	-	-	-	-	-	-	-	-	-	5	10
1959	2	-	-	-	-	-	-	-	-	-	-	-	2
1960	-	-	-	-	-	-	-	-	-	-	-	-	0
1961	22	-	-	-	-	-	-	-	-	-	-	-	22
1962	-	-	-	-	-	-	-	-	-	-	-	-	0
1963	15	-	-	-	-	-	-	-	-	-	-	31	46
1964	2	-	-	-	-	-	-	-	-	-	-	-	2
Total	41	5	0	0	0	0	0	0	0	0	0	36	

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TABLE 2.3.10

NUMBER AND DURATION OF DISCRETE OCCURRENCES
OF FREEZING RAIN AT JACKSON, MISSISSIPPI
1955 THROUGH 1964 (10 YEARS)

	Duration								
Month	1 Hr	2 to 3 Hrs	4 to 7 Hrs	8 to 11 Hrs	12 to 17 Hrs	18 to 23 Hrs	24 to 35 Hrs	Max. Duration Hrs	Total Occur-rences
Jan	6	8	3					7	17
Feb		2						3	2
Mar									
Apr									
May									
Jun									
Jul									
Aug									
Sep									
Oct									
Nov									
Dec	2	1	4	1				9	8
Total	8	11	7	1	0	0	0		27

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TABLE 2.3.11

MONTHLY SUMMARY OF OCCURRENCES OF
ICE STORMS AT JACKSON, MISSISSIPPI
1955 THROUGH 1964 (10 YEARS)

	J	F	M	A	M	J	J	A	S	O	N	D
Total Hours:	41	5	0	0	0	0	0	0	0	0	0	36
No. of Discrete Events:	17	2	0	0	0	0	0	0	0	0	0	8
Avg. Hrs. Per Event:	2.4	2.5	-	-	-	-	-	-	-	-	-	4.5
Maximum Duration of Single Event:	7	3	0	0	0	0	0	0	0	0	0	9
% Freq. of Occurrence:	0.6	<.1	0	0	0	0	0	0	0	0	0	0.5

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TABLE 2.3.12

ANNUAL SUMMARY OF OCCURRENCES OF ICE
STORMS AT JACKSON, MISSISSIPPI
1955 THROUGH 1964

Year	Total Hours	No. of Discrete Events	Avg.Hrs. Per Event	Max. Hrs. Duration	% Freq. of Occurrences
1955	0	0	-	-	0
1956	0	0	-	-	0
1957	0	0	-	-	0
1958	10	3	3.3	5	0.11
1959	2	1	2.0	2	0.02
1960	0	0	-	-	0
1961	22	7	3.1	7	0.25
1962	0	0	-	-	0
1963	46	15	3.1	9	0.53
1964	2	1	2.0	2	0.02
ALL	82	27	3.0	9	0.09

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TABLE 2.3.13

OCCURRENCE OF DUST, BLOWING DUST OR
BLOWING SAND AT JACKSON, MISSISSIPPI
1955 THROUGH 1964 (10 YEARS)

	Total Hours of Occurrence Per Month												
Year	J	F	M	A	M	J	J	A	S	O	N	D	Year
1955	-	-	-	12	-	-	-	-	-	-	-	-	12
1956	-	2	-	-	-	-	-	-	-	-	-	-	2
1957	-	-	2	-	-	-	-	-	-	-	-	3	5
1958	-	-	-	4	-	-	-	-	-	-	-	-	4
1959	-	4	2	-	1	-	-	-	-	-	-	-	7
1960	-	3	-	-	-	-	-	-	-	-	-	-	3
1961	-	-	-	-	-	-	-	-	-	-	-	-	0
1962	-	-	-	-	-	-	-	-	-	-	-	-	0
1963	-	-	-	-	-	-	-	-	-	-	-	-	0
1964	-	-	-	-	-	-	-	-	-	-	-	-	0
Total	0	9	4	16	1	0	0	0	0	0	0	3	

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TABLE 2.3.14

NUMBER AND DURATION OF DISCRETE OCCURRENCES
OF DUST, BLOWING DUST OR BLOWING SAND
AT JACKSON, MISSISSIPPI
1955 THROUGH 1964 (10 YEARS)

Month	Duration		Maximum Duration Hours	Total Occurrences
	1 Hr	More Than 1 Hr		
Jan				
Feb	9	0	1	9
Mar	4	0	1	4
Apr	16	0	1	16
May	1	0	1	1
Jun				
Jul				
Aug				
Sep				
Oct				
Nov				
Dec	3	0	1	3
Total	33	0		33

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TABLE 2.3.15

MONTHLY SUMMARY OF OCCURRENCES OF
DUST, BLOWING DUST OR BLOWING SAND AT
JACKSON, MISSISSIPPI
1955 THROUGH 1964 (10 YEARS)

	J	F	M	A	M	J	J	A	S	O	N	D
Total Hours:		9	4	16	1							3
No. of Discrete Events:		9	4	16	1							3
Avg. Hrs. Per Event:		1	1	1	1							1
Maximum Duration of Single Event:		1	1	1	1							1
% Freq. of Occurrence:	0.13	0.05	0.22		0.01						0.04	

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TABLE 2.3.16

ANNUAL SUMMARY OF OCCURRENCES OF
DUST, BLOWING DUST OR BLOWING SAND
AT JACKSON, MISSISSIPPI
1955 THROUGH 1964 (10 YEARS)

Year	Total Hours	No. of Discrete Events	Avg.Hrs. Per Event	Max. Hrs. Duration	% Freq. of Occurrence
1955	12	12	1	1	0.14
1956	2	2	1	1	0.02
1957	5	5	1	1	0.06
1958	4	4	1	1	0.05
1959	7	7	1	1	0.08
1960	3	3	1	1	0.03
1961	0	0	-	-	0
1962	0	0	-	-	0
1963	0	0	-	-	0
1964	0	0	-	-	0
ALL	33	33	1	1	0.04

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TABLE 2.3.17

TOTAL MAXIMUM WINTER PRECIPITATION

JACKSON, MISSISSIPPI

Season	Maximum 48 Hour Precipitation (Inches)
1960-61	3.13
1961-62	3.65
1962-63	1.67
1963-64	4.03
1964-65	5.31
1965-66	2.54
1966-67	1.69
1967-68	3.15
1968-69	1.84
1969-70	2.32
1970-71	2.27
1971-72	4.77
1972-73	2.91
1973-74	4.47
1974-75	3.41

Data Source = "Local Climatological Data, Jackson, Mississippi," monthly for the years 1960 through 1975. U. S. Department of Commerce.

TABLE 2.3.18

PERCENTAGE FREQUENCY OF WIND DIRECTION AND SPEED
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 10 Years
January

Direction	Hourly Observations of Wind Speed (mph)										
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 Over	Total	Avg Speed
N	1.0	1.5	2.4	3.3	0.3					8.6	10.8
NNE	0.9	1.3	2.3	1.7	0.1					6.2	9.6
NE	1.2	1.7	2.1	0.4						5.3	7.2
ENE	1.1	1.2	0.8	0.1						3.2	5.9
E	1.0	0.8	0.6	0.1						2.5	5.8
ESE	1.1	1.0	1.0	0.2	0.1					3.4	6.7
SE	2.0	1.7	1.6	0.8	0.1					6.1	7.1
SSE	1.8	2.9	4.7	2.9	0.4	*	*			12.8	9.5
S	1.6	2.5	4.6	2.8	0.3					11.7	9.5
SSW	0.7	1.7	3.0	2.1	0.2	0.1				7.8	10.2
SW	1.0	1.1	1.4	1.3	0.2	*				5.0	9.6
WSW	0.4	0.5	0.8	0.7	0.1	*				2.5	9.7
W	0.9	0.6	0.5	0.5	0.1	*				2.6	8.0
WNW	0.7	1.0	1.2	0.8	0.1	*				3.9	9.0
NW	1.7	1.7	1.7	1.5	0.6	*				7.3	9.3
NNW	0.7	1.3	2.2	2.6	1.0	0.1				7.9	12.0
CALM	3.2									3.2	
TOTAL	21.0	22.5	30.9	21.8	3.6	0.2	*			100	8.9

Note: * indicates more than 0 but less than 0.05

Data Source: Climatogaphy of the United States 82-22, Summary of Hourly Observations, 1951-1960, U. S. Department of Commerce, Weather Bureau, 1963.

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TABLE 2.3.19

PERCENTAGE FREQUENCY OF WIND DIRECTION AND SPEED
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 10 Years
February

Direction	Hourly Observations of Wind Speed (mph)										
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 Over	Total	Avg Speed
N	0.8	1.4	2.8	2.0	0.3					7.3	10.3
NNE	0.9	1.7	2.5	2.0	0.1					7.2	9.4
NE	1.7	1.8	2.3	0.5	*					6.3	7.1
ENE	1.3	1.4	1.0	0.3						3.9	6.2
E	1.5	0.9	0.5	0.2	*					3.1	5.5
ESE	1.1	1.2	1.3	0.5	0.1					4.2	7.5
SE	1.5	1.5	1.9	1.0	0.2	0.1				6.1	8.4
SSE	1.2	1.9	3.6	2.8	0.3	*				9.8	10.2
S	1.2	1.5	3.1	3.0	0.6	0.1				9.5	10.8
SSW	0.6	1.6	1.9	2.1	0.5	0.1				6.8	11.0
SW	1.0	1.4	1.6	1.5	0.4	*				5.9	9.8
WSW	0.5	0.8	1.3	1.1	0.3	*				4.1	10.7
W	0.8	0.8	1.1	0.6	*	*				3.3	8.2
WNW	0.8	0.7	1.0	0.6	0.1	*				3.3	8.5
NW	1.7	1.6	1.6	1.5	0.4					6.8	8.9
NNW	0.8	1.2	1.9	2.7	0.8	0.1				7.6	12.0
CALM	4.8									4.8	
TOTAL	22.0	21.5	29.5	22.4	4.1	0.5				100	9.0

Note:; *indicates more than 0 but less than 0.05

Data Source: Climatography of the United States No. 82-22, Summary of Hourly Observations, 1951-1960, U. S. Department of Commerce, Weather Bureau, 1963.

TABLE 2.3.20

PERCENTAGE FREQUENCY OF WIND DIRECTION AND SPEED
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 10 Years
March

	Hourly Observations of Wind Speed (mph)										
Direction	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 Over	Total	Avg Speed
N	0.9	1.7	2.2	2.0	0.4	*				7.2	10.2
NNE	1.1	1.9	2.3	1.4	0.1	*				6.8	8.7
NE	1.7	1.9	1.7	0.5						5.8	6.6
ENE	1.1	1.3	1.1	0.2						3.6	6.4
E	1.3	1.2	0.8	0.1	*					3.5	5.6
ESE	1.0	1.2	1.1	0.1	*					3.5	6.2
SE	1.6	1.5	2.2	0.7	*					6.0	7.5
SSE	1.2	1.9	3.2	2.4	0.5	0.1				9.3	10.2
S	1.2	2.0	3.0	2.9	0.4	0.1	*			9.6	10.4
SSW	0.6	1.5	3.1	3.7	0.9	0.1				9.9	12.2
SW	0.9	1.3	1.6	1.4	0.2					5.5	9.6
WSW	0.7	0.9	1.1	1.0	0.1	*				3.8	9.6
W	0.7	0.6	0.9	0.5	0.1	*				2.7	8.2
WNW	0.6	0.7	1.1	1.4	0.2	*				4.0	10.7
NW	1.4	1.2	1.6	1.7	0.3	*				6.2	9.5
NNW	1.1	1.4	2.3	2.1	0.6	*				7.6	10.5
CALM	5.0									5.0	
TOTAL	22.0	22.3	29.3	22.2	3.8	0.4	*			100	8.9

Note: *indicates more than 0 but less than 0.05

Data Source: Climatography of the United States No. 82-22, Summary of Hourly Observations, 1951-1960, U. S. Department of Commerce, Weather Bureau, 1963.

TABLE 2.3.21

PERCENTAGE FREQUENCY OF WIND DIRECTION AND SPEED
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 10 Years
April

Direction	Hourly Observations of Wind Speed (mph)									
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 Over	Total	Avg Speed
N	0.8	1.3	2.1	1.7	0.2	*				6.0	9.9
NNE	0.5	1.2	1.4	1.1	0.1					4.2	9.1
NE	0.8	1.2	1.1	0.4	*					3.6	7.1
ENE	0.8	0.8	0.6	0.2						2.4	6.2
E	1.0	0.8	0.5	*						2.3	5.2
ESE	1.0	1.1	0.8	0.1						3.1	5.9
SE	1.6	1.6	2.0	0.9	*					6.2	7.5
SSE	2.3	3.3	5.1	3.8	0.4	0.1		*		14.9	9.5
S	2.4	3.0	5.3	2.9	0.2	0.1	0.1			14.0	9.1
SSW	1.2	2.3	3.2	2.3	0.3		*	*		9.4	9.6
SW	1.2	2.0	1.8	1.4	0.1					6.5	8.7
WSW	0.7	1.0	1.2	0.7	0.1					3.7	8.6
W	0.8	0.6	0.9	0.5	0.2	*				3.0	9.0
WNW	1.0	0.6	1.0	1.1	0.2	*				3.9	9.6
NW	1.8	1.2	1.3	1.3	0.4	*	*			6.1	8.9
NNW	0.6	0.9	2.0	1.5	0.1	*				5.2	10.2
CALM	5.7									5.7	
TOTAL	24.3	22.9	30.2	19.8	2.4	0.3	0.1	*		100	8.3

Note: * indicates more than 0 but less than 0.05

Data Source: Climatography of the United States No. 82-22, Summary of Hourly Observations, 1951-1960, U. S. Department of Commerce, Weather Bureau, 1963.

TABLE 2.3.22

PERCENTAGE FREQUENCY OF WIND DIRECTION AND SPEED
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 10 Years
May

Direction	Hourly Observations of Wind Speed (mph)									
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 Over	Total	Avg SPEED
N	1.1	1.2	1.2	0.7	*					4.2	7.6
NNE	0.9	1.0	1.6	0.7	*					4.3	8.0
NE	1.7	1.5	1.2	0.2						4.6	5.8
ENE	1.2	1.1	0.7	0.1						3.1	5.7
E	1.8	1.1	0.7	0.1						3.8	5.2
ESE	1.1	1.2	1.1	0.5						3.9	6.9
SE	2.7	2.1	2.0	0.9	0.1					7.9	7.0
SSE	2.7	3.5	4.2	2.0	0.1	*				12.5	8.0
S	3.2	3.1	3.7	1.8	0.2	*				12.2	7.8
SSW	1.8	2.5	2.5	1.4	0.1					8.3	8.0
SW	2.2	2.2	1.9	0.9	*					7.2	7.0
WSW	0.9	1.1	1.4	0.4						3.8	7.4
W	1.2	1.0	0.9	0.1						3.3	5.8
WNW	1.3	1.4	1.2	0.4		*				4.3	6.6
NW	2.5	1.3	1.3	0.6	0.1	*				5.8	6.5
NNW	1.0	1.2	1.2	0.8	0.2	*				4.2	6.6
CALM	6.6									6.6	
TOTAL	34.0	26.6	26.9	11.6	0.8	0.1				100	6.7

Note: * indicates more than 0 but less than 0.05

Data Source: Climatography of the United States 82-22, Summary of Hourly Observations, 1951-1960, U. S. Department of Commerce, Weather Bureau, 1963.

TABLE 2.3.23

PERCENTAGE FREQUENCY OF WIND DIRECTION AND SPEED
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 10 Years
June

Direction	Hourly Observations of Wind Speed (mph)										
	0-3	4-7	8-12	13-18	19-14	25-31	32-38	39-46	47 Over	Total	Avg Speed
N	1.3	1.2	0.9	0.4	*					3.8	6.7
NNE	1.1	1.2	0.9	0.2	*					3.4	6.3
NE	2.0	1.2	0.9	0.2						4.2	5.2
ENE	1.2	1.2	0.6	0.1						3.0	5.5
E	1.6	0.9	0.5	0.1	*					3.1	5.1
ESE	1.7	1.1	0.9	0.3	*					4.0	6.0
SE	2.9	2.3	1.3	0.4	*					7.0	5.7
SSE	3.2	3.4	3.1	0.7	0.2	*	*	*		10.7	6.9
S	3.5	3.4	2.9	0.4			*			10.2	6.1
SSW	2.3	3.1	2.6	0.6	*	*				8.6	6.7
SW	2.8	3.3	2.4	0.5	*	*				8.9	6.3
WSW	1.5	1.9	2.0	0.6	*					6.0	7.2
W	1.8	1.6	1.2	0.3						4.9	6.0
WNW	1.7	1.3	1.3	0.5	*					4.8	6.6
NW	2.3	1.6	1.1	0.3	*	*				5.3	5.6
NNW	0.8	1.0	1.2	0.4	*	*				3.3	7.7
CALM	8.8									8.8	
TOTAL	40.2	29.5	23.8	5.9	0.4	0.1	*	*		100	5.7

Note: * indicates more than 0 but less than 0.05

Data Source: Climatography of the United States No. 82-22, Summary of Hourly Observations, 1951-1960, U. S. Department of Commerce, Weather Bureau, 1963.

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TABLE 2.3.24

PERCENTAGE FREQUENCY OF WIND DIRECTION AND SPEED
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 10 Years
July

Direction	Hourly Observations of Wind Speed (mph)										
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 Over	Total	Avg Speed
N	1.3	1.1	0.8	0.2	*					3.4	6.0
NNE	1.0	1.3	0.8	0.1	*	*				3.2	6.0
NE	1.7	1.2	0.8	0.1						3.8	5.3
ENE	1.1	1.0	0.6	0.2	*					3.0	6.0
E	1.5	1.1	0.6	0.1						3.4	5.2
ESE	1.5	1.4	0.8	0.3	*	*				4.0	6.2
SE	3.4	2.1	1.6	0.7	*					7.9	6.0
SSE	3.6	3.2	2.0	0.6	*					9.4	5.9
S	3.7	2.6	1.7	0.2	*					8.3	5.4
SSW	2.0	2.6	1.7	0.4	*					6.7	6.2
SW	3.5	3.6	1.8	0.3	*					9.3	5.5
WSW	1.6	2.8	2.7	0.5	*					7.6	7.0
W	2.1	1.8	1.7	0.2						5.7	5.8
WNW	1.5	1.5	1.4	0.4	*					4.9	6.7
NW	2.1	1.5	1.4	0.2	*					5.2	5.8
NNW	1.1	1.2	1.3	0.4	*					4.0	6.9
CALM	10.2									10.2	
TOTAL	43.0	30.0	21.7	5.0	0.3	*				100	5.4

Note: * indicates more than 0 but less than 0.05

Data Source: Climatography of the United States 82-22, Summary of Hourly Observations, 1951-1960, U. S. Department of Weather Bureau, 1963.

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TABLE 2.3.25

PERCENTAGE FREQUENCY OF WIND DIRECTION AND SPEED
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 10 Years
August

Direction	Hourly Observations of Wind Speed (mph)										
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 Over	Total	Avg Speed
N	1.5	1.6	1.3	0.6	*					4.9	6.8
NNE	1.2	1.3	1.3	0.5	*					4.3	7.2
NE	2.0	1.4	1.4	0.3	*					5.1	5.9
ENE	1.6	1.2	0.8	0.3	*	*				3.9	6.0
E	2.6	1.4	1.2	0.2	*					5.3	5.4
ESE	2.1	1.5	1.1	0.3	*					4.9	5.7
SE	3.8	2.6	1.1	0.3	*					7.8	4.9
SSE	3.5	2.7	1.6	0.4	0.1		*			8.3	5.7
S	3.5	2.2	1.1	0.3	*					7.1	5.0
SSW	2.2	2.3	1.5	0.2	*					6.1	5.7
SW	2.8	2.6	1.3	0.1	*					6.9	5.2
WSW	1.6	2.0	2.1	0.4						6.0	6.7
W	1.6	1.5	1.5	0.2						4.8	6.2
WNW	1.6	1.7	1.5	0.2	*	*				4.9	6.2
NW	3.1	1.5	1.1	0.4	*					6.2	5.4
NNW	1.2	1.3	0.9	0.4	*					3.8	6.9
CALM	9.5									9.5	
TOTAL	45.2	28.7	20.8	4.9	0.3	*	*			100	5.3

Note: * indicates more than 0 but less than 0.05

Data Source: Climatography of the United States No. 82-22, Summary of Hourly Observations, 1951-1960, U. S. Department of Commerce, Weather Bureau, 1963.

TABLE 2.3.26

PERCENTAGE FREQUENCY OF WIND DIRECTION AND SPEED
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 10 Years
September

Direction	Hourly Observations of Wind Speed (mph)										
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 Over	Total	Avg Speed
N	1.7	1.7	1.8	0.7						5.8	7.0
NNE	1.7	1.9	3.0	1.3	0.1					7.9	8.3
NE	3.0	3.3	3.2	1.2	*					10.7	7.0
ENE	2.3	2.4	2.1	0.6	*					7.4	6.5
E	2.6	2.0	2.1	0.3						6.9	5.9
ESE	2.1	2.1	1.9	0.5	*					6.6	6.5
SE	3.2	2.4	2.0	0.5	*					8.1	6.0
SSE	2.5	2.6	2.6	0.8	*	*				8.4	6.8
S	2.1	2.1	1.3	0.2			*			5.6	5.6
SSW	0.9	1.3	1.2	0.2						3.7	6.7
SW	1.1	1.0	0.7	0.1						2.9	5.8
WSW	0.5	0.5	0.5	0.1						1.5	6.2
W	1.0	0.5	0.2	*						1.7	4.5
WNW	1.0	0.6	0.3	0.1						2.0	4.9
NW	3.1	1.5	1.1	0.1						5.7	4.8
NNW	1.2	1.3	1.3	0.5	*					4.3	7.1
CALM	10.7									10.7	
TOTAL	40.5	27.1	25.2	7.0	0.2	*	*			100	5.8

Note: *indicates more than 0 but less than 0.05

Data Source: Climatography of the United States No. 82-22, Summary of Hourly Observations, 1951-1960, U. S. Department of Weather Bureau, 1963.

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TABLE 2.3.27

PERCENTAGE FREQUENCY OF WIND DIRECTION AND SPEED
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 10 Years
October

Direction	Hourly Observations of Wind Speed (mph)										
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 Over	Total	Avg Speed
N	1.6	1.7	1.9	1.7	0.2	*				7.1	8.8
NNE	1.4	1.8	1.8	1.6	0.2					6.9	8.9
NE	2.6	2.7	2.3	0.6	0.1					8.3	6.5
ENE	2.1	1.9	1.1	0.2	*					5.4	5.6
E	2.6	1.4	0.5	*						4.4	4.2
ESE	1.7	1.5	1.0	0.2						4.4	5.8
SE	4.0	2.6	2.1	0.3						8.9	5.5
SSE	2.6	2.5	2.6	0.8	*					8.7	6.9
S	2.3	2.0	1.4	0.4						6.2	6.0
SSW	0.6	1.0	1.1	0.4	*					3.2	7.6
SW	1.0	0.7	0.6	0.3	*					2.5	6.4
WSW	0.5	0.8	0.6	0.1						2.0	6.6
W	0.9	0.7	0.7	0.2	*					2.5	6.6
WNW	0.8	0.8	0.9	0.4	0.1					3.1	7.5
NW	3.1	1.9	1.6	0.6	0.1					7.2	6.1
NNW	1.5	1.6	1.9	1.7	0.2	*				6.8	8.8
CALM	12.4									12.4	
TOTAL	41.8	25.5	22.1	9.7	0.9	*				100	5.9

Note: * indicates more than 0 but less than 0.05

Data Source: Climatography of the United States No. 82-22, Summary of Hourly Observations, 1951-1960, U. S. Department of Commerce, Weather Bureau, 1963.

TABLE 2.3.28

PERCENTAGE FREQUENCY OF WIND DIRECTION AND SPEED
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 10 Years
November

Direction	Hourly Observations of Wind Speed (mph)										
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 Over	Total	Avg Speed
N	0.9	1.7	2.5	1.5	0.2					6.8	9.3
NNE	0.9	1.3	1.8	0.4	0.1					5.6	9.2
NE	1.5	1.7	1.4	0.8	*					5.5	7.2
ENE	1.3	1.0	0.6	0.2						3.1	5.6
E	1.5	1.2	0.6	*						3.3	4.9
ESE	1.6	1.2	0.7	0.1						3.5	5.1
SE	2.9	2.3	1.7	0.5	*					7.4	5.9
SSE	2.5	2.6	3.6	3.3	0.4	*				12.4	9.4
S	1.9	1.8	2.6	1.5	0.2		*			7.9	8.4
SSW	0.8	0.9	1.5	1.1	0.1	0.1				4.5	9.7
SW	1.0	0.9	1.0	0.5	*					3.4	7.5
WSW	0.6	0.7	0.9	0.4	0.1	*				2.6	7.9
W	0.8	0.7	0.5	0.3	*					2.5	6.8
WNW	1.4	0.9	0.9	0.8	0.1	*				4.1	7.9
NW	3.2	1.9	2.0	1.6	0.2	*				8.9	7.6
NNW	1.1	2.0	2.4	2.8	0.5	*				8.8	10.6
CALM	9.5									9.5	
TOTAL	33.4	22.7	24.7	16.9	2.0	0.2	*			100	7.3

Note: * indicates more than 0 but less than 0.05

Data Source: Climatography of the United States N0. 82-22, Summary of Hourly Observations, 1951-1960, U. S. Department of Commerce, Weather Bureau, 1963.

TABLE 2.3.29

PERCENTAGE FREQUENCY OF WIND DIRECTION AND SPEED
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 10 Years
December

	Hourly Observations of Wind Speed (mph)									
Direction	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 Over	Total	Avg Speed
N	1.1	1.4	1.8	2.0	0.3	*				6.6	9.8
NNE	1.0	1.5	2.2	1.3	0.1					6.1	8.8
NE	1.1	1.4	1.4	0.3						4.3	6.6
ENE	0.9	1.1	0.7	0.1						2.7	5.8
E	1.0	0.8	0.4	0.1						2.4	5.1
ESE	1.3	1.1	0.9	0.4						3.6	6.4
SE	2.7	2.3	2.9	1.5	0.1	*				9.5	7.7
SSE	2.5	2.3	4.1	3.0	0.4					12.3	9.2
S	2.0	2.0	2.8	2.2	0.3	*				9.3	9.1
SSW	1.1	1.4	1.6	1.7	0.4	0.1				6.3	9.9
SW	1.3	1.4	1.6	0.6	0.1					4.9	7.6
WSW	0.9	0.9	1.0	0.9	0.1	*				3.8	8.6
W	1.0	0.6	0.7	0.4	0.1	*				2.7	7.3
WNW	1.4	0.9	1.0	1.1	0.2	*				4.6	8.8
NW	2.3	1.6	1.9	1.5	0.4	*				7.7	8.7
NNW	1.2	1.3	1.8	2.0	0.7	0.1				7.2	10.6
CALM	5.9									5.9	
TOTAL	28.8	22.1	26.7	19.0	3.1	0.4				100	8.1

Note: * indicates more than 0 but less than 0.05

Data Source: Climatography of the United States No. 82-22, Summary of Hourly Observations, 1951-1960, U. S. Department of Commerce, Weather Bureau, 1963.

TABLE 2.3.30

PERCENTAGE FREQUENCY OF WIND DIRECTION AND SPEED
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 10 Years
Annual

	Hourly Observations of Wind Speed (mph)										
Direction	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	47 Over	Total	Avg. Speed
N	1.2	1.4	1.8	1.4	0.2	*				6.0	9.0
NNE	1.1	1.5	1.8	1.1	0.1	*				5.5	8.5
NE	1.8	1.7	1.6	0.5	*					5.6	6.6
ENE	1.3	1.3	0.9	0.2	*	*				3.7	6.0
E	1.7	1.1	0.8	0.1	*					3.7	5.3
ESE	1.4	1.3	1.0	0.3	*	*				4.1	6.3
SE	2.7	2.1	1.9	0.7	*	*				7.4	6.5
SSE	2.5	2.7	3.4	1.9	0.2	*	*	*		10.8	8.3
S	2.4	2.3	2.8	1.5	0.2	*	*			9.3	8.0
SSW	1.2	1.9	2.1	1.3	0.2	*	*	*		6.8	8.8
SW	1.6	1.8	1.5	0.7	0.1	*				5.7	7.3
WSW	0.9	1.2	1.3	0.6	0.1	*				4.0	7.9
W	1.1	0.9	0.9	0.3	*	*				3.3	6.8
WNW	1.2	1.0	1.1	0.6	0.1	*				4.0	7.8
NW	2.4	1.5	1.5	0.9	0.2	*	*			6.5	7.4
NNW	1.0	1.3	1.7	1.5	0.3	*				5.9	9.8
CALM	7.7									7.7	
TOTAL	33.1	25.1	26.0	13.8	1.8	0.2	*	*		100	7.1

Note: *indicates more than 0 but less than 0.05

Data Source: Climatography of the United States No. 82-22, Summary of Hourly Observations, 1951-1960, U. S. Department of Commerce, Weather Bureau, 1963.

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TABLE 2.3.31

PERCENTAGE FREQUENCY OF WIND DIRECTION AND SPEED
AT GRAND GULF SITE
PERIOD OF RECORD - AUGUST 1972 TO JULY 1973

ANNUAL

	Hourly Average 33-Foot Wind Speed (mph)						
Direction	0-3	4-7	8-12	13-18	19-Over	Total	Avg. Speed
N	3.0	4.1	1.1	*		8.2	4.2
NNE	2.8	2.2	0.1			5.1	3.1
NE	4.1	2.2	0.1			6.4	2.8
ENE	5.2	2.8	0.2			8.2	2.7
E	4.7	3.8	0.5			9.0	3.2
ESE	3.2	3.0	0.9	*		7.1	3.8
SE	2.4	3.6	1.5	0.1		7.6	4.8
SSE	1.6	3.5	2.4	0.6	*	8.2	6.1
S	1.5	2.6	1.4	0.1		5.6	5.1
SSW	1.1	2.3	0.8	0.1		4.3	4.9
SW	1.0	3.4	1.5	*		5.9	5.3
WSW	1.0	2.3	0.8			4.1	4.7
W	0.9	2.3	0.9			4.1	4.9
WNW	0.9	2.0	0.5			3.4	4.4
NW	0.9	3.2	1.3	*		5.5	5.2
NNW	1.2	3.5	2.5	0.1		7.3	5.8
Calm	<0.01						
Total	35.6	46.8	16.5	1.0	*	100	4.4

NOTE: * indicates more than 0 but less than 0.05

SOURCE: On-site measurements program

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TABLE 2.3.32

PERCENTAGE FREQUENCY OF WIND DIRECTION AND SPEED
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
PERIOD OF RECORD - AUGUST 1972 TO JULY 1973

ANNUAL

Direction	Hourly Observations of 20-Foot Wind Speed (mph) 0-3	4-7	8-12	13-18	19-Over	Total	Avg. Speed
N	1.3	3.0	3.4	2.1	0.4	10.2	8.8
NNE	0.8	2.0	1.6	0.4		4.8	7.0
NE	0.7	1.6	0.9	0.1		3.4	5.6
ENE	1.0	1.9	0.6	0.1	*	3.5	4.9
E	0.8	2.0	1.0	0.2	*	4.0	5.8
ESE	1.2	2.2	1.3	0.4	0.1	5.1	6.5
SE	2.2	4.6	3.1	2.3	0.7	12.9	8.2
SSE	1.9	4.0	3.0	1.7	0.5	11.1	7.9
S	1.5	3.2	2.9	1.8	0.7	10.2	8.7
SSW	1.4	3.0	1.9	0.6	0.1	6.9	6.7
SW	0.9	1.7	1.0	0.2	*	3.9	5.8
WSW	0.7	1.4	1.0	0.2		3.3	6.3
W	1.1	2.3	1.6	0.7	*	5.7	6.7
WNW	0.7	1.6	1.4	0.6	0.1	4.4	7.4
NW	0.5	1.4	1.4	0.9	0.2	4.5	9.0
NNW	0.8	1.5	2.0	1.5	0.3	6.1	9.5
Calm	16.8						
Total	34.3	37.4	28.2	13.7	3.2	100	7.6

NOTE: * indicates more than 0 but less than 0.05

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TABLE 2.3.33

PERCENTAGE FREQUENCY OF WIND DIRECTION AND SPEED
AT GRAND GULF SITE
PERIOD OF RECORD - AUGUST 1972 TO JULY 1974

ANNUAL

	Hourly Average 33-Foot Wind Speed (mph)						
Direction	0-3	4-7	8-12	13-18	19-Over	Total	Avg. Speed
N	3.0	4.6	1.0	*		8.6	4.6
NNE	2.8	1.8	0.1			4.7	3.3
NE	4.0	1.5	0.1			5.5	2.8
ENE	6.9	1.9	0.1			8.8	2.5
E	6.5	2.6	0.2	*		9.2	2.9
ESE	4.9	3.3	0.7	*		8.9	3.7
SE	3.1	3.4	1.0	*	*	7.5	4.6
SSE	2.2	3.7	2.0	0.3	*	8.2	5.9
S	1.8	3.0	2.6	0.1		7.4	6.2
SSW	1.3	2.1	1.1	0.1	*	4.5	5.5
SW	1.4	3.0	1.1	0.1		5.6	5.5
WSW	1.1	2.1	0.6	*	*	3.7	5.0
W	1.3	1.8	0.4	*		3.5	4.6
WNW	1.0	1.5	0.3			2.8	4.7
NW	1.1	2.3	0.7			4.1	5.1
NNW	1.6	3.4	1.8	0.1		6.8	5.8
Calm	*						
Total	43.9	41.7	13.7	0.7	*	100	4.4

NOTE: * indicates more than 0 but less than 0.05

SOURCE: On-site measurements program

TABLE 2.3.34

RELATIVE FREQUENCY OF HOURLY OBSERVATIONS OF WIND DIRECTION AND SPEED, JANUARY, GRAND GULF, MISSISSIPPI, AUGUST 1972 - JULY 1974

162/33 Foot Delta T., 33 Foot Winds

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	CALM DIST
N	0.0223	0.1284	0.0223	0.0	0.0	0.0	0.0	0.0	0.0	0.1734	0.0
NNE	0.0223	0.0419	0.0335	0.0	0.0	0.0	0.0	0.0	0.0	0.0675	0.0
NE	0.0251	0.0188	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0446	0.0
ENE	0.0306	0.0150	0.0014	0.0	0.0	0.0	0.0	0.0	0.0	0.0481	0.0
E	0.0352	0.0362	0.0070	0.0	0.0	0.0	0.0	0.0	0.0	0.0794	0.0
ESE	0.0258	0.0453	0.0167	0.0007	0.0	0.0	0.0	0.0	0.0	0.0884	0.0
SE	0.0244	0.0481	0.0149	0.0007	0.0	0.0	0.0	0.0	0.0	0.0870	0.0
SSE	0.0153	0.0320	0.0204	0.0021	0.0	0.0	0.0	0.0	0.0	0.0703	0.0
S	0.0077	0.0244	0.0272	0.0014	0.0	0.0	0.0	0.0	0.0	0.0606	0.0
SSW	0.0077	0.0125	0.0145	0.0049	0.0	0.0	0.0	0.0	0.0	0.0397	0.0
SW	0.0146	0.0181	0.0209	0.0021	0.0	0.0	0.0	0.0	0.0	0.0564	0.0
WSW	0.0077	0.0188	0.0056	0.0	0.0	0.0	0.0	0.0	0.0	0.0320	0.0
W	0.0070	0.0139	0.0028	0.0	0.0	0.0	0.0	0.0	0.0	0.0237	0.0
WNW	0.0056	0.0111	0.0049	0.0	0.0	0.0	0.0	0.0	0.0	0.0216	0.0
NW	0.0091	0.0146	0.0097	0.0	0.0	0.0	0.0	0.0	0.0	0.0334	0.0
NNW	0.0174	0.0355	0.0209	0.0	0.0	0.0	0.0	0.0	0.0	0.0738	0.0
TOTAL	0.2786	0.5167	0.1929	0.0118	0.0	0.0	0.0	0.0	0.0	1.0000	0.0

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TABLE 2.3.35

RELATIVE FREQUENCY OF HOURLY OBSERVATIONS OF WIND DIRECTION AND SPEED, FEBRUARY, GRAND GULF, MISSISSIPPI, AUGUST 1972 - JULY 1974

162/33 FT. DELTA T. 33 FT. WINDS

	WIND SPEED (MPH)										
DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	CALM DIST
N	0.0251	0.0348	0.0245	0.0007	0.0	0.0	0.0	0.0	0.0	0.0859	0.0015
NNE	0.0217	0.0194	0.0022	0.0	0.0	0.0	0.0	0.0	0.0	0.0433	0.0
NE	0.0254	0.0090	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0351	0.0
ENE	0.0338	0.0060	0.0022	0.0	0.0	0.0	0.0	0.0	0.0	0.0418	0.0
E	0.0396	0.0187	0.0022	0.0	0.0	0.0	0.0	0.0	0.0	0.0605	0.0
ESE	0.0329	0.0568	0.0112	0.0	0.0	0.0	0.0	0.0	0.0	0.1008	0.0
SE	0.0082	0.0194	0.0232	0.0015	0.0	0.0	0.0	0.0	0.0	0.0523	0.0
SSE	0.0082	0.0232	0.0234	0.0067	0.0022	0.0	0.0	0.0	0.0	0.0642	0.0
S	0.0060	0.0321	0.0284	0.0015	0.0	0.0	0.0	0.0	0.0	0.0680	0.0
SSW	0.0022	0.0217	0.0187	0.0	0.0007	0.0	0.0	0.0	0.0	0.0433	0.0
SW	0.0075	0.0232	0.0366	0.0015	0.0	0.0	0.0	0.0	0.0	0.0687	0.0
WSW	0.0045	0.0202	0.0202	0.0015	0.0007	0.0	0.0	0.0	0.0	0.0471	0.0
W	0.0090	0.0142	0.0179	0.0022	0.0	0.0	0.0	0.0	0.0	0.0433	0.0
WNW	0.0060	0.0306	0.0082	0.0	0.0	0.0	0.0	0.0	0.0	0.0448	0.0
NW	0.0105	0.0388	0.0202	0.0	0.0	0.0	0.0	0.0	0.0	0.0695	0.0
NNW	0.0142	0.0426	0.0702	0.0045	0.0	0.0	0.0	0.0	0.0	0.1314	0.0
TOTAL	0.2554	0.4100	0.3107	0.0202	0.0037	0.0	0.0	0.0	0.0	1.0000	0.0015

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TABLE 2.3.36

RELATIVE FREQUENCY OF HOURLY OBSERVATIONS OF WIND DIRECTION AND SPEED, MARCH, GRAND GULF, MISSISSIPPI, AUGUST 1972 - JULY 1974

162/33 FT. DELTA T. 33 FT. WINDS

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	CALM DIST
N	0.0124	0.0224	0.0142	0.0	0.0	0.0	0.0	0.0	0.0	0.0499	0.0
NNE	0.0152	0.0108	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0276	0.0
NE	0.0196	0.0189	0.0013	0.0	0.0	0.0	0.0	0.0	0.0	0.0398	0.0
ENE	0.0391	0.0276	0.0020	0.0	0.0	0.0	0.0	0.0	0.0	0.0688	0.0
E	0.0351	0.0344	0.0088	0.0007	0.0	0.0	0.0	0.0	0.0	0.0789	0.0
ESE	0.0330	0.0486	0.0229	0.0007	0.0	0.0	0.0	0.0	0.0	0.1052	0.0
SE	0.0155	0.0205	0.0294	0.0007	0.0	0.0	0.0	0.0	0.0	0.0661	0.0
SSE	0.0083	0.0211	0.0371	0.0115	0.0	0.0	0.0	0.0	0.0	0.0944	0.0
S	0.0089	0.0283	0.0775	0.0020	0.0	0.0	0.0	0.0	0.0	0.1167	0.0
SSW	0.0067	0.0142	0.0233	0.0	0.0	0.0	0.0	0.0	0.0	0.0492	0.0
SW	0.0135	0.0303	0.0394	0.0047	0.0	0.0	0.0	0.0	0.0	0.0883	0.0
WSW	0.0047	0.0303	0.0189	0.0	0.0	0.0	0.0	0.0	0.0	0.0539	0.0
W	0.0074	0.0230	0.0121	0.0	0.0	0.0	0.0	0.0	0.0	0.0486	0.0
WNW	0.0067	0.0152	0.0091	0.0	0.0	0.0	0.0	0.0	0.0	0.0310	0.0
NW	0.0047	0.0182	0.0088	0.0	0.0	0.0	0.0	0.0	0.0	0.0317	0.0
NNW	0.0067	0.0135	0.0224	0.0007	0.0	0.0	0.0	0.0	0.0	0.0459	0.0
TOTAL	0.2394	0.4268	0.3129	0.0209	0.0	0.0	0.0	0.0	0.0	1.0000	0.0

TABLE 2.3 57

RELATIVE FREQUENCY OF HOURLY OBSERVATIONS OF WIND DIRECTION AND SPEED, APRIL, GRAND GULF, MISSISSIPPI, AUGUST 1972 - JULY 1974

162/33 FT. DELTA T. 33 FT. WINDS

	WIND SPEED (MPH)										
DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	CALM DIST
N	0.0210	0.0280	0.0021	0.0	0.0	0.0	0.0	0.0	0.0	0.0510	0.0
NNE	0.0217	0.0077	0.0014	0.0	0.0	0.0	0.0	0.0	0.0	0.0307	0.0007
NE	0.0328	0.0091	0.0035	0.0	0.0	0.0	0.0	0.0	0.0	0.0454	0.0014
ENE	0.0475	0.0161	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0636	0.0
E	0.0524	0.0328	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0860	0.0
ESE	0.0384	0.0496	0.0098	0.0	0.0	0.0	0.0	0.0	0.0	0.0978	0.0
SE	0.0189	0.0692	0.0252	0.0014	0.0	0.0	0.0	0.0	0.0	0.1153	0.0
SSE	0.0175	0.0636	0.0524	0.0098	0.0	0.0	0.0	0.0	0.0	0.1433	0.0
S	0.0056	0.0273	0.0321	0.0035	0.0	0.0	0.0	0.0	0.0	0.0685	0.0
SSW	0.0112	0.0133	0.0126	0.0014	0.0	0.0	0.0	0.0	0.0	0.0384	0.0
SW	0.0098	0.0252	0.0049	0.0	0.0	0.0	0.0	0.0	0.0	0.0398	0.0
WSW	0.0042	0.0217	0.0112	0.0	0.0	0.0	0.0	0.0	0.0	0.0370	0.0
W	0.0049	0.0259	0.0140	0.0	0.0	0.0	0.0	0.0	0.0	0.0447	0.0
WNW	0.0049	0.0259	0.0070	0.0	0.0	0.0	0.0	0.0	0.0	0.0377	0.0
NW	0.0077	0.0280	0.0189	0.0	0.0	0.0	0.0	0.0	0.0	0.0545	0.0
NNW	0.0154	0.0231	0.0077	0.0	0.0	0.0	0.0	0.0	0.0	0.0461	0.0
TOTAL	0.3138	0.4061	0.2034	0.0161	0.0	0.0	0.0	0.0	0.0	1.0000	0.0021

TABLE 2.3.38

RELATIVE FREQUENCY OF HOURLY OBSERVATIONS OF WIND DIRECTION AND SPEED, MAY, GRAND GULF, MISSISSIPPI, AUGUST 1972 - JULY 1974

162/33 FT. DELTA T. 33 FT. WINDS

	WIND SPEED (MPH)										
DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	CALM DIST
N	0.0168	0.0282	0.0020	0.0	0.0	0.0	0.0	0.0	0.0	0.0470	0.0
NNE	0.0208	0.0121	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0336	0.0
NE	0.0376	0.0128	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0511	0.0
ENE	0.0726	0.0155	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0880	0.0
E	0.0524	0.0242	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0773	0.0
ESE	0.0390	0.0195	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0591	0.0
SE	0.0363	0.0316	0.0054	0.0	0.0	0.0	0.0	0.0	0.0	0.0733	0.0
SSE	0.0269	0.0592	0.0181	0.0027	0.0	0.0	0.0	0.0	0.0	0.1169	0.0
S	0.0161	0.0793	0.0450	0.0	0.0	0.0	0.0	0.0	0.0	0.1405	0.0
SSW	0.0114	0.0578	0.0195	0.0	0.0	0.0	0.0	0.0	0.0	0.0887	0.0
SW	0.0121	0.0430	0.0148	0.0	0.0	0.0	0.0	0.0	0.0	0.0699	0.0
WSW	0.0074	0.0269	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0343	0.0
W	0.0081	0.0108	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0188	0.0
WNW	0.0081	0.0108	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0188	0.0
NW	0.0074	0.0188	0.0087	0.0	0.0	0.0	0.0	0.0	0.0	0.0349	0.0
NNW	0.0108	0.0309	0.0060	0.0	0.0	0.0	0.0	0.0	0.0	0.0477	0.0
TOTAL	0.3837	0.4913	0.1223	0.0027	0.0	0.0	0.0	0.0	0.0	1.0000	0.0

TABLE 2.3.39

RELATIVE FREQUENCY OF HOURLY OBSERVATIONS OF WIND DIRECTION AND SPEED, JUNE, GRAND GULF, MISSISSIPPI, AUGUST 1972 - JULY 1974

162/33 FT. DELTA T. 33 FT. WINDS

	WIND SPEED (MPH)										
DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	CALM DIST
N	0.0334	0.0368	0.0139	0.0	0.0	0.0	0.0	0.0	0.0	0.0841	0.0
NNE	0.0403	0.0160	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0563	0.0
NE	0.0500	0.0069	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0570	0.0
ENE	0.0834	0.0076	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0910	0.0
E	0.0890	0.0111	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1001	0.0
ESE	0.0674	0.0146	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0820	0.0
SE	0.0514	0.0257	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0771	0.0
SSE	0.0320	0.0327	0.0145	0.0	0.0	0.0	0.0	0.0	0.0	0.0792	0.0
S	0.0264	0.0361	0.0250	0.0	0.0	0.0	0.0	0.0	0.0	0.0876	0.0
SSW	0.0160	0.0361	0.0083	0.0	0.0	0.0	0.0	0.0	0.0	0.0605	0.0
SW	0.0202	0.0424	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0625	0.0
WSW	0.0153	0.0250	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0403	0.0
W	0.0188	0.0069	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0257	0.0
WNW	0.0125	0.0076	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0208	0.0
NW	0.0160	0.0222	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0382	0.0
NNW	0.0146	0.0229	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0375	0.0
TOTAL	0.5865	0.3509	0.0625	0.0	0.0	0.0	0.0	0.0	0.0	1.0000	0.0

TABLE 2.3.40

RELATIVE FREQUENCY OF HOURLY OBSERVATIONS OF WIND DIRECTION AND SPEED, JULY, GRAND GULF, MISSISSIPPI, AUGUST 1972 - JULY 1974

162/33 FT. DELTA T. 33 FT. WINDS

	WIND SPEED (MPH)										
DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	CALM DIST
N	0.0215	0.0229	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0444	0.0
NNE	0.0215	0.0108	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0330	0.0
NE	0.0330	0.0074	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0404	0.0
ENE	0.0707	0.0067	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0774	0.0
E	0.0902	0.0108	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1009	0.0
ESE	0.1077	0.0054	0.0013	0.0	0.0	0.0	0.0	0.0	0.0	0.1144	0.0
SE	0.0653	0.0114	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0774	0.0
SSE	0.0471	0.0188	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0666	0.0
S	0.0505	0.0296	0.0013	0.0	0.0	0.0	0.0	0.0	0.0	0.0814	0.0
SSW	0.0269	0.0269	0.0020	0.0	0.0	0.0	0.0	0.0	0.0	0.0559	0.0
SW	0.0276	0.0606	0.0013	0.0	0.0	0.0	0.0	0.0	0.0	0.0895	0.0
WSW	0.0236	0.0256	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0491	0.0
W	0.0397	0.0303	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0707	0.0
WNW	0.0182	0.0101	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0283	0.0
NW	0.0162	0.0168	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0330	0.0
NNW	0.0108	0.0269	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0377	0.0
TOTAL	0.6703	0.3210	0.0087	0.0	0.0	0.0	0.0	0.0	0.0	1.0000	0.0

GG
ER

TABLE 2.3-41

RELATIVE FREQUENCY OF HOURLY OBSERVATIONS OF WIND DIRECTION AND SPEED, AUGUST, GRAND GULF, MISSISSIPPI, AUGUST 1972 - JULY 1974

162/33 FT. DELTA T. 33 FT. WINDS

	WIND SPEED (MPH)										
DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	CALM DIST
N	0.0643	0.0399	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.1089	0.0
NNE	0.0491	0.0142	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0633	0.0
NE	0.0698	0.0114	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0811	0.0
ENE	0.1082	0.0178	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1260	0.0
E	0.0804	0.0135	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0947	0.0
ESE	0.0626	0.0085	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0719	0.0
SE	0.0320	0.0107	0.0014	0.0	0.0	0.0	0.0	0.0	0.0	0.0441	0.0
SSE	0.0263	0.0142	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0413	0.0
S	0.0278	0.0157	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0434	0.0
SSW	0.0221	0.0185	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0413	0.0
SW	0.0185	0.0427	0.0028	0.0	0.0	0.0	0.0	0.0	0.0	0.0641	0.0
WSW	0.0192	0.0221	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0413	0.0
W	0.0228	0.0199	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0427	0.0
WNW	0.0164	0.0107	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0270	0.0
NW	0.0192	0.0221	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0413	0.0
NNW	0.0299	0.0342	0.0036	0.0	0.0	0.0	0.0	0.0	0.0	0.0676	0.0
TOTAL	0.6726	0.3160	0.0114	0.0	0.0	0.0	0.0	0.0	0.0	1.0000	0.0

GG
ER

TABLE 2.3.42

RELATIVE FREQUENCY OF HOURLY OBSERVATIONS OF WIND DIRECTION AND SPEED, SEPTEMBER, GRAND GULF, MISSISSIPPI, AUGUST 1972 - JULY 1974

162/33 FT. DELTA T. 33 FT. WINDS

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	CALM DIST
N	0.0315	0.0264	0.0029	0.0	0.0	0.0	0.0	0.0	0.0	0.0608	0.0
NNE	0.0344	0.0081	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0425	0.0
NE	0.0512	0.0117	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0630	0.0
ENE	0.1193	0.0564	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.1764	0.0
E	0.1047	0.0432	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1479	0.0
ESE	0.0703	0.0271	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0974	0.0
SE	0.0564	0.0249	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0820	0.0
SSE	0.0373	0.0285	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0666	0.0
S	0.0307	0.0154	0.0037	0.0	0.0	0.0	0.0	0.0	0.0	0.0498	0.0
SSW	0.0227	0.0146	0.0029	0.0	0.0	0.0	0.0	0.0	0.0	0.0403	0.0
SW	0.0205	0.0205	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0410	0.0
WSW	0.0110	0.0022	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0132	0.0
W	0.0102	0.0066	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0168	0.0
WNW	0.0117	0.0059	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0176	0.0
NW	0.0088	0.0132	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0220	0.0
NNW	0.0227	0.0307	0.0095	0.0	0.0	0.0	0.0	0.0	0.0	0.0630	0.0
TOTAL	0.5435	1.3353	0.0212	0.0	0.0	0.0	0.0	0.0	0.0	1.0000	0.0

GG
ER

TABLE 2.3-43

RELATIVE FREQUENCY OF HOURLY OBSERVATIONS OF WIND DIRECTION AND SPEED, OCTOBER, GRAND GULF, MISSISSIPPI, AUGUST 1972 - JULY 1974

162/33 FT. DELTA T. 33 FT. WINDS

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	CALM DIST
N	0.0448	0.0490	0.0041	0.0	0.0	0.0	0.0	0.0	0.0	0.0979	0.0
NNE	0.0414	0.0290	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0703	0.0
NE	0.0669	0.0303	0.0014	0.0	0.0	0.0	0.0	0.0	0.0	0.0986	0.0
ENE	0.1379	0.0234	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.1621	0.0
E	0.0972	0.0248	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.1228	0.0
ESE	0.0566	0.0297	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0862	0.0
SE	0.0276	0.0276	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0552	0.0
SSE	0.0186	0.0276	0.0041	0.0	0.0	0.0	0.0	0.0	0.0	0.0503	0.0
S	0.0131	0.0145	0.0021	0.0	0.0	0.0	0.0	0.0	0.0	0.0297	0.0
SSW	0.0110	0.0152	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0262	0.0
SW	0.0083	0.0241	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0324	0.0
WSW	0.0159	0.0131	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0297	0.0
W	0.0090	0.0117	0.0014	0.0	0.0	0.0	0.0	0.0	0.0	0.0221	0.0
WNW	0.0159	0.0097	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0255	0.0
NW	0.0124	0.0200	0.0014	0.0	0.0	0.0	0.0	0.0	0.0	0.0338	0.0
NNW	0.0152	0.0372	0.0048	0.0	0.0	0.0	0.0	0.0	0.0	0.0572	0.0
TOTAL	0.5917	0.3869	0.0214	0.0	0.0	0.0	0.0	0.0	0.0	1.0000	0.0

GG
ER

TABLE 2.3.44

RELATIVE FREQUENCY OF HOURLY OBSERVATIONS OF WIND DIRECTION AND SPEED, NOVEMBER, GRAND GULF, MISSISSIPPI, AUGUST 1972 - JULY 1974

162/33 FT. DELTA T. 33 FT. WINDS

	WIND SPEED (MPH)										
DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	CALM DIST
N	0.0463	0.0628	0.0112	0.0	0.0	0.0	0.0	0.0	0.0	0.1207	0.0
NNE	0.0265	0.0216	0.0014	0.0	0.0	0.0	0.0	0.0	0.0	0.0495	0.0
NE	0.0412	0.0321	0.0014	0.0	0.0	0.0	0.0	0.0	0.0	0.0747	0.0
ENE	0.0537	0.0230	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0768	0.0
E	0.0642	0.0286	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0928	0.0
ESE	0.0335	0.0384	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0726	0.0
SE	0.0154	0.0440	0.0007	0.0	0.0	0.0	0.0	0.0	0.0	0.0600	0.0
SSE	0.0174	0.0502	0.0370	0.0014	0.0	0.0	0.0	0.0	0.0	0.1061	0.0
S	0.0098	0.0237	0.0370	0.0014	0.0	0.0	0.0	0.0	0.0	0.0719	0.0
SSW	0.0070	0.0105	0.0035	0.0	0.0	0.0	0.0	0.0	0.0	0.0209	0.0
SW	0.0042	0.0140	0.0049	0.0007	0.0	0.0	0.0	0.0	0.0	0.0237	0.0
WSW	0.0084	0.0258	0.0035	0.0	0.0	0.0	0.0	0.0	0.0	0.0377	0.0
W	0.0077	0.0314	0.0021	0.0	0.0	0.0	0.0	0.0	0.0	0.0412	0.0
WNW	0.0056	0.0265	0.0028	0.0	0.0	0.0	0.0	0.0	0.0	0.0349	0.0
NW	0.0119	0.0279	0.0063	0.0	0.0	0.0	0.0	0.0	0.0	0.0461	0.0
NNW	0.0112	0.0302	0.0091	0.0	0.0	0.0	0.0	0.0	0.0	0.0705	0.0
TOTAL	0.3643	0.5108	0.1214	0.0035	0.0	0.0	0.0	0.0	0.0	1.0000	0.0

GG
ER

TABLE 2.3.45

RELATIVE FREQUENCY OF HOURLY OBSERVATIONS OF WIND DIRECTION AND SPEED, DECEMBER, GRAND GULF, MISSISSIPPI, AUGUST 1972 - JULY 1974

152/33 FT. DELTA T. 33 FT. WINDS

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	CALM DIST
N	0.0222	0.0065	0.0222	0.0	0.0	0.0	0.0	0.0	0.0	0.1109	0.0
NNE	0.0255	0.0195	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0450	0.0
NE	0.0262	0.0094	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0356	0.0
ENE	0.0371	0.0074	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0444	0.0
E	0.0403	0.0282	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0685	0.0
ESE	0.0189	0.0578	0.0155	0.0	0.0	0.0	0.0	0.0	0.0	0.0921	0.0
SE	0.0298	0.0491	0.0383	0.0	0.0	0.0	0.0	0.0	0.0	0.1082	0.0
SSE	0.0050	0.0376	0.0329	0.0040	0.0	0.0	0.0	0.0	0.0	0.0806	0.0
S	0.0074	0.0262	0.0282	0.0007	0.0	0.0	0.0	0.0	0.0	0.0625	0.0
SSW	0.0101	0.0094	0.0168	0.0013	0.0	0.0	0.0	0.0	0.0	0.0376	0.0
SW	0.0081	0.0141	0.0094	0.0	0.0	0.0	0.0	0.0	0.0	0.0316	0.0
WSW	0.0040	0.0128	0.0087	0.0	0.0	0.0	0.0	0.0	0.0	0.0255	0.0
W	0.0094	0.0134	0.0020	0.0	0.0	0.0	0.0	0.0	0.0	0.0249	0.0
WNW	0.0050	0.0208	0.0047	0.0	0.0	0.0	0.0	0.0	0.0	0.0316	0.0
NW	0.0134	0.0316	0.0148	0.0	0.0	0.0	0.0	0.0	0.0	0.0598	0.0
NNW	0.0188	0.0638	0.0571	0.0013	0.0	0.0	0.0	0.0	0.0	0.1411	0.0
TOTAL	0.2742	0.4377	0.2507	0.0074	0.0	0.0	0.0	0.0	0.0	1.0000	0.0

TABLE 2.3.46

MAXIMUM NUMBER OF CONSECUTIVE HOURS WITH
WIND FROM A SINGLE SECTOR (22.5°) AT
JACKSON, MISSISSIPPI

Sector	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	All	Avg.
N	13	19	14	12	9	6	17	12	18	10	19	13.0
NNE	8	15	10	11	9	11	8	13	13	10	15	10.8
NE	17	9	13	13	14	14	7	26	6	7	26	12.6
ENE	8	9	10	14	8	9	6	6	12	6	14	8.8
E	7	4	6	7	9	6	10	6	8	12	12	7.5
ESE	9	6	14	6	13	12	7	8	8	6	14	8.2
SE	12	12	9	14	11	27	12	16	8	16	27	13.5
SSE	17	27	29	22	16	10	15	9	11	9	29	16.5
S	15	16	12	17	14	12	13	16	17	11	17	14.3
SSW	16	13	5	6	9	6	8	12	16	11	16	10.2
SW	8	11	17	9	8	11	7	9	11	6	17	9.7
WSW	7	9	8	18	8	10	11	11	12	5	18	9.9
W	8	5	7	7	7	7	9	7	4	8	9	6.9
WNW	10	20	7	8	14	11	9	8	7	9	20	10.3
NW	8	15	8	9	14	26	21	10	9	8	26	12.8
NNW	11	8	10	12	13	14	23	19	17	17	23	14.4
Calm	10	19	11	11	13	16	17	12	11	11	19	13.1

GG
ER

TABLE 2.3.47

MAXIMUM NUMBER OF CONSECUTIVE HOURS WITH
WIND FROM THREE ADJACENT SECTORS (67.5°)
AT JACKSON, MISSISSIPPI

Central Sector	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	All	Avg.
N	27	46	42	45	36	29	45	49	46	88	88	45.3
NNE	36	39	56	53	42	47	27	48	50	24	56	42.2
NE	42	33	84	56	37	29	19	30	22	19	84	37.1
ENE	29	18	32	34	29	47	25	28	18	28	47	28.8
E	43	16	24	25	56	33	52	22	38	16	56	32.5
ESE	24	18	16	27	50	43	26	19	21	36	50	28.0
SE	43	76	77	37	39	79	46	33	23	34	79	48.7
SSE	36	73	75	56	63	38	43	35	45	56	75	52.0
S	59	59	97	39	66	35	53	41	39	44	97	53.2
SSW	71	60	33	21	45	14	41	30	36	40	71	39.1
SW	55	32	26	33	28	26	16	41	29	21	55	30.7
WSW	19	42	31	26	22	23	36	21	27	21	42	26.8
W	27	16	27	14	29	26	25	26	36	21	36	24.7
WNW	30	41	19	23	30	28	20	20	16	23	41	25.0
NW	30	35	25	20	40	51	28	27	23	42	51	32.1
NNW	27	37	37	41	36	33	35	39	32	43	43	36.0

TABLE 2.3.48

MAXIMUM NUMBER OF CONSECUTIVE HOURS WITH
WIND FROM FIVE ADJACENT SECTORS (112.5°)
AT JACKSON, MISSISSIPPI

Central Sector	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	All	Avg.
N	70	158	68	62	86	52	66	58	64	91	158	77.5
NNE	73	59	69	114	67	55	53	63	96	88	114	73.7
NE	49	72	84	67	49	58	28	45	61	77	84	59.0
ENE	65	30	98	60	78	56	53	28	48	67	98	58.3
E	65	20	54	52	80	85	52	35	87	54	87	58.4
ESE	66	84	81	66	54	82	114	24	46	61	114	67.8
SE	53	78	80	45	49	90	69	46	79	68	90	65.7
SSE	61	75	171	56	85	79	100	52	67	75	171	82.1
S	91	98	182	65	68	84	113	90	107	66	182	96.4
SSW	99	74	108	80	66	45	112	104	111	60	112	85.9
SW	109	79	31	36	56	32	34	51	68	47	109	54.3
WSW	41	72	40	48	56	34	36	44	61	31	72	46.3
W	52	37	35	31	38	36	46	66	41	31	66	41.3
WNW	50	46	27	31	42	59	35	37	38	35	59	40.0
NW	45	43	54	47	40	56	47	42	39	51	56	46.4
NNW	48	81	65	50	61	72	68	42	53	84	84	62.4

GG
ER

TABLE 2.3.49

MAXIMUM NUMBER OF CONSECUTIVE HOURS WITH WIND FROM A SINGLE SECTOR (22.5°) AT GRAND GULF SITE

Sector	1972 -73	1973 -74	All	Avg.
N	15	21	21	18
NNE	8	8	8	8
NE	11	11	11	11
ENE	11	10	11	11
E	12	17	17	15
ESE	12	11	12	12
SE	25	14	25	20
SSE	14	15	15	15
S	10	16	16	13
SSW	10	10	10	10
SW	10	9	10	10
WSW	18	8	18	13
W	17	10	17	14
WNW	9	9	9	9
NW	11	11	11	11
NNW	55	17	55	36

GG
ER

TABLE 2.3.50

MAXIMUM NUMBER OF CONSECUTIVE HOURS WITH
WIND FROM THREE ADJACENT SECTORS (67.5°)
AT GRAND GULF SITE

Central Sector	1972 -73	1973 -74	All	Avg.
N	86	49	86	68
NNE	32	53	53	43
NE	18	22	22	20
ENE	28	44	44	36
E	20	39	39	30
ESE	35	36	36	36
SE	50	41	50	46
SSE	42	67	67	55
S	21	31	31	26
SSW	30	38	38	34
SW	29	22	29	26
WSW	43	17	43	30
W	41	20	41	31
WNW	31	17	31	24
NW	63	42	63	53
NNW	101	45	101	73

GG
ER

TABLE 2.3.51

MAXIMUM NUMBER OF CONSECUTIVE HOURS WITH
WIND FROM FIVE ADJACENT SECTORS (112.5°) AT
GRAND GULF SITE

Central Sector	1972 -73	1973 -74	All	Avg.
N	101	55	101	78
NNE	86	86	86	86
NE	44	88	88	66
ENE	40	46	46	43
E	39	90	90	65
ESE	57	70	70	64
SE	82	67	82	75
SSE	57	83	83	70
S	58	93	93	76
SSW	50	102	102	76
SW	49	40	49	45
WSW	50	30	50	40
W	45	24	45	35
WNW	63	45	63	54
NW	101	49	101	75
NNW	101	50	101	76

TABLE 2.3.52

COMPARISON OF MAXIMUM WIND PERSISTENCE
AT GRAND GULF SITE[1] AND AT JACKSON, MS[2]

Central Sector	Maximum Consecutive Hours in Single Sector		Three Adjacent Sectors		Five Adjacent Sectors	
	G.G.	J.	G.G.	J.	G.G.	J.
N	21	19	86	88	101	158
NNE	8	15	53	56	86	114
NE	11	26	22	84	88	84
ENE	11	14	44	47	46	98
E	17	12	39	56	90	87
ESE	12	14	36	50	70	114
SE	25	27	50	79	82	90
SSE	15	29	67	75	83	171
S	16	17	31	97	93	182
SSW	10	16	38	71	102	112
SW	10	17	29	55	49	109
WSW	18	18	43	42	50	72
W	17	9	41	36	45	66
WNW	9	20	31	41	63	59
NW	11	26	63	51	101	56
NNW	55	23	101	43	101	84

[1] Period of record: August 1972 - July 1974

[2] Period of record: 1955-1964

(Sector(s) with maximum persistence underlined)

GG
ER

TABLE 2.3.53

MAXIMUM NUMBER OF CONSECUTIVE HOURS
WITH WIND FROM A SINGLE SECTOR, BY MONTH,
AT JACKSON, MISSISSIPPI
1955 THROUGH 1964

	Month												
Sector	J	F	M	A	M	J	J	A	S	O	N	D	Sector Max.
N	14	14	18*	13	10	7	6	8	10	12	19	13	19
NNE	15	12	13	11	8	5	7	10*	13	10	13	11	15
NE	13	10	11	7	13	9	6	6	14*	17*	26*	8	26
ENE	14	8	10	9	5	6	6	8	12	10	6	8	14
E	10	7	7	6	8	6	6	6	9	12	7	7	12
ESE	11	9	7	6	11	8	4	9	14*	5	12	13	14
SE	16	9	10	8	15*	9	9	9	12	14	18	27*	27
SSE	29*	25*	15	13	15*	27*	8	7	12	17*	22	22	29
S	17	17	16	15*	13	11	7	9	9	7	15	12	17
SSW	12	13	16	12	10	5	7	6	6	5	14	11	16
SW	17	9	10	11	7	11	9	9	6	5	7	10	17
WSW	11	18	10	7	7	7	10*	6	4	5	9	9	18
W	7	8	9	5	5	6	7	7	4	7	6	6	9
WNW	20	9	14	12	10	8	6	6	4	10	8	7	20
NW	26	16	10	15*	14	5	6	7	13	9	14	12	26
NNW	23	12	11	7	8	9	6	9	8	14	17	13	23
Calm	13	13	10	11	15	13	13	14	14	17	19	13	19

* Monthly Maximum (Sector Maximum is underlined)

TABLE 2.3.54

AVERAGE MONTHLY OCCURRENCES OF EXTREME TEMPERATURES AT MUNICIPAL AIRPORT, JACKSON AND VICKSBURG POST OFFICE BUILDING

Length of Record: Jackson - 12 Years; Vicksburg - 29 Years

	Jackson Temperatures				Vicksburg Temperatures			
	Maximum		Minimum		Maximum		Minimum	
Month	≥90°F	≤32°F	≤ 32°F	≤0°F	≥90°F	≤32°F	≤32°F	≤0°F
January	0	*	12	0	0	1	9	0
February	0	*	13	0	0	*	5	0
March	0	0	5	0	0	*	1	0
April	*	0	*	0	*	0	0	0
May	5	0	0	0	2	0	0	0
June	18	0	0	0	14	0	0	0
July	24	0	0	0	20	0	0	0
August	21	0	0	0	20	0	0	0
September	11	0	0	0	9	0	0	0
October	1	0	*	0	1	0	*	0
November	0	0	5	0	0	0	2	0
December	0	0	10	0	0	*	6	0
Annual	80	*	46	0	66	2	23	0

* Less than one-half

Data Sources: Local Climatological Data, Jackson, Mississippi, 1975, U.S. Department of Commerce, NOAA, and Vicksburg, Mississippi, U.S. Department of Commerce, ESSA, 1966.

TABLE 2.3.55

TEMPERATURE MEANS AND EXTREMES (F) AT
GRAND GULF (GG) AND JACKSON, MS (J)
AUGUST 1973 - JULY 1974

	Daily Maximum		Monthly Mean		Daily Minimum	
Month	GG	J	GG	J	GG	J
Jan	64.4	63.8	54.5	55.1	44.6	46.4
Feb	60.3	61.8	49.0	50.1	37.8	38.3
Mar	71.2	73.5	61.8	62.4	52.3	51.2
Apr	72.9	75.5	62.6	63.1	52.3	50.7
May	82.2	83.3	73.7	73.8	65.1	64.3
Jun	84.2	85.2	74.8	74.8	65.3	64.3
Jul	87.1	90.8	78.2	80.4	69.4	70.0
Aug	88.5	90.9	78.9	80.1	69.3	69.2
Sep	83.8	85.6	76.6	77.6	69.4	69.5
Oct	78.3	79.8	68.8	68.6	59.2	57.4
Nov	71.6	73.1	61.2	61.7	50.9	50.3
Dec	59.2	60.3	48.2	49.3	37.2	38.2
Annual	74.9	77.0	65.5	66.4	56.1	55.8

GG
ER

TABLE 2.3.56

TEMPERATURE MEANS AND EXTREMES (F) AT GRAND GULF (GG)
AND JACKSON, MISSISSIPPI (J)
AUGUST 1972 - JULY 1973

	Daily Maximum		Monthly Mean		Daily Minimum	
	GG	J	GG	J	GG	J
January	53.0	55.1	44.8	44.3	36.7	33.5
February	56.7	59.2	47.6	46.9	38.4	34.6
March	71.5	72.9	62.2	62.1	52.9	51.2
April	70.4	73.1	61.1	62.5	51.8	51.8
May	78.5	82.7	69.2	70.9	59.9	59.1
June	87.2	91.6	78.4	81.3	69.5	70.9
July	90.1	93.7	81.0	83.7	71.8	73.6
August	89.5	93.8	80.0	82.8	70.4	71.8
September	88.7	92.3	79.2	81.5	69.6	70.7
October	74.7	79.5	65.4	68.0	56.1	56.5
November	58.9	61.2	51.0	52.0	43.1	42.7
December	59.8	60.9	49.5	50.1	39.2	39.3
Annual	73.3	76.4	64.2	65.6	55.0	54.8

TABLE 2.3.57

ANNUAL FREQUENCY DISTRIBUTION OF SATURATION DEFICIT VERSUS WIND SPEED BY SECTOR AT JACKSON, MISSISSIPPI, 1955-1964 87596 OBSERVATIONS

WIND DIR.= N
NO. OBS. = 5704
PERCENT = 6.5

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	8	5	5	9	28	0.5	0.5
1.0- 3.0	102	372	548	552	724	1898	33.3	33.8
3.0- 5.0	85	300	300	287	712	1682	29.5	63.3
5.0- 7.0	75	269	246	256	470	1319	23.1	86.4
7.0-10.0	21	164	171	175	202	733	12.9	99.2
GT.10.0	2	18	8	5	11	44	0.8	100.0
TOTAL	287	1131	1078	1080	2128	5704	100.0	
% FR	5.0	19.8	18.9	18.9	37.3	100.0		
CUM %	5.0	24.9	43.8	62.7	100.0			

WIND DIR.= NNE
NO. OBS. = 4896
PERCENT = 5.6

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	3	4	4	6	2	19	0.4	0.4
1.0- 3.0	90	355	393	356	798	1992	40.7	41.1
3.0- 5.0	69	259	312	299	713	1647	33.6	74.7
5.0- 7.0	62	170	166	196	353	947	19.3	94.1
7.0-10.0	24	60	55	50	91	280	5.7	99.8
GT.10.0	1	1	4	4	1	11	0.2	100.0
TOTAL	248	849	934	911	1958	4896	100.0	
% FR	5.0	17.3	19.1	18.6	40.0	100.0		
CUM %	5.0	22.3	41.4	60.0	100.0			

GG
ER

TABLE 2.3.57 Continued

(Annual saturation deficit)

WIND DIR.= NE
NO. OBS. = 4650
PERCENT = 5.3

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	2	12	8	13	13	48	1.0	1.0
1.0- 3.0	115	431	452	499	1017	2514	54.1	55.1
3.0- 5.0	80	251	289	262	616	1498	32.2	87.3
5.0- 7.0	28	71	68	103	245	515	11.1	98.4
7.0-10.0	8	8	16	13	29	74	1.6	100.0
GT.10.0	0	0	1	0	0	1	0.0	100.0
TOTAL	233	773	834	890	1920	4650	100.0	
% FR	5.0	16.6	17.9	19.1	41.3	100.0		
CUM %	5.0	21.6	39.6	58.7	100.0			

WIND DIR.= ENE
NO. OBS. = 3601
PERCENT = 4.1

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	17	5	7	9	39	1.1	1.1
1.0- 3.0	109	338	417	422	823	2109	58.6	59.7
3.0- 5.0	82	134	189	189	518	1112	30.9	90.5
5.0- 7.0	25	31	30	59	162	307	8.5	99.1
7.0-10.0	6	4	6	2	15	33	0.9	100.0
GT.10.0	0	0	0	0	1	1	0.0	100.0
TOTAL	223	524	647	679	1528	3601	100.0	
% FR	6.2	14.6	18.0	18.9	42.4	100.0		
CUM %	6.2	20.7	38.7	57.6	100.0			

GG
ER

TABLE 2.3.57 Continued

(Annual saturation deficit)

WIND DIR.= E
NO. OBS. = 3619
PERCENT = 4.1

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	3	27	20	12	17	79	2.2	2.2
1.0- 3.0	104	362	485	459	812	2222	61.4	63.6
3.0- 5.0	46	110	159	218	464	997	27.5	91.1
5.0- 7.0	10	30	29	66	152	287	7.9	99.1
7.0-10.0	3	11	2	7	8	31	0.9	99.9
GT.10.0	0	2	0	1	0	3	0.1	100.0
TOTAL	166	542	695	763	1453	3619	100.0	
% FR	4.6	15.0	19.2	21.1	40.1	100.0		
CUM %	4.6	19.6	38.8	59.9	100.0			

WIND DIR.= ESE
NO. OBS. = 3694
PERCENT = 4.2

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	5	11	7	7	9	39	1.1	1.1
1.0- 3.0	109	411	419	460	679	2078	56.3	57.3
3.0- 5.0	59	153	153	270	494	1129	30.6	87.9
5.0- 7.0	23	59	58	84	157	381	10.3	98.2
7.0-10.0	3	11	13	13	24	64	1.7	99.9
GT.10.0	0	2	0	0	1	3	0.1	100.0
TOTAL	199	647	650	834	1364	3694	100.0	
% FR	5.4	17.5	17.6	22.6	36.9	100.0		
CUM %	5.4	22.9	40.5	63.1	100.0			

GG
ER

TABLE 2.3.57 Continued

(Annual saturation deficit)

WIND DIR.= SE
NO. OBS. = 6655
PERCENT = 7.6

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	9	34	22	11	18	94	1.4	1.4
1.0- 3.0	207	826	834	715	1094	3676	55.2	56.6
3.0- 5.0	93	228	396	433	776	1926	28.9	85.6
5.0- 7.0	32	75	152	153	296	708	10.6	96.2
7.0-10.0	4	38	42	58	86	228	3.4	99.7
GT.10.0	2	9	2	10	0	23	0.3	100.0
TOTAL	347	1210	1448	1380	2270	6655	100.0	
% FR	5.2	18.2	21.8	20.7	34.1	100.0		
CUM %	5.2	23.4	45.2	65.9	100.0			

WIND DIR.= SSE
NO. OBS. = 8693
PERCENT = 9.9

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	10	21	14	8	15	68	0.8	0.8
1.0- 3.0	147	862	803	618	1106	3586	41.3	42.0
3.0- 5.0	100	457	577	612	1082	2828	32.5	74.6
5.0- 7.0	55	207	322	329	658	1551	17.8	92.4
7.0-10.0	12	79	118	162	253	624	7.2	99.6
GT.10.0	0	7	9	6	14	36	0.4	100.0
TOTAL	354	1633	1843	1735	3128	8693	100.0	
% FR	4.1	18.8	21.2	20.0	36.0	100.0		
CUM %	4.1	22.9	44.1	64.0	100.0			

GG
ESR

TABLE 2.3.57 Continued

(Annual saturation deficit)

WIND DIR.= S
NO. OBS. = 7985
PERCENT = 9.1

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	4	21	22	9	11	67	0.8	0.8
1.0- 3.0	150	680	766	650	1089	3335	41.8	42.6
3.0- 5.0	68	380	483	573	958	2462	30.8	73.4
5.0- 7.0	24	146	287	309	697	1463	18.3	91.8
7.0-10.0	4	43	109	163	280	599	7.5	99.3
GT.10.0	0	2	3	16	38	59	0.7	100.0
TOTAL	250	1272	1670	1720	3073	7985	100.0	
% FR	3.1	15.9	20.9	21.5	38.5	100.0		
CUM %	3.1	19.1	40.0	61.5	100.0			

WIND DIR.= SSW
NO. OBS. = 5283
PERCENT = 6.0

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	4	2	5	8	19	0.4	0.4
1.0- 3.0	68	434	425	439	783	2045	38.7	39.1
3.0- 5.0	44	154	246	355	861	1650	31.2	70.3
5.0- 7.0	7	54	152	203	628	1044	19.8	90.1
7.0-10.0	0	17	49	109	319	494	9.4	99.4
GT.10.0	1	1	0	4	25	31	0.6	100.0
TOTAL	106	564	874	1115	2624	5283	100.0	
% FR	2.0	10.7	16.5	21.1	49.7	100.0		
CUM %	2.0	12.7	29.2	50.3	100.0			

EGER

TABLE 2.3.57 Continued

(Annual saturation deficit)

WIND DIR.= SW
NO. OBS. = 4585
PERCENT = 5.2

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM)							
	0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	13	15	10	13	51	1.1	1.1
1.0- 3.0	58	297	410	499	955	2219	48.4	49.5
3.0- 5.0	20	115	192	285	791	1403	30.6	80.1
5.0- 7.0	5	28	65	133	422	653	14.2	94.4
7.0-10.0	3	1	19	55	169	247	5.4	99.7
GT.10.0	0	0	0	1	11	12	0.3	100.0
TOTAL	86	454	701	983	2361	4585	100.0	
% FR	1.9	9.9	15.3	21.4	51.5	100.0		
CUM %	1.9	11.8	27.1	48.5	100.0			

WIND DIR.= WSW
NO. OBS. = 3183
PERCENT = 3.6

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM)							
	0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	2	8	12	1	3	26	0.8	0.8
1.0- 3.0	57	186	227	249	644	1363	42.8	43.6
3.0- 5.0	14	85	148	205	645	1097	34.5	78.1
5.0- 7.0	8	45	63	79	320	515	16.2	94.3
7.0-10.0	3	12	13	30	112	170	5.3	99.6
GT.10.0	0	1	0	0	11	12	0.4	100.0
TOTAL	84	337	463	564	1735	3183	100.0	
% FR	2.6	10.6	14.5	17.7	54.5	100.0		
CUM %	2.6	13.2	27.8	45.5	100.0			

GG
ER

TABLE 2.3.57 Continued

(Annual saturation deficit)

WIND DIR.= W
NO. OBS. = 2820
PERCENT = 3.2

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	7	19	9	1	19	55	2.0	2.0
1.0- 3.0	67	240	238	236	584	1365	48.4	50.4
3.0- 5.0	30	83	105	146	485	849	30.1	80.5
5.0- 7.0	10	32	52	85	241	420	14.9	95.4
7.0-10.0	5	5	18	17	72	115	4.1	99.4
GT.10.0	1	0	3	1	11	16	0.6	100.0
TOTAL	120	377	425	486	1412	2820	100.0	
% FR	4.3	13.4	15.1	17.2	50.1	100.0		
CUM %	4.3	17.6	32.7	49.9	100.0			

WIND DIR.= WNW
NO. OBS. = 3365
PERCENT = 3.8

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	5	13	9	12	8	45	1.3	1.3
1.0- 3.0	104	341	251	203	552	1451	43.1	44.5
3.0- 5.0	45	116	93	150	578	980	29.1	73.6
5.0- 7.0	35	87	67	121	279	589	17.5	91.1
7.0-10.0	16	33	45	57	127	278	8.3	99.3
GT.10.0	2	3	3	4	10	22	0.7	100.0
TOTAL	203	593	468	547	1554	3365	100.0	
% FR	6.0	17.6	13.9	16.3	46.2	100.0		
CUM %	6.0	23.7	37.6	53.8	100.0			

GG
ER

TABLE 2.3.57 Continued

(Annual saturation deficit)

WIND DIR.= SE
NO. OBS. = 4910
PERCENT = 5.6

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	11	31	8	15	19	84	1.7	1.7
1.0- 3.0	190	537	482	595	779	2453	50.0	51.7
3.0- 5.0	87	210	194	174	536	1201	24.5	76.1
5.0- 7.0	61	114	145	131	255	706	14.4	90.5
7.0-10.0	44	104	83	74	123	430	8.8	99.3
GT.10.0	5	8	4	4	10	36	0.7	100.0
TOTAL	398	1106	896	793	1722	4910	100.0	
% FR	7.9	22.5	18.2	16.3	35.1	100.0		
CUM %	7.9	30.3	48.7	64.9	100.0			

GG
ER

WIND DIR.= SSE
NO. OBS. = 5060
PERCENT = 5.8

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	5	9	8	3	4	29	0.6	0.6
1.0- 3.0	105	384	324	236	497	1546	30.6	31.2
3.0- 5.0	77	265	242	245	633	1460	28.9	60.0
5.0- 7.0	67	241	222	209	421	1180	23.3	83.3
7.0-10.0	45	177	170	168	211	771	15.2	98.6
GT.10.0	4	26	14	12	12	72	1.4	100.0
TOTAL	527	1102	980	873	1778	5060	100.0	
% FR	10.5	21.7	19.4	17.3	35.1	100.0		
CUM %	10.5	32.2	51.6	68.9	100.0			

TABLE 2.3.57 Continued

(Annual saturation deficit)

*IND DIR.=CALM
NO. OBS. = 8893
PERCENT = 10.2

*IND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	766	2914	2219	1274	1720	8893	100.0	100.0
1.0- 3.0	0	0	0	0	0	0	0.0	100.0
3.0- 5.0	0	0	0	0	0	0	0.0	100.0
5.0- 7.0	0	0	0	0	0	0	0.0	100.0
7.0-10.0	0	0	0	0	0	0	0.0	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	766	2914	2219	1274	1720	8893	100.0	
% FR	8.6	32.8	25.0	14.3	19.3	100.0		
CUM %	8.6	41.4	66.3	80.7	100.0			

*IND DIR.=TOTL
NO. OBS. = 87596
PERCENT =100.0

*IND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	832	5166	2389	1399	1897	9683	11.1	11.1
1.0- 3.0	1818	7056	7254	6790	12936	35854	40.9	52.0
3.0- 5.0	980	3298	4078	4703	10862	23921	27.3	79.3
5.0- 7.0	530	1659	2124	2516	5756	12585	14.4	93.7
7.0-10.0	201	767	929	1153	2121	5171	5.9	99.6
GT.10.0	22	80	51	73	156	382	0.4	100.0
TOTAL	4383	18026	16825	16634	33728	87596	100.0	
% FR	5.0	20.5	19.2	19.0	38.5	100.0		
CUM %	5.0	25.5	42.5	61.5	100.0			

GG
ER

TABLE 2.3.58

SPRING SEASON FREQUENCY DISTRIBUTION OF SATURATION DEFICIT VERSUS WIND SPEED BY SECTOR AT JACKSON, MISSISSIPPI, 1955-1964
22076 OBSERVATIONS

WIND DIR.= N
NO. OBS. = 1261
PERCENT = 5.7

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	2	0	0	1	3	0.2	0.2
1.0- 3.0	12	70	69	83	157	391	31.0	31.2
3.0- 5.0	7	51	54	72	194	378	30.0	61.2
5.0- 7.0	14	50	42	59	135	300	23.8	85.0
7.0-10.0	5	16	20	55	85	179	14.2	99.2
GT.10.0	0	2	0	4	4	10	0.8	100.0
TOTAL	38	191	185	273	576	1261	100.0	
% FR	2.9	15.1	14.7	21.6	45.7	100.0		
CUM %	2.9	18.0	32.7	54.3	100.0			

WIND DIR.= NNE
NO. OBS. = 1012
PERCENT = 4.6

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	0	1	1	0	2	0.2	0.2
1.0- 3.0	7	50	62	74	169	386	38.1	38.3
3.0- 5.0	5	42	53	73	189	364	36.0	74.3
5.0- 7.0	5	24	25	55	86	195	19.3	93.6
7.0-10.0	5	1	10	11	29	62	6.1	99.7
GT.10.0	0	0	0	3	0	3	0.3	100.0
TOTAL	22	127	171	219	473	1012	100.0	
% FR	2.2	12.5	16.9	21.6	46.7	100.0		
CUM %	2.2	14.7	31.6	53.3	100.0			

TABLE 2.3.58 Continued

(Spring saturation deficit)

WIND DIR.= NE
NO. OBS. = 941
PERCENT = 4.3

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	2	1	4	4	12	1.3	1.3
1.0- 3.0	19	77	72	116	206	490	52.1	53.3
3.0- 5.0	14	35	63	64	133	309	32.8	86.2
5.0- 7.0	2	10	14	28	59	113	12.0	98.2
7.0-10.0	0	1	6	6	4	17	1.8	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	36	125	156	218	406	941	100.0	
% FR	3.8	13.3	16.6	23.2	43.1	100.0		
CUM %	3.8	17.1	33.7	56.9	100.0			

WIND DIR.= ENE
NO. OBS. = 735
PERCENT = 3.3

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	1	1	3	0	5	0.7	0.7
1.0- 3.0	22	60	72	95	146	395	53.7	54.4
3.0- 5.0	14	26	36	44	114	244	33.2	87.6
5.0- 7.0	7	8	11	21	36	83	11.3	98.9
7.0-10.0	3	1	3	0	1	8	1.1	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	51	96	123	168	297	735	100.0	
% FR	6.9	13.1	16.7	22.9	40.4	100.0		
CUM %	6.9	20.0	36.7	59.6	100.0			

TABLE 2.3.58 Continued

(Spring saturation deficit)

WIND DIR.= E
SPL OBS. = 761
PERCENT = 5.4

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	3	5	2	3	14	1.8	1.8
1.0- 3.0	15	68	114	107	132	436	57.3	59.1
3.0- 5.0	15	47	28	52	87	229	30.1	89.2
5.0- 7.0	2	14	8	15	32	70	9.2	98.4
7.0-10.0	1	5	0	4	1	11	1.4	99.9
GT.10.0	0	1	0	0	0	1	0.1	100.0
TOTAL	34	137	155	180	255	761	100.0	
% FR	4.5	18.0	20.4	23.7	33.5	100.0		
CUM %	4.5	22.5	42.8	66.5	100.0			

WIND DIR.= ESE
SPL OBS. = 840
PERCENT = 5.4

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	1	1	0	1	3	0.4	0.4
1.0- 3.0	12	87	101	108	128	436	51.9	52.3
3.0- 5.0	15	58	42	80	89	284	33.8	86.1
5.0- 7.0	6	24	15	26	33	104	12.4	98.5
7.0-10.0	0	4	1	2	6	13	1.5	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	33	174	160	216	257	840	100.0	
% FR	3.9	20.7	19.0	25.7	30.6	100.0		
CUM %	3.9	24.6	43.7	69.4	100.0			

TABLE 2.3.58 Continued
(Spring saturation deficit)

WIND DIR.= SE
NO. OBS. = 1537
PERCENT = 7.0

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	2	4	4	3	6	19	1.2	1.2
1.0- 3.0	20	168	158	114	213	673	43.8	45.0
3.0- 5.0	17	71	96	105	230	517	33.6	78.7
5.0- 7.0	6	32	52	32	108	230	15.0	93.6
7.0-10.0	0	19	20	17	40	96	6.2	99.9
GT.10.0	1	0	1	0	0	2	0.1	100.0
TOTAL	46	294	331	269	597	1537	100.0	
% FR	3.0	19.1	21.5	17.5	38.8	100.0		
CUM %	3.0	22.1	43.7	61.2	100.0			

WIND DIR.= SSE
NO. OBS. = 2581
PERCENT = 11.7

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	3	4	2	5	15	0.6	0.6
1.0- 3.0	23	200	190	152	271	816	31.6	32.2
3.0- 5.0	27	131	168	178	401	905	35.1	67.3
5.0- 7.0	7	62	94	106	314	583	22.6	89.8
7.0-10.0	4	21	27	63	130	245	9.5	99.3
GT.10.0	0	5	2	4	6	17	0.7	100.0
TOTAL	62	422	485	485	1127	2581	100.0	
% FR	2.4	16.4	18.8	18.8	43.7	100.0		
CUM %	2.4	18.8	37.5	56.3	100.0			

TABLE 2.3.58 Continued

(Spring saturation deficit)

WIND DIR.= S
NO. OBS. = 2754
PERCENT = 12.5

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	4	6	0	6	16	0.6	0.6
1.0- 3.0	20	145	163	168	342	838	30.4	31.0
3.0- 5.0	16	98	169	193	429	905	32.9	63.9
5.0- 7.0	4	33	101	141	365	644	23.4	87.3
7.0-10.0	3	11	52	76	169	311	11.3	98.5
GT.10.0	0	0	2	10	28	40	1.5	100.0
TOTAL	43	291	493	588	1339	2754	100.0	
% FR	1.6	10.6	17.9	21.4	48.6	100.0		
CUM %	1.6	12.1	30.0	51.4	100.0			

WIND DIR.= SSW
NO. OBS. = 1980
PERCENT = 9.0

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	0	1	3	1	5	0.3	0.3
1.0- 3.0	15	66	89	107	281	558	28.2	28.4
3.0- 5.0	4	44	85	127	369	629	31.8	60.2
5.0- 7.0	0	11	53	85	360	509	25.7	85.9
7.0-10.0	0	2	26	55	181	264	13.3	99.2
GT.10.0	0	0	0	2	13	15	0.8	100.0
TOTAL	19	123	254	379	1205	1980	100.0	
% FR	1.0	6.2	12.8	19.1	60.9	100.0		
CUM %	1.0	7.2	20.0	39.1	100.0			

GG
ER

TABLE 2.3.58 Continued

(Spring saturation deficit)

WIND DIR.= SW
NO. OBS. = 1423
PERCENT = 6.4

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	1	3	2	3	9	0.6	0.6
1.0- 3.0	5	61	78	106	284	534	37.5	38.2
3.0- 5.0	6	34	44	74	294	462	32.5	70.6
5.0- 7.0	1	5	25	55	221	305	21.4	92.1
7.0-10.0	2	1	8	21	77	109	7.7	99.7
GT.10.0	0	0	0	0	4	4	0.3	100.0
TOTAL	14	102	158	261	888	1423	100.0	
% FR	1.0	7.2	11.1	18.3	62.4	100.0		
CUM %	1.0	8.2	19.3	37.6	100.0			

WIND DIR.= WSW
NO. OBS. = 796
PERCENT = 3.6

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	1	0	0	2	7	0.9	0.9
1.0- 3.0	17	45	44	49	172	327	41.1	42.0
3.0- 5.0	4	16	22	46	165	253	31.8	73.7
5.0- 7.0	4	5	10	22	94	135	17.0	90.7
7.0-10.0	0	1	6	8	54	69	8.7	99.4
GT.10.0	0	0	0	0	5	5	0.6	100.0
TOTAL	25	68	86	125	492	796	100.0	
% FR	3.1	8.5	10.8	15.7	61.8	100.0		
CUM %	3.1	11.7	22.5	38.2	100.0			

GG
ER

TABLE 2.3.58 Continued
(Spring saturation deficit)

WIND DIR.= *
NO. OBS. = 671
PERCENT = 5.0

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	3	5	2	0	4	12	1.8	1.8
1.0- 3.0	12	47	40	41	142	282	42.0	43.8
3.0- 5.0	6	25	31	35	100	197	29.4	73.2
5.0- 7.0	4	5	16	25	82	132	19.7	92.8
7.0-10.0	1	0	7	4	28	40	6.0	98.8
GT.10.0	1	0	5	1	3	8	1.2	100.0
TOTAL	27	80	99	110	355	671	100.0	
% FR	4.0	11.9	14.8	16.4	52.9	100.0		
CUM %	4.0	15.9	30.7	47.1	100.0			

GG
ER

WIND DIR.= ***
NO. OBS. = 866
PERCENT = 6.9

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	3	0	1	3	7	0.8	0.8
1.0- 3.0	12	69	60	38	106	285	32.9	33.7
3.0- 5.0	7	33	19	44	135	238	27.5	61.2
5.0- 7.0	10	31	23	51	94	209	24.1	85.3
7.0-10.0	8	15	23	20	49	115	13.3	98.6
GT.10.0	1	2	3	2	4	12	1.4	100.0
TOTAL	58	153	128	156	391	866	100.0	
% FR	6.4	17.7	14.8	18.0	45.2	100.0		
CUM %	6.4	24.1	38.8	56.8	100.0			

TABLE 2.3.58 Continued

(Spring saturation deficit)

WIND DIR.= NW
NO. OBS. = 1094
PERCENT = 5.0

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	2	8	2	4	5	21	1.9	1.9
1.0- 3.0	23	135	116	71	146	491	44.9	46.8
3.0- 5.0	11	42	34	42	113	242	22.1	68.9
5.0- 7.0	9	24	46	44	74	197	18.0	86.9
7.0-10.0	6	18	29	22	55	130	11.9	98.8
GT.10.0	5	1	0	6	3	13	1.2	100.0
TOTAL	56	228	227	189	396	1094	100.0	
% FR	4.4	20.8	20.7	17.3	36.2	100.0		
CUM %	4.9	25.8	46.5	63.8	100.0			

GG
ER

WIND DIR.= NNW
NO. OBS. = 1147
PERCENT = 5.2

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	2	1	1	2	6	0.5	0.5
1.0- 3.0	11	66	85	75	106	343	29.9	30.4
3.0- 5.0	7	47	58	61	143	316	27.6	58.0
5.0- 7.0	11	42	56	53	130	292	25.5	83.4
7.0-10.0	4	22	41	38	68	173	15.1	98.5
GT.10.0	0	7	4	5	1	17	1.5	100.0
TOTAL	33	186	245	233	450	1147	100.0	
% FR	2.9	16.2	21.4	20.3	39.2	100.0		
CUM %	2.9	19.1	40.5	60.8	100.0			

TABLE 2.3.58 Continued

(Spring saturation deficit)

WIND DIR.=CALM
NO. OBS. = 1677
PERCENT = 7.6

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	132	553	428	274	290	1677	100.0	100.0
1.0- 3.0	0	0	0	0	0	0	0.0	100.0
3.0- 5.0	0	0	0	0	0	0	0.0	100.0
5.0- 7.0	0	0	0	0	0	0	0.0	100.0
7.0-10.0	0	0	0	0	0	0	0.0	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	132	553	428	274	290	1677	100.0	
% FR	7.9	33.0	25.5	16.3	17.3	100.0		
CUM %	7.9	40.8	66.4	82.7	100.0			

GG
ER

WIND DIR.=TOTL
NO. OBS. = 22076
PERCENT =100.0

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	142	591	464	300	336	1833	8.3	8.3
1.0- 3.0	245	1418	1533	1484	3001	7681	34.8	43.1
3.0- 5.0	180	800	1002	1509	3190	6472	29.3	72.4
5.0- 7.0	92	379	591	816	2223	4101	18.6	91.0
7.0-10.0	40	144	279	406	973	1842	8.3	99.3
GT.10.0	6	18	15	37	71	147	0.7	100.0
TOTAL	705	3350	3884	4343	9794	22076	100.0	
% FR	3.2	15.2	17.6	19.7	44.4	100.0		
CUM %	3.2	18.4	36.0	55.6	100.0			

TABLE 2.3.59

SUMMER SEASON FREQUENCY DISTRIBUTION OF SATURATION DEFICIT VERSUS WIND SPEED BY SECTOR AT JACKSON, MISSISSIPPI, 1955-1964 22080 OBSERVATIONS

WIND DIR.= N
NO. OBS. = 938
PERCENT = 4.2

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	1	3	2	3	9	1.0	1.0
1.0- 3.0	7	19	51	88	310	475	50.6	51.6
3.0- 5.0	0	13	25	29	251	318	33.9	85.5
5.0- 7.0	1	1	5	11	95	113	12.0	97.5
7.0-10.0	0	0	0	5	18	23	2.5	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	8	34	84	135	677	938	100.0	
% FR	0.9	3.6	9.0	14.4	72.2	100.0		
CUM %	0.9	4.5	13.4	27.8	100.0			

WIND DIR.= NNE
NO. OBS. = 874
PERCENT = 4.0

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	0	1	3	2	7	0.8	0.8
1.0- 3.0	11	33	57	85	311	497	56.9	57.7
3.0- 5.0	2	5	24	28	215	274	31.4	89.0
5.0- 7.0	0	2	2	4	72	80	9.2	98.2
7.0-10.0	2	0	0	3	10	15	1.7	99.9
GT.10.0	0	0	0	0	1	1	0.1	100.0
TOTAL	16	40	84	123	611	874	100.0	
% FR	1.8	4.6	9.6	14.1	69.9	100.0		
CUM %	1.8	6.4	16.0	30.1	100.0			

GG
ER

TABLE 2.3.59 Continued

(Summer saturation deficit)

WIND DIR.= NE
NO. OBS. = 923
PERCENT = 4.2

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	3	2	6	6	17	1.8	1.8
1.0- 3.0	10	36	70	104	357	577	62.5	64.4
3.0- 5.0	3	15	18	24	204	264	28.6	93.0
5.0- 7.0	1	0	0	4	54	59	6.4	99.3
7.0-10.0	0	0	2	0	4	6	0.7	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	14	54	92	138	625	923	100.0	
% FR	1.5	5.9	10.0	15.0	67.7	100.0		
CUM %	1.5	7.4	17.3	32.3	100.0			

WIND DIR.= ENE
NO. OBS. = 786
PERCENT = 3.6

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	3	3	1	5	12	1.5	1.5
1.0- 3.0	3	34	68	85	314	504	64.1	65.6
3.0- 5.0	1	5	18	17	166	207	26.3	92.0
5.0- 7.0	1	1	0	6	45	53	6.7	98.7
7.0-10.0	0	1	1	1	7	10	1.3	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	5	44	90	110	537	786	100.0	
% FR	0.6	5.6	11.5	14.0	68.3	100.0		
CUM %	0.6	6.2	17.7	31.7	100.0			

GG
ER

TABLE 2.3.59 Continued

(Summer saturation deficit)

WIND DIR.= E
NO. OBS. = 972
PERCENT = 4.4

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	4	6	5	4	19	2.0	2.0
1.0- 3.0	9	52	131	117	334	643	66.2	68.1
3.0- 5.0	1	11	28	45	153	238	24.5	92.6
5.0- 7.0	0	4	3	11	46	64	6.6	99.2
7.0-10.0	0	0	1	2	5	8	0.8	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	10	71	169	180	542	972	100.0	
% FR	1.0	7.3	17.4	18.5	55.8	100.0		
CUM %	1.0	8.3	25.7	44.2	100.0			

WIND DIR.= ESE
NO. OBS. = 872
PERCENT = 3.9

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	4	0	5	1	11	1.3	1.3
1.0- 3.0	10	61	115	119	245	550	63.1	64.3
3.0- 5.0	2	9	25	46	160	242	27.8	92.1
5.0- 7.0	1	5	5	11	38	60	6.9	99.0
7.0-10.0	0	0	4	2	3	9	1.0	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	14	79	149	183	447	872	100.0	
% FR	1.6	9.1	17.1	21.0	51.3	100.0		
CUM %	1.6	10.7	27.8	48.7	100.0			

GG
ER

TABLE 2.3.59 Continued

(Summer saturation deficit)

WIND DIR.= SE
NO. OBS. = 1939
PERCENT = 7.4

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	1	10	7	9	28	1.7	1.7
1.0- 3.0	24	180	280	240	422	1146	69.9	71.6
3.0- 5.0	5	29	65	69	197	376	22.9	94.6
5.0- 7.0	0	2	4	22	36	64	3.9	98.5
7.0-10.0	0	1	4	5	14	24	1.5	99.9
GT.10.0	0	1	0	0	0	1	0.1	100.0
TOTAL	29	211	363	363	673	1639	100.0	
% FR	1.8	12.9	22.1	22.1	41.1	100.0		
CUM %	1.8	14.8	36.8	58.9	100.0			

WIND DIR.= SSE
NO. OBS. = 1939
PERCENT = 8.8

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	6	5	5	5	20	1.0	1.0
1.0- 3.0	51	234	279	230	383	1157	59.7	60.7
3.0- 5.0	5	65	113	146	254	581	30.0	90.7
5.0- 7.0	3	4	14	34	79	134	6.9	97.6
7.0-10.0	0	1	7	10	20	38	2.0	99.5
GT.10.0	0	0	4	0	5	9	0.5	100.0
TOTAL	60	308	422	423	746	1939	100.0	
% FR	3.1	15.9	21.8	21.8	38.5	100.0		
CUM %	3.1	17.9	39.7	61.5	100.0			

TABLE 2.3.59 Continued

(Summer saturation deficit)

WIND DIR.= S
NO. OBS. = 1922
PERCENT = 8.7

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	7	4	5	5	24	1.2	1.2
1.0- 3.0	22	200	291	245	408	1167	60.7	61.9
3.0- 5.0	7	58	106	152	228	551	28.7	90.6
5.0- 7.0	0	4	20	36	103	163	8.5	99.1
7.0-10.0	0	0	3	5	11	17	0.9	99.9
GT.10.0	0	0	0	1	0	1	0.1	100.0
TOTAL	30	269	429	441	753	1922	100.0	
% FR	1.6	14.0	22.3	22.9	39.2	100.0		
CUM %	1.6	15.6	37.9	60.8	100.0			

GG ER

WIND DIR.= SSW
NO. OBS. = 1391
PERCENT = 6.3

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	1	0	2	3	6	0.4	0.4
1.0- 3.0	5	100	205	173	286	767	55.1	55.6
3.0- 5.0	2	52	65	118	251	488	35.5	89.1
5.0- 7.0	1	6	10	44	80	130	9.3	98.4
7.0-10.0	0	4	2	2	12	20	1.4	99.9
GT.10.0	1	0	0	0	1	2	0.1	100.0
TOTAL	9	163	280	329	633	1391	100.0	
% FR	0.6	10.5	20.1	23.7	45.5	100.0		
CUM %	0.6	11.1	30.8	54.5	100.0			

TABLE 2.3.59 Continued

(Summer saturation deficit)

WIND DIR.= S
NO. OBS. = 1604
PERCENT = 7.3

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	10	6	2	5	23	1.4	1.4
1.0- 3.0	5	85	200	252	431	973	60.7	62.1
3.0- 5.0	3	21	67	96	302	489	30.5	92.6
5.0- 7.0	1	2	8	24	71	106	6.6	99.2
7.0-10.0	0	0	2	2	9	13	0.8	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	9	118	283	376	818	1604	100.0	
% FR	0.6	7.4	17.6	23.4	51.0	100.0		
CUM %	0.6	7.9	25.6	49.0	100.0			

WIND DIR.= SSW
NO. OBS. = 1265
PERCENT = 5.7

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	2	2	1	1	6	0.5	0.5
1.0- 3.0	5	45	105	139	523	817	48.9	49.3
3.0- 5.0	0	10	54	96	333	495	39.2	88.5
5.0- 7.0	0	0	13	16	97	126	10.0	98.5
7.0-10.0	0	1	1	1	9	18	1.4	99.9
GT.10.0	0	0	0	0	1	1	0.1	100.0
TOTAL	5	58	175	261	764	1265	100.0	
% FR	0.4	4.6	13.9	20.7	60.5	100.0		
CUM %	0.4	5.0	18.8	39.5	100.0			

GG
ER

TABLE 2.3.59 Continued

(Summer saturation deficit)

WIND DIR.= W
NO. OBS. = 1064
PERCENT = 4.8

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	6	1	0	11	18	1.7	1.7
1.0- 3.0	6	47	105	118	300	574	53.9	55.6
3.0- 5.0	3	4	16	53	285	361	33.9	89.6
5.0- 7.0	1	1	2	12	80	96	9.0	98.6
7.0-10.0	0	1	1	0	13	15	1.4	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	10	59	123	183	689	1064	100.0	
% FR	0.9	5.5	11.6	17.2	64.8	100.0		
CUM %	0.9	6.5	18.0	35.2	100.0			

WIND DIR.= WSW
NO. OBS. = 1063
PERCENT = 4.8

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	5	5	9	2	19	1.8	1.8
1.0- 3.0	6	62	78	81	316	543	51.1	52.9
3.0- 5.0	2	1	13	47	313	376	35.4	88.2
5.0- 7.0	0	2	3	6	95	106	10.0	98.2
7.0-10.0	0	1	1	2	14	19	1.8	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	8	68	100	145	742	1063	100.0	
% FR	0.8	6.4	9.4	13.6	69.8	100.0		
CUM %	0.8	7.1	16.6	30.2	100.0			

GG
ER

TABLE 2.3.59 Continued

(Summer saturation deficit)

WIND DIR.= NW
NO. OBS. = 1105
PERCENT = 5.0

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	6	3	9	8	26	2.4	2.4
1.0- 3.0	9	90	86	121	360	666	60.3	62.6
3.0- 5.0	5	4	19	18	263	307	27.8	90.4
5.0- 7.0	0	3	3	4	83	93	8.4	98.8
7.0-10.0	1	0	2	2	7	12	1.1	99.9
GT.10.0	0	0	0	0	1	1	0.1	100.0
TOTAL	15	103	113	154	722	1105	100.0	
% FR	1.2	9.3	10.2	13.9	65.3	100.0		
CUM %	1.2	10.5	20.7	34.7	100.0			

GG ER

WIND DIR.= NNW
NO. OBS. = 847
PERCENT = 3.8

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	1	2	2	0	5	0.5	0.6
1.0- 3.0	3	39	54	59	210	345	40.7	41.3
3.0- 5.0	1	15	19	20	274	330	39.7	81.0
5.0- 7.0	1	2	2	13	107	125	14.8	95.7
7.0-10.0	1	0	2	3	28	34	4.0	99.8
GT.10.0	0	0	0	0	2	2	0.2	100.0
TOTAL	6	56	79	83	621	847	100.0	
% FR	0.7	6.6	9.3	9.8	73.3	100.0		
CUM %	0.7	7.3	16.9	26.7	100.0			

TABLE 2.3.59 Continued

(Summer saturation deficit)

WIND DIR.=CALM
NO. OBS. = 2878
PERCENT = 15.0

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	68	586	884	565	775	2878	100.0	100.0
1.0- 3.0	0	0	0	0	0	0	0.0	100.0
3.0- 5.0	0	0	0	0	0	0	0.0	100.0
5.0- 7.0	0	0	0	0	0	0	0.0	100.0
7.0-10.0	0	0	0	0	0	0	0.0	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	68	586	884	565	775	2878	100.0	
% FR	2.4	20.4	30.7	19.6	26.9	100.0		
CUM %	2.4	22.7	53.4	73.1	100.0			

GG
ER

WIND DIR.=TOTL
NO. OBS. = 22080
PERCENT =100.0

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	72	656	942	825	838	3127	14.2	14.2
1.0- 3.0	1844	1517	2173	2237	5310	11201	50.7	64.9
3.0- 5.0	40	287	673	1032	3849	5881	26.6	91.5
5.0- 7.0	12	39	90	240	1181	1572	7.1	98.6
7.0-10.0	4	4	33	49	186	281	1.3	99.9
GT.10.0	1	1	8	1	11	18	0.1	100.0
TOTAL	2961	2504	3919	4192	11375	22080	100.0	
% FR	13.4	11.3	17.7	19.0	51.5	100.0		
CUM %	13.4	24.7	42.5	61.5	100.0			

TABLE 2.3.60

FALL SEASON FREQUENCY DISTRIBUTION OF SATURATION DEFICIT VERSUS WIND SPEED BY SECTOR AT JACKSON, MISSISSIPPI, 1955-1964 21840 OBSERVATIONS

WIND DIR.= N
NO. OBS. = 1649
PERCENT = 7.6

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	5	1	1	1	7	0.4	0.4
1.0- 3.0	25	122	122	114	208	589	35.7	36.1
3.0- 5.0	6	79	96	94	215	490	29.7	65.9
5.0- 7.0	9	55	71	105	161	379	23.0	88.8
7.0-10.0	1	15	21	64	66	167	10.1	99.0
GT.10.0	0	4	6	1	6	17	1.0	100.0
TOTAL	40	256	317	379	657	1649	100.0	
% FR	2.4	15.5	19.2	23.0	39.8	100.0		
CUM %	2.4	18.0	37.2	60.2	100.0			

WIND DIR.= NNE
NO. OBS. = 1462
PERCENT = 6.7

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	2	0	2	0	5	0.3	0.3
1.0- 3.0	15	115	128	120	255	632	43.2	43.6
3.0- 5.0	6	49	88	105	241	487	33.3	76.9
5.0- 7.0	12	12	28	60	148	260	17.8	94.7
7.0-10.0	0	2	9	20	41	72	4.9	99.6
GT.10.0	1	1	5	1	0	6	0.4	100.0
TOTAL	55	182	258	306	685	1462	100.0	
% FR	2.3	12.4	17.5	20.9	46.9	100.0		
CUM %	2.3	14.7	32.2	53.1	100.0			

GG
ER

TABLE 2.3.60 Continued
(Fall saturation deficit)

WIND DIR.= NE
NO. OBS. = 1578
PERCENT = 7.2

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	3	4	2	3	12	0.8	0.8
1.0- 3.0	24	132	160	171	376	869	55.1	55.8
3.0- 5.0	12	49	83	103	221	468	29.7	85.5
5.0- 7.0	4	21	23	42	102	192	12.2	97.7
7.0-10.0	6	4	8	4	14	36	2.3	99.9
GT.10.0	0	0	1	0	0	1	0.1	100.0
TOTAL	46	209	279	328	716	1578	100.0	
% FR	2.9	13.2	17.7	20.8	45.4	100.0		
CUM %	2.9	16.2	33.8	54.6	100.0			

WIND DIR.= ENE
NO. OBS. = 1198
PERCENT = 5.5

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	8	1	2	4	16	1.3	1.3
1.0- 3.0	11	119	144	163	277	714	59.6	60.9
3.0- 5.0	11	53	60	71	185	360	30.1	91.0
5.0- 7.0	0	12	5	16	63	96	8.0	99.0
7.0-10.0	1	1	2	1	6	11	0.9	99.9
GT.10.0	0	0	0	0	1	1	0.1	100.0
TOTAL	24	173	212	253	536	1198	100.0	
% FR	2.0	14.4	17.7	21.1	44.7	100.0		
CUM %	2.0	16.4	34.1	55.3	100.0			

GG
ER

TABLE 2.3.60 Continued
(Fall saturation deficit)

WIND DIR.= F
NO. OBS. = 1203
PERCENT = 5.5

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	16	5	4	8	34	2.8	2.8
1.0- 3.0	19	121	145	160	283	734	61.0	63.8
3.0- 5.0	10	20	54	79	185	348	28.9	92.8
5.0- 7.0	1	5	6	21	53	86	7.1	99.9
7.0-10.0	0	1	0	0	0	1	0.1	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	31	163	210	270	529	1203	100.0	
% FR	2.6	13.5	17.5	22.4	44.0	100.0		
CUM %	2.6	16.1	33.6	56.0	100.0			

WIND DIR.= ESE
NO. OBS. = 1112
PERCENT = 5.1

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	5	5	0	6	16	1.4	1.4
1.0- 3.0	25	112	134	139	237	647	58.2	59.6
3.0- 5.0	7	26	44	82	187	346	31.1	90.7
5.0- 7.0	0	3	12	17	66	98	8.8	99.6
7.0-10.0	0	1	0	0	3	4	0.4	99.9
GT.10.0	0	1	0	0	0	1	0.1	100.0
TOTAL	32	148	195	238	499	1112	100.0	
% FR	2.9	13.3	17.5	21.4	44.9	100.0		
CUM	2.9	16.2	33.7	55.1	100.0			

GG
ER

TABLE 2.3.60 Continued

(Fall saturation deficit)

WIND DIR.= SE
NO. OBS. = 1948
PERCENT = 8.9

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	2	14	4	0	7	27	1.4	1.4
1.0- 3.0	41	220	228	244	347	1080	55.4	56.8
3.0- 5.0	7	61	126	148	252	594	30.5	87.3
5.0- 7.0	0	6	43	46	119	214	11.0	98.3
7.0-10.0	0	2	4	11	16	33	1.7	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	50	303	405	449	741	1948	100.0	
% FR	2.6	15.6	20.8	23.0	38.0	100.0		
CUM %	2.6	18.1	38.9	62.0	100.0			

WIND DIR.= SSE
NO. OBS. = 2131
PERCENT = 9.8

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	5	5	3	3	4	20	0.9	0.9
1.0- 3.0	36	212	158	139	320	865	40.6	41.5
3.0- 5.0	14	104	126	156	306	706	33.1	74.7
5.0- 7.0	1	43	85	94	181	404	19.0	93.6
7.0-10.0	0	8	29	36	58	131	6.1	99.8
GT.10.0	0	0	0	2	3	5	0.2	100.0
TOTAL	56	372	401	430	872	2131	100.0	
% FR	2.6	17.5	18.8	20.2	40.9	100.0		
CUM %	2.6	20.1	38.9	59.1	100.0			

GG
ER

TABLE 2.3.60 Continued

(Fall saturation deficit)

WIND DIR.= S
NO. OBS. = 1312
PERCENT = 6.0

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	2	7	5	6	0	18	1.4	1.4
1.0- 3.0	25	148	155	106	235	669	51.0	52.4
3.0- 5.0	4	57	66	95	172	394	30.0	82.4
5.0- 7.0	4	8	29	33	105	179	13.6	96.0
7.0-10.0	0	2	6	10	32	50	3.8	99.8
GT.10.0	0	0	0	0	2	2	0.2	100.0
TOTAL	35	222	259	250	546	1312	100.0	
% FR	2.7	16.9	19.7	19.1	41.6	100.0		
CUM %	2.7	19.6	39.3	58.4	100.0			

WIND DIR.= SSW
NO. OBS. = 688
PERCENT = 3.2

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	0	0	0	4	4	0.6	0.6
1.0- 3.0	7	61	52	67	138	325	47.2	47.8
3.0- 5.0	3	17	24	25	121	190	27.6	75.4
5.0- 7.0	0	4	16	16	80	116	16.9	92.3
7.0-10.0	0	2	7	7	37	53	7.7	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	10	84	99	115	380	688	100.0	
% FR	1.5	12.2	14.4	16.7	55.2	100.0		
CUM %	1.5	13.7	28.1	44.8	100.0			

GG
ER

TABLE 2.3.60 Continued

(Fall saturation deficit)

WIND DIR.= SW
NO. OBS. = 541
PERCENT = 2.5

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	0	3	2	3	8	1.5	1.5
1.0- 3.0	10	46	50	50	152	308	56.9	58.4
3.0- 5.0	0	13	9	21	97	140	25.9	84.3
5.0- 7.0	0	8	5	8	47	68	12.6	96.9
7.0-10.0	1	0	1	3	12	17	3.1	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	11	67	68	84	311	541	100.0	
% FR	2.0	12.4	12.6	15.5	57.5	100.0		
CUM %	2.0	14.4	27.0	42.5	100.0			

GG
ER

WIND DIR.= WS=
NO. OBS. = 387
PERCENT = 1.8

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	3	5	0	0	9	2.3	2.3
1.0- 3.0	8	28	40	18	91	185	47.8	50.1
3.0- 5.0	1	7	20	17	80	125	32.3	82.4
5.0- 7.0	0	6	2	7	42	57	14.7	97.2
7.0-10.0	1	2	0	0	8	11	2.8	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	11	46	67	42	221	387	100.0	
% FR	2.8	11.9	17.3	10.9	57.1	100.0		
CUM %	2.8	14.7	32.0	42.9	100.0			

TABLE 2.3.60 Continued

(Fall saturation deficit)

WIND DIR.= W
NO. OBS. = 446
PERCENT = 2.0

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	7	2	0	4	14	3.1	3.1
1.0- 3.0	12	46	42	33	98	231	51.8	54.9
3.0- 5.0	3	15	14	27	60	119	26.7	81.6
5.0- 7.0	0	6	3	12	44	65	14.6	96.2
7.0-10.0	0	1	1	0	15	17	3.8	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	16	75	62	72	221	446	100.0	
% FR	3.6	16.8	13.9	16.1	49.6	100.0		
CUM %	3.6	20.4	34.3	50.4	100.0			

WIND DIR.= WNW
NO. OBS. = 601
PERCENT = 2.8

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	2	4	3	2	2	13	2.2	2.2
1.0- 3.0	17	92	60	43	88	300	49.9	52.1
3.0- 5.0	3	18	23	24	92	160	26.6	78.7
5.0- 7.0	3	15	12	17	43	90	15.0	93.7
7.0-10.0	0	1	7	5	24	37	6.2	99.8
GT.10.0	1	0	0	0	0	1	0.2	100.0
TOTAL	26	130	105	91	249	601	100.0	
% FR	4.3	21.6	17.5	15.1	41.4	100.0		
CUM %	4.3	26.0	43.4	58.6	100.0			

GE ER

TABLE 2.3.60 Continued
(Fall saturation deficit)

WIND DIR.= NW
NO. OBS. = 1328
PERCENT = 6.1

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	4	9	2	2	6	23	1.7	1.7
1.0- 3.0	48	210	128	139	204	729	54.9	56.6
3.0- 5.0	23	82	60	56	120	341	25.7	82.3
5.0- 7.0	12	22	35	24	58	151	11.4	93.7
7.0-10.0	3	17	12	19	27	78	5.9	99.5
GT.10.0	0	0	1	1	4	6	0.5	100.0
TOTAL	90	340	238	241	419	1328	100.0	
% FR	6.8	25.6	17.9	18.1	31.6	100.0		
CUM %	6.8	32.4	50.3	68.4	100.0			

GG
ER

WIND DIR.= NNW
NO. OBS. = 1428
PERCENT = 6.5

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	4	1	0	1	7	0.5	0.5
1.0- 3.0	18	121	88	74	128	429	30.0	30.5
3.0- 5.0	6	77	72	99	161	415	29.1	59.6
5.0- 7.0	9	56	57	81	143	346	24.2	83.8
7.0-10.0	3	38	33	68	70	212	14.8	98.7
GT.10.0	2	4	4	3	6	19	1.3	100.0
TOTAL	39	300	255	325	509	1428	100.0	
% FR	2.7	21.0	17.9	22.8	35.6	100.0		
CUM %	2.7	23.7	41.6	64.4	100.0			

TABLE 2.3.60 Continued

(Fall saturation deficit)

WIND DIR.=CALM
NO. OBS. = 2828
PERCENT = 12.9

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	236	1097	651	332	512	2828	100.0	100.0
1.0- 3.0	0	0	0	0	0	0	0.0	100.0
3.0- 5.0	0	0	0	0	0	0	0.0	100.0
5.0- 7.0	0	0	0	0	0	0	0.0	100.0
7.0-10.0	0	0	0	0	0	0	0.0	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	236	1097	651	332	512	2828	100.0	
% FR	8.3	38.8	23.0	11.7	18.1	100.0		
CUM %	8.3	47.1	70.2	81.9	100.0			

WIND DIR.=TOTL
NO. OBS. = 21840
PERCENT =100.0

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	258	1187	693	358	565	3061	14.0	14.0
1.0- 3.0	557	1906	1834	1792	3437	9306	42.6	56.6
3.0- 5.0	116	707	965	1200	2695	5683	26.0	82.6
5.0- 7.0	55	260	432	599	1455	2801	12.8	95.5
7.0-10.0	16	97	140	248	429	930	4.3	99.7
GT.10.0	4	10	15	8	22	59	0.3	100.0
TOTAL	786	4167	4079	4205	8603	21840	100.0	
% FR	3.6	19.1	18.7	19.3	39.4	100.0		
CUM %	3.6	22.7	41.4	60.6	100.0			

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TABLE 2.3.61

WINTER SEASON FREQUENCY DISTRIBUTION OF SATURATION DEFICIT VERSUS WIND SPEED BY SECTOR AT JACKSON, MISSISSIPPI 1955-1964 21600 OBSERVATIONS

WIND DIR.= N
NO. OBS. = 1856
PERCENT = 8.6

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	2	1	2	4	9	0.5	0.5
1.0- 3.0	60	161	106	67	49	443	23.9	24.4
3.0- 5.0	70	157	125	92	52	496	26.7	51.1
5.0- 7.0	54	185	128	81	79	527	28.4	79.5
7.0-10.0	17	133	130	51	33	364	19.6	99.1
GT.10.0	2	12	2	0	1	17	0.9	100.0
TOTAL	203	650	492	293	218	1856	100.0	
% FR	10.9	35.0	26.5	15.8	11.7	100.0		
CUM %	10.9	46.0	72.5	88.3	100.0			

GG
ER

WIND DIR.= NNE
NO. OBS. = 1548
PERCENT = 7.2

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	2	2	0	0	5	0.3	0.3
1.0- 3.0	59	152	126	77	63	477	30.8	31.1
3.0- 5.0	51	163	147	93	68	522	33.7	64.9
5.0- 7.0	45	132	111	77	47	412	26.6	91.5
7.0-10.0	17	51	36	16	11	131	8.5	99.9
GT.10.0	0	0	1	0	0	1	0.1	100.0
TOTAL	174	500	423	263	189	1548	100.0	
% FR	11.2	32.3	27.3	17.0	12.2	100.0		
CUM %	11.2	43.5	70.8	87.8	100.0			

TABLE 2.3.61 Continued

(Winter saturation deficit)

WIND DIR.= NE
NO. OBS. = 1208
PERCENT = 5.6

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	4	1	1	0	7	0.6	0.6
1.0- 3.0	62	188	150	102	76	578	47.8	48.4
3.0- 5.0	51	152	125	71	58	457	37.8	86.3
5.0- 7.0	21	40	31	29	30	151	12.5	98.8
7.0-10.0	2	3	0	3	7	15	1.2	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	137	385	307	206	173	1208	100.0	
% FR	11.3	31.9	25.4	17.1	14.3	100.0		
CUM %	11.3	43.2	68.6	85.7	100.0			

GG
ER

WIND DIR.= ESE
NO. OBS. = 882
PERCENT = 4.1

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	6	5	0	1	0	6	0.7	0.7
1.0- 3.0	73	125	133	79	86	496	56.2	56.9
3.0- 5.0	51	70	75	52	54	301	34.1	91.0
5.0- 7.0	17	10	14	16	18	75	8.5	99.5
7.0-10.0	2	1	0	0	1	4	0.5	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	149	211	222	148	158	882	100.0	
% FR	16.2	23.9	25.2	16.8	17.9	100.0		
CUM %	16.2	40.1	65.3	82.1	100.0			

TABLE 2.3.61 Continued

(Winter saturation deficit)

WIND DIR.= E
NO. OBS. = 685
PERCENT = 5.2

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	4	4	1	2	12	1.8	1.8
1.0- 3.0	61	121	95	69	63	409	59.9	61.6
3.0- 5.0	20	32	49	42	39	182	26.6	88.3
5.0- 7.0	7	8	12	19	21	67	9.8	98.1
7.0-10.0	2	5	1	1	2	11	1.6	99.7
GT.10.0	0	1	0	1	0	2	0.3	100.0
TOTAL	91	171	161	133	127	685	100.0	
% FR	13.3	25.0	23.5	19.5	18.6	100.0		
CUM %	13.3	38.4	61.9	81.4	100.0			

GG
ER

WIND DIR.= ESE
NO. OBS. = 870
PERCENT = 4.0

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	4	1	1	2	1	9	1.0	1.0
1.0- 3.0	62	151	89	94	89	485	51.1	52.2
3.0- 5.0	35	80	42	62	58	257	29.5	81.7
5.0- 7.0	16	27	26	30	20	119	13.7	95.4
7.0-10.0	3	6	8	9	12	38	4.4	99.8
GT.10.0	0	1	0	0	1	2	0.2	100.0
TOTAL	120	246	146	197	161	870	100.0	
% FR	13.8	28.3	16.8	22.6	18.5	100.0		
CUM %	13.8	42.1	58.9	81.5	100.0			

TABLE 2.3.61 Continued

(Winter saturation deficit)

WIND DIR.= SE
NO. OBS. = 1531
PERCENT = 7.1

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	5	9	4	1	1	20	1.3	1.3
1.0- 3.0	122	258	168	117	112	777	50.8	52.1
3.0- 5.0	64	76	109	93	97	439	28.7	80.7
5.0- 7.0	26	35	53	53	33	200	13.1	93.8
7.0-10.0	4	16	14	25	16	75	4.9	98.7
GT.10.0	1	8	1	10	0	20	1.3	100.0
TOTAL	222	402	349	299	259	1531	100.0	
% FR	14.5	26.3	22.8	19.5	16.9	100.0		
CUM %	14.5	40.8	63.6	83.1	100.0			

WIND DIR.= SSE
NO. OBS. = 2042
PERCENT = 9.5

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	3	7	2	0	1	13	0.6	0.6
1.0- 3.0	107	216	176	117	132	748	36.6	37.3
3.0- 5.0	54	159	170	132	121	636	31.1	68.4
5.0- 7.0	24	98	129	95	84	430	21.1	89.5
7.0-10.0	8	49	55	53	45	210	10.3	99.8
GT.10.0	0	2	3	0	0	5	0.2	100.0
TOTAL	196	531	535	397	383	2042	100.0	
% FR	9.6	26.0	26.2	19.4	18.8	100.0		
CUM %	9.6	35.6	61.8	81.2	100.0			

TABLE 2.3.61 Continued

(Winter saturation deficit)

WIND DIR.= S
NO. OBS. = 1997
PERCENT = 9.2

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	3	4	0	2	10	0.5	0.5
1.0- 3.0	85	187	157	130	104	661	33.1	33.6
3.0- 5.0	41	167	142	133	129	612	30.6	64.2
5.0- 7.0	16	101	137	99	124	477	23.9	88.1
7.0-10.0	1	30	48	74	68	221	11.1	99.2
GT.10.0	0	2	1	5	8	16	0.8	100.0
TOTAL	142	490	489	441	435	1997	100.0	
% FR	7.1	24.5	24.5	22.1	21.8	100.0		
CUM %	7.1	31.6	56.1	78.2	100.0			

WIND DIR.= SSW
NO. OBS. = 1224
PERCENT = 5.7

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	3	1	0	0	4	0.3	0.3
1.0- 3.0	39	107	79	92	78	395	32.3	32.6
3.0- 5.0	25	61	74	85	120	365	29.8	62.4
5.0- 7.0	7	33	73	68	108	289	23.6	86.0
7.0-10.0	3	9	14	45	89	157	12.8	98.9
GT.10.0	0	1	0	2	11	14	1.1	100.0
TOTAL	71	214	241	292	406	1224	100.0	
% FR	5.8	17.5	19.7	23.9	33.2	100.0		
CUM %	5.8	23.3	43.0	66.8	100.0			

GG
ER

TABLE 2.3.61 Continued

(Winter saturation deficit)

WIND DIR.= SW
NO. OBS. = 1017
PERCENT = 4.7

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	0	2	3	4	2	11	1.1	1.1
1.0- 3.0	38	105	82	91	88	404	39.7	40.8
3.0- 5.0	11	47	72	89	93	312	30.7	71.5
5.0- 7.0	3	13	27	48	83	174	17.1	88.6
7.0-10.0	0	0	8	29	71	108	10.6	99.2
GT.10.0	0	0	0	1	7	8	0.8	100.0
TOTAL	52	167	192	262	344	1017	100.0	
% FR	5.1	16.4	18.9	25.8	33.8	100.0		
CUM %	5.1	21.5	40.4	66.2	100.0			

WIND DIR.= WSW
NO. OBS. = 737
PERCENT = 3.4

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	2	1	0	0	4	0.5	0.5
1.0- 3.0	27	68	38	43	58	234	31.8	32.3
3.0- 5.0	9	52	52	44	67	224	30.4	62.7
5.0- 7.0	8	34	38	34	87	197	26.7	89.4
7.0-10.0	2	8	6	15	41	72	9.8	99.2
GT.10.0	0	1	0	0	5	6	0.8	100.0
TOTAL	47	165	135	136	258	737	100.0	
% FR	5.8	22.4	18.3	18.5	35.0	100.0		
CUM %	5.8	28.2	46.5	65.0	100.0			

GG
ER

TABLE 2.3.61 Continued

(Winter saturation deficit)

WIND DIR.= W
NO. OBS. = 639
PERCENT = 5.0

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	3	3	4	1	0	11	1.7	1.7
1.0- 3.0	37	100	53	44	44	278	43.5	45.2
3.0- 5.0	18	39	44	31	40	172	26.9	72.1
5.0- 7.0	5	20	31	36	35	127	19.9	92.0
7.0-10.0	4	1	9	9	20	43	6.7	98.7
GT.10.0	0	0	0	0	8	8	1.3	100.0
TOTAL	67	163	141	121	147	639	100.0	
% FR	10.5	25.5	22.1	18.9	23.0	100.0		
CUM %	10.5	36.0	58.1	77.0	100.0			

GG
ER

WIND DIR.= WNW
NO. OBS. = 835
PERCENT = 5.9

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	1	3	1	0	1	6	0.7	0.7
1.0- 3.0	69	118	53	41	42	323	38.7	39.4
3.0- 5.0	31	64	38	35	38	206	24.7	64.1
5.0- 7.0	22	39	29	47	47	184	22.0	86.1
7.0-10.0	8	17	14	30	38	107	12.8	98.9
GT.10.0	0	1	0	2	6	9	1.1	100.0
TOTAL	131	242	135	155	172	835	100.0	
% FR	15.7	29.0	16.2	18.6	20.6	100.0		
CUM %	15.7	44.7	60.8	79.4	100.0			

TABLE 2.3.61 Continued

(Winter saturation deficit)

WIND DIR.= NW
NO. OBS. = 1383
PERCENT = 6.4

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	5	8	1	0	0	14	1.0	1.0
1.0- 3.0	100	202	132	64	69	567	41.0	42.0
3.0- 5.0	50	82	81	58	40	311	22.5	64.5
5.0- 7.0	40	65	61	59	40	265	19.2	83.7
7.0-10.0	34	71	40	31	34	210	15.2	98.8
GT.10.0	2	7	3	2	2	16	1.2	100.0
TOTAL	231	435	318	214	185	1383	100.0	
% FR	16.7	31.5	23.0	15.5	13.4	100.0		
CUM %	16.7	48.2	71.1	86.6	100.0			

WIND DIR.= NNW
NO. OBS. = 1638
PERCENT = 7.6

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	4	2	4	0	1	11	0.7	0.7
1.0- 3.0	73	158	97	50	53	431	26.3	27.0
3.0- 5.0	65	123	93	59	55	393	24.0	51.0
5.0- 7.0	66	141	107	62	41	417	25.5	76.4
7.0-10.0	37	117	94	59	45	352	21.5	97.9
GT.10.0	6	15	6	4	3	34	2.1	100.0
TOTAL	249	556	401	234	198	1638	100.0	
% FR	15.2	33.9	24.5	14.3	12.1	100.0		
CUM %	15.2	49.1	73.6	87.9	100.0			

GG
ER

TABLE 2.3.61 Continued

Winter saturation deficit)

WIND DIR.=CALM
NO. OBS. = 1510
PERCENT = 7.0

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM%
0.0- 1.0	330	678	256	103	143	1510	100.0	100.0
1.0- 3.0	0	0	0	0	0	0	0.0	100.0
3.0- 5.0	0	0	0	0	0	0	0.0	100.0
5.0- 7.0	0	0	0	0	0	0	0.0	100.0
7.0-10.0	0	0	0	0	0	0	0.0	100.0
GT.10.0	0	0	0	0	0	0	0.0	100.0
TOTAL	330	678	256	103	143	1510	100.0	
% FR	21.9	44.9	17.0	6.8	9.5	100.0		
CUM %	21.9	66.8	83.7	90.5	100.0			

GG
ER

WIND DIR.=TOTL
NO. OBS. = 21600
PERCENT =100.0

WIND SPEED (MPS)	SATURATION DEFICIT (GRAMS/KILOGRAM) 0.00 - 0.29	0.29 - 1.00	1.00 - 2.00	2.00 - 4.00	>4.00	TOTAL	% FR	CUM %
0.0- 1.0	360	738	290	116	158	1662	7.7	7.7
1.0- 3.0	1072	2415	1714	1277	1188	7666	35.5	43.2
3.0- 5.0	644	1504	1438	1171	1128	5885	27.2	70.4
5.0- 7.0	373	981	1007	853	897	4111	19.0	89.5
7.0-10.0	141	517	477	450	533	2118	9.8	99.3
GT.10.0	11	51	17	27	52	158	0.7	100.0
TOTAL	2601	6206	4943	3894	3956	21600	100.0	
% FR	12.0	28.7	22.9	18.0	18.3	100.0		
CUM %	12.0	40.8	63.7	81.7	100.0			

GG
ER

TABLE 2.3.62

PRECIPITATION MEANS AND EXTREMES (INCHES)
AT VICKSBURG, MISSISSIPPI

Length of Record: Means - 30 Years; Other - 29 Years

Month	Monthly Mean	Monthly Max.	Year	Monthly Min.	Year	Mean No. Days ≥ 0.01 in.
Jan	5.13	12.91	1946	1.72	1959	11
Feb	5.31	13.69	1966	1.41	1947	10
Mar	5.73	12.75	1951	0.62	1966	10
Apr	4.92	12.73	1953	1.03	1960	9
May	4.13	10.00	1953	0.48	1951	8
Jun	3.46	9.79	1945	0.23	1952	9
Jul	3.90	9.54	1940	0.39	1942	10
Aug	3.01	16.58	1960	0.35	1951	7
Sep	2.50	9.93	1958	0.11	1963	7
Oct	2.04	6.85	1945	T	1963	5
Nov	4.43	16.28	1948	0.04	1949	8
Dec	4.94	13.91	1961	1.45	1958	10
Annual	49.50	16.58	1960	T	1963	104

NOTE: Extremes at other local sites: Max. Monthly Precip: 22.24 in. 4/1874
Max. Monthly Snowfall: 10.1 in. 1/1919

DATA SOURCE: Local Climatological Data, Annual Summary for Vicksburg, MS, U.S. Department of Commerce, ESSA, 1966

TABLE 2.3.63

PRECIPITATION MEASUREMENTS
AT GRAND GULF, MISSISSIPPI
(Inches)
Length of Record: 2 Years

Month	Monthly Mean	Maximum 24-Hour Precipitation	Mean No. of Days ≥0.01 in.
January	10.17	3.33	22
February	4.17	2.72	11
March	6.65	3.28	15
April	12.13	9.24	18
May	4.70	2.24	19
June	2.32	0.98	15
July	2.69	1.93	10
August	2.47	1.36	10
September	4.83	2.22	10
October	2.25	1.99	12
November	4.40	2.41	10
December	9.53	5.39	18
Annual	66.31	9.24	170

TABLE 2.3.64

MONTHLY PRECIPITATION AMOUNTS AND HOURS* WITH PRECIPITATION AT THE GRAND GULF SITE, JACKSON, MS, AND ALEXANDRIA, LA

Month	Grand Gulf		Jackson, MS		Alexandria, LA	
	inches	hours	inches	hours	inches	hours
1972						
Aug	0.72	3	2.84	21	1.87	23
Sep	2.38	17	5.04	42	4.75	32
Oct	2.46	34	2.08	16	7.17	46
Nov	1.80	32	3.52	46	3.67	53
Dec	10.19	82	9.67	84	10.95	82
1973						
Jan	6.56	82	4.59	74	6.68	94
Feb	3.63	31	4.23	35	5.07	40
Mar	9.37	49	6.12	52	10.88	83
Apr	11.54	61	9.44	58	8.75	61
May	7.68	56	5.96	56	7.70	50
Jun	1.71	14	0.32	8	3.89	38
Jul	1.39	17	1.99	19	4.72	35
Aug	4.22	42	2.38	23	1.68	27
Sep	7.27	79	4.44	53	9.53	85
Oct	2.03	34	2.72	34	5.17	52
Nov	7.00	51	6.15	46	7.05	46
Dec	8.87	74	6.71	58	4.88	37
1974						
Jan	13.77	133	11.00	108	11.93	100
Feb	4.71	48	6.72	54	3.48	33
Mar	3.93	49	3.50	42	2.85	33
Apr	12.72	63	6.74	41	7.71	29
May	1.72	52	3.01	44	6.04	44
Jun	2.93	35	3.39	24	0.57	10
Jul	3.97	22	1.54	23	1.67	16
1976						
Jan	6.13	43	3.64	45	3.17	31
Feb	1.68	15	1.43	13	1.88	16
Mar	13.43	95	15.13	106	6.74	77
Apr	5.86	29	2.08	21	1.85	17
May	5.35	54	8.01	54	5.18	47
Jun	2.44	31	2.80	30	4.51	40
Jul	2.30	10	4.96	31	3.62	18
Aug	6.53	32	5.26	15	2.24	16
Sep	1.89	22	3.78	28	1.19	18
Oct	3.54	25	3.52	33	2.50	25
Nov	2.79	58	3.34	56	3.37	59
Dec	5.63	80	3.44	66	5.28	81

*Only hours with measurable amounts are included.

TABLE 2.3.65

RAINFALL RATE FREQUENCY DISTRIBUTION AT
GRAND GULF, MS

August 1972-July 1974, January 1976-December 1976
(Totals for 36-Month Period)

Inches Per Hour	Number of Hours												
	J	F	M	A	M	J	J	A	S	O	N	D	Annual
0.01	76	21	56	44	50	33	20	25	38	44	47	62	516*
0.02-0.09	102	39	73	49	73	30	12	26	49	35	58	111	657
0.10-0.24	50	25	28	29	23	10	6	11	19	6	27	34	268
0.25-0.49	21	5	22	13	10	3	7	8	8	4	7	18	126
0.50-0.99	8	4	12	12	6	4	3	5	3	2	1	10	70
1.00-1.99	1		2	4			1	2	1	2	1	1	15
2.0 & over				2									2
Total	258	94	193	153	162	80	49	77	118	93	141	236	1654

*Only hours with measurable amounts are included.

TABLE 2.3.66

RAINFALL RATE FREQUENCY DISTRIBUTION AT
JACKSON, MS

August 1972-July 1974, January 1976-December 1976
(Totals for 36-Month Period)

Inches Per Hour	Number of Hours												
	J	F	M	A	M	J	J	A	S	O	N	D	Annual
0.01	61	19	45	24	37	17	16	8	34	26	36	48	371*
0.02-0.09	108	51	81	51	69	32	29	29	53	34	74	93	704
0.10-0.24	36	19	43	21	30	8	17	8	19	12	27	47	287
0.25-0.49	19	8	20	14	12	2	8	9	12	7	6	15	132
0.50-0.99	3	4	10	9	6	2	3	3	4	3	5	5	57
1.00-1.99		1	1	1		1		2	1	1			8
2.0 & over													--
Total	227	102	200	120	154	62	73	59	123	83	148	208	1559

*Only hours with measurable amounts are included.

TABLE 2.3.67

RAINFALL RATE FREQUENCY DISTRIBUTION AT
ALEXANDRIA, LA

August 1972-July 1974, January 1976-December 1976
(Totals for 36-Month Period)

Inches Per Hour	Number of Hours												
	J	F	M	A	M	J	J	A	S	O	N	D	Annual
0.01	51	18	39	18	26	19	14	22	37	33	50	38	365*
0.02-0.09	107	45	96	44	64	37	30	25	52	53	73	101	727
0.10-0.24	41	14	35	23	29	25	10	12	32	16	21	38	296
0.25-0.49	19	7	17	13	13	4	12	6	8	16	7	15	137
0.50-0.99	7	4	5	7	7	3	2	1	4	3	7	8	58
1.00-1.99		1	1	1	2		1		2	2			10
2.0 & over				1									1
Total	225	89	193	107	141	88	69	66	135	123	158	200	1594

*Only hours with measurable amounts are included.

TABLE 2.3.68

ANNUAL RAINFALL RATE FREQUENCY DISTRIBUTION AT GRAND GULF, MS

August 1972-July 1974, January 1976-December 1976
(Annual Average for 3-Year Period; Hours Rounded to Nearest Whole Number)

Inches Per Hour	Average Number of Hours												
	J	F	M	A	M	J	J	A	S	O	N	D	Annual
0.0-0.01	25	7	19	15	17	11	7	8	13	15	16	21	174
0.02-0.09	34	13	24	16	24	10	4	9	16	12	19	37	218
0.10-0.24	16	8	9	10	8	3	2	4	6	2	9	11	88
0.25-0.49	7	2	7	4	3	1	2	3	3	1	2	6	41
0.50-0.99	3	1	4	4	2	1	1	2	1	1	+	3	23
1.00-1.99	+		1	1			+	1	+	1	+	+	5*
2.0 & over				1									1
Total	85	31	64	51	54	26	16	27	39	32	46	78	550

+Greater than 0 but less than one.

*Includes cummulative + values.

TABLE 2.3.69
ANNUAL RAINFALL RATE FREQUENCY DISTRIBUTION AT
JACKSON, MS

August 1972-July 1974, January 1976-December 1976
(Annual Average for 3-Year Period; Hours Rounded to Nearest Whole Number)

Inches Per Hour	Average Number of Hours												
	J	F	M	A	M	J	J	A	S	O	N	D	Annual
0.0-0.01	20	6	15	8	12	6	5	3	11	9	12	16	124
0.02-0.09	36	17	27	17	23	11	10	10	18	11	25	31	236
0.10-0.24	12	6	14	7	10	3	6	3	6	4	9	16	96
0.25-0.49	6	3	7	5	4	1	3	3	4	2	2	5	44
0.50-0.99	1	1	3	3	2	1	1	1	1	1	2	2	19
1.00-1.99		+	+	+		+		1	+	+			2*
2.0 & over													--
Total	75	33	66	40	51	22	25	21	40	27	50	70	521

+Greater than 0 but less than one.

*Includes cummulative + values.

GG
ER

TABLE 2.3.70

ANNUAL RAINFALL RATE FREQUENCY DISTRIBUTION AT ALEXANDRIA, LA

August 1972-July 1974, January 1976-December 1976
(Annual Average for 3-Year Period; Hours Rounded to Nearest Whole Number)

Inches Per Hour	Number of Hours												
	J	F	M	A	M	J	J	A	S	O	N	D	Annual
0.01	17	6	13	6	9	6	5	7	12	11	17	13	122
0.02-0.09	36	15	32	15	21	12	10	8	17	18	24	34	242
0.10-0.24	14	5	12	8	10	8	3	4	11	5	7	13	99
0.25-0.49	6	2	6	4	4	1	4	2	3	5	2	5	45
0.50-0.99	2	1	2	2	2	1	1	+	1	1	2	3	18
1.00-1.99		+	+	+	1		+		1	1			3
2.0 & over				+									+
Total	75	29	65	35	47	28	23	21	45	41	52	68	530

+Greater than 0 but less than one

TABLE 2.3.72

MAXIMUM OBSERVED SHORT PERIOD PRECIPITATION (in.)
VICKSBURG, MISSISSIPPI*

	Minutes				Hours					
Time Period	5	10	15	30	1	2	3	6	12	24
Amount	0.83	1.20	1.41	2.44	3.44	4.17	5.78	7.10	8.73	9.97
Date	4/12	5/12	8/19	8/22	8/22	2/17	2/17	7/13	4/29	3/27
Year	1909	1923	1918	1960	1960	1927	1927	1907	1953	1951

*Length of record: 5 to 30 minutes, 66 years; 1 to 24 hours, 69 years.

Data Source: Jennings, A. H., Maximum Recorded United States Point Rainfall for 5 Minutes to 24 Hours at 296 First Order Stations, U. S. Weather Bureau Technical Paper 2, Washington, D. C., 1963.

TABLE 2.3.73

PERCENT OF TOTAL OBSERVATIONS (BY MONTHS) OF INDICATED WIND DIRECTIONS AND PRECIPITATION, JACKSON, MISSISSIPPI

Length of Record - 10 Years

	J	F	M	A	M	J	J	A	S	O	N	D	Average Annual
N	1.7	1.2	0.5	0.5	0.2	0.4	0.1	0.1	0.4	0.6	0.8	0.9	0.6
NNE	1.0	1.1	0.5	0.5	0.3	0.4	0.2	0.3	0.6	0.4	0.5	1.2	0.6
NE	1.2	1.0	0.8	0.4	0.3	0.3	0.2	0.3	0.9	0.7	0.8	0.8	0.6
ENE	1.0	0.6	0.7	0.4	0.3	0.4	0.2	0.3	0.6	0.2	0.5	0.8	0.5
E	0.6	0.4	0.5	0.5	0.4	0.4	0.2	0.3	0.6	0.2	0.5	0.4	0.4
ESE	0.7	0.6	0.7	0.6	0.4	0.6	0.3	0.3	0.5	0.2	0.4	0.9	0.5
SE	1.2	1.1	0.9	0.8	0.6	0.7	0.4	0.3	0.5	0.6	0.6	1.1	0.7
SSE	1.3	1.0	1.4	0.9	0.3	0.6	0.6	0.4	0.6	0.6	1.0	1.3	0.8
S	0.9	0.8	0.9	0.6	0.4	0.5	0.6	0.3	0.4	0.4	0.5	0.9	0.6
SSW	0.4	0.4	0.5	0.4	0.2	0.3	0.5	0.3	0.2	0.1	0.4	0.7	0.4
SW	0.5	0.3	0.2	0.3	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.5	0.3
WSW	0.4	0.3	0.2	0.2	0.2	0.2	0.3	0.3	0.1	0.0	0.2	0.2	0.2
W	0.2	0.4	0.3	0.4	0.1	0.1	0.3	0.2	0.1	0.1	0.1	0.3	0.2
WNW	0.7	0.5	0.4	0.4	0.2	0.2	0.3	0.2	0.1	0.1	0.4	0.5	0.3
NW	0.8	1.1	0.6	0.4	0.2	0.2	0.1	0.3	0.4	0.4	1.0	0.8	0.5
NNW	1.6	1.3	0.6	0.3	0.2	0.2	0.2	0.2	0.4	0.3	1.0	1.0	0.6
CALM	0.4	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.3	0.4	0.2
TOTAL	15	12	10	8	5	6	5	4	7	5	9	12	8
SPEED (MPH)	9.7	10.6	10.3	9.8	9.0	7.3	7.8	6.7	8.1	8.1	8.9	8.6	9.1

Data Source: Precipitation and Non-Precipitation Winds, U. S. Department of Commerce, NOAA, National Climatic Center, 1972.

TABLE 2.3.74

FREQUENCY DISTRIBUTION JAN FROM 1972 TO 1976 STATION: GGNS PCPN WINROSES

162/33 FT. DELTA T. 33 FT. WINDS

DIRECTION	WIND SPEED (MPH) 0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	4.	30.	2.	0.	0.	0.	0.	0.	0.	56.	5.4	0.0
NNE	7.	18.	1.	0.	0.	0.	0.	0.	0.	26.	4.5	0.0
NE	4.	7.	0.	0.	0.	0.	0.	0.	0.	11.	3.8	0.0
ENE	2.	7.	0.	0.	0.	0.	0.	0.	0.	9.	4.7	0.0
E	4.	8.	6.	0.	0.	0.	0.	0.	0.	18.	5.9	0.0
ESE	2.	10.	11.	0.	0.	0.	0.	0.	0.	23.	7.2	0.0
SE	3.	12.	7.	0.	0.	0.	0.	0.	0.	24.	6.1	0.0
SSE	4.	5.	5.	0.	0.	0.	0.	0.	0.	14.	6.3	0.0
S	1.	8.	11.	1.	0.	0.	0.	0.	0.	21.	7.7	0.0
SSW	1.	1.	1.	0.	0.	0.	0.	0.	0.	3.	5.2	0.0
SW	0.	4.	3.	1.	0.	0.	0.	0.	0.	8.	7.3	0.0
WSW	1.	3.	2.	0.	0.	0.	0.	0.	0.	6.	5.8	0.0
W	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.0	0.0
WNW	1.	3.	6.	0.	0.	0.	0.	0.	0.	10.	6.8	0.0
NW	0.	1.	0.	0.	0.	0.	0.	0.	0.	1.	5.0	0.0
NNW	0.	10.	8.	0.	0.	0.	0.	0.	0.	24.	6.6	0.0
TOTAL	30.	153.	63.	2.	0.	0.	0.	0.	0.	254.		0.0
AVG SPD	2.5	5.4	9.1	13.1	0.0	0.0	0.0	0.0	0.0		5.9	

GG
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TABLE 2.3.75

FREQUENCY DISTRIBUTION FEB FROM 1972 TO 1976 STATION: GGNS PCPN WINROSES

162/33 FT. DELTA T. 33 FT. WINDS

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	0.	3.	8.	1.	0.	0.	0.	0.	0.	12.	8.7	0.0
NNE	0.	0.	1.	0.	0.	0.	0.	0.	0.	1.	9.5	0.0
NE	1.	3.	0.	0.	0.	0.	0.	0.	0.	4.	4.4	0.0
ENE	0.	2.	2.	0.	0.	0.	0.	0.	0.	4.	7.3	0.0
E	2.	5.	2.	0.	0.	0.	0.	0.	0.	9.	5.3	0.0
ESE	0.	4.	0.	0.	0.	0.	0.	0.	0.	4.	5.1	0.0
SE	0.	1.	0.	0.	0.	0.	0.	0.	0.	1.	7.4	0.0
SSE	1.	6.	1.	2.	1.	0.	0.	0.	0.	11.	8.3	0.0
S	3.	1.	4.	1.	0.	0.	0.	0.	0.	9.	7.9	0.0
SSW	1.	2.	3.	1.	1.	0.	0.	0.	0.	8.	9.5	0.0
SW	0.	1.	1.	2.	0.	0.	0.	0.	0.	4.	10.9	0.0
WSW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.0	0.0
W	0.	0.	3.	0.	0.	0.	0.	0.	0.	3.	9.2	0.0
WNW	0.	3.	0.	0.	0.	0.	0.	0.	0.	3.	4.5	0.0
NW	1.	2.	1.	0.	0.	0.	0.	0.	0.	4.	6.1	0.0
NNW	1.	5.	7.	4.	0.	0.	0.	0.	0.	17.	8.7	0.0
TOTAL	10.	38.	33.	11.	2.	0.	0.	0.	0.	94.		0.0
AVG SPD	2.7	5.6	9.1	13.6	20.5	0.0	0.0	0.0	0.0		7.8	

GG
ER

TABLE 2.3.76

FREQUENCY DISTRIBUTION MAR FROM 1972 TO 1976 STATION: GGNS PCPN WINROSES

162/33 FT. DELTA T. 33 FT. WINDS

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	5.	17.	2.	0.	0.	0.	0.	0.	0.	24.	5.3	0.0
NNE	6.	24.	3.	0.	0.	0.	0.	0.	0.	33.	5.2	0.0
NE	4.	10.	1.	0.	0.	0.	0.	0.	0.	15.	4.8	0.0
ENE	4.	4.	0.	0.	0.	0.	0.	0.	0.	8.	3.9	0.0
E	3.	4.	2.	1.	0.	0.	0.	0.	0.	10.	6.7	0.0
ESE	2.	7.	11.	1.	0.	0.	0.	0.	0.	21.	7.5	0.0
SE	1.	6.	2.	0.	0.	0.	0.	0.	0.	9.	6.2	0.0
SSE	2.	5.	3.	2.	0.	0.	0.	0.	0.	12.	7.6	0.0
S	3.	6.	8.	0.	0.	0.	0.	0.	0.	17.	7.0	0.0
SSW	1.	8.	3.	0.	0.	0.	0.	0.	0.	12.	5.9	0.0
SW	2.	3.	3.	0.	0.	0.	0.	0.	0.	8.	6.5	0.0
WSW	1.	2.	1.	0.	0.	0.	0.	0.	0.	4.	6.0	0.0
W	0.	3.	1.	0.	0.	0.	0.	0.	0.	4.	6.5	0.0
WNW	0.	0.	1.	0.	0.	0.	0.	0.	0.	1.	12.0	0.0
NW	0.	1.	3.	0.	0.	0.	0.	0.	0.	4.	9.8	0.0
NNW	3.	5.	3.	0.	0.	0.	0.	0.	0.	11.	5.4	0.0
TOTAL	37.	105.	47.	4.	0.	0.	0.	0.	0.	193.		0.0
AVG SPD	2.8	5.5	9.3	13.7	0.0	0.0	0.0	0.0	0.0		6.1	

GGNS ER

TABLE 2.3.77

FREQUENCY DISTRIBUTION APR FROM 1972 TO 1976 STATION: GGNS PCPN WINROSES

162/33 FT. DELTA T. 33 FT. WINDS

DIRECTION	WIND SPEED (MPH) 0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	4.	12.	1.	0.	0.	0.	0.	0.	0.	17.	5.0	0.0
NNE	4.	4.	5.	0.	0.	0.	0.	0.	0.	13.	5.8	1.0
NE	2.	7.	3.	0.	0.	0.	0.	0.	0.	12.	5.3	2.0
ENE	1.	2.	0.	0.	0.	0.	0.	0.	0.	3.	4.8	0.0
E	2.	8.	0.	0.	0.	0.	0.	0.	0.	10.	5.0	0.0
ESE	4.	12.	6.	0.	0.	0.	0.	0.	0.	22.	5.6	0.0
SE	0.	11.	4.	0.	0.	0.	0.	0.	1.	16.	8.7	0.0
SSE	0.	4.	3.	1.	0.	0.	0.	0.	0.	8.	8.3	0.0
S	2.	5.	2.	0.	0.	0.	0.	0.	0.	9.	5.8	0.0
SSW	1.	3.	4.	0.	0.	0.	0.	0.	0.	8.	7.1	0.0
SW	0.	5.	0.	0.	0.	0.	0.	0.	0.	5.	5.5	0.0
WSW	0.	2.	2.	0.	0.	0.	0.	0.	0.	4.	7.3	0.0
W	1.	1.	3.	0.	0.	0.	0.	0.	0.	5.	7.4	0.0
WNW	1.	4.	2.	0.	0.	0.	0.	0.	0.	7.	6.4	0.0
NW	0.	1.	4.	0.	0.	0.	0.	0.	0.	5.	7.6	0.0
NNW	0.	6.	1.	0.	0.	0.	0.	0.	0.	7.	6.4	0.0
TOTAL	22.	87.	40.	1.	0.	0.	0.	0.	1.	151.		3.0
AVG SPD	2.1	5.6	8.7	14.3	0.0	0.0	0.0	0.0	51.5		6.3	

GG
ER

TABLE 2.3.78

FREQUENCY DISTRIBUTION MAY FROM 1972 TO 1976 STATION: GGNS PCPN WINROSES

162/33 FT. DELTA T. 33 FT. WINDS

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	2.	1.	0.	0.	0.	0.	0.	0.	0.	3.	4.8	0.0
NNE	6.	7.	0.	0.	0.	0.	0.	0.	0.	13.	3.5	0.0
NE	2.	2.	0.	0.	0.	0.	0.	0.	0.	4.	3.3	0.0
ENE	4.	5.	0.	0.	0.	0.	0.	0.	0.	9.	3.7	0.0
E	4.	10.	1.	0.	0.	0.	0.	0.	0.	15.	4.4	0.0
ESE	4.	5.	1.	0.	0.	0.	0.	0.	0.	10.	4.3	0.0
SE	6.	12.	1.	0.	0.	0.	0.	0.	0.	21.	4.5	0.0
SSE	1.	10.	5.	0.	0.	0.	0.	0.	0.	16.	6.2	0.0
S	2.	10.	6.	0.	0.	0.	0.	0.	0.	18.	6.1	0.0
SSW	3.	4.	1.	0.	0.	0.	0.	0.	0.	8.	5.0	0.0
SW	0.	8.	1.	0.	0.	0.	0.	0.	0.	9.	5.0	0.0
WSW	0.	1.	0.	0.	0.	0.	0.	0.	0.	1.	5.6	0.0
W	4.	2.	0.	0.	0.	0.	0.	0.	0.	5.	3.2	0.0
WNW	2.	2.	0.	0.	0.	0.	0.	0.	0.	4.	4.0	0.0
NW	0.	1.	1.	0.	0.	0.	0.	0.	0.	3.	5.3	0.0
NNW	1.	5.	0.	0.	0.	0.	0.	0.	0.	12.	3.7	0.0
TOTAL	49.	97.	17.	0.	0.	0.	0.	0.	0.	163.		0.0
AVG SPD	2.6	5.0	8.8	0.0	0.0	0.0	0.0	0.0	0.0		4.7	

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ER

TABLE 2.3.79

FREQUENCY DISTRIBUTION JUN FROM 1972 TO 1976 STATION: GGNS PCPN WINROSES

162/33 FT. DELTA T. 33 FT. WINDS

DIRECTION	WIND SPEED (MPH) 0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	4.	5.	1.	0.	0.	0.	0.	0.	0.	10.	4.3	0.0
NNE	3.	4.	0.	0.	0.	0.	0.	0.	0.	7.	4.0	0.0
NE	1.	1.	0.	0.	0.	0.	0.	0.	0.	2.	3.1	0.0
ENE	1.	3.	0.	0.	0.	0.	0.	0.	0.	4.	3.9	0.0
E	3.	3.	0.	0.	0.	0.	0.	0.	0.	6.	3.4	0.0
ESE	5.	0.	0.	0.	0.	0.	0.	0.	0.	5.	2.8	0.0
SE	5.	1.	0.	0.	0.	0.	0.	0.	0.	6.	3.3	0.0
SSE	1.	2.	1.	0.	0.	0.	0.	0.	0.	4.	5.1	0.0
S	2.	3.	1.	0.	0.	0.	0.	0.	0.	6.	5.3	0.0
SSW	1.	3.	1.	0.	0.	0.	0.	0.	0.	5.	5.4	0.0
SW	1.	5.	0.	0.	0.	0.	0.	0.	0.	6.	4.8	0.0
WSW	1.	2.	0.	0.	0.	0.	0.	0.	0.	3.	4.2	0.0
W	1.	1.	0.	0.	0.	0.	0.	0.	0.	2.	3.6	0.0
WNW	2.	2.	1.	0.	0.	0.	0.	0.	0.	5.	4.3	0.0
NW	3.	1.	0.	0.	0.	0.	0.	0.	0.	4.	2.8	0.0
NNW	1.	1.	0.	0.	0.	0.	0.	0.	0.	2.	2.9	0.0
TOTAL	35.	37.	5.	0.	0.	0.	0.	0.	0.	77.		0.0
AVG SPD	2.5	5.0	8.4	0.0	0.0	0.0	0.0	0.0	0.0		4.1	

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TABLE 2.3.80

FREQUENCY DISTRIBUTION JUL FROM 1972 TO 1976 STATION: GGNS PCPN WINROSES

162/33 FT. DELTA T. 33 FT. WINDS

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	1.	0.	0.	0.	0.	0.	0.	0.	0.	1.	2.3	0.0
NNE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.0	0.0
NE	0.	2.	0.	0.	0.	0.	0.	0.	0.	2.	4.7	0.0
ENE	2.	1.	0.	0.	0.	0.	3.	0.	0.	3.	2.7	0.0
E	0.	1.	0.	0.	0.	0.	0.	0.	0.	1.	3.8	0.0
ESE	2.	2.	0.	0.	0.	0.	0.	0.	0.	4.	2.8	0.0
SE	1.	3.	0.	0.	0.	0.	0.	0.	0.	4.	3.5	0.0
SSE	1.	3.	1.	0.	0.	0.	0.	0.	0.	5.	5.3	0.0
S	3.	3.	0.	0.	0.	0.	0.	0.	0.	6.	4.5	0.0
SSW	2.	4.	1.	0.	0.	0.	0.	0.	0.	7.	4.3	0.0
SW	2.	3.	1.	0.	0.	0.	0.	0.	0.	6.	5.2	0.0
WSW	1.	4.	0.	0.	0.	0.	0.	0.	0.	5.	4.5	0.0
W	0.	2.	1.	0.	0.	0.	0.	0.	0.	3.	5.5	0.0
WNW	2.	0.	0.	0.	0.	0.	0.	0.	0.	2.	3.3	0.0
NW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.0	0.0
NNW	0.	1.	0.	0.	0.	0.	0.	0.	0.	1.	4.0	0.0
TOTAL	17.	29.	4.	0.	0.	0.	0.	0.	0.	50.		0.0
AVG SPD	2.6	4.7	8.6	0.0	0.0	0.0	0.0	0.0	0.0		4.3	

GG
ER

TABLE 2.3.81

FREQUENCY DISTRIBUTION AUG FROM 1972 TO 1976 STATION: GGNS PCPN WINROSES

162/33 FT. DELTA T. 33 FT. WINDS

	WIND SPEED (MPH)											
DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	1.	4.	1.	0.	0.	0.	0.	0.	0.	6.	4.9	0.0
NNE	0.	1.	0.	0.	0.	0.	0.	0.	0.	1.	6.4	0.0
NE	4.	1.	0.	0.	0.	0.	0.	0.	0.	5.	2.6	0.0
ENE	0.	2.	0.	0.	0.	0.	0.	0.	0.	4.	2.7	0.0
E	4.	3.	1.	0.	0.	0.	0.	0.	0.	8.	4.3	0.0
ESE	7.	2.	0.	0.	0.	0.	0.	0.	0.	9.	3.4	0.0
SE	2.	3.	2.	0.	0.	0.	0.	0.	0.	7.	5.6	0.0
SSE	3.	5.	1.	0.	0.	0.	0.	0.	0.	9.	4.8	0.0
S	2.	2.	0.	0.	0.	0.	0.	0.	0.	4.	3.2	0.0
SSW	0.	1.	0.	0.	0.	0.	0.	0.	0.	1.	5.0	0.0
SW	1.	1.	1.	0.	0.	0.	0.	0.	0.	3.	5.8	0.0
WSW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.0	0.0
W	0.	1.	0.	0.	0.	0.	0.	0.	0.	1.	3.5	0.0
WNW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.0	0.0
NW	1.	0.	1.	0.	0.	0.	0.	0.	0.	2.	5.5	0.0
NNW	3.	1.	1.	0.	0.	0.	0.	0.	0.	5.	4.9	0.0
TOTAL	34.	27.	8.	0.	0.	0.	0.	0.	0.	69.		0.0
AVG SPD	2.3	5.0	4.6	0.0	0.0	0.0	0.0	0.0	0.0		4.2	

GG
ER

TABLE 2.3.82

FREQUENCY DISTRIBUTION SEP FROM 1972 TO 1976 STATION: GGNS PCPN WINDROSES

162/33 FT. DELTA T. 33 FT. WINDS

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	1.	1.	0.	0.	0.	0.	0.	0.	0.	2.	2.6	0.0
NNE	3.	0.	0.	0.	0.	0.	0.	0.	0.	3.	2.1	0.0
NE	3.	3.	0.	0.	0.	0.	0.	0.	0.	6.	3.7	0.0
ENE	4.	20.	1.	0.	0.	0.	0.	0.	0.	25.	4.9	0.0
E	4.	9.	0.	0.	0.	0.	0.	0.	0.	13.	4.5	0.0
ESE	2.	7.	0.	0.	0.	0.	0.	0.	0.	9.	4.3	0.0
SE	3.	2.	0.	0.	0.	0.	0.	0.	0.	5.	2.5	0.0
SSE	2.	2.	0.	0.	0.	0.	0.	0.	0.	4.	4.1	0.0
S	4.	2.	0.	0.	0.	0.	0.	0.	0.	6.	3.5	0.0
SSW	1.	4.	1.	0.	0.	0.	0.	0.	0.	6.	5.2	0.0
SW	2.	2.	0.	0.	0.	0.	0.	0.	0.	4.	3.7	0.0
WSW	2.	2.	0.	0.	0.	0.	0.	0.	0.	4.	3.3	0.0
W	2.	1.	0.	0.	0.	0.	0.	0.	0.	3.	3.4	0.0
WNW	3.	0.	0.	0.	0.	0.	0.	0.	0.	3.	1.2	0.0
NW	2.	1.	0.	0.	0.	0.	0.	0.	0.	3.	2.2	0.0
NNW	3.	0.	1.	0.	0.	0.	0.	0.	0.	4.	4.6	0.0
TOTAL	47.	56.	3.	0.	0.	0.	0.	0.	0.	106.		0.0
AVG SPD	2.2	5.1	9.0	0.0	0.0	0.0	0.0	0.0	0.0		3.9	

GGNS ER

TABLE 2.3.83

FREQUENCY DISTRIBUTION OCT FROM 1972 TO 1976 STATION: GGNS PCPN WINROSES

162/33 FT. DELTA T. 33 FT. WINDS

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	4.	9.	0.	0.	0.	0.	0.	0.	0.	13.	4.2	0.0
NNE	3.	6.	0.	0.	0.	0.	0.	0.	0.	9.	4.1	0.0
NE	3.	6.	0.	0.	0.	0.	0.	0.	0.	9.	4.2	0.0
ENE	1.	4.	0.	0.	0.	0.	0.	0.	0.	5.	4.6	0.0
E	3.	6.	2.	0.	0.	0.	0.	0.	0.	11.	5.2	0.0
ESE	2.	2.	2.	0.	0.	0.	0.	0.	0.	6.	5.0	0.0
SE	3.	2.	0.	0.	0.	0.	0.	0.	0.	5.	3.5	0.0
SSE	0.	1.	0.	0.	0.	0.	0.	0.	0.	1.	5.0	0.0
S	1.	3.	0.	0.	0.	0.	0.	0.	0.	4.	4.4	0.0
SSW	1.	3.	0.	0.	0.	0.	0.	0.	0.	4.	4.9	0.0
SW	0.	5.	0.	0.	0.	0.	0.	0.	0.	5.	5.4	0.0
WSW	3.	4.	0.	0.	0.	0.	0.	0.	0.	7.	4.6	0.0
W	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.0	0.0
WNW	0.	2.	0.	0.	0.	0.	0.	0.	0.	2.	5.8	0.0
NW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.0	0.0
NNW	3.	5.	2.	0.	0.	0.	0.	0.	0.	10.	5.7	0.0
TOTAL	27.	58.	6.	0.	0.	0.	0.	0.	0.	91.		0.0
AVG SPD	2.1	5.5	8.3	0.0	0.0	0.0	0.0	0.0	0.0		4.7	

GG
ER

TABLE 2.3.84

FREQUENCY DISTRIBUTION NOV FROM 1972 TO 1976 STATION: GGNS PCPN WINROSES

162/33 FT. DELTA T. 33 FT. WINDS

DIRECTION	WIND SPEED (MPH) 0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	2.	12.	7.	0.	0.	0.	0.	0.	0.	21.	6.1	0.0
NNE	2.	7.	0.	0.	0.	0.	0.	0.	0.	9.	4.3	0.0
NE	4.	8.	0.	0.	0.	0.	0.	0.	0.	12.	3.9	0.0
ENE	3.	5.	0.	0.	0.	0.	0.	0.	0.	8.	4.0	0.0
E	3.	2.	0.	0.	0.	0.	0.	0.	0.	5.	3.6	0.0
ESE	4.	6.	1.	0.	0.	0.	0.	0.	0.	11.	4.7	0.0
SE	8.	7.	1.	0.	0.	0.	0.	0.	0.	16.	3.9	0.0
SSE	2.	3.	3.	0.	0.	0.	0.	0.	0.	8.	6.9	0.0
S	4.	6.	6.	0.	0.	0.	0.	0.	0.	16.	6.2	0.0
SSW	2.	3.	1.	0.	0.	0.	0.	0.	0.	6.	5.0	0.0
SW	2.	3.	1.	1.	0.	0.	0.	0.	0.	7.	6.2	0.0
WSW	0.	2.	0.	0.	0.	0.	0.	0.	0.	2.	4.8	0.0
W	0.	4.	2.	0.	0.	0.	0.	0.	0.	6.	6.5	0.0
WNW	1.	0.	1.	0.	0.	0.	0.	0.	0.	2.	5.1	0.0
NW	3.	1.	0.	0.	0.	0.	0.	0.	0.	4.	3.3	0.0
NNW	2.	5.	0.	0.	0.	0.	0.	0.	0.	7.	4.1	0.0
TOTAL	42.	74.	23.	1.	0.	0.	0.	0.	0.	140.		0.0
AVG SPD	2.3	5.3	8.8	14.0	0.0	0.0	0.0	0.0	0.0		5.1	

GG
ER

TABLE 2.3.85

FREQUENCY DISTRIBUTION DEC FROM 1972 TO 1976 STATION: GGNS PCPN WINROSES

162/33 FT. DELTA T. 33 FT. WINDS

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	10.	20.	6.	2.	0.	0.	0.	0.	0.	44.	5.1	0.0
NNE	4.	5.	0.	0.	0.	0.	0.	0.	0.	9.	4.0	0.0
NE	4.	7.	0.	0.	0.	0.	0.	0.	0.	11.	3.6	0.0
ENE	5.	4.	0.	0.	0.	0.	0.	0.	0.	10.	3.4	0.0
E	5.	18.	0.	0.	0.	0.	0.	0.	0.	23.	4.5	0.0
ESE	0.	15.	4.	0.	0.	0.	0.	0.	0.	19.	6.1	0.0
SE	0.	7.	8.	0.	0.	0.	0.	0.	0.	21.	5.8	0.0
SSE	1.	1.	9.	2.	0.	0.	0.	0.	0.	13.	9.7	0.0
S	5.	3.	1.	0.	0.	0.	0.	0.	0.	9.	3.8	0.0
SSW	1.	8.	0.	1.	0.	0.	0.	0.	0.	10.	6.2	0.0
SW	1.	2.	1.	0.	0.	0.	0.	0.	0.	4.	5.7	0.0
WSW	0.	6.	1.	0.	0.	0.	0.	0.	0.	7.	6.5	0.0
W	3.	2.	0.	0.	0.	0.	0.	0.	0.	5.	3.9	0.0
WNW	1.	5.	5.	0.	0.	0.	0.	0.	0.	11.	6.5	0.0
NW	0.	6.	4.	0.	0.	0.	0.	0.	0.	10.	6.6	0.0
NNW	3.	17.	10.	0.	0.	0.	0.	0.	0.	30.	6.5	0.0
TOTAL	56.	126.	49.	5.	0.	0.	0.	0.	0.	236.		0.0
AVG SPD	2.0	5.3	8.9	13.8	0.0	0.0	0.0	0.0	0.0		5.6	

GG
ER

TABLE 2.3.86

FREQUENCY DISTRIBUTION 1972 TO 1976 STATION: GGNS PCHN WINDROSES

162/33 FT. DELTA T. 33 FT. WINDS

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	30.	140.	28.	3.	0.	0.	0.	0.	0.	221.	5.3	0.0
NNE	30.	76.	10.	0.	0.	0.	0.	0.	0.	124.	4.6	1.0
NE	32.	57.	4.	0.	0.	0.	0.	0.	0.	93.	4.1	2.0
ENE	34.	59.	3.	0.	0.	0.	0.	0.	0.	95.	4.2	0.0
E	37.	77.	14.	1.	0.	0.	0.	0.	0.	129.	4.9	0.0
ESE	34.	72.	36.	1.	0.	0.	0.	0.	0.	143.	5.6	0.0
SE	42.	67.	25.	0.	0.	0.	0.	0.	1.	135.	5.4	0.0
SSE	18.	47.	32.	7.	1.	0.	0.	0.	0.	105.	6.9	0.0
S	32.	52.	39.	2.	0.	0.	0.	0.	0.	125.	5.1	0.0
SSW	13.	44.	16.	2.	1.	0.	0.	0.	0.	76.	6.0	0.0
SW	11.	42.	12.	4.	0.	0.	0.	0.	0.	69.	6.0	0.0
WSW	7.	28.	6.	0.	0.	0.	0.	0.	0.	41.	5.3	0.0
W	11.	17.	10.	0.	0.	0.	0.	0.	0.	38.	5.4	0.0
WNW	13.	21.	16.	0.	0.	0.	0.	0.	0.	50.	5.6	0.0
NW	10.	21.	14.	0.	0.	0.	0.	0.	0.	45.	5.7	0.0
NNW	20.	67.	33.	4.	0.	0.	0.	0.	0.	124.	5.1	0.0
TOTAL	412.	897.	298.	24.	2.	0.	0.	0.	1.	1624.		3.0
AVG SPD	2.9	5.3	7.0	13.6	20.5	0.0	0.0	0.0	51.5		5.4	

GG ER

TABLE 2.3.87

FREQUENCY DISTRIBUTION JAN FROM 1972 TO 1976 STATION: JAMES POINT

#IND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG #IND SPEED	CALM DIST
N	7.	20.	31.	7.	1.	0.	0.	0.	0.	86.	8.7	2.2
NNE	1.	10.	17.	3.	0.	0.	0.	0.	0.	31.	9.1	0.9
NE	5.	14.	7.	0.	0.	0.	0.	0.	0.	26.	6.2	1.5
ENE	9.	4.	4.	2.	0.	0.	0.	0.	0.	19.	5.6	3.3
E	3.	2.	1.	1.	0.	0.	0.	0.	0.	7.	6.4	0.4
ESE	3.	9.	2.	1.	0.	0.	0.	0.	0.	15.	6.4	1.0
SE	2.	10.	18.	5.	0.	0.	0.	0.	0.	35.	8.4	1.0
SSE	11.	16.	23.	7.	1.	0.	0.	0.	0.	58.	7.6	11.1
S	6.	17.	25.	11.	1.	0.	0.	0.	0.	60.	9.2	3.9
SSW	3.	5.	6.	0.	0.	0.	0.	0.	0.	14.	6.9	0.5
SW	1.	3.	1.	0.	0.	0.	0.	0.	0.	5.	5.3	0.3
WSW	0.	1.	0.	1.	0.	0.	0.	0.	0.	2.	8.3	0.1
W	1.	0.	1.	0.	0.	0.	0.	0.	0.	2.	6.1	0.1
WNW	3.	4.	1.	1.	0.	0.	0.	0.	0.	9.	6.4	0.5
NW	2.	3.	5.	10.	3.	0.	0.	0.	0.	23.	12.4	0.4
NNW	2.	7.	22.	17.	5.	0.	0.	0.	0.	53.	11.9	0.7
TOTAL	59.	125.	184.	66.	11.	0.	0.	0.	0.	450.		33.0
AVG SPD	2.3	5.9	9.8	14.6	20.9	0.0	0.0	0.0	0.0		8.6	

GG
ER

TABLE 2.3.88

FREQUENCY DISTRIBUTION FEB FROM 1972 TO 1976 STATION: JAMES POINT ROSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	4.	3.	16.	16.	0.	0.	0.	0.	0.	39.	11.1	2.6
NNE	0.	2.	1.	3.	0.	0.	0.	0.	0.	6.	11.7	0.0
NE	2.	0.	0.	0.	0.	0.	0.	0.	0.	2.	3.3	0.1
ENE	0.	1.	1.	1.	0.	0.	0.	0.	0.	3.	8.7	0.0
E	1.	3.	0.	0.	0.	0.	0.	0.	0.	4.	5.1	0.1
ESE	0.	1.	1.	0.	0.	0.	0.	0.	0.	2.	6.8	0.0
SE	6.	6.	9.	1.	1.	2.	0.	0.	0.	25.	8.8	3.1
SSE	1.	11.	14.	1.	0.	1.	0.	0.	0.	28.	8.6	1.3
S	2.	12.	14.	3.	0.	0.	0.	0.	0.	31.	8.1	1.0
SSW	0.	5.	11.	1.	0.	0.	0.	0.	0.	17.	8.7	0.2
SW	0.	2.	1.	0.	0.	0.	0.	0.	0.	3.	5.6	0.1
WSW	0.	1.	1.	1.	0.	0.	0.	0.	0.	3.	9.1	0.0
W	0.	1.	3.	0.	0.	0.	0.	0.	0.	4.	9.1	0.0
WNW	1.	2.	3.	0.	0.	0.	0.	0.	0.	6.	7.4	0.0
NW	0.	1.	1.	5.	0.	0.	0.	0.	0.	7.	13.3	0.0
NNW	1.	6.	10.	6.	2.	0.	0.	0.	0.	25.	10.6	1.1
TOTAL	19.	57.	86.	38.	3.	3.	0.	0.	0.	207.		11.0
AVG SPD	2.1	5.0	7.6	13.0	21.5	27.0	0.0	0.0	0.0		9.3	

GG ER

TABLE 2.3.89

FREQUENCY DISTRIBUTION MAR FROM 1972 TO 1976 STATION: JAMES POSEY

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	5.	3.	13.	7.	0.	0.	0.	0.	0.	29.	9.2	4.2
NNE	1.	4.	4.	1.	0.	0.	0.	0.	0.	10.	7.5	0.7
NE	3.	7.	2.	1.	0.	0.	0.	0.	0.	13.	5.6	3.2
ENE	7.	7.	3.	1.	0.	0.	0.	0.	0.	18.	5.2	5.3
E	5.	7.	7.	1.	0.	0.	0.	0.	0.	20.	6.5	4.5
ESE	10.	7.	4.	2.	1.	0.	0.	0.	0.	24.	6.2	6.8
SE	2.	11.	10.	6.	1.	0.	0.	0.	0.	30.	8.9	1.8
SSE	8.	14.	12.	1.	1.	0.	0.	0.	0.	36.	6.8	5.7
S	5.	15.	16.	6.	1.	1.	0.	0.	0.	44.	8.4	3.4
SSW	5.	7.	11.	4.	0.	0.	0.	0.	0.	27.	7.9	4.5
SW	0.	1.	2.	0.	0.	0.	0.	0.	0.	3.	7.0	0.2
WSW	0.	1.	1.	0.	0.	0.	0.	0.	0.	2.	7.0	0.2
W	2.	0.	0.	0.	0.	0.	0.	0.	0.	2.	3.1	0.3
WNW	5.	0.	0.	0.	0.	0.	0.	0.	0.	5.	1.5	4.0
NW	0.	0.	0.	1.	1.	0.	0.	0.	0.	2.	14.0	0.0
NNW	0.	2.	7.	2.	0.	0.	0.	0.	0.	11.	9.5	0.3
TOTAL	61.	86.	42.	33.	5.	1.	0.	0.	0.	274.		46.0
AVG SPD	1.6	5.7	9.4	13.1	20.5	27.5	0.0	0.0	0.0		7.5	

GGER

TABLE 2.3.90

FREQUENCY DISTRIBUTION APR FROM 1972 TO 1976 STATION: JAN.MS PCPN ROSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	2.	1.	1.	1.	0.	0.	0.	0.	0.	5.	8.2	0.5
NNE	1.	3.	1.	1.	0.	0.	0.	0.	0.	6.	7.4	0.8
NE	0.	1.	0.	0.	0.	0.	0.	0.	0.	1.	5.7	0.3
ENE	4.	2.	1.	0.	0.	0.	0.	0.	0.	7.	4.4	1.4
E	0.	1.	0.	0.	1.	0.	0.	0.	0.	2.	11.8	0.3
ESE	0.	0.	2.	0.	0.	0.	0.	0.	0.	2.	9.2	0.0
SE	3.	4.	7.	1.	0.	0.	0.	0.	0.	15.	7.2	1.7
SSE	12.	11.	13.	3.	0.	0.	0.	0.	0.	39.	6.3	10.0
S	7.	7.	5.	0.	0.	0.	0.	0.	0.	19.	5.7	5.2
SSW	4.	7.	7.	2.	0.	0.	0.	0.	0.	20.	7.5	2.5
SW	0.	0.	2.	0.	0.	0.	0.	0.	0.	2.	9.2	0.0
WSW	0.	1.	0.	0.	0.	0.	0.	0.	0.	1.	5.7	0.3
W	0.	0.	0.	1.	0.	0.	0.	0.	0.	1.	15.0	0.0
WNW	0.	0.	2.	0.	0.	0.	0.	0.	0.	2.	11.5	0.0
NW	1.	2.	1.	1.	0.	0.	0.	0.	0.	5.	8.2	0.5
NNW	2.	1.	3.	2.	0.	0.	0.	0.	0.	8.	9.1	0.5
TOTAL	35.	41.	45.	12.	1.	0.	0.	0.	0.	134.		24.0
AVG SPD	1.7	5.8	10.0	14.7	20.7	0.0	0.0	0.0	0.0		7.0	

GG
ER

TABLE 2.3.91

FREQUENCY DISTRIBUTION MAY FROM 1972 TO 1976 STATION: JAMES POWER ROSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	2.	3.	5.	2.	0.	0.	0.	0.	0.	12.	8.3	1.3
NNE	6.	2.	2.	1.	0.	0.	0.	0.	0.	11.	5.2	3.1
NE	1.	2.	3.	0.	0.	0.	0.	0.	0.	6.	7.2	0.5
ENE	4.	1.	1.	0.	0.	0.	0.	0.	0.	6.	4.2	1.6
E	3.	3.	0.	1.	0.	0.	0.	0.	0.	7.	5.2	2.4
ESE	6.	2.	4.	0.	0.	0.	0.	0.	0.	12.	5.4	3.6
SE	6.	8.	7.	5.	0.	0.	0.	0.	0.	26.	7.4	5.1
SSE	8.	9.	13.	1.	0.	0.	0.	0.	0.	31.	6.8	3.6
S	6.	7.	7.	0.	0.	0.	0.	0.	0.	20.	6.1	2.8
SSW	7.	17.	14.	0.	0.	0.	0.	0.	0.	38.	6.3	4.4
SW	8.	4.	4.	0.	0.	0.	0.	0.	0.	16.	5.2	3.6
WSW	4.	4.	3.	0.	0.	0.	0.	0.	0.	11.	5.2	1.7
W	7.	3.	7.	0.	0.	0.	0.	0.	0.	17.	5.9	1.6
WNW	1.	5.	4.	0.	0.	0.	0.	0.	0.	10.	6.8	0.6
NW	0.	0.	4.	0.	0.	0.	0.	0.	0.	4.	8.5	0.0
NNW	3.	2.	2.	0.	0.	0.	0.	0.	0.	7.	5.5	1.1
TOTAL	71.	72.	80.	10.	0.	0.	0.	0.	0.	235.		39.0
AVG SPD	2.2	6.0	7.3	14.3	0.0	0.0	0.0	0.0	0.0		6.3	

GG
ER

TABLE 2.3.92

FREQUENCY DISTRIBUTION JUN FROM 1972 TO 1976 STATION: JAMES POINT ROSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	1.	3.	0.	0.	0.	0.	0.	0.	0.	4.	4.2	1.5
NNE	1.	1.	2.	1.	0.	0.	0.	0.	0.	5.	8.0	0.5
NE	20.	4.	1.	0.	0.	0.	0.	0.	0.	25.	2.3	16.0
ENE	2.	3.	0.	0.	0.	0.	0.	0.	0.	5.	4.1	1.5
E	7.	2.	0.	0.	0.	0.	0.	0.	0.	9.	2.8	3.9
ESE	0.	1.	2.	0.	0.	0.	0.	0.	0.	3.	7.3	0.0
SE	8.	14.	5.	1.	0.	0.	0.	0.	0.	28.	5.2	6.0
SSE	18.	16.	10.	0.	0.	0.	0.	0.	0.	44.	4.8	12.3
S	19.	12.	2.	0.	0.	0.	0.	0.	0.	33.	3.7	14.8
SSW	9.	4.	3.	0.	0.	0.	0.	0.	0.	16.	4.1	5.4
SW	4.	4.	1.	0.	0.	0.	0.	0.	0.	9.	4.8	1.5
WSW	1.	2.	1.	0.	0.	0.	0.	0.	0.	4.	5.4	0.5
W	9.	5.	1.	0.	0.	0.	0.	0.	0.	15.	3.4	6.6
WNW	0.	1.	0.	0.	0.	0.	0.	0.	0.	1.	5.7	0.0
NW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.0	0.0
NNW	1.	1.	0.	0.	0.	0.	0.	0.	0.	2.	4.2	0.5
TOTAL	99.	74.	28.	2.	0.	0.	0.	0.	0.	203.		71.0
AVG SPD	1.7	3.6	4.6	12.7	0.0	0.0	0.0	0.0	0.0		4.2	

GG
ER

TABLE 2.3.93

FREQUENCY DISTRIBUTION JUL FROM 1972 TO 1976 STATION: JAN.MS PCPN ROSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	23.	6.	2.	0.	0.	0.	0.	0.	0.	31.	2.7	18.6
NNE	2.	2.	0.	0.	0.	0.	0.	0.	0.	4.	3.5	1.3
NE	0.	1.	0.	0.	0.	0.	0.	0.	0.	1.	4.0	0.2
ENE	9.	1.	0.	0.	0.	0.	0.	0.	0.	10.	1.9	6.5
E	3.	3.	1.	0.	0.	0.	0.	0.	0.	7.	4.3	1.8
ESE	2.	0.	0.	0.	0.	0.	0.	0.	0.	2.	2.1	1.1
SE	14.	13.	1.	0.	0.	0.	0.	0.	0.	28.	3.5	11.9
SSE	26.	20.	5.	1.	0.	0.	0.	0.	0.	52.	4.1	18.6
S	19.	20.	3.	0.	0.	0.	0.	0.	0.	42.	3.9	15.6
SSW	32.	21.	3.	0.	0.	0.	0.	0.	0.	56.	3.4	26.5
SW	12.	4.	1.	0.	0.	0.	0.	0.	0.	17.	3.2	7.6
WSW	1.	0.	1.	0.	0.	0.	0.	0.	0.	2.	5.3	0.2
W	2.	6.	1.	0.	0.	0.	0.	0.	0.	9.	4.6	1.7
WNW	13.	4.	0.	0.	0.	0.	0.	0.	0.	17.	2.4	9.9
NW	4.	2.	0.	0.	0.	0.	0.	0.	0.	6.	3.1	2.4
NNW	5.	1.	0.	0.	0.	0.	0.	0.	0.	6.	2.9	1.9
TOTAL	165.	104.	18.	1.	0.	0.	0.	0.	0.	288.		126.0
AVG SPD	1.6	5.5	8.6	13.8	0.0	0.0	0.0	0.0	0.0		3.5	

GG ER

TABLE 2.3.94

FREQUENCY DISTRIBUTION AUG FROM 1972 TO 1976 STATION: JAY.MS PCPV ROSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	14.	5.	5.	0.	0.	0.	0.	0.	0.	25.	3.9	10.4
NNE	16.	5.	1.	0.	0.	0.	0.	0.	0.	22.	3.1	11.5
NE	10.	7.	1.	0.	0.	0.	0.	0.	0.	18.	3.5	6.7
ENE	18.	7.	0.	0.	0.	0.	0.	0.	0.	25.	2.8	12.0
E	11.	4.	3.	0.	0.	0.	0.	0.	0.	18.	3.9	6.9
ESE	10.	2.	0.	0.	0.	0.	0.	0.	0.	12.	2.5	5.7
SE	18.	16.	0.	0.	0.	0.	0.	0.	0.	34.	3.5	13.8
SSE	8.	10.	4.	0.	0.	0.	0.	0.	0.	22.	4.9	5.3
S	9.	19.	4.	0.	0.	0.	0.	0.	0.	23.	4.7	8.0
SSW	12.	8.	1.	0.	0.	0.	0.	0.	0.	21.	3.5	9.5
SW	3.	2.	1.	0.	0.	0.	0.	0.	0.	6.	3.6	2.4
WSW	3.	1.	0.	0.	0.	0.	0.	0.	0.	4.	2.6	1.9
W	4.	2.	0.	0.	0.	0.	0.	0.	0.	6.	3.0	3.0
WNW	3.	1.	1.	0.	0.	0.	0.	0.	0.	5.	3.7	1.9
NW	0.	1.	0.	0.	0.	0.	0.	0.	0.	1.	4.0	0.0
NNW	4.	5.	1.	0.	0.	0.	0.	0.	0.	10.	4.5	3.1
TOTAL	144.	87.	22.	0.	0.	0.	0.	0.	0.	253.		102.0
AVG SPD	1.7	5.7	6.7	0.0	0.0	0.0	0.0	0.0	0.0		3.7	

GG ER

TABLE 2.3.95

FREQUENCY DISTRIBUTION SEP FROM 1972 TO 1976 STATION: JAN.MS PCPN ROSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	10.	7.	2.	1.	0.	0.	0.	0.	0.	20.	4.4	5.2
NNE	12.	9.	1.	0.	0.	0.	0.	0.	0.	22.	3.9	5.8
NE	10.	6.	1.	0.	0.	0.	0.	0.	0.	17.	3.8	5.4
ENE	10.	3.	0.	0.	0.	0.	0.	0.	0.	13.	3.2	3.9
E	11.	9.	5.	1.	0.	0.	0.	0.	0.	26.	5.1	7.1
ESE	19.	12.	10.	0.	0.	0.	0.	0.	0.	41.	4.6	14.9
SE	24.	22.	8.	0.	0.	0.	0.	0.	0.	54.	4.3	21.0
SSE	21.	20.	8.	0.	0.	0.	0.	0.	0.	49.	4.5	16.3
S	9.	19.	7.	0.	0.	0.	0.	0.	0.	35.	5.1	9.3
SSW	12.	7.	6.	0.	0.	0.	0.	0.	0.	25.	4.4	6.9
SW	6.	2.	1.	0.	0.	0.	0.	0.	0.	9.	3.5	2.6
WSW	1.	1.	0.	0.	0.	0.	0.	0.	0.	2.	3.7	0.2
W	4.	1.	1.	0.	0.	0.	0.	0.	0.	6.	3.6	2.0
WNW	7.	8.	3.	0.	0.	0.	0.	0.	0.	18.	4.7	5.5
NW	4.	8.	2.	0.	0.	0.	0.	0.	0.	14.	5.3	2.6
NNW	8.	9.	4.	0.	1.	0.	0.	0.	0.	22.	5.3	4.5
TOTAL	169.	143.	59.	2.	1.	0.	0.	0.	0.	376.		115.0
AVG SPD	1.8	5.7	9.1	13.0	20.7	0.0	0.0	0.0	0.0		4.5	

GG
ER

TABLE 2.3.96

FREQUENCY DISTRIBUTION OCT FROM 1972 TO 1978 STATION: JAMES POWER ROSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	9.	5.	9.	10.	0.	0.	0.	0.	0.	33.	6.7	6.7
NNE	2.	2.	3.	0.	0.	0.	0.	0.	0.	7.	6.6	0.7
NE	1.	2.	9.	0.	0.	0.	0.	0.	0.	13.	5.1	4.1
ENE	18.	2.	3.	1.	0.	0.	0.	0.	0.	24.	3.7	11.0
E	6.	2.	1.	1.	0.	0.	0.	0.	0.	10.	4.7	2.9
ESE	4.	1.	4.	1.	0.	0.	0.	0.	0.	10.	6.8	2.3
SE	25.	15.	13.	1.	0.	0.	0.	0.	0.	54.	4.9	20.8
SSE	27.	13.	7.	0.	0.	0.	0.	0.	0.	47.	3.9	20.5
S	9.	10.	9.	0.	0.	0.	0.	0.	0.	18.	5.8	3.5
SSW	11.	11.	5.	0.	0.	0.	0.	0.	0.	27.	4.7	7.7
SW	4.	2.	1.	1.	0.	0.	0.	0.	0.	8.	5.4	1.1
WSW	0.	2.	4.	1.	0.	0.	0.	0.	0.	7.	9.1	0.3
W	1.	3.	2.	2.	0.	0.	0.	0.	0.	8.	8.8	0.5
WNW	4.	0.	0.	0.	0.	0.	0.	0.	0.	4.	3.0	0.7
NW	6.	2.	3.	1.	0.	0.	0.	0.	0.	12.	5.2	4.3
NNW	1.	3.	4.	5.	0.	0.	0.	0.	0.	13.	10.5	0.7
TOTAL	128.	75.	87.	24.	0.	0.	0.	0.	0.	294.		88.0
AVG SPD	1.8	5.7	7.9	14.5	0.0	0.0	0.0	0.0	0.0		5.7	

GG
ER

TABLE 2.3-97

FREQUENCY DISTRIBUTION NOV FROM 1972 TO 1976 STATION: JAVAMS PCPW ROSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	19.	9.	35.	16.	0.	0.	0.	0.	0.	79.	8.3	14.0
NNE	0.	3.	4.	4.	0.	0.	0.	0.	0.	11.	10.0	0.4
NE	0.	2.	2.	1.	0.	0.	0.	0.	0.	5.	9.0	0.0
ENE	2.	1.	3.	0.	0.	0.	0.	0.	0.	6.	6.5	0.4
E	6.	4.	6.	2.	0.	0.	0.	0.	0.	18.	6.9	2.5
ESE	3.	6.	5.	3.	0.	0.	0.	0.	0.	17.	8.5	1.0
SE	4.	9.	7.	6.	0.	0.	0.	0.	0.	24.	8.5	3.0
SSE	5.	12.	11.	1.	0.	0.	0.	0.	0.	30.	6.6	3.8
S	12.	16.	12.	3.	0.	0.	0.	0.	0.	43.	6.4	9.1
SSW	8.	7.	5.	1.	0.	0.	0.	0.	0.	21.	5.5	6.4
SW	0.	2.	1.	0.	0.	0.	0.	0.	0.	3.	6.1	0.3
WSW	0.	1.	1.	0.	0.	0.	0.	0.	0.	2.	7.1	0.1
W	0.	0.	1.	2.	0.	0.	0.	0.	0.	4.	5.5	5.3
WNW	0.	1.	4.	4.	0.	0.	0.	0.	0.	9.	12.0	0.1
NW	4.	2.	1.	1.	0.	0.	0.	0.	0.	12.	4.3	5.7
NNW	5.	9.	17.	10.	0.	0.	0.	0.	0.	41.	9.2	4.8
TOTAL	79.	84.	114.	56.	0.	0.	0.	0.	0.	333.		57.0
AVG SPD	1.7	5.8	9.1	14.1	0.0	0.0	0.0	0.0	0.0		7.7	

GG
ER

TABLE 2.3.98

FREQUENCY DISTRIBUTION DEC FROM 1972 TO 1976 STATION: JAMES POINT ROSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	5.	16.	21.	19.	2.	0.	0.	0.	0.	63.	9.8	3.0
NNE	5.	4.	11.	3.	0.	0.	0.	0.	0.	23.	7.7	1.3
NE	4.	7.	4.	0.	0.	0.	0.	0.	0.	17.	5.8	1.6
ENE	10.	5.	3.	0.	0.	0.	0.	0.	0.	21.	4.4	2.5
E	3.	8.	5.	2.	0.	0.	0.	0.	0.	18.	6.8	1.4
ESE	5.	11.	1.	3.	0.	0.	0.	0.	0.	21.	6.5	2.2
SE	5.	9.	6.	14.	0.	0.	0.	0.	0.	34.	9.2	3.4
SSE	3.	6.	6.	5.	0.	0.	0.	0.	0.	20.	8.9	2.1
S	1.	1.	9.	5.	0.	0.	0.	0.	0.	16.	10.7	0.2
SSW	4.	5.	5.	3.	0.	0.	0.	0.	0.	17.	7.7	1.6
SW	2.	0.	0.	1.	0.	0.	0.	0.	0.	3.	6.0	0.3
WSW	2.	2.	0.	0.	0.	0.	0.	0.	0.	4.	3.5	1.3
W	2.	5.	1.	1.	0.	0.	0.	0.	0.	9.	6.1	1.6
WNW	1.	4.	6.	3.	0.	0.	0.	0.	0.	14.	9.0	0.6
NW	2.	8.	10.	9.	2.	0.	0.	0.	0.	31.	10.8	1.1
NNW	5.	8.	25.	20.	5.	0.	0.	0.	0.	64.	11.4	1.7
TOTAL	60.	109.	119.	88.	9.	0.	0.	0.	0.	383.		34.0
AVG SPD	2.4	5.5	7.8	14.8	20.5	0.0	0.0	0.0	0.0		8.7	

GG
ER

TABLE 2.3.99

FREQUENCY DISTRIBUTION 1972 TO 1976 STATION: SAVANNAH POWER ROSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	92.	82.	100.	14.	3.	0.	0.	1.	0.	416.	5.3	59.8
NNE	48.	47.	47.	17.	0.	0.	0.	0.	0.	159.	6.7	28.1
NE	62.	55.	25.	2.	0.	0.	0.	0.	0.	144.	4.8	39.3
ENE	90.	47.	19.	3.	0.	0.	0.	0.	0.	160.	4.1	51.8
E	62.	44.	29.	4.	1.	0.	0.	0.	0.	149.	5.5	35.6
ESE	55.	32.	35.	12.	1.	0.	0.	0.	0.	155.	6.1	30.7
SE	112.	137.	99.	40.	2.	2.	0.	0.	0.	382.	6.4	87.6
SSE	149.	134.	127.	20.	2.	1.	0.	0.	0.	457.	5.9	110.8
S	105.	145.	108.	28.	2.	1.	0.	0.	0.	391.	6.5	83.9
SSW	110.	104.	77.	11.	0.	0.	0.	0.	0.	302.	5.5	79.3
SW	44.	26.	16.	2.	0.	0.	0.	0.	0.	88.	4.6	24.3
WSW	13.	17.	12.	5.	0.	0.	0.	0.	0.	47.	5.7	9.3
W	47.	27.	18.	0.	0.	0.	0.	0.	0.	98.	4.9	33.2
WNW	42.	30.	24.	8.	0.	0.	0.	0.	0.	104.	5.7	28.5
NW	29.	29.	27.	28.	6.	0.	0.	0.	0.	119.	8.8	18.7
NNW	40.	34.	46.	82.	13.	0.	0.	0.	0.	265.	9.6	25.0
TOTAL	1184.	1052.	994.	332.	30.	4.	0.	0.	0.	3435.		746.0
AVG SPD	1.8	5.7	9.5	14.7	20.8	27.6	0.0	0.0	0.0		6.5	

GG
ER

TABLE 2.3.100

FREQUENCY DISTRIBUTION JAN FROM 1972 TO 1976 STATION: ALKALA POWER HOUSE

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	4.	11.	55.	33.	1.	0.	0.	0.	0.	117.	10.8	4.1
NNE	10.	12.	34.	20.	1.	0.	0.	0.	0.	82.	9.5	9.4
NE	6.	12.	17.	8.	0.	0.	0.	0.	0.	43.	8.3	4.5
ENE	8.	13.	11.	3.	0.	0.	0.	0.	0.	35.	6.8	5.6
E	21.	19.	4.	0.	0.	0.	0.	0.	0.	44.	3.9	17.5
ESE	14.	11.	3.	1.	0.	0.	0.	0.	0.	29.	4.2	12.5
SE	7.	19.	7.	2.	0.	0.	0.	0.	0.	35.	5.9	6.0
SSE	5.	10.	12.	0.	0.	0.	0.	0.	0.	27.	7.0	3.8
S	19.	18.	24.	5.	0.	0.	0.	0.	0.	66.	6.7	11.6
SSW	6.	5.	3.	2.	0.	0.	0.	0.	0.	15.	5.0	3.9
SW	5.	3.	4.	2.	0.	0.	0.	0.	0.	14.	6.9	2.8
WSW	4.	10.	5.	3.	0.	0.	0.	0.	0.	27.	6.4	7.6
W	4.	5.	5.	0.	0.	0.	0.	0.	0.	14.	5.5	3.2
WNW	5.	3.	5.	0.	0.	0.	0.	0.	0.	13.	5.6	5.1
NW	0.	1.	4.	2.	0.	0.	0.	0.	0.	7.	10.7	0.4
NNW	0.	0.	5.	5.	1.	0.	0.	0.	0.	12.	13.8	0.0
TOTAL	122.	152.	210.	97.	3.	0.	0.	0.	0.	582.		98.0
AVG SPD	1.5	5.7	10.3	14.3	20.7	0.0	0.0	0.0	0.0		7.8	

GG
ER

TABLE 2.3.101

FREQUENCY DISTRIBUTION FEB FROM 1972 TO 1976 STATION: ALA.LA POWER POSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	2.	0.	7.	2.	1.	0.	0.	0.	0.	12.	11.0	0.7
NNE	0.	0.	4.	4.	0.	0.	0.	0.	0.	8.	12.2	0.0
NE	0.	0.	1.	1.	0.	0.	0.	0.	0.	2.	13.8	0.0
ENE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.0	0.0
E	1.	1.	2.	0.	0.	0.	0.	0.	0.	4.	6.4	0.7
ESE	3.	0.	1.	1.	0.	0.	0.	0.	0.	5.	5.8	1.4
SE	8.	7.	1.	0.	0.	0.	0.	0.	0.	16.	3.5	7.2
SSE	4.	3.	4.	2.	0.	0.	0.	0.	0.	13.	6.9	2.8
S	14.	19.	19.	3.	0.	0.	0.	0.	0.	55.	6.6	13.1
SSW	7.	5.	2.	0.	0.	0.	0.	0.	0.	14.	4.1	5.8
SW	2.	4.	1.	0.	0.	0.	0.	0.	0.	7.	4.0	2.1
WSW	3.	5.	0.	0.	1.	0.	0.	0.	0.	9.	5.4	3.1
W	27.	5.	1.	0.	0.	0.	0.	0.	0.	33.	2.4	21.5
WNW	3.	0.	2.	0.	0.	0.	0.	0.	0.	5.	4.7	2.4
NW	1.	1.	0.	0.	0.	0.	0.	0.	0.	2.	3.8	0.7
NNW	1.	1.	1.	0.	0.	0.	0.	0.	0.	3.	5.4	0.7
TOTAL	76.	51.	48.	13.	2.	0.	0.	0.	0.	191.		63.0
AVG SPD	1.5	5.5	7.5	13.2	20.2	0.0	0.0	0.0	0.0		5.7	

GG
ER

TABLE 2.3-102

FREQUENCY DISTRIBUTION MAR FROM 1972 TO 1976 STATION: ALA-LA PCPN ROSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	7.	9.	12.	4.	0.	0.	0.	0.	0.	27.	7.8	6.0
NNE	3.	7.	6.	2.	0.	0.	0.	0.	0.	18.	7.4	2.4
NE	8.	7.	5.	0.	0.	0.	0.	0.	0.	20.	4.7	7.1
ENE	3.	8.	15.	1.	0.	0.	0.	0.	0.	27.	7.6	2.4
E	6.	9.	14.	2.	0.	0.	0.	0.	0.	31.	7.2	5.1
ESE	5.	7.	9.	7.	2.	0.	0.	0.	0.	30.	9.4	5.5
SE	4.	12.	12.	6.	1.	0.	0.	0.	0.	35.	8.9	3.8
SSE	7.	14.	23.	2.	0.	0.	0.	0.	0.	46.	7.4	6.9
S	3.	12.	23.	10.	5.	0.	0.	0.	0.	58.	10.2	3.5
SSW	1.	5.	5.	3.	0.	0.	0.	0.	0.	14.	8.4	1.4
SW	7.	3.	3.	4.	0.	0.	0.	0.	0.	17.	6.9	3.6
WSW	6.	4.	3.	0.	0.	0.	0.	0.	0.	13.	5.4	3.1
W	5.	1.	4.	2.	0.	0.	0.	0.	0.	12.	7.1	2.9
WNW	1.	2.	0.	1.	0.	0.	0.	0.	0.	4.	6.4	0.7
NW	4.	2.	3.	1.	1.	0.	0.	0.	0.	11.	7.8	2.7
NNW	1.	2.	1.	1.	0.	0.	0.	0.	0.	5.	7.0	0.7
TOTAL	72.	99.	143.	46.	9.	0.	0.	0.	0.	369.		58.0
AVG SPD	1.5	5.8	9.7	15.0	20.6	0.0	0.0	0.0	0.0		8.0	

CG
ER

TABLE 2.3.103

FREQUENCY DISTRIBUTION APR FROM 1972 TO 1976 STATION: ALASKA POPN ROSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	6.	2.	9.	3.	0.	0.	0.	0.	0.	20.	7.3	5.4
NNE	10.	6.	5.	2.	1.	0.	0.	0.	0.	24.	5.8	9.1
NE	7.	2.	3.	0.	1.	0.	0.	0.	0.	13.	4.8	6.9
ENE	2.	4.	5.	0.	1.	0.	0.	0.	0.	12.	8.4	1.7
E	7.	3.	3.	1.	0.	0.	0.	0.	0.	14.	5.0	4.7
ESE	4.	5.	4.	0.	0.	0.	0.	0.	0.	14.	6.0	3.0
SE	8.	6.	6.	1.	0.	0.	0.	0.	0.	21.	5.3	6.0
SSE	24.	7.	8.	6.	0.	0.	0.	0.	0.	45.	5.1	22.1
S	4.	5.	15.	2.	1.	0.	0.	0.	0.	27.	8.9	2.6
SSW	0.	1.	1.	0.	0.	0.	0.	0.	0.	2.	6.3	0.4
SW	2.	2.	4.	0.	0.	0.	0.	0.	0.	8.	6.7	1.3
WSW	0.	3.	2.	0.	0.	0.	0.	0.	0.	5.	6.7	0.4
W	3.	2.	1.	1.	0.	0.	0.	0.	0.	7.	4.5	4.9
WNW	0.	0.	2.	0.	0.	0.	0.	0.	0.	2.	10.9	0.0
NW	1.	1.	1.	0.	0.	0.	0.	0.	0.	3.	3.0	5.4
NNW	0.	0.	1.	3.	0.	0.	0.	0.	0.	4.	15.8	0.0
TOTAL	87.	50.	70.	19.	4.	0.	0.	0.	0.	230.		74.0
AVG SPD	1.4	5.4	9.8	14.9	20.4	0.0	0.0	0.0	0.0		6.3	

ER
GG

TABLE 2.3.104

FREQUENCY DISTRIBUTION MAY FROM 1972 TO 1976 STATION: ALX•LA PCPN ROSES

#IND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	2.	3.	8.	0.	0.	0.	0.	0.	0.	13.	7.8	2.0
NNE	6.	8.	4.	2.	0.	0.	0.	0.	0.	20.	5.9	6.0
NE	1.	2.	3.	1.	1.	0.	0.	0.	0.	13.	9.3	0.6
ENE	3.	3.	2.	0.	0.	0.	0.	0.	0.	10.	5.2	1.8
E	4.	7.	6.	1.	0.	0.	0.	0.	0.	23.	5.3	7.9
ESE	4.	4.	2.	0.	0.	0.	0.	0.	0.	10.	4.9	3.9
SE	4.	4.	6.	2.	0.	0.	0.	0.	0.	16.	7.4	2.7
SSE	3.	3.	5.	7.	0.	0.	0.	0.	0.	18.	10.0	2.3
S	7.	12.	4.	4.	0.	0.	0.	0.	0.	32.	7.0	5.4
SSW	5.	10.	12.	2.	0.	0.	0.	0.	0.	30.	7.1	5.0
SW	3.	5.	7.	1.	0.	0.	0.	0.	0.	16.	7.4	2.3
WSW	3.	4.	2.	0.	0.	0.	0.	0.	0.	14.	3.9	5.7
W	5.	7.	1.	0.	0.	0.	0.	0.	0.	14.	4.0	5.3
WNW	4.	4.	1.	0.	0.	0.	0.	0.	0.	17.	3.5	8.4
NW	4.	4.	0.	0.	0.	0.	0.	0.	0.	8.	3.2	3.6
NNW	2.	3.	1.	0.	0.	0.	0.	0.	0.	6.	4.6	2.0
TOTAL	77.	95.	76.	20.	1.	0.	0.	0.	0.	270.		66.0
AVG SPD	1.4	5.7	9.5	14.6	19.6	0.0	0.0	0.0	0.0		6.2	

GG
ER

TABLE 2.3-105

FREQUENCY DISTRIBUTION JUN FROM 1972 TO 1975 STATION: ALKALA POWER HOUSES

*IND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG *IND SPEED	CALM DIST
N	24.	7.	3.	0.	0.	0.	0.	0.	0.	34.	3.1	19.1
NNE	10.	5.	0.	0.	0.	0.	0.	0.	0.	15.	2.9	7.8
NE	6.	6.	0.	0.	0.	0.	0.	0.	0.	12.	3.2	5.9
ENE	7.	2.	0.	0.	0.	0.	0.	0.	0.	9.	2.2	6.1
E	5.	3.	0.	0.	0.	0.	0.	0.	0.	8.	2.7	3.6
ESE	12.	7.	0.	0.	0.	0.	0.	0.	0.	19.	3.0	9.9
SE	6.	5.	2.	0.	0.	0.	0.	0.	0.	13.	3.9	6.2
SSE	0.	1.	2.	0.	0.	0.	0.	0.	0.	3.	7.6	0.2
S	11.	9.	4.	0.	0.	0.	0.	0.	0.	24.	4.3	8.9
SSW	1.	4.	1.	0.	0.	0.	0.	0.	0.	6.	5.4	0.9
SW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.0	0.0
*SW	27.	5.	1.	0.	0.	0.	0.	0.	0.	33.	2.0	24.2
W	12.	3.	1.	0.	0.	0.	0.	0.	0.	16.	2.1	11.6
*NW	1.	1.	0.	0.	0.	0.	0.	0.	0.	2.	4.4	0.4
NW	3.	1.	0.	1.	0.	0.	0.	0.	0.	5.	4.7	1.8
NNW	5.	4.	1.	0.	0.	0.	0.	0.	0.	11.	3.0	6.3
TOTAL	131.	69.	15.	1.	0.	0.	0.	0.	0.	233.		136.0
AVG SPD	1.3	5.4	8.8	12.7	0.0	0.0	0.0	0.0	0.0		2.9	

GG
ER

TABLE 2.3-106

FREQUENCY DISTRIBUTION JUL FROM 1972 TO 1976 STATION: ALASKA POWER ROSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	4.	5.	1.	0.	0.	0.	0.	0.	0.	10.	2.4	9.5
NNE	8.	5.	0.	0.	0.	0.	0.	0.	0.	14.	3.1	7.0
NE	0.	0.	1.	0.	0.	0.	0.	0.	0.	1.	9.2	0.0
ENE	0.	2.	1.	0.	0.	0.	0.	0.	0.	3.	6.1	0.2
E	0.	2.	1.	0.	0.	0.	0.	0.	0.	3.	6.8	0.2
ESE	4.	1.	0.	0.	0.	0.	0.	0.	0.	5.	2.2	3.2
SE	3.	4.	0.	0.	0.	0.	0.	0.	0.	7.	3.4	3.5
SSE	24.	5.	2.	0.	0.	0.	0.	0.	0.	31.	2.5	19.9
S	42.	12.	0.	0.	0.	0.	0.	0.	0.	54.	2.4	34.4
SSW	15.	3.	2.	0.	0.	0.	0.	0.	0.	20.	2.6	12.6
SW	14.	4.	0.	0.	0.	0.	0.	0.	0.	18.	2.2	12.2
WSW	24.	10.	2.	0.	0.	0.	0.	0.	0.	47.	3.0	27.3
W	30.	10.	3.	0.	0.	0.	0.	0.	0.	43.	2.8	27.1
WNW	1.	1.	1.	0.	0.	0.	0.	0.	0.	3.	5.1	0.5
NW	7.	2.	0.	0.	0.	0.	0.	0.	0.	11.	2.1	8.2
NNW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.0	0.0
TOTAL	191.	78.	14.	0.	0.	0.	0.	0.	0.	294.		182.0
AVG SPD	1.3	3.4	4.3	0.0	0.0	0.0	0.0	0.0	0.0		2.7	

GG
ER

TABLE 2.3.107

FREQUENCY DISTRIBUTION AUG FROM 1972 TO 1976 STATION: ALASKA POWER ROSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	33.	14.	8.	0.	0.	0.	0.	0.	0.	55.	3.5	30.4
NNE	23.	12.	0.	0.	0.	0.	0.	0.	0.	37.	2.7	22.1
NE	2.	3.	1.	0.	0.	0.	0.	0.	0.	6.	5.0	1.9
ENE	19.	11.	0.	0.	0.	0.	0.	0.	0.	30.	2.6	17.9
E	11.	2.	1.	0.	0.	0.	0.	0.	0.	14.	2.4	9.8
ESE	1.	0.	0.	0.	0.	0.	0.	0.	0.	1.	2.7	0.5
SE	2.	3.	0.	0.	0.	0.	0.	0.	0.	5.	3.8	1.7
SSE	39.	3.	0.	0.	0.	0.	0.	0.	0.	42.	1.4	36.8
S	5.	8.	0.	0.	0.	0.	0.	0.	0.	14.	3.8	4.9
SSW	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.0	0.0
SW	1.	2.	1.	0.	0.	0.	0.	0.	0.	4.	5.2	1.0
WSW	7.	5.	0.	0.	0.	0.	0.	0.	0.	12.	2.7	7.3
W	17.	4.	0.	0.	0.	0.	0.	0.	0.	21.	2.0	15.0
WNW	2.	1.	0.	0.	0.	0.	0.	0.	0.	3.	2.3	1.7
NW	18.	3.	0.	0.	0.	0.	0.	0.	0.	21.	2.0	15.0
NNW	2.	5.	1.	0.	0.	0.	0.	0.	0.	8.	4.6	1.9
TOTAL	185.	78.	12.	0.	0.	0.	0.	0.	0.	277.		170.0
AVG SPD	1.2	3.4	4.1	0.0	0.0	0.0	0.0	0.0	0.0		2.8	

GG
ER

TABLE 2.3.108

FREQUENCY DISTRIBUTION SEP FROM 1972 TO 1976 STATION: ALX,LA PCPN ROSES

WIND SPEED (MPH)

IRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	26.	17.	13.	1.	0.	0.	0.	0.	0.	57.	4.7	24.5
NNE	13.	13.	1.	0.	0.	0.	0.	0.	0.	27.	3.6	12.3
NE	5.	10.	8.	1.	0.	0.	0.	0.	0.	24.	6.4	5.1
ENE	12.	15.	12.	1.	0.	0.	0.	0.	0.	40.	5.5	11.3
E	35.	9.	20.	3.	0.	0.	0.	0.	0.	67.	5.1	32.0
ESE	15.	11.	4.	2.	0.	0.	0.	0.	0.	32.	4.5	13.9
SE	27.	11.	5.	0.	0.	0.	0.	0.	0.	43.	3.5	21.4
SSE	16.	9.	4.	0.	0.	0.	0.	0.	0.	29.	3.9	11.9
S	22.	9.	1.	1.	0.	0.	0.	0.	0.	33.	3.1	18.1
SSW	10.	3.	0.	0.	0.	0.	0.	0.	0.	13.	2.0	10.3
SW	8.	2.	0.	0.	0.	0.	0.	0.	0.	10.	2.2	6.7
WSW	3.	1.	0.	0.	0.	0.	0.	0.	0.	4.	2.0	2.7
W	13.	5.	2.	0.	0.	0.	0.	0.	0.	20.	3.1	12.0
WNW	8.	3.	1.	0.	0.	0.	0.	0.	0.	12.	3.2	6.6
NW	5.	3.	2.	0.	0.	0.	0.	0.	0.	10.	4.3	4.6
NNW	7.	3.	7.	1.	0.	0.	0.	0.	0.	18.	5.5	7.4
TOTAL	225.	124.	80.	10.	0.	0.	0.	0.	0.	442.		204.0
AVG SPD	1.3	5.5	7.5	14.0	0.0	0.0	0.0	0.0	0.0		4.3	

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TABLE 2.3.109

FREQUENCY DISTRIBUTION OCT FROM 1972 TO 1976 STATION: ALASKA PCPN GAGES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-17	18-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	19.	14.	3.	1.	1.	0.	0.	1.	0.	39.	4.4	17.3
NNE	19.	5.	4.	1.	0.	0.	0.	1.	0.	29.	3.4	16.7
NE	7.	5.	4.	2.	0.	0.	0.	0.	0.	18.	5.8	7.4
ENE	14.	5.	5.	3.	0.	0.	0.	0.	0.	27.	5.2	11.8
E	32.	8.	4.	2.	0.	0.	0.	0.	0.	46.	3.5	27.3
ESE	5.	7.	7.	6.	0.	0.	0.	0.	0.	25.	6.0	5.0
SE	14.	7.	5.	5.	0.	0.	0.	0.	0.	31.	6.0	11.8
SSE	7.	7.	2.	2.	0.	0.	0.	0.	0.	18.	5.4	7.5
S	6.	2.	0.	0.	0.	0.	0.	0.	0.	8.	2.3	4.6
SSW	4.	1.	0.	0.	0.	0.	0.	0.	0.	5.	2.2	2.9
SW	47.	4.	0.	0.	0.	0.	0.	0.	0.	51.	1.5	45.5
WSW	9.	5.	0.	1.	0.	0.	0.	0.	0.	15.	3.1	9.5
W	8.	5.	5.	0.	0.	0.	0.	0.	0.	18.	4.8	6.7
WNW	7.	4.	4.	0.	0.	0.	0.	0.	0.	15.	4.7	7.0
NW	1.	1.	7.	2.	0.	0.	0.	0.	0.	11.	9.4	0.8
NNW	6.	3.	2.	1.	0.	0.	0.	0.	0.	12.	4.9	4.1
TOTAL	205.	83.	52.	28.	1.	0.	0.	0.	0.	367.		186.0
AVG SPD	1.2	5.7	9.8	14.2	23.0	0.0	0.0	0.0	0.0		4.4	

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TABLE 2.3.110

FREQUENCY DISTRIBUTION NOV FROM 1972 TO 1976 STATION: ALX•LA PCPN ROSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	13.	22.	22.	11.	0.	0.	0.	0.	0.	70.	7.6	13.5
NNE	10.	13.	15.	16.	0.	0.	0.	0.	0.	54.	8.6	8.2
NE	5.	10.	5.	5.	0.	0.	0.	0.	0.	25.	7.0	4.2
ENE	1.	9.	3.	0.	0.	0.	0.	0.	0.	14.	5.0	4.8
E	5.	12.	6.	3.	0.	0.	0.	0.	0.	27.	6.7	4.6
ESE	2.	3.	5.	1.	0.	0.	0.	0.	0.	13.	6.8	1.9
SE	14.	15.	4.	0.	0.	0.	0.	0.	0.	33.	4.8	10.9
SSE	4.	2.	5.	2.	0.	0.	0.	0.	0.	13.	7.8	1.5
S	12.	14.	7.	1.	0.	0.	0.	0.	0.	34.	5.1	10.9
SSW	2.	2.	1.	0.	0.	0.	0.	0.	0.	5.	4.5	1.1
SW	12.	3.	1.	0.	0.	0.	0.	0.	0.	16.	3.5	7.8
WSW	10.	2.	2.	1.	0.	0.	0.	0.	0.	15.	4.4	7.6
W	10.	4.	2.	0.	0.	0.	0.	0.	0.	16.	3.7	8.8
WNW	5.	2.	5.	0.	0.	0.	0.	0.	0.	12.	6.2	2.7
NW	7.	15.	10.	1.	0.	0.	0.	0.	0.	34.	6.8	7.3
NNW	11.	10.	15.	4.	0.	0.	0.	0.	0.	43.	7.1	6.9
TOTAL	130.	146.	117.	45.	0.	0.	0.	0.	0.	438.		103.0
AVG SPD	1.5	5.4	9.3	14.1	0.0	0.0	0.0	0.0	0.0		6.5	

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TABLE 2.3-111

FREQUENCY DISTRIBUTION DEC FROM 1972 TO 1976 STATION: ALASKA POWER RIVERS

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	4.	37.	28.	14.	0.	0.	0.	0.	0.	93.	8.3	8.6
NNE	3.	8.	30.	6.	0.	0.	0.	0.	0.	47.	9.0	2.1
NE	1.	5.	13.	1.	0.	0.	0.	0.	0.	21.	8.3	1.4
ENE	4.	5.	5.	0.	0.	0.	0.	0.	0.	21.	5.4	2.8
E	10.	10.	3.	0.	0.	0.	0.	0.	0.	23.	4.2	5.0
ESE	5.	9.	3.	2.	0.	0.	0.	0.	0.	20.	5.9	5.1
SE	8.	9.	10.	1.	0.	0.	0.	0.	0.	23.	6.8	6.3
SSE	3.	15.	9.	4.	1.	0.	0.	0.	0.	32.	7.9	2.6
S	5.	13.	15.	4.	0.	0.	0.	0.	0.	40.	7.8	4.5
SSW	1.	5.	2.	0.	0.	0.	0.	0.	0.	9.	5.8	1.4
SW	0.	3.	5.	0.	0.	0.		0.	0.	9.	7.3	0.5
WSW	0.	3.	1.	0.	0.	0.	0.	0.	0.	4.	7.1	0.5
W	2.	8.	8.	0.	0.	0.	0.	0.	0.	18.	7.3	1.9
WNW	5.	5.	5.	1.	2.	0.	0.	0.	0.	19.	7.9	3.8
NW	5.	7.	14.	5.	0.	0.	0.	0.	0.	31.	9.0	1.9
NNW	3.	7.	4.	10.	0.	0.	0.	0.	0.	24.	9.7	1.6
TOTAL	71.	150.	157.	53.	3.	0.	0.	0.	0.	434.		51.0
AVG SPD	1.7	5.7	9.8	14.8	21.1	0.0	0.0	0.0	0.0		7.8	

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TABLE 2.3.112

FREQUENCY DISTRIBUTION 1972 TO 1976 STATION: ALA.LA PCPN MOSES

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	158.	136.	142.	70.	3.	0.	0.	0.	0.	553.	7.2	143.4
NNE	124.	95.	108.	53.	2.	0.	0.	0.	0.	386.	6.6	112.8
NE	53.	55.	68.	17.	2.	0.	0.	0.	0.	207.	6.7	44.5
ENE	80.	80.	60.	8.	1.	0.	0.	0.	0.	229.	5.6	62.9
E	150.	85.	64.	12.	0.	0.	0.	0.	0.	311.	4.7	128.2
ESE	74.	73.	38.	20.	2.	0.	0.	3.	0.	211.	5.8	66.7
SE	116.	97.	60.	17.	1.	0.	0.	0.	0.	293.	5.4	100.3
SSE	99.	79.	75.	25.	1.	0.	0.	0.	0.	280.	6.1	81.8
S	155.	144.	122.	30.	6.	0.	0.	0.	0.	457.	6.1	130.5
SSW	52.	43.	24.	7.	0.	0.	0.	0.	0.	133.	5.2	43.6
SW	76.	37.	27.	7.	0.	0.	0.	0.	0.	147.	4.5	61.0
WSW	121.	53.	19.	3.	1.	0.	0.	0.	0.	208.	3.4	108.0
W	155.	39.	33.	3.	0.	0.	0.	0.	0.	250.	3.5	136.8
WNW	54.	32.	26.	2.	2.	0.	0.	0.	0.	120.	4.9	49.6
NW	69.	41.	47.	12.	1.	0.	0.	0.	0.	170.	5.9	57.7
NNW	37.	35.	42.	26.	1.	0.	0.	0.	0.	144.	7.4	30.1
TOTAL	1585.	1169.	1030.	322.	23.	0.	0.	0.	0.	4127.		1391.0
AVG SPD	1.3	3.7	7.3	14.3	20.7	0.0	0.0	0.0	0.0		5.7	

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TABLE 2.3.113

MONTHLY AND ANNUAL MEAN NUMBER OF DAYS WITH HEAVY FOG*
JACKSON, MISSISSIPPI AND BATON ROUGE, LOUISIANA

Length of Record - 12 and 23 Years

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Jackson	4	3	2	2	1	1	1	2	2	2	3	4	26
Baton Rouge	5	3	3	3	3	1	2	2	3	3	4	4	37

* Visibility one quarter mile or less

DATA SOURCE: Local Climatological Data, Annual Summary with Comparative Data for Jackson, Mississippi, Department of Commerce, NOAA, 1975.

Local Climatological Data, Annual Summary with Comparative Data for Baton Rouge, Louisiana, Department of Commerce, NOAA, 1974.

TABLE 2.3.114

MONTHLY AND ANNUAL PERCENTAGE FREQUENCY OF
OCCURRENCE OF VISIBILITY RESTRICTED WITH MODERATE FOG*

Greenwood AFB, Mississippi

Period of Record: May 1938-December 1941; February 1943-October 1945

J	F	M	A	M	J	J	A	S	O	N	D	Annual
1.1	0.9	0.4	0.6	0.1	0.2	0.3	0.7	0.3	0.5	0.6	2.7	0.7

Greenville AFB, Mississippi

Period of Record: February 1942-January 1946 and April 1953-June 1960

J	F	M	A	M	J	J	A	S	O	N	D	Annual
2.4	2.8	0.6	0.4	0.6	0.2	0.2	0.4	0.6	0.7	1.5	2.6	1.1

Jackson, Mississippi (Hawkins Field)

Period of Record: 1951-1960

J	F	M	A	M	J	J	A	S	O	N	D	Annual
0.6	0.5	0.1	0.2	+	0.2	0.1	0.3	0.3	0.4	0.5	0.6	0.3

* Visibility $\leq$ 1/2 mile
+ Indicates more than 0 but less than 0.05

DATA SOURCES: "Climatography of the United States No. 82-22, Summary of Hourly Observations for Jackson, Mississippi, 1951-1960," U. S. Department of Commerce, Weather Bureau, 1963.

"Uniform Summary of Weather Observations, Part A, Greenville AFB, Mississippi," Department of the Air Force, National Climatic Center, February 1942-June 1960, less April-July 1945 and February 1946-March 1953.

"Summary of Mean Percentages, Greenwood AFB, Mississippi," U. S. Department of Commerce, Weather Bureau, May 1938-December 1941.

"Summary of Monthly Percentages, Greenwood AFB, Mississippi," Air Weather Service, Data Control Unit, National Climatic Center, February 1943-October 1945.

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TABLE 2.3.115

OCCURRENCE OF FOG (INCLUDING SMOG) AT
JACKSON, MISSISSIPPI
1955 THROUGH 1964 (10 YEARS)

	Total Hours of Occurrence Per Month												
Year	J	F	M	A	M	J	J	A	S	O	N	D	Year
1955	101	69	16	30	5	6	26	23	24	11	28	72	411
1956	96	143	47	16	27	19	3	6	11	34	30	142	574
1957	178	88	54	19	8	24	25	8	103	68	146	24	745
1958	83	22	123	57	54	46	21	46	86	52	63	103	756
1959	42	101	7	90	10	58	33	55	80	128	43	69	716
1960	173	88	85	17	10	1	13	39	72	68	93	120	779
1961	122	91	30	18	5	103	30	18	43	75	106	152	793
1962	122	83	60	64	17	18	4	2	17	50	99	196	732
1963	180	32	21	41	16	18	46	69	37	25	72	76	633
1964	79	59	23	32	28	33	51	46	101	62	105	125	744
Total	1176	776	466	384	180	326	252	312	574	573	785	1079	6883

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TABLE 2.3.116

NUMBER AND DURATION OF DISCRETE OCCURRENCES
OF FOG (INCLUDING SMOG) AT
JACKSON, MISSISSIPPI
1955 THROUGH 1964

		Duration								
Month	1 Hr	2 to 3 Hrs	4 to 7 Hrs	8 to 11 Hrs	12 to 17 Hrs	18 to 23 Hrs	24 to 35 Hrs	> 35 Hrs	Max. Duration Hours	Total Occurrences
Jan	18	28	38	10	15	7	11	3	51	130
Feb	27	39	47	15	7	4	2	1	49	142
Mar	26	32	36	9	2	3			23	108
Apr	38	40	24	5	4		1		32	112
May	20	41	8	1	1				16	71
Jun	21	35	26	5	1	2			10	90
Jul	16	38	23	2	1				13	80
Aug	32	34	25	6	1				12	98
Sep	38	39	43	9	3			2	43	134
Oct	24	51	43	14	5				15	137
Nov	26	33	34	19	7	4	2	2	44	127
Dec	16	36	28	25	14	6	6	2	46	133
Total	302	446	375	120	61	26	22	10		1362

TABLE 2.3.117

MONTHLY SUMMARY OF OCCURRENCES OF FOG
(INCLUDING SMOG) AT JACKSON, MISSISSIPPI
1955 THROUGH 1964

	J	F	M	A	M	J	J	A	S	O	N	D
Total Hours:	1176	776	466	384	180	326	252	312	574	573	785	1079
No. of Discrete Events:	130	142	108	112	71	90	80	98	134	137	127	133
Avg. Hrs. Per Event:	9.0	5.5	4.3	3.4	2.5	3.6	3.2	3.2	4.3	4.2	6.2	8.1
Maximum Duration of Single Event:	51	49	23	32	16	10	13	12	43	15	44	46
% Freq. of Occurrence:	15.8	11.5	6.3	5.3	2.4	4.5	3.4	4.2	8.0	7.7	10.9	14.5

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TABLE 2.3.118

ANNUAL SUMMARY OF OCCURRENCES OF FOG
(INCLUDING SMOG) AT JACKSON, MISSISSIPPI
1955 THROUGH 1964

Year	Total Hours	No. of Discrete Events	Avg.Hrs Per Event	Max. Hrs. Duration	% Freq. of Occurrence
1955	411	88	4.7	28	4.7
1956	574	104	5.5	49	6.5
1957	745	153	4.9	50	8.5
1958	756	146	5.2	33	8.6
1959	716	147	4.9	36	8.2
1960	779	150	5.2	51	8.9
1961	793	149	5.3	34	9.1
1962	732	122	6.0	36	8.4
1963	633	134	4.7	27	7.2
1964	744	169	4.4	43	8.5
All	6883	1362	5.1	51	7.9

TABLE 2.3.119

OCCURRENCE OF HEAVY FOG OR HEAVY SMOG (VISIBILITY < 5/16 MILE) AT JACKSON, MISSISSIPPI 1955 THROUGH 1964

	Total Hours of Occurrence Per Month												
Year	J	F	M	A	M	J	J	A	S	O	N	D	Year
1955	14							2					16
1956		2			1				4		3	20	30
1957	18	6				3			7	13	2		49
1958			1	8	1	2		1	4	1	9	2	29
1959		5		2		3	4	2	3	5	1		25
1960	1	8	3							2	11	11	36
1961	7		1	1			2			6	4	10	31
1962	2	12	7	4		1			1	5	2	38	72
1963	4	1	2		1			3	1	1	13	1	27
1964	3	2	3		1		1	2	12	2	7	24	57
Total	49	36	17	15	4	9	7	10	32	35	52	106	372

TABLE 2.3.120

NUMBER AND DURATION OF OCCURRENCES OF HEAVY FOG OR HEAVY SMOG (VISIBILITY < 5/16 MILE) AT JACKSON, MISSISSIPPI 1955-1964

	Duration				Max.	
Month	1 Hr	2 to 3 Hrs	4 to 7 Hrs	8 to 11 Hrs	Duration Hours	Total Occurrences
Jan	6	10	4		7	20
Feb	6	2	3	1	8	12
Mar	4	5			3	9
Apr	1	4	1		6	6
May	4				1	4
Jun	1	3			3	4
Jul	2	2			3	4
Aug	4	3			2	7
Sep	9	4	3		6	16
Oct	8	7	1	1	8	17
Nov	13	7	1	2	8	23
Dec	8	9	9	3	10	29
Total	66	56	22	7		151

TABLE 2.3.121

MONTHLY SUMMARY OF OCCURRENCES OF
HEAVY FOG OR HEAVY SMOG (VISIBILITY < 5/16 MILE)
AT JACKSON, MISSISSIPPI
1955 - 1964

	J	F	M	A	M	J	J	A	S	O	N	D
Total Hours:	49	36	17	15	4	9	7	10	32	35	52	106
No. of Discrete Events:	20	12	9	6	4	4	4	7	16	17	23	29
Avg. Hrs. Per Event:	2.4	3.0	1.9	2.5	1.0	2.2	1.8	1.4	2.0	2.1	2.3	3.7
Maximum Duration of Single Event:	7	8	3	6	1	3	3	2	6	8	8	10
% Freq. of Occurrence:	0.7	0.5	0.2	0.2	0.1	0.1	0.1	0.1	0.4	0.5	0.7	1.4

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TABLE 2.3.122

ANNUAL SUMMARY OF OCCURRENCES OF HEAVY FOG
AND HEAVY SMOG (VISIBILITY < 5/16 MILE)
AT JACKSON, MISSISSIPPI
(1955 - 1964)

Year	Total Hours	No. of Discrete Events	Avg.Hrs. Per Event	Max. Hrs. Duration	% Freq. of Occurrence
1955	16	6	2.7	5	0.2
1956	30	11	2.7	7	0.3
1957	49	19	2.6	8	0.6
1958	29	13	2.2	8	0.3
1959	25	13	1.9	5	0.3
1960	36	11	3.3	10	0.4
1961	31	14	2.2	7	0.4
1962	72	23	3.1	9	0.8
1963	27	13	2.1	8	0.3
1964	57	28	2.0	7	0.6
All	372	151	2.5	10	0.4

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TABLE 2.3.123

OCCURRENCE OF SMOG AT JACKSON, MISSISSIPPI
1955 THROUGH 1964

	Total Hours of Occurrence Per Month												
Year	J	F	M	A	M	J	J	A	S	O	N	D	Year
1955	2	7	2			2	4		6	3	1	3	30
1956	16			1	1				1	4	2	2	27
1957			5	2		1	3	1	7	6	9		34
1958	8	3	3	10	4	1	6	12		7	3		57
1959	5	3	1	7		3	4		3	5	4	2	37
1960	12	15	4		2		2	3	25	20	7		90
1961	9	6		1	1	8		10	13	11	5	6	70
1962		13	2	2	10	3							30
1963		7	2	9	2	1	4	17	3	19	3		67
1964					2	9	10	4	5	2	21		53
Total	52	54	19	32	22	28	33	47	63	77	55	13	495

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TABLE 2.3.124

NUMBER AND DURATION OF DISCRETE OCCURRENCES
OF SMOG AT JACKSON, MISSISSIPPI
1955 THROUGH 1964

Month	Duration				Max. Duration Hours	Total Occurrences
	1 Hr	2 to 3 Hrs	4 to 7 Hrs	8 to 11 Hrs		
Jan	6	6	4	1	11	17
Feb	17	9	2	1	8	29
Mar	7	3	1		5	11
Apr	9	5	2		5	16
May	10	5			3	15
Jun	6	9			3	15
Jul	7	10	1		4	18
Aug	20	7	2		7	29
Sep	22	5	5		7	32
Oct	26	17	2		6	45
Nov	12	10	1	2	9	25
Dec	2	5			3	7
Total	144	91	20	4		259

GG
ER

TABLE 2.3.125

MONTHLY SUMMARY OF OCCURRENCES OF SMOG
AT JACKSON, MISSISSIPPI
1955 - 1964

	J	F	M	A	M	J	J	A	S	O	N	D
Total Hours:	52	54	19	32	22	28	33	47	63	77	55	13
No. of Discrete Events:	17	29	11	16	15	15	18	29	32	45	25	7
Avg. Hrs. Per Event:	3.1	1.9	1.7	2.0	1.5	1.9	1.8	1.6	2.0	1.7	2.2	1.9
Maximum Duration of Single Event:	11	8	5	5	3	3	4	7	7	6	9	3
% Freq. of Occurrence:	0.7	0.8	0.3	0.4	0.3	0.4	0.4	0.6	0.9	1.0	0.8	0.2

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TABLE 2.3.126

ANNUAL SUMMARY OF OCCURRENCES OF SMOG
AT JACKSON, MISSISSIPPI
1955 - 1964

Year	Total Hours	No. of Discrete Events	Avg.Hrs. Per Event	Max. Hrs. Duration	% Freq. of Occurrence
1955	30	17	1.8	4	0.3
1956	27	10	2.7	11	0.3
1957	34	21	1.6	5	0.4
1958	57	30	1.9	6	0.7
1959	37	23	1.6	3	0.4
1960	90	43	2.1	8	1.0
1961	70	44	1.6	7	0.8
1962	30	19	1.6	5	0.3
1963	67	28	2.4	7	0.8
1964	53	24	2.2	9	0.6
All	495	259	1.9	11	0.6

TABLE 2.3.127A

FREQUENCY DISTRIBUTION FOR PASQUILL STABILITY CLASS A 1972 TO 1976 STATION: GGNS MET SYSTEM

162/33 FT. DELTA T. 33 FT. WINDS

DIRECTION	WIND SPEED (MPH) 0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED (UP)	CALM DIST
N	8.	125.	63.	2.	0.	0.	0.	0.	0.	198.	6.6	0.0
NNE	6.	47.	19.	0.	0.	0.	0.	0.	0.	72.	6.3	0.0
NE	2.	22.	3.	0.	0.	0.	0.	0.	0.	27.	5.3	0.0
ENE	4.	15.	2.	0.	0.	0.	0.	0.	0.	21.	4.6	0.0
E	0.	25.	5.	0.	0.	0.	0.	0.	0.	30.	5.3	0.0
ESE	6.	34.	6.	0.	0.	0.	0.	0.	0.	46.	5.6	0.0
SE	13.	41.	12.	1.	0.	0.	0.	0.	0.	67.	5.7	0.0
SSE	6.	45.	44.	2.	0.	0.	0.	0.	0.	97.	7.1	0.0
S	23.	77.	60.	4.	0.	0.	0.	0.	0.	164.	6.9	0.0
SSW	24.	204.	96.	4.	0.	0.	0.	0.	0.	328.	6.3	0.0
SW	38.	340.	98.	3.	0.	0.	0.	0.	0.	499.	5.8	0.0
WSW	12.	278.	52.	0.	0.	0.	0.	0.	0.	402.	5.1	0.0
W	110.	234.	51.	0.	0.	0.	0.	0.	0.	401.	4.8	0.0
WNW	62.	241.	38.	3.	0.	0.	0.	0.	0.	344.	5.1	0.0
NW	41.	232.	83.	0.	0.	0.	0.	0.	0.	356.	5.8	0.0
NNW	18.	162.	68.	0.	0.	0.	0.	0.	0.	248.	6.2	0.0
TOTAL	465.	2122.	700.	19.	0.	0.	0.	0.	0.	3306.		0.0
AVG SPD	2.9	5.2	9.0	13.7	0.0	0.0	0.0	0.0	0.0		5.7	

GG
ER

TABLE 2.3.127B

FREQUENCY DISTRIBUTION FOR PASQUILL STABILITY CLASS B 1972 TO 1976 STATION: GGNS MET SYSTEM

162/33 FT. DELTA T, 33 FT. WINDS

DIRECTION	WIND SPEED (MPH) 0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED (UP)	CALM DIST
N	9.	55.	15.	1.	0.	0.	0.	0.	0.	80.	5.8	0.0
NNE	5.	43.	4.	0.	0.	0.	0.	0.	0.	53.	5.4	0.0
NE	2.	20.	1.	0.	0.	0.	0.	0.	0.	23.	5.2	0.0
ENE	2.	21.	1.	0.	0.	0.	0.	0.	0.	24.	5.3	0.0
E	0.	24.	5.	0.	0.	0.	0.	0.	0.	29.	5.7	0.0
ESE	4.	25.	4.	0.	0.	0.	0.	0.	0.	33.	5.5	0.0
SE	12.	26.	18.	1.	0.	0.	0.	0.	0.	57.	6.3	0.0
SSE	2.	30.	24.	8.	0.	0.	0.	0.	0.	64.	8.1	0.0
S	5.	32.	26.	4.	0.	0.	0.	0.	0.	67.	7.4	0.0
SSW	19.	31.	22.	6.	0.	0.	0.	0.	0.	78.	6.5	0.0
SW	18.	51.	17.	1.	0.	0.	0.	0.	0.	87.	5.4	0.0
WSW	18.	34.	1.	0.	0.	0.	0.	0.	0.	53.	4.1	0.0
W	20.	22.	2.	0.	0.	0.	0.	0.	0.	44.	4.0	0.0
WNW	34.	37.	10.	1.	0.	0.	0.	0.	0.	82.	4.6	0.0
NW	29.	55.	15.	0.	0.	0.	0.	0.	0.	99.	5.1	0.0
NNW	14.	68.	13.	0.	0.	0.	0.	0.	0.	95.	5.4	0.0
TOTAL	194.	574.	178.	22.	0.	0.	0.	0.	0.	968.		0.0
AVG SPD	2.8	5.2	9.1	13.8	0.0	0.0	0.0	0.0	0.0		5.6	

GG
ER

TABLE 2.3.127C

FREQUENCY DISTRIBUTION FOR PASQUILL STABILITY CLASS C 1972 TO 1976 STATION: GGNS MET SYSTEM

162/33 FT. DELTA T. 33 FT. WINDS

DIRECTION	WIND SPEED (MPH) 0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED (UP)	CALM DIST
N	43.	132.	43.	2.	0.	0.	0.	0.	0.	220.	5.6	0.0
NNE	23.	97.	15.	0.	0.	0.	0.	0.	0.	135.	5.1	0.0
NE	10.	85.	5.	0.	0.	0.	0.	0.	0.	106.	4.8	0.0
ENE	11.	45.	0.	0.	0.	0.	0.	0.	0.	56.	4.6	0.0
E	6.	63.	5.	0.	0.	0.	0.	0.	0.	74.	5.1	0.0
ESE	15.	60.	17.	0.	0.	0.	0.	0.	0.	92.	5.3	0.0
SE	23.	75.	19.	1.	0.	0.	0.	0.	0.	118.	5.4	0.0
SSE	21.	84.	45.	7.	0.	0.	0.	0.	0.	157.	6.4	0.0
S	20.	101.	60.	12.	0.	0.	0.	0.	0.	193.	6.8	0.0
SSW	27.	71.	47.	11.	0.	0.	0.	0.	0.	156.	6.8	0.0
SW	32.	55.	21.	2.	0.	0.	0.	0.	0.	130.	4.9	1.0
WSW	43.	32.	5.	0.	0.	0.	0.	0.	0.	80.	3.9	0.0
W	39.	46.	6.	0.	0.	0.	0.	0.	0.	91.	4.1	0.0
WNW	43.	34.	23.	1.	0.	0.	0.	0.	0.	101.	5.1	0.0
NW	53.	94.	30.	1.	0.	0.	0.	0.	0.	178.	5.2	0.0
NNW	40.	118.	40.	0.	0.	0.	0.	0.	0.	198.	5.6	0.0
TOTAL	473.	1192.	381.	37.	0.	0.	0.	0.	0.	2085.		1.0
AVG SPD	2.7	5.1	9.2	13.9	0.0	0.0	0.0	0.0	0.0		5.5	

GG
ER

TABLE 2.3.127D

FREQUENCY DISTRIBUTION FOR PASQUILL STABILITY CLASS D 1972 TO 1976 STATION: GGNS MET SYSTEM

162/33 FT. DELTA T. 33 FT. WINDS

	WIND SPEED (MPH)											
DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED (UP)	CALM DIST
N	176.	501.	102.	0.	0.	0.	0.	0.	0.	779.	5.1	1.0
NNE	166.	310.	29.	0.	0.	0.	0.	0.	0.	505.	4.4	1.0
NE	123.	208.	13.	0.	0.	0.	0.	0.	0.	344.	4.1	2.0
ENE	139.	191.	7.	0.	0.	0.	0.	0.	0.	337.	4.1	0.0
E	120.	235.	30.	0.	0.	0.	0.	0.	0.	385.	4.5	0.0
ESE	130.	268.	96.	1.	0.	0.	0.	0.	0.	495.	5.2	0.0
SE	161.	279.	157.	10.	0.	0.	0.	0.	0.	607.	5.7	0.0
SSE	117.	295.	253.	36.	0.	0.	0.	0.	0.	701.	6.9	0.0
S	140.	303.	348.	18.	0.	0.	0.	0.	0.	809.	6.9	0.0
SSW	114.	167.	120.	17.	0.	0.	0.	0.	0.	418.	6.1	0.0
SW	89.	133.	46.	5.	0.	0.	0.	0.	0.	273.	5.1	1.0
WSW	61.	84.	34.	0.	0.	0.	0.	0.	0.	179.	4.9	0.0
W	81.	113.	39.	0.	0.	0.	0.	0.	0.	233.	4.9	0.0
WNW	72.	128.	38.	0.	0.	0.	0.	0.	0.	238.	5.0	0.0
NW	102.	189.	126.	1.	0.	0.	0.	0.	0.	418.	5.9	0.0
NNW	127.	381.	168.	9.	0.	0.	0.	0.	0.	85.	5.9	2.0
TOTAL	1913.	3785.	1666.	97.	0.	0.	0.	0.	0.	36.		7.0
AVG SPD	2.5	5.3	9.2	13.7	0.0	0.0	0.0	0.0	0.0		5.5	

GG
ER

TABLE 2.3.127E

FREQUENCY DISTRIBUTION FOR PASQUILL STABILITY CLASS E 1972 TO 1974 STATION: GGNS MET SYSTEM

162/33 FT. DELTA T. 33 FT. WINDS

DIRECTION	WIND SPEED (MPH) 0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED (UP)	CALM DIST
N	225.	146.	5.	0.	0.	0.	0.	0.	0.	376.	3.3	1.0
NNE	257.	113.	2.	0.	0.	0.	0.	0.	0.	372.	2.9	0.0
NE	258.	84.	0.	0.	0.	0.	0.	0.	0.	342.	2.6	0.0
ENE	270.	115.	3.	0.	0.	0.	0.	0.	0.	388.	3.0	0.0
E	336.	180.	8.	1.	0.	0.	0.	0.	0.	525.	3.2	0.0
ESE	317.	217.	25.	1.	0.	0.	0.	0.	0.	560.	3.6	0.0
SE	321.	270.	35.	1.	0.	0.	0.	0.	0.	627.	3.9	0.0
SSE	250.	350.	87.	7.	3.	0.	0.	0.	0.	703.	4.7	0.0
S	252.	300.	97.	1.	0.	0.	0.	0.	0.	650.	4.7	0.0
SSW	174.	127.	29.	1.	1.	0.	0.	0.	0.	332.	4.1	0.0
SW	87.	65.	27.	0.	0.	0.	0.	0.	0.	179.	4.4	1.0
WSW	55.	68.	23.	2.	1.	0.	0.	0.	0.	149.	4.9	0.0
W	59.	52.	18.	3.	0.	0.	0.	0.	0.	132.	4.6	0.0
WNW	50.	27.	3.	0.	0.	0.	0.	0.	0.	80.	3.5	0.0
NW	88.	54.	7.	0.	0.	0.	0.	0.	0.	149.	3.6	0.0
NNW	119.	82.	18.	0.	0.	0.	0.	0.	0.	219.	3.8	0.0
TOTAL	3124.	2250.	387.	17.	5.	0.	0.	0.	0.	5783.		2.0
AVG SPD	2.3	5.0	8.9	14.7	20.3	0.0	0.0	0.0	0.0		3.8	

GG
ER

TABLE 2.3.127F

FREQUENCY DISTRIBUTION FOR PASQUILL STABILITY CLASS F 1972 TO 1976 STATION: GGNS MET SYSTEM

162/33 FT. DELTA T, 33 FT. WINDS

	WIND SPEED (MPH)											
DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED (UP)	CALM DIST
N	143.	9.	0.	0.	0.	0.	0.	0.	0.	152.	2.0	0.0
NNE	225.	13.	0.	0.	0.	0.	0.	0.	0.	238.	2.1	0.0
NE	261.	30.	0.	0.	0.	0.	0.	0.	0.	291.	2.1	0.0
ENE	304.	42.	0.	0.	0.	0.	0.	0.	0.	346.	2.2	0.0
E	373.	69.	1.	0.	0.	0.	0.	0.	0.	443.	2.3	0.0
ESE	320.	40.	1.	0.	0.	0.	0.	0.	0.	361.	2.2	0.0
SE	226.	51.	0.	0.	0.	0.	0.	0.	0.	277.	2.4	0.0
SSE	143.	51.	2.	0.	0.	0.	0.	0.	0.	196.	2.8	0.0
S	81.	16.	0.	0.	0.	0.	0.	0.	0.	97.	2.3	0.0
SSW	46.	9.	1.	0.	0.	0.	0.	0.	0.	56.	2.2	1.0
SW	29.	9.	0.	0.	0.	0.	0.	0.	0.	38.	2.5	0.0
WSW	12.	10.	0.	0.	0.	0.	0.	0.	0.	22.	3.4	0.0
W	26.	5.	0.	0.	0.	0.	0.	0.	0.	31.	1.9	0.0
WNW	15.	1.	0.	0.	0.	0.	0.	0.	0.	16.	1.8	0.0
NW	34.	2.	0.	0.	0.	0.	0.	0.	0.	36.	1.5	0.0
NNW	55.	1.	0.	0.	0.	0.	0.	0.	0.	56.	1.8	0.0
TOTAL	2293.	338.	5.	0.	0.	0.	0.	0.	0.	2656.		1.0
AVG SPD	1.9	4.3	9.0	0.0	0.0	0.0	0.0	0.0	0.0		2.3	

GG
ER

TABLE 2.3.127G

FREQUENCY DISTRIBUTION FOR PASQUILL STABILITY CLASS G 1972 TO 1976 STATION: GGNS MET SYSTEM

162/33 FT. DELTA T, 33 FT. WINDS

DIRECTION	WIND SPEED (MPH) 0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED (UP)	CALM DIST
N	58.	3.	0.	0.	0.	0.	0.	0.	0.	61.	2.0	0.0
NNE	103.	3.	0.	0.	0.	0.	0.	0.	0.	106.	1.9	0.0
NE	394.	9.	0.	0.	0.	0.	0.	0.	0.	403.	1.8	0.0
ENE	1033.	40.	0.	0.	0.	0.	0.	0.	0.	1073.	1.8	1.0
E	1026.	127.	0.	0.	0.	0.	0.	0.	0.	1153.	2.0	0.0
ESE	508.	88.	0.	0.	0.	0.	0.	0.	0.	596.	2.2	0.
SE	159.	17.	0.	0.	0.	0.	0.	0.	0.	176.	2.1	0.0
SSE	45.	8.	0.	0.	0.	0.	0.	0.	0.	53.	2.2	0.0
S	13.	4.	0.	0.	0.	0.	0.	0.	0.	17.	1.9	1.0
SSW	5.	0.	0.	0.	0.	0.	0.	0.	0.	5.	1.2	0.0
SW	7.	1.	0.	0.	0.	0.	0.	0.	0.	8.	1.6	2.0
WSW	8.	0.	0.	0.	0.	0.	0.	0.	0.	8.	1.2	1.0
W	4.	2.	0.	0.	0.	0.	0.	0.	0.	6.	3.0	0.0
WNW	5.	0.	0.	0.	0.	0.	0.	0.	0.	5.	1.2	0.0
NW	4.	0.	0.	0.	0.	0.	0.	0.	0.	4.	1.3	0.0
NNW	9.	0.	0.	0.	0.	0.	0.	0.	0.	9.	1.4	0.0
TOTAL	3381.	302.	0.	0.	0.	0.	0.	0.	0.	3683.		5.0
AVG SPD	1.7	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0		1.9	

GG
ER

TABLE 2.3.127H

FREQUENCY DISTRIBUTION 1972 TO 1976 STATION: GGNS MET SYSTEM

162/33 FT. DELTA T. 33 FT. WINDS

DIRECTION	WIND SPEED (MPH) 0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	662.	971.	228.	5.	0.	0.	0.	0.	0.	1866.	4.6	2.0
NNE	786.	626.	69.	0.	0.	0.	0.	0.	0.	1481.	3.7	1.0
NE	1050.	458.	22.	0.	0.	0.	0.	0.	0.	1530.	2.9	2.0
ENE	1703.	469.	13.	0.	0.	0.	0.	0.	0.	2245.	2.5	1.0
E	1867.	723.	54.	1.	0.	0.	0.	0.	0.	2645.	2.8	0.0
ESE	1300.	732.	149.	2.	0.	0.	0.	0.	0.	2183.	3.5	0.0
SE	915.	759.	241.	14.	0.	0.	0.	0.	0.	1929.	4.3	0.0
SSE	590.	863.	455.	60.	3.	0.	0.	0.	0.	1971.	5.6	0.0
S	534.	833.	591.	39.	0.	0.	0.	0.	0.	1997.	5.9	1.0
SSW	409.	609.	315.	39.	1.	0.	0.	0.	0.	1373.	5.6	1.0
SW	340.	654.	209.	11.	0.	0.	0.	0.	0.	1214.	5.2	5.0
WSW	209.	506.	115.	2.	1.	0.	0.	0.	0.	893.	4.8	1.0
W	345.	474.	116.	3.	0.	0.	0.	0.	0.	938.	4.6	0.0
WNW	281.	468.	112.	5.	0.	0.	0.	0.	0.	866.	4.8	0.0
NW	351.	626.	261.	2.	0.	0.	0.	0.	0.	1240.	5.3	0.0
NNW	382.	812.	307.	9.	0.	0.	0.	0.	0.	1510.	5.4	2.0
TOTAL	11850.	10583.	3257.	192.	5.	0.	0.	0.	0.	25887.		16.0
AVG SPD	2.1	3.1	4.1	13.8	20.3	0.0	0.0	0.0	0.0		4.3	

GG
ER

TABLE 2.3.128A

JOINT FREQUENCY DISTRIBUTION OF WIND DIRECTION AND
WIND SPEEDS FOR PASQUILL STABILITY CLASS A
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 5 Years (1960-1964)
Annual - 8 Observations Per Day

	SPEED(KTS)						
DIRECTION	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	TOTAL
N	0.000525	0.000411	0.000000	0.000000	0.000000	0.000000	0.000936
NNE	0.000763	0.000342	0.000000	0.000000	0.000000	0.000000	0.001106
NE	0.000593	0.000342	0.000000	0.000000	0.000000	0.000000	0.000936
ENE	0.000489	0.000616	0.000000	0.000000	0.000000	0.000000	0.001106
E	0.000508	0.000342	0.000000	0.000000	0.000000	0.000000	0.000850
ESE	0.000220	0.000205	0.000000	0.000000	0.000000	0.000000	0.000425
SE	0.000610	0.000411	0.000000	0.000000	0.000000	0.000000	0.001021
SSE	0.000321	0.000274	0.000000	0.000000	0.000000	0.000000	0.000595
S	0.000423	0.000342	0.000000	0.000000	0.000000	0.000000	0.000765
SSW	0.000354	0.000411	0.000000	0.000000	0.000000	0.000000	0.000765
SW	0.000234	0.000616	0.000000	0.000000	0.000000	0.000000	0.000850
WSW	0.000267	0.000753	0.000000	0.000000	0.000000	0.000000	0.001021
W	0.000099	0.000411	0.000000	0.000000	0.000000	0.000000	0.000510
WNW	0.000166	0.000342	0.000000	0.000000	0.000000	0.000000	0.000510
NW	0.000050	0.000205	0.000000	0.000000	0.000000	0.000000	0.000255
NNW	0.000541	0.000479	0.000000	0.000000	0.000000	0.000000	0.001021
TOTAL	0.006165	0.006507	0.000000	0.000000	0.000000	0.000000	

RELATIVE FREQUENCY OF OCCURRENCE OF A STABILITY = 0.012672

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH A STABILITY = 0.002456

GG
ER

TABLE 2.3.128B

JOINT FREQUENCY DISTRIBUTION OF WIND DIRECTION AND
WIND SPEEDS FOR PASQUILL STABILITY CLASS B
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 5 Years (1960-1964)
Annual - 8 Observations Per Day

	SPEED(KTS)						
DIRECTION	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	TOTAL
N	0.001912	0.001986	0.001438	0.000000	0.000000	0.000000	0.005337
NNE	0.001896	0.003562	0.001233	0.000000	0.000000	0.000000	0.006691
NE	0.002354	0.002466	0.001096	0.000000	0.000000	0.000000	0.005916
ENE	0.001650	0.002603	0.000822	0.000000	0.000000	0.000000	0.005075
E	0.001851	0.002260	0.001301	0.000000	0.000000	0.000000	0.005413
ESE	0.002829	0.001849	0.001233	0.000000	0.000000	0.000000	0.005911
SE	0.003202	0.002397	0.001438	0.000000	0.000000	0.000000	0.007038
SSE	0.002002	0.002534	0.001233	0.000000	0.000000	0.000000	0.005769
S	0.001841	0.001986	0.001027	0.000000	0.000000	0.000000	0.004855
SSW	0.001867	0.002740	0.001712	0.000000	0.000000	0.000000	0.006320
SW	0.003023	0.003356	0.002260	0.000000	0.000000	0.000000	0.008640
WSW	0.001787	0.002466	0.001849	0.000000	0.000000	0.000000	0.006102
W	0.001877	0.003014	0.002055	0.000000	0.000000	0.000000	0.006946
WNW	0.001041	0.003425	0.001712	0.000000	0.000000	0.000000	0.006178
NW	0.001603	0.003288	0.001438	0.000000	0.000000	0.000000	0.006329
NNW	0.001938	0.002740	0.001712	0.000000	0.000000	0.000000	0.006391
TOTAL	0.032673	0.042674	0.023563	0.000000	0.000000	0.000000	

RELATIVE FREQUENCY OF OCCURRENCE OF B STABILITY = 0.098911

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH B STABILITY = 0.002534

GG
ER

TABLE 2.3.128C

JOINT FREQUENCY DISTRIBUTION OF WIND DIRECTION AND
WIND SPEEDS FOR PASQUILL STABILITY CLASS C
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 5 Years (1960-1964)
Annual - 8 Observations Per Day

	SPEED(KTS)						
DIRECTION	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	TOTAL
N	0.000930	0.001438	0.004041	0.000548	0.000000	0.000000	0.006958
NNE	0.000764	0.001986	0.005411	0.000753	0.000000	0.000000	0.008915
NE	0.000962	0.001712	0.002466	0.000205	0.000000	0.000000	0.005345
ENE	0.000588	0.001781	0.002808	0.000068	0.000000	0.000000	0.005245
E	0.001473	0.001507	0.002877	0.000205	0.000000	0.000000	0.006062
ESE	0.001344	0.001712	0.003219	0.000137	0.000000	0.000000	0.006412
SE	0.001368	0.002329	0.003836	0.000205	0.000000	0.000000	0.007738
SSE	0.000964	0.002397	0.004384	0.000479	0.000000	0.000000	0.008225
S	0.001122	0.001781	0.005343	0.001301	0.000000	0.000000	0.009548
SSW	0.001773	0.002123	0.006165	0.000959	0.000068	0.000000	0.011089
SW	0.001626	0.001507	0.004589	0.000822	0.000068	0.000000	0.008612
WSW	0.001099	0.001575	0.004041	0.000616	0.000000	0.000000	0.007332
W	0.001265	0.001027	0.004178	0.000274	0.000000	0.000000	0.006744
WNW	0.000962	0.001712	0.003630	0.000411	0.000000	0.000000	0.006715
NW	0.000869	0.001575	0.003562	0.000616	0.000000	0.000000	0.006623
NNW	0.000640	0.001575	0.004726	0.000890	0.000000	0.000000	0.007832
TOTAL	0.017946	0.027742	0.065278	0.008494	0.000137	0.000000	

RELATIVE FREQUENCY OF OCCURRENCE OF C STABILITY = 0.119597

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH C STABILITY = 0.004726

GG
ER

TABLE 2.3.128D

JOINT FREQUENCY DISTRIBUTION OF WIND DIRECTION AND
WIND SPEEDS FOR PASQUILL STABILITY CLASS D
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 5 Years (1960-1964)
Annual - 8 Observations Per Day

	SPEED(KTS)						
DIRECTION	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	TOTAL
N	0.001888	0.004589	0.011782	0.013357	0.002260	0.000000	0.033877
NNE	0.002805	0.006439	0.009453	0.005411	0.000205	0.000137	0.024450
NE	0.002137	0.005069	0.006370	0.001849	0.000000	0.000000	0.015425
ENE	0.002835	0.004589	0.005822	0.000822	0.000000	0.000000	0.014068
E	0.002424	0.006165	0.006644	0.001436	0.000000	0.000068	0.016740
ESE	0.002287	0.003973	0.007261	0.002603	0.000068	0.000000	0.016192
SE	0.003854	0.005754	0.013494	0.006507	0.000822	0.000068	0.030499
SSE	0.002385	0.006713	0.014042	0.011782	0.001027	0.000137	0.036086
S	0.002822	0.005548	0.016097	0.013426	0.001027	0.000479	0.039400
SSW	0.001636	0.005206	0.011097	0.008631	0.000822	0.000068	0.027460
SW	0.001088	0.004584	0.005069	0.004178	0.000205	0.000000	0.015130
WSW	0.001302	0.002192	0.003904	0.002945	0.000205	0.000000	0.010549
W	0.001589	0.003286	0.004384	0.003562	0.000342	0.000000	0.013165
WNW	0.001199	0.002877	0.004795	0.005617	0.000411	0.000000	0.014899
NW	0.001923	0.003973	0.007672	0.008151	0.001761	0.000000	0.023499
NNW	0.001255	0.003767	0.010823	0.015412	0.001438	0.000137	0.032832
TOTAL	0.033427	0.074731	0.138708	0.105692	0.010617	0.001096	

RELATIVE FREQUENCY OF OCCURRENCE OF D STABILITY = 0.364272

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH D STABILITY = 0.006370

CG
ER

TABLE 2.3.128E

JOINT FREQUENCY DISTRIBUTION OF WIND DIRECTION AND WIND SPEEDS FOR PASQUILL STABILITY CLASS E
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 5 years (1960-1964)
Annual - 8 Observations Per Day

	SPEED(KTS)						
DIRECTION	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	TOTAL
N	0.000000	0.003014	0.005343	0.000000	0.000000	0.000000	0.008357
NNE	0.000000	0.003151	0.002808	0.000000	0.000000	0.000000	0.005959
NE	0.000000	0.003767	0.000411	0.000000	0.000000	0.000000	0.004178
ENE	0.000000	0.003836	0.000822	0.000000	0.000000	0.000000	0.004658
E	0.000000	0.004110	0.001712	0.000000	0.000000	0.000000	0.005822
ESE	0.000000	0.003356	0.001370	0.000000	0.000000	0.000000	0.004726
SE	0.000000	0.006370	0.003904	0.000000	0.000000	0.000000	0.010275
SSE	0.000000	0.007877	0.006096	0.000000	0.000000	0.000000	0.013974
S	0.000000	0.006644	0.006918	0.000000	0.000000	0.000000	0.013563
SSW	0.000000	0.003288	0.003082	0.000000	0.000000	0.000000	0.006370
SW	0.000000	0.002534	0.002260	0.000000	0.000000	0.000000	0.004795
WSW	0.000000	0.001438	0.001233	0.000000	0.000000	0.000000	0.002671
W	0.000000	0.001233	0.001233	0.000000	0.000000	0.000000	0.002466
WNW	0.000000	0.000753	0.001438	0.000000	0.000000	0.000000	0.002192
NW	0.000000	0.001438	0.002123	0.000000	0.000000	0.000000	0.003562
NNW	0.000000	0.002534	0.003767	0.000000	0.000000	0.000000	0.006302
TOTAL	0.000000	0.055346	0.044524	0.000000	0.000000	0.000000	

RELATIVE FREQUENCY OF OCCURRENCE OF E STABILITY = 0.099870

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH E STABILITY = 0.000000

GG
ER

TABLE 2.3.128F

JOINT FREQUENCY DISTRIBUTION OF WIND DIRECTION AND WIND SPEEDS FOR PASQUILL STABILITY CLASS F
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 5 Years (1960-1964)
Annual - 8 Observations Per Day

	SPEED(KTS)						
DIRECTION	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	TOTAL
N	0.002694	0.005274	0.000000	0.000000	0.000000	0.000000	0.007968
NNE	0.003425	0.006028	0.000000	0.000000	0.000000	0.000000	0.009452
NE	0.004755	0.004932	0.000000	0.000000	0.000000	0.000000	0.009687
ENE	0.003476	0.004726	0.000000	0.000000	0.000000	0.000000	0.008202
E	0.004929	0.005617	0.000000	0.000000	0.000000	0.000000	0.010546
ESE	0.003369	0.004521	0.000000	0.000000	0.000000	0.000000	0.007890
SE	0.007910	0.009042	0.000000	0.000000	0.000000	0.000000	0.016952
SSE	0.006539	0.010960	0.000000	0.000000	0.000000	0.000000	0.017499
S	0.006017	0.008357	0.000000	0.000000	0.000000	0.000000	0.014374
SSW	0.003336	0.006507	0.000000	0.000000	0.000000	0.000000	0.009843
SW	0.003046	0.005000	0.000000	0.000000	0.000000	0.000000	0.008046
WSW	0.001576	0.002877	0.000000	0.000000	0.000000	0.000000	0.004453
W	0.001529	0.001986	0.000000	0.000000	0.000000	0.000000	0.003515
WNW	0.001832	0.001918	0.000000	0.000000	0.000000	0.000000	0.003750
NW	0.004102	0.004178	0.000000	0.000000	0.000000	0.000000	0.008281
NNW	0.002498	0.005548	0.000000	0.000000	0.000000	0.000000	0.008046
TOTAL	0.061032	0.087471	0.000000	0.000000	0.000000	0.000000	

RELATIVE FREQUENCY OF OCCURRENCE OF F STABILITY = 0.148503

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH F STABILITY = 0.018289

GG
ER

TABLE 2.3.128G

JOINT FREQUENCY DISTRIBUTION OF WIND DIRECTION AND WIND SPEEDS FOR PASQUILL STABILITY CLASS G
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 5 Years (1960-1964)
Annual - 8 Observations Per Day

	SPEED(KTS)						
DIRECTION	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	TOTAL
N	0.010577	0.000000	0.000000	0.000000	0.000000	0.000000	0.010577
NNE	0.007835	0.000000	0.000000	0.000000	0.000000	0.000000	0.007835
NE	0.011361	0.000000	0.000000	0.000000	0.000000	0.000000	0.011361
ENE	0.007182	0.000000	0.000000	0.000000	0.000000	0.000000	0.007182
E	0.012013	0.000000	0.000000	0.000000	0.000000	0.000000	0.012013
ESE	0.008618	0.000000	0.000000	0.000000	0.000000	0.000000	0.008618
SE	0.018020	0.000000	0.000000	0.000000	0.000000	0.000000	0.018020
SSE	0.012536	0.000000	0.000000	0.000000	0.000000	0.000000	0.012536
S	0.013711	0.000000	0.000000	0.000000	0.000000	0.000000	0.013711
SSW	0.007051	0.000000	0.000000	0.000000	0.000000	0.000000	0.007051
SW	0.006529	0.000000	0.000000	0.000000	0.000000	0.000000	0.006529
WSW	0.003917	0.000000	0.000000	0.000000	0.000000	0.000000	0.003917
W	0.004440	0.000000	0.000000	0.000000	0.000000	0.000000	0.004440
WNW	0.007965	0.000000	0.000000	0.000000	0.000000	0.000000	0.007965
NW	0.013450	0.000000	0.000000	0.000000	0.000000	0.000000	0.013450
NNW	0.010969	0.000000	0.000000	0.000000	0.000000	0.000000	0.010969
TOTAL	0.156175	0.000000	0.000000	0.000000	0.000000	0.000000	

RELATIVE FREQUENCY OF OCCURRENCE OF G STABILITY = 0.156175

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH G STABILITY = 0.074252

GG
ER

TABLE 2.3.129A

JOINT FREQUENCY DISTRIBUTION OF WIND DIRECTION AND WIND SPEEDS FOR PASQUILL STABILITY CLASS A
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 5 Years (1965-1969)
Annual - 8 Observations Per Day

DIRECTION	SPEED(KTS) 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	TOTAL
N	0.000130	0.000479	0.000000	0.000000	0.000000	0.000000	0.000610
NNE	0.000100	0.000890	0.000000	0.000000	0.000000	0.000000	0.000990
NE	0.000084	0.000068	0.000000	0.000000	0.000000	0.000000	0.000152
ENE	0.000115	0.000342	0.000000	0.000000	0.000000	0.000000	0.000457
E	0.000168	0.000137	0.000000	0.000000	0.000000	0.000000	0.000305
ESE	0.000115	0.000342	0.000000	0.000000	0.000000	0.000000	0.000457
SE	0.000008	0.000068	0.000000	0.000000	0.000000	0.000000	0.000076
SSE	0.000084	0.000068	0.000000	0.000000	0.000000	0.000000	0.000152
S	0.000023	0.000205	0.000000	0.000000	0.000000	0.000000	0.000229
SSW	0.000062	0.000548	0.000000	0.000000	0.000000	0.000000	0.000610
SW	0.000046	0.000411	0.000000	0.000000	0.000000	0.000000	0.000457
WSW	0.000015	0.000137	0.000000	0.000000	0.000000	0.000000	0.000152
W	0.000085	0.000753	0.000000	0.000000	0.000000	0.000000	0.000838
WNW	0.000046	0.000411	0.000000	0.000000	0.000000	0.000000	0.000457
NW	0.000015	0.000137	0.000000	0.000000	0.000000	0.000000	0.000152
NNW	0.000138	0.000548	0.000000	0.000000	0.000000	0.000000	0.000686
TOTAL	0.001233	0.005548	0.000000	0.000000	0.000000	0.000000	

RELATIVE FREQUENCY OF OCCURRENCE OF A STABILITY = 0.006781

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH A STABILITY = 0.000685

TABLE 2.3.129B

JOINT FREQUENCY DISTRIBUTION OF WIND DIRECTION AND WIND SPEEDS FOR PASQUILL STABILITY CLASS B
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 5 Years (1965-1969)
Annual - 8 Observations Per Day

DIRECTION	SPEED(KTS) 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	TOTAL
N	0.000804	0.003082	0.001918	0.000000	0.000000	0.000000	0.005804
NNE	0.000650	0.002671	0.001781	0.000000	0.000000	0.000000	0.005102
NE	0.000568	0.002329	0.001301	0.000000	0.000000	0.000000	0.004198
ENE	0.000429	0.002397	0.001233	0.000000	0.000000	0.000000	0.004059
E	0.000749	0.003562	0.001301	0.000000	0.000000	0.000000	0.005612
ESE	0.000279	0.002123	0.001096	0.000000	0.000000	0.000000	0.003498
SE	0.000622	0.001781	0.000753	0.000000	0.000000	0.000000	0.003156
SSE	0.000465	0.001301	0.000548	0.000000	0.000000	0.000000	0.002314
S	0.000924	0.002397	0.001575	0.000000	0.000000	0.000000	0.004896
SSW	0.000948	0.003151	0.001164	0.000000	0.000000	0.000000	0.005263
SW	0.000935	0.002740	0.001096	0.000000	0.000000	0.000000	0.004770
WSW	0.000335	0.001644	0.000685	0.000000	0.000000	0.000000	0.002663
W	0.000571	0.002397	0.001507	0.000000	0.000000	0.000000	0.004475
WNW	0.000879	0.003219	0.001712	0.000000	0.000000	0.000000	0.005811
NW	0.000909	0.001918	0.000685	0.000000	0.000000	0.000000	0.003511
NNW	0.000346	0.001986	0.001096	0.000000	0.000000	0.000000	0.003428
TOTAL	0.010411	0.038699	0.019452	0.000000	0.000000	0.000000	

RELATIVE FREQUENCY OF OCCURRENCE OF B STABILITY = 0.068562

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH B STABILITY = 0.001507

CC
ER

TABLE 2.3.129C

JOINT FREQUENCY DISTRIBUTION OF WIND DIRECTION AND WIND SPEEDS FOR PASQUILL STABILITY CLASS C
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 5 Years (1965-1969)
Annual - 8 Observations Per Day

DIRECTION	SPEED(KTS) 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	TOTAL
N	0.000512	0.001781	0.010205	0.001986	0.000000	0.000000	0.014485
NNE	0.000541	0.001370	0.005890	0.000753	0.000000	0.000000	0.008555
NE	0.000673	0.001849	0.004658	0.000274	0.000000	0.000000	0.007454
ENE	0.000649	0.001644	0.002671	0.000137	0.000000	0.000000	0.005101
E	0.000520	0.001849	0.004315	0.000137	0.000000	0.000000	0.006821
ESE	0.000581	0.001712	0.003767	0.000137	0.000000	0.000000	0.006197
SE	0.001313	0.001438	0.006027	0.000685	0.000000	0.000000	0.009464
SSE	0.000601	0.001233	0.004452	0.001233	0.000068	0.000000	0.007588
S	0.000467	0.002055	0.006575	0.001027	0.000137	0.000000	0.010262
SSW	0.001090	0.002808	0.006575	0.001096	0.000000	0.000000	0.011569
SW	0.000346	0.002329	0.003082	0.000205	0.000000	0.000000	0.005963
WSW	0.000340	0.000959	0.002329	0.000205	0.000000	0.000000	0.003834
W	0.000402	0.002808	0.003493	0.000137	0.000000	0.000000	0.006840
WNW	0.000617	0.001370	0.004315	0.000479	0.000000	0.000000	0.006782
NW	0.000617	0.001370	0.003219	0.000548	0.000000	0.000000	0.005754
NNW	0.000456	0.001301	0.004384	0.000616	0.000000	0.000000	0.006758
TOTAL	0.009726	0.027877	0.075959	0.009658	0.000205	0.000000	

RELATIVE FREQUENCY OF OCCURRENCE OF C STABILITY = 0.123425

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH C STABILITY = 0.003904

EE GG

TABLE 2.3.129D

JOINT FREQUENCY DISTRIBUTION OF WIND DIRECTION AND WIND SPEEDS FOR PASQUILL STABILITY CLASS D
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 5 Years (1965-1969)
Annual - 8 Observations Per Day

	SPEED(KTS)						
DIRECTION	0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	TOTAL
N	0.001457	0.006164	0.018836	0.018014	0.001507	0.000068	0.046046
NNE	0.001214	0.004795	0.013904	0.009452	0.000479	0.000000	0.029844
NE	0.001774	0.006507	0.008562	0.002397	0.000000	0.000068	0.019308
ENE	0.001659	0.004863	0.005068	0.001096	0.000056	0.000000	0.012755
E	0.002255	0.008151	0.011644	0.002808	0.000137	0.000068	0.025063
ESE	0.001527	0.005068	0.010000	0.002534	0.000068	0.000068	0.019266
SE	0.001964	0.006849	0.021370	0.014384	0.001370	0.000479	0.046396
SSE	0.001028	0.005274	0.020000	0.017397	0.001164	0.000000	0.044864
S	0.001025	0.004178	0.019658	0.022123	0.001986	0.000274	0.049244
SSW	0.001973	0.007260	0.015068	0.013836	0.000822	0.000000	0.038959
SW	0.001143	0.003767	0.003699	0.001644	0.000000	0.000000	0.010252
WSW	0.000456	0.002329	0.003493	0.001575	0.000068	0.000000	0.007922
W	0.001138	0.003699	0.004589	0.002192	0.000000	0.000000	0.011617
WNW	0.000765	0.004658	0.006918	0.004726	0.000685	0.000000	0.017751
NW	0.000548	0.002603	0.006507	0.007740	0.001164	0.000205	0.018767
NNW	0.000849	0.003767	0.011438	0.010096	0.001849	0.000274	0.034274
TOTAL	0.020753	0.079934	0.180753	0.138013	0.011370	0.001507	

RELATIVE FREQUENCY OF OCCURRENCE OF D STABILITY = 0.432329

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH D STABILITY = 0.006575

GG
ER

TABLE 2.3.129E

JOINT FREQUENCY DISTRIBUTION OF WIND DIRECTION AND WIND SPEEDS FOR PASQUILL STABILITY CLASS E
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 5 Years (1955-1969)
Annual - 8 Observations Per Day

DIRECTION	SPEED(KTS) 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	TOTAL
N	0.000000	0.003493	0.006370	0.000000	0.000000	0.000000	0.009863
NNE	0.000000	0.002945	0.003219	0.000000	0.000000	0.000000	0.006164
NE	0.000000	0.003425	0.002192	0.000000	0.000000	0.000000	0.005616
ENE	0.000000	0.004452	0.000548	0.000000	0.000000	0.000000	0.005000
E	0.000000	0.004521	0.002123	0.000000	0.000000	0.000000	0.006644
ESE	0.000000	0.005068	0.002260	0.000000	0.000000	0.000000	0.007329
SE	0.000000	0.007192	0.008425	0.000000	0.000000	0.000000	0.015616
SSE	0.000000	0.008973	0.010411	0.000000	0.000000	0.000000	0.019384
S	0.000000	0.005137	0.006849	0.000000	0.000000	0.000000	0.011986
SSW	0.000000	0.007329	0.004521	0.000000	0.000000	0.000000	0.011849
SW	0.000000	0.002192	0.000685	0.000000	0.000000	0.000000	0.002877
WSW	0.000000	0.000685	0.000205	0.000000	0.000000	0.000000	0.000890
W	0.000000	0.000685	0.000274	0.000000	0.000000	0.000000	0.000959
WNW	0.000000	0.001438	0.001644	0.000000	0.000000	0.000000	0.003082
NW	0.000000	0.001027	0.001438	0.000000	0.000000	0.000000	0.002466
NNW	0.000000	0.001712	0.004658	0.000000	0.000000	0.000000	0.006370
TOTAL	0.000000	0.060274	0.055822	0.000000	0.000000	0.000000	

RELATIVE FREQUENCY OF OCCURRENCE OF E STABILITY = 0.116096

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH E STABILITY = 0.000000

GG
ER

TABLE 2.3.129F

JOINT FREQUENCY DISTRIBUTION OF WIND DIRECTION AND WIND SPEEDS FOR PASQUILL STABILITY CLASS F
MUNICIPAL AIRPORT, JACKSON, MISSISSIPPI
Length of Record - 5 Years (1965-1969)
Annual - 8 Observations Per Day

DIRECTION	SPEED(KTS) 0 - 3	4 - 6	7 - 10	11 - 16	17 - 21	GREATER THAN 21	TOTAL
N	0.003401	0.007603	0.000000	0.000000	0.000000	0.000000	0.011004
NNE	0.002509	0.004110	0.000000	0.000000	0.000000	0.000000	0.006619
NE	0.003419	0.006096	0.000000	0.000000	0.000000	0.000000	0.009515
ENE	0.003262	0.005342	0.000000	0.000000	0.000000	0.000000	0.008605
E	0.003972	0.006370	0.000000	0.000000	0.000000	0.000000	0.010342
ESE	0.004121	0.005890	0.000000	0.000000	0.000000	0.000000	0.010011
SE	0.005720	0.011986	0.000000	0.000000	0.000000	0.000000	0.017706
SSE	0.005180	0.013767	0.000000	0.000000	0.000000	0.000000	0.018947
S	0.003316	0.007192	0.000000	0.000000	0.000000	0.000000	0.010508
SSW	0.004112	0.008630	0.000000	0.000000	0.000000	0.000000	0.012742
SW	0.001874	0.001849	0.000000	0.000000	0.000000	0.000000	0.003723
WSW	0.000779	0.000959	0.000000	0.000000	0.000000	0.000000	0.001737
W	0.001164	0.000822	0.000000	0.000000	0.000000	0.000000	0.001986
WNW	0.000904	0.001164	0.000000	0.000000	0.000000	0.000000	0.002068
NW	0.001032	0.001781	0.000000	0.000000	0.000000	0.000000	0.002813
NNW	0.002290	0.004247	0.000000	0.000000	0.000000	0.000000	0.006536
TOTAL	0.047055	0.087808	0.000000	0.000000	0.000000	0.000000	

RELATIVE FREQUENCY OF OCCURRENCE OF F STABILITY = 0.134863

RELATIVE FREQUENCY OF CALMS DISTRIBUTED ABOVE WITH F STABILITY = 0.023219

ER GG

GG
ER

TABLE 2.3.130

PERCENTAGE FREQUENCY DISTRIBUTION OF PASQUILL STABILITY CLASSES, GRAND GULF, MISSISSIPPI
AUGUST 1972-JULY 1973, AUGUST 1973-JULY 1974
AUGUST 1972-JULY 1974

	A			B			C			D			E			F			G		
Month	'72-'73	'73-'74	'72-'74	'72-'73	'73-'74	'72-'74	'72-'73	'73-'74	'72-'74	'72-'73	'73-'74	'72-'74	'72-'73	'73-'74	'72-'74	'72-'73	'73-'74	'72-'74	'72-'73	'73-'74	'72-'74
January	9	10	10	2	3	3	6	12	9	46	35	41	14	27	20	9	5	7	14	8	11
February	17	15	16	2	2	2	4	9	6	33	23	28	23	29	26	9	4	7	10	19	15
March	11	12	12	3	2	2	7	7	7	40	37	38	23	30	26	9	7	8	7	5	6
April	18	7	13	3	3	3	5	10	7	38	34	36	17	23	20	8	11	9	12	13	12
May	21	7	14	4	3	3	4	9	6	24	30	27	22	32	27	9	8	9	16	12	14
June	23	16	20	6	4	5	6	7	7	12	19	16	24	22	23	12	12	12	17	19	18
July	27	25	26	3	0	1	4	5	5	13	14	14	23	26	24	17	17	17	13	13	13
August	10	19	15	3	6	4	6	4	5	19	13	16	21	18	19	21	23	22	21	17	19
September	11	17	14	3	3	3	6	3	4	23	32	27	27	18	23	18	12	15	11	15	13
October	11	14	12	2	2	2	8	4	6	26	14	20	23	28	26	11	8	10	20	29	24
November	6	3	5	4	1	2	6	5	6	45	19	32	27	42	34	8	14	11	5	16	11
December	7	9	8	2	3	3	5	5	5	46	31	39	26	34	30	7	5	6	7	12	9
Average Annual	14	13	14	3	3	3	6	7	6	31	25	28	22	27	25	11	11	11	13	15	14

GG
ER

TABLE 2.3.131

NUMBER OF INVERSION[1] OCCURRENCES DURING JANUARY
AT JACKSON, MISSISSIPPI

DURATION[2]	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	MEAN
1	7	10	7	9	9	6	11	10	15	12	10
2	2	8	5	6	5	4	2	3		5	4
3	3	2	4	1	2	2	3	2	1	3	2
4	2	2			4	1	4	1	2	2	2
5	3	1	2	3	2	3	1	1	1	3	2
6	1	4	1	3	3		1			1	1
7	2	1	1	1			1	2	2	1	1
8			1	1			2			1	1
9	2			2	1	4		1			1
10		3	1								1
11			1	1			1	1			<1
12	1			1	1	2				1	1
13	1			1		1		3	2		1
14		2	1	3			1	1	2	4	1
15	8			3	5	4	4	3	3	1	3
16	2	7	2	8	6	5	9	5	5	4	5
17											
≥18											
TOTAL[3]	34	40	26	43	38	32	40	33	33	38	36

NOTES: 1 Based on Pasquill-Turner calculation of E, F or G from hourly surface observations.

2 Consecutive hours of E, F or G stability for each discrete occurrence.

3 Number of discrete occurrences.

(No entry in tables means "zero")

GG
ER

TABLE 2.3.132

NUMBER OF INVERSION[1] OCCURRENCES DURING FEBRUARY
AT JACKSON, MISSISSIPPI

DURATION[2]	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	MEAN
1	10	10	10	5	11	4	6	9	6	12	8
2	6	3	4	4	3	6	3	4	3		4
3	3	1	3	3	4	5		4	1	4	3
4	3	2	1	2	2	1	1	3			2
5		1	4	1	1	1		2	1	3	1
6	2	1	4	2	1	1	1	3	4	4	2
7		1	2		1	2	1	2	3		1
8	1	1				1		2			1
9	2	1	1	1			1				1
10			1			1	1	1		3	1
11	1	1	1	1	1		1		1		1
12			1	2				1	1	2	1
13		1	1	3	1		2	2	2	2	1
14	3	1		3	3	1	5	2	4	3	2
15	3	4	5	5	5	8	6	4	5	3	5
16											
17											
≥18											
TOTAL[3]	34	28	38	32	33	31	28	39	31	36	34

NOTES: 1 Based on Pasquill-Turner calculation of E, F or G from hourly surface observations.

2 Consecutive hours of E, F or G stability for each discrete occurrence.

3 Number of discrete occurrences.

(No entry in table means "zero")

GG
ER

TABLE 2.3.133

NUMBER OF INVERSION[1] OCCURRENCES DURING MARCH
AT JACKSON, MISSISSIPPI

DURATION[2]	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	MEAN
1	11	14	13	7	9	10	15	8	7	5	10
2	6	2	5	6	6	8	8	1	4	2	5
3	6	3	3	4	1	4	1	5		1	3
4	7	1	4	2	4	1		3	4	1	3
5	2	1	1		3	1	1	1	1	1	1
6	3	3	1	1		3	3		2	1	2
7	2	1	1	3	1	1	3		2		1
8	1		3			2		1	1	1	1
9		2	1	2		3			3	1	1
10		1	2	3	1			1			1
11	1		2	1	3	3	1		1	2	1
12		1	1		1		1	1	1	3	1
13	4	5	2	3	3	3	2	6	4	2	3
14	3	4	4	3	5	4	7	5	6	4	4
15			1	1	2		1				1
16											
17											
≥18											
TOTAL[3]	46	38	44	36	39	43	43	33	36	24	38

NOTES: 1 Based on Pasquill-Turner calculation of E, F or G from hourly surface observations.

2 Consecutive hours of E, F or G stability for each discrete occurrence.

3 Number of discrete occurrences.

(No entry in table means "zero")

GG
ER

TABLE 2.3.134

NUMBER OF INVERSION[1] OCCURRENCES DURING APRIL
AT JACKSON, MISSISSIPPI

DURATION[2]	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	MEAN
1	11	12	8	12	11	8	9	12	20	10	11
2	5	6	3	2	8	7	6	5	5	8	6
3	1	1	7	7	1	10	2	2	4	2	4
4		1	1	1	2	3	2	2	5	2	2
5		2	2	5		2	1	1	3	3	2
6	4			3	3	1	2	1	3	1	2
7				2	1	1	1	1	1		1
8		1	1	1		1	1	2	2	2	1
9	1	1	2					4		1	1
10		2	1		1		2	2	1		1
11	2		1	1	1			1			1
12	1	2	6	2	2	1	2		1		2
13	11	10	5	8	10	13	12	9	5	5	9
14											
15											
16											
17											
≥18											
TOTAL[3]	36	38	37	44	40	47	40	42	50	34	43

NOTES: 1 Based on Pasquill-Turner calculation of E, F or G from hourly surface observations.

2 Consecutive hours of E, F or G stability for each discrete occurrence.

3 Number of discrete occurrences.

(No entry in table means "zero")

GG
ER

TABLE 2.3.135

NUMBER OF INVERSION[1] OCCURRENCES DURING MAY
AT JACKSON, MISSISSIPPI

DURATION[2]	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	MEAN
1	7	8	11	8	11	2	7	3	3	6	7
2	3	5	5	3	5	2	3	2	4	4	4
3	5	6	2	1	4		4	2	5	1	3
4	1	2	6	2		1	3	1	2	3	2
5	4	6	3	2	4	2	3	2	2	1	3
6	1	3	1	1		2	3		2		1
7	3		1	1	1	4	4		2	3	2
8	1		1	2		2	2	1	1	1	1
9	1	4	1	2		1			3	1	1
10				1	4			2	3	1	1
11	6	3	2	2	1	2	4	2	3	1	3
12	3	6	6	6	5	10	5	8	3	11	6
13	8	5	6	7	10	7	7	14	9	4	8
14											
15											
16											
17											
≥18											
TOTAL[3]	43	48	45	38	45	35	45	37	42	37	42

NOTES: 1 Based on Pasquill-Turner calculation of E, F or G from hourly surface observations.

2 Consecutive hours of E, F or G stability for each discrete occurrence.

3 Number of discrete occurrences.

(No entry in table means "zero")

GG
ER

TABLE 2.3.136

NUMBER OF INVERSION[1] OCCURRENCES DURING JUNE
AT JACKSON, MISSISSIPPI

DURATION[2]	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	MEAN
1	1	3	6	7	7	2	6	8	8	9	6
2	2	4	6	1	5	2	2	4	3	4	4
3	2	1	4	3	3	1	2	2	3	3	2
4	2	2		3		3			3	1	1
5	1	1	3	5	2	1	3	4		3	2
6	1	1	2	1	1	1			2	2	1
7		2	2	1	2			1	1	3	1
8			3	2	2	1		3	1	2	1
9	2	2	1			1	2	1	1		1
10		1	1	3				6	2		1
11	23	18	15	15	20	23	18	14	16	18	18
12											
13											
14											
15											
16											
17											
≥18											
TOTAL[3]	34	35	43	4[illegible]	42	35	33	43	40	45	38

NOTES: 1 Based on Pasquill-Turner calculation of E, F or G from hourly surface observations.

2 Consecutive hours of E, F or G stability for each discrete occurrence.

3 Number of discrete occurrences.

(No entry in table means "zero")

GG
ER

TABLE 2.3.137

NUMBER OF INVERSION[1] OCCURRENCES DURING JULY
AT JACKSON, MISSISSIPPI

DURATION[2]	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	MEAN
1	4	3	3	12	6	5	3	3	7	5	5
2	2	4	5	5	4		1	3	2	7	3
3	3	5	1	4	1	1	2		4	3	2
4	3	2		2		2	1	1	4	1	2
5	2	2	2	1	3	4	2	5	3	4	3
6		2	1	3	1	1				1	1
7	1	1	1	3	3		3	1	5	3	2
8	2	3	3	3	2	2		2	2	3	2
9	3	1	2		2		2		2	2	1
10	2	2	2	2	2	8	1		1		2
11	7	5	7	6	6	7	6	9	6	6	6
12	10	13	13	8	12	10	15	15	9	8	11
13											
14											
15											
16											
17											
≥18											
TOTAL[3]	39	43	40	49	42	40	36	39	45	43	40

NOTES: 1 Based on Pasquill-Turner calculation of E, F or G from hourly observations.

2 Consecutive hours of E, F or G stability for each discrete occurrence.

3 Number of discrete occurrences.

(No entry in table means "zero")

GG
ER

TABLE 2.3.138

NUMBER OF INVERSION[1] OCCURRENCES DURING AUGUST
AT JACKSON, MISSISSIPPI

DURATION[2]	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	MEAN
1	5	6	6	5	8	9	9	4	4	7	6
2	1	3	2	2	2	3	4	2	2	11	3
3	2	2	3	3		2	2		3	2	2
4	3		1	1	1	2	1	3		2	1
5	1	3	2	3		4	3	3	2	5	3
6	1		1	1	1	2	3	2	1	2	1
7	1	1			2	1		2	2	2	1
8	3	2	3		1	1	1				1
9	2	1	1	3	3	1	2		2		2
10	2		3		5	2	1	1	2	1	2
11	1	2	2	2	1	4	3	5	3	4	3
12		2	2	1	2	3	1	2	2	4	2
13	18	19	17	20	16	12	17	17	18	9	16
14											
15											
16											
17											
≥18											
TOTAL[3]	40	41	43	41	42	46	47	41	41	49	43

NOTES: 1 Based on Pasquill-Turner calculation of E, F or G from hourly surface observations.

2 Consecutive hours of E, F or G stability for each discrete occurrence.

3 Number of discrete occurrences.

(No entry in table means "zero")

GG
ER

TABLE 2.3.139

NUMBER OF INVERSION[1] OCCURRENCES DURING SEPTEMBER
AT JACKSON, MISSISSIPPI

DURATION[2]	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	MEAN
1	3	5	4	9	6	2	9	6	4	8	6
2	5	3	2	5	3	2	5	2	6	2	4
3	2	2	5	1	4		4	3	3	1	2
4	1		1	2	1	4	1		1	1	1
5	1		1	2	3	2	2	3	2	2	2
6			5	3	4	1		2		2	2
7		1	2	1	1	3	3	4	4	1	2
8	1		3	1	1	2	1	1	1		1
9		2	2		2		2	1			1
10	1	2	1	3		1	1	1	1	2	1
11	2	2	2		1			2	2		1
12		1			1	2	1	4	2		1
13	20	18	4	8	11	13	10	12	14	13	12
14	3	2	2	4	2	2	5	2	1	1	2
15											
16											
17											
≥18											
TOTAL[3]	39	38	34	39	40	34	44	43	41	33	38

NOTES: 1 Based on Pasquill-Turner calculation of E, F or G from hourly surface observations.

2 Consecutive hours of E, F or G stability for each discrete occurrence.

3 Number of discrete occurrences.

(No entry in table means "zero")

GG
ER

TABLE 2.3.140

NUMBER OF INVERSION[1] OCCURRENCES DURING OCTOBER
AT JACKSON, MISSISSIPPI

DURATION[2]	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	MEAN
1	4	4	7	7	6	3	6	10	3	10	6
2	2	5	5	1	3	3	3	5	1	3	3
3	2	2	3	2	3	4	1	5		4	3
4	2		2	1	4	1	1	2	1	4	2
5	2	2		1	3			1	2	3	1
6	1	1		1	1				1		1
7	1	1	2	1	1	2	2	3		2	2
8	2			2	2		1				1
9	3	1	2	2		1		2	1		1
10			2	2	2		2	5	1		1
11	2		1	3			1	4			1
12	2	2			3		1		2		1
13		2	2	1	1	1	1	1		1	1
14	4	6	8	2	3	8	5	6	8	5	6
15	14	13	5	14	4	14	14	6	16	13	11
16											
17											
≥18											
TOTAL[3]	41	39	39	40	36	37	38	50	36	45	41

NOTES: 1 Based on Pasquill-Turner calculation of E, F or G from hourly surface observations.

2 Consecutive hours of E, F or G stability for each discrete occurrence.

3 Number of discrete occurrences.

(No entry in table means "zero")

GG
ER

TABLE 2.3.141

NUMBER OF INVERSION[1] OCCURRENCES DURING NOVEMBER
AT JACKSON, MISSISSIPPI

DURATION[2]	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	MEAN
1	14	9	10	4	10	8	7	7	20	5	9
2	6	1	12	1	3	1	2	1	2	10	4
3	4	5	1	2	2	3	2	4	2	4	3
4	2	3	1		1	2	1	4	5	1	2
5	2	3	5	1	2	2	3	4	1	3	3
6	4	1	2		1	3	3	2	1		2
7	1	2	1		2	2	1	2	3	2	2
8	1	2	2	1	3		2	1	1	1	1
9	1	1					1	1		1	1
10	1	1	2	1		2	1		2	3	1
11		1			2					1	*
12		1		1	1	1	1			1	1
13		1			1	3	1	1		1	1
14		2	2	2	1		1		1	1	1
15	5	8	1	9	5	8	4	6	9	8	6
16	5	3	3	6	5	5	3	3	2	1	4
17											
≥18											
TOTAL[3]	46	44	42	28	39	40	33	36	49	43	41

NOTES: 1 Based on Pasquill-Turner calculation of E, F or G from hourly surface observations.

2 Consecutive hours of E, F or G stability for each discrete occurrence.

3 Number of discrete occurrences.

(No entry in table means "zero")

* Less than one-half but greater than zero.

GG
ER

TABLE 2.3.142

NUMBER OF INVERSION[1] OCCURRENCES DURING DECEMBER
AT JACKSON, MISSISSIPPI

DURATION[2]	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	MEAN
1	17	12	10	8	6	14	11	8	5	7	10
2	3	1	3	6	4	3	6	8	3	2	4
3	3	3	5	1	1	3	1	2	4	3	3
4	1	2	4	2	1	3	3	3	5	4	3
5	1	2	1	1	3			2	1	1	1
6		3	1	1	2	1	2	2	1	3	2
7	3	2		3	5	1	1	2	3		2
8	1	2		1	2	2		2	2		1
9			3			2	1	4		2	1
10	2	2		1	1		2	1	1	2	1
11		1		1	1		1			1	1
12	2		1		1	1		1			1
13	3		2		3		1		2		1
14				1				1	1	1	*
15	2	3	5	2	1	2	2	2	6	1	3
16	4	7	6	7	9	7	6	4	2	2	5
17											
≥18											
TOTAL[3]	42	40	41	35	40	39	37	42	36	29	39

NOTES 1 Based on Pasquill-Turner calculation of E, F or G from hourly surface observations.

2 Consecutive hours of E, F or G stability for each discrete occurrence.

3 Number of discrete occurrences.

(No entry in table means "zero")

* Less than one-half but greater than zero.

GG
ER

TABLE 2.3.143

MEAN NUMBER OF INVERSION[1] OCCURRENCES DURING 1955 - 1964
AT JACKSON, MISSISSIPPI

	Month												
DURATION[2]	J	F	M	A	M	J	J	A	S	O	N	D	ANNUAL
1	10	8	10	11	7	6	5	6	6	6	9	10	94
2	4	4	5	6	4	4	3	3	4	3	4	4	48
3	2	3	3	4	3	2	2	2	2	3	3	3	32
4	2	2	3	2	2	1	2	1	1	2	2	3	23
5	2	1	1	2	3	2	3	3	2	1	3	1	24
6	1	2	2	2	1	1	1	1	2	1	2	2	18
7	1	1	1	1	2	1	2	1	2	2	2	2	18
8	1	1	1	1	1	1	2	1	1	1	1	1	13
9	1	1	1	1	1	1	1	2	1	1	1	1	13
10	1	1	1	1	1	1	2	2	1	1	1	1	14
11	*	1	1	1	3	18	6	3	1	1	*	1	36
12	1	1	1	2	6		11	2	1	1	1	1	28
13	1	1	3	9	8			16	12	1	1	1	53
14	1	2	4						2	6	1	*	16
15	3	5	1							11	6	3	29
16	5										4	5	14
17													
≥18													
TOTAL[3]	36	34	38	43	42	38	40	43	38	41	41	39	473

NOTES: 1 Based on Pasquill-Turner calculation of E, F or G from hourly surface observations.

2 Consecutive hours of E, F or G stability for each discrete occurrence.

3 Number of discrete occurrences.

(No entry in table means "zero")

* Less than one-half but greater than zero.

GG
ER

TABLE 2.3.144

PERCENT OF HOURS WITH INVERSION*
AT JACKSON, MISSISSIPPI

	MONTH												
YEAR	J	F	M	A	M	J	J	A	S	O	N	D	ANNUAL
1955	34.7	26.6	30.1	32.5	40.6	41.8	41.1	47.0	51.4	53.8	37.4	33.2	39.3
1956	33.1	23.8	29.8	32.2	40.0	37.9	44.0	48.1	49.7	51.2	47.2	37.2	39.6
1957	17.1	32.6	33.6	32.4	36.0	38.8	44.9	49.6	31.9	41.7	29.4	39.5	35.7
1958	45.8	36.8	29.7	34.0	37.2	38.8	39.2	48.9	36.5	50.4	42.5	33.3	39.5
1959	35.1	29.2	34.4	33.1	40.5	40.6	43.4	48.9	40.8	33.9	41.1	44.4	38.8
1960	33.9	31.6	32.7	38.3	42.7	41.9	45.0	45.8	42.5	51.5	47.2	32.5	40.5
1961	40.7	36.5	32.3	37.1	41.5	34.3	43.0	48.7	43.6	50.7	33.8	31.7	39.5
1962	32.7	35.0	30.8	35.3	47.7	41.1	45.7	49.9	49.3	49.5	34.9	35.0	40.6
1963	30.1	36.5	34.4	28.5	43.2	37.1	41.3	50.5	45.4	56.4	40.4	35.5	40.0
1964	29.8	34.2	24.7	21.0	37.2	40.6	38.0	42.1	34.9	47.2	42.1	22.7	34.5
MEAN	33.3	32.3	31.2	32.4	40.7	39.3	42.6	48.0	42.6	48.6	36.6	34.5	38.8

* Based on Pasquill-Turner calculations of E, F or G stability from hourly surface observations.

TABLE 2.3.145

NUMBER OF INVERSION OCCURRENCES DURING JANUARY AT GRAND GULF SITE

Duration (hrs.)	1973	1974	1976	Total
1	4	11	9	24
2	5	8	7	20
3	1	11	4	16
4	3	6	4	13
5	2	2	1	5
6	6	2	3	11
7	11	8	9	28
8	1	3	7	11
9	11	6	2	19
10	1	0	0	1
11	0	0	0	0
12	0	2	0	2
13	0	0	0	0
14	0	1	0	1
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
≥18	0	0	0	0
Total Number of Discrete Events	45	61	46	152

GG
ER

TABLE 2.3.146

NUMBER OF INVERSION OCCURRENCES DURING FEBRUARY AT GRAND GULF SITE

Duration (hrs.)	1973	1974	1976	Total
1	4	3	6	13
2	2	1	5	8
3	3	2	4	9
4	3	1	4	8
5	2	4	2	8
6	13	8	11	32
7	9	6	4	19
8	9	5	9	23
9	3	14	5	22
10	1	1	0	2
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
≥18	0	0	0	0
Total Number of Discrete Events	49	47	50	146

GG
ER

TABLE 2.3.147

NUMBER OF INVERSION OCCURRENCES DURING MARCH AT GRAND GULF SITE

Duration (hrs.)	1973	1974	1976	Total
1	11	7	14	32
2	4	8	6	18
33	6	5	2	13
4	3	5	3	13
5	3	2	2	11
6	14	16	11	41
7	10	8	3	21
8	6	10	4	20
9	2	1	1	4
10	1	0	0	1
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
≥18	0	0	0	0
Total Number of Discrete Events	60	62	46	168

GG
ER

TABLE 2.3.148

NUMBER OF INVERSION OCCURRENCES DURING APRIL AT GRAND GULF SITE

Duration (hrs.)	1973	1974	1976	Total
1	9	8	8	25
2	5	5	2	12
3	6	5	4	15
4	1	8	4	13
5	4	3	8	15
6	17	16	13	46
7	7	14	11	32
8	6	7	10	23
9	0	0	0	0
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
≥ 18	0	0	0	0
Total Number of Discrete Events	55	66	60	181

GG
ER

TABLE 2.3.149

NUMBER OF INVERSION OCCURRENCES DURING MAY AT GRAND GULF SITE

Duration (hrs.)	1973	1974	1976	Total
1	11	8	6	25
2	3	3	6	12
3	5	3	1	9
4	7	3	4	14
5	3	3	1	7
6	22	21	22	65
7	16	15	13	44
8	4	8	2	14
9	0	3	1	4
10	0	0	0	0
11	0	0	0	0
12	0	1	0	1
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
≥18	0	0	0	0
Total Number of Discrete Events	71	68	56	195

GG
ER

TABLE 2.3.150

NUMBER OF INVERSION OCCURRENCES DURING JUNE AT GRAND GULF SITE

Duration (hrs.)	1973	1974	1976	Total
1	3	8	12	23
2	3	2	5	10
3	2	1	4	7
4	3	2	2	7
5	7	6	3	16
6	22	22	19	63
7	25	15	14	54
8	0	6	4	10
9	0	3	0	3
10	1	2	0	3
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
≥ 18	0	0	0	0
Total Number of Discrete Events	66	67	63	196

GG
ER

TABLE 2.3.151

NUMBER OF INVERSION OCCURRENCES DURING JULY AT GRAND GULF SITE

Duration (hrs.)	1973	1974	1976	Total
1	4	4	9	17
2	1	3	3	7
3	1	1	3	5
4	3	4	7	14
5	7	6	5	18
6	27	17	20	64
7	20	24	20	64
8	3	5	3	11
9	1	0	0	1
10	0	1	0	1
11	0	1	0	1
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
≥ 18	0	0	0	0
Total Number of Discrete Events	67	67	70	204

GG
ER

TABLE 2.3.152

NUMBER OF INVERSION OCCURRENCES DURING AUGUST AT GRAND GULF SITE

Duration (hrs.)	1972	1973	1976	Total
1	1	5	6	12
2	1	0	2	3
3	1	0	3	4
4	1	2	6	9
5	2	3	3	8
6	7	15	21	43
7	30	28	21	79
8	11	11	8	30
9	5	2	0	7
10	2	1	1	4
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	1	0	0	1
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
≥ 18	0	0	0	0
Total Number of Discrete Events	62	67	71	200

GG
ER

TABLE 2.3.153

NUMBER OF INVERSION OCCURRENCES DURING SEPTEMBER AT GRAND GULF SITE

Duration (hrs.)	1972	1973	1976	Total
1	4	6	7	17
2	0	3	4	7
3	1	4	3	8
4	4	1	0	5
5	2	6	3	11
6	3	5	8	16
7	34	10	25	69
8	12	1	13	26
9	3	2	0	5
10	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
≥ 18	0	0	0	0
Total Number of Discrete Events	63	53	63	179

GG
ER

TABLE 2.3.154

NUMBER OF INVERSION OCCURRENCES DURING OCTOBER AT GRAND GULF SITE

Duration (hrs.)	1972	1973	1976	Total
1	5	2	7	14
2	7	2	3	12
3	6	3	5	14
4	4	5	1	10
5	3	0	4	7
6	3	0	4	7
7	22	12	15	49
8	19	22	18	59
9	0	12	1	13
10	0	3	0	3
11	0	0	0	0
12	0	0	0	0
13	0	1	0	1
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
≥18	0	0	0	0
Total Number of Discrete Events	69	63	58	190

GG
ER

TABLE 2.3.155

NUMBER OF INVERSION OCCURRENCES DURING NOVEMBER AT GRAND GULF SITE

Duration (hrs.)	1972	1973	1976	Total
1	16	6	6	28
2	8	1	2	11
3	3	5	0	8
4	5	3	1	9
5	3	0	0	3
6	3	2	1	6
7	11	8	17	36
8	12	23	13	48
9	2	5	5	12
10	0	4	1	5
11	0	0	0	0
12	0	1	0	1
13	0	3	0	3
14	0	0	0	0
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
≥18	0	0	0	0
Total Number of Discrete Events	63	65	46	174

TABLE 2.3.156

NUMBER OF INVERSION OCCURRENCES DURING DECEMBER AT GRAND GULF SITE

Duration (hrs.)	1972	1973	1976	Total
1	9	4	4	17
2	2	10	4	16
3	4	6	2	12
4	2	2	4	8
5	2	3	2	7
6	7	2	1	10
7	11	14	13	38
8	10	14	7	31
9	14	9	9	32
10	2	0	2	4
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	0	1	0	1
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
≥ 18	0	0	0	0
Total Number of Discrete Events	53	65	48	166

GG
ER

TABLE 2.3.157

NUMBER OF INVERSION OCCURRENCES AT GRAND GULF SITE

Duration (hrs.)	1972-1973	1973-1974	1976	Total
1	81	72	94	247
2	41	46	49	136
3	39	46	35	120
4	39	42	40	121
5	40	38	34	113
6	144	126	134	404
7	206	167	165	538
8	93	124	98	315
9	31	56	24	111
10	8	14	4	26
11	0	1	0	1
12	0	4	0	4
13	0	4	0	4
14	1	2	0	3
15	0	0	0	0
16	0	0	0	0
17	0	0	0	0
≥18	0	0	0	0
Total Number of Discrete Events	723	751	677	2151

GG
ER

TABLE 2.3.158

PERCENT OF HOURS WITH INVERSION AT GRAND GULF SITE

Month	1972 - 1973	1973 - 1974	1976	Annual
JAN	37.1	39.3	28.4	34.8
FEB	43.1	51.8	28.1	44.2
MAR	39.5	41.8	24.5	35.3
APR	36.1	46.4	43.8	42.1
MAY	47.2	51.6	39.0	45.9
JUN	52.6	53.6	41.3	49.3
JUL	52.6	55.7	48.5	52.2
AUG	62.5	57.8	54.3	58.2
SEP	57.2	45.2	50.8	51.3
OCT	53.3	65.6	44.9	54.5
NOV	39.6	71.9	41.7	51.2
DEC	40.1	51.3	40.1	43.8
MEAN	46.6	52.7	41.2	46.8

GG
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TABLE 2.3.159

AVERAGE MIXING HEIGHTS AND WIND SPEEDS
FOR JACKSON, MISSISSIPPI

	Morning		Afternoon	
	Avg. Mix. Height (m)	Avg. Wind Speed (m/s)	Avg. Mix. Height (m)	Avg. Wind Speed (m/s)
Winter	470	4.9	1088	5.9
Spring	467	4.9	1543	6.2
Summer	421	3.1	1830	4.5
Fall	343	3.6	1349	5.1
Annual	425	4.1	1453	5.4

DATA SOURCE: Holzworth, George C., "Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States," EPA, Research Triangle Park, North Carolina, 1972.

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TABLE 2.3.160

MEAN DAILY MIXING DEPTHS BY MONTH

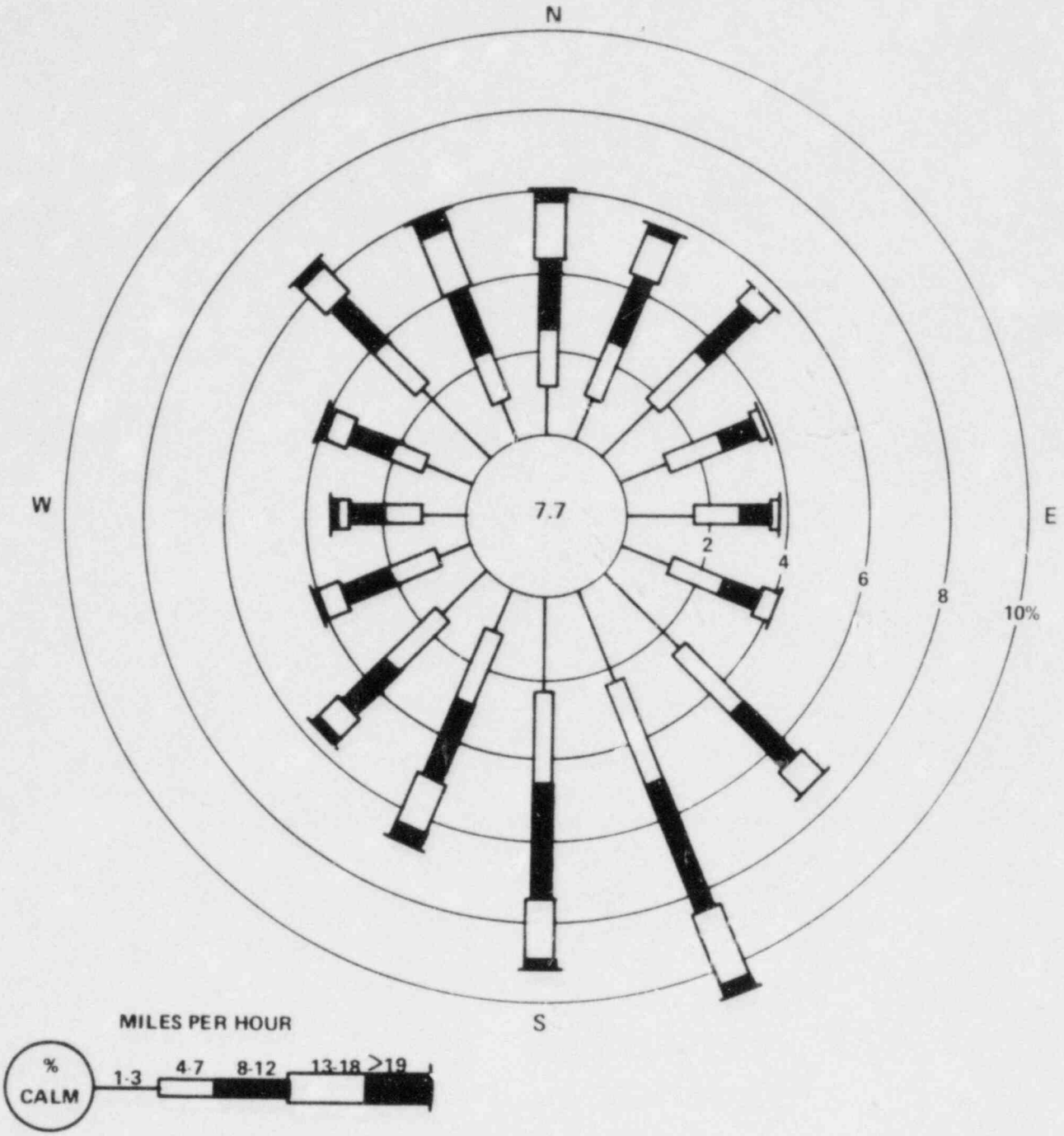
Data Period: 1/59 - 12/62

Station: Jackson, Mississippi

	Morning (m)	Afternoon (m)	Mean (m)
JAN	467	849	658
FEB	462	968	715
MAR	513	1182	848
APR	492	1429	961
MAY	432	1653	1043
JUN	458	1666	1062
JUL	401	1753	1077
AUG	405	1721	1063
SEP	373	1504	939
OCT	358	1277	656
NOV	385	980	683
DEC	412	898	655

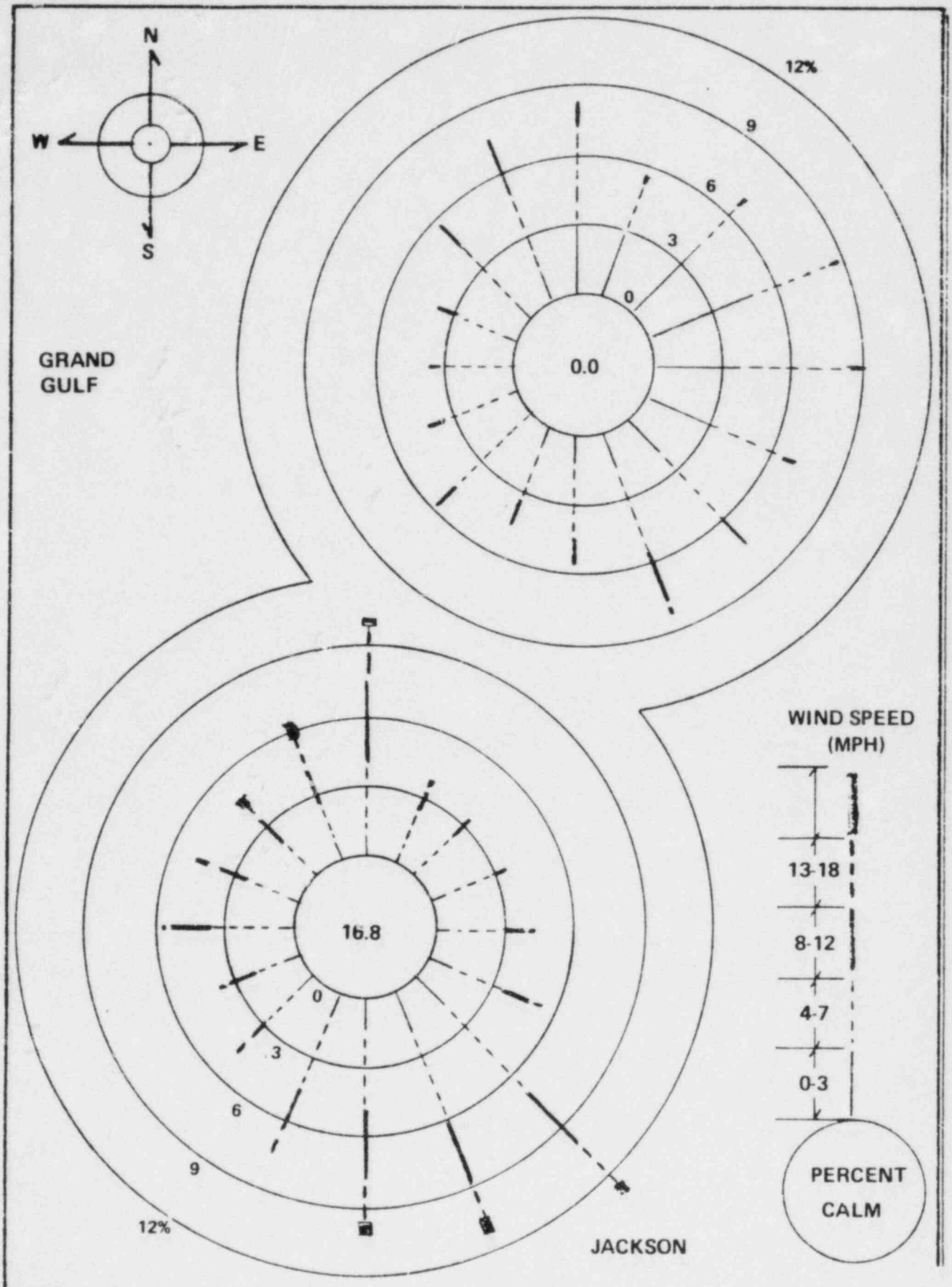
Data Source: "Tabulation III - Daily Mixing Depth and Average Wind Speed, Jackson, Mississippi, (1959-1962)",
U. S. Department of Commerce, ESSA, National Weather Records Center, 1968

LENGTH OF RECORD - 10 YEARS

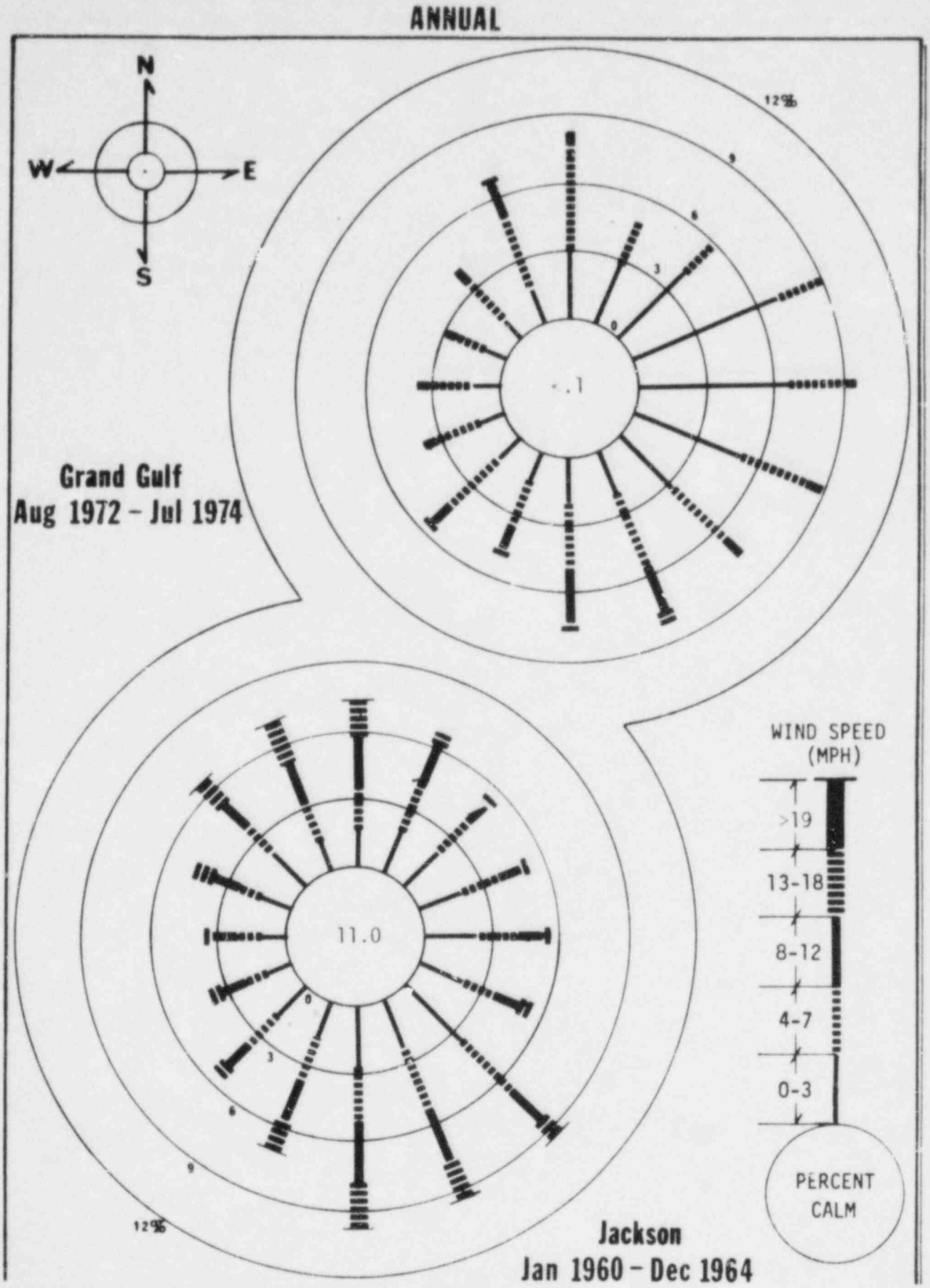


DATA SOURCE: CLIMATOGRAPHY OF THE UNITED STATES NO. 82 22, SUMMARY OF HOURLY OBSERVATIONS, 1951-1960, U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU, 1963.

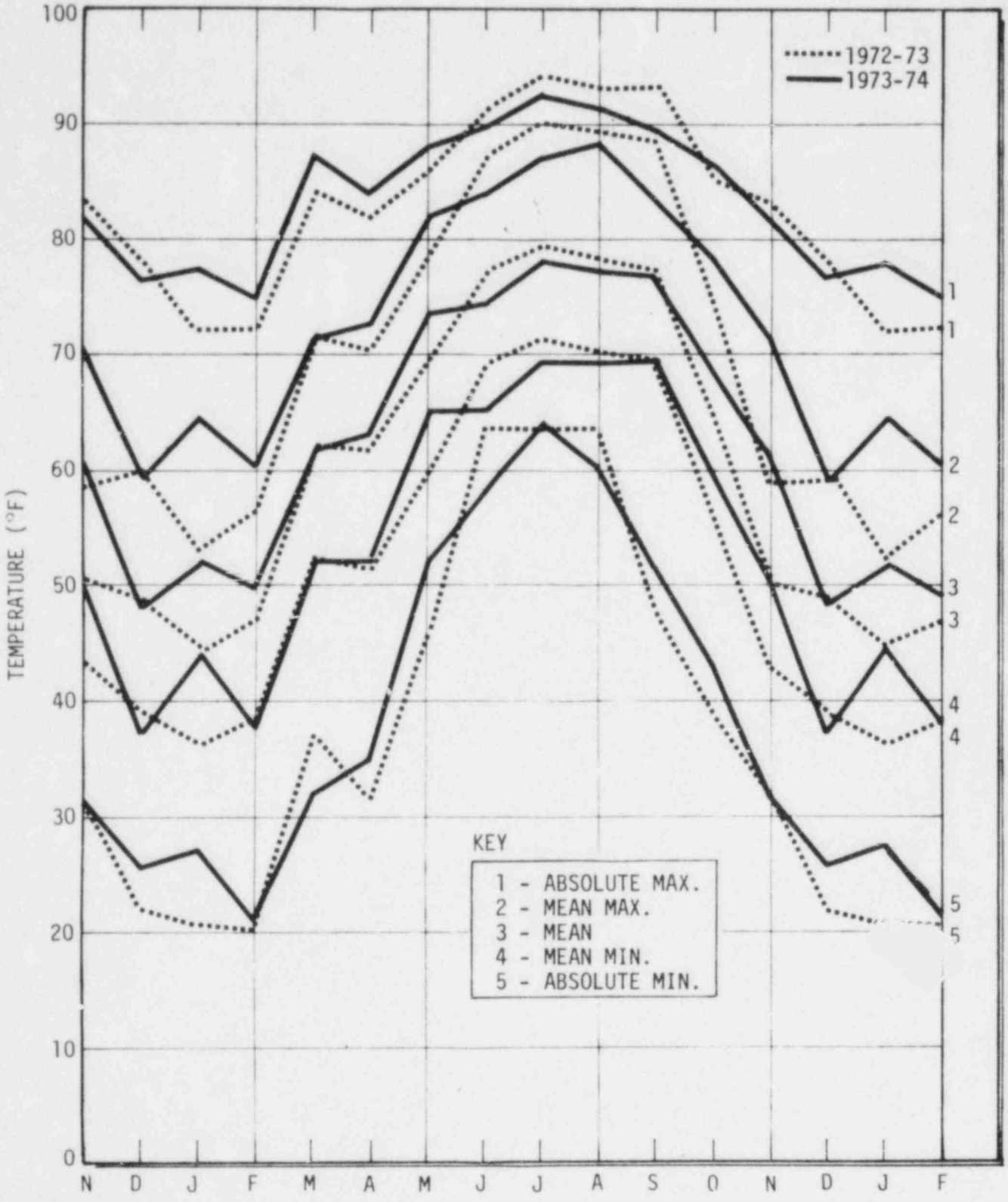
MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	ANNUAL WIND ROSE JACKSON, MISSISSIPPI FIGURE 2.3-1



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	ANNUAL WIND ROSE AUGUST 1972 - JULY 1973 FIGURE 2.3-2

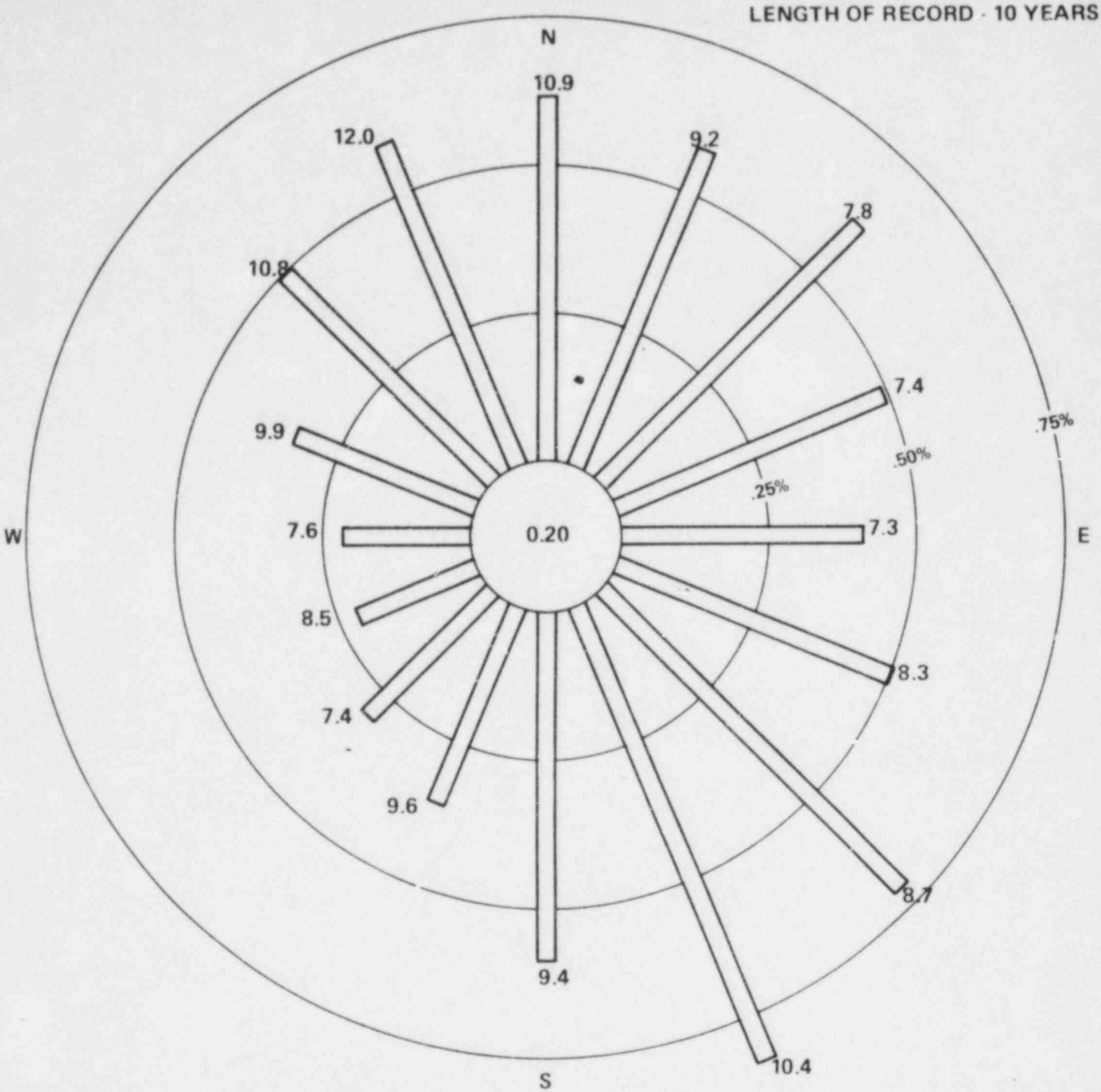


MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	COMPARISON OF WIND DIRECTIONS AND SPEEDS AT GRAND GULF, MISS., 1972 - 1974 AND AT JACKSON, MISS., 1960 - 1964 FIGURE 2.3-3



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	COMPARISON OF TEMPERATURE AND EXTREMES (F) AT GRAND GULF, MISS., AUGUST 1972-JULY 1973, AUGUST 1973-JULY 1974 FIGURE 2.3-4

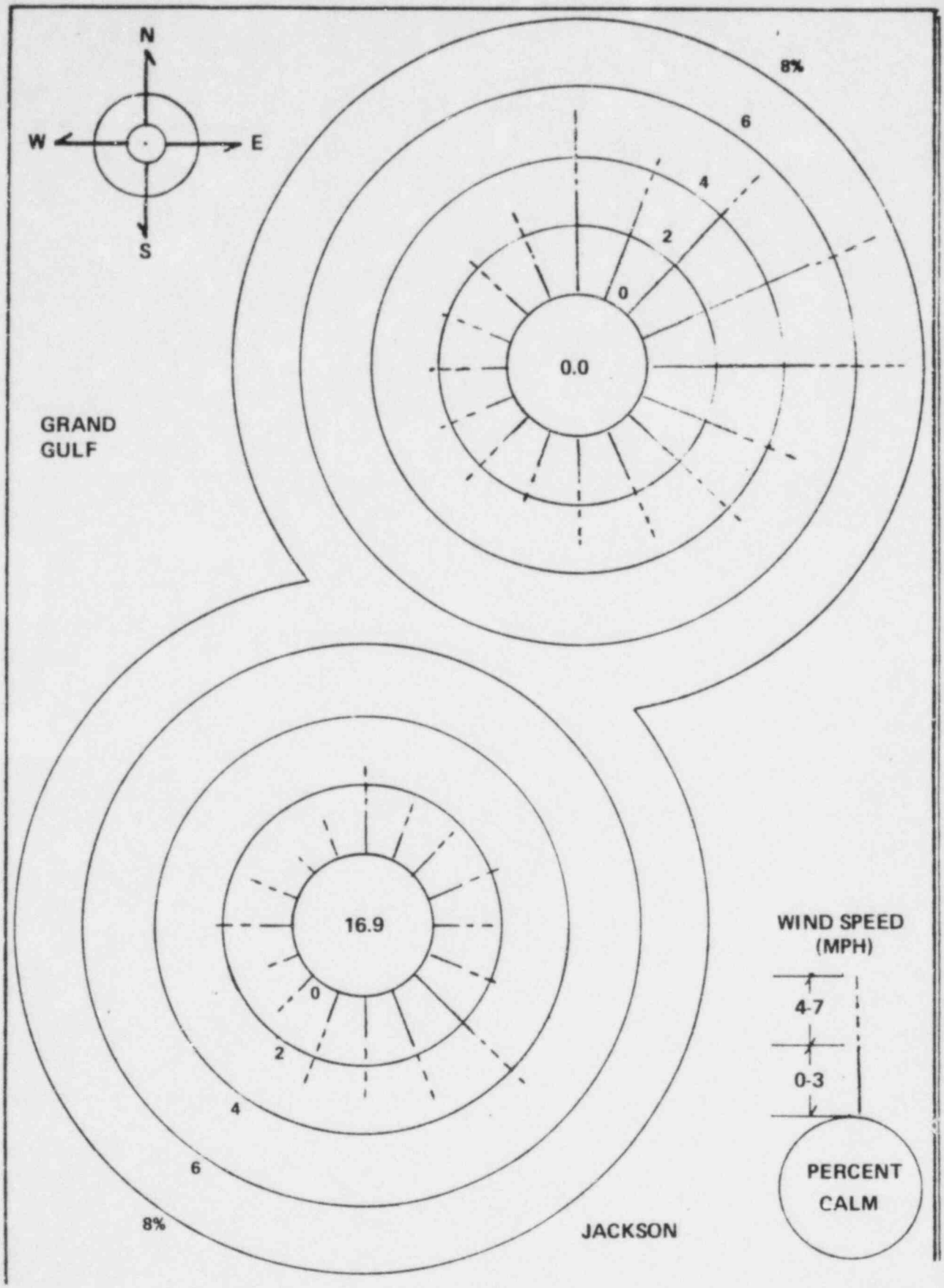
LENGTH OF RECORD - 10 YEARS



NOTES: THE VALUE IN THE CENTER OF THE INNER CIRCLE GIVES THE PERCENTAGE OF CALM WINDS. DATA WERE PLOTTED IN HUNDREDTHS PRIOR TO ROUNDING FOR TABLE 2.3.65 VALUES AT ENDS OF BARS ARE AVERAGE ANNUAL WIND SPEEDS, BY DIRECTION, DURING PRECIPITATION, IN MILES PER HOUR.

DATA SOURCE: PRECIPITATION AND NON-PRECIPITATION WINDS, JOB NO. 13267, U. S. DEPARTMENT OF COMMERCE, NOAA, NATIONAL CLIMATIC CENTER, FEBRUARY, 1972.

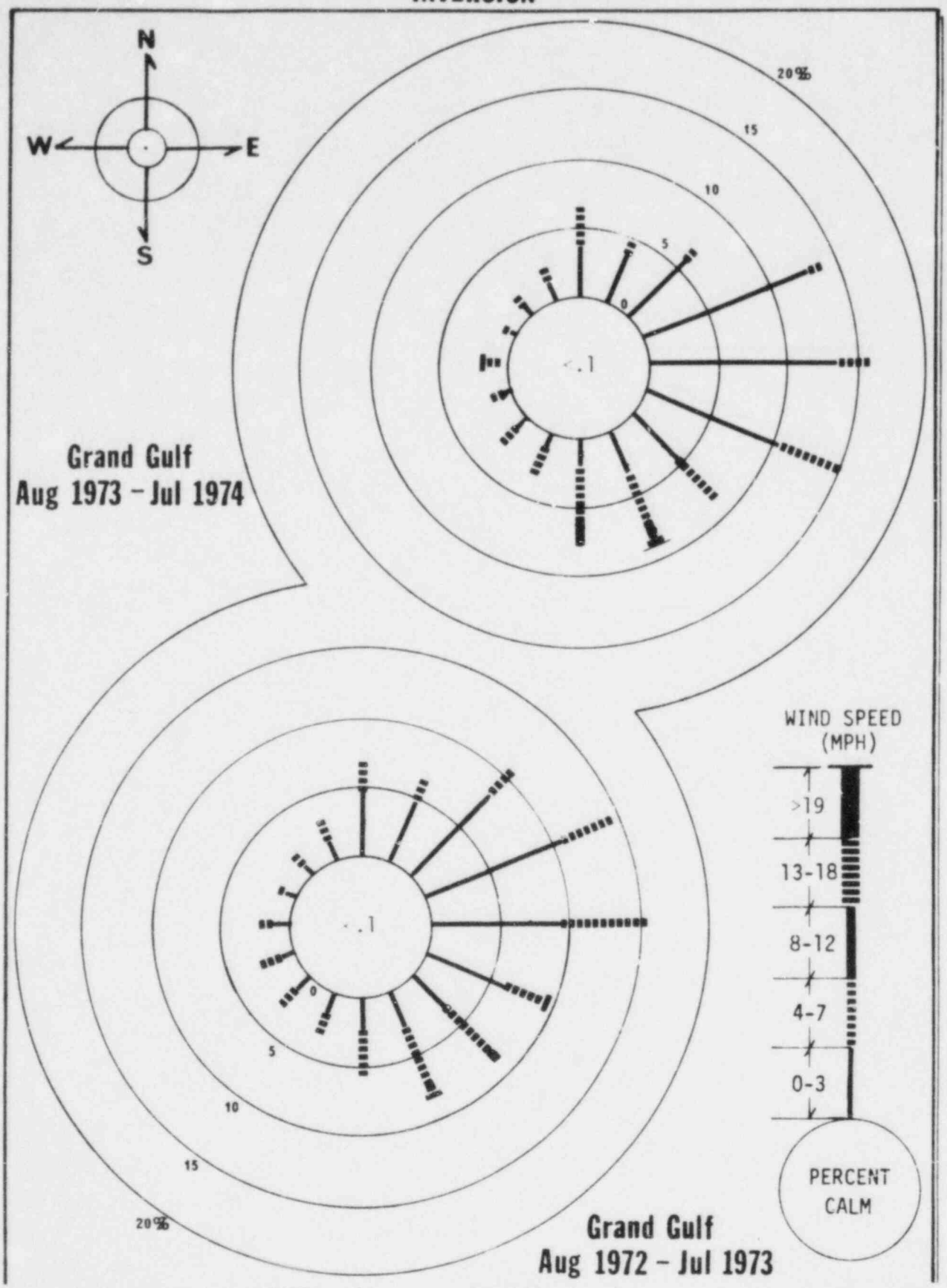
MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	ANNUAL PRECIPITATION WIND ROSE (PERCENT OF TOTAL OBSERVATIONS) JACKSON, MISSISSIPPI FIGURE 2.3-5



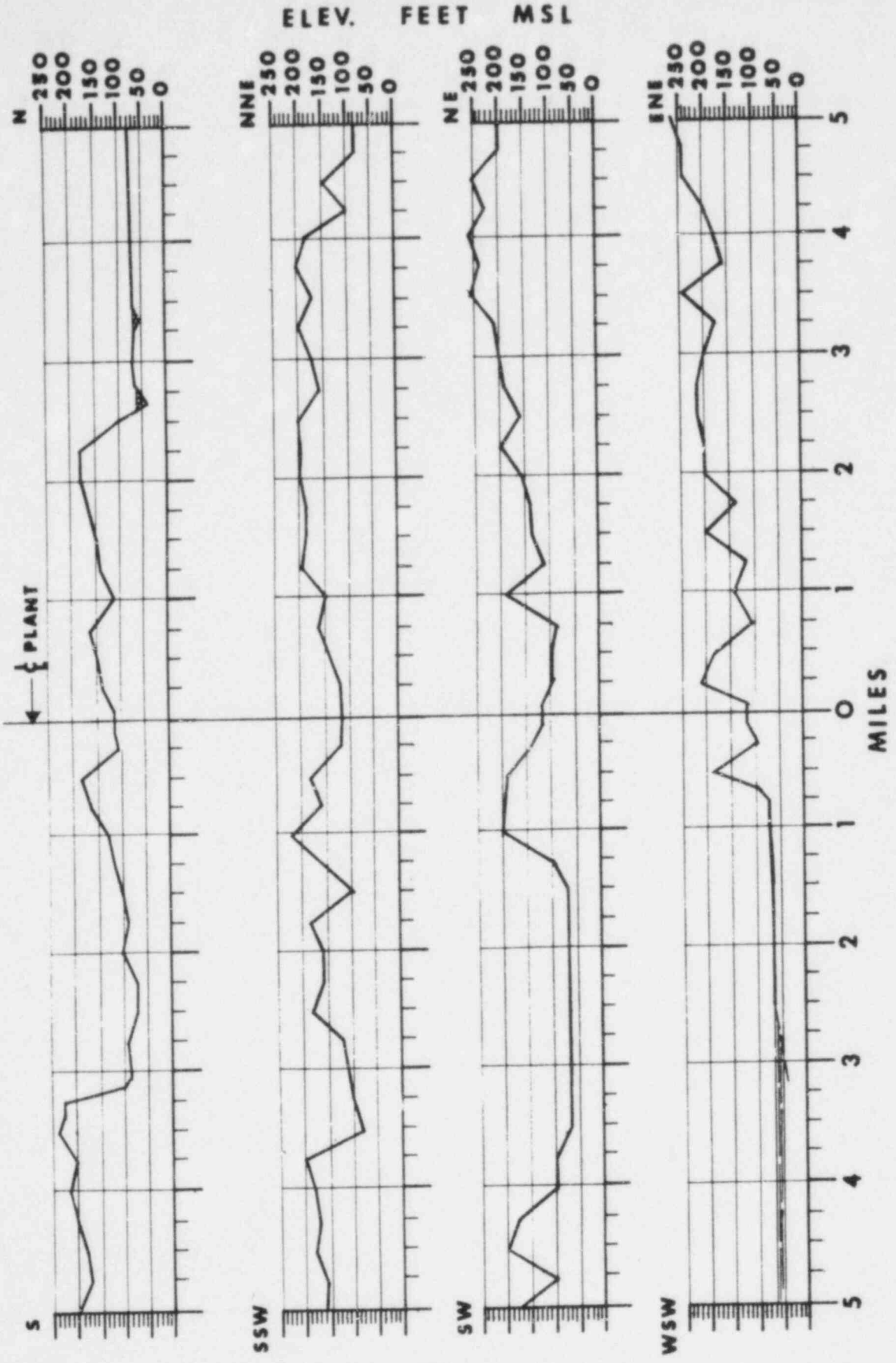
MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

LOW SPEED WIND ROSE
AUGUST 1972 - JULY 1973

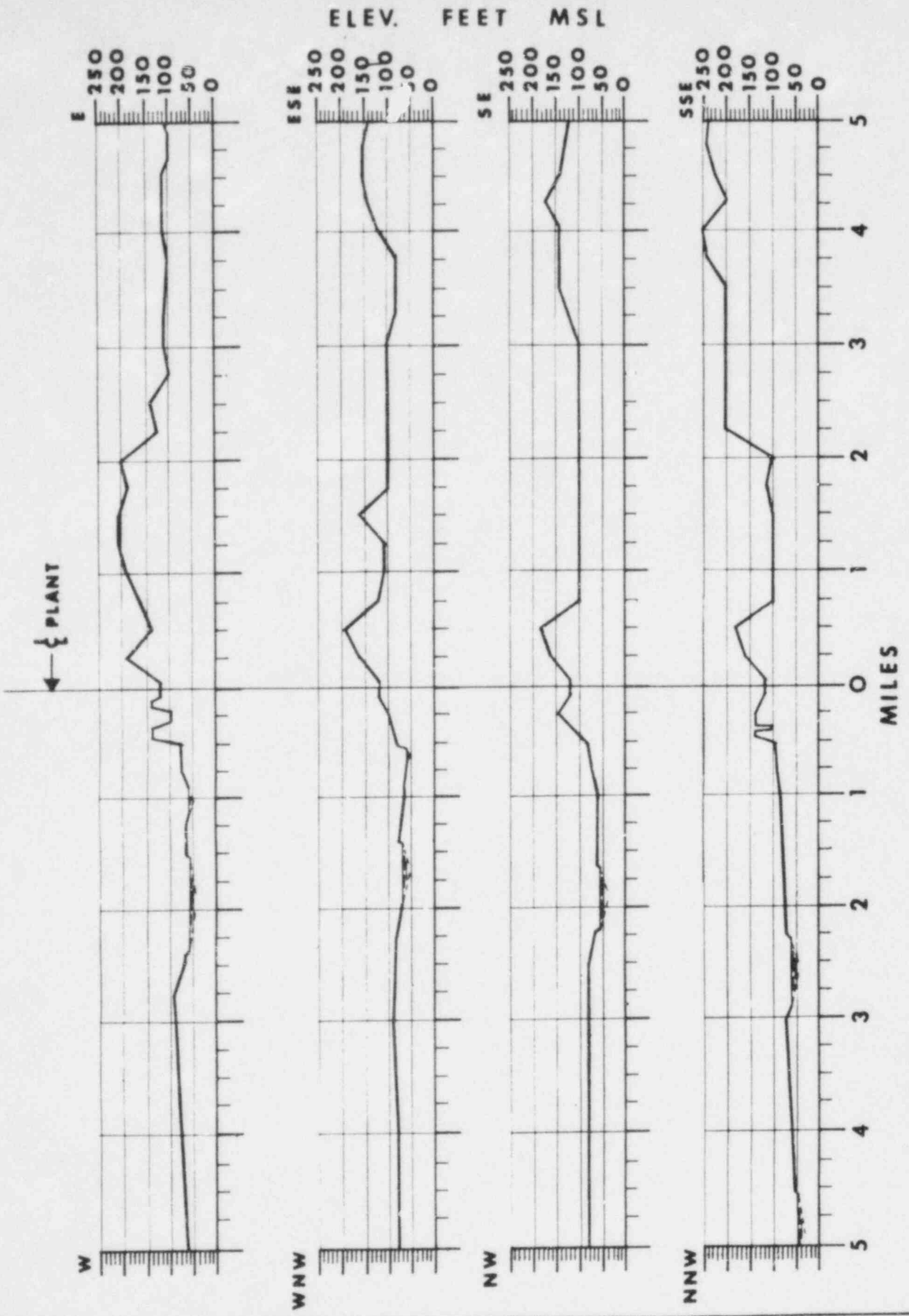
FIGURE 2.3-6



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	COMPARISON OF WIND DIRECTION AND SLOW SPEEDS (<7 MPH) AT GRAND GULF, MISS., UNDER STABLE ATMOSPHERIC CONDITIONS, 1973-1974, 1972-1973 FIGURE 2.3-7



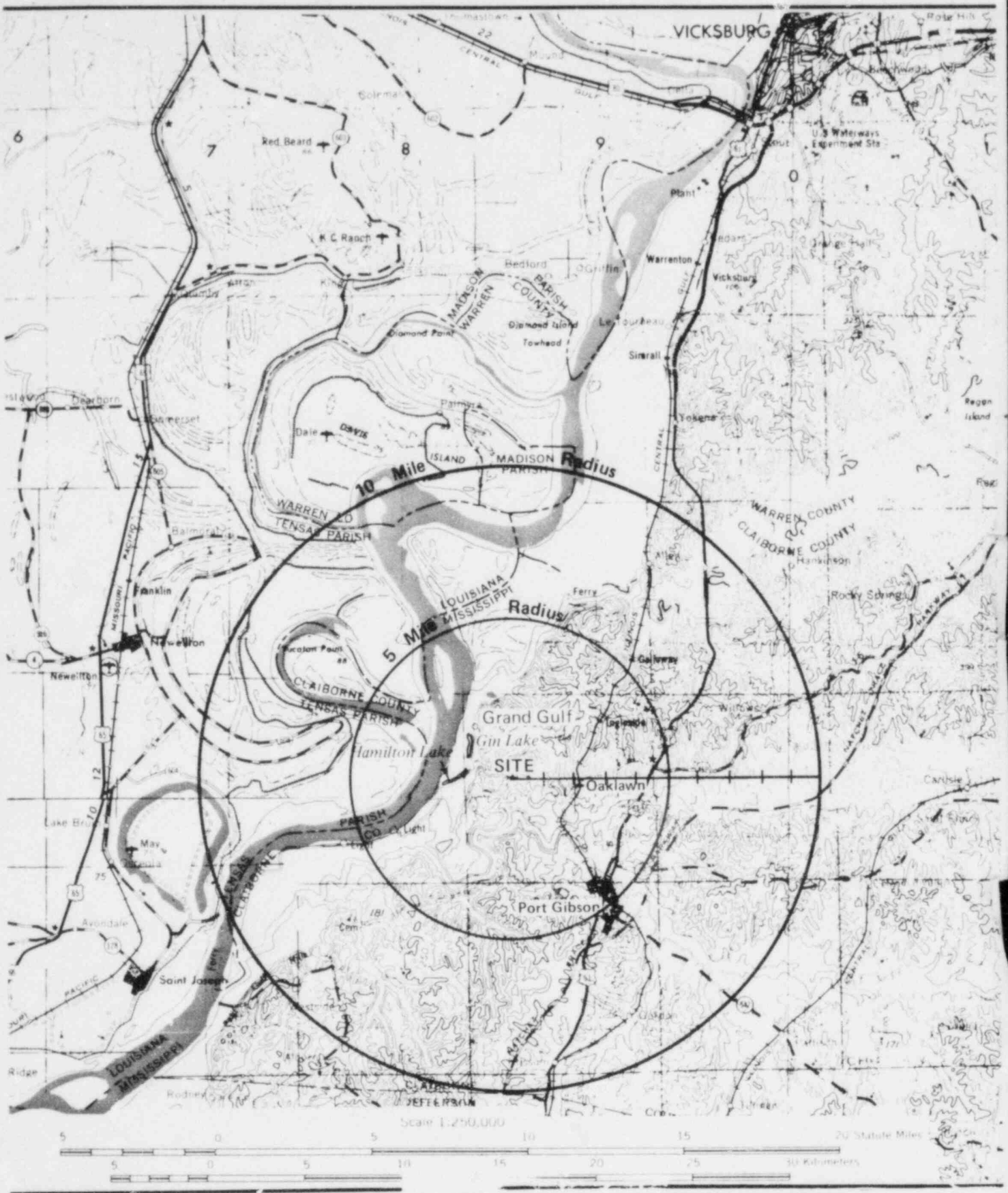
MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	TOPOGRAPHIC PROFILES FIGURE 2.3-8



MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

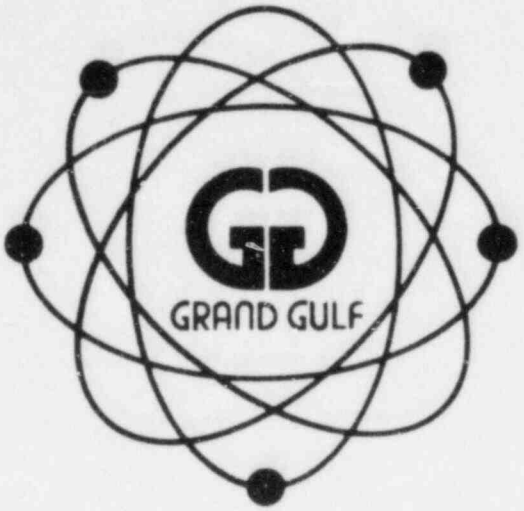
TOPOGRAPHIC PROFILES

FIGURE 2.3-9



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	TOPOGRAPHIC PLAN OF AREA WITHIN 5 MILES OF PLANT FIGURE 2.3-10

FINAL ENVIRONMENTAL REPORT



GRAND GULF NUCLEAR STATION

UNITS 1 AND 2

MISSISSIPPI POWER & LIGHT COMPANY

MIDDLE SOUTH ENERGY, INC.

MIDDLE SOUTH UTILITIES SYSTEM

VOLUME 2

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SUMMARY TABLE OF CONTENTS

CHAPTER 1.0

PURPOSE OF THE PROPOSED FACILITY AND ASSOCIATED TRANSMISSION

		Page
1.1	SYSTEM DEMAND AND RELIABILITY	1.1-1
1.2	OTHER OBJECTIVES	1.2-1
1.3	CONSEQUENCES OF DELAY	1.3-1

CHAPTER 2.0

THE SITE AND ENVIRONMENTAL INTERFACES

2.1	GEOGRAPHY AND DEMOGRAPHY	2.1-1
2.2	ECOLOGY	2.2-1
2.3	METEOROLOGY	2.3-1
2.4	HYDROLOGY	2.4-1
2.5	GEOLOGICAL SUMMARY	2.5-1
2.6	REGIONAL HISTORIC, ARCHEOLOGICAL, ARCHITECTURAL, SCENIC, CULTURAL, AND NATURAL FEATURES	2.6-1
2.7	NOISE	2.7-1

CHAPTER 3.0

THE STATION

3.1	EXTERNAL APPEARANCE	3.1-1
3.2	REACTOR AND STEAM ELECTRIC SYSTEM	3.2-1
3.3	STATION WATER USE	3.3-1
3.4	HEAT DISSIPATION SYSTEM	3.4-1
3.5	RADWASTE SYSTEMS AND SOURCE TERMS	3.5-1
3.6	CHEMICAL AND BIOCIDE WASTES	3.6-1

SUMMARY TABLE OF CONTENTS (Cont.)

		Page
3.7	SANITARY AND OTHER WASTE SYSTEMS	3.7-1
3.8	REPORTING OF RADIOACTIVE MATERIAL MOVEMENT	3.8-1
3.9	TRANSMISSION FACILITIES	3.9-1
	CHAPTER 4.0	
	ENVIRONMENTAL EFFECTS OF SITE PREPARATION, STATION CONSTRUCTION, AND TRANSMISSION FACILITIES CONSTRUCTION	
4.1	SITE PREPARATION AND STATION CONSTRUCTION	4.1-1
4.2	TRANSMISSION FACILITIES CONSTRUCTION	4.2-1
4.3	RESOURCES COMMITTED	4.3-1
4.4	RADIOACTIVITY	4.4-1
4.5	CONSTRUCTION IMPACT CONTROL PROGRAM	4.5-1
	CHAPTER 5.0	
	ENVIRONMENTAL EFFECTS OF STATION OPERATION	
5.1	EFFECTS OF OPERATION OF HEAT DISSIPATION SYSTEM	5.1-1
5.2	RADIOLOGICAL IMPACT FROM ROUTINE OPERATION	5.2-1
5.3	EFFECTS OF CHEMICAL AND BIOCIDE DISCHARGES	5.3-1
5.4	EFFECTS OF SANITARY WASTE DISCHARGES	5.4-1
5.5	EFFECTS OF OPERATION AND MAINTENANCE OF THE TRANSMISSION SYSTEMS	5.5-1
5.6	OTHER EFFECTS	5.6-1
5.7	RESOURCES COMMITTED	5.7-1
5.8	DECOMMISSIONING AND DISMANTLING	5.8-1

SUMMARY TABLE OF CONTENTS (Cont.)

		Page
	CHAPTER 6.0	
	EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS	
6.1	PREOPERATIONAL ENVIRONMENTAL PROGRAMS	6.1-1
6.2	PROPOSED OPERATIONAL MONITORING PROGRAMS	6.2-1
6.3	RELATED ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAMS	6.3-1
6.4	PREOPERATIONAL ENVIRONMENTAL RADIOLOGICAL MONITORING DATA	6.4-1
	CHAPTER 7.0	
	ENVIRONMENTAL EFFECTS OF ACCIDENTS	
7.1	STATION ACCIDENTS INVOLVING RADIOACTIVITY	7.1-1
7.2	TRANSPORTATION ACCIDENTS INVOLVING RADIOACTIVITY	7.2-1
7.3	OTHER ACCIDENTS	7.3-1
	CHAPTER 8.0	
	ECONOMIC AND SOCIAL EFFECTS OF STATION CONSTRUCTION AND OPERATION	
8.1	BENEFITS	8.1-1
8.2	COSTS	8.2-1
	CHAPTER 9.0	
	ALTERNATIVE ENERGY SOURCES AND SITES	
9.1	ALTERNATIVES NOT REQUIRING THE CREATION OF NEW GENERATING CAPACITY	9.1-1
9.2	ALTERNATIVES REQUIRING THE CREATION OF NEW GENERATING CAPACITY	9.2-1
9.3	COST EFFECTIVENESS ANALYSIS OF CANDIDATE SITE-PLANT ALTERNATIVES	9.3-1
9.4	COSTS OF ALTERNATIVE POWER GENERATION METHODS	9.4-1

GG
ER

SUMMARY TABLE OF CONTENTS (Cont.)

		Page
	CHAPTER 10.0	
	STATION DESIGN ALTERNATIVES	
10.1	CIRCULATING COOLING WATER SYSTEM	10.1-3
10.2	INTAKE SYSTEM	10.2-1
10.3	DISCHARGE SYSTEM	10.3-1
10.4	CHEMICAL WASTE TREATMENT	10.4-1
10.5	BIOCIDE TREATMENT	10.5-1
10.6	SANITARY WASTE SYSTEM	10.6-1
10.7	LIQUID RADWASTE SYSTEM ALTERNATIVES	10.7-1
10.8	GASEOUS RADWASTE SYSTEM ALTERNATIVES	10.8-1
10.9	TRANSMISSION FACILITIES	10.9-1
10.10	OTHER SYSTEMS	10.10-1
	CHAPTER 11.0	
	SUMMARY COST-BENEFIT ANALYSIS	
11.1	BENEFITS	
11.2	COSTS	
11.3	CONCLUSION	
	CHAPTER 12.0	
	ENVIRONMENTAL APPROVALS AND CONSULTATION	
	CHAPTER 13.0	
	REFERENCES	

2.4 HYDROLOGY

2.4.1 Introduction

The Grand Gulf Nuclear Station site is located in the loessial uplands on the east bank of the Mississippi River in the vicinity of River Mile 406. The two-unit plant utilizes natural draft cooling towers for dissipating the condenser heat load. The makeup and service water is supplied by a series of radial collector wells located in the floodplain parallel to the Mississippi River. During normal operation, plant service water is discharged to the cooling towers to supply the required cooling tower makeup water. The cooling tower blowdown is diverted to the discharge basin, and then to the Mississippi River via a single pipeline. Emergency service water is provided from closed, buried, concrete basins.

The following sections describe the hydrological, physical, chemical, and biological characteristics of the hydrologic environment in the vicinity of the Grand Gulf site, including their typical seasonal ranges and averages and their historical lows and highs. The hydrologic environment is divided into surface water and ground water environments. The characteristics of each of the two environments are described separately.

2.4.2 Surface Water Hydrology

2.4.2.1 Mississippi River

The dominant hydrologic feature in the vicinity of the site is the Mississippi River (Figure 2.4-1). In the Grand Gulf region, the Mississippi River is characterized by a wide alluvial floodplain, flanked to the east by high loessial bluffs. The floodplain in the vicinity of the site is about 60 miles wide; however, the levee system to the west reduces the width to 2 to 4 miles. The floodplain adjacent to the site is relatively low and flat with elevations ranging from 55 to 75 feet msl.

The plant site is located in the loessial uplands with a plant grade elevation of 132.5 feet msl. This elevation is well above the water levels in the Mississippi River as summarized below:

Item	Elevation, feet msl
U. S. Corps of Engineers Design Project Flood	96.2

West bank levee existing grade	103.0
100-year flood elevation	91.4
Mean annual flood elevation	75.5
Low-water elevation (Lowest recorded at Vicksburg projected to Grand Gulf)	28.0

The drainage pattern of the Mississippi River is that of a river in a stage of maturity with meanders and oxbow lakes. The average water surface slope of the Mississippi River in the vicinity of the site is between 0.1 and 0.4 feet/mile.

The Mississippi River is known to have undergone, and is presently undergoing, lateral shifting near the Grand Gulf region. This is evidenced by the presence of oxbow lakes, low lying swamps, and sand bars. The river divides itself around Middle Ground Island, rejoining at approximately River Mile 408 (Figure 2.4-2). In order to stabilize the river alignment, the Corps of Engineers has carried out extensive river control work in this area. This includes construction of a submerged dike across the western channel for diverting flow to the eastern channel and revetments from approximately River Mile 400.8 to 409.6. The revetments in the two sections from approximately River Mile 400.8 to 405.0 and 408.5 to 409.6 were completed first. The intervening section, which includes the river stretch near the Grand Gulf site, was left unprotected to undergo erosion until it attains an acceptable alignment. A revetment of articulated concrete mattress was completed in 1975 between River Mile 405.0 and 406.0. Based on the June 1980 hydrographic survey (Figure 2.4-2), the revetment from River Mile 406.0 to the barge ship at River Mile 406.7 has also been completed. The upper banks are paved with riprap. It is expected that these measures, together with the future completion of the revetment between River Mile 406.7 and 408.5, will stabilize the Mississippi River near the site. 5

In addition to changes in river alignment, the cross section of the Mississippi River undergoes changes with the river discharge. Figure 2.4-3 shows channel cross sections, during and after the flood in 1973, about 1000 feet downstream of the barge slip into which the blowdown is discharged (see Fig. 2.1-1). These changes occur mainly in the river bottom far from the blowdown discharge structure. Furthermore, the bottom elevation of the barge slip at its junction with the river is 39.23 feet msl, about 40 feet above the river bed. The barge slip bed near the blowdown discharge structure is concrete lined and the side slopes are riprapped. No scouring is, therefore, expected near the blowdown discharge structure. In addition, there is no surface water supply intake for the Grand Gulf Nuclear Station. Therefore, changes in the river cross section will not affect plant operation.

The Mississippi River has three major tributaries upstream of the site (the Missouri, Ohio, and Arkansas Rivers) and one downstream (the Red River). Floods occur in the Lower Mississippi River chiefly as a result of flooding in its tributaries. The flood season extends from mid-December to July. The number of peaks, duration of near-peak flow, and the flood volume during a year vary greatly. Flood discharges at three key stations during six of the highest floods of record are summarized in Table 2.4.1. Water surface profiles for the floods on the Mississippi River between Red River Landing and Arkansas City in 1937, 1961, and 1969, are shown in Figure 2.4-4.

Floods in the Lower Mississippi River are confined on the west bank by a system of levees. The levees are designed to contain the U. S. Army Corps of Engineers' Design Project Flood with design freeboards. In the vicinity of the Grand Gulf site the water surface elevation corresponding to the Design Project Flood is 96.2 feet msl, with freeboard of not less than 5 feet.

Seasonal variations in streamflow of the Mississippi River are evident in the observed mean flows at Vicksburg, Mississippi, given in Table 2.4.2, for the period from 1929 to 1973. The major flows usually occur during the months of March and April (Ref. 1).

Low flow records from 1932 to 1979 (Table 2.4.3) for Vicksburg show that a minimum 1-day flow of 99,400 cfs was recorded on November 1, 1940 (Ref. 2). During the same year, the mean 30-day low flow was 108,000 cfs. A stage of 39.2 feet msl at Vicksburg was observed on February 3, 1940, when the discharge was reduced by ice jams upstream. |5

Table 2.4.4 gives the 1-, 7-, and 30-day low flows for different recurrence intervals at Vicksburg (obtained from the U. S. Geological Survey). The 7-day, 10-year low flow is 129,000 cfs. The minimum design water level for the radial collector wells is 28 feet msl. This corresponds to a river discharge of about 100,000 cfs, which is equal to the 30-day, 100-year low flow. |5

Figure 2.4-5 shows the rating curve for the Mississippi River at the Grand Gulf site. The rating curve at the site is based on the rating curve at Vicksburg. It is obtained by correlating the stages at Vicksburg and at the site during the period 1972 to 1974, and using the data from water surface profiles (Figure 2.4-4). The discharges at the two locations are assumed equal, since there are no major tributary streams between these locations except the Big Black River, which has a runoff of less than 1 percent of the Mississippi River flows at Vicksburg.

2.4.2.2 Local Streams

The upland region in which the Grand Gulf site is located contains numerous streams. The drainage is of the dendritic pattern, being characterized by irregular branching of tributary streams in many directions. Several such streams flow from the uplands into the oxbow lakes or the Mississippi River. The average channel gradients in the uplands are on the order of 40 to 60 feet/mile. Ground elevations range between 100 and 250 feet msl.

Two streams are located in the plant vicinity (Figure 2.4-6). One of them drains an area of 2.8 square miles (basin A) while the other, in which most plant facilities are located, drains an area of about 0.6 square miles (basin B), up to points A and B, respectively, where the streams discharge into the floodplain of the Mississippi River (Figure 2.4-6).

Based on field observations, the flow in the local stream draining basin A is perennial, while the flow in the stream draining basin B is intermittent. No systematic data on the flow characteristics of these streams are available on a long-term basis. However, some flow measurements were made during 1973 (Refs. 3 and 4), and these are summarized in Table 2.4.5. During rainstorms, the two streams convey the surface runoff from the plant and surrounding area. The quantity and quality of the surface runoff into these streams will not be affected significantly during plant operation, since the patterns of natural drainage have not been significantly changed. Most plant effluents are discharged into the discharge basin which discharges to the barge slip at the Mississippi River. The surface runoff from streams A and B discharges into Hamilton Lake, which is connected to the Mississippi River.

The alignment of the channel draining basin B has been modified around the cooling tower for Unit 1, and the channel has been concrete-lined up to an expected water surface elevation resulting from a 100-year rainfall. For the most part the natural drainage patterns have not been changed; where modifications have been made, they are to increase drainage efficiency. Refer to section 4.1.2.4.3 for the details of the erosion control measures for the site area.

371.02

2.4.2.3 Local Lakes

There are a number of lakes in the vicinity of the site as well as several swamps and slack-water areas. The lakes are mostly of the oxbow type. Those situated between the levees and the river channel have indirect or seasonal connections with the river and are submerged during floods. Hamilton and Gin Lakes

are located on the site. They are surrounded by slack-water areas and have partially active connections with the Mississippi River. The areal extent and depth of water in these lakes vary seasonally.

Gin and Hamilton Lakes have a direct connection with the Mississippi River when the water levels in the river are at or above elevation 63 and 56 ft msl, respectively. The Mississippi River at the site has a water level elevation of 56 to 63 ft msl on the average during February through June. On the basis of the flow duration analysis (Ref. 1) of the Mississippi River near Vicksburg, Mississippi (period 1931-1967), it is estimated that the river water level at the Grand Gulf Nuclear Station will exceed elevation 56 ft msl and 63 ft msl about 36 percent and 24 percent of the time, respectively.

The Corps of Engineers bank stabilization plans will not affect the connection of the above lakes to the Mississippi River. The bank stabilization plans consist of placing the articulated concrete mattress under water up to low water level and stone (riprap) paving above the water. During this process, no existing outlets or connections to the river are modified.

Hamilton and Gin Lakes were connected by a stream channel running through the wetlands between the lakes. However, due to construction of the haul road, this connecting channel has been modified and the flow in the lakes is connected by a series of culverts under the haul road in the vicinity of the old stream channel. Figure 2.4-12 shows the lake and Mississippi River stage hydrographs in the vicinity of the site.

2.4.3 Physical Properties of Surface Waters

2.4.3.1 Flow Velocity

The U. S. Army Corps of Engineers has made limited velocity measurements on the Mississippi River in the vicinity of the site. Pertinent data on the locations and velocities measured are presented in Table 2.4.6. Measured average velocities in the channel vary from 3.7 to 6.7 fps, corresponding to river discharges of about 425,000 and 1,493,000 cfs, respectively.

Mississippi River current velocities at various depths were measured on September 25, 1975 at five stations located on a cross-river transect about 1000 feet downstream of the barge slip (Ref. 4). The velocities ranged from 1.3 fps near the bottom to a maximum of 3.5 fps near the surface. Surface velocities near the river banks were about 2 fps, whereas they were over 3 fps midstream. The river discharge was about 293,000 cfs with an average velocity of about 2 fps.

301.4

2.4.3.2 Water Temperature

As part of the environmental field measurements programs, water temperature measurements were carried out for the Mississippi River near the Grand Gulf site and for Gin and Hamilton Lakes for the base period November 1972 to November 1973 (Ref. 5). During this period, the temperature ranged from 40 F to 84 F. The temperature values at the site were found to be almost identical to those recorded at Vicksburg, Mississippi, where long-term data exist. The Mississippi River water temperatures at Vicksburg are, therefore, used for assessing long-term behavior of the water temperature. Table 2.4.7 summarizes these data for the period 1962 to 1979. The water temperature of the Mississippi River at Vicksburg seldom falls below the freezing point. 5

Figure 2.4-7 presents vertical temperature profiles at four stations (for locations of these stations see Figure 2.4-8) based on temperature measurements taken on February 19, 1973. The rates of temperature change with depth are extremely small, and the river can be considered well-mixed from top to bottom.

2.4.4 Water Quality

In a recent survey made on the Lower Mississippi River (Ref. 1), it was found that the chemical quality of water in the Mississippi River changes very little from the Arkansas State Line (River Mile 505) to Baton Rouge (River Mile 236). In the 1974 Report to Congress on the quality of the waters of the Nation, prepared by the Environmental Protection Agency (Ref. 6), the locations of urban areas, agricultural areas, and industrial point sources of pollutants along the entire length of the Mississippi River are given. There are no such sources of pollutants within 50 miles of the site. The water quality station nearest the plant site is at St. Francisville, Louisiana (River Mile 270). Table 2.4.8 presents the chemical analysis of Mississippi River water near and below St. Francisville.

Tests have been carried out on surface water samples of the Mississippi River near the site and of Hamilton and Gin Lakes for the period November 1972 to November 1973 (Refs. 4 and 5). Pertinent data on the water quality of the Mississippi River at stations 3 and 11 are summarized in Table 2.4.9. The values determined for the Mississippi River are characteristic of a hard, turbid water, rich in suspended solids. Near the site, the observed range of dissolved oxygen values is 5 to 11 mg/l.

2.4.5 Ground Water

2.4.5.1 Regional Conditions

The principal sources of ground water in the region (Claiborne County and bordering areas of Warren, Hinds, Copiah and Jefferson Counties, in Mississippi, and Tensas Parish, in Louisiana) are the Holocene alluvial deposits of the Mississippi River floodplain, the Pleistocene terrace deposits, and the Miocene Catahoula Formation. Water-bearing formations below the Catahoula are rarely used in the vicinity because of their great depth and generally poor quality of the water. Geologic formations dip south across the region at an average gradient of 26 feet/mile and strike east-west. The regional water table slopes southward, generally conforming to the attitude of geologic structure and land surface (Ref. 7).

2.4.5.2 Plant Site Conditions

Geologic and foundation exploratory borings indicate that the site is mantled by permeable Holocene and Pleistocene sediments. Holocene alluvial sand, clay, and gravel deposits immediately under the floodplain or western portion of the site, with several feet of organic silty clay forming the surface over most of the area. In the area between the Mississippi River and Hamilton and Gin Lakes, alluvial sands and gravels extend to depths of about 100 feet below the surficial clay deposits (Figure 2.4-9). East of the lakes, the sand and gravel deposits become thinner and intermingle with silt and clay lenses. A clay lens (remnant of an ancient Mississippi River meander) lies beneath Hamilton and Gin Lakes. It extends downward to within 20 feet of the top of the Catahoula at some locations, thus limiting the thickness of the alluvial sands and gravels. Ground water within the floodplain alluvium occurs under unconfined conditions, with water levels generally within 5 to 20 feet of ground surface. The Mississippi River controls ground water levels in the floodplain to a large extent.

The eastern upland area of the site is blanketed by 22 to 82 feet of Pleistocene loess. The loess deposits generally lie above the regional water table. However, saturated zones were encountered at a few locations just above the contact between the loess and the underlying terrace deposits. These are localized occurrences in areas where terrace clay lenses form impermeable surfaces on which downward migrating water accumulates.

The loess deposits are underlain by 0 to 151 feet of Pleistocene terrace deposits consisting of discontinuous lenses and layers of sand, gravel, silt, and clay. Ground water within the

terrace deposits occurs under unconfined and perched conditions. Perched water tables were encountered at various depths in the areas indicated on Figure 2.4-9. In the general vicinity of the station, the Catahoula surface forms a ridge-like feature which rises to about El. 90 feet msl. The top of this feature is about 20 feet above the regional water table elevation. At certain locations on this feature, it appears that recharge from precipitation percolates through the terrace deposits and accumulates on the relatively impermeable Catahoula surface before reaching the regional water table. At other locations, such as OW 201 and OW 208 (Figure 2.4-9), perched water tables result where terrace clay lenses form impermeable basins in which downward-migrating ground water collects.

The Catahoula is continuous across the entire site and lies beneath the alluvium and terrace deposits, and, at a few locations, directly beneath the loess. It consists of lenticular beds of fine-sand, silty clay and clayey silt, with occasional silt and fine sand seams, locally indurated. Ground water occurs in the sand strata in the upper portion of the formation. Water-bearing zones within the lower portion of the formation consist of thin, fine-grained sand layers (usually less than 10 feet thick) which are contained between thick clay or clayey silt layers.

Values of permeability (hydraulic conductivity), total and effective porosity, bulk density, storage coefficient, and dispersion and distribution (sorption) coefficients for the various deposits represented at the site are given in Tables 2.4.10 and 2.4.11.

In the floodplain alluvium, the primary source of recharge is infiltration of precipitation; however, the Mississippi River provides recharge during high river stages. The primary source of recharge to the terrace deposits is via percolation through the overlying loess. Water-bearing zones within the Catahoula receive recharge from percolation through overlying terrace or alluvium.

2.4.5.3 Ground Water Withdrawals and Use

Most of the water wells in the region are used for domestic purposes. The Catahoula Formation supplies water for the majority of these wells. Use of ground water from alluvial and terrace deposits is limited to areas bordering the Mississippi River and its larger tributaries. The only concentrated ground water withdrawal near the site is the Port Gibson municipal water system, located about 5 miles southeast of the site.

This municipal system comprises five wells which are completed in the Catahoula Formation and provide a daily average of 640,000 gallons (Ref. 7).

A survey of water users within 2 miles of the site revealed that most use rainwater stored in cisterns, rather than wells (Figure 2.4-10 and Table 2.4.12). Twenty-nine wells were surveyed. Of these, four lie within the site boundary and will be abandoned prior to completion of the Grand Gulf Nuclear Station. Of the remaining 25 wells, 12 are developed in the Catahoula Formation, 11 in the Pleistocene terrace deposits, and 2 in the Mississippi River alluvium.

The estimated total ground water withdrawal within a 2-mile radius of the site is about 500 gpd. Future ground water demands are expected to parallel population growth. From Table 2.1.1, the population within 2 miles of the plant is expected to increase by 36 persons in the next 50 years. It is conservatively assumed that the additional residents will all use well water and that per capita use will remain constant. The estimated total ground water use by the year 2020 is about 7500 gpd. Because of this gradual increase, no change of ground water flow direction due to offsite use is foreseen.

2.4.5.4 Ground Water Levels and Movements

There are three levels of ground water in the site area: (1) the regional water table in the Mississippi River alluvium and adjacent terrace deposits, (2) perched water tables in the terrace deposits, and (3) the potentiometric level of the confined aquifer within the Catahoula Formation. Ground water levels measured in selected piezometers (Table 2.4.13) and observation wells (Table 2.4.14) are presented as hydrographs in Figure 2.4-11 (5 sheets). Hydrographs of water levels of the Mississippi River in the vicinity of the site and in Gin and Hamilton Lakes, based on field observations from 1972 to 1976, are shown on Figure 2.4-12. In the site area, the ground water table slopes gently westward, with local gradients dipping toward the major tributary valleys. The gradient steepens toward Hamilton and Gin Lakes. West of the lakes, the ground water table slopes toward the river at a gradient that varies with the prevailing river stage (Figure 2.4-9). The regional ground water table within the site property ranges from about 60 to 80 feet msl during normal river elevations. The normal ground water gradient in the floodplain and the bluffs is temporarily reversed during flood stages of the Mississippi River. Figure 2.4-13 shows the configuration of the ground water table at the site during the spring flood of 1973. These ground water contours represent the highest ground water levels recorded at the site during the period January 1972 to May 1976. The water level contours shown in Figures 2.4-9 and 2.4-13 indicate that the interaction of ground water and surface water in the site area is such that the ground water discharges into the Mississippi River during normal conditions and receives recharge

371.03

from the river during flood conditions. The water levels in Hamilton and Gin Lakes rise only when the lakes are recharged by the river during high flow periods (Figure 2.4-12). The water level fluctuations in observation wells and Hamilton and Gin Lakes (Figures 2.4-11 and 2.4-12) indicate that the lakes are not in direct hydraulic communication with the ground water.

The ground water levels recorded in observation wells F-4 and F-6 and the water level in Hamilton Lake during the long-term pumping test of collector wells 3 and 5 are shown on the hydrograph in Figure 2.4-15. Hamilton Lake is located between observation wells F-4 and F-6 (Figure 371.07-1). The hydrograph indicates that the drawdown cone created during the test lowered ground water levels beneath Hamilton Lake. This phenomenon further indicates that Hamilton Lake is not in direct hydraulic communication with the ground water.

Perched water zones occur in the areas indicated on Figure 2.4-9. The perched water levels range from 90 to 130 feet msl in the site area. The highest perched water level (130 feet msl) was recorded at observation well OW-201, located near the eastern site property line. Observation wells OW-6, OW-6A, OW-6B, OW-6C, OW-115A, OW-115B, OW-116, and OW-118 were constructed in the perched water zone in the vicinity of the power blocks for Units 1 and 2. The highest perched water level recorded in these wells was 112 feet msl at OW-6A (Figure 2.4-11, Sheets 4 and 5).

The water levels in observation wells and piezometers constructed within the Catahoula Formation range from about 55 to 80 feet msl during normal river elevations. The highest water level recorded in observation wells or piezometers in the Catahoula was 113 feet at P-117A; however, the hydrograph of P-117A (Figure 2.4-11, Sheet 5) indicates that the piezometer is not functioning properly. Therefore, the 113-foot water level does not represent actual ground water conditions. In the immediate station vicinity, the regional water table intersects the Catahoula Formation (Figure 2.4-14). In this area the Catahoula surface forms a ridge-like feature which rises above the regional water table to about 90 feet msl.

2.4.5.5 Ground Water Quality

Several samples of ground water and surface water were taken for chemical analyses to evaluate the quality of water in the site area. Ground water samples were taken from piezometers and observation wells at the site and from private wells completed in each of the local aquifers within the limits of the water-well survey. Surface water samples were obtained from the Mississippi River and Bayou Pierre. Locations where water samples were taken are shown on Figure 2.4-10, and results of chemical analyses are presented in Table 2.4.15.

Chemical analyses of samples taken from the Mississippi River alluvial aquifer indicate the water is a sodium-calcium bicarbonate type, high in total dissolved solids (358 to 604 ppm). Samples of ground water from the terrace deposits are a calcium-magnesium bicarbonate type with a total dissolved solids contents of 277 to 442 ppm. The total dissolved solids concentration of a water sample from the Catahoula Formation is 460 ppm. The surface water samples are low in dissolved solids and less mineralized than ground water sampled in the site locality.

The results of past chemical analysis of both Mississippi surface water (Subsection 2.4.4) and the Mississippi alluvial aquifer (Subsection 2.4.5.5) will be supplemented by the water quality monitoring program for the plant service water (PSW) system (Subsection 3.4.2.2). This program calls for daily analysis of the PSW for pH, conductivity, alkalinity, hardness, and iron. The weekly analytical program calls for microbiological analyses and determination of total suspended solids, free available chlorine, and total residual chlorine. The daily and weekly sampling schedules and parameters will be adjusted as necessary for proper system operation. 6

2.4.6 References

1. U. S. Army Corps of Engineers, Mississippi River Commission, Lower Mississippi Region Comprehensive Study, Vicksburg, Mississippi, Appendices C and L, 1974.

2. U. S. Geological Survey, Surface Water Records, Water Supply Papers, 1929-1973.

3. Mississippi Power & Light Company, "Environmental Field Measurements Programs," Grand Gulf Nuclear Station Units 1 and 2, Interim Reports, 1973.

4. Mississippi Power & Light Company, "Environmental Field Measurements Programs", Grand Gulf Nuclear Station Units 1 and 2, Final Report, 1973.

5. Mississippi Power & Light Company, "Environmental Field Measurements Programs", Grand Gulf Nuclear Station Units 1 and 2, Supplementary Report, 1974.

6. Environmental Protection Agency, National Water Quality Inventory Report to the Congress, Office of Water Planning and Standards, Washington, D. C. (EPA-440/9-74-001), Vol. 1, 1974.

7. Callahan, J.A., et al, 1963, Water Resources of Adams, Claiborne, Jefferson, and Warren Counties, Mississippi: U.S. Geol. Survey and Mississippi Ind. and Tech. Res. Com. Bull. 63-1.

TABLE 2.4.1

FLOOD DISCHARGE AT KEY LOCATIONS ON MISSISSIPPI RIVER DURING SIX HIGHEST FLOODS OF RECORD*

	Maximum Discharge in 1000 cfs					
Station	1913	1927	1937	1945	1950	1973
St. Louis	487	889	374	610	466	852
Cairo	1971	1800	2002	1470	1624	1534
Vicksburg	1783	2278	2080	1922	1876	1962

*Based on Corps of Engineers and USGS Water Supply Papers

TABLE 2.4.2

OBSERVED MEAN DISCHARGE, 1000 cfs,
AT VICKSBURG, MISS.

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Annual
1929	284	363	619	516	812	999	1464	1530	1523	744	340	223	785
1930	241	429	470	838	1046	933	618	553	452	266	143	147	511
1931	144	132	182	160	210	370	553	479	362	230	224	214	272
1932	182	165	619	924	1300	928	827	580	334	560	278	205	573
1933	193	239	329	833	864	818	1140	1160	1050	293	264	246	616
1934	182	165	249	429	204	583	735	341	216	184	172	191	305
1935	202	206	402	496	720	838	1357	1076	1181	942	433	281	677
1936	154	290	368	473	402	695	1093	636	264	198	125	127	402
1937	263	356	267	869	1944	1140	567	896	583	430	251	222	641
1938	175	275	237	452	759	963	1135	691	839	546	493	269	567
1939	267	214	248	349	958	1367	1179	936	469	476	276	160	573
1940	110	122	130	146	263	608	647	751	388	352	235	236	333
1941	134	157	280	388	413	325	495	467	454	369	197	251	327
1942	493	709	361	408	596	805	1044	716	605	711	369	346	596
1943	321	382	523	987	675	672	1040	1072	1383	677	363	228	693
1944	174	213	179	242	333	959	1227	1392	702	483	262	279	537
1945	278	200	294	698	459	1494	1848	1315	1117	831	356	257	764
1946	554	368	485	1021	989	957	792	687	783	531	329	232	642
1947	230	448	471	718	698	461	952	1088	1021	881	296	230	623
1948	174	249	301	418	594	1175	1331	867	356	576	471	207	560
1949	174	301	637	1021	1500	1241	1071	627	632	538	328	270	650
1950	331	348	447	1269	1796	1414	1061	953	780	617	604	580	844
1951	388	366	703	769	996	1241	1143	977	655	1010	580	484	775
1952	347	551	923	1013	1113	966	1262	929	514	375	276	222	705
1953	154	154	294	352	561	838	817	857	578	359	278	188	452
1954	145	142	173	296	406	373	409	583	380	310	216	198	302
1955	258	270	239	491	466	976	1010	567	456	332	230	166	455
1956	238	217	243	150	810	955	735	546	397	334	309	214	427
1957	158	160	286	388	983	644	909	892	1106	736	375	274	572
1958	260	574	866	715	595	627	806	1070	565	682	849	358	663
1959	304	254	313	333	823	791	681	558	476	303	303	216	443
1960	484	354	517	715	702	650	944	794	638	586	282	271	578
1961	215	249	272	315	315	1090	1161	1261	897	430	430	357	584
1962	377	479	681	729	988	1276	1368	729	528	385	296	280	674
1963	299	295	280	351	318	851	901	433	392	269	240	192	402
1964	149	152	185	221	322	821	1033	755	348	327	213	213	395
1965	230	211	472	567	695	774	1166	803	517	428	272	385	542
1966	503	287	268	504	631	675	504	982	489	270	253	225	466
1967	212	268	465	392	416	684	695	853	616	642	378	245	491
1968	275	390	675	764	767	553	1029	701	839	416	407	236	586
1969	268	340	523	632	1233	613	917	898	525	747	438	287	615
1970	361	340	369	588	616	698	877	1158	693	380	326	288	557
1971	498	529	474	678	679	1121	597	597	475	359	354	285	554
1972	256	289	569	684	555	808	743	1011	405	471	420	336	546
1973	414	825	1063	1106	1162	1111	1774	1850	1244	613	473	324	995
Mean	268	311	421	587	749	865	970	858	649	493	358	259	563

Source: U.S.G.S. Water Supply Papers

TABLE 2.4.3

MINIMUM DAILY FLOWS AND STAGES OBSERVED ON
MISSISSIPPI RIVER
VICKSBURG, MISSISSIPPI
1932 - 1979*

Water Year	Date	Minimum Daily Discharge, 1000 cfs	Stage, feet msl
1932	Nov 19	127	49.12
1933	Oct 3	156	51.32
1934	Aug 18 Nov 29, 30	142	47.87
1935	Nov 3	157	48.58
1936	Aug 29, 31 Sept 1, 2	101	42.73
1937	Sept 30	156	46.36
1938	Dec 21	141	43.12
1939	Sept 29	128	42.08
1940	Nov 1	99	39.35
1941	Oct 31	118	39.42
1942	Oct 7	268	49.13
1943	Sept 25 - 27	214	48.52
1944	Jan 1	156	43.72
1945	Nov 7 - 13	178	45.42
1946	Sept 14	188	46.42
1947	Oct 17	182	45.52
1948	Oct 18, 25	156	44.32
1949	Oct 8	150	45.22
1950	Dec 2, 3	223	48.82
1951	Nov 8, 9	248	51.92
1952	Sept 30	183	47.42
1953	Nov 3	132	44.02
1954	Nov 24 - 28	136	41.87
1955	Sept 23	143	43.72
1956	Jan 27, 28	128	40.62
1957	Oct 28	133	42.12

TABLE 2.4.3 (Cont.)

Water Year	Date	Minimum Daily Discharge, 1000 cfs	Stage, feet msl
1958	Oct 17	230	49.22
1959	Sept 28	162	43.87
1960	Oct 1	175	44.22
1961	Nov 5, 6	187	46.32
1962	Aug 29, 30	217	48.82
1963	Sept 30	163	44.22
1964	Jan 8	126	40.52
1965	Nov 9	179	45.62
1966	Sept 21	202	47.12
1967	Nov 7	197	46.52
1968	Sept 14	204	49.02
1969	Oct 1	237	50.72
1970	Sept 19	222	51.12
1971	Aug 26	249	52.72
1972	Oct 20	208	50.12
1973	Sept 26	291	55.32
1974	Oct 16	289	52.90
1975	Oct 14	303	55.72
1976**	Sept 30	170	46.35
1977**	Aug 14	178	46.64
1978**	Nov 17	217	49.34
1979**	Nov 2	371	58.73

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*Source U.S.G.S. Water Supply Papers

**Personal Communication with U.S. Army Corps of Engineers, Vicksburg

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TABLE 2.4.4

LOW-FLOW VALUES, CFS, FOR 1, 7 AND 30 DAYS

FOR SELECTED RETURN PERIODS FOR

MISSISSIPPI RIVER AT VICKSBURG, MISSISSIPPI*

Duration Days	Return Period, year			
	5	10	100	
1	142,000	125,000	93,000	
7	147,000	129,000	95,000	5
30	161,000	141,000	100,000	

* Obtained from U.S.G.S. Statistical output for Vicksburg Gaging Station based on the period of record of 1933 - 1979. 5

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TABLE 2.4.5

MAXIMUM DISCHARGES OF STREAM DRAINING BASIN A

AT STATION 2*

Date	Max. Discharge,** cfs
Feb. 3, 1973	25
March 4, 1973	30
March 10, 1973	140
March 16, 1973	400
March 24, 1973	390
April 7, 1973	30
April 24, 1973	210
April 26, 1973	60
May 2, 1973	375
June 12, 1973	10

*For location of Station 2, see Figure 2.4-6
** Based on Figures 4.2-13 of Interim Report (Ref. 3) and 2.2-17 of Final Report (Ref. 4)

TABLE 2.4.6

VELOCITY, DISCHARGE, AND WATER SURFACE ELEVATIONS FOR MISSISSIPPI RIVER AT SITE

River Mile	Date	Total Width, Feet	Total Average Depth, Feet	Total Area, Feet^2	Average Velocity, fps	Discharge cfs	Slope, fpm	Temperature, F	ALWP, Feet	Water Surface Elevation Feet
408.40	12-14-71	2,450	34.9	82,525	5.97	510,805	0.6912	48	34.20	54.50
	3-18-71	2,425	61.4	148,900	5.23	778,121	0.5862	47	34.20	73.65
	10-6-70	2,628	20.2	53,073	4.08	216,642	0.6475	70	34.20	59.63
407.6	12-14-71	3,350	31.6	105,750	5.11	540,748	0.7133	48	34.00	53.95
	3-18-71	3,600	53.0	190,925	5.86	1,119,309	0.5044	47	34.00	73.22
	10-6-70	3,600	35.4	127,375	4.75	605,089	0.4326	71	34.00	56.66
406.8	12-14-71	3,050	31.1	94,800	6.19	586,514	0.1280	48	33.70	53.50
	3-19-71	3,925	56.2	220,450	6.77	1,492,672	0.3524	47	33.70	72.87
	10-14-70	3,026	35.1	106,221	4.16	442,136	0.2353	66	33.70	49.12
406.0	3-31-70	3,292	46.0	151,482	4.46	675,368	0.3007	49	33.50	59.03
	10-14-70	3,262	33.9	110,522	3.89	430,175	0.2353	66	33.50	48.93
	3-19-71	3,405	54.9	187,075	6.44	1,205,089	0.3524	47	33.50	72.58
395.6	12-20-71	3,500	41.8	146,400	5.25	769,121	-0.0179	50	31.80	56.96
	3-23-71	3,927	49.3	193,715	5.31	1,029,399	0.0574	49	31.80	67.02
	10-16-70	3,789	29.9	113,463	3.75	425,273	0.2840	65	31.80	44.79

Source: Based on data supplied by U. S. Army Corps of Engineers.

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TABLE 2.4.7

RANGES OF WATER TEMPERATURES FOR MISSISSIPPI RIVER
AT VICKSBURG, MISSISSIPPI*

Range of Temperatures, F

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1962	34-41	44-50	43-48	48-60	64-78	77-80	82-86	82-84	80-84	64-73	52-60	41-52
1963	33-40	35-38	40-52	54-65	66-70	72-80	81-85	83-86	72-82	70-74	56-65	36-52
1964	34-44	42-43	44-51	52-65	66-78	74-82	82-85	80-86	75-84	62-71	49-63	42-44
1965	40-47	35-42	39-44	46-62	62-74	75-76	81-84	80-84	73-80	62-70	58-61	45-51
1966	34-47	35-44	42-54	54-63	61-70	72-79	80-87	78-86	73-82	60-68	49-65	42-51
1967	38-46	41-47	41-54	56-66	62-68	69-82	76-82	79-84	70-78	62-70	51-55	42-49
1968	35-42	39-44	39-50	51-65	66-71	70-79	79-84	81-85	71-79	64-73	50-62	43-49
1969	38-44	41-45	43-50	50-62	62-73	73-79	81-85	79-84	74-81	58-73	50-57	43-48
1970	30-40	39-42	45-49	51-65	63-73	74-80	80-84	79-84	78-84	62-72	48-61	44-50
1971	40-41	39-42	44-50	49-63	65-70	70-82	80-86	79-84	76-86	70-77	51-70	47-50
1972	42-50	40-46	46-53	53-62	62-	75-80	77-85	83-84	79-83	57-75	47-60	40-47
1973	38-44	41-43	46-55	54-61	64-77	72-82	82-86	81-84	75-80	66-75	56-61	43-57
1974	37-47	44-48	46-57	54-69	67-74	73-76	76-86	81-83	69-83	64-68	52-67	45-49
1975	43-47	42-50	40-50	48-60	61-72	70-78	77-79	76-84	68-83	61-69	48-62	42-52
1976	38-43	40-50	51-55	57-64	61-67	69-79	78-84	80-84	75-79	58-73	46-55	42-46
1977	34-37	35-45	44-55	57-65	66-78	77-82	80-84	76-83	71-78	56-70	49-60	38-48
1978	35-38	30-38	38-44	48-58	58-64	68-80	82-84	80-85	74-80	60-72	54-60	42-50
1979	32-42	32-40	38-48	51-58	59-70	69-76	76-80	78-81	69-79	61-70	47-59	40-46

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*Source: U.S. Army Corps of Engineers

TABLE 2.4.8

CHEMICAL ANALYSES OF WATER FROM THE MISSISSIPPI RIVER
NEAR ST. FRANCISVILLE, LOUISIANA
(in milligrams per liter, except as noted)

Date Sampled	Discharge*, 10^3 cfs	Silica (SiO_3)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue at 180 C)	Hardness as $CaCO_3$ Calcium magnesium	Hardness as $CaCO_3$ Non-Carbonate	Specific conductance (Micromhos at 25 C)	pH	Color
Mississippi River near St. Francisville, La.																		
10-13-70	322	5.1	0.01	34	9.7	12	4.3	115	36	14	0.2	3.8	184	120	31	312	7.0	5
11-10-70	405	5.5	-	46	14.0	24	4.3	143	65	26	.2	4.6	264	170	55	444	7.2	10
12-3-70	384	-	-	-	-	-	-	-	-	-	-	-	-	-	-	411	-	-
12-17-70	291	8.1	-	51	12.0	20	3.9	157	61	17	.2	4.4	284	180	49	437	7.6	20
1-6-71	569	6.4	.05	39	8.4	13	3.4	106	46	17	.1	-	-	-	-	-	-	-
1-21-71	516	7.0	.03	36	7.8	13	3.0	99	42	16	.1	4.3	189	120	41	304	7.4	10
2-4-71	404	-	-	-	-	-	-	-	-	-	-	-	-	-	-	342	-	-
2-23-71	620	6.8	-	32	7.3	12	2.9	89	39	15	.2	3.2	213	110	37	288	7.2	80
3-5-71	907	-	-	-	-	-	-	-	-	-	-	-	-	-	-	315	-	-
3-18-71	871	14.0	.02	32	8.0	10	3.1	89	38	13	.2	5.0	172	110	40	287	7.4	20
4-6-71	525	9.1	.02	41	12.0	14	3.7	128	15	15	.2	6.7	230	150	45	365	8.0	5
4-27-71	359	-	-	-	-	-	-	-	-	-	-	-	-	-	-	463	-	-
5-6-71	349	6.6	.02	44	14.0	18	3.8	152	53	16	.2	3.5	252	170	43	410	8.0	10
6-1-71	438	6.7	.03	36	9.7	15	3.4	102	51	15	.2	3.5	199	130	46	332	8.1	15
6-15-71	346	-	-	-	-	-	-	-	-	-	-	-	-	-	-	398	-	-
9-15-71	203	4.5	.02	42	13.0	27	3.5	150	57	24	.2	1.0	264	160	34	438	7.0	20
Mississippi River below St. Francisville, La.																		
10-13-70	322	5.0	0.01	36	8.8	13	4.3	118	38	17	0.2	2.0	186	130	29	316	6.9	5
10-27-70	340	-	-	-	-	-	-	-	-	-	-	-	-	-	-	374	-	-
11-10-70	405	4.5	-	44	13.0	21	4.3	142	58	21	.2	4.1	254	160	46	427	7.2	5
12-3-70	384	-	-	-	-	-	-	-	-	-	-	-	-	-	-	421	-	-
12-16-70	283	5.5	-	50	14.0	18	3.6	155	61	18	.2	4.5	257	180	57	433	7.2	5
1-6-71	569	7.0	.04	38	8.5	13	3.2	103	46	16	.2	4.0	189	130	45	323	7.2	25
2-4-71	404	7.8	.04	40	11.0	12	2.0	120	45	16		2.9	196	140	46	332	7.0	15
2-18-71	596	-	-	-	-	-	-	-	-	-	-	-	-	-	-	347	-	-
3-5-71	907	-	-	-	-	-	-	-	-	-	-	-	-	-	-	308	-	-
3-25-71	742	7.5	.02	33	9.1	11	3.4	101	39	14	.2	4.7	184	120	37	303	8.0	5
4-6-71	525	8.6	.02	40	12.0	13	3.4	128	46	15	.2	4.5	218	150	44	361	7.9	10
5-6-71	349	7.1	.03	44	14.0	18	3.7	148	56	17	.3	3.5	243	170	46	410	8.0	15
6-2-71	418	-	-	-	-	-	-	-	-	-	-	-	-	-	-	344	-	-
6-15-71	346	-	-	-	-	-	-	-	-	-	-	-	-	-	-	410	-	-
6-12-71	348	-	-	-	-	-	-	-	-	-	-	-	-	-	-	449	-	-
9-15-71	203	3.9	.02	42	12.0	26	3.4	142	57	24	.2	1.5	260	160	40	437	7.3	15

* Estimated from Vicksburg Data

Source: Lower Mississippi Region, Comprehensive Study, Appendix C, Vol 1, 1974

TABLE 2.4.9

SUMMARY OF WATER QUALITY PARAMETERS FOR MISSISSIPPI RIVER AT GRAND GULF
NOVEMBER 1972 THROUGH NOVEMBER 1973

Parameter	Location	No. of Samples	Mean	Standard Deviation	Standard Error	Minimum	Maximum	Date Initiated
Temperature, C	3	27	17.60	7.92	1.52	4.22	28.79	7-25-72
	11	27	17.73	6.33	0.94	4.60	33.68	8-3-72
Dissolved oxygen, mg/l	3	25	8.64	1.72	0.34	5.50	11.23	11-6-72
	11	25	8.60	1.61	0.32	5.65	11.50	11-6-72
Biochemical oxygen demand, mg/l	3	21	2.2	2.6	0.6	0.3	11.0	12-20-72
	11	21	1.9	2.3	0.5	0.1	10.9	12-20-72
Apparent color, Pt-Co units	3	21	8.0	5.0	1.0	2.0	18.0	1-15-73
	11	21	7.0	5.0	1.0	2.0	18.0	1-15-73
Chlorine Demand (Total available residual, 1-hr), mg/l	3	19	2.77	0.75	0.17	1.86	4.70	2-6-73
	11	20	2.62	0.80	0.18	1.58	4.78	2-6-73
Chlorine demand (Free available residual 1-hr), mg/l	3	20	2.69	0.89	0.20	0.73	4.86	2-6-73
	11	19	2.50	0.69	0.22	1.54	4.86	2-6-73
Conductivity, micromhos/cm^2	3	21	317	85	18	125	542	11-6-72
	11	22	331	74	16	150	544	11-6-72
Total solids, mg/l	3	21	373	106	23	149	594	1-15-73
	11	21	393	107	23	233	630	1-15-73
Dissolved solids, mg/l	3	21	242	68	15	21	340	1-15-73
	11	21	231	61	13	143	400	1-15-73
Suspended solids, mg/l	3	21	133	90	20	8	360	1-15-73
	11	21	162	92	20	65	439	1-15-73
Total hardness (as $CaCO_3$), mg/l	3	20	138	26	6	92	189	2-6-73
	11	20	148	29	6	112	248	2-6-73
Turbidity, ftu	3	25	88	25	5	16	120	11-22-72
	11	25	84	34	7	0	138	11-22-72
Total Alkalinity (as $CaCO_3$), mg/l	3	18	105	22	5	73	151	2-6-73
	11	18	110	18	4	87	151	2-6-73
pH, standard units	3	25	7.5	0.3	0.1	7.0	8.2	10-25-72
	11	25	7.5	0.3	0.1	6.8	8.2	10-25-72
Nitrite - Nitrogen (as N), mg/l	3	21	0.02	0.01	0.00	<0.01	0.04	1-15-73
	11	21	0.02	0.01	0.00	<0.01	0.04	1-15-73
Nitrate - Nitrogen (as N), mg/l	3	21	0.65	0.26	0.06	<0.04	1.02	1-15-73
	11	21	0.72	0.24	0.05	<0.11	1.02	1-15-73
Total phosphorus (as P), mg/l	3	21	0.21	0.17	0.04	<0.01	0.59	1-15-73
	11	21	0.20	0.17	0.04	<0.01	0.50	1-15-73
Dissolved phosphorus (as P), mg/l	3	21	0.07	0.09	0.02	<0.01	0.32	1-15-73
	11	21	0.06	0.09	0.02	<0.01	0.32	1-15-73

*Based on Table 2.9 of Environmental Field Measurements Programs, Supplementary Report, 1974 (Ref. 5)

TABLE 2.4.10

PERMEABILITY TEST RESULTS

Test Well 1

Location[1]	Depth, feet	Formation	Drawdown Permeability, cm/sec	Recovery Permeability cm/sec
TW#1	153	Terrace	--	2.4×10^{-1}
OW29A	130	Terrace	2.6×10^{-1}	2.8×10^{-1}
OW29B	153	Terrace	2.8×10^{-1}	2.6×10^{-1}
OW69A	100	Terrace	2.1×10^{-1}	-
OW69B	95	Terrace	1.4×10^{-1}	2.1×10^{-1}
OW73	110	Terrace	1.4×10^{-1}	-
OW9	100	Terrace	2.4×10^{-1}	-

Variable Head Permeability Tests

Location[1]	Depth, feet	Formation	Drawdown Permeability, cm/sec
P34B	40	Terrace	4×10^{-3}
P34C	55	Terrace	8×10^{-2}
P 4	275	Catahoula	6.3×10^{-9}
TW-3	121	Terrace	2.6×10^{-4}

Laboratory Consolidation Tests

Location[1]	Depth, feet	Formation	Unified Classification	Permeability, cm/sec
B-110	114-116	Catahoula	CL	4.3×10^{-8}
B-110	137-139	Catahoula	CL	2.4×10^{-8}
B-120	114-116	Catahoula	CL	5.8×10^{-8}
B-120	134-136	Catahoula	CL	2.2×10^{-8}
B-120	144-146	Catahoula	SC	2.9×10^{-8}
B-4	19-20	Alluvium	CH	7.8×10^{-8}
B-4	49-51	Alluvium	ML	5.9×10^{-8}

1. Well, piezometer, and boring locations are shown in Figure 2.4-9

TABLE 2.4.11

SITE HYDROGEOLOGIC PARAMETERS

	Terrace Deposits	Clay-Silt Alluvium	Sand-Gravel Alluvium
Total Porosity	0.40	0.48	0.35
Effective Porosity	0.25	0.25	0.25
Bulk Density (gm/ml)	2.07	1.87	1.87
Storage Coefficient	0.15	0.10	0.15
Longitudinal Dispersion Coefficient ($ft^2/yr.$)	1.87	0.018	1.32
Distribution Coefficient (ml/gm) Sr-90	8.79	7.24	7.24
C_S-137	314.95	259.29	259.29

TABLE 2.4.12

WATER-USE SURVEY, VICINITY OF SITE

Well Number	Owner	Type	Well Depth, feet	Well Diameter, inches	Yield gpm	Source of Water	Use of Water
1	Mr. White	Drilled	63	4	*	Alluvium	Domestic
2	D. O. Gladjo	Driven	35	3	*	Alluvium	Domestic
3	W. C. Towme	Cistern	--	--	--	Rain Water	Domestic
4	Grand Gulf Park	Drilled	257	4	*	Catahoula Fm	Domestic
5	Sylvia Tyler	Drilled	230	2	8	Catahoula Fm	Domestic
6	C. H. Brown	Drilled	80+	*	*	Alluvium	Domestic
7	J. Turner	Cistern	--	--	--	Rain Water	Domestic
8	Mrs. Carter	Cistern	--	--	--	Rain Water	Domestic
9	J. Frazier	Drilled	230	4	*	Catahoula Fm	Domestic
10	J. Hudson	Cistern	--	--	--	Rain Water	Domestic
11	Lenora McAlpin	Cistern	--	--	--	Rain Water	Domestic
12	H. Turner	Cistern	--	--	--	Rain Water	Domestic
13	*	Cistern	--	--	--	Rain Water	Domestic
14	*	Cistern	--	--	--	Rain Water	Domestic
15a	W. Hatcher	Drilled	100	*	5-6	Terrace	Domestic
15b	W. Hatcher	Drilled	400	*	9	Catahoula Fm	Domestic
15c	W. Hatcher	Drilled	196	*	*	Catahoula Fm	Domestic
16	C. Hays	Cistern	--	--	--	Rain Water	Domestic
17	C. Hays	Cistern	--	--	--	Rain Water	Domestic
18	T. Hall	Cistern	--	--	--	Rain Water	Domestic
19	E. McGee	Cistern	--	--	--	Rain Water	Domestic
20	*	Cistern	--	--	--	Rain Water	Domestic
21	*	Cistern	--	--	--	Rain Water	Domestic
22	*	Cistern	--	--	--	Rain Water	Domestic
23	*	Cistern	--	--	--	Rain Water	Domestic
24	Ruth Keller	Cistern	--	--	--	Rain Water	Domestic
25	*	Cistern	--	--	--	Rain Water	Domestic
26	L. Frazier	Drilled	150	2	*	Catahoula Fm	Domestic
27	H. Gain	Cistern	--	--	--	Rain Water	Domestic
28	Essie Price	Cistern	--	--	--	Rain Water	Domestic
29	Rosie Dobson	Cistern	--	--	--	Rain Water	Domestic
30	H. Wells	Cistern	--	--	--	Rain Water	Domestic
31	J. R. Trimble	Drilled	165	*	*	Terrace	Domestic
32	Viola Ward	Cistern	--	--	--	Rain Water	Domestic
33	C. Garver	Cistern	--	--	--	Rain Water	Domestic
34	R. Thomas	Cistern	--	--	--	Rain Water	Domestic
35	Maggie Jackson	Cistern	--	--	--	Rain Water	Domestic
36	Faye Sullivan	Cistern	--	--	--	Rain Water	Domestic
37	*	Cistern	--	--	--	Rain Water	Domestic
38	A. L. Arnold	Drilled	286	*	*	Catahoula Fm	Domestic, stock
39	Deer Creek Hunting Club	Drilled	215	6.5	12	Catahoula Fm	Domestic
40	Clyde Hays #1	Drilled	150	4	5-10	Terrace	Restaurant
41	Clyde Hays #2	Drilled	280	4	dry-aband.	Catahoula Fm	
42	Clyde Hays #3 (Mrs)	Drilled	240	4	25	Catahoula Fm	Restaurant
43	Essie Pierson	Drilled	180	4	dry-aband.	Terrace	
44	Essie Pierson	Drilled	148	4	dry-aband.	Terrace	
45	Jordan Davis, Jr.	Drilled	50	4	10-20	Alluvium	Domestic
46	Wiley Hatcher	Drilled	386	4	24	Catahoula Fm	Domestic
47	James Marsalis	Drilled	400	4	5	Catahoula Fm	Domestic

TABLE 2.4.12 (Cont.)

Well Number	Owner	Type	Well Depth, feet	Well Diameter, inches	Yield gpm	Source of Water	Use of Water
48	Dwight Gladjo	Drilled	275	4	10	Catahoula Fm	Domestic
49	J. E. Cassell	Drilled	150	4	10	Terrace	Domestic
50	River Road Dev. Co. (Arnold's Acres) #1	Drilled	75	4	60	Terrace	Trailer Park
51	River Road Dev. Co. (Arnold's Acres) #2	Drilled	70	4	50	Terrace	Trailer Park
52	River Road Dev. Co. (Arnold's Acres) #3	Drilled	180	4	25	Terrace	Trailer Park
53	River Road Dev. Co. (Arnold's Acres) #4	Drilled	75	4	dry-aband.	Terrace	Trailer Park
54	River Road Dev. Co. (Arnold's Acres) #5	Drilled	60	4	dry-aband.	Terrace	Trailer Park
55	River Road Dev. Co. (Arnold's Acres) #6	Drilled	60	4	dry-aband.	Terrace	Trailer Park

*Information not available

NOTE: Cistern and well locations are shown on Figure 2.4-10.

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TABLE 2.4.13

PIEZOMETER INVENTORY

Piezometer Number	Hole Depth (feet)	Elevation Top of Casing (feet msl)	Perforated Interval (feet msl)	Casing Diameter (inch)	Formation[1]	Water Level Elevation (feet msl) Highest Water Level 1972	'73	'74	'75	'76	Lowest Water Level 1972	'73	'74	'75	'76
P4	447	79.35	-188 to -213	1	C	62	89	83	78	64	55	57	62	61	61
P5	142	156.39	18 to 15	3	C	77	82	82	83	81	75	72	79	79	79
P11	51	82.53	34 to 31	3	T	75	88	82			69	72	77		
P17	105	153.26	57 to 47	3	T	71	71	71			70	70	71		
P34A	29	95.76	71 to 66	1	A	77	90	84			70	74	79		
P34B	41	95.78	55 to 53	3	T	75	84	82			70	73	80		
P34C	59	96.19	39 to 36	3	T	75	84	82			70	70	78		
P34D	110	95.10	8 to -16	1	C	73	86	79			66	71	75		
P37	42	96.82	58 to 53	3	A	77	84	84			72	74	79		
P57	173	93.48	-81	3	C	68	81	74			61	67	78		
P95	195	160.59	-31 to -37	3	C	70	81	76			66	67	71		
P111	249	192.40	-16 to -58	3	C	71	80	78			69	71	75		
P117A	178	144.68	-30 to -35	3	C	70	110	113			69	70	110		
P117B	118	143.83	33 to 24	3	C	75	84	82			73	75	79		
P201	191	193.36	1 to 0	3	T	82	83	83			71	76	79		

[1] A=Alluvium; C=Catahoula; T=Terrace Deposits

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TABLE 2.4.14

OBSERVATION WELL INVENTORY

Well Number	Depth (feet)	Elevation Top of Casing (feet msl)	Perforated Interval (feet msl)	Casing Diameter (inch)	Formation[1]	Water Level Elevation (feet msl) Highest Water Level 1972	'73	'74	'75	'76	Lowest Water Level 1972	'73	'74	'75	'76
OW4	80	77.86	7 to - 3	3	A	75	89	79	75		70	71	75	75	
OW5	110	157.08	54 to 44	3	T	77	83	82	83	81	72	73	78	80	79
OW6	116	207.24	90	4	T	105	95				92	94			
OW6A	115	208.22	91	1	T	112	112				108	111			
OW6B	110	207.46	107 to 97	3	T	111	106	105			72	104	105		
OW6C	114	207.13	101 to 91	3	T		98	98				98	98		
OW7	100	158.49	56	1-1/4	T	76	84	83	84	80	102	75	80	76	79
OW8	93	81.77	-11	1-1/4	A	72	88	77			66	70	74		
OW9	100	157.04	65 to 55	3	T	75	84	83			70	72	77		
OW10	98	156.98	78 to 58	1-1/4	C	87	84	85	86	84	75	77	81	82	83
OW12	100	156.56	63 to 53	3	T	75	84	83			72	73	77		
OW29A	130	162.84	29	3	T	73	84	84	82	76	70	73	74	74	71
OW29B	153	160.64	6	1	T	77	84	87			69	73	77		
OW35	57	103.09	53 to 43	1-1/4	A	80	83	81			66	72	77		
OW43	80	74.12	4 to - 6	1	A	73	89	81	74		50	52	50	60	
OW69A	100	85.22	- 5 to -15	1	A	75	89	82	81	77	69	72	73	74	74
OW69B	95	83.36	- 2 to -12	1	A	75	89	83			69	72	77		
OW73	110	121.68	9	1	T	73	84	81			70	73	77		
OW94	135	174.88	48 to 38	3	T	74	84	84			72	74	79		
OW95	115	160.55	53 to 43	3	T	75	85	84			72	75	78		
OW107	65	164.21	102 to 97	[illegible]	T										
OW108	60	156.08	106 to 96	[illegible]	T										
OW112	105	194.05	97 to 87	3	T	95	95	95			94	94	94		
OW115A	72	152.38	89 to 79	1	T		97	96				95	95		
OW115B	73	153.45	88 to 78	3	T		97	97				95	95		
OW116	100	196.47	105 to 95	3	T	96	96	96			94	95	95		
OW117	50	144.52	103 to 93	3	T										
OW118	39	122.91	92 to 82	3	T	106	107	107			96	101	103		
OW118B	39	124.22	93 to 83	3	T		106	106				101	102		
OW121	125	157.29	30	3	T	76	85	81			70	71	76		
OW201	131	193.05	70 to 60	3	T	130	120	97	93		107	98	90	91	
OW202	157	195.52	36	3	T	76	85	82	95	80	73	75	78	79	79
OW208	117	199.71	95 to 80	3	T										
OW209A	105	195.63	88	3	T				90	89				88	88
OW209B	150	198.15	56 to 46	3	C	84	82	80			78	76	76		
TW#1	153	159.25	50 to 10	8	T	71	84	83			67	70	75		

1/ A = Alluvium; C = Catahoula; T = Terrace Deposits

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TABLE 2.4.15

RESULTS OF CHEMICAL ANALYSES OF WATER SAMPLES

	A	B	C	D	E	F	G	H	J	K	L
pH	7.9	7.2	8.3	7.6	8.0	7.3	7.4	7.1	7.8	7.6	7.2
Dissolved carbon dioxide (ppm)	8.2	5.5	1.5	4.6	4.4	37.0	22.0	58.0	7.0	23.0	10.0
Conductivity (mhos/cm)	640.0	250.0	480.0	75.0	375.0	490.0	450.0	460.0	325.0	430.0	210.0
Color (co-Pt units)	5.0	5.0	10.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Total solids (ppm)	664.0	514.0	516.0	184.0	408.0	626.0	548.0	448.0	508.0	434.0	902.0
Suspended solids (ppm)	60.0	88.0	56.0	106.0	50.0	154.0	98.0	6.0	192.0	22.0	625.0
Dissolved solids (ppm)	604.0	426.0	460.0	78.0	358.0	472.0	450.0	442.0	316.0	412.0	277.0
Total hardness as $CaCO_3$ (ppm)	285.1	275.3	4.0	20.2	290.4	443.3	405.7	350.8	141.9	326.8	208.0
Calcium (ppm)	66.2	64.3	0.8	3.3	70.7	99.2	92.4	68.5	30.8	62.8	-
Magnesium (ppm)	29.0	27.8	0.5	2.9	28.5	47.4	42.4	43.6	15.8	41.2	-
Alkalinity as $CaCO_3$ (ppm PP)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
(MO)	596.0	372.0	368.0	30.0	326.0	445.0	401.0	371.0	114.0	337.0	210.0
Silica (ppm)	17.5	16.5	12.4	17.1	17.5	22.5	22.5	22.5	7.0	22.5	17.5
Chlorides (ppm)	9.8	6.8	18.0	5.5	4.8	3.5	5.5	5.5	18.0	5.5	9.0
Sulfates (ppm)	2.1	5.3	3.7	8.2	2.5	*0.1	*0.1	*0.1	45.7	*0.1	22.6
Nitrates (ppm)	*0.05	*0.05	*0.05	*0.05	*0.05	*0.05	*0.05	0.05	*0.05	0.10	0.3
Iron (ppm)	*0.3	*0.3	*0.3	3.6	*0.3	*0.3	*0.3	*0.020	*0.020	*0.020	0.55
Manganese, (ppm)	0.44	0.22	*0.013	0.013	0.019	3.4	*0.05	*0.009	*0.009	*0.009	*0.03
Potassium (ppm)	5.9	5.9	7.4	1.5	3.6	1.6	2.0	1.46	3.69	1.79	1.8
Sodium (ppm)	94.2	44.2	158.0	7.1	11.9	6.6	7.2	12.3	19.5	8.2	15.5
Lead (ppm)	*0.05	*0.05	*0.05	*0.05	*0.05	*0.05	*0.05	*0.009	*0.009	*0.009	*0.01
Zinc (ppm)	0.19	0.32	*0.05	0.60	0.23	1.0	0.50	*0.020	*0.020	*0.020	*0.02
Copper (ppm)	*0.01	*0.01	*0.01	*0.01	*0.01	-	0.0	*0.020	*0.020	*0.020	*0.01
Aluminum (ppm)	*0.1	*0.1	*0.1	*0.1	*0.1	*0.1	*0.1	*0.009	*0.009	*0.009	*0.01
Coliform	--	--	--	--	--	Negative	Negative	--	--	--	-
Arsenic (ppm)	0.009	0.009	0.003	0.009	0.001	-	--	0.005	0.009	0.004	0.011
Chromium (ppm)	--	--	--	--	--	*0.005	--	*0.009	*0.009	*0.009	*0.01
Fluoride, (ppm)	--	--	0.10	0.10	0.10	-	--	0.10	0.10	0.10	0.10

Sample Identification and Date of Sample Collection

A - Well 6[2/]; Mississippi River Alluvium, 2/9/72
B - Well 31; Pleistocene Terrace Deposits, 2/10/72
C - Well 4; Catahoula Formation, 2/10/72
D - Bayou Pierre (surface water), 2/9/72
E - Well 1; Mississippi River Alluvium, 2/9/72
F - P11; Mississippi river Alluvium, 5/3/72
G - OW4; Mississippi River Alluvium, 5/3/72
H - Test Water Well 1, Pleistocene Terrace Deposits, 6/30/72
J - Mississippi River (surface water), 6/29/72
K - Piezometer p34 (El. +55); Pleistocene Terrace Deposits, 5/24/72
L - OW118; Pleistocene Terrace Deposits, 10/10/72

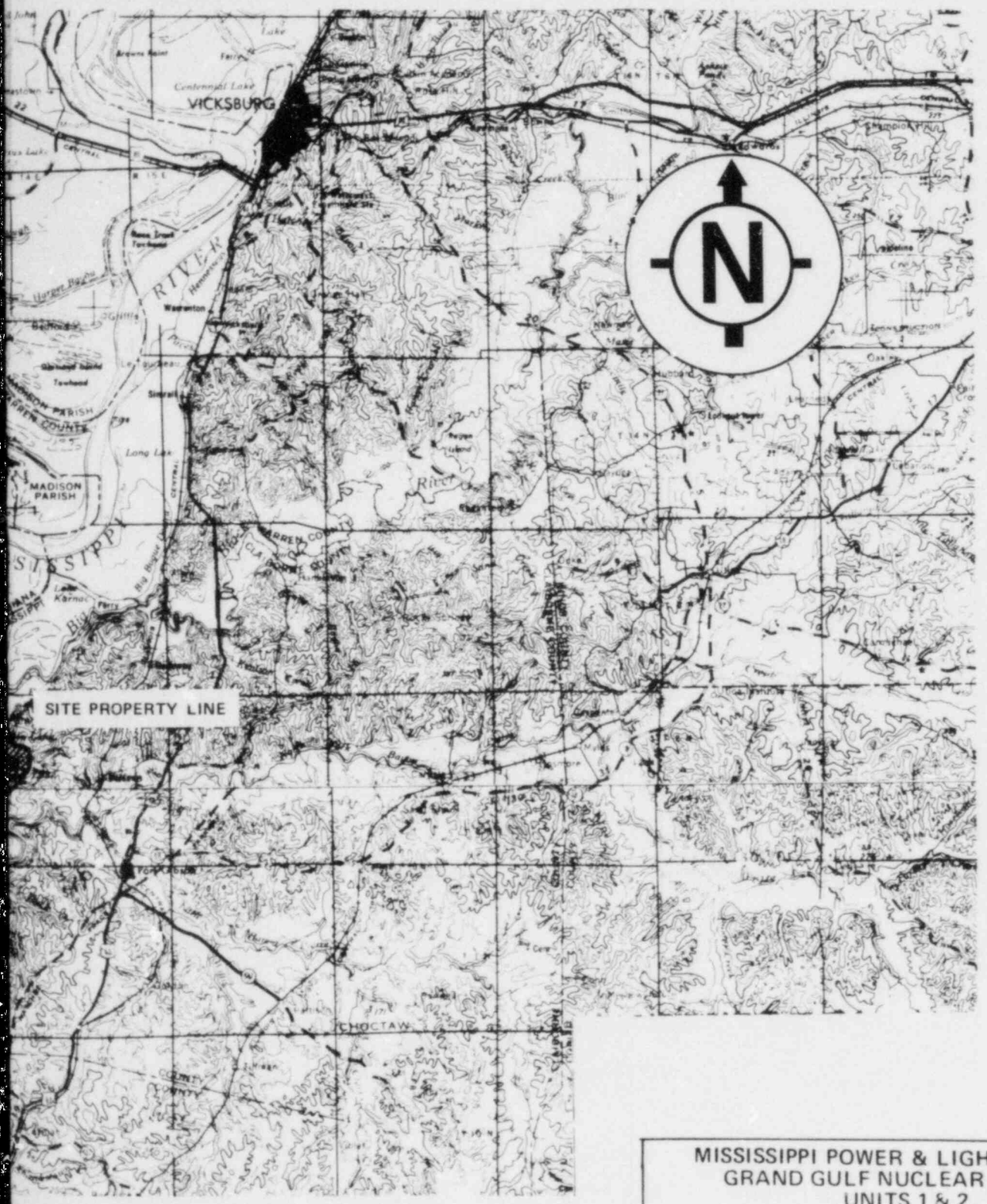
NOTES

1/ Sample locations shown on Figure 2.4-10.
2/ Well data contained in Table 2.4.12.

* Less than

THIS MAP WAS PREPARED FROM PORTIONS OF USGS JACKSON. MISS.; LA. (1955-62) AND NATCHEZ, MISS.; LA. (1953-65) TOPOGRAPHIC MAPS.

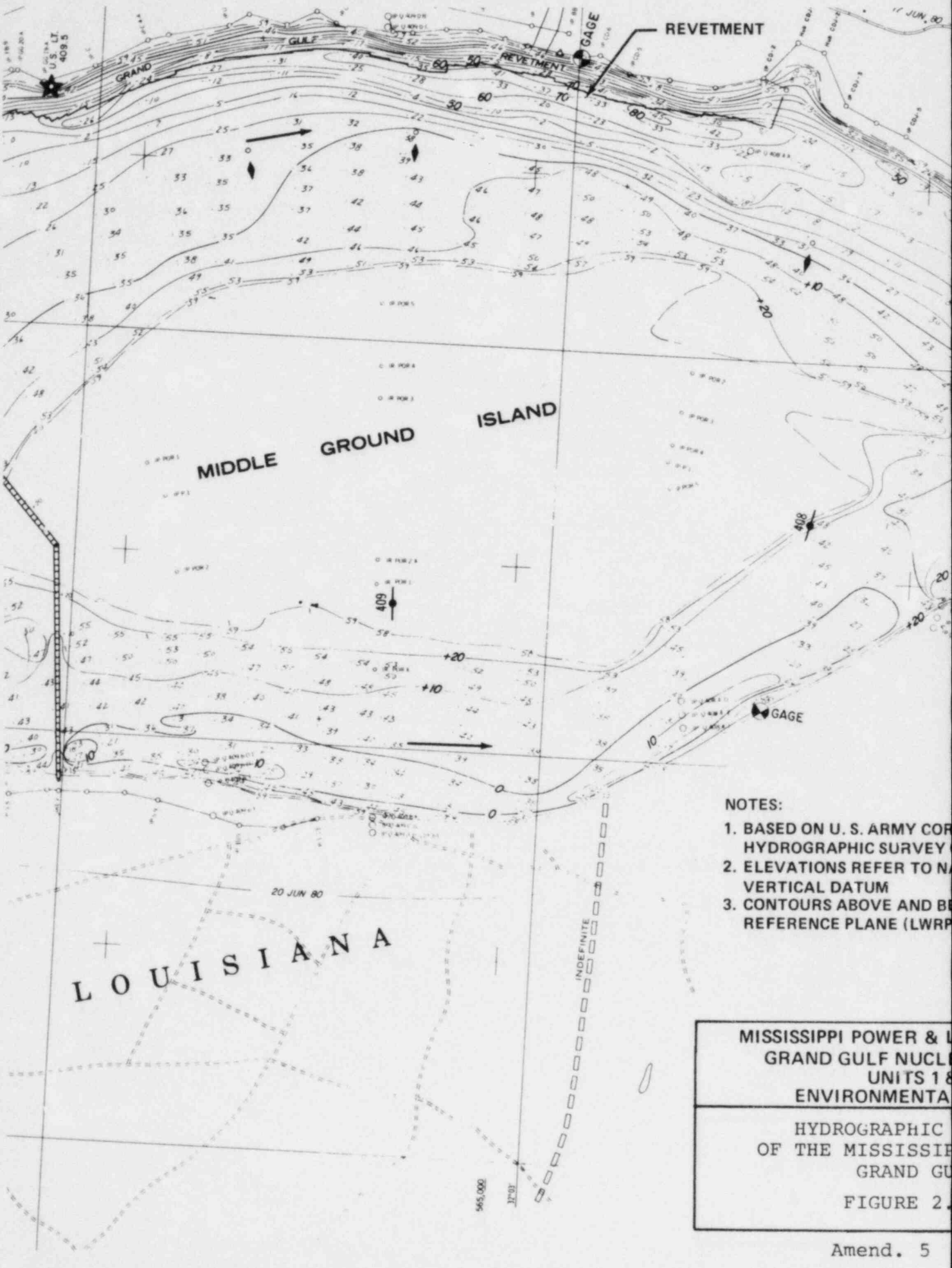
CONTOUR INTERVAL IS 50 FEET WITH SUPPLEMENTARY CONTOURS AT 25 FOOT INTERVALS. DATUM IS MSL.



MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

REGIONAL TOPOGRAPHY

FIGURE 2.4-1

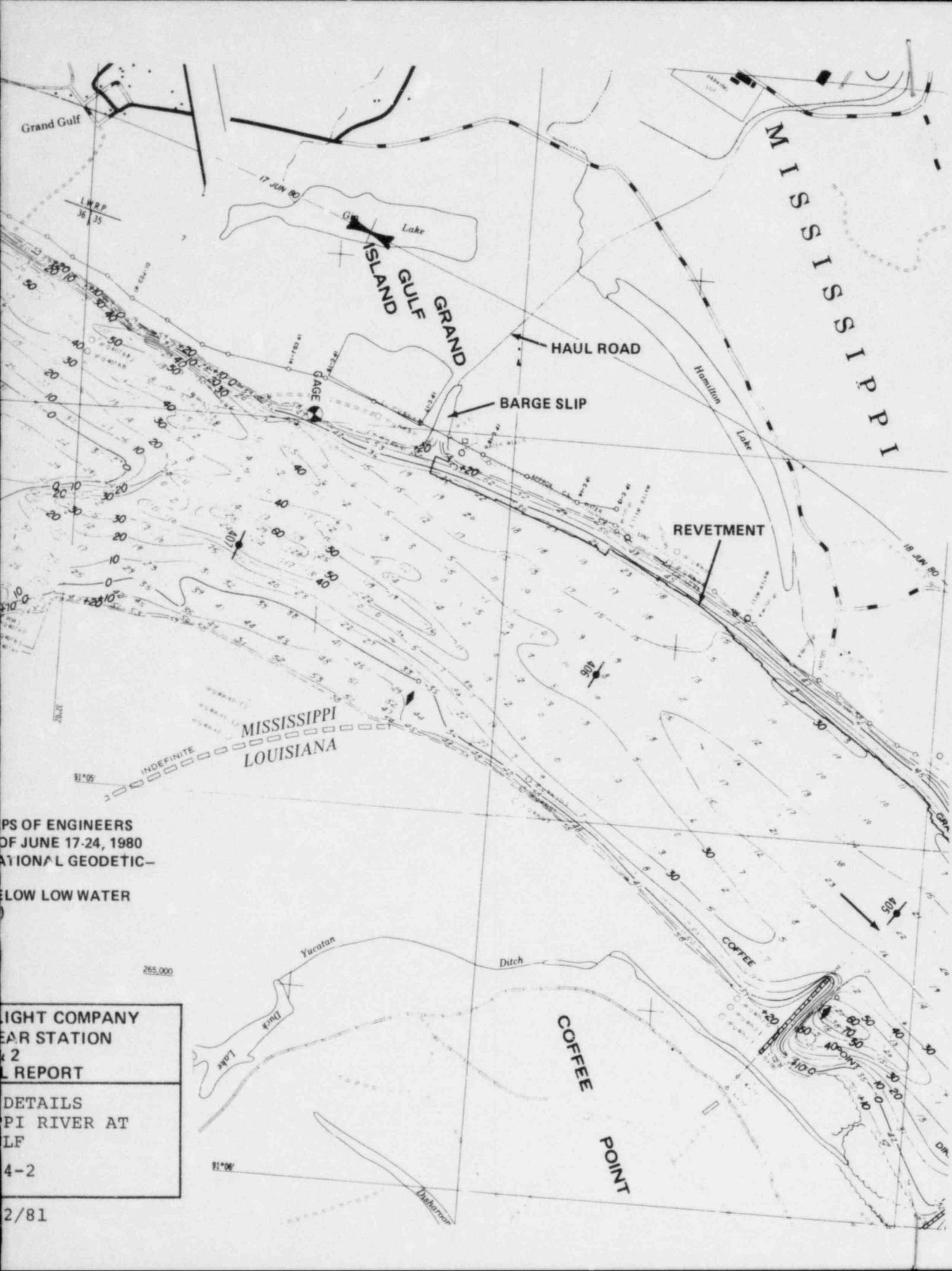


NOTES:

1. BASED ON U. S. ARMY COR
   HYDROGRAPHIC SURVEY
2. ELEVATIONS REFER TO NA
   VERTICAL DATUM
3. CONTOURS ABOVE AND BE
   REFERENCE PLANE (LWRP

MISSISSIPPI POWER & L GRAND GULF NUCL UNITS 1 & ENVIRONMENTA
HYDROGRAPHIC OF THE MISSISSI GRAND GU FIGURE 2.

Amend. 5



PS OF ENGINEERS
OF JUNE 17-24, 1980
ATIONAL GEODETIC–

ELOW LOW WATER

LIGHT COMPANY
EAR STATION
2
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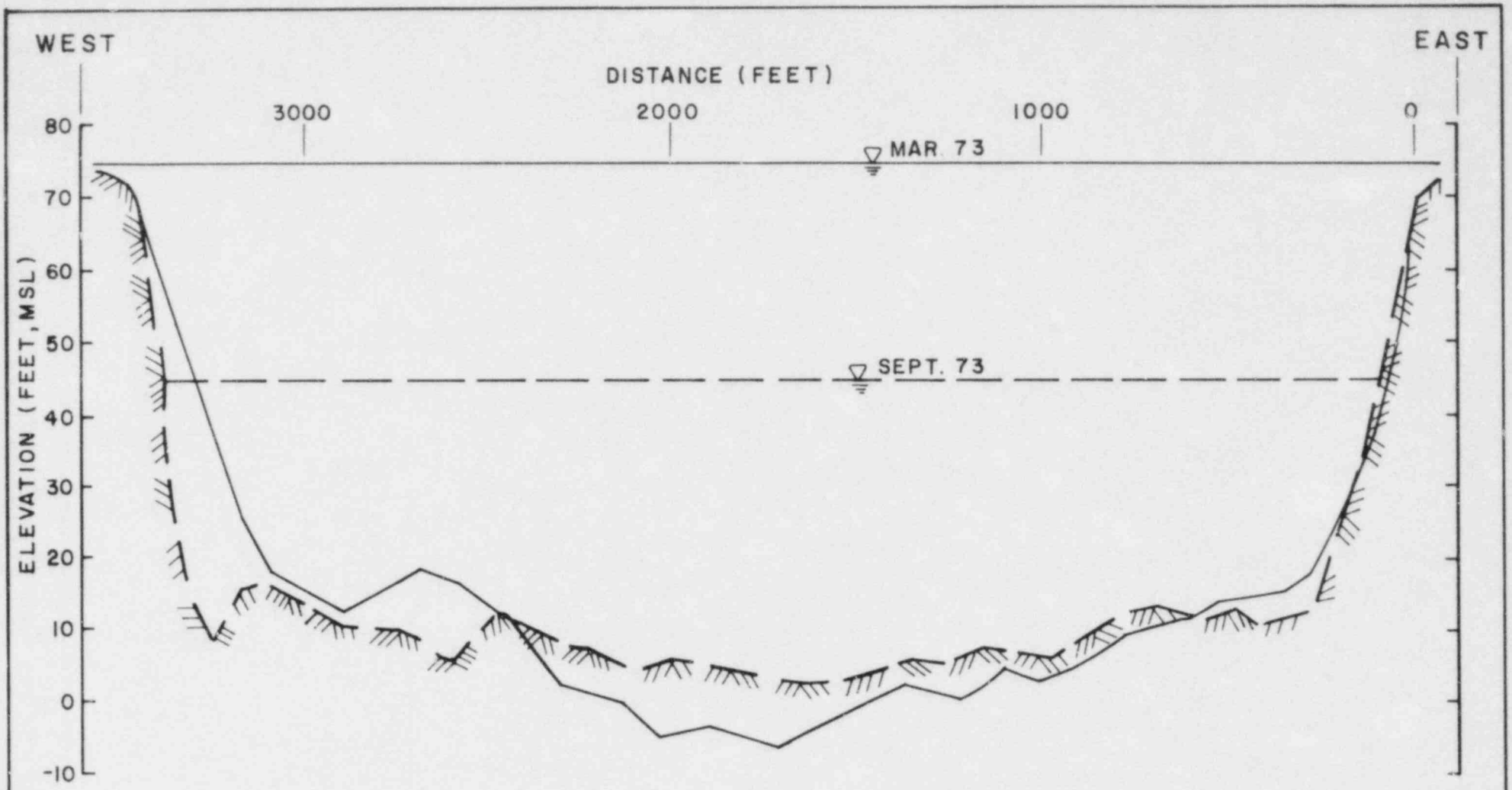
DETAILS
PI RIVER AT
LF
4-2

2/81



NOTE:

CROSS SECTIONS SHOWN LOOKING UPSTREAM.

LEGEND:

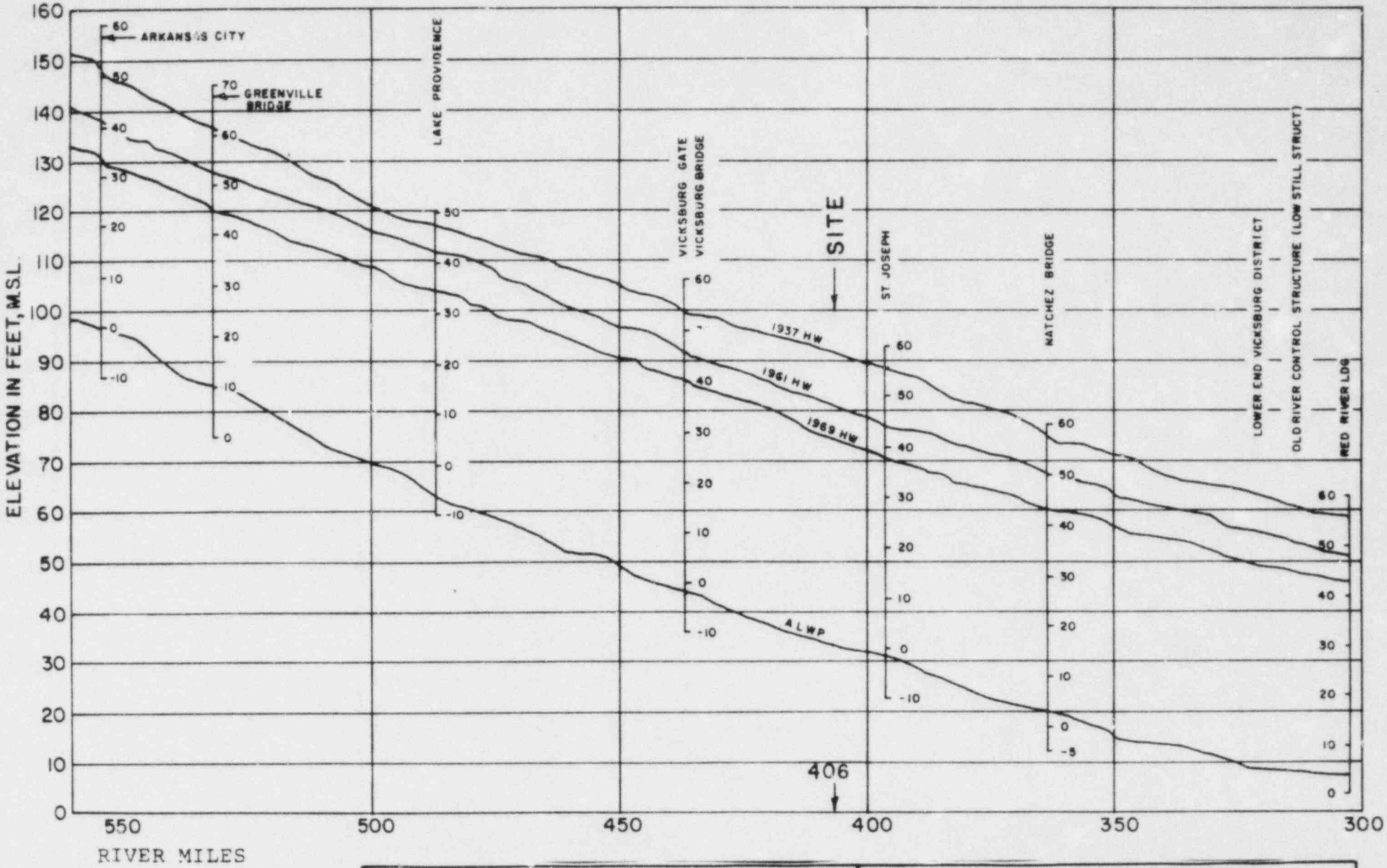
——— SURVEY MARCH 19, 1973

SURVEY SEPTEMBER 24, 1973

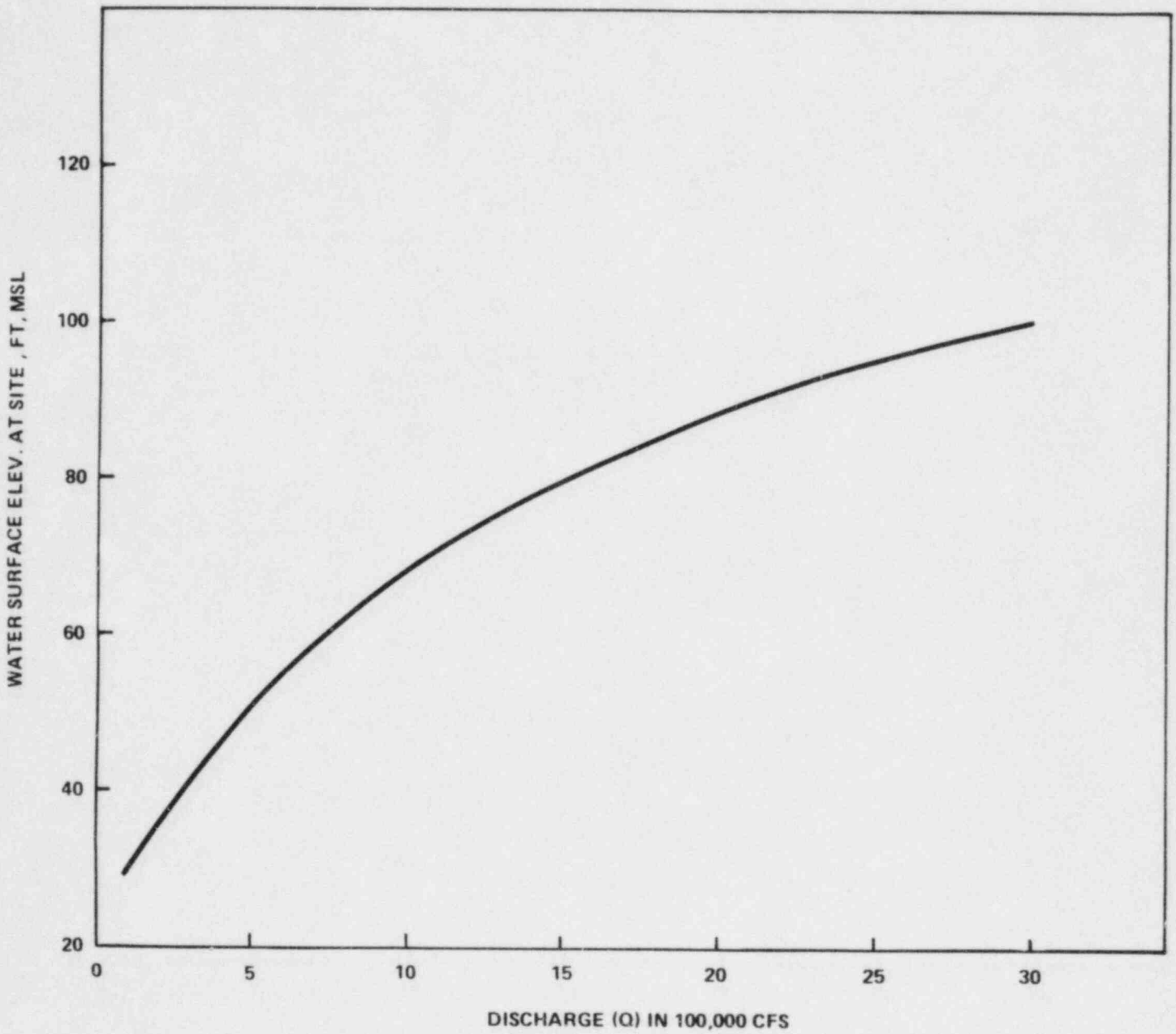
MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

CHANNEL CROSS SECTIONS
OF THE MISSISSIPPI RIVER IN THE
VICINITY OF THE
DISCHARGE STRUCTURE
FIGURE 2.4-3

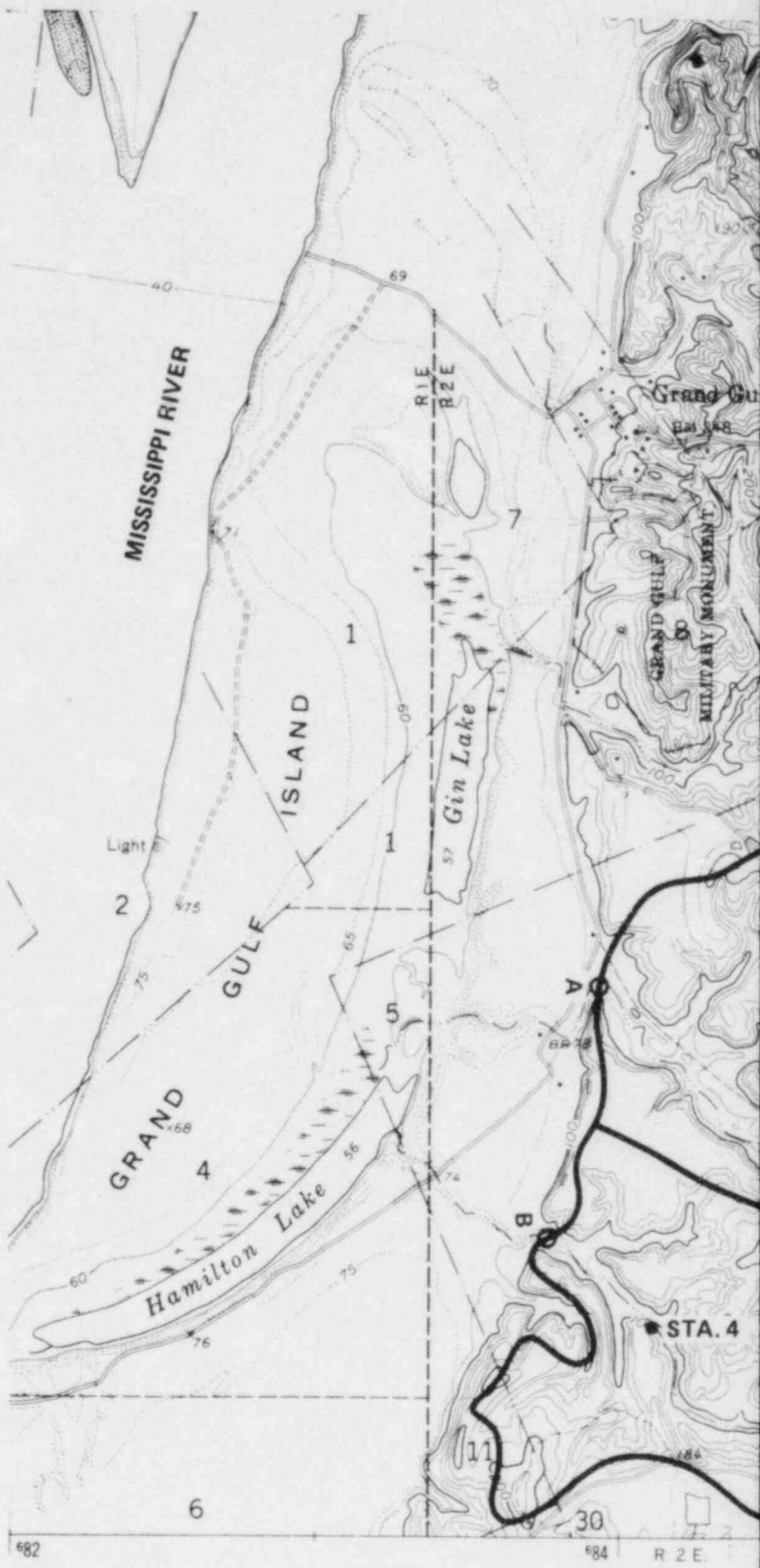
(Adapted from Corps of Engineers)

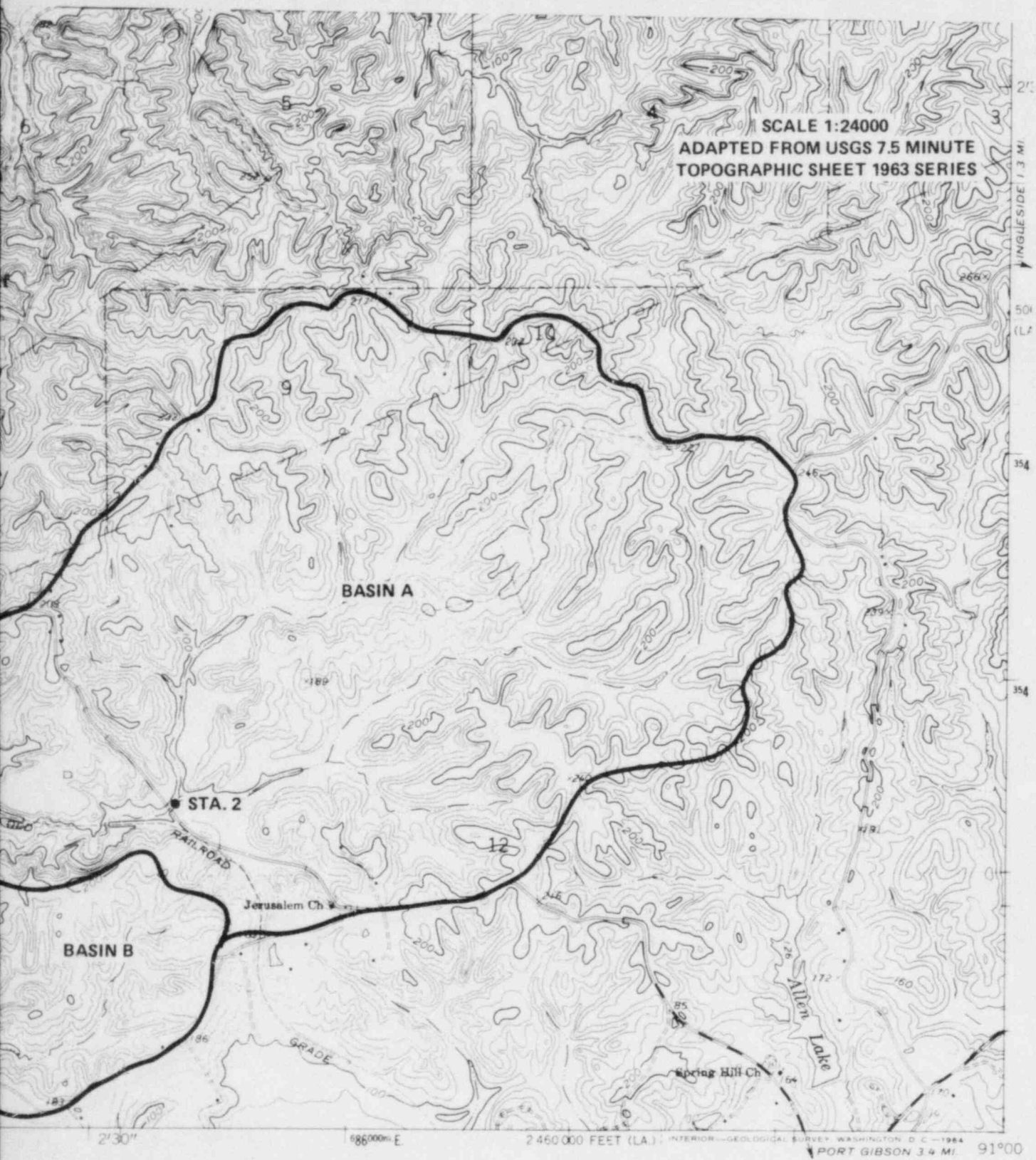


MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	WATER SURFACE PROFILES FOR HIGH FLOWS ON THE MISSISSIPPI RIVER FIGURE 2.4-4



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	RATING CURVE FOR THE MISSISSIPPI RIVER AT GRAND GULF SITE FIGURE 2.4-5

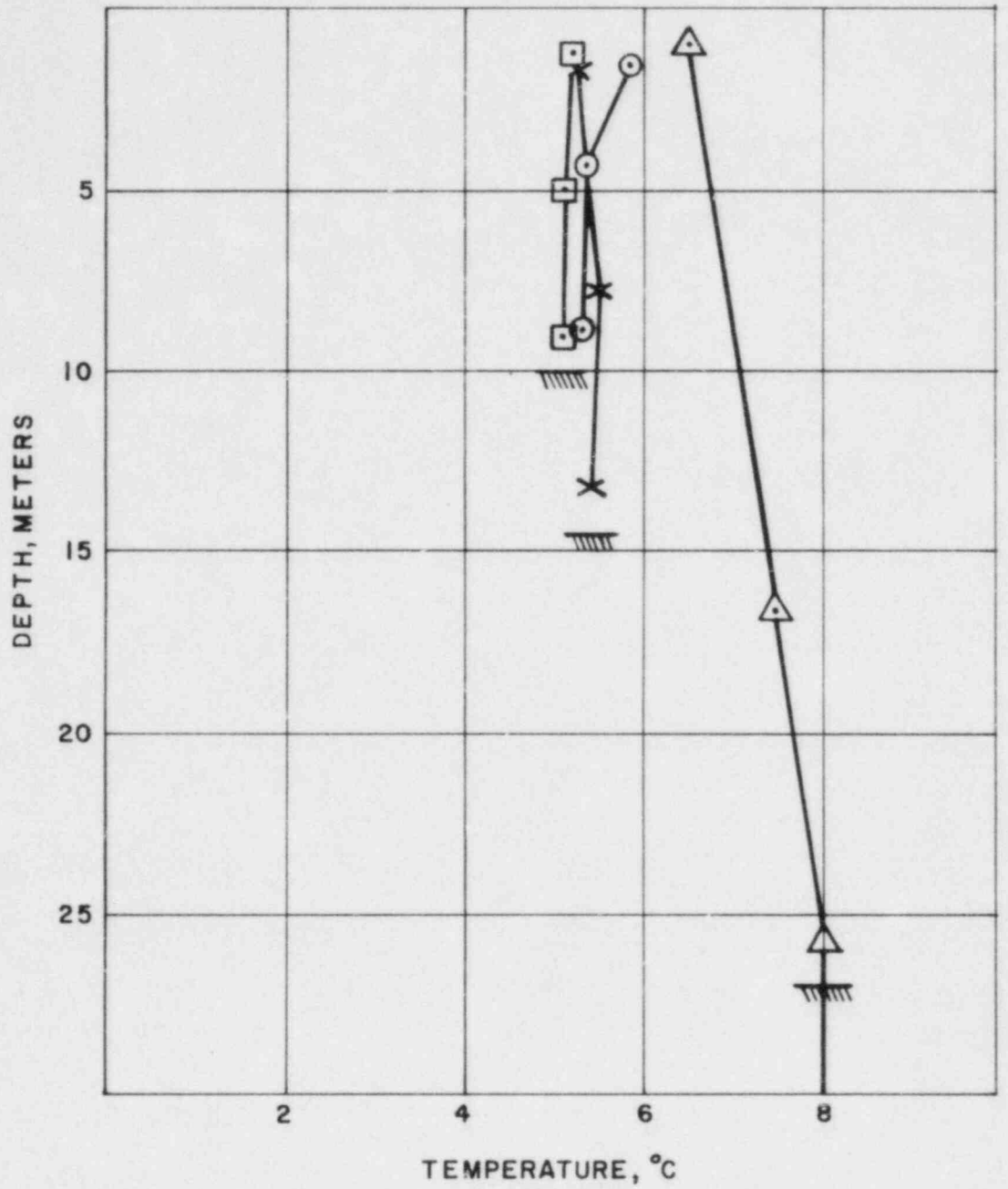

MISSISSIPPI RIVER
R1E
R2E
Grand Gu
GRAND GULF MILITARY
ISLAND
Gin Lake
GULF
GRAND
Hamilton Lake
Light
A
B
STA. 4
1
2
3
4
5
6
7
8
11
30
682
684
R. 2 E.



MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

LOCAL DRAINAGE BASINS

FIGURE 2.4-6

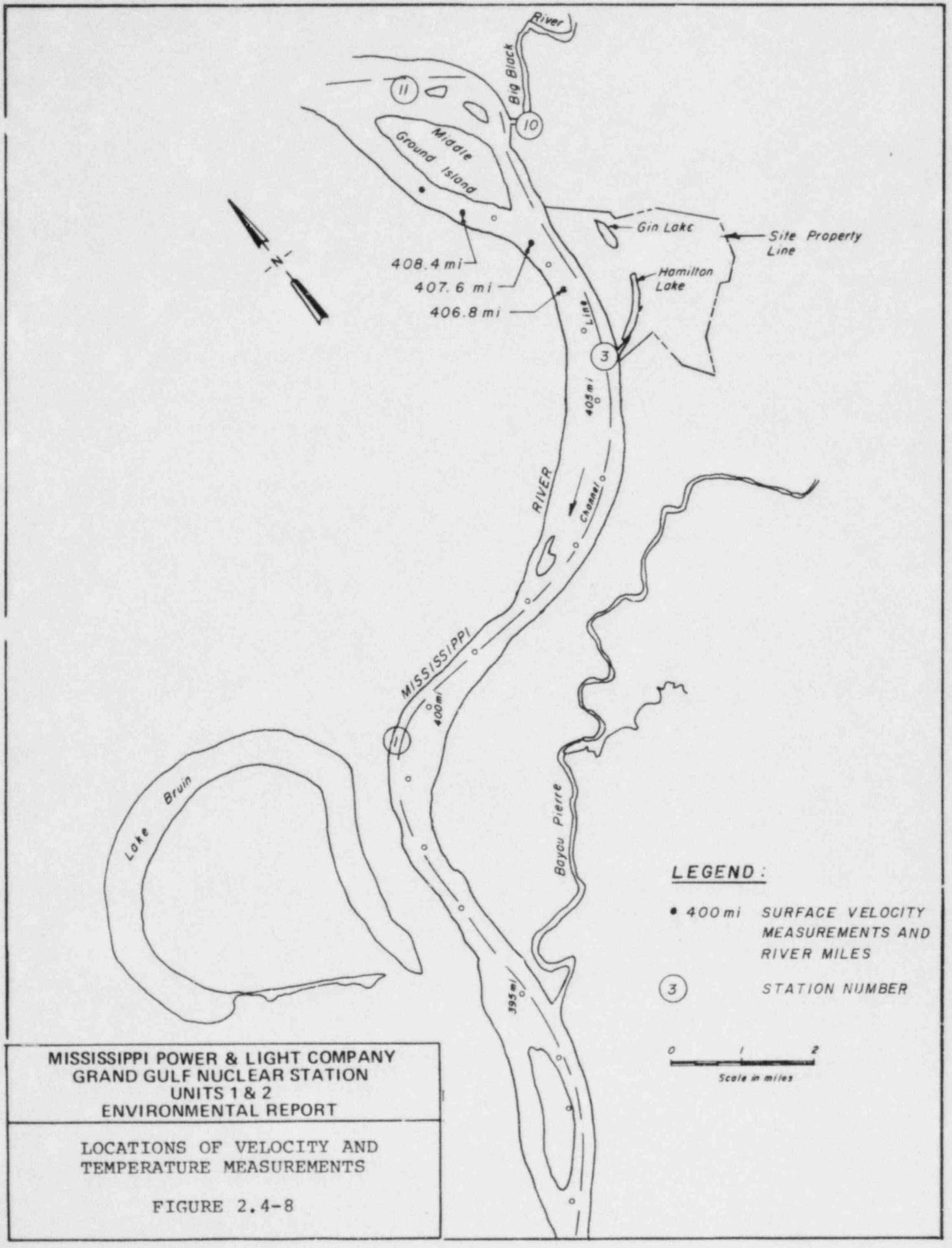


LEGEND:

- STATION 1
- STATION 3
- STATION 10
- STATION 11
- APPROX. BOTTOM

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

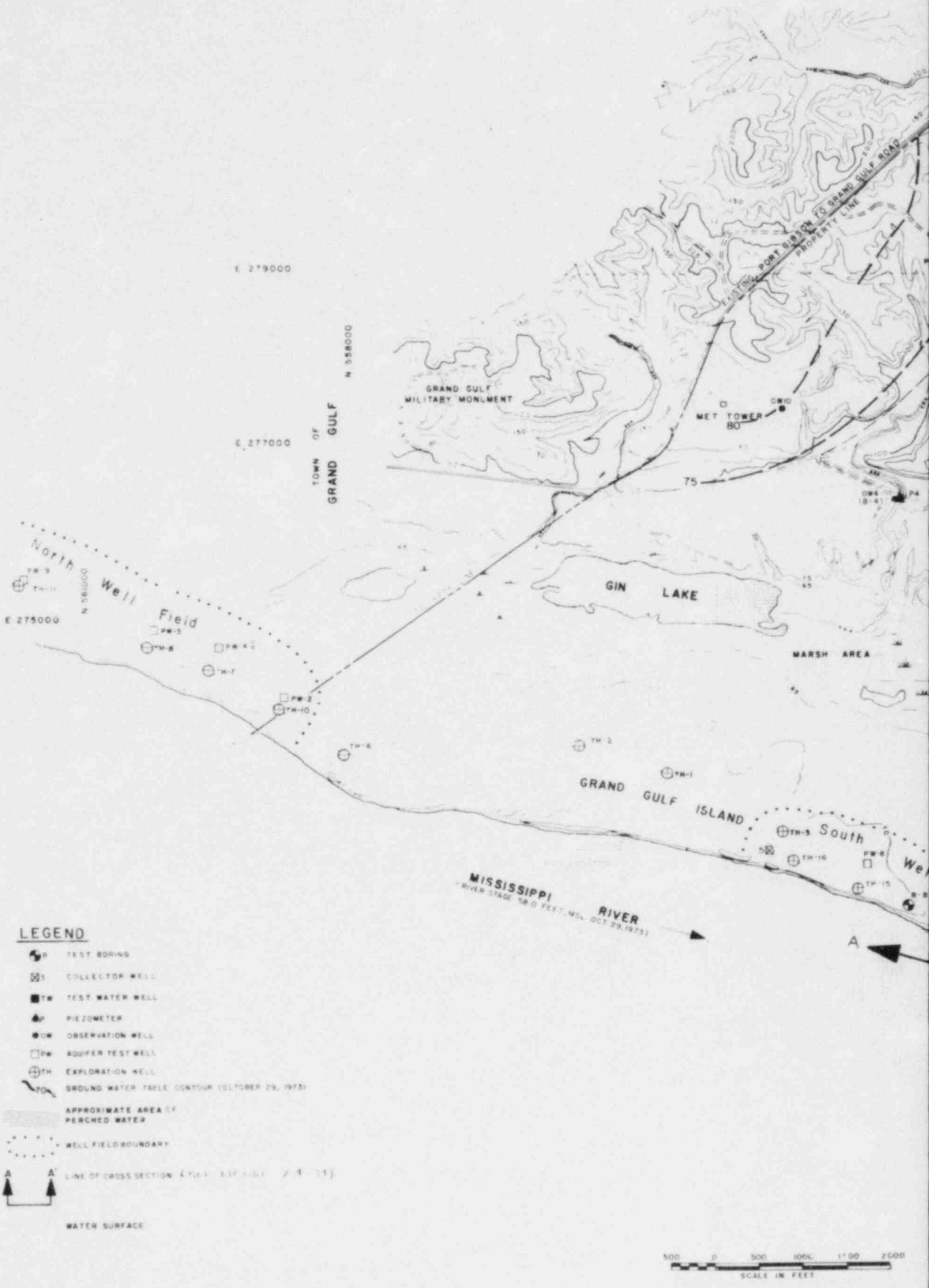
VERTICAL TEMPERATURE PROFILE
MISSISSIPPI RIVER
FEBRUARY 19, 1973
FIGURE 2.4-7

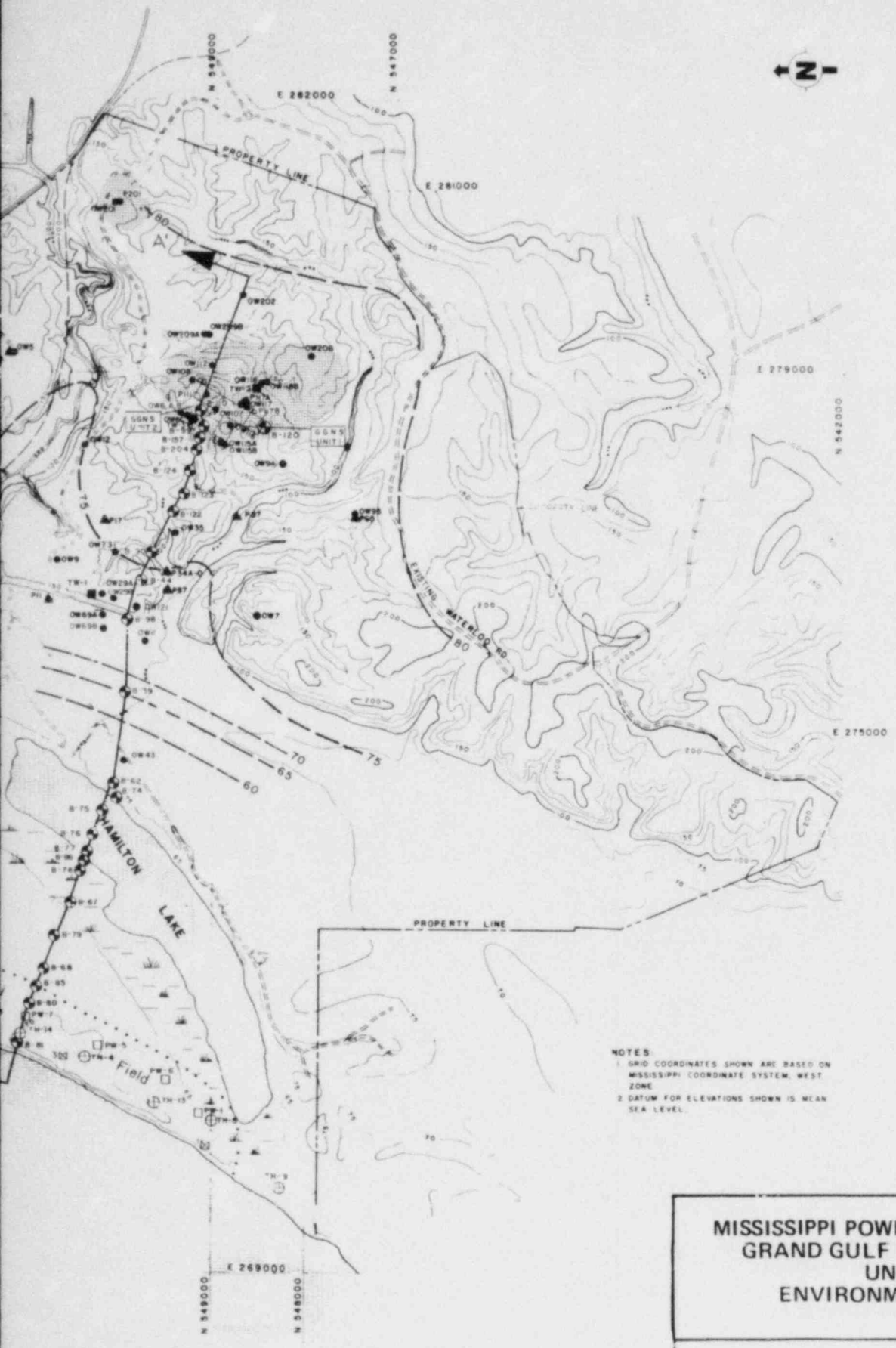


MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

LOCATIONS OF VELOCITY AND TEMPERATURE MEASUREMENTS

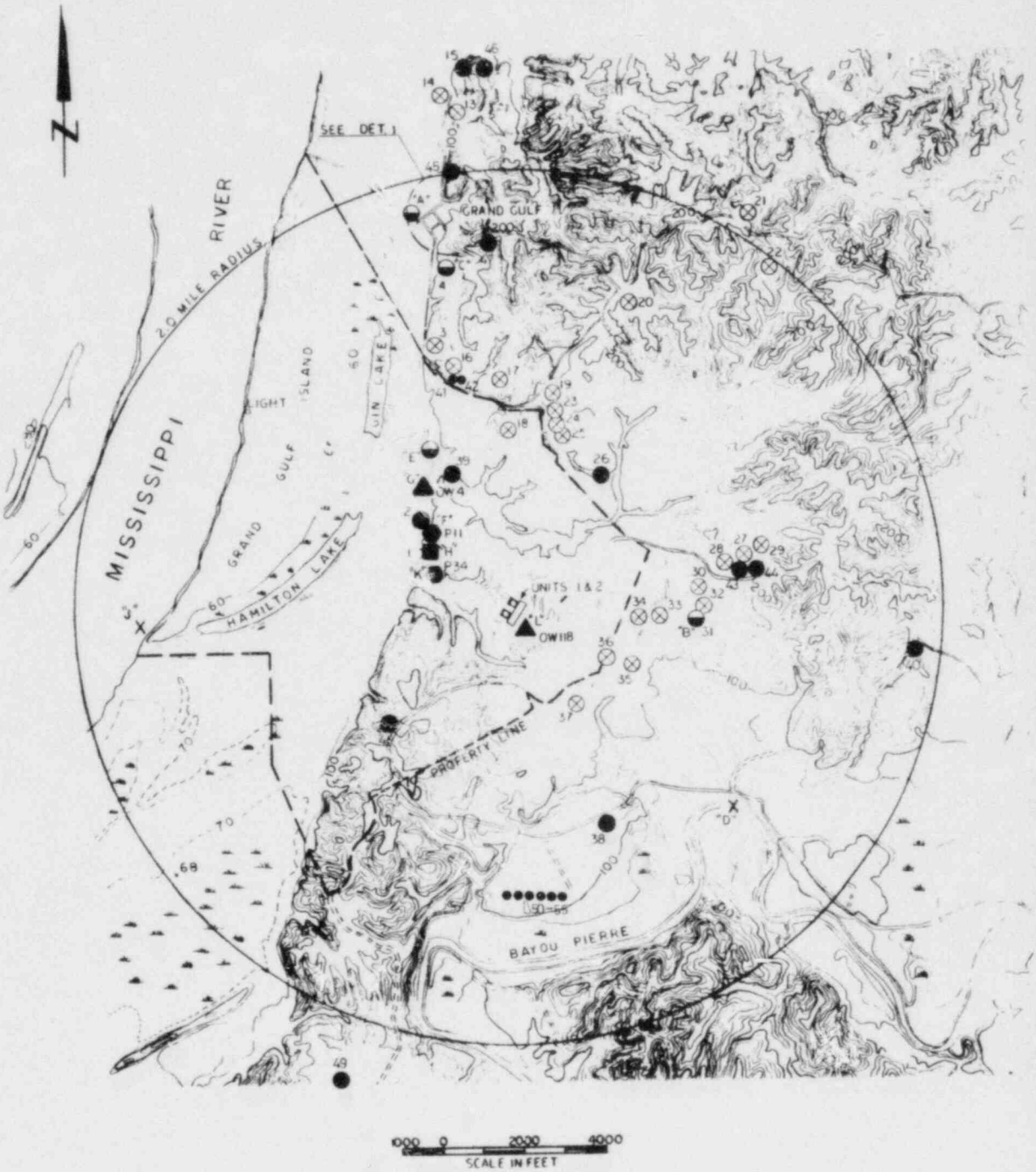
FIGURE 2.4-8

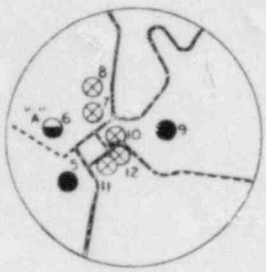

E 279000
E 277000
E 275000
N 558000
N 561000
TOWN OF GRAND GULF
GRAND GULF MILITARY MONUMENT
EXISTING PORT GIBSON TO GRAND GULF ROAD
PROPERTY LINE
MET TOWER
80
75
GIN LAKE
MARSH AREA
North Well Field
GRAND GULF ISLAND
South
MISSISSIPPI RIVER
RIVER STAGE 98.0 FEET, MSL OCT 29,1973
A
A'
LEGEND
TEST BORING
COLLECTOR WELL
TEST WATER WELL
PIEZOMETER
OBSERVATION WELL
AQUIFER TEST WELL
EXPLORATION WELL
GROUND WATER TABLE CONTOUR (OCTOBER 29, 1973)
APPROXIMATE AREA OF PERCHED WATER
WELL FIELD BOUNDARY
LINE OF CROSS SECTION
WATER SURFACE
500 0 500 1000 1500 2000
SCALE IN FEET



MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

SITE HYDROLOGIC FEATURES
(NORMAL CONDITIONS)
FIGURE 2.4-9


N
SEE DET. 1
MISSISSIPPI RIVER
2.0 MILE RADIUS
GRAND GULF
GULF
GRAND
HAMILTON LAKE
UNITS 1&2
OW118
OW4
P11
P34
PROPERTY LINE
BAYOU PIERRE
SCALE IN FEET



GRAND GULF
DET. 1

LEGEND

- WATER WELL - UNSAMPLED
- WATER WELL - SAMPLED
- RAIN WATER CISTERN
- TEST WATER WELL - SAMPLED
- "6" OW 4 — OBSERVATION WELL-SAMPLED
- "P" P11 — PIEZOMETER - SAMPLED
- "D" X — SURFACE WATER SAMPLE

NOTES

FOR TABULATION OF WATER USERS, SEE TABLE 2.4-12

CHEMICAL ANALYSIS OF WATER SAMPLES PRESENTED IN TABLE 2.4-15

REFERENCES

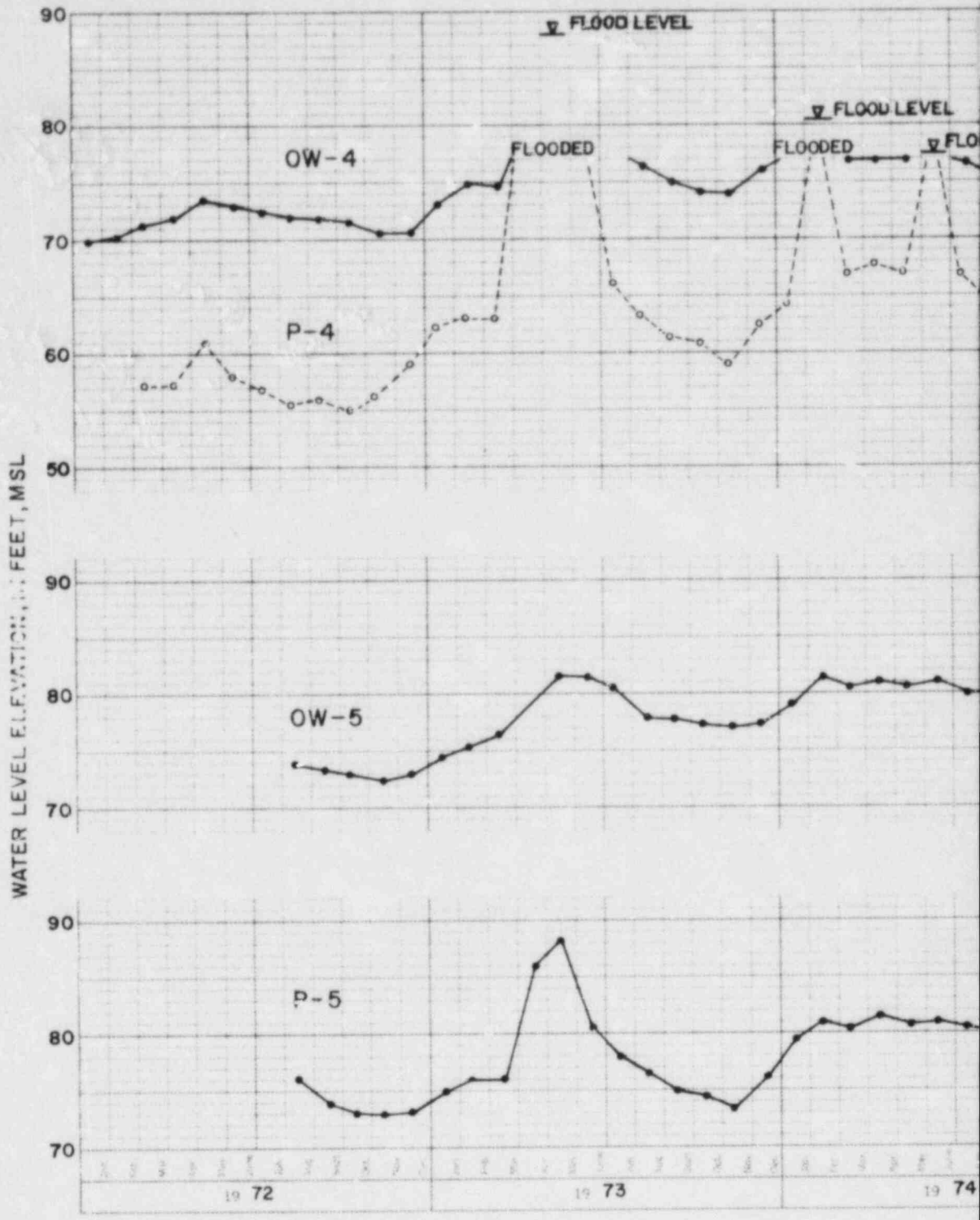
USGS QUADRANGLES: GRAND GULF MISS.-LA., 1963
SAINT JOSEPH MISS.-LA., 1958

GENERAL HIGHWAY MAP, CLAIBORNE CO., MISSISSIPPI, 1967

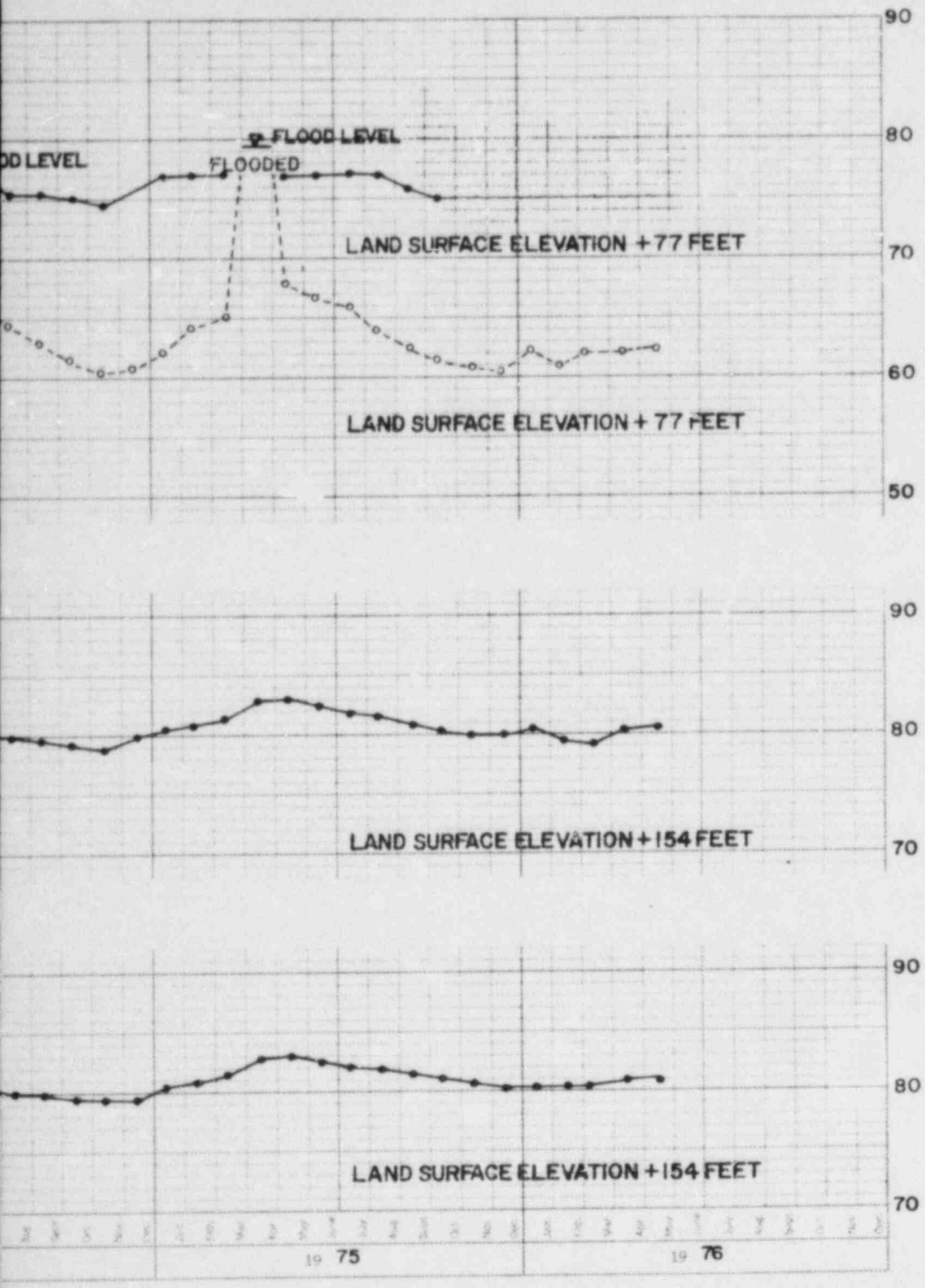
MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

WATER WELL LOCATION

FIGURE 2.4-10



NOTE:
OBSERVATION WELL
ARE SHOWN IN FIGU

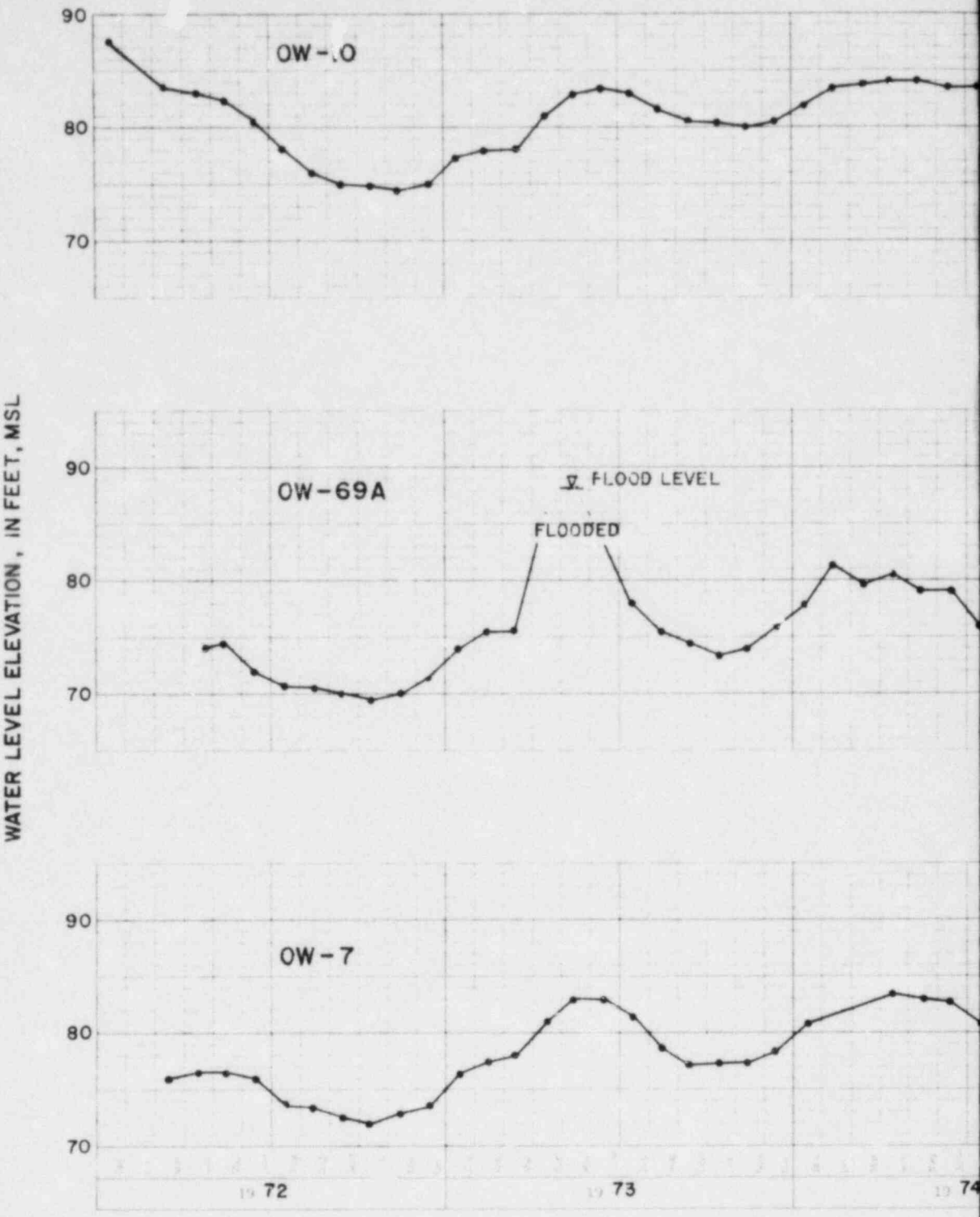


AND PIEZOMETER LOCATIONS

RE 2.4-9

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

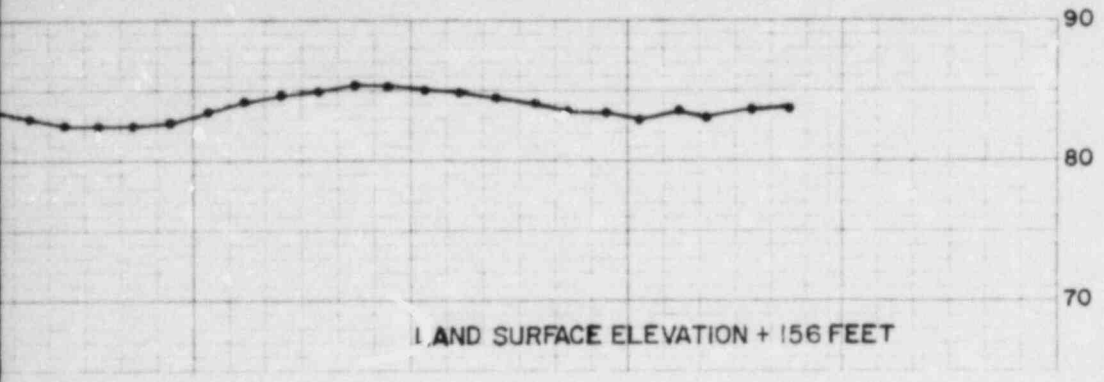
HYDROGRAPHS OF WELLS
AND PIEZOMETERS
(SHEET 1 OF 5)
FIGURE 2.4-11

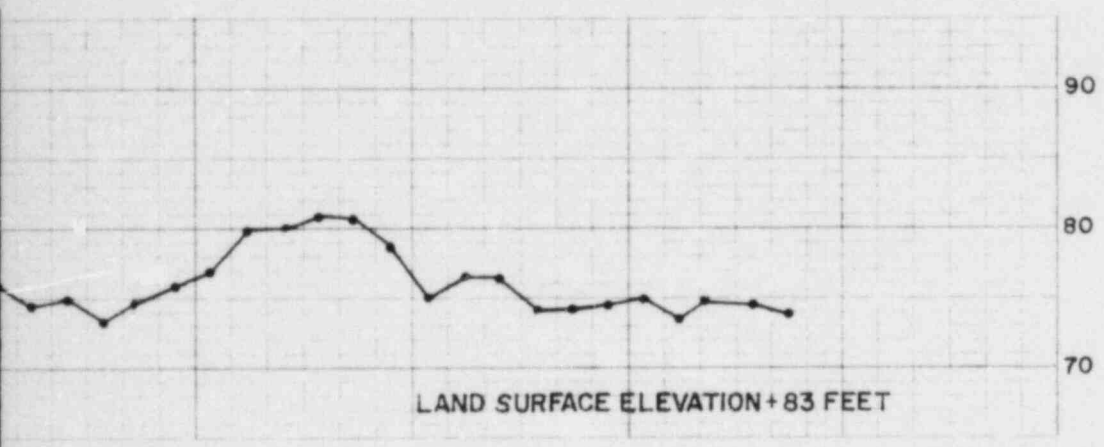


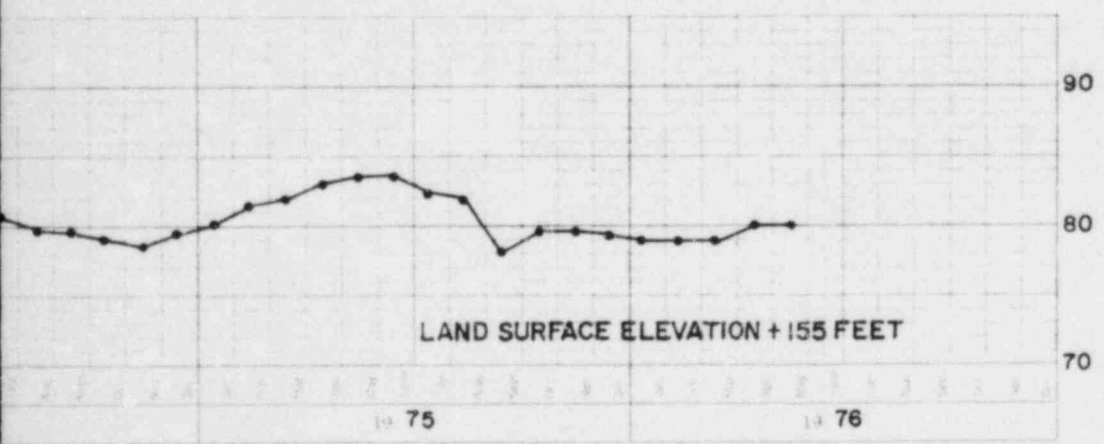
NOTE:

OBSERVATION WE

ARE SHOWN IN FI





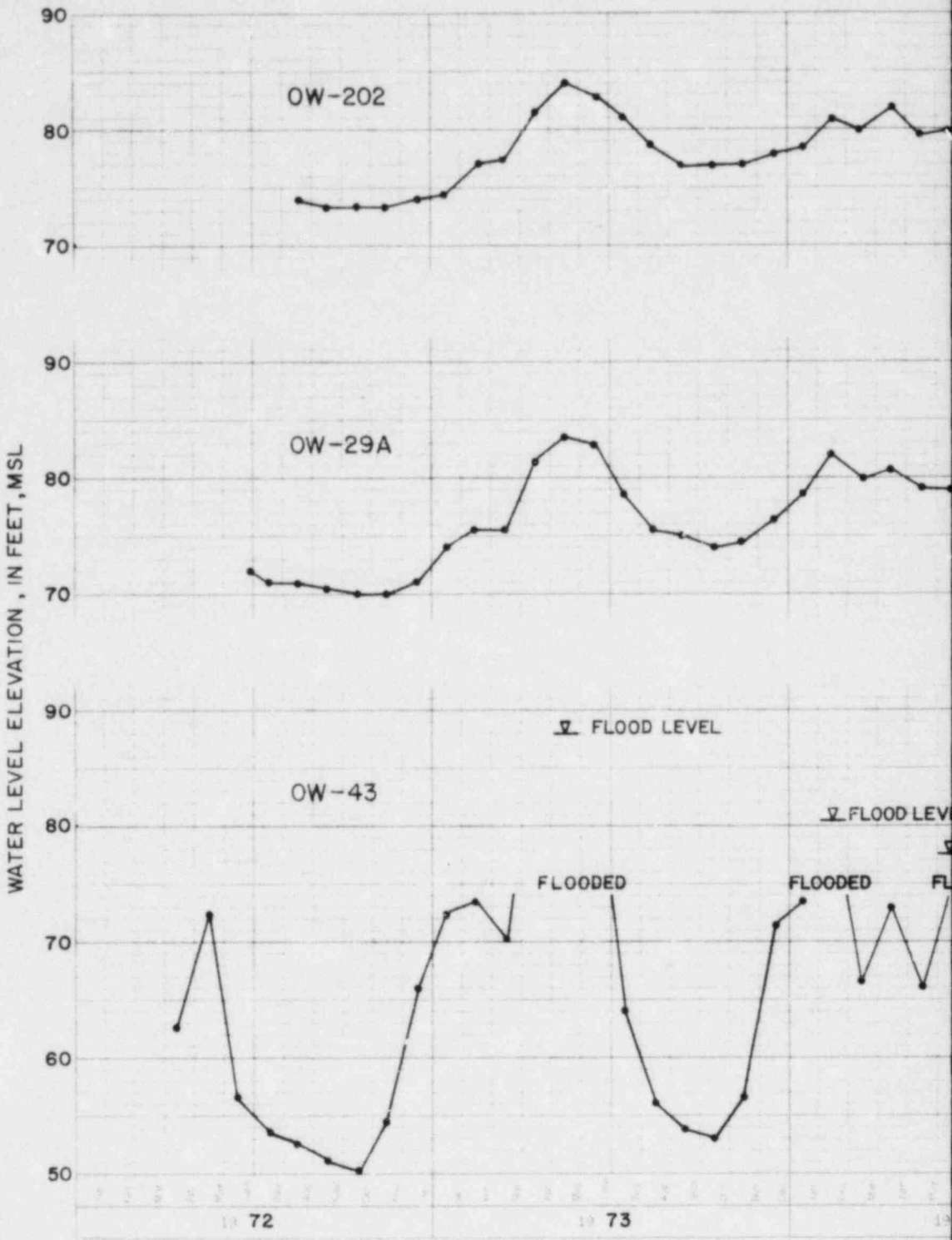


LL LOCATIONS

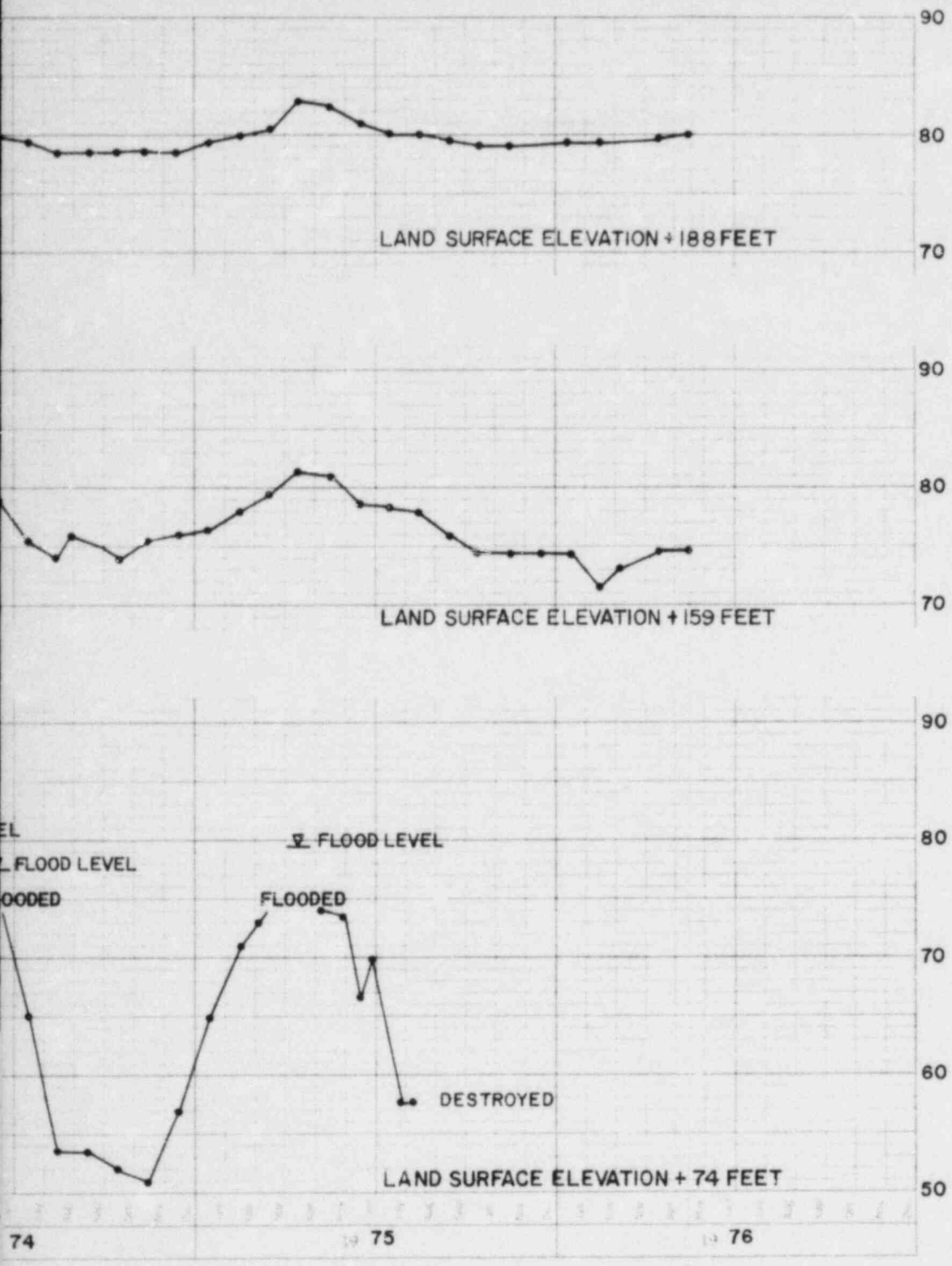
GURE 2.4-9

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

HYDROGRAPHS OF WELLS
AND PIEZOMETERS
(SHEET 2 OF 5)
FIGURE 2.4-11



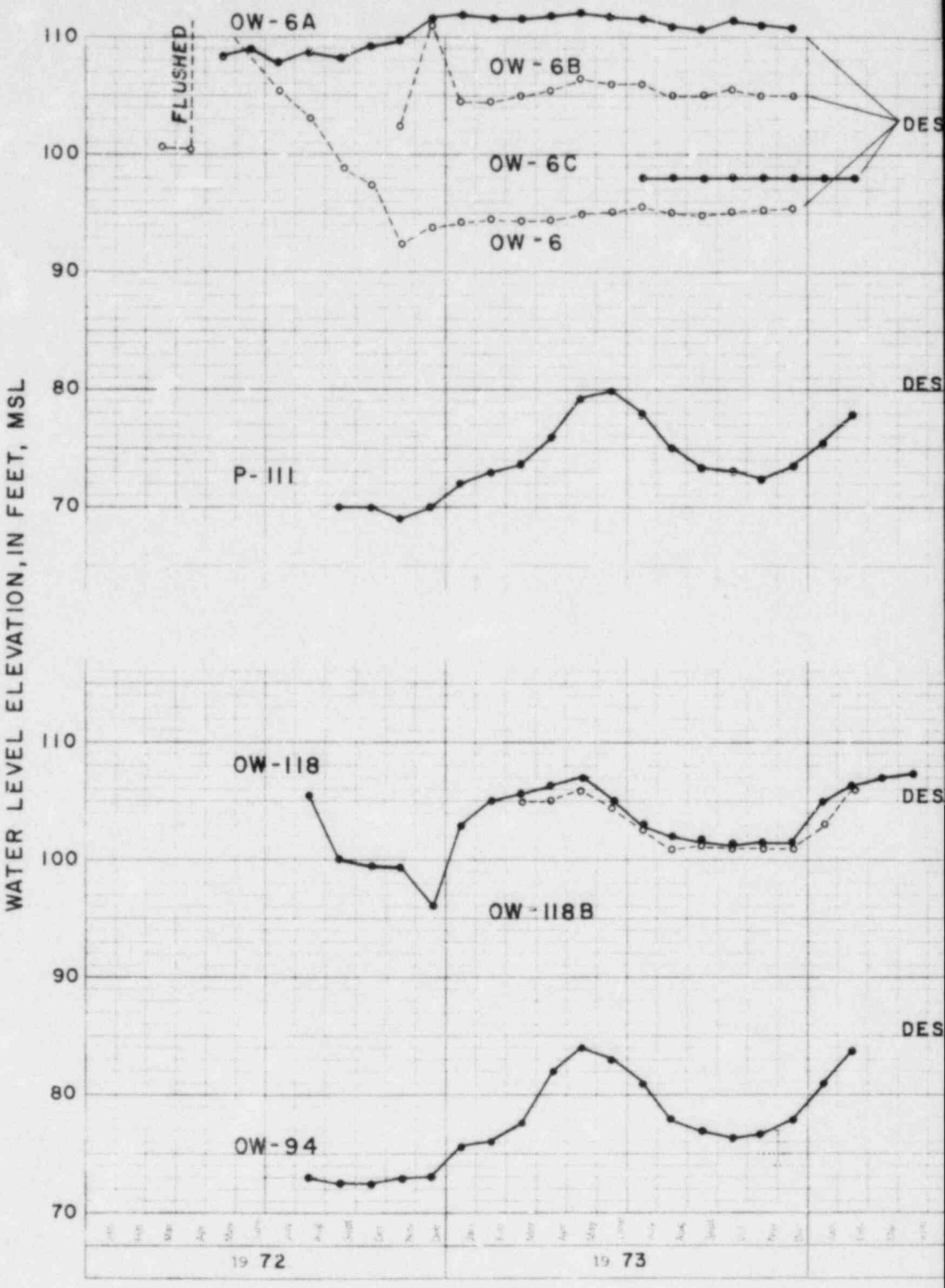
NOTE:
OBSERVATIO
ARE SHOWN



N WELL LOCATIONS
N FIGURE 2.4-9

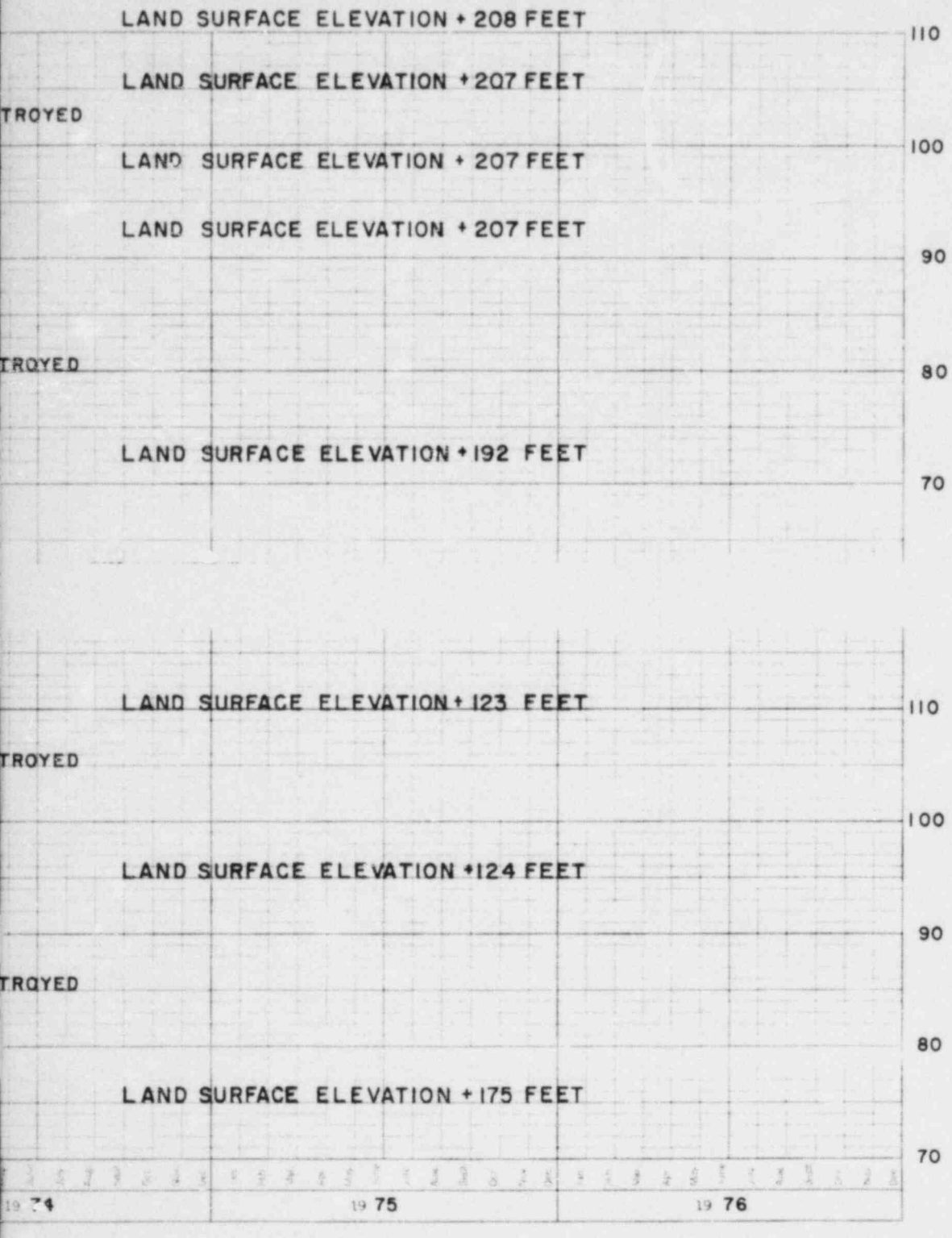
MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

HYDROGRAPHS OF WELLS
AND PIEZOMETERS
(SHEET 3 OF 5)
FIGURE 2.4-11



NOTE:

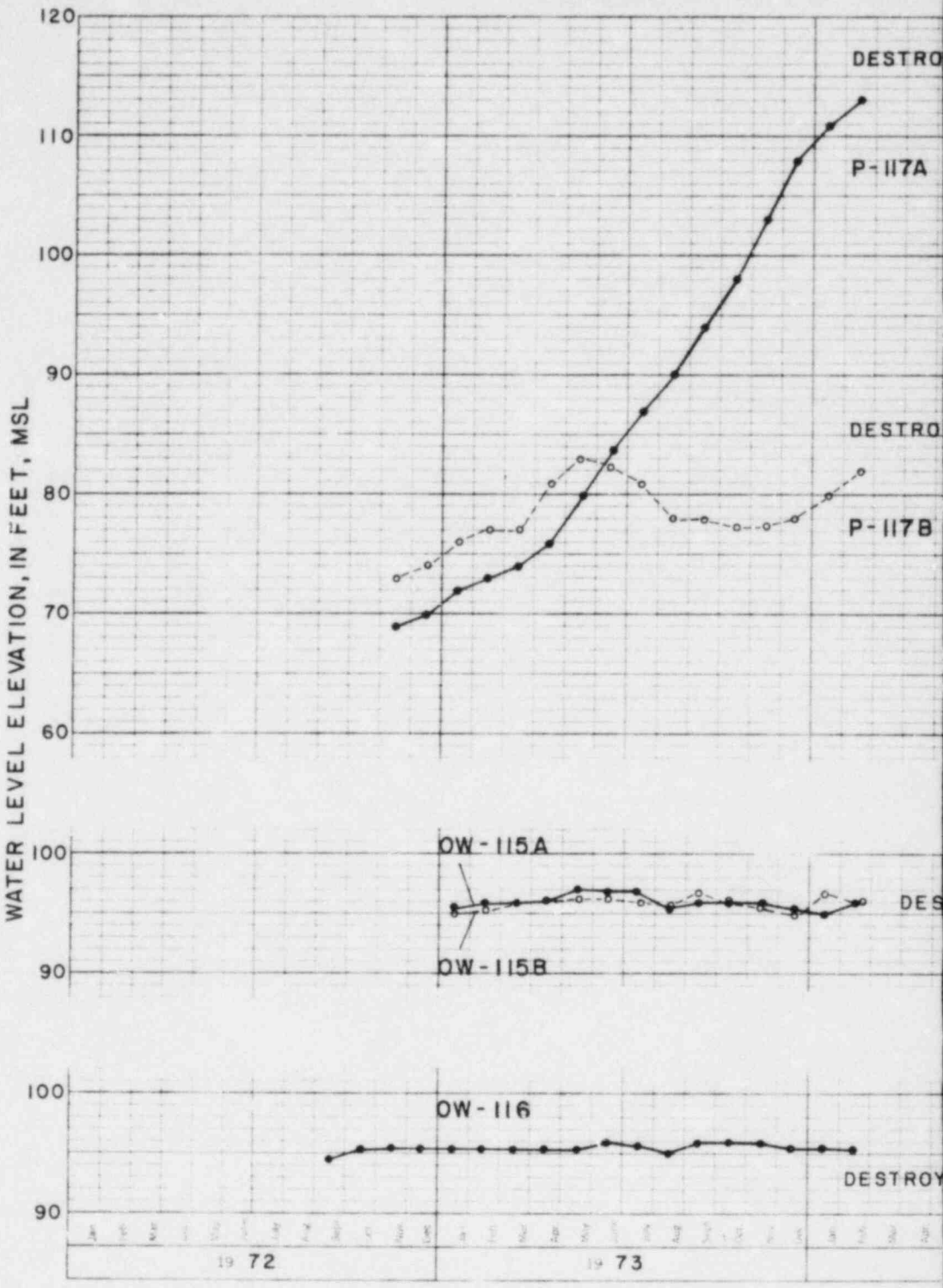
OBSERVATION WELL
LOCATIONS ARE SHOW



ND PIEZOMETER
N IN FIGURE 2.4-9

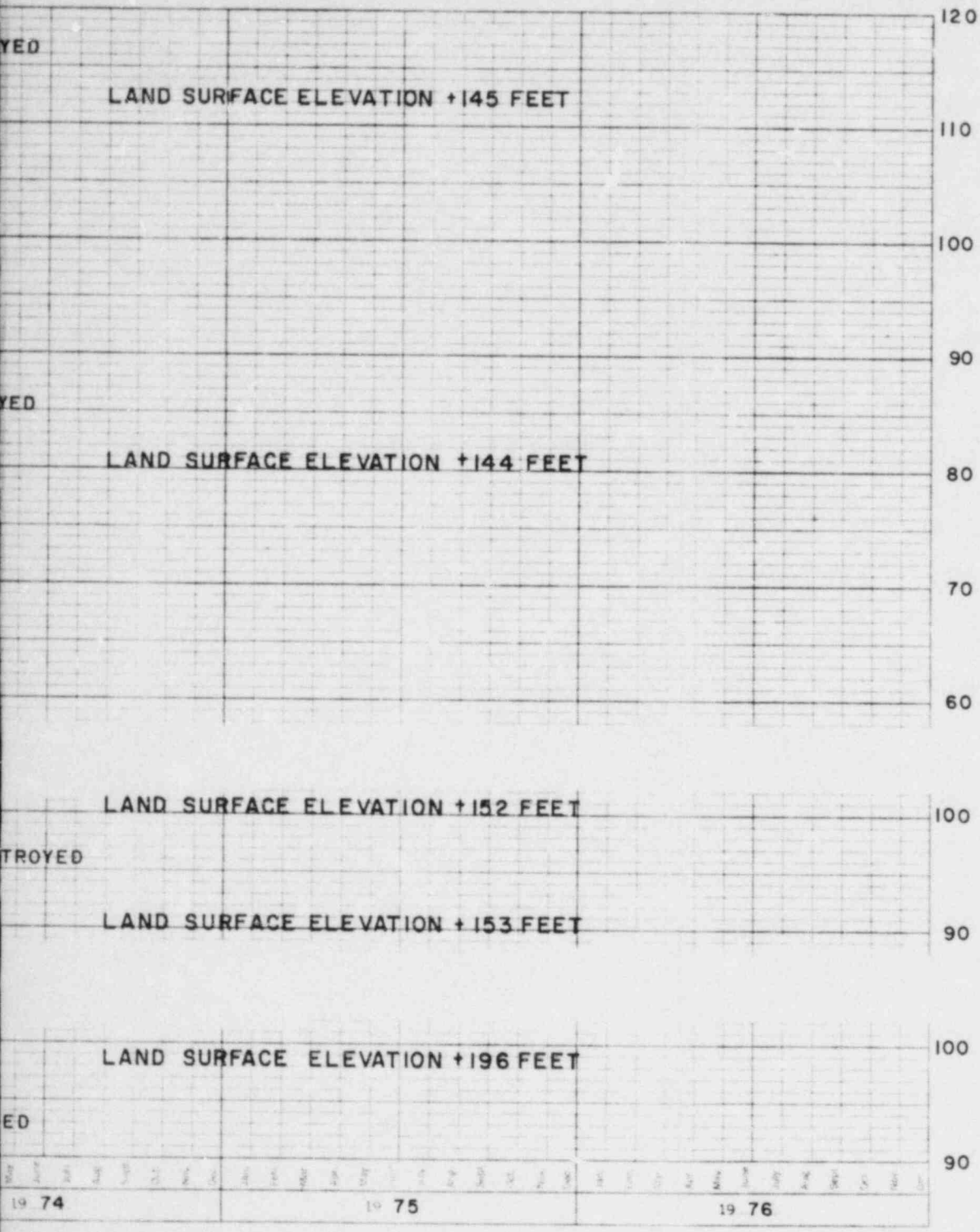
MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

HYDROGRAPHS OF WELLS
AND PIEZOMETERS
(SHEET 4 OF 5)
FIGURE 2.4-11



NOTE:

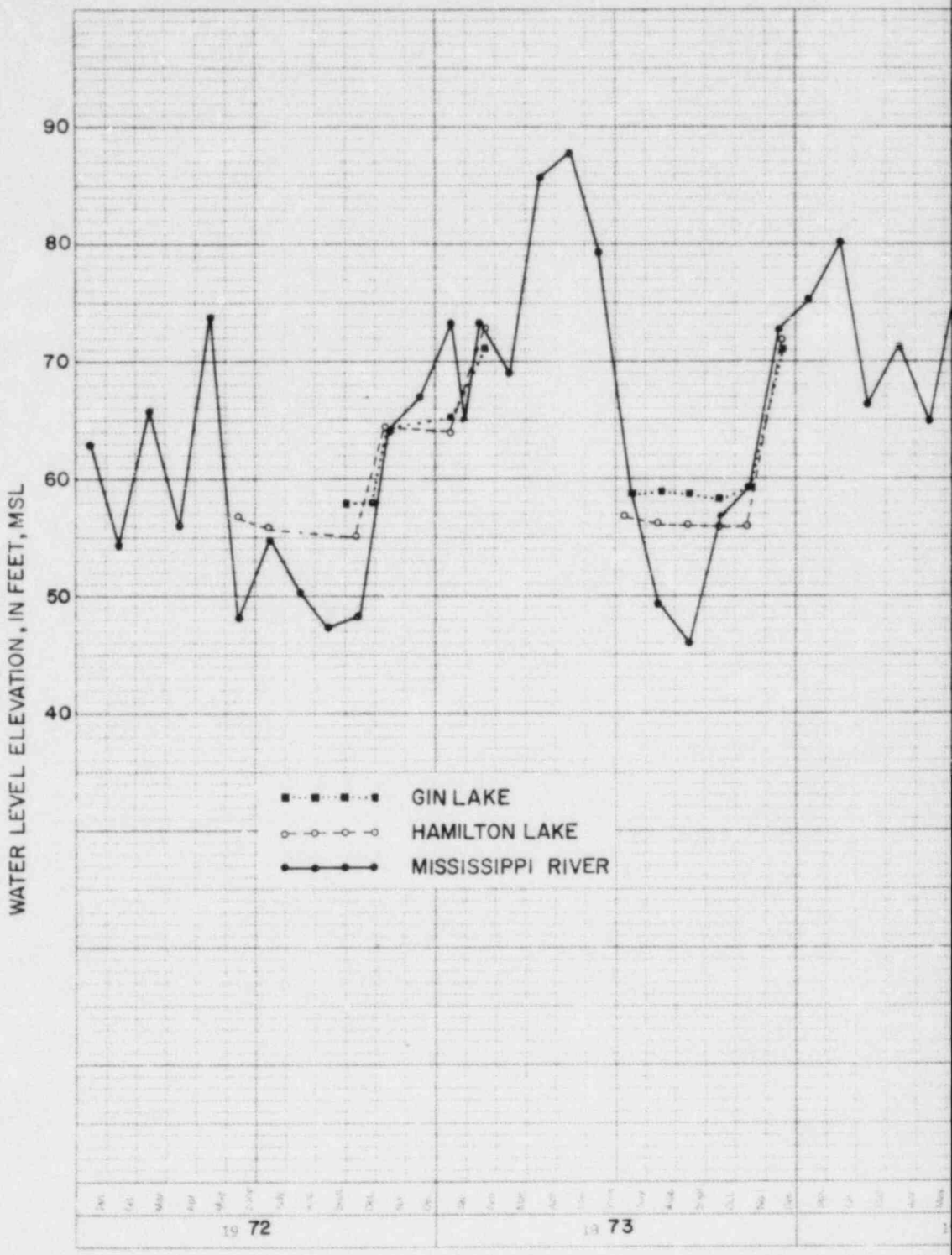
OBSERVATION
LOCATIONS AR



WELL AND PIEZOMETER
E SHOWN IN FIGURE 2.4-9

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

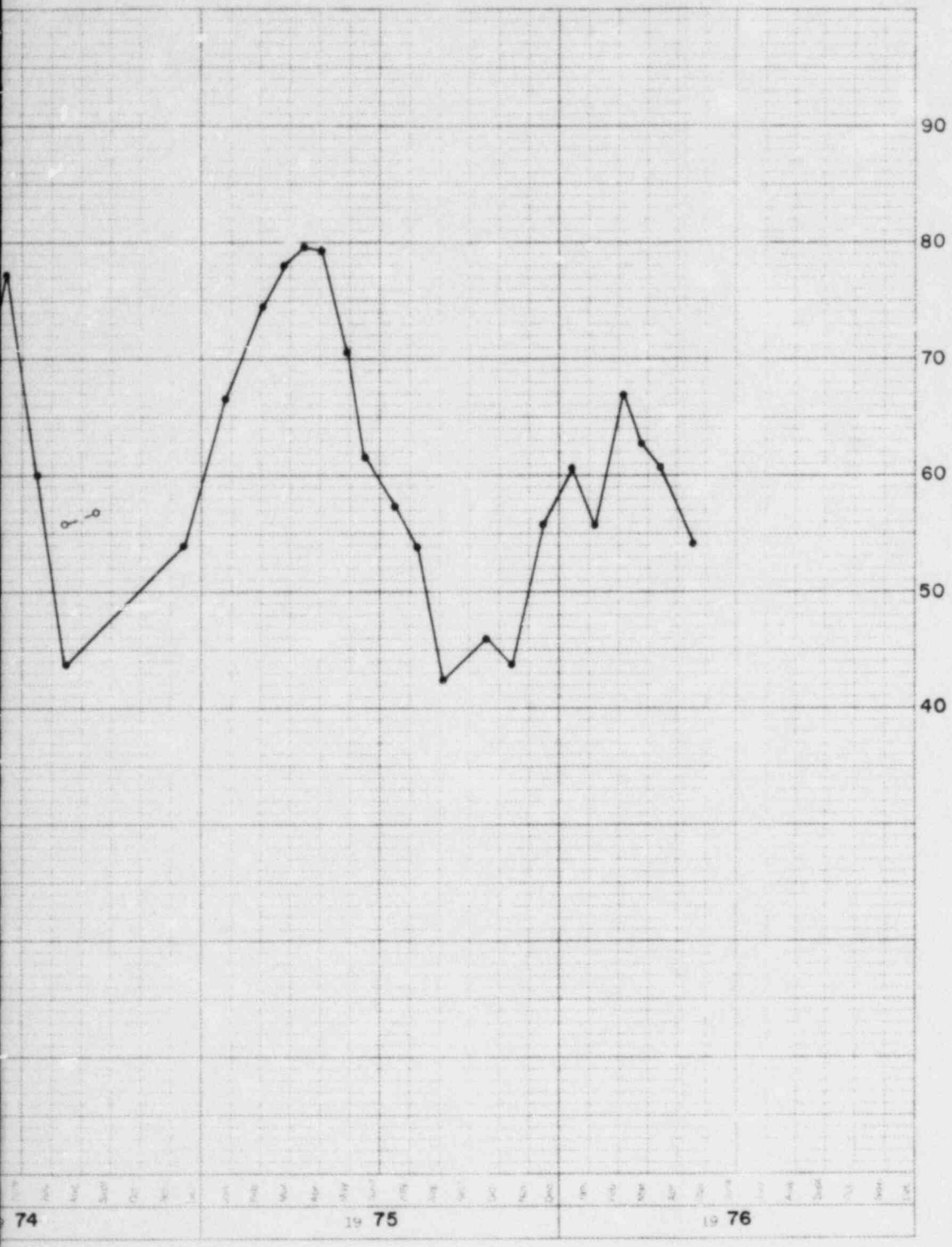
HYDROGRAPHS OF WELLS
AND PIEZOMETERS
(SHEET 5 OF 5)
FIGURE 2.4-11



NOTE:

LOCATIONS OF

GIN LAKES ARE

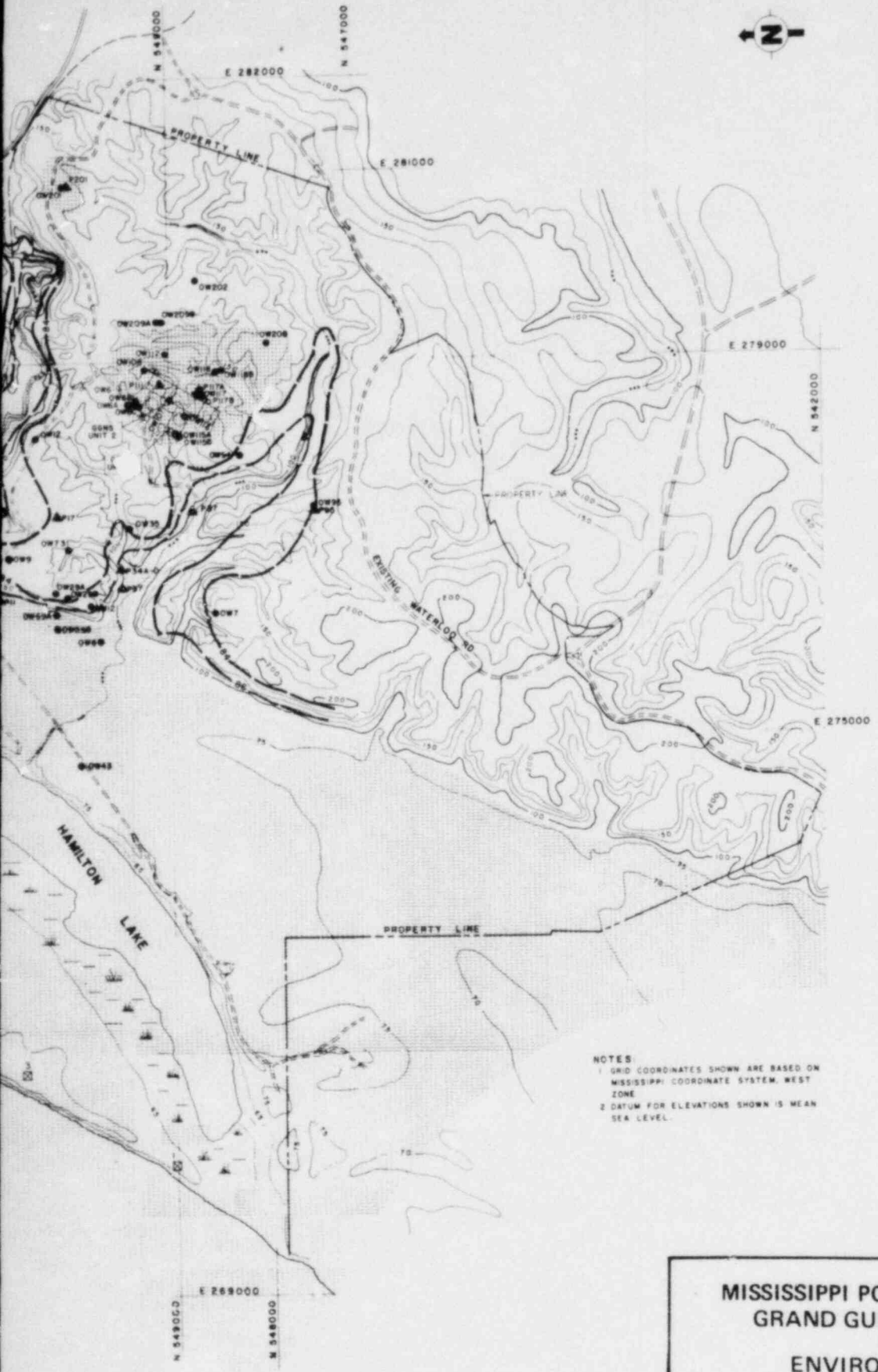


MISSISSIPPI RIVER, HAMILTON &
E SHOWN IN FIGURE 2.4-9

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

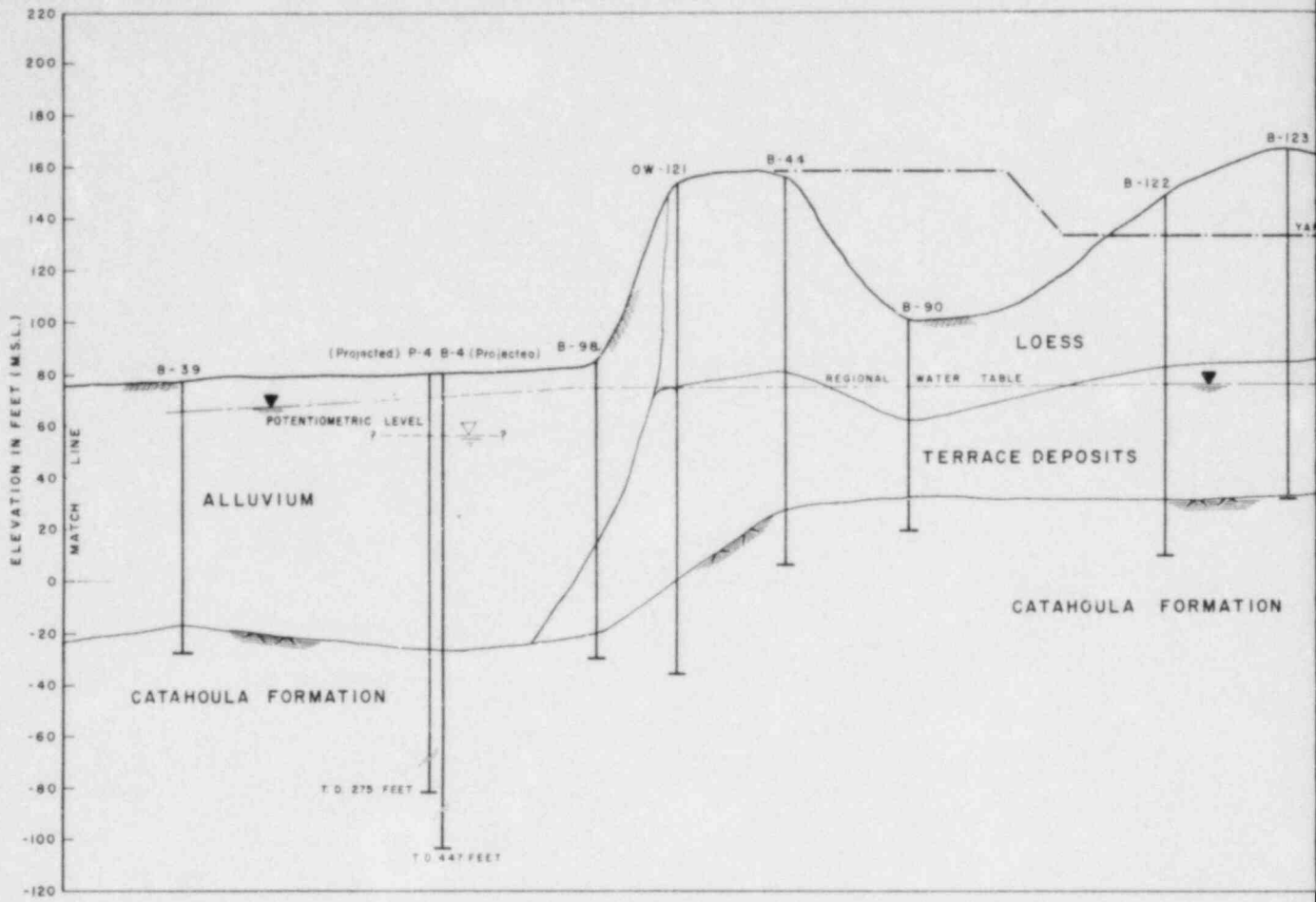
HYDROGRAPHS OF MISSISSIPPI RIVER,
GIN LAKE AND HAMILTON LAKE
FIGURE 2.4-12

E 279000
E 277000
E 275000
N 558000
N 561000
TOWN OF GRAND GULF
GRAND GULF MILITARY MONUMENT
MET TOWER
EXISTING PORT GIBSON TO GRAND GULF ROAD
PROPERTY LINE
GIN LAKE
MARSH AREA
GRAND GULF ISLAND
MISSISSIPPI RIVER
(RIVER STAGE 88.0 FEET, MSL MAY 27, 1973)
82
84
86
LEGEND
PIEZOMETER
OBSERVATION WELL
COLLECTOR WELL
GROUND WATER TABLE CONTOUR (MAY 27, 1973)
APPROXIMATE AREA OF PERCHED WATER
AREA OCCUPIED BY MISSISSIPPI RIVER
500 0 500 1000 1500 2000
SCALE IN FEET

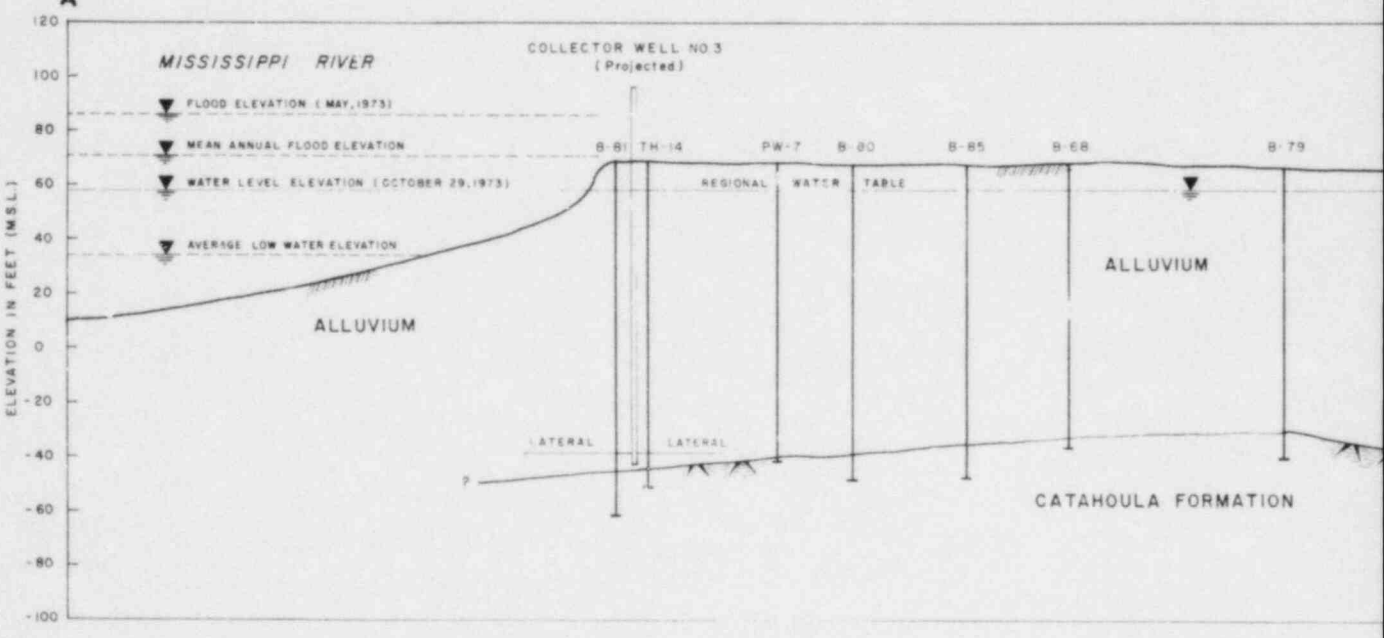


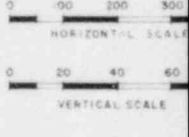
MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

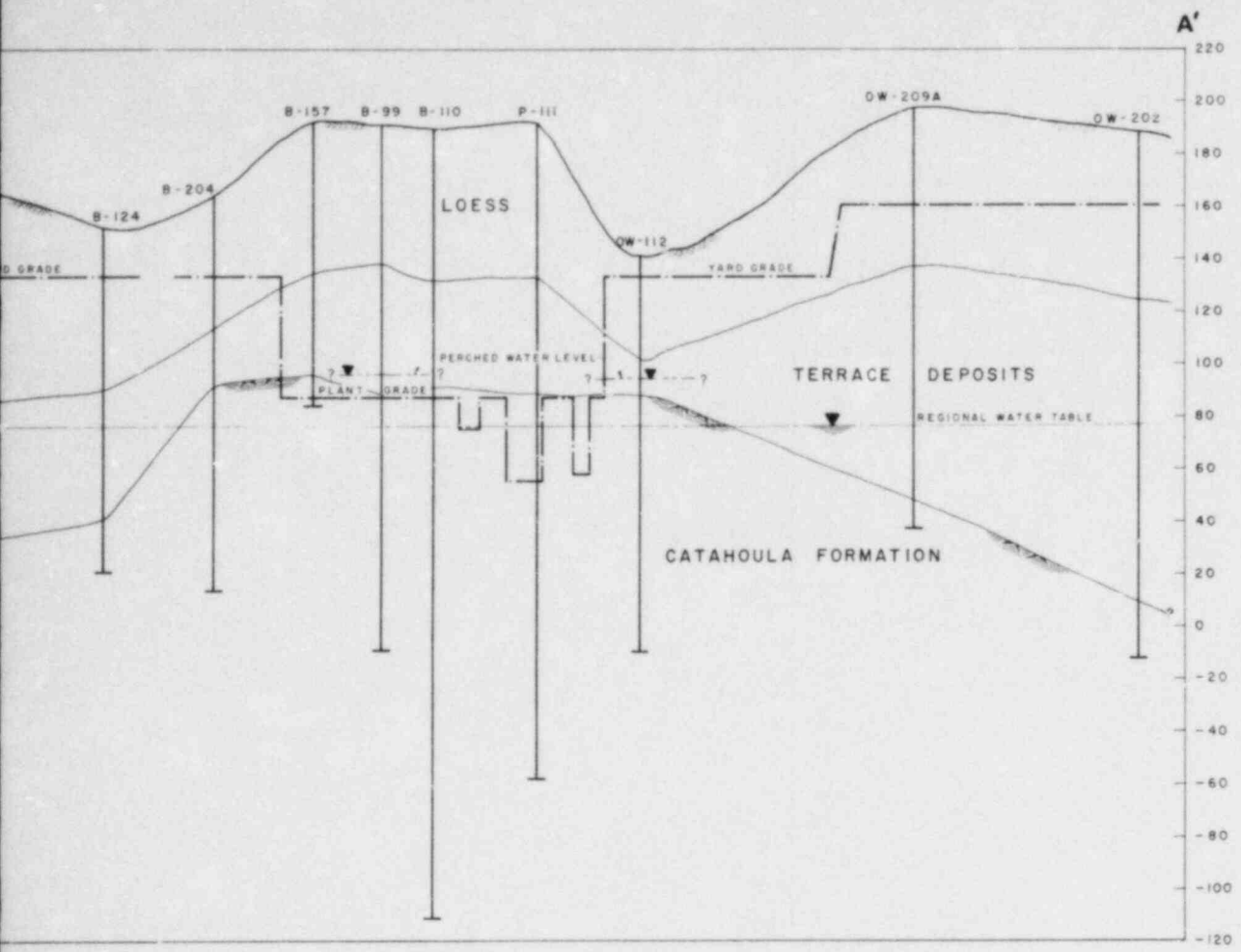
SITE HYDROLOGIC FEATURES
(FLOOD CONDITIONS MAY 1973)
FIGURE 2.4-13

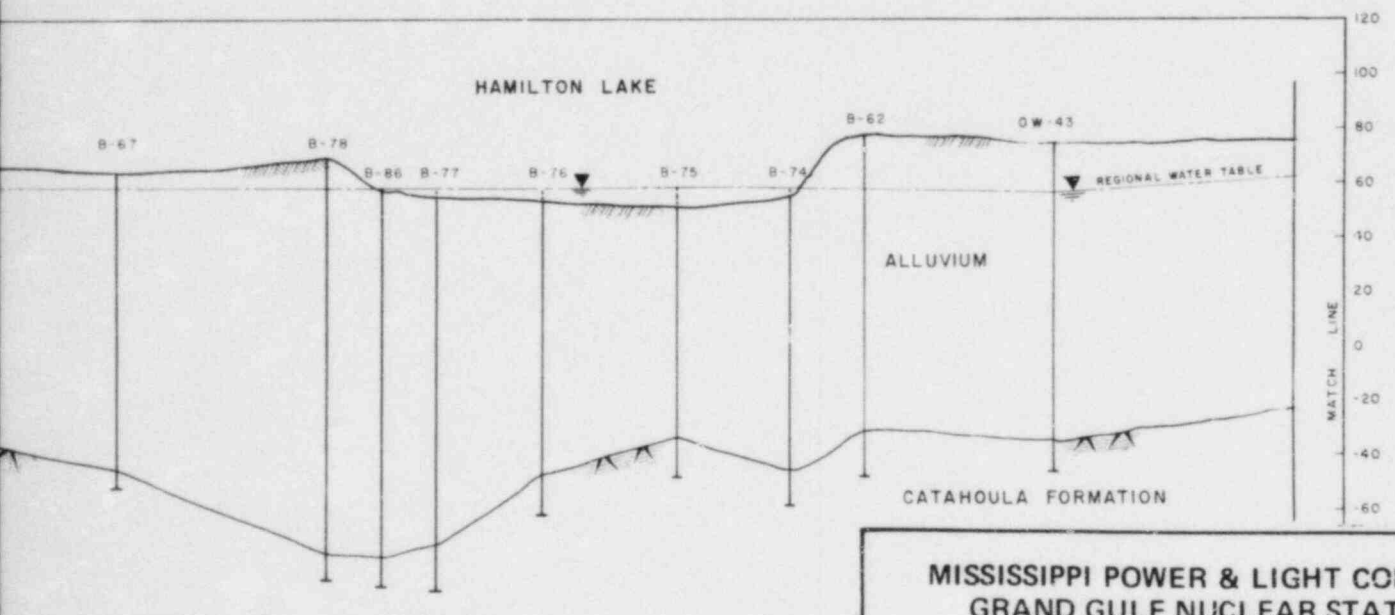

ELEVATION IN FEET (MSL.)
MATCH LINE
B-39
(Projected) P-4 B-4 (Projected)
B-98
OW-121
B-44
B-90
B-122
B-123
POTENTIOMETRIC LEVEL
REGIONAL WATER TABLE
LOESS
TERRACE DEPOSITS
ALLUVIUM
CATAHOULA FORMATION
T.D. 275 FEET
T.D. 447 FEET
CATAHOULA FORMATION

A


ELEVATION IN FEET (MSL.)
MISSISSIPPI RIVER
COLLECTOR WELL NO.3
(Projected)
FLOOD ELEVATION (MAY, 1973)
MEAN ANNUAL FLOOD ELEVATION
WATER LEVEL ELEVATION (OCTOBER 29, 1973)
AVERAGE LOW WATER ELEVATION
B-81
TH-14
PW-7
B-80
B-85
B-68
B-79
REGIONAL WATER TABLE
ALLUVIUM
ALLUVIUM
LATERAL
LATERAL
CATAHOULA FORMATION


0
100
200
300
HORIZONTAL SCALE
0
20
40
60
VERTICAL SCALE





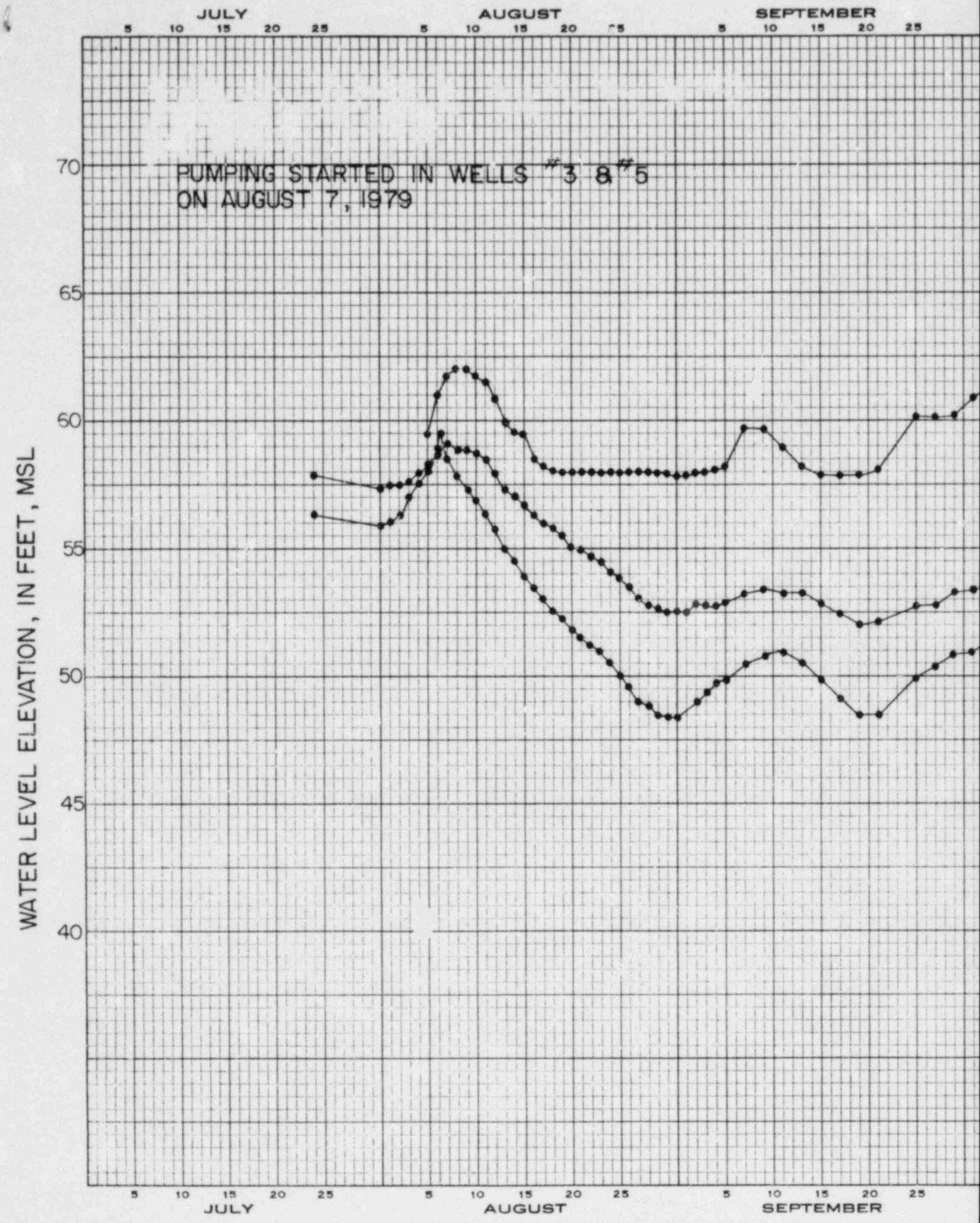
400 FEET

80 FEET

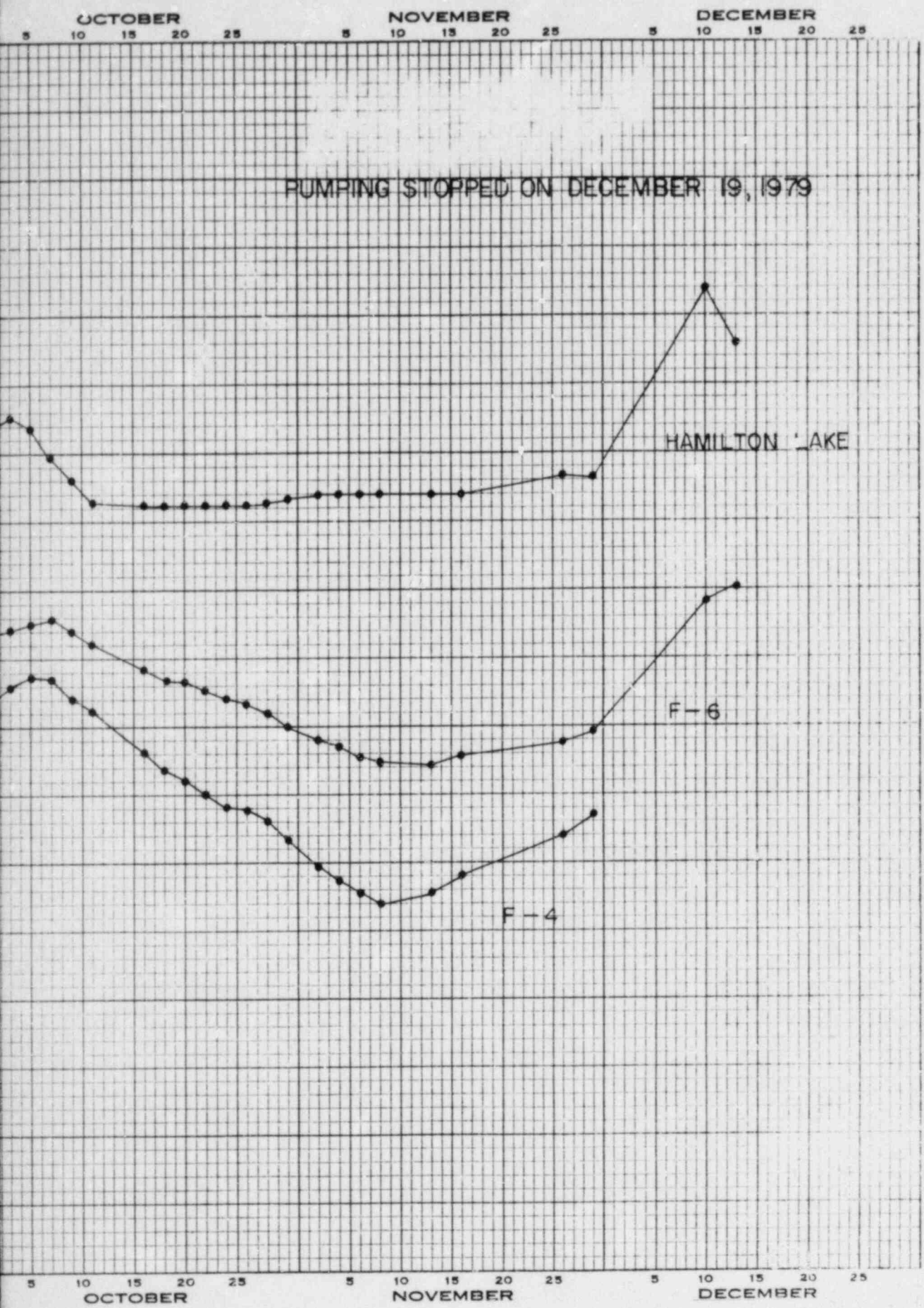
NOTE: FOR SECTION LOCATION, REFER TO FIGURE 2.4-9

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

HYDROGEOLOGIC CROSS SECTION A-A'
FIGURE 2.4-14


JULY
AUGUST
SEPTEMBER
5 10 15 20 25
PUMPING STARTED IN WELLS #3 & #5
ON AUGUST 7, 1979
70
65
60
55
50
45
40
WATER LEVEL ELEVATION, IN FEET, MSL

1979



HYDROGRAPHS OF HAMILTON LAKE AND OBSERVATION WELLS F-4 AND F-6 DURING PUMP TESTS

FIGURE 2.4-15

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

Amend. 6 2/81

2.5 GEOLOGICAL SUMMARY

2.5.1 General

This section describes the major geologic features within a 10-mile radius of the site.

The site is located 25 miles south of Vicksburg, Mississippi, in western Claiborne County, on the margin of two subdivisions of the Gulf Coastal Plain physiographic province. These subdivisions are the Mississippi Alluvial Valley on the west and the Loess or Bluff Hills on the east (Figure 2.5-1). The Mississippi Alluvial Valley is essentially flat, with a maximum relief of 30 feet and a poorly developed drainage pattern. By contrast, the Loess Hills area is severely dissected by a dendritic pattern of streams with nearly vertical valley walls, and relief exceeds 150 feet.

2.5.2 Geologic Investigation Program

The program of geologic investigation consisted of the following:

a. A thorough review of all pertinent geologic literature

b. Interviews with university, State, and Federal geologists having knowledge of geologic conditions in the area

c. Geologic reconnaissance of the plant site and surrounding area

d. Interpretation of maps and aerial photographs

e. An investigation of the subsurface, including soil and ground water conditions in the area, by means of a test boring program, electric logging, laboratory analyses, and seismic refraction traverses

f. Geologic mapping of all major foundations within the plant site

2.5.3 Stratigraphy

The site stratigraphy was determined from a comprehensive literature search, boring program, seismic refraction surveys, correlation of electrical and gamma logs, and geologic mapping of the plant structure excavations. Borings with depths from 55 to 447 feet penetrated Quaternary and Tertiary age formations.

2.5.3.1 Quaternary Deposits

The Quaternary sediments in the site vicinity consist of surficial deposits of sands, gravels, silts, and clays of Holocene and Pleistocene ages. (Figure 2.5-2). In the Mississippi Alluvial Valley and its tributaries, fluvial material ranges in thickness from 22 to 182 feet. In the Loess Hills, the older fluvial sediments range in thickness from 0 to 151 feet and are overlain by 22 to 82 feet of loess. The fluvial deposits underlying the loess are referred to as terrace deposits. The contact between the loess and the terrace deposits is unconformable.

2.5.3.2 Tertiary Deposits

Tertiary sediments underlie Quaternary deposits in the study area and include the Miocene age Catahoula Formation and four formations belonging to the Vicksburg Group of late Oligocene age. Pre-Vicksburg materials were not investigated.

The Catahoula consists of up to 319 feet of hard to very hard, gray to gray-green, fine sandy, silty clay and clayey silt with some locally indurated clay, sand, and silt seams. This formation is the bearing stratum for the major structures of the plant. The contact between the Catahoula and overlying Quaternary material is unconformable.

Unconformably underlying the Catahoula Formation is a sequence of four formations which comprise the Vicksburg Group of Oligocene age. These formations, from youngest to oldest, are the Bucatunna, the Byram, the Glendon, and the Mint Spring.

The Bucatunna is a 53-foot thick layer of stiff to hard greenish black to black clay with thin, gray, fine sand seams. Regionally, the Bucatunna occurs discontinuously, as it was partially eroded before deposition of the overlying Miocene sediments.

The Byram Marl, underlying the Bucatunna, is hard to very hard, green to gray, fine sandy, calcareous clay approximately 5 feet thick. The Byram Marl is also discontinuous throughout the region.

Conformably underlying the Byram Marl is the Glendon Formation. It consists of a series of interbedded, light gray, fossiliferous limestone and hard to partly indurated, grayish green, fine sandy, calcareous clays. Total thickness is about 46 feet. Core samples of the Glendon showed no evidence of solution activity.

Underlying the Glendon is the Mint Spring Marl, which consists of hard, grayish green fossiliferous, glauconitic sand and clay. Forty feet of the Mint Spring Marl was penetrated at the plant site; however, the total thickness of the formation was not determined.

2.5.4 Structure

Structural relationships within the study area were determined by investigation of existing structure contour maps and construction of new structural maps based on data obtained from the geologic borings. The major structural features include a gentle southward dip of Tertiary strata, two salt domes within 10 miles of the site, and a northwest-southeast trending subsurface ridge in the southwestern part of Claiborne County.

2.5.4.1 Regional Dip

Tertiary strata present below the site dip gently and uniformly southward (Figure 2.5-3) in response to downwarping of basement rock in the Gulf Coast Basin. Quaternary strata do not exhibit this southward dip, indicating that downwarping has not affected the study area since deposition of the Glendon Limestone in Oligocene time.

2.5.4.2 Salt Domes

Two relatively shallow piercement type salt domes occur within 10 miles of the site (Figure 2.5-2). The Bruinsburg dome, 8 miles from the plant site in southwest Claiborne County, has a depth to caprock of 1981 feet and depth to salt of 2020 feet. On the Warren-Claiborne County line, 8 miles northeast of the site, the Galloway dome has a depth to caprock of 3990 feet and a depth to salt of 4196 feet. These salt domes appear to influence the configuration of the Glendon Formation to the extent that some local unwarping of the top of the Glendon near the domes has occurred. However, that section of the Glendon over which the site is located is nearly flat, dipping gently to the southeast, with no upwarping due to the salt domes (Figure 2.5-4). No movement of the salt has occured since Vicksburg (Oligocene) time, and no strata younger than the Glendon have been affected by salt movement.

One possible dome of intermediate depth may occur 8 miles north-northwest of the site, on the Warren County-Tensas Parish line. Wells in that vicinity drilled as deep as 12,000 feet show displacements of Midway (Paleocene) and Wilcox (Early Eocene) strata of up to 400 feet. Less than 2 miles from the inferred dome, no displacements of the same strata have been recorded. Strata of Claiborne (Middle Eocene) age, above the Wilcox, also lack displacement over the dome. If a domal structure exists in that area, it is fairly deep seated, since caprock and salt were not reported in two wells drilled directly into the proposed structure to depths of about 7500 feet. No movement of salt possibly responsible for this structure could have occurred after Wilcox time, since Claiborne-age beds immediately above the Wilcox beds have not been displaced.

2.5.4.3 Faults

No faults exist within 60 miles of the site. The nearest fault is within the Pickens-Gilbertown fault zone, about 65 miles east-northeast of the site. Other fault zones within 200 miles of the site include the South Arkansas fault zone and the Baton Rouge fault zone, both over 100 miles from the site. Faults within these zones are termed "growth" or "contemporaneous faults" and resemble large scale slump structures. Displacements, generally small near the surface, characteristically increase with depth. No connection between contemporaneous faulting and basement faulting is apparent in the literature. The nearest fault displacing surface beds is in the Baton Rouge fault zone, about 110 miles south of the site.

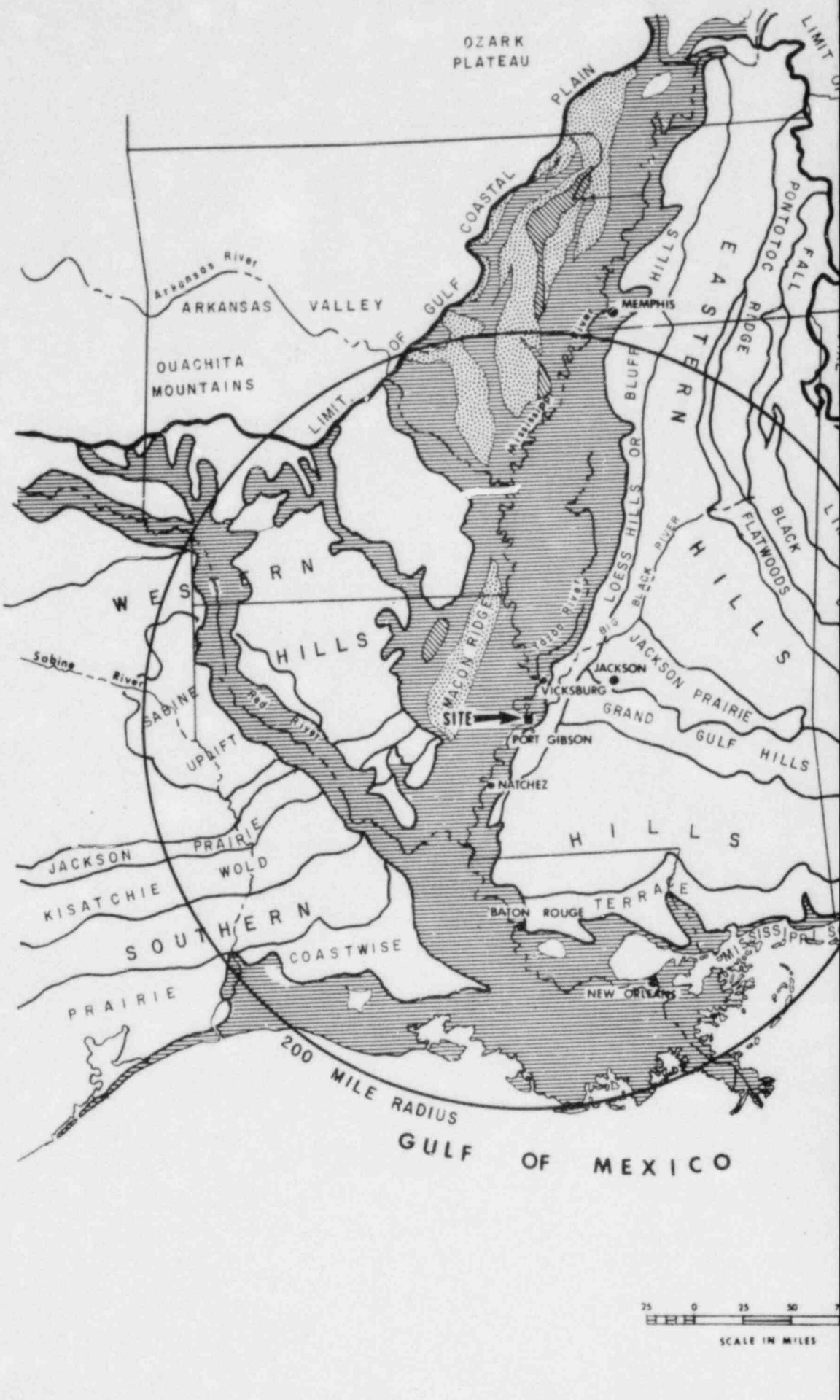
The New Madrid fault zone is located more than 200 miles north of the site.

Fisk's "Geological Investigations of the Alluvial Valley of the Lower Mississippi River" indicated that two possible fault zones may intersect north of the site. Cross sections, based on borings from various sources, were constructed to investigate the existence of these zones. It was concluded that there is no evidence supporting the existence of fault zones in that area.

2.5.5 Petroleum Production

The site is located in the Interior Salt Basin, midway between the Bruinsburg dome and the Galloway dome. Although most of the salt domes within this basin are nonproductive with respect to petroleum, Middle Eocene sands provided gas from a shallow (890 to 910 foot) well on the Bruinsburg dome 8 miles southwest of the site. Production from the field was 225,573,000 cubic feet of gas, until production ceased in 1966. There are no petroleum producing areas within 10 miles of the site. Petroleum exploration in Claiborne County has been unsuccessful; 12 dry wells have been drilled within 6 miles of the site. Depths of the dry holes range from 6500 to 11,500 feet, all penetrating Cretaceous strata.

Regionally, a northwest-southeast structural ridge extends through the southwestern part of Claiborne County. This structure has been associated with production from an abandoned oil field 9 miles northwest of the site and a producing oil field 12 miles southeast of the site. Nine wells drilled in this structure to the Lower Cretaceous in Claiborne County have not been successful in locating hydrocarbons. As the site is located on the flank of the structural ridge, about midway between the axis of the ridge and the Mississippi Alluvial Valley trough, the outlook for petroleum production in the vicinity of the site is unfavorable.


OZARK PLATEAU
COASTAL PLAIN
LIMIT OF GULF
Arkansas River
ARKANSAS VALLEY
OUACHITA MOUNTAINS
LIMIT
MEMPHIS
PONTOTOC RIDGE
FALL
EASTERN HILLS
LOESS BLUFF HILLS
BLACK
FLATWOODS
BLACK RIVER
WESTERN HILLS
MACON RIDGE
Sabine River
SABINE UPLIFT
Red River
JACKSON
VICKSBURG
SITE
PORT GIBSON
JACKSON PRAIRIE
GRAND GULF
HILLS
NATCHEZ
JACKSON PRAIRIE
KISATCHIE WOLD
SOUTHERN COASTWISE PRAIRIE
BATON ROUGE
TERRACE
NEW ORLEANS
200 MILE RADIUS
GULF OF MEXICO
25 0 25 50
SCALE IN MILES

LEGEND

MISSISSIPPI ALLUVIAL VALLEY

- FLOOD PLAIN
- OLDER ALLUVIAL PLAINS LOCALLY ABOVE FLOOD LEVEL
- UPLANDS WITHIN ALLUVIAL VALLEY

REFERENCE:

FISK, H.N., "GEOLOGICAL INVESTIGATIONS OF THE ALLUVIAL VALLEY OF THE LOWER MISSISSIPPI RIVER," MISSISSIPPI RIVER COMMISSION, VICKSBURG, MISS., 1944.

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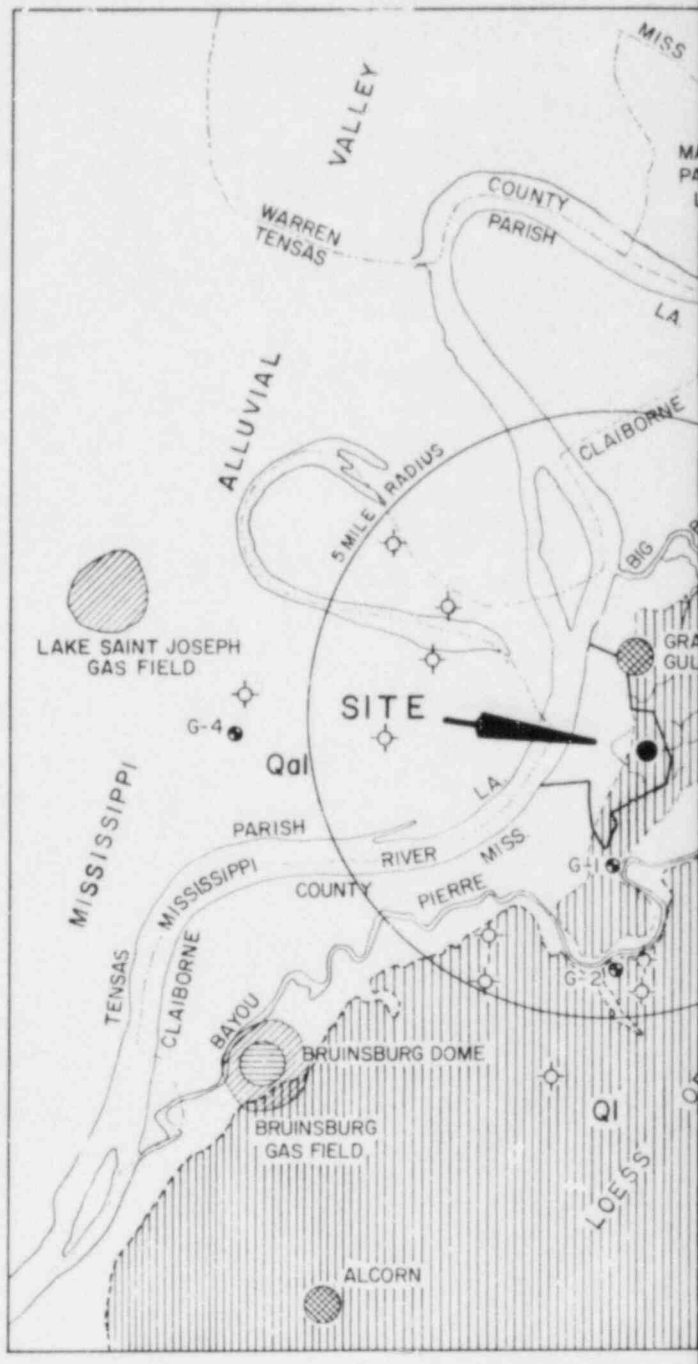
UNITS 1 & 2
ENVIRONMENTAL REPORT

REGIONAL PHYSIOGRAPHIC MAP

FIGURE 2.5-1


MISS
VALLEY
COUNTY
PARISH
WARREN
TENSAS
LA
ALLUVIAL
CLAIBORNE
5 MILE RADIUS
BIG
LAKE SAINT JOSEPH
GAS FIELD
SITE
G-4
Qal
LA
PARISH
MISSISSIPPI
RIVER
MISS
COUNTY
PIERRE
MISSISSIPPI
TENSAS
CLAIBORNE
BAYOU
BRUINSBURG DOME
BRUINSBURG
GAS FIELD
Ql
LOESS
ALCORN
1 0 1 2 3
SCALE IN MILES

LEGEND

QUATERNARY

HOLOCENE — Qal — ALLUVIUM - FINE TO COARSE GRAINED SAND, CHERT AND QUARTZ GRAVEL, SILT AND CLAY INCLUDES REWORKED LOESS IN SMALL STREAM VALLEYS

PLEISTOCENE — QI — LOESS - TAN TO BROWN SILT AND ARGILLACEOUS SILT, CALCAREOUS ZONES, LAND SNAIL SHELLS

SALT DOME - MINIMUM DEPTH OF TOP APPROXIMATELY 2000'

GAS FIELD (ABANDONED)

TOWN

PETROLEUM WELL (DRY)

G-2 TEST BORING

INDEFINITE STRATIGRAPHIC CONTACT

STATE BOUNDARY

SITE BOUNDARY

4 5

REFERENCES

"GEOLOGIC MAP OF MISSISSIPPI", MISSISSIPPI GEOLOGICAL SURVEY, 1965.

ROLLO, J.R., "GROUND WATER IN LOUISIANA", LOUISIANA DEPARTMENT OF CONSERVATION, WATER RESOURCES BULLETIN 1, PLATE 1. 1960.

BICKER, A.R., JR., ET AL., "CLAIBORNE, COUNTY GEOLOGY AND MINERAL RESOURCES," MISSISSIPPI GEOLOGICAL, ECONOMIC AND TOPOGRAPHICAL SURVEY, BULL 107, 1966.

DURHAM, JR., C.O., "GRAND GULF SITE PETROLEUM PRODUCTION", PERSONAL COMMUNICATION, 1972.

MELLEN, F.F., "WARREN COUNTY MINERAL RESOURCES," MISSISSIPPI GEOL. SURVEY, BULLETIN 43 1941.

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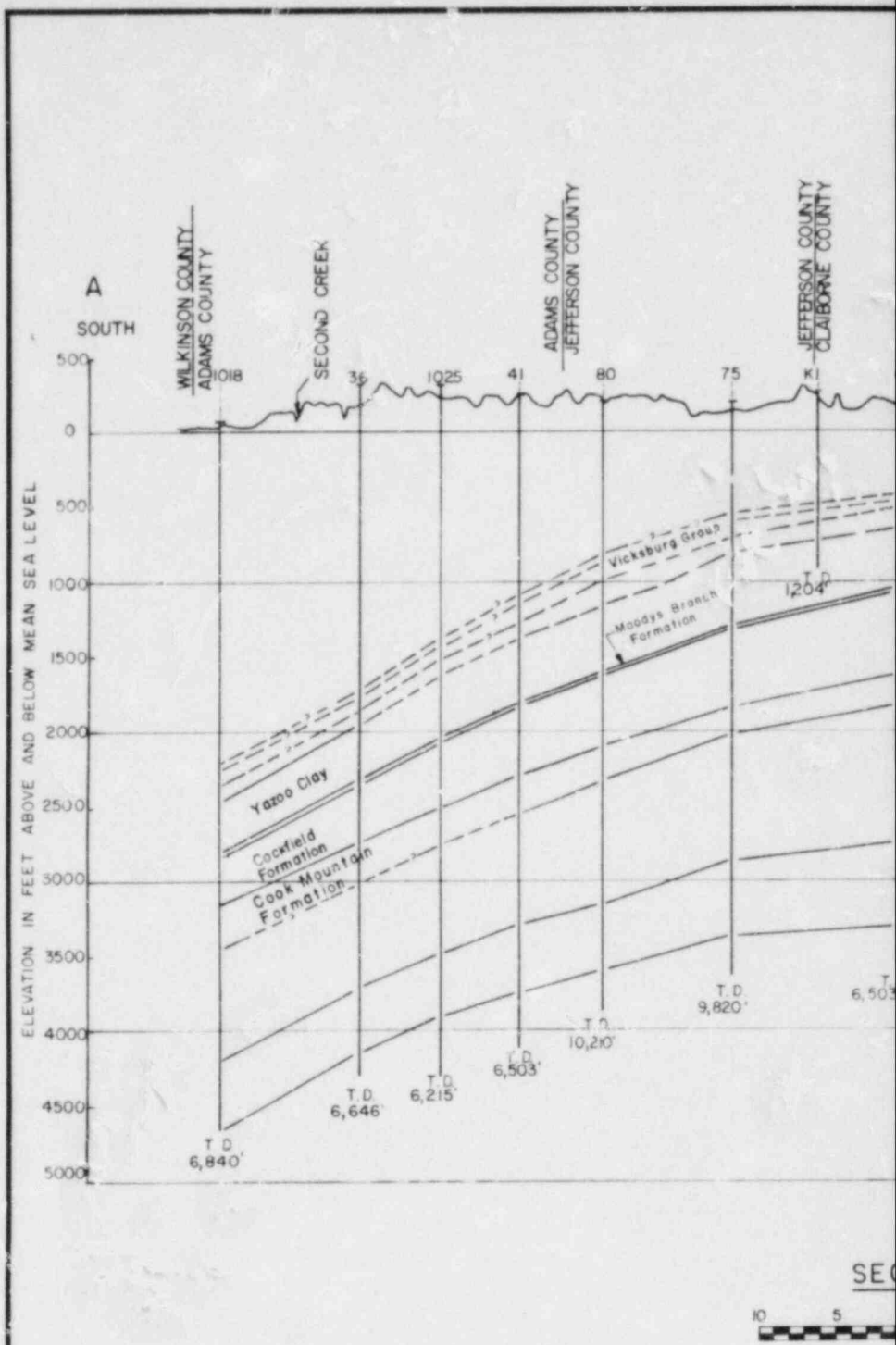
ENVIRONMENTAL REPORT

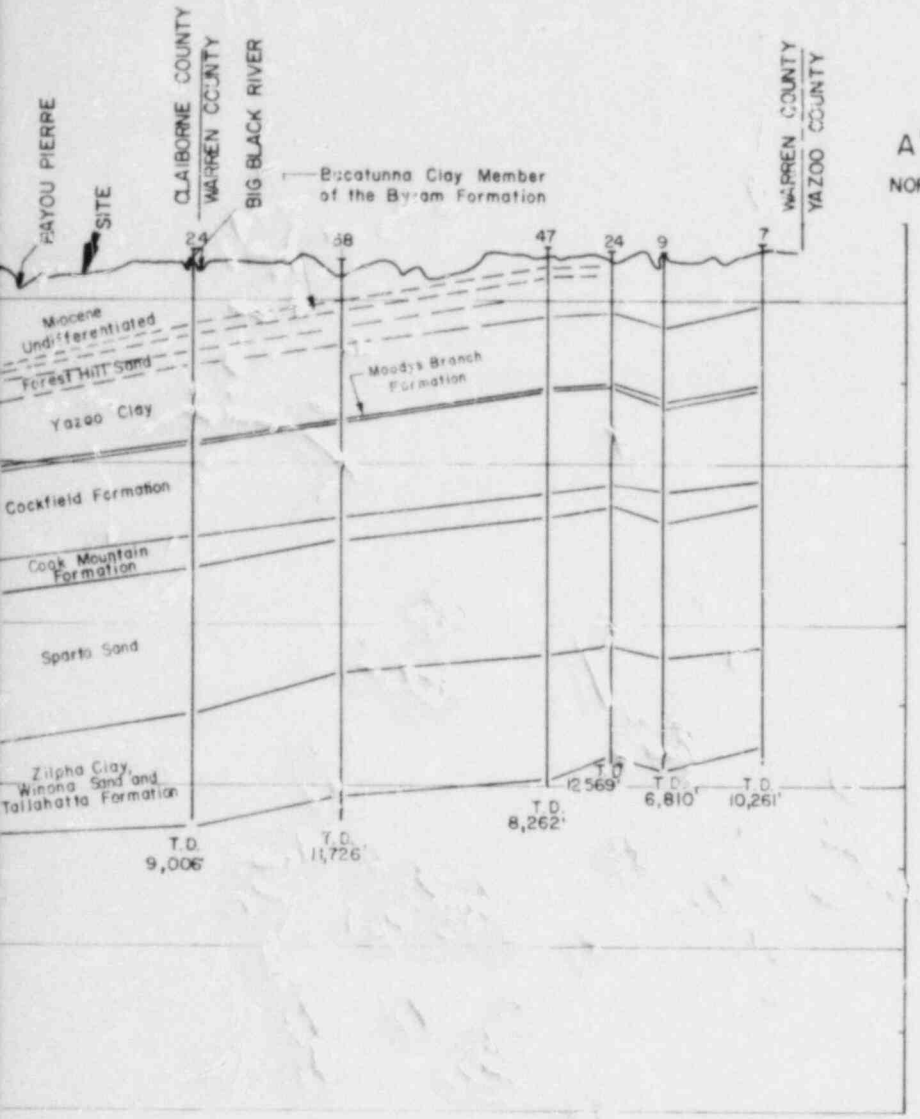
LOCAL GEOLOGIC MAP

FIGURE 2.5-2


A
SOUTH
WILKINSON COUNTY
ADAMS COUNTY
SECOND CREEK
ADAMS COUNTY
JEFFERSON COUNTY
JEFFERSON COUNTY
CLAIBORNE COUNTY
1018
35
1025
41
80
75
K
ELEVATION IN FEET ABOVE AND BELOW MEAN SEA LEVEL
500
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Vicksburg Group
Moodys Branch Formation
Yazoo Clay
Cocksfield Formation
Cook Mountain Formation
T.D. 1,204'
T.D. 9,820'
T.D. 10,210'
T.D. 6,503'
T.D. 6,215'
T.D. 6,646'
T.D. 6,840'

SEC

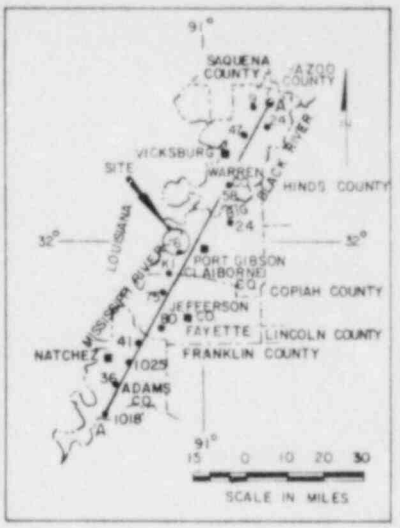
10 5



TION A-A'

0 10 20

SCALE IN MILES



KEY TO ELECTRICAL LOGS

1018	SERIO-PUNCHES OIL CO., NO. 1 BOOZE-FORT
36	CALLON AND TISCHENER, NO. 1 GOUSETT
1025	DUNCAN-TAYLOR AND SCHUMACHER, NO. 1-A STANTON
41	S.C. AND J.S. CALLON, NO. 1 ABBOTT
80	OHIO OIL CO., NO. 1 HARDTIMES PLANTATION
75	UNION OIL CO., OF CALIFORNIA, NO. 1 WAGNER
K1	ALCORN COLLEGE, TEST HOLE
6	SERIO, JUSTISS-MEARS AND CLEMENTS, NO. 1 WILSON
24	DANCIGER OIL & REFINING CO., NO. 1 TAYLOR
58	UNION PRODUCING CO., NO. 1 HARLIN
47	MAGNOLIA PETROLEUM CO., NO. 1 FIELD ESTATE
24	CALIFORNIA CO., NO. 1 S-1 ANDERSON-TULLY
9	ROY LEE, TRUSTEE, NO. 1 ANDERSON-TULLY
7	D.T. DOUGHERTY, NO. 1 HINTSON

REFERENCE:

CALLAHAN, J.A., SKELTON, J., EVERETT, D.R., HARVEY, E.J., "WATER RESOURCES OF ADAMS, CLAIBORNE, JEFFERSON, AND WARREN COUNTIES, MISSISSIPPI," WATER RESOURCES BULLETIN 63-1, 1963.

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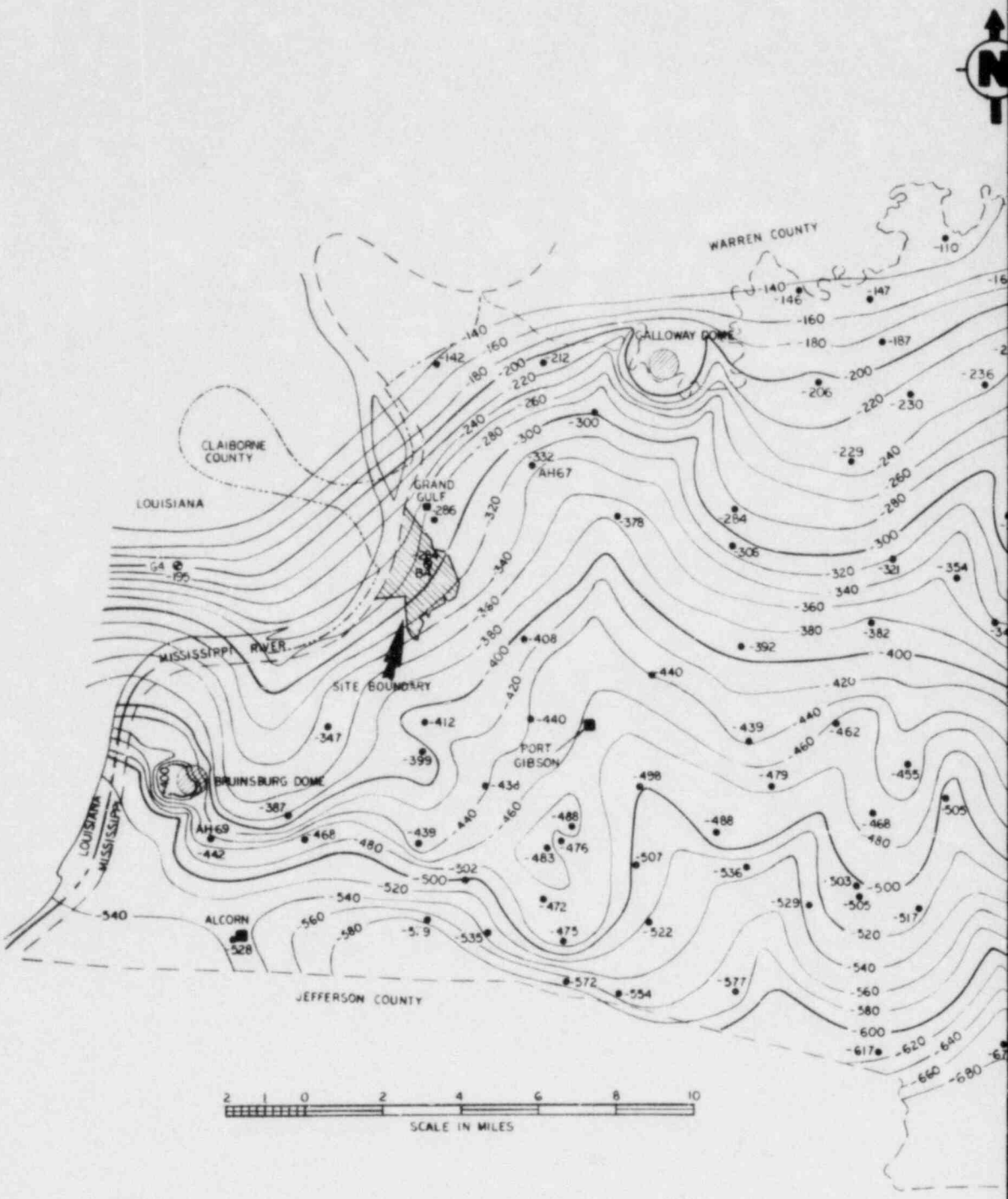
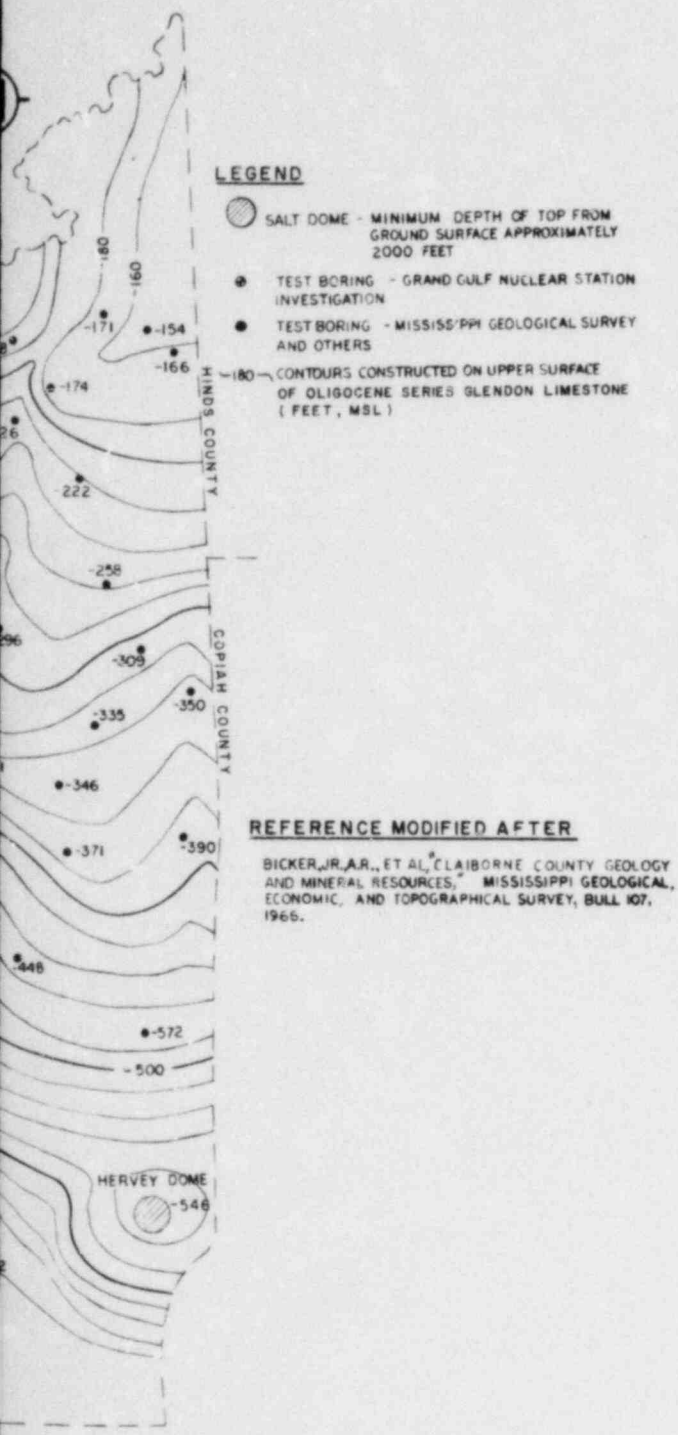
UNITS 1 & 2
ENVIRONMENTAL REPORT

GEOLOGIC SECTION, ADAMS COUNTY THROUGH WARREN COUNTY, MISSISSIPPI
FIGURE 2.5-3


N
WARREN COUNTY
CALLOWAY DOME
CLAIBORNE COUNTY
LOUISIANA
GRAND GULF
AH67
MISSISSIPPI RIVER
SITE BOUNDARY
PORT GIBSON
BRUINSBURG DOME
AH69
ALCORN
JEFFERSON COUNTY
2 1 0 2 4 6 8 10
SCALE IN MILES



REFERENCE MODIFIED AFTER

BICKER, JR., A.R., ET AL, "CLAIBORNE COUNTY GEOLOGY AND MINERAL RESOURCES," MISSISSIPPI GEOLOGICAL, ECONOMIC, AND TOPOGRAPHICAL SURVEY, BULL 107, 1966.

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

CONTOUR MAP OF THE
GLENDON LIMESTONE OF
CLAIBORNE COUNTY
FIGURE 2.5-4

2.6 REGIONAL, HISTORIC, ARCHEOLOGICAL, ARCHITECTURAL, SCENIC, CULTURAL AND NATURAL FEATURES

Grand Gulf Nuclear Station is located in a richly historic section of Mississippi. Claiborne County was one of the first counties organized in the State and boasts many historic features, including antebellum homes, Civil War battlefields, and Indian relics. Grand Gulf Nuclear Station obtained its name from the Grand Gulf Military Park located immediately north of the site.

MP&L contracted with the Mississippi Department of Archives and History in 1972 for an archaeological, architectural and historical survey of the Grand Gulf Nuclear Station site, the perimeter area, and the transmission line routes. The purpose of this survey was three-fold: (1) to record as completely as possible the archaeological, architectural, and historical data on the site, the perimeter area, and the transmission line routes; (2) to interpret the meaning and importance of the recovered data; and (3) to suggest the means of safeguarding any areas which warrant preservation or excavation.

An initial survey by the Mississippi Department of Archives and History in June, 1972 disclosed only one nonexpendable archaeological site within the Grand Gulf Nuclear Station site and its associated transmission routes. This was a Marksville period (150 B.C. - 300 A.D.) Indian burial mound which lay about 1000 feet directly south of the meteorological tower. On the recommendation of the Department, MP&L initiated measures to prevent looting and erosion, and funded excavation of the mound. The excavation work was performed in the winter of 1972-1973 under the direction of Mr. James H. Stone, then Assistant Administrator of the Division of Historic Sites and Archaeology of the Mississippi Department of Archives and History. Upon completion of the salvage archaeological excavation, the Department deemed it unnecessary to preserve the site since the mound no longer existed.

The only structure of any architectural interest on or immediately adjacent to the Grand Gulf Nuclear Station site, excepting structures in the Grand Gulf Military Park, is an antebellum farm house known locally as the Callendar House. The Mississippi Department of Archives and History has no intention of nominating it for the National Register of Historic Places. The official position taken by the Department is that MP&L should be allowed to make the decisions regarding the Callendar House. The home is in rather poor condition and MP&L has no plans for the structure at the present time.

The Mississippi Department of Archives and History noted three interrelated sites of historic importance in the area: the Grand Gulf Military Park, a portion of the old Grand Gulf townsite, and the remains of the U.S.S. Rattler. MP&L transferred a 164-acre tract of land, which included the bulk of the remaining portion of the old Grand Gulf townsite, to the Grand Gulf Military Monument Commission on June 19, 1974. The remains of the U.S.S. Rattler, a Federal tinclad gunboat which was forced ashore near Grand Gulf, are believed to be slightly north of the tract of land transferred to the Grand Gulf Military Monument Commission. As State property, the park is protected by the Mississippi Antiquities Law of 1970. In addition, the Grand Gulf Military Park is on the National Register of Historic Places.

The station structures have a visual impact on the landscape; however, architectural and aesthetic considerations ameliorate these changes insofar as practicable. Only portions of the station and switchyard are visible from nearby Grand Gulf Road. The natural draft cooling towers, which are 522 feet above grade elevation, have the greatest visual impact on the surrounding area. An artist's concept of the view of Grand Gulf Nuclear Station from the Mississippi River is shown in Figure 2.6-1.

To minimize the adverse aesthetic impact of the Grand Gulf transmission line corridors, areas of potential aesthetic, cultural, or historical sensitivity were identified and evaluated in designing the routes. The only recommendation that the Mississippi Department of Archives and History had, in regard to the transmission line routes, involved the visual impact of the Baxter Wilson line on the Grand Gulf Military Park. Their major concern was that the line was too close to the eastern boundary of the park. To minimize the adverse aesthetic impact, the transmission line has been located as far east as practicable. Details of specific features, including the visual effects of the associated transmission lines on nearby cultural, scenic, historic, park, and recreation areas, are discussed in Section 3.9.

2.6.1 References

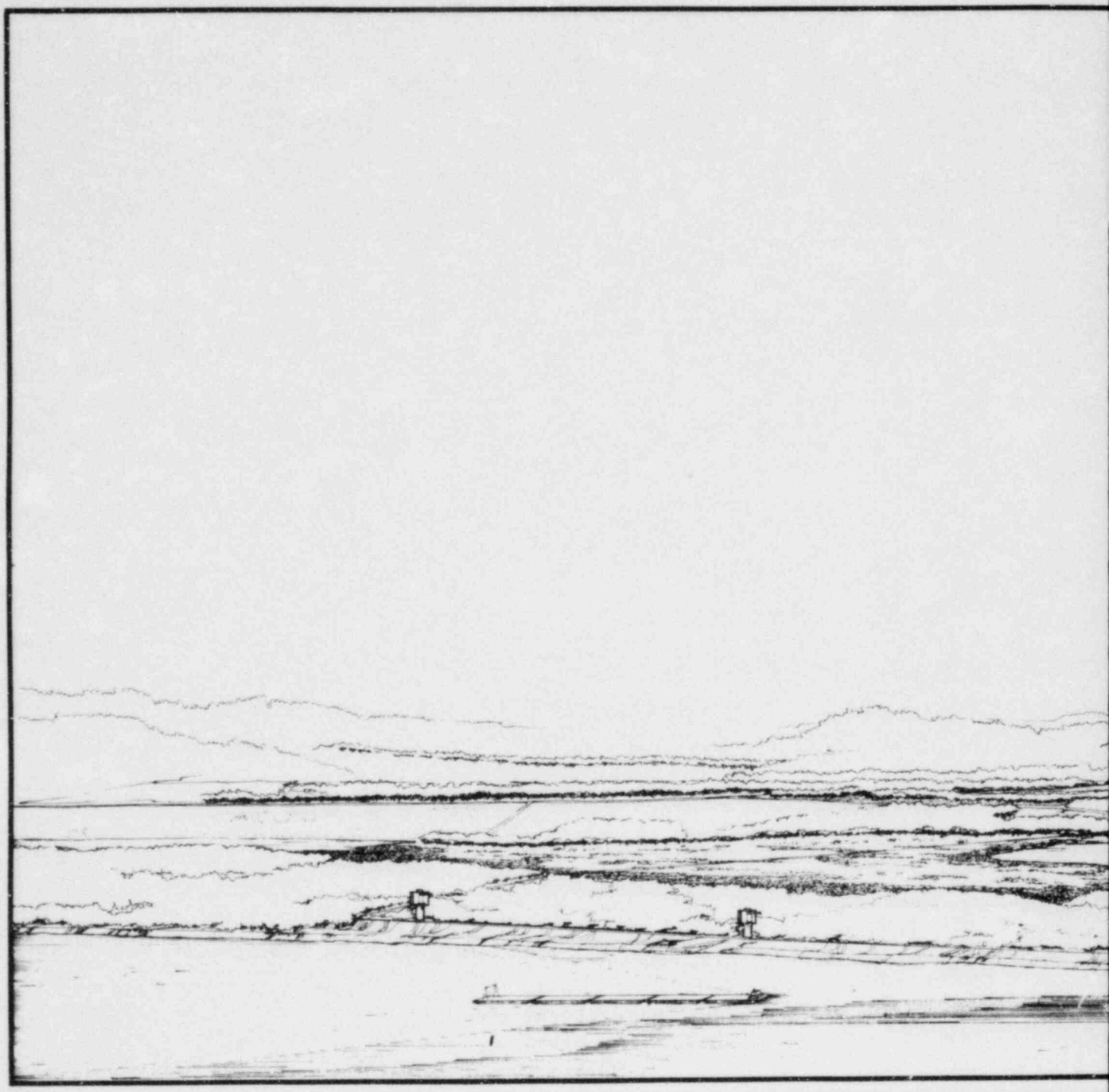
1. Brookes, S.O., S.O. McGahey, and P.M. Lowrey, editors, 1976, "Archeological Report No. 1: The Grand Gulf Mound (22-Cb-522)-Salvage Excavation of an Early Marksville Burial Mound", Mississippi Department of Archives and History, Jackson, Mississippi.

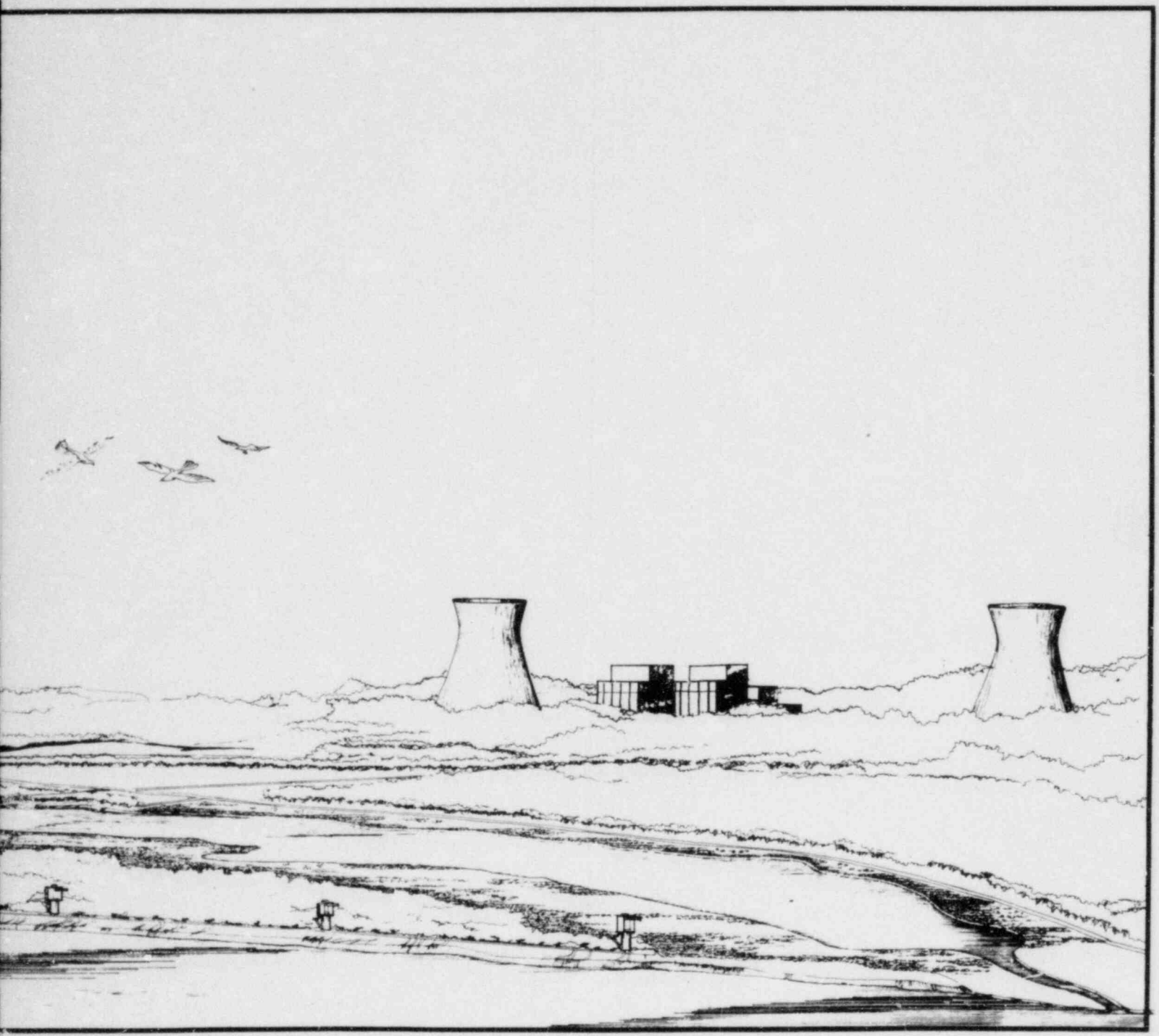
2. Brookes, S. O., B. Inmon, and J. H. Stone, editors, 1973. "Mississippi Archaeological Survey Report No. 3: Archaeological Survey of Claiborne County, Mississippi," Mississippi Department of Archives and History, Jackson, Mississippi.

3. Douglas, E. P.and J. H. Stone, editors, 1974. "Architecture in Claiborne County: A Selective Guide," Mississippi Department of Archives and History, Jackson, Mississippi.

4. Stone, J. H., E. P. Douglas, S. O. Brookes, and B. Inmon, August 1, 1972. "Preliminary Archaeological, Architectural, and Historical Survey of the Grand Gulf Nuclear Station Site, the Perimeter Area, and the Proposed Power Line Routes," unpublished report, Mississippi Department of Archives and History.

5. U. S. Department of the Interior, National Park Service, August 1973. "Preparation of Environmental Statements: Guidelines for Discussion of Cultural (Historic, Archaeological, Architectural) Resources."





MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	ARTIST'S CONCEPT OF GRAND GULF NUCLEAR STATION FIGURE 2.6-1

2.7 NOISE

The following noise surveys have been conducted:

a. An ambient background noise level survey was conducted at selected representative locations on July 27 and 28, 1973.

b. A series of five bimonthly noise surveys were conducted during various phases of construction. The dates of the five surveys and primary activities occurring during each of them are presented in Table 2.7.1.

Additional construction noise surveys were also conducted for documentation purposes but were not analyzed because prior results had indicated that the noise levels at the site were clearly acceptable.

2.7.1 Monitoring Locations and Schedule

2.7.1.1 Ambient Background Noise Survey (July 27-28, 1973)

Ambient background noise levels were measured at eight accessible, representative locations on and near the property line of the site and in nearby populated areas (Figure 2.7-1). Point 8, not shown on Figure 2.7-1, was located at the entrance to Addison Junior High School on the northwestern edge of Port Gibson, Mississippi, about 7 miles southeast of the site. Each location was monitored four times a day during diurnal and nocturnal hours on one weekday and one weekend day. Measurements were typically made in the morning (0830 hours), noon (1300 hours), afternoon (1800 hours), and night (2230 hours). These time periods were considered adequate and sufficient to cover differences due to human activities and insect and animal behaviors, and to obtain representative data for a typical summer day.

2.7.1.2 Construction Noise Surveys

To facilitate the comparison of results from the above ambient noise survey with each of the five bimonthly surveys, similar procedures with respect to sampling technique, sampling schedule, monitoring locations, and equipment were employed. One major consideration, time of year, could not be duplicated and still permit noise surveys to coincide with selected phases of construction. Therefore, in addition to studying the effects of construction on the noise environment, natural seasonal variations, primarily due to insects, were also studied.

2.7.1.2.1 Survey No. 1 (June 5-6, 1974)

Each of the monitoring points shown in Figure 2.7-1, except point number 7 which was inaccessible because of flooding, were monitored five times a day for 2 consecutive days between the hours of 7:00 A.M. one day and 1:00 A.M. of the next day.

2.7.1.2.2 Survey No. 2 (August 27-30, 1974)

Monitoring points 1, 3, 4, 5, 6 and 8, shown in Figure 2.7-1, were monitored six times a day, or once every 4 hours, for 2 consecutive days. Modifications made included an additional survey time at 4:00 A.M. to cover adequately the lengthened work schedule and the elimination of monitoring points 2 and 7 as redundant or unnecessary.

2.7.1.2.3 Survey No. 3 (October 16-18, 1974)

Monitoring points 1, 3, 4, 5 and 6, shown in Figure 2.7-1, were monitored six times a day, or once every 4 hours, for 2 consecutive days. Monitoring point number 8 in Port Gibson was eliminated from this survey because a good baseline for this point had already been established by earlier surveys; and because differences in the type of construction activity at the site had little or no effect at this point.

2.7.1.2.4 Survey No. 4 (December 9-10, 1974)

Monitoring points 1, 3, 4, 5, and 6, shown in Figure 2.7-1, were monitored six times a day, or once every 4 hours for 2 consecutive days.

2.7.1.2.5 Survey No. 5 (February 25-27, 1975)

Monitoring points 1, 3, 4, 5, and 6, shown in Figure 2.7-1, were monitored six times a day, or once every 4 hours, for 2 consecutive days.

2.7.2 Equipment

A General Radio Model 1933 Sound Analysis System, equipped with a 1-inch electret-condenser microphone and its windscreen, and a Simpson Model 2745 Graphic Level Recorder were used during the ambient and construction noise surveys to measure and record noise levels. The measuring and recording equipment were calibrated as a unit with a General Radio Type 1562-A external calibrator. Calibration was performed prior to each monitoring period.

2.7.3 Monitoring Procedure

2.7.3.1 Ambient Background Noise Survey

Measurements at each monitoring location during the four monitoring periods each day consisted of a 5-minute reading on the A-weighted scale and an octave band analysis. The A-weighted scale, was designed to duplicate the human ear in its response to sound. The octave band analysis, performed immediately following each 5-minute dB(A) measurement, consisted of a 20-second reading on each of the 10 octave bands comprising the human audio spectrum.

2.7.3.2 Construction Noise Surveys

Sound levels were measured and recorded on an analog strip chart recorder for 5 minutes on the dB(A) scale and for 30 seconds on each of the 10 octave bands at each point. The dB(A) record is a true random sample in that no attempt was made to eliminate unusual or intrusive sound since they are taken into account in the analysis of data. However, every attempt was made to eliminate all sounds except background noises during the octave band measurements to prevent biasing any particular octave. This was accomplished by waiting until all such sounds had died away before making the recording. The short sample time and desire to obtain a continuous spectrum of background noise required that such a procedure be followed. To ensure proper operation of the equipment, a calibration check was performed prior to beginning each new round of monitoring points.

2.7.4 Method of Data Analysis

Three noise levels were determined from each 5-minute record of dB(A) levels. They are the L_{10}, L_{50}, and L_{90} decibel levels, or the decibel level exceeded 10, 50 and 90 percent of the time respectively during the 5-minute sample. The L_{90} level is defined as the ambient or background noise level, the L_{50} is the median noise level, and the L_{10} is the intrusive noise level. This method of analysis provides a more realistic description of the noise environment by taking the exposure time to certain noise levels into account. Simple means and maximums cannot yield such an analysis.

Only one level was determined from each 30-second octave band record. Since an attempt was made during the recording to eliminate all but background sounds, this level should correspond closely to an L_{90} decibel level.

To facilitate a direct comparison of the results of the two surveys, original data from both surveys were operated on separately by the logarithmic averaging program. Only data from points 1 through 6 (points on the site boundary monitored during both surveys) were used in the program.

2.7.5 Interpretation of Results

2.7.5.1 Ambient Background Noise Survey

The diel variation of ambient background noise levels (solid line) at each monitoring location was compared with the average noise level (dashed line) of all seven locations on and near the property line in Figure 2.7-2. At all locations, ambient noise levels were greater at night than during the day. These increased nocturnal noise levels can be attributed almost entirely to the crickets which were most active at night.

Noise levels at near-site populated or recreational areas (points 1, 2, and 3) were generally somewhat higher than the mean noise level from all seven near-site locations. At point 3, located approximately 100 yards from the Shady Rest Grocery, the only local restaurant in the area at the time, ambient noise levels were louder on Friday during both the day and night than on Saturday afternoon, primarily because of increased human activity at the restaurant.

On the bank of the Mississippi River, point 7 was noticeably quieter than the mean site noise level because there was little traffic or human activity nearby. However, riverboats pass by frequently on the Mississippi; the noise level of one typical boat was measured at a steady 67 dB(A) for the few minutes it took to pass the monitoring point.

Measured ambient noise levels at all other monitoring locations were very similar to the mean site levels. The overall average noise level for the Grand Gulf site during the survey was 50.2 dB(A).

2.7.5.2 Construction Noise Surveys

2.7.5.2.1 Survey No. 1 (June 1974)

A comparison of the median dB(A) noise levels (level exceeded 50 percent of the time and denoted by L_{50}) at each monitoring point, between the ambient background noise survey and construction noise survey No. 1, is presented in Figure 2.7-3. The anticipated result of higher noise levels during construction hours is not as apparent as expected. The only directly observable increase attributed to construction by the survey team occurred at points 4 and 5, the nearest construction activity. At times when no construction was in progress, noise levels were significantly lower than those obtained during the previous survey. A lower insect population, whether from natural cuases or from land clearing operations, is the most probable cause of this. However, since the same pheno-

menon was observed at point 8, 7 miles from the construction site (a distance great enough so that construction activities could have no effect), it must be assumed that the noise level reduction is widespread and independent of construction.

The variation of the dB(A) levels, L_{10}, L_{50}, and L_{90}, with time for the entire site is shown in Figure 2.7-4 for the June 1974 survey and in Figure 2.7-5 for the July 1973 survey. Construction appears to have raised the overall daytime levels a few decibels, whereas the reduced number of crickets and cicadas has lowered the nighttime levels by about 5 decibels. The combined effect is a reduction in the diurnal variation giving a more constant noise level throughout the day and night at the L_{90} and L_{50} decibel levels. The higher L_{10} level during the day shows the influence of increased traffic volume. All levels fall within the "normally acceptable" range for community acceptance as defined by HUD in the HUD Noise Assessment Guidelines, Technical Background.

The overall averages of these three levels for both surveys are presented in the table below. The limits of HUD's four categories are also shown for comparison. These limits do not constitute a set of standards, but serve as a guide in selecting sites for housing projects.

	July 1973	June 1974	HUD's Categories[1] 1	2	3	4
L_{10} (intrusive)	56.1	58.7	<53	53-67	67-82	>82
L_{50} (median)	53.7	51.7	<45	45-60	60-75	>75
L_{90} (ambient)	51.7	49.7	<41	41-56	56-70	>70

Note: All numbers in dB(A) units.

The overall effect for the entire site (monitoring points 1 through 6) for all monitoring times of both survey days is illustrated in Figure 2.7-6.

[1] 1 - Clearly acceptable
2 - Normally acceptable
3 - Normally unacceptable
4 - Clearly unacceptable

2.7.5.2.2 Survey No. 2 (August 1974)

Median noise levels from this survey are compared with levels from the preconstruction survey in Figure 2.7-7. Point 5, immediately adjacent to construction activities, had clearly experienced the greatest increase in noise levels. Points 3, 4, and 6 were about equidistant from noise producing activities, but vegetation and terrain combined to attenuate levels reaching points 4 and 6 to or below those measured during the preconstruction survey. Point 3 did not share these attenuating factors to the same degree and hence had a higher noise level. The shape and magnitude of the curves from points 1, 4, 6, and 8 are similar for both surveys, indicating virtually no noise impact at these points caused by construction activities.

Even though construction continues around the clock, the pace, and hence noise level, is not constant. Breaks for meals and machinery maintenance caused drastic reductions in the noise level. At these times the noise level was even quieter than it was before the land was cleared, because the number of insects and frogs, had been reduced by clearing.

2.7.5.2.3 Survey No. 3 (October 1974)

Median noise levels from this survey are compared with levels from the preconstruction survey in Figure 2.7-8. As before, point 5 experienced the greatest increase in noise level because it was immediately adjacent to construction activity. Point 4 had levels about the same as before construction began, but the other points experienced levels significantly lower than preconstruction levels most of the time. The natural seasonal variation in insect and frog populations accounts for this decrease in level. Because of the lower background level, construction noise could be heard more distinctly at these points even though the noise produced was not louder than before.

2.7.5.2.4 Survey No. 4 (December 1974)

Median noise levels from this survey are compared with levels from the preconstruction survey in Figure 2.7-9. All points except point 5 experienced significant decreases in noise levels (up to 20 dB(A)) since the July 1973 survey, thus indicating a strong seasonal influence. Point 5 was subjected to noise from construction traffic on Waterloo Road and construction machinery on the site proper. The noise level at this point fluctuated above and below levels previously measured, thereby displaying the combined effects of construction and natural seasonal variations.

2.7.5.2.5 Survey No. 5 (February 1975)

Median noise levels from this survey are compared with levels from the preconstruction survey in Figure 2.7-10. As a result of the seasonal reduction in insect numbers and actitivies, the background noise levels measured during this survey were below those measured during the preconstruction survey.

The highest L_{50} levels were measured at point 5, nearest the construction site; however, the dominant source of noise at this point and also at point 4 was truck and auto traffic associated with construction, rather than actual construction equipment. Points 1, 3 and 6, which experience little construction traffic, had correspondingly lower noise levels.

2.7.6 Conclusions

2.7.6.1 Ambient Background Noise Survey (July 1973)

Since typical summer weather[2] prevailed during the sampling periods, it can be assumed that normal agricultural, commercial, and recreational activities were conducted during the ambient background noise survey. The amount of human activity appeared to be similar on both days. The slight differences in noise levels between Friday and Saturday were probably due to random sampling error over the short time period monitored.

Insects had a greater influence on the overall site noise levels than did the people in the area.

2.7.6.2 Construction Noise Surveys

2.7.6.2.1 Survey No. 1 (June 1974)

Even though construction was in progress and noise was being produced, the reduction in noise levels from the insects more than offset this to yield an overall reduction in dB(A) noise levels. The reduction, however, was very small. The range between the overall L_{90} and L_{10} levels increased from 3 dB to 9 dB, indicating a slightly less acceptable noise environment. However, offsetting this factor was a reduction in the diurnal variation yielding a more constant level throughout the day and night.

---

[2]The weather was clear and hot with slight breezes both days, with the exception of a very short rain shower on Saturday afternoon.

2.7.6.2.2 Survey No. 2 (August 1974)

Noise levels at point 5, and to a lesser degree at point 3, increased because of construction activities. At monitoring points 1, 4, 6, and 8, near single residences or communities, noise levels were virtually unchanged.

2.7.6.2.3 Survey No. 3 (October 1974)

Construction activity produced noise levels similar to those measured during the previous construction noise survey. A natural reduction in the number of insects reduced the level of background noise, thereby permitting construction noise to be more evident at greater distances. However, overall noise levels were slightly lower than those of the previous survey.

2.7.6.2.4 Survey No. 4 (December 1974)

A temporary reduction in construction activity and the continued reduction of insect noise resulted in a significant decrease in noise levels at the Grand Gulf site.

2.7.6.2.5 Survey No. 5 (February 1975)

Resumption of normal construction activity slightly increased noise levels around the site. Because of the opening of the new site access road, point 4 experienced a definite increase in noise level. Insect activity remained at a low level as it had during the previous winter surveys.

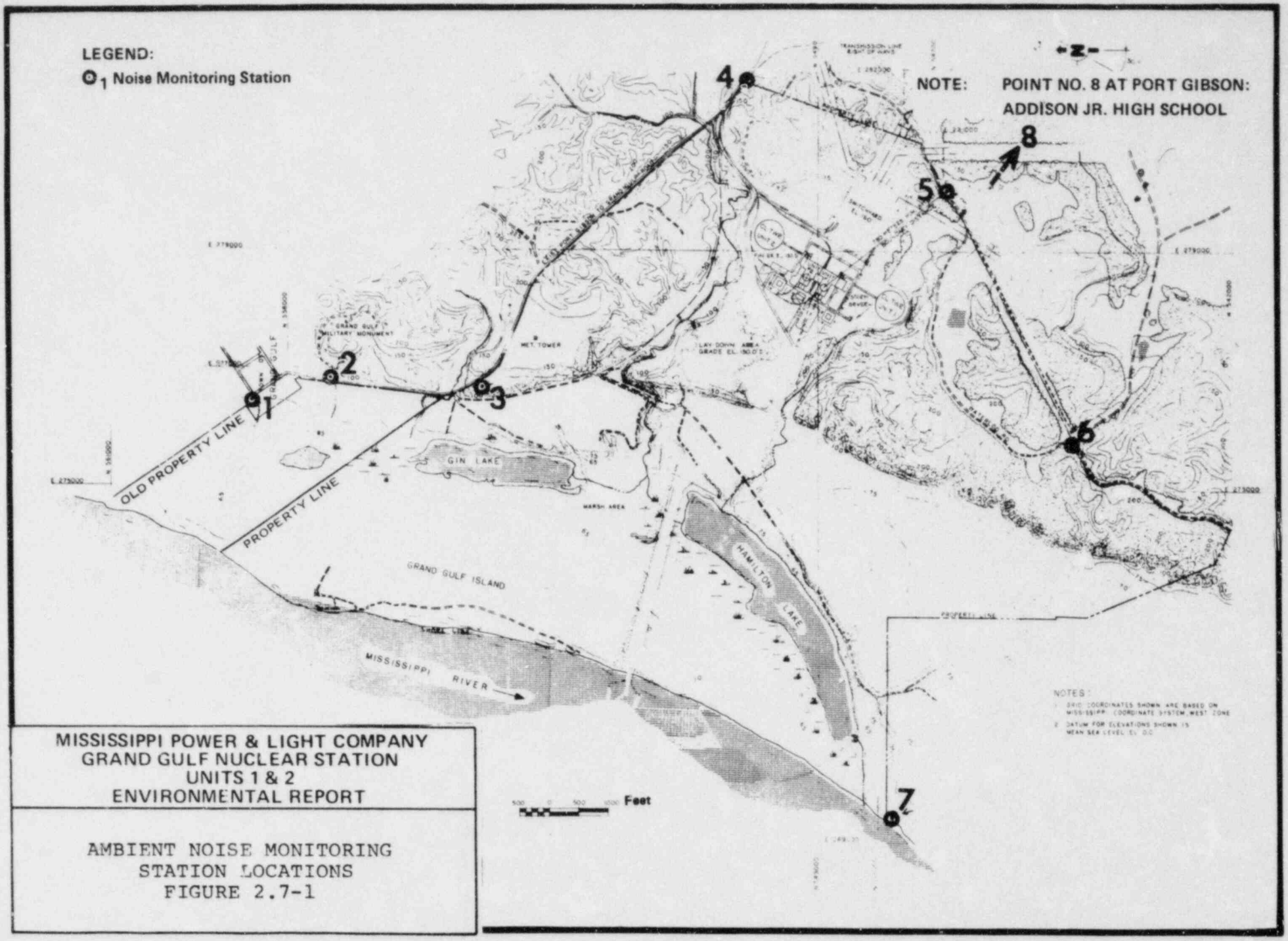
2.7.6.3 Evaluation of Noise-Level Effects

Periodic noise surveys made at the site boundary under a range of representative conditions showed that construction appeared to have raised the overall daytime levels only a few decibels. This slight increase in noise levels and lack of complaints from nearby residents substantiates conclusions that noise levels at the site do not exceed acceptable levels. As a result, the noise surveys have been discontinued.

TABLE 2.7.1

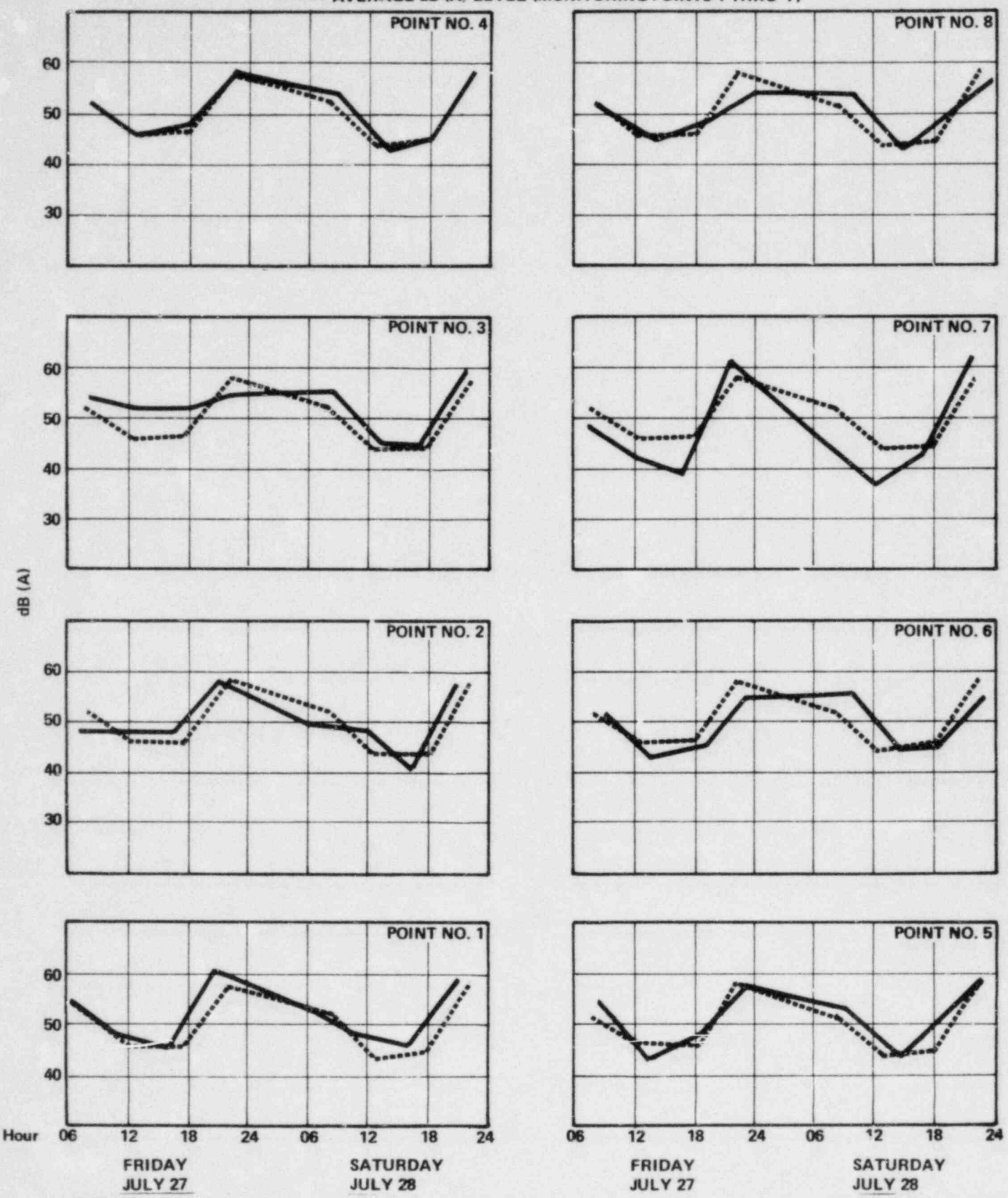
PRIMARY ACTIVITIES OCCURRING DURING EACH OF THE CONSTRUCTION NOISE SURVEYS

Survey No.	Date	Activities
1	June 5-6, 1974	Logging and ground clearing operations on-site. Crews were working one 10-hour shift from 7 a.m. to 5 p.m. with a break for lunch.
2	August 27-30, 1974	In the two months since the first survey was conducted, construction activities progressed from one 10-hour shift clearing ground to two 10-hour shifts operating around the clock preparing foundations. The shifts were separated by a 2-hour machinery maintenance period.
3	October 16-18, 1974	Excavation for foundations and other earth moving operations were in progress on a 24-hour basis.
4	December 9-10, 1974	Excavation in the power block area was in progress, but at a reduced rate due to heavy rains. Only three or four machines were working at one time.
5	February 25-27, 1975	Foundation construction was in progress and the opening of a new site access road between monitoring points 3 and 4 affected noise levels at point 4.

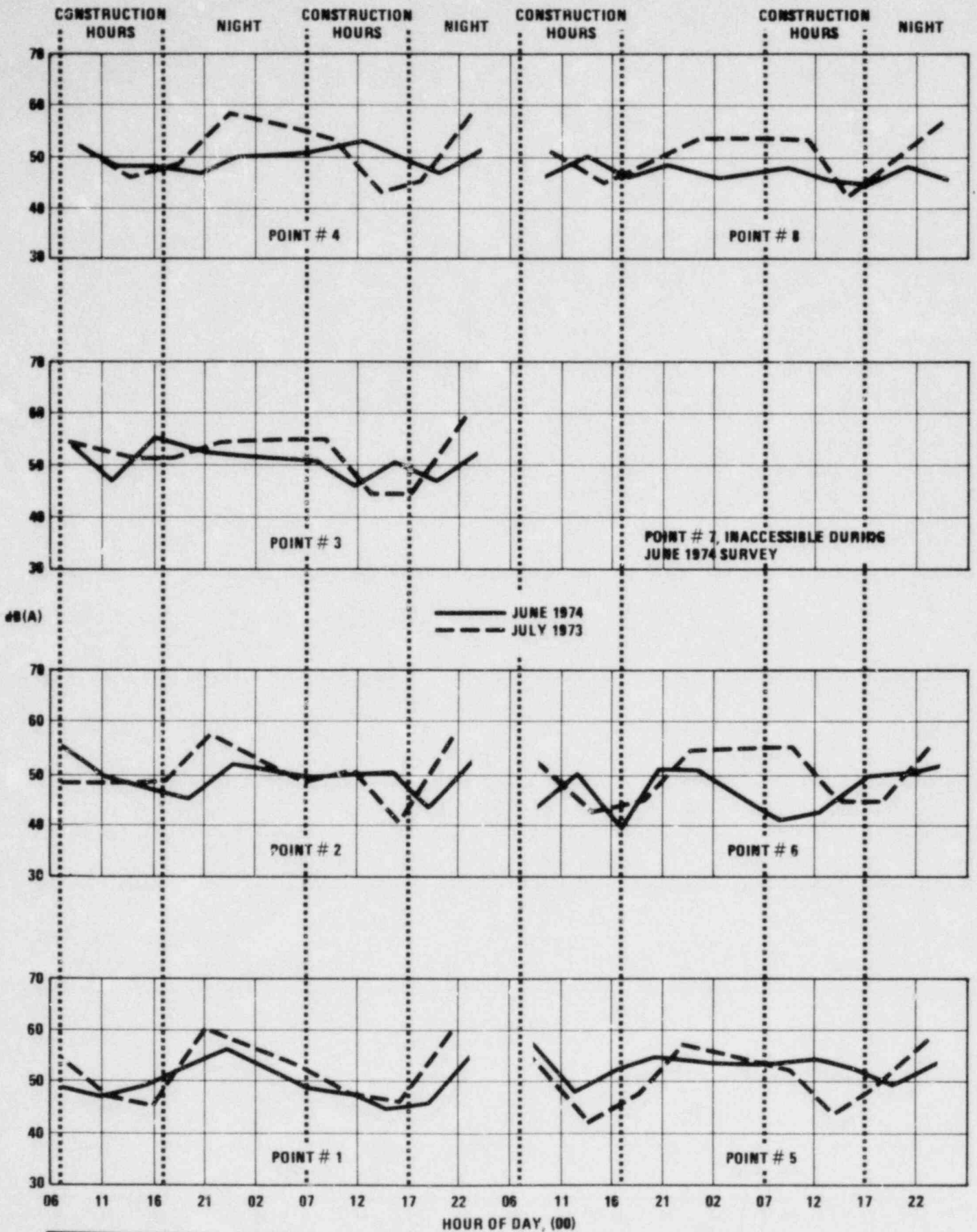


MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

AMBIENT NOISE MONITORING
STATION LOCATIONS
FIGURE 2.7-1



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	DIEL VARIATIONS dB(A) BACKGROUND NOISE LEVELS FIGURE 2.7-2



MISSISSIPPI POWER & LIGHT COMPANY
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UNITS 1 & 2
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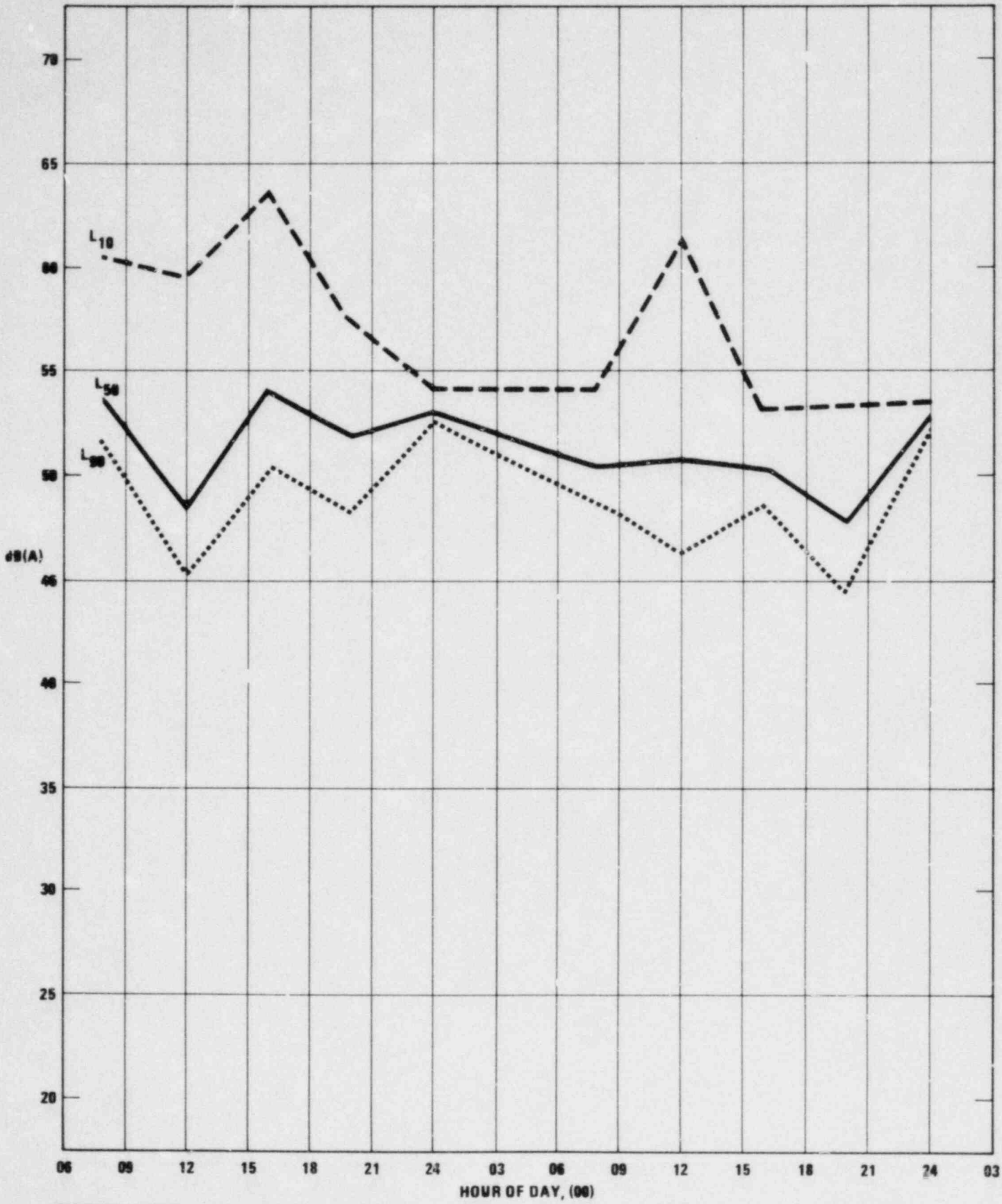
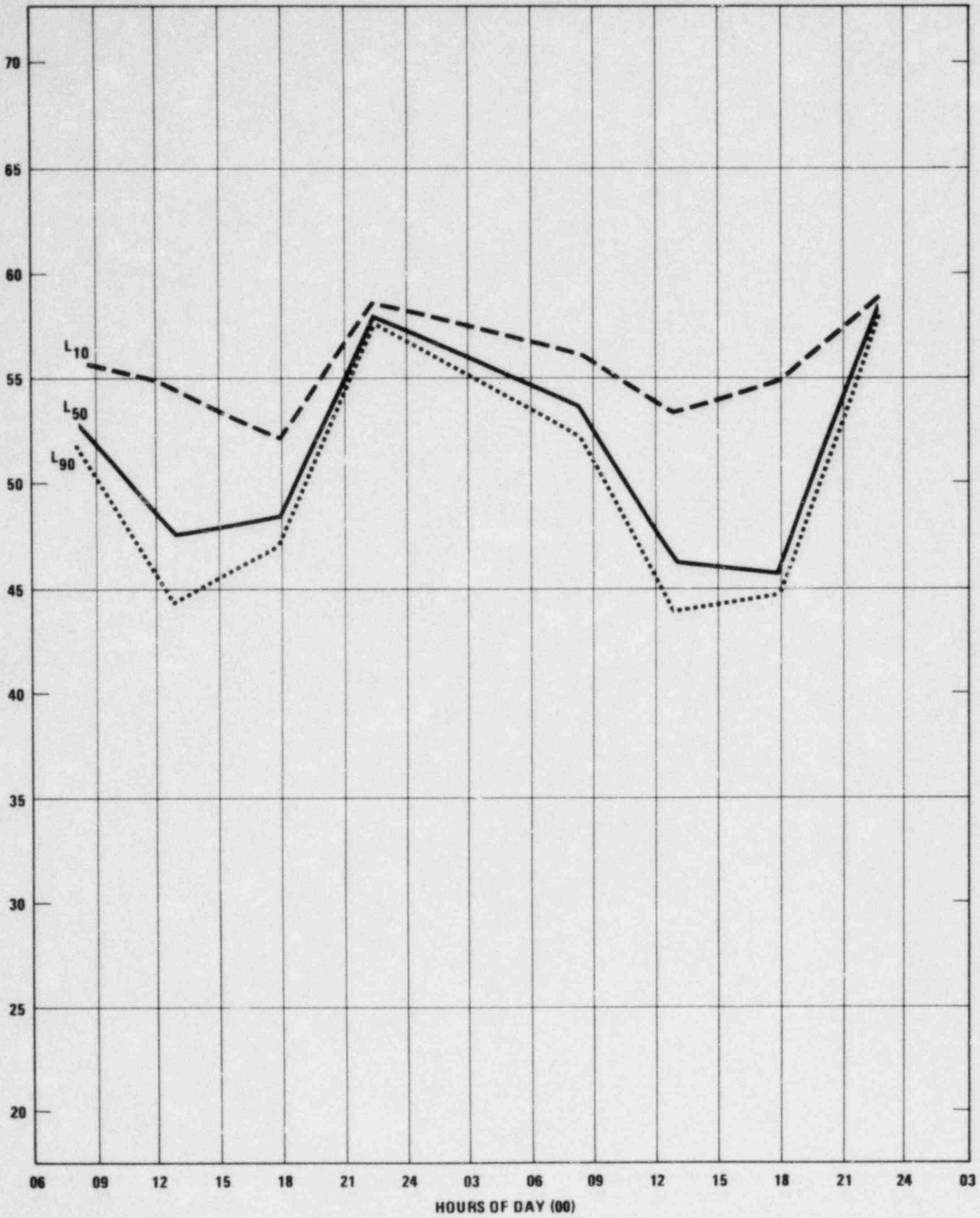
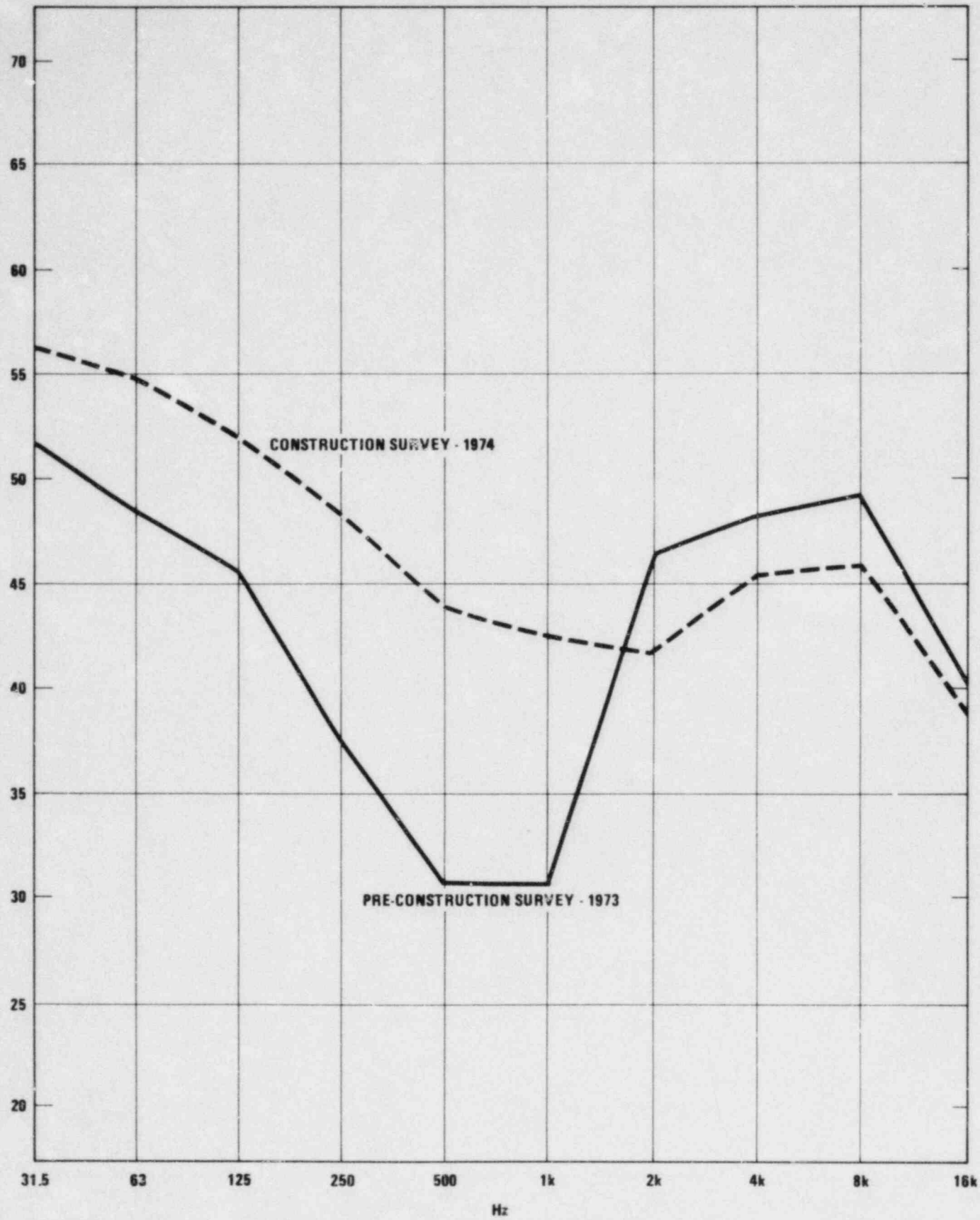
COMPARISON OF MEDIAN (L_{50})
dB(A) NOISE LEVELS BETWEEN
JULY 1973 AND JUNE 1974 SURVEYS
FIGURE 2.7-3



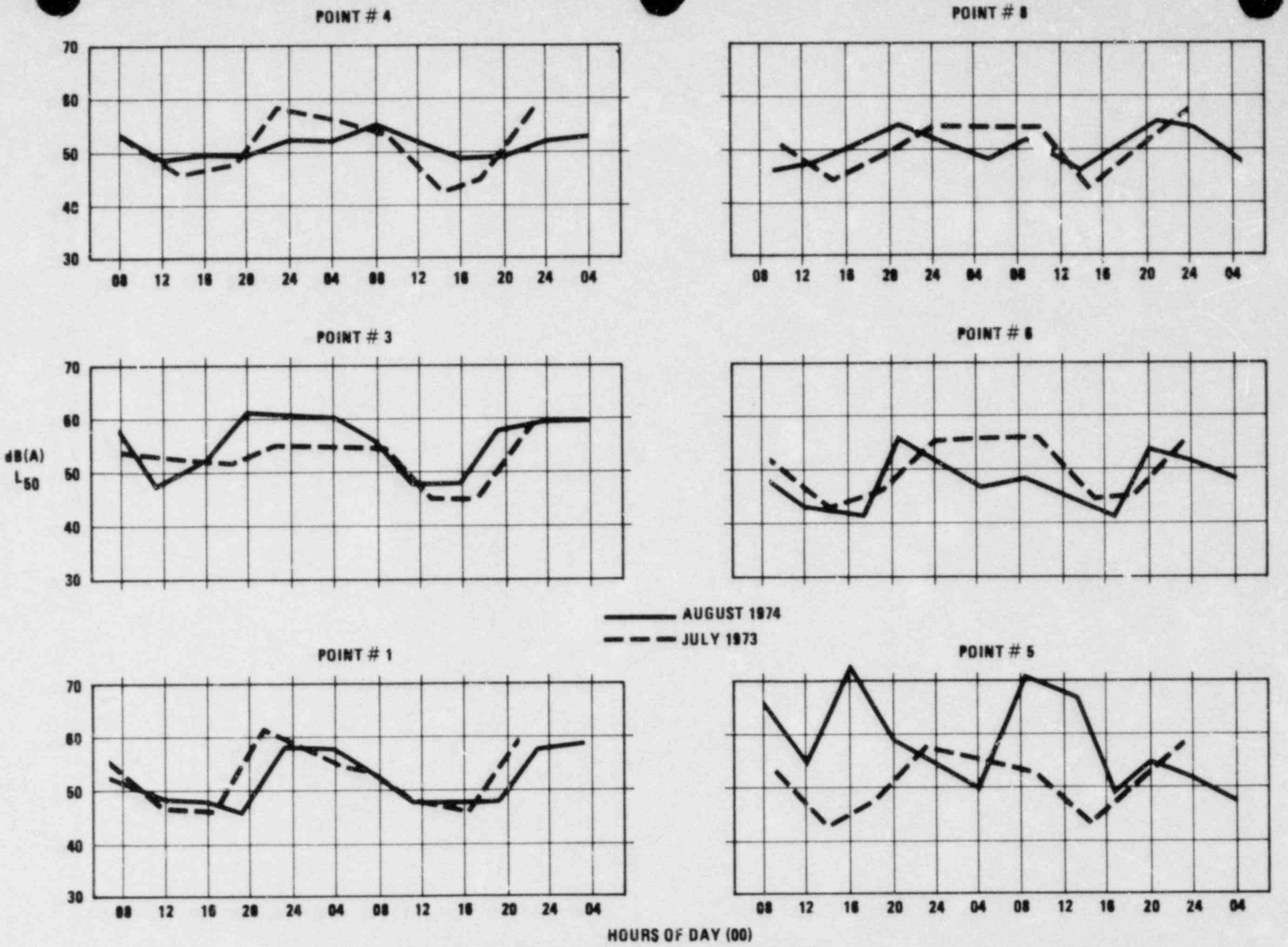
MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	VARIATION OF dB(A) NOISE LEVELS WITH TIME DURING THE CONSTRUCTION NOISE SURVEY, JUNE 1974 FIGURE 2.7-4



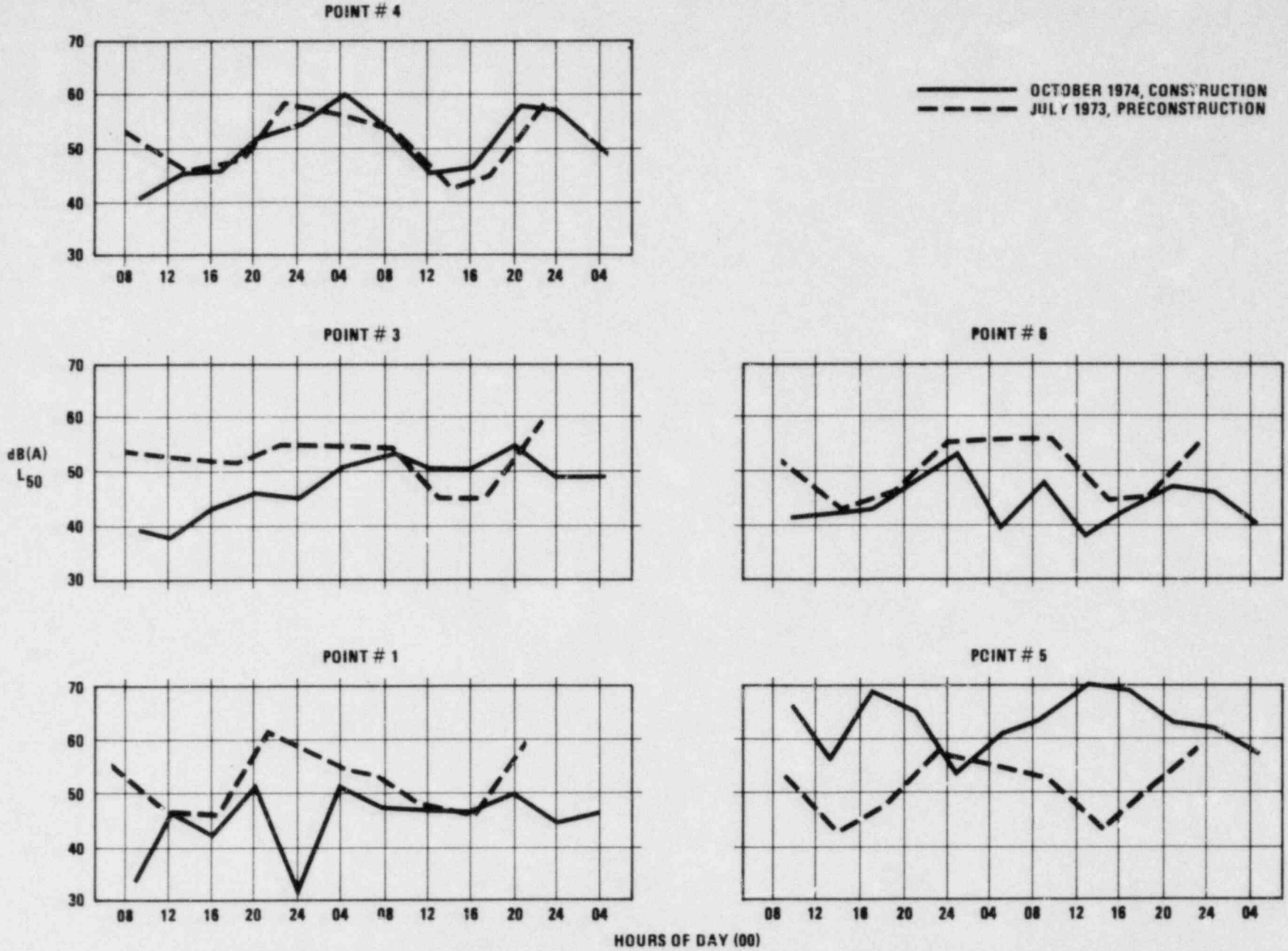
MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	VARIATION OF dB(A) NOISE LEVELS WITH TIME DURING THE AMBIENT BACKGROUNG NOISE SURVEY, JULY 1973 FIGURE 2.7-5



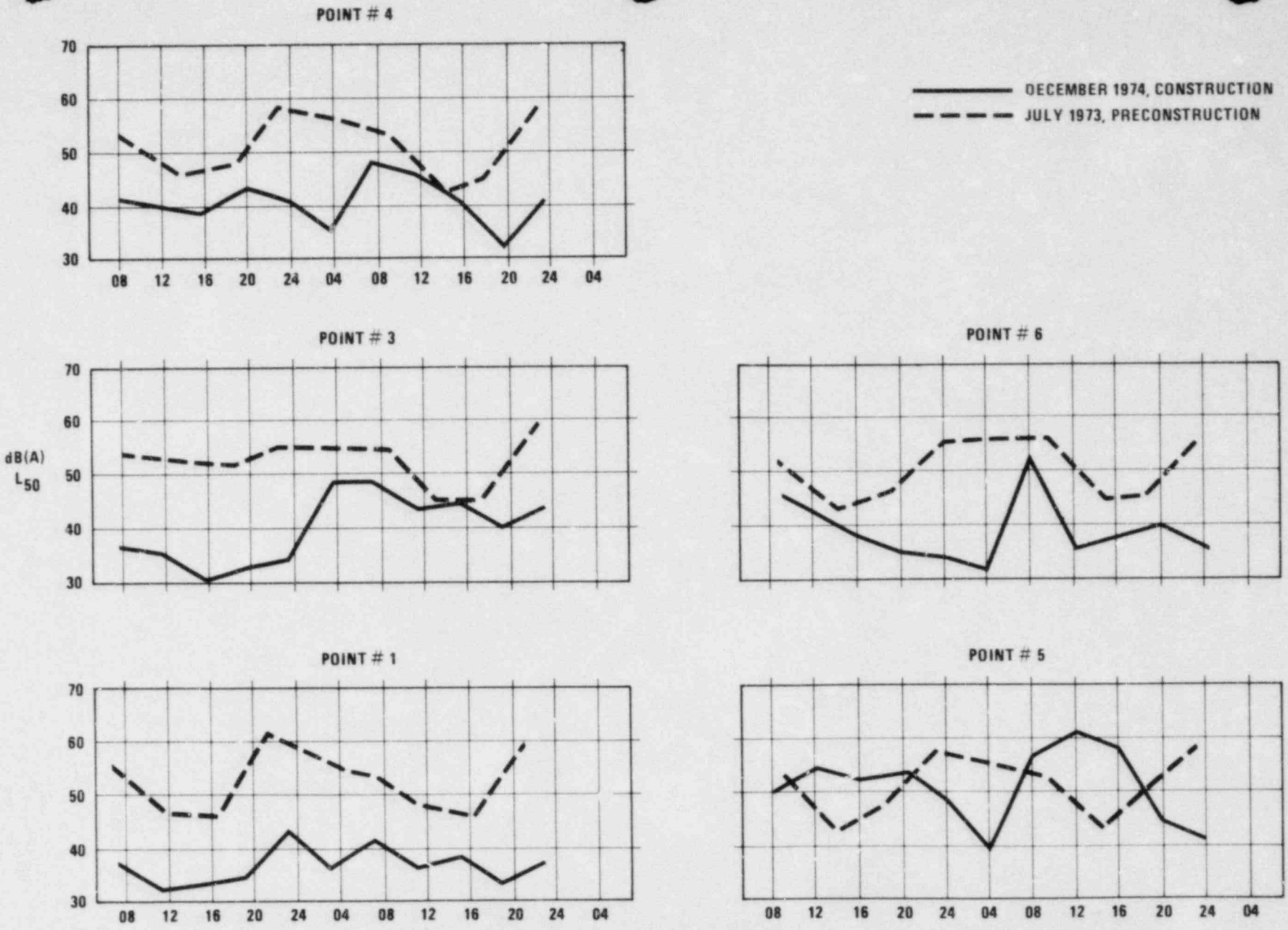
MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	OVERALL MEAN OCTAVE BAND LEVELS DURING THE JULY 1973 AND JUNE 1974 SURVEYS FIGURE 2.7-6



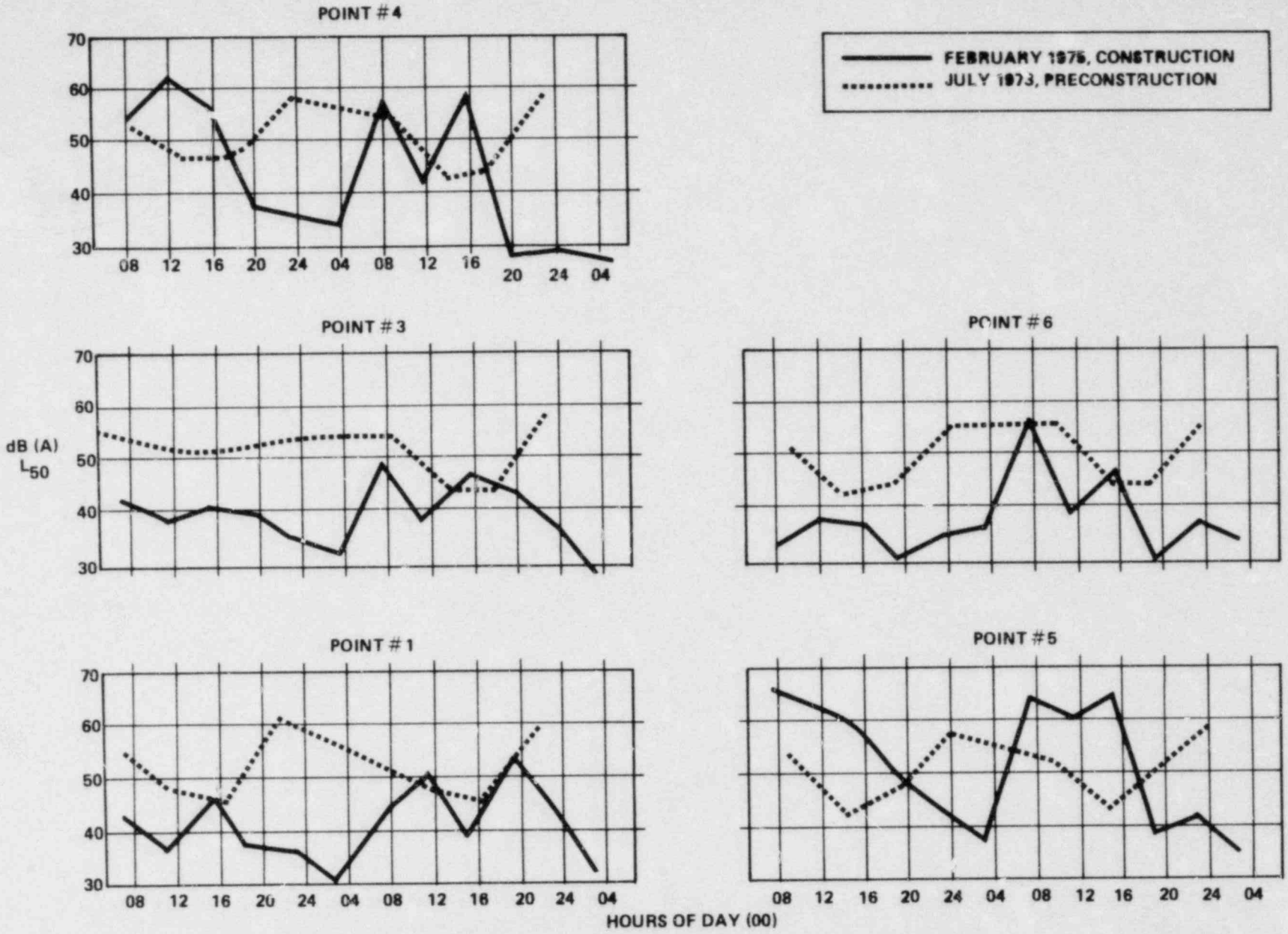
MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	COMPARISON OF MEDIAN (L_{50}) dB(A) NOISE LEVELS BETWEEN JULY 1973 AND AUGUST 1974 SURVEYS FIGURE 2.7-7



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	COMPARISON OF MEDIAN (L_{50}) dB(A) NOISE LEVELS BETWEEN JULY 1973 AND OCTOBER 1974 SURVEYS FIGURE 2.7-8



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	COMPARISON OF MEDIAN (L_{50}) dB(A) NOISE LEVELS BETWEEN JULY 1973 AND DECEMBER 1974 SURVEYS FIGURE 2.7-9



MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

COMPARISON OF MEDIAN (L_{50}) dB(A) NOISE LEVELS BETWEEN THE JULY 1973 PRE-CONSTRUCTION AND FEBRUARY 1975 CONSTRUCTION NOISE SURVEYS, GRAND GULF SITE

FIGURE 2.7-10

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CHAPTER 3

THE STATION

TABLE OF CONTENTS

		Page
3.1	EXTERNAL APPEARANCE	3.1-1
3.2	REACTOR AND STEAM ELECTRIC SYSTEM	3.2-1
	3.2.1 Primary Steam Cycle	3.2-1
	3.2.2 Cooling	3.2-2
	3.2.3 Radioactive By-Products	3.2-2
	3.2.4 Shutdown	3.2-2
	3.2.5 Plant Arrangement	3.2-3
	3.2.6 General	3.2.3
3.3	STATION WATER USE	3.3-1
	3.3.1 Water Source and Distribution	3.3-1
	3.3.2 Water Losses and Makeup	3.3-1
	3.3.3 Liquid Waste Collection and Recycling	3.3-3 |1
	3.3.4 Liquid Discharge System	3.3-3
	3.3.5 Plant Water Use In Relation to Low Flow of Record in the Mississippi River	3.3-3
3.4	HEAT DISSIPATION SYSTEM	3.4-1
	3.4.1 General Description	3.4-1
	3.4.2 Cooling Water	3.4-1
	3.4.2.1 Circulating Water System	3.4-1
	3.4.2.2 Plant Service Water System	3.4-2
	3.4.2.3 Standby Service Water System	3.4-2
	3.4.3 Cooling Towers	3.4-2
	3.4.3.1 General Description	3.4-2
	3.4.3.2 Design Point	3.4-3
	3.4.4 Blowdown Facilities	3.4-3

TABLE OF CONTENTS (Cont.)

3.4.5	Cooling Tower Makeup Water Facilities	3.4-4
3.4.6	Operating Characteristics of Heat Dissipation System	3.4-4
3.4.6.1	Operating Scheme	3.4-4
3.4.6.2	Operating Characteristics	3.4-5
3.4.7	References	3.4-5
3.5	RADWASTE SYSTEMS AND SOURCE TERMS	3.5-1
3.5.1	Source Terms	3.5-1
3.5.1.1	Introduction	3.5-1
3.5.1.2	Sources of Radioactivity in Liquid Effluents	3.5-2
3.5.1.3	Sources of Radioactivity in Gaseous Effluents	3.5-2
3.5.1.4	Sources of C-14, H-3 and Ar-41	3.5-4
3.5.1.5	Sources for the Solid Radwaste Processing System	3.5-5
3.5.2	Liquid Radwaste Systems	3.5-5
3.5.2.1	Equipment Drain Subsystem (Clean or High Purity Liquid Radwaste)	3.5-5
3.5.2.2	Floor Drain Subsystem (Dirty or Low Purity Liquid Radwaste)	3.5-6
3.5.2.3	Chemical Waste Subsystem	3.5-7
3.5.2.4	Laundry Wastes	3.5-7
3.5.2.5	Summary	3.5-7
3.5.3	Gaseous Radwaste System (Airborne Releases)	3.5-8
3.5.3.1	Releases of Airborne Activity from Ventilation Systems	3.5-8
3.5.3.2	Offgas System	3.5-8
3.5.4	Solid Radwaste System	3.5-9
3.5.4.1	Wet Solid Wastes	3.5-9
3.5.4.2	Dry Solid Wastes	3.5-11
3.5.5	Process and Effluent Monitoring	3.5-11
3.5.5.1	Liquid Effluent Monitors	3.5-11
3.5.5.2	Gaseous Effluent Monitors	3.5-12
3.5.5.2.1	Containment and Drywell Ventilation System	3.5-12
3.5.5.2.2	Fuel Handling Area Ventilation System	3.5-13
3.5.5.2.3	Turbine Building Ventilation System	3.5-14

TABLE OF CONTENTS (Cont.)

3.5.5.2.4	Radwaste Building Ventilation System	3.5-14		
3.5.5.2.5	Offgas Posttreatment Radiation Monitors	3.5-14		
3.5.5.3	Solid Radwaste Monitoring	3.5-15		
3.5.6	References	3.5-15		
3.6	CHEMICAL AND BIOCIDE WASTES	3.6-1		
3.6.1	Cooling Tower Blowdown	3.6-2		
3.6.2	Cooling Tower Drift	3.6-4		
3.6.3	Treatment of Circulating Water and Service Water Systems Against Biological Fouling	3.6-4		
3.6.4	Makeup Water Treatment	3.6-5		
3.6.4.1	Pretreatment System	3.6-5	1	5
3.6.4.2	Activated Carbon Filters	3.6-6		
3.6.4.3	Makeup Demineralizers	3.6-6		
3.6.5	Corrosion Inhibitors	3.6-7		
3.6.6	Auxiliary Boiler Blowdown	3.6-7		
3.6.7	Laundry Waste	3.6-8		7
3.6.8	Corrosion Products	3.6-8		
3.6.9	References	3.6-8		
3.7	SANITARY AND OTHER WASTE SYSTEMS	3.7-1		
3.7.1	Sanitary Waste System	3.7-1		
3.7.2	Other Waste Systems	3.7-2		
3.7.2.1	Diesel Generator and Water Treatment Buildings	3.7-2		
3.7.2.2	Fire Water Pumphouse and Administration Building	3.7-3		
3.7.2.3	Water Pumphouse Valve Pit	3.7-3		
3.7.2.4	Turbine Building Oily Waste Clean Drains	3.7-3		
3.7.2.5	Chemical Waste System	3.7-4		
3.7.2.6	Surface Drainage and Roof Drains	3.7-4	1	
3.7.2.7	Gaseous Effluents	3.7-4		

TABLE OF CONTENTS (Cont.)

3.8	REPORTING OF RADIOACTIVE MATERIAL MOVEMENT	3.8-1	
3.9	TRANSMISSION FACILITIES	3.9-1	
	3.9.1 Transmission Line Routes	3.9-1	
	3.9.1.1 Baxter Wilson Steam Electric Station Route	3.9-1	
	3.9.1.2 Ray Braswell EHV Substation Route	3.9-1	
	3.9.1.3 Franklin EHV Substation Route	3.9-2	
	3.9.1.4 Port Gibson Substation Route	3.9-2	
	3.9.2 Route Selection	3.9-2	
	3.9.3 Route Descriptions	3.9-3	
	3.9.3.1 Baxter Wilson Route	3.9-3	
	3.9.3.2 Ray Braswell Route	3.9-4a	1
	3.9.3.3 Franklin Route	3.9-6	
	3.9.3.4 Port Gibson Route	3.9-8	
	3.9.4 General Features of Transmission Line Corridors	3.9-8a	1
	3.9.4.1 Current Land Use	3.9-8a	1
	3.9.4.2 Aesthetic Considerations	3.9-9	
	3.9.4.3 Historical Sites	3.9-9	
	3.9.4.4 Dominant Plants and Animals	3.9-9	
	3.9.4.5 Rare or Endangered Species	3.9-10	
	3.9.4.6 Soils	3.9-10	
	3.9.4.7 Alternate Routes and Alignments	3.9-12	
	3.9.4.8 Multiple-Use Projects	3.9-12	
	3.9.5 Description of Transmission Facilities	3.9-13	
	3.9.6 Description of Switchyard	3.9-14	
	3.9.7 References	3.9-14	

LIST OF TABLES

Table No	Title
3.3.1	Estimated Plant Water Use - Two Units
3.3.2	Anticipated Monthly Average Storm Drainage Flow Rates - Two Units
3.4.1	Cooling Tower Design Parameters and Dimensions Two-Unit Operation
3.4.2	Cooling Tower Water Loss Two-Unit Operation
3.4.3	Cooling Tower Evaporation and Water Temperature - 100 Percent Load Factor
3.4.4	Cooling Tower Evaporation and Water Temperature - 80 Percent Load Factor
3.5.1	Data for Radioactive Source Term Calculations
3.5.2	Input For BWR-GALE Code Calculation
3.5.3	Annual Releases of Activity in Liquid Effluents
3.5.4	Annual Releases of Activity in Gaseous Effluents
3.5.5	Expected Solid Radwaste Volumes and Specific Activity
3.5.6	Expected Solid Radwaste Curie Content At Time of Solidification and After 30 Days Storage
3.6.1	List of Chemicals To Be Used at Station
3.6.2	Laboratory Chemicals
3.6.3a	Intake, Circulating, and Blowdown Water Qualities
3.6.3b	Plant Discharge, Mississippi River, and Discharge Limit Water Qualities
3.6.4	Design Discharge Concentrations

5

LIST OF TABLES (Cont.)

Table No	Title
3.6.5	Makeup Demineralizer Regeneration Data
3.7.1	Yearly Emissions from Diesel Generators
3.9.1	Current Land Use Adjacent to Grand Gulf Nuclear Station Transmission Line Routes
3.9.2	Basic Plant Communities Along Transmission Line Routes
3.9.3	Plants and Wildlife Typically Occurring In Basic Plant Communities Along Grand Gulf Nuclear Station Transmission Line Routes
3.9.4	Physical Characteristics of Transmission Line Routes

LIST OF FIGURES

Figure No.	Title
3.1-1	Photograph of Model
3.2-1	Simplified BWR Flow Diagram
3.3-1	Station Water Use Diagram
3.4-1	Heat Dissipation System Flow Diagram
3.4-2	Natural Draft Cooling Tower
3.4-3	Station Discharge Structure
3.4-4	Station Discharge Structure Detail
3.4-5	Plant Service Water Radial Collector Well
3.5-1	Schematic of Liquid Radwaste Processing System
3.5-2	Schematic of Chemical Radwaste Processing System
3.5-3	Schematic of Gaseous Releases from Building Ventilation Exhausts
3.5-4	Schematic of Offgas Radwaste Processing System
3.5-5	Schematic of Solid Radwaste Handling System
3.6-1	Station Operational Waste Diagram (Nonradioactive)
3.9-1	System Map - Mississippi Power & Light Company
3.9-2	Transmission Line Routes
3.9-3	Features Along Baxter Wilson and Ray Braswell Routes

LIST OF FIGURES (Cont.)

Figure No.	Title
3.9-4	Features Along Franklin and Port Gibson Routes
3.9-5	Soil Type Map of Mississippi
3.9-6	Typical 500 kV Transmission Line Tower
3.9-7	Typical 115 kV H-Frame Woodpole Transmission Line Tower
3.9-8	Typical 115 kV Single Woodpole Transmission Line Tower

3.3 STATION WATER USE

Water required for plant operation is taken from the Mississippi River using a series of radial collector wells. The wells accumulate river water and some ground water through the alluvial aquifer at a rate sufficient to satisfy the plant service water system cooling and main cooling tower and other makeup requirements.

Flow rates associated with yard drainage vary on a monthly basis owing to changes in meteorological conditions. Table 3.3.2 lists the monthly average flow rates for the yard drainage.

Flow rates associated with the circulating water system also vary on a monthly basis owing to changes in meteorological conditions. Table 3.4.4 lists the maximum and monthly average flow rates for evaporation and blowdown.

Flow rates associated with other plant water streams do not vary on a monthly basis. Figure 3.3-1 and Table 3.3.1 show the maximum, average, and minimum flow rates to and from these other streams.

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3.3.1 Water Source and Distribution

Most of the water taken from the Mississippi River is used in the plant service water system, which supplies cooling water to the various heat exchangers and chillers. Approximately 150 gpm are diverted and processed as makeup water (demineralized and domestic water storage tanks) and 229 gpm are diverted for cooling water for the administration building HVAC systems.

The discharge from the plant service water system serves to replenish losses in the cooling water from the main cooling tower operation. Of the total water withdrawn from the river, about 22,600 gpm are normally returned to the river after use. A more complete description of the plant service water system is presented in Section 3.4.

3.3.2 Water Losses and Makeup

Cooling towers dissipate residual heat from power generation to the atmosphere primarily through the evaporation of water. In addition, a very small volume of the circulating water is lost as drift from the cooling towers. This evaporation increases the concentration of chemicals and solids in the circulating water system, and a continuous blowdown to the river maintains the concentration at the desired level. Makeup water to the cooling towers from the plant service water system replenishes water losses due to evaporation, drift, and blowdown. A more detailed description of the circulating water system associated with the cooling tower operation is presented in Section 3.4.

Water may also be lost from other systems in the station due to evaporation, leakage, and drainage from equipment and components. Makeup water is added to maintain a constant inventory in the reactor coolant system and other tanks and systems, including the following:

a. Condensate storage tank

b. Component cooling water system

c. Standby liquid control system

d. Turbine building cooling water system

e. Auxiliary boiler condensate return storage tank

f. Condensate cleanup system

g. Samples (chemistry) laboratory

h. Plant chilled water system

i. Main condensers

j. Fuel pool cooling and cleanup system

k. Diesel generators

l. Standby service water system

m. Liquid radwaste system

n. Chlorination system

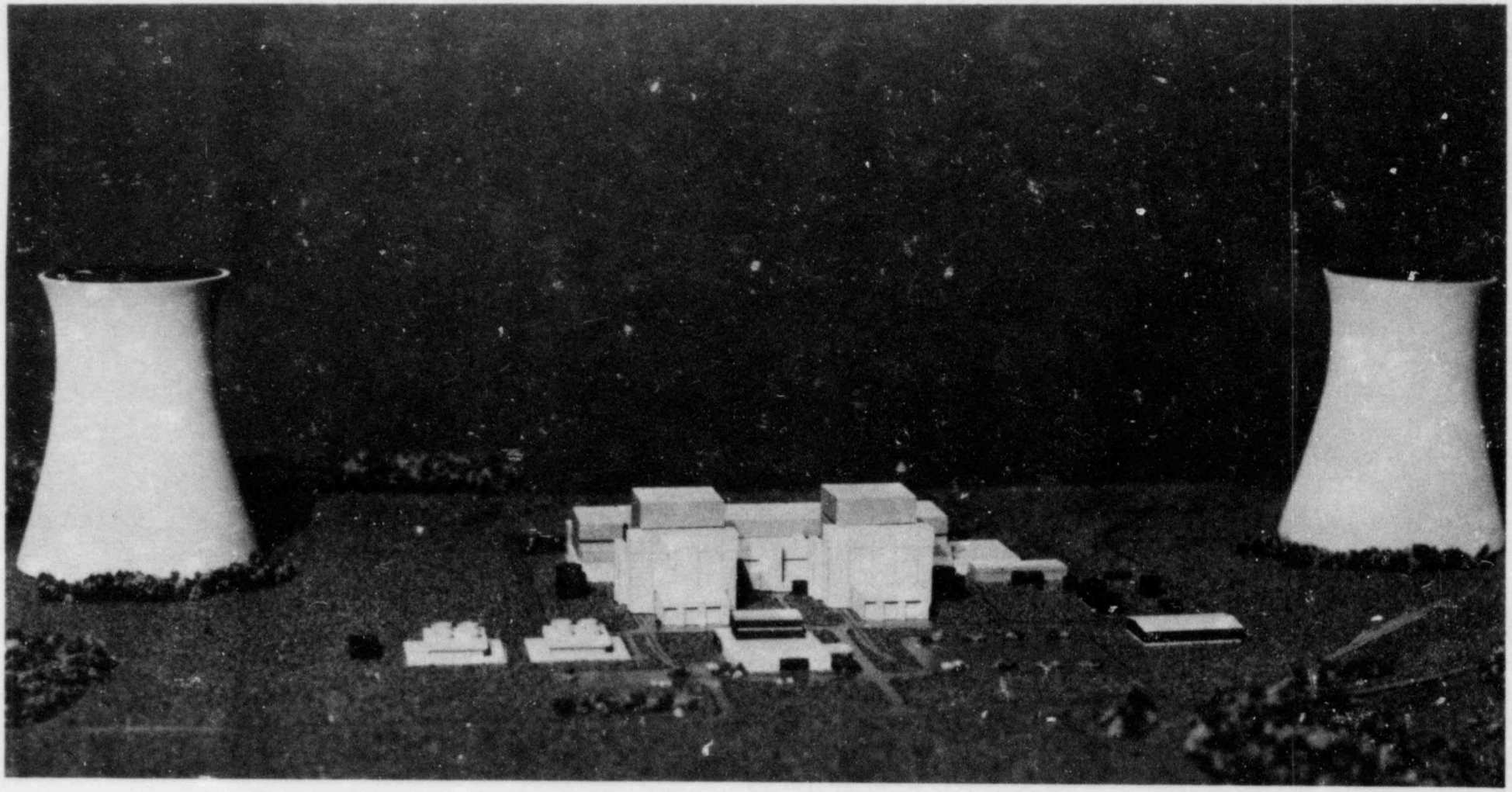
o. Residual heat removal system

p. Decontamination stations

q. Domestic water system

r. Fire protection system

The makeup water is taken primarily from the plant service water system (a small portion is processed liquid radwaste; see subsection 3.3.3 and Section 3.5). Before use, it is purified in the makeup water treatment system. Makeup water is filtered, demineralized, and monitored for quality before release for use in the station. In purifying the makeup water, the treatment system accumulates chemical wastes which are discharged from the station. Section 3.6 presents a more detailed description of this system.



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	PHOTOGRAPH OF MODEL FIGURE 3.1-1

3.2 REACTOR AND STEAM ELECTRIC SYSTEM

Units 1 and 2 each use a boiling water reactor (BWR) to produce steam to drive a turbine generator to generate electricity. Figure 3.2-1 is a simplified flow diagram of the BWR. A detailed description of the steam supply system is presented in the Final Safety Analysis Report. The rated and design capacities in MW for each unit are:

Rated electrical power	1306
Design electrical power	1361
Rated thermal power	3833
Design thermal power	4025

Approximate in-plant electrical power consumption is 51 MW.

3.2.1 Primary Steam Cycle

The heart of the BWR is the reactor core, a complex assembly of zirconium tubes, called fuel rods, which contains the nuclear fuel (cylindrical pellets of uranium oxide). The fuel rods are grouped into bundles with each bundle containing 62 rods. There are 800 fuel bundles and 49,600 fuel rods in the reactor core. The core is contained in a large, water-filled steel tank called the reactor vessel. Each initial core contains 322,376 lbs of uranium with an average enrichment of 1.697 percent.

In a fully assembled core, a self-sustaining fission chain reaction occurs when a neutron splits a uranium atom, producing a large amount of heat and setting free two or three other neutrons. These freed neutrons then split other uranium atoms, producing more heat and setting more neutrons free to continue the chain reaction.

The chain reaction is controlled by 193 movable control rods, which can be moved up or down so that they enter or leave the core. The control rods contain material which absorbs neutrons to prevent them from continuing the chain reaction. When all the control rods are fully inserted in the core, the chain reaction is stopped and the reactor ceases operating. To resume operation, the control rods are withdrawn from the core to allow the chain reaction to take place and heat to be produced.

The water (called reactor coolant) circulates through the reactor core, absorbing heat which is produced at a rate equivalent to 3833 MW. The heated water boils and the resulting steam which accumulates at the top of the reactor vessel is piped to the turbine. In going through the turbine, the steam expands, loses energy, and cools. The turbine cycle heat rate is expected to be 10,029 Btu, 10,495 Btu, and 11,434 Btu per kWh for guaranteed

reactor rating, 75, and 50 percent plant loads, respectively. These rates are for constant condenser back pressures of 2.37/2.91/3.62 inches HgA, with a design circulating water flow rate of 572,000 gpm. The turbine steam is condensed in the main condenser into liquid (condensate) and is treated in the condensate demineralizers to remove any trace impurities it may have picked up in the pipes, turbine, or condenser. The treated liquid, called condensate and then feedwater, is then heated and pumped back for use in the reactor, becoming reactor coolant.

3.2.2 Cooling

To cool the steam in the main condenser, cooling water in the circulating water system is pumped through tubes in the condenser to absorb the heat from the condensing steam. The circulating water system pumps the heated cooling water to natural draft cooling towers, where the heat is dissipated to the atmosphere.

3.2.3 Radioactive By-Products

Operation of the reactor produces limited amounts of radioactive by-products. Those formed in the fissioning of uranium are confined in the fuel rods, although a minute amount may get into the reactor coolant through minor leaks in a very small fraction of the fuel rods. Some radioactive by-products are formed in the reactor coolant itself, as normally non-radioactive trace metals, nitrogen, and oxygen in the reactor coolant become radioactive through exposure to the chain reaction neutrons. A reactor cleanup system cleans the coolant continuously to keep the level of by-products low. In addition, small amounts of liquids containing radioactive by-products accumulate from equipment drains and small leaks. These are cleaned up by the radioactive waste processing systems described in subsection 3.5.2. Radioactive gases formed in plant operation are treated as described in subsection 3.5.3. The plant is designed to reuse as much of the wastewater as possible, thus minimizing releases of radioactivity to the environment (see Section 3.5).

3.2.4 Shutdown

The plant is shut down periodically to allow spent fuel bundles to be replaced. The depleted fuel bundles are stored in the spent fuel storage pool, where the residual radioactivity in the fuel can decay and diminish until it reaches low enough levels to permit shipment offsite. During shutdown, the reactor continues to produce small amounts of heat due to the decay of fission products in the fuel. A residual heat removal system cools the reactor during shutdown.

3.2.5 Plant Arrangement

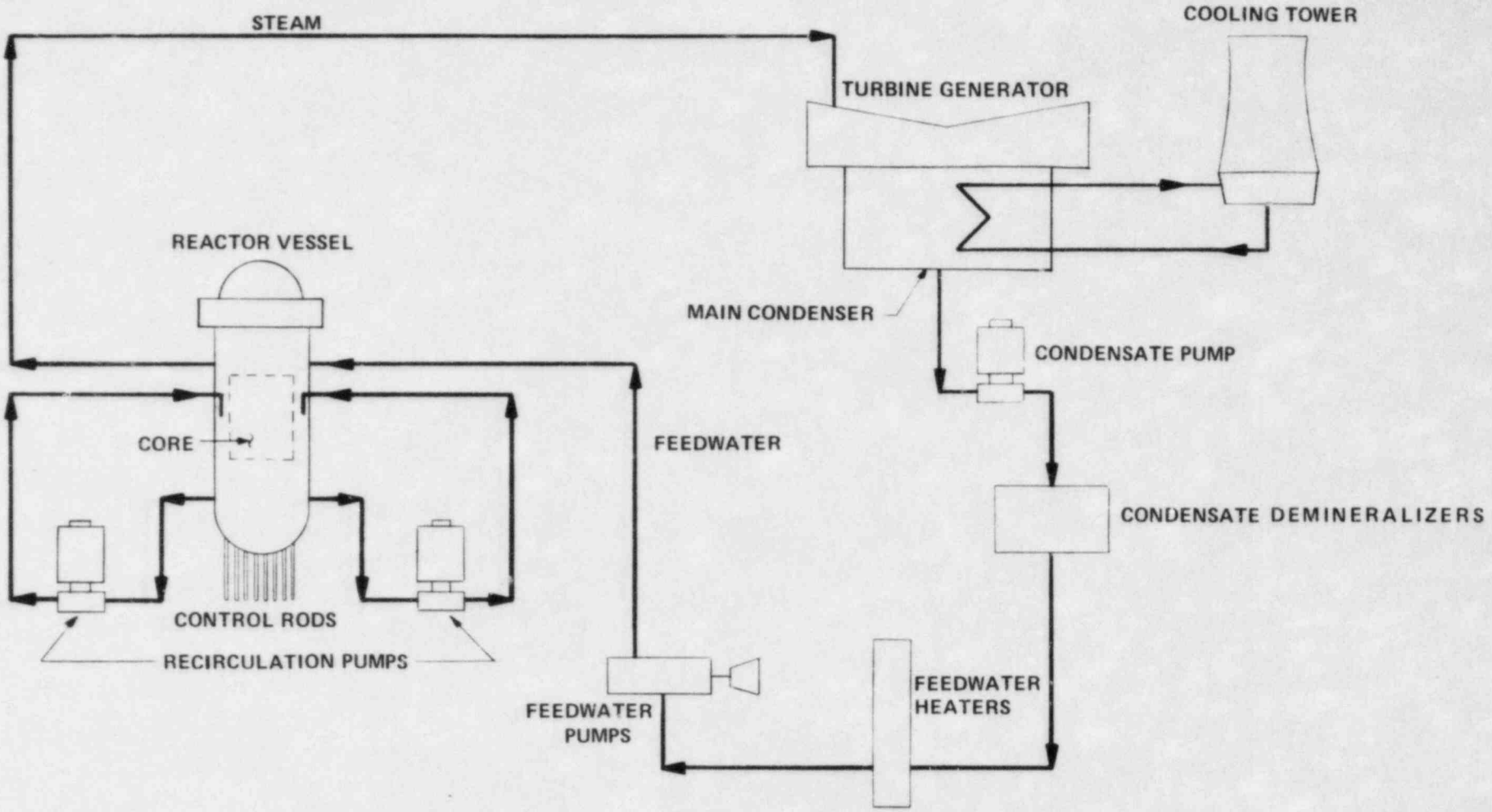
The reactor vessel is located inside a concrete structure, called a drywell, which, in turn, is located inside the containment building. The turbine and condenser are in the turbine-generator building. The radioactive waste processing systems are housed in the radwaste building.

3.2.6 General

The reactor, fuel, and other principal equipment are supplied by the General Electric Company. General Electric has been engaged in the development, design, construction, and operation of boiling water reactors since 1955 and thus has substantial experience and knowledge in this area. Bechtel Power Corporation is the architect-engineer for the plant. Bechtel has had experience in the design of more than 200 power plants, of which almost half the generating capacity is nuclear.

The turbine-generator system is supplied by Allis-Chalmers Power Systems, Inc. and its technical parent, Kraftwerk Union. A-CPSI and KU have provided 145 turbine-generator systems, now operating or under construction, of at least 200 MW capacity each, for fossil and nuclear plants since 1965 throughout the world. Thirty-nine of these systems are for nuclear applications.

The proposed station operating life is 40 years.



MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

SIMPLIFIED BWR FLOW DIAGRAM

FIGURE 3.2-1

3.3 STATION WATER USE

Water required for plant operation is withdrawn from the Mississippi River and alluvial aquifer using a series of radial collector wells. The wells accumulate river water and ground water through the alluvial aquifer at a rate sufficient to satisfy the plant service water system cooling and main cooling tower and other makeup requirements. 5

Flow rates associated with yard drainage vary on a monthly basis owing to changes in meteorological conditions. Table 3.3.2 lists the monthly average flow rates for the yard drainage.

Flow rates associated with the circulating water system also vary on a monthly basis owing to changes in meteorological conditions. Table 3.4.4 lists the maximum and monthly average flow rates for evaporation and blowdown. 371.05

Flow rates associated with other plant water streams do not vary on a monthly basis. Figure 3.3-1 and Table 3.3.1 show the maximum, average, and minimum flow rates to and from these other streams.

3.3.1 Water Source and Distribution

Most of the water withdrawn from the radial collector wells is used in the plant service water system, which supplies cooling water to the various heat exchangers and chillers. Approximately 150 gpm are diverted and processed as makeup water (demineralized and domestic water storage tanks) and 229 gpm are diverted for cooling water for the administration building HVAC systems. 5

The discharge from the plant service water system serves to replenish losses in the cooling water from the main cooling tower operation. Of the total water withdrawn from the wells, about 21,200 gpm are normally discharged to the river after use. A more complete description of the plant service water system is presented in Section 3.4. 5

3.3.2 Water Losses and Makeup

Cooling towers dissipate residual heat from power generation to the atmosphere primarily through the evaporation of water. In addition, a very small volume of the circulating water is lost as drift from the cooling towers. This evaporation increases the concentration of chemicals and solids in the circulating water system, and a continuous blowdown to the river maintains the concentration at the desired level. Makeup water to the cooling towers from the plant service water system replenishes water losses due to evaporation, drift, and blowdown. A more detailed description of the circulating water system associated with the cooling tower operation is presented in Section 3.4.

Water may also be lost from other systems in the station due to evaporation, leakage, and drainage from equipment and components. Makeup water is added to maintain a constant inventory in the reactor coolant system and other tanks and systems, including the following:

a. Condensate storage tank

b. Component cooling water system

c. Standby liquid control system

d. Turbine building cooling water system

e. Auxiliary boiler condensate return storage tank

f. Condensate cleanup system

g. Samples (chemistry) laboratory

h. Plant chilled water system

i. Main condensers

j. Fuel pool cooling and cleanup system

k. Diesel generators

l. Standby service water system

m. Liquid radwaste system

n. Chlorination system

o. Residual heat removal system

p. Decontamination stations

q. Domestic water system

r. Fire protection system

The makeup water is taken primarily from the plant service water system (a small portion is processed liquid radwaste; see subsection 3.3.3 and Section 3.5). Before use, it is purified in the makeup water treatment system. Makeup water is filtered, demineralized, and monitored for quality before release for use in the station. In purifying the makeup water, the treatment system accumulates chemical wastes which are discharged from the station. Section 3.6 presents a more detailed description of this system.

3.3.3 Liquid Waste Collection and Recycling

Leakage and drainage from equipment are collected in the floor and equipment drain system and processed by the liquid radwaste system. Nonradioactive and radioactive wastes which originate from the same areas are collected together and processed through the radwaste system to ensure that radioactive wastes are not inadvertently released. The liquid radwaste system is described in subsection 3.5.2. The operating basis of the station is to recycle all water wastes containing radioactivity for reuse as makeup water, thus virtually eliminating liquid radioactive discharges. However, a full plant water inventory occasionally may prohibit reuse of all the processed wastewater. On such occasions, small quantities, containing very low concentrations of radioactivity, are discharged to the river. The radiation levels are maintained below those required by NRC regulations.

Nonradioactive waste leakage and drainage from the buildings in the station are collected and discharged to the river. Oily wastes are processed through an oil/water interceptor and the oil disposed of via drum packaging. The design of this system ensures that effluents meet Federal and State regulations.

Plant sanitary wastes are processed in the sewage treatment system (described in Section 3.7) with the treated effluent discharged to the Mississippi River.

3.3.4 Liquid Discharge System

In each unit, the plant service water system discharges to the suction of the circulating water pumps as required. Blowdown from cooling towers and other liquid effluents of the station (see Figure 3.6-1) are discharged, via a common discharge basin and conduit, to the Mississippi River. Plant service water flow exceeding the makeup requirements of the plant is discharged directly to this basin. Storm and roof drains are diverted into major drainage courses which flow into Hamilton Lake.

3.3.5 Plant Water Use In Relation to Low Flow of Record in the Mississippi River

The expected water usage for the two units of the Grand Gulf Nuclear Station is about 43,000 gpm. This makeup flow is obtained from the Mississippi River and ground water, via the radial collector well system. The proportion of the radial well intake water derived from ground water under high and low river flow conditions is provided in the Questions and Responses section of the Environment Report (Question 371.07). The lowest recorded water elevation in the Mississippi River near the site is 28 feet msl, which provides adequate head to induce flow to the collector wells. At this lowest recorded elevation, the flow in the river is 100,000 cfs, i.e. 44,880,000 gpm. Therefore, no station outages are foreseen due to an insufficient supply of operational cooling water.

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TABLE 3.3.1

ESTIMATED PLANT WATER USE - TWO UNITS
(Ref. Figure 3.3-1)

Item	Maximum[1] (gpm)	Average[1] (gpm)	Minimum[1] (gpm)	
Raw Water from Radial Collector Wells				
Fire water makeup	1,250	<30	0	
Makeup water treatment (Makeup demineralizers)	300	130	0	
Domestic water	200	20	0	
SSW cooling tower makeup	1,088	164[6]	0	
Administration bldg. HVAC systems	400	229	229	
Processed Plant Waste				
Sewage treatment plant effluent	10	6	3	
Water effluent from oil/water separator	600	<5	0	
Liquid radwaste effluent	35[2]	1.3[5]	0	
Regeneration waste neutralizing tank effluent	200	50	0	
Storm drainage	76,300[7]	(Note 4)	0	
Circulating Water System				
Cooling tower makeup	35,875	25,750	7,750	5
Cooling tower evaporation and drift	28,700	20,600	6,200	
Cooling tower blowdown[3]	7,175	5,150	1,550	5
Disposal to Mississippi River				
CW cooling tower blowdown[3]	14,200	22,400	6,680	
Administration bldg. HVAC systems	400	229	229	
SSW cooling tower blowdown	700	106[6]	0	

TABLE 3.3.1 (Cont.)

Notes:

1. Maximum, Average, and Minimum flows refer to 100 percent, 80 percent and 15 percent load factor (anticipated minimum power) operation except for intermittent flows for which a value of 0 is shown.

2. Based on a minimum required circulating water system blowdown dilution of 300.

3. When operating at 100 percent load factor with maximum cooling (maximum conditions), the amount of cooling tower blowdown is reduced below the average due to the increase in evaporation rate while maintaining a nearly constant makeup flow. 5

4. Average flow rates vary on a monthly basis due to changes in meteorological conditions. Refer to Table 3.3.2 for monthly average storm drainage flow rates.

5. Based on discharge of 10 percent of processed floor drains.

6. Based on 15 percent system operating time.

7. Maximum storm drainage corresponds to the design flow rate of 170 cfs for the underground portion of the drainage system piping. This piping drains approximately 35 acres of land including the power block area.

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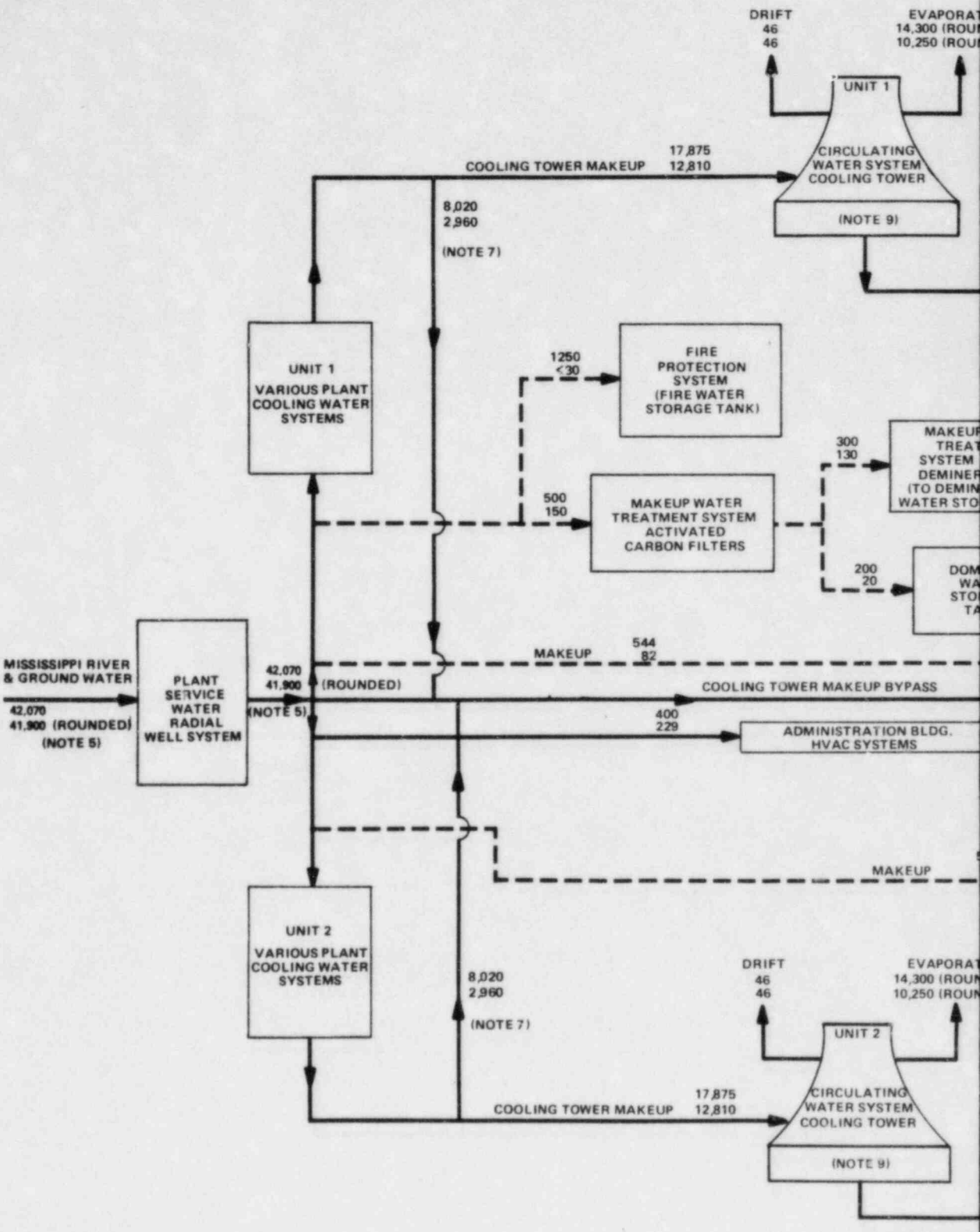
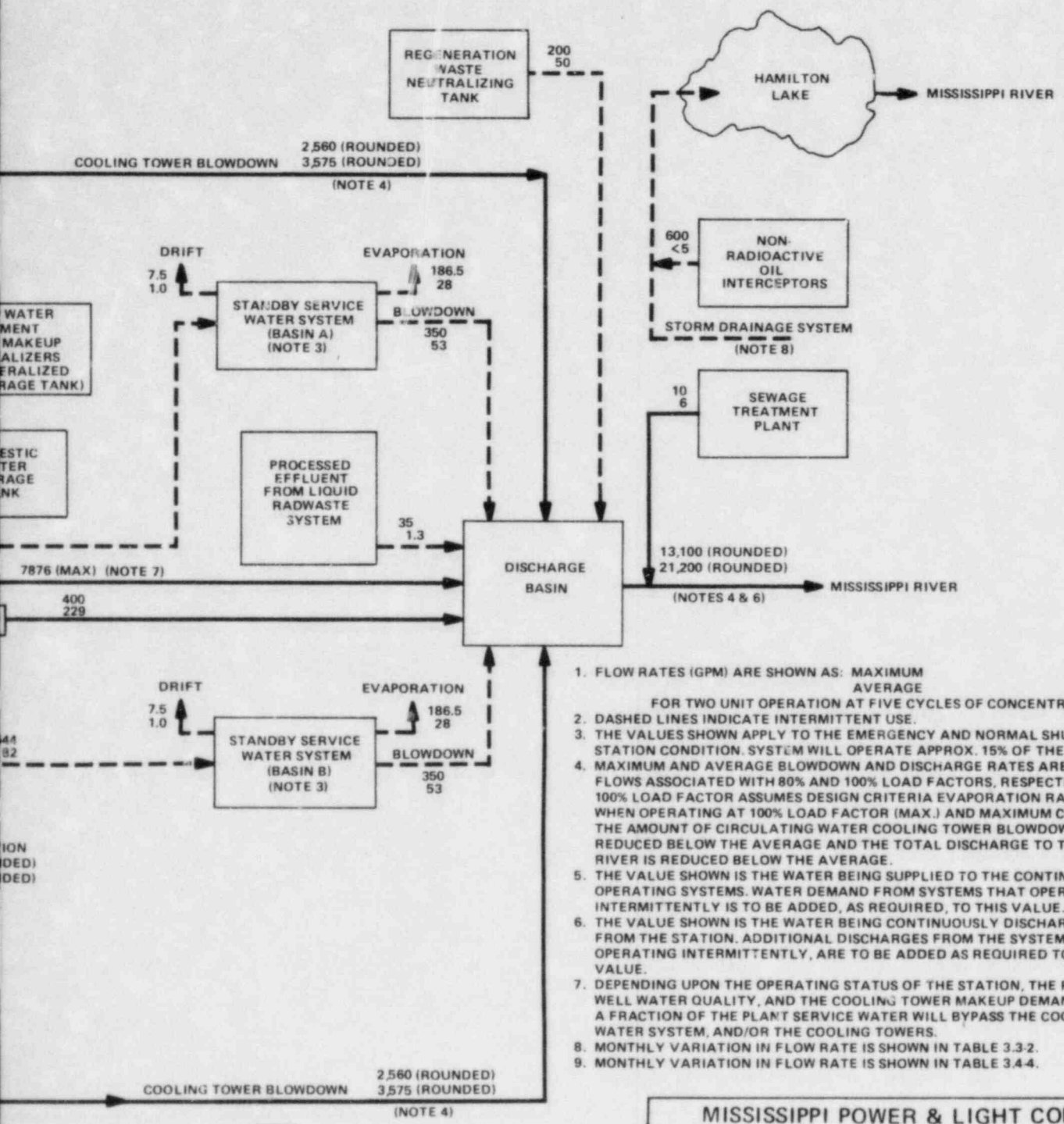
TABLE 3.3.2

ANTICIPATED MONTHLY AVERAGE STORM DRAINAGE FLOW RATES - TWO UNITS

Month	Anticipated Monthly Average Storm Drainage Flow (gpm)
Jan	115
Feb	120
Mar	125
Apr	110
May	90
Jun	75
Jul	85
Aug	65
Sep	55
Oct	45
Nov	100
Dec	110


DRIFT
46
46
EVAPORAT
14,300 (ROU
10,250 (ROU
UNIT 1
CIRCULATING WATER SYSTEM COOLING TOWER
(NOTE 9)
17,875
12,810
COOLING TOWER MAKEUP
8,020
2,960
(NOTE 7)
UNIT 1
VARIOUS PLANT COOLING WATER SYSTEMS
1250
<30
FIRE PROTECTION SYSTEM (FIRE WATER STORAGE TANK)
300
130
MAKEUP TREAT SYSTEM DEMINER (TO DEMIN WATER STO
500
150
MAKEUP WATER TREATMENT SYSTEM ACTIVATED CARBON FILTERS
200
20
DOM WA STO TA
MISSISSIPPI RIVER & GROUND WATER
42,070
41,900 (ROUNDED)
(NOTE 5)
PLANT SERVICE WATER RADIAL WELL SYSTEM
42,070
41,900 (ROUNDED)
(NOTE 5)
MAKEUP
544
82
COOLING TOWER MAKEUP BYPASS
400
229
ADMINISTRATION BLDG. HVAC SYSTEMS
MAKEUP
UNIT 2
VARIOUS PLANT COOLING WATER SYSTEMS
8,020
2,960
(NOTE 7)
DRIFT
46
46
EVAPORAT
14,300 (ROU
10,250 (ROU
UNIT 2
CIRCULATING WATER SYSTEM COOLING TOWER
(NOTE 9)
17,875
12,810
COOLING TOWER MAKEUP



1. FLOW RATES (GPM) ARE SHOWN AS: MAXIMUM
   AVERAGE
   FOR TWO UNIT OPERATION AT FIVE CYCLES OF CONCENTRATION
2. DASHED LINES INDICATE INTERMITTENT USE.
3. THE VALUES SHOWN APPLY TO THE EMERGENCY AND NORMAL SHUTDOWN STATION CONDITION. SYSTEM WILL OPERATE APPROX. 15% OF THE TIME.
4. MAXIMUM AND AVERAGE BLOWDOWN AND DISCHARGE RATES ARE THE FLOWS ASSOCIATED WITH 80% AND 100% LOAD FACTORS, RESPECTIVELY. 100% LOAD FACTOR ASSUMES DESIGN CRITERIA EVAPORATION RATE. WHEN OPERATING AT 100% LOAD FACTOR (MAX.) AND MAXIMUM COOLING, THE AMOUNT OF CIRCULATING WATER COOLING TOWER BLOWDOWN IS REDUCED BELOW THE AVERAGE AND THE TOTAL DISCHARGE TO THE RIVER IS REDUCED BELOW THE AVERAGE.
5. THE VALUE SHOWN IS THE WATER BEING SUPPLIED TO THE CONTINUOUSLY OPERATING SYSTEMS. WATER DEMAND FROM SYSTEMS THAT OPERATE INTERMITTENTLY IS TO BE ADDED, AS REQUIRED, TO THIS VALUE.
6. THE VALUE SHOWN IS THE WATER BEING CONTINUOUSLY DISCHARGED FROM THE STATION. ADDITIONAL DISCHARGES FROM THE SYSTEMS, OPERATING INTERMITTENTLY, ARE TO BE ADDED AS REQUIRED TO THIS VALUE.
7. DEPENDING UPON THE OPERATING STATUS OF THE STATION, THE RADIAL WELL WATER QUALITY, AND THE COOLING TOWER MAKEUP DEMAND, A FRACTION OF THE PLANT SERVICE WATER WILL BYPASS THE COOLING WATER SYSTEM, AND/OR THE COOLING TOWERS.
8. MONTHLY VARIATION IN FLOW RATE IS SHOWN IN TABLE 3.3-2.
9. MONTHLY VARIATION IN FLOW RATE IS SHOWN IN TABLE 3.4-4.

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

STATION WATER USE DIAGRAM

FIGURE 3.3-1

3.4 HEAT DISSIPATION SYSTEM

3.4.1 General Description

Heat (thermal energy) is a by-product of the generation of electricity from a fuel. The heat dissipation system, an integral part of the power generation station, is designed to dissipate or transfer this energy to the environment.

The main turbine condenser for each unit rejects heat at a rate of 8.6×10^9 Btu/hr during normal full-load operation. Circulating cooling water is pumped through the condenser to the cooling tower where heat, transferred to the cooling water in the condenser, is dissipated to the environment by evaporation. In addition, the plant service water system rejects 2.25×10^8 Btu/hr to the environment by way of the circulating water system cooling tower.

During the dissipation process, some water is evaporated, resulting in an increase in the solids level in the circulating water. To control solids levels or concentrations, a portion of the circulating water must be continually removed or blown down. In addition to the blowdown, an extremely small percentage of water droplets is lost from the system. This water droplet loss is termed drift. Water pumped from radial collector wells replaces that lost by evaporation, drift, and blowdown from the cooling towers. Blowdown water is continuously (except during chlorination) returned to the Mississippi River. The heat dissipation system flow diagram is shown in Figure 3.4-1. 5

3.4.2 Cooling Water

3.4.2.1 Circulating Water System

The circulating water system provides cooling water to and collects thermal energy from the main condenser.

The major components of the system, per unit, are the main condenser, two 50-percent capacity (290,000 gpm each) vertical circulating water pumps, and a natural draft counter-flow cooling tower.

Circulating water discharged by the two vertical circulating water pumps is conveyed to the low-pressure condenser-shell water boxes through two 120-inch diameter pressure pipes. The flow then circulates through the intermediate and high-pressure shells of the main condenser and discharges to the cooling tower. After passing through the noncombustible cooling tower fill, the cooled water falls into the concrete basin and then runs by gravity to the circulating water pumphouse located adjacent to the turbine building. The two circulating water pipes to and from the cooling tower are also 120-inch diameter pressure pipes. At design conditions, the temperature of water entering and leaving the condenser is 95 F and 125.4 F, respectively.

3.4.2.2 Plant Service Water System

The plant service water (PSW) system provides water to various plant heat exchangers for heat rejection; to the makeup water treatment system for processing; and to the circulating water system pump house, the fire protection system, and the standby service water system for makeup. The system consists of pumps in radial collector wells, heat exchangers, piping and valves, instrumentation, and controls.

The plant service water system receives water from the PSW radial collector well system. After passing through the plant heat exchangers the water is discharged to the circulating water pump house for cooling tower makeup. Bypasses are provided in the event that makeup requirements are not the same as heat exchanger requirements. The excess water is discharged to the discharge basin.

The system is designed to provide 25,000 gpm/unit of cooling water from the radial collector wells at 75 F or less to power block auxiliary equipment.

3.4.2.3 Standby Service Water System

The standby service water (SSW) system provides a reliable source of heat rejection for plant components which require cooling during a plant shutdown and reactor isolation. The system includes the ultimate heat sink for removal of reactor residual heat.

The SSW system consists of mechanical draft cooling towers, heat sink basins, pumps, piping, valves, and instrumentation. The two cooling towers with their associated makeup basins provide shutdown cooling for both units. Each basin has two SSW pumps, one for each unit, and a high pressure core spray (HPCS) service water pump. Water is circulated to and from each unit by two redundant and independent main SSW supply and return headers and one independent HPCS service water supply and return header.

3.4.3 Cooling Towers

3.4.3.1 General Description

Cooling towers are used to dissipate heat from the circulating and plant service water systems. Each power block has a single counterflow type reinforced concrete natural draft cooling tower. Each tower is equipped with noncombustible fill and drift eliminators complete with concrete basin. The concrete basin is equipped with inlet and outlet water connections and service access. The tower dimensions are approximately 404 feet base diameter and 522 feet in height.

Warm water from the condensers and auxiliary equipment heat exchangers enters the tower distribution system about 40 feet above the tower basin water level and is distributed uniformly over a matrix fill that breaks up the flow. As the water cascades through this fill, heat is removed by direct contact with atmospheric air flowing up through the tower. Most of the heat is removed by evaporation; the remainder is removed by sensible heat transfer to the air. An outline drawing of the circulating water system natural draft cooling tower is given in Figure 3.4-2. Site location for these towers is shown in Figure 2.1-1.

3.4.3.2 Design Point

It is expected that both units will operate at or near rated capacity (1306 MWe/unit) whenever they are available for service. Considering normal service outages for refueling, forced outages for equipment repair, and variation of generation to meet system demands, the overall capacity factor for each unit is expected to be 80 percent. The heat rejection rate for each unit when operating at rated capacity (1306 MWe) is 8.6×10^9 Btu/hr. The duty is about 1.25×10^8 Btu/hr when the unit is at the no-load, hot-standby condition. The cooling towers are designed to dissipate the maximum heat rejected from each unit at its rated capacity.

The towers are designed for 79 F maximum wet-bulb temperature, with 30.4 F range and 16 F approach to the wet bulb. The 79 F wet-bulb temperature is the 1 percent cumulative frequency level which is equalled or exceeded about 29 hours during the summer season (June to September) (Ref. 1). Design parameters and typical dimensions of the cooling towers are shown in Table 3.4.1.

The circulating water system is designed for a solids concentration factor in the approximate range of two to five. Table 3.4.2 summarizes the average yearly water requirements while Tables 3.4.3 and 3.4.4 illustrate these quantities on an average monthly basis. 5

3.4.4 Blowdown Facilities

The blowdown water from the circulating water system is discharged from the circulating water (CW) pumphouse into the common discharge basin. Starting at the CW pumphouse for Unit 2, it is discharged through a 24-inch diameter pipeline until it joins the 24-inch discharge line from the CW pumphouse for Unit 1. A 36-inch diameter pipeline takes the combined discharge of the two units to the common discharge basin, where this flow comes together with the bypass discharge from the plant service water system and effluents from the regeneration waste neutralizing tank and low-level radioactive waste system. From the discharge basin, a single station discharge line (36-inch diameter) takes all liquid discharge to a manhole where the two 36-inch diameter cooling tower drain pipes are connected. From this manhole a pipeline composed of approximately 1000 feet of 54-inch-diameter concrete pipe and approximately 5700 feet of 48-inch-diameter RTRP (fiberglass pipe) transports all 5

liquid discharges to the south bank of the existing barge slip with 54-inch diameter outlet pipe. Figure 3.4-3 shows the layout of the discharge pipe at the outfall and Figure 3.4-4 shows details of the discharge pipe at the barge slip. 5

The barge slip has a bed width of 50 feet and is concrete lined with 3:1 side slopes. At the end of the concrete slab shown on Figure 3.4-3 the elevation is about 39 feet msl.

The velocity of the discharge from the 54-inch-diameter pipe varies from 2.0 fps to 2.5 fps for monthly average plant discharges of 14,370 gpm and 18,170 gpm, respectively, assuming two-unit operation, 100 percent load factor, and five cycles of concentration (Table 5.1.1a). The velocity of flow in the barge slip depends on the river water level. During low-flow period, when the river water level elevation is below 39 ft msl, the barge slip is not affected by the river. Under this condition, the flow in the barge slip will be uniformly distributed at its outlet with an approximate velocity of 3.5 fps. During mean water level elevation of the Mississippi River of 54 ft msl, the flow velocity at the outlet of the barge slip channel is about 0.10 fps. 5 371.06 5

3.4.5 Cooling Tower Makeup Water Facilities

The radial well system consists of three wells, six pumps, valves, instrumentation, and piping. A typical well is shown in Figure 3.4-5. An additional well or wells may be constructed as required to meet the station requirements for water based on the performance of the initial wells. The location of the existing wells is shown in Figure 2.1-1. The radial wells are large reinforced concrete caissons, installed vertically, that extend into the alluvial sediments adjacent to the Mississippi River. Water is derived from the Mississippi River via induced infiltration and enters the caisson through horizontal screened pipes, called laterals, that extend radially from the caisson into the alluvial sediments. This naturally filtered water is pumped to the plant by two vertical plant service water pumps installed on the operating floor of each well at an elevation that is above the 100-year flood level. The maximum radial well water temperature is 75 F.

3.4.6 Operating Characteristics of Heat Dissipation System

3.4.6.1 Operating Scheme

Two equal-capacity circulating water pumps provide a total of 572,000 gpm of cooling water per unit to the condenser.

Both circulating water pumps are designed to operate in parallel. However, in case one pump is out of service, the remaining pump is capable of delivering the required flow for at least half-load operation. The plant service water radial well pumps provide the required flow to auxiliary equipment heat exchangers. The combined flow from the heat exchangers is then returned to the cooling tower for dissipating the primary plant heat load. Cooling tower design parameters are shown in Table 3.4.1. Tables 3.4.3 and 3.4.4 summarize the average monthly temperature of the cooling tower blowdown for two units operating at a 100-percent and 80-percent capacity factor respectively.

3.4.6.2 Operating Characteristics

Sodium hypochlorite solution is added to the circulating water system to prevent biological fouling (e.g., accumulation of algae growth) in the cooling tower and the main condenser. Hypochlorite solution is injected into the circulating water pump sumps in a controlled manner so that the residual chlorine concentration in the cooling tower blowdown is in compliance with 40 CFR 423.

The cooling tower makeup is provided by the plant service water system which utilizes water from radial collector wells. By varying the system blowdown flow rate, the solids concentration ratio of the circulating water flow is maintained in the range of two to five. 5

The time of travel through the condenser tubes is 20 seconds when operating at the design circulating water system flow rate (572,000 gpm).

Considering two, three, and five cycles of concentration and 100 percent load factor, the monthly average time of travel of the circulating water system blowdown and makeup bypass water to the barge slip ranges from approximately 20 minutes to 80 minutes. 5

3.4.7 References

1. Air Conditioning Criteria, Page 35, Jackson, Engineering Weather Data, U.S. Government Printing Office, Washington; 1967

2. Local Climatological Data, Annual Summary With Comparative Data, Vicksburg, Mississippi, 1966, ESSA

TABLE 3.4.1

COOLING TOWER DESIGN PARAMETERS AND DIMENSIONS

TWO-UNIT OPERATION

Design Parameter	Value
Total MWe plant output	2612
Total dissipated heat load, Btuh	17.14×10^9
Total water capacity, gpm	1.144×10^6
Tower Dimensions	
Number of towers	2
Tower base diameter, ft	404
Tower top diameter, ft	250
Overall height of towers, ft	522
Design Point	
Wet bulb temperature, F	79
Relative humidity, percent	60
Cold water temperature, F	95
Hot water temperature, F	125.4
Water flow/tower, gpm	572,000
Range, F	30.4
Approach, F	16
Drift (0.008 percent of circulating water flow) gpm	92

TABLE 3.4.2

COOLING TOWER WATER LOSS

TWO-UNIT OPERATION

Average Yearly Operating Condition (Based on 80 percent capacity factor)	Value	
Evaporation rate (rounded), gpm	20,500	
Blowdown rate (rounded), gpm	5,148	5
Drift loss, gpm	92	
Cooling tower makeup water rate, gpm	25,740	5
Cycles of concentration	5	

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TABLE 3.4.3

COOLING TOWER EVAPORATION AND WATER TEMPERATURE - 100 PERCENT LOAD FACTOR

. TWO-UNIT OPERATION
. FIVE CYCLES OF CONCENTRATION

Month	Wet Bulb Temp.F*	Relative Humidity, %	Cold Water Temp. F	Flow Rate gpm	
				Evaporation	Blowdown
JAN	45.3	74.8	75.3	23,500	5,875
FEB	47.6	74.0	76.4	23,800	5,950
MAR	52.5	70.8	79.0	24,600	6,150
APR	60.5	74.0	82.8	24,800	6,200
MAY	67.8	75.8	87.5	26,440	6,610
JUN	74.4	78.0	91.2	27,100	6,775
JUL	76.6	79.8	92.5	27,220	6,805
AUG	76.4	79.0	92.0	27,300	6,825
SEP	71.4	78.3	89.3	26,800	6,700
OCT	62.8	77.8	84.4	25,800	6,450
NOV	52.2	76.5	78.7	24,500	6,125
DEC	46.7	76.5	75.7	23,700	5,925
Monthly Average for Year (Rounded)				25,460	6,370
**Design Criteria	79.0	60.0	95.0	28,640	7,160

*Monthly temperatures are mean value (Ref. 2)

**See subsection 3.4.3.2 for explanation of design criteria

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TABLE 3.4.4

COOLING TOWER EVAPORATION AND WATER TEMPERATURE - 80 PERCENT LOAD FACTOR

. TWO-UNIT OPERATION
. FIVE CYCLES OF CONCENTRATION

Month	Wet Bulb Temp. F*	Relative Humidity %	Cold Water Temp. F	Flow Rate gpm Evaporation	Flow Rate gpm Blowdown
JAN	45.3	74.8	73.7	18,800	4,700
FEB	47.6	74.0	74.8	19,000	4,750
MAR	52.5	70.8	77.8	19,680	4,920
APR	60.5	74.0	82.0	20,600	5,150
MAY	67.8	75.8	86.3	21,300	5,325
JUN	74.4	78.0	90.8	21,800	5,450
JUL	76.6	79.8	91.7	22,060	5,515
AUG	76.4	79.0	91.5	22,100	5,525
SEP	71.4	78.3	88.4	21,540	5,385
OCT	62.8	77.8	83.6	20,700	5,175
NOV	52.2	76.5	77.3	19,460	4,865
DEC	46.7	76.5	74.3	18,900	4,725
Monthly Average For Year (Rounded)				20,500	5,125

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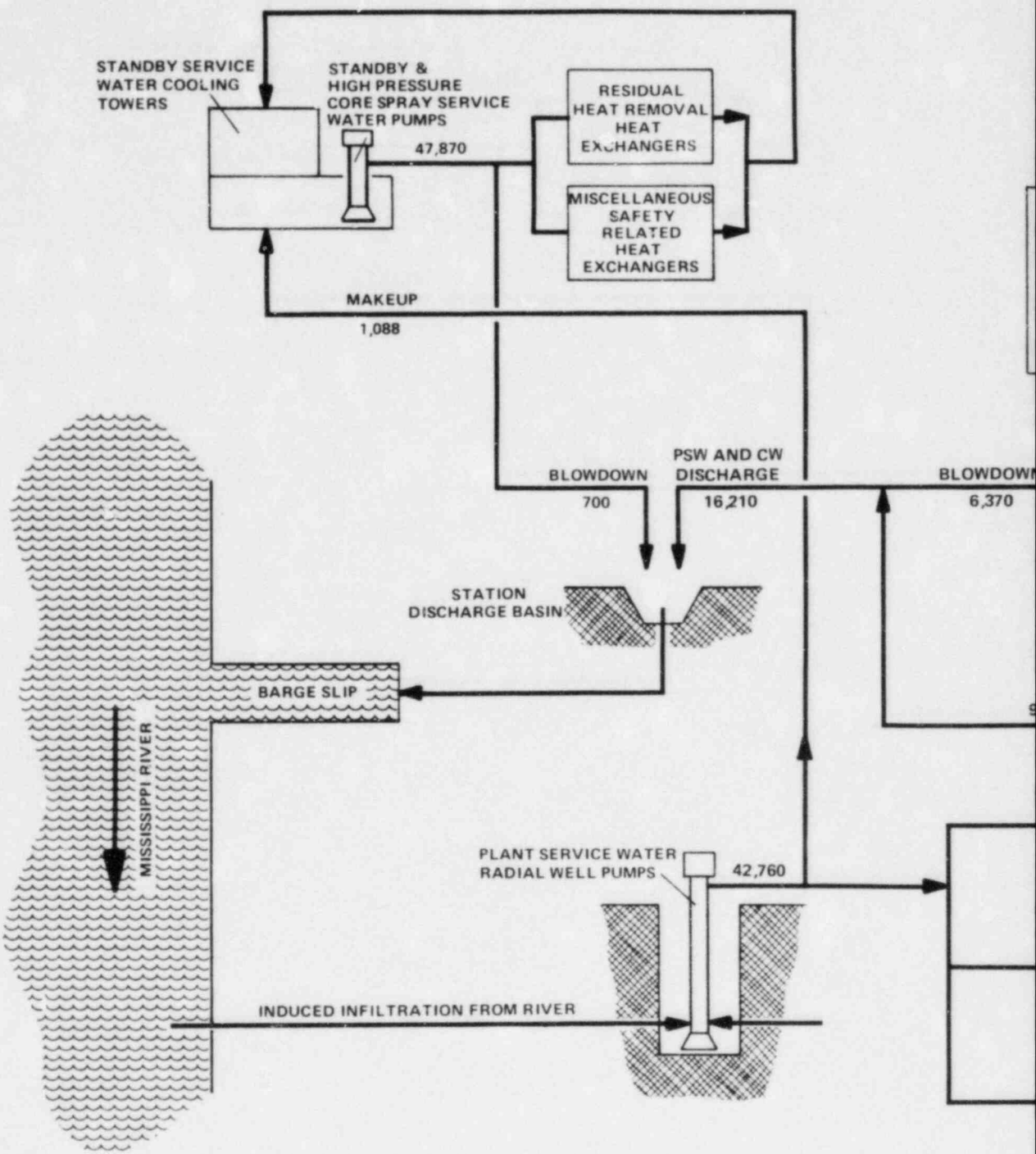
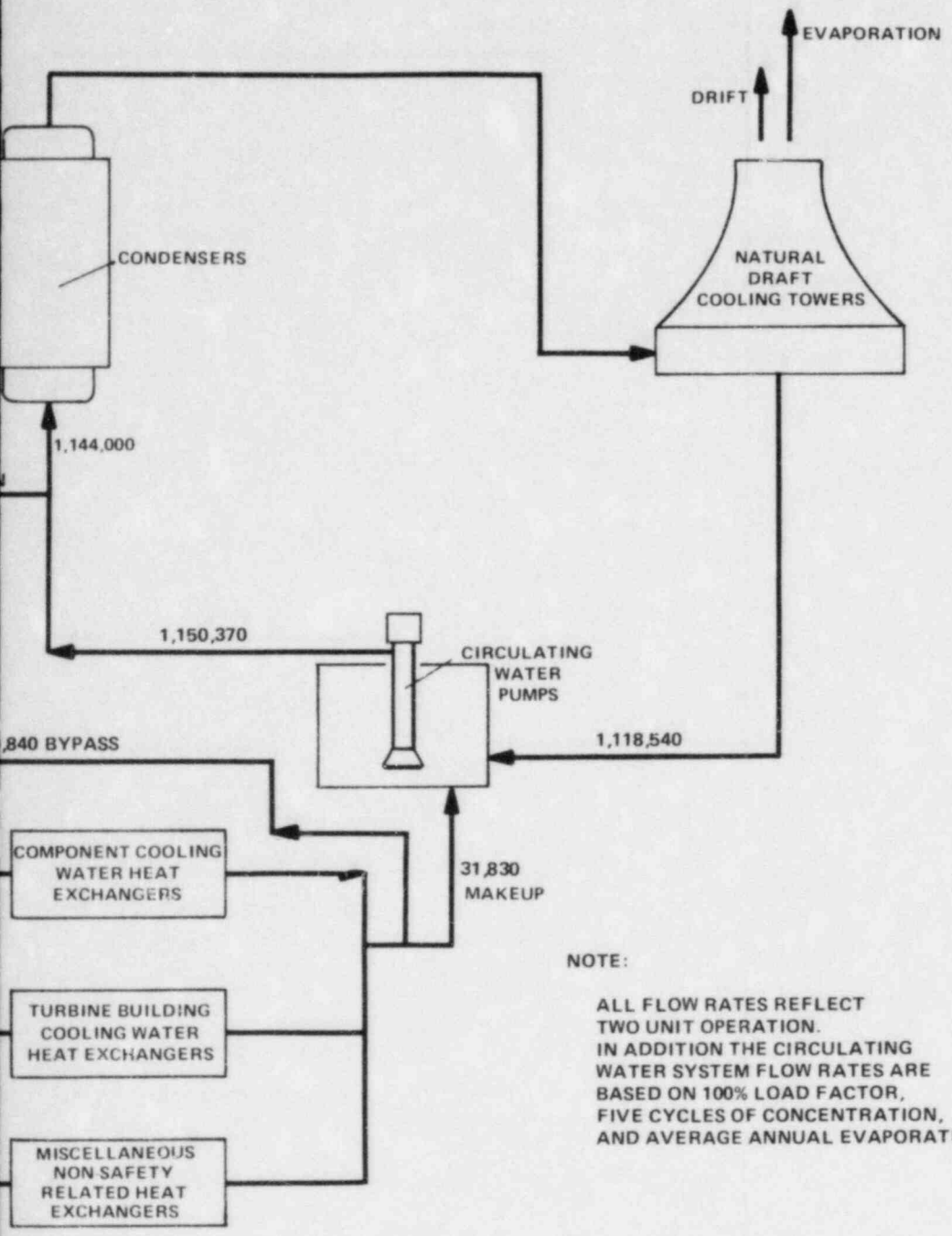
* Monthly temperatures are mean values (Ref. 2)


STANDBY SERVICE WATER COOLING TOWERS
STANDBY & HIGH PRESSURE CORE SPRAY SERVICE WATER PUMPS
47,870
RESIDUAL HEAT REMOVAL HEAT EXCHANGERS
MISCELLANEOUS SAFETY RELATED HEAT EXCHANGERS
MAKEUP
1,088
BLOWDOWN
700
PSW AND CW DISCHARGE
16,210
BLOWDOWN
6,370
STATION DISCHARGE BASIN
BARGE SLIP
MISSISSIPPI RIVER
PLANT SERVICE WATER RADIAL WELL PUMPS
42,760
INDUCED INFILTRATION FROM RIVER



NOTE:

ALL FLOW RATES REFLECT TWO UNIT OPERATION. IN ADDITION THE CIRCULATING WATER SYSTEM FLOW RATES ARE BASED ON 100% LOAD FACTOR, FIVE CYCLES OF CONCENTRATION, AND AVERAGE ANNUAL EVAPORATION RATE.

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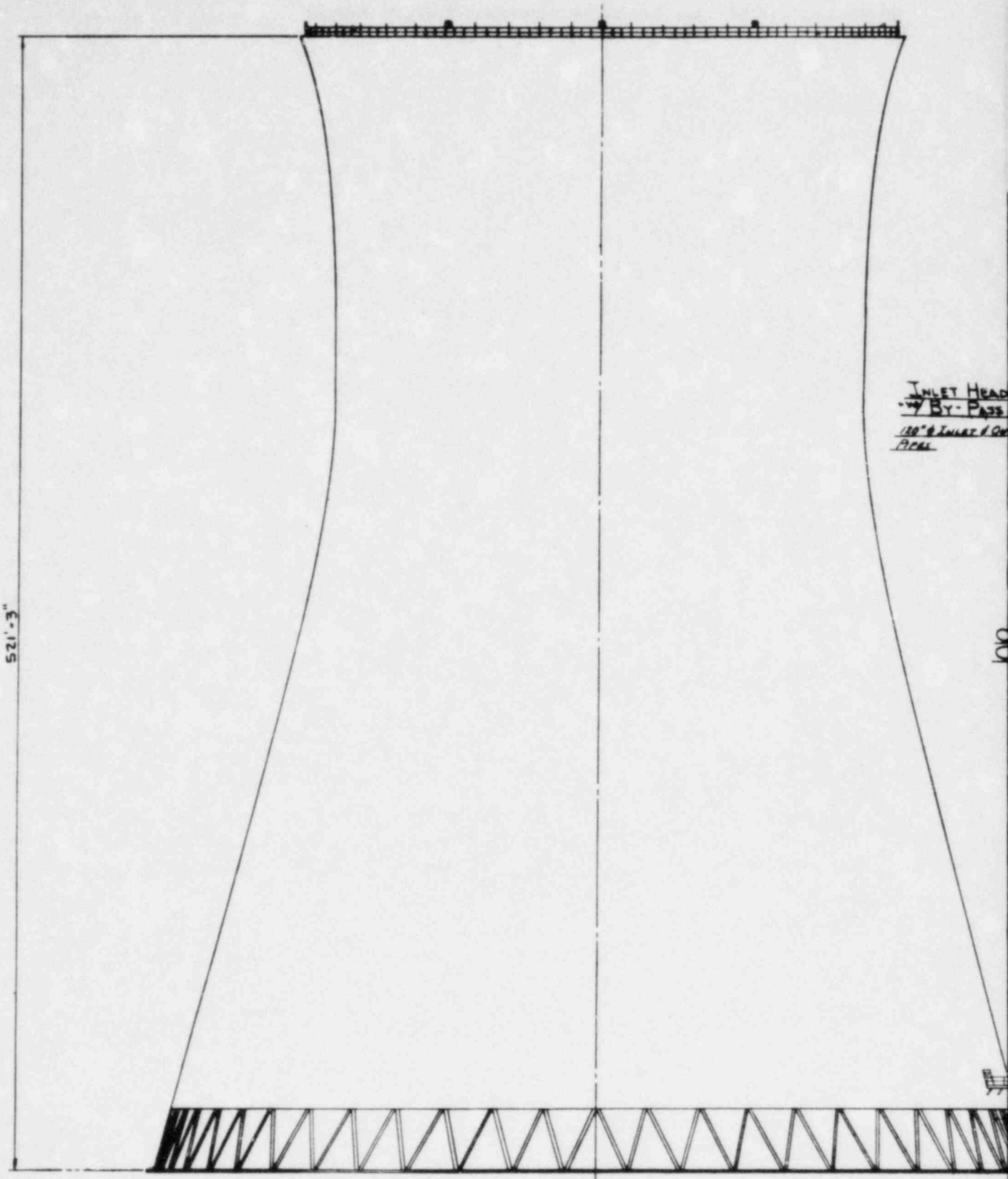
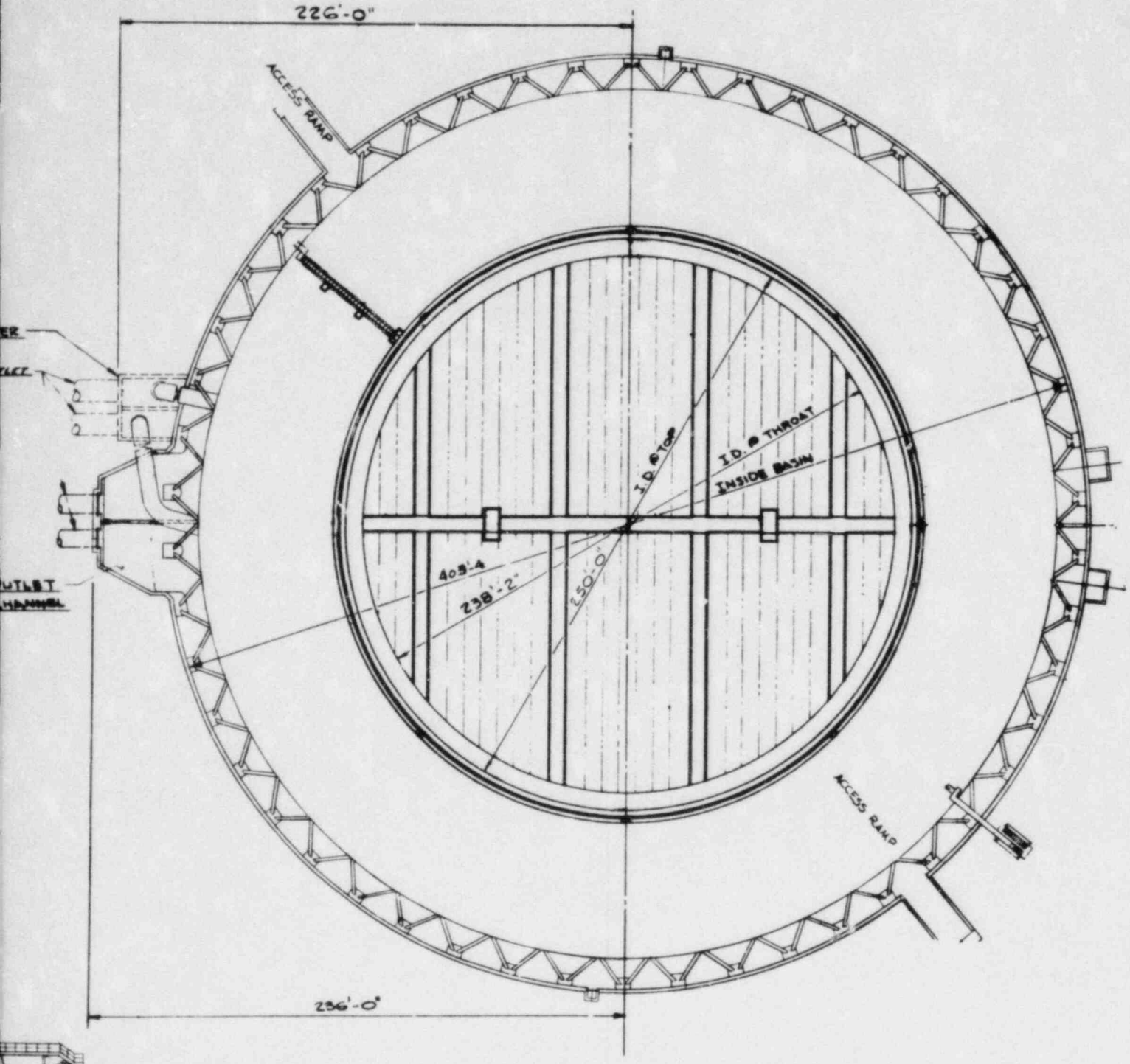
ENVIRONMENTAL REPORT

HEAT DISSIPATION SYSTEM FLOW DIAGRAM
FIGURE 3.4-1



ELEVATION



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MISSISSIPPI POWER & LIGHT COMPANY
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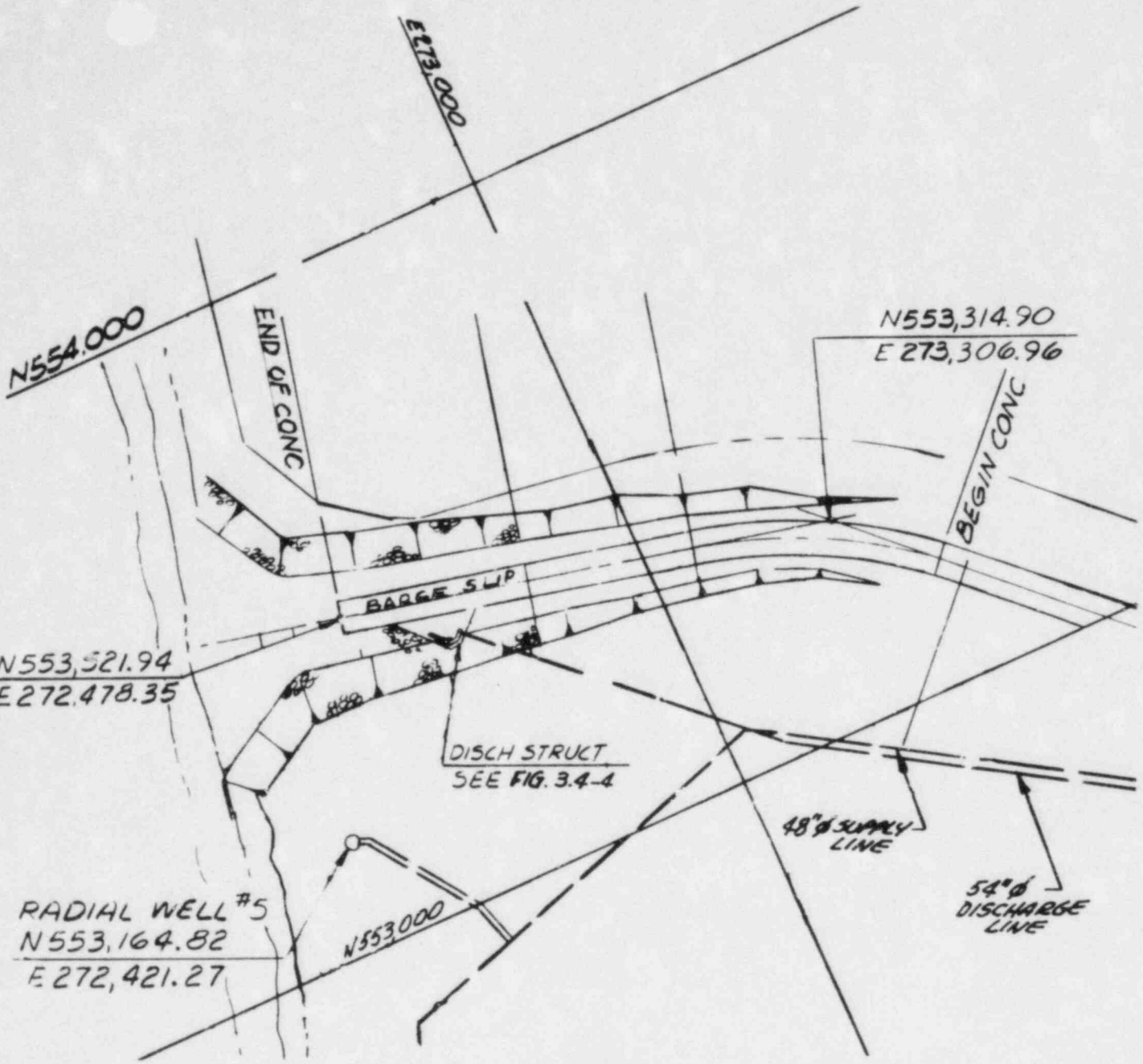
UNITS 1 & 2
ENVIRONMENTAL REPORT

NATURAL DRAFT COOLING TOWER

FIGURE 3.4-2



PLAN

200 0 200 400

GRAPHIC SCALE IN FEET

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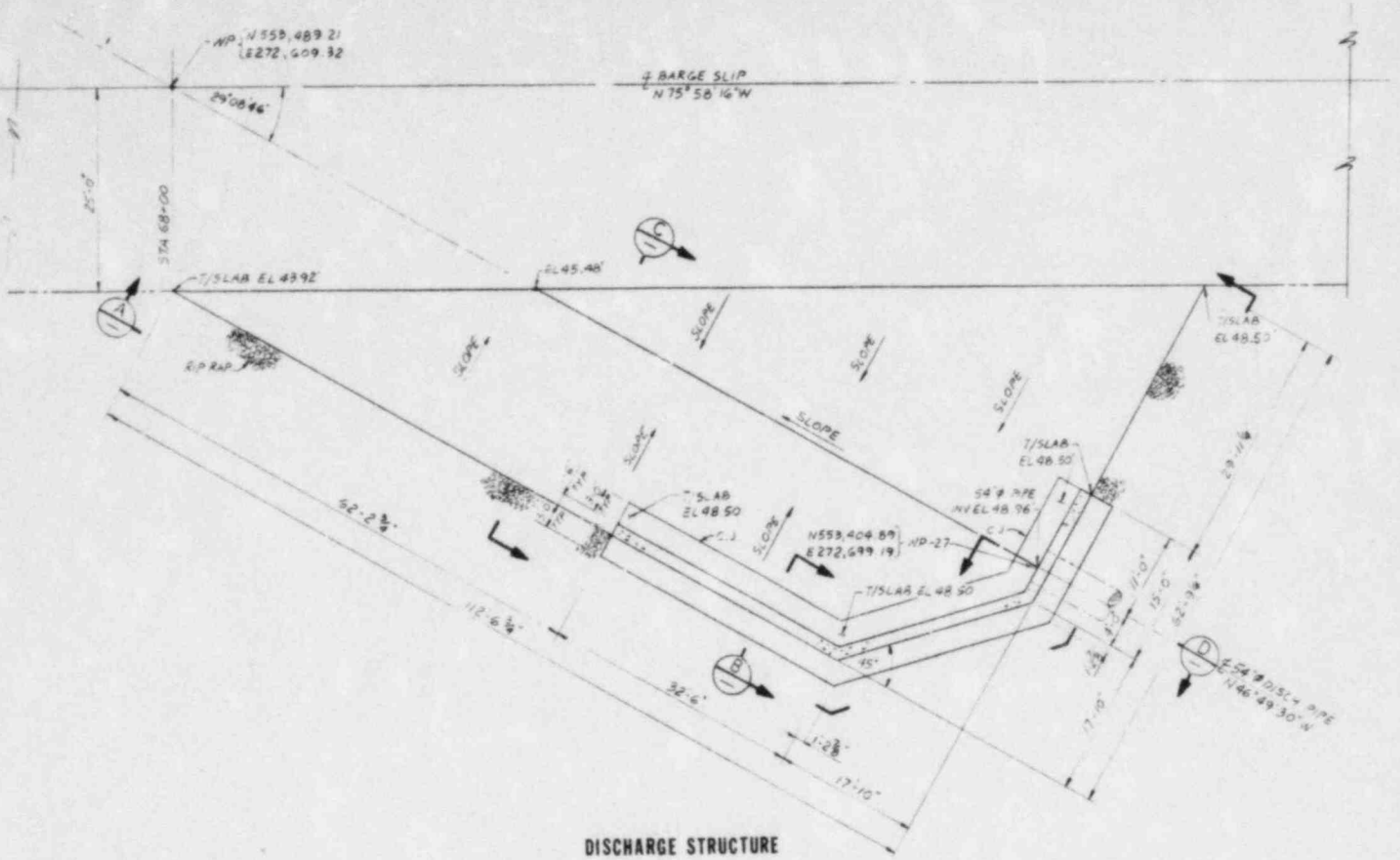
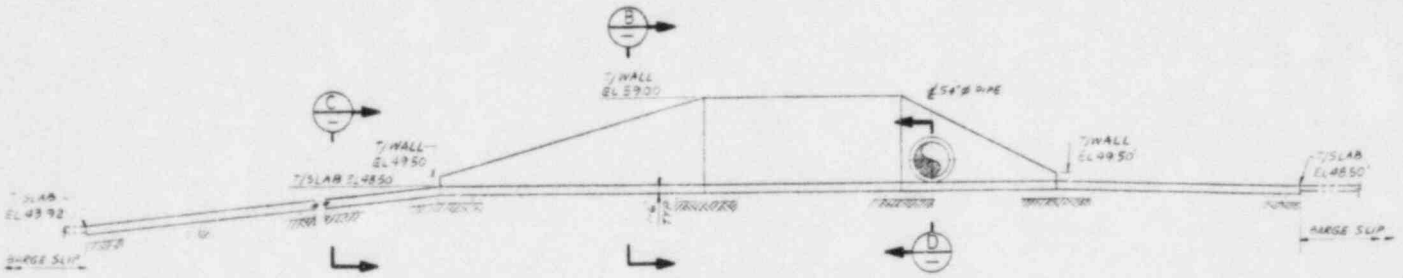
STATION DISCHARGE STRUCTURE

FIGURE 3.4-3



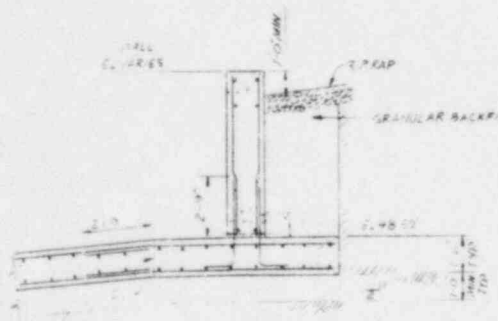
DISCHARGE STRUCTURE DETAIL

GRAPHIC SCALE IN FEET



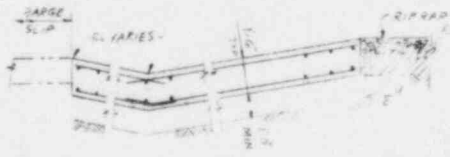
SECTION A

GRAPHIC SCALE IN FEET



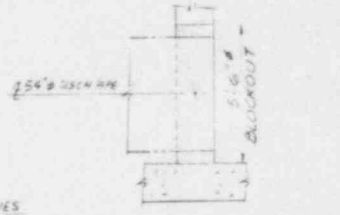
SECTION B

SCALE NONE



SECTION C

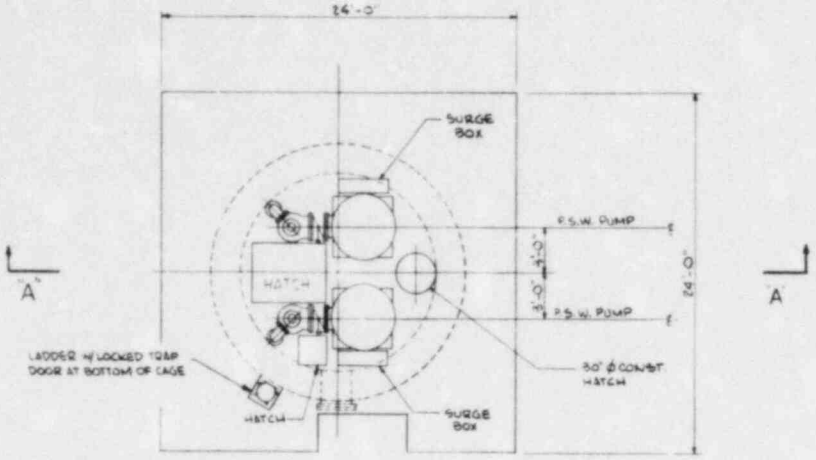
SCALE NONE



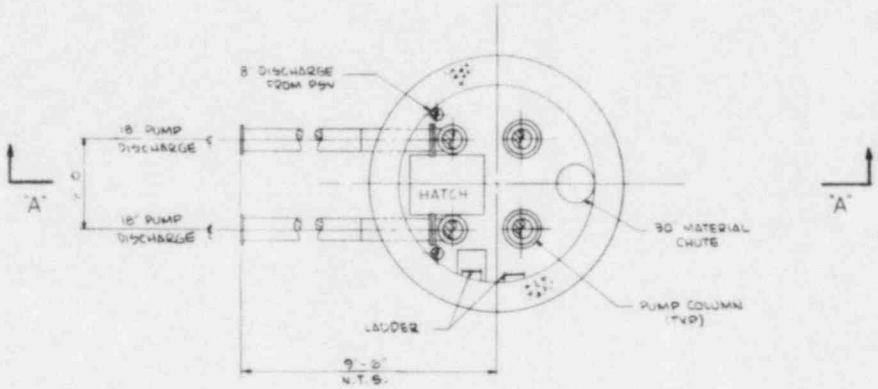
SECTION D

GRAPHIC SCALE IN FEET

MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	STATION DISCHARGE STRUCTURE DETAIL FIGURE 3.4-4

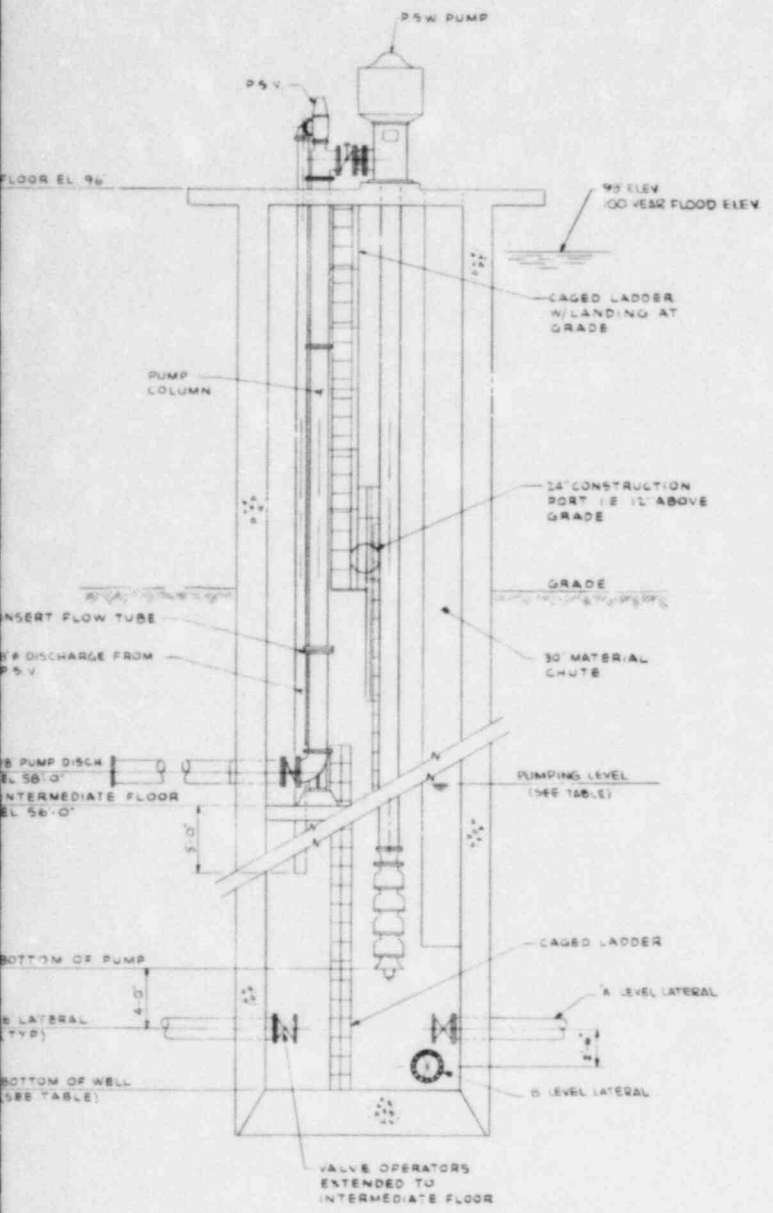


PLAN AT EL 96'



PLAN AT INTERMEDIATE FLOOR
EL 56'-0"

SCALE: 1/4" = 1'-0"



SECTION 'A'-'A'

RADIAL COLLECTOR WELL DATA

	WELL 1	WELL 3	WELL 5
Elevation of pumping level in caisson, ft. msl.	-25	-21	-25
Total length of laterals, linear ft.	2300	2300	2300
Diameter of laterals, in.	16	16	16
Number of laterals	12	12	11
Elevation of centerline of laterals, ft. msl.	-45	-39	-45
Dimensions of caisson I.D. X O.D., ft	13 X 17	13 X 17	13 X 17
Elevation of bottom of caisson, ft. msl.	-49	-43	-49
Elevation at top of aquifer, ft. msl.	+21	+55	+67

MISSISSIPPI POWER & LIGHT COMPANY
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UNITS 1 & 2
ENVIRONMENTAL REPORT

PLANT SERVICE WATER
RADIAL COLLECTOR WELL

FIGURE 3.4-5

3.5 RADWASTE SYSTEMS AND SOURCE TERMS

3.5.1 Source Terms

3.5.1.1 Introduction

In normal operation of the Unit 1 and 2 reactors, fission neutrons activate some nonradioactive materials normally present in the reactor coolant, namely deuterium, oxygen, nitrogen and trace metals, such as iron, cobalt, and manganese. Resulting activated materials are called activation products. Small amounts of fission activated products within the fuel may enter the coolant by diffusing through the fuel cladding or by escaping through minor fuel leaks, if they occur. Thus, the reactor coolant water normally carries materials with varying degrees of radioactivity. For the purposes of this section, only the radioactive impurities are addressed.

Reduction of activity levels in the reactor coolant is achieved in three principal ways:

a. The natural process of radioactive decay of radioisotopes

b. A side stream of reactor coolant is continuously withdrawn, processed through the reactor water cleanup (RWCU) system filter/demineralizers and returned to the reactor vessel

c. After passing through the turbine, the condensed steam is processed through the condensate cleanup system demineralizers and returned to the reactor vessel.

The two cleanup systems, (i.e., RWCU and condensate cleanup) remove particulates and ionic impurities from the reactor coolant. The natural process of radioactive decay plays an important role in further reducing the levels of relatively short-lived radioisotopes.

Other mechanisms which reduce the activity levels in the reactor coolant are:

a. Activity removal due to reactor coolant leakage

b. Activity removal through the steam jet air ejectors.

Calculations of activity concentrations in the reactor coolant and release of radioactivity to the environment in liquid and gaseous effluents are performed by using the BWR-GALE Computer Code described in NRC'S NUREG-0016 report (Ref. 1), which is a companion document to Regulatory Guide 1.112, April 1976 "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light Water-Cooled Power Reactors."

Parameters for calculating the coolant activity and the release of activity to the environment in liquid and gaseous effluents from each unit of the plant are given in Table 3.5.1. Input for the BWR-GALE Code calculation is given in Table 3.5.2.

3.5.1.2 Sources of Radioactivity in Liquid Effluents

The following sources are considered in calculating the release of radioactivity in liquid effluents from normal operations, including anticipated operational occurrences:

a. Processed liquid wastes from the equipment drain subsystem

b. Processed liquid wastes from the floor drain subsystem

c. Processed liquid wastes from the chemical waste subsystem

d. Processed liquid regenerant wastes

e. Detergent wastes

The radioactivity inputs to the liquid radwaste system are based on flow rates of liquid waste streams and their radioactivity levels, expressed as a function of the primary reactor coolant activity (PCA).

3.5.1.3 Sources of Radioactivity in Gaseous Effluents

The following sources are considered in calculating the release of radioactive materials (noble gases, radioactive particulates, and iodine) in gaseous effluents from normal operations, including anticipated operational occurrences:

a. Main condenser offgas system

b. Mechanical vacuum pumps

c. Ventilation exhaust air from the containment, auxiliary, radwaste, and turbine buildings

Clean (nonradioactive) steam is used for the turbine gland seal system. Therefore, release of radioactivity from this source to the environment is zero. Releases of radioactive materials in ventilation exhaust air from any other building not covered in item c. above are considered negligible.

Radioactivity inputs to the main condenser offgas system are built into the BWR-GALE code. These inputs are based on data from operating BWRs normalized to a power level of 3400 MWt and

an 80 percent plant capacity factor. The iodine-131 input is approximately 5 Ci/yr and average noble gas input is approximately 60,000 μCi/sec after 30 minutes of decay. These built-in inputs are adjusted by the code to a power level of 4025 MWt for Grand Gulf.

The mechanical vacuum pump is used only before startup for hogging the main condenser. It is used to reduce the condenser pressure to approximately 5 in. Hg absolute at which point the air ejectors take over. Following a refueling shutdown period, little radioactive gas should be present in the condenser when the mechanical vacuum pump is in operation. Following other shutdowns, the mechanical vacuum pump is not normally required.

The following releases from the main condenser vacuum pump are built into the BWR-GALE code:

Xe-133	2300 Ci/yr
Xe-135	350 Ci/yr
I-131	0.03 Ci/yr

These are considered to be independent of the plant's power level.

Leakage of reactor coolant, main steam, and contaminated fluid may occur through valve stems, pump seals and flanged connections in systems carrying such fluids.

Some radioactivity may become airborne in the atmosphere of buildings due to the following:

a. Evaporation or flashing of leaked water

b. Escape of gaseous activity from leaked water to air

c. Direct mixing of steam leakage with the turbine building atmosphere

d. Venting of tanks which collect and store contaminated fluids

e. Evolution from the water in the fuel pool

Analytical evaluations of the source of airborne releases to the environment are complicated. Therefore the BWR-GALE code makes direct use of measurements of activity releases from building ventilation exhausts of operating BWRs. These releases are considered to be independent of a plant's power level (except

for tritium). Measured values of annual releases of radioiodine, radioactive particulates and noble gases specified in the BWR-GALE code are modified only as needed to reflect filtration by charcoal and/or HEPA filters prior to release.

3.5.1.4 Sources of C-14, H-3 and Ar-41

The principal source of C-14 in a BWR is neutron-activated 0-17 in the reactor coolant. Another source of C-14 is neutron activated N-14 dissolved in the reactor coolant and also present in the drywell air.

It is assumed that the resulting C-14 reacts with the oxygen in the reactor water, behaves like a noble gas fission product, and all of it is released to the environment principally in the form of CO_2. Reference 1 assumes an annual release of 9.5 Ci of C-14 to the environment.

In a BWR, tritium is produced by three principal methods:

a. Activation of naturally occurring deuterium in the reactor coolant

b. Tertiary fission of uranium fuel

c. Neutron reaction with boron used in control rods

The prime source of tritium available for release from a BWR is that produced by activation of deuterium in the reactor water. A small fraction of the tritium produced by fission may escape from the fuel to the coolant. The release of tritium formed in the control rods is believed to be negligible.

The BWR-GALE code assumes that the annual release of tritium by liquid and vapor pathways is 0.025 Ci/MWt.

The quantity of tritium released through the liquid pathway is based on the calculated volume of liquid released with a tritium concentration of 0.01 μCi/ml up to a maximum of 50 percent of the total quantity of tritium calculated to be available for release. The remainder of the tritium produced is assumed to be released as vapor from the plant ventilation exhausts.

The tritium concentration of 0.01 μCi/ml (Ref. 1) for the liquid releases is based on a review of tritium concentrations in BWR liquid streams.

Annual releases of tritium to the environment via liquid and gaseous effluents from each unit of the plant, directly obtained from BWR-GALE code output, are presented in Tables 3.5.3 and 3.5.4, respectively.

Argon-41 is formed by neutron activation of stable naturally occurring Argon-40 in the drywell air, and is released to the environment via the containment vent when the drywell is vented or purged. Reference 1 assumes an annual release of 25 Ci of Ar-41 from a BWR.

3.5.1.5 Sources for the Solid Radwaste Processing System

Radioactivity inputs to the solid radwaste system are predominantly radioactive nuclides accumulated in filters, demineralizer resins, and waste evaporator bottoms. Additional radioactive inputs are from air filters, paper, rags, contaminated clothing, contaminated tools and equipment, and solid laboratory wastes.

3.5.2 Liquid Radwaste Systems

Liquid radioactive wastes originate from minor leaks or drainage of equipment containing water contaminated with radioactivity. The liquid radwaste system collects, processes, and disposes of liquid radioactive wastes and collects and transfers to the solid radwaste system certain solid wastes that are produced during shutdown, startup, and normal plant operation. To provide greater system efficiency, the liquid radwaste system is divided into three primary subsystems: equipment drains, floor drains, and chemical waste processing subsystems. If condensate storage tanks are full and no satisfactory capacity is available in the radwaste system, any of the processed wastes from these subsystems may be discharged, provided proper dilution is available. It is anticipated that normally 100 percent of the equipment drain and chemical waste water and 90 percent of the floor drain water will be recycled. For calculating offsite doses, discharges to the environment of 1 percent of processed equipment drains and 10 percent of other processed liquid radwastes are conservatively assumed (Ref. 1).

The releases of activity to the environment in liquid effluents are presented in Table 3.5.3 which are obtained from the BWR-GALE code output. The releases in this table include the increment of 0.15 Ci/yr to account for anticipated occurrences such as operator errors resulting in unplanned releases.

3.5.2.1 Equipment Drain Subsystem (Clean or High Purity Liquid Radwaste)

Wastes of high radioactivity level come from equipment drains in the drywell, containment, auxiliary building, turbine building, and radwaste building, the reactor water cleanup system,

residual heat removal system, and the fuel pool cooling and cleaning system.

These wastes, including decant wastes from the liquid and solid radwaste systems, are collected in equipment drain collector and waste surge tanks and then are processed through a filter and demineralizer to remove undissolved and dissolved radionuclides. The radionuclides collect on the resins in the filters and demineralizers. The treated water is sent to a sample tank and tested to assure that it meets water quality requirements for reuse.

A flow diagram of the equipment drain processing subsystem is presented in Figure 3.5-1.

3.5.2.2 Floor Drain Subsystem (Dirty or Low Purity Liquid Radwaste)

Floor drain wastes of low activity level are collected in the drywell, containment, auxiliary, turbine and radwaste buildings. They are of lower activity than the equipment drains since they contain a lesser percentage of reactor coolant.

The floor drain oil separator is used to prevent known sources of oil from entering the liquid radwaste processing stream. Oil is separated from the water on the basis of the difference in their specific gravities. Oil which is collected on the surface of the water is removed by a skimming process, stored in an oil storage compartment within the unit, and finally, after sufficient accumulation, discharged into 55 gallon drums. The oil-free effluent from the oil separator overflows, by gravity, to the floor drain collector tank.

The wastes which are collected in the floor drain collector tank are processed through a filter and demineralizer in the same manner as the equipment drains and sent to the floor drain sample tank to be tested.

If, on testing, the water in the sample tank does not meet specified requirements, it is reprocessed.

If necessary, the contents of the floor drain sample tanks may be processed through the floor drain evaporator prior to discharge. The evaporator concentrate bottoms are collected in the evaporator bottoms storage tanks and routed to the solid radwaste system.

A flow diagram of the floor drain processing subsystem is presented in Figure 3.5-1.

3.5.2.3 Chemical Waste Subsystem

The chemical waste subsystem collects and treats all liquid radioactive wastes that result from chemical processing. These wastes come from the regeneration (cleaning) of the resins in the condensate demineralizer, from decontamination drains in the plant shop, turbine building, auxiliary building, and from the laboratory drains.

Condensate demineralizers have lower amounts of corrosion products and radioactivity when compared with other demineralizers in the plant, and, therefore, the resins in the condensate demineralizers can be chemically regenerated. Sodium hydroxide (NaOH) and sulfuric acid (H_2SO_4) are used to regenerate the resins by stripping the metallic and nonmetallic ions from the resins due to the high exchange capability of NaOH and H_2SO_4. Regeneration of one condensate demineralizer requires the use of 179 gallons of 50 percent NaOH solution and 79 gallons of H_2SO_4. The wastes from the regeneration process, including activation and fission products, are transferred to the condensate demineralizer regeneration solution receiver tank.

Miscellaneous chemical wastes which may contain some small amounts of radioactivity, include chemistry laboratory wastes. The volume of laboratory wastes is largely due to cleaning of laboratory equipment. These wastes are sent through chemical drains in the floor to chemical sumps in the various buildings for transfer to the miscellaneous chemical waste receiver tank.

The regeneration and miscellaneous wastes are collected in separate tanks and normally processed by separate evaporators, since the miscellaneous chemical wastes may not be of the same quality as the condensate regeneration solutions.

The chemical wastes are neutralized, if necessary, then pumped to the waste evaporators for purification. The evaporators concentrate the wastes so they can be properly treated.

A schematic diagram showing the manner in which the chemical wastes are processed is presented in Figure 3.5-2.

3.5.2.4 Laundry Wastes

Contaminated laundry is shipped to a processing facility offsite.

3.5.2.5 Summary

It is evident that only very small amounts of low level radioactivity in liquid wastes are discharged to the environment. Most of the water is cleaned up and reused in plant operations. To minimize further the effect on the environment, any

treated liquid radioactive wastes discharged are further diluted in the 22,600 gpm (11,300 gpm per unit) plant discharge. The discharge concentrations of radioactivity are a small fraction of the limits specified in 10 CFR 20, Appendix B. When mixed with the Mississippi River (lowest recorded flow of 44,880,000 gpm), the effect of the radioactive releases is negligible.

If the evaporator which processes the regenerant chemical waste is temporarily unavailable, enough storage capacity is available to accumulate the regenerant chemical waste in the regenerant solution collector tank in the turbine building and the regenerant solution receiving tank in the radwaste building over a period longer than 9 days.

If the evaporator which processes the miscellaneous chemical waste and/or floor drains is temporarily unavailable, the existing cross connections allow these wastes to be processed by the evaporator which is normally used for processing the regenerant chemical waste.

Therefore, neither of the above circumstances results in any additional release of radioactivity to the environment. Unavailability of both the evaporators at the same time is not anticipated.

3.5.3 Gaseous Radwaste System (Airborne Releases)

Radioactive waste products in the form of gases or airborne particles can be released to the environment by the ventilation systems or by the offgas systems.

The annual releases of radioactivity in gaseous effluents are presented in Table 3.5.4.

3.5.3.1 Releases of Airborne Activity from Ventilation Systems

Releases of activity in gaseous effluents from each unit's ventilation exhausts are described in subsection 3.5.1.

The flow diagrams of release pathways from the containment, auxiliary, turbine, and radwaste buildings are shown in Figure 3.5-3.

3.5.3.2 Offgas System

The other principal source of radioactive gases and particulates is the condenser air ejector, which pulls gases from the steam in the main condenser to improve the functioning of the turbine. The offgas system processes these gases to reduce the radioactivity to a level as low as is reasonably achievable.

The flow diagram of the offgas system is shown in Figure 3.5-4. The gases in the three condenser shells are removed by two-stage steam jet air ejectors. Hydrogen and oxygen are present, along

with the radioactive gases, as a result of air leaking into the system and also as a result of decomposition of some small amounts of water in the reactor. The air ejectors add steam to the gases to dilute the hydrogen. This steam-gas mixture is superheated, passed through a catalytic recombiner which converts the hydrogen and oxygen into water, then passed through a small condenser and water separator to remove moisture. The remaining gases are sent through piping which is designed to delay the gases for 10 minutes. This permits the N-16, N-13, 0-19, and most of the xenon and krypton isotopes to decay. These may form solid decay products which are removed by filtration. The gases then pass through a cooler-condenser, a moisture separator, and a dryer, to reduce the relative humidity of the gases to less than 5 percent. The purpose of reducing the humidity is to improve the performance of the charcoal adsorbers into which the gases pass next.

The charcoal beds delay the remaining radioactive noble gases allowing additional time for decay. The xenon and krypton gases are adsorbed by charcoal molecules and then desorbed. Moving from molecule to molecule in this way increases significantly their time of passage through the beds. With the charcoal beds cooled to 0 F, and with the expected total condenser air inleakage of 6 cfm, the delay time for xenon is 213 days and krypton 233 hours. However the BWR-GALE Code assumes 10 cfm of air inleakage per condenser shell which results in delay times of 42.6 days and 1.9 days in charcoal beds for xenon and krypton, respectively. This effectively removes almost all the radioactive gases except Kr-85 which decays very slowly. There are eight charcoal bed adsorbers, each 4 feet in diameter and 21 feet in length. Each vessel contains a 19-foot section packed with approximately 3 tons of 8-14 mesh activated carbon (approximately 200 ft^3 charcoal). A final filter, just before release, prevents charcoal particles or solid decay products from escaping.

Iodine input to this system is expected to be small, since it is preferentially retained in the condensate and removed by the demineralizer. However, any iodine which may excape into the offgas system is adsorbed by the charcoal beds.

3.5.4 Solid Radwaste System

Certain amounts of radioactive materials are generated in solid form. The solid radwaste system collects, processes, packages, and stores these solid radioactive wastes for offsite shipment and permanent disposal. Solid wastes are divided into wet and dry wastes, based on their different origins and different modes of processing. Estimated quantities of solid wastes from all sources for both units in terms of volume and curies per cubic foot are presented in Table 3.5.5. Total curie content is given in Table 3.5.6.

3.5.4.1 Wet Solid Wastes

In the wet solid processing subsystem, wet solids are collected in three waste holding tanks capable of dewatering slurries.

These tanks are furnished with level detection devices and mixing and flushing equipment. Inputs to the waste holding tanks are as follows:

a. Wastes resulting from backwash of the reactor water cleanup (RWCU) system filter/demineralizers and fuel pool cooling and cleanup system filter/demineralizers are transferred from the containment and auxiliary buildings to one of the two RWCU phase separator decay tanks located in the radwaste building. The RWCU decant pump drains excess water and transfers it to the equipment drain collector tank for further processing. When sufficient decay of Powdex Resin/ Solka Floc waste in the RWCU phase separator decay tank has been achieved, the contents of the tank are slurried to one of the waste holding tanks. If it is determined that excess water is present in the waste holding tank, after the solids have settled the excess water may be transferred back to the RWCU phase separator decay tank.

b. The spent resin tank collects exhausted resins from the equipment drain, floor drain, and condensate demineralizers. Also, overflow from the ultrasonic resin cleaner (condensate cleanup system) is collected in the spent resin tank via the condensate clean waste tank. The spent resin pump and eductor are used to transfer the resins from the spent resin tank to one of the three waste holding tanks. Excess water from the waste holding tank may be decanted and transferred to the RWCU phase separator decay tank.

c. The liquid and solid wastes resulting from the backwash of the condensate precoat filters are collected in the condensate clean waste tank (floor and equipment drains system) and then are pumped to one of the waste surge tanks in the liquid radwaste system. From this tank the wastes are transferred to one of the waste holding tanks.

d. Evaporator bottoms are collected in the evaporator bottoms tanks and are then transferred to one of the waste holding tanks.

e. Solids from the equipment and floor drain filters are discharged directly to the waste holding tanks. Each filter is capable of discharging a maximum of approximately 26.5 cubic feet at one time.

After wastes have been collected in the waste holding tank, and when the proper liquid/solid ratios for solidification have been attained (usually by addition of evaporator bottoms), solidification procedures may begin. A hot water heater is provided to ensure sufficiently hot condensate for flushing of the waste holding tanks to prevent crystallization of residual evaporator bottoms in the tanks and associated piping.

Radioactive waste packaging and solidification are accomplished by using the appropriate waste metering pump, waste/solidification agent mixer unit, static mixer, chemical additive pump, air slide, rotary feed valve to meter predetermined amounts of filter waste (or high solids content waste), evaporator bottoms, solidification agent and chemical additive, through one of the two fill ports into the shipping container. Cross connections between mixer unit inlets are provided so that the contents of any two of the three waste holding tanks can be processed concurrently.

At times, when the quantity of evaporator bottoms to be disposed of exceeds that which can be added and mixed with the filter waste, the excess can be disposed of directly, as described above, without combining with any additional wastes.

A flow diagram for the waste solidification system is presented in Figure 3.5-5.

3.5.4.2 Dry Solid Wastes

The solid radwaste system also disposes of dry waste consisting of small tools, air filters, miscellaneous paper, rags, and decontaminated clothing, equipment parts which cannot be effectively decontaminated, wood, and solid laboratory waste. Compressible wastes are compacted in a hydraulic press baling machine to reduce their volume. Ventilation is provided to maintain control of contaminated particles when operating this packaging equipment. Noncompressible wastes are packaged manually in appropriate containers. Because of its low activity, this waste can be stored until enough is accumulated to permit economic transportation offsite for final disposal.

3.5.5 Process and Effluent Monitoring

Radiation monitoring instrumentation is provided at all radioactive effluent release points. Radioactive material can leave the plant in liquid, gaseous and solid forms.

3.5.5.1 Liquid Effluent Monitors

Liquid waste can be discharged from several radwaste processed water tanks as described in subsection 3.5.2. Immediately upstream of the discharge flow control valve and isolation valve in the common discharge pipe, the processed liquid radwaste is continuously sampled and monitored for radioactivity.

The radiation monitor provides high and high-high trip outputs. The high-high upscale trip is used to automatically terminate liquid discharge by closing the radwaste system discharge valve. The high upscale trip actuates an annunciator in the control room. Effluent radiation level is continuously indicated and recorded in the control room.

3.5.5.2 Gaseous Effluent Monitors

Gaseous radioactive material can be discharged from several ventilation systems, or from the offgas radwaste system, as discussed in subsection 3.5.1.3.

3.5.5.2.1 Containment and Drywell Ventilation System

Containment and drywell ventilation gases are monitored by two separate systems prior to their release to the atmosphere. They are first monitored by a series of four radiation detectors located in the ventilation duct upstream of the containment isolation valves. These detectors are arranged into separate trip channels to initiate containment isolation. Each of the four radiation signals is continuously indicated and one signal from each pair of trip channels described below is recorded in the control room.

Each radiation monitor provides both an analog output signal and a contact which opens on upscale (high-high) radiation or an inoperative circuit. Two-out-of-two upscale/inoperative trips in channels A and C initiate closure of the containment ventilation outboard isolation valves and the drywell inboard isolation valves. The same condition for channels B and D initiates closure of the containment inboard valves and drywell outboard valves.

An upscale/inoperative trip is visually displayed on the affected radiation monitor and actuates a containment and drywell ventilation exhaust high-high radiation control room annunciator common to channels A and D or B and C. A downscale trip is also visually displayed on the radiation monitor. Containment and drywell high radiation and downscale control room annunciators common to all channels are generated from the analog signal.

The containment ventilation gases are also sampled and monitored immediately prior to discharge by another radiation monitoring system. This system monitors the containment ventilation discharge for gross radiation level and collects halogen and particulate samples. A representative sample is continuously extracted from the ventilation ducting through an isokinetic probe in accordance with ANSI NBI-1969, passed through the containment ventilation sample panel for monitoring and sampling, and returned to the ventilation ducting. The sample panel has a pair of filters (one for particulate collection followed by one for halogen collection) in parallel (with respect to flow) with a continuous gross radiation detection assembly. The gross radiation detection assembly consists of a shielded chamber, a beta-sensitive detector, and a check source. A radiation monitor in the control room analyzes and visually displays the measured gross radiation level. Radiation level is continuously recorded in the control room.

The recorder has two pens, one used by this system and the other used by the offgas and radwaste building ventilation radiation monitoring system.

The sample panel shielded chambers can be purged with room air to check detector response to background radiation by using a three-way solenoid valve operated from the control room. The sample panel measures and indicates sample line flow. A solenoid operated check source operated from the control room can be used to check operability of the gross radiation channel.

The radiation monitor has three trip circuits: two upscale (high-high and high), and one downscale (low). Each trip is visually displayed on the radiation monitor. These trips actuate corresponding control room annunciators: containment ventilation high-high radiation, containment ventilation high radiation, and containment ventilation downscale. High or low sample flow measured at the sample panel actuates a control room containment ventilation sample high-low flow annunciator.

If required, containment isolation or the standby gas treatment system may be manually initiated by the operator.

3.5.5.2.2 Fuel Handling Area Ventilation System

The fuel handling area ventilation system is served by three separate radiation monitoring systems. The fuel pool sweep exhaust and fuel handling area exhaust radiation monitoring systems are identical. The pool sweep exhaust monitors the air from the cask storage pool, transfer canal, and spent fuel pool. The fuel handling area exhaust monitors the air coming into the ventilation system.

These systems monitor the radiation level exterior to the auxiliary building fuel handling area ventilation duct. The systems consist of four channels identical to the channels in the containment and drywell ventilation radiation monitoring system with the same arrangement, corresponding annunciators, and two-pen recorders.

Two-out-of-two upscale (high-high)/inoperative trips in channels A and C initiate closure of the inboard isolation valves of the auxiliary building fuel handling area ventilation system, and initiate startup of standby gas treatment system (SGTS) train A. The same condition for channels B and D initiates closure of the corresponding outboard isolation valves and initiates startup of SGTS train B.

The fuel handling area vent radiation monitoring system continuously withdraws a sample, analyzes it for gross radiation level, and collects halogen and particulate samples. This monitor samples the effluent stream downstream of the two monitoring systems

just described where the pool sweep and area exhaust ducts combine. The system is identical to the containment ventilation radiation monitoring system. The high level alarm trips an annunciator in the control room. It shares a recorder with the turbine building radiation monitoring system.

3.5.5.2.3 Turbine Building Ventilation System

This system continuously samples and monitors the turbine building ventilation discharge for gross radiation level and collects halogen and particulate samples. The system is identical to the containment ventilation radiation monitoring system with corresponding annunciators and indicators. A two-pen recorder is shared between this system and the fuel handling area ventilation radiation monitoring system.

The high level alarm trips an annunciator in the control room.

3.5.5.2.4 Radwaste Building Ventilation System

This system continuously samples and monitors the radwaste building ventilation discharge for gross radiation level and collects halogen and particulate samples. The system is identical to the containment ventilation radiation monitoring system with corresponding annunciators and indicators. It shares a two-pen recorder with the containment ventilation radiation monitoring system. In addition, a high-high radiation trip isolates the radwaste building ventilation system.

The radwaste building ventilation system radiation detector monitors the discharge of the offgas system which is discharged into the radwaste building vent upstream of the monitor, as well as airborne radioactivity from the building ventilation system.

3.5.5.2.5 Offgas Posttreatment Radiation Monitors

This system monitors radioactivity in the offgas piping downstream of the offgas system charcoal adsorbers and upstream of the offgas system discharge valve. A continuous sample is extracted from the offgas system piping, passed through the offgas posttreatment sample panel for monitoring and sampling, and returned to the offgas system piping. The sample panel has a pair of filters (one for particulate collection followed by one for halogen collection) in parallel (with respect to flow) with two identical continuous gross radiation detection assemblies. Each gross radiation assembly consists of a shielded chamber, a detector, and a check source. Two radiation monitors in the control room analyze and visually display the measured gross radiation level.

The sample panel shielded chambers can be purged with room air to check detector response to background radiation by using a three-way solenoid valve operated from the control room. The sample

panel measures and indicates sample line flow. A solenoid operated check source for each detection assembly operated from the control room can be used to check operability of the gross radiation channel.

Each radiation monitor has four trip circuits: two upscale (high-high-high, and high), one downscale (low) and one inoperative. Each trip is visually displayed on the radiation monitor. The first three trips actuate corresponding control room annunciators: offgas posttreatment high-high-high radiation, offgas posttreatment high radiation, and offgas posttreatment downscale. A trip circuit on the recorder actuates an offgas posttreatment high-high radiation annunciator. High or low sample flow measured at the sample panel actuates a control room offgas vent sample high-low flow annunciator.

A trip auxiliary unit in the control room takes the high-high-high (HHH) and downscale trip outputs and, if its logic is satisfied, initiates closure of the offgas system discharge and drain valves. The logic is satisified if two HHH, one HHH and one downscale, or two downscale trips occur. The HHH trip setpoints are determined such that valve closure is initiated prior to exceeding technical specification limits. Any one high upscale trip initiates closure of offgas system bypass line valve and initiates opening of the treatment line valve.

A vial sampler panel is provided for grab sample collection to allow isotopic analysis and gross monitor calibration.

3.5.5.3 Solid Radwaste Monitoring

Solid radwaste is processed as described in subsection 3.5.4. Prior to loading containers of solid radwaste onto trucks or rail cars, a final radiological survey is taken.

3.5.6 References

1. USNRC NUREG-0016, April 1976, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors (BWR-GALE Code)."

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Table 3.5.1

DATA FOR RADIOACTIVE SOURCE TERM CALCULATIONS

Item Description	Input	Reference
1. General		
Maximum core thermal power level, MWt (Note: all relevant parameters have been adjusted to 105 percent of full power level)	4025	FSAR Ch. 1
Tritium released in liquid effluent, Ci/yr/reactor	24	GALE output
Tritium released in gaseous effluent, Ci/yr/reactor	81	GALE output
Annual average dilution flow rate for liquid waste discharge, gpm	11300	FSAR Section 11.2
2. Nuclear Steam Supply System		
Total steam flow rate, lb/hr	1.73×10^7	FSAR Section 10.1
Mass of reactor coolant in reactor vessel at full power, lb	5.5×10^5	FSAR Ch. 5, Fig. 5.1-1 and 5.1-2
Mass of steam in reactor vessel at full power, lb	2.26×10^4	FSAR Ch. 5, Fig. 5.1-1 and 5.1-2
3. Reactor Water Cleanup System		
Average flow rate, lb/hr	1.782×10^5	FSAR Subsection 5.4.8
Number of demineralizers	2 in parallel	FSAR Subsection 5.4.8
Type of demineralizer	Septum type, using Powdex and Solka Floc	FSAR Subsection 5.4.8
Size of demineralizer, ft^3	4.4	
Replacement frequency, batch/day: Normal Startup (1 batch includes 2 filter/demineralizer backwashes)	 1/7.5 1/1	 FSAR Section 11.2 FSAR Section 11.2
Regenerant volume and activity, if applicable, gal/event	Not applicable Since Powdex is used	

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Table 3.5.1 (Cont.)

	Item Description	Input		Reference
4.	Condensate Demineralizers			
	Average flow rate, lb/hr	1.11×10^7		FSAR Subsection 10.4.6
	Demineralizer type	Mixed deepbed		FSAR Subsection 10.4.6
	Number of demineralizers Note: There are 8 demineralizers in parallel including 2 spares.	6 in parallel		FSAR Subsection 10.4.6
	Size of one demineralizer, cu.ft.	475		FSAR Subsection 10.4.6
	Regeneration frequency, days for each bed	10		FSAR Section 11.2
	Is ultrasonic resin cleaning used?	Yes		FSAR Subsection 10.4.6
	Waste liquid volume due to URC, gal/day (per unit)	1805		NUREG-0016
	Regenerant backwash chemical volume, gal/event	24000		FSAR Section 11.2
	Activity of regenerant backwash chemical volume	calculated internally by GALE Code		NUREG-0016
5.	Liquid Waste Processing Systems			
	Source	Flow rate (gpd per unit)	Fraction of PCA	Reference
a.	High Purity (Equipment Drain) Waste			
	Dry well equipment drain	4100	1.0	FSAR Section 11.2 for flowrate NUREG-0016 for PCA fraction
	Containment equipment drain	3710	0.01	Same as above
	Auxiliary building equipment drain	2000	0.01	Same as above
	Radwaste building equipment drain	500	0.01	NUREG-0016
	Turbine building equipment drain	6220	0.01	FSAR Section 11.2 and NUREG-0016
	RWCU phase separator decant	1207.1	0.002	FSAR Section 11.2 for flowrate and NUREG-0016 for PCA fraction
	Condensate clean waste regenerant and resin transfer waste	3908	0.002	Same as above
	Condensate and refueling water storage and transfer system	104.9	0.01	FSAR Section 11.2 for flowrate Fraction of PCA is an estimate
	RHR system	500	0.0022	FSAR Section 11.2 for flowrate Fraction of PCA has been estimated from GE design data. Doc. no. 22A2739, Rev. 2
	Total	22250	0.190 weighted average	

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Table 3.5.1 (Cont.)

Source	Flow rate (gpd per unit)	Fraction of PCA	Reference
b. Low purity (floor drain) waste			
Radwaste building floor drain	500	0.01	FSAR, Section 11.2 for flow rate and NUREG-0016 for PCA fraction
Drywell floor drain	700	1.0	Same as above
Containment floor drain	2000	0.01	Same as above
Auxiliary building floor drain	2050	0.01	Same as above
Turbine building floor drain and Control building hot machine shop	2000	0.01	Same as above
Ultrasonic resin cleaner and Condensate demineralizer bed transfer	1805	0.05	Same as above
Total	9055	0.0945 weighted average	
c. Chemical (Nonregenerant) Waste			
Turbine building chemical waste sumps	2000	0.02	FSAR Section 11.2 for flow rate NUREG-0016 for PCA fraction
Auxiliary building chemical waste sump	1000	0.02	Same as above
Radwaste building chemical waste sump	500	0.02	Same as above
Total	3500	0.02 weighted average	
d. Regenerant Solution Waste			
	2400	Calculated by BWR-GALE internally	FSAR Section 11.2

e. Detergent Waste

There is no onsite laundry (refer to FSAR Section 11.2)

f. Holdup Times Associated with Collection, Processing, and Discharge of all Liquid Streams

Waste Stream	Collection Time (days)	Process Time (days) Tp	Discharge Time (days) Td	Effective Decay Time Tp+(Td/2), (days)	Reference
High purity waste	0.902	0.074	Not allowed	0.074	FSAR Section 11.2 and also NUREG-0016
Low purity waste	0.663	0.0278	0.0556	0.0556	Same as above
Chemical waste	0.571	0.111	Not allowed	0.111	Same as above
Regenerant solution waste	5.83	0.778	Not allowed	0.778	Same as above

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TABLE 3.5.1 (Cont.)

g. Capacities of All Tanks and Processing Equipment Considered in Calculating Holdup Times

Waste Stream	Collector Tank Number and Capacity, gal	Collector Tank Pump Number and Flowrate, gpd	Processing Equipment Type, Number, and Flow Rate, gpd	Sample Tank Number and Capacity, gal	Sample Tank Pump Number and Discharge Flowrate, gpd	Reference
High Purity Waste	1 per unit, 40,000 gal. + 1 surge tank per unit of 50,000 gal.	1 pump at 4.32×10^5 gpd for 2 units + 1 surge pump at 4.32×10^5 gpd for 2 units	1 filter & 1 mixed deepbed non-regen. demin. each at 4.32×10^5 gpd for 2 units	1 per unit 40,000 gal.	1 pump at 4.32×10^5 for 2 units	FSAR Seccion 11.2
Low purity waste	1/2 a tank per unit. Full tank capacity is 30,000 gal.	1 pump at 4.32×10^5 gpd for 2 units	1 filter & 1 mixed deepbed non-regen. demin. each at 4.32×10^5 gpd for 2 units	1 tank/unit 30,000 gal.	1 pump at 4.32×10^5 gpd for 2 units	FSAR Section 11.2
Chemical waste	1/2 a tank per unit. Full tank capacity is 10,000 gal.	1 pump at 4.32×10^4 gpd for 2 units	1 evaporator at 3.6×10^4 gpd for 2 units	1/2 a tank per unit. Full tank capacity is 10,000 gal.	2 pumps for 2 units for both chemical and regen. solution wastes each at 7.2×10^4 gpd	FSAR Section 11.2
Regenerant solution waste	1 per unit, 35,000 gal.	1 pump at 4.32×10^4 gpd for 2 units	1 evaporator at 3.6×10^4 gpd for 2 units	1/2 a tank per unit. Full tank capacity is 10,000 gal.	Same as given for Chemical Waste	FSAR Section 11.2

Note: Discharge to environment if done would be limited to 5.04×10^4 gpd.

h. Decontamination Factors for Each Processing Step

Waste Stream	Processing Equipment	Decontamination Factor			Reference
		Iodine	Cs&Rb	Other	
High purity waste	Equip. drain precoat filter & 1 mixed deepbed nonregenerative demineralizer	10^2	10	10^2	NUREG-0016
Low purity	Floor drain precoat filter & 1 mixed deepbed nonregenerative demineralizer	10^2	2	10^2	Same as above
Chemical waste	1 evaporator	10^3	10^4	10^4	Same as above
Regeneratant solutions waste	1 evaporator	10^3	10^4	10^4	Same as above

TABLE 3.5.1 (Cont.)

i. Fraction of Each Processing Stream Expected to be Discharged Over the Life of the Plant

Waste Stream	Fractional Discharged	Reference
High purity waste	0.01	FSAR Section 11.2 gives this fraction as 0.0. However, conservatively, NUREG-0016 fraction of 0.01 has been assumed.
Low purity waste	0.10	FSAR Section 11.2
Chemical waste	0.10	FSAR Section 11.2 gives this fraction as 0.0. However, NUREG-0016 value of 0.1 has been used.
Regenerant solutions waste	0.10	Same as given for chemical waste.

6. Main Condenser and Turbine Gland Seal Air Removal Systems

Description	Input	Reference
Holdup time for offgases from the main condenser air ejector prior to processing by the offgas treatment system, hr	0.167	FSAR Subsection 11.3.2
Treatment system for offgases from condenser air ejector	Charcoal delays system - 8 beds	For description of the system, see FSAR subsection 11.3.2
Offgases from the mechanical vacuum pump	No treatment prior to release	For description of the system, see FSAR Subsections 10.4.2 and 11.3.2
Air inleakage per condenser shell, cfm	10 cfm	Built into GALE Code. However design leakage is 40 cfm for 3 shells and expected inleakage is 6 cfm for 3 shells.
Number of condenser shells	3	FSAR Subsections 11.3.2 and 10.4.1
Iodine source term from the condenser	0	NUREG-0016
Mass of charcoal in the charcoal delay systems, tons	24	FSAR Section 11.3
Operating temperature of the delay system, F	0	FSAR Subsection 11.3.2
Dew point temperature of the delay system, F	-90	FSAR Subsection 11.3.2
Dynamic adsorption coefficient for xenon, cm^3/g	2410	NUREG-0016
Dynamic adsorption coefficient for krypton, cm^3g	105	NUREG-0016
Cryogenic distillation system	Not used	
Steam flow to turbine gland seal, lb/hr	0.0	Clean steam is used
Source of steam to the turbine gland seal	Seal steam generator or auxiliary boiler	FSAR Subsection 10.4.3

TABLE 3.5.1 (Cont.)

7. Ventilation and Exhaust Systems

	Item Description	Input	Reference
a.	Provisions incorporated to reduce radioactivity releases through ventilation exhaust systems:		
	i) Containment building	Release through charcoal and HEPA filters.	FSAR subsection 9.4.7
	ii) Drywell purge	Same as for containment	FSAR subsection 9.4.8
	iii) Auxiliary building	No treatment of releases	FSAR subsection 9.4.2
	iv) Turbine building	No treatment of releases	FSAR subsection 9.4.4
	v) Radwaste building	Release through HEPA filters; there are charcoal filters for tank vents.	FSAR subsection 9.4.3; no credit is taken for charcoal filters for tank vents
b.	Decontamination factors for iodine and particulates:		
	i) Containment building and drywell purge	0.01, 0.01	FSAR subsection 9.4.7
	ii) Auxiliary building	1, 1	
	iii) Turbine building	1,1	
	iv) Radwaste building	1.0, 0.01	NUREG-0016
c.	Release rates for radioiodines, noble gases, and radioactive particulates	Table 3.5.2	Adjusted BWR-GALE Code output
d.	Description of release points, etc.	Treated as ground release	
e.	Continuous containment purge rate cfm (maximum)	6000	FSAR subsection 9.4.7

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Table 3.5.2

INPUT FOR BWR-GALE CODE CALCULATION (PER REACTOR)

GRAND GULF	BWR
THERMAL POWER LEVEL (MEGAWATTS)	4025.0000
PLANT CAPACITY FACTOR	0.80
TOTAL STEAM FLOW (MILLION LBS/HR)	17.3120
MASS OF WATER IN REACTOR VESSEL(MILLIONLBS)	.5500
FISSION PRODUCT CARRY-OVER FRACTION	.0010
HALOGEN CARRY-OVER FRACTION	.0200
CLEAN UPDEMINERALIZER FLOW(MILLION LBS/HR)	.1780
CONDENSATE DEMINERALIZER REGENERATION TIME (DAYS)	60.0000
FRACT FEEDWATER THRU CNDSATE DEMIN	.6420
RADWASTE DILUTION FLOW(THOUSAND GPM)	11.3000

LIQUID WASTE INPUTS

STREAM	FLOW RATE (GAL/DAY)	FRACTION OF PCA	FRACTION DISCHARGED	COLLECTION TIME (DAYS)	DECAY TIME (DAYS)	DECONTAMINATION FACTORS I	CS	OTHERS
HIGH PURITY WASTE	2.22+04	.190	.010	.902	.074	1.00+02	1.00+01	1.00+02
LOW PURITY WASTE	9.05+03	.094	.100	.663	.056	1.00+02	2.00+00	1.00+02
CHEMICALWASTE INP	3.50+03	.020	.100	.571	.111	1.00+03	1.00+04	1.00+04
REGENERANT SOLS	2.40+03		.100	5.830	.778	1.00+03	1.00+04	1.00+04

GASEOUS WASTE INPUTS

GLAND SEAL STEAM FLOW (THOUSAND LBS/HR)		.0000
MASSSOF STEAM INREACTOR VESSEL(MILLIONLBS)		.0226
GAAND SEAL HOLD UP TIME (HOURS)		.0000
AIR EJECTOR OFFGAS HOLDUP TIME(HOURS)		.1670
CNTMT BUILDING	IODINE RELEASE FRACTION	.10000
	PARTICULA RELEASE FRACTION	.01000
TURBINE BUILDING	IODINE RELEASE FRACTION	1.00000
	PARTICULAT RELEASE FRATION	1.00000
	RELEASE FRACT.-SPECIAL DES. FEATURES	1.00000
GLAND SEAL VENT IODINE PF		1.0000
AIR EJECTOR OFFGAS IODINE PF		.0000
AUXILIARY BLDG	IODINE RELEASE FRACTION	1.00000
	PARTICULA RELEASE FRACTION	1.00000
RADWASTE BUILDINGIODINE RELEASE FRACTION		1.00000
	PARTICULA RELEASE FRACTION	.01000
THERE IS A CHARCOAL DELAY SYSTEM		
KRYPTON DYNAMIC ADSORPTION COEFFICIENT (CM3/GN)		105.0000
XENON DYNAMIC ADSORPTION COEFFICIENT (CM3/GM)		2410.0000
NUMBER OF MAIN CONDENSER SHELLS		3.0000
MASS OF CHARCOAL (SHORT TONS)		48.0000
KRYPTON HOLDUP TIME (DAYS)		1.8550
XENON HOLDUP TIME (DAYS)		42.5767
THERE IS NOT AN ON-SITE LAUNDRY		

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Table 3.5.3

ANNUAL RELEASES OF ACTIVITY IN LIQUID EFFLUENTS
(PER REACTOR)

NUCLIDE	HALF-LIFE (DAYS)	GRAND GULF CONCENTRATION IN PRIMARY COOLANT (MICRO CI/ML)	LIQUID EFFLUENTS ANNUAL RELEASES TO DISCHARGE CANAL HIGH PURITY (CURIES)	LOW PURITY (CURIES)	CHEMICAL (CURIES)	TOTAL LWS (CURIES)	ADJUSTED TOTAL (CI/YR)	DETERGENT WASTES (CI/YR)	TOTAL (CI/YR)
CORROSION AND ACTIVATION PRODUCTS									
NA 24	6.25-01	8.06-03	.00274	.00635	.00001	.00910	.01486	.00000	.01500
P 32	1.43+01	1.81-04	.00010	.00021	.00002	.00034	.00055	.00000	.00055
CR 51	2.78+01	4.54-03	.00262	.00531	.00114	.00907	.01482	.00000	.01500
MN 54	3.03+02	5.45-05	.00003	.00006	.00003	.00012	.00020	.00000	.00020
MN 56	1.08-01	4.33-02	.00269	.00825	.00001	.01095	.01789	.00000	.01800
FE 55	9.50+02	9.08-04	.00053	.00107	.00050	.00211	.00344	.00000	.00340
FE 59	4.50+01	2.72-05	.00002	.00003	.00001	.00006	.00009	.00000	.00009
CO 58	7.13+01	1.61-04	.00011	.00021	.00007	.00039	.00064	.00000	.00064
CO 60	1.92+03	3.63-04	.00021	.00043	.00020	.00085	.00138	.00000	.00140
NI 65	1.07-01	2.60-04	.00002	.00005	.00000	.00006	.00011	.00000	.00011
CU 64	5.33-01	2.68-02	.00838	.01978	.00002	.02818	.04604	.00000	.04600
ZN 65	2.45+02	1.82-04	.00011	.00021	.00009	.00041	.00066	.00000	.00066
ZN 69M	5.75-01	1.79-03	.00058	.00136	.00000	.00195	.00318	.00000	.00320
ZN 69	3.96-02	.00	.00061	.00142	.00000	.00204	.00333	.00000	.00330
W187	9.96-01	2.70-04	.00011	.00025	.00000	.00036	.00058	.00000	.00058
NP239	2.35+00	6.33-03	.00318	.00669	.00003	.00990	.01617	.00000	.01600
FISSION PRODUCTS									
BR 83	1.00-01	2.55-03	.00014	.00045	.00000	.00059	.00097	.00000	.00097
BR 84	2.21-02	4.14-03	.00001	.00004	.00000	.00005	.00008	.00000	.00008
RB 89	1.07-02	4.12-03	.00000	.00015	.00000	.00016	.00026	.00000	.00026
SR 89	5.20+01	9.07-05	.00005	.00011	.00003	.00019	.00032	.00000	.00032
SR 90	1.03+04	5.45-06	.00000	.00001	.00000	.00001	.00002	.00000	.00002
SR 91	4.03-01	3.56-03	.00093	.00228	.00000	.00322	.00526	.00000	.00530
Y 91M	3.47-02	.00	.00059	.00143	.00000	.00202	.00330	.00000	.00330
Y 91	5.68+01	3.63-05	.00003	.00006	.00002	.00011	.00018	.00000	.00018
SR 92	1.13-01	8.67-03	.00058	.00176	.00000	.00234	.00382	.00000	.00380
Y 92	1.47-01	5.24-03	.00133	.00362	.00000	.00495	.00809	.00000	.00810
Y 93	4.25-01	3.57-03	.00097	.00235	.00000	.00332	.00543	.00000	.00540
ZR 95	6.50+01	6.35-06	.00000	.00001	.00000	.00001	.00002	.00000	.00002
NB 95	3.50+01	6.35-06	.00000	.00001	.00000	.00001	.00002	.00000	.00002
NB 98	3.54-02	3.37-03	.00003	.00010	.00000	.00013	.00021	.00000	.00021
MO 99	2.79+00	1.81-03	.00093	.00195	.00001	.00289	.00472	.00000	.00470
TC 99M	2.50-01	1.77-02	.00367	.00925	.00002	.01294	.02114	.00000	.02100
TC101	9.72-03	7.44-02	.00000	.00004	.00000	.00004	.00006	.00000	.00006
RU103	3.96+01	1.81-05	.00001	.00002	.00001	.00004	.00006	.00000	.00006
RH103M	3.96-02	.00	.00001	.00002	.00001	.00004	.00006	.00000	.00006
TC104	1.25-02	6.63-02	.00001	.00010	.00000	.00011	.00018	.00000	.00018
RU105	1.85-01	1.76-03	.00032	.00062	.00000	.00084	.00138	.00000	.00140
RH105M	5.21-04	.00	.00032	.00062	.00000	.00085	.00138	.00000	.00140
RH105	1.50+00	.00	.00008	.00016	.00000	.00024	.00039	.00000	.00039
RU106	3.67+02	2.72-06	.00000	.00000	.00000	.00001	.00001	.00000	.00001
RH106	3.47-04	.00	.00000	.00000	.00000	.00001	.00001	.00000	.00001
TE129M	3.40+01	3.63-05	.00002	.00004	.00001	.00007	.00012	.00000	.00012
TE129	4.79-02	.00	.00001	.00003	.00001	.00005	.00008	.00000	.00008
TE131M	1.25+00	9.01-05	.00004	.00009	.00000	.00013	.00021	.00000	.00021
TE131	1.74-03	.00	.00001	.00002	.00000	.00002	.00004	.00000	.00004

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Table 3.5.3 (Cont.)

NUCLIDE	HALF-LIFE (DAYS)	CONCENTRATION IN PRIMARY COOLANT (MICRO CI/ML)	ANNUAL RELEASES TO DISCHARGE CANAL HIGH PURITY (CURIES)	LOW PURITY (CURIES)	CHEMICAL (CURIES)	TOTAL LWS (CURIES)	ADJUSTED TOTAL (CI/YR)	DETERGENT WASTES (CI/YR)	TOTAL (CI/YR)
I131	8.05+00	4.53-03	.00253	.00518	.05614	.06385	.10433	.00000	.10000
TE132	3.25+00	9.05-06	.00000	.00001	.00000	.00001	.00002	.00000	.00002
I132	9.58-02	2.55-02	.00134	.00418	.00003	.00555	.00907	.00000	.00910
I133	8.75-01	1.79-02	.00703	.01573	.00035	.02311	.03777	.00000	.03800

GRAND GULF — LIQUID EFFLUENTS (CONTINUED)

NUCLIDE	HALF-LIFE (DAYS)	CONCENTRATION IN PRIMARY COOLANT (MICRO CI/ML)	ANNUAL RELEASES TO DISCHARGE CANAL HIGH PURITY (CURIES)	LOW PURITY (CURIES)	CHEMICAL (CURIES)	TOTAL LWS (CURIES)	ADJUSTED TOTAL (CI/YR)	DETERGENT WASTES (CI/YR)	TOTAL (CI/YR)
I134	3.67-02	5.84-02	.00049	.00193	.00001	.00243	.00396	.00000	.00400
CS134	7.49+02	2.72-05	.00016	.00161	.00001	.00178	.00290	.00000	.00290
I135	2.79-01	1.75-02	.00339	.00883	.00007	.01229	.02008	.00000	.02000
CS136	1.30+01	1.81-05	.00010	.00105	.00000	.00115	.00189	.00000	.00190
CS137	1.10+04	6.35-05	.00037	.00376	.00002	.00415	.00678	.00000	.00660
BA137M	1.77-03	.00	.00035	.00351	.00002	.00388	.00634	.00000	.00630
CS138	2.24-02	8.28-03	.00017	.00425	.00000	.00443	.00724	.00000	.00720
BA139	5.76-02	8.52-03	.00019	.00065	.00000	.00083	.00136	.00000	.00140
BA140	1.28+01	3.63-04	.00021	.00042	.00004	.00067	.00109	.00000	.00110
LA140	1.67+00	.00	.00004	.00006	.00005	.00015	.00024	.00000	.00024
BA141	1.25-02	8.28-03	.00000	.00001	.00000	.00001	.00002	.00000	.00002
LA141	1.63-01	.00	.00007	.00021	.00000	.00029	.00047	.00000	.00047
CE141	3.24+01	2.72-05	.00002	.00003	.00001	.00006	.00010	.00000	.00010
LA142	6.39-02	4.27-03	.00013	.00044	.00000	.00058	.00094	.00000	.00094
CE143	1.37+00	2.71-05	.00001	.00003	.00000	.00004	.00006	.00000	.00006
PR143	1.37+01	3.63-05	.00002	.00004	.00001	.00007	.00011	.00000	.00011
CE144	2.84+02	2.72-06	.00000	.00000	.00000	.00001	.00001	.00000	.00001
PR144	1.20-02	.00	.00000	.00000	.00000	.00001	.00001	.00000	.00001
ALL OTHERS		7.41-03	.00001	.00002	.00000	.00003	.00005	0.0	.00005
TOTAL (EXCEPT TRITIUM)		4.52-01	.04861	.12900	.05904	.23664	.38664	.00000	.38000
TRITIUM RELEASE		24	CURIES PER YEAR						

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TABLE 3.5.4

ANNUAL RELEASES OF ACTIVITY IN GASEOUS EFFLUENTS (PER REACTOR BASIS) (1) (2)

Nuclide	GASEOUS RELEASE RATE (CURIES PER YEAR)								
	Reactor Steam Concentration (μCi/gram)	Containment[3]	Turbine Building	Auxiliary Building	Radwaste Building	Gland Seal	Air Ejector	Mechanical Vacuum Pump	Total
KR-83M	1.100-03	0	0	0	0	0	0	0	0
KR-85M	1.900-03	3.0+00	6.8+01	3.0+00	0	0	9.2+01	0	1.7+02
KR-85	6.000-06	0	0	0	0	0	3.3+02	0	3.3+02
KR-87	6.600-03	3.0+00	1.3+02	3.0+00	0	0	0	0	1.4+02
KR-88	6.600-03	3.0+00	2.3+02	3.0+00	0	0	6.0+00	0	2.4+02
KR-89	4.100-02	0	0	0	0	0	0	0	0
XE-131M	4.700-06	0	0	0	0	0	2.1+01	0	2.1+01
XE-133M	9.000-05	0	0	0	0	0	0	0	0
XE-133	2.600-03	6.6+01	2.5+02	6.6+01	1.0+01	0	5.3+02	2.3+03	3.2+03
XE-135M	8.400-04	4.6+01	6.5+02	4.6+01	0	0	0	0	7.4+02
XE-135	7.200-03	3.4+01	6.3+02	3.4+01	4.5+01	0	0	3.5+02	1.1+03
XE-137	4.700-02	0	0	0	0	0	0	0	0
XE-138	2.800-02	7.0+00	1.4+03	7.0+00	0	0	0	0	1.4+03
Ar-41									2.5+01
Total Noble gases									7.4+03
I-131	8.400-05	1.7-03	1.9-01	1.7-01	5.0-02	0	0	3.0-02	4.4-01
I-133	3.604-04	6.8-03	7.6-01	6.8-01	1.8-01	0	0	0	1.6+00
Tritium Gaseous Release									**8.1+01**
C-14 Release									**9.5+00**

TABLE 3.5.4 (Cont.)

AIRBORNE PARTICULATE RELEASE RATE
(CURIES PER YEAR)

Nuclide	Containment	Turbine Building	Auxiliary Building	Radwaste Building	Mechanical Vacuum Pump	Total
CR-51	3.0-06	1.3-02	3.0-04	9.0-05	0	1.3-02
MN-54	3.0-05	6.0-04	3.0-03	3.0-04	0	3.9-03
FE-59	4.0-06	5.0-04	4.0-04	1.5-04	0	1.1-03
CO-58	6.0-06	6.0-04	6.0-04	4.5-05	0	1.3-03
CO-60	1.0-04	2.0-03	1.0-02	9.0-04	0	1.3-02
ZN-65	2.0-05	2.0-04	2.0-03	1.5-05	0	2.2-03
SR-89	9.0-07	6.0-03	9.0-05	4.5-06	0	6.1-03
SR-90	5.0-08	2.0-05	5.0-06	3.0-06	0	2.8-05
ZR-95	4.0-06	1.0-04	4.0-04	5.0-07	0	5.0-04
SB-124	2.0-06	3.0-04	2.0-04	5.0-07	0	5.0-04
CS-134	4.0-05	3.0-04	4.0-03	4.5-05	3.0-06	4.4-03
CS-136	3.0-06	5.0-05	3.0-04	4.5-06	2.0-06	3.6-04
CS-137	5.5-05	6.0-04	5.5-03	9.0-05	1.0-05	6.3-03
BA-140	4.0-06	1.1-02	4.0-04	1.0-06	1.1-05	1.1-02
CE-141	1.0-06	6.0-04	1.0-04	2.6-05	0	7.3-04

Notes:

1. $1.100\text{-}03 = 1.100 \times 10^{-3}$
2. 0 appearing in the table indicates release is less than 1.0 Ci/yr for noble gas, 0.0001 Ci/yr for Iodine.
3. Containment iodine releases given by the BWR-GALE code output have been reduced by a factor of 10 to account for provision of 8-inch deep bed charcoal adsorbers on the containment exhaust line.

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TABLE 3.5.5

EXPECTED SOLID RADWASTE VOLUMES AND SPECIFIC ACTIVITY

	Volume (ft^3/yr) (1)(2)		Specific Activity ($\mu Ci/gm$)	
	Normal	Max.	Normal	Max.
Equipment drain filter sludge	1335	9325	1.99	2.04
Floor drain filter sludge	1485	12,740	.37	.38
Radwaste system spent resin	3000	13,725	.52	2.09
Condensate precoat filter sludge	820	820	.28	.28
RWCU and FPC & CU spent resin	2450	2450	31.2	70.0
Condensate regenerative evaporator bottoms	12,190	291,500	17.3	109
Miscellaneous evaporator bottoms	550	550	.12	.26
Total waste solidified	21,839	331,125	-	-
Miscellaneous dry compacted waste	4,400 (3)	-	- (4)	-

Notes:
(1) Solidified waste volume
(2) Based on 292 days operation per year
(3) Based on data from operating nuclear power plants
(4) Activity is expected to be negligible

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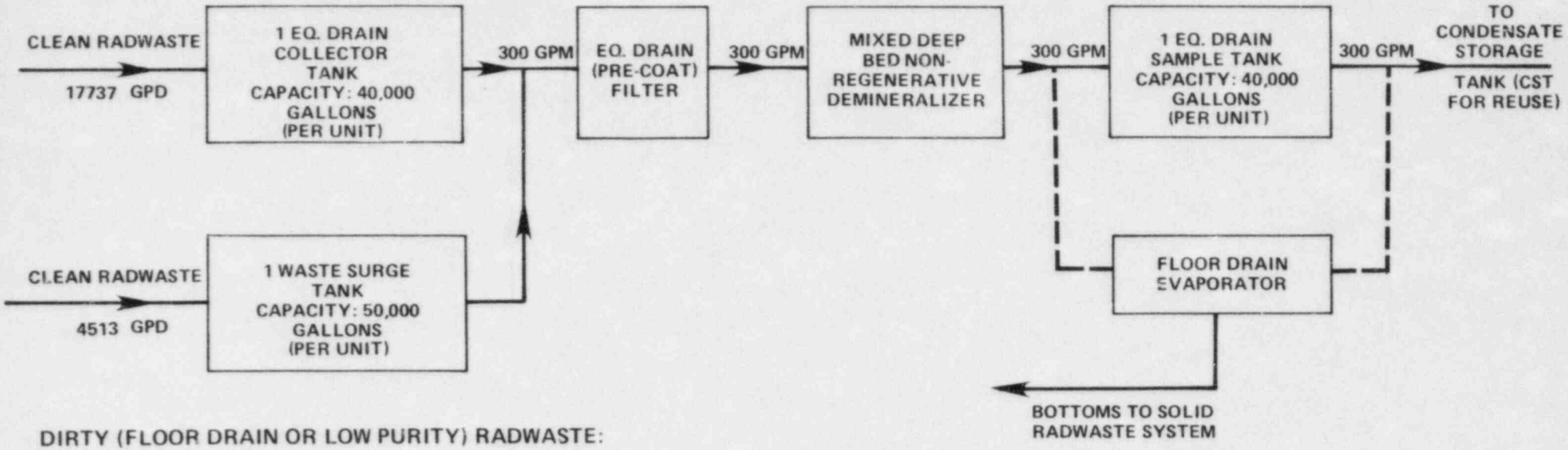
TABLE 3.5.6

EXPECTED SOLID RADWASTE CURIE CONTENT AT TIME OF SOLIDIFICATION AND AFTER 30 DAYS STORAGE

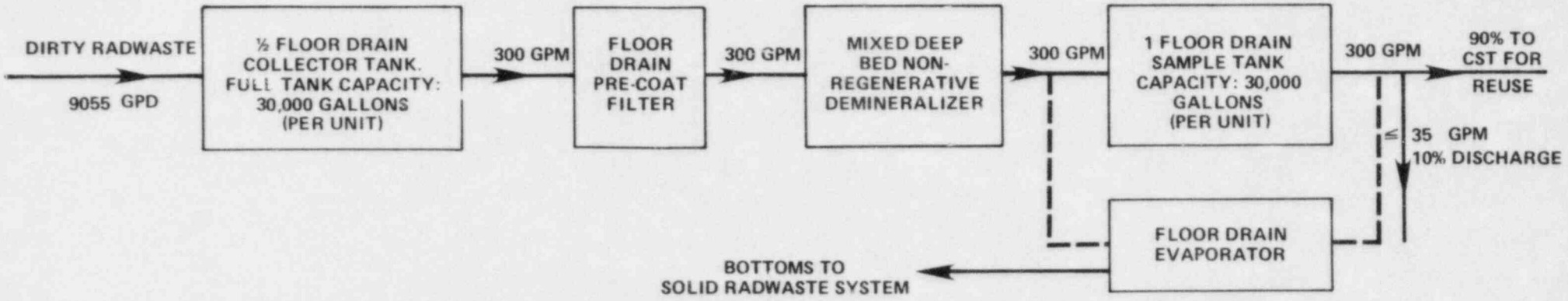
		At Solidification (Ci/yr)		After 30 Days Storage (Ci/yr)	
		Normal	Max.	Normal	Max.
1.	Equipment drain filter sludge	68.8	70.6	32.4	40.4
2.	Floor drain filter sludge	14.5	14.8	$<14.5^{(1)}$	$<14.8^{(1)}$
3.	Radwaste system spent resin	33.2	132	5.8	35.6
4.	Condensate precoat filter sludge	4.4	4.4	$<4.4^{(1)}$	$<4.4^{(1)}$
5.	RWCU and FPC & CU spent resin	1876	4200	1617	3350
6.	Condensate regenerative evaporator bottoms	840	5300	207	626
7.	Miscellaneous evaporator bottoms	0.5	1.0	$<0.5^{(1)}$	$<1.0^{(1)}$

Note: (1) 30 days decay credit has not been applied to these streams since their contribution is insignificant.

CLEAN (EQUIPMENT DRAIN OR HIGH PURITY) RADWASTE:



DIRTY (FLOOR DRAIN OR LOW PURITY) RADWASTE:



NOTE: HUNDRED PERCENT OF PROCESSED HIGH PURITY WASTE WATER IS EXPECTED TO BE REUSED. HOWEVER, CONSERVATIVELY, 1% OF THIS WATER MAY BE ASSUMED TO BE DISCHARGED AFTER APPROPRIATE DILUTION (REF. 1).

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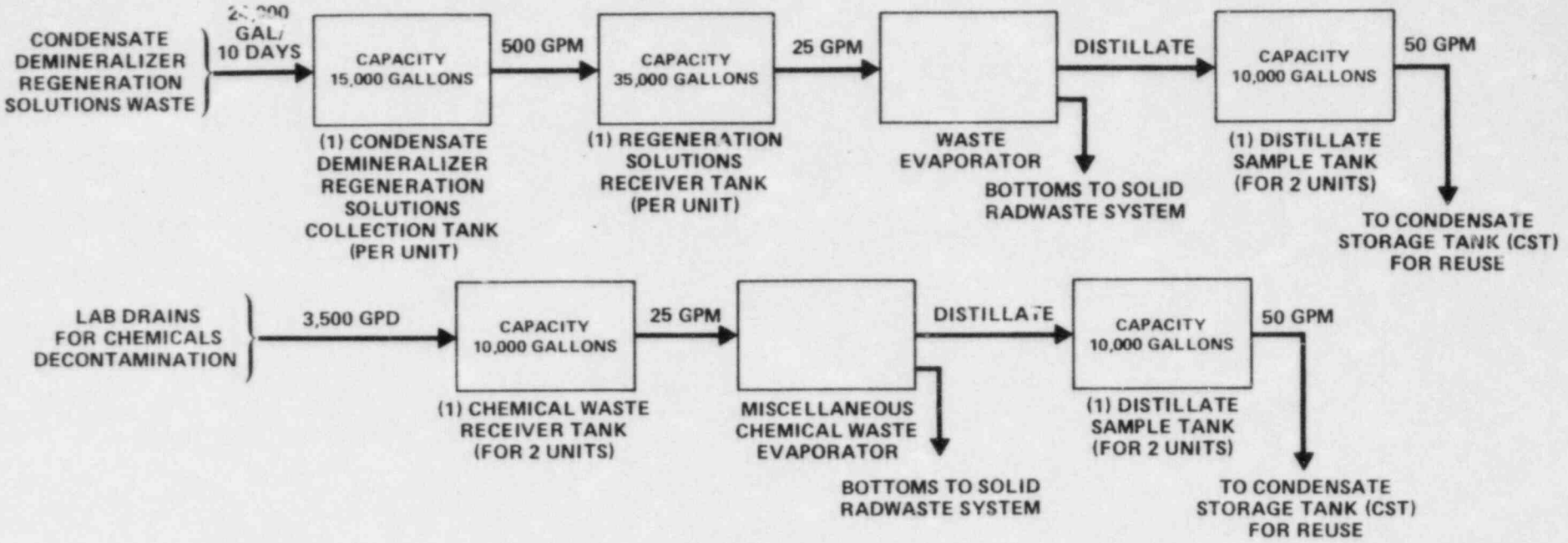
CHEMICAL WASTE



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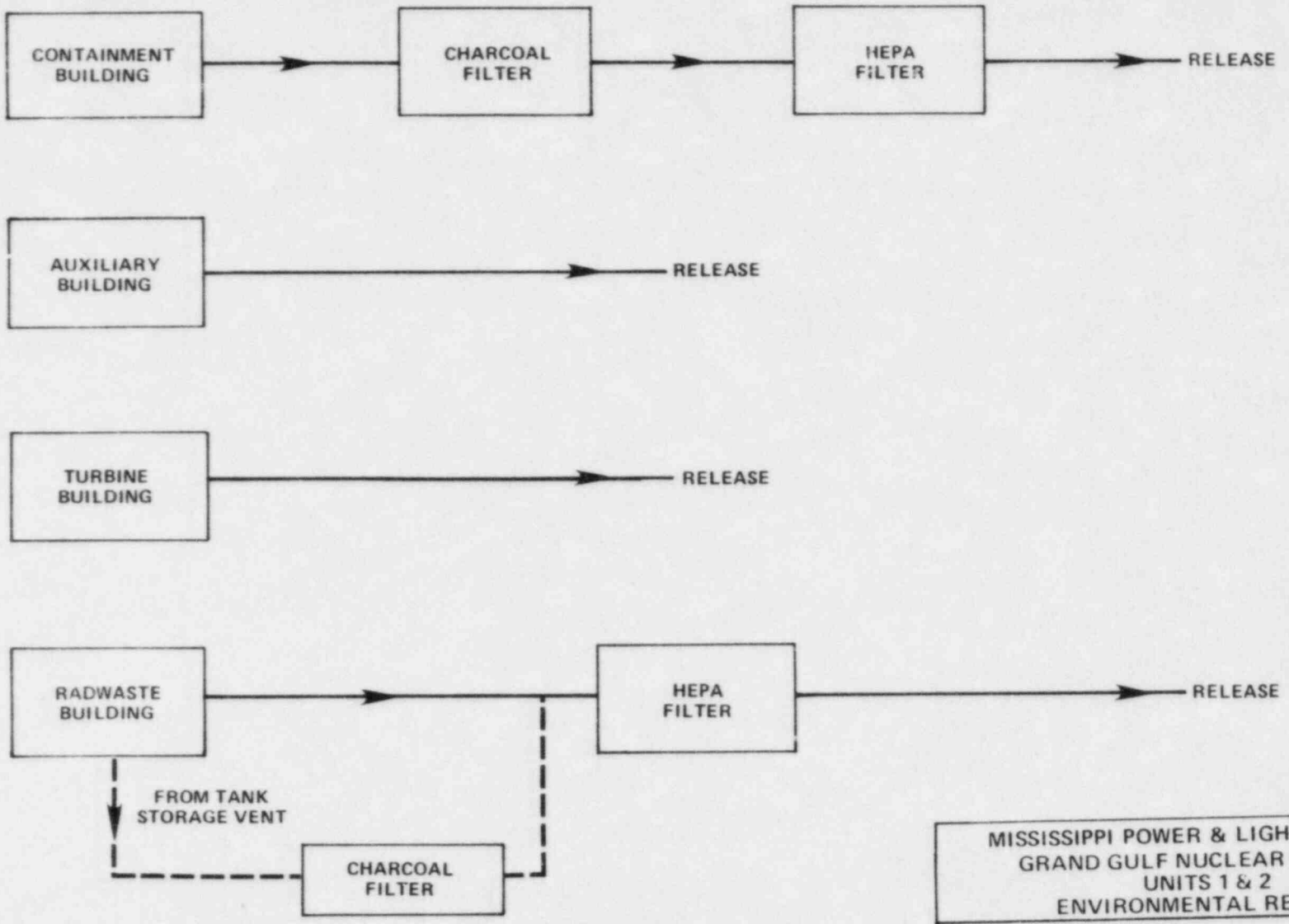
SCHEMATIC OF CHEMICAL RADWASTE PROCESSING SYSTEM

FIGURE 3.5-2

GASEOUS EFFLUENTS FROM BUILDING EXHAUSTS:



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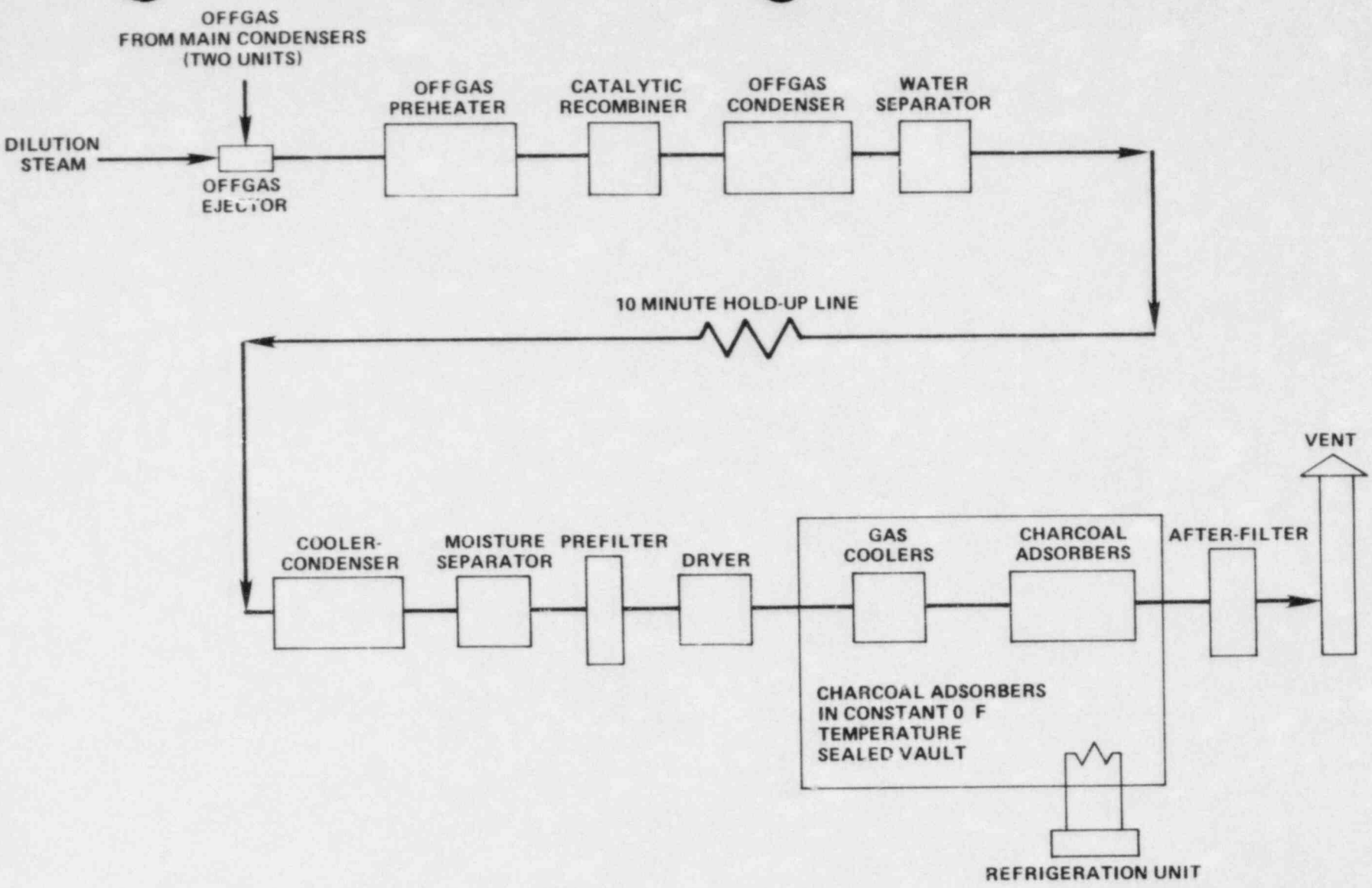
SCHEMATIC OF GASEOUS RELEASES FROM BUILDING VENTILATION EXHAUSTS

FIGURE 3.5-3



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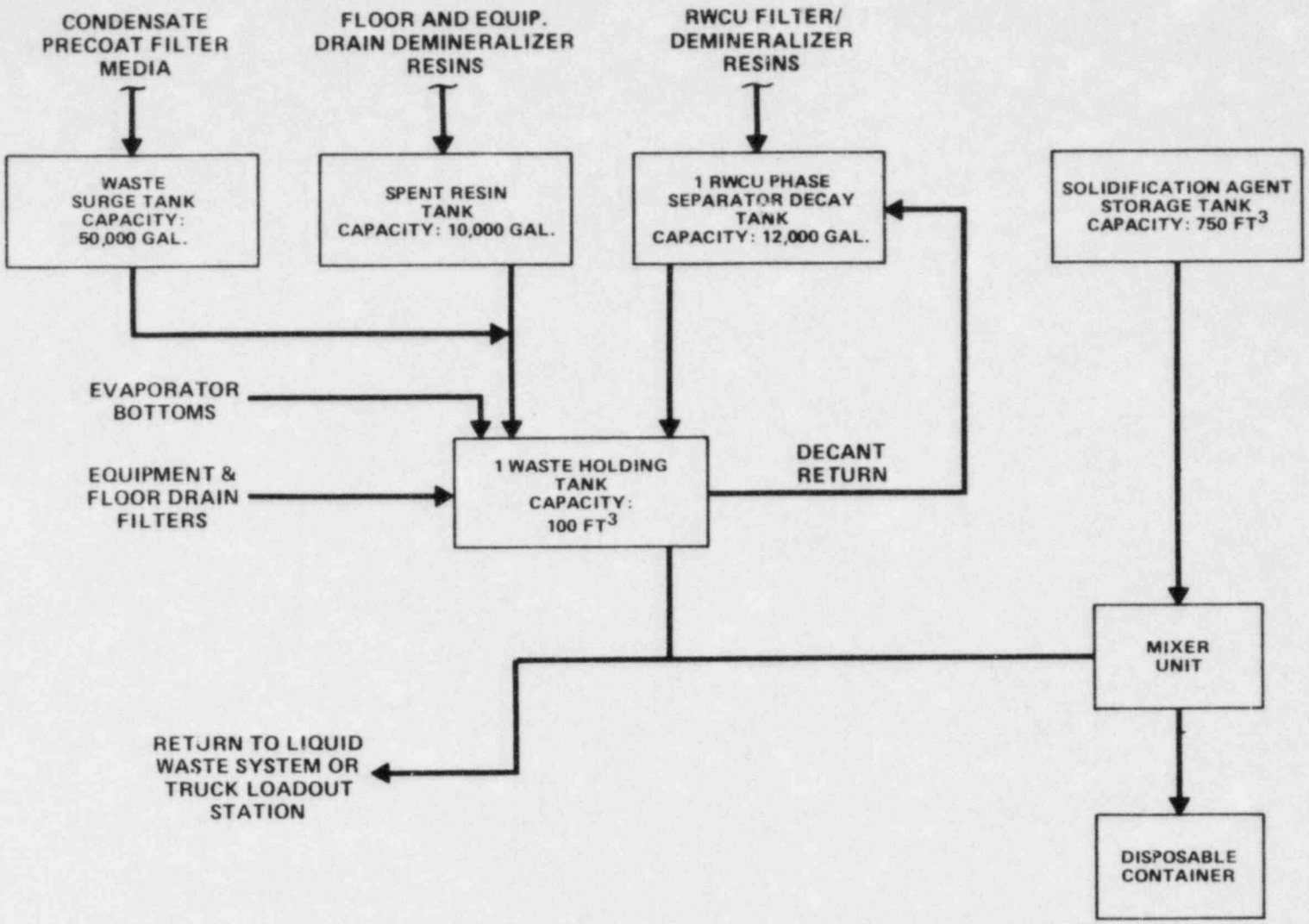
SCHEMATIC OF OFFGAS
RADWASTE PROCESSING SYSTEM

FIGURE 3.5-4



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SCHEMATIC OF SOLID RADWASTE HANDLING SYSTEM

FIGURE 3.5-5

3.6 CHEMICAL AND BIOCIDE WASTES

Chemicals are used to control water quality, scale, corrosion, and biological fouling as well as for equipment and building comfort cooling, extinguishing fires, waste solidification, equipment lubrication, fuel, regeneration of demineralizers, and for laboratory operations. Quantities and types of chemicals added to station systems and resultant discharges due to station operation are given in Tables 3.6.1 through 3.6.5 and various subsections in Sections 3.6 and 3.7 for two unit operation. Sources of chemicals discharged by the station are identified by the waste categories specified in 40 CFR Part 423 in Tables 3.6.3a, 3.6.3b, and 3.6.4. A station operational waste diagram is shown on Figure 3.6-1. 5

The principal chemicals and their uses are as follows:

a. Sulfuric acid and caustic soda are used for regeneration of the makeup and condensate demineralizers.

b. Salt is used to generate sodium hypochlorite on site.

c. Sodium hypochlorite and sulfuric acid are added to the circulating water and standby service water systems to prevent biological fouling, and for pH/scale control.

d. Sodium hypochlorite is added to disinfect the domestic water supply.

e. Sodium hypochlorite is added to the plant service water system to prevent biological fouling.

f. A non-toxic, liquid, polycarboxylic acid co-polymer is added to the plant service water and circulating water systems to disperse iron and silt.

g. A polyphosphonate is used in the circulating water as a calcium and hardness dispersion agent. 7

h. A biocide enhancer (surfactant) is added to the circulating water system. Addition is on an intermittent basis. 5

i Sodium nitrite and caustic soda may be added to the component cooling water and turbine building cooling water systems to minimize corrosion and for pH control. 7

j. Sodium nitrite and caustic soda may be added to the chilled water system to minimize corrosion and for pH control. |7

k. An EPA registered nonoxidizing biocide is used to prevent biological fouling in the standby service water system.

l. An organic/phosphonate polymer is added to the standby service water to disperse iron and silt. |7

m. Gaseous carbon dioxide is used for purging the main station generators of air or hydrogen and as a fire extinguishing agent. |7

n. Gaseous hydrogen is used for cooling the main station generators. |7

o. Portland cement, Type I or II, and sodium silicate are used during the solidification process in the solid radwaste system. |7

p. Various halogenated hydrocarbons are used as refrigerants in air conditioning systems and as fire extinguishing agents. |7 5

q. Various chemicals and solutions are used in the plant laboratories. |7

r. SAE 40 and No. 2 fuel oil are used for lubrication and fuel, respectively, for the standby and high pressure core spray (HPCS) system diesel engines. |7

s. No. 1 or No. 2 diesel fuel oil is used to fuel the diesel driven fire pumps. |7

t. Lube oil is used for lubricating the main station turbines and the reactor feed pump turbines. |7

u. Sodium nitrate and caustic soda are added to the diesel generator cooling water jackets to minimize corrosion and for pH control. |7

v. Borax and boric acid are mixed to produce sodium pentaborate which may be used to control reactor power level.

3.6.1 Cooling Tower Blowdown

As described in Section 3.4, the evaporation of water in the cooling tower results in an increase in the concentration of chemicals and solids in the circulating water. The circulating water system is operated to maintain the cycles of concentration between two and five (i.e., the concentration of solids 340.22

in the circulating water is two to five times that in the makeup water). This concentration ratio is maintained by a continuous blowdown of the circulating water from the system to the discharge basin and from there to the Mississippi River (see Figure 3.6-1). Cooling tower makeup replenishes this loss. Increasing the solids concentration increases the scaling tendencies of the water. Sulfuric acid and other chemicals are added to the circulating water to control scaling, prevent iron deposition, and maintain pH between 7.0 and 8.5.

Table 3.6.3a presents the design makeup water analysis and the predicted circulating water analyses for two, three, and five cycles of concentration. Based on pumpout tests conducted in late 1979, the makeup water is nominally expected to be composed of approximately 70 percent Mississippi River water and 30 percent ground water (alluvial aquifer) at the site; the radial collector well laterals extended under the river promote such a partitioning. The conservative, mean makeup water quality presented in Table 3.6.3a assumes a 50 percent mixture of ground water and river water. Plant discharge quality, Mississippi River water quality, and Federal discharge limitations are presented in Table 3.6.3b. The plant discharge is basically a combination of the cooling tower blowdown and makeup bypass.

Iron in the intake water is expected to be primarily in the dissolved (soluble ferrous) form. Due to oxygenation within the cooling towers, dissolved iron will be oxidized to suspended (ferric), and essentially no dissolved iron will, therefore, be present in the cooling tower blowdown. However, under certain operating conditions (e.g., high cycles of concentration in the circulating water system), a portion of the intake water containing dissolved iron will be bypassed directly to discharge. Then, when this bypass and the blowdown stream are combined, the dissolved ferrous iron is oxidized by the dissolved oxygen in the cooling tower blowdown; ferrous iron is, therefore, reduced by both oxidation and dilution. The net effect of combining the two streams is that the dissolved iron concentrations in the discharge to the Mississippi River are below the makeup water's dissolved iron concentration.

Although the intake water is oxygen deficient, recirculation and reaeration in the cooling towers increase the dissolved oxygen concentration to saturation levels. However, oxidation of dissolved iron in any bypass reduces the dissolved oxygen concentrations in the plant discharge. Section 5.3 provides a discussion of the possible impact of discharge of cooling water with slightly reduced oxygen levels.

Neutralization of bicarbonate for scale control produces a large excess of carbon dioxide in the circulating water; therefore, local, instantaneous concentrations of several

340.22

hundred parts per million can be expected. However, elevated temperatures and recirculation combined with gas stripping in the cooling towers can be expected to reduce the CO_2 level in the blowdown to the order of 1 mg/l.

The concentrations of conservative substances in the plant effluent are determined entirely by the relative magnitude of the plant makeup and discharge. At two cycles of concentration, no makeup bypass is required; therefore, the plant discharge is just the cooling tower blowdown. At higher cycles of concentrations (e.g., three and five cycles), both the total plant makeup and discharge are constant (bypass flow rates do differ); therefore, the discharge concentrations of conservative substances remain the same. 340.22

3.6.2 Cooling Tower Drift

Chemical and solids concentrations in the cooling tower drift are essentially the same as those in the circulating water. The design cooling tower drift rate is 0.008 percent of the design circulating water system flow rate resulting in a drift flow rate of 46 gpm per unit. Ground deposition of chemicals entrained in the drift is given in subsection 5.1.4.

3.6.3 Treatment of Circulating Water and Service Water Systems Against Biological Fouling 340.4

To minimize undesirable slime and algal growths in the circulating water systems, a biocide is added intermittently. An onsite generated, 0.8 percent equivalent chlorine, sodium hypochlorite solution is used as the biocide. The actual dosage of hypochlorite depends on the chlorine demand of the water, presence of organic substances, ammonia, etc. A biocide enhancement agent may also be added if determined to be necessary on the basis of plant operating experience. However, two basic criteria govern the biocide dosage applied: 1) to keep the chlorine residuals in the blowdown within the permissible regulatory limits, and 2) to apply sufficient dosage so that flow and heat transfer efficiencies are maintained at their design values. 17 5

Hypochlorination is normally performed two times a day per unit during which period the blowdown discharge is interrupted for approximately 1 hour. The injection times of each unit are staggered. During the first half-hour period of the treatment process, hypochlorite solution is added until a free chlorine residual of 0.5 mg/l is attained and maintained at the condenser outlet. During the remaining half-hour period the residual chlorine is allowed to decay. Upon resumption of blowdown the maximum free available chlorine concentration is less than 0.5 mg/l and is expected to average less than 0.2 mg/l. With both units operating and only one unit chlorinated at a given time, the discharge from the second unit provides additional dilution and total

residual chlorine reduction, when the blowdown from the unit which has undergone treatment is resumed. Neither detectable free available chlorine nor total residual chlorine is discharged from any unit for more than 2 hours in any one

day. Only actual operating experience will permit an accurate determination of the level of biocide treatment required. Thus, injection frequency, applied dosage, as well as free chlorine residuals may be adjusted during operation. All adjustments will be consistent with regulatory requirements.

The plant service water system is hypochlorinated three times a day per unit for one hour each injection to produce a 0.5 mg/l chlorine residual. Maximum and average annual usage of sodium hypochlorite is shown in Table 3.6.1. The injection frequency, duration residuals, and usage are design maximums. Actual operating practice will be directed toward minimum use of chlorination. 340.4

As described in subsection 3.4.2.2, excess plant service water can bypass various plant systems and be discharged to the discharge basin; however, operation of this bypass system is interlocked with the chlorination system so that when the bypass is open, chlorination of the plant service water system cannot occur.

3.6.4 Makeup Water Treatment

The makeup water treatment system consists of a pretreatment system, activated carbon filters, and layered bed demineralizers including associated water storage, transfer equipment, and regeneration facilities.

3.6.4.1 Pretreatment System |5

High dissolved iron concentrations in the makeup water from the radial wells (Table 3.6.3a) necessitate iron removal to prevent fouling/degradation of demineralizer cation exchange resins. Iron removal by oxidation and filtration (e.g., with greensand filters) will probably suffice for this service. Such treatment will be provided on a temporary and/or contract basis until makeup water treatment plant operation defines pretreatment requirements more precisely. Wastewaters generated during iron removal (e.g., due to regeneration of greensand filters) will either be treated onsite with other low volume wastes in the wastewater treatment basin or disposed of through approved contract services. 371.07

Since the radial well water is also expected to have moderately high levels of hardness and alkalinity (Table 3.6.3a), operating experience may indicate that reduction of these constituents as well as iron (e.g., by lime softening) is preferred. Besides protecting the makeup demineralizer system against the impacts of dissolved iron, this approach may effectively increase the capacity of the demineralizer. Wastewaters generated by this pretreatment will also either be treated onsite in the wastewater treatment basin or disposed of through approved contract services.

3.6.4.2 Activated Carbon Filters

The primary functions of the two activated carbon filters are removal of chlorine and color, if present. Although the filters have some capability to filter suspended solids, given the ground water nature of the plant service water radial well system and pretreatment to remove contained iron, it is not expected that the filters will collect significant quantities of suspended solids during design operating conditions. Modification of the activated carbon filters to serve exclusively as filters for suspended solids may be required if a pretreatment process to reduce alkalinity, hardness, and iron is eventually selected.

The normal flow rate of water through the filters ranges from approximately 100 to 350 gpm with a maximum rate of 500 gpm. The effluent from the filters is routed to the two makeup demineralizer trains with a normal flow rate range of 100 to 300 gpm and to the domestic water storage tank with a normal flow rate range of 0 to 200 gpm. Revivification of the filters, consisting of backwashing and rinsing, is performed on one filter at a time. Revivification frequency is once a week or more frequently if an increase in pressure drop across the filter of more than 3 to 5 psi is noted. The filters are backwashed for at least 15 minutes at 325 gpm and then rinsed for 10 minutes at 150 gpm. For the reason previously noted, the quantity of suspended solids removed during this process is expected to be negligible. The filters require backwashing and rinsing at least once a week to maintain the proper gradation of the filter media. Regeneration wastewaters so produced are routed to the wastewater treatment basin.

3.6.4.3 Makeup Demineralizers

Up to 300 gpm of water from the activated carbon filters is deionized by two trains of ion exchange demineralizers. Each train is designed for a 150 gpm flow rate. The flow trains consist of layered bed cation and anion vessels.

a. Each cation vessel contains weak and strong acid resins. Sulfuric acid (66° Be') is utilized for regeneration of resins.

b. Each anion vessel contains weak and strong base resins. Caustic soda (50 percent NaOH) is utilized for regeneration of resins.

The expected average and maximum design discharge concentrations of each pollutant for the makeup demineralizer liquid wastes are listed in Table 3.6.4. Representative regeneration data is given in Table 3.6.5. On a maximum and average basis, approximately 470,000 and 72,000 gallons per day, respectively, of these wastes are produced. The pH of the

wastes is adjusted to between 6 and 9 prior to discharge to the station discharge basin. The design maximum and average discharge flow rates are 200 gpm and 50 gpm, respectively.

3.6.5 Corrosion Inhibitors

Corrosion inhibitors may be used in the turbine building cooling water systems, component cooling water systems, chilled water systems, standby diesel generator cooling jackets, and the auxiliary steam system. With the exception of the auxiliary steam system, all are closed loop systems with no discharge to the environment. 7 7

3.6.6 Auxiliary Boiler Blowdown

Two auxiliary boilers, each with a rated capacity of approximately 35,000 pounds per hour, are used to provide steam during station startup, normal operation, and shutdown. Boiler water quality is maintained by blowdown, makeup, chemical feed and mechanical deaeration. Conductivity and pH are controlled by the addition of sodium hydroxide and sodium sulfite in order to maintain a maximum conductivity of 4000 μmhos/cm and a minimum pH of 8.5. The addition of sodium hydroxide is very infrequent due to the concentrating characteristics of the boiler. Maximum limits on conductivity and pH are controlled by blowdown and demineralized makeup water. Maximum quantity of NaOH used will be determined by the frequency of use but will not exceed 100 pounds per year. Disodium phosphate will be added as required to maintain a 2 ppm phosphate residual for scale control. 7

Oxygen is controlled by mechanical deaeration and minimum sulfite addition to the condenser system. Other chemical parameters are controlled by blowdown and addition of demineralized makeup water. 7

Corrosion inhibition is maintained in the condenser and feedwater system by the addition of a proprietary ascorbic acid.

Blowdown does not generate large quantities of solid waste. Based on reported data, concentrations of total suspended solids, oil and grease, and copper and iron should be less than that allowed by 40 CFR Part 423.15 (Ref. 1). The pH of the blowdown is adjusted to between 6 and 9 prior to discharge to the station discharge basin.

3.6.7 Laundry Waste

Contaminated clothing originating from the site will be either shipped to a commercial radioactive laundry facility or processed on site. Laundry processed on site will be either dry cleaned or wet laundered. The contaminated fluids (solvents or water) will be processed as radioactive waste, resulting in zero discharge to the plant or the environment from other than the liquid radwaste processing system (see Subsection 3.5.2.3). 7

3.6.8 Corrosion Products

The condenser tubes, as well as the component cooling water heat exchanger tubes and turbine building cooling water heat exchanger tubes, are stainless steel. The circulating water piping is primarily cement lined carbon steel. The plant service water piping from the radial wells through the yard is primarily carbon steel. The stainless steel condenser tubes would not be expected to contribute appreciable amounts of corrosion/erosion products to the plant discharge. Iron resulting from corrosion of the carbon steel piping in the associated pathways and the carbon steel condenser water boxes is expected to be present to some degree in the cooling tower blowdown, but the amount is uncertain. No copper materials are used in the circulating water system. 7

3.6.9 References

1. EPA 440/1-77/084, Supplement for Pretreatment to the Development Document for the Steam Electric Power Generating, Point Source Category, April 1977, Table V-4, Page 54

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TABLE 3.6.1

LIST OF CHEMICALS TO BE USED AT STATION (Note 1)

Chemical		Use	Frequency of Use	Maximum (Note 2)	Average/Annual Quantity
Sulfuric acid (66° Be')	a.	Makeup demineralizers - regeneration	Daily	426 gal (day)	38,125 gal
	b.	Condensate deep bed demineralizers - regeneration	30-90 days	632 gal (day)	7,200 gal
	c.	Circulating water system - makeup water pH/scale control	Essentially continuous	280 gal (hour)	1,630,000 gal
	d.	Standby service water system - pH/scale control	Refueling and scheduled maintenance outage (once per year per unit	34,560 gal (annual)	17,280 gal
Caustic soda	a.	Makeup demineralizers - regeneration	Daily	384 gal (day)	65,840 gal
	b.	Condensate deep bed demineralizers - regeneration	30-90 days	716 gal (day)	16,370 gal
	c.	Turbine building cooling water system - pH adjustment	As required	Sufficient to maintain pH between 9.0 and 9.7	
	d.	Component cooling water system - pH adjustment	As required	Sufficient to maintain pH between 9.0 and 9.7	
	e.	Diesel generator cooling water jackets	As required	Sufficient to maintain pH between 9.0 and 9.7	
	f.	Auxiliary boiler - Conductivity and pH adjustment	As required	<100 lbs (annual)	7
Sodium sulfite	a.	Auxiliary boiler conductivity adjustment	Continuous	70 lbs (day)	20,000 lbs
Salt (NaCl)	a.	Makeup water treatment system - to produce NaOCl	Daily	7,400 lbs (day)	2,117,000 lbs
Sodium hopochlorite (0.8% Cl_2 equivalent)	a.	Circulating water system-biocide	(See subsection 3.6.3)	(Note 3)	8,450,000 gal
	b.	Plant service water system - biocide	Three 1-hour injections per day per unit	430,000 gal (annual)	390,000 gal
	c.	Standby service water water system - biocide	During system operation which is at refueling (once/year/unit) and system testing (once/month/unit)	72,000 gal (annual)	36,000 gal
	d.	Domestic water system - disenfectant	Essentially continuous	1.3 gal (day)	300 gal

TABLE 3.6.1 (Cont.)

Chemical		Use	Frequency of Use	Maximum (Note 2)	Average/Annual Quantity	
Ascorbic acid	a.	Auxiliary boiler condenser and feed system corrosion inhibition	Continuous	1c gal (day)	3,650 gal	7
Disodium phosphate	a.	Auxiliary boiler scale control	Continuous	0.5 lb (day)	183 lbs	
Polycarbolic acid copolymer	a.	Plant service system and circulating water system - iron and silt dispersant	Continuous	1,150 lbs (day)	253,000 lbs	7
Polyphosphonate	a.	Circulating water system - calcium dispersant	Continuous	775 lbs (day)	339,000 lbs	5 7
Surfactant	a.	Circulating water system - biocide enhancer	Twice daily with chlorination if required	200 lbs (day)	50,000 lbs	7
Chlorine	a.	Sanitary waste system effluent - disinfectant	Essentially continuous	1 lb (day)	230 lbs	
Sodium nitrite	a.	Turbine building cooling water system - corrosion inhibitor	Monthly	1 1/4 lbs (annual)	1 lb	
	b.	Component cooling water system - corrosion inhibitors	Monthly	1 1/4 lbs (annual)	1 lb	
	c.	Chilled water system - corrosion inhibitor	As required	10 lbs (annual)	7 lbs	
	d.	Diesel generator cooling water jackets	As required	1 lb (annual)	-	7
EPA registered nonoxidizing biocide	a.	Standby service water system - biocide	Not determined	Not determined	Not determined	
Gaseous carbon dioxide	a.	Carbon dioxide system - purging the main station generators	*9180 ft^3/unit required prior to gassing the generator and 9180 ft^3/unit when removing hydrogen from the generator during maintenance only	36,720 ft^3 (*)	-	
	b.	Fire protection system - automatic fire suppression agent	1. *At initial plant startup	40 tons (*)	Nominal leakage	
			2. *In case of fire	14 tons (*)	Nominal leakage	
	c.	Fire protection system - hand held fire extinguishers	*In case of fire	80 lbs (*)	Nominal leakage	

TABLE 3.6.1 (Cont.)

Chemical		Use	Frequency of Use	Maximum (Note 2)	Average/Annual Quantity
Gaseous hydrogen	a.	Hydrogen system - cooling main station generators	1. *Estimated once per year. At initial fill or during shut-down	59,670 ft^3 (*)	-
			2. Leakage	1950 ft^3 (day)	<711,750 ft^3
Organic phosphonate a polymer		Standby service water system	As required	15 gal (day)	5,500 gal
Portland cement Type I or II	a.	Solid radwaste system - solidification process	14.6 batches per year	1.5×10^7 lbs (annual)	8.9×10^5 lbs
Sodium silicate	a.	Solid radwaste system - solidification process	2.4 batches per year	2.3×10^6 lbs (annual)	1.6×10^5 lbs

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TABLE 3.6.1 (Cont.)

Chemical	Use	Frequency of Use	Maximum (Note 2)	Average/Annual Quantity
Chlorodifluoro-methane (R-22)	a. Control room HVAC system - refrigerant	*Initial fill (for maximum usage)	900 lbs (*)	Nominal leakage
	b. Water treatment building ventilation system - refrigerant	*Initial fill (for maximum usage)	45 lbs (*)	Nominal leakage
Dichlorodi-fluoromethane (R-12)	a. Plant chilled water system - refrigerant	*Initial fill (for maximum usage)	13,740 lbs (*)	Nominal leakage
	b. Fire protection system - test Halon 1301 system	*Full discharge at initial plant startup only	1,142 lbs (*)	Nominal leakage
Trichloro-fluoromethane (R-11) or Tetrachlorodi-fluoroethane (R-112)	a. Various charcoal filtered HVAC systems - testing charcoal efficiency	Once per year for each filter	(Note 3)	300 lbs (R-11)
Bromotri-fluoromethane (Halon 1301)	a. Fire protection system - fire supression agent	*Only in case of fire	2088 lbs (*)	Nominal leakage
Nitrogen	a. Fire protection system - for actuation of Halon 1301 fire supression agent	*Only in case of fire	24 oz (*)	Nominal leakage
	b. Part of carbon dioxide and hydrogen system - purging primary water tank (Note 4)	*Whenever generator is degassed	700 ft^3 (*)	-
Lube oil	a. SAE 40 - lubricating standby and high pressure core spray systems diesel engines	Once per year	(Note 3)	3,620 gal
	b. 200 SSU @ 100 F - lubricating main station turbines and reactor feed pump turbines	*Initial fill for maximum use	51,400 gal (*)	-
Fuel oil	a. No. 2 fuel oil - fuel standby and high pressure core spray systems diesel engines	Four hours per month	(Note 3)	490,000 gal (Note 5)

TABLE 3.6.1 (Cont.)

Chemical	Use	Frequency of Use	Maximum (Note 2)	Average/Annual Quantity
	b. No. 1 or No. 2 diesel fuel oil - fuel diesel driven fire pumps	1. Two hours per week	(Note 3)	1,000 gal
		2. Six hours per year	(Note 3)	60 gal
Borax and boric acid	a. Mixed to produce sodium pentaborate which in turn may be used to control reactor power output	Emergency use only/leakage	7,406 lbs (Note 6)	300 lbs
Hand held dry chemical extinguishers	a. Fire protection system - fire suppression agent	*Only in case of fire	2,924 lbs (*)	-
Hand held Halon 1211 fire extinguishers	a. Fire protection system - fire suppression agent	*Only in case of fire	1,360 lbs (*)	Nominal leakage
Palladium	a. Catalytic absorption of dissolved oxygen in primary water system (Note 4)	-	2.108 pounds is contained in 380 liters of alumina ($Al_2 O_3$)	
Tritium	a. Activate primary water system (Note 4)	-	Sufficient to activate primary water up to a specific activity of 3×10^{-2} $\mu c/cm^3$	
Thallium	a. Conductivity control in primary water system (Note 4)	-	(Note 3)	0.44 lbs
Methane	a. Leakage detection in primary water system (Note 5)	-	340 ft^3 (day)	124,100 ft^3

NOTES: * Frequency of use initiated by an asterisk refers to corresponding maximum quantity indicated by an asterisk enclosed by parentheses.

1. Two unit operation quantities are provided
2. Maximum usage time frame varies according to chemical use.
3. Average and maximum usage for a typical year are essentially equivalent.
4. Primary water system is a closed cooling water system serving the main station generators.
5. Quantity based on replacement of entire storage capacity of fuel oil.
6. Maximum usage based on initial loading per standby liquid control unit.

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TABLE 3.6.2

LABORATORY CHEMICALS (Note 1)

Quantity	Description
2 cases	Acetic acid, glacial, 12 x 1 pt
2 cases	Acetone, 4 x 8 pt
2 cans	Acetone, 5 gallons
2 lbs	Ammonium acetate
1 lb	Ammonium chloride
1/4 lb	Ammonium chromate
2 cases	Ammonium hydroxide, 12 x 1 pt
1 lb	Ammonium molybdate
1 lb	Ammonium oxalate
1/4 lb	Ammonium phosphate, dibasic
1 lb	Ammonium thiocyanate
1 lb	1-Amino-2-naphthol-4-sulfonic acid
1/4 lb	Antimony trichloride
4 pts	n-Amyl alcohol
1 lb	Barium chloride
1 lb	Barium nitrate
1 case	Benzene, 8 x 1 qt
200 gm	Benzoin antoxime (αbenzoinoxime)
15 gm	2, 2-Bipyridine
2 lbs	Boric acid
1/4 lb	Bromine
12 pts	Carbon tetrachloride
1/4 lb	Cerium chloride
10 gm	Cesium chloride
8 pts	Chloroform
10 gm	Chloroplatinic acid (Platinum chloride)
1 case	Chromic sulfuric acid, 6 x 1 qt
2 lbs	Citric acid
1/4 lb	Cobolt nitrate
1/4 lb	Copper wire
50 gm	Curcumin
1/2 pt	Cyclohexanone
1 lb	Dimethylglyoxime
50 gm	1, 5-Diphenyl-carbohydrazide
4 pts	Ether, anhydrous
2 pts	Ethyl acetate
2 gal	Ethyl alcohol, absolute
1/4 lb	Ferric chloride
5 lbs or more	Gelgard M (Fire control polymer by Dow Chemical)
2 cases	Hydrochloric acid, 12 x 1 pt
6 each	Hydrochloric acid in Dilut-it (by J. T. Baker)
1 lb	Hydrofluoric acid

TABLE 3.6.2 (Cont.)

Quantity	Description
1/4 pt	Hydrogen peroxide, 30 percent
3	Hydrogen sulfide, lecture bottles
1 lb	Hydroxylamine hydrochloride
1 lb	8-hydroxyquinoline (8-quinolinol)
1/4 lb	Iron wire, 0.009-in.
6 lbs	Isopropyl ether
1 case	Lanolin (stain remover and hand cream), 12 x 6 oz
1/4 lb	Lanthanum nitrate or chloride
1 lb	Lead acetate
3 lbs	Magnesium acetate
3 lbs	Mannitol
1 lb	Magnesium chloride
1/4 lb	Manganous chloride
4 gal	Methanol
1 gm	Methyl orange (indicator)
1 gm	Methyl red (indicator)
10 gm	(Neocuproine) 2, 9-Dimethyl-1 10-Phenanthroline hemihydrate
1/4 lb	Nickel(ous) nitrate
1 lb	Nickel foil
2 cases	Nitric acid, 12 x 1 pt
5 lbs	Nitric acid, fuming
1 lb	Oxalic acid
3 lbs	Perchloric acid (70%)
100 gm	Phenolphthalein (indicator)
25 gm	4-Phenylazodiphenylamine (indicator)
1 lb	Phosphoric acid
1 lb	Phthalic anhydride
1/2 lb	Potassium chlorate
2 pts	Potassium chloride-saturated solution
2 lbs	Potassium chloride
1/4 lb	Potassium dichromate
2 lbs	Potassium hydroxide
2 lbs	Potassium iodide
5 lbs	Potassium nitrite
1/4 lb	Potassium permanganate
1 lb	Potassium pyrosulfate
2 pts	Isopropyl ether
1 lb	Silicotungstic acid
1 lb	Silver nitrate
1 lb	Sodium acetate
1/4 lb	Sodium azide
1 lb	Sodium bisulfite
1/2 lb	Sodium bromate
2 lbs	Sodium carbonate
2 lbs	Sodium chloride
1/4 lb	Sodium citrate
1/4 lb	Sodium fluoride
1 case	Sodium hydroxide, 50 percent solution, 12 x 1 pt
6 each	Sodium hydroxide in Dilut-it (by J. T. Baker)
1 gal	Sodium hypochlorite, 4 to 6 percent (household laundry bleach)

TABLE 3.6.2 (Cont.)

Quantity	Description
1/4 lb	Sodium nitrate
1/4 lb	Sodium nitrite
1/2 lb	Sodium phosphate, monobasic
1/2 lb	Sodium phosphate, dibasic
1 lb	Sodium silicate
1 lb	Sodium sulfite
1/4 lb	Sodium tungstate
1 case	Sparkleen™ (biodegradable glassware detergent by Fisher), 12 x 3 1/4 lbs
1/4 lb	Strontium nitrate
1 lb	Sodium sulfate
2 cases	Sulfuric acid, 12 x 1 pt
1 lb	Sulfurous acid (6%)
1 lb	d-Tartaric acid
1 lb	Uranyl acetate
10 gm	Yttrium nitrate
1 lb	Zinc, granular, 30 mesh
1/4 lb	Zirconium nitrate or chloride

Radiochemicals (liquid solutions)

Co^{60}	source 10 mc
Cs^{137}	source 10 mc
Cs^{137}	standard 1 μc
Co^{60}	standard 1 μc
Sr^{90}-Y^{90}	standard 1 μc

National Bureau of Standards Mixed Radionuclide Gamma Ray Standards 4242 D and 4243 D containing Y88, Co^{60}, Cs^{137}, Sr^{85}, Sn^{113}, Co^{57}, Ce^{139} and Hg^{203}

NOTES: 1. Typical list of chemical supplies and reagents for setting up and operating the chemical and radiochemical laboratory. During normal operation list is subject to change.

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TABLE 3.6.3a

INTAKE, CIRCULATING, AND BLOWDOWN WATER QUALITIES

(mg/l or other units as noted)

Parameter	Intake (Radial Well System) Water	Circulating Water & Blowdown [a] 2 Cycles	3 Cycles	5 Cycles
Dissolved Solids	376	752	1128	1880
Hardness (as $CaCO_3$)	332	664	996	1660
Calcium	93	186	279	465
Magnesium	24	48	72	120
Sodium	18.4	36.8	55.2	92.0
Potassium	4.1	8.2	12.3	20.5
Sulfate [b]	33.5	446	743	1410
Chloride	19	38	57	95
Nitrate	3.6	7.2	10.8	18.0
Silica	17	34	51	85
Nitrogen (total)	5.5	11.0	16.5	27.5
Ammonia - Nitrogen	0.53	1.1	1.6	2.7
Aluminum	<0.11	n/a	n/a	n/a
Copper	<0.05	n/a	n/a	n/a
Iron (dissolved) [c]	10	0	0	0
Zinc	<0.1	n/a	n/a	n/a
Chlorine Demand	3.9	7.8	11.7	19.5
Chlorine (free available)	n/a	(d)	(d)	(d)
Dissolved Oxygen	n/a	(e)	(e)	(e)

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TABLE 3.6.3a (Cont.)

Parameter	Intake (Radial Well System) Water	Circulating Water & Blowdown [a] 2 Cycles	3 Cycles	5 Cycles
Carbon Dioxide	n/a	(f)	(f)	(f)
pH[g]	7.2	7.0 - 8.5	7.0 - 8.5	7.0 - 8.5
Suspended Solids	19.1[h]	38.3	57.6	95.5
Conductivity (μmhos/cm)	576	1152	1728	2880

(a) Blowdown refers to cooling tower blowdown not plant discharge. Plant service water may be mixed with blowdown prior to discharge.

(b) Sulfate concentrations include sulfate from sulfuric acid addition.

(c) Ferrous (dissolved) iron will be oxidized in the cooling tower.

(d) Chlorination is controlled to effect a maximum of less than 0.5 mg/l and an average of less than 0.2 mg/l free available chlorine in the blowdown. Neither free available chlorine nor total residual chlorine is discharged from any unit for more than 2 hours in any one day and not more than one unit will discharge free available or total residual chlorine at any one time.

(e) Absorption in the cooling towers is expected to lead to concentrations consistently greater than 5.0 mg/l.

(f) Carbon dioxide could vary from around 0.5 to tens of mg/l; several mg/l (of the order of the river) are usually to be expected.

(g) pH will be adjusted during circulating water system operation.

(h) Suspended solids indicated for the intake well water are those from complete iron oxidation and precipitation assuming ferric hydroxide formation; suspended solids due to entrained sand or silt are not included due to the lack of long-term estimates for same.

n/a - not available

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TABLE 3.6.3b

PLANT DISCHARGE, MISSISSIPPI RIVER, AND DISCHARGE LIMIT WATER QUALITIES

(mg/l or other units as noted)

Parameter	Plant Discharge[a] 2 Cycles	3 Cycles	5 Cycles	Mississippi[b] River	Federal Discharge Limits[c]
Dissolved Solids	752	974	974	230	-
Hardness (as $CaCO_3$)	664	860	860	40	-
Calcium	186	241	241	39	-
Magnesium	48	62	62	10	-
Sodium	36.8	48	48	20	-
Potassium	8.2	10.6	10.6	2.8	-
Sulfate[d]	446	599	581	50	-
Chloride	38	49.2	49.2	23	-
Nitrate	7.2	9.3	9.3	2.8	-
Silica	34	44	44	8.7	-
Nitrogen (total)	11.0	14.2	14.2	2.0	-
Ammonia-Nitrogen	1.1	1.4	1.4	0.13	-
Aluminum	n/a	n/a	n/a	0.024	-
Copper	n/a	n/a	n/a	0.012	-
Iron (dissolved)	0.0	0.0	0.9	0.039	-
Zinc	n/a	n/a	n/a	0.046	-
Chlorine Demand	7.8	10.1	10.1	2.4	-
Chlorine (free available)	(e)	(e)	(e)	-	0.5 max., 0.2 avg.
Dissolved Oxygen	7.8	5.9	2.4	8.6	-
Carbon Dioxide	(f)	(f)	(f)	4.0	-
pH	8.0	7.6	7.2	7.5	6.0 - 9.0

TABLE 3.6.3b (Cont.)

Parameter	Plant Discharge[a] 2 Cycles	3 Cycles	5 Cycles	Mississippi[b] River	Federal Discharge Limits[c]
Suspended Solids	38.3	49.5	49.5	150	-
Conductivity (μmhos/cm)	1152	1492	1492	370	-

(a) At two cycles of concentration there is no makeup bypass; therefore, the plant discharge is the cooling tower blowdown. For three and five cycles the concentration of conservative substances is controlled by the makeup and discharge quantities for the entire plant. Since these quantities are the same at three and five cycles, the concentrations are also the same.

(b) U.S. Army Corps of Engineers Water Quality Data for St. Francesville, Louisiana (1954-1968) and Delta Point, Louisiana (1959-1968) plus river site monitoring data (Nov. 1972 - Nov. 1973) for dissolved oxygen, suspended solids and pH.

(c) Federal discharge limitations are taken from U.S. EPA Standards of Performance for New Sources (40 CFR 423.15).

(d) Sulfate concentrations include sulfate from sulfuric acid addition.

(e) Chlorination is controlled to effect a maximum of less than 0.5 mg/l and an average of less than 0.2 mg/l free available chlorine in the blowdown. Neither free available chlorine nor total residual chlorine is discharged from any unit for more than 2 hours. In addition, makeup bypass water will provide some dilution.

(f) Carbon dioxide could vary from around 0.5 to tens of mg/l; several mg/l (of the order of the river) are usually to be expected.

n/a - not available

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TABLE 3.6.4

DESIGN DISCHARGE CONCENTRATIONS
(mg/l or other units as noted)

Waste Stream	Pollutant	Design Discharge Concentration Maximum	Design Discharge Concentration Average	EPA Waste Category (Note 1) (Allowable Discharge Concentration-Maximum/Average)
a. Makeup demineralizer-liquid wastes	TSS	Negligible (Note 2)		LVS (100/30)
	Oil & grease	< 20	< 15	LVS (20/15)
	pH	6.0 < pH range < 9.0		AD (6.0 < pH range < 9.0)
b. Activated carbon filters - backwash and rinse	TSS	(Note 3)		LVS (100/30)
	Oil & grease	< 20	< 15	LVS (20/15)
	pH	6.0 < pH range < 9.0		AD (6.0 < pH range < 9.0)
c. Floor drainage Fire water pump house	TSS	(Note 5)		LVS (100/30)
	Oil & grease	(Note 5)		LVS (20/15)
	pH	6.0 < pH range < 9.0		AD (6.0 < pH range < 9.0)
Diesel generator and water treatment building	TSS	(Note 5)		LVS (100/30)
	Oil & grease	(Note 5)		LVS (20/15)
	pH	6.0 < pH range < 9.0		AD (6.0 < pH range < 9.0)
Administration building	TSS	(Note 5)		LVS (100/30)
	Oil & grease	(Note 5)		LVS (20/15)
	pH	6.0 < pH range < 9.0		AD (6.0 < pH range < 9.0)
d. Standby service water system - blowdown (Note 4)	TSS	< 100	< 30	LVS (100/30)
	Oil & grease	< 20	< 15	LVS (20/15)
	pH	6.0 < pH range < 9.0		AD (6.0 < pH range < 9.0)

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TABLE 3.6.4 (Cont.)

Waste Stream	Pollutant	Design Discharge Concentration Maximum	Design Discharge Concentration Average	EPA Waste Category (Note 1) (Allowable Discharge Concentration-Maximum/Average)
e. Auxiliary boiler blowdown	TSS	(Note 6)		BBD (100/30)
	Oil & grease	(Note 6)		BBD (20/15)
	Copper, total	(Note 6)		BBD (1.0/1.0)
	Iron, total	(Note 6)		BBD (1.0/1.0)
	pH	6.0 < pH range < 9.0		AD (6.0 < pH range < 9.0)

NOTES:

1. EPA waste categories and allowable discharge concentration are from 40 CFR 423.15.
   LVS - Low Volume Waste Sources
   AD - All Discharges
   BBD - Boiler Blowdown

2. Small quantities of resin fines may be present.

3. Although the filters have some capability to filter suspended solids, given the ground, water nature of the plant service water radial well system, it is not expected that the filters will collect significant quantities of suspended solids during design operating conditions.

4. When makeup water is available from the plant service water system, a portion of the standby service water system will be blown down (during operation) to prevent the concentration of fouling agents. System operates during plant emergency, refueling (once per year per unit), and system testing (once per month per unit).

5. Gravity type oil interceptors are used for oil and solids removal. The design free oil removal efficiency is 90%.

6. Actual discharge concentrations should be less than allowable discharge concentrations as reported in Reference 1.

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TABLE 3.6.5

MAKEUP DEMINERALIZER REGENERATION DATA (Note 1)

Unit	Portion of Cycle	Rate (gpm)	Time (min)	Volume/Cycle (gal/train)
Anion	Backwash	70	15	1,050
Cation	Backwash I	95	15	1,425
	Backwash II	95	15	1,425
Cation/Anion	Settle	-	5	-
Anion (Note 2)	Bed warm-up	38	20	760
	a. Blocking water	48	20	960
	Caustic in I			
	a. Dilution water	38	25	950
	b. Caustic (50 w%)	2.2	25	55
	c. Blocking water	48	25	1,200
	Caustic in II			
	a. Dilution water	38	50.5	1,919
	b. Caustic (50 w%)	2.2	50.5	111
	c. Blocking water	48	50.5	2,424
	Caustic in III (Note 3)			
	a. Dilution water	38	3	114
	b. Caustic (50 w%)	2.2	3	7
	c. Blocking water	48	3	144
	Slow rinse	38	40	1,520
	a. Blocking water	48	40	1,920
Cation (Note 2)	Acid in I			
	a. Dilution water	42	64	2,688
	b. Acid (66° Be')	0.5	64	32
	c. Intermediate dilution to 0.8%	65	64	4,160
	d. Blocking water	129	64	8,256
	Acid in II			
	a. Dilution water	42	61.5	2,583
	b. Acid (66° Be')	1	61.5	62
	c. Intermediate dilution to 1.6%	65	61.5	3,998
	d. Blocking water	129	61.5	7,934

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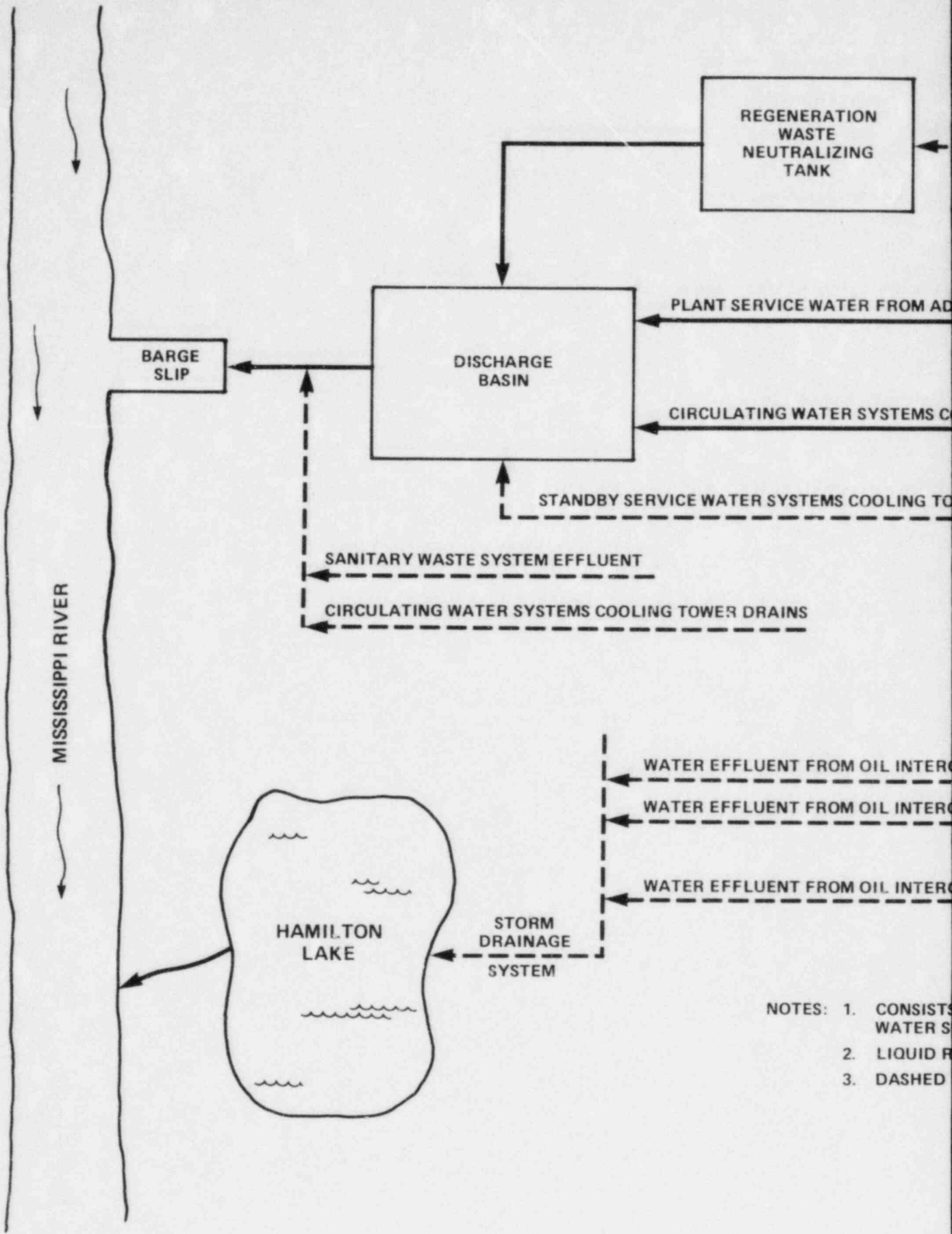
TABLE 3.6.5 (Cont.)

Unit	Portion of Cycle	Rate (gpm)	Time (min)	Volume/Cycle (gal/train)
	Acid in III (Note 3)			
	a. Dilution water	42	3	126
	b. Acid (66° Be')	1	3	3
	c. Intermediate dilution to 1.6%	65	3	195
	d. Blocking water	129	3	387
	Slow rinse	42	15	630
	a. Intermediate dilution	65	15	975
	b. Blocking water	129	15	1,935
	Backflush	180	1	180
	Fast rinse	180	20	3,600
Cation/Anion	Fast rinse	180	16	2,880
	Flush I	200	0.5	100
	Flush II	200	0.5	100
	Final (conductivity) rinse	180	120 (maximum)	21,600 (maximum)
				Total Per Regeneration 78,408 (maximum) (Note 4)

Notes:
1. There are two trains of makeup demineralizers. Each train contains a layered bed cation and anion exchanger. The volumes shown will vary depending upon the resin age, influent water temperature, organic fouling of resins and concentration of regenerant chemicals.
2. At this point both the cation and anion exchanger regenerations start simultaneously.
3. These are optional steps.
4. Total gallons per regeneration are approximately 56,800 without final (conductivity) rinse.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PLANT SERVICE WATER FROM AD
DISCHARGE BASIN
BARGE SLIP
CIRCULATING WATER SYSTEMS C
STANDBY SERVICE WATER SYSTEMS COOLING TO
SANITARY WASTE SYSTEM EFFLUENT
CIRCULATING WATER SYSTEMS COOLING TOWER DRAINS
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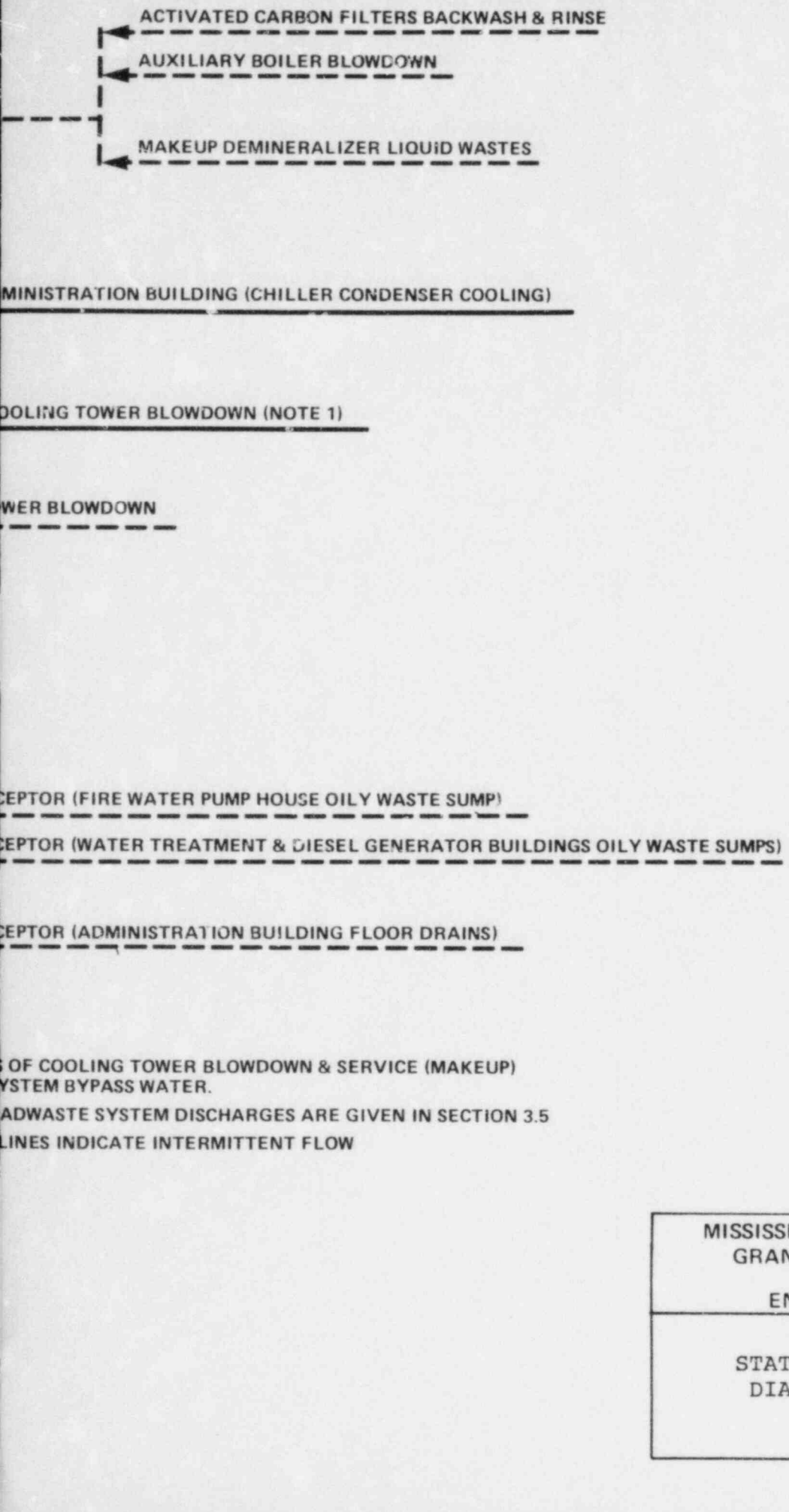

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

STATION OPERATIONAL WASTE
DIAGRAM (NONRADIOACTIVE)

FIGURE 3.6-1

3.7 SANITARY AND OTHER WASTE SYSTEMS

In addition to the systems discussed in previous sections, several other waste treatment systems are necessary to treat and dispose of waste materials at the Grand Gulf Nuclear Station. Typically, a generating station produces a wide variety of waste materials, such as sanitary waste and floor and equipment drainage, which must be processed prior to discharge to the environment. Several systems are necessary to control the amount of waste produced within a generating station and to minimize the environmental effect of discharging either water or gases to the environment.

3.7.1 Sanitary Waste System

The sanitary waste system is designed solely to treat domestic type wastes. Industrial type materials, such as effluent from the chemistry laboratory, have been excluded from the system. The system was designed for a wastewater flow of 15,000 gpd which assumes a design population of 300 with per capita contribution of 50 gallons per day.

A package type extended aeration unit was selected for treating this low flow sanitary waste. The unit eliminates the need for primary treatment since the influent sewage passes directly into the aeration tank from the comminutor chamber. The sewage is then thoroughly mixed with a sludge containing active microorganisms. The sludge consumes nutrients available in the wastewater and grows into an easily flocculated mass. This is an aerobic process, so it is necessary that a certain minimum level of oxygen be maintained in the aeration tank. The tank is outfitted with aeration equipment to maintain an oxygen concentration of 2 mg/l. The wastewater/sludge mixture is retained in the aeration tank for 24 hours. This retention time is necessary to ensure removal of BOD through adequate growth of the activated sludge. The mixture is then transferred to a settling tank where the solids are separated from the effluent.

The effluent is then passed through a chlorine contact chamber where the water is treated with chlorine for disinfection. Contact chambers are equipped with baffles which increase the treatment time and intimacy of contact between the water and chlorine. Typically, a contact time of 15 to 30 minutes is necessary for proper disinfection. Baffling ensures the necessary contact time.

The solids are returned to sludge storage tanks where they are aerated to continue digestion of the waste materials. Eventually, the microorganisms consume most waste materials contained in

the settled mass. What remains is an activated sludge, part of which is recycled to the aeration tank for treating additional sanitary waste. The remainder of the sludge is trucked offsite by a commerical contractor.

The treated water (i.e., effluent from the chlorine contact tank) has more than 90 percent of the suspended solids and BOD removed. Less than 20 mg/l of both suspended solids and BOD remain in the effluent which joins the cooling tower blowdown and other station effluents before being discharged into the Mississippi River. The blowdown and effluent mix thoroughly, thus diluting the concentration of suspended solids and BOD. The dilution ratio is greater than 2000:1 so the resulting concentrations of suspended solids and BOD, attributable to the sanitary effluent, are less than 0.01 mg/l. It should be emphasized that the blowdown and waste effluent are not combined to reduce pollutant concentrations, but rather because it is the most convenient manner of discharging both without duplicating facilities.

3.7.2 Other Waste Systems

Disposal of radioactive waste materials is discussed in Section 3.5. Disposal of nonradioactive wastes generated in such areas as the diesel generator building, water treatment building, fire water pumphouse, etc. are discussed in this subsection.

Before discussing the specific nonradwaste systems, a general description of floor and equipment drain systems is necessary to explain the operation of equipment used in most of the drainage systems.

Both equipment and floor drainage systems utilize sumps which are provided with level instrumentation to start and stop the sump pumps and to activate high-high level alarms. As the level in a sump reaches a preset level, one of the two pumps is automatically started. If the liquid level continues to rise, a second level point is reached, the second pump is started, and the alarm is activated. When the level is reduced to a minimum, the running pump(s) is (are) automatically stopped.

If the fire protection system in any of the areas serviced by the oily waste clean (OWC) drainage system requires the use of both sump pumps simultaneously to drain the sump, a signal from the fire protection system to the valving on the pump discharge lines directs the flow to the floor drain oil interceptor.

3.7.2.1 Diesel Generator and Water Treatment Buildings

Nonradioactive waste materials from the diesel generator and water treatment buildings are collected in oily waste sumps which are located in both buildings. The diesel generator building contains two oily waste sumps, one in each bay, in order to provide redundancy of equipment. This redundancy of equipment is utilized to

provide backup facilities wherever frequent breakdown or maintenance is liable to occur which would hamper system or plant operation.

In the diesel generator building, oil is stored in small containers which are segregated from one another. The only other source of oil would be leakage from the equipment.

In the water treatment building, the only source of oil would be leakage from the equipment.

Except for accidents, routine area washdowns will lead to only very minor and intermittent oil waste discharges to the sumps. See section 5.6.7 for additional information.

301.6

The waste material from these sumps is pumped through a gravity oil interceptor which processes the effluent from the oily waste sumps of both the diesel generator and the water treatment buildings. The waste oil collected is stored in a waste oil tank while the effluent water is routed to the storm drainage system. The system has a design capacity of approximately 100 to 400 gpm.

3.7.2.2 Fire Water Pumphouse and Administration Building

Floor and equipment drainage from the fire water pumphouse is collected in a sump. The discharge from this sump is also routed to a gravity oil interceptor. The oil is collected in a waste oil tank, and the effluent is routed to the storm drainage system. This system has a maximum design capacity of 200 gpm. Water effluent from the administration building floor drains oil interceptor is also routed to the storm drainage system. The design capacity is 50 gpm.

301.6

3.7.2.3 Water Pumphouse Valve Pit

Nonradioactive drains from the circulating water pumphouse valve pit are collected in the circulating water pumphouse pit; from this sump the liquid is pumped to the circulating water inlet structure.

3.7.2.4 Turbine Building Oily Waste Clean Drains

Nonradioactive, potentially oily drains from the lube oil conditioner, reactor feed pump turbine lube oil coolers and tank, and the main turbine lube oil reservoir are collected in the turbine building OWC drain sump. Normal oil leakage is pumped to the stabilizing sump and floor drain oil interceptor located in the radwaste building. Tne content of the floor drain sumps in the turbine building is also pumped to a stabilizing sump located in the radwaste building. Additional processing of the turbine building oily waste is covered in Section 3.5 which discusses treatment of radwaste materials.

3.7.2.5 Chemical Waste System

Chemical wastes from laboratory drains, equipment decontamination, and chemical additives are collected in chemical waste sumps located throughout the plant. Wastes from these tanks are transferred to the chemical waste tank of the radwaste disposal system which is located in the radwaste building. These chemical waste sumps are also equipped with high-high level electronics similar to those utilized in the equipment and floor drain systems.

3.7.2.6 Surface Drainage and Roof Drains

The immediate plant area surrounding the major structures is drained by a storm drainage system which conveys the runoff and roof drains into major drainage courses and finally to Hamilton Lake which is linked to the Mississippi River.

3.7.2.7 Gaseous Effluents

Two major systems, HPCS diesel generator system and the standby diesel generator system, discharge gases into the atmosphere.

The HPCS generator (one per unit) supplies power exclusively to the high pressure core spray system when there is a failure of the normal power source. This system is used only under emergency conditions or when the system is tested. Effluent gases in this operation contain particulates, sulfur compounds, carbon monoxide, hydrocarbons, and nitrogen oxides.

The function of the standby diesel generator (two per unit) is to furnish an alternate source of electrical power to shut down the reactor and to maintain the reactor in a safe shutdown condition during loss of power. It operates only under emergency conditions or when it is tested. The same pollutants are discharged by this system as are discharged by the HPCS system.

Pollution controls are not used on either system since both only experience intermittent service and small quantities of pollutants are discharged to the atmosphere. Table 3.7.1 summarizes the emissions of both systems.

TABLE 3.7.1

YEARLY EMISSIONS FROM DIESEL GENERATORS[1,2]

Pollutant Discharged	HPCS Diesel Generators (lb)	Standby Diesel Generators (lb)
Particulates	329	1,397
Sulfur oxides	1,580	6,705
Carbon monoxide	4	19
Hydrocarbons	66	279
Nitrogen oxides	1,316	5,587

1. Both HPCS diesel generator and standby diesel generator emissions are based on 4 hours per month operation for each of the generators.

2. At the Grand Gulf Nuclear Station Units 1 and 2, there are a total of two HPCS diesel generators and four standby diesel generators.

3.8 REPORTING OF RADIOACTIVE MATERIAL MOVEMENT

The environmental risks associated with the transportation of radioactive fuel and wastes to and from Grand Gulf Nuclear Station Units 1 and 2 are as set forth in Summary Table S-4 of 10 CFR Part 51.

3.9 TRANSMISSION FACILITIES

The Grand Gulf Nuclear Station is linked to load demand areas by a system of transmission lines. Planning studies have shown that the most practical means of transmitting the approximately 2500 MW generated is to interconnect the station with existing 500 kV transmission facilities. A map of the MP&L service area showing the existing transmission system is presented in Figure 3.9-1.

The most economical transmission line routing results from a minimum length (straight line) between the station and the existing transmission facilities. However, environmental, economic, and engineering considerations require that, whenever possible, the routes be established away from areas that are densely populated, historically unique, ecologically sensitive, and/or aesthetically pleasing.

NRC General Design Criterion 17, Electric Power System, requires that the station switchyard be supplied with offsite ac power by means of physically independent circuits to minimize simultaneous failure of all offsite power sources.

3.9.1 Transmission Line Routes

The transmission routing from the Grand Gulf Nuclear Station is shown in Figure 3.9-2. A 43.6-mile single-circuit 500 kV transmission line connects to the Franklin EHV Switching Station, located southeast of the site, and a similar 22-mile line connects to the Baxter Wilson Steam Electric Station and its EHV Switchyard. A 5.5-mile single-circuit 115 kV transmission line to the Port Gibson Substation provides construction power and an alternate source of emergency startup power. These transmission lines are required for operation of Unit 1. A third 500 kV transmission line, 24 miles in length, connects the Grand Gulf Nuclear Station to the Ray Braswell EHV Substation located northeast of the site and is required for operation of Unit 2.

3.9.1.1 Baxter Wilson Steam Electric Station Route

A 22-mile single-circuit 500 kV transmission line connects the Grand Gulf Nuclear Station to the Baxter Wilson EHV Substation near Vicksburg, Mississippi. This connection utilizes the existing EHV system emanating from the Baxter Wilson Steam Electric Station, thus connecting the Grand Gulf Nuclear Station with transmission lines serving northern Mississippi, northern Louisiana, and Arkansas.

3.9.1.2 Ray Braswell EHV Substation Route

A 24-mile single-circuit 500 kV transmission line connects the Grand Gulf Nuclear Station to an existing 500 kV transmission line feeding into the Ray Braswell EHV Substation near Jackson, Mississippi.

Through deactivation of a 6.11-mile segment of the existing 500 kV line, this connection enables the Grand Gulf Nuclear Station to feed into the service area of the Ray Braswell facility without requiring the construction of an additional EHV switching station or substation.

3.9.1.3 Franklin EHV Substation Route

A 43.6-mile single-circuit 500 kV transmission line connects the Grand Gulf Nuclear Station to the Franklin EHV Substation. The Franklin EHV Substation is centrally located to serve as a focal point of high-voltage distribution to a large area. This station is tied to the north by a 500 kV line from the Ray Braswell EHV Substation and to the south by a 500 kV line of the Gulf States Utilities System which serves southeastern Louisiana (see Figure 3.9-1). The line from the Grand Gulf Nuclear Station facilitates a three-way feed into the load center served by the Franklin Substation. Juncture with the north-south EHV trunkline at any other point would require the construction of another EHV switching station and additional lower voltage transmission lines.

3.9.1.4 Port Gibson Substation Route

A 5.5-mile single-circuit 115 kV transmission line connects the Grand Gulf Nuclear Station to the Port Gibson Substation. This connection provides construction power and an alternate source of emergency startup power.

3.9.2 Route Selection

Reconnaissance surveys were conducted for each of the four proposed lines to establish flight patterns for aerial strip photography. Several possible routes were outlined on state highway planning maps, and the most feasible general routing corridor for each line was selected. Each corridor was then flown and photographed, a mosaic was compiled from the photographs of each corridor, and alternate alignments for each route were studied. A ground reconnaissance team, consisting of two terrestrial biologists and a construction specialist, collected field data from representative areas throughout the length of each corridor. These ground reconnaissance data were evaluated to determine the most desirable routing in each corridor.

Factors considered in final route selection included:

a. Historic sites
b. Physical and aesthetic effects on the environment
c. Wildlife, particularly rare or endangered species, occurring along the routes
d. Current private land use

e. Current and future public land use
f. Restoration and multiple use of line right-of-way corridors
g. Maximum utilization of proposed transmission design capabilities
h. Line construction and maintenance
i. Right-of-way acquisition

The design of the transmission lines has been guided by the Department of Interior/Department of Agriculture publication entitled "Environmental Criteria for Electric Transmission Systems" and the Federal Power Commission publication, "Electric Power Transmission and the Environment."

3.9.3 Route Descriptions

Current land use and basic plant communities along the transmission line routes are summarized in Tables 3.9.1 and 3.9.2, respectively. A summary of plants and wildlife typically occurring in various basic plant communities is presented in Table 3.9.3. Various physical characteristics (e.g., major highway and river crossings) along the routes are compared in Table 3.9.4. Details of specific features, especially potentially aesthetically sensitive areas along each transmission line route, are discussed below.

The transmission line routings do not materially affect current land use. No residences were relocated along the routes.

3.9.3.1 Baxter Wilson Route

The 22-mile single-circuit 500 kV transmission line route to the Baxter Wilson Substation has been located as far east of the Grand Gulf Military Park as practical. Approximately 110 transmission line towers are required to construct this line.

The right-of-way traverses a rural, sparsely populated area with agriculture and forestry as the predominating land uses. With the exception of MP&L's property, this line traverses only one small industrial area (see Figure 3.9-3). This route passes through approximately 10.3 miles of hardwood forest, markedly irregular loessial bluff terrain, 1.7 miles of relatively flat hardwood-forested Big Black River bottomland, and 10 miles of farmland located on the Mississippi River floodplain.

The northern portion of the route runs parallel to an existing 115 kV line for 6.9 miles. Approximately 3 miles of this section of the route is located 1/4 to 1/2 mile west of U. S. Highway 61 and the adjacent Illinois Central Gulf Railroad tracks. This route also runs parallel to and approximately 100 feet east of an existing 13 kV distribution circuit right-of-way for 2.2 miles in Warren County.

Areas of potential aesthetic sensitivity occurring along this route are described below and are keyed to like numbers in Figure 3.9-3 which are indicated in parentheses following each heading.

a. Grand Gulf Military Park Observation Tower (1)

This 55-foot-high tower, located on the loessial bluffs overlooking the Mississippi River, provides a panoramic view of the Grand Gulf Military Park area. The tops of some transmission towers are partly visible from the observation tower as one looks eastward away from the Mississippi River. To minimize the adverse aesthetic impact, the powerline route has been located as far east of the tower as practicable (approximately 10,000 feet).

b. Grand Gulf Boy Scout Trail (2)

The powerline crosses a dirt road that is used as a hiking trail by Boy Scouts when they camp at the Grand Gulf Military Park. The crossing is in a wooded area where the aesthetic impact is minimal.

c. Big Black River Crossing (3)

The powerline crosses the Big Black River parallel and adjacent to the Illinois Central Gulf Railroad crossing. This crossing is in a remotely wooded area, and the aesthetic impact is negligible.

d. U. S. Highway 61 (4)

For approximately 3.6 miles, the powerline parallels an existing 115 kV line located approximately 1/4 to 1/2 mile west of U. S. Highway 61. This entire area is currently used as soybean fields and pastures; the powerline is, therefore, visible to motorists looking west from the highway. The Illinois Central Gulf Railroad tracks are located adjacent to the western shoulder of the highway at this point. The existence of the present transmission line and railroad facilities near to and visible from the highway minimizes the adverse aesthetic impact created by constructing the 500 kV transmission line in this area.

The Baxter Wilson route does not cross any prime farmland (capability Class I) within Claiborne County (Ref. 4). Within Warren County the route passes over about 35 acres of capability Class I soils (Ref. 5). Soil types crossed are Memphis silt loam (0-2 percent slope) (3.5 acres) and Commerce silt loam (31.5 acres). The former series consists of nearly level, deep, well-drained, and

301.1

moderately well drained soils on the loessial uplands. This series is well suited for row crops, small grains, most grasses and legumes, and pecans. Commerce silt loam soils, located in alluvium along the Mississippi River, are nearly level and moderately well drained to somewhat poorly drained. This series is well suited to row crops, many grasses and legumes, and pecans. Memphis silt loam (0-2 percent slope) soils cover about 2790 acres, or 0.8 percent of Warren County, while Commerce silt loam covers 3135 acres, or 0.9 percent of the county. Including all Class I soils, there are 18,570 acres of prime farmland in Warren County. Thus, the acreage of prime farmland crossed is minimal when compared to the county as a whole. 301.1

3.9.3.2 Ray Braswell Route

A 24-mile single-circuit 500 kV transmission line, requiring the construction of approximately 125 transmission towers, connects the Grand Gulf Nuclear Station to the 500 kV Ray Braswell line southeast of Vicksburg.

Between the nuclear station and U. S. Highway 61, this route traverses approximately 11 miles of almost entirely unpopulated hardwood forest, markedly irregular loessial bluff terrain, and

1.4 miles of relatively flat, hardwood-forested Big Black River bottomland (see Figure 3.9-3). North of U. S. Highway 61, the route passes through about 12 miles of sparsely populated loessial bluff hardwood or mixed hardwood and pine forest, interspersed with small farms and occasional residences.

This route crosses the Big Black River and U. S. Highway 61 and traverses an undeveloped portion of the Lake Park Estates residential development southwest of Vicksburg.

Areas of potential aesthetic sensitivity occurring along this route are described below and are keyed to like numbers in Figure 3.9-3 which are indicated in parentheses following each heading.

a. Grand Gulf Military Park Observation Tower (1)

This 55-foot-high tower, located on the loessial bluffs overlooking the Mississippi River, provides a panoramic view of the Grand Gulf Military Park area. The tops of some transmission towers are partly visible from the observation tower as one looks eastward away from the Mississippi River. To minimize the adverse aesthetic impact, the powerline route has been located as far east of the tower as practicable (approximately 10,000 feet).

b. Grand Gulf Boy Scout Trail (5)

The powerline crosses a dirt road that is used as a hiking trail by Boy Scouts when they camp at the Grand Gulf Military Park. The crossing is in a wooded area where the aesthetic impact is minimal.

c. Big Black River Crossing (6)

The powerline crosses the Big Black River in a remote wooded area, creating a negligible impact.

d. U. S. Highway 61 Crossing (7)

The powerline crosses U. S. Highway 61 near an existing crossing of a 115 kV transmission line. The area is wooded and the crossing occurs at a curve in the highway. Shielding by the curve and the trees minimizes the aesthetic impact of the powerline on motorists.

e. Lake Park Estates Residential Development (8)

The powerline crosses the Lake Park Estates housing development about 2 miles southeast of Vicksburg. The routing utilizes an undeveloped section of the development that is a mixture of pasture and small woodlots.

Most of the houses in this development are built near a lake located about 1 mile east of the route. This routing does not require the relocation of any houses. This transmission line creates only a minimal adverse aesthetic impact.

The Ray Braswell route does not cross any prime farmland within Claiborne County (Ref. 4); it does cross about 16 acres within Warren County (Ref. 5). Soils crossed include Memphis silt loam (0-2 percent slope) (14 acres) and Memphis and Loring silt loam (0-2 percent slope) (2 acres). Both soil types are in capability Class I-1 and are nearly level, deep, well-drained, and moderately well drained. Soils in this capability class are found in the loessial bluffs and are well suited for row crops, small grains, most grasses and legumes, and pecans. Memphis silt loam (0-2 percent slope) soils cover about 2790 acres, or 0.8 percent of Warren County, while Memphis and Loring silt loam (0-2 percent slope) covers 320 acres, or 0.1 percent of the county. Including all Class I soils, there are 18,570 acres of prime farmland in Warren County. Thus, the acreage of prime farmland crossed is small when compared to the county-wide figures.

301.1

3.9.3.3 Franklin Route

A 43.6-mile single-circuit 500 kV transmission line, requiring the construction of 212 transmission line towers, connects the Grand Gulf Nuclear Station to the Franklin Substation southeast of the site. This route traverses approximately 10 miles of loessial bluff hardwood forest and fields, and 34 miles of pine and hardwood forested gently rolling hills interspersed with small farms (see Figure 3.9-4).

Major highways crossed by this route are U. S. Highway 61, the Natchez Trace Parkway, Mississippi Highway 28, and Mississippi Highway 550. This route also crosses Bayou Pierre and the Homochitto River and traverses portions of the Homochitto National Forest.

Other than U. S. Highway 61, this route does not cross any heavily traveled roads or approach any populous areas. All road crossings are in rural areas and are nearly perpendicular. Potentially adverse aesthetic impact on travelers is therefore minimal because of shielding by trees, particularly at the Natchez Trace crossing.

The 6-mile segment immediately south of the station was selected to avoid the town of Port Gibson and the scene of the Civil War Battle of Port Gibson (see Figure 3.9-4). In addition, the Mosswood Country Club and golf course, located approximately 1 mile north of the U. S. Highway 61 crossing, is avoided by this alignment.

Special consideration was given to that portion of the line which necessarily crosses a part of the Homochitto National Forest. A possible route was considered that would pass through the National Forest boundaries entirely on privately owned land. However, this route would require paralleling the Homochitto River and was determined to be aesthetically undesirable. Through careful alignment adjustments, the route obtains a near perpendicular crossing of the Homochitto River. It passes through the forest boundaries on approximately 9.5 miles of privately owned land and traverses only 1.6 miles of National Forest land. Multiple-use projects on the private land right-of-way corridors, similar to past practices by MP&L have been implemented. See subsection 3.9.4.8 for a description of these projects.

Areas of potential aesthetic sensitivity occurring along this route are described below and are keyed to like numbers in Figure 3.9-4 which are indicated in parentheses following each heading.

a. Port Gibson Lookout (9)

The Port Gibson Lookout is located on loessial bluffs overlooking the eastern bank of Bayou Pierre. To avoid the area of the Battle of Port Gibson, the powerline crosses Bayou Pierre within partial view of the lookout. The route is located in a thickly wooded area about 1 mile west of the lookout. A 100-foot buffer strip parallel with and on each side of the top bank has been selectively cleared to minimize the adverse aesthetic impact.

b. Natchez Trace Parkway Crossing (10)

The powerline crosses the Natchez Trace close to a thickly wooded area. A 50-foot buffer strip has been maintained to shield the transmission line from the view of motorists on the Trace.

c. U. S. Highway 61 Crossing (11)

The powerline crosses U. S. Highway 61 in a rural area south of Port Gibson. This crossing is in an open agricultural area and avoids the Mosswood Country Club. Trees shield the powerline from the vision of motorists driving south toward Natchez. The powerline is visible to motorists driving north for a distance of about 0.5 mile. The aesthetic impact of this crossing is therefore minimal.

d. Mississippi Highway 28 Crossing (12)

The powerline crosses Highway 28 in a rural, semi-wooded pasture area. These conditions are typical along the highway, and the adverse aesthetic impact is minimal.

e. Mississippi Highway 550 Crossing (13)

The powerline crosses Highway 550 in a rural semi-wooded pasture area. As in the case of the Highway 28 crossing, these conditions are typical along the highway and the adverse aesthetic impact is minimal.

f. Homochitto River Crossing (14)

The powerline crosses the Homochitto River about 1500 feet south of the Mississippi Highway 550 bridge in a thickly forested area. Only the tower tops are visible to motorists. The alignment of the right-of-way does not parallel the river, thereby minimizing the aesthetic impact on canoeists.

g. Homochitto National Forest Crossing (15)

The powerline crosses the Homochitto National Forest almost entirely on privately owned land. About 1.6 miles of the line are located on National Forest land. This crossing occurs in a thickly wooded area and does not create any adverse aesthetic impact. An alternate route through the forest, entirely utilizing privately owned land, was rejected because it required paralleling the Homochitto River, which would create an adverse aesthetic impact.

It is not possible to determine the acreage of prime farmland (capability Class I) crossed by the Franklin route in Jefferson and Franklin counties, since soil survey maps are not available for these counties. Within Claiborne County the route crosses approximately 2.5 acres of prime farmland. All of it is classified as Memphis silt loam (0-2 percent slope) (Ref. 4). The characteristics of this soil type are discussed in Section 3.9.3.1. There are 6045 acres of Memphis silt loam (0-2 percent slope) and a total of 8200 acres of all Class I soils in Claiborne County. Thus, the line will affect only a small percentage of prime farmland in the county. There is no prime farmland in Lincoln County (Ref. 6). 301.1

3.9.3.4 Port Gibson Route

A 5.5-mile single-circuit 115 kV transmission line, requiring the construction of approximately 56 transmission line structures, connects the Grand Gulf Nuclear Station to the Port Gibson Substation. This route traverses lightly populated agricultural areas of field and small woodlots (see Figure 3.9-4). The route alignment was adjusted to avoid residential areas of Port Gibson.

A railroad spur was built from the Illinois Central Gulf Railroad tracks to the nuclear station. The 115 kV transmission line was constructed adjacent to this spur for approximately 2.4 miles, eliminating the ecological damage resulting from the clearing of an additional right-of-way corridor for the transmission line for this distance.

The only area of potentially aesthetic sensitivity on this route is the U. S. Highway 61 Crossing, which is shown in Figure 3.9-4 as Location 16. The crossing is located in a nonscenic commercial area containing two gasoline stations and oil storage tanks. The aesthetic impact of the powerline is therefore negligible.

The Port Gibson route crosses about 3.8 acres of prime farmland within Claiborne County (Ref. 4). All of this is classified as Memphis silt loam (0-2 percent slope), the characteristics of which are discussed above (see section 3.9.3.1). This represents only a small portion of the total acreage of Class I soils within the county (8200 acres). 301.1

3.9.4 General Features of Transmission Line Corridors

Many features requiring consideration during transmission line route selection are common or at least similar for all of the transmission line routes emanating from Grand Gulf Nuclear Station. These general features are described in this subsection. Specific descriptions of each transmission line route are presented in subsection 3.9.3.

3.9.4.1 Current Land Use

Approximately 98 percent of the land adjacent to all of the transmission line corridors is currently used for forestry (58 percent) or agricultural (40 percent) purposes. The remaining land is presently used for residential (1 percent) or industrial (1 percent) purposes. Current land use types are quantified in miles

for each transmission line route in Table 3.9.1 and are illustrated for the Baxter Wilson and Ray Braswell routes in Figure 3.9-3 and for the Franklin and Port Gibson routes in Figure 3.9-4. Almost all of the land may be utilized for recreational hunting.

3.9.4.2 Aesthetic Considerations

The clearance of right-of-way corridors in wooded areas and the intrusion of man-made structures may have an adverse impact on the scenic beauty of an area. Aesthetic values are difficult to evaluate inasmuch as they vary with the individual observer.

To minimize the adverse aesthetic impact of the Grand Gulf transmission line corridors, areas of potentially aesthetic sensitivity were identified and evaluated in designing the routes. Emphasis was placed on minimizing adverse aesthetic impact in areas of particular natural beauty, in residential areas, and at all major highway and river crossings.

3.9.4.3 Historical Sites

The Grand Gulf Nuclear Station site is located in an old and historic section of Mississippi. Claiborne County was one of the first counties organized in the State and contains many historic features, including antebellum homes, Civil War battlefields, and Indian relics. The northern boundary of the site is adjacent to the Grand Gulf Military Park, which is included in the National Register of Historic Places.

To determine the location of historically significant sites in the vicinity of the station and the transmission line corridors, MP&L has conducted historic site analyses which included the funding of a survey by the Mississippi Department of Archives and History. Information obtained from this survey was used to ensure that the transmission line routes avoid historically important areas.

3.9.4.4 Dominant Plants and Animals

The basic plant communities occurring along the transmission line routes and the estimated length and acreage of right-of-way in each basic plant community are presented in Table 3.9.2. The locations of these basic plant communities along transmission line routes are shown in Figures 3.9-3 and 3.9-4. The common plant and animal species typically occurring in each basic plant community are listed in Table 3.9.3.

Forests in the western portion of Mississippi are typically dominated by oak, hickory, and sweetgum in loessial bluffs; oak, sugarberry, and green ash in river bottomlands; and loblolly pine and shortleaf pine in upland hills. In most instances, the same forest-dependent wildlife species are commonly found in all three forest communities.

3.9.4.5 Rare or Endangered Species

With the exception of the red-cockaded woodpecker (Dendrocops borealis), no rare or endangered species are known to be resident in the vicinity of the transmission line routes. The last reported records of rare or endangered species resident in southwest Mississippi are those of red wolves in 1946 and bald eagles prior to 1960. Four sightings of black bear have occurred on the Grand Gulf Nuclear Station site in 1977 (see subsection 2.2.2.7).

The red-cockaded woodpecker, a resident of pine forests, is known to be nesting in portions of the Homochitto National Forest. After the right-of-way of the Franklin line was surveyed and staked by engineers, surveys were conducted to determine if any red-cockaded woodpecker nesting colonies lie within the right-of-way boundaries. No such colonies were found.

Rare or endangered terrestrial species, which formerly occurred in southwest Mississippi, are listed below:

Red wolf	(Canis niger)
Puma	(Felis concolor)
Southern bald eagle	(Haliaetus l. leucocephalus)
Peregrine falcon	(Falco peregrinus)
Osprey	(Pandion haliaetus)
Eskimo curlew	(Neumenius borealis)
Bachman's warbler	(Vermivora bachmanii)

The red wolf and puma are wilderness species which were extirpated from the region as the result of hunting and destruction of habitat. Suitable habitat for these species is present in the areas traversed by the transmission line routes. A summary of records of Mississippi land mammals compiled by Wolfe (Ref. 1), however, indicates that the last authenticated record of any of these species occurring in this region was in 1946 when a red wolf was collected in Claiborne County.

The bald eagle, osprey, peregrine falcon, and eskimo curlew may occur in this region, particularly along the Mississippi River, during migration. The bald eagle was reported nesting in the Mississippi River bottomland region north of the Big Black River prior to 1960 (Turcotte, personal communication, 1972). The transmission line routes are located east of the Mississippi River bottomlands and should not infringe on this potential eagle nesting habitat.

Bachman's warbler is a very rare species that inhabits moist deciduous woodlands. Records in the Mississippi Museum of Natural Science indicate the species is not present in the vicinity of the transmission line routes.

3.9.4.6 Soils

A soil-type map showing the areas of Mississippi that are traversed by the transmission line corridors is shown in Figure 3.9-5. The

corridors cross three basic categories of soil types: Mississippi Delta, brown loam, and thin loess. The following descriptions of these types were obtained from Reference 2.

a. Mississippi Delta

In the Delta area, the alluvial soil materials were deposited by the Mississippi River and other tributary streams. Since these materials were washed in from a broad and variable region covering the northern and western states, they vary in nature and composition. The fertility level is high, and young soils of the Delta are greatly influenced by the soil materials from which they developed.

Generally, the land in the Mississippi Delta is almost level, which is characteristic of most large floodplains. The lay of the land ranges from large flat areas of "buckshot" or slack-water clays to gently sloping natural levees.

b. Brown Loam (Thick Loess)

The soils of the brown loam area developed from loess or windblown material which is generally over 4 feet thick. This is the most uniform soil material found in Mississippi. Because of this uniformity in parent material, the number of different soils is small in comparison with other land resource areas. They are all high in silt content and, when sloping and steep, are subject to severe erosion. The uniform parent material contains sufficient native fertility for rapid plant growth. This is reflected in the production of forage and other crops throughout the brown loam area.

The lay of the land varies from level to steep and rugged. Soil erosion is common on the sloping and steep land where protective cover is not provided. On the other hand, the soils respond well to good management and are suitable for many uses.

c. Thin Loess

The soils in the thin loess area (less than 4-feet thick) are composed of silty material and overlie the various kinds of coastal plain materials. Under these conditions, the underlying materials influence soil development greatly and affect the erosion hazards of the area.

Gully erosion has been observed in the fields where the soils have loamy sands and sand under them. Such conditions have made it necessary to employ erosion control and flood-prevention measures.

The soils of this area are highly weathered and have reached the point where the fertility level is low. Complete fertilizers are needed for the production of all nonlegume crops, and lime is needed for most legumes.

3.9.4.7 Alternate Routes and Alignments

Selection of the transmission line routes was based partially on maximum utilization of existing electrical transmission facilities. Preliminary plans were to construct transmission lines connecting the Grand Gulf Nuclear Station to the Franklin EHV Substation, the Baxter Wilson EHV Substation, the Port Gibson Substation, and an EHV Substation in Sterlington, Louisiana.

As a result of route surveys, the Sterlington route was replaced by the Ray Braswell route because the powerlines of the original route would have crossed the Mississippi River and traversed ecologically sensitive Mississippi River bottomland hardwood forest, thus creating an adverse aesthetic and environmental impact. Additionally, the projected cost of the 79-mile line for the Sterlington route was significantly more than for the 24-mile Ray Braswell route.

The alignment of the original Baxter Wilson route was adjusted to avoid traversing approximately 6 miles of ecologically sensitive, mature, Mississippi River bottomland hardwood forest. This ecologically sensitive bottomland area has been avoided by shifting the alignment eastward to an abandoned 13 kV right-of-way that runs through loessial bluffs adjacent to the bottomlands.

The Franklin Route is not the most direct tie-in with the north-south EHV trunk line. The most direct tie-in with that trunk line would be a line going due east from the station, approximately 30 miles. However, since there currently is no switching station in this area, one would have to be constructed. In addition, new, low voltage transmission lines from this switching station would be required. The environmental and economic savings by using this more direct routing would be more than offset by the addition of a new switching station and the required new low voltage transmission lines.

There were no viable alternative routes considered for the Port Gibson line inasmuch as aesthetically pleasing, ecologically sensitive, historically important, and densely populated areas could be almost entirely avoided by minor route adjustments.

3.9.4.8 Multiple-Use Projects

A multiple-use wildlife project was formulated on a portion of the Ray Braswell Gulf States Utilities 500 kV line which passes through Copiah County, Mississippi. Working with the property owner, MP&L,

guided by recommendations of the U. S. Soil Conversation Service, reconditioned and seeded the cleared right-of-way. The utility corridor serves as a functional fire lane and affords both cover and forage for wildlife. The project has received enthusiastic support from conservationists, sportsmen, and the general public in the area. Another multiple-use project was initiated by MP&L to restore some 200 miles of EHV transmission corridors. Utilizing specifications and guidelines adopted by the Soil Conservation Service, the cleared rights-of-way were reconditioned and reseeded for multiple-use purposes. As a result of this extensive conservation project, MP&L received the first industrial award by the Mississippi Chapter of the Soil Conservation Society of America in 1968. In part, the citation read:

> "For outstanding accomplishments in soils and water conservation on 224 miles of EHV transmission line, covering some 1,100 acres from Attala County south to the Louisiana line and west from Jackson to Vicksburg."

The presentation of the award and citation and the conservation work are cited in Reference 3.

Similar multiple-use projects are being carried out on the transmission lines associated with Grand Gulf Nuclear Station. In addition to the construction procedures discussed in Section 4.2, MP&L is utilizing such techniques as selective cleaning, screening and handcutting in certain areas to minimize environmental impacts. Numerous food plots for wildlife have been planted in cooperation with surrounding landowners.

3.9.5 Description of Transmission Facilities

A typical nonguyed galvanized steel tower used by MP&L for 500 kV transmission lines is illustrated in Figure 3.9-6. The 115 kV transmission line is H-frame woodpole construction for 3.1 miles and single woodpole construction for 2.4 miles. Typical 115 kV transmission line towers of woodpole construction are illustrated in Figures 3.9-7 and 3.9-8 for H-frame and single pole, respectively. Right-of-way widths are 200 feet for the 500 kV lines and 100 feet for the 115 kV line. Typically, there are approximately 4.75 tower structures erected per mile for the 500 kV line, and approximately 8.5 tower structures per mile for the 115 kV line. Long spans are used to reduce the number of structure sites. Ruling span for the 500 kV transmission lines is 1150 feet and the ruling span for 115 kV line is 600 feet for the H-frame portion and 500 feet for the single pole portion.

The 115 kV lines are suspended from blue-gray, string insulators to reduce visual impact. The conductors are aluminum covered, steel-reinforced wire, with 336,000 circular mils cross section (336.4 MCM-ACSR). The normal and emergency ratings of the line are 61 and 105 MVA respectively. The 500 kV lines are suspended from blue-gray, V-string insulators to reduce sway and visual impact. MP&L's present standard of 500 kV conductor is delta-bundled, aluminum-covered, steel-reinforced wire, with 954,000 circular mils cross section (3-954 MCM-ACSR). The delta configuration of the conductors, illustrated in Figure 3.9-6, is maintained by spacers installed at intervals of approximately 250 feet. The normal and emergency ratings of the 500 kV lines are 1500 and 2000 MVA respectively.

3.9.6 Description of Switchyard

The switchyard is a breaker and one-half scheme. Galvanized steel bus supports are used in the switchyard with gray post insulators. Bus runs are at 30 and 55 feet levels and are aluminum tubing. Line and generator take offs are triple bundle 954 ACSR. All above-ground items are gray in color. Foundations are a natural concrete color. The ground is covered with reddish brown clay gravel. The switchyard fenced area is approximately 53 acres. 5

3.9.7 References

1. Wolfe, J. E., "Mississippi Land Mammals," Mississippi Game and Fish Commission, 1971.

2. Vanderford, H. B., "Soils of Mississippi," Mississippi Agricultural Experiment Station.

3. Industrial Award, Mississippi Chapter of the Soil Conservation Society of America (1968), "Transmission and Distribution Magazine," December 1968 and January 1969.

4. U.S.D.A., "Soil Survey, Claiborne County, Mississippi," Soil Conservation Service, 1963.

5. U.S.D.A., "Soil Survey, Warren County, Mississippi," Soil Conservation Service, 1964.

6. U.S.D.A., "Soil Survey, Lincoln County, Mississippi," Soil Conservation Service, 1963.

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TABLE 3.9.1

CURRENT LAND USE ADJACENT TO GRAND GULF NUCLEAR STATION TRANSMISSION LINE ROUTE (MILES)

Land Use	Routes				
	Baxter Wilson	Ray Braswell	Franklin	Port Gibson	Total
Agriculture	9	11.4	14	5	39.4
Forestry	12.0	11.6	29.6	0.5	53.7
Residential	0	1	0	0	1
Industrial	1	0	0	0	1
TOTAL	22.0	24.0	43.6	5.5	95.1

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TABLE 3.9.2

BASIC PLANT COMMUNITIES ALONG TRANSMISSION LINE ROUTES*

Transmission Line Route	Loessial Bluff Hardwood Forest (miles)	(acres)[1]	Bottomland Hardwood Forest (miles)	(acres)[1]	Mixed Hardwood Pine Forest (miles)	(acres)[1]	Pine Forest (miles)	(acres)[1]	Fields (miles)	(acres)[1]	Total (miles)	(acres)[1]
Grand Gulf to Baxter Wilson (500 kV)	10.3	244	1.7	41	0	0	0	0	10.0	236	22.0	521
Grand Gulf to Ray Braswell (500 kV)	16.1	400	1.4	34	2.5	62	0	0	4.0	100	24.0	596
Grand Gulf to Franklin (500 kV)	6.2	150	0	0	3.6	87	23.9	580	9.9	240	43.6	1057
Grand Gulf to Port Gibson (115 kV	1.8	22	0.6	7	0.5	6	0	0	2.6	32	5.5	67
TOTAL	34.4	816	3.7	82	6.6	155	23.9	580	26.5	608	95.1	2241

*Mileage and acreage data are approximate.

[1]Denotes amount of acreage of cleared right-of-way required.

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TABLE 3.9.3

PLANTS AND WILDLIFE TYPICALLY OCCURRING IN BASIC PLANT COMMUNITIES
ALONG GRAND GULF NUCLEAR STATION TRANSMISSION LINE ROUTES

Plant Community	Dominant Overstory	Typical Understory	Common Wildlife
Loessial bluff hardwood forest	Southern red oak, water oak, sweetgum, basswood, hickory, American elm, loblolly pine (on ridges)	Switchcane, grass, dewberry, poison ivy, Japanese honeysuckle	White-tailed deer, bobcat, gray fox, cottontail rabbit, armadillo, gray squirrel, white-footed mouse, shorttail shrew, red-bellied woodpecker, pileated woodpecker, Carolina wren, cardinal, blue jay, tufted titmouse
Bottomland hardwood forest	Sugarberry, green ash, sweetgum, pecan, nuttail oak, overcup oak	Aster, buckvine, dewberry, grass, poison ivy	White-tailed deer, bobcat, gray fox, raccoon, opossum, armadillo, swamp rabbit, fox squirrel, cotton mouse, shorttail shrew, wood duck, red-bellied woodpecker, pileated woodpecker, Carolina wren, blue jay, cardinal, rufous-side towhee
Mixed hardwood-pine forest	Southern red oak, sweetgum, hickory, loblolly pine	Poison ivy, grass, dewberry, Japanese honeysuckle	White-tailed deer, gray fox cottontail rabbit, armadillo, pine vole, white-footed mouse, shorttail shrew, red-bellied woodpecker, pileated woodpecker, Carolina wren, blue jay, cardinal, tufted titmouse
Pine forest	Loblolly pine, shortleaf pine	Japanese honeysuckle, grass, yellow jessamine, huckleberry	White-tailed deer, gray fox, armadillo, cottontail rabbit, gray squirrel, fox squirrel, white-footed mouse, shorttail shrew, red-bellied woodpecker, pileated woodpecker, Carolina wren, cardinal, blue jay, tufted titmouse
Fields	--	Crops - cotton, soybeans pasture grass, (winter wheat, rye grass, foxtail, Bermuda grass, crab grass, smut grass)	White-tailed deer, red fox, fox squirrel, cottontail rabbit, armadillo, striped skunk, raccoon, opossum, least shrew, cotton rat, fulvous harvest mouse, house mouse, red-tailed hawk, bobwhite quail, red-headed woodpecker, indigo bunting, cardinal, mockingbird

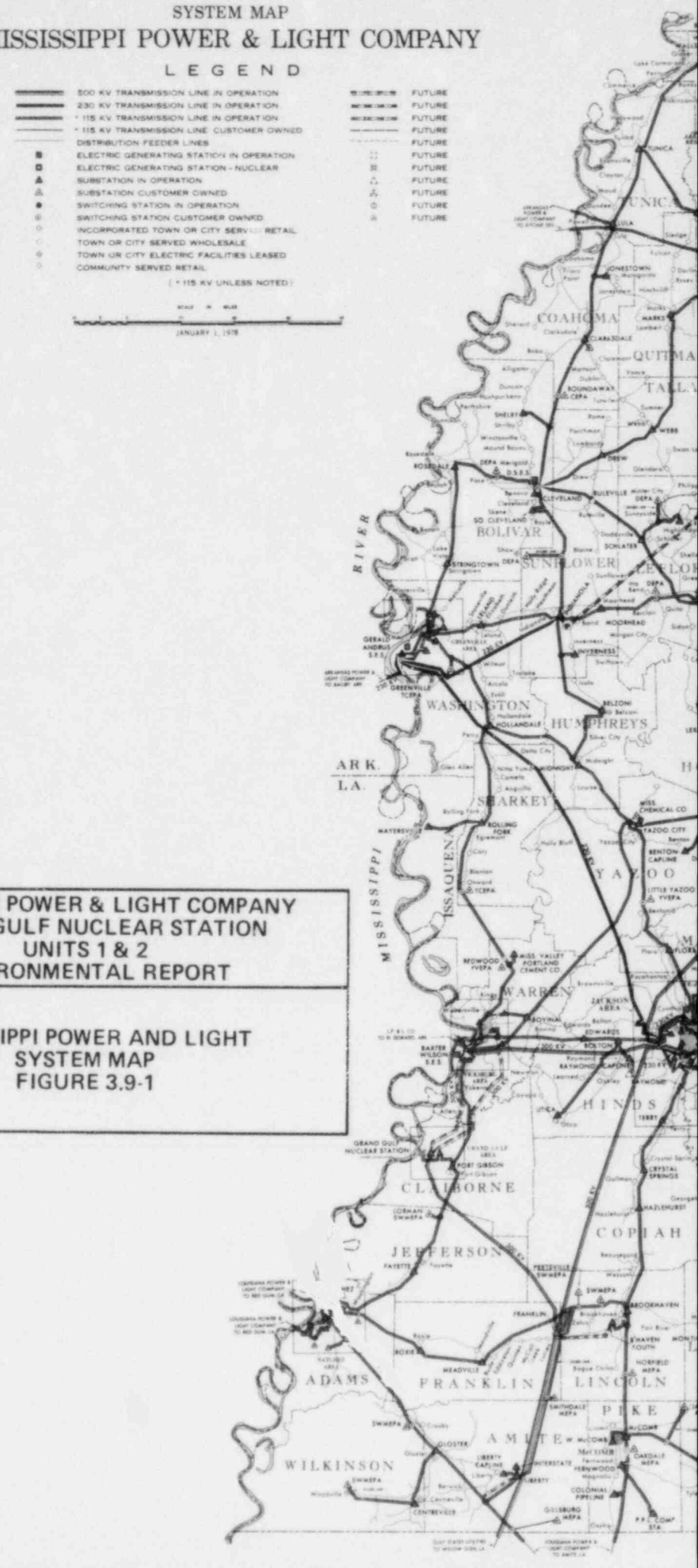
TABLE 3.9.4

PHYSICAL CHARACTERISTICS OF TRANSMISSION LINE ROUTES

Transmission Line Route	Major Highway Crossings	Secondary Road Crossings (no.)	Major River Crossings	Large Stream Crossings (no.)	Railroad Crossings (no.)	Powerline Crossings (no.)	Gas Line Crossings (no.)	Approx. Length (mi)
Grand Gulf to Baxter Wilson (500 kV)	0	4	Big Black River	4	2	0	0	22.0
Grand Gulf to Ray Braswell (500 kV)	U.S. 61	13	Big Black River	1	1	1	0	24.0
Grand Gulf to Franklin (500 kV)	Natchez Trace U.S. 61 Ms. 28 Ms. 550	18	Bayou Pierre Homochitto River	8	2	2	2	43.6
Grand Gulf to Port Gibson (115 kV)	U.S. 61	2	Bayou Pierre	0	1	0	0	5.5
TOTAL	6	37	5	13	6	3	2	95.1

SYSTEM MAP

MISSISSIPPI POWER & LIGHT COMPANY



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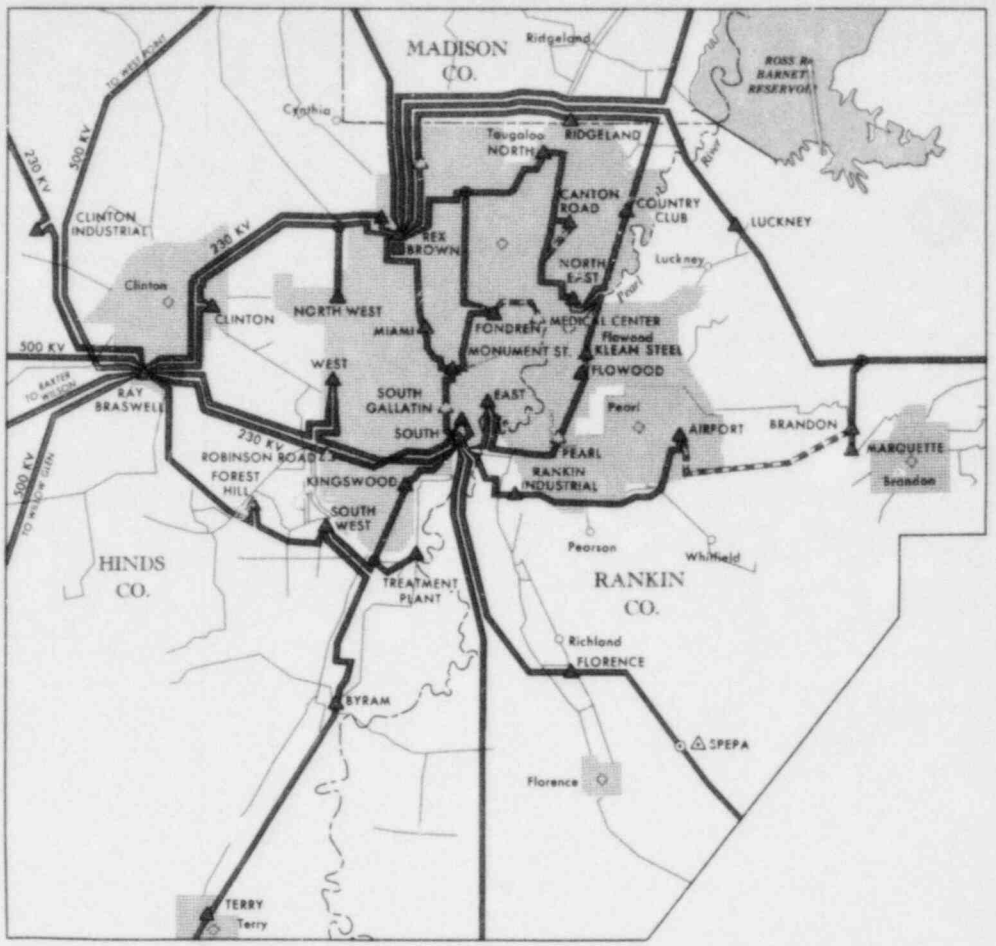
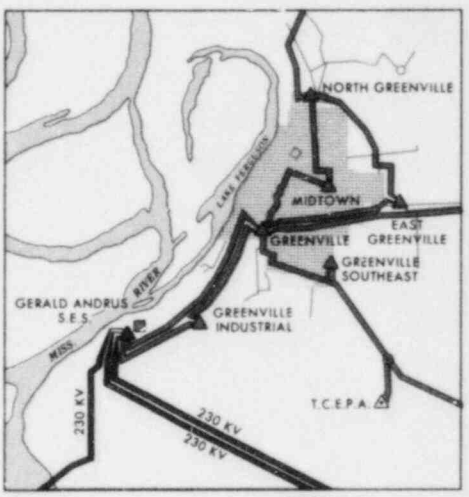
MISSISSIPPI POWER AND LIGHT
SYSTEM MAP
FIGURE 3.9-1

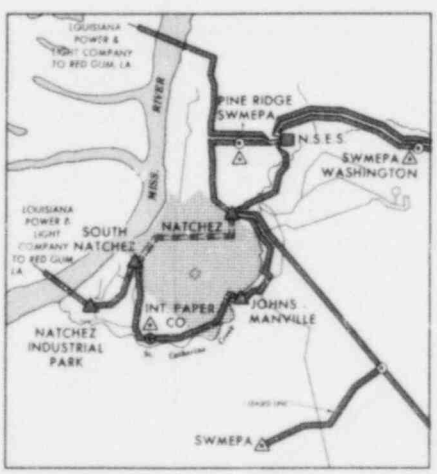


JACKSON AREA SCALE IN MILES

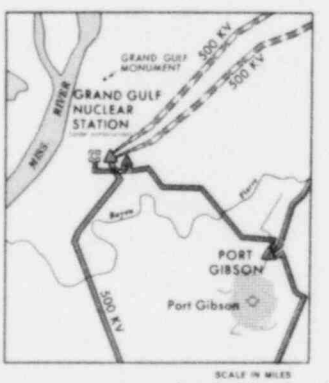
VICKSBURG AREA SCALE IN MILES



GREENVILLE AREA SCALE IN MILES



NATCHEZ AREA SCALE IN MILES



GRAND GULF AREA SCALE IN MILES

SOURCE: Official highway map - Louisiana (1970)
Official highway map - Mississippi (1971)

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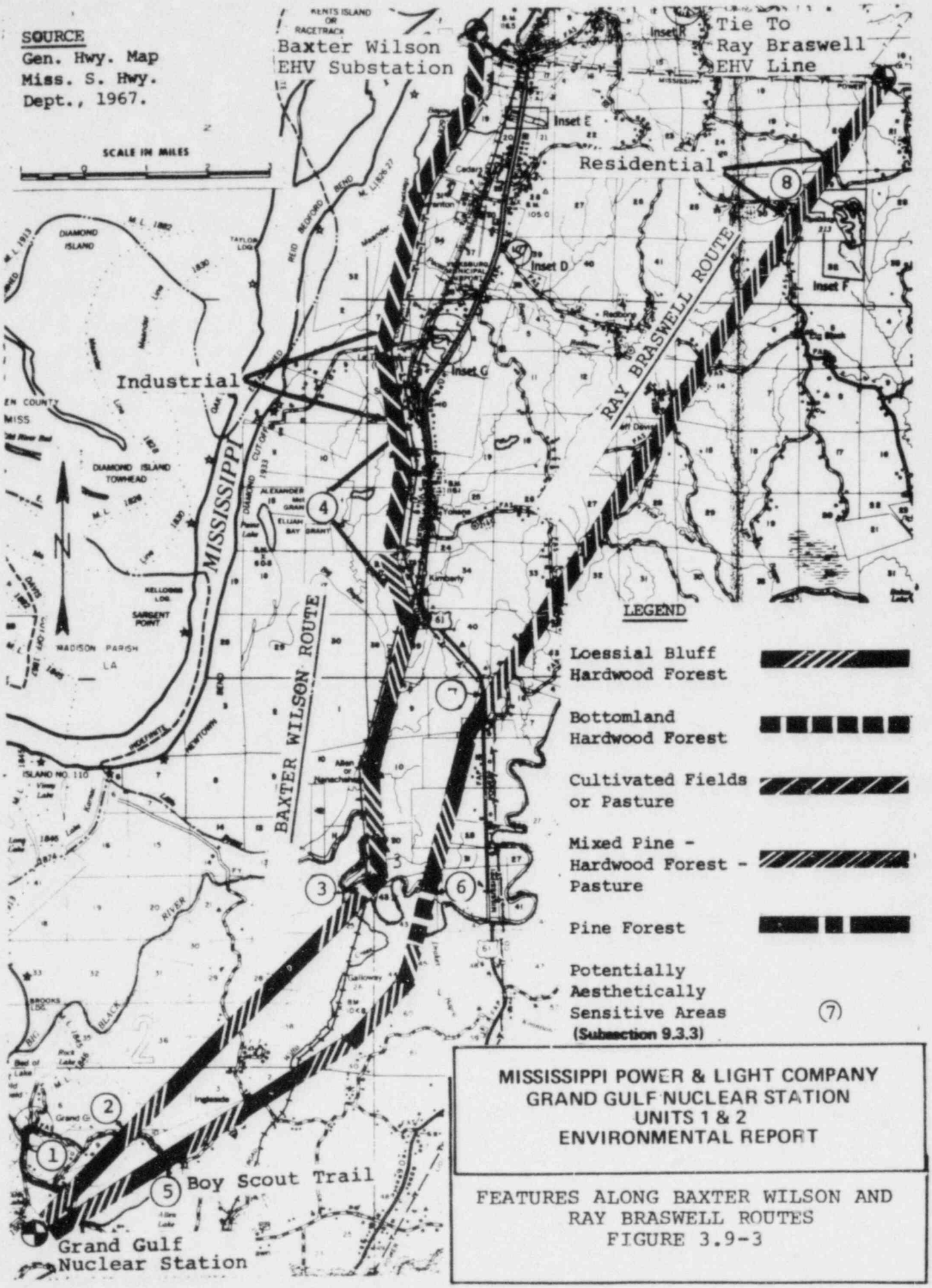
TRANSMISSION LINE ROUTES

FIGURE 3.9-2



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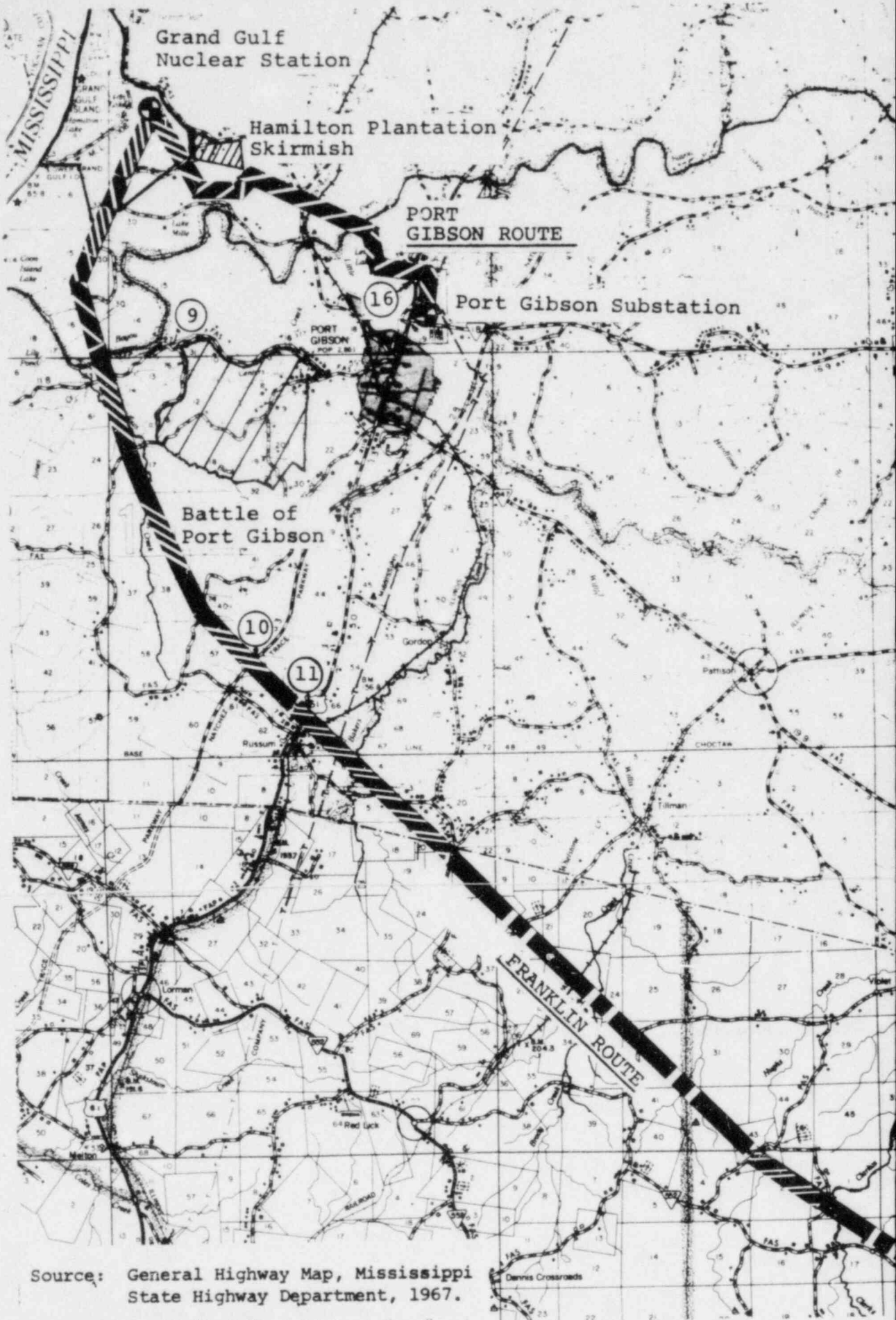
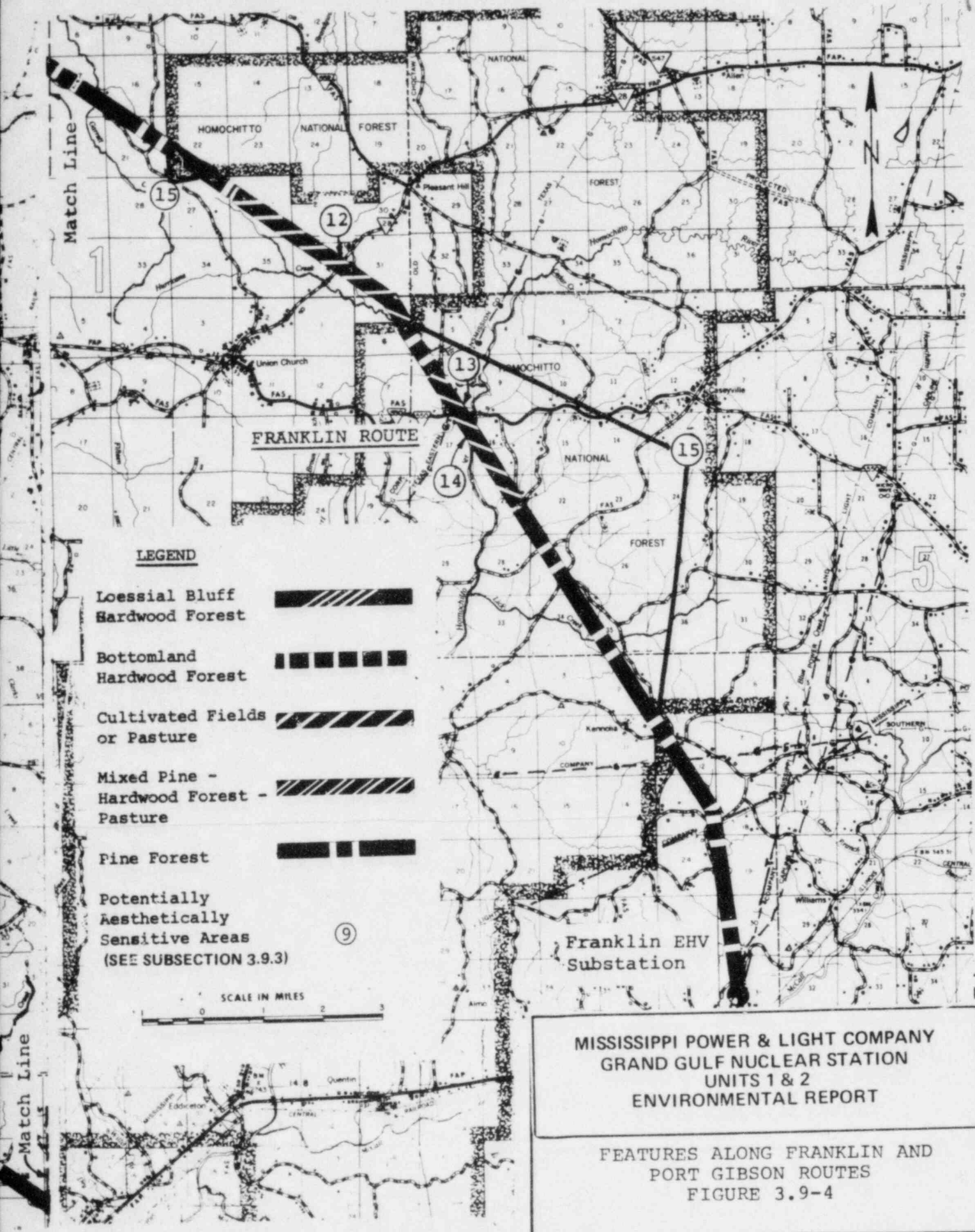
FEATURES ALONG BAXTER WILSON AND RAY BRASWELL ROUTES
FIGURE 3.9-3



Source: General Highway Map, Mississippi State Highway Department, 1967.



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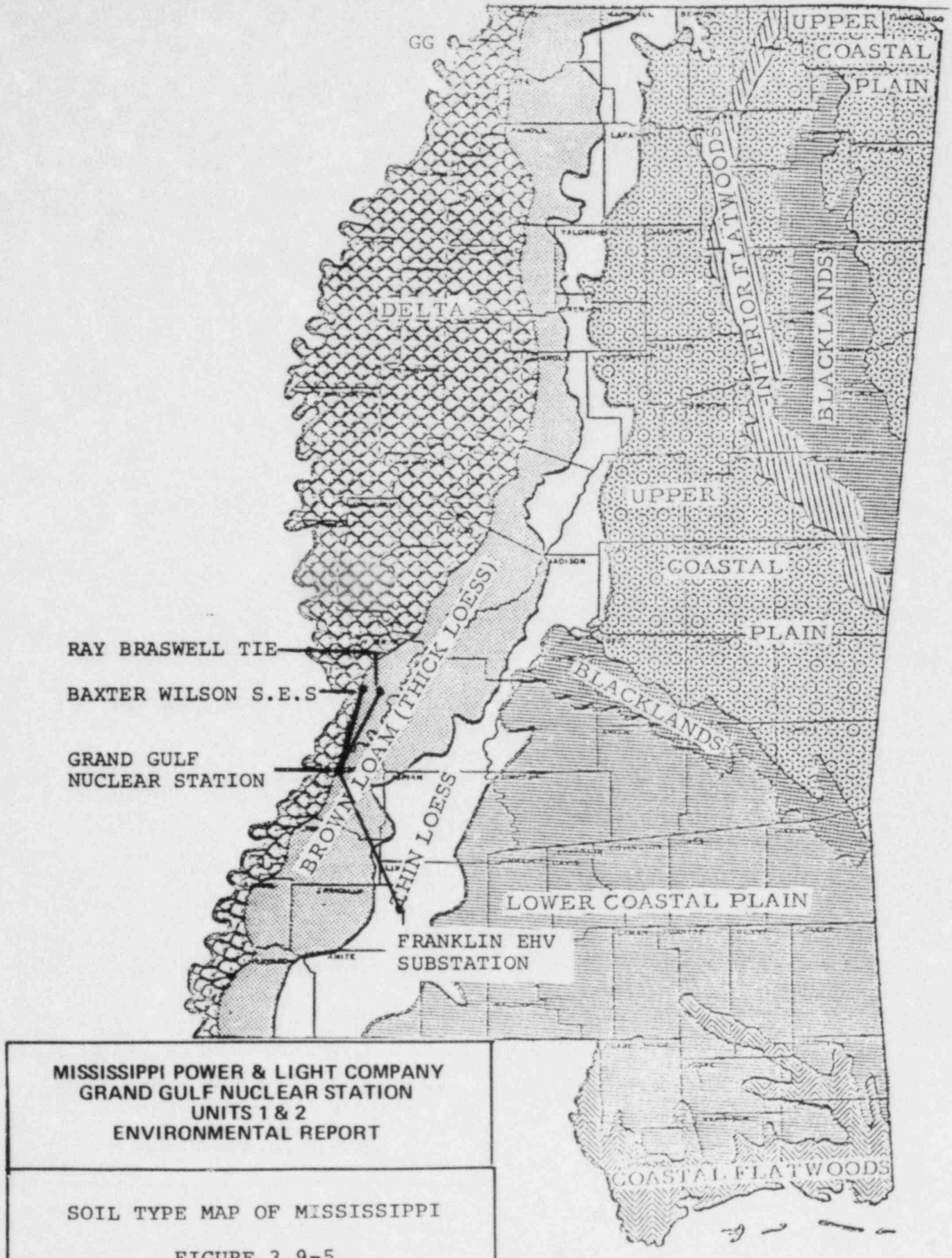
FEATURES ALONG FRANKLIN AND PORT GIBSON ROUTES
FIGURE 3.9-4



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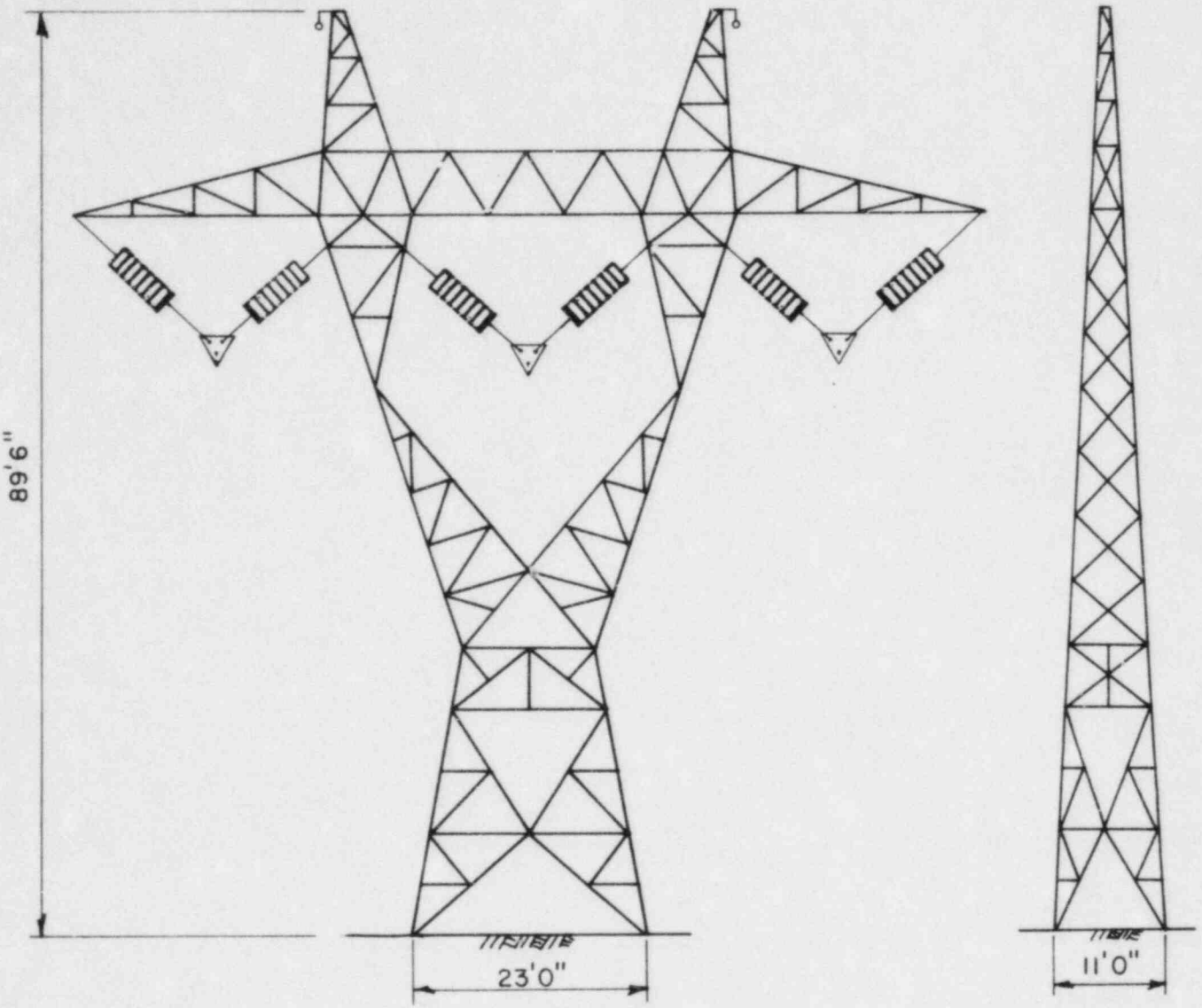
SOIL TYPE MAP OF MISSISSIPPI

FIGURE 3.9-5



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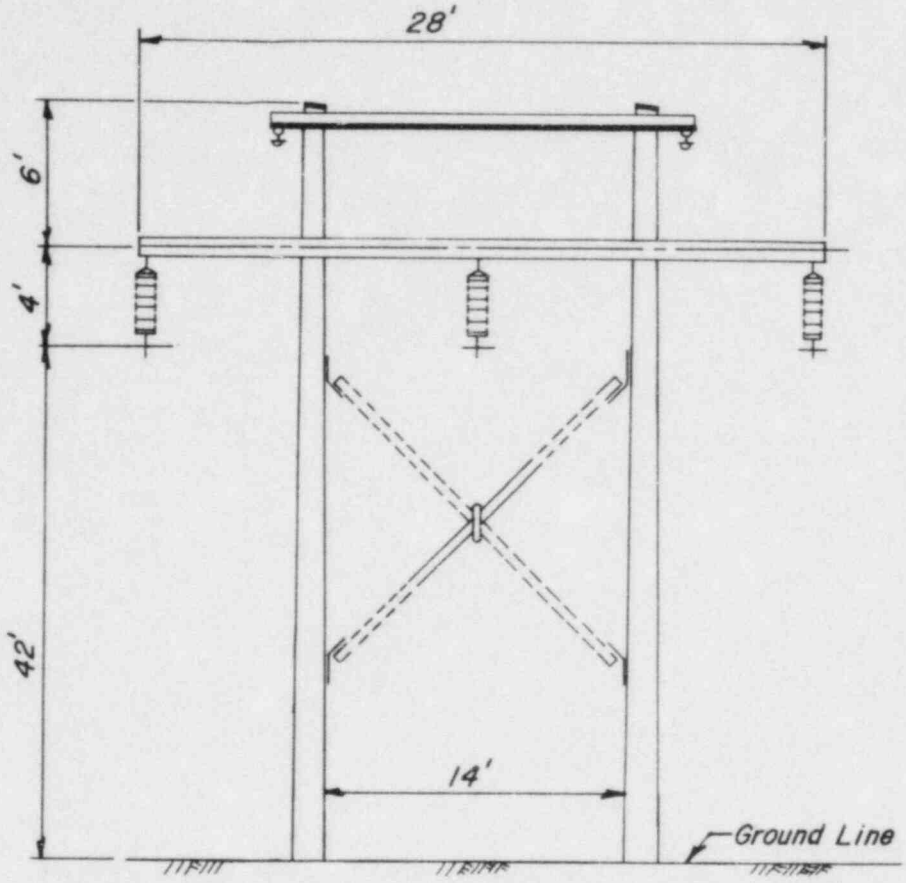
TYPICAL 500 kV TRANSMISSION
LINE TOWER
FIGURE 3.9-6



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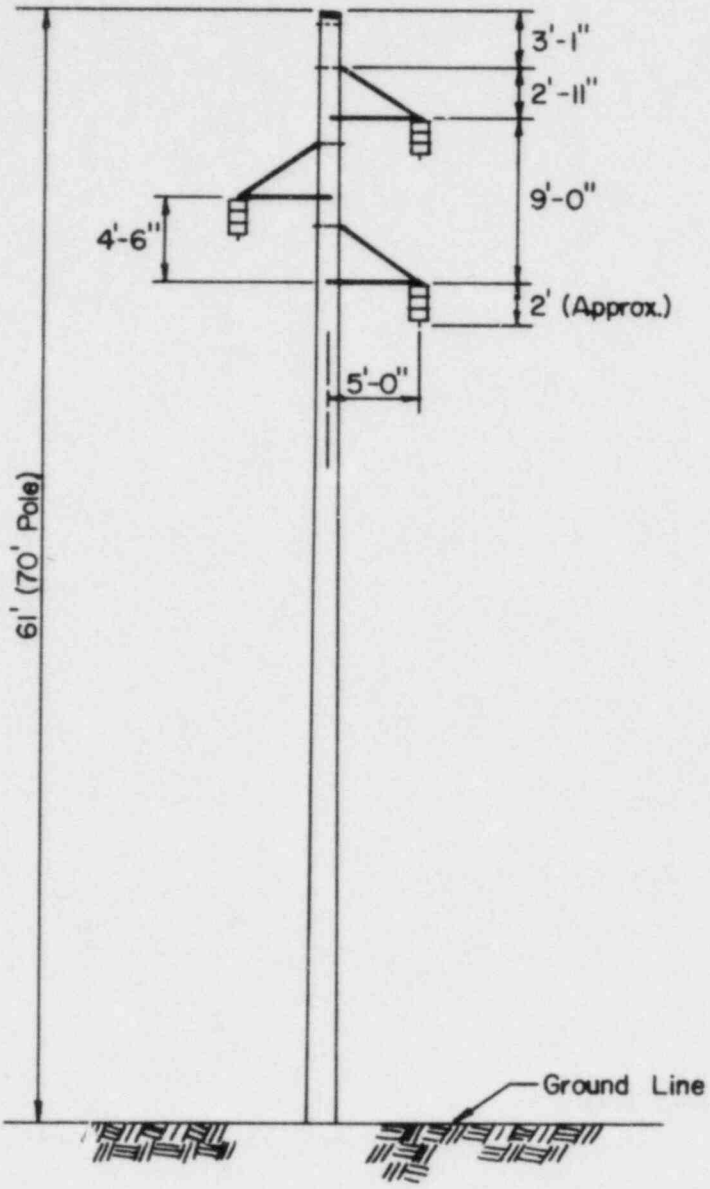
TYPICAL 115 kV H-FRAME WOODPOLE
TRANSMISSION LINE TOWER

FIGURE 3.9-7



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TYPICAL 115 kV SINGLE WOODPOLE
TRANSMISSION LINE TOWER

FIGURE 3.9-8

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CHAPTER 4

ENVIRONMENTAL EFFECTS OF SITE PREPARATION, STATION CONSTRUCTION, AND TRANSMISSION FACILITIES CONSTRUCTION

TABLE OF CONTENTS

		Page
4.1	SITE PREPARATION AND STATION CONSTRUCTION	4.1-1
	4.1.1 Introduction	4.1-1
	4.1.2 Summary of Construction Activities	4.1-2
	4.1.2.1 Schedule	4.1-2
	4.1.2.2 Manpower Requirements	4.1-2
	4.1.2.3 Site Preparation	4.1-2
	4.1.2.3.1 Clearing and Grubbing	4.1-2
	4.1.2.3.2 Excavation and Spoil Disposal	4.1-3
	4.1.2.3.3 Dewatering	4.1-3
	4.1.2.4 Plant and Facilities Construction	4.1-4
	4.1.2.4.1 Construction Facilities	4.1-4
	4.1.2.4.2 Plant Construction	4.1-6
	4.1.2.4.3 Environmental Protection Measures	4.1-7
	4.1.3 Effects of Construction on Land Resources	4.1-13
	4.1.3.1 Effects on Offsite Land Use	4.1-13
	4.1.3.2 Effects on Onsite Terrain, Topography and Drainage	4.1-15
	4.1.3.3 Effects on Terrestrial Biota	4.1-17
	4.1.3.3.1 Vegetation	4.1-17
	4.1.3.3.2 Wildlife	4.1-17
	4.1.4 Effects of Construction on Water Resources	4.1-19
	4.1.4.1 Effects on Water Use	4.1-19
	4.1.4.1.1 Effects on Ground Water Resources	4.1-19
	4.1.4.1.2 Effects on Surface Water Resources	4.1-20
	4.1.4.2 Effects on Aquatic Biota	4.1-23
	4.1.5 References	4.1-26
4.2	TRANSMISSION FACILITIES CONSTRUCTION	4.2-1
	4.2.1 Construction Procedures	4.2-1
	4.2.2 Transmission Line Construction	4.2-2
	4.2.3 Towers	4.2-3

TABLE OF CONTENTS (Cont.)

	4.2.4 Monitoring	4.2-3	
	4.2.4.1 Preconstruction Phase	4.2-3	
	4.2.4.2 Construction Phase	4.2-4	
	4.2.4.3 Postconstruction Phase	4.2-4	
	4.2.5 References	4.2-4	1
4.3	RESOURCES COMMITTED	4.3-1	
4.4	RADIOACTIVITY	4.4-1	
4.5	CONSTRUCTION IMPACT CONTROL PROGRAM	4.5-1	
	Appendix A - Environmental Protection Program Respecting Construction of Grand Gulf Nuclear Station Units 1 and 2	4.5A-1	

LIST OF TABLES

Table No.	Title
4.1.1	Acreages Affected by Various Facilities Associated With Grand Gulf Nuclear Station
4.1.2	Construction Schedule (Start and Finish Dates to the Nearest Quarter) for Various Phases of the Grand Gulf Project

LIST OF FIGURES

Figure No.	Title
4.1-1	Aerial View-Grand Gulf Site-October 1976
4.1-2	Site and Yardwork - Site Plan
4.1-3	Site Grading Drainage and Erosion Control Plan
4.1-4	Bottom Contour Map of Hamilton Lake
4.1-5	Bottom Contour Map of Gin Lake

CHAPTER 4.0

ENVIRONMENTAL EFFECTS OF SITE PREPARATION, STATION CONSTRUCTION, AND TRANSMISSION FACILITIES CONSTRUCTION

4.1 SITE PREPARATION AND STATION CONSTRUCTION

4.1.1 Introduction

Construction of the Grand Gulf Nuclear Station has resulted in alterations to the plant site. Some of these alterations are unavoidable and irreversible; others are unavoidable but subject to amelioration. This section sets forth the effects that site preparation and station construction either have had or will have on both land and water use. Certain socioeconomic impacts are discussed in this chapter, however, effects that are primarily economic or social in character are discussed in Chapter 8.

Approximately 465 acres of the 2300-acre Grand Gulf Nuclear Station site have been affected by construction, however, permanent structures and facilities occupy only 124 acres. Since the station itself is located in the loessial bluff portion of the site, most site preparation and construction activities are concentrated in this area (Figure 4.1-1). About 374 acres of upland have been disturbed (100 acres of field and 274 acres of forest). Approximately 111 acres of this total are occupied by permanent structures and facilities. About 91 acres have been disturbed within the bottomlands (15 acres of field and 76 acres of forest). However, only about 13 acres of this total are occupied by permanent structures and facilities. Acreages affected by structures occupying more than 2 acres are given in Table 4.1.1. |5

The major impact-producing actions during site preparation and construction have been:

a. Clearing and grubbing

b. Excavation, spoil deposition and dewatering

c. Creation of roads, railroads, fences and transmission rights-of-way

d. Operation of internal combustion engines and vehicles

e. Operation of noise and vibration producing equipment

f. Increased human activity

The major types of impact resulting from these activities have been:

a. Alteration of existing vegetation and watershed drainage patterns

b. Alteration of topography

c. Alteration of the water quality of site drainage

d. Introduction of open areas and barriers

e. Changes in onsite vegetation patterns and both onsite and surrounding area wildlife populations

4.1.2 Summary of Construction Activities

4.1.2.1 Schedule

Site preparation for Units 1 and 2 began in May 1974 upon receipt of a limited work authorization. The construction permit was issued in September 1974. Fuel loading for Unit 1 is to start in October 1980; commercial operation of this unit is due to begin in April 1981. Unit 2 fuel loading is scheduled to take place in July 1983, with commercial operation to commence in January 1984. Table 4.1.2 shows the construction schedule (start and finish dates to the nearest quarter) for various phases of the Grand Gulf project.

4.1.2.2 Manpower Requirements

The construction work force built up rapidly during the second half of 1974, from approximately 70 to about 960 men. It continued to increase at a steady rate through the third quarter of 1976, peaking at approximately 3400 men. The work force then dropped to 2800 men at the beginning of 1977. Manpower is expected to peak again at the end of the second quarter of 1978 at about 4200 men; it is anticipated that it will remain above 4000 men through the end of 1978. From the first quarter of 1979 through the end of 1983, manpower requirements are expected to decline at the rate of approximately 800 men per year.

4.1.2.3 Site Preparation

4.1.2.3.1 Clearing and Grubbing

About 75 percent (350 acres) of the site area affected by construction (465 acres) was originally forested (274 acres of bluff forest and 76 acres of bottomland forest). Additionally, 73 acres of the offsite railroad right-of-way and the 115 kV service line was forested. Wooded acreages have been cleared,

and all areas except the spoil disposal areas, sedimentation basins, and 115 kV transmission right-of-way, have been grubbed. Merchantable timber sales totaled $17,845. Unmerchantable timber, slash, and brush were burned in accordance with permits issued by the Mississippi Air and Water Pollution Control Commission.

4.1.2.3.2 Excavation and Spoil Disposal

During construction of the Grand Gulf Nuclear Station approximately 6.66 million cubic yards of material were displaced in the bluff area. Approximately 5.88 million cubic yards were moved to bring the plant site to finished grade, while about 0.78 million cubic yards were excavated from the main powerblock site. This material consisted of approximately 60 percent loessial and 40 percent terrace soils. Excavation within the bottomlands involves moving about 681,000 cubic yards of material. Material excavated to date includes 3000 cubic yards from the radial collector well system, 190,000 cubic yards from the barge slip, and 574,000 cubic yards from the borrow pit. It is expected that an additional 500,000 cubic yards of material will be removed from the borrow pit. The service water intake and station discharge lines involved the temporary displacement of 50,000 cubic yards of lowland deposits; however, nearly all of this has been used as backfill. Explosives have not been used during any of these operations.

The excavation program included subgrades for railroads and access roads, drainage structures and channels, and excavation and drainage of the power block area. Vertical wall excavation, through the use of a tie-back wall, was utilized for the turbine building, circulating water lines and pumphouse, radwaste building, control building, auxiliary and containment building, and standby service water heat sinks. This allowed for a minimum of excavation.

Approximately 2.2 million cubic yards of spoils were deposited in three major areas in the upland bluff. One of these areas is located in the upper reaches of plant site drainage basin B while the other two are on the north slope of drainage basin A (Figure 4.1-1). Soil overburden was removed to a spoils site. Spoils from the barge slip have been placed in the borrow pit, including 190,000 cubic yards from the slip itself and 10,000 cubic yards from the removal of a sand bar at its mouth. The use of spoils as construction backfill has been limited; approximately 12,000 cubic yards of clay is used as a seal around structures in the power block area. Spoils were not used in road or railroad construction.

4.1.2.3.3 Dewatering

Construction activities which involved dewatering are power block excavation, radial collector well construction, and pipeline construction. Localized perched ground water was encountered

during power block excavation. Perched seepage, surface runoff, and precipitation were collected in sumps installed in perimeter ditches. The water was then pumped through drainage courses into either sediment basin A or B, depending upon which area of the excavation was being dewatered.

Three radial collector wells are installed in alluvial deposits adjacent to the Mississippi River (Figure 4.1-2). Each well consists of a cylindrical concrete caisson extending into the alluvial aquifer. The bottom is sealed with a concrete plug, and horizontal pipes project into the aquifer from the base of the caisson. The caissons were positioned by excavating the material inside which allowed each caisson to sink under its own weight. The horizontal perforated pipes (laterals) were driven into the aquifer through ports near the bottom of the caisson by a jetting and jacking process. The excavated material was deposited around each well site to build up the land surface and provide a slope away from the well. The water used in the jetting process was discharged into the Mississippi River. Additional wells, if required, will be installed in connection with Unit 2.

Construction of the intake and discharge pipelines across the bottomlands required dewatering of the trench due to high water table levels in that area.

4.1.2.4 Plant and Facilities Construction

4.1.2.4.1 Construction Facilities

a. Transportation Facilities

Grand Gulf Road and Waterloo Road, which provide access to the site, have been improved. Work has included the upgrading of a bridge on Grand Gulf Road over stream A and the establishment of a bypass around it for heavy truck traffic. This work was carried out by the Grand Gulf Nuclear Station Project. Work on Waterloo Road has included the relocation of a small section of the road so that it aligns with the future permanent site access road. The Grand Gulf Nuclear Station Project paid the engineering costs on this work while the County carried out the actual realignment. Work roads within the plant site have been developed as needed. The most significant onsite road is the heavy haul road which runs between the barge slip and the plant itself. This road, and the intake and discharge pipelines which border it, required the clearing of about 38 acres of bottomland.

Railroad access to the site is provided by a 2.7-mile spur line constructed between the site and the Illinois Central Gulf Railroad. This spur occupies about 52

acres of land, and required the excavating and filling of 190,000 and 140,000 cubic yards of material, respectively. Onsite railroad spurs occupy about 6 acres of land. Permanent onsite spurs run between the site boundary and the turbine and auxiliary buildings, and warehouse. Temporary railroad lines service the main laydown area which is located west of the plant, and the batch plant.

b. Buildings and Offices

During the initial phases of construction, an office complex was located south of stream B. This office has been replaced by a permanent two-story metal field construction office. This office contains administrative, engineering, and support services accommodations and is located near the power block excavation. A metal warehouse building has been constructed near the power block excavation and contains controlled and general storage areas and office space. These buildings are fully fire protected and are provided with appropriate services and utilities. Additional metal buildings have also been erected to support construction activities, train workmen, provide services, and maintain site security.

A concrete batch plant has been constructed south of the switch-yard on approximately 10 acres of land. This plant consists of two independent units, each having a capacity of 200 cubic yards per hour. Provisions have been made for the storage of 5500 barrels of cement and 26,000 tons of aggregate. The aggregate and cement are principally delivered by rail.

c. Utilities

A new 115 kV transmission line from Port Gibson provides permanent construction power through a 10 MVA 115/13.8 kV construction transformer. Primary underground distribution is at 13.8 kV to eight substations through a parallel loop-type distribution system with isolation switches to provide maximum reliability and redundancy to the construction power supply. The 115 kV transmission line also provides power for plant startup.

Two wells are currently in use at the site, providing water for all construction activities such as the concrete batch plant, backfilling, and domestic uses. The wells are located on the bluff line near the main (northwest) laydown area. Each well is used on an alternating 24-hour basis at pumping rates of 500-800 gpm, varying with total demand on the supply. Chlorine is injected at the pump at 1.5 mg/l, and the water is stored in two 300,000 gallon tanks, with an additional 10,000 gallons of storage at the concrete batch plant. The two large storage tanks are maintained at a minimum level of 200,000 gallons each. Total demand on the water supply varies with the number of employees on each shift, and other factors such as batch plant operation and the amount of backfilling being done. Total usage has reached as high as 1 million gallons per day. Sanitary waste disposal facilities are covered in subsection 4.1.2.4.3.g.

The construction area is enclosed with a 7-foot high chainlink fence topped with barbed wire in order to establish control over access and to implement a construction security program. Before fuel load for Unit 1, additional required security measures will be put into force.

4.1.2.4.2 Plant Construction

a. Power Block Structures

Construction activities for the power block structures are concentrated in and around the plant excavation area. This includes construction of nonnuclear structures such as the turbine and water treatment buildings, and nuclear structures like the auxiliary, containment, radwaste, and control buildings. Construction of the power block structures involved installation of a vertical tieback wall and excavation of soils within the vertical wall generally down to the foundation level at 85 feet msl. Subsequent construction activities included the installation or placement of air-blown mortar, waterproofing, pump and sump liners, reinforcing steel, concrete, circulating water, radwaste and other piping, and required appurtenances for the power block structures. Appurtenances include numerous miscellaneous and special circumstance items such as, but not limited to, the following: mudmats, formwork, piping sleeves, conduit, junction box anchor bolts, beaming plates, curb angles, embeds for structural attachments, ground cables and lugs, waterstops, and reinforcing bar supports.

b. Intake and Discharge Facilities

The location of the radial collector wells and the routing of the supply and discharge lines are shown in Figure 4.1-2. Radial collector well installation techniques are described in subsection 4.1.2.3.3. The well system occupies approximately 15 acres of land in a strip immediately adjacent to the Mississippi River and south of the barge slip. The supply and discharge lines are 48 inches and 54 inches in diameter, respectively, and run in a common trench just south of the heavy haul road from the barge slip to the plant. The trench is generally about 10 feet deep except at the point of discharge in the barge slip where it is about 18 feet deep. The haul road and pipelines together pass between Hamilton and Gin Lakes and occupy about 38 acres of bottomland. In the bluffs near the plant, these pipelines, which serve both Units 1 and 2, are buried beneath areas which have been otherwise disturbed by construction activities.

c. Barge Landing

A barge landing was constructed to make possible river transport of some of the larger items needed for construction of the plant. Items which either have been or will be delivered to the site by barge include reactor pressure vessels, condensers, and turbine generators. As of the first quarter of 1977, six barge shipments were unloaded at the site, and 10 more are expected by completion of the project. These shipments should have no effect on barge traffic on the Mississippi River. Approximately 8 acres of bottomland forest were disturbed by building the barge slip and related facilities. Construction involved the excavation of approximately 190,000 cubic yards of material, as well as the placement of dolphins, winch pads, and a concrete pad in the bottom of the slip. In addition to receiving construction related materials, the barge slip is the point of discharge for plant service water.

4.1.2.4.3 Environmental Protection Measures

a. Erosion Controls

An erosion control program was instituted shortly after the site was prepared for construction. A control program was necessary because changes in vegetative cover and topography altered the amount of runoff from the site, along with increasing the silt and nutrient loading of the runoff. Erosion controls have taken

the form of diversion dikes, lined flumes, storm drains, two sediment basins (A and B), grading of slopes, and seeding with the use of erosion netting where necessary (Figure 4.1-3). Natural drainage patterns at the site centered on stream A draining the northern portion of the site, and stream B draining the southern portions. The natural drainage patterns of these two streams were maintained and supplemented with concrete or rip-rap linings and the storm drain system. Each stream empties into a sediment retention basin where the runoff is held prior to discharge. The two sediment basins are maintained at a minimum storage capacity of 0.2 inch of rainfall per acre of drainage area, with a design capacity of 0.5 inch of rainfall per acre of drainage area. Basin A has a surface area of 8 acres, while basin B has an area of 4 acres. Maintenance dredging spoils from the basins are placed in the main (northeast) spoils site.

An important aspect of the erosion control plan is grading at the spoils disposal sites. Two of the three spoils sites have been brought to grade with one of these being used as a laydown area, after having been compacted and covered with an aggregate base. The remaining active spoil site (northeast) is maintained through constant grading and compaction by earth-moving equipment. Reseeding of completed portions of the spoil site has been accomplished, primarily at a sloped area near basin A at the upper west site, and the northern portions of the active spoils area. Nylon erosion netting has been used as a stablization measure and to assist reseeding. Only the active construction areas have not been reseeded (e.g., spoils site, laydown areas, roads, power block, switchyard, cooling towers, and ancillary areas).

The more northerly portions of the site, such as the area draining into Gin Lake, have not required substantial erosion controls because they have not been subjected to earth moving or topography changes and are essentially in their preconstruction state of either forest or turf.

Erosion controls in the bottomlands have also been minimal due to the topography and lack of intense construction activity. Stream A and the outfall from Gin Lake pass through culverts beneath the haul road and enter Hamilton Lake. The bottomlands, since clearing of the road and pipeline corridor, have reestablished low growing vegetation very quickly which

provides for control of any erosion potential in that area. Erosion along the barge slip banks is minimized by the use of rip-rap and seeding. The borrow pit area and access road are graded and maintained in a suitable condition.

The erosion control measures taken at the site are continually maintained and improved where necessary. Where heavy rainfall has resulted in washout of reseeded areas, repairs have been instituted at the proper time.

b. Dust Control

Excessive dust resulting from vehicular traffic on unpaved roads during dry weather has been controlled by spraying the problem areas with water. Dust from wind action on offroad cleared areas, such as around the power block or inactive portions of spoils areas, has been minimized by reseeding. The paving of access roads and portions of the parking lots further aided in controlling dust. The concrete batch plant, although equipped with a dust-control system, has emitted excessive dust at various times during construction. Currently, this operation is checked weekly and dust collector bag filters changed as required. Fuel burning equipment has been checked to see that it is operating properly and has been repaired or replaced when found to be emitting excessive exhaust.

c. Burning Controls

Open burning at the site has been confined to the burn pit located near the main (northeast) spoils disposal area. All burnable materials such as scrap lumber are transported to the burn pit which is 40 feet long, 10 feet wide, and 12 feet deep. The pit has vertical walls of reinforced concrete with a refractory lining and an air curtain destructor apparatus along the top of the south wall. Through the use of the air curtain device, combustion of burnable trash is more efficient and smoke levels are kept well within the limits set by the Mississippi Air and Water Pollution Control Commission.

Uncontrolled burning and unauthorized fires are expressly prohibited at the site. Minor fires, such as warming fires started by construction personnel, have occured. These fires were promptly stopped.

d. Control of Off Limits Vehicular Movement

Several instances of vehicular movement in off limits areas have occurred during construction of the Grand Gulf Nuclear Station. These have involved violations by clearing and grubbing personnel, surveyors, hunters, an employee living in an abandoned car, damage to vegetation by equipment, the clearing of an unauthorized road, and additional minor violations. In each case corrective action was taken, such as warning contractor personnel, removing trespassers, repairing damaged vegetation, or more clearly marking off limits areas. The appropriate onsite personnel continue to monitor violations and take preventive and corrective actions as required.

e. Noise Controls

Five construction noise surveys were carried out at selected points on the site boundary, as well as one point at Port Gibson during the period from June 1974 to February 1975 (see Section 2.7). When compared with preconstruction ambient noise levels, no significant increases were found (other than increases from construction traffic to and from the site). During some time periods surveyed, actual decreases in sound levels from preconstruction values were observed, which were almost certainly due to decreases in insect activity. The decrease in insect activity probably resulted from the season during which samples were taken or from a loss of available habitat, or both.

The construction noise surveys have been discontinued with NRC concurrence following the five surveys since: a) during peak earth moving activities only slight increases in levels were observed, b) there had been no complaints by local residents, and c) the major earth moving activities were completed.

At the time of pile driving operations during June 1976, noise surveys were again carried out. No significant increases in sound pressure levels were observed at the site boundary.

In addition to the above surveys, onsite environmental personnel monitor construction noise to see that standard noise control devices on trucks and other equipment are maintained in effective condition.

f. Disposal of Construction Wastes and Debris

Solid wastes are generated daily by virtually all phases and elements of construction at the site.

Wastes are placed in containers (drums and dumpsters) located throughout the site. Waste pickup is on a daily basis, with most waste disposal at the main (northeast) spoils area where it is separated into burnable and nonburnable materials and either burned or buried. Some construction wastes are salvaged. Where possible, usable lumber is reclaimed for later construction activities. Scrap iron and steel are salvaged for sale to a scrap dealer. Scrap iron and steel are sold at the prevailing rate at the given time. Most of the salvaged materials are being stockpiled for eventual use during construction of Unit 2.

Waste disposal at the site is carefully monitored by onsite environmental personnel on a daily basis. A few minor instances of unauthorized solid waste disposal have occurred since construction began. These have included one episode of rebar disposal in stream A, dumping of concrete truck washings, trash deposited in the parking lots, and trash and other material left at the radial well sites. In all cases, prompt action was taken to prevent further violations. The concrete wash pit is situated at the main (northeast) spoils area, where all concrete trucks proceed for cleaning. The washings are eventually buried, and a new pit is constructed when necessary. This has been reinforced by instructions to all new truck drivers regarding the unauthorized dumping of these wastes and the location of the wash pit, along with surveillance by environmental personnel.

Liquid wastes at the site consist primarily of lubricating oil and some chemicals. These wastes are stored in sumps and either sold, in the case of reclaimable petroleum products, or removed from the site for disposal by a subcontractor. All chemicals or liquids for use in construction are subject to approval by onsite environmental personnel. Some substances, for example a cleaning-disinfecting agent for use on potable water coolers, have been rejected for onsite usage and acceptable substitutes acquired.

g. Sanitary Waste Disposal

With the exception of portable facilities which are serviced by a subcontractor, all domestic sewage generated at the site is treated in the sewage treatment plant. The plant consists of two 15,000 gpd design

capacity prefabricated units which utilize an activated sludge (aerobic digestion) process for treatment. Sludge is stored in two 940-gallon holding tanks for pickup and offsite disposal by a subcontractor. The effluent is chlorinated prior to discharge to sediment basin A, and chlorine levels average 0.4 mg/l. A second treatment plant is located on the south side of the site at the former location of the administration building on Waterloo Road. This plant has a capacity of 2500 gpd and is currently maintained in operating condition through the addition of bulk material to assure adequate sludge levels for effective treatment. The small plant discharges its liquid effluent to a large concrete lined ditch which leads into basin B.

h. Oil Spills

Prevention, containment, and clean up of oil spills are an important part of the environmental protection measures instituted during construction by the Grand Gulf Nuclear Station Project. Prevention consists of rigid monitoring of all petroleum storage sites and equipment by onsite environmental personnel. Dikes and impermeable berms have been constructed around storage locations such as the main fueling site and around small storage areas where oil is kept in drums. Subcontractors are responsible for the maintenance of these structures which are continually inspected for adequacy and integrity. Equipment is also inspected for leakage and faulty machinery repaired or removed from the site.

Spills are unavoidable in any construction project of this magnitude. Land spills are cleaned up with sand or disposal of the contaminated soil. Water based spills can be contained with oil booms, then cleaned up with sorbent pads or granular sorbent. The Grand Gulf Nuclear Station Project maintains 500 feet of river boom and 500 feet of inland boom at the site, along with a minimum of 100 cases of sorbent pad and 2 tons of granular sorbent. Oil booms have been installed in basins A and B. Sand is also readily available from the deposits in the bottomlands. A boat and motor are also maintained at the site for use when necessary. The river boom is normally deployed across the mouth of the barge slip during barge unloading as a containment measure against the possibility of oil spillage from the barge.

Environmental personnel at the site monitor the basins for any evidence of oil spillage reaching the drainage system. They are supplemented by construction personnel assigned to the normal maintenance of the environmental protection measures at the site such as the sewage treatment plant and erosion program. In addition, close cooperation with other personnel working at the site provides an effective expansion of the regular monitoring by environmental personnel. In the event of a major spill, additional personnel can be quickly mobilized from the work force.

4.1.3 Effects of Construction on Land Resources

Principal alterations to the terrestrial environment have involved the clearing and grading of the site. Approximately 465 acres have been cleared and about 5.88 million yards of material have been moved to bring the site to grade. These operations, as well as other construction activities, either have, or will, result in both long-term and short-term impacts to the terrestrial environment. Long-term effects are related to the permanent alteration of topography and loss of biological production from about 6 percent (124 acres) of the site. Short-term impacts include the temporary loss of biological production from about 16 percent (341 acres) of the site, the alteration of habitat types and the temporary disruption of wildlife. During site preparation and construction, methods described in subsection 4.1.2.4.3 have been and continue to be used to minimize impacts on the terrestrial environment.

4.1.3.1 Effects on Offsite Land Use

Land use within 5 miles of the site is largely devoted to commercial forests with some agriculture. Approximately 71 percent (226,000 acres) of Claiborne County, Mississippi is devoted to commercial forestry (Ref. 1). Within Tensas Parish, Louisiana, about 39 percent (162,000 acres) is covered by commercial forests (Ref. 2). Agricultural activities are mainly related to the production of beef, corn, soybeans, and cotton. Recreational activities in the vicinity of the plant site are related to deer hunting, the Grand Gulf Military Park, YMCA camp, and Lake Claiborne development.

The only archaelogical site located within the boundary of the Grand Gulf Nuclear Station site, an Indian burial mound located about 1000 feet south of the meteorological tower, was removed during archaeological excavation by the Mississippi Department of Archives and History (see Section 2.6). Upon completion of the excavation, the Department deemed it unnecessary to preserve the site since the mound no longer existed. Sites of historic interest located either on or near the Grand Gulf Nuclear Station site include: a) an antebellum farm house, b) a portion of the old Grand

Gulf townsite, c) the remains of the U.S.S. Rattler, and d) the Grand Gulf Military Park. Only the Grand Gulf Military Park is listed on the National Register of Historic Places. The antebellum house (the Callendar House), which is located on the site and is of interest from an architectural standpoint, is not impacted by construction. On June 19, 1974, MP&L transferred 164 acres of land, located north of Gin Lake, to the Grand Gulf Military Park. Most of the old Grand Gulf townsite is located on this land and is not affected by construction. The remains of the U.S.S. Rattler, a Civil War tinclad, are believed to be buried in the river bank just north of the tract transferred to the Park and are not affected by construction of the station.

Accessibility to the Grand Gulf Military Park has not been seriously hampered by construction activities. Early morning construction traffic should have no effect on visitors, however late afternoon traffic could cause delays to persons going from the Park to U.S. Highway 61. Access to the old Grand Gulf townsite has not been affected by construction. Access to the Callendar House and the site of the Indian burial mound are controlled since they are located on the site itself. The nearest National Geodetic Control Network bench mark (BM 248) is located near the Grand Gulf Military Park. This mark has not been affected by construction of the station.

The remaining two recreational facilities within the site vicinity are the Warner YMCA Camp (located off US 61, 2.2 miles from the site) and the Lake Claiborne Development (located off Grand Gulf Road, 4.4 miles from the site). Representatives of both facilities have been contacted and have indicated that the only problems they have experienced related to construction of the Grand Gulf Nuclear Station are associated with increased traffic.

The main offsite impacts have been in the form of increased traffic, construction of a 115 kV service line from Port Gibson, and construction of a 2.7-mile rail spur from the Illinois Central Gulf Railroad line, which runs between Port Gibson and Vicksburg, Mississippi, to the site boundary.

With a work force (day shift) of 2200 men, between 1100 and 1200 vehicles were recorded at the jobsite in September, 1976. Thus, assuming a continued occupancy of two persons per car, traffic volume could reach approximately 2100 vehicles per day when the peak work force is reached during the second quarter of 1978. Improvements that have been made to local roads (Grand Gulf Road and Waterloo Road) to aid in accommodating this increased traffic are discussed in subsection 4.1.2.4.1.a. As noted previously, construction traffic causes inconvenience to users of nearby recreational facilities, primarily during afternoon shift changes.

The 2.7-mile rail spur which runs from the site to the Illinois Central Gulf Railroad line, and the portion of the right-of-way for the 115 kV transmission line which parallels it, occupy 79 acres of land. Approximately 67 percent (53 acres) of this land has been cleared of its forest cover; the remaining acreage was originally field. The railroad spur itself required the excavation and filling of 190,000 and 140,000 cubic yards of material, respectively. This spur is used to bring heavy material to the site. Use of the railroad for this purpose aids in relieving traffic volume on local highways.

The 115 kV transmission line runs from a substation just north of Port Gibson to the site. This line crosses a mixture of fields and woodlands for approximately 3 miles until it reaches the rail spur leading to the site which it parallels for 2.4 miles. Including woodland cleared for the rail spur, a total of approximately 73 acres of forest were cleared for this transmission line.

An additional offsite impact of the project is related to the property which immediately borders the easternmost portion of the site. With the permission of the owners, two actions were taken which affected this land. In one case, approximately 29 acres of land (13 acres of forest and 16 acres of field) between the main spoil area and Waterloo Road have been cleared and spoils deposited in two of three ravines that occur on the property. This action prevented blockage of natural drainage and the consequent flooding of the property by the deposition of spoils on the site itself. Spoils deposited on this private land have been properly graded, fertilized, and seeded. Fencing has also been replaced and the area is again being used as grazing land by the owner. A third ravine located on this same piece of land has been dammed at the request of the owner and a pond of about 3 acres formed. In the second case, soil stability problems, along the rail spur approximately 0.75 mile from the plant, damaged a small pond. By agreement with the owner, a new pond was constructed on the south side of the spur a little more than 1 mile from the site.

4.1.3.2 Effects on Onsite Terrain, Topography and Drainage

Construction activities have, of necessity, altered use of the 2170-acre site. Since construction began, recreational use of the property has been limited primarily to activities associated with Gin and Hamilton Lakes. Fishing is permitted and the boat landings on each lake have remained open to the public. Hunting, however, is no longer permitted on the site. Additional land uses affected by construction are timber production and agriculture. While $17,845 worth of usable timber was recovered during clearing operations, current plans do not call for any commercial

production of wood products during construction or operation of the station. Agricultural use of the site has always been limited.

Within the Grand Gulf site there are two soil series which may be considered prime farmland (capability Class I). These are Memphis silt loam (0-2 percent slope) and Commerce silt loam (Ref. 3). The former series consists of nearly level, deep, well-drained, and moderately well drained soils on the loessial uplands. This series is well suited for row crops, small grains, most grasses and legumes, and pecans. Commerce silt loam soils, located in alluvium along the Mississippi River, are nearly level and moderately well drained to somewhat poorly drained. This series is well suited to row crops, many grasses and legumes, and pecans.

Before construction there were about 70 acres of Memphis silt loam (0-2 percent slope) soils on the site. Approximately 40 acres were affected by construction of the power plant. About 4 acres of the approximately 45 acres of Commerce silt loam soils located on the site were affected by construction of the haul road and intake and discharge pipelines. On a county-wide basis, the loss of this land represents a very small percentage of each soil type. Within Claiborne County there are 6045 acres of Memphis silt loam (0-2 percent slope) and 1410 acres of Commerce silt loam soils. The extent of these soils in the county is 1.9 and 0.5 percent, respectively. Including all Class I soils, there are 8200 acres of prime farmland in the county. The only crop currently harvested on the site is hay. This crop is cut from fields in the lowlands, the western portions of which are classified as Commerce silt loam, and the meteorological tower field, all of which is classified as Memphis silt loam (0-2 percent slope).

301.1

The topography of the site has been altered by excavation, spoil deposition, and backfilling. The site grade in the plant area has been altered from a variable topography to a finished grade at 132.5 feet msl. The spoil resulting from this alteration was deposited in low areas of the upland bluff as indicated in Figure 4.1-3. Within the bluff area, a total of about 5.88 million cubic yards of material were moved to bring the site to finished grade, and approximately 0.78 million cubic yards of material were removed from the power block area. Material removed from the bluff area was approximately 60 percent loessial and 40 percent terrace soils. The former is primarily a silty material that contains a significant amount of humus, while the latter is made up of clay, sand, and gravel. With the exception of 12,000 cubic yards of clay used as a 2-foot seal around power block structures, very little loess or terrace soil is used for structural backfill.

The topography of the bottomland area has not been altered to a great degree by the project. A total of approximately 767,000 cubic yards of material has been removed from the barge slip (190,000 cubic yards), borrow pit (574,000 cubic yards), and well field (3000 cubic yards). An additional 500,000 cubic yards are expected to be taken from the borrow pit before construction is finished. The other alterations of the bottomland have been the building of the heavy haul road and the plant service water supply and discharge lines which run between the barge slip and the plant site. Building the haul road involved deposition of 366,000 cubic yards of fill for the roadbed. Nearly all material excavated for the pipeline (50,000 cubic yards) was used during backfill operations.

Site drainage has been affected to the extent that the loss of vegetative cover has probably increased the volume of runoff and the nutrient and silt loading of the drainage water. The natural drainage patterns at the site have been maintained and some of the natural drainage courses stabilized with rip-rap and concrete lining. Drainage has also been supplemented with storm drains in the main construction site on the bluff. Until construction of the plant service water intake and discharge lines (third quarter 1977), bottomland drainage patterns were maintained with three sets of culverts (two 48-inch culverts per set) beneath the haul road. Pipeline construction has resulted in the permanent blockage of the set of culverts which carried stream A to Hamilton Lake. Stream A has been redirected and presently flows into Hamilton Lake through the other two sets of culverts.

Runoff from the bluff area moves through the drainage courses to sedimentation basin A or B where silt loads can settle out prior to discharge to the bottomland stream beds.

4.1.3.3 Effects on Terrestrial Biota

4.1.3.3.1 Vegetation

Construction activities involved the clear cutting of approximately 274 acres of bluff forest and 76 acres of bottomland forest. About 100 acres of upland fields and 15 acres of bottomland fields were also cleared of existing vegetation. Thus, a total of 465 acres of the 2300-acre site (20 percent) have been cleared in connection with plant construction. Of the 465 acres initially cleared, 124 are permanently removed from biological production. This acreage is occupied by the station, switchyards, rail spurs, access roads, parking lots, haul road, switchgear house, well field, and other miscellaneous structures. The remaining 341 acres that have been cleared of natural vegetation in connection with construction activities, such as spoils and laydown areas, either have been or will be fertilized and reseeded. For example, inactive sections of the spoils areas and the north berm of the haul road have been revegetated. In the former case, common Bermuda grass and winter rye grass were used, and in the latter case, about 2500 sycamore and sweetgum seedlings were planted. |5

Beyond the initial clearing of vegetation from work areas, construction activities have had a minimal impact on vegetation at the site.

Observations have detected no damage to vegetation growing outside of the disturbed construction areas as a result of dewatering activities required to drain the localized perched water between 94 and 103 feet msl, or to keep dry those individual excavations which extend below the principal water table at 73 feet msl. It has also been observed that any minor change in ambient air quality resulting from the operation of equipment at the site has not affected vegetative growth. Semiannual measurements taken at seven vegetative plots have shown no abnormal conditions.

4.1.3.3.2 Wildlife

As noted in the previous section, approximately 465 acres of forest and field habitat have been denuded by construction activities. Within the bluff area about 274 acres of forest and 100 acres of fields have been cleared, while in the bottomlands the figures are 76 acres and 15 acres, respectively. This loss of habitat has resulted in a concomitant loss of wildlife. Amphibians and reptiles,

as well as certain less mobile mammals, have no doubt been lost due to clearing and grubbing activities. Since much of this activity was carried out during the spring and summer of 1974, young of even the more mobile species (e.g., birds, raccoons, squirrels) would also have been lost. The successful reestablishment of displaced species would have depended on the availability of suitable unoccupied habitat near those areas affected by construction.

Additional, although unmeasured, effects of construction related disturbances, such as traffic, noise, and increased human activity, on wildlife populations include changes in behavior, reproductive rates, age and sex structure, and movements. It is expected that certain species adjusted readily to construction activities while others may have experienced effects such as those cited above. Effects of construction are not, of course, limited to the site itself and, for example, roadkills would have been expected to increase along routes leading to the site.

One of the more important species found on and near the Grand Gulf site is the white-tailed deer. Within 5 miles of the site, there are 22 deer hunting clubs and several privately organized hunts which take deer each year. Three clubs and two private hunts which operate near the site have reported either increased kills, or similar kills, for 1976 over 1973 through 1975. Any adverse effects of construction on deer hunting, such as the loss of habitat, increased roadkills, or the loss of land on which to hunt due to posting the site, have apparently been offset by the recovery of the deer herd from the severe 1973 flood and locally improved habitat conditions resulting from logging operations.

The only endangered species present on the Grand Gulf site is the American alligator. Prior to the 1973 spring flood, no alligators had been observed on the site, although one had been sighted on the bank of the Big Black River. This species has not apparently been affected by construction activities as its presence has been confirmed by several observations. One was found dead (shot) in Hamilton Lake in November 1974, two were sighted in each lake in September 1975, one was seen on the west bank of Hamilton Lake in September 1976, and two were observed in Gin Lake in July 1977.

The black bear, listed as a threatened species by both the Mississippi Game and Fish Commission and the Mississippi Natural Heritage Program, has only recently been seen on the Grand Gulf site (since February 1977). Thus, construction activities seem not to have adversely affected this species.

Once the construction phase of the Grand Gulf project is complete and all but the 124 acres of land that will be permanently out of biological production is revegetated, wildlife use of the site will increase. While there will be less forest habitat on the site,

there will be more field habitat and forest-field ecotone. Thus, in many cases, repopulation by species other than those that originally occupied the disturbed areas, can be expected.

Although plans have not yet been finalized concerning implementation, the Mississippi Game and Fish Commission and Mississippi Wildlife Federation have been consulted in connection with recommendations for effective management of wildlife on the Grand Gulf site. Recommendations under consideration include:

a. Maintaining open-field habitat to add to the diversity of wildlife on the site

b. Allowing field borders to succeed to a shrub stage in order to create an ecotone between field and forest

c. Placing of nest boxes for certain song birds as well as wood ducks

d. Allowing continued sport fishing in Hamilton and Gin Lakes

e. Limited bow hunting to prevent deer overpopulation

Consideration is also being given to the use of the area for scientific and educational purposes.

4.1.4 Effects of Construction on Water Resources

4.1.4.1. Effects on Water Use

The principal alterations to water resources at the site occurred during the early phases of the project. The work areas were cleared of vegetation, the site brought to grade through earth moving, the power block excavation dewatered, and a water supply was constructed. The surface waters at the site were exposed to higher discharges, along with increased silt and nutrients from the exposed soils on the bluff. Ground water at the site was subject to localized dewatering during power block excavation and radial well construction.

4.1.4.1.1 Effects on Ground Water Resources

Dewatering at the power block excavation and the radial wells has been necessary for plant construction. At the power block excavation, the use of tie-back walls effectively restricted dewatering to a localized area. Perched water levels declined about 10 feet within the confines of the dewatering zone for the power block excavation. Since the localized perched water in this zone does not constitute a water source for the site area, existing ground water use was not affected by dewatering of the power block excavation. Observation well historical data is discussed in subsection 2.4.5.

Ground water from the terrace deposits provides up to 1 million gallons per day for construction and domestic needs. The withdrawal of this amount of water has not had an adverse impact on the ground water reservoir or existing ground water users (see subsection 2.4.5).

Radial well construction has required dewatering. The ground water levels in this area vary with the Mississippi River stage and recharge rates are high. For these reasons, dewatering for well construction has not had an impact on ground water resources in the bottomlands.

Construction of the intake and discharge pipelines in the bottomlands required dewatering of the trench excavations. Again, since ground water levels in the bottomlands vary with the river stage and have a high recharge rate, combined with the short-term nature of dewatering operations, little impact to the bottomland ground water occurred.

4.1.4.1.2 Effects on Surface Water Resources

The surface water resources at the site consist of five bluff stock ponds, streams A and B, Hamilton Lake, Gin Lake, and the Mississippi River (Figures 2.2-12 and 4.1-1). The bluff stock ponds have been affected to the extent that two of the ponds (pond 4 southeast of the Unit 1 cooling tower and pond 1 within the main spoil area) were filled during construction. The remaining stock ponds have been essentially unaffected. These ponds were originally man made for stock watering, and the loss of the two ponds will eventually be compensated for through the creation of additional terrestrial habitat. A discussion of the effects of construction on offsite ponds is included in subsection 4.1.3.1.

Streams A and B have been exposed to the impacts arising from station construction. Steam A has been channeled through a culvert under the plant access road. Stream B has been stabilized with rip-rap or concrete pads, on the bluff, and passes through culverts where necessitated by grading and filling operations. Sediment retention basins were constructed on each stream (basins A and B) in mid-1974 as one of the early erosion control measures. Both streams received increased runoff, silt, and nutrient loads during the early construction phases as a result of the heavy earth moving activity and the loss of vegetative cover from the active bluff construction zones. Dewatering of the power block excavation added to stream volume, although this input was minimized by the use of the tie-back walls and was temporary in nature. Heavy rains during 1974 decreased the effectiveness of the sediment retention basins, necessitating repairs and sediment removal. During 1975, the basins were improved in stability and effectiveness, although heavy rains again required repairs and sediment removal. In 1976, the reseeding program at inactive areas of the bluffs served to

improve the functioning of the two basins. Suspended solids levels of the stream waters below the two dams have been measured. During 1976, a general improvement in the effectiveness of the sediment retention basins was noted from midyear on as the reseeding program took effect. In general, the basins remained effective in 1977. Basin B, which receives most of the site runoff, was often characterized by suspended solids in the runoff which required extended periods of time before settling occurred. In May of 1976, a settling agent was added to the basin (55 gallons of Betz polymer) and settling occurred rapidly. Since that time, the basin has significantly increased in effectiveness.

In the bottomlands, site stream A was modified during construction of the haul road to the extent that it flowed to Hamilton Lake through the first (easternmost) of three sets of culverts which were placed beneath the road. All three bottomland stream courses (streams A and B, and the Gin Lake outlet stream) received increased runoff as the corridor through the bottomlands was cleared of vegetation and the haul road constructed. The runoff decreased with the reestablishment of low growing vegetation along the corridor. In the third quarter of 1977, the set of culverts through which stream A flowed was permanently blocked by construction of the intake and discharge pipelines and the stream was redirected to Hamilton Lake through the other two sets of culverts. Some increase in silt loads occurred during this period although this was short term in nature.

Prior to the initiation of construction activities on the Grand Gulf Nuclear Station site, stream B became blocked with sediment near its exit from the bluff and ceased to flow into Hamilton Lake, except during periods of very heavy rainfall. It split into rivulets and flowed into the floodplain southeast of Hamilton Lake, where it joined existing drainage channels and ultimately flowed into the Mississippi River via Bayou Pierre. Stream B is redirected so that it flows into the north end of Hamilton Lake along its original course, and it will be maintained to follow this course.

During the period when the stream was diverted (approximately 1973 - 1978), suspended solids which passed from sedimentation basin B, flowed into the floodplain. However, sedimentation basin B retained most of the sediment transported from the construction area.

The site streams continue to be subject to runoff from the construction areas, although the quality of the runoff should improve as disturbed areas are further stabilized with vegetation and construction of Unit 2 nears completion.

Gin Lake has been largely unaffected by station construction due to its location to the north of the active construction areas. The Gin Lake drainage basin has remained in a relatively undisturbed condition.

Hamilton Lake receives site runoff via streams A and B. Gin Lake flows into Hamilton Lake through a small stream which passes beneath the haul road. Direct connection exists between the river and Hamilton Lake (when the Mississippi River stage rises above 56 feet msl) through the discharge stream at the south end of Hamilton Lake.

Bathymetric surveys of Hamilton and Gin Lakes were conducted in April, 1973, and again in September, 1977 (Hamilton Lake) and December, 1977 (Gin Lake). Data from the bathymetric surveys is presented in Figures 4.1-4 and 4.1-5.

During flood periods, the level of suspended solids in Mississippi River water increases due to transport of silt from upstream areas. The increase in suspended solids in the river water contributes to siltation of Hamilton and Gin Lakes. Bathymetric surveys of Gin Lake (which receives insignificant runoff from the plant site) show that the lake has silted about 3 to 4 feet from 1973 to 1977 (Figure 4.1-5). During this period, the Mississippi River floods exceeded the floodplain elevation annually. Hamilton Lake bathymetric surveys show an increase in bottom elevation of about 2 to 3 feet (Figure 4.1-4). This change is mostly due to Mississippi River floods, since a similar increase in elevation has occured in Gin Lake. Runoff from the plant site that discharges to Hamilton Lake first passes through sedimentation basins A and B which retain most of the sediment transported from the construction area. Suspended sediment that passes from the sedimentation basins flows into Hamilton Lake, however, its contribution to the silting of Hamilton Lake is insignificant compared to the Mississippi River contribution.

The Mississippi River has received dewatering effluent from radial well construction, runoff from the bluff area via the site streams and Hamilton Lake, and very minor and localized turbidity during construction and maintenance of the barge slip. Dewatering effluent from the radial wells has been very low in volume relative to river volumes, and has consisted of recharge water to the aquifer from the river, hence water quality has not been significantly altered. A minor amount of turbidity has been added in the immediate area of the discharge pipes.

Site runoff reaching the Mississippi River via Hamilton Lake has been buffered by the lake itself. There have been no indications that the river has been altered in the area of the Hamilton Lake outlet. Construction of the barge slip was performed at low river water and entailed no dredging or earth moving in the river itself. The material removed consisted primarily of sand which was spoiled at the borrow pit. Soil overburden was removed to a spoils site. Since most of the material disturbed was sand,

very little turbidity was induced in the river. Since construction of the barge slip, several dredging operations have taken place. A permit was obtained from the Corps of Engineers to remove a sand bar at the mouth of the barge slip. The operation took place at low river water stage and resulted in the removal of about 10,000 cubic yards of river sand which was spoiled at the borrow pit. Since the river was at low water, and the material was sand, very little turbidity or siltation occurred in the river. The barge slip has also been dredged once to enlarge it and several times to maintain it. To date, water quality of the Mississippi River has not been altered to any appreciable extent from station construction due to the large volume of the water body and the overriding influence of upstream factors on water quality. The effect of station construction on navigation in the river is discussed in subsection 4.1.2.4.2.c.

Additional construction activities near the river include installation of the discharge structure, laying the intake and discharge pipelines, and possible construction of additional radial collector wells in connection with Unit 2. Installation of the discharge structure at the barge slip was accomplished during low river water periods when little or no water is found in the slip. Very little silt should have reached the river since this was essentially a land-based construction. Any sediment transported to the river should not have had a significant effect upon the river.

The intake and discharge pipelines were constructed in a trench extending across the bottomlands to the bluff. In this area, the trench has required dewatering. Water has been pumped from the trench to the river or onto the floodplain. Localized increases in turbidity have resulted, along with some siltation in the immediate area. Since the water from the trench was comprised essentially of recharge water from the river itself, little impact on the river should have occurred.

The additional radial collector wells, if required for Unit 2, will be constructed in the same manner as the three in place. Dewatering effluent will be discharged to the river. The effluents will be of low volume and will consist of recharge water from the river itself. Some turbidity may be induced in the immediate discharge areas, but no significant change should occur in the river.

4.1.4.2 Effects on Aquatic Biota

Prior to construction, during the Environmental Field Measurements Programs, two of the five bluff stock ponds (ponds 1 and 2, Figure 2.2-12), were sampled for adult fish populations. The bluff ponds had been stocked with fish by previous owners. Pond 2 (0.25 acre) contained bluegill, mosquitofish, and a few channel catfish (see Section 2.2). This pond, along with ponds 3 and

5, has remained relatively unaffected by station construction. Pond 1 (about 0.5 acre) was sampled, and contained a stunted population of bluegill and a small population of mosquitofish. Pond 1, along with pond 4, was filled with spoils from site excavation and earth moving. The loss of these two small ponds does not represent a significant loss to regional populations or habitat.

Site stream A was also sampled during the field program. This stream has a drainage area of about 2.8 square miles with most of this area situated offsite. The stream was perennial, characterized by negligible flow, and isolated pools within the site boundary. Significant erosion and heavy deposits of loess in the stream bed also characterized the stream at the site. Twenty-one species of fish were collected from the stream. Samples were dominated by bluntnose minnow, green sunfish, longear sunfish, silvery minnow (a river species which probably entered the stream during the high river flood of March 1973), and blackspotted topminnow. Compared to samples taken upstream at the site boundary, population density within the site was low (see Section 2.2).

Station construction, altered the stream bed along that portion of stream A which flows across the site east of the bluff. The stream flows through a culvert into sedimentation basin A. The sedimentation basin represents an increase in the available aquatic habitat associated with stream A. Treated effluent from the main sewage treatment plant is discharged into basin A during construction. The discharge has the potential to stimulate oxygen depletion in the basin waters due to a combination of seasonal conditions and the oxygen demand of the sewage effluent. There has been no evidence to date that this situation has arisen. Aquatic biota in the stream have been subjected to increased runoff and turbidity from earth moving activities at the site and mortality of the less tolerant species has probably occurred.

Stream B, intermittent in nature, did not support stable or productive fish populations prior to construction. The stream bed near the main (northeast) spoils area was filled with excavation spoils. As the stream traverses the bluff, the bed has been lined with rip-rap and flumes constituting a change in the nature of the available habitat for aquatic life. Sediment retention basin B has expanded the aquatic habitat of the stream. Fish have populated this basin, possibly being transported to the basin as eggs on the bodies of ducks.

An important source of potential impact to aquatic biota in the streams is the spillage of oil and chemicals into these water courses. To date, several very small oil spills have occurred. In one instance, diesel oil placed on stagnant pools of water in conjunction with attempts to control an encephalitis outbreak in

the region, was washed from the pools into the streams by a heavy rainfall. The diesel fuel was contained and cleaned up with sorbent pads before it could reach Hamilton Lake. All oil spills to date have been successfully contained and cleaned up before the spills reached Hamilton Lake. As an added precaution, oil booms have been installed in both basins. Oil spills have had no apparent effect on biota in the sediment retention basins or in Hamilton Lake. A discharge of a chemical solution occurred in February of 1977. The material was an industrial type detergent cleaning solution which was being used by workers to clean out water coolers. The effluent entered the plant runoff, passing into basin A where the mortality of about 75 small shad occurred. The detergent was immediately removed from the site and shipped back to the manufacturer. A nontoxic substitute was put into use.

Aquatic biota inhabiting the site streams continue to be subject to impacts from station construction. Impact potential has decreased since completion of the heavy earth moving operations and power block excavation, and continues to decrease as the erosion control program stabilizes and revegetates further areas of the site which become inactive construction zones.

Effects of station construction on Hamilton Lake are discussed in subsection 4.1.4.1.2. Gin Lake, due to its location, has been largely unaffected by station construction. Gin Lake is buffered from the bottomland borrow pit activities by intervening vegetation and there have been no apparent impacts to the lake. Improved access to the lakes has resulted in some increase in fishing pressure, primarily from bank fishermen and some boat fishing.

Mississippi River biota should not have been significantly affected by construction activities. Construction activities directly affecting the river center on barge slip construction and maintenance and radial well dewatering. Since barge slip construction took place at low river levels, river biota were exposed to minimal impacts. Maintenance dredging has had a minimal impact also, since it has been performed during low water levels and spoils are deposited in the borrow pit. Dewatering of the radial wells should not have affected biota to any significant degree other than some very local displacement of fish and benthos in the immediate areas of the discharge. Construction of the discharge structure at the barge slip took place at low water and should have had essentially no impact on river biota. Installation of the intake and discharge pipelines across the bottomlands has resulted in the discharge of trench dewatering effluent into the river and the floodplain. Some siltation and increased turbidity have been experienced in the immediate area of the discharge. Some benthic biota sensitive to the increased siltation may have been lost and some fish displaced from the localized area. These impacts were temporary in nature, and with completion of this activity, river biota should have returned to its normal state in the affected area.

4.1.5 References

1. Van Hooser, D., "Midcycle Evaluation of Mississippi Timber Resources," U.S.D.A. Forest Resource Bulletin 50-44, 1973.

2. Earles, J.M., "Forest Statistics for Louisiana Parishes," U.S.D.A. Forest Resource Bulletin 50-52, 1975.

3. U.S.D.A., "Soil Survey, Claiborne County, Mississippi," Soil Conservation Service, 1963.

TABLE 4.1.1

ACREAGES AFFECTED BY VARIOUS FACILITIES ASSOCIATED WITH GRAND GULF NUCLEAR STATION

Entity or Facility	Area (acres)	
Site	2300	5
Station area		
Permanent buildings	8	
Cooling towers	28	
Standby service water cooling towers and basins	4	
Switchyard	53	5
Roads, railroad spurs, grass areas, etc.	17	
Concrete batch plant	10	
Parking Lots:		
Permanent	4	
Temporary	13	
Laydown areas (includes 18 acres of former spoils area)	70	
Spoils areas (includes 18 acres presently used as a laydown area)	64	
Settling basins:		
Basin A	8	
Basin B	4	
Access roads within bluff area (including those in the station area)	34	
Railroad spurs:		
Offsite	83	5
Onsite (includes those within the station area)	6	
Plant service water well system, access road, and switchgear control house	15	
Plant service water supply and discharge line and heavy haul road	38	
Barge slip and associated facilities	8	
Borrow pit	30	
Transmission line corridors:		
115 kV	67	
Baxter Wilson	521	
Ray Braswell	596	
Franklin	1057	

TABLE 4.1.2

CONSTRUCTION SCHEDULE (START AND FINISH DATES TO THE NEAREST QUARTER) FOR VARIOUS PHASES OF THE GRAND GULF PROJECT

Event	Start		Finish	
	Unit 1	Unit 2	Unit 1	Unit 2
Site preparation	2nd, 1974	2nd, 1974	3rd, 1980	4th, 1983
Reactor and turbine building	3rd, 1974	4th, 1977	1st, 1980	3rd, 1982
Cooling towers	1st, 1976	2nd, 1978	3rd, 1978	3rd, 1980
Intake/discharge lines	2nd, 1977	2nd, 1977	4th, 1977	4th, 1977
Fuel load	4th, 1980	3rd, 1983	4th, 1980	3rd, 1983
Commercial operation	2nd, 1981	1st, 1984		

SPOIL
AREA
MET TOWER
GIN LAKE
BORROW
PIT
BARGE
SLIP
MISSISSIPPI RIVER

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

AERIAL VIEW GRAND GULF SITE
OCTOBER 1976
FIGURE 4.1-1

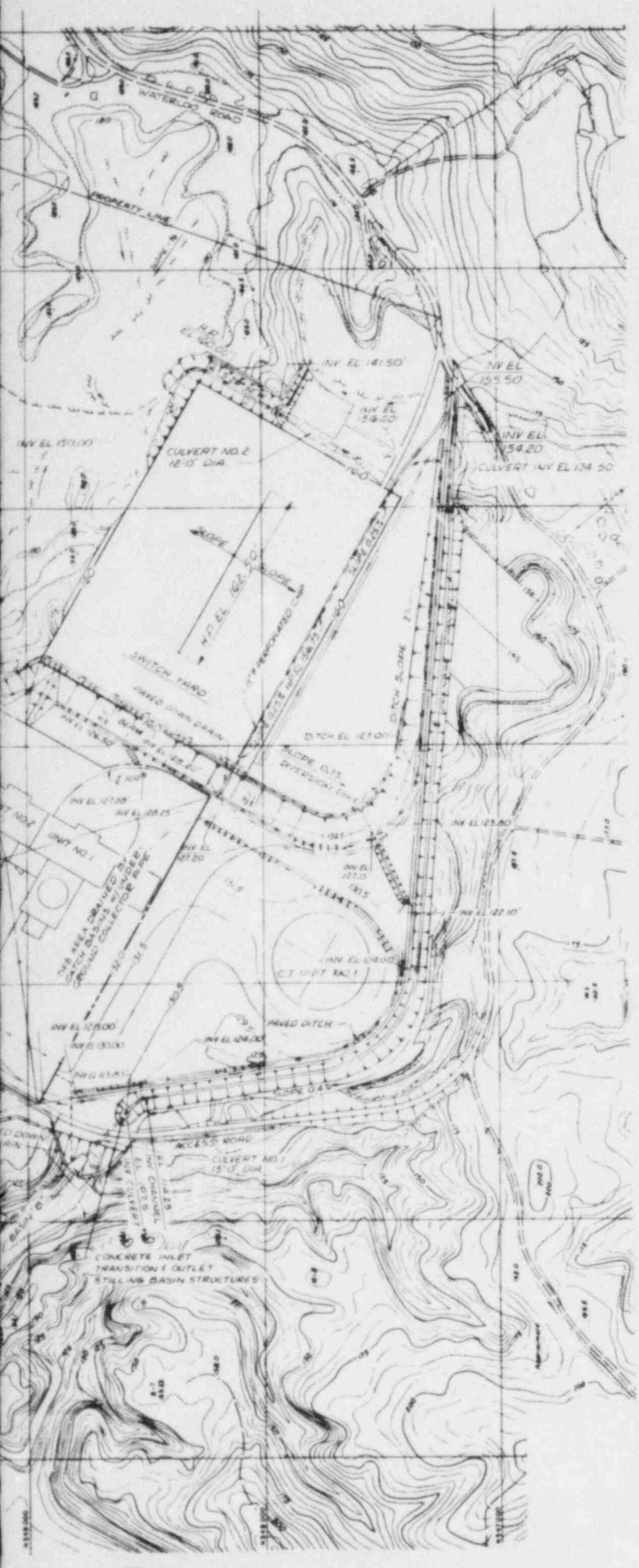
PROPERTY LINE
GIN LAKE
HAMILTON LAKE
MISSISSIPPI RIVER
OLD RAILROAD EMBANKMENT
ILLINOIS CENTRAL R.R.
N550,000
PLANT
PROPERTY LINE
E281,000
GRAND GULF SPUR
KEY LOCATION PLAN
N.T.S.
E282,000
E281,000
E280,000
E279,000
PORT GIBSON - GRAND GULF ROAD
E278,000
E277,000
E276,000
E275,000
E274,000
E273,000
GIN LAKE
HAUL ROAD
PROPERTY LINE
SUPPLY LINE
CORPS OF ENGINEERS PROPOSED FUTURE SHORE LINE
PLANT DISCHARGE LINE & DIFFUSER
RADIAL COLLECTOR WELL
BARGE SLIP
PROPERTY LINE
E272,000
MISSISSIPPI RIVER
E271,000
E270,000
N561,000
N560,000
N559,000
N558,000
N557,000
N556,000
N555,000
N554,000
N553,000
N552,000
N551,000

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

SITE AND YARD WORK SITE PLAN

FIGURE 4.1-2

STD END SECTION(TYP)
INLET EL.
OUTLET EL.
TYPICAL CULVERT DETAIL
E 280 000
E 279 000
E 278 000
E 277 000
E 276 000
N 551 000
N 550 000
EL 176.50
ACCESS ROAD
SPILLWAY CHUTE
EL 156.00
CULVERT 12.0 DIA
EL 152.00
CURVED DOWN DRAIN
EL 124.00
LAYDOWN AREA
EL 135.00
EL 132.00
EL 130.00
EL 129.00
EL 113.00
DAM
GRAPHIC SCALE IN FEET
200
0
200
400

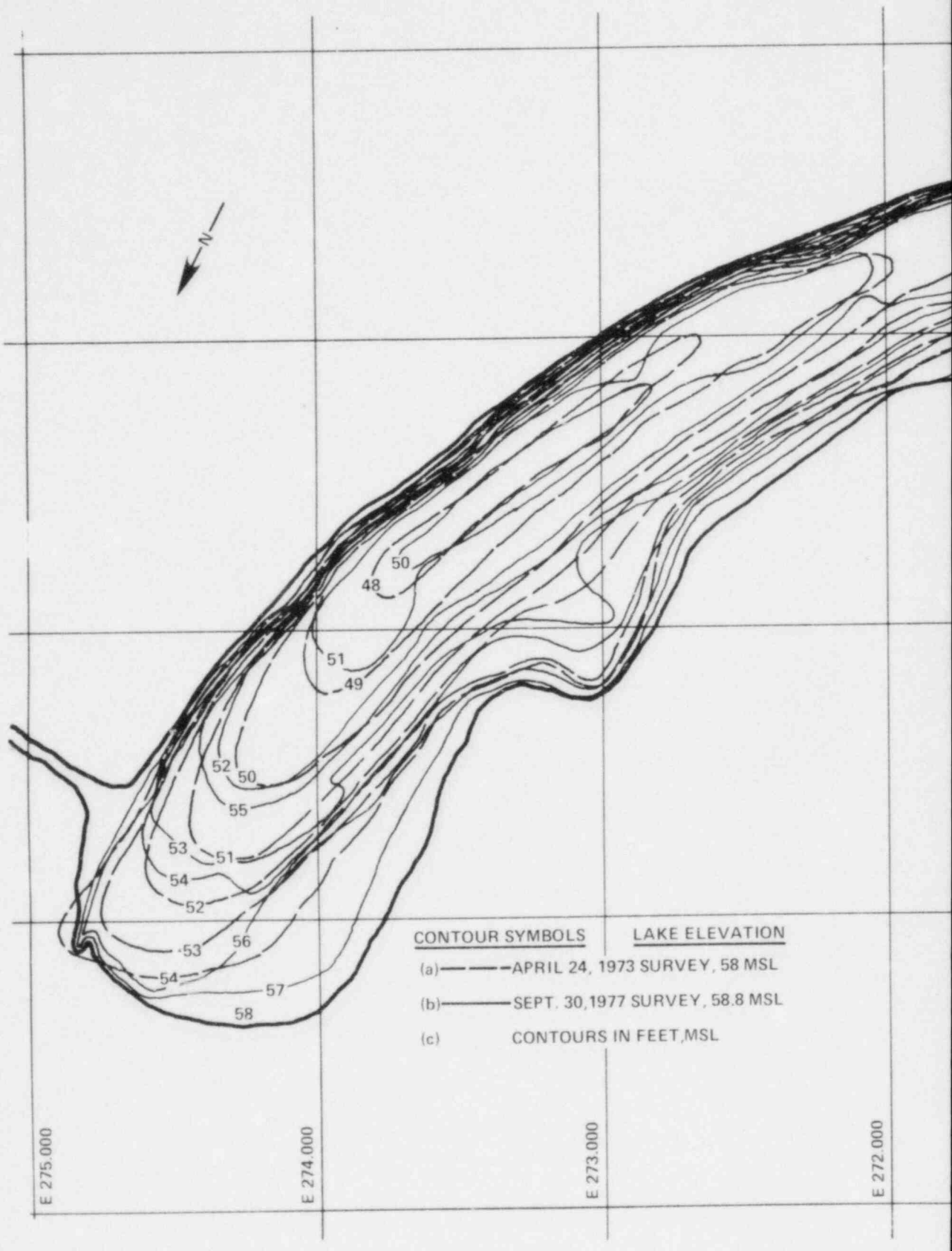


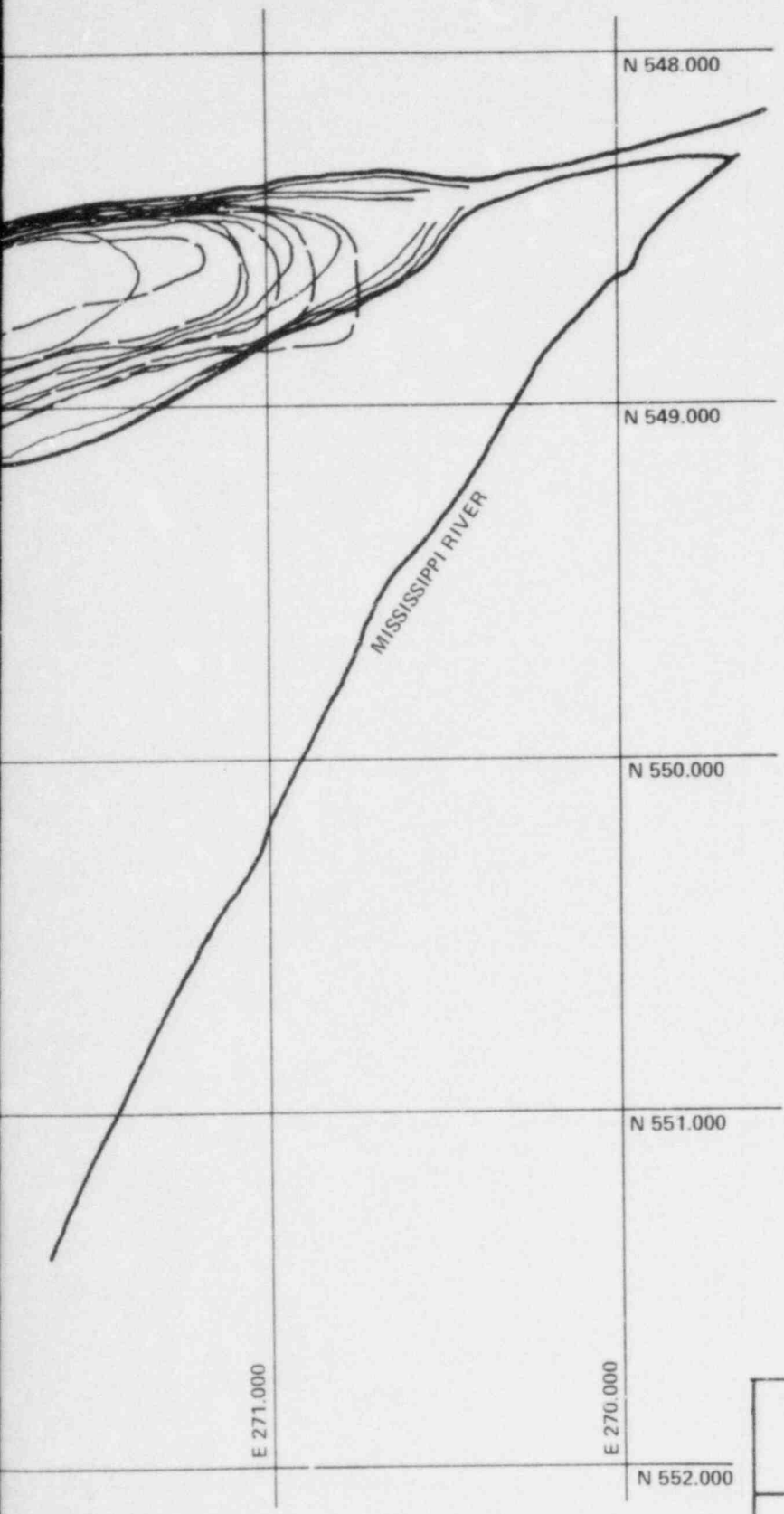
LEGEND

- GRASS LINED DITCHES
- GRASS LINED WATERWAYS
- PAVED DITCHES (3" GUNNITE OR 4" CONCRETE)
- SPILLWAY OUTLETS (OR STILLING BASIN)
- PIPED STORM DRAIN
- CULVERTS
- RAILROAD

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

SITE GRADING DRAINAGE
AND EROSION CONTROL PLAN
FIGURE 4.1-3

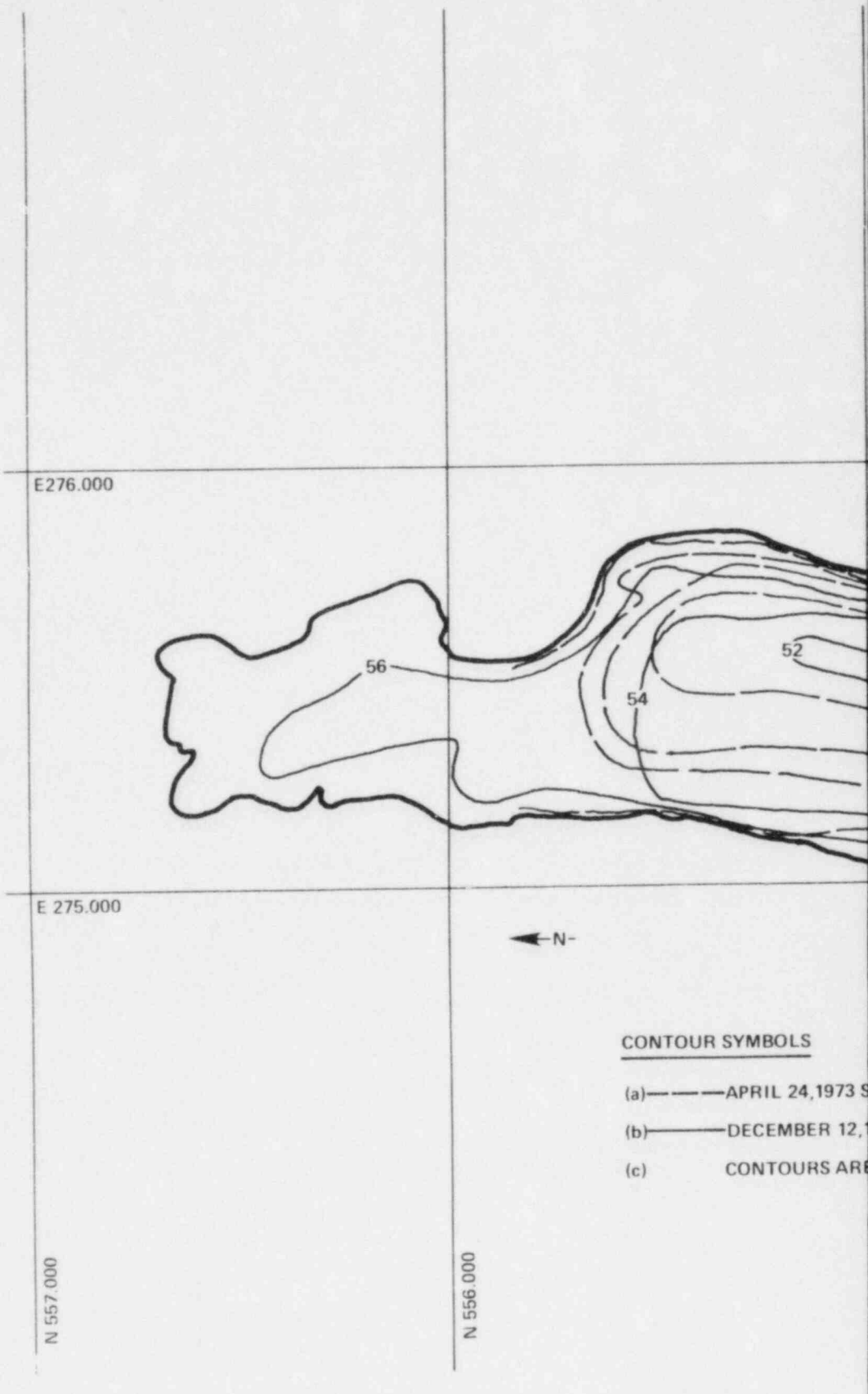

N
50
48
51
49
52
50
55
53
51
54
52
53
56
54
57
58
CONTOUR SYMBOLS
LAKE ELEVATION
(a) APRIL 24, 1973 SURVEY, 58 MSL
(b) SEPT. 30, 1977 SURVEY, 58.8 MSL
(c) CONTOURS IN FEET, MSL
E 275.000
E 274.000
E 273.000
E 272.000

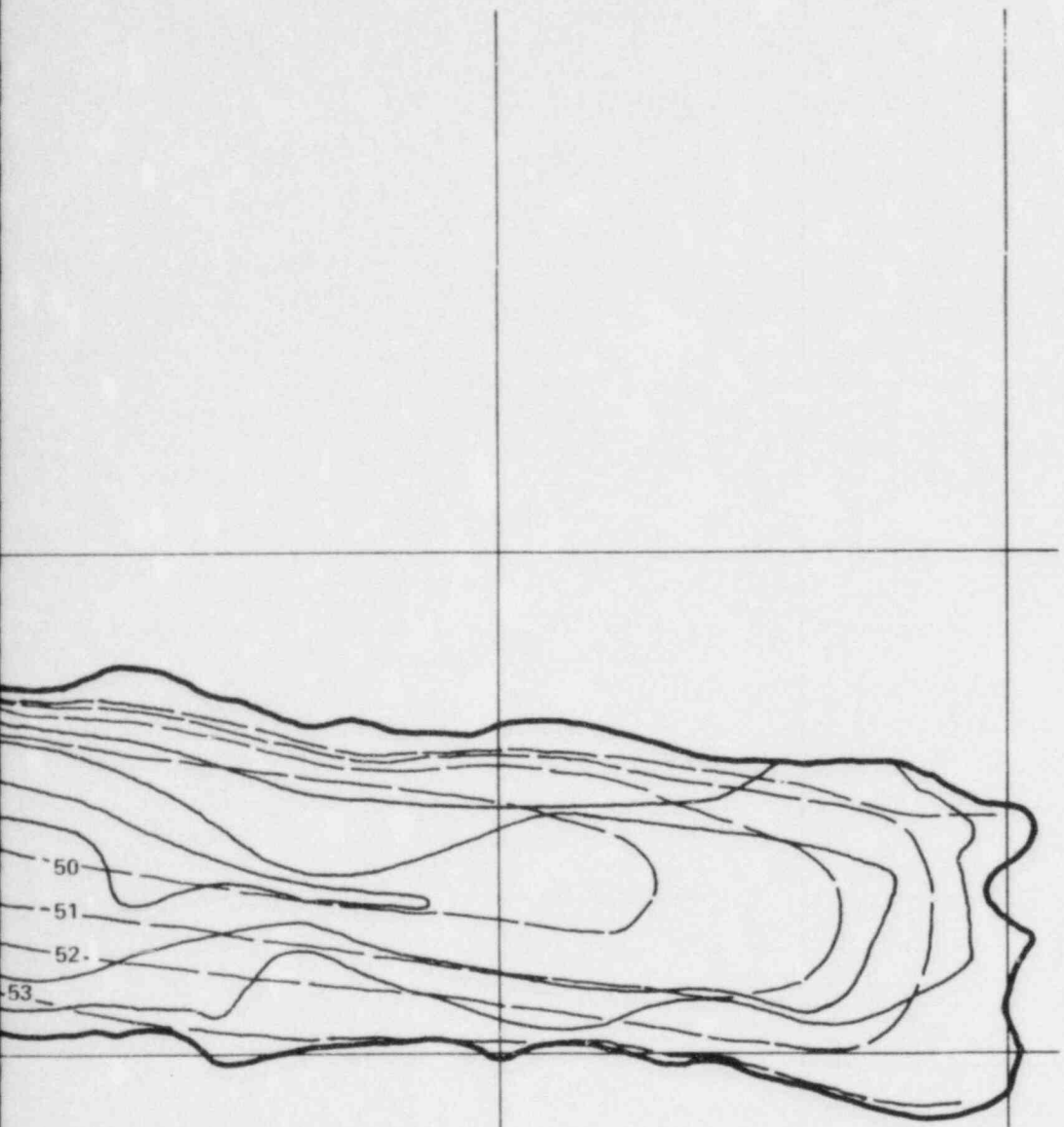


MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

BOTTOM CONTOUR MAP OF
HAMILTON LAKE

FIGURE 4.1-4


E276.000
56
54
52
E 275.000
N
N 557.000
N 556.000
CONTOUR SYMBOLS
(a)
APRIL 24,1973 S
(b)
DECEMBER 12,
(c)
CONTOURS ARE



N 553.000

N 554.000

N 555.000

LAKE ELEVATION

URVEY,58 FT. MSL

977 SURVEY,60.3 FT. MSL

IN FEET, MSL

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

BOTTOM CONTOUR MAP OF
GIN LAKE

FIGURE 4.1-5

4.2 TRANSMISSION FACILITIES CONSTRUCTION

4.2.1 Construction Procedures

It is MP&L's practice to use existing roads and open areas to provide access to new transmission line rights-of-way. Access into wooded areas is provided by working along the new rights-of-way as they are cleared.

During construction of the transmission lines, precautions are taken to prevent displacement of top soil. Commercially marketable timber is harvested before general clearing begins. Where possible, trees are sheared at ground line to minimize erosion, particularly along the steep loess slopes where erosion is most likely to occur. The clearing specifications provide for disposing of brush by windrowing and burning. All burning is done in accordance with applicable regulations. MP&L requires the contractor to repair all fences that may be cut and not to pile trees, limbs, or brush on or near any fences either on or off the right-of-way; to pile danger timber in such a way as not to damage fences or the right-of-way; and to keep all gates or gaps in fences closed when not in use. Danger timber is felled toward the right-of-way, limbs trimmed, and limbs and logs placed as near the outer boundary of the right-of-way as practical. All merchantable timber is sawed into log lengths and stacked.

Areas subject to damaging erosion are seeded immediately following the clearing operation. After construction, the right-of-way is reconditioned and seeded with permanent grasses. Critical areas are mulched to prevent erosion and fertilized as required to establish ground cover. Specifications prepared by the Mississippi State Highway Department and the Soil Conservation Service are used as planting guides.

Whenever possible, farm roads and turn rows are used to minimize damage to crops. In locations where terraces are traversed by the line, damage to terraces is repaired. Holes in the right-of-way due to stumps being pushed up are filled and leveled. Ruts due to maneuvering of heavy equipment are leveled. At the end of construction, ditches, creeks, or other natural drainage ways are cleared to permit unobstructed drainage. Special attention is directed to protection and restoration of highway, road, and railroad rights-of-way. Ditches in these areas are cleared out after crossing.

The sequential operations of timber harvesting, clearing, tower foundations, tower erection, and conductor stringing follow closely to minimize the time of impact upon the area tranversed, with the intent that two or more of these separate operating progress concurrently. MP&L makes a complete cleanup operation at the end of each line project. The cleanup operation completely covers the line project and no further intrusion of the area is required until major maintenance of the right-of-way or lines is needed. Each contractor is required to clean up his major damage such as vehicle ruts, holes and potential serious erosion, as he completes his work.

4.2.2 Transmission Line Construction

Construction of approximately 95 miles of transmission line for the Grand Gulf Nuclear Station requires clearing about 2240 acres of right-of-way. This construction may temporarily affect people living near the rights-of-way. However, the construction activity is distributed over the length of the line and is of short duration in any one place. The effects of this activity include noise from sawing operations and some occasional visible smoke from authorized burning. The overall impact on nearby residents is insignificant.

There are areas of the rights-of-way which, as a result of construction activity, have surficial soils exposed to erosion. These areas are landscaped and seeded.

During construction, there is some displacement of wildlife, particularly in forested areas. However, the clearance and maintenance of rights-of-way through forested areas creates a shrub-type habitat which benefits those species of wildlife that favor the edge areas between the forest and open field. Through proper wildlife management techniques, the terrestrial community along the rights-of-way can be influenced to create habitats favorable to forest-edge species. Some of these species occurring in Mississippi are the mockingbird, Baltimore oriole, bobwhite quail, mourning dove, wild turkey, cottontail rabbit, and white-tailed deer.

Transmission line corridors represent potential barriers to movement and migratory patterns of animals. The transmission line routes, however, are not expected to appreciably disrupt migration of wildlife in the region for the following reasons:

a. There are no records of existing powerlines (in Mississippi) having adversely affected or altered migration of birds that pass through the State each spring and fall.

b. There are no migratory land mammals, such as caribou, resident in the State.

c. The transmission line routes pass through an area of mixed farmland and forest, thus decreasing the "strip" effect that is created when a transmission line corridor passes through pure forest.

d. The transmission line structures and corridors are no larger than some presently in existance in the State.

The Bayou Pierre system is unique in that it contains the endemic bayou darter which is considered endangered. The range of the bayou darter extends from approximately two miles below the Smyrna crossing to the Port Gibson Area, with the range extending a few miles into Turkey, Fosters' and White Oak Creeks. The bayou darter is an inhabitant of eroded channel sections where water flowing over gravel or sandstone has created a riffle effect. In the area of Port Gibson the channel becomes deeper and possesses a sandy bottom which provides little or no habitat. None of the tributaries in this area harbor the bayou darter (Teels, 1976). A survey of potential habitats performed by U.S. Fish and Wildlife, U.S.D.A. Soil Conservation Service and Mississippi Power & Light indicated that the bayou darter does not reside in the waterways crossing the Franklin 500 kV Transmission Line.

340.5

4.2.3 Towers

During tower erection, components are hauled from the stringing area to the tower sites. The towers are assembled on the site in two or more sections and these sections are put in place with a crane. The conductor stringing equipment is set up to pull in two directions. The lengths of pulls are 2 to 4 miles. The stringing operations are coordinated by use of radio contact. Guard structures are installed at roads, railroads, power and communication lines, and other places where needed for the safety of the facilities and the public.

4.2.4 Monitoring

A transmission line construction monitoring program is conducted to identify potential environmental problem areas, design and implement procedures to minimize impacts, and monitor the effectiveness of these measures or any remedial actions taken. The transmission line construction monitoring activities are generally implemented in three time phases: preconstruction, construction, and postconstruction. Section 4.5 presents a more detailed description of the monitoring program.

4.2.4.1 Preconstruction Phase

During the preconstruction phase, when transmission line corridors are being surveyed and staked, these areas are inspected to determine the following:

a. Major stream banks that should be protected

b. Potential erosion areas that should be reseeded immediately after clearing

c. Vegetation types best suited for use in revegetating cleared or disturbed areas within the rights-of-way

d. Areas which may require fertilization to assure adequate revegetation of the cleared or disturbed areas within the rights-of-way

e. Existence of unique or unusual features located within or immediately adjacent to the construction rights-of-way

f. Areas where adverse aesthetic impacts may occur

Prior to initiation of construction activities in transmission line corridors, coordination meetings are held with the contractor to identify the sensitive construction areas and to recommend remedial procedures.

4.2.4.2 Construction Phase

During transmission line construction, weekly visual observations are made to ensure that potential problem areas are protected and that proper construction practices are followed.

4.2.4.3 Postconstruction Phase

Subsequent to the completion of transmission line construction activities, semiannual inspections of these areas are conducted to determine the effectiveness of the procedures in minimizing impacts and to delineate areas where remedial action may be needed.

4.2.5 REFERENCES

Teels, B.M., 1976. "The Ecology of Endangered Fish in Bayou Pierre." Proceedings of Mississippi Water Resources Conference: 73-78.

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4.3 RESOURCES COMMITTED

Numerous resources either have been or will be committed during construction of the Grand Gulf Nuclear Station.

Construction of the facility has disturbed 465 acres of the 2170-acre site (124 acres are permanently removed from biological productivity). The remaining 1705 acres of the site will be left essentially undisturbed. A detailed discussion of the land committed during construction is presented in Section 4.1.

Other resources committed are the supplies and energy used to construct the plant. They are as follows:

Lumber	- 7.4 million board feet
Concrete	- 514,000 cubic yards
Steel	- 110,000 tons
Aluminum	- 90 tons
Electricity	- 212 million kWh (over 6 years)
Oxygen	- 3.2 million cubic feet
Acetylene	- 0.45 million cubic feet
Diesel oil	- 2.6 million gallons
Gasoline	- 2.1 million gallons

For a more detailed discussion of resources committed, refer to Section 5.7.

4.4 RADIOACTIVITY

Refer to FSAR subsection 12.4.3 for information on man-rem doses to Unit 2 construction workers due to the operation of Unit 1.

4.5 CONSTRUCTION IMPACT CONTROL PROGRAM

Grand Gulf Nuclear Station is being constructed in accordance with the Environmental Protection Program Respecting Construction of Grand Gulf Nuclear Station Units 1 and 2, as set out in Staff Exhibit 2-A in the evidentiary hearing on environmental matters conducted by the Atomic Safety and Licensing Board, February 19-21, 1974. The objective of this program (presented in Appendix A) is to assure that construction is accomplished with practices which cause minimum impact.

There has been only one amendment to the program since construction began. In January of 1976 the Nuclear Regulatory Commission agreed that it was appropriate to discontinue the bimonthly noise level surveys since survey results indicated that noise levels did not exceed acceptable levels. Efforts have continued to reduce excessive and objectionable vehicular noise, and continued observations by environmental inspectors have shown that construction activities have not resulted in noise levels sufficient to warrant resumption of the noise level surveys.

An evaluation of the effectiveness of the Environmental Protection Program Respecting Construction, along with other measures implemented for the protection of the environment during construction, is presented in subsection 4.1.2.4.3 and Section 4.2.

APPENDIX A

(STAFF EXHIBIT 2-A)

ENVIRONMENTAL PROTECTION PROGRAM RESPECTING CONSTRUCTION OF GRAND GULF NUCLEAR STATION UNITS 1 AND 2

There are two parts to the Environmental Protection Program. Part One relates to general work practices and addresses vehicle movement, dust control, noise control, and chemical and solid waste management. Part Two covers specific construction activities which merit special attention because of potential impact. Part Two includes site clearing and grubbing, excavation, dewatering, road construction, river structures, and transmission line construction.

This program describes construction practices and monitoring programs which must be followed to assure minimal environmental impact. The applicant will provide administrative controls which assure immediate corrective action when any departure from the described practices occurs. Compliance with Parts One and Two will be assured by a weekly reconnaissance of the site by the Applicant. In addition, a reconnaissance of erosion and sediment control structures will be made within twenty-four hours after every rainstorm, but is not required more than once in a twenty-four hour period.

Observations on each of the points covered in the Program will be maintained in written records which will be kept up-to-date and available for inspection by the Regulatory staff at all times during normal working hours. These records shall indicate the corrective actions prescribed by the Applicant's inspector for any noted deviation from this program. Completion of the prescribed corrective action as noted on subsequent inspections will be documented therein.

Applicant's management will receive monthly reports with respect to the Environmental Protection Program from its own inspectors. A summary of these monthly reports will be submitted to the AEC Regulatory staff every six months.

A preoperational monitoring report, prepared at the Operating License Stage, will include a more thorough discussion of observations of environmental effects observed during the course of construction.

The Applicant will assure that contractors and subcontractors are familiar with and that their construction practices are in accordance with the Environmental Protection Program as described in Parts One and Two. Records will be maintained by the Applicant to document steps taken to familiarize contractors with the Environmental Protection Program.

PART ONE - GENERAL WORK PRACTICES

1. VEHICLE MOVEMENT

Areas where uncontrolled traffic can cause severe damage, such as vegetative filter strips along waterways and all undisturbed open spaces, will be delineated on a site map and designated as "off limits" areas for all construction vehicular traffic.

For woodland areas, all vehicular traffic will stay within the roadway, access corridor, or utility rights-of-way shown on the site map.

Traffic will be restricted from crossing streams or stabilized drainageways except at approved stabilized crossing locations.

The construction area will be fenced to establish control over access and to implement a construction security program. Permanent plant fencing, consisting of 7-foot high cyclone fencing topped with three strands of barbwire, will be utilized.

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2. DUST CONTROL

Dust, smoke, engine exhausts and concrete plant operations represent air pollution potentials which can be controlled. Good drainage and dry weather wetting, or the paving of the most traveled construction roads will reduce dust generated by vehicular traffic. Bare areas will be seeded to provide a ground cover where necessary. Care will be taken to control smoke or other undesirable emissions. The Applicant will adhere to applicable air-pollution control regulations of Claiborne County and the State of Mississippi as they relate to open burning or the operation of certain fuel-burning equipment. Permits and operating certificates will be secured where required. Fuel-burning equipment will be maintained in good mechanical order to reduce excessive emissions. Reasonable precautions will be taken to prevent accidental brush or forest fires. The concrete plant will be equipped with dust-control systems to avoid excessive releases of cement dust.

Dust resulting from vehicular traffic on unpaved haul roads and access roads during dry weather will be controlled by spraying problem areas with water, as necessary. Dust from wind action on off-road, cleared areas will be minimized by applications of mulch and the reseeding of bare areas as part of the erosion control efforts. Uses of gravel on heavily traveled roads and the paving of all permanent access roads and parking areas during early construction activities will further eliminate potential dust problems.

Open burning of tree wastes (slash) resulting from site preparation will utilize an air curtain destructor system to insure thorough combustion, to reduce the quantity of ash produced and to minimize particulate emissions. All open burning will be conducted in accordance with the Mississippi Air Quality Regulation APC-S-1, Section 3.7 on Open Burning.

Visual observations for excessive dust will be made daily during peak construction activity periods. Existing dust control measures will be modified if necessary.

3. NOISE CONTROL

Action will be taken to reduce excessive and objectionable vehicular noise. Standard noise control devices on trucks and other equipment will be provided and maintained in effective condition.

Noise levels at the site boundary will be documented by a bimonthly survey using a portable sound level meter. Noise levels will be surveyed during periods of peak noise-producing activity.

4. CHEMICAL AND SOLID WASTE MANAGEMENT

Liquid wastes, such as chemicals, fuels, lubricants, bitumens and flushing solutions, will be deposited or discharged into tanks for salvage or subsequent removal to appropriate off-site locations. Adequate care will be taken to avoid handling or storing liquids in close proximity to major drainage areas, thereby avoiding damaging spills to the site streams. Washings from concrete transporting equipment will be processed in a waste concrete separator which will provide aggregate recovery and control the quality of the effluent.

Construction scrap and debris will be collected in designated on-site areas for salvage, incineration or burial. Unuseable, combustible materials will be incinerated in a portable incineration unit located on the site. Emission levels and operation of the incinerator will be in accordance with Mississippi Air Quality Regulation APC-S-1. Emissions and odors will be kept at an acceptable minimum and all control devices on the incinerator will be maintained in good working order. Incombustible solid wastes will be buried at designated landfill areas on the site.

Most of the plant piping systems and equipment which will carry water or steam must be cleaned shortly before normal operation begins. The flush-cleaning of a two-unit nuclear plant is a complex operation, requiring extensive planning and the preparation of a voluminous manual of procedures and instructions. At the present design stage, the flushing volumes, sequence and discharge rates involved in this process have not been determined. Preparation of the cleaning procedures will include consideration of proper disposal. The Regulatory staff will be provided with a copy of the disposal procedures six months prior to the date designated by the applicant for start of cleaning operations.

PART TWO - SPECIFIC CONSTRUCTION ACTIVITIES

1. SITE CLEARING AND GRUBBING

Most site preparation and construction activities will be conducted in upland areas. The containment structures, turbine buildings, cooling towers, switchyard, laydown areas, and spoil deposition areas will occupy approximately 270 acres of uplands (of which 70 will be for permanent structures). The plant service water pipes and plant discharge pipelines will be located in the bottomlands. The area of the bottomlands directly involved will be about 20 acres. Roughly 90 pecent, or about 300 acres, of the affected area is wooded and will have to be cleared.

All sediment structures will be installed prior to or concurrent with the initiation of clearing and grading operation. Stream stabilization work will be performed prior to or concurrent with the initiation of clearing and grading operations in the watershed.

Clearing and grubbing of the site will be limited to the area needed to construct the facility and to dispose of waste materials within the confines of the site.

Unmerchantable timber and timber wastes (slash) will be burned in accordance with the State of Mississippi Air Quality Regulation APC-S-1 (Mississippi Air and Water Pollution Control Commission, 1972). Brush and tree limbs can be shredded and used as mulch for erosion control on spoil disposal areas. Erosion in the construction area will be controlled by providing piped drainage, intercept and berm ditches, and ground covers where necessary. Earth materials will be deposited and protected in selected areas so that high water or surface runoff will not transport sediments to the lakes or to the Mississippi River.

Natural drainage into Hamilton Lake will be maintained during construction. Spoil areas will be graded and permanently landscaped to natural drainage patterns. Settling ponds will be provided, if necessary.

The contractor will minimize the amount of land to be exposed at any one time. Sediment retention structures will be maintained for the duration that ground is uncovered.

A monthly visual inspection of vegetation on the periphery of the cleared area will be conducted. This surveillance will document abnormalities or stresses with particular attention being given to areas possibly affected by water imbalances. Measures to reduce stress will be taken.

Diversion dikes will be constructed at the following numbered locations (see Attachment VIII to the 12/18/73 Request for Construction Exemption) and at other locations as required.

(1) South end of spoil areas A & B

(2) Along the edge of the switchyard and adjacent area

(3) Along the edge of the laydown area

Chutes or flumes will be constructed and used at all points where runoff will be diverted and concentrated by the diversion dikes. For outlet protection, the chutes will be provided with energy-dissipating devices at the toe of the slope, like concrete building blocks on edge anchored to the chute lining and projecting a minimum of 6 inches above the lining (see Attachment XXIII to the 12/18/73 Request for Construction Exemption (RCFE)).

The chutes/flumes will be installed at locations numbered 4, 5, 6, 7, and 8 (see Attachment VIII to the 12/18/73 RCFE).

Two sediment retention basins will be constructed at the site (see Attachment VIII to the 12/18/73 RCFE for locations). Details of the dams and their construction are shown on Attachments IX and X to the 12/18/73 RCFE. The two dams will each provide adequate storage for about 0.5 inch per acre of drainage area, and they will be maintained so that at no time will there be less storage capacity than about 0.2 inch per acre of drainage area. At this time they will be cleaned out to restore their original capacity. Sediment basins are temporary in nature and will be removed upon completion of the construction work at the site. All graded areas, exposed to or through the maximum erosion hazard season, will be protected by seeding and mulching or by mulching alone, as may be appropriate. Mulch will be properly anchored in any event.

Surface water stage will be monitored at two stations on each stream: at the head of each basin and immediately below each dam. A continuous stage recorder will be installed to document stage. The recorded stage will be correlated with surface water quality measurements to document the effectiveness of the sediment control structures in reducing sediment contents in water discharged from the basins.

The surface water quality monitoring program is designed to detect pollution caused by construction operations. Frequent visual inspections to detect pollution at its source will be a key feature of this program. If routine monitoring indicates that construction activities may be causing unacceptable water pollution, additional tests will be made as required to identify the extent of the pollution, trace it to its source, and determine the appropriate remedial action.

Table 1 outlines the surface water quality program.

2. EXCAVATION AND SOIL DEPOSITION

The first major operation required under the excavation program is the construction of principal sediment control structures and the implementation of an overall soil erosion control program to stabilize the site during construction. The excavation program will include subgrades for railroads and access roads, drainage structures and channels, excavation and drainage of the power block area structures utilizing a tied back, soldier pile vertical wall-type excavation for the turbine building, circulating water lines and pump house, radwaste building, control building, auxiliary and containment building, and standby service water heat sinks for both Grand Gulf Units 1 and 2. (Reference Attachments IV, V, VI, VII, VIII, IX, and X.3 to 12/18/73 Request for Construction Exemption).

It is presently estimated that approximately six million yards of loessial and terrace soils will have to be excavated and deposited elsewhere as spoil. The terrace soils may be used for structural backfill, but the loessial probably will be unsuitable for construction uses. The spoil will be deposited in the upper reaches of a ravine which roughly parallels the easternmost boundary, running through the switchyard area. Some of the spoil may be used in the relocation of Waterloo Road along the southern boundary.

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TABLE 1

SURFACE WATER QUALITY MONITORING PROGRAM DURING CONSTRUCTION

Water Body	Parameter	Technique	Frequency	Locations
Plant site Streams	Stage Suspended Solids	Stage recorder Standard Methods	Continuous During periods of high runoff	Head of each basin and immediately below each dam.
Entire Site	Weekly visual inspection to detect excessive turbidity, oil films, and other sources of pollution.			

Excavation in the bottomland for installation of the service water intake and station discharge pipelines may involve an additional 900,000 cubic yards of floodplain deposits.

During and immediately following the filling of each spoil disposal area, the fill will be graded to acceptable slopes to minimize potential erosion problems before turf cover is established.

Until the turf has stabilized the disposal areas, maintenance will be performed to correct local areas of excessive erosion or inadequate turf cover. The drainage from the proposed spoil areas, during and after construction, will be designed to follow the natural drainage patterns now existing. The flow from all spoil areas will drain either into streams A or B.

Diversion dikes will be constructed on spoil areas and other erodible areas to divert surface flow away from unstabilized slopes. Flumes will be constructed at all points where runoff will be diverted and concentrated by diversion dikes.

3. DEWATERING

Construction dewatering will consist of draining the localized perched water between El. 94 and 103 feet in the area of excavation. There will be no effect on the principal water table since the bottom of the plant excavation (El. 85 feet) will be approximately 12 feet above the principal water table (El. 73 feet).

When certain structures (e.g. circulating water lines, equipment drain sumps, etc.) will require excavation below El. 73 feet, dewatering will be limited to the immediate area of each structure. Due to the very low permeability of the Catahoula Formation, no significant dewatering is anticipated from these excavations.

The perched water and surface runoff from precipitation will be collected in subdrainage trenches and sumps. This water will then be pumped to the natural drainage channels where check dams will control erosion and the quality of the effluent.

Possible dewatering effects on groundwater levels will be monitored at approximately 10 wells on the site on a biweekly basis.

Subsidence could also result from "loss of ground" wherein soil grains from subsurface deposits are removed along with the pumped ground water. The dewatering system will be carefully installed and its effluent periodically checked to ensure that loss of ground does not occur.

4. ROAD CONSTRUCTION

The total paved area on the site will be approximately twenty-eight acres and will be constructed similar to county roads with similar drainage.

Highways connecting the site with U.S. Highway 61 (Grand Gulf Road, Waterloo Road and State Road 462) will be improved. Two roads providing access onto the site will be constructed and paved; one directly from Grand Gulf Road, one from Waterloo Road. A third existing road to the floodplain will be improved. Work roads within the construction area will be developed and paved as required. Parking lots and work areas around principal buildings will be protected to minimize erosion, control dust and maintain a year-round work area.

5. RIVER STRUCTURES

Although plans for the construction operations in the river are not complete at this time, it is recognized that reasonable precautions will be necessary to avoid excessive damage to the aquatic environment. The Applicant is considering use of barge carriers to transport the reactor to the site. At the present time, however, plans for the barge landing have not been completed.

A plan for environmental protection during construction of river structures will be developed as part of the construction plans. This will be kept on file and available for inspection at the construction site during these construction activities.

6. TRANSMISSION LINE CONSTRUCTION

Transmission line construction monitoring will identify potential construction problem areas, design and implement procedures to minimize impacts, and monitor the effectiveness of these measures or any remedial actions taken. The transmission line construction monitoring activities will be implemented generally in three time phases: preconstruction, construction, and post-construction.

Pre-Construction Phase

During the pre-construction phase, when transmission line corridors are being surveyed and staked, these areas will be inspected to determine the following:

1. Major stream banks that should be protected.
2. Potential erosion areas that should be reseeded immediately after clearing.
3. Vegetation types best suited for use in revegetating cleared or disturbed areas within the rights-of-way.
4. Areas which may require fertilization to assure adequate re-vegetation of the cleared or disturbed areas within the rights-of-way.
5. Existence of unique or unusual features located within or immediately adjacent to the construction rights-of-way.
6. Areas where adverse aesthetic impacts may occur.

Prior to initiation of construction activities in transmission line corridors, coordination meetings will be held with the contractor to identify the sensitive construction areas and to recommend remedial procedures.

Construction Phase

During construction of the transmission lines, precautions will be taken to prevent displacement of top soil. The clearing specification will provide for disposing of timber and brush by windrowing and burning. All burning will be done in accordance with applicable regulations. The applicant shall require the Contractor to repair all fences that may be cut, not to pile trees, limbs or brush on or near any fences, either on or off the right of way; to pile "danger timber" in such a way as to not damage fences or the right of way; to keep all gates or gaps in fences closed when not in use. "Danger timber" shall be felled toward right of way, limbs trimmed, limbs and logs placed as near the outer boundary of the right of way as practical. All merchantable timber shall be sawed into log lengths and stacked.

Areas subject to damaging erosion will be seeded immediately following the clearing operation. After construction, the right of way will be reconditioned, fertilized, and seeded with permanent grasses. Critical areas will be mulched to prevent erosion until growth is established. Specifications prepared by the Mississippi State Highway Department and the Soil Conservation Service will be used as planting guides.

Whenever possible, farm roads and turn rows shall be used to minimize damage to crops. In locations where terraces are traversed by the line, damage to terraces shall be repaired. Holes in the right of way due to stumps being pushed up shall be filled and leveled. Ruts due to maneuverings of heavy equipment shall be leveled. At the end of construction, ditches, creeks, or other natural drainage ways will be cleared to permit unobstructed drainage. Special attention shall be directed to protection and restoration of highway, road and railroad rights-of-way. Ditches in these areas shall be cleared out after crossing.

Existing roads and open areas will be used to provide access to new transmission line rights-of-way. Access into wooded areas will be provided by working along the new right-of-way as it is cleared.

Post-Construction Phase

Subsequent to the completion of transmission line construction activities, semi-annual inspection of these areas will be conducted to determine the effectiveness of the procedures in minimizing impacts, and to delineate areas where remedial action may be needed.

FINAL ENVIRONMENTAL REPORT

GRAND GULF NUCLEAR STATION

UNITS 1 AND 2

MISSISSIPPI POWER & LIGHT COMPANY

MIDDLE SOUTH ENERGY, INC.

MIDDLE SOUTH UTILITIES SYSTEM

VOLUME 3

GG
ER

SUMMARY TABLE OF CONTENTS

CHAPTER 1.0

PURPOSE OF THE PROPOSED FACILITY AND ASSOCIATED TRANSMISSION

		Page
1.1	SYSTEM DEMAND AND RELIABILITY	1.1-1
1.2	OTHER OBJECTIVES	1.2-1
1.3	CONSEQUENCES OF DELAY	1.3-1

CHAPTER 2.0

THE SITE AND ENVIRONMENTAL INTERFACES

2.1	GEOGRAPHY AND DEMOGRAPHY	2.1-1
2.2	ECOLOGY	2.2-1
2.3	METEOROLOGY	2.3-1
2.4	HYDROLOGY	2.4-1
2.5	GEOLOGICAL SUMMARY	2.5-1
2.6	REGIONAL HISTORIC, ARCHEOLOGICAL, ARCHITECTURAL, SCENIC, CULTURAL, AND NATURAL FEATURES	2.6-1
2.7	NOISE	2.7-1

CHAPTER 3.0

THE STATION

3.1	EXTERNAL APPEARANCE	3.1-1
3.2	REACTOR AND STEAM ELECTRIC SYSTEM	3.2-1
3.3	STATION WATER USE	3.3-1
3.4	HEAT DISSIPATION SYSTEM	3.4-1
3.5	RADWASTE SYSTEMS AND SOURCE TERMS	3.5-1
3.6	CHEMICAL AND BIOCIDE WASTES	3.6-1

SUMMARY TABLE OF CONTENTS (Cont.)

		Page
3.7	SANITARY AND OTHER WASTE SYSTEMS	3.7-1
3.8	REPORTING OF RADIOACTIVE MATERIAL MOVEMENT	3.8-1
3.9	TRANSMISSION FACILITIES	3.9-1
	CHAPTER 4.0	
	ENVIRONMENTAL EFFECTS OF SITE PREPARATION, STATION CONSTRUCTION, AND TRANSMISSION FACILITIES CONSTRUCTION	
4.1	SITE PREPARATION AND STATION CONSTRUCTION	4.1-1
4.2	TRANSMISSION FACILITIES CONSTRUCTION	4.2-1
4.3	RESOURCES COMMITTED	4.3-1
4.4	RADIOACTIVITY	4.4-1
4.5	CONSTRUCTION IMPACT CONTROL PROGRAM	4.5-1
	CHAPTER 5.0	
	ENVIRONMENTAL EFFECTS OF STATION OPERATION	
5.1	EFFECTS OF OPERATION OF HEAT DISSIPATION SYSTEM	5.1-1
5.2	RADIOLOGICAL IMPACT FROM ROUTINE OPERATION	5.2-1
5.3	EFFECTS OF CHEMICAL AND BIOCIDE DISCHARGES	5.3-1
5.4	EFFECTS OF SANITARY WASTE DISCHARGES	5.4-1
5.5	EFFECTS OF OPERATION AND MAINTENANCE OF THE TRANSMISSION SYSTEMS	5.5-1
5.6	OTHER EFFECTS	5.6-1
5.7	RESOURCES COMMITTED	5.7-1
5.8	DECOMMISSIONING AND DISMANTLING	5.8-1

SUMMARY TABLE OF CONTENTS (Cont.)

		Page
	CHAPTER 6.0	
	EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS	
6.1	PREOPERATIONAL ENVIRONMENTAL PROGRAMS	6.1-1
6.2	PROPOSED OPERATIONAL MONITORING PROGRAMS	6.2-1
6.3	RELATED ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAMS	6.3-1
6.4	PREOPERATIONAL ENVIRONMENTAL RADIOLOGICAL MONITORING DATA	6.4-1
	CHAPTER 7.0	
	ENVIRONMENTAL EFFECTS OF ACCIDENTS	
7.1	STATION ACCIDENTS INVOLVING RADIOACTIVITY	7.1-1
7.2	TRANSPORTATION ACCIDENTS INVOLVING RADIOACTIVITY	7.2-1
7.3	OTHER ACCIDENTS	7.3-1
	CHAPTER 8.0	
	ECONOMIC AND SOCIAL EFFECTS OF STATION CONSTRUCTION AND OPERATION	
8.1	BENEFITS	8.1-1
8.2	COSTS	8.2-1
	CHAPTER 9.0	
	ALTERNATIVE ENERGY SOURCES AND SITES	
9.1	ALTERNATIVES NOT REQUIRING THE CREATION OF NEW GENERATING CAPACITY	9.1-1
9.2	ALTERNATIVES REQUIRING THE CREATION OF NEW GENERATING CAPACITY	9.2-1
9.3	COST EFFECTIVENESS ANALYSIS OF CANDIDATE SITE-PLANT ALTERNATIVES	9.3-1
9.4	COSTS OF ALTERNATIVE POWER GENERATION METHODS	9.4-1

GG
ER

SUMMARY TABLE OF CONTENTS (Cont.)

		Page
	CHAPTER 10.0	
	STATION DESIGN ALTERNATIVES	
10.1	CIRCULATING COOLING WATER SYSTEM	10.1-3
10.2	INTAKE SYSTEM	10.2-1
10.3	DISCHARGE SYSTEM	10.3-1
10.4	CHEMICAL WASTE TREATMENT	10.4-1
10.5	BIOCIDE TREATMENT	10.5-1
10.6	SANITARY WASTE SYSTEM	10.6-1
10.7	LIQUID RADWASTE SYSTEM ALTERNATIVES	10.7-1
10.8	GASEOUS RADWASTE SYSTEM ALTERNATIVES	10.8-1
10.9	TRANSMISSION FACILITIES	10.9-1
10.10	OTHER SYSTEMS	10.10-1
	CHAPTER 11.0	
	SUMMARY COST-BENEFIT ANALYSIS	
11.1	BENEFITS	
11.2	COSTS	
11.3	CONCLUSION	
	CHAPTER 12.0	
	ENVIRONMENTAL APPROVALS AND CONSULTATION	
	CHAPTER 13.0	
	REFERENCES	

GG
ER

CHAPTER 5

ENVIRONMENTAL EFFECTS OF STATION OPERATION

TABLE OF CONTENTS

		Page	
5.1	EFFECTS OF OPERATION OF HEAT DISSIPATION SYSTEM	5.1-1	
5.1.1	Effluent Limitations and Water Quality Standards	5.1-1	
5.1.2	Physical Effects	5.1-1	
5.1.2.1	System Description	5.1-1	
5.1.2.2	Blowdown Water and Mississippi River Water Characteristics	5.1-1	
5.1.2.3	Analysis	5.1-2	
5.1.2.3.1	Assumptions	5.1-2	
5.1.2.3.2	Near Field Analysis	5.1-4	5
5.1.2.3.3	Far Field Analysis	5.1-4	
5.1.2.4	Results	5.1-5	
5.1.2.4.1	Two-Unit Operation: Mean River Water Level Condition	5.1-5	
5.1.2.4.2	Two-Unit Operation: Low River Water Level Condition	5.1-6	5
5.1.2.4.3	One-Unit Operation: Mean and Low River Water Level Conditions	5.1-6	
5.1.3	Biological Effects	5.1-6	
5.1.3.1	Intake Operation	5.1-6	
5.1.3.2	Discharge Operation	5.1-7	
5.1.3.2.1	Thermal Plume Effects at Mean River Water Level	5.1-8	
5.1.3.2.2	Thermal Plume Effects at Low River Water Level	5.1-10	5
5.1.3.3	Effects of Plant Shutdowns	5.1-12	
5.1.3.4	Effects of Cooling Towers on Migratory Birds	5.1-13a	
5.1.4	Effects of Heat Dissipation Facilities	5.1-13b	1
5.1.4.1	Cooling Tower Plumes and Fogging	5.1-13c	1
5.1.4.2	Blowdown Discharge	5.1-17	
5.1.4.3	Cooling System Effects on Meteorological Variables	5.1-18	
5.1.4.3.1	Wind	5.1-18	
5.1.4.3.2	Temperature	5.1-18	
5.1.4.3.3	Atmospheric Water Vapor	5.1-18	
5.1.4.3.4	Precipitation	5.1-18	
5.1.4.3.5	Fog and Icing	5.1-19	
5.1.4.3.6	Stability	5.1-19	
5.1.4.3.7	Dew	5.1-19	
5.1.4.3.8	Dispersion of Radioactive Effluents	5.1-19	

TABLE OF CONTENTS (Cont.)

5.1.4.4	Summary	5.1-19
5.1.4.5	Effects of Cooling Tower Drift	5.1-19
5.1.4.5.1	Description of the Diffusion and Deposition	5.1-20
5.1.4.5.2	Computational Approach	5.1-21
5.1.4.5.3	Results of the Drift Analysis	5.1-22

GG
ER

TABLE OF CONTENTS (Cont.)

		Page
	5.1.4.6 Ground Water Effects	5.1-23
	5.1.5 References	5.1-23
	Appendix A - Model Assessment Tables	5.1A-1
	Appendix B - Corps of Engineers' Shoreline Modification Program	5.1B-1
5.2	RADIOLOGICAL IMPACT FROM ROUTINE OPERATION	5.2-1
	5.2.1 Exposure Pathways	5.2-1
	5.2.1.1 Pathways for Exposure to Man	5.2-1
	5.2.1.2 Pathways for Exposure of Biota Other than Man	5.2-2
	5.2.2 Radioactivity in Environment	5.2-3
	5.2.2.1 Liquid Radioactive Effluent	5.2-3
	5.2.2.2 Atmospheric Diffusion Model	5.2-4
	5.2.2.2.1 Average Relative Concentration	5.2-4
	5.2.2.2.2 Average Relative Deposition	5.2-5
	5.2.3 Dose Rate Estimates for Biota Other Than Man	5.2-6
	5.2.3.1 Aquatic Flora and Fauna	5.2-6
	5.2.3.2 Terrestrial Animals	5.2-7
	5.2.4 Dose Rate Estimates for Man	5.2-7
	5.2.4.1 Estimated Doses Due to Liquid Effluents	5.2-7
	5.2.4.2 Estimated Doses Due to Gaseous Effluents	5.2-8
	5.2.4.3 Direct Radiation From Facility	5.2-9
	5.2.5 References	5.2-10
	Appendix A - Dose Models for Biota Other Than Man	5.2A-1
5.3	EFFECTS OF CHEMICAL AND BIOCIDE DISCHARGES	5.3-1
	5.3.1 General	5.3-1
	5.3.2 Mixing of Chemical Discharges Into the Mississippi River and State Water Quality Criteria Contours	5.3-1
	5.3.2.1 Chemical Dispersion Analysis	5.3-2
	5.3.2.1.1 Assumptions	5.3-2
	5.3.2.1.2 Near Field Analysis	5.3-3
	5.3.2.1.3 Far Field Analysis	5.3-3
	5.3.2.2 Chemical Dispersion Analysis Results	5.3-4
	5.3.2.3 Discussion of Results	5.3-4
	5.3.3 Effects of Cooling Tower Drift	5.3-6
	5.3.4 Environmental Effects of Chemical and Biocide Discharges	5.3-6

TABLE OF CONTENTS (Cont.)

		Page	
	5.3.5 References	5.3-10	1 5
	Appendix A - FWPCA Section 401 Certification	5.3A-1	
5.4	EFFECTS OF SANITARY WASTE DISCHARGES	5.4-1	
	5.4.1 Sanitary Waste Discharge and Standards	5.4-1	
	5.4.2 Environmental Effect of Sanitary Effluent	5.4-1	
5.5	EFFECTS OF OPERATION AND MAINTENANCE OF THE TRANSMISSION SYSTEMS	5.5-1	
	5.5.1 Effects of Transmission Lines	5.5-2	1
	5.5.2 References	5.5-4	
5.6	OTHER EFFECTS	5.6-1	
	5.6.1 Noise Effects	5.6-1	
	5.6.2 Land Use and Water Use	5.6-2	
	5.6.3 Aesthetic Effects	5.6-2	
	5.6.4 Intera tion With Other Plants	5.6-2	
	5.6.5 Fossil-Fueled Facilities on the Site	5.6-3	1
	5.6.6 Spills	5.6-3	
	5.6.7 Effects of Storm Drainage System Discharge on Lakes and Streams	5.6-3	
	5.6.8 References	5.6-4	
5.7	RESOURCES COMMITTED	5.7-1	
	5.7.1 Uranium Resources	5.7-1	
	5.7.2 Land Resources	5.7-1	
	5.7.3 Water Resources	5.7-1	
	5.7.4 Environmental Resources	5.7-1	

GG
ER

TABLE OF CONTENTS (Cont.)

		Page
5.8	DECOMMISSIONING AND DISMANTLING	5.8-1
	5.8.1 Long Term Land Use	5.8-1
	5.8.2 Irretrievable Commitment of Land	5.8-1
	5.8.3 Decommissioning Plans	5.8-1
	5.8.4 Environmental Impact	5.8-2
	5.8.5 Decommissioning Costs	5.8-2

LIST OF TABLES

Table No.	Title
5.1.1a	Plant Discharge Rates and Temperatures
5.1.1b	Summary of Cases Analyzed
5.1.2a	Summary of Thermal Plume Analysis - One-Unit Operation
5.1.2b	Summary of Thermal Plume Analysis - Two-Unit Operation
5.1.3	Biota Sampled Along the River Bank Habitat During the 1972-73 Environmental Field Measurements Programs
5.1.4	Thermal Tolerance Data for Fish Species Sampled Along the River Bank Habitat at the Grand Gulf Site During 1972-73 Field Programs
5.1.5	Average Visible Plume Lengths By Wind Direction
5.1.6	Percentage Frequencies of Visible Plumes By Length and Wind Direction for Two Natural Draft Cooling Towers - January
5.1.7	Percentage Frequencies of Visible Plumes by Length and Wind Direction for Two Natural Draft Cooling Towers - April
5.1.8	Percentage Frequencies of Visible Plumes by Length and Wind Direction for Two Natural Draft Cooling Towers - July
5.1.9	Percentage Frequencies of Visible Plumes by Length and Wind Direction for Two Natural Draft Cooling Towers - October
5.1.10	Visible Plume Length Summary for the Four Cardinal Months
5.1.11	Drift Sizes and Mass Distributions
5.1.12	Frequency Distribution for Pasquill Stability Class A
5.1.13	Frequency Distribution for Pasquill Stability Class B
5.1.14	Frequency Distribution for Pasquill Stability Class C
5.1.15	Frequency Distribution for Pasquill Stability Class D
5.1.16	Frequency Distribution for Pasquill Stability Class E
5.1.17	Frequency Distribution for Pasquill Stability Class F
5.1.18	Frequency Distribution for Pasquill Stability Class G
5.1.19	Wind Speed Classes
5.1.20	Emission Rates

5

5

LIST OF TABLES (Cont.)

Table No.	Title	
5.1.21	Location of Nearest Homes and Gardens	
5.1.22	Terminal Fall Velocities	5
5.1.23	Deposition Rate	
5.1.24	Bird Mortalities Resulting from Collisions at the Davis-Besse Nuclear Station	1
5.2.1	Annual Average Concentration of Radionuclides in the Liquid Plant Effluents at Various Locations	
5.2.2	Parameters Used in Calculation of Doses to Primary and Secondary Biota Other Than Man	
5.2.3	Doses to Primary and Secondary Organisms	
5.2.4	Maximum Individual Doses From Liquid Effluents	
5.2.5	Population Doses From Liquid Effluents Via the Aquatic Food Pathway	
5.2.6	Maximum Individual Doses From Gaseous Effluents	
5.2.7	Population Doses From Gaseous Releases	
5.2.8	χ/Q and D/Q for the Vegetable Gardens, Residences and Cows Within 5 Miles	
5.2.9	Estimated N-16 Doses at Outside Locations	
5.3.1	Ambient River Chemical Concentrations and State Water Quality Criteria	7
5.3.1a	Plant Effluent Water Quantity and Quality (One-Unit Operation)	
5.3.1b	Plant Effluent Water Quantity and Quality (Two-Unit Operation)	
5.3.2	Summary of Cases Considered for Chemical Dispersion Analysis	
5.3.3	Plant Discharge Quality for Chemical Plume Analysis	
5.3.4	Concentration Distributions of Chemicals Discharged in Plant Discharge - Mean River Flow Cases	5
5.3.5	Concentration Distributions of Chemicals Discharged in Plant Discharge - 7-Day, 10-Yr. Low Flow Cases	
5.3.6	Concentration Distributions of Chemicals Discharged in Plant Discharge - Low Flow of Record Cases	
5.4.1	Wastewater Effluent Regulations Vs. Grand Gulf Sanitary Waste Discharge	

LIST OF FIGURES

Figure No.	Title
5.1-1	Blowdown Discharge Surface Isotherms Mean River Water Level Case: Summer Mean - Two Units
5.1-2	Blowdown Discharge Surface Isotherms Mean River Water Level Case: Winter Mean - Two Units
5.1-3	Blowdown Discharge Surface Isotherms Mean River Water Level Case: Summer Extreme - Two Units
5.1-4	Blowdown Discharge Surface Isotherms Mean River Water Level Case: Winter Extreme - Two Units
5.1-5	Blowdown Discharge Surface Isotherms Low River Water Level Case: Summer Mean - Two Units
5.1-6	Blowdown Discharge Surface Isotherms Low River Water Level Case: Winter Mean - Two Units
5.1-7	Blowdown Discharge Surface Isotherms Low River Water Level Case: Summer Extreme - Two Units
5.1-8	Blowdown Discharge Surface Isotherms Low River Water Level Case: Winter Extreme - Two Units
5.1-8a	Blowdown Discharge Surface Isotherms Low River Water Level Case: Winter Extreme - One Unit
5.1-9	Drift Particle Density Distribution
5.2-1	Generalized Exposure Pathways for Man
5.2-2	Generalized Exposure Pathways for Organisms Other Than Man

5

CHAPTER 5.0 ENVIRONMENTAL EFFECTS OF STATION OPERATION

5.1 EFFECTS OF OPERATION OF HEAT DISSIPATION SYSTEM

5.1.1 Effluent Limitations and Water Quality Standards

The State of Mississippi Air and Water Pollution Control Commission Water Quality Criteria for Intrastate, Interstate, and Coastal Waters, adopted April 24, 1973, and amended November 12, 1974, Section III (4C) as applicable to the Mississippi River, requires that the maximum temperature rise above natural temperatures before the addition of artificial heat shall not exceed 5 F, nor shall the maximum water temperature exceed 90 F beyond the mixing zone. The mixing zone limits are to be defined by the Commission on a case-by-case basis, according to Section I (8) of the Mississippi Water Quality Criteria. The criteria also require that there shall be no thermal block to the migration of aquatic organisms. 5

5.1.2 Physical Effects

5.1.2.1 System Description

The plant blowdown water is discharged from a 54-inch diameter pipe into the barge slip about 300 feet from the river bank and eventually enters the Mississippi River as a shoreline discharge. The pipe invert is at 49 feet msl. Section 3.4 describes the system in detail (see Figures 3.4-3 and 3.4-4).

Since it is expected that one unit will operate alone for some time, the effects of one- and two-unit operation are evaluated in this section. A 100 percent load factor for both units was assumed. 5

5.1.2.2 Blowdown Water and Mississippi River Water Characteristics

The mean monthly plant discharge rates for two-unit operation range from 60.7 cfs to 32.2 cfs. The plant discharge rates for one-unit operation are one-half of those for two-unit operation. The mean monthly plant discharge temperatures range from 75.3 F in the winter to 95.4 F in the summer for both one- and two-unit operation. Mean monthly values of the plant discharge rates and temperatures are summarized in Table 5.1.1a. 5

Mississippi River mean monthly water temperatures at Vicksburg, about 30 miles upstream from the site, range from 41 F in the winter to 82 F in the summer. The extreme river temperature ranges from 34 F in the winter to 87 F in the summer. 5

In order to assess the physical effects of the plant discharging into the Mississippi River corresponding to the mean conditions, the mean monthly discharges and temperatures are considered along with the mean monthly river temperatures. The extreme conditions are determined by use of the mean monthly discharges and temperatures and the extreme values of river temperature. |5 |5 |5

Seasonal effects are determined for both the mean and extreme conditions by considering a critical summer month (July) and a critical winter month (January). These months were selected since the river and plant discharge conditions for these months yielded the largest plume dimensions.

Since the plant discharge quantity and quality depend upon the operation mode of the cooling towers of the plant circulating water system (Section 3.4), various cycles of concentration (two, three and five cycles of concentration in the cooling tower loop) are considered in the analyses of the thermal plumes. 5

Each case is analyzed for the mean river water surface elevation at the site of 54 feet msl, with a river discharge of 560,000 cfs, and for the 7-day, 10-yr low flow of 129,000 cfs at 31 feet msl. River cross sections are taken from the hydrographic surveys of the U. S. Army Corps of Engineers during 1980. At the water levels considered, the river reach near the site is approximately 3000 feet wide. The bank-protection revetments considered in the analyses are based on the U. S. Army Corps of Engineers' specifications (Ref. 1). |5 |5

A summary of the 12 cases analyzed is presented in Table 5.1.1b. |5

5.1.2.3 Analysis

Analysis of the discharge mixing in the Mississippi River is based on available analytical models for the near field (Refs. 2,3) and the far field (Refs. 4, 5) and on certain conservative assumptions as discussed in the following subsections. |5

5.1.2.3.1 Assumptions

Several assumptions were made in performing the analyses which lend conservatism to the results. The most significant of these assumptions are addressed below.

a. The far field model used assumes only a two-dimensional temperature field, hence a plume of constant depth. Only lateral dispersion is considered in the model, resulting in conservatively large plume surface areas.

b. The lateral dispersion coefficient, D_y, used in all cases, is based on local conditions on the shore revetment. The coefficient is determined by the relationship:

$$D_y = \alpha R_h U_*$$

where:

R_h = hydraulic radius

U_* = shear velocity = $\sqrt{gR_h S}$

α = empirical coefficient

g = gravitational acceleration

S = slope of river water surface in reach

The value of D_y calculated for the bank section is 0.8 ft^2/sec, based on a conservatively assumed value of $\alpha = 0.2$. Supporting references indicate this to be a conservative value for rivers as large as the Mississippi. E. A. Prych (Ref. 6) summarized published data on lateral diffusion which showed $\alpha = 0.2$ to be representative of laboratory plume experiments. However, published values of α for the Columbia River near Richland, Washington, and the Missouri River near Blair, Nebraska, were 0.72 and 0.6, respectively (Ref. 6). 5

c. For the low water level cases, no initial mixing of the discharge in the river is considered, as the cases are assessed entirely on a far field approach. This assumption results in conservatively large plume surface areas for the higher isotherms.

To establish the thickness of the plume for the low water cases, an analysis of the surface jet penetration near the shoreline was made utilizing the work of Stolzenbach as reported in Jirka, et al (Ref. 31). In addition, the hydrographic conditions of the Mississippi River (Section 2.4) were utilized. Based upon this analysis, the plume depth was determined to be 5.0 feet. 5

d. In assessing the phenomena of surface heat transfer for the far field analyses, a representative value of the heat exchange coefficient is assumed for both the summer and winter of 115 and 70 Btu/ft^2/day/degree F, respectively (Ref. 7).

e. The local river velocities near the bank are estimated to be 1.2 and 1.0 ft/sec for the mean and low water level cases, respectively. These are based on available velocity profile data and revetment geometries. | 5

5.1.2.3.2 Near Field Analysis

At the mean river elevation of 54 feet msl, the barge slip contains water at an average depth of 11 feet between the discharge pipe and the outlet into the river. The amount of dilution obtained inside the barge slip and the plume depth are determined by estimating the induced return current of denser receiving water, which is mixed with the less dense discharge water, according to the method of B. P. Rigter (Ref. 2). This method was used since it provides less dilution than using the method of Pritchard as presented by Benedict, et al (Ref. 3). An assessment of this method, made in accordance with NRC Regulatory Guide 4.4, is presented in Appendix A to this section.

The resulting mixed temperature and discharges at the outlet of the barge slip are used as input to the far field analyses of the mean water level cases. The jet mixing effect at the barge slip exit is neglected, leading to a conservative estimate of the far field isotherm areas. | 5

5.1.2.3.3 Far Field Analysis

The far field analysis used in all cases is based on the method formulated by J. E. Edinger and E. M. Polk (Ref. 4). The model considers the horizontal dispersion of a two-dimensional plume from a shoreline point source in the presence of an ambient current parallel to the shoreline. Surface heat transfer is accounted for in the model. A critique of this model is presented by Policastro (Ref. 8) indicating that this model is applicable for far field analysis when turbulent diffusion is the dominating factor in the temperature decay. The results from the near field analysis discussed in subsection 5.1.2.3.2 are used as input into the far field analysis for the mean water level cases. When the river level corresponds to the 7-day, 10-year low flow condition, the barge slip is above the river water, and the plant discharge runs down the river bank at the end of the slip and into the river below. No temperature or volumetric losses are assumed to occur between the point of discharge of the blowdown and entrance into the river. Therefore, the plant discharge rates and temperatures are used as sources for the far field analyses in all low water cases. Initial dilution of the plant discharge | 5 | 5 | 5

with the river was neglected in this analysis, leading to a very conservative analysis. An assessment of this model in accordance with NRC Regulatory Guide 4.4 appears in Appendix A.

The density of the surface plumes was evaluated for each winter case for various temperature rise isotherms to determine their buoyant tendencies. In some cases, the plume became denser than the receiving water. Since no mathematical models are presently available which predict the behavior of an initially buoyant plume which becomes negatively buoyant, the plume was analyzed as surface plume. The mixing which is expected to occur during the sinking of the plume was neglected. Such mixing would reduce the size of the plume obtained from the analysis. 5

5.1.2.4 Results

The results of the analyses are presented in Tables 5.1.2a and 5.1.2b for both one- and two-unit operation. As seen in these tables, the maximum plumes during summer occur for the plant discharges resulting from two cycles of concentration and during winter for plant discharges resulting from five cycles of concentration. The largest plume for the 5 F temperature rise isotherm occurs when two units are in operation with the cooling tower loop operating at five cycles of concentration, and a 7-day, 10-year low flow in the river with extreme winter conditions. The widths of all the plumes are insignificant compared to the river width, and hence, the formation of a thermal barrier is precluded.

Since the two-unit operation yielded larger thermal plumes than the one-unit operation, only the plumes resulting from two-unit operation for the various season and river conditions are shown in graphical form. These plumes show the variation in plume size during the different seasons and river conditions and are presented in Figures 5.1-1 through 5.1-8, and discussed in Subsections 5.1.2.4.1 and 5.1.2.4.2. Thermal plumes resulting from one-unit operation are discussed in Subsection 5.1.2.4.3. Only the maximum plume resulting from one-unit operation is shown (Figure 5.1-8a). The actual shape of the plumes may vary from the ones shown in the figures due to the initial mixing which was neglected in this analysis. 5

5.1.2.4.1 Two-Unit Operation: Mean River Water Level Condition

Figures 5.1-1 and 5.1-2 present the mean water level cases, for the mean conditions, for both the summer and winter, respectively. Figures 5.1-3 and 5.1-4 present the mean water level cases for the extreme conditions for both the summer and winter, respectively. The plume depths obtained from the near field analysis are about 8.5 feet for both the summer and winter seasons. These depths are conservatively assumed to remain constant in the far field.

The 5 F isotherm (maximum 87 F) is reached at the barge slip outlet for the mean summer case, as is the 3 F (90 F) isotherm for the extreme summer case. For the mean winter case, the 5 F isotherm has a calculated maximum width of approximately 20 feet and extends about 750 feet along the river bank. For the extreme winter case the 5 F isotherm extends about 950 feet along the river bank with a maximum calculated width of approximately 25 feet.

5.1.2.4.2 Two-Unit Operation: Low River Water Level Condition

Figures 5.1-5 through 5.1-8 summarize the results for the four low water level cases. The plume depth shown on Figures 5.1-6 and 5.1-8 is based on the local water depth in the river at the point of discharge and assumed conservatively to remain constant in the far field. The 5 F isotherm for the mean summer case extends about 300 feet downstream, with a maximum calculated width of approximately 15 feet. The 3 F isotherm for the extreme summer case extends about 250 feet downstream with a maximum calculated width of about 10 feet.

For the mean winter case, the 5 F isotherm is calculated to be about 2600 feet long and 40 feet at its widest point. The 5 F isotherm for the extreme winter case extends about 3400 feet downstream with a maximum calculated width of 45 feet.

It should be noted that the 3 F and 5 F isotherms shown in the figures may not reach the extent indicated because of the anticipated vertical mixing accompanying the loss of buoyancy (Ref. 4).

5.1.2.4.3 One-Unit Operation: Mean and Low River Water Level Conditions

Three operation modes of the plant circulating water system were considered in the analysis of the thermal plumes resulting from one-unit operation. The cases analyzed are given in Table 5.1.1b. The results of the analysis are given in Table 5.1.2a. The maximum plume for one-unit operation is shown in Figure 5.1-8a and occurs during the 7-day, 10-year low flow, extreme winter conditions and with the cooling tower loop operating at five cycles of concentration. All other plumes considered for one-unit operation are smaller than the above case as shown in Table 5.1.2a.

5.1.3 Biological Effects

5.1.3.1 Intake Operation

Since the adopted intake design (radial collector wells) does not withdraw water directly from the river, the potential impacts associated with intake structures (i.e., impingement, entrainment) are not of concern.

5.1.3.2 Discharge Operation

The potential effects of the discharge of heated water have been effectively minimized by the utilization of cooling towers as a primary means of heat dissipation. Some limited thermal effects may be associated with the discharge of the heated plant discharge. At Grand Gulf, the habitat most likely to be in contact with this discharge is the river bank area at and downstream of the barge slip. This area formerly consisted of unstable eroding clay banks (Section 2.2) which have now been stabilized with concrete mats through the Corps of Engineers shoreline modification program (Appendix B). This assessment addresses only the plumes from five-cycle operation in winter and two-cycle operation in summer, since these conditions result in the corresponding largest plumes. 5

The potential for scouring and siltation attributable to the discharge of effluents is low, due primarily to low discharge velocities and stabilized substrates within the barge slip. When the river is at mean (54 feet msl) water levels, the barge slip and discharge pipe are underwater. Effluent velocities at the discharge pipe range from 1.0 to 3.9 fps on a seasonal basis (Appendix A). Since the barge slip is largely stabilized by concrete pads and riprapping, scouring within the barge slip itself is expected to be negligible. As the effluent transits the barge slip, velocity is reduced, reaching the river at 0.1 to 0.2 fps. In addition, the river bank, from the barge slip downstream, has been stabilized with concrete mats by the Corps of Engineers (see Appendix B to this section and Subsection 2.4.2). 5 5

When the river is at low (31 feet msl) water level, the barge slip is devoid of water and the effluent flows directly over the concrete discharge pad and barge slip base into the river with an initial velocity at the pipe of 1.0 to 3.9 fps. Upon reaching the river, the effluent velocity is expected to range between 2.2 and 3.3 fps, (Appendix A). Some scouring of the bottom may be experienced between the end of the barge slip base and the river proper. However, once the effluent reaches the river proper, no further effect is expected due to the hydrology of the river. 5

During mean river water levels, there is a negligible amount of modification in river currents at the mouth of the barge slip due to the greatly diminished effluent velocities in the area. At low water levels, some minor changes in currents in this area occur. Since river current velocities are assumed to be about 1.0 fps at these times (Subsection 5.1.2), any modification of ambient current patterns is limited to the immediate vicinity of the barge slip.

5.1.3.2.1 Thermal Plume Effects at Mean River Water Level

During the summer under two-unit operation, when the river is at mean water level, only the 5 F (or lower) isotherm reaches the river (mean and extreme cases, Figures 5.1-1 and 5.1-3); the bulk of the waste heat is dissipated within the barge slip. Temperatures at the discharge pipe are 92 F, with a rapid decrease to 87 F (summer mean case) or 90 F (summer extreme case) through the 300 feet to the barge slip outlet. Considering the composition of the fish community expected in the river bank habitat and the known thermal tolerances of these species (Table 5.1.4), it is possible that species such as gizzard shad, channel catfish, flathead catfish, crappie, bass, and some minnows may actively reside within the barge slip at mean river levels. Assuming this to be the case, the bulk of the summer resident fish would be found closer to the mouth of the barge slip where temperatures are further from the individual's tolerance limits. Considering the dimensions of the barge slip (less than 1 acre: discharge to outlet), it is improbable that large populations of fish will take up summertime residence in this area. Fish populations residing in the river bank habitat near the barge slip outlet are not expected to be adversely affected by the discharge plume which, in this area, is confined to isotherms below 5 F. Hence, it is anticipated that fish and other resident aquatic populations along the river bank will experience little, if any, impact to normal trophic or population dynamics. Benthic drift, larval fish, and plankton populations passing the discharge zone are not expected to be subject to thermal mortality or production enhancement and should pass the Grand Gulf site area essentially unaffected.

During the winter, the thermal plume extends into the river a short distance (about 20 feet) and the 5 F isotherm extends 750 to 950 feet downriver (winter mean and extreme cases, respectively) (see Table 5.1.2b, and Figures 5.1-2 and 5.1-4). Water temperatures within the barge slip vary from 91 F at the discharge, to 51 F (winter mean case) or 44 F (winter extreme case) at the outlet to the river. Considering the known thermal tolerances of fish inhabiting the river bank area (Table 5.1.4), there should be little direct temperature-related mortality in the barge slip. Some species such as gizzard shad (a winter dominant) may reside within the barge slip during the winter at mean river water levels, but due to the lower productivity of the surrounding habitat this is not anticipated. Some spawning may take place in the barge slip, since late winter is when local spawning aggregations normally occur in the vicinity of the site. Fish entering the barge slip during this period may spawn earlier than normal due to the elevated temperatures. Such early spawnings may be subject to greater than normal larval mortality, due in part to a potential asynchrony with food source development, or cold shock of larval species which migrate from the area shortly

after hatching. Considering the small areal extent of the barge slip and the unsuitability of habitat, it is unlikely that spawning in the barge slip will represent a significant fraction of spawning in the area.

The plume extending into the river proper is, during the winter, expected to be confined largely to the 10 F isotherm and lower. The areal extent of the plume in the river for the winter mean case has been approximated at about 0.3 acres, with the 5 F isotherm extending 950 feet along the shoreline. Some fish will probably be attracted by the elevated temperatures within this area, with some species residing in the plume for extended periods. Acceleration of spawning times may be experienced by some of these species, possibly leading to some increase in larval mortality from asynchrony with food source development or cold shock of migrant larvae. Considering the small areal extent of the plume, the magnitude of accelerated spawning should be quite small and have a negligible effect on total river populations at the site and within the region. | 5

In downstream reaches, the river bank has been stabilized with concrete mats through the Corps of Engineers shoreline modification program. Therefore, the phenomena of an "enhanced benthic community" will be limited, thus limiting the number of fish which might be affected by the 5 F isotherm (Figures 5.1-2 and 5.1-4, insets). | 5

Drifting benthos, plankton, and perhaps larval fish, passing the site during the winter will experience a maximum transit time through the plume (out of the 5 F isotherm) by travelling along the shoreline. The winter mean case will entail a transit time of 625 seconds (750 feet of plume at a transit velocity of 1.2 fps), while winter extreme requires about 792 seconds (950 feet of plume at 1.2 fps). Such a passage will require that an organism pass through a zone of warmer water where excess temperature could reach 10 F or more within that time frame. Some mortality may be experienced by less resistant biota during the passage. Wintertime mortality of drifting benthos should be relatively low since total drift is substantial only during early summer (Section 2.2). Very few larval fish will probably be subjected to the stresses of plume entrainment, since this life stage does not generally appear until later in the springtime. The magnitude of any impacts arising from plume entrainment at mean river water levels should be relatively insignificant, compared to the populations at large, and regional populations should not be appreciably affected. | 5 | 5

When Unit 1 is operating along, the largest plume would occur under extreme winter conditions, (Table 5.1.2a). In this case, the 5 F isotherm would have a length of about 250 feet, | 5

a maximum width of 10 feet, and a surface area of about 0.04 acre. The mean winter case results in a smaller plume (5 F isotherm) of about 0.03 acre surface area. In the summer cases (mean and extreme), the 5 F isotherm would be essentially confined to the barge slip with little or no penetration into the river proper. Given the composition of the fish communities in the river bank habitat, and the known thermal tolerances of these species (Table 5.1.4), there should be little temperature-related mortality associated with the discharge of heated effluents from Unit 1 operating alone. Other populations in this area such as benthic invertebrates, and transient forms such as benthic drift and plankton should not experience significant impact relative to populations at the site or in the region. 5

5.1.3.2.2 Thermal Plume Effects at Low River Water Level

When the river is at low water level, the thermal effluent is assumed to reach the river with little dilution (subsection 5.1.2.3.3). Therefore, plume dimensions are expected to be larger than the plumes estimated for the mean river water level cases (Figures 5.1-5 through 5.1-8). The summer mean and extreme cases (Table 5.1.2b; Figures 5.1-5 and 5.1-7) are expected to result in plumes of about 0.1 acre (within the 5 F isotherm). In both cases, the plume area is of limited extent and the temperatures are generally within the known tolerance ranges for most of the fish inhabiting the river bank habitat. Thus little impact should be felt within resident populations. Those species not capable of tolerating these temperatures will probably avoid the plume zone. 5

The Corps of Engineers' shoreline modification program has stabilized the river bank habitat within the plume area (5 F isotherm) with concrete mats. Thermal impacts to benthos should be minimal, if not negligible.

Drifting biota passing the site during the summer will be subject to transit times of about 300 seconds in both the mean and extreme cases (300 feet of plume at 1 fps). The maximum temperature difference (about 5 F) occurs in the summer mean case, while transient biota will experience a 3 F increase at summer extremes. Some mortality may be experienced by those populations, although the rate may be low due to the degree of thermal acclimation imparted by the relatively high ambient river temperatures outside the plume area. Neglecting increased survivability effects, any losses to drifting populations from plume entrainment should be minimal, considering the small area of the plume. 5

Wintertime plumes during low river water levels (Table 5.1.2b; Figures 5.1-6 and 5.1-8) are considerably larger in extent than for the other cases considered. The winter mean case results in a plume of about 1.5 acres (within the 5 F isotherm), 5

which extends about 2600 feet downriver, while the winter extreme plume extends 3400 feet downriver with a surface area (within the 5 F isotherm) of 2.5 acres. 5

In either case, various species of fish may be attracted to the plume area over the winter. Any fish residing in the plume may experience an acceleration in spawning activities, with possible higher than normal larval mortality from asynchronous food source development or cold shock of migrant larvae. Any impacts to regional biota are not expected to be significant due to the unstable benthic habitat and its inability to support a significant biological community. 5

The winter extreme case results in a negatively buoyant plume which is smaller in extent than shown in Figure 5.1-8, due to faster mixing as the plume descends from the surface. Assuming the plume were to achieve the approximate dimensions shown, the surface area within the 5 F isotherm would be about 2.5 acres. 5 Assuming such extreme conditions could persist for relatively long periods during the winter, more fish could be attracted to the plume area due to the warmer water. Since this zone is small relative to the total habitat in the site region, the effects of plume attraction are not expected to be significant.

Organisms drifting past the site which become entrained in the plume will have much longer maximum transit times during low river water level conditions than during mean river water level conditions. In the case of winter mean-low water, the maximum transit time along the shoreline could reach 2600 seconds (2600-foot plume, 1 fps river velocity), while in the winter extreme case the time could approach 3400 seconds (3400-foot plume, 1 fps river velocity). Organisms making such a transit would be subjected to a temperature rise of 10 F or greater for both mean and extreme cases. Since 5 organisms entering the plume area will have been acclimated to the cooler ambient river temperatures, some mortality of susceptible biota making the passage along the shoreline could occur. Since the low water conditions assumed for these estimates should be only a short-term occurrence and the plume widths are a small fraction of the total river width, mortality attributable to plume entrainment will not be a significant factor in regard to the total drift passing the plant. 5

Unit 1, operating along, would generate a maximum plume (5 F isotherm) in the winter cases. The extreme winter plume would extend about 850 feet downriver, with a maximum width of 20 feet and a surface area of about 0.30 acre (Table 5.1.2a; Figure 5.1-8a). The mean winter plume would be smaller, with a surface area of 0.20 acre. In the summer cases (mean and extreme) the plumes would be very small, with a length of less than 100 feet. Given the composition of the fish community in the plume area, and the known thermal tolerances of those species (Table 5.1.4), little temperature-related mortality 5

would occur, and any losses would be insignificant relative to both site and regional populations. Few significant adverse impacts would be experienced by other populations in the area such as benthic invertebrates, plankton or benthic drift. 5

5.1.3.3 Effects of Plant Shutdowns

Two types of reactor shutdowns occur during two-unit operation of the station: 5

a. Unscheduled "debugging" shutdowns during the first 2 years, numbering approximately five per year, and lasting for periods of 1 week to 6 months per occurrence

b. Scheduled shutdowns for refueling, numbering one per year, typically occurring in the spring or fall, lasting from 5 to 8 weeks with each of the two units shut down at different times

When a plant shutdown occurs, the heated effluent is withdrawn from the environment, and the mixing zone (thermal plume area) temperatures rapidly decrease to the cooler river water ambient temperatures. A rapid decrease in environmental temperature can result in mortality of susceptible biota residing within the plume area. The magnitude of any such effects due to a shutdown at the Grand Gulf Nuclear Station is largely dependent upon season of the year and whether one or both units are shut down. Refueling is scheduled to occur at only one unit at a time. Since it is unlikely for a two-unit shutdown to occur, the general condition assumes the withdrawal of one unit from service. A shutdown of this nature results in a decrease of 50 percent in the volume of heated effluent being discharged, although discharge temperatures are unaffected. Under these conditions the thermal plume decreases in size from that normally experienced with two-unit operation (subsection 5.1.2). During the summer, at mean river water levels, the plume is largely confined to the barge slip, with only the isotherms lower than 5 F penetrating into the river. At lower river water levels, the barge slip is devoid of water but the plumes in the river are quite small (<0.01 acres for the 5 F isotherm). A one-unit shutdown, with subsequent contraction of plume dimensions, should have very little effect on the biota residing in the plume areas. The maximum temperature increase (9 F) within the plume is found at the discharge pipe, and most organisms will experience a drop in temperature of much less than 5 F to 9 F (5 F and 9 F being the excess temperature of the discharge in the summer). The summertime temperature differential between the effluent and ambient river conditions is of such small magnitude, and the plume areas (even at low river levels) are less than 0.01 acres, that even if both units are simultaneously withdrawn from 5 5

service, the impact to biota in the plume areas is expected to be minor and have very little effect on aquatic populations on a regional level.

With the shutdowns being scheduled for spring or fall and the alternating of the refueling cycle, it is highly unlikely that a complete shutdown will occur in wintertime. When the river is at mean water level, the winter plumes have been estimated at 0.2 to 0.3 acres (winter mean and extreme cases, respectively). A contraction of plume dimensions with a one-unit shutdown will probably result in cold shock mortality of some of the nonmobile biota, but such losses are expected to have little impact on site and regional populations. A two-unit shutdown would increase the impact zone to include the entire plume area within the river and the barge slip (about 1 acre total) and would subject resident biota to a 33-40 F decrease in environmental temperature (mean and extreme cases, respectively). Assuming complete cold shock mortality of biota in the higher isotherms (10 F or greater), the loss of biota to site and regional populations is not expected to have a significant long-term impact since the areas affected are quite small in size. A shutdown of Unit 1 operating alone would affect even fewer organisms due to the smaller plume areas (Table 5.1.2a; Table 5.1.2b). 5

When the river reaches low water level in the winter, the plume increases in size to 1.5 to 2.5 acres. A shutdown of one unit, with the consequent decrease in plume dimensions would impact more biota than under other seasonal conditions. Relative to regional populations, cold shock mortality under these circumstances would be minimal. In relation to total site habitat, the losses would be insignificant, since the affected river bank habitat has been stabilized with concrete mats, and probably does not support a diverse biological community. Further, if some losses did occur, their effects would be short term in nature with repopulation beginning shortly after the resumption of plant operation, or in the spring of the year. A two-unit shutdown would result in an abrupt withdrawal of heat from the entire plume area. Since, as previously discussed, the river bank in the plume area probably does not support a diversified biological community, any cold shock mortality would be localized and not represent a significant loss to regional populations. It is anticipated that the affected area would return to its former productivity and species composition within a relatively short period of time. This would also be the case with a shutdown of Unit 1 operating alone. 5

Plant operation with reduced circulating flows is not anticipated. Since this operation mode would be required by the failure of one of the pumps, plant load would be reduced along with a reduction in blowdown volume. Blowdown temperatures are not expected to increase as a consequence. Impacts to

aquatic biota would vary with season and should be of the same relative magnitude as postulated for the one-unit shutdown situations. Unit 1, operating alone, in a reduced circulating mode would result in a contraction of plume dimensions in response to reduced load. Any cold shock effects should not be significant, given the small plume areas involved. 5

5.1.3.4 Effects of Cooling Towers on Migratory Birds

Relatively little literature is available concerning the effects of cooling towers on birds. Most data to date involve studies at the Davis-Besse Nuclear Station near Port Clinton, Ohio. Because this plant is situated along migratory paths for both songbirds and waterfowl, it has been monitored closely since 1973. The Unit 1 cooling tower is 493 feet high and has high-intensity strobe lights during the day and standard red navigational lights at night (Ref. 27). Data relating to this plant were obtained from Rybak, Jackson, and Vessey (Ref. 28) and from the Fish and Wildlife Service publication "Avian Mortality at Man-Made Structures: An Annotated Bibliography" (Ref. 29). Citations referred to within this work are indicated in the following manner: Ref. 29-105, where 105 is the reference number as it appears within the work itself.

An overview of the Davis-Besse studies is presented in Table 5.1.24. Assuming that during the spring and fall of 1977 the cooling tower accounted for 64 and 75 percent of the total mortality, respectively, and that the overall loss due to scavengers was 50 percent, then the total cooling tower-related mortality occurring during migratory periods, from 1973 through 1977, was about 2000 birds. Heaviest losses were suffered by warblers, vireos, finches, and kinglets (Refs. 28 and 29). Ducks and gulls are apparently able to avoid plant structures (Ref. 27), and it has been noted that less than one percent of recorded mortalities were nonpasserines (Ref. 29-370).

High mortality in the spring is most likely to occur with a cold front coming from the west or northwest, frequently accompanied by thunderstorms and gusting winds. Moderate mortality is related to overcast conditions associated with warm fronts and postfronted lows. In the fall, high mortality occurs the first and second night after the passage of a high-pressure front. The weather is usually clear with strong winds (Ref. 29-370). Bird mortality at the Davis-Besse Nuclear Station (resulting from collisions with all structures) is not expected to have a significant impact on migrating birds (Ref. 27).

Minimal losses (i.e., 64 between July 1973 and May 1975 and 7 during the spring and fall of 1977) have also been reported at the Three Mile Island Nuclear Station in Pennsylvania (Ref. 29-504,579), while at the Montague Nuclear Station in

301.10

Massachusetts major bird kills resulting from collisions with the cooling towers are not expected (Ref. 30).

The Grand Gulf Nuclear Station has two 522-foot natural draft cooling towers. These are approximately 1.4 miles from the Mississippi River and 0.8 mile from Hamilton and Gin Lakes. The cooling towers are located in the upland area and are surrounded by forest and fields, with no significant waterfowl habitat any closer than the lakes.

As noted in Subsection 2.2.2.3.3, several hundred to several thousand wood ducks, mallards, gadwalls, and green-winged teal utilize the lowland areas adjacent to and including the site from October through March. Summer use of the lakes by waterbirds is low. Flight lines are generally between fields north of the site, where birds feed, to Hamilton and Gin Lakes, where they roost. This flight path does not bring them into conflict with the cooling towers. Thus, considering local conditions and past experience (see comments concerning the collision of ducks and gulls at Davis-Besse), major waterfowl collision incidents are not expected to occur.

Collisions of songbirds into the cooling towers during the spring and fall migratory periods may occur, since the cooling towers rise about 500 feet above bluff forests and fields. Collisions may be most likely to occur during adverse weather conditions associated with passing frontal systems, such as low ceilings and visibility and strong winds; however, collision incidents would not be expected to be any greater than those at the other nuclear power station cooling towers discussed above.

301.10

5.1.4 Effects of Heat Dissipation Facilities

Operation of Grand Gulf Nuclear Station will modify the local climatology. A discussion of the extent of these modifications is presented in this section. First, the effects of the natural draft cooling towers on the local meteorological environment are presented. The major thrust of this discussion is aimed at an evaluation of the cooling tower plume effects. An assessment of the contribution of moisture to the ambient environment from the blowdown waste heat discharge is included. Finally, a qualitative evaluation of the effects of the cooling system on daily variations of several meteorological parameters is presented.

A number of literature sources were reviewed to determine the nature and extent of studies made of the effects of waste heat disposal systems on the meteorological environment. The literature search revealed a lack of definitive, empirical studies and validated methods to approach the complex problems involved in quantitatively assessing the extent of the modifications of the atmosphere. Although many theoretical models

have been postulated for calculating cooling tower visible plume lengths, none of the models reviewed have been adequately verified by scientific observations.

5.1.4.1 Cooling Tower Plumes and Fogging

All cooling systems which depend on evaporation of water for a major portion of the heat dissipation increase the atmospheric humidity and thus create a potential for fogging and/or icing augmentation. An assessment of the natural fogging frequency for the Grand Gulf site is contained in subsection 2.3.2. Heavy fog (visibility ≤1/4 mile) is estimated to occur at the site approximately 0.6 percent of the time on an annual average basis.

A preliminary study of cooling tower plume formation and spatial distribution was conducted, based on the monthly (January, April, July, and October) editions of Local Climatological Data (LCD) for Jackson, Mississippi, from April 1967 to January 1972 (Ref. 9), concurrent editions of Summary of Constant Pressure

Data (WBAN 33) for Jackson (Ref. 10), and the preliminary design specifications for the cooling towers. The LCD provides surface observations at 3-hour intervals, while wind, temperature, and humidity data at the 1000, 950 and 900 millibar pressure levels are extracted from the WBAN 33 at 12-hour intervals.

Plume rise was calculated according to Briggs (Ref. 11) for stable lapse rate conditions. For neutral and unstable conditions, a modified form of the Briggs equation (Ref. 12) was used. Both equations were tested, using data observed by TVA during a 1-year study at the Paradise Valley Power Plant in Central City, Kentucky. Preliminary results appear satisfactory. Austin (Ref. 13), using Paradise Valley data, found the Briggs equations to be accurate predictors of plume rise. The two equations used are:

Stable Conditions

$$\Delta H = 2.9 \left(\frac{F}{\overline{U} S} \right)^{1/3}$$

Neutral or Unstable Conditions

$$\Delta H = (10h)^{2/3} \quad (C) \quad \left(\frac{F}{\overline{U}} \right)^{1/3}$$

where:

ΔH = plume rise, m

$F = g V_s r^2 \frac{\Delta \rho}{\rho_a}$, m^4/sec^3

$S = \left(\frac{g}{T_a} \right) \frac{\Delta \Theta}{\Delta Z}$, sec^{-2}

$C = 1.58 - \left(41.4 \frac{\Delta \Theta}{\Delta Z} \right)$

h = physical tower height, m

$\overline{U}$ = average wind speed between top of tower (152 meters) and maximum plume height (approximately the 900 mb or 1000 meter level), m/sec

g = gravitational acceleration, m/sec^2

V_s = tower exit velocity, m/sec

r = interior tower radius at top, m

T_a = ambient air temperature at tower top, ^oK

$\Delta \rho = \rho_a - \rho_s$, gm/m^3

ρ_a = density of ambient air, gm/m^3

ρ_s = density of effluent, gm/m^3

T_s = tower effluent exit temperature, ^oK

$\frac{\Delta\rho}{\rho_a} = \frac{\Delta T}{T_s}$, using the equation of state and assuming no pressure change

$\frac{\Delta\theta}{\Delta z}$ = lapse rate of potential temperature, $^oK/m$

For this study, $\Delta\theta/\Delta z$ was determined by subtracting the dry adiabatic lapse rate (-1 C/100m) from the Pasquill-determined mean lapse rate for each stability class, where classes A and G lapse rates were assumed to be -2.2 C/100 m and +4.1 C/100 m, respectively. T_a was determined by applying Pasquill gradients to surface temperature data.

Various theoretical models for predicting visible plume lengths were tested during the TVA study, but, without exception, all gave poor results. Colbaugh (Ref. 14), through a rigorous statistical analysis, found that the moisture deficiency of the ambient air (saturation vapor deficit) is the only meteorological parameter which can be correlated with the visible plume lengths with satisfactory results. He developed an empirical regression equation which predicts plume lengths by relating moisture deficits and the ratio of the vapor emission rate of the plant (whose plume length is being predicted) to that of the Paradise Plant. Colbaugh's equation is:

$$L = [11{,}197 - 3816\ (D_m)] \left(\frac{Q_v}{Q_p}\right)^{1.32}$$

where:

L = visible plume length, ft.

D_m = saturation deficit (additional mass of water vapor per unit volume needed to cause saturation, a function of temperature and relative humidity) identical to the term Δmass

Q_v = vapor emission rate of plant, gm/sec

Q_p = vapor emission rate of Paradise Plant, 768,558 gm/sec

Values for saturation deficit were based on WBAN 33 data at mean effective tower height (950 mb)

The Colbaugh equation was modified to account for the interaction of the two Grand Gulf plumes. The adjusted equation is:

$$L = [11{,}197 - 3816 \times \Delta\text{mass}] \left(\frac{Q_v}{Q_p}\right)^{1.32} + PLI$$

where:

L = total visible plume length, ft

Δmass = as previously defined (see D_m above)

Q_v = total water vapor from both plumes added to the ambient atmosphere at the point of plume interaction, gm/sec. Average rate of emission from tower exit = 852,000 gm/sec

Q_p = vapor emission rate of Paradise Plant, 768,558 gm/sec

PLI = visible plume length (ft) from the upwind tower to the point of plume interaction.

The following procedures were used in applying the adjusted Colbaugh equation to determine Grand Gulf plume lengths:

Δmass values were used as previously determined since there was no change in saturation deficiency.

Q_v = RU (852,000) + RD (852,000),

where:

$$RU = \frac{\text{Distance from upwind tower to plume interaction (mi)}}{2.42 \text{ mi}}$$

and RD is similar ratio for the downwind tower.

PLI is computed using straightforward geometry with the known factors being wind direction, orientation of cooling towers with respect to north, the design distance between cooling towers, and plume sector widths of 22-1/2 degrees.

Thus, all parameters in the adjusted plume length equation can be determined. A complete set of plume length data was computed using the 5 years of meteorological data for Jackson, Mississippi.

The Colbaugh equation generally overestimates long plume lengths and underestimates short plume lengths (less than 700 meters) and their frequencies of occurrence. However, it was concluded to be the best available approach for this study. The overestimation of longer plume lengths lends a degree of conservatism to computations of frequency of occurrence of visible plumes extending beyond site boundaries.

The maximum theoretical visible plume length to be expected from the adjusted Colbaugh equation is 5.81 miles. This occurs when Δmass = 0 and the wind is directly aligned with the orientation of the two cooling towers. Plumes of this length are rarely

visible since they normally occur with already existing obscuring low cloud or low visibility conditions or both.

Table 5.1.5 presents average computed visible plume lengths in miles, by wind directions, for each cardinal month, based on 0600 and 1800 CST observations. It also presents the average for all directions for each cardinal month. Longest average plume lengths occur in January and the shortest in July. Tables 5.1-6 through 5.1-9 present the percentage frequencies of visible plume lengths of all observations at 0600 CST and 1800 CST by wind direction for the 4 months (January, April, July, and October).

Table 5.1.10 is a summary showing significant features in Tables 5.1.5 through 5.1.9.

Since upper air data are available only for the 0600 and 1800 CST times, and these data are not considered fully representative of daytime conditions, plume lengths were considered for 1200 CST, based on surface measurements of saturation deficits. Since relative humidity at 1200 CST is the lowest of the day, visible plumes rarely extend beyond the site boundary during daylight hours. An inspection of 5 years of surface data at 1200 CST reveals that the simultaneous occurrence of moisture deficits small enough to produce long visible plumes and cloud cover less than eight-tenths, is rare. Therefore, the amount of sunshine blocked by the vapor plume is expected to be small, and considering wind direction variability, not of great practical importance.

5.1.4.2 Blowdown Discharge

By applying the steam fog index method developed by Currier, et al (Ref. 15) for cooling ponds, steam fog occurrence probabilities, over the core (+10 F isotherm) of the plume, of 38 percent were obtained during extreme February morning conditions. In June, the probability is only 5 percent.

Initially, the results for February appear to be extremely significant. However, it must be pointed out that the steam fog index over the ambient river water yields a probability of 13 percent, and the core of the thermal plume covers an area of only 0.007 acre. The 5 F isotherm encloses an area of 2.6 acres with a steam fog occurrence probability only a few percent higher than over ambient river water. A separate approach, based on humidity increases due to evaporation, yielded even lower probabilities.

5.1.4.3 Cooling System Effects on Meteorological Variables

5.1.4.3.1 Wind

Operation of natural draft cooling towers creates a miniconvective cell above the tower. Air surrounding the tower near the surface is drawn into the base of the tower. This air is heated in the tower, rises, and, with the excess moisture picked up while passing through the tower, creates the vapor plume. Therefore, the surface winds in the vicinity of the towers are deflected toward the towers. No quantitative estimate has been made of the horizontal extent of this effect, but it certainly does not extend as far as the site boundaries.

5.1.4.3.2 Temperature

The vast majority of heat released to the atmosphere by the cooling system is carried aloft with the cooling tower plumes, thereby warming considerably the air in the plumes. Surface air temperatures near the cooling tower are expected to be slightly cooler than ambient during the day and slightly warmer at night due to weak entrainment of air aloft in the convective circulation. Also air temperature near the heated blowdown discharge plume in the Mississippi River may be slightly above ambient. These differences are so small and local that they cannot be measured beyond a few hundred feet from the tower or thermal plume.

5.1.4.3.3 Atmospheric Water Vapor

In the vicinity of the vapor plumes, both the absolute and relative humidity aloft is increased as evidenced by calculated frequency of visible plume occurrence. Absolute humidity at the surface is increased only slightly. However, relative humidity near the tower may be increased during the colder months due to relatively low moisture-bearing capacities of cold air. As has been noted, blowdown thermal discharge influences on atmospheric humidity will be insignificant.

5.1.4.3.4 Precipitation

Light drizzle and snow occasionally have been noted within a few hundred meters downwind from cooling towers (Ref. 16), but these phenomena are very localized and should have no effect outside the site boundary. Huff compared the flux of water vapor and air from natural draft cooling towers with those occurring in natural convective showers. His results indicate that some enhancement of small rain showers might be expected, as tower fluxes are within an order of magnitude of the shower fluxes. Large thunderstorms, with their much greater flux values, should not be significantly affected, except that formation may occur somewhat earlier in the day than would otherwise be expected, with the cooling tower plume possibly acting as a triggering mechanism.

5.1.4.3.5 Fog and Icing

Studies conducted by Broehl (Ref. 17), Zeller (Ref. 18), and Hosler (Ref. 19) indicate that surface fogging from natural draft towers does not present a significant problem. Broehl and Zeller found no cases of cooling tower plumes reaching the ground, while Hosler noted only one in a 2-year study at the Keystone Power Plant, near Shelcota, in western Pennsylvania. It follows that ground level icing should be considered insignificant at Grand Gulf because of the combined low probabilities of ground level plumes and freezing conditions.

5.1.4.3.6 Stability

No quantitative assessment can be made of the influence of the cooling system on atmospheric stability. It can be reasoned that beneath the cooling tower plumes somewhat more stable conditions might be expected than would otherwise be experienced during the day and slightly less stable at night.

5.1.4.3.7 Dew

A study conducted at Plant Bowen, Carterville, Georgia (Ref. 20), indicates that dew formation may be significantly retarded beneath the cooling tower plume, especially during the winter months.

5.1.4.3.8 Dispersion of Radioactive Effluents

Although atmospheric ventilation may be reduced beneath the cooling tower plumes, this effect may well be more than compensated for by increases in dispersion due to cooling tower convection. When the winds carry vented effluents toward the towers, a portion of the effluents may be caught up in the influx of air at the base of the towers and carried aloft with the plume.

5.1.4.4 Summary

The effect of natural draft cooling tower plumes at ground level does not appear to be a significant problem at Grand Gulf.

5.1.4.5 Effects of Cooling Tower Drift

Each of the two units of Grand Gulf Nuclear Station has a reinforced concrete, counter-flow type, wet natural draft cooling tower about 522 feet high and 250 feet in diameter at the top. The towers are provided with drift eliminators. Pertinent design and operating data for the towers are given in Section 3.4.

In such cooling towers, drift eliminators remove a great percentage of the drift droplets. Some droplets are, nevertheless, swept out of the tops of the towers in the moving

air stream. This drift essentially has the same concentrations of dissolved and suspended solids as the water in the cooling tower basin.

The Mississippi Air Pollution Control Regulations (APC-S-1, Section 3) specify that emissions or particulate fallout shall not exceed background levels by 5.25 g/m^2 - month, if such fallout occurs on property other than that from which the fallout originates.

The environmental impact of deposition of salts and particulates from Grand Gulf cooling towers has been reanalyzed to reflect the revised water quality of the cooling tower circulation water. The primary step in the assessment of the environmental impacts of salts and particulate fallout was the prediction of the concentrations and the deposition rates of these constituents in the vicinity of the cooling towers. The Israel and Overcamp drift deposition model (Refs. 21,22) was used to accomplish the prediction. The results of the analysis are shown in Tables 5.1.11 through 5.1.16. | 5

5.1.4.5.1 Description of the Diffusion and Deposition

The drift droplets containing dissolved salt and particulates are swept out of the tops of the cooling towers. Initially, these droplets rise in the plume's updraft, but due to their high settling velocity, they eventually break away from the plume, and then evaporate, settle downward, and are dispersed by atmospheric turbulence.

The dispersion and deposition of the drift from cooling towers are influenced by the following factors:

a. Factors associated with the design and operation of the cooling tower

    1. Volume of water circulating in the tower per unit time (circulating water flow rate)

    2. Salt or particulates concentrations in the water

    3. Drift rate

    4. Mass size distribution of drift droplets

    5. Plume rise influenced by tower diameter, height and mass flux | 5

b. Factors related to atmospheric conditions

    1. Humidity

    2. Wind speed

3. Wind direction

4. Temperature

5. Pasquill's stability class

Humidity is an important factor in assessing the drift deposition because it controls the evaporation of the droplets, which in turn changes the size of the droplets and therefore the settling velocity.

5.1.4.5.2 Computational Approach

The drift deposition model which was used to calculate the dissolved salt and particulate concentrations and their deposition rates in the vicinity of the cooling towers is described in Subsection 6.1.3.2.3.b. For the computation, the following tower parameters were used: 5

a. Number of natural draft cooling towers - 2

b. Circulation water flow rate - 572,000 gpm per tower

c. Drift rate - 0.008 percent of the circulating water flow rate

d. Exit air velocity - 13 fps

e. Exit air temperature - 113 F 5

f. Height of the towers - 522 ft

g. Tower top diameter - 250 ft

The salt content and the dissolved solids in the circulating water were obtained from Table 3.6.3.

In the calculation, all drift droplets were assumed to be emitted at a geometric center between the two towers. Representative drift sizes and their mass distribution as given in Table 5.1.11 were derived from the drift particle density distribution (Figure 5.1-9 and Ref. 23). 5

Three years of meteorological data from August 1972 to August 1974 and 1976 for the Grand Gulf site were used. In the joint frequency tables (Tables 5.1.12 through 5.1.18), the temperature difference is measured between 33 and 162 feet, and wind speed and direction are measured at 162 feet above the ground. Six wind speed categories, 16 wind directions, and 6 stability classes (combined stability classes F and G into one class) were used in the computation. 5

The six wind speed classes and the representative wind speed for each class used in the computation are given in Table 5.1.19. Emission rates of the total dissolved solids, sodium salt, and iron salt are given in Table 5.1.20. Deposition of salt at nearest homes and gardens was evaluated to assess the impact on vegetation. The locations of the nearest homes and gardens are given in Table 5.1.21. The mean annual mixing heights for Jackson, Mississippi (Ref. 24) are as follows: 5

Morning: 425 m (stable conditions)

Afternoon: 1453 m (unstable and neutral conditions)

For conservative estimation of the ground level concentrations and deposition rates of the drift from cooling towers, the plume is assumed to be a perfect reflecting Gaussian plume. The wind profile is assumed to obey the power law. The standard deviations of the width and thick ss of the plume versus downwind distance from the source for rious stabilities are based on Pasquill's curves (Ref. 25). The terminal fall velocities of the droplets as given in Table 5.1.22 are based on Ref. 26. 5 5

In estimating the centerline ground level concentrations of the effluents from the cooling tower, the first step is to compute the plume rise and the effective tower height and then calculate the concentrations at ground level by using the modified Gaussian dispersion theory and assuming the imaginary source at the effective tower height. The effective tower height is not allowed to be greater than the appropriate mixing height for different stabilities in this approach. Wind speeds at the top of the cooling towers are used in plume rise calculations, and wind speeds at the effective tower height are used to obtain the ground level concentrations. Finally, the deposition rates are obtained by multiplying the deposition velocities of the drift droplets by the ground level concentrations and assuming the deposition velocities of small droplets are essentially the same as their terminal fall velocities.

5.1.4.5.3 Results of the Drift Analysis

The salt and particulate ground level concentrations and deposition calculations were made at the nearest homes and gardens in the vicinity of the site. The results of these estimations are given in Table 5.1.23. The maximum predicted total dissolved solids (TDS), sodium salt, and iron salt are 4.7×10^{-2}, 2.4×10^{-3}, and 4.2×10^{-4} g/m^2-month, respectively. 5

In summary, the deposition of total dissolved solids and salts within a 5 km radius of the cooling towers is significantly less than the standard of 5.25 g/m^2-month. Based on the results of land above, it is apparent that the surrounding vegetation should not be affected.

5.1.4.6 Ground Water Effects

Plant service water is supplied from radial collector wells located in the floodplain parallel to the Mississippi River (Figure 4.1-2). The collector wells are designed to derive water via induced infiltration from the Mississippi River. Operation of the radial collector wells does not alter the ground water regime in the site vicinity, other than in the immediate area of the well field. The creation of a depression cone in the well field area results in induced infiltration from the river to the wells. The projected ground water level drawdown within the well field area will be provided following the performance of pumping tests on the three existing radial collector wells. During the pumping tests, the wells will be pumped at their operating capacity. Ground water level data will be obtained from observation wells in the floodplain and in the plant areas to detect the spread and magnitude of the depression cone. The water levels of Gin and Hamilton Lakes will also be monitored during the pumping tests. There is no impact of collector well field drawdown on existing wells, as there are not ground water users that withdraw from the alluvial aquifer in the vicinity of the well field.

301.7

5.1.5 References

1. U. S. Army Corps of Engineers, "Bank Protection - Master Specification for Hired Labor Work;" Office of the President, Mississippi River Commission, Vicksburg, Miss., May 1971

2. Rigter, B. P., "Density Inducted Return Currents in Outlet Channels," ASCE Journal of the Hydraulics Division HY2, February 1970

3. Benedict, B. A., J. L. Anderson, and E. L. Yandell, Jr., "Analytical Modeling of Thermal Discharges, A Review of the State of the Art," Argonne National Laboratories Report ANL/ES, 18 April 1974

4. Edinger, J. E., and E. M. Polk, Jr., "Initial Mixing of Thermal Discharges into a Uniform Current," Dept. of Environmental and Water Resources Engineering, Vanderbilt University, Nashville, Tenn., Report No. 1, October 1969

5. Brooks, N. H., "Diffusion of Sewage Effluent in an Ocean Current," Proceedings of the 1st International Conference on Waste Disposal in the Marine Environment, Pergaman Press, 1960

6. Prych, E. A., "Effects of Density Difference on Lateral Mixing in Open Channel Flows," W. M. Keck Laboratory Report No. KH-R-21, California Institute of Technology, Pasadena, Calif., May 1970

7. "Effect of Geographical Location on Cooling Pond Requirements and Performance," Vanderbilt University, Nashville, Tennessee, Report for the EPA Water Quality Office, Project No. 16130 FDQ, March 1971

8. Policastro, A. J., "Heated Effluent Dispersion in Large Lakes - State-of-the-Art of Analytical Models," Part 1, Argonne National Laboratories, ANL/ES-11, January 1972

9. "Local Climatological Data," Jackson, Mississippi, monthly editions for January, April, July, October, U. S. Department of Commerce, NOAA, April 1967 - January 1972.

10. "Summary of Constant Pressure Data," WBAN 33, monthly editions for January, April, July, October, U. S. Department of Commerce, Weather Bureau, April 1967 - January 1972.

11. Briggs, G. A., "Plume Rise," U. S. Atomic Energy Commission, Division of Technical Information, 1969.

12. Thomas, F. W., et al, "Plume Rise Estimates for Electric Generating Stations," Journal of the Air Pollution Control Association, 20 (3), March 1970.

13. Austin, J. M., "Summary of TVA Vapor Plume Study," memorandum dated April 29, 1972.

14. Colbaugh, W. C., TVA Air Quality Branch, May 1972, Personal Communication.

15. Currier, et al, "The Environmental Effects of the Midland Plant Cooling Pond," Report done for Bechtel Corporations, 1972.

16. Huff, F. A., et al, "Effects of Cooling Tower Effluents on Atmospheric Conditions in Northeastern Illinois, a Preliminary Report," Illinois Water Survey, 1971.

17. Broehl, D. J., "Field Investigations of Envrionmental Effects of Cooling Towers for Large Steam Electric Plants," Portland General Electric Company, 1968.

18. Zeller, R. W., et al, "Report on Trip to Seven Thermal Power Plants," Pollution Control Council, Pacific Northwestern Area, 1971.

19. Hosler, C. L., "Wet Cooling Tower Plume Behavior," Pennsylvania State University, University Park, Pennsylvania, 1971.

20. Tate, A., "Effects of a Natural Draft Cooling Tower on the Environment," Emory University, Atlanta, Georgia, May, 1972.

21. Israel, G. W., and T. J. Overcamp, "Drift Deposition Model for Natural Draft Cooling Towers," in Proceedings of Cooling Tower Environment - 1974, March 4-6, 1974, pp. 514-628, Technical Information Center, Office of Public Affairs, USERDA, 1975.

22. Overcamp, T. J., "A General Gaussian Diffusion Deposition Model for Elevated Point Sources," Journal of Applied Meteorology, Vol. 15, 1976, pp. 1167-1171.

23. Typical Drift Particulate Density Distribution for Mechanical and Natural Draft Towers, Zurn Industries, Inc.

24. Holzworth, G. C., "Mixing Heights, Wind Speed and Potential for Urban Air Pollution Throughout the Contiguous United States," Environmental Protection Agency, Research Triangle Park, N. C., 1972.

25. Slade, D. H., "Meteorology and Atomic Energy - 1968," USAEC Report TID-24190, 1968, pp. 408-409.

26. Wobus, H. B., F. W. Murray, and L. R. Koenig, "Calculation of the Terminal Velocity of Water Drops," Journal of Applied Meteorology, Vol. 10, 1971, pp. 751-754.

27. U.S. Nuclear Regulatory Commission, "Final Environmental Statement Related to the Construction of Davis-Besse Nuclear Power Station Units 2 and 3," Toledo Edison Co. Docket Nos. 50-500 and 50-501, 1975.

28. Rybak, E. J., W. B. Jackson, and S. H. Vessey, "Impact of Cooling Towers on Bird Migration," Proceedings Sixth Bird Control Seminar, Bowling Green State Univ., Bowling Green, Ohio, 187-194, 1973.

29. Avery, M. L., P. F. Springer, and N. S. Daily, "Avian Mortality at Man-Made Structures: An Annotated Bibliography," U.S. Department of the Interior, Fish and Wildlife Service, FWS/OBS-78/58, 108 pp., 1978.

30. U.S. Nuclear Regulatory Commission, "Final Environmental Statement Related to Construction of Montague Nuclear Power Station Units 1 and 2," Northeast Nuclear Energy Company, Docket Nos. 50-496, 50-497, 1977.

31. Jirka, G. H., G. Abraham, and D. R. F. Harleman, "An Assessment of Techniques for Hydrothermal Impact Prediction," Massachusetts Institute of Technology, Department of Civil Engineering, Report No. 203, 1974.

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TABLE 5.1.1a

PLANT DISCHARGE RATES AND TEMPERATURES

Month	2-Cycle			3-Cycle			5-Cycle		
	Plant Discharge, gpm		Temp. °F	Plant Discharge, gpm		Temp. °F	Plant Discharge, gpm		Temp. °F
	1 Unit	2 Unit		1 Unit	2 Unit		1 Unit	2 Unit	
JAN	11750	23500	75.3	9083	18166	83.3	9083	18166	90.7
FEB	11900	23800	76.4	8933	17866	83.6	8933	17866	90.8
MAR	12300	24600	79.0	8533	17066	84.3	8533	17066	91.1
APR	12400	24800	82.8	8433	16866	86.8	8433	16866	92.4
MAY	13200	26400	87.5	7613	15226	88.9	7613	15226	93.4
JUN	13550	27100	91.2	7283	14566	91.7	7283	14566	94.8
JUL	13610	27220	92.5	7223	14446	92.8	7223	14446	95.4
AUG	13650	27300	92.0	7183	14366	92.3	7183	14366	95.1
SEP	13400	26800	89.3	7433	14866	90.2	7433	14866	94.1
OCT	12900	25800	84.4	7933	15866	86.9	7933	15866	92.5
NOV	12250	24500	78.7	8583	17166	84.2	8583	17166	91.1
DEC	11850	23700	75.7	8983	17966	83.3	8983	17966	90.6
AVG	12730	25460	83.7	8101	16202	87.4	8101	16202	92.7

NOTE: Number of cycles refer to the cycles of concentration in the cooling tower loop.

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TABLE 5.1.1b

SUMMARY OF CASES ANALYZED

Case	Ambient River Temperature °F	Cycles of Concentration	Plant Discharge Rate 1 Unit cfs	Plant Discharge Rate 2 Unit cfs	Plant Discharge Temperature °F
Summer Mean	82	2	30.3	60.7	92.5
		3	16.1	32.2	92.8
		5	16.1	32.2	95.4
Summer Extreme	87	2	30.3	60.7	92.5
		3	16.1	32.2	92.8
		5	16.1	32.2	95.4
Winter Mean	41	2	26.2	52.4	75.3
		3	20.2	40.5	83.3
		5	20.2	40.5	90.7
Winter Extreme	34	2	26.2	52.4	75.3
		3	20.2	40.5	83.3
		5	20.2	40.5	90.7

NOTE: (1) All cases listed were analyzed for both mean flow and 7-day, 10-year low flow condition.

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TABLE 5.1.2a

SUMMARY OF THERMAL PLUME ANALYSIS - ONE-UNIT OPERATION

Cycles of Concentration	Case Studied	Isotherm Considered °F	Low Flow Plume Dimensions			Mean Flow Plume Dimensions		
			Plume Length Ft.	Max. Plume Width, Ft.	Area Acres	Plume Length Ft.	Max. Plume Width, Ft.	Area Acres
5	Extreme Winter	5	850	20	0.30	250	10	0.04
	Mean Winter	5	650	20	0.20	200	10	0.03
	Extreme Summer	3	<50	<5	<0.01	<50	<5	<0.01
	Mean Summer	5	<50	<5	<0.01	<50	<5	<0.01
3	Extreme Winter	5	600	20	0.20	200	10	0.03
	Mean Winter	5	450	15	0.10	150	10	0.02
	Extreme Summer	3	<50	<5	<0.01	<50	<5	<0.01
	Mean Summer	5	<50	<5	<0.01	<50	<5	<0.01
2	Extreme Winter	5	750	20	0.20	200	10	0.03
	Mean Winter	5	550	15	0.10	150	10	0.02
	Extreme Summer	3	60	<10	<0.01	<50	<5	<0.01
	Mean Summer	5	70	<10	<0.01	<50	<5	<0.01

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TABLE 5.1.2b

SUMMARY OF THERMAL PLUME ANALYSIS - TWO-UNIT OPERATION

Cycles of Concentration	Case Studied	Isotherm Considered °F	Low Flow Plume Dimensions			Mean Flow Plume Dimensions		
			Plume Length Ft.	Max. Plume Width, Ft.	Area Acres	Plume Length Ft.	Max. Plume Width, Ft.	Area Acres
5	Extreme Winter	5	3400	45	2.5	950	25	0.30
	Mean Winter	5	2600	40	1.5	750	20	0.20
	Extreme Summer	3	100	10	0.01	< 50	< 5	< 0.01
	Mean Summer	5	100	10	0.01	< 50	< 5	< 0.01
3	Extreme Winter	5	2500	40	1.5	700	20	0.20
	Mean Winter	5	1800	35	0.80	500	15	0.10
	Extreme Summer	3	70	5	< 0.01	< 50	< 5	< 0.01
	Mean Summer	5	80	5	< 0.01	< 50	< 5	< 0.01
2	Extreme Winter	5	3100	45	2.0	850	20	0.20
	Mean Winter	5	2100	35	0.90	600	15	0.10
	Extreme Summer	3	250	10	0.04	60	5	< 0.01
	Mean Summer	5	300	15	0.06	70	5	< 0.01

TABLE 5.1.3

BIOTA SAMPLED ALONG THE RIVER BANK HABITAT DURING THE 1972-73 ENVIRONMENTAL FIELD MEASUREMENTS PROGRAMS(1)

Fish

gizzard shad	(Dorosoma cepedianum)
threadfin shad	(Dorosoma petenense)
common carp	(Cyprinus carpio)
channel catfish	(Ictalurus punctatus)
flathead catfish	(Pylodictis olivaris)
blue catfish	(Ictalurus furcatus)
bigmouth buffalo	(Ictiobus cyprinellus)
freshwater drum	(Aplodinotus grunnieus)
shortnose gar	(Lepisosteus platostomus)
shovelnose sturgen	(Scaphirhynchus platorynchus)
stoneroller	(Campostoma anomalum)
emerald shiner	(Notropis atherinoides)
river shiner	(Notropis blennius)
white crappie	(Pomoxis annularis)
mosquitofish	(Gambusia affinis)
largemouth bass	(Micropterus salmoides)
bluegill	(Lepomis machrochirus)

Benthic Macroinvertebrates

burrowing mayfly	(Tortopus spp.)
burrowing mayfly	(Pentagenia spp.)

Bethic Drift

Chironomid pupae
Chaoborus spp. larvae
Coleoptera larvae
Amphipods
Larval fish (generally dominated by shad, drum and minnows, with carp, crappie, and sunfish)

River Shrimp

Macrobrachium ohione (seasonally abundant)

(1) Samples taken from habitat in the vicinity of the present barge slip and downriver near the outlet of Hamilton Lake.

TABLE 5.1.4

THERMAL TOLERANCE DATA FOR FISH SPECIES SAMPLED ALONG THE RIVER BANK HABITAT AT THE GRAND GULF SITE DURING 1972-73 FIELD PROGRAMS (SEE SECTION 2.2)

Species	Life Stage	Tolerance Data		Data Source
Gizzard Shad	Unknown-Ohio and Tennessee stocks	Acclimation Temp(F)	Lethal Threshold(F)	1
		77.0	94.0	
		86.0	96.8	
		95.0	98.0	
Threadfin Shad	Unknown	Lower lethal temperature reported at 44.6 F; high mortality noted at 45 F in lower Tennessee River.		2
Common Carp	Unknown	Acclimation Temp(F)	Selected Temp(F)	3
		50.0	62.6	
		59.0	77.0	
		68.0	80.6	
		77.0	87.8	
		86.0	87.8	
		95.0	98.6	
			Lethal Threshold(F)	2
		68.0	87.8-93.2	
		78.8	96.0	
		-	Final Lethal Temp = 96.8-100.4	4

Table 5.1.4 (Cont.)

Species	Life Stage	Tolerance Data		Data Source
		Acclimation Temp(F)	Lethal Threshold(F)	
Channel Catfish	Juvenile(44-57 days old)-Arkansas Stock	78.8 86.0 93.2	97.0 99.0 100.4	1
	Juvenile(11.5 months old)-Arkansas Stock	77.0 86.0 95.0	96.0 98.6 100.0	1
	Adult-Ohio Stock Upper Tolerances-	59.0 68.0 77.0	87.0 90.0 92.0	1
	Lower Tolerances-	59.0 68.0 77.0	0 0 0	1
		77.0	Final Lethal Temp = 93.2	4
Flathead Catfish	Unknown	-	Final Lethal Temp = 93.2-96.8	4
White Crappie	Unknown	-	Final Lethal Temp = 93.2-96.8	4
Shovelnose Sturgeon	Unknown	-	Final Lethal Temp = 82.4-86.0	4
Stoneroller	Unknown	-	Final Lethal Temp = 89.6-93.2	4

Table 5.1.4 (Cont.)

Species	Life Stage	Tolerance Data		Data Source
		Acclimation Temp(F)	Lethal Threshold(F)	
Mosquitofish	Unknown	77.0	98.6	1
		86.0	98.6	
		95.0	98.6	
Largemouth Bass	Juvenile(9-10 months old)-Florida stock	68.0	89.6	1
		77.0	91.4	
		86.0	92.0	
		68.0	41.0	1
		77.0	44.6	
		86.0	51.0	
	Unknown-Ohio Stock	68.0	90.0	1
		77.0	94.0	
		86.0	97.0	
		68.0	42.0	1
		86.0	53.0	
	Underyearling-Tennesse Stock	86.0	97.0	1
		95.0	97.0	
	Unknown-Wisconsin Stock	71.6	88.0	1
	Unknown	86.0	Final Lethal Temp = 101.5	4

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Table 5.1.4 (Cont.)

Species	Life Stage	Tolerance Data		Data Source
		Acclimation Temp(F)	Lethal Threshold(F)	
Bluegill	Adult-Florida Stock	59.0	87.0	1
		68.0	89.6	
		77.0	91.4	
		86.0	93.0	
		59.0	36.0	1
		68.0	41.0	
		77.0	45.0	
		86.0	51.8	
	Juvenile-(less than 12mm)-Arkansas Stock	77.0	96.0	1
		86.0	98.0	
		95.0	99.5	
Emerald Shiner	Juvenile-less than 1 year old)-Ontario Stock	41.0	74.0	1
		50.0	80.0	
		59.0	84.0	
		68.0	89.0	
		77.0	89.0	
		59.0	35.0	
		68.0	41.0	
		77.0	46.4	

Table 5.1.4 (Cont.)

DATA SOURCES

1. National Academy of Sciences, 1973, Water Quality Criteria, 1972. Ecological Research Series, Environmental Protection Agency, No. R3-73-033, Washington, D.C., pp. 410-419

2. U.S. A.E.C. Grand Gulf Nuclear Station, Units 1 and 2, Final Environmental Impact Statement, Docket No. 50-416 and 50-417, Appendix A, Table A-2, 1973

3. Pitt T. K., Garside, E. T., and Hepburn, R. L., Temperature selection of the carp (Cyprinis carpio Linn.) Canadian J. Zoll. 34: 555-557, 1956

4. U. S. A.E.C. Callaway Units 1 and 2, Draft Environmental Impact Statement, Docket No. STN 50-483 and STN 50-486, p. 5-5, 1974

TABLE 5.1.5

AVERAGE VISIBLE PLUME LENGTHS (MILES) BY WIND DIRECTION

(Two Natural Draft Cooling Towers)

Wind Direction	January	April	July	October
N	3.41	3.52	2.10	3.77
NNE	3.94	3.15	4.66	2.53
NE	2.67	3.60	1.59	4.07
ENE	3.62	1.22	2.98	4.24
E	2.57	0.00	2.12	2.31
ESE	3.42	3.95	0.00	2.28
SE	3.67	0.00	1.46	2.30
SSE	3.22	3.16	3.52	3.37
S	3.30	3.15	3.04	3.71
SSW	3.90	3.89	3.45	3.39
SW	3.77	3.15	3.04	4.02
WSW	4.55	2.80	2.39	1.66
W	2.97	2.03	2.63	3.05
WNW	3.28	2.69	2.60	2.95
NW	2.86	2.48	2.82	3.52
NNW	3.41	2.56	2.20	2.95
AVG	3.42	3.19	2.72	3.11

Average visible plume lengths = arithmetic average of computed visible plume occurrences (does not include cases of no visible plume).

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TABLE 5.1.6

PERCENTAGE FREQUENCIES OF VISIBLE PLUMES (OF ALL 0600 CST AND 1800 CST OBSERVATIONS) BY LENGTH AND WIND DIRECTION FOR TWO NATURAL DRAFT COOLING TOWERS

JANUARY

Visible Plume Length, L, (miles)

Wind Direction	$0 < L \leq 1.0$	$1.0 < L \leq 2.0$	$2.0 < L \leq 3.0$	$3.0 < L \leq 4.0$	$4.0 < L \leq 5.0$	$L > 5.0$	Total
N	0.7	1.6	1.0	2.0	1.6	2.0	8.9
NNE	--	0.7	1.3	1.0	1.0	1.6	5.6
NE	0.7	0.3	0.7	1.3	0.3	--	3.3
ENE	--	--	0.3	--	--	--	0.3
E	--	0.3	--	--	0.3	--	0.6
ESE	--	--	0.3	0.7	0.3	--	1.3
SE	--	--	--	0.3	--	--	0.3
SSE	--	0.7	0.3	0.3	0.7	--	2.0
S	--	0.3	2.6	1.3	1.3	0.7	6.2
SSW	--	0.3	0.3	1.3	1.0	0.3	3.2
SW	--	--	1.3	1.3	1.3	0.3	4.5
WSW	0.3	--	--	0.3	1.0	0.7	2.3
W	--	--	0.3	--	--	--	0.3
WNW	--	0.3	0.3	1.3	--	--	1.9
NW	--	0.7	2.0	1.6	--	--	4.3
NNW	--	1.0	0.7	2.0	1.6	--	5.3
TOTAL	1.7	6.2	11.4	14.7	10.7	5.5	50.2

Percentage frequency of no visible plumes for all wind directions = 49.8

TABLE 5.1.7

PERCENTAGE FREQUENCIES OF VISIBLE PLUMES (OF ALL 0600 CST AND 1800 CST OBSERVATIONS) BY LENGTH AND WIND DIRECTION FOR TWO NATURAL DRAFT COOLING TOWERS

APRIL
Visible Plume Length, L, (miles)

Wind Direction	$0 < L \leq 1.0$	$1.0 < L \leq 2.0$	$2.0 < L \leq 3.0$	$3.0 < L \leq 4.0$	$4.0 < L \leq 5.0$	$L > 5.0$	Total
N	--	--	0.3	--	0.3	--	0.6
NNE	--	0.7	--	0.3	1.0	--	2.0
NE	--	0.3	--	--	0.3	--	0.6
ENE	--	0.3	--	--	0.3	--	0.6
E	--	--	--	--	--	--	0.0
ESE	--	--	--	0.3	--	--	0.3
SE	--	--	--	--	--	--	0.0
SSE	--	--	0.7	0.7	--	--	1.4
S	--	1.4	0.7	1.7	1.3	--	5.1
SSW	--	0.3	1.0	1.4	0.7	1.0	4.4
SW	0.3	0.3	1.0	0.7	1.4	--	3.7
WSW	0.3	0.3	0.3	0.3	0.7	--	1.9
W	--	0.7	0.3	0.3	--	--	1.3
WNW	--	--	0.7	--	--	--	0.7
NW	--	0.3	0.7	0.3	--	--	1.3
NNW	0.3	0.3	0.7	0.3	0.3	--	1.9
TOTAL	0.9	4.9	6.4	6.3	6.3	1.0	25.8

Percentage frequency of no visible plumes for all wind directions = 74.2

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TABLE 5.1.8

PERCENTAGE FREQUENCIES OF VISIBLE PLUMES (OF ALL 0600 CST AND 1800 CST OBSERVATIONS) BY LENGTH AND WIND DIRECTION FOR TWO NATURAL DRAFT COOLING TOWERS

JULY

Visible Plume Length, L, (miles)

Wind Direction	$0 < L \leq 1.0$	$1.0 < L \leq 2.0$	$2.0 < L \leq 3.0$	$3.0 < L \leq 4.0$	$4.0 < L \leq 5.0$	$L > 5.0$	Total
N	---	---	0.3	---	---	---	0.3
NNE	---	---	---	---	0.3	---	0.3
NE	---	0.3	---	---	---	---	0.3
ENE	---	---	0.3	---	---	---	0.3
E	---	---	0.3	---	---	---	0.3
ESE	---	---	---	---	---	---	0.0
SE	---	0.7	---	---	---	---	0.7
SSE	---	---	---	0.3	---	---	0.3
S	---	0.7	0.7	---	0.7	0.3	2.4
SSW	---	---	1.0	0.7	0.3	0.3	2.3
SW	0.3	---	0.7	0.3	0.3	---	1.6
WSW	---	1.3	1.6	0.7	---	---	3.6
W	---	0.7	0.3	1.0	---	---	2.0
WNW	---	---	1.3	---	---	---	1.3
NW	---	---	0.3	0.3	---	---	0.6
NNW	---	0.3	0.7	---	---	---	1.0
TOTAL	0.3	4.0	7.5	3.3	1.6	0.6	17.3

Percentage frequency of no visible plumes for all wind directions = 82.7

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TABLE 5.1.9

PERCENTAGE FREQUENCIES OF VISIBLE PLUMES (OF ALL 0600 CST AND 1800 CST OBSERVATIONS) BY LENGTH AND WIND DIRECTION FOR TWO NATURAL DRAFT COOLING TOWERS

OCTOBER
Visible Plume Length, L, (miles)

Wind Direction	$0 < L \leq 1.0$	$1.0 < L \leq 2.0$	$2.0 < L \leq 3.0$	$3.0 < L \leq 4.0$	$4.0 < L \leq 5.0$	$L > 5.0$	Total
N	---	---	0.7	0.7	1.4	---	2.8
NNE	0.3	0.3	---	0.3	---	0.3	1.2
NE	---	---	0.3	---	0.3	0.3	0.9
ENE	---	---	---	0.3	0.3	---	0.6
E	---	---	1.4	---	---	---	1.4
ESE	---	0.3	---	0.3	---	---	0.6
SE	---	1.4	1.4	0.7	---	---	3.5
SSE	---	0.3	0.3	0.7	0.3	---	1.6
S	---	---	1.4	0.3	1.0	0.3	3.0
SSW	---	0.3	---	0.7	0.3	---	1.3
SW	---	---	0.3	---	---	---	0.3
WSW	0.3	---	---	0.3	---	---	0.6
W	---	0.3	0.3	1.0	---	---	1.6
WNW	---	---	0.3	---	---	---	0.3
NW	---	---	---	0.3	---	---	0.3
NNW	---	0.3	0.7	1.0	---	---	2.0
TOTAL	0.6	3.2	7.1	6.6	3.6	0.9	22.0

Percentage frequency of no visible plumes for all wind directions = 78.0

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TABLE 5.1.10

VISIBLE PLUME LENGTH SUMMARY FOR THE FOUR CARDINAL MONTHS

	January	April	July	October
Wind direction during which plumes occur most frequently	N, S	S, SSW, SE	S, SSW, SW	N, SE, S
Percent of visible plumes with length ≤ 2.0 mi	16	22	25	17
Percent of visible plumes with length L within 2.0 mi < L ≤ 5 mi	73	74	72	79
Percent of visible plumes with length > 5.0 mi	11	4	3	4

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TABLE 5.1.11

DRIFT SIZES AND MASS DISTRIBUTIONS

Diameter (μm)	Mass (%)
10 to 40	26.1
40 to 60	11.8
60 to 80	5.0
80 to 120	5.3
120 to 160	4.4
160 to 180	3.7
180 to 200	5.2
200 to 220	7.1
220 to 240	8.8
240 to 260	8.3
260 to 280	7.7
280 to 290	7.1

TABLE 5.1.12

FREQUENCY DISTRIBUTION FOR PASQUILL STABILITY CLASS A

1972 to 1976
Station: GGNS Main Met System
162/33 ft. Delta T, 162 ft. Winds

Wind Direction	Wind Speed (mph)									Total	Avg Wind Speed (Up)	Calm Dist
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	>46			
N	13.	88.	170.	57.	3.	0.	0.	0.	0.	331.	9.3	0.0
NNE	2.	27.	66.	10.	0.	0.	0.	0.	0.	105.	9.1	0.0
NE	3.	19.	11.	1.	0.	0.	0.	0.	0.	34.	6.7	0.0
ENE	1.	4.	6.	0.	0.	0.	0.	0.	0.	11.	6.8	0.0
E	1.	14.	8.	0.	0.	0.	0.	0.	0.	23.	6.5	0.0
ESE	5.	15.	21.	1.	0.	0.	0.	0.	0.	42.	7.4	0.0
SE	3.	33.	39.	10.	1.	0.	0.	0.	0.	86.	8.4	0.0
SSE	2.	26.	34.	23.	1.	0.	0.	0.	0.	86.	9.8	0.0
S	5.	24.	55.	28.	1.	0.	0.	0.	0.	113.	10.2	0.0
SSW	10.	31.	74.	28.	0.	0.	0.	0.	0.	143.	9.3	0.0
SW	24.	128.	139.	57.	21.	1.	0.	0.	0.	370.	9.2	0.0
WSW	26.	288.	212.	52.	1.	0.	0.	0.	0.	579.	7.6	0.0
W	34.	242.	69.	21.	4.	0.	0.	0.	0.	370.	6.4	0.0
WNW	40.	192.	60.	43.	2.	0.	0.	0.	0.	337.	6.9	0.0
NW	30.	167.	48.	18.	0.	2.	0.	0.	0.	265.	6.5	0.0
NNW	18.	198.	144.	43.	1.	1.	0.	0.	0.	405.	7.9	0.0
TOTAL	217.	1496.	1156.	392.	35.	4.	0.	0.	0.	3300.		0.0
AVG SPD	2.8	5.4	9.6	14.7	20.1	27.4	0.0	0.0	0.0		8.0	

Amend. 5 2/81

TABLE 5.1.13

FREQUENCY DISTRIBUTION FOR PASQUILL STABILITY CLASS B

1972 to 1976
Station: GGNS Main Met System
162/33 ft. Delta T, 162 ft. Winds

Wind Direction	Wind Speed (mph)									Total	Avg Wind Speed (Up)	Calm Dist
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	>46			
N	14.	102.	120.	30.	3.	0.	0.	0.	0.	269.	8.4	0.0
NNE	5.	41.	47.	6.	0.	0.	0.	0.	0.	99.	7.8	0.0
NE	6.	36.	20.	0.	0.	0.	0.	0.	0.	62.	6.5	0.0
ENE	0.	30.	24.	0.	0.	0.	0.	0.	0.	54.	7.0	0.0
E	2.	18.	12.	0.	0.	0.	0.	0.	0.	32.	6.8	0.0
ESE	3.	34.	28.	6.	0.	0.	0.	0.	0.	71.	7.9	0.0
SE	7.	50.	56.	19.	0.	0.	0.	0.	0.	132.	8.4	0.0
SSE	4.	33.	46.	24.	9.	0.	0.	0.	0.	116.	10.0	0.0
S	7.	32.	55.	29.	12.	0.	0.	0.	0.	135.	10.7	0.0
SSW	7.	43.	46.	22.	9.	0.	0.	0.	0.	127.	9.6	0.0
SW	15.	53.	29.	23.	12.	1.	0.	0.	0.	133.	9.1	0.0
WSW	25.	86.	20.	5.	0.	0.	0.	0.	0.	136.	5.9	0.0
W	14.	54.	10.	4.	0.	0.	0.	0.	0	82.	5.6	0.0
WNW	37.	44.	19.	3.	1.	0.	0.	0.	0.	104.	5.5	0.0
NW	24.	52.	20.	6.	0.	1.	0.	0.	0.	103.	6.2	0.0
NNW	11.	109.	59.	8.	3.	0.	0.	0.	0.	190.	7.0	0.0
TOTAL	181.	817.	611.	185.	49.	2.	0.	0.	0.	1845.		0.0
AVG SPD	2.8	5.3	9.6	14.9	20.3	27.4	0.0	0.0	0.0		7.9	

GG
ER

TABLE 5.1.14

FREQUENCY DISTRIBUTION FOR PASQUILL STABILITY CLASS C

1972 to 1976
Station: GGNS Main Met System
162/33 ft. Delta T, 162 ft. Winds

Wind Direction	Wind Speed (mph)									Total	Avg Wind Speed (Up)	Calm Dist
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	>46			
N	12.	52.	79.	42.	2.	0.	0.	0.	0.	187.	9.4	0.0
NNE	8.	45.	50.	7.	0.	0.	0.	0.	0.	110.	7.9	0.0
NE	4.	39.	19.	1.	0.	0.	0.	0.	0.	63.	6.7	0.0
ENE	4.	24.	8.	0.	0.	0.	0.	0.	0.	36.	6.1	0.0
E	1.	22.	9.	0.	0.	0.	0.	0.	0.	32.	6.4	0.0
ESE	4.	38.	25.	8.	0.	0.	0.	0.	0.	75.	7.4	0.0
SE	2.	39.	43.	7.	0.	0.	0.	0.	0.	91.	8.0	0.0
SSE	7.	28.	24.	19.	1.	0.	0.	0.	0.	79.	9.0	0.0
S	4.	28.	42.	26.	6.	1.	0.	0.	0.	107.	10.8	0.0
SSW	3.	23.	16.	12.	1.	0.	0.	0.	0.	55.	9.1	0.0
SW	13.	18.	16.	9.	1.	0.	0.	0.	0.	57.	7.8	0.0
WSW	12.	31.	10.	4.	0.	0.	0.	0.	0.	57.	6.2	0.0
W	15.	20.	12.	2.	1.	0.	0.	0.	0.	50.	5.8	0.0
WNW	14.	16.	3.	4.	0.	0.	0.	0.	0.	37.	5.3	0.0
NW	20.	15.	10.	6.	1.	0.	0.	0	0.	52.	6.5	0.0
NNW	13.	50.	25.	27.	9.	0.	0.	0.	0.	124.	9.1	0.0
TOTAL	136.	488.	391.	174.	22.	1.	0.	0.	0.	1212.		0.0
AVG SPD	2.7	5.4	9.7	15.2	20.0	27.2	0.0	0.0	0.0		8.2	

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GG
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TABLE 5.1.15

FREQUENCY DISTRIBUTION FOR PASQUILL STABILITY CLASS D

1972 to 1976
Station: GGNS Main Met System
162/33 ft. Delta T, 162 ft. Winds

Wind Direction	Wind Speed (mph)									Total	Avg Wind Speed (Up)	Calm Dist
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	>46			
N	55.	262.	522.	173.	10.	0.	0.	0.	0.	1022.	9.3	1.0
NNE	41.	245.	305.	38.	1.	0.	0.	0.	0.	630.	7.9	0.0
NE	20.	179.	133.	4.	0.	0.	0.	0.	0.	336.	7.0	0.0
ENE	21.	153.	58.	5.	0.	0.	0.	0.	0.	237.	6.2	0.0
E	25.	118.	115.	15.	0.	0.	0.	0.	0.	273.	7.3	0.0
ESE	33.	171.	253.	96.	9.	1.	0.	0.	0.	563.	9.1	0.0
SE	36.	161.	284.	199.	20.	0.	0.	0.	0.	700.	10.4	0.0
SSE	36.	133.	285.	263.	46.	2.	0.	0.	0.	765.	11.4	0.0
S	39.	112.	267.	262.	32.	1.	0.	0.	0.	713.	11.3	0.0
SSW	38.	134.	197.	96.	20.	1.	0.	0.	0.	486.	9.6	0.0
SW	37.	118.	90.	68.	19.	0.	0.	0.	0.	332.	9.2	0.0
WSW	42.	84.	81.	22.	4.	0.	0.	0.	0.	233.	7.5	1.0
W	28.	61.	55.	51.	8.	0.	0.	0.	0.	203.	9.1	0.0
WNW	37.	55.	55.	51.	7.	1.	0.	0.	0.	206.	9.2	0.0
NW	37.	57.	79.	59.	7.	0.	0.	0.	0.	239.	9.3	0.0
NNW	48.	128.	175.	109.	25.	0.	0.	0.	0.	485.	9.6	0.0
TOTAL	573.	2171.	2954.	1511.	208.	6.	0.	0.	0.	7423.		2.0
AVG SPD	2.6	5.5	9.9	14.9	20.1	25.6	0.0	0.0	0.0		9.4	

TABLE 5.1.16

FREQUENCY DISTRIBUTION FOR PASQUILL STABILITY CLASS E

1972 to 1976
Station: GGNS Main Met System
162/33 ft. Delta T, 162 ft. Winds

Wind Direction	Wind Speed (mph) 0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	>46	Total	Avg Wind Speed (Up)	Calm Dist
N	29.	158.	170.	11.	0.	1.	0.	0.	0.	369.	7.3	1.0
NNE	19.	138.	177.	1.	0.	0.	0.	0.	0.	335.	7.5	0.0
NE	18.	123.	119.	4.	0.	0.	0.	0.	0.	264.	7.2	1.0
ENE	20.	95.	102.	3.	0.	0.	0.	0.	0.	220.	7.3	0.0
E	15.	96.	115.	7.	0.	0.	0.	0.	0.	233.	7.5	2.0
ESE	24.	109.	287.	64.	5.	2.	0.	0.	0.	491.	9.3	0.0
SE	14.	146.	432.	148.	12.	1.	0.	0.	0.	753.	10.2	1.0
SSE	23.	154.	419.	124.	9.	6.	0.	0.	0.	735.	9.8	0.0
S	23.	149.	282.	96.	3.	0.	1.	0.	0.	554.	9.3	0.0
SSW	21.	169.	257.	32.	0.	0.	0.	0.	0.	479.	8.2	0.0
SW	31.	150.	203.	47.	6.	0.	0.	0.	0.	437.	8.5	0.0
WSW	28.	99.	87.	36.	3.	1.	1.	0.	0.	255.	8.1	0.0
W	17.	81.	62.	31.	2.	3.	0.	0.	0.	196.	8.5	0.0
WNW	13.	52.	46.	29.	0.	0.	0.	0.	0.	140.	8.4	0.0
NW	15.	58.	27.	14.	0.	0.	0.	0.	0.	114.	7.3	0.0
NNW	23.	101.	71.	16.	1.	0.	0.	0.	0.	212.	7.2	0.0
TOTAL	333.	1878.	2856.	663.	41.	14.	2.	0.	0.	5787.		5.0
AVG SPD	2.4	5.8	9.6	14.4	20.0	27.7	32.5	0.0	0.0		8.6	

TABLE 5.1.17

FREQUENCY DISTRIBUTION FOR PASQUILL STABILITY CLASS F

1972 to 1976
Station: GGNS Main Met System
162/33 ft. Delta T, 162 ft. Winds

Wind Direction	Wind Speed (mph)									Total	Avg Wind Speed (Up)	Calm Dist
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	>46			
N	20.	104.	51.	0.	0.	0.	0.	0.	0.	175.	6.1	0.0
NNE	12.	80.	98.	0.	0.	0.	0.	0.	0.	190.	7.3	0.0
NE	5.	76.	99.	4.	0.	0.	0.	0.	0.	184.	7.8	0.0
ENE	13.	41.	73.	9.	0.	0.	0.	0.	0.	136.	8.0	0.0
E	11.	40.	79.	2.	1.	0.	0.	0.	0.	133.	8.1	0.0
ESE	5.	47.	130.	16.	0.	0.	0.	0.	0.	198.	9.1	0.0
SE	3.	75.	146.	29.	0.	0.	0.	0.	0.	253.	9.2	0.0
SSE	15.	93.	157.	27.	1.	0.	0.	0.	0.	293.	8.6	0.0
S	11.	103.	98.	15.	0.	0.	0.	0.	0.	227.	7.8	0.0
SSW	11.	112.	113.	1.	0.	0.	0.	0.	0.	237.	7.1	0.0
SW	26.	76.	68.	1.	0.	0.	0.	0.	0.	171.	6.5	0.0
WSW	21.	65.	35.	4.	0.	0.	0.	0.	0.	125.	6.3	0.0
W	23.	43.	14.	5.	0.	0.	0.	0.	0.	85.	5.6	0.0
WNW	15.	42.	12.	1.	0.	0.	0.	0.	0.	70.	5.4	0.0
NW	19.	47.	16.	0.	0.	0.	0.	0.	0.	82.	5.1	0.0
NNW	27.	67.	13.	0.	0.	0.	0.	0.	0.	107.	5.2	0.0
TOTAL	237.	1111.	1202.	114.	2.	0.	0.	0.	0.	2666.		0.0
AVG SPD	2.5	5.6	9.5	14.1	20.4	0.0	0.0	0.0	0.0		7.5	

GG
ER

TABLE 5.1.18

FREQUENCY DISTRIBUTION FOR PASQUILL STABILITY CLASS G

1972 to 1976
Station: GGNS Main Met System
162/33 ft. Delta T, 162 ft. Winds

Wind Direction	Wind Speed (mph)									Total	Avg Wind Speed (Up)	Calm Dist
	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	>46			
N	62.	124.	40.	1.	0.	0.	0.	0.	0.	227.	5.1	0.0
NNE	31.	117.	84.	2.	0.	0.	0.	0.	0.	234.	6.3	0.0
NE	25.	113.	85.	3.	0.	0.	0.	0.	0.	226.	6.7	0.0
ENE	28.	100.	103.	3.	0.	0.	0.	0.	0.	234.	6.9	2.0
E	20.	92.	129.	4.	0.	0.	0.	0.	0.	245.	7.3	0.0
ESE	23.	85.	157.	38.	0.	0.	0.	0.	0.	303.	8.7	1.0
SE	20.	85.	166.	46.	1.	0.	0.	0.	0.	318.	9.0	0.0
SSE	20.	98.	178.	50.	0.	0.	0.	0.	0.	346.	8.8	0.0
S	31.	135.	130.	23.	0.	0.	0.	0.	0.	319.	7.5	0.0
SSW	39.	194.	104.	4.	0.	0.	0.	0.	0.	341.	6.4	0.0
SW	44.	184.	46.	1.	0.	0.	0.	0.	0.	275.	5.5	1.0
WSW	59.	111.	30.	0.	0.	0.	0.	0.	0.	200.	4.9	1.0
W	49.	73.	5.	0.	0.	0.	0.	0.	0.	127.	4.1	0.0
WNW	45.	49.	6.	0.	0.	0.	0.	0.	0.	100.	4.0	0.0
NW	45.	37.	0.	1.	0.	0.	0.	0.	0.	83.	3.6	0.0
NNW	30.	72.	4.	0.	0.	0.	0.	0.	0.	106.	4.3	0.0
TOTAL	571.	1669.	1267.	176.	1.	0.	0.	0.	0.	3684.		5.0
AVG SPD	2.3	5.4	9.5	14.2	19.2	0.0	0.0	0.0	0.0		6.7	

GG
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TABLE 5.1.19

WIND SPEED CLASSES

Range (mph	Representative Wind Speed Used (mph)
0 to 3	1.5
4 to 7	5.5
8 to 12	10.0
13 to 18	15.5
19 to 24	21.5
>25	28.0

GG
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TABLE 5.1.20

EMISSION RATES

Drift Size (μm)	Total Dissolved Solids (mg/s)	Sodium Salt (mg/s)	Iron Salt (mg/s)
10 to 40	1701.7	87.6	15.1
40 to 60	769.4	39.6	6.8
60 to 80	326.0	16.8	2.9
80 to 120	345.6	17.8	3.1
120 to 160	286.9	14.8	2.5
160 to 180	241.2	12.4	2.1
180 to 200	339.0	17.5	3.0
200 to 220	462.9	23.8	4.1
220 to 240	573.8	29.6	5.1
240 to 260	541.2	27.9	4.8
260 to 280	502.0	25.9	4.5
280 to 290	462.9	23.8	4.1

GG
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TABLE 5.1.21

LOCATION OF NEAREST HOMES AND GARDENS

Site	Distance to Cooling Tower
Home	1000 m to the E
Garden	2400 m to the NNE
Garden	2800 m to the N
Garden	4400 m to the ESE
Garden	4800 m to the ENE

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TABLE 5.1.22

TERMINAL FALL VELOCITIES

Droplet Size (μm)	Fall Velocity (m/s)
10 to 40	0.03
40 to 60	0.08
60 to 80	0.15
80 to 120	0.27
120 to 160	0.40
160 to 180	0.50
180 to 200	0.70
200 to 220	0.80
220 to 240	0.90
240 to 260	1.00
260 to 280	1.10
280 to 290	1.15

TABLE 5.1.23

DEPOSITION RATE
(g/m^2-month)

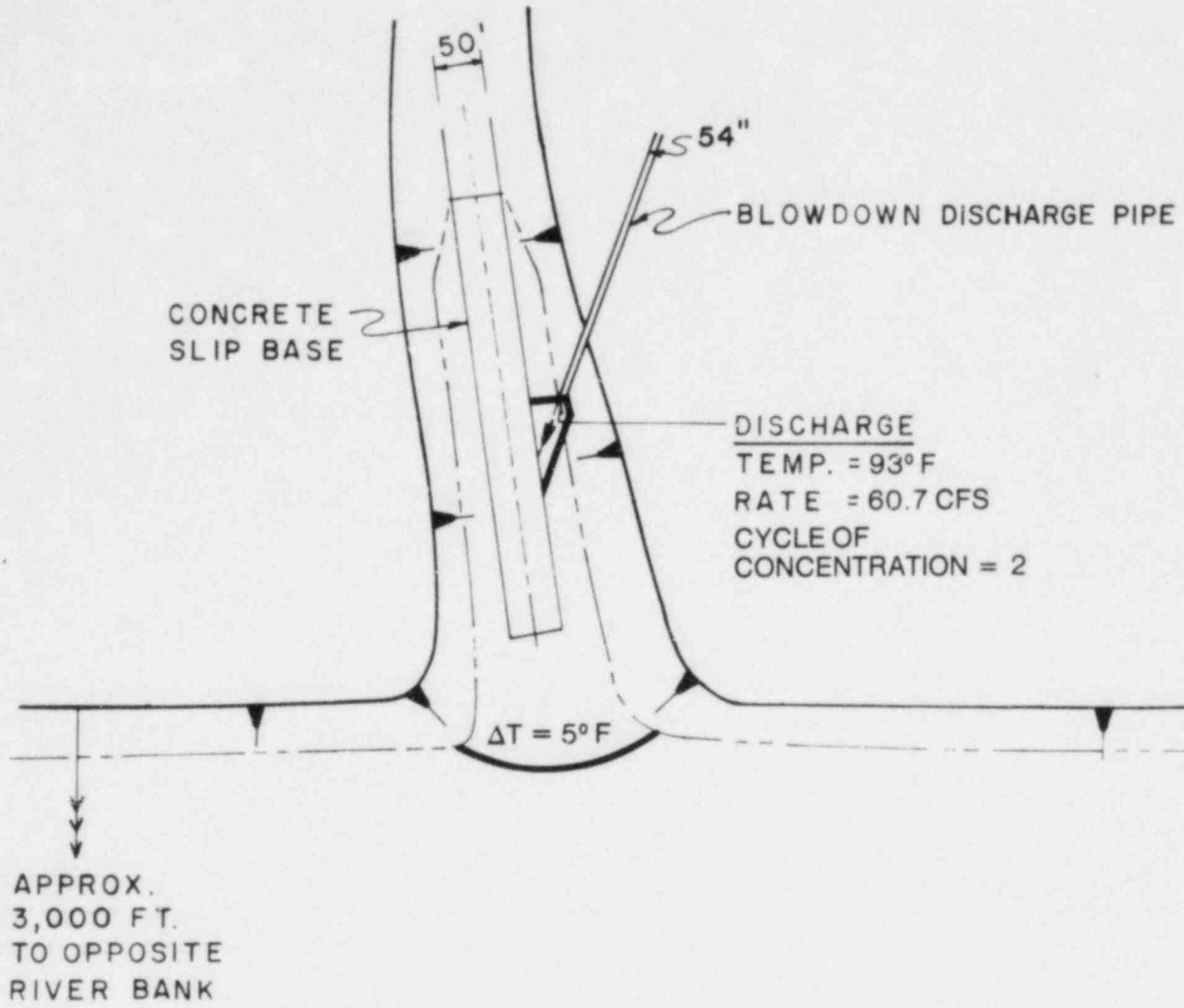
Site	Direction	Distance (m)	TDS	NaCl	Fe+
Nearest Home	E	1000	4.70×10^{-2}	2.42×10^{-3}	4.16×10^{-4}
Garden	NNE - E	2400	2.47×10^{-2}	1.27×10^{-3}	2.18×10^{-4}
Garden	N	2800	1.16×10^{-2}	5.97×10^{-4}	1.03×10^{-4}
Garden	ESE	4400	1.16×10^{-2}	5.96×10^{-4}	1.21×10^{-4}
Garden	ENE	4800	2.89×10^{-2}	1.67×10^{-4}	2.91×10^{-5}

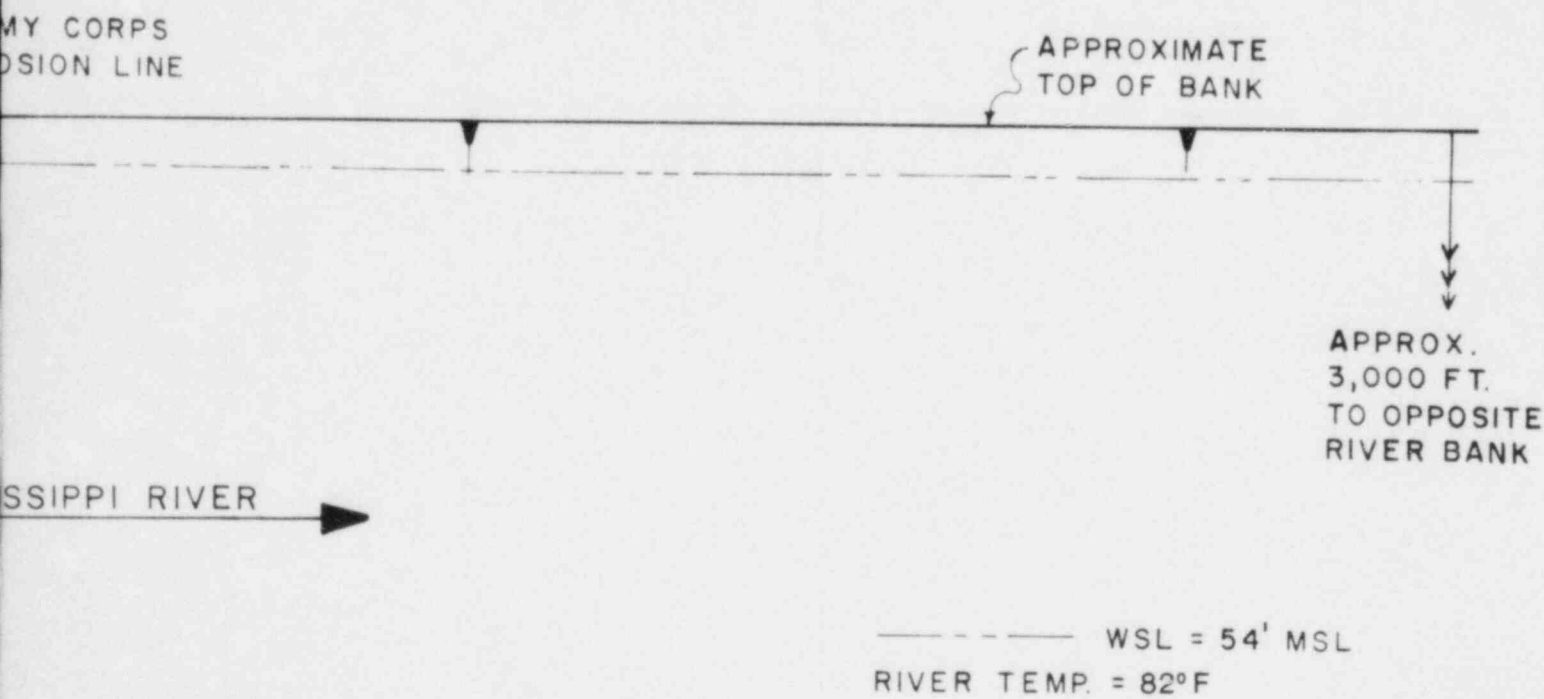
TABLE 5.1.24

BIRD MORTALITIES RESULTING FROM COLLISIONS AT THE DAVIS-BESSE NUCLEAR STATION*

Date	Total Number of Dead Birds		Percent of Deaths Due to Cooling Tower		Number of Species		Percent of Birds Taken by Scavengers	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
1973	44	102	77	≈50	22	24		50(estimated)
1974	176	342	66	82	45	47		76
1975	57	155	42	80	29	35	38	20
1976	62	207	69	88	31	35		50(estimated)
1977	48	151			21	25		

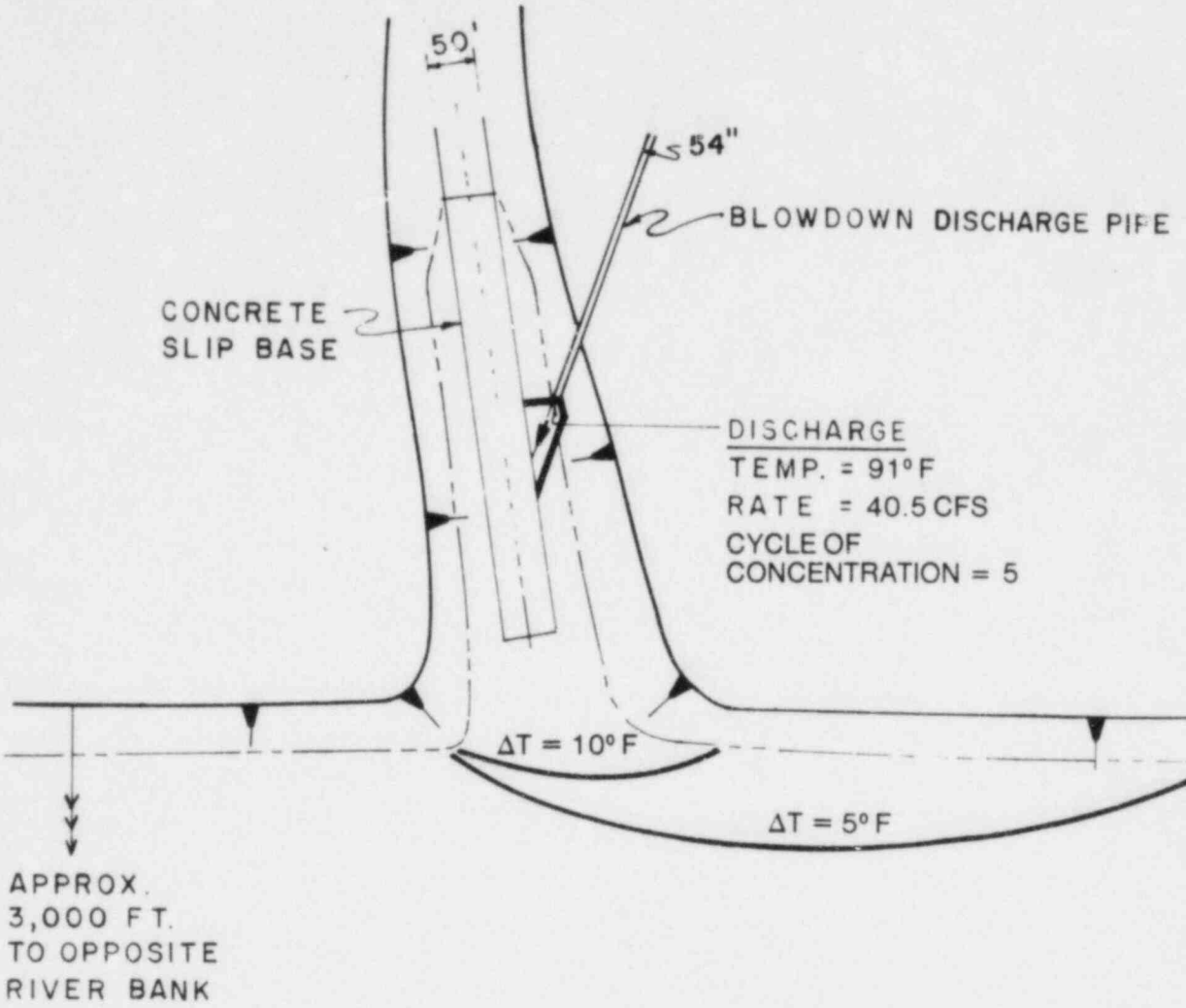
*Refs. 28 and 29, Article 370, 371, 654, 745, 746, 836, 837, 838


50'
54"
BLOWDOWN DISCHARGE PIPE
CONCRETE
SLIP BASE
DISCHARGE
TEMP. = 93° F
RATE = 60.7 CFS
CYCLE OF
CONCENTRATION = 2
ΔT = 5° F
APPROX.
3,000 FT.
TO OPPOSITE
RIVER BANK



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT
BLOWDOWN DISCHARGE SURFACE ISOTHERMS MEAN RIVER WATER LEVEL CASE: SUMMER MEAN - TWO UNITS FIGURE 5.1-1

Amend. 5 2/81



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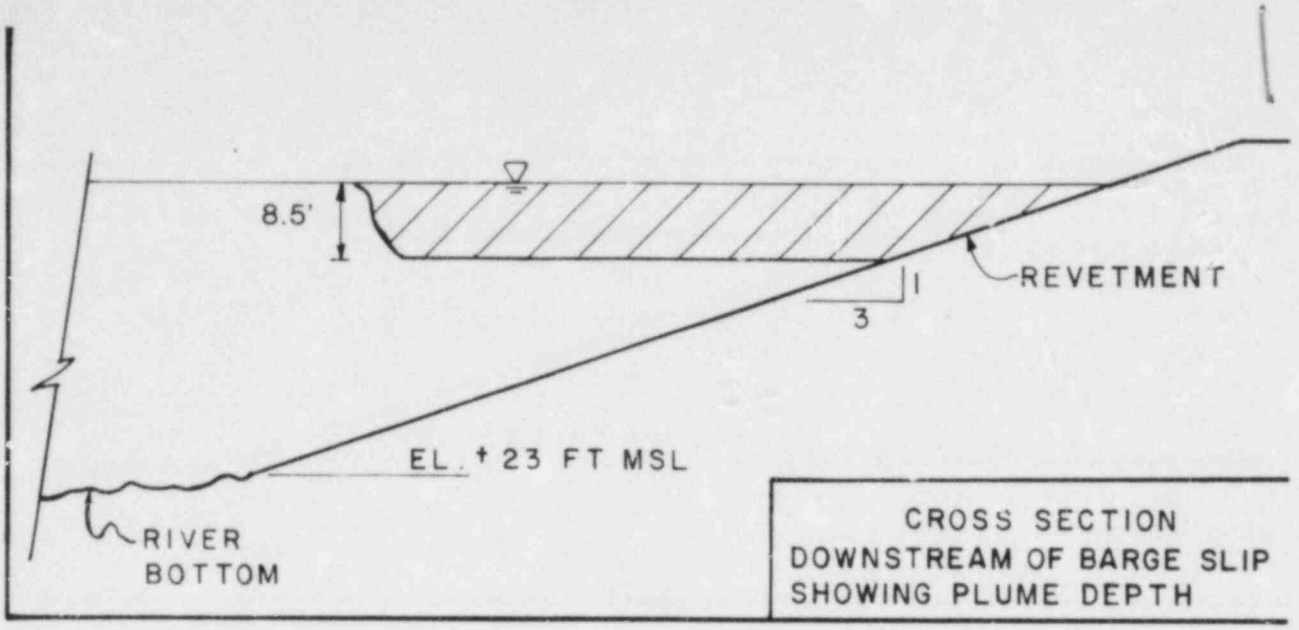


CROSS SECTION
DOWNSTREAM OF BARGE SLIP
SHOWING PLUME DEPTH

CORPS
ION LINE

APPROXIMATE
TOP OF BANK

APPROX.
3,000 FT.
TO OPPOSITE
RIVER BANK

SIPPI RIVER

WSL = 54' MSL

RIVER TEMP. = 41°F

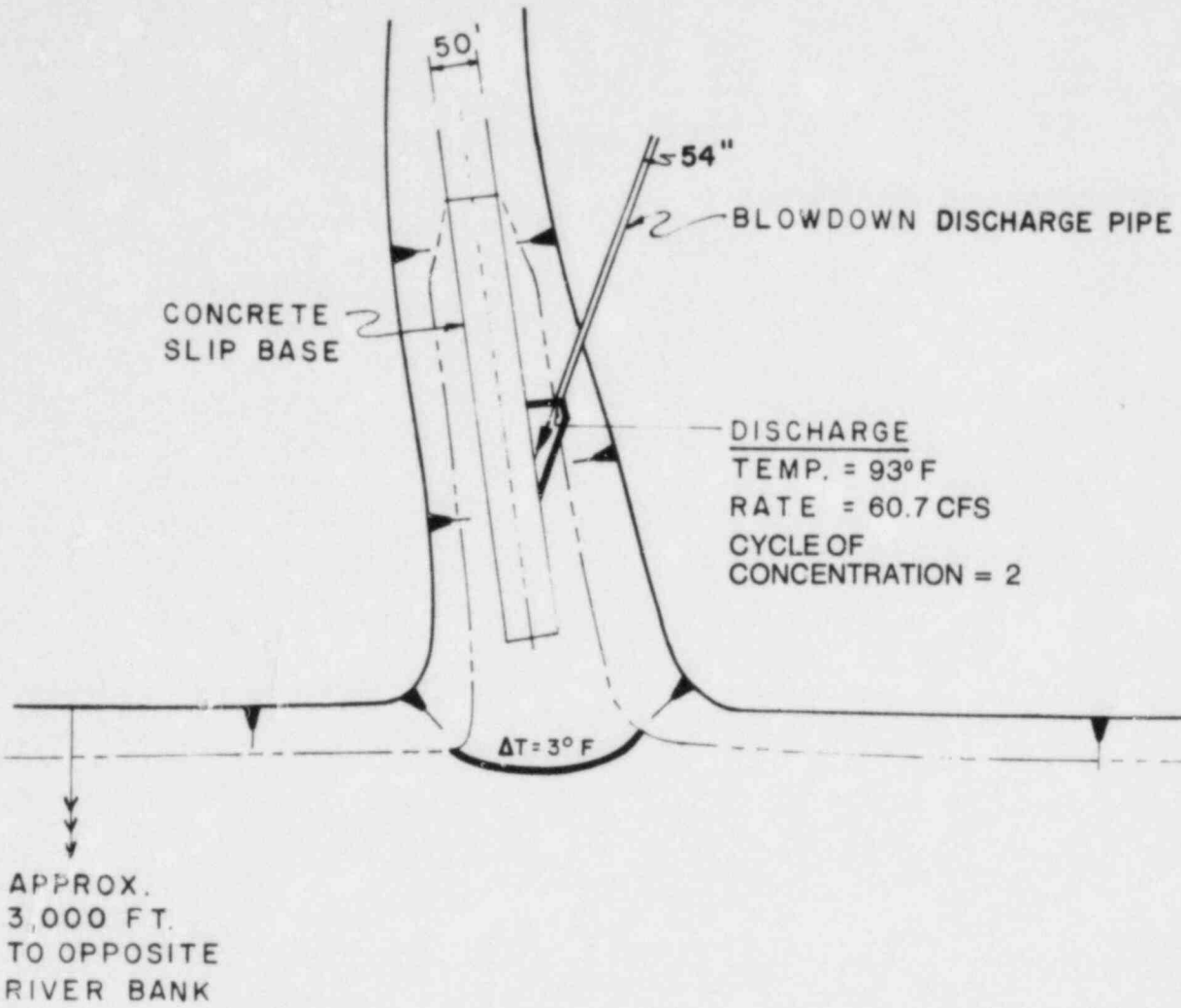
ATERAL
0 40 60

0 200 300
GITUDINAL
S IN FEET)

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

BLOWDOWN DISCHARGE
SURFACE ISOTHERMS
MEAN RIVER WATER LEVEL
CASE: WINTER MEAN - TWO UNITS
FIGURE 5.1-2

Amend. 5 2/81



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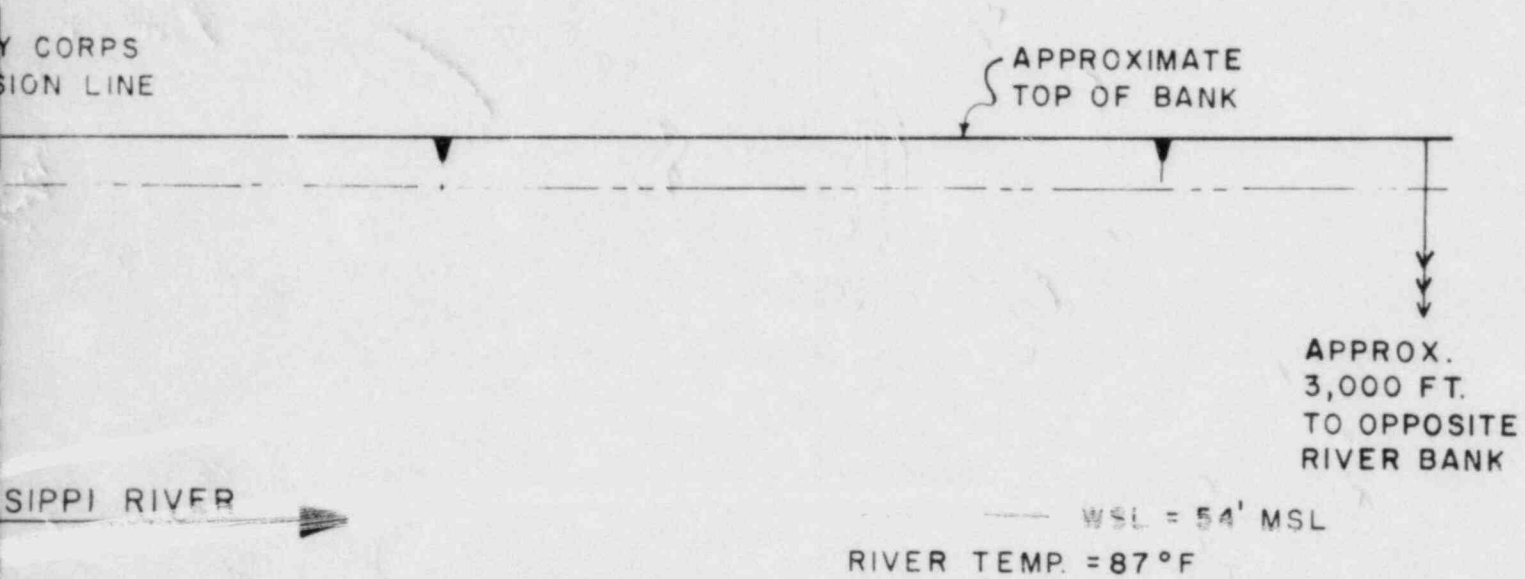
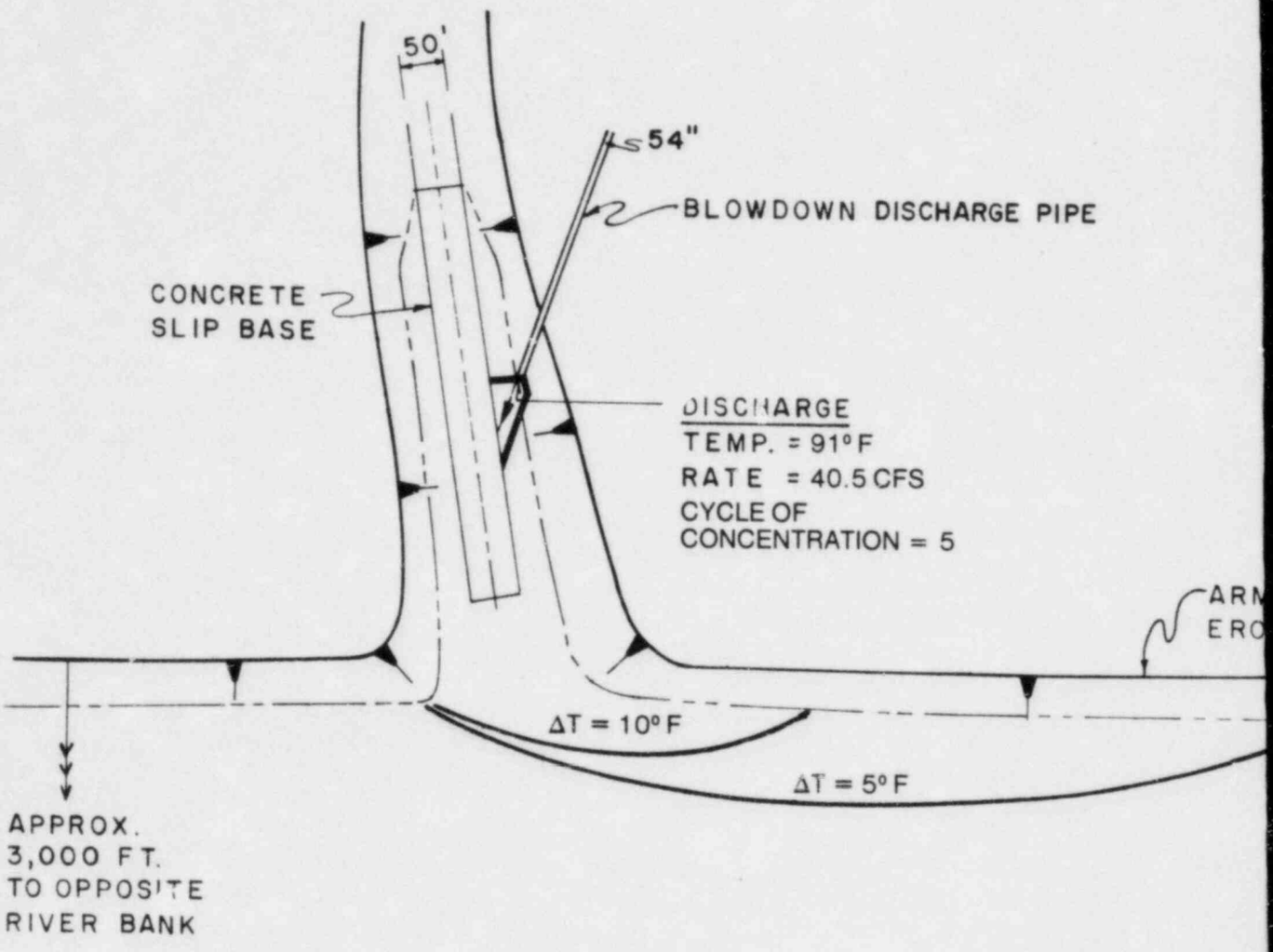
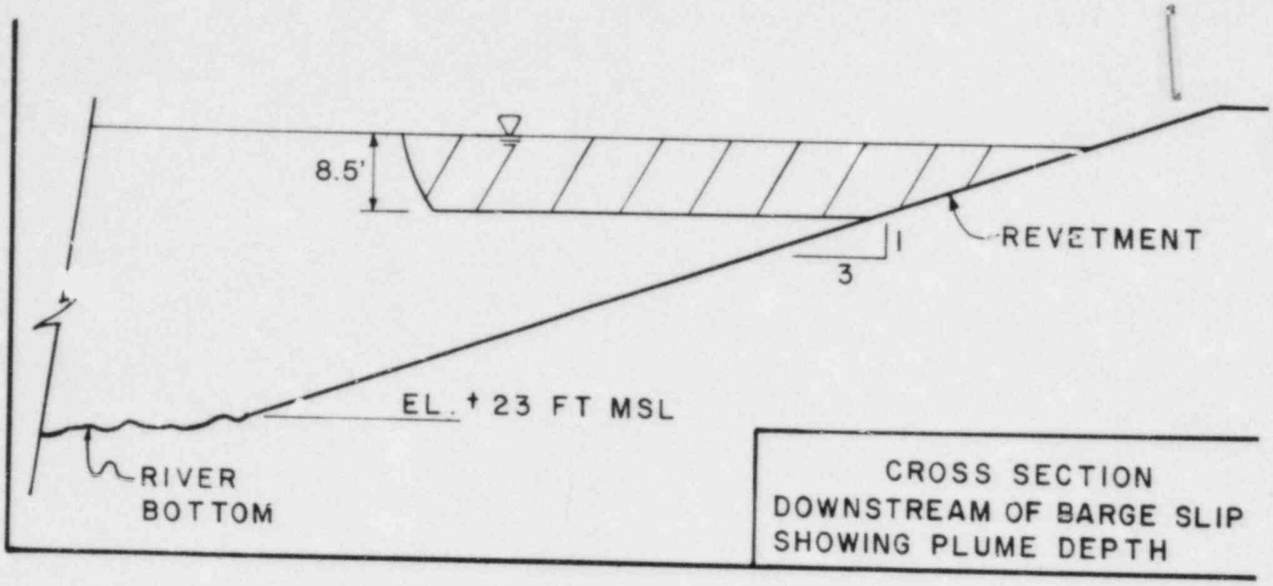


ATERAL
10 20 30
00 200 300
GITUDINAL
ES IN FEET)

MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT
BLOWDOWN DISCHARGE SURFACE ISOTHERMS MEAN RIVER WATER LEVEL CASE: SUMMER EXTREME - TWO UNITS FIGURE 5.1-3

Amend. 5 2/81


50'
54"
BLOWDOWN DISCHARGE PIPE
CONCRETE SLIP BASE
DISCHARGE
TEMP. = 91°F
RATE = 40.5 CFS
CYCLE OF CONCENTRATION = 5
ΔT = 10°F
ΔT = 5°F
APPROX. 3,000 FT. TO OPPOSITE RIVER BANK



CROSS SECTION
DOWNSTREAM OF BARGE SLIP
SHOWING PLUME DEPTH

Y CORPS
SION LINE

APPROXIMATE
TOP OF BANK

APPROX.
3,000 FT.
TO OPPOSITE
RIVER BANK

WSL = 54' MSL
RIVER TEMP. = 34°F

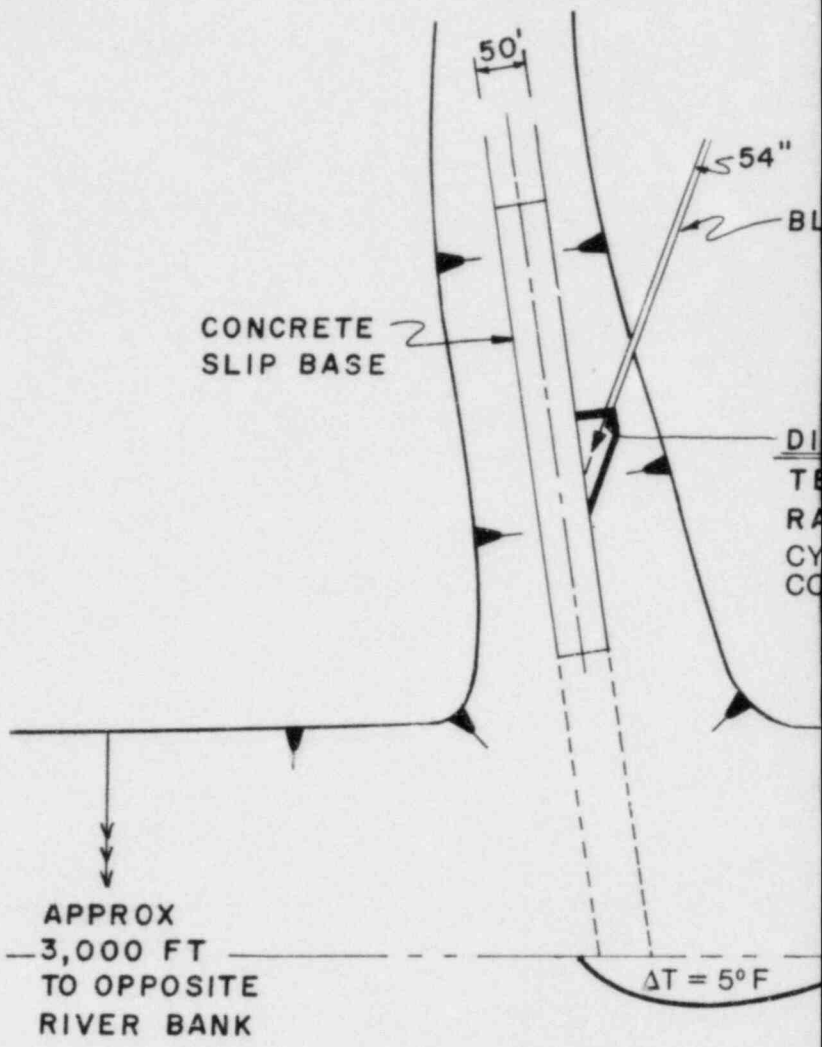
SIPPI RIVER

ATERAL
20 40 60
00 200 300
NGITUDINAL
ES IN FEET)

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

BLOWDOWN DISCHARGE
SURFACE ISOTHERMS
MEAN RIVER WATER LEVEL
CASE: WINTER EXTREME - TWO UNITS
FIGURE 5.1-4

Amend. 5 2/81



MISSISSIPPI RIVE

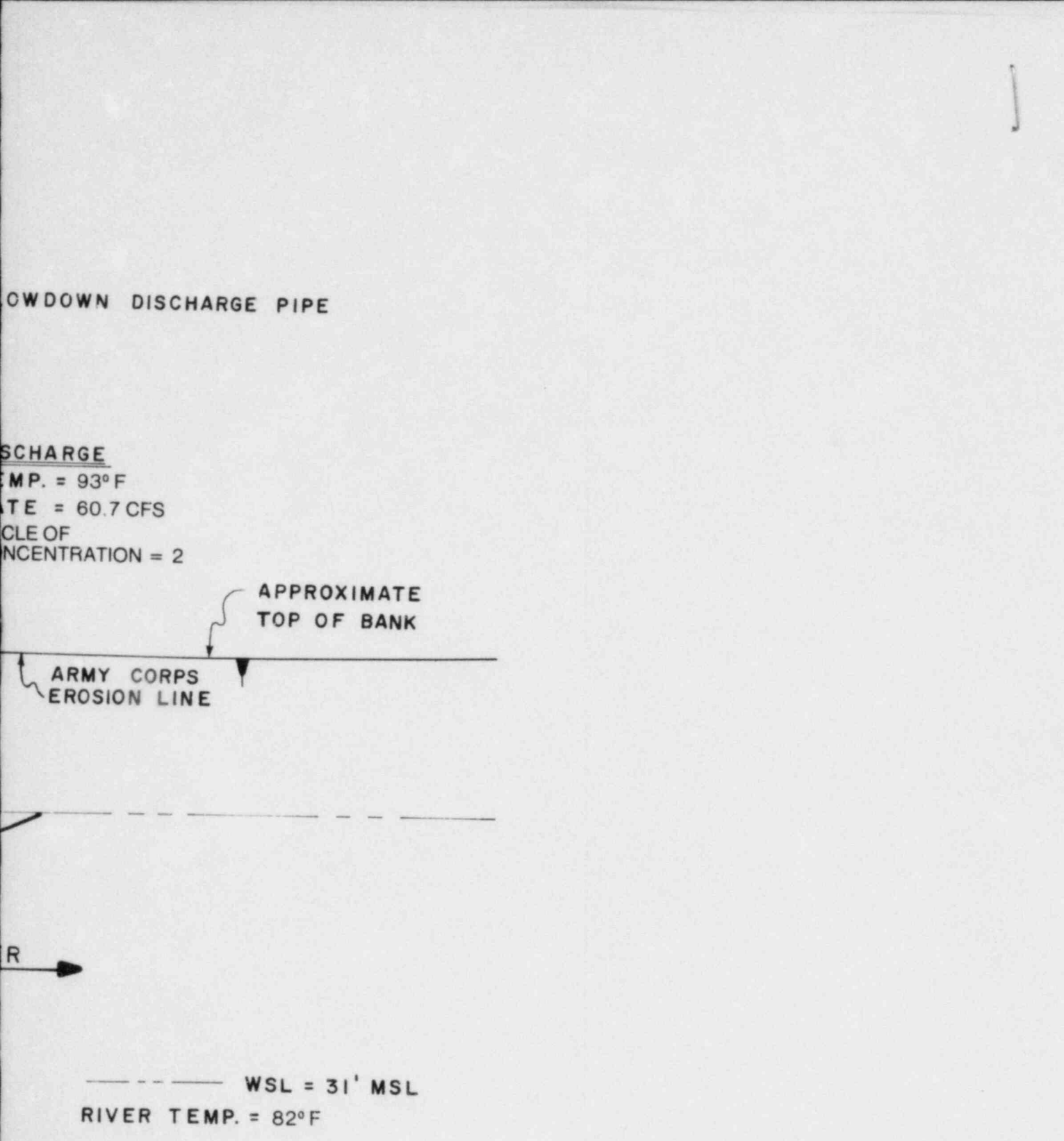
LATERAL

0 50 100 150

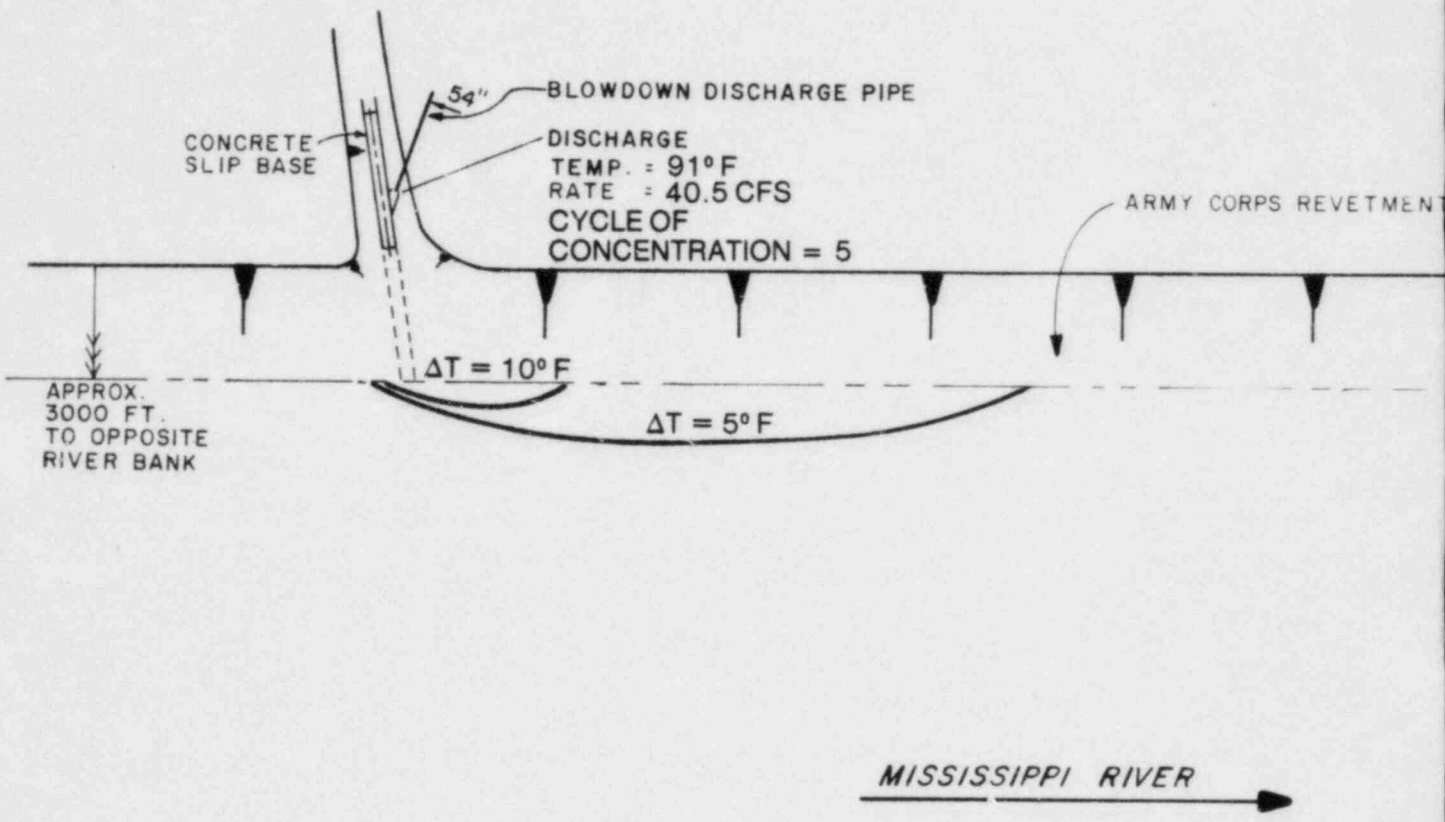
0 100 200 300

LONGITUDINAL

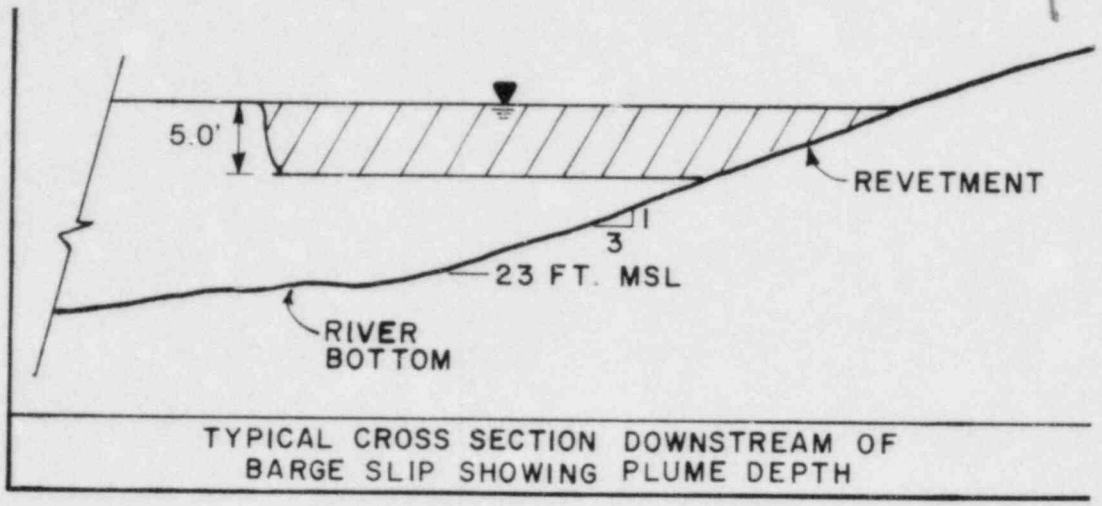
(SCALES IN FEET)



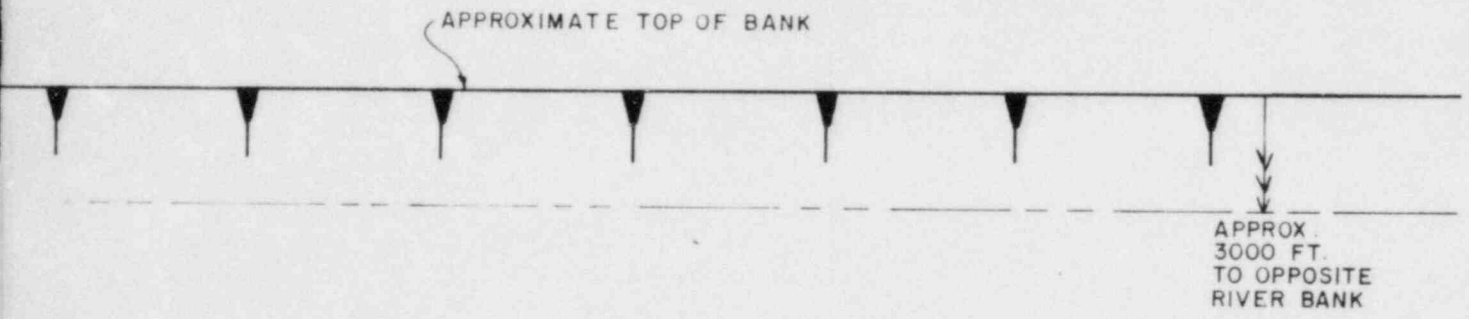
MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT
BLOWDOWN DISCHARGE SURFACE ISOTHERMS LOW RIVER WATER LEVEL CASE: SUMMER MEAN - TWO UNITS FIGURE 5.1-5



LATE
0 100
0 400
LONGITU
(SCALES



TYPICAL CROSS SECTION DOWNSTREAM OF
BARGE SLIP SHOWING PLUME DEPTH



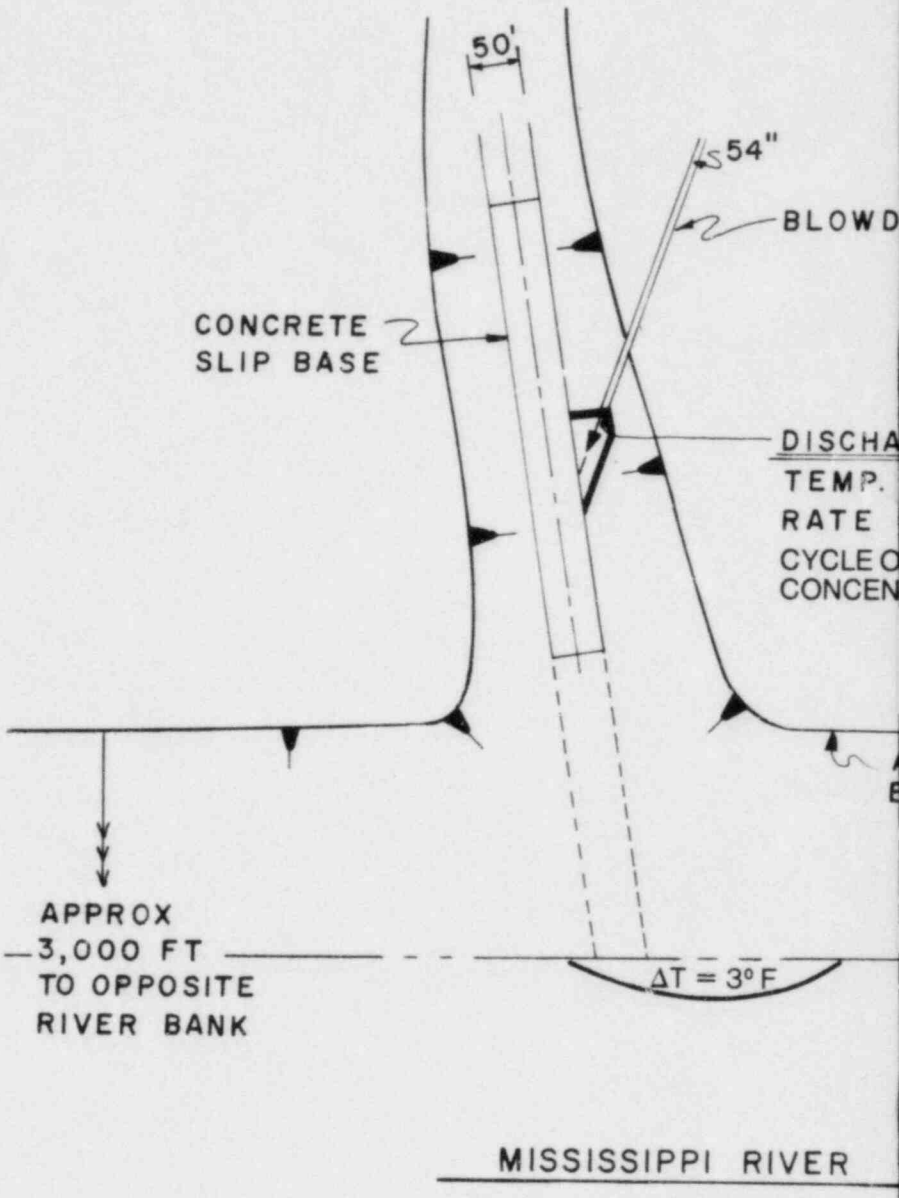
——— - - - ——— WSL = 31' MSL

RIVER TEMP. = 41° F

RAL
200 300

800 1200
JDINAL
N FEET)

MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT
BLOWDOWN DISCHARGE SURFACE ISOTHERMS LOW RIVER WATER LEVEL CASE: WINTER MEAN - TWO UNITS FIGURE 5.1-6



LATERAL

0 50 100 150

0 100 200 300

LONGITUDINAL

(SCALES IN FEET)

OWN DISCHARGE PIPE

RGE
= 93° F
= 60.7 CFS
F
TRATION = 2

APPROXIMATE
TOP OF BANK

RMY CORPS
ROSION LINE

WSL = 31' MSL
RIVER TEMP. = 87° F

MISSISSIPPI POWER & LIGHT COMPANY
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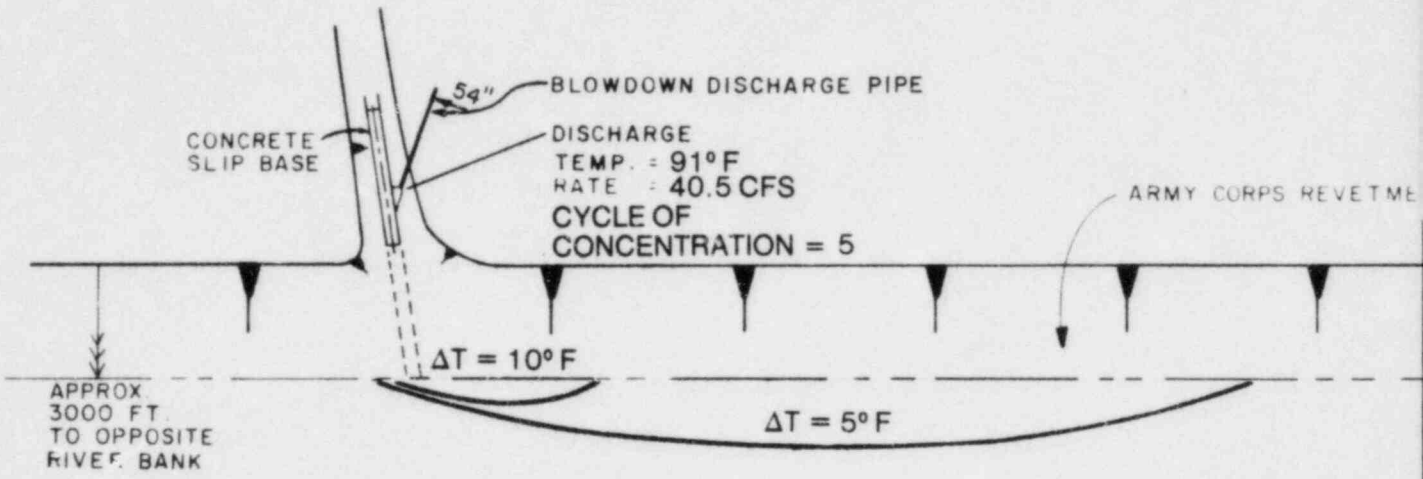
ENVIRONMENTAL REPORT

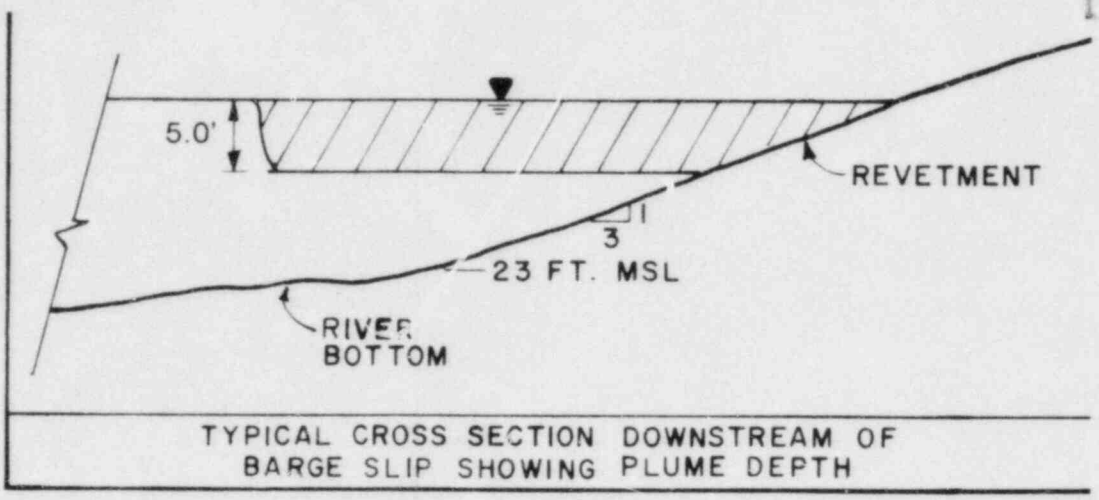
BLOWDOWN DISCHARGE
SURFACE ISOTHERMS
LOW RIVER WATER LEVEL
CASE: SUMMER EXTREME - TWO UNITS
FIGURE 5.1-7

Amend. 5 2/81



MISSISSIPPI RIVER

LAT
0 100
0 40
LONGI
(SCALES



TYPICAL CROSS SECTION DOWNSTREAM OF
BARGE SLIP SHOWING PLUME DEPTH

NT

——— - - - - - WSL = 31' MSL

RIVER TEMP. = 34° F

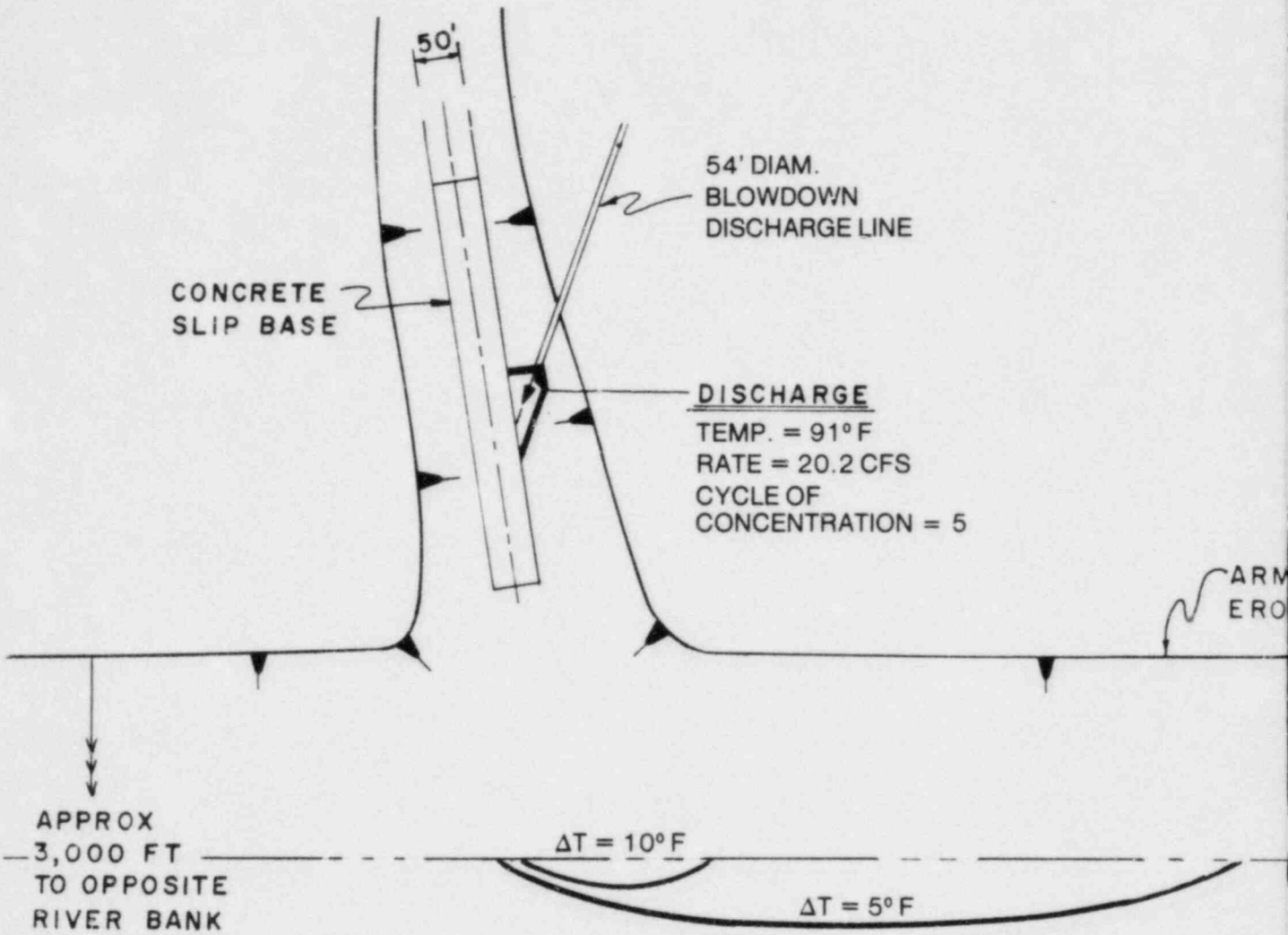
ERAL
200 300

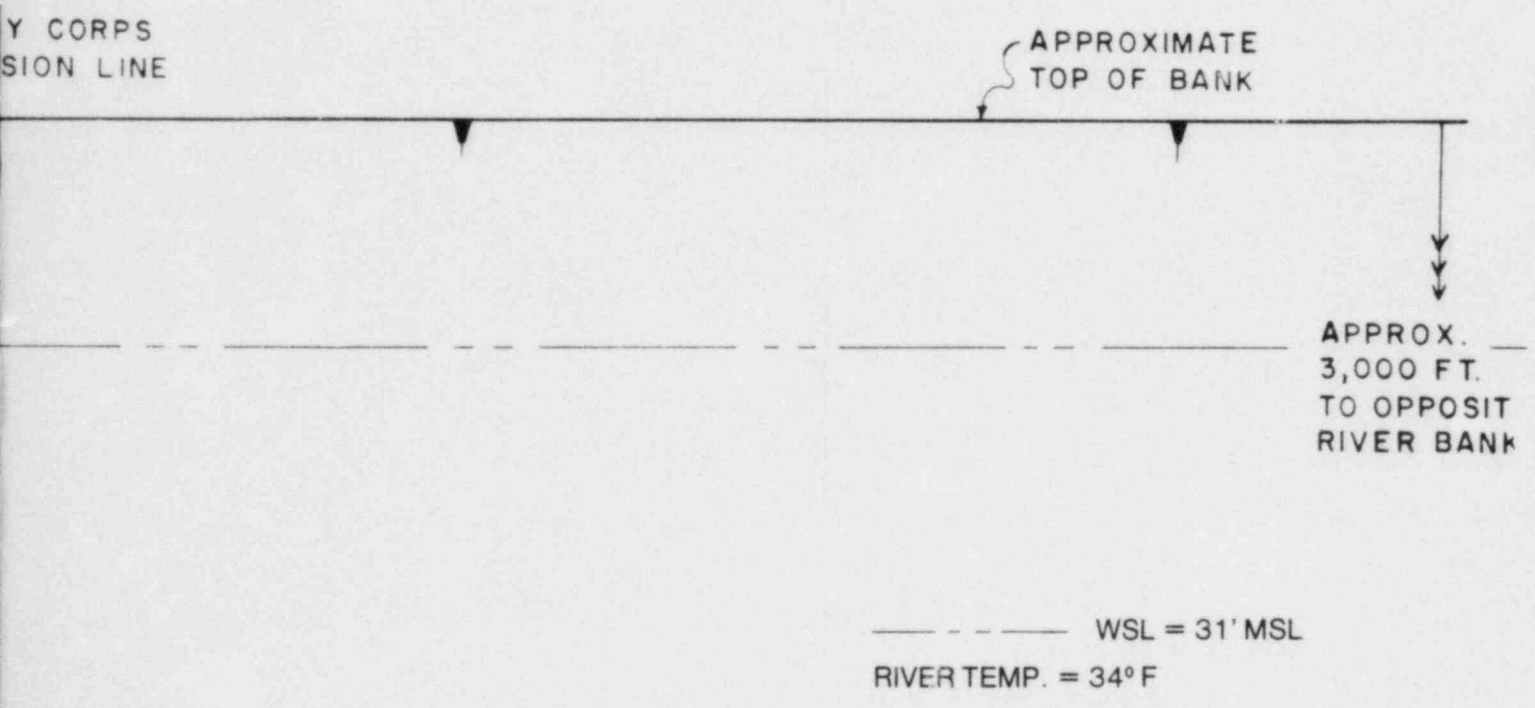
800 1200
TUDINAL
IN FEET)

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

BLOWDOWN DISCHARGE
SURFACE ISOTHERMS
LOW RIVER WATER LEVEL
CASE: WINTER EXTREME - TWO UNITS
FIGURE 5.1-8

Amend. 5 2/81


50'
54' DIAM.
BLOWDOWN
DISCHARGE LINE
CONCRETE
SLIP BASE
DISCHARGE
TEMP. = 91° F
RATE = 20.2 CFS
CYCLE OF
CONCENTRATION = 5
ARM
ERO
APPROX
3,000 FT
TO OPPOSITE
RIVER BANK
ΔT = 10° F
ΔT = 5° F
MISSISSIPPI RIVER
LATERAL
0 50 100
0 100 200
LONGITUDINA
(SCALES IN F



WSL = 31' MSL

RIVER TEMP. = 34° F

150

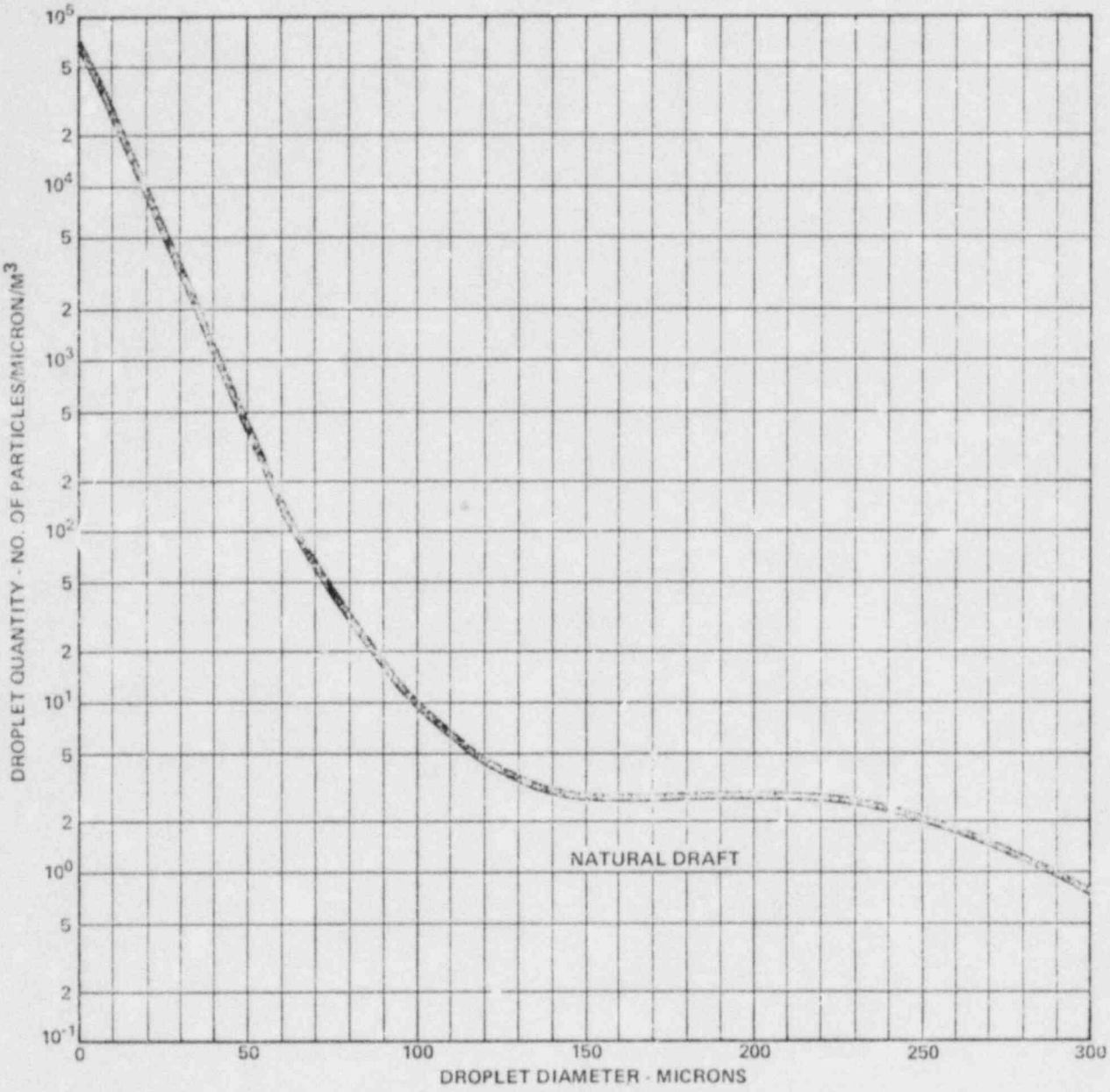
300

L

EET)

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

BLOWDOWN DISCHARGE
SURFACE ISOTHERMS
LOW RIVER WATER LEVEL
CASE: WINTER EXTREME - ONE UNIT
FIGURE 5.1-8a



MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

DRIFT PARTICLE DENSITY
DISTRIBUTION

FIGURE 5.1-9

APPENDIX A

MODEL ASSESSMENT TABLES

MODEL ASSESSMENT TABLE			PROTOTYPE	MODEL	B. F.Rigter (Ref. 2)	MODEL	MODEL
DISCHARGE	TYPE	SINGLE PORT	Yes		Yes		
		MULTIPORT					
	SHAPE	ROUND	Yes				
		RECTANGULAR			Yes		
	LOCATION	SHORELINE	N/A		N/A		
		OFFSHORE					
	POSITION	SURFACE					
		SUBMERGED	Yes		Yes		
	DIRECTION	HORIZONTAL	Yes		Yes		
		NON-HORIZONTAL					
	VOLUME FLOW RATE (M^3/SEC)		0.46-1.7				
	DISCHARGE VELOCITY (M/SEC)		0.31-1.2				
	EXCESS TEMPERATURE (deg C)		3-32				
RECEIVING WATER	TYPE		barge slip		outlet channel		
	DEPTH AT OUTFALL (M)		2.5				
	BOTTOM SLOPE (deg)		1.5°		0		
	NATURAL STRATIFICATION		No		No		
	CURRENT	SPEED (M/SEC)	N/A		N/A		
		DIRECTION (deg)	N/A		N/A		
DISCHARGE/RECEIVING WATER INTERACTIONS	JET ENTRAINMENT		Yes		Yes		
	FROUDE NUMBER		1.5-10				
	ENTRAINMENT COEFFICIENT	LONGITUDINAL			N/A		
		LATERAL			N/A		
		VERTICAL			N/A		
	CROSS FLOW		No		No		
	VELOCITY RATIO		N/A		N/A		
	PRESSURE DRAG		N/A		N/A		
	DRAG COEFFICIENT				N/A		
	NATURAL TURBULENCE		N/A		N/A		
	EDDY DIFFUSIVITY (M^2/SEC)	LONGITUDINAL			N/A		
		LATERAL			N/A		
		VERTICAL			N/A		
	WIND STRESS		N/A		N/A		
	BUOYANCY		Yes		Yes		
	RECIRCULATION		N/A		N/A		
	SURFACE HEAT TRANSFER		No		No		
	HEAT TRANSFER COEF (CAL/M^2 SEC-deg C)				N/A		
	EQUILIBRIUM TEMPERATURE (deg C)				N/A		
MODEL	FIELD				1		
	DIMENSION	LONGITUDINAL			Yes		
		LATERAL			No		
		VERTICAL			Yes		
	MATHEMATICAL APPROACH				2		
	APPROXIMATIONS				1.3		
	MODEL VERIFICATION				Lab/Field		
	COMPUTER PROGRAM				4		

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FAR FIELD ANALYSIS
(low water level)

MODEL ASSESSMENT TABLE			PROTOTYPE	MODEL	Edinger & Polk (Ref. 4)	MODEL	MODEL	
DISCHARGE	TYPE	SINGLE PORT	Yes		Yes			
		MULTIPORT						
	SHAPE	ROUND						
		RECTANGULAR	Yes		N/A			
	LOCATION	SHORELINE	Yes		Yes			
		OFFSHORE						
	POSITION	SURFACE	Yes		Yes			
		SUBMERGED						
	DIRECTION	HORIZONTAL	Yes		Yes			
		NON-HORIZONTAL						
	VOLUME FLOW RATE (M^3/SEC)		0.46-1.7					5
	DISCHARGE VELOCITY (M/SEC)		0.66-1.0					5
	EXCESS TEMPERATURE (deg C)		3-32					5
RECEIVING WATER	TYPE		3		3			
	DEPTH AT OUTFALL (M)		1.5					
	BOTTOM SLOPE (deg)							
	NATURAL STRATIFICATION		No		No			
	CURRENT	SPEED (M/SEC)	.31		any current parallel to shore			
		DIRECTION (deg)						
DISCHARGE/RECEIVING WATER INTERACTIONS	JET ENTRAINMENT		N/A		N/A			
	FROUDE NUMBER		N/A		N/A			
	ENTRAINMENT COEFFICIENT	LONGITUDINAL			N/A			
		LATERAL			N/A			
		VERTICAL			N/A			
	CROSS FLOW		Yes		Yes			
	VELOCITY RATIO		.31-.47		N/A			5
	PRESSURE DRAG		N/A		N/A			
	DRAG COEFFICIENT				N/A			
	NATURAL TURBULENCE		Yes		Yes			
	EDDY DIFFUSIVITY (M^2/SEC)	LONGITUDINAL			No			
		LATERAL		0.07	Yes			5
		VERTICAL			No			
	WIND STRESS		N/A		N/A			
	BUOYANCY		Yes		No			
	RECIRCULATION		N/A		N/A			
	SURFACE HEAT TRANSFER		Yes		Yes			
	HEAT TRANSFER COEF (CAL/M^2 SEC-deg C)				$(1.4-2.4)\times10^4$			
	EQUILIBRIUM TEMPERATURE (deg C)				10-34			
MODEL	FIELD				3			
	DIMENSION	LONGITUDINAL			Yes			
		LATERAL			Yes			
		VERTICAL			No			
	MATHEMATICAL APPROACH				2			
	APPROXIMATIONS				1			
	MODEL VERIFICATION				Field			
	COMPUTER PROGRAM				Not used			

MODEL ASSESSMENT TABLE			PROTOTYPE	MODEL	Edinger & Polk (Ref. 4)	MODEL	MODEL
DISCHARGE	TYPE	SINGLE PORT	Yes		Yes		
		MULTIPORT					
	SHAPE	ROUND					
		RECTANGULAR	Yes		N/A		
	LOCATION	SHORELINE	Yes		Yes		
		OFFSHORE					
	POSITION	SURFACE	Yes		Yes		
		SUBMERGED					
	DIRECTION	HORIZONTAL	Yes		Yes		
		NON-HORIZONTAL					
	VOLUME FLOW RATE (M^3/SEC)		1.4-2.9				
	DISCHARGE VELOCITY (M/SEC)		0.03-0.06				
	EXCESS TEMPERATURE (deg C)		2-12				
RECEIVING WATER	TYPE		3		3		
	DEPTH AT OUTFALL (M)						
	BOTTOM SLOPE (deg)						
	NATURAL STRATIFICATION		No		No		
	CURRENT	SPEED (M/SEC)	.37		any uniform current		
		DIRECTION (deg)	N/A		N/A		
DISCHARGE/RECEIVING WATER INTERACTIONS	JET ENTRAINMENT		N/A		N/A		
	FROUDE NUMBER		N/A		N/A		
	ENTRAINMENT COEFFICIENT	LONGITUDINAL			N/A		
		LATERAL			N/A		
		VERTICAL			N/A		
	CROSS FLOW		Yes		Yes		
	VELOCITY RATIO		0.08-0.16		N/A		
	PRESSURE DRAG		N/A		N/A		
	DRAG COEFFICIENT				N/A		
	NATURAL TURBULENCE		Yes		Yes		
	EDDY DIFFUSIVITY (M^2/SEC)	LONGITUDINAL		0	No		
		LATERAL		0.07	Yes		
		VERTICAL		0	No		
	WIND STRESS		N/A		N/A		
	BUOYANCY		Yes		No		
	RECIRCULATION		N/A		N/A		
	SURFACE HEAT TRANSFER		Yes		Yes		
	HEAT TRANSFER COEF (CAL/M^2 SEC-deg C)				$(1.4-2.4)10^4$		
	EQUILIBRIUM TEMPERATURE (deg C)				10-34		
MODEL	FIELD				3		
	DIMENSION	LONGITUDINAL			Yes		
		LATERAL			Yes		
		VERTICAL			No		
	MATHEMATICAL APPROACH				2		
	APPROXIMATIONS				1		
	MODEL VERIFICATION				Field		
	COMPUTER PROGRAM				Not used		

APPENDIX B

CORPS OF ENGINEER'S SHORELINE MODIFICATION PROGRAM

APPENDIX B

Corps of Engineers' Shoreline Modification Program[1]

Present Status: The Corps of Engineers has been engaged in stabilizing the shoreline of the Mississippi River using techniques such as revetments with articulated concrete mats. These techniques are applied as the river bank reaches the desired alignment through the natural erosive action of the river itself. Two revetments are currently located on the east bank of the river in the vicinity of the Grand Gulf Nuclear Station site: the Upper Grand Gulf Revetment and the Lower Grand Gulf Revetment. The upper revetment currently extends about 3000 feet downriver from the mouth of the Big Black River to within approximately 9000 feet of the Grand Gulf Nuclear Station barge slip. The lower revetment has been completed up to the barge slip.

Future Work: At such time as the river bank reaches the proper alignment, the Upper Grand Gulf Revetment will be completed, and the shoreline along the Grand Gulf Nuclear Station site will be stabilized. The Corps' normal work season for these activities is in July. 5

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(1) General details of the program were obtained from: River Stabilization Branch, Department of the Army, Corps of Engineers, Vicksburg District. Personal communication. The distances stated and the work schedule are approximations only.

5.2 RADIOLOGICAL IMPACT FROM ROUTINE OPERATION

5.2.1 Exposure Pathways

It is generally held that the limits of radiation exposure established for man are conservative in relation to other species (Ref. 1). Auerbach et. al. (Ref. 2) suggested that radiation effects on both are not demonstrable at dose rates of less than 1 rad per day. However, there is a lack of information regarding the effects of low-level irradiation of flora and fauna. Thus, it is necessary to put estimated doses to biota in perspective by comparing them with doses from natural background radiation.

Whole body dose to individuals living in the site region from existing radiation sources is expected to average about 130 mrem/yr. The major portion of this radiation dose is due to external exposure from cosmic-induced radiation (approximately 40 mrem/yr) and radiation from naturally occurring radionuclides in the soil and air (approximately 65 mrem/yr). A dose of approximately 25 mrem/yr is due to internal exposure from naturally occurring radionuclides such as potassium-40 that become incorporated in body tissues (Ref. 3).

Man-made sources of radiation existing in the environment add small amounts of radiation dose. Tritium concentrations in the Mississippi River reached a peak of approximately 5 pCi/ml in 1963, due to fallout from weapon testing, and have decreased since then to about 0.5 pCi/ml (Refs. 4, 5). If the concentration in body water is the same as in surface water, the existing tritium concentration represents an insignificant dose to body tissue of approximately 0.09 mrem/yr. The concentration of gross beta radioactivity in Mississippi River water was measured in 1968 at West Memphis, Arkansas, and at New Orleans, Louisiana. The measured gross beta radioactivity ranged from 9 to 26 pCi/l (Ref. 6). The whole body dose associated with worldwide fallout in drinking water at this site is less than 1 mrem/yr.

Applying the average background individual whole body dose of 130 mrem/yr to the estimated total population of about 321,000 people in 1980 within 50 miles of the site, results in approximately 41,800 man-rem/yr.

Assuming the natural background radiation remains the same as today, this man-rem/yr estimate to the population within 50 miles will increase in direct proportion to increases in the population.

5.2.1.1 Pathways for Exposure to Man

Operation of the Grand Gulf Nuclear Station slightly increases the radiation exposure over that of natural background to individuals living in the vicinity of the site.

The principal pathways of potential exposure of man to radionuclides in effluents from the plant are illustrated in Figure 5.2-1. Studies of current and projected land and water use in the area around the site have revealed that some pathways in Figure 5.2-1 do not present significant potential for exposure to plant effluents. Radiation dose to man resulting from the release of radioactive materials has been evaluated for liquid effluents released into the Mississippi River and gaseous emissions released to the atmosphere. The critical pathways to man for routine releases at this site are radiation exposure from submersion in air, inhalation of contaminated air, drinking milk from a cow that feeds on open pasture near the site, eating vegetables from a garden near the site, and eating fish caught in the Mississippi River. Other less important pathways to be considered include: external irradiation from radionuclides deposited on the ground surface, eating animals and food crops, shoreline activities, and direct radiation from radioactivity contained within the station.

The relative importance of the potential pathways to man have been evaluated by calculating estimated doses from routine operation of the Grand Gulf Nuclear Station from each pathway. The assumptions, methodology, results, and conclusions are presented in the following subsections.

5.2.1.2 Pathways for Exposure of Biota Other Than Man

In addition to the dose due to background radiation, biota other than man living in the vicinity of the site receive some exposure from the routine releases of radioactive effluents. Potential pathways for exposure are shown in Figure 5.2-2. These pathways include ingestion of water and aquatic foods, submersion in air, immersion in water and exposure to sediments and shorelines. Other pathways (such as inhalation, direct radiation, and deposition of radionuclides on soils) are not considered significant for inclusion in the total dose to such organisms (Ref. 3).

Aquatic organisms such as fish, crustacea, mollusks and plants can concentrate radionuclides from their water environment, either directly or through their food chains. These so-called "primary" organisms can be consumed by their predators, certain aquatic and terrestrial mammals and birds. Selected predators, "secondary" organisms in relation to the liquid effluents, are herons, raccoons, and plant-eating ducks (Ref. 7). In the case of aquatic biota, the internal exposure to the organism is more significant than the external exposure, because of the high bioaccummulation factors (defined as the ratio of radionuclide concentration in the organism to that in water).

The primary pathways for internal exposure of terrestrial animals are expected to be ingestion of vegetation containing radionuclides and inhalation of airborne radioisotopes. Pathways for external

exposure are, in addition to natural background, air submersion and surface deposition. The external exposure to terrestrial biota is approximately the same as to man. The external exposures to man due to gaseous discharges are shown in subsection 5.2.4.2.

Evidence collected to date suggests that no living organism is considerably more sensitive to radiation than man (Ref. 4). In addition, guidelines for limiting exposure to man from radioactive effluents are generally held to be conservative for other species (Ref. 1). Since radionuclides in effluents from the Grand Gulf Nuclear Station conform to the guidelines of Appendix I to 10 CFR 50, no significant adverse effects on flora and fauna are anticipated from exposure by any of the pathways described above. Predicted doses to some biota found in the environs of the nuclear plant are discussed in subsection 5.2.3.

5.2.2 Radioactivity in Environment

5.2.2.1 Liquid Radioactive Effluent

The plant liquid radioactive effluent is mixed with the cooling tower blowdown and discharged into the Mississippi River via the barge slip. Details of the discharge system and the barge slip are presented in Section 3.4.

The mixing of the diluted radioactive effluent with the Mississippi River water is analyzed for the mean river level of 54 feet msl, corresponding to a discharge of 560,000 cfs. The mean annual plant discharge is about 22,600 gpm (50.4 cfs).

At the mean annual river stage, the average water depth in the barge slip is about 11 feet. The amount of dilution caused by mixing of the plant discharge with the river water in the barge slip due to the discharge momentum is obtained from an analysis following the method of B. P. Rigter (Ref. 8). An assessment of this method in accordance with NRC Regulatory Guide 4.4 is presented in Appendix A to Section 5.1.

The isotopic concentrations in the liquid effluent for two units at the point of discharge to the barge slip are given in Table 5.2.1. These are based on the liquid effluent releases (Table 3.5.3) and dilution by the annual average cooling tower blowdown rate of 22,400 gpm for two units, as well as disposal of water at a rate of 200 gpm from the administrative building HVAC system. Additional dilution of about 1:1 can be achieved in the barge slip (Section 5.1). The isotopic concentrations in the liquid effluents at the barge slip outlet utilizing this additional dilution are given in Table 5.2.1.

The outflow from the barge slip mixes with the Mississippi River water, resulting in additional dilution of the effluent as discussed in Section 5.1.

5.2.2.2 Atmospheric Diffusion Model

The long-term diffusion characteristics of the Grand Gulf site were evaluated in accordance with Regulatory Guide 1.111 (USNRC, 1977). The routine diffusion analysis was performed using 3 years of onsite meteorological data, extending from August 1972 through July 1974 and January 1976 through December 1976, and the plant parameters. In the analysis, a long-term ground level continuous release, with effluent distributed evenly across a 22-1/2 degree sector was assumed. Ground release concentrations were estimated using the USNRC computer code XOQDOQ. No terrain recirculation factors were considered in this analysis.

5.2.2.2.1 Average Relative Concentration

The average relative concentrations, $\frac{\overline{\chi}}{Q}$, were calculated with two equations modified from Turner (Ref 9). The two equations are:

$$\frac{\overline{\chi}}{Q}(x,k) = \frac{2.032}{x} RF_k(x) \sum_{ij} DEPL_{ijk}(x) \cdot DEC_i(x) \cdot f_{ijk} \cdot \left[\overline{u}_i \left(\sigma^2_{zj}(x) + D^2_z / 2\pi \right)^{1/2} \right]^{-1} \quad (1)$$

$$\frac{\overline{\chi}}{Q}(x,k) = \frac{2.032}{x} RF_k(x) \sum_{ij} DEPL_{ijk}(x) \cdot DEC_i(x) \cdot f_{ijk} \cdot \left(\sqrt{3}\ \overline{u}_i\ \sigma_{zj}(x) \right)^{-1} \quad (2)$$

where:

$\frac{\overline{\chi}}{Q}(x,k)$ = average effluent concentration normalized by source strength at distance x and direction k, sec/m^3

$\overline{u}_i$ = average values of the ith wind speed class, m/sec

$\sigma_{zj}(x)$ = vertical (z) spread of effluent at distance x for the jth stability class, m

f_{ijk} = joint probability of the ith wind speed class, jth stability class, and kth wind direction

x = downwind distance from release point or building, m

$DEC_i(x)$ = reduction factor due to radioactive decay at distance x for the ith wind speed class

$DEPL_{ijk}(x)$ = reduction factor due to plume depletion at distance x for the ith wind speed class, jth stability class, and kth wind direction

$RF_k(x)$ = correction factor for air recirculation and stagnation at distance x and kth wind direction.

D_z is the building height which is used to describe the dilution due to the building wake, from Yanskey, et al (Ref. 10). Equation 2 represents the maximum building wake dilution allowed; the higher value of $(\overline{\chi/Q})$ calculated from equations 1 and 2 was used.

Values of χ/Q (x,k) were calculated at 22 downwind distances between 0.25 and 50 miles. Each of the 16 directional sectors were divided into 10 downwind segments and an average value was determined for each sector as follows:

$$\overline{(\chi/Q)}_{seg} = \frac{R_1 (\chi/Q)_{R_1} + r_1 (\chi/Q)_{r_1} + \ldots + r_n (\chi/Q)_{r_n} + R_2 (\chi/Q)_{R_2}}{R_1 + r_1 + \ldots + r_n + R_2} \quad (3)$$

where:

$\overline{(\chi/Q)}_{seg}$ = average value of χ/Q for the segment, sec/m^3

$(\chi/Q)_r$ = $\frac{\chi}{Q}$ (x=r,k) calculated at distance r, sec/m^3

R_1, R_2 = the downwind distance of the segment boundaries, m

$r_1 \ldots r_n$ = selected radii between R_1 and R_2, m.

In addition to the standard 22 distances in each direction, values of $\overline{\chi/Q}$ (x,k) at actual site boundaries and locations of cows, vegetable gardens and residences within 5 miles of the reactor were calculated.

5.2.2.2.2 Average Relative Deposition

For a 22-1/2 degree sector, the basic equation to calculate the average relative deposition per unit area, D/Q, for a specified downwind distance is:

$$\overline{\frac{D}{Q}}\ (x,k) = \frac{RF_k(x) \cdot \sum_{ij} D_{ij}\ f_{ijk}}{(2\pi/16)x} \quad (4)$$

where:

$\frac{\bar{D}}{Q}(x,k)$ = average relative deposition per unit area at a downwind distance x and direction k, m^{-2}

D_{ij} = the relative deposition rate for the ith wind speed class and jth stability class, m^{-1}

f_{ijk} = joint probability of the ith windspeed, jth stability class, and kth wind direction

x = downwind distance, m

$RF_k(x)$ = correction factor for air recirculation and stagnation at distance x and kth wind direction.

Equation 3 is used to calculate average values of D/Q for the downwind segments, with D replacing χ in the equation.

The D/Q values by sector were calculated for the 22 downwind distances, between 0.25 and 50 miles, specific locations of cows, vegetable gardens and residences within 5 miles of the reactor, and actual site boundaries.

5.2.3 Dose Rate Estimates for Biota Other Than Man

5.2.3.1 Aquatic Flora and Fauna

Although concentrations of radionuclides in liquid effluents are greatly diluted in the river, the ability of aquatic organisms to concentrate these materials presents a potential radiological hazard to species living in the contaminated water. To assess the potential impact of liquid releases to river biota, radiation doses to aquatic plants (algae, etc.), invertebrates, and fish were considered

Internal dose to aquatic organisms results from intake of radionuclides through food chain ingestion and direct absorption from water.

Immersion doses to benthic organisms such as invertebrates and periphytic algae may be slightly underestimated, since the source term from radionuclides absorbed onto inorganic and organic bottom sediments is negligible and is generally not included in the dose calculations.

Radioactive effluents from the liquid radwaste system are released only if a minimum dilution factor of 300 by the cooling tower blowdown can be guaranteed. The discharges are further diluted 1:1 in the barge slip. Under these conditions an annual average dilution factor of 600 is achieved.

The annual average isotopic concentrations in the plant liquid effluents at the point of discharge to the Mississippi River are listed in Table 5.2.1. The doses to the aquatic flora and fauna, calculated with the dose models given in Reference 7 and discussed in Appendix A to this section and the parameters of Table 5.2.2, are presented in Table 5.2.3.

A perusal of the doses to aquatic fauna and flora, given in Table 5.2.3, indicates that adverse effects to these organisms resulting from the release of radioactive effluents from the Grand Gulf Nuclear Station are insignificant in comparison with natural background radiation.

5.2.3.2 Terrestrial Animals

External doses to terrestrial animals from radioactive materials in gaseous effluents and from direct radiation from the plant are expected to be similar to those estimated for man. Inhalation doses to animals from radioactive iodine releases are less than for man, assuming animals have no greater uptake and retention properties for iodine than humans. These doses to man are presented in subsection 5.2.4.

Internal doses to terrestrial animals result from ingestion of contaminated plants or food chain organisms (primary organisms). Among the terrestrial animals the duck is expected to receive the maximum dose (Ref. 11). This dose is assumed to be received by the duck due to its consumption of algae growing in the water near the point of discharge of liquid radioactive effluents (bio-accumulation factor for radionuclides in algae is 10^1 to 10^4).

The dose to a duck and a raccoon, both common terrestrial animals living in the Mississippi River bottomlands and adjacent loessial bluffs, is given in Table 5.2.3. It was assumed that all food is located at the point of discharge to the Mississippi River; other pertinent assumptions are listed in Table 5.2.2.

A perusal of the doses to terrestrial animals, given in Table 5.2.3, indicates that adverse effects to these organisms resulting from the release of radioactive effluents from the Grand Gulf Nuclear Station are insignificant in comparison with natural background radiation.

5.2.4 Dose Rate Estimates for Man

5.2.4.1 Estimated Doses Due to Liquid Effluents

Release of radioactive materials in liquid effluents to the discharge basin, from where radioactive materials are subsequently released to and mix with the Mississippi River water, results in minimal radiological exposures to individuals and the general public. Since irrigation has not been found necessary or observed in the area around the Grand Gulf site (average rainfall

for Vicksburg - 50 inches), this pathway has not been considered in the evaluation of doses. Likewise, the dose due to drinking water has not been considered since the nearest point for potable use of water is below Baton Rouge, Louisiana, about 197 river miles downstream. Shoreline use is very limited with essentially no swimming, sunbathing, or fishing from the bank, and consequently is expected to be an insignificant pathway in comparison with the pathway of aquatic foods. Nevertheless, for purposes of conservatism, this pathway has been included in the evaluation of doses for the maximum exposed individual.

Annual radiation exposures to the maximum exposed individual via the pathways of aquatic foods and shoreline deposits, and to the population within a 50-mile radius of the Grand Gulf Nuclear Station via the pathway of aquatic foods are given in Tables 5.2.4 and 5.2.5 respectively. These doses have been evaluated using the models and the values for the required parameters given in NRC Regulatory Guide 1.109 (Ref. 12). A single dilution factor was conservatively chosen for all points of exposure or harvest of aquatic food (for dilution factor, see subsection 5.2.3.1). For shore width, a value of 0.2, given in Reference 12, for river shoreline was chosen. Expected population distribution by sectors and distances in the year 2000, given in subsection 2.1.2, and the commercial aquatic food catch data, provided in Table 2.1.67, were used to evaluate population exposures.

As can be seen from Table 5.2.4, the maximum exposed individual annual doses from the discharge of radioactive materials in liquid effluents from the Grand Gulf Nuclear Station meet the guidelines of Appendix I to 10 CFR Part 50. Since the guidelines for the maximum individual exposure via hydrospheric pathways are much more restrictive (at least by a factor of 160) than the standards of 10 CFR Part 20, it can be inferred that radioactive releases in liquid effluents from the two Grand Gulf units meet the standards for concentrations of released radioactive materials in water (accessible to a maximum exposed individual of the general public), as specified in Column 2 of Table II of 10 CFR Part 20.

5.2.4.2 Estimated Doses Due to Gaseous Effluents

Release of radioactive materials in gaseous effluents from each Grand Gulf unit to the environment results in minimal radiological exposure to individuals and the general public. Annual radiation exposures to the maximum exposed individual and the population within a 50-mile radius of the Grand Gulf Nuclear Station via the pathways of submersion, ground contamination, inhalation and ingestion are given in Tables 5.2.6 and 5.2.7, respectively. These doses have been evaluated using the release data given in Table 3.5.4 and atmospheric dilution and deposition factors (χ/Q and D/Q) given in Section 2.3 and Table 5.2.8. The noble gas submersion doses were evaluated using the finite cloud model for gammas given in Reference 13 and a semi-infinite cloud model for betas given in Reference 12. Doses due to radioiodines and particulates were

evaluated using the models and the values of required parameters given in Reference 12. Annual production rates of vegetables, grains, meat and milk, and the estimated population distribution in the year 2000 within a 50-mile radius of the Grand Gulf Nuclear Station, given in Section 2.1, were used to evaluate the population exposures.

As can be seen from Table 5.2.6, annual doses to the maximum exposed individual due to release of radioactive materials in gaseous effluents from each Grand Gulf unit meet the guidelines of Appendix I to 10 CFR Part 50. Since the guidelines of Appendix I to 10 CFR Part 50 for maximum individual exposures via atmospheric pathways are much more restrictive (by a factor of ~100) than the standards of 10 CFR Part 20, it can be inferred that radioactive releases via gaseous effluents from the two Grand Gulf units meet the standards for concentrations of released radioactive materials in air (at the locations of maximum annual dose to an individual and hence, at all locations accessible to the general public), as specified in Column 1 of Table II of 10 CFR Part 20.

5.2.4.3 Direct Radiation From Facility

The maximum whole body dose estimates due to direct radiation from Grand Gulf Nuclear Station are summarized in this subsection. This dose is due almost entirely to the direct and air-scattered N-16 radiation from the turbines and moisture separators. Other contributors, such as the condensate storage tanks, were examined and resultant doses were found to be negligible.

There are no schools, hospitals, or public facilities within 1 mile of the station.

N-16 doses are due to direct radiation and atmospheric scattering of the high energy gammas emitted by decaying N-16 present in reactor steam in the main steam lines, turbines, and moisture separators. These doses have been evaluated by using the program SKYSHINE (Ref. 14). Data regarding the source term and the major shields used in the dose evaluation are listed below:

a. Specific activity of N-16 in the reactor steam is 50 μci/gm.

b. A 2-foot thick concrete floor is located above the moisture separator-reheaters.

c. Four and one half-foot thick concrete walls are used below the above floors.

d. A 3-inch thick steel plate is located between the turbine and generator. A three and one half-foot thick concrete shield is located at the other end of the turbine.

An operating load factor of 80 percent was used to estimate the doses at various outside locations given in Table 5.2.9. The dose point distances are measured from the intersection of the turbine-generator axis and the boundary between the Unit 1 and Unit 2 turbine buildings.

5.2.5 References

1. Auerbach, S. I., "Ecological Considerations in Siting Nuclear Power Plants: The Long Term Biota Effects Problems," Nuclear Safety, 12, 25, 1971.

2. Auerbach, S. I., et al., "Ecological Considerations in Reactor Power Plant Siting," IAEA-SM/146/53, 1970.

3. U. S. Environmental Protection Agency, 1972. "Environmental Radioactivity Surveillance Guide." Doc. ORP/SID 72-2.

4. U. S. Department of Health, Education and Welfare, 1970, "Radiological Health Data and Reports," Vol. 11, No. 9.

5. U. S. Environmental Protection Agency, 1971. "Radiological Health Data and Reports," Vol. 12, No. 11.

6. U. S. Department of Health, Education and Welfare, 1969. "Radiological Health Data and Reports," Vol. 10, Nos. 1-4.

7. U. S. Atomic Energy Commission, 1973. "Final Environmental Statement Concerning Rule Making Action," Wash 1258 Vol. Nos. 1-3.

8. Rigter, B. P., "Density Induced Return Currents in Outlet Channels," ASCE Journal of the Hydraulics Division, HY2, Feb. 1970.

9. Turner, D. B., "Workbook of Atmospheric Dispersion Estimates," Office of Air Programs Publications No. AP-26, Environmental Protection Agency, Research Triangle Park, North Carolina, 1970.

10. Yanskey, G. R., E. H. Markee, Jr., and A. P. Richter, "Climatography of the National Reactor Testing Station," Idaho Operations Office, USAEC, IDO-12048, Idaho Falls, Idaho.

11. U. S. Atomic Energy Commission's Final Environmental Statement for Shoreham Nuclear Power Station - Docket No. 50-322, 1972.

12. U. S. Nuclear Regulatory Commission, 1977. "Calculation of Annual Doses to Man from Routine Releases of Reactor

Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Regulatory Guide 1.109 Rev. 1.

13. Slade, D. H., "Meteorology and Atomic Energy," TID-24190 1968.

14. Collins, D. G. et al., "SKYSHINE, A Computer Procedure for Evaluating Effect of Structure Design on N-16 Gamma Ray Dose Rates," RRA-7729, 1972.

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TABLE 5.2.1

ANNUAL AVERAGE CONCENTRATION OF RADIONUCLIDES IN THE LIQUID PLANT EFFLUENTS AT VARIOUS LOCATIONS
μCi/ml

Isotope[1]	At Point of Discharge to Barge Slip	At Barge Slip Outlet	MPC[2]
H-3	1.06-06	5.30-07	3.00-03
NB-24	6.63-10	3.31-10	3.00-05
CR-51	6.63-10	3.31-10	2.00-03
MN-54	8.84-12	4.42-12	1.00-04
FE-55	1.50-10	7.51-11	8.00-04
FE-59	3.98-12	1.99-12	5.00-05
CO-58	2.83-11	1.41-11	9.00-05
CO-60	6.19-11	3.09-11	3.00-05
SR-89	1.41-11	7.07-12	3.00-06
SR-90	8.84-13	4.42-13	3.00-07
SR-91	2.34-10	1.17-10	5.00-05
SR-92	1.68-10	8.40-11	6.00-05
Y-91	7.96-12	3.98-12	3.00-05
Y-92	3.58-10	1.79-10	6.00-05
Y-93	2.39-10	1.19-10	3.00-05
ZR-95	8.84-13	4.42-13	6.00-05
NB-95	8.84-13	4.42-13	1.00-04
MO-99	2.08-10	1.04-10	4.00-05
TC-99	9.28-10	4.64-10	2.00-04
RU-103	2.65-12	1.33-12	8.00-05
RU-105	6.19-11	3.09-11	1.00-04
RH-105	1.72-11	8.62-12	1.00-04
TE129M	5.30-12	2.65-12	2.00-05
TE131M	9.28-12	4.64-12	4.00-05
I-131	4.24-09	2.21-09	3.00-07
I-132	4.02-10	2.01-10	8.00-06
I-133	1.68-09	8.40-10	1.00-06
I-135	8.84-10	4.42-10	4.00-06
CS-134	1.28-10	6.41-11	9.00-06
CS-136	8.40-11	4.20-11	6.00-05
CS-137	3.01-10	1.50-10	2.00-05
CS-138	3.18-10	1.59-10	- - -
BA-140	4.86-11	2.43-11	2.00-05
LA-140	1.06-11	5.30-12	2.00-05
LA-141	2.08-11	1.04-11	3.00-06
CE-141	4.42-12	2.21-12	9.00-05
CE-143	2.65-12	1.33-12	4.00-05
W-187	2.56-11	1.28-11	6.00-05
NP-239	7.07-10	3.54-10	1.00-04

(1) Shortlived isotopes and isotopes contributing insignificantly to the dose are omitted.

(2) 10 CFR Part 20 - App. B - Table II - Col. 2

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TABLE 5.2.2

PARAMETERS USED IN CALCULATION OF DOSES TO PRIMARY AND SECONDARY BIOTA OTHER THAN MAN

Organism	Body Class (kg)	Effective Radius (cm)	Source of Nuclide	Intake Rate gm/day	Annual Exposure (hrs.) Air	Sediment	Immersion	Water Surface
Primary								
Fish	N/A(1)	2	Water(2)	N/A	0	8766/4	8766	0
Crustacea	N/A	2	Water(2)	N/A	0	8766/4	8766	0
Mollusks	N/A	2	Water(2)	N/A	0	8766	0	8766
Algae	N/A	2	Water(2)	N/A	0	0	8766	0
Secondary								
Raccoon	12	20	Crustacea & Mollusks	200	8766	8766/4	0	0
Duck	1	10	Algae	100	8766	8766/2	0	8766/2

(1) N/A - not applicable

(2) At point of discharge to the Mississippi River.

TABLE 5.2.3

DOSES TO PRIMARY AND SECONDARY ORGANISMS
(mrad/yr)

Organism	Internal Dose	External Dose
Fish	11.2	0.11 (1)
Crustacea	10.9	0.11 (1)
Mollusks	10.9	0.11 (1)
Algae	48.5	0.11 (1)
Duck	4.2	1.02 (2)
Raccoon	1.05	0.51 (2)

(1) Immersion dose

(2) Shoreline exposure (does not include cloud immersion or direct radiation)

Table 5.2.4

MAXIMUM INDIVIDUAL DOSES FROM LIQUID EFFLUENTS
(mrem/yr)

Pathway	Annual Dose		Guidelines
	Total Body	Thyroid	Appendix I
Aquatic Foods	0.84	1.42	
Shoreline Deposits	0.0012	NA	
Total from all pathways	0.84	1.42	Total Body: 3 Any organ: 10

Note: Dose to other organs not listed above are less than the dose to the thyroid.

Table 5.2.5

POPULATION DOSES FROM LIQUID EFFLUENTS VIA THE AQUATIC FOOD PATHWAY
(Man-rem/yr)

Organ	Dose
Thyroid	13.79
Total Body	16.17

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TABLE 5.2.6

MAXIMUM INDIVIDUAL DOSES FROM GASEOUS EFFLUENTS (PER UNIT)

Noble Gases

Pathway	Location	Annual Dose	10 CFR 50 Appendix I Guidelines
Cloud Submersion			
- Total Body	SSE Sector - Site Boundary - 740 meters	0.55 mrem	5 mrem
- Skin	SSE Sector - Site Boundary - 740 meters	1.52 mrem	15 mrem
Air Dose			
- Gamma	SSE Sector - Site Boundary - 740 meters	0.82 mrad	10 mrad
- Beta	WSW Sector - Site Boundary - 1722 meters	1.38 mrad	20 mrad

Radioiodines and Particulates (Thyroid)(1)

Location and Pathway	Age Group	Annual Dose (mrem)	10 CFR 50 Appendix I Guidelines (mrem)
WSW Sector - Site Boundary - 1722 meters			
- Inhalation	Child	1.55	15 from all pathways
- Ground Plane	Child	0.06	
SW Sector - Residence - 1432 meters			
- Inhalation	Child	1.13	"
- Meat (2)	Child	0.07	
- Ground Plane	Child	0.06	
N Sector - Vegetable Garden - 2816 meters			
- Vegetable	Child	0.74	"
- Inhalation	Child	0.20	
- Ground Plane	Child	0.02	
E Sector - Pasture - 8047 meters			
- Cow's Milk	Infant	0.96	"
- Inhalation	Infant	0.01	
- Ground Plane	Infant	0.002	

(1) Doses to other organs are less than dose to thyroid.

(2) Assuming 25 percent of meat consumption is mutton produced at this location.

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TABLE 5.2.7

POPULATION DOSES FROM GASEOUS RELEASES

Pathway	Total Body Dose (man-rem)	Thyroid Dose (man-rem)
Noble Gases		
Cloud Submersion	0.26	0.26
Radioiodine and Particulates		
Ground Contamination	0.036	0.036
Inhalation	0.024	0.964
Vegetable Consumption	0.053	0.283
Milk Consumption	0.126	2.15
Meat Consumption	0.109	0.356
	0.348	3.789

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TABLE 5.2.8

X/Q AND D/Q FOR THE VEGETABLE GARDENS, RESIDENCES AND COWS WITHIN 5 MILES

Item	Sector	Distance (Meters)	X/Q ($Sec/meter^3$)	D/Q ($1/meter^2$)
Vegetable Garden	NNE	2414	4.2-07	1.6-09
	ENE	4828	6.9-08	3.1-10
	E	2414	2.3-07	1.1-09
	ESE	4426	7.3-08	3.6-10
	N	2816	5.6-07	1.8-09
Residence	NNE	1448	9.4-07	3.9-09
	NE	1062	1.0-06	5.8-09
	ENE	4297	8.2-08	3.9-10
	E	982	9.6-07	5.1-09
	ESE	4007	8.5-08	4.2-10
	SE	3299	1.9-07	8.6-10
	SSE	1690	7.8-07	3.3-09
	S	1770	1.3-06	3.8-09
	SSW	3734	4.9-07	8.2-10
	SW	1432	3.0-06	4.5-09
	WNW	6437	4.9-07	4.6-10
	NNW	1738	1.4-06	4.1-09
	N	1481	1.5-06	5.5-09
Cow	E	8047	3.7-08	1.3-10

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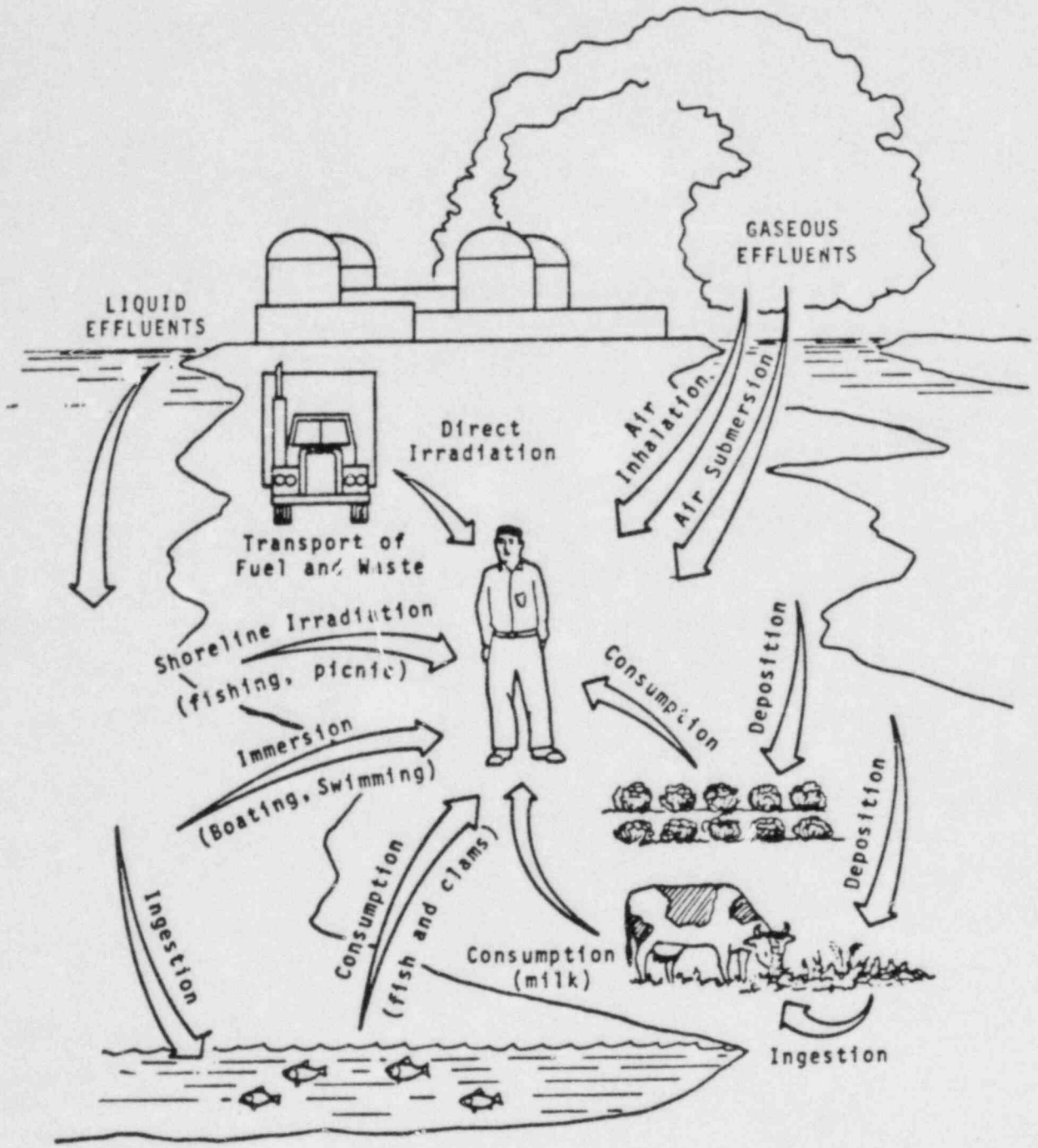
TABLE 5.2.9

ESTIMATED N-16 DOSES AT OUTSIDE LOCATIONS

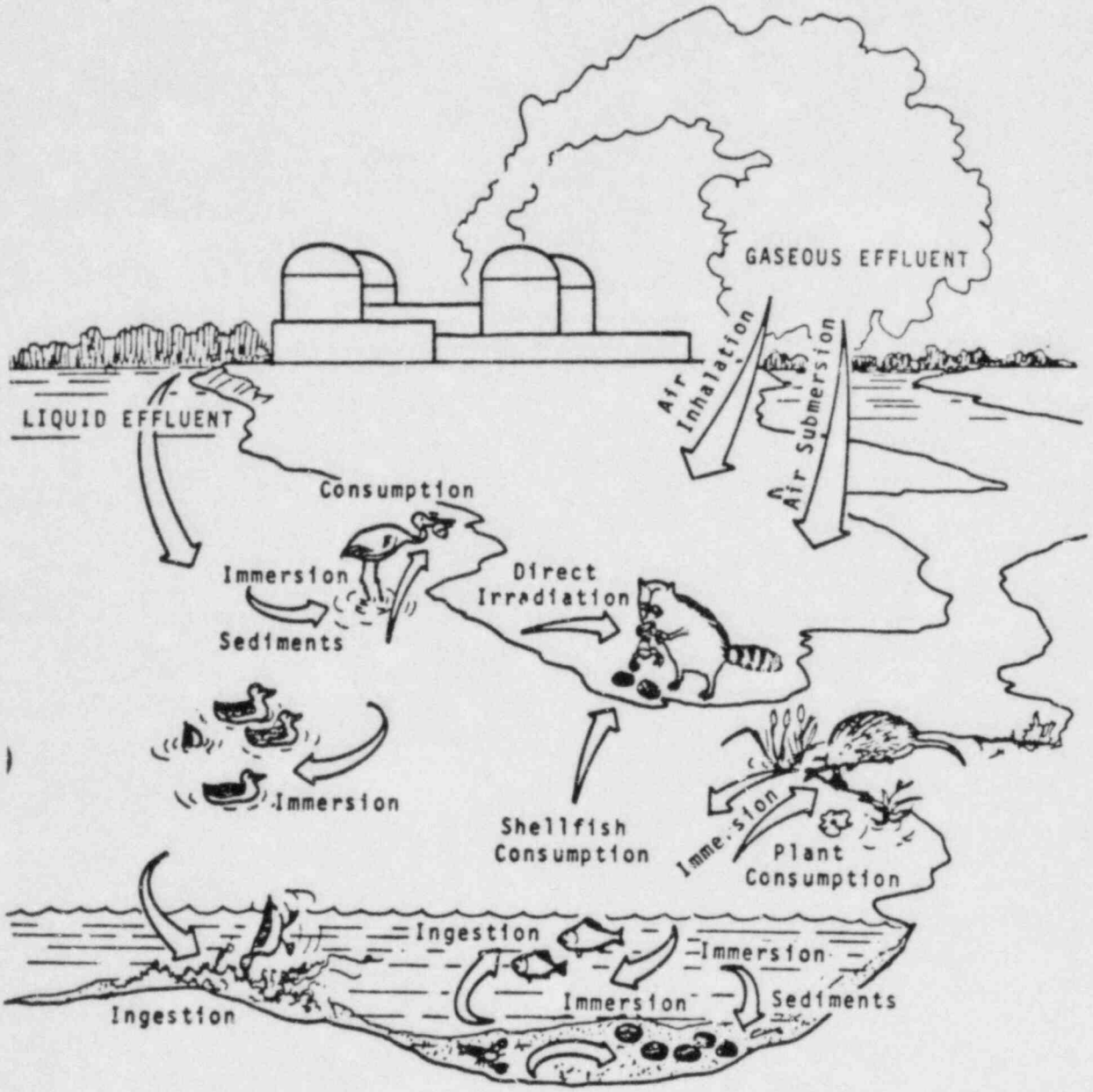
Location	Occupancy (hrs/wk)	Dose (mrem/yr)
Boundary of the restricted area (SE)*(2,450 ft)	84	2.6
Boundary of the restricted area (North)*(3,350 ft)	84	1.1

* Weekly occupancy fraction of 0.5 is assumed



MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

GENERALIZED EXPOSURE PATHWAYS
FOR MAN
FIGURE 5.2-1



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GENERALIZED EXPOSURE PATHWAYS
FOR ORGANISMS OTHER THAN MAN
FIGURE 5.2-2

APPENDIX A

DOSE MODELS FOR BIOTA OTHER THAN MAN

The following is a brief discussion of the models used for calculating doses from radionuclide discharges to organisms other than man.

5.2A.1 Individual Dose Models for Biota Other Than Man

Pathways of exposure associated with liquid effluents are generally the most significant contributors to radiation dose to organisms other than man, since aquatic organisms can concentrate radionuclides from their water environment either directly or via their food chains. For purposes of calculating equilibrium concentrations of radionuclides, organisms other than man are divided into two classifications: "primary organisms" which are aquatic and for which bioaccumulation factors are available, and "secondary organisms" which feed upon primary organisms.

Radionuclide concentrations for primary organisms are calculated directly from the water concentrations and bioaccumulation factors. The primary organisms are fish, crustacea, mollusks and plants. Radionuclide concentrations for secondary organisms must be calculated from their diet of primary organisms. Representative birds and mammals were selected such that each primary organism would be in the diet of at least one secondary organism. The predatory birds and mammals commonly selected are herons, raccoons, muskrats and plant-eating ducks.

5.2A.1.1 Internal Doses via Liquid Pathways (Ref. 1)

The total-body dose rate to an aquatic organism is

$$(DR)_c = 0.0187 \sum_{i=1}^{N} b_{ic}\, \varepsilon_{ic} \qquad \text{(A-1)}$$

where: $(DR)_c$ = dose rate to total body of organism c, mrad/yr

ε_{ic} = effective absorbed energy in MeV per disintegration (dis) for nuclide i in organism c

b_{ic} = specific body burden of nuclide i in organism c, pCi/kg

N = number of isotopes in the releases, and

0.0187 = conversion factor calculated as follows:

$$\left(3.7 \times 10^{-2} \frac{\text{dis}}{\text{sec-pCi}}\right)\left(3.156 \times 10^{7} \frac{\text{sec}}{\text{yr}}\right)\left(1.6 \times 10^{-6} \frac{\text{erg}}{\text{MeV}}\right)\left(\frac{\text{kg-mrad}}{100\ \text{erg}}\right)$$

$$= 0.0187 \frac{\text{dis-kg-mrad}}{\text{pCi-yr-MeV}}.$$

For a primary organism, b_{ic} is given by

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$$b_{ic} = C_{iw} B_{ic} = 1120 \frac{Q_i}{F_R (DF)} e^{-\lambda_i t_p} B_{ic} \qquad \text{(A-2)}$$

where:

C_{iw} = concentration of nuclide i in water, pCi/liter

B_{ic} = bioaccumulation factor for nuclide i in organism c, the ratio of the radionuclide concentration in the organism to that in water, pCi/kg/PCi/liter

Q_i = release rate of isotope i, Ci/yr

F_R = flow rate of the liquid effluent, ft^3/sec

DF = dilution factor at the point of consumption

λ_i = radiological decay constant for nuclide i, hr^{-1}

t_p = average transit time from the point of discharge to the point where water leaves the receiving water body and enters a specific pathway, hr.

Combining (A-1) and (A-2) yields

$$(DR)_c = 20.93 \sum_{i=1}^{N} \frac{Q_i}{F_R (DF)} e^{-\lambda_i t_p} B_{ic} \varepsilon_{ic} \qquad \text{(A-3)}$$

The total-body dose factor, F'_{iK} from nuclide i for a secondary organism k is

$$F'_{ik} = \frac{0.0021 \, (f_w)'_i \, \varepsilon'_{ik} \left(1 - e^{-\lambda'_{Ei} t}\right)}{\lambda'_{Ei} \, m'_k} \left(\frac{\text{mrad/yr}}{\text{pCi/yr intake}}\right) \qquad \text{(A-4)}$$

where:

$(f_w)'_i$ = fraction of ingested nuclide i retained in secondary organism (unitless)

ε'_{ik} = effective absorbed energy in MeV per disintegration for secondary organism k

m'_k = mass of secondary organism k, g

$\lambda'_{Ei} = \lambda_i + \lambda'_{Bi}$ = effective decay constant of nuclide i in secondary organism, hr^{-1}, where

λ'_{Bi} = biological removal constant of nuclide i in secondary organism, hr^{-1};

t = period of exposure, hr

The parameters $(f_w)'_i$ and λ'_{Ei} are taken to be the same as those for Standard Man because data for other organisms are lacking. It is convenient to use an alternate formulation for Equation (A-4) as follows:

$$F'_{ik} = \frac{\varepsilon'_{ik}}{m'_k} \frac{m_{man} D_{i,man}}{\varepsilon_{i,man}} = \frac{\varepsilon'_{ik}}{m'_k} \frac{70{,}000\ D_{i,man}}{\varepsilon_{i,man}} \quad \text{(A-5)}$$

where 70,000 g is the total body mass of the adult.

The radiation dose rate to the total body of the secondary organism expressed in a different format is

$$(DR)'_k = 0.365 \sum_{i=1}^{N} b_{ic}\ P'_{ck}\ F'_{ik} \quad \text{(A-6)}$$

where P'_{ck} = consumption rate of primary organism c by secondary organism k (g/d), and

0.365 = (kg/g)(d/yr).

Substituting the values of b_{ic} and F'_{ik} from Equations (A-2) and (A-5), respectively, into Equation (A-6) yields

$$(DR)'_k = 2.86 \times 10^7 \sum_{i=1}^{N} B_{ic} \frac{Q_i}{F_R(DF)} e^{-\lambda_i t_p} P'_{ck} \frac{\varepsilon'_{ik} D_{i,man}}{m'_k \varepsilon_{i,man}} \quad \text{(A-7)}$$

where 2.86×10^7 = (0.365)(1120)(70,000).

The effective absorbed energies ε and ε', listed in Table 5.2A.1, are a function of the effective radius of the organism considered. The effective radius as a function of body weight can be determined from Figure 5.2A-1 (Ref. 2). The effective energy absorbed by man, ε_{man}, is assumed to correspond to an effective radius of 30 cm (Ref. 1).

5.2A.1.2 Other Doses to Aquatic and Terrestrial Animals

Primary and secondary organisms are also exposed to radiation from nuclides in water, bottom sediment, and shoreline silt. Although resultant doses are usually relatively insignificant, they are calculated using the same methods used for calculating doses to humans. For shoreline exposure, a correction must be made for the difference in height of exposure between animals and men. For small organisms this correction factor is 2 and has been incorporated in the shore width factor.

Secondary organisms are exposed to radiation from inhaled nuclides, radiation from airborne nuclides or nuclides deposited from air. Air submersion doses are of possible significance and are calculated using the same methods used for doses to humans. Exposure from inhalation and materials deposited by air are usually relatively insignificant.

5.2A.2 References

1. U.S. Atomic Energy Commission, 1973. "Final Environmental Statement Concerning Rule Making Action," Wash 1258 Vol. 2.

2. Environmental Analysts, Inc. "Standard Methodology for Calculating Radiation Doses to Lower Form Biota," AIF/NESP-006, 1975.

TABLE 5.2A.1

EFFECTIVE ABSORBED BETA AND GAMMA ENERGIES (MeV/Dis) IN FINITE VOLUMES OF MUSCLE TISSUE (Ref. 1)

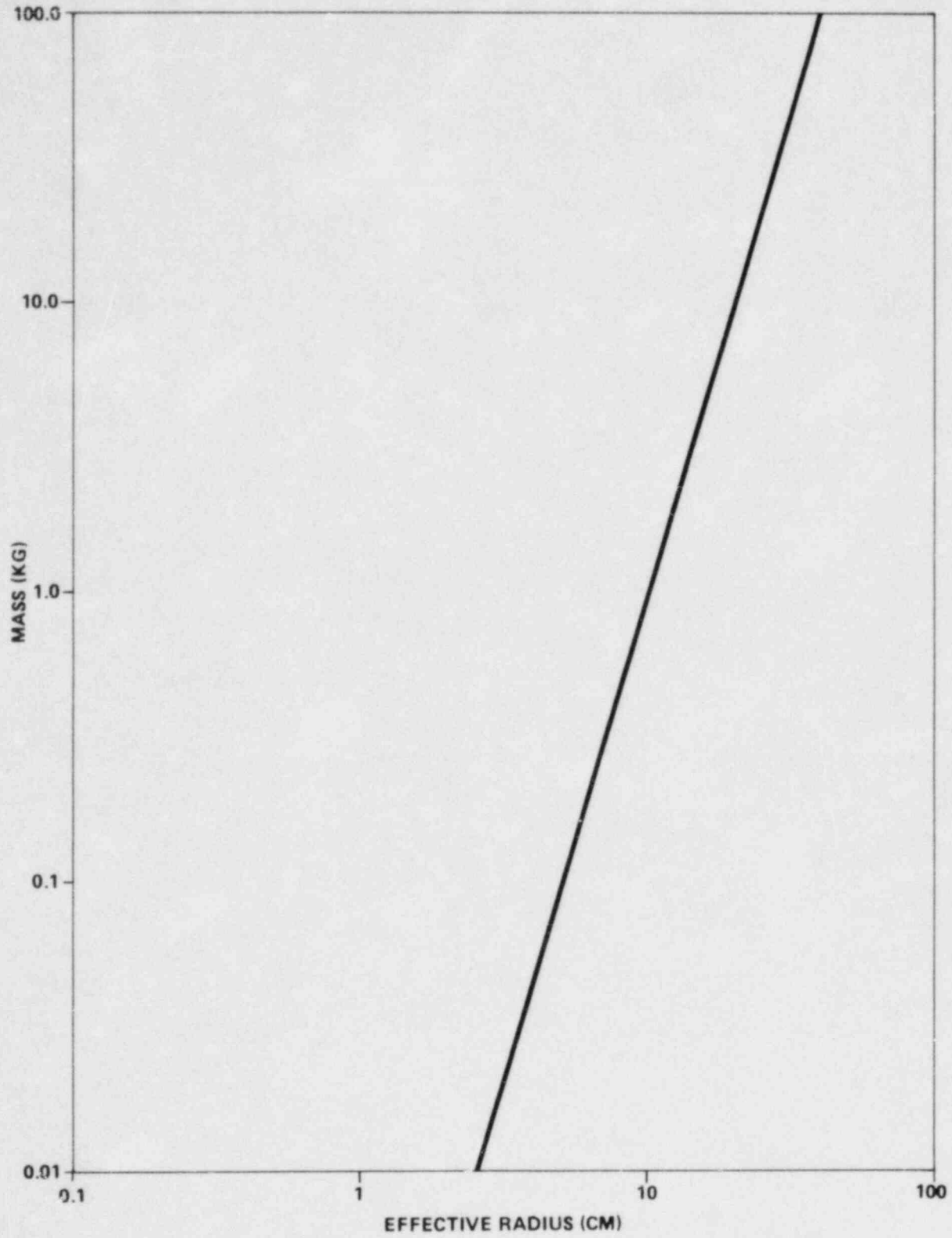
	Effective Radius							
Isotope	1.4 cm	2 cm	3 cm	5 cm	7 cm	10 cm	20 cm	30 cm
H-3	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
C-14	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
N-13	0.538	0.557	0.587	0.646	0.701	0.777	0.983	1.13
F-18	0.285	0.304	0.334	0.391	0.444	0.518	0.717	0.861
Na-22	0.286	0.325	0.387	0.507	0.619	0.775	1.20	1.51
Na-24	0.712	0.771	0.868	1.05	1.23	1.48	2.19	2.74
P-32	0.695	0.695	0.695	0.695	0.695	0.695	0.695	0.695
Ar-39	0.194	0.194	0.194	0.194	0.194	0.194	0.194	0.194
Ar-41	0.519	0.541	0.576	0.642	0.705	0.793	1.04	1.22
Sc-46	0.197	0.232	0.290	0.399	0.501	0.644	1.03	1.32
Cr-51	0.00222	0.00276	0.00363	0.00529	0.00685	0.00901	0.0149	0.0191
Mn-54	0.0364	0.0514	0.0758	0.122	0.166	0.227	0.392	0.512
Mn-56	0.875	0.904	0.951	1.04	1.13	1.24	1.57	1.82
Fe-55	0.00726	0.00726	0.00726	0.00726	0.00726	0.00726	0.00726	0.00726
Fe-59	0.171	0.191	0.224	0.286	0.346	0.428	0.655	0.824
Co-57	0.0390	0.0409	0.0439	0.0496	0.0550	0.0626	0.0840	0.100
Co-58	0.0728	0.0905	0.119	0.174	0.226	0.297	0.492	0.633
Co-60	0.195	0.237	0.306	0.437	0.560	0.732	1.21	1.56
Ni-63	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176	0.0176
Ni-65	0.641	0.651	0.666	0.695	0.723	0.762	0.869	0.949
Cu-64	0.133	0.137	0.143	0.154	0.165	0.180	0.220	0.249
Zn-65	0.0289	0.0386	0.0544	0.0846	0.113	0.153	0.261	0.342
Zn-69m+d	0.0400	0.0477	0.0603	0.0842	0.107	0.138	0.221	0.282
Zn-69	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32
Br-82	0.248	0.294	0.368	0.510	0.643	0.828	1.33	1.70
Br-83+d	0.363	0.363	0.364	0.364	0.364	0.365	0.366	0.367
Br-84	1.31	1.34	1.39	1.47	1.56	1.67	2.00	2.25
Br-85	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
Kr-83m	0.0438	0.0438	0.0438	0.0438	0.0438	0.0438	0.0438	0.0438
Kr-85m	0.245	0.248	0.252	0.260	0.268	0.279	0.309	0.331
Kr-85	0.224	0.224	0.224	0.224	0.224	0.225	0.225	0.225
Kr-87	1.21	1.24	1.27	1.34	1.41	1.50	1.77	1.97
Kr-88	0.449	0.475	0.517	0.599	0.677	0.786	1.09	1.33
Rb-86	0.666	0.668	0.671	0.676	0.680	0.687	0.705	0.719
Rb-88	2.15	2.16	2.18	2.21	2.24	2.28	2.40	2.49
Rb-89	0.694	0.733	0.797	0.919	1.03	1.20	1.64	1.98
Sr-89	0.564	0.564	0.564	0.564	0.564	0.564	0.564	0.564
Sr-90	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14
Sr-90d	0.939	0.939	0.939	0.939	0.939	0.939	0.939	0.939
Sr-91	0.702	0.721	0.752	0.812	0.867	0.944	1.15	1.31
Sr-92	0.249	0.272	0.310	0.381	0.449	0.543	0.805	1.00
Y-90	0.939	0.939	0.939	0.939	0.939	0.939	0.939	0.939
Y-91m	0.0518	0.0615	0.0773	0.107	0.135	0.174	0.280	0.355
Y-91	0.590	0.590	0.591	0.591	0.591	0.591	0.592	0.592
Y-92	1.47	1.47	1.48	1.49	1.51	1.52	1.57	1.61
Y-93	1.18	1.18	1.18	1.19	1.19	1.20	1.22	1.23
Zr-95	0.227	0.254	0.297	0.380	0.458	0.565	0.857	1.07
Zr-95d	0.0767	0.0906	0.113	0.156	0.197	0.253	0.405	0.515
Zr-97	0.763	0.778	0.802	0.848	0.891	0.951	1.11	1.23
Zr-97d	0.500	0.512	0.532	0.570	0.606	0.656	0.790	0.887
Nb-95	0.0767	0.0906	0.113	0.156	0.197	0.253	0.405	0.515
Nb-97	0.500	0.512	0.532	0.570	0.606	0.656	0.790	0.887
Mo-99+d	0.419	0.423	0.430	0.444	0.457	0.475	0.524	0.561
Mo-99d	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084
Tc-99m	0.132	0.134	0.138	0.144	0.150	0.159	0.181	0.199
Tc-99	0.084	0.084	0.084	0.084	0.084	0.084	0.084	0.084
Tc-101	0.485	0.492	0.503	0.524	0.543	0.570	0.643	0.697

TABLE 5.2A.1 (Cont.)

Isotope	Effective Radius 1.4 cm	2 cm	3 cm	5 cm	7 cm	10 cm	20 cm	30 cm
Ru-103+d	0.116	0.125	0.140	0.168	0.194	0.230	0.328	0.399
Ru-105+d	0.496	0.508	0.527	0.563	0.597	0.644	0.772	0.865
Ru-106+d	1.44	1.44	1.45	1.46	1.47	1.49	1.53	1.56
Rh-105	0.158	0.159	0.162	0.167	0.172	0.179	0.198	0.212
Pd-109+d	0.389	0.389	0.389	0.389	0.389	0.390	0.390	0.391
Ag-110m+d	0.188	0.235	0.311	0.456	0.593	0.782	1.30	1.68
Ag-111	0.361	0.362	0.362	0.364	0.365	0.367	0.372	0.376
Sn-125	0.906	0.907	0.910	0.914	0.919	0.925	0.942	0.954
Sb-124	0.459	0.491	0.544	0.644	0.739	0.871	1.24	1.51
Sb-125	0.105	0.113	0.126	0.156	0.173	0.205	0.291	0.353
Sb-127	0.433	0.448	0.472	0.518	0.561	0.620	0.782	0.899
Te-125m	0.111	0.111	0.112	0.112	0.112	0.113	0.113	0.114
Te-127m	0.00197	0.00197	0.00197	0.00198	0.00199	0.00200	0.00203	0.00205
Te-127	0.223	0.223	0.223	0.223	0.223	0.224	0.224	0.224
Te-129m+d	0.599	0.601	0.605	0.612	0.619	0.627	0.651	0.667
Te-129	0.535	0.538	0.541	0.548	0.555	0.563	0.585	0.601
Te-131m	0.269	0.291	0.327	0.396	0.468	0.550	0.796	0.978
Te-131	0.786	0.791	0.800	0.817	0.833	0.855	0.916	0.961
Te-132	0.121	0.125	0.131	0.143	0.154	0.169	0.211	0.242
Te-132d	0.581	0.624	0.693	0.826	0.958	1.12	1.59	1.94
Te-133m+d	0.502	0.542	0.685	0.726	0.848	0.998	1.43	1.74
Te-134	0.114	0.117	0.122	0.130	0.138	0.148	0.175	0.194
I-129	0.0474	0.0475	0.0476	0.0478	0.0479	0.0481	0.0485	0.0487
I-130	0.388	0.427	0.490	0.611	0.724	0.881	1.31	1.61
I-131	0.206	0.213	0.224	0.245	0.266	0.293	0.368	0.422
I-132	0.581	0.624	0.693	0.826	0.950	1.12	1.59	1.94
I-133	0.467	0.478	0.497	0.533	0.566	0.613	0.738	0.829
I-134	0.779	0.838	0.934	1.12	1.29	1.53	2.19	2.67
I-135	0.481	0.514	0.566	0.667	0.761	0.893	1.26	1.53
Xe-131m	0.136	0.136	0.136	0.137	0.137	0.137	0.138	0.139
Xe-133m	0.176	0.177	0.178	0.180	0.182	0.184	0.191	0.196
Xe-133	0.137	0.137	0.138	0.140	0.141	0.143	0.148	0.152
Xe-135m	0.118	0.126	0.139	0.163	0.186	0.217	0.302	0.363
Xe-135	0.330	0.335	0.342	0.355	0.368	0.386	0.434	0.469
Xe-137	1.68	1.68	1.68	1.69	1.70	1.71	1.74	1.76
Xe-138	0.505	0.527	0.562	0.630	0.694	0.784	1.04	1.23
Cs-134m	0.0483	0.0496	0.0517	0.0558	0.0597	0.0652	0.0805	0.0922
Cs-134	0.230	0.259	0.306	0.396	0.480	0.596	0.913	1.14
Cs-135	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
Cs-136	0.233	0.273	0.337	0.458	0.573	0.732	1.17	1.49
Cs-137	0.257	0.267	0.284	0.316	0.346	0.388	0.500	0.582
Cs-138	1.18	1.22	1.27	1.38	1.48	1.62	2.02	2.32
Cs-139	1.61	1.61	1.62	1.64	1.66	1.68	1.75	1.79
Ba-139	0.927	0.927	0.929	0.931	0.933	0.936	0.944	0.950
Ba-140	0.315	0.320	0.328	0.343	0.357	0.376	0.428	0.465
Ba-140d	0.698	0.734	0.793	0.907	1.01	1.16	1.58	1.89
Ba-141	1.10	1.11	1.12	1.16	1.19	1.23	1.36	1.44
Ba-142	0.601	0.622	0.656	0.722	0.783	0.869	1.10	1.28
La-140	0.698	0.734	0.793	0.907	1.01	1.16	1.58	1.89
La-141	0.966	0.967	0.967	0.969	0.970	0.972	0.977	0.981
La-142	0.937	0.973	1.03	1.14	1.25	1.40	1.82	2.14
Ce-141	0.173	0.174	0.175	0.179	0.182	0.187	0.199	0.209
Ce-143	0.420	0.426	0.435	0.453	0.470	0.493	0.555	0.601
Ce-144+d	1.32	1.32	1.32	1.33	1.33	1.33	1.34	1.35
Pr-143	0.314	0.314	0.314	0.314	0.314	0.314	0.314	0.314
Pr-144	1.23	1.23	1.23	1.24	1.24	1.24	1.24	1.25
Nd-147	0.257	0.259	0.264	0.272	0.280	0.291	0.320	0.342
Pm-147	0.0620	0.0620	0.0620	0.0620	0.0620	0.0620	0.0620	0.0620
Pm-148	0.727	0.737	0.755	0.788	0.819	0.862	0.982	1.07
Pm-149	0.366	0.367	0.367	0.367	0.368	0.368	0.370	0.371
Pm-151	0.327	0.332	0.340	0.356	0.370	0.390	0.445	0.484
Sm-153	0.270	0.271	0.272	0.273	0.275	0.277	0.283	0.288
Eu-156	0.471	0.490	0.521	0.588	0.636	0.714	0.930	1.09
W-181	0.00316	0.00316	0.00317	0.00318	0.00320	0.00322	0.00327	0.00331
W-185	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144
W-187	0.331	0.339	0.353	0.379	0.403	0.437	0.529	0.595
U-237	0.146	0.150	0.155	0.162	0.169	0.178	0.204	0.223
Np-238	0.275	0.282	0.294	0.318	0.339	0.369	0.452	0.513
Np-239	0.212	0.213	0.216	0.220	0.225	0.231	0.248	0.260
Pu-238	55.0	55.0	55.0	55.0	55.0	55.0	55.0	55.0
Pu-239	51.5	51.5	51.5	51.5	51.5	51.5	51.5	51.5
Pu-240	51.6	51.6	51.6	51.6	51.6	51.6	51.6	51.6

TABLE 5.2A.1 (Cont.)

	Effective Radius							
Isotope	1.4 cm	2 cm	3 cm	5cm	7 cm	10 cm	20 cm	30 cm
Pu-241+d	0.00636	0.00636	0.00636	0.00636	0.00636	0.00636	0.00636	0.00636
Pu-242	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9
Am-241	54.8	54.8	54.8	54.8	54.8	54.8	54.8	54.8
Am-243+d	52.7	52.7	52.7	52.7	52.7	52.7	52.7	52.7
Cm-242	61.1	61.1	61.1	61.1	61.1	61.1	61.1	61.1
Cm-244	58.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0
Cf-252	165.0	165.0	165.0	165.0	165.0	165.0	165.0	165.0



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	REGRESSION LINE FOR ORGANISM MASS AS A FUNCTION OF EFFECTIVE RADIUS (REF. 2) FIGURE 5.2A-1

5.3 EFFECTS OF CHEMICAL AND BIOCIDE DISCHARGES

5.3.1 General

Grand Gulf Nuclear Station chemical and boicide discharges are described and compared with applicable Federal effluent limitations (40 CFR Part 423) in Section 3.6. Appendix A to this section contains the Grand Gulf Nuclear Station Certification under Section 401 of the Federal Water Pollution Control Act. Water resources and use are discussed in Sections 2.4 and 3.3, respectively. Various liquid waste streams resulting from plant operation are combined at the discharge basin[1] (Figure 3.6-1), and the combined stream is discharged via a 54-inch diameter pipe to the discharge structure in the barge slip. From the barge slip the station effluents flow to the Mississippi River by gravity. The plant discharge system is described in Subsection 5.1.2.1. In the following discussion the word "blow-down" is used interchangeably with the plant discharge (combined liquid wastes from the plant (Figure 3.3-1). 5

5.3.2 Mixing of Chemical Discharges Into the Mississippi River and State Water Quality Criteria Contours

The concentrations of several significant chemical parameters of Mississippi River water are presented in Table 5.3.1, along with State water quality criteria for both Mississippi and Louisiana. Table 3.6.3b compares station discharges with ambient river chemical concentrations.

The dilution of the plant discharge in the Mississippi River was determined for several combinations of factors, including seasonal variation of plant discharge quantity and variations in river flow. Variations in the concentration of constituents in the blowdown were accounted for by considering plant service water and cooling tower operation for two, three, and five cycles of concentration in the winter and summer. Typical cooling tower operation is somewhere between these degrees of concentration. The chemical characteristics of the plant discharge for one- and two-unit operation for 100 percent load factor are summarized in Tables 5.3.1a and 5.3.1b, respectively. To reflect the effect of operation of one unit or both units simultaneously, both conditions are analyzed and are discussed in the following sections. Table 5.3.2 summarizes the river flow conditions considered in performing the analyses for one- and two-unit operation. 5

Note 1. The following station effluents do not go through the discharge basin: sanitary waste system effluent, main cooling tower drains and storm drains. The first two streams discharge into the discharge pipe downstream of the discharge basin, while the third flows into site stream B. 5

Total dissolved solids (TDS), sulfates, chlorides, and dissolved oxygen are the constituents for which State water quality criteria exist, and these constituents are considered in the dispersion analysis. Since the chloride concentrations in the plant discharge shown in Tables 5.3.1a and 5.3.1b are always below the State water quality criteria of 75 mg/l, they were not analyzed for dispersion. Table 5.3.3 summarizes the water quality for sulfates and TDS at the point of discharge for two, three and five cycles of concentration for winter and summer seasons. 5

The three river levels considered in the analysis, as prescribed in NRC Regulatory Guide 4.2, Revision 2, are the mean river water surface elevation at the site of 54 feet msl with a discharge of 560,000 cfs; the 7-day, 10-year low flow of 129,000 cfs at 31 feet msl; and the lowest recorded river discharge of 100,000 cfs at 28 feet msl. The average Mississippi River water quality used is as follows: TDS 230 mg/l, sulfates 50 mg/l, and chlorides 23 mg/l (Table 3.6.3b). For dissolved oxygen, the average Mississippi River concentration as shown in Table 3.6.3b is 8.6 mg/l, but values as low as 5.5 mg/l have been observed in the summer months (Table 2.4.9). 5 5

5.3.2.1 Chemical Dispersion Analysis

The analysis of the mixing of blowdown constituents into the Mississippi River is based on available analytical models for the near field (Refs. 1 and 2) and far field (Ref. 3), as used for the analysis of the thermal plume presented in subsection 5.1.2.

5.3.2.1.1 Assumptions

Several conservative assumptions were made in performing the analyses. The most significant of these assumptions are addressed below:

a. For the mean river level, the 7-day, 10-year low flow and the lowest recorded flow cases, the far field model used considers only a two-dimensional discharge field. Only lateral diffusion is considered in the model, resulting in conservatively large plume surface areas. A plume of constant depth as determined at the point of entry into the river is used in the analyses. 5

b. The lateral diffusion coefficient, D_y, used in all far field cases, is based on local conditions near the shore revetment. The coefficient is determined by the use of the relationship presented by Prych (Ref. 4) and described in subsection 5.1.2.3.1. For the mean and 7-day, 10-year low flow conditions, the 5

calculated value of D_y is 0.8 ft^2/sec. For the lowest recorded river level case, the calculated value of D_y is 0.7 ft^2/sec. 5

c. For the 7-day, 10-year low flow and lowest recorded flow cases, no initial mixing due to the momentum of the blowdown discharge as it enters the river is considered, as the cases were assessed entirely on a far field approach. This assumption results in conservatively larger plume surface areas for the higher concentrations.

d. The local river velocities near the bank are estimated to be 1.2 and 1.0 ft/sec for the mean and 7-day, 10-year low flow cases, respectively. These velocities are based on available velocity profile data and revetment bank geometry. 5

5.3.2.1.2 Near Field Analysis

At the mean river elevation of 54 feet msl, the barge slip contains water at an average depth of 11 feet between the discharge pipe and the outlet into the river. The amount of dilution obtained inside the barge slip and the plume depth are determined by estimating the induced return current of denser receiving water which is mixed with the less dense discharge water according to the method of B. P. Rigter (Ref. 1). The densities used in the analyses are based on the ambient and discharge temperatures and concentrations of total dissolved solids. This method is used since it provides less dilution than using the method of Pritchard, as presented by Benedict et al (Ref. 2). An assessment of this method, made in accordance with NRC Regulatory Guide 4.4, is presented in Appendix A to Section 5.1.

The resulting mixed concentrations and discharges at the outlet of the barge slip are used as input to the far field analyses of the mean water level cases. The jet mixing effect at the barge slip exit is neglected, leading to a conservative estimate of the far field contour surface areas.

5.3.2.1.3 Far Field Analysis

The far field analysis used in the mean river level, the 7-day, 10-year, and the lowest recorded river level cases is based on the method formulated by J. E. Edinger and E. M. Polk (Ref. 3). The model considers the horizontal diffusion of a two-dimensional plume from a shoreline point source in the presence of an ambient current parallel to the shoreline. A critique of this model is presented by Policastro (Ref. 5) indicating that this model is applicable for far field analysis when turbulent diffusion is the dominating factor in mixing. An assessment of this model, in accordance with NRC Regulatory Guide 4.4, appears in Appendix A to Section 5.1. 5 5

The results from the near field analysis, discussed in subsection 5.3.2.1.2, are used as input into the far field analysis for the mean water level cases. The plume depth for the mean river level cases as obtained from the near field analysis and used in the far field analysis, is about 8.5 feet. 5

When the river level corresponds to the 7-day, 10-year low flow condition, the barge slip with a bottom elevation at its outlet of about 39 feet msl is above the river water, and the blowdown discharge runs down the river bank at the end of the slip and into the river. No volumetric losses are assumed to occur between the point of discharge of the blowdown and entrance into the river. Therefore, the blowdown discharge rates and concentrations are used as sources for the far field analyses in all low water cases. Initial dilution of the blowdown water as it enters the river was neglected in this analysis, leading to conservative results for the higher concentrations. The plume depth of 5 feet for the 7-day, 10-year low flow case was obtained by the methods described in Subsection 5.1.2.

For the minimum recorded flow (28 feet msl), the plume thickness of 4 feet was established based on the surface jet penetration near the shoreline which was determined by utilizing the work of Jirka et al (Ref. 6) and the hydrographic conditions of the Mississippi River (Section 2.4). 5

The two-dimensional model of Edinger and Polk was used, since an analysis using the three-dimensional model of Edinger and Polk resulted in less conservative plume areas. The three-dimensional analysis was performed using a vertical diffusion coefficient of .001 ft^2/sec, which corresponds to the lowest (most conservative) limit of the range of values presented in NRC Regulatory Guide 1.113, Rev. 1.

5.3.2.2 Chemical Dispersion Analysis Results

The results of the analyses for all one- and two-unit operation cases are summarized in Tables 5.3.4 through 5.3.6 for TDS and sulfate dispersion. The plume lengths and surface areas corresponding to State water quality criteria contours are reported for all cases considered. These results, as well as the results of the dispersion analysis for dissolved oxygen, are discussed below. 5

5.3.2.3 Discussion of Results

The chemical dispersion analysis was carried out for 18 cases divided into three groups; i.e., the mean river flow, 7-day, 10-year low flow, and the lowest recorded flow. For the case of mean river flow (Table 5.3.4), the chemical plume length for TDS is less than 150 feet, with a surface area of less than 0.02 acre, enclosed by the 400 mg/l contour (State water quality criteria contour) for both the winter and summer cases 5 5

and for one- and two-unit operation. For sulfates, the minimum and maximum plume lengths are 150 and 550 feet, respectively, for the 120 mg/l contour. The sulfate plume areas are less than 0.02 and 0.15 acre for the two cases, respectively. The effective plume width for the worst case at mean river flow is approximately 5 feet for TDS and 10 feet for sulfates for one-unit operation. For two-unit operation, these widths are approximately 10 feet for TDS and 15 feet for sulfates.

The second group of cases involves 7-day, 10-year low flow in the Mississippi River (Table 5.3.5). For TDS, the maximum plume lengths for one- and two-unit operation are 150 feet and 560 feet (in summer at two cycles of concentration), respectively. The corresponding plume areas are 0.02 and 0.15 acre. For sulfates, the maximum plume lengths for one- and two-unit operation are 500 and 1900 feet, respectively. The corresponding plume areas are 0.15 and 1.0 acre. The effective plume widths for the worst case for this river level for one-unit operation are approximately 10 feet for TDS and 20 feet for sulfates. For two-unit operation, the maximum plume widths are approximately 20 feet for TDS and 35 feet for sulfates.

The third group of cases considers chemical dispersion during the lowest flow of record in the Mississippi River (Table 5.3.6). The maximum plume lengths for TDS for one- and two-unit operation are 250 feet and 1000 feet (in summer at two cycles of concentration), respectively. The corresponding plume areas are 0.04 and 0.40 acre. For sulfates, the maximum plume lengths for one- and two-unit operation are 900 feet and 3400 feet, respectively. The corresponding plume areas are 0.30 and 2.10 acres. The effective plume widths for the worst case for one-unit operation are approximately 15 feet for TDS and 20 feet for sulfates. For two-unit operation, the maximum effective plume widths are approximately 25 feet for TDS and 45 feet for sulfates. It should be noted that State water quality criteria are applicable only to river flow rates exceeding 7-day, 10-year levels.

The dispersion analysis for dissolved oxygen was performed considering the lowest concentration of dissolved oxygen in the plant discharge and low concentration of dissolved oxygen in the Mississippi River. These values are 2.4 mg/l (Table 3.6.3b) and 5.5 mg/l (Table 2.4.9), respectively. Analyses were made for the three flows considered above for two-unit operation. The State water quality criteria of 5.0 mg/l was used for all three flows. The case involving the lowest flow of record yielded the largest plume dimensions: a length of 1300 feet, a width of 30 feet, and an area of 0.45 acre. This plume is smaller than the plume required to meet the State water quality criteria for sulfates under the same conditions. As in the case of the other river flows, the plume dimensions for dissolved oxygen are smaller than the sulfate plumes.

5.3.3 Effects of Cooling Tower Drift

The discussion of cooling tower blowdown and other liquid wastes leaving the station through the discharge pipeline into the Mississippi River, contained in Subsections 5.3.1 and 5.3.2 dealt with the major waste stream leaving the station. Cooling tower drift of 46 gallons per minute per tower represents a minor waste stream entering the environment due to station operation. Standby service water system cooling towers add a small amount (about 7.5 gpm maximum per tower) to this normal cooling tower drift when in operation. Cooling tower drift has essentially the same chemical composition as the circulating water blowdown which is given in Table 3.6.3. Details regarding the drift dispersion in the atmosphere and ground deposition of solids in the drift are presented in Subsection 5.1.4. Since the deposition rate was found to be considerably below the State allowed rate, it is concluded that the effect of cooling tower drift on the environment is negligible.

5.3.4 Environmental Effects of Chemical and Biocide Discharges

Through careful planning, the use of chemicals in the station is reduced to optimal levels, and the discharge of these chemicals to the environment is minimized through in-plant chemical and/or physical treatment. At the point of discharge, the four chemical constituents (TDS, sulfates, chlorides and dissolved oxygen) to which State water quality criteria apply are rapidly diluted either within the barge slip itself or within a small plume area in the Mississippi River. At the Grand Gulf Nuclear Station site, the width of the Mississippi River is approximately 3000 feet. The estimated width of the area enclosed by a contour corresponding to the State water quality criteria for the worst case is about 45 feet, which is approximately 1 percent of the receiving water width. 5 5

The habitat most likely to be impacted by this discharge is the river bank area at and downstream of the barge slip. This area has been stabilized with concrete mats from the Corps of Engineers shoreline modification program, thus reducing the potential for, and extent of, any further effects on these biological communities, due to station discharges. 5

During both one- and two-unit operation, with the exception of dissolved oxygen, the highest concentrations of water quality parameters occur during three- and five-cycle operation (Table 3.6.3b), while the plumes covering the greatest surface areas occur with two-cycle operation (sulfate, Tables 5.3.5 and 5.3.6). Sulfate determines the largest chemical plumes since, of the discharge parameters subject to State water quality criteria (Table 5.3.1), sulfate is discharged at the greatest differential from the criteria, requiring a greater amount of dilution. The largest chemical plumes, which occur in the summer case under lowest flow of record river conditions 5

(Table 5.3.6), fall within the confines of the largest thermal plumes generated by one- and two-unit operation under 7-day, 10-year flow flow river conditions (winter extreme case, Tables 5.1.2a and 5.1.2b).

On the basis of the plant discharge data provided in Table 3.6.3b, and the limited areal extent of the chemical plumes, it is reasonable to assume that few significant adverse impacts would accrue to aquatic populations at the site or in the region. Fish are the most probable organisms that could utilize the plume area for extended periods of time. Few benthic organisms would be affected by the chemical plume, given stabilization of the river bank habitat from the barge slip downstream with concrete mats under the Corps of Engineers shoreline modification program. Drifting benthos and planktonic organisms would experience only short-term exposures to the chemical plume while moving past the site with the river current and should, therefore, sustain little impact.

Within the chemical plume, aquatic organisms will be subject to increased water temperatures as well. The most probable source of potential impact is low dissolved oxygen levels within the confines of the chemical plume when the facility is operating in the five-cycle mode (Table 3.6.3b). In this case, the dissolved oxygen concentration of the plant discharge (2.4 mg/l) is below the State water quality criterion of 5.0 mg/l (Table 5.3.1). Under worst-case conditions (lowest flow of record, two-unit operation), dissolved oxygen levels in the chemical plume will increase to the 5.0 mg/l level over a distance of 1300 feet, with a maximum plume width of 30 feet and a surface area of 0.4 acre (Subsection 5.3.2.3). Within this area of elevated temperature and decreased dissolved oxygen, some species and life stages of fish with extended residence times in the plume will probably be impacted, while others will be able to tolerate conditions within the plume. Largemouth bass (Micropterus salmoides) embryos, for example, have shown successful hatching at 77 F with dissolved oxygen levels as low as 2.8 mg/l without significant decreases in larval survival (Ref. 8). Black crappie (Pomoxis nigromaculatus) have spawned successfully in dissolved oxygen levels as low as 2.5 mg/l at 68 F, with no significant effect on embryo survival, hatching, or larval survival through the "swim-up" stage (Ref. 9). Diel fluctuations in dissolved oxygen may affect spawning success, hatching, larval survival, and juvenile growth, and may result in behavioral abberrations such as increased ventilation rates, erratic swimming, and breaking the water surface (Refs. 10, 11, 12). Black crappie, for example, did not spawn at 59 to 68 F, with diel fluctuations in dissolved oxygen levels between 1.8 and 4.1 mg/l, while spawning did occur with diel fluctuations between 2.6 and 5.6 mg/l (Ref. 12). Food conversion efficiency and growth may also be affected within the dissolved oxygen plume. Dissolved oxygen levels below 7 mg/l have been noted to decrease growth

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of channel catfish fry (Ictalurus punctatus) at temperatures of 75 to 86 F (Refs. 13, 14), while dissolved oxygen levels below air saturation decreased the growth rates of juvenile largemouth bass at temperatures ranging from 68 to 84 F (Ref. 15).

In summary, some species and life stages of fish residing in the dissolved oxygen plume resulting from five-cycle operation of the facility will probably exhibit lowered growth rates and perhaps some mortality. Considering diel fluctuations in dissolved oxygen levels, some species may experience lowered spawning success, with decreased larval survival rates. These effects will be experienced within a very limited area of the plume nearer the point of discharge where dissolved oxygen concentrations will be at or near the 2.4 mg/l level of the plant discharge. Other species of fish will be capable of existing within the dissolved oxygen plume, experiencing few adverse effects. With the facility operating at two to three cycles, dissolved oxygen levels in the plant discharge are above the 5.0 mg/l State criteria, thus reducing the potential for adverse impacts to biota residing within the dissolved oxygen plume.

Ammonia-nitrogen levels in the plant discharge may also have some impact on aquatic biota within the chemical plume. The U.S. Environmental Protection Agency (Ref. 16) has suggested a limit of 0.02 mg/l (the un-ionized fraction of ammonia-nitrogen) for the protection of aquatic life. At a water temperature of 86 F and a pH of 7.5 to 8.0, the total ammonia-nitrate levels corresponding to this suggested limit are 0.81 and 0.27 mg/l, respectively (Ref. 16). Under these temperature and pH conditions, the plant discharge would contain 0.03 to 0.10 mg/l of un-ionized ammonia. Since the toxicity of un-ionized ammonia increases with decreased dissolved oxygen and elevated temperature (Ref. 17), some species of fish residing for prolonged periods in the chemical plume, expecially near the plant discharge, may experience some impacts. Juvenile channel catfish, and golden shiners (Notemigonus crysoleucas) have exhibited short-term mortalities at 96-hour LC_{50} levels of 1.6 and 0.99 mg/l, respectively (Ref. 18). The more probable impacts include a decrease in growth rate of some species, and effects on organs and tissues such as gill hyperplasia and necrosis. Carp (Cyprinus carpio) have exhibited necrotic tissue changes and tissue disintegration in various organs with exposure to un-ionized ammonia at concentrations of 0.11 to 0.34 mg/l (Ref. 17). Growth of channel catfish has been reduced at levels of 0.12 mg/l (Ref. 19), while the growth rate of largemouth bass decreased at levels of 0.63 to 0.86 mg/l (Ref. 20). Some species of fish have also exhibited acclimation to the un-ionized ammonia, for example, Tilapia aurea. This species survived 48-hour exposure to levels ranging from 2.35 to 3.40 mg/l after having been exposed to lower levels of 0.43 to 0.53 mg/l for 35 days (Ref. 21).

In summary, while some species may experience mortality from the un-ionized fraction of the ammonia-nitrogen in the plant discharge, more likely impacts will be decreased growth rates and tissue changes. Some species will, in fact, be able to either tolerate or acclimate to the increased ammonia-nitrogen levels in the plume, experiencing few, if any, adverse effects.

Few adverse effects should be associated with the remaining constituents of the plant discharge for which data are listed in Table 3.6.3b. Dissolved solids typically consist of the ionizable carbonate, sulfate, chloride phosphate, and nitrate salts of calcium, sodium, potassium, magnesium and iron (Ref. 17). The dissolved solids concentrations of the plant discharge (752 to 974 mg/l) are below the tolerance range demonstrated for several species of fish (10,000 to 15,000 mg/l), according to the U.S. Environmental Protection Agency (Ref. 16). As noted in Subsection 5.3.2, the chloride level of the plant discharge (38 to 49.2 mg/l) is below the State water quality criterion of 75 mg/l. Nitrate concentrations in the plant discharge range from 7.2 to 9.3 mg/l and are below the levels noted by the U.S. Environmental Protection Agency (Ref. 16) as having adverse effects on fish species such as bluegill (Lepomis macrochirus), largemouth bass, and channel catfish (400 to 2000 mg/l). Dissolved iron in the plant discharge is below the suggested limit for iron of 1.0 mg/l for the protection of aquatic life (Ref. 16), while suspended solids are expected to be below the ambient level in the Mississippi River (150 mg/l). 5

Considering the small size of the chemical plume and the tolerances noted above, significant adverse impacts should not occur to site or regional populations of aquatic biota. Some impacts may be expected on species sensitive to decreased dissolved oxygen and increased ammonia-nitrogen levels, particularly near the point of discharge. Other, more tolerant, species should experience few, if any, effects due to residence within the chemical plume.

Biocide (sodium hypochlorite solution) usage is kept to a minimum through inspection and dosage adjustments and automatic feedback control loops. Biocide use is intermittent and staggered between units to take full advantage of dilution with unchlorinated water from the other unit, thereby placing free available and total residual chlorine discharges well within the Federal (40 CFR 423) limits. The low concentrations of chlorine (less than 0.2 mg/l) are further reduced quickly by the chlorine demands of the Mississippi River water and the makeup well water so that beyond the immediate vicinity of the discharge the effect of the biocide on the environment is very insignificant. A chlorine minimization study will be conducted to further define the residual chlorine levels in the plant discharge. Based upon the results of that study, appropriate action will be instituted at the facility to minimize chlorine use and discharge concentrations. 340.6 5

Free available chlorine in the main circulating water system is allowed to dissipate prior to discharge; similarly, the service water, when chlorinated, is discharged to the main circulating water system to promote dissipation. Low levels of ammonia and organic nitrogen in the Mississippi River water (Table 3.6.3b) as well as effective removal of nitrogen associated with organic suspended solids by the groundwater aquifer (Ref. 7) will tend to minimize formation of combined chlorine. Maximum and average concentrations of total residual chlorine in the discharge are expected to be less than 0.5 and 0.2 mg/l, respectively, and the impact of total residual chlorine on the river should be essentially similar to that for free available chlorine discussed previously in this report section. See Subsection 10.5.3.1 for a discussion of federal limitations regarding discharge of total residual chlorine. | 5 | 340.6

5.3.5 References

1. Rigter, B. P., "Density Induced Return Currents in Outlet Channel," ASCE Journal of the Hydraulics Division, HY2, February 1970.

2. Benedict, B. A., J. L. Anderson, and E. L. Yandell, Jr., "Analytical Modeling of Thermal Discharges, A Review of the State of the Art," ANL Report ANL/ES 18 April 1974.

3. Edinger, J. E., and E. M. Polk, Jr., "Initial Mixing of Thermal Discharges into a Uniform Current," Dept. of Environmental and Water Resources Engineering, Vanderbilt University, Nashville, Tennessee, Report No. 1 (Oct. 1969).

4. Prych, E. A., "Effects of Density Difference on Lateral Mixing in Open Channel Flows," W. M. Keck Laboratory Report No. KH-R-21, California Institute of Technology, Pasadena, Calif., May 1970.

5. Policastro, A. J., "Heated Effluent Dispersion in Large Lakes - State-of-the-Art of Analytical Models," Part I, Argonne National Laboratories, ANL/ES-11, January 1972.

6. Jirka, G. H., G. Abraham, and D. R. F. Harleman, "An Assessment of Techniques for Hydrothermal Impact Prediction," Massachusetts Institute of Technology, Department of Civil Engineering, Report No. 203, 1974. | 5

7. Davis, S. N., and R. J. M. De Wiest, Hydrogeology, John Wiley & Sons, Inc., New York, 1966. | 340.6

8. Dudley, R. G. and A. W. Eipper, "Survival of Largemouth Bass at Low Oxygen Concentrations," Trans. Amer. Fish Soc. 104: 122-128, 1975. | 5

9. Siefert, R. E. and L. J. Herman, "Spawning Success of the Black Crappie, Pomoxis nigromaculatus, at Reduced Dissolved Oxygen Concentrations," Trans. Amer. Fish. Soc. 106: 376-379, 1977.

10. Whitworth, W. R., "Effects of Diurnal Fluctuations of Dissolved Oxygen on Growth of Brook Trout," J. Fish. Res. Board Can. 25: 579-584, 1968.

11. Spoor, W. A., "Oxygen Requirements of Embryos and Larvae of the Largemouth Bass, Micropterus salmoides (Lacepede)," J. Fish. Biol. 11: 77-86, 1977.

12. Carlson, A. R. and L. J. Herman, "Effect of Long-Term Reduction and Diel Fluctuation in Dissolved Oxygen on Spawning of Black Crappie, Pomoxis nigromaculatus," Trans. Amer. Fish. Soc. 107: 742-746, 1978.

13. Andrews, J. W. and Y. Matsuda, "The Influence of Various Culture Conditions on the Oxygen Consumption of Channel Catfish," Trans. Amer. Fish. Soc. 104: 322-327, 1975.

14. Andrews, J. W., T. Murai, and G. Gibbons, "The Influence of Dissolved Oxygen on the Growth of Channel Catfish," Trans. Amer. Fish. Soc. 102: 835-838, 1973.

15. Warren, C. E., P. Doudoroff, and D. L. Shumway, Development of Dissolved Oxygen Criteria for Freshwater Fish, prepared for: U.S. Environmental Protection Agency, Washington, D.C., EPA-R3-73-019, 1973.

16. U.S. Environmental Protection Agency, Quality Criteria for Water, Washington, D.C., EPA-440/9-76-023, 1976.

17. National Academy of Sciences and National Academy of Engineering, Water Quality Criteria 1972, prepared for: U.S. Environmental Protection Agency, Washington, D.C., EPA-R3-73-033, 1973.

18. Spehar, R. L., R. W. Carlson, A. E. Lemke, D. I. Mount, Q. H. Pickering, and V. M. Snarski, "Effects of Pollution on Freshwater Fish," J. Water Poll. Control Fed. 52: 1703-1768, 1980.

19. Robinette, H. R., "Effect of Selected Sublethal Levels of Ammonia on the Growth of Channel Catfish (Ictalurus punctatus)," Prog. Fish. Cult. 38: 26-29, 1976.

20. Woltering, D. M., J. L. Hedtke, and L. J. Weber, "Predator-Prey Interactions of Fishes Under the Influence of Ammonia," Trans. Amer. Fish. Soc. 107: 500-504, 1978.

21. Redner, B. D. and R. P. Stickney, "Acclimation to Ammonia by Tilapia aurea," Trans. Amer. Fish. Soc. 108: 383-388, 1979.

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TABLE 5.3.1

AMBIENT RIVER CHEMICAL CONCENTRATIONS AND STATE WATER QUALITY CRITERIA
(Note 1)

Parameters	Units	Ambient River Concentration (Note 2)	Water Quality Criteria Mississippi (Note 3)	Water Quality Criteria Louisiana (Note 4)
Total dissolved solids	mg/l	230	400	400
Dissolved oxygen	mg/l	8.6	5 (Note 5)	5 (Note 5)
pH	No units	7.5	6-8.5 (Note 6)	6.5-9.0 (Note 6)
Bacteria (fecal coliform)	(log mean count)	Not available	2000/100 ml (Note 7)	1000/100 ml Note 8)
Specific Conductance	micromho/cm	370	1000 (Note 9)	(Note 10)
Phenolic compounds	mg/l	Not available	0.05	(Note 10)
Temperature	degrees (F)	(Note 11)	Max. temp. rise 5 F; Max. temp. 90 F. (Note 11)	Max. temp. rise 5 F Max. temp. 90 F (Note 11)
Sulfates	mg/l	50	120	120
Chlorides	mg/l	23	75	75

Notes:

1. All criteria apply at all stages of streamflow which exceed the 7-day, 10-year minimum flow.
2. Ambient river concentrations are provided in Table 3.6.3.b. Only those parameters for which a specific numerical criteria exists are given in this table.
3. Abstracted from "Mississippi Air and Water Pollution Control Commission Water Quality Criteria for Intrastate, Interstate, and Coastal Waters;" adopted April 24, 1973, amended November 12, 1974.
4. Abstracted from "Louisiana Water Quality Criteria;" adopted August 14, 1973 by Louisiana Stream Control Commission.
5. Dissolved oxygen concentration may range between 4.0 and 5.0 mg/l under extreme conditions.
6. Discharges shall not cause the pH to vary more than 1.0 unit above or below normal pH of the water.
7. Not more than 10 percent of the samples examined shall exceed a log mean fecal coliform count of 4000/100 ml.
8. Not more than 10 percent of the samples examined shall exceed a log mean fecal coliform count of 2000/100 ml.
9. Limit given in applicable to fresh water streams.
10. No numerical standard exists for this parameter.
11. See Sections 3.4 and 5.1 for details regarding thermal discharges.

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TABLE 5.3.1a

PLANT EFFLUENT WATER QUANTITY AND QUALITY (ONE-UNIT OPERATION)

	2-CYCLE				3-CYCLE				5-CYCLE			
MONTH	FLOW	TDS	SULFATE	CHLORIDE	FLOW	TDS	SULFATE	CHLORIDE	FLOW	TDS	SULFATE	CHLORIDE
	gpm	mg/1	mg/1	mg/1	gpm	mg/1	mg/1	mg/1	gpm	mg/1	mg/1	mg/1
JAN	11750	752	446	38	9083	861	492	44	9083	861	479	44
FEB	11900	752	446	38	8933	876	507	44	8933	876	492	44
MAR	12300	752	446	38	8533	917	545	46	8533	917	529	46
APR	12400	752	446	38	8433	929	556	47	8433	929	537	47
MAY	13200	752	446	38	7613	1030	650	52	7613	1030	631	52
JUN	13550	752	446	38	7283	1075	694	54	7283	1075	674	54
JUL	13610	752	446	38	7223	1083	703	55	7223	1083	682	55
AUG	13650	752	446	38	7183	1090	708	55	7183	1090	688	55
SEP	13400	752	446	38	7433	1053	674	53	7433	1053	654	53
OCT	12900	752	446	38	7933	989	611	50	7933	989	593	50
NOV	12250	752	446	38	8583	914	540	46	8583	914	525	46
DEC	11850	752	446	38	8983	872	502	44	8983	872	488	44
AVG	12730	752	446	38	8101	974	599	49	8101	974	581	49

NOTE: Number of cycles refer to the cycles of concentration in the cooling tower loop.

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TABLE 5.3.1b

PLANT EFFLUENT WATER QUANTITY AND QUALITY (TWO-UNIT OPERATION)

	2-CYCLE				3-CYCLE				5-CYCLE			
MONTH	FLOW	TDS	SULFATE	CHLORIDE	FLOW	TDS	SULFATE	CHLORIDE	FLOW	TDS	SULFATE	CHLORIDE
	gpm	mg/l	mg/l	mg/l	gpm	mg/l	mg/l	mg/l	gpm	mg/l	mg/l	mg/l
JAN	23500	752	446	38	18166	861	492	44	18166	861	479	44
FEB	23800	752	446	38	17866	876	507	44	17866	876	492	44
MAR	24600	752	446	38	17066	917	545	46	17066	917	529	46
APR	24800	752	446	38	16866	929	556	47	16866	929	537	47
MAY	26400	752	446	38	15226	1030	650	52	15226	1030	631	52
JUN	27100	752	446	38	14566	1075	694	54	14566	1075	674	54
JUL	27220	752	446	38	14446	1083	703	55	14446	1083	682	55
AUG	27300	752	446	38	14366	1090	708	55	14366	1090	688	55
SEP	26800	752	446	38	14866	1053	674	53	14866	1053	654	53
OCT	25800	752	446	38	15866	989	611	50	15866	989	593	50
NOV	24500	752	446	38	17166	914	540	46	17166	914	525	46
DEC	23700	752	446	38	17966	872	502	44	17966	872	488	44
AVG	25460	752	446	38	16202	974	599	49	16202	974	581	49

NOTE: Number of cycles refer to the cycles of concentration in the cooling tower loop.

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TABLE 5.3.2

SUMMARY OF CASES CONSIDERED FOR CHEMICAL DISPERSION ANALYSIS

River Condition	River Level (ft msl)	River Discharge (cfs)	Season	Cycles of Concentration	Plant Discharge (gpm)	
					1 Unit	2 Unit
Mean flow	54	560,000	Winter	2	11,750	23,500
Mean flow	54	560,000	Summer	2	13,610	27,220
Mean flow	54	560,000	Winter	3	9,083	18,166
Mean flow	54	560,000	Summer	3	7,223	14,446
Mean flow	54	560,000	Winter	5	9,083	18,166
Mean flow	54	560,000	Summer	5	7,223	14,446
7-day 10-yr low flow	31	129,000	Winter	2	11,750	23,500
7-day 10-yr low flow	31	129,000	Summer	2	13,610	27,220
7-day 10-yr low flow	31	129,000	Winter	3	9,083	18,166
7-day 10-yr low flow	31	129,000	Summer	3	7,223	14,446
7-day 10-yr low flow	31	129,000	Winter	5	9,083	18,166
7-day 10-yr low flow	31	129,000	Summer	5	7,223	14,446
Low flow of record	28	100,000	Winter	2	11,750	23,500
Low flow of record	28	100,000	Summer	2	13,610	27,220
Low flow of record	28	100,000	Winter	3	9,083	18,166
Low flow of record	28	100,000	Summer	3	7,223	14,446
Low flow of record	28	100,000	Winter	5	9,083	18,166
Low flow of record	28	100,000	Summer	5	7,223	14,446

NOTES: 1. Data from Table 5.3.1a and 5.3.1b have been used to estimate the discharge rates.

2. For conservative estimates, winter and summer parameters used are those for the months of January and July, respectively.

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TABLE 5.3.3

PLANT DISCHARGE QUALITY FOR
CHEMICAL PLUME ANALYSIS

CONCENTRATION, mg/l

	2 CYCLES*		3 CYCLES*		5 CYCLES*	
CONSTITUENTS	WINTER+	SUMMER++	WINTER	SUMMER	WINTER	SUMMER
SULFATES	446	446	492	703	479	682
TDS	752	752	861	1083	861	1083

NOTE: For all cases the chlorides are below the State Water Quality Criteria of 75 mg/l.

+ Month of January

++ Month of July

* Number of cycles refer to the cycle of concentrations in the cooling tower loop.

TABLE 5.3.4

CONCENTRATION DISTRIBUTIONS OF CHEMICALS DISCHARGED IN PLANT DISCHARGE - MEAN RIVER FLOW CASES

(Plume Area Enclosed by State Water Quality Criteria Contours)

Season	Cycle of Concentration	TDS					SULFATE				
		Contour Concentration	1-Unit		2-Unit		Contour Concentration	1-Unit		2-Unit	
			Plume Length	Plume Area	Plume Length	Plume Area		Plume Length	Plume Area	Plume Length	Plume Area
		mg/l	(ft)	(acres)	(ft)	(acres)	mg/l	(ft)	(acres)	(ft)	(acres)
Winter	2	400	<50	<0.01	<150	<0.02	120	<150	<0.02	400	0.10
Winter	3	400	<50	<0.01	<150	<0.02	120	<150	<0.02	<400	<0.10
Winter	5	400	<50	<0.01	<150	<0.02	120	<150	<0.02	<400	<0.10
Summer	2	400	<50	<0.01	<150	<0.02	120	<150	<0.02	550	0.15
Summer	3	400	<50	<0.01	<150	<0.02	120	<150	<0.02	<550	<0.15
Summer	5	400	<50	<0.01	<150	<0.02	120	<150	<0.02	<550	<0.15

NOTE: For all cases, the chloride concentrations of plant discharge are below the State Water Quality Criteria of 75 mg/l

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TABLE 5.3.5

CONCENTRATION DISTRIBUTIONS OF CHEMICALS DISCHARGED IN PLANT DISCHARGE - 7-DAY 10-YR LOW FLOW CASES

(Plume Area Enclosed by State Water Quality Criteria Contours)

Season	Cycle of Concentration	TDS					SULFATE				
		Contour Concentration	1-Unit		2-Unit		Contour Concentration	1-Unit		2-Unit	
			Plume Length	Plume Area	Plume Length	Plume Area		Plume Length	Plume Area	Plume Length	Plume Area
		mg/l	(ft)	(acres)	(ft)	(acres)	mg/l	(ft)	(acres)	(ft)	(acres)
Winter	2	400	<110	<0.01	420	0.10	120	350	0.08	1400	0.60
Winter	3	400	<110	<0.01	<420	<0.10	120	260	0.04	1100	0.40
Winter	5	400	<110	<0.01	<420	<0.10	120	250	0.04	1000	0.30
Summer	2	400	150	0.02	560	0.15	120	500	0.15	1900	1.0
Summer	3	400	<150	<0.02	420	0.10	120	400	0.10	1450	0.50
Summer	5	400	<150	<0.02	420	0.10	120	400	0.10	<1450	<0.50

NOTE: For all cases, the chloride concentrations of plant discharge are below the State Water Quality Criteria of 75 mg/l

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TABLE 5.3.6

CONCENTRATION DISTRIBUTIONS OF CHEMICALS DISCHARGED IN PLANT DISCHARGE - LOW FLOW OF RECORD CASES

(Plume Area Enclosed by State Water Quality Criteria Contours)

Season	Cycle of Concentration	TDS					SULFATE				
		Contour Concentration	1-Unit		2-Unit		Contour Concentration	1-Unit		2-Unit	
			Plume Length	Plume Area	Plume Length	Plume Area		Plume Length	Plume Area	Plume Length	Plume Area
		mg/l	(ft)	(acres)	(ft)	(acres)	mg/l	(ft)	(acres)	(ft)	(acres)
Winter	2	400	200	0.03	750	0.20	120	650	0.20	2500	1.40
Winter	3	400	<200	<0.03	<750	<0.20	120	500	0.10	1900	0.80
Winter	5	400	<200	<0.03	<750	<0.20	120	<500	<0.10	1800	0.70
Summer	2	400	250	0.04	1000	0.40	120	900	0.30	3400	2.10
Summer	3	400	<250	<0.04	750	0.25	120	700	0.15	2600	1.10
Summer	5	400	<250	<0.04	750	0.25	120	<700	<0.15	<2600	<1.10

NOTE: For all cases, the chloride concentrations of plant discharge are below the State Water Quality Criteria of 75 mg/l

APPENDIX A

FWPCA SECTION 401 CERTIFICATION

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Air & Water Pollution Control Commission

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Geological Survey
W. H. Moore

February 5, 1974

Mr. Donald C. Lutken, President
Mississippi Power and Light Company
P. O. Box 1640
Jackson, Mississippi 39205

Dear Mr. Lutken:

This certification is issued to the Mississippi Power and Light Company, Jackson, in conformity with the requirements of Section 401 of the Federal Water Pollution Control Act as amended (33 USC 1341) with respect to the discharge of treated wastewater resulting from the operation of the company's proposed Grand Gulf Nuclear Station near Port Gibson, Mississippi.

After publication of notice of the requested certification in The Clarion Ledger, Jackson, on December 6, 1973, and The Reveille, Port Gibson, on December 6, 1973, the Mississippi Air and Water Pollution Control Commission hereby certifies, after examination of pertinent materials supplied by the company, that no limitations or standards have been established pursuant to Sections 301, 302, 306, or 307 and further that there is reasonable assurance that the proposed activity of the company will be conducted in a manner which will not violate applicable water quality standards.

Very truly yours,

Glen Wood, Jr.
Executive Director

GWjr:kh

5.4 EFFECTS OF SANITARY WASTE DISCHARGES

All sanitary wastes generated at the Grand Gulf Nuclear Station are treated onsite as described in Section 3.7. The treated effluent water is discharged to the Mississippi River. This section discusses the environmental effects of the sanitary effluent on the river.

5.4.1 Sanitary Waste Discharge and Standards

For sanitary waste effluent, EPA[1] prescribes average discharge concentrations of suspended solids and BOD to be less than 30 mg/l each. The treated sanitary waste effluent from Grand Gulf Nuclear Station contains less than 20 mg/l of suspended solids and BOD. This represents 90 percent removal, whereas EPA requires 85 percent removal. The EPA limitations for sanitary waste and the station discharge are compared in Table 5.4.1. The residual chlorine concentration of the sanitary effluent is between 0.1 mg/l and 0.5 mg/l.

5.4.2 Environmental Effect of Sanitary Effluent

The sanitary effluent is greatly diluted before it reaches the Mississippi River. It is combined with the cooling tower blowdown which has a flow rate greater than 20,000 gpm, whereas the treated sanitary effluent flow rate is less than 10 gpm. The dilution ratio exceeds 2000:1, so the pollutant concentrations are greatly reduced. Both the suspended solids and BOD levels attributable to the sanitary effluent are less than 0.01 mg/l when they reach the river. The localized effect of these pollutants on the environment is negligible.

1 EPA regulations (40 CFR 133) provide information on the level of effluent quality attainable through the application of secondary treatment. There are no specific Federal limitations for sanitary effluents from power plants.

TABLE 5.4.1

WASTEWATER EFFLUENT REGULATIONS VS. GRAND GULF SANITARY WASTE DISCHARGE

	EPA Regulations (40CFR133)	Station Effluent
Biochemical oxygen demand	a. Effluent concentration shall not exceed 30 mg/l for any 30-day period.	20 mg/l
	b. Effluent concentration shall not exceed 45 mg/l for any 7-day period.	20 mg/l
	c. Effluent concentration shall not exceed 15% of influent concentration i.e., 85% removal	10% in effluent or 90% removal
Suspended solids	a. Effluent concentration shall not exceed 30 mg/l for any 30-day period.	20 mg/l
	b. Effluent concentration shall not exceed 45 mg/l for any 7-day period.	20 mg/l
	c. Effluent concentration shall not exceed 15% of influent concentration i.e. 85% removal	10% in effluent or 90% removal
pH	Should be in the range 6.0 to 9.0	6.0 to 9.0

NOTE: There are no Mississippi State effluent standards. However, Mississippi has water quality criteria, which the Grand Gulf combined station effluent (sewage plant effluent, cooling tower blowdown, etc.) must comply with. Because of the high efficiency of removal of BOD, suspended solids, coliform bacteria, and the 2000:1 dilution provided by the cooling tower blowdown, no difficulty is foreseen in complying with the State water quality criteria applicable to sanitary effluent.

5.5 EFFECTS OF OPERATION AND MAINTENANCE OF THE TRANSMISSION SYSTEMS

The presence of the transmission lines has minimal effect upon the appearance or land use of the areas they traverse. The irregular topography minimizes the appearance of long stretches of towers and lines, and the blue-gray insulators tend to blend with the sky. The use of long spans and nonguyed towers (each occupying less than 300 square feet of ground) avoids interference with normal farming activities. Probably the most visible effect of transmission line presence is due to the cleared rights-of-way through forested areas; however, through the multiple-use approach described in Section 3.9, the environmental effects, other than aesthetic, can be significantly reduced. Some species of small game may actually prefer the cleared areas.

Routine maintenance of the lines and rights-of-way will not be disruptive to the environment. MP&L's experience has been that herbicides or defoliants have not been necessary for this purpose. Should the use of herbicides become necessary, they will be of a type approved by the Environmental Protection Agency and will be applied by a registered applicator. The rights-of-way will be inspected at least semiannually. Inspection and maintenance activities will have virtually no environmental impact. Air patrols may be conducted on a scheduled basis and after major storms.

Major maintenance and repair activities will have only temporary environmental effects. The transmission lines cross State and county roads which provide direct access to the rights-of-way at a number of points. In addition, land subdivision lines and section lines are often characterized by roads or farm lanes which may be used by line repair vehicles.

MP&L has experienced no significant environmental problems associated with the electrical effects of modern EHV transmission systems. The audible and visible effects of corona discharge are intermittent, depending largely upon atmospheric conditions, and they are for the most part eliminated by present-day high voltage equipment. In addition, these effects, when they are detectable, are usually of low intensity and most likely escape notice by the casual observer. The same can be said of the audible humming noise known to be associated with high voltage lines. MP&L has also experienced no significant problems with electromagnetic noise or radio interference. Should this kind of problem arise in operation of the lines, MP&L may transpose conductors, a frequently effective solution.

So far, neither EPRI-sponsored research nor research from other sources has demonstrated that electric fields possibly encountered by humans can have a biological effect on them (Ref. 1).

The station switchyard probably will be the source of the most frequently observed electrical effects of operation, because of

the concentration and variety of high voltage equipment. The normal hum and other occasional noises of normal operation will present no difficulty. On some occasions, high voltage circuit breakers may activate with a very loud report; however, these components can be muffled if necessary, and, in any case, such reports probably will go unnoticed by people not at the station, because of the distance involved.

While ozone undoubtedly will be a by-product of transmission operations, very little is known about the quantities and concentrations which will be produced. Along the transmission lines, ozone production will be so distributed that it probably will have no discernible environmental effect. Ozone concentrations might be greater in the switchyard and substations; however, MP&L is not aware of any adverse environmental effect which could be attributed to production of ozone by their existing facilities.

Actual operation and maintenance of the 115 kV transmission line presents minimal environmental effects. No complaints of an environmental nature have been received from this type of line due to its operation or maintenance.

5.5.1 Effects of Transmission Lines

Various factors related to transmission-line wire strikes by birds have been summarized by Thompson (Ref. 2). Species, condition, weather and visibility, habitat adjacent to rights-of-way, and type and arrangement of wires are all cited as related to wire strikes. Various species seem to be differentially susceptible to wire strikes. Large migratory birds are apparently more likely to strike wires than are smaller birds. Birds which are members of the Orders Podicipediformes, Pelecaniformes, Ciconiiformes, Anseriformes, Gruiformes, and Charadriiformes are often victims. Within these groups, species that flock, fly at high speed and low altitudes, are less maneuverable, and migrate at night are most vulnerable. It has been noted that raptors, because of their visual acuity, rarely strike wires.

The condition of birds may also be related to wire strikes. In general, young, inexperienced birds and migrants unfamiliar with the terrain are most likely to strike wires. Additionally, birds which are alarmed, pursued, hunted, searching for food, engaged in courtship, following cones of light at night, taking off, or landing have an increased susceptibility to wire strikes.

Weather and visibility-related variables which may increase wire strikes include darkness, heavy fog, low ceilings, snowstorms, and windstorms. These factors not only reduce visibility, but also cause birds to fly closer to the ground and hence within the space within which wires are placed.

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The relationship of a transmission line to the habitat through which it passes will affect the probability of wire strikes. Waterfowl are more likely to strike wires where the transmission line passes between feeding and roosting areas and/or through wetlands or grainfields. Thompson (Ref. 2) noted that water bird collisions have rarely been reported other than in these situations; however, passerines have been found under lines in upland areas.

The type and configuration of wires may also affect the rate at which bird strikes occur. Small diameter, low (less than 20 feet) high-density lines (e.g., telephone lines with 20 or more wires and low-voltage transmission and distribution lines) are considered to be a greater cause of mortality than high-voltage transmission lines, especially when strung in bundles, because of their greater diameter (and hence visibility), and possibly their corona discharge and associated noise or electromagnetic field. When deaths occur as a result of high-voltage lines, it is often due to the static wire, which is relatively less visible than are the conducting wires. The relatively less visible guy wires of some television towers may be responsible for large numbers of deaths (Refs. 3 and 4). The importance of guy wires in causing mortality has been demonstrated at the Davis-Besse nuclear station where a meteorological tower, without guy wires, has not caused any bird mortalities (Ref. 5, Article 838).

Stout and Cornwell (Ref. 6) studied nonhunting mortality of waterfowl. Among the reported causes of nonhunting deaths were various types of collisions. It was noted that impacts with telephone and power lines were the most important type of collision; however, the 1487 deaths within this category accounted for only 0.07 percent of the total sample, so the overall impact on waterfowl populations would be minimal. It should be further noted that collisions were not subdivided into those involving telephone and transmission lines. The potential effect of each is quite different, as noted above. Thompson (Ref. 2) has summarized the works of Anderson (The Wilson Bulletin, in press) in Illinois and Lee (M.S. thesis being prepared for The Wilson Bulletin), in which these authors reported that of the waterfowl flights in the vicinity of transmission lines, 0.01 and 0.03 to 0.05 percent resulted in fatal collisions, respectively.

The routes of the four transmission lines associated with the Grand Gulf Nuclear Station are reported in section 3.9. While several river systems are crossed, the lines primarily pass over upland forests and fields. The northern section of the Baxter Wilson route passes through about 10 miles of farmland located on the Mississippi River floodplain.

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As noted above, passerines have been found under lines; however, the type of line and number of birds involved were not specified (Ref. 2). In light of the fact that the larger migrating birds are more likely to strike wires than smaller birds and that small-diameter high-density telephone wires are more of a problem than transmission lines, it is unlikely that significant losses would occur.

There are no extensive wetland areas crossed by any of the transmission line routes. They do cross several river systems where possible conflict with water birds could occur. Since these crossings pass primarily through forested tracts, collisions are not expected to be significant. The Baxter Wilson route passes through 10 miles of farmland on the Mississippi River floodplain. The degree of use of these fields, if any, as feeding areas by waterfowl is not known.

301.10

5.5.2 References

1. "Effects of Electric Fields on Large Animals," EPRI E.A.-331, Project 799-1, Interim Report, December 1976.

2. Thompson, L. S., "Transmission Line Wire Studies: Mitigation Through Engineering Design and Habitat Modification (Draft)," Presented at the Workshop on Impact of Transmission Lines on Migratory Birds, Oak Ridge, Tennessee, January 31 to February 2, 1978.

3. Brewer, R., and J. A. Ellis, "An Analysis of Migrating Birds Killed at a Television Tower in East-Central Illinois," September 1955 to May 1957, Auk, 75: 400-414, 1958.

4. Taylor, W. K., and B. H. Anderson, "Nocturnal Migrants Killed at a Central Florida TV Tower, Autumns 1969-1971," The Wilson Bull., 85(1): 42-51, 1973.

5. Avery, M. L., P. F. Springer, and N. S. Dailey, "Avian Mortality at Man-Made Structures: An Annotated Bibliography," U.S. Department of the Interior, Fish and Wildlife Service, FWS/OBS-78/58, 108 pp., 1978.

6. Stout, J. and G. W. Cornwell, "Nonhunting Mortality of Fledged North American Waterfowl," Jour. Wildl. Mgmt., 40(4): 681-693, 1976.

301.10

5.6 OTHER EFFECTS

5.6.1 Noise Effects

The two most audible noise sources associated with normal station operation are the switchyard and the waterfall within the natural draft cooling towers.

On the basis of the literature and operating experience from other nuclear sites, the following sound levels can be expected:

Natural draft cooling tower operation (Ref. 1-3)	45 to 55 dBA @ 1000 ft
Switchyard operation (Ref. 4) (transformer noise)	90 to 92 dBA @ 6 ft

To project the above sound levels to the nearest site boundary, which is approximately 1/2 mile from the center of the Unit 1 reactor (point 5 of Figure 2.7-1), the following equation was used, which is valid for free field hemispherical divergence of the noise source:

$$SPL_2 = SPL_1 - 20 \log_{10} \left(\frac{r_2}{r_1} \right) - A_e \qquad \text{(Ref. 5)}$$

where:

SPL_2 = Sound pressure level at distance r_2 from the source

SPL_1 = Sound pressure level at distance r_1 from the source

A_e = excess attenuation

The excess attenuation factor was not considered to be applicable.

On the basis of the above equation, the expected noise levels at point 5 would be:

From cooling tower operation	37 to 47 dBA
From switchyard operation	48 to 50 dBA

Since the background noise level at point 5 was measured to be between 45 and 59 dBA, the resulting noise level there would be 52 to 60 dBA. Point 8 is representative of nearby sensitive land use and is farther from the plant than point 5; therefore, it is unlikely that any of the noise generated by the station will annoy or even be audible to the nearby populace.

340.7

5.6.2 Land Use and Water Use

Station operation has little effect on land or water use beyond the site boundary. Probably the most noticeable effect is traffic, generated by station employees. There are, of necessity, some modifications of land and water use within the site boundary. Although MP&L continues to allow fishing in the two oxbow lakes within the boundary, no firearms hunting is permitted.

MP&L plans to preserve the undisturbed portion of the site (approximately 1705 acres) as a natural wildlife area. Several wildlife management practices suggested by the Mississippi Game and Fish Commission and the Mississippi Wildlife Federation are under consideration. Other potential educational and recreational uses of the site are also being evaluated.

5.6.3 Aesthetic Effects

The basic structures of the station are designed to present a low profile and to blend with their surroundings (see Section 3.1). The surrounding terrain is irregular and predominantly wooded, thus it obscures the plant buildings from view in almost every direction. From the river, almost a mile and a half distant, the buildings appear unobtrusive. The two natural draft cooling towers dominate the visual impact of the station. Though their size prohibits shielding or disguise, they are well proportioned, graceful in appearance, and they provide landmarks for river navigators.

5.6.4 Interaction with Other Plants

The closest industrial activity is in Port Gibson, some 5 miles southeast of the site. The nearest power generating facility is MP&L's Baxter Wilson Steam Electric Station, about 20 miles north (30 river miles) on the southern edge of Vicksburg. The closest nuclear power plant will be (when completed) Gulf States Utilities System's River Bend Station near Saint Francisville, Louisiana, well over 50 miles from Grand Gulf Nuclear Station.

No environmental interaction with these installations is expected.

5.6.5 Fossil-Fueled Facilities on the Site

Section 3.7 describes the fossil-fueled components of the station and their emissions.

5.6.6 Spills

The potential for spills of oil or other nonradioactive substances is extremely low. The diesel generator fuel oil storage, part of

a safety-related system, is underground and seismic Category I. The relatively small quantities of oil and other potentially hazardous materials maintained on the site are stored in appropriate containers. Storage and handling facilities comply with the applicable requirements of the Occupational Safety and Health Act (OSHA). Delivery of these materials to the site is by land routes, simplifying transfer problems and eliminating the possibility of spills contaminating the aquatic environment. Soil and ground water conditions at the site prevent contamination of wells.

5.6.7 Effects of Storm Drainage System Discharge on Lakes and Streams

Discharge from the storm drainage system will contain oil and petroleum products on an intermittent basis when routine washdowns are performed in areas such as the diesel generator, water treatment buildings, the fire water pumphouse, and administration building, and during rainstorms. The effluent will be carried to the Mississippi River via the site streams and Hamilton Lake. As a consequence, stream and lake biota will be subject only to intermittent exposures to petroleum products as opposed to a continuous exposure. The site streams are intermittent in nature, with the low-density fish population congregating in pools during the dry season. The effluent releases from the plant, particularly during a rainstorm when the highest plant discharges would be experienced, would be subject to dilution from increased stream flow, with further dilution occurring in Hamilton Lake. Effluent standards require that petroleum product discharges be held to a 20 ppm maximum concentration and no greater than 15 ppm on the average. Concentration of this order, particularly with dilution in the stream and the lake, should have little significant impact on resident biota. Impacts would be further lessened during those periods when the Mississippi River is at flood stage, inundating the two site lakes.

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5.6.8 References

1. Rittenhouse, R. C., "Noise Control in Power Plants," Power Engineering, July 1976.

2. Capano, G. A., and W. E. Beadley, "Radiation of Noise from Large Natural Draft and Mechanical Cooling Towers," ASME Publication 74-WA/HT-35.

3. Teplitzky, A. M., Estimating Cooling Tower Emission Levels, Power Engineering, September 1977.

4. "Transformers, Regulators and Reactors," NEMA Standard No. TR-1-1974.

5. Beranek, L., Noise Reduction, McGraw-Hill, 1960.

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5.7 RESOURCES COMMITTED

No significant irreversible or irretrievable commitments of resources result from station operation. Some resources, such as uranium, land, and water, are consumed or permanently committed, but the quantities are very small compared to supplies.

Resources committed during plant construction are described in Section 4.3.

5.7.1 Uranium Resources

The reactors are fueled with uranium dioxide pellets with an average enrichment of 1.697 percent of the fissionable U-235 isotope. Each core consists of 800 fuel bundles, approximately one-fourth of which are replaced annually. Fuel requirements for operation of Grand Gulf Nuclear Station Units 1 and 2 depend on fuel management practices. Assuming 80 percent capacity, the plant will fission about 57 metric tons of U-235 over its 40-year life. This represents a commitment of about 22,332 metric tons of natural U_3O_8, assuming no reprocessing of spent fuel.

5.7.2 Land Resources

Approximately 124 acres (6 percent) of the 2170-acre site are removed from biological productivity by station buildings, roads, and other facilities. Approximately 1705 acres (78 percent) of the site has not been affected by site construction activities and remains in its natural state. Of the area originally affected by construction, 341 acres will be, and in many cases have already been, fertilized and reseeded.

The degree of permanent commitment of land resources will depend on the decommissioning plan adopted (See Section 5.8).

5.7.3 Water Resources

Makeup water is supplied by a series of radial wells at an average rate of 43,000 gpm. This represents less than 0.1 percent of the lowest recorded flow in the Mississippi River. An average of 20,592 gpm of water is lost through evaporation and drift from the natural draft cooling towers. Although most of this water is eventually returned to the earth as precipitation, it is an immediate loss to the local area. An average blowdown of 22,400 gpm is eventually returned to the Mississippi River.

5.7.4 Environmental Resources

There are no expected significant environmental losses due to plant operation.

5.8 DECOMMISSIONING AND DISMANTLING

5.8.1 Long Term Land Use

The Grand Gulf site has two general edaphic types - loessial bluffs and alluvial river bottomlands. The forest communities are the largest habitat. Prior to construction, the forest communities covered approximately 80 percent of the 2330-acre site. Of this, approximately 775 acres was loessial bluff forest and about 1010 acres was bottomland forest. Later, in 1974, 164 acres of bottomland were donated to the Grand Gulf Military Park.

The land area within 5 miles of the site is almost entirely commercial forest. Commercial forest occupies approximately 71 percent of the land area in Claiborne County (Ref. 1).

5.8.2 Irretrievable Commitment of Land

An irretrievable commitment is one which either consumes a resource or excludes certain uses of that resource. Generally, the land commitment is not irretrievable except for the portion of the site devoted to building foundations. The amount and type of land committed will depend on the decommissioning plan adopted. The degree of commitment will be a function of the level of decommissioning and dismantling. Of the land used for various facilities, only a small portion may be irretrievable due to the cost of dismantling and removing massive concrete structures and foundations and the limited benefit which would be obtained.

5.8.3 Decommissioning Plans

Detailed decommissioning plans have not been developed at this time. In view of unforeseeable changes in rules and regulations concerning decommissioning, flexibility in these plans must be maintained. MP&L will evaluate pertinent NRC regulations in force at the time of decommissioning and provide detailed decommissioning plans at that time.

Based on the information currently available on plant decommissioning, the initial phase will probably include the following activities:

a. Reactor deactivation including fuel removal

b. Draining and flushing of process systems and cleanup of plant areas

c. Disposal of radioactive wastes in accordance with the existing procedures and requirements

d. Sealing of contaminated building areas after removal of salvageable components

e. Modification of security system to the required extent

It is expected that after a number of years in this decommissioned state, most areas of the plant could easily be entered and those systems still contaminated by residual radioactivity could be removed. The buildings could also be dismantled if necessary so that other uses of the location could be made. However, it is anticipated that this site may be used for future power generation facilities after retirement of these particular units and that complete dismantling may not be economically justified or desirable.

If there is an urgent need to use the land on which the plant buildings are located or some requirement for immediate removal of all radioactivity from the site after cessation of operations, prompt removal is feasible and has been demonstrated.

5.8.4 Environmental Impact

No significant environmental effects are expected from decommissioning the plant. The degree of dismantlement, as with most decommissioned industrial plants, will take into account the intended new use of the site and a balance among health, safety, salvage, and environmental impact.

5.8.5 Decommissioning Costs

A recent study of decommissioning alternatives (Ref. 2), provides cost estimates in 1975 dollars for decommissioning a typical nuclear power plant rated at about 3600 MWt. Using either the prompt removal and dismantling alternative or a delayed removal and dismantling alternative, the estimated cost is less than 32 million dollars.

REFERENCES

1. United States Department of Agriculture, 1969. "Forest Resources of Mississippi." Forest Service Resource Bulletin.

2. "An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternatives" AIF/NESP - 009, Atomic Industrial Forum, Inc., National Environmental Studies Project, November 1976.

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CHAPTER 6

EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

TABLE OF CONTENTS

		Page
6.1	PREOPERATIONAL ENVIRONMENTAL PROGRAMS	6.1-1
	6.1.1 Surface Waters	6.1-4
	6.1.1.1 Physical and Chemical Parameters of Mississippi and Big Black Rivers	6.1-4
	6.1.1.1.1 Stage	6.1-4
	6.1.1.1.2 Current Velocity Measurements	6.1-5
	6.1.1.1.3 River Bathymetry	6.1-5
	6.1.1.1.4 Temperature	6.1-5
	6.1.1.2 Physical and Chemical Parameters of Hamilton and Gin Lakes	6.1-5
	6.1.1.2.1 Stage	6.1-5
	6.1.1.2.2 Lake Bathymetry	6.1-6
	6.1.1.2.3 Temperature	6.1-6
	6.1.1.2.4 Volume	6.1-6
	6.1.1.3 Water Chemistry	6.1-6
	6.1.1.4 Plant Site Drainage Basin Streams	6.1-7
	6.1.1.4.1 Stage	6.1-7
	6.1.1.4.2 Velocity Measurements	6.1-7
	6.1.1.5 Ecological Parameters - Aquatic Ecology	6.1-7
	6.1.1.5.1 Fishes	6.1-8
	6.1.1.5.2 Benthic Macroinvertebrates	6.1-9
	6.1.1.5.3 Plankton	6.1-9
	6.1.2 Ground Water	6.1-10
	6.1.2.1 Physical and Chemical Parameters	6.1-10
	6.1.2.2 Models	6.1-10
	6.1.3 Air	6.1-10
	6.1.3.1 Meteorology	6.1-10
	6.1.3.1.1 Meteorological Data Processing	6.1-12
	6.1.3.1.2 Collected Data	6.1-16
	6.1.3.2 Models	6.1-17
	6.1.3.2.1 Short-Term (Accident) Diffusion Estimates	6.1-17
	6.1.3.2.2 Long-Term (Routine) Diffusion Estimates	6.1-19
	6.1.3.2.3 Cooling Tower Assessment	6.1-19

TABLE OF CONTENTS (Cont.)

	Page
6.1.4 Land	6.1-24
6.1.4.1 Geologic Investigation Program	6.1-24
6.1.4.2 Stratigraphy	6.1-24
6.1.4.3 Ecological Parameters	6.1-24
6.1.4.3.1 Vegetation	6.1-24
6.1.4.3.2 Birds	6.1-24
6.1.4.3.3 Mammals	6.1-25
6.1.4.3.4 Reptiles and Amphibians	6.1-25
6.1.5 Preoperational Radiological Environmental Monitoring Program	6.1-25
6.1.5.1 Introduction	6.1-25
6.1.5.2 Sample Collection	6.1-27
6.1.5.2.1 Direct Radiation	6.1-27
6.1.5.2.2 Airborne Particulate	6.1-27
6.1.5.2.3 Airborne Radioiodine	6.1-28
6.1.5.2.4 Surface and Drinking Water	6.1-28
6.1.5.2.5 Milk	6.1-28
6.1.5.2.6 Fish and Invertebrates	6.1-28
6.1.5.2.7 Beef (or Goat)	6.1-28
6.1.5.2.8 Deer Meat	6.1-29
6.1.5.2.9 Fruits and Vegetables	6.1-29
6.1.5.2.10 Sediment	6.1-29
6.1.5.2.11 Soil	6.1-29
6.1.5.3 Data Analysis and Presentation	6.1-29
6.1.5.3.1 Direct Radiation	6.1-29
6.1.5.3.2 Airborne Particulate	6.1-30
6.1.5.3.3 Airborne Iodine	6.1-30
6.1.5.3.4 Water	6.1-30
6.1.5.3.5 Milk	6.1-30
6.1.5.3.6 Fish and Invertebrates	6.1-30
6.1.5.3.7 Beef (or Goat), Deer	6.1-30
6.1.5.3.8 Sediment and Soil	6.1-30
6.1.6 Supplementary Programs	6.1-30
6.1.6.1 Baxter Wilson Impingement Study	6.1-30
6.1.6.2 Environmental Photography	6.1-31
6.1.6.2.1 Flight Schedule	6.1-31
6.1.6.2.2 Equipment	6.1-32
6.1.6.3 Noise Surveys	6.1-32
6.1.6.4 Transmission Line Corridor Survey	6.1-32
6.1.7 References	6.1-32

TABLE OF CONTENTS (Cont.)

		Page
6.2	PROPOSED OPERATIONAL MONITORING PROGRAMS	6.2-1
6.3	RELATED ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAMS	6.3-1
	6.3.1 References	6.3-1
6.4	PREOPERATIONAL ENVIRONMENTAL RADIOLOGICAL MONITORING DATA	6.4-1

LIST OF TABLES

Table No.	Title
6.1.1	Summary of Surface Water Physical Measurements Program
6.1.2	Summary of Surface Water Quality Measurements Program
6.1.3	Summary of Aquatic Ecological Measurements Program
6.1.4	Summary of Terrestrial Ecological Measurements Program
6.1.5	Census Techniques Employed to Determine Seasonal Avian Species Composition and Relative Abundance at the Grand Gulf Site
6.1.6	Summary of Meteorological Measurements Program
6.1.7	Summary of Supplementary Sampling Activities
6.1.8	Water Chemistry Parameters Measured at Grand Gulf
6.1.9	Meteorological Equipment Specification and Performance Characteristics
6.1.10	Monthly and Annual Data Recovery Rate, Data Period: 8/72 - 7/73
6.1.11	Monthly and Annual Data Recovery Rate, Data Period: 8/73 - 7/74
6.1.12	Monthly and Annual Data Recovery Rate, Data Period: 1/76 - 12/76
6.1.13	Format of the Meteorological Input Data Tape Presented to USNRC
6.1.14	Cumulative Frequency of Relative Concentration (χ/Q) of Effluent at the Minimum Site Boundary (696 m)
6.1.15	Cumulative Frequency of Relative Concentration (χ/Q) of Effluent at the Low Population Zone Distance (0-2 Hours)

LIST OF TABLES (Cont.)

Table No.	Title
6.1.16	Cumulative Frequency of Relative Concentration (χ/Q) of Effluent at the Low Population Zone Distance (2-8 Hours)
6.1.17	Cumulative Frequency of Relative Concentration (χ/Q) of Effluent at the Low Population Zone Distance (8-24 Hours)
6.1.18	Cumulative Frequency of Relative Concentration (χ/Q) of Effluent at the Low Population Zone Distance (1-4 Days)
6.1.19	Cumulative Frequency of Relative Concentration (χ/Q) of Effluent at the Low Population Zone Distance (4-30 Days)
6.1.20	0-2 Hr Chi/Q Frequency Distribution for Minimum Site Boundary, 696 Meters)
6.1.21	0-2 Hr Chi/Q Frequency Distribution for Downwind Distance = 3218.6 Meters
6.1.22	2-8 Hr Chi/Q Frequency Distribution for Downwind Distance = 3218.6 Meters
6.1.23	8-24 Hr Chi/Q Frequency Distribution for Downwind Distance = 3218.6 Meters
6.1.24	1-4 Day Chi/Q Frequency Distribution for Downwind Distance = 3218.6 Meters
6.1.25	4-30 Day Chi/Q Frequency Distribution for Downwind Distance = 3218.6 Meters
6.1.26	Annual Average χ/Q and D/Q
6.1.27	Annual Average Relative Concentration, χ/Q (No Decay, Undepleted)
6.1.28	Annual Average Relative Concentration, χ/Q (No Decay, Depleted)
6.1.29	Annual Average Relative Deposition, D/Q
6.1.30	GGNS Preoperational Radiological Environmental Monitoring Program Summary

LIST OF TABLES (Cont.)

Table No.	Title
6.1.31	Required Minimum Detectable Activities for Gamma Isotopic Analyses
6.4.1	Airborne I-131 and Gross Beta Concentrations in Air Particulate Filters (Weekly Collections)
6.4.2	Radionuclides in Air Particulate Samples (Quarterly Analysis on Composite of Weekly Collections)
6.4.3	Radionuclides in Surface Water Samples (Monthly Collections)
6.4.4	Tritium Concentrations in Surface Water Samples
6.4.5	Radionuclides in Well Water Samples (Quarterly Collections)
6.4.6	Radioactivity in Cistern Water Samples (Monthly Collections)
6.4.7	Tritium Concentrations in Cistern Water Samples (Quarterly Collections)
6.4.8	Radioactivity in Milk Samples (Monthly Collections)
6.4.9	Gamma Emitters in Fruit and Vegetable Samples (Collected at Harvest)
6.4.10	Gamma Emitters in Fish Samples (Semiannual Collections)
6.4.11	Gamma Emitters in Meat Samples (Semiannual Collections)
6.4.12	Gamma Emitters in Sediment Samples (Semiannual Collections)
6.4.13	Gamma Emitters in Soil Samples (Collection Once Prior to Plant Operation)
6.4.14	Gamma Radiation - Average mR/Qtr. Using Thermoluminescent Dosimeters - 1978
6.4.15	Air Sampler Collection Sites
6.4.16	Miscellaneous Collection Sites
6.4.17	TLD Locations

2

LIST OF FIGURES

Figure No.	Title
6.1-1	Data Collection Periods - Surface Water Hydrology
6.1-2	Data Collection Periods - Surface Water Quality
6.1-3	Data Collection Periods - Aquatic Ecology - Fishes
6.1-4	Data Collection Periods - Aquatic Ecology - Benthos and Plankton
6.1-5	Data Collection Periods - Terrestrial Ecology
6.1-6	Radiological Environmental Monitoring Locations
6.4-1	Collection Site Locations - General Area Map
6.4-2	Collection Site Locations - Claiborne County, Mississippi
6.4-3	Collection Site Locations - Site Perimeter

2

CHAPTER 6.0 EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

6.1 PREOPERATIONAL ENVIRONMENTAL PROGRAMS

The environmental field measurements programs for the Grand Gulf Nuclear Station were designed and conducted to collect approximately 1 year of baseline information in most parameters. This baseline information established a reference framework of environmental conditions on and near the site prior to the initiation of site preparation, plant construction and station operation. Additionally these data were used:

a. To confirm preliminary ecological predictions described in the Environmental Report, Construction Permit Stage;

b. To assess and predict potential effects (primarily ecological) of site preparation, plant construction and station operation;

c. To assist in evaluating the actual ecological effects of site preparation, plant construction and station operation;

d. To verify design assumptions relating to physical forces (e.g., hydrologic and meteorologic) on or adjacent to the site which were described in the Preliminary Safety Analysis Report; and

e. To provide a basis to assist in further design of the station.

The environmental field measurements programs conducted on and adjacent to the Grand Gulf site consisted of reconnaissance, observation, field sampling, laboratory analyses and data reduction and evaluation activities. These programs provided site-specific baseline information in the following categories:

a. Surface Waters - physical, chemical and microbial components of the aquatic systems on and adjacent to the site.

b. Aquatic Ecology[1] - fishes, larval fishes, benthic macroinvertebrates, drifting benthic macroinvertebrates, river shrimp, crayfish,

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1 Including observations of rare and endangered species and disease and pest infestations in biota.

zooplankton, phytoplankton, periphyton and macrophyton.

c. Terrestrial Ecology[2] - vegetation, birds, mammals, amphibians and reptiles.

d. Meteorology[3] - wind speed, wind direction, air temperature, differential air temperature, relative humidity and rainfall.

Although baseline radiological information is required, the preoperational radiological environmental monitoring program will not be implemented until approximately 2 years prior to Unit 1 operation.

Supplementary environmental field measurements programs were also conducted as follows:

a. Impingement Study - conducted at MP&L's Baxter Wilson Steam Electric Station at Vicksburg, Mississippi to assess the impingement of aquatic organisms on the traveling screens of the condenser cooling water intake structures.

b. Environmental Photography Survey - conducted over the site and surrounding areas to document pre-construction site conditions, to assist in the identification of vegetation assemblages, to delineate areas of suspected existing stressed or diseased vegetation, to delineate existing drainage patterns, and to delineate areas of suspected high soil moisture.

c. Noise Surveys

1. Ambient Background Noise Survey - conducted on and near the site and in nearby populated areas to document ambient background noise levels for a typical summer day prior to the initiation of construction activities.

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2 Including observations of rare and endangered species and disease and pest infestations in biota.

3 Parameters and instrumentation accuracies to meet requirements at least as stringent as those required by NRC Regulatory Guide 1.23.

2. Construction Noise Surveys - a series of five surveys conducted to determine the effects of construction on ambient background noise levels.

d. Transmission Line Corridor Survey - reconnaissance surveys of representative sections of all proposed transmission line routes and alternate alignments were conducted by two terrestrial biologists and a construction specialist to obtain field data useful in determining the most desirable routing within each proposed corridor.

The acquisition of onsite meteorological data began in March 1972 using two temporary meteorological stations. The main meteorological station was installed in July and began operation about August 1, 1972. Other environmental field measurements programs were implemented during the summer of 1972. Reconnaissance and preliminary sampling were conducted in June and July 1972. Systematic sampling for some parameters was initiated in July, and for essentially all parameters, in August and September 1972.

The scope and objectives of the environmental field measurements programs were revised during the course of these programs as field sampling results became available and as station design parameters changed. Most program revisions consisted of changes in the frequency and location of sampling, changes in sampling and laboratory procedures, and the addition of other parameters to the programs.

The environmental field measurements programs were conducted through August 1973 to provide approximately 1 year of baseline information in most parameters. Certain programs were continued after August 1973 to provide the desired 1 year of baseline information for programs which were generally initiated later (November 1972 through March 1973). These programs consisted of collection of additional data concerning water chemistry, larval fish, drifting benthic macroinvertebrates and impingement of aquatic organisms at MP&L's Baxter Wilson Steam Electric Station. The first year of baseline meteorological data collection activities (at the main meteorological station) was completed July 31, 1973. Operation of the main meteorological station has continued.

Summaries of the environmental field measurements programs at Grand Gulf are listed by major discipline in Tables 6.1.1 through 6.1.7. These tables include the parameters measured, the method of measurement, the frequency of sampling and the location of measuring stations. The periods and frequency of sampling for each discipline are depicted in Figures 6.1-1 through 6.1-5.

The environmental field measurements programs were implemented and conducted by a full-time field staff consisting of engineers,

aquatic and terrestrial biologists, chemists and microbiologists, meteorological technicians, hydrological technicians, field and laboratory technicians, and clerical personnel. Meteorological technicians were assigned to the site in March 1972. The remainder of the staff was mobilized in June and July 1972. Most field staff positions were filled by August 1972, all positions by late October 1972.

6.1.1 Surface Waters

The hydrology program was initiated in August 1972 and continued through August 1973 (Figure 6.1-1). Incomplete parameter sampling was also conducted in September 1973. A summary of the surface waters physical measurements program is presented in Table 6.1.1.

Preliminary sampling for the surface water quality measurements program was instituted in June 1972 with additional parameter determinations added throughout the summer and fall of 1972 as equipment became available. Essentially full sampling capabilities of the surface water quality program were attained by December 1972. A summary of the surface water quality measurements program is presented in Table 6.1.2; the sampling schedule is shown in Figure 6.1-2.

The purposes of the preoperational hydrologic measurements program were: (1) to determine existing hydrologic conditions and (2) to verify design assumptions related to site hydrology. Hydrologic features studied in the program included the Mississippi and Big Black Rivers, Hamilton and Gin Lakes and streams in the plant site drainage basins. The parameters studied for the Mississippi and Big Black Rivers included stage, velocity, temperature and channel bed characteristics. Hamilton and Gin Lakes were monitored for water level and temperature; a bathymetric survey was conducted in each lake. The site drainage basin streams were monitored for current velocity, flow duration and stage. The locations of sampling stations in the Mississippi and Big Black Rivers are shown in Figure 2.2-9. Sampling locations for Hamilton and Gin Lakes and the site drainage basin streams are shown in Figures 2.2-10 and 2.2-12, respectively.

6.1.1.1 Physical and Chemical Parameters of Mississippi and Big Black Rivers

6.1.1.1.1 Stage

Mississippi River stage measurements were collected daily when possible by observation of a staff gage located in the vicinity of the outfall stream from Hamilton Lake at its junction with the Mississippi River. The elevation of the staff gage was surveyed with reference to the USGS bench mark "Grand Gulf." Staff gage readings were recorded in the morning hours to coincide as closely as possible with the 8 AM daily Vicksburg gage readings.

6.1.1.1.2 Current Velocity Measurements

Surface current velocity measurements were obtained using a General Oceanics flow meter Model 2030 at biological sampling stations occupied on a biweekly schedule. Station locations are shown in Figure 2.2-9. Three observations of 100 seconds duration were made at each station. The results of the three velocity observations were then averaged to obtain the surface velocity at the station.

6.1.1.1.3 River Bathymetry

River bathymetry (see Figure 2.2-9) was conducted by running river transects with a Ross Laboratories Model Fineline 200 precision depth sounder. The transect locations were surveyed at 200-foot intervals along the river bank and at 400-foot intervals at the extremities. Navigation during the survey was accomplished by following range markers placed on each transect line while measuring angles to the positions of the survey boat from a fixed point on the river bank. Angles were measured with a transit located near US LT 406.7 at 1-minute timed intervals during each traverse of a transect line. All angles measured were referenced to magnetic north. Timing of the fix points and marking of the bathymetric chart were controlled from the survey boat by radio communication between the survey boat and the shore party.

6.1.1.1.4 Temperature

Temperature of the Mississippi and Big Black Rivers was measured in conjunction with biological and water chemistry sampling.

An InterOcean CSTD probe system was employed to measure insitu conductivity, temperature, depth, dissolved oxygen, pH and turbidity in both the rivers and the lakes. The probe was interrogated near the surface, mid-depth and bottom of the water column at each anchor station. Additional data on depth and surface temperature were obtained at each station.

6.1.1.2 Physical and Chemical Parameters of Hamilton and Gin Lakes

6.1.1.2.1 Stage

Water elevation measurements of Hamilton and Gin Lakes were obtained from staff gages placed in each lake at convenient locations near existing boat landings (see Figure 2.2-10). Gage elevations were surveyed from secondary bench marks established onsite. Gage readings were recorded daily during periods of rapid change and semiweekly during stable periods.

6.1.1.2.2 Lake Bathymetry

Bathymetric measurements of Hamilton and Gin Lakes were conducted by traversing the lakes along established transverse transect lines while operating a Ross Laboratories Model Fineline 200 percision depth sounder. Eight transects were run on Hamilton Lake and Six on Gin Lake. In addition, a longitudinal transect was run on each lake.

6.1.1.2.3 Temperature

As in the rivers, temperature in the lakes was measured in conjunction with biological and water chemistry sampling.

6.1.1.2.4 Volume

Lake volumes were determined from the bottom contour maps prepared for Hamilton and Gin Lakes.

6.1.1.3 Water Chemistry

Water chemistry sampling was conducted semimonthly at various locations in the Mississippi and Big Black Rivers and Hamilton and Gin Lakes. Mississippi River stations 3 and 11 and Big Black River station 10 (see Figure 2.2-9) were sampled regularly; additional sampling was periodically conducted at other river stations (1 through 11) to confirm the degree of representation of stations 3, 10 and 11. Hamilton and Gin Lakes were sampled at stations located in the northern, central and southern portions of each lake (see Figure 2.2-10). Two diel samplings were conducted in each lake during the study period to determine diurnal and nocturnal variations of insitu probe parameters over a 24-hour period.

An InterOcean CSTD probe system was employed to measure insitu conductivity, temperature, depth, dissolved oxygen, pH and turbidity in both the rivers and the lakes. The probe was interrogated near the surface, mid-depth and bottom of the water column at each station. Water samples were collected with a 4.1-liter Van Dorn bottle at a depth of 1 meter below the surface for the purpose of cross calibration of the probe system. Various other water chemistry parameters (Table 6.1.8) were determined using selected chemical analyses on these samples. Water chemistry sampling procedures and laboratory methods are described in detail in the Environmental Report, Construction Permit Stage, Amendment 2, Item 22. Procedures for color, pesticide and metals analyses are presented in Environmental Field Measurements Programs, Interim Report 2, Section 4.0. Temperature and dissolved oxygen measured in the course of this study indicated a cyclic variation throughout the year (the data approached fitting a simple sine curve). A multiple linear regression technique was employed to determine the appropriate

sinusoidal expression. Details of the technique are presented in Interim Report 2, Section 4.0.

6.1.1.4 Plant Site Drainage Basin Streams

6.1.1.4.1 Stage

Leopold and Stevens Type F water level recorders were installed at four locations on the two site drainage basin streams at locations shown in Figure 2.2-12 to measure water stage in the stream beds. Stations 1 and 2 were located on stream A, while stations 3 and 4 were on Stream B.

At station 1, the recorder and standpipe were mounted on an abandoned bridge structure located near the Lower Grand Gulf Landing Road. At station 2, the recorder and standpipe were mounted on pilings approximately 1 foot in diameter installed in the creek bed. Access to the recorder for servicing was obtained by a walkway constructed from the creek bank to the pilings. At stations 3 and 4 on stream B, the stage recorders and standpipes were mounted on structures cantilevered from existing trees growing at the edge of the creek bank. The stage zero reference for each installation was the bottom of the creek bed channel at the gage location.

6.1.1.4.2 Velocity Measurements

Velocity measurements were made with a General Oceanics Model 2030 flow meter at stations 2 and 4, and with a Marsh-McBirney Model 722 current meter at station 2.

At each station, four readings of 2 minutes duration were taken at mid-depth at two locations on a transect with a General Oceanics flow meter. The readings were then averaged to obtain the mean velocity of the stream flow. The velocity data along with the stage reading and time were recorded in a log book. These measurements were taken during storms on an opportunity basis.

At station 2, a Marsh-McBirney current meter was installed with its sensor at a fixed elevation of 3 feet above the creek bed. A float switch was installed to turn the instrument on when the creek stage reached an elevation of 3 feet. The velocity data were recorded on an Esterline Angus Model 601-R strip chart recorder.

6.1.1.5 Ecological Parameters - Aquatic Ecology

Section 2.2 contains a summary of aquatic ecology data. The Mississippi River, the Big Black River and Hamilton and Gin Lakes, are the major features of the aquatic environment on and near the Grand Gulf site (see Figure 2.2-9). In addition, in the bluffs, there were five small stock ponds and two streams with

normally negligible flow. Fishes, benthic macroinvertebrates and plankton were systematically sampled in the major aquatic systems. In addition, fish sampling was conducted in two stock ponds and one of the streams. Periphyton and macrophyton assemblages of the lakes were generally characterized. Sport fishing and recreational activities in the site vicinity were also documented.

For purposes of sampling and description, each of the oxbow lakes was treated as a single macrohabitat; the Mississippi River system, however, was divided into backwater, river bank, main channel and tributary macrohabitats. The study was conducted in the reach of the river extending from River Mile 400 to 410.

Reconnaissance and systematic sampling activities were conducted from June 1972 through August 1973 in these aquatic systems. Detailed field and laboratory procedures are presented in the Environmental Report, Construction Permit Stage, Amendment 2, Item 22, and in the Environmental Field Measurements Programs, Interim Reports, Section 3.0. Detailed results of aquatic sampling from June 1972 through February 1973 are presented in the Interim Report, Section 3.0. Results of sampling from March through June 1973 are presented in Interim Report 2, Section 3.0. Similar sampling results from July and August 1973 are presented in the Environmental Field Measurements Programs, Final Report, Section 3.0.

6.1.1.5.1 Fishes

Fish sampling was conducted with various frequencies and intensities in the aquatic systems on and adjacent to the Grand Gulf site from June 1972 through August 1973. The aquatic systems sampled included the Mississippi River (River Mile 400 to 410), the mouth of the Big Black River, Hamilton and Gin Lakes, site stream A and two bluff stock ponds.

Sampling was conducted monthly from September 1972 through August 1973 for 3 to 15 consecutive days at backwater macrohabitat station 1, river bank macrohabitat stations 3, 5, 6, and 8 and tributary macrohabitat station 10 (see Figure 2.2-9) with various mesh sizes of gill, trammel and hoop nets. Sampling of the river channel macrohabitat (between stations 3 and 6) was conducted once in September 1972 and monthly from June through September 1973 with an otter trawl and a fish-locating echo sounder. Periodic sampling of the near-shore macrohabitats at stations 1, 3, 6 and 8 was performed with a beach seine. Nektonic larval fish were systematically sampled monthly or semi-monthly at river stations 3 and 6 from January through July 1973. Hamilton and Gin Lakes were generally sampled bi-monthly with electrofishing gear or gill and trammel nets from June 1972 through August 1973 (see Figures 2.2-10 and 2.2-11). Site stream A was sampled twice and two bluff stock ponds were each sampled once with electrofishing gear during the study

period (see Figure 2.2-12). Sport fishing creel and recreation activities were recorded frequently for the Mississippi and Big Black Rivers and Hamilton and Gin Lakes from April through August 1973. Mississippi River commercial fishing creels were censused during January and February 1973.

Sampling with fish nets and electrofishing gear was standardized so that valid comparisons of temporal changes in fish catches among macrohabitats could be made. Each net was set and fished for 24 hours (a net-day) if conditions permitted. River condition, river stage, weather conditions and equipment problems (e.g., lost, torn or clogged nets) occasionally required modifications of the planned schedule and procedures. Data on fish catches with nets and electrofishing gear were transformed to catch-per-unit-effort bases for comparisons among water bodies and macrohabitats.

Fish diet was characterized in a preliminary study for 13 fish species collected from the Mississippi River and Hamilton Lake. Reproductive periodicity of river fishes was inferred from spawning condition of adults and from detailed densities of larval fishes. Population density and standing stock estimates of fishes in the Mississippi River, site stream A, and the two bluff ponds were made. Occurrence of fish disease and parasites was recorded during regularly scheduled field collecting activities.

6.1.1.5.2 Benthic Macroinvertebrates

Benthic sampling was conducted at various locations in the Mississippi and Big Black Rivers (see Figure 2.2-9) and Hamilton and Gin Lakes (see Figure 2.2-10). River samples were collected monthly beginning in September 1972 with a Shipek sediment sampler; lake samples were collected monthly beginning in October 1972 with a Ponar bottom grab. Starting in January 1973, drifting benthic macroinvertebrate samples were collected near the water surface at two stations in the Mississippi River using a 1-meter diameter plankton net (505-micron mesh). Shrimp were also collected in the Mississippi, generally on a monthly basis, using box traps measuring 4 x 2 x 1 feet. Crayfish were sampled in the bottomland fields adjacent to the lakes in June after the 1973 spring flood receded.

6.1.1.5.3 Plankton

Plankton sampling was conducted at various locations in the Mississippi and Big Black Rivers (see Figure 2.2-9) and Hamilton and Gin Lakes (see Figure 2.2-10) with various frequencies (monthly to semi-monthly) and intensities beginning in September 1972. Replicate river samples were collected at stations 1 through 10 prior to December 1972, and subsequently at stations 1, 3, 6 and 10. Throughout the study, sampling was not standardized at specific times of the day because of the logistic

problems associated with the sampliny of four water bodies. Zooplankton densities were determined from samples obtained with a Clarke-Bumpus sampler (No. 10 mesh net). Phytoplankton densities were determined from whole-water samples. Zooplankton standing stock and phytoplankton standing crop were determined using their densities and biovolume/biomass estimates. After January 1973, an additional measure of phytoplankton standing crop was obtained from chlorophyll-a analysis.

6.1.2 Ground Water

6.1.2.1 Physical and Chemical Parameters

A detailed description of the ground water conditions in the site environs is given in subsection 2.4.5. Background data regarding physical and chemical parameters of ground water are contained in Tables 2.4.12 through 2.4.15 and Figure 2.4-11.

6.1.2.2 Models

No digital or analog models are used to evaluate the effects of the plant on ground water conditions, as the plant will have no detectable impact on the ground water regime in the site area.

6.1.3 Air

The onsite meteorological measurements program has been designed to meet requirements at least as stringent as those required by NRC Regulatory Guide 1.23.

6.1.3.1 Meteorology

Two temporary weather masts were installed on March 12 and 13, 1972. One of these masts was located in an open field, about 160 feet above mean sea level, approximately 5000 feet NNW of the center of the Unit 1 reactor; the other mast was approximately 5400 feet, slightly north of west from the first, just east of the Mississippi River bank, about 75 feet above mean sea level. Each temporary tower was 33 feet high (above grade) and had an MRI 1071 Mechanical Weather Station at its top.

The first mast was installed adjacent to the location of a permanent tower which became operational about August 1, 1972. Both temporary masts were dismantled in March 1973.

The permanent tower is 162 feet high and initially had the following equipment installed at each of the indicated levels (all heights above grade):

Surface	-	MRI 302	Tipping bucket rain gauge
33 feet	-	MRI 1090-1	Air bearing anemometer
		MRI 1074-2	Wind System
		MRI 809	Delta temperature system (with reference temperature)
		MRI 830	Relative humidity sensor
		MRI 830	Temperature sensor
133 feet	-	MRI 1074-2	Wind system
		MRI 809	Delta temperature system
162 feet	-	MRI 1074-2	Wind System
		MRI 809	Delta temperature system
		MRI 830	Relative humidity sensor

All arms used to place gear are 12 feet from the tower face.

Table 6.1.9 shows the specifications which pertain to the original and current meteorological equipment installed at Grand Gulf. All data collected since the starting date of about August 1, 1972, have met Regulatory Guide 1.23 requirements except the relative humidity data. Maintenance and operational difficulties were experienced with the relative humidity sensors. The sensors were replaced by two Tech-Ecology MetSet 5-T Dewpoint Systems in December 1976. |7 |8

A full-time resident weather equipment technician was assigned to the site from March 1972 through July 1973. During the second annual cycle, August 1973 through July 1974, the tower and equipment were serviced and maintained by technicians from Vicksburg. The original MRI sensors were replaced in January 1980 with Climatronics and General Eastern equipment. A breakdown of the sensors at each of the indicated levels is given below:

Surface*	Climatronics	100097	Tipping bucket rain gauge	8
	Climatronics	100088-2	Delta temperature translator (utilizes 33- and 162-foot temperature sensors)	7
33 feet*	Climatronics	100075	Wind speed sensor	8
		100076	Wind direction sensor	
		100093	Temperature sensor	
	General Eastern	1200 MSCM	Dew point sensor	

*All parameters are measured by duplicate sensors at each level. |8

162 feet*	Climatronics	100075	Wind speed sensor	8
		100076	Wind direction sensor	
		100093	Temperature sensor	

*All parameters are measured by duplicate sensors at each level. 8

Table 6.1.9 also shows the specifications which pertain to the new meteorological equipment. 7

Meteorological data from the permanent tower will be supplemented with information from the backup meteorological system. This system will monitor wind speed, wind direction, and sigma theta. The information from the backup system will be supplied to the control room via a telemetry system. This information will be utilized to ensure data availability should a temporary loss of information from the permanent tower occur. Table 6.1.9 outlines the specifications for the backup meteorological equipment. 8 8

All information recorded by the meteorological instruments on the permanent tower are stored both in digital and analog forms. The analog traces serve as backup to the digital system. Data from the temporary tower instrumentation were recorded by analog trace only.

The permanent (main) tower serves as a representative observation station (i.e., meteorological conditions at that location are considered to be representative of the site). The river station was installed primarily to measure and record winds in and along the river valley to evaluate the possible meteorological effects of the hills along the eastern shoreline.

The percentage of data recovery during the first annual cycle at the Grand Gulf main meteorological station is given in Table 6.1.10 for the combination of sensor systems used in preparation of joint frequency distributions presented in this report and used in diffusion analyses. For this combination of sensor systems (162-foot/33-foot ΔT, 33-foot wind direction and speed), 98.73 percent of all possible sets of hourly values from August 1, 1972 through July 31, 1973 were recovered.

Corresponding data recovery percentages for the second and third annual cycle are shown in Table 6.1.11 and 6.1.12.

During the first two annual data cycles, the meteorological systems were calibrated by professional meteorologists and technicians employed by Woodward-Envicon/Woodward-Clyde Consultants. In the third annual cycle, Grand Gulf plant staff performed the required calibration program with assistance from the consultants. All calibrations were performed in compliance with Regulatory Guide 1.23.

6.1.3.1.1 Meteorological Data Processing

The data processing procedure for 3 years of Grand Gulf meteorological data involves three basic steps:

a. Data collection

b. Data processing

c. Data analysis

Seven computer programs have been developed to process the collected data according to steps b and c above. This section includes a summary of the data collection methods and a description of the applications of the system of programs.

a. Data Collection

The onsite meteorological data are recorded in both analog and digital form.

The Analog Data

The analog traces are recorded on strip charts which act mainly as a backup and verification for the digital data. The data are recorded continuously on six chart rolls, one for each of the following sets of parameters: 8

1. 162-foot wind speed and direction, Sensor A
2. 162-foot wind speed and direction, Sensor B
3. 33-foot wind speed and direction, Sensor A
4. 33-foot wind speed and direction, Sensor B 7
5. 33-foot temperature and 162-foot/33-foot ΔT, surface precipitation, and dew point temperature, Sensor A 8
6. 33-foot temperature and 162-foot/33-foot ΔT, surface precipitation, and dew point temperature, Sensor B

All wind speeds are recorded in miles per hour. Wind directions are recorded on a 0-540 degree scale. Temperatures are recorded in F (degrees Fahrenheit). The precipitation is a step trace, each step representing 0.01 inch. 7

The Digital Data

The digital data consist of a 15-minute average value derived from 180 samples obtained every 5 seconds (for every recorded parameter). This 15-minute average value is recorded on a 9-track, 1600 bit per inch magnetic tape. Each record on the tape is headed by a date-time identifier (Julian date and minute of the day). This tape is the source of input for the computer programs. 7

Data Available to the Control Room

The meteorological data are telemetered to the main control room (Bristol telemetry system Model 877231A) and is available to personnel via the balance of plant computer. Those parameters which are telemetered to the control room are outlined below:

1. Wind speed - 33-foot and 162-foot elevations
2. Wind direction - 33-foot and 162-foot elevations 7
3. Temperature - 33-foot elevation
4. Differential temperature (ΔT) - 33-foot and 162-foo elevations
5. Dewpoint - 33-foot elevation
6. Precipitation - ground level

b. Data Processing

Currently plans call for the meteorological data to be processed by the Emergency Response Facility Information System computer. The original meteorological data (1972-1976) utilized the digital data from the magnetic tapes in processing information. In order to get the digital data from the magnetic tapes into an acceptable format, the data had to go through three processing phases. 8

Editing Data

The first phase consists of editing the tape for computer compatibility and editing the data for meteorological reasonability.

1. The first action of the editing phase is to lengthen all records to a standard length of 4507 bytes. Most records are already this length (75 bytes for each of the 60 one-minute data sequences, and 7 for the date-time identifier).

However, there are often several short records due to power failure or equipment malfunction. Thus a program (EDIT 1) has been developed to lengthen these short records by adding the appropriate number of zeros to the end of the record.

2. Next, the data are checked for meteorological reasonability and sequential errors. Each minute of data is checked against criteria that have been established for absolute level and relative variation of each parameter in time and space. Notification of each violation of these limits is printed out. The program developed for this function is the EDIT program.

3. The output of the EDIT program is submitted to a professional meteorologist. He checks all of the EDIT printout with the analog charts and determines which of the data, if any, need replacing. These data (from those hours requiring data replacement) are coded onto forms from the chart rolls where possible (or coded as missing data otherwise). A card deck is punched as input to the next phase.

Consolidation of the Data

The second phase consists of consolidating the minute-by-minute data on the tape with the card corrections from the editing phase into a data base of hourly values. The program that provides this capability is the DATBAS program. The data base that is created by this program is used as input, directly or indirectly, for all subsequent programs.

Quality Control

Before each data set (usually 1 month of data) is entered onto the permanent file, a printed summary of the consolidated hourly data undergoes a third phase consisting of a quality control check against the analog charts to ensure the validity of the data. Any necessary corrections are coded and added to the card input deck of DATBAS. This program is then rerun using the complete input deck and the output is entered onto the permanent file.

c. Data Analysis

Six major computer programs have been used to perform certain calculations on the data. Most of these programs have the capability to accept both onsite data and Jackson, Mississippi data from the National Climatic Center (N.C.C.) in Asheville, North Carolina. The other programs can easily be adapted to accept the N.C.C. data. This provides the capability to compare Jackson data with data from the Grand Gulf site.

WINROS (Joint Frequency Distribution Program)

The WINROS program calculates and prints out the following frequency and relative frequency distribution tables for both 33-foot and 162-foot level winds.

1. Wind speed vs. wind direction for each stability class

2. Wind speed vs. wind direction for all stability classes combined

3. Stability class vs. wind direction

4. Wind speed vs. direction for inversion conditions only

Also included in these tables are average wind speeds and calm distributions. The tables are printed for each month, year, and 3-year composite. Delta temperature of 162-foot/33-foot levels was utilized for all tables.

WINROS can be run with any combination of wind and ΔT levels for onsite data, and also accepts data from the N.C.C. in Asheville.

XQSB (χ/Q at Site Boundary Program)

The XQSB Program was used to determine the 5 percent and 50 percent 0-2 hour accident χ/Q values at the minimum site boundary distance (696 meters). A value of χ/Q is calculated for each hour of input data. These values are ranked in descending order and the 5 percent - 95 percent cases are printed out in increments of 5 percent along with the worst, 2 percent and 98 percent cases. The 0-2 hour χ/Q determined by this program is a directionally independent, 1-hour χ/Q value. This program was run using meteorological data collected at the 33-foot level of the meteorological tower for three individual annual cycles and 3 years combined.

XQLPZ (Low Population Zone (χ/Q Program)

The XQLPZ program calculated the average relative concentrations at the low population zone for each 2-hour, 6-hour, 16-hour, 72-hour and 624-hour time frame during the period of record. These are, respectively, the 0-2 hour, 2-8 hour, 8-24 hour, 1-4 day, and 4-30 day average χ/Q values. These average values are then ranked in descending order and

the values of the worst, 2 percent, 5 percent - 95 percent (increments of 5 percent) and 98 percent cases are printed out. This program was run using meteorological data collected at the 33-foot level of the meteorological tower for three individual annual cycles and 3 years combined.

XOQDOQ (Annual Average X/Q and D/Q Program)

The XOQDOQ computer program was developed by the USNRC for utilization in its meteorological evaluation for routine releases. The program calculates average relative concentrations (X/Q's) and average relative deposition values (D/Q's) at specified locations, and at standard radial distances and segments for downwind sectors. It also calculates these values at the specified locations for intermittent releases. No terrain recirculation factor has been applied to the computer code. This program was run using meteorological data collected at the 33-foot level of the meteorological tower for three individual annual cycles and 3 years combined.

PRSIST (Wind Directional Persistence Program)

This program determines the longest one, three, and five sector directional wind persistences for each direction from the hourly values of wind direction on the data base. Also given is the average wind speed for each persistence period. Low wind speed persistence and stability class persistence can also be determined.

The Turner Subroutine (Determined Atmospheric Stability by the Pasquill-Turner Method)

This subroutine determines the atmospheric stability by the Pasquill-Turner method using input from the N.C.C. in Asheville. It can also be used to determine the wind direction from data from that same source. This subroutine is already implemented in XQSB and XQLPZ; a modified version of it can be applied in the PRSIST program.

6.1.3.1.2 Collected Data

The processed hourly data extending from August 1972 through July 1974 and January 1976 through December 1976 are presented in Appendix 2.3A of the FSAR (limited distribution to NRC only). The representativeness of these data to long-term conditions are discussed in subsection 2.3.2.1.6. The format of the hourly data tape presented to USNRC is given in Table 6.1.13.

6.1.3.2 Models

6.1.3.2.1 Short-Term (Accident) Diffusion Estimates

a. General

The efficiency of diffusion is primarily dependent on winds (speed and direction) and atmospheric stability characteristics. Dispersion is rapid within stability classes A through D and much slower for classes E through G. That is, atmospheric dispersion capabilities decrease with progression from class A to G, with an abrupt reduction from class D to E.

Relative concentrations of released gases as a function of downwind distance from the reactor containment building were calculated for each hour assuming ground level releases. The diffusion equations used in the calculations were:

1. The basic centerline concentration equation, including the building wake term:

$$\chi/Q = \frac{1}{\left(\pi\ \sigma_y\ \sigma_z + cA\right)\ \bar{u}} \qquad (1)$$

2. The sector-averaging equation:

$$\chi/Q = \frac{2.032}{\sigma_z\ \bar{u}x} \qquad (2)$$

Where:

χ = Concentration at point downwind, Ci/m^3

Q = Source emission rate, Ci/sec

χ/Q = Relative concentration, sec/m^3

$\bar{u}$ = Observed mean wind speed, m/sec

σ_y = Horizontal Pasquill dispersion coefficient, m

σ_z = Vertical Pasquill dispersion coefficient, m

c = Building shape factor, dimensionless

A = Minimum cross-sectional area of the reactor building, m^2

x = Downwind centerline distance from reactor building, m

For the Grand Gulf site, the values used for A and c were 2444 m^2 and 0.5. The Pasquill dispersion coefficients, σ_y and σ_z, are measures of the atmosphere mixing efficiency under the various Pasquill classes and were taken from "Meteorology and Atomic Energy," Slade, 1968.

The ratios of the concentration (χ) to source emission rate (Q) were computed for two distance categories: a) minimum site boundary distance and b) distance of low population zone. Equation 1 was used for minimum site boundary distance and low population zone of time averaging periods less than 8 hours; equation 2 was used only at low population zone distance for time averaging periods equal to and greater than 8 hours.

b. Calculations

All hourly values calculated for the minimum site boundary distance of 696 meters were ranked and a cumulative frequency table was derived. Table 6.1.14 presents the cumulative frequencies of hourly values calculated from Grand Gulf (August 1972-July 1973, August 1973-July 1974, and January 1976-December 1976). Median (50 percent) values may be used in making realistic estimates of the environmental effects of potential radiological accidents; conservative estimates may be based on calculated 5 percent values.

Hourly values of χ/Q calculated by equation 1 for the low population zone distance were summed over consecutive 2- and 6-hour periods, incremented hourly. Average values were then derived for each 2- and 8-hour period. Cumulative frequencies of these average χ/Q's are presented in Tables 6.1.15 and 6.1.16. The relative concentrations derived by the sector averaging equation (equation 2) for the low population zone distance were summed and averaged over consecutive 16-, 72-, and 624-hour (26-day) periods, incremented hourly in each case. Cumulative frequencies of these average values (8-24 hours, 1-4 days, and 4-30 days after a postulated accident) are presented in Tables 6.1.17 through 6.1.19.

Tables 6.1.20 through 6.1.26 present the cumulative frequency distributions of 0-2 hours χ/Q at the

minimum site boundary, and the 0-2 hours, 2-8 hours, 8-24 hours, 1-4 days, and 4-30 days χ/Q at the low population zone after a postulated accident, based on the 3 years of onsite data combined for radiological dose estimations.

6.1.3.2.2 Long-Term (Routine) Diffusion Estimates

a. General

For a routine release, the concentration of radioactive material in the surrounding region depends on the amount of effluent released, the height of the release, the momentum and buoyancy of the emitted plume, the wind speed, atmospheric stability, air-flow patterns of the site, and various effluent removal mechanisms.

b. Calculations

The XOQDOQ computer program, which was developed by NRC, implements the assumptions outlined in NRC Regulatory Guide 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Release from Light-Water-Cooled Reactors." This program was used to generate the annual average relative concentration, χ/Q, and annual average relative deposition, D/Q, at actual site boundaries, specific locations of cows, vegetables, etc., and at standard radial distances and segments for downwind sectors out to 50 miles. A ground level release was assumed for the routine vent release for Grand Gulf. No terrain recirculation factor was applied to the computer program. Results of the calculations, based on 3 years of onsite data, are presented in Tables 6.1.26 through 6.1.29.

6.1.3.2.3 Cooling Tower Assessment

a. Cooling Tower Plume and Fogging

The model used to assess the cooling tower plume and fogging is described in subsection 5.1.4.1.

b. Drift Diffusion - Deposition Model

The prediction of the ground level concentrations and deposition rates of the drift from cooling towers can be assessed by first computing the plume rise and the effective tower height. The concentrations from the modified Gaussian diffusion transport theory are then computed assuming that drift is emitted at the effective tower height. The deposition rates can be

computed by multiplying the deposition velocity by the drift concentration at ground level.

A modified Gaussian plume model (Ref. 1 & 2) was used for these calculations.

Estimation of the Plume Rise

The drift plume rise of the cooling towers is estimated by using the following equation:

$$\Delta h_D = \frac{2}{3\beta^2} \frac{F}{u\ V_s^2} \qquad (1)$$

where: Δh_D = drift plume rise, m

F = buoyancy flux, m^4/sec^3

u = wind speed at the top of the cooling tower, m/sec

V_s = terminal velocity of the droplet, m/sec

β = entrainment coefficient

The entrainment coefficient, β, has been assumed for these calculations to have the value of 0.7 (Ref. 3).

Then equation 1 becomes:

$$\Delta h_D = 1.36\ F/(u\ V_s^2) \qquad (2)$$

The effective tower height is the sum of the physical height of the cooling tower, h_s, and Δh_D:

$$H_D = h_s + \Delta h_D \qquad (3)$$

where: H_D = effective tower height, m

h_s = physical height of the cooling tower, m

Reference 1 suggests that equation 2 is not universally valid and bounds have to be set for the drift plume rise, Δh_D. They use the exit diameter, D_T, of the cooling tower as the lower limit and the maximum dry vapor plume rise, Δh, as the upper limit for the drift plume rise. 5

For stable stratified atmosphere, the dry vapor plume rise Δh, is given (Ref. 1) by:

$$\Delta h = 2.9\ (F/u\ s)^{1/3} \qquad (4)$$

where: $s = \frac{g}{T}\left(\frac{\partial T}{\partial z} + \Gamma\right)$

and: g = gravitational acceleration, m/sec^2

T = temperature, ^oK

z = height, m

Γ = dry adiabatic lapse rate, $-0.01\ ^oC/m$

$\frac{\partial T}{\partial z}$ = vertical temperature gradient, $^oK/m$

For unstable and neutral atmosphere, the Briggs' plume rise formula (Ref. 4) is recommended:

$$\Delta h = 1.6\ F^{1/3}\ (3.5\ x^*)^{2/3}/u \qquad (5)$$

where: $x^* = 34F^{2/5}$

The buoyancy flux, F, in all the dry plume rise equations is defined (Ref. 5) as:

$$F = 0.25\ g\ w_o\ D_T^2 \left(\frac{T_e - T_a}{T_e}\right) \qquad (6)$$ |5

where: w_o = effluent exit velocity, m/sec

D_T = diameter at the top of the cooling tower, m |5

T_e = effluent exit temperature, ^oK

T_a = ambient air temperature, ^oK

The effective tower height is the sum of the physical height of the cooling tower, h_s, and Δh:

$$H = h_s + \Delta h$$

In equations 1 through 5, wind speed at the top of the cooling tower is assumed. |5

Methodology for Calculation of Concentration and Deposition

Once the maximum effective height of emission for droplets of a given size has been reached, the droplets settle downward and disperse by atmospheric turbulence.

The equation for the centerline ground level concentration (Ref. 2) is:

$$C(x) = \frac{Q(1 + \alpha_o)}{2\pi\ u\ \sigma_y\ \sigma_z} \exp\left[-\frac{\left(H_D - \frac{x\ V_s}{u}\right)^2}{2\ \sigma_z^2}\right] \qquad (7)$$ |5

where: $$\alpha_o(x) = 1 - \left[\frac{2\ V_d}{V_s + V_d + \left(u\ H_D - V_s\ x\right)\frac{d\left(\ln\ \sigma_z\right)}{dx}}\right]$$

in which α_o = partial reflection coefficient

H_D = effective tower height, m

x = downwind distance, m

σ_y = standard deviation of the lateral concentration distribution, m

σ_z = standard deviation of the vertical concentration distribution, m

V_s = terminal velocity of the droplet, m/sec

V_d = deposition velocity of the droplet, m/sec

and Q = source emission rate, µg/sec

For a gaseous plume that is perfectly reflected, $\alpha_o = 1$. Equation 7 can be rewritten as:

$$C(x) = \frac{Q}{\pi\, u\, \sigma_y\, \sigma_z} \exp\left[\frac{-\left(H_D - \frac{x\, V_s}{u}\right)^2}{2\,\sigma_z^2}\right] \qquad (8)$$

5

For conservative estimation of the ground level concentrations and deposition rates of the drift from cooling towers, the plume is assumed to be perfectly reflected at the ground and wind speed is assumed at the top of the effective tower height in this study.

The deposition of salts and particulates is the product of the deposition velocity, V_d, and the ground level concentration.

$$D(x) = V_d\, C(x) \qquad (9)$$

In practice, mixing heights serve as an upper bound to the cooling tower plume rise. For this study, the lower value between the mixing height and effective tower height was used as the actual effective tower height in the calculation. The emission droplet size spectrum was broken into two classes and the deposition was computed for each class. The total deposition for a given direction and distance is then the sum of the deposition from each class. In the deposition calculations, no evaporation was considered and the deposition velocities of droplets were assumed to be the same as their terminal fall velocities.

6.1.4 Land

6.1.4.1 Geologic Investigation Program

The program of geologic investigation consisted of the following:

a. A thorough review of all pertinent geologic literature.

b. Interviews with university, State, and Federal geologists having knowledge of geologic conditions in the area.

c. Geologic reconnaissance of the plant site and surrounding area.

d. Interpretation of maps and aerial photographs.

e. An investigation of the subsurface, including soil and ground water conditions in the area by means of a test boring program, electric logging, laboratory analyses, and seismic refraction traverses.

6.1.4.2 Stratigraphy

The stratigraphy of the area was determined from a comprehensive literature search, foundation and geologic borings, seismic refraction surveys, and correlations between electrically logged borings. These borings, drilled to depths between 65 and 447 feet, penetrated Quaternary- and Tertiary-age formations (see Section 2.5).

6.1.4.3 Ecological Parameters

Section 2.2 contains a summary of terrestrial ecology data. Detailed descriptions of terrestrial ecology sampling procedures and methods of analysis are presented in the Environmental Report, Construction Permit Stage, Amendment 2, Item 22.

6.1.4.3.1 Vegetation

Systematic sampling of the forest overstory was conducted in 0.1-acre plots and the understory vegetation was sampled in mil-acre (0.001-acre) plots. Sample plots were established at 5-chain intervals (330 feet) along parallel transect lines spaced approximately 1000 feet apart. Vegetation sampling locations are shown in Figure 2.2-1.

6.1.4.3.2 Birds

Field observations using several different systematic methods were employed to inventory birds on the site. A monthly census of birds was made from observation stations established on

Hamilton and Gin Lakes, at the Grand Gulf Military Park observation tower and on the east bank of the Mississippi River. Bimonthly censuses were conducted in 40-acre plots located in the bluff and bottomland forest communities. Birds occurring along two 300-foot-wide belt transects which traversed all habitats on the site, and along approximately 16,100 feet of field edge in both the bottomlands (8000 feet) and bluffs (8100 feet) were also censused bimonthly. Census locations are shown in Figure 2.2-6.

6.1.4.3.3 Mammals

Field data on mammals were gathered by direct field observations, hunter bag checks, trapping, censusing squirrel nests, nightlight counts, and tallying road kills. The location of mammalian sampling plots and nightlighting routes are shown in Figure 2.2-7.

6.1.4.3.4 Reptiles and Amphibians

Information on reptiles and amphibians was compiled by tallying road kills, periodic field collection and sampling in conjunction with fish sampling.

6.1.5 Preoperational Radiological Environmental Monitoring Program

6.1.5.1 Introduction

This program will be implemented at least 2 years prior to Initial Criticality of Unit 1 to document background levels of direct radiation and concentrations of radionuclides that exist in the environment. The preoperational program will continue up to Initial Criticality of Unit 1 at which time the operational radiological environmental monitoring program will commence. The operational program will essentially be a continuation of the preoperational program described below with some adjustment of sampling frequencies in expected critical exposure pathways such as increasing milk sampling frequency and deletion of fruit, vegetable, soil, and gamma radiation survey samples. NRC Radiological Assessment Branch Position (formulated after issue of Regulatory Guide 4.8 for comment) and the Environmental Surveillance Guide (ORP/SID 72-2, May 1, 1972) of The Environmental Protection Agency have been used as guidelines for the development of this program. The proposed operational program will be reviewed prior to plant operation. Modification will be based upon anomalies and/or exposure pathway variations observed during the preoperational program or at the request of NRC, providing requested changes are agreeable to MP&L.

Several changes have been made in the radiological environmental monitoring program subsequent to the Environmental Report, Construction Permit Stage. These changes and reasons for them are listed below by sample type:

a. Direct Radiation

The annual TLD measurement frequency was deleted as being unnecessary since quarterly measurements are being performed and are adequate.

b. Airborne Particulate

An additional control sample location was added.

c. Drinking Water

No drinking water supplies are taken from the Mississippi River within 50 river miles downstream of the plant outfall. Hence, the drinking water pathway is monitored by sampling cistern and ground water (well water).

d. Cistern Water

A sampling parameter was added to provide for exposure pathway to man from ingestion of cistern water containing deposited airborne particulate radioactivity.

e. Sediment

Collection and analysis frequency was changed from quarterly to semiannually since this is not a critical exposure pathway for Grand Gulf.

f. Meat (Beef or Goat)

Sample frequency was changed from annually to semiannually.

g. Soil

Sample locations were changed to air sampling station locations.

h. Deer

A separate sampling category was added to further define sample type.

i. Green Leafy Vegetables

This sample was added due to importance of exposure pathway for I-131.

j. All water supplies

Gamma isotopic analysis will be performed on all water samples regardless of gross beta activity to simplify analysis requirements and for analysis completeness.

6.1.5.2 Sample Collection

Sampling locations, frequencies, and analyses for the different types of environmental samples are discussed below in general. More specific information for each sampling parameter is given in Table 6.1.30.

6.1.5.2.1 Direct Radiation

A gamma radiation survey will be made in the immediate vicinity of the site before plant operation. TLD badges will be used to document long-term integrated dose rates. These measurements will be made quarterly at the Grand Gulf Military Park, Port Gibson, on the site perimeter, at distances 5 to 10 miles, and 10 to 20 miles northeast of the site. Each dose measurement will be based on readings of at least two thermo-luminescent dosimeters. The exact locations of TLD stations are based on meterological data and the gamma radiation survey. A comparison of perimeter and more distant TLD stations will provide a basis for distinguishing changes due to plant operation from changes due to other causes.

6.1.5.2.2 Airborne Particulate

As a part of the atmospheric measurements program, air sampling stations will be established in each quadrant at the site perimeter, at the residence having the highest χ/Q value, at Grand Gulf Military Park, and in the town of Port Gibson (Figure 6.1-6). The site perimeter and the residence having the highest χ/Q value represent the areas of highest potential concentrations. Grand Gulf Military Park and Port Gibson represent potential population exposure areas. Exact locations of the samples were based on onsite meterological data. In addition, two background air sampling stations will be established as a control at a distance of 10 to 20 miles northeast of the site (Figure 6.1-6). Airborne particulate material will be collected continuously on high efficiency filters. Filters will be changed weekly to avoid excessive dust loading and a beta count taken after a 48-hour decay period to permit decay of naturally occurring Radon and Thoron daughter products. Once each quarter, a gamma isotopic analysis will be performed on a composite sample of the filters.

6.1.5.2.3 Airborne Radioiodine

For the first 6 months and the final 6 months of the preoperational environmental radiological monitoring program, each air sampling station will be equipped with charcoal cartridges for the collection of iodine. These cartridges will be removed and analyzed weekly for Iodine-131. This frequency was selected to avoid decay of the Iodine-131 prior to analysis.

6.1.5.2.4 Surface and Drinking Water

Mississippi River water will be sampled monthly upstream between the mouth of the Big Black River and the plant outfall and downstream between the plant outfall and the St. Joseph Ferry. These samples will have a gamma isotopic analysis performed monthly. Tritium analysis will be performed quarterly on a composite from each sampling location. Drinking water from sources most likely to be affected by plant operations (cisterns near the plant) will be collected and analyzed monthly. Iodine-131 and gamma isotopic analyses will be performed. In addition, a quarterly composite will be analyzed for Tritium. One well near the site and wells at Grand Gulf Military Park and Port Gibson will be sampled and analyzed quarterly. Gamma isotopic and tritium analyses will be performed on these samples of untreated well water.

6.1.5.2.5 Milk

Milking animals are not normally present in the site environs. However, should one or more be introduced, samples will be taken from the animal in the higher D/Q sector. Samples will also be taken from milking animals in areas if the dose, due to effluents, is calculated to be greater than 1 mrem/hr (maximum of three samples; if more than three areas are involved, the worst three cases will be selected). A control sample will be collected from the dairy herd at the Alcorn State University. Iodine-131 and gamma isotopic analyses will be performed on each sample.

6.1.5.2.6 Fish and Invertebrates 2

Important sport and commercial fish will be sampled semiannually in the plant discharge outfall area (Hamilton Lake may be sampled if it is not feasible to obtain a sample from the Mississippi River). Specimens collected will have a gamma isotopic analysis performed on the edible portions.

6.1.5.2.7 Beef (or Goat) Meat

Samples of beef (or goat) will be obtained semiannually from farms within 10 miles of the site which may be affected by plant discharges. If such samples prove to be unavailable, feed stuff and forage will be substituted. A background sample will be

taken from farms, preferably 10 to 20 miles northeast of the site. Gamma isotopic analysis will be performed on edible portions of samples. 2

6.1.5.2.8 Deer Meat

Deer will be sampled annually in the general vicinity of the site in areas where hunting is permitted. Gamma isotopic analysis will be performed on edible portions of each sample upon collection.

6.1.5.2.9 Fruits and Vegetables

Vegetables will be sampled at time of harvest except for green leafy vegetables, which will be sampled monthly when available. Samples will be collected from the garden nearest the point of greatest D/Q value. Commercial and private fruit production is rare in the site vicinity. Wild fruit is present, however. Wild fruit will be collected, as available, from the site environs, preferably from high D/Q sectors. Fruit and vegetable background samples will be obtained from an area preferably 10 to 20 miles northeast of the site. Gamma isotopic analysis will be performed on each sample upon collection. 2

6.1.5.2.10 Sediment

Shoreline sediment will be sampled semiannually downstream of the plant outfall. The amount of silt in and the flow of the Mississippi River render midstream sediment sampling impractical. Gamma isotopic analysis will be performed on each sample. 1

6.1.5.2.11 Soil

One set of soil samples will be taken prior to plant operation. Samples will be collected at each air sampling location. Gamma isotopic analyses will be performed on each sample. 8

6.1.5.3 Data Analysis and Presentation

A report will be prepared to present and evaluate preoperational environmental radiological monitoring results. Data obtained from the preoperational monitoring program will be used along with meterological data to reestimate the possible dose to man from plant operations. Suitability of sampling media, locations, and frequency will be reevaluated prior to plant operation. Changes to the program may be made as indicated by this reevaluation and applicable guides.

6.1.5.3.1 Direct Radiation

Gamma radiation survey results will be reported in R/hr. Direct radiation TLD badge results will be reported as a quarterly integrated dose in mR along with the average and standard

deviation for all readings. Quarterly doses at indicator stations will be compared with quarterly doses at background (control) stations.

6.1.5.3.2 Airborne Particulate

All results will be reported in pCi/m^3. A statistical evaluation will be made of station-to-station and week-to-week variations in gross beta results. These variations will be evaluated in terms of seasonal fluctuations, influences of worldwide fallout, and other sources. Gamma isotopic analysis data will be used to identify any radionuclides that may be attributed to reactor operation.

6.1.5.3.3 Airborne Iodine

All results will be reported in pCi/l. If iodine-131 is detected on the charcoal cartridges, the source of the iodine-131 will be evaluated.

6.1.5.3.4 Water

All results will be reported in pCi/l.

6.1.5.3.5 Milk

Results will be reported in pCi/l. Indicator stations, if available, will be compared to data from the dairy herd at Alcorn State University. 2

6.1.5.3.6 Fish and Invertebrates

Results will be reported in pCi/kg wet weight.

6.1.5.3.7 Beef (or Goat), Deer

Results will be reported in pCi/kg wet weight. Radionuclides which could be identified with plant operation will be evaluated in terms of the dose to man.

6.1.5.3.8 Sediment and Soil

Results will be reported in pCi/kg dry weight and will only be used as indicators of buildup of radioactivity in the environment.

6.1.6 Supplementary Programs

6.1.6.1 Baxter Wilson Impingement Study

Systematic sampling of organisms impinged on the traveling screens of the condenser cooling water intake structures of both Units 1 and 2 at MP&L's Baxter Wilson Steam Electric Station was

conducted from March 1973 through February 1974. Samples from operating units were generally collected on a daily basis from March 12 through May 11. Subsequently, samples were collected 2 days per week.

Detailed descriptions of the intake structures and sampling and laboratory analyses methods are presented in the Environmental Field Measurements Programs, Interim Report 2, Section 3.6. Results of the sampling program are presented in the Environmental Field Measurements Programs, Supplementary Report.

6.1.6.2 Environmental Photography

One series of late summer overflights using thermal infrared imagery, color infrared and color aerial photography was made over the site and surrounding area. This remote-sensing survey served to document existing site conditions, assisted in the identification of vegetation assemblages, delineated areas of suspected existing stress or disease in these vegetation assemblages, and provided delineation of existing drainage patterns on and adjacent to the Grand Gulf site. The aerial survey was conducted by the Services Group of Texas Instruments, Inc. on October 2, 1972 before deciduous trees had lost their leaves.

6.1.6.2.1 Flight Schedule

Each remote sensing mission, thermal infrared, color infrared and color photography, was conducted with specialized equipment during separate overfights which utilized various flight traverses and altitudes to ensure complete coverage of the study area.

a. Thermal Infrared. Predawn thermal infrared imagery was collected between the hours of 0630 and 0700 along five traverses flown in a NNE-SSW direction and one traverse in a NW-SE direction at an altitude of 6000 feet. The resulting imagery consisted of an original negative at an approximate scale of 1 inch = 3800 feet along the center track of the imagery, and enlarged prints at an approximate scale of 1 inch = 1900 feet.

b. Color Infrared. Color infrared photography was collected between the hours of 1300 and 1400 along six traverses flown in a NNE-SSW direction at an altitude of 4500 feet. The resulting imagery consisted of color infrared prints at an approximate scale of 1 inch = 1300 feet.

c. Color Photography. Color photography was collected between the hours of 1500 and 1530 along six traverses flown in a NNE-SSW direction at an altitude of

4500 feet. The resulting photography consisted of prints at an approximate scale of 1 inch = 1300 feet.

6.1.6.2.2 Equipment

The aerial remote-sensing survey was conducted from a twin-engine Beechcraft Queen Air which was structurally modified and specially equipped for a variety of airborne remote sensing missions.

6.1.6.3 Noise Surveys

Refer to Section 2.7 for a description of both the ambient background and construction noise surveys.

6.1.6.4 Transmission Line Corridor Survey

Refer to subsection 3.9.4 and Section 4.5 for a description of the transmission line corridor surveys.

6.1.7 References

1. Israel, G. W. and T. J. Overcamp, "Drift Deposition Model for Natural Draft Cooling Towers," in Proceedings of Cooling Tower Environment - 1974, March 4-6, 1974, pp. 614-628, Technical Information Center, Office of Public Affairs, USERDA, 1975.

2. Overcamp, T. J., "A General Gaussian Diffusion Deposition Model for Elevated Point Sources," Journal of Applied Meteorology, 15, 1976, 1167-1171.

3. Hewett, T. A., J. A. Fay, and D. P. Hoult, "Laboratory Experiments of Smokestack Plumes in a Stable Atmosphere," Atmospheric Environment, 5, 1971, 767-789.

4. Briggs, G. A., Some Recent Analyses of Plume Rise Observation, in Proceedings of the Second International Clean Air Congress, Washington, D. C., December 6-11, 1970, pp. 1029-1032, H. M. Englund and W. T. Beery (Eds.), Academic Press, Inc., New York, 1971.

5. Briggs, G. A., Plume Rise, USAEC, 1969.

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TABLE 6.1.1

SUMMARY OF SURFACE WATER PHYSICAL MEASUREMENTS PROGRAM

1972-1973

Measurement	Parameter Measured	Measuring Technique	Frequency	Location of Measuring Stations
MISSISSIPPI RIVER				
River stage	Water level	Staff gages	Daily	Figure 2.2-9 Hamilton Lake outfall
Current velocity[1]	Velocity	Flowmeter	Semimonthly	Figure 2.2-9
Velocity profile	Velocity and depth	Flowmeter	Once	Figure 2.2-9 (see bathymetric survey locations
Bathymetric survey	River bottom profile	Depth sounder	During low and high river stages	Figure 2.2-9
BIG BLACK RIVER				
Bathymetric survey	River bottom profile	Depth sounder	Once	Figure 2.2-9
HAMILTON AND GIN LAKES				
Water level	Water level	Staff gages	Daily	Figure 2.2-10
Bathymetric survey	Lake bottom profile	Depth sounder	Once	Lakes

1 These measurements are coordinated with aquatic biological sampling.

TABLE 6.1.1 (Cont.)

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Measurement	Parameter Measured	Measuring Technique	Frequency	Location of Measuring Stations
PLANT SITE DRAINAGE BASIN STREAMS				
Stage	Water level	Float gages	Continuous	Figure 2.2-12
Runoff	Flow	Flowmeter	Periodic	Figure 2.2-12

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TABLE 6.1.2

SUMMARY OF SURFACE WATER QUALITY MEASUREMENTS PROGRAM

1972-1973

		Mississippi River		Hamilton and Gin Lakes	
Parameter Measured	Measuring Technique	Frequency	Location of Stations	Frequency	Location of Stations
Temperature	Thermometer	Semimonthly[3]	Figure 2.2-9	Semimonthly	Figure 2.2-10
	Thermistor	"	"	"	"
Depth[1]	Pressure sensor	"	"	"	"
Conductivity[1]	Inductance coil	"	"	"	"
Turbidity[1]	Photoelectric probe	"	"	"	"
Dissolved oxygen[1]	Permeable membrane cell	"	"	"	"
pH[1]	Glass electrode	"	"	"	"
Total coliform[2]	Standard Methods or equivalent	"	"	"	"
Fecal coliform	"	"	"	"	"
Fecal streptococci	"	"	"	"	"
Nitrogen:	"	"	"	"	"
Nitrite	"	"	"	"	"
Nitrate	"	"	"	"	"

1 Periodic water samples were taken one meter below the surface with a Van Dorn water sampler and analyzed in the laboratory by wet chemistry technique to calibrate the probe and provide estimates of probe accuracy.

2 From June through October 1972, analyses performed with field test kit; higher accuracy data obtained starting in November 1972 with laboratory equipment.

3 Stations 1 through 11 sampled from November 1972 to January 1973; stations 3, 10 and 11 only sampled from late January through August 1973.

TABLE 6.1.2 (Cont.)

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Parameter Measured	Measuring Technique	Mississippi River		Hamilton and Gin Lakes	
		Frequency	Location of Stations	Frequency	Location of Stations
Phosphorus:	Standard Methods or equivalent	Semimonthly[3]	Figure 2.2-9	Semimonthly	Figure 2.2-10
Total	"	"	"	"	"
Dissolved	"	"	"	"	"
Solids:	"	"	"	"	"
Total	"	"	"	"	"
Suspended	"	"	"	"	"
Volatile solids:	"	"	"	"	"
Total	"	"	"	"	"
Suspended	"	"	"	"	"
Color (apparent)	"	"	"	"	"
Biochemical oxygen demand	"	"	"	"	"
Chemical oxygen demand	"	"	"	"	"
Chlorine demand[4]	"	"	"	-	-
Total alkalinity ($CaCO_3$)	"	"	"	Semimonthly	Figure 2.2-10
Total hardness ($CaCO_3$)	"	"	"	"	"
Metals[5]	"	Once	Stations 3, 10 and 11	Once	Composite from entire lake
Pesticides[6]	"	"	"	"	"

4 Chlorine demand analysis was not performed in lakes.

5 Metals analyses included: Aluminum, Arsenic, Barium, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Nickel, Strontium, Tin and Zinc.

6 Pesticides analyses included: Aldrin, BHC, Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Lindane, Methoxychlor, TDE, Toxophlen, 2,4-D, and 2,4,5-T.

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TABLE 6.1.3

SUMMARY OF AQUATIC ECOLOGICAL MEASUREMENTS PROGRAM[1]

1972-1973

Task	Method	Frequency	Location
Determination of adult fish assemblage in river	a. Nets	Monthly[2]	Figure 2.2-9 Station 1, 3, 5, 6, 8, 10
	b. Trawl	Monthly[2]	Channel between Station 3 and 6
	c. Seine	Monthly[2]	Station 1, 3, 6, 8
Determination of adult fish assemblage in lakes	a. Nets	Bimonthly[2]	Figure 2.2-10
	b. Electro-fishing	Quarterly[2]	Figure 2.2-10
Determination of adult fish assemblage in stream A	a. Electro-fishing	Semiannually	Figure 2.2-12
	b. Seine	Once	Figure 2.2-12
Determination of adult fish population in two bluff ponds	a. Electro-fishing	Once per pond	Figure 2.2-12

1 Including observations for rare and endangered species.
2 As river stage conditions permitted.

TABLE 6.1.3 (Cont.)

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Task	Method	Frequency	Location
Determination of larval and juvenile fish assemblage in river	a. Meter net	Monthly[4]	Figure 2.2-9 Station 3 and 6
	b. Seine	Monthly[2]	Station 1, 3, 6, 8
Commercial and recreational uses of lakes and river	a. Creel census and interviews	As required	Lakes and river
Determination of benthic communities of river	a. Shipek grab	Monthly	Figure 2.2-9 Station 1, 3, 6, 10
		Bimonthly	Station 9
		Quarterly	Station 4 and 7
	b. Shrimp traps	Monthly	Stations 5 and 8; at and between station 3 and 6
Determination of drifting macroinvertebrates assemblage in river	a. Meter net	Monthly[4]	Figure 2.2-9 Station 3 and 6
Determination of plankton populations in river	Net (zoo.) and whole water samples (phyto.)	Monthly to Semimonthly	Station 1, 3, 6, 10, Figure 2.2-9
Determination of plankton populations in lakes	Net (zoo.) and whole water samples (phyto.)	Monthly to Semimonthly	Figure 2.2-10

4 Semimonthly during peak spawning period.

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TABLE 6.1.4

SUMMARY OF TERRESTRIAL ECOLOGICAL MEASUREMENTS PROGRAM[1]

1972-1973

Task	Method	Frequency	Location
Type-map overstory vegetation	0.1-acre plots	Once	Figure 2.2-1
Type-map understory vegetation	0.001-acre plots	Summer, winter and spring	"
Determination of bird populations			
a. Species composition and relative abundance	Belt transect and field-edge census	Bimonthly	Figure 2.2-6
b. Passerine populations	Observation plots in major forest habitats	Bimonthly	"
c. Nocturnal raptors	Evening observation census	Monthly in spring	"
d. Diurnal raptors	Tower observation census	Monthly	"
e. Waterbird populations	Lake census	Monthly	"
f. Blackbirds	Roost census	Monthly	"
g. Abundance of upland game birds	Hunter census	Periodic during hunting season	"
h. Importance of Gin and Hamilton Lakes to wood ducks	Live trapping	Once in late summer and fall	"
i. Bird impaction on cooling towers	Interviews; evaluation of local avian populations	Once	-

1 Including observations for rare and endangered species.

TABLE 6.1.4 (Cont.)

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Task	Method	Frequency	Location
Determination of abundance and population status of deer	a. Hunt club records	Daily during hunting season	Grand Gulf vicinity
	b. Nightlight census	Biweekly	Figure 2.2-7
	c. Correlation with State records	Once	-
	d. Discussions with local experts	Once	-
Determination of medium-sized mammal populations	Hunt club records plus:		Grand Gulf
a. rabbits	a. Live trapping[2]	Once	Figure 2.2-7
b. squirrels	b. Nest census[2]	Once	"
c. beaver	c. Lodge census	Once	"
d. other mammals	d. Nightlight census	Biweekly	"
Evaluation of populations of small mammals	Trapping in major habitats	Quarterly	"
Determination of species and relative abundance of reptiles and amphibians	Searching selected habitats	Periodic; increased intensity during spring	*[3]
Determination of plants and animals in the area eaten by man	a. Literature b. Interviews	Once	-

2 Augmented with hunter bag census periodically during hunting season.

3 *Reptile and amphibian collection activities were also conducted in conjunction with and at the locations of the aquatic field sampling programs (see Figures 2.2-9, 2.2-10 and 2.2-12).

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TABLE 6.1.5

CENSUS TECHNIQUES EMPLOYED TO DETERMINE SEASONAL AVIAN SPECIES COMPOSITION AND RELATIVE ABUNDANCE AT THE GRAND GULF SITE 1972-1973

Census Type	Census Unit	Frequency	Location
Plot census	40 Acres	Bimonthly	Bluff forest Bottomland forest
Field-edge census	8000' x 100'	Bimonthly	Bluff fields Bottomland fields
Waterbird census	Hamilton and Gin Lakes	Monthly	Lakes
Soaring bird census	Range of vision[1]	Monthly	Entire site
Belt transect census	5000' x 300'	Bimonthly	Bluffs Bottomlands
Blackbird roost census	Middle Ground Island[2]	Monthly	Bottomland forest
Nocturnal raptor	Entire site	Monthly during spring	Entire site
Wood duck trapping	Hamilton and Gin Lakes	Late summer and fall	Lakes

1 Census conducted from Grand Gulf Military Park observation tower.
2 Roost is on Middle Ground Island in Mississippi River, west of site.

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TABLE 6.1.6

SUMMARY OF METEOROLOGICAL MEASUREMENTS PROGRAM

Measurement	Method	Frequency	Location
TEMPORARY STATIONS			
Wind velocity, wind direction and air temperature at 33 feet	Analog strip chart	Continuous	Grand Gulf Island and near Main Meteorological tower, Figure 2.2-12
MAIN STATION			
Ground level			
Rainfall	Event recorder	Continuous	Grand Gulf site Main Meteorological tower, Figure 2.2-12
33-foot level			
Wind velocity, wind direction, air temperature and relative humidity	Analog strip chart and digital magnetic tape recording at 1-minute intervals	"	"
133-foot level			
Wind velocity, wind direction and Delta temperature	"	"	"
162-foot level			
Wind velocity, wind direction, Delta temperature and relative humidity	"	"	"

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TABLE 6.1.7

SUMMARY OF SUPPLEMENTARY SAMPLING ACTIVITIES

Task	Method	Frequency	Location
Sediment and soil grain-size analysis[1]			
a. Mississippi and Big Black Rivers	ASTM[2] procedures	Once	Figure 2.2-9 Stations 1-11
b. Hamilton and Gin Lakes	ASTM procedures	Once	Figure 2.2-10 Hamilton and Gin Lakes
c. Site soil samples	ASTM procedures	Once	Plant excavation area
Determination of aquatic biota impingement on intake water screens	Wire mesh baskets in screen wash discharge	Daily Semiweekly[3]	Baxter Wilson Steam Electric Station, Vicksburg, Mississippi
Lake periphyton and macrophyton			
a. periphyton	Sample analyses and observations during aquatic sampling	Twice	Figure 2.2-10 Hamilton and Gin Lakes
b. macrophyton		Periodically	
Diseases and pest infestations in biota			
a. fish	Observations during regular sampling	Periodically[4]	Figures 2.2-9, 2.2-10 and 2.2-12
b. vegetation		Periodically[4]	Site area
c. wildlife		Periodically[4]	Site area

1 Representative site soil samples were also analyzed for pesticide residue and metals concentrations.
2 American Society for Testing and Materials.
3 Sampled daily from March through May 1973 and semiweekly from June through August 1973.
4 Observations for diseases and pest infestations in biota were conducted during scheduled field sampling activities.

TABLE 6.1.7 (Cont.)

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Task	Method	Frequency	Location
Environmental photography	Thermal and color infrared and color aerial photography	Once	Grand Gulf site and adjacent areas
Ambient noise survey	Sound analysis system	Once	Grand Gulf site and adjacent areas
Transmission line corridor survey	Reconnaissance surveys by terrestrial biologists and construction specialist	Once	All proposed transmission line routes and alternate alignments

TABLE 6.1.8

WATER CHEMISTRY PARAMETERS MEASURED AT GRAND GULF[1]

Temperature, C

Dissolved oxygen, mg/l

Biochemical oxygen demand, mg/l

Chemical oxygen demand[2], mg/l

Apparent color, Pt-Co color units

Chlorine demand (total available and free available), mg/l

Specific conductance at 25 C, micromhos/cm[2]

Total residue (total solids), mg/l

Nonfilterable residue (suspended solids), mg/l

Volatile residue (volatile total and volatile suspended solids, mg/l

Total hardness (as $CaCo_3$), mg/l

Turbidity, formazin turbidity units (FTU)

Total alkalinity (as $CaCo_3$), mg/l

pH, standard units

Nitrite (as N), mg/l

Nitrate (as N), mg/l

Total phosphorus (as P), mg/l

Dissolved phosphorus (as P), mg/l

Pesticides[3], g/l

Aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, lindane, methoxychlor, TDE, toxophen, 2,4-D, 2,4,5-T

TABLE 6.1.8 (Cont.)

Metals, mg/l

Aluminum, arsenic, barium, cadmium, calcium, total chromium, cobalt, copper, total iron, lead, magnesium, manganese, mercury, nickel, strontium, tin, zinc

Total coliform bacteria, MPN/100 ml

Fecal coliform bacteria, MPN/100 ml

Fecal streptococci, MPN/100 ml

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1 All laboratory procedures performed in accordance with "Standard Methods" (APHA, 1971), unless noted otherwise.
2 Performed in accordance with COD Short Method (Jenkins et al., 1965).
3 Performed in accordance with "Guide to the Analysis of Pesticide Residues" (Burchfield and Johnson, 1965).

TABLE 6.1.9

METEOROLOGICAL EQUIPMENT SPECIFICATION
AND PERFORMANCE CHARACTERISTICS

Temporary Towers (these towers were removed in March 1973) |8

MRI 1071 Mechanical Weather Station

Wind Direction	Start threshold: <0.75 mph Accuracy: ±4 degree azimuth Delay distance: 50% recovery - 8 ft
Wind Run (Speed)	Start threshold: <0.5 mph Accuracy: ±2% Response distance: 18 ft (63% recovery)
Temperature	Range: -30 F to 120 F Accuracy: ±3 F (Calibrated to ±1 F)

Permanent Tower (this equipment was replaced in January 1980) |8

MRI 1074-2 Wind Systems

Wind Direction	Start threshold: 0.75 mph Accuracy: ±1% Delay distance: 4 ft (50% recovery)
Wind Speed	Start threshold: 0.75 mph Accuracy: ±0.4 mph or 1% (whichever is greater) Response distance: 18 ft (63% recovery)

MRI 809 Temperature

Temperature	Range: -30 C to +50 C Accuracy: ±0.5 C
Differential Temperature	Range: ±5 C Accuracy: ±0.1 C

Rain Gauge - MRI 302 Tipping Bucket Rain Gauge

Accuracy: ±1% at 3 in. of rain/hr
Picks up each 0.01 in. of rain for each tip of bucket.

TABLE 6.1.9 (Cont.)

Permanent Tower (Cont.)

MRI 1090-1 Air Bearing Anemometer (wind speed only)

Start threshold: <0.25 mph
Response distance: Approximately 10 ft at 2 mph
Range: 0.25 to 20 mph
Accuracy: 0.10 mph or 1% of reading

MetSet 5-T Dewpoint Sensor (installed in December 1976)

Range: -50 C to +50 C
Accuracy: ±0.5 C

New Equipment (this equipment was installed in January 1980) | 8

Climatronics System

Wind Direction	Start threshold: 0.6 mph Accuracy: ±3 degrees Delay distance: 0.76 meters Dampening ratio: 0.4/3.7 feet Range: 0 to 540 degrees
Wind Speed	Start threshold: 0.6 mph Accuracy: ±1% or 0.1 mph Distance constant: 5 ft Range: 0 to 100 mph
Temperature	Accuracy: ±0.2 F Range: -30 F to 122 F
ΔT	Accuracy: ±0.1 F or 1% of ΔT
Precipitation	Accuracy: ±1% up to 3 in./hr Resolution: 0.01 to 15 in.
Dew Point	Accuracy: ±0.72 F

7

Backup Tower

Teledyne Geotech System

Wind Direction - Model 1565B Sensor and Model 53.2 Vane | 8

Start threshold: 0.7 mph
Dampening ratio: 0.4 at 10 degrees
Distance constant: 3.7 feet

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TABLE 6.1.9 (Cont.)

Backup Tower (Cont.)

Teledyne Geotech System (Cont.)

Wind Speed - Model 1564B Sensor with Model 170-41 Wind Cups

Start threshold: 0.6 mph
Turning radius: 3-3/4 inches
Distance constant: 1.5 feet

8

Auto Met V Microprocessor

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TABLE 6.1.10

MONTHLY AND ANNUAL DATA RECOVERY RATE

Data Period: 8/72 - 7/73

162/33 Foot ΔT - 33-Foot Winds

Grand Gulf Main Meteorological Station

Month	Recovery Rate (%)
August 1972	88.84
September 1972	100.00
October 1972	98.79
November 1972	99.72
December 1972	100.00
January 1973	97.58
February 1973	99.85
March 1973	100.00
April 1973	100.00
May 1973	100.00
June 1973	100.00
July 1973	100.00
Annual	98.71

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TABLE 6.1.11

MONTHLY AND ANNUAL DATA RECOVERY RATE

Data Period: 8/73 - 7/74

162/33 Foot ΔT - 33 Foot Winds

Grand Gulf Meteorological Station

Month	Recovery Rate (%)
August 1973	100.00
September 1973	89.72
October 1973	96.10
November 1973	99.31
December 1973	100.00
Janaury 1974	95.43
February 1974	99.40
March 1974	99.33
April 1974	99.75
May 1974	100.00
June 1974	99.86
July 1974	99.73
Annual	98.14

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TABLE 6.1.12

MONTHLY AND ANNUAL DATA RECOVERY RATE

Data Period: 1/76 - 12/76

162/33 Foot ΔT-33 Foot Winds

Grand Gulf Main Meteorological Station

Month (1976)	Recovery Rate (%)
January	100.00
February	100.00
March	100.00
April	100.00
May	100.00
June	95.56
July	100.00
August	91.26
September	100.00
October	100.00
November	93.89
December	100.00
Annual	98.39

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TABLE 6.1.13

FORMAT OF THE METEOROLOGICAL INPUT DATA TAPE
PRESENTED TO USNRC

A. General Information

Record Length = 80
Blockage = 1600
Density = 1600 BPI
9 Track Tape

B. Description Format

The first five records give a description of the tape including plant name, location, dates, and recording levels. The format of the first five records is (20A4).

C. Meteorological Data Format

All data is to a tenth of a unit except precipitation which is to a hundreth of a unit. Data is presented on two levels - 33 ft. and 162 ft.

A6 Identifier
I3 Year
I2 Month
I4 Day
I5 Hour
I5 Upper measurements height (ft)
F5.1 Wind direction (degrees) missing data = 999.9
F5.1 Wind speed (mph) missing data = 999.9
I5 Lower measurements, height (feet)
F5.1 Wind direction (degrees) missing data = 999.9
F5.1 Wind speed (mph) missing data = 999.9
F5.1 Wind speed air bearing (mph) missing data = 999.9
F5.1 Temperature (F) missing data = 999.9
F5.1 Delta temperature (upper/lower) (F/100m)
missing data = 999.9
F5.2 Precipitation (inches) missing data = 999.9

TABLE 6.1.14

CUMULATIVE FREQUENCY OF RELATIVE CONCENTRATION (X/Q) OF EFFLUENT AT THE MINIMUM SITE BOUNDARY (696 m)

(0 - 2 Hours)

Frequency Level	Grand Gulf 8/72 - 7/73	Grand Gulf 8/73 - 7/74	Grand Gulf 1/76 - 12/76
Worse	3.69×10^{-3}	7.33×10^{-3}	1.12×10^{-2}
5%	1.00×10^{-3}	1.00×10^{-3}	1.17×10^{-3}
25%	3.67×10^{-4}	3.94×10^{-4}	4.07×10^{-4}
50%	1.29×10^{-4}	1.38×10^{-4}	1.36×10^{-4}
75%	5.21×10^{-5}	5.21×10^{-5}	4.71×10^{-5}
95%	4.06×10^{-6}	4.42×10^{-6}	4.27×10^{-6}

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TABLE 6.1.15

CUMULATIVE FREQUENCY OF RELATIVE CONCENTRATION (X/Q) OF EFFLUENT AT THE LOW POPULATION ZONE DISTANCE

(0 - 2 Hours)

Frequency Level	Grand Gulf 8/72 - 7/74	Grand Gulf 8/73 - 7/74	Grand Gulf 1/76 - 12/76
Worse	8.14×10^{-4}	9.49×10^{-4}	3.80×10^{-3}
5%	3.15×10^{-4}	3.17×10^{-4}	3.56×10^{-4}
25%	7.12×10^{-5}	8.15×10^{-5}	8.13×10^{-5}
50%	1.68×10^{-5}	1.87×10^{-5}	1.64×10^{-5}
75%	5.95×10^{-6}	6.12×10^{-6}	4.68×10^{-6}
95%	1.10×10^{-7}	1.23×10^{-7}	1.27×10^{-7}

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TABLE 6.1.16

CUMULATIVE FREQUENCY OF RELATIVE CONCENTRATION (X/Q) OF EFFLUENT AT THE LOW POPULATION ZONE DISTANCE

(2 - 8 Hours)

Frequency Level	Grand Gulf 8/72 - 7/73	Grand Gulf 8/73 - 7/74	Grand Gulf 1/76 - 12/76
Worse	6.55×10^{-4}	7.68×10^{-4}	2.19×10^{-3}
5%	2.70×10^{-4}	2.81×10^{-4}	3.22×10^{-4}
25%	8.33×10^{-5}	9.40×10^{-5}	$9\ 55 \times 10^{-5}$
50%	2.28×10^{-5}	2.46×10^{-5}	2.30×10^{-5}
75%	7.93×10^{-6}	8.75×10^{-6}	7.16×10^{-6}
95%	8.30×10^{-7}	9.78×10^{-7}	9.21×10^{-7}

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TABLE 6.1.17

CUMULATIVE FREQUENCY OF RELATIVE CONCENTRATION (X/Q) OF EFFLUENT AT THE LOW POPULATION ZONE DISTANCE

(8 - 24 Hours)

Frequency Level	Grand Gulf 8/72 - 7/73	Grand Gulf 8/73 - 7/74	Grand Gulf 1/76 - 12/76
Worse	7.18×10^{-5}	8.02×10^{-5}	1.96×10^{-4}
5%	3.91×10^{-5}	3.99×10^{-5}	4.63×10^{-5}
25%	1.97×10^{-5}	2.12×10^{-5}	2.29×10^{-5}
50%	1.04×10^{-5}	1.13×10^{-5}	1.14×10^{-5}
75%	5.07×10^{-5}	5.22×10^{-6}	5.35×10^{-6}
95%	2.48×10^{-6}	2.39×10^{-6}	2.12×10^{-6}

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TABLE 6.1.18

CUMULATIVE FREQUENCY OF RELATIVE CONCENTRATION (X/Q) OF EFFLUENT AT THE LOW POPULATION ZONE DISTANCE

(1 - 4 Days)

Frequency Level	Grand Gulf 8/72 - 7/73	Grand Gulf 8/73 - 7/74	Grand Gulf 1/76 - 12/76
Worse	4.87×10^{-5}	4.63×10^{-5}	7.71×10^{-5}
5%	3.00×10^{-5}	3.28×10^{-5}	3.58×10^{-5}
25%	1.85×10^{-5}	2.00×10^{-5}	2.14×10^{-5}
50%	1.22×10^{-5}	1.33×10^{-5}	1.44×10^{-5}
75%	8.09×10^{-6}	7.87×10^{-6}	8.84×10^{-6}
95%	4.41×10^{-6}	4.09×10^{-6}	4.51×10^{-6}

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TABLE 6.1.19

CUMULATIVE FREQUENCY OF RELATIVE CONCENTRATION (X/Q) OF EFFLUENT AT THE LOW POPULATION ZONE DISTANCE

(4 - 30 Days)

Frequency Level	Grand Gulf 8/72 - 7/73	Grand Gulf 8/73 - 7/74	Grand Gulf 1/76 - 12/76
Worse	2.36×10^{-5}	2.66×10^{-5}	2.71×10^{-5}
5%	$2.25\% \times 10^{-5}$	2.47×10^{-5}	2.54×10^{-5}
25%	1.85×10^{-5}	1.77×10^{-5}	2.01×10^{-5}
50%	1.24×10^{-5}	1.40×10^{-5}	1.66×10^{-5}
75%	1.01×10^{-5}	1.09×10^{-5}	1.37×10^{-5}
95%	7.29×10^{-6}	7.65×10^{-6}	1.04×10^{-5}

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TABLE 6.1.20

0-2 HR CHI/Q FREQUENCY DISTRIBUTION FOR MINIMUM SITE BOUNDARY, 696 Meters

GGNS MET DATA 1972-74,1976
162/33 FT DELTA T 33 FT WINDS

% OF A/Q S: GREATER THAN OR EQUAL TO:	ARRAY POSITION:
0 % 0.1123E-01	1
2 % 0.1403E-02	517
5 % 0.1079E-02	1294
10 % 0.7881E-03	2588
15 % 0.6374E-03	3882
20 % 0.4888E-03	5176
25 % 0.3859E-03	6470
30 % 0.3065E-03	7764
35 % 0.2444E-03	9058
40 % 0.1982E-03	10352
45 % 0.1629E-03	11646
50 % 0.1333E-03	12940
55 % 0.1111E-03	14234
60 % 0.9228E-04	15528
65 % 0.7564E-04	16822
70 % 0.6235E-04	18116
75 % 0.5070E-04	19410
80 % 0.3598E-04	20704
85 % 0.1691E-04	21998
90 % 0.0458E-05	23292
95 % 0.4197E-05	24586
98 % 0.3148E-05	25370

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TABLE 6.1.21

0-2 HR CHI/Q FREQUENCY DISTRIBUTION FOR DOWNWIND DISTANCE=3218.6 METERS

GGNS MET DATA 1972-1974, 1976

162/33 FT DELTA T 33 FT WINDS

% OF X/Q S:	GREATER THAN OR EQUAL TO:	ARRAY POSITION:
0 %	0.3798E-02	1
2 %	0.4199E-03	521
5 %	0.3264E-03	1303
10 %	0.2355E-03	2606
15 %	0.1667E-03	3909
20 %	0.1145E-03	5212
25 %	0.7789E-04	6515
30 %	0.5274E-04	7818
35 %	0.3827E-04	9121
40 %	0.2885E-04	10424
45 %	0.2202E-04	11727
50 %	0.1731E-04	13030
55 %	0.1371E-04	14333
60 %	0.1101E-04	15636
65 %	0.8923E-05	16939
70 %	0.7231E-05	18242
75 %	0.5644E-05	19545
80 %	0.3578E-05	20848
85 %	0.1506E-05	22151
90 %	0.3018E-06	23454
95 %	0.1160E-06	24757
98 %	0.8015E-07	25542

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TABLE 6.1.22

2-8 HR CHI/Q FREQUENCY DISTRIBUTION FOR DOWNWIND DISTANCE=3218.6 METERS

GGNS MET DATA 1972-1974, 1976

162/33 FT DELTA T 33FT WINDS

% OF X/Q S:	GREATER THAN OR EQUAL TO:	ARRAY POSITION:
0 %	0.2187E-02	1
2 %	0.3766E-03	521
5 %	0.2908E-03	1302
10 %	0.2114E-03	2604
15 %	0.1609E-03	3906
20 %	0.1215E-03	5208
25 %	0.9059E-04	6510
30 %	0.6771E-04	7812
35 %	0.5080E-04	9114
40 %	0.3924E-04	10416
45 %	0.3027E-04	11718
50 %	0.2343E-04	13020
55 %	0.1840E-04	14322
60 %	0.1477E-04	15624
65 %	0.1193E-04	16926
70 %	0.9717E-05	18228
75 %	0.7872E-05	19530
80 %	0.6227E-05	20832
85 %	0.4704E-05	22134
90 %	0.2841E-05	23436
95 %	0.8759E-06	24738
98 %	0.1724E-06	25534

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TABLE 6.1.23

8-24 HR CHI/Q FREQUENCY DISTRIBUTION FOR DOWNWIND DISTANCE=3218.6 METERS

GGNS MET DATA 1972-1974, 1976

162/33 FT DELTA T 33 FT WINDS

% OF X/Q S:	GREATER THAN OR EQUAL TO:	ARRAY POSITION:
0 %	0.1964E-03	1
2 %	0.5286E-04	520
5 %	0.4215E-04	1301
10 %	0.3333E-04	2602
15 %	0.2812E-04	3903
20 %	0.2420E-04	5204
25 %	0.2122E-04	6505
30 %	0.1865E-04	7806
35 %	0.1643E-04	9107
40 %	0.1440E-04	10408
45 %	0.1258E-04	11709
50 %	0.1098E-04	13010
55 %	0.9584E-05	14311
60 %	0.8354E-05	15612
65 %	0.7187E-05	16913
70 %	0.6115E-05	18214
75 %	0.5210E-05	19515
80 %	0.4388E-05	20816
85 %	0.3690E-05	22117
90 %	0.3032E-05	23418
95 %	0.2318E-05	24719
98 %	0.1792E-05	25515

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TABLE 6.1.24

1-4 DAY CHI/Q FREQUENCY DISTRIBUTION FOR DOWNWIND DISTANCE=3218.6 METERS

GGNS MET DATA 1972-1974, 1976

162/33 FT DELTA T 33 FT WINDS

% OF X/Q S:	GREATER THAN OR EQUAL TO:	ARRAY POSITION:
0 %	0.7705E-04	1
2 %	0.3987E-04	518
5 %	0.3327E-04	1296
10 %	0.2741E-04	2592
15 %	0.2399E-04	3888
20 %	0.2184E-04	5184
25 %	0.1995E-04	6480
30 %	0.1845E-04	7776
35 %	0.1715E-04	9072
40 %	0.1586E-04	10368
45 %	0.1458E-04	11664
50 %	0.1332E-04	12960
55 %	0.1227E-04	14256
60 %	0.1123E-04	15552
65 %	0.1006E-04	16848
70 %	0.9095E-05	18144
75 %	0.8220E-05	19440
80 %	0.7386E-05	20736
85 %	0.6613E-05	22032
90 %	0.5551E-05	23328
95 %	0.4333E-05	24624
98 %	0.3238E-05	25405

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TABLE 6.1.25

4-30 DAY CHI/Q FREQUENCY DISTRIBUTION FOR DOWNWIND DISTANCE=3218.6 METERS

GGNS MET DATA 1972-1974, 1976

162/33 FT DELTA T 33 FT WINDS

% OF X/Q S:	GREATER THAN OR EQUAL TO:	ARRAY POSITION:
0 %	0.2711E-04	1
2 %	0.2566E-04	496
5 %	0.2324E-04	1241
10 %	0.2165E-04	2482
15 %	0.2061E-04	3723
20 %	0.1982E-04	4964
25 %	0.1890E-04	6205
30 %	0.1822E-04	7446
35 %	0.1742E-04	8687
40 %	0.1644E-04	9928
45 %	0.1508E-04	11169
50 %	0.1446E-04	12410
55 %	0.1392E-04	13651
60 %	0.1318E-04	14892
65 %	0.1262E-04	16133
70 %	0.1186E-04	17374
75 %	0.1118E-04	18615
80 %	0.1054E-04	19856
85 %	0.9995E-05	21097
90 %	0.9181E-05	22338
95 %	0.7980E-05	23579
98 %	0.7053E-05	24323

TABLE 6.1.26

ANNUAL AVERAGE X/Q and D/Q
(Data Period 1972-1974, 1976)

Combined Vent - Ground Level Releases Only

Location	Direction	Distance (Miles)	Distance (Meters)	X/Q (Sec/Cub Meter) No Decay Undepleted	X/Q (Sec/Cub Meter) No Decay Depleted	D/Q Per. Sq. Meter
Site Boundary	S	0.61	982.	3.241E-06	2.922E-06	1.017E-08
Site Boundary	SSW	0.65	1046.	3.288E-06	2.953E-06	7.315E-09
Site Boundary	SW	0.85	1368.	3.214E-06	2.843E-06	4.825E-09
Site Boundary	WSW	1.07	1722.	4.203E-06	3.662E-06	4.763E-09
Site Boundary	W	1.14	1835.	4.204E-06	3.646E-06	5.039E-09
Site Boundary	WNW	1.34	2157.	2.220E-06	1.902E-06	3.152E-09
Site Boundary	NW	1.37	2205.	1.351E-06	1.156E-06	2.681E-09
Site Boundary	NNW	1.02	1642.	1.533E-06	1.340E-06	4.542E-09
Site Boundary	N	0.79	1271.	1.928E-06	1.713E-06	7.100E-09
Site Boundary	NNE	0.66	1062.	1.556E-06	1.396E-06	6.569E-09
Site Boundary	NE	0.63	1014.	1.128E-06	1.015E-06	6.294E-09
Site Boundary	ENE	0.63	1014.	7.937E-07	7.140E-07	4.636E-09
Site Boundary	E	0.55	885.	1.135E-06	1.030E-06	6.087E-09
Site Boundary	ESE	0.55	885.	9.659E-07	8.768E-07	5.584E-09
Site Boundary	SE	0.51	821.	1.773E-06	1.617E-06	9.082E-09
Site Boundary	SSE	0.46	740.	2.936E-06	2.695E-06	1.301E-08
Nearest Home	S	1.10	1770.	1.294E-06	1.125E-06	3.772E-09
Nearest Home	SSW	2.32	3734.	4.928E-07	4.022E-07	8.232E-10
Nearest Home	SW	0.89	1432.	3.008E-06	2.653E-06	4.463E-09
Nearest Home	WNW	4.00	6437.	4.902E-07	3.763E-07	4.618E-10
Nearest Home	NNW	1.08	1738.	1.404E-06	1.222E-06	4.119E-09
Nearest Home	N	0.92	1481.	1.515E-06	1.333E-06	5.485E-09
Nearest Home	NNE	0.90	1448.	9.433E-07	8.314E-07	3.892E-09
Nearest Home	NE	0.66	1062.	1.044E-06	9.373E-07	5.821E-09
Nearest Home	ENE	2.67	4297.	8.216E-08	6.609E-08	3.866E-10
Nearest Home	E	0.61	982.	9.558E-07	8.618E-07	5.135E-09
Nearest Home	ESE	2.49	4007.	8.542E-08	6.922E-08	4.232E-10
Nearest Home	SE	2.05	3299.	1.899E-07	1.569E-07	8.563E-10
Nearest Home	SSE	1.05	1690.	7.761E-07	6.771E-07	3.300E-09
Nearest Garden	N	1.75	2816.	5.592E-07	4.687E-07	1.816E-09
Nearest Garden	NNE	1.50	2414.	4.238E-07	3.600E-07	1.622E-09
Nearest Garden	ENE	3.00	4828.	6.907E-08	5.486E-08	3.146E-10
Nearest Garden	E	1.50	2414.	2.261E-07	1.921E-07	1.117E-09
Nearest Garden	ESE	2.75	4426.	7.342E-08	5.887E-08	3.552E-10
Nearest Garden	E	5.00	8047.	3.742E-08	2.789E-08	1.332E-10

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TABLE 5.1.27

ANNUAL AVERAGE RELATIVE CONCENTRATION, X/Q

COMBINED VENT - GROUND LEVEL RELEASES ONLY
NO DECAY. UNDEPLETED

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCE IN MILES

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	1.321E-05	4.443E-06	2.346E-06	1.499E-06	8.058E-07	5.226E-07	3.750E-07	2.867E-07	2.289E-07	1.884E-07	1.591E-07
SSW	1.461E-05	4.932E-06	2.643E-06	1.709E-06	9.327E-07	6.114E-07	4.424E-07	3.404E-07	2.734E-07	2.263E-07	1.918E-07
SW	2.213E-05	7.102E-06	3.850E-06	2.544E-06	1.428E-06	9.538E-07	7.000E-07	5.450E-07	4.417E-07	3.687E-07	3.144E-07
WSW	4.110E-05	1.284E-05	6.887E-06	4.616E-06	2.638E-06	1.782E-06	1.319E-06	1.034E-06	8.423E-07	7.063E-07	6.051E-07
W	4.459E-05	1.385E-05	7.545E-06	5.045E-06	2.870E-06	1.940E-06	1.434E-06	1.123E-06	9.142E-07	7.660E-07	6.560E-07
WNW	2.930E-05	9.388E-06	5.091E-06	3.367E-06	1.893E-06	1.266E-06	9.295E-07	7.240E-07	5.871E-07	4.902E-07	4.185E-07
NW	1.841E-05	6.196E-06	3.326E-06	2.157E-06	1.182E-06	7.774E-07	5.639E-07	4.349E-07	3.497E-07	2.899E-07	2.460E-07
NNW	1.341E-05	4.633E-06	2.467E-06	1.580E-06	8.522E-07	5.560E-07	3.984E-07	3.051E-07	2.439E-07	2.012E-07	1.699E-07
N	1.152E-05	3.908E-06	2.096E-06	1.329E-06	7.084E-07	4.566E-07	3.261E-07	2.483E-07	1.974E-07	1.623E-07	1.365E-07
NNE	7.214E-06	2.431E-06	1.267E-06	7.993E-07	4.243E-07	2.728E-07	1.945E-07	1.479E-07	1.174E-07	9.651E-08	8.119E-08
NE	5.253E-06	1.604E-06	8.488E-07	5.317E-07	2.816E-07	1.808E-07	1.289E-07	9.798E-08	7.788E-08	6.393E-08	5.377E-08
ENE	3.793E-06	1.178E-06	5.966E-07	3.732E-07	1.979E-07	1.273E-07	9.084E-08	6.916E-08	5.503E-08	4.522E-08	3.807E-08
E	4.310E-06	1.344E-06	6.824E-07	4.273E-07	2.268E-07	1.459E-07	1.041E-07	7.924E-08	6.306E-08	5.180E-08	4.360E-08
ESE	3.720E-06	1.140E-06	5.761E-07	3.582E-07	1.880E-07	1.200E-07	8.505E-08	6.441E-08	5.103E-08	4.176E-08	3.504E-08
SE	5.729E-06	1.842E-06	9.414E-07	5.884E-07	3.094E-07	1.975E-07	1.401E-07	1.061E-07	8.402E-08	6.875E-08	5.764E-08
SSE	7.753E-06	2.575E-06	1.334E-06	8.394E-07	4.428E-07	2.833E-07	2.011E-07	1.524E-07	1.208E-07	9.886E-08	8.292E-08

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCE IN MILES

BEARING	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	1.368E-07	7.694E-08	5.144E-08	2.941E-08	1.992E-08	1.476E-08	1.157E-08	9.427E-09	7.900E-09	6.764E-09	5.890E-09
SSW	1.655E-07	9.444E-08	6.378E-08	3.695E-08	2.523E-08	1.881E-08	1.482E-08	1.212E-08	1.020E-08	8.758E-09	7.647E-09
SW	2.732E-07	1.597E-07	1.096E-07	6.499E-08	4.506E-08	3.400E-08	2.704E-08	2.231E-08	1.890E-08	1.633E-08	1.433E-08
WSW	3.273E-07	1.922E-07	1.316E-07	7.897E-08	5.501E-08	4.156E-08	3.312E-08	2.736E-08	2.322E-08	2.009E-08	1.765E-08
W	3.713E-07	2.176E-07	1.489E-07	8.965E-08	6.253E-08	4.730E-08	3.774E-08	3.121E-08	2.652E-08	2.297E-08	2.020E-08
WNW	3.635E-07	2.127E-07	1.461E-07	8.671E-08	6.015E-08	4.540E-08	3.612E-08	2.980E-08	2.525E-08	2.182E-08	1.914E-08
NW	2.125E-07	1.218E-07	8.246E-08	4.796E-08	3.282E-08	2.451E-08	1.934E-08	1.584E-08	1.334E-08	1.147E-08	1.002E-08
NNW	1.461E-07	8.243E-08	5.520E-08	3.160E-08	2.139E-08	1.584E-08	1.241E-08	1.011E-08	8.463E-09	7.242E-09	6.302E-09
N	1.171E-07	6.522E-08	4.328E-08	2.446E-08	1.642E-08	1.208E-08	9.413E-09	7.630E-09	6.366E-09	5.428E-09	4.709E-09
NNE	8.957E-08	3.874E-08	2.571E-08	1.455E-08	9.783E-09	7.209E-09	5.626E-09	4.556E-09	3.814E-09	3.256E-09	2.827E-09
NE	4.613E-08	2.579E-08	1.718E-08	9.803E-09	6.651E-09	4.937E-09	3.877E-09	3.169E-09	2.656E-09	2.278E-09	1.986E-09
ENE	3.268E-08	1.834E-08	1.226E-08	7.024E-09	4.783E-09	3.561E-09	2.803E-09	2.293E-09	1.928E-09	1.656E-09	1.446E-09
E	3.742E-08	2.096E-08	1.398E-08	7.994E-09	5.430E-09	4.035E-09	3.171E-09	2.590E-09	2.174E-09	1.867E-09	1.629E-09
ESE	3.001E-08	1.670E-08	1.109E-08	6.307E-09	4.277E-09	3.175E-09	2.493E-09	2.036E-09	1.709E-09	1.466E-09	1.279E-09
SE	4.934E-08	2.732E-08	1.807E-08	1.021E-08	6.883E-09	5.084E-09	3.976E-09	3.234E-09	2.707E-09	2.319E-09	2.014E-09
SSE	7.093E-08	3.917E-08	2.585E-08	1.452E-08	9.728E-09	7.149E-09	5.567E-09	4.510E-09	3.762E-09	3.207E-09	2.782E-09

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

DIRECTION FROM SITE	SEGMENT BOUNDARIES IN MILES .5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	2.436E-06	8.339E-07	3.790E-07	2.301E-07	1.596E-07	7.890E-08	3.009E-08	1.486E-08	9.458E-09	6.777E-09
SSW	2.730E-06	9.623E-07	4.467E-07	2.747E-07	1.923E-07	9.660E-08	3.770E-08	1.893E-08	1.216E-08	8.773E-09
SW	3.992E-06	1.465E-06	7.057E-07	4.434E-07	3.153E-07	1.627E-07	6.405E-08	3.417E-08	2.236E-08	1.635E-08
WSW	7.157E-06	2.697E-06	1.328E-06	8.452E-07	6.063E-07	3.173E-07	1.316E-07	6.912E-08	4.545E-08	3.368E-08
W	7.835E-06	2.942E-06	1.444E-06	9.173E-07	6.572E-07	3.433E-07	1.419E-07	7.438E-08	4.906E-08	3.607E-08
WNW	5.279E-06	1.942E-06	9.389E-07	5.893E-07	4.194E-07	2.186E-07	8.811E-08	4.562E-08	2.987E-08	2.188E-08
NW	3.444E-06	1.219E-06	5.892E-07	3.513E-07	2.466E-07	1.244E-07	4.890E-08	2.464E-08	1.589E-08	1.148E-08
NNW	2.554E-06	8.814E-07	4.026E-07	2.451E-07	1.704E-07	8.449E-08	3.231E-08	1.595E-08	1.014E-08	7.254E-09
N	2.174E-06	7.345E-07	3.298E-07	1.986E-07	1.370E-07	6.700E-08	2.507E-08	1.217E-08	7.658E-09	5.439E-09
NNE	1.316E-06	4.403E-07	1.968E-07	1.182E-07	8.141E-08	3.980E-08	1.491E-08	7.262E-09	4.582E-09	3.262E-09
NE	8.891E-07	2.924E-07	1.304E-07	7.831E-08	5.395E-08	2.648E-08	1.004E-08	4.970E-09	3.175E-09	2.282E-09
ENE	6.284E-07	2.055E-07	9.184E-08	5.533E-08	3.819E-08	1.882E-08	7.191E-09	3.584E-09	2.300E-09	1.659E-09
E	7.161E-07	2.354E-07	1.053E-07	6.340E-08	4.374E-08	2.152E-08	8.188E-09	4.061E-09	2.598E-09	1.870E-09
ESE	6.053E-07	1.950E-07	8.810E-08	5.132E-08	3.517E-08	1.716E-08	6.468E-09	3.196E-09	2.042E-09	1.469E-09
SE	9.849E-07	3.218E-07	1.448E-07	8.451E-08	5.786E-08	2.810E-08	1.048E-08	5.121E-09	3.245E-09	2.320E-09
SSE	1.394E-06	4.600E-07	2.036E-07	1.215E-07	8.320E-08	4.031E-08	1.491E-08	7.204E-09	4.527E-09	3.214E-09

GG
ER

TABLE 6.1.28

ANNUAL AVERAGE RELATIVE CONCENTRATION, X/Q

COMBINED VENT + GROUND LEVEL RELEASES ONLY
NO DECAY, DEPLETED

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCE IN MILES

SECTOR	0.250	0.500	0.750	1.000	1.500	2.000	2.500	3.000	3.500	4.000	4.500
S	1.250E-05	4.057E-06	2.091E-06	1.312E-06	6.843E-07	4.327E-07	3.039E-07	2.277E-07	1.784E-07	1.448E-07	1.203E-07
SSW	1.382E-05	4.504E-06	2.355E-06	1.496E-06	7.921E-07	5.063E-07	3.584E-07	2.705E-07	2.113E-07	1.717E-07	1.450E-07
SW	2.094E-05	6.488E-06	3.431E-06	2.227E-06	1.213E-06	7.898E-07	5.670E-07	4.329E-07	3.447E-07	2.830E-07	2.379E-07
WSW	3.890E-05	1.155E-05	6.138E-06	4.041E-06	2.240E-06	1.476E-06	1.068E-06	8.210E-07	6.573E-07	5.422E-07	4.575E-07
W	4.220E-05	1.265E-05	6.723E-06	4.416E-06	2.442E-06	1.606E-06	1.162E-06	8.917E-07	7.134E-07	5.880E-07	4.960E-07
WNW	2.173E-05	8.572E-06	4.537E-06	2.947E-06	1.608E-06	1.048E-06	7.529E-07	5.751E-07	4.582E-07	3.763E-07	3.164E-07
NW	1.743E-05	5.658E-06	2.964E-06	1.888E-06	1.004E-06	6.438E-07	4.568E-07	3.454E-07	2.729E-07	2.226E-07	1.860E-07
NNW	1.269E-05	4.230E-06	2.199E-06	1.383E-06	7.237E-07	4.588E-07	3.227E-07	2.423E-07	1.903E-07	1.544E-07	1.284E-07
N	1.091E-05	3.634E-06	1.886E-06	1.184E-06	6.010E-07	3.781E-07	2.642E-07	1.973E-07	1.542E-07	1.246E-07	1.032E-07
NNE	8.828E-06	2.260E-06	1.129E-06	6.997E-07	3.603E-07	2.259E-07	1.576E-07	1.174E-07	9.176E-08	7.409E-08	6.136E-08
NE	4.972E-06	1.520E-06	7.564E-07	4.655E-07	2.391E-07	1.497E-07	1.044E-07	7.783E-08	6.077E-08	4.907E-08	4.065E-08
ENE	3.590E-06	1.076E-06	5.316E-07	3.267E-07	1.681E-07	1.054E-07	7.358E-08	5.493E-08	4.294E-08	3.471E-08	2.878E-08
E	4.079E-06	1.228E-06	6.081E-07	3.741E-07	1.927E-07	1.208E-07	8.434E-08	6.296E-08	4.920E-08	3.976E-08	3.296E-08
ESE	3.52UE-06	1.047E-06	5.134E-07	3.136E-07	1.597E-07	9.933E-08	6.890E-08	5.116E-08	3.982E-08	3.206E-08	2.649E-08
SE	5.422E-06	1.66CE-06	8.389E-07	5.154E-07	2.628E-07	1.636E-07	1.135E-07	8.427E-08	6.556E-08	5.278E-08	4.359E-08
SSE	7.337E-06	2.352E-06	1.18RE-06	7.347E-07	3.760E-07	2.346E-07	1.629E-07	1.211E-07	9.425E-08	7.589E-08	6.269E-08

ANNUAL AVERAGE CHI/Q (SEC/METER CUBED) — DISTANCE IN MILES

BEARING	5.000	7.500	10.000	15.000	20.000	25.000	30.000	35.000	40.000	45.000	50.000
S	1.019E-07	5.424E-08	3.456E-08	1.829E-08	1.103E-08	8.167E-09	6.102E-09	4.760E-09	3.871E-09	3.159E-09	2.654E-09
SSW	1.234E-07	6.658E-08	4.285E-08	2.298E-08	1.473E-08	1.041E-08	7.816E-09	6.122E-09	4.944E-09	4.090E-09	3.446E-09
SW	2.030E-07	1.125E-07	7.365E-08	4.041E-08	2.632E-08	1.881E-08	1.426E-08	1.126E-08	9.163E-09	7.625E-09	6.460E-09
WSW	3.931E-07	2.201E-07	1.453E-07	8.067E-08	5.295E-08	3.808E-08	2.901E-08	2.300E-08	1.878E-08	1.567E-08	1.331E-08
W	4.259E-07	2.380E-07	1.569E-07	8.699E-08	5.703E-08	4.097E-08	3.119E-08	2.472E-08	2.014E-08	1.682E-08	1.428E-08
WNW	2.711E-07	1.499E-07	9.818E-08	5.342E-08	3.513E-08	2.512E-08	1.905E-08	1.504E-08	1.224E-08	1.019E-08	8.615E-09
NW	1.584E-07	8.583E-08	5.540E-08	2.982E-08	1.917E-08	1.356E-08	1.020E-08	7.999E-09	6.468E-09	5.354E-09	4.515E-09
NNW	1.084E-07	5.811E-08	3.709E-08	1.965E-08	1.249E-08	8.765E-09	6.545E-09	5.102E-09	4.104E-09	3.382E-09	2.840E-09
N	8.729E-08	4.598E-08	2.908E-08	1.521E-08	9.590E-09	6.685E-09	4.965E-09	3.853E-09	3.087E-09	2.535E-09	2.122E-09
NNE	5.186E-08	2.731E-08	1.727E-08	9.045E-09	5.713E-09	3.984E-09	2.967E-09	2.305E-09	1.850E-09	1.520E-09	1.274E-09
NE	3.438E-08	1.818E-08	1.154E-08	6.096E-09	3.884E-09	2.732E-09	2.045E-09	1.598E-09	1.288E-09	1.064E-09	8.951E-10
ENE	2.436E-08	1.293E-08	8.234E-09	4.368E-09	2.793E-09	1.970E-09	1.478E-09	1.158E-09	9.350E-10	7.733E-10	6.517E-10
E	2.789E-08	1.478E-08	9.345E-09	4.971E-09	3.171E-09	2.233E-09	1.673E-09	1.310AE-09	1.055E-09	8.719E-10	7.341E-10
ESE	2.237E-08	1.177E-08	7.451E-09	3.922E-09	2.498E-09	1.757E-09	1.315E-09	1.02AE-09	8.289E-10	6.847E-10	5.764E-10
SE	3.078E-08	1.920E-08	1.214E-08	6.348E-09	4.020E-09	2.813E-09	2.097E-09	1.633E-09	1.313E-09	1.081E-09	9.076E-10
SSE	5.288E-08	2.782E-08	1.736E-08	9.028E-09	5.682E-09	3.956E-09	2.936E-09	2.277E-09	1.824E-09	1.498E-09	1.254E-09

CHI/Q (SEC/METER CUBED) FOR EACH SEGMENT

DIRECTION FROM SITE	.5-1	1-2	2-3	SEGMENT BOUNDARIES IN MILES 3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	2.182E-06	7.120E-07	3.077E-07	1.798E-07	1.207E-07	5.609E-08	1.895E-08	8.265E-09	4.790E-09	3.171E-09
SSW	2.451E-06	8.214E-07	3.626E-07	2.146E-07	1.455E-07	6.865E-08	2.373E-08	1.053E-08	6.158E-09	4.105E-09
SW	3.657E-06	1.250E-06	5.728E-07	3.464E-07	2.386E-07	1.155E-07	4.153E-08	1.899E-08	1.132E-08	7.649E-09
WSW	6.408E-06	2.301E-06	1.078E-06	6.602E-07	4.587E-07	2.253E-07	8.271E-08	3.842E-08	2.311E-08	1.572E-08
W	7.019E-06	2.509E-06	1.172E-06	7.166E-07	4.973E-07	2.437E-07	8.922E-08	4.134E-08	2.483E-08	1.687E-08
WNW	4.727E-06	1.657E-06	7.805E-07	4.804E-07	3.173E-07	1.538E-07	5.540E-08	2.536E-08	1.512E-08	1.022E-08
NW	3.088E-06	1.040E-06	4.621E-07	2.744E-07	1.866E-07	8.843E-08	3.077E-08	1.371E-08	8.044E-09	5.373E-09
NNW	2.208E-06	7.562E-07	3.268E-07	1.915E-07	1.289E-07	6.006E-08	2.034E-08	8.871E-09	5.134E-09	3.395E-09
N	1.599E-06	6.272E-07	2.678E-07	1.552E-07	1.037E-07	4.765E-08	1.579E-08	6.772E-09	3.879E-09	2.545E-09
NNE	1.181E-06	3.760E-07	1.594E-07	9.239E-08	6.161E-08	2.830E-08	9.192E-09	4.040E-09	2.321E-09	1.527E-09
NE	7.467E-07	2.497E-07	1.059E-07	6.119E-08	4.083E-08	1.883E-08	6.324E-09	2.765E-09	1.608E-09	1.068E-09
ENE	5.614E-07	1.755E-07	7.461E-08	4.323E-08	2.890E-08	1.338E-08	4.527E-09	1.993E-09	1.164E-09	7.782E-10
E	6.417E-07	2.010E-07	8.552E-08	4.954E-08	3.310E-08	1.530E-08	5.154E-09	2.259E-09	1.316E-09	8.752E-10
ESE	5.431E-07	1.671E-07	6.992E-08	4.010E-08	2.662E-08	1.221E-08	4.073E-09	1.774E-09	1.034E-09	6.873E-10
SE	8.825E-07	2.748E-07	1.152E-07	6.604E-08	4.379E-08	1.999E-08	6.601E-09	2.849E-09	1.644E-09	1.085E-09
SSE	1.259E-06	3.929E-07	1.653E-07	9.492E-08	6.297E-08	2.867E-08	9.393E-09	4.088E-09	2.293E-09	1.504E-09

GG
ER

TABLE 6.1.29

ANNUAL AVERAGE RELATIVE DEPOSITION, D/Q

COMBINED VENT - GROUND LEVEL RELEASES ONLY

RELATIVE DEPOSITION PER UNIT AREA (M**-2) AT FIXED POINTS BY DOWNWIND SECTORS

DIRECTION FROM SITE	DISTANCES IN MILES										
	0.25	0.50	0.75	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50
S	4.163E-08	1.408E-08	7.228E-09	4.434E-09	2.213E-09	1.344E-09	9.074E-10	6.475E-10	5.000E-10	3.939E-10	3.189E-10
SSW	3.312E-08	1.120E-08	5.750E-09	3.531E-09	1.760E-09	1.068E-09	7.218E-10	5.231E-10	3.977E-10	3.133E-10	2.537E-10
SW	3.634E-08	1.161E-08	5.961E-09	3.661E-09	1.825E-09	1.107E-09	7.483E-10	5.423E-10	4.123E-10	3.248E-10	2.630E-10
WSW	5.014E-08	1.606E-08	8.206E-09	5.036E-09	2.665E-09	1.616E-09	1.093E-09	7.919E-10	6.022E-10	4.744E-10	3.841E-10
W	5.912E-08	1.949E-08	1.026E-08	6.303E-09	3.142E-09	1.906E-09	1.288E-09	9.337E-10	7.099E-10	5.593E-10	4.529E-10
WNW	4.881E-08	1.651E-08	8.479E-09	5.204E-09	2.594E-09	1.573E-09	1.064E-09	7.709E-10	5.862E-10	4.618E-10	3.739E-10
NW	4.314E-08	1.459E-08	7.490E-09	4.599E-09	2.293E-09	1.391E-09	9.402E-10	6.813E-10	5.180E-10	4.081E-10	3.304E-10
NNW	4.406E-08	1.490E-08	7.650E-09	4.698E-09	2.342E-09	1.420E-09	9.604E-10	6.959E-10	5.292E-10	4.169E-10	3.375E-10
N	4.464E-08	1.510E-08	7.751E-09	4.759E-09	2.373E-09	1.439E-09	9.730E-10	7.051E-10	5.361E-10	4.224E-10	3.419E-10
NNE	3.051E-08	1.032E-08	5.298E-09	3.253E-09	1.622E-09	9.836E-10	6.651E-10	4.819E-10	3.664E-10	2.887E-10	2.337E-10
NE	2.704E-08	9.144E-09	4.695E-09	2.883E-09	1.437E-09	8.717E-10	5.893E-10	4.271E-10	3.247E-10	2.558E-10	2.071E-10
ENE	1.992E-08	6.735E-09	3.458E-09	2.124E-09	1.059E-09	6.421E-10	4.341E-10	3.144E-10	2.392E-10	1.884E-10	1.524E-10
E	2.102E-08	7.107E-09	3.649E-09	2.241E-09	1.117E-09	6.775E-10	4.581E-10	3.320E-10	2.524E-10	1.988E-10	1.610E-10
ESE	1.928E-08	6.520E-09	3.348E-09	2.056E-09	1.025E-09	6.215E-10	4.202E-10	3.045E-10	2.314E-10	1.824E-10	1.477E-10
SE	2.773E-08	9.379E-09	4.815E-09	2.957E-09	1.474E-09	8.941E-10	6.045E-10	4.380E-10	3.331E-10	2.624E-10	2.124E-10
SSE	3.364E-08	1.138E-08	5.841E-09	3.587E-09	1.788E-09	1.084E-09	7.332E-10	5.313E-10	4.040E-10	3.183E-10	2.577E-10

DIRECTION FROM SITE	DISTANCES IN MILES										
	5.00	7.50	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
S	2.638E-10	1.293E-10	8.110E-11	4.099E-11	2.481E-11	1.664E-11	1.192E-11	8.951E-12	6.999E-12	5.599E-12	4.598E-12
SSW	2.098E-10	1.028E-10	6.452E-11	3.261E-11	1.974E-11	1.323E-11	9.483E-12	7.121E-12	5.537E-12	4.431E-12	3.610E-12
SW	2.175E-10	1.066E-10	6.689E-11	3.381E-11	2.046E-11	1.372E-11	9.831E-12	7.382E-12	5.740E-12	4.595E-12	3.742E-12
WSW	3.177E-10	1.557E-10	9.769E-11	4.937E-11	2.988E-11	2.004E-11	1.436E-11	1.078E-11	8.382E-12	6.706E-12	5.465E-12
W	3.746E-10	1.836E-10	1.152E-10	5.821E-11	3.523E-11	2.362E-11	1.693E-11	1.271E-11	9.886E-12	7.908E-12	6.443E-12
WNW	3.093E-10	1.516E-10	9.509E-11	4.806E-11	2.909E-11	1.950E-11	1.398E-11	1.049E-11	8.160E-12	6.528E-12	5.320E-12
NW	2.733E-10	1.339E-10	8.404E-11	4.248E-11	2.571E-11	1.724E-11	1.235E-11	9.274E-12	7.211E-12	5.768E-12	4.702E-12
NNW	2.792E-10	1.368E-10	8.584E-11	4.339E-11	2.626E-11	1.761E-11	1.262E-11	9.474E-12	7.366E-12	5.892E-12	4.803E-12
N	2.828E-10	1.386E-10	8.697E-11	4.396E-11	2.661E-11	1.784E-11	1.278E-11	9.594E-12	7.459E-12	5.967E-12	4.864E-12
NNE	1.933E-10	9.474E-11	5.945E-11	3.005E-11	1.819E-11	1.219E-11	8.737E-12	6.561E-12	5.101E-12	4.079E-12	3.326E-12
NE	1.713E-10	8.398E-11	5.268E-11	2.663E-11	1.612E-11	1.080E-11	7.742E-12	5.814E-12	4.520E-12	3.615E-12	2.947E-12
ENE	1.262E-10	6.184E-11	3.880E-11	1.961E-11	1.187E-11	7.959E-12	5.703E-12	4.282E-12	3.330E-12	2.663E-12	2.171E-12
E	1.332E-10	6.528E-11	4.095E-11	2.070E-11	1.253E-11	8.399E-12	6.018E-12	4.519E-12	3.514E-12	2.809E-12	2.291E-12
ESE	1.222E-10	5.987E-11	3.754E-11	1.899E-11	1.149E-11	7.705E-12	5.521E-12	4.144E-12	3.223E-12	2.575E-12	2.102E-12
SE	1.757E-10	8.611E-11	5.403E-11	2.731E-11	1.653E-11	1.108E-11	7.941E-12	5.963E-12	4.636E-12	3.704E-12	3.023E-12
SSE	2.131E-10	1.044E-10	6.554E-11	3.313E-11	2.005E-11	1.344E-11	9.632E-12	7.233E-12	5.624E-12	4.492E-12	3.667E-12

RELATIVE DEPOSITION PER UNIT AREA (M**-2) BY DOWNWIND SECTORS

DIRECTION FROM SITE	SEGMENT BOUNDARIES IN MILES									
	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	1.510E-09	2.320E-09	9.233E-10	5.046E-10	3.207E-10	1.377E-10	4.271E-11	1.493E-11	9.040E-12	5.598E-12
SSW	1.475E-09	1.846E-09	7.345E-10	4.014E-10	2.551E-10	1.096E-10	3.399E-11	1.347E-11	7.192E-12	4.452E-12
SW	1.194E-09	1.914E-09	7.615E-10	4.161E-10	2.645E-10	1.136E-10	3.523E-11	1.394E-11	7.454E-12	4.615E-12
WSW	1.846E-09	2.795E-09	1.112E-09	6.077E-10	3.862E-10	1.659E-10	5.145E-11	2.039E-11	1.089E-11	6.740E-12
W	1.986E-09	3.245E-09	1.311E-09	7.165E-10	4.554E-10	1.956E-10	6.064E-11	2.404E-11	1.284E-11	7.944E-12
WNW	1.606E-09	2.721E-09	1.083E-09	5.916E-10	3.760E-10	1.615E-10	5.008E-11	1.985E-11	1.060E-11	6.561E-12
NW	1.782E-09	2.404E-09	9.567E-10	5.228E-10	3.323E-10	1.427E-10	4.424E-11	1.754E-11	9.367E-12	5.798E-12
NNW	1.949E-09	2.456E-09	9.773E-10	5.340E-10	3.394E-10	1.458E-10	4.521E-11	1.792E-11	9.569E-12	5.923E-12
N	1.954E-09	2.488E-09	9.901E-10	5.410E-10	3.439E-10	1.477E-10	4.580E-11	1.815E-11	9.694E-12	6.000E-12
NNE	1.505E-09	1.701E-09	6.768E-10	3.699E-10	2.350E-10	1.010E-10	3.131E-11	1.241E-11	6.628E-12	4.101E-12
NE	1.387E-09	1.507E-09	5.997E-10	3.277E-10	2.083E-10	8.947E-11	2.774E-11	1.100E-11	5.874E-12	3.634E-12
ENE	1.093E-09	1.110E-09	4.418E-10	2.414E-10	1.534E-10	6.590E-11	2.044E-11	8.108E-12	4.329E-12	2.677E-12
E	1.192E-09	1.171E-09	4.662E-10	2.547E-10	1.619E-10	6.954E-11	2.157E-11	8.557E-12	4.569E-12	2.825E-12
ESE	1.078E-09	1.075E-09	4.278E-10	2.337E-10	1.485E-10	6.380E-11	1.978E-11	7.846E-12	4.189E-12	2.592E-12
SE	1.403E-09	1.546E-09	6.151E-10	3.361E-10	2.136E-10	9.177E-11	2.846E-11	1.128E-11	6.023E-12	3.728E-12
SSE	1.669E-09	1.875E-09	7.461E-10	4.077E-10	2.591E-10	1.113E-10	3.452E-11	1.368E-11	7.305E-12	4.520E-12

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TABLE 6.1.30

GGNS PREOPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM SUMMARY

Sample Type	Sampling Frequency	Number and Approximate Location of Samples	Analysis Type & Frequency	MDA or Min. Sensitivity
Direct Radiation	Quarterly	15 Site perimeter 1 Port Gibson 1 Grand Gulf Military Park 9 5 - 10 mi. from site 4 10 - 20 mi. from site in least prevalent wind direction (control)	Gamma exposure, quarterly	22 ± 7 mR/Qtr
Airborne-Radio Iodine	Weekly	4 Site perimeter 1 Port Gibson 1 Grand Gulf Military Park 2 10 - 20 mi. NE of Site on U.S. 61 (control) 1 Residence having highest X/Q (Glodjo)	Iodine 131, weekly	.07 pCi/m^3
Air Particulate	Weekly	Same as airborne iodine	Gross Beta, weekly Gamma Isotopic, quart	.01 pCi/m^3 Table 6.1.31
Surface Water (Miss. River)	Monthly	1 Miss River downstream of Outfall 1 Miss River upstream	Gamma Isotopic, monthly Tritium, quarterly	Table 6.1.31 330 pCi/l
Cistern Water	Monthly	1 Cistern used for drinking water in area with highest X/Q	Gross Beta, monthly Iodine 131, monthly Gamma Isotopic, monthly	1 pCi/l 1 pCi/l Table 6.1.31
		1 Cistern at least 10 miles from site	Tritium, quarterly	330 pCi/l
Ground Water	Quarterly	1 Grand Gulf Military Park 1 Port Gibson 1 or more nearby wells	Gamma Isotopic, quarterly Tritium, quarterly	Table 6.1.31 330 pCi/l

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Table 6.1.30 (Cont.)

Sample Type	Sampling Frequency	Number and Approximate Location of Samples	Analysis Type & Frequency	MDA or Min. Sensitivity	
Milk	Monthly	1 Alcorn State University 1 Milking animal in the vicinity of GGNS (if available)	Iodine 131, monthly Gamma Isotopic, monthly	1 pCi/l Table 6.1.31	2
Fish and Invertebrates	Semiannually	1 Discharge outfall area (or Hamilton Lake) 1 Control sample from area not influenced by plant discharges	Gamma Isotopic, semiannually	Table 6.1.31	2
Beef (or Goat) Meat	Semiannually, as available	1 Within 10 mi. of the site (if not available, feedstuff and forage may be substituted)	Gamma Isotopic, semiannually	Table 6.1.31	2
Deer	Annually	1 In general vicinity of site in areas where hunting is permitted	Gamma Isotopic, annually	Table 6.1.31	
Fruits & Vegetables	Annually, at harvest	1 Garden preferably from a high D/Q sector 1 Wild fruit collected from site environs (when available and preferably from high D/Q sectors) 1 Control sample from area not influenced by plant effluents	Gamma Isotopic, on collection	Table 6.1.31	2
Green Leafy Vegetables	Monthly (as available)	1 Garden preferably from a high D/Q sector 1 Control sample from area not influenced by plant effluents	Gamma Isotopic, on collection	Table 6.1.31	2
Sediment	Semiannually	1 Shoreline sediment downstream of the plant outfall	Gamma Isotopic, Semiannually	Table 6.1.31	1
Soil	Once prior to plant operation	9 Air Sampling Locations	Gamma Isotopic-on collection	Table 6.1.31	5
Gamma Radiation Survey	Once prior to plant operation	30 Same as direct radiation	Gamma Radiation Exposure Rate	Approximately 10 μR/hr	

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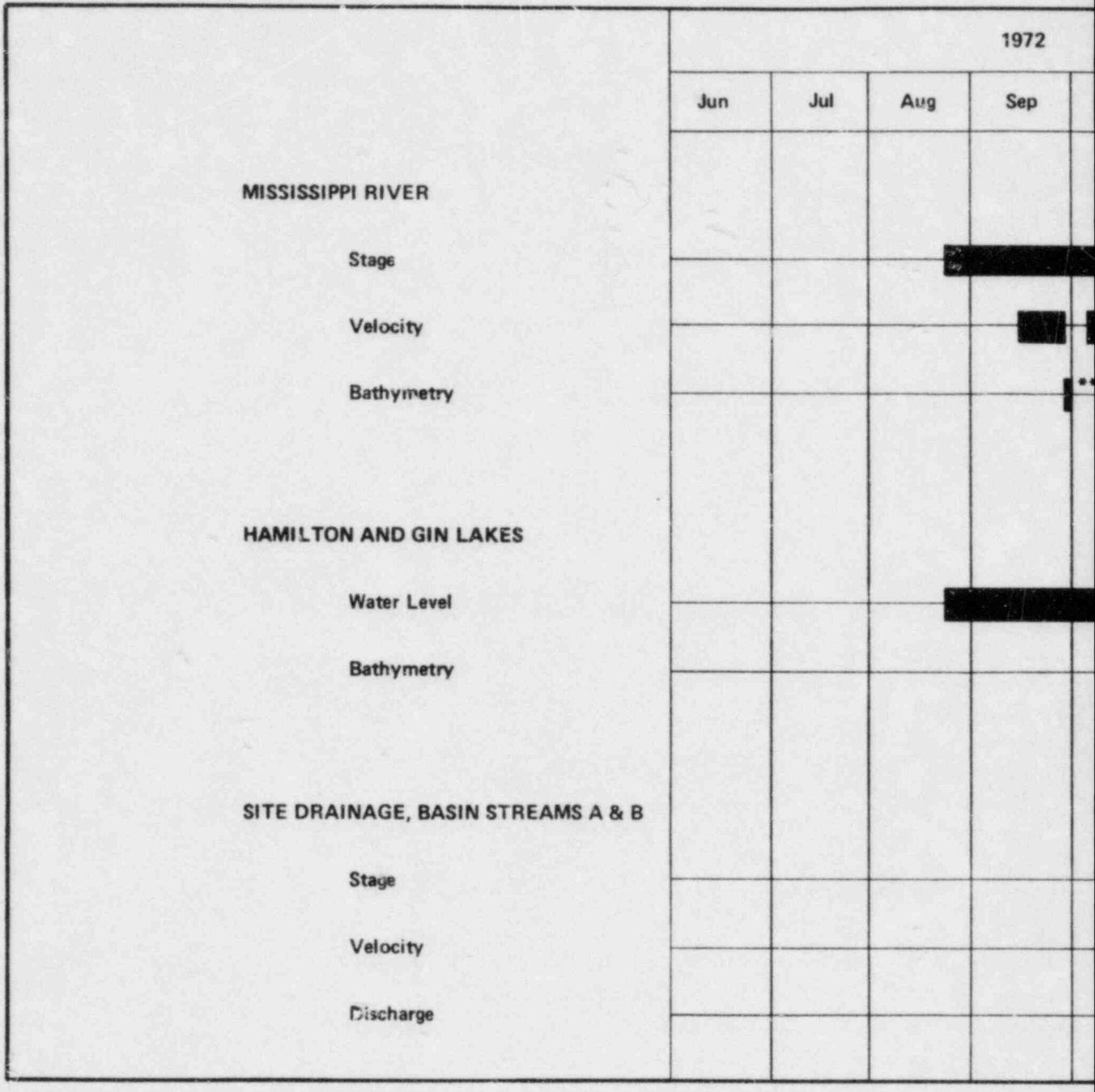
Table 6.1.31

REQUIRED MINIMUM DETECTABLE ACTIVITIES FOR GAMMA ISOTOPIC ANALYSES

	SAMPLE TYPE						
Isotope	Water (pCi/l)	Airborne Particulate (pCi/m^3)	Fish, Beef, Deer (pCi/kg,wet)	Soil, Sediment (pCi/kg dry)	Milk (pCi/l)	Vegetation (pCi/kg, wet)	5
54Mn	15		130				
59Fe	30		260				
58Co	15		130				
60Co	15		130				
95Zr-Nb	10						
131I	10*				10*	25	5
134-137Cs	15	1×10^{-2}	130	150	15	80	
140Ba-La	15				15		

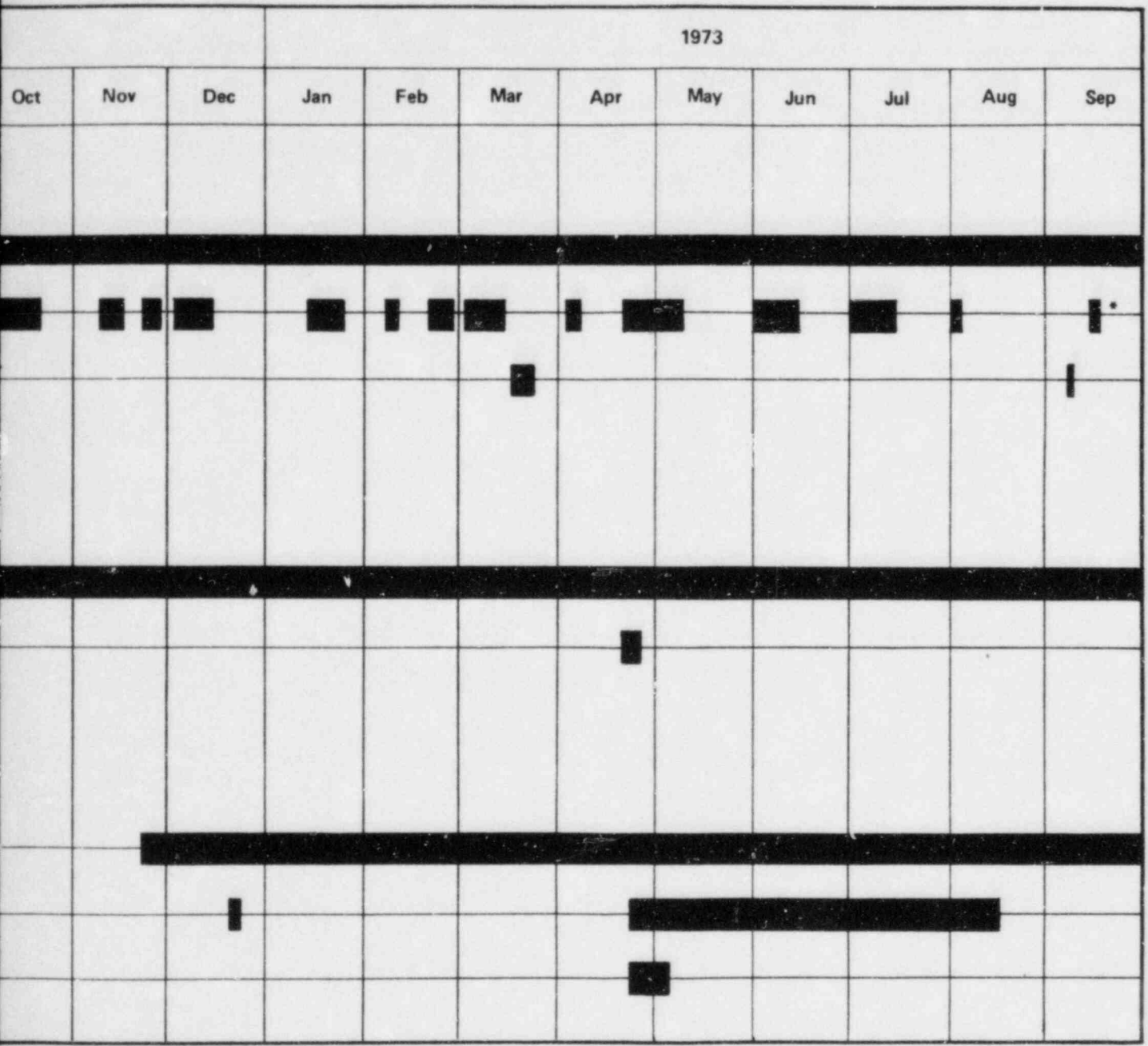
*MDA is above that normally required but analysis will be performed as a back-up to radiochemical separation and low background Beta counting for 131I. 5



Notes:

* Velocity profiles.

** Big Black River survey.



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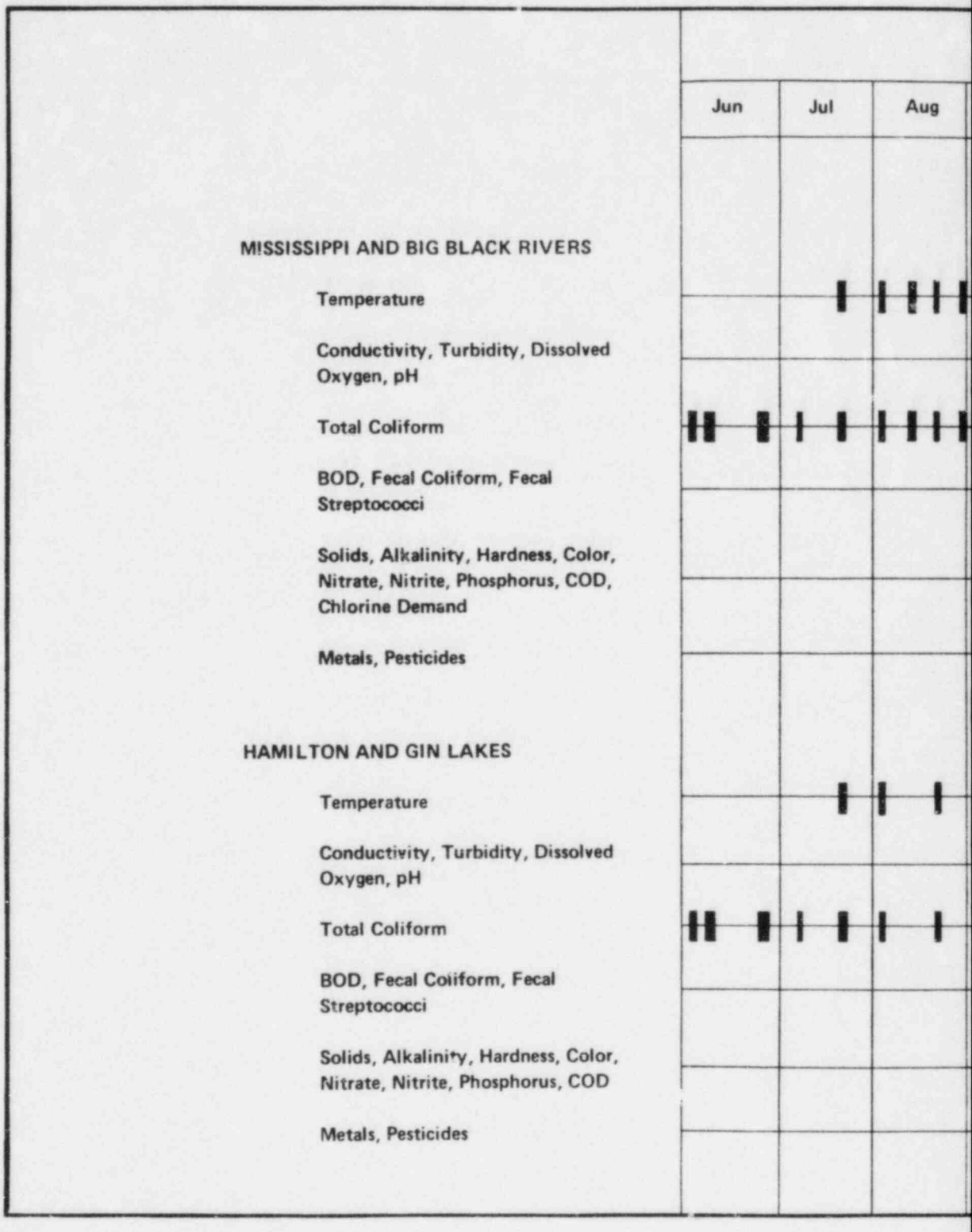
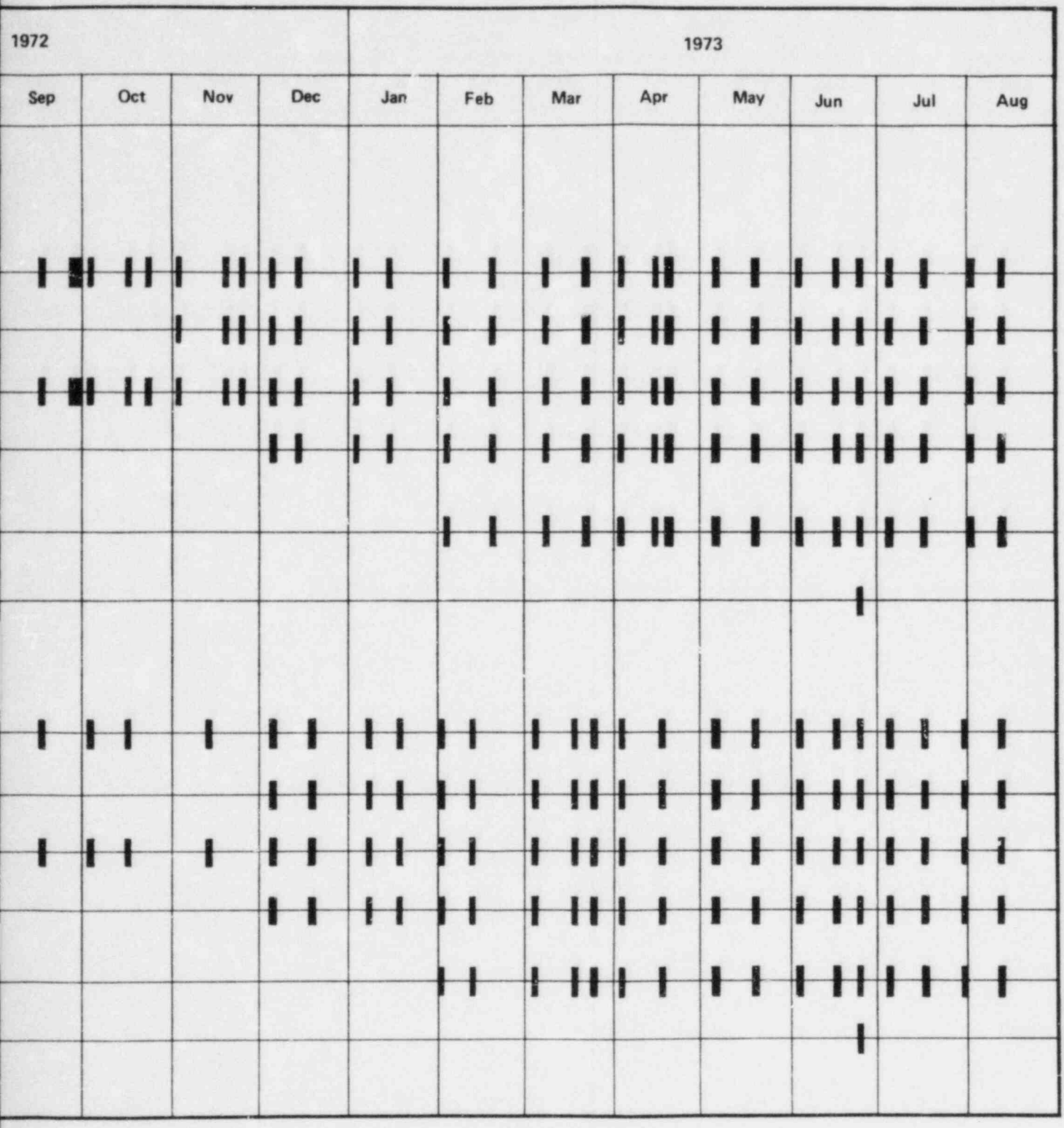
DATA COLLECTION PERIODS
SURFACE WATERS HYDROLOGY
FIGURE 6.1-1


Jun
Jul
Aug
MISSISSIPPI AND BIG BLACK RIVERS
Temperature
Conductivity, Turbidity, Dissolved Oxygen, pH
Total Coliform
BOD, Fecal Coliform, Fecal Streptococci
Solids, Alkalinity, Hardness, Color, Nitrate, Nitrite, Phosphorus, COD, Chlorine Demand
Metals, Pesticides
HAMILTON AND GIN LAKES
Temperature
Conductivity, Turbidity, Dissolved Oxygen, pH
Total Coliform
BOD, Fecal Coliform, Fecal Streptococci
Solids, Alkalinity, Hardness, Color, Nitrate, Nitrite, Phosphorus, COD
Metals, Pesticides



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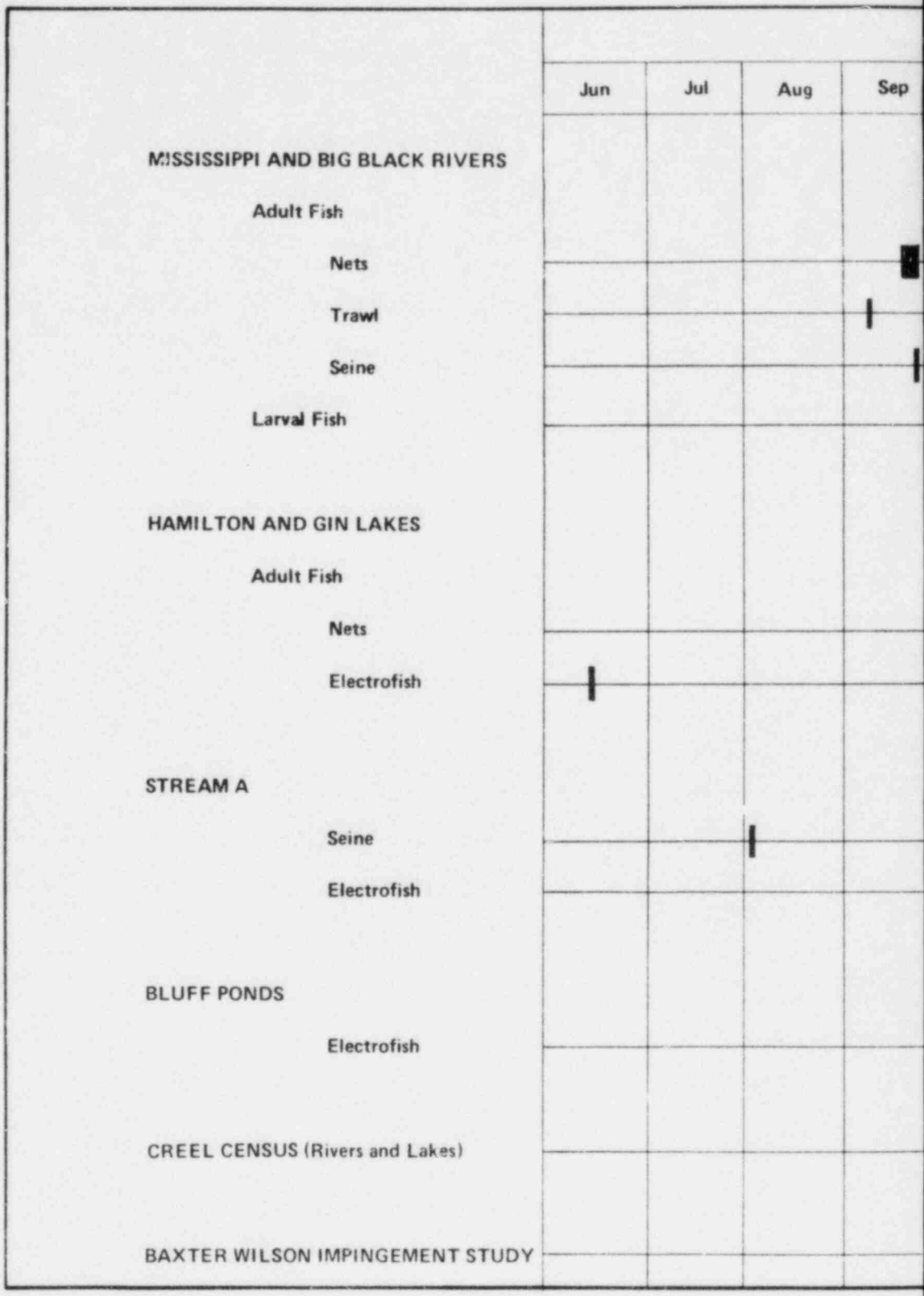
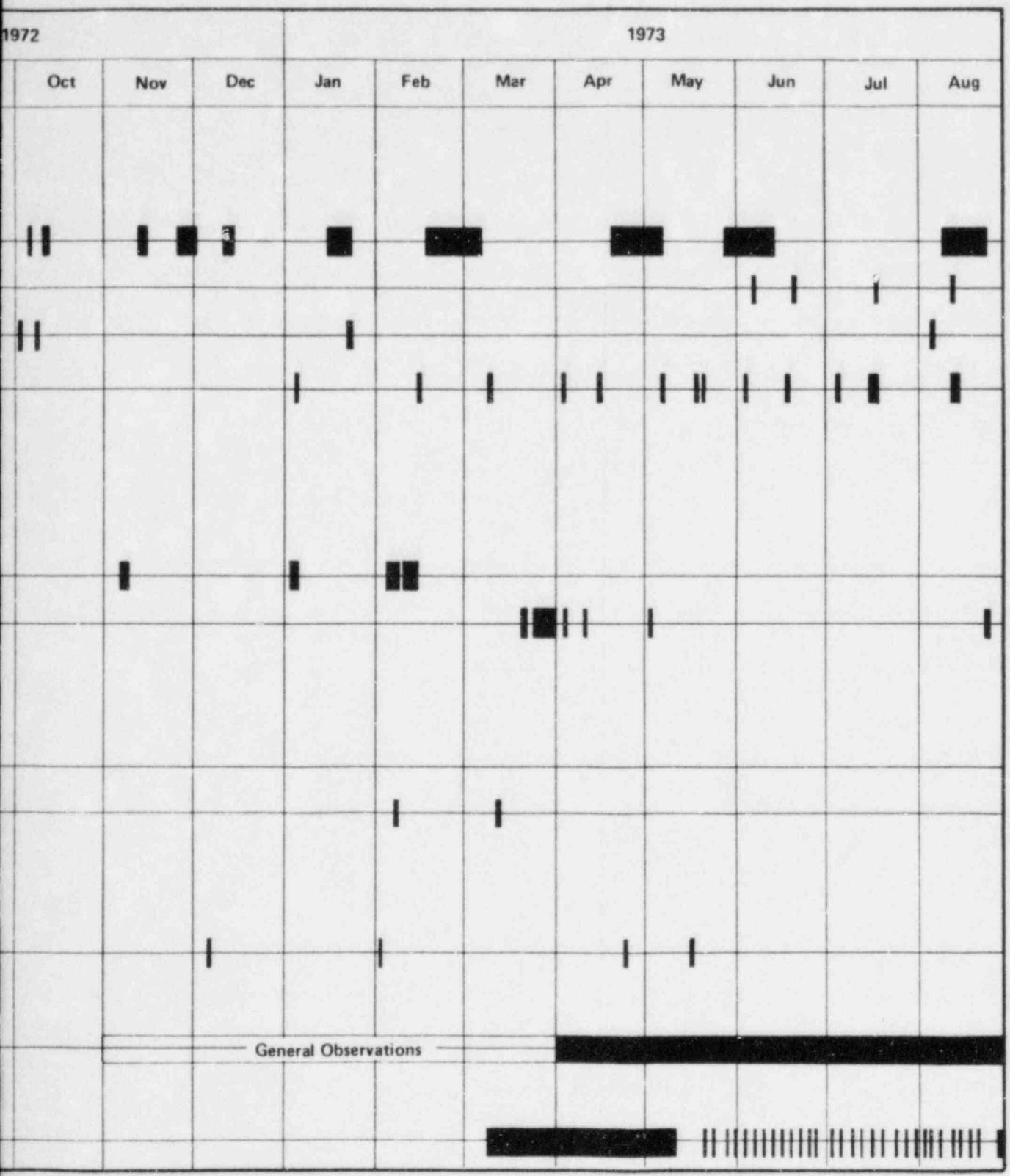
DATA COLLECTION PERIODS
SURFACE WATER QUALITY
FIGURE 6.1-2


Jun
Jul
Aug
Sep
MISSISSIPPI AND BIG BLACK RIVERS
Adult Fish
Nets
Trawl
Seine
Larval Fish
HAMILTON AND GIN LAKES
Adult Fish
Nets
Electrofish
STREAM A
Seine
Electrofish
BLUFF PONDS
Electrofish
CREEL CENSUS (Rivers and Lakes)
BAXTER WILSON IMPINGEMENT STUDY



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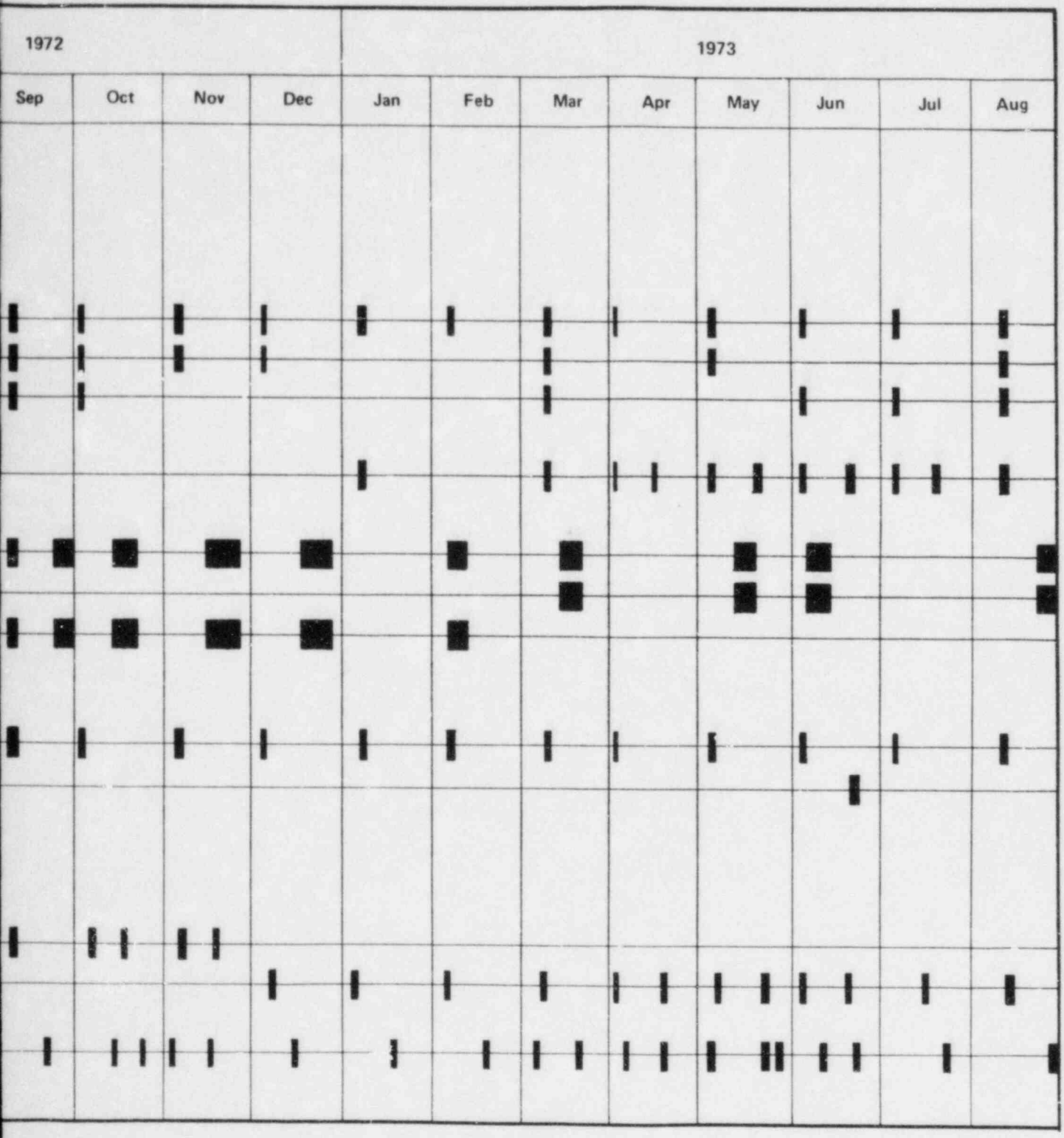
DATA COLLECTION PERIOD
AQUATIC ECOLOGY-FISHES
FIGURE 6.1-3

	Jun	Jul	Aug
BENTHIC MACROINVERTEBRATES			
MISSISSIPPI AND BIG BLACK RIVERS			
Benthos			
Sta. 1, 3, 5, 6 & 10			
Sta. 9			
Sta. 4 & 7			
Drifting Benthos			
Sta. 3 & 6			
Shrimp			
Sta. 3 & 6			
Between Sta. 3 & 6			
Sta. 5 & 8			
HAMILTON AND GIN LAKES			
Benthos			
Crayfish			
PLANKTON (Zooplankton and Phytoplankton)			
MISSISSIPPI AND BIG BLACK RIVERS			
Sta. 1 through 10			
Sta. 1, 3, 6 & 10			
HAMILTON AND GIN LAKES			



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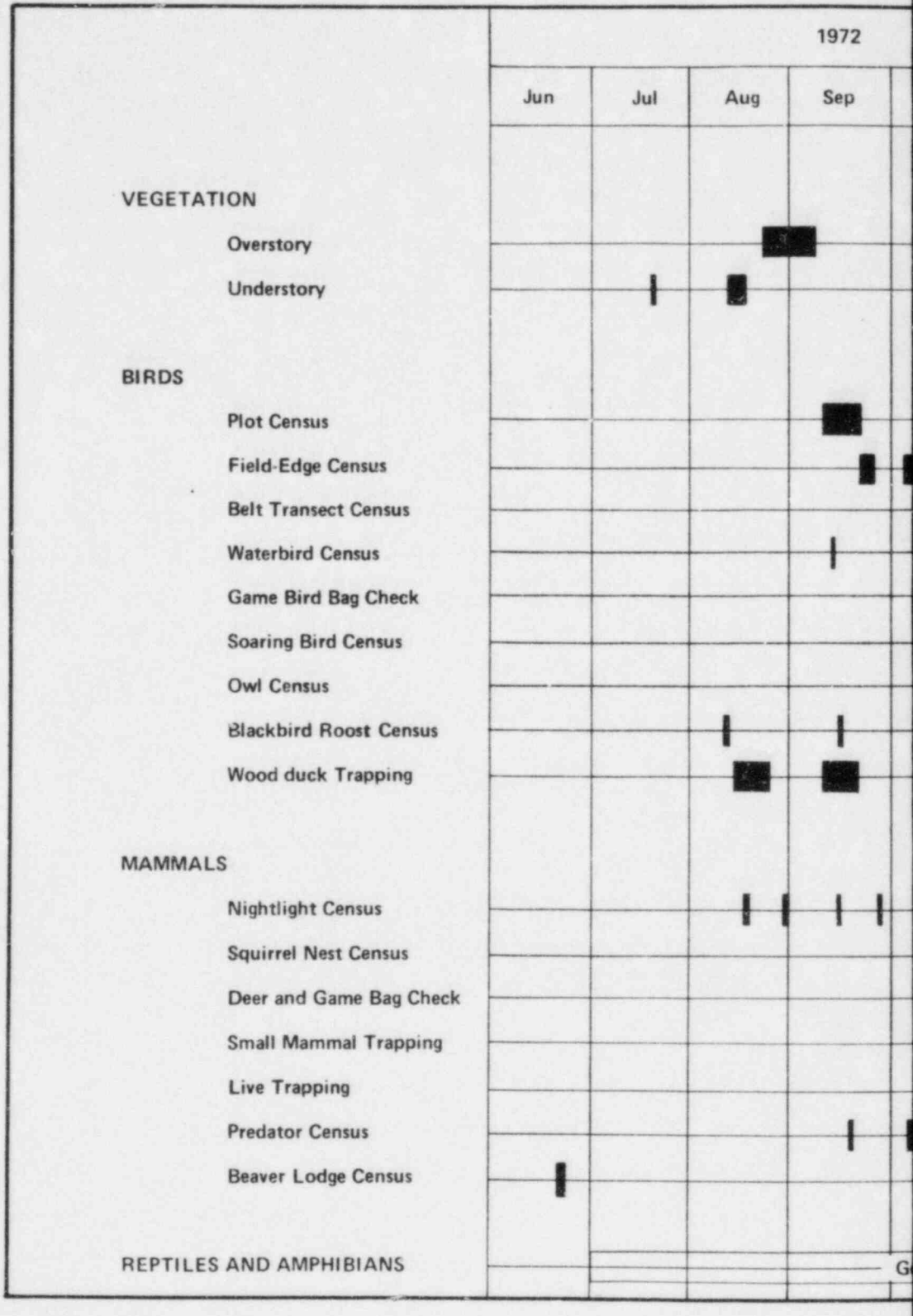
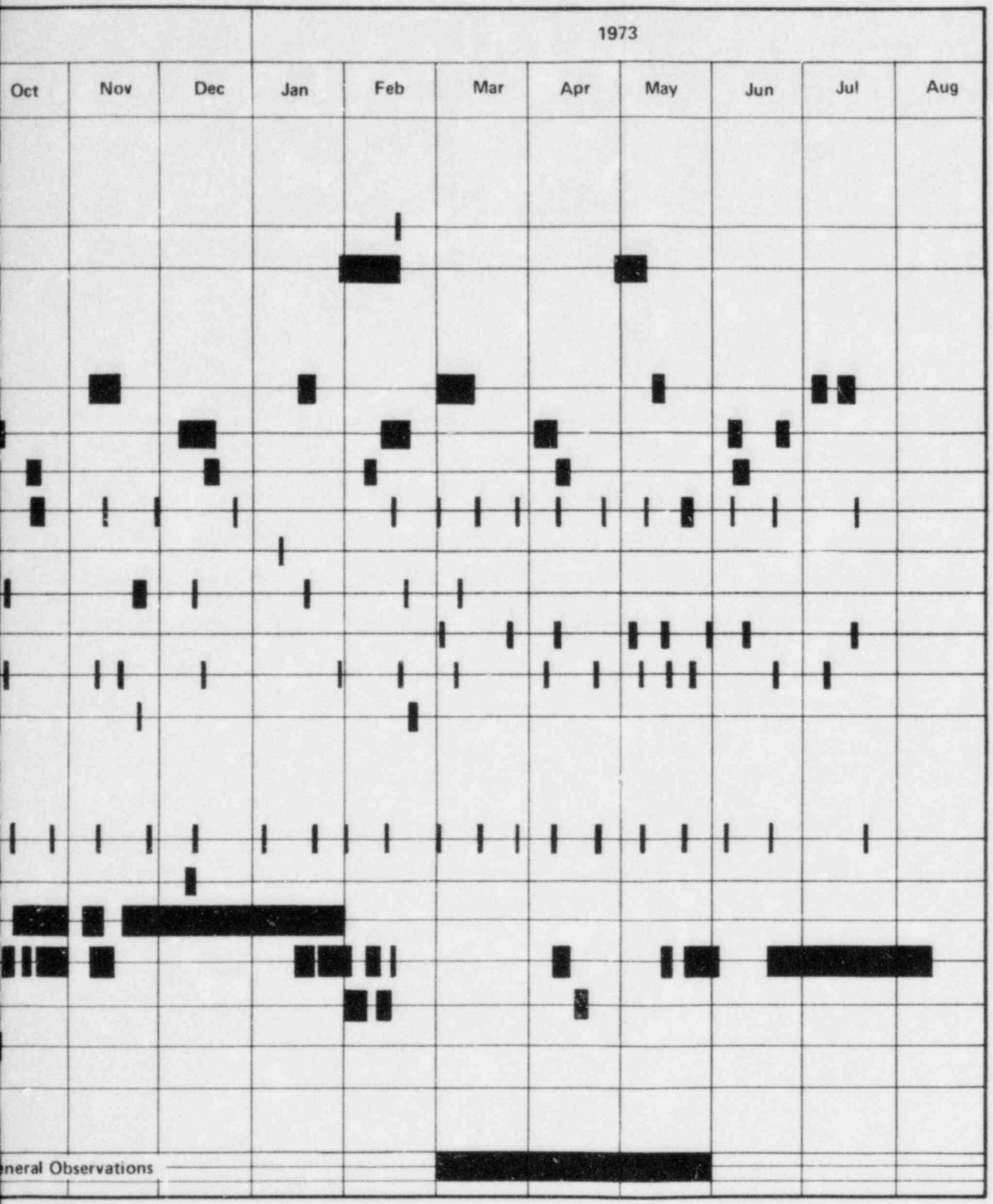
DATA COLLECTION PERIODS
AQUATIC ECOLOGY-
BENTHOS AND PLANKTON
FIGURE 6.1-4


1972
Jun
Jul
Aug
Sep
VEGETATION
Overstory
Understory
BIRDS
Plot Census
Field-Edge Census
Belt Transect Census
Waterbird Census
Game Bird Bag Check
Soaring Bird Census
Owl Census
Blackbird Roost Census
Wood duck Trapping
MAMMALS
Nightlight Census
Squirrel Nest Census
Deer and Game Bag Check
Small Mammal Trapping
Live Trapping
Predator Census
Beaver Lodge Census
REPTILES AND AMPHIBIANS



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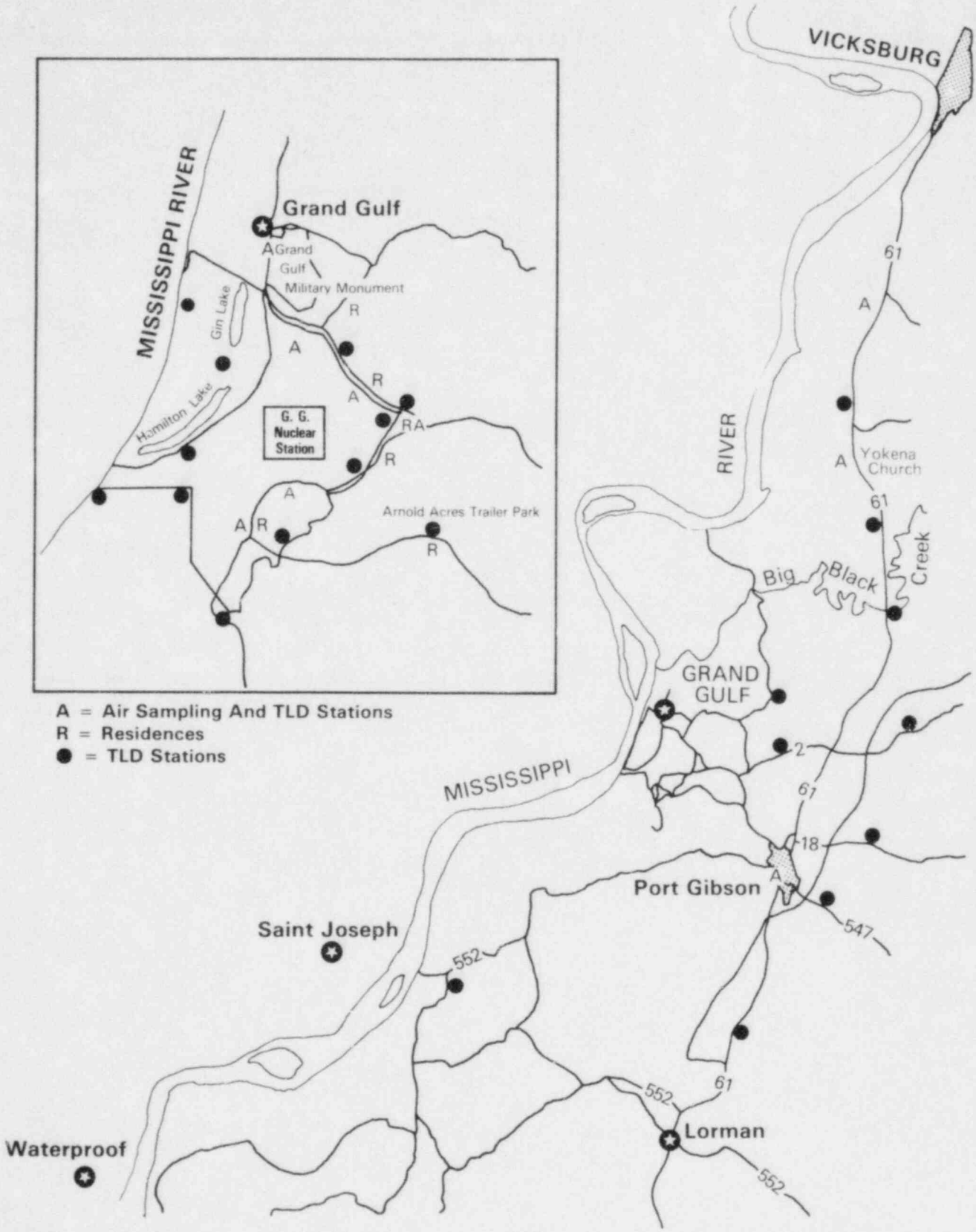
UNITS 1 & 2
ENVIRONMENTAL REPORT

DATA COLLECTION PERIODS
TERRESTRIAL ECOLOGY
FIGURE 6.1-5



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	RADIOLOGICAL ENVIRONMENTAL MONITORING LOCATIONS FIGURE 6.1-6

6.2 PROPOSED OPERATIONAL MONITORING PROGRAMS

Operational environmental monitoring programs are described in the Grand Gulf Nuclear Station Environmental Technical Specifications.

6.3 RELATED ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAMS

With the exception of the programs sponsored by Mississippi Power & Light Company or other operating companies of the Middle South Utilities System, few ongoing environmental monitoring programs are being carried out in the region near Grand Gulf Nuclear Station.

The National Water Data System, operated by the U. S. Geological Survey and cooperating State and Federal agencies in Mississippi have systematically collected stream-flow records since 1931 and water quality records since 1964. Water resources data for Mississippi consist of records of stage, discharge, and water quality for streams; stage, contents, and water quality of lakes and reservoirs; and water levels of wells.

Stage, flow, and temperature records are collected on the Mississippi River by the U. S. Army Corps of Engineers.

The National Weather Service routinely records 24 hourly observations each day at Jackson, Mississippi and Alexandria, Louisiana.

The Mississippi and Louisiana State Boards of Health each plan to initiate a monitoring program for the assessment of environmental radiation levels prior to Grand Gulf Nuclear Station operation. Details of these programs have not been finalized to date.

MP&L will monitor the status of ongoing programs conducted by public agencies in the region for data useful in interpreting the results of their programs.

6.3.1 References

1. "Water Resources Data for Mississippi, Water Year 1976," U. S. Geological Survey Water Data Report ME-76-1, U. S. Department of the Interior, 1977.

2. "Stages and Discharges of the Mississippi River and Tributaries in the Vicksburg District, 1975," U. S. Army Engineer District, Vicksburg Corps of Engineers.

3. Ronald J. Forsythe, Mississippi State Board of Health, Division of Radiological Health, personal communication, 1977.

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6.4 PREOPERATIONAL ENVIRONMENTAL RADIOLOGICAL MONITORING DATA

The various phases of the radiological monitoring program have been discussed in sections 6.1.5 and 6.2. This section summarizes the first six months of data collected from July through December 1978. 2

Tables 6.4.1 through 6.4.14 summarize the analytical data. The collection sites are described in Tables 6.4.15 through 6.4.17. Figures 6.4-1, 6.4-2, and 6.4-3 show locations of these collection sites.

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TABLE 6.4.1

AIRBORNE I-131 AND GROSS BETA CONCENTRATIONS IN AIR PARTICULATE FILTERS
(Weekly Collections)

Collection Date	Collection Site: PG (1) Location: Figure 6.4-2 Volume (m^3)	(10^{-2} pCi/m^3) Gross B	I-131	Collection Site: 61N (2) Location: Figure 6.4-1 Volume (m^3)	(10^{-2} pCi/m^3) Gross B	I-131	Collection Site: 61VA (3) Location: Figure 6.4-1 Volume (m^3)	(10^{-2} pCi/m^3) Gross B	I-131
07-03-78	323	5±1	<7	370	7±1	<7	376	5±1	<7
07-10-78	393	4±1	<7	374	4±1	<7	382	4±1	<7
07-17-78	458	4±1	<7	365	4±1	<7	376	5±1	<7
07-24-78	456	4±1	<7	376	6±1	<7	385	4±1	<7
07-31-78	487	2±1	<7	376	2±1	<7	382	1±1	<7
08-07-78	464	4±1	<7	362	6±1	<7	362	4±1	<7
08-14-78	478	3±1	<7	374	2±1	<7	388	2±1	<7
08-21-78	453	2±1	<7	376	2±1	<7	385	1±1	<7
09-05-78	498	2±1	<7	427	1±1	<7	444	2±1	<7
09-11-78	385	5±1	<7	320	2±1	<7	325	4±1	<7
09-18-78	399	1±1	<7	374	1±1	<7	390	1±1	<7
09-25-78	365	2±1	<7	374	3±1	<7	382	2±1	<7
10-02-78	393	2±1	<7	382	2±1	<7	379	3±1	<7
10-09-78	402	3±1	<7	388	3±1	<7	376	2±1	<7
10-16-78	385	2±1	<7	388	2±1	<7	365	2±1	<7
10-23-78	368	3±1	<7	385	3±1	<7	354	3±1	<7
10-30-78	402	4±1	<7	385	4±1	<7	348	3±1	<7
11-06-78	645	1±1	<7	376	5±1	<7	331	5±1	<7
11-13-78	1129	1±1	<7	679	1±1	<7	673	1±1	<7
11-20-78	458	1±1	<7	475	2±1	<7	526	3±1	<7
11-27-78	430	2±1	<7	348	3±1	<7	328	2±1	<7
12-04-78	566	1±1	<7	498	2±1	<7	518	2±1	<7
12-11-78	631	1±1	<7	572	2±1	<7	501	2±1	<7
12-18-78	625	2±1	<7	521	2±1	<7	495	3±1	<7
12-27-78	790	5±1	<7	657	8±1	<7	623	9±1	<7

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TABLE 6.4.1 (Continued)

AIRBORNE I-131 AND GROSS BETA CONCENTRATIONS IN AIR PARTICULATE FILTERS
(Weekly Collections)

	Collection Site: GJOE ④ Location: Figure 6.4-3			Collection Site: HPO ⑤ Location: Figure 6.4-3			Collection Site: RS ⑥ Location: Figure 6.4-3		
		(10^{-2} pCi/m^3)			(10^{-2} pCi/m^3)			(10^{-2} pCi/m^3)	
Collection Date	Volume (m^3)	Gross B	I-131	Volume (m^3)	Gross B	I-131	Volume (m^3)	Gross B	I-131
07-03-78	391	6±1	<7	382	6±1	<7	362	6±1	<7
07-10-78	399	5±1	<7	385	4±1	<7	204	8±2	<7
07-17-78	422	5±1	<7	385	4±1	<7	374	4±1	<7
07-24-78	405	5±1	<7	393	5±1	<7	379	13±1	<7
07-31-78	424	2±1	<7	390	2±1	<7	368	2±1	<7
08-07-78	419	6±1	<7	382	6±1	<7	371	6±1	<7
08-14-78	427	3±1	<7	107	7±1	<7	665	2±1	<7
08-21-78	422	3±1	<7	402	2±1	<7	91	6±1	<7
08-28-78	393	6±1	<7	402	6±1	<7	422	5±1	<7
09-05-78	464	3±1	<7	450	1±1	<7	374	3±1	<7
09-11-78	354	5±1	<7	348	4±1	<7	325	4±1	<7
09-18-78	419	2±1	<7	410	1±1	<7	379	1±1	<7
09-25-78	410	3±1	<7	422	3±1	<7	385	3±1	<7
10-02-78	399	6±1	<7	407	3±1	<7	388	3±1	<7
10-09-78	379	3±1	<7	419	2±1	<7	399	4±1	<7
10-16-78	365	3±1	<7	422	3±1	<7	402	2±1	<7
10-23-78	340	2±1	<7	413	3±1	<7	388	3±1	<7
10-30-78	376	3±1	<7	427	3±1	<7	410	4±1	<7
11-06-78	354	4±1	<7	407	5±1	<7	388	6±1	<7
11-13-78	716	2±1	<7	809	1±1	<7	795	1±1	<7
11-20-78	348	4±1	<7	405	2±1	<7	393	3±1	<7
11-27-78	348	3±1	<7	376	2±1	<7	351	3±1	<7
12-04-78	457	3±1	<7	444	2±1	<7	504	2±1	<7
12-11-78	685	2±1	<7	464	2±1	<7	529	2±1	<7
12-18-78	226	6±1	<7	464	2±1	<7	512	3±1	<7
12-27-78	563	9±1	<7	577	7±1	<7	665	8±1	<7

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TABLE 6.4.1 (Continued)

AIRBORNE I-131 AND GROSS BETA CONCENTRATIONS IN AIR PARTICULATE FILTERS
(Weekly Collections)

	Collection Site: MET (7) Location: Figure 6.4-3 (10-2 pCi/m3)			Collection Site: WR (8) Location: Figure 6.4-3 (10-2 pCi/m3)			Collection Site: GGMP (9) Location: Figure 6.4-3 (10-2 pCi/m3)		
Collection Date	Volume (m^3)	Gross B	I-131	Volume (m^3)	Gross B	I-131	Volume (m^3)	Gross B	I-131
07-03-78	340	7±1	<7	425	5±1	<7	382	5±1	<7
07-10-78	345	5±1	<7	481	3±1	<7	430	3±1	<7
07-17-78	342	5±1	<7	464	3±1	<7	436	4±1	<7
07-24-78	351	6±1	<7	487	4±1	<7	391	4±1	<7
07-31-78	340	2±1	<7	495	1±1	<7	300	2±1	<7
08-07-78	345	7±1	<7	393	4±1	<7	266	7±1	<7
08-14-78	348	2±1	<7	665	2±1	<7	385	2±1	<7
08-21-78	340	2±1	<7	427	1±1	<7	379	2±1	<7
08-28-78	351	6±1	<7	393	3±1	<7	382	6±1	<7
09-05-78	374	2±1	<7	385	1±1	<7	427	2±1	<7
09-11-78	294	3±1	<7	345	3±1	<7	323	4±1	<7
09-18-78	345	2±1	<7	337	<1	<7	379	1±1	<7
09-25-78	351	2±1	<7	259	2±1	<7	382	2±1	<7
10-02-78	351	2±1	<7	458	1±1	<7	388	2±1	<7
10-09-78	357	3±1	<7	374	2±1	<7	413	2±1	<7
10-16-78	359	2±1	<7	348	2±1	<7	393	2±1	<7
10-23-78	345	4±1	<7	354	2±1	<7	390	4±1	<7
10-30-78	354	4±1	<7	402	4±1	<7	399	3±1	<7
11-06-78	348	6±1	<7	351	4±1	<7	390	4±1	<7
11-13-78	707	1±1	<7	690	1±1	<7	790	1±1	<7
11-20-78	351	3±1	<7	473	2±1	<7	393	2±1	<7
11-27-78	325	4±1	<7	351	2±1	<7	351	2±1	<7
12-04-78	436	3±1	<7	526	2±1	<7	509	2±1	<7
12-11-78	481	2±1	<7	540	2±1	<7	523	2±1	<7
12-18-78	464	2±1	<7	518	2±1	<7	526	2±1	<7
12-27-78	608	8±1	<7	690	6±1	<7	665	9±1	<7

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TABLE 6.4.2

RADIONUCLIDES IN AIR PARTICULATE SAMPLES
(Quarterly Analysis on Composite of Weekly Collections)

Collection Site	Location	No.	3rd Quarter 1978 (pCi/m^3) Ce-144	3rd Quarter 1978 (pCi/m^3) Other Gamma*	4th Quarter 1978 (pCi/m^3) Ce-144	4th Quarter 1978 (pCi/m^3) Other Gamma*
PG	Figure 6.4-2	1	<.03	<.01	<0.02	<0.01
61N	Figure 6.4-1	2	<.03	<.01	<0.02	<0.01
61VA	Figure 6.4-1	3	.03±.01	<.01	<0.02	<0.01
GJOE	Figure 6.4-3	4	<.03	<.01	<0.02	<0.01
HPO	Figure 6.4-3	5	<.03	<.01	<0.02	<0.01
RS	Figure 6.4-3	6	<.03	<.01	<0.02	<0.01
MET	Figure 6.4-3	7	<.03	<.01	<0.02	<0.01
WR	Figure 6.4-3	8	<.03	<.01	<0.02	<0.01
GGMP	Figure 6.4-3	9	<.03	<.01	<0.02	<0.01

*The spectrum is computer scanned from ∿20 to ∿2000 keV. Specifically included are Ce-144, Ba-La-140, Cs-134, Cs-137, Zr-Nb-95, Co-58, Co-60, Mn-54, Zn-65. Naturally occurring gamma emitters such as K-40 and Ra daughters are frequently detected but not listed here. Data listed as "<" are at the 3σ level; others are 2σ. Unless otherwise noted, listed concentration is for Cs-137 and may be slightly more or less sensitive for other nuclides.

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TABLE 6.4.3

RADIONUCLIDES IN SURFACE WATER SAMPLES
(Monthly Collections)

Collection Period		Gamma Emitters* (pCi/1)	
		Collection Site: MRUP Location: Figure 6.4-3 (1)	Collection Site: MRDOWN Location: Figure 6.4-3 (2)
1978	July	<15	<15
	August	<15	<15
	September	<15	<15
	October	<15	<15
	November	<15	<15
	December	<15	<15

*The spectrum is computer scanned from ∿20 to ∿2000 keV. Specifically included are Ce-144, Ba-La-140, Cs-134, Cs-137, Zr-Nb-95, Co-58, Co-60, Mn-54, Zn-65. Naturally occurring gamma emitters such as K-40 and Ra daughters are frequently detected but not listed here. Data listed as "<" are at the 3σ level; others are 2σ. Unless otherwise noted, listed concentration is for Cs-137 and may be slightly more or less sensitive for other nuclides.

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TABLE 6.4.4

TRITIUM CONCENTRATIONS IN SURFACE WATER SAMPLES

	Tritium (pCi/l)	
Collection Period	Collection Site: MRUP Location: Figure 6.4-3 (1)	Collection Site: MRDOWN Location: Figure 6.4-3 (2)
09/12/78	250 ± 130	240 ± 140
10/11/78	450 ± 130	410 ± 130
12/16/78	400 ± 100	200 ± 100

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TABLE 6.4.5

RADIONUCLIDES IN WELL WATER SAMPLES
(Quarterly Collections)

Collection Period	Collection Site: ARKWELL Location: Figure 6.4-2 [5]		Collection Site: TRIMWELL Location: Figure 6.4-2 [2]		Collection Site: PGWELL Location: Figure 6.4-2 [4]		Collection Site: MPWELL Location: Figure 6.4-2 [6]	
	pCi/l		pCi/l		pCi/l		pCi/l	
	γEmitters*	Tritium	γEmitters*	Tritium	γEmitters*	Tritium	γEmitters*	Tritium
July, 1978	<15	---	<15	---	New wells beginning August, 1978			
August, 1978	Well deleted August, 1978		<15	1200±400	<15	450±380	<15	---
12/07/78			<15	<330	<15	<330	<15	470±90

*The spectrum is computer scanned from ∿20 to ∿2000 keV. Specifically included are Ce-144, Ba-La-140, Cs-134, Cs-137, Zr-Nb-95, Co-58, Co-60, Mn-54, Zn-65. Naturally occurring gamma emitters such as K-40 and Ra daughters are frequently detected but not listed here. Data listed as "<" are at the 3σ level; others are 2σ. Unless otherwise noted, listed concentration is for Cs-137 and may be slightly more or less sensitive for other nuclides.

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TABLE 6.4.6

RADIOACTIVITY IN CISTERN WATER SAMPLES
(Monthly Collections)

	Collection Period	Collection Site: ARKCIST Location: Figure 6.4-2 [5] pCi/l			Collection Site: TRIMCIST Location: Figure 6.4-2 [2] pCi/l		
		Gross Beta	I-131	Gamma Emitters*	Gross Beta	I-131	Gamma Emitters*
1978	July	2±2	<1	<15	2±2	<1	<15
	August	<3	<1	<15	10±2	<1	<15
	September	5±2	<1	<15	5±2	<1	<15
	October	<2	<1	<15	<2	<1	<15
	November	3±1	<1	<15	2±2	<1	<15
	December	4±1	<1	<15	6±2	<1	<15

*The spectrum is computer scanned from ∿20 to ∿2000 keV. Specifically included are Ce-144, Ba-La-140, Cs-134, Cs-137, Zr-Nb-95, Co-58, Co-60, Mn-54, Zn-65. Naturally occurring gamma emitters such as K-40 and Ra daughters are frequently detected but not listed here. Data listed as "<" are at the 3σ level; others are 2σ. Unless otherwise noted, listed concentration is for Cs-137 and may be slightly more or less sensitive for other nuclides.

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TABLE 6.4.7

TRITIUM CONCENTRATIONS IN CISTERN WATER SAMPLES
(Quarterly Collections)

Collection Period	Tritium (pCi/l)	
	Collection Site: ARKCIST Location: Figure 6.4-2 [5]	Collection Site: TRIMCIST Location: Figure 6.4-2 [2]
1978 3rd Quarter	<330	<330
4th Quarter	<320	<330

TABLE 6.4.8

RADIOACTIVITY IN MILK SAMPLES
(Monthly Collections)

	Collection Period	Collection Site[1]	pCi/l I-131	pCi/l Gamma Emitters[2]
1978	July	ALCONT	<0.5	<15
	August	ALCONT	<0.5	<15
	September	ALCONT	<0.5	<15
	October	ALCONT	<0.5	<15
	November	ALCONT	<1	<15
	December	ALCONT	<1	<15
	December	ALCONT	<1	<15

[1]All samples collected at Alcorn University. See Figure 6.4-2 [5]

[2]The spectrum is computer scanned from ∿20 to ∿2000 keV. Specifically included are Ce-144, Ba-La-140, Cs-134, Cs-137, Zr-Nb-95, Co-58, Co-60, Mn-54, Zn-65. Naturally occurring gamma emitters such as K-40 and Ra daughters are frequently detected but not listed here. Data listed as "<" are at the 3σ level; others are 2σ. Unless otherwise noted, listed concentration is for Cs-137 and may be slightly more or less sensitive for other nuclides.

TABLE 6.4.9

GAMMA EMITTERS* IN FRUIT AND VEGETABLE SAMPLES
(Collected at Harvest)

Sample Type	Location	Collection Date	γEmitters pCi/g wet wt.
Pecans	Figure 6.4-2 [2]	03/18/78	<0.08
Mustard Greens	Figure 6.4-2 [5]	11/22/78	<0.08
Turnip Greens	Figure 6.4-2 [5]	11/22/78	<0.08

*The spectrum is computer scanned from ∿20 to ∿2000 keV. Specifically included are Ce-144, Ba-La-140, Cs-134, Cs-137, Zr-Nb-95, Co-58, Co-60, Mn-54, Zn-65. Naturally occurring gamma emitters such as K-40 and Ra daughters are frequently detected but not listed here. Data listed as "<" are at the 3σ level; others are 2σ. Unless otherwise noted, listed concentration is for Cs-137 and may be slightly more or less sensitive for other nuclides.

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TABLE 6.4.10

GAMMA EMITTERS IN FISH SAMPLES
(Semiannual Collections)

Collection Site	Location	Collection Date	Species	pCi/g (wet) Gamma Emitters*
Hamilton Lake	Figure 6.4-2 [1]	10/03/78	Buffalo	<0.13
Hamilton Lake	Figure 6.4-2 [1]	10/03/78	White Bass	<0.13
Hamilton Lake	Figure 6.4-2 [1]	10/03/78	Fresh Water Drum	<0.13
Hamilton Lake	Figure 6.4-2 [1]	10/03/78	Catfish	<0.13
Hamilton Lake	Figure 6.4-2 [1]	10/03/78	White Crappie	<0.13

*The spectrum is computer scanned from ∿20 to ∿2000 keV. Specifically included are Ce-144, Ba-La-140, Cs-134, Cs-137, Zr-Nb-95, Co-58, Co-60, Mn-54, Zn-65. Naturally occurring gamma emitters such as K-40 and Ra daughters are frequently detected but not listed here. Data listed as "<" are at the 3σ level; others are 2σ. Unless otherwise noted, listed concentration is for Cs-137 and may be slightly more or less sensitive for other nuclides.

TABLE 6.4.11

GAMMA EMITTERS IN MEAT SAMPLES
(Semiannual Collections)

Collection Site	Location	Collection Date	Sample Type	pCi/g (wet) Gamma Emitters*	pCi/g (wet) Fe-59 Zn-65
MET	Figure 6.4-3 (7)	12/12/78	Deer	<0.13	<0.26
MET	Figure 6.4-3 (7)	12/12/78	Rabbit	<0.13	<0.26

*The spectrum is computer scanned from ∿20 to ∿2000 keV. Specifically included are Ce-144, Ba-La-140, Cs-134, Cs-137, Zr-Nb-95, Co-58, Co-60, Mn-54, Zn-65. Naturally occurring gamma emitters such as K-40 and Ra daughters are frequently detected but not listed here. Data listed as "<" are at the 3σ level; others are 2σ. Unless otherwise noted, listed concentration is for Cs-137 and may be slightly more or less sensitive for other nuclides.

TABLE 6.4.12

GAMMA EMITTERS* IN SEDIMENT SAMPLES
(Semiannual Collections)

Collection Site	Location	Collection Date	pCi/g dry Gamma Emitters*
MRUP	Figure 6.4-3 (1)	10/26/78	<0.15
MRDOWN	Figure 6.4-3 (2)	10/26/78	<0.15
BRGSLP	Figure 6.4-3 (3)	10/27/78	<0.15

*The spectrum is computer scanned from ∿20 to ∿2000 keV. Specifically included are Ce-144, Ba-La-140, Cs-134, Cs-137, Zr-Nb-95, Co-58, Co-60, Mn-54, Zn-65. Naturally occurring gamma emitters such as K-40 and Ra daughters are frequently detected but not listed here. Data listed as "<" are at the 3σ level; others are 2σ. Unless otherwise noted, listed concentration is for Cs-137 and may be slightly more or less sensitive for other nuclides.

TABLE 6.4.13

GAMMA EMITTERS[1] IN SOIL SAMPLES
(Collection Once Prior to Plant Operation)

Collection Site[2]		Location	Collection Date	pCi/g dry Cs-137	pCi/g dry Other Gamma[1]
PG	(T)	Figure 6.4-2 (1)	10/26/78	<0.15	<0.15
PG	(M)		10/26/78	<0.15	<0.15
PG	(B)		10/26/78	<0.15	<0.15
HPO	(T)	Figure 6.4-3 (5)	10/31/78	<0.15	<0.15
HPO	(M)		10/31/78	<0.15	<0.15
HPO	(B)		10/31/78	<0.15	<0.15
GJOE	(T)	Figure 6.4-3 (4)	10/29/78	0.43±0.09	<0.15
GJOE	(M)		10/29/78	0.30±0.10	<0.15
GJOE	(B)		10/29/78	0.30±0.10	<0.15
61n	(T)	Figure 6.4-1 (2)	10/26/78	0.99±0.15	<0.15
61n	(M)		10/26/78	0.83±0.12	<0.15
61n	(B)		10/26/78	0.33±0.09	<0.15
61n	(T)	Figure 6.4-1 (3)	10/26/78	0.58±0.09	<0.15
61n	(M)		10/26/78	0.22±0.06	<0.15
61n	(B)		10/26/78	0.31±0.06	<0.15
GGMP	(T)	Figure 6.4-3 (9)	10/27/78	0.26±0.06	<0.15
GGMP	(M)		10/27/78	0.11±0.04	<0.15
GGMP	(B)		10/27/78	<0.15	<0.15
MET	(T)	Figure 6.4-3 (7)	10/30/78	0.66±0.10	<0.15
MET	(M)		10/30/78	0.33±0.08	<0.15
MET	(B)		10/30/78	0.36±0.07	<0.15
WR	(T)	Figure 6.4-3 (8)	10/30/78	0.76±0.14	<0.15
WR	(M)		10/30/78	0.80±0.12	<0.15
WR	(B)		10/30/78	0.43±0.10	<0.15
RS	(T)	Figure 6.4-3 (6)	10/30/78	<0.15	<0.15
RS	(M)		10/30/78	<0.15	<0.15
RS	(B)		10/30/78	<0.15	<0.15

[1]The spectrum is computer scanned from ∿20 to ∿2000 keV. Specifically included are Ce-144, Ba-La-140, Cs-134, Cs-137, Zr-Nb-95, Co-58, Co-60, Mn-54, Zn-65. Naturally occurring gamma emitters such as K-40 and Ra daughters are frequently detected but not listed here. Data listed as "<" are at the 3σ level; others are 2σ. Unless otherwise noted, listed concentration is for Cs-137 and may be slightly more or less sensitive for other nuclides.

[2](T) = Top soil; detritus, shallow roots.
(M) = Middle soil; undisturbed for past 5 years.
(B) = Bottom soil; never disturbed.

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TABLE 6.4.14

GAMMA RADIATION
AVERAGE mR/QTR. USING THERMOLUMINESCENT DOSIMETERS
1978

			3rd quarter	4th quarter
Date Annealed:			06/20/78	09/21/78
Date Read:			10/11/78	01/11/79
Collection Site	Location	No.	mR/Quarter	
M-00 Control	Figure 6.4-2	0	4.7±0.7	4.4±0.8
M-01	Figure 6.4-2	1	14.3±2.6	16.9±2.6
M-02	Figure 6.4-2	2	missing	16.9±2.6
M-03	Figure 6.4-2	3	11.1±1.4	12.1±1.8
M-04	Figure 6.4-2	4	14.3±1.3	14.3±1.3
M-05	Figure 6.4-2	5	15.7±2.6	16.9±3.9
M-06	Figure 6.4-2	6	13.0±2.6	16.9±2.6
M-07	Figure 6.4-2	7	11.6±2.6	13.0±1.3
M-08	Figure 6.4-2	8	14.3±1.3	15.6±1.3
M-09	Figure 6.4-2	9	14.3±1.3	14.3±2.6
M-10	Figure 6.4-3	10	13.0±2.6	15.6±1.3
M-11	Figure 6.4-1	11	14.3±1.3	14.3±2.6
M-12	Figure 6.4-1	12	13.0±1.3	14.3±1.3
M-13	Figure 6.4-1	13	12.9±1.7	14.3±2.6
M-14	Figure 6.4-1	14	14.3±1.3	14.3±2.6
M-15	Figure 6.4-3	15	9.5±1.7	11.4±1.6
M-16	Figure 6.4-3	16	12.5±1.3	14.3±2.6
M-17	Figure 6.4-3	17	12.2±2.0	14.3±2.6
M-18	Figure 6.4-3	18	missing	12.9±1.3
M-19	Figure 6.4-3	19	13.0±1.3	missing
M-20	Figure 6.4-3	20	13.0±2.6	14.3±2.5
M-21	Figure 6.4-3	21	11.8±2.6	14.3±2.1
M-22	Figure 6.4-3	22	14.3±2.5	14.3±1.3
M-23	Figure 6.4-3	23	12.0±1.4	14.3±1.3
M-24	Figure 6.4-3	24	14.3±1.3	15.6±5.2
M-25	Figure 6.4-3	25	14.3±1.3	14.3±3.9
M-26	Figure 6.4-3	26	15.6±2.6	15.6±2.5
M-27	Figure 6.4-3	27	12.9±2.1	14.3±2.6
M-28	Figure 6.4-3	28	14.3±1.3	14.3±2.6
M-29	Figure 6.4-3	29	14.3±1.3	15.6±2.6
M-30	Figure 6.4-3	30	missing	14.3±3.9

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TABLE 6.4.15

AIR SAMPLER COLLECTION SITES

Collection Sites	Description
PG	Port Gibson City Barn - located inside fence, west side
61N	Hwy 61 North at Yokena Church
61VA	Hwy 61 North at Vicksburg Airport
GJOE	On southwest boundary of Gladjo lot and residence
HPO	Located behind the temporary MP&L Staff Offices
RS	Northeast of site, at roadside across from residences located 100 meters west of Creek Bridge, site perimeter
MET	Located east side of Met Shack within fenced boundary
WR	Located on Waterloo Road at residence nearest site perimeter
GGMP	Located in Grand Gulf Military Park on road leading to cemetery, north side of road

TABLE 6.4.16

MISCELLANEOUS COLLECTION SITES

Collection Site	Description
ARKCIST	Cistern water sample from the ARK, property of Col. S. B. McGruder
ARKWELL	Well water sample from the ARK, property of Col. S. B. McGruder
PGWELL	Ground water sample from Port Gibson well system (composite of all wells operational on the day of sampling)
ALCONT	Milk sample (control) from Alcorn University Dairy Herd
MRUP	Surface water sample from the Mississippi River (control) upstream
MRDOWN	Surface water sample from the Mississippi River downstream
BRGSLP	Grand Gulf Nuclear Station bargeslip; discharge structure empties into the bargeslip
FISH	Fish sample from Lake Hamilton
MPWELL	Ground water sample from Grand Gulf Military Park well
TRIMCIST	Cistern water sample from tenant house at GGNS property line
TRIMWELL	Ground water sample from Ms. M. L. Trimble property near site boundary

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TABLE 6.4.17

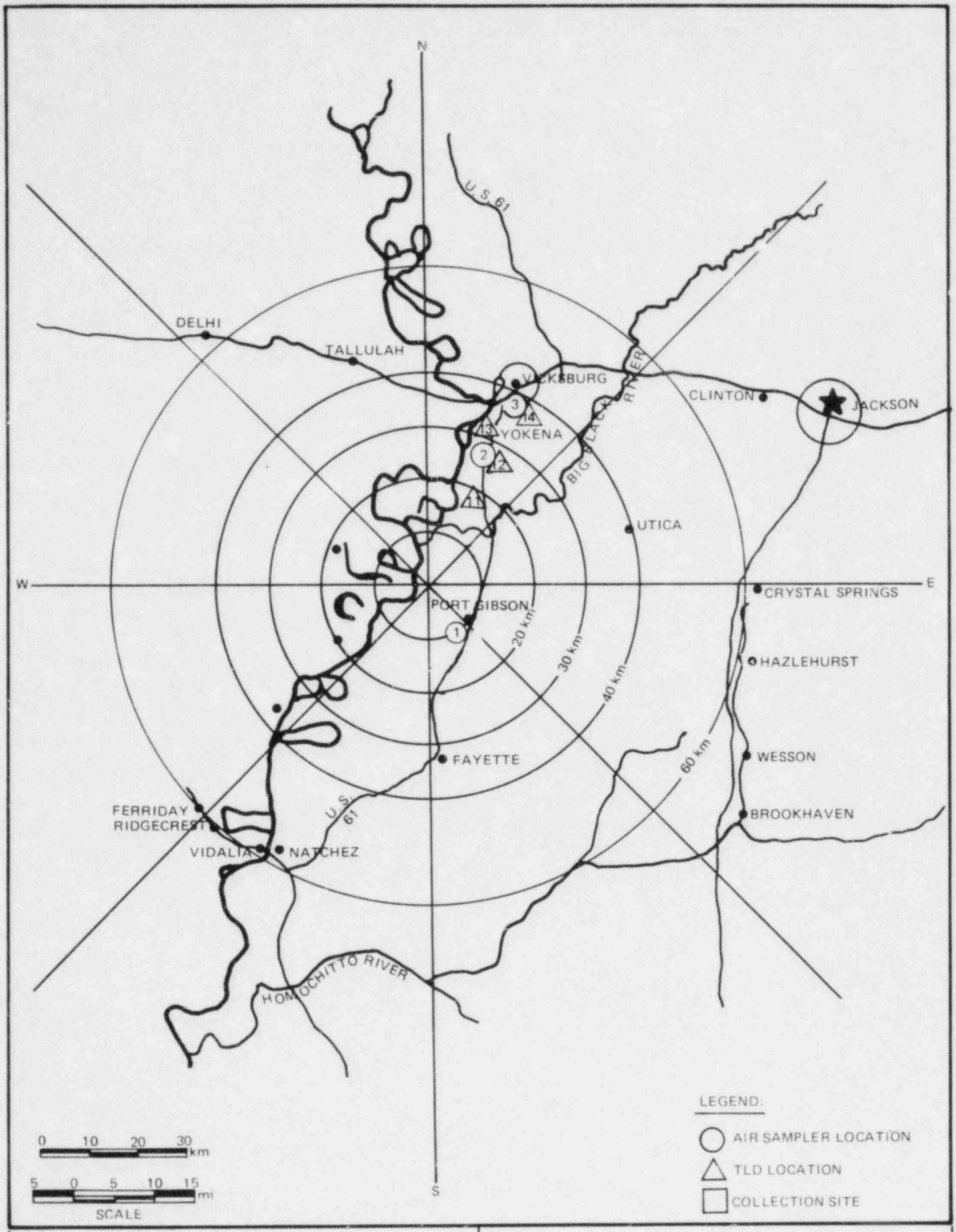
TLD LOCATIONS

Collection Site	Description
	SITE AND WARREN COUNTY
M11	Hwy 61 - 5 km north of Big Black River Bridge
M12	Hwy 61 - at 61N location - YOKENA
M13	Hwy 61 - 13 km north of Big Black River Bridge, west side of Hwy
M14	Hwy 61 - at 61VA location - Vicksburg Airport
	SITE PERIMETER AND WITHIN 3 KILOMETERS
M10	South of main gate GRAND GULF MILITARY PARK 25 meters
M15	Northern most point of site perimeter - river's edge
M16	At MET location - Met Shack, site
M17	At RS location - GRAND GULF ROAD
M18	Eastern site boundary
M19	Eastern site boundary
M20	Eastern site boundary
M21	At HPO location - behind Health Physics Offices
M22	South of HP offices 200 meters
M23	Cross roads - heavy haul road and Bucksnort N/C road
M24	Radial well pump switching station, river's edge
M25	Hamilton Lake boat launching area
M26	Bucksnort H/C boundary in woods 100 meters from road
M27	Southern most point of site perimeter - river's edge
M28	At GJOE location - near Gladjo residence
M29	Road to Waterloo Plantation, 2 km from Waterloo Road turnoff
M30	Arnold Acres Trailer Park

TABLE 6.4.17 (Continued)

CLAIBORNE COUNTY

Collection Site	Description
M01	REA pole east of the entry gate to Lake Claiborne approximately 100 meters
M02	At the entrance to Windsor castle or the REA power pole
M03	South of Port Gibson, near the entrance to the Mosswood Country Club, east side of highway on REA power pole
M04	Hwy 547, east of the Natchez Trace Overpass approximately 100 meters, between the twin power lines
M05	Hwy 18, north of the highway approximately 25 meters located on the REA power line
M06	East of the Willows, beyond the MMB church, on the REA power pole, Hwy 462
M07	Port Gibson City Barn
M08	At the south entrance to the Big Black River Bridge
M09	Oak Tree south of the entrance to Warner-Tully YMCA camp



MISSISSIPPI POWER & LIGHT COMPANY
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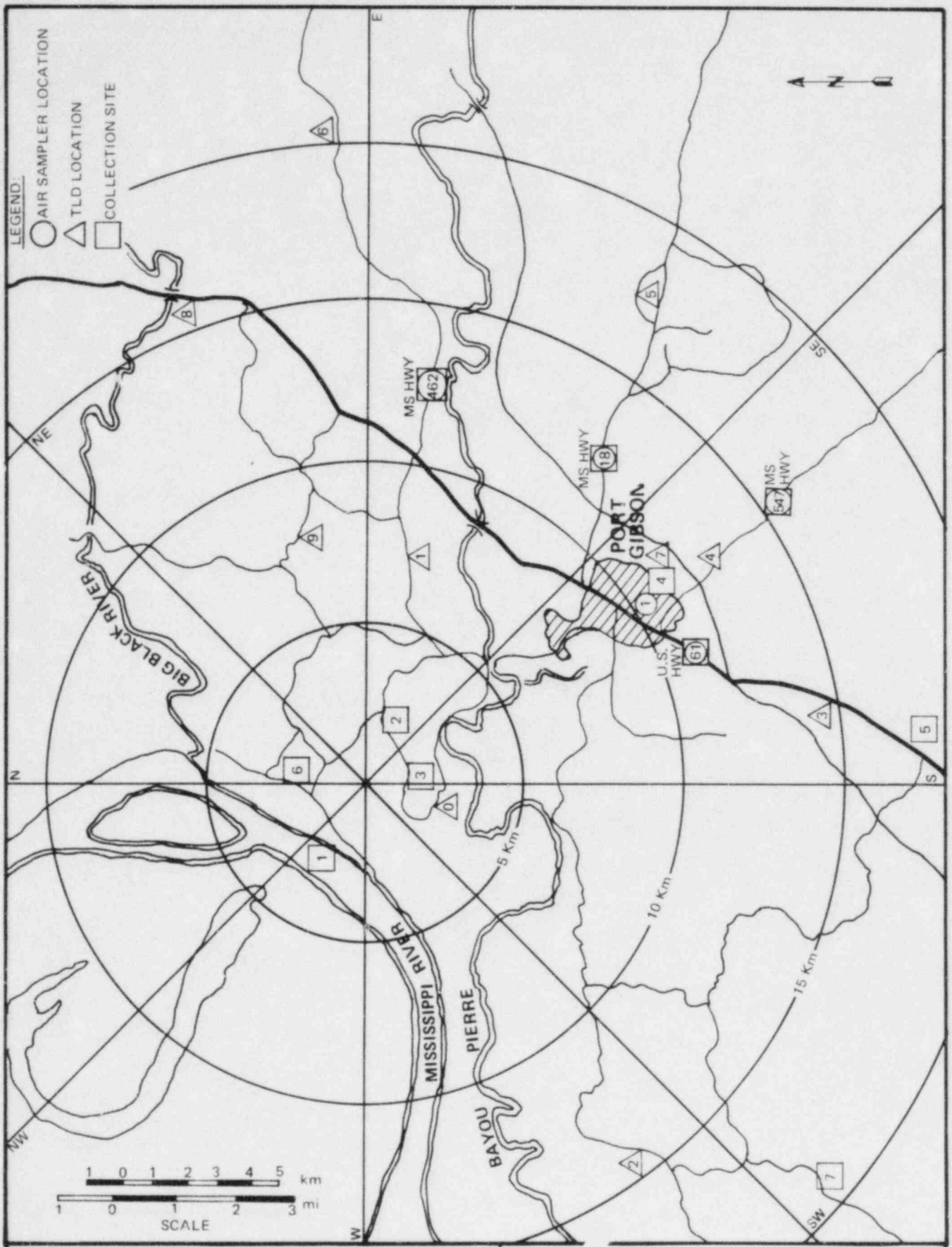
UNITS 1 & 2
ENVIRONMENTAL REPORT

COLLECTION SITE LOCATIONS
GENERAL AREA MAP

FIGURE 6.4-1



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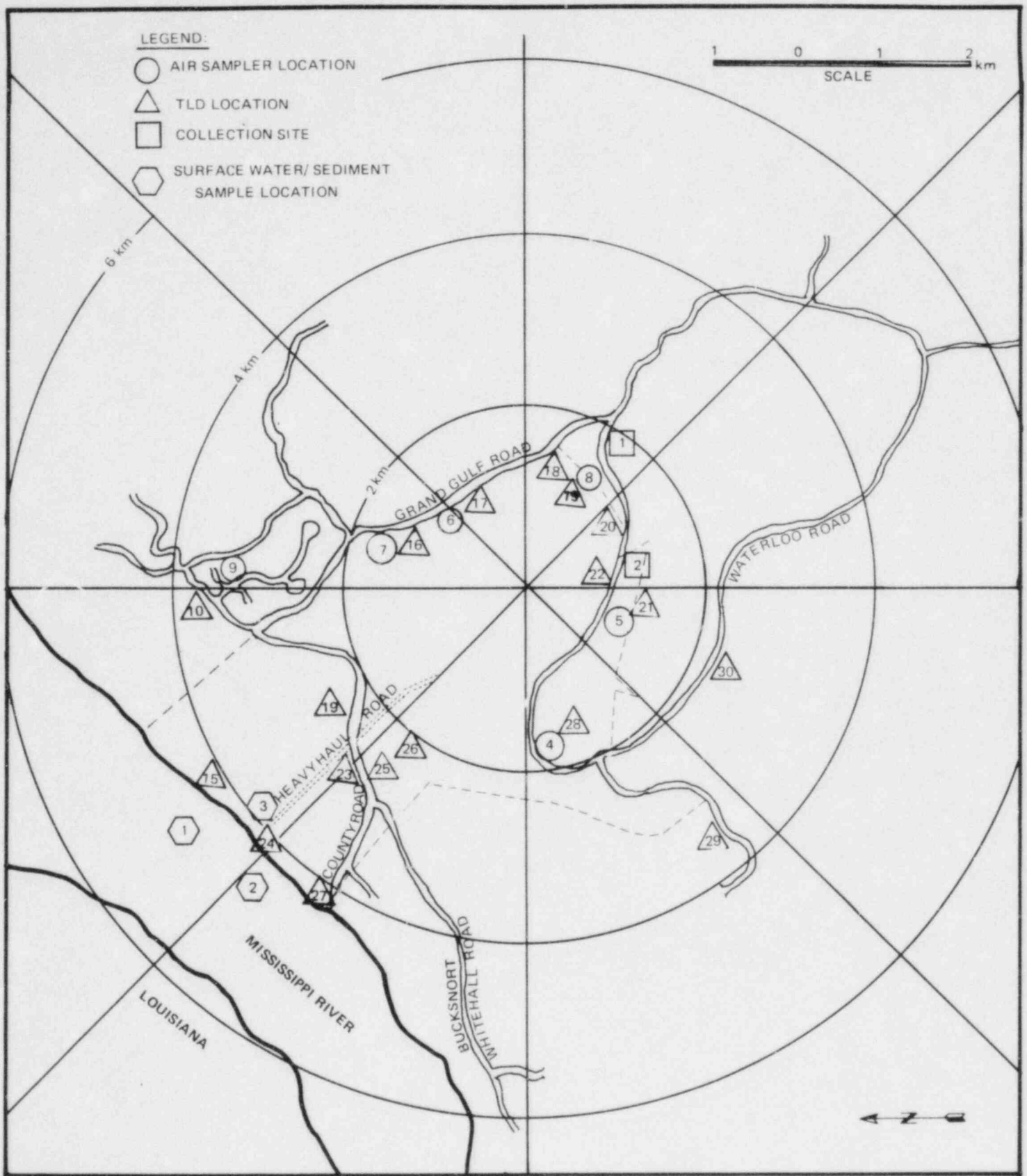
CC ECTION SITE LOCATIONS
CLAIBORNE COUNTY, MISSISSIPPI

FIGURE 6.4-2



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	COLLECTION SITE LOCATIONS SITE PERIMETER FIGURE 6.4-3

Amend. 2 11/79

CHAPTER 7

ENVIRONMENTAL EFFECTS OF ACCIDENTS

TABLE OF CONTENTS

		Page
7.1	STATION ACCIDENTS INVOLVING RADIOACTIVITY	7.1-1
	7.1.1 Class 1 - Trivial Incidents	7.1-2
	7.1.2 Class 2 - Small Releases Outside Containment	7.1-2
	7.1.3 Class 3 - Radwaste System Failures	7.1-2
	7.1.3.1 Equipment Leakage or Malfunction (Including Operator Error)	7.1-2
	7.1.3.2 Release of Gaseous Waste Storage Tank Contents	7.1-3
	7.1.3.3 Release of Liquid Waste Storage Tank Contents	7.1-3
	7.1.4 Class 4 - Fission Products to Primary System (BWR)	7.1-3
	7.1.4.1 Fuel Cladding Defects	7.1-3
	7.1.4.2 Off-design Transients That Induce Fuel Failures Above Those Expected	7.1-4
	7.1.5 Class 5 - Fission Products to Primary and Secondary Systems (PWR)	7.1-4
	7.1.6 Class 6 - Refueling Accidents	
	7.1.6.1 Fuel Bundle Drop	7.1-4
	7.1.6.2 Heavy Object Drop onto Fuel in Core	7.1-5
	7.1.7 Class 7 - Spent Fuel Handling Accident	7.1-5
	7.1.7.1 Fuel Assembly Drop in Fuel Storage Pool	7.1-5
	7.1.7.2 Heavy Object Drop onto Fuel Rack	7.1-6
	7.1.7.3 Fuel Cask Drop	7.1-6
	7.1.8 Class 8 - Accidents Considered in the Design-Basis Evaluation in the Safety Analysis Report	7.1-6
	7.1.8.1 Loss-of-Coolant Accidents	7.1-7
	7.1.8.1.1 Small Pipe Break	7.1-7
	7.1.8.1.2 Large Pipe Break	7.1-7
	7.1.8.2 Rod Drop Accident	7.1-8
	7.1.8.3 Steam Line Breaks	7.1-8
	7.1.8.3.1 Small Pipe Break	7.1-8
	7.1.8.3.2 Large Pipe Break	7.1-9

TABLE OF CONTENTS (Cont.)

		Page
7.2	TRANSPORTATION ACCIDENTS INVOLVING RADIOACTIVITY	7.2-1
7.3	OTHER ACCIDENTS	7.3-1

LIST OF TABLES

Table No	Title
7.1.1	Reactor Facility-Classification of Postulated Accidents and Occurrences
7.1.2	Summary of Doses at Minimum Site Boundary
7.1.3	Summary of Population Doses
7.1.4	Releases Resulting from Postulated Accidents
7.3.1	Chemicals Stored Onsite

CHAPTER 7.0 ENVIRONMENTAL EFFECTS OF ACCIDENTS

7.1 STATION ACCIDENTS INVOLVING RADIOACTIVITY

This section discusses the environmental effects of possible accidents which may occur within the station. This is done by providing the following:

a. A determination and explanation of the representative type of accident appropriate for each accident class (according to NRC Regulatory Guide 4.2, Appendix I) together with its basic assumptions.

b. A determination of the radiological effects and their significance for each NRC-BWR classification accident as they apply to the Grand Gulf Nuclear Station.

c. An evaluation of environmental impacts of the radiological effects.

Protection against the occurrence of postulated design-basis accidents is provided through the defense in depth concept of design, manufacture, operation and testing, and the quality assurance program used to establish the necessary high degree of integrity of the reactor primary system. Off-design conditions that may occur are limited by protection systems which place and hold the power station in a safe condition. Notwithstanding this, the conservative postulation is made that serious accidents might occur, even though unlikely, and engineered safety features are installed to mitigate the consequences of these postulated events.

Specifically, the radiological environmental effects analysis is a systematic examination of anticipated occurrences and abnormal transient and postulated accident occurrences for all modes of BWR operation. The environmental effects analysis is related to the safety analy is documented in the FSAR. The significant differences betwee i the two analytical approaches are in the degree of the analyses and the extent of conservatism used in basic assumptions.

The safety analysis, using more conservative design basis assumptions, is programmed to demonstrate and assure that the facility's ultimate capabilities (or limitations) can accommodate the postulated phenomena in each event within acceptable limits. The environmental effects analysis in this section is designed to predict effects which reflect a more realistic representation of the postulated occurrences. However, because many parameters and processes are involved in the determination of applicable sources and the estimation of transport of the fission products of interest, and because there is a tendency to use "worst-expected" values for some of these parameters, results in this section are considered conservative.

Table 7.1.1 identifies the accidents considered according to the NRC classification scheme. Table 7.1.2 gives a summary of the radiological consequences of each accident to a hypothetical maximum exposed individual at the site boundary. Table 7.1.3 summarizes the population doses for each accident for a 50-mile radius. Table 7.1.4 lists the activity released to the environment as a result of each accident.

All airborne releases are conservatively assumed to be ground level releases. No credit is taken for depletion of the released activity by deposition or decay. The breathing rate of persons offsite is assumed to be in strict accordance with the rates given in NRC Regulatory Guide 1.3. Short-term atmospheric dispersion factors (χ/Q) are as evaluated in subsection 6.1.3.

Evaluation of the dose to the population for short-term releases assumes that the release is dispersed in a 22.5-degree sector from the plant. The χ/Q values are evaluated at the distances of each population segment midpoint. Each population segment is assumed to be the average 22.5-degree sector population for the respective annular population ring, as provided in Tables 2.1.1 and 2.1.3, for the population projected to the year 2020.

Calculations of doses to individuals are performed in accordance with the methods of NRC Regulatory Guide 1.3. Calculations of population dose are performed with the same methods.

7.1.1 Class 1 - Trivial Incidents

These incidents have been evaluated under routine releases in accordance with Appendix I to 10 CFR 50, and are reported in Section 5.2.

7.1.2 Class 2 - Small Releases Outside Containment

These incidents have been evaluated under routine releases in accordance with Appendix I to 10 CFR 50, and are reported in Section 5.2.

7.1.3 Class 3 - Radwaste System Failures

This class of occurrence is represented by three separate events.

7.1.3.1 Equipment Leakage or Malfunction (Including Operator Error)

The most severe radwaste system failure results from a failure of the low temperature charcoal adsorption beds. It is assumed that a small rupture of the beds occurs, releasing 25 percent of the accumulated bed activity of the noble gases. Accumulation

is based on an effective buildup of 693 and 29 days for xenon and krypton, respectively. Based on a normalized total noble gas release rate of 150,000 μCi/sec from the offgas system after a 30-minute delay, the release rates of noble gases, after a 10-minute delay in the offgas system, are computed and used to determine the activity accumulated in the beds. All of the activity is assumed to be released to the environment within 2 hours of the accident.

The calculated dose to the hypothetical maximum exposed individual is 14.1 mrem total body gamma. The integrated dose to the population is 0.97 man-rem total body gamma.

7.1.3.2 Release of Gaseous Waste Storage Tank Contents

This accident is identical to the accident described above for equipment leakage except that 100 percent of the activity accumulated in the beds is released to the atmosphere.

The calculated dose to the hypothetical maximum exposed individual is 56.2 mrem total body gamma. The integrated dose to the to the population is 3.86 man-rem total body gamma.

7.1.3.3 Release of Liquid Waste Storage Tank Contents

The radwaste tank with the highest expected activity level is the regeneration solution receiving tank which has a capacity of 35,000 gallons. The release of the entire contents of this tank to the radwaste building is postulated.

Radioiodine concentrations in the regenerant solution are based on coolant concentrations corresponding to an I-131 release rate of 350 μCi/sec from the fuel to the reactor coolant. The fraction of iodine in the spill which becomes airborne is assumed to be 0.1 percent. All activity is assumed released unfiltered to the environment within 2 hours of the accident.

No significant concentrations of noble gas activity are expected in this tank, therefore no noble gas release is assumed for this event.

The calculated doses to the hypothetical maximum exposed individual are 4.47 mrem thyroid and 3.18×10^{-3} mrem total body gamma. The integrated doses to the population are 0.307 man-rem thyroid and 2.18×10^{-4} man-rem total body gamma.

7.1.4 Class 4 - Fission Products to Primary System (BWR)

7.1.4.1 Fuel Cladding Defects

These incidents have been evaluated under routine releases in accordance with Appendix I to 10 CFR 50, and are reported in Section 5.2.

7.1.4.2 Off-design Transients That Induce Fuel Failures Above Those Expected

An off-design transient is postulated that induces fuel failures above those expected. Activity is assumed to be carried over to the condenser.

A representative source has been defined as 0.02 percent of the core inventory of noble gases and halogens released to the reactor water, in addition to reactor water concentrations of halogens consistent with a release rate of 350 μCi/sec of I-131 from fuel to the reactor coolant. One percent of the halogens and 100 percent of the noble gases are assumed to be carried to the condenser, where all the gases and 10 percent of the halogens are available for leakage from the condenser to the turbine building at 0.5 percent/day. The accident is assumed to continue for 24 hours after which all radioactive releases are terminated.

All activity released during the accident is assumed to be released from the turbine building with no credit taken for holdup or plateout on the turbine building internal structures.

The calculated doses to the hypothetical maximum exposed individual are 1.02 mrem thyroid and 1.00 mrem total body gamma for a 2-hour exposure at the minimum site boundary. The doses to an individual at the low population zone for the duration of the accident are 1.09 mrem thyroid and 0.53 mrem total body gamma. The integrated doses to the population are 0.464 man-rem thyroid and 0.198 man-rem total body gamma.

7.1.5 Class 5 - Fission Products to Primary and Secondary Systems (PWR)

This class of occurrence is defined as not applicable to the BWR.

7.1.6 Class 6 - Refueling Accidents

7.1.6.1 Fuel Bundle Drop

One fuel assembly is assumed to be dropped underwater during refueling, damaging one row of fuel pins. Activity is released from the rod gaps of the damaged pins and transported to the containment atmosphere. Release is through the normal ventilation system, until the containment is isolated.

A representative source has been defined as the average rod-gap activity for eight rods as predicted for each isotope with credit for 7 days of decay. (Gap activity is assumed to be 1 percent of total activity in a pin). The activity is released underwater,

and the retention factor of the water for iodine is assumed to be 500. The released activity is conservatively assumed to be instantaneously available in the containment refueling floor atmosphere. Exhaust from the containment during fuel handling is through charcoal filters.

On a high radiation signal, the normal fresh air supply and exhaust lines are isolated and the containment is isolated. During the time required to isolate the containment (approximately 6.5 seconds) radioactivity is exhausted through the normal 8-inch deep bed charcoal filters. Conservatively, no credit has been taken for adsorption in the deep bed charcoal adsorbers in the exhaust line.

The calculated doses to the hypothetical maximum exposed individual are 1.19×10^{-2} mrem thyroid and 2.23×10^{-4} mrem total body gamma. The integrated doses to the population are 8.20×10^{-4} man-rem thyroid and 1.50×10^{-5} man-rem total body gamma.

7.1.6.2 Heavy Object Drop onto Fuel in Core

A heavy object is assumed to be dropped onto the reactor core during the refueling operation, damaging the equivalent of one complete fuel assembly. Activity is released from the rod gaps of the damaged pins and transported to the refueling floor atmosphere. Release is through the normal ventilation system, until the containment is isolated.

A representative source has been defined as the average rod-gap activity for 62 rods as predicted for each isotope with credit for 100 hours of decay. The activity release mechanism is as described in subsection 7.1.6.1.

The calculated doses to the hypothetical maximum exposed individual are 0.124 mrem thyroid and 2.57×10^{-3} mrem total body gamma. The integrated doses to the population are 8.52×10^{-3} man-rem thyroid and 1.76×10^{-4} man-rem total body gamma.

7.1.7 Class 7 - Spent Fuel Handling Accident

This class of occurrence is represented by three separate events.

7.1.7.1 Fuel Assembly Drop in Fuel Storage Pool

One fuel assembly is assumed dropped underwater during fuel handling, damaging one row of fuel pins. Activity is released from the rod gaps of the damaged pins and transported to the fuel storage area atmosphere. Release is through the standby gas treatment system (SGTS).

A representative source has been defined as the average rod-gap activity for eight rods as predicted for each isotope with credit for 7 days of decay. The activity is released underwater, and the retention factor of the water for iodine is assumed to be 500. The released activity is conservatively assumed to be instantaneously available in the fuel storage area atmosphere. Monitors in the exhaust line, sensing a high radiation signal, isolate the line prior to release of the radiation, isolate the fresh air intake, initiate the SGTS and divert the air in the line to the SGTS. The SGTS deep bed charcoal filters are assumed 99 percent efficient for iodines. All activity is assumed to be released from the fuel building in the 2-hour period following the accident.

The calculated doses to the hypothetical maximum exposed individual are 0.119 mrem thyroid and 0.223 mrem total body gamma. The integrated doses to the population are 8.20×10^{-3} man-rem thyroid and 1.50×10^{-2} man-rem total body gamma.

7.1.7.2 Heavy Object Drop onto Fuel Rack

A heavy object is assumed to be dropped onto the spent fuel rack damaging the equivalent of one complete fuel assembly. Activity is released from the rod gaps of the damaged pins and transported to the fuel storage area atmosphere. Release is through the SGTS.

A representative source has been defined as the average rod-gap activity for 62 rods as predicted for each isotope with credit for 30 days of decay. The activity release mechanism is as described in subsection 7.1.7.1.

The calculated doses to the hypothetical maximum exposed individual are 0.130 mrem thyroid and 8.70×10^{-2} mrem total body gamma. The integrated doses to the population are 8.93×10^{-3} man-rem thyroid and 5.96×10^{-3} man-rem total body gamma.

7.1.7.3 Fuel Cask Drop

The spent fuel cask crane has been designed to be single failure proof. Therefore, this accident is not considered credible.

7.1.8 Class 8 - Accidents Considered in the Design-Basis Evaluation in the Safety Analysis Report

This class of occurrence has been represented by three separate events, two of which are further reduced to "large" and "small" categories.

7.1.8.1 Loss-of-Coolant Accidents

7.1.8.1.1 Small Pipe Break

As a result of a postulated small pipe break, the radioactivity inventory in the reactor coolant consistent with a release rate of 350 μCi/sec for I-131 from the fuel to the reactor coolant is assumed to be released to the containment. This activity is conservatively assumed to leak from the containment at a rate of 0.4 percent per day. The total leakage is assumed to be released through the SGTS deep bed charcoal filters, which are assumed to be 99 percent efficient for removal of all forms of iodine. The dose reduction factor due to plateout and sprays is assumed to be five for iodines.

The calculated doses to a hypothetical maximum exposed individual at the site boundary are 2.83×10^{-4} mrem thyroid and 1.87×10^{-6} mrem total body gamma. The doses to an individual at the low population zone for the duration of the accident are 9.22×10^{-4} mrem thyroid and 1.32×10^{-6} mrem total body gamma. The integrated doses to the population for the duration of the accident are 5.24×10^{-4} man-rem thyroid and 5.86×10^{-7} man-rem total body gamma.

7.1.8.1.2 Large Pipe Break

The assumptions for a postulated accident of a large pipe break are the same as given in subsection 7.1.8.1.1, except that an additional source corresponding to 0.2 percent of the core inventory of iodines and noble gases is assumed to be released instantaneously to the containment.

The representative source has been defined as the total coolant inventory consistent with a release rate of 350 μCi/sec of I-131 from the fuel to the reactor coolant, with an additional 0.2 percent of the core inventory of iodines and noble gases. The source is assumed to be instantly available to the containment which leaks at 0.4 percent/day. The total leakage is assumed to be released through the SGTS deep bed charcoal filters, which are assumed to be 99 percent efficient for removal of all iodines. The dose reduction factor for plateout and suppression pool credit is conservatively assumed to be a factor of five for iodines.

The calculated doses to a hypothetical maximum exposed individual at the site boundary are 16.2 mrem thyroid and 7.52 mrem total body gamma. The doses to an individual at the low population zone for the duration of the accident are 93 mrem thyroid and 5.6 mrem total body gamma. The integrated doses to the population for the duration of the accident are 55.1 man-rem thyroid and 2.53 man-rem total body gamma.

7.1.8.2 Rod Drop Accident

This event postulates that a control rod is dropped out of the core, resulting in a transient which induces fuel failure. Activity is assumed to be carried to the condenser, where condenser leakage is released to the turbine building and subsequently to the atmosphere.

A representative source has been defined as 0.025 percent of the core inventory of noble gases and halogens released to the reactor water in addition to reactor water concentrations of halogens consistent with a release rate of 350 μCi/sec of I-131 from the fuel to the reactor coolant. One percent of the halogens and 100 percent of the noble gases are assumed to be carried to the condenser, where all the noble gases and 10 percent of the halogens are available for leakage from the condenser to the environment via the turbine building at 0.5 percent/day, for 1 day, with no credit taken for holdup or plateout on the turbine building internal structures.

The calculated doses to a hypothetical maximum exposed individual at the site boundary are 1.28 mrem thyroid and 1.26 mrem total body gamma. The doses to an individual at the low population zone for the duration of the accident are 1.36 mrem thyroid and 0.66 mrem total body gamma. The integrated doses to the population for the duration of the accident are 0.580 man-rem thyroid and 0.248 man-rem total body gamma.

7.1.8.3 Steam Line Breaks

7.1.8.3.1 Small Pipe Break

This event is postulated as a double-ended rupture of a 6-inch reactor core isolation cooling (RCIC) steamline. Steam is released from the break until the line is isolated.

Coolant iodine concentrations are assumed to be consistent with a release rate of 350 μCi/sec of I-131 from the fuel to the reactor coolant. The reactor steam concentrations of noble gases are based on a total noble gas release rate of 150,000 μCi/sec from the offgas system after a 30-minute delay. The release is continuous for 33 seconds, after which the line is isolated and no further release occurs. The total steam release is estimated to be 11,130 pounds. Halogens in the fluid released are assumed to be at 1/10 the primary system liquid concentrations. All activity is assumed to be instantaneously released to the environment.

The calculated doses to the hypothetical maximum exposed individual are 0.94 mrem thyroid and 6.74×10^{-2} mrem total body gamma. The integrated doses to the population are 6.46×10^{-2} man-rem thyroid and 4.62×10^{-3} man-rem total body gamma.

7.1.8.3.2 Large Pipe Break

This event is postulated as the sudden complete severance of a main steam line. The isolation signal is expected to occur within 0.5 second after the break and an additional 5 seconds are assumed for effecting full closure of the main steam isolation valve. During this period of 5.5 seconds, an integrated quantity of 107,600 pounds of reactor coolant and 26,600 pounds of reactor steam are estimated to be released in the turbine building. Fifty percent of the iodines in the liquid coolant and 100 percent of the iodines and the noble gases in the reactor steam are assumed to be released to the environment via the turbine building vent system. The iodine releases are assumed to be unfiltered. The iodine concentrations in the reactor coolant and steam are assumed to be the same as those given in 7.1.8.3.1. The noble gas concentrations in the reactor steam are assumed to be the same as those given in 7.1.8.3.1.

The calculated doses to the hypothetical maximum exposed individual are 47.8 mrem thyroid and 0.604 mrem total body gamma. The integrated doses to the population are 3.28 man-rem thyroid and 4.14×10^{-2} man-rem total body gamma.

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TABLE 7.1.1

REACTOR FACILITY - CLASSIFICATION
OF POSTULATED ACCIDENTS AND OCCURRENCES

Class	Description	NRC Reg. Guide 4.2 - Appendix I	Plant Design-Analyses
1	Trivial incidents	Releases in accordance with Appendix I to 10 CFR 50	Included in normal releases
2	Small releases outside containment	Spills	Reactor coolant leaks (below allowable tech spec limits) included in normal releases
		Leaks and pipe breaks	
3	Radwaste system failures	Equipment leakage or malfunction (including operator error)	25% of charcoal bed activity
		Release of gas or liquid-storage tank contents	100% of charcoal bed activity. Failure of regeneration solution receiving tank
4	Fission products to primary system (BWR)	Fuel-cladding defects	.02% core inventory with release through condenser leakage
		Off-design transients that induce fuel failure	
5	Fission products to primary system (PWR)	NA	NA
6	Refueling accidents	Fuel bundle drop in canal	One row of fuel pins at 1 week decay
		Heavy-object drop onto core	One assembly at 100 hours decay
7	Spent-fuel-handling accident	Fuel bundle drop in fuel storage pool	One row of fuel pins at 1 week decay
		Heavy-object drop onto fuel rack	One assembly at 30 days decay
		Fuel cask drop	NA
8	Accidents considered in design-basis evaluation in the SAR	Loss-of-coolant accident	Small break and large break
		Instrument line break	NA
		Rod ejection accident (PWR)	NA
		Rod drop accident	.025% core inventory with release through condenser leakage
		Main steam line break	Small break and large break

TABLE 7.1.2

SUMMARY OF DOSES AT MINIMUM SITE BOUNDARY

Accident	Thyroid Dose (mrem)	Total Body Gamma Dose (mrem)
Equipment malfunction	-	1.41 + 01 (1)
Charcoal delay bed failure	-	5.62 + 01
Liquid waste storage tank failure	4.47 + 00	3.18 - 03
Off-design transients that induce fuel failures	1.02 + 00	1.00 + 00
Fuel bundle drop in refueling pool	1.19 - 02	2.23 - 04
Heavy object drop onto fuel in core	1.24 - 01	2.57 - 03
Fuel bundle drop in fuel storage pool	1.19 - 01	2.23 - 01
Heavy object drop onto fuel rack	1.30 - 01	8.70 - 02
Loss-of-coolant - Small pipe break	2.83 - 04	1.87 - 06
- Large pipe break	1.62 + 01	7.52 + 00
Control rod drop	1.28 + 00	1.26 + 00
Steam line break - Small pipe	9.40 - 01	6.74 - 02
- Large pipe	4.78 + 01	6.04 - 01

(1) $1.41 + 01 = 1.41 \times 10^{1}$

TABLE 7.1.3

SUMMARY OF POPULATION DOSES

Accident	Thyroid Dose (man-rem)	Total Body Gamma Dose (man-rem)
Equipment malfunction	-	9.65 - 01
Charcoal delay bed failure	-	3.86 + 00
Liquid waste storage tank failure	3.07 - 01 (1)	2.18 - 04
Off-design transients that induce fuel failures	4.64 - 01	1.98 - 01
Fuel bundle drop in refueling pool	8.20 - 04	1.50 - 05
Heavy object drop onto fuel in core	8.52 - 03	1.76 - 04
Fuel assembly drop in fuel storage pool	8.20 - 03	1.50 - 02
Heavy object drop onto fuel storage rack	8.93 - 03	5.96 - 03
Loss-of-coolant - Small pipe break	5.24 - 04	5.86 - 07
- Large pipe break	5.51 + 01	2.53 + 00
Control rod drop accident	5.80 - 01	2.48 - 01
Small steam line break	6.46 - 02	4.62 - 03
Large steam line break	3.28 + 00	4.14 - 02

(1) $3.07 - 01 - 3.07 \times 10^{-1}$

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TABLE 7.1.4

RELEASES RESULTING FROM POSTULATED ACCIDENTS

Releases (Ci)

	Equipment Malfunction	Charcoal Delay Bed Failure	Liquid Waste Tank	Off-Design Transient			Fuel Bundle Drop in Refueling Pool	Heavy Object Drop Onto Fuel in Core	Fuel Assembly Drop in Fuel Storage Pool	Heavy Object Drop Onto Fuel Rack
Isotope	0-2 hr	0-2 hr	0-2 hr	0-2 hr	2-8 hr	8-24 hr	0-2 hr	0-2 hr	0-2 hr	0-2 hr
I-131	-	-	5.49 - 02 (1)	8.41 - 03	2.49 - 02	6.36 - 02	1.79 - 04	1.81 - 03	1.79 - 03	1.96 - 03
I-132	-	-	5.99 - 03	9.43 - 03	9.53 - 03	1.85 - 03	-	-		
I-133	-	-	3.96 - 02	1.88 - 02	4.94 - 02	9.24 - 02	2.94 - 06	2.19 - 04	2.94 - 05	
I-134	-	-	4.57 - 03	1.13 - 02	2.83 - 03	2.35 - 05	-	-	-	
I-135	-		1.92 - 02	1.62 - 02	3.27 - 02	3.07 - 02	-	1.77 - 07	-	
Xe-131m	6.93 + 00	2.77 + 01	-	6.37 - 02	1.89 - 01	4.89 - 01	8.23 - 04	7.68 - 03	8.23 - 01	1.69 + 00
Xe-133m	3.05 + 01	1.22 + 02	-	4.87 - 01	1.39 + 00	3.21 + 00	1.12 - 03	2.11 - 02	1.12 + 00	7.65 - 03
Xe-133	1.98 + 03	7.92 + 03	-	1.93 + 01	5.66 + 01	1.42 + 02	1.50 - 01	1.72 + 00	1.50 + 02	5.77 + 01
Xe-135m	8.53 + 00	3.41 + 01	-	9.75 - 01	4.74 - 03	-	-	-	-	-
Xe-135	3.88 + 02	1.55 + 03	-	1.70 + 01	3.78 + 01	4.60 + 01	1.03 - 06	1.42 - 03	1.03 - 03	-
Xe-137	3.03 + 00	1.21 + 01	-	8.16 - 01	-	-	-	-	-	-
Xe-138	2.53 - 01	1.01 + 02	-	3.57 + 00	3.11 - 02	-	-	-	-	-
Kr-83m	1.16 + 01	4.63 + 01	-	1.06 + 00	8.62 - 01	1.04 - 01	-	-	-	-
Kr-85m	5.10 + 01	2.04 + 02	-	3.23 + 00	5.34 + 00	3.11 + 00	-	-	-	-
Kr-85	1.89 + 01	7.46 + 01	-	1.27 - 01	3.79 - 01	1.01 + 00	2.46 - 03	1.94 - 02	2.46 + 00	1.93 + 01
Kr-87	4.50 + 01	1.80 + 02	-	4.41 + 00	2.13 + 00	8.31 - 02	-	-	-	
Kr-88	1.04 + 02	4.17 + 02	-	8.15 + 00	9.83 + 00	2.82 + 00	-	-	-	
Kr-89	1.52 + 00	6.07 + 00	-	5.09 - 01	-	-	-	-	-	

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TABLE 7.1.4 (Cont.)

Releases (Ci)

	Loss-of-Coolant Accident Small Pipe Break					Loss-of-Coolant Accident Large Pipe Break				
Isotope	0-2 hr	2-8 hr	8-24 hr	1-4 day	4-30 day	0-2 hr	2-8 hr	8-24 hr	1-4 day	4-30 day
I-131	1.08 - 06	3.19 - 06	8.16 - 06	3.12 - 05	9.10 -05	1.34 - 01	3.95 - 01	1.01 + 00	3.86 + 00	1.13 + 01
I-132	7.51 - 06	7.59 - 06	1.48 - 06	1.20 - 08	-	1.50 - 01	1.51 - 01	2.94 - 02	2.38 - 04	-
I-133	7.18 - 06	1.89 - 05	3.53 - 05	4.58 - 05	4.63 - 06	2.98 - 01	7.84 - 01	1.47 + 00	1.90 + 00	1.92 - 01
I-134	9.98 - 06	2.50 - 06	2.08 - 08	-	-	1.79 - 01	4.50 - 02	3.74 - 04	-	-
I-135	9.78 - 06	1.97 - 05	1.85 - 05	4.35 - 06	-	2.58 - 01	5.19 - 01	4.87 - 01	1.15 - 01	6.61 - 05
Xe-131m	-	-	-	-	-	5.05 - 01	1.50 + 00	3.89 + 00	1.56 + 01	6.07 + 01
Xe-133m	-	-	-	-	-	3.86 + 00	1.10 + 01	2.55 + 01	6.72 + 01	4.36 + 01
Xe-133	-	-	-	-	-	1.53 + 02	4.49 + 02	1.13 + 03	3.98 + 03	7.70 + 03
Xe-135m	-	-	-	-	-	7.74 + 00	3.76 - 02	-	-	-
Xe-135	-	-	-	-	-	1.35 + 02	3.00 + 02	3.65 + 02	1.53 + 02	6.44 - 01
Xe-137	-	-	-	-	-	6.48 + 00	3.56 - 09	-	-	-
Xe-138	-	-	-	-	-	2.83 + 01	2.47 - 01	1.59 - 07	-	-
Kr-83m	-	-	-	-	-	8.45 + 00	6.84 + 00	8.24 - 01	2.17 - 03	-
Kr-85m	-	-	-	-	-	2.57 + 01	4.24 + 01	2.47 + 01	2.16 + 00	2.53 - 05
Kr-85	-	-	-	-	-	1.00 + 00	3.01 + 00	8.02 + 00	3.58 + 01	2.92 + 02
Kr-87	-	-	-	-	-	3.50 + 01	1.69 + 01	6.60 - 01	1.04 - 04	-
Kr-88	-	-	-	-	-	6.46 + 01	7.80 + 01	2.24 + 01	4.34 - 01	-
Kr-89	-	-	-	-	-	4.04 + 00	-	-	-	-

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TABLE 7.1.4 (Cont.)

Releases (Ci)

	Control Rod Drop Accident			Small Steam Line Break	Large Steam Line Break
Isotope	0-2 hr	2-8 hr	8-24 hr	0-2 hr	0-2 hr
I-131	1.05 - 02	3.11 - 02	7.95 - 02	3.28 - 03	1.66 - 01
I-132	1.18 - 02	1.19 - 02	2.31 - 03	3.02 - 02	1.54 + 00
I-133	2.35 - 02	6.18 - 02	1.16 - 01	2.24 - 02	1.14 + 00
I-134	1.41 - 02	3.54 - 03	2.94 - 05	6.05 - 02	3.07 + 00
I-135	2.03 - 02	4.09 - 02	3.84 - 02	3.28 - 02	1.66 + 00
Xe-131m	7.96 - 02	2.36 - 01	6.11 - 01	5.46 - 05	1.31 - 04
Xe-133m	6.09 - 01	1.74 + 00	4.01 + 00	1.06 - 03	2.52 - 03
Xe-133	2.41 + 01	7.08 + 01	1.78 + 02	2.98 - 02	7.13 - 02
Xe-135m	1.22 + 00	5.93 - 03	-	9.46 - 02	2.26 - 01
Xe-135	2.13 + 01	4.73 + 01	5.75 + 01	8.01 - 02	1.91 - 01
Xe-137	1.02 + 00	-	-	5.46 - 01	1.31 + 00
Xe-138	4.46 + 00	3.89 - 02	-	3.24 - 01	7.74 - 01
Kr-83m	1.33 + 00	1.08 + 00	1.30 - 01	1.24 - 02	2.96 - 02
Kr-85m	4.04 + 00	6.68 + 00	3.89 + 00	2.22 - 02	5.31 - 02
Kr-85	1.59 - 01	4.74 - 01	1.26 + 00	7.28 - 05	1.74 - 04
Kr-87	5.51 + 00	2.66 + 00	1.04 - 01	7.28 - 02	1.74 - 01
Kr-88	1.02 + 01	1.23 + 01	3.53 + 00	7.28 - 02	1.74 - 01
Kr-89	6.36 - 01	-	-	4.73 - 01	1.13 + 00

(1) $5.49 - 02 = 5.49 \times 10^{-2}$

7.2 TRANSPORTATION ACCIDENTS INVOLVING RADIOACTIVITY

The environmental risks associated with the transportation of radioactive fuel and wastes to and from Grand Gulf Nuclear Station Units 1 and 2 are as set forth in Summary Table S-4 of 10 CFR Part 51.

7.3 OTHER ACCIDENTS

Grand Gulf Nuclear Station, like any large industrial plant, could experience industrial accidents as a result of station operation. Chemicals stored onsite are listed in Table 7.3.1.

The chlorine required to treat the circulating water system, the plant service water system, the standby service water system, and the domestic water system is generated onsite by a sodium hypochlorite system. Liquid chlorine is not used or stored onsite.

Postulated accidental release of chemicals such as nitrogen (280 ft^3), carbon dioxide (10 tons, largest tank), hydrogen (125,730 ft^3), and methane (2800 ft^3) show no significant environmental effects at distances greater than the exclusion radius of 696 meters. Due to the physical and chemical properties of hydrogen and methane, rapid dissipation of the vapor clouds is assumed. An unconfined hydrogen-air mixture burns rather than explodes. Ground level concentrations of postulated released chemicals are estimated to be below their toxicity limits under all meteorological conditions at distances greater than the exclusion radius.

In the event of an explosion at the location of the underground fuel oil tank, an open pool fire is assumed with dimensions of 15 by 60 feet and a burning rate of 8 in/hr. Due to the tremendous amount of heat generated from the oil fire, the estimated plume rise under a high wind speed condition of 124 mph (which yields high ground level concentrations) is 135 meters at the exclusion radius. The resultant maximum ground level concentrations of all the products of combustion (e.g., SO_2, CO_2, CO, NO_x) are calculated to be two orders of magnitude or more smaller than toxicity limits. No significant environmental effects are anticipated.

All other hazardous chemicals stored onsite are in small quantities. Any postulated accident would have no environmental significance at distances greater than the exclusion radius.

TABLE 7.3.1

CHEMICALS STORED ONSITE

Chemical	Quantity
Caustic	20,000 gal
Hypochlorite solution	2700 lb (dry wt)
Salt	85 tons (dry)
Brine solution	900 gal (4 tanks)
Lube oil	122,320 gal (total)
Hydrogen*	125,730 cu ft (total 18 tubes)
Methane*	2880 cu ft
Nitrogen*	280 cu ft at 2400 psig (1 tube)
Freon R-22*	200 lb (total)
Freon R-12*	2290 lb per chiller (3 chillers) 45 lb (total)
Halon 1301*	2088 lb (total)
Carbon dioxide*	10 tons (1 tank) 4 tons (1 tank)
Sodium hypochlorite	55 gal tank
Sodium nitrite Sodium hydroxide	50 gal tank
No. 2 fuel oil*	75,000 gal per tank (6 tanks) 550 gal tank (6 tanks)
Sulfuric Acid	40,000 gal each (3 tanks)

* Potentially hazardous materials

CHAPTER 8

ECONOMIC AND SOCIAL EFFECTS OF STATION CONSTRUCTION AND OPERATION

TABLE OF CONTENTS

		Page	
8.1	BENEFITS	8.1-1	
	8.1.1 Direct Benefits	8.1-1	
	8.1.1.1 Value of Delivered Products	8.1-1	
	8.1.2 Indirect Benefits	8.1-2	
	8.1.2.1 Employment	8.1-2	
	8.1.2.2 Wages	8.1-4	
	8.1.2.3 Tax Benefits	8.1-5	
	8.1.2.4 Educational/Recreational Benefits	8.1-7	1
	8.1.2.5 Other Indirect Benefits	8.1-8	1
	8.1.2.5.1 Transportation	8.1-8	1
	8.1.2.5.2 Land Use (Economic Viewpoint)	8.1-10	1
	8.1.2.5.3 Housing	8.1-10	1
	8.1.2.5.4 Community Services	8.1-10	1
	Appendix A - Socio-Economic Impact of Grand Gulf Nuclear Station	8.1A-1	
8.2	COSTS	8.2-1	
	8.2.1 Internal Costs	8.2-1	
	8.2.2 External Costs	8.2-1	
	8.2.2.1 Temporary External Costs	8.2-1	
	8.2.2.2 Long-term External Costs	8.2-1	
	8.2.3 References	8.2-2	

LIST OF TABLES

Table No.	Title
8.1.1	Employment Data By Type Claiborne County
8.1.2	Employment Data By Type Warren County
8.1.3	Direct and Induced Effects in Income and Employment
8.1.4	Comparison of Change in Ad Valorem Assessment Claiborne County and State of Mississippi
8.1.5	Percent Change in Sales Tax Receipts 1973-1976

LIST OF FIGURES

Figure No.	Title
8.1-1	Annual Per Capita Income of United States, Mississippi, Claiborne and Adjacent Counties 1959-1975

CHAPTER 8.0 ECONOMIC AND SOCIAL EFFECTS OF STATION CONSTRUCTION AND OPERATION

8.1 BENEFITS

The construction of a nuclear power plant produces both direct and indirect effects which have economic and social impacts on the surrounding communities. Measurement of this impact does not lend itself to standardized units, so some approximation is required. Primary benefits due to the construction of the Grand Gulf Nuclear Station may be obvious, but the secondary or induced benefits have to be discerned by evaluation of the trends present before construction and the trends set in motion by the construction. The impact on the socioeconomic situation of the areas around the power plant may be measured by considering the difference in:

a. The situation if the plant were not built and

b. The situation incorporating the construction of the plant.

In the evaluation of the socioeconomic situation without the power plant, normal growth trends must be considered. These growth trends may be accelerated by the construction of the plant, however. Whether the impact is a net positive or negative effect determines whether it is considered a benefit or cost. Examination of several factors concerned with the Grand Gulf Project revealed that there was a net effect of zero, or that the situation remained unchanged by the construction of the station. Appendix A to this Section presents a detailed assessment of the socioeconomic impacts of Grand Gulf Nuclear Station.

8.1.1 Direct Benefits

8.1.1.1 Value of Delivered Products

The station will provide 2500 MWe of electrical power to supply the energy needs of the plant service area. Assuming a capacity factor of 80 percent, this amounts to some 17.5 billion kilowatt hours annually. On the basis of historical trends, it is estimated that about one half of this output will be required to fill commercial and industrial needs and about one third will supply residential needs. The remainder will be used by governmental agencies and municipalities and by utilities within the Middle South Utilities (MSU) System.

A major expressed goal for the State of Mississippi is to achieve a substantial improvement in the standard of living. The availability of an abundant, reliable supply of electrical power will contribute toward the attainment of this goal, directly and indirectly.

No major brownouts have occurred in the MSU System but the reserve margins of the MSU System were lowered in 1975 and will be lowered again by 1981, lessening the high level of reliability that has been previously maintained within the system. This situation is further discussed in Chapter 1.

The annual displacement of scarce fossil fuels that would be required for each Grand Gulf unit is approximately 82,000 million cubic feet of natural gas or 13,000,000 barrels of fuel oil. Since the long-term availability of fuel oil and natural gas is quite uncertain, these energy services are not considered viable alternatives.

The use of nuclear energy instead of coal energy will minimize the solid and gaseous products of combustion. A 1250 MW coal plant would produce on the order of 11 and 13 tons of particulates, 120 to 150 tons of sulfur dioxide, 70 to 90 tons of oxides of nitrogen, and small concentrations of carbon monoxide per day. In addition, 700 to 900 tons of ash would have to be deposited in storage ponds.

300.2

8.1.2 Indirect Benefits

8.1.2.1 Employment

Construction of the Grand Gulf Nuclear Station Units 1 and 2 began in 1974 and is slated for completion in 1980 and 1983, respectively. The effect of the construction on employment in Claiborne County is shown in Table 8.1.1, which gives a breakdown of employment by type. Total employment in the county has increased dramatically.

From Table 8.1.1 it can be noted that construction employment in Claiborne County increased very little from 1976 to 1977 after substantial increases from 1973 through 1976. This indicates that construction employment at the nuclear station is leveling off. Construction employment was 38.7 percent of the total number employed in Claiborne County during 1976. This compares with 2.1 percent for 1973 before construction began. Construction work in Claiborne County other than at the nuclear station is still negligible, as little construction is in progress except for the Claiborne County Hospital.

From Table 8.1.2 it can be determined that the number employed in construction in Warren County was at about the same level in 1976 as in 1973 before construction of the nuclear station began at Grand Gulf in 1974. This indicates that construction work in Warren County has been affected very little up until the present time by the construction at the nuclear station.

There has also been little change in employment in Warren County for the wholesale and retail trades, with an increase of only 7.1 percent from 1973 to 1976; for services and miscellaneous the increase between the same years was 5.9 percent, and there was actually a decrease of 13.9 percent in manufacturing employment during this period.

For Claiborne County, the changes in number employed for selected types of employment were somewhat higher than for Warren County. For the wholesale and retail trades, the increase between 1973 and 1976 was 34.5 percent; for service and miscellaneous, the increase between the same years was 50.0 percent; and for manufacturing there was an increase of 39.4 percent during this same period. This shows there was a greater overall effect on employment in Claiborne County due to the construction of the nuclear station than in Warren County. The increase in manufacturing employment in Claiborne County up to the present time, though, has not been due to the construction of the nuclear station. Nonmanufacturing employment, other than construction, increased from 1400 in 1973 to 2230 in 1976, an increase of 59.3 percent. Seventy-four and seven-tenths percent of this increase was in public education, but since public school enrollment dropped 8.1 percent during this period, it is obvious that the construction of the nuclear station had no effect on this type of employment.

Other than an increase in public education and construction, there was an increase of only slightly more than 200 jobs during this 1973 to 1976 period that could be related to the construction of the nuclear station.

Even though approximately 60 percent of the construction workers live in Warren County, it would be extremely difficult to determine the effect on nonmanufacturing employment in that county because of other changes that have taken place. Nonmanufacturing employment increased by 410, excluding government employment from 1973 to 1976, but manufacturing employment dropped by 630 during the same period. The increase in government employment, primarily the Corps of Engineers, Mississippi River Commission, and the Waterways Experiment Station, was 600 during this time period. Federal employment would have the same multiplier effect on other nonmanufacturing employment as manufacturing, construction, and other basic types of employment have. 5

It is estimated by the U. S. Chamber of Commerce that in the United States, for every 100 new jobs created for factory workers, a type of basic employment, 65 new jobs are created in the nonmanufacturing job market. The relative impact on employment in the nuclear station area is not the national ratio because many of the construction workers already lived in the area. As a consequence, fewer local nonmanufacturing jobs are required to service the influx of construction workers. Some researchers have estimated that the ratio for rural areas of low population density similar to the Grand Gulf area is not the national 0.65:1.00 ratio, but a ratio of 0.30:1.00. With an increase of almost 2900 construction jobs, using the above estimated ratio, there should be 870 new nonmanufacturing jobs created in the area. Up to this time, there have been only 230

nonmanufacturing jobs created that could be related to, but not all necessarily caused by, the construction of the nuclear station. This is approximately 8 new nonmanufacturing jobs created for every 100 new manufacturing (construction) jobs created by the construction of the nuclear station, or a ratio of only 0.08:1.00 in the Claiborne County area.

Approximately 30 percent of the plant construction workers live in Claiborne County. If the counties where the remaining 75 percent of the workers reside are assumed to be the "region" of the plant, then the ratio of 0.30:1.00 would be reasonably accurate for the region, provided the buildup in nonmanufacturing employment is complete. (2900 new jobs x 0.3, multiplier x 25 percent of employees = approximately 218 new jobs in Claiborne County). The remaining 640 possible new jobs would be elsewhere in the plant's region. Claiborne County data was used as the basis, since the effects of the plant construction on Warren County, for example, are not easily discernible, due to the fact that the plant construction workers make up only a small segment of the population. An additional 800 to 1000 construction workers will be employed by the end of 1978, which should mean an additional 240 to 300 new nonmanufacturing jobs at the peak of construction, or a total of slightly over 1100 new nonmanufacturing jobs for the area. |5

8.1.2.2 Wages

The effects of the station on local and regional income occur in two phases. The first is during construction, when large expenditures are made for payrolls, materials, and equipment; the second is the period after the station is in operation.

During construction, a total of approximately $400 million is made in payroll expenditures (over a period of about 10 years). During operation, the annual payroll will be about $6.0 million. It is obvious that the release of this much new money has a major effect on the area's economy. To place these figures in perspective, consider that the per capita income in Claiborne County was estimated to be $3400 in 1975 compared with $4079 for the State of Mississippi and $5902 for the United States. Figure 8.1-1 shows the trend in Claiborne County per capita income relative to neighboring counties, Mississippi, and the United States as a whole.

The above estimates are for direct income (i.e., those dollars which are actually dispersed as payroll). When the indirect effects of this income on the local and regional economy are taken into consideration, the values raise by factors of 2.0 and 3.0 respectively. In the region, these induced income effects amount to an estimated $1109 million over the 10-year construction period; the corresponding value for permanent operations is $16.5 million per year. The distribution of direct and induced income with respect to time is presented in Table 8.1.3.

The multipliers used here are believed to be appropriate for the two areas of concern: the local area (within a 15-mile radius of the site) and the regional area (within 16 to 75 miles). The regional multiplier of 3.0 is based on two elements: the so-called "pure multiplier" effect which is estimated to be 1.7 for Mississippi (Mississippi Research and Development Center, 1970) and the "acceleration principle," which accounts for the additional effect that consumption has on income, via investment spending. (The Federal Council of Economic Advisors has estimated that the pure multiplier of 2 for the U. S. as a whole is increased to about 3 or 4 when the acceleration principle is taken into account.)

The income multipliers employed here consider both effects. The local multiplier is less than the regional multiplier (2.0 vs 3.0), reflecting the fact that much of the money introduced by income is spent outside the immediate area (the supply of consumer goods and service in the local area is simply not sufficient to meet the demands of the great number of construction workers and their families).

Note that the above discussion considers only payroll income and does not include any purchase of materials in the local area. Most of the large capital investment for this plant is spent for equipment manufactured outside the state and has little or no effect on the income of the area. However, local purchases have a multiplier effect similar to that of payrolls.

Once the station has been constructed, the permanent payroll is estimated to be about $6.0 million per year. Some 250 persons will be required to operate the station. They will be highly skilled, professional people who will likely own homes and become permanent citizens of the area; thus, it is probable that the multiplier effect of their income will be greater than for the payroll during the construction period.

8.1.2.3 Tax Benefits

The nuclear station's effects on the local and regional economies due to tax revenues are substantial.

It is difficult to assess the annual ad valorem tax which will be collected by Claiborne County once the GGNS units go operational because the primary factor in determination of the amount of ad valorem tax collected is the millage rate. The County Board of Supervisors annually determines the required millage rate on the basis of the relationship between overall assessment and county revenue requirements.

Two models were used to estimate the annual ad valorem tax payable by Middle South Energy, Inc., the generating subsidiary of Middle South Utilities System which owns Grand Gulf Nuclear Station, for the year 1985 when both units will be operational. A determination of 1975 countywide ad valorem tax collections was made on the basis of January 1, 1975, total county assessment. The 1975 ad valorem

1

tax collection figure was expanded on an eight percent per annual growth rate to January 1, 1985. In this model the expected 1985 ad valorem taxes paid by Middle South Energy, Inc. would be in excess of $2.5 million. In the second model a projection of 1985 ad valorem collection was determined by using the 1978 tax year as the base for expanding ad valorem tax requirements for 1985. The 1978 base year was expanded by the same eight percent growth factor. Based on this model, the 1985 ad valorem tax payment would be in excess of $7 million. However, the $2.5 million figure which was previously discussed will actually be exceeded by the 1978 ad valorem tax payment, which will be in excess of $3.4 million. This illustrates the difficulty associated in projecting a 1985 ad valorem tax figure because of the millage factor, which is controlled by the County Board of Supervisors. Regardless of the millage rate used, the ad valorem taxes paid by Middle South Energy, Inc. in 1985 will be in excess of 90 percent of Claiborne County's ad valorem tax collection.

Claiborne County is charged with the responsibility of collecting four mills on each dollar of assessed value for the state of Mississippi. Assuming this remains constant under the law, the 1985 contribution by Claiborne County will be $1,200,000. This contribution will be over 14 times greater than the 1976 amount.

The ad valorem tax burden on the basis of assessed valuation for Middle South Energy, Inc. in comparison to the remaining county taxpayers is as follows:

	Middle South Energy, Inc.	Other
1974	0	100%
1975	17%	83%
1977	67%	33%
1978	79%	21%
1985	90%	10%

As shown above, the transfer of the ad valorem tax burden is significant even before commercial operation of the plant.

Upon commercial operation of Unit 2 in 1984, the total ad valorem tax assessment of Claiborne County will be increased to over twenty-five times the present amount for the county minus the present assessment for the Grand Gulf Nuclear Station. This means the total ad valorem assessment for Claiborne County will be in excess of $300 million.

Assuming the county expenditures double by 1984, the ad valorem tax burden of the average person living in the county will be only 10 percent of what would otherwise prevail.

The state rebates to incorporated communities 19 percent of the sales taxes which they collect. Due to the estimated $400 million which is paid during construction, a substantial amount

300.6

of rebate income is realized by the incorporated communities in the area. Between 1973 and 1976, sales tax receipts increased by 37.1 percent in Port Gibson and by 48.5 percent in Vicksburg. Port Gibson collected $627.059 for 1976 and Vicksburg collected $7,069,833 for the same year.

The State's general fund also benefits from earnings on securities issued to finance the nuclear station, sales taxes not rebated to incorporated communities, State franchise taxes, State income taxes, and ad valorem taxes paid to the State along with other taxes that are relatively insignificant.

It is also of interest to note how much more rapidly ad valorem tax assessments have increased for Claiborne County in comparison to the State of Mississippi. (See Table 8.1.4.)

A very accurate way to determine change in business activity in a city, county, or area is to study the sales tax receipts. In addition, it is possible to determine the change in the types of sales by category since the Mississippi State Tax Commission reports sales and tax receipts for 10 different types of sales.

From Table 8.1.5 it is obvious that three categories have been affected quite dramatically in Claiborne County:

a. Machinery, equipment, and supplies

b. Contracting lumber and building materials

c. Miscellaneous services

These three categories account for 76.6 percent of the $1,190,769 increase in total sales tax receipts for Claiborne County between 1973 and 1976. All three categories are directly related to the construction of the Grand Gulf Nuclear Station.

8.1.2.4 Educational/Recreational Benefits

Plant construction had no effect on an archaeological site located on the station site. The site consisted of an Indian burial mound, which was removed during archaeological excavation by the Mississippi Department of Archives and History. The old town of Grand Gulf and the surrounding area have a rich history dating back to the 1700s. In 1974, a tract of land consisting of 164 acres, located north of Gin Lake, was transferred from the station site to the Grand Gulf Military Park. Most of the old Grand Gulf townsite was located in this tract.

MP&L continues to allow fishing in the two oxbow lakes contained within the site boundaries. Although no firearm hunting is allowed on site, limited bow hunting, to prevent deer overpopulation, is presently under consideration.

8.1.2.5 Other Indirect Benefits

Other items that were examined to determine whether they were benefits or costs included: transportation, land use, housing, and community services. The effect of these items appears to be nil, negligible, or beneficial.

8.1.2.5.1 Transportation

The only new roads that were constructed were located on the station site. The Grand Gulf Road which provides access to the temporary site access road from State Highway 61 has been resurfaced. In addition, the bridge over stream A has been upgraded and a bypass provided for heavy truck traffic. A small section of Waterloo Road has been relocated so that it aligns with the future permanent site access road.

The highway capacity of Grand Gulf Road as calculated by the Mississippi State Highway Department is 1500 per hour with 1 percent trucks, 1300 per hour with 5 percent trucks, and 1100 per hour with 10 percent trucks. The maximum traffic count for any given hour for days that traffic has been counted on the Grand Gulf road is 1075. This count is approaching capacity when the traffic is composed of 10 percent trucks, but on several occasions when traffic was observed during peak hours, trucks made up less than 1 percent of the traffic. This indicates that the road is only at approximately 70 percent of capacity.

With the increased traffic on the Grand Gulf Road due to the construction of the nuclear facility there has been an increase in traffic accidents. The number of accidents reported to the Claiborne County Sheriff's Office in Port Gibson is listed below.

Year	Number of Reported Accidents
1971	3
1972	4
1973	6
1974	8
1975	21
1976	26
1977	36
1978	26 (through September 21, 1978)

Average daily traffic count on Grand Gulf Road counted by the Mississippi State Highway Department was 110 in 1973 and approximately 3900 in 1977. The distance from Highway 61 to the site is approximately 10 miles which indicates 1100 total miles traveled in 1973 and 30,000 total miles traveled in 1977. In 1973 there was an accident reported for every 183 miles traveled and for 1977 this figure was 1834 miles traveled for each reported accident.

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Based on traffic counts, highway capacities, and contacts with local and state agencies, the roadways have not been overloaded due to construction of the station. Traffic has been a problem on Grand Gulf Road during shift changes but this increase is restricted to two to three hours in the morning and two to three hours in the evening as shown below. 301.8

HOURLY TRAFFIC COUNT OF GRAND GULF ROAD ON MAY 30, 1978 BY MISSISSIPPI STATE HIGHWAY DEPARTMENT

HOUR	12 M. to 8 AM
12-1	14
1-2	5
2-3	5
3-4	10
4-5	26
5-6	386
6-7	1,075
7-8	195
Subtotal	1,716* T
	8 AM to 4 PM
8-9	123
9-10	145
10-11	131
11-12	166
12-1	160
1-2	138
2-3	348
3-4	1,058
Subtotal	2,269
	4 PM to 12 M.
4-5	603
5-6	199
6-7	79
7-8	52
8-9	60
9-10	35
10-11	294
11-12	35
Subtotal	1,357* T
Total	5,342* T

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8.1.2.5.2 Land Use (Economic Viewpoint)

There has been no substantial change in land use. The station site is 2170 acres, bounded on the west by the Mississippi River. Only 125 acres of row crops and pastureland were displaced by the station. Of the 2170 acres in the site, only 124 are reserved for station use, leaving 2046 for other uses such as a wildlife refuge.

8.1.2.5.3 Housing

No large scale house building was done in Claiborne County to meet the expected demand for housing by construction employees. In 1973-1976, approximately 25 new homes were built in Claiborne County with about one-half due to the station. In the same period, one apartment unit doubled its size to 40 units, but other apartment construction has been nil. There are three motels (less than 100 rooms total) in Claiborne County, with two being due to the station's construction. Most of the construction workers who live in Claiborne County live in approximately 300 house trailers. Apartment and housing costs are comparable to other areas in the state and did not increase due to the station's construction. Population increase in 1973-1976 was less than 1000 persons in Claiborne County. About 50 percent of the construction workers live in Warren County, but they comprise such a small fraction of the population that there is no measurable effect on the county economy. The land values of small acreages near the station site did not decrease as might be expected, but rather increased. There has been no measurable effect on the price of regular agricultural land in the county.

8.1.2.5.4 Community Services

Municipal services, such as the sewer system, telephone, water, and electricity, have not been overburdened. The trailer parks outside Port Gibson have their own sewage disposal systems (lagoons). The hospital in Port Gibson is being renovated and enlarged by 10 beds, financed primarily by tax revenues from the station. There has been no overcrowding of the public or private schools in either Claiborne or Warren counties due to the children of the construction workers. Public school enrollment in both counties has declined each year since station construction began. The private schools in the area have adequate space available for the children of the construction workers, who make up about 10 percent or less of the private school enrollment.

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TABLE 8.1.1

EMPLOYMENT DATA BY TYPE

CLAIBORNE COUNTY

	1971	1972	1973	1974	1975	1976	Ave. Jan-June 1977
Manufacturing	530	550	660	720	760	920	839
Nonmanufacturing	1380	1320	1460	1830	2770	5180	5429
Construction	80	40	60	380	1090	2950	3173
Wholesale and retail trade	260	270	290	300	310	390	390
Service and miscellaneous	240	210	220	260	280	330	350

Source: Mississippi Employment Security Commission

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TABLE 8.1.2

EMPLOYMENT DATA BY TYPE

WARREN COUNTY

	1971	1972	1973	1974	1975	1976	Jan-June Ave. 1977
Manufacturing	4,200	4,900	4,540	4,610	4,220	3,910	3,876
Nonmanufacturing	12,290	12,220	12,900	13,570	14,070	14,030	13,958
Construction	950	720	890	1,270	1,300	890	906
Wholesale and retail trades	3,060	3,270	3,360	3,500	3,470	3,600	3,620
Service and miscellaneous	2,420	2,330	2,560	2,600	2,690	2,710	2,684

Source: Mississippi Employment Security Commission

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TABLE 8.1.3

DIRECT AND INDUCED EFFECTS IN INCOME AND EMPLOYMENT

	Income			Employment		
		Induced Income, Millions			Induced Employment	
Year	Station Payroll, Millions	Local Multiplier of 2.0	Regional Multiplier of 3.0	Average No. of Station Employees	Local Multiplier of 0.08	Regional Multiplier of 0.30
1974	2.8	5.6	8.4	445	35.6	133.5
1975	19.4	38.8	58.2	1700	136.0	510.0
1976	39.8	79.6	119.4	2920	396.6	876.0
1977*	53.5	107.0	160.5	3200	256.0	960.0
1978*	69.	139.4	209.1	3750	300.0	1125.0
1979*	56.7	113.4	170.1	3702	296.2	1110.6
1980*	46.4	92.8	139.2	2600	208.0	780.0
1981*	48.3	96.6	144.9	2100	168.0	630.0
1982*	29.9	59.8	89.7	1100	88.0	330.0
1983*	3.1	6.2	9.3	200	16.0	60.0
TOTALS	369.6	739.2	1108.8	-	-	-
Permanent operating staff	5.5	16.5**	16.5	250	75.0**	75.0

*Estimated
**An income multiplier-accelerator factor of 3.0 is estimated for the long-term local effect because of the permanent nature of the staff's residence. The corresponding long-term employment multiplier is estimated to be 0.30.

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TABLE 8.1.4

COMPARISON OF CHANGE IN AD VALOREM ASSESSMENT
CLAIBORNE COUNTY AND STATE OF MISSISSIPPI

Total Assessment Year

	1973	1974	1975	1976
Claiborne County	$ 10,762,855	$ 11,036,838	$ 14,341,668	$ 25,626,278
Percent change		+2.5	+29.9	+78.7
State of Mississippi	3,125,444,221	3,325,371,089	3,509,809,101	3,782,323,486
Percent change		+6.4	+5.5	+7.8

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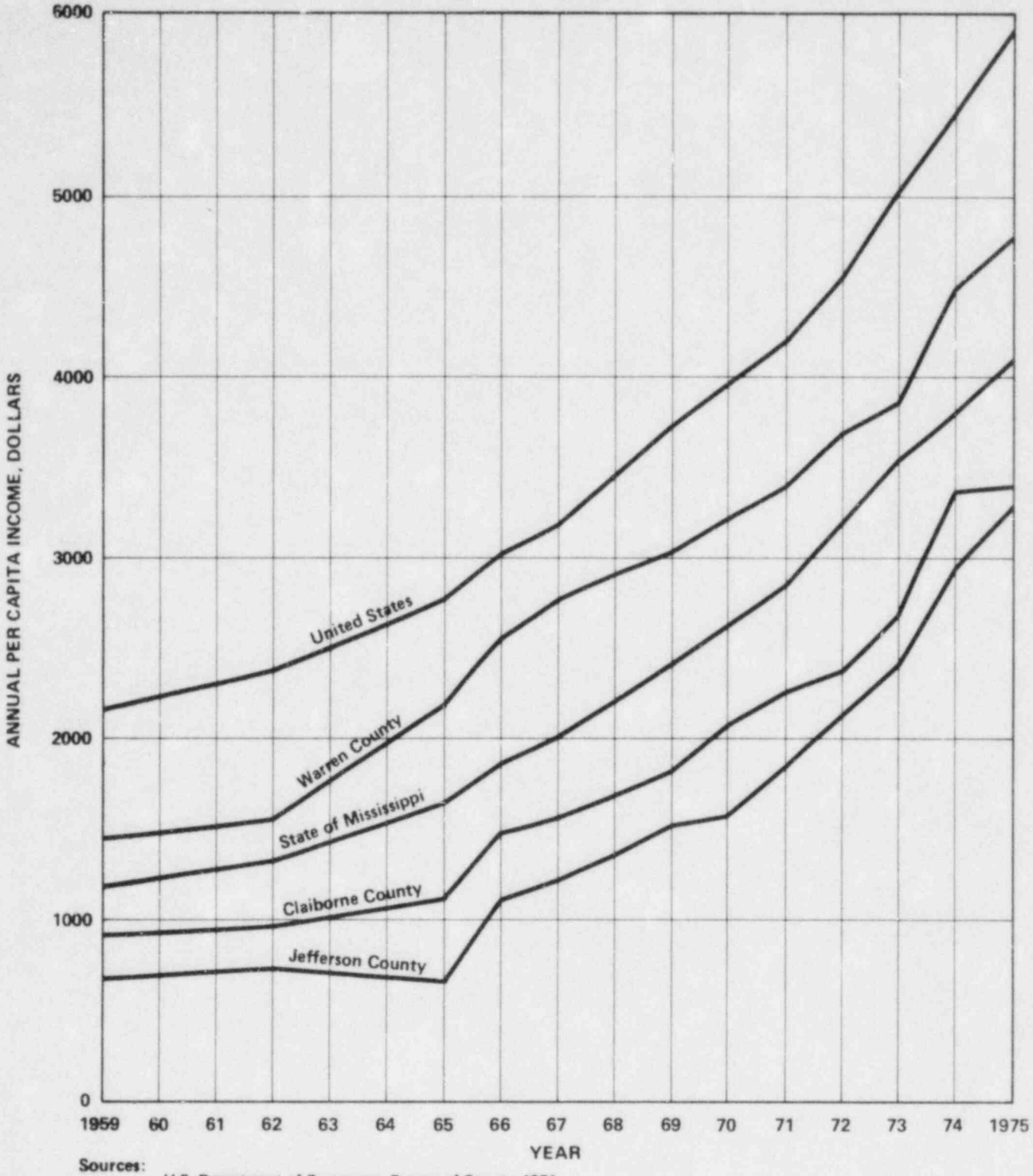
TABLE 8.1.5

PERCENT CHANGE IN SALES TAX RECEIPTS
1973-1976

	Claiborne County	Warren County	Port Gibson	Vicksburg
Automotive	37.4	38.5	23.4	45.5
Machine equipment	1991.5	74.9	181.2	99.1
Food and beverages	50.0	40.6	39.6	51.9
Furniture and fixtures	102.7	27.7	111.1	23.7
Public utilities	75.5	45.4	75.5	45.4
Apparel and general merchandise	51.3	42.8	48.1	42.8
Contract, labor and building, material	452.6	55.9	-17.8	41.3
Miscellaneous retail	49.4	45.2	53.7	67.2
Miscellaneous services	243.8	44.3	32.0	65.4
TOTAL CHANGE (Percent)	169.6	44.0	37.1	48.5



Sources:

U.S. Department of Commerce, Bureau of Census, 1971. "Statistical Abstract of United States."

Mississippi Statistical Abstract, 1976, by Division of Research, College of Business and Industry, Mississippi State University, November, 1976. Mississippi Research and Development Center

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

ANNUAL PER CAPITA INCOME OF UNITED STATES, MISSISSIPPI, CLAIBORNE AND ADJACENT COUNTIES 1959-1975
FIGURE 8.1-1

APPENDIX A

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SOCIO-ECONOMIC IMPACT OF
GRAND GULF NUCLEAR STATION

PREPARED BY

RECON, INC.
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Clinton, Mississippi

August, 1977

TABLE OF CONTENTS

Page

Introduction 1

Employment Effects 3

Income Effects 16

Tax Effects on Local Area 20

Sales Tax Receipts 25

Industrial Development
Claiborne County 31
Warren County 32

Projected Long-Run Commercial and
Industrial Development 33

Effect on Banking
Claiborne County 39
Warren County 40

Effect on Housing and Other Social Factors
In Claiborne County 48

Housing - Warren County 54

Comparison of Food Store Prices 57

Impact on Public Schools
Claiborne County 63
Warren County 64

Hospitals and Health Care 74

Recreational Facilities 76

Effect of Grand Gulf Nuclear Station on
Sport and Game Fishing and
Deer Hunting in Area 79

Effect on Land Area in Vicinity of Plant 81

Economic Impact of Nuclear Station on
Land Values in Claiborne County 82

Bonded Debt 83

INTRODUCTION

The region surrounding the site has long been one of the most impoverished in the United States. It was relatively prosperous from before the Civil War until in the twenties when the boll weevil practically destroyed its major source of income - the cotton industry. The depression of the thirties had a rather severe effect on the already depressed area and recovery has been slow. The population of Claiborne County has declined continuously since 1940 and is only about one-half what it was in 1900[1]. Another problem is that the area has a large number of unskilled and semi-skilled workers and industrial development has been very slow, therefore employment opportunities for the labor that was available have been limited. There are only slightly more than 700 people employed in manufacturing at the present time in Claiborne County. Per capita income in Claiborne County was estimated to be $2,563 in 1975 compared

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[1]Statistical Summary of Population 1800-1970, Mississippi Power & Light Company

with $3,581 for Mississippi and $5,020 for the United States[2]. The construction and operation of the Grand Gulf Nuclear Station is presently having, and will continue to have, a pronounced positive impact through direct and induced increases in employment and income. The long-run effect will be determined by the induced investment forthcoming because of the construction of the station and the industrial development that takes place due to the availability of sufficient energy if the other factors necessary for development are present.

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[2]Marketing Economics Guide 1976-77, Marketing Economics Institute, N. Y., N. Y.

EMPLOYMENT EFFECTS

Construction of the Grand Gulf Nuclear Station began in 1974 and is slated for completion in 1983. The peak level of total on site employment is expected to be approximately 4,000 by the end of 1978. The present on-site employment is about 3,200. Construction employment will drop very rapidly after the peak is reached. At the end of 1979 the total construction employment will be about 3,000; at the end of 1980 - 2,200; at the end of 1981 - 1,800; at the end of 1982 - 400; and at the end of 1983 the total construction employment will be zero.

From Tables 1 and 3 it can be noted that construction employment in Claiborne County increased very little from 1976 to 1977 after substantial increases from 1973 through 1976. This indicates that construction employment at the nuclear station is leveling off. Construction employment was 38.7 percent of the total number employed in Claiborne County during 1976. This compares with 2.1% for 1973 before construction began. Construction work in Claiborne County other than at the nuclear station is

still negligible as little construction is in progress except for the Claiborne County Hospital.

From Tables 2 and 4 it can be determined that the number employed in construction in Warren County was at about the same level in 1976 as in 1973 before construction of the nuclear station began at Grand Gulf in 1974. This indicates that construction work in Warren County has been affected very little up until the present time by the construction at the nuclear station. As noted in another part of this report, other factors than the potential for adequate energy must be present for industrial development to begin. There has also been little change in employment in Warren County for the wholesale and retail trades with an increase of only 7.1 percent from 1973 to 1976, for services and miscellaneous the increase between the same years was 5.9 percent, and there was actually a decrease of 13.9 percent in manufacturing employment during this period.

For Claiborne County the changes in number employed for selected types of employment were somewhat higher than for Warren County. For the wholesale and retail trades the increase between 1973 and 1976 was 34.5 percent, for service and miscellaneous the

increase between the same years was 50.0 percent and for manufacturing there was an increase of 39.4 percent during this same period. This shows there was a greater overall effect on employment in Claiborne County due to the construction of the nuclear station than in Warren County. The increase in manufacturing employment in Claiborne County up to the present time though has not been due to the construction of the nuclear station.

As noted above, employment has increased rather dramatically in Claiborne County since construction of the nuclear station began in 1974. Nonmanufacturing employment, other than construction, increased from 1,400 in 1973 to 2,230 in 1976 an increase of 59.3 percent. Seventy-four and seven-tenths percent of this increase was in public education, but since public school enrollment dropped 8.1 percent during this period it is obvious that the construction of the nuclear station had no effect on this type of employment. In addition, most of the construction workers either send their children to private schools in Claiborne County or the public schools in Warren County rather than the public schools of Claiborne County. Other than an increase in public education

and construction, there was an increase of only slightly more than 200 jobs during this 1973 to 1976 period that could be related to the construction of the nuclear station.

Even though approximately 60 percent of the construction workers live in Warren County, it would be extremely difficult to determine the effect on nonmanufacturing employment in that county because of other changes that have taken place. Nonmanufacturing employment increased by 410, excluding government employment, from 1973 to 1976 but manufacturing employment dropped by 630 during the same period. The increase in government employment, primarily the Corps of Engineers, Mississippi River Commission, and The Waterways Experiment Station, was 600 during this time period. Federal employment would have a multiplier effect on other nonmanufacturing employment the same as manufacturing, construction and other basic types of employment.

It is estimated by the U. S. Chamber of Commerce that for the United States, for every 100 new jobs created for factory workers, a type of basic employment, that 65 new jobs are created in the nonmanufacturing job market. The relative impact on

7

employment in the nuclear station area will not be the national ratio because many of the construction workers already live in the area. As a consequence, fewer local nonmanufacturing jobs will be required to service the influx of construction workers. Some researchers have estimated that the ratio for areas similar to this will not be the national 0.65:1.00 ratio. but a ratio of 0.30:1.00[1]. With an increase of almost 2,900 construction jobs, using the above estimated ratio, there should be 870 new nonmanufacturing jobs created in the area. Up to this time, there have been only 230 nonmanufacturing jobs created that could be related to, not all necessarily caused by, the construction of the nuclear station. This is approximately eight new nonmanufacturing jobs created for every 100 new manufacturing (construction) jobs created by the construction of the nuclear station. If the number of construction workers at the nuclear station live in Claiborne County is at the level estimated, 30 percent, and the build-up in nonmanufacturing employment is complete, then the estimated ratio of 0.30:1.00 would be reasonably accurate. The total increase in nonmanufacturing employment for the impact area - due to the construction

15

[1]Delmarva Power & Light Co. Environmental Report

of the nuclear station - would be, if the above ratio is used, approximately 870 new jobs. An additional 300 to 1000 construction workers will be employed by the end of 1978 which should mean an additional 240 to 300 new nonmanufacturing jobs at the peak of construction which would mean a total of slightly over 1100 new non-manufacturing jobs for the area.

It should be noted that the employment multiplier works negatively as well as positively and experience has shown that although there is a gradual build-up of service employment due to a change in basic employment, there is an almost immediate decline in local service industries when there is a drop in employment in the basic industry. Thus the employment multiplier would not be permitted full play as the negative effects would be felt before all the positive effects are realized from peak employment.

It can be noted from Tables 5 and 6 that unemployment is less than the present national average (June, 1977) in Claiborne County but higher in Warren County. It can also be noted that the total number employed has changed very little in Warren County since 1973[2]. This indicates the construction of the nuclear station had a very beneficial effect in taking

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[2]Mississippi Employment Security Commission

up some of the slack in employment caused by other firms either closing or reducing their work force.

SUMMARY

There was a substantial increase in the number of persons employed for selected types of employment in Claiborne County between 1973-1976. For wholesale and retail trades the increase was 34.5 percent, for services and miscellaneous the increase was 50.0 percent and for manufacturing the increase was 39.4 percent.

For Warren County the changes have been less dramatic. Between 1973 and 1976 the increase for wholesale and retail trades was 7.1 percent, for services and miscellaneous the increase was 5.9 percent with an actual decrease of 13.9 percent for manufacturing.

Construction employment for Claiborne County for the same period increased from 60 to 3200 or over 5000 percent. For Warren County the increase was from 890 to 906 or 1.8 percent.

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TABLE NO. 1

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EMPLOYMENT DATA BY TYPE

CLAIBORNE COUNTY

	1971	1972	1973	1974	1975	1976	Ave. Jan.-June 1977
Manufacturing	530	550	660	720	760	920	839
Non Manufacturing	1380	1320	1460	1830	2770	5180	5429
Construction	80	40	60	380	1090	2950	3173
Wholesale & Retail Trade	260	270	290	300	310	390	390
Service & Misc.	240	210	220	260	280	330	350

Source: Mississippi Employment Security Commission

TABLE NO. 2

EMPLOYMENT DATA BY TYPE

WARREN COUNTY

	1971	1972	1973	1974	1975	1976	Ave. Jan-June 1977
Manufacturing	4,200	4,900	4,540	4,610	4,220	3,910	3,876
Non Manufacturing	12,290	12,220	12,900	13,570	14,070	14,030	13,958
Construction	950	720	890	1,270	1,300	890	906
Wholesale & Retail Trades	3,060	3,270	3,360	3,500	3,470	3,600	3,620
Service & Misc.	2,420	2,330	2,560	2,600	2,690	2,710	2,684

Source: Mississippi Employment Security Commission

TABLE NO. 3

PERCENT CHANGE IN EMPLOYMENT
BY SELECTED MAJOR TYPES
CLAIBORNE COUNTY

	1972 to 1973	1973 to 1974	1974 to 1975
Manufacturing	20.0%	9.1%	5.6%
Non Manufacturing	10.6%	25.3%	51.4%
Construction	50.0%	533.3%	186.8%
Wholesale & Retail Trade	7.4%	3.4%	3.3%
Service & Misc.	4.8%	15.4%	7.7%

	1975 to 1976	1976 to 1977*
Manufacturing	21.1%	- 8.8%
Non Manufacturing	87.0%	4.8%
Construction	170.6%	7.6%
Wholesale & Retail Trade	25.8%	0.0%
Service & Misc.	17.9%	6.1

* 1977 data is average for January through June

Source: Mississippi Employment Security Commission

TABLE NO. 4

PERCENT CHANGE IN EMPLOYMENT
BY SELECTED MAJOR TYPES
WARREN COUNTY

	1972 to 1973	1973 to 1974	1974 to 1975
Manufacturing	-7.3%	1.5%	- 8.5%
Non Manufacturing	5.6%	5.2%	3.7%
Construction	23.6%	42.7%	2.4%
Wholesale & Retail Trade	2.8%	4.2%	- 0.9%
Service & Misc.	9.9%	1.6%	3.5%

	1975 to 1976	1976 to 1977*
Manufacturing	- 7.3%	- 0.9%
Non Manufacturing	- 0.3%	- 0.5%
Construction	-31.5%	1.8%
Wholesale & Retail Trade	3.7%	0.6%
Service & Misc.	0.7%	- 1.0%

*1977 data is average for January through June

Source: Mississippi Employment Security Commission

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TABLE NO. 5

UNEMPLOYMENT DATA
CLAIBORNE COUNTY

	1972	1973	1974	1975	1976
Civilian Labor Force	2,730	3,030	3,630	5,000	8,050
Percent Unemployment	5.9%	5.3%	5.2%	8.0%	5.2%
Total Number Employed	2,570	2,870	3,440	4,600	7,630

1977

	Jan.	Feb.	Mar.	Apr.	May
Civilian Labor Force	7,987	8,187	8,515	8,470	8,605
Percent Unemployment	6.1%	5.8%	5.1%	4.6%	4.6%
Total Number Employed	7,500	7,709	8,077	8,082	8,206

	June
Civilian Labor Force	8,372
Percent Unemployment	5.9%
Total Number Employed	7,875

Source: Mississippi Employment Security Commission

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TABLE NO. 6

UNEMPLOYMENT DATA
WARREN COUNTY

	1972	1973	1974	1975	1976
Civilian Labor Force	16,540	16,860	17,430	17,920	16,830
Percent Unemployment	4.9%	5.5%	4.7%	9.3%	8.6%
Total Number Employed	15,730	15,940	16,610	16,250	15,390

	1977				
	Jan.	Feb.	Mar.	Apr.	May
Civilian Labor Force	16,486	16,690	16,708	16,526	17,179
Percent Unemployment	9.1%	9.1%	8.8%	6.6%	8.1%
Total Number Employed	14,992	15,165	15,246	15,442	15,786

	June
Civilian Labor Force	17,903
Percent Unemployment	9.2%
Total Number Employed	16,263

Source: Mississippi Employment Security Commission

INCOME EFFECTS

The effects of the impact on local and regional income of the construction of the nuclear station cannot normally be directly estimated because of the lack of adequate information on local employment, income and spending patterns. The effects will occur in two phases, the first will occur during construction when large expenditrues will be made for payrolls, materials and equipment and the second will be the period after the station is in operation.

During construction, a total of $400 million will be made in payroll expenditures over about a ten year period. During operation, the annual payroll for both units will be approximately $6 million. The above estimates are for direct income (those dollars actually dispersed as payroll). There is, also, an expansionary effect which is due to the income multiplier and the acceleration principle.

The Mississippi Research and Development Center estimates the"pure" multiplier to be 1.7 for Mississippi[1]. Other studies have shown the multiplier to be at about

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[1]Mississippi Research and Development Center

this magnitude under similar conditions. A multiplier of 1.6 was developed for a local area where most of the workers commuted from outside the area. Another study indicated a multiplier of 1.68 for new factory workers in a small town, while still another developed a multiplier of 1.66 for contract construction in a rural area.[2] The Federal Council of Economic Advisors has estimated a "pure" multiplier of two and an acceleration principle of three for the U. S. as a whole. The "pure" multiplier is an estimate of the expansionary effect for the local economy and the acceleration principle for the regional economy. The acceleration principle accounts for the additional effect that consumption has on income, via investment spending.[3]

It appears a "pure" multiplier of 1.6 to 1.7 is appropriate for the local area as several studies of similar situations, where most of the workers commuted from outside the area and/or were rural in nature, have indicated a value of this magnitude to be correct.[2] No studies have been conducted to determine the regional impact via the acceleration principle for a rural area with many of the workers commuting from outside the area,

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[2]Delmarva Power & Light Co. Environmental Report.

[3]Federal Reserve Bank of Boston, 1966.

but a value of approximately 50 percent more, which would be about 2.5, would appear appropriate based on the relationship determined by the Federal Council of Economic Advisors for the U. S. as a whole.

Using the value of 1.65 for the "pure" multiplier and 2.5 for the acceleration principle, the expansionary effect would amount to a total of $660 million for the ten year construction period and $9.9 million each year after permanent operation begins for the local area and $1 billion for the construction period and $15 million during operation for the region.

Note that the above discussion considers only payroll income and does not include any purchase of materials in the local area. Most of the large capital investment expenditures for this plant will be spent for equipment manufactured outside the area and will have little or no effect on the income of the area.

SUMMARY

The income effect on the local area is and will continue to be dramatic. Including the effect due to the multiplier, the total income effect on the local area will amount to $660 million for the ten year construction period and $9.9 million each year after permanent operation begins. For the region, the total

income effect will be $1 billion for the construction period and $15 million each year after permanent operation begins.

TAX EFFECTS ON LOCAL AREA

The nuclear station's effects on the local and regional economies due to tax monies will be substantial.

Upon commercial operation of Unit 2 in 1984, the total ad valorem tax assessment of Claiborne County will be increased to over twenty times the present amount for the county minus the present assessment for the Grand Gulf Nuclear Station (See Tables 7 and 8.) This means the total ad valorem assessment for Claiborne County would be in excess of $250 million. This would be almost seven percent of the total ad valorem assessment for the state of Mississippi for 1976.[1]

Assuming the county expenditures double by 1984, the ad valorem tax burden of the average person living in the county would be only fifteen percent of what would otherwise prevail.

The state rebates to incorporated communities nineteen percent of the sales taxes which they collect. Due to the estimated $400 million which will be paid during construction, a substantial amount of rebate income will be realized by the incorporated communities

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[1]Mississippi Power & Light Company Internal Data.

in the area. Between 1973 and 1976, Port Gibson collected 37.1 percent more sales taxes and Vicksburg 48.5 percent more with Port Gibson collecting $627,059 for 1976 and Vicksburg collecting $7,069,833 for the same year.[2]

The State's general fund will also benefit from earnings on securities which will be issued to finance the nuclear station, sales taxes not rebated to incorporated communities, state franchise taxes, state income taxes and ad valorem taxes paid to the state along with other taxes that are relatively insignificant.

It is, also, of interest to note how much more rapidly ad valorem tax assessments have increased for Claiborne County in comparison to the state of Mississippi. (See Table 9.)

SUMMARY

The ad valorem tax effects will be dramatic. The county expenditures could double by 1984 and the ad valorem tax burden of the average person living in the county would be only fifteen percent of what would otherwise prevail.

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[2]Mississippi State Tax Commission.

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TABLE NO. 7

AD VALOREM ASSESSMENT

CLAIBORNE COUNTY

	1973*	1974*	1975*	1976
Personal	$ 2,779,778	$ 2,762,798	$ 3,374,026	$ 5,207,566
Real Estate	6,806,930	6,958,305	7,317,665	7,580,355
Public Service	1,176,147***	1,315,735***	3,649,977	12,838,357
Total Assessment	$ 10,762,855	$ 11,036,838	$14,341,668	$25,626,278

* Tax Levy - 60 mills

** Tax Levy - 62 mills

*** Includes $ 27,444 on which only 4 mill state tax is levied

Source: Mississippi State Tax Commission

TABLE NO. 8

AD VALOREM ASSESSMENT*

STATE OF MISSISSIPPI

	1973	1974	1975	1976
Personal	$ 885,681,698	$ 932,675,475	$ 994,392,824	$1,102,382,443
Real Estate	1,604,081,798	1,719,116,380	1,806,292,717	1,937,535,642
Public Service	635,680,725	673,579,234	709,123,560	742,405,401
Total Assessment	3,125,444,221	3,325,371,089	3,509,809,101	3,782,323,486

* Includes Assessments on which only state tax is levied

Source: Mississippi State Tax Commission

TABLE NO. 9

COMPARISON OF CHANGE IN AD VALOREM ASSESSMENT

CLAIBORNE COUNTY AND STATE OF MISSISSIPPI

	Total Assessment Year			
	1973	1974	1975	1976
Claiborne Co.	$ 10,762,855	$ 11,036,859	$ 14,341,668	$ 25,626,278
Percent Change		+2.5%	+29.9%	+78.7%
State of Miss.	3,125,444,221	3,325,371,089	3,509,809,101	3,782,323,486
Percent Change		+6.4%	+5.5%	+7.8%

Source: Mississippi State Tax Commission

SALES TAX RECEIPTS

A very accurate way to determine change in business activity in a city, county or area is to study the sales tax receipts. In addition, it is possible to determine the change in the types of sales by category as the Mississippi State Tax Commission reports sales and tax receipts for ten different types of sales.

From Tables 10 and 14 it is obvious that three categories have been affected quite dramatically in Claiborne County:

1. Machinery, equipment and supplies*
2. Contracting lumber & building materials*
3. Miscellaneous services*

* These three categories account for 76.6% of the $1,190,769 increase in total sales tax receipts for Claiborne County between 1973 and 1976.

All three categories are directly related to the construction of the Grand Gulf Nuclear Station.

SUMMARY

Sales tax receipts increased 169.6 percent for Claiborne County between 1973-1976 and 44.0 percent for Warren County. This compares with a 36.9 percent increase for the state as a whole for the same period.

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TABLE NO. 10

SALES TAX RECEIPTS
CLAIBORNE COUNTY

	1973	1974	1975	1976
Automotive	$185,022	$195,600	$ 213,504	$ 254,228
Machinery Equip.	24,029	41,339	97,923	502,566
Food & Beverages	267,039	308,969	354,008	400,678
Furniture & Fixtures	10,469	9,730	15,816	21,223
Public Utilities	27,768	31,893	40,178	48,734
Apparel & Gen. Mdse.	49,422	57,429	70,513	74,773
Cont., Lbr., & Bldg, Mat.	91,592	120,043	239,075	506,106
Misc. Retail	37,811	44,964	49,039	56,472
Misc. Services	8,058	8,584	12,289	27,706
Total Retail	701,210	818,553	1,092,344	1,892,486
Total Wholesale	1,036	2,154	1,096	529
TOTAL FOR COUNTY	$702,246	$820,707	$1,053,439	$1,893,015

Source: Mississippi State Tax Commission

TABLE NO. 11

SALES TAX RECEIPTS
WARREN COUNTY

	1973	1974	1975	1976
Automotive	$1,303,066	$1,576,243	$1,631,035	$1,804,314
Machinery Equip.	285,463	357,855	595,429	499,382
Food & Beverages	1,767,007	1,940,796	2,228,219	2,483,911
Furniture & Fixtures	211,911	247,740	261,572	270,670
Public Utilities	281,079	298,946	358,440	480,614
Apparel & Gen. Mdse.	1,038,577	1,158,164	1,335,752	1,483,112
Cont., Lbr., & Bldg., Mat.	832,783	1,020,227	1,231,184	1,298,397
Misc. Retail	397,423	432,146	513,688	576,943
Misc. Service	224,406	265,390	280,104	323,711
Natural Resources	4,151	1,418	2,753	2,528
Total Retail	7,345,866	7,298,925	8,438,176	9,151,583
Total Wholesale	32,061	35,638	33,585	29,780
TOTAL FOR COUNTY	$6,377,928	$7,334,563	$8,471,762	$9,181,363

Source: Mississippi State Tax Commission

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TABLE NO. 12

SALES TAX RECEIPTS
PORT GIBSON

	1973	1974	1975	1976
Automotive	$ 126,257	$ 124,431	$ 141,720	$ 155,765
Machinery Equip.	4,399	15,120	10,850	12,368
Food & Beverages	159,303	168,163	190,830	222,448
Furniture & Fixtures	9,608	8,974	14,875	20,283
Public Utilities	27,768	31,893	40,178	48,734
Apparel & Gen. Mdse.	47,286	55,113	67,067	70,025
Cont., Lbr., & Bldg., Mat.	37,876	34,928	27,812	31,144
Misc. Retail	36,474	43,821	47,915	56,075
Misc. Services	7,528	7,999	7,771	9,934
Total Retail	456,500	490,442	549,018	626,776
Total Wholesale	956	548	1,066	283
TOTAL FOR TOWN	$ 457,457	$ 490,990	$ 550,085	$ 627,059

Source: Mississippi State Tax Commission

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TABLE NO. 13

SALES TAX RECEIPTS
VICKSBURG

Automotive	$1,007,720	$1,229,436	$1,314,132	$1,465,935
Machinery Equip.	114,367	94,761	156,140	227,745
Food & Beverages	1,349,307	1,572,687	1,813,169	2,049,922
Furniture & Fixtures	208,845	243,174	252,185	258,424
Public Utilities	281,079	298,946	358,440	408,614
Apparel & Gen. Mdse.	1,026,822	1,144,033	1,321,764	1,466,481
Cont., Lbr. & Bldg., Mat.	326,598	438,681	469,084	461,459
Misc. Retail	296,476	339,402	411,493	495,575
Misc. Services	127,500	106,675	116,470	210,839
Total Retail	4,738,713	5,467,775	6,212,876	7,045,915
Total Wholesale	21,275	23,371	23,158	23,918
TOTAL FOR CITY	$4,759,988	$5,491,146	$6,236,034	$7,069,833

Source: Mississippi State Tax Commission

TABLE NO. 14

PERCENT CHANGE IN TAX RECEIPTS
1973-1976

	Claiborne County	Warren County	Port Gibson	Vicksburg
Automotive	37.4	38.5	23.4	45.5
Mach. Equip.	1991.5	74.9	181.2	99.1
Food & Beverages	50.0	40.6	39.6	51.9
Furniture & Fixtures	102.7	27.7	111.1	23.7
Public Utilities	75.5	45.4	75.5	45.4
Apparel & Gen. Mdse.	51.3	42.8	48.1	42.8
Cont., Lbr. & Bldg., Mat.	452.6	55.9	-17.8	41.3
Misc. Retail	49.4	45.2	53.7	67.2
Misc. Services	243.8	44.3	32.0	65.4
TOTAL CHANGE (Percent)	169.6	44.0	37.1	48.5

INDUSTRIAL DEVELOPMENT

CLAIBORNE COUNTY

The Port Commission of Claiborne County is developing 528 acres on the Mississippi River. Part of the acreage is subject to the same limitation as the development across the Mississippi River from Vicksburg in Louisiana - flooding. There is another definite limitation and that is no port facilities are currently available. It is anticipated that the Corps of Engineers will assist in the building of a port. A port would not be absolutely necessary for the industrial park to be successful, but would be very beneficial in that industries could locate in the park that used less expensive water transportation.

There are no new industries in the planning stage at this time for the county. One industry that employed 100 workers recently closed due to - as related through personal contacts - local political problems that pressured the company to employ unqualified workers in managerial positions, and excessive costs during the construction phase.

Warren County

Plans are being formulated to convert the present Vicksburg airport consisting of 300 acres into an industrial park. The airport would be relocated and some thought is being given to moving it just across the Mississippi River into Louisiana, but a site is also available a few miles east of Vicksburg toward Jackson just off Interstate Highway 20. It is also anticipated that the Corps of Engineers will increase the size of the present Vicksburg harbor industrial area by 100 acres.

This is a 1,000 acre privately owned industrial park just across the Mississippi River in Louisiana. Part of this acreage - adjacent to the river - is subject to flooding and would, of course, limit the kind of industry that could locate in the flood prone area. The flood prone area would be limited to facilities primarily for the loading and unloading of grains and possibly cotton and other products during other than the flood season.

SUMMARY

The effect on industrial development in Claiborne and Warren Counties has been negligible up to this time.

PROJECTED LONG-RUN

COMMERCIAL AND INDUSTRIAL DEVELOPMENT

Claiborne County, and to a lesser degree Warren County, is faced, as is a majority of rural counties in the United States, with the problem of inadequate commercial and industrial facilities. This deficiency is one of the major factors contributing to the decline of the population in rural counties. This trend is being reversed in some rural areas as companies attempt to utilize the available labor by establishing small, efficient, manufacturing facilities.

There has been, and there will continue to be, a sizable influx of new people into the area during the construction phase which will last into the early 1980's. In spite of this influx of new people, there has yet to be any new industrial development and only a very limited number of new commercial businesses have been established. Commercial development as been limited to businesses characterized by low initial investments such as eating establishments, small motels, and trailer parks and the expansion and renovation of existing businesses.[1] A

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[1] Port Gibson-Claiborne County and Vicksburg-Warren County Chambers of Commerce.

majority of the loans from local banks in Claiborne County during the first few years of construction were for commercial development. One local bank official stated that these ventures have not been as successful as anticipated and that this can be noted by checking the rather slow increase in local bank deposits by local businesses. Another contributing factor to the slow growth in local commercial business volume was a boycott by blacks that began in August, 1976. In checking on the volume of business with one local firm that has both black and white customers, it was determined that the store volume did not reach pre-boycott levels until about one year after the boycott began.[2]

It doesn't appear that appreciable additional commercial development will be forthcoming as the labor force at the nuclear station is at about the peak level at the present time and adequate commercial facilities appear to be currently available.

The impact of the letdown after the construction period is over should be minimal on the general economic conditions of the area. This letdown will definitely be felt by a few firms that depend largely on the work force at the nuclear station for their existence. These

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[2]Confidential personal contacts.

are limited in number and some, such as the motels, could be moved to another area where there is a need. Should there have been a tremendous growth in commercial establishments in anticipation of the influx of new people, the situation could be quite serious when the construction is over.

The Claiborne County Port Commission is striving to get the Bruinsburg salt dome mined that is located in Claiborne County.[3] It offers the potential of water transportation as the dome is located less than one mile from Bayou Pierre. The major disadvantage is that the top of the salt stock is at a depth of 2,020 feet. This compares with 722 feet for the Richton salt dome which is the largest in a real extent of any salt dome yet identified in the state. The Richton salt dome is also located close to available transportation so it appears it would be more feasible to mine this salt dome before the Bruinsburg salt dome.[4]

Industrial development requires many factors in addition to an adequate power source. Some of those those factors are a stable, progressive local government, adequate transportation facilities, good public

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[3]Claiborne County Port Commission.

[4]Economic Minerals of Mississippi by A. R. Bicker, Jr.

schools, sufficient recreational facilities, and an adequate skilled or trainable labor force. These factors and others must be present but in addition there must also be an initiating spark for industrial development to begin and proceed at a good pace. An adequate energy source will not of and by itself insure industrial development but the absence of an adequate energy source could prevent industrial development from taking place.

SUMMARY

As noted above, an adequate energy source will not of and by itself insure that industrial development will take place but an absence of an adequate energy source would prevent industrial development from taking place.

TABLE NO. 15

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MANUFACTURING EMPLOYMENT
CLAIBORNE COUNTY

COMPANY	1973	1974	1975	1976	1977
American Paper Tube Co.	80	80	80	80	85
Beesley Timber Co.	*	*	*	16	26
National Home Products	210	210	210	250	263
Parks Lumber Co.	*	135	145	145	161
Pickens Lumber Co.	*	*	*	70	87
Port Gibson Oil Works	50	55	55	55	49
Temple Industries	**	**	50	100	***
Port Gibson Wood Products	*	40	40	40	48
Masonite Corporation	74	74	81	84	89

* Employment information not available
** Not opened at this time
*** Closed

Source: Port Gibson Chamber of Commerce
Mississippi Research and Development Center

TABLE NO. 16

MANUFACTURING EMPLOYMENT
WARREN COUNTY

COMPANY	1973	1974	1975	1976	1977
Anderson, Clayton & Co.	75	75	75	80	65
Anderson-Tully Co.	614	614	700	525	750
Batesville Casket Co.	*	40	32	40	54
Coca-Cola Bottling Co.	70	70	71	70	76
Foam Packaging, Inc.	15	25	25	31	25**
Gould, Inc.	*	*	23	60	50
Guerdon Industries, Inc.	330	*	250	250	230
Houston Brothers	48	48	47	48	57
International Paper Co.	400	400	360	400	345
Koestler's Bakery	85	85	81	77	**
Lloyd Mattress	30	30	37	37	**
Ludke Electric Co.	20	20	18	20	16
Marathon-LeTourneau	1200	1200	1200	1000	950
Marathon Shipbuilding	110	110	75	110	60
Masonite Corporation	75	95	55	95	100
Mid-South Lumber & Supply	80	80	45	20	20
Oliver Division of Sangamo	204	204	160	204	182
Runyan Construction Co.	122	122	335	237	170
U. S. Rubber Reclaiming Co.	97	97	100	98	100
Vicksburg Concrete Co.	29	29	29	29	32
Vicksburg Chemical Co.	135	135	310	300	300
Vicksburg Electromagnetics	60	60	**	**	**
Vicksburg Printing	59	59	59	59	59
Westinghouse Electric Corp.	440	440	350	440	415

* Employment information not available
** Closed

Source: Vicksburg-Warren County Chamber of Commerce
Mississippi Research and Development Center
Corps of Engineers, Vicksburg District
Personal contacts

EFFECT ON BANKING

CLAIBORNE COUNTY

The effect on the deposit structure is not as great as was originally expected as the workers could not be accommodated and many of them moved to Vicksburg and other areas.

The loan volume increased substantially more at the Bank of Port Gibson than is reflected in the statistical data.[1] The bank has $1.5 to $2.0 million in loan participations in 1973 that were purchased from correspondent banks in Jackson. These have now been liquidated and the loan volume now reflects the true loan volume of the bank.

A major part of the loan volume has been commercial in nature rather than personal.[2] These loans have been primarily for new commercial ventures and expanding the existing business firms. The deposit volume was not appreciably affected as most of the workers live out of the county. The rate of deposit volume at the Bank of Port Gibson from 1973-76 was not appreciably different from 1968-73.

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[1]Hal Gage, Vice President, Bank of Port Gibson.
[2]Ronnie L. Daughdrill, Executive Vice President, Mississippi Southern Bank.

With commercial loan volume up appreciably and deposit volume not affected as much, it is apparent that businesses have not done as well as they had expected. Another factor affecting business volume and resulting deposit volume was the boycott of Port Gibson business firms by blacks that began in August, 1976, and that has still not officially ended.

WARREN COUNTY

There has been a rather substantial increase in bank loan and deposit volume in Warren County. (See Table 21.) Since the number of construction workers and their families make up a very small part of the total population of Warren County, they have had a rather insignificant effect on banking in the county.

SUMMARY

The effect on banking in Claiborne County has not been nearly as great as was originally expected. Commercial loan volume was up 41.6 percent between 1973 and 1976 but deposit volume was up only 35.0 percent which indicates that businesses have not done as well as they had anticipated. The black boycott that began in August, 1976 was an important contributing factor to the lower business sales volume than expected.

The effect on banking in Warren County was rather insignificant.

TABLE NO. 17

AVERAGE DEPOSIT & LOAN VOLUME

CLAIBORNE COUNTY

DATE	BANK OF PORT GIBSON		MISSISSIPPI SOUTHERN BANK	
	Average Deposit Volume	Average Loan Volume	Average Deposit Volume	Average Loan Volume
5/73	$12,678,000	$9,803,000	$6,937,233	$3,608,303
5/74	13,251,000	9,647,000	8,024,699	3,947,146
5/75	13,700,000	11,284,000	9,071,979	4,178,762
5/76	14,400,000	11,635,000	8,742,032	4,804,436
5/77	16,800,000	13,639,000	9,689,733	5,356,471

Source: Hal Gage, Vice President, Bank of Port Gibson
Ronnie L. Daughdrill, Executive Vice President, Mississippi Southern Bank

TABLE NO. 18

PERCENT CHANGE IN DEPOSIT & LOAN VOLUME

CLAIBORNE COUNTY

DATE	BANK OF PORT GIBSON		MISSISSIPPI SOUTHERN BANK	
	Percent Change In Deposit Volume	Percent Change In Loan Volume	Percent Change In Deposit Volume	Percent Change In Loan Volume
5/73 to 5/74	+ 4.5	+ 1.6	+15.7	+ 9.4
5/74 to 5/75	+ 3.4	+17.0	+13.1	+ 5.9
5/75 to 5/76	+ 5.1	+ 3.1	- 3.6	+15.0
5/76 to 5/77	+16.7	+17.2	+10.8	+11.5

Source: Hal Gage, Vice President, Bank of Port Gibson.
Ronnie L. Daughdrill, Executive Vice President, Mississippi Southern Bank.

TABLE NO. 19

BANK LOAN TO DEPOSIT RATIO

CLAIBORNE COUNTY

DATE	BANK OF PORT GIBSON	MISSISSIPPI SOUTHERN BANK
5/73	77.3	52.0
5/74	72.8	49.2
5/75	82.4	46.1
5/76	80.8	55.0
5/77	81.2	55.3

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TABLE NO. 20

AVERAGE DEPOSIT VOLUME

DATE	BANK OF VICKSBURG	MERCHANTS NATIONAL	FIRST NATIONAL BANK
5/73	*	$ 43,225,315	$ 49,126,304
5/74	*	53,182,902	54,841,562
5/75	$ 10,488,838	53,005,485	57,864,326
5/76	18,246,000	60,038,000	60,746,000
5/77	24,204,000	62,296,901	70,327,799

*Opened July 15, 1974

AVERAGE LOAN VOLUME

DATE	BANK OF VICKSBURG	MERCHANTS NATIONAL	FIRST NATIONAL BANK
5/73	*	$ 22,261,194	$ 29,373,232
5/74	*	31,534,172	35,932,050
5/75	$ 6,308,628	33,936,453	34,483,765
5/76	12,599,000	35,252,000	37,766,000
5/77	16,949,000	37,107,291	45,704,201

*Opened July 15, 1974

Source: Statements of condition for respective banks

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TABLE NO. 21

PERCENT CHANGE IN DEPOSIT & LOAN VOLUME

WARREN COUNTY

DATE	BANK OF VICKSBURG		MERCHANTS NATIONAL		FIRST NATIONAL BANK	
	Percent Change In Deposit Volume	Percent Change In Loan Volume	Percent Change In Deposit Volume	Percent Change In Loan Volume	Percent Change In Deposit Volume	Percent Change In Loan Volume
5/73 to 5/74	*	*	+23.0	+41.7	+11.6	+22.3
5/74 to 5/75	*	*	- .3	+ 7.6	+ 5.5	- 4.0
5/75 to 5/76	+74.0	+99.7	+13.3	+ 3.9	+ 5.0	+ 9.5
5/76 to 5/77	+32.7	+34.5	+ 3.8	+ 5.3	+15.8	+21.0

*Opened July 15, 1974

Source: Statements of condition for respective banks

TABLE NO. 22

BANK LOAN TO DEPOSIT RATIO

WARREN COUNTY

DATE	BANK OF VICKSBURG	MERCHANTS NATIONAL BANK	FIRST NATIONAL BANK
5/73	*	51.5	59.8
5/74	*	59.3	65.5
5/75	60.1	64.0	59.6
5/76	69.1	58.7	62.2
5/77	70.0	59.6	65.0

*Opened July 15, 1974

Source: Statement of Condition for respective banks

EFFECT ON HOUSING AND OTHER SOCIAL FACTORS IN CLAIBORNE COUNTY

Housing presents a very serious problem as there are very few homes for sale in the county. Land is available in the area for residential construction with three acres selling for $7,500. These lots have electricity, water and telephone service available. Building costs are about average for this section of the state at about $24 to $25 per square foot excluding land cost. Builders are available so the only difficulty is having to wait a few months for a house to be built.[1]

There could possibly have been some speculative houses built in the county when construction began on the station, but mortgage money was not available. This situation has now been largely alleviated but speculative homes are still not being built.

Comments have been made that housing costs have increased dramatically since construction of the station began. Even though housing costs have increased, the influx of new people has not been the major factor.

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[1] Joe Bilbro, Real Estate Agent.

The housing situation was in a very depressed condition in 1973 and has now apparently returned to normal. This in addition to the increased costs due to inflation, explains most of the increase in costs of housing.

Approximately 25 new homes have been built in the area in the past three years with about one-half due to the station. The price range for homes is from $32,000 to $75,000. One apartment unit has doubled its size to 40 units but other apartment building has been nil. Apartments in the only large complex rent for $189 per month which would be about the same for comparable apartments in other parts of the state.

There are three motels in the area with two being due to the station's construction. There are slightly less tha 100 motel rooms in Port Gibson and Claiborne County with the occupancy rate close to 100 percent.

It is felt that because of the temporary nature of the situation the area will be better off in the long run by having not built a large number of speculative houses and a sufficient number of apartments to house the construction workers and their families, as there would be a sizable vacancy rate when the construction ends unless other employment became available.

Due to the shortage of housing, although

approximately 300 house trailers are in use, the population increase in Claiborne County is estimated to be slightly less than 1,000.

Many of the workers who have school age children have selected Warren County as a place of residence because of the school situation in Claiborne County and Vicksburg. In Claiborne County, it is either a private school with relatively high tuition or the public schools where the students are 98 to 99 percent black. If adequate housing were available, it is very unlikely that many more of the workers with school age children would have chosen Claiborne County as a place of residence.

Municipal services - sewer system, telephone, water and electricity - have not been overburdened. The trailer parks outside Port Gibson have their own sewage disposal systems (lagoons) and the homes outside Port Gibson have septic tanks.

Social problems - drug usage, assault and battery, etc. - have increased some but no more than would be expected with an influx of this many construction workers into an area. The problems are somewhat more visible due to the rural nature of the area.[2]

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[2]Dan McKay, Sheriff, Claiborne County.

Traffic has been a problem on the Grand Gulf Road during shift changes (See Table 24) but personal observation after the hand operated traffic light was installed at Highway No. 61 is that the traffic problem is not extremely serious. Accidents have increased somewhat but this is to be expected with the increased traffic flow. More of the accidents have been on the parking lots at the station site than on the highways.

The increased traffic flow has affected the moving of farm equipment over the entire county, especially during shift changes.[3]

SUMMARY

Housing has presented a problem as sufficient single family houses and apartments have not been available in Claiborne County. This shortage, though, has not inflated prices above the norm for other areas of the state - just brought housing from a depressed condition. The positive aspect is that after construction is over there will not be as much of an adjustment that would have to be made.

The only other social factor appreciably affected was the increase in traffic flow, especially during shift changes.

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[3]Randolph Smith, County Agent, Claiborne County.

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TABLE NO. 23

MONTHLY TRAFFIC COUNT
NATCHEZ TRACE PARKWAY
PORT GIBSON TO JACKSON SECTION

DATE	1972	1973	1974	1975	1976	1977
July	33,236	33,535	30,365	37,889	36,110	
June	31,885	27,791	30,951	31,085	33,796	37,684
May	35,347	29,146	29,470	37,015	38,127	38,295
Apr.	34,426	31,579	27,970	36,318	39,404	40,650
Mar.	36,005	28,144	25,450	33,917	39,456	38,710
Feb.	28,528	22,659	25,688	28,170	36,661	30,483
Jan.	33,236	23,385	25,866	32,913	39,345	30,715
Dec.	27,151	30,175	33,989	37,594	33,060	
Nov.	30,226	34,449	35,726	37,431	37,870	
Oct.	29,864	31,043	33,411	39,049	38,325	
Sept.	28,194	30,803	31,104	37,165	34,415	
Aug.	32,431	32,241	31,427	37,504	37,556	
	380,529	354,950	361,417	426,050	444,125	

Percent Change:

1972 to 1973	1973 to 1974	1974 to 1975	1975 to 1976
- 6.7	+ 1.8	+17.9	+ 4.2

Average Per Month:

31,711	29,579	30,118	35,504	37,010

Source: Natchez Trace Parkway

TABLE NO. 24

AVERAGE DAILY TRAFFIC COUNT
CLAIBORNE COUNTY

	1973	1974	1975	1976
Grand Gulf Rd.	110	570	2,550*	-**
Highway 462	-**	320	820*	-**
Highway 61 N.	2,120	2,080	-**	3,960
Highway 61 S.	3,260	3,250	3,480	3,750
Highway 18 E.	-**	-**	1,790	1,990

* 6 A.M. to 6 P.M. - May 1975

** Data unavailable

Source: Mississippi State Highway Department

HOUSING - WARREN COUNTY

Housing was very critical in 1974-75, but the situation has eased up quite a lot since then. There are several homes for sale in all three of the major subdivisions in the county school district with new homes also being built.[1] A large number of homes are for sale in the subdivision that was recently annexed by the City of Vicksburg because of the school situation - schools in Vicksburg are predominantly black. It is estimated that the vacancy rate for apartments is approximately 10 percent at the present time which means there are from 115 to 125 vacant apartments.

Unless some new industries move into the Vicksburg area by the time the Grand Gulf Plant is completed, there will be a rather high vacancy rate for apartments. One apartment complex has 75 to 80 percent of its apartments rented to workers at the nuclear station.[2] This is an exceptionally high rate and is somewhat higher than for other apartment complexes. A very high vacancy rate is one of the problems that could exist when plant construction is

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[1]Edward Arnold, Residential Representative, Mississippi Power & Light Company.

[2]Roger Chatam, Real Estate Broker, Vicksburg, Ms.

over unless new industries move in or existing industries expand.

Housing costs are roughly comparable to other areas in Mississippi. Real estate agents estimate the cost of residential construction is approximately $24 to $25 per square foot excluding land costs. One real estate broker stated that the nuclear station employees did not cause an increase in the price of homes - that almost all building materials came from Jackson which has not been affected by the plant construction, and sufficient land has been available to prevent a rapid increase in land costs.[2] Lot prices vary but $7500 to $8500 would be typical prices for quite acceptable lots. Apartment prices are roughly comparable to other urban areas in Mississippi and one apartment complex manager, with 20 to 25 percent of his apartments rented to plant employees, said the rent for his apartments has increased only $5 to $10 since 1973. He stated that plant employees affected the vacancy rate but not the price.

SUMMARY

Vacancy rates in apartments have been rather dramatically reduced due to the construction of the nuclear station. Rents have been affected very little.

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[2]Roger Chatam, Real Estate Broker, Vicksburg, Ms.

Single family residences cost about the same per square foot as for other areas in Mississippi.

COMPARISON OF FOOD STORE PRICES

A comparison of food store prices was made among stores in Port Gibson, Vicksburg, Prentiss and Jackson, Mississippi. It is recognized that the items checked were not weighted in this study according to the relative usage by a typical family but the prices on the 55 items selected will give a good indication of the differences in the prices of goods normally purchased at a food store.

Using the total price for the one large food store in Port Gibson as the base, the average prices for the items in Prentiss, for a store in the same chain, were exactly the same. In Vicksburg, for the four stores checked, the prices were 3.5% lower and for the three stores checked in Jackson the prices were 7.3% lower than for Port Gibson. As noted above, prices in Port Gibson and Prentiss did not differ. In further analyzing the prices in the same food stores located and checked both in Vicksburg and Jackson, it can be noted that the differences in prices completely disappear.

Two important points should be noted from the above analysis. It appears the differences in prices are due, at least in part, to the absence of substantial competition for stores in small towns located in somewhat rural areas. In addition, the differences could also be due to the pricing structure of the different companies for categories of stores located in different regions.

SUMMARY

In analyzing the total situation pertaining to prices in the food stores checked it seems reasonable to assume that the construction of the Grand Gulf Nuclear Station located near Port Gibson has not had a preceptible effect on the prices of the items checked.

TABLE NO. 25

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COMPARISON OF FOOD STORE PRICES

ITEM	PORT GIBSON	VICKSBURG				JACKSON			PRENTISS
	Piggly Wiggly	Jitney Jungle # 2	A & P	Winn-Dixie	Kroger	A & P	Kroger	Food Center # 38	Piggly Wiggly
Bacon 1 lb. Bryan or equiv.	$ 1.49	$ 1.79	$1.79	$ 1.79	$ 1.79	$ 1.99	$ 1.79	$ 1.69	$ 1.79
Ground Beef 1 lb.	.89	.99	.88	.89	.88	.88	.88	.89	.89
Ground Chuck 1 lb.	1.29	1.29	1.18	1.29	1.35	1.39	1.29	1.28	1.29
Pork Chops 1 lb. center cut	1.59	2.09	1.69	1.99	1.99	1.88	2.19	1.99	1.79
Chicken 1 lb. frying	.47	.63	*.44	.59	.65	*.44	.65	.59	.61
Bananas 1 lb.	.31	.29	.25	.29	.29	.25	.29	.29	.25
Lettuce 1 head	.39	.39	.33	.33	.43	.33	.43	.59	.49
Oranges 1 lb.	.29	.31	.31	.31	.31	.28	.40	.45	.28
Milk 2 qts.	1.13	1.05	1.09	1.07	1.08	1.09	1.09	1.09	1.06
Bathrm. Tissue 4 rolls Charmin or equiv.	1.01	.89	.83	.89	.89	.83	.89	.89	.97
Paper Towels 1 roll Scott	.79	.69	.63	.75	.63	.69	.63	.63	.67
Detergent 49 oz. Tide	1.43	1.39	*1.19	1.43	*1.19	1.19	1.19	1.19	1.43
Cheese 2 lbs. Velvetta	2.87	2.45	1.59	2.69	1.59	2.19	1.59	1.59	2.63
June Peas 1 can Del Monte	.43	.39	.45	.43	.39	.39	.39	.39	.35*
Tomatoes 1 can Del Monte Peeled	.55	.57	.59	.59	.57	.59	.59	.57	.57
Pork & Beans Campbells	.33	.33	.39	.33	.33	.34	.34	.33	.33
Apple Pie Filling Lucky Leaf	.73	.79	.65	.83	.77	.81	.69	.69	.74

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59 61

TABLE NO. 25

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COMPARISON OF FOOD STORE PRICES

ITEM	PORT GIBSON	VICKSBURG				JACKSON			PRENTISS
	Piggly Wiggly	Jitney Jungle # 2	A & P	Winn-Dixie	Kroger	A & P	Kroger	Food Center # 38	Piggly Wiggly
Oleo Margarine 1 lb. Blue Bonnett	$ .75	$ .57	$ .73	$ .75	$ .43	$ .73	$ .43	$ .49	$* .50
Tuna Fish Star Kist	.87	.79	.69	.79	.59	.69	.59	.59	.59
Ice Cream ½ gal. Borden or equiv.	1.29	1.29	1.65	1.65	1.69	1.65	1.65	1.69	1.55
Potato Chips 6 oz. Lays	.69	.69	.69	.69	.69	.69	.69	.69	.69
Doritos	.59	.59	.59	.59	.59	.59	.59	.59	.59
Crisco 3 lb.	2.10	2.02	1.35	1.89	1.39	1.35	1.35	1.35	2.09
Wesson Oil 48 oz.	2.25	2.29	1.89	2.13	1.89	1.89	1.89	2.09	2.09
Tea 100 bags Liptons	2.25	2.59	2.59	2.29	1.69	2.59	1.69	1.69	2.55
Soap Pads 10 pads SOS	.53	.55	.55	.55	.49	.55	.49	.49	.55
Apples 1 lb. Red Delicious	.59	.59	.59	.59	.59	.55	.59	.59	.59
Potatoes 1 lb. White-baking	.33	.33	.33	.44	.39	.33	.39	.39	.39
Eggs 1 doz. Large-Grade A	.87	.83	.79	.85	.77	.79	.77	.87	.85
Catsup 14 oz. Del Monte	.49	.49	.53	.53	.45	.53	.49	.42	.39
Sandwich Spread Kraft or equiv.	.93	.95	.97	.85	.89	.83	.89	.89	.89
Peaches 16 oz. Del Monte	.55	.51	.53	.51	.47	.47	.47	.47	.59
Jello 1 pkg.	.25	.25	.23	.25	.23	.23	.23	.23	.22

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62

TABLE NO. 25

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COMPARISON OF FOOD STORE PRICES

ITEM	PORT GIBSON	VICKSBURG				JACKSON			PRENTISS
	Piggly Wiggly	Jitney Jungle # 2	A & P	Winn-Dixie	Kroger	A & P	Kroger	Food Center # 38	Piggly Wiggly
Soup 1 can Vegetable Beef	.33	.26	.33	.32	.30	.33	.30	.33	.33
Ham 1 lb. Cooked	2.99	2.99	2.99	2.99	2.89	2.49	2.89	2.49	2.99
Coffee 1 lb. Maxwell House	3.75	3.69	3.95	3.85	3.29	3.69	3.29	3.29	3.79
Crackers 1 lb. Krispy	.65	.69	.68	.63	.67	.71	.67	.67	.67
Bread 1 loaf Sunbeam	.55	.54	.53	.54	.53	.53	.53	.53	.53
Bleach 2 qts. Clorox	.71	.67	.65	.69	.63	.65	.65	.65	.65
Diswasher Soap 35 oz. Cascade	1.35	1.29	1.29	1.29	1.19	1.29	1.19	1.19	1.31
Hand Soap 1 bar Camay	.25	.26	.25	.26	.25	.25	.25	.25	.25
Dog Food 5 lbs. Jim Dandy or equiv.	1.53	1.57	1.59	1.63	1.55	1.59	1.49	1.55	1.65
Flour 5 lbs. Gold Medal	.93	.79	.59	.79	.59	.59	.59	.59	.79
Cereal 20 oz Raisin Bran-Kellogs	1.23	1.23	1.19	1.15	1.13	1.13	1.13	1.13	1.19
Meal 5 lbs. Martha White	1.11	1.05	.99	1.05	.99	.99	.99	.99	1.05
Sugar 5 lbs. Godchaux or equiv.	.99	1.02	.95	.75	1.09	1.09	1.09	1.05	.95
Syrup 24 oz Mrs. Butterworth's	1.33	1.39	1.49	1.39	1.35	1.49	1.84	1.35	1.37
Black Pepper 4 oz. French's or equiv.	1.07	1.09	1.05	1.09	1.09	1.05	.83	.99	1.09

TABLE NO. 25

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COMPARISON OF FOOD STORE PRICES

ITEM	PORT GIBSON	VICKSBURG				JACKSON			PRENTISS
	Piggly Wiggly	Jitney Jungle # 2	A & P	Winn-Dixie	Kroger	A & P	Kroger	Food Center # 38	Piggly Wiggly
Cream Corn 1 can Del Monte	.41	.39	.44	.35	.41	.37	.33	.41	.33
Evaporated Milk Pet 1 can	.20	.20	.20	.20	.19	.20	.19	.19	.19
Tomato Juice 46 oz. Campbell's	.79	.75	.73	.75	.69	.73	.69	.73	.79
Pineapple 1 can Del Monte	.65	.65	.65	.67	.69	.65	.69	.63	.65
Beer 6 pack Schlitz	1.99	1.89	1.85	1.85	1.93	1.98	1.99	1.99	1.99**
Peanut Butter 18 oz. Jif Crunchy	1.19	1.19	1.49	1.25	1.09	1.19	1.09	1.23	.93
Cokes 16 oz. 8 pack	1.19*	1.49	1.87	1.77	1.37	1.35	1.39	1.39	1.77
TOTAL OF 55 ITEMS	$57.23	$56.75	$54.73	$57.10	$52.24	$54.37	$52.59	$52.29	$56.52
AVERAGE	$56.51		$55.21				$53.08		$56.52
RELATIVE PRICE	100%		97.7%				93.9%		100%
AVE. A & P AND KROGER			$53.49				$53.48		

*Store special for that week

**Not available in Prentiss - Estimated price to be the same as Port Gibson.

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62

64

IMPACT ON PUBLIC SCHOOLS

CLAIBORNE COUNTY

The impact of the influx of new people in Claiborne County due to the construction of the nuclear station on the Claiborne County Public Schools has been nil.[1] The slight impact, which is favorable, is with the private schools in the county.

Enrollment in the Claiborne County Public Schools has declined each year since the construction began as can be noted on Table 26.[2] The decrease between the 1972-73 school year and the 1976-77 school year was 11.3 percent. The students enrolled in the public schools are between 98 and 99 percent black and the white construction workers and other whites with school age children enroll them in the private schools.

The impact on the two private schools in the county has been favorable as space was available or the extra funds from the tuition provided a way to expand the school to provide more adequate facilities for all the students attending these schools. About ten percent of the students attending the Claiborne Education

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[1]Charles Noble, Superintendent of Education Claiborne County.

[2]Mississippi State Department of Education.

Foundation School - grades one through six - are the result of the construction of the nuclear station.[3] Less than ten percent of the day students at Chamberlain-Hunt Academy - grades seven through twelve - are the result of the construction of the station.[4] Adequate space is available at the Chamberlain-Hunt Academy so these students are a definite asset.

The Claiborne Education Foundation is adding three new classrooms to the eight classrooms presently in use. Only one of the new classrooms will be used for that purpose during the 1977-78 school year with one used for a library and one for storage.

The administrators of both private schools stated the children of the MP&L employees were a very definite asset to the schools as they rate quite high academically and their parents are interested in education.

WARREN COUNTY

It is of interest to note that comments have been made that the children of the construction workers at the nuclear station have caused a severe overcrowding of the public schools in Vicksburg and Warren County. The actual and, of course, accurate statistics do not

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[3]Mrs. Joe Bilbro, Principal, Claiborne Education Foundation.

[4]C. A. Johnson, President, Chamberlain-Hunt Academy.

bear this out at all. The total enrollment of the Warren County Schools and the Vicksburg Public Schools has declined 2.4 percent between the 1972-73 school year and the 1976-77 school year as can be noted on Table No. 30. There was a rather substantial increase in the enrollment in the Vicksburg Public Schools during the 1976-77 school year - a total of 487 or 11.7 percent more than the previous year. This was offset in large part by a decrease in the Warren County Schools during that same year - a total decrease of 343 or 5.7 percent less than the enrollment for the previous year.[2] These changes were due to the City of Vicksburg annexing additional territory in the county prior to that school year. Even with the increase of 11.7 percent in enrollment in the Vicksburg Public Schools for the 1976-77 school year there was apparently no overcrowding as one school was closed just prior to that school year.

It is more difficult to determine the change in enrollment figures for the private schools on a year to year basis as some information was unavailable as it was destroyed in a fire. The impact of the children of construction workers at the station has been negligible although the private school that is not church related -

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[2]Mississippi State Department of Education.

Council # 9 or sometimes called Porters Chapel - has had a decline in enrollment since the 1973-74 school year as can be noted on Table 31.[5] Additional students would be more than welcome at this school and the few due to the construction of the nuclear station are definitely an asset.

SUMMARY

On balance, it appears that the impact of the children of construction workers and MP&L employees associated with the Grand Gulf Nuclear Station on all the schools in the two counties, Claiborne and Warren, has either been nil, negligible or an asset.

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[5]Personal contact with administrators of each private school.

TABLE NO. 26

PUBLIC SCHOOL ENROLLMENT*

CLAIBORNE COUNTY

SCHOOLS	1972-73	1973-74	1974-75	1975-76	1976-77
Richardson (Grades 1-6)	511	497	491	472	503
Addison (Grades 7-9)	1,329	1,257	1,163	1,110	1,071
Port Gibson High (Grades 10-12)	526	530	527	534	525
Total Enrollment	2,366	2,284	2,181	2,116	2,099
Percent Change		-3.5%	-4.5%	-3.0%	-1.0%

* Present Enrollment is 98-99% black

Source: Charles Noble, Superintendent of Education, Claiborne County

TABLE NO. 27

PRIVATE SCHOOL ENROLLMENT

CLAIBORNE COUNTY

SCHOOL	1973-74	1974-75	1975-76	1976-77	(Projected) 1977-78
Claiborne Education Foundation (Grades 1-6)	141	148	153	162**	175-180***
Chamberlain-Hunt Academy, Day Students (Grades 7-12)	*	140	141	150	155-160

* Information not available

** 11 students due to construction of Grand Gulf Nuclear Station

*** Expect 15 to 20 students due to construction of Grand Gulf Nuclear Station

Source: C. A. Johnson, President, Chamberlain-Hunt
Mrs. Joe Bilbro, Principal, Claiborne Education Foundation

TABLE NO. 28

PUBLIC SCHOOL ENROLLMENT
VICKSBURG PUBLIC SCHOOLS
WARREN COUNTY

SCHOOL	1972-73	1973-74	1974-75	1975-76	1976-77
Grove Street Elem.	557	536	509	512	662
Karyl Ken Elem.	277	217	**	**	**
Bowman Ave. Elem.	645	516	489	491	388
Hall's Ferry Elem.	339	260	414	387	450
Cherry Street Elem.	576	520	542	476	**
Vicksburg Middle Sch.	*	654	584	562	797
Vicksburg Jr. High	1,353	833	850	810	858
Vicksburg High	1,098	934	912	911	1,481
TOTAL	4,845	4,470	4,300	4,149	4,636***
PERCENT CHANGE		-7.7%	-3.8%	-3.5%	+11.7%

Note: Grades at each school were changed during this period therefore the total figures are the only ones that can be directly compared.

* Not open at this time

** Closed

*** Vicksburg annexed additional territory

Source: Mississippi State Department of Education

TABLE NO. 29

PUBLIC SCHOOL ENROLLMENT

WARREN COUNTY PUBLIC SCHOOLS

WARREN COUNTY

SCHOOLS	1972-73	1973-74	1974-75	1975-76	1976-77
Culkin Academy					
(Grades 1-7)	839	971			
(Grades 1-6			867	883	702
Jett					
(Grades 1-7)	718	672			
(Grades 1-6)			534	493	641
Redwood					
(Grades 1-7)	352	320			
(Grades 1-6)			254	256	250
Warrenton Elem.					
(Grades 1-7)	678	848			
(Grades 1-6)			750	843	729
Cedars					
(Grades 1-7)	438	488			
(Grades 1-6)			437	419	304
Kings					
(Grades 1-7)	590	257			
(Grades 1-6)			215	192	223
Warren Central J.H.S.					
(Grades 7-8)	*	*	1,142	1,154	1,037
Warren Central H.S.					
(Grades 8-12)	2,117	2,207			
(Grades 9-12			1,743	1,808	1,819
TOTAL ENROLLMENT	5,749	5,763	5,942	6,048	5,705**
PERCENT CHANGE		+0.2%	+3.1%	+1.8%	-5.7%

* Opened for 1974-75 school year
** City of Vicksburg annexed additional territory in the county

Source: Mississippi State Department of Education

TABLE NO. 30

TOTAL PUBLIC SCHOOL ENROLLMENT

WARREN COUNTY

SCHOOLS	1972-73	1973-74	1974-75	1975-76	1976-77
Warren County	5,749	5,763	5,942	6,048	5,705
Vicksburg Public	4,845	4,470	4,300	4,149	4,636
Total	10,594	10,233	10,242	10,197	10,341
Percent Change		-3.4%	+0.1%	-0.4%	+1.4%

Source: Mississippi State Department of Education

TABLE NO. 31

PRIVATE SCHOOL ENROLLMENT

WARREN COUNTY

SCHOOLS	1973-74	1974-75	1975-76	1976-77	1977-78
Council #9	378	352	328	306	295*
St. Francis	387	372	377	362	360*
St. Aloysius	335	341	**	335	320***
All Saints	113	123	131	155	150-160*

* Projected

** Already enrolled - July, 1977

*** Records destroyed by fire - building new high school

Source: Personal Contact with administrator of each school

TABLE NO. 32

TOTAL SCHOOL ENROLLMENT
PUBLIC & PRIVATE SCHOOLS

WARREN COUNTY

SCHOOLS	1972-73	1973-74	1974-75	1975-76	1976-77
Warren County	5,749	5,763	5,942	6,048	5,705
Vicksburg Public	4,845	4,470	4,300	4,149	4,636
Private	*	1,213	1,188	**	1,158
	**	11,446	11,430	**	11,499

* Enrollment information not available

** Enrollment information incomplete

HOSPITALS AND HEALTH CARE

CLAIBORNE COUNTY

The Claiborne County Hospital is being increased from 25 beds to 35 beds with the addition of very up-to-date out patient services. This construction and renovation is estimated to cost $2 million when completed in October, 1977. One and one-half million dollars was provided by the Claiborne County Board of Supervisors and one-half million dollars was secured from a Hill-Burton grant.

The hospital administrator stated without equivocation that the hospital construction and renovation was due entirely to the construction of the Grand Gulf Nuclear Station. There has been a real need for better hospital facilities in all the rural counties of Mississippi and the changes in the Claiborne County Hospital will be a definite asset in providing better health facilities and care for the people in this area as well as attracting more medical doctors.

The occupancy rate is rather low at the present time due to the construction and renovation of the hospital, but a sharp increase is expected after the

construction and renovation are over.[1]

SUMMARY

The health care facilities of Claiborne County have improved appreciably. A $2 million construction and renovation at the Claiborne County Hospital is nearing completion.

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[1]Elvyn Spencer, Hospital Administrator, Claiborne County Hospital.

RECREATIONAL FACILITIES

CLAIBORNE COUNTY

The Grand Gulf Military Park is an outstanding small park and a definite asset to the area. Attendance has been increasing quite substantially over the past two to three years and the increase is expected to continue at the same rate or even faster in the future. A fifty percent increase is expected between 1976 and 1981 and, if the present trend continues, this is a very conservative estimate.[1]

If a visitor's center is opened at the nuclear facility after the construction phase is over, there will be an even more rapid increase in attendance at the park. This, coupled with better access and better roads, will have a very beneficial effect on the area. The multiplier effect is operable with expenditures for recreational purposes the same as if the funds were spent for a government project or for food or clothing.

WARREN COUNTY

Plans are being formulated to convert the King Merritt farms - 280 acres - that are located a few miles

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[1]Grand Gulf Military Park.

east of Vicksburg on Interstate 20 into a recreational park.[2] This is a very needed facility as there are no other public family type of recreational parks in Warren County other than the Vicksburg National Military Park.

This development does not appear to be related to the Grand Gulf Nuclear Station but would be available for the construction workers during construction and the permanent staff of the station when in operation to use and enjoy.

SUMMARY

Recreational facilities have not changed due to the construction of the nuclear station.

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[2]Vicksburg-Warren County Chamber of Commerce.

TABLE NO. 33

GRAND GULF MILITARY PARK

Yearly Attendance Figures

YEAR	ATTENDANCE	PERCENT INCREASE
1972	75,310	
1973	85,116	13.0
1974	89,210	4.8
1975	103,9	16.5
1976	123,444	18.8
1981*	185,166*	50.0*

* Projected

Source: Grand Gulf Military Park, Port Gibson, Mississippi

EFFECT OF GRAND GULF NUCLEAR STATION
ON SPORT AND GAME FISHING AND DEER HUNTING IN AREA

There are two sport fishing lakes on the 2,164 acre nuclear station site - Gin and Hamilton. These lakes will continue to be available for sport fishing, and a personal inspection of the area plus a conference with the local game warden would indicate the station should not have any effect on fishing in the area.[1] The lakes will probably be utilized more in the future due to better access roads being available.

Commercial fishing in the Mississippi River and the Big Black River in the area should not be affected.[1] The Big Black River neither traverses, nor is it adjacent to, the station property. The Mississippi River constitutes the western boundary of the property but the only way the station would affect commercial fishing would be to make the river more accessible due to improved roads.

This part of the Mississippi River delta and rolling hill country is prime deer hunting territory. There will be no hunting allowed on the 2,164 acre site,

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[1] J. D. Price, Jr., Game Warden, Claiborne County, Mississippi.

except possibly bow hunting. There will be 87 acres fenced in the immediate station area with 61 additional acres set aside for permanent utilization - a total of 148 acres. This leaves 2,016 acres of the total 2,164 acres at the site that will be utilized for wildlife. This 2,016 acres will be an excellent area that will be used as a game preserve.

One deer camp and part of another have been affected in that one deer camp had to be abandoned and the acreage was reduced for the second. The members who belonged to the abandoned deer camp have found other areas in the southwestern part of the state to establish other deer camps.[1]

SUMMARY

On balance it appears the station will not affect or will effect in a positive manner the sport and game fishing and deer hunting in the area.

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[1] J. D. Price, Jr., Game Warden, Claiborne County, Mississippi.

EFFECT ON LAND AREA IN VICINITY OF PLANT

Approximately 100 acres of row crops and 100 acres of permanent pastures have been removed from use by the plant construction, but 75 acres of hay land has been added back. This would be a net loss of only 125 acres of row crop and improved pasture land that has been removed from use.[1]

The excavation at the site has not caused any land erosion in the station area.

SUMMARY

The effect on the land area in the immediate vicinity of the plant has been minimal as no erosion has taken place and very few acres have been removed from circulation.

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[1] Randolph Smith, County Agent, Claiborne County.

ECONOMIC IMPACT OF NUCLEAR STATION

ON LAND VALUES IN CLAIBORNE COUNTY

There has been an increase in the price of small acreages of five to ten acres for home sites, businesses and trailer parks, especially in the vicinity of the station. The price increases have been as much as four fold when compared to prices before construction began.[1,2]

There has been no measurable effect on the price of regular agricultural land in the county.[3] Prices of agricultural land have increased but have been due to other factors, primarily demand for agricultural purposes and inflation.

SUMMARY

There has been no measurable effect on the price of regular agricultural land. Some inflation in prices has taken place with small acreages, especially in the vicinity of the nuclear station.

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[1]Joe Bilbro, Real Estate Agent.

[2]Don McKay, Sheriff, Claiborne County.

[3]Randolph Smith, County Agent, Claiborne County.

BONDED DEBT

CLAIBORNE COUNTY

The bonded debt for Claiborne County was 5.1% less on September 30, 1975, than on September 30, 1971. The only bonds issued during this period were $105,000 on November 1, 1973, for an office building and $220,000 on December 18, 1974, for road and bridge purposes.[1]

In further researching the bonded debt situation, it was determined that in December, 1975, the Claiborne County Board of Supervisors approved the issuance of $1.5 million in general obligation bonds to renovate and make an addition to the Claiborne County Hospital.[2] This information was made available locally as the Mississippi Department of Audit has not published figures on bonded debt since the report that provided the information was dated September 30, 1975. These bonds are being issued in half-million dollar amounts as funds are needed as the construction and renovation of the hospital require. One million dollars of these bonds have been issued up to the present time, but all should be issued sometime this year as the construction and renovation of the hospital is scheduled for completion in October.

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[1]Mississippi State Department of Audit.

[2]Claiborne County Board of Supervisors.

These bonds are being issued without an increase in the millage rate which is possible due to the increase in assessed valuation of property in the county.

The bonds are being sold to the Federal Housing Administration at an interest rate of five percent after private investors could not be secured to purchase them at the six percent tax-free rate that was allowable.

The millage rate was increased from 60 mills to 62 mills in 1976, but only for the purpose of reassessing all property in the county to make the assessed valuation more equitable.

SUMMARY

The bonded debt has increased due to the hospital construction and renovation but will not be a burden because of the tremendous increase in assessed valuation of real property in the county.

TABLE NO. 34

BONDED DEBT
CLAIBORNE COUNTY

DATE	DEBT OUTSTANDING
9-30-71	$ 786,000.00
9-30-72	693,000.00
9-30-73	598,000.00
9-30-74	610,000.00
9-30-75*	746,000.00

* $1 million of a total of $1.5 million authorized have been issued since this date for construction and renovation of the Claiborne County Hospital.

Source: Mississippi State Department of Audit

8.2 COSTS

8.2.1 Internal Costs

The Grand Gulf Nuclear Station site of about 2330 acres was purchased for approximately one million dollars. A 164-acre plot was transferred in 1974 to the Grand Gulf Military Monument Commission. Of the remaining acreages (approximately 2170), only 124 acres are used for permanent structures and facilities. The cost of land acquisition, improvement, and facility construction associated with the plant amounts to about $2.1 billion, excluding the fuel. The cost of the transmission and substation facilities for connection of the Grand Gulf Nuclear Station is about $34 million. The annual fuel costs are estimated to be $53 million per unit based on 6/mills/kWh. Yearly operation and maintenance cost is given in Table 9.4.4. Additional fees that have been or will be paid to the NRC include (1) $70,000 construction permit application, (2) $1,060,000 construction permit, (3) $35,000 Special Nuclear Materials License, (4) $1,559,000 operating license and (5) $498,290 annual. Plant decommissioning costs can vary from $2.5 to $31.2 million, depending on the decommissioning method used (Ref. 1).

Table 9.4.2 provides plant cost information. Comparison may be made between this table and Table 9.4.1, which provides similar information for a coal-fired plant.

8.2.2 External Costs

8.2.2.1 Temporary External Costs

As discussed in subsection 8.1.2.5, construction of the station has not created a housing shortage, escalated rentals or prices, overloaded water supplies or sewage treatment facilities, or crowded schools, hospitals, or roadways.

The fact that the area around the station site did not develop to accommodate the construction workers means that there will be little "boom and bust" adjustment to be made after construction. Of course, some businesses that depended largely on the work force, such as restaurants and trailer parks adjoining the site, will have difficulties after construction.

8.2.2.2 Long-term External Costs

There are not any significant long-term external costs due to the station construction.

The construction of the Grand Gulf Nuclear Station has not restricted access to scenic, historic, or cultural areas, as dicussed in subsection 4.1.3.3. Land values of small acreages near the station site did not decrease, but rather increased. The two lakes on the site, Gin and Hamilton Lakes, are still

available for public fishing. Commercial fishing in the Mississippi River, the west boundary of the site, is not affected. Portions of the site were used for deer hunting prior to plant construction, but no hunting is presently allowed on the site. However, over 90 percent of the site will be left in its natural state, which is beneficial to wildlife.

The taxes levied on the plant offset any increase in cost or taxes to the residents of Claiborne County as a result of having to provide community services to the construction workers. Also, tax revenues from the station reduced the ad valorem tax liability for Claiborne County residents to 15 percent of what they would normally have been required to pay. See subsection 8.1.2.3 for additional information on taxes.

8.2.3 References

1. "An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternatives - Summary Report," Nov. 1976, Atomic Industrial Forum AIF/NESP-009SR, page 1.

2. "Socio-Economic Impact of Grand Gulf Nuclear Station," by Recon, Inc., Clinton, Mississippi, August 1977.

3. Mississippi Research and Development Center.

CHAPTER 9

ALTERNATIVE ENERGY SOURCES AND SITES

TABLE OF CONTENTS

		Page
9.1	ALTERNATIVES NOT REQUIRING THE CREATION OF NEW GENERATING CAPACITY	9.1-1
9.2	ALTERNATIVES REQUIRING THE CREATION OF NEW GENERATING CAPACITY	9.2-1
	9.2.1 Alternative Sites	9.2-1
	9.2.2 Alternative Energy Sources	9.2-1
	9.2.2.1 Hydroelectric	9.2-1
	9.2.2.2 Geothermal	9.2-1
	9.2.2.3 Natural Gas	9.2-1
	9.2.2.4 Fuel Oil	9.2-3
	9.2.2.5 Coal vs Nuclear	9.2-3
	9.2.2.5.1 Fuel Availability	9.2-3
	9.2.2.5.2 Fuel Transport	9.2-4
	9.2.2.5.3 Physical Plant Requirements	9.2-4
	9.2.2.5.4 Aesthetics	9.2-4
	9.2.2.5.5 Transmission Facilities	9.2-4
	9.2.2.5.6 Effluents from Plant Operations	9.2-5
	9.2.3 References	9.2-5 | 1
9.3	COST EFFECTIVENESS ANALYSIS OF CANDIDATE SITE-PLANT ALTERNATIVES	9.3-1
9.4	COSTS OF ALTERNATIVE POWER GENERATION METHODS	9.4-1

LIST OF TABLES

Table No.	Title
9.2.1	Proportion of kWh Generated by Three Primary Fuels in the MSU System
9.2.2	Estimates of Domestic Reserves of Various Fuels
9.3.1	Comparison of Project Costs if Unit 2 Delayed One Year
9.3.2	Comparative Costs for Peaking Capacity if Unit 2 Delayed One Year
9.4.1	Cost Information for Coal-Fired Units
9.4.2	Cost Information for Nuclear Station
9.4.3	Estimated Annual Costs of Coal-Fired Generation
9.4.4	Estimated Annual Costs of Nuclear Generation

CHAPTER 9.0 ALTERNATIVE ENERGY SOURCES AND SITES

9.1 ALTERNATIVES NOT REQUIRING THE CREATION OF NEW GENERATING CAPACITY

If a new generation facility is not constructed, alternatives, such as purchasing power from other utility systems, upgrading or not retiring older, inefficient plants, or converting existing peaking units to base load operation, must be considered. Purchasing power from neighboring utilities for long-term power requirements is not practical. The reserve margins of adjacent utilities are at or below the desired level to assure reliability. By 1981, the regular diversity exchange between the MSU System and TVA will have been reduced by 243 MW, increasing the MSU System's peak load responsibility by a corresponding amount. Upgrading existing, older facilities or converting peaking units to base load operation is not feasible.

9.2 ALTERNATIVES REQUIRING THE CREATION OF NEW GENERATING CAPACITY

9.2.1 Alternative Sites

An evaluation of alternative sites is contained in subsections 8.3.1 and 8.3.2 of the Environmental Report, Construction Permit Stage.

9.2.2 Alternative Energy Sources

Alternative energy sources include: hydroelectric, geothermal, nuclear, and fossil fuels (e.g., natural gas, fuel oil, and coal). Other methods of power generation include: solar cells, fuel cells, coal gasification, magneto-hydrodynamics, thermonuclear fusion, wind power, and tidal power. These methods are excluded from further consideration as they are judged to be in the developmental stage.

9.2.2.1 Hydroelectric

There are no base load type hydroelectric sites within the MSU System service area that have sufficient flow and head to be considered appropriate for development of the required 2500 MW. As discussed in subsection 8.3.1 of the Environmental Report, Construction Permit Stage, it was not considered appropriate to investigate for hydroelectric sites outside this service area.

There are numerous hydroelectric sites within the MSU System service area in Arkansas that would be suitable for pumped-storage operation. This type of facility is only designed for peak shaving and is not suitable for base load operation. Since the demand of the MSU System is such that 2500 MW of base load capacity is required in the 1981 - 1984 period, pumped-storage is not considered as a viable alternative source.

9.2.2.2 Geothermal

Geothermal energy is currently being used as a source of power in Europe and, to a limited extent, in the western part of the United States. The only potential geothermal sites within the MSU System service area are located in South Louisiana, and are of the geopressured water type. To date, the development of this type of geothermal resource is not very far along, and there are still many questions concerning the economics and environmental effects of this resource. For these reasons, further consideration was not given to this alternative energy source.

9.2.2.3 Natural Gas

The MSU System has traditionally burned natural gas as its primary fuel but has in recent years needed to burn increased amounts of oil.

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For the 12 months ending September 30, 1978, approximately 84 percent of the natural gas used by the generating stations as boiler fuel was obtained from intrastate sources, and approximately 16 percent was obtained from interstate pipeline companies which have been deemed to be subject to regulation under the Natural Gas Act. Deliveries of natural gas by these interstate pipeline companies are subject to curtailment programs in effect and in the process of development under the Act. As a result of gas supply curtailments, the proportion of kWh generated by the MSU System using oil as fuel has increased from approximately 11 percent in 1972 to 47 percent for the 12 months ending September 30, 1978, as shown in Table 9.2.1. |1

The FERC has authority (formerly exercised by the FPC) to allocate natural gas supplies of interstate pipelines to all customers regardless of the nature of any contracts with individual customers. The MSU System anticipates that curtailments of natural gas deliveries from the MSU System's interstate pipeline suppliers will increase over the curtailments experienced to date.

As a result of curtailments of natural gas, the MSU System operating companies expect to burn substantial amounts of oil during 1979. However, as a result of burning oil, the generating units require greater maintenance and restoration work. During the peak load season of 1979, the MSU System estimates that its net generating capability will be reduced by approximately 6 percent by the substitution of oil for natural gas. |1

To assure the availability of the generating units normally supplied with interstate natural gas and to reduce restoration and maintenance work on such units, it has been necessary to convert certain units and will be necessary to convert others to permit the use of oil as a primary fuel.

Efforts to secure a gas supply for a 761 MW unit that began commercial operation in 1975 were completely unsuccessful, even on an interruptible basis and despite the plant being located in close proximity to a number of major gas transmission pipelines. The replies received from gas suppliers were so completely negative that gas line facilities were not provided into the plant.

Future supplies and prices of natural gas are quite uncertain and subject to Federal and State legislation. Some proposed legislation would go as far as to completely prohibit the use of natural gas as a boiler fuel for the generation of electric energy.

The above facts preclude serious consideration of natural gas as a viable fuel when planning for future large generating stations on the MSU System.

9.2.2.4 Fuel Oil

In recent years, curtailment of the natural gas supply, conversion of coal-fired generating units to oil in order to meet air quality standards, and growth in the demand for electric energy has caused a phenomenal increase in the consumption of fuel oil by the electric utility industry. Between 1966 and 1976, the industry has quadrupled its consumption of fuel oil (Ref. 1). During this same period, the MSU System's annual oil requirements have risen from 37,000 barrels to 25,128,000 barrels, with a further increase to 35,895,000 barrels for 1977 and approximately 39,200,000 barrels for 1978. 1

This rapid growth in the demand for oil was also experienced in other sectors, with the result being a decrease in domestic reserves and a corresponding increase in the dependence on foreign sources of oil. It is projected that by 1980, the United States will be importing about four times as much oil from these foreign sources as it did in 1974 (Ref. 2).

The long-term availability of the foreign oil supply is quite uncertain, since the reliability of this supply is subject to the varying economic and political climates within the exporting countries and throughout the world. Therefore, the lack of a dependable long-range supply eliminates fuel oil as a feasible alternative energy source.

For the long term, the MSU System has firm commitments for 50,000 barrels per day of residual fuel oil. However, this quantity will not totally fulfill projected long-term requirements, and is contingent upon a reliable supply of oil from foreign sources.

9.2.2.5 Coal vs Nuclear

The remaining alternative energy sources considered are coal and nuclear. The following is an evaluation of these alternatives on the basis of fuel availability, fuel transport, physical plant requirements, aesthetics, transmission facilities, and effluents from plant operation.

9.2.2.5.1 Fuel Availability

Forecasts through the year 2000 indicate that there will be sufficient domestic supplies of coal and nuclear fuel to meet the future power demands of the nation. Table 9.2.2 gives an estimate of domestic reserves of fossil and nuclear fuels and the approximate time of total depletion, assuming a 5 percent annual growth rate in consumption of electrical energy.

The domestic reserves of uranium resources (U_3O_8) are estimated between 1.5 and 3.6 million tons (Ref. 3). If the breeder reactor is developed, use of the nuclear fuel supply will be substantially prolonged.

Coal reserves within the United States are estimated between 200 and 600 billion tons (Ref. 3). These reserves consist of the subbituminous coal of Wyoming, Montana, Colorado, and New Mexico; bituminous coal of Illinois, Indiana, Kentucky, Virginia, and Pennsylvania; and lignite in the southern states of Texas, Arkansas, Louisiana, Mississippi, and Alabama. While adequate reserves are available in this country, reserves with the sulfur content low enough to meet the Environmental Protection Agency's emission standards are not so widespread.

9.2.2.5.2 Fuel Transport

Compared to nuclear fuel, the logistics of transporting coal to the site are much more involved, and the associated costs are much higher. Coal could be delivered to the site by slurry pipeline, unit trains, river barges, or a combination of any of these. A 1250 MW coal plant operating at a 65 percent capacity factor would require approximately 4,000,000 tons of coal per year. (In the Environmental Report, Construction Permit Stage, an 85 percent capacity factor was used. This now seems to be a typographical error, since the fuel consumption stated agrees with that for a capacity factor of 65 percent.) Using unit trains consisting of 100 cars, each with a capacity of 100 tons, 400 train deliveries per year would be required. Considering a 5-day, 50-hour work week, an average of 1.6 train deliveries would have to be made each working day. Barge transportation would involve about 10 1500-ton barges per working day, and legislation granting slurry pipelines the right of eminent domain is required before this mode of transportation can be used. Supplying fuel to a nuclear power plant of similar size would require shipments of less than 100 tons per year.

9.2.2.5.3 Physical Plant Requirements

A coal-fired plant would require a much larger area of land than a nuclear facility of the same capacity. Several hundred acres are required for storage of 60-to 90-day coal reserves and bottom and fly ash storage ponds. In addition, coal-fired plants require extensive fuel handling facilities, such as conveyors and barge unloading docks, which are normally not required in a nuclear facility.

9.2.2.5.4 Aesthetics

A nuclear generating station is aesthetically more pleasing than a coal-fired plant primarily due to the lack of the visual impact of coal storage piles.

9.2.2.5.5 Transmission Facilities

Assuming the same plant site, there would be no difference in the transmission facilities required for either a coal or nuclear generating station.

9.2.2.5.6 Effluents from Plant Operations

Thermal discharges associated with circulative water systems are common to both nuclear and coal-fired plants. The amount of heat to be dissipated from nuclear units is greater because of their lower thermal efficiency.

Effluents unique to coal-fired plants are the solid and gaseous products of combustion and any liquid runoff from the coal storage piles. On an average day, applying current EPA emission standards (40 CFR 60.42 60.43, and 60.44), stack effluents from a 1250 MW plant contain on the order of 11 to 13 tons of particulates, 120 to 150 tons of sulfur dioxide, 70 to 90 tons of oxides of nitrogen, and small concentrations of carbon monoxide. In addition, 700 to 900 tons of ash are deposited in storage ponds.

Effluents unique to nuclear plant operation are liquid and gaseous radioactive wastes. Under current NRC requirements, the concentrations of radioactive effluents permitted to be released into the evironment are insignificant and are closely monitored and controlled. Also, spent fuel and solid radioactive wastes are containerized and shipped offsite for treatment and/or disposal.

9.2.3 References

1. "1977 Annual Statistical Report," Electrical World, Volume 187, page 50, March 15, 1977.

2. Olds, F. C., "Nuclear Power Engineering," Power Engineering, Volume 80, page 24, February 1976.

3. Spencer, D. F., "The Spectrum of Future Electric Generation Alternatives," Annual Conference, Engineering and Operation Division, Southeastern Electric Exchange, New Orleans, 1976.

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TABLE 9.2.1

PROPORTION OF KWH GENERATED BY
THREE PRIMARY FUELS (1) IN THE MSU SYSTEM

	Natural Gas		Oil		Nuclear	
	Percent of Generation	Fuel Cost Per kWh	Percent of Generation	Fuel Cost Per kWh	Percent of Generation	Fuel Cost Per kWh (2)
1972	88	.29¢	11	.69¢	----	----
1973	77	.31¢	22	.89¢	----	----
1974	70	.36¢	28	1.82	1 (3)	.27¢
1975	62	.49¢	25	1.87	13	.26¢
1976	53	.57¢	37	1.87	10	.25¢
1977	43	.66¢	46	1.97	11	.24¢
Twelve months ending September 30, 1978	43	.72¢	47	1.97	10	.26¢

1. The balance of the MSU System's total generation (approximately 1% during 1972, 1973 and 1974) was provided by hydroelectric power.

2. Credits for sale of spent fuel (including plutonium and uranium residuals) pursuant to existing contract are taken in computing item costs and amounted to approximately .02¢, .02¢, .01¢, 0.1¢, and 0.1¢ per kWh, respectively, for the years 1974, 1975, 1976, 1977 and the 12 months ending September 30, 1978 respectively. The costs of reprocessing of spent fuel are not included in computing item costs.

3. The MSU System's first nuclear unit was placed into commercial operation on December 19, 1974.

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TABLE 9.2.2

ESTIMATES OF DOMESTIC RESERVES OF VARIOUS FUELS

	Range of Estimated Recoverable Reserves	Electric Energy Equivalent (Billions of kWh)	Approximate Time of Total Depletion (5%/Year Growth in Electricity Consumption)
Fossil Fuels			
Coal	200 - 600 billion tons	400,000 - 1,200,000	2050
Natural Gas	240 - 750 trillion cubic feet	24,000 - 72,000	2000 - 2010
Oil	45 - 150 billion barrels	25,000 - 75,000	2000 - 2010
Nuclear Fission			
Uranium (U_3O_8 Resource, U-235 Fueling)	1.5 - 3.6 million tons (estimated resource)	50,000 - 150,000	2020 - 2030
With breeding	(0.7 million tons - reserves	2,500,000 - 10,500,000	2100

9.3 COST EFFECTIVENESS ANALYSIS OF CANDIDATE SITE-PLANT ALTERNATIVES

An analysis of the cost effectiveness of candidate site-plant alternatives is presented in subsection 8.3.4 of the Environmental Report, Construction Permit Stage.

Grand Gulf Nuclear Station Unit 2 was originally scheduled to begin commercial operation in 1982. In June 1975, this unit was deferred until 1984 for a number of reasons, including spiraling inflation, the cost and availability of capital, the cost of accommodating environmental requirements, the reappraisal of electric load growth, and the impact of price elasticity and conservation upon energy usage. At the same time, and for many of the same reasons, other units were deferred or cancelled.

Section 1.3 discusses the consequences of any further delays in the construction of Unit 2 if no effort is made to increase the capacity of the MSU System. However, if a reasonable level of reliability is to be maintained, alternatives that would supply the necessary capability must be considered. Alternatives such as purchasing power from other utilities or not retiring existing capacity are ruled out in Section 9.1. Therefore, the only other courses of action are the addition of peaking units or the advancement of coal units scheduled for later years.

Table 9.3.1 shows that a 1-year delay in the construction of Unit 2 would increase the cost of Grand Gulf Nuclear Station almost $60,000,000 (including AFDC). If this capacity is to be replaced by peaking units, 1221 MW must be added in 1984 to assure a 16 percent reserve margin (Table 1.1.15). If this plan is compared to the schedule of adding peaking capacity that would exist if Unit 2 is not delayed, it is seen that much of the 1221 MW added in 1984 would not be needed again until the 1990's. Therefore, when an economic analysis, comparing the capital costs of both plans, is done (Table 9.3.2), it is seen that the addition of 1221 MW of peaking capacity in 1984 would increase the associated capital expenditures by almost $70,000,000 (1984 present worth). Also, there would be a dramatic increase in the MSU system's fuel cost (on the order of $200,000,000), since nuclear generation would be replaced by oil generation. 1

However, this increase in fuel cost would be partially offset by the possible sale of excess capacity resulting from the accelerated peaking addition schedule in Plan A, the 1984 present worth of which is approximately $60,000,000. 1

If the capacity lost, due to a 1-year delay of Unit 2, is to be replaced by coal capacity, the two 700 MW coal units scheduled for 1985 (Table 1.1.12 shows Independence Unit 2 as only a 420 MW unit, because 280 MW from the unit are being sold to Arkansas Electric Cooperative and the city of Jonesboro, Arkansas) must be advanced to 1984. Normally, an 8-year construction schedule is required for a coal unit, with the eighth year being the first year of commercial operation. However, if these two coal units are to be advanced to 1984, this would allow only 6 years for construction to be completed, assuming work begins in 1979. 1

In the case of Independence Unit 2, this schedule could possibly be achieved since the unit is the second one at the site, and much of the design work has been done. It is estimated that a 1984 completion date would save between $12,000,000 and $18,000,000 in the total cost of this unit. 1

For Mississippi Coal Unit 1, the situation is different. It is the first unit at the site, and to date, very little of the design work has been initiated. Completion of this unit by 1984 would be virtually impossible, and any savings realized by decreased escalation would probably be negated by increased labor costs. Again, fuel costs would increase substantially (on the order of $85,000,000), since nuclear generation would be replaced by coal generation. 1 1

Delays beyond 1 year would further increase the cost of Grand Gulf Nuclear Station Unit 2 and substantially increase fuel costs. Savings in escalation would be realized from advancing any coal units to replace this capacity, but this would not offset the increase in the cost of Unit 2.

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TABLE 9.3.1

COMPARISON OF PROJECT COSTS IF UNIT 2 DELAYED ONE YEAR
(Thousands of Dollars)

		Project Cost (W/AFDC)*	
	Year	Unit 2 On-Line 1984	Unit 2 On-Line 1985
Through	1976	447,117	447,117
	1977	398,191	375,439
	1978	323,808	280,787
	1979	265,425	265,948
	1980	253,073	240,527
	1981	174,052	172,282
	1982	112,610	149,336
	1983	66,436	107,195
	1984	-	60,853
	1985	-	-
	TOTAL	2,040,712	2,099,484

Difference - 58,772

* Costs presented here are from a previous analysis and do not necessarily agree with the most recent costs presented in Table 9.4.2. However, increases in project costs due to a one-year delay of Unit 2 should be quite similar.

TABLE 9.3.2

COMPARATIVE COSTS FOR PEAKING CAPACITY IF UNIT 2 DELAYED ONE YEAR

Plan A - Delay Unit 2 one year and install 1221 MW of peaking capacity in 1984.

Plan B - Keep Unit 2 on schedule and add peaking as needed and as follows:

Year	MW
1987	450
1988	50
1989	200
1990	-
1991	-
1992	-
1993	250
1995	271
	1221

Assumptions:

Capital cost	$230/kW (1984 Dollars)
Cost of money	10.0%
Escalation	5.0%

Plan A (thousands of 1984 dollars):

Total Capital Cost	280,830

Plan B (thousands of 1984 dollars):

Present worth of total capital costs	211,405

Plan A - Plan B = 69,425

9.4 COSTS OF ALTERNATIVE POWER GENERATION METHODS

From the information presented in Tables 9.4.1 through 9.4.4, the capital investment and generation costs of the nuclear station can be compared to those for a 2500 MW coal plant. Table 9.4.1 gives the capital investment for two 1250 MW coal units. Unit 1 goes commercial in 1981 and burns low-sulfur coal, for which scrubbers are not required. Unit 2 goes commercial in 1984 and burns high-sulfur coal, for which scrubbers are required. The total cost of the plant is approximately $1.7 billion, or about $680/kW. The levelized generation costs are shown in Table 9.4.3. Assuming a 30-year life and a 70 percent annual capacity factor, the average, levelized generation cost for the plant is 42.7 mills/kWh.

Table 9.4.2 gives the estimated capital investment for the nuclear station. The total cost of the plant is $2.1 billion, or about $808/kW. The levelized generation costs are shown in Table 9.4.4. Assuming a 30-year life and a 70 percent annual capacity, the average, levelized generation cost for the station is 36.3 mills/kWh, which is 6.4 mills/kWh less than that for the coal plant. This difference translates into a yearly savings of $102 million in the cost of generation.

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TABLE 9.4.1
COST INFORMATION FOR COAL-FIRED UNITS
(Millions of Dollars)

1.	Interest during construction	7.5 %/year 7.64 compound rate (semi-annually)	
2.	Length of construction workweek	40	hours/week
3.	Estimated site labor requirement	6	man-hours/kWe
4.	Average site labor pay rate (including fringe benefits) effective at month and year of NSSS order	5.28	$/hour
5.	Escalation rates		
	Site Labor	8	%/year
	Materials	6	%/year
	Composite Escalation Rate	6.77	%/year

6. Power Station Cost
(Base Costs in 1976 Dollars)

Direct Costs	Unit 1[(a)] - 1981 (Two - 1250 MW Units)	Unit 2[(b)] 1984
a. Land and land rights	3.4	3.4
b. Structures and site facilities	84.8	62.5
c. Reactor (boiler) plant equipment	168.8[(c)]	181.8[(c)]
d. Turbine plant equipment not including heat rejection systems	45.6	33.6
e. Heat rejection system	21.7	16.0
f. Electric plant equipment	23.3	17.2
g. Miscellaneous equipment	4.3	3.2
h. Spare parts allowance	--	--
i. Contingency allowance	50.0	44.2
Subtotal	401.9	361.9

Indirect Costs	Unit 1	Unit 2
a. Construction facilities, equipment, and services	34.9	30.2
b. Engineering and construction management services	30.4	26.3
c. Other costs	9.5	8.3
d. Interest during construction (@ 7-1/2%/year)	80.1	69.0
Escalation		
Escalation during construction at 6.77%/year	293.2	362.8
Total Cost		
Total Station Cost, at Start of Commercial Operation	850.0	858.5

a. Unit 1 designed to burn low-sulfur coal. Scrubbers not necessary. Commercial operating date of January 1981.

b. Unit 2 designed to burn high-sulfur coal. Scrubbers are included. Commercial operating date of January 1984.

c. Includes air quality control system.

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TABLE 9.4.2

COST INFORMATION FOR NUCLEAR STATION
(Millions of Dollars)

1.	Interest during construction (AFDC)	7.5 %/year,	4.	Average site labor pay rate (including fringe benefits) effective at month and year of NSSS order	5.70 $/hour
2.	Length of construction workweek	40 hours/week	5.	Escalation rates	
3.	Estimated site labor requirement	17 man-hours/kWe		Site labor	7 %/year
				Materials	7 %/year
				Composite escalation rate	7 %/year

6. Power Station Cost
(Base Cost in 1976 Dollars)
(Millions of Dollars)

Direct Costs	Unit 1	Unit 2
a. Land and land rights	1.05	--
b. Structures and site facilities	195.1	102.3
c. Reactor (boiler) plant equipment	112.9	101.0
d. Turbine plant equipment not including heat rejection systems	108.4	89.4
e. Heat rejection system	23.8	16.9
f. Electric plant equipment	39.9	25.9
g. Miscellaneous equipment	1.4	1.0
h. Spare parts allowance	4.4	2.4
i. Contingency allowance	24.8	13.6
Subtotal	511.75	352.5

Indirect Costs	Unit 1	Unit 2
a. Construction facilities, equipment, and services	94.3	50.9
b. Engineering and construction management services	142.2	78.5
c. Other costs	24.0	14.0
d. Interest during construction (@ 7.5%/year)	316.7	211.1
Escalation Escalation during construction @ 7 %/year	114.0	171.0
Total Cost Total Station Cost, @ Start of Commercial Operation	1202.95	878.0

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TABLE 9.4.3

ESTIMATED ANNUAL COSTS OF COAL-FIRED GENERATION
(LEVELIZED OVER THIRTY-YEAR LIFE)

	Mills/kWh	
	Unit 1 - 1981	Unit 2 - 1984
Fixed Charges[a]		
Cost of Money	8.0	8.0
Depreciation	3.7	3.7
Interim Replacements	--	-
Taxes	4.1	4.2
Fuel Cycle Costs[b]	23.6[c]	22.7[d]
Costs of Operation and Maintenance		
Fixed Component[e]	1.2	1.5
Variable Component[f]	1.6	3.0
Costs of Insurance		
Property Insurance	0.06	0.06
Liability Insurance	0.01	0.01
Total	42.27	43.17

a. 70% capacity factor assumed. Levelized fixed-charge rate is 14.2%.
b. Fuel cost escalated at 5%/year.
c. Low-sulfur coal. Heat rate of 10,000 BTU/kWh assumed.
d. High-sulfur coal. Heat rate of 10,350 BTU/kWh assumed.
e. Escalated at 8%/year.
f. Escalated at 6%/year.

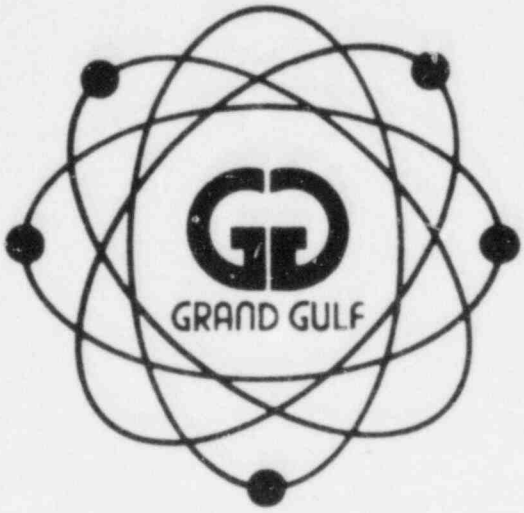
TABLE 9.4.4

ESTIMATED ANNUAL COSTS OF NUCLEAR GENERATION
(LEVELIZED OVER THIRTY-YEAR LIFE)

	Mills/kWh	
	Unit 1 - 1981	Unit 2 - 1984
Fixed Charges[a]		
Cost of Money	16.3	13.7
Depreciation	1.1	0.9
Interim Replacements	0.9	0.8
Taxes	5.2	4.3
Fuel Cycle Costs[b]		
U_3O_8	3.6	4.6
Conversion and Enrichment	2.5	3.0
Conversion and Fabrication of Fuel Elements	1.1	1.1
Processing Spent Fuel[c]	N/A	N/A
Carrying Charge on Fuel Inventory	2.0	2.5
Waste Disposal	1.3	1.5
Plutomiun or U-233 Credit[c]	N/A	N/A
Costs of Operation and Maintenance		
Fixed Component[d]	1.2	1.5
Variable Component[e]	1.6	1.9
Costs of Insurance		
Property and Liability Insurance	0.9	0.8
Total	37.7	36.6

a. 70% capacity factor assumed. Levelized fixed-charge rate is 14.2%.
b. 10,000 BTU/kWh heat rate. AFDC included at 7-1/2%/year.
c. Throw-away fuel cycle assumed.
d. Escalated at 8%/year.
e. Escalated at 6%/year.

FINAL ENVIRONMENTAL REPORT



GRAND GULF NUCLEAR STATION

UNITS 1 AND 2

MISSISSIPPI POWER & LIGHT COMPANY

MIDDLE SOUTH ENERGY, INC.

MIDDLE SOUTH UTILITIES SYSTEM

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GG
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SUMMARY TABLE OF CONTENTS

CHAPTER 1.0

PURPOSE OF THE PROPOSED FACILITY AND ASSOCIATED TRANSMISSION

		Page
1.1	SYSTEM DEMAND AND RELIABILITY	1.1-1
1.2	OTHER OBJECTIVES	1.2-1
1.3	CONSEQUENCES OF DELAY	1.3-1

CHAPTER 2.0

THE SITE AND ENVIRONMENTAL INTERFACES

2.1	GEOGRAPHY AND DEMOGRAPHY	2.1-1
2.2	ECOLOGY	2.2-1
2.3	METEOROLOGY	2.3-1
2.4	HYDROLOGY	2.4-1
2.5	GEOLOGICAL SUMMARY	2.5-1
2.6	REGIONAL HISTORIC, ARCHEOLOGICAL, ARCHITECTURAL, SCENIC, CULTURAL, AND NATURAL FEATURES	2.6-1
2.7	NOISE	2.7-1

CHAPTER 3.0

THE STATION

3.1	EXTERNAL APPEARANCE	3.1-1
3.2	REACTOR AND STEAM ELECTRIC SYSTEM	3.2-1
3.3	STATION WATER USE	3.3-1
3.4	HEAT DISSIPATION SYSTEM	3.4-1
3.5	RADWASTE SYSTEMS AND SOURCE TERMS	3.5-1
3.6	CHEMICAL AND BIOCIDE WASTES	3.6-1

SUMMARY TABLE OF CONTENTS (Cont.)

		Page
3.7	SANITARY AND OTHER WASTE SYSTEMS	3.7-1
3.8	REPORTING OF RADIOACTIVE MATERIAL MOVEMENT	3.8-1
3.9	TRANSMISSION FACILITIES	3.9-1
	CHAPTER 4.0	
	ENVIRONMENTAL EFFECTS OF SITE PREPARATION, STATION CONSTRUCTION, AND TRANSMISSION FACILITIES CONSTRUCTION	
4.1	SITE PREPARATION AND STATION CONSTRUCTION	4.1-1
4.2	TRANSMISSION FACILITIES CONSTRUCTION	4.2-1
4.3	RESOURCES COMMITTED	4.3-1
4.4	RADIOACTIVITY	4.4-1
4.5	CONSTRUCTION IMPACT CONTROL PROGRAM	4.5-1
	CHAPTER 5.0	
	ENVIRONMENTAL EFFECTS OF STATION OPERATION	
5.1	EFFECTS OF OPERATION OF HEAT DISSIPATION SYSTEM	5.1-1
5.2	RADIOLOGICAL IMPACT FROM ROUTINE OPERATION	5.2-1
5.3	EFFECTS OF CHEMICAL AND BIOCIDE DISCHARGES	5.3-1
5.4	EFFECTS OF SANITARY WASTE DISCHARGES	5.4-1
5.5	EFFECTS OF OPERATION AND MAINTENANCE OF THE TRANSMISSION SYSTEMS	5.5-1
5.6	OTHER EFFECTS	5.6-1
5.7	RESOURCES COMMITTED	5.7-1
5.8	DECOMMISSIONING AND DISMANTLING	5.8-1

SUMMARY TABLE OF CONTENTS (Cont.)

		Page
	CHAPTER 6.0	
	EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS	
6.1	PREOPERATIONAL ENVIRONMENTAL PROGRAMS	6.1-1
6.2	PROPOSED OPERATIONAL MONITORING PROGRAMS	6.2-1
6.3	RELATED ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAMS	6.3-1
6.4	PREOPERATIONAL ENVIRONMENTAL RADIOLOGICAL MONITORING DATA	6.4-1
	CHAPTER 7.0	
	ENVIRONMENTAL EFFECTS OF ACCIDENTS	
7.1	STATION ACCIDENTS INVOLVING RADIOACTIVITY	7.1-1
7.2	TRANSPORTATION ACCIDENTS INVOLVING RADIOACTIVITY	7.2-1
7.3	OTHER ACCIDENTS	7.3-1
	CHAPTER 8.0	
	ECONOMIC AND SOCIAL EFFECTS OF STATION CONSTRUCTION AND OPERATION	
8.1	BENEFITS	8.1-1
8.2	COSTS	8.2-1
	CHAPTER 9.0	
	ALTERNATIVE ENERGY SOURCES AND SITES	
9.1	ALTERNATIVES NOT REQUIRING THE CREATION OF NEW GENERATING CAPACITY	9.1-1
9.2	ALTERNATIVES REQUIRING THE CREATION OF NEW GENERATING CAPACITY	9.2-1
9.3	COST EFFECTIVENESS ANALYSIS OF CANDIDATE SITE-PLANT ALTERNATIVES	9.3-1
9.4	COSTS OF ALTERNATIVE POWER GENERATION METHODS	9.4-1

GG
ER

SUMMARY TABLE OF CONTENTS (Cont.)

		Page
	CHAPTER 10.0	
	STATION DESIGN ALTERNATIVES	
10.1	CIRCULATING COOLING WATER SYSTEM	10.1-3
10.2	INTAKE SYSTEM	10.2-1
10.3	DISCHARGE SYSTEM	10.3-1
10.4	CHEMICAL WASTE TREATMENT	10.4-1
10.5	BIOCIDE TREATMENT	10.5-1
10.6	SANITARY WASTE SYSTEM	10.6-1
10.7	LIQUID RADWASTE SYSTEM ALTERNATIVES	10.7-1
10.8	GASEOUS RADWASTE SYSTEM ALTERNATIVES	10.8-1
10.9	TRANSMISSION FACILITIES	10.9-1
10.10	OTHER SYSTEMS	10.10-1
	CHAPTER 11.0	
	SUMMARY COST-BENEFIT ANALYSIS	
11.1	BENEFITS	
11.2	COSTS	
11.3	CONCLUSION	
	CHAPTER 12.0	
	ENVIRONMENTAL APPROVALS AND CONSULTATION	
	CHAPTER 13.0	
	REFERENCES	

CHAPTER 10

STATION DESIGN ALTERNATIVES

TABLE OF CONTENTS

		Page
10.1	CIRCULATING COOLING WATER SYSTEM	10.1-3
10.1.1	Closed-Cycle Spray Canal	10.1-3
10.1.2	Closed-Cycle Cooling Ponds	10.1-3
10.1.3	Dry Cooling Towers	10.1-4
10.1.4	Closed-Cycle, Wet, Natural Draft Cooling Tower (Alternative A)	10.1-4
10.1.5	Closed-Cycle, Wet, Mechanical Draft Cooling Tower (Alternative B)	10.1-4
10.1.6	Open-Cycle Once-Through System (Alternative C)	10.1-4
10.1.7	Discussion of Alternatives - Open versus Closed - Cycle Systems	10.1-5
10.1.8	Discussion of Alternatives - Natural versus Mechanical Draft Cooling Tower	10.1-5
10.1.9	Summary	10.1-6
10.2	INTAKE SYSTEM	10.2-1
10.2.1	Alternative Intake Systems	10.2-1
10.2.1.1	Intake Direct - Cribs and Pipe to Intake Structure	10.2-1
10.2.1.2	Intake Direct - Intake Channel to Intake Structure	10.2-2
10.2.2	Environmental Effects of Intake Alternatives	10.2-2
10.2.2.1	Intake Direct - Cribs and Pipe to Intake Structure	10.2-2
10.2.2.2	Intake Direct - Intake Channel to Intake Structure	10.2-4

TABLE OF CONTENTS (Cont.)

	Page
10.2.3 Monetized Costs	10.2-5
10.2.3.1 Capital Costs	10.2-5
10.2.3.2 Annual Fuel Costs	10.2-6
10.2.3.3 Annual Operating Costs	10.2-6
10.2.3.4 Annual Makeup Power Costs	10.2-6
10.2.3.5 Generating Costs	10.2-6
10.2.4 References	10.2-7
10.3 DISCHARGE SYSTEM	10.3-1
10.3.1 Alternative Discharge Systems	10.3-1
10.3.1.1 Single-Port Offshore Jet	10.3-1
10.3.1.2 Single-Port Shoreline Jet	10.3-1
10.3.2 Environmental Effects of Discharge Alternatives	10.3-2
10.3.2.1 Single-Port Offshore Discharge	10.3-2
10.3.2.2 Single-Port Shoreline Discharge	10.3-3
10.3.3 Monetized Costs	10.3-4
10.3.3.1 Capital Costs	10.3-4
10.3.3.2 Annual Fuel Costs	10.3-5
10.3.3.3 Annual Operating Costs	10.3-5
10.3.3.4 Annual Makeup Power Costs	10.3-5
10.3.3.5 Generating Costs	10.3-5
APPENDIX A Alternatives of Blowdown Discharge Schemes	
10.4 CHEMICAL WASTE TREATMENT	10.4-1
10.4.1 General	10.4-1
10.4.2 Circulating Water System Treatment	10.4-1
10.4.3 Plant Makeup Water Treatment	10.4-1
10.4.4 Alternative Waste Treatment and Disposal Systems	10.4-2
10.4.4.1 Source Abatement	10.4-3
10.4.4.2 Diversion and Evaporation	10.4-3
10.4.5 References	10.4-4
10.5 BIOCIDE TREATMENT	10.5-1
10.5.1 General	10.5-1
10.5.2 Alternative Biocide Systems	10.5-1
10.5.2.1 Chemical Treatment	10.5-1
10.5.2.1.1 Chlorination	10.5-1

TABLE OF CONTENTS (Cont.)

		Page
10.5.2.1.2	Ozonation	10.5-2
10.5.2.1.3	Copper Sulfate Treatment	10.5-3
10.5.2.2	Mechanical Systems	10.5-3
10.5.2.2.1	Intermittent Scrubbing	10.5-3
10.5.2.2.2	Continuous Scouring	10.5-4
10.5.3	Evaluation of Alternative Biocide Systems	10.5-4
10.5.3.1	Chlorination	10.5.4
10.5.3.2	Ozonation	10.5-5
10.5.3.3	Copper Sulfate Treatment	10.5-5
10.5.3.4	Mechanical Systems (Continuous Scouring and Intermittent Scrubbing)	10.5-5
10.5.4	Monetized Costs	10.5-5
10.5.4.1	Capital Costs	10.5-6
10.5.4.2	Annual Fuel Cost	10.5-6
10.5.4.3	Annual Operating Costs	10.5-6
10.5.4.4	Annual Makeup Power Cost	10.5-6
10.5.4.5	Generating Costs	10.5-7
10.5.5	References	10.5-7
10.6	SANITARY WASTE SYSTEM	10.6-1
10.6.1	Criteria for Treatment Plant	10.6-1
10.6.2	Sources of Waste	10.6-1
10.6.3	Alternative Sanitary Waste Treatment and Disposal Systems	10.6-1
10.6.4	Evaluation of Environmental Effects of Alternative Systems	10.6.2
10.6.5	Summary and Conclusions	10.6-3
10.7	LIQUID RADWASTE SYSTEM ALTERNATIVES	10.7-1
10.8	GASEOUS RADWASTE SYSTEM ALTERNATIVES	10.8-1

TABLE OF CONTENTS (Cont.)

		Page
10.9	TRANSMISSION FACILITIES	10.9-1
	10.9.1 Ray Braswell Route	10.9-1
	10.9.2 Baxter Wilson Route	10.9-1
	10.9.3 Franklin Route	10.9-1
	10.9.4 Port Gibson Route	10.9-2
10.10	OTHER SYSTEMS	10.10-1
	10.10.1 Standby Power Supply	10.10-1

LIST OF TABLES

Table No.	Title
10.1.1	Summary of Technical and Economic Data of Alternative Cooling Water Systems
10.1.2	Summary of Incremental Generating and Environmental Costs for Alternative Cooling Water Systems
10.1.3	Summary of Environmental Impact of Alternative Cooling Water Systems
10.1.4	Estimated Size of Thermal Plume Associated with Alternative Cooling Water Systems
10.2.1	Impingement Estimates for the Grand Gulf Offshore Crib Intake Design Derived From the Baxter Wilson Studies
10.2.2	Alternative Intake System Costs
10.3.1	Alternative Discharge System Costs
10.3.2	Comparison of Plume Dimensions of the Adopted Design, Offshore Alternative, and Shoreline Discharge Alternative for Winter Mean and Extreme Cases at Low River Water Level of 31 Ft MSL
10.5.1	Alternative Biocide Treatment System Costs
10.9.1	Estimated Cost of Alternative Transmission Routes

LIST OF FIGURES

Figure No.	Title
10.1-1	Spray Canals Cooling System
10.1-2	Alternative A-Natural Draft Cooling Tower System
10.1-3	Alternative B-Mechanical Draft Cooling Tower System
10.1-4	Alternative C-Open Cycle Once Through Cooling System
10.2-1	Alternative A Intake and Discharge Structure Locations
10.2-2	Alternative Service Water Intake Crib (Typical)
10.2-3	Schematic of Service Water Intake System (Alternative A)
10.2-4	Alternative B Intake and Discharge Structure Locations
10.3-1	Single-Port Offshore Discharge Jet Location
10.3-2	Single-Port Offshore Discharge Jet Outlet
10.3-3	Single-Port Shoreline Jet
10.9-1	Alternative Transmission Line Routing

CHAPTER 10.0 STATICN DESIGN ALTERNATIVES

This chapter presents the logic supporting the decision making processes that led to the selection of designs for individual plant systems as well as for the plant as a whole. The various environmental, economic, and engineering feasibility considerations, which were evaluated to establish the preferential design from among the alternatives considered, are presented.

The systems for which design alternatives were considered are as follows:

a. Circulating water system (exclusive of intake and discharge)

b. Intake system

c. Discharge system

d. Chemical system

e. Biocide system

f. Sanitary waste system

g. Liquid radwaste system

h. Gaseous radwaste system

i. Transmission facilities

j. Other systems

As a first step in the consideration of the alternatives for any plant system, a preliminary evaluation was made to determine the viable alternatives for that system. This preliminary evaluation consisted of a qualitative assessment of the environmental effects, economic cost, and engineering feasibility of a number of alternative systems, and was used to limit the number of alternatives to be considered in detail.

The major environmental effects of the viable alternatives for each plant system, as well as the economic costs for each, were compared. Where environmental effects of a particular nature are common to all system alternatives, these effects were not considered with respect to comparison of alternatives. These

common effects, however, were considered in the overall decision-making process and are described in detail in the text of Chapter 5. The quantified environmental costs associated with each alternative are presented in the summary tables of this chapter.

The comparison of system alternatives was based on conceptual designs for each alternative as described in Chapter 8 of the Environmental Report, Construction Permit Stage. The actual design for a specific plant system, as presented in Chapter 3, may differ somewhat from the conceptual design for that system used in this chapter. This results from the fact that once the optimum conceptual design was chosen, that one design was subjected to a detailed analysis in order to optimize it from various standpoints, including environmental considerations. For any particular system, however, the differences between the actual selected design presented in Chapter 3 and the conceptual design described in this chapter are not significant and would not change the relative order of preference of the design alternatives.

Economic costs for each alternative were determined in terms of the present worth of the capital investment at the anticipated date of operation and in terms of the annual operating cost. These costs are in accordance with formulations presented in the Environmental Report, Construction Permit Stage.

10.1 CIRCULATING COOLING WATER SYSTEM

Heat (thermal) energy is a by-product of the generation of electricity from a fuel. The heat dissipation system, an integral part of the power generation station, is designed to dissipate or transfer this thermal energy to the environment.

Essentially, there are two alternative systems available for the removal of this heat: once-through (open-cycle) and recycle (closed-cycle) systems. In once-through cooling systems, water is passed through the condenser (heat exchanger) once and then returned to the cooling water source. In the recycle cooling system, heat is dissipated through auxiliary cooling facilities, after which the cooled water is recirculated to the condenser.

For the Grand Gulf site the alternatives considered for cooling water systems are: (a) closed-cycle spray canals; (b) closed-cycle cooling ponds; (c) closed-cycle dry cooling towers; (d) closed-cycle, wet, natural draft cooling towers; (e) closed-cycle, wet, mechanical draft cooling towers; and (f) open-cycle once-through systems.

10.1.1 Closed-Cycle Spray Canal

A proposed arrangement of a closed-cycle spray canal system is presented in Figure 10.1-1. Separate spray canal systems would be required for each unit. The canal systems would be constructed mostly in the flood plains in the area of both Gin and Hamilton Lakes, encompassing an area of approximately 750 acres. The canals would be protected against flooding by dikes raised to elevation of 110 feet on the river side. Blowdown water would be returned to the river through an underground pipe. This system would utilize about 400 to 500 floating modular spray units to dissipate heat to the atmosphere.

Construction of the canal would result in permanent damage to the ecologically rich aquatic-terrestrial ecosystems in the bottomlands and the lakes and was judged unacceptable. The additional requirements to construct protective dikes against flooding and to prepare the site and foundation for canal and dike construction would result in a comparatively higher construction cost. Drift rate was estimated to be higher than other closed-cycle systems. For these reasons, and on comparison with other closed-cycle systems (natural and mechanical draft cooling towers) which impose less environmental impact, the spray canal was eliminated from further consideration.

10.1.2 Closed-Cycle Cooling Ponds

A preliminary study showed that cooling ponds would require more than 5000 acres of land per unit, an average of about 2 acres per megawatt, to provide adequate cooling. This sizeable land area was not readily available and, because site topography

would make construction of this size pond exceedingly expensive and ecologically destructive to terrestrial wildlife, no further consideration was given to this alternative.

10.1.3 Dry Cooling Towers

At present, dry cooling towers have not been operated for power generating stations greater than 265 MWe. While it appears that it is theoretically feasible to scale up dry cooling to the large sizes required for Grand Gulf, the magnitude of increase would present various design and construction problems that could result in delay and cost escalation. For example, the high back pressure (up to 15 inches of mercury) imposed on the turbine by dry cooling towers will require considerable redesign of conventional turbines. An AEC report (TID-26007, March 1972) comparing the costs of dry cooling towers with those of an evaporative-type cooling system, indicates approximately one mil per kilowatt hour disadvantage for dry cooling towers. In addition, the report noted that further research would be necessary to develop the technology for using dry cooling towers for boiling water reactors. Therefore, no further consideration was given to this alternative.

The remaining three cooling water alternatives were given detailed consideration. They are identified as alternative A (natural draft cooling tower), alternative B (mechanical draft tower), and alternative C, (open-cycle once-through system). The technical data and the cost of each system are presented in Table 10.1.1. The proposed arrangements of each system are presented in Figures 10.1-2, 10.1-3, and 10.1-4. Each system is described below.

10.1.4 Closed-Cycle, Wet, Natural Draft Cooling Tower (Alternative A)

This system requires one tower near each unit. Intake and discharge pipelines would be required to bring in river water for cooling and to discharge blowdown. Each tower would be approximately 500 feet high and 400 feet in diameter. The maximum estimated discharge flow from cooling tower blowdown would be 10,000 gpm/unit.

10.1.5 Closed-Cycle, Wet, Mechanical Draft Cooling Tower (Alternative B)

This system requires, for each unit, four separate structures, called bays, about 70 feet high and 230 feet long, each containing eight cells. The towers would be located near the units. Similar to natural draft cooling towers, underground intake and discharge pipelines would be required. The maximum estimated discharge flow from blowdown would be 10,000 gpm/unit.

10.1.6 Open-Cycle Once-Through System (Alternative C)

This system would require an intake structure pump house located on the bluffs. Cooling water at the rate of 520,000 gpm/unit would be drawn through four 10-foot diameter underground pipes, passed through the condenser, and discharged into Hamilton Lake to mini-

mize the length of the discharge pipe and utilize the partial cooling potential of the lake before discharging into the Mississippi River. An open channel would connect Hamilton Lake with the east bank of the Mississippi River as shown in Figure 10.1-4.

10.1.7 Discussion of Alternatives - Open versus Closed-Cycle Systems

Table 10.1.2 summarizes the incremental generating and environmental costs for the three alternative cooling water systems. Table 10.1.3 summarizes the environmental impact of the alternative systems. To the extent practicable at the time the Environmental Report, Construction Permit Stage, was issued, the environmental costs and effects were quantified. Where quantification was not made, qualitative evaluations, based on best available information and judgement, were presented.

Tables 10.1.1, 10.1.2, and 10.1.3 show that an open-cycle system is more economical than the closed-cycle cooling tower systems, but would result in greater environmental impact. An open-cycle, once-through system would discharge considerably greater amounts of heated water (1,040,000 gpm) than a closed-cycle cooling tower system (20,000 gpm). The size of the thermal plume from the open-cycle system would be considerably larger than the plume resulting from cooling tower blowdown (see Table 10.1.4). This greater volume of discharge and larger thermal plume could theoretically (although probably not in reality, in view of the very high river flow rate) have greater impact on the river aquatic ecosystem. In addition, an open-cycle system would have greater construction effects because of the larger amount of excavation required. Permanent use of Hamilton Lake as part of the receiving body of water would result in permanent destruction of its ecology. For these reasons, closed-cycle systems were favored over open-cycle systems at Grand Gulf.

10.1.8 Discussion of Alternatives - Natural versus Mechanical Draft Cooling Tower

The environmental effects of natural draft cooling towers are discussed in Sections 5.1 and 5.3.

With the exception of fogging, environmental effects of mechanical draft cooling towers are essentially similar to those of natural draft towers. The increased probability of fog for alternative heat dissipation systems which depend primarily on evaporation is greatest for those having the lowest plume height. At Grand Gulf the physical height of mechanical draft towers would be about 70 feet. The lower tower height, and hence lower plume rise for mechanical draft towers, means a higher probability of ground level fog from mechanical draft towers than is likely from natural draft towers.

10.1.9 Summary

Between the two wet, closed-cycle towers, the economics and environmental costs (ground level fogging) slightly favor natural draft towers for Grand Gulf Nuclear Station.

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TABLE 10.1.1

SUMMARY OF TECHNICAL AND ECONOMIC DATA OF ALTERNATIVE COOLING WATER SYSTEMS (2 UNITS)

Alternative	Closed-Cycle Systems		Open-Cycle System
	A	B	C
	Natural Draft Cooling Tower Subaqueous Intake and Discharge	Mechanical Draft Cooling Tower Subaqueous Intake and Discharge	Open-Cycle Once-Through System Discharge through Hamilton Lake
Technical Details			
Construction	1 tower/unit, 410 ft dia x 492 ft high hyperbolic	4 towers/unit 72 x 231 ft x 70 ft high	4 suction pipes 10 ft dia Intake structure, open discharge channel
Performance	Approach 16 F; 4 pumps; 3785 HP/unit; flow--548,000 gpm; temp rise--31.7 F; makeup-25,000 gpm/unit; blowdown--10,000 gpm/unit. Total heat load 8.7×10^9 Btu/hr/unit	Approach 14 F; 4 pumps; 3170 HP/unit; fan motors, 32 @ 200 HP each; flow--534,000 gpm; temp rise--32.5 F; makeup-25,000 gpm/unit; blowdown-10,000 gpm/unit. Total heat load 8.7×10^9 Btu/hr/unit	Multiple pressure condenser; flow--520,000 gpm/unit; no. of pumps/unit-4; temp rise-31.7 F; total heat load 8.7×10^9 Btu/hr/unit
Operational Factors	Tower maintenance	Fan and tower maintenance	
Construction Cost ($million)	68	69	74
Capitalized Operating Cost ($million)	31	31	18
Total Cost ($million)	99	100	92

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TABLE 10.1.2

SUMMARY OF INCREMENTAL GENERATING AND ENVIRONMENTAL COSTS FOR ALTERNATIVE COOLING WATER SYSTEMS

				ALTERNATIVES		
				A	B	C
INCREMENTAL GENERATING COST	Present Worth	$x10^6		0	+1.0	
	Annualized	$x10^3		0		-7.0
CAPACITY FACTOR					+88.8	-621.8
ENVIRONMENTAL COSTS Primary Impact	Population or Resource Affected		UNITS	Magnitude	Magnitude	Magnitude
1. Natural Surface Water Body (Mississippi River)			lbs	N	N	N
1.1 Impingement or entrapment by cooling water intake structure	1.1.1	Fish				
1.2 Passage through or retention in cooling systems	1.2.1	Phytoplankton and zooplankton	lbs	N	N	M
	1.2.2	Fish	lbs	N	N	M
1.3 Discharge area and thermal plume	1.3.1	Water quality, excess heat (See Table 10.1-4)	Acres	3.5	3.5	882
	1.3.2	Water quality, oxygen availability	Acre-ft.	0	0	N
	1.3.3	Aquatic organisms	lbs	N	N	M
	1.3.4	Wildlife (including birds, aquatic and amphibious mammals, and reptiles)	Acres	3.5	3.5	882
	1.3.5	Fish, migration	lbs/yr	N	N	N
1.4 Chemical effluents	1.4.1	Water quality, chemical	Acres	0	0	0
	1.4.2	Aquatic organisms	lbs/yr	N	N	N
	1.4.3	Wildlife (including birds, aquatic and amphibious mammals, and reptiles)	Acres	0	0	H
	1.4.4	People	User-days	N	N	N
1.5 Radioactive nucleides				NA	NA	NA
1.6 Consumptive use (evaporative losses)	1.6.1	People	gpy	0	0	0
	1.6.2	Property	Acres/ft/yr	0	0	0
1.7 Plant construction (including site preparation)	1.7.1	Water quality, physical	Acres/ft/yr	N	N	N
	1.7.2	Water quality, chemical	Acres	N	N	M
1.8 Other impacts			-	-	-	-
1.9 Combined or interactive effects			-	-	-	-
1.10 Net effects						

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TABLE 10.1.2 (Cont.)

ENVIRONMENTAL COSTS Primary Impact		Population or Resource Affected	UNITS	ALTERNATIVES A Magnitude	B Magnitude	C Magnitude
2. Ground water						
2.1	Raising/lowering of ground water levels	2.1.1 People		0	0	0
		2.1.2 Plants		0	0	0
2.2	Chemical contamination of ground water (excluding salt)	2.2.1 People		0	0	0
		2.2.2 Plants		0	0	0
2.4	Other impacts on ground water			-	-	-
3. Air						
3.1	Fogging and icing (caused by evaporation and drift)	3.1.1 Ground transportation	hr/yr	N	M	0
		3.1.2 Air transportation	hr/yr	N	0	0
		3.1.3 Water transportation	hr/yr	0	0	N
		3.1.4 Plants	acres	N	N	0
3.2	Chemical discharge to ambient air	3.2.1 Air quality, chemical	%/lbs	N	N	0
		3.2.2 Air quality, odor	statement	0	0	0
3.3	Radionuclides discharged into the air			NA	NA	NA
4. Land						
4.1	Site selection	4.1.1 Land, amount approx. max.	acres	200	200	200
4.2	Construction activities (including site preparation)	4.2.1 People (amenities)	-	NA	NA	NA
		4.2.2 People (accessibility of historical sites	-	NA	NA	NA
		4.2.3 People (accessibility of archeological sites)	-	NA	NA	NA
		4.2.4 Wildlife	opinion	N	M	M
		4.2.5 Land (erosion)		N	N	N

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TABLE 10.1.2 (Cont.)

ENVIRONMENTAL COSTS Primary Impact	Population or Resource Affected	UNITS	ALTERNATIVES A Magnitude	B Magnitude	C Magnitude
4.3 Plant operation	4.3.1 People (amenities)	No. of People	0	N	0
	4.3.2 People (aesthetics)	opinion	H	M	0
	4.3.3 Wildlife	opinion	N	M	M
	4.3.4 Land, flood control impact (NI-not implied; C-complies)	Potential	NI	NI	C
4.4 Salts discharged from cooling towers	4.4.1 People	lb/sft/yr	N	N	0
	4.4.2 Plants and animals	acres	N	N	0
4.8 Other land impacts			-	-	-
4.9 Combined or interactive effects			-	-	-
4.10 Net effects					

H - High
M - Moderate
N - Negligible
NA- Not Applicable

TABLE 10.1.3

SUMMARY OF ENVIRONMENTAL IMPACT OF ALTERNATIVE COOLING WATER SYSTEMS

Primary Impact	Description of Present Environment	Alternative A Natural Draft Cooling Towers	Alternative B Mechanical Draft Cooling Towers	Alternative C Once-Through System
1. Natural Waters				
a. Surface Water	Major Features: Mississippi River and Hamilton and Gin Lakes, Mississippi River maximum flow in past 30 yrs about 2 million cfs; minimum about 100,000 cfs. Approx. average temperature: summer-- 65-80 F, winter-- 35-50 F. Water quality generally acceptable by state standards. Gin and Hamilton Lakes: 8-10 ft; total volume-- 800 acre-ft	Maximum blowdown 20,000 gpm; $\Delta T \simeq 13$ F. Thermal plume will be 600 ft long and about 3.5 acres in area (+3 F isotherm). The prevailing water quality standards of the states of Mississippi and Louisiana will be satisfied. Plant construction will have little effect on water quality of Mississippi River and Hamilton Lake, no effect on Gin Lake. No permanent effect on Hamilton Lake	Same as A	Mississippi River: A total quantity of 1.76×10^7 BTU/hr of heat will be discharged; $\Delta T \simeq 31$ F. Thermal plume about 3 miles long (+3 F isotherm) covering about 900 acres. Temporary impairment of water quality due to plant construction. Permanent disturbance to Hamilton Lake. Water quality in the plume zone may be unsatisfactory. No effect on Gin Lake
b. Ground Water		No effect	No effect	No effect
2. Air	Air quality-good. Incidence of heavy natural fog-- 53 hr/yr; moderate fog-- 61-60 hr/yr. Fog frequency high in winter	Small change in air quality due to drift loss. Evaporation will create a visible plume; the plume will rarely touch ground and will be restricted to the site boundary. No significant steam fogs on the river.	Same as A. Increase in near-surface fogging.	Same as A. Some steam fogging on river expected.
3. Land	Virtually undeveloped lowland and upland forest overlooking the floodplain of the Mississippi River	Total plant site area about 2,170 acres. Loss of about 200 acres to plant and facilities	Same as A. Loss of about 200 acres to plant and facilities	Same as A. Loss of about 500 acres for plant and facility
4. Biological				
a. Aquatic Life	Larval, commercial and sport fish, also forage fish. Zooplankton and phytoplankton. Benthic insects and other organisms	Limited effect on fish near blowdown plume in summer. Little effect on plankton. Little effect on benthos	Same as A Same as A Same as A	Exclusion of fish from thermal plume in summer; probably loss of fish due to thermal shock, probable loss of plankton in the once-through system and the thermal plume, probable loss of benthic life near the discharge and in the thermal plume
b. Terrestrial	Fauna in the upland and bottomland hardwoods includes species of interest to sport and commerce. The area serves as nesting and rearing habitat, also as temporary refuge for migratory species.	Loss of about 200 acres of habitat	Loss of about 200 acres of habitat.	Loss of about 500 acres of habitat
5. Radiological	Background natural radiation of 140 mrem/yr	None	None	None
6. Others				
a. Noise		No change	Noise in the vicinity of the plant.	No change
b. Aesthetics	A wooded area on bluffs overlooking the floodplain of the Mississippi River	Natural draft cooling tower will dominate the scene for some distance.	No impact	No impact
c. Recreation	Hunting Fishing in Mississippi River and Hamilton and Gin lakes	Will not be permitted within the exclusion zone. No change	Same as A No Change	Same as A Loss of Hamilton Lake and some area in the river plume

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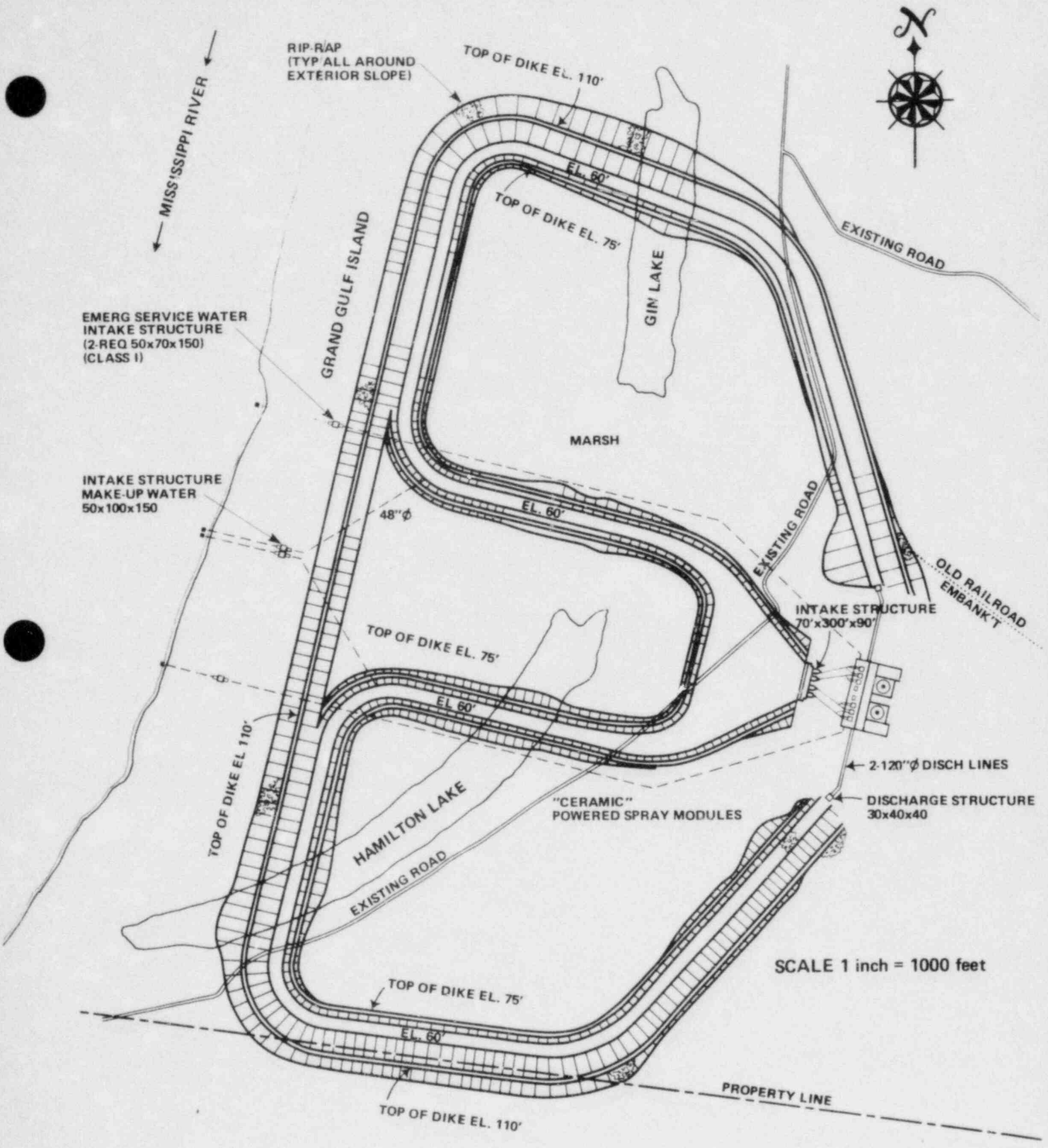
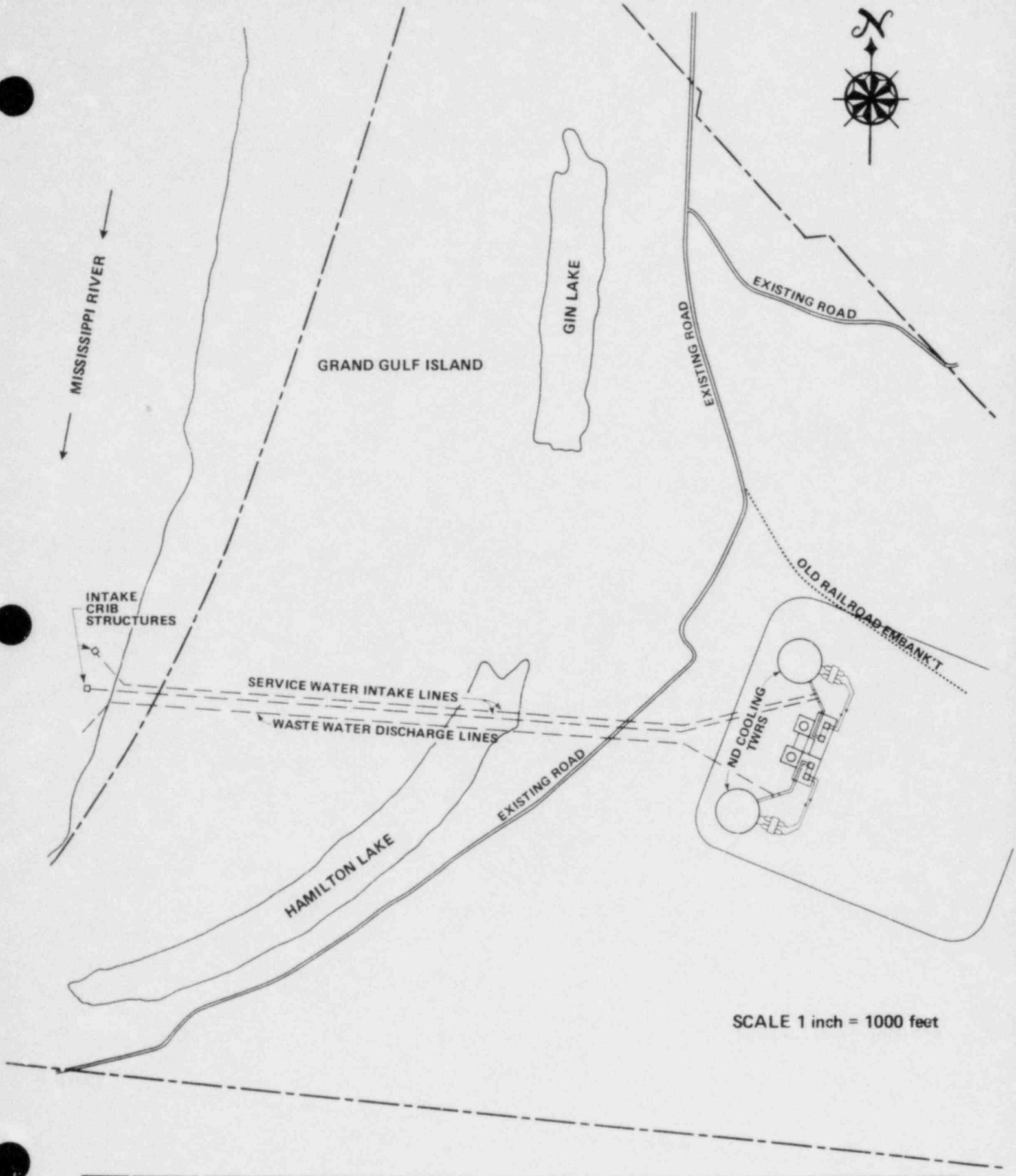
TABLE 10.1.4

ESTIMATED SIZE OF THERMAL PLUME ASSOCIATED WITH ALTERNATIVE COOLING WATER SYSTEMS

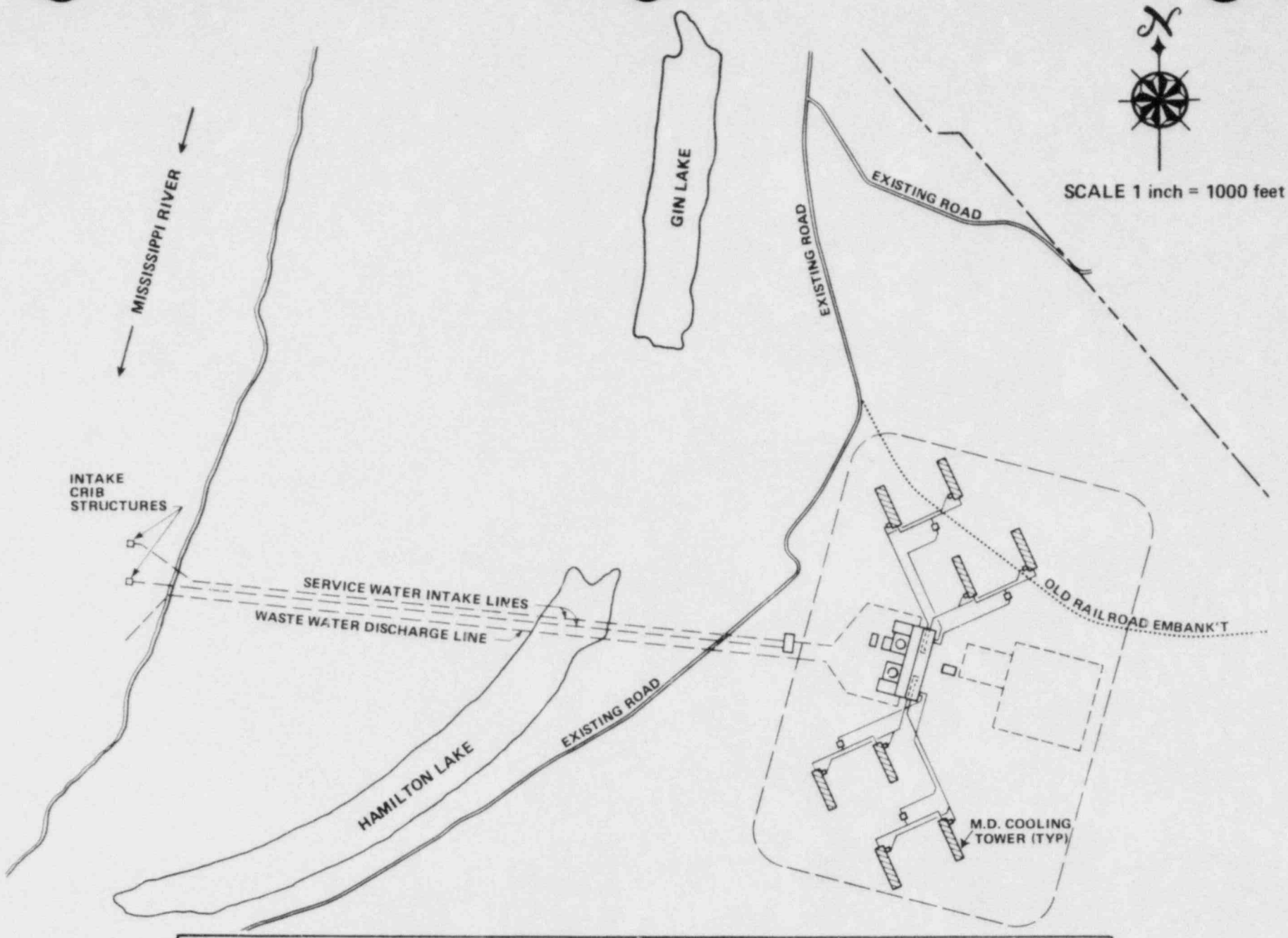
Alternative	Description	Condition at Discharge	Width (ft) Isotherm +F			Length (mi) Isotherm +F			Subsurface area (acres) Isotherm +F		
			1	3	5	1	3	5	1	3	5
A and B	Natural and mechanical draft cooling tower	1. Cooling tower blowdown	636	194	72	0.58	0.107	0.062	36	3.5	0.46
		2. Cooling tower blowdown at high water	417	128	49	0.36	0.041	0.112	16	1.5	0.21
C	Open-cycle once-through system	1. Open shoreline discharge at low water	2760	2700	2540	12.6	3.1	1.6	3630	882	429
		2. Open shoreline discharge at high water	444	257	202	17.0	5.2	2.9	794	141	62



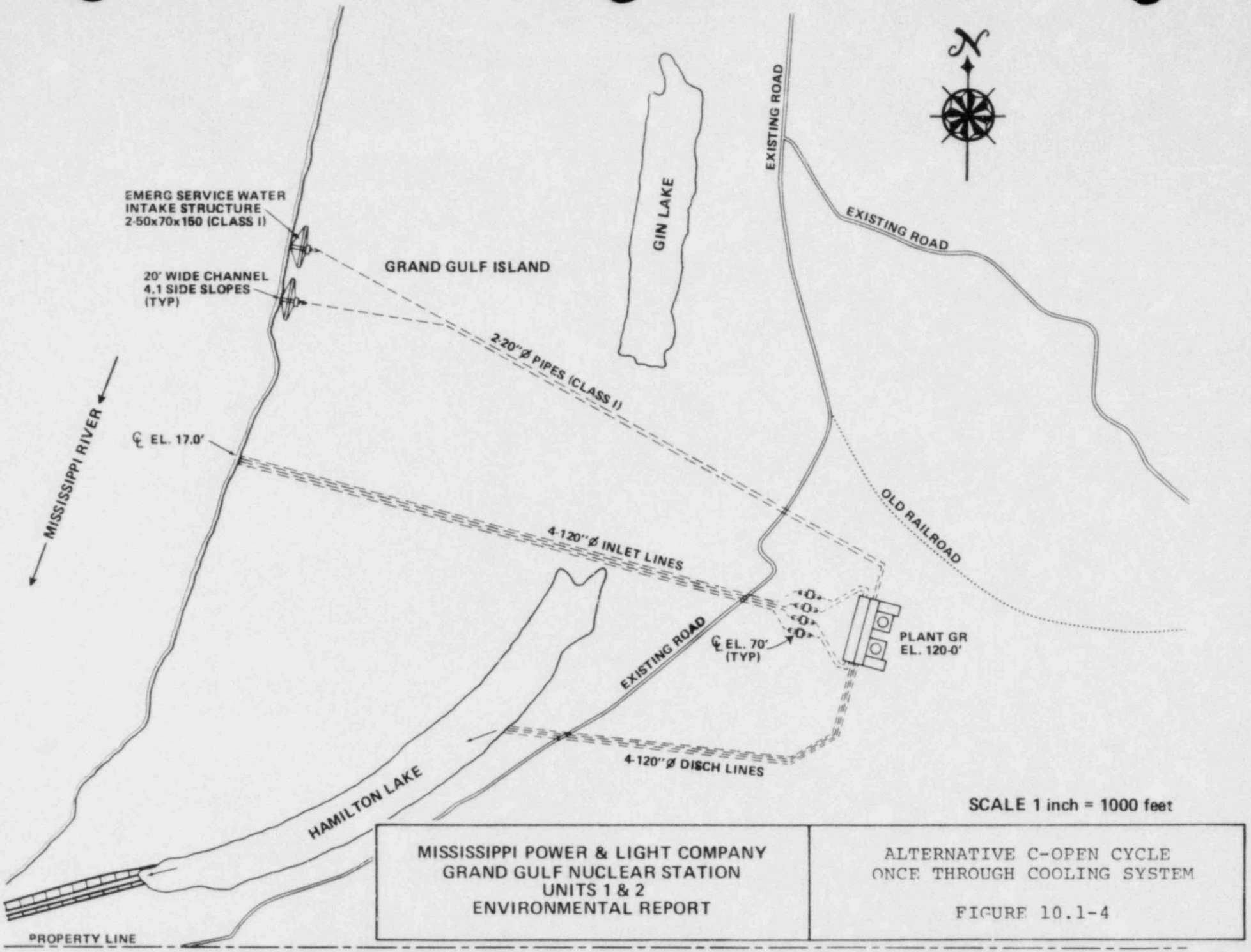
MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	SPRAY CANALS COOLING SYSTEM FIGURE 10.1-1



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	ALTERNATIVE A-NATURAL DRAFT COOLING TOWER SYSTEM FIGURE 10.1-2



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	ALTERNATIVE B-MECHANICAL DRAFT COOLING TOWER SYSTEM FIGURE 10.1-3



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	ALTERNATIVE C-OPEN CYCLE ONCE THROUGH COOLING SYSTEM FIGURE 10.1-4

10.2 INTAKE SYSTEM

The selected service water intake system, alluvial aquifer, induced infiltration from the Mississippi River (radial collector wells), is described in subsection 3.4.5.

10.2.1 Alternative Intake Systems

Two alternative intake systems were considered. They are: (a) intake direct from the Mississippi River through cribs and 5-foot diameter pipe to intake structure and (b) intake direct from the Mississippi River through an intake channel to the intake structure.

10.2.1.1 Intake Direct - Cribs and Pipe to Intake Structure

In this alternative, water is taken directly from the Mississippi River through two redundant intake cribs (Figure 10.2-1) located approximately 400 feet from shore, 300 feet apart and 17 feet below the lowest river stage. The water flows by gravity through two 5-foot diameter pipes to an intake structure located near the river. All crib surfaces open to the river water would be protected with trash rack panels to prevent large fish and debris from entering the system. Debris and fish small enough to pass through the crib grating would be carried to the intake pumphouse where they could be removed by the traveling screens and flushed back into the river through a separate pipe.

The crib faces would consist of removable grating, made of 3/8 x 3-inch vertical bars, spaced 3 inches on centers. The crib openings must be small enough to prevent the passage of debris which could damage the traveling screens or the intake pumps yet large enough to avoid excessive accumulation of small debris which would impede the intake flow. The 3-inch spacing of the bars is a compromise, based on operating experience and engineering judgement.

The intake cribs must also be sturdy enough to withstand the impact of most large objects, such as sunken logs, which are likely to be swept into them by river current. To minimize scouring and fish entrainment, the opening of the pipe would be elevated about 3 feet above the river bottom (Figures 10.2-2 and 10.2-3).

The location of the two intake cribs could be affected by the heavy sedimentation transport and deposition characteristic of the Mississippi River. It would have to be changed, extending it

a minimum of 2000 feet into the river in order to clear the bottom; this would present many problems not only from the construction point of view but also as a potential hazard to navigation.

10.2.1.2 Intake Direct - Intake Channel to Intake Structure

Another alternative considered was the excavation of an open channel to El 10 feet msl, approximately, from the river to the intake structure, as shown in Figure 10.2-4. Sheet piling walls would be driven on both sides of the channel which would be 40 feet wide at the intake structure and 75 feet wide at the outer end. The sheet pile top would go from EL 65 feet msl at the intake structure to EL 10 feet msl at the outer ends. The embankments on both sides of the channel would be protected against erosion by a suitable revetment.

Trash racks and traveling screens would be installed at the intake structure to protect the pumps.

Sediment deposition could also be a problem for this alternative, requiring frequent and extensive dredging operations.

10.2.2 Environmental Effects of Intake Alternatives

10.2.2.1 Intake Direct - Cribs and Pipe to Intake Structure

Construction of the intake and discharge pipelines, maintenance road, and intake structure in the bottomlands would necessitate the disturbance of approximately 27 acres of forest and 7 acres of old field terrestrial habitats. A total of 5 acres of bottomland would be altered for the life of the station. The removal of trees would eliminate potential nesting habitat for wood duck, prothonotary warbler, and rough-winged swallow. Some of this habitat would be recovered through reforestation along the pipeline corridor, and an increased amount of forest edge habitat would be created by the clearing activities. Some alteration of bottomland topography would be unavoidable, and natural drainage between Gin Lake and Hamilton Lake would be temporarily disrupted. Silt loading of runoff reaching the lakes would be minimized by interception from the surrounding bottomland forest. Beaver inhabiting the stream connecting the two lakes would probably be displaced temporarily, but should repopulate the area once construction ceases. Any American alligators inhabiting the lakes probably would not be significantly disturbed since this species has a high tolerance for man's presence. Drainage between the lakes would be reestablished with culverts and bridges along the

pipeline roadway. Construction impact in the bottomlands would be relatively short-lived and would necessarily be confined to the nonflood periods of the year.

Construction activities in the river would result in a temporary increase in siltation and some localized modification in ambient river currents. In view of the high silt loads and strong currents normally experienced in the river, these impacts would probably be negligible. Nearshore fishes would be temporarily displaced from the immediate area, but should return with the cessation of construction. Benthic habitat would be temporarily disturbed in the construction area and would be essentially lost to benthic production. The benthic populations should become reestablished once construction in the river is completed.

Operation of the intake would have a negligible effect on use and the water budget of the river. The maximum intake volume (43,360 gpm) represents only 0.11 percent of low river flow conditions (54.3 million gpm). Current patterns in the immediate vicinity of the intake cribs may be modified somewhat, although the potential for scouring would be minimized by locating the cribs about 3 feet off the river bottom.

Impingement and entrainment impacts have been estimated from studies conducted at MP&L's Baxter Wilson Steam Electric Station located 30 miles upriver near Vicksburg, Mississippi (Ref. 1). Estimates were derived by averaging the rates noted at both intake structures at the Baxter Wilson plant, which draw river water from 300 feet offshore. The intake velocities are 1.1 fps and 4.3 fps, which add a conservative element to the estimates for the Grand Gulf intakes which would have a velocity of 0.5 fps. The impingement rates estimated for Grand Gulf (Table 10.2.1) should have a minimal impact on aquatic biota relative to the populations found in the river. The majority of biomass impinged (90-97 percent) would probably be juveniles of species such as gizzard shad, freshwater drum, threadfin shad, white crappie, carp, and suckers. River shrimp would probably be the only major invertebrate impinged in significant numbers (76 percent of the invertebrates impinged). If the intake cribs had to be moved further into the river channel (e.g. 2000 feet), the impingement rates would be expected to lessen because the channel proper has been found to be the least productive of the river habitats in the site area (see Section 2.2).

Entrainment rates derived from the Baxter Wilson studies indicate that the impact to river populations of plankton, drifting benthos, and larval fish would be minimal, perhaps undetectable, since the intake volume represents 0.1 percent

of total river flow under extreme low river discharge conditions (54.3 million gpm). For the various trophic groups subject to entrainment, the estimates represent losses of 0.016 percent of the total phytoplankton passing the plant annually, 0.017 percent of the zooplankton, 0.012 percent of the estimated total mean river drifting benthos, and 0.01 percent of the estimated mean annual larval fish population. The estimates for larval fish entrainment are conservative since the annual population estimates were based upon data obtained from the peak spawning periods. Assuming it would be necessary to move the cribs to an area 2000 feet into the river, the entrainment rates would probably drop since this location is in an area with a paucity of aquatic populations.

The net impact arising from this alternative intake design is expected to be less than that of the second alternative discussed below. Somewhat less terrestrial habitat in the bottomlands would be permanently committed to the project, and the effects on ambient river currents and siltation/scouring potential are expected to be lower. Permanent disturbance of benthic habitat should be less, and impingement and entrainment rates should be lower. Relative to the adopted intake design (radial collector wells), there would be greater net impact to the river and its biota (both impact sources being avoided by the radial well system), while disturbance of the bottomlands remains approximately at the same magnitude.

10.2.2.2 Intake Direct - Intake Channel to Intake Structure

Construction of this alternative would require a slight increase in the amount of bottomland habitat permanently altered to somewhat less than 6 acres. This would be required for the intake channel and revetments that would encroach into the bottomlands. A small increase in edge habitat created by the necessary clearing would result. The impact to bottomland topography, disturbance of drainage between the lakes, and impact on resident fauna would remain the same as expected for the first alternative. Activities in the river would be more localized and probably of shorter duration. This would probably yield somewhat less temporary impact to river biota through siltation.

Operation of the channel design requires a greater permanent committment of benthic habitat to the channel itself and the revetments. While benthic biota would probably repopulate the channel, this habitat would be essentially unstable since periodic maintenance dredging would be required in the channel. The benthic habitat in the immediate vicinity of the channel

may be subject to modification from increased siltation or scouring in various areas as a result of changes in ambient current patterns.

The presence of the channel in the more biologically productive nearshore zone could prove attractive to spawning adult fish and schooling juvenile fish. The impingement rates estimated for the first intake alternative could increase as a result of this and of the funneling effect of the channel on juvenile fish. Some organisms may also be subject to entrapment within the channel; this could lead eventually to impingement. Entrainment may also increase slightly, but should remain relatively the same as that estimated for the first alternative. Impingement and entrainment are not expected to have a significant impact on aquatic biota relative to the populations found in the river.

Relative to the adopted intake design (radial collector wells), this alternative would have approximately the same amount of impact on bottomland terrestrial habitat. With respect to impact on river biota, the adopted design avoids even the minimal impact expected from either of the alternative designs.

10.2.3 Monetized Costs

Table 10.2.2 presents the monetized costs for each of the following intake systems:

a. Alluvial aquifer, Mississippi River, induced infiltration, radial collector wells

b. Mississippi River direct, through intake cribs and 5-foot diameter pipes to intake structure

c. Mississippi River direct, through intake channel to intake structure

10.2.3.1 Capital Costs (C_I)

The capital costs (C_I) associated with each intake system are presented in Table 10.2.2.

Alluvial Aquifer (Selected):

The capital cost items include the well pumps and drivers; radial collector wells construction including laterals, water pipelines, excavation and backfill; and electrical wiring and conduit.

Mississippi River direct, 5-foot diameter pipes:

The capital cost items include redundant cribs and pipelines, intake structure with trash removal equipment, pumps and drivers, water pipelines, excavation and backfill, and electrical wiring and conduits.

Mississippi River direct, intake channel:

The capital cost items include excavation and dredging of intake channel, intake structure with trash removal equipment, pumps and drivers, water pipelines excavation and backfill, and electrical wiring and conduits.

The capital costs were adjusted for escalation and interest during construction to arrive at a capital cost (C_I) consistent with 1981 operation.

10.2.3.2 Annual Fuel Costs (F_t)

The annual fuel costs (F_t) presented in Table 10.2.2 were computed on an incremental basis based on the auxiliary power requirements.

10.2.3.3 Annual Operating Costs (O_t)

The annual operating costs (O_t) presented in Table 10.2.2 were computed based on revenue requirements associated with the capital investment.

10.2.3.4 Annual Makeup Power Costs (P_t)

The annual makeup power costs (P_t) presented in Table 10.2.2 were computed on an incremental basis based on the auxiliary power requirements.

10.2.3.5 Generating Costs (GC_p and GC_a)

Total generating cost, present value (GC_p), and total generating cost, present value annualized (GC_a), are listed on Table 10.2.2 for each intake system. The economic parameters used to evaluate each system are:

Economic life	30 Years
Capacity factor	73 Percent

Minimum acceptable return (i)	7.5 percent
Escalation	7.5 percent
Fixed charge rate	18 percent
Levelized annual fuel cost (F_t)	$ .005/kW
Levelized annual makeup power cost (P_t)	$500.00/kW
Present worth factor for a levelized annual cost	11.74

10.2.4 References

1. "Environmental Field Measurements Programs, Supplementary Report (September 1973 through March 1974)" Grand Gulf Nuclear Station, Units 1 and 2, MP&L.

TABLE 10.2.1

IMPINGEMENT ESTIMATES FOR THE GRAND GULF OFFSHORE CRIB INTAKE DESIGN DERIVED FROM THE BAXTER WILSON STUDIES

Period	Number of Organisms	Biomass, lbs.
Daily	78	1.5
Monthly	2380	46.0
Annually	28558	560.0

Note: Mean estimated impingement rates

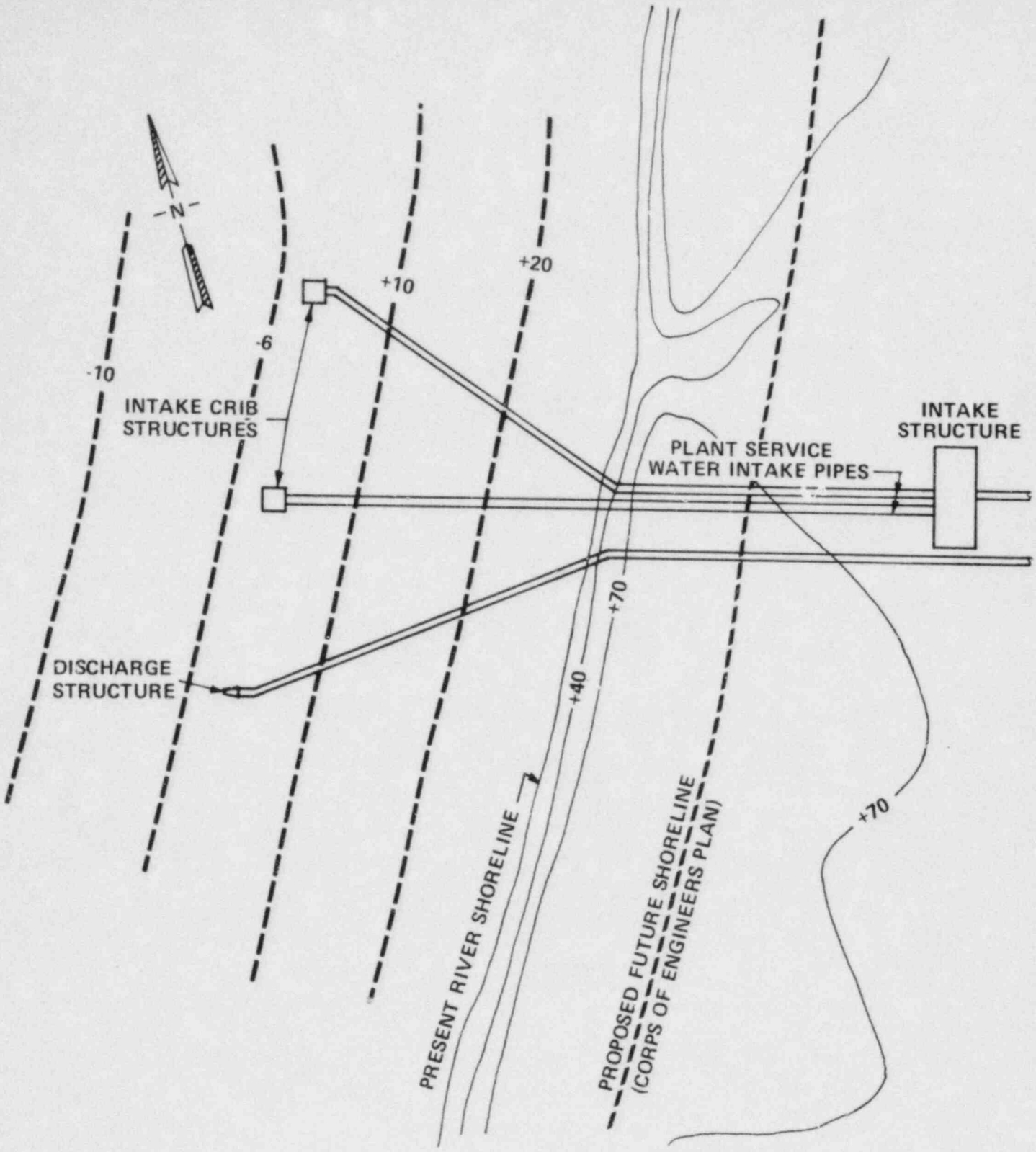
TABLE 10.2.2

ALTERNATIVE INTAKE SYSTEM COSTS ($ X 10^3)
UNITS 1 AND 2

Alternatives	Alluvial Aquifer Radial Collector Wells (Selected)	Mississippi River Direct-Pipe Intake	Mississippi River Direct-Intake Channel
Project cost (C_I)	16,000.0	22,000.0	15,000.0
Auxiliary power, kW	2,810.0	2,850.0	2,720.0
Annual operating cost (O_t)	3,849.5	5,296.0	3,615.4
Annual fuel cost (F_t)	98.5	99.9	95.3
Annual makeup power cost (P_t)	N/A	N/A	N/A
Total generating cost (GC_p) (present value)	67,717.0	92,728.2	63,595.6
Total generating cost (GC_a) (present value annualized)	6,094.5	8,345.5	5,723.6

NOTES:

1. i = 7.5%
2. Annual operating cost (O_t) includes capital revenue
3. Annual fuel cost (F_t) based on $.005/kWh levelized annual cost
4. Annual makeup power costs (P_t) based on $500.0/kW levelized annual cost
5. Present value - 1981



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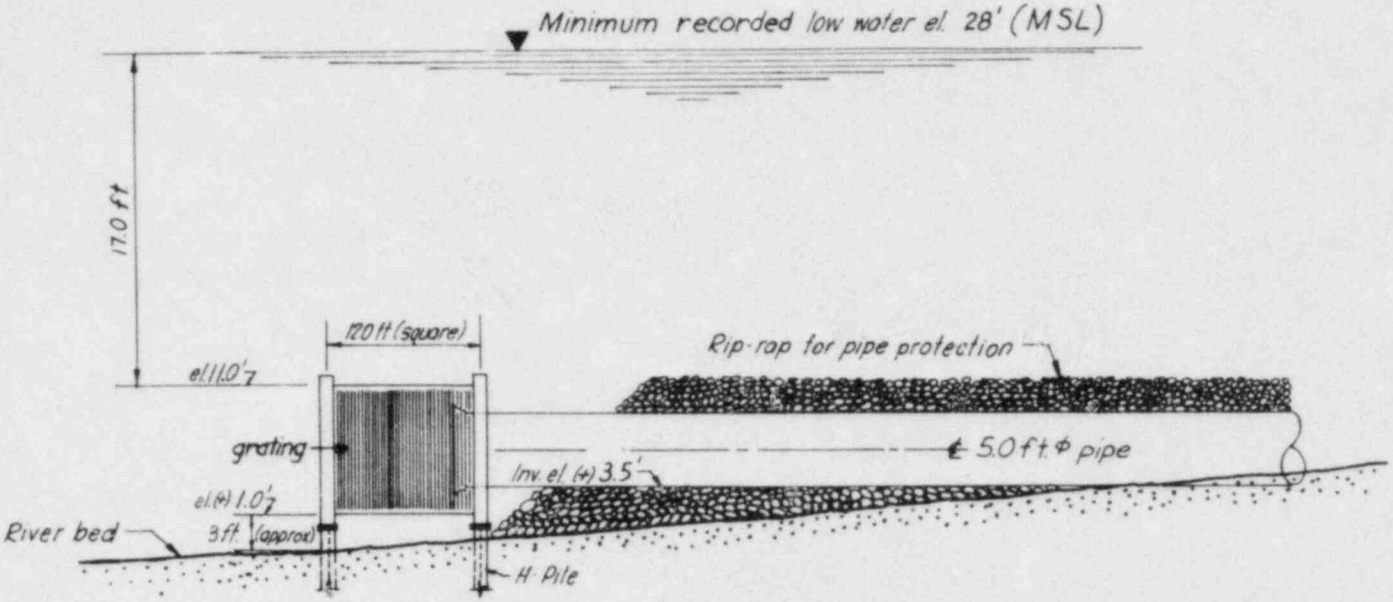
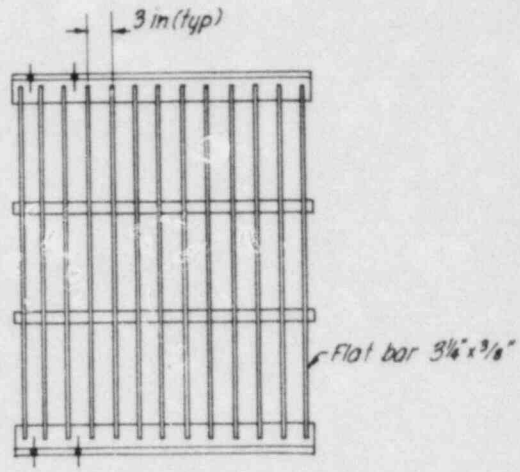
ALTERNATIVE A
INTAKE AND DISCHARGE
STRUCTURE LOCATIONS
FIGURE 10.2-1



ELEVATION

Note: All elevations in ft above sea level (MSL)



GRATING DETAIL (TYPICAL)

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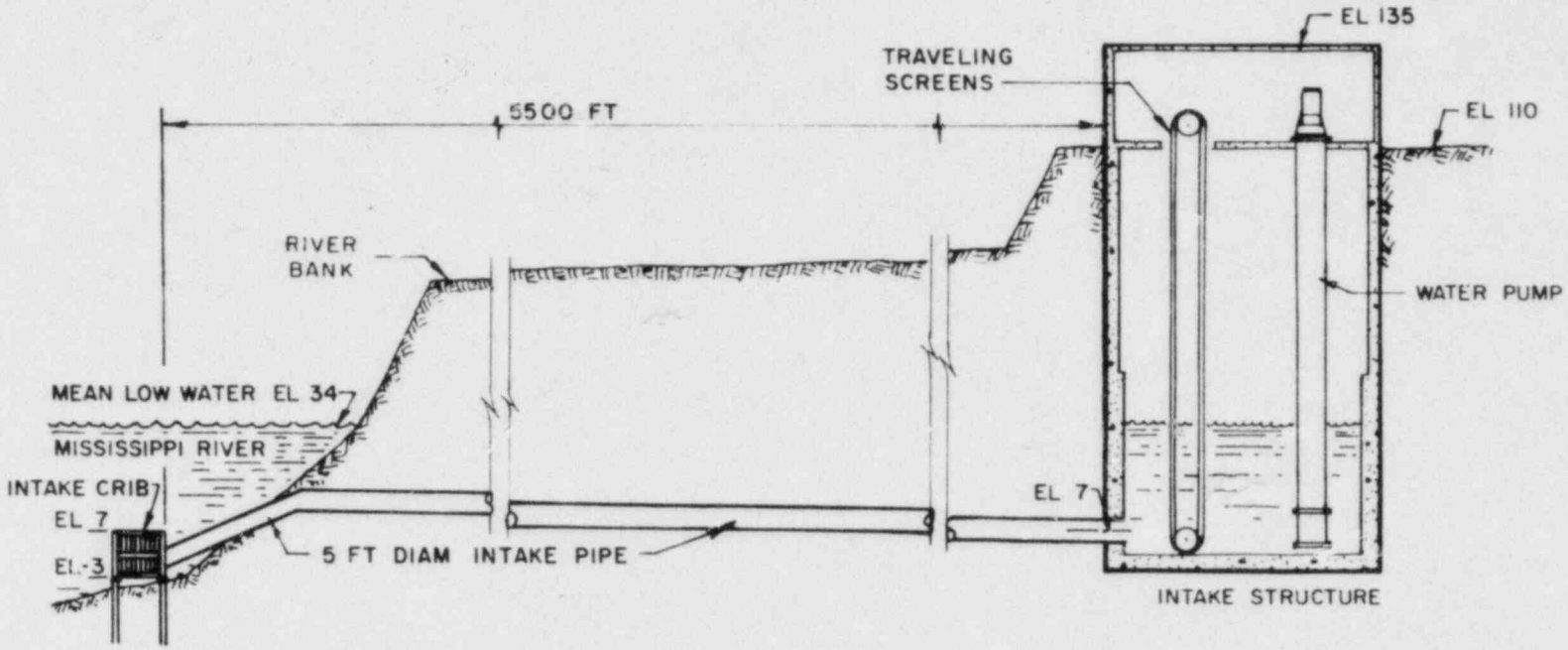
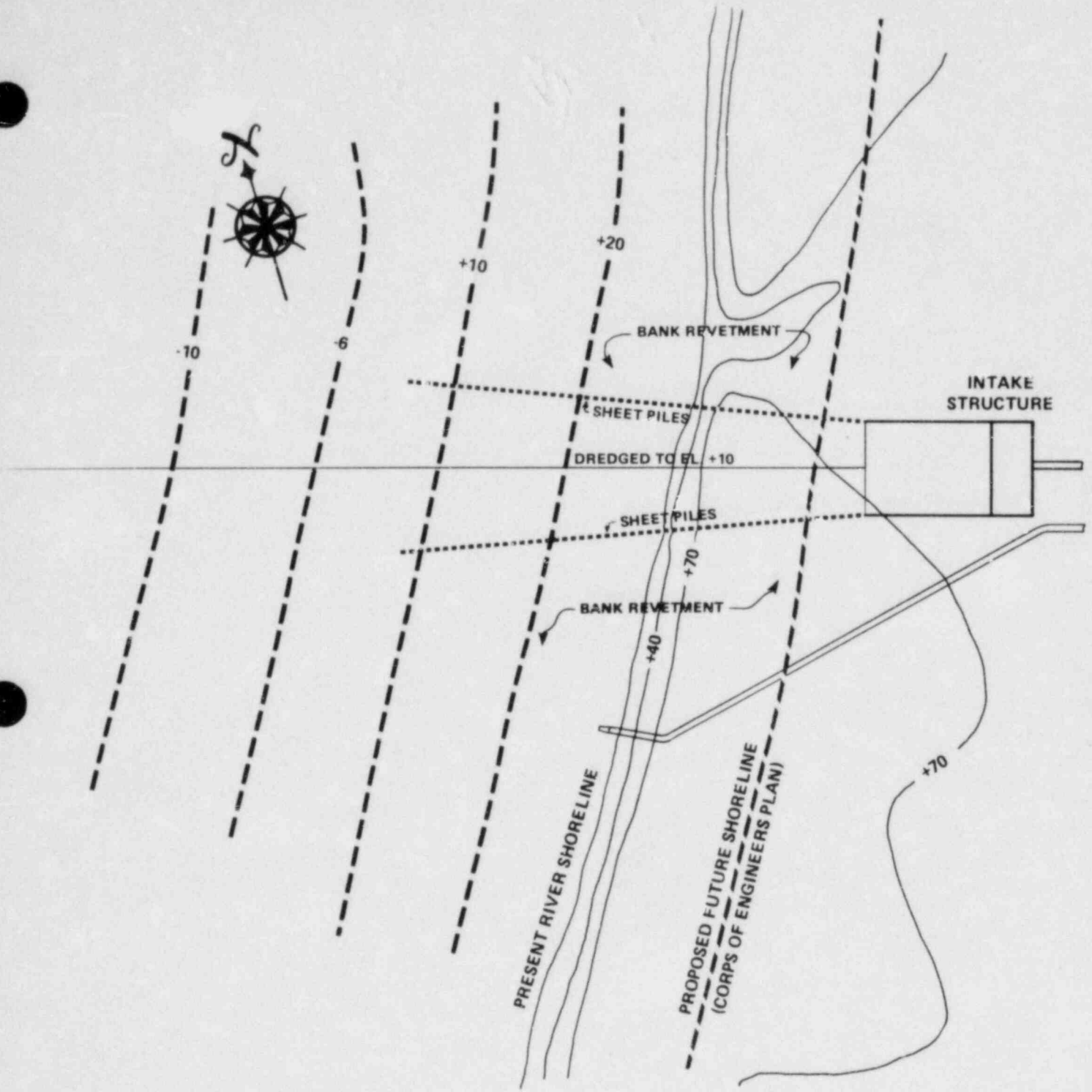
ALTERNATIVE SERVICE WATER
INTAKE CRIB (TYPICAL)
FIGURE 10.2-2



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	SCHEMATIC OF SERVICE WATER INTAKE SYSTEM (ALTERNATIVE A) FIGURE 10.2-3



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ALTERNATIVE B
INTAKE AND DISCHARGE
STRUCTURE LOCATIONS
FIGURE 10.2-4

10.3 DISCHARGE SYSTEM

The selected cooling tower blowdown discharge system free outfall pipe discharge into the barge slip is discussed in subsection 3.4.4.

10.3.1 Alternative Discharge Systems

Two alternatives have been considered for discharge of the cooling tower blowdown into the Mississippi River. They are single-port offshore jet and single-port shoreline jet.

10.3.1.1 Single-Port Offshore Jet

From the common discharge basin, a single discharge pipe would transport all liquid discharges to the river. This pipe would be buried with the intake pipes and extended to a point approximately at the middle of the river (Figure 10.3-1). The discharge would be a single-port offshore jet designed to maximize mixing with the river flow (Figure 10.3-2). The 36-inch nozzle would be at an angle of 15 degrees above the horizontal to minimize jet interaction with the river bottom.

Because of the sediment deposition characteristics of the Mississippi River, the single-port offshore jet discharge must be located a minimum of 2000 feet into the river. The construction of a pipeline of this length presents many problems, not only from the construction point of view but also may pose a hazard to navigation. For these reasons, and after comparison with the selected discharge scheme, which imposes less construction impact, the single-port offshore jet was eliminated from further consideration for design purposes.

10.3.1.2 Single-Port Shoreline Jet

In this alternative the discharge pipe (54-inch diameter) would be continued with the same slope of 0.2 percent until it cuts through the bank of the river at El. 46.6 feet msl, as shown in Figure 10.3-3. Two entraining walls would be constructed at each side of the pipe, and the bank and bottom immediately below the end of the pipe would be protected against erosion with riprap. A 42-inch diameter nozzle would be installed at the end of the pipe.

This discharge would act as a free outfall at low water river stages, as a surface jet at mean water level (El. 54 feet msl), and as a submerged jet at flood water levels.

The construction of the two entraining walls and the placing of the riprap would involve a great amount of dewatering and the construction of a coffer dam in the immediate area make this alternative very costly. Therefore, no further consideration was given to this alternative for design purposes.

10.3.2 Environmental Effects of Discharge Alternatives

10.3.2.1 Single-Port Offshore Discharge

Construction of this discharge alternative 2000 feet into the river channel would require a greater amount of disturbance to the river, with a consequent greater temporary loss of benthic habitat than either the adopted design or the shoreline alternative. The impact would extend downstream with siltation of benthic habitat and probably some temporary shifts in species composition towards more silt-tolerant forms. Impact to the bottomlands should be of the same magnitude, and similar in nature, to that associated with the adopted intake design and shoreline alternative and has been discussed in subsection 10.2.2.1.

Some localized modification to ambient river currents can be expected due to discharge velocity and the structure itself. Scouring of bottom habitat should be minimized by locating the port at least 4 feet off the river bottom and at an angle of 15 degrees above the horizontal. The thermal plume for this alternative has been estimated for both winter mean and extreme cases at low-river water level (Appendix A to this Section). The operational and river parameters assumed are those used in the plume calculations for the adopted discharge design (Table 10.3.2). In both the winter mean and extreme cases, the river channel alternative has smaller plume areas within the 5 F isotherm than the adopted design and the entrainment wall discharge alternative. This is due to more rapid mixing of the discharge with the deeper, faster moving channel waters. Fewer fish would be subjected to the plume from this alternative because the river channel was found to be the least productive of the river habitats sampled in the 1972-73 field program (see Section 2.2). It is unlikely that the plume would contact the river bank benthic habitat except possibly for the very low temperature rise isotherms below 5 F. A plume impingement of this nature should not significantly affect benthic productivity, and organisms residing in this river bank zone would have a low cold shock potential. The river bank in this area is subject to future modification and consequent loss of benthic habitat to the Corps of Engineers shoreline stabilization program.

Few species of fish would populate the plume in the river channel proper due to the strong currents. Organisms which do reside in this zone would have a relatively high cold shock potential. If a

cold shock incident were to occur, it should not seriously affect the stability of channel populations due to the small areal extent of the plume and the small number of organisms that would be involved.

Plume entrainment of drifting biota (plankton, drifting macroinvertebrates, and larval fish) is to be expected. Larger, strong-swimming organisms such as adult fish would probably avoid prolonged contact with the higher temperature areas of the plume, although a few species of adult fish would probably reside in the plume. The strong currents in the channel combined with the small areal extent of the plume yield a short transit time for organisms passing through the plume. Although some mortality may occur, it is expected to have only minimal or negligible impacts relative to total river populations.

In summary, construction of this alternative would entail a greater amount of temporary disturbance to the river itself, with consequent impacts to biota, than either the adopted design or the shoreline alternative. The thermal plume resulting from the channel discharge will be smaller in areal extent than either the adopted design or shoreline alternative. As a result, on a relative basis, fewer organisms would be directly affected by the plume, particularly along the river bank habitat, and the relative potential for cold shock mortality would be somewhat lower. It should be emphasized that, on an absolute basis, both the adopted design and the shoreline entrainment wall alternative also affect only a small area of the river and its habitat.

10.3.2.2 Single-Port Shoreline Discharge

Construction of this alternative would necessitate considerable disturbance to the river itself, even if construction were timed for a low river water period. Construction of the discharge pipeline would entail impact of the same nature and magnitude as the adopted intake and channel designs, and has been discussed in subsection 10.2.2.1.

Operation of this alternative requires the permanent commitment of a small area of river bank habitat (less than 0.1 acre) to the discharge structure, entrainment walls, and bank stabilizing riprap. This does not represent a significant loss of this habitat type to the region, particularly since this shoreline area will eventually be stabilized with concrete mats as part of the Corps of Engineers shoreline stabilization program. The entrainment walls may result in some local modification of ambient river currents, leading to some scouring or siltation near the walls. The thermal plume from this alternative, for the winter mean and extreme cases at low river water level, should be

similar to those estimated for the adopted discharge design (Table 10.3.2) and Appendix A. While the areal extent of the lower isotherms (5 F) is nearly the same, the shape and length of the plumes will be different due to the higher entrance velocity into the river associated with this alternative. Since the plume areas are about the same, this alternative would potentially affect about the same numbers of organisms as the adopted design. The plume would impinge upon the river bank habitat due to the shoreline nature of the discharge, but the area affected would be less than that estimated for the adopted design due to the trajectory and shorter length of the plume. Cold shock potential for this alternative should be of the same magnitude and involve about the same number of organisms as the adopted discharge, (see subsection 5.1.3). Plume entrainment of drifting biota would involve about the same amount of organisms as the selected design.

In summary, the entrainment wall configuration would result in significantly less impact during construction than entailed by the channel alternative, but considerably more than entailed by the adopted design. The thermal plumes should be larger in areal extent than the channel discharge and nearly the same in area to the adopted design plumes. On a relative basis, the plumes from this alternative and the adopted design would affect greater numbers of biota than the channel design and also have a greater relative potential for cold shock mortality, although in absolute terms, all three designs affect only small areas of the river.

10.3.3 Monetized Costs

Table 10.3.1 presents the monetized costs (C_I) for the following discharge systems: (a) free outfall pipe discharge into barge slip, (b) single-port offshore jet, Mississippi River, and (c) single-port shoreline jet, Mississippi River.

10.3.3.1 Capital Costs (C_I)

The capital costs (C_I) associated with each discharge are presented in Table 10.3.1 and include:

Free outfall pipe, barge slip (selected):

The capital cost items include the 54-inch pipeline from the common discharge basin to the south bank of the barge slip, concrete apron and headwalls at the end of the pipe, and excavation and backfill.

Single-port offshore jet, Mississippi River

The capital cost items include the 54-inch pipeline from the common discharge basin to the east bank of the Mississippi River, concrete and pile support for the pipe and nozzle at the end, river bank protection, excavation and backfill.

Single-port shoreline jet, Mississippi River

The capital cost items include a shorter length of 54-inch pipeline and entraining walls in addition to the ones included in the single-port offshore alternative.

All the capital costs developed for the above alternatives have been adjusted for escalation and interest during construction to arrive at a capital cost (C_I) consistent with 1981 operation.

10.3.3.2 Annual Fuel Costs (F_t)

The annual fuel costs (F_t) presented in Table 10.3.1 were computed on an incremental basis based on auxiliary power requirements.

10.3.3.3 Annual Operating Costs (O_t)

The annual operating costs (O_t) presented in Table 10.3.1 were computed based on revenue requirements associated with the capital investment.

10.3.3.4 Annual Makeup Power Costs (P_t)

The annual makeup power costs (P_t) presented in Table 10.3.1 were computed on an incremental basis based on the auxiliary power requirements.

10.3.3.5 Generating Costs (GC_p and GC_a)

The economic parameters used to evaluate the discharge (blowdown) systems are the same as shown in subsection 10.2.3.5.

TABLE 10.3.1

ALTERNATIVE DISCHARGE SYSTEM COSTS ($ X 10^3)
UNITS 1 AND 2

Alternative Discharge	Free-outfall Barge Slip	Mississippi River-Direct Single-Port Shoreline Jet	Mississippi River-Direct Single-Port Offshore Jet
Project cost (C_I)	1,500.0	3,000.0	5,500.0
Auxiliary power, kW	0	0	0
Annual operating cost (O_t)	270.0	540.0	990.0
Annual fuel cost (F_t)	0	0	0
Annual makeup power cost (P_t)	0	0	0
Total Generating Cost (GC_p) (present value)	4,695	9,390	17,216
Total generating cost (GC_a) (present value annualized)	397	793	1,455

NOTES:

1. i = 7.5%
2. Annual operating cost (O_t) includes capital revenue requirement
3. Annual fuel cost (F_t) based on $.005/kWh levelized annual cost
4. Annual makeup power costs (P_t) based on $500.0/kW levelized annual cost
5. Present value - 1981

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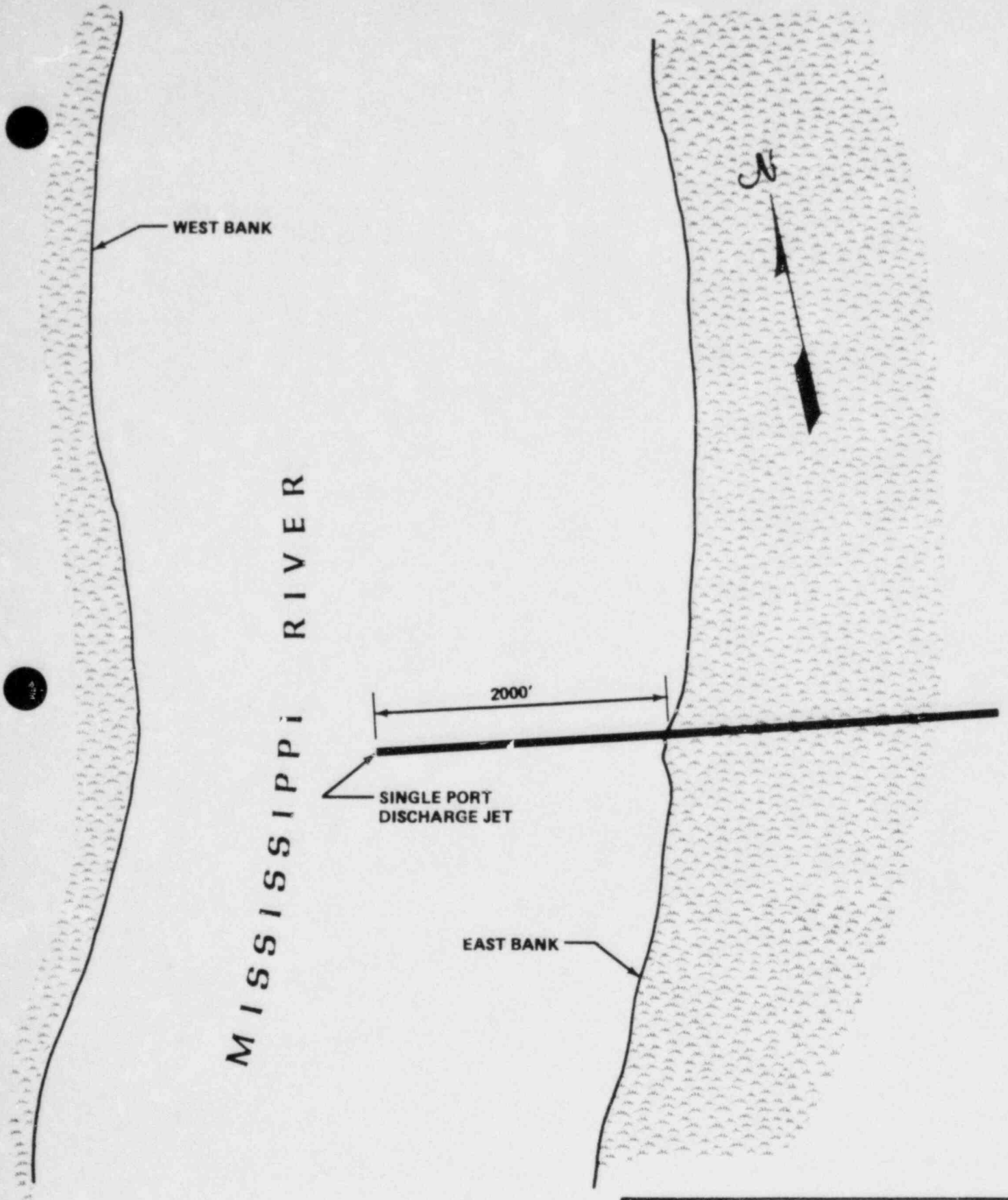
TABLE 10.3.2

COMPARISON OF PLUME DIMENSIONS OF THE ADOPTED DESIGN, OFFSHORE ALTERNATIVE, AND SHORELINE DISCHARGE ALTERNATIVE FOR WINTER MEAN AND EXTREME CASES AT LOW RIVER WATER LEVEL OF 31 FT MSL (FROM SUBSECTION 5.1.3 AND APPENDIX A)

Seasonal Case	River Temp, F	Discharge Temp, F	Discharge Vol, gpm	River Plume Surface Area (5 F Isotherm) (acres)			Contact Area with Shoreline Benthic Habitat (acres)		
				Adopted	Offshore	Shoreline	Adopted	Offshore	Shoreline
Winter Mean	41	74	24,046	2.6	0.4	2.4	0.9	nil	0.9
Winter extreme	34	74	24,046	4.2[b]	0.6	3.5	2.1[a]	nil	2.1

a. Area of plume contact based upon estimated cross section of plume and bank slope. See Section 5.1.3.2 for more complete details.

b. Plume sinks due to temperature-density differences. This should decrease the actual area of the plume.



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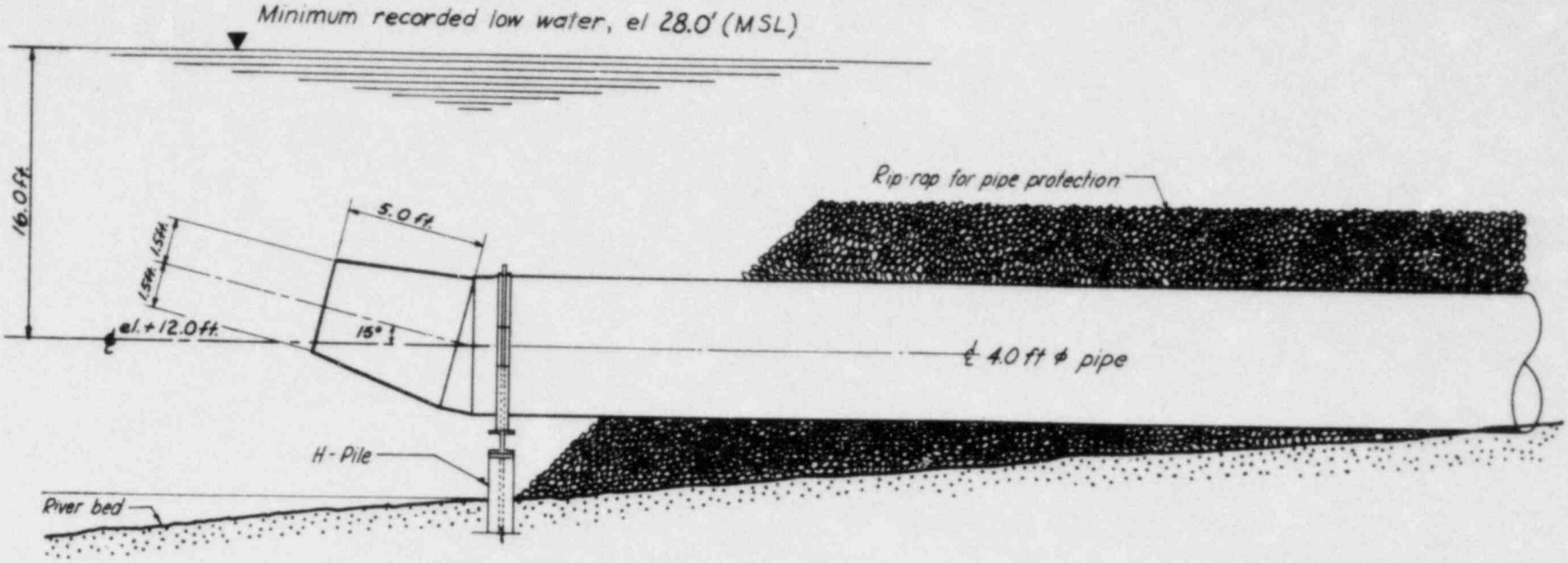
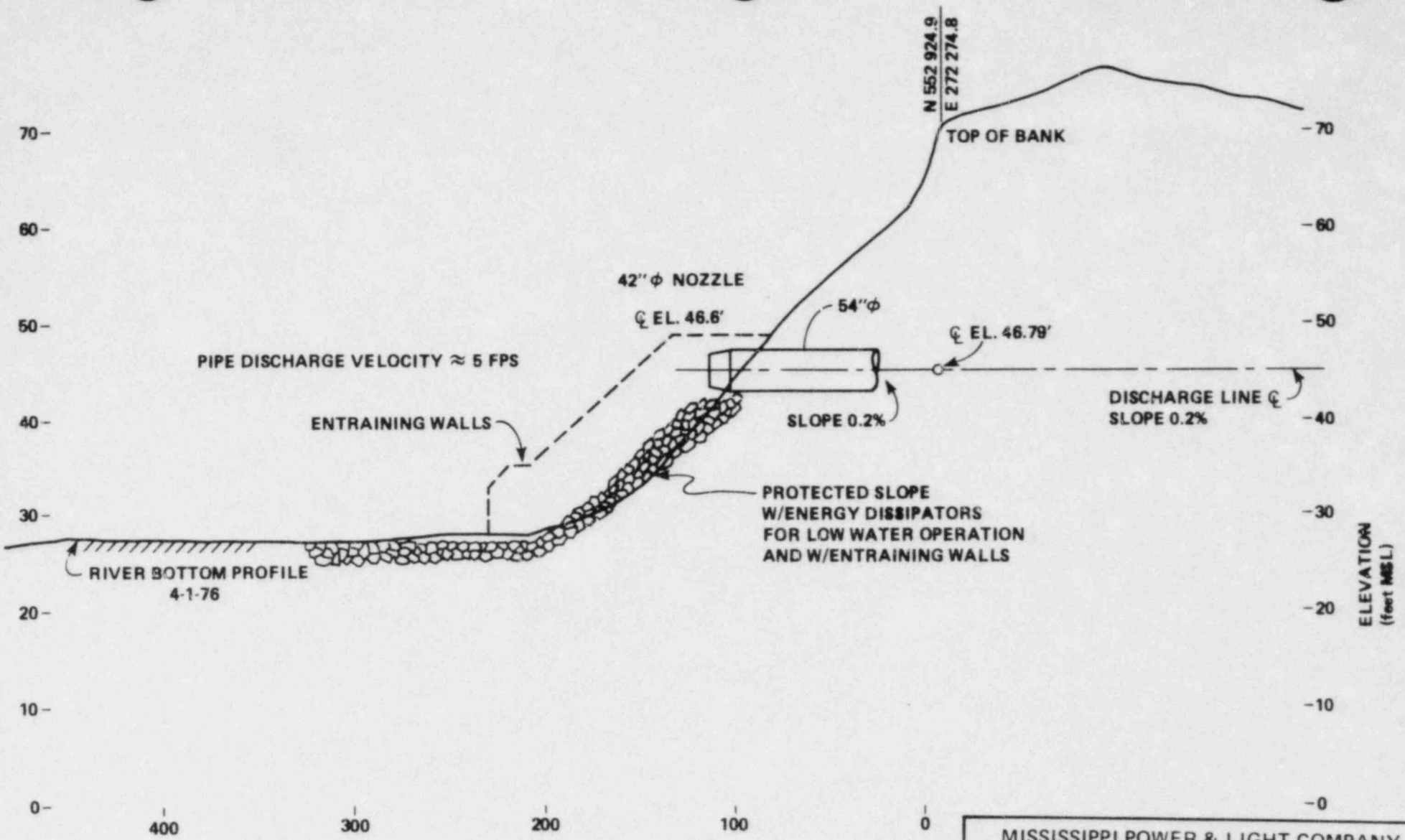
SINGLE PORT OFFSHORE
DISCHARGE
JET LOCATION

FIGURE 10.3-1



PROFILE

MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT
SINGLE PORT OFFSHORE DISCHARGE JET OUTLET FIGURE 10.3-2



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SINGLE-PORT
SHORELINE JET

FIGURE 10.3-3

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APPENDIX A

ALTERNATIVES OF BLOWDOWN DISCHARGE SCHEMES

Thermal Plume Analysis

1. BASIC DATA AND SYSTEM DESCRIPTION

The cooling tower blowdown rates and temperatures and the Mississippi River conditions used in this study are discussed in subsection 5.1.2. A description of the two alternatives considered (i.e. the single-port offshore jet and the single-port shoreline jet) is presented in Section 10.3.

Based on the results of the analysis presented in subsection 5.1.1 for the adopted discharge scheme, the winter mean and extreme conditions for the low river level are analyzed for the two alternatives, since these conditions have the highest heat load discharge into the Mississippi River.

2. ANALYSIS

Analysis of the blowdown plume in the Mississippi River is based on available analytical models for surface jets, developed by Pritchard, (Benedict, et. al. Ref. 1) and by Carter (Ref. 2), and for submerged jets, developed by Fan and Koh (Ref. 3).

2.1 Assumptions

Several assumptions were made in performing the analyses which lend conservatism to the results. The most significant of these assumptions are addressed below.

a. The local river velocities near the bank and in the river channel are assumed to be 1.0 fps and 2.0 fps, respectively, for the low water level corresponding to the 7 day - 10 yr low flow of 31 feet msl considered. Based on available velocity profiles and on the river hydraulics, these velocities are lower than actual.

b. The plume depth of 3.5 feet considered for the shoreline single-port discharge alternative is based on the local water depth in the river at the point of discharge, as determined from the U. S. Army Hydrographic Survey of 1975. This assumption results in a conservative (large) plume surface area, since the water depth in the river along the bank increases significantly downstream from this point.

c. Surface heat transfer from the plume is considered negligible, resulting in conservatively larger plume surface areas.

2.2 Single-Port Offshore Discharge

At the low water level of 31 feet msl the water depth above the top of the jet is about 17 feet. The discharge velocity from the 3-foot diameter jet for the winter blowdown rate is 7.6 fps.

Analysis of the thermal plume was accomplished by the use of a computer program which simulates the initial mixing of a submerged thermal discharge from a multipart diffuser into a stagnant receiving water based on a mathematical model and program developed by Han and Koh (Ref. 3).

The single port discharge in this analysis was simulated by assuming a port spacing sufficiently large so that the jet reached the free surface before any interaction with the discharge from an adjacent port.

This model was used since it resulted in less dilution than obtained from using the method of Shiraze and Davis (Ref. 4) for single port discharges into moving ambient water.

The results of the analysis indicate that the plume centerline temperature rise when reaching the surface is in excess of 5 F and with an excess velocity of about 3.5 fps. These results are used as the initial conditions for the analysis of the surface jet. The model developed by Pritchard (Benedict, et. al. Ref. 1) was used to estimate the extent of the surface plume to reach the 5 F temperature rise isotherm. The results of the analysis are presented in the form of surface areas for the 5 F temperature rise isotherms for the two cases in Table 1 of this Appendix.

2.3 Single-Port Shoreline Discharge

For the low water level considered, the blowdown discharge will exit the port above the water surface and will run down the river bank between the two retaining walls (spaced 4 feet apart) and into the river. The initial jet depth is assumed to equal the available water depth near the bank of 3.5 feet. The corresponding blowdown discharge velocity is about 3.8 fps. Carter's two dimensional model (Ref. 2) is used to predict the thermal plume mixing in the river. The results of the analysis are presented as surface areas for the 5 F and 10 F temperature rise isotherms in Table 2 of this Appendix.

In performing the analysis for these two cases, the plumes at some temperature rise isotherms became denser than the receiving water, as discussed in subsection 5.1.2. Since no mathematical models are presently available which predict the behavior of an initially buoyant plume which becomes negatively buoyant, the plume was analyzed as surface plume. The amount of mixing which is expected to occur due to the ambient current or during the sinking plume was neglected. Such mixing minimizes the extent of the plume obtained from the analysis.

3. REFERENCES

1. Benedict, B. A., J. L. Anderson, and E. L. Yandell, Jr., "Analytical Modeling of Thermal Discharges, A Review of the State of the Art," ANL Report ANL/ES 18 April, 1974.

2. Carter, H. H., E. W. Schiemer, R. Regier, "The Buoyant Surfact Jet Discharging Normal to an Ambient Flow for Various Depths," Chesapeake Bay Institute Technical Report 81, February 1973.

3. Koh, R. C. Y. and L. N. Fan, "Mathematical Models for the Prediction of Temperature Distributions Resulting from the Discharge of Heated Water Into Large Bodies of Water," Water Pollution Control Research Series Report No. 16130DWO EPA.

4. Shirazi, M. A. and L. R. Davis, "Workbook of Thermal Plume Prediction - Vol. 1, Submerged Discharge," EPA-R2-72-005a, August, 1972.

TABLE 10.3A-1

SINGLE-PORT OFFSHORE DISCHARGE

THERMAL PLUME ANALYSIS

Case	Surface Temperature Rise Isotherm, F	Approximate Area, Acres
Winter extreme	10	*
Winter extreme	5	0.6
Winter mean	10	*
Winter mean	5	0.4

*The 10 F temperature rise isotherm will be reached in the subsurface near field due to the dilution by the jet momentum.

TABLE 10.3A-2

SINGLE-PORT SHORELINE DISCHARGE

THERMAL PLUME ANALYSIS

Case	Surface Temperature Rise Isotherm, F	Approximate Area, Acres
Winter extreme	10	0.5
Winter extreme	5	3.5
Winter mean	10	0.3
Winter mean	5	2.4

10.4 CHEMICAL WASTE TREATMENT

10.4.1 General

A description of plant water use is presented in Section 3.3 of this report. Various chemicals are used to control water quality, scale, corrosion, biological fouling, and for regeneration of demineralizers, equipment lubrication, laboratory operations, extinguishing fires, and solidification of wastes. Quantities and types of chemicals added to station systems and resultant discharges due to station operation are given in Tables 3.6.1 through 3.6.4 and various subsections in Sections 3.6 and 3.7. Figure 3.6-1 is a schematic diagram outlining the systems and processes that contribute chemical wastes to the total plant discharge. This section describes alternative chemical/physical treatment and disposal systems that may be utilized in circulating water and makeup water treatment systems. The liquid radwaste system is discussed in Section 10.7.

10.4.2 Circulating Water System Treatment

The largest quantities of chemicals released from the station are the necessary result of selecting closed-cycle natural draft wet cooling towers. The naturally occurring chemicals in the river (and aquifer) water are concentrated by a factor of between two and three in the circulating water system due to the evaporative loss of water in the cooling towers. This loss of water would actually tend to continually increase the concentration of solids in the circulating water. However, it is controlled by continuously blowing down a portion of the circulating water so as to limit the concentration factor between two and three. Makeup water is continually added to the circulating water system to compensate for the losses due to evaporation, blowdown, and drift (from the cooling towers). To control circulating water pH and scaling tendencies, sulfuric acid is added using a feed-forward control loop.

Circulating water is also treated with sodium hypochlorite solution to control biological fouling of the main condenser and the cooling tower . Details regarding this treatment are provided in Section 10.5.

10.4.3 Plant Makeup Water Treatment

Mississippi River water drawn through the radial collector well system is treated in the plant makeup water treatment system to remove chlorine, color (due to organics), and the majority of dissolved solids. This system consists of activated carbon filters and layered bed demineralizers along with storage,

transfer, and regeneration facilities. The primary function of the activated carbon filter is removal of chlorine and color, if present. The effluent from the filters is processed through two makeup demineralizer trains with each train designed for 150 gpm capacity. Each demineralizer train consists of a layered bed cation vessel containing a mixture of weak and strong acid resins and a layered bed anion vessel containing a mixture of weak and strong base resins. Sulfuric acid and caustic soda are used for the regeneration of the cationic and anionic resins, respectively. Regeneration wastes are neutralized by acid or alkali addition in a tank before being pumped to the discharge basin.

On an average basis, the regeneration liquid waste has the following characteristics before neutralization:

Volume	78,400 gallons per day (24 hours)
pH	acidic
Total dissolved solids	3860 mg/l

The regeneration acid and alkali addition is so adjusted that very small quantities of either acid or alkali are required for neutralization of the regeneration liquid wastes. Therefore, the characteristics of the wastes remain essentially unaltered after neutralization except for pH change to neutral, i.e. approximately 7 (actual values may lie between the EPA effluent limitation guideline range of 6.0 to 9.0).

10.4.4 Alternative Waste Treatment and Disposal Systems

There are two basic generic alternatives for nonradioactive liquid waste treatment and disposal:

a. Source abatement

b. Diversion and evaporation

10.4.4.1 Source Abatement

There are two ways of reducing the quantities of contaminants entering the environment; first by using only the bare minimum quantities of chemicals required for safe and reliable process operation which, in the present case, is makeup water demineralization and circulating water treatment; secondly, by using alternative processes that either do not require chemicals or require significantly less.

Reverse osmosis (R.O.) is frequently mentioned as one such alternative water treatment technique. On closer examination it is found that this alternative does not meet the requirements of

a nuclear power plant: the quality of water produced by R.O. is not comparable to that produced by demineralizers; R.O. membranes are the weakest part of the R.O. system with limited service life and need for frequent replacement; and R.O. membranes are subject to scaling, fouling and abrasion. Due to these and economic reasons, R.O. systems are not preferred in the utility industry despite the advantages of simplicity and elimination of the use of regeneration chemicals.

The selected ion-exchange system (demineralizers) is operated with minimum use of chemicals (sulfuric acid and caustic soda) so that, on discharge to the environment, the liquid wastes shall have a minimum impact (if any).

The makeup water for the circulating water system is treated with sulfuric acid to control scaling and pH. An alternative to the use of sulfuric acid is hydrochloric acid. Use of hydrochloric acid would result in lowering the quantities of acid required for scale control and hence produce lower amounts of wastes. However, hydrochloric acid is very corrosive, involves handling problems, and is expensive relative to sulfuric acid. Therefore, use of sulfuric acid for pH and scale control of makeup water is the accepted standard practice in the power generation industry in the U.S.

The circulating water is treated with sodium hypochlorite solution to protect the main condensers, the cooling towers, and other associated equipment and piping against biological fouling. The selected process and alternatives are discussed in Section 10.5.

10.4.4.2 Diversion and Evaporation

The alternative method for disposal of liquid wastes involves diversion of the combined (blowdown, regeneration wastes, etc.) waste stream to a lined evaporation pond. Through the processes of natural and forced evaporation, the liquid wastes would be reduced to a smaller volume of solids wastes. Local climatological data in References 1 and 2 indicate a mean annual lake evaporation of 45 inches and an average annual total precipitation of 56.8 inches.

Blowdown from the two units, being slightly warmer than the natural water temperature, would create forced evaporation, especially during the winter months. A net annual evaporation rate of approximately 8.3 inches would be expected at this site. For two-unit operation at average conditions, the required evaporation pond area would be approximately 53,200 acres. Although technically feasible, this alternative involves excessive acreage of land. In addition, final disposal of evaporated salts is a solid waste problem that is created by this alternative method of liquid waste disposal. This alternative would evaporate water to the atmosphere, causing loss of Mississippi

River water. The selected system of wastewater disposal to the river does not involve this evaporative loss of water.

10.4.5 References

1. U. S. Department of Commerce, "Local Climatological Data (1940-1973) Annual Summary with Comparative Data, Miami, Florida," Washington, D. C., 1973.

2. Environmental Science Services Administration, U.S. Department of Commerce, Climatic Atlas of the United States (1945), page 63, plate 2, June 1968.

10.5 BIOCIDE TREATMENT

10.5.1 General

Due to the recycling and heating of the cooling water in the circulating water system, an environment suitable for the growth of microorganisms is created. Biocide treatment is required to prevent biological fouling in the cooling towers and main condensers.

Two basic approaches to biocide treatment exist: chemical and mechanical.

10.5.2 Alternative Biocide Systems

10.5.2.1 Chemical Treatment

10.5.2.1.1 Chlorination

The most widely used biocide is chlorine. Although other biocides are available, utilities generally use this substance because of economics and effectiveness. When dissolved in water, chlorine hydrolyzes to form hydrochloric and hypochlorous acids. Hypochlorous acid (HOCl) and hypochlorite ion (ClO^-) are the effective biocide. Because of this, gaseous, liquid, or solid chemicals may be used for treatment: chlorine as a compressed gas, sodium hypochlorite solution, or solid calcium hypochlorite.

Biological control in a cooling water system is achieved by adding sufficient chlorine to obtain a killing residual. The residual must be maintained long enough to destroy microorganisms. Chlorine, hypochlorous acid, and hypochlorite remaining in the system after disinfection are known as free chlorine residual. Combined chlorine residual is the portion of the total chlorine existing in the form of chloramine, or organic chloramines which are biocides requiring large concentrations or long contact time to produce the same kill as low concentrations of free residual chlorine.

There are generally four operational approaches to chlorination:

a. Continuous Chlorination Maintaining a Free Chlorine Residual

   This approach is the most effective and most expensive of the four. It may not be technically or economically feasible at a given site if large amounts of organic matter are present which can combine with the chlorine. Generally, this approach results in consumption of excessive amounts of chlorine and unacceptable residual levels.

b. Continuous Chlorination Maintaining a Combined Residual

This involves a lower cost than approach a. due to decreased chlorine requirement, but it is less effective than continuously maintaining a free residual. Severe fouling problems may not be controlled by this procedure.

c. Intermittent Chlorination Maintaining a Free Residual for a Specified Period

This is the most widely used approach and is very effective when severe fouling problems do not occur. It is significantly less costly than continuous chlorination.

d. Intermittent Chlorination Maintaining a Combined Residual

This is the least effective and least expensive approach.

10.5.2.1.2 Ozonation

Ozone is one of the most powerful biocidal agents known. It is the reactive triatomic allotrope of oxygen (O_3). Ozone is produced by passing clean, dry air or oxygen through a zone of high-voltage, high-frequency electrical discharge. Under optimum conditions, only a small fraction of the oxygen gas is converted to ozone. Several commercial ozone generators are available in the market-place ranging in production capacity from a few hundred grams to several hundred pounds of ozone per day.

Although ozone is used widely in Europe for disinfection of potable water, it is not used very widely in the United States. No use in the biocide treatment of large cooling water volumes is known to exist. The high cost relative to chlorine, lack of an economic storage alternative, and absence of actual operating experience weigh critically against its use at the present time. Absorption on silica gel and absorption in liquid fluorocarbons at cryogenic temperatures are demonstrated, feasible storage alternatives; however, the costs for such storage generally exceed the cost for greater instantaneous production capacity. The lack of operating experience can only be remedied by pilot studies or full-scale operation of ozonation facilities for cooling water systems and these are yet to occur.

In summary, ozone does have a biocidal activity from several to hundreds of times that of chlorine depending on the particular application. Since ozone cannot be stored practicably, continuous generating systems must be used. Quantities of ozone must be produced to provide a contact time of several minutes at

levels of about 0.1 to 5 ppm. Ozone decomposes rapidly in water to form dissolved oxygen which, although environmentally acceptable, necessitates a very large instantaneous production capacity for either intermittent or continuous ozonation. These factors plus the lack of operating data make the use of ozone as a biocide unattractive.

10.5.2.1.3 Copper Sulfate Treatment

Copper sulfate has been used as an algicide in small cooling systems but its use in larger cooling systems is essentially nonexistent. At high pH values, the copper ion is precipitated as insoluble copper hydroxide. Stabilizing agents must, therefore, be used in conjunction with copper salts to preserve toxicity by preventing precipitation of the copper ions.

The toxicity of copper salts may be enhanced by using wetting agents which increase the penetration of the copper ions into slime and algal growths.

Copper salts are seldom used alone to control biological fouling in circulating water systems. The reason is that although copper salts are effective against algae, other chemicals must still be used for the control of bacteria and fungi. Such a severe limitation in its effectiveness weighs critically against the use of copper salts for waters requiring more general biocidal action.

10.5.2.2 Mechanical Systems

Mechanical removal of biological growth from cooling water systems is usually limited to the inside surfaces of the condenser tubes. This may be either intermittent by the controlled passage of scrubbing brushes through the tubes or continuous by recirculating scouring media with the cooling water. Brief discussions of these two approaches follow.

10.5.2.2.1 Intermittent Scrubbing

An intermittent scrubbing system is commercially available for use in condenser tubes to reduce slime formation and buildup. This system requires that cages be fitted to the inlet and outlet ends of each condenser tube and a small plastic brush be inserted in the tube between cages. To cause these brushes to travel over the length of the tubes, an external arrangement of piping water flow control valves is utilized. By periodically reversing the direction of the water flow, the scrubbing brushes are moved through the tubes.

10.5.2.2.2 Continuous Scouring

A proprietary mechanical cleansing system is available that uses sponge rubber balls of a diameter slightly larger than the inside diameter of the condenser tubes. These balls are continually recirculated through the condenser tubes. Their rubbing action scours the tube walls to maintain the heat transfer rate.

10.5.3 Evaluation of Alternative Biocide Systems

10.5.3.1 Chlorination

Either type of intermittent chlorination as discussed previously would be acceptable from both operational and environmental viewpoints. Continuous chlorination would not be satisfactory since it would require a continuous discharge of residual chlorine and unduly high operating costs. Intermittent chlorination based on residual free chlorine and treatment of each unit at different times is preferred since it assures effective biocidal action and has a long history of successful operation at power plants.

A sodium hypochlorite system has been selected. Gaseous chlorine could be used but has been ruled out due to associated safety, handling, and supply problems. Worst summer conditions are assumed to require the equivalent of 5 ppm of total chlorine for three 30 minute periods per day per unit. This level will be adjusted based on actual experience during operation. Free chlorine at the discharge of the condensers will be maintained at from 0.1 to 0.5 ppm, again depending on actual operating experience. This sort of concentration level has been found adequate for similar power plants and sites.

According to the regulations (Ref. 1), free available chlorine is limited to maximum and average concentrations of 0.5 and 0.2 mg/l respectively. Also, neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day, and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate to the permit issuing authority that the units in a particular location cannot operate at or below this level of chlorination. That is, for each unit there is a two-hour window per day outside of which limits of detectability, about 0.04 ppm (Ref. 2), of free and total chlorine may not be exceeded. To operate under the postulated worst summer conditions, close control over the discharge is required. Since the units are chlorinated at different times, both dissipation and dilution effects are maximized.

The average chlorine concentration of the recirculating water discharged to the river will not exceed 0.2 mg/l. This discharge will be rapidly diluted by the high flow of the river, resulting in a chlorine level several orders of magnitude below .2 mg/l.

Therefore, the chlorine discharged in the recirculating water blowdown to the Mississippi River will have no significant effect on the environment.

10.5.3.2 Ozonation

From an environmental viewpoint, ozonation is probably the ideal biocide treatment approach. Residual ozone is reduced in minutes to molecular oxygen which is either released to the atmosphere or remains in solution, enhancing water quality. Unfortunately, no operating experience exists on the scale required for condenser cooling water systems, and costs, both capital and operating, are approximately twice those for equivalent chlorination systems. This approach will not be feasible until favorable operating, economic, and safety data are made available. For these reasons, ozonation is not considered acceptable.

10.5.3.3 Copper Sulfate Treatment

This biocide treatment approach is also considered unacceptable. Copper is too toxic environmentally and too specific in its biocidal activity for the use envisioned here.

10.5.3.4 Mechanical Systems (Continuous Scouring and Intermittent Scrubbing)

Both approaches under this category are considered environmentally acceptable. However, the additional capital and operating costs associated with these systems which basically clean only the condenser tubes are not warranted at the present time.

10.5.4 Monetized Costs

Table 10.5.1 presents the monetized costs for each of the following biocide systems:

- Gaseous chlorination
- Sodium hypochlorination

As noted in subsection 10.5.3.3, copper is too toxic environmentally and too specific in its biocidal activity to be used as the plant biocide. Thus, copper sulfate treatment costs are not considered.

As noted in subsection 10.5.3.2 ozonation has not been used for large condenser cooling water systems to date, and until favorable operating and safety data are made available, ozone as the plant biocide is not considered technologically feasible. Thus, specific costs for ozonation are not considered.

Similarly, mechanical scouring will not be considered unless the proposed chlorination system proves unable to maintain clean condenser tubes; associated costs are, therefore, not given.

10.5.4.1 Capital Costs (C_I)

The capital costs (C_I) presented in Table 10.5.1 include the following items:

a. Sodium Hypochlorination (Selected)

The capital cost items include hypochlorite generators, aqueous hypochlorite storage tank, booster pumps and drivers, associated piping, wiring, conduit and controls, injectors and diffusers, storage tanks, and associated excavation.

b. Gaseous Chlorination

The capital cost items include the chlorinators, evaporators, booster pumps and drivers, associated piping, wiring, conduit and controls, chlorinator and chlorine storage buildings, injectors, and diffusers.

The above-mentioned capital costs have been adjusted for escalation and interest during construction to arrive at a capital cost consistent with 1981 operation.

10.5.4.2 Annual Fuel Cost (F_t)

The annual fuel costs (F_t) presented in Table 10.5.1 were computed on an incremental basis based on the auxiliary power requirements.

10.5.4.3 Annual Operating Costs (O_t)

The annual operating costs (O_t) presented in Table 10.5.1 include revenue requirements due to capital investment and charges for items used (e.g., salt and electrodes for the sodium hypochlorite system and chlorine in ton cylinders for the gaseous chlorine system).

10.5.4.4 Annual Makeup Power Cost (P_t)

The annual makeup power costs (P_t) presented in Table 10.5.1 were computed on an incremental basis based on the auxiliary power requirements.

10.5.4.5 Generating Costs (GC_p and GC_a)

The economic parameters used to evaluate the biocide systems are the same as shown in subsection 10.2.3.5.

10.5.5 References

1. U. S. Environmental Protection Agency, "Steam Electric Power Generating Point Source Category Effluent Guidelines and Standards," Federal Register 39, Number 196, Part III. Article 423.15 (i) and (j), October 1974.

2. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, "Standard Methods for the Examination of Water and Wastewater," 13th Edition, page 110, August 1971.

TABLE 10.5.1

ALTERNATIVE BIOCIDE TREATMENT SYSTEM COSTS

UNITS 1 & 2

Alternative Discharge	Sodium Hypochlorination (dollars)	Gaseous Chlorination (dollars)
Project Cost (C_I)	945,000	921,000
Auxiliary Power, kW	208.7 kW	54.2 kW
Annual Fuel Cost (F_t)	7000/yr	1800/yr
Annual Operating Cost (O_t) (80 percent capacity)	264,300/yr	289,500/yr
Annual Makeup Power Cost (P_t)	80,000/yr	20,000/yr
Total Generating Cost (GC_p) (Present Value)	5,387,100	4,884,700
Total Generating Cost (GC_a) (Present Value Annualized)	458,800	416,000

NOTES:

1. i = 7.5%
2. Annual operating cost (O_t) includes capital revenue requirement.
3. Annual fuel cost (F_t) based on $.005/kWh levelized annual cost.
4. Annual makeup power cost (P_t) based on $500/kW levelized annual cost.
5. Present value - 1981

10.6 SANITARY WASTE SYSTEM

10.6.1 Criteria for Treatment Plant

Sanitary facilities are provided for the personnel located at the Grand Gulf Nuclear Station. The wastes generated by these facilities must be processed and disposed of in a manner which will ensure compliance with standards established by Federal and State authorities.

10.6.2 Sources of Waste

Sanitary wastes produced at the plant originate from the use of the sanitary facilities. The design population and unit flow rates are discussed in Section 3.7.

10.6.3 Alternative Sanitary Waste Treatment and Disposal Systems

Several alternative treatment/disposal systems were investigated to determine the appropriate system for the Grand Gulf Nuclear Station. Primary treatment systems, settling ponds, and septic tank systems were eliminated from consideration since the effluent obtained from these facilities cannot comply with existing effluent standards.

Secondary treatment utilizing an activated sludge was selected as the treatment for sanitary wastes. This biological treatment utilizes a concentrated mixture of microorganisms to stabilize the solid materials in the waste water. Influent waste water and activated sludge are thoroughly mixed and aerated. Mixing ensures intimate contact between waste solids and microorganisms, while aeration ensures proper oxygen concentrations for effective activity. These microorganisms consume available nutrients, and grow into a mass that can be flocculated and settled. This mass, when settled, removes entrapped organic/inorganic materials from the water.

Grand Gulf Nuclear Station utilizes a package type extended aeration unit which is a modified version of the activated sludge process. Extended aeration units maintain intimate contact between sewage and the activated sludge for a longer time period (24 hours or more) than do conventional units. This tends to stabilize the process in the mixing tank and lessens the probability of system upsets. Package units are usually designed for handling strictly domestic waste. The Grand Gulf sanitary system contains only domestic waste, so the package type extended aeration unit is an appropriate selection. Effluent from this system contains less than 20 mg/l of both biochemical oxygen demand and suspended solids, which is consistent with current effluent standards for publicly owned sewage treatment plants.

The effluent from this system is adequately treated with chlorine so that the discharge is disinfected. Chlorination reduces bacteriological activity in the waste water to the required level before disposal.

Several alternatives have been investigated to determine a suitable method for disposing of treated waste water. The first method investigated was to return the water to the circulating water system. This proved unsatisfactory since it promotes biological activity on heat exchange surfaces. Trace quantities of suspended solids which lodge in heat exchanger tubes can become biologically active in these warm surroundings. Eventually, this activity can plug heat exchanger tubes.

The second method investigated was to commercially transport the treated water to another location. This alternative proved inadequate since additional storage capacity would be required and a vehicle would be necessary to transport the waste water.

The third method was to discharge directly into the Mississippi River. However, this method necessitates additional piping which duplicates other lines discharging directly to the river.

The alternative finally selected for Grand Gulf is to discharge the treated waste water into the station's combined effluent discharge line which releases the effluents to the barge slip and ultimately to the Mississippi River. This arrangement utilizes existing facilities to dispose of the waste effluent. In this manner, greater utilization is made of available facilities and the need for additional equipment which would duplicate existing facilities is eliminated. Combining the waste effluent and blowdown also dilutes the concentration of both suspended solids and BOD in the waste water being disposed. The dilution ratio of the waste effluent is greater than 2000:1 so the resulting concentrations of suspended solids and BOD are considerably less than that allowed by effluent standards. Therefore, the environmental effect of the waste water disposal is minimized. Dilution was not a consideration when the decision was made to combine these flows; however, it is a benefit derived by using this alternative.

10.6.4 Evaluation of Environmental Effects of Alternative Systems

Each alternative investigated produces an effluent which is low in suspended solids and BOD. Primary type systems were discounted since the associated effluent BOD and suspended solid concentrations were totally unacceptable. However, the other alternatives that utilize secondary treatment generate effluents with less than 20 mg/l of both suspended solids and BOD. These levels are in full compliance with discharge standards and have minimum environmental effect.

The alternative selected for Grand Gulf Nuclear Station produces a station effluent with less than 0.01 mg/l of suspended solids and BOD contributed by the sanitary waste water. These pollutant concentrations are greatly reduced when they mix with the Mississippi river water. The environmental effect of these concentrations is negligible.

10.6.5 Summary and Conclusions

Based on environmental, technical, and economic criteria, a package type extended aeration unit coupled with discharge to the station's combined effluent discharge line provides the optimum waste treatment system. This system is consistent with appropriate standards and provides a cost effective, unitized system for use at the Grand Gulf Nuclear Station.

10.7 LIQUID RADWASTE SYSTEM ALTERNATIVES

The quantities of radioactive material in effluents are limited to levels that are within the numerical guides for design objectives and limiting conditions of operation set forth in Appendix I of 10 CFR 50. Therefore, no liquid radwaste system alternatives need to be considered.

10.8 GASEOUS RADWASTE SYSTEM ALTERNATIVES

The quantities of radioactive material in effluents are limited to levels that are within the numerical guides for design objectives and limiting conditions of operation set forth in Appendix I of 10 CFR 50. Therefore, no gaseous radwaste system alternatives need be considered.

10.9 TRANSMISSION FACILITIES

Selection of the transmission line routes was based partially on maximum utilization of existing transmission facilities. Section 3.9 discusses the transmission line routing and the economic and environmental impact of these routes. Alternative routes were investigated but were found to be both economically and environmentally less desirable. Figure 10.9-1 shows the alternative routes investigated, and Table 10.9.1 compares the costs of the alternative routes considered.

10.9.1 Ray Braswell Route

The 500 kV line from the station to an existing transmission line feeding into the Ray Braswell Substation was selected after investigating a route from Grand Gulf to Sterlington, Louisiana. The Sterlington route would be approximately 79 miles long and would require crossing the Mississippi River, traversing Mississippi River bottomland hardwood forest, and construction of a 500 kV switching station at Sterlington. The cost of these facilities and the added environmental impact made this route undesirable.

10.9.2 Baxter Wilson Route

The alignment of the 500 kV line from the station to the Baxter Wilson Steam Electric Station was adjusted to avoid traversing approximately 6 miles of mature, Mississippi River bottomland hardwood forest. This area has been avoided by shifting the alignment eastward to an abandoned 13 kV right-of-way that runs through loessial bluffs adjacent to the bottomlands. The line is located as far east of the Grand Gulf Military Monument as practical and does not transect any park or historic monument in its routing. Any other routing would not only be more expensive, but also more environmentally disruptive since it would require more clearing of trees and brush. Therefore, no alternative was considered for the Baxter Wilson Route.

10.9.3 Franklin Route

The 500 kV line from the station to the Franklin Substation, 44 miles southeast of the site, is not the most direct tie-in with the north-south EHV trunk line. The most direct tie-in with that trunk line would be a line going due east from the station, approximately 30 miles. However, since there currently is no switching station in this area, one would have to be constructed. In addition, new, low voltage transmission lines from this switching station would be required. The environmental and economic savings by using this more direct routing would be more than offset by the addition of a new switching station and the required new low voltage transmission lines.

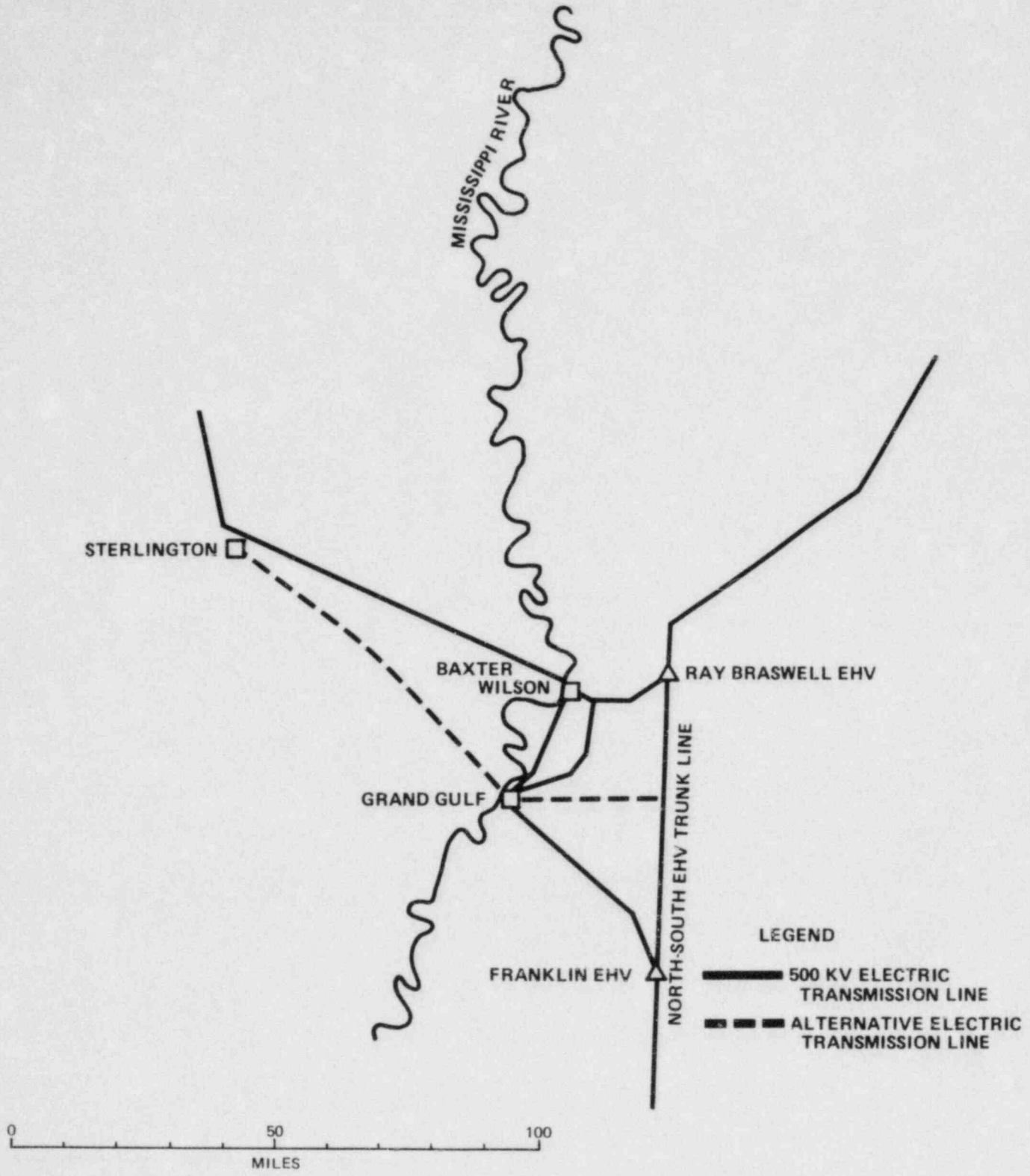
10.9.4 Port Gibson Route

No viable alternative routes were considered for the 115 kV Port Gibson line inasmuch as aesthetically pleasing, ecologically sensitive, historically important, and densely populated areas could be almost entirely avoided by minor route adjustments.

TABLE 10.9.1

ESTIMATED COST OF ALTERNATIVE TRANSMISSION ROUTES (DOLLARS)

Grand Gulf to:	Transmission	Substation	Total
Ray Braswell	4,800,000	-	4,800,000
Sterlington	15,000,000	4,000,000	19,000,000
Franklin	8,800,000	1,395,000	10,195,000
Tap (Franklin-Braswell)	6,400,000	4,000,000	10,400,000



MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

ALTERNATIVE TRANSMISSION
LINE ROUTING

FIGURE 10.9-1

10.10 OTHER SYSTEMS

10.10.1 Standby Power Supply

Diesel generator sets are being used as the onsite ac standby power supply for the Grand Gulf Station, since alternatives with the capability and reliability of starting in time to mitigate the consequences of postulated accidents are not available. The standby and high pressure core spray (HPCS) diesel generators are described in more detail in subsection 3.7.2.7.

CHAPTER 11

SUMMARY COST - BENEFIT ANALYSIS

TABLE OF CONTENTS

		Page
11.1	BENEFITS	11.1-1
	11.1.1 Direct Benefits	11.1-1
	11.1.2 Indirect Benefits	11.1-1
	11.1.2.1 Employment and Wages	11.1-1
	11.1.2.2 Tax Benefits	11.1-1
	11.1.2.3 Educational, Historical, Cultural, and Ecological Benefits	11.1-1
11.2	COSTS	11.2-1
	11.2.1 Direct Costs	11.2-1
	11.2.2 Indirect Costs	11.2-1
11.3	CONCLUSION	11.3-1

LIST OF TABLES

Table No.	Title
11.2.1	GGNS Environmental Costs Description

CHAPTER 11.0 SUMMARY COST - BENEFITS ANALYSIS

11.1 BENEFITS

11.1.1 Direct Benefits

Chapter 1 discusses the value of the electricity produced by the Grand Gulf Nuclear Station to the Middle South Utilities (MSU) System and the Southwest Power Pool of the National Electric Reliability Council. Grand Gulf plays an important part in the MSU System's reserve capability. Assuming a capacity factor of 80 percent, Grand Gulf will produce 17.5 billion kilowatt-hours annually.

11.1.2 Indirect Benefits

11.1.2.1 Employment and Wages

Construction employment numbers vary yearly, but a peak construction employment is expected in 1978 with 4200 workers. The estimated payroll over the 10-year construction period is $400 million. There will be about 250 permanent employees with an annual payroll of $6.0 million. Induced income effects on the area around the station are estimated to be $1109 million over the 10-year construction period and $16.5 million per year of operation.

11.1.2.2 Tax Benefits

When Unit 2 joins Unit 1 in commercial operation in 1984, the total ad valorem tax assessment of Claiborne County will be in excess of $300 million. Sales tax revenues in the plant area increased by about 40 percent between 1973 and 1976. |1

11.1.2.3 Educational, Historical, Cultural, and Ecological Benefits

The use of Grand Gulf Nuclear Station Units 1 and 2 in lieu of equivalent coal-generated energy will reduce air emissions per year by approximately 10,000 tons of particulates and 110,000 tons of nitrogen oxides. In addition, approximately 657,000 tons of ash per year will not be deposited in storage ponds.

The information from the archaeological, historical, architectural, and ecological surveys which have been funded by the Grand Gulf Nuclear Station project has educational value for residents of Mississippi and surrounding states. Numerous speeches, slide presentations, and films dealing with Grand Gulf Nuclear Station, nuclear power, and/or the environment have been presented to civic groups, professional societies, and schools

all over the State of Mississippi. In addition, frequent site tours have been conducted during the course of construction.

Mississippi Power & Light Company plans to keep the undisturbed portion of the site (1705 acres) in its natural state for use as a wildlife refuge. Several wildlife management practices suggested by the Mississippi Game and Fish Commission and the Mississippi Wildlife Federation have already been implemented.

For many years the Grand Gulf Military Monument Commission was unable to purchase riverfront property until MP&L transferred a 164-acre plot to the Park in 1974. This land includes most of the old Grand Gulf townsite.

11.2 COSTS

11.2.1 Direct Costs

The cost of land acquisition, improvement, and facility construction associated with the plant amounts to about $2.1 billion. Transmission and substation facilites cost about $34 million. Operating costs are given in Table 9.4.4 with fuel costs amounting to about $53 million per year per unit. Plant decommissioning costs are estimated to vary between 2.5 and 31.2 million dollars, depending on the decommissioning method used.

11.2.2 Indirect Costs

The Grand Gulf plant is located in an area of low population density, so few lives have been or will be disrupted because of the plant construction. Approximately 125 acres of row crops were displaced by the station. Some of the land now occupied by the station was originally used by a deer hunting club, which was relocated, since hunting is no longer allowed on the site. Limited bow hunting to prevent deer overpopulation is being considered. Fishing is still allowed on the two lakes on the site.

The area water supply, sewage treatment facilities, schools, and other public facilities have not been overloaded by the plant construction, and since the permanent staffing levels will be much less than construction staffing levels, the area services will not be overburdened permanently. Some congestion of local streets and highways has occurred during construction, primarily during shift changes, which affects movement of farm equipment on the roads somewhat, but when the large construction employment departs the area, the operating staffing level is not expected to affect traffic. Apartment and housing costs are comparable to other areas in the state and did not increase due to the station's construction. Prices of small acreages of 5 to 10 acres in the vicinity of the station have increased to as much as four times their preconstruction prices, but there has been no measurable effect on the price of regular agricultural land in the county. Some postconstruction economic letdown may be felt by businesses directly dependent on the large numbers of construction workers and also in apartment and housing vacancy rates, which will drop back to the preconstruction levels. Thus far, no major businesses have moved into the area of the station, possibly because other economic factors conducive to businesses are not present in the area, such as skilled workers, high population density, and above-average family incomes.

The station site is not a particularly scenic area. Some historical or cultural interest exists in the old town of Grand Gulf and the associated Grand Gulf Military Park, but 164 acres of the original station site containing most of the old town were deeded to the Grand Gulf Military Park in 1974.

The environmental costs of the Grand Gulf facility are tabulated in Table 11.2.1.

The one archaeological site on the plant site, an Indian burial mound from the Marksville Period, has been excavated by the Mississippi Department of Archives and History. There are no significant environmental costs related to the construction or operation of Grand Gulf Nuclear Station.

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TABLE 11.2.1

GGNS ENVIRONMENTAL COSTS DESCRIPTION
GENERATING COST (Present Worth) $2.1 Billion
TRANSMISSION AND HOOKUP COST (Present Worth) $34 MILLION

Environmental Cost	Units	Magnitude	Applicable Section
A. SURFACE WATER (Mississippi River)			
1. Thermal Discharge			
Excess heat-5 F isotherm max	acres	4.2	5.1.3
Water Quality			
Dissolved oxygen	mg/l	>5	3.6
Nutrients	---	Negligible	3.6
Suspended sediment	mg/l	<1	3.6
Plankton	---	Negligible	5.1.3
Macroinvertebrates	---	Negligible	5.1.3
Fish	---	Negligible	5.1.3
2. Chemical Discharge			
Water quality, chemical	---	Acceptable under 40CFR423.15	3.6
Environment	---	Negligible	5.3.4

Table 11.2.1 (Cont.)

Environmental Cost	Units	Magnitude	Applicable Section
3. Radionuclide Discharge	---	Acceptable, meet regulatory limitations	5.2.2.1, 5.2.4.1
4. Sanitary Waste Effluent	---	Minimal	5.4
5. Consumptive Use	gallons/year	1.08×10^{10}	5.7
6. Plant Construction/site preparation			
Water quality, physical	---	Moderate	4.1
Water quality, chemical	---	Negligible	4.1
B. GROUND WATER			
1. Raising/lowering of ground water levels	---	Localized dewatering only; No effect on existing ground water levels	4.1.4, 5.6
People		No Effect	4.1.4
Plants		No Effect	4.1.3
2. Chemical contamination of ground water			
Construction		No Effect	4.1.2
Operation		No Effect	5.6.6

Table 11.2.1 (Cont.)

Environmental Cost	Units	Magnitude	Applicable Section
3. Radionuclide contamination of ground water	---	None	5.2
C. AIR			
1. Cooling system effects on meteorological variables	---	Negligible	5.1.4
2. Plume deposition (spatial maximum)			
salt	gm/m^2-month	0.071	5.1.4.5.3
total solids	gm/m^2-month	0.949	5.1.4.5.3
3. Radionuclides discharged to ambient air and direct radiation from radioactive materials	---	Acceptable, meet regulatory limitations	5.2.2.2, 5.2.4.2, 5.2.4.3
4. Noise			
Construction	HUD Noise Assessment Guidelines	Normally acceptable	2.7.6
Operation	---	Negligible	5.6.1
D. LAND			
1. Site, amount	Acres	2170	4.1.1

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Table 11.2.1 (Cont.)

Environmental Cost	Units	Magnitude	Applicable Section
2. Construction activities			
People (amenities)	---	Negligible	8.2.2
People (accessibility of historical sites)	visitors/year	No effect	4.1.3
People (recreation)	---	Site proper no longer available for fire-arms hunting No effect on fishing	8.2.2
Wildlife		Negligible	4.1.3
Land, excavation and displacement	cubic yards	6.6×10^6	4.1.2
3. Plant operation			
People (amenities)	---	Negligible	8.2.2
People (aesthetics)	---	Minimal	5.6.3
Wildlife	---	Negligible	4.1, 5.3, 5.4
4. Transmission facilities			
Land, amount	acres	2241	4.1
Land use and land value			
Woodland		1633	3.9
Fields		608	3.9
People (aesthetics)	---	Minimal	3.9

Table 11.2.1 (Cont.)

Environmental Cost	Units	Magnitude	Applicable Section
5. Transmission facilities construction			
Land adjacent to right-of-way	miles	95.1	3.9
Land, erosion	---	Negligible	4.2
Wildlife	---	Negligible	4.2
6. Transmission line operation			
Land use	---	Negligible	5.5
Wildlife	---	Negligible	5.5
E. INTERACTION WITH OTHER PLANTS			
1. Industrial installations	---	No effect	5.6.4
2. Power generating facilities	---	No effect	5.6.4

11.3 CONCLUSION

Although some aspects such as land use and natural resources are altered permanently by the plant's construction, the environmental and economic costs are far outweighed by the improvement in the standard of living produced as an effect from the construction and operation of the plant. The social cost of plant construction has not affected the surrounding community except as a net benefit. The prosperity induced by plant construction is expected to continue into the plant's operation phase.

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CHAPTER 12

ENVIRONMENTAL APPROVALS AND CONSULTATIONS

TABLE OF CONTENTS

		Page
12.1	GENERAL	12.1-1
	12.1.1 Federal	12.1-1
	12.1.2 State	12.1-1
12.2	WATER-USE AND PLANNING	12.2-1
	12.2.1 Federal	12.2-1
	12.2.2 State	12.2-1
12.3	AIR	12.3-1
	12.3.1 State	12.3-1
12.4	AVIATION	12.4-1
	12.4.1 Federal	12.4-1
12.5	ENVIRONMENTAL MONITORING	12.5-1
	12.5.1 State	12.5-1
12.6	TRANSMISSION	12.6-1
	12.6.1 Federal	12.6-1
	12.6.2 State	12.6-1
	12.6.3 Other	12.6-1
12.7	CONSULTATIONS	12.7-1

CHAPTER 12.0 ENVIRONMENTAL APPROVALS AND CONSULTATIONS

This chapter lists and presents those licenses, permits, and other approvals of station construction and operation for Grand Gulf Nuclear Station Units 1 and 2 required by Federal, State, local, and regional authorities for the protection of the environment. Certain ones, included only for completeness, may only incidentally protect the environment. All licenses, permits, and approvals are presented in this chapter and have been received, except where specifically noted.

12.1 GENERAL

12.1.1 Federal

12.1.1.1 Atomic Energy Commission: Limited Work Authorization for Units 1 and 2. Atomic Energy Act of 1954, as amended, and Regulation 10 CFR 50.10(e)(1); issued May 3, 1974.

12.1.1.2 Atomic Energy Commission: Construction Permits (Permit Nos. CPPR-118 and CPPR-119). Atomic Energy Act of 1954, as amended, issued September 4, 1974.

12.1.1.3 Nuclear Regulatory Commission: Operating License for Units 1 and 2. Docket Nos. 50-416 and 50-417; Atomic Energy Act of 1954, as amended; application filed, 1978.

12.1.1.4 Nuclear Regulatory Commission: Special Nuclear Materials License to receive and store nuclear fuel. Atomic Energy Act of 1954, as amended; application to be filed in 1980.

12.1.2 State

12.1.2.1 Mississippi Public Service Commission: Certificate of Public Convenience and Necessity to construct, own and operate Units 1 and 2; Public Utilities Act of 1956, Section 77-3-1, et. seq. Miss. Code Ann. (1972); issued May 29, 1974.

12.2 WATER-USE AND PLANNING

12.2.1 Federal

12.2.1.1 U. S. Army Corps of Engineers: Permit to construct a barge slip and earthen haul road. No. LMKOD-NP 1522-14 (Miss. R.)-42. Section 10 of the Rivers and Harbors Act of March 3, 1899 (33 U.S.C. 403) and Section 404 of the Federal Water Pollution Control Act of 1972, as amended; Public Law No. 92-500; issued September 8, 1975.

12.2.1.2 U. S. Army Corps of Engineers: Permit to construct a mooring dolphin in the barge slip. No. LMKOD-RF 1522-15 (Miss. R.)-58. Section 10 of the Rivers and Harbors Act of March 3, 1899; (33 U.S.C. 403); issued January 5, 1976.

12.2.1.3 U. S. Army Corps of Engineers: Permit to dredge existing barge slip. No. LMKOD-FE 1522-14 (Miss. R.)-67. Section 10 of the Rivers and Harbors Act of March 3, 1899 (33 U.S.C. 403); issued November 12, 1976.

12.2.1.4 U. S. Army Corps of Engineers: Permit to construct plant discharge structure. No. LMKOD-FE 1522-14 (Miss. R.)-55. Section 10 of the Rivers and Harbors Act of March 3, 1899; (33 U.S.C. 403) and Section 404 of the Federal Water Pollution Control Act of 1972, as amended; Public Law No. 92-500; issued October 15, 1976.

12.2.1.5 U. S. Army Corps of Engineers: General permit No. LMKOD-F 1522-14-GP (Miss. R.)-7 to fill an existing barge slip with sand to facilitate barge unloadings. 33CFR323.42 (effective July 19, 1977); issued September 28, 1977.

12.2.2 State

12.2.2.1 Mississippi Air and Water Pollution Control Commission: Water Quality Certification. In compliance with section 401 of Federal Water Pollution Control Act of 1972, as amended; Public Law No. 92-500; issued February 5, 1974.

12.2.2.2 Mississippi Air and Water Pollution Control Commission: Permit for Construction and Operation of Temporary/Construction Sewage Treatment Plant. NPDES Permit No. MS0027031. Mississippi Air and Water Pollution Control Law (Sections 49-17-1, et. seq., Miss. Code Ann. (1972)), and the regulations and standards adopted and promulgated thereunder, and under authority granted to the Mississippi Air and Water Pollution Control Commission pursuant to Section 402(b) of the Federal Water Pollution Control Act of 1972, as amended; issued October 15, 1974, revised January 2, 1975, and renewed April 27, 1977.

12.2.2.3 Mississippi Air and Water Pollution Control Commission: Temporary permit to Construct/Operate Permanent/Construction

Sewage Treatment Plant. Temporary NPDES Permit No. 75-004. Mississippi Air and Water Pollution Control Law (Sections 49-17-1, et. seq., Miss. Code Ann. (1972)), and the regulations and standards adopted and promulgated thereunder, and under authority granted to the Mississippi Air and Water Pollution Control Commission pursuant to Section 402(b) of the Federal Water Pollution Control Act of 1972, as amended; issued January 30, 1975 and replaced by NPDES Permit No. MS0029173 on August 8, 1975.

12.2.2.4 Mississippi Air and Water Pollution Control Commission: Permit for Plant Discharge. Mississippi Air and Water Pollution Control Law (Sections 49-17-1, et. seq., Miss. Code Ann. (1972)) and the regulations and standards adopted and promulgated thereunder, and under authority granted to the Mississippi Air and Water Pollution Control Commission pursuant to Section 402 (b) of the Federal Water Pollution Control Act of 1972, as amended, applied for October 26, 1977.

12.3 AIR

12.3.1 State

12.3.1.1 Mississippi Air and Water Pollution Control Commission: Permit to Burn Waste Material. Mississippi Air and Water Pollution Control Law (Sections 49-17-1, et. seq., Miss. Code Ann. (1972)), and the regulations and standards adopted and promulgated thereunder; issued January 8, 1975.

12.4 AVIATION

12.4.1 Federal

12.4.1.1 Federal Aviation Administration: Approval to construct two natural draft cooling towers. Federal Aviation Regulations, Part 77, Subchapter B; issued November 9, 1973 (Aeronautical Study Nos. 73-SO-2234-OE and 73-SO-2233-OE); revised November 4, 1977 (Aeronautical Study No. 77-ASO-1769-OE).

12.4.1.2 Federal Aviation Administration: Approved for use of temporary cranes during cooling tower construction. Aeronautical Study Nos. 77-ASO-1758-OE and 77-ASO-1759-OE. Federal Aviation Regulations, Part 77, Subchapter B; issued October 28, 1977.

12.5 ENVIRONMENTAL MONITORING

12.5.1 State

12.5.1.1 Mississippi Game & Fish Commission: Administrative scientific collection permit for preconstruction surveys; Section 49-1-41 Miss. Code Ann. (1972); issued June 1, 1972.

12.5.1.2 Louisiana Wildlife and Fisheries Commission: Administrative scientific collection permit for preconstruction surveys; (La. Stat. Rev. Tit. 56, Sec. 104H and 318 (1950)); issued May 23, 1972.

12.5.1.3 Mississippi State Board of Health: Permit for use of radiological source and by-product material for instruments used in environmental radiological monitoring; Mississippi Radiation Protection Act of 1976, Section 45-14-1 Miss. Code Ann. (Supp 1977); issued June 15, 1977.

12.5.1.4 Mississippi Game & Fish Commission: Administrative scientific collection permit for preoperational environmental radiological monitoring program; Section 49-1-41 Miss. Code Ann. (1972); issued November 7, 1977.

12.6 TRANSMISSION

12.6.1 Federal

12.6.1.1 National Park Service: Special Use Permit for rights-of-way through Natchez Trace Parkway land (16 U.S.C. 460a); issued April 5, 1976.

12.6.1.2 U.S.D.A. Forest Service: Special Use Permit for construction, operation and maintenance of Franklin 500kV transmission line within the Homochitto National Forest; Regulations 36 CFR 251; issued September 9, 1976.

12.6.1.3 U. S. Army Corps of Engineers: Permit for Baxter Wilson 500kV transmission line aerial crossing over Big Black River. Permit No. LMKOD-FE 1522-15 (Big Black River)-2. Section 10 of the Rivers and Harbors Act of March 3, 1899 (33 U.S.C. 403); issued September 9, 1977.

12.6.1.4 U. S. Army Corps of Engineers: Permit for Ray Braswell 500kV transmission line aerial crossing over Big Black River. Permit No. LMKOD-FE 1522-15 (Big Black River)-3. Section 10 of the Rivers and Harbors Act of March 3, 1899 (33 U.S.C. 403); issued September 9, 1977.

12.6.2 State

12.6.2.1 Mississippi Public Service Commission: Certificate of Public Convenience and Necessity to construct and operate the GGNS to Port Gibson Substation 115kV transmission line (Docket No. U2819); Public Utilities Act of 1956, Section 77-3-1, et. seq. Miss. Code Ann. (1972); issued June 4, 1974.

12.6.2.2 Mississippi Public Service Commission: Certificate of Public Convenience and Necessity to construct and operate the Franklin 500kV transmission line (Docket No. U2993); Public Utilities Act of 1956, Section 77-3-1, et. seq. Miss. Code Ann. (1972); issued June 3, 1975.

12.6.2.3 Mississippi Public Service Commission: Certificate of Public Convenience and Necessity to construct and operate the Baxter Wilson and Ray Braswell 500kV transmission lines (Docket No. 3410); Public Utilities Act of 1956, Section 77-3-1, et. seq. Miss. Code Ann. (1972); issued December 8, 1977.

12.6.3 Other

Other laws which may be applicable to the proposed transmission system include:

a. The Endangered Species Act of 1973 (16 U.S.C. 1531 et. seq.)

b. The Federal Power Act of 1920 (16 U.S.C. 791a et. seq.)

c. The National Historic Preservation of 1966 (16 U.S.C. 470)

d. The Federal Water Pollution Control Act of 1972

12.7 CONSULTATIONS

Office of the Governor - Coordinator of Federal-State Programs

Department of Agriculture and Commerce

Forestry Commission

Mississippi Park Commission

Soil and Water Conservation Committee

Mississippi Agricultural and Industrial Board

Department of Archives and History

State Oil and Gas Board

Mississippi Geological Economic and Topographical Survey

State Board of Health

Motor Vehicle Comptroller

State Highway Department

Mississippi Aeronautics Commission

Mississippi Civil Defense Council

Research and Development Center

Mississippi National Guard

U. S. Coast Guard

CHAPTER 13.0 REFERENCES

13.1 REFERENCES TO CHAPTER 1.0

1.1 References

1. "EEI Statistical Year Book of the Electrical Utility Industry for 1973."

1.2 References

None

1.3 References

None

13.2 REFERENCES TO CHAPTER 2.0

2.1 References

1. "General Highway Map, Claiborne County," Mississippi Highway Department, 1976.

2. "Count Population by Enumeration District-Mississippi," U. S. Census Bureau, 1970.

3. "Master Enumeration List - Louisiana," U. S. Census Bureau, 1970.

4. "Final Population Counts - Mississippi," U. S. Census Bureau, PC (V1)-26, 1970.

5. "Final Population Counts - Louisiana," U. S. Census Bureau, PC (V1)-20, 1970.

6. "General Highway Maps - By Parish," Louisiana Department of Highways, 1962-1967.

7. "General Highway Maps - By County," Mississippi State Highway Department, 1962-1967.

8. "Population Projections - OBE Areas 134, 135, and 138," U. S. Department of Commerce, Bureau of Economic Analysis, 1968.

9. "Population Projections - OBE Areas 132 - 139," U. S. Department of Commerce, Bureau of Economic Analysis, 1968.

10. Henry L. DeGraff, Chief, Regional Economics Division, Bureau of Economic Analysis, personal

communications; Washington, D. C., February, 1972.

11. C. V. Lyle, Chief, Regional Economist, Economic Analysis Office, personal communications; Atlanta, Ceorgia, March, 1972.

12. Woodrow Wilson, Park Manager, Grand Gulf Military Monument Commission, personal communications; Grand Gulf, Mississippi, August, 1977.

13. Wes Stevens, Warner YMCA Camp Director, personal communications, Vicksburg, Mississippi, August, 1977.

14. Earl Moore, Lake Claiborne, Inc., personal communication; Port Gibson, Mississippi, August, 1977.

15. Mrs. Woodrow Bowman, Lake Bruin State Park, personal communications; St. Joseph, Louisiana, August, 1977.

16. Joseph D. Price, Jr., Conservation Officer, Claiborne County, personal communications; Port Gibson, Mississippi, August, 1977.

17. "Public School Enrollment, 1976-77," State Department of Education, Jackson, Mississippi, 1977.

18. "Louisiana School Directory, Session 1976-1977," State Department of Education, Baton Rouge, Louisiana.

19. "Labor Market Data," Mississippi Employment Security Commission, July, 1977.

20. David L. Gibson, Assistant to the Superintendent, Illinois Central Gulf Railroad, Vicksburg Office, personal communications; Vicksburg, Mississippi, August, 1977.

21. Pat Wingerter, Operations Manager, Delta Queen Steamboat Company, personal communications; New Orleans, Louisiana, August, 1977.

22. Lenore Barkley, Director, Vicksburg Hospitality House, personal communications; Vicksburg, Mississippi, August, 1977.

23. Alfred R. Smith, Claiborne County Agent, personal communications; August 10, 1977.

24. Charles. B. Jones, Tensas Parish Agent, personal communications; August 25, 1977.

25. "Socioeconomic Impact of Grand Gulf Nuclear Station," compiled by Recon, Inc., for Mississippi Power & Light Company, August, 1977.

26. Charles Prouty, Airport Planning Division, FAA, District Office, Jackson, Mississippi, 969-4628, personal communications by Henry Ramsey, August 12, 1977.

27. National Oceanic and Atmospheric Administration, "Climate of Louisiana," National Climatic Center, Asheville, N. C., December, 1976.

28. National Oceanic and Atmospheric Administration, "Climate of Mississippi," National Climatic Center, Asheville, N. C., March, 1977.

29. Charles Wells, Adams County Agent, personal communications, August-October, 1977.

30. William D. Craft, Amite County Agent, personal communications, August-October, 1977.

31. Alfred R. Smith, Claiborne County Agent, personal communications, August-October, 1977.

32. Wiley Ray, Copiah County Agent, personal communications, August-October, 1977.

33. John Monroe, Franklin County Agent, personal communications, August-October, 1977.

34. Charles Estus, Hinds County Agent, personal communications, August-October, 1977.

35. James McVeil, Issaquena County Agent, personal communications, August-October, 1977.

36. Julius Mann, Jefferson County Agent, personal communications, August-October, 1977.

37. Travis Tedlock, Lincoln County Agent, personal communications, August-October, 1977.

38. Buck Coates, Madison County Agent, personal communications, August-October, 1977.

39. Robert Barker, Rankin County Agent, personal communications, August-October, 1977.

40. Benjamin. F. Corbin, Sharkey County Agent, personal communications, August-October, 1977.

41. Sam Dyar, Simpson County Agent, personal communications, August-October, 1977.

42. Hunter George, Warren County Agent, personal communications, August-October, 1977.

43. John R. Date, Jr., Wilkinson County Agent, personal communications, August-October, 1977.

44. Rick Lange, Yazoo County Agent, personal communications, August-October, 1977.

45. Thomas Breland, Hinds County ASC, personal communications, August-October, 1977.

46. Donald Hollis, Cadwell Parish Agent, personal communications, August-October, 1977.

47. Rodney Ewing, Catahoula Parish Agent, personal communications, August-October, 1977.

48. Joe. W. Milby, Concordia Parish Agent, personal communications, August-October, 1977.

49. Sidney Reech, East Carroll Parish Agent, personal communications, August-October, 1977.

50. Austin Johnson, Franklin Parish Agent, personal communications, August-October, 1977.

51. Buck Roby, Madison Parish Agent, personal communications, August-October, 1977.

52. Basil Doles, Richland Parish Agent, personal communications, August-October, 1977.

53. Charles James, Tensas Parish Agent, personal communications, August-October, 1977.

54. Jessie Peterson, West Carroll Parish Agent, personal communications, August-October, 1977.

55. "General Highway Map, Adams County," Mississippi Highway Department, 1967.

56. "General Highway Map, Amite County," Mississippi Highway Department, 1969.

57. "General Highway Map, Claiborne County," Mississippi Highway Department, 1976.

58. "General Highway Map, Copiah County," Mississippi Highway Department, 1976.

59. "General Highway Map, Franklin County," Mississippi Highway Department, 1967.

60. "General Highway Map, Hinds County," Mississippi Highway Department, 1974.

61. "General Highway Map, Issaquena County," Mississippi Highway Department, 1971.

62. "General Highway Map, Jefferson County," Mississippi Highway Department, 1976.

63. "General Highway Map, Lincoln County," Mississippi Highway Department, 1969.

64. "General Highway Map, Madison County," Mississippi Highway Department, 1975.

65. "General Highway Map, Rankin County," Mississippi Highway Department, 1974.

66. "General Highway Map, Sharkey County," Mississippi Highway Department, 1972.

67. "General Highway Map, Simpson County," Mississippi Highway Department, 1967.

68. "General Highway Map, Warren County," Mississippi Highway Department, 1967.

69. "General Highway Map, Wilkinson County," Mississippi Highway Department, 1969.

70. "General Highway Map, Yazoo County," Mississippi Highway Department, 1970.

71. "General Highway Map, Caldwell Parish," Louisiana Highway Department, 1971.

72. "General Highway Map, Catahoula Parish," Louisiana Highway Department, 1971.

73. "General Highway Map, Concordia Parish," Louisiana Highway Department, 1971.

74. "General Highway Map, East Carroll Parish," Louisiana Highway Department, 1973.

75. "General Highway Map, Franklin Parish," Louisiana Highway Department, 1971.

76. "General Highway Map, Madison Parish," Louisiana Highway Department, 1972.

77. "General Highway Map, Richland Parish," Louisiana Highway Department, 1971.

78. "General Highway Map, Tensas Parish," Louisiana Highway Department, 1972.

79. "General Highway Map, West Carroll Parish," Louisiana Highway Department, 1973.

80. "Rice, County Estimates," Mississippi Crop and Livestock Reporting Service, Mississippi Department of Agriculture, 1976.

81. "Wheat, County Estimates," Mississippi Crop and Livestock Reporting Service, Mississippi Department of Agriculture, 1976.

82. "Corn, County Estimates," Mississippi Crop and Livestock Reporting Service, Mississippi Department of Agriculture, 1976.

83. "Soybeans, County Estimates," Mississippi Crop and Livestock Reporting Service, Mississippi Department of Agriculture, 1976.

84. "Parish Estimates of Cotton, Corn, Soybeans, and Vegetables," Louisiana Crop and Livestock Reporting Service, Louisiana Department of Agriculture, 1977.

85. Ted Pullin, Extension Service, Mississippi Department of Agriculture, personal communications, August-October, 1977.

86. "Nutritive Value of American Foods," Agricultural Handbook No. 456, United States Department of Agriculture.

87. J. Mike Cannon, Extension Service, Louisiana Department of Agriculture, personal communications, August, 1977.

88. "Livestock County Estimates," Mississippi Crop and Livestock Reporting Service, Mississippi Department of Agriculture, 1977.

89. "1976 Report on Production Testing," The Louisiana Dairy Herd Improvement Records Committee and The Louisiana Animal Breeding

Cooperative, LSU Cooperative Extension Service, 1976.

90. "Louisiana Directory of Manufacturers," Department of Commerce and Industry, State of Louisiana, 1972.

91. "Mississippi Directory of Manufacturers, 1977," Mississippi Research and Development Center, Jackson, Mississippi, 1976.

92. "Louisiana 1974 Census of Agriculture," U. S. Department of Commerce, Louisiana Department of Agriculture, 1976.

93. Freddie Passbach, Jr., Passbach Meats, Inc., Natchez, Mississippi, personal communications, August-October, 1977.

94. Thomas W. Jones, Lincoln County Slaughter House, Brookhaven, Mississippi, personal communications, August-October, 1977.

95. Roger Jones, Hinds Junior College Cold Storage, Raymond, Mississippi, personal communications, August-October, 1977.

96. Danny Smith, County Meat Market, Brookhaven, Mississippi, personal communications, August-October, 1977.

97. Jack Wilson, Wilson Slaughter House, Crystal Springs, Mississippi, personal communications, August-October, 1977.

98. James Meadows, Meat Inspector Division, Mississippi Department of Agriculture, personal communications, August-October, 1977.

99. Bobby Durr, Meat Grading and Inspection, Louisiana Department of Agriculture, personal communications, August-October, 1977.

100. Linda Doiga, Meat Grading and Inspection, Louisiana Department of Agriculture, personal communications, August-October, 1977.

101. Kelton Anderson, Mississippi Extension Service, Mississippi State University, personal communications, August-October, 1977.

102. "Summary of Operating Units and Landings, Mississippi River and Tributaries Within

Louisiana, 1976," National Marine Fisheries Service.

103. "Summary of Operating Units and Landings, Mississippi River and Tributaries, Within Mississippi, 1976," National Marine Fisheries Service.

104. "Environmental Field Measurements Programs, Final Report," Grand Gulf Nuclear Station Units 1 and 2, 1973, Mississippi Power & Light Company.

105. "1975-1976 Deer Kill Survey," Louisiana Wildlife and Fisheries Commission, Baton Rouge, Louisiana.

106. "Mississippi 1976-1977 Deer Kill," Mississippi Game and Fish Commission, Jackson, Mississippi.

107. "Water Use In Mississippi, 1975," Water Resources Investigations, Open File Report No. 76-125, U. S. Geological Survey.

108. Jack W. Pepper, Mississippi Board of Water Commissioners, personal communications, September, 1977.

109. James E. Rogers, Water Resources Division, U. S. Geological Survey, Alexandria, Louisiana, personal communications, August, 1977.

110. Merrick S. Whitfield, Water Resources Division, U. S. G. S. Alexandria, Louisiana, personal communications, September, 1977.

111. "Lower Mississippi River Basin Water Quality Management Plan, State of Louisiana," Louisiana Stream Control Commission, Prepared by Burk and Associates, Inc., New Orleans, La., June 1973.

2.2 References

1. Stansky, J. J., 1969. "Deer Habitat Quality of Major Forest Types in the South." In Proceedings of Symposium: White-tailed Deer in the Southern Forest Habitat. Southern Forest Experiment Station, Nacogdoches, Texas, pp. 42-45.

2. Yancey, R. K., 1970. "The Vanishing Delta Hardwoods: Their Wildlife Resources." La. Conservationists, March-April, p. 26.

3. Putnam, J. R., G. M. Furnival and J. S. McKnight, 1960. "Management and Inventory of Southern Hardwoods." Handbook No. 181, U. S. Department of Agriculture, Washington.

4. Murphy, P. K., 1973. Personal Communication. Graduate Student, School of Forestry and Wildlife Management, Louisiana State University, Baton Rouge.

5. Noble, R. E., 1972. Personal Communication. School of Forestry and Wildlife Management, Louisiana State University, Baton Rouge.

6. Robbins, C. S., B. Brunn, and H. S. Zim, 1966. "Birds of North America." Golden Press, New York.

7. U. S. Department of the Interior, 1976. "Endangered and Threatened Wildlife and Plants." Federal Register, Vol. 41 (208): 47180-47198.

8. American Birds, 1971. "Announcing the Blue List: An Early Warning System for Birds." American Birds 25(6): 948-949.

9. American Ornithologists' Union, 1957. "Check-list of North American Birds." Port City Press, Inc., Baltimore, Md.

10. Sheldon, W. G., 1971. "The Book of the American Woodcock." University of Massachusetts Press, Amherst.

11. Turcotte, W. H., 1976. Personal Communication. Chief, Game and Fisheries Division, Mississippi Game and Fish Commission, Jackson.

12. Public Notice 1790, April 9, 1975. An order and regulations adopting an official list of endangered or threatened vertebrates in

Mississippi, State Game and Fish Commission, Jackson.

13. Mississippi Natural Heritage Program. 1977 Special Plant and Animal Lists for the State of Mississippi.

14. Wolfe, J. E., 1971. "Mississippi Land Mammals." Mississippi Game and Fish Commission.

15. Lack, D., 1954. "The Natural Regulations of Animal Numbers." Oxford University Press, London.

16. Golly, F. B., 1962. "Mammals of Georgia." University of Georgia Press, Athens.

17. Hayden, D. C. and W. F. MacCallum. 1976. Effects of prolonged flooding on small mammal populations in an area of the Lower Mississippi River Valley. J. Miss. Academy of Sci. Vol. XXI: 84-88.

18. Uhlig, H. G., 1956. "The Gray Squirrel in West Virginia." Bulletin 3, West Virginia Conservation Commission, Division of Game Management, Charleston.

19. Brandt, G. W., 1938. "A Study of Beaver Colonies in Michigan." Journal of Mammalogy 19: 139-162.

20. Burt, W. H. and R. P. Grossenheider, 1964. "A Field Guide to the Mammals." Houghton Mifflin Company, Boston.

21. Glasgow, L. L. and R. E. Noble, 1971. "The Importance of Bottomland Hardwoods to Wildlife." Proceedings Symposium on Southeastern Hardwoods, U. S. Department Agricultural Forest Service, State and Private Forestry, Atlanta, Ga.: 30-43.

22. Neal, W. A., 1973. Personal Communication, Game Biologist, Mississippi Game and Fish Commission, Jackson.

23. Murphy, P. K., 1974. "The Monthly Availability and Use of Browse Plants by Deer on a Bottomland Hardwood Area in Tensas Parish, Louisiana." M. S. Thesis Submitted to Graduate School, Louisiana State University, Baton Rouge.

24. Conant, R., 1958. "A Field Guide to Reptiles and Amphibians," Houghton Mifflin Company, Boston.

25. Cook, F. A., 1942. "Alligator and Lizards of Mississippi," State Wildlife Museum, Jackson, Mississippi.

26. Cook, F. A., 1954. "Snakes of Mississippi." State Wildlife Museum, Jackson, Mississippi.

27. Klots, E. B., 1966. "New Field Book of Freshwater Life." G. P. Putnam's Sons, New York.

28. Morris, R. C., 1973. Personal Communication. U. S. Department of Agriculture, Southern Forest Experiment Station, Southern Hardwoods Laboratory, Stoneville, Mississippi.

29. Collins, R., 1976. Personal Communication. Mississippi Forestry Commission, Jackson.

30. Coley, J., 1976. Personal Communication. Division of Plant Industry, Mississippi Department of Agriculture, Starkville.

31. Fusselle, P., 1976. Personal Communication. Mississippi State Board of Health, Jackson.

32. Prestwood, A. K., 1976. Personal Communication. Southeastern Cooperative Wildlife Disease Study, College of Veterinary Medicine, University of Georgia, Athens.

33. Zippin, C., 1958. "The Removal Method of Population Estimation." Journal of Wildlife Management 22(1): 82-90.

34. Lagler, K. F., 1956. "Freshwater Fishery Biology." Wm. C. Brown Company, Dubuque, Iowa.

35. Adams, L., 1951. "Confidence Limits for the Peterson or Lincoln Index Used in Animal Population Studies." Journal of Wildlife Management 15(1): 13-19.

36. Federal Water Pollution Control Administration, 1969. "Endrin Pollution in the Lower Mississippi River Basin." U. S. Department of Interior, Washington.

37. Guillory, V., 1973. Personal Communication. Graduate Student, Department of Wildlife and Fisheries, Louisiana State University, Baton Rouge.

38. Smith, P. W., A. C. Lopinot and W. L. Pflieber, 1971. "A Distributional Atlas of Upper Mississippi River Fishes." Biological Notes No. 73, Illinois Natural History Survey, Urbana.

39. Bailey, R. M., 1973. Personal Communication, Letter dated September 12, 1973. Curator of Fishes, Museum of Zoology, University of Michigan, Ann Arbor.

40. Clemmer, G., 1973. "Taxonomic Verification on Various Fishes Collected from the Mississippi River in the Area of the Proposed Grand Gulf Nuclear Station." Consultant's Report, Mississippi State University, State College, Mississippi.

41. Hemphill, A.F., 1954. "A Preliminary Survey of Fishes in the Streams Emerging from the Vicksburg Bluffs, Warren County, Mississippi." M. A. Thesis, University of Alabama, Auburn.

42. Cook, F. A., 1959. "Freshwater Fishes in Mississippi." Mississippi Game and Fish Commission, Jackson.

43. Miller, R. R., 1972. "Threatened Freshwater Fishes of the United States." Transactions American Fisheries Society 101(2): 239-252.

44. Barnickol, P. G. and W. C. Starrett, 1951. "Commercial and Sport Fishes of the Mississippi River Between Caruthersville, Missouri, and Dubuque, Iowa." Bulletin of the Illinois Natural History Survey Volume 25(5).

45. Butler, R. L., 1965. "Freshwater Drum, Aplotinotus grunniens, in the Navigational Impoundments of the Upper Mississippi River." Transactions American Fisheries Society 94(4): 339-349.

46. Hayes, C., 1972. Personal Communication. Former Commercial Fisherman, Grand Gulf, Mississippi.

47. Chadwich, H. K., C. E. von Geldren, Jr. and M. L. Johnson, 1966. "White Bass." In: "Inland Fisheries Management," A. Calhoun, Ed., State of California, Resources Agency, Department of Fish and Game, Sacramento: 412-422.

48. Taber, C. A., 1969. "The Distribution and Identification of Larval Fishes in the Buncombe

Creek Arm of Lake Texoma with Observations on Spawning Habits and Relative Abundance." Ph. D. Thesis, University of Oklahoma, Norman.

49. Starrett, W. C., 1951. "Some Factors affecting the Abundance of Minnows in the Des Moines River, Iowa." Ecology 32(1): 13-27.

50. Breder, C. M. and D. E. Rosen, 1966. "Modes of Reproduction in Fishes." T. F. H. Publications, Jersey City, New Jersey.

51. Daiber, F. C., 1953. "Notes on the Spawning Population of the Freshwater Drum (Aplodinotus grunniens Rafinesque) in Western Lake Erie." American Midland Naturalist 50(1): 159-1971.

52. Waters, T. F., 1965. "Interpretation of Invertebrate Drift in Streams." Ecology 46: 327-334.

53. Hutchison, G. E., 1967. "A Treatise on Limnology," Vol. II. "Introduction to Lake Biology and the Limnoplankton." John Wileys and Sons, New York.

54. Ricker, W. E., 1954. "Causes of Death Among Indiana Fishes." Transactions of 10th American Wildlife Conference, American Wildlife Institute, Washington: 267-279.

55. Hoffman, G., 1976. Personal Communication. Parasitologist, U. S. Department of Interior, Fish Farming and Experimental Station, Stuttgart, Arkansas.

56. Wellborn, T. L., Jr., 1976. Personal Communication. Fish Parasitologist, Agricultural Extension Service, Mississippi State University, State College, Mississippi.

57. Freeman, B. O., 1976. Personal Communication, Chief, Fisheries Division, Mississippi Game and Fish Commission, Jackson.

58. Rogers, W. A., 1969. "A Summary of Fish Disease Cases Received Over a Five-Year Period at the Southeastern Cooperative Fish Disease Laboratory." Presented at 23rd Annual Conference, Southeastern Association of Game and Fish Commissioners, Mobile. (Mimeograph Copy).

59. Allison, R. and H. D. Kelley, 1963. "An Epizootic of Ichthyophthirus multifilies in a River Fish Population." Progressive Fish Culturist 19(2): 58-63.

60. Bailey, R. M. (Chairman), 1970. "A List of Common and Scientific Names of Fishes from the United States and Canada," 3rd Edition. American Fisheries Society, Special Publication No. 6.

2.3 References

1. "Climatography of the United States No. 60-22, Climates of the States, Mississippi," U. S. Department of Commerce, Weather Bureau, 1959.

2. "Local Climatological Data, Annual Summary with Comparative Data, Jackson, Mississippi," U. S. Department of Commerce, 1965-1975.

3. "Local Climatological Data, Annual Summary with Comparative Data, Jackson, Mississippi," U. S. Department of Commerce, NOAA, 1975.

4. "Local Climatological Data, Annual Summary with Comparative Data, Vicksburg, Mississippi," U. S. Department of Commerce, ESSA, 1966.

5. "Climatography of the United States No. 82-22, Summary of Hourly Observations, Jackson, Mississippi, 1951-1960," U. S. Department of Commerce, Weather Bureau, 1963.

6. "Report on Hurricane Camille," U. S. Army Corps of Engineers, Mobile District, May 1970.

7. Thom, H. C. S., "Tornado Probabilities," Monthly Weather Review, Vol. 91, October-December 1963, pp 730-736.

8. Grand Gulf, Mississippi Area Tornado Summary provided by the National Severe Storms Forecast Center, Kansas City, Missouri, May 1976.

9. Draft "Safety Guide on Meteorology - Extreme Meteorological Conditions in Nuclear Power Plant Siting," International Atomic Energy Agency, April 1976.

10. Malone, T. F., (Editor), "Compedium of Meteorology," American Meteorological Society, Boston, Massachusetts, 1951.

11. Visher, S. S., "Climatic Atlas of the United States," Harvard University Press, Cambridge, Massachusetts, 1966, p. 403.

12. "Tabulation III - Daily Mixing Depth and Average Wind Speed, Jackson, Mississippi (1959-62)," U. S. Department of Commerce, ESSA, National Weather Records Center, 1968.

13. Korshover, Julius, "Climatology of Stagnating Anticyclones East of the Rocky Mountains, 1936-1970," NOAA Technical Memorandum ERL ARL-34, U. S. Department of Commerce, 1971.

14. Bennett, Ivan, "Glaze: Its Meteorology and Climatology, Geographical Distribution, and Economic Effects," Headquartermaster Research and Engineering Command, U. S. Army, Quartermaster Research and Engineering Center, Environmental Protection Research Division, Natick, Massachusetts, March, 1959.

15. Thom, H. C. S., "Some Methods of Climatological Analysis," WMO Technical Note No. 81. Secretariat of the World Meteorological Organization, Geneva, Switzerland, 1966.

16. Huschke, Ralph E., Ed., "Glossary of Meteorology," American Meteorological Society, Boston, Massachusetts, 1959.

17. "Climatic Atlas of the United States," U. S. Department of Commerce, 1968.

18. Thom, H. C. S., "New Distributions of Extreme Winds in the United States," Journal of the Structural Division, Proceedings of the American Society of Civil Engineers, Vol. 94, No. ST 7, pp 1787-1801, 1968.

19. Task Committee on Wind Forces, "Wind Forces on Structures," Paper 3269, Reprinted From Transactions, Vol. 126, Part II 1961, ASCE 1962.

20. "Climatography of the United States No. 82-22, Summary of Hourly Observations for Jackson, Mississippi, 1951-1960," U. S. Department of Commerce, Weather Bureau, 1963.

21. Fluor Products Company, "Evaluated Weather Data for Cooling Equipment Design, Addendum No. 1." Ecodyne Corporation, P. O. Box 1267, Santa Rosa, California, 52 pp., 1964.

22. Bailey, Desmond T., "A Wet-Bulb Climatology of the United States," (Ph. D) dissertation, Cornell University, Ithaca, New York, 1976.

23. Hershfield, David M., "Rainfall Frequency Atlas of the United States for Duration from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years," U. S. Weather Bureau Technical Paper 40, Washington, D. C., 1961.

24. Miller, John F., "Two to Ten Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States," U. S. Weather Bureau Technical Paper 49, Washington, D. C., 1964.

25. Jennings, A. H., "Maximum Recorded United States Point Rainfall for 5 Minutes to 24 Hours at 296 First Order Stations," U. S. Weather Bureau Technical Paper 2, Washington, D. C., 1963.

26. "Precipitation and Non-Precipitation Winds for Jackson, Mississippi (1955-1964)," U. S. Department of Commerce, NOAA, National Climatic Center, 1972.

27. "Local Climatological Data, Annual Summary with Comparative Data for Baton Rouge, Louisiana," U. S. Department of Commerce, NOAA, 1974.

28. "Uniform Summary of Weather Observations, Part A, Greenville AFB, Mississippi," Department of the Air Force, National Climatic Center, February 1942 - June 1960, less April-July 1945, and February 1946-March 1953.

29. "Summary of Mean Percentages, Greenwood AFB, Mississippi," U. S. Department of Commerce, Weather Bureau, May 1938 - December 1941.

30. "Summary of Monthly Percentages, Greenwood AFB, Mississippi," National Climatic Center, February 1943 - October 1945.

31. George, J. J., "The Prediction of Very Low Ceilings and Fogs," Eastern Air Lines, Inc., Meteorology Department, Atlanta, Georgia, Scientific Report No. 1, 1958.

32. Brooks, C. E. P., and N. Carruthers "Handbook of Statistical Methods in Meteorology," London H.M.S.O., 1953.

33. Holzworth, George C., "Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States," Environmental Protection Agency, Research Triangle Park, North Carolina, January 1972.

2.4 References

1. U. S. Army Corps of Engineers, Mississippi River Commission, Lower Mississippi Region Comprehensive Study, Vicksburg, Mississippi, Appendices C and L, 1974.

2. U. S. Geological Survey, Surface Water Records, Water Supply Papers, 1929-1973.

3. Mississippi Power & Light Company, "Environmental Field Measurements Program," Grand Gulf Nuclear Station Units 1 and 2, Interim Reports, 1973.

4. Mississippi Power & Light Company, "Environmental Field Measurements Program," Grand Gulf Nuclear Station Units 1 and 2, Final Report, 1973.

5. Mississippi Power & Light Company, "Environmental Field Measurements Programs," Grand Gulf Nuclear Station Units 1 and 2, Supplementary Report, 1974.

6. Environmental Protection Agency, National Water Quality Inventory Report to the Congress, Office of Water Planning and Standards, Washington, D. C. (EPA-440/9-74-001) Vol. 1, 1974.

7. Callahan, J. A., et al, 1963, Water Resources of Adams, Claiborne, Jefferson, and Warren Counties, Mississippi: U. S. Geol. Survey and Mississippi Ind. and Tech. Res. Com. Bull. 63-1.

2.5 References

None

2.6 References

1. Brookes, S. O., S. O. McGahey, and P. M. Lowrey, editors, 1976, "Archeological Report No. 1: The Grand Gulf Mound (22-Cb-522) - Salvage Excavation of an Early Marksville Burial Mound," Mississippi Department of Archives and History, Jackson, Mississippi.

2. Brookes, S. O., B. Inmon, and J. H. Stone, editors, 1973, "Mississippi Archaeological Survey Report No. 3: Archaeological Survey of Claiborne County, Mississippi," Mississippi Department of Archives and History, Jackson, Mississippi.

3. Douglas, E. P., J. H. Stone, editors, 1974. "Architecture in Claiborne County: A Selective Guide," Mississippi Department of Archives and History, Jackson, Mississippi.

4. Stone, J. H., E. P. Douglas, S. O. Brookes, and B. Inmon, August 1, 1972. "Preliminary Archaeological, Architectural, and Historical Survey of the Grand Gulf Nuclear Station Site, the Perimeter Area, and the Proposed Power Line Routes," unpublished report, Mississippi Department of Archives and History.

5. U. S. Department of the Interior, National Park Service, August 1973. "Preparation of Environmental Statements: Guidelines for Discussion of Cultural (Historic, Archaeological, Architectural) Resources."

2.7 References

None

13.3 REFERENCES TO CHAPTER 3.0

3.1 References

None

3.2 References

None

3.3 References

None

3.4 References

1. Air Conditioning Criteria, Page 35, Jackson, Engineering Weather Data, U. S. Government Printing Office, Washington; 1967.

2. Local Climatological Data, Annual Summary With Comparative Data, Vicksburg, Mississippi, 1966, ESSA.

3.5 References

1. USNRC NUREG-0016, April 1976, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors (BWR-GALE Code)."

3.6 References

1. EPA 440/1-77/084, Supplement for Pretreatment to the Development Document for the Steam Electric Power Generating, Point Source Category, April 1977, Table V-4, Page 54.

3.7 References

None

3.8 References

None

3.9 References

1. Wolfe, J. E., "Mississippi Land Mammals." Mississippi Game and Fish Commission, 1971.

2. Vanderford, H. B., "Soils of Mississippi," Mississippi Agricultural Experiment Station.

3. Industrial Award, Mississippi Chapter of the Soil Conservation Society of America (1968), "Transmission and Distribution Magazine," December 1968 and January 1969.

13.4 REFERENCES TO CHAPTER 4.0

4.1 References

1. Van Hooser, D., "Midcycle Evaluation of Mississippi Timber Resources," U.S.D.A. Forest Resource Bulletin 50-44, 1973.

2. Earles, J. M., "Forest Statistics for Louisiana Parishes." U.S.D.A. Forest Resource Bulletin 50-52, 1975.

4.2 References

None

4.3 References

None

4.4 References

None

4.5 References

None

13.5 REFERENCES TO CHAPTER 5.0

5.1 References

1. U. S. Army Corps of Engineers, "Bank Protection - Master Specification for Hired Labor Work," Office of the President, Mississippi River Commission, Vicksburg, Miss., May 1971.

2. Rigter, B. P., "Density Induced Return Currents in Outlet Channels," ASCE Journal of the Hydraulics Division HY2, February 1970.

3. Benedict, B. A., J. L. Anderson, and E. L. Yandell, Jr., "Analytical Modeling of Thermal Discharges, A Review of the State of the Art," Argonne National Laboratories Report ANL/ES 18 April 1974.

4. Edinger, J. E., and E. M. Polk, Jr., "Initial Mixing of Thermal Discharges into a Uniform Current," Dept. of Environmental and Water Resources Engineering, Vanderbilt University, Nashville, Tenn., Report No. 1 October 1969.

5. Brooks, N. H., "Diffusion of Sewage Effluent in an Ocean Current," Proceedings of the 1st International Conference on Waste Disposal in the Marine Environment, Pergaman Press 1960.

6. Prych, E. A., "Effects of Density Difference on Lateral Mixing in Open Channel Flows," W. M. Keck Laboratory Report No. KH-R-21, California Institute of Technology, Pasadena, Calif., May 1970.

7. "Effect of Geographical Location on Cooling Pond Requirements and Performance," Vanderbilt University, Nashville, Tennesse, Report for the EPA Water Quality Office, Project No. 16130 FDQ, March 1971.

8. Policastro, A. J., "Heated Effluent Dispersion in Large Lakes State-of-the-Art of Analytical Models," Part 1, Argonne National Laboratories, ANL/ES-11, January 1972.

9. "Local Climatological Data," Jackson, Mississippi, monthly editions for January, April, July, October, U. S. Department of Commerce, NOAA, April 1967 - January 1972.

10. "Summary of Constant Pressure Data," WBAN 33, monthly editions for January, April, July, October, U.S. Department of Commerce, Weather Bureau, April 1967 - January 1972.

11. Briggs, G. A., "Plume Rise," U. S. Atomic Energy Commission, Division of Technical Information, 1969.

12. Thomas, F. W., et al, "Plume Rise Estimates for Electric Generating Stations," Journal of the Air Pollution Control Association, 20 (3), March 1970.

13. Austin, J. M., "Summary of TVA Vapor Plume Study," memorandum dated April 29, 1972.

14. Colbaugh, W. C., TVA Air Quality Branch, May 1972, personal communication.

15. Currier, et al, "The Environmental Effects of the Midland Plant Cooling Pond," report done for Bechtel Corporations, 1972.

16. Huff, F. A., et al, "Effects of Cooling Tower Effluents on Atmospheric Conditions in Northeastern Illinois, a Preliminary Report," Illinois Water Survey, 1971.

17. Broehl, D. J., "Field Investigations of Environmental Effects of Cooling Towers for Large Steam Electric Plants," Portland General Electric Company, 1968.

18. Zeller, R. W., et al, "Report on Trip to Seven Thermal Power Plants," Pollution Control Council, Pacific Northwestern Area, 1971.

19. Hosler, C. L., "Wet Cooling Tower Plume Behavior," Pennsylvania State University, University Park, Pennsylvania, 1971.

20. Tate, A., "Effects of a Natural Draft Cooling Tower on the Environment," Emory University, Atlanta, Georgia, May, 1972.

21. Israel, G. W., and T. J. Overcamp, "Drift Deposition Model for Natural Draft Cooling Towers," in Proceedings of Cooling Tower Environment - 1974, March 4-6, 1974, pp. 614-628, Technical Information Center, Office of Public Affairs, USERDA, 1975.

22. Overcamp, T. J., "A General Gaussian Diffusion Deposition Model for Elevated Point Sources," Journal of Applied Meteorology, Vol. 15, 1976, pp. 1167-1171.

23. Typical Drift Particulate Density Distribution for Mechanical and Natural Draft Towers, Zurn Industries, Inc.

24. Holzworth, G. C., "Mixing Heights, Wind Speed and Potential for Urban Air Pollution Throughout the Contiguous United States," Environmental Protection Agency, Research Triangle Park, N. C., 1972.

25. Slade, D. H ., "Meteorology and Atomic Energy - 1968," USAEC Report TID-24190, 1968, pp. 408-409.

26. Wobus, H. B., F. W. Murray, and L. R. Koenig, "Calculation of the Terminal Velocity of Water Drops," Journal of Applied Meteorology, Vol. 10, 1971, pp. 751-754.

5.2 References

1. Auberbach, S. I., "Ecological Considerations in Siting Nuclear Power Plants: The Long Term Biota Effects Problems," Nuclear Safety, 12, 25, 1971.

2. Auerbach, S. I., et al, "Ecological Considerations in Reactor Power Plant Siting," IAEA-SM/146/53, 1970.

3. U. S. Environmental Protection Agency, 1972. "Environmental Radioactivity Surveillance Guide." Doc. ORP/SID 72-2.

4. U. S. Department of Health, Education and Welfare, 1970, "Radiological Health Data and Reports," Vol. 11, No. 9.

5. U. S. Environmental Protection Agency, 1971. "Radiological Health Data and Reports," Vol. 12, No. 11.

6. U. S. Department of Health, Education and Welfare, 1969. "Radiological Health Data and Reports," Vol. 10, Nos. 1-4.

7. U. S. Atomic Energy Commission, 1973. "Final Environmental Statement Concerning Rule Making Action," Wash 1258 Vol. Nos. 1-3.

8. Rigter, B. P., "Density Induced Return Currents in Outlet Channels," ASCE Journal of the Hydraulics Division, HY2, Feb. 1970.

9. Turner, D. B., "Workbook of Atmospheric Dispersion Estimates," Office of Air Programs Publications No. AP-26, Environmental Protection Agency, Research Triangle Park, North Carolina, 1970.

10. Yanskey, G. R., E. H. Markee, Jr, and A. P., Richter, "Climatography of the National Reactor Testing Station," Idaho Operations Office, USAEC, IDO-12048, Idaho Falls, Idaho.

11. U. S. Atomic Energy Commission's Final Environmental Statement for Shoreham Nuclear Power Station - Docket No. 50-322, 1972.

12. U. S. Nuclear Regulatory Commission, 1977. "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluent for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Regulatory Guide 1.109 Rev. 1.

13. Slade, D. H., "Meteorology and Atomic Energy," TID-24190, 1968.

14. Collins, D. G., et al, "SKYSHINE, A Computer Procedure for Evaluating Effect of Structure Design on N-16 Gamma Ray Dose Rates," RRA-7729, 1972.

5.2A References to Appendix A

1. U. S. Atomic Energy Commission, 1973 "Final Environmental Statement Concerning Rule Making Action," Wash 1258 Vol. 2.

2. Environmental Analysts, Inc. "Standard Methodology for Calculating Radiation Doses to Lower Form Biota," AIF/NESP-006, 1985.

5.3 References

1. Rigter, B. P., "Density Induced Return Currents in Outlet Channel," ASCE Journal of the Hydraulics Division, HY2, February 1970.

2. Benedict, B. A., J. L. Anderson, and E. L. Yandell, Jr., "Analytical Modeling of Thermal Discharges, A Review of the State of the Art,": ANL Report ANL/ES-18, April 1974.

3. Edinger, J. E., and E. M. Polk, Jr., "Initial Mixing of Thermal Discharges into a Uniform Current," Dept. of Environmental and Water Resources Engineering, Vanderbilt University, Nashville, Tennessee, Report No. 1 (Oct. 1969).

4. Prych, E. A., "Effects of Density Difference on Lateral Mixing in Open Channel Flows," W. M. Keck Laboratory Report No. KH-R-21, California Institute of Technology, Pasadena, Calif., May 1970.

5. Policastro, A. J., "Heated Effluent Dispersion in Large Lakes - State-of-the-Art of Analytical Models," Part I, Argonne National Laboratories, ANL/ES-11, January 1972.

6. Weil, J., and H. B. Fischer, "Effect of Stream Turbulence on Heated Water Plumes," Jour. Hyd. Div. ASCE, Vol. 100, HY7, July 1974.

5.4 References

None

5.5 References

1. "Effects of Electric Fields on Large Animals," EPRI E.A.-331, Project 799-1, Interim Report, December 1976.

5.6 References

None

5.7 References

None

5.8 References

1. United States Department of Agriculture, 1969. "Forest Resources of Mississippi." Forest Service Resource Bulletin.

2. "An Engineering Evaluation of Nuclear Reactor Decommissioning Alternatives," AIF/NESP-009, Atomic Industrial Forum, Inc., National Environmental Studies Project, November 1976.

13.6 REFERENCES TO CHAPTER 6.0

6.1 References

1. Israel, G. W. and T. J. Overcamp, "Drift Deposition Model for Natural Draft Cooling Towers," in Proceedings of Cooling Tower Environment - 1974, March 4-6, 1974, pp. 614-628, Technical Information Center, Office of Public Affairs, USERDA, 1975.

2. Overcamp, T. J., "A General Gaussian Diffusion Deposition Model for Elevated Point Sources," Journal of Applied Meteorology, 15, 1976, 1167-1171.

3. Hewett, T. A., J. A. Fay, and D. P. Hoult, "Laboratory Experiments of Smokestack Plumes in a Stable Atmosphere," Atmospheric Environment, 5, 1971, 767-789.

4. Briggs, G. A., Some Recent Analyses of Plume Rise Observation, in Proceedings of the Second International Clean Air Congress, Washington, D. C., December 6-11, 1970, pp. 1029-1032, H. M. Englund and W. T. Beery (Eds.), Academic Press, Inc., New York, 1971.

5. Briggs, G. A., Plume Rise, USAEC, 1969.

6.2 References

None

6.3 References

1. "Water Resources Data for Mississippi, Water Year 1976," U. S. Geological Survey Water Data Report MS-76-1, U. S. Department of the Interior, 1977.

2. "Stages and Discharges of the Mississippi River and Tributaries in the Vicksburg District, 1975,"

U. S. Army Engineer District, Vicksburg Corps of Engineers.

3. Ronald J. Forsythe, Mississippi State Board of Health, Division of Radiological Health, personal communication, 1977.

6.4 References

None

13.7 REFERENCES TO CHAPTER 7.0

None

13.8 REFERENCES TO CHAPTER 8.0

8.1 References

None

8.2 References

1. "An Engineering Evaluation of Nuclear Power Reactor Decommissioning Alternatives - Summary Report," Nov. 1976, Atomic Industrial Forum AIF/NESP-009SR, page 1.

2. "Socio-Economic Impact of Grand Gulf Nuclear Station," by Recon, Inc., Clinton, Mississippi, August 1977.

3. Mississippi Research and Development Center.

13.9 REFERENCES TO CHAPTER 9.0

9.1 References

None

9.2 References

1. "1977 Annual Statistical Report," Electrical World, Volume 187, page 50, March 15, 1977.

2. Olds, F. C., "Nuclear Power Engineering," Power Engineering, Volume 80, page 24, February 1976.

3. Spencer, D. F., "The Spectrum of Future Electric Generation Alternatives," Annual Conference, Engineering and Operation Division, Southeastern Electric Exchange, New Orleans, 1976.

9.3 References

None

9.4 References

None

13.10 REFERENCES TO CHAPTER 10.0

10.1 References

None

10.2 References

1. "Environmental Field Measurements Programs, Supplementary Report (September 1973 through March 1974)," Grand Gulf Nuclear Station, Units 1 and 2, MP&L.

10.3 References

None

References to Appendix A

1. Benedict, B. A., J. L. Anderson, and E. L. Yandell, Jr., "Analytical Modeling of Thermal Discharges, A Review of the State of the Art," ANL Report ANL/ES 18 April, 1974.

2. Carter, H. H., E. W. Schiemer, R. Regier, "The Buoyant Surface Jet Discharging Normal to an Ambient Flow for Various Depths," Chesapeake Bay Institute Technical Report 81, February 1973.

3. Koh, R. C. Y. and L. N. Fan, "Mathematical Models for the Prediction of Temperature Distributions Resulting from the Discharge of Heated Water Into Large Bodies of Water," Water Pollution Control Research Series Report No. 16130DWO EPA.

4. Shirazi, M. A. and L. R. Davis, "Workbook of Thermal Plume Prediction - Vol.-1, Submerged Discharge," EPA-R2-72-005a, August, 1972.

10.4 References

1. U. S. Department of Commerce, "Local Climatological Data (1940-1973) Annual Summary with Comparative Data, Miami, Florida," Washington, D. C., 1973.

2. Environmental Science Services Administration, U. S. Department of Commerce, Climatic Atlas of the United States (1945), page 63 plate 2, June 1968.

10.5 References

1. U. S. Environmental Protection Agency, "Steam Electric Power Generating Point Source Category Effluent Guidelines and Standards," Federal Register 39, Number 196, Part-III, Article 423.15 (i) and (j), October 1974.

2. American Public Health Association, American Water Works Association, and Water Pollution Control Federation, "Standard Methods for the Examination of Water and Wastewater," 13th Edition, page 110, August 1971.

10.6 References

None

10.7 References

None

10.8 References

None

10.9 References

None

10.10 References

None

13.11 REFERENCES TO CHAPTER 11.0

None

13.12 REFERENCES TO CHAPTER 12.0

None

QUESTIONS AND RESPONSES

TABLE OF CONTENTS

NRC Question	Amendment No.	Q&R Page No.
300.1	1	1.1-1
300.2	1	8.1-1
300.3	1	1.1-3
300.4	1	1.1-4
300.5	1	8.1-2
300.6	1	8.1-3
300.7	1	4.1-1
301.1	1	3.9-1
301.2	1	2.1-1
301.3	1	2.2-1
301.4	1	2.4-1
301.5	1	3.3-1
301.6	1	3.7-1
301.7	1	5.1-1
301.8	1	8.1-4
301.9	1	1.1-5
301.10	1	5.1-2
340.1	1	2.2-2
340.2	1	2.2-3
340.3	1	3.6-1
340.4	1	3.6-2
340.5	1	4.2-1
340.6	1	5.3-1
340.7	1	5.6-1
340.8	1	6.1-1
340.9	1	12.2-1
340.10	3	3.6-3
340.11	3	3.6-4
340.12	3	2.2-4
340.13	3	4.2-2
340.14	3	5.5-1
340.15	3	2.4-4
340.16	3	4.5-1
340.17	3	2.4-5
340.18	3	11.1-1
340.19	3	4.1-2
340.20	3	4.2-3
340.21	3	5.5-3
340.22	5	5.3-2
340.23	5	12.2-2
350.1	3	8.1-5
350.2	3	8.1-6
350.3	3	9.4-1
350.4	3	9.4-2
350.5	3	9.2-1

QUESTIONS AND RESPONSES

TABLE OF CONTENTS (CONT.)

NRC Question	Amendment No.	Q&R Page No.
350.6	3	1.1-6
350.7	3	8.1-7
350.8	3	8.1-8
350.9	5	2.1-3
350.10	5	8.1-9
350.11	5	8.1-10
350.12	5	8.1-11
350.13	3	2.6-1
350.14	3	2.6-2
350.15	3	2.6-3
371.01	1	2.1-2
371.02	1	2.4-2
371.03	1	2.4-3
371.04	1	3.3-2
371.05	1	3.3-4
371.06	1	3.4-1
371.07	5	2.4-10
372.1	1	2.3-1
372.2	1	2.3-3
372.3	1	2.3-5
372.4	1	5.2-1
372.5	1	6.1-2
372.6	1	6.1-5
372.7	1	6.1-6
372.8	1	6.1-7
451.1	5	3.7-2
1.	4	2.4-6
2.	4	2.4-7
3.	4	4.1-3
4.	4	2.4-8
5.	4	2.4-9
6.	4	10.2-1
7.	4	10.2-2

GG
ER

QUESTION

300.1 (1.1) Supply detailed information and analyses to show whether economic savings support the issuance of an operating license, including use of production cost computer codes or other analytical methods to show the MSU system production costs in the 1981-85 period with and without the Grand Gulf units in service.

(1) The analysis should be performed for varying growth rates in energy requirements (i.e., the MSU system official forecast of 7.4% and lower growth rates of 3% and 5% per year) to show the sensitivity of these cost estimates to load growth.

(2) Data for each operating unit or grouping of similar units should be presented showing fuel and O&M costs, forced outage rates, scheduled maintenance, assumed capacity factor, and other relevant operating characteristics.

(3) The analyses should use MSU's existing capacity to make up the energy that would have been generated by the Grand Gulf units. If fuel supply constraints will impact this, provide support and documentation for this assumption. In the case where you assume your own official forecast and Grand Gulf not available, new capacity such as that discussed in Section 9.3 of the ER, or purchased energy, may be required. In this event, include any capital charges associated with these sources of energy and full justification for this choice of replacement power.

RESPONSE

(1) The increase in fuel costs resulting from removing the Grand Gulf generation from the three load growth projections is summarized below.

GG
ER

INCREASE IN FUEL COST - $1,000's

Year	Current Forecast (6.9%)	Load Growth Rate 5%	3%
1981	$ 99,968	$ 97,147	$ 90,555
1982	132,637	123,622	111,280
1983	154,823	143,994	127,726
1984	297,318	261,816	191,197
1985	333,665	280,261	227,761
Total	$1,018,411	$906,840	$748,519

(2) The computer program we use is deterministic in nature, and therefore, the forced outage rates of the units are not incorporated in the data. By the same token, operating and maintenance costs are not represented in our program and are not included in the above figures. The data used for the 1985 case with the current load forecast, and without Grand Gulf, is shown on the enclosed computer printout, which also shows the fuel estimate for that year.

(3) In the case of the 3 percent and 5 percent growth rates, the System's capacity was adequate to make up the energy that Grand Gulf would have generated. However, for the current load forecast, supplemental energy was required to supply the System's requirements. The amount and cost of this supplemental energy was determined by including a phantom unit with an assumed cost of 45 mils/kWh. The generation from this phantom unit was minimal, compared to total System requirements. The energy and its cost included in the above tabulation were:

Year	Supplemental Energy MWH	Cost - $1,000's
1981	0	$ 0
1982	4,200	188
1983	41,500	1,868
1984	193,500	8,707
1985	399,100	17,958
Total	638,300	$28,721

It should be noted that without the Grand Gulf units, the System's reserves will be substantially below the desired level of 16 percent. The costs tabulated above represent energy cost only and do not include any provisions for additional capacity required to maintain adequate reserves.

FUEL ESTIMATING PROGRAM

STUDY ENTITLED

-1985- MSU FUEL FORECAST (W/O GRAND GULF 1* - REVISED 27 SEPT 1978)

10/24/78

THE ESTIMATED ELECTRICAL ENERGY REQUIREMENTS USED IN THIS FORECAST ARE: 8500040

	MWH	
AMP	2,148,000	8500080
APL	30,349,103	8500100
LPL	38,484,598	8500120
MPL	12,375,000	8500140
NOP	6,165,038	8500160
MSU	89,521,739	8500200

8500060 8500180 8500220

CAPACITY ADDITIONS ARE IN ACCORDANCE WITH THE LOAD & CAPABILITY FORECAST 8500240
CAST OF 11 MAY 1978. (EXCEPT W/O GRAND GULF 1* & 2*) 8500260
8500280
8500300
SPI FUEL OIL PRICES (REVISED 12 JUNE 1978) ARE 8500320
(1979 DOLLARS PER BARREL ARE ESCALATED AT 6% PER YEAR) 8500340

TYPE	$/BBL	MMBTU/BBL	$/MMBTU
#2	21.20	5.8	
#6-LS	18.44	6.25	
#6-HS	16.31	6.25	

8500360 8500380 8500400 8500420
(1976 FUEL OIL TRANSPORTATION COSTS PER 9/15/76 CORRESPONDENCE 8500440
ARE ESCALATED AT 5% PER YEAR) 8500460

BLOCK TRANSACTIONS FOLLOW-

IDENTIFICATION	MW	PERIODS		FRACTION	INTERVALS	
TOLEDO BN-1A	23.0	5	9	0.0	1	11
TOLEDO BN-1B	23.0	7	9	0.0	12	20
TOLEDO BN-1C	23.0	7	10	0.0	25	26
NEW MADRID	116.0	4	12	0.75	1	26
SPA - 1	127.0	5	9	0.0	1	26
SPA -2	17.0	5	11	0.0	1	26
TVA-SUMER-1A	91.7	6	11	1.00	11	20
TVA-SUMER-1B	104.8	6	11	0.50	12	19
TVA-WINTR-1A	-106.0	4	9	0.50	1	6
TVA-WINTR-1B	-106.0	4	9	0.50	1	5
TVA-WINTR-2A	-106.0	4	9	0.50	23	26
TVA-WINTR-2B	-106.0	4	9	0.50	24	26
ARKCO-IMATER	-17.0	6	12	0.0	1	26
UNION ELECT.	49.0	5	11	0.50	1	26
DEGRAY - 2A	-60.0	7	8	0.0	1	13
DEGRAY - 2B	-60.0	6	9	0.0	14	18
DEGRAY - 2C	-60.0	6	8	0.0	19	26
BLAKELY - 2A	-75.0	7	9	0.0	1	11
BLAKELY - 2B	-75.0	6	9	0.0	12	26
DEGRAY - 1A	70.0	5	8	0.0	1	11
DEGRAY - 1B	70.0	7	8	0.0	12	22
DEGRAY - 1C	70.0	5	10	0.0	23	26
BLAKELY - 1A	75.0	5	11	0.0	1	5
BLAKELY - 1B	75.0	6	10	0.0	6	13
BLAKELY - 1C	75.0	7	9	0.0	14	22
BLAKELY - 1D	75.0	5	10	0.0	23	26
CARPENTER-1A	50.0	5	11	0.0	1	5
CARPENTER-1B	50.0	6	9	0.0	6	13
CARPENTER-1C	50.0	7	8	0.0	14	22
CARPENTER-1D	50.0	5	10	0.0	23	26
REMMEL - 1A	10.0	1	12	0.0	1	5
REMMEL - 1B	10.0	5	10	0.0	6	22
REMMEL - 1C	10.0	2	12	0.0	23	26

MWH BY MONTHS OF YEAR

SYSTEM PURCHASES	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEM.	OCTOBER	NOVEMBER	DECEMBER	TOTAL
SCHEDULED													
TOLEDO BR-1A	5093	4600	5093	4929	5093	493	0	0	0	0	0	0	25301
TOLEDO BR-1B	0	0	0	0	0	2661	3056	3056	2957	690	0	0	12420
TOLEDO BR-1C	0	0	0	0	0	0	0	0	0	0	0	3680	3680
NEW MADRID	60105	54288	60105	58166	60105	58166	60105	60105	58166	60105	58166	58166	705748
SPA - 1	28121	25400	28121	27214	28121	27214	28121	28121	27214	28121	27214	27214	330196
SPA -2	5270	4760	5270	5100	5270	5100	5270	5270	5100	5270	5100	5100	61880
TVA-SUMER-1A	0	0	0	0	12102	33005	34105	34105	33005	7701	0	0	154023
TVA-SUMER-1B	0	0	0	0	0	29104	33416	33416	24793	0	0	0	120729
UNION ELECT.	18228	16464	18228	17640	18228	17640	18228	18228	17640	18228	17640	17640	214032
DEGRAY - 1A	12400	11200	12400	12000	12400	1200	0	0	0	0	0	0	61600
DEGRAY - 1B	0	0	0	0	0	5400	6200	6200	6000	6200	800	0	30800
DEGRAY - 1C	0	0	0	0	0	0	0	0	0	0	15600	18000	33600
BLAKELY - 1A	23250	21000	8250	0	0	0	0	0	0	0	0	0	52500
BLAKELY - 1B	0	0	10714	16071	16607	16071	536	0	0	0	0	0	59999
BLAKELY - 1C	0	0	0	0	0	0	9643	9964	9643	9964	1286	0	40500
BLAKELY - 1D	0	0	0	0	0	0	0	0	0	0	16714	19286	36000
TOTAL	152467	137712	148181	141120	157926	196054	198680	198465	184518	136279	142520	149086	1943008
UNSCHEDULED													
[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0
PURCHASES	152467	137712	148181	141120	157926	196054	198680	198465	184518	136279	142520	149086	1943008

MWH BY MONTHS OF YEAR

SYSTEM SALES	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEM.	OCTOBER	NOVEMBER	DECEMBER	TOTAL
SCHEDULED													
TVA-WINTR-1A	33799	30528	27257	0	0	0	0	0	0	0	0	0	91584
TVA-WINTR-1B	33799	30528	11993	0	0	0	0	0	0	0	0	0	76320
TVA-WINTR-2A	0	0	0	0	0	0	0	0	0	0	28347	32709	61056
TVA-WINTR-2B	0	0	0	0	0	0	0	0	0	0	13083	32709	45792
ARKCO-WATER	5270	4760	5270	5100	5270	5100	5270	5270	5100	5270	5100	5100	61880
DEGRAY - 2A	5314	4800	5314	5143	5314	5143	171	0	0	0	0	0	31199
DEGRAY - 2B	0	0	0	0	0	0	10286	10629	3086	0	0	0	24001
DEGRAY - 2C	0	0	0	0	0	0	0	0	5400	7971	7714	7714	28799
BLAKELY - 2A	9964	9000	9964	9643	9964	964	0	0	0	0	0	0	49499
BLAKELY - 2B	0	0	0	0	0	11571	13286	13286	12857	13286	12857	12857	90000
TOTAL	88146	79616	59798	19886	20548	22778	29013	29185	26443	26527	67101	91089	560130
UNSCHEDULED													
TOTAL	0	0	0	0	0	0	0	0	0	0	0	0	0
SALES	88146	79616	59798	19886	20548	22778	29013	29185	26443	26527	67101	91089	560130

MWH BY MONTHS OF YEAR

SYSTEM MYORO	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEM.	OCTOBER	NOVEMBER	DECEMBER	TOTAL
CARPENTER-1A	15500	14000	5500	0	0	0	0	0	0	0	0	0	35000
CARPENTER-1B	0	0	5714	8571	8857	8571	286	0	0	0	0	0	31999
CARPENTER-1C	0	0	0	0	0	0	4286	4429	4286	4429	571	0	18001
CARPENTER-1D	0	0	0	0	0	0	0	0	0	0	11143	12857	24000
KEMMEL - 1A	5314	4800	1886	0	0	0	0	0	0	0	0	0	12000
KEMMEL - 1B	0	0	1714	2571	2657	2571	2657	2657	2571	2657	343	0	20398
KEMMEL - 1C	0	0	0	0	0	0	0	0	0	0	4086	4714	8800
TOTAL	20814	18800	14814	11142	11514	11142	7229	7086	6857	7086	16143	17571	150198
MYORO	20814	18800	14814	11142	11514	11142	7229	7086	6857	7086	16143	17571	150198

GENERATION DATA PRINT - CARD #1

AREA	CO.	PLANT	UNIT NO.	UNIT NAME	PRI. CAP.	TYPE UNIT	PRI. FUEL	PRI. COST	PRI. HTU	ALT. FUEL	ALT. COST	ALT. HTU	ALT. LIMIT	ALT. CAP.	FIXED O & M	VAR. O & M
1	1	1	1	J.HILL	35.	0	1	0.0	1000.	2	0.0	6250.	100.	35.	0.0	0.0
1	1	2	2	RLYT CT1	62.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	1	2	3	RLYT CT2	62.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	1	2	4	RLYT CT3	64.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	1	3	7	EMER TWO	1000.	0	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	1	3	8	EMER ONE	1000.	0	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	2	3	9	COOLM 1	30.	0	1	0.0	1000.	2	0.0	6250.	100.	25.	0.0	0.0
1	2	3	10	COOLM 2	131.	0	1	0.0	1000.	2	0.0	6250.	100.	120.	0.0	0.0
1	2	4	11	LYNCM 1	28.	0	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	2	4	12	LYNCM 2	55.	0	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	2	4	13	LYNCM 3	130.	0	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	2	5	14	LCAIM 1	45.	0	2	0.0	6250.	5	0.0	0.	0.	0.	0.0	0.0
1	2	5	15	LCAIM 2	44.	0	2	0.0	6250.	5	0.0	0.	0.	0.	0.0	0.0
1	2	5	16	LCAIM 3	90.	0	2	0.0	6250.	5	0.0	0.	0.	0.	0.0	0.0
1	2	5	17	LCAIM 4	459.	0	2	0.0	6250.	5	0.0	0.	0.	0.	0.0	0.0
1	2	6	18	MOSES 1	63.	0	2	0.0	6250.	5	0.0	0.	0.	0.	0.0	0.0
1	2	6	19	MOSES 2	63.	0	2	0.0	6250.	5	0.0	0.	0.	0.	0.0	0.0
1	2	7	20	KILCRE 1	310.	0	2	0.0	6250.	5	0.0	0.	0.	0.	0.0	0.0
1	2	7	21	KILCRE 2	510.	0	2	0.0	6250.	5	0.0	0.	0.	0.	0.0	0.0
1	2	8	22	KILCRE 3	15.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	2	9	23	MABELV 1	15.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	2	9	24	MABELV 2	15.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	2	9	25	MABELV 3	15.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	2	9	26	MABELV 4	15.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	2	10	27	BAILEY	122.	0	1	0.0	1000.	2	0.0	6250.	100.	122.	0.0	0.0
1	2	10	28	MC CLEL	134.	0	1	0.0	1000.	2	0.0	6250.	100.	120.	0.0	0.0
1	2	11	29	ANO 1	836.	0	3	0.0	2400.	5	0.0	0.	0.	0.	0.0	0.0
1	2	11	30	ANO 2	912.	0	3	0.0	2400.	5	0.0	0.	0.	0.	0.0	0.0
1	2	12	31	WHBLUF 1	700.	0	4	0.0	8500.	5	0.0	0.	0.	0.	0.0	0.0
1	2	12	32	WHBLUF 2	700.	0	4	0.0	8500.	5	0.0	0.	0.	0.	0.0	0.0
1	2	13	33	INDEP 1	700.	0	4	0.0	8500.	5	0.0	0.	0.	0.	0.0	0.0
1	2	13	34	INDEP 2	700.	0	4	0.0	8500.	5	0.0	0.	0.	0.	0.0	0.0
1	3	10	36	LP-IM-MN	206.	0	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	3	1	37	SIER/ARC	203.	0	1	0.0	1025.	2	0.0	5800.	100.	203.	0.0	0.0
1	3	1	39	SIER 5	44.	0	1	0.0	1000.	5	0.0	0.	0.	0.	0.0	0.0
1	3	1	40	SIER 6	224.	0	1	0.0	1000.	2	0.0	6250.	100.	210.	0.0	0.0
2	3	3	46	L GTP 1	244.	0	1	0.0	1050.	2	0.0	5800.	0.	210.	0.0	0.0
2	3	3	47	L GTP 2	436.	0	1	0.0	1050.	2	0.0	5800.	0.	380.	0.0	0.0
2	3	3	48	L GTP 3	573.	0	1	0.0	1050.	2	0.0	5800.	0.	510.	0.0	0.0
2	3	4	49	DUKAS 8	19.	1	1	0.0	1050.	2	0.0	5800.	100.	19.	0.0	0.0
2	3	5	50	WINFRD 1	411.	0	2	0.0	6250.	5	0.0	0.	0.	0.	0.0	0.0
2	3	5	51	WINFRD 2	411.	0	2	0.0	6250.	5	0.0	0.	0.	0.	0.0	0.0
2	3	6	52	WINFRD 3	1110.	0	3	0.0	2400.	5	0.0	0.	0.	0.	0.0	0.0
2	3	12	53	NINEMI 1	74.	0	1	0.0	1050.	2	0.0	6250.	100.	70.	0.0	0.0
2	3	12	54	NINEMI 2	107.	0	1	0.0	1050.	2	0.0	6250.	100.	90.	0.0	0.0
2	3	12	55	NINEMI 3	135.	0	1	0.0	1050.	2	0.0	6250.	100.	125.	0.0	0.0
2	3	12	56	NINEMI 4	748.	0	1	0.0	1050.	2	0.0	5800.	100.	700.	0.0	0.0

GENERATOR DATA PRINT - CARD #1

AREA	CO.	PLANT	UNIT NO.	UNIT NAME	PRI. CAP.	TYPE UNIT	PRI. FUEL	PRI. COST	PRI. HTU	ALT. FUEL	ALT. COST	ALT. HTU	ALT. LIMIT	ALT. CAP.	FIXED O & M	VAR. O & M
2	3	2	45	NINEMI 5	763.	0	1	0.0	1050.	2	0.0	5800.	0.	700.	0.0	0.0
1	4	1	64	REX BR 1	36.	0	1	0.0	1000.	2	0.0	5800.	100.	36.	0.0	0.0
1	4	1	65	REX BR 2	47.	0	1	0.0	1000.	5	0.0	0.	0.	0.	0.0	0.0
1	4	1	66	REX BR 3	76.	0	1	0.0	1000.	2	0.0	5800.	100.	69.	0.0	0.0
1	4	1	67	REX BR 4	231.	0	1	0.0	1000.	2	0.0	5800.	100.	210.	0.0	0.0
1	4	2	68	REX BR 5	11.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	4	3	69	DELTA 1	104.	0	1	0.0	1000.	2	0.0	6250.	100.	95.	0.0	0.0
1	4	3	70	DELTA 2	103.	0	1	0.0	1000.	2	0.0	6250.	100.	95.	0.0	0.0
1	4	4	71	NATCH 1	73.	0	1	0.0	1000.	2	0.0	6250.	100.	73.	0.0	0.0
1	4	5	72	B.WLSN 1	550.	0	1	0.0	1000.	2	0.0	6250.	100.	525.	0.0	0.0
1	4	5	73	B.WLSN 2	771.	0	1	0.0	1000.	2	0.0	6250.	100.	650.	0.0	0.0
1	4	6	60	ANDRUS 1	761.	0	2	0.0	6250.	5	0.0	0.	0.	0.	0.0	0.0
2	5	2	87	PATRSN 1	46.	0	1	0.0	1078.	2	0.0	6250.	100.	46.	0.0	0.0
2	5	2	88	PATRSN 2	44.	0	1	0.0	1078.	2	0.0	6250.	100.	42.	0.0	0.0
2	5	2	89	PATRSN 3	56.	0	1	0.0	1078.	2	0.0	6250.	100.	55.	0.0	0.0
2	5	2	90	PATRSN 4	87.	0	1	0.0	1078.	2	0.0	6250.	100.	80.	0.0	0.0
2	5	4	91	PATRSN 5	16.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
2	5	5	92	MICHOU 1	113.	0	1	0.0	1078.	2	0.0	6250.	100.	114.	0.0	0.0
2	5	5	93	MICHOU 2	244.	0	1	0.0	1078.	2	0.0	6250.	100.	244.	0.0	0.0
2	5	5	94	MICHOU 3	548.	0	1	0.0	1078.	2	0.0	6250.	100.	525.	0.0	0.0
1	0	8	63	NPEAK	195.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	0	8	95	NPEAK	65.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	2	9	96	AP3PEK84	150.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	4	5	97	MP1PEK83	50.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	1	3	98	AMP PEAK	50.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	0	1	74	G.GULF 1	1250.	0	3	0.0	2400.	5	0.0	0.	0.	0.	0.0	0.0
1	0	1	75	G.GULF 2	1250.	0	3	0.0	2400.	5	0.0	0.	0.	0.	0.0	0.0
2	3	2	76	COAL 7LP	700.	0	4	0.0	8500.	5	0.0	0.	0.	0.	0.0	0.0
1	0	2	77	LPCOAL 2	700.	0	4	0.0	8500.	5	0.0	0.	0.	0.	0.0	0.0
1	0	2	78	LPCOAL 3	700.	0	4	0.0	8500.	5	0.0	0.	0.	0.	0.0	0.0
1	0	2	79	LPCOAL 4	700.	0	4	0.0	8500.	5	0.0	0.	0.	0.	0.0	0.0
2	3	3	57	LP3PEK84	150.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
2	5	5	58	NP1PEK84	50.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	4	4	59	MP1PEK84	50.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
2	0	9	61	SPEAK	50.	1	2	0.0	5800.	5	0.0	0.	0.	0.	0.0	0.0
1	4	7	62	MP COAL1	700.	0	4	0.0	8200.	5	0.0	0.	0.	0.	0.0	0.0
1	4	7	80	MPCOAL 1	700.	0	4	0.0	8500.	5	0.0	0.	0.	0.	0.0	0.0
1	0	4	81	COAL 84P	700.	0	4	0.0	8500.	5	0.0	0.	0.	0.	0.0	0.0
2	0	4	82	MPCOAL 3	700.	0	4	0.0	8500.	5	0.0	0.	0.	0.	0.0	0.0
2	0	4	83	MPCOAL 4	700.	0	4	0.0	8500.	5	0.0	0.	0.	0.	0.0	0.0
1	0	5	84	COAL A 1	700.	0	4	0.0	8500.	5	0.0	0.	0.	0.	0.0	0.0
1	0	5	85	COAL A 2	700.	0	4	0.0	8500.	5	0.0	0.	0.	0.	0.0	0.0
1	0	5	86	COAL A 3	700.	0	4	0.0	8500.	5	0.0	0.	0.	0.	0.0	0.0
1	2	14	35	COAL 6AP	700.	0	4	0.0	8500.	5	0.0	0.	0.	0.	0.0	0.0
2	0	0	36	COAL 9UA	700.	0	4	0.0	8500.	5	0.0	0.	0.	0.	0.0	0.0
1	0	7	5	NUC A 1	1200.	0	3	0.0	2400.	5	0.0	0.	0.	0.	0.0	0.0
1	0	7	6	NUC A 2	1200.	0	3	0.0	2400.	5	0.0	0.	0.	0.	0.0	0.0

GENERATOR DATA PRINT- CARD #2

UNIT	BTU1	MW1	BTU2	MW2	BTU3	MW3	BTU4	MW4	BTU5	MW5
1	74.0	5.0	203.0	17.0	236.0	20.0	294.0	25.0	413.7	35.0
2	444.8	29.7	660.9	49.8	751.9	59.4	769.8	61.3	771.6	62.0
3	444.8	29.7	660.9	49.8	751.9	59.4	769.8	61.3	771.6	62.0
4	444.8	30.6	660.9	51.2	751.9	61.2	769.8	63.4	771.6	64.0
7	10.0	1.0	3000.0	300.0	6000.0	600.0	9000.0	900.0	10000.0	1000.0
8	10.0	1.0	3000.0	300.0	6000.0	600.0	9000.0	900.0	10000.0	1000.0
9	143.0	10.0	200.0	15.0	260.0	20.0	285.0	22.0	323.0	25.0
10	403.0	35.0	756.0	66.0	1027.0	92.0	1161.0	104.0	1371.0	122.0
11	159.0	10.0	211.0	15.0	270.0	20.0	333.0	25.0	374.0	28.0
12	282.0	20.0	394.0	30.0	507.0	40.0	624.0	50.0	684.0	55.0
13	430.0	35.0	626.0	55.0	876.0	80.0	1084.0	100.0	1418.0	130.0
14	397.0	30.0	434.0	33.0	475.0	36.0	527.0	40.0	594.0	45.0
15	397.0	30.0	434.0	33.0	475.0	36.0	527.0	40.0	594.0	44.0
16	371.0	30.0	513.0	45.0	657.0	60.0	801.0	75.0	946.0	90.0
17	1683.0	150.0	2292.0	225.0	2929.0	300.0	3594.0	375.0	4372.0	459.0
18	188.0	12.0	390.0	32.0	505.0	43.0	600.0	52.0	720.0	63.0
19	188.0	12.0	390.0	32.0	505.0	43.0	600.0	52.0	720.0	63.0
20	940.0	80.0	1560.0	150.0	2142.0	214.0	2682.0	272.0	3144.0	310.0
21	1992.0	200.0	2490.0	255.0	3511.0	360.0	3966.0	400.0	4761.0	510.0
22	102.0	5.0	114.0	6.0	148.0	10.0	186.0	13.0	210.0	15.0
23	102.0	5.0	114.0	6.0	148.0	10.0	186.0	13.0	224.0	16.0
24	102.0	5.0	114.0	6.0	148.0	10.0	186.0	13.0	224.0	16.0
25	102.0	5.0	114.0	6.0	148.0	10.0	186.0	13.0	224.0	16.0
26	102.0	5.0	114.0	6.0	148.0	10.0	186.0	13.0	224.0	16.0
27	370.0	30.0	536.0	50.0	838.0	82.0	1232.0	119.0	1428.0	136.0
28	370.0	30.0	536.0	50.0	914.0	90.0	1127.0	110.0	1402.0	134.0
29	2819.0	217.0	4991.0	433.0	7226.0	649.0	8260.0	745.0	9262.0	836.0
30	2585.0	183.0	5193.0	429.0	8309.0	724.0	10389.0	905.0	10821.0	950.0
31	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
32	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
33	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
34	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
38	135.0	10.0	850.0	50.0	1250.0	100.0	1800.0	150.0	2369.0	206.0
37	404.0	37.0	724.0	74.0	1047.0	111.0	1494.0	161.0	1969.0	214.0
39	232.0	18.0	278.0	22.4	397.2	32.8	463.9	37.9	583.1	46.5
40	1031.0	100.0	1510.0	149.2	2130.0	208.1	2290.0	224.0	0.0	0.0
46	1120.0	110.0	1350.0	133.0	1600.0	162.0	1840.0	189.0	2395.0	245.0
47	2650.0	250.0	2891.0	280.0	3600.0	360.0	3992.0	400.0	4333.0	436.0
48	2935.0	300.0	3785.0	400.0	4078.0	431.0	4890.0	521.0	5384.0	573.0
49	216.0	15.0	227.0	16.0	239.0	17.0	250.0	18.0	264.0	19.0
50	1177.0	100.0	2087.0	200.0	2997.0	300.0	3935.0	400.0	4214.0	430.0
51	1177.0	100.0	2087.0	200.0	2997.0	300.0	3935.0	400.0	4214.0	430.0
52	3005.0	288.0	6218.0	576.0	8790.0	865.0	10220.0	1015.0	11650.0	1165.0
53	243.0	20.0	322.3	27.5	428.0	37.5	537.6	47.5	867.0	75.0
54	262.0	20.0	479.5	42.5	685.1	62.5	892.0	82.5	1200.0	110.0
55	400.0	35.0	706.0	67.5	934.0	92.5	1070.0	107.5	1401.0	137.5
56	2931.0	300.0	3935.0	402.4	5611.0	596.7	6546.0	694.0	7145.0	762.4
45	2931.0	300.0	3935.0	402.4	5611.0	596.7	6546.0	694.0	7152.0	763.0

GENERATOR DATA PRINT- CARD #2

UNIT	BTU1	MW1	BTU2	MW2	BTU3	MW3	BTU4	MW4	BTU5	MW5
64	180.0	10.0	211.6	15.0	269.0	20.2	392.3	30.7	469.0	36.0
65	147.0	10.0	280.3	22.5	370.8	30.7	466.2	38.8	577.1	47.0
66	212.0	15.0	398.0	33.5	611.4	52.4	735.0	62.4	948.0	78.0
67	790.0	70.0	1386.0	130.0	1764.0	169.0	2105.0	201.0	2490.0	240.0
68	18.0	1.0	117.0	5.0	137.5	7.0	158.5	9.0	182.0	11.0
69	237.0	18.0	508.0	47.4	703.0	66.2	820.0	77.6	1105.0	104.0
70	237.0	18.0	508.0	47.4	703.0	66.2	820.0	77.6	1093.0	103.0
71	218.0	14.2	449.2	37.7	569.3	49.5	697.8	61.2	843.9	73.0
72	1740.0	165.0	2558.0	253.0	2984.0	306.0	4524.0	480.0	5371.0	562.0
73	2620.0	250.0	4149.0	437.0	5321.0	586.0	6423.0	700.0	7093.0	775.0
80	2388.0	250.0	3846.0	425.0	5045.0	570.0	6021.0	685.0	6703.0	761.0
87	260.0	20.0	353.4	28.7	471.9	38.9	537.3	44.3	578.0	47.5
88	258.9	20.0	324.2	26.0	395.9	32.0	469.7	38.0	544.4	44.0
89	282.0	23.2	373.0	32.4	480.0	43.0	597.0	53.6	662.0	59.5
90	413.0	35.0	578.1	50.1	704.6	61.7	746.5	65.5	1033.0	88.5
91	142.0	12.0	173.0	13.0	204.0	14.0	215.0	15.0	226.0	16.0
92	400.0	35.0	636.5	58.9	782.5	73.6	1033.0	97.2	1293.0	119.5
93	750.0	70.0	1157.0	113.2	1636.0	166.4	2102.0	215.0	2435.0	246.2
94	3070.0	300.0	3969.0	398.1	4881.0	492.1	5223.0	525.2	5613.0	563.3
63	2141.0	183.0	2282.0	195.0	0.0	0.0	0.0	0.0	0.0	0.0
95	713.0	61.0	761.0	65.0	0.0	0.0	0.0	0.0	0.0	0.0
96	550.0	47.0	23287.0	1990.0	0.0	0.0	0.0	0.0	0.0	0.0
97	550.0	47.0	23287.0	1990.0	0.0	0.0	0.0	0.0	0.0	0.0
98	550.0	47.0	23287.0	1990.0	0.0	0.0	0.0	0.0	0.0	0.0
74	6375.0	375.0	7100.0	500.0	8962.0	750.0	10960.0	1000.0	13125.0	1250.0
75	6375.0	375.0	7100.0	500.0	8962.0	750.0	10960.0	1000.0	13125.0	1250.0
76	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
77	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
78	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
79	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
57	550.0	47.0	23287.0	1990.0	0.0	0.0	0.0	0.0	0.0	0.0
58	550.0	47.0	23287.0	1990.0	0.0	0.0	0.0	0.0	0.0	0.0
59	550.0	47.0	23287.0	1990.0	0.0	0.0	0.0	0.0	0.0	0.0
61	550.0	47.0	585.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0
62	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
80	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
81	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
82	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
83	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
84	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
85	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
86	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
35	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
36	2813.0	250.0	4180.0	400.0	5100.0	500.0	6060.0	600.0	7000.0	700.0
5	3667.0	305.0	5761.0	610.0	8137.0	915.0	10611.0	1200.0	0.0	0.0
6	3667.0	305.0	5761.0	610.0	8137.0	915.0	10611.0	1200.0	0.0	0.0

EXPORT LIMIT DATA FOLLOWS-

AREA NUMBER = 2 MW EXPORT LIMIT = 3000.0 PERCENT LOAD IN AREA 2= 40.0 TEXACO GAS COST,MMILEI-4 = $ 0.0 PER MMBTU

OVERNIGHT BANKING PERMITTED

ANNUAL MAINTENANCE DATA FOLLOWS-

NO.	NAME		FROM INTERVAL	THRU INTERVAL	FROM INTERVAL	THRU INTERVAL
29	ANO	1	6	9	0	0
30	ANO	2	23	26	0	0
31	WHBLUF	1	20	22	0	0
32	WHBLUF	2	23	23	0	0
33	INDEP	1	3	4	0	0
34	WILKRU	3	1	4	0	0

PRIMARY FUEL CONSTRAINT DATA FOLLOWS-

CONTRACT NO.	DAILY MCF LIMIT	BTU/CF	UNITS UNDER CONTRACT																EFF. INT.
1	0.	0.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
3	0.	0.	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
4	0.	0.	49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
5	215000.	0.	46	47	48	0	0	0	0	0	0	0	0	0	0	0	0	0	1
7	250000.	0.	45	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
8	1000.	0.	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
9	40000.	0.	64	65	66	67	0	0	0	0	0	0	0	0	0	0	0	0	1
10	0.	0.	72	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
11	0.	0.	69	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
12	0.	0.	71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
13	0.	0.	87	88	89	90	92	93	94	0	0	0	0	0	0	0	0	0	1
15	0.	0.	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
16	0.	0.	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
20	200.	0.	39	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
23	2500.	0.	53	54	55	0	0	0	0	0	0	0	0	0	0	0	0	0	1

GENERATING UNIT STATUS CHANGES FOLLOW-

UNIT NO.	STATUS	MW LIMIT	PRI. FUEL COST	ALT. FUEL COST	EFF.INT.
1	4	0.0	99.0000	3.3000	1
2	4	0.0	4.1000	0.0	1
3	4	0.0	4.1000	0.0	1
4	4	0.0	4.1000	0.0	1
5	1	0.0	0.0	0.0	1
6	1	0.0	0.0	0.0	1
7	4	0.0	4.5000	0.0	1
8	4	0.0	4.5000	0.0	1
9	1	0.0	0.0	0.0	1
10	0	0.0	1.4500	3.3400	1
11	1	0.0	0.0	0.0	1
12	1	0.0	0.0	0.0	1
13	4	0.0	3.8200	0.0	1
14	1	0.0	0.0	0.0	1
15	1	0.0	0.0	0.0	1
16	4	0.0	3.2400	0.0	1
17	4	0.0	3.2400	0.0	1
18	4	0.0	3.1700	0.0	1
19	4	0.0	3.1700	0.0	1
20	4	0.0	3.0600	0.0	1
21	4	0.0	3.0600	0.0	1
22	4	0.0	3.7900	0.0	1
23	4	0.0	3.8400	0.0	1
24	4	0.0	3.8800	0.0	1
25	4	0.0	3.8800	0.0	1
26	4	0.0	3.8800	0.0	1
27	4	0.0	99.0000	3.3200	1
28	4	0.0	99.0000	3.3200	1
29	3	770.0	0.5400	0.0	1
29	2	0.0	0.5400	0.0	13
29	3	770.0	0.5400	0.0	19

GENERATING UNIT STATUS CHANGES FOLLOW-

UNIT NO.	STATUS	MW LIMIT	PRI. FUEL COST	ALT. FUEL COST	EFF.INT.
30	3	840.0	0.5900	0.0	1
30	2	0.0	0.5900	0.0	13
30	3	840.0	0.5900	0.0	19
31	3	410.0	1.4400	0.0	1
31	2	0.0	1.4400	0.0	13
31	3	410.0	1.4400	0.0	19
32	3	415.0	1.4400	0.0	1
32	2	0.0	1.4400	0.0	13
32	3	415.0	1.4400	0.0	19
33	3	485.0	1.6800	0.0	1
33	2	0.0	1.6800	0.0	13
33	3	485.0	1.6800	0.0	19
34	3	350.0	1.6800	0.0	1
34	2	0.0	1.6800	0.0	13
34	3	350.0	1.6800	0.0	19
35	1	0.0	0.0	0.0	1
36	1	0.0	0.0	0.0	1
37	4	0.0	1.5400	4.1000	1
38	4	0.0	4.1000	0.0	1
39	1	0.0	0.0	0.0	1
40	5	200.0	2.1000	3.3500	1
40	6	0.0	2.1000	3.3500	6
40	5	200.0	2.1000	3.3500	11
40	6	0.0	2.1000	3.3500	20
40	5	200.0	2.1000	3.3500	26
45	4	0.0	0.3000	3.7100	1
46	4	0.0	0.3000	3.7100	1
47	4	0.0	0.3000	3.7100	1
48	4	0.0	0.3000	3.7100	1
49	4	0.0	99.0000	3.8300	1
50	4	0.0	2.9900	0.0	1
51	4	0.0	2.9900	0.0	1
52	3	1025.0	0.5000	0.0	1
52	2	0.0	0.5000	0.0	13
52	3	1025.0	0.5000	0.0	19
53	4	0.0	1.3000	2.9900	1
54	4	0.0	1.3000	2.9900	1
55	4	0.0	1.3000	2.9900	1
56	4	0.0	0.3000	3.7100	1
57	4	0.0	3.7100	0.0	1
58	4	0.0	3.7200	0.0	1
59	4	0.0	4.1000	0.0	1
60	4	0.0	2.7100	0.0	1
61	1	0.0	0.0	0.0	1
62	3	400.0	1.8400	0.0	1
62	2	0.0	1.8400	0.0	13
62	3	400.0	1.8400	0.0	19
63	1	0.0	0.0	0.0	1
64	4	0.0	1.3500	2.7600	1
65	4	0.0	1.3500	2.7600	1
66	4	0.0	1.3500	2.7600	1
67	6	0.0	1.3500	2.7600	1

GENERATING UNIT STATUS CHANGES FOLLOW-

UNIT NO.	STATUS	MW LIMIT	PRI. FUEL COST	ALT. FUEL COST	EFF.INT.
66	4	0.0	3.6300	0.0	1
67	4	0.0	99.0000	3.0100	1
67	0	0.0	99.0000	3.0100	11
67	2	0.0	99.0000	3.0100	20
70	4	0.0	99.0000	3.0100	1
71	4	0.0	99.0000	3.6400	1
71	0	0.0	99.0000	3.6400	11
71	2	0.0	99.0000	3.6400	20
72	4	0.0	99.0000	2.7000	1
73	4	0.0	99.0000	2.7000	1
74	1	0.0	0.0	0.0	1
75	1	0.0	0.0	0.0	1
76	1	0.0	0.0	0.0	1
77	1	0.0	0.0	0.0	1
78	1	0.0	0.0	0.0	1
79	1	0.0	0.0	0.0	1
80	1	0.0	0.0	0.0	1
81	1	0.0	0.0	0.0	1
82	1	0.0	0.0	0.0	1
83	1	0.0	0.0	0.0	1
84	1	0.0	0.0	0.0	1
85	1	0.0	0.0	0.0	1
86	1	0.0	0.0	0.0	1
87	4	0.0	99.0000	3.0000	1
88	4	0.0	99.0000	3.0000	1
89	4	0.0	99.0000	3.0000	1
90	4	0.0	99.0000	3.0000	1
91	4	0.0	3.7200	0.0	1
92	4	0.0	99.0000	3.0000	1
93	4	0.0	99.0000	3.0000	1
94	4	0.0	99.0000	3.0000	1
95	1	0.0	0.0	0.0	1
96	4	0.0	3.8800	0.0	1
97	4	0.0	3.7600	0.0	1
98	1	0.0	0.0	0.0	1

SOLUTION REQUEST...INTERVAL 1 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 2 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 3 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 4 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 5 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 6 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 7 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 8 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 9 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 10 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 11 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 12 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 13 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 14 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 15 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 16 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 17 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 18 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 19 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 20 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 21 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 22 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 23 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 24 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 25 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

SOLUTION REQUEST...INTERVAL 26 ANNUAL ENERGY=89.522 *10**6 SPINNING RESERVE = 6.0

F U E L E S T I M A T I N G P R O G R A M
FORECAST OF FUEL & LOADING
FOR ENTIRE STUDY

UNIT NO.	NAME	GAS MILLION CF	GAS $THOUS.	OIL THOUS.BBL	OIL $THOUS.	NUCLEAR KGU	NUCLEAR $THOUS.	COAL THOUS.TONS	COAL $THOUS.	LOADING MWH	LOADING $THOUS.
1	J.HILL	0.0	0.0	30.27	635.58	0.0	0.0	0.0	0.0	16000.	635.58
PLANT TOTAL		0.0	0.0	30.27	635.58	0.0	0.0	0.0	0.0	16000.	635.58
2	BLYT CT1	0.0	0.0	0.54	12.74	0.0	0.0	0.0	0.0	248.	12.74
3	BLYT CT2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
4	BLYT CT3	0.0	0.0	1.07	25.49	0.0	0.0	0.0	0.0	512.	25.49
PLANT TOTAL		0.0	0.0	1.61	38.23	0.0	0.0	0.0	0.0	759.	38.23
7	EMER TWO	0.0	0.0	474.36	12380.93	0.0	0.0	0.0	0.0	275132.	12380.93
8	EMER ONE	0.0	0.0	213.69	5577.30	0.0	0.0	0.0	0.0	123940.	5577.30
PLANT TOTAL		0.0	0.0	688.05	17958.23	0.0	0.0	0.0	0.0	399072.	17958.23
CO. TOTAL		0.0	0.0	719.93	18632.04	0.0	0.0	0.0	0.0	415831.	18632.04
9	COUCH 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
10	COUCH 2	0.0	0.0	1108.73	23144.71	0.0	0.0	0.0	0.0	586103.	23144.71
PLANT TOTAL		0.0	0.0	1108.73	23144.71	0.0	0.0	0.0	0.0	586103.	23144.71
11	LYNCH 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
12	LYNCH 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
13	LYNCH 3	0.0	0.0	100.77	2232.66	0.0	0.0	0.0	0.0	5358.	2232.66
PLANT TOTAL		0.0	0.0	100.77	2232.66	0.0	0.0	0.0	0.0	5358.	2232.66
14	LCAIN 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
15	LCAIN 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
16	LCAIN 3	0.0	0.0	135.54	2744.73	0.0	0.0	0.0	0.0	74589.	2744.73
17	LCAIN 4	0.0	0.0	1744.97	35335.58	0.0	0.0	0.0	0.0	1122047.	35335.58
PLANT TOTAL		0.0	0.0	1880.51	38080.30	0.0	0.0	0.0	0.0	1201635.	38080.30
18	MOSES 1	0.0	0.0	70.80	1402.66	0.0	0.0	0.0	0.0	38446.	1402.66
19	MOSES 2	0.0	0.0	67.61	1339.47	0.0	0.0	0.0	0.0	36617.	1339.47
PLANT TOTAL		0.0	0.0	138.40	2742.13	0.0	0.0	0.0	0.0	75063.	2742.13
20	RITCHIE 1	0.0	0.0	855.19	16355.48	0.0	0.0	0.0	0.0	528909.	16355.48
21	RITCHIE 2	0.0	0.0	4531.55	86666.00	0.0	0.0	0.0	0.0	2969656.	86666.00
PLANT TOTAL		0.0	0.0	5386.74	103021.44	0.0	0.0	0.0	0.0	3498565.	103021.44
22	RITCHIE 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
PLANT TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
23	MABELV 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
24	MABELV 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
25	MABELV 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0

F U E L E S T I M A T I N G P R O G R A M
FORECAST OF FUEL & LOADING
FOR ENTIRE STUDY

UNIT NO. NAME	GAS MILLION CF	GAS $THOUS.	OIL THOUS.BBL	OIL $THOUS.	NUCLEAR KGU	NUCLEAR $THOUS.	COAL THOUS.TONS	COAL $THOUS.	LOADING MWH	LOADING $THOUS.
26 MARSLV 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
PLANT TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
27 BAILEY	0.0	0.0	147.46	3059.80	0.0	0.0	0.0	0.0	88877.	3059.80
28 MC LEE	0.0	0.0	161.33	3347.56	0.0	0.0	0.0	0.0	97905.	3347.56
PLANT TOTAL	0.0	0.0	308.79	6407.36	0.0	0.0	0.0	0.0	186782.	6407.36
29 ANO 1	0.0	0.0	0.0	0.0	25311.12	32803.16	0.0	0.0	5476301.	32803.16
30 ANO 2	0.0	0.0	0.0	0.0	28573.11	40459.36	0.0	0.0	5974456.	40459.36
PLANT TOTAL	0.0	0.0	0.0	0.0	53884.22	73262.50	0.0	0.0	11450757.	73262.50
31 WHBLUF 1	0.0	0.0	0.0	0.0	0.0	0.0	2141.72	52429.13	3525402.	52429.13
32 WHBLUF 2	0.0	0.0	0.0	0.0	0.0	0.0	2318.43	56755.00	3815619.	56755.00
PLANT TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	4460.15	109184.13	7341021.	109184.13
33 INDEP 1	0.0	0.0	0.0	0.0	0.0	0.0	2453.58	70074.25	4084225.	70074.25
34 INDEP 2	0.0	0.0	0.0	0.0	0.0	0.0	2112.96	60346.11	3431401.	60346.11
PLANT TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	4566.55	130420.31	7515626.	130420.31
CO. TOTAL	0.0	0.0	8923.95	175628.50	53884.22	73262.50	9026.70	239604.44	31909072.	488495.44
38 LP-1H-MN	0.0	0.0	10.78	256.30	0.0	0.0	0.0	0.0	5307.	256.30
PLANT TOTAL	0.0	0.0	10.78	256.30	0.0	0.0	0.0	0.0	5307.	256.30
37 STEM/ABC	66.34	104.72	147.12	3498.56	0.0	0.0	0.0	0.0	100966.	3603.28
39 STEM 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
40 STEM 6	72.80	152.88	2565.41	53712.89	0.0	0.0	0.0	0.0	1574131.	53865.77
PLANT TOTAL	139.14	257.60	2712.53	57211.45	0.0	0.0	0.0	0.0	1675096.	57469.04
46 L GTP 1	18316.04	5769.54	0.0	0.0	0.0	0.0	0.0	0.0	1368086.	5769.54
47 L GTP 2	24176.20	7615.48	0.0	0.0	0.0	0.0	0.0	0.0	2464950.	7615.48
48 L GTP 3	32009.87	10083.11	1775.91	38213.96	0.0	0.0	0.0	0.0	4674834.	48297.07
PLANT TOTAL	74502.06	23468.13	1775.91	38213.96	0.0	0.0	0.0	0.0	9107870.	61682.10
49 BURAS 8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
PLANT TOTAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
50 WINPRO 1	0.0	0.0	3152.39	58910.25	0.0	0.0	0.0	0.0	1986327.	58910.25
51 WINPRO 2	0.0	0.0	2797.03	52269.34	0.0	0.0	0.0	0.0	1759892.	52269.34
PLANT TOTAL	0.0	0.0	5949.42	111179.56	0.0	0.0	0.0	0.0	3746219.	111179.56
52 WINPRO 3	0.0	0.0	0.0	0.0	30610.11	36732.07	0.0	0.0	7284486.	36732.07
PLANT TOTAL	0.0	0.0	0.0	0.0	30610.11	36732.07	0.0	0.0	7284486.	36732.07
53 NINEMI 1	162.41	221.55	76.02	1420.65	0.0	0.0	0.0	0.0	56093.	1642.20

F U E L E S T I M A T I N G P R O G R A M
FORECAST OF FUEL & LOADING
FOR ENTIRE STUDY

UNIT NO.	NAME	GAS MILLION CF	GAS $THOUS.	OIL THOUS.BBL	OIL $THOUS.	NUCLEAR KBU	NUCLEAR $THOUS.	COAL THOUS.TONS	COAL $THOUS.	LOADING MWH	LOADING $THOUS.
54	NINEMI 2	75.27	102.74	164.22	3068.80	0.0	0.0	0.0	0.0	101621.	3171.54
55	NINEMI 3	629.09	858.71	814.81	15226.73	0.0	0.0	0.0	0.0	570954.	16085.43
56	NINEMI 4	42344.24	13338.44	2216.42	47692.81	0.0	0.0	0.0	0.0	6119286.	61031.25
PLANT TOTAL		43210.91	14521.43	3271.47	67408.94	0.0	0.0	0.0	0.0	6847953.	81930.31
45	NINENI 5	43069.04	13566.75	0.0	0.0	0.0	0.0	0.0	0.0	4763955.	13566.75
PLANT TOTAL		43069.04	13566.75	0.0	0.0	0.0	0.0	0.0	0.0	4763955.	13566.75
CO. TOTAL		160921.06	51813.92	13720.11	274270.19	30610.11	36732.07	0.0	0.0	33430880.	362816.13
64	REX GR 1	301.44	406.95	0.0	0.0	0.0	0.0	0.0	0.0	23225.	406.95
65	REX GR 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
66	REX GR 3	770.12	1039.66	0.0	0.0	0.0	0.0	0.0	0.0	64503.	1039.66
67	REX GR 4	15651.18	21129.04	675.39	10811.59	0.0	0.0	0.0	0.0	1876080.	31940.63
PLANT TOTAL		16722.74	22575.64	675.39	10811.59	0.0	0.0	0.0	0.0	1963807.	33387.23
68	REX GR 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
PLANT TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
69	DELTA 1	0.0	0.0	501.98	9443.58	0.0	0.0	0.0	0.0	294770.	9443.58
70	DELTA 2	0.0	0.0	222.66	4188.86	0.0	0.0	0.0	0.0	130640.	4188.86
PLANT TOTAL		0.0	0.0	724.65	13632.44	0.0	0.0	0.0	0.0	425409.	13632.44
71	NAICH 1	0.0	0.0	378.29	8606.18	0.0	0.0	0.0	0.0	204614.	8606.18
PLANT TOTAL		0.0	0.0	378.29	8606.18	0.0	0.0	0.0	0.0	204614.	8606.18
72	B.WLSN 1	0.0	0.0	5006.51	84484.94	0.0	0.0	0.0	0.0	3277639.	84484.94
73	B.WLSN 2	0.0	0.0	6624.88	111794.81	0.0	0.0	0.0	0.0	4475667.	111794.81
PLANT TOTAL		0.0	0.0	11631.39	196279.75	0.0	0.0	0.0	0.0	7753306.	196279.75
60	ANDRUS 1	0.0	0.0	7942.56	134527.19	0.0	0.0	0.0	0.0	5615393.	134527.19
PLANT TOTAL		0.0	0.0	7942.56	134527.19	0.0	0.0	0.0	0.0	5615393.	134527.19
CO. TOTAL		16722.74	22575.64	21352.28	363857.13	0.0	0.0	0.0	0.0	15962529.	386432.75
87	PAINSN 1	0.0	0.0	50.42	945.41	0.0	0.0	0.0	0.0	25866.	945.41
88	PAINSN 2	0.0	0.0	43.78	820.81	0.0	0.0	0.0	0.0	22117.	820.81
89	PAINSN 3	0.0	0.0	108.81	2040.26	0.0	0.0	0.0	0.0	60660.	2040.26
90	PAINSN 4	0.0	0.0	97.56	1829.22	0.0	0.0	0.0	0.0	52862.	1829.22
PLANT TOTAL		0.0	0.0	300.57	5635.70	0.0	0.0	0.0	0.0	161505.	5635.70
91	PAINSN 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0

F U E L E S T I M A T I N G P R O G R A M
FORECAST OF FUEL & LOADING
FOR ENTIRE STUDY

UNIT NO.	NAME	GAS MILLION CF	GAS $THOUS.	OIL THOUS.BBL	OIL $THOUS.	NUCLEAR KGU	NUCLEAR $THOUS.	COAL THOUS.TONS	COAL $THOUS.	LOADING MWH	LOADING $THOUS.
PLANT TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
92 MICHIGAN 1		0.0	0.0	247.45	4639.64	0.0	0.0	0.0	0.0	143876.	4639.64
93 MICHIGAN 2		0.0	0.0	1223.58	22942.01	0.0	0.0	0.0	0.0	773734.	22942.01
94 MICHIGAN 3		0.0	0.0	2927.99	54899.85	0.0	0.0	0.0	0.0	1836424.	54899.85
PLANT TOTAL		0.0	0.0	4399.02	82481.50	0.0	0.0	0.0	0.0	2754234.	82481.50
CO. TOTAL		0.0	0.0	4699.59	88117.19	0.0	0.0	0.0	0.0	2915738.	88117.19
83 NPEAK		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
95 NPEAK		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
PLANT TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
CO. TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
96 ANPEAK4		0.0	0.0	2.42	54.48	0.0	0.0	0.0	0.0	1200.	54.48
PLANT TOTAL		0.0	0.0	2.42	54.48	0.0	0.0	0.0	0.0	1200.	54.48
CO. TOTAL		0.0	0.0	2.42	54.48	0.0	0.0	0.0	0.0	1200.	54.48
97 MPIPEAK3		0.0	0.0	18.16	395.93	0.0	0.0	0.0	0.0	8998.	395.93
PLANT TOTAL		0.0	0.0	18.16	395.93	0.0	0.0	0.0	0.0	8998.	395.93
CO. TOTAL		0.0	0.0	18.16	395.93	0.0	0.0	0.0	0.0	8998.	395.93
98 AMP PEAK		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
PLANT TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
CO. TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
99 G.GULF 1		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
99 G.GULF 2		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
PLANT TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
CO. TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
70 COAL FLP		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
PLANT TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
CO. TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
71 [illegible]		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0

FUEL ESTIMATING PROGRAM
FORECAST OF FUEL & LOADING
FOR ENTIRE STUDY

UNIT NO.	NAME	GAS MILLION CF	GAS $THOUS.	OIL THOUS.BBL	OIL $THOUS.	NUCLEAR KGU	NUCLEAR $THOUS.	COAL THOUS.TONS	COAL $THOUS.	LOADING MWH	LOADING $THOUS.
78	LPCOAL 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
79	LPCOAL 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
PLANT TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
CO. TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
57	LPJPER84	0.0	0.0	64.15	1380.34	0.0	0.0	0.0	0.0	31794.	1380.34
PLANT TOTAL		0.0	0.0	64.15	1380.34	0.0	0.0	0.0	0.0	31794.	1380.34
CO. TOTAL		0.0	0.0	64.15	1380.34	0.0	0.0	0.0	0.0	31794.	1380.34
58	MPJPER84	0.0	0.0	18.16	391.72	0.0	0.0	0.0	0.0	8998.	391.72
PLANT TOTAL		0.0	0.0	18.16	391.72	0.0	0.0	0.0	0.0	8998.	391.72
CO. TOTAL		0.0	0.0	18.16	391.72	0.0	0.0	0.0	0.0	8998.	391.72
59	MPJPER84	0.0	0.0	0.81	19.19	0.0	0.0	0.0	0.0	400.	19.19
PLANT TOTAL		0.0	0.0	0.81	19.19	0.0	0.0	0.0	0.0	400.	19.19
CO. TOTAL		0.0	0.0	0.81	19.19	0.0	0.0	0.0	0.0	400.	19.19
61	SPEAK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
PLANT TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
CO. TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
62	MP COAL1	0.0	0.0	0.0	0.0	0.0	0.0	2340.69	70632.44	3706084.	70632.44
80	MPCOAL 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
PLANT TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	2340.69	70632.44	3706084.	70632.44
CO. TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	2340.69	70632.44	3706084.	70632.44
81	COAL BMP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
82	MPCOAL 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
83	MPCOAL 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
PLANT TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
84	COAL A 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0

F U E L E S T I M A T I N G P R O G R A M
FORECAST OF FUEL & LOADING
FOR ENTIRE STUDY

...U N I T... NO.	NAME	.....G A S..... MILLION CF	$THOUS.	.....O I L..... THOUS.BBL	$THOUS.	.....N U C L E A R.... KGU	$THOUS.	.....C O A L..... THOUS.TONS	$THOUS.	....L O A D I N G... MWH	$THOUS.
85	COAL A 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
86	COAL A 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
PLANT TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
CO. TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
35	COAL GAP	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
PLANT TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
CO. TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
36	COAL WUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
PLANT TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
5	NUC A 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
6	NUC A 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
PLANT TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
CO. TOTAL		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.0
SYSTEM TOTAL		177643.75	74389.50	49519.52	922746.30	84494.31	109994.56	11367.39	310236.88	88391456.	*********

F U E L E S T I M A T I N G P R O G R A M
OPERATING FORECAST
FOR ENTIRE STUDY

UNIT NO.	UNIT NAME	RATED MW	OUTPUT MWH	HOURS RUN	HOURS BANKED	CAP. FACTOR	NO. STARTS	MILLS /KWH	HEAT RATE	FUEL QTY.	FUEL UNITS	FUEL USE	FUEL COST	O & M $ EST.
1	J.HILL		0.							0.0	MIL.CF	PRI.	0.	
1	J.HILL		10000.							30.3	TH.BBL	ALT.	635577.	
1	J.HILL	35.	10000.	542.	2824	0.052	1.0	39.724	11822.	189.2	BILBTU	COMB	635577.	0.
2	BLYT CT1	62.	248.	4.	0	0.000	2.0	51.427	12543.	3.1	BILBTU	PRI.	12743.	0.
3	BLYT CT2	62.	0.	0.										0.
4	BLYT CT3	64.	512.	8.	0	0.001	4.0	49.812	12149.	6.2	BILBTU	PRI.	25486.	0.
			759.					50.334		1.6	MBBL	PRI.	38228.	
			10000.					39.724		30.3	MBBL	ALT.	635577.	
PLANT TOTALS		223.	10759.			0.009		40.205	11843.	198.5	BBTU	TOT.	673805.	
7	EMER TWO	1000.	275132.	364.	2992	0.032	1.0	45.000	10000.	2751.3	BILBTU	PRI.	12380936.	0.
8	EMER ONE	1000.	123940.	172.	1506	0.014	3.0	45.000	10000.	1239.4	BILBTU	PRI.	5577298.	0.
9	COOLH 1	30.	0.	0.										0.
10	COOLH 2		0.							0.0	MIL.CF	PRI.	0.	
10	COOLH 2		586103.							1108.7	TH.BBL	ALT.	23144720.	
10	COOLH 2	131.	586103.	8736.	0	0.513	0.0	39.489	11823.	6929.6	BILBTU	COMB	23144720.	0.
			399072.					45.000		688.1	MMCF	PRI.	17958224.	
			586103.					39.489		1108.7	MBBL	ALT.	23144720.	
PLANT TOTALS		2161.	985175.			0.052		41.721	11085.	10920.3	BBTU	TOT.	41102944.	
11	LYNCH 1	28.	0.	0.										0.
12	LYNCH 2	55.	0.	0.										0.
13	LYNCH 3	130.	53558.	476.	2880	0.047	1.0	41.987	10913.	584.5	BILBTU	PRI.	2232664.	0.
			53558.					41.687		100.8	MBBL	PRI.	2232664.	
PLANT TOTALS		213.	53558.			0.029		41.687	10913.	584.5	BBTU	TOT.	2232664.	
14	LCAIN 1	45.	0.	0.										0.

F U E L E S T I M A T I N G P R O G R A M
OPERATING FORECAST
FOR ENTIRE STUDY

....UNIT.... NO.	NAME	RATED MW	OUTPUT MWH	.... HOURS.... RUN	BANKED	CAP. FACTOR	NO. STARTS	MILLS /KWH	HEAT RATE	.....F U E L..... QTY.	UNITS	USE	COST	O & M $ EST.
15	LCAIN 2	44.	0.	0.										0.
16	LCAIN 3	90.	79589.	1016.	5362	0.101	3.0	34.486	10644.	847.1	BILBTU	PRI.	2744727.	0.
17	LCAIN 4	459.	1122047.	3184.	5207	0.280	1.0	31.492	9720.	10906.1	BILBTU	PRI.	35335584.	0.
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			1201634.					31.690		1880.5	MBBL	PRI.	38080304.	
PLANT TOTALS		638.	1201634.			0.216		31.690	9781.	11753.2	BBTU	TOT.	38080304.	
18	MOSES 1	63.	38446.	680.	4018	0.070	3.0	36.484	11509.	442.5	BILBTU	PRI.	1402657.	0.
19	MOSES 2	63.	36617.	668.	4030	0.067	3.0	36.580	11540.	422.5	BILBTU	PRI.	1339474.	0.
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			75063.					36.531		138.4	MBBL	PRI.	2742131.	
PLANT TOTALS		126.	75063.			0.068		36.531	11524.	865.0	BBTU	TOT.	2742131.	
20	RITCHIE 1	310.	528999.	2144.	5912	0.196	2.0	30.918	10104.	5344.9	BILBTU	PRI.	16355488.	0.
21	RITCHIE 2	510.	2969566.	7160.	1566	0.667	0.0	29.185	9537.	28322.2	BILBTU	PRI.	86666016.	0.
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			3498563.					29.497		5396.7	MBBL	PRI.	103021504.	
PLANT TOTALS		820.	3498563.			0.489		29.447	9623.	33667.2	BBTU	TOT.	103021504.	
22	RITCHIE 3	15.	0.	0.										0.
23	MADELV 1	15.	0.	0.										0.
24	MADELV 2	15.	0.	0.										0.
25	MADELV 3	15.	0.	0.										0.
26	MADELV 4	15.	0.	0.										0.
27	BAILEY		0.							0.0	MIL.CF	PRI.	0.	
27	BAILEY		88877.							147.5	TH.BBL	ALT.	3059798.	
27	BAILEY	122.	88877.	824.	4546	0.083	4.0	34.427	10370.	921.6	BILBTU	COMB	3059798.	0.
28	MC CLEL		0.							0.0	MIL.CF	PRI.	0.	
28	MC CLEL		97905.							161.3	TH.BBL	ALT.	3347563.	
28	MC CLEL	134.	97905.	900.	5142	0.084	4.0	34.192	10239.	1008.3	BILBTU	COMB	3347563.	0.
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			0.					0.		0.0	MMCF	PRI.	0.	

		186782.				34.394		308.8	MMBL	ALT.	6407361.		
PLANT TOTALS	256.	186782.			0.084	34.309	10333.	1929.9	BBTU	TOT.	6407361.		

FUEL ESTIMATING PROGRAM
OPERATING FORECAST
FOR ENTIRE STUDY

....UNIT.... NO.	NAME	RATED MW	OUTPUT MWH	.... HOURS.... RUN	BANKED	CAP. FACTOR	NO. STARTS	MILLS /KWH	HEAT RATE	.....FUEL..... QTY.	UNITS	USE	COST	O & M $ EST.
29	ANO 1	836.	5476301.	7392.	0	0.751	1.0	5.9[illegible]	11093.	60746.7	BILBTU	PRI.	32803168.	0.
30	ANO 2	912.	5974456.	7392.	0	0.751	0.0	6.772	11478.	68575.4	BILBTU	PRI.	40459360.	0.
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			11450751.					6.398		53884.2	KG U	PRI.	73262528.	
PLANT TOTALS		1748.	11450751.			0.751		6.398	11294.	129322.1	BBTU	TOT.	73262528.	
31	ARKLOW 1	700.	3525402.	7728.	0	0.577	1.0	14.872	10328.	36409.2	BILBTU	PRI.	52429136.	0.
32	ARKLOW 2	700.	3815619.	8400.	0	0.625	1.0	14.874	10329.	39413.4	BILBTU	PRI.	56755008.	0.
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			7341019.					14.873		4460.2	MTON	PRI.	109184144.	
PLANT TOTALS		1400.	7341019.			0.601		14.873	10329.	75822.6	BBTU	TOT.	109184144.	
33	INDEP 1	700.	4084225.	8064.	0	0.669	1.0	17.157	10213.	41711.0	BILBTU	PRI.	70074272.	0.
34	INDEP 2	700.	3431401.	8416.	314	0.562	0.0	17.586	10468.	35920.4	BILBTU	PRI.	60346112.	0.
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			7515624.					17.353		4566.5	MTON	PRI.	130420384.	
PLANT TOTALS		1400.	7515624.			0.615		17.353	10329.	77631.3	BBTU	TOT.	130420384.	
36	LP-IH-MN	206.	5307.	36.	639	0.003	1.0	48.293	11779.	62.5	BILBTU	PRI.	256249.	0.
37	SIEK/ARC		7452.							66.3	MIL.CF	PRI.	104720.	
37	SIEK/ARC		93514.							147.1	TH.BBL	ALT.	349856.	
37	SIEK/ARC	203.	100966.	568.	3124	0.057	1.0	35.688	9125.	921.3	BILBTU	COMB	3603275.	0.
39	SIEK 5	44.	0.	0.										0.
40	SIEK 6		7115.							72.8	MIL.CF	PRI.	152879.	
40	SIEK 6		156716.							2565.4	TH.BBL	ALT.	5371296.	
40	SIEK 6	224.	1574131.	8736.	0	0.805	0.0	34.219	10232.	16106.6	BILBTU	COMB	53865760.	0.
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			14567.					17.684		139.1	MMCF	PRI.	257593.	
			1660529.					34.454		2712.5	MMBL	ALT.	57211440.	
PLANT TOTALS		471.	1675045.			0.408		34.308	10165.	17027.9	BBTU	TOT.	57469024.	

F U E L E S T I M A T I N G P R O G R A M
OPERATING FORECAST
FOR ENTIRE STUDY

....UNIT.... NO.	NAME	RATED MW	OUTPUT MWH	.... HOURS.... RUN	BANKED	CAP. FACTOR	NO. STARTS	MILLS /KWH	HEAT RATE	.....F U E L..... QTY.	UNITS	USE	COST	O & M $ EST.
46	L OTP 1		1968085.							18316.0	MIL.CF	PRI.	5769540.	
46	L OTP 1		1.							0.0	TH.BBL	ALT.	0.	
46	L OTP 1	244.	1968086.	8736.	0	0.924	0.0	2.932	9772.	19231.8	BILBTU	COMB	5769540.	0.
47	L OTP 2		2484944.							24176.2	MIL.CF	PRI.	7615486.	
47	L OTP 2		1.							0.0	TH.BBL	ALT.	0.	
47	L OTP 2	430.	2484950.	8350.	375	0.648	0.0	3.070	10298.	25585.0	BILBTU	COMB	7615486.	0.
48	L OTP 3		3578239.							32089.9	MIL.CF	PRI.	10083113.	
48	L OTP 3		1096595.							1275.9	TH.BBL	ALT.	38213968.	
48	L OTP 3	573.	4674834.	8736.	0	0.935	0.0	10.331	9393.	43910.7	BILBTU	COMB	48297072.	0.
		8011273.						2.929		74502.1	MMCF	PRI.	23468128.	
		1096597.						34.848		1275.9	MMBL	ALT.	38213968.	
PLANT TOTALS		1253.	9107870.			0.833		9.776	9760.	88527.9	BBTU	TOT.	61682096.	
49	BOMAG 8	19.	0.	0.										0.
50	WINFKU 1	411.	1980327.	5060.	3066	0.554	0.0	29.658	9919.	19702.4	BILBTU	PRI.	58910256.	0.
51	WINFKU 2	411.	1759842.	5124.	3602	0.491	0.0	29.708	9933.	17481.4	BILBTU	PRI.	52269344.	0.
		3740217.						29.678		5949.4	MMBL	PRI.	111179600.	
PLANT TOTALS		822.	3740217.			0.522		29.678	9926.	37183.9	BBTU	TOT.	111179600.	
52	WINFKU 3	1110.	7284480.	7392.	0	0.752	1.0	5.043	10085.	73464.3	BILBTU	PRI.	36732080.	0.
53	WINEMI 1		14808.							162.3	MIL.CF	PRI.	221551.	
53	WINEMI 1		91285.							76.0	TH.BBL	ALT.	1420652.	
53	WINEMI 1	74.	506093.	8760.	5166	0.087	9.0	29.277	11509.	545.6	BILBTU	COMB	1642202.	0.
54	WINEMI 2		7260.							75.3	MIL.CF	PRI.	102741.	
54	WINEMI 2		44355.							164.2	TH.BBL	ALT.	3067796.	
54	WINEMI 2	107.	101621.	1296.	5417	0.109	2.0	31.210	10878.	1105.4	BILBTU	COMB	3171537.	0.
55	WINEMI 3		65554.							629.1	MIL.CF	PRI.	858706.	
55	WINEMI 3		505400.							814.8	TH.BBL	ALT.	15226730.	
55	WINEMI 3	135.	570954.	5180.	3546	0.485	0.0	28.173	10076.	5757.1	BILBTU	COMB	16085435.	0.
56	WINEMI 4		4746824.							42344.2	MIL.CF	PRI.	1333442.	
56	WINEMI 4		1372402.							2216.4	TH.BBL	ALT.	47692816.	
56	WINEMI 4	748.	6119280.	8736.	0	0.938	0.0	9.974	9967.	57316.7	BILBTU	COMB	61031248.	0.
		[illegible]						4.884		44210.9	MMCF	PRI.	14521437.	

		2013501.			33.478		3271.5	MBBL	ALT.	67408972.	
PLANT TOTALS	1064.	5847952.		0.738	11.564	9866.	54820.7	BBTU	TOT.	81930416.	

F U E L E S T I M A T I N G P R O G R A M
OPERATING FORECAST
FOR ENTIRE STUDY

....UNIT.... NO.	NAME	RATED MW	OUTPUT MWH	.... HOURS.... RUN	BANKED	CAP. FACTOR	NO. STARTS	MILLS /KWH	HEAT RATE	.....F U E L..... QTY.	UNITS	USE	COST	O & M $ EST.
45	NINEMI 5		4763954.							43069.0	MIL.CF	PRI.	13566755.	
45	NINEMI 5		1.							0.0	TH.BBL	ALT.	0.	
45	NINEMI 5	763.	4763955.	8736.	0	0.716	0.0	2.848	9493.	45222.5	BILBTU	COMB	13566755.	0.
64	REA BR 1		23225.							301.4	MIL.CF	PRI.	406948.	
64	REA BR 1		0.							0.0	TH.BBL	ALT.	0.	
64	REA BR 1	30.	23225.	704.	3994	0.074	3.0	17.522	12979.	301.4	BILBTU	COMB	406948.	0.
65	REA BR 2	47.	0.	0.										0.
66	REA BR 3		64503.							770.1	MIL.CF	PRI.	1039660.	
66	REA BR 3		0.							0.0	TH.BBL	ALT.	0.	
66	REA BR 3	76.	64503.	1140.	5238	0.097	3.0	16.118	11939.	770.1	BILBTU	COMB	1039660.	0.
67	REA BR 4		1500523.							15051.2	MIL.CF	PRI.	21129040.	
67	REA BR 4		375557.							675.4	TH.BBL	ALT.	10811593.	
67	REA BR 4	231.	1876080.	8736.	0	0.931	0.0	17.025	10430.	19568.4	BILBTU	COMB	31940624.	0.
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			1588250.					14.214		16722.7	MMCF	PRI.	22575648.	
			375557.					28.788		675.4	MBBL	ALT.	10811593.	
PLANT TOTALS		390.	1963807.			0.577		17.001	10510.	20540.0	BBTU	TOT.	33387232.	
68	REA BR 5	11.	0.	0.										0.
69	DELTA 1		0.							0.0	MIL.CF	PRI.	0.	
69	DELTA 1		294770.							502.0	TH.BBL	ALT.	9443582.	
69	DELTA 1	104.	294770.	3584.	3805	0.325	3.0	32.037	10644.	3137.4	BILBTU	COMB	9443582.	0.
70	DELTA 2		0.							0.0	MIL.CF	PRI.	0.	
70	DELTA 2		130640.							222.7	TH.BBL	ALT.	4188862.	
70	DELTA 2	103.	130640.	1628.	6092	0.145	3.0	32.064	10653.	1391.6	BILBTU	COMB	4188862.	0.
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			0.					0.0		0.0	MMCF	PRI.	0.	
			425409.					32.045		724.6	MBBL	ALT.	13632444.	
PLANT TOTALS		207.	425409.			0.236		32.045	10646.	4529.1	BBTU	TOT.	13632444.	
71	NAICH 1		0.							0.0	MIL.CF	PRI.	0.	
71	NAICH 1		204614.							378.3	TH.BBL	ALT.	8606183.	
71	NAICH 1	73.	204614.	3112.	248	0.321	1.0	42.041	11555.	2364.3	BILBTU	COMB	8606183.	0.

FUEL ESTIMATING PROGRAM
OPERATING FORECAST FOR ENTIRE STUDY

....UNIT.... NO.	NAME	RATED MW	OUTPUT MWH	.... HOURS.... RUN	BANKED	CAP. FACTOR	NO. STARTS	MILLS /KWH	HEAT RATE	.....FUEL..... QTY.	UNITS	USE	COST	O & M $ EST.
72	B.MLSN 1		0.											
72	B.MLSN 1		3211639.							0.0	MIL.CF	PRI.	0.	
72	B.MLSN 1	550.	3211639.	1809.	923	0.683	0.0	25.776	9547.	5006.5	TH.BBL	ALT.	84484976.	
										31290.7	BILBTU	COMB	84484976.	0.
73	B.MLSN 2		0.											
73	B.MLSN 2		4475667.							0.0	MIL.CF	PRI.	0.	
73	B.MLSN 2	771.	4475667.	8464.	265	0.665	0.0	24.978	9251.	6624.9	TH.BBL	ALT.	111794848.	
										41405.5	BILBTU	COMB	111794848.	0.
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			0.					0.0		0.0	MMCF	PRI.	0.	
			7753306.					25.316		11631.4	MBBL	ALT.	196279824.	
PLANT TOTALS		1321.	7753306.			0.673		25.316	9376.	72696.2	BBTU	TOT.	196279824.	
80	ANDRUS 1	761.	5615393.	8720.	13	0.846	0.0	23.957	8840.	49641.0	BILBTU	PRI.	134527200.	0.
87	PATRSN 1		0.											
87	PATRSN 1		25866.							0.0	MIL.CF	PRI.	0.	
87	PATRSN 1	46.	25866.	648.	3714	0.064	3.0	36.551	12184.	50.4	TH.BBL	ALT.	945408.	
										315.1	BILBTU	COMB	945408.	0.
88	PATRSN 2		0.											
88	PATRSN 2		22117.							0.0	MIL.CF	PRI.	0.	
88	PATRSN 2	44.	22117.	576.	3116	0.058	1.0	37.112	12371.	43.8	TH.BBL	ALT.	820812.	
										273.6	BILBTU	COMB	820812.	0.
89	PATRSN 3		0.											
89	PATRSN 3		60660.							0.0	MIL.CF	PRI.	0.	
89	PATRSN 3	56.	60660.	1280.	5098	0.124	3.0	33.634	11211.	108.8	TH.BBL	ALT.	2040261.	
										680.1	BILBTU	COMB	2040261.	0.
90	PATRSN 4		0.											
90	PATRSN 4		52862.							0.0	MIL.CF	PRI.	0.	
90	PATRSN 4	87.	52862.	728.	4306	0.070	3.0	34.604	11535.	97.6	TH.BBL	ALT.	1829217.	
										609.7	BILBTU	COMB	1829217.	0.
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			0.					0.0		0.0	MMCF	PRI.	0.	
			161505.					34.895		303.6	MBBL	ALT.	5635697.	
PLANT TOTALS		233.	161505.			0.079		34.895	11632.	1878.6	BBTU	TOT.	5635697.	
91	PATRSN 5	16.	0.	0.										0.
92	MICHOU 1		0.											
92	MICHOU 1		143876.							0.0	MIL.CF	PRI.	0.	
92	MICHOU 1	113.	143876.	1472.	5241	0.146	2.0	32.243	10749.	247.4	TH.BBL	ALT.	4639639.	
										1546.5	BILBTU	COMB	4639639.	0.

F U E L E S T I M A T I N G P R O G R A M
OPERATING FORECAST
FOR ENTIRE STUDY

....UNIT.... NO.	NAME	RATED MW	OUTPUT MWH	.... HOURS.... RUN	BANKED	CAP. FACTOR	NO. STARTS	MILLS /KWH	HEAT RATE	.....F U E L..... QTY.	UNITS	USE	COST	O & M $ EST.
93	MICHOU 2		0.							0.0	MIL.CF	PRI.	0.	
93	MICHOU 2		773934.							1223.6	TH.BBL	ALT.	22942016.	
93	MICHOU 2	244.	773934.	3868.	4858	0.363	0.0	29.643	9881.	7647.4	BILBTU	COMB	22942016.	0.
94	MICHOU 3		0.							0.0	MIL.CF	PRI.	0.	
94	MICHOU 3		1836424.							2928.0	TH.BBL	ALT.	54899856.	
94	MICHOU 3	548.	1836424.	4112.	4279	0.384	1.0	29.895	9965.	18299.9	BILBTU	COMB	54899856.	0.
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			0.					0.0		0.0	MMCF	PRI.	0.	
			2754234.					29.947		4399.0	MBBL	ALT.	82481504.	
PLANT TOTALS		905.	2754234.			0.349		29.947	9982.	27493.8	BBTU	TOT.	82481504.	
83	APEAK	195.	0.	0.										0.
85	APEAK	65.	0.	0.										0.
86	APJPEAK84	150.	1200.	8.	0	0.001	4.0	45.404	11702.	14.0	BILBTU	PRI.	54475.	0.
87	APIPEAK83	50.	8998.	180.	0	0.021	48.0	44.000	11702.	105.3	BILBTU	PRI.	395927.	0.
88	AMP PEAK	50.	0.	0.										0.
14	G.GULF 1	1250.	0.	0.										0.
15	G.GULF 2	1250.	0.	0.										0.
16	COAL PLP	700.	0.	0.										0.
17	LPCOAL 2	700.	0.	0.										0.
18	LPCOAL 3	700.	0.	0.										0.
19	LPCOAL 4	700.	0.	0.										0.
57	LPJPEAK84	150.	31794.	212.	0	0.024	48.0	43.415	11702.	372.1	BILBTU	PRI.	1380340.	0.
58	MPIPEAK84	50.	8998.	180.	0	0.021	48.0	43.532	11702.	105.3	BILBTU	PRI.	391716.	0.
59	MPIPEAK84	50.	400.	8.	0	0.001	4.3	47.979	11702.	4.7	BILBTU	PRI.	19188.	0.
61	SPEAK	50.	0.	0.										0.

F U E L E S T I M A T I N G P R O G R A M

OPERATING FORECAST
FOR ENTIRE STUDY

UNIT NO.	UNIT NAME	RATED MW	OUTPUT MWH	HOURS RUN	HOURS BANKED	CAP. FACTOR	NO. STARTS	MILLS /KWH	HEAT RATE	FUEL QTY.	FUEL UNITS	FUEL USE	FUEL COST	O & M $ EST.
02	MP COAL 2	700.	3700083.	8348.	382	0.601	0.0	19.059	10358.	38387.3	BILBTU	PRI.	70632448.	0.
00	MPCOAL 1	700.	0.	0.										0.
		1400.	3700083.			0.303		19.059		2340.7	MTON	PRI.	70632449.	
PLANT TOTALS		1400.	3700083.			0.303		19.059	10358.	38387.3	BBTU	TOT.	70632448.	
01	COAL BMP	700.	0.	0.										0.
02	MPCOAL 3	700.	0.	0.										0.
03	MPCOAL 4	700.	0.	0.										0.
04	COAL A 1	700.	0.	0.										0.
05	COAL A 2	700.	0.	0.										0.
06	COAL A 3	700.	0.	0.										0.
15	COAL BAP	700.	0.	0.										0.
16	COAL BUA	700.	0.	0.										0.
5	NUC A 1	1200.	0.	0.										0.
6	NUC A 2	1200.	0.	0.										0.
														0.

FUEL ESTIMATING PROGRAM
MONTHLY ENERGY, COST, AND QUANTITY SUMMARY BY FUELS
NATURAL GAS

ENERGY GENERATED - MWH

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
APL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LPL	1497648.	1347095.	1465409.	1450927.	1503103.	1481968.	1511252.	1511740.	1461455.	1504472.	1455016.	1453937.	17623776.
MPL	136292.	123090.	136197.	131742.	135910.	129736.	133797.	132940.	130201.	134993.	131662.	131682.	1588240.
NUPS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	1633940.	1470785.	1601601.	1582669.	1639013.	1611703.	1645049.	1644679.	1591656.	1639465.	1586677.	1585618.	19212016.

FUEL COST - THOUSANDS OF DOLLARS

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
APL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LPL	4413.	3967.	4330.	4274.	4417.	4290.	4418.	4464.	4279.	4420.	4279.	4263.	51814.
MPL	1920.	1735.	1919.	1857.	1920.	1806.	1926.	1926.	1867.	1920.	1859.	1859.	22576.
NUPS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	6333.	5702.	6249.	6131.	6337.	6196.	6360.	6370.	6146.	6339.	6138.	6122.	74390.

THERMAL HEAT ENERGY - BILLIONS OF BTU

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
APL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LPL	14413.	12958.	14138.	13961.	14422.	13955.	14433.	14430.	13943.	14408.	13977.	13923.	168962.
MPL	1422.	1285.	1422.	1376.	1422.	1382.	1428.	1426.	1383.	1422.	1377.	1377.	16723.
NUPS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	15837.	14243.	15560.	15338.	15844.	15337.	15861.	15856.	15326.	15830.	15354.	15300.	185685.

MILLION OF CUBIC FEET - MMCF

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
APL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
LPL	13769.	12341.	13460.	13296.	13736.	13291.	13747.	13743.	13280.	13722.	13311.	13260.	160921.
MPL	1422.	1285.	1422.	1376.	1422.	1382.	1428.	1426.	1383.	1422.	1377.	1377.	16723.
NUPS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	15191.	13626.	14882.	14672.	15158	14673.	15175.	15179.	14663.	15144.	14688.	14637.	177644.

FUEL ESTIMATING PROGRAM
MONTHLY ENERGY, COST, AND QUANTITY SUMMARY BY FUELS
NO. 6 FUEL OIL

ENERGY GENERATED - MWH

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	414.	3764.	3995.	4297.	2147.	1383.	0.	0.	16000.
APL	343404.	339688.	251743.	296043.	403005.	615223.	628505.	626236.	613592.	528002.	423875.	478491.	5548156.
LPL	500378.	447007.	326538.	377760.	443665.	578512.	564752.	581639.	590794.	514604.	502706.	526084.	5954429.
MPL	1135250.	1049255.	1053037.	1059707.	1129354.	1256549.	1267138.	1296884.	1235660.	1155748.	1150600.	1179562.	13990744.
NOPS	199262.	188193.	91738.	143989.	183746.	333437.	336748.	341918.	317431.	266368.	241720.	270595.	2915742.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	2178292.	2024742.	1723106.	1877498.	2160184.	2791784.	2801138.	2850973.	2759623.	2466104.	2318900.	2454731.	28433040.

FUEL COST - THOUSANDS OF DOLLARS

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	16.	149.	153.	171.	85.	55.	0.	0.	636.
APL	10688.	10554.	7802.	9149.	12539.	19277.	19812.	19779.	19287.	16549.	13107.	14851.	173396.
LPL	15552.	13910.	10271.	11668.	13701.	17930.	17486.	17989.	18323.	15890.	15595.	16294.	184609.
MPL	28620.	25961.	26129.	26286.	28463.	32705.	32822.	33631.	31734.	28830.	28599.	29264.	353046.
NOPS	5962.	5654.	2769.	4344.	5514.	10147.	10236.	10453.	9625.	8038.	7267.	8108.	88117.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	60822.	56079.	46971.	51446.	60235.	80208.	80514.	82024.	79055.	69362.	64569.	68518.	799804.

THERMAL HEAT ENERGY - BILLIONS OF BTU

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	5.	44.	47.	51.	25.	16.	0.	0.	189.
APL	3425.	3385.	2514.	2939.	3995.	6104.	6252.	6245.	6098.	5252.	4193.	4743.	55145.
LPL	5019.	4488.	3311.	3791.	4441.	5820.	5666.	5834.	5952.	5163.	5053.	5274.	59812.
MPL	10581.	9597.	9662.	9718.	10425.	11605.	11838.	12130.	11495.	10624.	10551.	10805.	129231.
NOPS	1987.	1885.	923.	1448.	1838.	3382.	3412.	3484.	3208.	2679.	2422.	2703.	29372.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	21013.	19354.	16410.	17896.	20704.	27155.	27215.	27785.	26778.	23734.	22219.	23524.	273749.

THOUSANDS OF BARRELS

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	1.	7.	8.	8.	4.	3.	0.	0.	30.
APL	548.	542.	402.	470.	639.	977.	1000.	999.	976.	840.	671.	759.	8923.
LPL	803.	718.	530.	607.	711.	931.	907.	933.	952.	826.	808.	844.	9570.
MPL	1693.	1536.	1540.	1555.	1668.	1859.	1894.	1941.	1839.	1700.	1688.	1729.	20677.
NOPS	314.	302.	148.	232.	294.	541.	546.	558.	513.	427.	388.	432.	4700.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	3362.	3097.	2620.	2863.	3313.	4345.	4356.	4419.	4285.	3794.	3555.	3764.	43800.

FUEL ESTIMATING PROGRAM
MONTHLY ENERGY, COST, AND QUANTITY SUMMARY BY FUELS
NO. 2 FUEL OIL

ENERGY GENERATED - MWH

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	6625.	212324.	54169.	79886.	31739.	15088.	0.	0.	399831.
APL	0.	0.	0.	0.	1533.	13094.	13595.	11971.	8601.	5364.	0.	0.	54757.
LPL	44932.	152976.	34293.	97719.	175119.	337644.	351612.	360276.	331864.	260189.	183534.	264838.	2599997.
MPL	24122.	22364.	19283.	22802.	25470.	43107.	47387.	53263.	40995.	33187.	26023.	26366.	384969.
NOPS	0.	0.	0.	0.	157.	2614.	2142.	2557.	1028.	300.	0.	0.	8998.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	69054.	175340.	53576.	120522.	208904.	609584.	468906.	507953.	414228.	314128.	209558.	296204.	3448549.

FUEL COST - THOUSANDS OF DOLLARS

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	298.	9555.	2441.	3596.	1428.	679.	0.	0.	17996.
APL	0.	0.	0.	0.	64.	570.	570.	502.	359.	223.	0.	0.	2287.
LPL	1993.	5323.	1198.	3401.	6102.	11877.	12399.	12701.	11614.	9094.	6385.	9383.	91042.
MPL	712.	644.	556.	656.	736.	1284.	1401.	1575.	1196.	960.	749.	759.	11227.
NOPS	0.	0.	0.	0.	7.	122.	93.	111.	45.	13.	0.	0.	392.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	2277.	5967.	1753.	4057.	7206.	23408.	16903.	18485.	14642.	10969.	7134.	10142.	122944.

THERMAL HEAT ENERGY - BILLIONS OF BTU

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	66.	2123.	543.	799.	317.	151.	0.	0.	4000.
APL	0.	0.	0.	0.	17.	149.	149.	131.	94.	58.	0.	0.	599.
LPL	422.	1435.	323.	917.	1643.	3181.	3318.	3395.	3118.	2442.	1721.	2529.	24443.
MPL	238.	233.	201.	238.	266.	453.	497.	559.	429.	347.	271.	275.	4027.
NOPS	0.	0.	0.	0.	2.	33.	25.	30.	12.	4.	0.	0.	105.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	660.	1668.	524.	1155.	1994.	5939.	4533.	4914.	3970.	3002.	1993.	2804.	33174.

THOUSANDS OF BARRELS

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	11.	366.	94.	138.	55.	26.	0.	0.	690.
APL	0.	0.	0.	0.	3.	26.	26.	23.	16.	10.	0.	0.	103.
LPL	73.	247.	56.	158.	283.	548.	572.	585.	538.	421.	297.	436.	4214.
MPL	44.	40.	35.	41.	46.	78.	85.	96.	74.	60.	47.	47.	694.
NOPS	0.	0.	0.	0.	0.	5.	4.	5.	2.	1.	0.	0.	18.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	117.	288.	90.	199.	344.	1024.	781.	847.	684.	518.	344.	483.	5720.

FUEL ESTIMATING PROGRAM
MONTHLY ENERGY, COST, AND QUANTITY SUMMARY BY FUELS
NUCLEAR

ENERGY GENERATED - MWH

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
APL	1126320.	1017329.	1188493.	568770.	1022083.	1130235.	1222334.	1222334.	1117867.	1126328.	597061.	521225.	11450756.
LPL	0.	69402.	111153.	694019.	111153.	118662.	775918.	775918.	711080.	717153.	694019.	694019.	7284493.
MPL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NOPS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	1126320.	1086730.	1299998.	1262789.	1739236.	1898917.	1998251.	1998251.	1828946.	1843481.	1291079.	1215243.	18735232.

FUEL COST - THOUSANDS OF DOLLARS

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
APL	1207.	6510.	5123.	3852.	6583.	7231.	7818.	7818.	7152.	7207.	3637.	3123.	73263.
LPL	0.	350.	3621.	3504.	3621.	3621.	3901.	3901.	3585.	3621.	3504.	3504.	36732.
MPL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NOPS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	1207.	6860.	8745.	7356.	10203.	10852.	11719.	11719.	10737.	10828.	7141.	6627.	109995.

THERMAL HEAT ENERGY - MILLIONS OF BTU

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
APL	12122.	11491.	8807.	6528.	11566.	12104.	13800.	13800.	12625.	12722.	6654.	5784.	129322.
LPL	0.	701.	7241.	7008.	7241.	7243.	7802.	7802.	7170.	7241.	7008.	7008.	73464.
MPL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NOPS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	12122.	12192.	16048.	13536.	18807.	20006.	21601.	21601.	19795.	19964.	13662.	12792.	202786.

KILOGRAMS OF URANIUM

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
APL	5301.	4738.	3699.	2720.	4819.	5318.	5750.	5750.	5260.	5301.	2773.	2410.	53884.
LPL	0.	292.	3017.	2920.	3017.	3018.	3251.	3251.	2988.	3017.	2920.	2920.	30610.
MPL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
NOPS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	5301.	5030.	6716.	5640.	7836.	8336.	9001.	9001.	8248.	8318.	5692.	5330.	84494.

FUEL ESTIMATING PROGRAM
MONTHLY ENERGY, COST, AND QUANTITY SUMMARY BY FUELS
COAL

ENERGY GENERATED - MWH

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
APL	1120014.	750812.	1142988.	1112489.	1159319.	1431218.	1958142.	1958142.	1289270.	862474.	941517.	1118503.	14856672.
LPL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MPL	253833.	244160.	267959.	244272.	238149.	354495.	489536.	489536.	325599.	269623.	264467.	264467.	3706088.
NOPS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	1373847.	1000972.	1410920.	1356761.	1397468.	1785712.	2447677.	2447677.	1614869.	1132097.	1205984.	1382970.	18562736.

FUEL COST - THOUSANDS OF DOLLARS

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
APL	18396.	12100.	18079.	18192.	18974.	22801.	30664.	30664.	20780.	14454.	15601.	18300.	239605.
LPL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MPL	4921.	4734.	5197.	4735.	4617.	6884.	9042.	9042.	6182.	5227.	5127.	5127.	70633.
NOPS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	23318.	16833.	23276.	22927.	23590.	29685.	39706.	39706.	26961.	19681.	20727.	23427.	310237.

THERMAL HEAT ENERGY - BILLIONS OF BTU

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
APL	11813.	7983.	11983.	11665.	12158.	14935.	19656.	19656.	13265.	9038.	9871.	11729.	153454.
LPL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MPL	2674.	2573.	2824.	2574.	2509.	3733.	4914.	4914.	3360.	2841.	2786.	2786.	38387.
NOPS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	14487.	10555.	14807.	14238.	14667.	18667.	24571.	24571.	16625.	11879.	12657.	14516.	191841.

THOUSANDS OF TONS

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
APL	675.	470.	705.	686.	715.	881.	1155.	1156.	780.	532.	581.	690.	9027.
LPL	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MPL	163.	157.	172.	157.	153.	222.	300.	300.	205.	173.	170.	170.	2341.
NOPS	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	838.	626.	877.	843.	868.	1102.	1456.	1456.	985.	705.	751.	860.	11367.

FUEL ESTIMATING PROGRAM
MONTHLY ENERGY, COST, AND QUANTITY SUMMARY BY FUELS
ALL FUELS

ENERGY GENERATED - MWH

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	7039.	21[illegible]088.	58164.	[illegible]4182.	33885.	16471.	0.	0.	415831.
APL	2595750.	2113627.	2173606.	1977302.	2545539.	3199[illegible]88.	3822575.	3818683.	3029329.	2522168.	1962453.	2118218.	31910336.
LPL	2042556.	2017078.	2543447.	2619924.	2839038.	3096785.	3203[illegible]42.	3229571.	3095193.	2996416.	2835274.	2943877.	33462656.
MPL	1570095.	1438868.	1476474.	1458523.	1528883.	1743385.	1937857.	1972681.	1732450.	1593551.	1572751.	1602075.	19678032.
NOPS	199292.	188793.	91738.	143989.	183903.	338251.	338891.	344475.	318460.	266667.	241720.	270595.	2924740.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	6407664.	5758367.	6285266.	6199738.	7144804.	8633695.	9461030.	9[illegible]2532.	8209318.	7395274.	6612197.	6934765.	88391568.

FUEL COST - THOUSANDS OF DOLLARS

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	315.	9[illegible]04.	2599.	3761.	1513.	734.	0.	0.	18632.
APL	36293.	29164.	31606.	31192.	38160.	45879.	58864.	58763.	47578.	38434.	32344.	36275.	488550.
LPL	21530.	23552.	19420.	22846.	27840.	37718.	38223.	39835.	37801.	33025.	29763.	33443.	364197.
MPL	36173.	33073.	33800.	33534.	35737.	42538.	45193.	46174.	40979.	36937.	36334.	37009.	457481.
NOPS	5962.	5654.	2769.	4344.	5520.	10269.	10329.	10565.	9670.	8051.	7267.	8108.	88509.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	99958.	91442.	87595.	91917.	107572.	150108.	155208.	158303.	137541.	117179.	105709.	114835.	1417368.

THERMAL HEAT ENERGY - MILLIONS OF BTU

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	71.	21[illegible]8.	590.	859.	343.	167.	0.	0.	4189.
APL	27963.	22859.	23363.	21132.	27135.	33051.	39857.	39833.	32081.	27071.	20718.	22256.	338520.
LPL	19856.	19581.	25019.	25676.	27748.	30198.	31219.	31461.	30183.	29254.	27758.	28734.	326691.
MPL	14936.	13688.	14109.	13904.	14622.	17213.	18678.	19029.	16667.	15233.	14986.	15243.	188368.
NOPS	1987.	1885.	923.	1448.	1840.	3415.	3437.	3514.	3221.	2683.	2422.	2703.	29478.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	64742.	58013.	63409.	62161.	72016.	86704.	93781.	94687.	82494.	74409.	65884.	68935.	887236.

FUEL ESTIMATING PROGRAM
NATURAL GAS
BILLIONS OF BTU AND MILLIONS OF CUBIC FEET, ACTUAL USE

CONTRACT		JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR	
1	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
3	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
4	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
5	BBTU=	5611.	5990.	6563.	6468.	6692.	6468.	6691.	6686.	6464.	6680.	6463.	6452.	78227.	
	MMCF=	6296.	5705.	6230.	6160.	6373.	6160.	6372.	6367.	6156.	6362.	6155.	6145.	74502.	
6	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	UNTD
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	IXCO
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
7	BBTU=	7721.	6892.	7492.	7412.	7645.	7391.	7643.	7639.	7390.	7637.	7433.	7390.	89684.	
	MMCF=	7353.	6564.	7135.	7059.	7281.	7039.	7279.	7275.	7038.	7273.	7079.	7038.	85413.	
8	BBTU=	0.	0.	0.	0.	2.	14.	16.	21.	8.	7.	0.	0.	68.	
	MMCF=	0.	0.	0.	0.	2.	14.	15.	21.	8.	7.	0.	0.	66.	
9	BBTU=	1422.	1285.	1422.	1376.	1422.	1382.	1428.	1426.	1383.	1422.	1377.	1377.	16723.	
	MMCF=	1422.	1285.	1422.	1376.	1422.	1382.	1428.	1426.	1383.	1422.	1377.	1377.	16723.	
10	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
11	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
12	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
13	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
15	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
18	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
20	BBTU=	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	73.	
	MMCF=	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	73.	
23	BBTU=	77.	70.	77.	75.	77.	75.	77.	77.	75.	77.	75.	75.	910.	
	MMCF=	74.	67.	74.	71.	74.	71.	74.	74.	71.	74.	71.	71.	867.	
TOTAL	BBTU=	15837.	14243.	15560.	15336.	15844.	15337.	15861.	15856.	15326.	15830.	15354.	15300.	185685.	
	MMCF=	15151.	13626.	14887.	14672.	15158.	14673.	15175.	15170.	14663.	15144.	14688.	14637.	177644.	

FUEL ESTIMATING PROGRAM
NATURAL GAS
BILLIONS OF BTU AND MILLIONS OF CUBIC FEET, AVAILABLE

CONTRACT		JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR	
1	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
3	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
4	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
5	BBTU=	6985.	6321.	7016.	6763.	7016.	6763.	6985.	7016.	6763.	6985.	6795.	6763.	82173.	
	MMCF=	6652.	6020.	6682.	6441.	6682.	6441.	6652.	6682.	6441.	6652.	6471.	6441.	78260.	
6	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	UNTD
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	TXCO
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
7	BBTU=	8122.	7350.	8158.	7864.	8158.	7864.	8122.	8158.	7864.	8122.	7901.	7864.	95550.	
	MMCF=	7735.	7000.	7770.	7490.	7770.	7490.	7735.	7770.	7490.	7735.	7525.	7490.	91000.	
8	BBTU=	32.	29.	32.	31.	32.	31.	32.	32.	31.	32.	31.	31.	373.	
	MMCF=	31.	28.	31.	30.	31.	30.	31.	31.	30.	31.	30.	30.	364.	
9	BBTU=	1423.	1288.	1430.	1378.	1430.	1378.	1423.	1430.	1378.	1423.	1385.	1378.	16744.	
	MMCF=	1423.	1288.	1430.	1378.	1430.	1378.	1423.	1430.	1378.	1423.	1385.	1378.	16744.	
10	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
11	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
12	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
13	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
15	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
18	BBTU=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
	MMCF=	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
20	BBTU=	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	73.	
	MMCF=	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	6.	73.	
23	BBTU=	81.	73.	82.	79.	82.	79.	81.	82.	79.	81.	79.	79.	955.	
	MMCF=	77.	70.	78.	75.	78.	75.	77.	78.	75.	77.	75.	75.	910.	
TOT	BBTU=	16049.	15067.	16724.	16121.	16724.	16121.	16649.	16724.	16121.	16649.	16197.	16121.	195868.	
	MMCF=	15925.	14412.	15997.	15420.	15997.	15420.	15925.	15997.	15420.	15925.	15492.	15420.	187350.	

F U E L E S T I M A T I N G P R O G R A M
N A T U R A L G A S
B I L L I O N S O F B T U A N D M I L L I O N S O F C U B I C F E E T, (A V A I L-U S E)

CONTRACT	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR	
1 BBTU-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
MMCF-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
3 BBTU-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
MMCF-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
4 BBTU-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
MMCF-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
5 BBTU-	374.	331.	454.	295.	324.	295.	294.	331.	309.	304.	332.	311.	3946.	
MMCF-	356.	315.	432.	281.	309.	281.	280.	315.	285.	290.	316.	297.	3758.	
6 BBTU-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	UNTO
MMCF-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
BBTU-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	TXCO
MMCF-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
7 BBTU-	401.	458.	666.	453.	514.	473.	479.	519.	474.	485.	468.	475.	5866.	
MMCF-	382.	436.	635.	431.	489.	451.	456.	495.	452.	462.	446.	452.	5586.	
8 BBTU-	32.	29.	32.	31.	30.	16.	16.	11.	22.	25.	31.	31.	305.	
MMCF-	31.	28.	31.	30.	30.	16.	16.	10.	22.	24.	30.	30.	298.	
9 BBTU-	1.	3.	8.	3.	1.	-4.	-5.	3.	-5.	1.	8.	1.	21.	
MMCF-	1.	3.	8.	3.	1.	-4.	-5.	3.	-5.	1.	8.	1.	21.	
10 BBTU-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
MMCF-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
11 BBTU-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
MMCF-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
12 BBTU-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
MMCF-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
13 BBTU-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
MMCF-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
15 BBTU-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
MMCF-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
18 BBTU-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
MMCF-	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	
20 BBTU-	-0.	0.	0.	-0.	0.	-0.	-0.	0.	-0.	-0.	0.	-0.	-0.	
MMCF-	-0.	0.	0.	-0.	0.	-0.	-0.	0.	-0.	-0.	0.	-0.	0.	
23 BBTU-	4.	4.	4.	4.	4.	4.	4.	4.	4.	4.	4.	4.	45.	
MMCF-	4.	3.	4.	3.	4.	3.	4.	4.	3.	4.	4.	3.	43.	
TOTBBTU-	811.	824.	1104.	785.	880.	785.	787.	868.	795.	819.	843.	822.	10183.	
MMCF-	774.	785.	1110.	749.	839.	748.	750.	827.	758.	781.	804.	783.	9706.	

FUEL ESTIMATING PROGRAM
MONTHLY OIL SUMMARY BY PLANTS
NO. 2 FUEL OIL

THOUSANDS OF BARRELS

PLANT	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
BLYT	0.	0.	0.	0.	0.	0.	1.	0.	0.	0.	0.	0.	2.
AMP	0.	0.	0.	0.	11.	366.	92.	137.	55.	26.	0.	0.	688.
AMP	0.	0.	0.	0.	11.	366.	94.	138.	55.	26.	0.	0.	690.
LYNC	0.	0.	0.	0.	3.	26.	24.	22.	16.	10.	0.	0.	101.
APSP	0.	0.	0.	0.	0.	0.	1.	1.	0.	0.	0.	0.	2.
APL	0.	0.	0.	0.	3.	26.	26.	23.	16.	10.	0.	0.	103.
SYEM	0.	0.	0.	0.	3.	34.	32.	43.	21.	14.	0.	0.	147.
LPSP	73.	103.	56.	82.	124.	230.	240.	239.	226.	193.	147.	127.	1840.
LP-1	0.	0.	0.	0.	0.	0.	6.	4.	0.	0.	0.	0.	11.
MINE	0.	144.	0.	76.	157.	285.	293.	299.	290.	214.	150.	309.	2216.
LPL	73.	247.	56.	158.	284.	548.	572.	585.	538.	421.	297.	436.	4214.
RLA	44.	40.	35.	41.	46.	72.	81.	91.	72.	59.	47.	47.	675.
MPLP	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	1.
MPLP	0.	0.	0.	0.	0.	6.	4.	5.	2.	1.	0.	0.	18.
MPL	44.	40.	35.	41.	46.	78.	86.	96.	74.	60.	47.	47.	694.
NPLP	0.	0.	0.	0.	0.	6.	4.	5.	2.	1.	0.	0.	18.
NUPS	0.	0.	0.	0.	0.	6.	4.	5.	2.	1.	0.	0.	18.
TOT	117.	288.	90.	199.	344.	1024.	781.	847.	684.	518.	344.	483.	5720.

FUEL ESTIMATING PROGRAM
MONTHLY OIL SUMMARY BY PLANTS
NO. 6 FUEL OIL

THOUSANDS OF BARRELS

PLANT	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
J.H1	0.	0.	0.	0.	1.	7.	8.	8.	4.	3.	0.	0.	30.
AMP	0.	0.	0.	0.	1.	7.	8.	8.	4.	3.	0.	0.	30.
COOC	55.	50.	55.	53.	87.	142.	149.	149.	142.	120.	53.	53.	1109.
LCAI	96.	95.	11.	49.	131.	226.	267.	225.	234.	188.	154.	205.	1881.
MOSE	0.	0.	0.	1.	4.	25.	30.	38.	22.	16.	1.	1.	138.
RITC	396.	395.	336.	364.	409.	534.	494.	508.	515.	488.	457.	492.	5387.
MC C	1.	2.	0.	3.	8.	49.	60.	79.	63.	28.	6.	8.	309.
APL	548.	542.	402.	470.	639.	977.	1000.	999.	976.	840.	671.	759.	8823.
STEM	242.	219.	165.	148.	187.	235.	242.	242.	234.	202.	217.	233.	2565.
WIRF	473.	448.	319.	401.	448.	586.	554.	561.	595.	524.	503.	532.	5949.
NINE	83.	51.	46.	58.	76.	110.	110.	131.	123.	100.	89.	78.	1055.
LPL	803.	718.	530.	607.	711.	931.	907.	933.	952.	826.	808.	844.	9570.
UELI	4.	4.	1.	5.	48.	144.	147.	152.	121.	39.	35.	25.	725.
MPIP	0.	0.	0.	0.	31.	87.	91.	93.	72.	5.	0.	0.	378.
MPIP	1001.	876.	909.	923.	943.	993.	990.	1027.	980.	988.	979.	1007.	11631.
ANOR	669.	635.	640.	627.	646.	664.	667.	669.	666.	669.	674.	697.	7943.
MPL	1693.	1536.	1546.	1555.	1668.	1889.	1894.	1941.	1839.	1700.	1688.	1729.	20677.
PATH	1.	1.	0.	2.	9.	61.	50.	77.	45.	28.	10.	6.	301.
NPIP	317.	300.	148.	229.	285.	489.	485.	480.	469.	401.	378.	426.	4399.
NOPS	316.	302.	148.	232.	294.	541.	546.	558.	513.	429.	388.	432.	4700.
TOT	3382.	3097.	2620.	2863.	3313.	4345.	4354.	4439.	4285.	3798.	3555.	3764.	43400.

F U E L E S T I M A T I N G P R O G R A M
M O N T H L Y E N E R G Y C O S T A N D A V E R A G E H E A T R A T E

E N E R G Y C O S T S - M I L S/K W H

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.0	0.0	0.0	0.0	44.6873	44.9074	44.6871	44.7478	44.6643	44.5535	0.0	0.0	44.8067
APL	13.9313	13.7480	14.5410	13.7753	14.7567	15.0327	15.3990	15.3882	15.7057	15.2384	16.4816	17.1250	15.3101
LPL	10.5409	11.0761	7.6352	8.7202	9.8092	12.1797	11.9315	12.0869	12.2128	11.0214	10.4976	11.3603	10.8837
MPL	23.0304	22.9456	22.8926	22.9920	23.3745	23.7130	23.3212	23.4073	23.6537	23.1781	23.1019	23.1008	23.2483
NOPS	29.7223	29.9966	30.1807	30.1685	30.0185	30.5399	30.4798	30.6691	30.3657	30.1900	30.0657	29.9643	30.2621
MSE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTL	15.5347	15.8794	13.9366	14.8259	15.0560	17.3863	16.5802	16.7525	16.7543	15.8452	15.9869	16.5594	16.0351

A V E R A G E H E A T R A T E S - B T U/K W H

COMPANY	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTAL YEAR
AMP	0.	0.	0.	0.	10107.	10032.	10.46.	10100.	10115.	10152.	0.	0.	10074.
APL	10773.	10815.	10749.	10688.	10723.	10547.	10427.	10431.	10590.	10733.	10557.	10507.	10608.
LPL	9721.	9708.	9635.	9800.	9774.	9751.	9745.	9741.	9752.	9763.	9790.	9760.	9763.
MPL	9513.	9513.	9550.	9533.	9564.	9629.	9638.	9647.	9620.	9559.	9528.	9515.	9573.
NOPS	9974.	9982.	10060.	10056.	10004.	10156.	10142.	10202.	10113.	10060.	10022.	9988.	10079.
MSE	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
TOTL	10104.	10075.	10089.	10026.	10080.	10043.	10018.	10020.	10049.	10062.	9964.	9941.	10038.

ENERGY MWH
DISPOSITION

SUMMARY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
BASIC LOAD	6442799	5835263	6388463	6332114	7293696	8818117	9537926	9525898	8374250	7512112	6703759	7010333	89924644
PSH-PUMPING	0	0	0	0	0	0	0	0	0	0	0	0	0
STS SALES	88146	79616	59798	19886	20548	22718	29013	29185	26443	26527	67101	91099	560130
TOTAL DISPOS	6530945	5914879	6448261	6352000	7314244	8840895	9566939	9555083	8400693	7538639	6770860	7101422	90484774
THERMAL	6407664	5758367	6285266	6199734	7144804	8633649	9361030	9449532	8209318	7395274	6612107	6934765	88391568
PSH-GEN	0	0	0	0	0	0	0	0	0	0	0	0	0
PUMP	0	0	0	0	0	0	0	0	0	0	0	0	0
STS PUR	173281	156512	162995	152266	169440	207146	205909	205551	191375	143365	158663	166657	2093206
HUR	0	0	0	0	0	0	0	0	0	0	0	0	0
T RESOURCES	6580945	5914879	6448261	6352000	7314244	8840895	9566939	9655083	8400693	7538639	6770860	7101422	90484774

GG
ER

QUESTION

300.2 (8.1) Discuss the benefits of replacing scarce fossil fuels and of reduced pollution associated with having Grand Gulf on-line.

RESPONSE

FER subsection 8.1.1 has been revised to include the information requested in the above question.

GG
ER

QUESTION

300.3 (1.1) Explain status of New Madrid plant (116 MW) and why it is not included in capacity reported in Tables 1.1.13 thru 1.1.15.

RESPONSE

The 116 MW of capacity identified as New Madrid represents the purchase of a portion of the output of a coal-fired unit owned by another utility. This capacity is not reported in Table 1.1.13; however, it is included in the "Purchase Without Reserves" shown on line 3 of Tables 1.1.14 and 1.1.15.

GG
ER

QUESTION

300.4 (1.1) Assumed curtailments for L. Cath 4, and Ritchie 1 and 2 as reported in Table 1.1.13 appear excessive given that you assume oil will be available. Explain this apparent discrepancy.

RESPONSE

The nominal oil ratings for Lake Catherine 4, Ritchie 1, and Ritchie 2 are 459 MW, 310 MW, and 510 MW, respectively, as shown on Table 1.1.13. These units were originally designed for gas-firing and, subsequently, modified to permit oil-burning. These nominal oil ratings are the values which would prevail when the units have just been maintained and "clean." Because of the size and efficiency of these units, they are typically kept on-line as much as practicable and, consequently, cannot be removed from service for frequent cleaning. The actual capability of these units after extended periods of oil burning would be degraded substantially below their nominal oil ratings. The monthly ratings shown on Table 1.1.13 represent a 5 percent degradation, which is considered typical.

GG
ER

QUESTION

300.5 (8.1) Correct or explain difference in 1975 per capita income figures reported for Claiborne County, the state of Mississippi, and the U.S.----ER page 8.1.4 and 8.1A-3&4.

RESPONSE

The 1975 per capita income figures reported on pages 8.1A-3 and 8.1A-4 were obtained by our consultant Recon, Inc. from the 1976-1977 Marketing Economics Guide for use in an August 1977 report which is included in the FER as Appendix A to Section 8.1. The figures reported on page 8.1-4 were obtained in November 1977 from the Mississippi Research and Development Center. Since per capita income figures are updated continuously as more income tax returns for a given year are received, figures for a given year may change as later tax forms are incorporated.

GG
ER

QUESTION

300.6 (8.1) Estimate the Grand Gulf Nuclear property tax that will accrue to Claiborne County and any other legal entity once the Grand Gulf units go operational -- provide levelized (annual) value.

RESPONSE

FER subsection 8.1.2.3 has been revised to include the information requested in the above question. In addition, tax benefits have been amended to reflect an estimated construction cost of $2.3 billion in contrast to the previously reported $1.9 billion.

GG
ER

QUESTION

300.7 (General) In addition to responses to other specifically requested information, provide a summary and discussion of differences between currently projected environmental effects of the nuclear power station (including those that would degrade and those that would enhance environmental conditions) and the effects discussed in the environmental report submitted at the construction stage.

RESPONSE

Table 300.7.1 (attached) has been developed in response to the above question.

GG
ER

TABLE 300.7.1

SUMMARY AND DISCUSSION OF DIFFERENCES BETWEEN THE ENVIRONMENTAL EFFECTS PROJECTED IN THE CONSTRUCTION STAGE ER(ER-CPS) AND THOSE SET FORTH IN THE FINAL ENVIRONMENTAL REPORT (FER)

ER-CPS		FER		
SECTION	HEADING AND SUMMARY	SECTION	HEADING AND SUMMARY	COMMENTS
4.1	Construction Planning	4.1	Site Preparation and Station Construction	
4.1.1	Introduction Land Areas Affected, acres Site area 2224 Permanent facilities (total) 116 Bluff 111 Lowland 5 Disturbed areas (total) 329 Bluff forest 225 Bluff field 71 Lowland forest 26 Lowland field 7	4.1.1	Introduction Land Areas Affected, acres Site area 2170 Permanent facilities (total) 124 Bluff 111 Lowland 13 Disturbed areas (total) 465 Bluff forest 274 Bluff field 100 Lowland forest 76 Lowland field 15	CPS values were estimates, while FER values are actual. Differences in lowlands utilization due mainly to change in service water system to radial collector wells (FER), and discharge system.
See also "Environmental Field Measurements Program, Final Report."*				
4.1.4	Schedule Commercial operation of Unit 1 set for June 1979. Commercial operation of Unit 2 set for Dec. 1980.	4.1.2	Summary of Construction Activities	
		4.1.2.1	Schedule Commercial operation of Unit 1 set for April 1981. Commercial operation of Unit 2 set for Jan. 1984.	
4.1.5	Manpower Requirements Peak manpower: 2500 men during second quarter of 1976	4.1.2.2	Manpower Requirements Peak manpower: 4200 men during second quarter of 1978	
4.1.2.a.	Clearing and Grubbing Cleared Areas, acres Bluff forest 225 Lowland forest 26 Timber sales $106,000 estimated	4.1.2.3	Site Preparation	CPS values were estimates. FER values are actual. Differences in lowlands due to changes in service water and discharge systems.
		4.1.2.3.1	Clearing and Grubbing Cleared areas, acres Bluff forest 274 Lowland forest 76 Timber sales $17,845 (actual)	
See also "Environmental Field Measurements Program, Final Report."*				

GG
ER

TABLE 300.7.1 (continued)

ER-CPS		FER		
SECTION	HEADING AND SUMMARY	SECTION	HEADING AND SUMMARY	COMMENTS
4.1.2.b.	Excavation and Spoil Deposition Excavation, million cubic yards Bluff (total) 6.00 Bring site to grade 5.25 Main power block 0.77 Lowlands 0.90 Spoil Disposal, million cubic yards 4+ See also "Environmental Field Measurements Program, Final Report."*	4.1.2.3.2	Excavation and Spoil Disposal Excavation, million cubic yards Bluff 6.66 To bring site to grade 5.88 Main power block 0.78 Lowlands 2.2	CPS values were estimates. FER stage values are actual. Lowlands values (FER) due to use of radial wells and additional material from borrow pit.
4.1.2.3.c.	Dewatering Dewatering of power block excavation only.	4.1.2.3.3	Dewatering Dewatering effluent from radial well construction discharged to Mississippi River.	Radial collector wells adopted subsequent to CPS submittal.
CPS section not included. See also "Environmental Field Measurements Program, Final Report."*		4.1.2.4.2.c	Barge Landing Covers 8 acres. 190,000 cubic yards excavated. Traffic expected to total 10 barges.	Plans not complete at time of CPS submittal.
CPS section not included. See also "Environmental Field Measurements Program, Final Report."*		4.1.2.4.3.g	Sanitary Waste Disposal 2500 gpd treatment plant constructed to handle early construction stage sanitary wastes.	Local soil condition precluded a septic system.
Section not in CPS. See "Environmental Field Measurements Program, Final Report."*		4.1.4.1.1	Effects on Ground Water Resources Dewatering of radial wells had no appreciable effects on water table which fluctuates with Mississippi River water levels.	Radial wells adopted subsequent to CPS submittal.
Section not in CPS. See "Environmental Field Measurements Program, Final Report."*		4.1.4.1.2	Bluff Ponds 2 of the 5 ponds actually filled	Both ponds filled with spoils.
		4.4	Radioactivity New section	

TABLE 300.7.1 (continued)

ER-CPS		FER		
SECTION	HEADING AND SUMMARY	SECTION	HEADING AND SUMMARY	COMMENTS
		4.5	Construction Impact Control Program New section	
5.1	Effects of Operation of Heat Dissipation System Conceptual design had blowdown discharged directly into the river via a high-velocity jet located about 2000 feet from shore in the river channel. Discharge situated at a depth below minimum river level. Discharge velocity 10 fps directed normal to river flow. Wet, natural draft cooling towers utilized.	5.1	Effects of Operation of Heat Dissipaton System Blowdown will be discharged through a 54-inch-diameter pipe located 300 feet from the river in the existing barge slip. Substrate of slip is stabilized with concrete mats and rip-rap. Wet, natural draft cooling towers are utilized.	Discharge relocated to barge slip in response to factors such as economics, anticipated dredging impacts, and hazards to navigation.
5.1.4	Effects of Thermal Discharge on Receiving Water Body Four cases considered utilizing a high river flow of 600,000 cfs and a low river flow of 121,000 cfs in both a winter month (February) and a summer month (July). A total heated discharge of about 62 cfs was utilized.	5.1.2.4.1 5.1.2.4.2	Mean River Water Level Condition Low River Water Level Condition Four cases were evaluated for both the mean river water level condition (560,000 cfs) and the low or 7-Q-10 water level condition (127,000 cfs). Summer and winter cases were evaluated for both mean and extreme ambient river water temperatures, with blowdown rates of 53.6 cfs and 46.3 cfs during winter and summer, respectively.	Direct comparisons cannot be made between the plume estimates in these ER's. The plume estimates generated in the FER were based on state-of-art, more conservative techniques than those in the CPS. For a more direct comparison of "worst cases" utilizing similar techniques and parameters, see FER section 10.3
5.1.6	Effects of Entrainment and Presence of Intake and Discharge Structures Impingement and entrainment impacts anticipated. For estimates, see "Environmental Field Measurements Program, Final Report."*	5.1.3 5.1.3.1	Biological Effects Intake Operation Impingement and entrainment of aquatic biota will not occur.	CPS intake based on preliminary engineering and environmental data. During detailed design, present radial well design was adopted in response to predicted impacts of CP stage offshore intake.

TABLE 300.7.1 (continued)

ER-CPS		FER		
SECTION	HEADING AND SUMMARY	SECTION	HEADING AND SUMMARY	COMMENTS
5.1.5	Effects of Released Heat on Aquatic Organisms Worst case plume (winter; low river flow), estimated to yield minimal exposure to aquatic biota. Swift currents of channel habitat seldom had sizable biologic assemblage. Biota most affected would be planktonic organisms passing through plume under worst case conditions (winter; low river flow). Maximum surface population passing through plume, 3% of assumed homogeneously distributed surface population. Minimal effects assumed at maximum transit time of 250 seconds. Few fish expected to reside in plume due to swift currents in channel habitat. See also, "Environmental Field Measurements Program, Final Report."*	5.1.3.2	Discharge Operation	See comment for FER sections 5.1.2.4.1 and 5.1.2.4.2 above. In FER section 10.3, the adopted design was compared with the CPS discharge using similar modeling techniques. The "worst case" (7-Q-10) plumes from the adopted design are larger in surface area, contacting the unstable, low-productivity clay bank habitat, while the CPS design plumes were confined to the low-productivity river channel habitat.
		5.1.3.2.1	Thermal Plume Effects at Mean River Water Level	
		5.1.3.2.2	Thermal Plume Effects at Low River Water Level Possible localized scouring at barge slip outlet during low river water level. Summer plumes expected to have little impact to fish, macrobenthos, or biota drifting through plumes. Plumes very small and localized, and riverbank habitat unstable with low benthic populations, probably attracting few fish. Winter plumes expected to be negatively buoyant, which should result in plumes actually smaller than calculated. Some fish attracted to plumes, should be few in number due to unsuitability of eroding clay bank habitat, and low macrobenthic population. If accelerated spawning occurs in plume	

TABLE 300.7.1 (continued)

ER-CPS		FER		
SECTION	HEADING AND SUMMARY	SECTION	HEADING AND SUMMARY	COMMENTS
			residents, larvae may experience cold shock with migration out of plume, or asynchrony with food resources. Low mortality of drift, larval fish, and plankton expected - drift not substantial until summer; larval fish do not appear until spring. Enhanced productivity not anticipated due to unstable nature of clay bank habitat.	
5.1.7	Effects of Plant Shutdown on Aquatic Organisms Little effect expected due to low populations inhabiting the swift current habitat of the river channel.	5.1.3.3	Effects of Plant Shutdown One unit shutdown assumed. Summer shutdowns expected to have little effect due to small plume areas, and small differential between plume and ambient river temperatures. Winter shutdown may result in some cold shock which should not significantly affect regional populations. Affected clay bank habitat is eroding and unstable, with low benthic populations and few resident fish. Populations should recover rapidly in spring. Plant operation with reduced circulator flows is not anticipated.	On a relative basis, a greater potential for wintertime cold shock exists for the adopted discharge (FER), due to shoreline location. It should be noted that the wintertime "worst case" (7-Q-10) conditions are not frequent in nature and that a one unit shutdown would shorten the plume, thus further reducing the absolute magnitude of cold shock to the few organisms expected to inhabit the unstable clay bank habitat.
5.2	Releases based on WASH 1258. Doses based on limited site data and offsite meteorological data.	5.2	Releases based on NUREG 0016. Doses based on comprehensive site data and onsite meteorological data. Doses calculated according to NRC Regulatory Guide 1.109.	

TABLE 300.7.1 (continued)

ER-CPS		FER		
SECTION	HEADING AND SUMMARY	SECTION	HEADING AND SUMMARY	COMMENTS
5.3.4	Effects of Cooling Tower Drift Solids deposition estimated to be less than Mississippi State regulations.	5.1.4	Effects of Heat Dissipation Facilities	
		5.1.4.5	Effects of Cooling Tower Drift New study results are presented. Total solids deposition within a 5-km radius is significantly less than Mississippi Air Pollution Control Regulations specify.	Increased amount of data and more detail and advancement of design made FER treatment of subject more extensive and complete.
5.3	Effects of Released Chemical and Sanitary Waste Discharges	5.3	Effects of Chemical and Biocide Discharges	
5.3.1	Comparison of Discharges with Ambient River Conditions Reference is made to section 3.7 for description of chemical and sanitary waste discharge systems and to Tables 3.7.1 and 3.7.2 for chemicals and their concentration estimated to be discharged into the Mississippi River. Discharge dominated by cooling tower blowdown. Station discharge: 30,000 gpm max 0.05% of river flow (5 million gpm)	5.3.1	General Reference is made to section 3.6 for description of chemical and biocide discharges and comparison with applicable Federal effluent limitations. The Grand Gulf Nuclear Station Certification under section 401 of the Federal Water Pollution Control Act is presented in Appendix A to this section. The discharge basin and the 54-inch-diameter pipe to the barge slip is mentioned as discharging all plant effluents except storm drains which discharge into site stream B. Cooling tower blowdown considered dominant component of discharge.	
5.3.2	Comparison of Waste Discharge with Existing Water Quality Standards A brief comparison of the existing applicable water quality standards of Mississippi and Louisiana and the conditions after discharge--compliance with the standards is expected.	5.3.2	Mixing of Chemical Discharges Into the Mississippi River and State Water Quality Criteria Contours An extensive analysis of chemical dispersion and results are presented.	The availability of more extensive data and the completeness of design details make the FER more precise and detailed than the CPS-ER.

TABLE 300.7.1 (continued)

ER-CPS		FER		
SECTION	HEADING AND SUMMARY	SECTION	HEADING AND SUMMARY	COMMENTS
5.3.3	Effects on Biota No effect is expected.	5.4.4	Environmental Effects of Chemical and Biocide Discharges Effects are insignificant.	
5.3.5	Effects of Biocide Effects are negligible.			
9.1	Economic and Social Effects of Plant Construction and Operation	8.0	Economic and Social Effects of Station Construction and Operation	
9.1.2	Value of Delivered Products Station provide baseload: 1300 MWe/ Unit Capacity factor: 85% Amounts to 19.4 billion kWh/yr	8.1.1.1	Value of Delivered Product Station provide baseload: 2500 MWe Capacity factor: 80% Amounts to 17.5 billion kWh/yr	
9.1.3	Income Effects Construction: (Direct) Payroll expenditures: $235 million over 7 years Annual payroll: $1.4 million Per capita personal income (Claiborne Co.): $1860 (1972) Induced income: Construction period: (7 years) $705 million Operations: $4.2 million/year	8.1.2.2	Wages Construction: (Direct) Payroll expenditures: $400 million over 10 years Annual payroll: $6.0 million Per capita income (Claiborne Co.): $3400 (1975) Induced income: Construction period: (10 years) $1109 million Operations: $16.5 million/year	
9.1.4	Employment Effects Different figures for different items not comparable.	8.1.2.1	Employment Construction of station began 1974 Slated for completion: Unit 1: 1980 Unit 2: 1983 Construction employment increased very little from 1976 to 1977 after substantial increases from 1973 through 1976 (Claiborne Co.) Construction employment: 38.7% of total employment (Claiborne Co.) (1976) = 2.1% (1973)	

TABLE 300.7.1 (continued)

ER-CPS		FER		
SECTION	HEADING AND SUMMARY	SECTION	HEADING AND SUMMARY	COMMENTS
8.2.3	Geothermal There are no known potential geothermal sites in the MSU service area. No further consideration.	9.2.2.2	Geothermal Only potential site within service area in southern Louisiana. Development of site not very far along. Many questions as to economics and environmental effects. No further consideration.	

*Environmental Field Measurements Program, Final Report, Grand Gulf Units 1 and 2, Mississippi Power & Light Co., December 1973.

GG
ER

QUESTION

301.1 (2.1.3) The ER should include a discussion of prime and unique farmland located onsite and within the transmission line corridors and the impacts to these lands associated with construction and operation of the plant.

RESPONSE

FER subsections 3.9.3.1, 3.9.3.2, 3.9.3.3, 3.9.3.4, 3.9.7, 4.1.3.2, and 4.1.5 have been revised to include the information requested in the above question.

GG
ER

QUESTION

301.2
(2.1.3)

On ER page 2.1-15, the statement is made that "Data on sport fishing within the 50-mile area is not available." The applicant should resolve this with the apparent contradiction made on ER pages 2.2-33 and 2.2-34: "Sport fishing creel and recreation activities were recorded frequently for the Mississippi and Big Black Rivers, Hamilton Lake, and Gin Lake from April through August 1973."

RESPONSE

FER subsection 2.1.3.4 has been revised to resolve the item mentioned in the above question.

QUESTION

301.3 (2.2.3) Are there any threatened or endangered aquatic or terrestrial invertebrate species known to be present on or near the Grand Gulf site? If so, provide details as to their spatial and temporal distribution in the area.

RESPONSE

Federal

There are no endangered or threatened aquatic or terrestrial invertebrates listed by the United States Department of the Interior in Mississippi (Ref. 1).

State

Only endangered or threatened vertebrates are listed by the State of Mississippi (Ref. 2).

Mississippi Natural Heritage Program

The Mississippi Natural Heritage Program has listed endangered, threatened, and peripheral invertebrate species (both aquatic and terrestrial) occurring within the state. None of the invertebrate species listed by this organization have been recorded in Claiborne County (Ref. 3).

References

1. U.S. Department of the Interior, Fish and Wildlife Service, "Endangered and Threatened Wildlife and Plants, Federal Register, 42(135): 36420-36431, 1977, and Supplemental list, 7 pp., September 6, 1978.

2. Mississippi State Game and Fish Commission, "Endangered and Threatened Vertebrates Regulations," Public Notice No. 1916, 1977.

3. Jacobs, J. W., Jr., Curator/Program Coordinator, Mississippi Natural Heritage Program, Personal Communication, 1978.

GG
ER

QUESTION

301.4 (2.2.3) How frequently and at what times of the year do Gin and Hamilton Lakes have a direct connection with the Mississippi River, i.e., when are the river levels at or above 63 and 56 feet msl? How will Corps of Engineers bank stabilization plans affect this relationship?

RESPONSE

FER subsection 2.4.2.3 has been revised to include the information requested in the above question.

GG
ER

QUESTION

301.5 (3.3.5) What proportion of the radial well intake water will come from groundwater under high river flow conditions and under low flow conditions?

RESPONSE

FER subsection 3.3.5 has been revised to include the information requested in the above question.

GG
ER

QUESTION

301.6 (3.7.2) Provide information on the chemical composition and rates of discharge of effluent water from the gravity oil interceptors. Discuss the effects that this effluent as well as runoff from the plant area and roof drains will have on the water quality and biota of onsite streams and Hamilton Lake.

RESPONSE

FER subsections 3.7.2.1 and 3.7.2.2 have been revised and subsection 5.6.7 has been added to provide the information requested in the above question. An estimated long-term average oil interceptor flow rate (less than 5 gpm) is provided in Table 3.3.1.

GG
ER

QUESTION

301.7 (5.1.4) Provide data on the size of the depression cone in the well field area resulting from operation of the radial well intake system under average and low flow conditions of the Mississippi River. Will the water levels of Gin and/or Hamilton Lakes be affected by operation of the radial well? Because additional wells may be required for operation of Unit 2 (ER, Section 4.1.2.3.3), the same analyses and discussion should be provided assuming operation of the expected maximum number of wells.

RESPONSE

FER subsection 5.1.4.6 has been revised to include the information requested in the above question.

GG
ER

QUESTION

301.8
(8.2.2) Traffic problems during construction had been identified in the CP review as potentially troublesome, but the ER (OL) gives little detail on this matter. Provide additional information as to upgrading of roads which was done, the extent of traffic flow versus roads' capacities, statictics on road accidents, and the bases for the conclusion that roadways were not crowded by construction of the station (page 8.2-1).

RESPONSE

FER subsection 8.1.2.5.1 has been revised to include the information requested in the above question.

GG
ER

QUESTION

301.9 (1.1) The description of forecasting methodology should be expanded to include discussion of variables considered and assumed future values of variables.

The description of forecasting methodology should also specifically address how, if at all, the following items were taken into account:

a) energy conservation,
b) substitution of electricity for other fuels, and
c) substitution of solar energy for electricity.

RESPONSE

FER subsection 1.1.3.2 has been revised to incorporate the information requested by the above question.

QUESTION

301.10 (5) Discuss the impacts of the cooling towers and transmission lines on migratory birds.

RESPONSE

FER subsections 5.1.5 and 5.5.1 have been revised and subsection 5.1.3.4, including Table 5.1.24, has been added to provide the information requested in the above question.

GG
ER

QUESTION

340.1 (2.2.3) Reference and describe any aquatic biological or water quality studies conducted in the immediate vicinity of the discharge structure/barge slip since 1973.

RESPONSE

No studies have been conducted in this area since completion of the environmental field program in 1973.

GG
ER

QUESTION

340.2 (2.2.3) Provide a description of any unique or unusually attractive aquatic habitat downstream of the discharge structure/barge slip that conceivably would be under the influence of the discharge plume.

RESPONSE

The habitat downstream of the discharge which is expected to come under the influence of the 5 F plume isotherm consists of approximately 2300 feet of unstable eroding clay banks which have been found generally incapable of supporting stable macrobenthic populations. From that point, downriver, the banks have been stabilized with articulated concrete mats under the Corps of Engineers bank stabilization program. As noted in Section 5.1, Appendix B, the revetments are expected to ultimately extend along the clay bank habitat noted above. The bank stabilization program will be completed once the eroding clay banks reach the proper alignment.

GG
ER

QUESTION

340.3 (3.6) Provide the name and relevant environmental characteristic (e.g., toxicity to aquatic species, biodegradability, chemical composition) of the "EPA registered nonoxidizing biocide" to be used in the standby service water system for control of biological fouling.

RESPONSE

An "EPA registered nonoxidizing biocide" will be used in the standby service water system; however, the specific biocide has not yet been selected.

QUESTION

340.4 (3.6) The plant service water system is to be chlorinated. Provide information on the anticipated frequency and rate of application of biocide. Describe the controls to be applied to the discharge from the system.

RESPONSE

FER subsection 3.6.3 has been revised to include the information requested in the above question.

GG
ER

QUESTION

340.5 (4.2) Provide the presently known distribution of Etheostoma rubrum and state whether or not the species is known from Bayou Pierre in the vicinity of the proposed Franklin and Port Gibson transmission crossings.

RESPONSE

FER subsection 4.2.2 has been revised to include the information requested in the above question.

QUESTION

340.6 (5.3) Although the dispersion of discharged chemicals from the plant is discussed, more information is needed on biocide discharges and their impacts to the near-shore area immediately downstream of the barge slip. Provide a quantitative discussion of the impact of biocides in this area of the river addressing total residual chlorine (TRC). Also, address the TRC discharge concentrations likely to be encountered due to treatment of both the service water and main circulating water systems, in view of the proposed discharge concentrations being at the EPA Effluent Guidelines levels (i.e., only controlled with respect to free available chlorine).

RESPONSE

FER subsections 5.3.4 and 5.3.5 have been revised to include the information requested in the above question.

GG
ER

QUESTION

340.7 (5.6) Provide estimates and bases for expected operational noise levels at the site boundaries. Identify nearby sensitive land used with respect to noise levels, if any, and estimate operational phase noise levels at these locations.

RESPONSE

FER subsection 5.6.1 has been revised and subsection 5.6.8 has been added to include the information requested in the above question.

GG
ER

QUESTION

340.8 (6.1) Provide a description of any preoperational nonradiological aquatic studies yet to be performed at the site.

RESPONSE

All preoperational studies have been completed, with the exception of the ongoing studies noted in ER section 6.1.

GG
ER

QUESTION

340.9 (12.2) Indicate the status of the NPDES permit application. Provide a copy of this application, if available.

RESPONSE

The plant NPDES permit was applied for on October 26, 1977 and is still currently under review. A copy of this application is attached.

GG
ER

QUESTION

340.10 (3.6) Page 3.6-1. Provide the name of the non-oxidizing biocide. If the product has not been selected, provide the names of several products from which it might be selected.

RESPONSE

The non-oxidizing biocide has not been selected. The non-oxidizing biocide may be selected from the following list of products:

Betz Slimicide C-30
Betz Slimicide J-12
Betz Slimicide 242
Betz Slimicide 508
Betz DE-364

Before instituting the use of any additional biocide or chemical used in cooling systems, other than chlorine, which may be toxic to aquatic life, MP&L is required to notify the Mississippi Bureau of Pollution Control in writing 60 days prior to use of the biocide. The Mississippi Bureau of Pollution Control will approve or disapprove use of the biocide.

GG
ER

QUESTION

340.11 (3.6) Provide the maximum, minimum and average calculated levels of total and free residual chlorine at the discharge, prior to mixing with the Mississippi River, during and after periods of circulating water chlorination.

RESPONSE

Total residual and free available chlorine in the effluent discharge of power plants is regulated by the National Pollutant Discharge Elimination System (NPDES). A NPDES permit for the Grand Gulf Nuclear Station has been issued in accordance with the provisions of the Mississippi Air and Water Pollution Control Law (Section 49-17-1 et. seq., Mississippi Code of 1972), and the regulations and standards adopted and promulgated thereunder, and under authority granted pursuant to Section 402(b) of the Federal Water Pollution Control Act. The free available chlorine concentration limitations of the NPDES permit are an average concentration of 0.2 mg/l and an instantaneous maximum concentration of 0.5 mg/l. Further limitations on chlorine discharge by the NPDES permit are also required. The permit states, "Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit may discharge free available or total residual chlorine at any one time. The exact time of discharge of free available or total residual chlorine shall be recorded for each unit and reported as required."

The Environmental Protection Agency (EPA) is actively involved in developing means to reduce chlorine discharge. As part of this nationwide program, the GGNS NPDES permit requires a chlorine minimization report study plan to be submitted 90 days prior to Unit 1 fuel loading. The minimization report is to be submitted 15 months after startup of Unit 1 and Unit 2. This study shall evaluate practicable methods to reduce total residual chlorine levels, including but not limited to 1) minimization of chlorine addition commensurate with control requirements, and 2) discontinuation of blowdown during chlorination and subsequent periods of high concentration.

GG
ER

QUESTION

340.12 (2.2.3) Page 2.2-1 of the Questions and Responses, Amendment 1. Provide a copy of reference 2.

RESPONSE

Reference 2, Mississippi State Game and Fish Commission "Endangered and Threatened Vertebrates Regulations," Public Notice No. 1916, 1977, has been transmitted by MP&L letter AECM-80/36, dated February 15, 1980.

GG
ER

QUESTION

340.13 (4.2) Page 4.2-3, Amendment 1. Provide a copy of Teels (1976), referenced in the first complete paragraph.

RESPONSE

A copy of this reference (Teels, B. M., "The Ecology of Endangered Fish in Bayou Pierre," Proceedings Mississippi Water Resources Conference, 1976) has been transmitted by MP&L letter AECM-80/37, dated February 15, 1980.

GG
ER

QUESTION

340.14 (5.5) Provide copies of correspondence between MP&L Co. and the State of Mississippi Natural Heritage Program documenting their review of the site and the four new transmission line right-of-ways associated with the construction of the Grand Gulf Nuclear Station.

RESPONSE

The Mississippi Natural Heritage Program was established by the Mississippi Bureau of Outdoor Recreation, the Wildlife Heritage Committee, and the Nature Conservancy in 1976. The Mississippi Natural Heritage program was established to identify significant natural areas and to recommend means of protecting these areas.

Information on ecologically sensitive areas in Mississippi can be obtained from the statewide inventory the Natural Heritage Program has been compiling since its establishment in 1976. Review of the Grand Gulf Nuclear Station site and the four new transmission line right-of-ways by the Mississippi Natural Heritage Program prior to construction was not possible since the program did not exist until 1976. However, a review was conducted by the appropriate state agency, the Mississippi Game and Fish Commission, as documented in the Construction Final Environmental Statement.

However, in 1977 MP&L consulted with the Mississippi Natural Heritage Program for information on ecologically sensitive areas near the GGNS site. As part of this consultation, MP&L provided the Mississippi Natural Heritage Program with pertinent sections of the GGNS Environmental Field Measurements Program Final Report. Computer printouts of special animal and plant species were obtained from the Mississippi Natural Heritage Program in 1977 and were reviewed.

In 1978 the Mississippi legislature organized the Mississippi Natural Heritage Program as a department in the Mississippi Game and Fish Commission State Agency. Personal communications with Mr. John Burris and Mr. Joseph Jacob of the Mississippi Natural Heritage Program were conducted in regard to the GGNS transmission coridors. The Mississippi Natural Heritage Program had no recorded sitings or collections of rare, threatened, endangered, or special concern plant or animal species along the GGNS transmission corridors.

GG
ER

Copies of correspondence between MP&L and the Mississippi Natural Heritage Program have been forwarded to the NRC by MP&L letter AECM-80/74, dated April 16, 1980.

GG
ER

QUESTION

340.15 (2.4) Provide a discussion of the ultimate disposition of the two sediment retention basins located on site. Indicate whether or not these basins will be retained indefinitely. If not, describe what changes will be made and will they be completed.

RESPONSE

The two sediment retention basins will be maintained through construction as required by the Environmental Protection Program. After all construction activities have been completed, the two sediment retention basins will not be maintained. During the operating life of GGNS, the basins will gradually fill through siltation and existing vegetation will encroach.

GG
ER

QUESTION

340.16 (4.5A) Page 4.5.A-2. Provide a copy of the preoperational monitoring report.

RESPONSE

The Preoperational Monitoring Report required by the Environmental Protection Program is presently being finalized, and will be submitted under separate cover.

GG
ER

QUESTION

340.17 (2.4) Provide a short narrative indicating the progress to date of the Corps of Engineers bank stabilization program downstream of the discharge structure.

RESPONSE

At the end of October 1979, the Corps of Engineers completed all planned bank stabilization activities downstream of the discharge structure.

GG
ER

QUESTION

340.18 (11.1) The ER, p. 11.1-2, states that "Several wildlife management practices suggested by the Mississippi Game and Fish Commission and the Mississippi Wildlife Federation have already been implemented." Please specify what these practices are and when they were implemented.

RESPONSE

Recommendations	Implementation
1. Field Maintenance - October 1979	1A. Conducted at haul road and county road junction
	1B. Pecan orchard
	1C. Conducted at tent area
	1D. Conducted adjacent to Waterloo Road
2. Wood Duck Nesting Boxes at Gin & Hamilton Lake - March 1978	2A. Not feasible at Gin & Hamilton Lake because of fluctuating water levels. Approximately 1/2 dozen duck boxes were placed around sediment basins A and B in 1978. No successful hatch has been observed in 2 years.
3. Sport Fishing on Lakes - Prior to Construction	3A. Sport fishing continues on both lakes with varied degrees of success.
4. Limited Hunting on Deer - 1974	4A. A "No Hunting" policy on GGNS property was established in the autumn of 1974.

Recommendations	Implementation
4. Limited Hunting on Deer - 1974 (Cont.)	This policy will continue for the time being. Present harvest at camps adjacent to GGNS lands indicates an excellent deer herd with little or no overbrowsing observed. Limited either-sex hunting on adjacent lands is conducted on an as-needed basis established by the Department of Wildlife Conservation.

The recommendations made by the Mississippi Wildlife Federation and the Mississippi Department of Wildlife Conservation (formerly the Mississippi Game & Fish Commission) are being implemented with regard to management of GGNS lands. A tree planting operation involving the sawtooth oak (Quercus acutissima) and various fruit trees was completed in early 1980.

GG
ER

QUESTION

340.19 (4.1) What will be the final disposition of the 30 acre borrow pit located in the bottom land (see Table 4.1.1)?

RESPONSE

The 30-acre borrow pit located in the bottom land will be gradually reclaimed by existing perimeter vegetation and wildlife. No reclamation activities are planned by MP&L.

GG
ER

QUESTION

340.21 (5.5) Will the resident biologist be involved in monitoring all transmission lines emanating from the GGNPP during the operating life of the plant?

RESPONSE

Maintenance and monitoring of the transmission lines will be conducted by personnel from the Engineering, System Operation, and Construction Department of Mississippi Power & Light Company. Engineering, System Operation, and Construction is responsible for transmission line inspections. These inspections are conducted by aerial surveys and walking patrols at periodic intervals. These inspections include monitoring for erosion, structural damage caused by wind, vehicular damage caused by right-of-way encroachment by hunters and loggers, shrub growth and broken insulators. Problem areas are identified by the aerial surveys, and walking patrols to the problem areas clarify the extent of the problem to be corrected.

QUESTION

340.22 (3.6, 5.3) Based on current water quality of the service water makeup from the radial collector wells update tables 3.6.3, 5.3.3 through 5.3.6, and sections 3.6.1, 3.6.2, 5.1.4.5.3, 5.3.2.2, 5.3.2.3, and 5.3.3.

RESPONSE

The three attached tables contain the plant effluent data necessary for updating the aforementioned ER tables and for performing the chemical plume analysis using the current water quality data for makeup water from the radial collector wells. Tables 1 and 2 contain the water quantity and quality data for the plant effluent for one- and two-unit operation, respectively. These tables summarize the plant effluent characteristics for operation with two, three, or five cycles of concentration in the cooling tower and with a 100 percent load factor. It can be seen in these tables that for two-unit operation, the effluent discharge is double that for one-unit operation, while temperature and chemicals concentration are independent of the number of units operating. Table 3 summarizes the effluent chemical characteristics to be used for the chemical plume analysis for both one- and two-unit operation for the various cycles of concentration. A winter case (January) and summer case (July) were chosen to perform the dispersion of the chemical plume as discussed in the ER.

Inspection of Tables 1 and 2 indicates that the chloride concentration is below the Mississippi/Louisiana Water Quality criteria of 75 mg/l (see ER Tables 5.3.1a and 5.3.1b) for all times and modes of operation.

Comparison of Table 3 and ER Table 5.3.3 indicates that the expected concentrations of TDS and sulfates for two- and three-cycle cases are relatively higher than the ones reported earlier.

The preliminary chemical plume analysis for two-unit operation with two and three cycles of concentration was performed using the current water quality parameters of Table 3 and the corresponding discharges. The 1980 Mississippi River hydrographic survey taken by the U.S. Army Corps of Engineers (Figure 1) was used in estimating the hydraulic characteristics of the river in the vicinity of the site for the dispersion analysis. The modeling techniques and river flow and water level data were identical to those described in ER Subsection 5.3.2.1. The results of this preliminary analysis were compared to those given in ER Tables 5.3.4 through 5.3.6. For the mean river flow cases (Table 5.3.4), the new plume lengths and areas are slightly smaller than those presented in ER Table 5.3.5, and for the lowest flow of record cases (Mississippi

River at elevation 28 feet MSL), the plumes are smaller than those presented in Table 5.3.6. This can be attributed mainly to the channel improvements and bank stabilization performed by the U.S. Army Corps of Engineers in the vicinity of the site.

Since the largest plumes were governed by the lowest flow of record cases (Table 5.3.6), it can be concluded that the change in makeup water quality does not result in an increase in the controlling plume areas given in the ER. Plumes for one-unit operation will, of course, be smaller due to the reduction in the plant effluent discharge.

The results of the revised chemical plume analysis for two, three, and five cycles and one- and two-unit operation will be submitted in the next ER Amendment.

GRAND GULF NUCLEAR PLANT

TABLE 1 - PLANT EFFLUENT WATER QUANTITY AND QUALITY (1 UNIT OPERATION)

MONTH	2-CYCLE					3-CYCLE					5-CYCLE				
	FLOW	TEMP	TDS	SULFATE	CHLORIDE	FLOW	TEMP	TDS	SULFATE	CHLORIDE	FLOW	TEMP	TDS	SULFATE	CHLORIDE
	gpm	°F	mg/l	mg/l	mg/l	gpm	°F	mg/l	mg/l	mg/l	gpm	°F	mg/l	mg/l	mg/l
JAN	11750	75.3	752	446	38	9083	83.3	861	492	44	9083	90.7	861	479	44
FEB	11900	76.4	752	446	38	8933	83.6	876	507	44	8933	90.8	876	492	44
MAR	12300	79.0	752	446	38	8533	84.3	917	545	46	8533	91.1	917	529	46
APR	12400	82.8	752	446	38	8433	86.8	929	556	47	8433	92.4	929	537	47
MAY	13200	87.5	752	446	38	7613	88.9	1030	650	52	7613	93.4	1030	631	52
JUN	13550	91.2	752	446	38	7283	91.7	1075	694	54	7283	94.8	1075	674	54
JUL	13610	92.5	752	446	38	7223	92.8	1083	703	55	7223	95.4	1083	682	55
AUG	13650	92.0	752	446	38	7183	92.3	1090	708	55	7183	95.1	1090	688	55
SEP	13400	89.3	752	446	38	7433	90.2	1053	674	53	7433	94.1	1053	654	53
OCT	12900	84.4	752	446	38	7933	86.9	989	611	50	7933	92.5	989	593	50
NOV	12250	78.7	752	446	38	8583	84.2	914	540	46	8583	91.1	914	525	46
DEC	11850	75.7	752	446	38	8983	83.3	872	502	44	8983	90.6	872	488	44
AVG	12730	83.7	752	446	38	8101	87.4	974	599	49	8101	92.7	974	581	49

NOTE: Number of cycles refer to the cycles of concentration in the cooling tower loop.

GRAND GULF NUCLEAR PLANT

TABLE 2 - PLANT EFFLUENT WATER QUANTITY AND QUALITY (2 UNIT OPERATION)

MONTH	2-CYCLE					3-CYCLE					5-CYCLE				
	FLOW	TEMP	TDS	SULFATE	CHLORIDE	FLOW	TEMP	TDS	SULFATE	CHLORIDE	FLOW	TEMP	TDS	SULFATE	CHLORIDE
	gpm	°F	mg/l	mg/l	mg/l	gpm	°F	mg/l	mg/l	mg/l	gpm	°F	mg/l	mg/l	mg/l
JAN	23500	75.3	752	446	38	18166	83.3	861	492	44	18166	90.7	861	479	44
FEB	23800	76.4	752	446	38	17866	83.6	876	507	44	17866	90.8	876	492	44
MAR	24600	79.0	752	446	38	17066	84.3	917	545	46	17066	91.1	917	529	46
APR	24800	82.8	752	446	38	16866	86.8	929	556	47	16866	92.4	929	537	47
MAY	26400	87.5	752	446	38	15226	88.9	1030	650	52	15226	93.4	1030	631	52
JUN	27100	91.2	752	446	38	14566	91.7	1075	694	54	14566	94.8	1075	674	54
JUL	27220	92.5	752	446	38	14446	92.8	1083	703	55	14446	95.4	1083	682	55
AUG	27300	92.0	752	446	38	14366	92.3	1090	708	55	14366	95.1	1090	688	55
SEP	26800	89.3	752	446	38	14866	90.2	1053	674	53	14866	94.1	1053	654	53
OCT	25800	84.4	752	446	38	15866	86.9	989	611	50	15866	92.5	989	593	50
NOV	24500	78.7	752	446	38	17166	84.2	914	540	46	17166	91.1	914	525	46
DEC	23700	75.7	752	446	38	17966	83.3	872	502	44	17966	90.6	872	488	44
AVG	25460	83.7	752	446	38	16202	87.4	974	599	49	16202	92.7	974	581	49

NOTE Number of cycles refer to the cycles of concentration in the cooling tower loop.

GRAND GULF NUCLEAR PLANT

TABLE 3

PLANT EFFLUENT WATER QUALITY FOR
CHEMICAL PLUME ANALYSIS

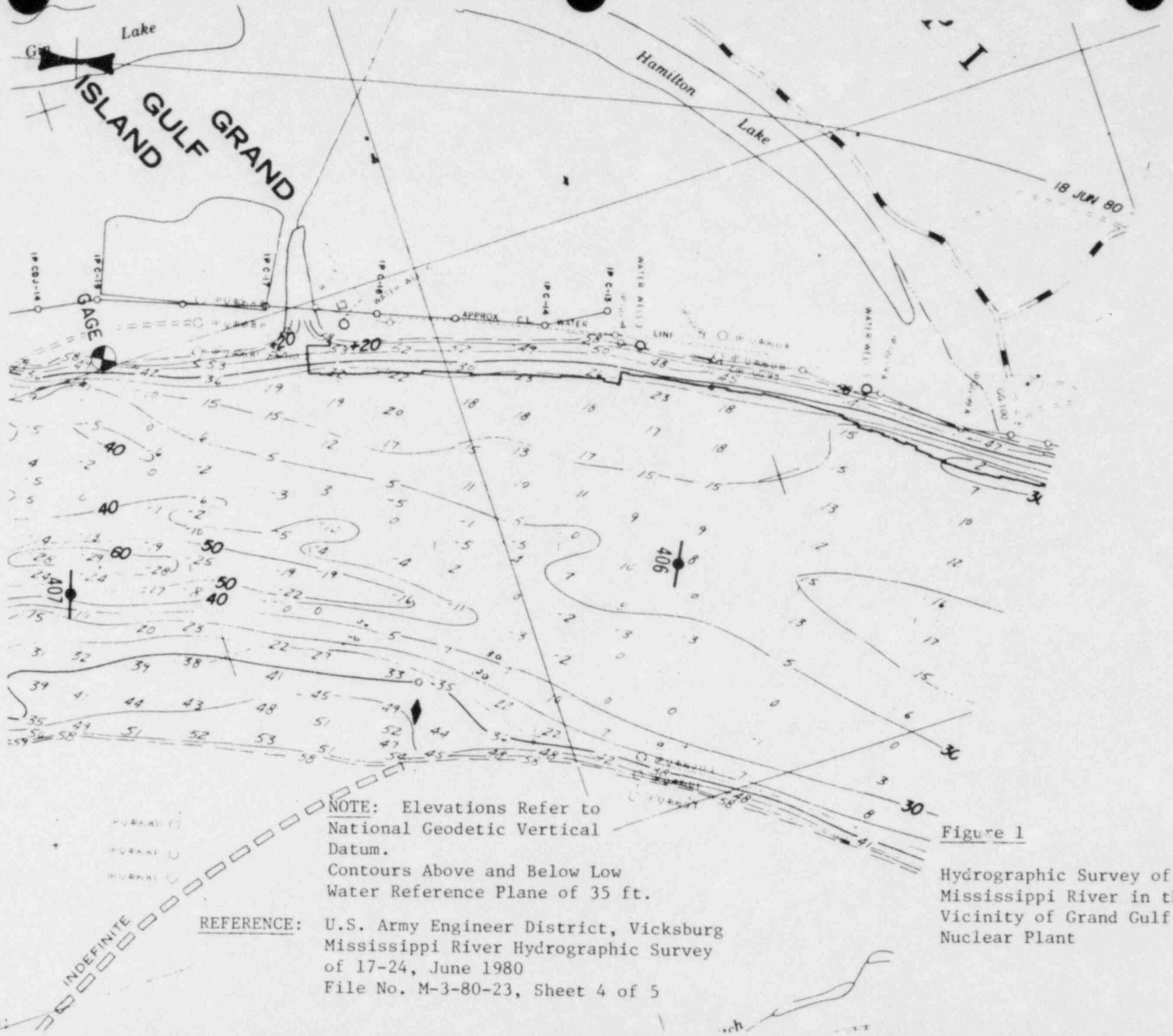
CONCENTRATION, mg/l

	2 CYCLES		3 CYCLES		5 CYCLES	
CONSTITUENTS	WINTER+	SUMMER++	WINTER	SUMMER	WINTER	SUMMER
SULFATES	446	446	492	703	479	682
CHLORIDE*	38	38	44	55	44	55
TDS	752	752	861	1083	861	1083

* For all cases the chlorides are below the State Water Quality Criteria of 75 mg/l.

+ Month of January

++ Month of July



NOTE: Elevations Refer to National Geodetic Vertical Datum.
Contours Above and Below Low Water Reference Plane of 35 ft.

REFERENCE: U.S. Army Engineer District, Vicksburg
Mississippi River Hydrographic Survey
of 17-24, June 1980
File No. M-3-80-23, Sheet 4 of 5

Figure 1

Hydrographic Survey of Mississippi River in the Vicinity of Grand Gulf Nuclear Plant

GG
ER

QUESTION

340.23 (12.2) Provide a copy of the current NPDES permit for the Grand Gulf site. Also provide a short narrative of the current status of the NPDES renewal activities.

RESPONSE

The present NPDES permit MS0029521 for the Grand Gulf Nuclear Station expires on June 30, 1981. Samples of all outfalls have been taken, and analysis is proceeding at this time to ensure that the revised permit application will be completed by December 31, 1980. A copy of the present permit (MS0029521) follows.

State of Mississippi
Water Pollution Control
PERMIT

TO DISCHARGE WASTEWATER IN ACCORDANCE WITH THE
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

THIS CERTIFIES THAT

Mississippi Power and Light Company
Grand Gulf Nuclear Station
Port Gibson, Mississippi

has been granted permission to discharge wastewater into the Mississippi River and Hamilton Lake.

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I, II, and III hereof. This permit is issued in accordance with the provisions of the Mississippi Air and Water Pollution Control Law (Section 49-17-1 et seq., Mississippi Code of 1972), and the regulations and standards adopted and promulgated thereunder, and under authority granted pursuant to Section 402 (b) of the Federal Water Pollution Control Act.

Issued this 11th day of February, 19 80.

MISSISSIPPI DEPARTMENT OF NATURAL RESOURCES
BUREAU OF POLLUTION CONTROL PERMIT BOARD

Charles H. Chisolm

Charles H. Chisolm, P. E., Director

Expires 30th day of June, 19 81.

Permit No. MS0029521

Application No. MS0029521

MPC 3-74

PART I

Permit No. MS0029521

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning February 1, 1980, and lasting until June 30, 1981, the permittee is authorized to discharge from Outfall Serial Number 001 - Discharge Basin.
Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)		Measurement	Sample
	Daily Avg.	Daily Max	Daily Avg.	Daily Max.	Frequency	Type
Flow – M^3Day (MGD)	-	-	-	-	Continuous	Recorder
Temperature*	-	-	-	-	Continuous	Recorder

*Discharge temperature shall not exceed the lowest temperature of the recirculating cooling water prior to the addition of make-up.

2. The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored weekly with a grab sample.
3. There shall be no discharge of floating solids or visible foam in other than trace amounts.
4. Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): at the plant discharge basin (following consolidation of Outfall Serial Numbers 002 - 008), but prior to entry into the Mississippi River.

I-1

PART I

Permit No. MS0029521

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning February 1, 1980, and lasting until June 30, 1981, the permittee is authorized to discharge fro
Outfall Serial Number 002 (Unit A) and 003 (Unit B) - Cooling Tower Blowdown.
Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day Daily Avg.	(lbs/day) Daily Max	Chlorination Period Avg.	Instan. Max.	Measurement Frequency	Sample Type
Flow – M^3Day (MGD)	-	-	-	-	3/Week	Instantaneous
Total Residual Chlorine	-	-	-	-	**	Multiple Grabs***
Free Available Chlorine	-	-	0.2 mg/l	0.5 mg/l	**	Multiple Grabs***
Time of Chlorine Discharge*	-	-	-	120 min.	**	Observation

*Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit may discharge free available or total residual chlorine at any one time. The exact time of discharge of free available or total residual chlorine shall be recorded for each unit and reported as required in Part I.C.2.

**During the first year of substantially full power operation of each unit, monitoring shall follow each application of chlorine to the condenser cooling water system for 3 days/week until sufficient operating experience has been obtained to assure conformance with limitations and then monitoring frequency may be reduced to one day/week. Start-up of blowdown shall not occur until a series of multiple grab samples indicate that the discharge is in conformance with the permit limitations.

2. The pH shall not be less than N/A standard units nor greater than N/A standard units and shall be monitored

3. There shall be no discharge of floating solids or visible foam in other than trace amounts.

4. Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): at each cooling tower blowdown point prior to mixing with any other waste streams.

***Multiple grab samples shall consist of a series of grab samples taken every 30 minutes following start-up of blowdown after chlorine addition until no total residual chlorine is detectable.

PART I

Permit No. MS0029521

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning February 1, 1980, and lasting until June 30, 1981, the permittee is authorized to discharge from Outfall Serial Number 004 (Unit A) and 005 (Unit B). Standby Service Cooling Tower Blowdown.
Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations kg/day (lbs/day) Daily Avg.	Daily Max	Chlorination Period Avg.	Instan. Max.	Monitoring Requirements Measurement Frequency	Sample Type
Flow – M^3Day (MGD)	-	-	-	-	3/Week	Instantaneous
Total Residual Chlorine	-	-	-	-	**	Multiple Grabs***
Free Available Chlorine	-	-	0.2 mg/l	0.5 mg/l	**	Multiple Grabs***
Time of Chlorine Discharge*	-	-	-	120 min.	**	Observation

*Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit may discharge free available or total residual chlorine at any one time. The exact time of discharge of free available or total residual chlorine shall be recorded for each unit and reported as required in Part I.C.2.

**During the first year of substantially full power operation of each unit, monitoring shall follow each application of chlorine to the condenser cooling water system for 3 days/week until sufficient operating experience has been obtained to assure conformance with limitations and then monitoring frequency may be reduced to one day/week. Start-up of blowdown shall not occur until a series of multiple grab samples indicate that the discharge is in conformance with the permit limitations.

2. The pH shall not be less than N/A standard units nor greater than N/A standard units and shall be monitored

3. There shall be no discharge of floating solids or visible foam in other than trace amounts.

4. Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): at each cooling tower blowdown point prior to mixing with any other waste streams.

***Multiple grab samples shall consist of a series of grab samples taken every 30 minutes following start-up of blowdown after chlorine addition until no total residual chlorine is detectable.

PART I

Permit No. MS0029521

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning **February 1, 1980,** and lasting until June 30, 1981, the permittee is authorized to discharge from **Outfall Serial Number 006 - Demineralizer Regeneration Waste.**
Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)		Measurement	Sample
	Daily Avg.	Daily Max	Daily Avg.	Daily Max.	Frequency	Type
Flow – M^3Day (MGD)	-	-	-	-	1/Week	*
Oil and Grease	4.5(10.0)	18.2(40.0)	15 mg/1	20 mg/1	1/Week	Grab
Total Suspended Solids	9.1(20.0)	91(200)	30 mg/1	100 mg/1	1/Week	Grab

*Weir reading, pump logs, or calculation for batch discharge. The flow reported shall be the total volume discharged in a 24-hour period.

2. The pH shall not be less than N/A standard units nor greater than N/A standard units and shall be monitored N/A

3. There shall be no discharge of floating solids or visible foam in other than trace amounts.

4. Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): Discharge from the treatment facility prior to mixing with any other water or wastewater.

I-1

PART I

Permit No. MS0029521

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning February 1, 1980, and lasting until June 30, 1981, the permittee is authorized to discharge from Outfall Serial Number 007 - Water Treatment Building and Diesel Generator Drain. Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Units (Specify)		Measurement	Sample
	Daily Avg.	Daily Max	Daily Avg.	Daily Max.	Frequency	Type
Flow – M^3Day (MGD)	-	-	-	-	1/Week	*
Oil and Grease	32.8(72.1)	43.7(96.1)	15 mg/1	20 mg/1	1/Week	Grab
Total Suspended Solids	65.5(144.1)	218.4(480.4)	30 mg/1	100 mg/1	1/Week	Grab

*Weir reading, pump logs, or calculation for batch discharge. The flow reported shall be the total volume discharged in a 24-hour period.

2. The pH shall not be less than N/A standard units nor greater than N/A standard units and shall be monitored N/A

3. There shall be no discharge of floating solids or visible foam in other than trace amounts.

4. Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): discharge from the oil separator treatment unit prior to mixing with any other water or wastewater.

I-1

Permit No. MS0029521

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning February 1, 1980, and lasting until June 30, 1981, the permittee is authorized to discharge from Outfall Serial Number 008 - Fire Water Pump House Oily Waste Sump. Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day) Daily Avg.	kg/day (lbs/day) Daily Max	Other Units (Specify) Daily Avg.	Other Units (Specify) Daily Max.	Measurement Frequency	Sample Type
Flow – M^3Day (MGD)	-	-	-	-	1/Week	*
Oil and Grease	16.4(36.0)	21.8(48.0)	15 mg/1	20 mg/1	1/Week	Grab
Total Suspended Solids	3[illegible]	109.2(240.2)	30 mg/1	100 mg/1	1/Week	Grab

*Weir reading, pump logs, or calculation for batch discharge. The flow reported shall be the total volume discharged in a 24-hour period.

2. The pH shall not be less than N/A standard units nor greater than N/A standard units and shall be monitored N/A

3. There shall be no discharge of floating solids or visible foam in other than trace amounts.

4. Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): discharge from the oil separator treatment unit prior to mixing with any other water or wastewater.

Permit No. MS0029521

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning **February 1, 1980,** and lasting until June 30, 1981, the permittee is authorized to discharge from Outfall Serial Number 009 - Administrative Building Floor Drains.
Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day) Daily Avg.	kg/day (lbs/day) Daily Max	Other Units (Specify) Daily Avg.	Other Units (Specify) Daily Max.	Measurement Frequency	Sample Type
Flow – M^3Day (MGD)	-	-	-	-	1/Week	*
Oil and Grease	4.1(9.0)	5.5(12.0)	15 mg/1	20 mg/1	1/Week	Grab
Total Suspended Solids	8.2(18.0)	27.3(60.0)	30 mg/1	100 mg/1	1/Week	Grab

*Weir reading, pump logs, or calculation for batch discharge. The flow reported shall be the total volume discharged in a 24-hour period.

2. The pH shall not be less than N/A standard units nor greater than N/A standard units and shall be monitored N/A

3. There shall be no discharge of floating solids or visible foam in other than trace amounts.

4. Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): discharge from the oil separator treatment unit prior to mixing with any other water or wastewater.

Permit No. MS0029521

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning February 1, 1980, and lasting until June 30, 1981, the permittee is authorized to discharge from Outfall Serial Number 010 - Sewage Treatment Plant Effluent.
Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day Daily Avg.	(lbs/day) Daily Max	Other Units (Specify) Daily Avg.	Daily Max.	Measurement Frequency	Sample Type
Flow - M^3Day (MGD)	-	-	171(0.045)	-	2/Week	Instantaneous
BOD_5	5.1(11.3)	7.7(16.9)	30 mg/1	45 mg/1	1/Quarter	24-Hour Composite
Total Suspended Solids	5.1(11.3)	7.7(16.9)	30 mg/1	45 mg/1	1/Quarter	24-Hour Composite

2. The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 2/week with a grab sample.

3. There shall be no discharge of floating solids or visible foam in other than trace amounts.

4. Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): discharge from the combined effluent of the three sewage treatment units prior to mixing with any other water or wastewater.

5. Influent and effluent pH, dissolved oxygen in the aeration basin, and 30-minute sludge settleability shall be monitored 2 days per week with a grab sample, for each of the three units.

6. Upon issuance of this permit, NPDES Permits MS0027031 and MS0029173 shall be void.

I-1

Permit No. MS0029521

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning February 1, 1980, and lasting until June 30, 1981, the permittee is authorized to discharge from Outfall Serial Number 011 - Liquid Radwaste System.
Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day) Daily Avg.	kg/day (lbs/day) Daily Max	Other Units (Specify) Daily Avg.	Other Units (Specify) Daily Max.	Measurement Frequency	Sample Type
Flow – M^3Day (MGD)	–	–	–	–	*	*
Total Suspended Solids	–	–	–	30 mg/l	*	Grab

*Measurements shall be taken daily whenever a batch is discharged. The flow reported shall be the total volume discharged in a 24-hour period.

2. The pH shall not be less than N/A standard units nor greater than N/A standard units and shall be monitored N/A

3. There shall be no discharge of floating solids or visible foam in other than trace amounts.

4. Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): discharge from the radwaste treatment system prior to mixing with any other water or wastewater.

II

PART I

Permit No. MS0029521

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning **February 1, 1980,** and lasting until June 30, 1981, the permittee is authorized to discharge from **Outfall Serial Number 012 - Preoperational Flushing and Metal Cleaning Wastes.**
Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day) Daily Avg.	kg/day (lbs/day) Daily Max	Other Units (Specify) Daily Avg.	Other Units (Specify) Daily Max.	Measurement Frequency	Sample Type
Flow – M^3Day (MGD)	–	–	–	–	**	Pump Logs or Batch Calculation
Total Suspended Solids	*	*	30 mg/1	100 mg/1	**	Composite***
Total Copper	–	*	–	1.0 mg/1	**	Composite***
Total Iron	–	*		1.0 mg/1	**	Composite***
Total Phosphorus (as P)	–	*	–	2.0 mg/1	**	Composite***
Oil and Grease	*	*	15 mg/1	20 mg/1	**	Grab

"Preoperational Flushing and Metal Cleaning Wastes" shall mean any cleaning compounds, rinse waters, or any other waterborne residues derived from cleaning any metal process equipment including, but notllimited to, boiler tube cleaning, boiler fireside cleaning and air preheater cleaning. This definition shall specifically exclude any water used for the sole purpose of hydrostatic testing, or flushing operations not involving the use of chemicals.

*The quantity of pollutants specified above shall not exceed the quantity (Kg/day or lbs/day) determined by multiplying the flow of the wastewater times the concentrations shown above.

**Once/Day whenever a discharge occurs from any flushing or cleaning operation.

2. There shall be no discharge of floating solids or visible foam in other than trace amounts.

3. Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s):

***A composite shall consist of 3 grab samples taken at the beginning of discharge, at the end of discharge, and a third taken at approximately equal time lapse between the beginning and end.

I-1

PART I

Permit No. MS0029521

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. During the period beginning February 1, 1980, and lasting until June 30, 1981, the permittee is authorized to discharge from Outfall Serial Numbers 013 - 014 (Construction Runoff) (Basins A and B, respectively). Such discharges shall be limited and monitored by the permittee as specified below:

Effluent Characteristic	Discharge Limitations				Monitoring Requirements	
	kg/day	(lbs/day)	Other Units (Specify)		Measurement	Sample
	Daily Avg.	Daily Max	Daily Avg.	Daily Max.	Frequency	Type
Flow – M^3Day (MGD)	-	-	-	-	1/Month*	Instantaneous
Total Suspended Solids	-	-	-	-	1/Month*	Grab

*Sampling shall be done during periods of actual discharge.

2. The pH shall not be less than 6.0 standard units nor greater than 9.0 standard units and shall be monitored 1/month with a grab sample.

3. There shall be no discharge of floating solids or visible foam in other than trace amounts.

4. Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): discharge point prior to mixing with any other water or wastewater.

5. Construction practices and control of site runoff shall be consistent with sound engineering practices. Ponds utilized for control of construction runoff shall be capable of containing a 10-year, 24-hour rainfall event.

B. SCHEDULE OF COMPLIANCE

1. The permittee shall achieve compliance with the effluent limitations specified for discharges in accordance with the following schedule:

a. Blowdown Minimization Report
(See Page 21, Part III.A.e.)

1. Study Plan - 90 days prior to Unit 1 fuel loading.

2. Initial Report - 15 months after commercial operation date of Unit 1.

3. Subsequent Reports - Annually after initial report.

b. Chlorine Minimization Report
(See Page 21, Part III.A.i.)

1. Study Plan - 90 days prior to Unit 1 fuel loading.

2. Report - 15 months after start-up of Unit 1 & 2.

2. No later than 10 calendar days following a date identified in the above schedule of compliance, the permittee shall submit either a report of progress or, in the case of specific actions being required by identified dates, a written notice of compliance or noncompliance. In the latter case, the notice shall include the cause of noncompliance, any remedial actions taken, and the probability of meeting the next scheduled requirement.

C. MONITORING AND REPORTING

1. Representative Sampling

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge.

2. Reporting

Monitoring results obtained during the previous 3 months shall be summarized for each month and reported on a Discharge Monitoring Report From (EPA No. 3320-1), postmarked no later than the 28th day of the month following the completed reporting period. The first report is due on April 28, 1980 . Signed copies of these, and all other reports required herein, shall be submitted to the Mississippi Air and Water Pollution Control Permit Board at the following address:

State of Mississippi
Air and Water Pollution Control Permit Board
P. O. Box 827
Jackson, Mississippi 39205

3. Definitions

a. The "daily average" discharge means the total discharge by weight during a calendar month divided by the number of days in the month that the production or commercial facility was operating. Where less than daily sampling is required by this permit, the daily average discharge shall be determined by the summation of all the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.

b. The "daily maximum" discharge means the total discharge by weight during any 24-hour period.

4. Test Procedures

Test procedures for the analysis of pollutants shall conform to regulation published pursuant to Section 304(g) of the Federal Water Pollution Control Act, as amended.

5. Recording of Results

For each measurement or sample taken pursuant to the requirements of this permit, the permittee shall record the following information:

a. The exact place, date, and time of sampling;

b. The dates the analyses were performed;

c. The person(s) who performed the analyses;

d. The analytical techniques or methods used; and

e. The results of all required analyses.

6. Records Retention

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed and calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation shall be retained for a maximum of three (3) years, or longer if requested by the Permit Board.

PART II

A. MANAGEMENT REQUIREMENTS

1. Change in Discharge

All discharges authorized herein shall be consistent with the terms and conditions of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Any anticipated facility expansions or treatment modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new NPDES application, or if such changes will not violate the effuent limitations specified in this permit, by notice to the Mississippi Air and Water Pollution Control Permit Board of such notice, the permit may be modified to specify and limit any pollutants not previously limited.

2. Noncompliance Notification

If, for any reason, the permittee does not comply with or will be unable to comply with any effluent limitation specified in this permit, the permittee shall provide the Mississippi Air and Water Pollution Control Permit Board with the following information, in writing, within five (5) days of becoming aware of such conditions:

a. A description of the discharge and cause of noncompliance; and

b. The period of noncompliance, including exact dates and times; or if not corrected, the anticipated time the noncompliance is expected to continue, and steps being taken to reduce, eliminate and prevent recurrence of the noncomplying discharge.

3. Facilities Operation

The permittee shall at all times maintain in good working order and operate as efficiently as possible all treatment or control facilities or systems installed or used by the permittee to achieve compliance with the terms and conditions of this permit.

4. Adverse Impact

The permittee shall take all reasonable steps to minimize any adverse impact to State waters resulting from noncompliance with any effluent limitations specified in this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

5. Bypassing

Any diversion from or bypass of wastewater collection and treatment facilities is prohibited, except (i) where unavoidable to prevent loss of life or severe

property damage, or (ii) where excessive storm drainage or runoff would damage any facilities necessary for compliance with the effluent limitations and prohibitions of this permit. The permittee shall notify the Mississippi Air and Water Pollution Control Permit Board in writing of each such diversion or bypass within 72 hours of the diversion or bypass and shall submit a plan to prevent recurrence of the bypass diversion within 30 days of the date of the incident.

6. Removed Substances

Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of in a manner such as to prevent any pollutant from such materials from entering State waters.

7. Power Failures

In order to maintain compliance with the effluent limitations and prohibitions of this permit, the permittee shall either:

a. In accordance with the Schedule of Compliance contained in Part I, provide an alternate power source sufficient to operate the wastewater collection and treatment facilities;

or, if such alternate power source is not in existence, and no date for its implemenation appears in Part I,

b. Provide a method whereby the effluent limitations contained in Part I shall be met upon the reduction, loss, or failure of the primary source of power to the wastewater collection and treatment facilities.

B. RESPONSIBILITIES

1. Right of Entry

The permittee shall allow the Mississippi Air and Water Pollution Control Commission and the Regional Administrator of the U. S. Environmental Protection Agency and/or their authorized representatives, upon the presentation of credentials:

a. To enter upon the permittee's premises where an effluent source is located or in which any records are required to be kept under the terms and conditions of this permit; and

b. At reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit; to inspect any monitoring equipment or monitoring method required in this permit; and to sample any discharge of pollutants.

2. Transfer of Ownership or Control

In the event of any change in control or ownership of facilities from which

the authorized discharges emanate, the permittee shall notify the succeeding owner or controller of the existence of this permit by letter, a copy of which shall be forwarded to the Mississippi Air and Water Pollution Control Permit Board.

3. Availability of Records

Except for data determined to be confidential under the Mississippi Air and Water Pollution Control Law, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the office of the Mississippi Air and Water Pollution Control Commission.

4. Permit Modification

After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part during its term for cause including, but not limited to:

a. Violation of any terms or conditions of this permit;

b. Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts; or

c. A change in any condition that required either a temporary or permanent reduction or elimination of the authorized discharge.

5. Toxic Pollutants

Notwithstanding Part II, B-4 above, if a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Federal Water Pollution Control Act for a toxic pollutant which is present in the discharge and such standard or prohibition is more stringent than any limitation for such pollutant in this permit, this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition and the permittee so notified.

6. Civil and Criminal Liability

Except as provided in permit conditions on "Bypassing" (Part II, A-5), nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance.

7. Oil and Hazardous Substance Liability

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject under Section 311 of the Federal Water Pollution Control Act and applicable provisions of the Mississippi Air and Water Pollution Control Law pertaining to spills of oil and hazardous materials.

8. Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State, or local laws or regulations.

9. Severability

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstance, and the remainder of this permit, shall not be affected thereby.

10. Expiration of Permit

Permittee shall not discharge after the expiration date. In order to receive authorization to discharge beyond the expiration date, the permittee shall submit such information, forms, and fees as are required by the agency authorized to issue permits no later than 180 days prior to the expiration date.

PART III

A. OTHER REQUIREMENTS

a. This permit shall be modified, or alternatively, revoked and reissued, to comply with any applicable effluent standard or limitation issued or approved under sections 301(b)(2) (C), and (D), 304(b)(2), and 307(a)(2) of the Clean Water Act, if the effluent standard or limitation so issued or approved:

(1) Contains different conditions or is otherwise more stringent than any effluent limitation in the permit; or
(2) Controls any pollutant not limited in the permit.

The permit as modified or reissued under this paragraph shall also contain any other requirements of the Act then applicable.

b. If the permittee, after monitoring for at least 12 months, determines that he is consistently meeting the effluent limits contained herein, the permittee may request of the Permit Board that the monitoring requirements be reduced to a lesser frequency or be eliminated.

c. There shall be no discharge of polychlorinated biphenyl compounds such as those commonly used for transformer fluid. In the event that PCB containing equipment is used on site, administrative procedures shall be instituted to (1) maintain a detailed inventory of PCB use, (2) assure engineering design and construction to preclude release of PCB's to the environment, and (3) effectively detect the loss of PCB's from equipment. Detail of such procedures shall be submitted within sixty (60) days following the effective date of this permit.

d. Blowdown shall contain no detectable amount of materials added for corrosion inhibition including, but not limited to, zinc, chromium and phosphorus. The company shall notify the Permit Board in writing not later than sixty (60) days prior to instituting use of any additional biocide or chemical used in cooling systems, other than chlorine, which may be toxic to aquatic life other than those previously reported to the Environmental Protection Agency. Such notification shall include:

1. name and general composition of biocide or chemical,
2. 96-hour median tolerance limit data for organisms representative of the biota of the waterway into which the discharge shall occur,
3. quantities to be used,
4. frequencies of use,
5. proposed discharge concentrations, and
6. EPA registration number, if applicable.

OTHER REQUIREMENTS (Continued)

e. Discharge of blowdown from the cooling system shall be limited to the minimum discharge of recirculating water necessary for the purpose of discharging materials contained in the process, the further build-up of which would cause concentrations or amounts exceeding limits established by best engineering practice. Discharge temperature shall not exceed the lowest temperature of the recirculating cooling water prior to the addition of make-up. A study of blowdown minimization including the minimization of the make-up bypass shall be implemented by the commercial operation date of Unit 1. A study plan, including detailed operational control procedures, shall be submitted for approval by the Permit Board no later than 90 days prior to fuel loading. Annual reports of operations experience shall be submitted starting 15 months after commercial cooperation date of Unit 1 and shall include data from Unit 2 when placed in commercial operation.

f. The receiving water shall not exceed a maximum water temperature change of 2.8°C (5.0°F) relative to the intake temperature, outside a mixing zone which shall not exceed a maximum width of 60 feet from the river edge and a maximum length of 6,000 feet downstream from the point of discharge, as measured at a depth of 5 feet. The maximum water temperature shall not exceed 32.2°C (90°F) outside the same mixing zone, except when ambient temperatures approach or exceed this value. Intake water temperature shall be monitored weekly and reported as required in Part I.C.2. The permittee shall monitor the Mississippi River within and surrounding the mixing area to document conformance with the thermal requirements of this paragraph. Such monitoring shall be conducted semiannually (once in winter and once in summer) during substantially full power production and shall be submitted to the Permit Board as required in Part I.C.2 of this permit.

g. Copies of any and all routine liquid effluent and water quality monitoring reports submitted to the Nuclear Regulatory Commission (NRC) shall be simultaneously submitted to the Mississippi Air and Water Pollution Control Permit Board and EPA. Copies of all routine and non-routine reports submitted to the Permit Board and EPA shall also be submitted to the NRC.

h. Discharge of uncontaminated wastes including fire protection water, condensate from air conditioning equipment, cooling tower make-up bypasses, and yard drains to the yard drainage system is permitted without limitation or monitoring requirements.

i. A study shall be instituted to evaluate practicable methods to reduce total residual chlorine levels, including, but not limited to (1) minimization of chlorine addition commensurate with control requirements and (2) discontinuation of blowdown during chlorination and subsequent periods of high concentration. Results of this study including facilities and/or methods proposed to reduce total chlorine residual shall be submitted no later than 15 months after the start-up dates of Units 1 and 2 respectively.

GG
ER

QUESTION

350.1 (8.1) What is Middle South Utilities peak for 1979?

RESPONSE

The peak was 10,687 MW.

GG
ER

QUESTION

350.2 (8.1) What is MSU's 1978 actual net energy for load and year to date net energy for load for 1979?

RESPONSE

The net energy for load in 1978 and 1979 is presented below:

1978	1979
54,780,805 MWH	56,937,223 MWH

GG
ER

QUESTION

350.3 (9.4) Send information describing MSU load forecasting model (including variables included).

RESPONSE

A manual, "Middle South Utilities Load Forecasting System Specifications," which contains the requested information, has been transmitted by MP&L letter AECM-80/35, dated February 12, 1980.

GG
ER

QUESTION

350.4 (9.4) Refer to Table 9.4.4 in Final Environmental Report:

a) What is cost of nuclear fuel in current dollars in each year 1981-1984?

b) What is the O & M used for nuclear in each year 1981-1984 (current dollars)?

c) What is price of U_3O_8 imbedded in fuel cycle costs (what are terms of contract - i.e. escalation)?

RESPONSE

a) What is the cost of nuclear fuel in current dollars in each year 1981-1984? The levelized fuel cost in Table 9.4.4 was calculated using the following current dollars:

i) Grand Gulf - 1 Fuel Cycle Costs
(Mills/kWh in current dollars)

Year	U_3O_8	Conv. & Enrich.	Fab.	Carrying Charge	Waste Disposal
1981	1.32	1.32	1.37	1.17	1.6
1982	1.37	1.37	1.07	0.93	1.25
1983	1.53	1.53	0.83	1.16	0.91
1984	1.84	1.84	0.79	1.34	0.86
1985	2.66	1.77	0.78	1.52	0.86
1986	3.01	2.00	0.81	1.68	0.88
1987	3.29	2.20	0.83	1.78	0.93
1988	3.51	2.33	0.85	1.86	0.97
1989 - on	Escalate 1988 figures at 5% per year				

ii) Grand Gulf - 2 Fuel Cycle Costs
(Mills/kWh in current dollars)

Year	U_3O_8	Conv. & Enrich.	Fab.	Carrying Charge	Waste Disposal
1984	3.04	1.77	1.59	1.84	1.86
1985	3.04	1.91	1.08	1.63	1.23
1986	3.18	2.02	0.92	1.83	1.01
1987	3.34	2.22	0.90	1.84	0.98
1988	3.51	2.33	0.91	1.90	0.99
1989	3.68	2.44	0.92	1.98	1.04
1990	3.87	2.56	0.94	2.07	1.09

1991 - on Escalate 1990 figures at 5% per year

b) What is the O & M used for nuclear in each year 1981-1984 (current dollars)?

i) Grand Gulf--1: The fixed O & M cost in current dollars for 1981 is estimated to be $3,900,000. To calculate the cost in current dollars for each year thereafter, escalate the 1981 figure by 8 percent per year. The variable O & M cost in current dollars for 1981 is estimated to be 0.9 mills/kWh. To calculate the cost in current dollars for each year thereafter, escalate the 1981 figure by 6 percent per year.

ii) Grand Gulf--2: The fixed O & M cost in current dollars for 1984 is estimated to be $4,912,950. To calculate the cost in current dollars for each year thereafter, escalate the 1984 figure by 8 percent per year. The variable O & M cost in current dollars for 1984 is estimated to be 1.07 mills/kWh. To calculate the cost in current dollars for each year thereafter, escalate the 1981 figure by 6 percent per year.

c) What is price of U_3O_8 imbedded in fuel cycle costs (what are terms of contract - i.e. escalation)?

The base price of U_3O_8 is $38.89 per pound with escalation of 5 percent per year.

GG
ER

QUESTION

350.5 (9.2) Supply percent generation by fuel for 1979 for Middle South.

RESPONSE

Percent generation by fuel for 1979 is presented below:

Natural Gas	56.8%
Oil	33.2%
Nuclear	9.5%
Hydro	0.5%
	100%

GG
ER

QUESTION

350.6
(1.1)

Refer to Question 300.1

a) What is BTU content of each fuel?

b) What is heat rate of each unit?

c) What fuel is replacement for Grand Gulf in the delay scenario and what is O & M of these units?

RESPONSE

	Fuel Oil				Coal			
Year	gwh	Btu(x 10^9)	K-bbl	Btu/kWh	gwh	Btu(x 10^9)	K-tons	Btu/kWh
1981	6,439	61,701	9,980	9,582	416	4,326	254	10,399
1982	7,170	68,967	11,177	9,619	298	3,083	181	10,346
1983	7,642	73,860	11,959	9,665	180	1,894	111	10,522
1984	15,354	149,152	24,151	9,714	668	6,871	404	10,286
1985	15,337	148,600	24,090	9,689	1,029	10,375	623	10,082

The O & M of these units was assumed to be zero.

GG
ER

QUESTION

350.7 (8.1) Provide an estimate of the average annual number of workers that will be required for the operation of the two units.

RESPONSE

The number of permanent plant staff workers is currently 250 people. The number of plant staff workers for 1984 is estimated to be 314 people.

QUESTION

350.8 (8.1) Identify the likely residential location (i.e., names of communities, counties) of the operating workers.

RESPONSE

Approximately 30 percent of plant staff employees live in the Port Gibson/Claiborne County area, approximately 60 percent live in the Vicksburg/Warren County area, and approximately 10 percent live in other surrounding areas. It is anticipated that the operating workers will live in the same areas.

QUESTION

350.9 (2.1) Identify any anticipated impacts in the affected communities' facilities and services (i.e., schools, hospitals, water and waste treatment, fire, police) that would result from the operating workers residence. List facilities and services that would require expansion or additions to capacity.

RESPONSE

Schools - Due to experiences in the past where public school enrollment has steadily dropped while private school enrollment has risen, even during the period of extensive construction activity, it is anticipated that this trend will continue and that most children from families of the operators of the plant will attend private schools. This should have a positive effect on the private schools, because of their increased revenues from greater enrollments, and any impact on the public schools should also be of a positive nature due to an increase in property tax revenue from GGNS.

Hospitals - The impact upon the hospitals in the area is expected to be small, but what impact there is should be positive due to the increased public revenues from taxes levied on GGNS. This increase should more than offset the slight increase in demand for the services of the hospitals.

Wastewater and Treatment Facilities - The small number of GGNS operating personnel (approximately 314) and their families living in the local area (60 percent Warren County, 30 percent Claiborne County, and 10 percent others) will have a negligible impact on these facilities, as the increased demand will be very small. 5

Fire Department - Most of the families will reside in existing housing, and those constructed will be more fire-resistant than older existing homes because of improved building materials and more stringent fire codes. Therefore, the overall impact on the Fire Department should be negligible.

Police Department - No significant impact is expected on the Police Department because of the small number of people the GGNS operating workforce will add to existing communities. The majority of these people will be middle income professionals which are historically less likely, as a group, to engage in unlawful activities.

Summary - The two factors that will minimize any impacts on the affected communities are (1) the relatively small number of people that will be required to operate GGNS; and (2) the

fact that these people will live in several communities because of the isolated location of the GGNS site. It is expected that any impacts that result will be of a positive character because of increased revenues collected by these communities via local spending, sales taxes, property taxes and the enhanced community involvement which these operating personnel will bring about. 5

GG
ER

QUESTION

350.10 (8.1) Provide an estimate of the average annual operating workers payroll for the two units.

RESPONSE

The projected annual payroll for 1981 is $8.3 million (Unit 1) and $12.1 million for 1986 (Units 1 and 2). Both estimates were made using 1980 dollars. 5

GG
ER

QUESTION

350.11 (8.1) Provide an estimate of the average annual dollar amount of local purchases of materials and supplies resulting from the operation of the two units. Include a definition of the local area in preparing the estimate (i.e., counties, major towns, nearest SMSA).

RESPONSE

Anticipated local purchases for GGNS during 1986 will be approximately $300,000, with this figure escalating approximately 10 percent per year due to inflation (estimate based on 1980 dollars). The local area is defined as Claiborne County, Warren County, and Jackson, Mississippi. 5

GG
ER

QUESTION

350.10 (8.1) Provide an estimate of the average annual operating workers payroll for the two units.

RESPONSE

Projected annual payroll for 1981 is $8.3 million and for 1986 is $12.2 million.

GG
ER

QUESTION

350.11 (8.1) Provide an estimate of the average annual dollar amount of local purchases of materials and supplies resulting from the operation of the two units. Include a definition of the local area in preparing the estimate (i.e., counties, major towns, nearest SMSA).

RESPONSE

Anticipated local purchases for GGNS during 1984 will be approximately $150,000. The local area is defined as Claiborne County, Warren County, and Jackson, Mississippi.

QUESTION

350.12 (8.1) In tabular form provide a dollar estimate of the taxes attributable to the two units of Grand Gulf Station. For each of the units first five years of operation, provide the dollar estimates by type of tax and by taxing jurisdictions. What percent of the jurisdictions' total tax revenues are represented by the taxes attributable to the Grand Gulf Station?

RESPONSE

Ad Valorem Taxes During First 5 Years of Operation:

Year	Unit 1*	Unit 2**
1	$6,880,000	$2,786,000
2	7,341,000	3,219,000
3	7,738,000	3,348,000
4	7,531,000	3,482,000
5	7,511,000	3,621,000

* Operational 1982
** Operational 1986

1980 dollars were used to make these projections, and the figures are rounded to the nearest $1,000. Ad valorem taxes are County and State taxes which are collected by the County, which in turn pays the State 4 mills per dollar collected.

During the period January 1, 1982 to January 1, 1990, inclusive, it is estimated that approximately 88 percent of the ad valorem taxes collected in Claiborne County will be attributable to GGNS.

5

GG
ER

QUESTION

350.13 (2.6) Provide copies of the report referenced in pages 2.6-2 and 2.6-3.

RESPONSE

The following references were transmitted by MP&L letter AECM-80/42, dated February 15, 1980:

1. Brookes, S. O., S. O. McGahey, and P. M. Lowrey, editors, 1976. "Archaeological Report No. 1: The Grand Gulf Mound (22-Cb-522) - Salvage Excavation of an Early Marksville Burial Mound," Mississippi Department of Archives and History, Jackson, Mississippi.

2. Brookes, S. O., B. Inmon, and J. H. Stone, editors, 1973. "Mississippi Archaeological Survey Report No. 3: Archaeological Survey of Claiborne County, Mississippi," Mississippi Department of Archives and History, Jackson, Mississippi.

3. Douglas, E. P., and J. H. Stone, editors, 1974. "Architecture in Claiborne County: A Selective Guide," Mississippi Department of Archives and History, Jackson, Mississippi.

4. Stone, J. H., E. P. Douglas, S. O. Brookes, and B. Inmon, August 1, 1972. "Preliminary Archaeological, Architectural, and Historical Survey of the Grand Gulf Nuclear Station Site, the Perimeter Area, and the Proposed Power Line Routes," unpublished report, Mississippi Department of Archives and History.

5. U.S. Department of the Interior, National Park Service, August 1973. "Preparation of Environmental Statements: Guidelines for Discussion of Cultural (Historic, Archaeological, Architectural) Resources."

GG
ER

QUESTION

350.14 (2.6) When completed, provide a copy of the ongoing study related to possible future disposition of the Callendar House located on the site.

RESPONSE

The Callendar House is an antebellum farmhouse which is in rather poor condition. In June 1973, Mr. James H. Stone, Assistant Administrator, Division of Historic Sites and Archaeology, Mississippi Department of Archives and History, discussed the official position of the state department in regards to the Callendar House in a letter to Ms. Myra Harrison, Acting Compliance Officer, Advisory Council on Historic Preservation. This letter was in response to comments made by Ms. Myra Harrison on the GGNS Construction Draft Environmental Statement. Mr. Stone of the Mississippi Department of Archives and History stated that the house had little historic or architectural significance and that the department did not intend to nominate it to The National Register of Historic Places. He further stated that MP&L should be allowed to make decisions regarding the future of the Callendar House.

A copy of this letter has been provided to the NRC as acknowledged in Question 350.15.

MP&L has not decided the future disposition of the Callendar House. The Callendar House has not been occupied for several years due to its uninhabitable condition. At the present time, the house is boarded and locked for safety and security reasons. As part of the decision process in regards to the disposition of the Callendar House, MP&L will consider several options for the house such as a visitor's display center, conference facilities, and demolition.

GG
ER

QUESTION

350.15 (2.6) Provide the enclosures to the letter from James Stone to Ms. Myra Harrison dated June 27, 1973. (A copy of the letter itself was provided to us earlier by your staff without the enclosures.)

RESPONSE

As referred to in the letter the three enclosures were a photograph of the Callendar House, the cover of the Mississippi Power & Light Company 1972 Annual Report, and a quandrangle map delineating the approximate limits of the Grand Gulf town ruins. The enclosures to the letter have not been found in MP&L's files. Personal communication with Mr. Paul Newson of the Mississippi Department of Archives and History revealed that the enclosures may not have been sent to MP&L and that the Department of Archives and History did not have a copy of the enclosures on file. Photographs of the Callendar House can be found in "Architecture in Claiborne County: A Selective Guide," Mississippi Department of Archives and History, which has been forwarded in response to Question 350.13. The 1972 Annual Report cover and a plat of real estate indicating the land conveyed to the Grand Gulf Military Monument Commission have been transmitted by MP&L letter AECM-80/44, dated February 21, 1980.

The Grand Gulf town ruins are located within the section of land conveyed to the Grand Gulf Military Monument Commission.

MISSISSIPPI POWER & LIGHT COMPANY
Helping Build Mississippi
P. O. BOX 1640, JACKSON, MISSISSIPPI 39205

NORRIS L. STAMPLEY
VICE PRESIDENT

October 26, 1977

Mr. Charles Chisolm, Acting Executive Director
Mississippi Air and Water Pollution
Control Commission
Post Office Box 827
Jackson, MS 39205

Re: Grand Gulf Nuclear Station
Claiborne County, Mississippi
NPDES Permit Application
File 0260/2700/15976
AP077/194

Dear Mr. Chisolm:

Attached are the completed application forms with related map and water use diagram for the subject application. Engineering design is not yet completed for some phases. This information will be forwarded as the design changes are finalized.

We would like to request approval to discharge the water utilized for pre-operational flushing and hydrostatic testing of Unit 1 prior to start-up. This flush will consist of less than ten percent treated with less than 50 ppm hydrazine, 70 percent demineralized water, and 20 percent plant water. Approximately 1500 gallons of tri-sodium-phosphate at a concentration of less than 100 ppm will be used as a wipe-down solution for the reactor pressure vessel prior to a flushing. These flush operations will remove particulate matter and any rust inside the piping. The flush water will go to an existing settling basin where the suspended particles will be allowed to settle before discharge into the Mississippi River. The flush is expected to begin in late 1978 and go into 1979. The total volume of water discharged is estimated to be approximately 20 million gallons.

If additional information is required, please advise.

Sincerely,

JEL: jk

Attachments

OMB No. 158-R0100

FOR AGENCY USE

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
APPLICATION FOR PERMIT TO DISCHARGE WASTEWATER

STANDARD FORM C – MANUFACTURING AND COMMERCIAL

SECTION I. APPLICANT AND FACILITY DESCRIPTION

Unless otherwise specified on this form all items are to be completed. If an item is not applicable indicate 'N.A.'

ADDITIONAL INSTRUCTIONS FOR SELECTED ITEMS APPEAR IN SEPARATE INSTRUCTION BOOKLET AS INDICATED. REFER TO BOOKLET BEFORE FILLING OUT THESE ITEMS.

Please Print or Type

1. Legal Name of Applicant (see instructions)	101	Mississippi Power & Light Company
2. Mailing Address of Applicant (see instructions)		
Number & Street	102a	Post Office Box 1640
City	102b	Jackson,
State	102c	Mississippi
Zip Code	102d	39205
3. Applicant's Authorized Agent (see instructions)		
Name and Title	103a	Norris L. Stampley Vice President - Production
Number & Street Address	103b	Post Office Box 1640
City	103c	Jackson
State	103d	Mississippi
Zip Code	103e	39205
Telephone	103f	601 (Area Code) 969-2335 (Number)
4. Previous Application If a previous application for a National or Federal discharge permit has been made, give the date of application. Use numeric designation for date.	104	___ ___ ___ YR MO DAY

I certify that I am familiar with the information contained in this application and that to the best of my knowledge and belief such information is true, complete, and accurate.

Norris L. Stampley Printed Name of Person Signing	102e	Vice President - Production Title
		___ ___ ___ YR MO DAY
Signature of Applicant or Authorized Agent	102f	Date Application Signed

18 U.S.C. Section 1001 provides that

Whoever, in any matter within the jurisdiction of any department or agency of the United States knowingly and willfully falsifies, conceals or covers up by any trick, scheme, or device a material fact, or makes any false, fictitious or fraudulent statement or representation, or makes or uses any false writing or document knowing same to contain any false, fictitious or fraudulent statement or entry, shall be fined not more than $10,000 or imprisoned not more than five years, or both.

FOR AGENCY USE

OFFICE: ____ EPA Region Number

Received ___ ___ ___
YR MO DAY

____ State

This section contains 4 pages.

FOR AGENCY USE

5. Facility/Activity (see instructions) Give the name, ownership, and physical location of the plant or other operating facility where discharge(s) does or will occur.

Name	105a	Grand Gulf Nuclear Station Mississippi Power & Light Company Port Gibson, Mississippi
Ownership (Public, Private or Both Public and Private)	105b	☐ PUB ☒ PRV ☐ BPP
Check block if Federal Facility and give GSA Inventory Control Number	105c	☐ FED
	105d	_____
Location Street & Number	105e	Post Office Box 756, Waterloo Road
City	105f	Port Gibson
County	105g	Claiborne
State	105h	Mississippi

6. Nature of Business State the nature of the business conducted at the plant or operating facility.

	106a	Generation and Transmission of Electricity
	106b	AGENCY USE

7. Facility Intake Water (see instructions) Indicate water intake volume per day by sources. Estimate average volume per day in thousand gallons per day.

Municipal or private water system	107a	0 thousand gallons per day
Surface water	107b	0 thousand gallons per day
Groundwater	107c	62,438 thousand gallons per day
Other*	107d	150 thousand gallons per day
Total item 7	107e	62,588 thousand gallons per day
*If there is intake water from 'other,' specify the source.	107f	Storm Water

8. Facility Water Use Estimate average volume per day in thousand gallons per day for the following types of water usage at the facility. (see instructions)

Noncontact cooling water	108a	55,696 thousand gallons per day
Boiler feed water	108b	432 thousand gallons per day
Process water (including contact cooling water)	108c	0 thousand gallons per day
Sanitary water	108d	30 thousand gallons per day
Other*	108e	6,430 thousand gallons per day
Total item 8	108f	62,588 thousand gallons per day
*If there are discharges to 'other,' specify.	108g	Plant Auxiliary Systems, Make-up Bypass, Storm Water
If there is 'Sanitary' water use, give the number of people served.	108h	200 people served

FOR AGENCY USE

9. All Facility Discharges and other Losses: Number and Discharge (see instructions) Volume. Specify the number of discharge points and the volume of water discharged or lost from the facility according to the categories below. Estimate average volume per day in thousand gallons per day.

		Number of Discharge Points		Total Volume Used or Discharged, Thousand Gal/Day
Surface Water	109a1	9	109a2	32,500
Sanitary wastewater transport system	109b1	0	108b2	0
Storm water transport system	109c1	0	109c2	0
Combined sanitary and storm water transport system	109d1	0	109d2	0
Surface impoundment with no effluent	109e1	0	109e2	0
Underground percolation	109f1	0	109f2	0
Well injection	109g1	0	109g2	0
Waste acceptance firm	109h1	0	109h2	0
Evaporation	109i1	4	109i2	29,656
Consumption	109j1	0	109j2	432
Other*	109k1	0	109k2	0
Facility discharges and volume Total Item 9.	109l1	13	109l2	62,588
*If there are discharges to 'other,' specify.	109m1			

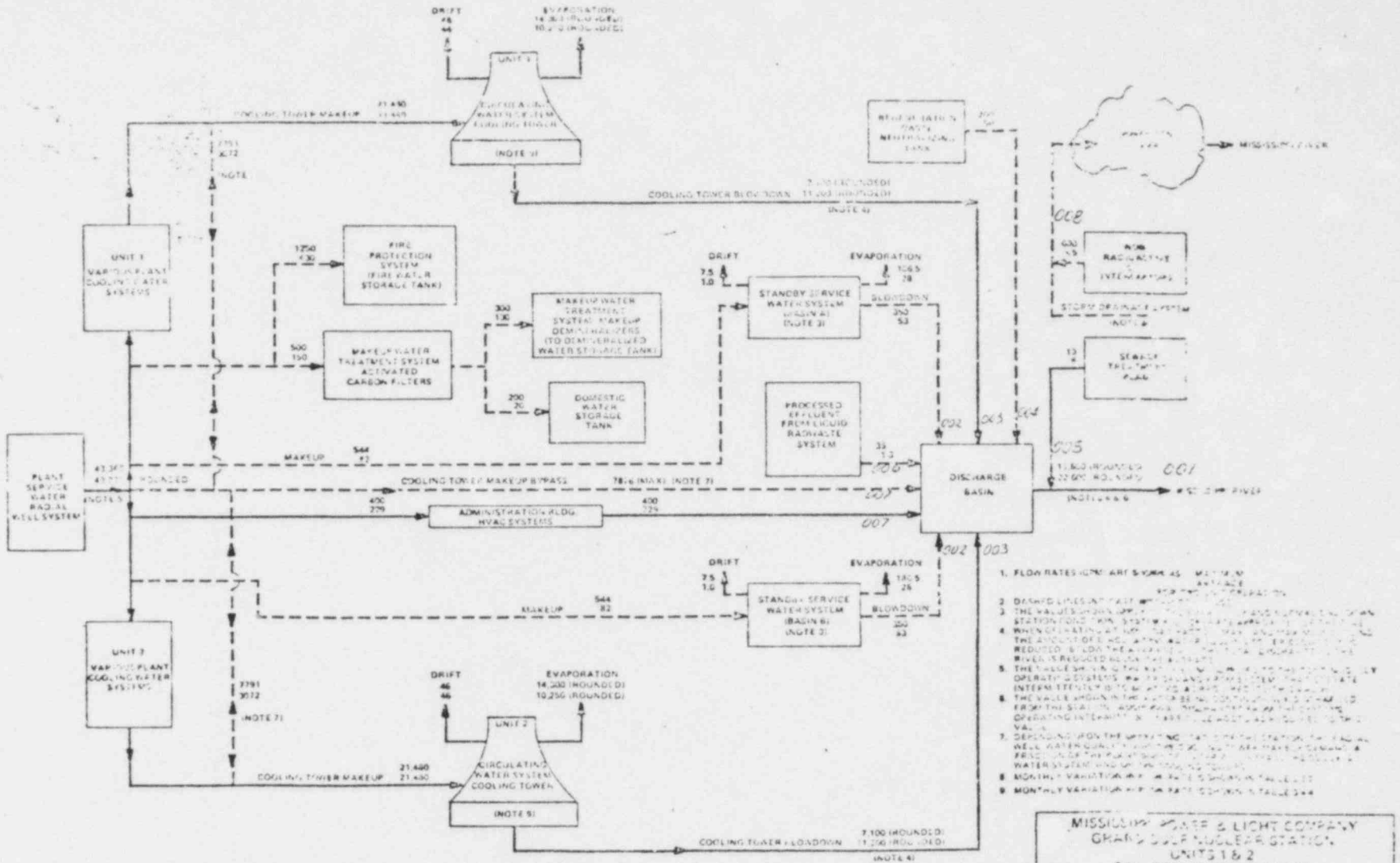
10. Permits, Licenses and Applications
List all existing, pending or denied permits, licenses and applications related to discharges from this facility (see instructions).

110	Issuing Agency (a)	For Agency Use (b)	Type of Permit or License (c)	ID Number (d)	Date Filed YR/MO/DA (e)	Date Issued YR/MO/DA (f)	Date Denied YR/MO/DA (g)	Expiration Date YR/MO/DA (h)
1.	MA&WPCC		Permit to Construct	MS0029521		75/02/14		
	MA&WPCC		Permit to Discharge	MS0029173		75/08/08		80/05/31
2.	MA&WPCC		Permit to Discharge	MS0027031		74/10/15		77/06/30
	Corps of Engineers			1522-15-58		76/01/05		77/01/05
3.	Corps of Engineers			1522-14-42		75/08/28		78/08/28
	NRC		Unit 1 Constr.	CPPR-118		74/09/04		79/10/01
	NRC		Unit 2 Constr.	CPPR-119		74/09/04		81/04/01

11. Maps and Drawings
Attach all required maps and drawings to the back of this application.(see instructions)

12. Additional Information

112 Item Number	Information



1. FLOW RATES IGNORE ART SYSTEMS
2. DASHED LINES AT FACILITY
3. THE VALUES SHOWN APPLY
STATION FOR THIS SYSTEM
4. WHEN OPERATING AT
THE AMOUNT OF
REDUCED BY
RIVER IS REDUCED
5. THE
OPERATING SYSTEMS
INTERMITTENTLY
6. THE
ERO
OPERATING
VALVE
7. DEPENDING ON THE
WELL WATER QUALITY
PRECIPITATION
WATER SYSTEM
8. MONTHLY VARIATIONS
9. MONTHLY VARIATIONS

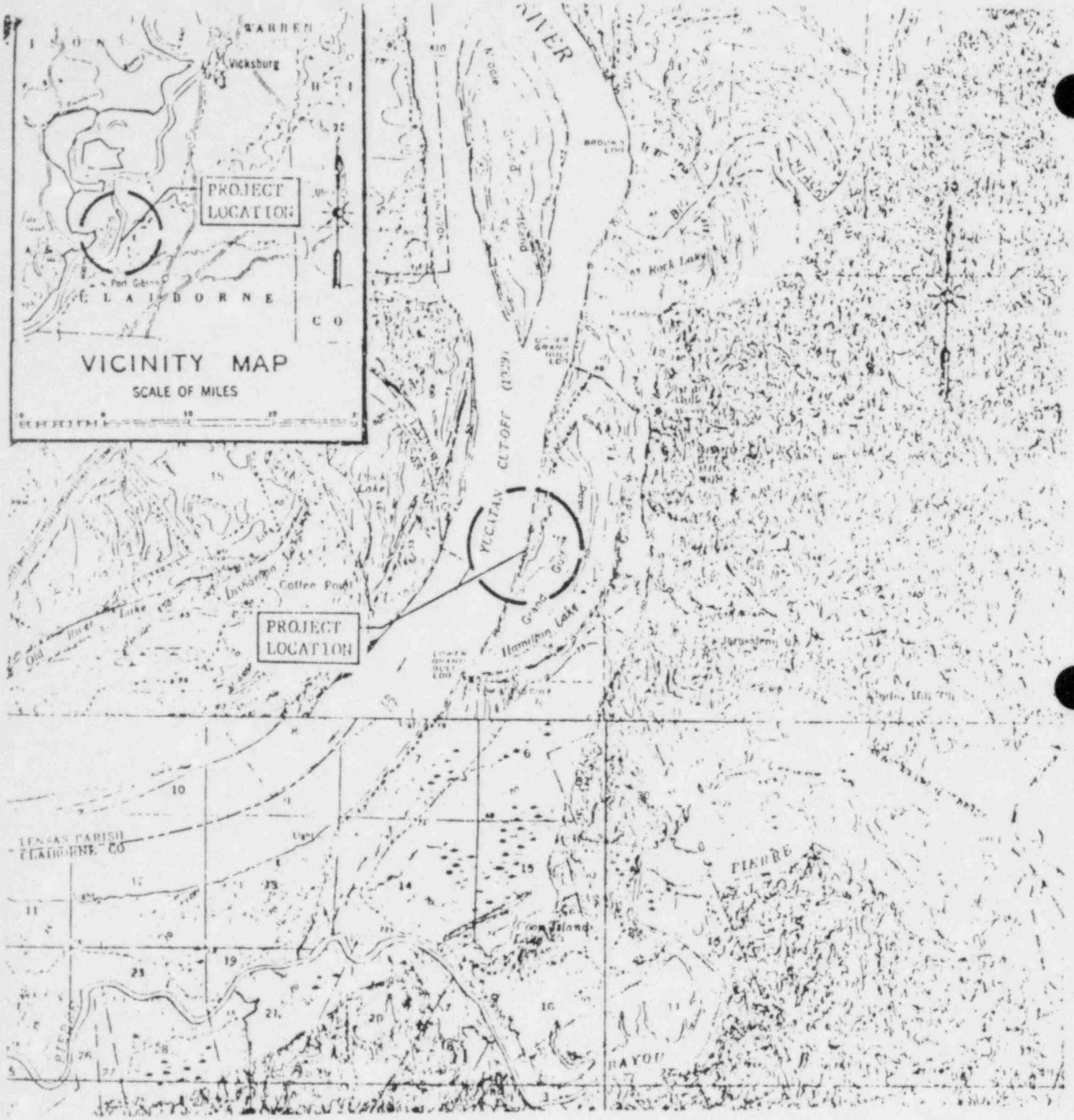
(003) COOLING TOWER BLOWDOWN DISCHARGES ARE COMBINED BEFORE ENTERING THE BASIN.

(002) STANDBY SERVICE WATER SYSTEM BLOWDOWN DISCHARGE ARE COMBINED BEFORE ENTERING THE BASIN.

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

STATION WATER USE DIAGRAM

FIGURE 3.3-1



Location Map
MP&L Grand Gulf Nuclear Station
Port Gibson, Claiborne County, MS
August 17, 1977

OMB No. 158-R0100

STANDARD FORM C – MANUFACTURING AND COMMERCIAL

FOR AGENCY USE

SECTION II. BASIC DISCHARGE DESCRIPTION

Complete this section for each discharge indicated in Section I, Item 9, that is to surface waters. This includes discharges to municipal sewerage systems in which the wastewater does not go through a treatment works prior to being discharged to surface waters. Discharges to wells must be described where there are also discharges to surface waters from this facility. SEPARATE DESCRIPTIONS OF EACH DISCHARGE ARE REQUIRED EVEN IF SEVERAL DISCHARGES ORIGINATE IN THE SAME FACILITY. All values for an existing discharge should be representative of the twelve previous months of operation. If this is a proposed discharge, values should reflect best engineering estimates.

ADDITIONAL INSTRUCTIONS FOR SELECTED ITEMS APPEAR IN SEPARATE INSTRUCTION BOOKLET AS INDICATED. REFER TO BOOKLET BEFORE FILLING OUT THESE ITEMS.

1. Discharge Serial No. and Name

a. Discharge Serial No. (see instructions)	201a	001
b. Discharge Name Give name of discharge, if any. (see instructions)	201b	Basin discharge
c. Previous Discharge Serial No. If previous permit application was made for this discharge (see Item 4, Section I), provide previous discharge serial number.	201c	N/A

2. Discharge Operating Dates

a. Discharge Began Date If the discharge described below is in operation, give the date (within best estimate) the discharge began.	202a	N/A (YR MO)
b. Discharge to Begin Date If the discharge has never occurred but is planned for some future date, give the date (within best estimate) the discharge will begin.	202b	78 7 (YR MO)
c. Discharge to End Date If discharge is scheduled to be discontinued within the next 5 years, give the date (within best estimate) the discharge will end.	202c	N/A (YR MO)

3. Engineering Report Available Check if an engineering report is available to reviewing agency upon request. (see instructions) 203 ☒

4. Discharge Location Name the political boundaries within which the point of discharge is located.

				Agency Use
State	204a	Mississippi	204d	
County	204b	Claiborne	204e	
(If applicable) City or Town	204c		204f	

5. Discharge Point Description Discharge is into (check one): (see instructions)

Stream (includes ditches, arroyos, and other intermittent watercourses)	205a	☒ STR
Lake		☐ LKE
Ocean		☐ OCE
Municipal Sanitary Wastewater Transport System		☐ MTS
Municipal Combined Sanitary and Storm Transport System		☐ MCS

FOR AGENCY USE

Municipal Storm Water Transport System ☐STS

Well (injection) ☐WEL

Other ☐OTH

If 'other' is checked, specify 205b

6. Discharge Point — Lat/Long Give the precise location of the point of discharge to the nearest second.

Latitude 206a N 32 DEG 1 MIN 15 SEC

Longitude 206b W 91 DEG 4 MIN 5 SEC

7. Discharge Receiving Water Name Name the waterway at the point of discharge.(see instructions)

207a Mississippi River

If the discharge is through an outfall that extends beyond the shoreline or is below the mean low water line, complete item 8.

207b

For Agency Use		
Major	Minor	Sub

207c

For Agency Use
303e

8. Offshore Discharge

a. Discharge Distance from Shore 208a _____ feet

b. Discharge Depth Below Water Surface 208b _____ feet

9. Discharge Type and Occurrence

a. Type of Discharge Check whether the discharge is continuous or intermittent. (see instructions) 209a

☒ (con) Continuous

☐ (int) Intermittent

b. Discharge Occurrence Days per Week Enter the average number of days per week (during periods of discharge) this discharge occurs. 209b 7 days per week

c. Discharge Occurrence —Months If this discharge normally operates (either intermittently, or continuously) on less than a year-around basis (excluding shutdowns for routine maintenance), check the months during the year when the discharge is operating. (see instructions) 209c N/A

☐JAN ☐FEB ☐MAR ☐APR

☐MAY ☐JUN ☐JUL ☐AUG

☐SEP ☐OCT ☐NOV ☐DEC

Complete items 10 and 11 if "Intermittent" is checked in item 9.a. Otherwise, proceed to item 12.

10. Intermittent Discharge Quantity State the average volume per discharge occurrence in thousands of gallons. 210 N/A thousand gallons per discharge occurrence.

11. Intermittent Discharge Duration and Frequency

a. Intermittent Discharge Duration Per Day State the average number of hours per day the discharge is operating. 211a N/A hours per day

b. Intermittent Discharge Frequency State the average number of discharge occurrences per day during days when discharging. 211b N/A discharge occurrences per day

12. Maximum Flow Period Give the time period in which the maximum flow of this discharge occurs. 212 From 01 (month) to 12 (month)

FOR AGENCY USE

13. Activity Description Give a narrative description of activity producing this discharge.(see instructions)

213a Consolidation of discharges which originate in the plant, including cooling tower blowdown, demineralizer regeneration effluent, liquid radwaste, and others as indicated by the schematic of water flow.

14. Activity Causing Discharge For each SIC Code which describes the activity causing this discharge, supply the type and maximum amount of either the raw material consumed (Item 14a) or the product produced (Item 14b) in the units specified in Table I of the Instruction Booklet. For SIC Codes not listed in Table I, use raw material or production units normally used for measuring production.(see instructions)

a. Raw Materials

	SIC Code	Name	Maximum Amount/Day	Unit (See Table I)	Shared Discharges (Serial Number)
214a	(1)	(2)	(3)	(4)	(5)

b. Products

	SIC Code	Name	Maximum Amount/Day	Unit (See Table I)	Shared Discharges (Serial Number)
214b	(1)	(2)	(3)	(4)	(5)
	4911	Electric Services	60	Z-1	002,003,004,005, 006,007,009

DISCHARGE SERIAL NUMBER

001

FOR AGENCY USE

15. Waste Abatement

a. Waste Abatement Practices
Describe the waste abatement practices used on this discharge with a brief narrative. (see instructions)

215a

Narrative: The discharge basin consolidates treated discharge source effluents which then discharges into the Mississippi River.

b. Waste Abatement Codes
Using the codes listed in Table II of the Instruction Booklet, describe the waste abatement processes for this discharge in the order in which they occur if possible.

215b

(1) ESEPAR, (2) ESEGRE, (3) ESURFA,
(4) EMERGE, (5) EPUMPS, (6) DCHEMI,
(7) DHYSIC, (8) RECOVE, (9) RECYCL,
(10) RHEATR, (11) MIONOX, (12) LOCALS,
(13) PTEMPE, (14) PMIXED, (15) CNEUTR,
(16) ____, (17) ____, (18) ____,
(19) ____, (20) ____, (21) ____,
(22) ____, (23) ____, (24) ____,
(25) ____.

DISCHARGE SERIAL NUMBER

OCL

FORM APPROVED
OMB No. 158-R0100

FOR AGENCY USE

16. Wastewater Characteristics

Check the box beside each constituent which is present in the effluent (discharge water). This determination is to be based on actual analysis or best estimate.(see instructions)

Parameter 216	Present	Parameter 216	Present
Color 00080		Copper 01042	X
Ammonia 00610	X	Iron 01045	X
Organic nitrogen 00605	X	Lead 01051	
Nitrate 00620	X	Magnesium 00927	X
Nitrite 00615		Manganese 01055	
Phosphorus 00665	X	Mercury 71900	
Sulfate 00945	X	Molybdenum 01062	
Sulfide 00745		Nickel 01067	
Sulfite 00740		Selenium 01147	
Bromide 71870		Silver 01077	
Chloride 00940	X	Potassium 00937	X
Cyanide 00720		Sodium 00929	X
Fluoride 00951	X	Thallium 01059	
Aluminum 01105		Titanium 01152	
Antimony 01097		Tin 01102	
Arsenic 01002	X	Zinc 01092	
Beryllium 01012		Alkicides* 74051	
Barium 01007	X	Chlorinated organic compounds* 74052	
Boron 01022	X	Pesticides* 74053	
Cadmium 01027		Oil and grease 00550	
Calcium 00916	X	Phenols 32730	
Cobalt 01037		Surfactants 38260	
Chromium 01034	X	Chlorine 50060	X
Fecal coliform bacteria 74055	X	Radioactivity* 74050	

*Specify substances, compounds and/or elements in Item 26.

Pesticides (insecticides, fungicides, and rodenticides) must be reported in terms of the acceptable common names specified in *Acceptable Common Names and Chemical Names for the Ingredient Statement on Pesticide Labels*, 2nd Edition, Environmental Protection Agency, Washington, D.C. 20250, June 1972, as required by Subsection 162.7(d) of the Regulations for the Enforcement of the Federal Insecticide, Fungicide, and Rodenticide Act.

DISCHARGE SERIAL NUMBER

001

FOR AGENCY USE

17. Description of Intake and Discharge

For each of the parameters listed below, enter in the appropriate box the value or code letter answer called for.(see instructions)

In addition, enter the parameter name and code and all required values for any of the following parameters if they were checked in Item 16: ammonia, cyanide, aluminum, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, phenols, oil and grease, and chlorine (residual).

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)
Flow* MGD 50050	0.15	62.4	32.5	10	40			
pH Units 00400			X					
Temperature (winter) °F 74028								
Temperature (summer) °F 74027								
Biochemical Oxygen Demand (BOD 5-day) mg/l 00310								
Chemical Oxygen Demand (COD) mg/l 00340								
Total Suspended (nonfilterable) Solids mg/l 00530								
Specific Conductance micromhos/cm at 25° C 00095			X					
Settleable Matter (residue) ml/l 00545								

*Other discharges sharing intake flow (serial numbers).(see instructions)

DISCHARGE SERIAL NUMBER
001

FOR AGENCY USE

17. (Cont'd.)

Parameter and Code 227a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)

18. **Plant Controls** Check if the following plant controls are available for this discharge. — 218

Alternate power source for major pumping facility. — ☒ APS

Alarm or emergency procedure for power or equipment failure — ☒ ALM

Complete item 19 if discharge is from cooling and/or steam water generation and water treatment additives are used.

19. **Water Treatment Additives** If the discharge is treated with any conditioner, inhibitor, or algicide, answer the following:

a. Name of Material(s) — 219a _____

b. Name and address of manufacturer — 219b _____

c. Quantity (pounds added per million gallons of water treated). — 219c _____

DISCHARGE SERIAL NUMBER

001

FOR AGENCY USE

d. Chemical composition of these additives (see instructions). | 219d | _____

_____

Complete items 20-25 if there is a thermal discharge (e.g., associated with a steam and/or power generation plant, steel mill, petroleum refinery, or any other manufacturing process) and the total discharge flow is 10 million gallons per day or more. (see instructions)

20. Thermal Discharge Source. Check the appropriate item(s) indicating the source of the discharge. (see instructions) | 220

Boiler Blowdown	☐ BLBD
Boiler Chemical Cleaning	☐ BCCL
Ash Pond Overflow	☐ APOF
Boiler Water Treatment — Evaporator Blowdown	☐ EPBD
Oil or Coal Fired Plants — Effluent from Air Pollution Control Devices	☐ OCFP
Condense Cooling Water	☐ COND
Cooling Tower Blowdown	☒ CTBD
Manufacturing Process	☐ MFPR
Other	☐ OTHR

21. Discharge/Receiving Water Temperature Difference

Give the maximum temperature difference between the discharge and receiving waters for summer and winter operating conditions. (see instructions)

Summer	221a	9 °F.
Winter	221b	40 °F.

22. Discharge Temperature, Rate of Change Per Hour | 222 | _____ °F./hour

Give the maximum possible rate of temperature change per hour of discharge under operating conditions. (see instructions)

23. Water Temperature, Percentile Report (Frequency of Occurrence)

In the table below, enter the temperature which is exceeded 10% of the year, 5% of the year, 1% of the year and not at all (maximum yearly temperature). (see instructions)

Frequency of occurrence		10%	5%	1%	Maximum
a. Intake Water Temperature (Subject to natural changes)	223a	°F	°F	°F	°F
b. Discharge Water Temperature	223b	°F	°F	°F	°F

24. Water Intake Velocity (see instructions) | 224 | _____ feet/sec.

25. Retention Time. Give the length of time, in minutes, from start of water temperature rise to discharge of cooling water. (see instructions) | 225 | _____ minutes

DISCHARGE SERIAL NUMBER

001

FOR AGENCY USE

26. Additional Information

226

Item	Information
217 a	Discharge is into the Mississippi River. Intake is provided by radial wells. The radial well system consists of three (3) wells presently, with the addition of two (2) more planned for the future. Each well consists of a reinforced concrete caisson with a base slab, and a set of lateral screens extending radially 250 feet to 300 feet from the well into the aquifer that exists beneath the river bed and along the bank. These wells will provide a mixture of normal ground water, and induced infiltration of river water passing through the river bottom to the collectors.

STANDARD FORM C – MANUFACTURING AND COMMERCIAL

FOR AGENCY USE

SECTION II. BASIC DISCHARGE DESCRIPTION

Complete this section for each discharge indicated in Section I, Item 9, that is to surface waters. This includes discharges to municipal sewerage systems in which the wastewater does not go through a treatment works prior to being discharged to surface waters. Discharges to wells must be described where there are also discharges to surface waters from this facility. SEPARATE DESCRIPTIONS OF EACH DISCHARGE ARE REQUIRED EVEN IF SEVERAL DISCHARGES ORIGINATE IN THE SAME FACILITY. All values for an existing discharge should be representative of the twelve previous months of operation. If this is a proposed discharge, values should reflect best engineering estimates.

ADDITIONAL INSTRUCTIONS FOR SELECTED ITEMS APPEAR IN SEPARATE INSTRUCTION BOOKLET AS INDICATED. REFER TO BOOKLET BEFORE FILLING OUT THESE ITEMS.

1. Discharge Serial No. and Name

a. Discharge Serial No. (see instructions) — 201a: 002

b. Discharge Name Give name of discharge, if any. (see instructions) — 201b: Standby Service Water Cooling Tower Blowdown

c. Previous Discharge Serial No. If previous permit application was made for this discharge (see Item 4, Section I), provide previous discharge serial number. — 201c: N/A

2. Discharge Operating Dates

a. Discharge Began Date If the discharge described below is in operation, give the date (within best estimate) the discharge began. — 202a: N/A (YR / MO)

b. Discharge to Begin Date If the discharge has never occurred but is planned for some future date, give the date (within best estimate) the discharge will begin. — 202b: 78 7 (YR / MO)

c. Discharge to End Date If discharge is scheduled to be discontinued within the next 5 years, give the date (within best estimate) the discharge will end. — 202c: N/A (YR / MO)

3. Engineering Report Available Check if an engineering report is available to reviewing agency upon request. (see instructions) — 203: ☒

4. Discharge Location Name the political boundaries within which the point of discharge is located.

			Agency Use	
State	204a	Mississippi	204d	
County	204b	Claiborne	204e	
(If applicable) City or Town	204c		204f	

5. Discharge Point Description Discharge is into (check one): (see instructions)

Stream (includes ditches, arroyos, and other intermittent watercourses)	205a	☒STR
Lake		☐LKE
Ocean		☐OCE
Municipal Sanitary Wastewater Transport System		☐MTS
Municipal Combined Sanitary and Storm Transport System		☐MCS

FOR AGENCY USE

Municipal Storm Water Transport System		☐STS
Well (Injection)		☐WEL
Other		☐OTH
If 'other' is checked, specify	205b	

6. Discharge Point — Lat/Long Give the precise location of the point of discharge to the nearest second.

Latitude	206a	N 32 DEG 1 MIN 15 SEC
Longitude	206b	W 91 DEG 4 MIN 5 SEC

7. Discharge Receiving Water Name Name the waterway at the point of discharge.(see instructions)

207a: Mississippi River

If the discharge is through an outfall that extends beyond the shoreline or is below the mean low water line, complete item 8.

207b

For Agency Use			207c	For Agency Use
Major	Minor	Sub		303e

8. Offshore Discharge

a. Discharge Distance from Shore	208a	_____ feet
b. Discharge Depth Below Water Surface	208b	_____ feet

9. Discharge Type and Occurrence

a. Type of Discharge Check whether the discharge is continuous or intermittent. (see instructions) — 209a

☐ (con) Continuous

☒ (int) Intermittent

b. Discharge Occurrence Days per Week Enter the average number of days per week (during periods of discharge) this discharge occurs. — 209b: 1 days per week

c. Discharge Occurrence —Months If this discharge normally operates (either intermittently, or continuously) on less than a year-around basis (excluding shutdowns for routine maintenance), check the months during the year when the discharge is operating. (see instructions) — 209c: N/A

☐JAN ☐FEB ☐MAR ☐APR

☐MAY ☐JUN ☐JUL ☐AUG

☐SEP ☐OCT ☐NOV ☐DEC

Complete items 10 and 11 if "Intermittent" is checked in item 9.a. Otherwise, proceed to item 12.

10. Intermittent Discharge Quantity State the average volume per discharge occurrence in thousands of gallons. — 210: 420 thousand gallons per discharge occurrence.

11. Intermittent Discharge Duration and Frequency

a. Intermittent Discharge Duration Per Day State the average number of hours per day the discharge is operating. — 211a: 0 hours per day

b. Intermittent Discharge Frequency State the average number of discharge occurrences per day during days when discharging. — 211b: 1 discharge occurrences per day

12. Maximum Flow Period Give the time period in which the maximum flow of this discharge occurs. — 212: From N/A (month) to _____ (month)

FORM A
OMB No. 158-R0100

FOR AGENCY USE

13. Activity Description Give a narrative description of activity producing this discharge.(see instructions)

213a The standby service water (S.S.W) aids in cooling the reactor in case of an emergency, and for normal shutdown. The S. S. W. cooling towers cool this water. Since this system should be used very infrequently, the blowdown from these towers will be very infrequent. Blowdown from both towers is combined before entering the basin.

14. Activity Causing Discharge For each SIC Code which describes the activity causing this discharge, supply the type and maximum amount of either the raw material consumed (Item 14a) or the product produced (Item 14b) in the units specified in Table I of the Instruction Booklet. For SIC Codes not listed in Table I, use raw material or production units normally used for measuring production.(see instructions)

a. Raw Materials

	SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Number) (5)
214a					

b. Products

	SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Number) (5)
214b	4911	Electric Service	60	Z-1	001, 003, 004, 005, 006, 007, 009

DISCHARGE SERIAL NUMBER

002

FOR AGENCY USE

15. Waste Abatement

a. Waste Abatement Practices
Describe the waste abatement practices used on this discharge with a brief narrative. (see instructions)

215a

Narrative: Cooling towers are used to reduce the thermal impact of discharge.

b. Waste Abatement Codes
Using the codes listed in Table II of the Instruction Booklet, describe the waste abatement processes for this discharge in the order in which they occur if possible.

215b

(1) ESEPAR, (2) RECYCL, (3) EPUMPS,
(4) PTEMPE, (5) _____, (6) _____,
(7) _____, (8) _____, (9) _____,
(10) _____, (11) _____, (12) _____,
(13) _____, (14) _____, (15) _____,
(16) _____, (17) _____, (18) _____,
(19) _____, (20) _____, (21) _____,
(22) _____, (23) _____, (24) _____,
(25) _____.

DISCHARGE SERIAL NUMBER

002

FORM APPROVED
OMB No. 158-R0100

FOR AGENCY USE

16. Wastewater Characteristics

Check the box beside each constituent which is present in the effluent (discharge water). This determination is to be based on actual analysis or best estimate.(see instructions)

Parameter 216	Present	Parameter 216	Present
Color 00080		Copper 01042	
Ammonia 00610		Iron 01045	
Organic nitrogen 00605		Lead 01051	
Nitrate 00620		Magnesium 00927	
Nitrite 00615		Manganese 01055	
Phosphorus 00665		Mercury 71900	
Sulfate 00945		Molybdenum 01062	
Sulfide 00745		Nickel 01067	
Sulfite 00740		Selenium 01147	
Bromide 71870		Silver 01077	
Chloride 00940		Potassium 00937	
Cyanide 00720		Sodium 00929	
Fluoride 00951		Thallium 01059	
Aluminum 01105		Titanium 01152	
Antimony 01097		Tin 01102	
Arsenic 01002		Zinc 01092	
Beryllium 01012		Algicides* 74051	
Barium 01007		Chlorinated organic compounds* 74052	
Boron 01022		Pesticides* 74053	
Cadmium 01027		Oil and grease 00550	
Calcium 00916		Phenols 32730	
Cobalt 01037		Surfactants 38260	
Chromium 01034		Chlorine 50060	
Fecal coliform bacteria 74055		Radioactivity* 74050	

*Specify substances, compounds and/or elements in Item 26.

Pesticides (insecticides, fungicides, and rodenticides) must be reported in terms of the acceptable common names specified in *Acceptable Common Names and Chemical Names for the Ingredient Statement on Pesticide Labels*, 2nd Edition, Environmental Protection Agency, Washington, D.C. 20250, June 1973, as required by Subsection 162.7(b) of the Regulations for the Enforcement of the Federal Insecticide, Fungicide, and Rodenticide Act.

DISCHARGE SERIAL NUMBER

002

FOR AGENCY USE

17. Description of Intake and Discharge

For each of the parameters listed below, enter in the appropriate box the value or code letter answer called for (see instructions)

In addition, enter the parameter name and code and all required values for any of the following parameters if they were checked in Item 16: ammonia, cyanide, aluminum, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, phenols, oil and grease, and chlorine (residual).

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)
Flow* Gallons per day 00056 50050 MGD	0	0	0	0	1.008			
pH Units 00400			X					
Temperature (winter) °F 74028								
Temperature (summer) °F 74027								
Biochemical Oxygen Demand (BOD 5-day) mg/l 00310								
Chemical Oxygen Demand (COD) mg/l 00340								
Total Suspended (nonfilterable) Solids mg/l 00530								
Specific Conductance micromhos/cm at 25° C 00095			X					
Settleable Matter (residue) ml/l 00545								

*Other discharges sharing intake flow (serial numbers) (see instructions)

DISCHARGE SERIAL NUMBER
00

OMB No. 158-R0100

FOR AGENCY USE

17. (Cont'd.)

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)

18. Plant Controls Check if the following plant controls are available for this discharge.

218

Alternate power source for major pumping facility. ☒ APS

Alarm or emergency procedure for power or equipment failure ☒ ALM

Complete item 19 if discharge is from cooling and/or steam water generation and water treatment additives are used.

19. Water Treatment Additives If the discharge is treated with any conditioner, inhibitor, or algicide, answer the following:

a. Name of Material(s) 219a Sulfuric acid, sodium hypochlorite

b. Name and address of manufacturer 219b

c. Quantity (pounds added per million gallons of water treated). 219c

DISCHARGE SERIAL NUMBER

002

FOR AGENCY USE

d. Chemical composition of these additives (see instructions).	219d	

Complete items 20-25 if there is a thermal discharge (e.g., associated with a steam and/or power generation plant, steel mill, petroleum refinery, or any other manufacturing process) and the total discharge flow is 10 million gallons per day or more. (see instructions)

20. Thermal Discharge Source Check the appropriate item(s) indicating the source of the discharge. (see instructions)	220	
Boiler Blowdown		☐ BLBD
Boiler Chemical Cleaning		☐ BCCL
Ash Pond Overflow		☐ APOF
Boiler Water Treatment — Evaporator Blowdown		☐ EPBD
Oil or Coal Fired Plants — Effluent from Air Pollution Control Devices		☐ OCFP
Condense Cooling Water		☐ COND
Cooling Tower Blowdown		☒ CTBD
Manufacturing Process		☐ MFPR
Other		☐ OTHR
21. Discharge/Receiving Water Temperature Difference Give the maximum temperature difference between the discharge and receiving waters for summer and winter operating conditions. (see instructions)		
Summer	221a	_____ °F.
Winter	221b	_____ °F.
22. Discharge Temperature, Rate of Change Per Hour Give the maximum possible rate of temperature change per hour of discharge under operating conditions. (see instructions)	222	_____ °F./hour

23. Water Temperature, Percentile Report (Frequency of Occurrence)

In the table below, enter the temperature which is exceeded 10% of the year, 5% of the year, 1% of the year and not at all (maximum yearly temperature). (see instructions)

Frequency of occurrence		10%	5%	1%	Maximum
a. Intake Water Temperature (Subject to natural changes)	223a	°F	°F	°F	°F
b. Discharge Water Temperature	223b	°F	°F	°F	°F

24. Water Intake Velocity (see instructions)	224	_____ feet/sec.
25. Retention Time Give the length of time, in minutes, from start of water temperature rise to discharge of cooling water. (see instructions)	225	_____ minutes

DISCHARGE SERIAL NUMBER

002

FOR AGENCY USE

26. Additional Information

226 Item	Information
217 a	Discharge is into the Mississippi River. Intake is provided by radial wells. The radial well system consists of three (3) wells presently, with the addition of two (2) more planned for the future. Each well consists of a reinforced concrete caisson with a base slab, and a set of lateral screens extending radially 250 feet to 300 feet from the well into the aquifer that exists beneath the river bed and along the bank. These wells will provide a mixture of normal ground water, and induced infiltration of river water passing through the river bottom to the collectors.

FORM [illegible]
OMB No. 158-R0100

STANDARD FORM C – MANUFACTURING AND COMMERCIAL

FOR AGENCY USE

SECTION II. BASIC DISCHARGE DESCRIPTION

Complete this section for each discharge indicated in Section I, Item 9, that is to surface waters. This includes discharges to municipal sewerage systems in which the wastewater does not go through a treatment works prior to being discharged to surface waters. Discharges to wells must be described where there are also discharges to surface waters from this facility. SEPARATE DESCRIPTIONS OF EACH DISCHARGE ARE REQUIRED EVEN IF SEVERAL DISCHARGES ORIGINATE IN THE SAME FACILITY. All values for an existing discharge should be representative of the twelve previous months of operation. If this is a proposed discharge, values should reflect best engineering estimates.

ADDITIONAL INSTRUCTIONS FOR SELECTED ITEMS APPEAR IN SEPARATE INSTRUCTION BOOKLET AS INDICATED. REFER TO BOOKLET BEFORE FILLING OUT THESE ITEMS.

1. Discharge Serial No. and Name		
a. Discharge Serial No. (see instructions)	201a	003
b. Discharge Name Give name of discharge, if any. (see instructions)	201b	Cooling Tower Blowdown
c. Previous Discharge Serial No. If previous permit application was made for this discharge (see Item 4, Section I), provide previous discharge serial number.	201c	N/A
2. Discharge Operating Dates		
a. Discharge Began Date If the discharge described below is in operation, give the date (within best estimate) the discharge began.	202a	N/A (YR MO)
b. Discharge to Begin Date If the discharge has never occurred but is planned for some future date, give the date (within best estimate) the discharge will begin.	202b	78 7 (YR MO)
c. Discharge to End Date If discharge is scheduled to be discontinued within the next 5 years, give the date (within best estimate) the discharge will end.	202c	N/A (YR MO)
3. Engineering Report Available Check if an engineering report is available to reviewing agency upon request. (see instructions)	203	☒
4. Discharge Location Name the political boundaries within which the point of discharge is located.		
State	204a	Mississippi
County	204b	Claiborne
(If applicable) City or Town	204c	
Agency Use	204d	
Agency Use	204e	
Agency Use	204f	
5. Discharge Point Description Discharge is into (check one): (see instructions)		
Stream (includes ditches, arroyos, and other intermittent watercourses)	205a	☒ STR
Lake		☐ LKE
Ocean		☐ OCE
Municipal Sanitary Wastewater Transport System		☐ MTS
Municipal Combined Sanitary and Storm Transport System		☐ MCS

FOR AGENCY USE

Municipal Storm Water Transport System ☐STS

Well (Injection) ☐WEL

Other ☐OTH

If 'other' is checked, specify 205b

6. Discharge Point — Lat/Long. Give the precise location of the point of discharge to the nearest second.

Latitude 206a N 32 DEG 1 MIN 15 SEC

Longitude 206b W 91 DEG 4 MIN 5 SEC

7. Discharge Receiving Water Name. Name the waterway at the point of discharge.(see instructions) 207a Mississippi River

If the discharge is through an outfall that extends beyond the shoreline or is below the mean low water line, complete Item 8.

207b

For Agency Use			207c	For Agency Use
Major	Minor	Sub		303e

8. Offshore Discharge

a. Discharge Distance from Shore 208a _____ feet

b. Discharge Depth Below Water Surface 208b _____ feet

9. Discharge Type and Occurrence

a. Type of Discharge. Check whether the discharge is continuous or intermittent. (see instructions) 209a ☒ (con) Continuous ☐ (int) Intermittent

b. Discharge Occurrence Days per Week. Enter the average number of days per week (during periods of discharge) this discharge occurs. 209b 7 days per week

c. Discharge Occurrence — Months. If this discharge normally operates (either intermittently, or continuously) on less than a year-around basis (excluding shutdowns for routine maintenance), check the months during the year when the discharge is operating. (see instructions) 209c N/A

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☐MAY ☐JUN ☐JUL ☐AUG
☐SEP ☐OCT ☐NOV ☐DEC

Complete Items 10 and 11 if "Intermittent" is checked in Item 9.a. Otherwise, proceed to Item 12.

10. Intermittent Discharge Quantity. State the average volume per discharge occurrence in thousands of gallons. 210 NA thousand gallons per discharge occurrence.

11. Intermittent Discharge Duration and Frequency

a. Intermittent Discharge Duration Per Day. State the average number of hours per day the discharge is operating. 211a __ hours per day

b. Intermittent Discharge Frequency. State the average number of discharge occurrences per day during days when discharging. 211b ____ discharge occurrences per day

12. Maximum Flow Period. Give the time period in which the maximum flow of this discharge occurs. 212 From _____ (month) to _____ (month)

FOR AGENCY USE

13. **Activity Description** Give a narrative description of activity producing this discharge.(see instructions)

213a Cooling Towers are used to remove heat from recirculating cooling water. This cooling tower blowdown is a relatively small portion of the cooled water that is discharged to maintain water quality in the system. The cooling tower blowdown from both units is combined before entering the discharge basin.

14. **Activity Causing Discharge** For each SIC Code which describes the activity causing this discharge, supply the type and maximum amount of either the raw material consumed (Item 14a) or the product produced (Item 14b) in the units specified in Table I of the Instruction Booklet. For SIC Codes not listed in Table I, use raw material or production units normally used for measuring production.(see instructions)

a. **Raw Materials**

	SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Number) (5)
214a					

b. **Products**

	SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Number) (5)
214b	4911	Electric Services	60	Z-1	001, 002, 004, 005, 006, 007, 009

DISCHARGE SERIAL NUMBER

003

FOR AGENCY USE

15. Waste Abatement

a. Waste Abatement Practices
Describe the waste abatement practices used on this discharge with a brief narrative. (see instructions)

215a

Narrative: Removal of heat by a cooling tower.

b. Waste Abatement Codes
Using the codes listed in Table II of the Instruction Booklet, describe the waste abatement processes for this discharge in the order in which they occur if possible.

215b

(1) ESEPAR, (2) ESURFA, (3) EPUMPS,
(4) RECYCL, (5) PTEMPE, (6) ____,
(7) ____, (8) ____, (9) ____,
(10) ____, (11) ____, (12) ____,
(13) ____, (14) ____, (15) ____,
(16) ____, (17) ____, (18) ____,
(19) ____, (20) ____, (21) ____,
(22) ____, (23) ____, (24) ____,
(25) ____.

DISCHARGE SERIAL NUMBER

003

FORM APPROVED
OMB No. 158-R0100

FOR AGENCY USE

16. Wastewater Characteristics

Check the box beside each constituent which is present in the effluent (discharge water). This determination is to be based on actual analysis or best estimate.(see instructions)

Parameter 216	Present	Parameter 216	Present
Color 00080		Copper 01042	
Ammonia 00610		Iron 01045	
Organic nitrogen 00605		Lead 01051	
Nitrate 00620		Magnesium 00927	
Nitrite 00615		Manganese 01055	
Phosphorus 00665		Mercury 71900	
Sulfate 00945		Molybdenum 01062	
Sulfide 00745		Nickel 01067	
Sulfite 00740		Selenium 01147	
Bromide 71870		Silver 01077	
Chloride 00940		Potassium 00937	
Cyanide 00720		Sodium 00929	
Fluoride 00951		Thallium 01059	
Aluminum 01105		Titanium 01152	
Antimony 01097		Tin 01102	
Arsenic 01002		Zinc 01092	
Beryllium 01012		Algicides* 74051	
Barium 01007		Chlorinated organic compounds* 74052	
Boron 01022		Pesticides* 74053	
Cadmium 01027		Oil and grease 00550	
Calcium 00916		Phenols 32730	
Cobalt 01037		Surfactants 38260	
Chromium 01034		Chlorine 50060	
Fecal coliform bacteria 74055		Radioactivity* 74050	

*Specify substances, compounds and/or elements in Item 26.

Pesticides (insecticides, fungicides, and rodenticides) must be reported in terms of the acceptable common names specified in *Acceptable Common Names and Chemical Names for the Ingredient Statement on Pesticide Labels*, 2nd Edition, Environmental Protection Agency, Washington, D.C. 20250, June 1972, as required by Subsection 162.7(b) of the Regulations for the Enforcement of the Federal Insecticide, Fungicide, and Rodenticide Act.

DISCHARGE SERIAL NUMBER

003

FOR AGENCY USE

17. Description of Intake and Discharge

For each of the parameters listed below, enter in the appropriate box the value or code letter answer called for.(see instructions)

In addition, enter the parameter name and code and all required values for any of the following parameters if they were checked in Item 16: ammonia, cyanide, aluminum, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, phenols, oil and grease, and chlorine (residual).

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)
Flow* Gallons per day 50050 MGD	0	55.7	28.2	7	33			
Units 00 00			X					
Temperature (winter) °F 74028								
Temperature (summer) °F 74027								
Biochemical Oxygen Demand (BOD 5-day) mg/l 00310								
Chemical Oxygen Demand (COD) mg/l 00340								
Total Suspended (nonfilterable) Solids mg/l 00530								
Specific Conductance micromhos/cm at 25° C 00095			X					
Settleable Matter (residue) ml/l 00545								

*Other discharges sharing intake flow (serial numbers).(see instructions)

17. (Cont'd.)

Parameter and Code 227a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)

18. Plant Controls Check if the following plant controls are available for this discharge. — 218

Alternate power source for major pumping facility. — ☒ APS

Alarm or emergency procedure for power or equipment failure — ☒ ALM

Complete item 19 if discharge is from cooling and/or steam water generation and water treatment additives are used.

19. Water Treatment Additives If the discharge is treated with any conditioner, inhibitor, or algicide, answer the following:

a. Name of Material(s) — 219a — Sodium Hypochlorite, Sulfuric Acid

b. Name and address of manufacturer — 219b

c. Quantity (pounds added per million gallons of water treated). — 219c

DISCHARGE SERIAL NUMBER
003

FOR AGENCY USE

d. Chemical composition of these additives (see instructions). | 219d | _____

Complete items 20-25 if there is a thermal discharge (e.g., associated with a steam and/or power generation plant, steel mill, petroleum refinery, or any other manufacturing process) and the total discharge flow is 10 million gallons per day or more. (see instructions)

20. Thermal Discharge Source Check the appropriate item(s) indicating the source of the discharge. (see instructions) | 220

- ☐ Boiler Blowdown — BLBD
- ☐ Boiler Chemical Cleaning — BCCL
- ☐ Ash Pond Overflow — APOF
- ☐ Boiler Water Treatment — Evaporator Blowdown — EPBD
- ☐ Oil or Coal Fired Plants — Effluent from Air Pollution Control Devices — OCFP
- ☐ Condense Cooling Water — COND
- ☒ Cooling Tower Blowdown — CTBD
- ☐ Manufacturing Process — MFPR
- ☐ Other — OTHR

21. Discharge/Receiving Water Temperature Difference

Give the maximum temperature difference between the discharge and receiving waters for summer and winter operating conditions. (see instructions)

Summer	221a	9 °F.
Winter	221b	40 °F.

22. Discharge Temperature, Rate of Change Per Hour | 222 | _____ °F./hour

Give the maximum possible rate of temperature change per hour of discharge under operating conditions. (see instructions)

23. Water Temperature, Percentile Report (Frequency of Occurrence)

In the table below, enter the temperature which is exceeded 10% of the year, 5% of the year, 1% of the year and not at all (maximum yearly temperature). (see instructions)

Frequency of occurrence		10%	5%	1%	Maximum
a. Intake Water Temperature (Subject to natural changes)	223a	°F	°F	°F	°F
b. Discharge Water Temperature	223b	°F	°F	°F	°F

24. Water Intake Velocity (see instructions) | 224 | _____ feet/sec.

25. Retention Time Give the length of time, in minutes, from start of water temperature rise to discharge of cooling water. (see instructions) | 225 | _____ minutes

DISCHARGE SERIAL NUMBER

003

FOR AGENCY USE

26. Additional Information

226

Item	Information
217 a	Discharge is into the Mississippi River. Intake is provided by radial wells. The radial well system consists of three (3) wells presently, with the addition of two (2) more planned for the future. Each well consists of a reinforced concrete caisson with a base slab, and a set of lateral screens extending radially 250 feet to 300 feet from the well into the aquifer that exists beneath the river bed and along the bank. These wells will provide a mixture of normal ground water, and induced infiltration of river water passing through the river bottom to the collectors.

STANDARD FORM C – MANUFACTURING AND COMMERCIAL

FOR AGENCY USE

SECTION II. BASIC DISCHARGE DESCRIPTION

Complete this section for each discharge indicated in Section I, Item 9, that is to surface waters. This includes discharges to municipal sewerage systems in which the wastewater does not go through a treatment works prior to being discharged to surface waters. Discharges to wells must be described where there are also discharges to surface waters from this facility. SEPARATE DESCRIPTIONS OF EACH DISCHARGE ARE REQUIRED EVEN IF SEVERAL DISCHARGES ORIGINATE IN THE SAME FACILITY. All values for an existing discharge should be representative of the twelve previous months of operation. If this is a proposed discharge, values should reflect best engineering estimates.

ADDITIONAL INSTRUCTIONS FOR SELECTED ITEMS APPEAR IN SEPARATE INSTRUCTION BOOKLET AS INDICATED. REFER TO BOOKLET BEFORE FILLING OUT THESE ITEMS.

1. Discharge Serial No. and Name

a. Discharge Serial No. (see instructions)	201a	004
b. Discharge Name Give name of discharge, if any. (see instructions)	201b	Regeneration Waste
c. Previous Discharge Serial No. If previous permit application was made for this discharge (see Item 4, Section I), provide previous discharge serial number.	201c	N/A

2. Discharge Operating Dates

a. Discharge Began Date If the discharge described below is in operation, give the date (within best estimate) the discharge began.	202a	N/A (YR MO)
b. Discharge to Begin Date If the discharge has never occurred but is planned for some future date, give the date (within best estimate) the discharge will begin.	202b	78 7 (YR MO)
c. Discharge to End Date If discharge is scheduled to be discontinued within the next 5 years, give the date (within best estimate) the discharge will end.	202c	N/A (YR MO)

3. Engineering Report Available
Check if an engineering report is available to reviewing agency upon request. (see instructions) — 203 — ☒

4. Discharge Location Name the political boundaries within which the point of discharge is located.

			Agency Use	
State	204a	Mississippi	204d	
County	204b	Claiborne	204e	
(If applicable) City or Town	204c		204f	

5. Discharge Point Description
Discharge is into (check one): (see instructions)

Stream (includes ditches, arroyos, and other intermittent watercourses)	205a	☒ STR
Lake		☐ LKE
Ocean		☐ OCE
Municipal Sanitary Wastewater Transport System		☐ MTS
Municipal Combined Sanitary and Storm Transport System		☐ MCS

FOR AGENCY USE

Municipal Storm Water Transport System ☐STS

Well (injection) ☐WEL

Other ☐OTH

If 'other' is checked, specify 205b

6. Discharge Point — Lat/Long Give the precise location of the point of discharge to the nearest second.

Latitude 206a N 32 DEG 1 MIN 15 SEC

Longitude 206b W 91 DEG 4 MIN 5 SEC

7. Discharge Receiving Water Name Name the waterway at the point of discharge.(see instructions) 207a Mississippi River

If the discharge is through an outfall that extends beyond the shoreline or is below the mean low water line, complete Item 8.

207b

For Agency Use			207c	For Agency Use
Major	Minor	Sub		303e

8. Offshore Discharge

a. Discharge Distance from Shore 208a _____ feet

b. Discharge Depth Below Water Surface 208b _____ feet

9. Discharge Type and Occurrence

a. Type of Discharge Check whether the discharge is continuous or intermittent. (see instructions) 209a ☐ (con) Continuous ☒ (int) Intermittent

b. Discharge Occurrence Days per Week Enter the average number of days per week (during periods of discharge) this discharge occurs. 209b 7 days per week

c. Discharge Occurrence —Months If this discharge normally operates (either intermittently, or continuously) on less than a year-around basis (excluding shutdowns for routine maintenance), check the months during the year when the discharge is operating. (see instructions) 209c N/A

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☐MAY ☐JUN ☐JUL ☐AUG
☐SEP ☐OCT ☐NOV ☐DEC

Complete Items 10 and 11 if "Intermittent" is checked in Item 9.a. Otherwise, proceed to Item 12.

10. Intermittent Discharge Quantity State the average volume per discharge occurrence in thousands of gallons. 210 80 thousand gallons per discharge occurrence.

11. Intermittent Discharge Duration and Frequency

a. Intermittent Discharge Duration Per Day State the average number of hours per day the discharge is operating. 211a 7 hours per day

b. Intermittent Discharge Frequency State the average number of discharge occurrences per day during days when discharging. 211b 1 discharge occurrences per day

12. Maximum Flow Period Give the time period in which the maximum flow of this discharge occurs. 212 NA From _____ (month) to _____ (month)

OMB No. 158-R0100

FOR AGENCY USE

13. **Activity Description** Give a narrative description of activity producing this discharge.(see instructions)

213a Regeneration of make-up demineralizer and neutralization of this waste, charcoal filter backwash, and auxiliary boiler blowdown.

14. **Activity Causing Discharge** For each SIC Code which describes the activity causing this discharge, supply the type and maximum amount of either the raw material consumed (item 14a) or the product produced (item 14b) in the units specified in Table I of the instruction Booklet. For SIC Codes not listed in Table I, use raw material or production units normally used for measuring production.(see instructions)

a. **Raw Materials**

	SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Number) (5)
214a					

b. **Products**

	SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Number) (5)
214b	4911	Electric Service	60	Z-1	001, 002, 003, 005, 006, 007, 009

DISCHARGE SERIAL NUMBER

001

FOR AGENCY USE

15. Waste Abatement

a. Waste Abatement Practices
Describe the waste abatement practices used on this discharge with a brief narrative. (see instructions)

215a

Narrative: The wastes are collected and neutralized as a batch before discharge and mixing with the other wastes.

b. Waste Abatement Codes
Using the codes listed in Table II of the Instruction Booklet, describe the waste abatement processes for this discharge in the order in which they occur if possible.

215b

(1) ESEPAR, (2) ESEGRE, (3) CNEUTR,
(4) ____, (5) ____, (6) ____,
(7) ____, (8) ____, (9) ____,
(10) ____, (11) ____, (12) ____,
(13) ____, (14) ____, (15) ____,
(16) ____, (17) ____, (18) ____,
(19) ____, (20) ____, (21) ____,
(22) ____, (23) ____, (24) ____,
(25) ____.

DISCHARGE SERIAL NUMBER

004

FORM APPROVED
OMB No. 158-R0100

FOR AGENCY USE

16. Wastewater Characteristics

Check the box beside each constituent which is present in the effluent (discharge water). This determination is to be based on actual analysis or best estimate.(see instructions)

Parameter 216	Present	Parameter 216	Present
Color 00080		Copper 01042	
Ammonia 00610		Iron 01045	
Organic nitrogen 00605		Lead 01051	
Nitrate 00620		Magnesium 00927	
Nitrite 00615		Manganese 01055	
Phosphorus 00665		Mercury 71900	
Sulfate 00945		Molybdenum 01062	
Sulfide 00745		Nickel 01067	
Sulfite 00740		Selenium 01147	
Bromide 71870		Silver 01077	
Chloride 00940		Potassium 00937	
Cyanide 00720		Sodium 00929	
Fluoride 00951		Thallium 01059	
Aluminum 01105		Titanium 01152	
Antimony 01097		Tin 01102	
Arsenic 01002		Zinc 01092	
Beryllium 01012		Algicides* 74051	
Barium 01007		Chlorinated organic compounds* 74052	
Boron 01022		Pesticides* 74053	
Cadmium 01027		Oil and grease 00550	
Calcium 00916		Phenols 32730	
Cobalt 01037		Surfactants 38260	
Chromium 01034		Chlorine 50060	
Fecal coliform bacteria 74055		Radioactivity* 74050	

*Specify substances, compounds and/or elements in Item 26.

Pesticides (insecticides, fungicides, and rodenticides) must be reported in terms of the acceptable common names specified in *Acceptable Common Names and Chemical Names for the Ingredient Statement on Pesticide Labels*, 2nd Edition, Environmental Protection Agency, Washington, D.C. 20250, June 1972, as required by Subsection 162.7(b) of the Regulations for the Enforcement of the Federal Insecticide, Fungicide, and Rodenticide Act.

DISCHARGE SERIAL NUMBER

004

FOR AGENCY USE

17. Description of Intake and Discharge

For each of the parameters listed below, enter in the appropriate box the value or code letter answer called for.(see instructions)

In addition, enter the parameter name and code and all required values for any of the following parameters if they were checked in Item 16: ammonia, cyanide, aluminum, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, phenols, oil and grease, and chlorine (residual).

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)
Flow* Gallons per day ~~00056~~ 50050 MGD		0.432	0.080	0.030	0.24			
pH Units 00400			X					
Temperature (winter) ° F 74028								
Temperature (summer) ° F 74027								
Biochemical Oxygen Demand (BOD 5-day) mg/l 00310								
Chemical Oxygen Demand (COD) mg/l 00340								
Total Suspended (nonfilterable) Solids mg/l 00530								
Specific Conductance micromhos/cm at 25° C 00095			X					
Settleable Matter (residue) ml/l 00545								

*Other discharges sharing intake flow (serial numbers) (see instructions)

17. (Cont'd.)

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)

18. Plant Controls Check if the following plant controls are available for this discharge. — 218

Alternate power source for major pumping facility. — ☒ APS

Alarm or emergency procedure for power or equipment failure — ☒ ALM

Complete item 19 if discharge is from cooling and/or steam water generation and water treatment additives are used.

19. Water Treatment Additives If the discharge is treated with any conditioner, inhibitor, or algicide, answer the following:

a. Name of Material(s) — 219a _____

b. Name and address of manufacturer — 219b _____

c. Quantity (pounds added per million gallons of water treated). — 219c _____

DISCHARGE SERIAL NUMBER

004

FOR AGENCY USE

d. Chemical composition of these additives (see instructions). | 219d | _____

_____

Complete items 20-25 if there is a thermal discharge (e.g., associated with a steam and/or power generation plant, steel mill, petroleum refinery, or any other manufacturing process) and the total discharge flow is 10 million gallons per day or more. (see instructions)

20. Thermal Discharge Source. Check the appropriate item(s) indicating the source of the discharge. (see instructions) | 220

- Boiler Blowdown — ☒ BLBD
- Boiler Chemical Cleaning — ☐ BCCL
- Ash Pond Overflow — ☐ APOF
- Boiler Water Treatment — Evaporator Blowdown — ☐ EPBD
- Oil or Coal Fired Plants — Effluent from Air Pollution Control Devices — ☐ OCFP
- Condense Cooling Water — ☐ COND
- Cooling Tower Blowdown — ☐ CTBD
- Manufacturing Process — ☐ MFPR
- Other — ☐ OTHR

21. Discharge/Receiving Water Temperature Difference

Give the maximum temperature difference between the discharge and receiving waters for summer and winter operating conditions. (see instructions)

- Summer | 221a | _____ °F.
- Winter | 221b | _____ °F.

22. Discharge Temperature, Rate of Change Per Hour | 222 | _____ °F./hour

Give the maximum possible rate of temperature change per hour of discharge under operating conditions. (see instructions)

23. Water Temperature, Percentile Report (Frequency of Occurrence)

In the table below, enter the temperature which is exceeded 10% of the year, 5% of the year, 1% of the year and not at all (maximum yearly temperature). (see instructions)

Frequency of occurrence		10%	5%	1%	Maximum
a. Intake Water Temperature (Subject to natural changes)	223a	°F	°F	°F	°F
b. Discharge Water Temperature	223b	°F	°F	°F	°F

24. Water Intake Velocity (see instructions) | 224 | _____ feet/sec.

25. Retention Time. Give the length of time, in minutes, from start of water temperature rise to discharge of cooling water. (see instructions) | 225 | _____ minutes

DISCHARGE SERIAL NUMBER

004

FOR AGENCY USE

26. Additional Information

226

Item	Information
217 a	Discharge is into the Mississippi River. Intake is provided by radial wells. The radial well system consists of three (3) wells presently, with the addition of two (2) more planned for the future. Each well consists of a reinforced concrete caisson with a base slab, and a set of lateral screens extending radially 250 feet to 300 feet from the well into the aquifer that exists beneath the river bed and along the bank. These wells will provide a mixture of normal ground water, and induced infiltration of river water passing through the river bottom to the collectors.

STANDARD FORM C – MANUFACTURING AND COMMERCIAL

FOR AGENCY USE

SECTION II. BASIC DISCHARGE DESCRIPTION

Complete this section for each discharge indicated in Section I, Item 9, that is to surface waters. This includes discharges to municipal sewerage systems in which the wastewater does not go through a treatment works prior to being discharged to surface waters. Discharges to wells must be described where there are also discharges to surface waters from this facility. SEPARATE DESCRIPTIONS OF EACH DISCHARGE ARE REQUIRED EVEN IF SEVERAL DISCHARGES ORIGINATE IN THE SAME FACILITY. All values for an existing discharge should be representative of the twelve previous months of operation. If this is a proposed discharge, values should reflect best engineering estimates.

ADDITIONAL INSTRUCTIONS FOR SELECTED ITEMS APPEAR IN SEPARATE INSTRUCTION BOOKLET AS INDICATED. REFER TO BOOKLET BEFORE FILLING OUT THESE ITEMS.

1. Discharge Serial No. and Name

a. Discharge Serial No. (see instructions) — 201a: 005

b. Discharge Name. Give name of discharge, if any. (see instructions) — 201b: Sewage Treatment Plant Effluent

c. Previous Discharge Serial No. If previous permit application was made for this discharge (see Item 4, Section I), provide previous discharge serial number. — 201c: 001

2. Discharge Operating Dates

a. Discharge Began Date. If the discharge described below is in operation, give the date (within best estimate) the discharge began. — 202a: 75 (YR) 10 (MO)

b. Discharge to Begin Date. If the discharge has never occurred but is planned for some future date, give the date (within best estimate) the discharge will begin. — 202b: N/A (YR) (MO)

c. Discharge to End Date. If discharge is scheduled to be discontinued within the next 5 years, give the date (within best estimate) the discharge will end. — 202c: N/A (YR) (MO)

3. Engineering Report Available

Check if an engineering report is available to reviewing agency upon request. (see instructions) — 203: ☒

4. Discharge Location. Name the political boundaries within which the point of discharge is located.

			Agency Use
State	204a	Mississippi	204d
County	204b	Claiborne	204e
(If applicable) City or Town	204c		204f

5. Discharge Point Description

[Discharge is into (check one)] (see instructions)

Stream (Includes ditches, arroyos, and other intermittent watercourses)	205a	☒STR
Lake		☐LKE
Ocean		☐OCE
Municipal Sanitary Wastewater Transport System		☐MTS
Municipal Combined Sanitary and Storm Transport System		☐MCS

FOR AGENCY USE

Municipal Storm Water Transport System ☐ STS

Well (Injection) ☐ WEL

Other ☐ OTH

If "other" is checked, specify 205b

6. Discharge Point — Lat/Long Give the precise location of the point of discharge to the nearest second.

Latitude 206a N 32 DEG 1 MIN 15 SEC

Longitude 206b W 91 DEG 4 MIN 5 SEC

7. Discharge Receiving Water Name Name the waterway at the point of discharge.(see instructions) 207a Mississippi River

If the discharge is through an outfall that extends beyond the shoreline or is below the mean low water line, complete Item 8.

207b

For Agency Use		
Major	Minor	Sub

207c

For Agency Use
303e

8. Offshore Discharge

a. Discharge Distance from Shore 208a _____ feet

b. Discharge Depth Below Water Surface 208b _____ feet

9. Discharge Type and Occurrence

a. Type of Discharge Check whether the discharge is continuous or intermittent. (see instructions) 209a ☒ (con) Continuous ☐ (int) Intermittent

b. Discharge Occurrence Days per Week Enter the average number of days per week (during periods of discharge) this discharge occurs. 209b 7 days per week

c. Discharge Occurrence —Months If this discharge normally operates (either intermittently, or continuously) on less than a year-around basis (excluding shutdowns for routine maintenance), check the months during the year when the discharge is operating. (see instructions) 209c N/A

☐ JAN ☐ FEB ☐ MAR ☐ APR

☐ MAY ☐ JUN ☐ JUL ☐ AUG

☐ SEP ☐ OCT ☐ NOV ☐ DEC

Complete Items 10 and 11 if "intermittent" is checked in Item 9.a. Otherwise, proceed to Item 12.

10. Intermittent Discharge Quantity State the average volume per discharge occurrence in thousands of gallons. 210 N/A thousand gallons per discharge occurrence.

11. Intermittent Discharge Duration and Frequency

a. Intermittent Discharge Duration Per Day State the average number of hours per day the discharge is operating. 211a N/A hours per day

b. Intermittent Discharge Frequency State the average number of discharge occurrences per day during days when discharging. 211b N/A discharge occurrences per day

12. Maximum Flow Period Give the time period in which the maximum flow of this discharge occurs. 212 From N/A (month) to _____ (month)

FOR AGENCY USE

13. **Activity Description** Give a narrative description of activity producing this discharge.(see instructions)

213a Collection and treatment of drinking water and restroom discharges.

14. **Activity Causing Discharge** For each SIC Code which describes the activity causing this discharge, supply the type and maximum amount of either the raw material consumed (Item 14a) or the product produced (Item 14b) in the units specified in Table I of the Instruction Booklet. For SIC Codes not listed in Table I, use raw material or production units normally used for measuring production.(see instructions)

a. **Raw Materials**

	SIC Code	Name	Maximum Amount/Day	Unit (See Table I)	Shared Discharges (Serial Number)
214a	(1)	(2)	(3)	(4)	(5)

b. **Products**

	SIC Code	Name	Maximum Amount/Day	Unit (See Table I)	Shared Discharges (Serial Number)
214b	(1)	(2)	(3)	(4)	(5)
	4911	Electric Service	60	Z-1	001, 002, 003, 004, 006, 007, 009

DISCHARGE SERIAL NUMBER

005

FOR AGENCY USE

15. Waste Abatement

a. Waste Abatement Practices
Describe the waste abatement practices used on this discharge with a brief narrative. (see instructions)

215a

Narrative: The waste is collected by a separate system and routed to a package sewage treatment plant. Within the plant the sewage is treated by aeration and activated sludge. The discharge is chlorinated and mixed with the other plant discharges after the discharge basin.

b. Waste Abatement Codes
Using the codes listed in Table II of the Instruction Booklet, describe the waste abatement processes for this discharge in the order in which they occur if possible.

215b

(1) ESEPAR, (2) ESEGRE, (3) OMONIT,
(4) PSCREE, (5) BACTIV, (6) SAEROB,
(7) PSKIMC, (8) CCLPIS, (9) _____,
(10) _____, (11) _____, (12) _____,
(13) _____, (14) _____, (15) _____,
(16) _____, (17) _____, (18) _____,
(19) _____, (20) _____, (21) _____,
(22) _____, (23) _____, (24) _____,
(25) _____.

DISCHARGE SERIAL NUMBER

005

OMB No. 158-R0100

FOR AGENCY USE

16. Wastewater Characteristics

Check the box beside each constituent which is present in the effluent (discharge water). This determination is to be based on actual analysis or best estimate.(see instructions)

Parameter 216	Present	Parameter 216	Present
Color 00080		Copper 01042	
Ammonia 00610		Iron 01045	
Organic nitrogen 00605		Lead 01051	
Nitrate 00620		Magnesium 00927	
Nitrite 00615		Manganese 01055	
Phosphorus 00665		Mercury 71900	
Sulfate 00945		Molybdenum 01062	
Sulfide 00745		Nickel 01067	
Sulfite 00740		Selenium 01147	
Bromide 71870		Silver 01077	
Chloride 00940		Potassium 00937	
Cyanide 00720		Sodium 00929	
Fluoride 00951		Thallium 01059	
Aluminum 01105		Titanium 01152	
Antimony 01097		Tin 01102	
Arsenic 01002		Zinc 01092	
Beryllium 01012		Algicides* 74051	
Barium 01007		Chlorinated organic compounds* 74052	
Boron 01022		Pesticides* 74053	
Cadmium 01027		Oil and grease 00550	
Calcium 00916		Phenols 32730	
Cobalt 01037		Surfactants 38260	
Chromium 01034		Chlorine 50060	X
Fecal coliform bacteria 74055	X	Radioactivity* 74050	

*Specify substances, compounds and/or elements in Item 26.

Pesticides (insecticides, fungicides, and rodenticides) must be reported in terms of the acceptable common names specified in *Acceptable Common Names and Chemical Names for the Ingredient Statement on Pesticide Labels*, 2nd Edition, Environmental Protection Agency, Washington, D.C. 20250, June 1972, as required by Subsection 162.7(b) of the Regulations for the Enforcement of the Federal Insecticide, Fungicide, and Rodenticide Act.

DISCHARGE SERIAL NUMBER

005

FOR AGENCY USE

17. Description of Intake and Discharge

For each of the parameters listed below, enter in the appropriate box the value or code letter answer called for.(see instructions)

In addition, enter the parameter name and code and all required values for any of the following parameters if they were checked in Item 16; ammonia, cyanide, aluminum, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, phenols, oil and grease, and chlorine (residual).

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)
Flow* Cubic meter day 50050 MGD	0	0.05	0.030	0.001	0.11			
pH Units 00400			X					
Temperature (winter) °F 74028								
Temperature (summer) °F 74027								
Biochemical Oxygen Demand (BOD 5-day) mg/l 00310								
Chemical Oxygen Demand (COD) mg/l 00340								
Total Suspended (nonfilterable) Solids mg/l 00530								
Specific Conductance micromhos/cm at 25° C 00095			X					
Settleable Matter (residue) ml/l 00545								

*Other discharges sharing intake flow (serial numbers).(see instructions)

17. (Cont'd.)

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)

18. Plant Controls Check if the following plant controls are available for this discharge. — 218

Alternate power source for major pumping facility. ☐ APS

Alarm or emergency procedure for power or equipment failure ☐ ALM

Complete item 19 if discharge is from cooling and/or steam water generation and water treatment additives are used.

19. Water Treatment Additives If the discharge is treated with any conditioner, inhibitor, or algicide, answer the following:

a. Name of Material(s) — 219a _____

b. Name and address of manufacturer — 219b _____

c. Quantity (pounds added per million gallons of water treated). — 219c _____

DISCHARGE SERIAL NUMBER

005

FOR AGENCY USE

d. Chemical composition of these additives (see instructions). | 219d | _____

_____

Complete items 20-25 if there is a thermal discharge (e.g., associated with a steam and/or power generation plant, steel mill, petroleum refinery, or any other manufacturing process) and the total discharge flow is 10 million gallons per day or more. (see instructions)

20. Thermal Discharge Source Check the appropriate item(s) indicating the source of the discharge. (see instructions) | 220

N/A

- ☐ Boiler Blowdown — BLBD
- ☐ Boiler Chemical Cleaning — BCCL
- ☐ Ash Pond Overflow — APOF
- ☐ Boiler Water Treatment — Evaporator Blowdown — EPBD
- ☐ Oil or Coal Fired Plants — Effluent from Air Pollution Control Devices — OCFP
- ☐ Condense Cooling Water — COND
- ☐ Cooling Tower Blowdown — CTBD
- ☐ Manufacturing Process — MFPR
- ☐ Other — OTHR

21 Discharge/Receiving Water Temperature Difference

Give the maximum temperature difference between the discharge and receiving waters for summer and winter operating conditions. (see instructions)

Summer | 221a | _____ °F.

Winter | 221b | _____ °F.

22. Discharge Temperature, Rate of Change Per Hour | 222 | _____ °F./hour

Give the maximum possible rate of temperature change per hour of discharge under operating conditions. (see instructions)

23. Water Temperature, Percentile Report (Frequency of Occurrence)

In the table below, enter the temperature which is exceeded 10% of the year, 5% of the year, 1% of the year and not at all (maximum yearly temperature). (see instructions)

Frequency of occurrence		10%	5%	1%	Maximum
a. Intake Water Temperature (Subject to natural changes)	223a	°F	°F	°F	°F
b. Discharge Water Temperature	223b	°F	°F	°F	°F

24. Water Intake Velocity (see instructions) | 224 | _____ feet/sec.

25. Retention Time Give the length of time, in minutes, from start of water temperature rise to discharge of cooling water. (see instructions) | 225 | _____ minutes

DISCHARGE SERIAL NUMBER

005

FOR AGENCY USE

26. Additional Information

226

Item	Information
217 a	Discharge is into the Mississippi River. Intake is provided by radial wells. The radial well system consists of three (3) wells presently, with the addition of two (2) more planned for the future. Each well consists of a reinforced concrete caisson with a base slab, and a set of lateral screens extending radially 250 feet to 300 feet from the well into the aquifer that exists beneath the river bed and along the bank. These wells will provide a mixture of normal ground water, and induced infiltration of river water passing through the river bottom to the collectors.

STANDARD FORM C – MANUFACTURING AND COMMERCIAL

FOR AGENCY USE

SECTION II. BASIC DISCHARGE DESCRIPTION

Complete this section for each discharge indicated in Section I, Item 9, that is to surface waters. This includes discharges to municipal sewerage systems in which the wastewater does not go through a treatment works prior to being discharged to surface waters. Discharges to wells must be described where there are also discharges to surface waters from this facility. SEPARATE DESCRIPTIONS OF EACH DISCHARGE ARE REQUIRED EVEN IF SEVERAL DISCHARGES ORIGINATE IN THE SAME FACILITY. All values for an existing discharge should be representative of the twelve previous months of operation. If this is a proposed discharge, values should reflect best engineering estimates.

ADDITIONAL INSTRUCTIONS FOR SELECTED ITEMS APPEAR IN SEPARATE INSTRUCTION BOOKLET AS INDICATED. REFER TO BOOKLET BEFORE FILLING OUT THESE ITEMS.

1. Discharge Serial No. and Name		
a. Discharge Serial No. (see instructions)	201a	006
b. Discharge Name Give name of discharge, if any. (see instructions)	201b	Liquid Radwaste System
c. Previous Discharge Serial No. If previous permit application was made for this discharge (see Item 4, Section I), provide previous discharge serial number.	201c	N/A
2. Discharge Operating Dates		
a. Discharge Began Date If the discharge described below is in operation, give the date (within best estimate) the discharge began.	202a	N/A (YR MO)
b. Discharge to Begin Date If the discharge has never occurred but is planned for some future date, give the date (within best estimate) the discharge will begin.	202b	78 7 (YR MO)
c. Discharge to End Date If discharge is scheduled to be discontinued within the next 5 years, give the date (within best estimate) the discharge will end.	202c	N/A (YR MO)
3. Engineering Report Available Check if an engineering report is available to reviewing agency upon request. (see instructions)	203	☒
4. Discharge Location Name the political boundaries within which the point of discharge is located.		
State	204a	Mississippi
County	204b	Claiborne
(If applicable) City or Town	204c	
Agency Use	204d	
Agency Use	204e	
Agency Use	204f	
5. Discharge Point Description Discharge is into (check one): (see instructions)		
Stream (includes ditches, arroyos, and other intermittent watercourses)	205a	☒ STR
Lake		☐ LKE
Ocean		☐ OCE
Municipal Sanitary Wastewater Transport System		☐ MTS
Municipal Combined Sanitary and Storm Transport System		☐ MCS

FOR AGENCY USE

Municipal Storm Water Transport System ☐STS

Well (Injection) ☐WEL

Other ☐OTH

If 'other' is checked, specify 205b

6. Discharge Point -- Lat/Long Give the precise location of the point of discharge to the nearest second.

Latitude 206a N 32 DEG 1 MIN 15 SEC

Longitude 206a W 91 DEG 4 MIN 5 SEC

7. Discharge Receiving Water Name Name the waterway at the point of discharge.(see instructions) 207a Mississippi River

If the discharge is through an outfall that extends beyond the shoreline or is below the mean low water line, complete Item 8.

207b

For Agency Use			207c	For Agency Use
Major	Minor	Sub		303e

8. Offshore Discharge

a. Discharge Distance from Shore 208a _____ feet

b. Discharge Depth Below Water Surface 208b _____ feet

9. Discharge Type and Occurrence

a. Type of Discharge Check whether the discharge is continuous or intermittent. (see instructions) 209a ☐ (con) Continuous * ☐ (int) Intermittent

b. Discharge Occurrence Days per Week Enter the average number of days per week (during periods of discharge) this discharge occurs. 209b ___days per week

c. Discharge Occurrence --Months If this discharge normally operates (either intermittently, or continuously) on less than a year-around basis (excluding shutdowns for routine maintenance), check the months during the year when the discharge is operating. (see instructions) 209c N/A

☐JAN ☐FEB ☐MAR ☐APR

☐MAY ☐JUN ☐JUL ☐AUG

☐SEP ☐OCT ☐NOV ☐DEC

* Engineering not yet complete. Further information will be forwarded at a later date.

Complete Items 10 and 11 if "Intermittent" is checked in Item 9.a. Otherwise, proceed to Item 12.

10. Intermittent Discharge Quantity State the average volume per discharge occurrence in thousands of gallons. 210 _____ thousand gallons per discharge occurrence.

11. Intermittent Discharge Duration and Frequency

a. Intermittent Discharge Duration Per Day State the average number of hours per day the discharge is operating. 211a ____hours per day

b. Intermittent Discharge Frequency State the average number of discharge occurrences per day during days when discharging. 211b ____discharge occurrences per day

12. Maximum Flow Period Give the time period in which the maximum flow of this discharge occurs. 212 From N/A (month) to _____ (month)

FORM APPROVED
OMB No. 158-R0100

FOR AGENCY USE

13. Activity Description (Give a narrative description of activity producing this discharge.(see instructions)

213a Liquid radioactive wastes originate from minor leaks or drainage of equipment containing water contaminated with radioactivity. The liquid radwaste system collects, processes, and disposes of liquid radioactive wastes and collects and transfers to the solid radwaste system certain solid wastes that are produced during shutdown, startup, and normal plant operation. To provide greater system efficiency, the liquid radwaste system is divided into three primary subsystems: equipment drains, floor drains, and chemical waste processing subsystems. The liquid radwaste system is designed to provide as much recycling of water as possible.

14. Activity Causing Discharge. For each SIC Code which describes the activity causing this discharge, supply the type and maximum amount of either the raw material consumed (Item 14a) or the product produced (Item 14b) in the units specified on Table I of the Instruction booklet. For SIC Codes not listed in Table I, use raw material or production units normally used for measuring production.(see instructions)

a. Raw Materials

	SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Numbers) (5)
214a					

b. Products

	SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Numbers) (5)
214b	4911	Electric Service	60	Z-1	001, 002, 003, 004, 005, 007, 009

DISCHARGE SERIAL NUMBER

C06

FOR AGENCY USE

15. Waste Abatement

a. Waste Abatement Practices
Describe the waste abatement practices used on this discharge with a brief narrative. (see instructions)

215a

Narrative: Flows are collected separately and solids are separated from liquids. The liquid is passed through ion exchange equipment to reduce the remaining radiation to very low levels, and then is discharged through the basin.

b. Waste Abatement Codes
Using the codes listed in Table II of the Instruction Booklet, describe the waste abatement processes for this discharge in the order in which they occur if possible.

215b

(1) ESEPAR,	(2) ESEGRE,	(3) ESURFA,
(4) EMERGE,	(5) ECOUNT,	(6) EPUMPS,
(7) DCHEMI,	(8) RECYCL,	(9) PMIXED,
(10) MIONOX,	(11) ____,	(12) ____,
(13) ____,	(14) ____,	(15) ____,
(16) ____,	(17) ____,	(18) ____,
(19) ____,	(20) ____,	(21) ____,
(22) ____,	(23) ____,	(24) ____,
(25) ____.		

DISCHARGE SERIAL NUMBER

00)

Form Approved
OMB No. 158-R0100

FOR AGENCY USE

16. Wastewater Characteristics

Check the box beside each constituent which is present in the effluent (discharge water). This determination is to be based on actual analysis or best estimate.(see instructions)

Parameter 216	Present	Parameter 216	Present
Color 00080		Copper 01042	
Ammonia 00610		Iron 01045	
Organic nitrogen 00605		Lead 01051	
Nitrate 00620		Magnesium 00927	
Nitrite 00615		Manganese 01055	
Phosphorus 00665		Mercury 71900	
Sulfate 00945		Molybdenum 01062	
Sulfide 00745		Nickel 01067	
Sulfite 00740		Selenium 01147	
Bromide 71870		Silver 01077	
Chloride 00940		Potassium 00937	
Cyanide 00720		Sodium 00929	
Fluoride 00951		Thallium 01059	
Aluminum 01105		Titanium 01152	
Antimony 01097		Tin 01102	
Arsenic 01002		Zinc 01092	
Beryllium 01012		Algicides* 74051	
Barium 01007		Chlorinated organic compounds* 74052	
Boron 01022		Pesticides* 74053	
Cadmium 01027		Oil and grease 00550	
Calcium 00916		Phenols 32730	
Cobalt 01037		Surfactants 38260	
Chromium 01034		Chlorine 50060	
Fecal coliform bacteria 74055		Radioactivity* 74050	

*Specify substances, compounds and/or elements in Item 26.

Pesticides (insecticides, fungicides, and rodenticides) must be reported in terms of the acceptable common names specified in *Acceptable Common Names and Chemical Names for the Ingredient Statement on Pesticide Labels*, 2nd Edition, Environmental Protection Agency, Washington, D.C. 20350, June 1972, as required by Subsection 162.7(b) of the Regulations for the Enforcement of the Federal Insecticide, Fungicide, and Rodenticide Act.

DISCHARGE SERIAL NUMBER

006

FOR AGENCY USE

17. Description of Intake and Discharge

For each of the parameters listed below, enter in the appropriate box the value or code letter answer called for.(see instructions)

In addition, enter the parameter name and code and all required values for any of the following parameters if they were checked in Item 10: ammonia, cyanide, aluminum, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, phenols, oil and grease, and chlorine (residual).

Parameter and Code 217a *	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)
Flow* Gallons per day 00056								
pH Units 00400			X					
Temperature (winter) °F 74028								
Temperature (summer) °F 74027								
Biochemical Oxygen Demand (BOD 5-day) mg/l 00310								
Chemical Oxygen Demand (COD) mg/l 00340								
Total Suspended (nonfilterable) Solids mg/l 00530								
Specific Conductance micromho/cm at 25° C 00095			X					
Settleable Matter (residue) ml/l 00545								

*Other discharges sharing intake flow (serial numbers) (see instructions)

* See Page II-2.

17. (Cont'd.)

Parameter and Code 227a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)

18. Plant Controls Check if the following plant controls are available for this discharge. — 218

Alternate power source for major pumping facility. — ☒ APS

Alarm or emergency procedure for power or equipment failure — ☒ ALM

Complete item 19 if discharge is from cooling and/or steam water generation and water treatment additives are used.

19. Water Treatment Additives If the discharge is treated with any conditioner, inhibitor, or algicide, answer the following: — N/A

a. Name of Material(s) — 219a

b. Name and address of manufacturer — 219b

c. Quantity (pounds added per million gallons of water treated). — 219c

DISCHARGE SERIAL NUMBER

006

FOR AGENCY USE

d. Chemical composition of these additives (see instructions).	219d	

Complete items 20-25 if there is a thermal discharge (e.g., associated with a steam and/or power generation plant, steel mill, petroleum refinery, or any other manufacturing process) and the total discharge flow is 10 million gallons per day or more. (see instructions)

20. Thermal Discharge Source Check the appropriate item(s) indicating the source of the discharge. (see instructions)	220	N/A
Boiler Blowdown		☐ BLBD
Boiler Chemical Cleaning		☐ BCCL
Ash Pond Overflow		☐ APOF
Boiler Water Treatment — Evaporator Blowdown		☐ EPBD
Oil or Coal Fired Plants — Effluent from Air Pollution Control Devices		☐ OCFP
Condense Cooling Water		☐ COND
Cooling Tower Blowdown		☐ CTBD
Manufacturing Process		☐ MFPR
Other		☐ OTHR
21. Discharge/Receiving Water Temperature Difference Give the maximum temperature difference between the discharge and receiving waters for summer and winter operating conditions. (see instructions)		
Summer	221a	_____ °F.
Winter	221b	_____ °F.
22. Discharge Temperature, Rate of Change Per Hour Give the maximum possible rate of temperature change per hour of discharge under operating conditions. (see instructions)	222	_____ °F./hour

23. Water Temperature, Percentile Report (Frequency of Occurrence)
In the table below, enter the temperature which is exceeded 10% of the year, 5% of the year, 1% of the year and not at all (maximum yearly temperature). (see instructions)

Frequency of occurrence		10%	5%	1%	Maximum
a. Intake Water Temperature (Subject to natural changes)	223a	°F	°F	°F	°F
b. Discharge Water Temperature	223b	°F	°F	°F	°F

24. Water Intake Velocity (see instructions)	224	_____ feet/sec.
25. Retention Time Give the length of time, in minutes, from start of water temperature rise to discharge of cooling water. (see instructions)	225	_____ minutes

DISCHARGE SERIAL NUMBER

006

FOR AGENCY USE

26. Additional Information

226

Item	Information
21.7 a	Discharge is into the Mississippi River. Intake is provided by radial wells. The radial well system consists of three (3) wells presently, with the addition of two (2) more planned for the future. Each well consists of a reinforced concrete caisson with a base slab, and a set of lateral screens extending radially 250 feet to 300 feet from the well into the aquifer that exists beneath the river bed and along the bank. These wells will provide a mixture of normal ground water, and induced infiltration of river water passing through the river bottom to the collectors.

OMB No. 158-R0100

STANDARD FORM C – MANUFACTURING AND COMMERCIAL

FOR AGENCY USE

SECTION II. BASIC DISCHARGE DESCRIPTION

Complete this section for each discharge indicated in Section I, Item 9, that is to surface waters. This includes discharges to municipal sewerage systems in which the wastewater does not go through a treatment works prior to being discharged to surface waters. Discharges to wells must be described where there are also discharges to surface waters from this facility. SEPARATE DESCRIPTIONS OF EACH DISCHARGE ARE REQUIRED EVEN IF SEVERAL DISCHARGES ORIGINATE IN THE SAME FACILITY. All values for an existing discharge should be representative of the twelve previous months of operation. If this is a proposed discharge, values should reflect best engineering estimates.

ADDITIONAL INSTRUCTIONS FOR SELECTED ITEMS APPEAR IN SEPARATE INSTRUCTION BOOKLET AS INDICATED. REFER TO BOOKLET BEFORE FILLING OUT THESE ITEMS.

1. Discharge Serial No. and Name

a. Discharge Serial No. (see instructions)	201a	007
b. Discharge Name Give name of discharge, if any. (see instructions)	201b	Administration Systems HVAC Systems
c. Previous Discharge Serial No. If previous permit application was made for this discharge (see Item 4, Section I), provide previous discharge serial number.	201c	NA

2. Discharge Operating Dates

a. Discharge Began Date If the discharge described below is in operation, give the date (within best estimate) the discharge began.	202a	NA YR MO
b. Discharge to Begin Date If the discharge has never occurred but is planned for some future date, give the date (within best estimate) the discharge will begin.	202b	78 7 YR MO
c. Discharge to End Date If discharge is scheduled to be discontinued within the next 5 years, give the date (within best estimate) the discharge will end.	202c	NA YR MO

3. Engineering Report Available
Check if an engineering report is available to reviewing agency upon request. (see instructions) 203 ☐

4. Discharge Location Name the political boundaries within which the point of discharge is located.

				Agency Use
State	204a	Mississippi	204d	
County	204b	Claiborne	204e	
(If applicable) City or Town	204c		204f	

5. Discharge Point Description
Discharge is into (check one): (see instructions)

Stream (includes ditches, arroyos, and other intermittent watercourses)	205a	☒STR
Lake		☐LKE
Ocean		☐OCE
Municipal Sanitary Wastewater Transport System		☐MTS
Municipal Combined Sanitary and Storm Transport System		☐MCS

(cont)

FOR AGENCY USE

Municipal Storm Water Transport System ☐STS

Well (Injection) ☐WEL

Other ☐OTH

If 'other' is checked, specify 205b

6. Discharge Point — Lat/Long Give the precise location of the point of discharge to the nearest second.

Latitude 206a N 32 DEG 1 MIN 15 SEC

Longitude 206b W 91 DEG 4 MIN 5 SEC

7. Discharge Receiving Water Name Name the waterway at the point of discharge.(see instructions) 207a Mississippi River

If the discharge is through an outfall that extends beyond the shoreline or is below the mean low water line, complete item 8.

207b

For Agency Use		
Major	Minor	Sub

207c

For Agency Use
303e

8. Offshore Discharge

a. Discharge Distance from Shore 208a _____ feet

b. Discharge Depth Below Water Surface 208b _____ feet

9. Discharge Type and Occurrence

a. Type of Discharge Check whether the discharge is continuous or intermittent. (see instructions) 209a ☒ (con) Continuous ☐ (int) Intermittent

b. Discharge Occurrence Days per Week Enter the average number of days per week (during periods of discharge) this discharge occurs. 209b __days per week

NA

c. Discharge Occurrence —Months If this discharge normally operates (either intermittently, or continuously) on less than a year-around basis (excluding shutdowns for routine maintenance), check the months during the year when the discharge is operating. (see instructions) 209c

☐JAN ☐FEB ☐MAR ☐APR
☐MAY ☐JUN ☐JUL ☐AUG
☐SEP ☐OCT ☐NOV ☐DEC

Complete items 10 and 11 if "intermittent" is checked in item 9.a. Otherwise, proceed to item 12.

10. Intermittent Discharge Quantity State the average volume per discharge occurrence in thousands of gallons. 210 _____ thousand gallons per discharge occurrence.

11. Intermittent Discharge Duration and Frequency

a. Intermittent Discharge Duration Per Day State the average number of hours per day the discharge is operating. 211a ____ hours per day

b. Intermittent Discharge Frequency State the average number of discharge occurrences per day during days when discharging. 211b ____ discharge occurrences per day

12. Maximum Flow Period Give the time period in which the maximum flow of this discharge occurs. 212 From ____ (month) to ____ (month)

OMB No. 158-R0100

FOR AGENCY USE

13. Activity Description Give a narrative description of activity producing this discharge.(see instructions)

213a This discharge consists of plant service water from the administration building that is used for chiller condenser cooling on the building HVAC system.

14. Activity Causing Discharge For each SIC Code which describes the activity causing this discharge, supply the type and maximum amount of either the raw material consumed (Item 14a) or the product produced (Item 14b) in the units specified in Table I of the Instruction Booklet. For SIC Codes not listed in Table I, use raw material or production units normally used for measuring production.(see instructions)

a. Raw Materials

	SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Number) (5)
214a					

b. Products

	SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Number) (5)
214b	4911	Electric Service	60	Z-1	001, 002, 003, 004, 005, 006, 009

DISCHARGE SERIAL NUMBER

00

FOR AGENCY USE

15. Waste Abatement

a. Waste Abatement Practices
Describe the waste abatement practices used on this discharge with a brief narrative. (see instructions)

215a

Narrative: This is an open-cycle, once through, non-contact heat exchange process for the HVAC system. No waste treatment is planned on this system.

b. Waste Abatement Codes
Using the codes listed in Table II of the Instruction Booklet, describe the waste abatement processes for this discharge in the order in which they occur if possible.

215b

(1) NONONE, (2) _____, (3) _____,
(4) _____, (5) _____, (6) _____,
(7) _____, (8) _____, (9) _____,
(10) _____, (11) _____, (12) _____,
(13) _____, (14) _____, (15) _____,
(16) _____, (17) _____, (18) _____,
(19) _____, (20) _____, (21) _____,
(22) _____, (23) _____, (24) _____,
(25) _____.

DISCHARGE NUMBER

001

OMB No. 158-R0100

FOR AGENCY USE

16. Wastewater Characteristics

Check the box beside each constituent which is present in the effluent (discharge water). This determination is to be based on actual analysis or best estimate.(see instructions)

Parameter 216	Present	Parameter 216	Present
Color 00080		Copper 01042	
Ammonia 00610		Iron 01045	
Organic nitrogen 00605		Lead 01051	
Nitrate 00620		Magnesium 00927	
Nitrite 00615		Manganese 01055	
Phosphorus 00665		Mercury 71900	
Sulfate 00945		Molybdenum 01062	
Sulfide 00745		Nickel 01067	
Sulfite 00740		Selenium 01147	
Bromide 71870		Silver 01077	
Chloride 00940		Potassium 00937	
Cyanide 00720		Sodium 00929	
Fluoride 00951		Thallium 01059	
Aluminum 01105		Titanium 01152	
Antimony 01097		Tin 01102	
Arsenic 01002		Zinc 01092	
Beryllium 01012		Algicides* 74051	
Barium 01007		Chlorinated organic compounds* 74052	
Boron 01022		Pesticides* 74053	
Cadmium 01027		Oil and grease 00550	
Calcium 00916		Phenols 32730	
Cobalt 01037		Surfactants 38260	
Chromium 01034		Chlorine 50060	
Fecal coliform bacteria 74055		Radioactivity* 74050	

*Specify substances, compounds and/or elements in Item 26.

Pesticides (insecticides, fungicides, and rodenticides) must be reported in terms of the acceptable common names specified in *Acceptable Common Names and Chemical Names for the Ingredient Statement on Pesticide Labels*, 2nd Edition, Environmental Protection Agency, Washington, D.C. 20250, June 1972, as required by Subsection 162.7(b) of the Regulations for the Enforcement of the Federal Insecticide, Fungicide, and Rodenticide Act.

DISCHARGE SERIAL NUMBER

007

FOR AGENCY USE

17. Description of Intake and Discharge

For each of the parameters listed below, enter in the appropriate box the value or code letter answer called for.(see instructions)

In addition, enter the parameter name and code and all required values for any of the following parameters if they were checked in Item 16: ammonia, cyanide, aluminum, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, phenols, oil and grease, and chlorine (residual).

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)
Flow* Gallons per day 00056	0.5	0	0.5	0.1	0.7			
pH Units 00400			X					
Temperature (winter) °F 74028								
Temperature (summer) °F 74027								
Biochemical Oxygen Demand (BOD 5-day) mg/l 00310								
Chemical Oxygen Demand (COD) mg/l 00340								
Total Suspended (nonfilterable) Solids mg/l 00530								
Specific Conductance micromhos/cm at 25° C 00095			X					
Settleable Matter (residue) ml/l 00545								

*Other discharges sharing intake flow (serial numbers).(see instructions)

17. (Cont'd.)

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)

18. Plant Controls Check if the following plant controls are available for this discharge. — 218

Alternate power source for major pumping facility. ☐ APS

Alarm or emergency procedure for power or equipment failure ☐ ALM

Complete Item 19 if discharge is from cooling and/or steam water generation and water treatment additives are used.

19. Water Treatment Additives If the discharge is treated with any conditioner, inhibitor, or algicide, answer the following:

a. Name of Material(s) — 219a

b. Name and address of manufacturer — 219b

c. Quantity (pounds added per million gallons of water treated). — 219c

DISCHARGE SERIAL NUMBER
007

FOR AGENCY USE

d. Chemical composition of these additives (see instructions). | 219d | _____

_____

Complete items 20-25 if there is a thermal discharge (e.g., associated with a steam and/or power generation plant, steel mill, petroleum refinery, or any other manufacturing process) and the total discharge flow is 10 million gallons per day or more. (see instructions)

20. Thermal Discharge Source Check the appropriate item(s) indicating the source of the discharge. (see instructions) | 220

- ☐ Boiler Blowdown — BLBD
- ☐ Boiler Chemical Cleaning — BCCL
- ☐ Ash Pond Overflow — APOF
- ☐ Boiler Water Treatment — Evaporator Blowdown — EPBD
- ☐ Oil or Coal Fired Plants — Effluent from Air Pollution Control Devices — OCFP
- ☐ Condense Cooling Water — COND
- ☐ Cooling Tower Blowdown — CTBD
- ☐ Manufacturing Process — MFPR
- ☐ Other — OTHR

21. Discharge/Receiving Water Temperature Difference

Give the maximum temperature difference between the discharge and receiving waters for summer and winter operating conditions. (see instructions)

Summer | 221a | _____ °F.

Winter | 221b | _____ °F.

22. Discharge Temperature, Rate of Change Per Hour | 222 | _____ °F./hour

Give the maximum possible rate of temperature change per hour of discharge under operating conditions. (see instructions)

23. Water Temperature, Percentile Report (Frequency of Occurrence)

In the table below, enter the temperature which is exceeded 10% of the year, 5% of the year, 1% of the year and not at all (maximum yearly temperature). (see instructions)

Frequency of occurrence		10%	5%	1%	Maximum
a. Intake Water Temperature (Subject to natural changes)	223a	°F	°F	°F	°F
b. Discharge Water Temperature	223b	°F	°F	°F	°F

24. Water Intake Velocity (see instructions) | 224 | _____ feet/sec.

25. Retention Time Give the length of time, in minutes, from start of water temperature rise to discharge of cooling water. (see instructions) | 225 | _____ minutes

DISCHARGE SERIAL NUMBER

007

FOR AGENCY USE

26. Additional Information

220

Item	Information
217 a	Discharge is into the Mississippi River. Intake is provided by radial wells. The radial well system consists of three (3) wells presently, with the addition of two (2) more planned for the future. Each well consists of a reinforced concrete caisson with a base slab, and a set of lateral screens extending radially 250 feet to 300 feet from the well into the aquifer that exists beneath the river bed and along the bank. These wells will provide a mixture of normal ground water, and induced infiltration of river water passing through the river bottom to the collectors.

FORM ... APPROVED
OMB No. 158-R0100

STANDARD FORM C – MANUFACTURING AND COMMERCIAL

FOR AGENCY USE

SECTION II. BASIC DISCHARGE DESCRIPTION

Complete this section for each discharge indicated in Section I, Item 9, that is to surface waters. This includes discharges to municipal sewerage systems in which the wastewater does not go through a treatment works prior to being discharged to surface waters. Discharges to wells must be described where there are also discharges to surface waters from this facility. SEPARATE DESCRIPTIONS OF EACH DISCHARGE ARE REQUIRED EVEN IF SEVERAL DISCHARGES ORIGINATE IN THE SAME FACILITY. All values for an existing discharge should be representative of the twelve previous months of operation. If this is a proposed discharge, values should reflect best engineering estimates.

ADDITIONAL INSTRUCTIONS FOR SELECTED ITEMS APPEAR IN SEPARATE INSTRUCTION BOOKLET AS INDICATED. REFER TO BOOKLET BEFORE FILLING OUT THESE ITEMS.

1. Discharge Serial No. and Name

a. Discharge Serial No. (see instructions) — 201a: 008

b. Discharge Name Give name of discharge, if any. (see instructions) — 201b: Storm Drainage System

c. Previous Discharge Serial No. If previous permit application was made for this discharge (see Item 4, Section I), provide previous discharge serial number. — 201c: N/A

2. Discharge Operating Dates

a. Discharge Began Date If the discharge described below is in operation, give the date (within best estimate) the discharge began. — 202a: N/A (YR / MO)

b. Discharge to Begin Date If the discharge has never occurred but is planned for some future date, give the date (within best estimate) the discharge will begin. — 202b: 78 (YR) 7 (MO)

c. Discharge to End Date If discharge is scheduled to be discontinued within the next 5 years, give the date (within best estimate) the discharge will end. — 202c: N/A (YR / MO)

3. Engineering Report Available Check if an engineering report is available to reviewing agency upon request. (see instructions) — 203: ☒

4. Discharge Location Name the political boundaries within which the point of discharge is located.

			Agency Use
State	204a: Mississippi	204d	
County	204b: Claiborne	204e	
(If applicable) City or Town	204c:	204f	

5. Discharge Point Description Discharge is into (check one): (see instructions)

	205a
Stream (includes ditches, arroyos, and other intermittent watercourses)	☒STR
Lake	☐LKE
Ocean	☐OCE
Municipal Sanitary Wastewater Transport System	☐MTS
Municipal Combined Sanitary and Storm Transport System	☐MCS

FOR AGENCY USE

Municipal Storm Water Transport System		☐STS
Well (injection)		☐WEL
Other		☐OTH
If 'other' is checked, specify	205b	

6. Discharge Point — Lat/Long Give the precise location of the point of discharge to the nearest second.

Latitude	206a	N 32 DEG 1 MIN 15 SEC
Longitude	206b	W 91 DEG 4 MIN 5 SEC

7. Discharge Receiving Water Name Name the waterway at the point of discharge.(see instructions)

207a: Mississippi River

If the discharge is through an outfall that extends beyond the shoreline or is below the mean low water line, complete item 8.

207b:

For Agency Use			207c	For Agency Use
Major	Minor	Sub		303e

8. Offshore Discharge

a. Discharge Distance from Shore 208a: _____ feet

b. Discharge Depth Below Water Surface 208b: _____ feet

9. Discharge Type and Occurrence

a. Type of Discharge Check whether the discharge is continuous or intermittent. (see instructions) 209a:
☐ (con) Continuous
☒ (int) Intermittent *

b. Discharge Occurrence Days per Week Enter the average number of days per week (during periods of discharge) this discharge occurs. 209b: N/A days per week

c. Discharge Occurrence —Months If this discharge normally operates (either intermittently, or continuously) on less than a year-around basis (excluding shutdowns for routine maintenance), check the months during the year when the discharge is operating. (see instructions) 209c: N/A
☐JAN ☐FEB ☐MAR ☐APR
☐MAY ☐JUN ☐JUL ☐AUG
☐SEP ☐OCT ☐NOV ☐DEC

Complete items 10 and 11 if "intermittent" is checked in item 9.a. Otherwise, proceed to item 12.

* More engineering data will be forwarded at a later date.

10. Intermittent Discharge Quantity State the average volume per discharge occurrence in thousands of gallons. 210: _____ thousand gallons per discharge occurrence.

11. Intermittent Discharge Duration and Frequency

a. Intermittent Discharge Duration Per Day State the average number of hours per day the discharge is operating. 211a: ____ hours per day

b. Intermittent Discharge Frequency State the average number of discharge occurrences per day during days when discharging. 211b: ____ discharge occurrences per day

12. Maximum Flow Period Give the time period in which the maximum flow of this discharge occurs. 212: From _____ to _____ (month) (month)

OMB No. 158-R0190

FOR AGENCY USE

13. **Activity Description** Give a narrative description of activity producing this discharge.(see instructions)

213a Collection of fire water flows and rainfall from roof and site drains. Also, water effluent from oil interceptors in the fire water pump house oily waste sump, the water treatment and diesel generator buildings oily waste sumps, and the administration building floor drains.

14. **Activity Causing Discharge** For each SIC Code which describes the activity causing this discharge, supply the type and maximum amount of either the raw material consumed (Item 14a) or the product produced (Item 14b) in the units specified in Table I of the Instruction Booklet. For SIC Codes not listed in Table I, use raw material or production units normally used for measuring production.(see instructions)

a. Raw Materials

	SIC Code	Name	Maximum Amount/Day	Unit (See Table I)	Shared Discharges (Serial Number)
214a	(1)	(2)	(3)	(4)	(5)

b. Products

	SIC Code	Name	Maximum Amount/Day	Unit (See Table I)	Shared Discharges (Serial Number)
214b	(1)	(2)	(3)	(4)	(5)
	4911	Electric Services	60	Z-1	008

DISCHARGE SERIAL NUMBER

003

FOR AGENCY USE

15. Waste Abatement

a. Waste Abatement Practices
Describe the waste abatement practices used on this discharge with a brief narrative. (see instructions)

215a

Narrative: Water effluent from oil interceptors and storm water flows are collected in a settling basin before discharge into the river. This basin is separate from the discharge basin that the other plant discharges flow through.

b. Waste Abatement Codes
Using the codes listed in Table II of the Instruction Booklet, describe the waste abatement processes for this discharge in the order in which they occur if possible.

215b

(1) ESEPAR, (2) PSEDIM, (3) _____,
(4) _____, (5) _____, (6) _____,
(7) _____, (8) _____, (9) _____,
(10) _____, (11) _____, (12) _____,
(13) _____, (14) _____, (15) _____,
(16) _____, (17) _____, (18) _____,
(19) _____, (20) _____, (21) _____,
(22) _____, (23) _____, (24) _____,
(25) _____.

DISCHARGE SERIAL NUMBER

003

FORM APPROVED
OMB No. 158-R0100

FOR AGENCY USE

16. Wastewater Characteristics

Check the box beside each constituent which is present in the effluent (discharge water). This determination is to be based on actual analysis or best estimate.(see instructions)

Parameter 216	Present	Parameter 216	Present
Color 00080		Copper 01042	
Ammonia 00610		Iron 01045	
Organic nitrogen 00605		Lead 01051	
Nitrate 00620		Magnesium 00927	
Nitrite 00615		Manganese 01055	
Phosphorus 00665		Mercury 71900	
Sulfate 00945		Molybdenum 01062	
Sulfide 00745		Nickel 01067	
Sulfite 00740		Selenium 01147	
Bromide 71870		Silver 01077	
Chlorine 00940		Potassium 00937	
Cyanide 00720		Sodium 00929	
Fluoride 00951		Thallium 01059	
Aluminum 01105		Titanium 01152	
Antimony 01097		Tin 01102	
Arsenic 01002		Zinc 01092	
Beryllium 01012		Algicides* 74051	
Barium 01007		Chlorinated organic compounds* 74052	
Boron 01022		Pesticides* 74053	
Cadmium 01027		Oil and grease 00550	
Calcium 00916		Phenols 32730	
Cobalt 01037		Surfactants 38260	
Chromium 01034		Chlorine 50060	
Fecal coliform bacteria 74055		Radioactivity* 74050	

*Specify substances, compounds and/or elements in Item 26.

Pesticides (insecticides, fungicides, and rodenticides) must be reported in terms of the acceptable common names specified in *Acceptable Common Names and Chemical Names for the Ingredient Statement on Pesticide Labels*, 2nd Edition, Environmental Protection Agency, Washington, D.C. 20250, June 1972, as required by Subsection 162.7(b) of the Regulations for the Enforcement of the Federal Insecticide, Fungicide, and Rodenticide Act.

EPA Form 3510-2A (7-77)

DISCHARGE SERIAL NUMBER

005

FOR AGENCY USE

17. Description of Intake and Discharge

For each of the parameters listed below, enter in the appropriate box the value or code letter answer called for.(see instructions)

In addition, enter the parameter name and code and all required values for any of the following parameters if they were checked in item 16: ammonia, cyanide, aluminum, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, phenols, oil and grease, and chlorine (residual).

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)
Flow* Estimate 50050 MGD	0	0	0	0	1.0	Estimate		
pH Units 00400			X					
Temperature (winter) °F 74028								
Temperature (summer) °F 74027								
Biochemical Oxygen Demand (BOD 5-day) mg/l 00310								
Chemical Oxygen Demand (COD) mg/l 00340								
Total Suspended (nonfilterable) Solids mg/l 00530								
Specific Conductance micromhos/cm at 25° C 00095			X					
Settleable Matter (residue) ml/l 00545								

*Other discharges sharing intake flow (serial numbers).(see instructions)

17. (Cont'd.)

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)

18. Plant Controls Check if the following plant controls are available for this discharge. — 218

Alternate power source for major pumping facility. ☐ APS

Alarm or emergency procedure for power or equipment failure ☐ ALM

Complete item 19 if discharge is from cooling and/or steam water generation and water treatment additives are used.

19. Water Treatment Additives If the discharge is treated with any conditioner, inhibitor, or algicide, answer the following:

N/A

a. Name of Material(s) — 219a

b. Name and address of manufacturer — 219b

c. Quantity (pounds added per million gallons of water treated). — 219c

DISCHARGE SERIAL NUMBER

003

FOR AGENCY USE

d. Chemical composition of these additives (see instructions).	219d	

Complete items 20-25 if there is a thermal discharge (e.g., associated with a steam and/or power generation plant, steel mill, petroleum refinery, or any other manufacturing process) and the total discharge flow is 10 million gallons per day or more. (see instructions)

20. Thermal Discharge Source Check the appropriate item(s) indicating the source of the discharge. (see instructions)	220	N/A
Boiler Blowdown		☐ BLBD
Boiler Chemical Cleaning		☐ BCCL
Ash Pond Overflow		☐ APOF
Boiler Water Treatment — Evaporator Blowdown		☐ EPBD
Oil or Coal Fired Plants — Effluent from Air Pollution Control Devices		☐ OCFP
Condense Cooling Water		☐ COND
Cooling Tower Blowdown		☐ CTBD
Manufacturing Process		☐ MFPR
Other		☐ OTHR
21. Discharge/Receiving Water Temperature Difference		
Give the maximum temperature difference between the discharge and receiving waters for summer and winter operating conditions. (see instructions)		
Summer	221a	_____ °F.
Winter	221b	_____ °F.
22. Discharge Temperature, Rate of Change Per Hour	222	_____ °F./hour
Give the maximum possible rate of temperature change per hour of discharge under operating conditions. (see instructions)		
23. Water Temperature, Percentile Report (Frequency of Occurrence)		
In the table below, enter the temperature which is exceeded 10% of the year, 5% of the year, 1% of the year and not at all (maximum yearly temperature). (see instructions)		

Frequency of occurrence

		10%	5%	1%	Maximum
a. Intake Water Temperature (Subject to natural changes)	223a	°F	°F	°F	°F
b. Discharge Water Temperature	223b	°F	°F	°F	°F

24. Water Intake Velocity (see instructions)	224	_____ feet/sec.
25. Retention Time Give the length of time, in minutes, from start of water temperature rise to discharge of cooling water. (see instructions)	225	_____ minutes

FOR AGENCY USE

26. Additional Information

226

Item	Information
217 a	Discharge is into the Mississippi River. Intake is provided by radial wells. The radial well system consists of three (3) wells presently, with the addition of two (2) more planned for the future. Each well consists of a reinforced concrete caisson with a base slab, and a set of lateral screens extending radially 250 feet to 300 feet from the well into the aquifer that exists beneath the river bed and along the bank. These wells will provide a mixture of normal ground water, and induced infiltration of river water passing through the river bottom to the collectors.

OMB No. 158-R0100

STANDARD FORM C – MANUFACTURING AND COMMERCIAL

FOR AGENCY USE

SECTION II. BASIC DISCHARGE DESCRIPTION

Complete this section for each discharge indicated in Section I, Item 9, that is to surface waters. This includes discharges to municipal sewerage systems in which the wastewater does not go through a treatment works prior to being discharged to surface waters. Discharges to wells must be described where there are also discharges to surface waters from this facility. SEPARATE DESCRIPTIONS OF EACH DISCHARGE ARE REQUIRED EVEN IF SEVERAL DISCHARGES ORIGINATE IN THE SAME FACILITY. All values for an existing discharge should be representative of the twelve previous months of operation. If this is a proposed discharge, values should reflect best engineering estimates.

ADDITIONAL INSTRUCTIONS FOR SELECTED ITEMS APPEAR IN SEPARATE INSTRUCTION BOOKLET AS INDICATED. REFER TO BOOKLET BEFORE FILLING OUT THESE ITEMS.

1. Discharge Serial No. and Name

a. Discharge Serial No. (see instructions)	201a	009
b. Discharge Name Give name of discharge, if any. (see instructions)	201b	Cooling Tower Makeup Bypass
c. Previous Discharge Serial No. If previous permit application was made for this discharge (see Item 4, Section I), provide previous discharge serial number.	201c	NA

2. Discharge Operating Dates

a. Discharge Began Date If the discharge described below is in operation, give the date (within best estimate) the discharge began.	202a	NA YR MO
b. Discharge to Begin Date If the discharge has never occurred but is planned for some future date, give the date (within best estimate) the discharge will begin.	202b	78 7 YR MO
c. Discharge to End Date If discharge is scheduled to be discontinued within the next 5 years, give the date (within best estimate) the discharge will end.	202c	NA YR MO

3. Engineering Report Available
Check if an engineering report is available to reviewing agency upon request. (see instructions) 203 ☐

4. Discharge Location Name the political boundaries within which the point of discharge is located.

			Agency Use	
State	204a	Mississippi	204d	
County	204b	Claiborne	204e	
(If applicable) City or Town	204c		204f	

5. Discharge Point Description
Discharge is into (check one): (see instructions)

Stream (Includes ditches, arroyos, and other intermittent watercourses)	205a	☐STR
Lake		☐LKE
Ocean		☐OCE
Municipal Sanitary Wastewater Transport System		☐MTS
Municipal Combined Sanitary and Storm Transport System		☐MCS

FOR AGENCY USE

Municipal Storm Water Transport System		☐ STS
Well (Injection)		☐ WEL
Other		☐ OTH
If 'other' is checked, specify	205b	

6. Discharge Point — Lat/Long Give the precise location of the point of discharge to the nearest second.

Latitude	206a	N 32 DEG 1 MIN 15 SEC
Longitude	206b	W 91 DEG 4 MIN 5 SEC

7. Discharge Receiving Water Name Name the waterway at the point of discharge (see instructions)

207a Mississippi River

If the discharge is through an outfall that extends beyond the shoreline or is below the mean low water line, complete Item 8.

207b

For Agency Use			207c	For Agency Use
Major	Minor	Sub		303e

8. Offshore Discharge

a. Discharge Distance from Shore	208a	_____ feet
b. Discharge Depth Below Water Surface	208b	_____ feet

9. Discharge Type and Occurrence

a. Type of Discharge Check whether the discharge is continuous or intermittent. (see instructions) — 209a
☐ (con) Continuous
☒ (int) Intermittent

b. Discharge Occurrence Days per Week Enter the average number of days per week (during periods of discharge) this discharge occurs. — 209b
_____ days per week *As required

NA

c. Discharge Occurrence — Months If this discharge normally operates (either intermittently, or continuously) on less than a year-around basis (excluding shutdowns for routine maintenance), check the months during the year when the discharge is operating. (see instructions) — 209c

☐ JAN ☐ FEB ☐ MAR ☐ APR
☐ MAY ☐ JUN ☐ JUL ☐ AUG
☐ SEP ☐ OCT ☐ NOV ☐ DEC

Complete Items 10 and 11 if "Intermittent" is checked in Item 9.a. Otherwise, proceed to Item 12.

10. Intermittent Discharge Quantity State the average volume per discharge occurrence in thousands of gallons. — 210
_____ thousand gallons per discharge occu *As required

11. Intermittent Discharge Duration and Frequency

a. Intermittent Discharge Duration Per Day State the average number of hours per day the discharge is operating.	211a	_____ hours per day
b. Intermittent Discharge Frequency State the average number of discharge occurrences per day during days when discharging.	211b	_____ discharge occurrences per day

NA

12. Maximum Flow Period Give the time period in which the maximum flow of this discharge occurs. — 212
From _____ to _____
month month

FOR AGENCY USE

13. **Activity Description** Give a narrative description of activity producing this discharge.(see instructions)

213a If makeup water is not needed for the cooling towers, it is bypassed back to the river through the discharge basin.

14. **Activity Causing Discharge** For each SIC Code which describes the activity causing this discharge, supply the type and maximum amount of either the raw material consumed (Item 14a) or the product produced (Item 14b) in the units specified in Table I of the instruction Booklet. For SIC Codes not listed in Table I, use raw material or production units normally used for measuring production.(see instructions)

a. **Raw Materials**

	SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Number) (5)
214a					

b. **Products**

	SIC Code (1)	Name (2)	Maximum Amount/Day (3)	Unit (See Table I) (4)	Shared Discharges (Serial Number) (5)
214b	4911	Electric Services	60	Z-1	001, 002, 003, 004, 005, 006, 007,

DISCHARGE SERIAL NUMBER

009

FOR AGENCY USE

15. Waste Abatement

a. **Waste Abatement Practices** Describe the waste abatement practices used on this discharge with a brief narrative. (see instructions)

215a

Narrative: None

b. **Waste Abatement Codes** Using the codes listed in Table II of the Instruction Booklet, describe the waste abatement processes for this discharge in the order in which they occur if possible.

215b

(1) NONONE , (2) _____ , (3) _____ ,

(4) _____ , (5) _____ , (6) _____ ,

(7) _____ , (8) _____ , (9) _____ ,

(10) _____ , (11) _____ , (12) _____ ,

(13) _____ , (14) _____ , (15) _____ ,

(16) _____ , (17) _____ , (18) _____ ,

(19) _____ , (20) _____ , (21) _____ ,

(22) _____ , (23) _____ , (24) _____ ,

(25) _____ .

DISCHARGE SERIAL NUMBER

001

FORM APPROVED
OMB No. 158-R0100

FOR AGENCY USE

16. Wastewater Characteristics

Check the box beside each constituent which is present in the effluent (discharge water). This determination is to be based on actual analysis or best estimate.(see instructions)

Parameter 216	Present	Parameter 216	Present
Color 00080		Copper 01042	
Ammonia 00610		Iron 01045	
Organic nitrogen 00605		Lead 01051	
Nitrate 00620		Magnesium 00927	
Nitrite 00615		Manganese 01055	
Phosphorus 00665		Mercury 71900	
Sulfate 00945		Molybdenum 01062	
Sulfide 00745		Nickel 01067	
Sulfite 00740		Selenium 01147	
Bromide 71870		Silver 01077	
Chloride 00940		Potassium 00937	
Cyanide 00720		Sodium 00929	
Fluoride 00951		Thallium 01059	
Aluminum 01105		Titanium 01152	
Antimony 01097		Tin 01102	
Arsenic 01002		Zinc 01092	
Beryllium 01012		Algicides* 74051	
Barium 01007		Chlorinated organic compounds* 74052	
Boron 01022		Pesticides* 74053	
Cadmium 01027		Oil and grease 00550	
Calcium 00916		Phenols 32730	
Cobalt 01037		Surfactants 38260	
Chromium 01034		Chlorine 50060	
Fecal coliform bacteria 74055		Radioactivity* 74050	

*Specify substances, compounds and/or elements in Item 26.

Pesticides (insecticides, fungicides, and rodenticides) must be reported in terms of the acceptable common names specified in *Acceptable Common Names and Chemical Names for the Inerdient Statement on Pesticide Labels*, 2nd Edition, Environmental Protection Agency, Washington, D.C. 20250, June 1972, as required by Subsection 162.7(b) of the Regulations for the Enforcement of the Federal Insecticide, Fungicide, and Rodenticide Act.

DISCHARGE SERIAL NUMBER

009

FOR AGENCY USE

17. Description of Intake and Discharge

For each of the parameters listed below, enter in the appropriate box the value or code letter answer called for.(see instructions)

In addition, enter the parameter name and code and all required values for any of the following parameters if they were checked in Item 16: ammonia, cyanide, aluminum, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, zinc, phenols, oil and grease, and chlorine (residual).

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)
Flow* Gallons per day 00056	0	0	0	0	11.3			
pH Units 00400			X					
Temperature (winter) °F 74028								
Temperature (summer) °F 74027								
Biochemical Oxygen Demand (BOD 5-day) mg/l 00310								
Chemical Oxygen Demand (COD) mg/l 00340								
Total Suspended (nonfilterable) Solids mg/l 00530								
Specific Conductance micromhos/cm at 25° C 00095			X					
Settleable Matter (residue) ml/l 00545								

*Other discharges sharing intake flow (serial numbers).(see instructions)

17. (Cont'd.)

Parameter and Code 217a	Influent		Effluent					
	Untreated Intake Water (Daily Average) (1)	In-Plant Treated Intake Water (Daily Average) (2)	Daily Average (3)	Minimum Value Observed or Expected During Discharge Activity (4)	Maximum Value Observed or Expected During Discharge Activity (5)	Frequency of Analysis (6)	Number of Analyses (7)	Sample Type (8)

18. Plant Controls. Check if the following plant controls are available for this discharge. 218

Alternate power source for major pumping facility. ☐ APS

Alarm or emergency procedure for power or equipment failure ☐ ALM

Complete item 19 if discharge is from cooling and/or steam water generation and water treatment additives are used.

19. Water Treatment Additives. If the discharge is treated with any conditioner, inhibitor, or algicide, answer the following: NA

a. Name of Material(s) 219a

b. Name and address of manufacturer 219b

c. Quantity (pounds added per million gallons of water treated). 219c

DISCHARGE SERIAL NUMBER

001

FOR AGENCY USE

d. Chemical composition of these additives (see instructions). | 219d | _____

Complete items 20-25 if there is a thermal discharge (e.g., associated with a steam and/or power generation plant, steel mill, petroleum refinery, or any other manufacturing process) and the total discharge flow is 10 million gallons per day or more. (see instructions)

20. Thermal Discharge Source Check the appropriate item(s) indicating the source of the discharge. (see instructions) | 220 | NA

- Boiler Blowdown ☐ BLBD
- Boiler Chemical Cleaning ☐ BCCL
- Ash Pond Overflow ☐ APOF
- Boiler Water Treatment — Evaporator Blowdown ☐ EPBD
- Oil or Coal Fired Plants — Effluent from Air Pollution Control Devices ☐ OCFP
- Condense Cooling Water ☐ COND
- Cooling Tower Blowdown ☐ CTBD
- Manufacturing Process ☐ MFPR
- Other ☐ OTHR

21. Discharge/Receiving Water Temperature Difference

Give the maximum temperature difference between the discharge and receiving waters for summer and winter operating conditions. (see instructions)

Summer | 221a | _____ °F.

Winter | 221b | _____ °F.

22. Discharge Temperature, Rate of Change Per Hour | 222 | _____ °F./hour

Give the maximum possible rate of temperature change per hour of discharge under operating conditions. (see instructions)

23. Water Temperature, Percentile Report (Frequency of Occurrence)

In the table below, enter the temperature which is exceeded 10% of the year, 5% of the year, 1% of the year and not at all (maximum yearly temperature). (see instructions)

Frequency of occurrence		10%	5%	1%	Maximum
a. Intake Water Temperature (Subject to natural changes)	223a	°F	°F	°F	°F
b. Discharge Water Temperature	223b	°F	°F	°F	°F

24. Water Intake Velocity (see instructions) | 224 | _____ feet/sec.

25. Retention Time Give the length of time, in minutes, from start of water temperature rise to discharge of cooling water. (see instructions) | 225 | _____ minutes

EPA Form 3510-2C (7-79)

DISCHARGE SERIAL NUMBER

009

FOR AGENCY USE

26. Additional Information

226

Item	Information
217 a	Discharge is into the Mississippi River. Intake is provided by radial wells. The radial well system consists of three (3) wells presently, with the addition of two (2) more planned for the future. Each well consists of a reinforced concrete caisson with a base slab, and a set of lateral screens extending radially 250 feet to 300 feet from the well into the aquifer that exists beneath the river bed and along the bank. These wells will provide a mixture of normal ground water, and induced infiltration of river water passing through the river bottom to the collectors.

QUESTION

371.01 (2.1) Provide clearer and more detailed topographic maps of the area. Include both pre- and post-construction conditions. The maps presented in Section 2 are not legible.

RESPONSE

In response to the above question, five copies of the following full-size (34" x 44") drawings were submitted to NRC only: 1

1. C-0001, Rev. 2, Site & Yard Work--Property Plan
2. C-0011, Rev. 3, Site & Yard Work--Site Plan

GG
ER

QUESTION

371.02 (2.4) Discuss the erosion and transport mechanisms applicable to surface water bodies in the site area.

RESPONSE

FER subsection 2.4.2.2 has been revised to include the information requested in the above question.

GG
ER

QUESTION

371.03 (2.4) Discuss the interaction of groundwater and surface water in the site area, including points at which groundwater discharges into streams.

RESPONSE

FER subsection 2.4.5.4 has been revised to include the information requested in the above question.

GG
ER

QUESTION

371.04 (3.3) Provide a summary of legal restrictions relating to water use imposed by State or Federal regulations.

RESPONSE

A. FEDERAL

No Federal legal restrictions relating to water use (withdrawal) have been identified that affect the Grand Gulf Nuclear Station.

B. STATE

Under Mississippi law, any person wishing to appropriate - take possession by diversion or otherwise - any of the surface streams, lakes, and other water courses of the State of Mississippi and to use the water for his benefit must make application for a permit to do so from the Mississippi Commission on Natural Resources (Section 51-3-31, Miss. Code Ann. (1972)). The Commission is obligated to approve all applications which are in conformance with the requirements of the chapter on "Surface Waters-Regulation and Control," Section 51-3-1, et seq., Miss. Code Ann. (1972), and "which contemplate the utilization of the water for beneficial purposes, within reasonable limitations, provided the proposed use does not prejudicially and unreasonably affect the public interest" (Section 51-3-13). No permit will be issued if the water use will result in a violation of the water quality standards under the pollution control laws of the State of Mississippi (Section 51-3-7(5)). The Commission on Natural Resources may specify in the permit the quantity of water to be used, the time and place of such use, and the rate of withdrawal or diversion.

The Mississippi Commission on Natural Resources is also responsible for licensing the drilling of wells for underground water in the State of Mississippi by persons desiring to engage in the business of drilling wells and for designating and regulating groundwater "capacity use areas" in the State of Mississippi. A "capacity use area" is an area where the Commission finds that the aggregate uses of groundwater in or affecting such area have developed or threatened to develop to a degree which exceeds or threatens to exceed or otherwise threatens or impairs, the renewal or replenishment of such waters or any part of them (Section 51-4-5, Miss. Code Ann. (Supp. 1978)).

The statute licensing persons in the business of drilling wells for underground water applies only to persons actually drilling

the wells, and not to the property owners on whose property a well will be located. Therefore, a well contractor, not the owner of the property, is the person who must obtain a license to drill a water well from the Mississippi Commission on Natural Resources.

Further, the Mississippi Commission on Natural Resources may declare and delineate from time to time groundwater "capacity use areas" of the state, where it finds that the use of groundwater requires coordination and limited regulation for protection of the interest and rights of residents or property owners of such area or of the public interest (Section 51-4-5). The Commission has the power to grant permits with conditions as it deems necessary to preserve the groundwater in the capacity use areas.

In summary, the Mississippi statutes relating to water use are:

a. Sections 51-3-1, et seq. Miss. Code Ann. (1972), "Surface Waters - Regulation and Control," - Regulates the appropriation of surface water from a river or lake.

b. Sections 51-5-1, et seq. Miss. Code Ann. (1972), "Subsurface Waters - Well Drillers," - Regulates persons engaged in the business of drilling water wells.

c. Sections 51-4-1, et seq. Miss. Code Ann. (Supp. 1978), "Groundwaters," - Regulates the use of groundwaters in areas designated "capacity use areas."

GG
ER

QUESTION

371.05 (3.3) Provide a description of seasonal plant water use variations under maximum, minimum and average conditions.

RESPONSE

FER section 3.3 has been revised to include the information requested in the above question.

GG
ER

QUESTION

371.06 (3.4) Provide the velocity distribution and flow characteristics at or near the discharge structure(s).

RESPONSE

FER subsection 3.4.4 has been revised to include the information requested in the above question.

QUESTION

371.07 (2.4) The groundwater quality, as measured during testing of the Ranney wells, is apparently poorer than previously expected. Induced infiltration of Mississippi River water has seemingly not been achieved, due to high groundwater levels in the floodplain alluvium. Since groundwater levels, quality, and use differ from those parameters originally reported, we require the following additional information in order to assess the effects and impacts of the Ranney well system:

a. Provide the results of the pumping tests performed on each of the Ranney wells. Information provided should include pumping rate, drawdowns and water levels in the pumped well and observation wells, and comparisons of water quality between the water withdrawn and the Mississippi River water.

b. Provide analyses of the proportions and amounts of groundwater that will be withdrawn from the alluvial aquifer and the river under various conditions of groundwater levels and river levels. For each condition, discuss the expected differences in groundwater quality, as compared to the groundwater quality if induced infiltration were achieved.

c. Discuss the cause of the abnormal groundwater levels. Provide rainfall records, analyses of groundwater levels and movement, and other pertinent data which support your conclusions.

d. Discuss the adverse or beneficial effects of high groundwater levels on the Mississippi River, Hamilton Lake, Gin Lake, and other small nearby water bodies and streams.

e. Identify the potential impact on plant facilities of the degraded water quality.

RESPONSE

Evidence of induced infiltration was first demonstrated in the test well program conducted during 1973 to 1974 and described in Subsection 2.4.13.2.4 (Hydrogeologic Properties of Subsurface Materials) and Appendix 2.4A (Pump Test Data and Well Logs from Radial Collector Well Exploration and Testing Program) of the FSAR. The long-term pumping tests of Ranney Wells 3 and 5

also demonstrate the close hydraulic connection between the wells and the river. The hydrographs of the pumping wells and the river shown on Figure 371.07-3 are parallel during the pumping test, indicating the stabilization of ground water levels by recharge from the river within several days after the start of pumping. The ground water levels, quality, and use during the performance of the long-term testing do not materially differ from what was expected, based on the original test well program.

Because water quality changes caused by induced infiltration of river water involve actual mass transport, changes in quality at the pumping wells will be slower than the potentiometric changes shown by the hydrographs. Water presently in the aquifer between the wells and the river will have to be extracted before water infiltrating from the river arrives at the wells. Our calculations indicate it will take at least 1 year of continuous pumping before 70 percent of the water pumped is infiltrated river water. However, this does not mean that water quality at the wells will reflect 70 percent of the water being derived from the river. Desorption of cations from the aquifer material can be expected to significantly alter the quality of the recharging river water. Therefore, it has been assumed that, from a quality viewpoint, only 50 percent of the pumped water will appear to be derived from the river.

a. A long-term pumping test was performed with two radial collector wells from August 7, 1979 to December 19, 1979 (134 days). Wells 3 and 5 (Figure 371.07-1) were pumped at the average rates of 8000 gpm and 7600 gpm, respectively. Well 1 was not included in the long-term pumping test because work was being performed in the caisson during the time of the pumping test. The Well 1 caisson was intermittently dewatered during the pumping test, and this pumping had minor interference effects on Observation Wells RW-1A and RW-1B (Figure 371.07-1).

   Water level measurements were made periodically during the testing of Wells 3 and 5, at 27 observation wells, and at staff gages in Hamilton Lake, Gin Lake, and the Mississippi River (locations shown in Figure 371.07-1). Periodic measurements of the pumping rates and the discharge water temperature from Wells 3 and 5, and of the temperature of the Mississippi River, were also taken. A compilation of all measurements made during the long-term pumping test is contained in Appendix 371.07-A.

   The quality of the water withdrawn during the pumping test may be compared to Mississippi River water quality using the analytical data gathered during the test. The accompanying tables (Tables 371.07.1 and

371.07.2) summarize the data as provided by Betz and Analytical Services Laboratory to Mississippi Power & Light. Note, however, that the data for both the river and wells represent short-term transient conditions due to the limited duration of the tests. Comparisons of long-term water qualities can be made using the projected average radial well water quality and the long-term average river water quality as presented in the attached copies of Tables 3.6.3a and 3.6.3b (revised) of the Grand Gulf Environmental Report.

b. The change in water source after pumping commences is slow because the river water must travel from the effective recharge boundary to the well. A measure of this is provided by the simultaneous, long-term testing of the two completed Ranney Wells 3 and 5. The proportions of water source to the six wells under steady-state conditions, and the period of time required to attain this condition, have been estimated with the aid of the finite element model Isoquad (Ref. 1).

The planned well field and the finite element mesh constructed for the computer model are shown on Figure 371.07-4. Input parameters to the model include permeability, aquifer thickness, initial water levels, and boundary conditions. A representative permeability of 1.3×10^5 ft/yr was selected from pumping test measurements (Appendix 2.4A of the FSAR). The top of the Catahoula Formation, shown on Figure 2.5-30 in the FSAR, was used as the base of the aquifer. Initial ground water levels were taken for two cases; high river conditions, represented by conditions on August 7, 1979 (Figure 371.07-1), and low river conditions, represented by conditions during November 17, 1978 (Figure 371.07-11). These are the extreme river levels for which prepumping ground water levels are available. The effective distance of the river from the wells as a recharge boundary was determined to be 850 feet, based on pumping tests of Ranney Wells 3 and 5 (Ref. 2).

It was assumed in operating the model that all six wells pump continuously, each at a rate of 8000 gpm. The model was run until steady-state potentiometric conditions were approximated, which was 6 days. The resulting water table conditions (potentiometric contours) for the two cases, high and low river conditions, are shown on Figures 371.07-5 and -6. Lines of flow were drawn perpendicular to the potentiometric contours to produce flow tubes as shown. These flow nets indicate that 60 percent of the discharge is

derived from the river when it is at elevation 39, and that 75 percent of the discharge is derived from the river when it is at elevation 62. Considering that the mean river stage is elevation 54 (ER, Section 2.4), the estimated average contribution by the river to the wells will be 70 percent.

Figures 371.07-5 and -6 represent steady-state potentiometric conditions. Steady-state water quality conditions involve the physical displacement of river water through the aquifer. This requires more or less time, depending on the flow path followed. The time for a water particle to travel along its flow path from the effective recharge boundary to the well depends on the seepage velocity, which is expressed as:

$$V = \frac{K\ (H/L)}{\theta} \qquad \text{(Ref. 3)}$$

Where K = Hydraulic conductivity (1.3×10^5 ft/yr)

V = Seepage velocity (ft/yr)

H = Head drop along flow line (ft)

L = Length of flow line (ft)

θ = Porosity (25 percent from Ref. 3)

and $T = L/V$

where T = Travel time (yrs)

Using lengths of flow paths measured on Figures 371.07-5 and -6, it will take as long as 1 year for some river water particles to arrive at the wells. This suggests that it will be approximately 1 year before 70 percent of the pumped water is derived from the river. However, the quality of the water being pumped after 1 year is not expected to reflect this ratio of river water and aquifer water because of the effects of ion exchange with the aquifer.

As river water of different quality enters the aquifer, ions adsorbed onto the aquifer material will desorb into the infiltrating river water, increasing the dissolved solids content. Thus, the river water reaching the wells will be of lesser quality. Ion exchange appears to be significant enough that the ultimate water quality of the water pumped will be as if only 50 percent is derived from the river. This conclusion is indicated by water quality analyses of

samples taken during the long-term testing of Ranney Wells 3 and 5.

Plots of water quality parameters, including hardness, iron, conductivity, and chlorides, are shown on Figures 371.07-7, -8, -9, and -10, respectively. The water quality in the aquifer is believed best represented by the samples from Ranney Wells 3 and 5 taken on August 6 and August 7, 1980 upon commencement of the long-term testing. These samples are similar in water quality to those from the Mississippi alluvium presented in Table 2.4-21 in the FSAR. The hardness, iron, and conductivity parameters improve in quality after only several days of pumping and then vary directly with concentrations in the river. The covariance of concentrations of these parameters in well discharge and river water indicates that induced infiltration has occurred. However, the relative qualities of the well discharge and river water do not appear to converge with time.

The percentage of water derived from the river and from the aquifer can be calculated from the following relationship:

$$C = \sum_{1}^{N} X_i C_i \qquad \text{(Ref. 4)}$$

Where N = the number of different waters

X_i = percent contributed by each source

C_i = concentration of each source

C = final concentration

Using this relationship, and the concentrations from samples taken during the long-term testing, between 50 percent and 70 percent of the well discharge appears to be derived from river water. The difference between the percentages arrived at by this method and the flow-net method is primarily due to the desorption of cations. The infiltrating river water has lower concentrations of cations than the aquifer waters. As the river water displaces ground water, the geochemical equilibrium is changed, and cations desorb from the aquifer material. As mentioned above, the relative qualities of well discharge and river water did not converge during the long-term testing. This indicates that concentrations of these cations will not improve significantly.

Concentrations of anions in well discharge, illustrated by chloride in Figure 371.07-10, approach river concentrations within several days after the start of pumping. Chlorides in the well discharge are approximately the same concentration as in the river water. This indicates that anions are not being either adsorbed or desorbed by the aquifer, and induced river infiltration is the major source of water.

References

1. Pinder, G. F., "Galerkin - Finite Element Models for Aquifer Simulation," Water Resources Program, Department of Civil Engineering, Princeton University, 1974, Revised 1976.

2. Letters to Bechtel Power Corporation from Ranney Company: Ranney letter No. 0-67 dated October 24, 1977; Ranney letter No. 0-102 dated September 6, 1978.

3. Freeze, A. R. and Cherry, A., "Groundwater," Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1979.

4. Gonfiantini, R., Monograph on "Stable Isotope Hydrology," Section of Isotope Hydrology International Atomic Energy Commission, Vienna, Austria, 1976.

c. Abnormal ground water levels do not exist at the site. Ground water level contours constructed from prepumping static levels are shown in Figure 371.07-1. Ground water level contours constructed from levels measured during the pumping test are shown in Figure 371.07-2. These figures show normal ground water levels expected in a floodplain environment.

The ground water level in Observation Well MW-4 (location shown on FSAR Figure 2.4-35a) rose to greater than elevation 112 in September 1978 and elevation 120 in January 1979. These anomalously high water levels were caused by recharge to the sand backfill of ponded surface water at the observation well. A more complete description of the cause of the anomalously high levels and a description of the remedial action are given in the FSAR (Amendment 38) on page 2.5-64a. The hydrograph of Observation Well MW-4, showing the high ground water levels and the return to normal levels after correction of the drainage condition, is shown in FSAR Figures 2.4-36a and 2.4-36b.

d. See revised Subsection 2.4.5.4.

e. Two major potential impacts on plant operating facilities have been identified based on the change in radial well water quality as ascertained from data obtained during the pumping tests: 1) scaling and deposition in the cooling tower circulating water system, and 2) resin fouling plus slightly decreased capacity in the makeup demineralizer system. Each of these potential impacts is discussed briefly below.

The radial well is now projected to be significantly higher in hardness, alkalinity, and iron so as to be inherently prone to scaling and iron deposition. Addition of appropriate scale inhibitors/dispersants will, therefore, be required for reliable operation of the circulating water system. Once such treatment is implemented, cycling of the chemical concentrations in the cooling tower loop due to evaporation can probably be increased. Therefore, assessment of the potential impacts due to blowdown from the cooling tower(s) is being revised to include operation at five cycles of concentration. Increased cycles of concentration may, in turn, reduce sulfuric acid addition requirements sufficiently such that operating costs are not greatly different than for operation at lower cycles of concentration with acid addition alone. In summary, calcium carbonate scaling and iron deposition control through appropriate chemical addition will limit the potentially serious impact of the lower quality radial well water on the circulating water system.

The higher total solids and iron levels, which are now being projected in the radial well water, present a potential impact on the plant's makeup demineralizer system. The former would reduce system capacity by increasing ionic loadings given the present design, while the latter would cause fouling/degradation of cation exchange resins through oxidation and precipitation of soluble iron within the exchange media. Pretreatment of the well water is being investigated as a solution to both problems. In the short term, iron removal by oxidation and filtration (e.g., with greensand filters) should suffice, while in the long run, pretreatment to reduce hardness, alkalinity, and iron (e.g., by lime softening) may be preferred. The latter will most probably reduce both operating costs and problems as compared to the former while potentially increasing the capacity of the makeup demineralizer system. In summary, standard pretreatment of the radial well water will render it suitable as feed for the makeup demineralizer system in both the short and long term.

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TABLE 371.07.1

INITIAL RADIAL WELL PUMPOUT AND RIVER WATER QUALITY

(mg/l except as noted)

	August 6, 1979			August 7, 1979		
	River	Well 3	Well 5	River	Well 3	Well 5
Alkalinity M.O. ($CaCO_3$)	120	408	441	94	420	414
Alkalinity P ($CaCO_3$)	0	0	0	0	0	0
Aluminum (Al)	9.6	0.28	0.17	11	0.14	0.17
Ammonia (N)	0.38	0.65	0.67	0.36	0.79	0.65
Calcium (Ca)	41	138	147	43	145	148
Carbon Organic (C)	<1	<1	<1	4	5	8
COD (O_2)	<50	<50	<50	<50	<50	<50
Chloride (Cl)	26	15	14	19	15	14
Chromium Total (Cr)	-	-	-	-	-	
Color (APHA)	20	12	12	24	14	18
Copper (Cu)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Fluoride (F)	-	-	-	-	-	
Hardness ($CaCO_3$)	158	488	506	164	512	511
Iron Total (Fe)	9.4	22.8	18.4	11.2	18.8	18.0
Magnesium (Mg)	13	35	34	14	36	34
Nitrate (N)	5.9	2.5	<1.0	5.9	<1.0	<1.0
Nitrite (N)	<1.0	<1.0	1.6	<1.0	<1.0	1.8
Nitrogen, Kjeldahl (N)	0.44	0.15	0.14	0.49	0.13	0.31
pH	7.2	6.9	7.1	7.1	7.1	7.0
Potassium (K)	4.4	3.8	3.4	4.9	3.3	3.3
Silica Soluble (SiO_2)	33	26	25	45	26	24
Sodium (Na)	17.9	20.2	16.8	18.3	21.0	16.8
Solids Dissolved	290	508	522	228	530	530
Solids Suspended	-	-	-	-	-	
Sp. Cond. 25 C µmhos/cm	375	810	853	366	848	850
Sulfate (SO_4)	57	<10	<10	57	<10	<10
Sulfide (S)	0.1	0.21	<0.1	0.42	<0.1	<0.1
Turbidity (FTU)	82	92	115	110	115	110
Zinc (Zn)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfite (SO_3)	Included In Sulfate					
Aromatic Acids	-	-	-	-	-	-
Carbon Dioxide (CO_2)	-	-	-	-	-	-

NOTE: Analyses by Betz

TABLE 371.07.2

RADIAL WELL PUMPOUT AND RIVER WATER QUALITY IN NOVEMBER AND DECEMBER 1979

(mg/l except as noted)

	11/13			11/15			11/27			11/29		
	River	Well 3	Well 5	River	Well 3	Well 5	River	Well 3	Well 5	River	Well 3	Well 5
Alkalinity M.O. ($CaCO_3$)	-	205	265	-	270	240	-	250	220	-	248	208
Alkalinity P ($CaCO_3$)	-	0	0	-	0	0	-	0	0	-	0	0
Aluminum (Al)	-	<0.1	<0.1	-	<0.1	<0.1	-	<0.1	<0.1	-	<0.1	<0.1
Ammonia (N)	-	0.7	0.7	-	0.6	0.2	-	0.7	0.6	-	0.8	1.0
Calcium (Ca)	-	72	74	-	73	68	-	80	76	-	76	68
Carbon Organic (C)	-	5	8	-	5	5	-	6	6	-	8	6
COD (O_2)	-	8	8	-	12	12	-	4	8	-	4	4
Chloride (Cl)	-	17	18	-	17	16	-	21	23	-	21	24
Chromium Total (Cr)	-	<0.03	<0.03	-	<0.03	<0.03	-	<0.03	<0.03	-	<0.03	<0.03
Color (APHA)	-	65	90	-	85	75	-	97	60	-	85	50
Copper (Ca)	-	0.04	0.05	-	<0.02	<0.02	-	<0.02	<0.02	-	<0.02	<0.02
Fluoride (F)	-	0.2	0.2	-	0.17	0.16	-	0.18	0.17	-	0.19	0.18
Hardness ($CaCO_3$)	-	244	284	-	284	276	-	275	255	-	280	244
Iron Total (Fe)	-	7.5	12	-	14	8.4	-	15	8.5	-	13	8.3
Magnesium (Mg)	-	16	24	-	24	25	-	18	16	-	22	18
Nitrate (N)	-	<0.1	0.3	-	0.3	0.2	-	1.3	2.3	-	0.4	0.4
Nitrite (N)	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	-	<0.01	<0.01
Nitrogen, Kjeldahl (N)	-	0.7	0.7	-	0.9	1.2	-	1.2	1.0	-	0.9	1.0
pH	-	7.1	7.0	-	7.0	7.0	-	7.2	7.2	-	7.3	7.3
Potassium (K)	-	2.4	2.8	-	2.7	2.3	-	2.8	2.4	-	3.0	2.4
Silica Soluble (SiO_2)	-	20	22	-	20	20	-	22	18	-	22	20
Sodium (Na)	-	14	19	-	20	15	-	22	20	-	20	20
Solids Dissolved	-	310	364	-	362	334	-	328	310	-	328	348
Solids Suspended	-	10	30	-	26	20	-	28	16	-	24	14
Sp. Cond., 25°C µmhos/cm	-	500	600	-	600	550	-	590	530	-	510	520
Sulfate (SO_4)	-	29	26	-	27	29	-	24	30	-	25	32
Sulfide (S)	-	<0.1	<0.1	-	<0.1	<0.1	-	<0.1	<0.1	-	<0.1	<0.1
Turbidity (NTU)	-	57	87	-	86	60	-	110	63	-	111	64
Zinc (Zn)	-	<0.02	0.13	-	0.1	<0.02	-	0.04	0.01	-	0.03	0.03
Sulfite (SO_3)	-	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	-	<0.5	<0.5
Aromatic Acids	-	1.1	1.6	-	1.0	1.6	-	0.6	0.8	-	1.5	0.8
Carbon Dioxide (CO_2)	-	33	52	-	54	48	-	31	27	-	26	21

NOTE: Analyses by Analytical Services Laboratory

TABLE 371.07.2 (Cont.)

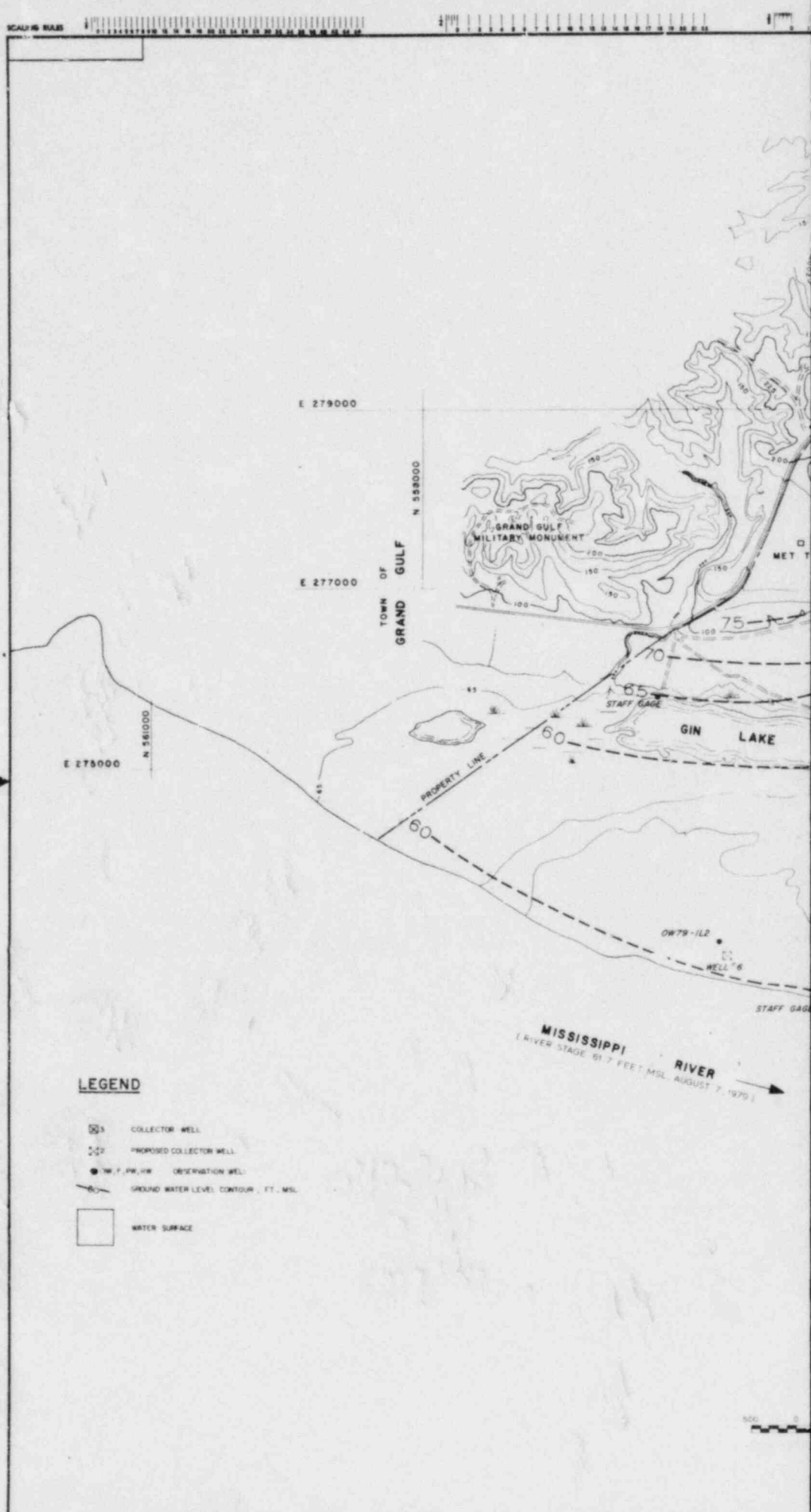
	12/4			12/6			No Date			12/12	
	River	Well 3	Well 5	River	Well 3	Well 5	River	Well 3	Well 5	River	Well 3	Well 5
Alkalinity M.O. ($CaCO_3$)	-	248	200	-	230	180	84	230	200	81	224	196
Alkalinity P ($CaCO_3$)	-	0	0	-	0	0	0	0	0	0	0	0
Aluminum (Al)	-	<0.1	<0.1	-	<0.1	<0.1	1.7	<0.1	<0.1	1.7	<0.1	<0.1
Ammonia (N)	-	1.3	1.2	-	0.9	0.7	0.4	1.0	0.3	0.7	0.8	1
Calcium (Ca)	-	72	66	-	74	62	26	66	53	27	66	58
Carbon Organic (C)	-	8	3	-	7	5	8	7	7	6	10	2
COD (O_2)	-	8	<4	-	<4	<4	14	6	10	4	4	<4
Chloride (Cl)	-	18	18	-	21	22	21	20	20	21	20	18
Chromium Total (Cr)	-	<0.03	<0.03	-	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Color (APHA)	-	64	45	-	50	35	-	-	-	15	74	50
Copper (Cu)	-	<0.02	<0.02	-	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fluoride (F)	-	0.16	0.15	-	0.21	0.18	0.14	0.19	0.18	0.13	0.28	0.16
Hardness ($CaCO_3$)	-	260	248	-	260	228	124	256	224	124	256	240
Iron Total (Fe)	-	14	5.0	-	14	7.7	2.7	9.9	6.3	2.5	11	7.0
Magnesium (Mg)	-	19	20	-	18	18	15	22	19	14	22	23
Nitrate (N)	-	0.7	1.3	-	0.3	<0.1	1.0	0.4	<0.1	1.4	0.2	0.2
Nitrite (N)	-	<0.01	<0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03
Nitrogen, Kjeldahl (N)	-	1.6	1.2	-	1.2	0.7	0.9	1.0	0.9	1.2	0.9	0.8
pH	-	7.1	7.3	-	7.1	7.2	7.6	7.1	7.2	7.2	7.2	7.2
Potassium (K)	-	3.8	2.7	-	3.0	2.6	3.6	2.5	2.2	3.3	2.6	2.5
Silica Soluble (SiO_2)	-	20	17	-	21	19	10	23	18	11	22	21
Sodium (Na)	-	21	18	-	18	20	16	21	19	17	22	18
Solids Dissolved	-	186	124	-	356	280	182	358	274	204	330	328
Solids Suspended	-	44	32	-	28	16	70	26	22	22	18	16
Sp. Cond., 25°C µmhos/cm	-	570	510	-	550	510	330	560	530	360	590	540
Sulfate (SO_4)	-	37	37	-	37	38	35	36	38	36	36	36
Sulfide (S)	-	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Turbidity (NTU)	-	90	61	-	87	55	58	87	62	-	83	54
Zinc (Zn)	-	0.18	0.22	-	<0.02	0.16	0.03	<0.02	<0.02	<0.02	<0.02	<0.02
Sulfite (SO_3)	-	<0.5	<0.5	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Aromatic Acids	-	0.5	2.3	-	<0.1	0.3	2.5	2.3	1.1	5.8	2.8	0.4
Carbon Dioxide (CO_2)	-	39	20	-	37	24	12	35	25	9	27	25

NOTE: Analyses by Analytical Services Laboratory

TABLE [illegible].07.2 (cont.)

	12/14			12/3[illegible]			Average			
	River	Well 3	Well 5	River	Well 3	Well 5	River	Well 3	Well 5	Well 385
Alkalinity M.O. ($CaCO_3$)	86	228	208	95	180	21[illegible]	87	231	213	222
Alkalinity P ($CaCO_3$)	0	0	0	0	0	0	0	0	0	0
Aluminum (Al)	8.2	<0.1	<0.1	2.6	<0.1	<0.1	3.6	<0.1	<0.1	<0.1
Ammonia (N)	0.3	0.8	0.7	0.2	0.8	0.8	0.4	0.8	0.7	0.8
Calcium (Ca)	30	67	66	35	54	67	30	70	66	68
Carbon Organic (C)	6	10	6	2	2	2	6	7	5	6
COD (O_2)	8	12	8	4	<4	<4	8	<7	<7	<7
Ch[illegible]ride (Cl)	21	19	19	20	19	18	21	19.3	19.6	19.5
Chromium total (Cr)	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Color (APHA)	30	75	60	15	7[illegible]	60	20	67	52	60
Copper (Cu)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Fluoride (F)	0.14	0.19	0.16	0.16	0.22	0.19	0.14	0.2	0.17	0.19
Hardness ($CaCO_3$)	130	260	260	140	230	240	130	258	250	254
Iron Total (Fe)	3.2	11	6.5	3.5	13	7.5	3.0	12.2	7.7	10.0
Magnesium (Mg)	13	22	23	13	18	19	14	20.1	20.5	20
Nitrate (N)	1.6	<0.1	1.2	0.9	0.1	0.4	1.2	0.4	0.6	0.5
Nitrite (N)	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.02	<0.01	<0.01	<0.01
Nitrogen, Kjeldahl (N)	0.7	0.8	0.8	0.8	0.8	0.8	0.9	1.0	0.9	1.0
pH	7.6	7.3	7.3	7.5	7.1	7.1	7.4	7.1	7.2	7.2
Potassium (K)	4.1	4.2	3.7	3.8	2.5	2.4	3.7	3.0	2.6	2.8
Silica Soluble (SiO_2)	16	21	20	21	20	21	14	20.6	19.6	20
Sodium (Na)	18	22	19	19	20	19	18	20	19	19
Solids Dissolved	238	356	326	226	308	30[illegible]	212	342	322	332
Solids Suspended	112	42	22	92	30	24	74	28	21	24
Sp. Cond., 25°C µmhos/cm	340	570	570	360	480	530	348	552	539	546
Sulfate (SO_4)	38	36	38	46	4[illegible]	36	39	33	30	31
Sulfide (S)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1
Turbidity (NTU)	51	90	62	56	82	66	55	88	63	76
Zinc (Zn)	0.1	0.05	<0.02	0.06	0.05	0.4	<0.11	<0.05	0.07	<0.06
Sulfite (SO_3)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Aromatic Acids	5.1	1.7	1.0	8	0.5	1.0	5.4	1.2	1.1	1.2
Carbon Dioxide (CO_2)	4	23	25	6	2[illegible]	14	5	33	30	32

NOTE: Analyses by Analytical Services Laboratory



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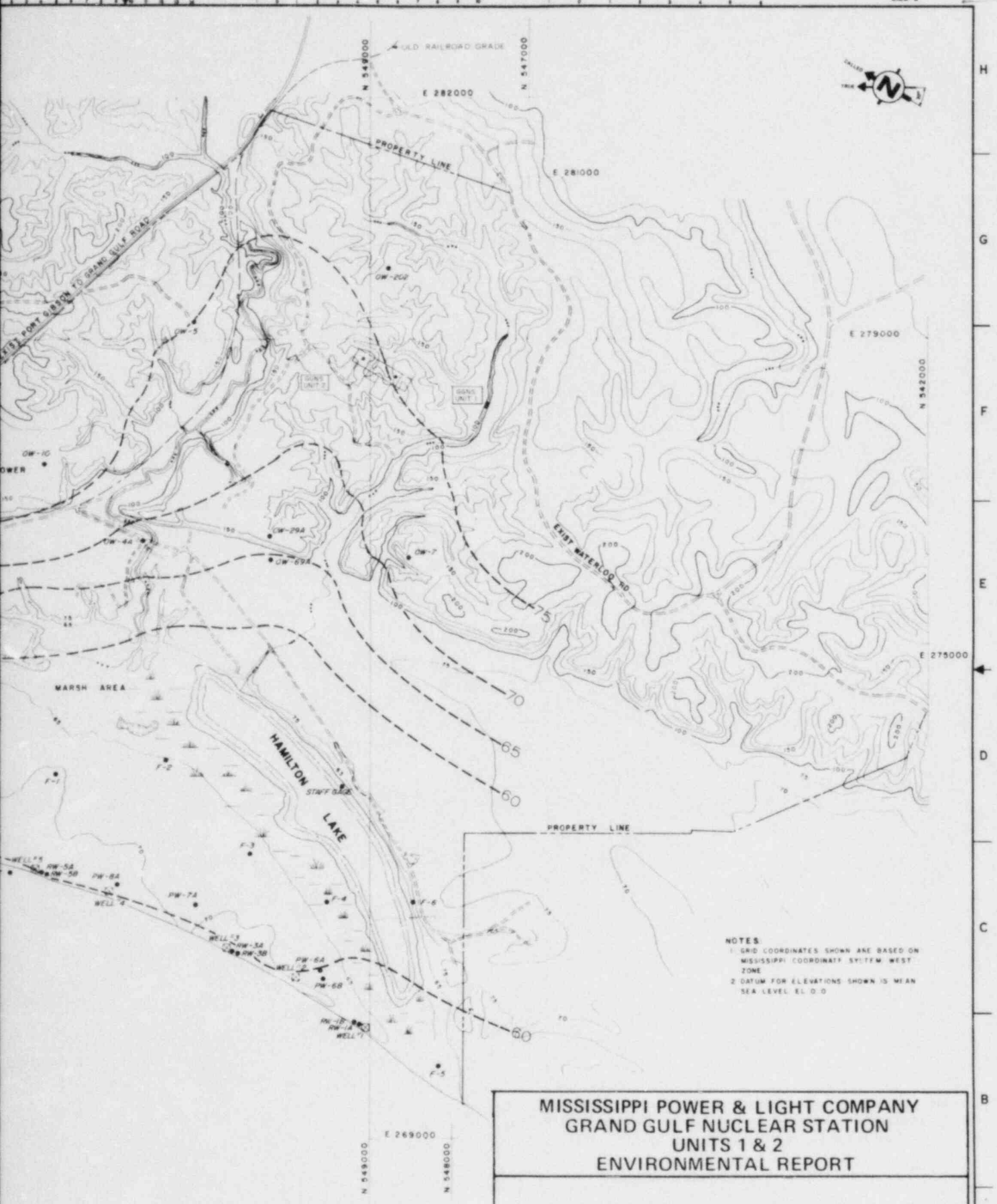

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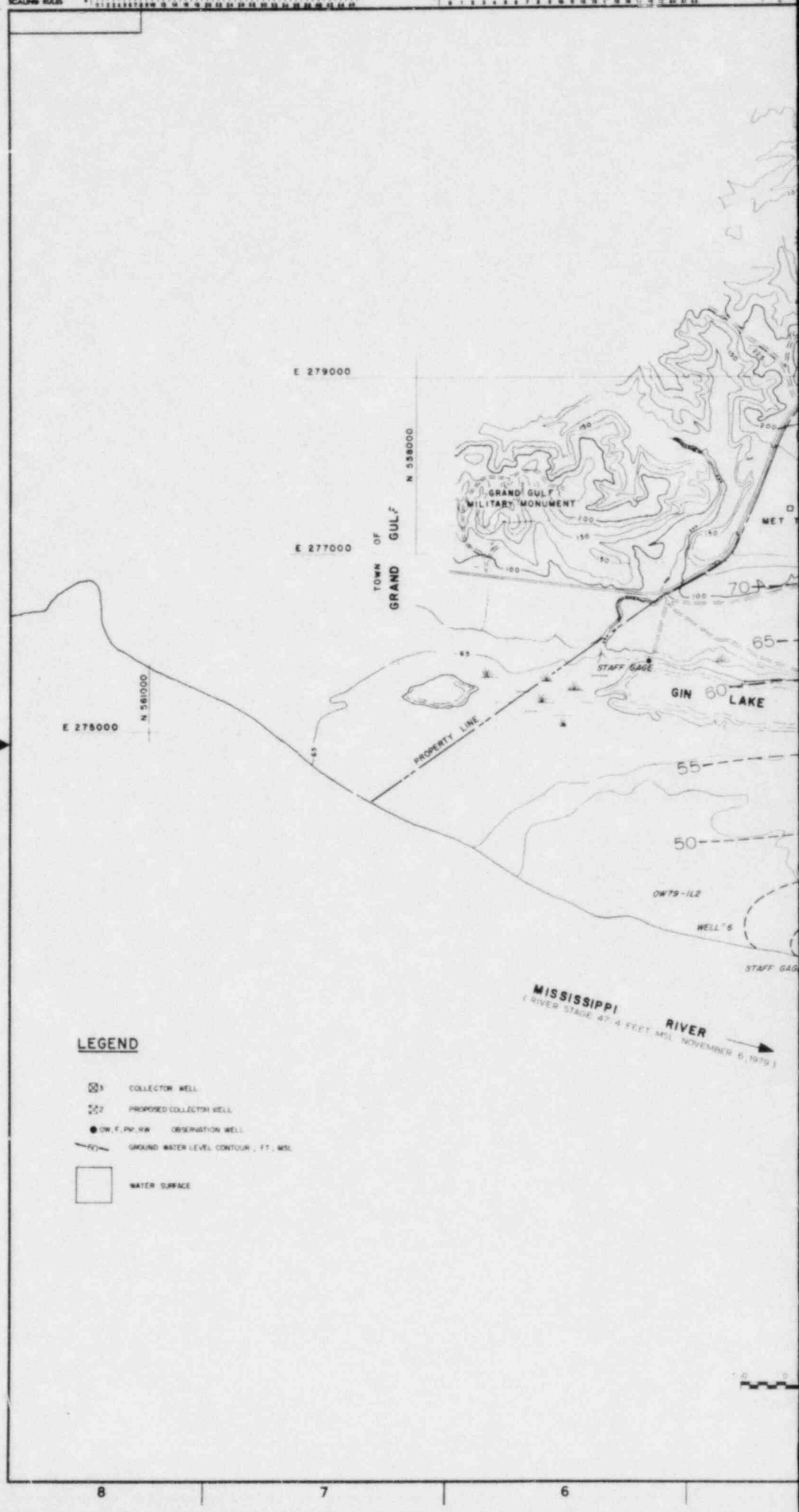
GROUND WATER LEVEL CONTOURS (HIGH RIVER LEVEL) AUGUST 7, 1979

FIGURE 371.07-1

Amend. 5 2/81



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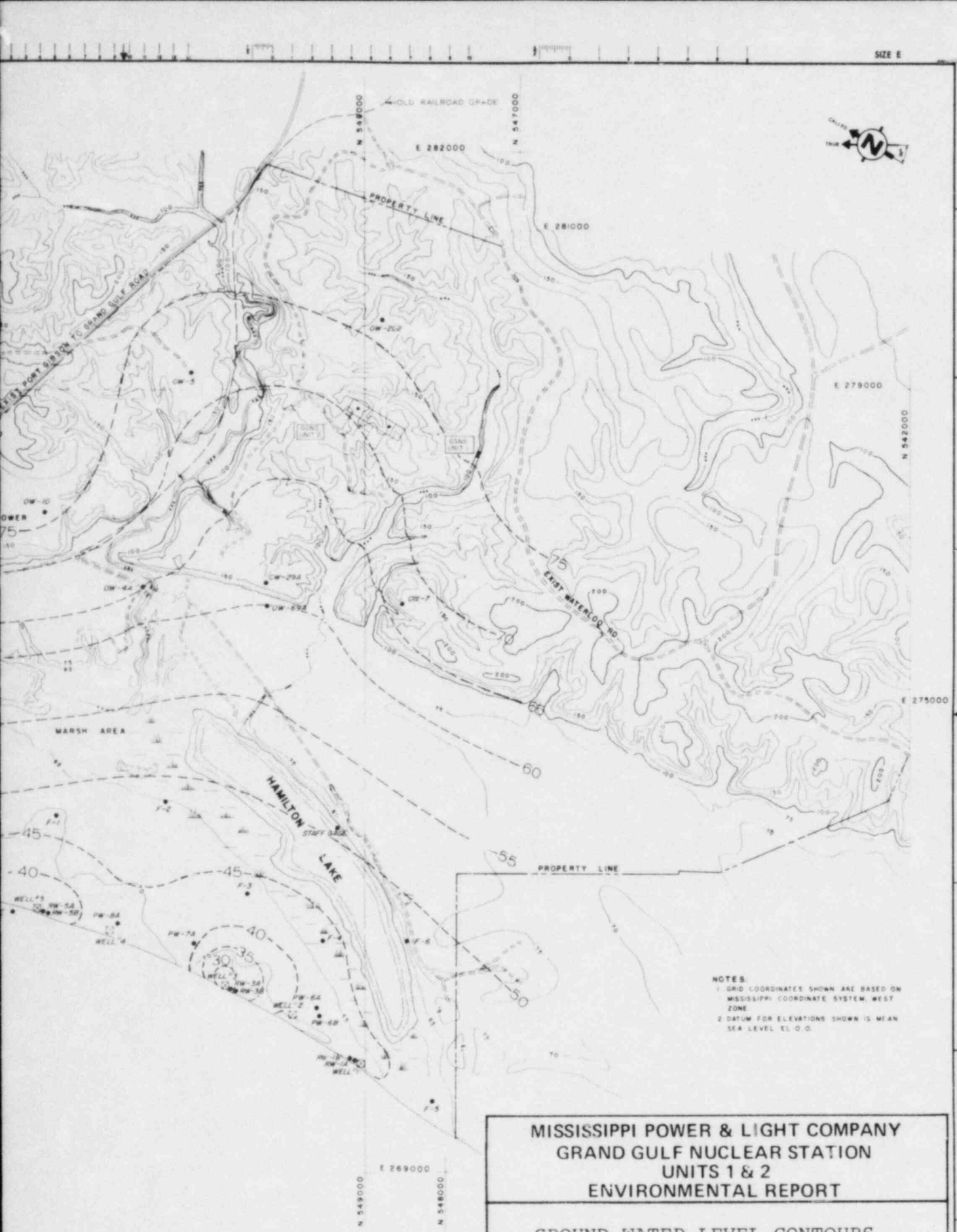

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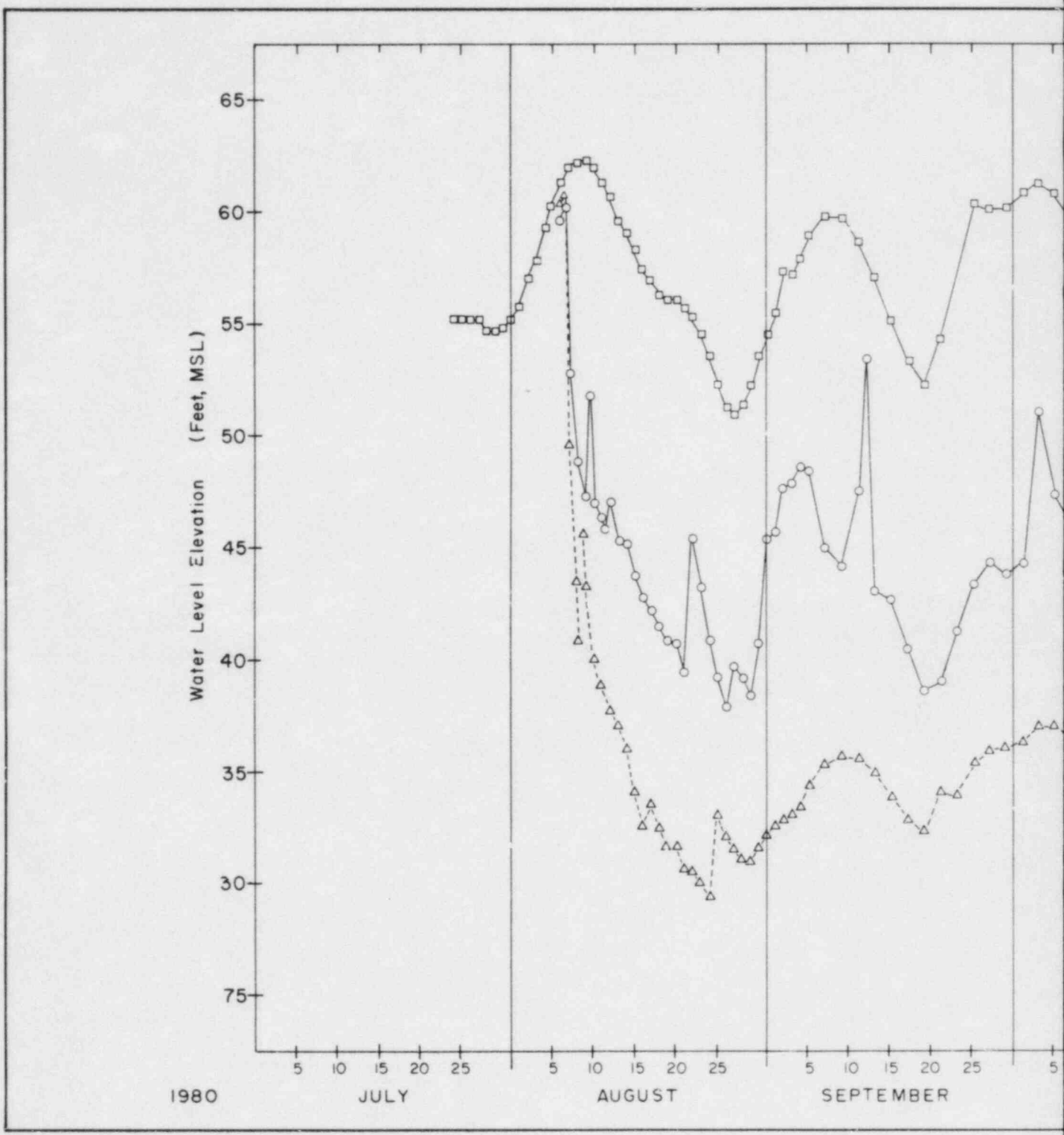
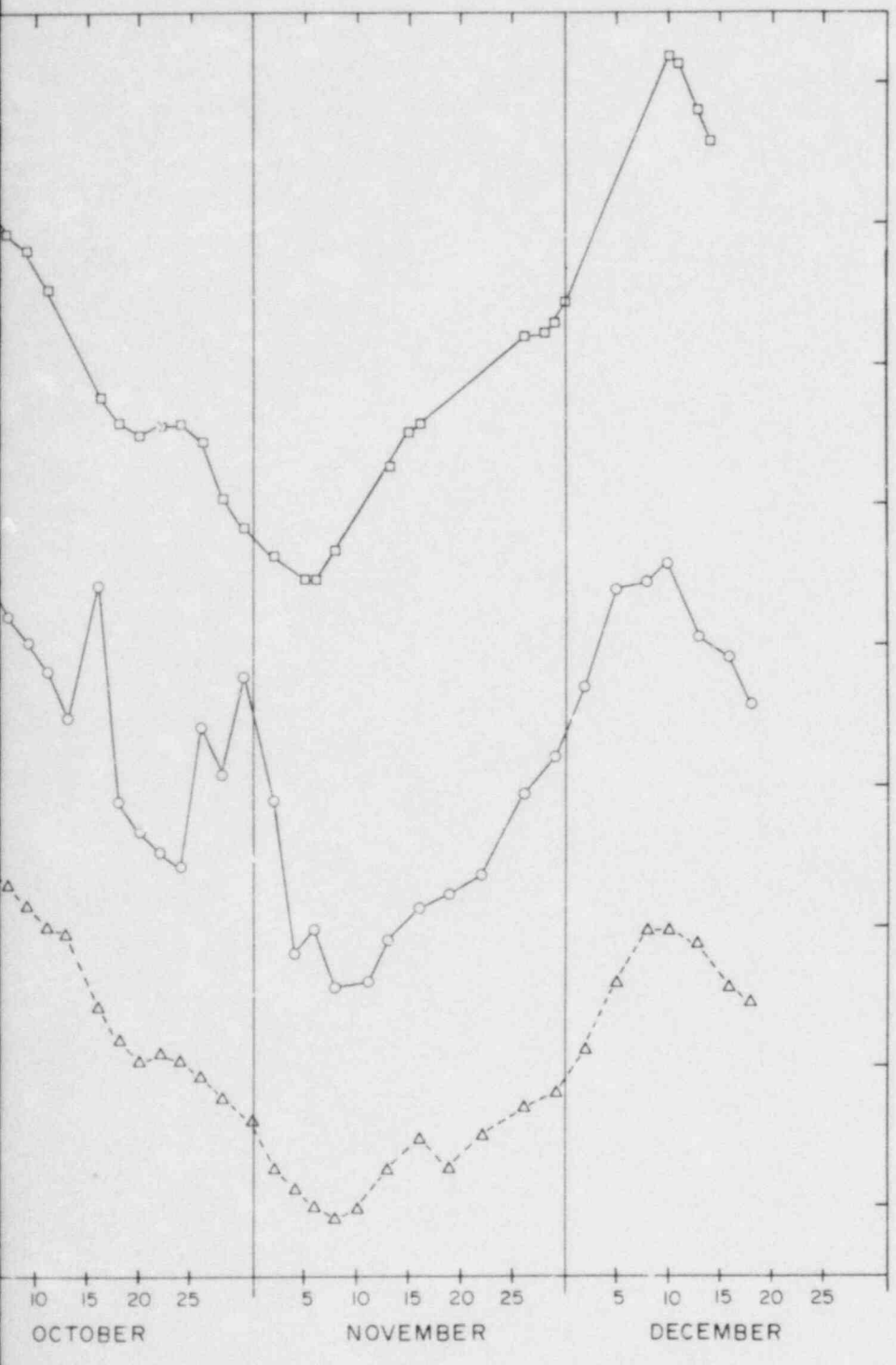
GROUND WATER LEVEL CONTOURS
NOVEMBER 6, 1979

FIGURE 371.07-2

Amend. 5 2/81


Water Level Elevation (Feet, MSL)
65
60
55
50
45
40
35
30
75
5
10
15
20
25
1980
JULY
AUGUST
SEPTEMBER



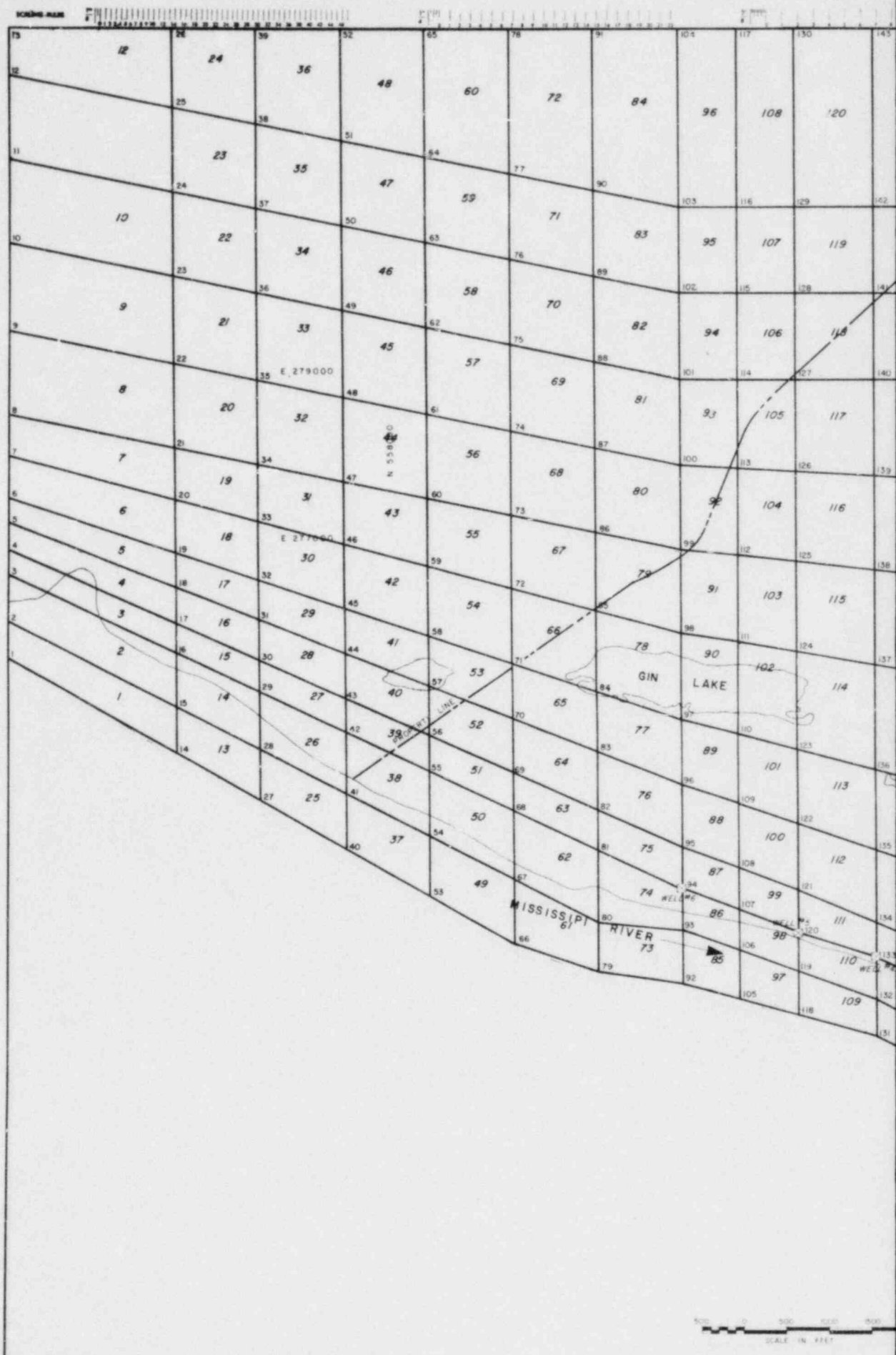
EXPLANATION

- □ MISSISSIPPI RIVER
- △ RANNEY WELL No. 3
- ○ RANNEY WELL No. 6

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

HYDROGRAPHS

FIGURE 371.07-3



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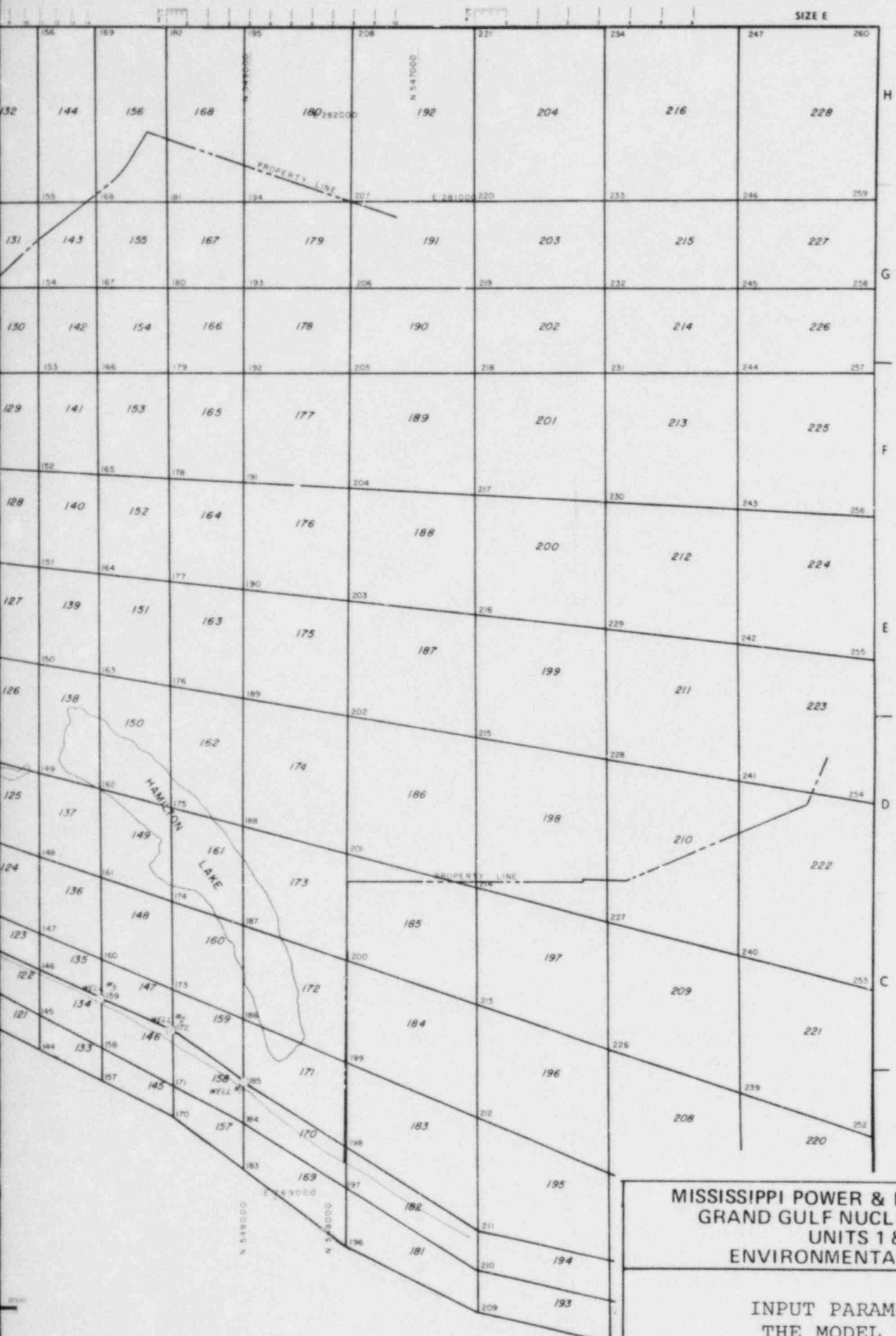
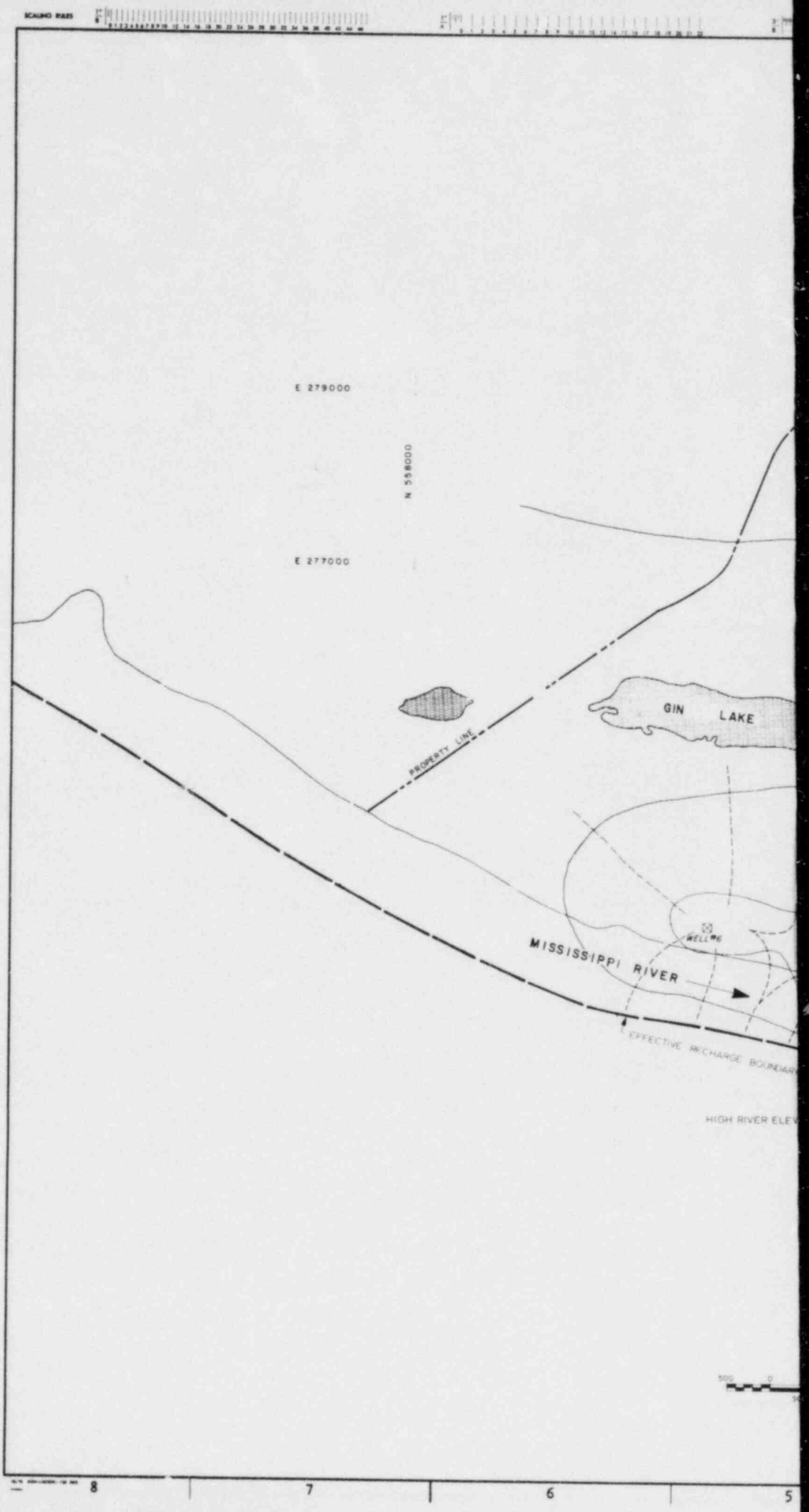


MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

INPUT PARAMETERS TO
THE MODEL ISOQUOD

FIGURE 371.07-4



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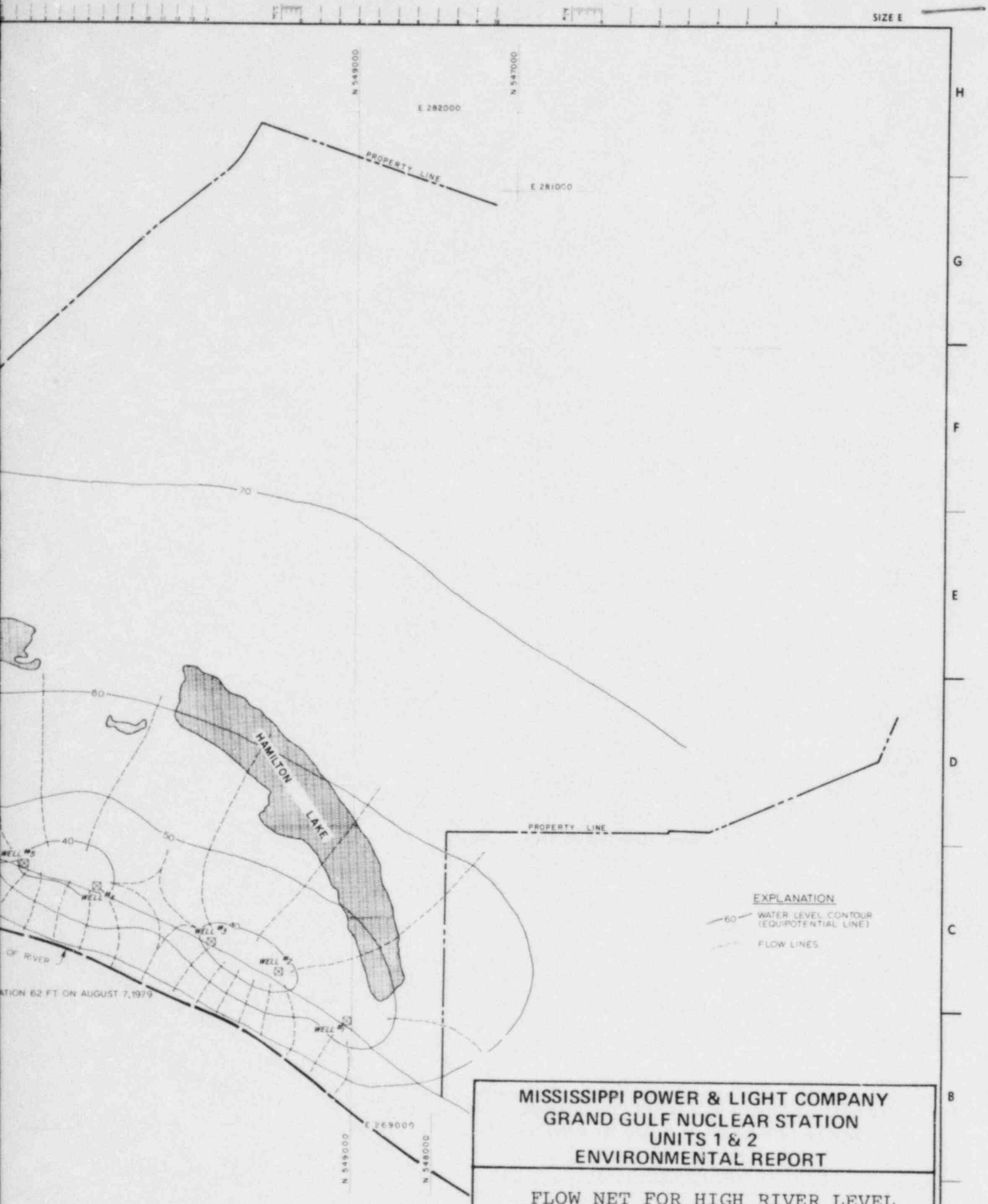

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

FLOW NET FOR HIGH RIVER LEVEL

FIGURE 371.07-5

Amend. 5 2/81

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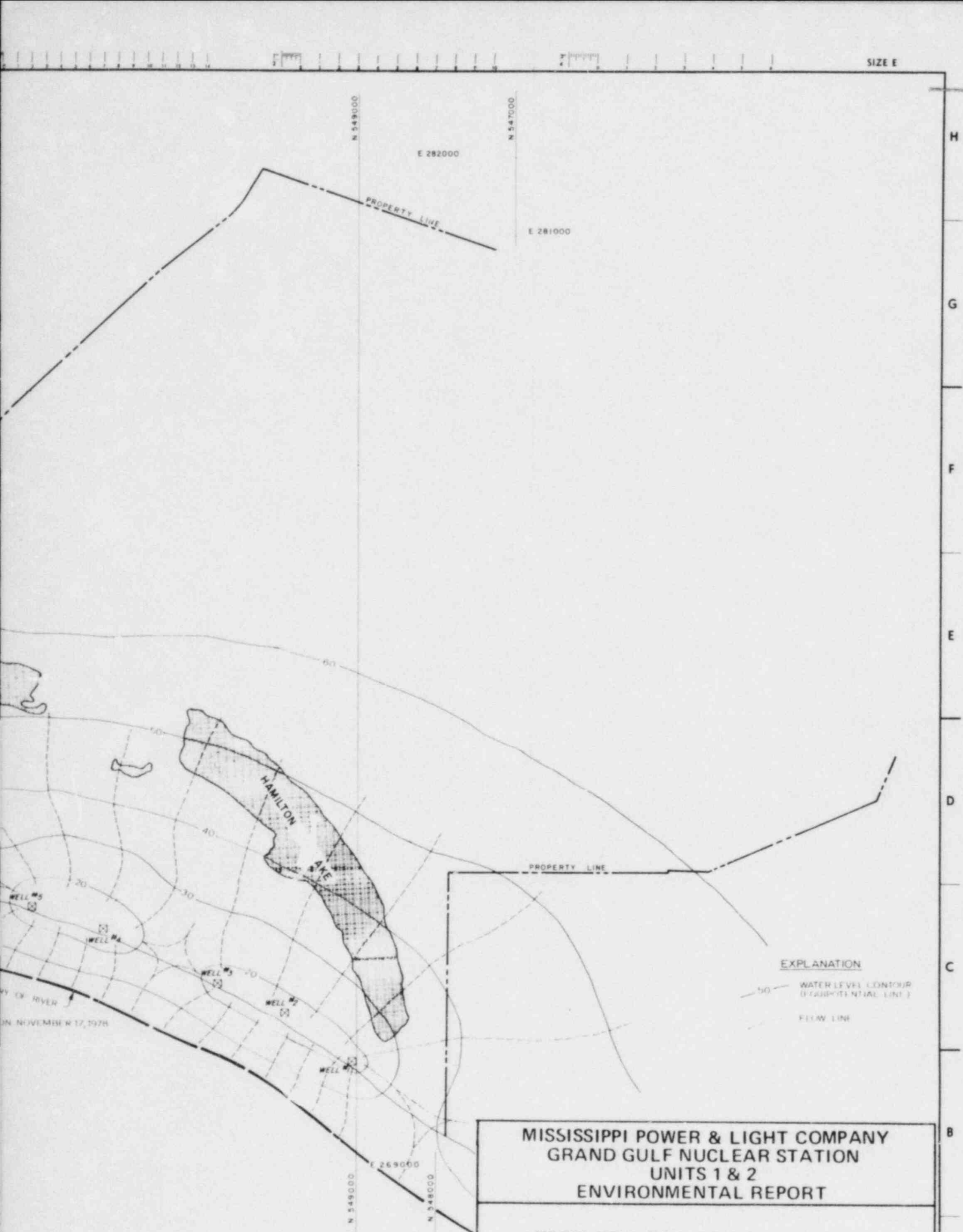
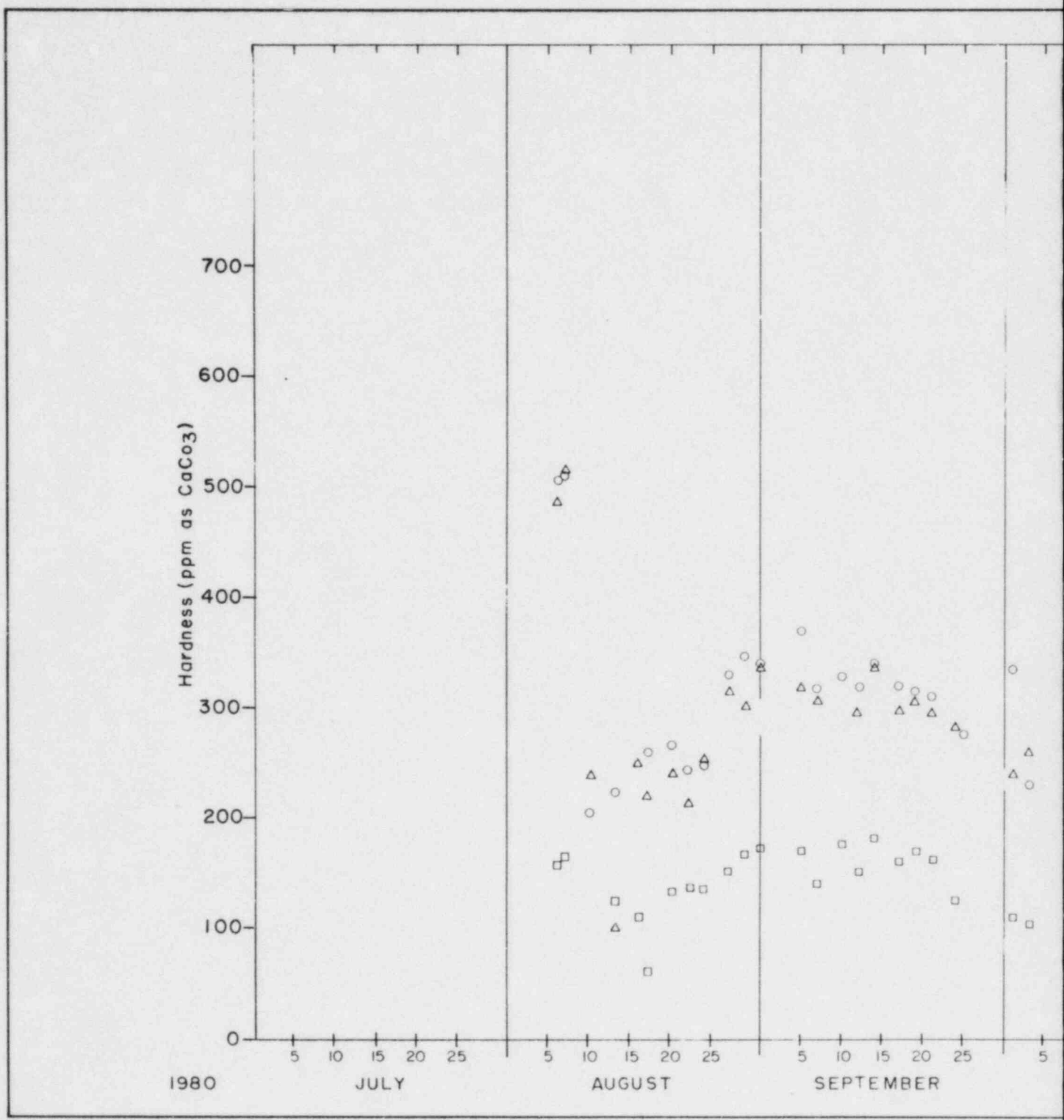


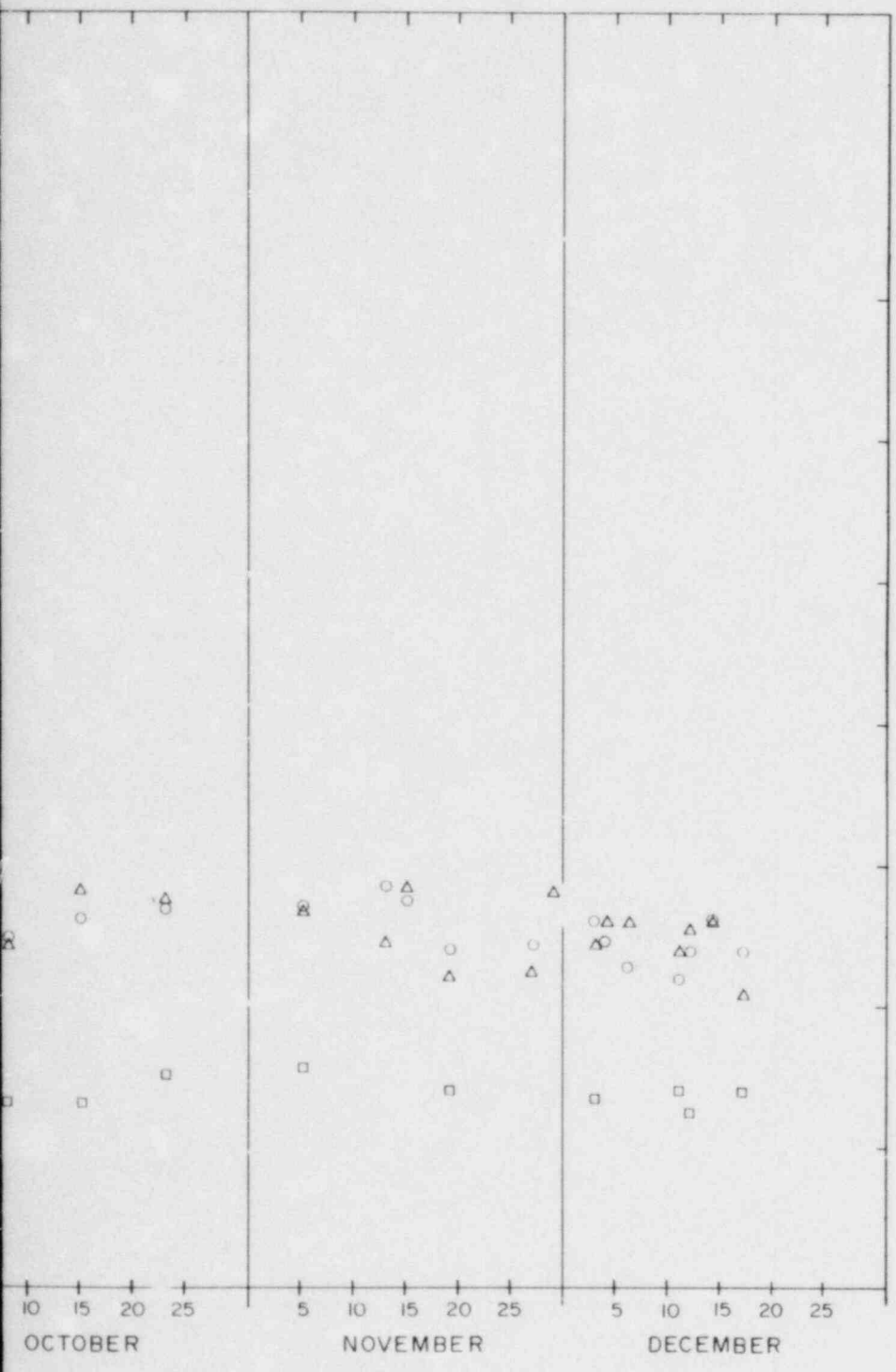
MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

FLOW NET FOR LOW RIVER LEVEL

FIGURE 371.07-6

Amend. 5 2/81

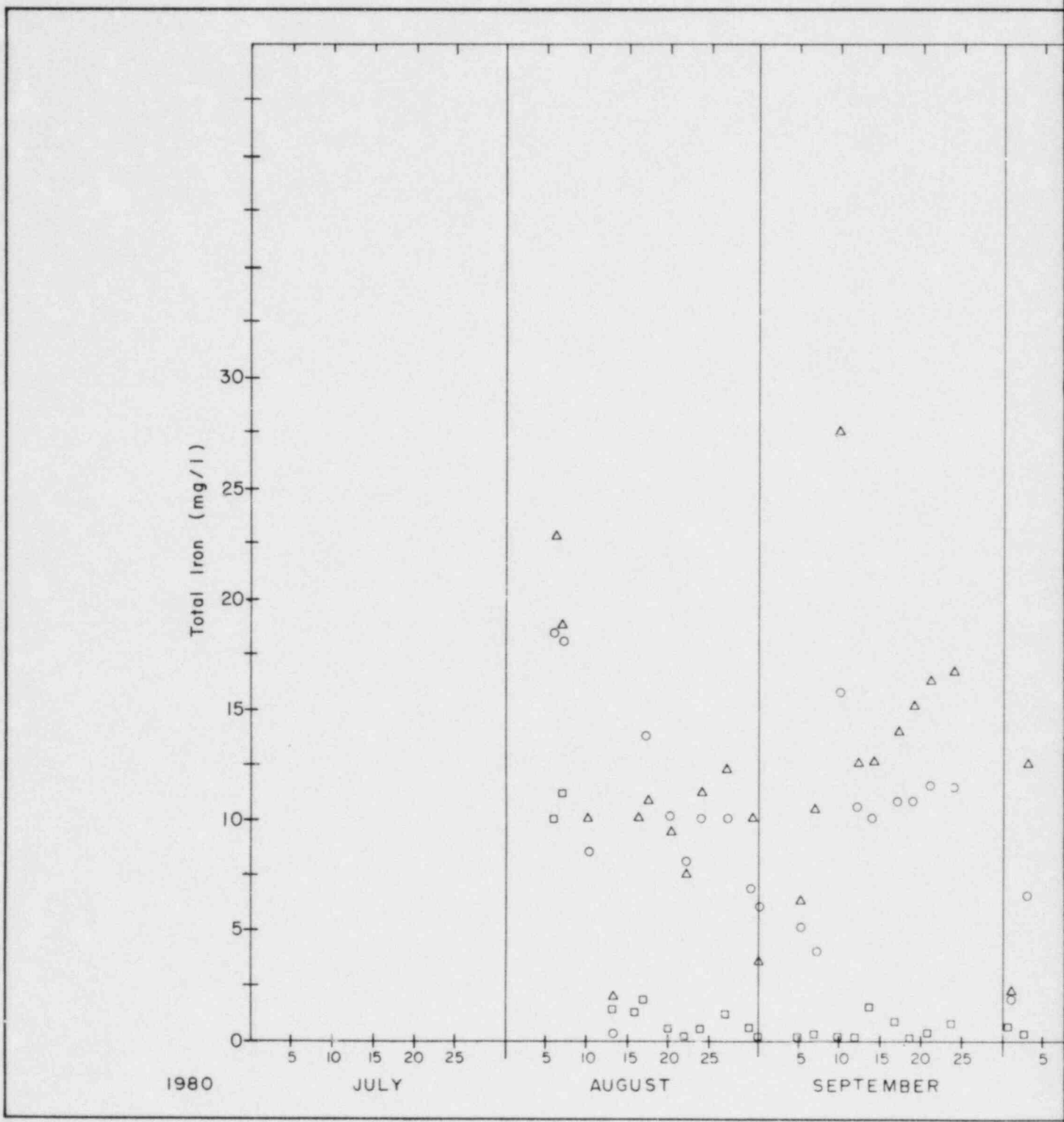

Hardness (ppm as CaCo3)
700
600
500
400
300
200
100
0
5
10
15
20
25
1980
JULY
AUGUST
SEPTEMBER

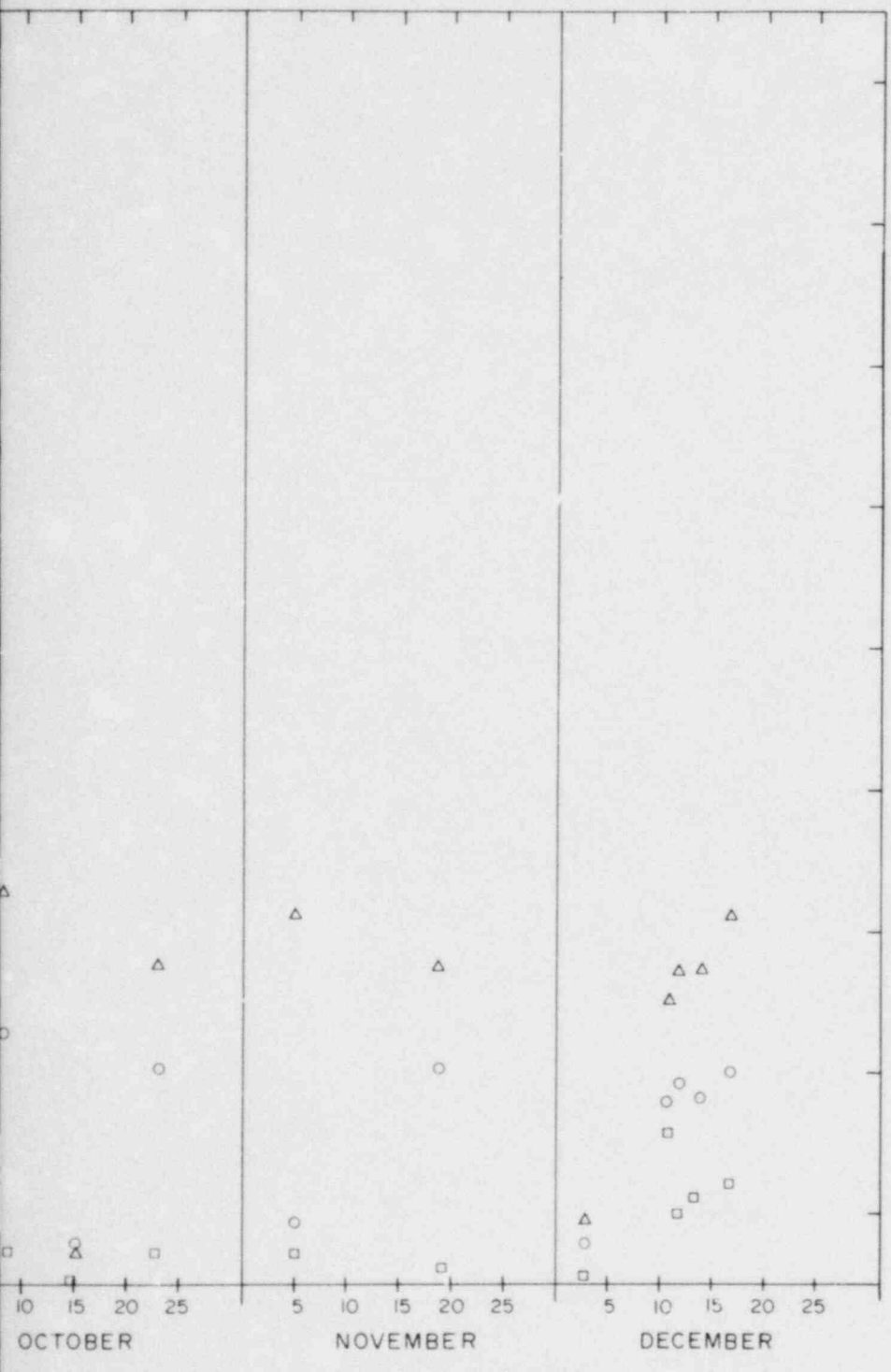


MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

WATER QUALITY HARDNESS

FIGURE 371.07-7

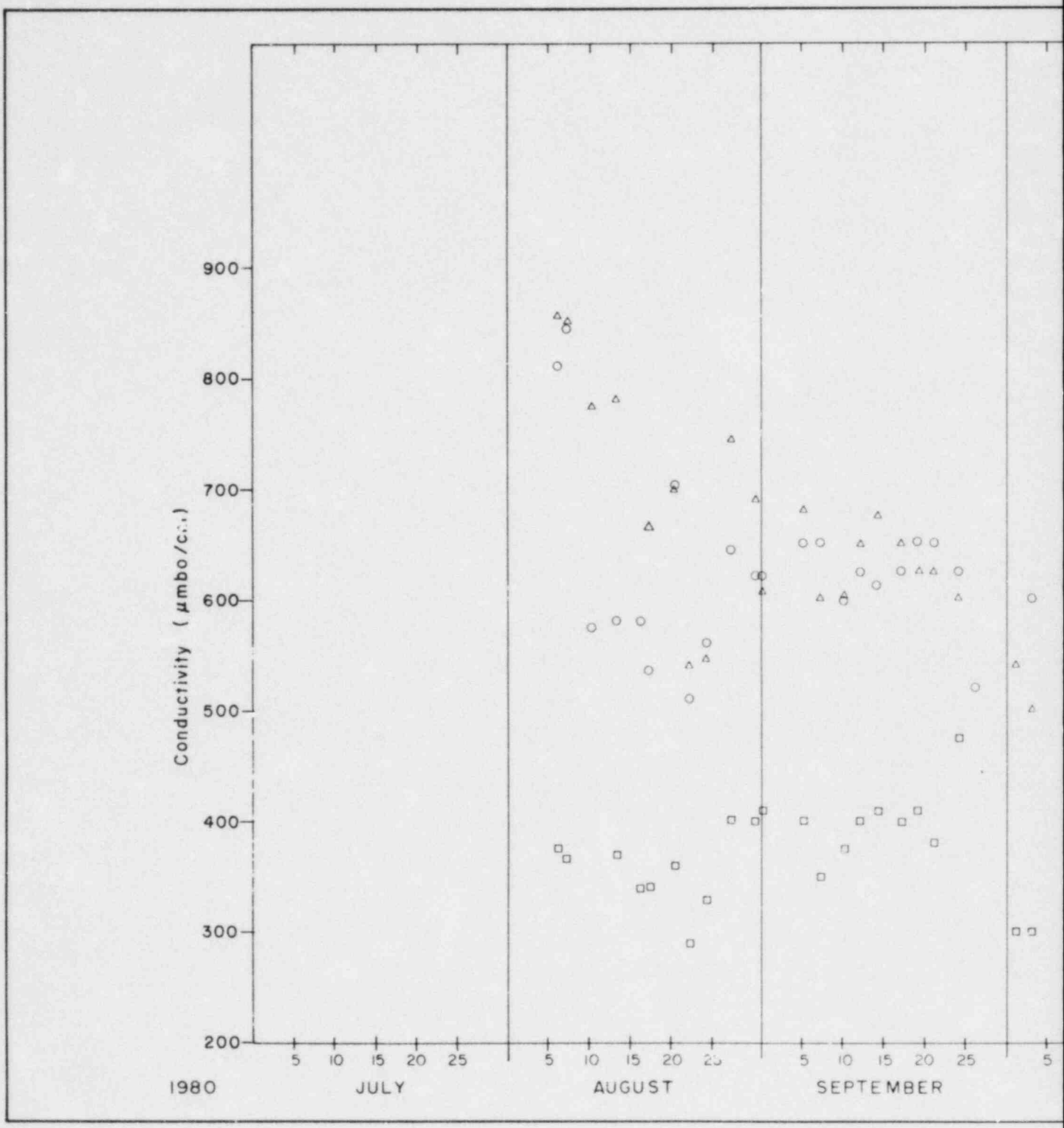

Total Iron (mg/l)
0
5
10
15
20
25
30
5
10
15
20
25
5
10
15
20
25
5
1980
JULY
AUGUST
SEPTEMBER



MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

WATER QUALITY TOTAL IRON

FIGURE 371.07-8


900
800
700
600
500
400
300
200
Conductivity (µmbo/cm)
5 10 15 20 25
5 10 15 20 25
5 10 15 20 25
5
1980
JULY
AUGUST
SEPTEMBER

EXPLANATION

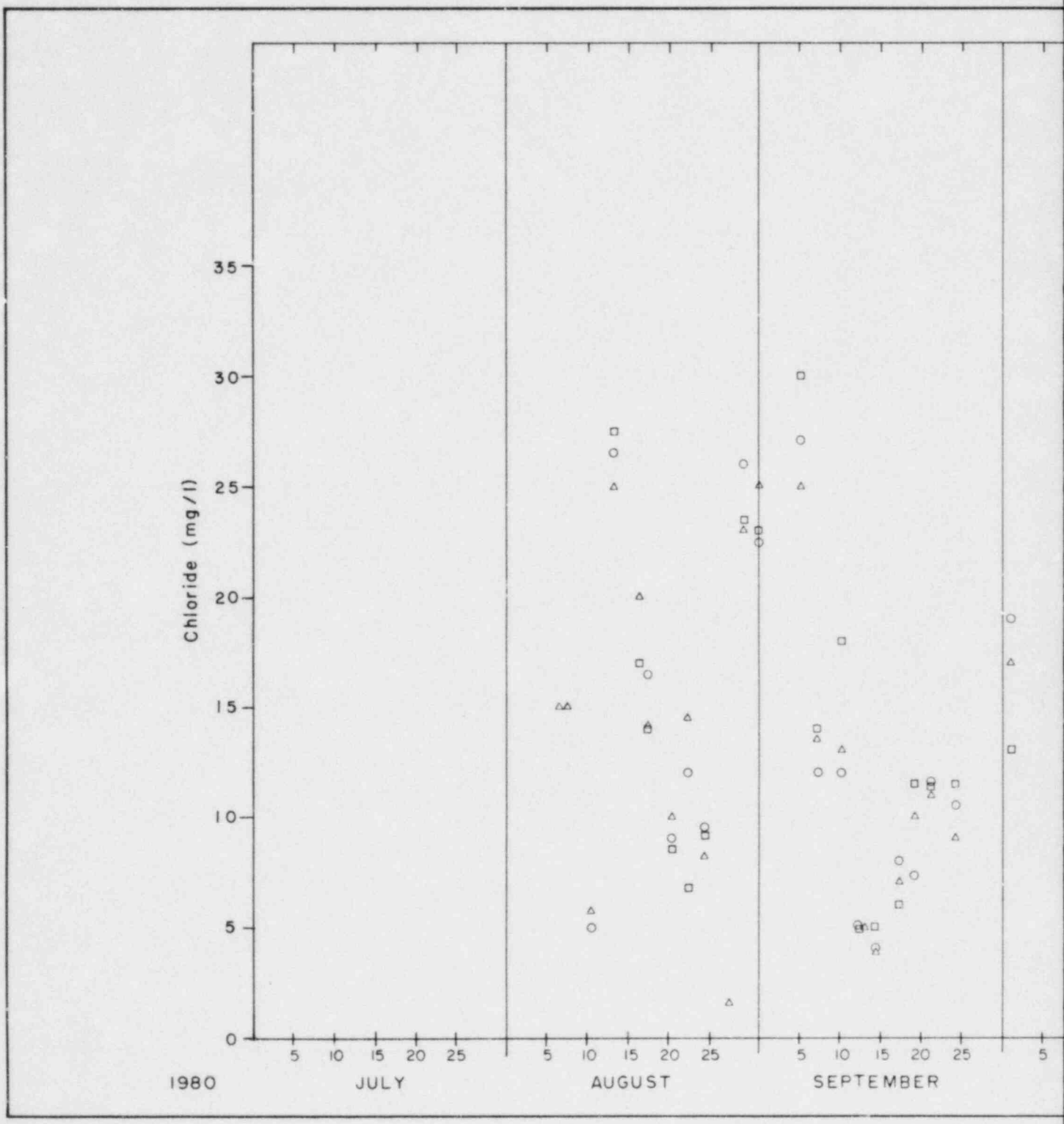
- □ MISSISSIPPI RIVER
- △ RANNEY WELL No. 3
- ○ RANNEY WELL No. 5

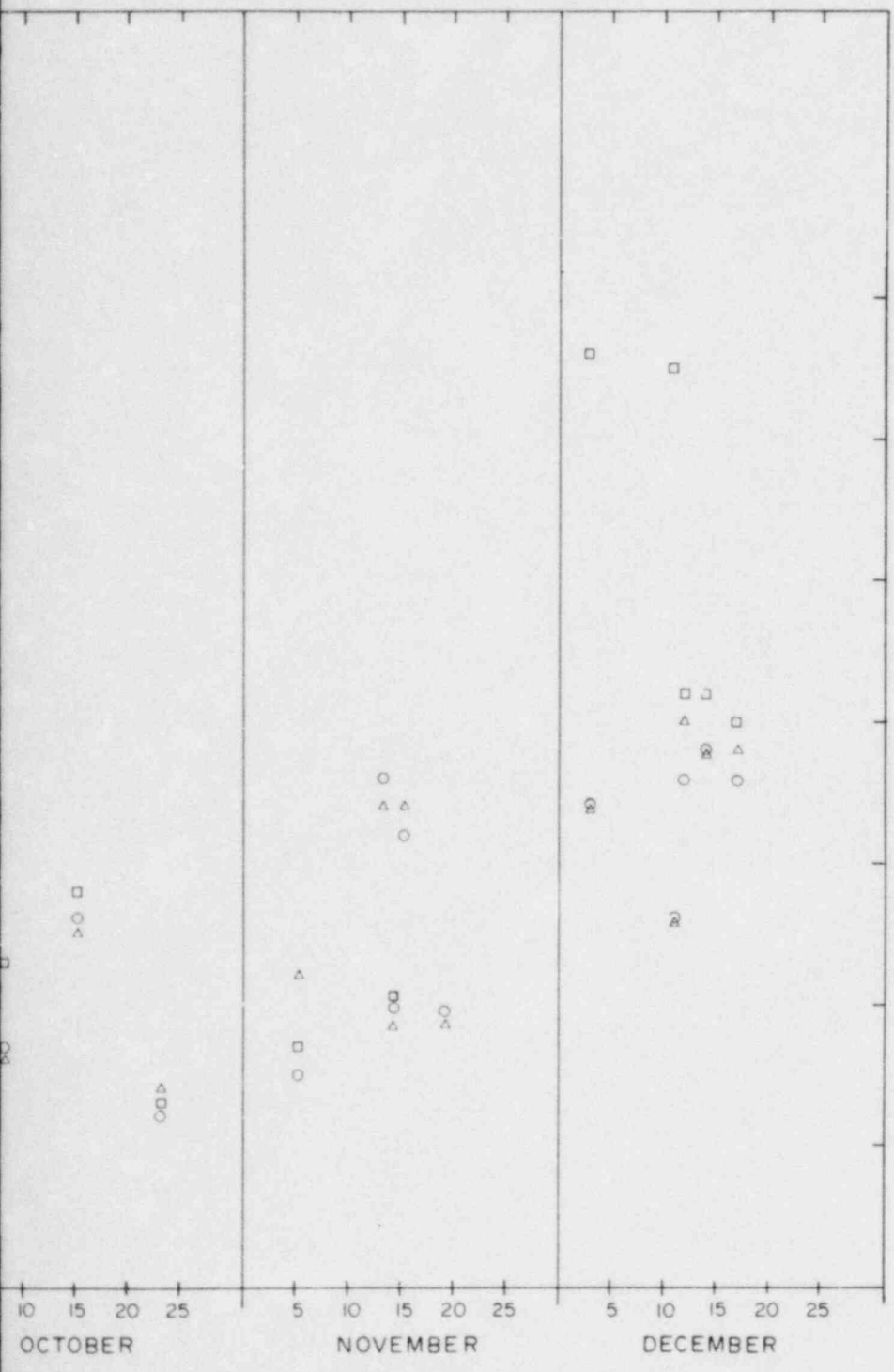
MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

WATER QUALITY CONDUCTIVITY

FIGURE 371.07-9

Amend. 5 2/81


Chloride (mg/l)
0
5
10
15
20
25
30
35
5
10
15
20
25
1980
JULY
AUGUST
SEPTEMBER

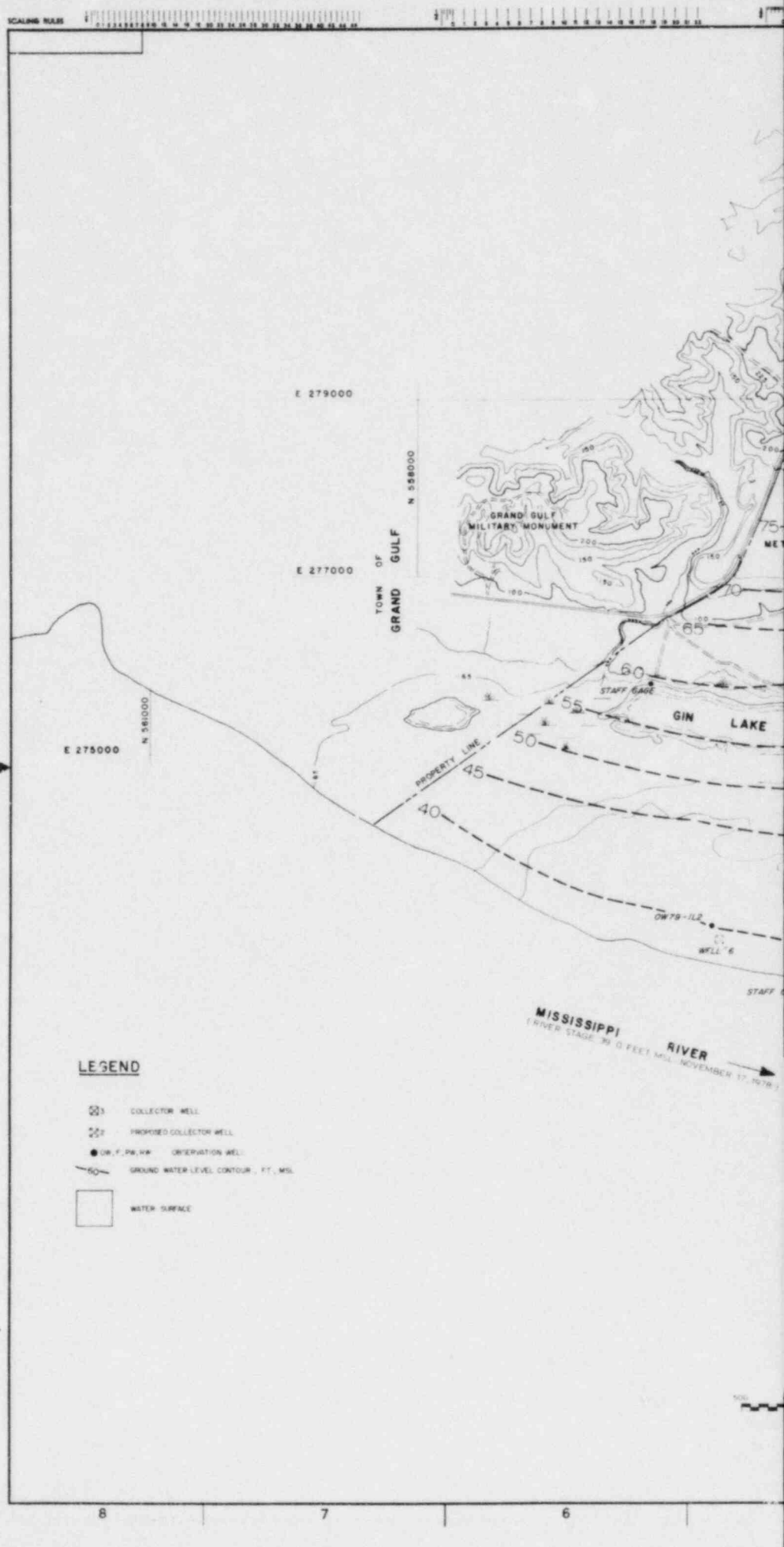


MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTA . REPORT

WATER QUALITY CHLORIDE

FIGURE 371.07-10

Amend. 5 2/81



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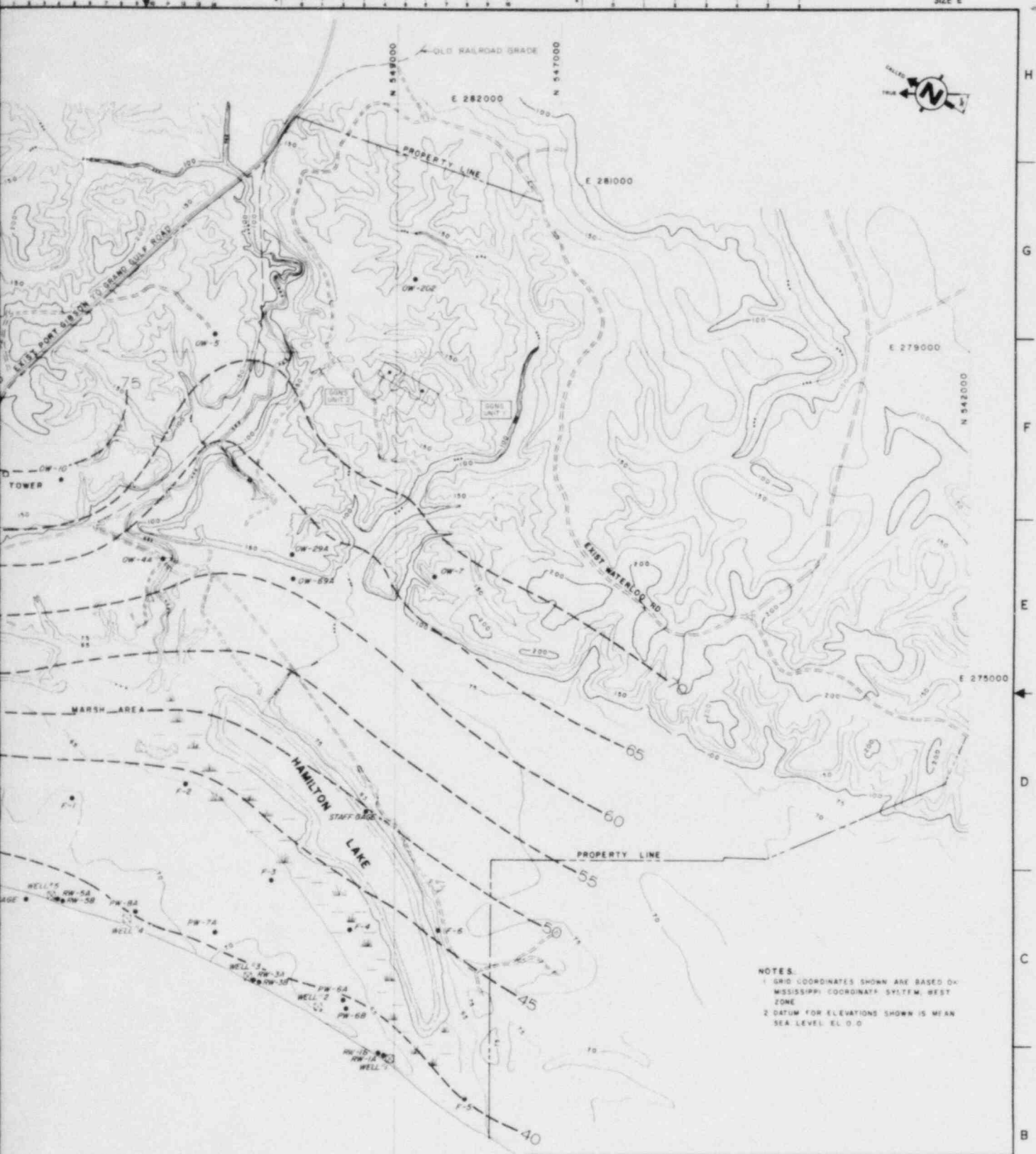

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

GROUND WATER LEVEL CONTOURS
(LOW RIVER LEVEL)
NOVEMBER 17, 1978

FIGURE 371.07-11

Amend. 5 2/81

APPENDIX 371.07-A

DATA

DATE 04/08/80 PAGE 1

BELL1 PUMP*TEST.DATA

ELT MK1 SL74K1 08/08/80 08:42:00 (24)

1.	22	F-1		21.03	10,49552,071.	125,184	080779	0830
2.	24	080779	0815	21.02				
3.	25	080779	0730	21.02				
4.	25	080779	0725	21.02				
5.	25	080779	0715	21.02				
6.	24	080779	0700	21.02				
7.	24	080579	1015	21.03				
8.	24	080879	1010	21.03				
9.	24	080779	0130	21.03				
10.	24	080779	0737	21.03				
11.	22	080779	0830	21.03				
12.	22	080779	0852	21.03				
13.	22	080779	0959	21.02				
14.	22	080779	2217	20.82				
15.	22	08 279	0100	20.78				
16.	22	090879	1325	20.75				
17.	22	081079	0930	20.92				
18.	22	090779	0830	21.03				
19.	22	090879	0830	21.03				
20.	22	090879	0730	21.03				
21.	22	090879	0835	21.03				
22.	22	160779	0852	21.03				
23.	22	110779	0959	21.02				
24.	22	101079	2217	20.82				
25.	22	010880	0830	20.78				
26.	22	010880	1325	20.75				
27.	22	031080	0930	20.92				
28.	22	120879	0830	21.03				
29.	22	020880	0852	21.03				
30.	22	050780	0959	21.02				
31.	22	030880	0752	20.82				
32.	22	030880	0830	20.82				
33.	22	030880	0825	20.82				
34.	22	030780	0830	20.82				
35.	22	022980	0830	20.82				
36.	22	125179	0830	20.78				
37.	22	010180	1325	20.75				
38.	22	022980	0900		20.75			
39.	22	080780	0830	21.03				
40.	23	080780	0825	21.03				
41.	22	080880	0930	21.03				
42.	23	080880	0930	21.03				
43.	23	080780	0830	21.03				
44.	22	99						

END ELT. ERRORS NONE. TEST 0.204 SEC. TAPE LENGTH 94

*HOLD,P

DATA1

DATA1 DATE 080080 PAGE 1

DELTA PUMPTEST.DATA1

ELI MK1 SLT4K1 08/08/80 09:02:09 (U)

1.	00	F-1		21.03	78.9032.0/10	123.7KH	0H0779	0H30 MI MF
2.	00	0H0779	0M1M	21.02			H700	65
3.	00	0H0779	0730	21.02				
4.	00	0H0779	0725	21.02				
5.	00	0H0779	0715	21.02				
6.	00	0H0779	0700	21.02				
7.	00	0H0579	1015	21.03				
8.	00	0H0579	1010	21.03				
9.	00	0H0779	0130	21.03				
10.	00	0H0779	0737	21.03				
11.	00	0H0779	0H30	21.03				
12.	00	0H0779	0H52	21.03				
13.	00	0H0779	0959	21.02				
14.	00	0H0779	2217	20.82				
15.	00	0H0H79	0100	20.78				
16.	00	0H0H79	1325	20.75				
17.	00	0H1079	0030	20.92				
18.	00	090779	0H30	21.03				
19.	00	090H79	0630	21.03				
20.	00	090H79	0730	21.03				
21.	00	090H79	0H35	21.03				
22.	00	100779	0H52	21.03				
23.	00	110779	0959	21.02				
24.	00	101079	2217	20.82				
25.	00	010H80	0H30	20.78				
26.	00	010H80	1325	20.75				
27.	00	031080	0030	20.92				
28.	00	120H79	0H30	21.03				
29.	00	020H80	0H52	21.03				
30.	00	030H80	0959	21.02				
31.	00	030H80	0752	20.82				
32.	00	030H80	0H30	20.82				
33.	00	030H80	0H25	20.82				
34.	00	030180	0H30	20.82				
35.	00	022480	0H30	20.82				
36.	00	123179	0H30	20.78				
37.	00	010180	1325	20.75				
38.	00	022H80	0900		20.75			
39.	00	0H0780	0H30	21.03				
40.	00	0H0780	0H25	21.03				
41.	00	0H0H80	0930	21.03				
42.	00	090MA1	0930	21.03				
43.	00	0H0781	0H30	21.03				
44.	00	99						

END ELI. ERRORS NONE. TIME: 0.231 SEC. IMAGE COUNT: 44

*HUG,P

HUGHES

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$DATA,IL PUMP$DATA.
DATA RN1=01 SL74N1 02/29/80 0413+1048 (m>1)
```

1.	F-1	21.03	78.90	5529304	2735904	080779	0831	
2.	080179		22.21					
3.	080279		22.21					
4.	080379		22.11					
5.	080479		21.92					
6.	080579		21.80					
7.	080679	1025	21.43					
8.	080779	0818	21.03					
9.	080779	0852	21.03					
10.	080779	0959	21.02					
11.	080779	1057	21.00					
12.	080779	1227	20.97					
13.	080779	1330	20.95					
14.	080779	1427	20.90					
15.	080779	1526	20.87					
16.	080779	1715	20.84					
17.	080779	1842	20.83					
18.	080779	2317	20.82					
19.	080879	0100	20.78					
20.	080879	0445	20.79					
21.	080879	0815	20.78					
22.	080879	1325	20.75					
23.	080879	2210	20.80					
24.	080979	0300	20.84					
25.	080979	0815	20.91					
26.	080979	1815	20.82					
27.	081079	0030	20.92					
28.	081079	0730	20.94					
29.	081079	1255	20.98					
30.	081079	1910	20.98					
31.	081179	0015	21.04					
32.	081179	0615	21.22					
33.	081179	1415	21.15					
34.	081179	1910	21.21					
35.	081279	0030	21.32					
36.	081279	0630	21.45					
37.	081279	1245	21.61					
38.	081279	1910	21.58					
39.	081279	2400	21.67					
40.	081379	0630	21.85					
41.	081379	1400	21.93					
42.	081379	2100	22.09					
43.	081379	2400	22.11					
44.	081479	0630	22.06					
45.	081479	1830	22.21					
46.	081579	0700	22.84					
47.	081579	1810	22.55					
48.	081679	0730	22.80					
49.	081679	1825	22.90					
50.	081779	0645	23.14					
51.	081779	1825	23.30					
52.	081879	0700	23.58					
53.	081879	1830	23.65					
54.	081979	0815	23.96					
55.	081979	1850	24.08					
56.	082079	0700	24.33					
57.	082079	1845	24.46					
58.	082179	0700	24.68					

119.	080779	1030	10.33
120.	080779	1230	10.30
121.	080779	1430	10.26
122.	080779	1630	10.22
123.	080779	1829	10.21
124.	080879	1910	10.04
125.	080879	2100	10.12
126.	080879	2300	10.13
127.	080979	0100	10.12
128.	080979	0300	10.11
129.	080979	0500	10.11
130.	080979	0700	10.13
131.	080979	0900	10.15
132.	080979	1100	10.15
133.	080979	1300	10.15
134.	080979	1500	10.14
135.	080979	1700	10.14
136.	080979	1900	10.16
137.	080979	2100	10.18
138.	080979	2300	10.21
139.	081079	0100	10.23
140.	081079	0300	10.25
141.	081079	0500	10.26
142.	081079	0705	10.28
143.	081079	0900	10.29
144.	081079	1100	10.29
145.	081079	1300	10.29
146.	081079	1500	10.28
147.	081079	1700	10.29
148.	081079	1900	10.29
149.	081079	2100	10.35
150.	081079	2300	10.37
151.	081179	0100	10.39
152.	081179	0300	10.39
153.	081179	0500	10.40
154.	081179	0700	10.43
155.	081179	0900	10.48
156.	081179	1100	10.50
157.	081179	1200	10.52
158.	081179	1800	10.58
159.	081179	1600	10.57
160.	081179	1800	10.60
161.	081179	2000	10.65
162.	081179	2800	10.75
163.	081279	0400	10.80
164.	081279	0800	10.89
165.	081279	1200	10.98
166.	081279	1600	11.08
167.	081279	2000	11.12
168.	081279	2800	11.22
169.	081379	0600	11.38
170.	081379	1200	11.51
171.	081379	1800	11.62
172.	081379	2800	11.75
173.	081479	0600	11.89
174.	081479	1800	12.05
175.	081579	0600	12.28
176.	081579	1810	12.36
177.	081679	0600	12.62
178.	081679	1800	12.75

179.	081779	0620	12.92
180.	081779	1800	13.04
181.	081879	0600	13.25
182.	081979	1515	13.65
183.	082079	0600	13.90
184.	082079	1900	14.04
185.	082179	0600	14.20
186.	082179	1500	14.26
187.	082279	0600	14.45
188.	082279	1800	14.62
189.	082379	0600	14.69
190.	082379	1800	14.77
191.	082479	0600	14.95
192.	082479	1700	15.03
193.	082579	0600	15.23
194.	082579	1800	15.36
195.	082679	0200	15.45
196.	082679	1730	15.55
197.	082879	0900	16.10
198.	082979	0600	16.38
199.	083079	1940	16.83
200.	083179	1750	16.99
201.	090279	1045	17.08
202.	090379	0935	17.08
203.	090479	1310	16.83
204.	090579	1115	16.83
205.	090779	1625	16.56
206.	090979	0805	16.31
207.	091179	0940	16.13
208.	091379	0740	16.10
209.	091579	1230	16.47
210.	091779	1535	16.73
211.	091979	1050	17.18
212.	092179	0810	17.35
213.	092579	0930	17.51
214.	092779	1100	17.06
215.	092979	1350	16.75
216.	100179	1510	16.38
217.	100379	1325	15.87
218.	100579	1755	15.31
219.	100779	1525	15.46
220.	100979	1105	15.60
221.	101179	1345	15.81
222.	101079	1930	16.58
223.	101479	1540	16.82
224.	102079	1615	17.20
225.	102279	1550	17.78
226.	102479	1810	18.40
227.	102679	1330	18.55
228.	102879	1655	18.95
229.	103079	1305	19.19
230.	110279	1100	19.66
231.	110479	0930	19.94
232.	110679	1105	20.42
233.	110879	0920	20.42
234.	111379	1310	21.94
235.	111679	0925	22.12
236.	112079	1710	21.45
237.	112979	1115	21.13
238.	121979	1130	11.96

239.	99			
240.	[illegible]	12.47	70.97	[illegible] 27d6131 080779 0810
241.	080179		14.67	
242.	080279		14.65	
243.	080379	1320	14.17	
244.	080479		13.67	
245.	080579	1100	13.55	
246.	080679	1030	12.91	
247.	080779	0840	12.47	
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251.	080779	1900	12.95	
252.	080879	0915	13.36	
253.	080879	1955	13.65	
254.	080879	2200	13.78	
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258.	080979	0600	13.92	
259.	080979	0800	13.96	
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261.	080979	1200	14.05	
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265.	080979	2000	14.18	
266.	080979	2200	14.25	
267.	081079	0000	14.28	
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269.	081079	0400	14.32	
270.	081079	0600	14.36	
271.	081079	0815	14.39	
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277.	081079	2000	14.50	
278.	081079	2200	14.55	
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291.	081279	0000	15.08	
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294.	081279	0600	15.22	
295.	081279	0800	15.28	
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303.	081379	0000	15.61
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307.	081379	1600	15.96
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309.	081479	0000	16.14
310.	081479	0400	16.25
311.	081479	0800	16.31
312.	081479	1200	16.38
313.	081479	1600	16.43
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317.	081579	1900	16.90
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319.	081679	0300	17.05
320.	081679	0700	17.18
321.	081679	1100	17.24
322.	081679	1520	17.28
323.	081679	1900	17.35
324.	081679	2300	17.49
325.	081779	0300	17.05
326.	081779	0700	17.58
327.	081779	1100	17.65
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329.	081779	1900	17.73
330.	081779	2300	17.82
331.	081879	0300	17.87
332.	081879	0700	17.94
333.	081879	1100	18.00
334.	081879	1500	18.03
335.	081879	1900	18.08
336.	081879	2300	18.19
337.	081979	1600	18.38
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339.	082079	0000	18.55
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344.	082079	2000	18.81
345.	082179	0000	18.88
346.	082179	0400	18.93
347.	082179	0800	19.00
348.	082179	1515	19.02
349.	082179	1900	19.08
350.	082279	0100	19.19
351.	082279	0700	19.24
352.	082279	1500	19.33
353.	082279	2100	19.42
354.	082379	0500	19.51
355.	082379	1300	19.59
356.	082379	1900	19.65
357.	082479	0500	19.80
358.	082479	1100	19.88

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360.	082579	0000	20.47				
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362.	082579	1600	20.27				
363.	082679	0000	20.34				
364.	082679	0600	20.50				
365.	082679	1400	20.59				
366.	082679	1925	20.69				
367.	083079	1925	21.33				
368.	083179	1720	21.85				
369.	090279	1025	22.08				
370.	090379	1050	22.16				
371.	090479	1305	22.08				
372.	090579	1120	23.08				
373.	090779	1710	21.60				
374.	090979	0850	21.36				
375.	091179	0845	21.12				
376.	091379	0830	21.15				
377.	091579	1145	21.55				
378.	091779	1450	21.80				
379.	091979	1220	22.25				
380.	092179	0900	22.55				
381.	092579	1320	22.28				
382.	092779	0855	21.98				
383.	092979	1510	21.61				
384.	100179	1025	21.33				
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387.	100779	1420	20.48				
388.	100979	1000	20.63				
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390.	101479	1800	21.81				
391.	101879	1425	22.22				
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393.	102279	1435	23.19				
394.	102479	1720	23.63				
395.	102679	0825	23.88				
396.	102879	1610	24.39				
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399.	110479	0830	25.82				
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403.	111679	0830	27.44				
404.	112679	0950	26.58				
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407.	121379	1420	16.81				
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414.	080579	1015	10.18				
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416.	080779	0822	08.69				
417.	080779	1850	09.57				
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420.	080779	2400	09.79
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422.	080879	0400	09.83
423.	080879	0600	09.89
424.	080879	0845	09.98
425.	080879	1010	10.15
426.	080879	1200	10.17
427.	080879	1400	10.18
428.	080879	1600	10.22
429.	080879	1800	10.28
430.	080879	2000	10.36
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432.	080879	2400	10.47
433.	080979	0200	10.50
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435.	080979	0600	10.56
436.	080979	0800	10.62
437.	080979	1000	10.71
438.	080979	1200	10.77
439.	080979	1400	10.81
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441.	080979	1800	10.89
442.	080979	2000	10.91
443.	080979	2200	10.95
444.	080979	2400	10.97
445.	081079	0400	10.98
446.	081079	0800	11.05
447.	081079	1200	11.14
448.	081079	1600	11.18
449.	081079	2000	11.31
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453.	081179	1200	11.61
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455.	081179	2000	11.82
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468.	081479	1800	13.67
469.	081479	2200	13.73
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471.	081579	1800	14.21
472.	081579	2400	14.37
473.	081679	0600	14.48
474.	081679	1800	14.78
475.	081779	0600	15.04
476.	081779	1800	15.28
477.	081879	0600	15.50
478.	081879	1800	15.66

479.	081979	0600	15.86
480.	081979	1800	15.94
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482.	082079	1800	16.37
483.	082179	0600	16.50
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485.	082179	1800	16.66
486.	082279	1800	17.06
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488.	082479	1915	17.68
489.	082579	1800	18.17
490.	082679	1900	18.72
491.	082779	1800	19.22
492.	082879	0940	18.46
493.	082979	1800	19.78
494.	083079	1900	19.84
495.	083179	1630	19.72
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497.	090379	1025	18.90
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503.	091379	0900	17.75
504.	091579	1100	18.47
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506.	091879	1125	18.85
507.	092179	0945	19.77
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512.	100379	1245	16.88
513.	100579	1715	16.53
514.	100779	1350	16.56
515.	100979	0930	17.15
516.	101179	1230	17.69
517.	101679	1815	19.25
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519.	102079	1350	20.31
520.	102279	1330	20.81
521.	102479	1710	21.14
522.	102679	0805	21.35
523.	102879	1545	21.76
524.	103079	0910	22.09
525.	110279	0920	23.43
526.	110479	0750	23.98
527.	110679	0755	24.42
528.	110879	0805	24.84
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544.	080779	1047	08.82
545.	080779	1218	08.87
546.	080779	1319	08.85
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555.	080879	0745	08.43
556.	080879	1320	08.48
557.	080879	2220	08.42
558.	080979	0230	08.39
559.	080979	0800	08.30
560.	080979	1835	08.35
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562.	081079	0700	08.27
563.	081079	1305	08.38
564.	081079	1920	08.82
565.	081079	2400	08.53
566.	081179	0615	08.87
567.	081179	1425	08.52
568.	081179	1915	08.59
569.	081179	2400	08.68
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571.	081279	1230	08.89
572.	081279	1920	09.07
573.	081279	2345	09.20
574.	081379	0630	09.34
575.	081379	1410	09.21
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577.	081379	2400	09.97
578.	081479	0615	10.10
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580.	081579	0730	10.02
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582.	081679	0720	11.31
583.	081679	1820	11.65
584.	081779	0635	11.91
585.	081779	1815	12.20
586.	081879	0650	12.41
587.	081879	1815	12.55
588.	081979	1020	12.76
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590.	082079	0650	12.87
591.	082079	1830	13.10
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593.	082179	1905	13.47
594.	082279	1740	13.73
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598.	082679	1720	16.34

594.	082779	1750	17.00				
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636.	110679	1110	21.23				
637.	110879	0925	21.02				
638.	111379	1315	17.58				
639.	111679	0935	16.19				
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675.	081079	1310	21.97
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691.	081579	0720	23.75
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718.	090479	1535	27.96

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726.	091979	1045	28.69					
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741.	102479	1820	29.68					
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744.	103079	1315	30.79					
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749.	111379	1320	32.09					
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765.	080779	1010	08.67					
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787.	081179	0045	08.22
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789.	081179	1320	08.15
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791.	081279	0045	08.48
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795.	081379	0015	09.18
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797.	081379	1340	10.77
798.	081379	2020	10.77
799.	081479	0030	10.45
800.	081479	0700	10.26
801.	081479	1925	11.58
802.	081579	0815	11.98
803.	081579	1830	12.21
804.	081679	0750	12.59
805.	081679	1900	12.71
806.	081779	0735	13.05
807.	081779	1900	13.05
808.	081879	0735	12.96
809.	081879	1910	13.10
810.	081979	0945	13.28
811.	081979	1920	13.30
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813.	082079	1910	14.41
814.	082179	0730	14.70
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817.	082379	1820	15.80
818.	082479	1935	16.81
819.	082579	1650	15.93
820.	082679	1840	17.59
821.	082779	1905	18.99
822.	082879	1855	18.85
823.	082979	1855	18.20
824.	083079	1850	17.25
825.	083179	1610	16.42
826.	090179	0950	14.79
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833.	091179	0750	12.96
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846.	100979	0905	15.51				
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856.	110179	1115	27.83				
857.	110279	0900	26.30				
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908.	081379	0700	12.12
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973.	111379	0950	24.52					
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1007.	081079	0045	29.93					
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1103.	080779	1205	21.55					
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1320.	080579		20.44
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1322.	080779	0757	19.05
1323.	080779	0859	19.00
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1325.	080779	1104	21.99
1326.	080779	1235	22.50
1327.	080779	1239	22.83
1328.	080779	1438	23.02
1329.	080779	1534	23.18
1330.	080779	1640	23.36
1331.	080779	1850	23.64
1332.	080779	2047	23.90
1333.	080779	2253	24.00
1334.	080879	0100	24.13
1335.	080879	0500	24.39
1336.	080879	0815	24.86
1337.	080879	1335	25.25
1338.	080879	2300	26.97
1339.	080979	0300	26.35
1340.	080979	0830	27.92
1341.	080979	1805	28.52
1342.	081079	0030	28.28
1343.	081079	0730	27.96
1344.	081079	1250	28.17
1345.	081079	1905	28.91
1346.	081179	0030	29.12
1347.	081179	0615	29.94
1348.	081179	1410	29.53
1349.	081179	1855	29.71
1350.	081279	0030	29.88
1351.	081279	0630	30.12
1352.	081279	1300	30.49
1353.	081279	1855	30.56
1354.	081279	2400	29.98
1355.	081379	0645	30.83
1356.	081379	1300	31.05
1357.	081379	2050	31.21
1358.	081479	0015	31.26
1359.	081479	0645	31.28
1360.	081479	1840	31.27
1361.	081579	0745	31.90
1362.	081579	1815	32.48
1363.	081679	0740	33.07
1364.	081679	1830	33.82
1365.	081779	0710	33.93
1366.	081779	1835	32.07
1367.	081879	0715	34.40
1368.	081879	1840	34.68
1369.	081979	0920	35.06
1370.	081979	1900	35.32
1371.	082079	0710	35.44
1372.	082079	1850	35.55
1373.	082179	0710	35.71
1374.	082179	1915	33.88
1375.	082279	1800	32.15
1376.	082379	1809	33.30
1377.	082479	1610	35.33
1378.	082579	1755	34.12

1379.	082679	1810	38.20				
1380.	082779	1815	37.29				
1381.	082879	1815	37.19				
1382.	082979	1815	38.20				
1383.	083079	1815	36.45				
1384.	083179	1550	32.58				
1385.	090179	0940	31.42				
1386.	090279	0935	30.56				
1387.	090379	0945	30.12				
1388.	090479	1425	31.15				
1389.	090579	1450	30.21				
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1392.	091179	0900	30.42				
1393.	091379	0810	33.30				
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1395.	091779	1510	35.96				
1396.	091979	1240	37.88				
1397.	092179	0825	37.71				
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1402.	100379	1055	27.49				
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1407.	101679	1855	30.98				
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1414.	103079	1000	34.53				
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1436.	080779	1000	11.24				
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1441.	080779	1500	11.61
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1447.	080879	0545	11.92
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1454.	081079	0100	12.54
1455.	081079	0800	12.54
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1457.	081079	1825	12.85
1458.	081179	0100	12.92
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1461.	081179	1825	13.30
1462.	081279	0045	13.52
1463.	081279	0700	13.68
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1465.	081279	1820	14.04
1466.	081379	0030	14.13
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1468.	081379	1335	14.78
1469.	081379	2015	15.05
1470.	081479	0030	15.19
1471.	081479	0700	15.22
1472.	081479	1915	15.62
1473.	081579	0825	15.95
1474.	081579	1835	16.22
1475.	081679	0800	16.59
1476.	081679	1905	16.92
1477.	081779	0740	17.06
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1479.	081879	0745	17.69
1480.	081879	1920	17.80
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1482.	081979	1930	18.17
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1485.	082179	0740	18.70
1486.	082179	1935	18.84
1487.	082279	1825	19.19
1488.	082379	1825	19.63
1489.	082479	1930	19.59
1490.	082579	1700	20.13
1491.	082679	1850	21.72
1492.	082779	1900	22.32
1493.	082879	1850	22.61
1494.	082979	1850	22.55
1495.	083079	1845	21.46
1496.	083179	1825	20.96
1497.	090179	1050	21.08
1498.	090279	1000	20.54

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1506.	091579	1100	20.00				
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1508.	091979	1115	22.08				
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1510.	092579	1350	18.51				
1511.	092779	0820	17.96				
1512.	092979	1030	17.52				
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1518.	101179	1220	19.07				
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1523.	102479	1700	23.24				
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1550.	080779	1405	10.87				
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1555.	080779	2315	11.09				
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1557.	080879	0545	10.97				
1558.	080879	0830	11.02				

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1560.	080879	2045	11.28
1561.	080979	0300	11.30
1562.	080979	0900	11.43
1563.	080979	1710	11.59
1564.	081079	0100	11.69
1565.	081079	0800	11.83
1566.	081079	1210	11.78
1567.	081079	1825	11.90
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1571.	081179	1820	12.32
1572.	081279	0045	12.54
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1582.	081479	1920	14.69
1583.	081579	0820	15.00
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1586.	081679	1910	15.98
1587.	081779	0745	16.37
1588.	081779	1910	16.54
1589.	081879	0745	16.76
1590.	081879	1920	16.90
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1593.	082079	0740	17.45
1594.	082079	1920	17.61
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1596.	082179	1935	17.90
1597.	082279	1825	18.27
1598.	082379	1825	18.66
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1600.	082579	1700	20.03
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1602.	082779	1900	21.56
1603.	082879	1850	21.15
1604.	082979	1850	20.97
1605.	083079	1845	20.47
1606.	083179	1625	19.71
1607.	090179	1055	19.88
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1609.	090379	1010	18.67
1610.	090479	1505	18.25
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1613.	090979	0940	16.21
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1635.	102879	1535	23.14				
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1637.	110279	0905	25.97				
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1657.	080779	1020	13.75				
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1660.	080779	1356	14.28				
1661.	080779	1500	14.37				
1662.	080779	1548	14.43				
1663.	080779	1653	14.51				
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1665.	080779	2100	14.78				
1666.	080779	2330	14.85				
1667.	080879	0145	14.98				
1668.	080879	0600	14.92				
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1672.	080979	0330	16.13				
1673.	080979	0900	16.41				
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1675.	081079	0115	16.60				
1676.	081079	0845	16.79				
1677.	081079	1235	16.80				
1678.	081079	1850	17.14				

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1680.	081179	0610	17.54
1681.	081179	1355	17.68
1682.	081179	1850	17.85
1683.	081279	0100	17.93
1684.	081279	0715	18.02
1685.	081279	1315	18.41
1686.	081279	1845	18.54
1687.	081379	0045	18.64
1688.	081379	0715	18.95
1689.	081379	1315	19.06
1690.	081379	2045	19.34
1691.	081479	0100	19.32
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1693.	081479	1855	19.65
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1697.	081679	1920	20.92
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1700.	081879	0800	21.51
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1707.	082179	2005	22.91
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1731.	092579	1300	24.52
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1746.	102879	1615	28.64				
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1771.	080779	1349	19.52				
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1774.	080779	1647	19.53				
1775.	080779	1858	19.52				
1776.	080779	2055	19.59				
1777.	080779	2345	19.60				
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1784.	080979	0915	19.78				
1785.	080979	1755	19.93				
1786.	081079	0115	20.00				
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1789.	081079	1855	20.24				
1790.	081179	0100	20.29				
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1800.	081379	1310	21.84
1801.	081379	2040	22.16
1802.	081479	0100	22.20
1803.	081479	0715	22.25
1804.	081479	1850	22.55
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1806.	081579	1815	23.12
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1809.	081779	0715	24.23
1810.	081779	1840	24.88
1811.	081879	0720	24.75
1812.	081879	1850	24.94
1813.	081979	0930	25.28
1814.	081979	1905	25.81
1815.	082079	0715	25.63
1816.	082079	1855	25.75
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1818.	082179	2010	26.06
1819.	082279	1840	26.11
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1822.	082579	1740	27.91
1823.	082679	1810	28.62
1824.	082779	1820	29.24
1825.	082879	1820	29.20
1826.	082979	1820	29.02
1827.	083079	1820	28.58
1828.	083179	1555	27.86
1829.	090179	1105	27.25
1830.	090279	1010	26.71
1831.	090379	1040	26.29
1832.	090479	1430	25.67
1833.	090579	1355	25.44
1834.	090779	1655	24.86
1835.	090979	0835	24.54
1836.	091179	0855	24.84
1837.	091379	0940	25.54
1838.	091579	1155	27.02
1839.	091779	1500	27.82
1840.	091979	1230	29.01
1841.	092179	0840	29.01
1842.	092579	1305	25.51
1843.	092779	1010	25.14
1844.	092979	1520	25.10
1845.	100179	1435	24.77
1846.	100379	1315	24.10
1847.	100579	1740	23.79
1848.	100779	1430	24.33
1849.	100979	1010	24.88
1850.	101179	1310	25.58
1851.	101679	1850	27.34
1852.	101879	1845	28.38
1853.	102079	1520	29.12
1854.	102279	1445	29.73
1855.	102479	1730	30.01
1856.	102679	0835	30.35
1857.	102879	1620	31.01
1858.	103079	0955	31.48

1859.	110279	1015	32.04				
1860.	110479	0845	33.31				
1861.	110679	0905	34.08				
1862.	110879	0840	34.55				
1863.	111379	1110	33.29				
1864.	111679	0840	32.09				
1865.	112679	0910	30.15				
1866.	112979	1025	29.08				
1867.	121079	1245	21.52				
1868.	121379	1435	21.96				
1869.	99						
1870.	IH-4	15.97	74.23	550408N	271475E	080779	0830
1871.	080179		15.67				
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1873.	080379		15.94				
1874.	080479		15.96				
1875.	080579		16.00				
1876.	080679	1010	15.96				
1877.	080779	0745	15.97				
1878.	080779	0900	15.99				
1879.	080779	0950	15.96				
1880.	080779	1050	15.98				
1881.	080779	1209	15.96				
1882.	080779	1300	15.95				
1883.	080779	1400	15.95				
1884.	080779	1850	15.98				
1885.	080779	1550	15.95				
1886.	080779	1820	16.10				
1887.	080779	2120	15.98				
1888.	080779	2330	16.03				
1889.	080879	0145	16.01				
1890.	080879	0505	16.02				
1891.	080879	0900	16.06				
1892.	080879	1410	16.09				
1893.	080879	2150	16.18				
1894.	080979	0330	16.27				
1895.	080979	0900	16.21				
1896.	080979	1720	16.32				
1897.	081079	0100	16.42				
1898.	081079	0800	16.50				
1899.	081079	1415	16.56				
1900.	081079	1835	16.62				
1901.	081179	0100	16.68				
1902.	081179	0645	16.80				
1903.	081179	1345	16.86				
1904.	081179	1835	16.94				
1905.	081279	0045	17.03				
1906.	081279	0700	17.13				
1907.	081279	1355	17.39				
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1909.	081379	0045	17.54				
1910.	081379	0715	17.69				
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1912.	081379	2035	17.92				
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1914.	081479	0700	18.02				
1915.	081479	1910	18.17				
1916.	081579	0830	18.43				
1917.	081979	1835	18.62				
1918.	081579	0810	18.89				

1919.	081679	1915	19.12
1920.	081779	0750	19.40
1921.	081779	1420	19.60
1922.	081879	0755	19.85
1923.	081879	1930	20.02
1924.	081979	1005	20.33
1925.	081979	1935	20.51
1926.	082079	0745	20.73
1927.	082079	1930	20.93
1928.	082179	0750	21.19
1929.	082179	1945	21.37
1930.	082279	1830	21.75
1931.	082379	1830	22.13
1932.	082479	1005	21.81
1933.	082579	1705	22.18
1934.	082679	1835	22.61
1935.	082779	1845	23.66
1936.	082879	1845	24.07
1937.	082979	1840	23.81
1938.	083079	1840	24.18
1939.	083179	1645	24.47
1940.	090179	1100	25.42
1941.	090279	1005	25.63
1942.	090379	1025	25.88
1943.	090479	1500	26.08
1944.	090579	1410	26.08
1945.	090779	1735	26.35
1946.	090879	0925	26.49
1947.	091179	0820	26.62
1948.	091379	0855	26.77
1949.	091579	1115	26.95
1950.	091779	1410	27.22
1951.	091979	1130	27.49
1952.	092179	0935	27.78
1953.	092579	1220	28.18
1954.	092779	0750	28.25
1955.	092979	1445	28.34
1956.	100179	1350	28.36
1957.	100379	1250	28.31
1958.	100579	1720	28.26
1959.	100779	1355	28.22
1960.	100979	0935	28.22
1961.	101179	1235	28.25
1962.	101679	1820	28.50
1963.	101879	1340	28.69
1964.	102079	1400	28.97
1965.	102279	1335	29.28
1966.	102879	1710	29.61
1967.	102679	0810	29.84
1968.	102879	1550	30.38
1969.	103079	0915	30.60
1970.	110279	0925	30.96
1971.	110479	0755	31.35
1972.	110679	0800	31.63
1973.	110879	0810	32.19
1974.	111379	1020	33.05
1975.	111679	0745	33.26
1976.	112679	0950	33.56
1977.	112979	0935	33.57
1978.	121079	1110	32.27

1979.	121379	1350	51.50				
1980.	99						
1981.	OM79-1L2		74.56	5548537N	2730942E	080779	0830
1982.	100579	1340	16.25				
1983.	100779	1510	16.63				
1984.	100979	1040	17.06				
1985.	101179	1330	17.65				
1986.	101679	1905	19.54				
1987.	101879	1520	20.28				
1988.	102079	1600	21.05				
1989.	102279	1535	21.63				
1990.	102479	1755	21.96				
1991.	102679	0850	22.25				
1992.	102879	1685	22.88				
1993.	103079	1250	23.60				
1994.	110279	1050	24.46				
1995.	110479	0915	25.21				
1996.	110679	0935	25.80				
1997.	110879	0905	26.18				
1998.	111379	1140	26.97				
1999.	111679	0910	23.67				
2000.	112679	1710	21.26				
2001.	112979	1055	20.36				
2002.	121079	1625	15.04				
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2004.	OM-4	7.5	77.9	551830N	2764485E	080779	0830
2005.	080679		7.5				
2006.	082079		8.6				
2007.	083179		9.4				
2008.	091479		9.9				
2009.	092879		10.0				
2010.	101279		10.2				
2011.	102679		10.5				
2012.	110979		10.4				
2013.	112679		10.9				
2014.	120779		11.4				
2015.	99						
2016.	OM-4A	9.2	78.0	551830N	2764485E	080779	0830
2017.	080679		9.2				
2018.	082079		10.2				
2019.	083179		11.0				
2020.	091479		11.6				
2021.	092879		11.3				
2022.	101279		12.0				
2023.	102679		12.6				
2024.	110979		13.0				
2025.	112679		12.6				
2026.	120779		10.7				
2027.	99						
2028.	OM-5	82.3	157.3	551200N	2742006E	080779	0830
2029.	080679		82.3				
2030.	082079		82.8				
2031.	083179		83.1				
2032.	091479		83.6				
2033.	092879		83.9				
2034.	101279		84.2				
2035.	102679		84.6				
2036.	110979		84.9				
2037.	112679		85.0				
2038.	120779		85.4				

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2040.	0N=7	85.6	158.5	548515N	276280E	080779	0830
2041.	080679		85.6				
2042.	082079		86.8				
2043.	083179		87.6				
2044.	091479		88.0				
2045.	092879		88.0				
2046.	101279		89.0				
2047.	102679		89.7				
2048.	110979		89.7				
2049.	112679		89.5				
2050.	120779		89.5				
2051.	99						
2052.	0N=10	77.9	167.0	553070N	277440E	080779	0830
2053.	080679		77.9				
2054.	082079		78.6				
2055.	083179		79.1				
2056.	091479		79.6				
2057.	092879		79.9				
2058.	101279		80.2				
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2060.	110979		80.7				
2061.	112679		80.8				
2062.	120779		81.7				
2063.	99						
2064.	0N=29A	97.8	162.7	550250N	276540E	080779	0830
2065.	080679		97.8				
2066.	082079		98.8				
2067.	083179		98.8				
2068.	091479		100.2				
2069.	092879		99.4				
2070.	101279		100.3				
2071.	102679		103.5				
2072.	110979		103.5				
2073.	112679		101.8				
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2075.	99						
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2077.	080679		17.7				
2078.	082079		18.6				
2079.	083179		19.3				
2080.	091479		19.9				
2081.	092879		20.5				
2082.	101279		21.2				
2083.	102679		22.3				
2084.	110979		22.8				
2085.	112679		22.3				
2086.	120779		22.6				
2087.	99						
2088.	0N=202	116.9	194.0	548770N	279880E	080779	0830
2089.	080679		116.9				
2090.	082079		117.2				
2091.	083179		117.5				
2092.	091479		117.9				
2093.	092879		117.9				
2094.	101279		118.0				
2095.	102679		118.5				
2096.	110979		118.5				
2097.	112679		118.5				
2098.	120779		118.2				

2094.	99						
2100.	UH-209A	110.0	198.2	5491805N	27455U0E	U8U779	U8S0
2101.	080679		110.0				
2102.	082079		109.9				
2103.	083179		109.7				
2104.	091479		110.0				
2105.	092879		109.9				
2106.	101279		109.8				
2107.	102679		109.9				
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2109.	112679		109.9				
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2112.	MFLL #3	39.89	100.52	5550770N	27:437E	U8U779	U8S0 WI MF
2113.	080679	1630	40.30			0	
2114.	080779	0815	39.89			0	
2115.	080779	1000	49.54			6100	
2116.	080779	1200	50.31			6100	
2117.	080779	1400	50.60			6100	
2118.	080779	1600	50.88			6100	
2119.	080779	1800	51.00			6100	
2120.	080779	2000	51.15			6100	
2121.	080779	2200	51.32			6000	
2122.	080779	2400	51.53			5950	
2123.	080879	0200	51.67			6000	
2124.	080879	0400	51.78			6000	
2125.	080879	0600	51.86			6000	
2126.	080879	0800	51.97			6000	68
2127.	080879	1000	52.03			6000	
2128.	080879	1200	52.08			6000	65
2129.	080879	1400	54.08			7300	
2130.	080879	1600	54.30			7300	
2131.	080879	1800	55.34			8100	
2132.	080879	2000	56.21			9400	
2133.	080879	2200	56.88			9300	
2134.	080879	2200	56.88			9300	
2135.	080979	0200	57.34			9300	
2136.	080979	0400	57.48			9300	61
2137.	080979	0700	57.66			9100	
2138.	080979	0800	59.00			10200	61
2139.	080979	1000	59.24			10100	
2140.	080979	1200	59.41			10100	64
2141.	080979	1400	59.68			10100	
2142.	080979	1600	59.84			10100	65
2143.	080979	1800	55.01			5450	
2144.	080979	2000	56.17			9100	64
2145.	080979	2200	56.43			8000	
2146.	080979	2400	57.33			8000	
2147.	081079	0200	57.35			8000	
2148.	081079	0400	57.37			8000	
2149.	081079	0600	57.40			8000	
2150.	081079	0800	57.44			8000	61
2151.	081079	1000	57.46			8000	
2152.	081079	1200	57.49			8000	
2153.	081079	1400	57.52			6800	62
2154.	081079	1600	59.42			9400	61
2155.	081079	1800	60.03			9900	
2156.	081079	2000	61.10			9800	60
2157.	081079	2200	60.73			9500	
2158.	081079	2400	60.50			9400	61

2159.	081179	0200	60.64	9400	
2160.	081179	0400	60.71	9400	
2161.	081179	0600	60.77	9850	60
2162.	081179	0800	60.87	9850	
2163.	081179	1000	61.05	9450	
2164.	081179	1200	61.10	9450	60
2165.	081179	1400	61.20	9450	
2166.	081179	1600	61.25	9450	60
2167.	081179	1800	61.35	9450	
2168.	081179	2000	61.70	9850	60
2169.	081179	2400	61.81	9850	61
2170.	081279	0400	61.89	9850	
2171.	081279	0800	62.14	9850	60
2172.	081279	1200	62.21	9850	60
2173.	081279	1600	62.35	9850	60
2174.	081279	2000	62.53	9700	60
2175.	081279	2400	62.85	9700	60
2176.	081379	0400	62.90	9700	60
2177.	081379	1200	63.06	9700	60
2178.	081379	1800	63.36	9700	60
2179.	081379	2400	63.48	9650	60
2180.	081479	0700	64.15	9650	60
2181.	081479	1800	64.56	9500	60
2182.	081579	0600	66.13	9400	60
2183.	081579	1800	66.44	9400	61
2184.	081679	0600	67.69	9700	60
2185.	081679	1800	68.07	9700	61
2186.	081779	0600	66.70	8400	61
2187.	081779	1800	66.85	8300	61
2188.	081879	0600	68.91	8300	61
2189.	081879	1800	68.09	8200	62
2190.	081979	0600	68.80	8400	62
2191.	081979	1800	68.91	8400	62
2192.	082079	0600	68.93	8400	62
2193.	082079	1500	68.86	8400	63
2194.	082179	1300	69.88	8300	63
2195.	082179	1800	69.89	8300	64
2196.	082279	0600	70.04	8300	
2197.	082279	1800	70.08	8300	64
2198.	082379	0600	70.15	8300	
2199.	082379	1800	70.47	8200	65
2200.	082479	0600	70.55	8200	
2201.	082479	1800	71.19	8100	65
2202.	082579	1200	69.66	8100	
2203.	082579	1800	67.60	8500	66
2204.	082679	0600	68.02	8500	
2205.	082679	1800	68.53	8400	66
2206.	082779	1800	68.95	8400	66
2207.	082879	1800	69.36	8300	67
2208.	082979	1800	69.83	8300	67
2209.	083079	1800	68.97	8400	68
2210.	083179	1600	68.39	8400	68
2211.	090179	1800	68.07	8200	
2212.	090279	1800	67.81	8300	
2213.	090379	1800	67.51	8500	
2214.	090879	1800	67.12	8700	
2215.	090579	1800	66.14	8200	
2216.	090779	1700	65.30	8300	67
2217.	090979	0900	64.90	8300	67
2218.	091179	0800	65.00	8300	67

2219.	091379	0900	65.70			8200	68
2220.	091579	1100	66.68			8100	68
2221.	091779	1435	67.65			8000	68
2222.	091979	1150	68.28			8000	69
2223.	092179	0915	66.50			8200	68
2224.	092379	1200	66.68			8100	
2225.	092579	1105	65.18			8300	71
2226.	092779	0740	64.65			8500	70
2227.	092979	1530	64.53			8400	71
2228.	100179	1255	64.24			8400	71
2229.	100379	0935	63.60			7900	71
2230.	100579	1825	63.63			8200	71
2231.	100779	1205	64.12			8200	71
2232.	100979	0850	64.90			8200	71
2233.	101179	1155	65.75			8200	71
2234.	101379	1600	65.84			8200	
2235.	101679	2010	68.48			8000	70
2236.	101879	1410	69.67			7900	70
2237.	102079	1440	70.33			8000	70
2238.	102279	1355	7[illegible].11			7900	70
2239.	102479	1435	70.41			7900	70
2240.	102679	1215	70.83			7800	70
2241.	102879	1555	71.42			7700	70
2242.	103079	0930	72.46			7700	70
2243.	110279	0940	74.13			7600	69
2244.	110479	0810	74.88			7500	69
2245.	110679	0815	75.60			7400	68
2246.	110879	1030	75.94			7250	69
2247.	111079	1200	75.78			7400	
2248.	111379	1035	74.23			7400	68
2249.	111679	0805	73.10			7300	68
2250.	111979	1200	74.13			7600	
2251.	112279	1200	73.00			7600	
2252.	112679	1735	71.96			7300	68
2253.	112979	0950	71.55			7700	67
2254.	120279	1200	70.00			7500	
2255.	120579	1200	67.60			7650	
2256.	120879	1200	65.66			7550	
2257.	121079	1145	65.72			8200	67
2258.	121379	1410	66.10			8200	66
2259.	121679	1200	67.78			8000	
2260.	121879	2300	68.25			7600	
2261.	99						
2262.	WELL #5	40.34	100.57	553105N	272921E	080779	0830 MT MF
2263.	080679	1320	40.90			0	
2264.	080779	0730	40.34			0	
2265.	080779	1200	46.01			6400	
2266.	080779	1400	46.62			6300	
2267.	080779	1600	46.94			6300	
2268.	080779	1800	47.17			6300	
2269.	080779	2000	47.40			6200	
2270.	080779	2200	47.57			6200	
2271.	080779	2400	47.70			6200	
2272.	080879	0200	47.83			6200	
2273.	080879	0400	47.96			6200	
2274.	080879	0600	48.01			6200	
2275.	080879	0800	48.07			6200	65
2276.	080879	1000	48.10			6200	
2277.	080879	1200	48.15			6200	
2278.	080879	1400	49.48			7600	

2279.	080879	1600	50.26	8700	
2280.	080879	1800	50.38	8700	
2281.	080879	2000	50.52	8700	
2282.	080879	2200	51.54	9800	
2283.	080879	2400	51.78	9800	
2284.	080979	0200	51.98	9800	
2285.	080979	0400	52.13	9800	62
2286.	080979	0600	52.25	9800	
2287.	080979	0800	52.58	10100	62
2288.	080979	1000	52.71	10100	
2289.	080979	1200	52.79	10100	65
2290.	080979	1400	52.90	10100	
2291.	080979	1600	53.00	10100	65
2292.	080979	1800	53.30	10000	
2293.	080979	2000	53.37	10000	64
2294.	080979	2200	52.58	9800	
2295.	080979	2400	52.34	9300	
2296.	081079	0200	88.81	8600	
2297.	081079	0400	52.11	9300	
2298.	081079	0600	52.30	9300	
2299.	081079	0800	52.36	9600	
2300.	081079	1000	52.43	9600	
2301.	081079	1200	52.49	9300	
2302.	081079	1400	52.58	9300	64
2303.	081079	1600	53.20	10000	64
2304.	081079	1800	53.30	10000	
2305.	081079	2000	53.41	9950	63
2306.	081079	2200	53.52	9950	
2307.	081079	2400	53.62	9950	62
2308.	081179	0200	53.67	10100	
2309.	081179	0400	53.70	9950	
2310.	081179	0600	53.78	9950	63
2311.	081179	0800	53.84	9900	
2312.	081179	1000	53.90	9800	
2313.	081179	1200	53.94	9800	63
2314.	081179	1400	54.00	9800	
2315.	081179	1600	54.05	9800	64
2316.	081179	1800	54.12	9800	
2317.	081179	2000	54.22	9800	64
2318.	081179	2400	54.32	10000	64
2319.	081279	0400	54.44	10000	
2320.	081279	0800	54.55	10000	64
2321.	081279	1200	54.70	10000	64
2322.	081279	1600	54.82	9800	64
2323.	081279	2000	53.74	10000	64
2324.	081279	2400	53.55	8500	64
2325.	081379	0600	55.15	9900	64
2326.	081379	1200	55.39	9850	64
2327.	081379	1800	55.03	9600	64
2328.	081379	2400	55.33	9600	64
2329.	081479	0600	55.55	9400	64
2330.	081479	1800	55.47	9100	64
2331.	081579	0600	56.03	9100	64
2332.	081579	1800	56.88	9800	64
2333.	081679	0600	57.39	9800	64
2334.	081679	1800	57.85	9800	64
2335.	081779	0600	58.26	9700	64
2336.	081779	1700	58.42	9700	64
2337.	081879	0600	58.70	9700	64
2338.	081879	1800	59.15	9700	64

2339.	081979	0600	59.32	9600	64
2340.	081979	1800	59.73	9600	64
2341.	082079	0600	59.74	9600	64
2342.	082079	1800	59.86	9600	64
2343.	082179	0600	60.16	9400	64
2344.	082179	1800	61.13	6100	64
2345.	082279	0600	60.84	5000	
2346.	082279	1800	55.25	5500	65
2347.	082379	0600	55.21	5500	
2348.	082379	1800	57.40	8000	64
2349.	082479	0600	59.88	9600	
2350.	082479	1800	59.75	8400	64
2351.	082579	0600	60.91	8600	
2352.	082579	1800	61.44	8600	65
2353.	082679	0600	62.25	8700	
2354.	082679	1800	62.77	8700	65
2355.	082779	1800	60.88	5400	65
2356.	082879	1800	61.39	8800	66
2357.	082979	1800	62.28	8400	66
2358.	083079	1800	53.92	7600	66
2359.	083179	1400	55.39	4600	67
2360.	090179	0900	58.89	4500	68
2361.	090279	0900	53.10	4600	67
2362.	090379	0900	52.69	5000	67
2363.	090479	1200	52.07	4900	67
2364.	090579	1500	52.25	8700	67
2365.	090779	1700	55.66	9400	66
2366.	090979	0800	56.38	9400	66
2367.	091179	0900	53.08	5300	68
2368.	091279	1600	47.18	0	
2369.	091379	0800	57.49	9300	68
2370.	091579	1300	57.88	7700	69
2371.	091779	1500	60.14	8900	68
2372.	091979	1245	61.99	8700	68
2373.	092179	0830	61.68	8700	68
2374.	092379	1200	59.36	8400	
2375.	092579	1020	57.21	8700	70
2376.	092779	0730	56.28	9400	70
2377.	092979	1300	56.84	9300	70
2378.	100179	1240	56.36	8800	70
2379.	100379	0920	49.54	4500	72
2380.	100579	1810	53.24	7600	70
2381.	100779	1135	54.63	7600	70
2382.	100979	0835	55.62	7650	70
2383.	101179	1140	56.60	7500	70
2384.	101379	1200	58.20	9100	
2385.	101679	2045	53.48	4100	70
2386.	101879	1510	61.28	6600	70
2387.	102079	1540	62.27	8700	69
2388.	102279	1500	63.10	8500	69
2389.	102479	1745	63.46	8500	69
2390.	102679	1230	58.59	3600	69
2391.	102879	1625	60.20	5700	69
2392.	103079	1005	56.73	3400	70
2393.	110279	1020	61.64	7650	69
2394.	110479	0855	66.62	8100	68
2395.	110679	0915	65.75	7900	68
2396.	110879	1050	67.41	7800	69
2397.	111079	1200	67.58	7950	
2398.	111379	1120	66.62	8200	69

2399.	111679	0859	64.90			8300	69	
2400.	111979	1200	64.45			8400		
2401.	112279	1200	63.87			8000		
2402.	112679	1815	60.67			6900	68	
2403.	112979	1040	59.48			6900	68	
2404.	120279	1200	57.03			6800		
2405.	120579	1200	53.51			6950		
2406.	120879	1200	53.33			7400		
2407.	121079	1555	52.65			7400	67	
2408.	121379	1445	55.35			8450	66	
2409.	121679	1200	55.90			7600		
2410.	121879	2300	57.64			7400		
2411.	99							
2412.	MISS RIVER		61.10	553092N	2743641	080779	0830 WI WF	
2413.	080179			55.75				
2414.	080279			57.0				
2415.	080379			57.7				
2416.	080479			59.1				
2417.	080579	1340		60.15				
2418.	080679	1100		61.10				
2419.	080679	1430		61.20				
2420.	080679	1700		61.30				
2421.	080779	0740		61.70				
2422.	080779	0935		61.70				
2423.	080779	1100		61.80				
2424.	080779	1200		61.80				
2425.	080779	1330		61.80				
2426.	080779	1530		61.80				
2427.	080779	1600		61.80				
2428.	080779	1700		61.90				
2429.	080779	1800		61.90				
2430.	080779	1900		61.90				
2431.	080879	0500		62.00				
2432.	080879	0900		62.00			83	
2433.	080979	1225		62.10				
2434.	080979	0400		62.20			81	
2435.	080979	0930		62.20			81	
2436.	080979	1325		62.10			83	
2437.	080979	1625		62.20			84	
2438.	080979	1900		62.20			84	
2439.	081079	0930		62.20			83	
2440.	081079	1225		62.10			84	
2441.	081079	1515		62.00			84	
2442.	081079	1720		61.90			84	
2443.	081079	1955		61.90			83	
2444.	081179	0130		61.90			83	
2445.	081179	0700		61.70			83	
2446.	081179	1150		61.60			84	
2447.	081179	1445		61.50			85	
2448.	081179	1700		61.40			84	
2449.	081179	2005		61.30			84	
2450.	081279	0100		61.25			84	
2451.	081279	0730		61.10			84	
2452.	081279	1300		60.90			85	
2453.	081279	1630		60.70			85	
2454.	081279	1950		60.60			84	
2455.	081379	0100		60.40			84	
2456.	081379	0645		60.20			84	
2457.	081379	1250		59.90			84	
2458.	081379	2010		59.70			83	

2459.	081379	2400	59.50	83
2460.	081479	0650	59.30	83
2461.	081479	1845	59.00	84
2462.	081579	0740	58.50	84
2463.	081579	1845	58.30	85
2464.	081679	0825	57.80	83
2465.	081679	1430	57.40	84
2466.	081779	0610	57.10	84
2467.	081779	1830	56.80	85
2468.	081879	0710	56.40	84
2469.	081879	1835	56.25	85
2470.	081979	1010	56.15	85
2471.	081979	1800	56.10	86
2472.	082079	0700	56.05	85
2473.	082079	2000	55.95	85
2474.	082179	0800	55.80	84
2475.	082179	2020	55.60	82
2476.	082279	1755	55.20	83
2477.	082379	1755	54.60	84
2478.	082479	1800	53.50	82
2479.	082579	1800	52.30	81
2480.	082679	1800	51.30	82
2481.	082779	1805	50.90	82
2482.	082879	1810	51.30	83
2483.	082979	1805	52.20	85
2484.	083079	1755	53.50	83
2485.	083179	1540	54.50	85
2486.	90179	0930	55.40	
2487.	090279	0930	57.30	
2488.	090379	0845	57.20	
2489.	090479	1200	57.90	
2490.	090579	1510	58.90	
2491.	090779	1645	59.70	88
2492.	090979	0820	59.60	78
2493.	091179	0920	58.65	80
2494.	091379	0800	57.00	78
2495.	091579	1210	55.00	80
2496.	091779	1505	53.35	77
2497.	091979	1310	52.30	76
2498.	092179	0820	54.30	74
2499.	092579	1045	60.30	74
2500.	092779	1020	60.10	73
2501.	092979	1535	60.10	75
2502.	100179	1445	60.85	77
2503.	100379	1100	61.30	73
2504.	100579	1330	60.90	73
2505.	100779	1445	59.70	71
2506.	100979	1030	59.00	70
2507.	101179	1325	57.60	70
2508.	101679	1900	53.90	66
2509.	101879	1500	53.00	70
2510.	102079	1550	52.50	69
2511.	102279	1510	52.80	69
2512.	102479	1740	52.90	66
2513.	102679	1250	52.25	68
2514.	102879	1635	50.20	68
2515.	103079	0830	49.20	66
2516.	110179	0830	48.10	69
2517.	110279	1040		68
2518.	110479	0900		63

2519.	110579	0800	47.40				
2520.	110679	0920	47.80			61	
2521.	110879	0855	47.80			60	
2522.	111379	1130	53.90			58	
2523.	111579	1430	55.20				
2524.	111679	0855	55.80			53	
2525.	112679	1820	58.50			55	
2526.	112879	1300	58.60				
2527.	112979	1705	58.95			53	
2528.	113079	1330	59.80				
2529.	121079	1600	66.20			48	
2530.	121179	0915	65.80				
2531.	121379	1450	64.10			49	
2532.	121479	1115	63.10				
2533.	99						
2534.	MAM LAKE		549353N	273450E	080779	0830	
2535.	080579	1310	59.55				
2536.	080679	1350	61.0				
2537.	080779	0730	61.60				
2538.	080779	0942	61.60				
2539.	080779	1038	61.60				
2540.	080779	1205	61.60				
2541.	080779	1408	61.65				
2542.	080779	1616	61.76				
2543.	080779	1809	61.75				
2544.	080879	0430	61.90				
2545.	080879	0745	62.00				
2546.	080879	1310	62.00				
2547.	080879	2255	62.10				
2548.	080979	0230	62.10				
2549.	080979	0800	62.10				
2550.	080979	1305	62.10				
2551.	080979	1840	62.10				
2552.	081079	0005	62.10				
2553.	081079	0645	62.05				
2554.	081079	1315	62.00				
2555.	081079	1500	61.95				
2556.	081079	1930	61.90				
2557.	081079	2400	61.80				
2558.	081179	0600	61.80				
2559.	081179	1435	61.60				
2560.	081179	1925	61.50				
2561.	081279	0015	61.40				
2562.	081279	0615	61.10				
2563.	081279	1225	61.00				
2564.	081279	1520	60.90				
2565.	081279	1930	60.80				
2566.	081279	2345	60.80				
2567.	081379	0615	60.50				
2568.	081379	1020	60.30				
2569.	081379	1950	60.10				
2570.	081379	2345	60.00				
2571.	081479	0615	59.80				
2572.	081479	1810	59.60				
2573.	081579	0717	59.30				
2574.	081579	1750	59.50				
2575.	081679	0700	58.80				
2576.	081679	1810	58.50				
2577.	081779	0650	58.30				
2578.	081779	1810	58.25				

2579.	081879	0640	58.15
2580.	081879	1810	58.10
2581.	081979	1050	58.05
2582.	081979	1830	58.00
2583.	082079	0655	58.00
2584.	082079	1840	58.00
2585.	082179	0655	58.00
2586.	082179	1855	58.00
2587.	082279	1730	58.00
2588.	082379	1735	58.00
2589.	082479	1710	58.00
2590.	082579	1820	58.00
2591.	082679	1710	58.00
2592.	082779	1735	57.95
2593.	082879	1740	57.95
2594.	082979	1740	57.95
2595.	083079	1730	57.90
2596.	083179	1520	57.85
2597.	090179	0900	57.90
2598.	090279	0900	58.00
2599.	090379	0820	58.00
2600.	090479	1530	58.10
2601.	090579	1445	58.20
2602.	090779	1545	59.70
2603.	090979	0745	59.70
2604.	091179	1000	59.00
2605.	091379	0720	58.20
2606.	091579	1245	57.90
2607.	091779	1555	57.90
2608.	091979	1005	57.90
2609.	092179	0750	58.60
2610.	092579	0905	60.15
2611.	092779	1115	60.20
2612.	092979	1600	60.10
2613.	100179	1525	60.90
2614.	100379	1125	61.25
2615.	100579	1400	60.90
2616.	100779	1540	59.85
2617.	100979	1120	59.00
2618.	101179	1400	58.30
2619.	101679	1940	58.20
2620.	101879	1610	58.15
2621.	102079	1630	58.15
2622.	102279	1610	58.15
2623.	102479	1825	58.15
2624.	102679	1545	58.15
2625.	102879	1710	58.10
2626.	103079	1320	58.35
2627.	110279	1115	58.50
2628.	110479	0940	58.35
2629.	110679	1120	58.45
2630.	110879	0935	58.45
2631.	111379	1320	58.50
2632.	111679	0940	58.50
2633.	112679	1725	59.25
2634.	112979	1130	59.20
2635.	121079	1615	60.20
2636.	121379	1535	64.10
2637.	99		
2638.	GIN LANE	5553294	2757971 0R0779 0R30

2639.	080579	1300	61.0
2640.	080679	1000	61.0
2641.	080779	0722	61.00
2642.	080779	1142	61.05
2643.	080779	1624	61.10
2644.	080779	1815	61.15
2645.	080879	0400	61.40
2646.	080879	0730	61.45
2647.	080879	1300	61.60
2648.	080879	1900	61.70
2649.	080979	0200	61.80
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2651.	080979	1315	61.90
2652.	080979	1850	62.00
2653.	081079	0010	62.10
2654.	081079	0630	62.00
2655.	081079	1320	62.00
2656.	081079	1510	61.95
2657.	081079	1940	61.90
2658.	081079	2400	61.80
2659.	081179	0600	61.80
2660.	081179	1040	61.60
2661.	081179	1930	61.50
2662.	081179	2400	61.45
2663.	081279	0615	61.30
2664.	081279	1215	61.25
2665.	081279	1525	61.20
2666.	081279	1940	61.10
2667.	081279	2345	61.00
2668.	081379	0615	60.90
2669.	081379	1430	60.80
2670.	081379	1945	60.70
2671.	081379	2345	60.60
2672.	081479	0600	60.50
2673.	081479	1800	60.40
2674.	081579	0711	60.30
2675.	081579	1755	60.30
2676.	081679	0655	60.10
2677.	081679	1800	60.10
2678.	081779	0620	60.10
2679.	081779	1800	60.05
2680.	081879	0630	60.05
2681.	081879	1800	60.05
2682.	081979	1040	60.00
2683.	081979	1950	60.00
2684.	082079	0810	60.00
2685.	082079	1945	60.00
2686.	082179	0635	60.00
2687.	082179	1850	59.95
2688.	082279	1725	59.85
2689.	082379	1730	59.95
2690.	082479	1705	59.95
2691.	082579	1825	59.95
2692.	082679	1705	59.90
2693.	082779	1730	59.90
2694.	082879	1725	59.90
2695.	082979	1735	59.80
2696.	083079	1725	59.80
2697.	083179	1515	59.80
2698.	090179	0900	59.80

2699.	090279	0850	59.90
2700.	090379	0810	59.90
2701.	090479	1200	59.90
2702.	090579	1525	59.90
2703.	090779	1535	59.80
2704.	090979	0735	59.80
2705.	091179	1005	59.70
2706.	091379	0715	59.70
2707.	091579	1255	59.70
2708.	091779	1640	59.60
2709.	091979	1340	59.60
2710.	092179	1015	61.10
2711.	092579	0850	60.75
2712.	092779	1125	60.80
2713.	092979	1610	60.90
2714.	100179	1530	60.70
2715.	100379	1130	60.80
2716.	100579	1405	60.90
2717.	100779	1545	60.80
2718.	100979	1125	60.75
2719.	101179	1405	60.70
2720.	101679	1945	60.55
2721.	101879	1620	60.50
2722.	102079	1640	60.50
2723.	102279	1615	60.45
2724.	102479	1830	60.40
2725.	102679	1350	60.35
2726.	102879	1710	60.35
2727.	103079	1325	60.50
2728.	110279	1120	60.60
2729.	110479	0950	60.55
2730.	110679	1125	60.50
2731.	110879	0940	60.50
2732.	111379	1325	60.55
2733.	111679	0950	60.55
2734.	112679	1755	61.40
2735.	112979	1135	61.35
2736.	121079	1630	64.30
2737.	121379	1540	64.35
2738.	99		

END DATA, ERRORS: NONE. TIME: 12.495 SEC. IMAGE COUNT: 2738

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@XQT PUMP*TEST.DUII

@ADD,P PUMP*DATA.
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2.4C-49

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
F-1	78.90	21.03	552930N 1273590E	080779	0850

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080179	0000	-8670.	22.21	56.69	1.18
080279	0000	-7230.	22.21	56.69	1.18
080379	0000	-5790.	22.11	56.79	1.08
080479	0000	-4350.	21.92	56.98	.89
080579	0000	-2910.	21.80	57.10	.77
080679	1025	-1325.	21.43	57.47	.40
080779	0818	-12.	21.03	57.87	.00
080779	0852	22.	21.03	57.87	.00
080779	0959	89.	21.02	57.88	-.01
080779	1057	147.	21.00	57.90	-.03
080779	1227	237.	20.97	57.93	-.06
080779	1330	300.	20.95	57.95	-.08
080779	1427	357.	20.90	58.00	-.13
080779	1526	416.	20.87	58.03	-.16
080779	1715	525.	20.84	58.06	-.19
080779	1842	612.	20.83	58.07	-.20
080779	2217	827.	20.82	58.08	-.21
080879	0100	990.	20.78	58.12	-.25
080879	0845	1215.	20.79	58.11	-.24
080879	0815	1425.	20.78	58.12	-.25
080879	1325	1735.	20.75	58.15	-.28
080879	2210	2260.	20.80	58.10	-.23
080979	0300	2550.	20.84	58.06	-.19
080979	0815	2865.	20.91	57.99	-.12
080979	1815	3465.	20.82	58.08	-.21
081079	0030	3840.	20.92	57.98	-.11
081079	0730	4260.	20.99	57.91	-.04
081079	1255	4585.	20.98	57.92	-.05
081079	1910	4960.	20.99	57.91	-.04
081179	0015	5265.	21.04	57.86	.01
081179	0615	5625.	21.22	57.68	.19
081179	1415	6105.	21.15	57.75	.12
081179	1910	6600.	21.21	57.69	.18
081279	0030	6720.	21.32	57.58	.29
081279	0630	7080.	21.45	57.45	.42
081279	1245	7455.	21.61	57.29	.58
081279	1910	7860.	21.58	57.32	.55
081279	2400	8130.	21.67	57.23	.64
081379	0630	8520.	21.85	57.05	.82
081379	1400	8970.	21.93	56.97	.90
081379	2100	9390.	22.09	56.81	1.06
081379	2400	9570.	22.11	56.79	1.08
081479	0630	9960.	22.08	56.82	1.05
081479	1830	10680.	22.21	56.69	1.18
081579	0700	11470.	22.44	56.46	1.41
081579	1810	12100.	22.55	56.35	1.52
081679	0730	12900.	22.80	56.10	1.77
081679	1825	13555.	22.90	56.00	1.87
081779	0645	14295.	23.18	55.72	2.15
081779	1825	14995.	23.30	55.60	2.27

2.4C-50

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
F-1	78.90	21.03	552930N ' 273590E	080774	0930

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
081879	0700	15750.	23.54	55.36	2.51
081879	1830	16440.	23.65	55.25	2.62
081979	0915	17325.	23.96	54.94	2.93
081979	1850	17900.	24.08	54.82	3.05
082079	0700	18630.	24.33	54.57	3.30
082079	1845	19335.	24.46	54.44	3.43
082179	0700	20070.	24.68	54.22	3.65
082179	1910	20800.	24.86	54.04	3.83
082279	1745	22155.	24.98	53.92	3.95
082379	1750	23600.	25.11	53.79	4.08
082479	1755	25085.	25.39	53.51	4.36
082579	1805	26495.	25.68	53.22	4.65
082679	1750	27920.	26.11	52.79	5.08
082779	1800	29370.	26.49	52.41	5.46
082879	1800	30810.	26.87	52.03	5.84
082979	1800	32250.	27.21	51.69	6.18
083079	1750	33680.	27.48	51.42	6.45
083179	1535	34985.	27.57	51.33	6.54
090179	0925	36055.	27.54	51.36	6.51
090279	0920	37490.	27.46	51.44	6.43
090379	0940	38950.	27.25	51.65	6.22
090479	1515	40725.	26.92	51.98	5.89
090579	1840	42130.	26.79	52.11	5.76
090779	1640	45130.	26.18	52.72	5.15
090879	0815	47505.	25.99	52.91	4.96
091179	0930	50460.	25.79	53.11	4.76
091379	0755	53245.	25.62	53.28	4.59
091579	1220	56390.	26.28	52.62	5.25
091779	1515	59445.	26.59	52.31	5.56
091979	1055	62065.	27.20	51.70	6.17
092179	0810	64780.	27.76	51.14	6.73
092579	0935	70625.	27.80	51.10	6.77
092779	1050	73580.	27.22	51.68	6.19
092979	1540	76750.	26.70	52.20	5.67
100179	1455	79585.	26.39	52.51	5.36
100379	1110	82240.	26.04	52.86	5.01
100579	1345	85275.	25.25	53.65	4.22
100779	1515	88245.	24.98	53.92	3.95
100979	1045	90855.	25.11	53.79	4.08
101179	1335	93905.	25.37	53.53	4.34
101579	1910	100000.	26.18	52.72	5.15
101879	1530	104100.	26.50	52.40	5.47
102079	1605	107015.	27.06	51.84	6.03
102279	1540	109870.	27.78	51.12	6.75
102479	1800	112890.	28.40	50.50	7.37
102679	0855	115225.	28.82	50.08	7.79
102879	1645	118575.	29.26	49.64	8.23
103079	1255	121625.	29.41	49.49	8.38
110279	1050	125420.	29.58	49.32	8.55
110479	0920	128210.	30.12	48.78	9.09

2.4C·57

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT.)	COORDINATES	START DATE	START TIME
E-1	78.90	21.03	55293UN 27559UE	0MU779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
110679	1055	131185.	50.90	28.00	9.87
110679	0910	133960.	31.48	47.42	10.45
111379	1255	181385.	32.53	46.37	11.50
111679	0915	145485.	32.38	46.52	11.35
112679	1730	160380.	31.29	47.61	10.26
112979	1105	164315.	30.65	48.25	9.62
121079	1600	180450.	23.63	55.27	2.60
121379	1520	184730.	22.60	56.30	1.57

2.4C-52

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
F-2	68.61	10.37	551540N 2737640E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080179	0000	-8670.	11.87	56.74	1.50
080279	0000	-7230.	11.88	56.73	1.51
080379	0000	-5790.	11.64	56.97	1.27
080479	0000	-4350.	11.32	57.29	.95
080579	1130	-2700.	11.36	57.25	.99
080679	1130	-1260.	10.80	57.81	.43
080779	0822	-8.	10.37	58.24	.00
080779	1030	120.	10.33	58.28	-.04
080779	1230	240.	10.30	58.31	-.07
080779	1430	360.	10.26	58.35	-.11
080779	1630	480.	10.22	58.39	-.15
080779	1829	599.	10.21	58.40	-.16
080879	1910	2080.	10.09	58.52	-.28
080879	2100	2190.	10.12	58.49	-.25
080879	2300	2310.	10.13	58.48	-.24
080979	0100	2430.	10.12	58.49	-.25
080979	0300	2550.	10.11	58.50	-.26
080979	0500	2670.	10.11	58.50	-.26
080979	0700	2790.	10.13	58.48	-.24
080979	0900	2910.	10.15	58.46	-.22
080979	1100	3030.	10.15	58.46	-.22
080979	1300	3150.	10.15	58.46	-.22
080979	1500	3270.	10.14	58.47	-.23
080979	1700	3390.	10.14	58.47	-.23
080979	1900	3510.	10.16	58.45	-.21
080979	2100	3630.	10.18	58.43	-.19
080979	2300	3750.	10.22	58.39	-.15
081079	0100	3870.	10.23	58.38	-.14
081079	0300	3990.	10.23	58.38	-.14
081079	0500	4110.	10.26	58.35	-.11
081079	0715	4245.	10.28	58.33	-.09
081079	0900	4350.	10.29	58.32	-.08
081079	1100	4470.	10.29	58.32	-.08
081079	1300	4590.	10.29	58.32	-.08
081079	1500	4710.	10.28	58.33	-.09
081079	1700	4830.	10.29	58.32	-.08
081079	1900	4950.	10.29	58.32	-.08
081079	2100	5070.	10.35	58.26	-.02
081079	2300	5190.	10.37	58.24	.00
081179	0100	5310.	10.39	58.22	.02
081179	0300	5430.	10.39	58.22	.02
081179	0500	5550.	10.40	58.21	.03
081179	0700	5670.	10.43	58.18	.06
081179	0900	5790.	10.48	58.13	.11
081179	1100	5910.	10.50	58.11	.13
081179	1200	5970.	10.52	58.09	.15
081179	1400	6090.	10.54	58.07	.17
081179	1600	6210.	10.57	58.04	.20
081179	1800	6330.	10.60	58.01	.23
081179	2000	6450.	10.65	57.96	.28

2.4C-53

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
F-2	68.61	10.57	551540N : 273764E	08?79	0850

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
081179	2400	8690.	10.75	57.86	.38
081279	0400	8930.	10.80	57.81	.43
081279	0800	7170.	10.89	57.72	.52
081279	1200	7410.	10.98	57.63	.61
081279	1600	7650.	11.04	57.57	.67
081279	2000	7890.	11.12	57.49	.75
081279	2400	8130.	11.22	57.39	.85
081379	0600	8490.	11.38	57.23	1.01
081379	1200	8850.	11.51	57.10	1.14
081379	1800	9210.	11.62	56.99	1.25
081379	2400	9570.	11.75	56.86	1.38
081479	0600	9930.	11.89	56.72	1.52
081479	1800	10650.	12.05	56.56	1.68
081579	0600	11370.	12.28	56.33	1.91
081579	1410	11860.	12.36	56.25	1.99
081679	0600	12810.	12.62	55.99	2.25
081679	1800	13530.	12.75	55.86	2.38
081779	0600	14250.	12.92	55.69	2.55
081779	1800	14970.	13.04	55.57	2.67
081879	0600	15690.	13.25	55.36	2.88
081979	1515	17685.	13.65	54.96	3.28
082079	0600	18570.	13.90	54.71	3.53
082079	1900	19350.	14.04	54.57	3.67
082179	0600	20010.	14.20	54.41	3.83
082179	1500	20550.	14.26	54.35	3.89
082279	0600	21450.	14.45	54.16	4.08
082279	1800	22170.	14.62	53.99	4.25
082379	0600	22890.	14.69	53.92	4.32
082379	1800	23610.	14.77	53.84	4.40
082479	0600	24330.	14.95	53.66	4.58
082479	1740	25030.	15.03	53.58	4.66
082579	0600	25770.	15.23	53.38	4.86
082579	1800	26490.	15.36	53.25	4.99
082679	0200	26970.	15.45	53.16	5.08
082679	1730	27900.	15.55	53.06	5.18
082879	0900	30270.	16.10	52.51	5.73
082979	0600	31530.	16.38	52.27	5.97
083079	1940	33790.	16.83	51.78	6.46
083179	1750	35120.	16.94	51.62	6.62
090279	1045	37575.	17.08	51.53	6.71
090379	0935	38905.	17.08	51.53	6.71
090479	1310	40600.	16.83	51.78	6.46
090579	1115	41925.	16.83	51.78	6.46
090779	1625	45115.	16.56	52.05	6.19
090979	0805	47895.	16.31	52.30	5.94
091179	0940	50470.	16.13	52.48	5.76
091379	0740	51230.	16.10	52.51	5.73
091579	1230	56400.	16.47	52.14	6.10
091779	1535	59865.	16.73	51.88	6.36
091979	1050	62060.	17.18	51.43	6.81

2.4C-54

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
F-2	68.61	10.37	551540N * 273764E	080779	0930

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
092179	0810	64780.	17.35	51.26	6.98
092579	0930	70620.	17.51	51.10	7.14
092779	1100	73590.	17.06	51.55	6.69
092979	1350	76640.	16.75	51.86	6.38
100179	1510	79600.	16.38	52.23	6.01
100379	1325	82375.	15.87	52.74	5.50
100579	1755	85525.	15.31	53.30	4.94
100779	1525	88255.	15.46	53.15	5.09
100979	1105	90875.	15.00	53.61	5.23
101179	1345	93915.	15.81	52.80	5.44
101679	1930	101800.	16.58	52.03	6.21
101879	1540	104110.	16.82	51.79	6.45
102079	1615	107025.	17.20	51.41	6.83
102279	1550	109880.	17.78	50.83	7.41
102479	1810	112900.	18.40	50.21	8.03
102679	1330	115500.	18.55	50.06	8.18
102879	1655	118585.	18.95	49.66	8.58
103079	1305	121235.	19.19	49.42	8.82
110279	1100	125430.	19.60	49.01	9.23
110479	0930	128220.	19.94	48.67	9.57
110679	1105	131195.	20.42	48.19	10.05
110879	0920	133970.	20.82	47.79	10.45
111379	1310	141800.	21.94	46.67	11.57
111679	0925	145495.	22.12	46.49	11.75
112679	1710	160360.	21.45	47.16	11.08
112979	1115	164325.	21.13	47.48	10.76
121479	1130	185940.	11.96	56.65	1.59

2.4C-55

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
F-3	70.97	12.47	550498N , 272615E	080779	0850

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080179	0000	-8670.	14.67	56.30	2.20
080279	0000	-7230.	14.65	56.32	2.18
080379	1320	-5670.	14.17	56.80	1.70
080479	0000	-4350.	13.67	57.30	1.20
080579	1140	-2730.	13.55	57.42	1.08
080679	1030	-1320.	12.91	58.06	.44
080779	0840	10.	12.47	58.50	.00
080779	1100	150.	12.50	58.47	.03
080779	1300	270.	12.68	58.29	.21
080779	1500	390.	12.83	58.14	.36
080779	1900	630.	12.95	58.02	.48
080879	0915	1485.	13.36	57.61	.89
080879	1955	2125.	13.65	57.32	1.18
080879	2200	2250.	13.74	57.23	1.27
080979	0000	2370.	13.78	57.19	1.31
080979	0200	2490.	13.80	57.17	1.33
080979	0400	2610.	13.85	57.12	1.38
080979	0600	2730.	13.92	57.05	1.45
080979	0800	2850.	13.98	56.99	1.51
080979	1000	2970.	14.00	56.97	1.53
080979	1200	3090.	14.05	56.92	1.58
080979	1400	3210.	14.07	56.90	1.60
080979	1600	3330.	14.10	56.87	1.63
080979	1800	3450.	14.15	56.82	1.68
080979	2000	3570.	14.18	56.79	1.71
080979	2200	3690.	14.25	56.72	1.78
081079	0000	3810.	14.28	56.69	1.81
081079	0200	3930.	14.30	56.67	1.83
081079	0400	4050.	14.32	56.65	1.85
081079	0600	4170.	14.36	56.61	1.89
081079	0815	4305.	14.39	56.58	1.92
081079	1000	4410.	14.37	56.60	1.90
081079	1200	4530.	14.38	56.59	1.91
081079	1400	4650.	14.38	56.59	1.91
081079	1600	4770.	14.40	56.57	1.93
081079	1800	4890.	14.42	56.55	1.95
081079	2000	5010.	14.50	56.47	2.03
081079	2200	5130.	14.55	56.42	2.08
081179	0000	5250.	14.58	56.39	2.11
081179	0200	5370.	14.59	56.38	2.12
081179	0400	5490.	14.63	56.34	2.16
081179	0600	5610.	14.66	56.31	2.19
081179	0800	5730.	14.73	56.24	2.26
081179	1000	5850.	14.75	56.22	2.28
081179	1230	6000.	14.80	56.17	2.33
081179	1400	6090.	14.82	56.15	2.35
081179	1600	6210.	14.86	56.11	2.39
081179	1800	6330.	14.90	56.07	2.43
081179	2000	6450.	14.97	56.00	2.50
081179	2200	6570.	15.05	55.92	2.58

2.4C-56

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
F-3	70.97	12.47	550498N - 272613E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
081279	0000	6690.	15.08	55.89	2.61
081279	0200	6810.	15.09	55.88	2.62
081279	0400	6930.	15.13	55.84	2.66
081279	0600	7050.	15.22	55.75	2.75
081279	0800	7170.	15.28	55.69	2.81
081279	1000	7290.	15.33	55.64	2.86
081279	1200	7410.	15.37	55.60	2.90
081279	1400	7530.	15.41	55.56	2.94
081279	1600	7650.	15.43	55.54	2.96
081279	1800	7770.	15.47	55.50	3.00
081279	2000	7890.	15.52	55.45	3.05
081279	2200	8010.	15.58	55.39	3.11
081379	0000	8130.	15.61	55.36	3.14
081379	0400	8370.	15.71	55.26	3.24
081379	0800	8610.	15.83	55.14	3.36
081379	1200	8850.	15.89	55.08	3.42
081379	1600	9090.	15.96	55.01	3.49
081379	2000	9330.	16.07	54.90	3.60
081479	0000	9570.	16.14	54.83	3.67
081479	0400	9810.	16.25	54.72	3.78
081479	0800	10050.	16.31	54.66	3.84
081479	1200	10290.	16.34	54.63	3.87
081479	1600	10530.	16.43	54.54	3.96
081479	2000	10770.	16.59	54.38	4.12
081579	0000	11010.	16.66	54.31	4.19
081579	1500	11910.	16.83	54.14	4.36
081579	1900	12150.	16.90	54.07	4.43
081579	2300	12390.	17.02	53.95	4.55
081679	0300	12630.	17.05	53.92	4.58
081679	0700	12870.	17.14	53.83	4.67
081679	1100	13110.	17.24	53.73	4.77
081679	1520	13370.	17.28	53.69	4.81
081679	1900	13590.	17.35	53.62	4.88
081679	2300	13830.	17.44	53.53	4.97
081779	0300	14070.	17.48	53.49	5.01
081779	0700	14310.	17.58	53.39	5.11
081779	1100	14550.	17.65	53.32	5.18
081779	1500	14790.	17.68	53.29	5.21
081779	1900	15030.	17.73	53.24	5.26
081779	2300	15270.	17.82	53.15	5.35
081879	0300	15510.	17.87	53.10	5.40
081879	0700	15750.	17.94	53.03	5.47
081879	1100	15990.	18.00	52.97	5.53
081879	1500	16230.	18.03	52.94	5.56
081879	1900	16470.	18.08	52.89	5.61
081879	2300	16710.	18.14	52.78	5.72
081979	1600	17730.	18.38	52.59	5.91
081979	2000	17970.	18.45	52.52	5.98
082079	0000	18210.	18.55	52.42	6.08
082079	0400	18450.	18.57	52.40	6.10

2.4C-57

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
E-3	70.97	12.47	550x9MN x 272x15E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
082079	0800	18690.	18.65	52.32	6.18
082079	1200	18930.	18.70	52.27	6.23
082079	1600	19170.	18.74	52.23	6.27
082079	2000	19410.	18.81	52.16	6.34
082179	0000	19650.	18.88	52.09	6.41
082179	0400	19890.	18.93	52.04	6.46
082179	0800	20130.	19.00	51.97	6.53
082179	1515	20565.	19.02	51.95	6.55
082179	1900	20790.	19.08	51.89	6.61
082279	0100	21150.	19.19	51.78	6.72
082279	0700	21510.	19.24	51.73	6.77
082279	1500	21990.	19.33	51.64	6.86
082279	2100	22350.	19.42	51.55	6.95
082379	0500	22830.	19.51	51.46	7.04
082379	1300	23310.	19.59	51.38	7.12
082379	1900	23670.	19.65	51.32	7.18
082479	0500	24270.	19.80	51.17	7.33
082479	1100	24630.	19.88	51.09	7.41
082479	1825	25075.	19.98	50.99	7.51
082579	0000	25410.	20.07	50.90	7.60
082579	0800	25890.	20.18	50.79	7.71
082579	1600	26370.	20.27	50.70	7.80
082679	0000	26850.	20.39	50.58	7.92
082679	0600	27210.	20.50	50.47	8.03
082679	1200	27690.	20.59	50.38	8.12
082679	1925	28015.	20.69	50.28	8.22
083079	1925	33775.	21.33	49.64	8.86
083179	1720	35090.	21.45	49.52	8.98
090279	1025	37555.	22.08	48.89	9.61
090379	1050	39020.	22.18	48.81	9.69
090479	1305	40595.	22.08	48.89	9.61
090579	1120	41930.	22.08	48.89	9.61
090779	1710	45160.	21.80	49.17	9.13
090979	0850	47540.	21.36	49.61	8.89
091179	0845	50415.	21.12	49.85	8.65
091379	0830	53280.	21.15	49.82	8.68
091579	1145	56355.	21.55	49.42	9.08
091779	1450	59420.	21.90	49.07	9.43
091979	1220	62150.	22.25	48.72	9.78
092179	0900	64830.	22.55	48.42	10.08
092579	1320	70850.	22.28	48.69	9.81
092779	0855	73465.	21.98	48.99	9.51
092979	1510	76720.	21.61	49.36	9.14
100179	1425	79555.	21.33	49.64	8.86
100379	1305	82355.	20.93	50.04	8.46
100579	1735	85505.	20.56	50.41	8.09
100779	1820	88190.	20.48	50.49	8.01
100979	1000	90810.	20.63	50.34	8.16
101179	1300	93870.	20.88	50.09	8.41
101679	1840	101410.	21.81	49.16	9.34

2.4C-58

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
F-3	70.97	12.47	550498N - 212615E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
101879	1425	104035.	22.22	48.75	9.75
102079	1505	106955.	22.71	48.26	10.24
102279	1435	109805.	23.19	47.78	10.72
102479	1720	112850.	23.63	47.34	11.16
102679	0825	115195.	23.88	47.09	11.41
102879	1610	118540.	24.39	46.58	11.92
103079	0945	121035.	24.74	46.23	12.27
110279	1000	125370.	25.31	45.66	12.84
110479	0830	128150.	25.82	45.15	13.35
110679	0835	131045.	26.32	44.65	13.85
110879	0830	133920.	26.78	44.19	14.31
111379	1055	141265.	27.54	43.43	15.07
111679	0330	145440.	27.94	43.53	14.97
112079	0930	159900.	26.56	44.41	14.09
112479	1010	164260.	26.14	44.83	13.67
121179	0930	181500.	16.87	54.10	4.40
121579	1020	188670.	16.81	54.16	4.34

2.4C-59

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
F-8	68.30	8.69	5495354 .272015E	080779	0850

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080179	0000	-8670.	12.17	56.13	3.48
080279	0000	-7230.	12.02	56.28	3.33
080379	1345	-5405.	11.25	57.05	2.56
080479	0000	-4350.	10.67	57.63	1.98
080579	1015	-2775.	10.18	58.12	1.49
080679	1000	-1350.	9.39	58.91	.70
080779	0822	-8.	8.69	59.61	.00
080779	1850	620.	9.57	58.73	.88
080779	2000	670.	9.65	58.65	.96
080779	2200	810.	9.75	58.55	1.06
080779	2400	950.	9.79	58.51	1.10
080879	0200	1050.	9.81	58.49	1.12
080879	0400	1170.	9.83	58.47	1.14
080879	0600	1290.	9.89	58.41	1.20
080879	0845	1455.	9.98	58.32	1.29
080879	1010	1540.	10.15	58.15	1.46
080879	1200	1650.	10.17	58.13	1.48
080879	1400	1770.	10.18	58.12	1.49
080879	1600	1890.	10.22	58.08	1.53
080879	1800	2010.	10.28	58.02	1.59
080879	2000	2130.	10.36	57.94	1.67
080879	2200	2250.	10.43	57.87	1.74
080879	2400	2370.	10.47	57.83	1.78
080979	0200	2490.	10.50	57.80	1.81
080979	0400	2610.	10.53	57.77	1.84
080979	0600	2730.	10.56	57.74	1.87
080979	0800	2850.	10.62	57.68	1.93
080979	1000	2970.	10.71	57.59	2.02
080979	1200	3090.	10.77	57.53	2.08
080979	1400	3210.	10.81	57.49	2.12
080979	1600	3330.	10.85	57.45	2.16
080979	1800	3450.	10.89	57.41	2.20
080979	2000	3570.	10.91	57.39	2.22
080979	2200	3690.	10.95	57.35	2.26
080979	2400	3810.	10.97	57.33	2.28
081079	0400	4050.	10.98	57.32	2.29
081079	0800	4290.	11.05	57.25	2.36
081079	1200	4530.	11.14	57.16	2.45
081079	1600	4770.	11.18	57.12	2.49
081079	2000	5010.	11.31	56.99	2.62
081079	2400	5250.	11.39	56.91	2.70
081179	0400	5490.	11.43	56.87	2.74
081179	0800	5730.	11.50	56.76	2.85
081179	1200	5970.	11.61	56.69	2.92
081179	1600	6210.	11.68	56.62	2.99
081179	2000	6450.	11.82	56.48	3.13
081179	2400	6690.	11.93	56.37	3.24
081279	0600	7050.	12.13	56.17	3.44
081279	1200	7410.	12.28	56.02	3.59
081279	1500	7590.	12.37	55.93	3.68

2.4C-60

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
F-9	68.30	8.69	549535N 2720132E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
081279	1800	7770.	12.43	55.87	3.74
081279	2400	8130.	12.61	55.69	3.92
081379	0600	8490.	12.79	55.51	4.10
081379	1200	8850.	12.95	55.35	4.26
081379	1800	9210.	13.12	55.18	4.43
081379	2400	9570.	13.30	55.00	4.61
081479	0600	9930.	13.44	54.86	4.75
081479	1200	10290.	13.58	54.72	4.89
081479	1800	10650.	13.67	54.63	4.98
081479	2200	10890.	13.73	54.57	5.04
081579	1530	11980.	14.17	54.13	5.48
081579	1800	12090.	14.21	54.09	5.52
081579	2400	12450.	14.37	53.93	5.68
081679	0600	12810.	14.48	53.82	5.79
081679	1800	13530.	14.78	53.52	6.09
081779	0600	14250.	15.04	53.26	6.35
081779	1800	14970.	15.28	53.02	6.59
081879	0600	15690.	15.50	52.80	6.81
081879	1800	16410.	15.66	52.64	6.97
081979	0600	17130.	15.86	52.44	7.17
081979	1800	17850.	15.98	52.32	7.29
082079	0600	18570.	16.15	52.15	7.46
082079	1800	19290.	16.37	51.93	7.68
082179	0600	20010.	16.50	51.80	7.81
082179	1530	20580.	16.62	51.68	7.93
082179	1800	20730.	16.66	51.64	7.97
082279	1800	22170.	17.05	51.25	8.36
082379	1800	23610.	17.29	51.01	8.60
082479	1915	25125.	17.69	50.61	9.00
082579	1800	26490.	18.17	50.13	9.48
082679	1900	27990.	18.72	49.58	10.03
082779	1800	29370.	19.22	49.08	10.53
082879	0940	30310.	19.45	48.85	10.76
082979	1800	32250.	19.78	48.52	11.09
083079	1900	33750.	19.84	48.46	11.15
083179	1630	35040.	19.72	48.58	11.03
090279	1035	37565.	19.19	49.11	10.50
090379	1025	38995.	18.90	49.40	10.21
090479	1300	40590.	18.56	49.74	9.87
090579	1130	41940.	18.40	49.90	9.71
090779	1740	45190.	17.75	50.55	9.06
090979	0930	47580.	17.43	50.87	8.74
091179	0810	50380.	17.35	50.95	8.66
091379	0900	53310.	17.75	50.55	9.06
091579	1100	56310.	18.47	49.83	9.78
091779	1405	59375.	19.17	49.13	10.48
091979	1125	62095.	19.85	48.45	11.16
092179	0945	64675.	19.77	48.53	11.08
092579	1345	70875.	18.39	49.91	9.70
092779	0830	73440.	17.88	50.42	9.19

2.4C-61

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
E-A	62.30	8.64	549535N * 272015E	080779	0850

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
092479	1440	76690.	17.47	50.83	8.78
100179	1345	79515.	17.33	50.97	8.64
100579	1245	82335.	16.84	51.46	8.15
100579	1715	85485.	16.53	51.77	7.84
100779	1350	88160.	16.56	51.74	7.87
100979	0930	90780.	17.15	51.15	8.46
101179	1250	93840.	17.69	50.61	9.00
101679	1415	101385.	19.25	49.05	10.56
101879	1335	103985.	19.88	48.42	11.19
102079	1350	106880.	20.31	47.99	11.62
102279	1330	109780.	20.81	47.49	12.12
102479	1710	112840.	21.14	47.16	12.45
102679	0805	115175.	21.35	46.95	12.66
102879	1545	118515.	21.76	46.54	13.07
103079	0910	121000.	22.49	45.81	13.80
110279	0920	125330.	23.45	44.87	14.74
110479	0750	128120.	23.94	44.36	15.25
110679	0755	131005.	24.42	43.88	15.73
110879	0805	133895.	24.84	43.46	16.15
111379	1915	141225.	24.42	43.88	15.73
111679	0740	145390.	23.71	44.59	15.02
112679	1000	159930.	22.16	46.14	13.47
112979	0930	164220.	21.62	46.68	12.93

2.4C-62

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
F-5	69.58	8.86	548124N : 2094AUE	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080179	0000	-8670.	13.42	56.16	4.56
080279	0000	-7230.	12.96	56.62	4.10
080379	0000	-5790.	12.11	57.47	3.25
080479	0000	-4350.	10.98	58.60	2.12
080579	1320	-2590.	10.10	59.48	1.24
080679	0930	-1380.	9.39	60.19	.53
080779	0743	-47.	8.86	60.72	.00
080779	0844	14.	8.86	60.72	.00
080779	0950	80.	8.86	60.72	.00
080779	1047	137.	8.82	60.76	-.04
080779	1218	228.	8.87	60.71	.01
080779	1319	289.	8.83	60.75	-.03
080779	1415	345.	8.79	60.79	-.07
080779	1517	407.	8.77	60.81	-.09
080779	1613	463.	8.76	60.82	-.10
080779	1806	576.	8.73	60.85	-.13
080779	2035	725.	8.70	60.88	-.16
080779	2234	844.	8.65	60.93	-.21
080879	0015	905.	8.62	60.96	-.24
080879	0430	1200.	8.52	61.06	-.34
080879	0745	1395.	8.43	61.15	-.43
080879	1320	1730.	8.48	61.10	-.38
080879	2220	2270.	8.42	61.16	-.44
080979	0230	2520.	8.39	61.19	-.47
080979	0800	2850.	8.30	61.28	-.56
080979	1835	3485.	8.35	61.23	-.51
081079	0015	3825.	8.32	61.26	-.54
081079	0700	4230.	8.27	61.31	-.59
081079	1305	4595.	8.38	61.20	-.48
081079	1920	4970.	8.42	61.16	-.44
081079	2400	5250.	8.53	61.05	-.33
081179	0615	5625.	8.47	61.11	-.39
081179	1425	6115.	8.52	61.06	-.34
081179	1915	6405.	8.59	60.99	-.27
081179	2400	6690.	8.68	60.90	-.18
081279	0630	7080.	8.74	60.84	-.12
081279	1230	7440.	8.89	60.69	.03
081279	1920	7850.	9.07	60.51	.21
081279	2345	8115.	9.20	60.38	.34
081379	0630	8520.	9.34	60.24	.48
081379	1410	8880.	9.21	60.37	.35
081379	2000	9330.	9.10	60.48	.24
081379	2400	9570.	9.97	59.61	1.11
081479	0615	9945.	10.10	59.48	1.24
081479	1820	10670.	10.51	59.07	1.65
081579	0730	11460.	10.02	59.56	1.16
081579	1800	12090.	11.06	58.52	2.20
081679	0720	12890.	11.31	58.27	2.45
081679	1820	13550.	11.65	57.93	2.79
081779	0635	14285.	11.91	57.67	3.05

24C-63

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
EOS	69.58	8.86	SW8129N 2099B0E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
081779	1815	14985.	12.20	57.38	3.34
081879	0650	15740.	12.41	57.17	3.55
081879	1815	16425.	12.55	57.03	3.69
081979	1020	17390.	12.76	56.82	3.90
081979	1840	17890.	12.86	56.76	3.96
082079	0650	18620.	12.87	56.71	4.01
082079	1830	19320.	13.10	56.48	4.24
082179	0640	20050.	13.18	56.40	4.32
082179	1905	20795.	13.27	56.11	4.61
082279	1740	22150.	13.73	55.85	4.87
082379	1745	23585.	14.17	55.41	5.31
082479	1725	25015.	14.86	54.72	6.00
082579	1815	26505.	15.59	53.99	6.73
082679	1720	27890.	16.34	53.24	7.48
082779	1750	29360.	17.00	52.58	8.14
082879	1755	30805.	17.04	52.54	8.18
082979	1760	32240.	15.69	53.89	6.83
083079	1740	33670.	16.02	53.56	7.16
083179	1530	34980.	15.34	54.26	6.46
090179	0920	36050.	14.75	54.83	5.89
090279	0910	37480.	13.92	55.66	5.06
090379	0830	38880.	13.33	56.25	4.47
090479	1540	40750.	12.71	56.87	3.85
090579	1455	42145.	12.17	57.41	3.31
090779	1600	45090.	11.33	58.25	2.47
090979	0750	47480.	11.04	58.54	2.18
091179	0950	50480.	11.59	57.99	2.73
091379	0730	53220.	12.52	57.06	3.66
091579	1235	56405.	14.06	55.52	5.20
091779	1545	59475.	15.32	54.26	6.46
091979	1030	62040.	16.21	53.37	7.35
092179	0742	64752.	15.33	54.25	6.47
092579	0915	70605.	11.19	58.39	2.33
092779	1110	73600.	11.28	58.30	2.42
092979	1555	76765.	10.82	58.76	1.96
100179	1515	79605.	10.75	58.83	1.89
100379	1115	82245.	10.22	59.36	1.36
100579	1350	85280.	10.46	59.12	1.60
100779	1530	88260.	10.66	58.92	1.80
100979	1115	90885.	11.85	57.73	2.99
101179	1350	93920.	12.88	56.70	4.02
101679	1935	101465.	15.55	54.03	6.69
101879	1555	104125.	16.40	53.18	7.54
102079	1625	107035.	16.32	53.26	7.46
102279	1600	109890.	16.52	53.06	7.66
102479	1815	112905.	16.84	52.74	7.98
102679	1335	115505.	17.35	52.23	8.49
102879	1700	118590.	17.93	51.65	9.07
103079	1315	121245.	19.56	50.02	10.70
110279	1110	125440.	20.89	48.69	12.03

2.4C-64

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
F-5	69.54	8.46	5481294 - 2044AUE	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
110479	0935	128225.	20.82	48.76	11.46
110679	1110.	131200.	21.23	48.35	12.37
110879	0925	133975.	21.02	48.56	12.16
111379	1315	141405.	17.58	52.00	8.72
111679	0935	145505.	16.19	53.39	7.33
112679	1720	160370.	13.61	55.97	4.75
112979	1120	164330.	13.00	56.58	4.14
121179	1105	181595.	6.43	63.15	-2.43
121379	1530	184740.	7.33	62.25	-1.53

2.4C-65

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
F-6	80.78	21.61	594850N 272010E	080779	0850

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080179	0000	-8670.	23.23	57.51	1.62
080279	0000.	-7230.	23.21	57.53	1.60
080379	0000	-5790.	23.13	57.61	1.52
080479	0000	-4350.	22.75	57.99	1.14
080578	1320	-2590.	22.48	58.26	.87
080679	0945	-1365.	22.05	58.69	.44
080779	0737	-53.	21.61	59.13	.00
080779	0840	10.	21.61	59.13	.00
080779	0945	75.	21.61	59.13	.00
080779	1042	132.	21.61	59.13	.00
080779	1213	223.	21.63	59.11	.02
080779	1311	281.	21.63	59.11	.02
080779	1410	340.	21.63	59.11	.02
080779	1511	401.	21.63	59.11	.02
080779	1607	457.	21.63	59.11	.02
080779	1802	572.	21.65	59.09	.04
080779	2027	717.	21.70	59.04	.09
080779	2227	837.	21.64	59.10	.03
080879	0045	975.	21.64	59.10	.03
080879	0430	1200.	21.61	59.13	.00
080879	0745	1395.	21.62	59.12	.01
080879	1315	1725.	21.73	59.01	.12
080879	2250	2280.	21.81	58.93	.20
080979	0230	2520.	21.85	58.89	.24
080979	0800	2850.	21.79	58.95	.18
080979	1830	3480.	21.87	58.87	.26
081079	2400	5250.	22.00	58.74	.39
081079	0015	3825.	21.90	58.84	.29
081079	0645	8215.	21.90	58.84	.29
081079	1310	4600.	21.97	58.77	.36
081079	1925	8475.	21.98	58.76	.37
081179	0600	5610.	22.20	58.54	.59
081179	1030	6120.	22.13	58.61	.52
081179	1920	6410.	22.16	58.58	.55
081279	0015	6705.	22.32	58.42	.71
081279	0615	7065.	22.38	58.36	.77
081279	1235	7445.	22.50	58.24	.89
081279	1925	7855.	22.59	58.15	.98
081279	2345	8115.	22.71	58.03	1.10
081379	0630	8520.	22.92	57.82	1.31
081379	1015	8985.	23.12	57.62	1.51
081379	1955	9325.	23.23	57.51	1.62
081379	2400	9570.	23.31	57.43	1.70
081479	0615	9945.	23.35	57.39	1.74
081479	1815	10865.	23.54	57.20	1.93
081579	0720	11450.	23.75	56.99	2.14
081579	1755	12085.	23.96	56.78	2.35
081679	0710	12880.	24.22	56.52	2.61
081679	1815	13545.	24.34	56.40	2.73
081779	0640	14290.	24.54	56.20	2.93

2.4C-66

WELL	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
	21.61	548458N 272610E		080779	0830

	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
081779	1820	14990.	28.69	56.05	3.08
082079	0645	15735.	24.88	55.66	3.27
081879	1820	16430.	24.94	55.80	3.33
081979	1025	17395.	25.21	55.53	3.60
081979	1835	17885.	25.27	55.47	3.66
082079	0640	18610.	25.49	55.25	3.88
082079	1835	19325.	25.55	55.19	3.94
082179	0650	20060.	25.72	55.02	4.11
082179	1900	20790.	25.80	54.94	4.19
082279	1735	22145.	26.04	54.70	4.43
082379	1700	23590.	26.28	54.46	4.67
082479	1720	25010.	26.59	54.15	4.98
082579	1820	26510.	26.91	53.83	5.30
082679	1715	27885.	27.22	53.52	5.61
082779	1745	29355.	27.61	53.13	6.00
082879	1750	30800.	27.85	52.89	6.24
082979	1705	32235.	28.05	52.69	6.44
083079	1740	33670.	28.13	52.61	6.52
083179	1525	34975.	28.14	52.60	6.53
090179	0915	36045.	28.17	52.57	6.56
090279	0915	37485.	28.00	52.74	6.39
090379	0835	38885.	27.96	52.78	6.35
090479	1535	40745.	27.96	52.78	6.35
090579	1450	42140.	27.83	52.91	6.22
090779	1555	45085.	27.46	53.28	5.85
090979	0750	47480.	27.30	53.44	5.69
091179	0955	50485.	27.37	53.37	5.76
091379	0725	53215.	27.41	53.33	5.80
091579	1240	56410.	27.93	52.81	6.32
091779	1550	59480.	28.33	52.41	6.72
091979	1025	62035.	28.69	52.05	7.08
092179	0745	64755.	28.57	52.17	6.96
092579	0910	70600.	28.01	52.73	6.40
092779	1115	73605.	27.99	52.75	6.38
092979	1600	76770.	27.52	53.22	5.91
100179	1520	79610.	27.43	53.31	5.82
100379	1120	82250.	27.16	53.58	5.55
100579	1355	85285.	26.98	53.76	5.37
100779	1535	88265.	26.81	53.93	5.20
100979	1120	90890.	27.23	53.51	5.62
101179	1400	93930.	27.58	53.16	5.97
101679	1940	101470.	28.59	52.15	6.98
101879	1600	104130.	29.01	51.73	7.40
102079	1630	107040.	29.08	51.66	7.47
102279	1605	109895.	29.33	51.41	7.72
102479	1820	112910.	29.68	51.06	8.07
102679	1340	115510.	29.95	50.79	8.34
102879	1705	118595.	30.23	50.51	8.62
103079	1315	121245.	30.79	49.95	9.18
110279	1115	125445.	31.28	49.46	9.67

24C67

WELL NO.	ELEV OF MEAS PT,(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
Em6	80.74	21.61	S08W30N 272U10E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
110879	0940	12M230.	31.81	48.93	9.80
110879	1115	131205.	31.87	48.87	10.26
110879	0930	133980.	31.97	48.77	10.36
111379	1320	141410.	32.09	48.65	10.48
111879	0940	145510.	31.91	48.83	10.30
112079	1725	160375.	31.51	49.43	9.70
112979	1130	168380.	31.08	49.70	9.43
121079	1610	180460.	26.14	54.60	4.53
121579	1535	184705.	25.56	55.18	3.95

2.4C-68

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
RW-18	68.67	7.88	549117N - 2705016	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080179	0000	-8670.	14.13	54.54	6.25
080279	0000	-7230.	13.46	55.21	5.58
080379	0000	-5790.	12.49	56.18	4.61
080479	0000	-4350.	10.18	58.49	2.30
080579	0000	-2910.	9.17	59.50	1.29
080679	0935	-1375.	9.23	59.44	1.35
080779	0727	-63.	7.88	60.79	.00
080779	0916	46.	8.69	59.98	.81
080779	1010	100.	8.87	60.00	.79
080779	1109	159.	8.66	60.01	.78
080779	1223	233.	8.67	60.00	.79
080779	1325	295.	8.67	60.00	.79
080779	1415	345.	8.68	59.99	.80
080779	1505	395.	8.67	60.00	.79
080779	1605	455.	8.62	60.05	.74
080779	1835	605.	8.59	60.08	.71
080779	2135	785.	8.26	60.41	.38
080779	2310	880.	8.10	60.57	.22
080879	0130	1020.	7.86	60.81	-.02
080879	0530	1260.	7.46	61.21	-.42
080879	0830	1440.	8.49	60.18	.61
080879	1425	1795.	8.57	60.10	.69
080879	2145	2235.	8.25	60.42	.37
080979	0300	2550.	7.69	60.98	-.19
080979	0845	2895.	8.53	60.14	.65
080979	1650	3380.	8.49	60.18	.61
081079	0045	3855.	7.89	60.78	.01
081079	0745	4275.	7.76	60.91	-.12
081079	1200	4530.	8.77	59.90	.89
081079	1815	4905.	8.54	60.13	.66
081179	0045	5295.	8.22	60.45	.34
081179	0645	5655.	8.01	60.66	.13
081179	1320	6050.	8.15	60.52	.27
081179	1815	6345.	8.30	60.37	.42
081279	0045	6735.	8.48	60.19	.60
081279	0645	7095.	8.65	60.02	.77
081279	1410	7540.	8.81	59.86	.93
081279	1815	7785.	8.90	59.77	1.02
081379	0015	8145.	9.18	59.49	1.30
081379	0700	8550.	9.57	59.10	1.69
081379	1340	8950.	10.77	57.90	2.89
081379	2020	9350.	10.77	57.90	2.89
081479	0030	9600.	10.45	58.22	2.57
081479	0700	9990.	10.26	58.41	2.38
081479	1925	10735.	11.58	57.09	3.70
081579	0815	11505.	11.98	56.69	4.10
081579	1830	12120.	12.21	56.46	4.33
081679	0750	12920.	12.59	56.08	4.71
081679	1900	13590.	12.71	55.96	4.83
081779	0735	14345.	13.45	55.22	5.57

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
RW-1A	68.67	7.88	549117N * 270501E	082779	0950

2-4C-69

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
081779	1900	15030.	13.05	55.62	5.17
081879	0735	15785.	12.96	55.71	5.08
081879	1910	16980.	13.10	55.57	5.22
081979	0945	17355.	13.28	55.39	5.40
081979	1920	17730.	13.30	55.37	5.42
082079	0730	18060.	14.43	54.24	6.55
082079	1910	19260.	14.41	54.26	6.53
082179	0730	20100.	14.70	53.97	6.82
082179	1930	20820.	14.75	53.92	6.87
082279	1820	22190.	15.23	53.44	7.35
082379	1820	23630.	15.80	52.87	7.92
082479	1935	25145.	16.41	52.26	8.53
082579	1650	26420.	15.93	52.74	8.05
082679	1840	27970.	17.54	51.13	9.66
082779	1905	29435.	18.99	49.68	11.11
082879	1855	30865.	18.85	49.82	10.97
082979	1855	32305.	18.20	50.47	10.32
083079	1850	33740.	17.25	51.42	9.37
083179	1610	35020.	16.82	52.25	8.58
090179	0950	36080.	14.79	53.88	6.91
090279	0950	37520.	13.50	55.17	5.62
090379	1005	38975.	13.83	54.84	5.95
090479	1455	40705.	13.67	55.00	5.79
090579	1430	42120.	12.96	55.71	5.08
090779	1805	45215.	11.66	57.01	3.78
090979	0950	47600.	10.67	58.00	2.79
091179	0750	50360.	12.96	55.71	5.08
091379	0920	53330.	14.15	54.52	6.27
091579	1050	56300.	14.52	54.15	6.64
091779	1135	59345.	17.08	51.59	9.20
091979	1105	62075.	18.10	50.57	10.22
092179	1000	64890.	16.56	52.11	8.68
092579	1305	70835.	14.82	53.85	6.94
092779	0810	73420.	13.72	54.95	5.84
092979	1420	76670.	10.40	58.23	2.56
100179	1315	79485.	14.44	54.23	6.56
100379	1030	82200.	14.05	54.62	6.17
100579	1300	85230.	13.27	55.40	5.39
100779	1325	88135.	10.46	58.21	2.58
100979	0905	90755.	15.51	53.16	7.03
101179	1210	93820.	16.83	51.84	8.45
101679	1755	101365.	18.66	50.01	10.78
101879	1310	103960.	21.75	46.92	13.87
102079	1320	106850.	16.93	51.74	9.05
102279	1300	109710.	18.49	50.18	10.61
102479	1420	112670.	20.47	48.20	12.59
102679	0745	115155.	20.61	48.06	12.73
102879	1530	118500.	18.92	49.75	11.04
103079	0850	120980.	20.66	48.01	10.78
110179	1135	124025.	27.43	41.24	19.55

2.4C-70

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
RW-1A	68.67	7.88	549117N , 270501E	082779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
110279	0900	125310.	26.30	42.37	18.42
110479	0730	128100.	21.92	46.75	14.04
110679	0740	130990.	24.81	43.86	16.93
110879	0745	133875.	21.98	46.69	14.10
111379	0950	141200.	23.11	45.56	15.23
111679	0715	145365.	19.13	49.54	11.25
112079	1020	149450.	18.34	50.33	10.46
112479	0905	164195.	12.80	55.87	4.92
121179	0905	181475.	5.59	63.08	-2.29
121379	1330	184620.	6.84	61.83	-1.04

2.4C-71

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
9N-1R	71.21	10.48	5491800 N 2705325 E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080179	0000	-8670.	16.92	54.79	5.48
080279	0000	-7230.	15.79	55.42	5.35
080379	0000	-5790.	14.79	56.42	4.35
080479	0000	-4350.	12.91	58.30	2.47
080579	0000	-2910.	11.67	59.54	1.23
080679	0930	-1380.	11.54	59.67	1.10
080779	0730	-60.	10.48	60.73	.04
080779	0914	14.	10.91	60.30	.47
080779	1009	99.	11.00	60.21	.56
080779	1105	155.	10.93	60.28	.49
080779	1220	230.	10.96	60.25	.52
080779	1322	292.	10.98	60.23	.54
080779	1415	345.	10.99	60.22	.55
080779	1502	392.	10.99	60.22	.55
080779	1002	92.	10.96	60.25	.52
080779	1840	610.	10.88	60.33	.44
080779	2134	784.	10.66	60.55	.22
080779	2305	875.	10.51	60.70	.07
080879	0130	1020.	10.37	60.84	-.07
080879	0530	1260.	10.00	61.21	-.44
080879	0830	1440.	10.83	60.38	.39
080879	1425	1795.	10.85	60.36	.41
080879	2140	2230.	10.64	60.57	.20
080979	0300	2550.	10.28	60.93	-.16
080979	0845	2895.	11.63	59.58	1.19
080979	1655	3385.	10.79	60.42	.35
081079	0045	3855.	10.38	60.83	-.06
081079	0745	4275.	10.29	60.92	-.15
081079	1200	4530.	11.08	60.13	.68
081079	1815	4905.	10.94	60.27	.50
081179	0045	5295.	10.70	60.51	.26
081179	0645	5655.	10.58	60.63	.14
081179	1320	6050.	10.71	60.50	.27
081179	1815	6345.	10.85	60.36	.41
081279	0045	6735.	11.01	60.20	.57
081279	0645	7095.	11.18	60.03	.74
081279	1410	7580.	11.45	59.76	1.01
081279	1815	7785.	11.58	59.63	1.14
081379	0015	8145.	11.72	59.49	1.28
081379	0700	8550.	12.12	59.09	1.68
081379	1345	8955.	13.12	58.09	2.68
081379	2025	9355.	13.16	58.05	2.72
081479	0030	9600.	12.97	58.24	2.53
081479	0700	9990.	12.79	58.42	2.35
081479	1925	10735.	13.96	57.25	3.52
081579	0810	11500.	14.32	56.89	3.88
081579	1810	12120.	14.57	56.64	4.13
081679	0750	12920.	14.97	56.24	4.53
081679	1855	13585.	15.14	56.07	4.70
081779	0735	14345.	15.78	55.43	5.34

2HC-72

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
RM-1M	71.21	10.44	549186N 270536E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
081779	1900	15030.	15.53	55.68	5.09
081879	0730	15780.	15.52	55.69	5.08
081879	1910	16480.	15.65	55.56	5.21
081979	0950	17360.	15.85	55.36	5.41
081979	1920	17930.	15.88	55.33	5.44
082079	0730	18660.	16.74	54.47	6.30
082079	1910	19360.	16.78	54.43	6.34
082179	0730	20100.	17.03	54.18	6.59
082179	1930	20820.	17.11	54.10	6.67
082279	1820	22190.	17.58	53.63	7.14
082379	1820	23630.	18.15	53.06	7.71
082479	1945	25155.	18.18	53.03	7.74
082579	1650	26420.	19.20	52.01	8.76
082679	1840	27970.	20.11	51.10	9.67
082779	1905	29435.	20.69	50.52	10.25
082879	1855	30865.	20.59	50.62	10.15
082979	1855	32305.	20.53	50.68	10.09
083079	1850	33740.	19.00	52.21	8.56
083179	1610	35020.	18.82	52.39	8.38
090179	0950	36080.	17.38	53.83	6.94
090279	0950	37520.	16.54	54.67	6.10
090379	1000	38970.	15.83	55.38	5.39
090479	1455	40705.	15.92	55.29	5.48
090579	1430	42120.	15.29	55.92	4.85
090779	1800	45210.	14.10	57.11	3.66
090979	0950	47600.	13.30	57.91	2.86
091179	0750	50360.	14.96	56.25	4.52
091379	0920	53330.	16.40	54.81	5.96
091579	1050	56300.	17.08	54.13	6.64
091779	1335	59345.	19.46	51.75	9.02
091979	1105	62075.	20.39	50.82	9.95
092179	1000	64890.	18.93	52.28	8.49
092579	1312	70842.	17.10	54.11	6.66
092779	0810	73420.	16.21	55.00	5.77
092979	1420	76070.	13.01	58.20	2.57
100179	1315	79485.	16.06	55.15	5.62
100379	1030	82200.	16.71	54.50	6.27
100579	1300	85230.	15.07	56.14	4.63
100779	1345	88135.	13.05	58.16	2.61
100979	0905	90755.	17.23	53.98	6.79
101179	1210	93820.	18.50	52.71	8.06
101679	1755	101305.	20.56	50.65	10.12
101879	1310	103960.	23.30	47.91	12.86
102079	1320	106850.	19.53	51.68	9.09
102279	1300	109710.	20.57	50.64	10.13
102479	1420	112670.	22.30	48.91	11.86
102679	0745	115155.	22.48	48.73	12.04
102879	1530	118500.	21.49	49.72	11.05
103079	0850	120980.	26.14	45.07	15.75
110179	1135	124025.	28.51	42.70	18.07

2.4/C-73

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
RW-1M	71.21	10.88	5491400N ,2705320E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
110279	0900	125310.	27.87	43.34	17.43
110479	0730	128100.	24.52	46.69	14.08
110679	0740	130490.	26.83	44.38	16.39
110879	0745	133875.	24.65	46.58	14.19
111379	0850	141300.	24.52	46.69	14.08
111679	0715	145365.	21.19	50.02	10.75
112679	1020	159450.	19.90	51.31	9.46
112979	0905	164195.	15.49	55.72	5.05
121079	1055	180185.	7.98	63.23	-2.46
121379	1330	184620.	9.49	61.72	-.95

2-4C-74

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
RM-3A	75.63	15.25	550713N 2714046E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080179	0000	-8670.	19.90	55.73	4.65
080279	0000	-7230.	19.63	56.00	4.38
080379	0000	-5790.	18.63	57.00	3.38
080479	0000	-4350.	17.55	58.08	2.30
080579	0000	-2910.	16.71	58.92	1.46
080679	1020	-1330.	15.83	59.80	.58
080779	0750	-40.	15.25	60.38	.00
080779	0854	24.	19.48	56.15	4.23
080779	0949	79.	22.35	53.28	7.10
080779	1048	138.	23.07	52.56	7.82
080779	1203	213.	23.43	52.20	8.18
080779	1250	260.	23.60	52.03	8.35
080779	1345	315.	23.82	51.81	8.57
080779	1440	370.	23.93	51.70	8.68
080779	1512	402.	23.98	51.65	8.73
080779	1812	582.	24.26	51.37	9.01
080779	2110	760.	24.55	51.08	9.30
080779	2300	870.	24.61	51.02	9.36
080879	0130	1020.	24.90	50.73	9.65
080879	0515	1245.	24.93	50.70	9.68
080879	0830	1440.	24.75	50.88	9.50
080879	1400	1770.	26.74	48.89	11.49
080879	2110	2200.	28.92	46.71	13.67
080979	0300	2550.	29.76	45.87	14.51
080979	0845	2895.	30.77	44.86	15.52
080979	1730	3420.	31.70	43.93	16.45
081079	0045	3855.	29.93	45.70	14.68
081079	0730	4260.	30.06	45.57	14.81
081079	1220	4550.	30.14	45.49	14.89
081079	1845	4935.	32.47	43.16	17.22
081179	0030	5280.	32.49	43.14	17.24
081179	0630	5640.	32.77	42.86	17.52
081179	1350	6080.	33.11	42.52	17.86
081179	1845	6375.	33.35	42.28	18.10
081279	0030	6720.	33.54	42.09	18.34
081279	0630	7080.	33.76	41.87	18.51
081279	1345	7515.	34.20	41.43	18.95
081279	1835	7805.	34.40	41.23	19.15
081379	0015	8145.	34.38	41.25	19.13
081379	0645	8535.	34.72	40.91	19.47
081379	1320	8930.	35.00	40.63	19.75
081379	2030	9360.	35.32	40.31	20.07
081479	0015	9585.	35.34	40.29	20.09
081479	0645	9975.	35.39	40.24	20.14
081479	1900	10710.	35.71	39.92	20.46
081579	0800	11490.	36.12	39.51	20.87
081579	1820	12110.	36.45	39.18	21.20
081679	0815	12945.	37.01	38.62	21.76
081679	1850	13580.	36.74	38.89	21.49
081779	0725	14335.	36.65	38.98	21.40

2.4C-75

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
RW-5A	75.03	15.25	SSOTISN ZTIWOWE	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
081779	1850	15020.	36.75	38.88	21.50
081879	0725	15775.	36.97	38.66	21.72
081879	1900	16470.	37.18	38.49	21.89
081979	0935	17345.	37.41	38.22	22.16
081979	1910	17920.	37.66	37.97	22.41
082079	0720	18650.	37.95	37.68	22.70
082079	1900	19350.	38.18	37.53	22.85
082179	0720	20090.	38.10	37.53	22.85
082179	1930	20810.	38.11	37.52	22.86
082279	1810	22180.	38.40	37.23	23.15
082379	1815	23036.	38.74	36.89	24.49
082479	1900	25110.	38.51	37.02	23.36
082579	1720	26450.	39.40	36.23	24.15
082679	1825	27955.	40.99	34.64	25.74
082779	1830	29400.	41.57	34.06	26.32
082879	1840	30850.	41.37	34.26	26.12
082979	1835	32285.	41.83	34.20	26.18
083079	1835	33725.	41.11	34.52	25.86
083179	1600	35010.	40.69	34.98	25.48
090179	0945	36075.	41.00	34.63	25.75
090279	0945	37515.	40.77	34.86	25.52
090379	0950	38960.	40.42	35.21	25.17
090479	1005	40405.	39.75	35.88	24.50
090579	1400	42090.	39.96	35.67	24.71
090779	1725	45175.	38.07	37.56	22.82
090979	0915	47565.	37.67	37.96	22.42
091179	0825	50395.	37.75	37.88	22.50
091379	0845	53295.	37.99	37.64	22.74
091579	1125	56335.	39.03	36.20	24.18
091779	1425	59395.	40.34	35.29	25.09
091979	1145	62115.	41.01	34.62	25.76
092179	0910	64840.	38.96	36.67	23.71
092579	1325	70855.	38.06	37.57	22.81
092779	0835	73445.	37.57	38.06	22.32
092979	1050	76700.	37.40	38.23	22.15
100179	1410	79540.	37.08	38.55	21.83
100379	1040	82210.	35.55	40.08	20.30
100579	1310	85240.	36.32	39.31	21.07
100779	1000	88170.	36.82	38.81	21.57
100979	0940	90790.	37.53	38.10	22.28
101179	1245	93656.	38.31	37.32	23.06
101679	1825	101395.	40.75	34.88	25.50
101879	1355	104005.	41.83	33.80	26.58
102079	1405	106895.	42.70	32.93	27.45
102279	1340	109750.	42.54	33.08	27.30
102479	1425	112675.	42.78	32.85	27.53
102679	0815	115185.	43.14	32.49	27.89
102879	1555	118525.	44.32	31.31	29.07
103079	0920	121010.	44.93	30.70	29.68
110179	1145	124035.	45.61	30.02	30.36

2.4C-76

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
RW-3A	75.65	15.25	550713N · 2714048	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
110279	0930	125340.	46.20	29.43	30.95
110479	0805	128135.	46.95	28.68	31.70
110679	0805	131015.	47.50	28.07	32.31
110879	0815	133905.	47.94	27.69	32.69
111379	1030	141200.	46.17	29.46	30.92
111679	0800	145410.	45.00	30.63	29.75
112079	0940	159410.	43.47	32.16	28.22
112979	0945	164235.	42.63	33.00	27.38
121079	1140	180190.	50.50	34.33	21.05
121379	1400	184650.	36.48	39.15	21.23

2.4C-77

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
RW-3H	76.09	15.12	5506SUN ' 2715AVE	080779	0850

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080179	0000	-8670.	19.75	56.34	4.63
080279	0000.	-7230.	19.32	56.77	4.20
080379	0000	-5790.	18.42	57.67	3.30
080479	0000	-4350.	17.38	58.71	2.26
080579	0000	-2910.	16.54	59.55	1.42
080679	1015	-1335.	15.67	60.42	.55
080779	0748	-82.	15.12	60.97	.00
080779	0850	20.	19.20	56.89	4.08
080779	0951	81.	21.50	54.59	6.38
080779	1050	140.	21.73	54.36	6.61
080779	1205	215.	21.55	54.54	6.43
080779	1254	264.	22.20	53.89	7.08
080779	1350	320.	22.35	53.74	7.23
080779	1445	375.	22.45	53.64	7.33
080779	1545	435.	22.57	53.52	7.45
080779	1815	585.	22.87	53.22	7.75
080779	2115	765.	23.11	52.98	7.99
080779	2300	870.	23.23	52.86	8.11
080879	0130	1020.	23.40	52.69	8.28
080879	0515	1245.	23.62	52.47	8.50
080879	0830	1440.	23.62	52.47	8.50
080879	1400	1770.	24.97	51.12	9.85
080879	2115	2205.	26.78	49.31	11.66
080979	0300	2550.	26.18	49.91	11.06
080979	0845	2895.	28.47	47.62	13.35
080979	1730	3420.	29.35	46.74	14.23
081079	0045	3855.	27.25	48.84	12.13
081079	0730	4260.	28.02	48.07	12.90
081079	1225	4555.	28.16	47.93	13.04
081079	1845	4935.	29.93	46.16	14.81
081179	0030	5280.	30.12	45.97	15.00
081179	0630	5640.	30.42	45.67	15.30
081179	1350	6080.	30.73	45.36	15.61
081179	1840	6570.	30.99	45.10	15.87
081279	0030	6720.	31.28	44.81	16.16
081279	1350	7520.	31.85	44.24	16.73
081279	1835	7805.	32.05	44.04	16.93
081379	0015	8145.	31.33	44.76	16.21
081379	0700	8550.	32.38	43.71	17.26
081379	1320	8930.	32.64	43.45	17.52
081379	2030	9360.	32.90	43.19	17.78
081479	0015	9585.	32.98	43.11	17.86
081479	0645	9975.	33.03	43.06	17.91
081479	1900	10710.	33.40	42.69	18.28
081579	0805	11495.	33.04	43.00	17.97
081579	1825	12115.	34.19	41.90	19.07
081679	0815	12945.	34.90	41.19	19.78
081679	1850	13580.	34.43	41.66	19.31
081779	0725	14335.	34.56	41.53	19.44
081779	1850	15020.	34.67	41.42	19.55

2.4C-78

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
RM-3M	76.09	15.12	550650N 271569E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
081879	0725	15775.	34.90	41.19	19.78
081879	1900	16470.	35.07	41.02	19.95
081979	0940	17350.	35.33	40.76	20.21
081979	1910	17920.	35.55	40.54	20.43
082079	0720	18650.	35.83	40.26	20.71
082079	1900	19350.	35.96	40.13	20.84
082179	0720	20090.	36.05	40.06	20.91
082179	1925	20815.	35.67	40.42	20.55
082279	1815	22185.	36.36	39.73	21.24
082379	1815	23625.	35.98	40.11	20.86
082479	1900	25110.	37.28	38.81	22.16
082579	1715	26445.	35.60	40.49	20.48
082679	1825	27955.	39.04	37.05	23.92
082779	1835	29405.	39.56	36.53	24.44
082879	1840	30850.	39.41	36.68	24.29
082979	1835	32285.	39.63	36.46	24.51
083079	1835	33725.	39.21	36.88	24.09
083179	1600	35010.	38.85	37.24	23.73
090179	0950	36480.	39.08	37.01	23.96
090279	0945	37915.	38.77	37.32	23.65
090379	0955	39365.	38.37	37.72	23.25
090479	1450	40700.	37.75	38.34	22.63
090579	1805	42095.	37.15	38.94	22.03
090779	1725	45175.	36.12	39.97	21.00
090979	0915	47565.	35.72	40.37	20.60
091179	0825	50395.	35.78	40.31	20.66
091379	0845	53295.	36.43	39.66	21.31
091579	1120	56330.	37.47	38.62	22.35
091779	1425	59395.	38.52	37.57	23.40
091979	1140	62110.	39.14	36.95	24.02
092179	0915	64845.	37.12	38.97	22.00
092579	1330	70860.	36.14	39.95	21.02
092779	0835	73445.	35.67	40.42	20.55
092979	1450	76700.	35.48	40.61	20.36
100179	1410	79540.	35.16	40.93	20.04
100379	1040	82210.	33.77	42.32	18.65
100579	1310	85240.	34.39	41.70	19.27
100779	1400	88170.	34.85	41.24	19.73
100979	0940	90790.	35.51	40.58	20.39
101179	1245	93855.	36.25	39.84	21.13
101679	1825	101395.	38.00	37.43	23.54
101879	1350	104000.	39.73	36.36	24.61
102079	1405	106895.	40.52	35.57	25.40
102279	1340	109750.	40.48	35.61	25.36
102479	1425	112675.	40.61	35.48	25.49
102679	0815	115185.	40.92	35.17	25.80
102879	1555	118525.	42.01	34.08	26.89
103079	0920	121010.	42.64	33.45	27.52
110179	1145	124035.	43.35	32.74	28.23
110279	0930	125340.	43.92	32.17	28.80

2.4C-79

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
MW-3M	76.09	15.12	5506SUN 2713694E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
110479	0805	128135.	46.65	31.00	29.53
110579	0805	131015.	45.20	30.89	30.08
110879	0815	133905.	45.57	30.52	30.45
111579	1030	141240.	43.79	32.30	28.67
111679	0800	145410.	42.53	33.56	27.41
112079	0945	154915.	40.79	35.30	25.67
112979	0940	164230.	40.12	35.97	25.00
121079	1140	180190.	33.38	42.71	18.26
121379	1400	184650.	33.65	42.44	18.53

2.4C-80

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
RW-5A	77.08	18.34	553095N 2123826E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080179	0000	-8670.	22.50	54.58	4.16
080279	0000	-7230.	22.27	54.81	3.93
080379	0000	-5790.	21.51	55.57	3.17
080479	0000	-4350.	20.80	56.28	2.46
080579	0000	-2910.	19.73	57.35	1.39
080679	1105	-1285.	18.72	58.36	.38
080779	0754	-36.	18.34	58.74	.00
080779	0857	27.	18.29	58.79	-.05
080779	1006	96.	18.25	58.83	-.09
080779	1103	153.	22.15	54.93	3.81
080779	1238	298.	22.68	54.40	4.34
080779	1335	305.	23.02	54.06	4.68
080779	1431	361.	23.21	53.87	4.87
080779	1532	422.	23.37	53.71	5.03
080779	1635	485.	23.56	53.52	5.22
080779	1848	618.	23.90	53.18	5.56
080779	2044	738.	24.10	52.98	5.76
080779	2249	859.	24.19	52.89	5.85
080879	0100	990.	24.35	52.73	6.01
080879	0500	1230.	24.58	52.50	6.24
080879	0815	1425.	24.69	52.39	6.35
080879	1330	1740.	25.69	51.39	7.35
080879	2200	2250.	27.60	49.48	9.26
080979	0300	2550.	28.26	48.82	9.92
080979	0830	2880.	28.65	48.43	10.31
080979	1800	3450.	29.20	47.88	10.86
081079	0030	3540.	29.12	47.96	10.78
081079	0730	4260.	28.51	48.57	10.17
081079	1245	4575.	28.72	48.36	10.38
081079	1905	4955.	29.55	47.53	11.21
081179	0030	5280.	29.77	47.31	11.43
081179	0615	5625.	30.02	47.06	11.68
081179	1410	6100.	30.15	46.93	11.81
081179	1900	6390.	30.34	46.74	12.00
081279	0030	6720.	30.44	46.64	12.10
081279	0630	7080.	30.75	46.33	12.41
081279	1255	7465.	31.11	45.97	12.77
081279	1900	7830.	31.14	45.94	12.80
081279	2400	8130.	30.45	46.63	12.11
081379	0630	8520.	31.46	45.62	13.12
081379	1300	8910.	31.68	45.40	13.34
081379	2050	9360.	31.72	45.36	13.38
081479	0015	9585.	31.81	45.27	13.47
081479	0645	9975.	31.82	45.26	13.48
081479	1835	10685.	31.77	45.31	13.43
081579	0745	11475.	32.40	44.68	14.06
081579	1810	12100.	33.02	44.06	14.68
081679	0735	12905.	33.65	43.43	15.31
081679	1850	13560.	34.00	43.08	15.66
081779	0705	14315.	34.48	42.60	16.14

2.4C-81

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
RW-5A	77.08	18.38	553095N 272582E	082779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
081779	1830	15000.	32.08	45.00	13.74
081879	0710	15760.	34.91	42.17	16.57
081879	1800	16650.	35.23	41.85	16.89
081979	0920	17330.	35.61	41.47	17.27
081979	1900	17910.	35.86	41.20	17.54
082079	0710	18640.	35.97	41.11	17.63
082079	1850	19300.	36.06	41.00	17.72
082179	0710	20080.	36.24	40.84	17.90
082179	1910	20600.	33.38	43.70	15.04
082279	1800	22170.	32.14	44.94	13.80
082379	1805	23615.	33.63	43.45	15.29
082479	1805	25055.	35.79	41.29	17.45
082579	1755	26485.	37.63	39.45	19.29
082679	1810	27940.	38.71	38.37	20.37
082779	1815	29385.	37.80	39.28	19.46
082879	1815	30825.	37.64	39.44	19.30
082979	1810	32260.	38.69	38.39	20.35
083079	1815	33705.	36.71	40.37	18.37
083179	1550	35000.	32.38	44.70	14.04
090179	0935	36065.	31.25	45.83	12.91
090279	0930	37500.	30.38	46.70	12.04
090379	0940	38950.	29.92	47.16	11.58
090479	1020	40470.	31.96	45.62	13.12
090579	1345	42075.	30.00	47.08	11.66
090779	1655	45145.	31.95	45.13	13.61
090979	0830	47520.	32.65	44.43	14.31
091179	0900	50430.	30.31	46.77	11.97
091379	0810	53260.	33.77	43.31	15.43
091579	1200	56370.	32.97	44.11	14.63
091779	1510	59440.	36.32	40.76	17.98
091979	1240	62170.	38.23	38.85	19.89
092179	0825	64795.	38.02	39.06	19.68
092579	1055	70705.	33.57	43.51	15.23
092779	1015	73545.	32.78	44.30	14.44
092979	1530	76740.	33.20	43.88	14.86
100179	1440	79570.	32.69	44.39	14.35
100379	1055	82225.	27.20	49.88	8.86
100579	1320	85250.	29.30	47.78	10.96
100779	1435	88205.	31.17	45.91	12.83
100979	1015	90825.	32.04	45.04	13.70
101179	1315	93885.	33.06	44.02	14.72
101679	1855	101425.	30.73	46.35	12.39
101879	1855	104085.	37.31	39.77	18.47
102079	1525	106975.	38.32	38.76	19.98
102279	1855	109825.	39.20	37.88	20.86
102479	1740	112870.	39.57	37.51	21.23
102679	0840	115210.	37.66	39.42	19.32
102879	1625	118555.	37.04	40.04	18.70
103079	1000	121050.	34.33	42.75	15.99
110179	1200	124050.	34.25	42.83	15.91

2.4C-82

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
RW-5A	77.08	18.39	553095N 2123R2E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
110279	1020	125390.	57.43	39.65	14.09
110479	0850.	128180.	42.68	34.40	24.34
110679	0910	131080.	41.67	35.41	23.33
110879	0850	133940.	43.95	33.13	25.01
111379	1120	141290.	42.18	38.44	23.80
111679	0845	145455.	40.93	36.15	22.59
112079	1045	159975.	37.77	39.31	19.43
112979	1030	169280.	35.63	41.45	17.29
121079	1545	180435.	28.52	48.56	10.18
121379	1440	184690.	30.85	46.23	12.51

2.4C-83

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
RW-5R	77.08	19.05	553035N 272558E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080179	0000	-8670.	23.13	53.95	4.08
080279	0000	-7250.	22.92	54.16	3.87
080379	0000	-5790.	22.20	54.88	3.15
080479	0000	-4350.	21.48	55.60	2.43
080579	0000	-2910.	20.42	56.66	1.37
080679	1110	-1280.	19.41	57.67	.36
080779	0757	-33.	19.05	58.03	.00
080779	0859	29.	19.00	58.08	-.05
080779	1010	100.	18.95	58.13	-.10
080779	1104	154.	21.99	55.09	2.94
080779	1245	205.	22.50	54.58	3.45
080779	1239	249.	22.83	54.25	3.78
080779	1438	364.	23.02	54.06	3.97
080779	1534	424.	23.18	53.90	4.13
080779	1640	490.	23.36	53.72	4.31
080779	1850	620.	23.64	53.44	4.59
080779	2047	737.	23.90	53.18	4.85
080779	2253	863.	24.00	53.08	4.95
080879	0100	990.	24.13	52.95	5.08
080879	0500	1230.	24.39	52.69	5.34
080879	0815	1425.	24.46	52.62	5.41
080879	1335	1745.	25.25	51.83	6.20
080879	2200	2250.	24.97	50.11	7.92
080979	0300	2550.	26.35	50.73	7.30
080979	0830	2880.	27.92	49.16	8.87
080979	1805	3455.	28.52	48.56	9.47
081079	0030	3840.	28.24	48.84	9.19
081079	0730	4260.	27.96	49.12	8.91
081079	1250	4580.	28.17	48.91	9.12
081079	1905	4955.	28.91	48.17	9.86
081179	0030	5280.	29.12	47.96	10.07
081179	0615	5625.	29.94	47.14	10.89
081179	1810	6100.	29.53	47.55	10.48
081179	1855	6385.	29.71	47.37	10.66
081279	0030	6720.	29.88	47.20	10.83
081279	0630	7080.	30.12	46.96	11.07
081279	1300	7470.	30.49	46.59	11.44
081279	1855	7825.	30.56	46.52	11.51
081279	2400	8130.	29.98	47.10	10.93
081379	0645	8535.	30.83	46.25	11.78
081379	1300	8910.	31.05	46.03	12.00
081379	2050	9380.	31.21	45.87	12.16
081479	0015	9585.	31.26	45.82	12.21
081479	0645	9975.	31.28	45.80	12.23
081479	1840	10690.	31.27	45.81	12.22
081579	0745	11475.	31.90	45.18	12.85
081579	1815	12105.	32.08	44.60	13.43
081679	0740	12910.	33.07	44.01	14.02
081679	1830	13560.	33.42	43.66	14.37
081779	0710	14320.	33.93	43.15	14.88

2.4C-84

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
RM-5R	77.00	19.05	553035N - 272350E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
081779	1835	15005.	32.07	45.01	13.02
081879	0715	15765.	34.40	42.68	15.35
081879	1240	16450.	34.00	42.40	15.03
081979	0920	17330.	35.06	42.02	16.01
081979	1900	17910.	35.32	41.76	16.27
082079	0710	18640.	35.44	41.64	16.39
082079	1850	19340.	35.55	41.53	16.50
082179	0710	20080.	35.71	41.37	16.66
082179	1915	20805.	33.48	43.60	14.43
082279	1800	22170.	32.15	44.93	13.10
082379	1805	23615.	33.30	43.78	14.25
082479	1810	25060.	35.33	41.75	16.28
082579	1755	26485.	37.12	39.96	18.07
082679	1810	27940.	38.20	38.88	19.15
082779	1815	29385.	37.29	39.79	18.24
082879	1815	30825.	37.19	39.89	18.14
082979	1815	32265.	38.20	38.88	19.15
083079	1815	33705.	36.45	40.63	17.40
083179	1550	35000.	32.58	44.50	13.53
090179	0940	36070.	31.42	45.66	12.37
090279	0935	37505.	30.56	46.52	11.51
090379	0945	38955.	30.12	46.96	11.07
090479	1025	40475.	31.15	45.93	12.10
090579	1450	42140.	30.21	46.87	11.16
090779	1655	45145.	31.50	45.52	12.51
090979	0830	47520.	32.21	44.87	13.16
091179	0900	50430.	30.42	46.66	11.37
091379	0810	53260.	33.30	43.78	14.25
091579	1200	56370.	33.00	44.00	14.03
091779	1510	59440.	35.96	41.12	16.91
091979	1240	62170.	37.84	39.24	18.79
092179	0825	64795.	37.71	39.37	18.66
092579	1055	70705.	33.27	43.81	14.22
092779	1015	73545.	32.46	44.62	13.41
092979	1530	76740.	32.88	44.20	13.83
100179	1440	79570.	32.37	44.71	13.32
100379	1055	82225.	27.49	49.59	8.44
100579	1320	85250.	29.12	47.96	10.07
100779	1435	88205.	30.91	46.17	11.86
100979	1015	90825.	31.71	45.37	12.66
101179	1315	93685.	32.76	44.32	13.71
101679	1855	101425.	30.98	46.10	11.93
101879	1450	104060.	36.81	40.27	17.76
102079	1525	106975.	37.83	39.25	18.78
102279	1455	109825.	38.71	38.37	19.66
102479	1740	112870.	39.06	38.02	20.01
102679	0840	115210.	37.80	39.28	18.75
102879	1625	118555.	36.91	40.17	17.86
103079	1000	121050.	34.53	42.55	15.48
110179	1200	124050.	34.54	42.54	15.49

2.4C-85

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
RW-5M	77.08	14.45	553453N, 272354E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
110279	1020	125390.	33.03	44.05	13.98
110479	0850	12M180.	42.10	34.98	23.05
110679	0910	131080.	41.20	35.88	22.15
110879	0950	134000.	43.40	33.68	24.35
111379	1120	141290.	41.54	35.49	22.54
111679	0845	145455.	40.34	36.74	21.29
112079	1040	159970.	37.37	39.71	18.32
112979	1030	164280.	35.23	41.85	16.18
121079	1545	180435.	27.90	49.18	8.85
121579	1440	184690.	30.00	47.08	10.95

2.03.86

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
PW-6A	71.22	11.17	549611N 2711718E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080179	0000	-8670.	15.87	55.35	4.70
080279	0000	-7230.	15.58	55.64	4.41
080379	0000	-5790.	14.80	56.42	3.63
080479	0000	-4350.	13.57	57.65	2.40
080579	1415	-2535.	12.58	58.64	1.41
080679	0950	-1360.	11.90	59.32	.73
080779	0739	-51.	11.17	60.05	.00
080779	0906	36.	11.20	59.98	.09
080779	1000	90.	11.29	59.93	.12
080779	1100	150.	11.40	59.82	.23
080779	1210	224.	11.53	59.69	.36
080779	1311	281.	11.57	59.65	.40
080779	1408	338.	11.58	59.64	.41
080779	1500	390.	11.61	59.61	.44
080779	1600	450.	11.69	59.53	.52
080779	1830	600.	11.83	59.39	.66
080779	2128	778.	11.90	59.32	.73
080779	2320	890.	11.94	59.28	.77
080879	0130	1020.	11.85	59.37	.68
080879	0545	1275.	11.92	59.30	.75
080879	0830	1440.	11.94	59.28	.77
080879	1420	1790.	12.02	59.20	.85
080879	2050	2180.	12.18	59.04	1.01
080979	0300	2550.	12.26	58.96	1.09
080979	0900	2910.	12.36	58.86	1.19
080979	1710	3400.	12.53	58.69	1.36
081079	0100	3870.	12.54	58.68	1.37
081079	0800	4290.	12.54	58.68	1.37
081079	1210	4540.	12.72	58.50	1.55
081079	1825	4915.	12.85	58.37	1.68
081179	0100	5310.	12.92	58.30	1.75
081179	0645	5655.	13.02	58.20	1.85
081179	1335	6065.	13.16	58.06	1.99
081179	1825	6355.	13.30	57.92	2.13
081279	0045	6735.	13.52	57.70	2.35
081279	0700	7110.	13.68	57.54	2.51
081279	1400	7530.	13.90	57.32	2.73
081279	1820	7790.	14.04	57.18	2.87
081379	0030	8160.	14.13	57.09	2.96
081379	0700	8550.	14.56	56.66	3.39
081379	1335	8945.	14.78	56.44	3.61
081379	2015	9345.	15.05	56.17	3.88
081479	0030	9600.	15.19	56.03	4.02
081479	0700	9990.	15.22	56.00	4.05
081479	1915	10725.	15.62	55.60	4.45
081579	0825	11515.	15.95	55.27	4.78
081579	1835	12125.	16.22	55.00	5.05
081679	0800	12930.	16.59	54.63	5.42
081679	1905	13595.	16.92	54.30	5.75
081779	0740	14350.	17.06	54.16	5.89

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
PW-6A	71.22	11.17	549611N 1211171E	080779	0850

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
081779	1910	15040.	17.42	53.80	6.25
081879	0745	15795.	17.69	53.53	6.52
081879	1920	16490.	17.80	53.42	6.63
081979	1000	17370.	18.08	53.14	6.91
081979	1930	17940.	18.17	53.05	7.00
082079	0740	18670.	18.37	52.85	7.20
082079	1920	19370.	18.53	52.69	7.36
082179	0740	20110.	18.70	52.52	7.53
082179	1935	20825.	18.84	52.38	7.67
082279	1825	22195.	19.19	52.03	8.02
082379	1825	23635.	19.63	51.59	8.46
082479	1930	25140.	19.59	51.63	8.42
082579	1700	26430.	20.13	51.09	8.96
082679	1850	27980.	21.72	49.50	10.55
082779	1900	29630.	22.32	48.90	11.15
082879	1850	30860.	22.61	48.61	11.44
082979	1850	32600.	22.55	48.67	11.38
083079	1845	33735.	21.46	49.76	10.29
083179	1625	35035.	20.90	50.26	9.79
090179	1050	36140.	21.08	50.14	9.91
090279	1000	37530.	20.54	50.68	9.37
090379	1010	38980.	19.92	51.30	8.75
090479	1505	40715.	19.42	51.80	8.25
090579	1420	42110.	19.00	52.22	7.83
090779	1755	45205.	17.94	53.28	6.77
090979	0940	47590.	17.55	53.67	6.38
091179	0755	50365.	17.98	53.24	6.81
091379	0910	53320.	18.99	52.23	7.82
091579	1100	56310.	20.00	51.22	8.83
091779	1350	59360.	21.19	50.03	10.02
091979	1115	62085.	22.08	49.14	10.91
092179	1130	64980.	21.52	49.70	10.35
092579	1350	70885.	18.51	52.71	7.34
092779	0820	73430.	17.96	53.26	6.79
092979	1030	76680.	17.54	53.70	6.35
100179	1330	79500.	17.60	53.62	6.43
100379	1235	82325.	17.05	54.17	5.88
100579	1710	85490.	16.67	54.55	5.50
100779	1335	88145.	16.97	54.25	5.80
100979	0915	90765.	18.18	53.04	7.01
101179	1220	93830.	19.07	52.15	7.90
101679	1805	101375.	21.41	49.81	10.24
101879	1320	103970.	22.29	48.93	11.12
102079	1335	106865.	22.45	48.77	11.28
102279	1315	109725.	22.91	48.31	11.74
102479	1700	112630.	23.24	47.98	12.07
102679	0755	115165.	23.37	47.85	12.20
102879	1535	118505.	24.10	47.12	12.93
103079	0940	120990.	25.39	45.83	14.22
110279	0905	125315.	26.73	44.49	15.56

6.4C-87

2.4C-88

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
PW-6A	71.22	11.17	549611N ' 271171E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
110479	0740	128110.	26.94	44.28	15.77
110679	0745	130995.	27.45	43.79	16.26
110879	0750	133880.	27.71	43.51	16.54
111379	1000	141210.	25.67	45.55	14.50
111679	0725	145575.	24.27	46.95	13.10
112079	1015	159405.	22.04	49.18	10.87
112479	0915	164205.	21.23	49.99	10.06
121079	1100	180150.	13.39	57.83	2.22
121379	1335	184625.	13.47	57.25	2.80

2.4C-89

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
PW-6M	70.91	10.61	549588N , 271065E	080779	0850

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080179	0000	-8670.	15.46	55.45	4.85
080279	0000	-7230.	15.08	55.83	4.47
080379	0000	-5790.	14.17	56.74	3.56
080479	0000	-4350.	12.90	58.01	2.29
080579	1415	-2536.	11.81	59.10	1.20
080679	0945	-1365.	11.18	59.73	.57
080779	0909	39.	10.61	60.30	.00
080779	1003	93.	10.64	60.27	.03
080779	1102	152.	10.72	60.19	.11
080779	1215	225.	10.81	60.10	.20
080779	1310	280.	10.83	60.08	.22
080779	1405	335.	10.87	60.04	.26
080779	1455	385.	10.93	59.98	.32
080779	1555	445.	10.96	59.95	.35
080779	1825	595.	11.03	59.88	.42
080779	2126	776.	11.10	59.81	.49
080779	2315	885.	11.09	59.82	.48
080879	0130	1020.	11.03	59.88	.42
080879	0545	1275.	10.97	59.94	.36
080879	0830	1440.	11.02	59.89	.41
080879	1420	1790.	11.20	59.71	.59
080879	2045	2175.	11.29	59.62	.68
080979	0300	2550.	11.30	59.61	.69
080979	0900	2910.	11.43	59.48	.82
080979	1710	3420.	11.59	59.32	.98
081079	0100	3870.	11.49	59.42	.88
081079	0800	4290.	11.63	59.28	1.02
081079	1210	4540.	11.78	59.13	1.17
081079	1825	4915.	11.90	59.01	1.29
081179	0100	5310.	11.92	58.99	1.31
081179	0845	5855.	12.06	58.85	1.45
081179	1330	6060.	12.15	58.76	1.54
081179	1820	6350.	12.32	58.59	1.71
081279	0045	6735.	12.54	58.37	1.93
081279	0700	7110.	12.67	58.24	2.06
081279	1405	7535.	12.89	58.02	2.28
081279	1825	7795.	13.02	57.89	2.41
081379	0030	8160.	13.09	57.82	2.48
081379	0700	8550.	13.55	57.36	2.94
081379	1335	8945.	13.81	57.10	3.20
081379	2015	9385.	14.12	56.79	3.51
081479	0030	9600.	14.18	56.73	3.57
081479	0700	9990.	14.22	56.69	3.61
081479	1920	10750.	14.69	56.22	4.08
081579	0820	11510.	15.00	55.91	4.39
081579	1835	12125.	15.32	55.59	4.71
081679	0800	12930.	15.66	55.25	5.05
081679	1910	13600.	15.99	54.92	5.38
081779	0745	14355.	16.37	54.54	5.76
081779	1910	15040.	16.54	54.37	5.93

2.4C-90

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
PW-6R	70.91	10.61	5495R1N P7106SE	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
081879	0745	15795.	16.76	54.15	6.15
081879	1920	16490.	16.90	54.01	6.29
081979	1000	17370.	17.14	53.77	6.53
081979	1930	17940.	17.21	53.70	6.60
082079	0740	18670.	17.45	53.46	6.84
082079	1920	19370.	17.61	53.30	7.00
082179	0740	20110.	17.76	53.15	7.15
082179	1935	20825.	17.90	53.01	7.29
082279	1825	22195.	18.27	52.64	7.66
082379	1825	23635.	18.66	52.25	8.05
082479	1950	25140.	18.71	52.20	8.10
082579	1700	26430.	20.03	50.88	9.42
082679	1850	27980.	20.90	50.01	10.29
082779	1900	29430.	21.56	49.35	10.95
082879	1850	30860.	21.15	49.76	10.54
082979	1850	32300.	20.97	49.94	10.36
083079	1845	33735.	20.47	50.44	9.86
083179	1625	35035.	19.71	51.20	9.10
090179	1055	36145.	19.88	51.03	9.27
090279	0955	37525.	19.29	51.62	8.68
090379	1010	38980.	18.67	52.24	8.06
090479	1505	40715.	18.25	52.66	7.64
090579	1815	42105.	17.58	53.33	6.97
090779	1755	45205.	16.57	54.34	5.96
090979	0940	47590.	16.21	54.70	5.60
091179	0755	50365.	16.71	54.20	6.10
091379	0910	53320.	17.81	53.10	7.20
091579	1100	56310.	18.97	51.94	8.36
091779	1350	59360.	20.25	50.66	9.64
091979	1115	62085.	21.15	49.76	10.54
092179	1130	64980.	20.43	50.48	9.82
092579	1350	70880.	17.21	53.70	6.60
092779	0820	73430.	16.65	54.26	6.04
092979	1430	76680.	16.15	54.76	5.54
100179	1330	79500.	16.31	54.60	5.70
100379	1235	82325.	15.80	55.11	5.19
100579	1710	85480.	15.55	55.36	4.94
100779	1335	88145.	15.72	55.19	5.11
100979	0915	90765.	17.08	53.83	6.47
101179	1220	93830.	18.04	52.87	7.43
101679	1805	101375.	20.50	50.41	9.89
101879	1320	103970.	21.43	49.48	10.82
102079	1335	106865.	21.43	49.48	10.82
102279	1315	109725.	21.93	48.98	11.32
102479	1700	112830.	22.22	48.69	11.61
102679	0755	115165.	22.48	48.43	11.87
102879	1535	118505.	23.14	47.77	12.53
113079	0900	165630.	24.61	46.30	14.00
110279	0905	125315.	25.97	44.94	15.36
110479	0740	128110.	26.14	44.77	15.53

2.4C-91

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
P####B	70.91	10.61	5895N / 2710E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
110679	0745	130995.	26.55	44.36	15.94
110879	0750.	133800.	26.72	44.19	16.11
111379	1000	141210.	24.48	46.43	13.87
111679	0725	145375.	22.91	48.00	12.30
112079	1010	159040.	20.71	50.20	10.10
112979	0915	164205.	19.78	51.13	9.17
121079	1100	180150.	11.91	59.00	1.30
121379	1335	184625.	12.65	58.26	2.04

2.HC-92

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
PW-7A	72.30	12.79	5511RON 2/1967E	080779	0850

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080179	0000	-8670.	16.02	56.34	3.28
080279	0000	-7230.	15.85	56.51	3.11
080379	0000	-5790.	15.34	57.02	2.60
080479	0000	-4350.	14.65	57.71	1.91
080579	1000	-2550.	13.97	58.39	1.23
080679	1050	-1300.	13.31	59.05	.57
080779	0809	-26.	12.74	59.62	.00
080779	0909	34.	13.27	59.09	.53
080779	1020	110.	13.75	58.61	1.01
080779	1118	168.	13.96	58.40	1.22
080779	1253	243.	14.18	58.18	1.44
080779	1356	326.	14.28	58.08	1.54
080779	1500	390.	14.37	57.99	1.63
080779	1548	438.	14.43	57.93	1.69
080779	1653	503.	14.51	57.85	1.77
080779	1904	634.	14.64	57.72	1.90
080779	2100	750.	14.78	57.58	2.04
080779	2330	900.	14.85	57.51	2.11
080879	0145	1035.	14.94	57.42	2.20
080879	0600	1290.	14.92	57.44	2.18
080879	0930	1500.	15.12	57.24	2.38
080879	1350	1760.	15.38	56.98	2.64
080879	2120	2210.	15.88	56.48	3.14
080979	0330	2580.	16.13	56.23	3.39
080979	0900	2910.	16.41	55.95	3.67
080979	1750	3440.	16.70	55.66	3.96
081079	0115	3885.	16.60	55.76	3.86
081079	0845	4335.	16.79	55.57	4.05
081079	1215	4565.	16.80	55.56	4.06
081079	1850	4940.	17.14	55.22	4.40
081179	0100	5310.	17.38	54.98	4.64
081179	0630	5640.	17.53	54.83	4.79
081179	1355	6085.	17.64	54.72	4.90
081179	1850	6380.	17.85	54.51	5.11
081279	0100	6750.	17.93	54.43	5.19
081279	0715	7125.	18.02	54.34	5.28
081279	1315	7485.	18.41	53.95	5.67
081279	1845	7815.	18.59	53.77	5.85
081379	0045	8175.	18.69	53.67	5.95
081379	0715	8565.	18.95	53.41	6.21
081379	1315	8925.	19.06	53.30	6.32
081379	2045	9375.	19.34	53.02	6.60
081479	0100	9630.	19.32	53.04	6.58
081479	0700	9990.	19.46	52.90	6.72
081479	1855	10705.	19.65	52.71	6.91
081579	0755	11485.	20.02	52.34	7.28
081579	1840	12130.	20.20	52.10	7.52
081679	0820	12950.	20.67	51.69	7.93
081679	1920	13610.	20.92	51.44	8.18
081779	0755	14365.	21.12	51.24	8.38

2.4C-93

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
PW-7A	72.36	12.79	5513BUN : 2719675	080779	0830

DATE	HOUR	TIME AFTER PUMPING START(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
081779	1930	15060.	21.27	51.09	8.53
081879	0800	15810.	21.51	50.85	8.77
081879	1940	16510.	21.68	50.68	8.94
081979	1010	17380.	21.95	50.41	9.21
081979	1940	17950.	22.13	50.23	9.39
082079	0755	18685.	22.32	50.04	9.58
082079	1935	19[illegible].	22.51	49.85	9.77
082179	0755	20125.	22.71	49.65	9.97
082179	2005	20855.	22.91	49.45	10.17
082279	1835	22205.	23.12	49.24	10.38
082379	1835	23645.	23.47	48.89	10.73
082479	1815	25065.	23.90	48.46	11.16
082579	1750	26480.	24.46	47.90	11.72
082679	1815	27945.	25.07	47.29	12.33
082779	1825	29395.	25.60	46.76	12.86
082879	1825	30835.	25.91	46.45	13.17
082979	1825	32275.	26.06	46.30	13.32
083079	1825	33715.	25.35	47.01	12.61
083179	1655	35065.	25.14	47.22	12.40
090179	1235	36245.	25.62	46.74	12.88
090279	0935	37505.	25.54	46.82	12.80
090379	1035	39005.	25.42	46.94	12.68
090479	1440	40690.	25.00	47.36	12.26
090579	1400	42090.	24.79	47.57	12.05
090779	1700	45150.	24.03	48.33	11.29
090979	0840	47530.	23.83	48.53	11.09
091179	0850	50420.	23.68	48.68	10.94
091379	0820	53270.	24.09	48.27	11.35
091579	1150	56300.	24.79	47.57	12.05
091779	1455	59425.	25.50	46.86	12.76
091979	1225	62155.	26.19	46.17	13.45
092179	0850	64820.	25.81	46.55	13.07
092579	1300	70630.	24.52	47.84	11.78
092779	1005	73535.	24.09	48.27	11.35
092979	1515	76725.	23.86	48.50	11.12
100179	1430	79560.	23.56	48.80	10.82
100379	1310	82360.	22.89	49.47	10.15
100579	1740	85510.	22.78	49.58	10.04
100779	1425	88195.	22.96	49.40	10.22
100979	1005	90815.	23.33	49.03	10.59
101179	1305	93675.	23.81	48.55	11.07
101679	1845	101415.	25.40	46.96	12.66
101879	1435	104045.	26.13	46.23	13.39
102079	1515	106965.	26.86	45.50	14.12
102279	1440	109810.	27.30	45.06	14.56
102479	1725	112855.	27.61	44.75	14.87
102679	0830	115200.	27.89	44.47	15.15
102879	1615	118545.	28.69	43.67	15.95
103079	0950	121040.	29.22	43.14	16.48
110279	1010	125340.	30.03	42.33	17.29

2.4C-94

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
PW-7A	72.30	12.79	5511RUN 271467E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
110479	0835	128105.	30.72	41.64	17.98
110679	0900	131070.	31.31	41.05	18.57
110879	0835	133425.	31.82	40.54	19.08
111379	1100	141270.	31.44	40.92	18.70
111679	0835	145085.	30.63	41.73	17.89
112679	0920	159890.	29.14	43.22	16.40
112979	1015	164265.	28.41	43.95	15.67
121079	1240	180250.	21.73	50.63	8.99
121379	1430	184680.	20.95	51.41	8.21

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
Pw-MA	78.43	14.57	552152N 2122222E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080179	0000	-8670.	23.08	55.35	8.51
080279	0000	-7230.	22.94	55.49	8.37
080379	0000	-5790.	22.29	56.14	7.72
080479	0000	-4350.	21.74	56.69	7.17
080579	1350	-2580.	20.18	58.25	5.61
080679	1100	-1290.	20.00	58.43	5.43
080779	0808	-26.	19.57	58.86	5.00
080779	0904	34.	19.57	58.86	5.00
080779	1015	105.	19.53	58.90	4.96
080779	1111	161.	19.50	58.93	4.93
080779	1246	256.	19.55	58.88	4.98
080779	1349	319.	19.52	58.91	4.95
080779	1455	385.	19.51	58.92	4.94
080779	1542	432.	19.50	58.93	4.93
080779	1647	497.	19.53	58.90	4.96
080779	1858	628.	19.52	58.91	4.95
080779	2055	746.	19.59	58.84	5.02
080779	2345	915.	19.60	58.83	5.03
080879	0200	1050.	19.52	58.91	4.95
080879	0600	1290.	19.62	58.81	5.05
080879	0930	1500.	19.59	58.84	5.02
080879	1343	1753.	19.57	58.86	5.00
080879	2130	2220.	19.71	58.70	4.86
080979	0330	2580.	19.81	58.62	4.78
080979	0915	2925.	19.78	58.65	4.81
080979	1755	3445.	19.93	58.50	4.96
081079	0115	3885.	20.00	58.43	5.03
081079	0845	4335.	20.11	58.32	5.14
081079	1240	4570.	20.12	58.31	5.15
081079	1855	4945.	20.24	58.19	5.27
081179	0100	5310.	20.29	58.14	5.32
081179	0630	5640.	20.45	57.98	5.48
081179	1400	6090.	20.56	57.87	5.59
081179	1855	6585.	20.71	57.72	5.74
081279	0100	6750.	20.83	57.60	5.86
081279	0715	7125.	20.86	57.57	5.89
081279	1310	7480.	21.19	57.24	6.22
081279	1850	7820.	21.36	57.07	6.39
081379	0100	8190.	21.58	56.89	6.57
081379	0730	8580.	21.74	56.69	6.77
081379	1310	8920.	21.89	56.58	6.92
081379	2040	9370.	22.16	56.27	7.19
081479	0100	9630.	22.20	56.23	7.23
081479	0715	10005.	22.25	56.18	7.28
081479	1850	10700.	22.55	55.88	7.58
081579	0750	11480.	22.95	55.48	7.98
081579	1815	12105.	23.12	55.31	8.15
081679	0745	12915.	23.59	54.84	8.62
081679	1840	13570.	23.88	54.59	8.87
081779	0715	14325.	24.23	54.20	9.06

2.4C-96

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
PW-8A	78.43	14.57	552152N 272222E	080779	0850

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
081779	1840	15010.	24.44	53.99	4.87
081879	0720	15770.	24.75	53.68	5.18
081879	1450	16460.	24.94	53.49	5.37
081979	0930	17340.	25.28	53.15	5.71
081979	1905	17915.	25.41	53.02	5.84
082079	0715	18645.	25.63	52.80	6.06
082079	1855	19345.	25.75	52.68	6.18
082179	0715	20085.	25.95	52.48	6.38
082179	2010	20860.	26.06	52.37	6.49
082279	1840	22210.	26.11	52.32	6.54
082379	1840	23650.	25.67	52.76	6.10
082479	1810	25060.	26.30	52.13	6.73
082579	1740	26470.	27.91	50.52	8.34
082679	1810	27940.	28.62	49.81	9.05
082779	1820	29390.	29.24	49.19	9.67
082879	1820	30830.	29.20	49.23	9.63
082979	1820	32270.	29.02	49.41	9.45
083079	1820	33710.	28.58	49.85	9.01
083179	1555	35005.	27.86	50.57	8.29
090179	1105	36155.	27.25	51.18	7.68
090279	1010	37540.	26.71	51.72	7.14
090379	1040	39010.	26.29	52.14	6.72
090479	1030	40480.	25.67	52.76	6.10
090579	1355	42085.	25.44	52.99	5.87
090779	1655	45145.	24.46	53.97	4.89
090979	0835	47525.	24.54	53.89	4.97
091179	0855	50425.	24.89	53.54	5.32
091379	0940	53350.	25.54	52.89	5.97
091579	1155	56305.	27.02	51.41	7.45
091779	1500	59430.	27.82	50.61	8.25
091979	1230	62160.	29.01	49.42	9.44
092179	0840	64810.	29.01	49.42	9.44
092579	1305	70835.	25.51	52.92	5.94
092779	1010	73540.	25.14	53.29	5.57
092979	1520	76730.	25.10	53.33	5.53
100179	1435	79565.	24.77	53.66	5.20
100379	1315	82365.	24.10	54.33	4.53
100579	1740	85510.	23.79	54.64	4.22
100779	1430	88200.	24.33	54.10	4.76
100979	1010	90820.	24.88	53.55	5.31
101179	1310	93840.	25.58	52.85	6.01
101679	1850	101420.	27.34	51.09	7.77
101879	1445	104055.	28.34	50.09	8.77
102079	1520	106970.	29.12	49.31	9.55
102279	1445	109815.	29.73	48.70	10.16
102479	1730	112860.	30.01	48.42	10.44
102679	0835	115205.	30.35	48.08	10.78
102879	1620	118550.	31.01	47.42	11.44
103079	0955	121045.	31.48	46.95	11.91
110279	1015	125385.	32.04	46.39	12.47

2.4C-97

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
PW-8A	78.43	14.57	552152N 272222E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
110479	0805	128175.	53.31	25.12	11.74
110679	0905	131075.	54.08	24.35	10.51
110879	0840	133930.	50.55	23.88	10.98
111379	1110	141280.	53.29	25.14	11.72
111679	0840	145450.	52.09	26.34	12.52
112679	0910	159880.	30.15	28.28	10.58
112979	1025	164275.	29.04	29.39	9.47
121079	1245	180255.	21.52	26.91	1.95
121379	1435	188685.	21.86	26.57	2.29

2.4C-98

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
TH-4	74.25	15.47	550408N -271475E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080179	0000	-8670.	15.67	58.58	-.20
080279	0000	-7230.	15.77	58.48	-.20
080379	0000	-5790.	15.94	58.29	-.03
080479	0000	-4350.	15.96	58.27	-.01
080579	0000	-2910.	16.00	58.23	.03
080679	1010	-1340.	15.96	58.27	-.01
080779	0745	-45.	15.97	58.26	.00
080779	0900	30.	15.99	58.24	.02
080779	0950	80.	15.96	58.27	-.01
080779	1054	144.	15.98	58.25	.01
080779	1209	219.	15.96	58.27	-.01
080779	1300	270.	15.95	58.28	-.02
080779	1400	330.	15.95	58.28	-.02
080779	1450	380.	15.94	58.29	-.03
080779	1550	440.	15.95	58.28	-.02
080779	1820	590.	16.10	58.13	.13
080779	2120	770.	15.98	58.25	.01
080779	2330	900.	16.03	58.20	.06
080879	0145	1035.	16.01	58.22	.04
080879	0545	1275.	16.02	58.21	.05
080879	0900	1470.	16.06	58.17	.09
080879	1410	1780.	16.09	58.14	.12
080879	2150	2280.	16.18	58.05	.21
080979	0330	2580.	16.27	57.96	.30
080979	0900	2910.	16.21	58.02	.24
080979	1720	3410.	16.32	57.91	.35
081079	0100	3870.	16.42	57.81	.45
081079	0800	4290.	16.50	57.73	.53
081079	1415	4865.	16.56	57.67	.59
081079	1835	4925.	16.62	57.61	.65
081179	0100	5310.	16.68	57.55	.71
081179	0645	5655.	16.80	57.43	.83
081179	1345	6075.	16.86	57.37	.89
081179	1835	6365.	16.94	57.29	.97
081279	0045	6735.	17.03	57.20	1.06
081279	0700	7110.	17.13	57.10	1.16
081279	1355	7525.	17.39	56.84	1.42
081279	1830	7800.	17.46	56.77	1.49
081379	0045	8175.	17.54	56.69	1.57
081379	0715	8565.	17.69	56.54	1.72
081379	1325	8935.	17.74	56.49	1.82
081379	2035	9365.	17.92	56.31	1.95
081479	0045	9615.	18.01	56.22	2.04
081479	0700	9990.	18.02	56.21	2.05
081479	1910	10720.	18.17	56.06	2.20
081579	0830	11520.	18.43	55.80	2.46
081579	1835	12125.	18.52	55.71	2.55
081679	0810	12940.	18.84	55.34	2.92
081679	1915	13605.	19.12	55.11	3.15
081779	0750	14360.	19.40	54.83	3.43

2.4C-99

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
IMW8	74.23	15.97	550400MU 2710752E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
081779	1920	15050.	19.60	54.63	5.63
081879	0755.	15805.	19.85	54.38	5.88
081879	1930	16500.	20.02	54.21	6.05
081979	1005	17375.	20.33	53.90	6.36
081979	1935	17945.	20.51	53.72	6.54
082079	0745	18675.	20.73	53.50	6.76
082079	1930	19380.	20.93	53.30	6.96
082179	0750	20120.	21.19	53.04	7.22
082179	1945	20835.	21.37	52.86	7.40
082279	1830	22200.	21.75	52.48	7.78
082379	1840	23640.	22.13	52.10	8.16
082479	1905	25115.	21.81	52.42	7.84
082579	1705	26435.	22.18	52.05	8.21
082679	1835	27965.	22.61	51.62	8.64
082779	1845	29415.	23.66	50.57	9.69
082879	1845	30855.	24.07	50.16	8.10
082979	1840	32290.	23.81	50.42	7.84
083079	1840	33730.	24.18	50.05	8.21
083179	1645	35055.	24.47	49.76	8.50
090179	1100	36150.	25.42	48.81	9.45
090279	1005	37535.	25.63	48.60	9.66
090379	1025	38995.	25.88	48.35	9.91
090479	1500	40710.	26.08	48.15	10.11
090579	1410	42100.	26.08	48.15	10.11
090779	1735	45185.	26.35	47.88	10.38
090979	0925	47575.	26.49	47.74	10.52
091179	0820	50390.	26.62	47.61	10.65
091379	0855	53305.	26.77	47.46	10.80
091579	1115	56325.	26.95	47.28	10.98
091779	1410	59380.	27.22	47.01	11.25
091979	1130	62100.	27.49	46.74	11.52
092179	0935	64865.	27.78	46.45	11.81
092579	1220	70790.	28.18	46.05	12.21
092779	0750	73400.	28.25	45.98	12.28
092979	1045	76095.	28.34	45.89	12.37
100179	1350	79520.	28.36	45.87	12.39
100379	1250	82340.	28.31	45.92	12.34
100579	1720	85490.	28.26	45.97	12.29
100779	1355	88165.	28.22	46.01	12.25
100979	0935	90785.	28.22	46.01	12.25
101179	1235	93645.	28.25	45.98	12.28
101679	1820	101390.	28.50	45.73	12.53
101879	1340	103990.	28.69	45.54	12.72
102079	1400	106690.	28.97	45.26	13.00
102279	1335	109285.	29.28	44.95	13.31
102479	1710	112040.	29.61	44.62	13.64
102679	0810	115180.	29.84	44.39	13.87
102879	1550	118520.	30.34	43.89	14.37
103079	0915	121005.	30.60	43.63	14.63
110279	0925	125335.	30.96	43.27	14.99

2.4C-100

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
IM-4	79.23	15.97	550400N 211475E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
110479	0755	128125.	31.35	42.88	15.38
110679	0800.	131010.	31.63	42.60	15.66
110879	0810	133990.	32.19	42.04	16.22
111379	1020	141230.	33.03	41.20	17.06
111679	0745	145395.	33.26	40.97	17.29
112679	0950	159420.	33.56	40.67	17.59
112979	0935	164225.	33.57	40.66	17.60
121079	1110	180160.	32.27	41.96	16.30
121379	1350	189690.	31.50	42.73	15.53

2.4C - 101

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
0A79-1L2	78.56	.00	5546537N 273092E	0807?9	0850

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
100579	1340	85270.	16.25	58.31	.00
100779	1510	88240.	16.63	57.93	.00
100979	1040	90850.	17.06	57.50	.00
101179	1330	93900.	17.65	56.91	.00
101679	1905	101436.	19.54	55.02	.00
101879	1520	104090.	20.28	54.28	.00
102079	1600	107010.	21.05	53.51	.00
102279	1535	109865.	21.63	52.93	.00
102479	1755	112685.	21.96	52.60	.00
102679	0850	115220.	22.25	52.31	.00
102879	1645	118575.	22.88	51.68	.00
103079	1250	121220.	23.60	50.96	.00
110279	1050	125420.	24.46	50.10	.00
110479	0915	128205.	25.21	49.35	.00
110679	0935	131105.	25.80	48.76	.00
110879	0905	133955.	26.18	48.38	.00
111379	1140	141310.	24.97	49.59	.00
111679	0910	145480.	23.67	50.89	.00
112079	1710	150360.	21.26	53.30	.00
112979	1055	164305.	20.36	54.20	.00
121079	1625	180475.	15.04	59.52	.00

R.4C-102

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
OW-4	77.99	7.50	5518SUN 2764WSE	080779	0930

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080679	0000	-1470.	7.50	70.40	.00
082079	0004	18210.	8.60	69.30	1.10
083179	0000	34050.	9.40	68.50	1.90
091479	0000	54210.	9.90	68.00	2.40
092879	0000	78370.	10.00	67.90	2.50
101279	0000	94530.	10.20	67.70	2.70
102679	0000	114690.	10.50	67.40	3.00
110979	0000	134850.	10.40	67.50	2.90
112679	0000	159330.	10.90	67.00	3.40
120779	0000	175170.	11.40	66.50	3.90

2.4C-163

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
DWR#A	78.00	4.20	SSIR3UN -2764R5E	0R0779	0R30

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
~~080679~~	~~0000~~	~~*1470.~~	~~9.20~~	~~68.80~~	~~.00~~
082079	0000	18210.	10.20	67.80	1.00
~~083179~~	~~0000~~	~~38050.~~	~~11.00~~	~~67.00~~	~~1.80~~
091479	0000	54210.	11.60	66.40	2.40
~~092879~~	~~0000~~	~~70470.~~	~~11.30~~	~~66.70~~	~~2.10~~
101279	0000	90530.	12.00	66.00	2.80
~~102679~~	~~0000~~	~~110690.~~	~~12.60~~	~~65.40~~	~~3.40~~
110979	0000	134850.	13.00	65.00	3.80
~~112679~~	~~0000~~	~~159330.~~	~~12.60~~	~~65.40~~	~~3.40~~
120779	0000	175170.	10.70	67.30	1.50

2.4C.104

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
DH-5	157.30	82.30	551200N 279200E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080679	0000	-1470.	82.30	75.00	.00
082079	0000	18210.	82.80	74.50	.50
083179	0000	34050.	83.10	74.20	.80
091479	0000	54210.	83.60	73.70	1.30
092679	0000	78370.	83.90	73.40	1.60
101279	0000	94530.	84.20	73.10	1.90
102679	0000	119090.	84.60	72.70	2.30
110979	0000	134850.	84.90	72.40	2.60
112679	0000	159330.	85.00	72.30	2.70
120779	0000	175170.	85.40	71.90	3.10

2.4C-105

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
OMW7	158.50	85.00	S485150 E2762HOE	080779	0850

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN.)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080679	0000	-1470.	85.00	72.90	.00
082079	0000	18210.	86.80	71.70	1.20
083179	0000	30050.	87.60	70.90	2.00
091479	0000	54210.	88.00	70.50	2.40
092879	0000	70370.	88.00	70.50	2.40
101279	0000	94530.	89.00	69.50	3.40
102679	0000	110690.	89.70	68.80	4.10
110979	0000	134850.	89.70	68.80	4.10
112679	0000	159330.	89.50	69.00	3.90
120779	0000	175170.	89.50	69.00	3.90

2.4C-106

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
DH-10	157.00	77.90	553070N '277440E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080679	0000	-1470.	77.90	79.10	.00
082079	0000	18210.	78.60	78.40	.70
083179	0000	34050.	79.10	77.90	1.20
091479	0000	54210.	79.60	77.40	1.70
092879	0000	74370.	79.90	77.10	2.00
101279	0000	94530.	80.20	76.80	2.30
102679	0000	114690.	80.70	76.30	2.80
110979	0000	134850.	80.70	76.30	2.80
112679	0000	159330.	80.80	76.20	2.90
120779	0000	175170.	81.70	75.30	3.80

2.4C-107

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
Dnm29A	162.70	97.80	5502SUH ' 2765 40E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080679	0000	*1670.	97.80	64.90	.00
082079	0000	18210.	98.80	63.90	1.00
083179	0000	34050.	98.80	63.90	1.00
091479	0000	54210.	100.20	62.50	2.40
092879	0000	74370.	99.40	63.30	1.60
101279	0000	94530.	100.30	62.40	2.50
102679	0000	114690.	103.50	59.20	5.70
110979	0000	134850.	103.50	59.20	5.70
112679	0000	159330.	101.80	60.90	4.00
120779	0000	175170.	103.10	59.60	5.30

2.4C-168

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES		START DATE	START TIME
DH-6°A	82.50	17.70	550245N	276245E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080679	0000	-1470.	17.70	64.80	.00
082079	0008	18210.	18.60	63.90	.90
083179	0000	34050.	19.30	63.20	1.60
091479	0000	54210.	19.90	62.60	2.20
092879	0000	70370.	20.50	62.00	2.80
101279	0000	90530.	21.20	61.30	3.50
102679	0000	110690.	22.30	60.20	4.60
110479	0000	130850.	22.40	60.10	4.70
112679	0000	159330.	22.30	60.20	4.60
120779	0000	175170.	22.60	59.90	4.90

2.4.-169

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COUNTY/STATE	START DATE	START TIME
Dm=202	194.00	116.90	SARTOUN '2794RUE	080779	0850

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080679	0000	14870.	116.90	77.10	.00
082079	0000	18210.	117.20	76.80	.30
083179	0000	34050.	117.50	76.50	.60
091479	0000	59210.	117.90	76.10	1.00
092679	0000	70830.	117.90	76.10	1.00
101279	0000	94530.	118.00	76.00	1.10
102679	0000	110690.	118.50	75.50	1.60
110979	0000	134850.	118.50	75.50	1.60
112679	0000	159330.	118.50	75.50	1.60
120779	0000	175170.	118.20	75.80	1.30

2.4C-110

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
OM-209A	198.20	110.00	5491A5N 2745OOE	080779	0850

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080879	0000	-1470.	110.00	88.20	.00
082079	0000	18210.	109.90	88.30	-.10
083179	0000	34650.	109.70	88.50	-.30
091479	0000	54210.	110.00	88.20	.00
092879	0000	72570.	109.90	88.30	-.10
101279	0000	94530.	109.80	88.40	-.20
102679	0000	114090.	109.90	88.30	-.10
110979	0000	134850.	109.90	88.30	-.10
112679	0000	159330.	109.90	88.30	-.10
120779	0000	175170.	110.00	88.20	.00

2.4C-111

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
WELL #3	100.52	34.69	SOUTH 2710 EAST	080779	0930

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)	WATER TEMP(F)	WELL FLOW (GPM)
080879	1630	-480.	80.30	60.22	.81		0
080779	0815	-15.	59.84	60.03	.00		0
080779	1000	90.	89.58	50.98	9.65		6100
080779	1200	210.	50.31	50.21	10.42		6100
080779	1400	330.	50.60	49.92	10.71		6100
080779	1600	450.	50.84	49.68	10.95		6100
080779	1800	570.	51.00	49.52	11.11		6100
080779	2000	690.	51.15	49.37	11.26		6100
080779	2200	810.	51.32	49.20	11.43		6000
080779	2400	930.	51.53	48.99	11.64		5950
080879	0200	1050.	51.67	48.85	11.78		6000
080879	0400	1170.	51.78	48.74	11.89		6000
080879	0600	1290.	51.86	48.66	11.97		6000
080879	0800	1410.	51.97	48.55	12.08	64	6000
080879	1000	1530.	52.03	48.49	12.14		6000
080879	1200	1650.	52.08	48.44	12.19	65	6000
080879	1400	1770.	52.08	48.44	12.19		7500
080879	1600	1890.	54.30	46.22	14.41		7500
080879	1800	2010.	55.34	45.18	15.45		8100
080879	2000	2130.	56.21	44.31	16.32		9400
080879	2200	2250.	56.88	43.64	16.99		9300
080879	2200	2250.	56.88	43.64	16.99		9300
080979	0200	2490.	57.30	43.18	17.45		9300
080979	0400	2610.	57.48	43.04	17.59	61	9300
080979	0700	2790.	57.66	42.86	17.77		9100
080979	0800	2850.	59.00	41.52	19.11	61	10200
080979	1000	2970.	59.24	41.28	19.35		10100
080979	1200	3090.	59.41	41.11	19.52	64	10100
080979	1400	3210.	59.68	40.84	19.79		10100
080979	1600	3330.	59.84	40.68	19.95	65	10100
080979	1800	3450.	55.01	45.51	15.12		5450
080979	2000	3570.	58.17	42.35	18.28	64	9100
080979	2200	3690.	56.43	44.09	16.58		8000
080979	2400	3810.	57.33	43.19	17.44		8000
081079	0200	3930.	57.35	43.17	17.46		8000
081079	0400	4050.	57.37	43.15	17.48		8000
081079	0600	4170.	57.40	43.12	17.51		8000
081079	0800	4290.	57.44	43.08	17.55	61	8000
081079	1000	4410.	57.46	43.06	17.57		8000
081079	1200	4530.	57.49	43.03	17.60		8000
081079	1400	4650.	57.52	43.00	17.63	62	8000
081079	1600	4770.	59.82	40.70	19.93	61	9400
081079	1800	4890.	60.03	40.49	20.14		9400
081079	2000	5010.	61.10	39.42	21.21	60	9600
081079	2200	5130.	60.73	39.79	20.84		9500
081079	2400	5250.	60.50	40.02	20.61	61	9400
081179	0200	5370.	60.64	39.88	20.75		9400
081179	0400	5490.	60.71	39.81	20.82		9400
081179	0600	5610.	60.77	39.75	20.88	60	9650
081179	0800	5730.	60.81	39.65	20.98		9650

2.4C-112

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
WELL #3	100.52	34.89	550770N '271437E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)	WATER TEMP(F)	WELL FLOW (GPM)
081179	1000	5850.	61.05	39.47	21.16		9950
081179	1200	5970.	61.10	39.42	21.21	60	9950
081179	1400	6090.	61.29	39.32	21.31		9950
081179	1600	6210.	61.25	39.27	21.36	60	9950
081179	1800	6330.	61.35	39.17	21.46		9950
081179	2000	6450.	61.74	38.78	21.85	60	9850
081179	2400	6690.	61.81	38.71	21.92	61	9850
081279	0400	6930.	61.89	38.63	22.00		9850
081279	0800	7170.	62.14	38.38	22.25	60	9850
081279	1200	7410.	62.21	38.31	22.32	60	9850
081279	1600	7650.	62.35	38.17	22.46	60	9850
081279	2000	7890.	62.53	37.99	22.64	60	9750
081279	2400	8130.	62.65	37.87	22.76	60	9700
081379	0600	8490.	62.90	37.62	23.01	60	9700
081379	1200	8850.	63.06	37.46	23.17	60	9700
081379	1800	9210.	63.36	37.16	23.47	60	9700
081379	2400	9570.	63.48	37.04	23.59	60	9650
081479	0700	9990.	64.15	36.37	24.26	60	9650
081479	1800	10650.	64.56	35.96	24.67	60	9500
081579	0600	11370.	66.13	34.39	26.24	60	9400
081579	1800	12090.	66.44	34.08	26.55	61	9400
081679	0600	12810.	67.69	32.83	27.80	60	9700
081679	1800	13530.	68.07	32.45	28.18	61	9700
081779	0600	14250.	66.70	33.82	26.81	61	8400
081779	1800	14970.	66.85	33.67	26.96	61	8500
081879	0600	15690.	66.91	33.61	27.02	61	8300
081879	1800	16410.	68.09	32.43	28.20	62	8200
081979	0600	17130.	68.40	32.12	28.51	62	8200
081979	1800	17850.	68.91	31.61	29.02	62	8400
082079	0600	18570.	68.93	31.59	29.04	62	8400
082079	1500	19110.	68.88	31.64	28.99	63	8400
082179	1300	20430.	69.88	30.64	29.99	63	8300
082179	1800	20730.	69.89	30.63	30.00	64	8300
082279	0600	21450.	70.04	30.48	30.15		8300
082279	1800	22170.	70.08	30.44	30.19	64	8300
082379	0600	22890.	70.15	30.37	30.26		8300
082379	1800	23610.	70.47	30.05	30.58	65	8200
082479	0600	24330.	70.55	29.97	30.66		8200
082479	1800	25050.	71.19	29.33	31.30	65	8100
082579	1200	26130.	69.66	30.86	29.77		8100
082579	1800	26490.	67.80	32.92	27.71	66	8500
082679	0600	27210.	68.02	32.50	28.13		8500
082679	1800	27930.	68.53	31.99	28.64	66	8400
082779	1800	29370.	68.95	31.57	29.06	66	8400
082879	1800	30810.	69.36	31.16	29.47	67	8300
082979	1800	32250.	69.43	31.09	29.54	67	8300
083079	1800	33690.	68.97	31.55	29.08	68	8400
083179	1600	35010.	68.39	32.13	28.50	68	8400
090179	1800	36570.	68.07	32.45	28.18		8200
090279	1800	38010.	67.81	32.71	27.92		8300

2.4C-113

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
WELL #3	100.52	34.89	550770N 2214372E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)	WATER TEMP(F)	WELL FLOW (GPM)
090579	1800	54450.	67.51	33.01	27.62		8500
090479	1800	40890.	67.12	33.40	27.23		8700
090579	1800	42330.	66.10	38.38	26.25		8600
090779	1700	45150.	65.30	35.22	25.41	67	8500
090979	0900	47550.	64.90	35.62	25.01	67	8500
091179	0800	50370.	65.00	35.52	25.11	67	8500
091379	0900	53310.	65.70	34.82	25.81	68	8200
091579	1100	56510.	66.68	33.84	26.79	68	8100
091779	1035	59405.	67.05	32.87	27.76	68	8000
091979	1150	62120.	68.28	32.24	28.39	69	8000
092179	0915	64805.	66.50	34.02	26.61	68	8200
092379	1200	67870.	66.68	33.84	26.79		8100
092579	1105	70715.	65.18	35.34	25.29	71	8500
092779	0940	73390.	64.65	35.87	24.76	70	8300
092979	1330	76620.	64.53	35.99	24.64	71	8400
100179	1255	79465.	64.24	36.28	24.35	71	8400
100379	0935	82185.	63.60	36.92	23.71	71	7900
100579	1825	85555.	63.63	36.89	23.74	71	8200
100779	1205	88055.	64.12	36.40	24.23	71	8200
100979	0850	90740.	64.90	35.62	25.01	71	8200
101179	1155	93805.	65.75	34.77	25.86	71	8200
101379	1600	96930.	65.84	34.68	25.95		8200
101679	2010	101500.	68.88	32.08	28.59	70	8000
101879	1410	104020.	69.67	30.85	29.78	70	7900
102079	1440	106930.	70.33	30.19	30.44	70	8000
102279	1355	109765.	70.11	30.41	30.22	70	7900
102479	1435	112685.	70.41	30.11	30.52	70	7900
102679	1215	115425.	70.83	29.69	30.94	70	7800
102879	1555	118525.	71.82	28.70	31.93	70	7700
103079	0930	121020.	72.46	28.06	32.57	70	7700
110279	0940	124350.	74.13	26.39	34.26	69	7600
110479	0810	128140.	74.88	25.64	34.99	69	7500
110679	0815	131025.	75.60	24.92	35.71	68	7400
110879	1030	134040.	75.99	24.53	36.10	69	7250
111079	1200	137010.	75.78	24.74	35.89		7400
111379	1035	141245.	74.23	26.29	34.34	68	7400
111679	0805	145415.	73.10	27.42	33.21	68	7500
111979	1200	149470.	74.13	26.39	34.24		7600
112279	1200	153290.	73.00	27.52	33.11		7600
112679	1735	160385.	71.96	28.56	32.07	68	7500
112979	0950	164280.	71.55	28.97	31.66	67	7700
120279	1200	168640.	70.00	30.52	30.11		7500
120579	1200	173010.	67.60	32.92	27.71		7050
120879	1200	177350.	65.68	34.84	25.79		7550
121079	1145	180195.	65.72	34.80	25.83	67	8200
121379	1410	184550.	66.10	34.42	26.21	66	8200
121679	1200	188850.	67.78	32.74	27.89		8000
121879	2300	192590.	68.25	32.27	28.36		7600

2.4C-114

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
WELL #5	100.57	40.34	553165N 2124211	080779	0930

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)	WATER TEMP(F)	WELL FLOW (GPM)
080679	1320	=1150.	40.40	54.07	.56		0
080779	0730	=60.	40.34	60.23	.00		0
080779	1200	210.	46.01	54.56	5.67		6400
080779	1400	330.	46.62	53.95	6.28		6300
080779	1600	450.	46.90	53.63	6.60		6300
080779	1800	570.	47.17	53.40	6.83		6300
080779	2000	690.	47.40	53.17	7.06		6200
080779	2200	810.	47.57	53.00	7.23		6200
080779	2400	930.	47.70	52.87	7.36		6200
080879	0200	1050.	47.83	52.74	7.49		6200
080879	0400	1170.	47.96	52.61	7.62		6200
080879	0600	1290.	48.01	52.56	7.67		6200
080879	0800	1410.	48.07	52.50	7.73	65	6200
080879	1000	1530.	48.10	52.47	7.76		6200
080879	1200	1650.	48.15	52.42	7.81		6200
080879	1400	1770.	49.48	51.09	9.14		7000
080879	1600	1890.	50.26	50.31	9.92		8700
080879	1800	2010.	50.30	50.27	9.96		8700
080879	2000	2130.	50.52	50.05	10.18		8700
080879	2200	2250.	51.54	48.98	11.25		9800
080879	2400	2370.	51.78	48.79	11.44		9800
080979	0200	2490.	51.98	48.59	11.64		9800
080979	0400	2610.	52.13	48.44	11.79	62	9800
080979	0600	2730.	52.25	48.32	11.91		9800
080979	0800	2850.	52.58	47.99	12.24	62	10100
080979	1000	2970.	52.71	47.86	12.37		10100
080979	1200	3090.	52.79	47.78	12.45	65	10100
080979	1400	3210.	52.90	47.67	12.56		10100
080979	1600	3330.	53.00	47.57	12.66	65	10100
080979	1800	3450.	53.30	47.27	12.96		10000
080979	2000	3570.	53.37	47.20	13.03	64	10000
080979	2200	3690.	52.58	47.99	12.24		9800
080979	2400	3810.	52.34	48.23	12.00		9300
081079	0200	3930.	48.81	51.76	8.47		8600
081079	0400	4050.	52.11	48.46	11.77		9300
081079	0600	4170.	52.30	48.27	11.96		9300
081079	0800	4290.	52.36	48.21	12.02		9600
081079	1000	4410.	52.43	48.14	12.09		9600
081079	1200	4530.	52.49	48.08	12.15		9300
081079	1400	4650.	52.54	48.03	12.20	64	9300
081079	1600	4770.	53.20	47.37	12.86	64	10000
081079	1800	4890.	53.30	47.27	12.96		10000
081079	2000	5010.	53.41	47.16	13.07	63	9950
081079	2200	5130.	53.52	47.05	13.18		9950
081079	2400	5250.	53.62	46.95	13.28	62	9950
081179	0200	5370.	53.67	46.90	13.33		10100
081179	0400	5490.	53.70	46.87	13.36		9950
081179	0600	5610.	53.78	46.79	13.44	62	9950
081179	0800	5730.	53.84	46.73	13.50		9900
081179	1000	5850.	53.90	46.67	13.56		9800

24C-115

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
WELL A5	100.57	80.58	5531554 '272821E	080774	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)	WATER TEMP(F)	WELL FLOW (GPM)
081179	1200	5470.	53.94	46.63	13.80	63	9800
081179	1400.	6090.	54.00	46.57	13.86		9800
081179	1600	6210.	54.05	46.52	13.71	64	9800
081179	1800	6330.	54.12	46.45	13.78		9800
081179	2000	6450.	54.24	46.35	13.88	64	9800
081179	2400	6690.	54.32	46.25	13.98	64	10000
081279	0800	6930.	54.48	46.13	14.10		10000
081279	0800	7170.	54.55	46.02	14.21	64	10000
081279	1200	7410.	54.70	45.87	14.36	64	10000
081279	1600	7650.	54.82	45.75	14.48	64	9600
081279	2000	7890.	53.74	46.83	13.40	64	10000
081279	2400	8130.	53.55	47.02	13.21	64	8500
081379	0600	8490.	55.15	45.42	14.81	64	9900
081379	1200	8850.	55.39	45.18	15.05	64	9850
081379	1800	9210.	55.03	45.54	14.69	64	9600
081379	2400	9570.	55.33	45.24	14.99	64	9600
081479	0600	9930.	55.55	45.02	15.21	64	9600
081479	1800	10650.	55.47	45.10	15.13	64	9100
081579	0600	11370.	56.03	44.54	15.69	64	9100
081579	1800	12090.	56.84	43.73	16.50	64	7800
081679	0600	12810.	57.39	43.18	17.05	64	9800
081679	1800	13530.	57.85	42.72	17.51	64	9600
081779	0600	14250.	58.20	42.61	17.92	64	9700
081779	1700	14910.	58.42	42.15	18.08	64	9700
081879	0600	15690.	58.70	41.87	18.36	64	9700
081879	1800	16410.	59.15	41.42	18.81	64	9700
081979	0600	17130.	59.32	41.25	18.98	64	9600
081979	1800	17850.	59.73	40.84	19.39	64	9600
082079	0600	18570.	59.78	40.83	19.80	64	9600
082079	1800	19290.	59.88	40.69	19.54	64	9600
082179	0600	20010.	60.18	40.39	19.84	64	9400
082179	1800	20730.	61.13	39.44	20.79	64	6100
082279	0600	21450.	60.84	39.73	20.50		5000
082279	1800	22170.	55.25	45.32	14.91	65	5500
082379	0600	22890.	55.21	45.36	14.87		5500
082379	1800	23610.	57.40	43.17	17.06	64	8000
082479	0600	24330.	54.88	46.69	19.58		9600
082479	1800	25050.	59.75	40.82	19.41	64	8400
082579	0600	25770.	60.91	39.66	20.57		8800
082579	1800	26490.	61.44	39.13	21.10	65	8800
082679	0600	27210.	62.25	38.32	21.91		8700
082779	1800	27930.	62.71	37.80	22.43	65	8700
082879	1800	28650.	60.88	39.09	20.59	65	5400
082979	1800	29370.	61.34	39.18	21.05	66	8600
083079	1800	30090.	62.20	38.29	21.44	66	8400
083179	1800	30810.	59.92	40.65	19.58	66	7000
090179	0900	31530.	55.34	45.18	15.05	67	8800
090279	0900	32970.	54.89	45.68	14.55	68	4500
090379	0900	34410.	53.10	47.47	12.76	67	4000
			52.69	47.88	12.35	67	5000

2.4C-116

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
WELL #5	100.57	40.38	553165N 272421E	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)	WATER TEMP(F)	WELL FLOW (GPM)
090479	1200	48550.	52.07	48.50	11.73	67	4900
090579	1500	42150.	52.25	48.32	11.91	67	4700
090779	1700	45150.	55.60	44.97	15.32	66	4400
090979	0800	47490.	56.36	44.19	16.04	66	4400
091179	0900	50450.	53.08	47.49	12.74	68	5500
091279	1600	52270.	47.18	53.39	6.84		0
091579	0800	55250.	57.49	43.08	17.15	68	9500
091579	1300	56450.	57.88	42.69	17.54	69	7700
091779	1500	59430.	60.14	40.43	19.80	68	8400
091979	1245	62175.	61.94	38.58	21.65	68	8700
092179	0830	64260.	61.68	38.83	21.39	68	8700
092379	1200	67890.	59.36	41.21	19.02		8400
092579	1020	70670.	57.21	43.36	16.87	70	8700
092779	0730	73560.	56.28	44.29	15.94	70	9400
092979	1300	76590.	56.84	43.73	16.50	70	9300
100179	1240	79450.	56.36	44.21	16.02	70	8800
100379	0920	82130.	49.54	51.03	9.20	72	9500
100579	1810	85540.	53.24	47.33	12.90	70	7600
100779	1135	88025.	54.63	45.94	14.29	70	7600
100979	0835	90725.	55.62	44.95	15.28	70	7650
101179	1140	93790.	56.00	44.57	15.26	70	7500
101379	1200	96690.	58.20	42.37	17.86		9100
101679	2005	101535.	53.08	47.09	13.14	70	8100
101879	1510	104040.	61.28	39.29	20.94	70	8600
102079	1540	106990.	62.27	38.30	21.93	69	8700
102279	1500	109830.	63.10	37.47	22.76	69	8500
102479	1745	112875.	63.46	37.11	23.12	69	8500
102679	1230	115440.	58.59	41.98	18.25	69	3600
102879	1625	118555.	60.20	40.37	19.86	69	5700
103079	1005	121055.	56.73	43.84	16.39	70	3400
110279	1020	125390.	61.64	38.93	21.30	69	7650
110479	0855	128185.	66.62	33.95	26.28	68	8100
110679	0915	131085.	65.75	34.82	25.41	68	7400
110879	1050	134060.	67.81	32.76	27.47	69	7800
111079	1200	137016.	67.58	32.99	27.24		7950
111379	1120	141290.	66.02	34.55	25.68	69	8200
111679	0850	145460.	64.90	35.67	24.56	69	8300
111979	1200	149970.	64.45	36.12	24.11		8400
112279	1200	154290.	63.87	36.70	23.53		8000
112679	1815	160425.	60.87	39.70	20.53	68	6400
112979	1040	164290.	59.48	41.09	19.14	68	6400
120279	1200	168690.	57.03	43.54	16.69		6800
120579	1200	173010.	53.51	47.06	13.17		6450
120879	1200	177330.	53.33	47.24	12.99		7400
121079	1555	180445.	52.65	47.92	12.31	67	7400
121379	1445	184095.	55.35	45.22	15.01	66	8450
121679	1200	188850.	55.90	44.67	15.56		7600
121879	2300	192390.	57.69	42.88	17.35		7400

2.4C-117

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
MISS RIVER	61.10	.00	5538420 2123604E	080779	0830

DATE	HHMM	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)	WATER TEMP(F)	WELL FLOW (GPM)
080179	0000	-8670.	.00	55.75	.00		
080279	0000	-7230.	.00	57.00	.00		
080379	0000	-5790.	.00	57.70	.00		
080479	0000	-4350.	.00	59.10	.00		
080579	1340	-2670.	.00	60.15	.00		
080679	1100	-1290.	.00	61.10	.00		
080679	1430	-1080.	.00	61.20	.00		
080679	1700	-930.	.00	61.30	.00		
080779	0740	-50.	.00	61.70	.00		
080779	0935	65.	.00	61.70	.00		
080779	1100	150.	.00	61.80	.00		
080779	1200	210.	.00	61.80	.00		
080779	1330	300.	.00	61.80	.00		
080779	1530	420.	.00	61.80	.00		
080779	1600	450.	.00	61.80	.00		
080779	1700	510.	.00	61.90	.00		
080779	1800	570.	.00	61.90	.00		
080779	1900	630.	.00	61.90	.00		
080879	0500	1230.	.00	62.00	.00		
080879	0900	1470.	.00	62.00	.00	83	
080879	1225	1675.	.00	62.10	.00		
080979	0400	2610.	.00	62.20	.00	81	
080979	0930	2880.	.00	62.20	.00	81	
080979	1325	3175.	.00	62.10	.00	83	
080979	1625	3355.	.00	62.20	.00	84	
080979	1900	3510.	.00	62.20	.00	84	
081079	0930	4590.	.00	62.20	.00	83	
081079	1225	4555.	.00	62.10	.00	84	
081079	1515	4725.	.00	62.00	.00	84	
081079	1720	4850.	.00	61.90	.00	84	
081079	1955	5005.	.00	61.90	.00	83	
081179	0130	5340.	.00	61.90	.00	83	
081179	0700	5670.	.00	61.70	.00	83	
081179	1150	5960.	.00	61.60	.00	84	
081179	1845	6335.	.00	61.50	.00	85	
081179	1700	6270.	.00	61.40	.00	84	
081179	2005	6455.	.00	61.30	.00	84	
081279	0100	6750.	.00	61.25	.00	84	
081279	0730	7140.	.00	61.10	.00	84	
081279	1300	7470.	.00	60.90	.00	85	
081279	1630	7680.	.00	60.70	.00	85	
081279	1950	7880.	.00	60.60	.00	84	
081379	0100	8190.	.00	60.40	.00	84	
081379	0645	8535.	.00	60.20	.00	84	
081379	1250	8900.	.00	59.90	.00	84	
081379	2010	9340.	.00	59.70	.00	83	
081379	2400	9570.	.00	59.50	.00	83	
081479	0630	9960.	.00	59.30	.00	83	
081479	1245	10695.	.00	59.00	.00	84	
081579	0740	11470.	.00	58.50	.00	84	

2.4C-118

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
MISS RIVER	61.10	.00	5534924 2723648	080779	0850

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)	WATER TEMP(F)	WELL FLOW (GPM)
081579	1845	12135.	.00	58.50	.00	85	
081679	0825	12955.	.00	57.60	.00	83	
081679	1930	13620.	.00	57.40	.00	84	
081779	0810	14280.	.00	57.10	.00	84	
081779	1830	15000.	.00	56.80	.00	85	
081879	0710	15760.	.00	56.80	.00	84	
081879	1835	16495.	.00	56.25	.00	85	
081979	1010	17380.	.00	56.15	.00	85	
081979	1800	17850.	.00	56.10	.00	86	
082079	0700	18630.	.00	56.05	.00	85	
082079	2040	19810.	.00	55.95	.00	85	
082179	0800	20130.	.00	55.80	.00	84	
082179	2020	20870.	.00	55.80	.00	82	
082279	1755	22165.	.00	55.20	.00	83	
082379	1755	23605.	.00	54.80	.00	84	
082479	1800	25050.	.00	53.50	.00	82	
082579	1800	26490.	.00	52.50	.00	81	
082679	1800	27930.	.00	51.30	.00	82	
082779	1805	29375.	.00	50.40	.00	82	
082879	1810	30820.	.00	51.30	.00	83	
082979	1805	32255.	.00	52.20	.00	85	
083079	1755	33685.	.00	53.50	.00	83	
083179	1540	34990.	.00	54.50	.00	85	
090179	0930	36060.	.00	55.40	.00		
090279	0930	37500.	.00	57.30	.00		
090379	0845	38895.	.00	57.20	.00		
090479	1200	40530.	.00	57.90	.00		
090579	1510	42160.	.00	58.90	.00		
090779	1645	45135.	.00	59.70	.00	88	
090979	0820	47510.	.00	59.00	.00	78	
091179	0920	50450.	.00	58.65	.00	80	
091379	0800	53250.	.00	57.00	.00	78	
091579	1210	56490.	.00	55.00	.00	80	
091779	1505	59435.	.00	53.35	.00	77	
091979	1310	62200.	.00	52.50	.00	76	
092179	0820	64790.	.00	54.50	.00	74	
092579	1045	70695.	.00	60.50	.00	74	
092779	1020	73550.	.00	60.10	.00	73	
092979	1535	76745.	.00	60.10	.00	75	
100179	1845	79575.	.00	60.85	.00	77	
100379	1100	82230.	.00	61.50	.00	73	
100579	1330	85260.	.00	60.90	.00	73	
100779	1445	88215.	.00	59.70	.00	71	
100979	1030	90840.	.00	59.00	.00	70	
101179	1325	93895.	.00	57.00	.00	70	
101679	1900	101430.	.00	55.90	.00	66	
101879	1500	104070.	.00	55.00	.00	70	
102079	1550	107000.	.00	52.50	.00	69	
102279	1510	109840.	.00	52.80	.00	69	
102479	1740	112870.	.00	52.90	.00	66	

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
MISS RIVER	61.10	.00	553092N 272306E	080779	0930

2.4C-119

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)	WATER TEMP(F)	WELL FLOW (GPM)
102679	1250	115960.	.00	52.25	.00	68	
102879	1635.	118565.	.00	50.20	.00	68	
103079	0830	120960.	.00	49.20	.00	66	
110179	0830	123840.	.00	48.10	.00	69	
110379	1040	125410.	.00	.00	.00	68	
110479	0900	128190.	.00	.00	.00	63	
110579	0800	129570.	.00	47.80	.00		
110679	0920	131090.	.00	47.40	.00	61	
110879	0855	133945.	.00	47.80	.00	60	
111379	1130	141300.	.00	55.90	.00	58	
111579	1430	144360.	.00	55.20	.00		
111679	0855	145465.	.00	55.40	.00	55	
112079	1820	150430.	.00	58.50	.00	55	
112079	1300	152490.	.00	58.00	.00		
112479	1705	156675.	.00	58.95	.00	53	
113079	1330	165900.	.00	59.80	.00		
121079	1600	180450.	.00	66.20	.00	48	
121179	0915	181485.	.00	65.80	.00		
121479	1450	184700.	.00	64.10	.00	49	
121479	1115	185925.	.00	63.10	.00		

2.4C-120

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
HAM LAKE	.00	.00	549555N 2734505E	080779	0960

DATE	MEDM	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080579	1310	-2600.	.00	59.55	.00
080679	1350	-1120.	.00	61.00	.00
080779	0750	-60.	.00	61.60	.00
080779	0942	72.	.00	61.60	.00
080779	1038	120.	.00	61.60	.00
080779	1205	215.	.00	61.60	.00
080779	1408	338.	.00	61.65	.00
080779	1616	466.	.00	61.70	.00
080779	1809	579.	.00	61.75	.00
080879	0430	1200.	.00	61.90	.00
080879	0745	1395.	.00	62.00	.00
080879	1310	1720.	.00	62.00	.00
080879	2235	2285.	.00	62.10	.00
080979	0230	2520.	.00	62.10	.00
080979	0800	2850.	.00	62.10	.00
080979	1305	3155.	.00	62.10	.00
080979	1840	3490.	.00	62.10	.00
081079	0005	3815.	.00	62.10	.00
081079	0645	4215.	.00	62.05	.00
081079	1315	4605.	.00	62.00	.00
081079	1500	4710.	.00	61.95	.00
081079	1930	4980.	.00	61.90	.00
081079	2000	5250.	.00	61.80	.00
081179	0600	5610.	.00	61.80	.00
081179	1035	6125.	.00	61.80	.00
081179	1925	6415.	.00	61.50	.00
081279	0015	6705.	.00	61.40	.00
081279	0615	7065.	.00	61.10	.00
081279	1205	7435.	.00	61.00	.00
081279	1520	7610.	.00	60.90	.00
081279	1930	7860.	.00	60.80	.00
081279	2345	8115.	.00	60.80	.00
081379	0615	8505.	.00	60.50	.00
081379	1420	8990.	.00	60.30	.00
081379	1950	9320.	.00	60.10	.00
081379	2345	9555.	.00	60.00	.00
081479	0615	9945.	.00	59.80	.00
081479	1810	10860.	.00	59.60	.00
081579	0717	11447.	.00	59.30	.00
081579	1750	12080.	.00	59.50	.00
081679	0700	12870.	.00	58.80	.00
081679	1810	13590.	.00	58.50	.00
081779	0630	14280.	.00	58.30	.00
081779	1810	14980.	.00	58.25	.00
081879	0640	15730.	.00	58.15	.00
081879	1810	16420.	.00	58.10	.00
081979	1030	17400.	.00	58.05	.00
081979	1830	17880.	.00	58.00	.00
082079	0655	18825.	.00	58.00	.00
082079	1840	19330.	.00	58.00	.00

2.4C-121

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
MAM LAKE	.00	.00	593556N 1213456W	080279	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
082179	0855	20005.	.00	58.00	.00
082179	1855	20745.	.00	58.00	.00
082279	1730	22180.	.00	58.00	.00
082579	1735	23585.	.00	58.00	.00
082679	1710	25600.	.00	58.00	.00
082979	1820	26510.	.00	58.00	.00
082679	1710	27680.	.00	58.00	.00
082779	1735	29345.	.00	57.95	.00
082879	1740	30790.	.00	57.95	.00
082979	1740	32230.	.00	57.95	.00
083079	1740	33660.	.00	57.90	.00
083179	1520	34970.	.00	57.85	.00
090179	0900	36030.	.00	57.90	.00
090279	0900	37470.	.00	58.00	.00
090379	0820	38870.	.00	58.00	.00
090479	1539	40740.	.00	58.10	.00
090679	1445	42136.	.00	58.20	.00
090779	1545	45075.	.00	58.70	.00
090879	0745	47475.	.00	58.70	.00
091179	1000	50490.	.00	59.00	.00
091379	0720	53210.	.00	58.20	.00
091579	1245	56415.	.00	57.90	.00
091779	1555	59486.	.00	57.90	.00
091979	1005	62015.	.00	57.90	.00
092179	0750	64760.	.00	58.60	.00
092579	0905	70595.	.00	60.15	.00
092779	1115	73695.	.00	60.20	.00
092979	1600	76770.	.00	60.10	.00
100179	1525	79615.	.00	60.30	.00
100379	1125	82255.	.00	61.25	.00
100579	1800	85290.	.00	60.90	.00
100779	1540	88270.	.00	59.85	.00
100979	1120	90890.	.00	59.00	.00
101179	1800	93930.	.00	58.50	.00
101379	1900	101070.	.00	58.20	.00
101679	1610	104190.	.00	58.15	.00
102079	1630	107090.	.00	58.15	.00
102279	1610	109900.	.00	58.15	.00
102479	1825	112915.	.00	58.15	.00
102679	1345	115515.	.00	58.15	.00
102879	1710	118600.	.00	58.10	.00
103079	1320	121250.	.00	58.35	.00
110279	1115	125445.	.00	58.50	.00
110479	0940	128230.	.00	58.45	.00
110679	1120	131210.	.00	58.45	.00
110879	0935	133985.	.00	58.45	.00
111079	1320	141010.	.00	58.50	.00
111679	0940	145510.	.00	58.50	.00
112079	1745	150375.	.00	59.25	.00
112479	1130	154340.	.00	59.20	.00

2.4C-122

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
MAM LAKE	.00	.00	5493530 '2734506	080779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(min)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
121079	1615	180465.	.00	66.20	.00
121379	1535	184745.	.00	66.10	.00

2.4C-123

WELL NO.	ELEV OF MEAS PT.(FT,MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
GIN LAKE	.00	.00	555424N 2757928	UNUTTY	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
080579	1300	=2610.	.00	61.00	.00
080679	1000	=1550.	.00	61.00	.00
080779	0722	=68.	.00	61.00	.00
080779	1142	192.	.00	61.05	.00
080779	1624	474.	.00	61.10	.00
080779	1815	585.	.00	61.15	.00
080879	0800	1170.	.00	61.40	.00
080879	0730	1380.	.00	61.45	.00
080879	1300	1710.	.00	61.60	.00
080879	1900	2070.	.00	61.70	.00
080979	0200	2490.	.00	61.80	.00
080979	0800	2850.	.00	61.00	.00
080979	1315	3165.	.00	61.90	.00
080979	1850	3500.	.00	62.00	.00
081079	0010	3820.	.00	62.10	.00
081079	0630	4200.	.00	62.00	.00
081079	1320	4610.	.00	62.00	.00
081079	1510	4720.	.00	61.95	.00
081079	1940	4990.	.00	61.90	.00
081079	2400	5250.	.00	61.80	.00
081179	0600	5610.	.00	61.80	.00
081179	1440	6130.	.00	61.60	.00
081179	1930	6420.	.00	61.50	.00
081179	2400	6690.	.00	61.45	.00
081279	0615	7065.	.00	61.30	.00
081279	1215	7425.	.00	61.25	.00
081279	1525	7615.	.00	61.20	.00
081279	1940	7870.	.00	61.10	.00
081279	2345	8115.	.00	61.00	.00
081379	0615	8505.	.00	60.90	.00
081379	1030	9000.	.00	60.80	.00
081379	1945	9315.	.00	60.70	.00
081379	2345	9555.	.00	60.60	.00
081479	0600	9930.	.00	60.50	.00
081479	1800	10650.	.00	60.40	.00
081579	0711	11441.	.00	60.30	.00
081579	1755	12085.	.00	60.30	.00
081679	0655	12865.	.00	60.10	.00
081679	1800	13530.	.00	60.10	.00
081779	0620	14270.	.00	60.10	.00
081779	1800	14970.	.00	60.05	.00
081879	0630	15720.	.00	60.05	.00
081879	1800	16410.	.00	60.05	.00
081979	1040	17410.	.00	60.00	.00
081979	1950	17960.	.00	60.00	.00
082079	0810	18700.	.00	60.00	.00
082079	1945	19495.	.00	60.00	.00
082179	0635	20045.	.00	60.00	.00
082179	1850	20780.	.00	59.95	.00
082279	1725	22135.	.00	59.95	.00

2.4C-124

WELL NO.	ELEV OF MEAS PT.(FT.MSL)	STATIC WATER LEVEL(FT)	COORDINATES	START DATE	START TIME
GIN LAKE	.00	.00	555324N 1275707E	082779	0830

DATE	HOUR	TIME AFTER PUMPING STARTED(MIN)	DEPTH TO WATER(FT)	WATER LEVEL ELEV(FT,MSL)	DRAWDOWN (FT)
082379	1730	23580.	.00	59.95	.00
082479	1705.	24495.	.00	59.95	.00
082579	1825	20515.	.00	59.85	.00
082679	1705	27675.	.00	59.90	.00
082779	1730	29380.	.00	59.90	.00
082879	1725	30775.	.00	59.90	.00
082979	1735	32225.	.00	59.80	.00
083079	1725	33655.	.00	59.80	.00
083179	1515	34965.	.00	59.80	.00
090179	0900	36030.	.00	59.80	.00
090279	0850	37460.	.00	59.80	.00
090379	0810	38860.	.00	59.90	.00
090479	1200	40530.	.00	59.80	.00
090579	1525	42175.	.00	59.90	.00
090779	1535	45165.	.00	59.80	.00
090979	0735	47465.	.00	59.80	.00
091179	1005	50495.	.00	59.70	.00
091379	0715	53205.	.00	59.70	.00
091579	1255	56825.	.00	59.70	.00
091779	1600	59490.	.00	59.60	.00
091979	1340	62230.	.00	59.60	.00
092179	1015	64905.	.00	61.10	.00
092379	0850	70580.	.00	60.75	.00
092779	1125	73615.	.00	60.60	.00
092879	1610	76780.	.00	60.90	.00
100179	1530	79620.	.00	60.70	.00
100379	1130	82280.	.00	60.80	.00
100579	1405	85295.	.00	60.90	.00
100779	1545	88275.	.00	60.80	.00
100979	1125	90895.	.00	60.75	.00
101179	1405	93935.	.00	60.70	.00
101679	1945	101475.	.00	60.55	.00
101879	1020	104150.	.00	60.50	.00
102079	1640	107050.	.00	60.50	.00
102279	1615	109905.	.00	60.85	.00
102479	1830	112920.	.00	60.40	.00
102679	1350	115520.	.00	60.35	.00
102679	1710	118000.	.00	60.35	.00
103079	1325	121255.	.00	60.50	.00
110279	1120	125450.	.00	60.60	.00
110479	0950	128280.	.00	60.55	.00
110679	1125	131215.	.00	60.50	.00
110879	0940	133490.	.00	60.50	.00
111379	1525	141415.	.00	60.55	.00
111879	0950	145520.	.00	60.55	.00
112679	1755	150405.	.00	61.40	.00
112979	1135	153585.	.00	61.35	.00
121079	1630	160480.	.00	60.30	.00
121379	1540	163750.	.00	60.35	.00

QUESTION

372.1 (2.3.1) Discuss the tornado that passed through the site area on April 17, 1978. Include meteorological information (e.g., peak gusts, wind shifts, pressure drop) and copies of analog traces obtained from all levels of the onsite tower along with estimates of tornado path width, length and intensity.

RESPONSE

A tornado struck the Grand Gulf Nuclear Station around 11:00 p.m. on April 17, 1978. The tornado was estimated to have: |1

a. Intensity

The tornado F-scale winds were F2 (113-157 mph) at the Unit 1 cooling tower and at the switchyard and F1 (73-112 mph) at the reactor containment. After leaving the power plant site, the tornado intensified to F3 (158-206 mph).

b. Length

The tornado touched down on the east side of the Mississippi River. It moved east-northeast and intensified to F2. The Grand Gulf cooling tower is located at the 8.5 path mileage. The tornado made a 25 to 30 degree right turn at the 13 path mileage. The total length of the tornado path is 17 miles as shown in Figure 372.01-1 (Rev. 1).

A. Width

Damage width at the plant is estimated to be 1500 to 1800 feet.

Analog traces of wind speed and direction (33-foot and 162-foot levels), ΔT (162/33 ft), dew point, and ambient temperatures from the Grand Gulf meteorological tower from 9:00 p.m., April 17, 1978, to 1:00 a.m., April 18, 1978, are shown in Figures 372.01-2 through 5.

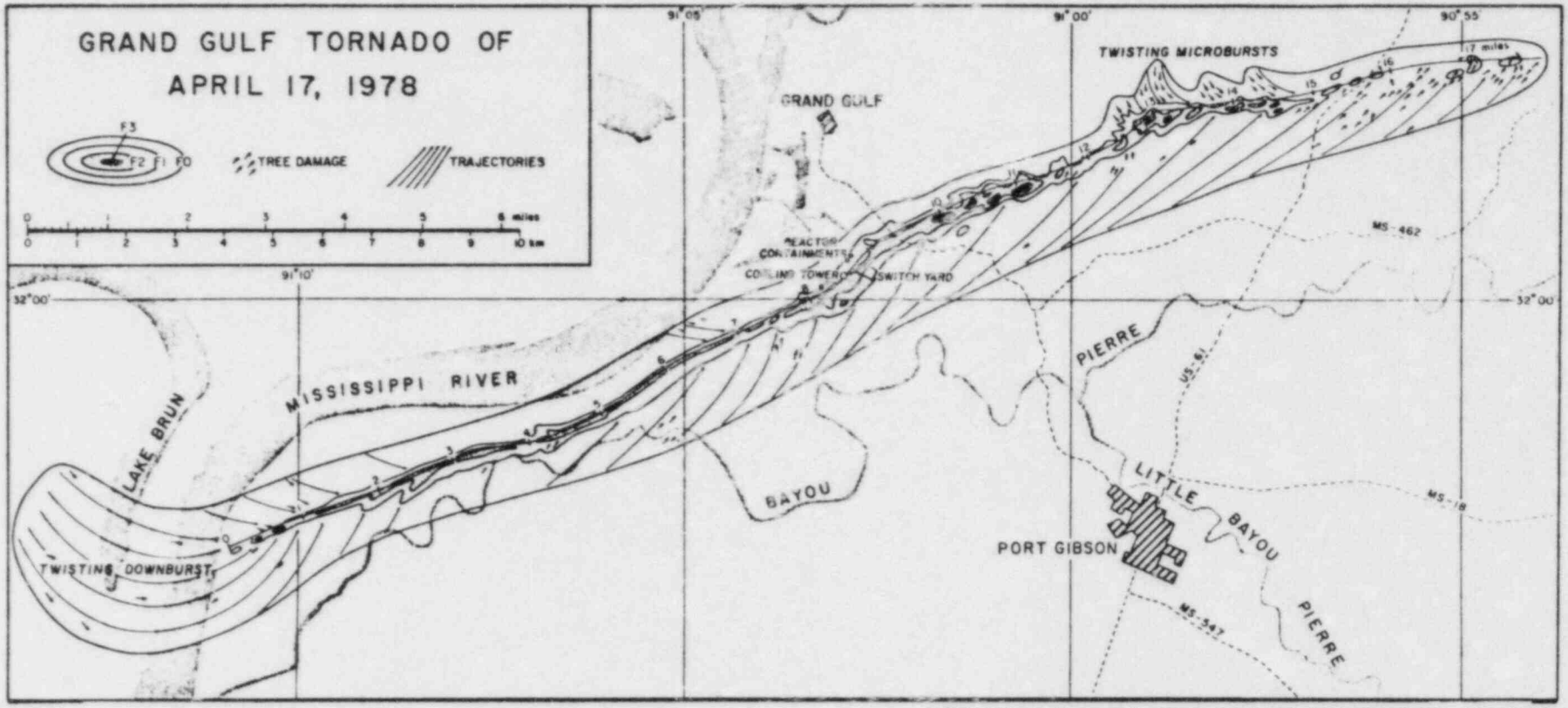
The peak gusts at the meteorological tower, located approximately 5,200 feet from the Unit 1 containment, were measured to be about 68 mph.

Several surveys have been performed to study the Grand Gulf tornado. These surveys are summarized in the following references:

1. Fujita, T. T., "Aerial Survey of Grand Gulf Plant and Vicinity After the April 17, 1978 Tornado," Satellite and Mesometeorology Research Project, Department of Geophysical Sciences, the University of Chicago, May 1978.

2. McDonald, J. R., "Assessment of Tornado Damage to the Grand Gulf Nuclear Generating Station," Institute for Disaster Research, Texas Technology University, June 1978.

3. Twisdale, L. A., "Ground Survey of the Grand Gulf Nuclear Station Tornado of April 17, 1978," Electric Power Research Institute, June 1978.



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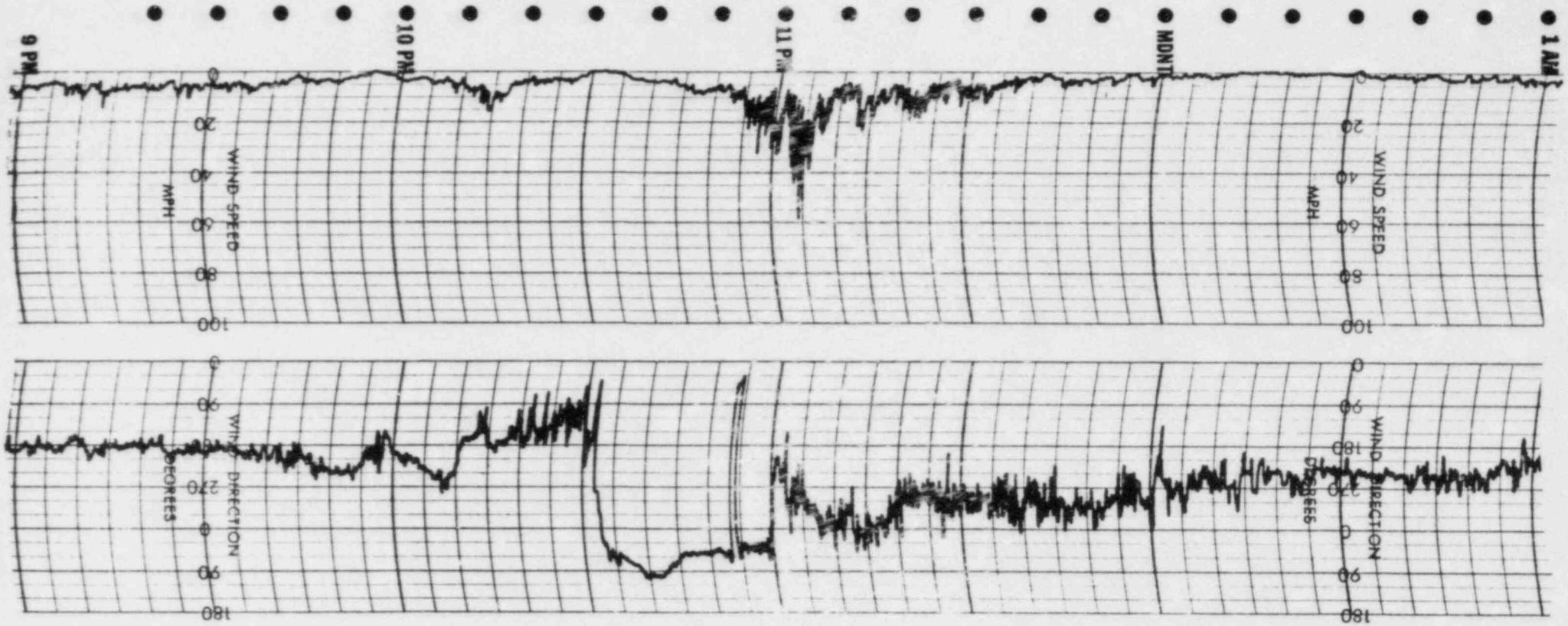
UNITS 1 & 2
ENVIRONMENTAL REPORT

F-SCALE CONTOURS
AND FLOW PATTERNS

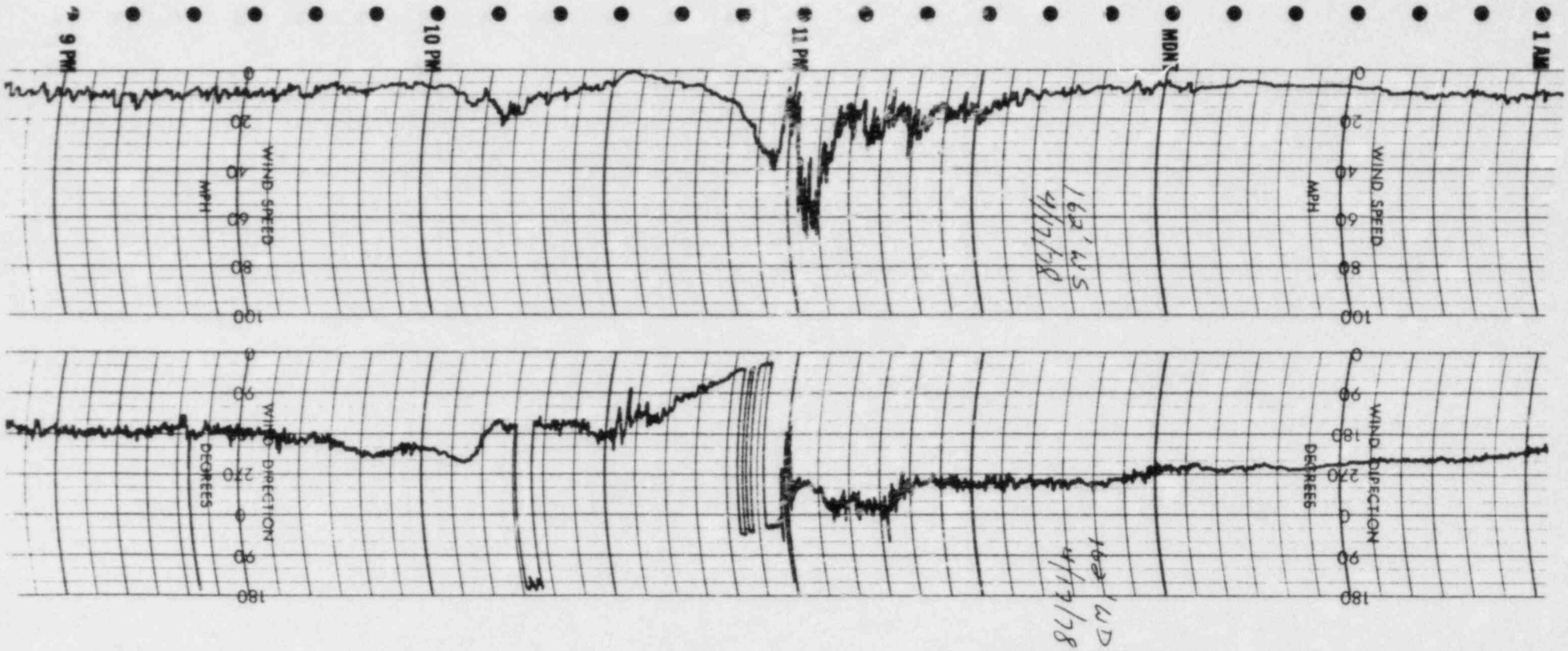
FIGURE 372.1-1

Amend. 1 3/79



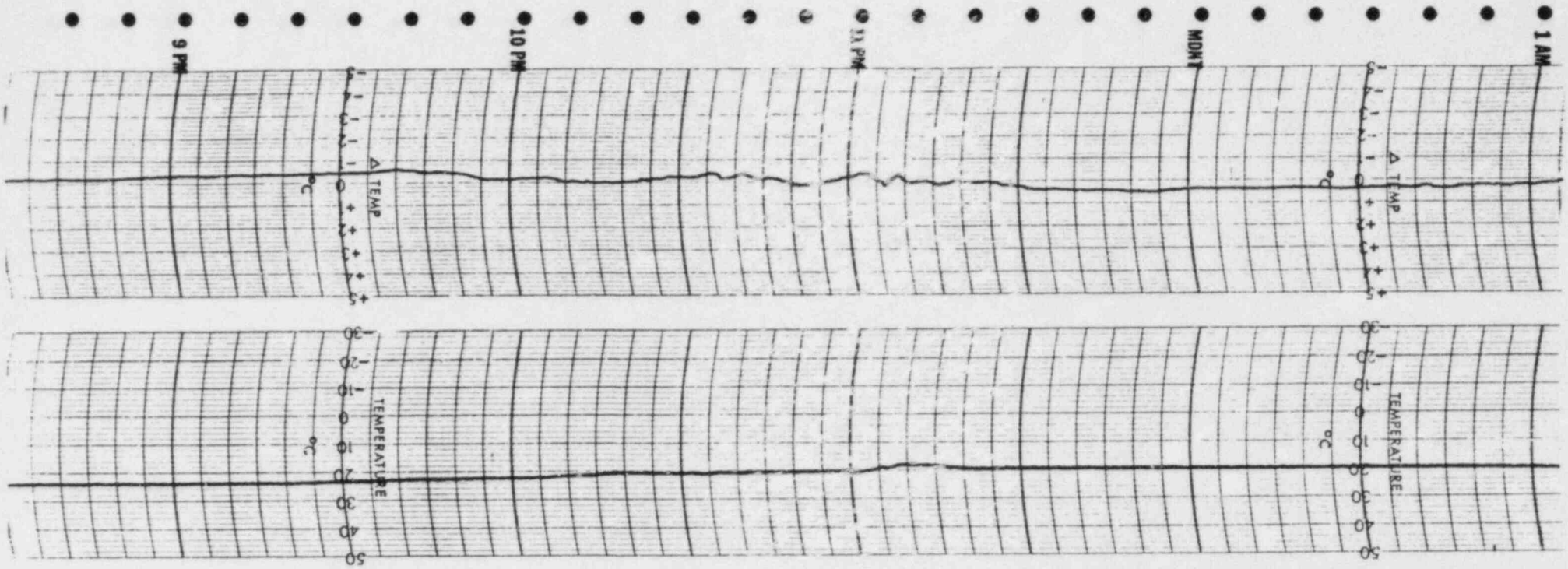
MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT
WIND SPEED AND WIND DIRECTION 33' LEVEL FIGURE 372.1-2

Amend. 1 3/79



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT
WIND SPEED AND WIND DIRECTION 162' LEVEL FIGURE 372.1-3

Amend. 1 3/79



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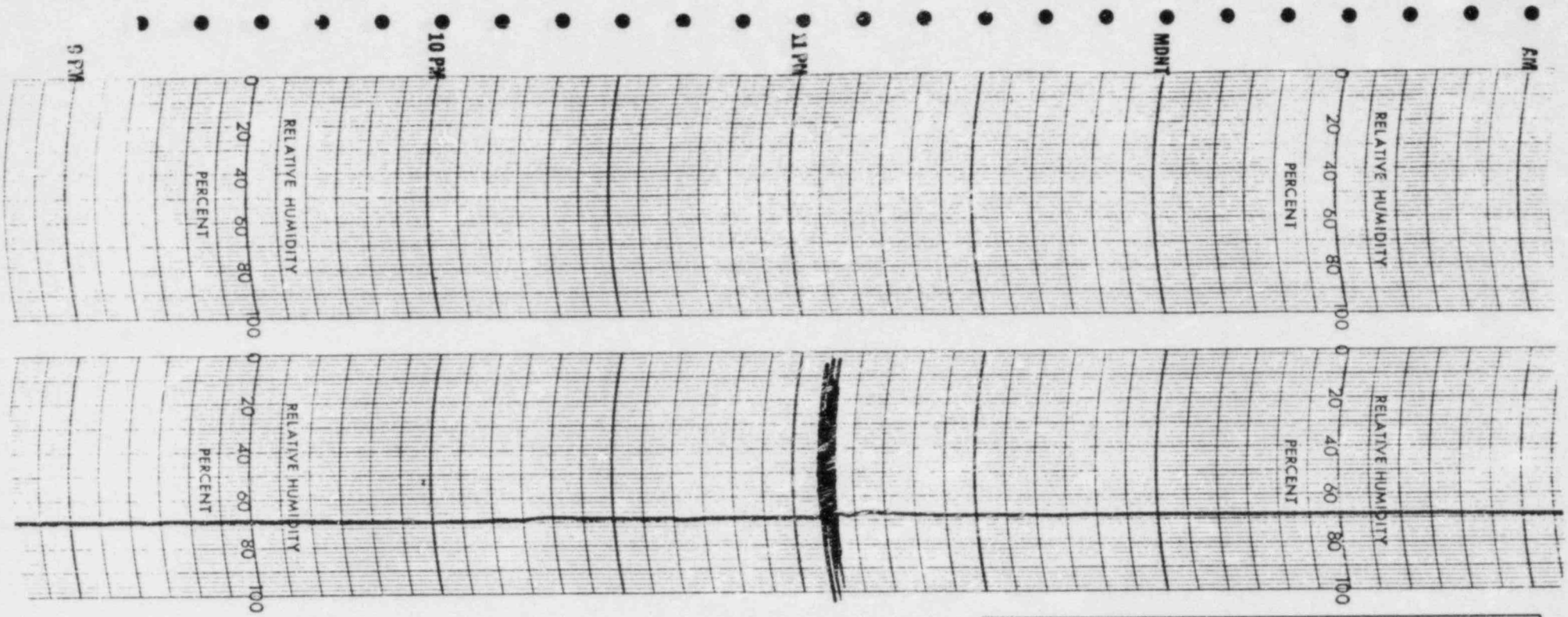
TEMPERATURE AND ΔT
33'-162' LEVEL

FIGURE 372.1-4

Amend. 1 3/79



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DEW POINT
33' LEVEL

FIGURE 372.1-5

Amend. 1 3/79

GG
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QUESTION

372.2 (2.3.1) Estimate the probability of a lightning strike and recurrence interval on the plant structures. (See for example, "Electrical Protection Guide for Land-Based Radio Facilities" by D. Bodle, 1971, (JES-159-3-3M 3/76), Joslyn Electronic Systems, or, Lightning Protection by J. L. Marshall, 1973, John Wiley & Sons, Inc.).

RESPONSE

The annual mean number of thunderstorm days in the Grand Gulf site area is estimated to be 66 from Table 2.3-7. The frequency of lightning strokes per thunderstorm day is estimated by (Lightning Protection, J. L. Marshall, 1973):

$$N_E = (0.1 + 0.35 \sin \lambda) \quad (0.40 \pm 0.20)$$

where N_E = the number of strokes to earth per thunderstorm day per square kilometer

λ = the geographical latitude of the site (Grand Gulf latitude = 32°0'27")

The upper limit of N_E is:

$$N_E = 0.161 \text{ strokes/km}^2 \text{ - thunderstorm day}$$

The lightning stroke density is:

$$D = N_E \, n$$

where n = the annual mean number of thunderstorm days

$$D = 0.161 \times 66 \text{ strokes/km}^2 \text{ - yr}$$

$$= 10.63 \text{ strokes/km}^2 \text{ - yr}$$

In subsection 2.3.1.2.1.4 the annual lightning stroke density in the Grand Gulf site area is defined to be 33 strokes per square mile or 12.7 strokes per square kilometer.

The area over which the structure can be expected to attract a lightning strike depends on the intensity of the stroke. The attractive areas of a conducting structure given in Lightning Protection by Marshall, 1973, are shown in Figure 372.02-1.

The attractive area, which corresponds to strike intensity 20 KA, or less, of the power block is (Marshall, 1973):

$$A = LW + 4H(L + W) + 4H^2 \pi$$

where L = the length of the block (650 ft)

W = the width of the block (420 ft)

H = the height of the tallest structure, containment (174 ft)

$\therefore A = 0.1299 \text{ km}^2$

See Figure 372.02-2.

The probability of lightning strikes in the Grand Gulf area is:

$$P = DA$$

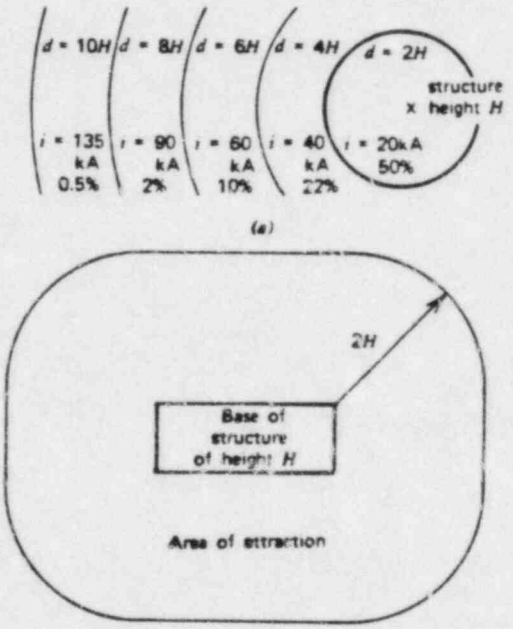
$$= 10.63 \text{ strokes/km}^2 - \text{yr} \times 0.1299 \text{ km}^2$$

$$= 1.38 \text{ strokes/yr}$$

The recurrence interval is:

$$R = \frac{1}{P}$$

$$= 0.72 \text{ yr}$$



Attractive area of a conducting structure: (a) variation of attractive distance of with magnitude of lightning current i and frequency of its occurrence; (b) average area of attraction.

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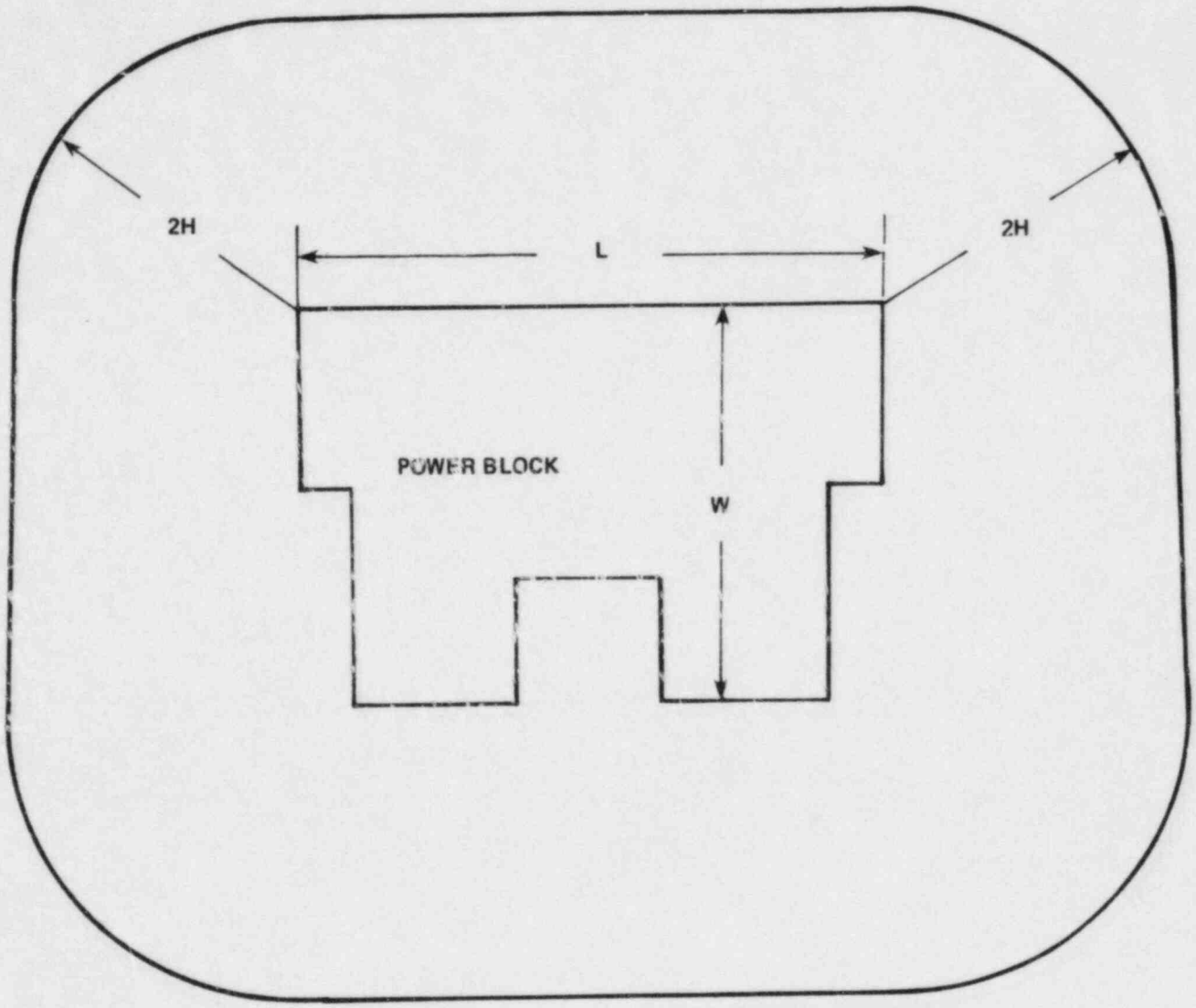
ATTRACTIVE AREA OF A CONDUCTING STRUCTURE FIGURE 372.2-1

Amend. 1 3/79



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ATTRACTIVE AREA
OF THE POWER BLOCK

FIGURE 372.2-2

Amend. 1 3/79

QUESTION

372.3 (2.3.2) The three years of onsite data (8/72-7/74, 1/76-12/76) at the Grand Gulf site indicate a much lower percentage (.02-1%) of calm windspeeds (which should be defined as wind speeds less than the starting speed of the anemometer) than would be expected for this region. Discuss the reasons for this low percentage of calm winds.

RESPONSE

Two instruments were installed at the 33-foot level of the Grand Gulf meteorological tower to measure surface wind speeds. The specification of both instruments is given in Table 372.03.1. The MRI 1074-2 anemometer has a start threshold of 0.75 mph, and the MRI 1090-1 air bearing anemometer has a start threshold of less than 0.25 mph. Since the air bearing anemometer is more sensitive at the low wind spectrum, with wind speed less than 20 mph, air bearing measurements were used in diffusion estimates of the site. The MRI 1074-2 anemometer data were substituted for the air bearing data when air bearing data were missing. |1

The surface wind observations in Jackson, Mississippi, were made with a wind instrument which has a start threshold of about 3 mph. Calm is defined as wind speed less than the starting speed of the anemometer or the response speed of the vane; therefore, the percentage of the calms reported in the Jackson data is for wind speeds of less than about 3 mph, while at Grand Gulf calms are for wind speeds less than 0.25 mph.

Based on 3 years of onsite data (8/72-7/74, 1/76-12/76) at the Grand Gulf site, 45.8 percent of the winds are below 3.5 mph (see Table 2.3-127H of the FER). Approximately 14 percent of observations are equal to or less than 1 mph. Less than 0.1 percent observations are recorded below 0.25 mph.

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TABLE 372.3.1

METEOROLOGICAL EQUIPMENT SPECIFICATION
AND PERFORMANCE CHARACTERISTICS

Temporary Towers

MRI 1071 Mechanical Weather Station

Wind Direction	Start threshold: <0.75 mph Accuracy: ±4 degree azimuth Delay distance: 50% recovery - 8 ft
Wind Run (Speed)	Start threshold: <0.5 mph Accuracy: ±2% Response distance: 18 ft (63% recovery)
Temperature	Range: -30F to 120F Accuracy: ±3F (Calibrated to ±1F)

Permanent Tower

MRI 1074-2 Wind Systems

Wind Direction	Start threshold: 0.75 mph Accuracy: ±1% Delay distance: 4ft (50% recovery)
Wind Speed	Start threshold: 0.75 mph Accuracy: ±0.4 mph or 1% (whichever is greater) Response distance: 18 ft (63% recovery)

MRI 809 Temperature

Temperature	Range: -30C to +50C Accuracy: ±0.5C
Differential Temperature	Range: ±5C Accuracy: ±0.1C

Rain Gauge - MRI 302 Tipping Bucket Rain Gauge

Accuracy: ±1% at 3 in. of rain/hr
Picks up each 0.01 in. of rain for each tip of bucket.

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TABLE 372.3.1 (Cont.)

MRI 1090-1 Air Bearing Anemometer (wind speed only)	Start threshold: <0.25 mph Response distance: Approximately 10 ft at 2 mph Range: 0.25 to 20 mph Accuracy: 0.10 mph or 1% of reading
MetSet %-T Dewpoint Sensor	(Installed in December 1976) Range: -50C to +50C Accuracy: ±0.5C

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QUESTION

372.4 (5.2.2) Discuss why terrain recirculation factors were not considered for the long-term diffusion analysis.

RESPONSE

The Grand Gulf site lies about 7,300 feet east of the Mississippi River, about 130 feet above mean sea level. The Big Black River empties into the Mississippi River about 3 miles to the north. Bayou Pierre, which lies generally from east to west, is approximately 1.5 miles south of the site at its closest point. The surrounding terrain is rolling hills which are wooded to the south and east. To the north and west, the terrain is generally flat, about 100 feet above mean sea level, and is also wooded. Numerous lakes of various sizes and isolated marshes dot the landscape. Ridges exist from Vicksburg, which is approximately 25 miles north upriver, to Natchez, which is approximately 37 miles south-southwest downriver of the Grand Gulf site; however, the ridges stop abruptly at the river floodplain, forming high bluffs 100 to 200 feet high along the east bank. No hill tops are over 300 feet elevation within 5 miles of the site. Farther out, to 50 miles from the site, several ridges are over 350 feet elevation on the east side of the river.

Topographic alteration of air flow direction and speed results in the production of shear in all directions which not only contributes to the production of turbulence but also results in effectively larger diffusion rates. Studies (Refs. 1 and 2) have demonstrated that dispersion over complex terrain can be several times greater than that observed over flat terrain, and the differences are dependent on atmospheric stability. Roffman (Ref. 3) has shown that plumes over complex terrain had measured concentrations almost a factor of nine less than that predicted for a Gaussian plume over flat terrain.

Measured plume peak concentrations from five separate field experiments (Ref. 4) under low-wind-speed inversion conditions were considerably lower than would be calculated using the stability typing method (vertical gradient of temperature) and the Pasquill-Gifford diffusion parameters. The enhanced horizontal diffusion is attributable mainly to the variability of wind direction, or meander, during low-wind-speed conditions. For a continuous emission over about one hour, no single plume centerline direction is obvious, and lateral concentration distribution is likely to be very non-Gaussian, with multiple peaks often spread over more than 180° of arc. The enhanced vertical diffusion is caused by roughness of the surface (topography and vegetation). Results of these experiments show the following:

1. Measured concentrations were lower by at least factors of 2.3, 1.3, and 3.6 compared to downwind concentrations calculated from type E, F, and G diffusion rates, respectively.

2. The highest measured concentrations generally occurred over the smooth, unforested terrain (Washington and Idaho tracer tests).

3. The next lower class of concentrations was measured over relatively flat forested terrain (Louisiana and Pennsylvania tracer tests).

4. The lowest concentrations were measured over a very hilly forested site (Tennessee tracer tests).

Tracer tests at River Bend site show the same findings. The station is located in West Feliciana Parish, two miles east of the Mississippi River and approximately 25 miles NNW of Baton Rouge, Louisiana. The area is heavily wooded. The ratios of River Bend diffusion coefficients to Pasquill coefficients at 600 meters are as follows:

Stability Class	R_{σ_y}	R_{σ_z}
A	1.7	2.2
B	2.3	3.3
C	3.1	4.1
D	4.2	5.0
E	5.2	3.4
F	6.6	2.8
G	9.8	2.4

Based on 3 years of onsite data, 99.3 percent of the total wind observations were with wind speeds less than 6 m/sec including 45.8 percent below 2 m/sec. Observations associated with stable atmospheric conditions (E, F, and G stability classes) and low wind speed (<2 m/sec) constituted 34.1 percent of the time. Meteorological measurements made at the Grand Gulf site indicate relatively light winds occurred frequently along with stable vertical lapse rates.

There are no pronounced hills to the east nor deep narrow valleys to the west of the Grand Gulf site to cause any air flow recirculation or hinder the diffusion rate. Also, 3 years of onsite meteorological data show no conclusive or systematic up

and down or cross valley flow. Therefore, to apply recirculation factors as indicated in Regulatory Guide 1.111 in long-term diffusion estimates for Grand Gulf site is inappropriate. Furthermore, studies discussed above have shown that the model employed in estimating the annual average diffusion condition, X/Q, for Grand Gulf site overpredicted ground level concentration. This is because the model does not account for horizontal meander under low wind conditions and vertical turbulence caused by surface roughness.

References

1. Start, G. E., N. R. Ricks, and C. R. Dickson, "Effluent Dilutions Over Mountainous Terrain," NOAA Tech. Memo. ERL ARL-51, 1974.

2. Start, G. E., C. R. Dickson, and L. L. Wendell, "Diffusion in a Canyon Within Rough Mountainous Terrain," JAM, 14, No. 3, 333-346, 1975.

3. Roffman, A., T. P. Kapsha, P. E. Kueser, G. L. Bethune, and M. P. Sullivan, "A Field Study on the Behaviors of an SO Plume from a Power Plant Near Complex Terrain and Under Stable Atmospheric Conditions," Third Symposium on Atmospheric Turbulence, Diffusion and Air Quality, Raleigh, N. C., 421, 429, 1976.

4. Van der Hoven, I., "A Survey of Field Measurements of Atmospheric Diffusion Under Low-Wind-Speed Inversion Conditions," Nuclear Safety, Vol. 17, No. 2, 1976.

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ER

QUESTION

372.5 (6.1.3) Provide monthly summaries of the meteorological data obtained from the two temporary meteorological towers and compare these summaries with the data from the 162 ft permanent tower. Discuss also the "effects of the hills along the eastern shoreline" (ER, p. 6.1-11) through analysis of data from the temporary river tower.

RESPONSE

Grand Gulf site lies about 7,300 feet east of the Mississippi River. The ground evaluations in the floodplain vary between 60 and 80 feet above mean sea level (msl), while elevations in the irregular loess hills east of the bluff vary from 80 to more than 200 feet above msl. The bluff which separates the floodplain from the loess hills averages about 70 feet in height and is sharply punctuated by deeply carved stream valleys. The floodplain and loess hills are heavily forested with trees about 65 to 75 feet high. The temporary main station was located in an open field, about 160 feet above msl, approximately 5,000 feet north of the reactor building. The river station was located about 5,500 feet west of the main station, about 75 feet above msl. Clearings with adequate exposure for representative wind observations were established for both sites. Figure 372.05-1 illustrates the general area layout and the locations of the two meteorological towers.

Wind direction and speed were determined at the river and temporary main stations by Meteorology Research, Inc. (MRI) Model 1071 mechanical weather stations. Each station was mounted at the top of a 33-ft tower. The starting threshold, accuracy, and delay distance of this system with respect to wind direction are less than 0.75 mph, $\pm 4°$ azimuth, and 8 feet (50% recovery), respectively. With regard to the wind speed, the starting threshold, accuracy, and response distance are less than 0.5 mph, $\pm 2\%$ and 18 feet (63% recovery), respectively. The temporary main and river station operated continuously for 1 year, the former beginning operation on March 12, the latter on March 13, 1972. Data recovery was 99% for the temporary main site and 98% for the river site for the year.

Wind direction and speed were recorded continuously on strip charts at both locations. Standard techniques were used to determine the mean vector wind for each hour of record. Hourly wind direction observations were grouped into the cardinal 16 points on a compass from which the wind was blowing. Monthly summaries of the meteorological data obtained from the two temporary meteorological towers are presented in Tables 372.05.1 through 372.05.24. Seasonal and annual wind roses were also constructed as shown in Figures 372.05-2 through 372.05-6.

A permanent tower was installed adjacent to the position of the temporary main station and became operational about August 2, 1972. The permanent tower serves as a representative observation station (i.e., meteorological conditions at the locations are considered to be representative of the site). It is 162 feet high, and the wind instruments installed at the 33-foot level were MRI 1090-1, air bearing anemometer, and MRI 1074-2, wind system. Table 372.05.25 shows their specifications. There is an overlapping period (8/72 - 2/73) of data collection at the permanent and temporary main stations. Tables 372.05.26 through 372.05.32 give the monthly summaries of the meteorological data collected at the permanent tower. Wind roses for the overlapping period (8/72 - 2/73) for both stations are presented in Figure 7.

Comparison of the main site temporary (Tables 372.05.6 to 372.05.12) and permanent tower (Tables 372.05.26 to 372.05.32) wind speed data from 8/72 - 2/73 shows little difference between the two towers. The temporary tower has approximately 10% more hours in the 0-3 miles per hour range than the permanent tower. The permanent tower has 10% more hours in the 4-7 miles per hour range than the temporary tower. These small differences can be related to the temporary tower anemometer, which records a greater number of light wind speeds because of its higher response threshold when compared to the permanent tower instrument.

Wind roses from the temporary and permanent towers on the main site are also quite similar (Figure 372.05-7) with the prevailing winds out of the N to NNW. The small differences in the wind direction frequency of occurrence between the two towers are probably related to the higher wind speed response threshold of the temporary tower instruments.

Thus the data from the permanent tower are in good agreement with the temporary tower data.

To assess the effects of the hills along the eastern shoreline, wind data from the temporary tower at the main site are compared with the river site tower data. A higher frequency of lower wind speeds (0-7 mph) is recorded at the main site (7775 hr) than at the river site (6790 hr) because the much larger surface roughness (trees, hills) at the main site retards the air flow. A much higher frequency of moderate strength winds (8-12 mph) is observed at the river site (1416 hr) compared to the main site (863 hr) also because of the larger surface roughness at the main site.

Annual average wind roses presented for the two sites in Figure 372.05-6 are indicative of the seasonal synoptic weather patterns of the region and the diurnal drainage flows that occur. The seasons are reflected by the southerly winds of the spring and summer (Figures 372.05-3 and 372.05-4) and north winds in the

fall and winter months (Figures 372.05-2 and 372.05-5). A high percentage of east to southeast winds are also observed, produced by nighttime drainage flow off of the loess hills east of the site (Figure 372.05-8).

Comparing the two sites, a higher frequency of winds from the north and south is observed at the river site than at the main site due to the channeling effect of the bluffs along the eastern shore on winds with a westerly component.

The effects of the terrain on easterly winds is also apparent from the annual wind roses. Easterly winds at the main site are turned to a southeasterly direction at the river site by the SE to NW slope of the land from the bluff to the river (Figure 372.05-1).

Seasonal wind roses for the two sites (Figures 372.05-2 to 372.05-5) also show the differences between the two sites present in the annual average wind roses. During the winter (Figure 372.05-2), when the synoptic pattern produces a northerly wind regime, a higher frequency of north winds occur at the river site than at the main site owing to the channeling effect. In each season the main site records east winds 9% to 14% of the time, whereas the river site records 9% to 11% southeasterly winds.

The effect of the terrain is also seen from the diurnal variations of the wind roses. At night (2 a.m. CST) the prevailing winds are from the east and southeast for the main site and river site, respectively (Figure 372.05-8), indicating cool dense air flowing down off of the hills east of the plant site. During the afternoon (2 p.m. CST) the daytime valley circulation dominates with westerly component winds occurring much more frequently than east winds at both sites (Figure 372.05-9).

These differences in wind flow characteristics between the two sites will enhance the dispersion of an effluent released to the air from the plant site in an east wind situation because of the higher wind speeds at the river. Thus the diffusion analysis using main site wind data will be somewhat conservative under east wind conditions.

TABLE 372.5.1

MONTHLY JOINT FREQUENCY TABLE FOR 3 / 1972 STATION-MAIN SITE

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	14.0	24.0	12.0	.0	.0	.0	.0	.0	.0	50.0
NNE	8.0	8.0	8.0	.0	.0	.0	.0	.0	.0	24.0
NE	23.0	2.0	5.0	.0	.0	.0	.0	.0	.0	30.0
ENE	25.0	14.0	.0	.0	.0	.0	.0	.0	.0	39.0
E	61.0	49.0	10.0	.0	.0	.0	.0	.0	.0	120.0
ESE	15.0	42.0	21.0	.0	.0	.0	.0	.0	.0	78.0
SE	5.0	27.0	13.0	5.0	2.0	.0	.0	.0	.0	52.0
SSE	7.0	12.0	25.0	13.0	.0	.0	.0	.0	.0	64.0
S	12.0	34.0	14.0	.0	.0	.0	.0	.0	.0	60.0
SSW	8.0	10.0	7.0	.0	.0	.0	.0	.0	.0	25.0
SW	10.0	33.0	3.0	.0	.0	.0	.0	.0	.0	46.0
WSW	10.0	23.0	4.0	.0	.0	.0	.0	.0	.0	37.0
W	15.0	18.0	.0	.0	.0	.0	.0	.0	.0	33.0
WNW	12.0	10.0	2.0	.0	.0	.0	.0	.0	.0	24.0
NW	12.0	12.0	3.0	.0	.0	.0	.0	.0	.0	27.0
NNW	10.0	20.0	19.0	.0	.0	.0	.0	.0	.0	49.0
TOTAL	247.0	345.0	146.0	18.0	2.0	.0	.0	.0	.0	758.0

CALM- 11

WIND
WIND IGNORED - IN CONTROL MODE

SYOT LIN-RCSM.PROGRAM
720

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TABLE 372.5.2

MONTHLY JOINT FREQUENCY TABLE FOR 4 / 1972 STATION-MAIN SITE

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	17.0	26.0	34.0	.0	.0	.0	.0	.0	.0	77.0
NNE	23.0	12.0	9.0	.0	.0	.0	.0	.0	.0	44.0
NE	31.0	8.0	.0	.0	.0	.0	.0	.0	.0	39.0
ENE	39.0	11.0	.0	.0	.0	.0	.0	.0	.0	50.0
E	58.0	14.0	.0	.0	.0	.0	.0	.0	.0	72.0
ESE	15.0	13.0	.0	.0	.0	.0	.0	.0	.0	28.0
SE	26.0	28.0	.0	.0	.0	.0	.0	.0	.0	54.0
SSE	12.0	59.0	11.0	.0	.0	.0	.0	.0	.0	82.0
S	6.0	81.0	55.0	2.0	.0	.0	.0	.0	.0	142.0
SSW	5.0	27.0	23.0	.0	.0	.0	.0	.0	.0	55.0
SW	2.0	13.0	5.0	.0	.0	.0	.0	.0	.0	20.0
WSW	.0	.0	.0	.0	.0	.0	.0	.0	.0	.0
W	4.0	6.0	.0	.0	.0	.0	.0	.0	.0	10.0
WNW	3.0	9.0	.0	.0	.0	.0	.0	.0	.0	12.0
NW	6.0	7.0	1.0	.0	.0	.0	.0	.0	.0	14.0
NNW	2.0	12.0	.0	.0	.0	.0	.0	.0	.0	14.0
TOTAL	256.0	326.0	136.0	2.0	.0	.0	.0	.0	.0	720.0

CALMS 0

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.ELOD
.END IGNORED - IN CONTROL MODE

.ELOF
.OF IGNORED - IN CONTROL MODE

.EFIN

TABLE 372.5.3

MONTHLY JOINT FREQUENCY TABLE FOR 5 / 1972 STATION-MAIN SITE

DIRECTION	WIND SPEED (MPH) 0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	18.0	43.0	4.0	.0	.0	.0	.0	.0	.0	65.0
NNE	22.0	19.0	2.0	.0	.0	.0	.0	.0	.0	43.0
NE	57.0	22.0	.0	.0	.0	.0	.0	.0	.0	79.0
ENE	115.0	12.0	.0	.0	.0	.0	.0	.0	.0	127.0
E	88.0	16.0	1.0	.0	.0	.0	.0	.0	.0	105.0
ESE	24.0	5.0	.0	.0	.0	.0	.0	.0	.0	29.0
SE	21.0	11.0	.0	.0	.0	.0	.0	.0	.0	32.0
SSE	14.0	20.0	.0	.0	.0	.0	.0	.0	.0	34.0
S	18.0	7.0	1.0	.0	.0	.0	.0	.0	.0	26.0
SSW	6.0	11.0	.0	.0	.0	.0	.0	.0	.0	17.0
SW	10.0	11.0	.0	.0	.0	.0	.0	.0	.0	21.0
WSW	12.0	2.0	.0	.0	.0	.0	.0	.0	.0	14.0
W	24.0	2.0	.0	.0	.0	.0	.0	.0	.0	26.0
WNW	8.0	2.0	.0	.0	.0	.0	.0	.0	.0	10.0
NW	15.0	11.0	.0	.0	.0	.0	.0	.0	.0	26.0
NNW	21.0	27.0	3.0	.0	.0	.0	.0	.0	.0	51.0
TOTAL	473.0	221.0	11.0	.0	.0	.0	.0	.0	.0	705.0

CALM= 39

```
END
READ IGNORED - IN CONTROL MODE

$XQT LIN-ROSM.PROGRAM
          720
```

GG
ER

TABLE 372.5.4

MONTHLY JOINT FREQUENCY TAPLE FOR 6 / 1972 STATION-MAIN SITE

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	23.0	23.0	5.0	.0	.0	.0	.0	.0	.0	51.0
NNE	31.0	20.0	4.0	.0	.0	.0	.0	.0	.0	55.0
NE	60.0	13.0	.0	.0	.0	.0	.0	.0	.0	73.0
ENE	84.0	5.0	.0	.0	.0	.0	.0	.0	.0	89.0
E	86.0	11.0	.0	.0	.0	.0	.0	.0	.0	97.0
ESE	40.0	6.0	.0	.0	.0	.0	.0	.0	.0	46.0
SE	29.0	11.0	.0	.0	.0	.0	.0	.0	.0	40.0
SSE	18.0	12.0	.0	.0	.0	.0	.0	.0	.0	30.0
S	25.0	30.0	6.0	.0	.0	.0	.0	.0	.0	61.0
SSW	9.0	46.0	3.0	.0	.0	.0	.0	.0	.0	58.0
SW	9.0	14.0	.0	.0	.0	.0	.0	.0	.0	23.0
WSW	14.0	.0	.0	.0	.0	.0	.0	.0	.0	14.0
W	11.0	3.0	.0	.0	.0	.0	.0	.0	.0	14.0
WNW	8.0	6.0	.0	.0	.0	.0	.0	.0	.0	14.0
NW	17.0	3.0	.0	.0	.0	.0	.0	.0	.0	20.0
NNW	15.0	15.0	.0	.0	.0	.0	.0	.0	.0	30.0
TOTAL	479.0	218.0	18.0	.0	.0	.0	.0	.0	.0	715.0

CALM= 5

END
$END IGNORED - IN CONTROL MODE

$EOF
$EOF IGNORED - IN CONTROL MODE

$FIN

GG
ER

TABLE 372.5.5

MONTHLY JOINT FREQUENCY TABLE FOR 7 / 1972 STATION-MAIN SITE

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	14.0	23.0	.0	.0	.0	.0	.0	.0	.0	37.0
NNE	24.0	9.0	.0	.0	.0	.0	.0	.0	.0	33.0
NE	34.0	14.0	.0	.0	.0	.0	.0	.0	.0	48.0
ENE	62.0	12.0	.0	.0	.0	.0	.0	.0	.0	74.0
E	87.0	22.0	.0	.0	.0	.0	.0	.0	.0	109.0
ESE	52.0	13.0	.0	.0	.0	.0	.0	.0	.0	65.0
SE	49.0	9.0	.0	.0	.0	.0	.0	.0	.0	58.0
SSE	44.0	21.0	1.0	.0	.0	.0	.0	.0	.0	66.0
S	42.0	43.0	2.0	.0	.0	.0	.0	.0	.0	87.0
SSW	21.0	31.0	.0	.0	.0	.0	.0	.0	.0	52.0
SW	20.0	16.0	.0	.0	.0	.0	.0	.0	.0	36.0
WSW	22.0	3.0	.0	.0	.0	.0	.0	.0	.0	25.0
W	23.0	.0	.0	.0	.0	.0	.0	.0	.0	23.0
WNW	10.0	.0	.0	.0	.0	.0	.0	.0	.0	10.0
NW	5.0	7.0	.0	.0	.0	.0	.0	.0	.0	12.0
NNW	2.0	7.0	.0	.0	.0	.0	.0	.0	.0	9.0
TOTAL	511.0	230.0	3.0	.0	.0	.0	.0	.0	.0	744.0

CALMS 0

*END
*END IGNORED - IN CONTROL MODE

GG
ER

*XQT LIN-RUSH,PROGRAM
700

TABLE 372.5.6

MONTHLY JOINT FREQUENCY TABLE FOR 8 / 1972 STATION=MAIN SITE

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	34.0	35.0	.0	.0	.0	.0	.0	.0	.0	69.0
NNE	25.0	8.0	.0	.0	.0	.0	.0	.0	.0	33.0
NE	29.0	8.0	.0	.0	.0	.0	.0	.0	.0	37.0
ENE	60.0	8.0	.0	.0	.0	.0	.0	.0	.0	68.0
E	99.0	3.0	.0	.0	.0	.0	.0	.0	.0	102.0
ESE	57.0	3.0	.0	.0	.0	.0	.0	.0	.0	60.0
SE	40.0	4.0	.0	.0	.0	.0	.0	.0	.0	44.0
SSE	28.0	8.0	.0	.0	.0	.0	.0	.0	.0	36.0
S	47.0	25.0	.0	.0	.0	.0	.0	.0	.0	72.0
SSW	32.0	19.0	.0	.0	.0	.0	.0	.0	.0	51.0
SW	12.0	22.0	.0	.0	.0	.0	.0	.0	.0	34.0
WSW	14.0	14.0	.0	.0	.0	.0	.0	.0	.0	28.0
W	26.0	5.0	.0	.0	.0	.0	.0	.0	.0	31.0
WNW	16.0	5.0	.0	.0	.0	.0	.0	.0	.0	21.0
NW	17.0	16.0	.0	.0	.0	.0	.0	.0	.0	33.0
NNW	9.0	16.0	.0	.0	.0	.0	.0	.0	.0	25.0
TOTAL	545.0	199.0	.0	.0	.0	.0	.0	.0	.0	744.0

CALM= 0

#END

#END IGNORED - IN CONTROL MODE

#EOF

#EOF IGNORED - IN CONTROL MODE

#FIN

GG
ER

TABLE 372.5.7

MONTHLY JOINT FREQUENCY TABLE FOR 9 / 1972 STATION-MAIN SITE

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	19.0	18.0	10.0	1.0	.0	.0	.0	.0	.0	47.0
NNE	29.0	15.0	.0	.0	.0	.0	.0	.0	.0	44.0
NE	22.0	2.0	.0	.0	.0	.0	.0	.0	.0	24.0
ENE	58.0	2.0	.0	.0	.0	.0	.0	.0	.0	60.0
E	102.0	6.0	.0	.0	.0	.0	.0	.0	.0	108.0
ESE	65.0	8.0	.0	.0	.0	.0	.0	.0	.0	73.0
SE	52.0	14.0	.0	.0	.0	.0	.0	.0	.0	66.0
SSE	44.0	26.0	2.0	.0	.0	.0	.0	.0	.0	72.0
S	40.0	14.0	1.0	.0	.0	.0	.0	.0	.0	55.0
SSW	24.0	17.0	.0	.0	.0	.0	.0	.0	.0	41.0
SW	19.0	11.0	.0	.0	.0	.0	.0	.0	.0	30.0
WSW	18.0	7.0	.0	.0	.0	.0	.0	.0	.0	25.0
W	18.0	5.0	.0	.0	.0	.0	.0	.0	.0	23.0
WNW	6.0	4.0	.0	.0	.0	.0	.0	.0	.0	10.0
NW	7.0	11.0	.0	.0	.0	.0	.0	.0	.0	18.0
NNW	7.0	14.0	3.0	.0	.0	.0	.0	.0	.0	24.0
TOTAL	525.0	174.0	20.0	1.0	.0	.0	.0	.0	.0	720.0

CALM= 0

GG
ER

@END
@END IGNORED - IN CONTROL MODE

@EOF
@EOF IGNORED - IN CONTROL MODE

@EIN

TABLE 372.5.8

MONTHLY JOINT FREQUENCY TABLE FOR 10 / 1972 STATION-MAIN SITE

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	20.0	35.0	13.0	.0	.0	.0	.0	.0	.0	68.0
NNE	44.0	17.0	1.0	.0	.0	.0	.0	.0	.0	62.0
NE	47.0	17.0	.0	.0	.0	.0	.0	.0	.0	64.0
ENE	98.0	22.0	.0	.0	.0	.0	.0	.0	.0	120.0
E	91.0	31.0	.0	.0	.0	.0	.0	.0	.0	122.0
ESE	25.0	13.0	.0	.0	.0	1.0	.0	.0	.0	39.0
SE	17.0	16.0	.0	.0	.0	.0	.0	.0	.0	33.0
SSE	13.0	19.0	1.0	.0	.0	.0	.0	.0	.0	33.0
S	21.0	10.0	6.0	.0	.0	.0	.0	.0	.0	37.0
SSW	12.0	5.0	.0	.0	.0	.0	.0	.0	.0	17.0
SW	9.0	18.0	.0	.0	.0	.0	.0	.0	.0	27.0
WSW	14.0	11.0	.0	.0	.0	.0	.0	.0	.0	25.0
W	9.0	8.0	.0	.0	.0	.0	.0	.0	.0	17.0
WNW	13.0	8.0	.0	.0	.0	.0	.0	.0	.0	21.0
NW	12.0	14.0	2.0	.0	.0	.0	.0	.0	.0	28.0
NNW	11.0	19.0	1.0	.0	.0	.0	.0	.0	.0	31.0
TOTAL	456.0	263.0	24.0	.0	.0	1.0	.0	.0	.0	744.0

CALM= 0

GG
ER

@END
@END IGNORED - IN CONTROL MODE

@XQT LIN=ROSM.PROGRAM
720

TABLE 372.5.9

MONTHLY JOINT FREQUENCY TABLE FOR 11 / 1972 STATION-MAIN SITE

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	41.0	46.0	9.0	.0	.0	.0	.0	.0	.0	96.0
NNE	27.0	38.0	2.0	.0	.0	.0	.0	.0	.0	67.0
NE	30.0	16.0	.0	.0	.0	.0	.0	.0	.0	46.0
ENE	57.0	20.0	.0	.0	.0	.0	.0	.0	.0	77.0
E	30.0	27.0	.0	.0	.0	.0	.0	.0	.0	57.0
ESE	7.0	13.0	2.0	.0	.0	.0	.0	.0	.0	22.0
SE	3.0	15.0	1.0	.0	.0	.0	.0	.0	.0	19.0
SSE	8.0	23.0	22.0	.0	.0	.0	.0	.0	.0	53.0
S	14.0	12.0	18.0	.0	.0	.0	.0	.0	.0	44.0
SSW	3.0	3.0	2.0	.0	.0	.0	.0	.0	.0	8.0
SW	3.0	7.0	.0	.0	.0	.0	.0	.0	.0	10.0
WSW	3.0	15.0	1.0	.0	.0	.0	.0	.0	.0	19.0
W	10.0	32.0	7.0	.0	.0	.0	.0	.0	.0	49.0
WNW	7.0	39.0	4.0	.0	.0	.0	.0	.0	.0	50.0
NW	12.0	32.0	1.0	.0	.0	.0	.0	.0	.0	45.0
NNW	7.0	38.0	13.0	.0	.0	.0	.0	.0	.0	58.0
TOTAL	242.0	376.0	82.0	.0	.0	.0	.0	.0	.0	720.0

CALM= 0

$END
$END IGNORED - IN CONTROL MODE

GG
ER

$XQT LIN-ROSM.PROGRAM
744

TABLE 372.5.10

MONTHLY JOINT FREQUENCY TABLE FOR 12 / 1972 STATION-MAIN SITE

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	10.0	49.0	20.0	.0	.0	.0	.0	.0	.0	79.0
NNE	19.0	29.0	5.0	.0	.0	.0	.0	.0	.0	53.0
NE	23.0	20.0	2.0	.0	.0	.0	.0	.0	.0	45.0
ENE	18.0	6.0	.0	.0	.0	.0	.0	.0	.0	24.0
E	33.0	23.0	.0	.0	.0	.0	.0	.0	.0	56.0
ESE	21.0	32.0	2.0	.0	.0	.0	.0	.0	.0	55.0
SE	25.0	53.0	20.0	.0	.0	.0	.0	.0	.0	98.0
SSE	14.0	38.0	17.0	2.0	.0	.0	.0	.0	.0	71.0
S	15.0	30.0	22.0	.0	.0	.0	.0	.0	.0	67.0
SSW	9.0	7.0	.0	.0	.0	.0	.0	.0	.0	16.0
SW	7.0	10.0	.0	.0	.0	.0	.0	.0	.0	17.0
WSW	8.0	8.0	.0	.0	.0	.0	.0	.0	.0	16.0
W	9.0	5.0	.0	.0	.0	.0	.0	.0	.0	14.0
WNW	8.0	6.0	.0	.0	.0	.0	.0	.0	.0	14.0
NW	12.0	7.0	8.0	.0	.0	.0	.0	.0	.0	27.0
NNW	14.0	36.0	41.0	1.0	.0	.0	.0	.0	.0	92.0
TOTAL	245.0	359.0	137.0	3.0	.0	.0	.0	.0	.0	744.0

CALMS= 0

FILE
SEND IGNORED - IN CONTROL MODE

FILE
FILE IGNORED - IN CONTROL MODE

FIN

GG
ER

TABLE 372.5.11

MONTHLY JOINT FREQUENCY TABLE FOR 1 / 1973 STATION=MAIN SITE

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	20.0	91.0	30.0	.0	.0	.0	.0	.0	.0	181.0
NNE	12.0	43.0	2.0	.0	.0	.0	.0	.0	.0	57.0
NE	14.0	19.0	.0	.0	.0	.0	.0	.0	.0	33.0
ENE	29.0	7.0	.0	.0	.0	.0	.0	.0	.0	36.0
E	57.0	27.0	14.0	.0	.0	.0	.0	.0	.0	78.0
ESE	11.0	25.0	27.0	1.0	.0	.0	.0	.0	.0	64.0
SE	13.0	19.0	20.0	7.0	.0	.0	.0	.0	.0	59.0
SSE	4.0	8.0	11.0	6.0	.0	.0	.0	.0	.0	29.0
S	6.0	9.0	13.0	1.0	.0	.0	.0	.0	.0	29.0
SSW	7.0	5.0	8.0	2.0	.0	.0	.0	.0	.0	22.0
SW	10.0	13.0	5.0	.0	.0	.0	.0	.0	.0	28.0
WSW	13.0	22.0	11.0	.0	.0	.0	.0	.0	.0	46.0
W	5.0	14.0	10.0	.0	.0	.0	.0	.0	.0	29.0
WNW	5.0	12.0	4.0	.0	.0	.0	.0	.0	.0	21.0
NW	2.0	16.0	4.0	.0	.0	.0	.0	.0	.0	22.0
NNW	5.0	13.0	21.0	.0	.0	.0	.0	.0	.0	39.0
TOTAL	193.0	343.0	180.0	17.0	.0	.0	.0	.0	.0	733.0

CALMS 11

*END
*END IGNORED - IN CONTROL MODE

*XQT LIN=NOSM,PROGRAM
672

GG
ER

TABLE 372.5.12

MONTHLY JOINT FREQUENCY TABLE FOR 2 / 1973 STATION=MAIN SITE

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	20.0	28.0	26.0	9.0	.0	.0	.0	.0	.0	83.0
NNE	25.0	19.0	1.0	.0	.0	.0	.0	.0	.0	45.0
NE	18.0	17.0	1.0	.0	.0	.0	.0	.0	.0	36.0
ENE	29.0	10.0	1.0	.0	.0	.0	.0	.0	.0	40.0
E	35.0	13.0	2.0	.0	.0	.0	.0	.0	.0	50.0
ESE	12.0	15.0	7.0	.0	.0	.0	.0	.0	.0	34.0
SE	7.0	7.0	14.0	1.0	1.0	.0	.0	.0	.0	30.0
SSE	3.0	10.0	7.0	1.0	.0	.0	.0	.0	.0	21.0
S	5.0	15.0	9.0	1.0	.0	.0	.0	.0	.0	30.0
SSW	7.0	17.0	.0	.0	.0	.0	.0	.0	.0	24.0
SW	3.0	9.0	1.0	.0	.0	.0	.0	.0	.0	13.0
WSW	5.0	24.0	11.0	.0	.0	.0	.0	.0	.0	40.0
W	21.0	28.0	15.0	.0	.0	.0	.0	.0	.0	64.0
WNW	13.0	19.0	.0	.0	.0	.0	.0	.0	.0	32.0
NW	10.0	24.0	.0	.0	.0	.0	.0	.0	.0	34.0
NNW	18.0	43.0	11.0	.0	.0	.0	.0	.0	.0	72.0
TOTAL	231.0	298.0	106.0	12.0	1.0	.0	.0	.0	.0	648.0

CALM= 24

GG
ER

*END
*END IGNORED - IN CONTROL MODE

*EOF
*EOF IGNORED - IN CONTROL MODE

*FIN

TABLE 372.5.13

MONTHLY JOINT FREQUENCY TABLE FOR 3 / 1972 STATION - RIVER

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	26.0	24.0	12.0	2.0	.0	.0	.0	.0	.0	64.0
NNE	12.0	6.0	13.0	.0	.0	.0	.0	.0	.0	31.0
NE	26.0	6.0	1.0	.0	.0	.0	.0	.0	.0	33.0
ENE	13.0	4.0	.0	.0	.0	.0	.0	.0	.0	17.0
E	41.0	11.0	.0	.0	.0	.0	.0	.0	.0	52.0
ESE	45.0	42.0	7.0	.0	.0	.0	.0	.0	.0	94.0
SE	31.0	28.0	9.0	2.0	.0	.0	.0	.0	.0	70.0
SSE	19.0	23.0	16.0	11.0	.0	.0	.0	.0	.0	69.0
S	14.0	22.0	24.0	3.0	.0	.0	.0	.0	.0	63.0
SSW	9.0	21.0	33.0	6.0	1.0	.0	.0	.0	.0	70.0
SW	5.0	9.0	4.0	.0	.0	.0	.0	.0	.0	18.0
WSW	3.0	1.0	4.0	1.0	.0	.0	.0	.0	.0	9.0
W	10.0	13.0	5.0	2.0	1.0	.0	.0	.0	.0	31.0
WNW	7.0	3.0	3.0	1.0	.0	.0	.0	.0	.0	14.0
NW	2.0	9.0	11.0	4.0	.0	.0	.0	.0	.0	26.0
NNW	6.0	21.0	22.0	15.0	3.0	.0	.0	.0	.0	67.0
TOTAL	269.0	243.0	164.0	47.0	5.0	.0	.0	.0	.0	728.0

CALM = 40

```
$END
$END IGNORED - IN CONTROL MODE

$XQT LIN-ROSE.PROGRAM
        720
```

GG
ER

TABLE 372.5.14

MONTHLY JOINT FREQUENCY TABLE FOR 4 / 1972 STATION - RIVER

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	20.0	17.0	34.0	14.0	.0	.0	.0	.0	.0	85.0
NNE	21.0	11.0	1.0	.0	.0	.0	.0	.0	.0	33.0
NE	19.0	9.0	.0	.0	.0	.0	.0	.0	.0	28.0
ENE	17.0	2.0	.0	.0	.0	.0	.0	.0	.0	19.0
E	50.0	15.0	.0	.0	.0	.0	.0	.0	.0	65.0
ESE	37.0	17.0	.0	.0	.0	.0	.0	.0	.0	54.0
SE	28.0	38.0	5.0	.0	.0	.0	.0	.0	.0	71.0
SSE	12.0	54.0	7.0	1.0	.0	.0	.0	.0	.0	74.0
S	7.0	37.0	74.0	27.0	2.0	.0	.0	.0	.0	147.0
SSW	2.0	12.0	18.0	14.0	5.0	.0	.0	.0	.0	51.0
SW	.0	2.0	.0	.0	.0	.0	.0	.0	.0	2.0
WSW	.0	.0	1.0	1.0	.0	.0	.0	.0	.0	2.0
W	2.0	.0	12.0	5.0	.0	.0	.0	.0	.0	19.0
WNW	1.0	8.0	2.0	.0	.0	.0	.0	.0	.0	11.0
NW	4.0	14.0	10.0	.0	.0	.0	.0	.0	.0	28.0
NNW	3.0	12.0	14.0	2.0	.0	.0	.0	.0	.0	31.0
TOTAL	223.0	248.0	178.0	64.0	7.0	.0	.0	.0	.0	720.0

CALM = 0

READ
SEND IGNORED - IN CONTROL MODE

READ
SEND IGNORED - IN CONTROL MODE

READY

GG
ER

TABLE 372.5.15

MONTHLY JOINT FREQUENCY TABLE FOR 5 / 1972 STATION - RIVER

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	28.0	39.0	20.0	.0	.0	.0	.0	.0	.0	87.0
NNE	27.0	12.0	2.0	.0	.0	.0	.0	.0	.0	41.0
NE	26.0	12.0	.0	.0	.0	.0	.0	.0	.0	38.0
ENE	46.0	3.0	.0	.0	.0	.0	.0	.0	.0	49.0
E	77.0	12.0	.0	.0	.0	.0	.0	.0	.0	89.0
ESE	76.0	14.0	.0	.0	.0	.0	.0	.0	.0	90.0
SE	59.0	15.0	2.0	.0	.0	.0	.0	.0	.0	76.0
SSE	29.0	6.0	.0	.0	.0	.0	.0	.0	.0	35.0
S	26.0	24.0	1.0	.0	.0	.0	.0	.0	.0	51.0
SSW	9.0	10.0	5.0	1.0	.0	.0	.0	.0	.0	25.0
SW	5.0	3.0	.0	.0	.0	.0	.0	.0	.0	8.0
WSW	6.0	2.0	.0	.0	.0	.0	.0	.0	.0	8.0
W	17.0	4.0	1.0	.0	.0	.0	.0	.0	.0	22.0
WNW	7.0	4.0	2.0	.0	.0	.0	.0	.0	.0	13.0
NW	10.0	18.0	5.0	.0	.0	.0	.0	.0	.0	33.0
NNW	14.0	38.0	23.0	4.0	.0	.0	.0	.0	.0	79.0
TOTAL	462.0	216.0	61.0	5.0	.0	.0	.0	.0	.0	744.0

CALM = 0

GG
ER

```
:END
?END IGNORED - IN CONTROL MODE

:XQT LIN-ROSE.PROGRAM
720
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TABLE 372.5.16

MONTHLY JOINT FREQUENCY TABLE FOR 6 / 1972 STATION - RIVER

DIRECTION	WIND SPEED (MPH) 0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	21.0	30.0	15.0	.0	.0	.0	.0	.0	.0	66.0
NNE	40.0	9.0	.0	.0	.0	.0	.0	.0	.0	49.0
NE	17.0	6.0	.0	.0	.0	.0	.0	.0	.0	23.0
ENE	22.0	3.0	.0	.0	.0	.0	.0	.0	.0	25.0
E	76.0	9.0	1.0	.0	.0	.0	.0	.0	.0	86.0
ESE	65.0	11.0	.0	.0	.0	.0	.0	.0	.0	76.0
SE	59.0	10.0	.0	.0	.0	.0	.0	.0	.0	69.0
SSE	34.0	16.0	1.0	.0	.0	.0	.0	.0	.0	51.0
S	9.0	29.0	10.0	.0	.0	.0	.0	.0	.0	48.0
SSW	5.0	13.0	15.0	14.0	.0	.0	.0	.0	.0	47.0
SW	5.0	10.0	19.0	10.0	.0	.0	.0	.0	.0	44.0
WSW	6.0	5.0	5.0	.0	.0	.0	.0	.0	.0	16.0
W	17.0	7.0	4.0	.0	.0	.0	.0	.0	.0	28.0
WNW	11.0	5.0	5.0	2.0	.0	.0	.0	.0	.0	23.0
NW	12.0	16.0	1.0	.0	.0	.0	.0	.0	.0	29.0
NNW	16.0	17.0	2.0	1.0	.0	.0	.0	.0	.0	36.0
TOTAL	415.0	196.0	78.0	27.0	.0	.0	.0	.0	.0	716.0

CALM = 4

GG
ER

SEND
SEND IGNORED - IN CONTROL MODE

SEOF
SEOF IGNORED - IN CONTROL MODE

SEIN

TABLE 372.5.17

MONTHLY JOINT FREQUENCY TABLE FOR 7 / 1972 STATION - RIVER

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	12.0	11.0	12.0	.0	.0	.0	.0	.0	.0	35.0
NNE	23.0	11.0	3.0	.0	.0	.0	.0	.0	.0	37.0
NE	24.0	7.0	1.0	.0	.0	.0	.0	.0	.0	32.0
ENE	38.0	5.0	.0	.0	.0	.0	.0	.0	.0	43.0
E	61.0	12.0	.0	.0	.0	.0	.0	.0	.0	73.0
ESE	65.0	26.0	1.0	.0	.0	.0	.0	.0	.0	92.0
SE	77.0	13.0	.0	.0	.0	.0	.0	.0	.0	90.0
SSE	44.0	18.0	1.0	.0	.0	.0	.0	.0	.0	63.0
S	23.0	49.0	3.0	.0	.0	.0	.0	.0	.0	75.0
SSW	7.0	24.0	16.0	2.0	.0	.0	.0	.0	.0	49.0
SW	12.0	28.0	18.0	2.0	.0	.0	.0	.0	.0	60.0
WSW	7.0	8.0	4.0	.0	.0	.0	.0	.0	.0	19.0
W	22.0	4.0	.0	.0	.0	.0	.0	.0	.0	26.0
WNW	10.0	3.0	.0	1.0	.0	.0	.0	.0	.0	14.0
NW	15.0	8.0	.0	.0	.0	.0	.0	.0	.0	23.0
NNW	3.0	10.0	.0	.0	.0	.0	.0	.0	.0	13.0
TOTAL	443.0	237.0	59.0	5.0	.0	.0	.0	.0	.0	744.0

CALM = 0

```
*END
*END IGNORED - IN CONTROL MODE

*XQT LIN-ROSE,PROGRAM
        744
```

GG
ER

TABLE 372.5.18

MONTHLY JOINT FREQUENCY TABLE FOR 8 / 1972 STATION - RIVER

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	24.0	53.0	11.0	.0	.0	.0	.0	.0	.0	88.0
NNE	32.0	12.0	.0	.0	.0	.0	.0	.0	.0	44.0
NE	30.0	3.0	.0	.0	.0	.0	.0	.0	.0	33.0
ENE	19.0	6.0	.0	.0	.0	.0	.0	.0	.0	25.0
E	62.0	5.0	.0	.0	.0	.0	.0	.0	.0	67.0
ESE	58.0	18.0	.0	.0	.0	.0	.0	.0	.0	76.0
SE	61.0	5.0	1.0	.0	.0	.0	.0	.0	.0	67.0
SSE	41.0	15.0	1.0	.0	.0	.0	.0	.0	.0	57.0
S	31.0	27.0	1.0	1.0	.0	.0	.0	.0	.0	60.0
SSW	8.0	35.0	15.0	.0	.0	.0	.0	.0	.0	58.0
SW	13.0	12.0	14.0	.0	.0	.0	.0	.0	.0	39.0
WSW	16.0	9.0	4.0	.0	.0	.0	.0	.0	.0	29.0
W	14.0	6.0	3.0	.0	.0	.0	.0	.0	.0	23.0
WNW	16.0	5.0	2.0	.0	.0	.0	.0	.0	.0	23.0
NW	17.0	5.0	.0	.0	.0	.0	.0	.0	.0	22.0
NNW	17.0	16.0	.0	.0	.0	.0	.0	.0	.0	33.0
TOTAL	459.0	232.0	52.0	1.0	.0	.0	.0	.0	.0	744.0

CALM = 0

GG
ER

#END
#END IGNORED - IN CONTROL MODE

#EOF
#EOF IGNORED - IN CONTROL MODE

#FIN

TABLE 372.5.19

MONTHLY JOINT FREQUENCY TABLE FOR 9 / 1972 STATION - RIVER

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	11.0	19.0	11.0	6.0	.0	.0	.0	.0	.0	47.0
NNE	35.0	16.0	1.0	5.0	.0	.0	.0	.0	.0	57.0
NE	20.0	3.0	.0	.0	.0	.0	.0	.0	.0	23.0
ENE	23.0	3.0	.0	.0	.0	.0	.0	.0	.0	26.0
E	54.0	3.0	.0	.0	.0	.0	.0	.0	.0	57.0
ESE	73.0	20.0	.0	.0	.0	.0	.0	.0	.0	93.0
SE	84.0	17.0	1.0	.0	.0	.0	.0	.0	.0	102.0
SSE	47.0	14.0	.0	.0	.0	.0	.0	.0	.0	61.0
S	23.0	27.0	6.0	1.0	.0	.0	.0	.0	.0	57.0
SSW	13.0	29.0	4.0	1.0	.0	.0	.0	.0	.0	47.0
SW	11.0	7.0	6.0	.0	.0	.0	.0	.0	.0	24.0
WSW	9.0	4.0	2.0	.0	.0	.0	.0	.0	.0	15.0
W	18.0	2.0	.0	.0	.0	.0	.0	.0	.0	20.0
WNW	19.0	3.0	1.0	.0	.0	.0	.0	.0	.0	23.0
NW	6.0	6.0	.0	.0	.0	.0	.0	.0	.0	12.0
NNW	11.0	27.0	5.0	1.0	.0	.0	.0	.0	.0	44.0
TOTAL	403.0	200.0	37.0	14.0	.0	.0	.0	.0	.0	720.0

CALM = 0

END
END IGNORED - IN CONTROL MODE

>GT LIN-POSF,PROGRAM
744

GG
ER

TABLE 372.5.20

MONTHLY JOINT FREQUENCY TABLE FOR 10 / 1972 STATION - RIVER

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	31.0	29.0	25.0	5.0	.0	.0	.0	.0	.0	90.0
NNE	49.0	27.0	15.0	.0	.0	.0	.0	.0	.0	91.0
NE	53.0	11.0	.0	.0	.0	.0	.0	.0	.0	64.0
ENE	52.0	5.0	.0	.0	.0	.0	.0	.0	.0	57.0
E	52.0	7.0	.0	.0	.0	.0	.0	.0	.0	59.0
ESE	56.0	18.0	.0	.0	.0	.0	.0	.0	.0	74.0
SE	40.0	34.0	.0	.0	.0	.0	.0	.0	.0	74.0
SSE	26.0	6.0	1.0	.0	.0	.0	.0	.0	.0	33.0
S	18.0	15.0	5.0	.0	.0	.0	.0	.0	.0	38.0
SSW	13.0	25.0	8.0	.0	.0	.0	.0	.0	.0	46.0
SW	4.0	4.0	4.0	1.0	.0	.0	.0	.0	.0	13.0
WSW	4.0	11.0	7.0	1.0	.0	.0	.0	.0	.0	23.0
W	8.0	3.0	1.0	.0	.0	.0	.0	.0	.0	12.0
WNW	10.0	6.0	3.0	.0	.0	.0	.0	.0	.0	19.0
NW	9.0	11.0	.0	1.0	.0	.0	.0	.0	.0	21.0
NNW	8.0	17.0	5.0	.0	.0	.0	.0	.0	.0	30.0
TOTAL	433.0	229.0	74.0	8.0	.0	.0	.0	.0	.0	744.0

CALM = 0

GG
ER

FED
ND IGNORED - IN CONTROL MODE

FCF
FCF IGNORED - IN CONTROL MODE

FFD

TABLE 372.5.21

MONTHLY JOINT FREQUENCY TABLE FOR 11 / 1972 STATION - RIVER

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	25.0	46.0	42.0	10.0	.0	.0	.0	.0	.0	123.0
NNE	29.0	35.0	7.0	.0	.0	.0	.0	.0	.0	71.0
NE	41.0	13.0	.0	.0	.0	.0	.0	.0	.0	54.0
ENE	34.0	10.0	.0	.0	.0	.0	.0	.0	.0	44.0
E	33.0	19.0	.0	.0	.0	.0	.0	.0	.0	52.0
ESE	8.0	8.0	.0	.0	.0	.0	.0	.0	.0	16.0
SE	17.0	13.0	3.0	.0	.0	.0	.0	.0	.0	33.0
SSE	21.0	30.0	8.0	.0	.0	.0	.0	.0	.0	59.0
S	8.0	19.0	18.0	2.0	.0	.0	.0	.0	.0	47.0
SSW	5.0	9.0	1.0	2.0	.0	.0	.0	.0	.0	17.0
SW	4.0	1.0	4.0	.0	.0	.0	.0	.0	.0	9.0
WSW	3.0	4.0	9.0	1.0	.0	.0	.0	.0	.0	17.0
W	.0	8.0	27.0	3.0	.0	.0	.0	.0	.0	38.0
WNW	1.0	6.0	35.0	4.0	.0	.0	.0	.0	.0	46.0
NW	1.0	6.0	28.0	.0	.0	.0	.0	.0	.0	35.0
NNW	4.0	22.0	30.0	3.0	.0	.0	.0	.0	.0	59.0
TOTAL	234.0	249.0	212.0	25.0	.0	.0	.0	.0	.0	720.0

CALM = 0

READ
END IGNORED - IN CONTROL MODE

GG
ER

$XQT LIN-ROSE.PROGRAM
744

TABLE 372.5.22

MONTHLY JOINT FREQUENCY TABLE FOR 12 / 1972 STATION - RIVER

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	12.0	34.0	43.0	29.0	5.0	.0	.0	.0	.0	123.0
NNE	19.0	22.0	8.0	.0	.0	.0	.0	.0	.0	49.0
NE	16.0	9.0	.0	.0	.0	.0	.0	.0	.0	25.0
ENE	5.0	.0	1.0	.0	.0	.0	.0	.0	.0	6.0
E	27.0	4.0	.0	.0	.0	.0	.0	.0	.0	31.0
ESE	24.0	25.0	1.0	.0	.0	.0	.0	.0	.0	50.0
SE	38.0	38.0	10.0	.0	.0	.0	.0	.0	.0	86.0
SSE	18.0	48.0	18.0	.0	.0	.0	.0	.0	.0	84.0
S	21.0	36.0	18.0	3.0	.0	.0	.0	.0	.0	78.0
SSW	5.0	16.0	7.0	.0	.0	.0	.0	.0	.0	28.0
SW	3.0	5.0	4.0	.0	.0	.0	.0	.0	.0	12.0
WSW	4.0	2.0	.0	.0	.0	.0	.0	.0	.0	6.0
W	3.0	6.0	3.0	.0	.0	.0	.0	.0	.0	12.0
WNW	1.0	3.0	3.0	.0	.0	.0	.0	.0	.0	7.0
NW	4.0	2.0	7.0	5.0	.0	.0	.0	.0	.0	18.0
NNW	4.0	9.0	22.0	18.0	5.0	.0	.0	.0	.0	58.0
TOTAL	204.0	259.0	145.0	55.0	10.0	.0	.0	.0	.0	673.0

CALM = 71

GG
ER

$END
$END IGNORED - IN CONTROL MODE

$ECF
$ECF IGNORED - IN CONTROL MODE

$FIN

TABLE 372.5.23

MONTHLY JOINT FREQUENCY TABLE FOR 1 / 1973 STATION - RIVER

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	7.0	43.0	79.0	18.0	.0	.0	.0	.0	.0	147.0
NNE	14.0	36.0	15.0	.0	.0	.0	.0	.0	.0	65.0
NE	12.0	9.0	1.0	.0	.0	.0	.0	.0	.0	22.0
ENE	12.0	1.0	.0	.0	.0	.0	.0	.0	.0	13.0
E	21.0	16.0	1.0	.0	.0	.0	.0	.0	.0	38.0
ESE	55.0	37.0	13.0	.0	.0	.0	.0	.0	.0	105.0
SE	29.0	29.0	23.0	1.0	.0	.0	.0	.0	.0	82.0
SSE	14.0	8.0	6.0	4.0	.0	.0	.0	.0	.0	32.0
S	16.0	13.0	8.0	2.0	.0	.0	.0	.0	.0	39.0
SSW	3.0	12.0	12.0	12.0	4.0	1.0	.0	.0	.0	44.0
SW	5.0	5.0	9.0	13.0	1.0	.0	.0	.0	.0	33.0
WSW	5.0	1.0	4.0	3.0	.0	.0	.0	.0	.0	17.0
W	7.0	3.0	5.0	4.0	1.0	.0	.0	.0	.0	20.0
WNW	3.0	3.0	1.0	4.0	.0	.0	.0	.0	.0	11.0
NW	6.0	1.0	3.0	13.0	1.0	.0	.0	.0	.0	24.0
NNW	4.0	11.0	11.0	13.0	2.0	.0	.0	.0	.0	41.0
TOTAL	217.0	228.0	191.0	87.0	9.0	1.0	.0	.0	.0	733.0

CALM = 11

GG
ER

$END
$END IGNORED - IN CONTROL MODE

$RUN LIN-ROSE.PROGRAM
672

TABLE 372.5.24

MONTHLY JOINT FREQUENCY TABLE FOR 2 / 1973 STATION - RIVER

WIND SPEED (MPH)

DIRECTION	0-3	4-7	8-12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL
N	25.0	47.0	49.0	21.0	11.0	.0	.0	.0	.0	153.0
NNE	25.0	17.0	5.0	.0	.0	.0	.0	.0	.0	47.0
NE	25.0	10.0	.0	.0	.0	.0	.0	.0	.0	35.0
ENE	18.0	5.0	.0	.0	.0	.0	.0	.0	.0	23.0
E	22.0	1.0	.0	.0	.0	.0	.0	.0	.0	23.0
ESE	20.0	8.0	.0	.0	.0	.0	.0	.0	.0	28.0
SE	31.0	14.0	9.0	2.0	.0	.0	.0	.0	.0	56.0
SSE	12.0	8.0	7.0	1.0	.0	.0	.0	.0	.0	28.0
S	10.0	17.0	16.0	.0	.0	.0	.0	.0	.0	43.0
SSW	5.0	18.0	23.0	1.0	.0	.0	.0	.0	.0	47.0
SW	5.0	.0	7.0	4.0	.0	.0	.0	.0	.0	16.0
WSW	4.0	3.0	7.0	5.0	.0	.0	.0	.0	.0	19.0
W	8.0	10.0	16.0	8.0	1.0	.0	.0	.0	.0	43.0
WNW	9.0	2.0	5.0	.0	.0	.0	.0	.0	.0	16.0
NW	7.0	7.0	9.0	1.0	.0	.0	.0	.0	.0	24.0
NNW	11.0	21.0	12.0	4.0	3.0	.0	.0	.0	.0	51.0
TOTAL	237.0	188.0	165.0	47.0	15.0	.0	.0	.0	.0	652.0

CALM = 20

GG ER

$END
$END IGNORED - IN CONTROL MODE

$EOF
$EOF IGNORED - IN CONTROL MODE

$FIN

Amend. 1 3/79

TABLE 372.5.25

FREQUENCY DISTRIBUTION AUG 1972 STATION: GGNS MET SYSTEM

162/33 FT. DELTA T, 33 FT. WINDS

	WIND SPEED (MPH)											
DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	38.	18.	0.	0.	0.	0.	0.	0.	0.	56.	2.9	0.0
NNE	26.	11.	0.	0.	0.	0.	0.	0.	0.	37.	2.8	0.0
NE	39.	9.	0.	0.	0.	0.	0.	0.	0.	48.	2.3	0.0
ENE	55.	11.	0.	0.	0.	0.	0.	0.	0.	66.	2.2	0.0
E	55.	7.	0.	0.	0.	0.	0.	0.	0.	62.	2.3	0.0
ESE	39.	8.	0.	0.	0.	0.	0.	0.	0.	47.	2.4	0.0
SE	28.	7.	1.	0.	0.	0.	0.	0.	0.	36.	2.8	0.0
SSE	22.	7.	0.	0.	0.	0.	0.	0.	0.	29.	2.6	0.0
S	22.	12.	0.	0.	0.	0.	0.	0.	0.	34.	3.0	0.0
SSW	23.	17.	3.	0.	0.	0.	0.	0.	0.	43.	3.7	0.0
SW	14.	23.	2.	0.	0.	0.	0.	0.	0.	39.	4.2	0.0
WSW	13.	20.	0.	0.	0.	0.	0.	0.	0.	33.	3.9	0.0
W	20.	15.	0.	0.	0.	0.	0.	0.	0.	35.	3.6	0.0
WNW	8.	11.	0.	0.	0.	0.	0.	0.	0.	19.	3.8	0.0
NW	20.	17.	0.	0.	0.	0.	0.	0.	0.	37.	3.5	0.0
NNW	17.	23.	0.	0.	0.	0.	0.	0.	0.	40.	3.6	0.0
TOTAL	439.	216.	6.	0.	0.	0.	0.	0.	0.	661.		0.0
AVG SPD	2.1	4.7	8.4	0.0	0.0	0.0	0.0	0.0	0.0		3.0	

GG
ER

Amend. 1 3/79

TABLE 372.5.26

FREQUENCY DISTRIBUTION SEP 1972 STATION: GGNS MET SYSTEM

162/33 FT. DELTA T, 33 FT. WINDS

DIRECTION	WIND SPEED (MPH) 0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	28.	15.	0.	0.	0.	0.	0.	0.	0.	43.	3.0	0.0
NNE	30.	8.	0.	0.	0.	0.	0.	0.	0.	38.	2.5	0.0
NE	43.	7.	0.	0.	0.	0.	0.	0.	0.	50.	2.4	0.0
ENE	60.	12.	0.	0.	0.	0.	0.	0.	0.	72.	2.3	0.0
E	69.	14.	0.	0.	0.	0.	0.	0.	0.	83.	2.4	0.0
ESE	63.	12.	0.	0.	0.	0.	0.	0.	0.	75.	2.3	0.0
SE	45.	22.	2.	0.	0.	0.	0.	0.	0.	69.	3.1	0.0
SSE	22.	24.	1.	0.	0.	0.	0.	0.	0.	47.	3.9	0.0
S	28.	14.	6.	0.	0.	0.	0.	0.	0.	48.	3.8	0.0
SSW	21.	21.	2.	0.	0.	0.	0.	0.	0.	44.	3.9	0.0
SW	10.	21.	0.	0.	0.	0.	0.	0.	0.	37.	3.7	0.0
WSW	8.	3.	0.	0.	0.	0.	0.	0.	0.	11.	3.2	0.0
W	6.	4.	0.	0.	0.	0.	0.	0.	0.	10.	3.3	0.0
WNW	6.	7.	0.	0.	0.	0.	0.	0.	0.	13.	3.5	0.0
NW	13.	15.	2.	0.	0.	0.	0.	0.	0.	30.	4.0	0.0
NNW	17.	19.	14.	0.	0.	0.	0.	0.	0.	50.	5.2	0.0
TOTAL	475.	218.	27.	0.	0.	0.	0.	0.	0.	720.		0.0
AVG SPD	2.1	4.7	8.8	0.0	0.0	0.0	0.0	0.0	0.0		3.1	

GG
ER

Amend. 1 3/79

TABLE 372.5.27

FREQUENCY DISTRIBUTION OCT 1972 STATION: GGNS MET SYSTEM

162/33 FT. DELTA T. 33 FT. WINDS

	WIND SPEED (MPH)											
DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	34.	31.	5.	0.	0.	0.	0.	0.	0.	70.	4.2	0.0
NNE	43.	26.	0.	0.	0.	0.	0.	0.	0.	69.	3.0	0.0
NE	68.	36.	0.	0.	0.	0.	0.	0.	0.	104.	2.9	0.0
ENE	89.	28.	2.	0.	0.	0.	0.	0.	0.	119.	2.6	0.0
E	32.	21.	0.	0.	0.	0.	0.	0.	0.	53.	3.2	0.0
ESE	20.	17.	0.	0.	0.	0.	0.	0.	0.	37.	3.4	0.0
SE	11.	18.	1.	0.	0.	0.	0.	0.	0.	30.	4.3	0.0
SSE	13.	20.	2.	0.	0.	0.	0.	0.	0.	35.	4.3	0.0
S	6.	12.	3.	0.	0.	0.	0.	0.	0.	21.	4.1	0.0
SSW	6.	18.	0.	0.	0.	0.	0.	0.	0.	24.	4.4	0.0
SW	5.	28.	0.	0.	0.	0.	0.	0.	0.	33.	5.2	0.0
WSW	13.	3.	0.	0.	0.	0.	0.	0.	0.	16.	3.2	0.0
W	7.	9.	0.	0.	0.	0.	0.	0.	0.	16.	3.4	0.0
WNW	12.	8.	0.	0.	0.	0.	0.	0.	0.	20.	3.5	0.0
NW	10.	26.	1.	0.	0.	0.	0.	0.	0.	37.	4.6	0.0
NNW	12.	33.	6.	0.	0.	0.	0.	0.	0.	51.	4.9	0.0
TOTAL	381.	334.	20.	0.	0.	0.	0.	0.	0.	735.		0.0
AVG SPD	2.1	4.9	8.5	0.0	0.0	0.0	0.0	0.0	0.0		3.6	

GG ER

TABLE 372.5.28

FREQUENCY DISTRIBUTION NOV 1972 STATION: GGNS MET SYSTEM

162/33 FT. DELTA T, 33 FT. WINDS

DIRECTION	WIND SPEED (MPH) 0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	44.	46.	5.	0.	0.	0.	0.	0.	0.	95.	4.0	0.0
NNE	28.	21.	1.	0.	0.	0.	0.	0.	0.	50.	3.5	0.0
NE	40.	36.	0.	0.	0.	0.	0.	0.	0.	76.	3.3	0.0
ENE	39.	28.	0.	0.	0.	0.	0.	0.	0.	67.	3.4	0.0
E	7.	26.	1.	0.	0.	0.	0.	0.	0.	34.	4.4	0.0
ESE	4.	9.	0.	0.	0.	0.	0.	0.	0.	13.	4.0	0.0
SE	4.	27.	2.	0.	0.	0.	0.	0.	0.	33.	5.2	0.0
SSE	7.	19.	30.	0.	0.	0.	0.	0.	0.	56.	7.2	0.0
S	8.	5.	3.	1.	0.	0.	0.	0.	0.	17.	5.2	0.0
SSW	5.	2.	1.	0.	0.	0.	0.	0.	0.	8.	4.0	0.0
SW	2.	10.	4.	0.	0.	0.	0.	0.	0.	16.	5.9	0.0
WSW	3.	26.	4.	0.	0.	0.	0.	0.	0.	33.	5.7	0.0
W	6.	47.	4.	0.	0.	0.	0.	0.	0.	57.	5.6	0.0
WNW	5.	30.	0.	0.	0.	0.	0.	0.	0.	35.	5.1	0.0
NW	11.	43.	9.	0.	0.	0.	0.	0.	0.	63.	5.4	0.0
NNW	16.	43.	6.	0.	0.	0.	0.	0.	0.	65.	4.9	0.0
TOTAL	229.	418.	70.	1.	0.	0.	0.	0.	0.	718.		0.0
AVG SPD	2.2	5.4	8.6	12.6	0.0	0.0	0.0	0.0	0.0		4.7	

GG
ER

Amend. 1 3/79

TABLE 372.5.29

FREQUENCY DISTRIBUTION DEC 1972 STATION: GGNS MET SYSTEM

162/33 FT. DELTA T, 33 FT. WINDS

	WIND SPEED (MPH)											
DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	20.	37.	7.	0.	0.	0.	0.	0.	0.	64.	4.6	0.0
NNE	23.	21.	0.	0.	0.	0.	0.	0.	0.	44.	3.3	0.0
NE	18.	7.	0.	0.	0.	0.	0.	0.	0.	25.	2.8	0.0
ENE	17.	4.	0.	0.	0.	0.	0.	0.	0.	21.	2.6	0.0
E	23.	34.	0.	0.	0.	0.	0.	0.	0.	57.	4.2	0.0
ESE	12.	47.	8.	0.	0.	0.	0.	0.	0.	67.	5.1	0.0
SE	20.	53.	27.	0.	0.	0.	0.	0.	0.	100.	5.9	0.0
SSE	8.	34.	24.	4.	0.	0.	0.	0.	0.	70.	6.9	0.0
S	7.	18.	11.	0.	0.	0.	0.	0.	0.	36.	6.3	0.0
SSW	9.	5.	1.	0.	0.	0.	0.	0.	0.	15.	4.0	0.0
SW	7.	15.	0.	0.	0.	0.	0.	0.	0.	22.	4.6	0.0
WSW	3.	5.	0.	0.	0.	0.	0.	0.	0.	8.	4.3	0.0
W	5.	4.	0.	0.	0.	0.	0.	0.	0.	9.	3.3	0.0
WNW	8.	10.	2.	0.	0.	0.	0.	0.	0.	20.	4.9	0.0
NW	14.	33.	28.	1.	0.	0.	0.	0.	0.	76.	6.3	0.0
NNW	18.	55.	37.	0.	0.	0.	0.	0.	0.	110.	6.3	0.0
TOTAL	212.	382.	145.	5.	0.	0.	0.	0.	0.	744.		0.0
AVG SPD	2.3	5.4	9.0	13.1	0.0	0.0	0.0	0.0	0.0		5.3	

GG
ER

Amend. 1 3/79

TABLE 372.5.30

FREQUENCY DISTRIBUTION JAN 1973 STATION: GGNS MET SYSTEM

162/33 FT. DELTA T, 33 FT. WINDS

	WIND SPEED (MPH)											
DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	14.	72.	2.	0.	0.	0.	0.	0.	0.	88.	5.1	0.0
NNE	11.	24.	0.	0.	0.	0.	0.	0.	0.	35.	4.3	0.0
NE	20.	12.	1.	0.	0.	0.	0.	0.	0.	33.	2.9	0.0
ENE	25.	20.	2.	0.	0.	0.	0.	0.	0.	47.	3.8	0.0
E	24.	45.	12.	0.	0.	0.	0.	0.	0.	81.	4.8	0.0
ESE	8.	25.	24.	1.	0.	0.	0.	0.	0.	58.	6.7	0.0
SE	12.	12.	18.	1.	0.	0.	0.	0.	0.	43.	6.9	0.0
SSE	5.	7.	15.	3.	0.	0.	0.	0.	0.	30.	8.1	0.0
S	4.	6.	10.	1.	0.	0.	0.	0.	0.	21.	7.5	0.0
SSW	5.	7.	15.	4.	0.	0.	0.	0.	0.	31.	7.6	0.0
SW	13.	17.	25.	0.	0.	0.	0.	0.	0.	55.	6.2	0.0
WSW	4.	8.	4.	0.	0.	0.	0.	0.	0.	16.	4.7	0.0
W	7.	12.	8.	0.	0.	0.	0.	0.	0.	27.	5.4	0.0
WNW	2.	18.	7.	0.	0.	0.	0.	0.	0.	27.	5.7	0.0
NW	7.	18.	18.	0.	0.	0.	0.	0.	0.	43.	6.3	0.0
NNW	6.	61.	24.	0.	0.	0.	0.	0.	0.	91.	6.2	0.0
TOTAL	167.	364.	185.	10.	0.	0.	0.	0.	0.	726.		0.0
AVG SPD	2.1	5.5	8.9	14.2	0.0	0.0	0.0	0.0	0.0		5.7	

GG
ER

Amend. 1 3/79

TABLE 372.5.31

FREQUENCY DISTRIBUTION FEB 1973 STATION: GGNS MET SYSTEM

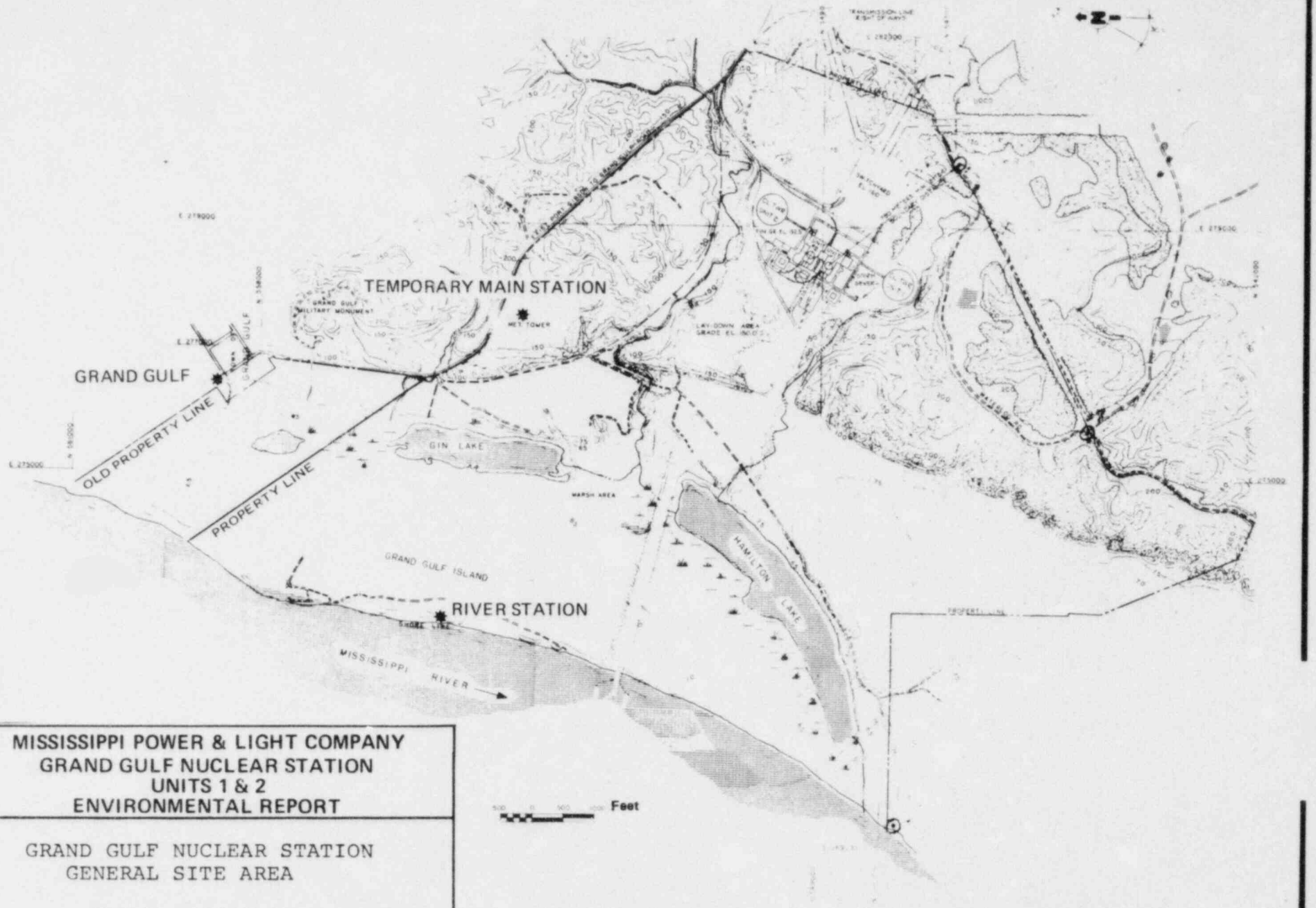
162/33 FT. DELTA T, 33 FT. WINDS

WIND SPEED (MPH)

DIRECTION	0 - 3	4 - 7	8 -12	13-18	19-24	25-31	32-38	39-46	> 46	TOTAL	AVG WIND SPEED	CALM DIST
N	20.	22.	2.	0.	0.	0.	0.	0.	0.	44.	3.9	0.0
NNE	25.	22.	2.	0.	0.	0.	0.	0.	0.	49.	3.5	0.0
NE	32.	10.	1.	0.	0.	0.	0.	0.	0.	43.	2.7	0.0
ENE	24.	3.	0.	0.	0.	0.	0.	0.	0.	27.	2.3	0.0
E	28.	15.	1.	0.	0.	0.	0.	0.	0.	44.	3.2	0.0
ESE	9.	15.	4.	0.	0.	0.	0.	0.	0.	28.	4.7	0.0
SE	6.	8.	11.	2.	0.	0.	0.	0.	0.	27.	6.6	0.0
SSE	7.	12.	14.	0.	0.	0.	0.	0.	0.	33.	6.5	0.0
S	6.	19.	10.	0.	0.	0.	0.	0.	0.	35.	6.1	0.0
SSW	2.	14.	6.	0.	0.	0.	0.	0.	0.	22.	6.1	0.0
SW	5.	14.	19.	0.	0.	0.	0.	0.	0.	38.	7.1	0.0
WSW	6.	11.	9.	0.	0.	0.	0.	0.	0.	26.	5.9	0.0
W	10.	24.	7.	0.	0.	0.	0.	0.	0.	41.	5.0	0.0
WNW	7.	32.	2.	0.	0.	0.	0.	0.	0.	41.	5.0	0.0
NW	13.	33.	23.	0.	0.	0.	0.	0.	0.	69.	6.0	0.0
NNW	19.	27.	53.	5.	0.	0.	0.	0.	0.	104.	7.4	2.0
TOTAL	219.	281.	164.	7.	0.	0.	0.	0.	0.	671.		2.0
AVG SPD	2.1	5.4	9.1	13.1	0.0	0.0	0.0	0.0	0.0		5.3	

GG
ER

Amend. 1 3/79

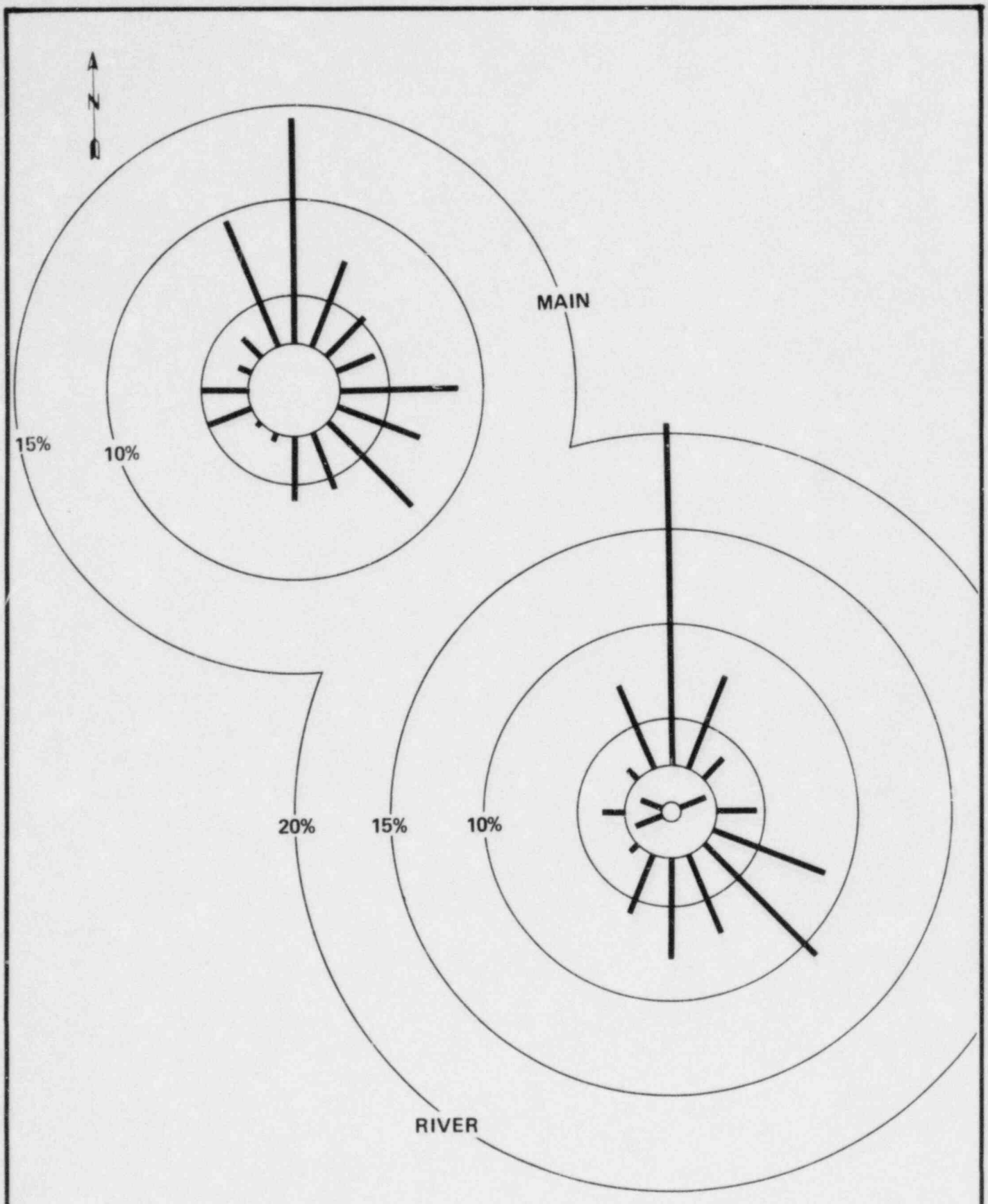


MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

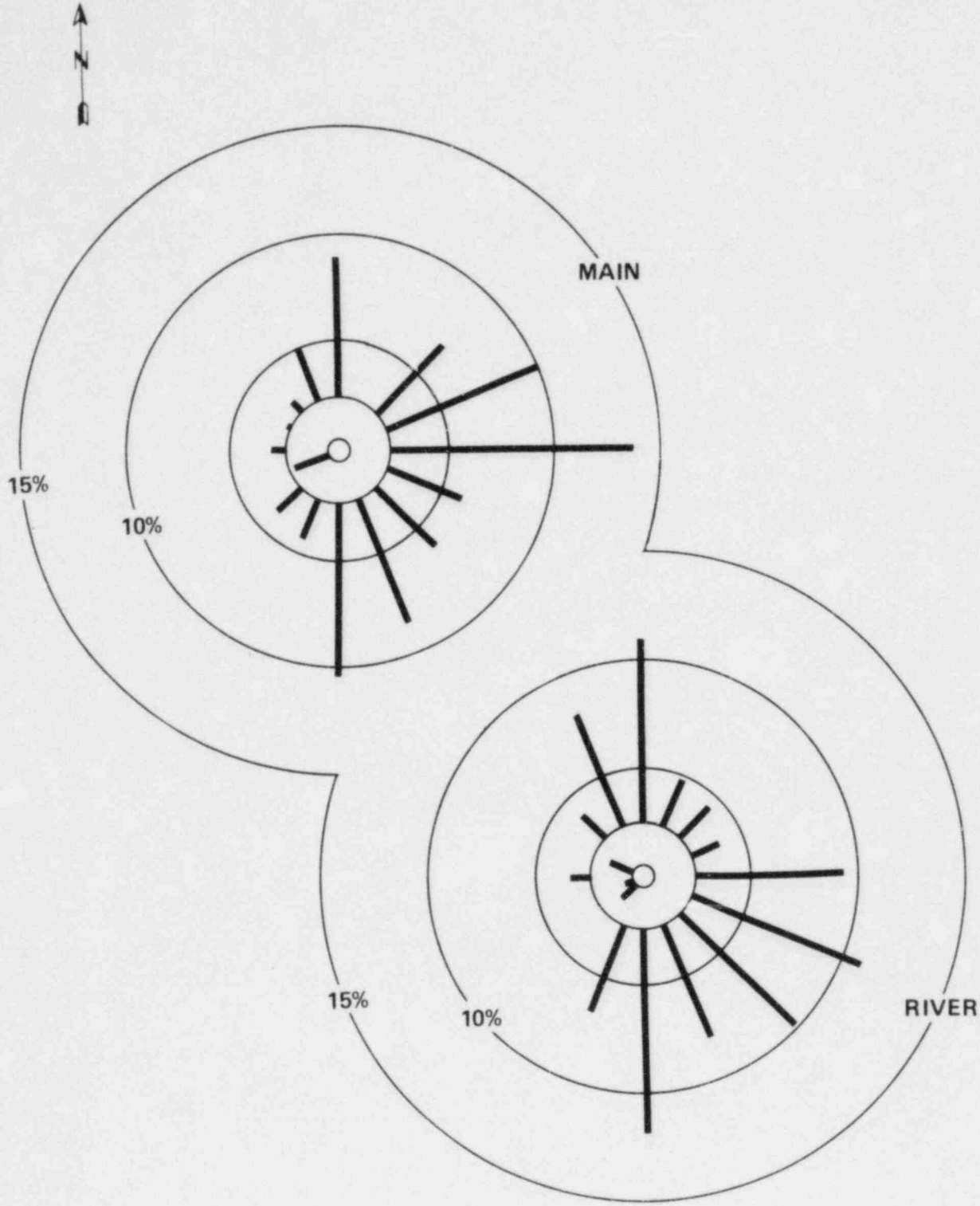
GRAND GULF NUCLEAR STATION
GENERAL SITE AREA

FIGURE 372.5-1

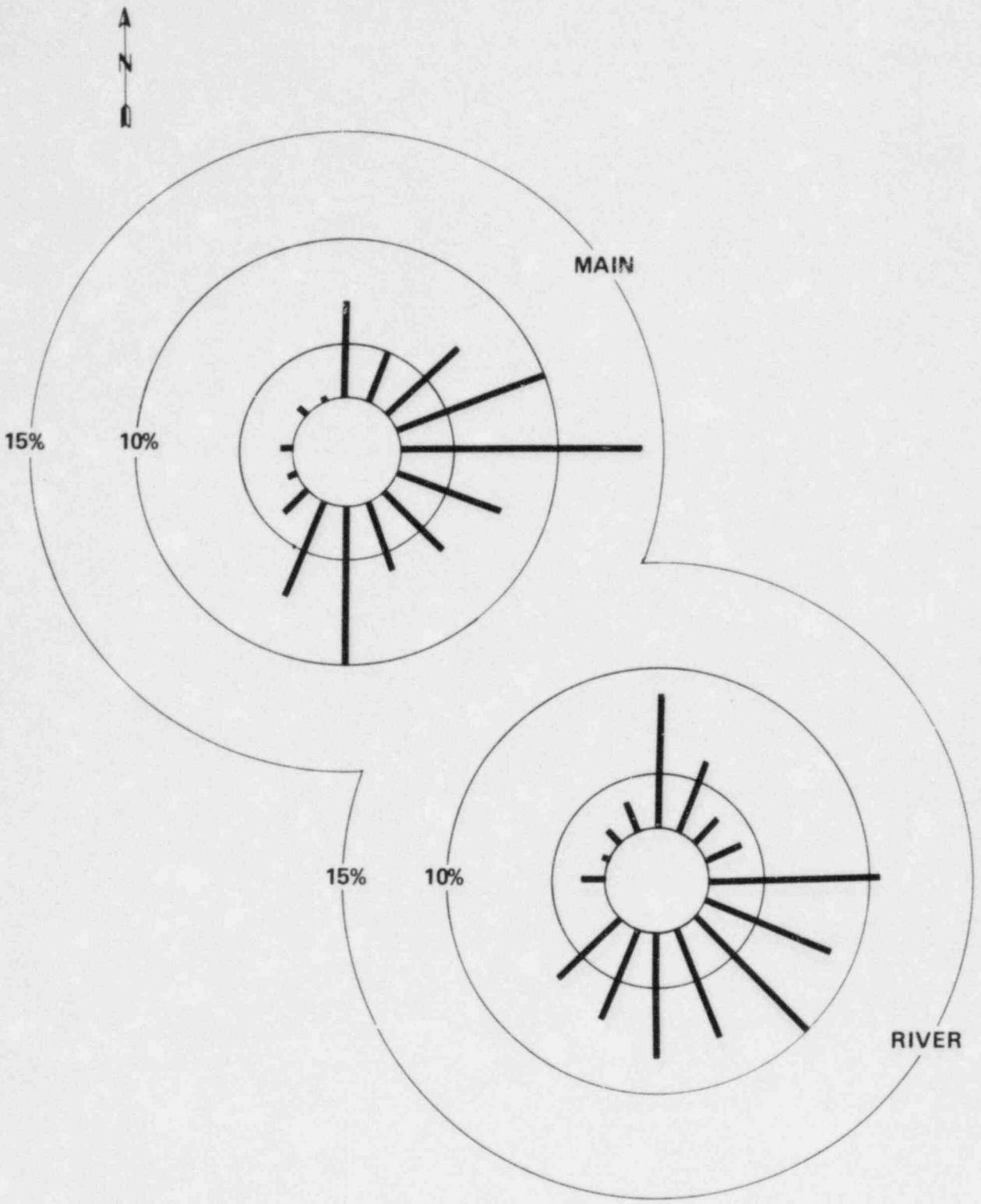
Amend. 1 3/79



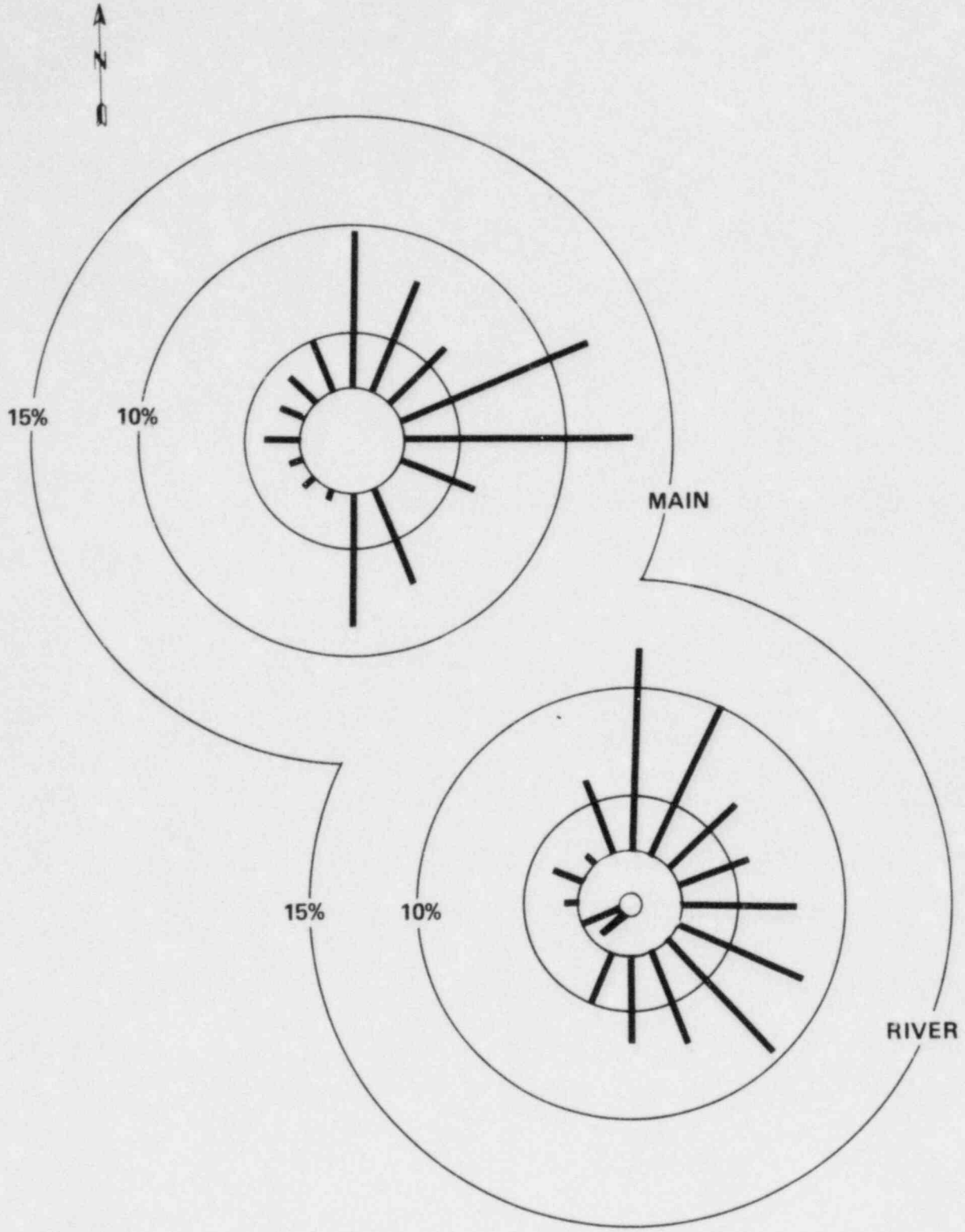
MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	WINTER WIND ROSE FOR THE TEMPORARY MAIN AND RIVER STATIONS, GRAND GULF (12/72-2/73) FIGURE 372.5-2



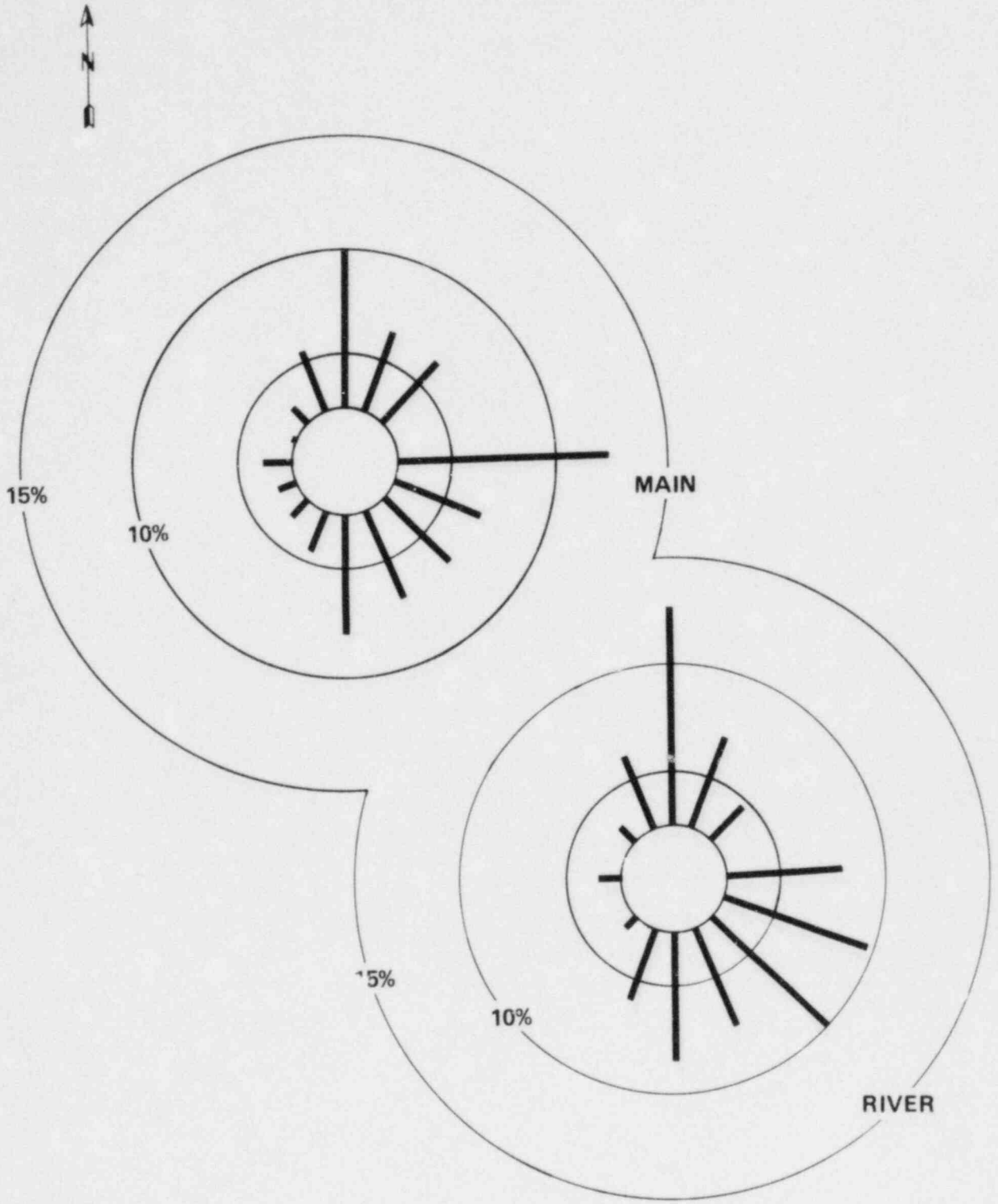
MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	SPRING WIND ROSE FOR THE TEMPORARY MAIN AND RIVER STATIONS, GRAND GULF (3/72-5/72) FIGURE 372.5-3



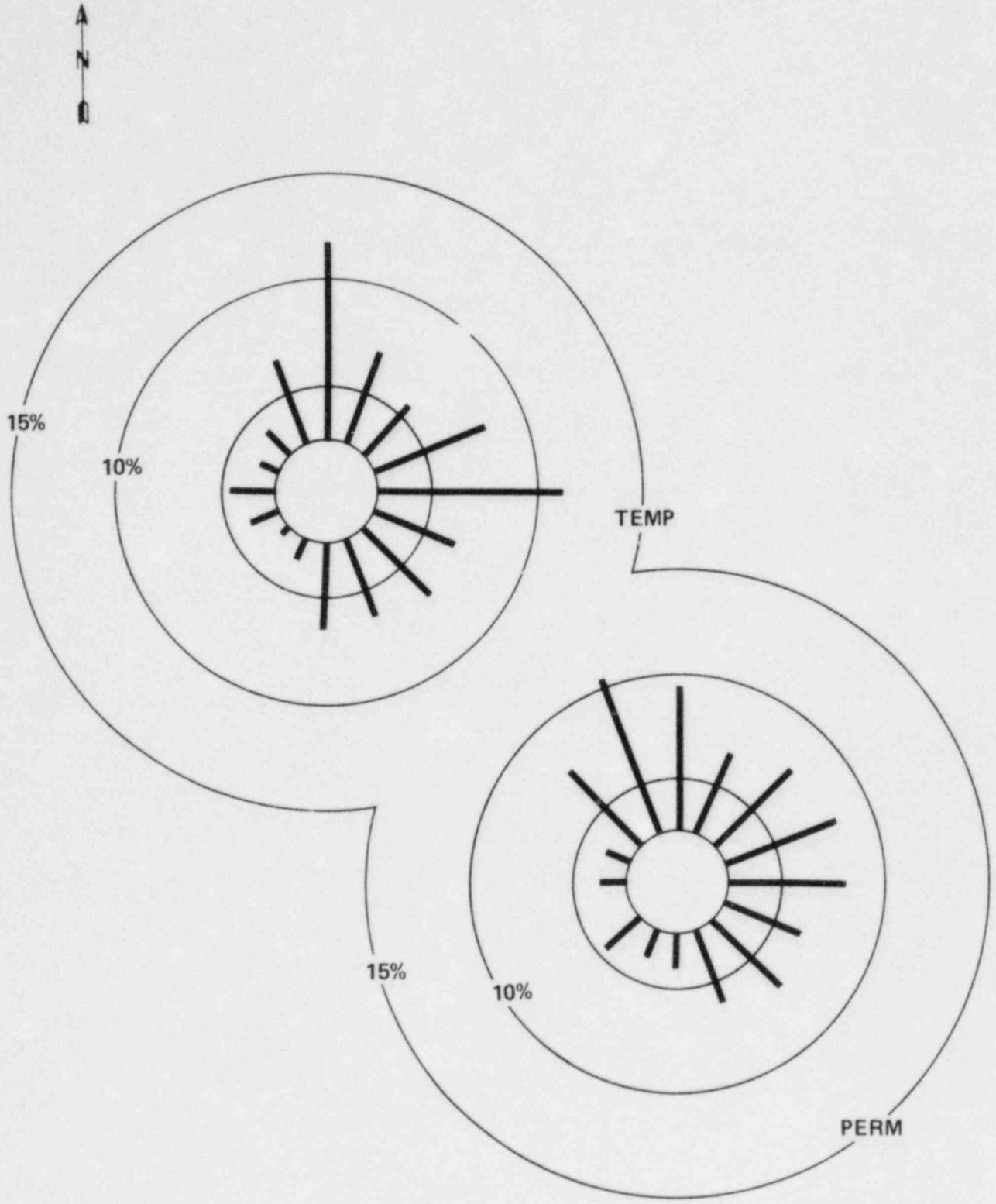
MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	SUMMER WIND ROSE FOR THE TEMPORARY MAIN AND RIVER STATIONS, GRAND GULF (6/72-8/72) FIGURE 372.5-4



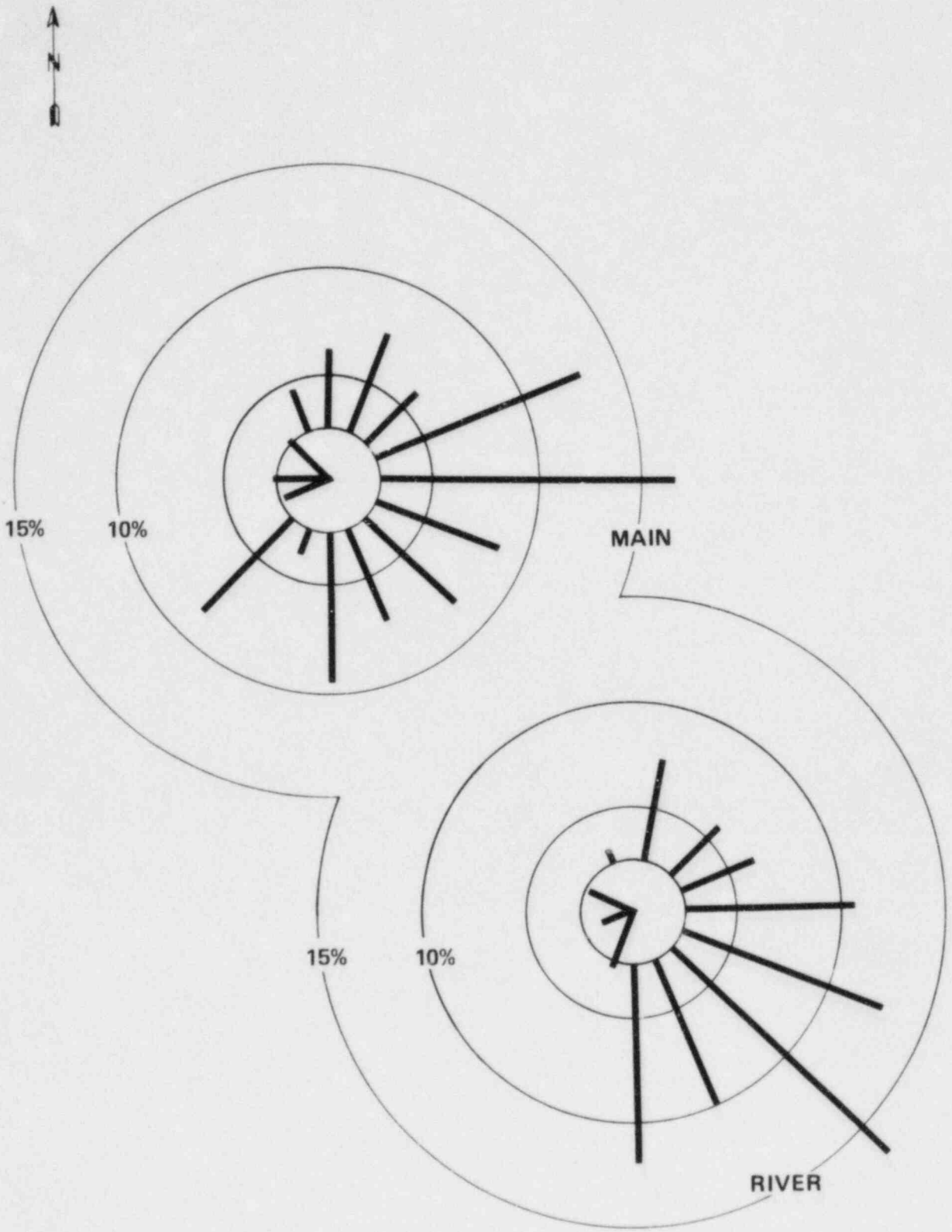
MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	AUTUMN WIND ROSE FOR THE TEMPORARY MAIN AND RIVER STATIONS, GRAND GULF (9/72-11/72) FIGURE 372.5-5



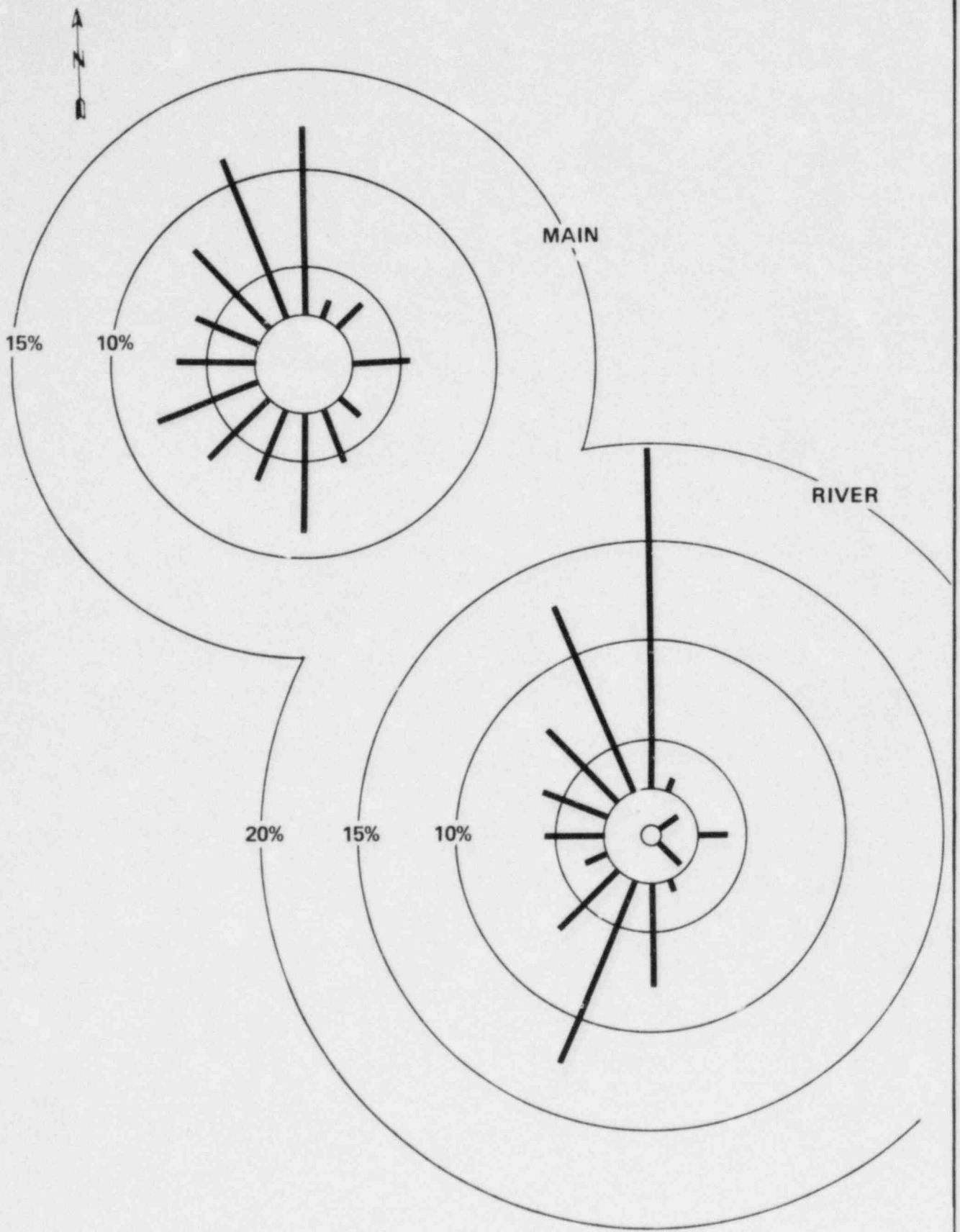
MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	ANNUAL AVERAGE WIND ROSE FOR THE TEMPORARY MAIN AND RIVER STATIONS, GRAND GULF (3/72-2/73) FIGURE 372.5-6



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	WIND ROSE FOR THE TEMPORARY AND PERMANENT TOWERS ON THE MAIN SITE, GRAND GULF (8/72-2/73) FIGURE 372.5-7



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	2 a.m. WIND ROSE FOR THE TEMPORARY MAIN AND RIVER STATIONS (3/72-2/73) FIGURE 372.5-8



MISSISSIPPI POWER & LIGHT COMPANY GRAND GULF NUCLEAR STATION UNITS 1 & 2 ENVIRONMENTAL REPORT	2 p.m. WIND ROSE FOR THE TEMPORARY MAIN AND RIVER STATIONS (3/72-2/73) FIGURE 372.5-9

GG
ER

QUESTION

372.6 (6.1.3) Provide a description of the area where the 162-ft meteorological tower is located. Include in the discussion such information as distances to the nearest bluffs and trees, their heights above the base of the tower, and a description of the ground surrounding the tower (i.e., is it grass, soil, etc.).

RESPONSE

The 162-foot meteorological tower with base elevation of 156 feet (msl) is located approximately 5,300 feet northwest of the control building of the station as shown in revised Figure 2.5-21. The nearest bluffs are 362 feet to the west of the meteorological tower. There are trees 35 feet high along these bluffs. Approximately 50 feet below the bluffs the floodplain extends 4,500 feet to the west to meet the Mississippi River at an elevation of 65 feet (msl). To the south and to the east, the nearest trees are 689 feet and 396 feet from the tower, respectively. Tree heights in these directions are between 50 to 60 feet. A country road passes the meteorological tower 400 feet to the north.

The meteorological tower is surrounded by a fence which is 7 feet high and 70 feet away from the base of the tower. An instrument shack about 8 feet high is installed near the base of the tower. The immediate vicinity of the tower is covered by Bermuda grass which is mowed periodically. The soil beneath the grass is loess.

GG
ER

QUESTION

372.7 (6.1.3) Describe the inspection, maintenance and calibration procedures for the onsite meteorological instrumentation and their frequencies.

RESPONSE

MP&L has established procedures for the inspection and maintenance of the onsite meteorological instrumentation. This responsibility is shared between the operation and maintenance sections.

Routine inspections are made to ensure proper operation of equipment and that no damage to the tower, shack, or any other structure or equipment has occurred. The strip charts are checked for proper operation and changed biweekly. The magnetic tape is changed periodically and the standby generator is tested for auto start on a routine basis. It is expected that once the permanent plant equipment is installed and operational, the frequency and scope of routine checks will change.

Semiannually, visual inspections of the tower and equipment are made to determine the conditions of sensors, cabinets, wiring, structures, and individual components. Comparisons of manually converted digital readings are made against the strip chart analog readings to verify proper operation of the equipment. A check on the battery bank and battery charger is made along with the proper operation of the standby generator and its inverter. The tower cables are adjusted for proper tension, and the following instrument channels are calibrated.

1. Differential temperature, El. 33' - 132'
2. Differential temperature, El. 33' - 162'
3. Dew point - El. 33'
4. Dew point - El. 162'
5. Wind speed - El. 33', 133', 162'
6. Wind direction - El. 33', 133', 162'
7. Low speed anemometer - El. 33'
8. Rain gauge - ground level
9. Ambient temperature - El. 33'

GG
ER

QUESTION

372.8 (6.1.3) Discuss the methodology by which calms are determined from the onsite wind data.

RESPONSE

Two instruments were installed at the 33-foot level of the Grand Gulf meteorological tower to measure surface wind. The MRI 1074-2 anemometer has a start threshold of 0.75 mph, and the MRI 1090-1 air bearing anemometer has a start threshold of less than 0.25 mph. The more sensitive air bearing anemometer measurements were used in the meteorological evaluation of the site.

Data recovery rate of the three years of onsite data (8/72-7/74, 1/76-12/76) at the Grand Gulf site is 98.4 percent. When air bearing data were missing, the MRI 1074-2 anemometer data were substituted for the air bearing data. A total of 3.2 percent of the data has been substituted, and less than 0.1 percent of these data were with wind speed below the MRI 1074-2 starting speed of 0.75 mph.

Calms are recorded when wind speeds are less than the starting speed, 0.25 mph, of the air bearing anemometer. For computation and averaging purposes, calms were set with wind speed equal to one-half of the instrument's starting speed, 0.125 mph, and the wind direction was measured at the next higher level of the meteorological tower. When data substitution was taking place the same procedure as described above was used to determine calm. The definition of wind speed (0.25 mph) and wind direction under calm were kept the same in order to be consistent throughout the meteorological evaluation program. This approach gives no impact to the short-term (five percentile) diffusion evaluation of the site because of the low percentage of data substitution.

QUESTION

451.1 (3.7) (1) Provide estimates of non-radioactive pollutant emissions at the site during operation. Consider the criteria pollutants identified in 40 CFR Part 51 from sources such as automobiles and frequently used unpaved roads and parking lots. Information on emissions from generators and cooling towers has previously been submitted.

(2) Provide background (ambient) pollutant concentrations in the site area for those pollutants emitted at the site.

RESPONSE

(1) The only significant non-radioactive pollutants at the plant site during operation, excepting generators and cooling towers, will be fugitive dust emissions and gaseous and particulate emissions from automobiles.

Fugitive Emissions Via Unpaved Roads and Parking Lots

The GGNS site contains less than 2 miles of unpaved roads, and all parking lots are paved. All existing unpaved roads are graveled, and a 20 mph speed limit is imposed on all vehicles while travelling on the plant site. The plant is designed so that only Company vehicles use the gravel roads to any significant extent. During the construction phase, all unpaved roads are watered on a daily basis as a dust control measure. These roads will not be watered during the operational phase because of the reduced number of vehicles on site and the subsequent reduction in traffic on the unpaved road. Under worst case conditions (Unit 1 operational and Unit 2 under construction with no watering of roads), emission quantities are estimated as follows:

Pounds of particulate/vehicle mile	1.81
Pounds of particulate/year	1.32×10^5

The figures were derived from information contained in EPA Manual AP-42, Vol. 3, p. 112, "Fugitive Dust Sources." It is anticipated that these estimates will be considerably reduced when both units are operational, as the number of employees and vehicles on site will be reduced.

Automobile Emissions

Estimated automobile emissions is presented in two different modes: one for the large number of vehicles operated by construction personnel after Unit 1 has been completed, and the other for vehicles operated after both Units 1 and 2 are completed and operational.

a. Unit 1 Complete:

	Employee Vehicles	Plant Site Vehicles
Estimated number	3013	150
No. of miles driven/year	7.47×10^7	3.58×10^5
Average speed of vehicles	55 mph*	20 mph

* Employees' commuting speed.

Pollutant	Total Emissions (lb/yr)
Carbon monoxide	1.17×10^6
Hydrocarbons	2.50×10^5
Nitrous oxides	1.60×10^5
Sulfur oxides	2.18×10^4
Particulates	1.81×10^4

b. Both Units 1 and 2 Complete:

	Employee Vehicles	Plant Site Vehicles
Estimated number	453**	150
No. of miles driven/year	1.12×10^7	3.58×10^5
Average speed	55 mph	20 mph

** During an outage the number of vehicles may approach 1,000.

Pollutant	Total Emissions (lb/yr)
Carbon monoxide	2.53×10^5
Hydrocarbons	3.30×10^4
Nitrous oxides	3.97×10^4
Sulfur oxides	3.90×10^3
Particulates	1.94×10^3

Information for the tables was derived from EPA Manual AP-42, Appendix D, "Projected Emission Factors for Highway Vehicles," and includes the employees commuting from their residences as well as Company vehicles on site.

(2) The background levels of ambient pollutants in the site area are shown in the following tabulation. The figures were obtained from two EPA State and Local Air Monitoring Stations (SLAMS) network stations, one located in the

Vicksburg area (approximately 25 miles north of the plant site), and the second located in the Natchez area (approximately 37 miles south of the site). The information was derived from 1979 monitoring data.

POLLUTANT	Concentration at Vicksburg Station ($\mu g/m^3$)	Concentration at Natchez Station ($\mu g/m^3$)
Particulates		
Maximum 24-hour	166	131
Minimum 24-hour	29	20
Annual geometric mean	69	51
Annual arithmetic mean (24-hour average)	74	55
Sulfur Dioxide		
Maximum 1-hour	484	N/A
Maximum 3-hour	329	N/A
Maximum 24-hour	87	36
Annual arithmetic mean (1-hour average)	15	7
Nitrous Oxides		
Maximum 24-hour	72	N/A
Annual arithmetic mean (24-hour average)	22	N/A

N/A = Not Available

(The only SLAMS monitoring station for carbon monoxide is located in north Jackson, Mississippi. There is no SLAMS monitoring station for hydrocarbons in Mississippi. For these reasons, estimated concentrations for these two pollutants are not shown.)

GG
ER

QUESTION

1. (2.4) Provide descriptions of the floodplains* of all water bodies, including intermittent water courses; within or adjacent to the site. On a suitable scale map provide delineations of those areas that will be flooded during the one-percent chance flood in the absence of plant effects (i.e., preconstruction floodplain).

*Floodplain: The lowland and relatively flat areas adjoining inland and coastal waters including floodprone areas of offshore islands, including at a minimum that area subject to a one percent or greater chance of flooding in any given year.

RESPONSE

Details of the Mississippi River and two local streams (Streams A and B) draining to the Mississippi River in the vicinity of the plant are discussed in FER Section 2.4. The Mississippi River flood plain adjacent to the site is relatively low and flat with elevations ranging from 55 to 75 feet msl. The 100-year flood elevation of the Mississippi River at Grand Gulf site is about 91.4 feet msl.

The 100-year flood elevation of Streams A and B in the bottom land area (floodplain of the Mississippi River) is affected by floods in the Mississippi River.

The preconstruction 100-year flood delineation boundary for the Mississippi River and Streams A and B is shown in Figure 1.

GG
ER

QUESTION

2. (2.4) Provide details of the methods used to determine the floodplains in response to 1. above. Include your assumptions of and bases for the pertinent parameters used in the computation of the one-percent flood flow and water elevation. If studies approved by Flood Insurance Administration (FIA), Housing and Urban Development (HUD) or the Corps of Engineers are available for the site or adjoining area, the details of analyses need not be supplied. Your can instead provide the reports from which you obtained the floodplain information.

RESPONSE

The Mississippi River 100-year flood elevation of 91.4 feet msl (FER Subsection 2.4.2.1) is based on the Elevation-Frequency Profile of the Mississippi River prepared by the U.S. Army Corps of Engineers District, Vicksburg, 1976.

The flood elevations of flood delineation boundaries for Streams A and B were estimated by developing flood hydrographs for the basins and carrying out backwater analyses for these streams.

The 100-year flood elevations for Streams A and B at their outlets in the Mississippi River floodplain are lower than the Mississippi River 100-year flood elevation. Therefore, the 100-year flood elevations for these streams in the floodplain of the Mississippi River are at elevation 91.4 feet msl. The flood elevations in the upstream reaches are shown on Figure 1.

GG
ER

QUESTION

3. (4.1) Identify, locate on a map, and describe all structures, construction activities and topographic alterations in the floodplains. Indicate the status of each such structure, construction activity and topographic alteration (in terms of start and completion dates) and work presently completed.

RESPONSE

Plant facilities located in the Mississippi River 100-year floodplain were shown on FER Figure 2.1-2 and are shown on Figure 2. These plant facilities include radial collector wells, radial well switchgear house, a portion of the haul road, a portion of the buried plant service water makeup and discharge pipe liner, barge slip, and plant discharge outlet.

In addition, there is a temporary borrow pit which will be gradually reclaimed by existing perimeter vegetation and wildlife when construction of the plant is completed.

The facilities located in the Stream A 100-year floodplain include a sedimentation basin and a 12-foot diameter culvert at the crossing of the access road (Figure 2).

Stream B, in the vicinity of the plant, has been realigned and partly lined to contain flow up to the probable maximum flood (PMF) within its bank. The modifications made in the Stream B 100-year floodplain include a sedimentation basin, a 15-foot diameter culvert at the crossing of the access road, regrading around the Unit 1 cooling tower, and realignment of Stream B as shown in Figure 2.

Construction of all plant facilities mentioned above is completed.

GG
ER

QUESTION

4. (2.4) Discuss the hydrologic effects of all items identified in 3. above. Discuss the potential for altered flood flows and levels, both upstream and downstream. Include the potential effect of debris accumulating on the plant structures. Additionally, discuss the effects of debris generated from the site on downstream facilities.

RESPONSE

The postconstruction 100-year flood delineation boundary for the Mississippi River and Streams A and B is shown on Figure 2.

The area occupied by plant facilities in the Mississippi River floodplain is insignificant compared to the overall floodplain area. Thus, the presence of the facilities in the floodplain has insignificant effect on preconstruction water levels. Further, because of the location and relatively small size of these facilities, no accumulation of debris is expected which could effect the upstream or downstream water levels.

The presence of a 12-foot diameter culvert at the access road crossing of Stream A and a sedimentation basin has no significant effect on the preconstruction water levels as shown in Figures 1 and 2.

The regrading of the Stream B drainage area in the plant vicinity and stream realignment have appreciably improved the preconstruction flooding conditions as shown on Figures 1 and 2. The postconstruction 100-year flood is contained within the lined portion of the stream channel.

Potential effect of debris accumulating on the culverts were assessed as presented in GGNS FSAR Section 2.4.3.5.2.

GG
ER

QUESTION

5. (2.4) Provide the details of your analysis used in response to 4. above. The level of detail is similar to that identified in item 2. above.

RESPONSE

Because of the relatively small size and area of plant facilities in the floodplain, no analysis was made of effects on water levels in the Mississippi River floodplain.

A backwater analysis for Streams A and B was conducted to establish the postconstruction flood delineation boundaries shown on Figure 2.

GG
ER

QUESTION

6. (10.2) Identify non-floodplain alternatives for each of the items (structures, construction activities and topographic alterations) identified in 3. above. Alternately, justify why a specific item must be in the floodplain.

RESPONSE

The structures, construction activities, and topographic alterations in the floodplain were listed in the response to Question 3.

Sections 10.2.1.1, 10.2.2.1, 10.3.1.1, and 10.3.2.1 of the FER describe non-floodplain alternatives of the intake and discharge structures.

As shown in response to Question 3, the status of all structures is complete. Therefore, alternatives are not evaluated further.

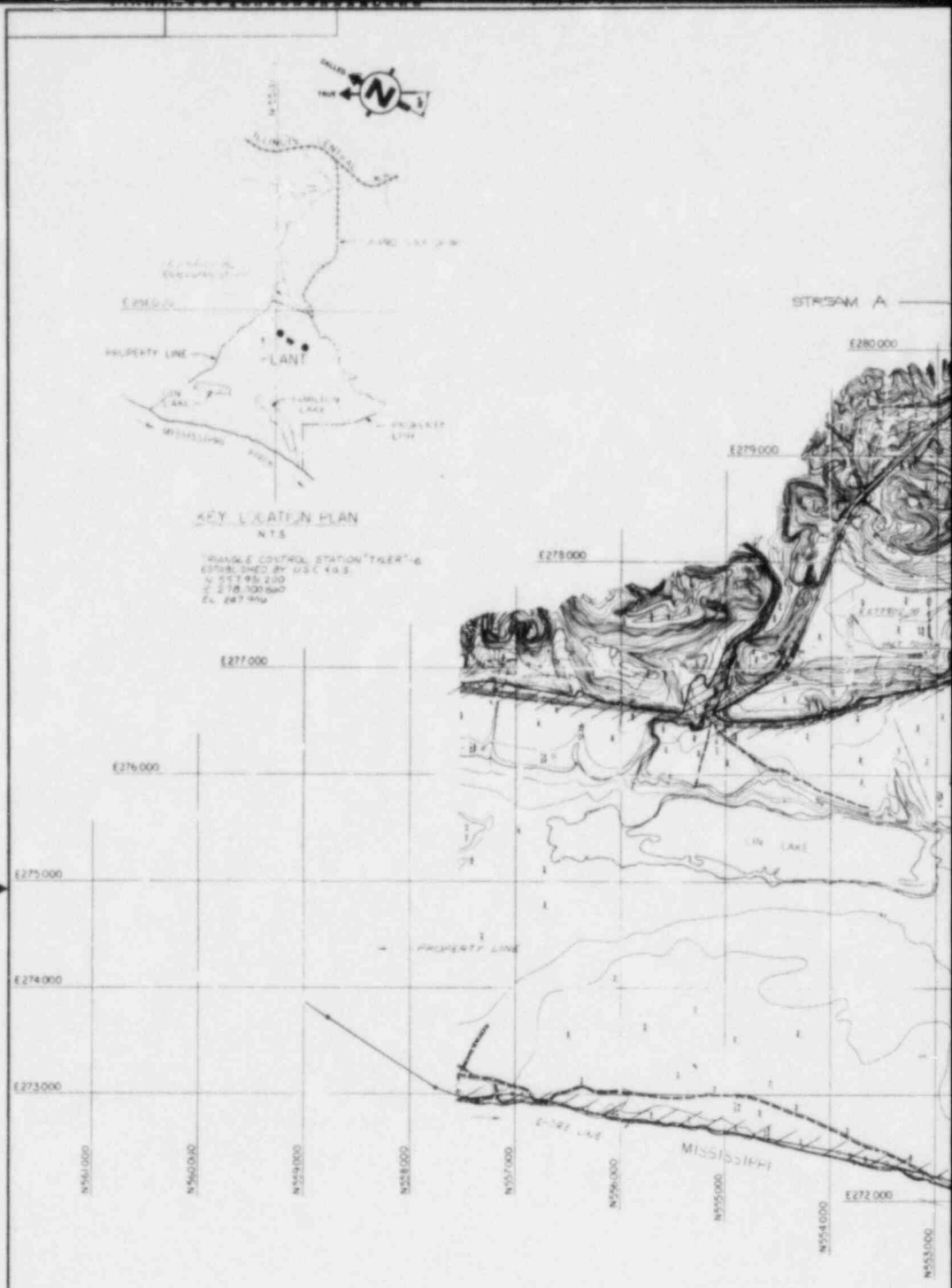
Three additional radial wells are under evaluation. No non-floodplain alternatives exist for these wells.

QUESTION

7. (10.2) For each item in 6. above that cannot be justified as having to be in the floodplain either show that all non-floodplain alternatives are not practicable or commit to re-locating the structure, construction activity or topographic alteration out of the floodplain.

RESPONSE

In Question 6 response the FER sections given show the reasons why the alternatives to the plant water intake and discharge were not selected. As indicated in the response to Question 6, all facilities in the floodplain are located there by necessity.



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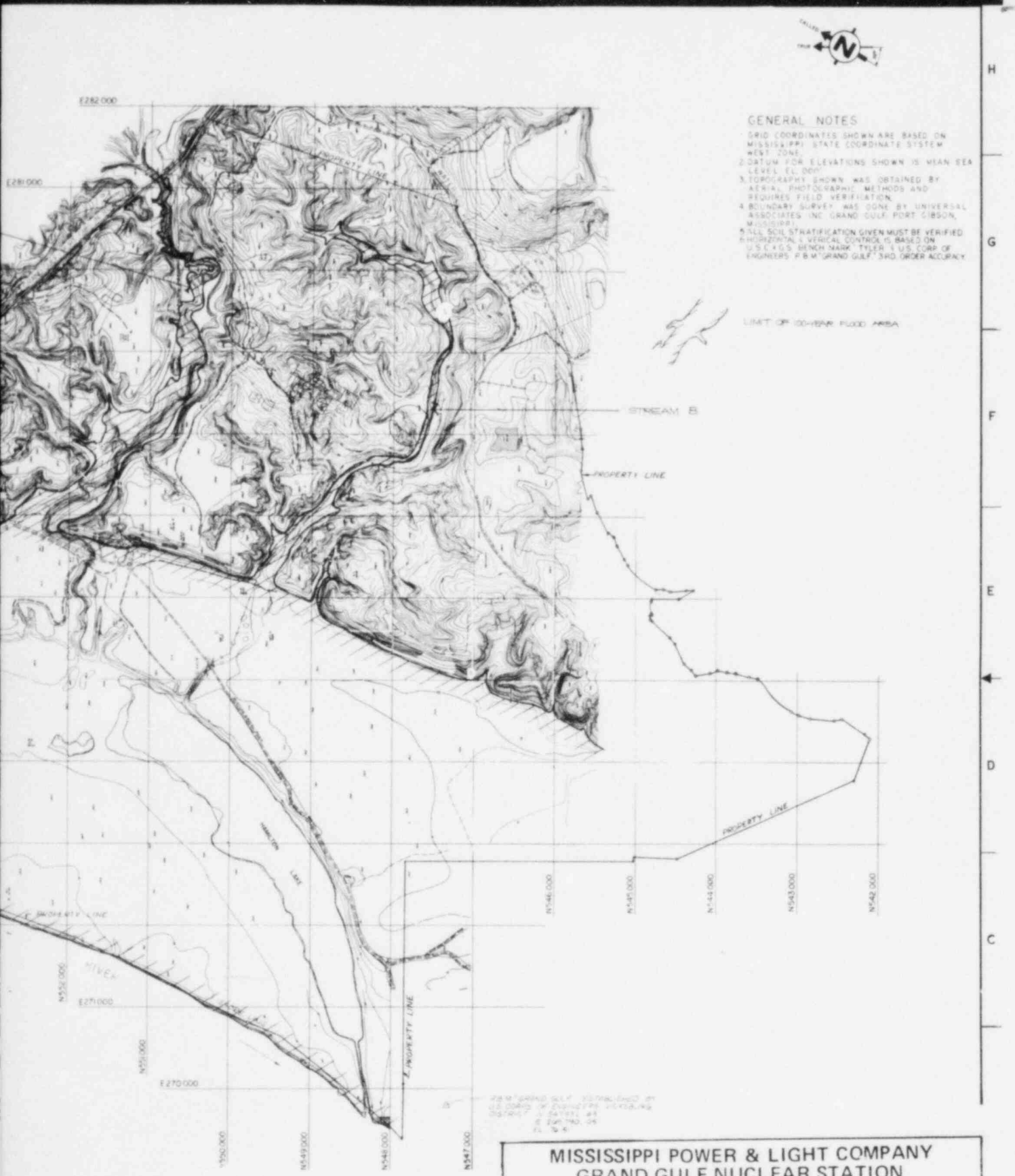
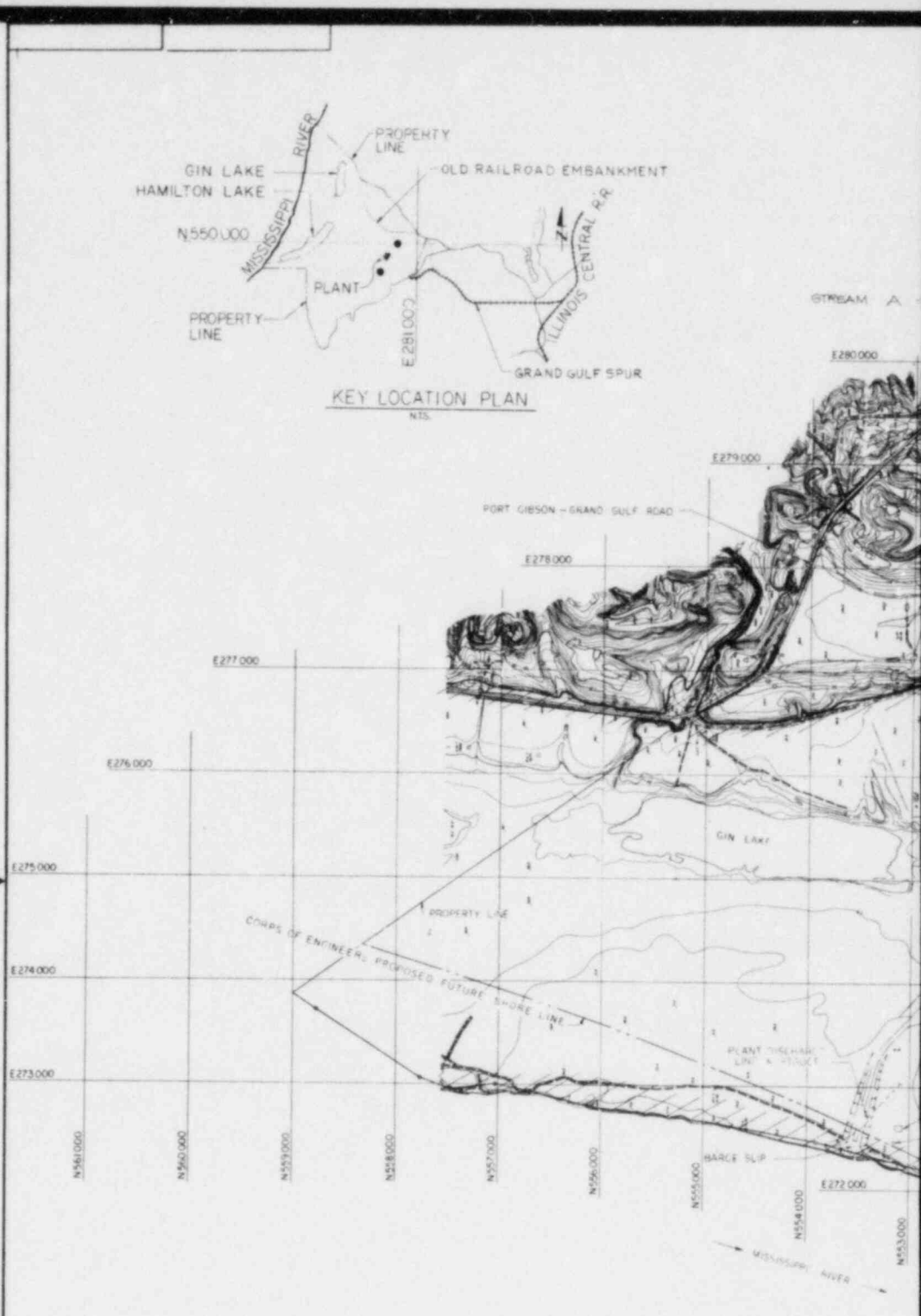


MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

PRE-CONSTRUCTION 100-YEAR FLOOD DELINEATION BOUNDARY

FIGURE 1

Amend. 4 5/80



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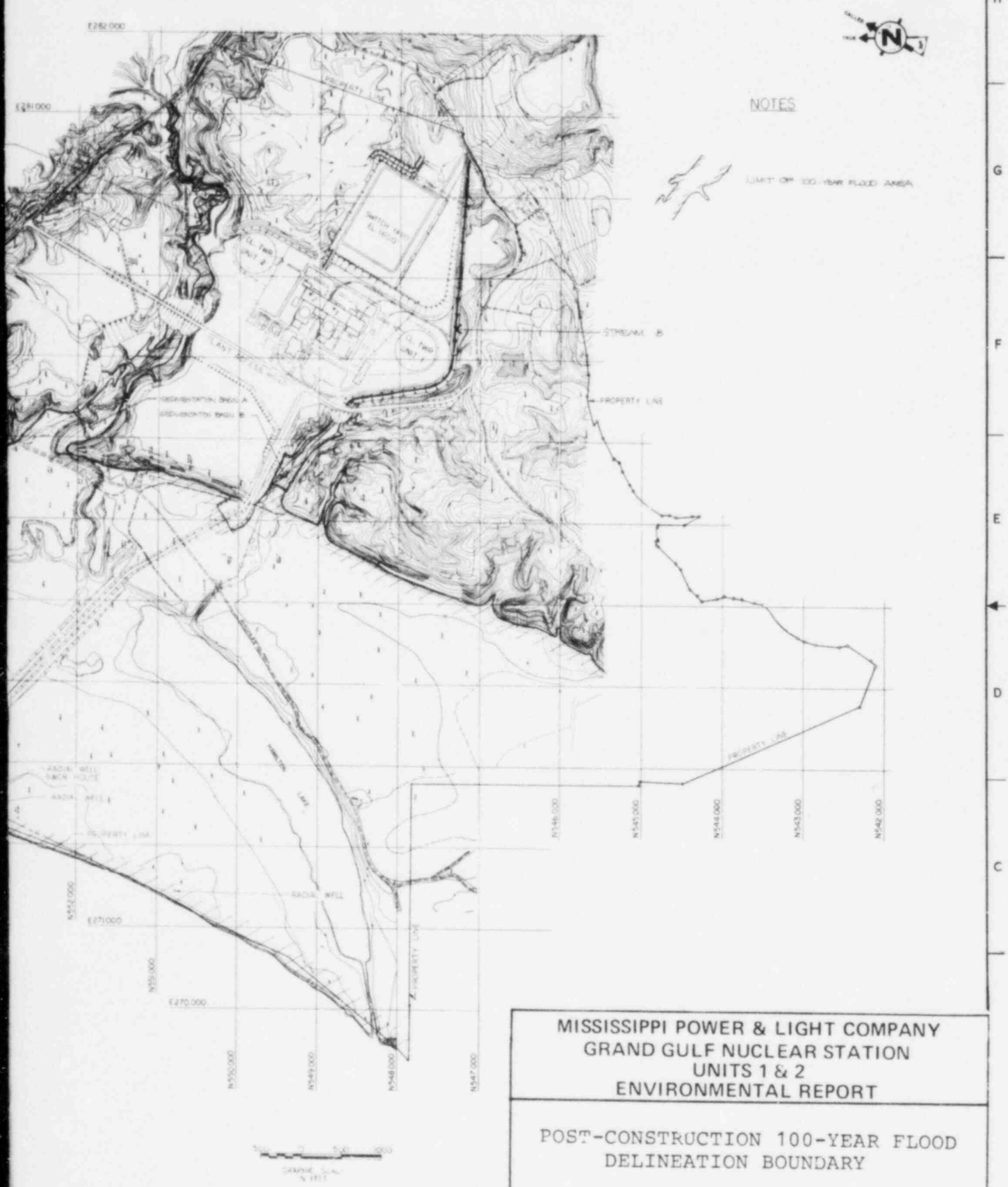


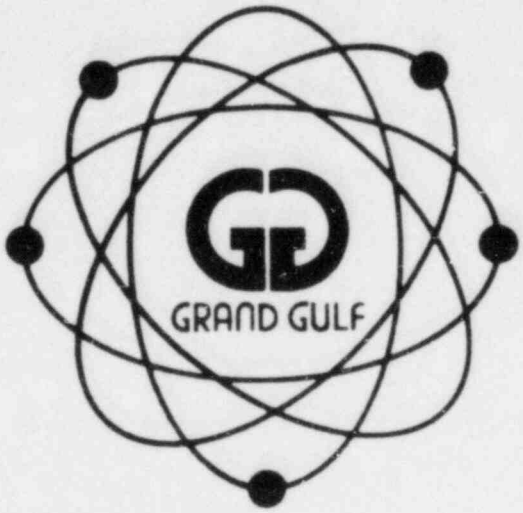
MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 & 2
ENVIRONMENTAL REPORT

POST-CONSTRUCTION 100-YEAR FLOOD DELINEATION BOUNDARY

FIGURE 2

Amend. 4 5/80

FINAL ENVIRONMENTAL REPORT



GRAND GULF NUCLEAR STATION

UNITS 1 AND 2

MISSISSIPPI POWER & LIGHT COMPANY

MIDDLE SOUTH ENERGY, INC.

MIDDLE SOUTH UTILITIES SYSTEM

AMENDMENT 1

7903160254

MISSISSIPPI POWER & LIGHT COMPANY
Helping Build Mississippi
P. O. BOX 1640, JACKSON, MISSISSIPPI 39205

NORRIS L. STAMPLEY
VICE PRESIDENT

March 15, 1979

U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D. C. 20555

ATTENTION: Mr. Harold R. Denton, Director

Dear Sir:

SUBJECT: Grand Gulf Nuclear Station
Units 1 and 2
Docket Nos. 50-416, 417
File 0260/0277/L-860.0/M-900.0
Amendment 1 to the Final
Environmental Report
AECM-79/19

Attached are forty-one copies and three notarized originals of Amendment 1 to the Final Environmental Report for the Grand Gulf Nuclear Station, Units 1 and 2.

In response to Question No. 371.01, we have also attached five full size copies of the following drawings:

C-0001, Rev. 2, Site & Yard Work - Property Plan
C-0011, Rev. 3, Site & Yard Work - Site Plan

Sincerely,

Norris L. Stampley

JRF/pa
Attachment

cc: Mr. T. B. Conner
Mr. R. B. McGehee

Dr. Ernst Volgenau, Director
Division of Inspection & Enforcement
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

BEFORE THE

UNITED STATES NUCLEAR REGULATORY COMMISSION

DOCKET NOS. 50-416 AND 50-417

IN THE MATTER OF

MISSISSIPPI POWER & LIGHT COMPANY
and
MIDDLE SOUTH ENERGY, INC.

AMENDMENT NO. 1 TO THE

FINAL ENVIRONMENTAL REPORT

Mississippi Power & Light Company for itself and on behalf of Middle South Energy, Inc. herewith files this Amendment No. 1 to their Final Environmental Report in the form of answers to certain questions relating to the Final Environmental Report and to other matter requested by the Commission in its letter to Mississippi Power & Light Company dated September 5, 1978.

Respectfully submitted,

Mississippi Power & Light Company

BY N. L. Stampley

N. L. STAMPLEY
VICE PRESIDENT

STATE OF MISSISSIPPI
COUNTY OF HINDS

N. L. Stampley, being duly sworn, states that he is a Vice President of Mississippi Power & Light Company, and that he is authorized on the part of said Company and of Middle South Energy, Inc. to sign and file with the Nuclear Regulatory Commission this Amendment No. 1 to the Final Environmental Report; that he signed the foregoing Amendment to the Final Environmental Report as Vice President of Mississippi Power & Light Company and as agent for Middle South Energy, Inc., and that the statements made and the matters set forth therein are true and correct to the best of his knowledge, information, and belief.

N. L. Stampley

N. L. STAMPLEY

SUBSCRIBED AND SWORN TO before me, a Notary Public, in and for the County and State above named, this 12th day of March, 1979.

(SEAL)

Linda L Lawson

NOTARY PUBLIC

My commission expires:

7/22/81

MISSISSIPPI POWER & LIGHT COMPANY
Helping Build Mississippi
P. O. BOX 1640, JACKSON, MISSISSIPPI 39205

NORRIS L. STAMPLEY
VICE PRESIDENT

November 30, 1979

U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D. C. 20555

Attention: Mr. Harold R. Denton, Director

Dear Sir:

SUBJECT: Grand Gulf Nuclear Station
Units 1 and 2
Docket Nos. 50-416 and 50-417
File 0260/0277/L-860.0/M-900.0
Amendment 2 to the Final
Environmental Report
AECM-79/129

Attached are forty-one copies and three notarized originals of Amendment 2 to the Final Environmental Report for the Grand Gulf Nuclear Station, Units 1 and 2. This amendment consists of information related to our Preoperational Radiological Environmental Monitoring Program and other miscellaneous information.

Sincerely,

Norris L Stampley

PVH/pa
Attachment

cc: Mr. T. B. Conner
Mr. R. B. McGehee

Mr. Victor Stello, Jr., Director
Division of Inspection & Enforcement
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

BEFORE THE

UNITED STATES NUCLEAR REGULATORY COMMISSION

DOCKET NOS. 50-416 AND 50-417

IN THE MATTER OF

MISSISSIPPI POWER & LIGHT COMPANY
and
MIDDLE SOUTH ENERGY, INC.

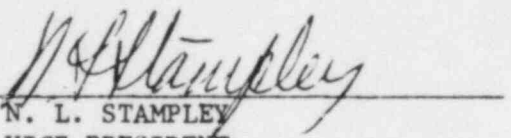
AMENDMENT NO. 2 TO THE

FINAL ENVIRONMENTAL REPORT

Mississippi Power & Light Company for itself and on behalf of Middle South Energy, Inc. herewith files this Amendment No. 2 to their Final Environmental Report.

Respectfully submitted,

Mississippi Power & Light Company

BY 

N. L. STAMPLEY
VICE PRESIDENT

STATE OF MISSISSIPPI
COUNTY OF HINDS

N. L. Stampley, being duly sworn, states that he is a Vice President of Mississippi Power & Light Company, and that he is authorized on the part of said Company and of Middle South Energy, Inc. to sign and file with the Nuclear Regulatory Commission this Amendment No. 2 to the Final Environmental Report; that he signed the foregoing Amendment to the Final Environmental Report as Vice President of Mississippi Power & Light Company and as agent for Middle South Energy, Inc., and that the statements made and the matters set forth therein are true and correct to the best of his knowledge, information, and belief.

N. L. Stampley
N. L. STAMPLEY

SUBSCRIBED AND SWORN TO before me, a Notary Public, in and for the County and State above named, this 21 day of November, 1979.

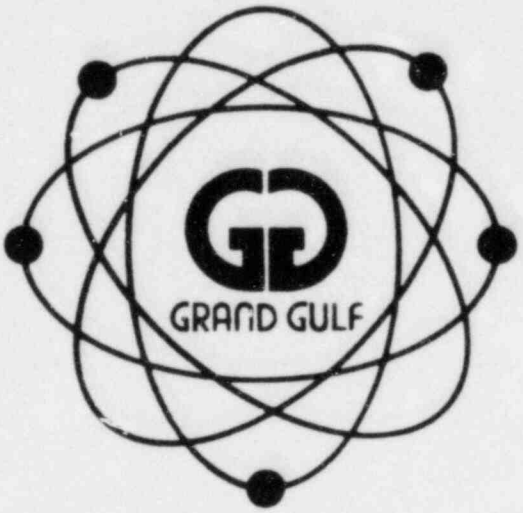
(SEAL)

Ethel Ferguson
NOTARY PUBLIC

My commission expires:

My Commission Expires July 23, 1983.

FINAL ENVIRONMENTAL REPORT



GRAND GULF NUCLEAR STATION

UNITS 1 AND 2

MISSISSIPPI POWER & LIGHT COMPANY

MIDDLE SOUTH ENERGY, INC.

MIDDLE SOUTH UTILITIES SYSTEM

AMENDMENT 3

8004220293

MISSISSIPPI POWER & LIGHT COMPANY
Helping Build Mississippi
P. O. BOX 1640, JACKSON, MISSISSIPPI 39205

NORRIS L. STAMPLEY
VICE PRESIDENT

April 18, 1980

U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D. C. 20555

Attention: Mr. Harold R. Denton, Director

Dear Sir:

SUBJECT: Grand Gulf Nuclear Station
Units 1 and 2
Docket Nos. 50-416 and 50-417
File 0260/0277/L-860.0/M-900.0
Amendment 3 to the Final
Environmental Report
AECM-80/72

Attached are forty-one copies and three notarized originals of Amendment 3 to the Final Environmental Report for the Grand Gulf Nuclear Station, Units 1 and 2. This amendment consists of responses to requests for additional information transmitted by the Commission to Mississippi Power & Light in the letter dated January 22, 1980.

Sincerely,

W. N. Stampley

JGC/ts
Attachments

cc: Mr. T. B. Conner
Mr. R. B. McGehee

Mr. Victor Stello, Jr., Director
Division of Inspection & Enforcement
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

BEFORE THE

UNITED STATES NUCLEAR REGULATORY COMMISSION

DOCKET NOS. 50-416 AND 50-417

IN THE MATTER OF

MISSISSIPPI POWER & LIGHT COMPANY
and
MIDDLE SOUTH ENERGY, INC.

AMENDMENT NO. 3 TO THE

FINAL ENVIRONMENTAL REPORT

Mississippi Power & Light Company for itself and on behalf of Middle South Energy, Inc. herewith files this Amendment No. 3 to their Final Environmental Report in the form of responses to certain questions and requests for additional information transmitted by the Commission to Mississippi Power & Light in the letter dated January 22, 1980.

Respectfully submitted,

Mississippi Power & Light Company

BY _____
N. L. STAMPLEY
VICE PRESIDENT

STATE OF MISSISSIPPI
COUNTY OF HINDS

N. L. Stampley, being duly sworn, states that he is a Vice President of Mississippi Power & Light Company, and that he is authorized on the part of said Company, and of Middle South Energy, Inc. to sign and file with the Nuclear Regulatory Commission this Amendment No. 3 to the Final Environmental Report; that he signed the foregoing Amendment to the Final Environmental Report as Vice President of Mississippi Power & Light Company and as agent for Middle South Energy, Inc., and that the statements made and the matters set forth therein are true and correct to the best of his knowledge, information, and belief.

N L Stampley

SUBSCRIBED AND SWORN TO before me, a Notary Public, in and for the County and State above named, this 10 day of April, 1980.

(SEAL)

Ethel Ferguson

My commission expires:

My Commission Expires July 22, 1983.

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION
UNITS 1 AND 2
DOCKET NOS. 50-416 AND 417
AMENDMENT 3

INSTRUCTIONS FOR FILING AMENDMENT 3, 4/80

At the end of Volume 4 remove and insert the following in the order shown.

1. After Questions and Responses tab, remove existing Table of Contents and insert new Table of Contents pages Q&R-i and Q&R-ii.

2. Insert new Questions and Responses between Question 340.9, page Q&R 12.2-1 and Question 371.01, page Q&R 2.1-2.

3. Insert Amendment 3 tab.

4. Insert transmittal letter.

5. Insert instructions for filing.

FINAL ENVIRONMENTAL REPORT

GRAND GULF
NUCLEAR STATION
UNITS 1 AND 2

MISSISSIPPI POWER & LIGHT COMPANY

MIDDLE SOUTH ENERGY, INC.

MIDDLE SOUTH UTILITIES SYSTEM

AMENDMENT 4

8006030229

MISSISSIPPI POWER & LIGHT COMPANY
Helping Build Mississippi
P. O. BOX 1640, JACKSON, MISSISSIPPI 39205

NORRIS L. STAMPLEY
VICE PRESIDENT

U. S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D. C. 20555

Attention: Mr. Harold R. Denton, Director

Dear Sir:

SUBJECT: Grand Gulf Nuclear Station
Units 1 and 2
Docket Nos. 50-416 and 50-417
File 0260/0277/L-860.0/M-900.0
Amendment 4 to the Final
Environmental Report
AECM-80/109

Attached are forty-one copies and three notarized originals of Amendment 4 to the Final Environmental Report for the Grand Gulf Nuclear Station, Units 1 and 2. This amendment consists of responses to requests for additional information transmitted by the Commission to Mississippi Power & Light in the letter dated March 14, 1980.

In addition, five (5) sets of full size drawings are included for reference purposes.

Sincerely,

N. L. Stampley

JRF/JDR:gks

Attachments

Mr. N. L. Stampley
Mr. R. B. McGehee
Mr. T. B. Conner

Mr. Victor Stello, Jr., Director
Division of Inspection & Enforcement
U. S. Nuclear Regulatory Commission
Washinington, D. C. 20555

BEFORE THE

UNITED STATES NUCLEAR REGULATORY COMMISSION

DOCKET NOS. 50-416 AND 50-417

IN THE MATTER OF

MISSISSIPPI POWER & LIGHT COMPANY
and
MIDDLE SOUTH ENERGY, INC.

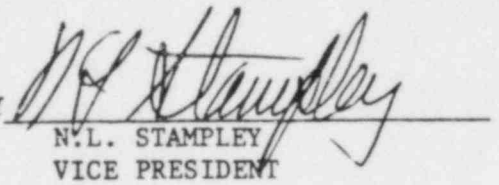
AMENDMENT NO. 4 TO THE

FINAL ENVIRONMENTAL REPORT

Mississippi Power & Light Company for itself and on behalf of Middle South Energy, Inc. herewith files this Amendment No. 4 to their Final Environmental Report in the form of responses to certain questions and requests for additional information transmitted by the Commission to Mississippi Power & Light in the Letter dated March 14, 1980.

Respectfully submitted,

Mississippi Power & Light Company

BY 

N.L. STAMPLEY
VICE PRESIDENT

STATE OF MISSISSIPPI
COUNTY OF HINDS

N. L. Stampley, being duly sworn, states that he is a Vice President of Mississippi Power & Light Company, and that he is authorized on the part of said Company, and of Middle South Energy, Inc. to sign and file with the Nuclear Regulatory Commission this Amendment No. 4 to the Final Environmental Report; that he signed the foregoing Amendment to the Final Environmental Report as Vice President of Mississippi Power & Light Company and as agent for Middle South Energy, Inc., and that the statements made and the matters set forth therein are true and correct to the best of his knowledge, information, and belief.

N. L. Stampley

SUBSCRIBED AND SWORN TO before me, a Notary Public, in and for the County and State above named, this 27 day of May, 1980.

(SEAL)

Sandra D. Vining

My commission expires:

8-13-83

MISSISSIPPI POWER & LIGHT COMPANY
GRAND GULF NUCLEAR STATION UNITS 1 AND 2
DOCKET NOS. 50-416 and 417
AMENDMENT 4

INSTRUCTIONS FOR FILING AMENDMENT 4, 5/80

At the end of Volume 4 remove and insert the following in the order shown.

1. After Questions and Responses tab, remove existing Table of Contents and insert new Table of Contents, Page Q&R-i/ii.

2. Insert new Questions and Responses Nos. 1 through 7 and Figures 1 and 2 after the last existing Question 372.8, Page Q&R 6.1-7.

3. Insert Amendment 4 tab.

4. Insert transmittal letter.

5. Insert instructions for filing.

BEFORE THE

UNITED STATES NUCLEAR REGULATORY COMMISSION

DOCKET NOS. 50-416 AND 50-417

IN THE MATTER OF

MISSISSIPPI POWER & LIGHT COMPANY
and
MIDDLE SOUTH ENERGY, INC.
and
SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION

AMENDMENT NO. 5 TO

APPLICATION FOR LICENSES
(FINAL ENVIRONMENTAL REPORT)

Mississippi Power & Light Company for itself and on behalf of Middle South Energy, Inc. and South Mississippi Electric Power Association herewith files this Amendment No. 5 to their Application for Licenses in the form of answers to certain questions relating to the Final Environmental Report and to other matters requested by the Commission verbally and in a letter to Mississippi Power & Light Company, dated November 10, 1980.

Respectfully submitted,

Mississippi Power & Light Company

BY _____
J. P. McGaughy, Jr.
Assistant Vice President
Nuclear Production

STATE OF MISSISSIPPI
COUNTY OF HINDS

J. P. McGaughy, Jr., being duly sworn, states that he is Assistant Vice President - Nuclear Production of Mississippi Power & Light Company; that he is authorized on the part of said Company to sign and file with the Nuclear Regulatory Commission this Amendment No. 5 to the Application for Licenses (Final Environmental Report) on behalf of Company, Middle South Energy, Inc. and South Mississippi Electric Power Association; that he signed the foregoing amendment as Assistant Vice President - Nuclear Production of Mississippi Power & Light Company; and that the statements made and the matters set forth therein are true and correct to the best of his knowledge, information, and belief.

J. P. McGaughy, Jr.

SUBSCRIBED AND SWORN TO before me, a Notary Public, in and for the County and State above named, this 27 day of January, 1981.

(SEAL)

Notary Public

My commission expires:

My Commission Expires July 23, 1983.

FINAL ENVIRONMENTAL REPORT

GRAND GULF NUCLEAR STATION

UNITS 1 AND 2

MISSISSIPPI POWER & LIGHT COMPANY

MIDDLE SOUTH ENERGY, INC.

MIDDLE SOUTH UTILITIES SYSTEM

AMENDMENT 6

8102230274

MISSISSIPPI POWER & LIGHT COMPANY
Helping Build Mississippi
P. O. BOX 1640, JACKSON, MISSISSIPPI 39205

February 20, 1981

JAMES P. McGAUGHY, JR.
ASSISTANT VICE PRESIDENT

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

Attention: Mr. Harold R. Denton, Director

Dear Sir:

SUBJECT: Grand Gulf Nuclear Station
Units 1 and 2
Docket Nos. 50-416 and 50-417
File 0260/0277/M-900.0
Amendment 6 to the Final
Environmental Report
AECM-81/64

Attached are forty-one copies and three notorized originals of Amendment 6 to the Application for Licenses for Grand Gulf Nuclear Station, Units 1 and 2, in the matter of the Final Environmental Report (FER). Amendment 6 consists of additional information on the Plant Service Water System (Section 2.4.5.5), a reorganization of section numbers in each volume of the FER, and the addition of Figure 2.4-15.

Yours truly,

JPM:lm
Attachments

cc: Mr. N. L. Stampley
Mr. G. B. Taylor
Mr. R. B. McGehee
Mr. T. B. Conner

Mr. Victor Stello, Jr., Director
Division of Inspection & Enforcement
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

BEFORE THE

UNITED STATES NUCLEAR REGULATORY COMMISSION

DOCKET NOS. 50-416 AND 50-417

IN THE MATTER OF

MISSISSIPPI POWER & LIGHT COMPANY
and
MIDDLE SOUTH ENERGY, INC.
and
SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION

AMENDMENT NO. 6 TO

APPLICATION FOR LICENSES
(FINAL ENVIRONMENTAL REPORT)

Mississippi Power & Light Company for itself and on behalf of Middle South Energy, Inc. and South Mississippi Electric Power Association herewith files this Amendment No. 6 to their Application for Licenses in the form of additional information to the FER, a reorganization of section numbers in each volume of the FER, and the addition of Figure 2.4-15.

Respectfully submitted,

Mississippi Power & Light Company

BY _____
J. P. McGaughy, Jr.
Assistant Vice President
Nuclear Production

STATE OF MISSISSIPPI
COUNTY OF HINDS

J. P. McGaughy, Jr., being duly sworn, states that he is Assistant Vice President - Nuclear Production of Mississippi Power & Light Company; that he is authorized on the part of said Company to sign and file with the Nuclear Regulatory Commission this Amendment No. 6 to the Application for Licenses (Final Environmental Report) on behalf of Company, Middle South Energy, Inc. and South Mississippi Electric Power Association; that he signed the forgoing amendment as Assistant Vice President - Nuclear Production of Mississippi Power & Light Company; and that the statements made and the matters set forth therein are true and correct to the best of his knowledge, information, and belief.

J. P. McGaughy, Jr.

SUBSCRIBED AND SWORN TO before me, a Notary Public, in and for the County and State above named, this 16 day of FEB., 1981.

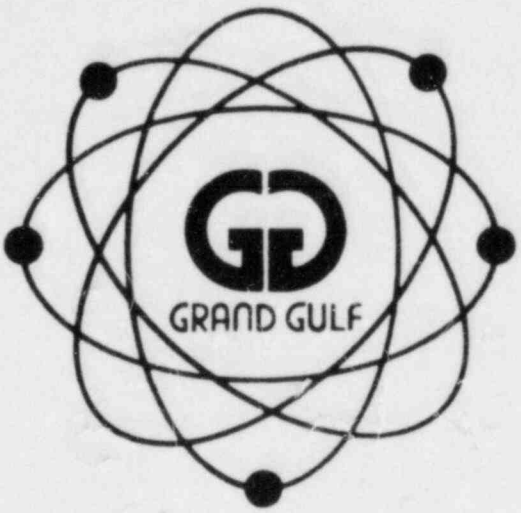
(SEAL)

Notary Public

My commission expires:

My Commission Expires Jan. 31, 1983

FINAL ENVIRONMENTAL REPORT



GRAND GULF NUCLEAR STATION UNITS 1 AND 2

MISSISSIPPI POWER & LIGHT COMPANY

MIDDLE SOUTH ENERGY, INC.

MIDDLE SOUTH UTILITIES SYSTEM

AMENDMENT 7

8108130216 810812
PDR ADOCK 05000416
C PDR

MISSISSIPPI POWER & LIGHT COMPANY
Helping Build Mississippi
P. O. BOX 1640, JACKSON, MISSISSIPPI 39205

JAMES P. McGAUGHY, JR.
ASSISTANT VICE PRESIDENT

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

August 12, 1981

Attention: Mr. Harold R. Denton, Director

Dear Sir:

SUBJECT: Grand Gulf Nuclear Station
Units 1 and 2
Docket Nos. 50-416 and 50-417
File 0260/0277/M-900.0
Amendment 7 to the Final
Environmental Report
AECM-81/271

Attached are forty-one copies and three notorized originals of Amendment 7 to the Application for Licenses for Grand Gulf Nuclear Station, Units 1 and 2, in the matter of the Final Environmental Report (FER). Amendment 7 consists of additions to Sections 3.6 (Chemical and Biocide Waste), 6.1.3.1 (Meteorology) and the addition of Table 5.3.1.

Yours truly,

JPM:lm
Attachments

cc: Mr. N. L. Stampley
Mr. G. B. Taylor
Mr. R. W. McGehee
Mr. E. L. Conner

[illegible] Stello, Jr., Director
Office of Inspection & Enforcement
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

BEFORE THE

UNITED STATES NUCLEAR REGULATORY COMMISSION

DOCKET NOS. 50-416 AND 50-417

IN THE MATTER OF

MISSISSIPPI POWER & LIGHT COMPANY
and
MIDDLE SOUTH ENERGY, INC.
and
SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION

AMENDMENT NO. 7 TO

APPLICATION FOR LICENSES
(FINAL ENVIRONMENTAL REPORT)

Mississippi Power & Light Company for itself and on behalf of Middle South Energy, Inc. and South Mississippi Electric Power Association herewith files this Amendment No. 7 to their Application for Licenses in the form of additions to Sections 3.6, 6.1.3.1 and the addition of Table 5.3.1.

Respectfully submitted,

Mississippi Power & Light Company

BY _____
J. P. McGaughy, Jr.
Assistant Vice President
Nuclear Production

STATE OF MISSISSIPPI
COUNTY OF HINDS

J. P. McGaughy, Jr., being duly sworn, states that he is Assistant Vice President - Nuclear Production of Mississippi Power & Light Company; that he is authorized on the part of said Company to sign and file with the Nuclear Regulatory Commission this Amendment No. 7 to the Application for Licenses (Final Environmental Report) on behalf of Company, Middle South Energy, Inc. and South Mississippi Electric Power Association; that he signed the forgoing amendment as Assistant Vice President - Nuclear Production of Mississippi Power & Light Company; and that the statements made and the matters set forth therein are true and correct to the best of his knowledge, information, and belief.

J. P. McGaughy, Jr.

SUBSCRIBED AND SWORN TO before me, a Notary Public, in and for the County and State above named, this 29 day of July, 1981.

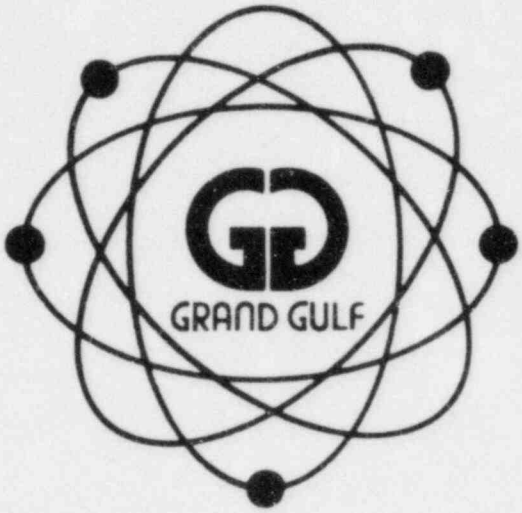
(SEAL)

Notary Public

My commission expires:

My Commission Expires July 23, 1983

FINAL ENVIRONMENTAL REPORT



GRAND GULF NUCLEAR STATION

UNITS 1 AND 2

MISSISSIPPI POWER & LIGHT COMPANY

MIDDLE SOUTH ENERGY, INC.

MIDDLE SOUTH UTILITIES SYSTEM

AMENDMENT 8

8112220542 811218
PDR ADOCK 05000416
C PDR

MISSISSIPPI POWER & LIGHT COMPANY
Helping Build Mississippi
P. O. BOX 1640, JACKSON, MISSISSIPPI 39205

JAMES P. McGAUGHY, JR.
ASSISTANT VICE PRESIDENT

December 18, 1981

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

Attention: Mr. Harold R. Denton, Director

Dear Sir:

SUBJECT: Grand Gulf Nuclear Station
Units 1 and 2
Docket Nos. 50-416 and 50-417
File 0260/0277/M-900.0
Amendment 8 to the Final
Environmental Report
AECM-81/461

Attached are forty-one copies and three notorized originals of Amendment 8 to the Application for Licenses for Grand Gulf Nuclear Station, Units 1 and 2, in the matter of the Final Environmental Report (FER). Amendment 8 consists of the deletion of Sr-90 analysis on soil samples (Section 6.1.5.2.11), additional information on the Grand Gulf Nuclear Station Meteorology System (Section 6.1.3.1), and revisions to the Chapter 2 Table of Contents.

Yours truly,

JPM:lm
Attachments

cc: Mr. N. L. Stampley
Mr. G. B. Taylor
Mr. R. B. McGehee
Mr. T. B. Conner

Mr. Richard C. DeYoung, Director
Office of Inspection & Enforcement
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

AE2Z1

BEFORE THE

UNITED STATES NUCLEAR REGULATORY COMMISSION

DOCKET NOS. 50-416 AND 50-417

IN THE MATTER OF

MISSISSIPPI POWER & LIGHT COMPANY
and
MIDDLE SOUTH ENERGY, INC.
and
SOUTH MISSISSIPPI ELECTRIC POWER ASSOCIATION

AMENDMENT NO. 8 TO
APPLICATION FOR LICENSES
(FINAL ENVIRONMENTAL REPORT)

Mississippi Power & Light Company for itself and on behalf of Middle South Energy, Inc. and South Mississippi Electric Power Association herewith files this Amendment No. 8 to their Application for Licenses in the form of the deletion of Sr-90 analysis on soil samples (Section 6.1.5.2.11), additional information on the Grand Gulf Nuclear Station Meteorology System (Section 6.1.3.1), and revisions to the Chapter 2 Table of Contents.

Respectfully submitted,

Mississippi Power & Light Company

BY _____
J. P. McGaughy, Jr.
Assistant Vice President
Nuclear Production

STATE OF MISSISSIPPI
COUNTY OF HINDS

J. P. McGaughy, Jr., being duly sworn, states that he is Assistant Vice President - Nuclear Production of Mississippi Power & Light Company; that he is authorized on the part of said Company to sign and file with the Nuclear Regulatory Commission this Amendment No. 8 to the Application for Licenses (Final Environmental Report) on behalf of Company, Middle South Energy, Inc. and South Mississippi Electric Power Association; that he signed the forgoing amendment as Assistant Vice President - Nuclear Production of Mississippi Power & Light Company; and that the statements made and the matters set forth therein are true and correct to the best of his knowledge, information, and belief.

J. P. McGaughy, Jr.

SUBSCRIBED AND SWORN TO before me, a Notary Public, in and for the County and State above named, this 4th day of DECEMBER, 1981.

(SEAL)

Notary Public

My commission expires:

13 FEBRUARY 1985