SUPPLY SYSTEM NUCLEAR PROJECT NO. 3

ENVIRONMENTAL REPORT

OPERATING LICENSE STAGE

DOCKET NO. 50-508

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

RICHLAND, WASHINGTON 99352

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INTRODUCTION

This Environmental Report-Operating License Stage (ER-OL) is submitted in support of the application filed in Docket No. STN 50-508 by the Washington Public Power Supply System (hereafter referred to as the "Supply System") for an operating license (OL) for a nuclear power generation unit designated as Nuclear Project No. 3 (WNP-3). This 1240-MWe unit is being constructed by the Supply System to satisfy the power needs of the Pacific Northwest region. The scheduled fuel load date is June 1986, although the target fuel load date is June 1985.

The Supply System is a joint operating agency formed in 1957 under Chapter 43.52 of the Revised Code of Washington. As a joint operating agency, the Supply System is legally empowered "to generate, produce, transmit, transfer, exchange or sell electric energy and to enter into contracts for any or all such purposes" (RCW 43.52.300). The Supply System sells electricity only to other electric utilities or to government agencies. These utilities and agencies in turn distribute the electricity to customers throughout most of the Pacific Northwest. The management and control of the Supply System is vested in a Board of Directors composed of a representative of each of its members, which are 19 public utility districts and the cities of Ellensburg, Richland, Seattle and Tacoma, all located in the State of Washington.

The Supply System owns and operates the 27-MWe Packwood Hydroelectric Project near the town of Packwood and the 860-MWe Hanford Generating Project (HGP) located on the Hanford Site of the United States Department of Energy (DOE). Steam for the HGP turbines is provided by DOE's N Reactor. The Supply System is also building two other nuclear electric generating plants on the Hanford Site: Supply System Nuclear Project No. 1 (WNP-1), and Supply System Project No. 2 (WNP-2).

A joint application for construction permits and operating licenses for twin units, WNP-3 and WNP-5, was filed with the Nuclear Regulatory Commission (NRC) in March 1974. Construction was commenced in April 1977 with issuance of a Limited Work Authorization. Construction Permit Nos. CPPR-154 and CPPR-155 were subsequently issued on April 11, 1978 for WNP-3 (Docket No. STN 50-508) and WNP-5 (Docket No. STN 50-509), respectively. On January 22, 1982 the Supply System Board of Directors moved to terminate construction of WNP-5. (Construction of another plant on the Hanford Site, WNP-4, was terminated at the same time.) A controlled termination is being pursued toward disposition of the partially completed unit. The first phase is directed at the possibile sale of WNP-5 as a complete plant. During this phase the equipment, components and structures will be maintained to preserve the licensability of the unit. Later phases would involve the sale or salvage of individual components.

This ER-OL is organized, with very few exceptions, according to the chapter/section/subsection format of Regulatory Guide 4.2.[1] As suggested by 10 CFR Part 51.21, the content of this document is largely an update of the Environmental Report-Construction Permit Stage (ER-CP).[2] However, this ER-OL is more than an update; it contains the information essential to an assessment of the environmental effects of plant operation independent of the ER-CP. Reference herein to the ER-CP is for the purpose of providing a source of supplementary information. Content of the document also reflects NRC rulemaking on the relevance of issues such as power need and alternative energy sources in OL proceeding.[3,4] The document describes and addresses the impacts of the single unit, WNP-3, except for a few evaluations (e.g., cooling system blowdown thermal dispersion) which were based on two-unit operation. An extra measure of conservatism regarding impact assessment is thus provided in these few instances.

References for Chapter 1

1. Preparation of Environmental Reports for Nuclear Power Stations, Regulatory Guide 4.2, Revision 2, U.S. Nuclear Regulatory Commission, Washington, D. C., July 1976.

2. Environmental Report-Construction Permit Stage, WPPSS Nuclear Project Number 3, Docket Nos. 50-508/509, Washington Public Power Supply System, Richland, Washington, 1974.

3. "Alternative Site Issues in Operating License Proceedings", Federal Register, 46(102):28630-28632, May 28, 1981.

4. "Need for Power and Alternative Energy Issues in Operating License Proceedings", Federal Register, 47(59):12940, March 26, 1982.

THE SITE AND ENVIRONMENTAL INTERFACES

2.1 GEOGRAPHY AND DEMOGRAPHY

2.1.1 Site Location and Description

2.1.1.1 Specification of Location

The Satsop site is located in southeastern Grays Harbor County, Washington, approximately one mile south of the Chehalis River near its confluence with the Satsop River. The site is about 26 miles west of Olympia and 16 miles east of Aberdeen (Figure 2.1-3). The central site area lies in Section 17 of Township 17 North, Range 6 West. The Reactor Building is located at latitude 46° 57' 33" N and longitude 123° 27' 58" W. The Universal Transverse Mercator coodinates are N^{52} 00, 525m and E^{4} 64, 517m.

2.1.1.2 Site Area Map

Figure 2.1-1 is a map showing the plant property lines and the principal plant features. Figure 2.1-2 is a map showing topography and local transportation routes. The land owned by the Supply System in the site proper totals about 1,120 acres. The Supply System also has ownership of miscellaneous properties in the site area such as the right-of-ways of the access roads from the east and west.

2.1.1.3 Boundaries for Establishing Effluent Release Limits

Boundaries for establishing effluent release limits conform to the plant property boundary and the boundary of properties encompassing the exclusion area (see Figure 2.1-1). Table 2.1-1 provides the distance from release points to this boundary in each compass sector.

2.1.2 Population Distribution

Table 2.1-2 presents, by compass segment and distance, population estimates for 1980 and forecasts by decade from 1990 to 2030. The table may be keyed to Figures 2.1-3 and 2.1-4 which are maps of areas within 10 and 50 miles, respectively, of the site.

Base population within the 10-mile radius of the WNP-3 was estimated by application of 1980 Bureau of Census household size figures to housing counts developed through field surveys. The area within ten miles is a rural section of Grays Harbor County with the exception of a six square mile rural area in the southwestern corner of Mason County. The 1980 population of Grays Harbor County was 66,314, more than half of which was located in the Aberdeen-Hoquiam area. This is an increase of 11.4 percent over the 1970 population of 59,553.(1)

From its early urbanizing period in the late 1800s, the county has experienced its major growth as a result of activity in the forest products industries. The growth of the towns within this area has been somewhat erratic following fluctuations in the industries. Trends indicate a "suburban shift" of population from the urban center of the county into the smaller outlying communities and the rural area. Since 1950, Aberdeen and Hoquiam have actually declined in population while the smaller outlying communities have grown significantly. The unincorporated rural population has also grown twice as fast as the county as a whole and four times as fast as all the cities combined. The fastest growing area in the county is the Elma area, followed by the Westport-Ocosta area. The north beaches are a close third. The total urban area is growing at a relatively slow pace of 1.1% per year.

The relatively unstable and limited employment in the County has caused a large emigration of people between ages 15-44 to more metropolitan areas in the Puget Sound region where there are more employment opportunities. This emigration together with the trend of increase in the portion of the population over 65 years of age will tend to stabilize population growth.[2]

For estimating the 1980 base population in the 10-50 mile area, 1980 census division boundary maps were overlaid with an appropriately scaled sector/radii grid. Census data was then allocated relative to the portion of each enumeration district, census tract, block group or block which fell within individual compass sectors. The 1990 to 2030 forecasts presented here are based on several sources: 1981 county population forecasts provided by the Washington State Office of Financial Management (OFM), county forecasts estimated by Bonneville Power Administration, U.S. Bureau of Census population estimates and projections, and various discussions with local regional planning agencies.[3-12]

The 50-mile radius includes Grays Harbor, Pacific, Wahkiakum, Cowlitz, Lewis, Thurston, Pierce, Kitsap, Jefferson, and Mason Counties. Individual county estimates were based on OFM projections through the year 2000 in order to provide a conservative and timely assessment. The BPA projections were used for comparison purposes. The OFM population projections were distributed within each county by compass sectors using various regional planning commission published projections and insights. Projections from 2000 to 2030 relied on Bureau of Census forecasts.[5]

A high growth scenario was applied to the rapid growth areas of Thurston and Pierce Counties, and an average growth scenario was applied to the more slowly growing areas.

2.1.2.1 Population Within Ten Miles

The 1980 population and projections by decade through the year 2030 for each of the sectors within ten miles of the plant site are listed in Table 2.1-2 which may be keyed to sectors shown in Figure 2.1-3.

The nearest incorporated communities with population exceeding 1,000 are the City of Elma, located approximately four miles northeast of the site with a 1980 population of 2,720, and the City of Montesano, located six miles west-northwest with a 1980 population of 3,247 people.[1] Of the 80 sectors (22.5^{o} x 1 radial mile areas) within a 5-mile radius of the site, 42 were uninhabited in 1980; it is anticipated that they will continue to remain uninhabited during the period through 2030.[13,14]

2.1.2.2 Population Between Ten and Fifty Miles

Population estimates and projections by decade through the year 2030 for each 22.5^{o} sector between the ten and fifty-mile radii are presented in Table 2.1-2. The 50-mile radius encompasses a ten-county region. The counties vary from a low rural population density to a high urban population density. The economic basis of the rural counties is primarily the forest products industry. These counties include Grays Harbor, Pacific, Lewis, Wahkiakum, Mason, Cowlitz, and Jefferson. Most of these counties have experienced a stable or moderate population growth for the last 30-40 years with the exception of the last decade in which higher growth rates have occurred. In the future, it is expected that these recent trends will continue as the rural counties expand their economic base.[15]

The urban counties of Pierce, Thurston, and Kitsap have high population densities and diversified economic bases. A substantial portion of industrialized Pierce County is located within the 50-mile radius. Pierce County has grown faster than most of the rural counties during the last ten years and it is projected to continue to grow at a substantial rate. Thurston County is the location of the State capital. During the last ten years, this county has experienced rapid growth in response to increased government employment. It is projected that growth in Thurston County will continue to respond to activity in the State government.

Kitsap County is less populated than Thurston or Pierce Counties, although it is still considered an urban region. Only a small portion of the county falls within the 50-mile radius of the plant. During the last ten years the county has grown rapidly as result of construction of the Trident Submarine Support Base. It is expected that Kitsap County will grow at a moderate rate in the future; although probably not to the extent it has in the past decade.

2.1.2.3 Transient Population

The transient population within ten miles is composed primarily of teachers and students at public schools, nursing home residents, employees in logging operations and at industrial facilities, and area hunters and fishermen.

Public facilities and institutions within 10 miles of the site where people may work or reside temporarily are listed in Table 2.1-3.[16-19] Also listed is the Mark E. Reed Memorial Hospital in McCleary which is slightly outside the 10-mile radius. In 1981 this institution was licensed for 26 beds and had an anverage occupancy of 50% in 22 beds.[18]

Excepting the Cities of Elma and Montesano, the four largest employers in the vicinity of WNP-3 are:

Employer	Employees		Location
	July 1981	Peak	
Elma Plywood	25	120	8 mi NE
Ventron Corporation	50	75	5 mi ENE
Anderson Logging Company	35	50	5 mi ENE
Elma Cedar Products	20	40	5 mi ENE

Logging activity can vary considerably from area to area. The approximately 100,000 acres of commercial forest within the 10-mile radius are shown in Figure 2.1-6. Table 2.1-4 illustrates the number of employees which could be employed in each sector based upon an annual yield estimate. Since one logging operation employs approximately 10 persons, it could be assumed that approximately 12 different logging operations (or about 120 persons) could be employed during the course of one year within this 10-mile radius.

Fishing and hunting are also contributors to transient populations. Figure 2.1-5 shows the estimated seasonal totals of big games and upland bird hunters within 10 miles of the site. The Chehalis River and its tributaries, the Satsop and Wynoochee Rivers, provide a number of public swimming, boating, hunting and fishing areas. Table 2.1-5 provides estimates of peak numbers of fishermen for areas with 10 miles of the plants. In addition, a total of 1600 waterfowl hunters may use the 25-mile segment of the Chehalis River Valley over the course of the hunting season.[20] All of these sportsmen cannot plausibly be expected to be in the area at the same time.

Table 2.1-6 lists county and state camping and fishing facilities located within 10 miles of the site. Camp Delezene, a year-round Boy Scout camp, is located at three miles southeast of WNP-3 on Delezene Creek Road. The

Twin Harbors Boy Scout Council reports a capacity of 150 campers (staying for periods of three weeks per session) during the peak summer months of July and August. There are approximately 350 scouts using the facilities in a twelve month period.[20]

The Oaksridge golf course is located approximately three miles north of the plant site and borders the north side of U.S. Highway 12. The facility consists of a clubhouse-restaurant and an eighteen-hole golf course.

Several mobile home parks are present within the 10-mile radius. It is difficult to determine which are considered "transient" type of facilities, and which would be considered permanent. With the start of construction of WNP-3 numerous mobile home parks have developed. Six "trailer" parks with 72 mobile homes within the 10-mile radius in 1974; Table 2.1-7 shows the status based on 1981 information.[20]

Figure 2.1-6 displays the various transient population generators within the 10-mile radius of WNP-3. Symbols are used to denote approximate locations of the various transient populations. There are no major attractants, such as resorts or convention centers, that would draw large numbers of transients from outside the area. Most of the people involved in the above activities would be included in the estimates of resident population.

2.1.3 Uses of Adjacent Lands and Waters

As noted in Subsection 2.1.1.2, Supply System land ownership in the site proper totals about 1,120 acres. Miscellaneous properties, primarily for access roads, total about 200 acres. Approximately 450 acres in the site proper were cleared and grubbed for plant construction. The land permanently occupied by the plant facilities (including WNP-5) totals about 100 acres. Land not required for operation will be revegetated to natural habitat. The Supply System has also leased a 68-acre parcel at the confluence of the Satsop and Chehalis Rivers to the Washington Department of Game to be managed as game habitat in mitigation of riparian areas disturbed by plant construction. Figures 2.1-1 and 2.1-2 show the location of principal structures and boundaries relative to natural features and transportation routes. Table 2.1-8 provides the distances from WNP-3 to various activities in each sector.

The principal land uses in the site area are related timber and agricultural production. Virtually all the land out to ten miles in the SE to WSW sectors is dedicated to timber production. Large areas north of the site are also owned and managed by timber companies (see Figure 2.1-6). Agricultural activities are concentrated in the fertile bottom lands and flood plains of the Chehalis and Satsop Rivers. Only a small percentage of the total land area contains soil suitable for sustained and intensive agriculture. The primary products are livestock, pasture grass, field crops, and vegetable crops. Livestock generally consists of poultry, sheep, hogs, and dairy and beef cattle.

All or part of ten counties lie within 50 miles of WNP-3 (see Figure 2.1-4). Table 2.1-9 lists the agricultural output from each county. The production numbers were weighted by the fraction of the land area within the 50-mile radius of WNP-3.

Dairy operations in the area ship their milk to Northwest Dairymen's Association, Seattle, for distribution through Safeway, Inc. Most of this milk is bottled as whole milk. The volume from dairies within 5 miles of the plant is estimated at 20,000 lbs/day. The total volume produced within 10 miles is estimated at 140,000 lbs/day.(31) Therefore, the dairy-dilution factor for the milk produced within 5 miles of the plant is 20,000/140,000 or 0.14.

Land use in the area has been changing since construction of WNP-3 began in 1977. The rate of residential lot creation in the unincorporated areas of eastern Grays Harbor County increased by 89 percent between 1976 and 1977, and another 45 percent in 1978. Much of the development has involved the conversion of agricultural land to residential property. In addition to short-platting and subdivision activity in the County, requests for conditional use permits for gravel operations and mobile home parks have increased. Because gravel deposits underlie much of the agricultural land along the Chehalis River, the increased gravel extraction has usurped agricultural land uses. Between January 1973 and December 1979, the County granted 47 conditional use permits for gravel extraction on agricultural land. Approximately 55 percent of all rezones in unincorporated parts of the County during the same period were conversions from agriculture to a higher density zone.(32)

Salmon and steelhead fishing is a major sport activity in the vicinity of the plant. Washington State Department of Fisheries (DOF) studies indicate that average sport salmon fishing success runs at about 0.055-0.065 fish/hour.(33) Fish caught range in weight from 1 to 14 kilograms. Steelhead fishing pressure is lighter and has an even lower fish/hour catch rate. The majority of sport fish taken from the Chehalis are nonresident fish which are migrating through to spawning areas in the tributaries. Maximum estimated residence time that these fish spend in waters mixed with the plant discharge is one month. Catch statistics compiled for 1978 by Washington State Department of Fisheries indicate that 2,900 salmon were taken by fishermen from the Chehalis River, 1,740 from the Satsop River and 840 from the Wynoochee River.(34) Commercial catch data for various species and water bodies are compiled by DOF. Data for the Chehalis River and Grays Harbor are listed in Table 2.1-10.

The area within 50 miles offers a wide variety of hunting opportunities as well. Table 2.1-11 lists the types and amounts of game harvested in the area. The numbers are weighted to reflect the proportion of the county which lies within the 50-mile radius where the game are taken. It is assumed that about eighty percent of the game taken is consumed locally, that is, in western Washington.

Water used in the Chehalis River valley is taken from both ground and surface resources. The Chehalis River is used primarily for irrigation or livestock with potable water taken from wells, springs or tributaries. There are only about twelve withdrawals from the Chehalis downstream of the plant site and all are for irrigation or industrial processing. Surface water users within ten miles of WNP-3, based on Department of Ecology (DOE) records, are shown in Figure 2.1-7.[38]

Groundwater in the Chehalis valley is obtained from shallow wells (usually less than 100 ft deep) which tap the alluvial aquifer which extends to a depth of about 150 feet. Above the valley, springs and wells draw from tertiary terraces (see Subsection 2.4.2.1). Domestic and farm water sources in the vicinity of WNP-3 are listed in Table 2.1-12 and plotted in Figure 2.1-8. Groundwater users out to ten miles, based on DOE records, are shown in Figure 2.1-9.[39]

The major municipal and community water systems within 20 miles of the plant site are listed in Table 2.1-13. Three of these systems are served by surface water supplies, four by groundwater resources, and one by a combination; none withdraw from the Chehalis River. The City of Aberdeen derives its muncipal supply for a population of 22,000 from Wiskkah River and its industrial water supply from the Wynoochee Reservoir located on the Wynoochee River. The City of Hoquaim obtains its municipal water supply for an estimated 11,300 persons from Davis Creek which is a branch of the west fork of the Hoquiam River, and from the north fork of the Little Hoquiam River which serves as an additional supply during peak demand periods. Muncipal supplies for smaller communities are obtained from groundwater resources near the point of use.

References for Section 2.1

1. Official State Population Count, U.S. Bureau of the Census, 1980.

2. Grays Harbor Overall Economic Development Plan 1979, Grays Harbor Regional Planning Commission, June 1979.

3. Forecasts of the State and County Population by Age and Sex 1985-2000 With Estimates for 1980, Special Report No. 36, Forecasting and Support Division, State of Washington Office of Financial Management, Olympia, Washington, May 1981.

4. Population Employment and Household Projected to 2000, Washington, U.S. Department of Energy, Bonneville Power Administration, July 1979.

5. Projections of the Population of the United States, 1977 to 2050, Current Population Report Series P-25, No. 704, U.S. Department of Commerce, Bureau of Census, July 1977.

6. Memorandum to Thurston Metropolitan Area Transportation Study (TMATS) Data Users, from George Buitlar, TMATS Coordinator, Thurston Regional Planning Council, July 2, 1980.

7. Pierce County Preliminary Population and Employment Forecasts by Small Area 1980-1990-2000, Pierce Subregional Council, Puget Sound Council of Governments, March 12, 1981.

8. Personal Communication, A. M. Lee and K. A. McGinnis, Supply System, with staff of Lewis County Planning Commission, June 25, 1981.

9. Personal Communication, A. M. Lee and K. A. McGinnis, Supply System, with staff of Cowlitz-Wahkiakum Governmental Conference, June 25, 1981.

10. Personal Communication, A. M. Lee and K. A. McGinnis, Supply System, with staff of Mason Regional Planning Commission, June 26, 1981.

11. Personal Communication, A. M. Lee and K. A. McGinnis, Supply System, with personnel of Thurston Regional Planning Council, June 26, 1981.

12. Personal Communication, K. A. McGinnis, Supply System, with Larry Weathers, Pacific Regional Planning Council, July 14, 1981.

13. Distribution of Housing Units and 1980 Estimated Resident Population in 10-Mile Radius of WNP-3/5 by Compass Direction and 1-Mile Radii Intervals, prepared for the Washington Public Power Supply System by Grays Harbor Regional Planning Commission, May 1981.

References for Section 2.1 (contd.)

14. Projections and Distribution of Population Within a 50-Mile Radius of Washington Public Power Supply System Nuclear Projects Nos. 3 and 5, By Compass Direction and Radii Intervals For Grays Harbor County, 1980-2030, prepared for the Washington Public Power Supply System by Grays Harbor Regional Planning Commission, July 1981.

15. Personal Communication, K. A. McGinnis, Supply System, with Lawrence Weisser, Washington State Office of Financial Management, June 23, 1981.

16. Personal Communication, A. M. Lee, Supply System, with Beverly Pennick, Secretary to the Superintendent, Elma School District #68, July 24, 1981.

17. Personal Communication, A. M. Lee, Supply System, with Kathy Schluter, Secretary to the Superintendent, Montesano School District #66, July 24, 1981.

18. Personal Communication, A. M. Lee, Supply System, with James Maki, Administrator, Mark E. Reed Memorial Hospital, Inc., July 27, 1981.

19. Personal Communication, A. M. Lee, Supply System, with Candy Nestor, Receptionist, Supply System's Elma Information Center, July 27, 1981.

20. Transient Populations Within 50-Mile Radius of WNP-3/5, Grays Harbor and Jefferson Counties, prepared for Washington Public Power Supply System by Grays Harbor Regional Planning Commission, July 1981.

21. Letter, Richard E. Moulton, County Extension Agent, Grays Harbor Cooperative Extension Service, to L. S. Schleder, Supply System, January 15, 1981.

22. Letter, Larry Guech, County Extension Agent, Lewis County Extension Service, to L. S. Schleder, Supply System, December 16, 1980.

23. Letter, Carol Carver, County Extension Agent, Wahkiakum County Extension Service to L. S. Schleder, Supply System, February 12, 1981.

24. Letter, Joseph P. Kropf, County Extension Agent, Cowlitz County Extension Service, to L. S. Schleder, Supply System, December 16, 1980.

25. Letter, William Scheer, Extension Agent, Pierce County Cooperative Extension Service, to L. S. Schleder, Supply System, December 12, 1980.

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26. Letter, Blair Wolfley, County Extension Agent, Jefferson County Extension Service, to L. S. Schleder, Supply System, December 18, 1980.

27. Letter, Steven Gibbs, County Extension Agent, Pacific County Cooperative Extension Service, to L. S. Schleder, Supply System, December 17, 1980.

28. Letter, Mr. Joseph Smith, County Extension Agent, Thurston County Cooperative Extension Service, to L. S. Schleder, Supply System, December 23, 1980.

29. Personal Communication, L. S. Schleder, Supply System, with M. Freed, County Extension Agent, Mason County Extension Service, February 10, 1981.

30. Personal Communication, L. S. Schleder, Supply System, with Mr. George Curlis, County Extension Agent, Kitsap County Cooperative Extension Service, December 11, 1980.

31. Personal Communication, Mark Miller, Supply System, with Mr. Frank Hotaling, Northwest Dairymen's Association, January 23, 1981.

32. Agricultural Element of the Grays Harbor County Comprehensive Plan, Grays Harbor Regional Planning Commission, Grays Harbor County, Washington, May 11, 1981.

33. Coastal Rivers Sport Fishing Investigations in 1973, 1974 and 1979, Progress Report #8, Washington State Department of Fisheries, Olympia, Washington, October 1976.

34. Washington State Sport Catch Report - 1978, Washington Department of Fisheries, Olympia, Washington.

35. Special Computer-Generated Report from Washington State Department of Fisheries listing data sorted by Year of Landing, Catch Area, Fish Species, Numbers Caught, and Approximate Weight, prepared February 25, 1981.

36. Washington Wildlife - Small Game Report(s), Wildlife Management Division, Washington State Department of Game, Olympia, Washington, 1975-1979.

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38. Special Computer-Generated Report from Washington Department of Ecology listing recorded Surface Water Withdrawals sorted by ID Number, Location, Source, Purpose, and Amount, prepared December 19, 1980.

39. Special Computer-Generated Report from Washington Department of Ecology listing recorded Groundwater Withdrawals sorted by ID Number, Location, Purpose, and Amount by Water Rights Inventory Area, Township, Range, Section and ID Number, prepared December 19, 1980.

40. Comprehensive Water and Sewer Plan, prepared for Grays Harbor County by R. W. Beck & Associates, Seattle, Washington, May 1970.

TABLE 2.1-1

DISTANCES TO RESTRICTED AREA BOUNDARY

	Distance to Nearest Portion of Boundary in Sector	
	Miles	Meters
N	1.00	1609
NNE	1.04	1674
NE	0.81	1304
ENE	0.81	1304
E	0.83	1336
ESE	0.84	1352
SE	0.81	1304
SSE	0.83	1336
S	0.86	1384
SSW	0.83	1336
SW	0.81	1304
WSW	0.83	1336
W	0.83	1336
WNW	0.86	1384
NW	1.04	1674
NNW	1.00	1609

TABLE 2.1-2
(SHEET 1 OF 4)
POPULATION WITHIN 50 MILE RADIUS OF WNP-3

DISTANCE (MILES)	DIRECTION (COMPASS SECTOR)	1980 NUMBER	1980 CUMULATIVE TOTAL	1986 NUMBER	1986 CUMULATIVE TOTAL	1990 NUMBER	1990 CUMULATIVE TOTAL	2000 NUMBER	2000 CUMULATIVE TOTAL	2010 NUMBER	2010 CUMULATIVE TOTAL	2020 NUMBER	2020 CUMULATIVE TOTAL	2030 NUMBER	2030 CUMULATIVE TOTAL
0-1	N	9	9	10	10	10	10	11	11	12	12	13	13	14	14
	NNE	0	9	0	10	0	10	0	11	0	12	0	13	0	14
	NE	0	9	0	10	0	10	0	11	0	12	0	13	0	14
	ENE	0	9	0	10	0	10	0	11	0	12	0	13	0	14
	E	0	9	0	10	0	10	0	11	0	12	0	13	0	14
	ESE	0	9	0	10	0	10	0	11	0	12	0	13	0	14
	SE	0	9	0	10	0	10	0	11	0	12	0	13	0	14
	SSE	0	9	0	10	0	10	0	11	0	12	0	13	0	14
	S	0	9	0	10	0	10	0	11	0	12	0	13	0	14
	SSW	0	9	0	10	0	10	0	11	0	12	0	13	0	14
	SW	0	9	0	10	0	10	0	11	0	12	0	13	0	14
	WSW	0	9	0	10	0	10	0	11	0	12	0	13	0	14
	W	3	12	3	13	3	13	3	14	3	15	3	16	3	17
	WNW	0	12	0	13	0	13	0	14	0	15	0	16	0	17
	NW	0	12	0	13	0	13	0	14	0	15	0	16	0	17
	NNW	3	15	3	16	3	16	3	17	3	18	3	19	3	20
1-2	N	8	23	9	25	9	25	10	27	11	29	12	31	13	33
	NNE	3	26	3	28	3	28	3	30	3	32	3	34	3	36
	NE	11	37	12	40	12	40	13	43	14	46	15	49	16	52
	ENE	0	37	0	40	0	40	0	43	0	46	0	49	0	52
	E	0	37	0	40	0	40	0	43	0	46	0	49	0	52
	ESE	0	37	0	40	0	40	0	43	0	46	0	49	0	52
	SE	0	37	0	40	0	40	0	43	0	46	0	49	0	52
	SSE	0	37	0	40	0	40	0	43	0	46	0	49	0	52
	S	0	37	0	40	0	40	0	43	0	46	0	49	0	52
	SSW	0	37	0	40	0	40	0	43	0	46	0	49	0	52
	SW	0	37	0	40	0	40	0	43	0	46	0	49	0	52
	WSW	0	37	0	40	0	40	0	43	0	46	0	49	0	52
	W	0	37	0	40	0	40	0	43	0	46	0	49	0	52
	WNW	29	66	31	71	32	72	35	78	38	84	41	90	44	96
	NW	31	97	33	104	34	106	38	116	42	126	46	136	50	146
	NNW	12	109	13	117	13	119	14	130	15	141	16	152	17	163
2-3	N	77	186	81	198	84	203	93	223	102	243	111	263	120	283
	NNE	280	466	302	500	317	520	367	590	419	662	474	737	530	813
	NE	13	479	14	514	14	534	16	606	18	680	20	757	22	835
	ENE	105	584	111	625	115	649	128	734	140	820	153	910	166	1,001
	E	3	587	3	628	3	652	3	737	3	823	3	913	3	1,004
	ESE	0	587	0	628	0	652	0	737	0	823	0	913	0	1,004
	SE	3	590	3	631	3	655	3	740	3	826	3	916	3	1,007
	SSE	0	590	0	631	0	655	0	740	[illegible]	826	0	916	0	1,007
	S	0	590	0	631	0	655	0	740	0	826	0	916	0	1,007
	SSW	0	590	0	631	0	655	0	740	0	826	0	916	0	1,007
	SW	0	590	0	631	0	655	0	740	0	826	0	916	0	1,007
	WSW	0	590	0	631	0	655	0	740	0	826	0	916	0	1,007
	W	0	590	0	631	0	655	0	740	0	826	0	[illegible]	0	1,007
	WNW	28	618	30	661	31	686	35	775	39	865	43	959	47	1,054
	NW	84	702	89	750	92	778	103	878	[illegible]	979	125	1,084	136	1,190
	NNW	204	906	215	965	222	1,000	246	1,124	269	1,248	293	1,377	316	1,506

TABLE 2.1-2
(SHEET 2 OF 4)
POPULATION WITHIN 50 MILE RADIUS OF WNP-3

DISTANCE (MILES)	DIRECTION (COMPASS SECTOR)	1980 NUMBER	1980 CUMULATIVE TOTAL	1986 NUMBER	1986 CUMULATIVE TOTAL	1990 NUMBER	1990 CUMULATIVE TOTAL	2000 NUMBER	2000 CUMULATIVE TOTAL	2010 NUMBER	2010 CUMULATIVE TOTAL	2020 NUMBER	2020 CUMULATIVE TOTAL	2030 NUMBER	2030 CUMULATIVE TOTAL
3-4	N	174	1,080	183	1,143	189	1,189	209	1,333	229	1,477	249	1,626	269	1,775
	NNE	419	1,499	456	1,604	483	1,672	570	1,903	660	2,137	756	2,382	854	2,629
	NE	716	2,215	748	2,352	770	2,442	841	2,744	910	3,047	980	3,362	1,049	3,678
	ENE	100	2,315	105	2,457	109	2,551	121	2,865	133	3,180	145	3,507	157	3,835
	E	20	2,335	21	2,478	22	2,573	24	2,889	26	3,206	28	3,535	30	3,865
	ESE	6	2,341	7	2,485	7	2,580	8	2,897	9	3,215	10	3,545	11	3,876
	SE	0	2,341	0	2,485	0	2,580	0	2,897	0	3,215	0	3,545	0	3,876
	SSE	0	2,341	0	2,485	0	2,580	0	2,897	0	3,215	0	3,545	0	3,876
	S	0	2,341	0	2,485	0	2,580	0	2,897	0	3,215	0	3,545	0	3,876
	SSW	0	2,341	0	2,485	0	2,580	0	2,897	0	3,215	0	3,545	0	3,876
	SW	0	2,341	0	2,485	0	2,580	0	2,897	0	3,215	0	3,545	0	3,876
	WSW	0	2,341	0	2,485	0	2,580	0	2,897	0	3,215	0	3,545	0	3,876
	W	18	2,359	19	2,504	19	2,599	20	2,917	21	3,236	22	3,567	23	3,899
	WNW	109	2,468	115	2,619	120	2,719	135	3,052	150	3,386	165	3,732	180	4,079
	NW	477	2,945	501	3,120	518	3,237	572	3,624	625	4,011	679	4,411	732	4,811
	NNW	116	3,061	122	3,242	126	3,363	139	3,763	152	4,163	165	4,576	178	4,989
4-5	N	61	3,122	64	3,306	66	3,429	73	3,836	80	4,243	87	4,663	94	5,083
	NNE	38	3,160	51	3,357	62	3,491	96	3,932	132	4,375	172	4,835	214	5,297
	NE	1,955	5,115	2,104	5,461	2,209	5,700	2,555	6,487	2,909	7,284	3,284	8,119	3,664	8,961
	ENE	129	5,244	137	5,598	142	5,842	159	6,646	176	7,460	193	8,312	210	9,171
	E	74	5,318	78	5,676	81	5,923	91	6,737	101	7,561	111	8,423	121	9,292
	ESE	46	5,364	48	5,724	50	5,973	55	6,792	60	7,621	65	8,488	70	9,362
	SE	0	5,364	0	5,724	0	5,973	0	6,792	0	7,621	0	8,488	0	9,362
	SSE	0	5,364	0	5,724	0	5,973	0	6,792	0	7,621	0	8,488	0	9,362
	S	0	5,364	0	5,724	0	5,973	0	6,792	0	7,621	0	8,488	0	9,362
	SSW	0	5,364	0	5,724	0	5,973	0	6,792	0	7,621	0	8,488	0	9,362
	SW	0	5,364	0	5,724	0	5,973	0	6,792	0	7,621	0	8,488	0	9,362
	WSW	0	5,364	0	5,724	0	5,973	0	6,792	0	7,621	0	8,488	0	9,362
	W	35	5,399	36	5,760	37	6,010	40	6,832	43	7,664	46	8,534	49	9,411
	WNW	356	5,755	374	6,134	387	6,397	427	7,259	466	8,130	506	9,040	545	9,956
	NW	53	5,808	56	6,190	58	6,455	64	7,323	70	8,200	76	9,116	82	10,038
	NNW	59	5,867	62	6,252	64	6,519	71	7,394	78	8,278	85	9,201	92	10,130
5-10	N*	210	6,077	221	6,473	229	6,748	254	7,648	279	8,557	304	9,505	329	10,459
	NNE*	62	6,139	67	6,540	70	6,818	81	7,729	92	8,649	104	9,609	116	10,575
	NE	1,462	7,601	1,552	8,092	1,615	8,433	1,820	9,549	2,027	10,676	2,243	11,852	2,459	13,034
	ENE	375	7,976	403	8,495	423	8,856	489	10,038	557	11,233	629	12,481	702	13,736
	E	562	8,538	594	9,089	617	9,473	690	10,738	762	11,995	836	13,317	910	14,646
	ESE	267	8,805	283	9,372	295	9,768	332	11,060	369	12,364	408	13,725	447	15,093
	SE	119	8,924	128	9,500	134	9,902	155	11,215	176	12,540	198	13,923	221	15,314
	SSE	0	8,924	0	9,500	0	9,902	0	11,215	0	12,540	0	13,923	0	15,314
	S	0	8,924	0	9,500	0	9,902	0	11,215	0	12,540	0	13,923	0	15,314
	SSW	17	8,941	18	9,518	19	9,921	21	11,236	23	12,563	25	13,948	27	15,341
	SW	0	8,941	0	9,518	0	9,921	0	11,236	0	12,563	0	13,948	0	15,341
	WSW	3	8,944	3	9,521	3	9,924	3	11,239	3	12,566	3	13,951	3	15,344
	W	1,748	10,692	1,945	11,466	2,088	12,012	2,585	13,824	3,138	15,704	3,768	17,719	4,457	19,801
	WNW	4,214	14,906	4,452	15,918	4,618	16,630	5,162	18,986	5,713	21,417	6,291	24,010	6,875	26,676
	NW	0	14,906	0	15,918	0	16,630	0	18,986	0	21,417	0	24,010	0	26,676
	NNW	259	15,165	274	16,192	285	16,915	320	19,306	355	21,772	391	24,401	427	27,103

TABLE 2.1-2
(SHEET 3 OF 4)
POPULATION WITHIN 50 MILE RADIUS OF WNP-3

DISTANCE (MILES)	DIRECTION (COMPASS SECTOR)	1980		1986		1990		2000		2010		2020		2030	
		NUMBER	CUMULATIVE TOTAL	NUMBER	CUMULATIVE TOTAL	NUMBER	CUMULATIVE TOTAL	NUMBER	CUMULATIVE TOTAL	NUMBER	CUMULATIVE TOTAL	NUMBER	CUMULATIVE TOTAL	NUMBER	CUMULATIVE TOTAL
10-20	N	410	15,575	445	16,637	469	17,384	522	19,828	561	22,333	602	25,003	636	27,739
	NNE	499	16,074	544	17,184	574	17,958	637	20,465	675	23,008	716	25,719	744	28,483
	NE	1,902	17,976	2,005	19,189	2,173	20,131	2,501	22,966	2,824	25,832	3,177	28,896	3,540	32,023
	ENE	2,292	20,268	2,453	21,642	2,560	22,691	2,817	25,783	3,107	28,939	3,423	32,319	3,725	35,748
	E	406	20,674	430	22,072	446	23,137	468	26,251	496	29,435	526	32,845	547	36,295
	ESE	2,491	23,105	2,783	24,855	2,979	26,116	3,322	29,573	3,557	32,992	3,816	36,661	4,029	40,324
	SE	1,789	24,954	2,012	26,867	2,160	28,276	2,683	32,256	3,323	36,315	3,621	40,282	5,095	45,419
	SSE	440	25,394	442	27,309	444	28,720	447	32,703	454	36,769	463	40,745	474	45,893
	S	562	25,956	562	27,871	562	29,282	562	33,265	562	37,331	562	41,307	562	46,455
	SSW	811	26,767	818	28,689	824	30,106	838	34,103	854	38,185	871	42,178	888	47,343
	SW	436	27,203	438	29,127	440	30,546	440	34,543	451	38,636	458	42,636	465	47,808
	WSW	147	27,350	160	29,287	168	30,714	189	34,732	213	38,849	239	42,875	266	48,074
	W	30,073	57,423	30,758	60,045	31,215	61,929	33,125	67,857	34,731	73,080	36,109	78,984	37,371	85,445
	WNW	1,107	58,530	1,143	61,188	1,167	63,096	1,259	69,116	1,341	74,421	1,420	80,404	1,490	86,935
	NW	430	58,960	444	61,632	453	63,549	480	6,902	518	74,939	549	80,953	576	87,511
	NNW	50	59,010	55	61,687	58	63,607	60	69,662	75	75,014	85	81,038	96	87,607
20-30	N	42	59,052	42	61,729	42	63,649	42	69,704	42	75,056	42	81,080	42	87,649
	NNE	1,019	60,071	1,110	62,839	1,172	64,821	1,301	71,005	1,379	76,435	1,448	82,528	1,506	89,155
	NE	8,680	68,751	9,461	72,300	9,982	74,803	11,080	82,085	11,745	88,180	12,450	94,978	12,948	102,103
	ENE	26,535	95,286	32,903	105,203	37,149	111,952	44,579	126,664	49,483	137,663	55,421	150,399	60,963	163,066
	E	34,920	130,206	43,300	148,503	48,888	160,840	58,666	185,330	65,119	202,782	72,934	223,333	80,227	243,293
	ESE	6,231	136,437	6,978	155,481	7,477	168,317	8,224	193,554	8,717	211,499	9,240	232,573	9,610	252,903
	SE	13,210	149,647	15,191	170,672	16,512	184,829	20,145	213,699	21,354	232,853	22,635	255,208	23,540	276,443
	SSE	638	150,285	676	171,348	702	185,531	758	214,457	803	233,656	851	256,059	885	277,328
	S	444	150,729	444	171,792	444	185,975	444	214,901	444	234,100	444	256,503	444	277,772
	SSW	1,919	152,648	1,976	173,768	2,014	189,989	2,074	216,975	2,198	236,298	2,330	258,833	2,423	280,195
	SW	4,128	156,776	4,462	178,230	4,685	192,674	4,690	221,665	4,961	241,259	5,259	264,092	5,469	285,664
	WSW	684	157,460	745	178,975	785	193,459	870	222,541	947	242,206	1,031	265,123	1,096	286,760
	W	3,937	161,397	4,059	183,034	4,143	197,602	4,462	227,003	4,745	246,951	5,014	270,137	5,254	292,014
	WNW	869	162,266	907	183,941	933	198,535	1,029	228,032	1,119	248,070	1,210	271,347	1,296	293,310
	NW	667	162,933	695	184,636	714	199,249	790	228,891	859	248,929	929	272,276	995	294,305
	NNW	145	163,078	146	184,782	146	199,395	148	229,040	148	249,077	148	272,424	148	294,453
30-40	N	18	163,096	18	184,800	18	199,413	18	229,058	18	249,095	18	272,442	18	294,471
	NNE	1,577	164,673	2,088	186,888	2,429	201,842	3,158	232,216	3,505	252,600	3,926	276,368	4,319	298,790
	NE	5,334	170,007	7,062	193,950	8,214	210,056	10,678	242,894	11,853	264,453	13,275	289,643	14,603	313,393
	ENE	13,321	183,328	18,116	212,066	21,314	231,370	27,708	270,602	30,756	295,209	34,447	324,090	37,891	351,284
	E	34,345	217,673	46,709	258,775	54,952	286,322	71,438	342,040	79,296	374,505	88,812	412,902	97,693	448,977
	ESE	2,760	220,433	3,174	261,949	3,450	289,772	4,209	346,249	4,462	378,967	4,730	417,632	4,919	453,896
	SE	12,560	232,993	1,444	263,393	15,700	305,472	19,154	365,403	20,303	399,270	21,521	439,153	22,382	476,278
	SSE	1,465	234,458	1,553	264,946	1,612	307,084	1,741	367,144	1,845	401,115	1,956	441,109	2,034	478,312
	S	396	234,854	396	265,342	396	307,480	396	367,540	396	401,511	396	441,505	396	478,708
	SSW	269	235,123	277	265,619	282	30,772	290	367,830	307	401,818	325	441,830	338	479,046
	SW	1,056	236,179	1,141	266,760	1,198	308,960	1,310	369,140	1,389	403,207	1,472	443,302	1,531	480,577
	WSW	1,596	237,775	1,815	268,575	1,962	310,922	2,450	371,590	2,683	405,890	3,738	447,040	4,574	485,151
	W	4,075	241,850	4,702	273,277	5,173	316,095	6,717	378,307	8,617	414,507	10,987	458,027	13,883	499,034
	WNW	2,255	244,105	2,630	275,907	2,914	319,009	3,853	382,160	5,035	419,542	6,532	464,559	8,402	507,436
	NW	46	244,151	49	275,956	51	319,060	58	382,218	63	419,605	68	464,627	73	507,509
	NNW	695	244,846	753	276,709	794	319,854	930	383,148	1,075	420,680	1,235	465,862	1,406	508,915

TABLE 2.1-2
(SHEET 4 OF 4)
POPULATION WITHIN 50 MILE RADIUS OF WNP-3

DISTANCE (MILES)	DIRECTION (COMPASS SECTOR)	1980 NUMBER	1980 CUMULATIVE TOTAL	1986 NUMBER	1986 CUMULATIVE TOTAL	1990 NUMBER	1990 CUMULATIVE TOTAL	2000 NUMBER	2000 CUMULATIVE TOTAL	2010 NUMBER	2010 CUMULATIVE TOTAL	2020 NUMBER	2020 CUMULATIVE TOTAL	2030 NUMBER	2030 CUMULATIVE TOTAL
40-50	N	3	244,849	3	276,712	3	319,857	3	383,151	3	420,683	3	465,865	3	508,918
	NNE	1,817	246,666	2,364	279,076	2,750	322,607	3,575	386,726	3,968	424,651	4,444	470,309	4,888	513,806
	NE	15,247	261,913	20,186	299,262	23,480	346,087	30,524	417,250	33,882	458,533	37,948	508,257	41,743	555,549
	ENE	223,901	485,814	249,835	549,097	267,125	613,212	302,535	719,785	335,814	794,348	376,112	884,369	413,723	969,272
	E	11,299	497,113	12,395	561,492	13,125	626,337	14,375	734,160	15,238	809,586	16,152	900,521	16,798	986,070
	ESE	2,438	499,551	2,584	564,076	2,682	629,019	2,897	737,057	3,071	812,657	3,255	903,776	3,385	989,455
	SE	6,619	506,170	7,015	571,091	7,280	636,299	7,862	744,919	8,334	820,991	8,834	912,610	9,187	998,642
	SSE	2,741	508,911	2,905	573,996	3,015	639,314	3,256	748,175	3,451	824,442	3,658	916,268	3,805	1,002,447
	S	1,111	510,022	1,135	575,131	1,144	640,458	1,184	74,935	1,208	825,650	1,214	917,482	1,263	1,003,718
	SSW	1,349	511,371	1,458	576,589	1,531	641,989	1,670	751,029	1,770	827,420	1,876	919,361	1,951	1,005,669
	SW	2,213	513,584	2,391	578,980	2,511	644,500	2,750	753,779	2,915	830,335	3,090	922,451	3,214	1,008,883
	WSW	0	513,584	0	578,980	0	0	0	753,779	0	830,335	0	922,451	0	1,008,883
	W	0	513,584	0	578,980	0	0	0	753,779	0	830,335	0	922,451	0	1,008,883
	WNW	73	513,657	81	579,061	87	644,587	107	753,886	135	830,470	169	922,620	209	1,009,092
	NW	749	514,406	854	579,915	932	645,519	1,185	755,071	1,489	831,959	1,860	924,480	2,302	1,011,394
	NNW	548	514,954	594	580,509	627	646,145	733	755,804	847	832,806	973	925,453	1,108	1,012,502

TABLE 2.1-3

PUBLIC FACILITIES WITHIN 10 MILES OF WNP-3

Type of Facility	Name of Facility	Direction	Distance (Miles)	Average Number of Users (1981)
Schools	Satsop School District #104: Satsop Elementary	NNW	3	62 Students; 6 Staff
	Elma School District #68:	NE	4	31 Staff; 810 Students; 62 Staff
	Elma Elementary	NE	4	
	Elma Secondary (Jr.-Sr. High)	NE	4	924 Students; 76 Staff
	Montesano School District #66:	WNW	7	101 Staff
	Simpson Avenue Elementary	WNW	7	380 Students
	Beacon Avenue Elementary	WNW	7	425 Students
	Montesano Jr.-Sr. High	WNW	7	673 Students
Hospitals	Mark E. Reed Hospital	NE	11	55 Staff; 11 Patients
Nursing Homes	Beechwood Nursing Home	NE	4	35 Patients; 20-23 Staff
	Oakhurst Convalescent Center	NE	4	180 Patients; 148 Staff
	Woodland Terrace Nursing Home	WNW	7	30 Patients; 35 Staff
	Edgewood Manor Nursing Home	WNW	7	37 Patients; 22-24 Staff
Penal Institutions	Grays Harbor County Jail	WNW	7	41 Prisoners; 12 Staff
Other Facilities	Elma Air Field (Washington State Aeronautics Commission)	NE	3-1/4	N/A
	Grays Harbor Youth Home Elma (Grays Harbor County Juvenile Dept.)			10 Residents; 7 Staff

TABLE 2.1-4

TIMBER PRODUCTION EMPLOYEES
WITHIN 10 MILES OF WNP-3

Sector	Primary Ownership	Acres	Average Annual Yield (10^3 bf)[a]	Employees[b]
N	Private	3,840	2,070	4.53
NNE	"	6,080	3,277	7.17
NE	"	320	172	.37
ENE	"	640	345	.76
E	State (Capital Forest)	1,920	1,035	2.27
ESE	Private/State	3,520	1,897	4.15
SE	"	8,320	4,484	9.82
SSE	"	12,480	6,727	14.73
S	"	12,800	6,899	15.11
SSW	"	12,160	6,554	14.35
SW	"	11,200	6,037	13.22
WSW	"	11,520	6,209	13.60
W	"	640	345	.76
WNW	Private/Local Government	2,560	1,380	3.02
NW15	Private	9,600	5,174	11.33
NWN	"	3,520	1,897	4.15
TOTAL		101,120	54,502	119.36

Source: Reference 2.1-20

(a)Acres X 1976 Grays Harbor Co yield/acre (0.539 thousand board feet)

(b)Average annual yield X number of employees/10^6 board feet (2.19)

TABLE 2.1-5

ESTIMATED NUMBER OF PEAK FISHERMEN WITHIN 10 MILES OF WNP-3

	Number of Miles	Total Fishermen[a]
Chehalis River Portions of Sectors N, NNE, NE, E, ESE, WSW, W, WNW, NW, AND NNW	25	68
Satsop River Main and West Fork, Portions of Sectors NW, and NNW	12	33
East Fork, Portions of Sectors NNW and N	6	16
Wynoochee River Portions of Sectors W and WNW	4	11
Estimated Maximum Number of Fishermen On Any Given Day	47	128

Source: Reference 2.1-20

(a)2.7 fishermen per mile based on 9.5 mile sample with a peak of 26 fisherman in Feb 1980.

TABLE 2.1-6

RECREATIONAL FACILITIES
WITHIN 10 MILES OF WNP-3

Facility Name	Location	Description
Lake Sylvia, St. Park	7 mile WNW	234 acres, 35 camping sites, swimming, boating, picnicing, concession stand, kitchen shelters, boat launch, restrooms, and showers.
Schafer, St. Park	9 miles N	119 acres, 53 campsites, (6 with trailer hookups), fishing, hiking, picnicing, swimming, kitchen shelters, restrooms, and showers.
Porter Creek Camp	9 miles E	10 camping units, drinking water, fishing, 6 picnic units, horse facilities, trails, hiking, motorcycle trails, parking.
Chehalis River Fishing Area	6 miles E	3.4 acres with 8,230' of waterfront, public fishing area.
Chehalis River Fishing Area	4 miles ENE	5.9 acres with 4,400' of waterfront, public fishing area.
Chehalis River Fishing Area	2-4 miles E	102 acres with 9,114' of waterfront, public fishing area.
Satsop River Fishing Area	6 miles NNW	3.5 acres with 550' of waterfront, public fishing area.
Satsop River Fishing Area	2.5 miles NNW	5 acres with 900' of waterfront, public fishing area.
Satsop River Fishing Area	2 miles NNW	660' of waterfront, public fishing area.
Satsop River Fishing Area	4 miles NNW	.15 acres with 1,200' of waterfront, public fishing area.
Satsop River Fishing Area 5-10 N	8 miles NNW	2.8 acres with 5,990' of waterfront, public fishing area.
Wynoochee River Fishing Area	7 miles W	104 acres with 3,960' of waterfront, public fishing area.

Source: Reference 2.1-20

TABLE 2.1-7

MOBILE HOME PARKS AND SPACES
WITHIN 10 MILES OF WNP-3

Distance (Miles)	Direction (Compass Segments)	Number of Mobile Home Parks	Number of Spaces
0-1	ALL	0	0
1-2	ALL	0	0
2-3	N	1	19
2-3	NNE	2	84
3-4	NW	1	12
3-4	NNE	1	45
4-5	NE	1	98[a]
4-5	ENE	1	19[b]
5-6	ENE	1	36[b]
5-6	NE	2	30
5-6	WNW	4	63
6-7	NE	1	45
6-7	NNW	2	20
7-8	W	1	8
8-9	N	1	5
8-9	W	3	148[b]
9-10	W	1	15[b]
9-10	N	1	15
Total within 0-10 miles:		24	662

Source: Reference 2.1-20

[a]Primarily RV accommodations.

[b]One park divided by sector.

TABLE 2.1-8

DISTANCE (MILES) FROM WNP-3 TO POINTS OF INTEREST

Sector	Resident	Veg. Garden	Beef Cattle	Milk Cow	Milk Goat
N	1.0	1.0	1.7	1.2[a]	--
NNE	1.5	1.5	1.6	1.5[a]	--
NE	1.6	1.6	1.6	1.7	1.7
ENE	2.3	2.3	2.2	2.6	4.1
E	4.4	4.4	4.2	--	--
ESE	3.9	3.9	3.9	--	3.8
SE	--	--	--	--	--
SSE	--	--	--	--	--
S	--	--	--	--	--
SSW	--	--	--	--	--
SW	--	--	--	--	--
WSW	--	--	--	--	--
W	3.7	3.7	3.8	--	--
WNW	1.1	1.2	1.5	1.5[a]	--
NW	2.0	2.0	3.1	1.8[a]	--
NNW	1.0	1.0	2.6	1.1	4.2

[a] Dairy operations.

TABLE 2.1-9

AGRICULTURAL PRODUCTION WITHIN 50 MILES OF WNP-3

Grays Harbor County

Annual Meat Production		Annual Milk Production	
Beef	- 3,458,000 kg	Number of Dairies	- 56
Pork	- 11,250 kg	Number of Cows	- 7,500
Sheep	- 12,150 kg	Milk Produced	- 44,513,000 l/yr

Annual Crop and Vegetable Production

Product	Acreage	Total Yield (kg)	Yield/Area (kg/m^2)
Corn Silage	640	10,471,700	4.03
Green Peas	1,300	2,481,800	0.5

Lewis County

Annual Meat Production		Annual Milk Production	
Beef	- 910,000 kg	Number of Dairies	- 82
Pork	- 90,000 kg	Number of Cows	- 7,200
Sheep	- 32,400 kg	Milk Produced	- 49,434,000 l/yr

Annual Vegetable Production

Product	Acreage	Total Yield (kg)	Yield/Area (kg/m^2)
Sweet Corn	1,915	10,444,400	1.35
Green Peas	4,432	8,461,100	0.5

Pierce County

Meat Production		Annual Milk Production	
Beef	- 218,400 kg	Number of Dairies	- 11
Pork	- 67,500 kg	Number of Cows	- 1,850
Sheep	- 2,160 kg	Milk Produced	- 11,883,000 l/yr

Annual Crop and Vegetable Production

Product	Acreage	Total Yield (kg)	Yield/Area (kg/m^2)
Cabbage	11	130,000	2.9
Carrots	12	218,180	4.5
Cucumbers	14	7,000	0.1
Celery	10	210,000	5.0
Sweet Corn	38	155,450	1.0
Lettuce	52	409,550	2.0
Spinach	15	115,910	2.0
Potatoes	12	136,000	2.8
Rhubarb	30	136,000	1.1
Blueberries	24	65,000	0.7
Raspberries	108	245,000	0.6
Strawberries	45	123,000	0.7

Pacific County

Annual Meat Production		Annual Milk Production	
Beef	- 706,160 kg	Milk Produced	- 7,922,000 l/yr
Pork	- 1,260 kg		
Sheep	- 1,200 kg		

TABLE 2.1-9 (contd.)

Pacific County (contd.)

Annual Crop and Vegetable Production

Cranberries - 6,360,000 kg/yr
Hay - 9,545,000 kg/yr

Thurston County

Annual Meat Production

Beef - 1,820,000 kg
Pork - 9,000 kg
Sheep - 26,487 kg
Poultry - 1,302,000 kg

Annual Milk Production

Number of Cows - 7,615
Milk Produced - 36,620,000 l/yr

Annual Crop and Vegetable Production

Product	Acreage	Total Yield (kg)	Yield/Area (kg/m^2)
Sweet Corn	408	2,225,000	1.3
Silage Corn	219	4,180,000	4.7
Wheat/Barley	140	236,640	0.4
Raspberries	60	163,000	0.7
Blueberries	30	6,800	0.6

Kitsap County

The land area of Kitsap County that falls within 50 miles of WNP-3 has no commercial beef, swine, sheep or dairy herds. In and around the small town of Holly there is limited farming and gardening. There are a few beef and milk cows owned by the local residents for home use.

Jefferson County

The area of Jefferson County that falls within the 50 miles of WNP-3 is either National Forest, National Park, privately-owned forest or Department of Natural Resources-owned forest. As such, there is no meat, milk or vegetable production in this area.

Cowlitz County

The area of Cowlitz County that falls within the 50 miles of WNP-3 has no commercial beef, swine, sheep or dairy herds. The majority of the land area is in forest, owned by the major timber companies. In and around the small town of Ryderwood, there is limited farming and gardening. There are a few beef, swine, sheep, goats and milk cows kept for personal use. There are an estimated 50-75 beef and dairy animals in the area.

Mason County

The land area of Mason County that falls within 50 miles of WNP-3 has no commercial beef, swine, sheep or dairy herds. The major agricultural activity is growing Christmas trees. The few beef, swine, dairy cows or sheep grown are for personal use. Five acres of commercial raspberries yield about 9,000 kg/yr.

Wahkiakum County

Meat production totals 180,000 kg/yr and milk from 2,000 cows is about 1,320,000 kg/yr. Livestock feed production includes corn silage (480 acres totaling 8,363,000 kg) and hay (2,670 acres totalling 54,300,000 kg).

Source: References 2.1-21 through 2.1-30

TABLE 2.1-10

ANNUAL COMMERCIAL FISHERY CATCH (POUNDS) IN WATERS CONTIGUOUS TO WNP-3[a]

Fish/Shellfish	Ocean (off Grays Harbor)	Grays Harbor	Humptulips River	Lower Chehalis River	Chehalis River
Chinook Salmon	858,900	102,000	13,300	13,700	33,000
Chum Salmon	200	30,300	7,600	2,100	12,700
Pink Salmon	100,000				
Coho Salmon	1,047,700	6,200	17,300	8,100	36,000
Steelhead			7,300	2,000	2,100
Sturgeon	12,500	21,000	900	2,200	
Bottom Fish		6,700			
Shad					1,900
Crab		40,400			

[a] Source: Reference 2.1-35

TABLE 2.1-11

GAME HARVEST WITHIN 50 MILES OF WNP-3[a]

County	Pheasant	Grouse	Duck	Quail	Chukar	Geese	Bear[b]	Elk	Deer
Cowlitz	174	1,904	1,440	19	27	72	20	137	340
Grays Harbor	3,330	18,340	36,282	65	77	1,207	324	597	2,247
Jefferson	74	1,340	2,093	46	0	31	20	108	211
Kitsap	205	407	1,655	50	8	2	5	0	64
Lewis	1,676	9,722	4,857	74	143	29	76	300	1,681
Mason	1,915	10,140	9,495	145	147	32	104	97	1,457
Pacific	780	9,450	28,232	62	0	1,955	168	905	1,720
Pierce	1,908	2,356	5,847	348	156	47	21	55	419
Thurston	7,072	11,790	25,072	872	655	125	65	0	1,627
Wahkiakum	352	1,829	2,970	0	39	89	49	335	442

[a] Source: Reference 2.1-36, 37

[b] About 50% of bear harvested are used for human consumption.

Table 2.1-12

GROUNDWATER USERS WITHIN TWO MILES OF WNP-3

No.	Owner	Use[(a)]	Comments
1	Ralph O. Willis	I	
2	C. Dale Willis	D	
3	C. C. Willis	D	
4	Lester Willis	I	(Willis Bros.)
5	Arnold E. Loew	D	Formerly Burlingame
6	Buford Goeres	F	
7	Melvin Henderson	D	
8	Buford Goeres	I	
9	Buford Goeres	I	
10	Lloyd Cooley	D	Not in use
11	Miles Fuller Estate	D, F	Pipe over river to spring
12	Claude Osgood	D, F	
13	Rex Valentine	D	Serves 3 residences, March 1982
14	Winifred Osgood	D	
15	William Correa	D	Spring, leased to R. Rieland
16	Supply System	D	Potable/Construction water, March 1982
17	Kermit Dewall	D	
18	Michael Brogan	D	
19	Larry Zepp	D	Wate Quality Station
20	Buford Goeres	I	
21	Ralf O. Willis	D, F	
22	C. Dale Willis	I	
23	C. C. Willis	I	
24	Howard Willis	D	
25	Normand Willis	D	
26	Lester Willis		Not in use, March 1982
27	Lester Willis	D	
28	William R. Roberts	D	
29	Buford Seares	D	
30	Ken Widner	D	Spring
31	Lee Ortquist	D	Spring
32	Lee Ortquist	D	Not in use, March 1982
33	Supply System	D	Standby source
34	Dennis Hery Ford	D	
35	Eric A. House		Old, not used
36	Elmer Haas	D, F	
37	Elmer Haas	I	
38	E. E. Pettit	D	
39	R. Gailouen	D	
40	S. Pettit	D	
41	George Schultz	D	
42	Randy Smith	D	
43	Douglas Taylor	D	
44	Earl Wilder	D	
45	Buford Goeres	D	

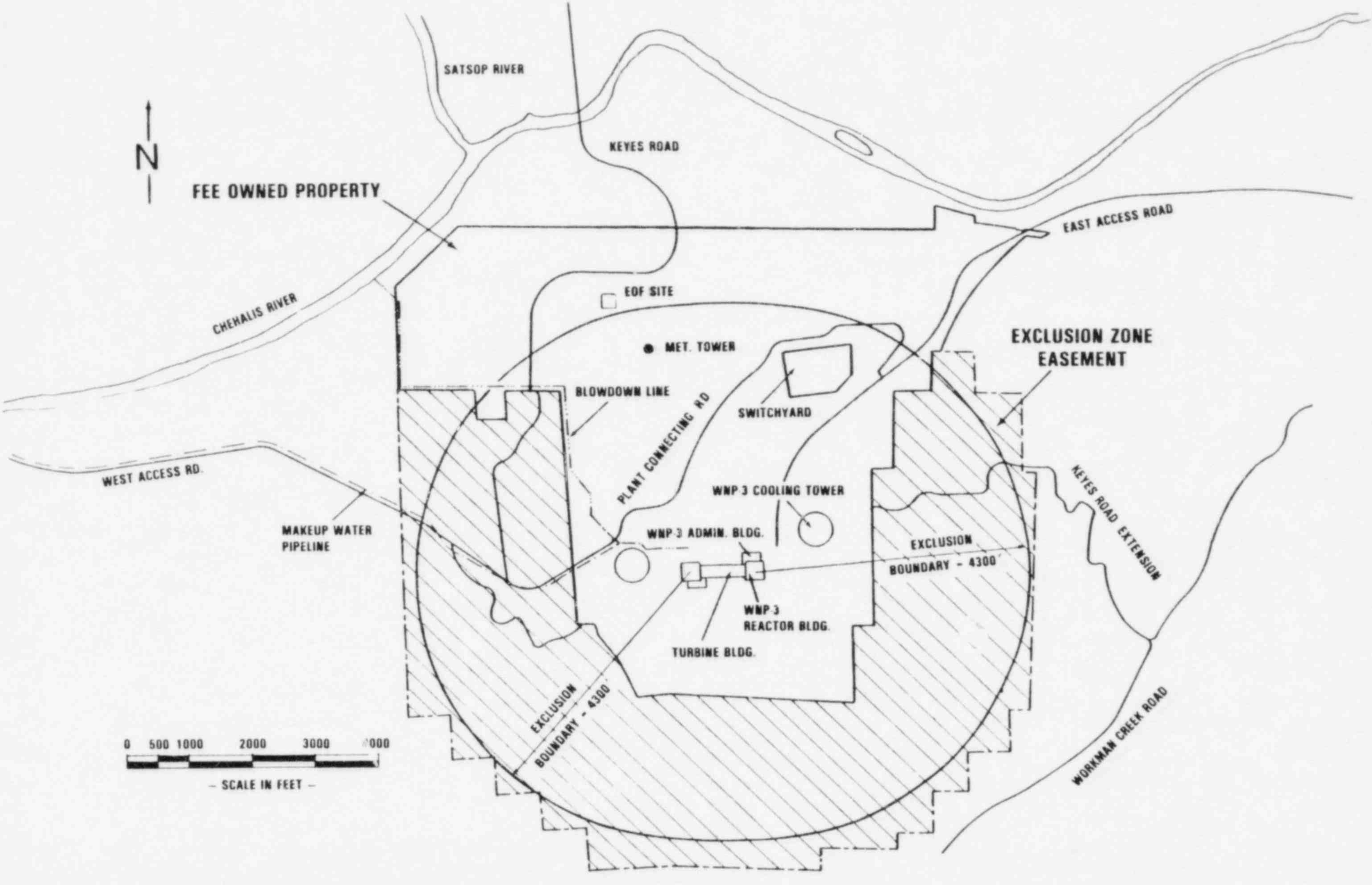
[(a)] (D) Domestic, (I) Crop Irrigation, (F) Other/Farm

Table 2.1-13

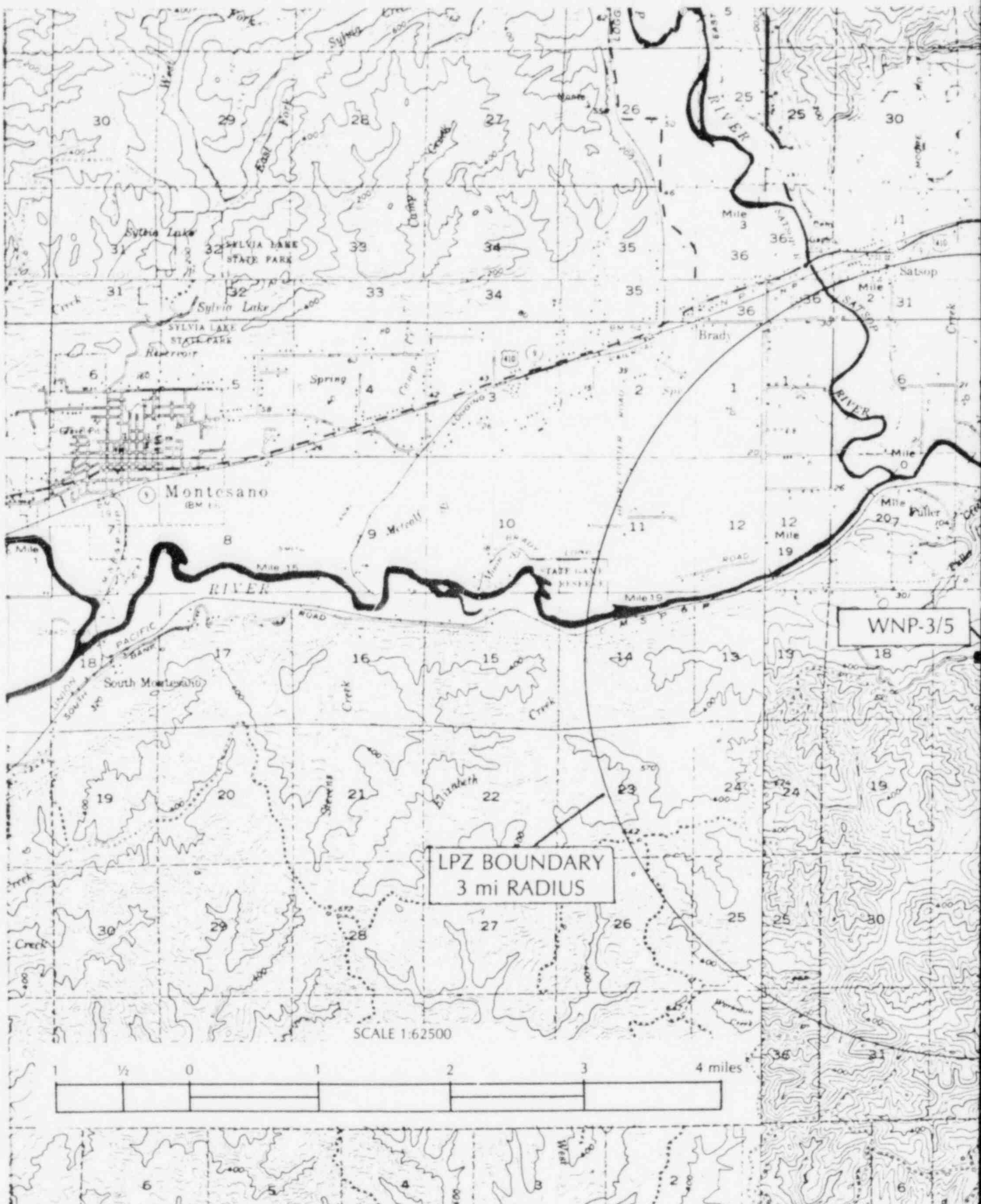
MAJOR MUNICIPAL WATER SUPPLY SYSTEMS WITHIN 20 MILES OF WNP-3

System Service Area	Distance/Direction from WNP-3	Water Source	Approximate Population Served	Safe Yield of Source (gpm)	Storage Facilities	Remarks
Elma	4 mi NE	3 Drilled Wells	2,700	2,000	500,000	
Montesano	6 mi W	2 Drilled Wells Sylvia Crk	3,200	2,200	1,500,000	
McCleary	11 mi NE	3 Drilled Wells	1,400	1,800	150,000	
Central Park	11 mi W	3 Drilled Wells	2,000	750	100,000	
Oakville	14 mi SE	Drilled Well	550	300	150,000	Roundtree Crk is Standby
Cosmopolis	15 mi W	City of Aberdeen	1,600	--	3,000	
Aberdeen	16 mi W	Wishkah R	22,000	5,000	25,000,000	Industrial Supply from Wynoochee R.
Hoquiam	20 mi W	Davis Crk Little Hoquiam R.	11,300	3,500	10,200,000	Little Hoquiam R. is standby

Source: Taken from Reference 2.1-40



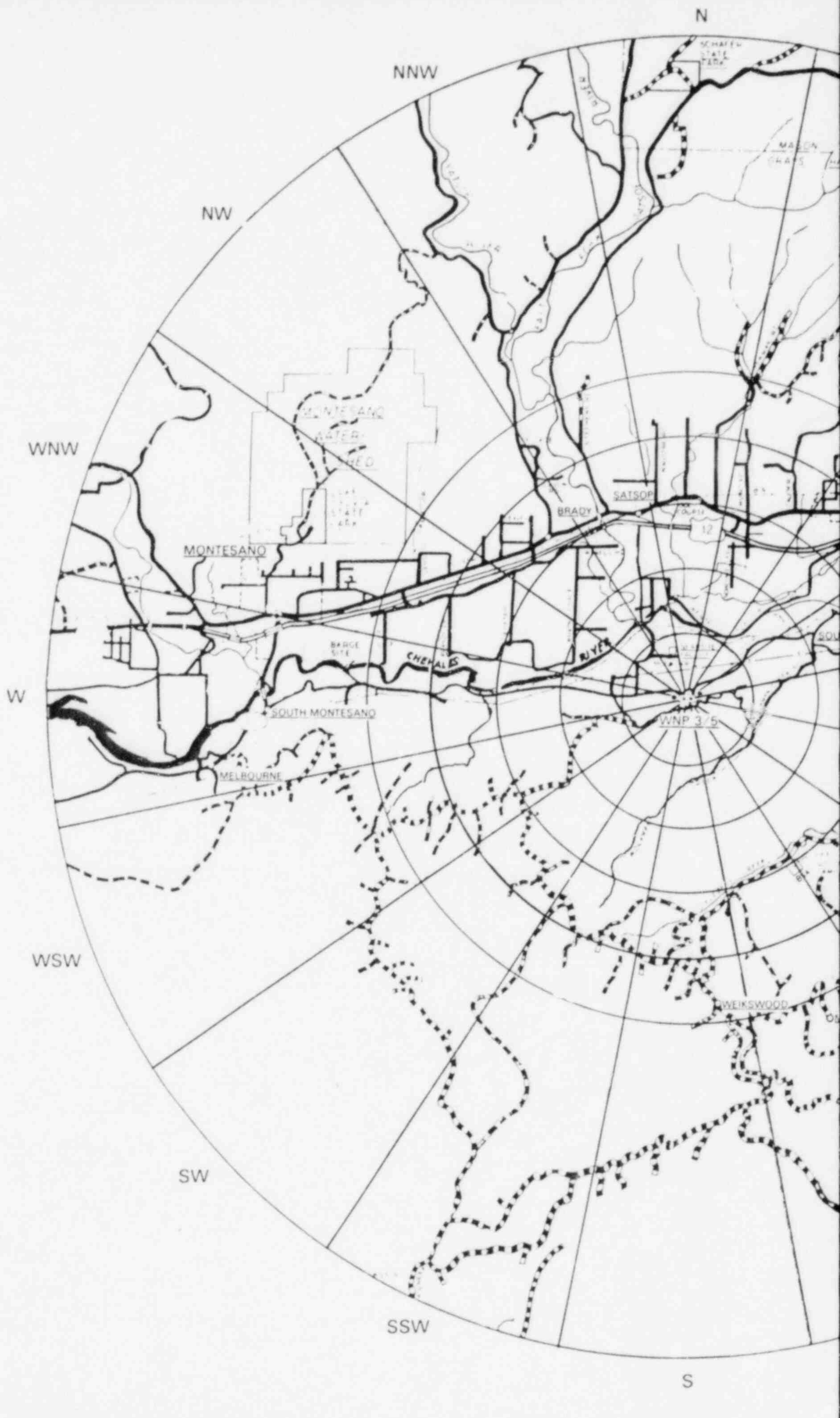
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	SITE FEATURES	FIGURE 2.1-1


WNP-3/5
LPZ BOUNDARY
3 mi RADIUS
SCALE 1:62500
1 ½ 0 1 2 3 4 miles
Montesano
South Montesano
Satsop
Brady
Sylvia Lake
SYLVIA LAKE STATE PARK
RIVER
SATSOP
Mile 3
Mile 2
Mile 0
Mile 15
Mile 19

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
WNP-3 ER-OL

LOCAL TOPOGRAPHY

FIGURE 2.1-2



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MONTESANO
SATSOP
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BARGE SITE
CHEHALIS
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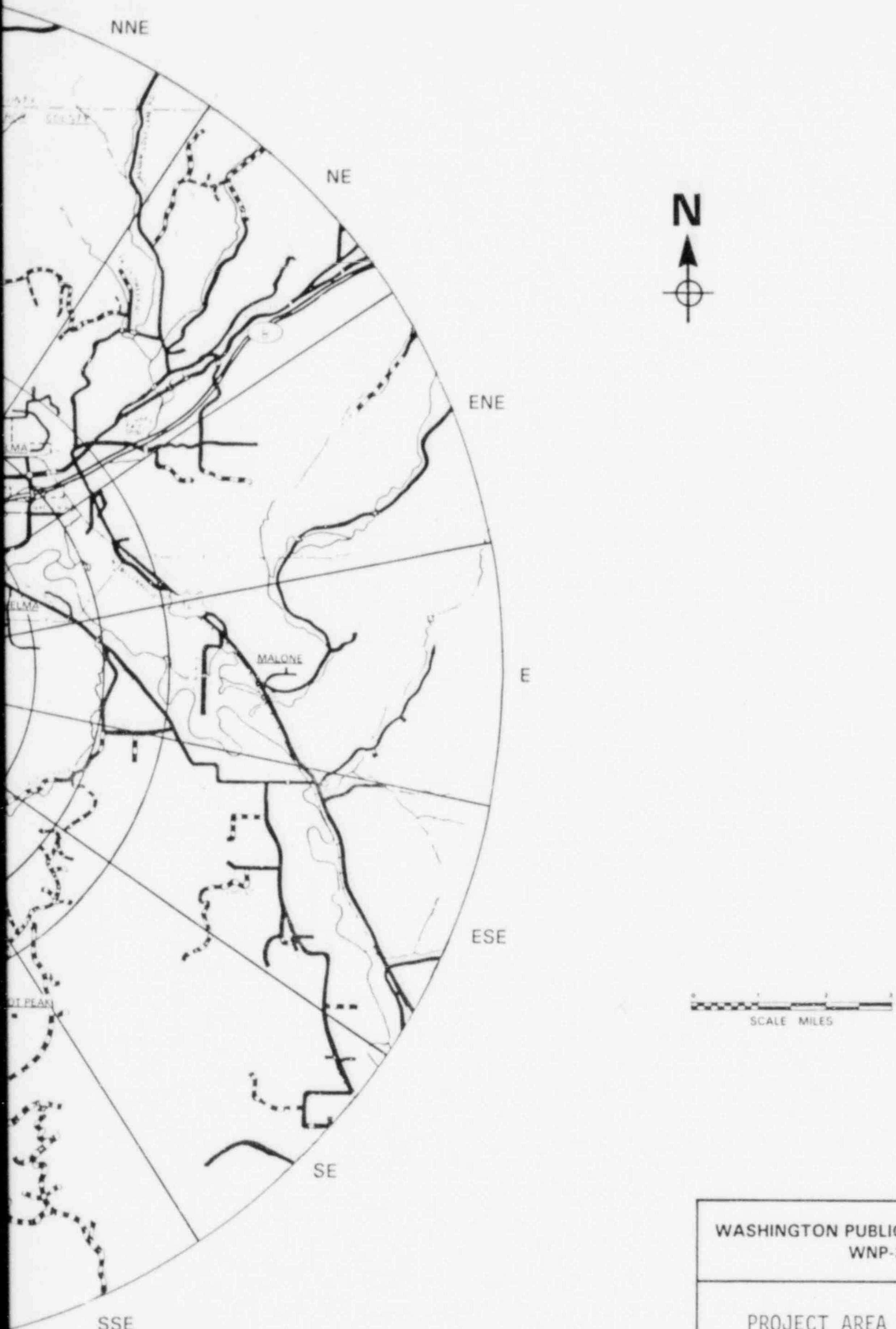
SOUTH MONTESANO
MELBOURNE
WNP 3/5
WEIKSWOOD

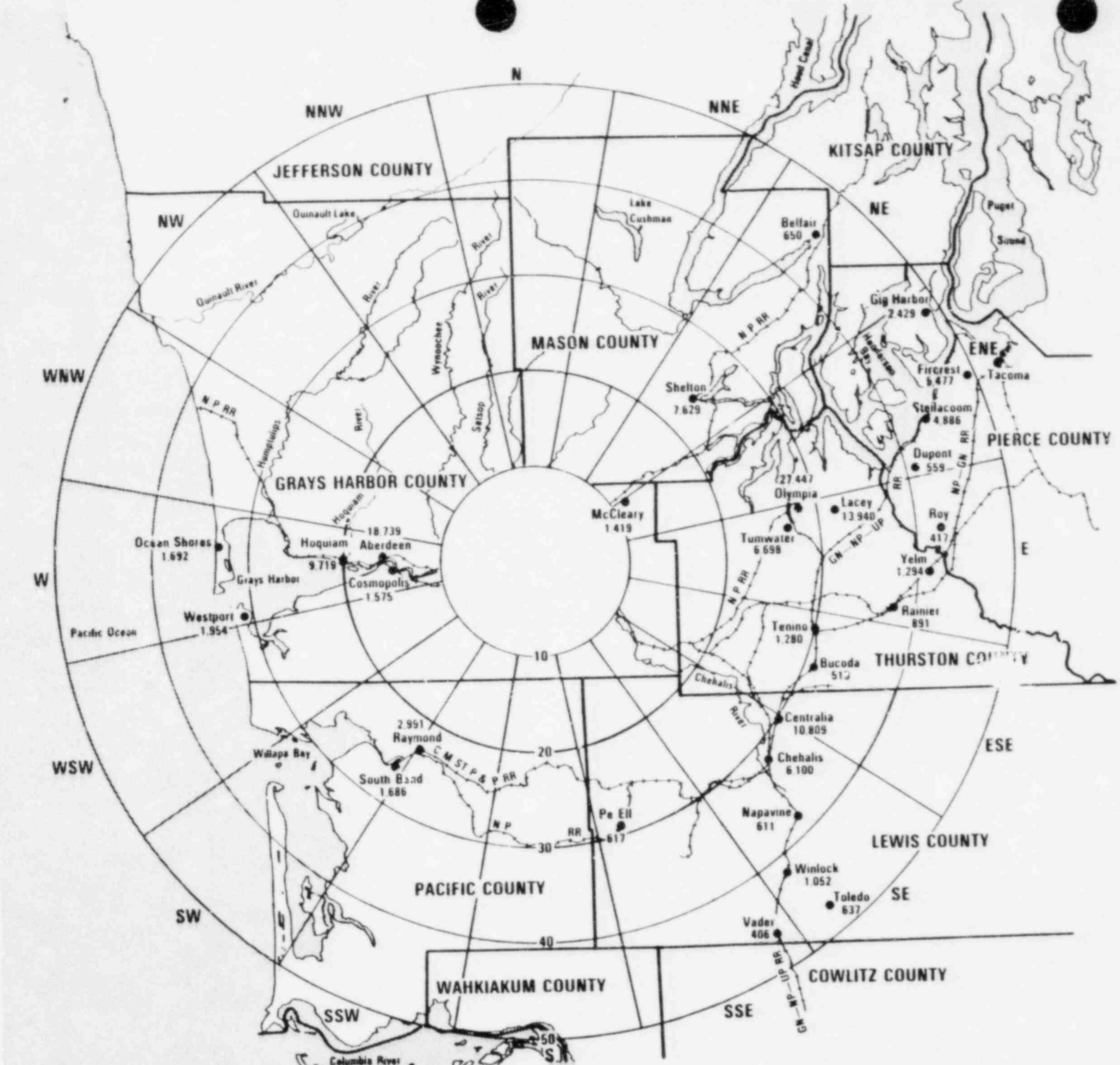


WASHINGTON PUBLIC POWER SUPPLY SYSTEM
WNP-3 ER-OL

PROJECT AREA MAP, 0-10 MILES

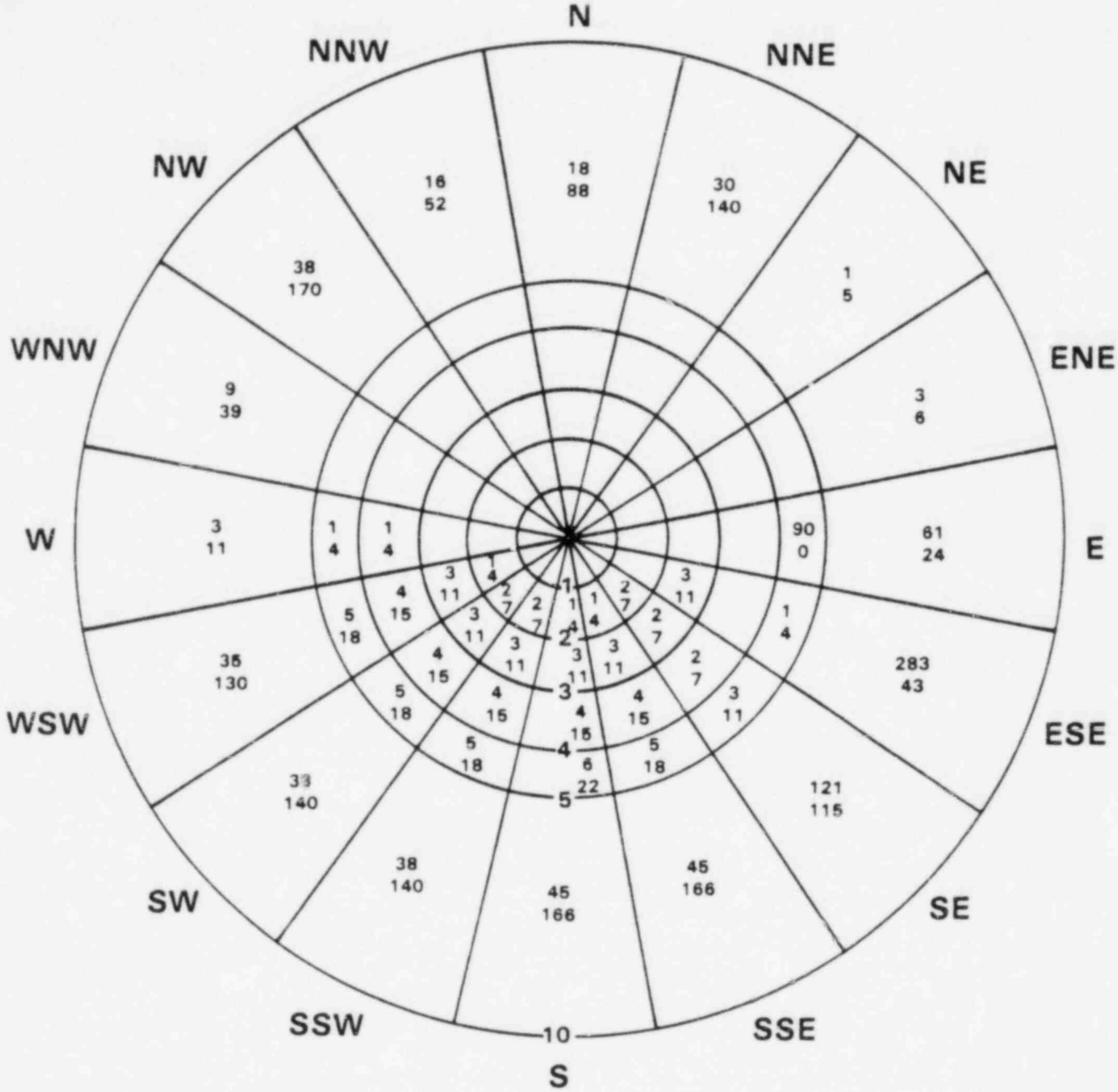
FIGURE 2.1-3

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT No. 3
OPERATING LICENSE
ENVIRONMENTAL REPORT



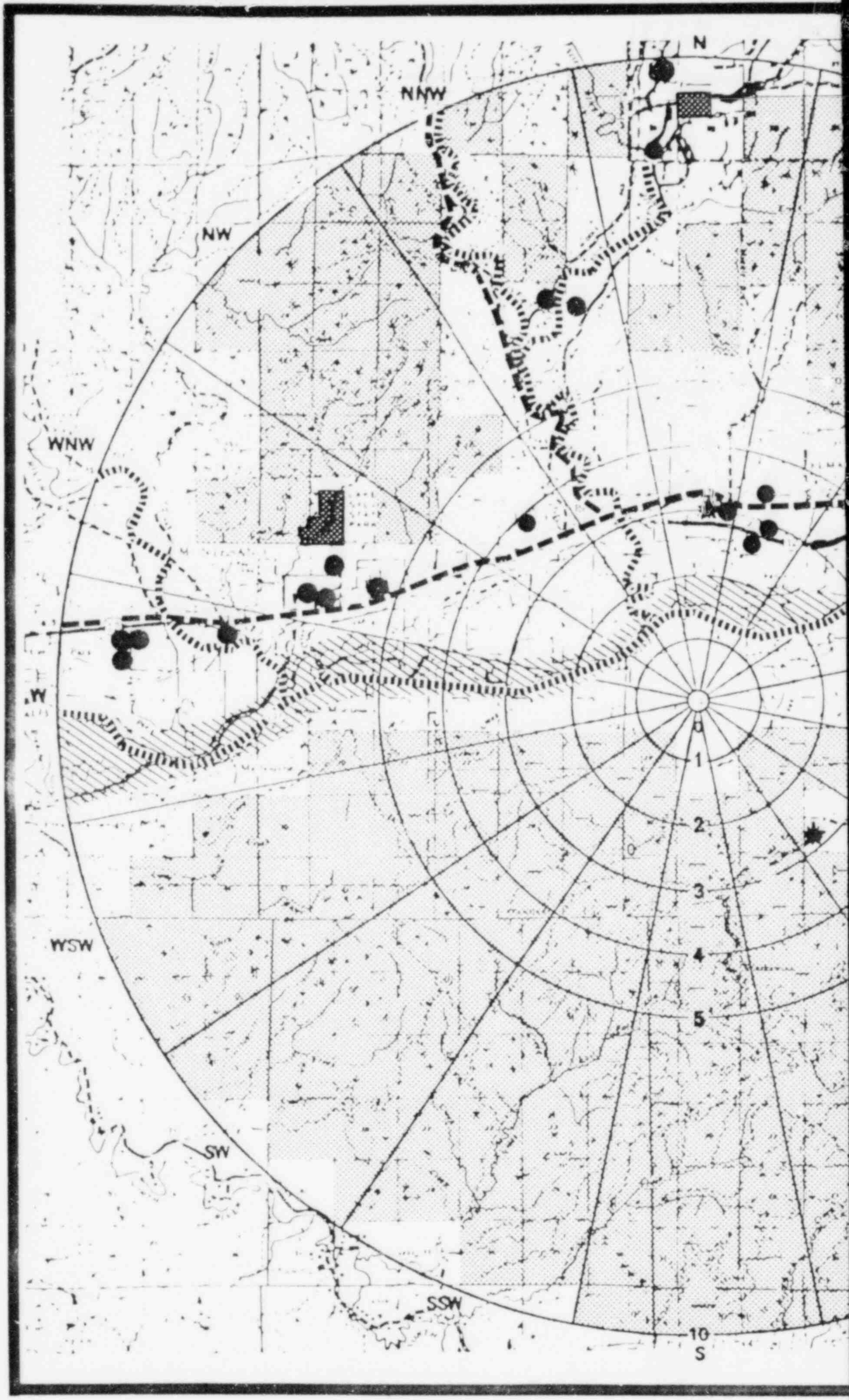
PROJECT AREA MAP, 10-50 MILES

FIGURE 2.1-4



LEGEND:
16-BIRD HUNTERS
52-BIG GAME HUNTERS

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	PEAK HUNTING ACTIVITY IN THE VICINITY OF WNP-3	FIGURE 2.1-5



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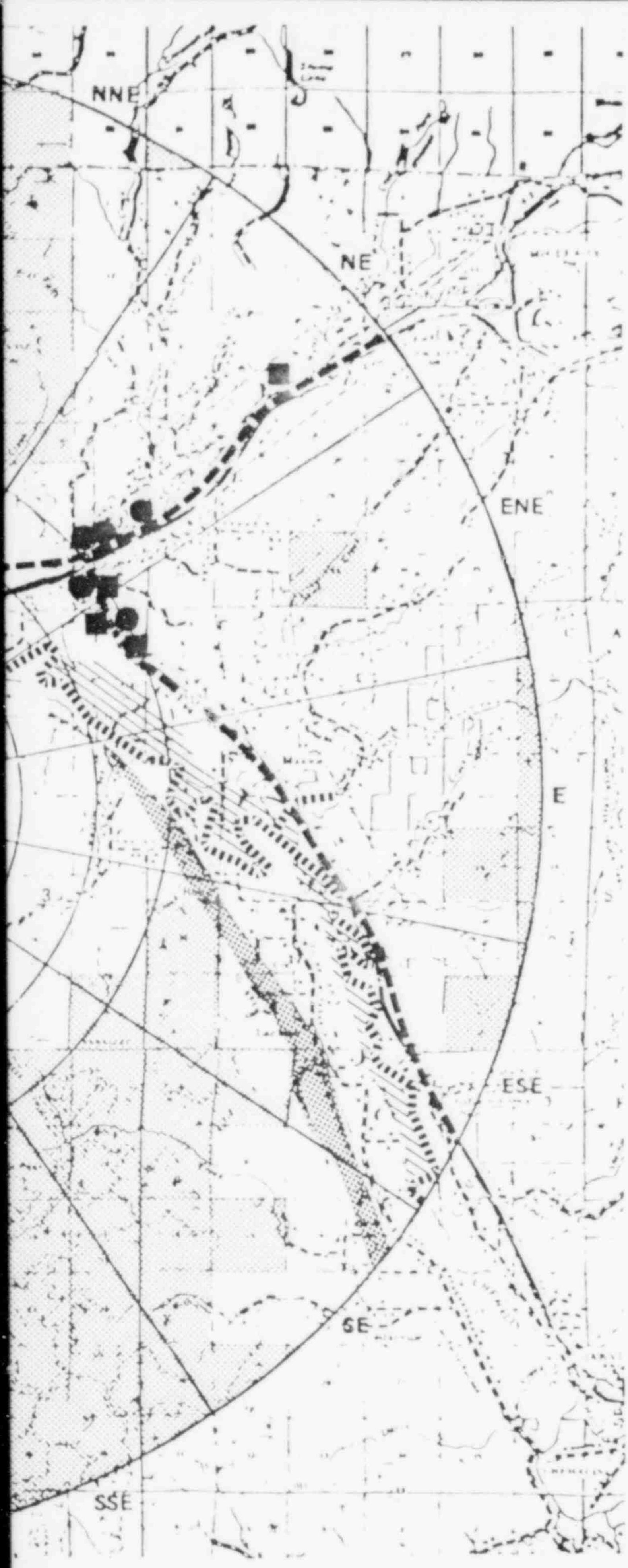


N

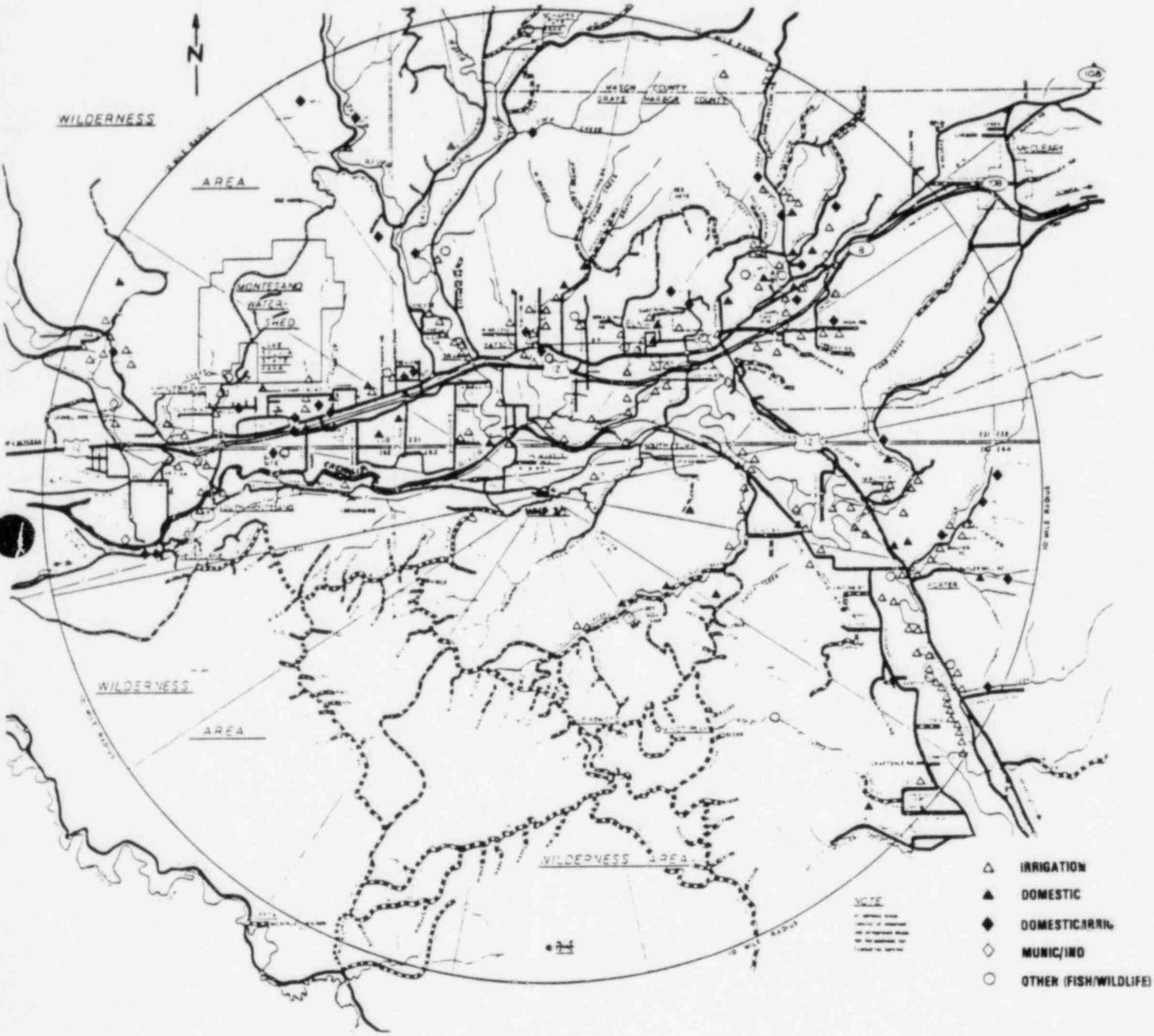
LEGEND

- Water Fowl Hunting Areas
- Fishing Areas
- Pheasant Hunting Areas
- Game Management Area Boundaries
- Commercial Timber Areas & Big Game Hunting Areas
- Parks
- Work Places
- RV/Mobile Home Parks
- Recreation Areas

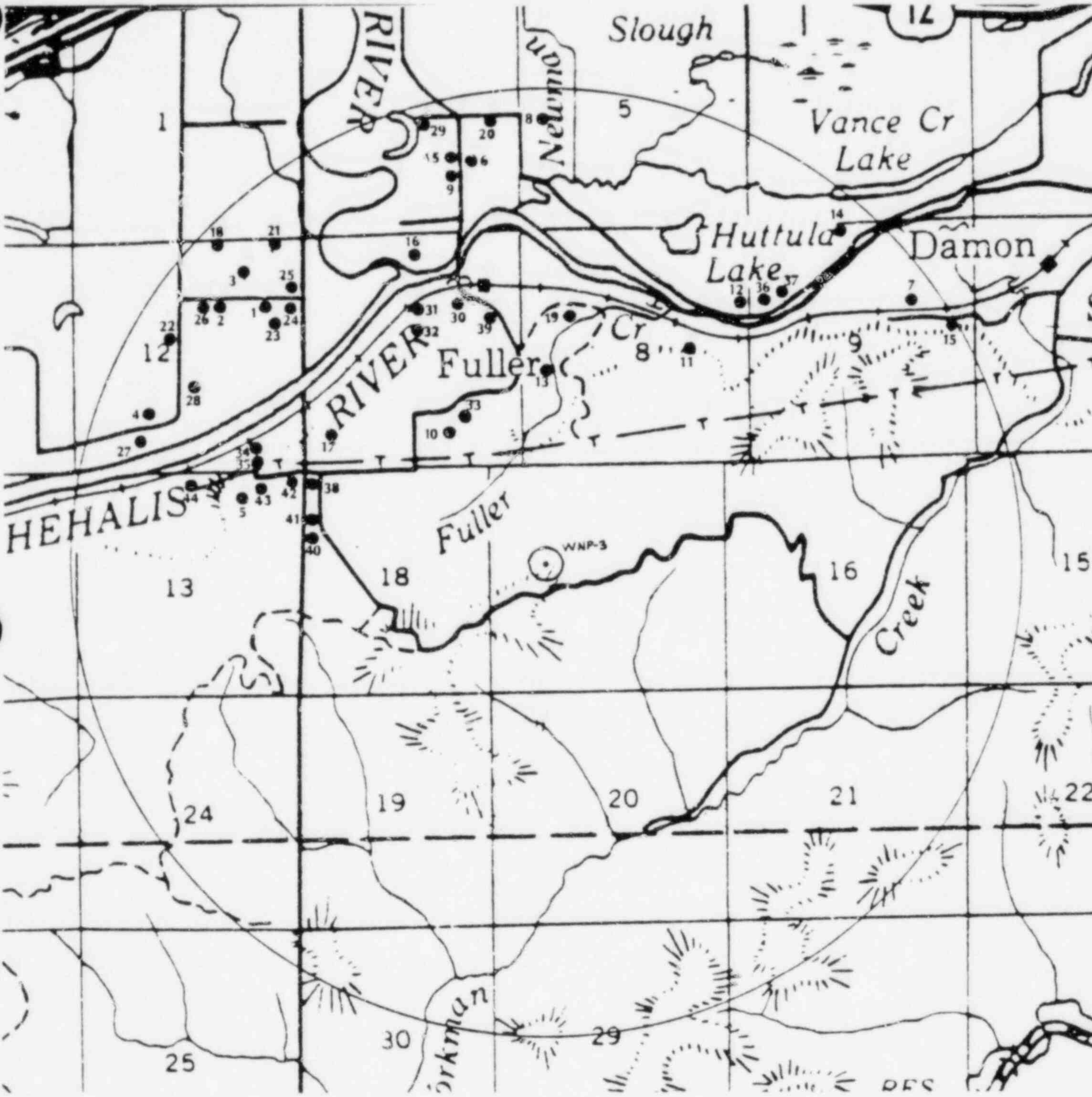
WASHINGTON PUBLIC POWER SUPPLY SYSTEM
WNP-3 ER-OL

TRANSIENT POPULATION GENERATORS, 0-10 MILES

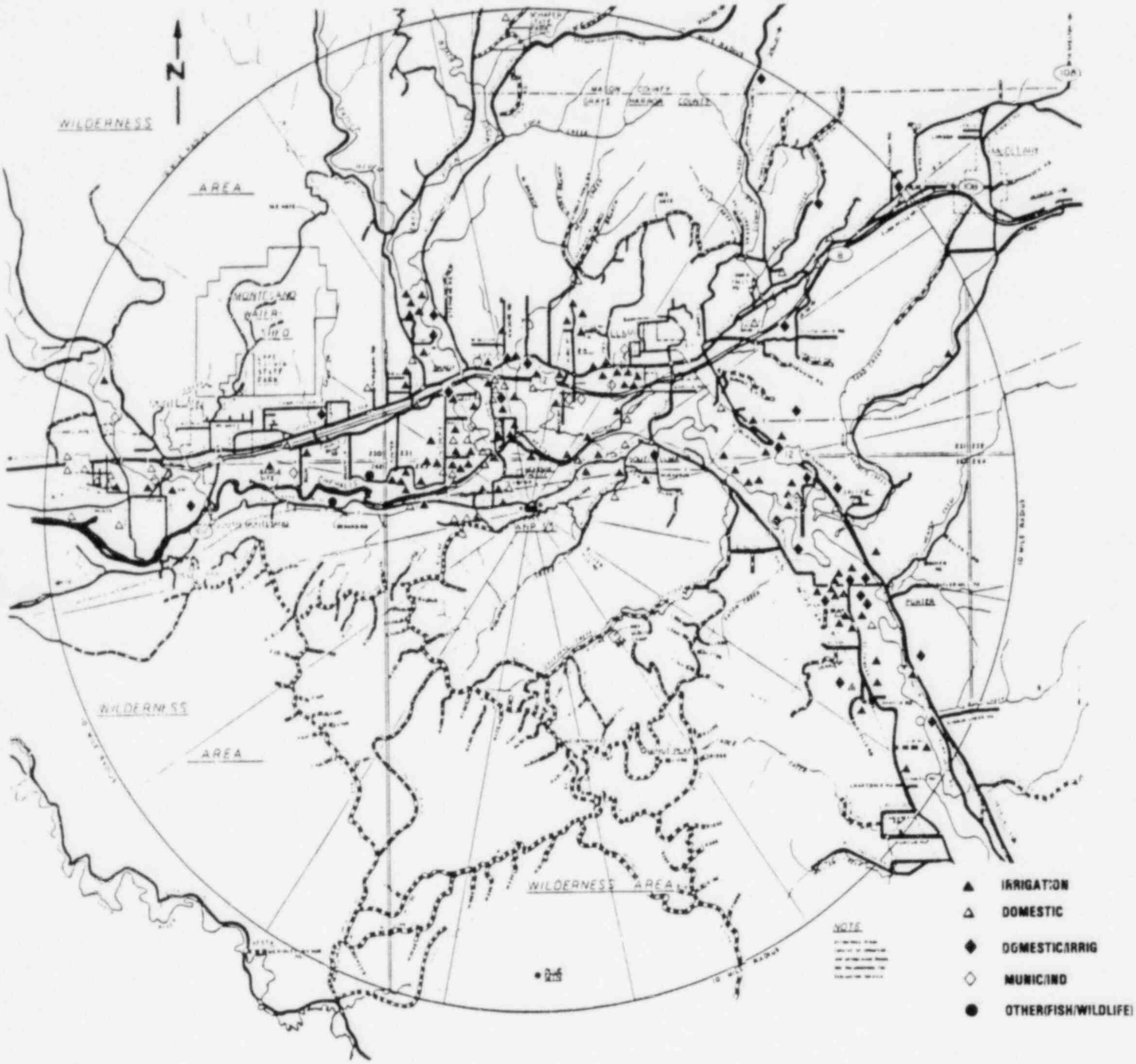
FIGURE 2.1-6



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	SURFACE WATER USERS, 0-10 MILES	FIGURE 2.1-7



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	GROUNDWATER USERS WITHIN 2 MILES	FIGURE 2.1-8



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	GROUNDWATER USERS, 0-10 MILES	FIGURE 2.1-9

2.2 ECOLOGY

2.2.1 Terrestrial Ecology

General descriptions and data collected before 1975 on flora and fauna found in the vicinity of WNP-3 are described in Section 2.7 of the Environmental Report-Construction Permit Stage.[1] The following discussions of the terrestrial ecology focuses on data collected from 1975 through 1980.

2.2.1.1 Vegetation

The vegetation communities surrounding the site can be divided into three topographic areas: upland areas, river terraces, and riparian areas along the Chehalis River and creek bottoms. In general, the site area is forested with some pasture and agriculture usage along the river (Figure 2.2-1). The upper creek bottoms and terraces are populated by stands of second growth hardwood dominated by red alder (Alnus rubra). Mixed stands of hardwoods and conifers are found on the river terraces. On the steep upper slopes, Douglas fir (Pseudotsuga menziesii) is the dominant timber. Above the 300-foot contour, nearly pure stands of conifers have developed. Bigleaf maple (Acer macrophyllum), vine maple (Acer circinatum), willow (Salix sp.), black cottonwood (Populas trichocarpa), cascara (Rhamnus purshiana), western hemlock (Tsuga heterophylla) and western red cedar (Thuja plicata) are the common species in the area. Forests in this area are generally managed so that they maintain the earlier stages of succession, because red alder is used for pulpwood and the Douglas fir for saw timber. The WNP-3 site is approximately 800 acres and in the past supported good coniferous vegetation. However, most of the vegetation on the site was harvested once before and represented second growth.

Table 2.2-1 presents a representative list of 219 plant species identified near the site, representing 165 genera and 65 families. The understories in forested areas are dominated by a dense growth of shrubs, herbaceous species, ferns and bryophytes. The principal shrub is salal (Gaultheria shallon). This straggling plant forms dense tangles in many areas. Red huckleberry (Vaccinium parvifolium), oregon grape (Berberis nervosa), and deciduous cascara are also common.

The approach of the Terrestrial Ecology programs in 1978 through 1980 was to use intensive sampling within four small watersheds as a basis for evaluating potential impacts. The watersheds were selected to be representative of the two major habitat types surrounding the site (i.e., maturing second-growth coniferous forests and recent clearcuts). They were selected in matched pairs so that areas adjacent to the plant site could be compared with areas outside the influence of the plant. Two forested watersheds (called treatment and control) near WNP-3 were sampled in 1978 (Figure 2.2-2).[1] The dominant species were similar in both forested areas. Sword fern (Polystichum munitum) covered 32 and 17 percent of the treatment and control forest plots, respectively. Salal was second to sword fern in cover dominance, with values of about 10 percent in both forests. Deer fern (Blechnum spicant) was third in dominance at over 6 percent in the treatment forest, but covered less than 1 percent in the control forest. Foamflower (Tiarella trifoliata) had a mean coverage of 5 percent in both forests, ranking third in dominance in the control forest and fourth in the treatment forest. Both salal and foamflower were widely distributed in the forested watersheds. Although low in coverage, Pacific brome grass (Bromus pacificus) and immature grass plants were well-distributed only in the control forest. Seedlings of western red-cedar and western hemlock yielded low coverage and frequency values in both forests, but only the control forest contained seedlings of Douglas fir.

Two clearcut watersheds (called treatment and control) near WNP-3 were sampled 1978-1980 (Figure 2.2-2).[2,3,4] The treatment and control clearcut watersheds were similar in plant species coverage and frequency in 1978 through 1980. In 1980, 39 and 41 vascular plant species were found in the mini-plots in each of the control and treatment clearcuts, respectively. Approximately 75 percent of the plants were common to both watersheds. Pacific blackberry (Rubus ursinus) was the dominant cover species, with coverage of 40.7 and 28.3 percent in the treatment and control clearcuts, respectively. Other species with relatively high cover values in both watersheds were bracken fern (Pteridium aquiliaum) and common velvet-grass (Holcus anatus). In the treatment clearcut, 13 species had cover values exceeding 2 percent. Predominant among these species were thimbleberry (Rubus parviflorus), Oregon grape, pearly-everlasting (Anaphalis margaritacea), and Douglas fir seedlings. In the control clearcut, 12 species had cover values exceeding 2 percent; predominant among these were hairy cat's-ear (Hypochaeris radicata), fireweed (Epilobium augustifolium), and seedlings of Douglas fir, vine maple and bitter cherry (Prunus emarginata).

In summary, vegetation near the site can be described as follows: (1) within the study site vegetation is highly diverse and is no longer representative of the former climax vegetation of the Western Hemlock Zone; (2) much of the vegetation diversity can be attributed to timber and agricultural practices; (3) the dominant vegetation in the lower elevation and moist areas is red alder and on the upper steep slopes Douglas fir is the dominant species; (4) the forest land produces high-quality timber; (5) forest management techniques (e.g., natural and artificial seeding, thinning, fertilization, etc.) are used to maintain vegetation in a state of intermediate forest succession so yields of the commercially valuable Douglas fir can be sustained; and (6) the early successional stages on the upper terraces and along the creeks result in an interspersion of cover types ideal for many wildlife species.

2.2.1.2 Wildlife

Visual observations and consultations with State game biologists indicate that the characteristic wildlife species of the region are well represented in the vicinity of the site. Forest management and agricultural practices often keep areas in early stages of succession, which is conducive to many desirable species of wildlife. The open hardwoods are important feeding areas for wildlife. The conifer areas provide cover and protection from severe weather conditions. Generally, most game animals thrive in areas of new growth which follow logging activity. Extensive pure stands of conifers are less desirable for wildlife production than mixed wood or hardwood forests.

Mammals

Forty-nine species of mammals representing 7 families and 17 orders are known to occur in the Satsop area (Table 2.2-2). Twelve species have been identified by sightings or other signs of activity, while an additional 37 species have not been observed but their range is thought to include the site environs.

The black-tailed deer (Odocoileus hemionus columbianus) is one of the most significant species in the area, both from an economic and a recreational viewpoint. Studies performed near the site in the 1950s indicate populations of 26 to 48 blacktail deer per square mile.(5) Recent estimates for the Wynooche-Satsop Game Management Unit project the population at about 21 per square mile.(6) Estimates in 1980 for two Washington Game Department Management units near WNP-3 ranged from 12 to 15 deer per square mile.(6)

Pellet-group counting was used to estimate deer population densities on forested and clearcut watersheds in the vicinity of WNP-3 (see Figure 2.2-2). Studies were performed during the spring and fall in 1978 through 1980 and densities ranged from 0 to 9 deer per square mile.(4) The control clearcut watershed had the highest deer densities each year. Deer use of both clearcuts in the fall has tended to increase each year from 1978, while deer use of the clearcuts in the spring has been relatively stable. Deer densities in the forested watersheds were low for both spring and fall 1978 through 1980. Deer populations are expected to continue to increase in both clearcuts during the initial years of plant succession and to remain low in the two forested watersheds. This relationship exists because second-growth forests (i.e., the forested watersheds) characteristically have low deer forage production while forage production in clearcuts typically increases during the early years of plant succession.(5)

The elk (Cervus canadensis) density for the Satsop area in 1980 was estimated at 2.4 individuals per square mile.[6] However, no elk pellets were found in 1978 through 1980 in the watersheds studied near the WNP-3 site.

Another important big game animal in Washington is the black bear (Ursus americanus). Black bear have been infrequently sighted near the site. The density for the Satsop game management unit in 1980 was estimated at 0.88 bear per square mile.[6] This is close to the one bear per square mile of available black bear habitat projected for the entire state by Poelker and Hartwell in 1973.[7]

Other terrestrial and aquatic mammals that occur near the site, but for which there is little specific information, are Mountain beaver (Aplodontia rufa), beaver (Castor canadensis), muskrat (Ondatra zibethica), raccoon (Procyon lotor), striped skunk (Mephitis mephitis), coyote (Canus latrans), long-tailed weasel (Mustela frenata) and red fox (Vulpes fulva).[1]

Small mammals (mice and shrews) were counted during 1978 using live-trapping and multiple mark-and-recapture methods.[2] A grid of 169 trap stations was established in each of four watersheds (Figure 2.2-2). Baited Sherman live traps were checked daily for four consecutive days. The mark-and-recapture method provided relative abundance and density estimates for deer mice (Peromyscus maniculatus), Pacific jumping mice (Zapus trinotatus), shrews (Sorex spp), Townsend's chipmunk (Eutamias townsendii), northern flying squirrel (Glaucomys sabrinus) and short-tailed weasel (Mustela erminea) (Table 2.2-3).

Amphibians and Reptiles

Amphibians and reptiles observed and known to occur in Grays Harbor County are listed in Table 2.2-4. The most abundant amphibians observed near the site are the Pacific Northwest newt (Tarica granulosa) and the Western wood frog (Rana aurora). Only one species of reptile, the dusky garter snake (Thamnophis elegans), was observed near WNP-3.

Birds

Birds are ecologically and aesthetically important components of the ecosystem surrounding WNP-3. A list of the species found near WNP-3 and the habitat in which they are found is presented in previous documents.[1,8,9] Bird studies performed in 1978 through 1980[2,3,4] near WNP-3 include: 1) breeding and winter surveys of watersheds and roadsides close to the site, 2) ruffed (Bonasa umbellas) and blue (Dendragapus obscurus) grouse surveys during the breeding season in forested and clear-cut watersheds, and 3) aquatic bird surveys of the Chehalis River.

Overall, 124 bird species were encountered in the study area during 1979-80 compared to 111 in 1978-79.[4] Results of the 1978-79 and 1979-80 surveys were quite similar. One hundred species were recorded in common for both survey periods. An additional 24 new species were encountered in 1979-80. Generally, all species occurred in low abundance.

Forty-six bird species were identified in the treatment watersheds (Figure 2.2-2) during the 1980 breeding season. This compares to 47 and 44 species encountered in 1978 and 1979, respectively. The number of species observed in the treatment and control forests were similar 1978-1980. Twenty-eight species in the control forest and 25 in the treatment forest were identified as breeders or visitors to the watersheds. The winter wren (Troglodytes troglodytes) was the most abundant species in both watersheds, while the golden-crowned kinglet, (Regulus satrapa), chestnut-backed chickadee (Parus rufescens), Wilson's warbler (Wilsonia pusilla), and western flycatcher (Empidonax difficilis) were common.

The control clearcut had more species than the treatment clearcut. Twenty-five species were observed in the control clearcut and 18 in the treatment clearcut. During 1978 and 1979, the species diversity was similar between the two clearcuts. The white-crowned sparrow (Zonotrichia leucophrys) and dark-eyed junco (Junco hyemalis) were the predominant species observed in both watersheds 1978-1980. During these three years, the American goldfinch (Carduelis tristis), song sparrow (Melospiza melodia), and rufous-sided towhee (Pipilo erythrophthalmus) were also common in the clearcut areas. The total density of birds in breeding territories was substantially higher in both clearcuts in 1980 than reported in previous years.

Winter bird surveys of the four watersheds were also conducted during 1978-79 and 1979-1980. During both surveys, species diversity and relative abundance of birds were greatest in the forest watersheds. These values were particularly high in the control forest. The golden-crowned kinglet and winter wren were consistently the most abundant species observed in the forested watersheds. In the clearcut watersheds, species diversity and relative abundance were generally highest in the treatment watershed during both survey periods. In the two clearcuts, the darkeyed junco was the predominant species recorded during the 1979-1980 surveys, while the golden-crowned sparrow (Zonotrichia atricapilla) was the predominant species in the 1978-1979 winter survey.

The results of the 1979 and 1980 roadside breeding bird surveys were similar. Eighty-eight species were observed in 1979 and 1980. Of these, 74 species were recorded in both years. While the species' richness was comparable between years, the mean number (478) of birds recorded during the 1978 surveys was 15 percent below that recorded in 1979.

The American robin (*Turdus migratorius*) and song sparrow were the most abundant and most frequently observed species. Other species abundantly present during both survey periods were the common crow, (*Corvus brachyrhynchos*), Swainson's thrush (*Catharus ustulatus*), savannah sparrow (*Passerculus sandwichensis*), and American goldfinch.

The principal forest game birds are ruffed and blue grouse. A minimum of five grouse surveys were performed during the spring of 1979 and 1980 at 15 roadside stations near the plant site (i.e., treatment route) and at 15 stations outside the influence of the plant (i.e., control route) (Figure 2.2-3).

The mean densities for the adult male ruffed grouse along treatment and control survey routes were similar in 1979 (2.2 vs 2.0).[2] However, in 1980 the control route had densities four times greater than the treatment route (2.8 vs 0.7).[3] The Washington Game Department reports ruffed grouse densities for Western Washington of 22, 13 and 23 acres per bird in 1977, 1978 and 1979, respectively.[10] The results of studies performed near WNP-3 appear to be in agreement with these estimates.

Adult blue grouse were also more abundant along the control route than the treatment route in both 1979 and 1980. The control route yielded means of 3.8 and 4.7 while the treatment means were 1.0 and 0.7 for 1979 and 1980 respectively.[2,3] The differences between control and treatment routes are probably due in part to higher noise levels near WNP-3 and to reduced coniferous habitat along the treatment route.

Previous studies[1] describe the birds using the aquatic habitat near WNP-3 and important migratory waterfowl common to the area. An update of this information is provided by aquatic bird surveys of the Chehalis River performed monthly, November 1978 through December 1980.[2,3]

During these surveys the green-winged teal (*Anas carolinensis*), American widgeon (*Mareca americana*), mallard (*Anas platyrhynohos*), scaup species (*Aythya* spp.) and the common (*Mergus merganser*) and hooded mergansers (*Lophodytes cucullatus*) were the most numerous waterfowl. The most commonly observed nonwaterfowl were the Killdeer (*Charadrius vociferus*), great blue heron (*Ardea herodias*), gulls (*Larus* spp.), double-crested cormorant (*Phalacrocorax auritus*), belted kingfisher (*Megaceryle alcyon*), spotted sandpiper (*Actitis maculaira*) and green heron (*Butorides virescens*).

Many avian predators are common to the site and the surrounding area. Hawks and falcons, which hunt during the day, are represented by at least ten species. The red-tailed hawk (*Buteo jamaicensis*) and sparrow hawk (*Falco sparverius*) are most commonly seen. The bald eagle (*Haliaeetus leucocephalus*), marsh hawk (*Circus cuaneus*), and osprey (*Pandion* haliaetus) have also been observed. Seven species of owl, which are nocturnal predators, are known to occur in the area. These generally nest in trees, wooded and bushy areas, or man-made structures. The largest of the owls is the Northwestern horned owl (Bubo virginianus lagophomis).

2.2.1.3 Threatened and Endangered Species

Two federally listed threatened or endangered animal species may occur near WNP-3, the bald eagle and peregrine falcon (Falco peregrinus).[11] Bald eagles were observed along the Chehalis River during the 1978-1980 aquatic bird surveys.[2,3,4] In 1979-1980 a single bald eagle was observed in November, March through May, July, August and October.[4] No active eagle nests were seen along the river in the three survey years. Peregrine falcon were not observed during bird surveys performed near the site 1978-1980.[2,3,4] The construction and operation of WNP-3 is not expected to result in the damage or loss of individuals of any species presently regarded as threatened or endangered.

2.2.2 Aquatic Ecology

The physical and chemical characteristics of the Chehalis River in the vicinity of WNP-3 are presented in Section 2.4. Studies concerned with various aquatic organisms in the Chehalis River, relating mainly to construction and preoperational phases of WNP-3, were conducted in 1976 through 1980.[2,3,4,12-17] Sampling locations for the 1980 program are shown in Figure 2.2-4. The following paragraphs summarize the essential characteristics of the major aquatic communities.

2.2.2.1 Phytoplankton and Macrophytes

Phytoplankton studies were performed July through October 1973.[1] Samples were examined to determine species composition and relative abundance. Nineteen diatom genera were identified. Sampling in the Chehalis River at Fuller Bridge showed a predominance of Navicula, Nitzschia, Cocconeis, and Melosira.

Qualitative surveys of macrophytes in the Chehalis River were performed April through September 1976 at three sampling areas.[12] During spring and early summer, macrophyte growth was sparse; most species appeared only during July through October. Twelve species were widely dispersed and occured in relatively small groups in the river. Potamogeton spp., Elodea canadensis and Fontinalis antipyretica were the predominant species collected.

Many characteristics of the Chehalis River are thought to limit the productivity of aquatic macrophytes. The banks along pool sections drop abruptly off to deeper water a short distance from shore. High turbidity of the river during many months prohibits macrophyte growth in deeper waters. Bank erosion is considerable, and in many areas riparian vegetation overhangs the river, providing shade. The shade and erosion discourage the establishment of emergent and submergent aquatic vegetation. During the winter, virtually the entire river bottom is scoured due to high sediment loads and current velocities.

In the lotic environment of the Chehalis River both phytoplankton and macrophyte contributions to the food web are limited because of low production and little grazing by herbivores.

2.2.2.2 Periphyton

Periphyton, algae that attaches to substrates, was sampled from 1976 through 1980 in the Chehalis River.(2,3,4,12,13) Since the Chehalis River is moderately fast flowing, primary production is probably limited to the attached forms of diatoms, blue-green algae and green algae. In 1980, 33 algal genera (3 blue-greens, 5 greens, and 25 diatoms) were identified from artificial (i.e., glass slide) samples.(4) Diatoms and blue-green algae represented 63 and 31 percent, respectively, of all genera counted in 1980. The most abundant diatom genera collected from 1978 through 1980 were Cocconeis, Achnanthes, Cymbella, Gomphonema, Synedra and Navicula. Chamaesiphon and Lyngbya were the dominant blue-green genera in 1978-1980 samples. Biomass averages for July and September collections in 1979 and 1980 were 1.0 and 1.2 gm/m^2, respectively. Cell density from artificial substrates collected during July and September averaged approximately 14,000, 37,000 and 15,000 $cells/mm^2$ during 1978, 1979 and 1980, respectively.(4) The greater density in 1979 was due to an increase in blue-green algae.

2.2.2.3 Zooplankton

Zooplankton was sampled along the shoreline of the Chehalis River in June and July 1973.(1) Zooplankton densities were consistently low and seldom averaged more than 300 individuals per sweep net station. Canthocamptus and Cyclops were the dominant copepod genera and were consistently greater than cladocerans in all samples. Dipterans (Tendipedidae) were the most abundant noncrustacean zooplankters collected. The paucity of zooplankton in the lower Chehalis River is probably related to river velocity, natural siltation and availability of littoral habitat.

2.2.2.5 Benthic Macroinvertebrates

Chehalis River macroinvertebrates were sampled 1976-1980 using either or both natural and artificial substrates.(3,4,12,13) Generally, natural substrate samples were collected monthly, March through September. At least two stations were sampled, including the intake and discharge areas. From 1976 to 1979 artificial substrates collected twice the number of benthic taxa and a much larger number of organisms than the natural substrates. Dominant orgamisms found in the vicinity of WNP-3 include midges (Chironomidae), scuds (Gammarus sp.), true flies (Diptera), mayflies (Ephemeroptera), caddisflies (Trichoptera), stoneflies (Plecoptera) and beetles (Coleoptera). The mean densities of macroinvertebrates collected on artificial substrates (i.e., multiple plate samples) range from approximately 1000 to 3000 individuals per sample in 1977 through 1979. Densities were generally highest in the spring and lowest for the autumn exposure period. Statistical tests reveal that densities were lowest in 1976 and 1978 and highest in 1977 and 1979.(17) The low densities may be the result of floods which preceded the 1976 and 1978 sampling programs.

2.2.2.6 Chehalis River Fish

A complete list of fish species in the Chehalis River Basin and fish life history information is presented in other documents.(1-4,12,13,18) Twenty-five fish species (Table 2.2-5) were captured by electrofishing and beach seining near WNP-3 from 1977 to 1979.(2,3,13) Anadromous threespine stickleback (Gasterosteus aculeatus), redside shiner (Richardsonius balteatus), northern squawfish (Ptychocheilus oregonensis) and largescale sucker (Catostomus macrocheilus) were the four most abundant fish, comprising 59 percent of the fish collected between 1977 and 1979. Salmon (i.e., chinook, chum, coho) and trout (rainbow and cutthroat) represented approximately 10 and 3 percent of the catch, respectively.

Of the fish found in the Chehalis River study area, various species of salmonids have the highest commercial and recreational value. Because of the value of chinook and coho salmon and rainbow/steelhead trout, concern for maintaining their populations is high. In recognition of this concern, the State of Washington maintains an extensive fisheries management program for these species. Chinook, coho and steelhead trout are stocked in numerous rivers and streams throughout the state and help to maintain the Pacific Northwest recreational and commercial fishery. In addition to their significance in terms of natural resource value, these salmonid species are known to be highly sensitive to such environmental variables as water temperature and water quality.

There are marked similarities between the life histories of different anadromous salmonids in the Chehalis River (see Figure 2.2-5). The adults spend one or more years in salt water, migrate into freshwater and spawn in suitable gravel beds where waters are cool and well oxygenated. The eggs develop from fall through spring, depending on the species, and hatch from late winter to late spring. The young usually remain in the gravel until the egg sac is absorbed. Young salmonids emerge from the gravel between late winter and early summer and, again depending on the species, reside in fresh water from several days to several years before migrating to salt water. Before entering salt water, salmonids undergo a transformation called smoltification. This process is the physiological and morphological adjustment necessary to accommodate the osmotic changes produced by movement from fresh to salt water. Details of salmonid life cycles in the Chehalis River Basin are presented below together with descriptions of abundance and distribution in the study area. The following subsections focus on chinook and coho salmon and rainbow/ steelhead trout, and their life histories, distribution and abundance in the Chehalis River study area.

Chinook Salmon (Oncorhynchus tshawytscha)

Chinook salmon originate from many of the rivers that drain into the North Pacific and support an important ocean sport fishery. In addition, chinook support a commercial trolling fishery from Central California through southeastern Alaska. As they return to fresh water to spawn, chinook are often caught in estuaries and rivers by commercial gill-net fisherman, Indians, and sport anglers.[19] Of all the Pacific salmon, chinook are the most highly regarded for the fresh fish trade. Chinook are categorized into three distinct spawning runs: fall, spring and summer. The Chehalis River has fall and spring adult chinook runs.

Fall chinook mature between 3 and 5 years. Their weight at maturity averages between 15 and 20 pounds.[20] Fall chinook spend from 3 to 5 months in freshwater and from 2 to 5 years in the ocean. Adults migrate upstream from August to November. Downstream migration of young chinook takes place from January to August.

Spring chinook reach maturity at 4 to 6 years of age and weigh an average of 15 pounds (range 10 to 20 pounds). They spend about one year in freshwater before migrating to the sea, and then remain in the ocean for 2 to 5 years. Adults migrate to the spawning grounds from March to early June and spawning occurs from August to mid-October. Young spring chinook, which average 5 to 6 inches, migrate downstream the second spring (1 + age-class) after the parent spawning run.[20]

The spawning patterns of the two races of chinook are distinct. Springrun chinook usually travel to upstream areas and spend the summer in resting holes before spawning in late summer; fall-run chinook usually travel shorter distances and spawn shortly thereafter.

The population density and distribution of juvenile chinook is controlled by numerous factors including availability of food, and chinook social behavior.[21] Juvenile chinook reside in waters with velocity and depth in proportion to their body size. As they grow, they shift to faster and deeper waters. Young chinook often move downstream from tributaries and remain in large streams during winter.[22]

The distribution and abundance of chinook salmon in the study area are consistent with the knowledge of the life history of these fish as described above. Only a small number of adult chinook (37 adults) were captured from spring to fall during five years of sampling. The small number of adults sampled in the study area indicates that upstream migrants spend relatively little time in this stretch of the Chehalis during the months of sampling.

Most of the chinook captured in the study area during the monitoring programs were 0 + age-class fish. It was concluded that these fish were juvenile downstream migrants from the fall spawning run. These juvenile out-migrants have been present in the study area from April to October, with peak abundance occurring April to June. Rearing spring-run juveniles were not present in the study area in significant numbers during the monitoring programs.

Young-of-the-year Chinook salmon (age 0+) comprised 43, 48, 83 and 77 percent of all juvenile salmon captured during 1976, 1977, 1978 and 1979, respectively.[3] From 1976 through 1979 the mean fork length ranged from 47 to 59 mm, 51 to 59 mm and 67 to 73 mm for April, May and June, respectively. Mean 1979 condition factors ranged from 0.84 in March to 1.18 in August.

In summary, while the Satsop River and upstream locations on the Chehalis River are the sites of early fall spawning runs, the study area is not a spawning area for chinook. The study area is used for upstream passage of migrating adults, downstream passage of juvenile out-migrants, and some rearing of spring-run juveniles. Within the study area, young chinook appear to prefer sheltered, slow-moving waters such as are found in parts of the holding area (Figure 2.2-4). As they grow, the young chinook move to more rapidly moving water.

Coho Salmon (Oncorhynchus kisutch)

The coho is an important sport and commercial fish along the Northern Pacific coast.[23] Like the chinook, coho are anadromous, spending one to two years in fresh water and two years or more in the ocean. Coho reach maturity at three years of age; adults weigh an average of eight pounds (range from 5 to 20 pounds).

Adult coho generally migrate to fresh water from September to January. In coastal Washington, adult migration peaks in October and November. Spawning occurs from mid-October to March with the peak period from

November to January. After emerging from the gravel of spawning streams, coho fry remain close to the shoreline in shallow water to conserve energy.[24] They often establish territories near fast currents because the current brings them food in the form of drifting terrestrial and aquatic insects. During downstream migration, which begins from March to July of their second year, the young coho form schools and move into swifter currents. Before and during this time they undergo smoltification. Both the Chehalis and Satsop Rivers provide suitable habitats for coho salmon. In fact, coho are the most important salmon species in the rivers in terms of commercial and sport harvest.

Limited numbers of yearling coho have been captured in the study area, mostly in April, May and June. Underyearlings have been present in all months sampled; the period of peak underyearling abundance has varied within the spring to fall sampling period.

Juvenile coho have exhibited slight distributional preferences. The greatest sample densities have generally occurred in the Satsop River and at the holding area (Figure 2.2-4). Large numbers of juvenile coho have also been found at the intake area. Within the discharge area (see Subsection 3.4.4), greater densities of juvenile coho have been found upstream of, rather than at the diffuser itself.

Waters in the discharge area appear to be utilized by adult coho only for migration passage. Jack coho and migrating adults (3 + age-class) have been sampled during the fall at Chehalis River locations downstream of the Satsop River, including the discharge area. No signs of coho spawning or egg incubation have been found in the discharge area during the ecological sampling programs.

Coho salmon have shown definite patterns of movement while migrating upstream through the WNP-3 diffuser area.[14] Fish movements tend to be associated with the deeper water. From approximately 550 m downstream of the diffuser, fish travel near the deeper area of the south bank. Just upstream of the diffuser, fish appear to cross into the deeper water of the northern bank. A sonic tracking program revealed that the majority (60%) of migrating coho whose movements were monitored passed the diffuser location during darkness.

Juvenile coho salmon were the fifth most abundant salmonid in catches during 1979, second in 1978 and 1976, and first in 1977. Representative scale analysis shows the downstream migrants to be 1+ years of age with a fork length of 68 to 203 mm. Mean condition factor for those individuals ranged from 1.02 in January to 1.35 in May 1979, whereas those for 0+ coho salmon ranged from 0.98 in April to 1.17 in September 1979.

Rainbow/Steelhead Trout (Salmo gairdneri)

Two varieties of this species exist. Trout that are strictly freshwater residents are commonly called rainbow trout, while the anadromous, or sea-run, variety is known as steelhead trout. Both varieties are highly prized as sport fish throughout the Pacific Northwest.

Steelhead mature at 3 to 6 years of age, reaching an adult weight of 5 to 30 pounds. They spend from 1 to 3 years in freshwater and 1 to 4 years in the ocean. The period of adult migration for summer-run steelhead is June to early August; that of winter-run fish is December through April. The actual spawning for both runs takes place from February to June; egg incubation occurs from February to July. Many steelhead spawn more than once. In fact, up to 31 percent of winter-run fish may spawn a second time.(23) Downstream migration of young steelhead occurs from March to June.

While in streams, juvenile steelhead remain out of the main current to conserve energy. They usually remain close to the substratum from which they make forays into the overlying currents to capture drifting food. Rainbow/steelhead trout in freshwater feed on bottom living and terrestrial insects, amphipods, oligochaetes, frogs, fish, cladocerans, stoneflies, caddisflies, and mayflies.(21)

Rainbow trout/steelhead comprised the fourth and third most frequently captured salmonid species in 1979-1980 and 1978, respectively. The highest densities of 0+ rainbow trout occurred in Satsop River catches beginning in August for 1976, 1977 and 1978. Extremely low river levels prevented Satsop River sampling in 1979. Young-of-the-year (age 0+) rainbow trout from other sampling areas generally increased in mean fork length from 32 mm in May to 77 mm in October 1979. Mean condition factors for these fish ranged from 0.85 in May to 1.20 in September 1979. Similar lengths and condition factors were recorded in 1980.

Although juveniles have been sampled extensively in the study area, few mature rainbow trout have been captured. It is concluded that most of the juveniles which have been captured are young steelhead and that most of the trout in the study area are of the anadromous variety.

Most of the juvenile steelhead encountered were of the 0 + age class. This age class is common in the study area from June to October with peak abundance occurring in June and July. A smaller number of yearlings and older steelhead have been captured in the study area. The 1+ and 2+ age class trout use areas in both the Satsop and Chehalis Rivers above the discharge area.

No seasonal peak in 1+ age class and older trout could be detected; nor were any spawning fish sampled. Washington Department of Game statistics indicate that the winter steelhead run in the Chehalis is larger than the summer run.

No distributional preferences have been observed for juvenile steelhead in the study area. Yearling and older trout have shown some preference for fast water areas with gravel substrate, as in sections of the holding area.

2.2.2.7 Stream Fish

Fish communities in tributary streams near WNP-3 were studied from 1976 through 1980.(2-4,12,13) Fish were collected by using an electroshocker. Initially, 15 stations were sampled(12) and in 1979-1980, eight of the original locations were still sampled.(3,4) The eight stations included three on Workman and Fuller Creeks and one each on Stein and Ein Creeks.

Electroshocking and mark-recapture methods were used 1977-1980(2-4,13,15) to estimate fish populations and other fishery characteristics (e.g., species composition) at each sampling location. Each sampling station was 200 m in length; to isolate the sample populations, block nets were placed at both ends of the sampling station. Two passes were made at each station. Sampling was performed in August 1980 and 1979, from August to October in 1978, and from December 1977 through February 1978. Thirteen fish species were collected 1977-1979 and sculpins (79.6%), trout (6.7%), lampreys (5.0%), and salmon (4.2%) comprised 95.5 percent of the 6,158 fish sampled.

Surveys of salmonid spawning potential have been conducted on Fuller, Workman, Elizabeth and Hyatt Creeks since 1968.(15) Methods of assessing potential spawning areas were adopted from Burner.(25) At least two surveys were conducted on each stream November 1977 through January 1978.(15) Six biweekly surveys were made of Fuller Creek and at least one in each of the other streams November 1978 through January 1979, and October 1979 through January 1980.(2-4)

The purpose of the spawning surveys was to estimate the potential spawning area available to salmonids in site streams and to document the presence or absence of spawning adults or redds. Table 2.2-6 presents the estimated potential spawning area for each stream. It is important to note that, prior to the start of construction of WNP-3, no potential spawning areas were available in any site stream sections directly affected by construction runoff except Fuller Creek.(12) A total lost of three coho or steelhead redds was estimated due to construction activities before 1978.(15) Subsequent surveys have not revealed any reduction in potential spawning areas as a result of construction activities.(4)

2.2.2.8 Threatened and Endangered Species

No federally listed threatened or endangered aquatic organisms are known to occur in the Chehalis River in the vicinity of WNP-3.[11] Consequently, the construction and operation of WNP-3 is not expected to result in the damage or loss of any aquatic species presently regarded as threatened or endangered.

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TABLE 2.2-1 (contd.)

Type Family Species	Common Name
<u>Ericaceae</u> (Heath)	
<u>Gaultheria</u> <u>shallon</u>	Salal
<u>Menziesia</u> <u>ferruginea</u>	Fool's huckleberry
<u>Leguminosae</u> (Pulse)	
<u>Cytissus</u> <u>scoparius</u>	Scotch Broom
<u>Ribesaceae</u> (Currant)	
<u>Ribes</u> <u>bracteosum</u>	Stinking currant
<u>Ribes</u> <u>divaricatum</u>	Coast black gooseberry
<u>Rosaceae</u> (Rose)	
<u>Amelanchier</u> <u>florida</u>	Serviceberry
<u>Holodiscus</u> <u>discolor</u>	Ocean spray
<u>Malus</u> <u>rivularis</u>	Oregon crabapple
<u>Osmaronia</u> <u>cerasiformis</u>	Indian plum
<u>Physocarpus</u> <u>capitatus</u>	Ninebark
<u>Rosa</u> <u>gymnocarpa</u>	Little wild rose
<u>Rosa</u> <u>nutkana</u>	Nutka rose
<u>Rosa</u> <u>rubiginosa</u>	Sweet briar rose
<u>Rubus</u> <u>laciniatus</u>	Evergreen blackberry
<u>Rubus</u> <u>leucodermis</u>	Wild blackcap
<u>Rubus</u> <u>parviflorus</u>	Thimbleberry
<u>Rubus</u> <u>spectabilis</u>	Salmonberry
<u>Rubus</u> <u>thyrsanthus</u>	Himalayan blackberry
<u>Rubus</u> <u>ursinus</u>	Wild or Trailing blackberry
<u>Spiraea</u> <u>douglasii</u>	Douglas's Spiraea
<u>Vaccinaceae</u> (Huckleberry)	
<u>Vaccinium</u> <u>membranecum</u>	Large leaved huckleberry
<u>Vaccinium</u> <u>parvifolium</u>	Red huckleberry
<u>Vaccinium</u> <u>uliginosum</u>	Bog huckleberry
Forbs (non-woody plants)	
<u>Alismataceae</u> (Water Plantain)	
<u>Alisma</u> <u>plantago</u> <u>aquatica</u>	Water plantain
<u>Araceae</u> (Arum)	
<u>Lysichiton</u> <u>americanum</u>	Skunk cabbage
<u>Aristolochiaceae</u> (Birthwort)	
<u>Asarum</u> <u>caudatum</u>	Wild ginger
<u>Campanulaceae</u> (Harebell)	
<u>Campanula</u> <u>scouleri</u>	Scouler's harebell
<u>Caryophyllaceae</u> (Chickweed)	
<u>Cerastium</u> <u>arvense</u>	Field chickweed
<u>Cerastium</u> <u>vulgatum</u>	Mouse ear chickweed
<u>Saponaria</u> <u>officinalis</u>	Bouncing bet
<u>Spergula</u> <u>arvensis</u>	Corn spurry
<u>Stellaria</u> <u>calycantha</u> var. <u>bongardiana</u>	Northern starwort
<u>Stellaria</u> <u>media</u>	Chickweed
Chenopodiaceae (Goosefoot)	
<u>Chenopodium</u> <u>album</u>	Lamb's quarters

TABLE 2.2-1 (contd.)

Type Family Species	Common Name
Forbs (contd.)	
Compositae (Sunflower)	
Achillea millifolium	Yarrow
Anaphalis margaritacea	Pearly everlasting
Antennaria dimprpna	Pussy toes
Anthemis cotula	Dog fennel
Arctium minus	Burdock
Artemisia suksdorffii	Coastal wormwood
Aster subspicatus	Douglas's aster
Bidens cernua	Beggar-ticks
Chrysanthemum leucanthemum	Ox eye daisy
Cirsium arvense	Canadium thistle
Cirsium edule	Indian thistle
Cirsium lanceolata	Common thistle
Helenium autumnale	Sneezeweed
Hieracium albertinum	Hawkweed
Hypochaeris radicata	Cat's ear
Lactuca biennis	Wild lettuce
Metricaria matricarioides	Pineapple weed
Petasites speciosus	Western colt's foot
Senecio jacobaea	Tansey ragwort
Senecio sylvaticus	Woods senecio
Senecio vulgaris	Groundsel
Tanacetum vulgare	Garden tansey
Taraxacum officinale	Dandelion
Convolvulaceae (Morning Glory)	
Convolvulus arnensis	Field bindweed
Convolvulus sepium	Morning glory
Cruciferaceae (Mustard)	
Brassica campestris	Wild turnip
Capsella bursa-pastoris	Shepard's purse
Cardamine angulata	Angle leaf cress
Cardamine oligosperma	Bittercress
Dentaria tenella	Slender dentaria
Descurainia sophia	Flixweed
Raphanus sativus	Wild radish
Roripa naxturtium-aquatica	Water cress
Sisymbrium officinale	Hedge mustard
Curcubitaceae (Gourd)	
Marah oregana	Wild cucumber
Cyperaceae (Sedge)	
Carex californica	California sedge
Carex obnupta	Rough slough sedge
Carex stipata	Awl-fruited sedge
Eleocharis palustris	Creeping sedge
Scirpus microcarpus	Small fruited bulrush
Scirpus validus	American great bulrush
Equisetaceae (Horsetail)	
Equisetum arvense	Common horsetail
Equisetum telmatea	Giant horsetail
Fumariaceae (Bleeding Heart)	
Corydalis scouleri	Western corydalis
Dicentra formosa	Western bleeding heart

TABLE 2.2-1 (contd.)

Type / Family / Species	Common Name
Forbs (contd.)	
Geraniaceae (Geranium)	
Erodium cicutarium	Stork's bill
Gramineae (Grass)	
Agropyron repens	Quack grass
Agrostis scabra	Rough hair grass
Aira caryophyllea	Silvery hair grass
Anthoxanthum odoratum	Sweet vernal grass
Bromus pacificus	Pacific brome-grass
Bromus sitchensis	Alaska Brome-grass
Dactylis glomeratus	Orchard grass
Elymus sp.	Ryegrass
Festuca arundinaceae	Meadow fescue
Glyceria borealis	Northern mana grass
Holcus lanatus	Velvetgrass
Lolium multiflorum	Perennial rye grass
Melica subulata	Alaska onion grass
Phalaris arundinacea	Reed canary grass
Poa annua	Annual blue grass
Poa pratensis	Kentucky blue grass
Hydrocharitaceae (Frog's Bit)	
Eleodea canadensis	Waterweed
Vallisneria americana	Tapegrass
Hydrophyllaceae (Waterleaf)	
Hydrophyllum tenuipes	Slender stemmed waterleaf
Phacelia nemoralis	Woodland placelia
Hypericaceae (St. John's Wort)	
Hypericum perforatum	St. John's wort
Juncaceae (Rush)	
Luzula campestris	Common wood rush
Luzula parviflora	Small flowered woodrush
Juncus effusus	Common rush
Labiatae (Mint)	
Mentha arvensis	Field mint
Prunella vulgaris	Heal all
Stachys ciliata	Hedge nettle
Leguminosae (Pulse)	
Hosoackia rosea	Rose flowered hosackia
Lathyrus latifolius	Perennial pea
Lotus corniculatus	Bird's foot trefoil
Lotus micranthus	Small flowered lotus
Lupinus bicolor	Lindley's annual lupine
Lupinus polyphyllus	Large leaved lupine
Trifolium dubium	Least hop clover
Trifolium hybridum	Alsike clover
Trifolium pratense	Red clover
Trifolium repens	White clover
Vicia americana	American vetch
Vicia angustifolia	Narrow leaf vetch
Vicia cracca	Cow vetch
Lemnaceae (Duckweed)	
Lemma minor	Duckweed

TABLE 2.2-1 (contd.)

Type / Family / Species	Common Name
Forbs (contd.)	
Liliaceae (Lily)	
Allium schoenoparsum	Wild chives
Disporum oreganum	Oregon fairy bells
Disporum smithii	Large-flowered fairy
Maianthemum bifolium	False lily of the valley
Smilacina amplexicaulis	False solomon's seal
Smilacina sessilifolia	Small false solomon's seal
Streptopus amplexifolia	Twisted stalk
Trillium ovatum	Trillium
Malvaceae (Mallow)	
Malva moschata	Musk mallow
Nymphaceae (Pond Lily)	
Nymphaea polysepala	Yellow pond lily
Onagraceae (Evening Primrose)	
Circaea pacifica	Enchanter's nightshade
Epilobium adenocaulon	Common western willowherb
Epilobium angustifolium	Fireweed
Eiplobium paniculatum	Tall annual willow herb
Orchidaceae (Orchid)	
Corallorhiza maculata	Spotted coral root
Goodyearea decipens var. oblongifolia	
Spiranthes romanzoffiana	Ladies tresses
Plantaginaceae (Plantain)	
Plantago lancellata	Rib grass
Plantago major	Wide leaf plantain
Polygonaceae (Knotweed)	
Polygonum aviculare	Doorweed
Polygonum convolvulus	Black bindweed
Polygonum persicaria	Ladies thumb
Rumex acetosella	Field sorrel
Rumex crispuus	Sour dock
Polypodiaceae (Fern)	
Adiantum pedatum	Maidenhair fern
Athyrium felix-feminea	Lady fern
Dryopteris dilatata	Wood fern
Polypodium glycyrrhiza	Licorice root fern
Polystichum munitum	Sword fern
Pteridium aquilinum	Bracken fern
Struthiopteris spicant	Deer fern
Portulacaceae (Plurslane)	
Montia perfoliata	Miner's lettuce
Montia sibirica	Western spring beauty
Montia spathulata	Pale monita
Potamogetonaceae (Pondweed)	
Potamogeton epihydrus	Nuttal's pondweed
Potamogeton richardsoni	Richardson's pondweed
Primulaceae (Primrose)	
Trientalis latifolia	Star flower

TABLE 2.2-1 (contd.)

Type Family Species	Common Name
Ranunculaceae (Buttercup)	
Actaea arguta	Baneberry
Aquilegia formosa	Columbine
Aruncus sylvester	Goat's beard
Coptis laciniatus	Western gold thread
Ranunculus acris	Tall field buttercup
Ranunculus bongardi	Bongard's buttercup
Ranunculus macouni	Macoun's buttercup
Ranunculus repens	Creeping buttercup
Rosaceae (Rose)	
Geum macrophyllum	Large leaved avens
Potentilla pacifica	Pacific silverweed
Potentilla palustris	Marsh Cinquefoil
Rubiaceae (Madder)	
Galium aparine	Bedstraw
Galium triflorum	Fragrant bedstraw
Saxifragaceae (Saxifrage)	
Mitella caulenscens	Leafy stemmed mitre wort
Tellima grandiflora	Large fringe cup
Tiarella trifoliata	Three leaved coolwort
Tolmiea menziesii	Bristle flower
Scrophulariaceae (Figwort)	
Digitalis purpurea	Foxglove
Glechoma hederacea	Ground ivy
Linaria vulgaris	Butter and eggs
Mimulus guttatus	Common monkey flower
Veronica americana	American speedwell
Solanaceae (Potato)	
Solanum dulcamara	Bittersweet nightshade
Sparganiaceae (Bur-reed)	
Sparganium simplex	Simple-stemmed but reed
Typhaceae (Cat-tail)	
Typha latifolia	Common cat-tail
Umbelliferae (Parsley)	
Daucus carota	Wild carrot
Heracleum lanatum	Cow parsnip
Oenanthe sarmentosa	Wooly head parsnip
Urticaceae (Stinging Nettle)	
Urtica lyallii	Stinging nettle
Violaceae (Violet)	
Viola glabella	Smooth woodland violet
Viola sempervirens	Evergreen violet
Berberidaceae (Barberry)	
Aclys triphylla	Vanilla leaf
Vancouveria hexandra	Inside-out-flower

TABLE 2.2-2

MAMMALS FOUND NEAR WNP-3

Family Order Species	Common Name
Marsupialia	Pouched Mammals
Didelphiidae	Opossums
Didelphis marsupialis	Opossum
Insectivora	Insect-Eaters
Soricidae	Shrews
Sorex bendirei	Pacific Water Shrew
Sorex cinereus	Masked Shrew
Sorex obscurus	Dusky Shrew
Sorex palustris	Northern Water Shrew
Sorex towbridgei	Towbridge Shrew
Sorex vagrens	Vagrant Shrew
Talpidae	Moles
Neuretrichus gibbsi	Shrew-Mole
Scapanus orarius	Pacific Mole
Scapanus townsendi	Townsend Mole
Chiroptera	Bats
Vespertilonidae	Plainnose Bats
Myotis californicus	California Myotis
Myotis evotis	Long-eared Myotis
Myotis lucifungus	Little Brown Myotis
Myotis volans	Hairy Winged Myotis
Myotis vumanensis	Yuma Myotis
Lasionverteris noctivagans	Silver Haired Bat
Lasiurus cinereus	Hoary Bat
Eptesicus fucus	Big Brown Bat
Plecotus townendi	Western Big-Eared Bat
Carnivora	Carnivores
Ursidae	Bears
Ursus americanus	Black Bear
Procyonidae	Racoons
Procyon lotor	Raccoon
Mustelidae	Weasels, Skunks, etc.
Martes americana	Marten
Mustela pennanti	Fisher
Mustela erminea	Shorttail Weasel
Mustela frenata	Longtail Weasel
Mustela vison	Mink
Lutra canadensis	River Otter
Mephitis mephitis	Striped Skunk
Spilogale putorius	Spotted Skunk

TABLE 2.2-2 (contd.)

Family Order Species	Common Name
Canidae	Dogs, Wolves and Foxes
Canus latrans	Coyote
Vulpes fulva	Red Fox
Felidae	Cats
Felis concolor	Mountain Lion
Lynx rufus	Bobcat
Rodentia	Gnawing Mammals
Aplodontiidae	Aplondontia
Aplondontia rufa	Mountain Beaver
Sciuridae	Squirrels
Eutamias townsendi	Townsend Chipmunk
Tamiasciurus douglasi	Chickaree
Glaucomys sabrinus	Northern Flying Squirrel
Castoridae	Beaver
Castor canadensis	Beaver
Cricetidae	Mice, Rats and Voles
Peromyscus maniculatis	Deer Mouse
Neotoma cinerea	Bushy tailed Woodrat
Microtus oregoni	Oregon Vole
Microtus longicandus	Longtail Vole
Microtus townsendi	Townsend Vole
Ondatra zibethica	Muskrat
Zapodidae	Jumping Mice
Zapus trinotatus	Pacific Jumping Mouse
Erethizontidae	Porcupines
Erethizon dorasatum	Porcupine
Lagomorpha	Hares and Rabbits
Leporidae	Hares and Rabbits
Lepus americanus	Snowshoe Hare
Artiodactyla	Even-Toed Hoofed Mammals
Cervidae	Deer
Cervus canadensis	Elk
Odocoileus hermionus columbianus	Black-tailed Deer

TABLE 2.2-3

NUMBER AND RELATIVE ABUNDANCE OF
SMALL MAMMALS COLLECTED NEAR WNP-3, 1978

Common Name	Scientific Name	TCW[a] No.	TCW[a] R.A.[b]	CCW No.	CCW R.A.	TFW No.	TFW R.A.	CFW No.	CFW R.A.
Deer Mouse	*Peromyscus maniculatus*	122	98.4	73	97.3	15	53.6	20	48.8
Pacific jumping mouse	*Zapus trinotatus*	1	0.8	0	-	1	3.6	10	24.4
Shrews[c]	*Sorex* spp.	0	-	0	-	10	35.7	11	26.8
Townsend's chip-munk	*Eutamias townsendi*	0	-	0	-	1	3.6	0	-
Northern flying squirrel	*Glaucomys sabrinus*	0	-	0	-	1	3.6	0	-
Short tailed weasel	*Mustela erminea*	1	0.8	2	2.7	0	-	0	-
TOTAL		124	100.0	75	100.0	28	100.1	41	100.0

(a) TCW = treatment clearcut Watershed
CCW = Control Clearcut Watershed
TFW = Treatment Forested Watershed
CFW = control forested Watershed

(b) Relative abundance is given in percent

(c) Shrews are difficult to positively identify without examination of skulls; most individuals were probably Trowbridge shrews (*Sorex trowbidgei*) and vagrant shrews (*Sorex vagrans*).

TABLE 2.2-4

AMPHIBIANS AND REPTILES WHICH OCCUR
IN GRAYS HARBOR COUNTY

Order Species	Common Name
Urodela	
Taricha granulosa granulosa	Pacific Northwest Newt[a]
Dicamptodon ensatus	Pacific Giant Salamander
Rhyacotriton olympicus olympicus	Olympic Mountain Salamander
Ambystoma gracile gracile	Northwestern Salamander
Ambystoma macrodactylum	Long-toed Salamander
Plethodon vandykei	Washington Salamander
Plethodon vehiculum	Western Red-Backed Salamander
Ensatina eschscholtzi oregonensis	Oregon Red Salamander
Anura	
Ascaphus truei	American Ribbed Toad
Bufo boreas boreas	Northwestern Toad
Hyla regilla	Pacific Tree Frog
Rana aurora aurora	Western Wood Frog[a]
Rana cascada	Washington Frog
Rana catesbieana	Bullfrog
Chelonia	
Chelonia mydas agassizi	East Pacific Green Turtle
Lacertilia	
Gerrhonotus coeruleaus principis	Northern Alligator Lizard
Serpentes	
Thamnophis ordinoides	Puget Garter Snake
Thamnophis elegans nigrescens	Dusky Garter Snake
Thamnophis sirtalis trilineata	Puget Sound Garter Snake
Thamnophis sirtalis fitchi	Northwestern Garter Snake

(a) Observed in the site area.

TABLE 2.2-5

FISH SPECIES SAMPLED IN CHEHALIS AND SATSOP RIVERS, 1977-1979

Scientific Name	Common Name
Oncorhynchus tshawytscha	Chinook Salmon
Oncorhynchus keta	Chum Salmon
Oncorhynchus kisutch	Coho Salmon
Salmo gairdneri	Rainbow Trout
Salmo clarki	Cutthroat Trout
Prosopium williamsoni	Mountain Whitefish
Pomoxis nigromaculatus	Black Crappie
Micropterus salmoides	Largemouth Bass
Rhinchthys cataractae	Longnose Dace
Rhinchthys osculus	Speckled Dace
Mylocheilus caurinus	Peamouth
Ptychocheilus oregonensis	Northern Squawfish
Richardsonius balteatus	Redside Shiner
Cyprinidae	Minnow (Unidentified)
Cyprinidae	Minnows (Peamouth & Redside Shiner)
Perca flavescens	Yellow Perch
Alosa sapidissima	American Shad
Catostomus macrocheilus	Largescale Sucker
Cottus asper	Prickly Sculpin
Cottus rhotheus	Torrent Sculpin
Cottus bairdi	Mottled Sculpin
Cottus aleuticus	Coastrange Sculpin
Gasterosteus aculeatus	Anadromous Stickleback
Gasterosteus aculeatus	Resident Stickleback
Gasterosteus aculeatus	Hybrid Stickleback
Petromyzontidae	Lamprey
Entosphenus tridentatus	Pacific Lamprey
Lampetra ayresi	River Lamprey
Lampetra richardsoni	Western Brook Lamprey
Platichthys stellatus	Starry Flounder

TABLE 2.2-6

POTENTIAL SPAWNING AREAS FOR SITE STREAMS

Year	1968-1968[a]		1976 [b]		1977-1978[b]		1978-1979		1979-1980		1980-1981	
	Number of Potential Coho Salmon or Steelhead		Number of Potential Coho Salmon or Steelhead		Number of Potential Coho Salmon or Steelhead		Number of Potential Coho Salmon or Steelhead		Number of Potential Coho Salmon or Steelhead		Number of Potential Coho Salmon or Steelhead	
Stream	Area (yd^2)	Redds	Area (yd^2)	Redds	Area (yd^2)	Redds	Area (yd^2)	Redds	Area (yd^2)	Redds	Area (yd^2)	Redds
Workman	--[c]	--	0[d]	0	1,246	89	1,179	84	1,303	93	1,091	78
Fuller	250	18	140	10	98	7	105	7	176[g]	12[g]	173[g]	12[g]
Hyatt	--	--	0	0	0	0	--	--	0[f]	0[f]	0[f]	0[f]
Elizabeth	660	47	290	21	70	5	42[e]	3[e]	56[e]	4[e]	63[e]	4[e]

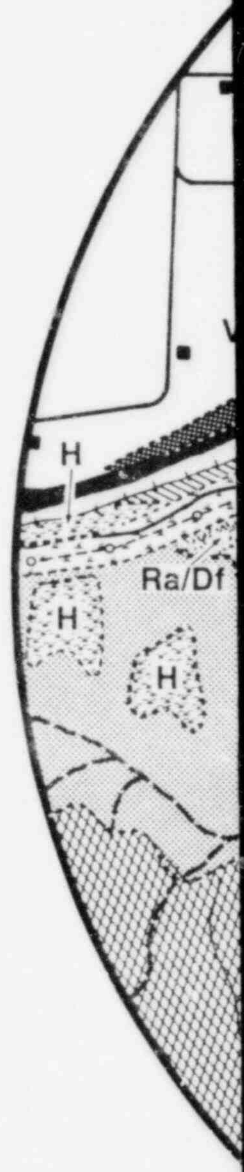
(a) Washington Department of Fisheries, 1969.
(b) Reference 2.2-15.
(c) --denotes no survey was conducted.
(d) Upper stretch of Workman not surveyed in 1976. This was the region where spawning was found in 1977-78.
(e) Potential in rechannelized portion only.
(f) Gravel present in upper areas but high culvert at mouth in 1979-80 and dam in 1980-81 eliminates all potential anadromous spawning.
(g) Maximum estimated during all surveys.

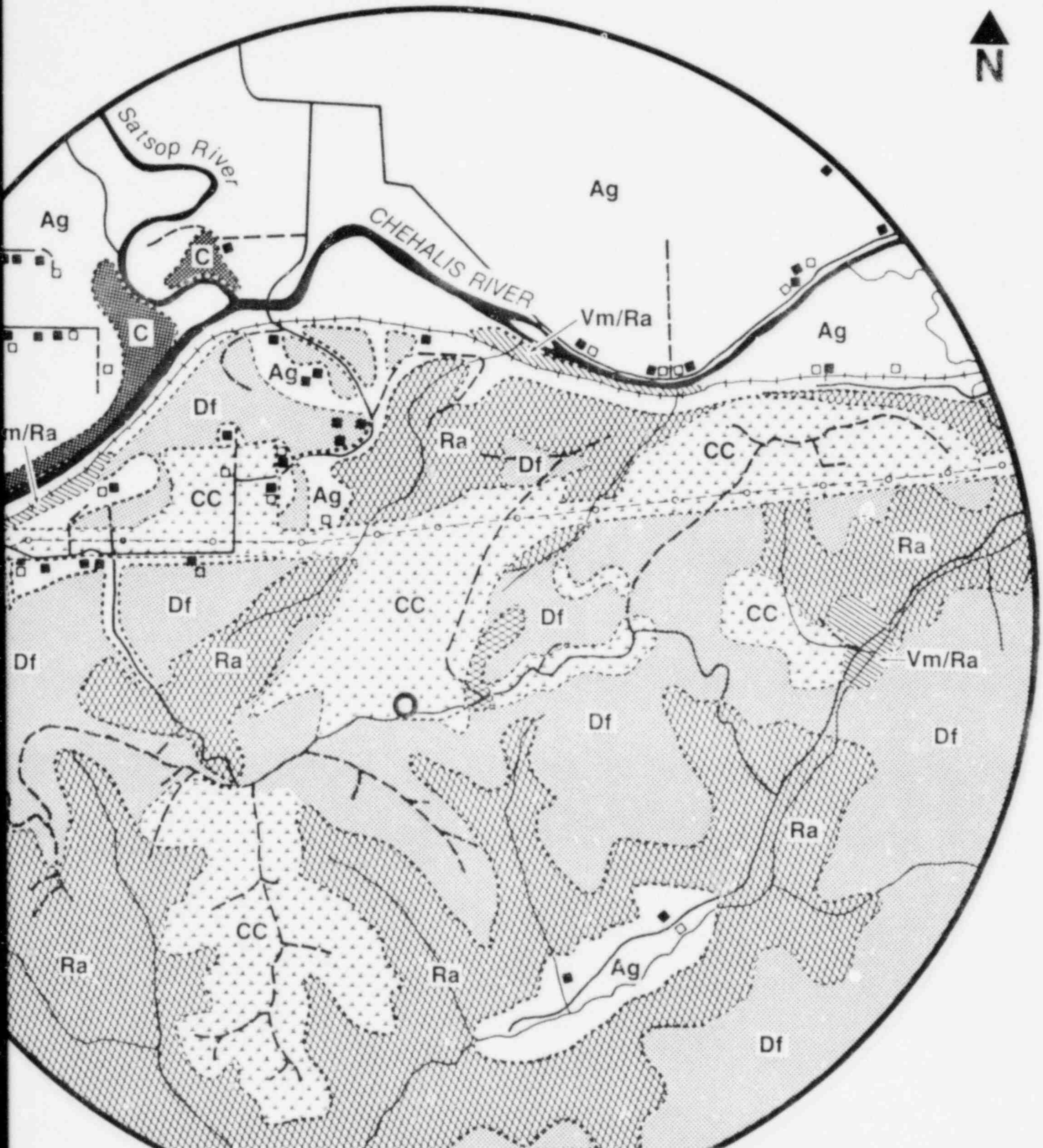
KEY

DOUGLAS	Df
RED ALDER	Ra
HEMLOCK	H
RED ALDER - DOUGLAS FIR MIX	Ra/Df
VINE MAPLE - RED ALDER MIX	Vm/Ra
COTTONWOOD	C
AGRICULTURAL	Ag
CLEAR CUT	CC

0 1 2

miles





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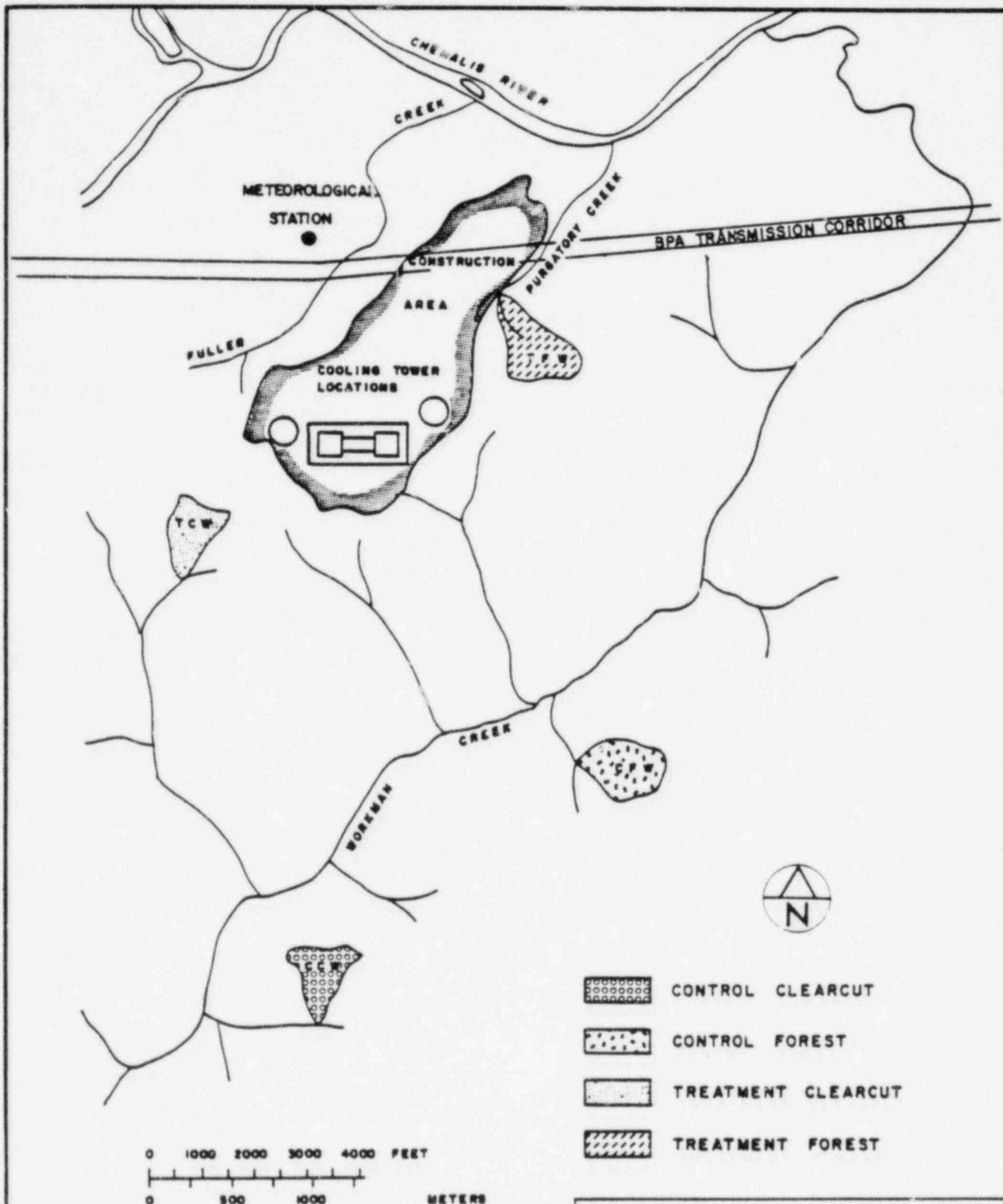
VEGETATION IN THE SITE AREA

FIGURE 2.2-1



WASHINGTON PUBLIC POWER SUPPLY SYSTEM
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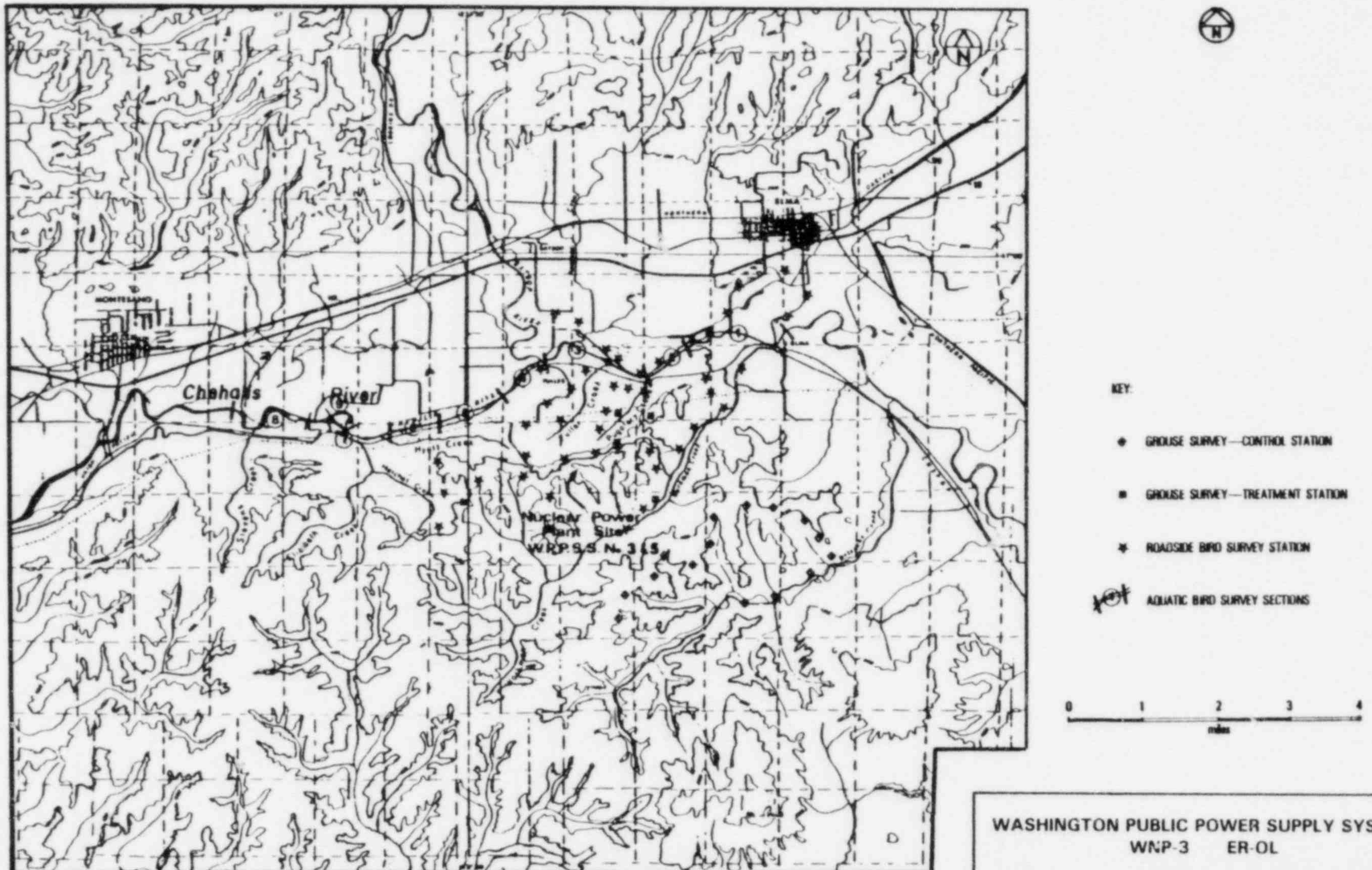
TERRESTRIAL ECOLOGY SAMPLING SITES

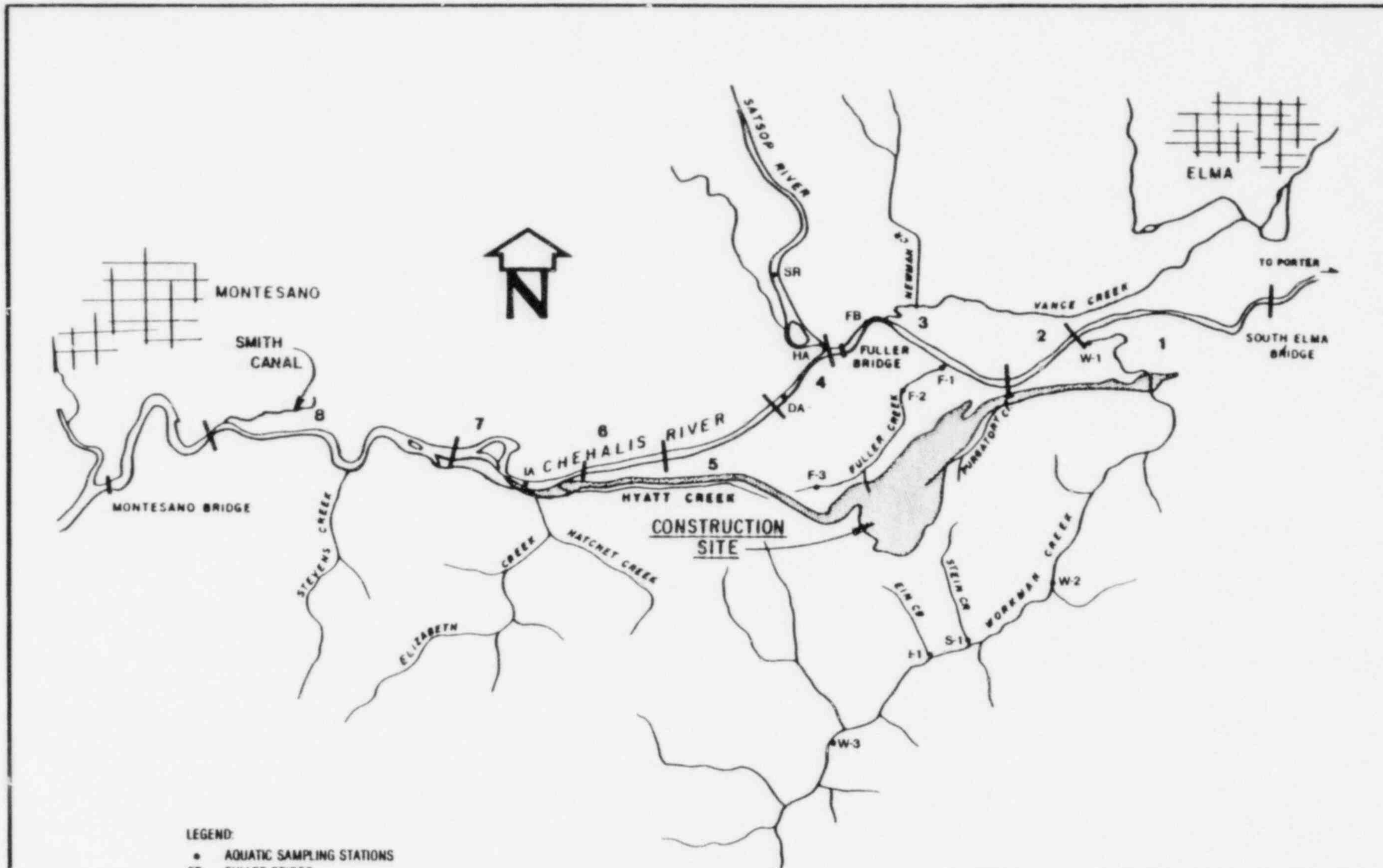
FIGURE 2.2-2



WASHINGTON PUBLIC POWER SUPPLY SYSTEM
WNP-3 ER-OL

BIRD SURVEY SITES

FIGURE 2.2-3



WASHINGTON PUBLIC POWER SUPPLY SYSTEM
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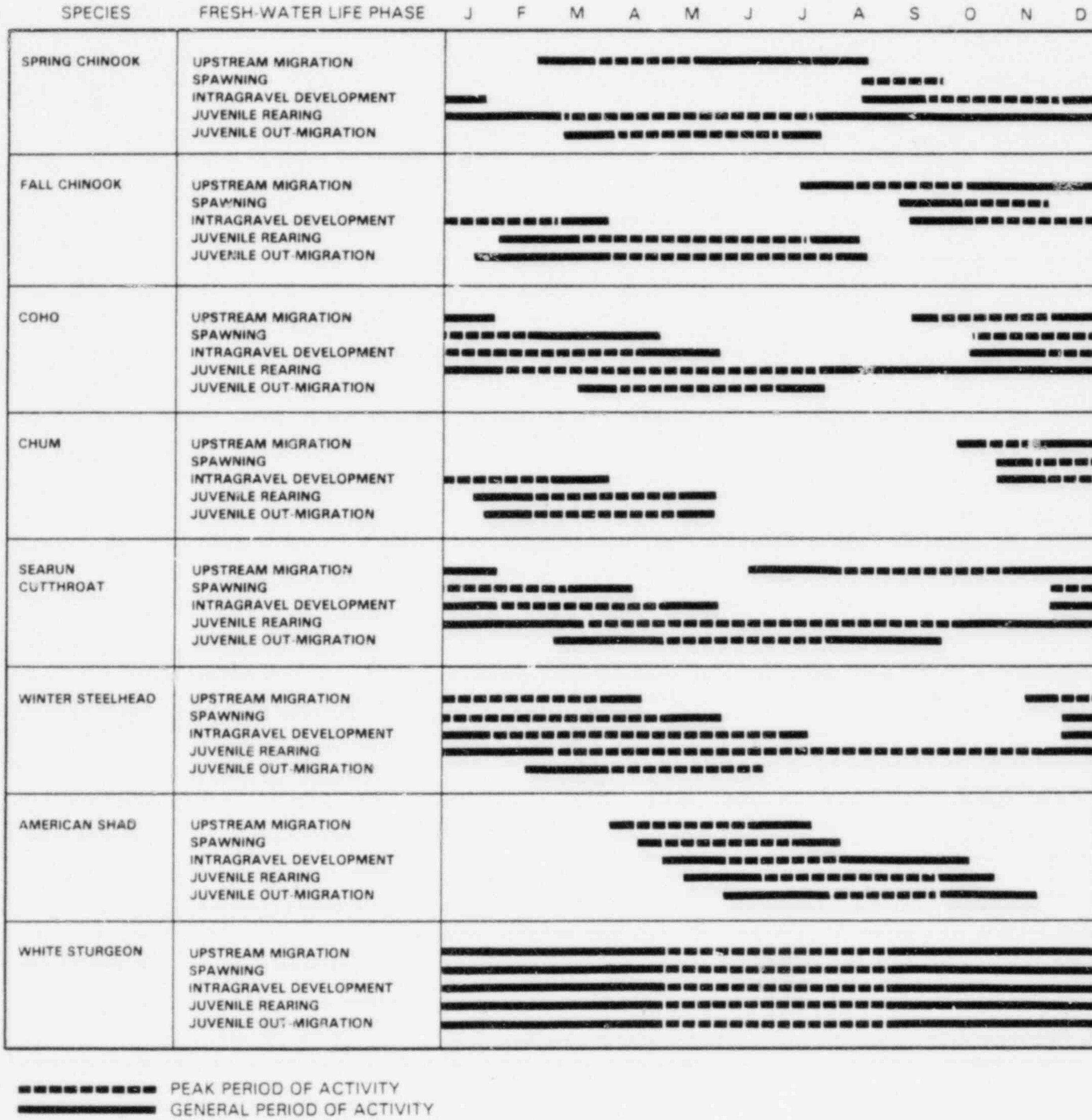
AQUATIC ECOLOGY SAMPLING AREAS

FIGURE 2.2-4



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	FRESHWATER LIFE PHASES OF ANADROMOUS FISH IN THE CHEHALIS RIVER	FIGURE 2.2-5

2.3 METEOROLOGY

2.3.1 Regional Climatology

The climate of the lowlands of western Washington is dominated by two large-scale meteorological factors: the mid-latitude westerly winds and the proximity of the Pacific Ocean. The mid-latitude westerly winds are a feature of the global climate from about 30°N to 60°N. The westerlies carry a recurring progression of low-pressure systems called synoptic storms, which develop, move east, and dissipate in the mid-latitudes. The westerlies and their associated storms are most intense in the winter months; they weaken and shift northward in the summer months.

The Pacific Ocean moderates the seasonal and daily variability in climate as air masses move eastward over the land. Winters are warmer and summers cooler than at other locations of the same latitude. Cloudiness and high humidities are also persistent features. The topography of Grays Harbor County does little to obstruct the eastward flow, especially at locations in the west-east trending Chehalis River Valley.

The westerlies and the proximity and exposure to the Pacific Ocean combine to cause a predominance of maritime polar air masses over the region. Humidities are generally high in these air masses with the morning maxima usually above 90 percent. The passage of storm systems often includes the passage of a boundary or front between the subtropical and polar air masses. The fronts are often indistinct and are related to broad bands of weather activity.

Winters in Grays Harbor County tend to have the worst weather of any season. The synoptic storms move repeatedly through the area, bringing continuous rain, cloudiness and windy conditions to exposed locations. Often, there is persistent cloudiness for several weeks duration. Heavy snows do occur about once every two or three years. Low temperatures are in the 30°F to 40°F range, with little daily variation.

The summer climate in this area reflects the weakening of the westerly winds and storms. Skies are often fair to partly cloudy and precipitation generally comes in the form of brief, rarely intense showers. Stormy cloudy conditions can dominate for several days in a row, but they are generally less pervasive or severe than in the winter months. The summer climate is generally pleasant and mild, with daily afternoon high temperatures in the 70°F to 80°F range.

2.3.2 Local Meteorology

Local meteorological conditions are described by both the onsite monitoring program (see Subsection 6.1.3) and longer term records for nearby stations. The data recorded between October 1979 and September 1981 are summarized in this section; additional detail and interpretation are provided in Section 2.3 of the WNP-3 Final Safety Analysis Report.

2.3.2.1 Temperature and Dew Point

The long-term temperatures for the site area can be described by data reported by first-order National Weather Service stations and cooperative observers at Aberdeen, Elma, Oakville, and Olympia.(1-5) Monthly temperatures at these locations are shown in Table 2.3-1. Also listed for comparison are the average monthly temperatures observed onsite during the two-year period ending September 1981. The moderating influence of the ocean noted in Subsection 2.3.1 is obvious when temperatures at Aberdeen are compared with those for the inland locations. Regarding extremes, the highest temperature on record at Elma is a July reading of 105°F while the lowest is 0°F recorded in January. The extremes of record for Olympia are 103°F (July 1941) and -7°F (January 1942).

Annual frequency distributions for onsite temperature versus time of day are given in Tables 2.3-2a and 2.3-2b for the two heights (10m and 60m). Temperatures above 30°C (86°F) occurred about 0.3 percent of the time.

The National Weather Service Station at Olympia provides a long-term record for regional dew point and humidity data. The monthly mean values of dew point and relative humidity for Olympia are compared with the two-year means recorded onsite in Table 2.3-3. Tables 2.3-4 and 2.3-5 provide the annual frequency distributions versus hour of day for measured dew points and calculated wet bulbs, respectively, for onsite data.

The representativeness of Olympia temperature and dew point data relative to the plant site is illustrated by Table 2.3-6 which compares the monthly means for the two locations for the same 12-month period. From this data it is seen that the site experiences slightly lower mean maximums and higher mean minimums than Olympia. Relative humidities at the site are lower than those for Olympia.

2.3.2.2 Wind Speed and Direction

Composite average wind rose data recorded on site at the 10-meter level from October 1979 through September 1981 are shown in Tables 2.3-7a through 2.3-7l. These data illustrate the climatological phenomenon of slightly stronger winds and more frequent calms during the winter months. The late fall and winter winds have a strong easterly component while the Spring-summer winds are dominated by the SSW direction. The annual summaries for each 12-month period are shown in Tables 2.3-8a and 2.3-8b. The first year (October 1979 - September 1980) had considerably more observations of calms than did the second year. The directional distributions for each year match very closely with the SSW wind predominating.

Tables 2.3-9a and 2.3-9b provide comparison of wind roses for 10m and 60m, respectively, for the two-year monitoring program. Average wind speeds at 10m and 60m were 1.5 and 3.1 m/sec, respectively. In addition to the expected higher winds, the 60m level has directional peaks in the ENE and WSW-W as compared with the singular SSW peak at the 10m level. The ENE direction is dominant at the 60m level during the winter months.

Olympia is the closest offsite weather station with long-term wind data available for comparison. The frequency distribution of annual winds (in knots) is given in Table 2.3-10 which shows prevailing winds are from SSW-SW. Average wind speed at Olympia is about 3 m/sec.

2.3.2.3 Atmospheric Stability

Stability classification of the onsite data is based on vertical temperature difference. Pasquill stability categories were assigned according to the delta-T ranges described in Regulatory Guide 1.23.(6) The categories are defined in Table 2.3-11. Table 2.3-12 is an annual summary of stability versus time-of-day. Class E is the most frequent in all hours and averages 62.9 percent occurrence. Classes D, F, and G average 17.9, 12.5, and 6.5 percent, respectively.

Joint frequencies of wind speed and direction for the various stability categories are shown in Tables 2.3-13a through 2.3-13g. The prevailing winds during neutral (Class D) and slightly stable (Class E) conditions are from the SSW. Winds are fairly uniformly distributed during moderately stable (Class F) conditions, although the southwesterly winds are least frequent. Under extremely stable (Class G) conditions, the northerly component predominates with the southwesterly winds occurring least frequently.

Regional atmospheric stability (and general diffusion potential) is indicated by mixing heights compiled by Holzworth(7) for locations throughout the United States. The station nearest the site for which data were used in the summary. Although not as representative as onsite data, these summaries depict the general nature of air pollution at coastal locations in the northwestern United States. The mean seasonal and annual mixing heights and wind speeds for Seattle are presented in Table 2.3-14. The diurnal variation apparent in these data is less than would be experienced generally at a continental location.

2.3.2.4 Precipitation

The WNP-3 site area receives about 75 percent of the annual precipitation in the 6-month period between mid-October and mid-April. Average monthly precipitation totals from the onsite data are listed in Table 2.3-15 with long-term observations for various stations in the area. The decrease in precipitation with distance from the ocean is evident. Precipitation at the site and Elma are compared for each month of a 12-month period in Table 2.3-16. The two locations have the same pattern with the plant site recording slightly less rainfall in most months. Elma averages about 180 days per year with measurable precipitation. Measurable precipitation occurred onsite about 16 percent of the time during the 24-month monitoring program.

Precipitation wind roses, composited by month, for the onsite data are given in Tables 2.3-17a through 2.3-17l. Tables 2.3-18a and 2.3-18b provide comparison of the precipitation wind roses for the two heights of measurement. The frequency distribution of rainfall intensities measured onsite is given by Table 2.3-19.

2.3.3 Topography

As shown in Figure 2.1-2, WNP-3 is located on a ridge about 300 ft above the Chehalis River valley. Figures 2.3-1 and 2.3-2 present topographic profiles out to 10 miles and 50 miles, respectively. The Chehalis valley to the north and Willapa Hills to the south are the dominant features near the plant. At distances beyond 10 miles, the Pacific Ocean to the west and the Olympic Mountains to the north are important topographic features.

References for Section 2.3

1. Hourly Meteorological Data - Olympia, Washington, 1948-1968, U.S. Department of Commerce, Asheville, North Carolina.

2. Local Climatological Data - Annual Summary with Comparative Data, U.S. Department of Commerce, Olympia, Washington, 1978.

3. Climatography of the United States No. 86-39, Climatic Summary of the United States-Supplement for 1951 through 1960, Weather Bureau, U.S. Department of Commerce, Washington, D.C., 1965.

4. Climatography of the United States, No. 20-45, Climatological Summary (Aberdeen-Hoquiam, Oakville, Olympia), U.S. Department of Commerce, in cooperation with the Washington State Department of Commerce and Economic Development.

5. Phillips, E. L. and Donaldson, W. R., Washington Climate for these Counties - Clallam, Grays Harbor, Jefferson, Pacific, and Wahkiakum, Cooperative Extension Service, College of Agriculture, Washington State University, Pullman, Washington, 1972.

6. Onsite Meteorological Programs, Regulatory Guide 1.23, U.S. Nuclear Regulatory Commission, Washington, D.C., September 1980.

7. Holzworth, G. C., Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution through the Contiguous United States, Publication No. AP-101, Environmental Protection Agency, Research Triangle Park, North Carolina, 1972.

TABLE 2.3-1

MONTHLY AND ANNUAL TEMPERATURES (^{o}F) IN THE SITE VICINITY

Month	Aberdeen[a] Average Daily Maximum	Aberdeen[a] Average Daily Minimum	Aberdeen[a] Monthly Average	Elma[b] Average Daily Maximum	Elma[b] Average Daily Minimum	Elma[b] Monthly Average	Oakville[c] Average Daily Maximum	Oakville[c] Average Daily Minimum	Oakville[c] Monthly Average	Olympia[d] Average Daily Maximum	Olympia[d] Average Daily Minimum	Olympia[d] Monthly Average	WNP-3 Site[e] Monthly Average
January	45.3	34.0	39.7	44.6	31.2	37.8	44.8	32.0	38.4	45.1	31.1	38.1	39.0
February	49.0	34.6	41.8	49.5	33.4	41.3	48.9	33.1	41.0	49.6	32.2	40.9	43.2
March	52.2	35.9	44.1	53.5	34.1	43.8	53.1	35.0	44.1	54.4	34.0	44.2	45.0
April	58.0	39.5	48.8	60.3	38.0	49.2	60.9	38.1	49.5	62.3	37.6	50.0	48.2
May	63.0	43.6	53.3	67.4	42.7	55.1	67.2	42.2	54.7	68.6	41.6	55.1	51.5
June	66.4	47.9	57.2	71.3	46.7	59.0	71.9	46.3	59.1	72.6	45.5	59.1	54.6
July	69.7	50.4	60.1	76.2	49.7	63.0	77.5	49.8	63.7	79.7	48.0	63.9	61.3
August	70.1	51.1	60.6	75.4	49.3	62.4	76.8	50.1	63.5	78.9	47.8	63.4	60.1
September	69.0	48.3	58.7	72.2	46.5	59.3	72.8	46.4	59.6	72.6	44.4	58.5	57.2
October	61.9	43.5	52.7	62.7	41.9	52.3	62.2	42.2	52.2	62.3	40.5	51.4	52.4
November	52.4	38.0	45.2	52.6	36.2	44.5	51.4	36.5	44.0	52.4	35.2	43.8	44.4
December	47.5	36.3	41.9	47.7	34.5	41.1	46.5	35.0	40.8	47.5	33.9	40.7	43.5
Annual	58.7	41.9	50.3	61.1	40.4	50.7	61.2	40.6	50.9	62.2	39.3	50.8	50.0

(a) 20 mi W of WNP-3 at Elev. 12 ft MSL. Period of record 1931-1960.
(b) 4 mi NE at Elev. <100 ft MSL. Period of record 1942-1960.
(c) 14 mi SE at Elev. <200 ft MSL. Period of record 1931-1960.
(d) 27 mi E at Elev. 190 ft MSL. Period of record 1931-1960.
(e) 10 m height on tower with base at Elev. 310 ft MSL. Period of record October 1979-September 1981.

TABLE 2.3-2A

ANNUAL FREQUENCY DISTRIBUTION OF TEMPERATURE VS. TIME OF DAY, 10-METER LEVEL

	TEMPERATURE (C)											
HOUR	BELOW -20	>-20 TO-15	>-15 TO-10	>-10 TO -5	> -5 TO 0	> 0 TO 5	> 5 TO 10	> 10 TO 15	> 15 TO 20	> 20 TO 25	> 25 TO 30	ABOVE 30
0	0.00	0.00	0.00	0.57	3.26	20.09	37.46	35.47	2.56	0.57	0.00	0.00
1	0.00	0.00	0.00	0.57	4.29	20.89	37.48	33.76	2.58	0.43	0.00	0.00
2	0.00	0.00	0.14	0.43	4.42	21.97	38.37	31.95	2.43	0.29	0.00	0.00
3	0.00	0.00	0.28	0.43	4.69	23.30	39.06	29.69	2.41	0.14	0.00	0.00
4	0.00	0.00	0.28	0.43	5.54	23.01	39.20	29.26	2.13	0.14	0.00	0.00
5	0.00	0.00	0.29	0.43	5.85	23.25	37.95	29.96	2.14	0.14	0.00	0.00
6	0.00	0.00	0.28	0.43	6.12	21.76	36.84	32.15	2.13	0.28	0.00	0.00
7	0.00	0.00	0.28	0.43	5.26	20.17	34.23	36.22	2.41	0.99	0.00	0.00
8	0.00	0.00	0.29	0.29	4.46	17.84	31.80	39.28	4.32	1.44	0.29	0.00
9	0.00	0.00	0.14	0.29	3.29	15.59	29.61	39.06	9.44	2.00	0.43	0.14
10	0.00	0.00	0.00	0.43	2.01	12.21	28.02	36.21	16.67	3.16	0.86	0.43
11	0.00	0.00	0.00	0.14	1.72	10.49	26.44	35.92	18.39	5.17	1.15	0.57
12	0.00	0.00	0.00	0.00	1.29	7.91	26.19	35.25	19.71	7.63	1.15	0.86
13	0.00	0.00	0.00	0.00	0.87	7.37	25.43	34.25	19.65	9.39	1.73	1.30
14	0.00	0.00	0.00	0.00	1.00	6.88	25.50	33.38	21.06	8.31	2.72	1.15
15	0.00	0.00	0.00	0.00	1.43	6.59	26.65	33.38	19.77	8.88	2.29	1.00
16	0.00	0.00	0.00	0.00	1.29	8.31	27.94	33.09	19.20	7.59	1.58	1.00
17	0.00	0.00	0.00	0.00	1.42	10.68	28.21	34.90	17.52	5.27	1.14	0.85
18	0.00	0.00	0.00	0.00	1.57	12.82	30.63	36.47	13.82	3.42	0.57	0.71
19	0.00	0.00	0.00	0.14	1.86	13.88	32.19	39.20	9.16	2.72	0.57	0.29
20	0.00	0.00	0.00	0.28	1.98	15.11	34.46	40.11	5.37	2.12	0.56	0.00
21	0.00	0.00	0.00	0.57	2.00	17.12	34.95	39.80	3.57	1.71	0.29	0.00
22	0.00	0.00	0.00	0.57	2.56	17.90	34.94	39.91	3.27	0.85	0.00	0.00
23	0.00	0.00	0.00	0.57	3.40	19.01	36.03	37.73	2.70	0.57	0.00	0.00

NUMBER OF OBSERVATIONS=16806
PERIOD OF RECORD 10/79 THROUGH 9/81

TABLE 2.3-2B

ANNUAL FREQUENCY DISTRIBUTION OF TEMPERATURE VS. TIME OF DAY, 60-METER LEVEL

	TEMPERATURE (C)											
HOUR	BELOW -20	>-20 TO-15	>-15 TO-10	>-10 TO -5	> -5 TO 0	> 0 TO 5	> 5 TO 10	> 10 TO 15	> 15 TO 20	> 20 TO 25	> 25 TO 30	ABOVE 30
0	0.00	0.00	0.00	0.48	1.93	16.88	38.75	39.55	2.09	0.32	0.00	0.00
1	0.00	0.00	0.00	0.48	2.25	18.20	38.97	38.16	1.77	0.16	0.00	0.00
2	0.00	0.00	0.00	0.64	2.42	18.36	40.42	36.23	1.77	0.16	0.00	0.00
3	0.00	0.00	0.00	0.64	2.71	18.82	40.99	35.09	1.59	0.16	0.00	0.00
4	0.00	0.00	0.00	0.64	3.20	19.36	40.64	34.40	1.60	0.16	0.00	0.00
5	0.00	0.00	0.00	0.64	3.19	19.81	38.98	35.78	1.44	0.16	0.00	0.00
6	0.00	0.00	0.00	0.64	3.53	18.91	35.58	39.42	1.76	0.16	0.00	0.00
7	0.00	0.00	0.00	0.48	3.38	17.39	32.53	41.38	4.03	0.64	0.16	0.00
8	0.00	0.00	0.00	0.49	3.24	15.53	29.94	40.13	9.22	1.13	0.32	0.00
9	0.00	0.00	0.00	0.49	1.62	12.62	29.13	38.83	14.56	2.27	0.49	0.00
10	0.00	0.00	0.00	0.49	1.47	10.77	26.43	35.73	18.60	5.06	1.14	0.33
11	0.00	0.00	0.00	0.00	1.62	8.93	24.19	35.55	21.75	6.17	1.14	0.65
12	0.00	0.00	0.00	0.00	1.14	6.66	23.21	36.69	20.62	8.60	2.27	0.81
13	0.00	0.00	0.00	0.00	0.99	6.08	22.50	34.98	22.17	9.36	2.79	1.15
14	0.00	0.00	0.00	0.00	1.13	5.67	23.82	35.33	20.91	9.40	2.76	0.97
15	0.00	0.00	0.00	0.00	1.45	5.64	23.99	36.23	21.58	7.89	2.42	0.81
16	0.00	0.00	0.00	0.00	1.44	6.73	25.00	36.86	20.51	7.85	0.96	0.64
17	0.00	0.00	0.00	0.00	1.59	8.44	27.07	37.10	18.79	5.57	0.80	0.64
18	0.00	0.00	0.00	0.00	1.60	9.94	29.97	39.42	14.90	3.37	0.32	0.48
19	0.00	0.00	0.00	0.00	1.77	10.91	32.74	41.73	10.43	1.77	0.32	0.32
20	0.00	0.00	0.00	0.00	1.92	11.34	35.30	44.25	6.07	0.96	0.16	0.00
21	0.00	0.00	0.00	0.32	1.93	12.54	35.85	44.05	4.50	0.48	0.32	0.00
22	0.00	0.00	0.00	0.48	1.74	14.58	36.13	42.79	3.80	0.32	0.16	0.00
23	0.00	0.00	0.00	0.48	1.91	15.90	37.36	41.18	2.54	0.64	0.00	0.00

NUMBER OF OBSERVATIONS=14922
PERIOD OF RECORD 10/79 THROUGH 9/81

TABLE 2.3-3

MEAN DEW POINT AND RELATIVE HUMIDITY
VALUES FOR OLYMPIA[a] AND WNP-3 SITE[b]

Month	Dew Point (^oF)		Relative Humidity (%)	
	Olympia	WNP-3	Olympia	WNP-3
January	33.5	33.1	88	78.5
February	35.3	40.0	84	88.5
March	35.5	39.4	80	81.5
April	38.5	40.2	75	75
May	43.0	42.8	73	74
June	48.3	46.1	73	75
July	50.9	50.2	70	69
August	51.2	51.4	73	75
September	48.6	49.2	78	75
October	44.9	46.7	85	81.5
November	38.3	40.3	88	86
December	36.5	41.3	89	91
Annual	41.8	43.4	81	79

(a) 1961 - 1969 and 1972 - 1978
(b) October 1979 - September 1981

TABLE 2.3-4

ANNUAL FREQUENCY DISTRIBUTION OF DEW POINT TEMPERATURE VS. TIME OF DAY, 60-METER LEVEL

	TEMPERATURE (C)											
HOUR	BELOW -20	>-20 TO-15	>-15 TO-10	>-10 TO -5	> -5 TO 0	> 0 TO 5	> 5 TO 10	> 10 TO 15	> 15 TO 20	> 20 TO 25	> 25 TO 30	ABOVE 30
0	0.00	0.28	0.57	1.28	4.69	29.73	42.39	20.34	0.71	0.00	0.00	0.00
1	0.00	0.14	0.72	1.00	5.29	29.90	42.20	20.03	0.72	0.00	0.00	0.00
2	0.00	0.14	0.57	0.85	5.84	32.05	40.88	18.80	0.85	0.00	0.00	0.00
3	0.00	0.14	0.71	0.85	6.55	29.63	43.30	17.95	0.85	0.00	0.00	0.00
4	0.00	0.14	0.71	0.85	7.07	33.10	40.88	16.69	0.57	0.00	0.00	0.00
5	0.00	0.14	0.72	0.72	6.50	32.08	42.77	16.47	0.58	0.00	0.00	0.00
6	0.00	0.14	0.85	0.71	6.39	31.82	41.90	17.76	0.43	0.00	0.00	0.00
7	0.00	0.28	0.57	1.00	5.83	30.16	43.67	18.21	0.28	0.00	0.00	0.00
8	0.00	0.14	0.72	1.01	6.34	30.55	41.64	18.73	0.86	0.00	0.00	0.00
9	0.00	0.43	0.43	1.00	6.45	27.08	41.98	21.63	1.00	0.00	0.00	0.00
10	0.00	0.29	0.43	1.01	5.89	27.73	41.67	21.55	1.44	0.00	0.00	0.00
11	0.00	0.29	0.43	0.72	5.90	26.76	42.16	22.30	1.44	0.00	0.00	0.00
12	0.00	0.57	0.14	1.01	6.03	26.58	42.10	21.84	1.72	0.00	0.00	0.00
13	0.00	0.58	0.14	0.72	5.34	25.83	44.01	21.79	1.59	0.00	0.00	0.00
14	0.00	0.57	0.14	1.00	6.15	26.61	42.63	21.60	1.29	0.00	0.00	0.00
15	0.00	0.57	0.14	1.15	5.60	25.54	44.91	20.95	1.15	0.00	0.00	0.00
16	0.00	0.57	0.29	0.86	5.45	28.26	42.90	20.52	1.15	0.00	0.00	0.00
17	0.00	0.58	0.29	0.72	5.04	27.19	43.17	22.30	0.72	0.00	0.00	0.00
18	0.00	0.43	0.57	0.71	5.11	27.23	42.70	22.13	1.13	0.00	0.00	0.00
19	0.00	0.43	0.43	0.85	4.99	27.92	42.17	22.51	0.71	0.00	0.00	0.00
20	0.00	0.85	0.14	0.70	4.37	30.70	40.56	22.11	0.56	0.00	0.00	0.00
21	0.00	0.43	0.43	0.85	4.26	29.40	43.04	20.88	0.71	0.00	0.00	0.00
22	0.00	0.28	0.57	1.13	3.69	29.79	43.26	20.71	0.57	0.00	0.00	0.00
23	0.00	0.28	0.57	1.28	3.70	30.44	42.53	20.48	0.71	0.00	0.00	0.00

NUMBER OF OBSERVATIONS=16801
PERIOD OF RECORD 10/79 THROUGH 9/81

TABLE 2.3-5

ANNUAL FREQUENCY DISTRIBUTION OF WET BULB TEMPERATURE VS. TIME OF DAY, 60-METER LEVEL

HOUR	BELOW -20	>-20 TO-15	>-15 TO-10	>-10 TO -5	> -5 TO 0	> 0 TO 5	> 5 TO 10	> 10 TO 15	> 15 TO 20	> 20 TO 25	> 25 TO 30	ABOVE 30
	TEMPERATURE (C)											
0	0.00	0.00	0.00	0.65	3.24	22.37	46.03	27.23	0.49	0.00	0.00	0.00
1	0.00	0.00	0.00	0.65	3.25	24.23	44.23	26.99	0.65	0.00	0.00	0.00
2	0.00	0.00	0.00	0.65	3.42	24.76	45.60	24.92	0.65	0.00	0.00	0.00
3	0.00	0.00	0.00	0.64	3.54	25.72	45.34	24.28	0.48	0.00	0.00	0.00
4	0.00	0.00	0.00	0.65	4.20	26.49	46.04	22.13	0.48	0.00	0.00	0.00
5	0.00	0.00	0.00	0.66	4.44	26.64	44.74	23.19	0.33	0.00	0.00	0.00
6	0.00	0.00	0.16	0.49	4.69	24.76	44.01	25.24	0.65	0.00	0.00	0.00
7	0.00	0.00	0.32	0.32	4.05	22.85	42.30	28.85	1.30	0.00	0.00	0.00
8	0.00	0.00	0.33	0.33	3.93	20.33	41.64	31.64	1.64	0.16	0.00	0.00
9	0.00	0.00	0.00	0.65	2.94	17.32	38.89	37.09	2.94	0.16	0.00	0.00
10	0.00	0.00	0.00	0.66	2.63	15.93	37.11	37.27	5.91	0.49	0.00	0.00
11	0.00	0.00	0.00	0.66	2.13	13.44	38.36	38.69	6.23	0.49	0.00	0.00
12	0.00	0.00	0.00	0.49	1.63	11.11	38.40	40.52	7.19	0.65	0.00	0.00
13	0.00	0.00	0.00	0.50	1.49	10.56	37.13	41.25	8.42	0.66	0.00	0.00
14	0.00	0.00	0.00	0.49	1.47	10.10	38.76	41.21	7.33	0.65	0.00	0.00
15	0.00	0.00	0.00	0.49	2.10	9.22	38.67	41.26	7.77	0.49	0.00	0.00
16	0.00	0.00	0.00	0.65	1.94	10.82	40.87	39.42	5.98	0.32	0.00	0.00
17	0.00	0.00	0.00	0.65	1.79	14.33	39.74	38.27	4.72	0.49	0.00	0.00
18	0.00	0.00	0.00	0.65	2.10	17.26	40.00	36.45	3.23	0.32	0.00	0.00
19	0.00	0.00	0.00	0.65	2.42	17.61	43.13	33.93	1.78	0.48	0.00	0.00
20	0.00	0.00	0.00	0.64	2.73	18.49	45.82	31.03	1.29	0.00	0.00	0.00
21	0.00	0.00	0.00	0.65	2.75	19.58	45.47	30.42	0.97	0.16	0.00	0.00
22	0.00	0.00	0.00	0.64	2.72	20.29	45.53	29.87	0.80	0.16	0.00	0.00
23	0.00	0.00	0.00	0.64	3.22	21.38	45.66	28.46	0.48	0.16	0.00	0.00

NUMBER OF OBSERVATIONS=14781

PERIOD OF RECORD 10/79 THROUGH 9/81

TABLE 2.3-6

MEAN TEMPERATURES AND RELATIVE HUMIDITIES FOR OLYMPIA AND WNP-3 SITE, OCTOBER 1979 - SEPTEMBER 1980

	Temperature (^{o}F)						Mean Monthly Dew Point (^{o}F)		Relative Humidity (%)	
	Average Daily				Average Monthly					
	Maximum		Minimum							
Month	WNP-3	Olympia	WNP-3	Olympia	WNP-3	Olympia	WNP-3	Olympia	WNP-3	Olympia
Oct	60.3	62.1	47.1	41.2	53.1	51.7	49	47	86	89
Nov	49.2	48.9	36.9	31.4	43.0	40.2	38	37	82	91
Dec	48.1	48.7	38.7	33.8	43.6	41.3	41	39	89	91
Jan	40.5	40.2	29.6	23.0	35.2	31.6	27	27	74	85
Feb	48.2	47.8	38.4	31.8	43.4	39.8	40	38	88	92
Mar	48.7	51.0	38.0	33.0	43.1	42.0	38	37	84	83
Apr	58.1	62.2	40.7	35.5	49.1	48.9	38	40	66	73
May	58.1	65.5	45.3	40.1	51.2	52.8	39	44	65	75
Jun	60.6	66.2	48.8	46.4	54.3	56.3	43	49	66	78
Jul	68.5	76.2	52.7	49.5	59.5	62.9	48	53	66	73
Aug	64.9	74.7	51.6	49.8	57.0	62.3	48	51	73	72
Sep	64.3	71.6	50.7	47.5	56.8	59.6	48	52	73	80

TABLE 2.3-7A

COMPOSITE MONTHLY FREQUENCY DISTRIBUTION OF WINDSPEED VS. DIRECTION, 10-METER LEVEL, JANUARY

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.47	1.02	0.94	1.18	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.76
NNE	0.00	0.94	0.71	1.41	1.41	0.55	0.63	0.00	0.00	0.00	0.00	0.00	0.00	5.65
NE	0.00	0.94	0.86	2.12	2.20	2.82	2.12	0.08	0.00	0.00	0.00	0.00	0.00	11.14
ENE	0.00	1.33	1.41	2.59	3.69	3.37	2.12	0.16	0.00	0.00	0.00	0.00	0.00	14.67
E	0.00	1.02	0.31	1.88	2.51	2.98	2.82	0.47	0.00	0.00	0.00	0.00	0.00	12.00
ESE	0.00	0.47	0.63	1.41	0.63	0.63	1.80	0.47	0.00	0.00	0.00	0.00	0.00	6.04
SE	0.00	0.63	0.55	1.25	1.02	1.25	0.31	0.55	0.00	0.00	0.00	0.00	0.00	5.57
SSE	0.00	0.39	0.55	0.55	0.94	0.78	0.39	0.00	0.00	0.00	0.00	0.00	0.00	3.61
S	0.00	0.71	0.47	1.41	0.86	1.33	0.94	0.39	0.00	0.00	0.00	0.00	0.00	6.12
SSW	0.00	1.10	0.63	1.49	2.98	1.49	1.10	0.08	0.24	0.31	0.00	0.00	0.00	9.41
SW	0.00	0.24	0.16	0.39	0.31	0.24	0.16	0.47	0.08	0.08	0.00	0.00	0.00	2.12
WSW	0.00	0.00	0.08	0.24	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71
W	0.00	0.08	0.08	0.08	0.39	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.94
WNW	0.00	0.16	0.16	0.08	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71
NW	0.00	0.63	0.39	0.31	0.08	0.08	0.16	0.00	0.00	0.00	0.00	0.00	0.00	1.65
NNW	0.00	0.08	0.24	0.39	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.86
CALMS	15.06													15.06
TOTAL	15.06	9.18	8.24	16.55	18.75	16.31	12.55	2.67	0.31	0.39	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 1275
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-7B

COMPOSITE MONTHLY FREQUENCY DISTRIBUTION OF WINDSPEED VS. DIRECTION, 10-METER LEVEL, FEBRUARY

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.24	0.24	0.40	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.21
NNE	0.00	0.56	0.32	0.48	0.72	0.16	0.32	0.00	0.00	0.00	0.00	0.00	0.00	2.57
NE	0.00	0.48	0.72	0.48	1.05	1.05	0.88	0.16	0.00	0.00	0.00	0.00	0.00	4.82
ENE	0.00	0.56	0.88	0.88	1.69	1.13	2.01	0.16	0.00	0.00	0.00	0.00	0.00	7.32
E	0.00	0.64	1.37	1.93	2.65	1.93	2.89	0.08	0.00	0.00	0.00	0.00	0.00	11.50
ESE	0.00	1.21	1.21	1.37	3.46	1.61	2.73	0.24	0.00	0.00	0.00	0.00	0.00	11.82
SE	0.00	1.05	1.05	1.05	3.14	2.01	1.37	0.24	0.00	0.00	0.00	0.00	0.00	9.89
SSE	0.00	0.64	1.05	1.05	0.88	0.48	0.88	0.08	0.00	0.00	0.00	0.00	0.00	5.06
S	0.00	0.48	0.64	0.64	1.93	1.21	1.45	0.32	0.00	0.00	0.00	0.00	0.00	6.67
SSW	0.00	0.96	0.64	0.80	1.21	0.88	2.41	1.93	0.32	0.00	0.00	0.00	0.00	9.16
SW	0.00	0.56	1.13	0.48	0.32	0.88	2.89	3.54	1.53	0.56	0.00	0.00	0.00	11.90
WSW	0.00	0.48	0.56	0.40	0.64	0.24	1.37	0.48	0.00	0.00	0.00	0.00	0.00	4.18
W	0.00	0.08	0.24	0.40	0.16	0.24	0.08	0.32	0.00	0.00	0.00	0.00	0.00	1.53
WNW	0.00	0.24	0.08	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48
NW	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16
NNW	0.00	0.32	0.16	0.24	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80
CALMS	10.93													10.93
TOTAL	10.93	8.68	10.29	10.77	18.25	11.82	19.29	7.56	1.85	0.56	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 1244
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-7C

COMPOSITE MONTHLY FREQUENCY DISTRIBUTION OF WINDSPEED VS. DIRECTION, 10-METER LEVEL, MARCH

WIND DIRECTION	WIND SPEED (M/SEC)													
	CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.34	0.61	0.74	0.41	0.14	0.07	0.00	0.00	0.00	0.00	0.00	0.00	2.30
NNE	0.00	0.20	0.14	0.74	0.54	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.82
NE	0.00	0.47	0.54	0.34	0.81	0.47	0.81	0.00	0.00	0.00	0.00	0.00	0.00	3.44
ENE	0.00	0.07	0.27	0.34	0.54	0.81	1.82	0.74	0.20	0.00	0.00	0.00	0.00	4.79
E	0.00	0.27	0.47	0.74	0.95	0.95	1.62	0.47	0.00	0.00	0.00	0.00	0.00	5.47
ESE	0.00	0.34	0.27	0.81	0.54	0.54	0.81	0.27	0.00	0.00	0.00	0.00	0.00	3.58
SE	0.00	0.54	0.88	0.27	0.68	0.54	0.81	0.34	0.07	0.00	0.00	0.00	0.00	4.12
SSE	0.00	0.74	0.47	1.15	1.01	0.74	0.95	0.14	0.00	0.00	0.00	0.00	0.00	5.20
S	0.00	0.20	1.15	1.28	1.35	0.81	1.08	0.34	0.00	0.00	0.00	0.00	0.00	6.21
SSW	0.00	1.55	1.76	1.42	2.63	1.69	3.85	2.97	0.07	0.00	0.00	0.00	0.00	15.94
SW	0.00	0.88	1.42	2.16	3.65	3.11	4.25	1.62	0.61	0.14	0.00	0.00	0.00	17.83
WSW	0.00	0.41	1.22	1.69	2.70	1.55	1.82	0.88	0.07	0.07	0.00	0.00	0.00	10.40
W	0.00	0.74	0.54	0.47	1.42	0.74	0.95	0.00	0.07	0.00	0.00	0.00	0.00	4.93
WNW	0.00	0.20	0.47	0.34	0.88	0.88	0.61	0.20	0.00	0.00	0.00	0.00	0.00	3.58
NW	0.00	0.20	0.41	0.34	0.68	0.68	0.54	0.00	0.00	0.00	0.00	0.00	0.00	2.84
NNW	0.00	0.61	0.47	0.20	0.54	0.14	0.27	0.00	0.00	0.00	0.00	0.00	0.00	2.23
CALMS	5.33													5.33
TOTAL	5.33	7.77	11.07	13.03	19.31	13.98	20.26	7.97	1.08	0.20	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 1481
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-7D

COMPOSITE MONTHLY FREQUENCY DISTRIBUTION OF WINDSPEED VS. DIRECTION, 10-METER LEVEL, APRIL

WIND DIRECTION	WIND SPEED (M/SEC)													
	CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.51	0.58	0.44	0.58	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.26
NNE	0.00	0.44	0.44	0.66	0.80	0.51	0.22	0.00	0.00	0.00	0.00	0.00	0.00	3.06
NE	0.00	0.44	0.15	0.58	0.73	0.58	1.02	0.66	0.00	0.00	0.00	0.00	0.00	4.15
ENE	0.00	0.22	0.15	0.36	1.24	0.73	1.75	0.51	0.00	0.00	0.00	0.00	0.00	4.95
E	0.00	0.29	0.66	0.36	1.02	1.09	0.36	0.15	0.00	0.00	0.00	0.00	0.00	3.93
ESE	0.00	0.36	0.29	0.44	0.44	0.36	0.73	0.07	0.00	0.00	0.00	0.00	0.00	2.69
SE	0.00	0.36	0.51	0.58	0.51	0.36	0.58	0.36	0.00	0.00	0.00	0.00	0.00	3.28
SSE	0.00	0.66	0.58	0.58	1.09	0.36	0.73	0.29	0.00	0.00	0.00	0.00	0.00	4.30
S	0.00	0.66	0.66	1.68	2.11	2.40	2.84	0.95	0.00	0.00	0.00	0.00	0.00	11.29
SSW	0.00	1.09	0.95	1.75	3.28	4.08	6.55	2.77	0.00	0.00	0.00	0.00	0.00	20.47
SW	0.00	0.58	0.73	1.02	1.60	2.48	3.06	1.60	0.00	0.00	0.00	0.00	0.00	11.07
WSW	0.00	0.58	0.73	0.44	1.17	1.97	1.09	0.07	0.00	0.00	0.00	0.00	0.00	6.05
W	0.00	0.66	0.44	0.15	1.09	2.18	1.68	0.00	0.00	0.00	0.00	0.00	0.00	6.19
WNW	0.00	0.58	0.36	0.29	1.02	0.87	0.80	0.00	0.00	0.00	0.00	0.00	0.00	3.93
NW	0.00	0.36	0.15	0.58	0.58	0.29	0.44	0.07	0.00	0.00	0.00	0.00	0.00	2.48
NNW	0.00	0.22	0.29	0.22	0.44	0.15	0.07	0.00	0.00	0.00	0.00	0.00	0.00	1.38
CALMS	8.52													8.52
TOTAL	8.52	8.01	7.65	10.12	17.70	18.57	21.92	7.50	0.00	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 1373
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-7E

COMPOSITE MONTHLY FREQUENCY DISTRIBUTION OF WINDSPEED VS. DIRECTION, 10-METER LEVEL, MAY

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.71	0.71	0.71	0.95	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.24
NNE	0.00	0.55	0.39	0.79	1.10	0.47	0.24	0.00	0.00	0.00	0.00	0.00	0.00	3.55
NE	0.00	0.39	0.24	0.63	0.95	0.71	0.79	0.16	0.00	0.00	0.00	0.00	0.00	3.87
ENE	0.00	0.24	0.16	0.71	0.63	0.16	0.47	0.00	0.00	0.00	0.00	0.00	0.00	2.37
E	0.00	0.00	0.32	0.39	0.63	0.71	0.32	0.00	0.00	0.00	0.00	0.00	0.00	2.37
ESE	0.00	0.24	0.00	0.16	0.32	0.47	0.55	0.00	0.00	0.00	0.00	0.00	0.00	1.74
SE	0.00	0.00	0.24	0.24	0.63	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	1.50
SSE	0.00	0.55	0.16	0.63	0.47	0.32	0.16	0.00	0.00	0.00	0.00	0.00	0.00	2.29
S	0.00	1.03	0.87	1.97	1.82	1.10	1.10	0.16	0.00	0.00	0.00	0.00	0.00	8.05
SSW	0.00	1.10	1.42	3.31	6.63	5.92	4.58	0.63	0.00	0.00	0.00	0.00	0.00	23.60
SW	0.00	0.71	0.95	1.89	3.55	4.58	2.53	0.39	0.00	0.00	0.00	0.00	0.00	14.60
WSW	0.00	0.16	0.39	1.10	2.76	2.53	1.34	0.00	0.00	0.00	0.00	0.00	0.00	8.29
W	0.00	0.24	0.39	0.79	2.45	2.53	1.50	0.00	0.00	0.00	0.00	0.00	0.00	7.89
WNW	0.00	0.32	0.24	0.55	2.37	1.74	1.10	0.00	0.00	0.00	0.00	0.00	0.00	6.31
NW	0.00	0.16	0.32	0.39	0.79	0.55	0.39	0.00	0.00	0.00	0.00	0.00	0.00	2.60
NNW	0.00	0.55	0.16	0.55	0.39	0.47	0.08	0.00	0.00	0.00	0.00	0.00	0.00	2.21
CALMS	5.52													5.52
TOTAL	5.52	6.95	6.95	14.84	26.44	22.42	15.55	1.34	0.00	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 1267
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-7F

COMPOSITE MONTHLY FREQUENCY DISTRIBUTION OF WINDSPEED VS. DIRECTION, 10-METER LEVEL, JUNE

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.51	0.37	0.51	0.95	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.56
NNE	0.00	0.37	0.29	0.51	0.37	0.29	0.07	0.00	0.00	0.00	0.00	0.00	0.00	1.90
NE	0.00	0.44	0.00	0.29	0.59	0.29	0.29	0.00	0.00	0.00	0.00	0.00	0.00	1.90
ENE	0.00	0.00	0.22	0.29	0.73	0.07	0.44	0.07	0.00	0.00	0.00	0.00	0.00	1.83
E	0.00	0.29	0.00	0.15	0.66	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.32
ESE	0.00	0.00	0.37	0.29	0.44	0.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.76
SE	0.00	0.00	0.29	0.07	0.22	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.73
SSE	0.00	0.59	0.44	0.51	0.37	0.29	0.07	0.00	0.00	0.00	0.00	0.00	0.00	2.27
S	0.00	0.73	0.59	1.76	2.78	0.95	1.17	0.00	0.00	0.00	0.00	0.00	0.00	7.97
SSW	0.00	0.88	2.05	3.73	7.46	7.39	7.61	0.88	0.00	0.00	0.00	0.00	0.00	29.99
SW	0.00	0.37	0.37	1.46	3.88	2.85	3.58	0.44	0.00	0.00	0.00	0.00	0.00	12.95
WSW	0.00	0.07	0.00	1.68	3.00	2.85	1.46	0.00	0.00	0.00	0.00	0.00	0.00	9.07
W	0.00	0.22	0.07	0.88	2.93	3.15	1.83	0.07	0.00	0.00	0.00	0.00	0.00	9.14
WNW	0.00	0.22	0.44	0.44	1.68	2.78	1.10	0.00	0.00	0.00	0.00	0.00	0.00	6.66
NW	0.00	0.07	0.37	0.37	1.54	0.88	0.29	0.00	0.00	0.00	0.00	0.00	0.00	3.51
NNW	0.00	0.22	0.66	0.29	0.80	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.19
CALMS	4.24													4.24
TOTAL	4.24	4.97	6.51	13.24	28.38	23.19	18.00	1.46	0.00	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 1367
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-7G

COMPOSITE MONTHLY FREQUENCY DISTRIBUTION OF WINDSPEED VS. DIRECTION, 10-METER LEVEL, JULY

WIND DIRECTION	WIND SPEED (M/SEC)													
	CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.21	0.28	0.35	0.69	0.63	0.07	0.00	0.00	0.00	0.00	0.00	0.00	2.22
NNE	0.00	0.00	0.21	0.21	0.35	0.69	0.42	0.00	0.00	0.00	0.00	0.00	0.00	1.88
NE	0.00	0.07	0.07	0.21	0.63	0.42	0.35	0.07	0.00	0.00	0.00	0.00	0.00	1.81
ENE	0.00	0.07	0.00	0.21	0.49	0.07	0.76	0.21	0.00	0.00	0.00	0.00	0.00	1.81
E	0.00	0.00	0.00	0.00	0.00	0.14	0.21	0.07	0.00	0.00	0.00	0.00	0.00	0.42
ESE	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
SE	0.00	0.00	0.07	0.07	0.28	0.21	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.90
SSE	0.00	0.21	0.21	0.42	0.21	0.07	0.14	0.00	0.00	0.00	0.00	0.00	0.00	1.25
S	0.00	0.21	0.83	1.53	1.39	0.69	0.28	0.00	0.00	0.00	0.00	0.00	0.00	4.93
SSW	0.00	2.08	1.46	2.29	7.57	7.36	6.11	0.69	0.00	0.00	0.00	0.00	0.00	27.57
SW	0.00	0.63	0.83	1.67	3.75	3.61	2.99	0.14	0.00	0.00	0.00	0.00	0.00	13.61
WSW	0.00	0.49	0.56	1.04	2.15	2.64	1.18	0.00	0.00	0.00	0.00	0.00	0.00	8.06
W	0.00	0.56	0.21	1.18	2.43	2.99	2.36	0.00	0.00	0.00	0.00	0.00	0.00	9.72
WNW	0.00	0.35	0.21	0.56	2.57	2.71	0.76	0.00	0.00	0.00	0.00	0.00	0.00	7.15
NW	0.00	0.14	0.14	0.35	1.18	2.78	1.39	0.00	0.00	0.00	0.00	0.00	0.00	5.97
NNW	0.00	0.42	0.21	0.56	0.35	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.15
CALMS	10.42													10.42
TOTAL	10.42	5.56	5.28	10.63	24.03	25.63	17.29	1.18	0.00	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 1440
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-7H

COMPOSITE MONTHLY FREQUENCY DISTRIBUTION OF WINDSPEED VS. DIRECTION, 10-METER LEVEL, AUGUST

WIND DIRECTION	WIND SPEED (M/SEC)													
	CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.14	0.70	2.09	2.72	1.26	0.28	0.00	0.00	0.00	0.00	0.00	0.00	7.19
NNE	0.00	0.21	0.21	0.91	0.77	0.56	0.49	0.00	0.00	0.00	0.00	0.00	0.00	3.14
NE	0.00	0.14	0.28	0.49	0.42	0.70	0.84	0.07	0.00	0.00	0.00	0.00	0.00	2.93
ENE	0.00	0.28	0.07	0.21	0.07	0.07	0.35	0.07	0.00	0.00	0.00	0.00	0.00	1.12
E	0.00	0.07	0.14	0.14	0.07	0.14	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.63
ESE	0.00	0.14	0.07	0.07	0.28	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.70
SE	0.00	0.14	0.00	0.14	0.28	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.63
SSE	0.00	0.28	0.14	0.42	0.21	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.12
S	0.00	0.42	0.98	0.98	1.74	0.84	0.35	0.07	0.00	0.00	0.00	0.00	0.00	5.37
SSW	0.00	0.63	0.91	2.23	9.28	8.86	5.09	0.42	0.07	0.00	0.00	0.00	0.00	27.49
SW	0.00	0.42	0.56	2.23	4.33	3.49	1.67	0.14	0.00	0.00	0.00	0.00	0.00	12.84
WSW	0.00	0.28	0.63	1.88	3.21	1.81	0.77	0.00	0.00	0.00	0.00	0.00	0.00	8.58
W	0.00	0.35	0.14	1.19	3.21	2.51	0.49	0.00	0.00	0.00	0.00	0.00	0.00	7.82
WNW	0.00	0.14	0.35	0.91	3.28	2.65	1.05	0.00	0.00	0.00	0.00	0.00	0.00	8.37
NW	0.00	0.14	0.56	0.98	2.23	2.09	0.91	0.00	0.00	0.00	0.00	0.00	0.00	6.91
NNW	0.00	0.21	0.14	0.77	1.67	0.91	0.07	0.00	0.00	0.00	0.00	0.00	0.00	3.77
CALMS	1.33													1.33
TOTAL	1.33	3.98	5.86	15.63	33.78	26.03	12.49	0.84	0.07	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 1433
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-7I

COMPOSITE MONTHLY FREQUENCY DISTRIBUTION OF WINDSPEED VS. DIRECTION, 10-METER LEVEL, SEPTEMBER

WIND DIRECTION	CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
	WIND SPEED (M/SEC)													
N	0.00	0.57	0.85	0.78	1.70	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.40
NNE	0.00	0.64	0.71	1.14	0.92	0.71	0.07	0.00	0.00	0.00	0.00	0.00	0.00	4.19
NE	0.00	0.43	0.28	0.71	1.14	1.14	0.99	0.14	0.00	0.00	0.00	0.00	0.00	4.83
ENE	0.00	0.28	0.43	0.71	1.42	1.35	1.77	0.50	0.00	0.00	0.00	0.00	0.00	6.46
E	0.00	0.50	0.43	0.64	1.42	0.64	0.85	0.07	0.00	0.00	0.00	0.00	0.00	4.54
ESE	0.00	0.50	0.64	0.78	0.28	0.14	0.28	0.00	0.00	0.00	0.00	0.00	0.00	2.63
SE	0.00	0.07	0.35	0.57	0.78	0.28	0.14	0.00	0.00	0.00	0.00	0.00	0.00	2.20
SSE	0.00	0.85	0.57	0.92	0.35	0.71	0.14	0.00	0.00	0.00	0.00	0.00	0.00	3.55
S	0.00	1.28	0.85	2.48	1.92	1.49	0.43	0.00	0.00	0.00	0.00	0.00	0.00	8.45
SSW	0.00	1.21	0.85	2.63	5.25	5.96	6.32	3.48	0.14	0.00	0.00	0.00	0.00	25.83
SW	[illegible]	0.78	1.06	1.63	3.12	2.48	1.14	0.07	0.00	0.00	0.00	0.00	0.00	10.29
WSW	0.00	0.64	0.43	0.85	1.49	0.50	0.71	0.00	0.00	0.00	0.00	0.00	0.00	4.61
W	0.00	0.57	0.43	0.50	1.35	1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.97
WNW	0.00	0.43	0.14	0.92	1.42	1.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.19
NW	0.00	0.50	0.50	0.78	0.78	0.85	0.57	0.00	0.00	0.00	0.00	0.00	0.00	3.97
NNW	0.00	0.43	0.85	0.99	0.78	0.50	0.07	0.00	0.00	0.00	0.00	0.00	0.00	3.62
CALMS	2.27													2.27
TOTAL	2.27	9.65	9.37	17.03	24.13	19.66	13.48	4.26	0.14	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 1409
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-7J

COMPOSITE MONTHLY FREQUENCY DISTRIBUTION OF WINDSPEED VS. DIRECTION, 10-METER LEVEL, OCTOBER

WIND DIRECTION	CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
	WIND SPEED (M/SEC)													
N	0.00	0.69	0.90	0.76	0.83	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.31
NNE	0.00	0.69	0.90	1.59	1.38	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.90
NE	0.00	0.62	0.97	1.80	1.52	1.24	0.76	0.00	0.00	0.00	0.00	0.00	0.00	6.91
ENE	0.00	0.55	1.10	1.38	1.66	2.00	2.62	1.59	0.00	0.00	0.00	0.00	0.00	10.91
E	0.00	0.62	1.24	1.45	1.17	1.10	4.14	0.35	0.00	0.00	0.00	0.00	0.00	10.08
ESE	0.00	0.69	0.35	0.69	1.04	1.10	0.97	0.00	0.00	0.00	0.00	0.00	0.00	4.83
SE	0.00	0.90	0.62	1.17	0.97	0.83	1.45	0.62	0.00	0.00	0.00	0.00	0.00	6.56
SSE	0.00	1.10	0.90	1.31	1.38	0.69	0.41	0.28	0.00	0.00	0.00	0.00	0.00	6.08
S	0.00	1.31	1.59	1.17	2.42	0.55	1.31	0.41	0.00	0.00	0.00	0.00	0.00	8.77
SSW	0.00	0.97	1.38	2.42	2.83	2.00	1.24	0.90	0.00	0.00	0.00	0.00	0.00	11.74
SW	0.00	0.76	1.10	1.10	0.55	0.35	0.41	0.07	0.00	0.00	0.00	0.00	0.00	4.35
WSW	0.00	0.76	0.35	0.69	0.62	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.49
W	0.00	0.83	0.48	0.62	1.10	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.31
WNW	0.00	0.35	0.55	0.55	0.83	0.48	0.07	0.00	0.00	0.00	0.00	0.00	0.00	2.83
NW	0.00	0.28	0.48	0.55	0.76	0.83	0.28	0.00	0.00	0.00	0.00	0.00	0.00	3.18
NNW	0.00	0.55	0.28	0.41	0.69	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00
CALMS	7.73													7.73
TOTAL	7.73	11.67	13.19	17.68	19.75	12.09	13.67	4.21	0.00	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 1448
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-7K

COMPOSITE MONTHLY FREQUENCY DISTRIBUTION OF WINDSPEED VS. DIRECTION, 10-METER LEVEL, NOVEMBER

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.28	0.64	0.93	0.36	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.28
NNE	0.00	0.21	0.71	1.28	1.14	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.85
NE	0.00	0.50	1.21	2.07	2.71	3.06	0.71	0.00	0.00	0.00	0.00	0.00	0.00	10.26
ENE	0.00	0.71	1.14	2.28	3.56	3.42	2.78	0.57	0.00	0.00	0.00	0.00	0.00	14.46
E	0.00	0.43	0.93	1.57	2.21	4.27	3.99	0.64	0.00	.00	0.00	0.00	0.00	14.03
ESE	0.00	0.57	1.07	1.50	1.57	1.78	2.49	0.07	0.00	0.00	0.00	0.00	0.00	9.05
SE	0.00	1.14	0.78	0.71	1.57	0.93	1.92	0.64	0.00	0.00	0.00	0.00	0.00	7.69
SSE	0.00	0.78	0.78	1.64	0.93	0.78	1.07	0.28	0.00	0.00	0.00	0.00	0.00	6.27
S	0.00	0.43	1.21	0.50	1.00	1.00	2.14	1.57	0.07	0.00	0.00	0.00	0.00	7.91
SSW	0.00	0.85	0.57	0.36	1.00	1.92	2.78	3.92	1.07	0.00	0.00	0.00	0.00	12.46
SW	0.00	0.14	0.43	0.57	0.36	0.43	0.36	0.14	0.00	0.00	0.00	0.00	0.00	2.42
WSW	0.00	0.28	0.28	0.50	0.28	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.42
W	0.00	0.50	0.07	0.36	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.07
WNW	0.00	0.07	0.21	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43
NW	0.00	0.14	0.14	0.07	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43
NNW	0.00	0.14	0.21	0.28	0.07	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78
CALMS	5.20													5.20
TOTAL	5.20	7.19	10.40	14.74	16.88	18.38	18.23	7.83	1.14	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 1404
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-7L

COMPOSITE MONTHLY FREQUENCY DISTRIBUTION OF WINDSPEED VS. DIRECTION, 10-METER LEVEL, DECEMBER

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.00	0.61	0.20	0.27	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.36
NNE	0.00	0.48	0.82	1.29	0.68	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.67
NE	0.00	0.61	1.09	0.95	2.31	1.77	0.68	0.00	0.00	0.00	0.00	0.00	0.00	7.41
ENE	0.00	0.27	1.02	1.97	4.08	3.20	2.92	0.07	0.00	0.00	0.00	0.00	0.00	13.53
E	0.00	0.54	1.02	2.11	2.86	1.90	1.50	0.20	0.00	0.00	0.00	0.00	0.00	10.13
ESE	0.00	0.54	0.54	1.02	1.50	1.29	2.24	0.27	0.00	0.00	0.00	0.00	0.00	7.41
SE	0.00	1.43	1.84	2.04	2.18	1.29	1.43	0.48	0.00	0.00	0.00	0.00	0.00	10.67
SSE	0.00	0.82	1.16	1.09	1.97	0.48	0.75	0.00	0.00	0.00	0.00	0.00	0.00	6.25
S	0.00	0.48	1.02	1.34	1.90	1.36	1.16	0.41	0.07	0.00	0.00	0.00	0.00	8.23
SSW	0.00	0.27	0.48	1.56	2.31	2.65	2.58	4.15	2.58	0.61	0.00	0.00	0.00	17.20
SW	0.00	0.27	0.20	0.82	0.95	0.61	0.61	0.61	0.27	0.14	0.00	0.00	0.00	4.49
WSW	0.00	0.07	0.14	0.20	0.14	0.14	0.27	0.14	0.00	0.00	0.00	0.00	0.00	1.09
W	0.00	0.07	0.14	0.07	0.14	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54
WNW	0.00	0.07	0.20	0.14	0.00	0.14	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.82
NW	0.00	0.20	0.34	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75
NNW	0.00	0.27	0.34	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95
CALMS	5.51													5.51
TOTAL	5.51	6.39	10.94	15.84	21.28	15.64	14.41	6.32	2.92	0.75	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 1471
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-8A

ANNUAL FREQUENCY DISTRIBUTION OF WIND SPEED VS. DIRECTION, 10-METER LEVEL, OCTOBER 1979 - SEPTEMBER 1980

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.35	0.59	0.59	0.69	0.21	0.06	0.00	0.00	0.00	0.00	0.00	0.00	2.49
NNE	0.00	0.51	0.37	0.60	0.47	0.17	0.04	0.00	0.00	0.00	0.00	0.00	0.00	2.16
NE	0.00	0.53	0.54	0.70	0.88	0.62	0.43	0.05	0.00	0.00	0.00	0.00	0.00	3.75
ENE	0.00	0.47	0.65	0.84	1.36	1.10	1.58	0.31	0.00	0.00	0.00	0.00	0.00	6.32
E	0.00	0.42	0.71	1.01	1.13	1.12	1.29	0.23	0.00	0.00	0.00	0.00	0.00	5.92
ESE	0.00	0.46	0.48	0.63	0.90	0.56	0.75	0.12	0.00	0.00	0.00	0.00	0.00	3.90
SE	0.00	0.60	0.69	0.74	1.16	0.70	1.00	0.46	0.01	0.00	0.00	0.00	0.00	5.36
SSE	0.00	0.77	0.66	0.92	0.84	0.49	0.51	0.07	0.00	0.00	0.00	0.00	0.00	4.27
S	0.00	0.70	1.15	1.54	1.80	0.82	0.87	0.19	0.00	0.00	0.00	0.00	0.00	7.07
SSW	0.00	1.01	1.28	2.52	5.25	4.65	3.32	1.15	0.34	0.12	0.00	0.00	0.00	19.63
SW	0.00	0.49	0.93	1.54	2.47	1.98	1.67	0.53	0.17	0.06	0.00	0.00	0.00	9.85
WSW	0.00	0.31	0.56	1.04	1.73	1.25	0.75	0.23	0.01	0.01	0.00	0.00	0.00	5.89
W	0.00	0.31	0.34	0.54	1.54	1.38	0.48	0.05	0.01	0.00	0.00	0.00	0.00	4.66
WNW	0.00	0.22	0.27	0.37	1.51	1.34	0.41	0.02	0.00	0.00	0.00	0.00	0.00	4.14
NW	0.00	0.21	0.33	0.47	0.80	0.69	0.36	0.00	0.00	0.00	0.00	0.00	0.00	2.85
NNW	0.00	0.33	0.33	0.33	0.54	0.23	0.05	0.00	0.00	0.00	0.00	0.00	0.00	1.80
CALMS	9.95													9.95
TOTAL	9.95	7.70	9.87	14.39	23.08	17.29	13.56	3.41	0.54	0.19	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 8288
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1980

TABLE 2.3-8B

ANNUAL FREQUENCY DISTRIBUTION OF WIND SPEED VS. DIRECTION, 10-METER LEVEL, OCTOBER 1980 - SEPTEMBER 1981

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.42	0.66	0.89	1.14	0.42	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3.54
NNE	0.00	0.36	0.60	1.24	1.21	0.73	0.36	0.00	0.00	0.00	0.00	0.00	0.00	4.51
NE	0.00	0.38	0.53	1.07	1.62	1.74	1.25	0.17	0.00	0.00	0.00	0.00	0.00	6.76
ENE	0.00	0.28	0.48	1.13	1.92	1.63	1.74	0.48	0.04	0.00	0.00	0.00	0.00	7.70
E	0.00	0.35	0.43	0.86	1.53	1.53	1.83	0.19	0.00	0.00	0.00	0.00	0.00	6.72
ESE	0.00	0.40	0.41	0.78	0.80	0.88	1.33	0.11	0.00	0.00	0.00	0.00	0.00	4.71
SE	0.00	0.44	0.52	0.62	0.85	0.58	0.47	0.10	0.00	0.00	0.00	0.00	0.00	3.58
SSE	0.00	0.50	0.50	0.80	0.80	0.47	0.44	0.11	0.00	0.00	0.00	0.00	0.00	3.64
S	0.00	0.61	0.68	1.33	1.74	1.45	1.49	0.58	0.02	0.00	0.00	0.00	0.00	7.92
SSW	0.00	1.11	0.91	1.48	3.52	3.77	5.08	2.72	0.43	0.04	0.00	0.00	0.00	19.05
SW	0.00	0.56	0.56	1.06	1.97	2.21	2.27	0.96	0.23	0.08	0.00	0.00	0.00	9.91
WSW	0.00	0.40	0.35	0.77	1.38	1.14	0.91	0.04	0.00	0.00	0.00	0.00	0.00	4.99
W	0.00	0.52	0.20	0.58	1.27	1.32	1.00	0.01	0.00	0.00	0.00	0.00	0.00	4.90
WNW	0.00	0.30	0.31	0.48	0.85	0.99	0.55	0.01	0.00	0.00	0.00	0.00	0.00	3.50
NW	0.00	0.29	0.31	0.36	0.66	0.86	0.48	0.01	0.00	0.00	0.00	0.00	0.00	2.98
NNW	0.00	0.35	0.35	0.55	0.47	0.30	0.05	0.00	0.00	0.00	0.00	0.00	0.00	2.07
CALMS	3.53													3.53
TOTAL	3.53	7.27	7.82	14.01	21.76	20.03	19.27	5.48	0.72	0.12	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 8324
PERIOD OF RECORD IS FROM OCTOBER 1, 1980 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-9A

ANNUAL FREQUENCY DISTRIBUTION OF WIND SPEED VS. DIRECTION, 10-METER LEVEL

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.39	0.63	0.74	0.92	0.31	0.04	0.00	0.00	0.00	0.00	0.00	0.00	3.02
NNE	0.00	0.43	0.49	0.92	0.84	0.45	0.20	0.00	0.00	0.00	0.00	0.00	0.00	3.33
NE	0.00	0.46	0.54	0.88	1.25	1.18	0.84	0.11	0.00	0.00	0.00	0.00	0.00	5.26
ENE	0.00	0.37	0.57	0.99	1.64	1.37	1.66	0.40	0.02	0.00	0.00	0.00	0.00	7.01
E	0.00	0.39	0.57	0.94	1.33	1.32	1.56	0.21	0.00	0.00	0.00	0.00	0.00	6.32
ESE	0.00	0.43	0.45	0.70	0.85	0.72	1.04	0.11	0.00	0.00	0.00	0.00	0.00	4.30
SE	0.00	0.52	0.60	0.68	1.01	0.64	0.73	0.28	0.01	0.00	0.00	0.00	0.00	4.47
SSE	0.00	0.64	0.58	0.86	0.82	0.48	0.48	0.09	0.00	0.00	0.00	0.00	0.00	3.95
S	0.00	0.66	0.92	1.44	1.77	1.14	1.18	0.39	0.01	0.00	0.00	0.00	0.00	7.49
SSW	0.00	1.06	1.10	2.00	4.38	4.21	4.20	1.93	0.39	0.08	0.00	0.00	0.00	19.34
SW	0.00	0.53	0.75	1.30	2.22	2.09	1.97	0.75	0.20	0.07	0.00	0.00	0.00	9.88
WSW	0.00	0.36	0.45	0.90	1.55	1.20	0.83	0.13	0.01	0.01	0.00	0.00	0.00	5.44
W	0.00	0.42	0.27	0.56	1.41	1.35	0.74	0.03	0.01	0.00	0.00	0.00	0.00	4.78
WNW	0.00	0.26	0.29	0.43	1.18	1.16	0.48	0.02	0.00	0.00	0.00	0.00	0.00	3.82
NW	0.00	0.25	0.32	0.42	0.73	0.78	0.42	0.01	0.00	0.00	0.00	0.00	0.00	2.91
NNW	0.00	0.34	0.34	0.44	0.51	0.26	0.05	0.00	0.00	0.00	0.00	0.00	0.00	1.93
CALMS	6.74													6.74
TOTAL	6.74	7.48	8.84	14.20	22.42	18.66	16.42	4.45	0.63	0.16	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 16612
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-9B

ANNUAL FREQUENCY DISTRIBUTION OF WIND SPEED VS. DIRECTION, 60-METER LEVEL

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.13	0.15	0.21	0.34	0.21	0.18	0.01	0.00	0.00	0.00	0.00	0.00	1.23
NNE	0.00	0.14	0.16	0.30	0.38	0.26	0.23	0.04	0.00	0.00	0.00	0.00	0.00	1.50
NE	0.00	0.21	0.20	0.46	0.79	0.61	1.47	1.46	0.18	0.02	0.04	0.00	0.00	5.43
ENE	0.00	0.23	0.29	0.51	1.16	1.44	3.78	4.29	0.81	0.02	0.00	0.00	0.00	12.53
E	0.00	0.17	0.29	0.37	1.00	0.97	2.35	2.13	0.21	0.00	0.00	0.01	0.00	7.50
ESE	0.00	0.16	0.17	0.40	0.64	0.59	1.38	1.61	0.14	0.01	0.00	0.00	0.00	5.09
SE	0.00	0.23	0.17	0.37	0.51	0.58	1.28	1.72	0.45	0.02	0.00	0.00	0.00	5.33
SSE	0.00	0.12	0.14	0.29	0.37	0.38	0.84	0.68	0.15	0.00	0.00	0.00	0.00	2.97
S	0.00	0.14	0.14	0.36	0.56	0.63	1.69	2.43	0.58	0.08	0.00	0.00	0.00	6.61
SSW	0.00	0.08	0.10	0.23	0.59	0.84	1.89	2.64	0.84	0.46	0.11	0.00	0.00	7.77
SW	0.00	0.07	0.07	0.23	0.54	0.77	2.45	3.15	0.94	0.39	0.08	0.00	0.00	8.67
WSW	0.00	0.14	0.11	0.27	0.62	0.96	3.57	7.39	3.45	0.66	0.06	0.00	0.00	17.22
W	0.00	0.10	0.11	0.27	0.56	0.88	2.20	4.43	3.13	0.57	0.00	0.00	0.00	12.27
WNW	0.00	0.09	0.12	0.25	0.30	0.31	0.39	0.14	0.05	0.01	0.00	0.00	0.00	1.66
NW	0.00	0.09	0.15	0.16	0.26	0.20	0.14	0.02	0.00	0.00	0.00	0.00	0.00	1.02
NNW	0.00	0.10	0.05	0.23	0.25	0.17	0.11	0.02	0.00	0.00	0.00	0.00	0.00	0.92
CALMS	2.27													2.27
TOTAL	2.27	2.21	2.40	4.92	8.88	9.80	23.93	32.13	10.93	2.23	0.28	0.01	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 16844
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-10

JOINT FREQUENCY (percent) OF ANNUAL WINDS BY SPEED AND DIRECTION FOR OLYMPIA[a]

Dir	0 To 3	4 To 6	7 To 10	11 To 16	17 To 21	22 To 27	Over 27	Total	Ave Speed
	Windspeed (knots)								
N	2.0	1.8	0.7	*[b]				4.6	4.4
NNE	1.9	1.7	0.7	0.1	*			4.5	4.5
NE	2.4	2.6	1.2	0.2	*	*		6.4	4.8
ENE	1.0	1.1	0.6	0.1	*			2.8	5.0
E	1.0	0.6	0.2	*	*			1.8	3.8
ESE	1.0	0.5	0.1	*				1.5	3.2
SE	1.5	0.7	0.1	*	*	*		2.3	3.3
SSE	1.4	0.9	0.6	0.5	0.2	*		3.6	6.5
S	1.8	2.4	2.8	1.9	0.6	0.2	*	9.7	8.4
SSW	1.9	3.6	5.6	3.2	0.6	0.1	*	15.1	8.4
SW	2.1	4.5	6.0	3.0	0.4	0.1	*	16.7	7.9
WSW	1.1	1.8	2.6	1.7	0.2	*		7.4	8.1
W	0.7	0.9	0.9	0.6	0.1	*		3.2	7.4
WNW	0.5	0.5	0.4	0.2	*	*		1.7	6.5
NW	0.8	0.6	0.3	0.1	*	*		1.9	4.8
NNW	1.0	0.8	0.4	*	*			2.2	4.5
Calm	15.1							15.1	
Total	37.2	25.0	23.2	11.6	2.1	0.4	0.2	100.0+	5.8

(a) Period of record 1948 - 1964
(b) *Indicates more than 0, but less than 0.05

TABLE 2.3-11

RELATIONSHIP BETWEEN
STABILITY CLASSES AND TEMPERATURE CHANGE

Pasquill Classes	Turner Classes	Description	Delta-T With Height ($^{o}C/100m$)
A	1	Extremely Unstable	< 1.9
B	2	Moderately Unstable	-1.9 to -1.7
C	3	Slightly Unstable	-1.7 to -1.5
D	4	Neutral	-1.5 to -0.5
E	5	Slightly Stable	-0.5 to 1.5
F	6,7	Moderately Stable	1.5 to 4.0
G	-	Extremely Stable	> 4

TABLE 2.3-12

ANNUAL FREQUENCY DISTRIBUTION OF STABILITY CLASS VS. TIME OF DAY

HOUR	A	B	C	D	E	F	G
	+ - - - - - - -	- STABILITY	CLASS - - -	- - - - - +			
0	0.00	0.00	0.00	13.87	62.13	13.48	5.53
1	0.00	0.00	0.00	20.09	60.97	11.97	6.98
2	0.00	0.00	0.00	19.60	59.94	13.07	7.39
3	0.00	0.00	0.00	19.38	59.12	13.86	7.64
4	0.00	0.00	0.00	18.22	60.03	13.84	7.91
5	0.00	0.00	0.00	16.62	58.52	14.63	10.23
6	0.00	0.00	0.00	13.94	59.89	13.66	12.52
7	0.00	0.00	0.00	11.77	60.85	14.61	12.77
8	0.00	0.00	0.00	11.94	58.71	16.55	12.81
9	0.00	0.14	0.00	14.02	55.65	18.17	12.02
10	0.14	0.14	0.00	17.36	52.94	19.37	10.04
11	0.29	0.14	0.14	19.54	56.32	15.95	7.61
12	0.14	0.00	0.14	23.42	55.17	14.80	6.32
13	0.14	0.29	0.43	24.28	56.03	12.93	5.89
14	0.00	0.14	0.14	25.18	60.23	10.30	4.01
15	0.00	0.00	0.14	21.17	68.96	8.58	1.14
16	0.00	0.00	0.00	15.74	75.54	8.15	0.57
17	0.00	0.00	0.00	12.52	79.80	6.83	0.85
18	0.00	0.00	0.00	13.05	77.87	7.09	1.99
19	0.00	0.00	0.00	15.38	73.79	8.69	2.14
20	0.00	0.00	0.00	18.42	67.37	10.55	3.66
21	0.00	0.00	0.00	19.03	64.49	11.51	4.97
22	0.00	0.00	0.00	20.79	62.09	11.17	5.94
23	0.00	0.00	0.00	20.06	62.99	10.88	6.07

NUMBER OF OBSERVATIONS =16854
PERIOD OF RECORD 10/79 THROUGH 9/81

TABLE 2.3-13A

ANNUAL FREQUENCY DISTRIBUTION OF WIND SPEED VS. DIRECTION FOR STABILITY CLASS A

WIND DIRECTION	WIND SPEED (M/SEC)												
	CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NNE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NE	0.00	0.00	0.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00
ENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E	0.00	0.00	20.00	0.00	0.00	0.00	20.00	20.00	0.00	0.00	0.00	0.00	0.00	60.00
ESE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SSE	0.00	0.00	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.00
S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SSW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
W	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WNW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NNW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CALMS	0.00													0.00
TOTAL	0.00	0.00	40.00	0.00	0.00	0.00	40.00	20.00	0.00	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 5
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-13B

ANNUAL FREQUENCY DISTRIBUTION OF WIND SPEED VS. DIRECTION FOR STABILITY CLASS B

WIND DIRECTION	WIND SPEED (M/SEC)												
	CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NNE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ESE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SSE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SSW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
W	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WNW	0.00	0.00	0.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.00
NW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NNW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CALMS	50.00													50.00
TOTAL	50.00	0.00	0.00	50.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 2
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-13C

ANNUAL FREQUENCY DISTRIBUTION OF WIND SPEED VS. DIRECTION FOR STABILITY CLASS C

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NNE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E	0.00	0.00	0.00	0.00	0.00	0.00	14.29	0.00	0.00	0.00	0.00	0.00	0.00	14.29
ESE	0.00	0.00	0.00	0.00	0.00	14.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.29
SE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SSE	0.00	0.00	0.00	0.00	0.00	14.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.29
S	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SSW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WSW	0.00	0.00	0.00	0.00	0.00	14.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.29
W	0.00	0.00	0.00	0.00	14.29	0.00	28.57	0.00	0.00	0.00	0.00	0.00	0.00	42.86
WNW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NNW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CALMS	0.00													0.00
TOTAL	0.00	0.00	0.00	0.00	14.29	42.86	42.86	0.00	0.00	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 7
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-13D

ANNUAL FREQUENCY DISTRIBUTION OF WIND SPEED VS. DIRECTION FOR STABILITY CLASS D

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.08	0.17	0.38	0.55	0.13	0.17	0.00	0.00	0.00	0.00	0.00	0.00	1.47
NNE	0.00	0.17	0.13	0.29	0.13	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.80
NE	0.00	0.21	0.21	0.51	0.67	0.59	0.51	0.00	0.00	0.00	0.00	0.00	0.00	2.70
ENE	0.00	0.25	0.13	0.55	1.98	1.81	3.50	0.46	0.00	0.00	0.00	0.00	0.00	8.68
E	0.00	0.17	0.17	0.51	1.35	2.23	2.02	0.46	0.00	0.00	0.00	0.00	0.00	6.91
ESE	0.00	0.17	0.13	0.34	0.80	0.88	1.90	0.12	0.00	0.00	0.00	0.00	0.00	4.34
SE	0.00	0.08	0.38	0.42	1.05	0.34	1.01	0.42	0.00	0.00	0.00	0.00	0.00	3.71
SSE	0.00	0.13	0.25	0.29	0.51	0.21	0.42	0.08	0.00	0.00	0.00	0.00	0.00	1.90
S	0.00	0.25	0.51	0.67	1.22	0.34	0.38	0.21	0.00	0.00	0.00	0.00	0.00	3.58
SSW	0.00	0.93	1.26	2.91	7.59	7.46	6.07	1.90	0.80	0.38	0.00	0.00	0.00	29.29
SW	0.00	0.29	0.55	2.44	3.83	2.57	1.52	0.76	0.17	0.17	0.00	0.00	0.00	12.31
WSW	0.00	0.25	0.46	1.35	1.77	0.93	0.84	0.17	0.00	0.00	0.00	0.00	0.00	5.77
W	0.00	0.08	0.08	0.72	1.26	0.97	1.39	0.04	0.00	0.00	0.00	0.00	0.00	4.55
WNW	0.00	0.21	0.21	0.46	0.97	1.43	1.39	0.00	0.00	0.00	0.00	0.00	0.00	4.68
NW	0.00	0.13	0.25	0.80	0.38	0.51	0.72	0.04	0.00	0.00	0.00	0.00	0.00	2.82
NNW	0.00	0.17	0.29	0.38	0.38	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.26
CALMS	5.23													5.23
TOTAL	5.23	3.58	5.18	13.02	24.44	20.48	21.87	4.68	0.97	0.55	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 2373
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-13E

ANNUAL FREQUENCY DISTRIBUTION OF WIND SPEED VS. DIRECTION FOR STABILITY CLASS E

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.27	0.42	0.27	0.23	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	1.27
NNE	0.00	0.29	0.30	0.46	0.33	0.14	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.56
NE	0.00	0.41	0.48	0.80	1.22	1.05	0.86	0.16	0.00	0.00	0.00	0.00	0.00	4.97
ENE	0.00	0.33	0.55	1.00	1.78	1.44	1.60	0.49	0.03	0.00	0.00	0.00	0.00	7.23
E	0.00	0.33	0.52	1.04	1.48	1.34	1.81	0.21	0.00	0.00	0.00	0.00	0.00	6.73
ESE	0.00	0.34	0.42	0.70	1.01	0.81	1.13	0.14	0.00	0.00	0.00	0.00	0.00	4.56
SE	0.00	0.50	0.54	0.68	1.07	0.82	0.86	0.31	0.01	0.00	0.00	0.00	0.00	4.79
SSE	0.00	0.57	0.59	0.91	0.90	0.56	0.43	0.08	0.00	0.00	0.00	0.00	0.00	4.04
S	0.00	0.64	0.90	1.76	2.18	1.53	1.49	0.45	0.02	0.00	0.00	0.00	0.00	8.96
SSW	0.00	1.05	1.11	2.21	4.78	4.60	4.87	2.46	0.41	0.04	0.00	0.00	0.00	21.53
SW	0.00	0.51	0.75	1.31	2.44	2.53	2.59	0.94	0.26	0.07	0.00	0.00	0.00	11.41
WSW	0.00	0.27	0.40	0.91	1.74	1.48	1.05	0.15	0.01	0.01	0.00	0.00	0.00	6.02
W	0.00	0.32	0.29	0.54	1.42	1.62	0.74	0.04	0.01	0.00	0.00	0.00	0.00	4.97
WNW	0.00	0.17	0.23	0.39	1.18	1.05	0.39	0.03	0.00	0.00	0.00	0.00	0.00	3.42
NW	0.00	0.19	0.26	0.27	0.62	0.55	0.41	0.00	0.00	0.00	0.00	0.00	0.00	2.31
NNW	0.00	0.23	0.29	0.25	0.14	0.04	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.99
CALMS	5.23													5.23
TOTAL	5.23	6.41	8.04	13.50	22.54	19.63	18.33	5.45	0.74	0.12	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 11099
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-13F

ANNUAL FREQUENCY DISTRIBUTION OF WIND SPEED VS. DIRECTION FOR STABILITY CLASS F

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	1.02	1.17	1.90	1.46	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.24
NNE	0.00	0.93	1.22	2.34	2.44	1.61	0.98	0.00	0.00	0.00	0.00	0.00	0.00	9.51
NE	0.00	0.54	0.88	1.61	2.05	2.54	1.51	0.00	0.00	0.00	0.00	0.00	0.00	9.12
ENE	0.00	0.49	1.02	1.27	1.02	1.17	0.73	0.05	0.00	0.00	0.00	0.00	0.00	5.75
E	0.00	0.39	1.17	1.02	1.17	0.88	0.39	0.00	0.00	0.00	0.00	0.00	0.00	5.02
ESE	0.00	0.88	0.73	1.22	0.44	0.29	0.15	0.00	0.00	0.00	0.00	0.00	0.00	3.71
SE	0.00	0.93	1.12	1.02	0.98	0.29	0.10	0.10	0.00	0.00	0.00	0.00	0.00	4.53
SSE	0.00	1.51	0.88	1.46	1.07	0.49	1.02	0.20	0.00	0.00	0.00	0.00	0.00	6.63
S	0.00	1.37	1.41	1.37	1.07	0.49	1.07	0.44	0.00	0.00	0.00	0.00	0.00	7.22
SSW	0.00	1.37	1.12	0.88	0.78	0.54	0.59	0.15	0.00	0.00	0.00	0.00	0.00	5.41
SW	0.00	0.93	1.17	0.59	0.20	0.24	0.15	0.10	0.00	0.00	0.00	0.00	0.00	3.36
WSW	0.00	0.83	0.73	0.63	0.88	0.49	0.00	0.05	0.00	0.00	0.00	0.00	0.00	3.61
W	0.00	1.12	0.44	0.44	1.61	0.68	0.10	0.00	0.00	0.00	0.00	0.00	0.00	4.39
WNW	0.00	0.63	0.68	0.63	1.46	1.80	0.15	0.00	0.00	0.00	0.00	0.00	0.00	5.36
NW	0.00	0.39	0.59	0.78	1.32	1.90	0.29	0.00	0.00	0.00	0.00	0.00	0.00	5.27
NNW	0.00	0.73	0.73	0.83	1.07	0.34	0.10	0.00	0.00	0.00	0.00	0.00	0.00	3.80
CALMS	11.07													11.07
TOTAL	11.07	14.04	15.07	17.99	19.02	14.43	7.31	1.07	0.00	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 2051
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-128

ANNUAL FREQUENCY DISTRIBUTION OF WIND SPEED VS. DIRECTION FOR STABILITY CLASS G

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	1.03	2.70	4.19	7.74	2.61	0.09	0.00	0.00	0.00	0.00	0.00	0.00	18.36
NNE	0.00	1.38	1.86	4.38	4.66	2.33	0.75	0.00	0.00	0.00	0.00	0.00	0.00	15.56
NE	0.00	1.40	1.21	1.21	1.40	1.21	0.39	0.00	0.00	0.00	0.00	0.00	0.00	6.52
ENE	0.00	0.84	0.84	1.30	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.63
E	0.00	1.40	0.75	0.75	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.98
ESE	0.00	1.03	0.84	0.56	0.19	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.70
SE	0.00	1.03	0.75	0.56	0.28	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.70
SSE	0.00	0.84	0.65	0.47	0.28	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.42
S	0.00	0.37	1.03	0.00	0.09	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.58
SSW	0.00	0.84	0.56	0.00	0.09	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	1.58
SW	0.00	0.47	0.37	0.09	0.28	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.30
WSW	0.00	0.56	0.47	0.37	0.47	0.19	0.09	0.00	0.00	0.00	0.00	0.00	0.00	2.14
W	0.00	0.84	0.19	0.65	1.12	0.65	0.37	0.00	0.00	0.00	0.00	0.00	0.00	3.82
WNW	0.00	0.56	0.37	0.28	1.12	0.56	0.09	0.00	0.00	0.00	0.00	0.00	0.00	2.98
NW	0.00	0.84	0.56	0.37	1.49	1.58	0.09	0.00	0.00	0.00	0.00	0.00	0.00	4.94
NNW	0.00	1.12	0.19	1.77	3.45	2.98	0.09	0.00	0.00	0.00	0.00	0.00	0.00	9.60
CALMS	17.15													17.15
TOTAL	17.15	14.73	13.33	16.96	23.39	12.67	1.77	0.00	0.00	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 1073
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-14

MEAN SEASONAL AND ANNUAL MIXING HEIGHTS FOR SEATTLE[(a)]

	Time of day[(b)]	Mixing Height (m)		Percent Non-P[(c)]	Mean Wind Speed (m/sec)	
		Non-P	All		Non-P	All
Winter	M	626	824	49.8	5.1	6.2
	A	585	718	45.8	4.7	5.4
Spring	M	611	838	55.2	4.6	5.5
	A	1490	1577	56.5	5.7	6.2
Summer	M	532	576	85.1	4.0	4.2
	A	1398	1419	89.5	4.8	4.9
Autumn	M	476	585	61.5	4.3	5.0
	A	898	987	66.3	4.6	5.0
Annual	M	578	705	62.8	4.5	5.2
	A	1092	1175	64.5	4.9	5.4

(a) From Reference 2.3-7.

(b) M = Morning, A = Afternoon

(c) Non-P = Non-precipitating cases, All = All cases.
Non-precipitating cases exclude those in which precipitation occurred near time of measurement and exclude those with missing data and those for which no mixing height could be calculated.

TABLE 2.3-15

MONTHLY AND ANNUAL PRECIPITATION (inches) IN THE SITE VICINITY

Month	Aberdeen[a]	Elma[b] Max	Elma[b] Min	Elma[b] Mean	Oakville[c]	Olympia[d]
January	12.70	23.61	1.59	10.48	8.49	7.93
February	10.23	14.96	2.34	7.95	8.56	5.97
March	9.19	13.16	0.82	7.22	5.70	4.81
April	5.56	8.17	0.48	4.49	3.34	3.14
May	3.43	6.47	0.33	2.56	2.28	1.88
June	2.70	5.53	0.12	1.98	1.86	1.57
July	1.51	3.41	0.02	1.02	0.65	0.70
August	1.79	5.40	0.04	1.53	1.10	1.17
September	3.71	6.21	0.03	2.84	2.25	2.12
October	8.13	14.51	0.97	6.47	5.46	5.28
November	11.09	17.44	1.72	9.36	7.42	7.98
December	14.50	16.67	3.93	10.71	9.44	8.19
Annual	84.54	80.27	41.01	66.51	54.55	50.74

(a) Period of record 1931 - 1960
(b) Period of record 1940 - 1977
(c) Period of record 1931 - 1960
(d) Period of record 1941 - 1970

TABLE 2.3-16

MONTHLY PRECIPITATION DATA FOR
WNP-3 SITE AND ELMA, OCTOBER 1979 - SEPTEMBER 1980

	Total Precip (in)		Max 24-hour Precip (in)		Days w/Measurable Precip (≥0.01 in)	
	WNP-3	Elma	WNP-3	Elma	WNP-3	Elma
Oct	6.45	7.75	1.44	1.37	23	13
Nov	1.07	3.26	.68	.72	4	14
Dec	12.08	18.48	4.00	2.78	18	29
Jan	6.30	6.50	1.94	1.98	13	16
Feb	10.41	9.95	3.06	1.86	20	20
Mar	5.04	4.72	.97	.89	25	25
Apr	3.50	4.91	.81	.90	16	15
May	1.25	1.81	.41	.55	10	13
Jun	1.17	2.26	.27	.64	15	15
Jul	.79	.71	.62	.43	7	5
Aug	1.25	1.27	.42	.26	9	8
Sep	2.72	2.95	.86	.68	18	14

TABLE 2.3-17A

COMPOSITE MONTHLY PRECIPITATION WIND ROSES, 10-METER LEVEL, JANUARY

WIND DIRECTION	WIND SPEED (M/SEC)													
	CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.00	0.47	0.00	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.89
NNE	0.00	0.94	0.00	0.47	1.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.83
NE	0.00	1.42	1.42	0.47	0.00	0.00	1.42	0.00	0.00	0.00	0.00	0.00	0.00	4.72
ENE	0.00	0.47	0.47	0.94	2.36	2.36	3.77	0.47	0.00	0.00	0.00	0.00	0.00	10.85
E	0.00	0.47	0.00	0.47	2.36	2.36	4.25	0.94	0.00	0.00	0.00	0.00	0.00	10.85
ESE	0.00	0.94	0.47	0.47	0.94	0.47	4.25	1.42	0.00	0.00	0.00	0.00	0.00	8.96
SE	0.00	0.00	0.47	1.89	0.94	1.42	1.42	1.89	0.00	0.00	0.00	0.00	0.00	8.02
SSE	0.00	0.47	0.94	0.00	0.94	0.47	1.42	0.00	0.00	0.00	0.00	0.00	0.00	4.25
S	0.00	0.47	1.42	2.83	3.30	2.83	2.83	2.36	0.00	0.00	0.00	0.00	0.00	16.04
SSW	0.00	0.94	0.47	0.94	1.42	2.83	3.77	0.47	1.42	1.89	0.00	0.00	0.00	14.15
SW	0.00	0.00	0.00	0.47	0.47	0.94	0.47	1.42	0.47	0.47	0.00	0.00	0.00	4.72
WSW	0.00	0.00	0.00	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.94
W	0.00	0.47	0.00	0.00	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.42
WNW	0.00	0.00	0.47	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.94
NW	0.00	0.47	0.94	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.36
NNW	0.00	0.00	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47
CALMS	6.60													6.60
TOTAL	6.60	7.08	8.02	11.32	16.51	13.68	23.58	8.96	1.89	2.36	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 212
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-17B

COMPOSITE MONTHLY PRECIPITATION WIND ROSES, 10-METER LEVEL, FEBRUARY

WIND DIRECTION	WIND SPEED (M/SEC)													
	CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.29	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58
NNE	0.00	0.00	0.29	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58
NE	0.00	0.00	0.87	0.00	0.29	0.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.02
ENE	0.00	0.29	0.29	0.29	0.58	0.29	1.45	0.00	0.00	0.00	0.00	0.00	0.00	3.18
E	0.00	0.00	0.00	0.87	1.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.02
ESE	0.00	1.45	0.29	1.16	2.60	0.29	0.58	0.00	0.00	0.00	0.00	0.00	0.00	6.36
SE	0.00	0.29	0.00	0.29	1.73	2.60	1.73	0.58	0.00	0.00	0.00	0.00	0.00	7.23
SSE	0.00	0.00	0.00	0.87	0.87	0.58	1.73	0.29	0.00	0.00	0.00	0.00	0.00	4.34
S	0.00	0.00	0.58	0.58	3.76	1.73	3.47	1.16	0.00	0.00	0.00	0.00	0.00	11.27
SSW	0.00	0.29	0.29	0.58	1.73	2.31	4.62	5.20	1.16	0.00	0.00	0.00	0.00	16.18
SW	0.00	0.29	1.45	0.58	0.87	2.60	7.51	8.38	4.91	2.02	0.00	0.00	0.00	28.61
WSW	0.00	0.00	0.58	0.58	1.73	0.58	3.47	1.16	0.00	0.00	0.00	0.00	0.00	8.09
W	0.00	0.00	0.29	0.87	0.58	0.58	0.29	0.29	0.00	0.00	0.00	0.00	0.00	2.89
WNW	0.00	0.00	0.00	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58
NW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NNW	0.00	0.29	0.00	0.58	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.16
CALMS	4.91													4.91
TOTAL	4.91	3.18	5.20	8.09	16.18	12.43	24.86	17.05	6.07	2.02	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 346
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-17C

COMPOSITE MONTHLY PRECIPITATION WIND ROSES, 10-METER LEVEL, MARCH

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37
NNE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NE	0.00	0.32	1.27	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.90
ENE	0.00	0.00	0.00	0.32	0.00	0.32	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.95
E	0.00	0.32	0.63	1.27	0.95	0.63	0.32	0.32	0.00	0.00	0.00	0.00	0.00	4.43
ESE	0.00	0.00	0.00	0.63	0.32	0.63	1.90	1.27	0.00	0.00	0.00	0.00	0.00	4.75
SE	0.00	0.32	0.63	0.63	0.63	1.58	1.58	0.63	0.32	0.00	0.00	0.00	0.00	6.33
SSE	0.00	0.95	0.63	1.58	2.22	0.95	1.58	0.63	0.00	0.00	0.00	0.00	0.00	8.54
S	0.00	0.00	0.32	0.63	0.63	1.27	2.22	0.63	0.00	0.00	0.00	0.00	0.00	5.70
SSW	0.00	0.00	0.00	1.27	1.27	2.53	9.18	10.76	0.32	0.00	0.00	0.00	0.00	25.32
SW	0.00	0.00	0.63	0.95	2.85	2.53	5.70	4.11	2.53	0.63	0.00	0.00	0.00	19.94
WSW	0.00	0.32	1.27	1.27	3.16	1.58	2.53	2.22	0.32	0.32	0.00	0.00	0.00	12.97
W	0.00	0.00	0.32	0.32	0.32	0.32	0.32	0.00	0.00	0.00	0.00	0.00	0.00	1.58
WNW	0.00	0.00	0.32	0.00	1.58	0.00	0.63	0.63	0.00	0.00	0.00	0.00	0.00	3.16
NW	0.00	0.00	0.00	0.00	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95
NNW	0.00	0.32	0.32	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.95
CALMS	2.22													2.22
TOTAL	2.22	2.53	6.33	9.49	13.92	13.29	26.58	21.20	3.48	0.95	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 316
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-17D

COMPOSITE MONTHLY PRECIPITATION WIND ROSES, 10-METER LEVEL, APRIL

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.59	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88
NNE	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29
NE	0.00	0.00	0.29	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59
ENE	0.00	0.00	0.29	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59
E	0.00	0.59	0.29	0.29	0.29	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.35
ESE	0.00	0.59	0.29	1.18	0.59	0.59	1.47	0.00	0.00	0.00	0.00	0.00	0.00	4.71
SE	0.00	0.00	0.59	0.29	0.88	0.59	0.00	0.29	0.00	0.00	0.00	0.00	0.00	2.65
SSE	0.00	0.00	0.29	0.29	2.06	0.29	2.35	1.18	0.00	0.00	0.00	0.00	0.00	6.47
S	0.00	0.29	0.29	0.88	3.24	5.59	7.35	2.94	0.00	0.00	0.00	0.00	0.00	20.59
SSW	0.00	0.59	0.29	0.29	1.47	5.88	11.18	8.53	0.00	0.00	0.00	0.00	0.00	28.24
SW	0.00	0.29	0.29	1.18	2.06	3.24	4.71	4.12	0.00	0.00	0.00	0.00	0.00	15.88
WSW	0.00	0.59	0.29	1.18	1.18	1.47	0.88	0.00	0.00	0.00	0.00	0.00	0.00	5.59
W	0.00	0.00	0.29	0.00	0.29	1.76	1.76	0.00	0.00	0.00	0.00	0.00	0.00	4.12
WNW	0.00	0.00	0.29	0.29	0.29	0.00	0.59	0.00	0.00	0.00	0.00	0.00	0.00	1.47
NW	0.00	0.00	0.29	0.00	0.59	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.18
NNW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CALMS	4.41													4.41
TOTAL	4.41	3.82	4.12	6.18	13.53	20.59	30.29	17.06	0.00	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 340
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-17E

COMPOSITE MONTHLY PRECIPITATION WIND ROSES, 10-METER LEVEL, MAY

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	2.60	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.25
NNE	0.00	0.65	1.95	2.60	1.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.14
NE	0.00	0.65	0.00	1.95	3.25	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.14
ENE	0.00	0.65	0.00	1.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60
E	0.00	0.00	0.65	0.65	0.65	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60
ESE	0.00	0.00	0.00	0.00	0.65	1.95	1.30	0.00	0.00	0.00	0.00	0.00	0.00	3.90
SE	0.00	0.00	0.00	0.00	0.65	0.00	0.65	0.00	0.00	0.00	0.00	0.00	0.00	1.30
SSE	0.00	0.00	0.65	0.00	0.65	2.60	0.65	0.00	0.00	0.00	0.00	0.00	0.00	4.55
S	0.00	0.00	1.30	0.65	1.30	1.95	5.84	0.65	0.00	0.00	0.00	0.00	0.00	11.69
SSW	0.00	0.65	1.30	2.60	7.79	4.55	8.44	2.60	0.00	0.00	0.00	0.00	0.00	27.92
SW	0.00	0.65	0.65	1.95	3.90	1.95	1.30	0.65	0.00	0.00	0.00	0.00	0.00	11.04
WSW	0.00	0.00	0.65	1.30	1.30	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.90
W	0.00	0.00	0.00	0.65	1.30	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60
WNW	0.00	0.00	0.00	1.30	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.95
NW	0.00	0.65	0.00	0.65	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.95
NNW	0.00	0.65	1.30	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.60
CALMS	3.90													3.90
TOTAL	3.90	7.14	9.09	16.88	24.68	16.23	18.18	3.90	0.00	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 154
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-17F

COMPOSITE MONTHLY PRECIPITATION WIND ROSES, 10-METER LEVEL, JUNE

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.55	0.00	0.55	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.65
NNE	0.00	0.55	0.00	0.55	1.10	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.75
NE	0.00	1.10	0.00	0.55	1.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.30
ENE	0.00	0.00	0.00	1.65	3.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.95
E	0.00	1.10	0.00	0.55	2.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.85
ESE	0.00	0.00	1.10	1.10	1.65	1.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.49
SE	0.00	0.00	0.00	0.00	1.65	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	2.20
SSE	0.00	0.00	[illegible]	[illegible]	0.55	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.75
S	0.00	[illegible]	[illegible]	[illegible]	3.85	2.20	2.75	0.00	0.00	0.00	0.00	0.00	0.00	10.99
SSW	[illegible]	[illegible]	[illegible]	2.20	3.85	8.24	18.13	1.65	0.00	0.00	0.00	0.00	0.00	35.16
SW	[illegible]	[illegible]	[illegible]	1.10	2.75	3.30	2.20	0.00	0.00	0.00	0.00	0.00	0.00	9.89
WSW	0.00	0.00	0.00	0.55	2.20	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	3.30
W	0.00	0.00	0.00	0.55	1.10	0.55	2.75	0.00	0.00	0.00	0.00	0.00	0.00	4.95
WNW	0.00	0.00	0.00	0.55	0.55	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.65
NW	0.00	0.00	0.00	1.65	0.55	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.75
NNW	0.00	0.00	1.10	0.55	1.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.75
CALMS	1.65													1.65
TOTAL	1.65	3.85	4.40	14.84	28.57	18.13	26.92	[illegible]	0.00	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 182
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-17G

COMPOSITE MONTHLY PRECIPITATION WIND ROSES, 10-METER LEVEL, JULY

WIND DIRECTION	CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
	WIND SPEED (M/SEC)													
N	0.00	0.00	0.00	0.00	2.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.33
NNE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NE	0.00	0.00	0.00	0.00	2.33	0.00	2.33	0.00	0.00	0.00	0.00	0.00	0.00	4.65
ENE	0.00	0.00	0.00	0.00	0.00	0.00	2.33	0.00	0.00	0.00	0.00	0.00	0.00	2.33
E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ESE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SE	0.00	0.00	0.00	0.00	4.65	6.98	4.65	0.00	0.00	0.00	0.00	0.00	0.00	16.28
SSE	0.00	0.00	0.00	0.00	4.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.65
S	0.00	0.00	2.33	2.33	6.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.63
SSW	0.00	0.00	2.33	2.33	11.63	11.63	9.30	2.33	0.00	0.00	0.00	0.00	0.00	39.53
SW	0.00	0.00	0.00	0.00	0.00	4.65	4.65	0.00	0.00	0.00	0.00	0.00	0.00	9.30
WSW	0.00	0.00	0.00	0.00	2.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.33
W	0.00	0.00	0.00	0.00	0.00	2.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.33
WNW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NW	0.00	0.00	0.00	0.00	0.00	2.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.33
NNW	0.00	0.00	0.00	0.00	2.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.33
CALMS	0.00													0.00
TOTAL	0.00	0.00	4.65	4.65	37.21	27.91	23.26	2.33	0.00	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 43
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-17H

COMPOSITE MONTHLY PRECIPITATION WIND ROSES, 10-METER LEVEL, AUGUST

WIND DIRECTION	CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
	WIND SPEED (M/SEC)													
N	0.00	0.00	2.67	1.33	2.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.67
NNE	0.00	0.00	1.33	1.33	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.67
NE	0.00	0.00	1.33	2.67	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00
ENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E	0.00	0.00	0.00	0.00	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33
ESE	0.00	0.00	1.33	0.00	2.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00
SE	0.00	1.33	0.00	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.67
SSE	0.00	0.00	0.00	1.33	2.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00
S	0.00	0.00	1.33	0.00	2.67	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.33
SSW	0.00	0.00	0.00	4.00	8.00	8.00	13.33	2.67	1.33	0.00	0.00	0.00	0.00	37.33
SW	0.00	1.33	1.33	1.33	2.67	5.33	2.67	0.00	0.00	0.00	0.00	0.00	0.00	14.67
WSW	0.00	0.00	0.00	0.00	0.00	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33
W	0.00	0.00	0.00	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33
WNW	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NW	0.00	0.00	0.00	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33
NNW	0.00	0.00	0.00	2.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.67
CALMS	2.67													2.67
TOTAL	2.67	2.67	9.33	18.67	30.67	16.00	16.00	2.67	1.33	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 75
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-17I

COMPOSITE MONTHLY PRECIPITATION WIND ROSES, 10-METER LEVEL, SEPTEMBER

WIND DIRECTION	CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
	WIND SPEED (M/SEC)													
N	0.00	0.00	0.54	1.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.61
NNE	0.00	0.54	0.00	1.08	1.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.69
NE	0.00	1.08	0.54	2.15	2.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.45
ENE	0.00	0.54	0.54	0.54	0.54	0.00	1.08	0.00	0.00	0.00	0.00	0.00	0.00	3.23
E	0.00	0.00	0.54	1.08	0.54	0.54	0.54	0.54	0.00	0.00	0.00	0.00	0.00	3.76
ESE	0.00	0.00	0.54	2.15	0.00	0.54	0.54	0.00	0.00	0.00	0.00	0.00	0.00	3.76
SE	0.00	0.00	0.00	0.00	2.69	1.61	1.08	0.00	0.00	0.00	0.00	0.00	0.00	5.38
SSE	0.00	0.00	1.08	0.00	1.08	3.76	1.08	0.00	0.00	0.00	0.00	0.00	0.00	6.99
S	0.00	1.08	0.00	0.54	4.30	2.69	1.61	0.00	0.00	0.00	0.00	0.00	0.00	10.22
SSW	0.00	0.54	0.54	1.61	4.84	4.30	9.68	17.20	1.08	0.00	0.00	0.00	0.00	39.78
SW	0.00	0.00	0.00	0.00	3.23	0.54	1.61	0.54	0.00	0.00	0.00	0.00	0.00	5.91
WSW	0.00	1.08	0.00	0.00	1.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.69
W	0.00	0.00	0.54	0.00	1.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.15
WNW	0.00	0.54	0.00	0.54	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.61
NW	0.00	0.00	0.00	0.54	0.54	1.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.15
NNW	0.00	0.54	0.00	0.00	0.00	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.08
CALMS	0.54													0.54
TOTAL	0.54	5.91	4.84	11.29	25.27	15.59	17.20	18.28	1.08	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 186
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-17J

COMPOSITE MONTHLY PRECIPITATION WIND ROSES, 10-METER LEVEL, OCTOBER

WIND DIRECTION	CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
	WIND SPEED (M/SEC)													
N	0.00	0.94	0.00	0.47	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.88
NNE	0.00	0.00	0.00	0.47	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.94
NE	0.00	0.00	0.00	0.47	0.94	0.00	0.47	0.00	0.00	0.00	0.00	0.00	0.00	1.88
ENE	0.00	0.94	0.94	0.47	0.00	2.35	3.29	0.00	0.00	0.00	0.00	0.00	0.00	7.98
E	0.00	0.94	0.94	0.94	1.88	0.94	1.88	0.47	0.00	0.00	0.00	0.00	0.00	7.98
ESE	0.00	0.47	0.00	1.41	1.88	2.82	2.82	0.00	0.00	0.00	0.00	0.00	0.00	9.39
SE	0.00	1.41	0.47	1.41	2.35	2.82	6.10	1.88	0.00	0.00	0.00	0.00	0.00	16.43
SSE	0.00	0.94	0.00	3.29	5.63	2.82	0.94	1.41	0.00	0.00	0.00	0.00	0.00	15.02
S	0.00	0.94	1.41	0.94	3.29	1.88	3.76	1.41	0.00	0.00	0.00	0.00	0.00	13.62
SSW	0.00	0.00	1.88	2.35	1.41	1.88	4.23	1.41	0.00	0.00	0.00	0.00	0.00	13.15
SW	0.00	0.47	0.47	1.41	0.47	0.00	0.47	0.00	0.00	0.00	0.00	0.00	0.00	3.29
WSW	0.00	0.00	0.00	0.00	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47
W	0.00	0.47	1.41	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.35
WNW	0.00	0.00	0.47	0.00	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.94
NW	0.00	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47
NNW	0.00	0.00	0.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47
CALMS	3.76													3.76
TOTAL	3.76	7.98	8.45	14.08	19.72	15.49	23.94	6.57	0.00	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 213
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-17K

COMPOSITE MONTHLY PRECIPITATION WIND ROSES, 10-METER LEVEL, NOVEMBER

WIND DIRECTION	WIND SPEED (M/SEC)													
	CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.00	0.00	0.39	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.17
NNE	0.00	0.00	0.78	0.00	0.39	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.56
NE	0.00	0.39	0.39	0.00	1.17	1.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.13
ENE	0.00	0.39	0.00	1.95	1.17	1.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.69
E	0.00	0.00	0.78	0.78	1.56	4.30	0.39	0.00	0.00	0.00	0.00	0.00	0.00	7.81
ESE	0.00	0.39	0.39	1.95	2.73	1.17	4.69	0.39	0.00	0.00	0.00	0.00	0.00	11.72
SE	0.00	0.39	0.39	0.39	3.52	0.39	3.52	1.17	0.00	0.00	0.00	0.00	0.00	9.77
SSE	0.00	0.00	0.00	1.17	1.56	2.34	4.30	1.56	0.00	0.00	0.00	0.00	0.00	10.94
S	0.00	0.39	0.39	0.78	0.39	1.95	5.08	7.81	0.39	0.00	0.00	0.00	0.00	17.19
SSW	0.00	0.39	0.00	0.00	0.39	2.34	5.08	15.23	3.91	0.00	0.00	0.00	0.00	27.34
SW	0.00	0.00	0.00	0.39	0.00	0.39	0.78	0.78	0.00	0.00	0.00	0.00	0.00	2.34
WSW	0.00	0.00	0.00	0.00	0.39	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78
W	0.00	0.00	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39
WNW	0.00	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39
NW	0.00	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39
NNW	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39
CALMS	0.00													0.00
TOTAL	0.00	2.34	3.52	8.59	14.45	16.02	23.83	26.95	4.30	0.00	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 256
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-17L

COMPOSITE MONTHLY PRECIPITATION WIND ROSES, 10-METER LEVEL, DECEMBER

WIND DIRECTION	WIND SPEED (M/SEC)													
	CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.00	0.67	0.22	0.45	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00
NNE	0.00	0.22	1.11	0.89	0.67	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.56
NE	0.00	0.00	0.45	0.45	2.23	2.90	1.11	0.00	0.00	0.00	0.00	0.00	0.00	7.13
ENE	0.00	0.00	0.67	0.89	2.90	2.67	4.23	0.22	0.00	0.00	0.00	0.00	0.00	11.58
E	0.00	0.22	0.00	2.67	2.23	1.11	2.00	0.45	0.00	0.00	0.00	0.00	0.00	8.69
ESE	0.00	0.89	0.89	1.56	2.00	2.67	4.68	0.22	0.00	0.00	0.00	0.00	0.00	12.92
SE	0.00	1.56	1.56	1.56	2.23	2.45	2.00	0.22	0.00	0.00	0.00	0.00	0.00	11.58
SSE	0.00	1.11	0.67	1.56	3.56	1.11	1.56	0.00	0.00	0.00	0.00	0.00	0.00	9.58
S	0.00	0.00	0.00	0.89	0.89	1.11	1.34	1.11	0.22	0.00	0.00	0.00	0.00	5.57
SSW	0.00	0.00	0.00	0.67	1.34	1.78	2.90	7.13	4.45	1.34	0.00	0.00	0.00	19.60
SW	0.00	0.00	0.00	0.22	0.22	0.00	0.67	0.89	0.45	0.22	0.00	0.00	0.00	2.67
WSW	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.45	0.00	0.00	0.00	0.00	0.00	0.67
W	0.00	0.00	0.00	0.22	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45
WNW	0.00	0.00	0.45	0.22	0.00	0.22	0.22	0.00	0.00	0.00	0.00	0.00	0.00	1.11
NW	0.00	0.22	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45
NNW	0.00	0.00	0.45	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67
CALMS	1.78													1.78
TOTAL	1.78	4.23	6.90	12.47	18.93	17.59	20.71	10.69	5.12	1.56	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 449
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-18A

ANNUAL PRECIPITATION WIND ROSE, 10-METER LEVEL

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.36	0.32	0.29	0.47	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.55
NNE	0.00	0.25	0.43	0.54	0.65	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.06
NE	0.00	0.36	0.58	0.54	1.23	0.76	0.36	0.00	0.00	0.00	0.00	0.00	0.00	3.82
ENE	0.00	0.25	0.32	0.79	1.08	0.97	1.55	0.07	0.00	0.00	0.00	0.00	0.00	5.05
E	0.00	0.32	0.32	1.05	1.37	1.08	0.90	0.25	0.00	0.00	0.00	0.00	0.00	5.30
ESE	0.00	0.54	0.43	1.15	1.44	1.23	2.31	0.32	0.00	0.00	0.00	0.00	0.00	7.43
SE	0.00	0.51	0.51	0.72	1.73	1.55	1.84	0.61	0.04	0.00	0.00	0.00	0.00	7.50
SSE	0.00	0.40	0.43	1.05	2.13	1.30	1.62	0.51	0.00	0.00	0.00	0.00	0.00	7.43
S	0.00	0.29	0.54	0.97	2.42	2.24	3.39	1.80	0.07	0.00	0.00	0.00	0.00	11.72
SSW	0.00	0.29	0.47	1.15	2.42	3.64	7.36	7.14	1.48	0.36	0.00	0.00	0.00	24.31
SW	0.00	0.18	0.43	0.76	1.48	1.70	2.89	2.42	1.01	0.40	0.00	0.00	0.00	11.26
WSW	0.00	0.18	0.29	0.54	1.19	0.54	0.87	0.47	0.04	0.04	0.00	0.00	0.00	4.15
W	0.00	0.07	0.25	0.32	0.51	0.47	0.47	0.04	0.00	0.00	0.00	0.00	0.00	2.13
WNW	0.00	0.04	0.22	0.36	0.36	0.07	0.18	0.07	0.00	0.00	0.00	0.00	0.00	1.30
NW	0.00	0.14	0.11	0.36	0.18	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.08
NNW	0.00	0.14	0.36	0.25	0.14	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.97
CALMS	2.92													2.92
TOTAL	2.92	4.33	6.02	10.86	18.80	16.16	23.77	13.71	2.63	0.79	0.00	0.00	0.00	100.00

TOTAL NUMBER OF OBSERVATIONS EQUALS 2772
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-18B

ANNUAL PRECIPITATION WIND ROSE, 60-METER LEVEL

WIND DIRECTION	WIND SPEED (M/SEC) CALMS	0.4 TO 0.5	0.6 TO 0.7	0.8 TO 1.0	1.1 TO 1.5	1.6 TO 2.0	2.1 TO 3.0	3.1 TO 5.0	5.1 TO 7.0	7.1 TO 10.	10.1 TO 13.	13.1 TO 18.	ABOVE 18.0	TOTAL
N	0.00	0.04	0.07	0.07	0.39	0.11	0.11	0.04	0.00	0.00	0.00	0.00	0.00	0.82
NNE	0.00	0.14	0.00	0.14	0.21	0.07	0.07	0.04	0.00	0.00	0.00	0.00	0.00	0.67
NE	0.00	0.07	0.18	0.14	0.46	0.25	0.74	0.85	0.11	0.00	0.00	0.00	0.00	2.80
ENE	0.00	0.07	0.04	0.14	0.50	[illegible]	1.59	2.55	0.28	0.00	0.00	0.00	0.00	5.81
E	0.00	0.04	0.11	0.21	0.53	0.92	1.17	1.91	0.21	0.00	0.00	0.04	0.00	5.14
ESE	0.00	0.11	0.11	0.25	0.71	0.78	1.49	3.76	0.35	0.04	0.00	0.00	0.00	7.58
SE	0.00	0.25	0.14	0.21	0.96	1.20	3.05	5.00	1.77	0.04	0.00	0.00	0.00	12.62
SSE	0.00	0.04	0.18	0.21	0.46	0.85	2.23	2.34	0.82	0.00	0.00	0.00	0.00	7.12
S	0.00	0.04	0.00	0.28	0.57	0.82	3.26	6.48	2.13	0.50	0.00	0.00	0.00	14.07
SSW	0.00	0.04	0.04	0.07	0.25	0.50	2.66	5.78	3.22	1.81	0.53	0.00	0.00	14.88
SW	0.00	0.04	0.04	0.18	0.18	0.39	1.28	4.36	3.22	1.70	0.46	0.00	0.00	11.84
WSW	0.00	0.04	0.07	0.07	0.35	0.53	1.20	3.51	2.09	1.10	0.21	0.00	0.00	9.18
W	0.00	0.00	0.07	0.14	0.35	0.35	0.89	1.38	1.03	0.57	0.00	0.00	0.00	4.78
WNW	0.00	0.04	0.14	0.00	0.21	0.21	0.11	0.04	0.04	0.00	0.00	0.00	0.00	0.78
NW	0.00	0.00	0.04	0.04	0.11	0.11	0.04	0.04	0.00	0.00	0.00	0.00	0.00	0.35
NNW	0.00	0.04	0.04	0.07	0.07	0.07	0.07	0.04	0.00	0.00	0.00	0.00	0.00	0.39
CALMS	1.17													1.17
TOTAL	1.17	0.96	1.24	2.23	6.31	7.80	19.95	38.09	15.27	5.74	1.20	0.04	0.00	100.00

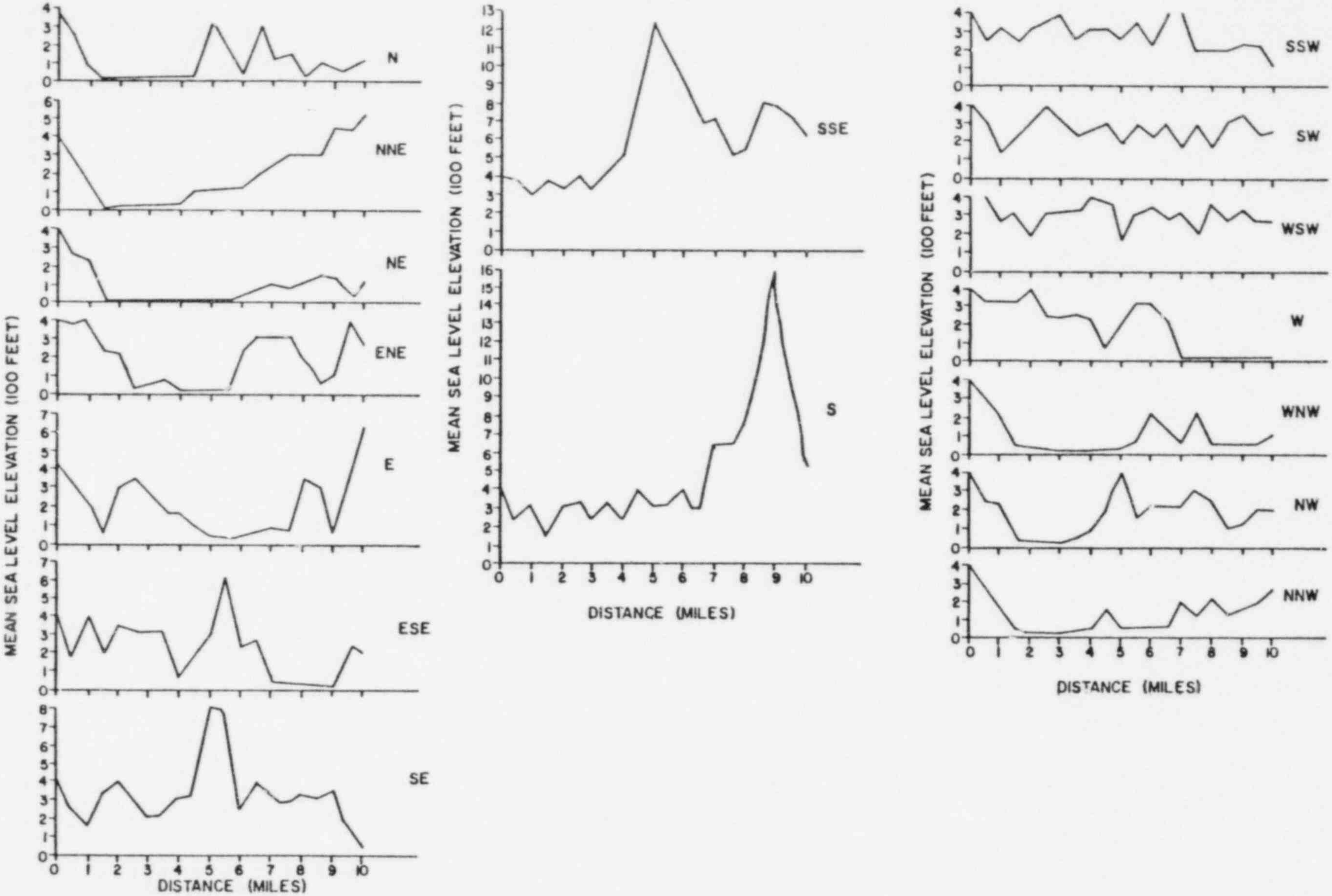
TOTAL NUMBER OF OBSERVATIONS EQUALS 2822
PERIOD OF RECORD IS FROM OCTOBER 1, 1979 THROUGH SEPTEMBER 30, 1981

TABLE 2.3-19

RAINFALL RATE (mm/hr)
DISTRIBUTION AT THE WNP-3 SITE[a]

Rate	Percent
0.1 - 0.5	52.3
0.6 - 1.0	17.5
1.1 - 2.0	16.1
2.1 - 3.0	7.1
3.1 - 4.0	2.8
4.1 - 5.0	2.4
5.1 - 6.0	1.0
6.1 - 8.0	0.7
Total	99.9

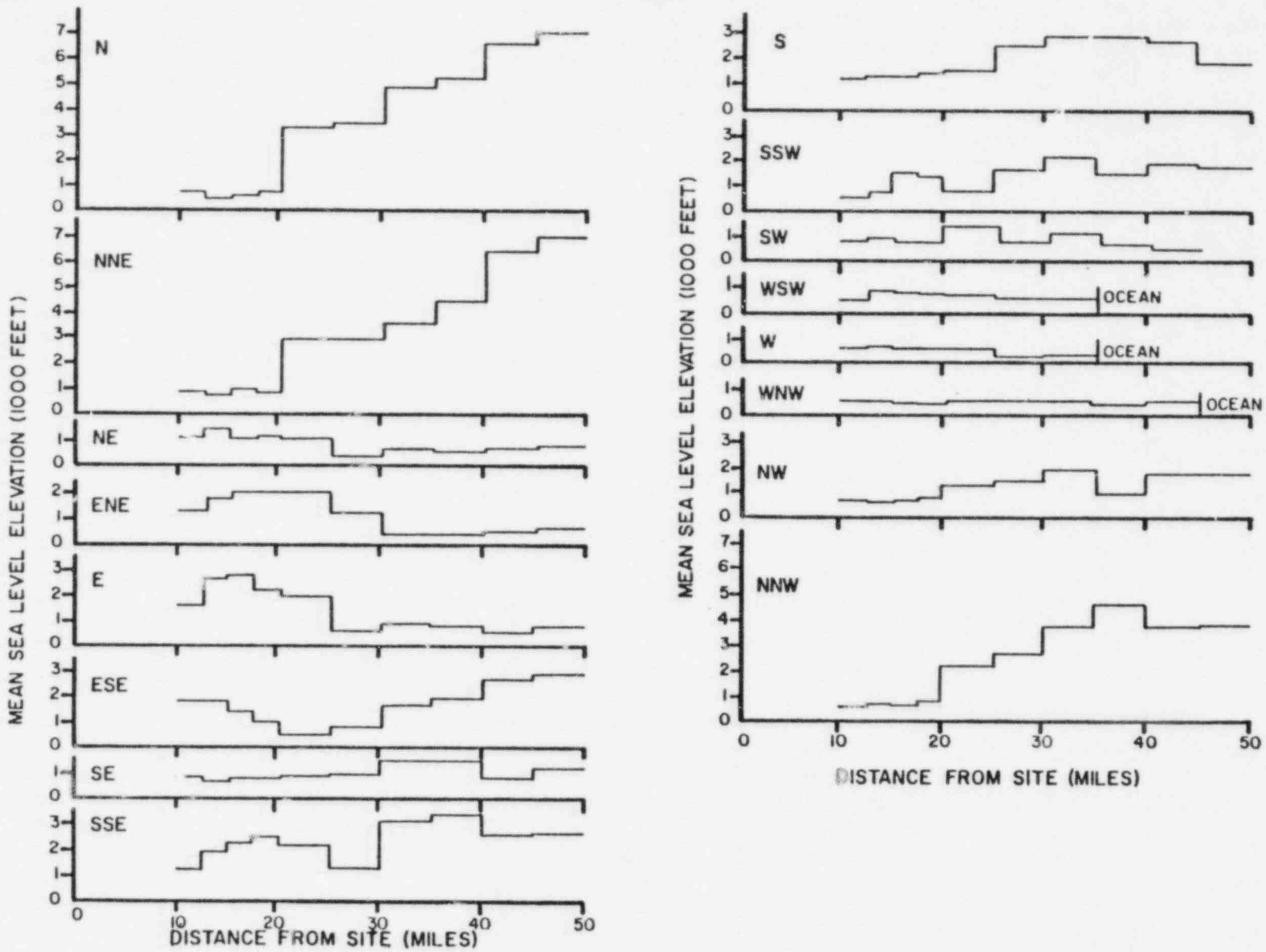
[a] October 1979 - September 1981



WASHINGTON PUBLIC POWER SUPPLY SYSTEM
NUCLEAR PROJECT No. 3
OPERATING LICENSE
ENVIRONMENTAL REPORT

TERRAIN HEIGHT, 0-10 MILES

FIGURE 2.3-1



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	TERRAIN HEIGHT, 10-50 MILES	FIGURE 2.3-2

2.4 HYDROLOGY

2.4.1 Surface Water

The WNP-3 project is located on a ridge 1.4 miles south of the confluence of the Chehalis and Satsop Rivers, and approximately 21 river miles (RM) upstream of the Chehalis River's confluence with Grays Harbor. Nominal plant grade is 390 ft mean sea level (MSL), about 370 ft above the Chehalis River floodplain. Makeup water for the Circulating Water System is supplied from induced infiltration of surface waters and groundwater within the Chehalis River by Ranney collector wells located slightly more than three miles downstream from the Satsop River confluence. Blowdown from the natural-draft cooling tower is discharged to the Chehalis River through a submerged multiport diffuser located 0.5 miles downstream from the confluence (see Section 3.4). The Chehalis River watershed is shown in Figure 2.4-1, and principal hydrologic features of the site vicinity are shown in Figure 2.4-2.

2.4.1.1 Chehalis River Hydrology and Physical Characteristics

The Chehalis River basin is a major river basin draining west-central Washington. The river heads in the Willapa Hills in southwestern Washington, flows generally northeastward to Grand Mound, and enters into Grays Harbor at Aberdeen. The higher portions of the river basin, where the river has an average slope of about 16 feet per mile, are rugged and densely forested. The slope flattens to about 3 feet per mile near the city of Chehalis and then 2 feet per mile near Satsop. The river and its tributaries have a drainage area of about 2,115 sq mi; the total area draining to the site is about 1,765 sq mi, of which approximately 300 sq mi is drainage area of the Satsop River.

A stream gage for the Chehalis River was installed and operated at the site by the United States Geological Survey (USGS) in 1977 using temporary facilities; permanent facilities were constructed in 1981. There are no other long-term gaging station records for the lower reach of the Chehalis River. However, long-term records are available for USGS gaging stations on the Chehalis at Grand Mound (1929-present) (RM 59.[illegible]), Porter (1952-1972; 1972-1979)(RM 33.3) and on the Satsop River near Satsop (1929-present)(RM 2.3 upstream from mouth). River flows near the site are estimated by adding the Satsop River flow to the flow in the Chehalis River at Porter or Grand Mound adjusted to the site by drainage area ratio.

The annual mean flow near the site is 6,630 cubic feet per second (cfs); the monthly mean flow ranges from 730 cfs in August to 14,865 cfs in January. The minimum monthly flow, 432 cfs, occurred in August 1951, while the maximum monthly flow, 40,876 cfs, occurred in December 1934. Estimated monthly average flows in the Chehalis River near the site are shown in Table 2.4-1. As indicated in the table, the flow in the river is quite variable and reflects the seasonal rainfall distribution within the basin. Also listed in Table 2.4-1 are the record minimum daily flows for each month.

The lowest daily flows in the site vicinity are normally expected in August and September. The one percent non-exceedence flows for these two months are 500 and 460 cfs, respectively. The once-in-10-year, 7-day duration low flow for the Chehalis River downstream of the Satsop confluence is 530 cfs based on recorded flow data for the period 1930-1981 (WNP-3 FSAR Appendix 2.4A). The 7-day low-flow frequency curve is shown on Figure 2.4-3.

Floods occur in the region primarily in December and January, but damaging floods may occur as early as the beginning of November and as late as the end of April. The estimated momentary maximum flood flow in the Chehalis River near the site, 97,100 cfs, occurred on December 21, 1933. The annual momentary maximum flows from 1930 to 1979 are listed in Table 2.4-2, and a frequency analysis of flood flow data is presented in Figure 2.4-4.

The Chehalis River channel at the site is approximately 250 feet wide and varies in depth from a few feet during low flow to greater than 30 feet during flooding conditions when the entire flood plain is inundated. Channel geometry varies considerably in the site vicinity. Figure 2.4-5 shows river cross-sections in the vicinity of the blowdown diffuser (see Subsection 3.4.4). River bed elevations near the site are variable, ranging from mean sea level just downstream of the Satsop confluence to approximately 19 feet below MSL just upstream of the confluence. The channel gradient or slope from about 10 miles upstream of the site to Grays Harbor (21 miles downstream of the site), is approximately 0.04 percent. The Satsop River exhibits a much steeper slope which ranges from approximately one percent in the vicinity of its confluence with the Chehalis River to nearly 15 percent at its head waters in the Olympic Mountains.

The velocity of the Chehalis River is quite variable. During low-flow conditions (< 200 cfs) upstream of the Satsop confluence, velocities of less than 0.2 fps are experienced. For the reach of river downstream of the Satsop confluence, velocities increase to approximately 0.4 fps during low-flow conditions (~ 400 cfs) due to the Satsop River inflow. During flood conditions (> 30,000 cfs) channel velocities reach 6 to 7 fps.

River flow in the site vicinity may also be influenced by tidal action. The degree of tidal effect depends on the river flow and the height of the ocean tide. The influence is most noticeable during spring high tides and low river flows, which in combination reduce and sometimes reverse the current velocity. During periods of high streamflow, the tidal effects on the river stage and flow are considerably less pronounced. Natural bathymetric features also affect river flow and tidal propagation in the river; a riffle area (approximately River Mile 19) reduces the effect of tidal propagation near the site area. In a 1975 field survey, the daily average flow ranged from 1,040 to 1,610 cfs; no reversals were observed during high tides above the riffle area, although current velocity at the riffle was reduced to about 10 percent of its steady flow velocity.[1] In 1977, when the daily average flow was 570 cfs, the velocity at River Mile 20.5 was decreased to 15 percent of the steady flow speed during peak high tide.[2] In mid-September and again a month later, current velocity was reduced to stagnation for at least one-half hour. The stagnations coincided with perigee spring high tides and river flows of 1,070 to 1,370 cfs. The steady flow velocity ranges from 0.44 fps when the river flow is 570 cfs to 2.8 fps when the river flow is 7500 cfs. Conductivity measurements indicate salinity at the site is representative of freshwater, and the saline estuarine zone does not extend upstream as far as the intake structure during flow reversals (see Subsection 2.4.1.3).

2.4.1.2 Site Hydrology

The plant is located on a ridge that divides the drainage basins of several streams none of which flow through the plant area; there are no ponds or wetlands in the immediate area. Five streams drain at least some portion of the site: Workman, Purgatory, Fuller, Hyatt, and Elizabeth Creeks. Stein Creek, a tributary to Workman Creek, and Purgatory and Fuller Creeks are within site boundaries. All are relatively short intermittent/permanent streams originating at elevations between 300 to 400 feet (90 to 120 meters) in hills south of Montesano and Elma. Both Purgatory Creek and Hyatt Creek flow through high culverts near their mouths which are only passable to salmon and trout when the Chehalis River floods.[3]

In general, site streams flow over bedrock composed of sandstone and siltstone. The lower portions of the streams are enclosed primarily by trenchlike banks composed of mud and clay. Streambeds within the lower sections are composed primarily of fine sand and silt created from erosion of the soft bedrock. Most streams exhibit a pool to riffle ratio favorable to salmonid spawning, however many lack significant reaches of spawning gravel necessary for successful propagation and two streams (Purgatory and Hyatt Creeks) are not accessible to upstream migrants. All are characteristically shallow with average depths ranging from approximately 2 to 12 inches during summer and fall.[3]

Total drainage areas for the site streams and the percent actually included in the plant construction zone are presented in Table 2.4-3. The watersheds of the site streams have been significantly affected by recent and past logging activities near the headwaters. The percentage of site stream watershed area clearcut since 1965 ranges from 48 percent for Hyatt Creek to 11 percent for Stein Creek.

Streamflows in Purgatory and Fuller Creeks were significantly altered by site erosion control runoff treatment measures during the construction phase. During early phases of construction water from these streams was pumped to project sedimentation ponds, treated with flocculant and subsequently discharged into the Chehalis River. Other streams which were directly influenced by plant construction are Hyatt Creek, which runs parallel to the existing Bonneville Power Administration corridor and the route of the transporter/west access road, and Elizabeth Creek, approximately 250 yards of which was rechanneled.

Figure 2.4-6 shows the post-construction drainage pattern. Storm runoff will drain to Fuller, Purgatory, and Workman Creeks. Runoff from an area of approximately 35 acres formerly drained by Stein Creek has been diverted to Fuller and Purgatory Creeks as a result of the site grading. This change will have no effect on any safety or environmental concerns, since the drainage area of the Workman Creek tributary is decreased by only 10%, and those of Fuller and Purgatory Creeks increased by only 5% and 3%, respectively.

2.4.1.3 Water Quality Characteristics

Pollution in the Chehalis River at the site is quite limited and is the result of agricultural runoff and municipal waste discharge from the small communities located along the Chehalis River. The total biochemical oxygen demand (BOD) loading of the Chehalis River as it passes Montesano has been estimated at 13,200 lbs BOD/day at a flow rate of 2,230 cfs or, assuming a completely mixed river, a concentration of approximately 1 mg/l. Although this BOD loading does not adversely affect the quality of the river at the site and is not considered a problem, considerable pollution loading is added near the mouth of the river (16 miles downstream of the site) and in Grays Harbor. Under adverse tide (flood tide) and water temperature ($> 21^{\circ}C$) conditions, the loading may cause depressed dissolved oxygen (< 6 mg/l) levels. The depressed oxygen levels and other possible quality problems (pH and toxicity) in turn affect the fisheries resources of the river system as well as its aesthetic values. This has been demonstrated to some extent by the Department of Fisheries findings which have shown the survival of hatchery coho to be much lower in the Chehalis system, where outmigrants must pass through inner Grays Harbor, than in the nearby Humptulips River[4].

Water quality data specific to the site vicinity has been collected through monitoring programs since 1977.[5,6] Data from these studies are summarized in Table 2.4-4.

The Chehalis River is influenced by several physical, chemical and biological processes which result in the cyclic variation of some important water quality parameters. Maximum pH levels (approx. 7.6) occur July through September and minimum values (approx. 6.5) occur from January through March. This seasonal variation may reflect longer residence time in the soil during the dry summer months. During the summer months the soil provides more buffering action for water infiltrating through the acidic organic material on the surface. Dissolved oxygen (DO) levels respond inversely with water temperature such that maximums (approx. 12.0 mg/l DO) occur in the winter and minimums (approx. 8.8 mg/l DO) occur in summer. Chehalis River stations upstream of the Satsop River confluence had slightly lower DO levels than downstream stations. This reflects the contribution of the oxygen-rich Satsop River.

Metals were the focus of a one-year study,[6] the results of which are included in Table 2.4-4. In general, the concentrations of all heavy metals in the Chehalis were low by compared to other surface waters[7] and to EPA water quality criteria.[8] Though metal concentrations show some seasonal fluctuation, the fluctuations are small and indistinct. As an example, Figure 2.4-7 shows the variation in copper. Iron, which is more abundant in the soil and rock of the drainage basin, responds more than other metals to precipitation and runoff events. The variation of iron is shown in Figure 2.4-8. Whereas iron had a relatively strong correlation with flow (r=0.83) and turbidity (r=0.85), copper showed a weak relationship with flow (r=0.37) and turbidity (r=0.38).[6]

The concentrations of dissolved minerals such as calcium, magnesium, potassium, and sodium are related to streamflow and the concentrations in groundwater. The concentrations are often greater in the groundwater than the surface water (see Table 2.4-4). During low-flow periods, the groundwater contributes significantly to streamflow, and, hence, concentrations are high. During high flow periods, most of the streamflow is from surface runoff which does not have sufficient contact time with the soil to become as mineralized as groundwater.[6]

Turbidity and suspended sediment correlate strongly with periods of intense rainfall and resultant peak runoff. The Chehalis River downstream of the Satsop River typically carries high sediment loads. Approximately 75 percent of this load is derived from the Satsop and Wynoochee Rivers, which represent 40 percent of the total drainage area of the lower basin. Transport of suspended sediment in the Chehalis River and its tributaries is highest during periods of high runoff which most frequently occur between November and January. On most of the streams in the Chehalis River basin, peak suspended sediment concentrations coincide with peak runoff. However, in the Chehalis River at Porter, peak suspended sediment concentrations generally precede the runoff peak by 24 hours.[9] Figure 2.4-9 shows the average particle size class distribution of suspended sediment and Figure 2.4-10 shows the relation between water discharge and suspended sediment for the Chehalis River near Grand Mound and the Satsop River at Satsop.

In the reach of the Chehalis River influenced by tides, salinities may vary from nearly ocean water concentrations in Grays Harbor to essentially zero at the confluence with the Satsop River. The salt front moves upriver and downriver in response to freshwater inflow to the estuary, tidal action and winds. For a freshwater flow of 10,000 cfs, the zero mean salinity point along the river occurs at approximately 14.5 miles and 20.5 miles downstream from the site at high- and low-water slack, respectively. With a river flow of 500 cfs, the salt wedge is located 7 miles downstream for both high and low-water slacks.

River water temperature near the site reflects the combined temperatures and flows of the Satsop and Chehalis Rivers upstream of the site. The monthly mean temperature ranges from 42°F (5.6°C) for the USGS stations in January to 60°F (15.6°C) at Satsop and 67°F (19.4°C) at Porter in July. Since the site is downstream from the confluence of these two rivers, weighted mean water temperatures were calculated based on both the flows and temperatures at the Satsop and Porter Stations. The weighted mean monthly temperatures in the vicinity of the site range from a low of 42°F (5.6°C) in January to a high of 65°F (18.3°C) in August. Table 2.4-5 summarizes mean and extreme monthly temperatures.

2.4.2 Groundwater

The nature and occurrence of groundwater in the Chehalis River Basin and site vicinity is determined by the geology of the area which is detailed in Section 2.5 of the Final Safety Analysis Report (FSAR). The geologic processes and groundwater resources have also been summarized by Eddy.[11]

2.4.2.1 Groundwater Sources

Groundwater at the plant site occurs in the alluvial valleys of the Chehalis, Satsop and tributary rivers The Chehalis River alluvial aquifer generally is confined by flood deposits of silt averaging about 11 feet thick in the site area. The pieziometric surface is within 10 to 20 feet of the ground surface.[12] Groundwater also occurs in a discontinuous manner in the unconsolidated terrace deposits in the northern area of the site, where three domestic wells were developed in small perched aquifers. Recharge to the terrace deposits is from precipitation on the watersheds and from the Chehalis River.

The southern portion of the site is situated on Tertiary sandstone sediments which contain little groundwater. There are no known producing wells located in the Tertiary formation in the area. Any recharge to the Tertiary sandstone formation is derived from rainfall and snowmelt. The very low permeability of the Astoria formation permits small amounts of recharge and minimal groundwater movement.

The aquifer in the Chehalis River Valley is horizontally limited by the occurrence of Teritiary sandstone sediments along the southern side of the Chehalis River. The southern edge of the Olympic Mountains serves as a boundary along the north side of the valley. The alluvial aquifer is confined at the side and extends two miles across the Chehalis River Valley, about 14 miles downsteam to Grays Harbor and about 15 miles upstream to the eastern limit of Grays Harbor County. The glacial till and outwash varies from 45 to 190 feet in thickness with a saturated zone averaging about 110 feet.

The groundwater table beneath the plant area follows the topography of the ridge and terraces and is parallel to the weathered and unweathered zones of the Astoria sandstone formation. The groundwater level slopes northward toward the Chehalis River. The level varies from 15 to 50 feet beneath the ground surface in the terrace deposits.

The range of water elevations in all plant area borings indicates only small seasonal fluctuations in groundwater. Site groundwater fluctuations during construction and the plant's permanent dewatering system are presented in Subsection 3.4.1.2 of the FSAR. Post-construction piezometric surfaces are shown in Figure 2.4-11.

The nearest water well to the plant site, producing from the Upper Pleistocene, is 5000 feet to the north-northwest in the direction of the groundwater flow. Ground permeability in this direction, taken from site data, is 2×10^{-5} cm/sec or about 0.06 ft/day. The hydraulic gradient between the plant and the well is about 0.04.

Makeup water for plant operation is produced from Ranney well collectors located at about River Mile 18. These wells withdraw a mixture of surface water (88 percent) infiltrated from the Chehalis River and groundwater (12 percent) from the alluvial valley fill.[13,14,15] The system is described in Section 3.4 and the effects of its operation are discussed in Section 5.6. Pump tests have shown the aquifer to have a permeability of about 430 ft/day.

2.4.2.2 Groundwater Quality

Regional groundwater quality characteristics are illustrated in Table 2.4-6 which is based on well water samples from the Chehalis River Basin. As noted in Subsection 2.4.1.3, Table 2.4-4 lists the results of a surface and groundwater monitoring program for metals. The groundwater sample was indicative of the alluvial aquifer which is in direct contact with the river water. Table 2.4-7 presents the results of an analysis for a sample of the Ranney well water during test pumping. This water should be more indicative of operational conditions since it includes the infiltrated surface waters.

The water produced from the Ranney collectors will have a seasonal temperature variation similar to that of the Chehalis River, except that it will be less in magnitude and lag that of the river. The estimated temperatures of the water from the Ranney collectors are shown in Figure 2.4-12. This graph is based upon average monthly water temperatures, since abrupt water temperature changes, which sometimes occur in the Chehalis River, will not be reflected in the Ranney collectors. The minimum water temperature will occur in March while the maximum will occur in late September or early October.

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14. Mikels, F.C., Additional Hydrogeological Studies, Ranney Collector Water Supply, Flink Farm, Lower Chehalis River, Washington Public Power Supply System Nuclear Projects Nos. 3 and 5, Satsop, Washington, Ranney Method Western Corporation, Kennewick, Washington, December 15, 1978.

15. Mikels, F.C., Report on Preliminary Test, Ranney Collector No. 1, Washington Public Power Supply System Nuclear Projects Nos. 3 and 5, Ranney Method Western Corporation, Kennewick, Washington, December 8, 1980.

TABLE 2.4-1

SUMMARY OF CHEHALIS RIVER FLOWS BY MONTH[a]

Month	Ave. Daily Flow (cfs)	Min. Daily Flow (cfs)	Year Of Occurence
Jan	16,200	1,698	1977
Feb	14,400	1,739	1977
Mar	11,000	2,410	1943
Apr	7,200	2,164	1965
May	3,600	1,308	1947
Jun	1,900	821	1951
Jul	1,100	540	1957
Aug	780	418	1967
Sep	980	399	1944
Oct	2,800	397	1952
Nov	9,300	539	1952
Dec	14,900	674	1952

(a) Period of record 1943-1977. Representative of flows at diffuser location (RM 20.5). From Reference 6.1-5.

TABLE 2.4-2

ESTIMATED MAXIMUM ANNUAL FLOOD FLOW OF THE CHEHALIS RIVER NEAR WNP-3[(a)]

Water Year	Date	Momentary Max. Q (cfs)	Water Year	Date	Momentary Max. Q (cfs)
1930	Feb 8, 1930	24190	1955	Nov 18, 1954	43520
1	Apr 1, 1931	38100	6	Dec 23, 1955	42300
2	Feb 26, 1932	52600	7	Dec 10, 1956	50260
3	Dec 3, 1932	42760	8	Dec 28, 1957	31610
4	Dec 21, 1933	97100	9	Jan 26, 1959	33690
5	Jan 22, 1935	81340			
6	Jan 13, 1936	70000	1960	Nov 23, 1959	52600
7	Apr 15, 1937	49300	1	Feb 23, 1961	40710
8	Dec 19, 1937	92610	2	Dec 23, 1961	34100
9	Feb 16, 1939	47200	3	Nov 28, 1963	38710
			4	Jan 27, 1964	47630
1940	Dec 17, 1939	46110	5	Jan 31, 1965	49100
1	Jan 18, 1941	49660	6	Jan 8, 1966	39030
2	Dec 20, 1941	51720	7	Dec 15, 1966	49030
3	Feb 7, 1943	39900	8	Jan 19, 1968	58220
4	Dec 3, 1943	36750	9	Jan 7, 1969	53100
5	Feb 9, 1945	48670			
6	Dec 30, 1945	45250	1970	Jan 22, 1970	67430
7	Jan 26, 1947	54200	1	Jan 26, 1971	86300
8	Jan 3, 1948	39440	2	Jan 22, 1972	76370
9	Feb 23, 1949	73380	3	Dec 16, 1972	59170
			4	Jan 17, 1974	72290
1950	Feb 26, 1950	60120	5	Jan 15, 1975	48400
1	Feb 10, 1951	93560	6	Dec 5, 1975	66570
2	Feb 5, 1952	39430	7	Mar 10, 1977	25960
3	Jan 31, 1953	46180	8	Dec 16, 1977	52030
4	Jan 7, 1954	48200	9	Feb 9, 1979	31560

[(a)]Derived from data of USGS Gaging Station on the Chehalis River at Porter or Grand Mound by the drainage area ratio plus corresponding flow in the Satsop River.

TABLE 2.4-3

CHARACTERISTICS OF STREAMS AT WNP-3 SITE

Stream	Length (feet)	Total Watershed Area (acres)	Watershed Area Within Plant Construction Area (acres)	(%)	Watershed Area Clearcut from 1965 - 1977 (acres)	(%)
Workman	48,000	7,090	60	1.1	2,690	37.9
Stein	6,700	360	40	11.7	40	11.1
Purgatory	7,000	320	120	37.5	130	40.6
Fuller	12,300	720	230	33.3	220	30.6
Hyatt	10,000	540	60	11.1	260	48.1
Elizabeth	21,000	2,730	10	0.4	520	19.0

Source: Reference 2.4-3

TABLE 2.4-4

SURFACE WATER AND GROUNDWATER QUALITY NEAR WNP-3 SITE[a]

		Discharge Area[b]		Intake Area[c]		Groundwater[d]	
		Mean	Range	Mean	Range	Mean	Range
		mg/l		mg/l		mg/l	
Calcium D		6.2	4.2 - 8.2	6.6	4.5 - 8.4	12.1	11.0 -13.1
Magnesium D		1.9	1.5 - 2.2	1.9	1.5 - 2.4	4.3	3.9 - 4.8
Sodium D		4.3	3.0 - 5.4	4.4	3.2 - 5.4	6.0	5.6 - 6.5
Potassium D		0.48	0.45- 0.50	0.55	0.45- 0.76	0.70	0.65- 0.77
Alkalinity (as $CaCO_3$)		28	20 - 34	28	14 - 38	56	51 -64
Hardness (as $CaCO_3$)		29	21 - 36	29	22 - 38	54	49 -60
TSS		14.2	0 -370			1	
DO		10.6	8.0 - 13.1				
pH			6.5 - 7.4		6.3 - 7.5		6.6 - 7.5
		μg/l		μg/l		μg/l	
Barium	T[e]			10	6 - 22	4	2 -12
	D			7	4 - 12	3	2 -10
Cadmium	T			< 0.1	< 0.1 - 0.5	< 0.1	< 0.1 - 0.2
	D			< 0.1	all < 0.1	< 0.1	all < 0.1
Chromium	T	1.0	< 0.5- 2.1	1.2	< 0.5 - 10.8	0.6	< 0.5 - 1.2
	D	0.9	< 0.5- 1.3	0.6	< 0.5 - 3.3	0.5	< 0.5 - 1.2
Copper	T	1	1 - 2	2	< 1 - 8	< 1	< 1 - 7
	D	1	< 1 - 1	1	< 1 - 3	< 1	< 1 - 4
Iron	T	512	200 -12[illegible]0	861	80 -7400	16	< 1 -90
	D	107	50 - 200	98	12 - 820	8	< 1 -80
Lead	T			4	< 1 - 36	< 1	< 1 - 1
	D			< 1	all < 1	< 1	all < 1
Manganese	T			29	11 - 80	1	< 1 - 4
	D			9	6 - 19	< 1	< 1 - 3
Mercury	T			0.4	< 0.2 - 1.3	< 0.2	< 0.2 - 0.7
	D			-		-	
Nickel	T	< 1	all < 1	1	< 1 - 14	< 1	< 1 -10
	D	< 1	all < 1	< 1	< 1 - 3	< 1	< 1 - 5
Zinc	T	< 5	all < 5	< 5	< 5 - 37	< 5	< 5 - 7
	D	< 5	all < 5	< 5	< 5 - 9	< 5	all < 5

(a) Sources: References 2.4-5 and 2.4-6
(b) River Mile 20.5
(c) River Mile 18
(d) Sample well near makeup water intake wells
(e) T = total, D = dissolved

TABLE 2.4-5

SUMMARY OF CHEHALIS RIVER TEMPERATURES BY MONTH[a]

	Temperature ($^{o}F/^{o}C$)		
Month	1st Percentile	Mean	99th Percentile
January	32/ 0.0	42/ 5.6	48/ 8.9
February	34/ 1.1	42/ 5.6	50/10.0
March	39/ 3.9	45/ 7.2	53/11.7
April	41/ 3.9	51/10.6	60/11.7
May	50/10.0	56/13.3	68/20.0
June	52/11.1	63/17.2	75/23.9
July	58/14.4	64/17.8	78/25.6
August	60/15.6	65/18.3	78/25.6
September	53/11.7	61/16.1	72/22.2
October	41/ 5.0	53/11.7	64/17.8
November	40/ 4.4	47/ 8.3	56/13.3
December	33/ 0.6	42/ 5.6	49/ 9.4
Annual Mean		52.6/11.4	

(a)Mean temperature is weighted for monthly mean Porter and Satsop flow rates. Representative of temperatures at diffuser location (RM 20.5).

TABLE 2.4-6

CHEMICAL ANALYSES OF GROUNDWATER IN THE CHEHALIS RIVER BASIN[a]

Well Number	Owner or Tenant	Parts Per Million Hardness ($CaCO_3$)	Iron (Fe)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved Solids	Well Depth
17/6-1C1	Chris Wheeler	22	0.04	4.4	3.0	3.5	67	76
17/6-4D1	City of Elma	24	0.00	2.1	4.0	1.9	58	40
17/7-7P1	Weyerhaeuser Timber Company	92	1.20	-	37.0	-	-	201
17/7-8Q1	"	60	0.50	-	11.0	-	-	141
17/7-9N1	"	51	0.30	-	20.2	-	-	160
17/7-9N2	"	50-54	0.03-0.11	-	9.5-12	-	-	102
17/7-9P1	"	50	0.20	-	11.0	-	-	153
17/7-11B1	Earl Richard	62	2.40	0.6	2.8	0.7	106	50
17/7-11E1	Robert Smith	76	0.73	0.6	3.2	0.2	119	36
17/7-11H1	Milton Larson	52	0.19	4.2	3.5	3.5	93	10
17/7-11K1	G. W. Stretter	58	0.29	4.0	4.0	0.6	108	51
17/7-11P1	Weyerhaeuser Timber Company	54	0.6-1.7	-	1.2	-	-	188
17/8-14K1	"	50	0.30	-	12-16	-	-	180
18/6-31H1	Erling Olson	52	0.33	2.6	3.5	0.1	100	98
18/12-27F1	Frank Minard	26	0.33	2.9	11.0	0.1	127	358

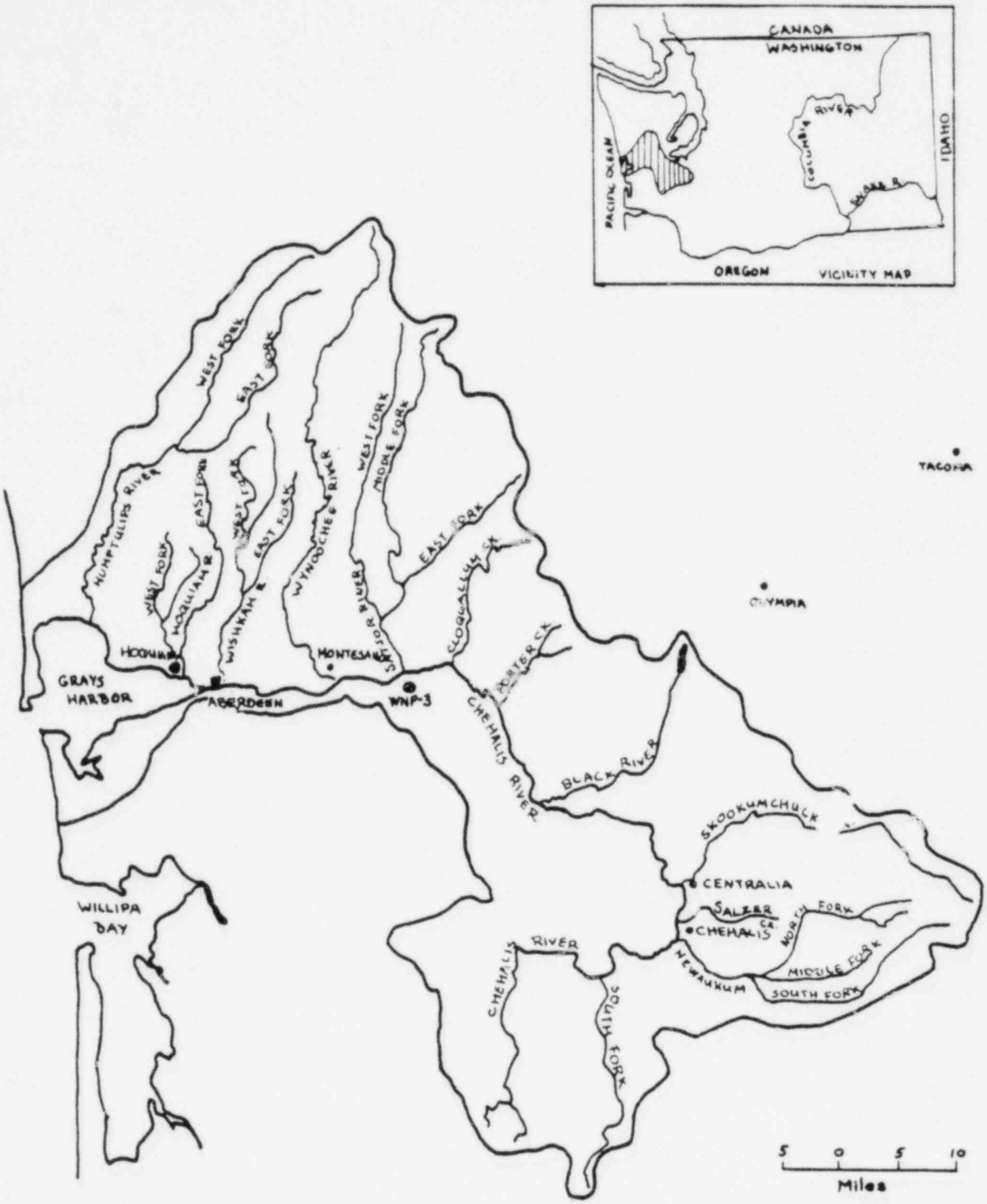
[a] Source: Reference 2.4-11

TABLE 2.4-7

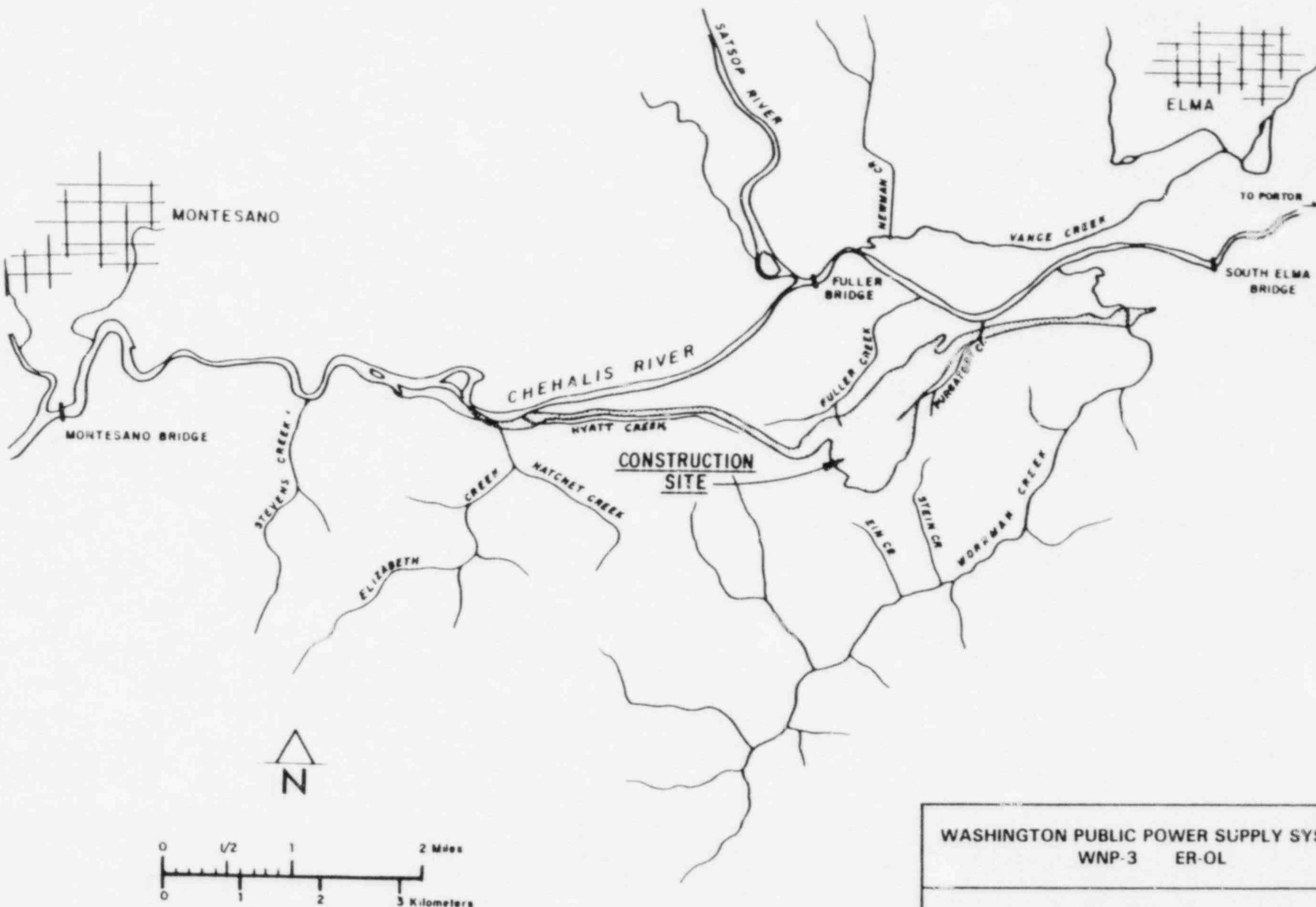
MAKEUP WELL WATER QUALITY[a]

Parameter	Concentration[b]
Biochemical Oxygen Demand	<1
Chemical Oxygen Demand	<5
Ammonia (as N)	<0.0005
Total Organic Carbon	<2
Bromide	0.30
Color (Color Units)	0
Fecal Coliform (MF) (colonies/100ml	<2
Fluoride	0.122
Nitrate + Nitrate (as N)	0.54
Total Organic Nitrogen (as N)	<0.50
Oil and Grease	<1
Total Phosphorus (as P)	0.240
Sulfate	2.7
Sulfide	<0.10
Surfactants (LAS-mg/l	<0.01
Gross Alpha (picocuries/l)	<0.60
Gross Beta (picocuries/l)	<10
Aluminum	<0.10
Boron	<0.01
Cobalt	<0.001
Molybdenum	<0.001
Tin	<0.03
Titanium	0.018
Antimony	<0.15
Arsenic	<0.001
Beryllium	<0.003
Silver	<0.0003
Thallium	0.008
Total Cyanide	<0.003
Phenol	<0.004
Iron	0.017
Maganese	<0.001
Barium	<0.10
Cadmium	<0.0001
Chromium	0.0006
Copper	<0.001
Lead	<0.001
Mercury	<0.0002
Nickel	0.002
Selenium	<0.002
Zinc	0.005
Magnesium	4.0

[a] Ranney Collector No. 1 test of November 25, 1981.
[b] Units of mg/l or as indicated.



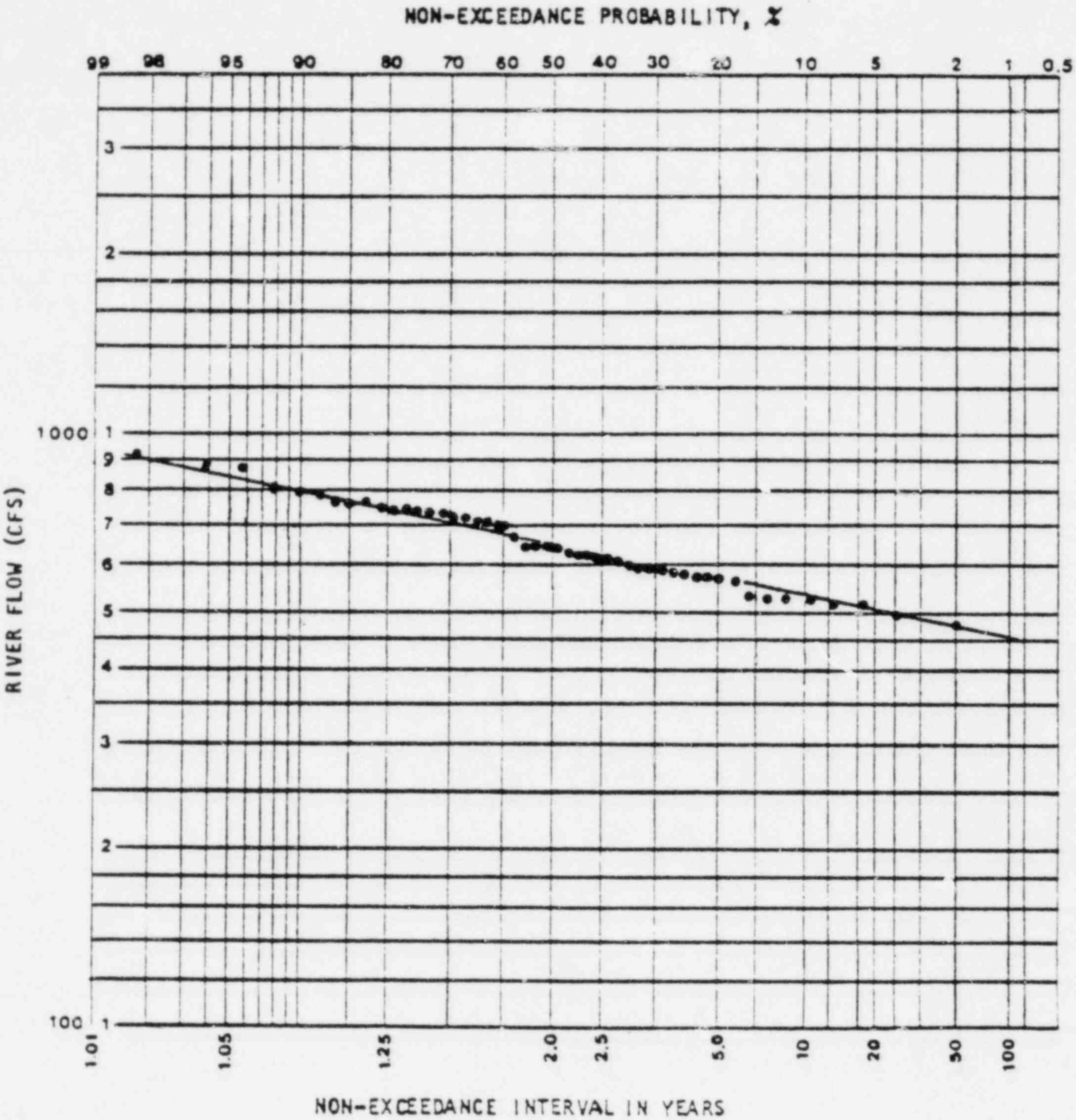
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	CHEHALIS RIVER BASIN	FIGURE 2.4-1



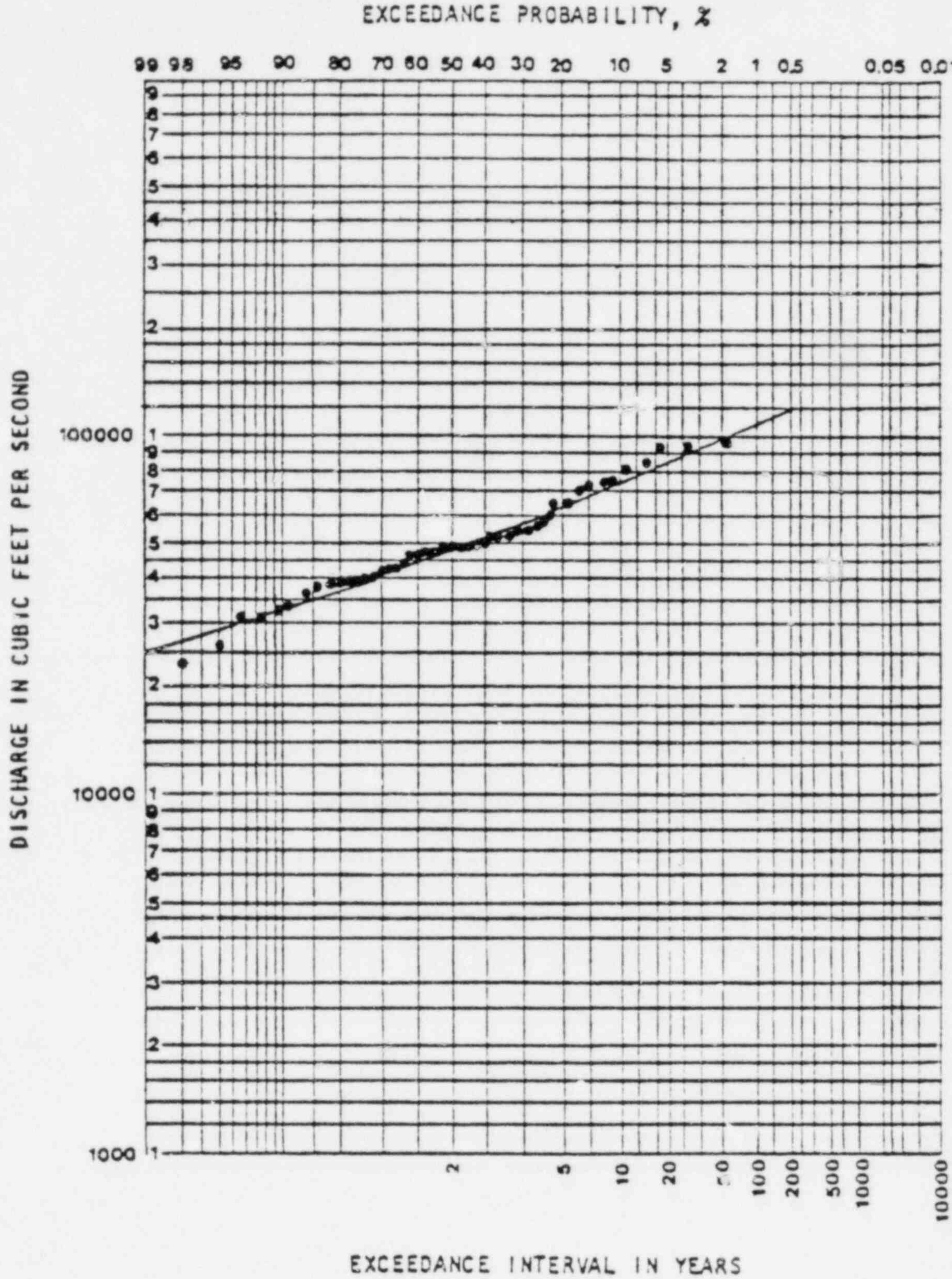
WASHINGTON PUBLIC POWER SUPPLY SYSTEM
WNP-3 ER-OL

HYDROLOGIC FEATURES NEAR WNP-3

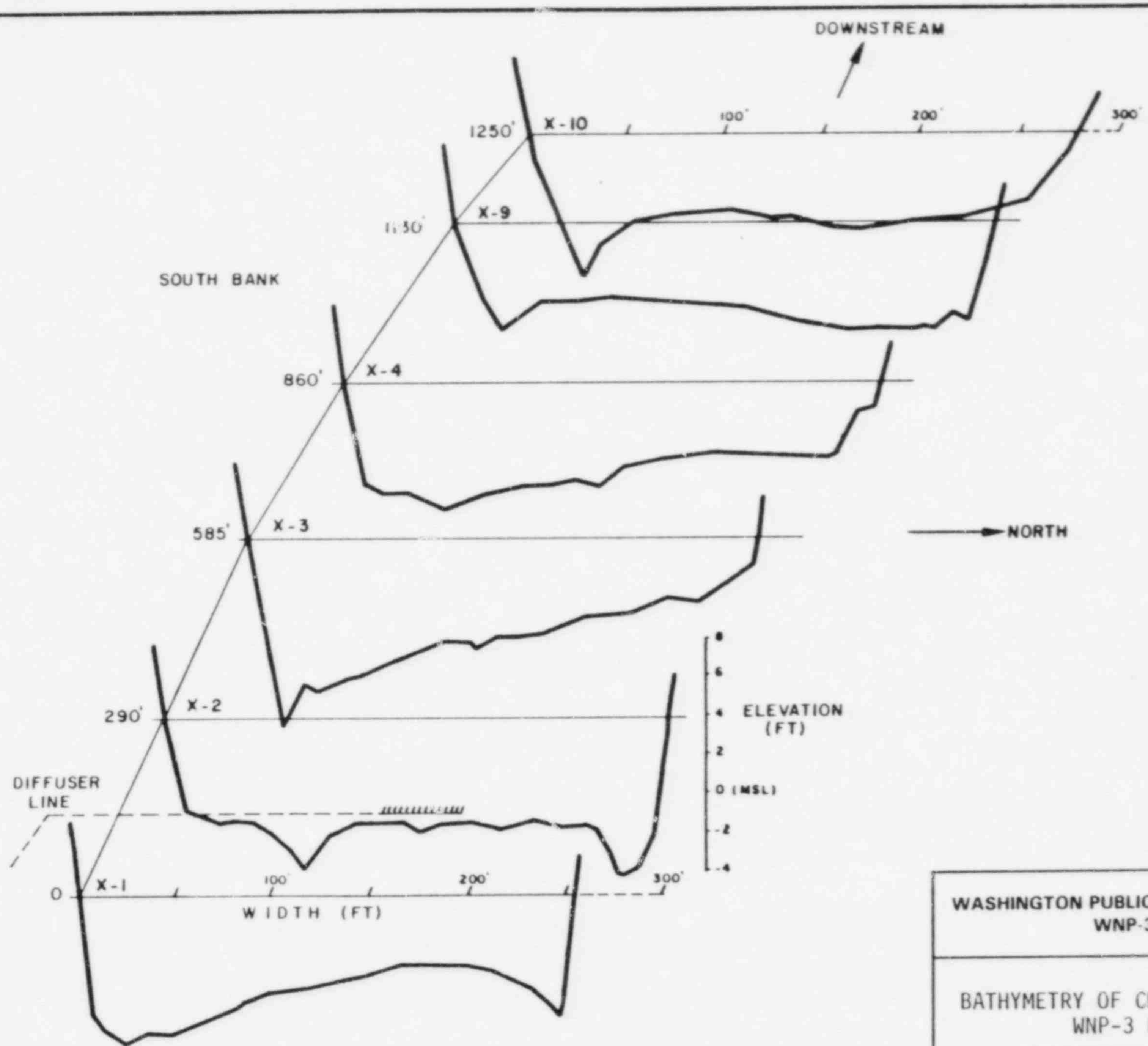
FIGURE 2.4-2



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	LOW-FLOW (7-DAY DURATION) CURVE FOR CHEHALIS RIVER DOWNSTREAM OF SATSOP CONFLUENCE	FIGURE 2.4-3



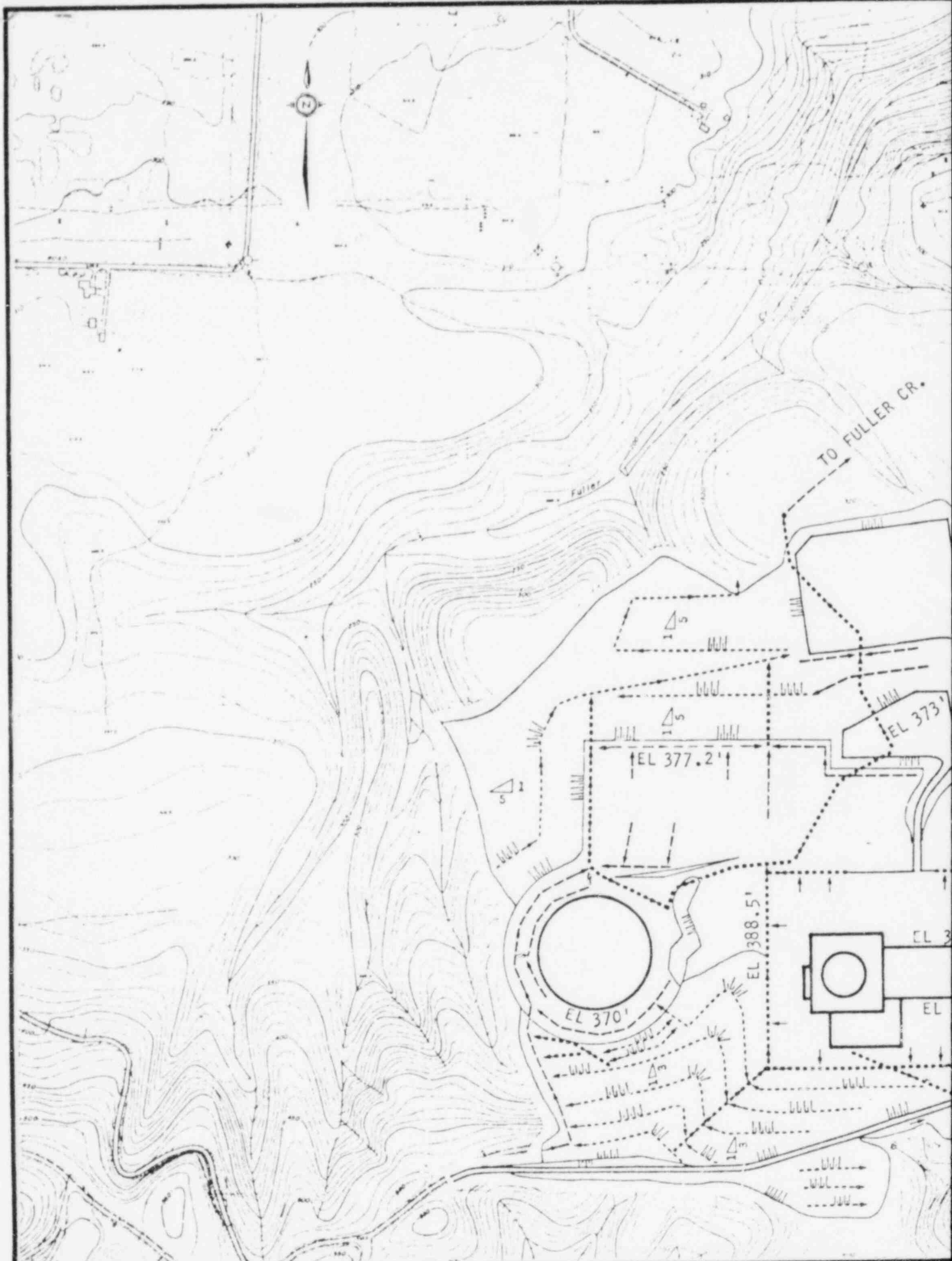
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	FREQUENCY CURVE OF MOMENTARY PEAK FLOWS ON CHEHALIS RIVER AT WNP-3	FIGURE 2.4-4



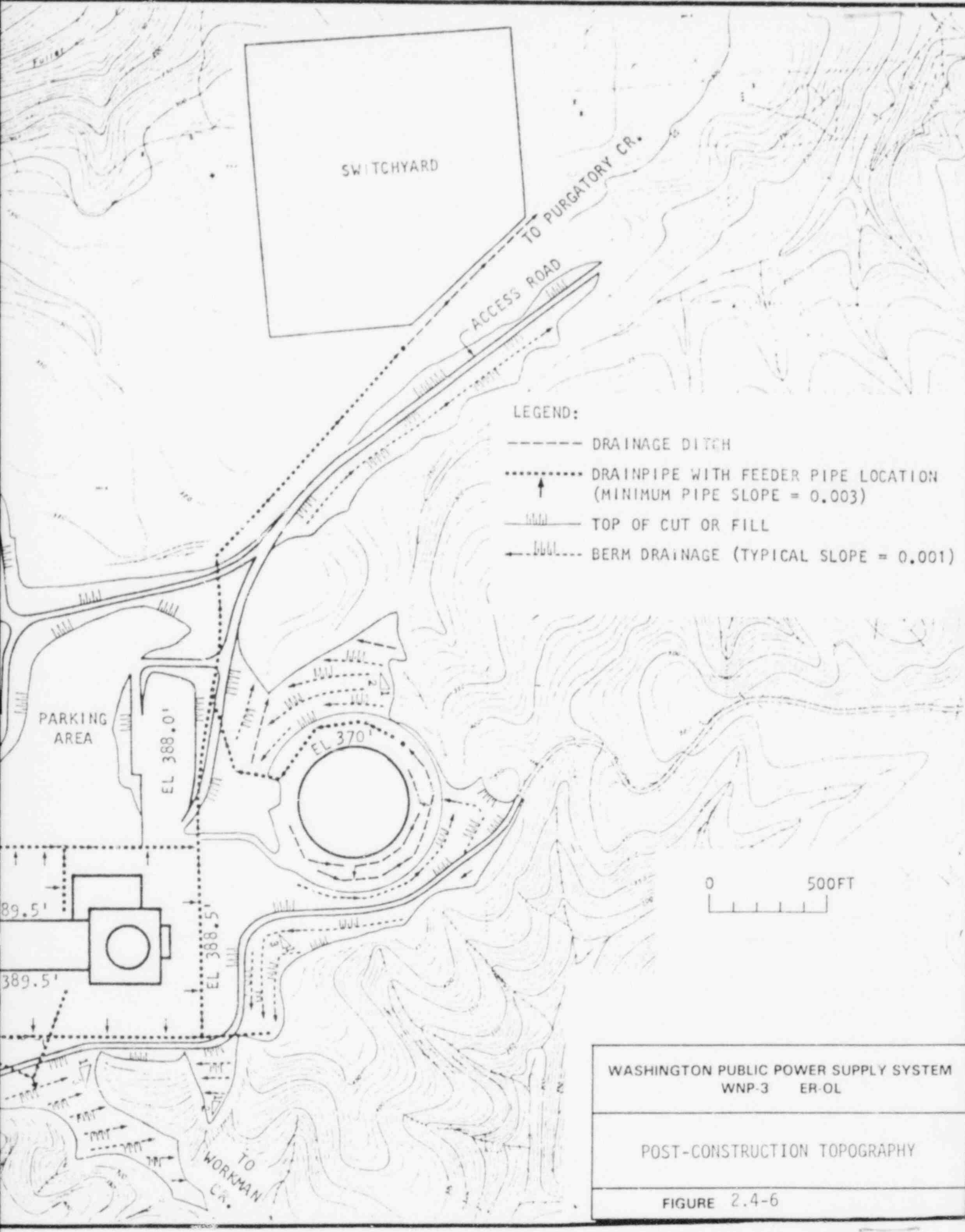
WASHINGTON PUBLIC POWER SUPPLY SYSTEM
WNP-3 ER-OL

BATHYMETRY OF CHEHALIS RIVER NEAR WNP-3 DIFFUSER

FIGURE 2.4-5



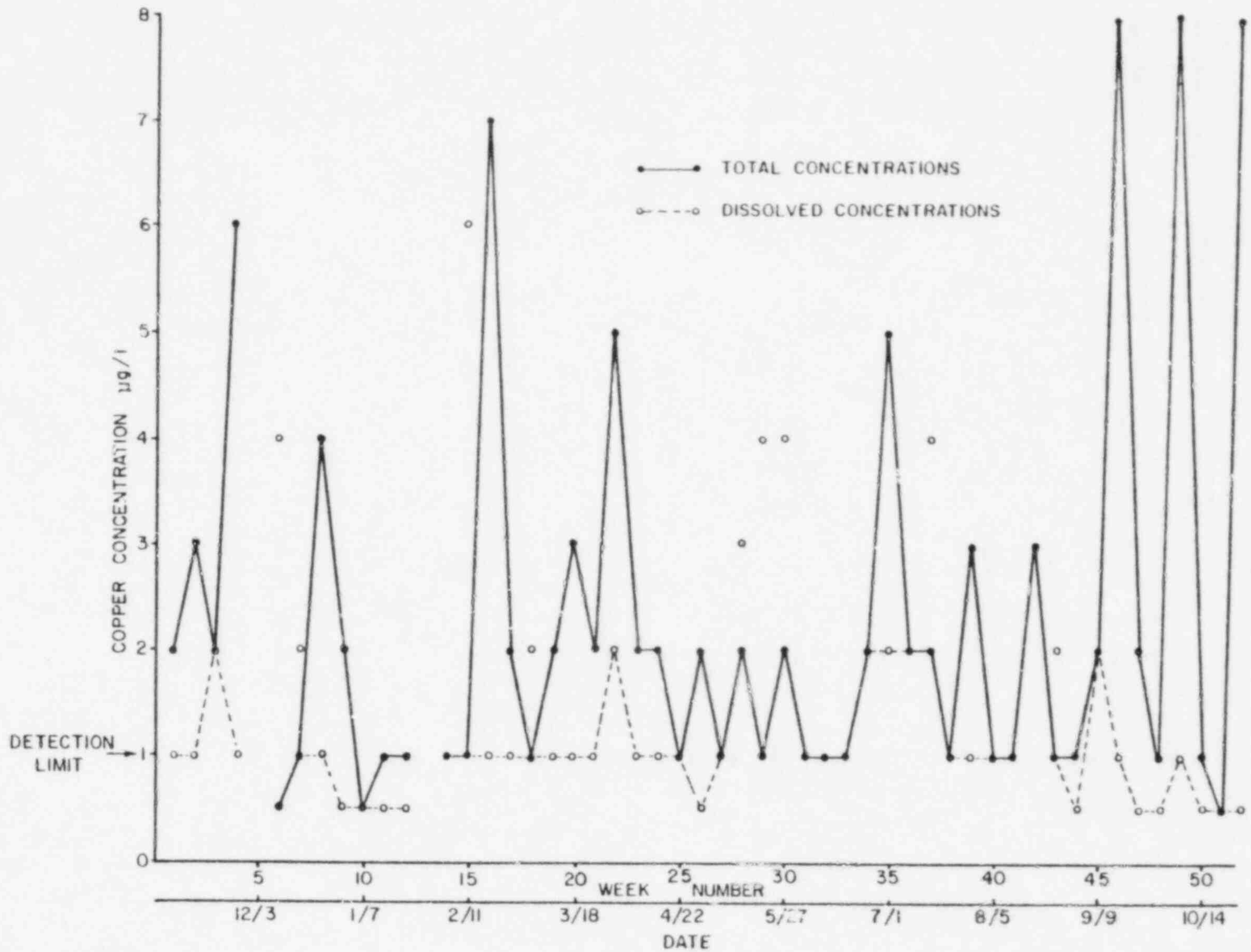
TO FULLER CR.
Fuller
EL 373'
EL 377.2'
EL 388.5'
EL 370'
EL 3
EL



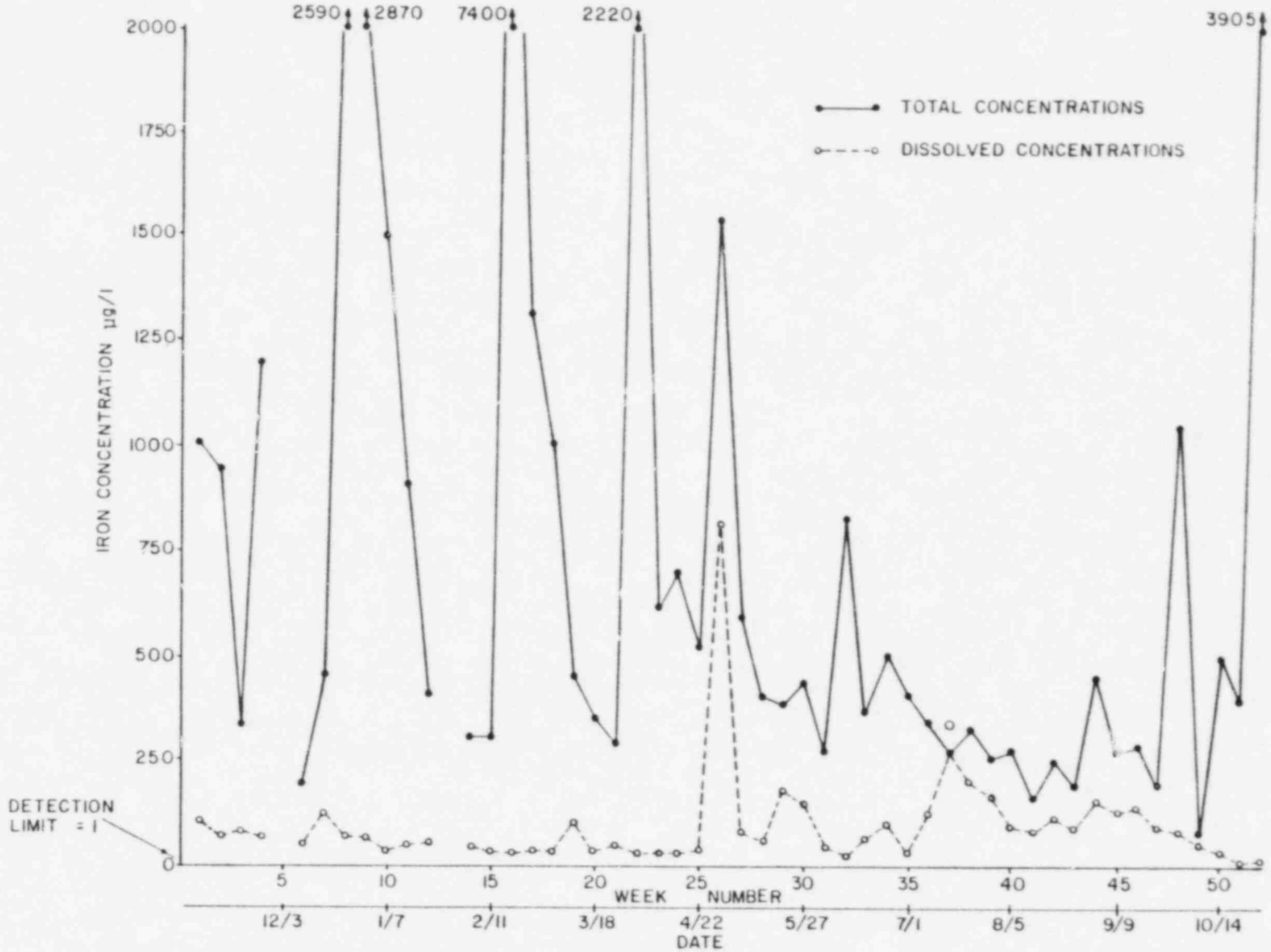
WASHINGTON PUBLIC POWER SUPPLY SYSTEM
WNP-3 ER-OL

POST-CONSTRUCTION TOPOGRAPHY

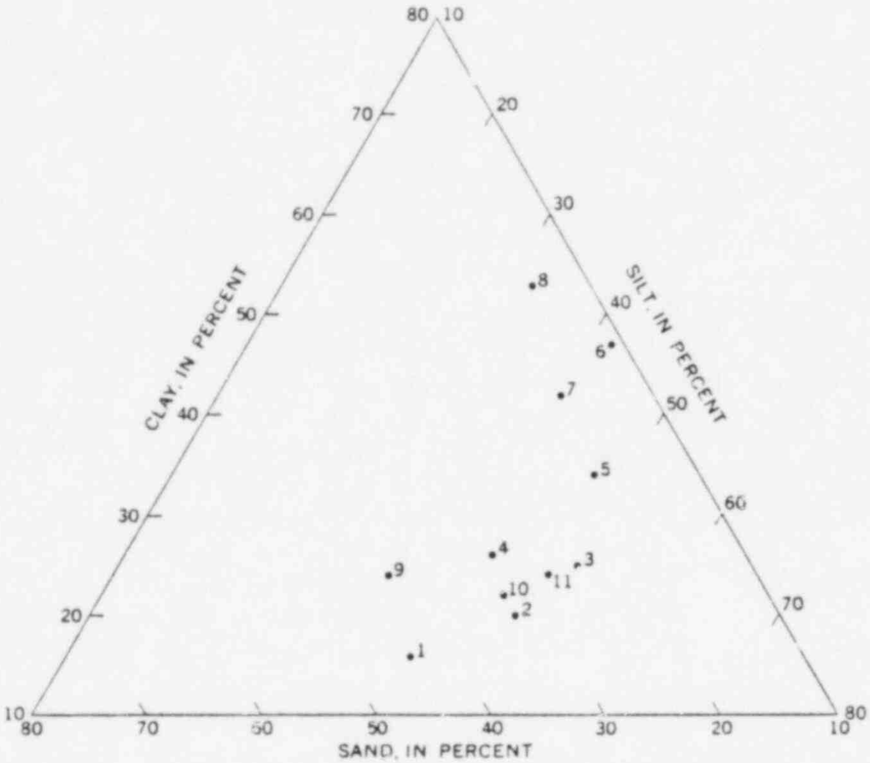
FIGURE 2.4-6



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	CHEHALIS RIVER COPPER CONCENTRATION AT WNP-3 INTAKE AREA	FIGURE 2.4-7

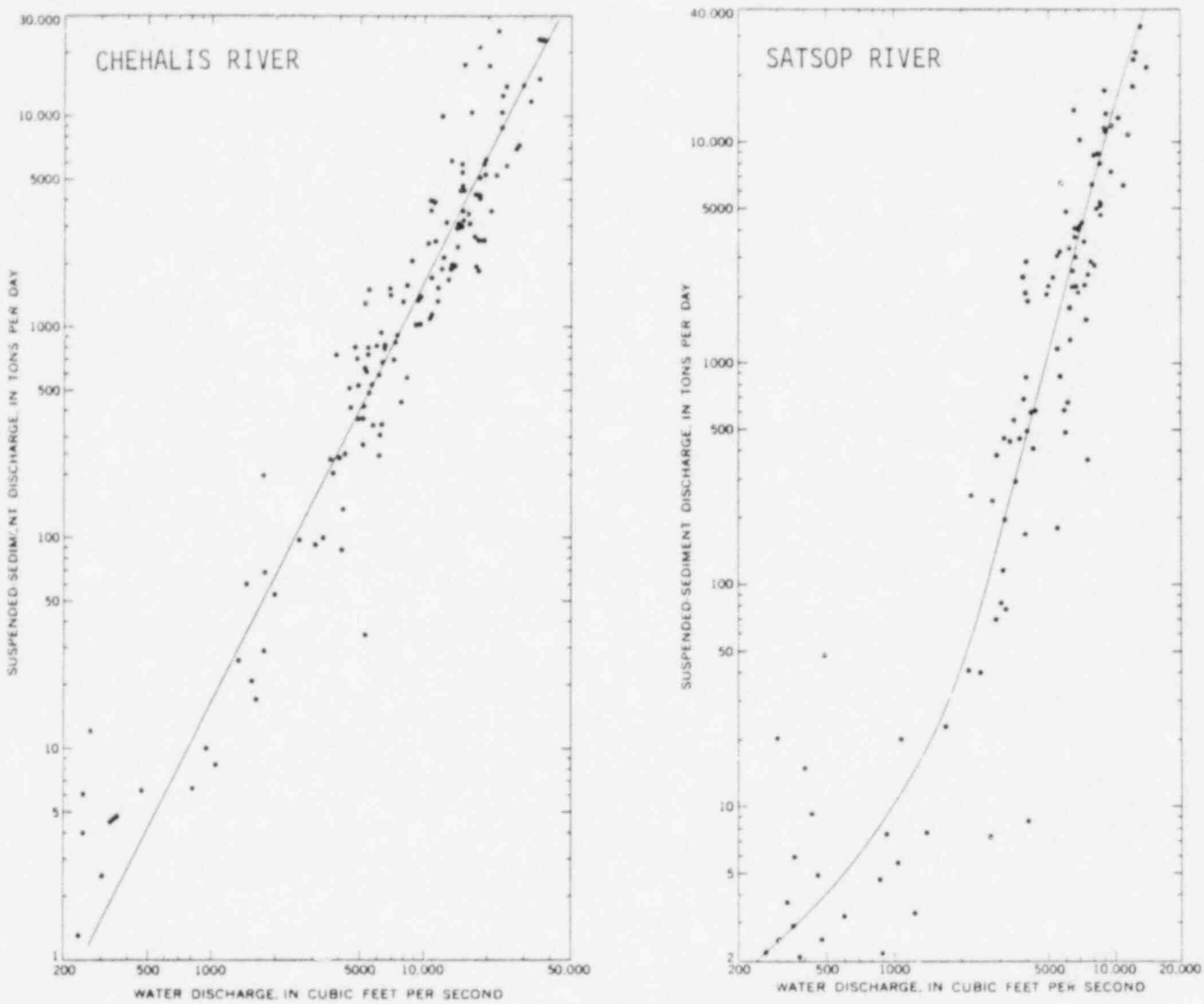


WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	CHEHALIS RIVER IRON CONCENTRATION AT WNP-3 INTAKE AREA	FIGURE 2.4-8



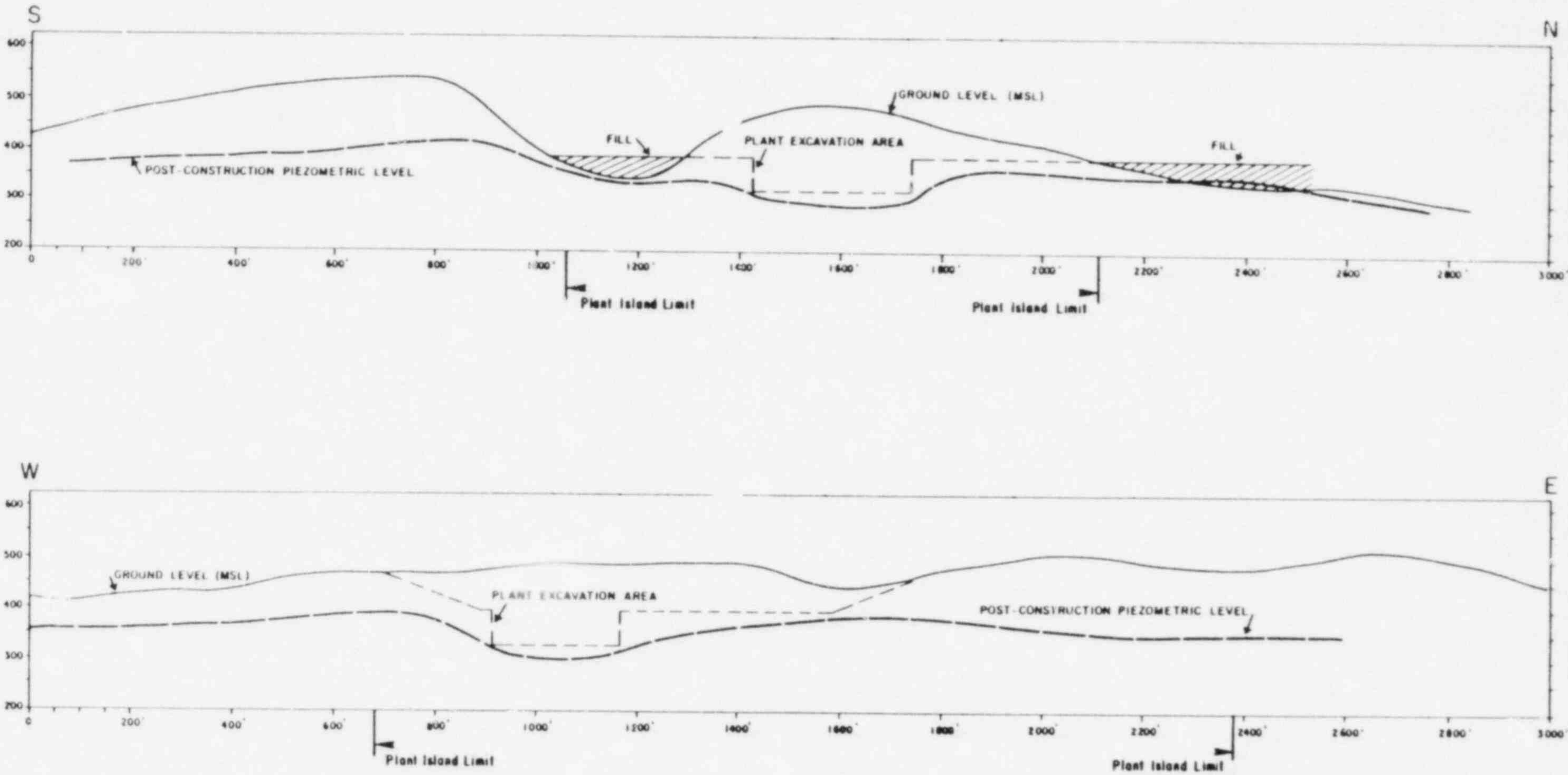
1. Chehalis River near Doty (2 samples).
2. South Fork Chehalis River (3 samples).
3. South Fork Newaukum River near Onalaska (4 samples).
4. North Fork Newaukum River near Forest (5 samples).
5. Newaukum River near Chehalis (17 samples).
6. Skookumchuck River at Centralia (2 samples).
7. Chehalis River near Grand Mound (7 samples).
8. Chehalis River at Porter (7 samples).
9. Cloquallum River at Elma (4 samples).
10. Satsop River near Satsop (11 samples).
11. Wynoochee River above Black Creek, near Montesano (14 samples).

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	PARTICLE SIZE CLASS DISTRIBUTION OF SUSPENDED SEDIMENT IN THE CHEHALIS RIVER BASIN	FIGURE 2.4-9

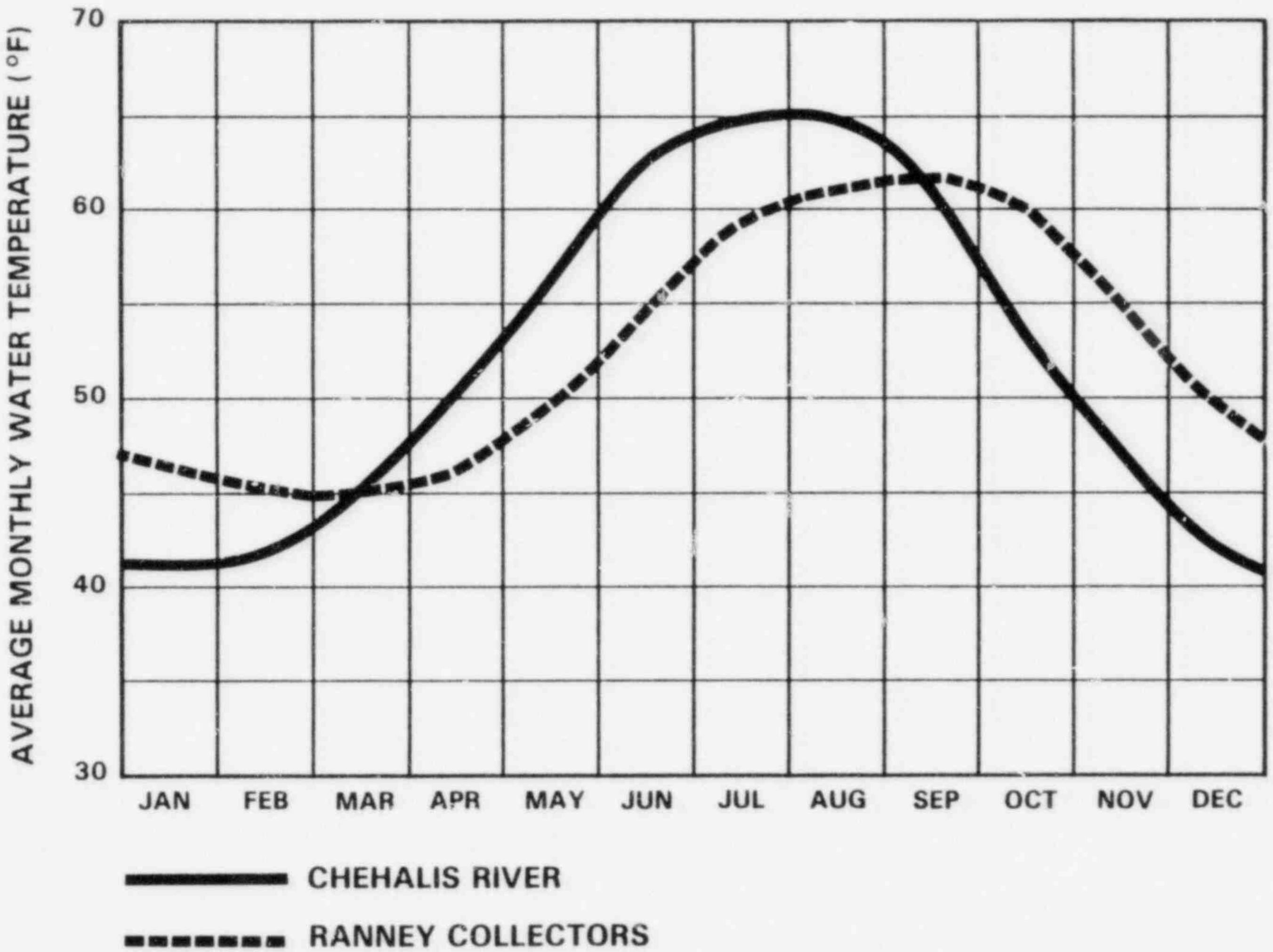


Source: Reference 2.4-9

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	SUSPENDED SEDIMENT VS. DISHARGE OF CHEHALIS AND SATSOP RIVERS	FIGURE 2.4-10



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	POST-CONSTRUCTION PIEZOMETRIC LEVELS AT WNP-3	FIGURE 2.4-11



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	SEASONAL VARIATION OF CHEHALIS RIVER AND WNP-3 MAKEUP WATER TEMPERATURES	FIGURE 2.4-12

2.5 GEOLOGY

Geologic aspects of the site are described in detail in Section 2.5 of the WNP-3 Final Safety Analysis Report. Operation of the plant will not alter or affect the geologic features described therein. Characteristics of the site related to geology (e.g., topography, soil types, aquifer parameters) are included in Sections 2.1 and 2.4 of this report.

2.6 HISTORIC AND PREHISTORIC RESOURCES

The regional archaeology, ethnography, and history are described in Section 2.3 of the WNP-3/5 Environment Report-Construction Permit Stage.(1) Operation of WNP-3 will not result in adverse impacts to historic and cultural resources incremental to the impacts resulting from plant construction.

Much of the information reported in the ER-CP is based on a comprehensive archaeological survey conducted from 1974 to 1976.(2) This survey included literature research (including journals, maps, land claims, etc.), informant (e.g., farmers, collectors, Indians) interviews, and field surveys. This preconstruction survey resulted in recommendations regarding the focus and intensity of archaeological monitoring during construction.

Upon issuance of the Limited Work Authorization (LWA) in April 1977, the Supply System retained professional archaeological services to orient construction personnel, conduct field reconnaissances, perform low level or intensive monitoring, and recover, evaluate and preserve cultural resource materials as required by the LWA and Construction Permits. Archaeological monitoring during construction (most intensive between April and September 1977) resulted in the identification of 2 prehistoric and 21 historic sites and a series of reports documenting the investigations.(3-6) Two construction activities associated with WNP-3 were the subject of particularly detailed studies: the relocation of the County's Keyes Road and constructon of a new bridge over the Chehalis River near site 45-GH-34(4,7) to improve access from the west, and the removal of farm buildings for construction of makeup water intake facilities near site 45-GH-40.(8) Archaeological materials were catalogued and placed in the Washington Archaeological Collections Repository in Pullman for curation. A few artifacts were released to the Supply System for display in the site visitors center.

There are no properties listed, or eligible for listing, on the National Register of Historic Places(9) or the National Registry of Natural Landmarks(10) in the vicinity of WNP-3.

References for Section 2.6

1. Environmental Report-Construction Permit Stage, WPPSS Nuclear Project Number 3, Docket Nos. 50-508/509, Washington Public Power Supply System, Richland, Washington, 1974.

2. Welch, J. M., A Summary of Three Archaeological Surveys for WPPSS Nuclear Projects 3 and 5, prepared for Ebasco Services, Inc., New York, New York, August 15, 1976.

3. Ayers, G. G., L. Hudson, R. M. Weaver, Archaeological Investigations for WPPSS Nuclear Projects No. 3 and 5, in Grays Harbor County, Washington 1977-1978, Vols. I & II, Cultural Resource Consultants, Inc., Sandpoint, Idaho, August 21, 1979.

4. Hudson, L. and G. G. Ayers, Archaeological Investigations for WPPSS Nuclear Projects No. 3 and 5, in Grays Harbor County, Washington 1978-1979, Cultural Resource Consultants, Inc., Sandpoint, Idaho, March 1980.

5. Hollenbeck, J. L., Report of Archaeological Monitoring for WPPSS Nuclear Projects 3/5, 1979-1980, Institute of Cooperative Research, Seattle, Washington, December 1980.

6. Onat, A. R. Blukis, Report of Archaeological Monitoring for WPPSS Nuclear Projects 3/5, 1980-1981 Institute of Cooperative Research, Seattle, Washington, 1981.

7. McClure, R. H., Archaeological Testing and Reconnaissance of the Keyes Road Bridge Right of Way, Grays Harbor County, Institute of Cooperative Research, Seattle, Washington, January 1981.

8. McClure, R. H., Report of Testing and Excavation of 45-GH-40, the Flink Farm Site, Institute of Cooperative Research, Seattle, Washington, March 1981.

9a. "National Register of Historic Places, Annual Listing of Historic Properties," Federal Register, 44(26):7621, February 6, 1979.

9b. 45(54):17485, March 18, 1980.

9c. 46(22):10667&10678, February 3, 1981.

9d. 47(22):4954&4968, February 2, 1982.

10. "National Registry of Natural Landmarks," Federal Register, 45(232):79721, December 1, 1980.

2.7 NOISE

As discussed in Section 2.1, WNP-3 is located on a forested ridge about one mile from the nearest residence. The principal noise sources will be the natural-draft cooling tower and outside transformers. Typically these cooling towers create a sound level of about 55 dB(A) at 1000 feet and less than 35 dB(A) at one mile with calm winds.[1,2] Because of the location of the site relative to residential areas, noise generated by the plant is not expected to be a problem.

References for Section 2.7

1. G. A. Capano and W. E. Bradley, "Noise Prediction Techniques for Siting Large Natural Draft Cooling Towers," In: Proceedings of the American Power Conference, 38:756-763, Chicago, Illinois, 1976.

2. A. M. Teplitzky, "Controlling Power Plant Noise," Power, 122(8): 23-27, August 1978.

THE STATION

3.1 EXTERNAL APPEARANCE

The most visible portions of WNP-3 are located on Fuller Ridge and can be seen from three areas: 1) U. S. Highway 12 between Satsop and Elma, 2) the main access road, and 3) gravel logging roads south of the plant. The surrounding terrain consists of open fields and rolling hills which, near the plant, reach elevations of 530 ft MSL. The hills around the plant contain mostly mixed stands of Douglas fir and red alder with the view from Highway 12 having mainly Douglas fir screening the site. An oblique aerial view of the site is shown in Figure 3.1-1. A profile view of the site from Keyes Road (approximately 2.5 mi NNW) is shown in Figure 3.1-2.

The most dominant features of the station are the twin cooling towers (one servicing WNP-3) with a base elevation of 370 ft MSL and a top elevation of 870 ft MSL. The other principle structures of WNP-3 are located adjacent to the cooling towers at base elevations between 335 and 390 ft MSL. These are the dry cooling tower, reactor building, and fuel handling building, turbine building, administration service building, supplementary cooling facilities, water treatment facilities and warehouse buildings. These structures are shown in Figure 3.1-3. The Ranney well intake is approximately 3.5 miles west of the plant island and has an access road along Hyatt Creek. The discharge diffuser is located approximately one mile northwest of the reactor on the Chehalis River.

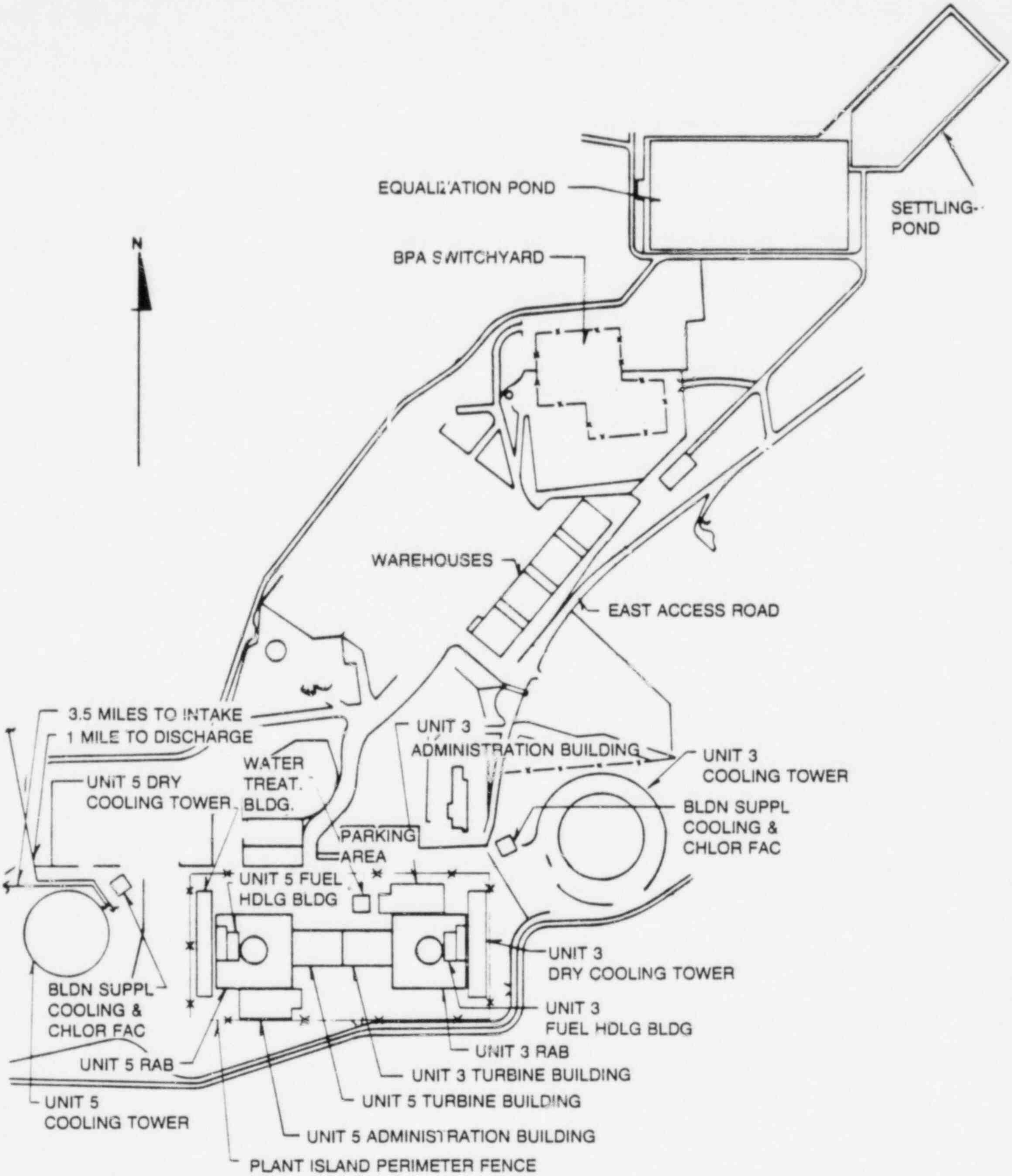
Except for the intake and discharge, the plant is a unified architectural form arranged with the reactor building as focus. The total appearance presents an integrated arrangement of form, texture, and color. The reactor building is seismic Category I structures (an NRC designation for safety-related structures) with a nonreflective concrete exterior. Except for the cooling tower, structures other than Category I are faced with metal panels of color and texture to harmonize with adjacent concrete structures. This continuity of color and texture complements the building arrangement.

The Ranney well structures are located in a former pasture in an isolated area and can only be seen from the South Bank and Brady Loop Roads, adjacent farms, and the Chehalis River. The discharge diffuser is completely under water and away from roads. The blowdown pipe will be visible to passing boats.

Disturbed areas along the east, west, and Ranney well access roads have been planted with fast-growing grass and will be planted with native varieties of trees and ground cover. Other disturbed areas will be restored with native plants or, in some areas, hardy ornamentals to retain naturalistic continuity.

The locations of release points of gaseous wastes are shown in Figure 3.5-8. The liquid release point is described in Subsection 3.4.4.

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	PROFILE VIEW OF SITE FROM NORTH (MAY 1982)	FIGURE 3.1-2



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	GENERAL PLANT LAYOUT	FIGURE 3.1-3

3.2 REACTOR AND STEAM ELECTRIC SYSTEM

The System 80 Nuclear Steam Supply System (NSSS) was designed and manufactured by Combustion Engineering, Inc. The WNP-3 unit consists of a 2-loop, 4-pump pressurized water reactor (PWR) and supporting auxiliary and safety-related systems. The containment structure consists of a steel containment vessel surrounded by reinforced concrete. The steam turbine generator was supplied by Westinghouse Electric Corporation.

The WNP-3 PWR system functions like other systems of this type. A controlled uranium fission reaction occurs only in the reactor core, which is an array of fuel assemblies inside the reactor vessel. The fission reaction generates heat. This heat is transferred in the "primary system" to the pressurized coolant that surrounds the fuel. This hot pressurized coolant is then pumped to a steam generator where the heat contained in the coolant is transferred through the walls of tubes in the steam generator to the water in the "secondary system" where steam is produced. The cooled reactor coolant is then pumped back to the reactor for reuse, forming a closed-cycle in the primary system.

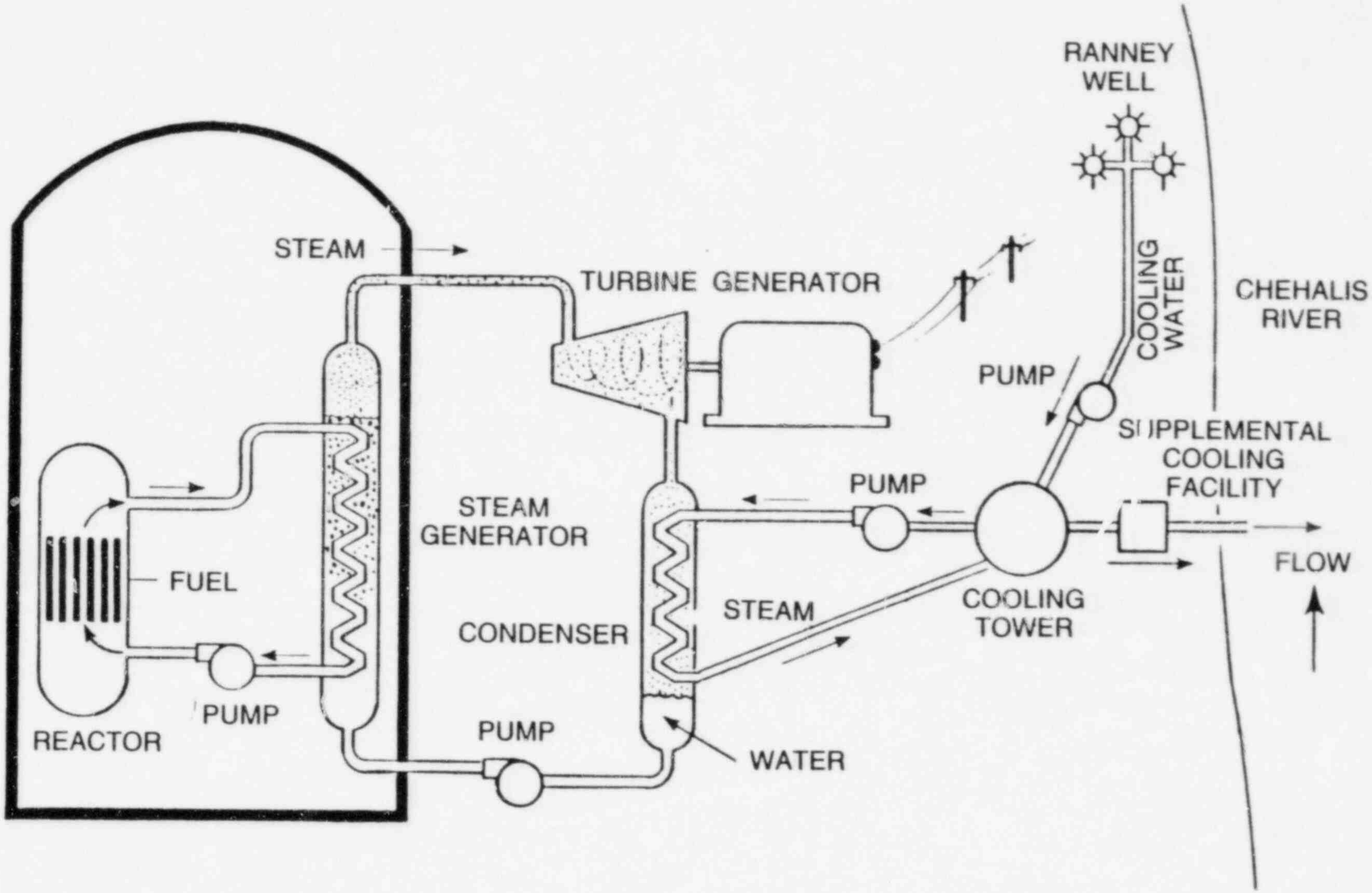
The steam in the secondary system does not come into contact with the nuclear fuel in the reactor. This steam flows through the turbine causing the spinning action necessary to generate electricity. After passing through the turbine, the steam is cooled and condensed back to water. The water is pumped back into the steam generator where it becomes steam again, forming a second closed-cycle system. A simplified diagram of this system is presented in Figure 3.2-1.

The reactor core is fueled with uranium dioxide pellets enclosed in Zircaloy tubes with welded end plugs. The tubes are fabricated into assemblies in which end fittings prevent axial motion and grids prevent lateral motion of the tubes. The control element assemblies (CEAs) consist of Inconel-clad boron carbide absorber rods which are guided by Zircolay tubes located within the fuel assembly. The core consists of 241 fuel assemblies loaded with 257,100 pounds of UO_2 with an average enrichment rate of 2.64 weight percent U^{235}.

The turbine is a Westinghouse tandem compound unit consisting of one double-flow, high-pressure turbine and three double-flow, low-pressure turbines running at 1800 rpm with 40-inch diameter last-stage blades. Exhaust steam from the high-pressure turbine passes through moisture separator/reheaters before entering the low-pressure turbine inlets. Steam extracted from the various turbine stages is used in all six feedwater heaters. During plant operation, steam from the low-pressure turbine will be exhausted directly downward into the condenser through exhaust openings in the bottom of the turbine casing. The main condenser is a three-shell and multi-pressure design and serves three low-pressure turbines. The condenser tubes are made of stainless steel and have a cooling surface area of 1,401,871 sq ft.

The rated thermal power of the System 80 is 3,817 MW. The rated gross electric output is 1,324 MWe and net output is 1,284 MWe. The station power consumption will be approximately 40 MWe for both rated or design level operation. The corresponding design levels of electrical output are 1,374 MWe and 1,334 MWe for gross and net values, respectively. The nominal net plant output is 1240 MWe.

Unit heat rates at a turbine back pressure of 3.5 inches of mercury for plant load factors of 100, 75, 50, 25 percent are 9833, 9954, 10637, 12376 Btu/kWh, respectively.



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	SCHEMATIC DIAGRAM OF PRESSURIZED WATER REACTOR	FIGURE 3.2-1

3.3 STATION WATER USE

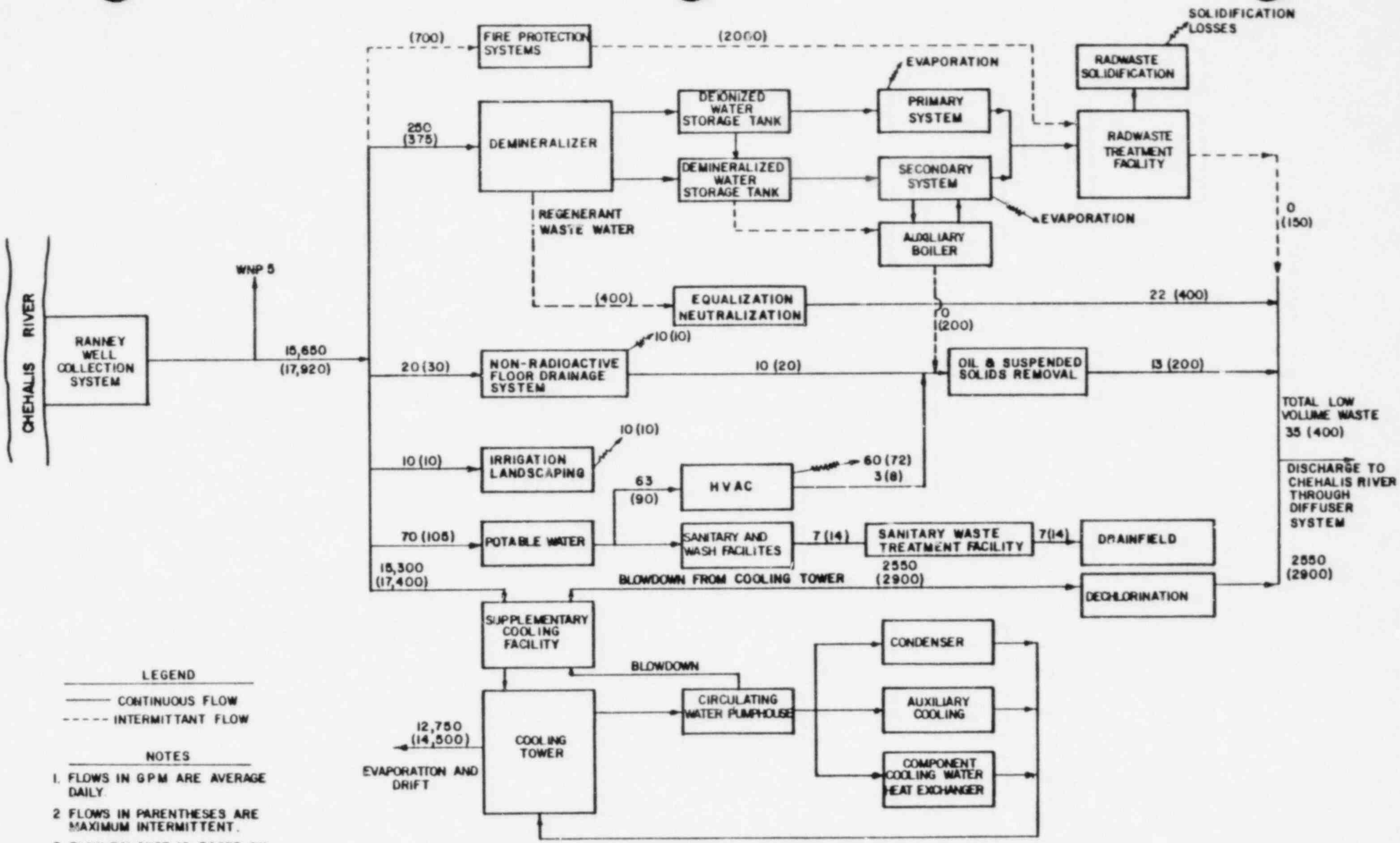
Water required for WNP-3 will be supplied from groundwater infiltration-type intake structures which are described in Subsection 3.4.5. The quantity of water required for plant operation is primarily dependent on water losses from the circulating cooling water system in the form of evaporation, drift and blowdown. Details on this system are provided in Section 3.4. Other systems in the plant water balance include: process water treatment system, potable and sanitary waste systems, and chemical and radwaste treatment systems. Additional information on these systems is included in Sections 3.5, 3.6, and 3.7.

Average and maximum flows and shutdown water usage are summarized in Table 3.3-1. Figure 3.3-1 is a schematic flow diagram showing in-plant flows for WNP-3. The maximum intake requirement is about 18,000 gpm. The capability of the intake system to provide this quantity is independent of low flows in the Chehalis River. The State Energy Facility Site Evaluation Council (EFSEC), however, has administratively established that plant makeup withdrawal (except for a hot-standby maintenance flow of 2 cfs) must cease when the daily average river flow goes below 550 cfs. The restriction is incorporated in the WNP-3 Site Certification Agreement (see Chapter 12). It is anticipated that river discharge will go below 550 cfs about four days per year.

TABLE 3.3-1

PLANT WATER USE (gpm)

Plant System	Station Condition		
	Maximum Power Operation	Temporary Shutdown	Average Power Operation
Heat Dissipation System			
Evaporation	14,500	0	12,750
Blowdown	2,900	0	2,550
Potable and HVAC Systems	105	42	70
Irrigation and Landscaping	10	10	10
Demineralized Water System	375	375	250
Balance of Plant (Equipment Washing and Cleaning)	30	10	20
Total	17,920	437	15,650



LEGEND

——— CONTINUOUS FLOW

- - - - - INTERMITTANT FLOW

NOTES

1. FLOWS IN GPM ARE AVERAGE DAILY.
2. FLOWS IN PARENTHESES ARE MAXIMUM INTERMITTENT.
3. FLOW BALANCE IS BASED ON AVERAGE DAILY.

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	PLANT WATER FLOW DIAGRAM	FIGURE 3.3-1

3.4 HEAT DISSIPATION SYSTEM

WNP-3 will produce approximately 8.7 x 10^9 Btu/hr of waste heat at rated power (1,284 MWe gross). The waste heat will be dissipated to the atmosphere by a natural-draft cooling tower. To prevent the buildup of dissolved solids in the cooling system, a certain amount of cooling water must be continuously blown down to the Chehalis River after first being further cooled by a supplemental cooling system. The blowdown discharge will be quickly diluted with the river water through the use of a submerged multiport diffuser. Makeup water must be supplied to replace the water lost by evaporation, blowdown, and drift. The makeup water will be supplied by a Ranney well intake system. The closed-cycle cooling water system is utilized to minimize water use and thermal discharge effects. Figure 3.4-1 is a schematic diagram of this system and Table 3.4-1 provides important system operating parameters.

A dry cooling tower is used as an ultimate heat sink during an accident situation and is connected to the component cooling water heat exchangers in the Reactor Auxiliary Building (RAB).

3.4.1 Circulating Cooling Water System

Three 177,223-gpm (395 cfs) capacity pumps (under the system resistance head of approximately 115 ft) circulate 531,670 gpm (1,185 cfs) of cooling water. This water is circulated from the cooling tower basin through the parallel main condenser cooling circuit and service water system cooling circuits and back to the cooling tower in a common conduit for the ultimate rejection of accumulated system heat. The system heat is rejected to the air stream by direct contact cooling within the natural draft cooling tower. The cooled water is collected in the concrete basin at the bottom of the cooling tower.

Sodium hypochlorite is added to the circulating water system periodically to control biological growth (see Subsection 3.6.4). The condenser will also be provided with an Amertap tube cleaning system. This system uses natural rubber sponge balls which continuously pass through the condenser tubes to clean the inner surfaces. Balls are collected in a strainer for reuse.

The total volume of water in the circulating water system is approximately 8.5 x 10^6 gallons. The approximate travel time of water through the system is 16 minutes. The blowdown travels to the river in about 36 minutes. The components of the system are made of the following materials:

- o Condenser - The approximately 1.4 x 10^6 sq ft of tubes are type 304 stainless steel. Tube sheets and water boxes are constructed of carbon steel coated with high-density epoxy paint. Water boxes are provided with cathodic protection by use of Durachlor anodes and zinc reference electrodes.

- Cooling Tower - Each cooling tower contains approximately 9×10^6 sq ft of wetted surface area of polyvinyl chloride (PVC) fill. Structural members are reinforced concrete which is either precast or cast-in-place.

- Circulating Water Pumps - The major components of the pumps are constructed of carbon steel, stainless steel, and cast iron. The auxiliary pump has a bronze impeller.

- Amertap System - All inside surfaces of the system are epoxy-coated. The Amertap balls are made of uncoated natural rubber sponge.

- Circulating Water Fine Screens - The screens, located upstream of the circulating water pumps, are made of galvanized iron protected by magnesium anodes.

- Service Water System - The service water system includes miscellaneous heat exchangers containing approximately 90,000 sq ft of 90/10 copper/nickel tubing.

3.4.2 Cooling Towers

The waste heat is transferred to the atmosphere via a natural-draft cooling tower. The tower is a concrete hyperbolic structure, approximately 500 ft tall and 420 ft in diameter at the base. Figure 3.4-2 shows the important parts of a typical counter-flow natural-draft cooling tower.

Hot water from the condenser is brought to the tower through the water inlet piping and into the inlet header located below the cold water basin. Hot water then flows up through five risers to the five precast concrete main distribution flumes which feed a composite of smaller, fiberglas-reinforced-polyester (FRP) pipes. These pipes are fitted with special spray nozzles which spray the hot water evenly over the PVC fill surface of the tower. Most of the cooling results from the evaporation of a portion of the circulating water. Sensible heat transfer by conduction to air also contributes to the cooling process.

Air circulation is induced by the difference in density between the air inside and outside of the cooling tower. The heated, moisture-laden air in the tower is lighter than the air outside, and the pressure difference at the inlet drives the air through the fill (packing) and up through the tower.

The tower drift eliminator system is located directly above and supported by the water distribution pipes. The drift eliminator is the impingement type consisting of PVC blades which change the air flow direction twice.

The water droplets separate from the air flow within the drift eliminator and collect and fall back to the fill surface. The drift eliminator system is guaranteed to limit the drift loss to 0.003 percent of the design flow. Table 3.4-2 lists the design parameters of the cooling tower. Figure 3.4-3 presents the tower performance under design conditions.

The concentration of dissolved solids within the circulating water system is controlled by continuous blowdown (at an annual average rate of 3.7×10^6 gpd) from the cooling tower basin. Blowdown flow will be determined by daily analyses of the circulating water chemistry; the flow will be adjusted by a remotely operated butterfly valve. A continuous makeup supply is provided to the system from the Ranney collectors for the loss due to evaporation, blowdown and cooling tower drift.

3.4.3 Supplemental Cooling System

Supplemental cooling of the blowdown water is provided by a countercurrent heat exchanger and associated control and monitoring equipment (see Figure 3.4-1). The heat exchanger uses plant makeup water as the cooling medium and is sized for a 3°F approach to the makeup (well water) temperature. The supplemental cooling system is constructed primarily of Type 304 stainless steel tubing with a total exposure of approximately 26,000 sq ft.

The thermal monitoring system for the circulating water system blowdown consists of temperature sensors for the river, makeup well water, and blowdown; and there are also flow sensors for the makeup and blowdown. The temperature control of the discharge (to Chehalis River) will be controlled by using a variable bypass around the heat exchanger. Discharge temperature will be controlled within the limits of the NPDES Permit (see Appendix A). The heat exchanger can be completely bypassed if the blowdown temperature falls within the acceptable limits.

3.4.4 Blowdown Diffuser

After passing through the supplemental cooling system, the blowdown water will be conveyed through a piping system consisting of approximately 6,900 ft of 21-inch reinforced concrete pipe, 1,200 ft of 20-inch carbon steel/fiberglas pipe; and 275 ft of 18-inch carbon steel pipe. The pipe runs to the Chehalis River at River Mile 20.5 (below the confluence with the Satsop River). The pipeline will extend north and under the river bed approximately 140 ft from the south bank of the river and includes a 32-foot long multiport diffuser (see Figure 3.4-4). The 32-foot diffuser is a 18-inch diameter pipe perforated with 46 discharge ports which are 2 inches in diameter and spaced at 8-inch intervals. The diffuser is located so that the projecting ports are one foot above the river bottom and direct the discharge downstream at a 12 degree angle above the horizontal. This orientation will minimize bottom scouring. Average discharge jet velocity will be about 6.25 fps. The discharge rate and temperature are tabulated by month on Table 3.4-1.

3.4.5 Makeup Water Intake

The makeup water system consists of two Ranney Collectors located on the south bank of the Chehalis River at about River Mile 18 (see Figure 3.4-5). (Three collector wells were planned to support operation of both WNP-3 and WNP-5). In general, each collector consists of a circular reinforced concrete caisson, a concrete plug near the base of the caisson, a series of horizontal screen laterals radiating from the base of the caisson, piping, valves, an extension stem and guide, and floor boxes with valve operating devices. The upper portion of the caisson holds the pumphouse. Figure 3.4-6 shows these major components.

The maximum makeup water requirement for WNP-3 is approximately 18,000 gpm and a single collector well is capable of supplying this amount on a continuous basis.

Water withdrawal through the Ranney collectors will induce the river water to flow from the river bottom and bank through the permeable aquifer to the collectors. With this type of groundwater system, extreme high summer water temperatures and extreme low winter water temperatures are moderated. Seasonal groundwater temperatures are expected to range from 50 to 58°F, with water temperatures lagging those of the river by about two months. The minimum water temperature is expected to occur during March while the maximum water temperature will occur in late September or early October (see Figure 2.4-12).

The advantages of this type of intake are the reduction of maintenance problems and elimination of entrainment of fish, organisms, and debris. The high permeability and transmissibility coefficients of the unconfined aquifer indicate that the aquifer reacts much like a reservoir. The aquifer accepts surface water for storage during high river flow until the underground storage is full. The permeable aquifer discharges readily into streams and rivers during periods of low flow. Any silt buildup on the riverbed of the Chehalis River will be minimal and will have little or no effect on the capacity of the groundwater collector system.

TABLE 3.4-1

COOLING SYSTEM OPERATING PARAMETERS

Month	Intake Water Temperature	Discharge Temperature	Average[a] Wet Bulb Temperature	Critical[b] Wet Bulb Temperature	Maximum[c] Blowdown	Maximum[c] Evaporation	Maximum[c] Makeup
	(°F/°C)	(°F/°C)	(°F/°C)	(°F/°C)	(cfs)	(cfs)	(cfs)
January	47.5/ 8.6	50.5/10.3	36.1/ 2.3	49.4/ 9.7	5.9	29.2	35.1
February	46.5/ 8.1	49.5/ 9.7	38.4/ 3.6	51.1/10.6	5.9	29.5	35.4
March	44.5/ 6.9	47.5/ 8.6	39.2/ 4.0	54.0/12.2	6.0	30.3	36.3
April	45.0/ 7.2	48.0/ 8.9	43.4/ 6.3	56.0/13.3	6.1	30.5	36.6
May	48.5/ 9.2	51.5/10.8	48.1/ 8.9	61.0/16.1	6.3	31.5	37.8
June	52.5/11.4	55.5/13.1	53.1/11.7	66.0/18.9	6.3	32.3	38.7
July	58.0/14.4	61.0/16.1	56.1/13.4	65.4/18.6	6.4	32.3	38.7
August	60.5/15.8	63.5/17.5	55.8/13.2	60.9/16.1	6.3	31.5	37.8
September	62.0/16.7	65.0/18.3	52.4/11.3	62.8/17.1	6.3	31.8	38.1
October	60.5/15.8	63.5/17.5	47.3/ 8.5	56.0/13.3	6.1	30.5	36.6
November	56.5/13.6	59.5/15.3	40.5/ 4.7	52.9/11.6	6.0	30.0	30.0
December	52.0/11.1	55.0/12.8	38.3/ 3.5	52.1/11.2	5.9	29.8	35.7

(a) Average wet-bulb temperatures at Olympia for 1948-1968.

(b) Daily critical wet-bulb temperatures at Olympia 1952-1977.

(c) Based on 40 percent relative humidity, critical wet-bulb temperatures, and operation at 6 cycles of concentration.

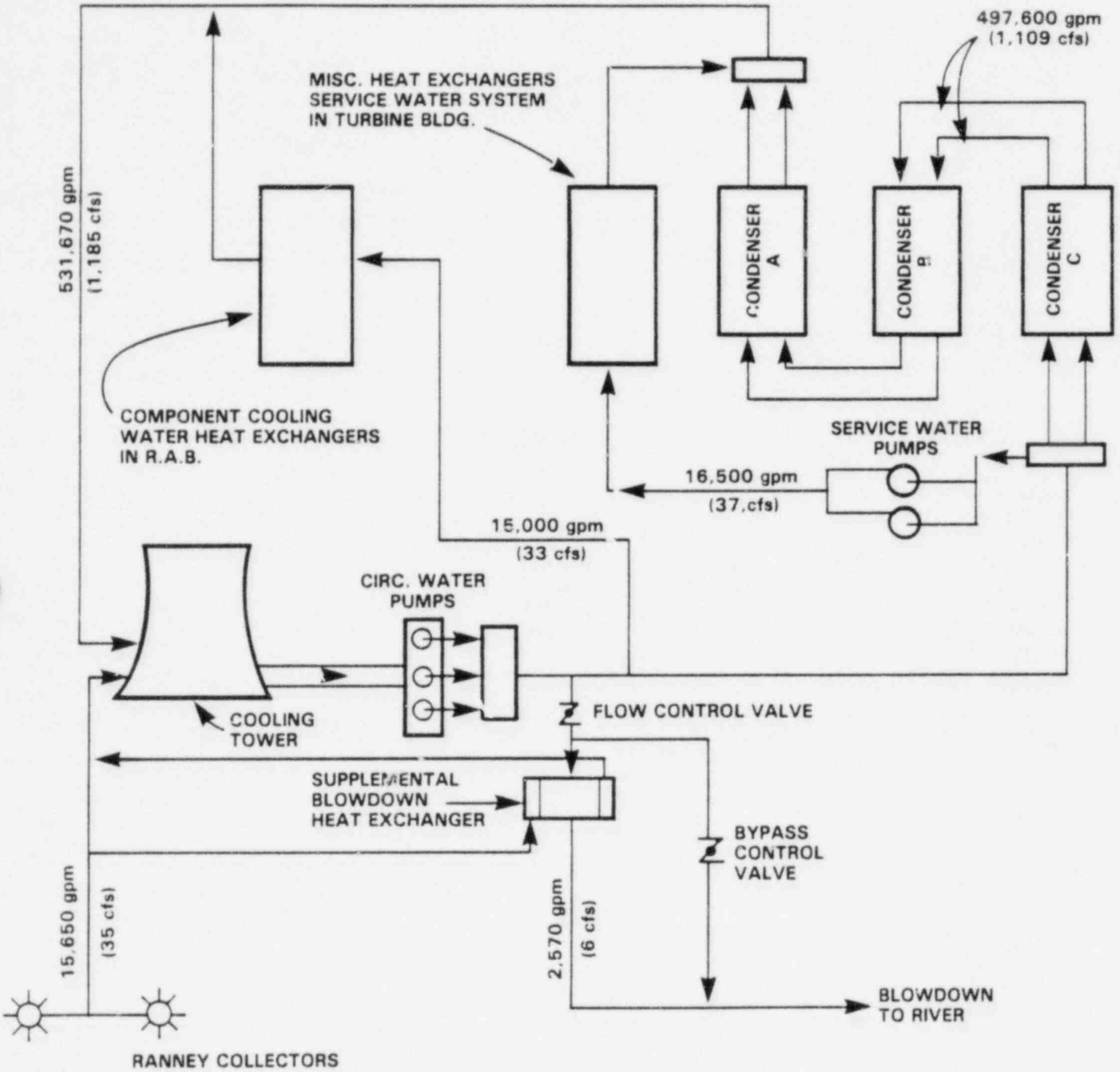
TABLE 3.4-2

COOLING TOWER DESIGN PARAMETERS

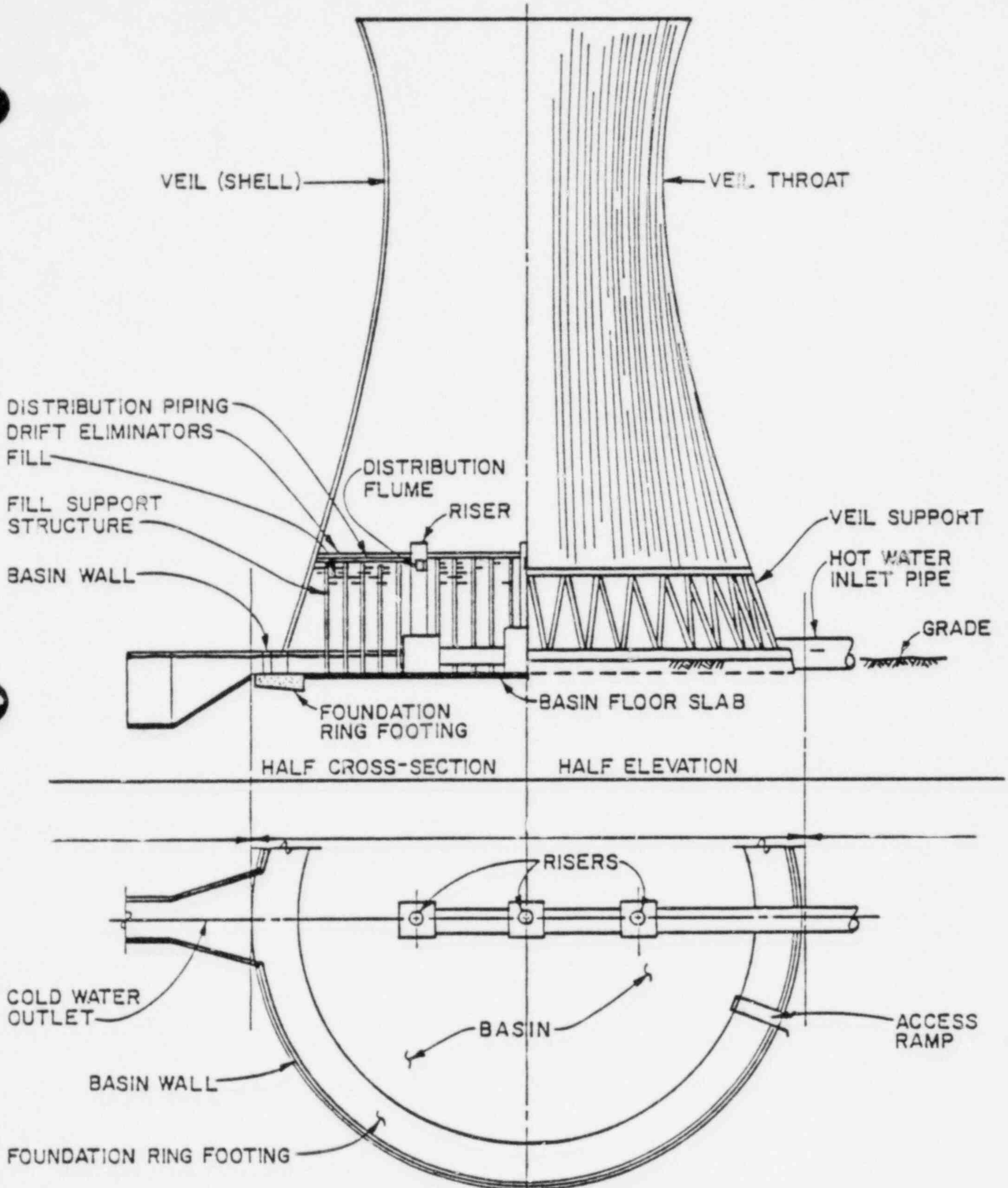
Wet-Bulb Temperature[(a)]	68°F
Approach to Wet-Bulb	18°F
Range	34°F
Water Flow	525,000 gpm[(b)]
Evaporation (maximum)	14,700 gpm
Drift Losses	15.8 gpm
Blowdown (maximum)	4,000 gpm

(a) This wet-bulb temperature is estimated to be exceeded only 22 hours per year.

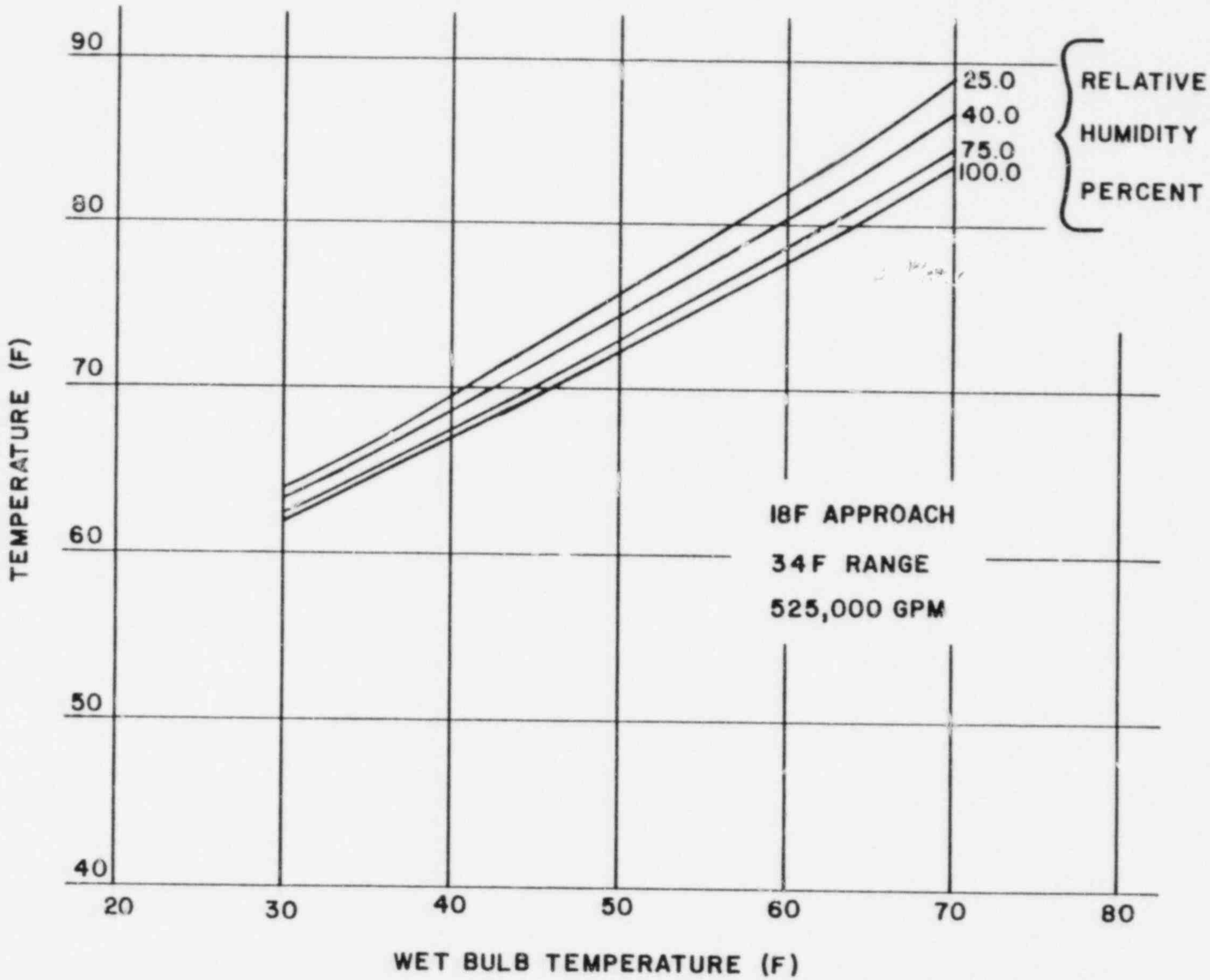
(b) The maximum cooling capacity by flow rate is 603,750 gpm (15 percent over design).



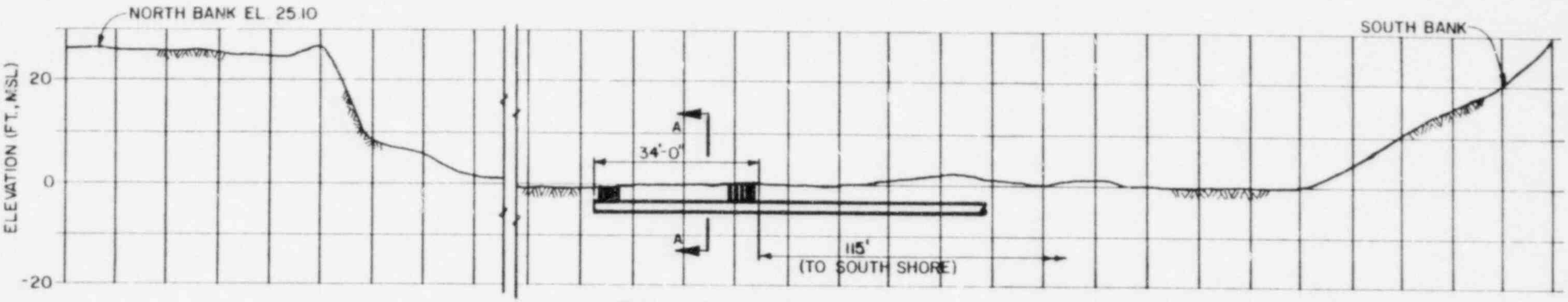
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	SCHEMATIC DIAGRAM OF CIRCULATING COOLING WATER SYSTEM	FIGURE 3.4-1



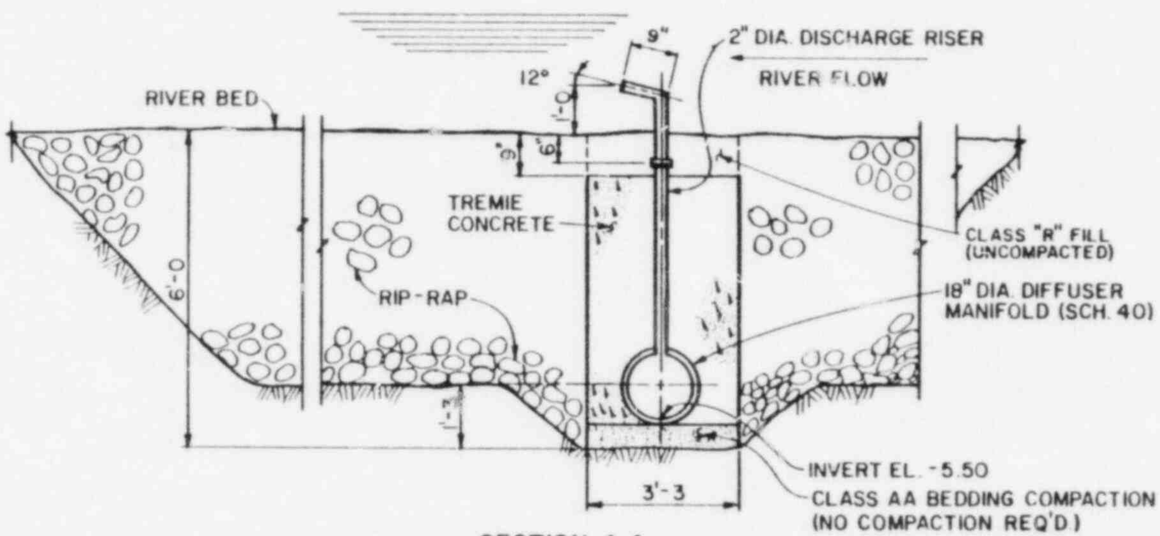
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	WET NATURAL-DRAFT COOLING TOWER (COUNTERFLOW TYPE)	FIGURE 3.4-2



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	NATURAL-DRAFT COOLING TOWER PERFORMANCE CURVE	FIGURE 3.4-3

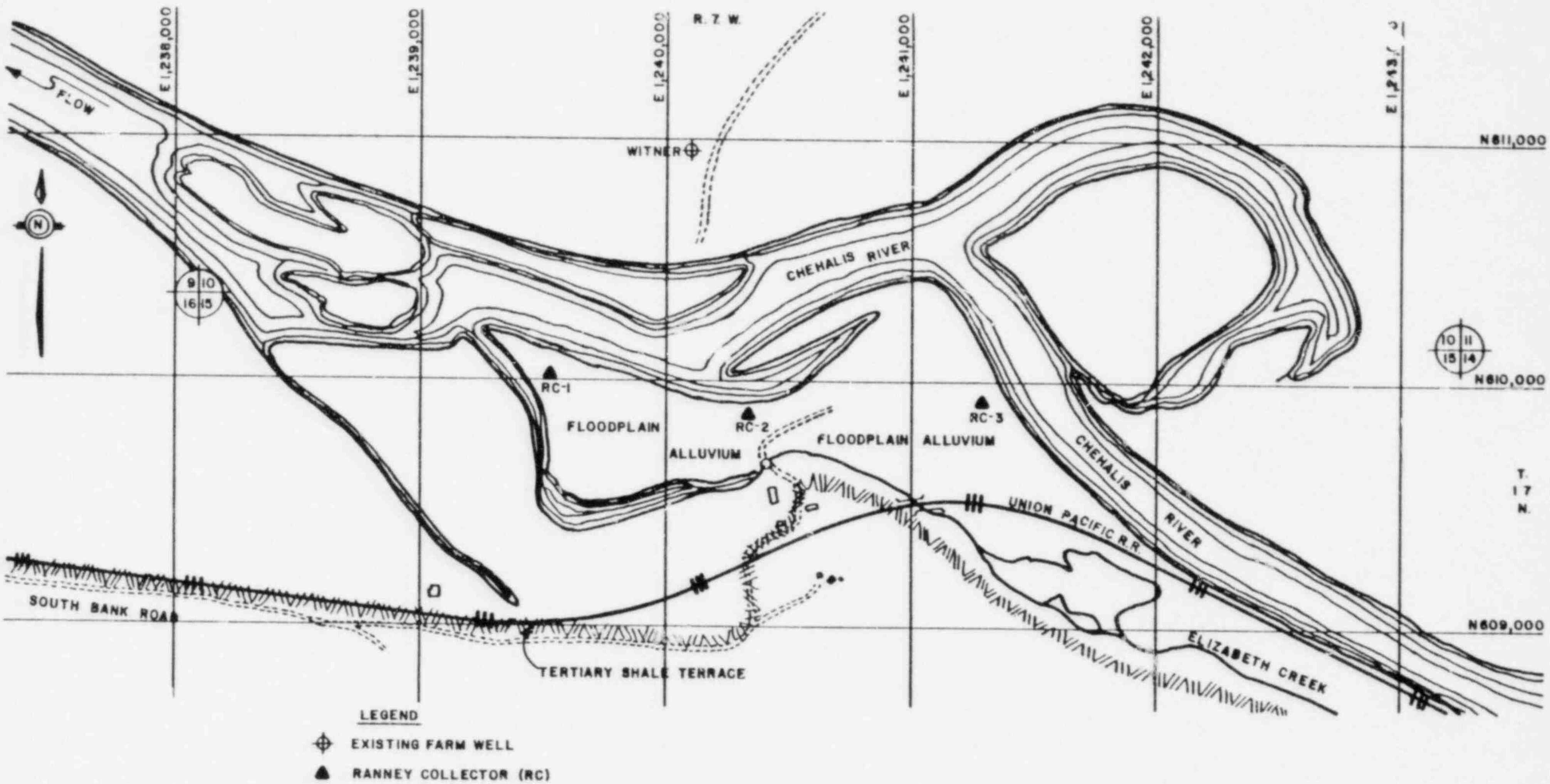


CHEHALIS RIVER CROSS-SECTION

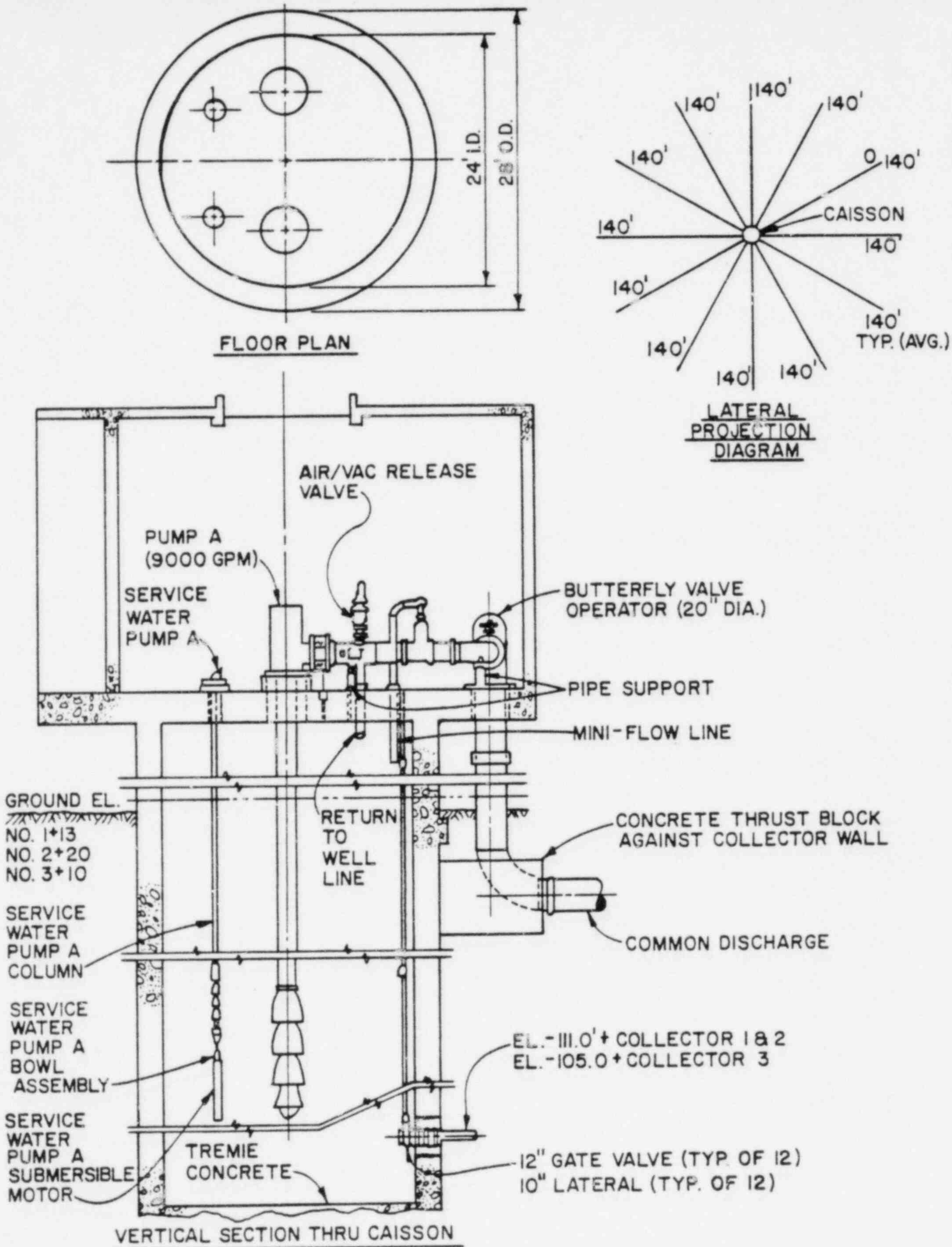


SECTION A-A

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	SCHEMATIC CROSS-SECTIONS OF DIFFUSER	FIGURE 3.4-4



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	LOCATION OF INTAKES (RANNEY COLLECTORS)	FIGURE 3.4-5



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	RANNEY GROUNDWATER COLLECTOR	FIGURE 3.4-6

3.5 RADWASTE SYSTEMS AND SOURCE TERM

This section describes the sources of liquid, gaseous and solid radioactive wastes (i.e., radwastes). It also describes the plant facilities that process the radwastes prior to disposal. Also presented are estimates of radionuclide release rates to the environment that are based on hypothetical conditions in order to place an upper bound on the possible routine radionuclide release rates.

3.5.1 Source Term

The sources of radwastes and the methods used to calculate the hypothetical amounts of radioactive material which may be released during normal operation, including during anticipated operational occurrences, are described below.

3.5.1.1 Primary and Secondary Coolant Activity

All radioactive wastes generated in a nuclear plant originate in the reactor. During the fission process, various solid and gaseous are generated within the fuel. The fuel is encapsulated in cladding which, in an idealized system, would contain all of the fission products. However, since there are approximately 56,876 such fuel rods in reactor, a small number may be expected to leak and release small amounts of fission products to the reactor coolant.

Not all radionuclides are generated in the fuel. Tritium, for example, is produced by activation of boron, lithium and deuterium in the reactor coolant and the control element assemblies. Activation of free metals, present as corrosion products within the reactor coolant, are also a source of radioactivity.

Ultimately all radioactive material in the plant and all radioactive waste generated by the plant in liquid and gaseous form originate in the primary coolant. An estimate of the concentration of radionuclides in the primary coolant under design basis conditions is provided in Section 11.1 of the Final Safety Analysis Report (FSAR). These estimates are based on mass balance models and input parameters obtained from the experience of operating nuclear power plants. However, for the purpose of estimating the average annual concentration of radionuclides in the primary and secondary coolant, including, anticipated operational occurrences, the methods provided in NUREG-0017(1) are more appropriate, because they represent expected as opposed to design basis conditions. Therefore, NUREG-0017 methods and assumptions have been used in all of the following calculations.

Table 3.5-1 lists the standard coolant activities as described in NUREG-0017. These coolant activities are applicable to a wide range of plant parameters which are listed in Table 3.5-2. For WNP-3 some of the parameters (e.g., removal rate of gas stripping) are outside the range of applicability. Appropriate adjustment factors were used to derive the plant specific values for liquid source terms presented in Table 3.5-3. The adjustment factors are based upon the mass balance equation:

$$C = \frac{s}{w\ (\lambda + R)\ k}$$

where:

C is the specific activity (μCi/cc);

s is the rate of release to and/or production of the nuclides in the system (μCi/hr);

w is the fluid weight (lbs);

λ is the decay constant (hr^{-1});

R is the removal rate of the element from the system due to demineralization, leakage, etc. (hr^{-1}); and

k is a conversion factor 454 cc/lb.

A detailed description of the application of the adjustment factors is provided in NUREG-0017.

3.5.1.2 Tritium Control

The principal sources of tritium in the reactor coolant are ternary fission and neutron-induced reactions in boron, lithium and deuterium present in the coolant, borated shim rods and Control Element Assemblies (CEA). The tritium produced in the coolant contributes immediately to the overall coolant tritium activity. The tritium produced by fission and neutron capture in the shim rods and the CEA's contributes to the overall tritium activity only by release through cladding. The long-term equilibrium concentration of tritium in the reactor coolant and spent fuel pool is estimated as 1.0 μCi/g.(1)

Tritium could be discharged in both the liquid and gaseous wastes. The principal discharge route will be through the Fuel Handling Building Ventilation System exhaust. Evaporation from the surface of the fuel pool is the potentially largest source of gaseous tritium release from the facility due to the high rate of evaporation (as high as 750 lbs/hr). The Containment Purge System is also a potential source of gaseous tritium release due to primary coolant leakage which flashes under ambient conditions. A less significant source is the HVAC exhaust from the Turbine Building due to a lower concentration of tritium in leakage, and the fact that large pools of water are not available for evaporation.

3.5.1.3 Fuel Pool System

The Fuel Pool System is designed to remove decay heat and the soluble and insoluble foreign matter from the spent fuel pool. Figure 3.5-1 presents a simplified block flow diagram of the Fuel Pool System. The detailed piping and instrument diagram is presented in Section 9.1 of the FSAR, along with the principal component design data. The radionuclide concentrations in the fuel pool during plant operations and refueling are listed in Table 3.5-4.

The values presented in Table 3.5-4 are based on the assumption that, upon shutdown for refueling, the Reactor Coolant System (RCS) is cooled for approximately two days. During this period, the primary coolant is let down through the purification filter, purification ion exchanger, and letdown strainer prior to return to the suction of the low-pressure safety injection pumps. When continuous degassification of primary coolant is desired, the letdown flow is diverted to the gas stripper and then to the VCT prior to return to the RCS. This serves two purposes: removal of noble gases in the gas stripper to avoid large releases of radioactivity to the Reactor Building following reactor vessel head removal, and reduction of dissolved fission and corrosion products in the coolant by ion exchange and filtration. At the end of about two days, the coolant above the reactor vessel flange is partially drained. The reactor vessel head is unbolted and the refueling water cavity is filled with a minimum of 470,000 gallons of water from the refueling water tank. The remaining reactor coolant volume containing radioactivity is then mixed with water in the refueling cavity and the Fuel Pool System. After refueling, the Fuel Pool System is isolated and the water in the refueling cavity is returned to the refueling water tank. This series of events determines the total activity to the Fuel Pool System. The specific activities of the radionuclides given in Table 3.5-4 are based upon a volume of 260,000 gallons. These values will be reduced by decay during refueling as well as by operation of the Fuel Pool System.

The Fuel Pool System has two basic parts: a cooling subsystem and a cleanup subsystem. The cooling subsystem of the Fuel Pool System is a closed-loop system consisting of two full-capacity pumps and heat exchangers. Water is withdrawn from the fuel pool near the surface and is circulated by pumps through a exchanger that rejects heat to the Component Cooling Water System. From the outlet of the fuel pool heat exchanger, the cooled water is returned to the bottom of the fuel pool through a distribution header.

The clarity and purity of the water in the fuel pool, refueling canal, and refueling water tank are maintained by the cleanup subsystem of the Fuel Pool System. The cleanup loop consists of two parallel trains of equipment, which include cleanup pump, ion exchanger, filter, strainers and surface skimmer. Most of the cleanup flow is drawn from the bottom of the fuel pool while a small fraction is drawn through the surface skimmer. A basket strainer is provided in the cleanup suction line to remove any relatively large particulate matter. The fuel pool water is circulated through a filter that removes particulates larger than five microns, then through an ion exchanger to remove ionic material, and finally through a strainer, which prevents resin beads from entering the fuel pool in the unlikely event of a failure of an ion exchanger retention element.

During plant operation the refueling water tanks hold a maximum of approximately 970,000 gallons. At the time of refueling a minimum of 470,000 gallons of water are used to fill the reactor canal, fuel transfer canal, and refueling water cavity.

The release rates of radioactive materials in gaseous effluents due to evaporation from the surface of the fuel pool and refueling canals during refueling and normal operation are presented in Table 3.5-4.

3.5.1.4 Ventilation System Exhausts

Liquid and steam leakage from various coolant and process streams can result in small quantities of radioactive gases entering the building atmospheres. These systems are described in detail in Subsection 3.5.3.1.

3.5.2 Liquid Radwaste System

3.5.2.1 System Description

The Liquid Radwaste System (LRS) collects all primary and secondary side radioactive liquid wastes and processes the wastes to permit its reuse or recycle within the plant. Differences in primary and secondary system water chemistry must be considered prior to reusing liquids. Untreatable radioactive process wastes, residues and concentrates are sent to the Solid Waste System (SWS) for disposal.

The LRS is divided into five subsystems. The subsystems and the sources of the water processed in each are:

Floor Drain System (FDS)

1) Radioactive floor drains
2) Component cooling water (if radioactive)
3) Decontamination area drains (no detergents)
4) Hot chemical lab drains
5) Primary sampling panel drains

Detergent Waste System (DWS)

1) Laundry and hot shower drains
2) Decontamination area drains (detergent solutions)

Secondary High Purity Waste System (SHP)

1) Turbine Building drains (high purity equipment)
2) Low dissolved solids (low particulate) waste

Secondary Particulate Waste System (SPWS)

1) Low dissolved solids (high particulate) waste
2) Turbine Building drains (floor drains)

Inorganic Chemical Waste System (ICW)

1) Demineralizer regeneration chemicals
2) Cold chemical lab drains
3) Secondary sampling panel drains

Radioactive liquid wastes are collected from the above subsystems and segregated based on their composition and process requirements. The LRS is capable of processing the design and anticipated off-standard system loads without affecting normal operation or plant availability. This includes leakage or spillage due to equipment malfunction or failure. The waste quanitities that must be processed by the five subsystems are shown in Table 3.5-5. The subsystems are discussed in the following paragraphs; more detail is included in Section 11.2 of the FSAR.

Floor Drain System (FDS)

Figure 3.5-2 presents a simplified flow diagram of the FDS. The floor drain tanks accumulate that which is collected in the containment, Reactor Auxiliary Building and Fuel Handling Building floor drain sumps. Additional sources of input to the FDS include the Detergent Waste System, the chemical labs, the Decontamination Sample Tank, and the Component Cooling Water System. This water is processed using filtration, organic scavenging, evaporation and ion exchange. Holdup is provided to store waste accumulation for an average of 14 days. The processed water is monitored and used as reactor makeup water. If the water quality does not meet the standards for reactor makeup, the water will be further processed. The radioactive concentrate produced during processing of this water is handled by the Solid Waste System.

Detergent Waste System (DWS)

Figure 3.5-3 presents a simplified block flow diagram of the DWS. The detergent waste tanks collect water from the laundry, hot shower and hot sink drains. In addition, the detergent waste tanks collect water that has been diverted from the decontamination sample tank. This water is processed by filtration and blended with the regenerative waste solutions from the Inorganic Chemical Waste System.

Inorganic Chemical Waste System (ICWS)

Figure 3.5-4 presents a simplified block flow diagram of the ICWS. The ICWS accumulates wastes from chemical lab drains and chemicals used to regenerate resins of the steam generator blowdown demineralizers and the condensate polishers. Additionally, the ICWS is used to transfer contents of ICW waste tanks to the neutralizing pond provided the tank contents are not radioactive as described in FSAR Subsection 9.2.3.2. The ICWS provides means to adjust pH to expedite processing and to sample contents of ICW tanks for radioactivity. The ICWS processes water accumulated in the inorganic chemical waste drain tanks when the waste is radioactive or when processing by the low-volume waste treatment system (see Subsection 3.6.6) is undesirable. Processing is accomplished by filtration, evaporation, and ion exchange. Water which satisfies chemical criteria is transferred to the secondary makeup water system. Water that does not satisfy these criteria will be processed further. The ICWS minimizes the volume of wastes that are handled by the SWS.

Secondary High Purity Waste System (SHP)

Figure 3.5-5 presents a simplified block flow diagram of the SHP. The SHP collects and processes water from the secondary side drains which contain low dissolved solids and particulates. The SHP also accumulates rinse water from the condensate polisher and steam generator blowdown demineralizer. This water is processed by filtration and ion exchange and, after processing, is used as secondary makeup water if chemical criteria are satisfied. If the criteria are not satisfied the water will be processed further. The system provides approximately three days storage capacity.

Secondary Particulate Waste System (SPWS)

Figure 3.5-6 presents a simplified block flow diagram of the SPWS. The SPWS accumulates water which normally has a high concentration of particulates including backflush water from the condensate polishers, steam generator blowdown demineralizers, steam generator blowdown electromagnetic filters, water sent to the Turbine Building drains after being collected in an oil separator or sump and monitored for chemical and radiochemical contamination. Water from secondary particulate waste tanks are processed using filtration and organic scavenging. Water which meets chemical criteria is used as secondary makeup water. Water which does not meet chemical criteria is reprocessed using the secondary high purity demineralizer. The system provides approximately two days storage capacity.

3.5.2.2 Radionuclide Releases

Releases to the environs of liquid radwastes are controlled and monitored to meet the concentration limits of 10 CFR Part 20 and the as low as is reasonably achievable (ALARA) criterion and the numerical guidelines of 10 CFR Part 50, Appendix I. The design release limits are based on normal operation of the nuclear power plant, including anticipated operational occurrences. Specifically, the provisions to treat the liquid radioactive waste are such that:

a) The calculated annual total quantity of all radioactive material released from the reactor during normal operation including anticipated operational occurrences at the site to unrestricted areas does not result in an estimated annual dose or dose commitment from liquid effluents for any individual in an unrestricted area from all pathways of exposure in excess of 3 mrem to the total body or 10 mrem to any organ.

b) The concentrations of radioactive materials in liquid effluents released during operation at design base fuel leakage (i.e., leakage from fuel producing one percent of the reactor power) to an unrestricted area does not exceed the limits in 10 CFR Part 20, Appendix B, Table II, Column 2.

c) The Liquid Radwaste System includes all items of reasonably demonstrated technology that when added to the system sequentially and in order of diminishing cost-benefit return, can, for a favorable cost-benefit ratio, effect reductions in dose to the population reasonably expected to be within 50 miles of the reactor.

d) In addition, the LRS has sufficient waste holding capacity, equipment and process stream redundancy and the capability to upgrade liquid radwastes to process makeup water quality so that there will be no intentional release of liquid radwaste to the environment under normal operating conditions.

Table 3.5-6 presents the calculated hypothetical radionuclide releases in the liquid effluents using the assumptions listed in Table 3.5-7. For the purpose of estimating hypothetical releases it is assumed that 10 percent of all processed liquid waste is discharged to cooling tower blowdown. This analysis was performed using the NRC GALE code.[1]

The analysis and demonstration of compliance with Appendix I to 10 CFR 50, including a cost-benefit analysis, was submitted as testimony at the June 1975 Environmental Hearings. Additional material was supplied in Supplement No. 6 to the Environmental Report-Construction Permit Stage (ER-CP). A review of the plant design and the site usage characteristics revealed that no major changes have occurred since these submittals. Therefore, a reanalysis of compliance with the cost-benefit requirements of Appendix I to 10 CFR 50 is not warranted. In addition, as demonstrated by those original analyses, the individual dose criteria of Appendix I are by far limiting. An evaluation of compliance with these criteria is included in Section 5.2.

3.5.3 Gaseous Radwaste System

3.5.3.1 System Description

This section describes the systems which collect, process and store gaseous wastes. Section 11.3 of the FSAR provides additional detail. The principal sources of gaseous waste are the Gaseous Waste Management System, the Gas Collection Header, and the Building Ventilation and Exhaust Systems.

Gaseous Waste Management System (GWMS)

A block flow diagram of the GWMS is presented in Figure 3.5-7. Waste gases which are routed to the GWMS are segregated according to source. The GWMS is divided into two subsystems, the retention subsystem and the recycle subsystem.

In the retention subsystem the gas surge header collects radioactive gases from the volume control tank, gas stripper, equipment and reactor drain tanks, and refueling failed fuel detector. The refueling failed fuel detector effluent is normally directed to the gas collection header; however, if the radioactivity is above a preset level, the effluent is directed to the gas surge header.

Gases from the gas surge header flow into the gas surge tank where they are collected. The gases remain in the gas surge tank until the pressure builds to a point which actuates a single waste gas compressor. The waste gas compressor feeds a preselected gas decay tank until the pressure in the gas surge tank drops to a point where the waste gas compressor stops. A second waste gas compressor will start if the pressure in the gas surge tank increases above a certain level. This automatic operation of the waste gas compressors continue until a gas decay tank is observed to approach its upper operating pressure. At this point another gas decay tank is manually lined up to receive the compressor discharge and the first tank is isolated. The filled gas decay tank is analyzed for hydrogen and oxygen content. Grab samples can also be taken for a radioactivity analysis.

After a gas decay tank has been sampled and analyzed it is then lined up to the gas recombiner system for processing. The processing is essentially a controlled reaction between hydrogen and oxygen to produce water. The influent hydrogen gas is diluted with nitrogen to maintain a 3 to 6 percent hydrogen mixture. This mixture is then preheated and oxygen is added to produce a stoichiometric mixture of hydrogen and oxygen. The addition of oxygen is controlled by analysis of either the influent or effluent hydrogen content. The entire gas stream is then passed over a catalyst bed. Recombination of hydrogen and oxygen occurs on the surface of the catalyst. The gas stream is then a mixture of nitrogen, steam and noble gases. The steam is condensed and separated out as water. The effluent is essentially nitrogen and noble gases.

The gas recombiner system effluent is then returned to the gas surge header where it reenters the system again through the gas surge tank and waste gas compressors. The gas recombiner will process until the gas decay tank pressure reaches a predetermined low level. The gas decay tank which is currently lined up to the waste gas compressors will collect the normal influents plus the hydrogen free gas recombiner effluent. When this gas decay tank is filled the process is repeated.

The gas which is in the isolated gas decay tank is allowed to decay for a period of time to reduce the activity of the gas. The GWMS design provides for a 3 to 5-year holdup for all gaseous wastes. Source term generation was conservatively based on a 90-day holdup.

The GWMS provides a means to control the discharge of gaseous waste. The operator in the WMS control room discharges the gas decay tanks through a flow meter and recorder, and a radiation monitor, which automatically terminates discharge flow on high activity. The Main Control Room operator must give permission to discharge activity and has overriding switches to terminate the discharge if required. The release of radioactive gases from the GWMS is controlled by the WMS operator by manually lining up the proper gas decay tank to the discharge header after sampling the tank for activity. If the activity released exceeds a predetermined setpoint, the process flow monitor automatically shuts two valves to terminate the release. The procedure of sampling the gas decay tank prior to release and continous monitoring of the release protects against operator error such as sampling one tank and lining up a different tank for discharge. The procedure for sampling and monitoring also protects against radiation monitor malfunction since the sample prior to discharge will be representative of tank contents.

The gases which are routed to the recycle subsystem are the nitrogen cover gases in the equipment drain tank (EDT) and the reactor drain tank (RDT). These tanks contain an initial nitrogen cover at a preset positive pressure. When liquid leakage enters either or both tanks it will raise the pressure of the cover gas. When the pressure reaches a specified upper limit the recycle compressor is actuated. The compressor discharges to the nitrogen recycle tank until the pressure in the equipment drain tank and reactor drain tank reduces to the normal operating pressure. Conversely when liquid is removed from either or both tanks, the cover gas pressure will drop to a lower limit. A pressure regulator valve then opens allowing nitrogen to flow into either or both tanks from the nitrogen recycle tank. The nitrogen recycle tank is periodically sampled by the gas analyzer. In the event of hydrogen or oxygen instrusion into the cover gas, the nitrogen recycle tank can be manually lined up with the gas recombiner system. The nitrogen recycle tank gas flows through a regulator valve into the gas recombiner system. The effluent, essentially nitrogen, from the gas recombiner system is returned by the gas recombiner compressor into the nitrogen recycle tank.

Gas Collection Header (GCH)

The GCH receives low activity gases containing oxygen from aerated tanks, ion exchangers, and concentrators. Detail on the sources and volumes to the GCH is provided in Table 11.3-6 of the FSAR.

Ventilation and Exhaust Systems

The major sources of building ventilation and exhaust include:

a) Reactor Building Heating, Ventilation, Air Conditioning (HVAC) System
b) Reactor Auxiliary Building HVAC System
c) Turbine Building HVAC System
d) Fuel Handling Building HVAC System.
e) Exhaust from the Steam Generator Blowdown System, Condenser Vacuum System and Gland Seal System

The Reactor Building HVAC System includes an internal containment recirculation system, known as the Airborne Radioactivity Removal System (ARRS). The ARRS includes two separate systems, each with a 12,500 cubic feet per minute (cfm) capacity. The system is designed to reduce airborne particulate and iodine activity within the Reactor Building and reduce discharge rates at times of purging the Reactor Building. The ARRS includes HEPA and charcoal filter beds.

During plant operation, the Reactor Building will be isolated or vented via eight-inch lines. Airborne activity can accumulate due to primary coolant leakage. Leak rates from the coolant to the Reactor Building atmosphere of 1.0 percent per day of the noble gases and 0.001 percent per day of the iodines are assumed.(1) Some of the activity will be released to the environment at times when the Reactor Building is vented. Such venting is assumed to be continuous at 2500 cfm. It is also assumed that during venting the Reactor Building atmosphere is passed through the ARRS continuously. During venting the release passes through HEPA and charcoal filters prior to discharge to the plant vent stack.

During shutdown, the containment is assumed to be continually purged through 48-inch purge lines. The radionuclide release rate from purging during shutdown is processed through HEPA and charcoal filters prior to discharge to the plant vent stack.

The HVAC exhaust from the RAB is discharged through the RAB exhaust filters. The Turbine Building and the Fuel Handling Building HVAC exhaust are normally released unfiltered due to their very small potential for contamination from radioactivity. Capability for filtration of Fuel Handling Building exhaust, in the event of an accident, is provided.

Additional potential sources of airborne radioactivity are: the non-condensible gases exhausted from the Steam Generator Blowdown System, Condenser Vacuum System, and Gland Seal System. Non-condensible gases from the main condenser and from the Gland Seal System are removed by the Condenser Mechanical Vacuum Pumps and passed through a demister, prefilter, charcoal adsorber, and an after-filter at a rate of 60 scfm (holding), and 5500 scfm (hogging).

The release points for all sources of gaseous effluents described above are summarized in Table 3.5-8, and Atmospheric Release Points shown in Figure 3.5-8.

3.5.3.2 Radionuclide Releases

The numerical design objectives for gaseous releases from the plant during normal operations, including anticipated operational occurrences, are based on 10 CFR Part 50, Appendix I which mandates:

a) The calculated annual air dose due to gamma radiation at or beyond the site boundary is not to exceed 10 millirads.

b) The calculated annual air dose due to beta radiation at or beyond the site boundary is not to exceed 20 millirads.

c) The calculated annual total quantity of radioactive gaseous effluent will not cause an estimated annual dose to any individual in an unrestricted area in excess of 5 mrem to the whole body.

d) The calculated annual total quantity of all radioactive iodine and radioactive material in particulate form will not result in an annual dose to any individual in an unrestricted area from all pathways in excess of 15 mrem/year to any organ.

Compliance with these criteria, and the cost-benefit criteria of Appendix I was provided as testimony at the June 1975 Environmental Hearings and additional material was provided in Supplement No. 6 to the ER-CP. This material demonstrated that individual dose criteria were limiting.

The results of the GALE code analysis for gaseous source terms are provided in Table 3.5-9. Assumptions and parameters used as input to the GALE code is provided in Table 3.5-10. An evaluation of compliance with the Appendix I criteria is included in Section 5.2.

3.5.4 Solid Waste System

The Solid Waste System (SWS) collects, processes, packages, and stores prior to transport to an offsite burial facility any disposable wet or dry solid radwaste generated in the operation of the plant. Types of wastes, quantities (maximum and expected volumes), activities, and radionuclide distributions are given in Tables 3.5-11 through 3.5-15. Figure 3.5-9 is a simplified block flow diagram of the SWS. Additional detail on the system is included in Section 11.4 of the FSAR.

The SWS handles liquids and slurries to be solidified and packaged by collecting them in the appropriate treatment tanks. These liquids and slurries (wet solid wastes) are processed and pumped to a mixer where they are combined with a solidification agent and are discharged into liners or 55-gallon drums. Solid disposable wastes are compressed into 55-gallon drums by a hydraulic compactor. The liners and drums are then stored in the onsite temporary storage area. After sufficient decaying time has elapsed, the liners or drums are shipped offsite to a burial facility. Spent filter cartridges are transferred to the drumming station in a cask especially designed for this purpose. At the drumming station each cartridge is transferred into a liner and solidified with waste and the solidification agent.

The concentrate storage tank receives and stores concentrate from the floor drain evaporator. Concentrate from the boric acid evaporator is collected in the concentrate storage tank only if the concentrate is not suitable for recycle to the Chemical and Volume Control System (CVCS). Exhausted resins from ion exchangers in the CVCS, the Fuel Pool Cooling and Cleanup System, and the LRS are sluiced to the spent resin tank. The concentrate storage tank and the spent resin tank both transfer their waste to the dewatering tank. The dewatering tank feeds, by means of the resin metering pump, the cement-solidification agent waste mixer at fillhead station B. The secondary particulate pre-treatment hopper receives the secondary particulate filter discharge and suitable quantities of inorganic chemical waste evaporator bottoms (concentrate) and/or detergent waste. The resultant waste mixture is transferred to the cement-solidification agent-waste mixer at fillhead station A by means of the particulate metering pump. The Volume Reduction System (VRS) collects and concentrates the inorganic chemical concentrator bottoms and detergent wastes. The waste is fed to the cement-solidification agent-waste mixer at fillhead station A by means of the VRS hopper metering pump. There is a cross-tie between the trains feeding stations A and B before the cement-solidification agent-waste mixers. Thus flexibility of controlling the final volume and activity of the solidified waste is provided.

The spent resin dewatering tank, the secondary particulate pre-treatment hopper and the VRS hopper are used primarily for waste processing and not for waste storage. Desired volumes of resins, concentrates, and sludges can be transferred to these process tanks and the waste conditioned for processing and solidification. The volume per batch depends on the size of the container used and the number of containers to be filled, however, the batch size is normally limited by the size of the spent resin dewatering tank or the secondary particulate filter pre-treatment hopper and VRS hopper. After producing a desirable mixture of wastes, the operator can set the total amount and rate of feed for both the waste and solidifying agent.

Thus, the SWS has provisions for controlling process flows and waste mixtures prior to solidification operations. Process flows and volumes are also controlled for solidification operations by adjusting the cement metering pumps. Controlled conditions of mixing assure that the liquids have been combined into a matrix that solidifies into a monolithic mass. Remote viewing is available to monitor for any excess water at the top of the liner (drum). Since several months storage space exists, any excess liquid could be allowed to evaporate with volatile radioactivity removed by ventilation systems. Additional solidification agent may also be added to solidify any free-standing liquid. The waste and solidification agent are processed through a fill station into disposable liners or 55-gallon drums. The containers, after monitoring for solidification, are capped and transferred to the Filled Liner Storage Area for temporary storage.

Prior to transporting the liners to an offsite burial facility, the containers and the vehicle are monitored for spreadable radioactivity and decontaminated as required for offsite shipment. The radioactive content of the containers is determined and additional packaging used, if necessary, to allow shipment and burial in accordance with 49 CFR Parts 170-179, 10 CFR Part 20, and 10 CFR Part 71. The expected volumes of solid waste to be shipped offsite are given in Table 3.5-16. The expected volumes of wastes to be shipped were calculated using the inputs to the SWS and a ratio of two volumes of waste to one volume of solidification material. The associated curie content, including a listing by principal nuclides is given in Table 3.5-17 for spent resins with six months decay, Table 3.5-18 for filter cartridges with six months decay, and Table 3.5-19 for precoat and particulate slurries, detergent concentrate and ICW concentrate. The basis for the activities is the radionuclide removals from the liquid processing streams.

The radioactive liner storage area can accommodate 60 liners. This is sufficient space for six months storage. This storage capability could be used to allow decay of short-lived isotopes before shipment; however, most of the drummed isotopes are long-lived and decay slowly. Therefore, the radioactive liner storage area capacity primarily provides flexibility in scheduling the offsite shipment of radwaste. The drums filled with compacted waste are stored in the 55-gallon drum storage area which can accommodate 50 to 100 drums, or at least one full offsite shipment.

3.5.5 Process and Effluent Radiological Monitoring

The Process and Effluent Monitoring and Sampling Systems provide the means for monitoring the liquid and gaseous effluents which could contain significant radioactivity. These systems are designed to give early warning of a malfunction which may lead to an unsafe condition, and to continually indicate and record radiation levels. To perform these tasks, radiation monitors are permanently installed, or specific sampling and analyses routines are established, to allow the evaluation of plant equipment performance and to measure, indicate, and record the radiation levels in the process and effluent streams during normal operation and anticipated operational occurrences. The overall system is designed to assist the plant operator in evaluating and controlling releases of radioactive materials to the environment to insure that the requirements of 10 CFR Part 20 and 10 CFR Part 50, Appendix I are maintained. Table 3.5-20 identifies the principal radiological process and effluent monitors. The Process and Effluent Monitoring Systems are discussed in detail in FSAR Sections 11.5.

References for Section 3.5

1. Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-Gale Code), NUREG-0017, U.S. Nuclear Regulatory Commission, Washington, D.C., April 1976.

2. Liquid Radioactive Waste Processing System for Pressurized Water Reactor Plants, ANSI N199-1976, American National Standards Institute, New York, New York, 1976.

3. Solid Radioactive Waste Processing System for Light Water Cooled Reactor Plants, ANSI/ANS-55.1-1979, American Nuclear Society, La Grange Park, Illinois, March 1979, Table 8-1.

TABLE 3.5-1

CONCENTRATIONS (μCi/g) IN PRINCIPAL STREAMS OF THE REFERENCE PWR WITH U-TUBE STEAM GENERATORS[a]

Isotope	Reactor Coolant[b]	Secondary Coolant[c] Water[d] Volatile	Secondary Coolant[c] Steam[e] Volatile
Noble Gases			
Kr-83m	2.1(-2)[f]	Nil	5.8(-9)
Kr-85m	1.1(-1)	Nil	3.1(-8)
Kr-85	1.5(-1)	Nil	4.2(-8)
Kr-87	6.0(-1)	Nil	1.6(-8)
Kr-88	2.0(-1)	Nil	5.5(-8)
Kr-89	5.0(-3)	Nil	1.4(-9)
Xe-131m	1.1(-1)	Nil	3.1(-8)
Xe-133m	2.2(-1)	Nil	6.2(-8)
Xe-133	1.8(+1)	Nil	5.0(-6)
Xe-135m	1.3(-2)	Nil	3.6(-9)
Xe-135	3.5(-1)	Nil	9.7(-8)
Xe-137	9.0(-3)	Nil	2.5(-9)
Xe-138	4.4(-2)	Nil	1.2(-8)
Halogens			
Br-83	4.8(-3)	6.9(-8)	6.9(-10)
Br-84	2.6(-3)	1.5(-8)	1.5(-10)
Br-85	3.0(-4)	2.0(-10)	2.0(-12)
I-130	2.1(-3)	4.6(-8)	4.6(-10)
I-131	2.7(-1)	6.8(-6)	6.8(-8)
I-132	1.0(-1)	1.9(-6)	1.9(-8)
I-333	3.8(-1)	8.9(-6)	8.9(-8)
I-134	4.7(-2)	3.8(-7)	3.8(-9)
I-135	1.9(-1)	3.8(-6)	3.8(-8)
Cs, Rb			
Rb-86	8.5(-5)	4.4(-9)	4.4(-12)
Rb-88	2.0(-1)	7.4(-7)	7.4(-10)
Cs-134	2.5(-2)	1.3(-6)	1.3(-9)
Cs-136	1.3(-2)	6.7(-7)	6.7(-10)
Cs-137	1.8(-2)	9.4(-7)	9.4(-10)
Water Activation Product			
N-16	4.0(+1)	1(-6)	1(-7)
Tritium			
H-3	1(0)	1(-3)	1(-3)

TABLE 3.5-1 (contd.)

Isotope	Reactor Coolant[b]	Secondary Coolant[c] Water[d] Volatile	Secondary Coolant[c] Steam[e] Volatile
Other Nuclides			
Cr-51	1.9(-3)	9(-8)	9(-11)
Mn-54	3.1(-4)	2(-8)	2(-11)
Fe-55	1.6(-3)	8(-8)	8(-11)
Fe-59	1.0(-3)	6(-8)	6(-11)
Co-58	1.6(-2)	8(-7)	8)-10)
Co-60	2.0(-3)	9(-8)	9(-11)
Sr-89	3.5(-4)	2(-8)	2(-12)
Sr-90	1.0(-5)	4(-10)	4(-13)
Sr-91	6.5(-4)	2(-8)	2(-11)
Y-90	1.2(-6)	8(-11)	8(-14)
Y-91m	3.6(-4)	1(-8)	1(-11)
Y-91	6.4(-5)	3(-9)	3(-12)
Y-93	3.4(-5)	1(-9)	1(-12)
Zr-95	6.0(-5)	4(-9)	4(-12)
Nb-95	5.0(-5)	4(-9)	4(-12)
Mo-99	8.4(-2)	4(-6)	4(-9)
Tc-99m	4.8(-2)	3(-6)	3(-9)
Ru-103	4.5(-5)	2(-9)	2(-12)
Ru-106	1.0(-5)	4(-10)	4(-13)
Rh-103m	4.5(-5)	2(-9)	2(-12)
Rh-106	1.0(-5)	4(-10)	4(-10)
Te-125m	2.9(-5)	1(-9)	1(-12)
Te-127m	2.8(-4)	1(-8)	1(-11)
Te-127	8.5(-4)	3(-8)	3(-11)
Te-129m	1.4(-3)	6(-8)	6(-11)
Te-129	1.6(-3)	6(-8)	6(-11)
Te-131m	2.5(-3)	1(-7)	1(-10)
Te-131	1.1(-3)	2(-8)	2(-11)
Te-132	2.7(-2)	1(-6)	1(-9)
Ba-137m	1.6(-2)	9(-7)	9(-10)
Ba-140	2.2(-4)	1(-8)	1(-11)
La-140	1.5(-4)	7(-9)	7(-12)
Ce-141	7.0(-5)	4(-9)	4(-12)
Ce-143	4.0(-5)	1(-9)	1(-12)
Ce-144	3.3(-5)	2(-9)	2(-12)
Pr-143	5.0(-5)	2(-9)	2(-12)
Pr-144	3.3(-5)	2(-9)	2(-12)
Np-239	1.2(-3)	6(-8)	6(-11)

TABLE 3.5-1 (contd.)

[a] Based on Reference 3.5-1.

[b] The concentrations given are for reactor coolant entering the letdown line.

[c] Based on a primary-to-secondary leak of 100 lb/day.

[d] The concentrations given are for water in a steam generator.

[e] The concentrations given are for steam leaving a steam generator.

[f] Numbers in parentheses denote power of 10.

TABLE 3.5-2

PARAMETERS USED TO DESCRIBE THE REFERENCE PWR AND WNP-3[a]

Parameter	Symbol	Units	Nominal Value	Range Maximum	Range Minimum	WNP-3
Thermal Power	P	MWt	3,400	3,800	3,000	3800
Steam flow rate	FS	lb/hr	1.5(7)	1.7(7)	1.3(7)	1.7(7)[b]
Weight of water in reactor coolant system	WP	lb	5.5(5)	6.0(5)	5.0(5)	5.7(5)
Weight of water in all steam generators	WS	lb	4.5(5)	5.0(5)	4.0(5)	3.3(5)
Reactor coolant letdown flow (purification)	FD	lb/hr	3.7(4)	4.2(4)	3.2(4)	3.6(4)
Reactor coolant letdown flow (yearly average for boron control)	FB	lb/hr	500	1,000	250	250
Steam generator blowdown flow (total) Volatile	FBD	lb/hr	75,000	100,000	50,000	50,000
Fraction of radioactivity in blowdown stream that is not returned to the secondary coolant system	NBD	-	1.0	1.0	0.9	1.0
Flow through the purification system action demineralizer	FA	lb/hr	3,700	7,500	0.0	0.0
Ratio of condensate demineralizer flow rate to the total steam flow rate volatile	NC	-	0.65	0.75	0.55	1.0
Ratio of the total amount of noble gases routed to gaseous radwaste from the purification system to the total amount of noble gases routed from the primary coolant system to the purification system (not including the boron recovery system)	Y	-	0.0	0.01	0.0	1.0

(a) From Table 2-4 of Reference 3.5-1.
(b) Numbers in parentheses denote power of 10.

TABLE 3.5-3

COOLANT ACTIVITIES FOR NORMAL OPERATION INCLUDING ANTICIPATED OPERATIONAL OCCURRENCES[a]

Nuclide	Primary Coolant Activity (μCi/cc)	Secondary Coolant Activity (μCi/cc)
Cr-51	1.90E-03	1.86E-07
Mn-54	3.10E-04	4.14E-08
Fe-55	1.60E-03	1.66E-07
Fe-59	1.00E-03	1.24E-07
Co-58	1.60E-02	1.65E-06
Co-60	2.00E-03	1.86E-07
Np-239	1.20E-03	1.20E-07
Br-83	4.80E-03	7.31E-08
Rb-86	8.50E-05	1.04E-08
Rb-88	2.00E-01	1.03E-06
Sr-89	3.50E-04	4.14E-08
Sr-91	6.50E-04	3.60E-08
Y-91M	3.60E-04	1.44E-08
Y-91	6.40E-05	6.20E-09
Zr-95	6.00E-05	8.27E-09
Nb-95	5.00E-05	8.26E-09
Mo-99	8.40E-02	8.06E-06
Tc-99M	4.80E-02	5.15E-06
Ru-103	4.50E-05	4.13E-09
Rh-103M	4.50E-05	2.90E-09
Ru-106	1.00E-05	8.28E-10
Te-127M	2.80E-04	2.07E-08
Te-127	8.50E-04	5.39E-08
Te-129M	1.40E-03	1.24E-07
Te-129	1.60E-03	8.81E-08
I-130	2.10E-03	4.36E-08
Te-131M	2.50E-03	1.95E-07
Te-131	1.10E-03	2.79E-08
I-131	2.70E-01	6.18E-06
Te-132	2.70E-02	2.02E-06
I-132	1.00E-01	2.02E-06
I-133	3.80E-01	8.29E-06
I-134	4.70E-02	4.44E-07
Cs-134	2.50E-02	3.09E-06
I-135	1.90E-01	3.71E-06
Cs-136	1.30E-02	1.58E-06
Cs-137	1.80E-02	2.24E-06
Ba-137M	1.60E-02	1.22E-06
Ba-140	2.20E-04	2.06E-08
La-140	1.50E-04	1.39E-08
Ce-141	7.00E-05	8.26E-09
Pr-143	5.00E-05	4.12E-09
Ce-144	3.30E-05	4.14E-09
Pr-144	3.30E-05	2.76E-09
All Others	(2.03E-01)	(1.06E-06)
Total (Except Tritium)	1.46E+00	4.84E-05

[a]At 0.12% failed fuel as derived from Reference 3.5-1.

TABLE 3.5-4

RADIONUCLIDE CONCENTRATIONS AND SOURCE TERMS FOR THE FUEL POOL SYSTEM

Nuclide	Specific Activity at 70° F (μCi/cc)	Refueling Releases (Ci/20 days)	Normal Releases (Ci/yr)
H-3	4.4(-1)[a]	2.44(1)	1.30(3)
Kr-83m	2.0(-12)	4.04(-12)	2.26(-12)
Kr-85m	1.4(-7)	1.08(-6)	3.00(-7)
Kr-85	1.3(-4)	1.72(-1)	3.80(-1)
Kr-87	2.4(-15)	1.32(-15)	1.62(-15)
Kr-88	4.7(-9)	1.49(-8)	6.45(-9)
I-131	1.4(-3)	1.52(-5)	1.08(-5)
I-132	7.1(-10)	2.58(-10)	4.84(-12)
I-133	4.9(-4)	3.28(-6)	2.35(-6)
I-135	1.1(-5)	3.19(-8)	2.70(-8)
Xe-131m	8.6(-5)	7.68(-2)	1.20(-2)
Xe-133m	1.2(-4)	2.24(-2)	3.34(-3)
Xe-133	1.3(-2)	5.70(0)	6.80(-5)
Xe-135	1.5(-5)	3.07(-4)	6.80(-5)

[a] Parentheses denote power of 10.

Assumptions:

1. All noble gases in pool water are immediately released to the Fuel Handling Building atmosphere and vented.
2. Iodines, particulates and tritium enter the Fuel Handling Building atmosphere via evaporation processes.
3. Evaporation rate of 750 lbs/hr.
4. Partition factor = 0.001 for iodines and particulates and 1.0 for noble gases.
5. pH = 4.5 to 10.2.
6. Temperature = 130°F.
7. Iodine Concentration = 10^{-11} μCi/liter.
8. Activity in pool declines exponentially via decay, evaporation and pool cleanup.
9. Cleanup Flow = 300 gpm; DF = 10 for all isotopes except tritium and noble gases.

TABLE 3.5-5

LIQUID RADWASTE SYSTEM INFLUENT STREAMS

System	Source	Volume[a] gal/yr	Volume[a] gpd	Activity Fraction[a] of RCS
Floor Drain System	Containment Sump	14,600	40	1.0
	Reactor Auxiliary Building	73,000	200	0.1
	Cask washdown	36,500	100	0.01
	Fuel Handling Bldg	36,500	100	0.1
	Pumps, valve leak drains, resin sluicing	60,225	165	0.1
	Hot Radio-Chem Lab drains	36,500	100	0.002
	Refueling	50,600	1,265[b]	0.1
	Reactor Containment Cooling System	365,000	1,000	0.001
	Spent Fuel Pit liner leakage	255,000	700	0.001
	Decontamination Drains	133,000	3,000[b] 40[c]	.01
Secondary Particulate Waste	High Particulate Turbine Bldg drains	4,560,000 2,628,000	12,500 7,200	NA[e] Condenser Hot-well Activity
Secondary High Purity Waste	Low particulate	832,000	2,300	NA
Detergent Waste System	Laundry, hot showers, hand	182,000	500	NA

TABLE 3.5-5 (contd.)

LIQUID RADWASTE SYSTEM INFLUENT STREAMS

System	Source	Volume[a] gal/yr	Volume[a] gpd	Activity Fraction[a] of RCS
Inorganic Chemical Waste	Inorganic chemical waste	832,000	2,300	NA
	Water analysis lab drains	525,600	1,440	Steam Generator Activity

(a) In agreement with Reference 3.5-2.
(b) During 40-day shutdown only.
(c) During remaining 325 days.
(d) 30 days of shutdown operations.
(e) NA = Not Applicable

TABLE 3.5-6

LIQUID SOURCE TERMS FOR NORMAL OPERATIONS[a]

Nuclide	Boron RS (Ci/Yr)	Misc Wastes (Ci/Yr)	Secondary (Ci/Yr)	Turb Bldg (Ci/Yr)	Total LWS (Ci/Yr)	Adjusted[b] Total (Ci/Yr)	Deter-gent Wastes (Ci/Yr)	Total (Ci/Yr)
Corrosion and Activation Products								
Cr-51	2.50E-07[c]	3.19E-04	2.59E-05	1.84E-06	3.47E-04	6.90E-04	0.	6.90E-04
Mn-54	4.55E-08	5.34E-05	6.57E-06	4.12E-07	6.04E-05	1.20E-04	1.00E-04	2.20E-04
Fe-55	2.37E-07	2.76E-04	2.66E-05	1.65E-06	3.05E-04	6.06E-04	0.	6.10E-04
Fe-59	1.38E-07	1.70E-04	1.82E-05	1.23E-06	1.89E-04	3.76E-04	0.	3.80E-04
Co-58	2.26E-06	2.73E-03	2.51E-04	1.64E-05	3.00E-03	5.97E-03	4.00E-04	6.40E-03
Co-60	2.96E-07	3.45E-04	2.99E-05	1.86E-06	3.77E-04	7.50E-04	8.70E-04	1.60E-03
Np-239	5.18e-08	1.51E-04	1.20E-05	1.11E-06	1.64E-04	3.26E-04	0.	3.30E-04
Fission Products								
Br-83	3.94E-10	1.98E-05	7.27E-06	1.30E-06	2.83E-05	5.63E-05	0.	5.60E-05
Rb-86	1.22E-08	1.41E-05	1.97E-05	1.03E-07	3.39E-05	6.74E-05	0.	6.70E-05
Rb-88	3.83E-28	2.75E-08	1.02E-03	8.36E-12	1.02E-03	2.03E-03	0.	2.03E-03
Sr-89	4.86E-08	5.96E-05	6.13E-06	4.10E-07	6.62E-05	1.32E-05	0.	1.30E-04
Sr-91	1.61E-09	2.46E-05	3.58E-06	2.33E-07	2.84E-05	5.64E-05	0.	5.60E-05
Y-91M	1.04E-09	1.59E-05	1.43E-06	1.50E-07	1.74E-05	3.47E-05	0.	3.50E-05
Y-91	9.63E-09	1.15E-05	9.41E-07	6.24E-08	1.26E-05	2.50E-05	0.	2.50E-05
Zr-95	8.45E-09	1.02E-05	1.25E-06	8.21E-08	1.16E-05	2.30E-05	1.40E-04	1.60E-04
Nb-95	7.53E-09	8.67E-06	1.32E-06	8.23E-08	1.01E-05	2.00E-05	2.00E-04	2.20E-04
Mo-99	4.28E-06	1.11E-02	8.11E-04	7.54E-05	1.20E-02	2.38E-02	0.	2.40E-02
Tc-99M	4.08E-06	9.93E-03	5.22E-04	5.94E-05	1.05E-02	2.09E-02	0.	2.10E-02
Ru-103	6.13E-09	7.62E-06	5.99E-07	4.10E-08	8.27E-06	1.64E-05	1.40E-05	3.00e-05
Rh-103M	6.13E-09	7.64E-06	4.76E-07	4.09E-08	8.17E-06	1.62E-05	0.	1.60E-05
Ru-106	1.47E-09	1.72E-06	1.32E-07	8.24E-09	1.87E-06	3.71E-06	2.40E-04	2.40E-04
Ag-110M	0.	0.	0.	0.	0.	0.	4.40E-05	4.40E-05
Te-127M	4.03E-08	4.80E-05	3.20E-06	2.06E-07	5.15E-05	1.02E-04	0.	1.00E-04
Te-127	4.17E-08	6.84E-05	6.49E-06	4.17E-07	7.54E-05	1.50E-04	0.	1.50E-04
Te-129M	1.88E-07	2.36E-04	1.77E-05	1.23E-06	2.55E-04	5.08E-04	0.	5.10E-04
Te-129	1.20E-07	1.52E-04	1.22E-05	7.89E-07	1.65E-04	3.29E-04	0.	3.30E-04

TABLE 3.5-6 (contd.)

Nuclide	Boron RS (Ci/Yr)	Misc Wastes (Ci/Yr)	Secondary (Ci/Yr)	Turb Bldg (Ci/Yr)	Total LWS (Ci/Yr)	Adjusted[b] Total (Ci/Yr)	Deter-gent Wastes (Ci/Yr)	Total (Ci/Yr)
I-130	9.12E-08	1.04E-04	4.34E-06	3.10E-06	1.12E-04	2.22E-04	0.	2.20E-04
Te-131M	5.01E-08	2.42E-04	1.94E-05	1.69E-06	2.63E-04	5.24E-04	0.	5.20E-04
Te-131	9.15E-09	4.42E-05	2.78E-06	3.09E-07	4.73E-05	9.41E-05	0.	9.40E-05
I-131	2.67E-04	4.24E-02	1.51E-03	6.02E-04	4.48E-02	8.91E-02	6.20E-06	8.90E-02
Te-132	1.57E-06	3.69E-03	2.05E-04	1.91E-05	3.92E-03	7.79E-03	0.	7.80E-03
I-132	1.66E-06	4.14E-03	2.05E-04	4.93E-05	4.40E-03	8.75E-03	0.	8.70E-03
I-133	4.41E-05	2.96E-02	8.25E-04	6.77E-04	3.11E-02	6.18E-02	0.	6.20E-02
I-134	6.42E-14	9.52E-06	4.41E-05	3.92E-07	5.41E-05	1.07E-04	0.	1.10E-04
Cs-134	4.29E-06	4.31E-03	8.28E-03	3.08E-05	1.26E-02	2.51E-02	1.30E-03	2.60E-02
I-135	1.72E-06	4.51E-03	3.69E-04	1.99E-04	5.08E-03	1.01E-02	0.	1.00E-02
Cs-136	1.73E-06	2.12E-03	2.65E-03	1.55E-05	4.79E-03	9.51E-03	0.	9.50E-03
Cs-137	3.10E-06	3.11E-03	6.04E-03	2.23E-05	9.18E-03	1.82E-02	2.40E-03	2.10E-02
Ba-137M	2.90E-06	2.91E-03	3.69E-03	2.08E-05	6.63E-03	1.32E-02	0.	1.30E-02
Ba-140	2.51E-08	3.58E-05	2.55E-06	2.02E-07	3.85E-05	7.66E-05	0.	7.70E-05
La-140	2.59E-08	2.97E-05	1.95E-06	1.44E-07	3.18E-05	6.32E-05	0.	6.30E-05
Ce-141	9.35E-09	1.18E-05	1.17E-06	8.18E-08	1.31E-05	2.60E-05	0.	2.60E-05
Pr-143	6.22E-09	8.44E-06	5.22E-07	4.07E-08	9.01E-06	1.79E-05	0.	1.80E-05
Ce-144	4.84E-09	5.69E-06	6.56E-07	4.12E-08	6.39E-06	1.27E-05	5.20E-04	5.30E-04
PR-144	4.84E-09	5.69E-06	5.19E-07	4.12E-08	6.25E-06	1.24E-05	0.	1.20E-05
All Others	9.18E-09	1.45E-05	2.84E-06	6.90E-08	1.74E-05	3.46E-05	0.	3.00E-05
Total (Except Tritium)	3.40E-04	1.23E-01	2.67E-02	1.81E-03	1.52E-01	3.02E-01	6.23E-03	3.10E-01
Tritium Release								1.10E+02

(a) Hypothetical releases based on assumptions in Table 3.5-7.
(b) Per Reference 3.5-1, 0.15 Ci/yr is added to the calculated amounts to account for operational occurrences using the same isotopic distribution.
(c) (E) Denotes power of 10.

TABLE 3.5-7

ASSUMPTIONS AND PARAMETERS USED TO CALCULATE
RELEASES OF RADIOACTIVE MATERIAL IN LIQUID EFFLUENTS

Plant Specific Data

Power Level	3800 MWt
Capacity Factor	80 Percent
Failed Fuel	Equivalent to 0.12 Percent

Process Parameters

Primary Coolant Mass	571,300 lbs
Secondary Coolant Mass	2,800,000 lbs
Primary to Secondary Leakrate	100 lbs/day
Mass of Steam per Steam Generator	16,000 lbs
Mass of Liquid per Steam Generator	167,000 lbs
Number of Steam Generators per Unit	2
Steam Flow at Rated Power	1.72×10^7 lbs/hr
Steam Generator Blowdown Rate	25,000 lbs/hr
Primary Coolant Letdown Rate	72 gpm
Letdown Cation Demineralizer Flow	14.4 gpm
Condensate Demineralizer Flow Fraction	1.0
Fission Product Carry Over	0.1 Percent
Halogen Carry Over	1.0 Percent

Radwaste Parameters

Stream	Flow Rate (Gal/Day)	Fraction of PCA	Fraction Dis-charged	Collec-tion Time (Days)	Decay Time (Days)	Decontamination Factors I	CS	Others
Shim bleed Rate	7.20E+02	1.000	0.100	8.333	0.833	1.00E+06	2.00E+06	1.00E+07
Floor Drain Sys	2.90E+03	0.037	0.100	8.333	0.833	1.00E+04	1.00E+05	1.00E+05
ICW	2.30E+03	0.003	0.100	10.400	0.555	1.00E+04	1.00E+05	1.00E+05
SPWS	1.25E+04	0.000	0.100	1.920	0.167	1.00E+00	1.00E+00	1.00E+00
Blow-down	7.19E+04	NA	0.100	0.000	0.000	1.00E+02	1.00E+01	1.00E+02
Untreated Blow-down	0.	NA	1.000	0.000	0.000	1.00E+00	1.00E+00	1.00E+00
SHP	2.30E+03	NA	0.100	10.400	0.167	1.00E+02	2.00E+00	1.00E+02

ICW = Inorganic Chemical Waste System
SPWS = Secondary Particulate Waste System
SHP = Secondary High Purity Waste System
NA = Not Applicable

TABLE 3.5-8

RELEASE POINT DATA

Release Point[a]	Elevation Above Grade (ft)	Inside Dimension (ft)	Temperature (°F)	Exit Velocity (FPM)
Fuel Handling Building Vent	130	8.5	120	742
Auxiliary Building Roof Vent	130	3.5	104	2800
Turbine Building Roof Vent	140	10.5	104	3000
Gland Steam Packing Exhaust	112	0.67	210	
Containment Purge	140	3.5	90	3100
Mechanical Vacuum Pumps	105	1.3	72	47

(a) Refer to Figure 3.5-8 for the location of release points.

TABLE 3.5-9

GASEOUS SOURCE TERMS FOR
NORMAL OPERATIONS INCLUDING ANTICIPATED OPERATIONAL OCCURRENCES[a]

			Release Rate (Ci/yr)							
	Primary Coolant	Secondary Coolant	Gas Stripping[b]		Building Ventilation			Blowdown Vent	Air Ejector	
Nuclide	(μCi/gm)	(μCi/gm)	Shutdown	Continuous	Reactor	Auxiliary	Turbine	Offgas	Exhaust	Total
Kr-83M	1.937E-02	4.671E-09	0.[c]	0.	2.0E+00	0.	0.	0.	0.	2.0E+00
Kr-85M	8.500E-02	2.091E-08	0.	0.	1.4E+01	2.0E+00	0.	0.	1.0E+00	1.7E+01
Kr-85	2.347E-03	5.737E-10	1.0E+00	2.7E+02	2.0E+00	0.	0.	0.	0.	2.7E+02
Kr-87	5.798E-02	1.350E-08	0.	0.	3.0E+00	1.0E+00	0.	0.	0.	4.0E+00
Kr-88	1.721E-01	4.133E-08	0.	0.	2.0E+01	4.0E+00	0.	0.	2.0E+00	2.6E+01
Kr-89	5.354E-03	1.309E-09	0.	0.	0.	0.	0.	0.	0.	0.
Xe-131M	6.065E-03	1.492E-09	0.	0.	4.0E+00	0.	0.	0.	0.	4.0E+00
Xe-133M	4.270E-02	1.051E-08	0.	0.	2.5E+01	0.	0.	0.	0.	2.5E+01
Xe-133	1.803E+00	4.373E-07	0.	0.	1.2E+03	3.8E+01	0.	0.	2.4E+01	1.3E+03
Xe-135M	1.367E-02	3.304E-09	0.	0.	0.	0.	0.	0.	0.	0.
Xe-135	2.073E-01	5.017E-08	0.	0.	5.8E+01	4.0E+00	0.	0.	3.0E+00	6.5E+01
Xe-137	9.629E-03	2.335E-09	0.	0.	0.	0.	0.	0.	0.	0.
Xe-138	4.617E-02	1.099E-08	0.	0.	0.	0.	0.	0.	0.	0.
Total Noble Gases										1.7E+03
I-131	3.089E-01	7.072E-06	0.	0.	2.1E-02	4.9E-03	3.8E-04	0.	3.1E-03	2.9E-02
I-133	4.263E-01	9.301E-06	0.	0.	1.8E-02	6.8E-03	5.0E-04	0.	4.2E-03	3.0E-02
Tritium Gaseous Release										1400
Ar-41										25
C-14										8

TABLE 3.5-9 (contd.)

Nuclide	Release Rate (Ci/yr) Waste Gas System	Building Ventilation Reactor	Building Ventilation Auxiliary	Total
Airborne Particulate				
Mn-54	4.5E-05	2.2E-04	1.8E-04	4.5E-04
Fe-59	1.5E-05	7.4E-05	6.0E-05	1.5E-04
Co-58	1.5E-05	7.4E-04	6.0E-04	1.5E-03
Co-60	7.0E-05	3.3E-04	2.7E-04	6.7E-04
Sr-89	3.3E-06	1.7E-05	1.3E-05	3.3E-05
Sr-90	6.0E-07	2.9E-06	2.4E-06	5.9E-06
Cs-134	4.5E-05	2.2E-04	1.8E-04	4.5E-04
Cs-137	7.5E-05	3.7E-04	3.0E-04	7.5E-04

(a) At 0.12% failed fuel as derived from Reference 3.5-1.

(b) The actual gas release point is the waste gas decay tanks.

(c) 0. indicates release is less than 1.0 Ci/yr for noble gas, 0.0001 Ci/yr for iodine.

TABLE 3.5-10

ASSUMPTIONS USED TO CALCULATE GASEOUS RADIOACTIVITY RELEASES

Continuous stripping of full letdown flow		
Flow rate through gas stripper (gpm)		74.0135
Holdup time for Xenon (days)		90
Holdup time for Krypton (days)		90
Fill time of decay tanks for the gas stripper (days)		90
Primary coolant leak to Auxiliary Bldg (lb/day)		160
Auxiliary Building leak	Iodine partition factor	0.0075
Gas Waste System	Particulate release fraction	0.0100
Auxiliary Building	Iodine release fraction	0.1000
	Particulate release fraction	0.0100
Containment volume (10^6 cuft)		3.450
Frequency of primary coolant degassing (times/yr)		2
Primary to secondary leak rate (lb/day)		100
There is a kidney filter		
Containment atmosphere cleanup rate (thousand cfm)		11.5
Cleanup filter efficiency	Iodine	0.9000
	Particulate	0.9900
Cleanup time of containment (hours)		16
Iodine partition factor (gas/liquid) in steam generator		0.0100
Frequency of containment high-volume purge (times/yr)		4
Containment high-vol purge	Iodine release fraction	0.1000
	Particulate release fraction	0.0100
Containment low-volume purge rate (cfm)		2500
	Iodine release fraction	0.1000
	Particulate release fraction	0.0100
Steam leak to Turbine Bldg (lb/hr)		1700
Fraction of Iodine released from blowdown tank vent		0.0
Fraction of Iodine released from main condenser ejector		0.1
No cryogenic off-gas system		

TABLE 3.5-11

SOLID WASTE SYSTEM INFLUENT STREAMS

Source	Form	Quantity[a] (ft^3/yr)
Spent Resins		
CVCS [b] Chemical and Volume Control	Dewatered	171
Fuel Pool[b]	Dewatered	180
Floor Drain System [c]	Dewatered	80
Secondary Liquid Treatment Systems[c]	Dewatered	80
Organic Traps[c]	Dewatered	60
Condensate Polishers[d]	Dewatered	500
Blowdown Demineralizers[d]	Dewatered	100
Evaporator Bottoms		
Floor Drains[e]	12 percent $Na_2B_4O_7$	2,930
ICW (Inorganic Chemical Waste)[f]	15 percent Na_2SO_4	5,000
CVCS (Boric Acid Concentrator)[g]	12 percent H_3BO_3	2,000
Filters		
Sludge	Precoat and Particulates in slurry	120
Cartridges	43 cartridges	101
Compressible Solids	Plastic, Rags, Paper, etc.	11,000
Detergent Waste[h]	Laundry Waste	40,000

[a] Bases for Values: Maximum annual volumes; normal operation, including anticipated operational occurrences. Expected annual volumes are inputs from the primary side treatment systems excluding the 12 percent boric acid concentrate.

[b] Normally changed during annual refueling.

[c] Normally changed twice per year.

[d] Reference 3.5-3.

[e] Based on volume reduction ratio of 50.

[f] Based on volume reduction ratio of 20.

[g] Assuming five percent of the boric acid concentrator thoughput is concentrated to twelve percent boric acid for disposal.

[h] Total volume collected in Detergent Waste System.

TABLE 3.5-12

SOLID WASTE SYSTEM INFLUENTS (CURIES/YEAR)
FROM EVAPORATOR BOTTOMS

Nuclide	Floor Drain Evaporator	ICW Evaporator	Boric Acid Evaporator
H-3	4.23E-00	1.46E-00	5.1E+01
Br-84	**	**	1.3E-05
I-129	4.90E-06	**	**
I-131	1.72E+02	3.78E-00	2.3E-01
I-132	2.84E-03	4.68E-04	2.1E-03
I-133	1.88E+01	7.08E-01	6.5E-02
I-134	**	**	3.8E-04
I-135	9.26E-01	5.14E-02	1.1E-02
Rb-88	**	**	2.7E-04
Rb-89	**	**	**
Sr-89	4.55E-01	7.01E-03	5.1E-04
Sr-90	2.37E-02	3.34E-04	1.7E-05
Sr-91	3.86E-03	1.79E-04	5.5E-05
Y-90	9.79E-04	3.05E-06	1.2E-04
Y-91	2.26E-01	3.46E-04	3.4E-03
Zr-95	6.73E-01	8.29E-03	4.2E-03
Mo-99	4.51E-01	1.39E-01	1.7E+00
Ru-103	7.51E-01	1.18E-02	6.2E-05
Ru-106	1.90E-01	2.71E-03	4.9E-05
Te-129	1.34E-00	2.15E-02	1.7E-05
Te-132	7.53E-00	2.22E-01	1.3E-02
Te-134	**	**	**
Cs-134	3.45E+01	4.89E-01	1.4E-02
Cs-136	2.03E+01	3.85E-01	5.2E-03
Cs-137	1.39E+02	1.97E-00	1.0E-02
Cs-140	**	**	**
Ba-140	5.30E-01	1.02E-02	2.3E-04
La-140	6.85E-02	2.34E-03	4.6E-05
Pr-143	4.06E-01	7.67E-02	5.3E-05
Ce-144	4.49E-01	6.45E-03	5.3E-05
Cr-51	5.37E-02	8.81E-05	2.5E-04
Mn-54	1.48E-03	2.12E-06	5.1E-05
Co-58	1.23E-01	1.86E-04	2.3E-03
Co-60	1.51E-02	2.14E-05	3.3E-04
Fe-59	7.08E-04	1.10E-06	1.4E-04

**Denote nuclide activity less than 1.0E-06 Curies/year.

TABLE 3.5-13

SOLID WASTE SYSTEM INFLUENTS (CURIES/YEAR)
FROM SPENT RESINS

Nuclide	Activity
H-3	7.41E-01
Br-84	4.621E-01
I-129	**
I-131	1.400E+04
I-132	4.661E+01
I-133	2.261E+03
I-134	1.27E+01
I-135	4.061E+02
Rb-88	1.081E+01
Rb-89	2.915E-01
Sr-89	1.102E+02
Sr-90	1.953E+01
Sr-91	9.453E-01
Y-90	7.160E-01
Y-91	5.580E+02
Zr-95	**
Mo-99	3.60E+03
Ru-103	1.502E+02
Ru-106	1.242E+02
Te-129	2.79E+02
Te-132	5.875E+02
Te-134	7.29E-01
Cs-134	5.22E+03
Cs-136	4.026E+02
Cs-137	2.362E+04
Cs-138	3.117E+00
Ba-140	5.097E+01
La-140	6.204E+00
Pr-143	3.995E+01
Ce-144	2.755E+02

**Denotes nuclide activity less than 1.0E-02 Curies/yr

TABLE 3.5-14

SOLID WASTE SYSTEM INFLUENTS (CURIES/YEAR)
FROM SPENT FILTER CARTRIDGES

Nuclide	Activity
Cr-51	68.9
Mn-54	7.67
Co-58	318.
Co-60	98.9
Fe-59	1.29
Zr-95	1.54

TABLE 3.5-15

SOLID WASTE SYSTEM INFLUENTS (CURIES/YEAR) FROM SECONDARY PARTICULATE FILTER SLUDGE

Nuclide	Activity
Cr-51	3.36E-05
Mn-54	7.42E-07
Co-58	6.68E-05
Co-60	7.44E-06
Fe-59	4.04E-07
Zr-95	3.45E-07

TABLE 3.5-16

SOLID WASTE SYSTEM EFFLUENT VOLUMES

Type of Waste	Form	Quantity (ft^3/yr) Expected	Maximum
Spent Resins	Solidified	650	1760
Evaporator Bottoms			
Floor Drain	Solidified	4395	4395
ICW	Solidified	7500	7500
CVCS	Solidified	2000	3000
Filters			
Backflush	Solidified	180	180
Cartridges	Solidified	162	162
Compressible Solids	Compressed in drums (Compaction factor = 4)	2750	2750
Detergent Concentrates	Solidified[a]	1200	1200

[a] Based on a volume reduction factor of 50 for volume reduction unit.

TABLE 3.5-17

SOLID WASTE SYSTEM EFFLUENTS (CURIES/YEAR)
FROM SPENT RESIN[(a)]

Nuclide	Half Life	Activity
H-3	12.3y	1.13E+01
Br-84	31.8m	***
I-129	$1.6x10^7$y	***
I-131	8.06d	2.18E-03
I-132	2.28h	***
I-133	20.8h	***
I-134	52.3m	***
I-135	6.7h	***
Rb-88	17.7m	***
Rb-89	15.2m	***
Sr-89	50.8d	9.27E+00
Sr-90	28.9y	1.93E+01
Sr-91	9.67h	***
Y-90	64.0h	***
Y-91	58.8d	6.54E+01
Zr-95	65.5d	***
Mo-99	66.6h	***
Ru-103	39.8d	6.12E+00
Ru-106	386 d	8.79E+01
Te-129	34.1e	1.14E+01
Te-132	78 H	***
Te-134	43m	***
Cs-134	2.06y	4.41E+03
Cs-136	13d	2.40E-02
Cs-137	30.26y	2.34E+03
Cs-138	32.2m	***
Ba-140	12.8d	2.59E-03
La-140	40.2h	***
Pr-143	13.6d	3.88E-03
Ce-144	284 d	1.77E+02

(a)Based on 6-months decay of influent activities.

***Denote nuclide activity less than 1.0 E-04 curies/year.

TABLE 3.5-18

SOLID WASTE SYSTEM EFFLUENTS (CURIES/YEAR)
FROM FILTER CARTRIDGES[a]

Nuclide	Half Life	Activity
Cr-51	27.8d	7.11E-01
Mn-54	291 d	5.04E+00
Co-58	71 d	5.20E+01
Co-60	5.27y	9.23E+01
Fe-59	45 d	7.73E-02
Zr-95	65 d	2.20E-01

(a)Based on 6 months decay of input activities.

TABLE 3.5-19

SOLID WASTE SYSTEM EFFLUENT (MICROCURIES/GRAM)[a] FROM PRECOAT AND PARTICULATE SLURRIES, DETERGENT CONCENTRATE, AND ICW CONCENTRATE

Nuclide	Normal Operation	Nuclide	Design Basis
Br-83	*(b)	Br-84	*
Br-84	*	I-129	1.84E-12
I-130	*	I-131	2.20E-11
I-131	1.73E-12	I-132	*
I-132	*	I-133	*
I-133	*	I-134	*
I-134	*	I-135	*
I-135	*	Rb-88	*
Rr-86	4.33E-12	Rb-89	*
Rb-88	*	Sr-89	1.62E-08
Cs-134	1.27E-05	Sr-90	6.09E-09
Cs-136	3.29E-11	Sr-91	*
Cs-137	2.63E-05	Y-90	8.44E-30
Sr-89	1.28E-09	Y-91	3.22E-09
Sr-90	4.35E-10	Zr-95	5.94E-08
Sr-91	*	Mo-99	6.76E-25
Y-90	2.43E-31	Ru-103	1.60E-08
Y-91M	*	Ru-106	4.73E-06
Y-91	3.27E-10	Te-129	*
Y-93	*	Te-132	1.04E-22
Zr-95	2.12E-08	Te-134	*
Nb-95	5.44E-08	Cs-134	3.49E-05
Mo-99	9.63E-26	Cs-136	1.54E-10
Tc-99M	*	Cs-137	7.93E-05
Ru-103	5.84E-09	Cs-138	*
Ru-106	1.81E-06	Ba-140	1.19E-11
Ru-103M	*	La-140	1.42E-40
Te-125M	1.43E-10	Pr-143	2.93E-12
Te-127M	3.66E-09	Ce-144	8.92E-06
Te-127	*	Cr-51	9.37E-10
Te-129M	1.31E-09	Mn-54	1.92E-07
Te-129	*	Co-58	3.05E-07
Te-131M	*	Co-60	2.45E-06
Te-131	*	Fe-59	2.80E-09
Te-132	1.33E-23	Fe-55	6.38E-08
		Total	1.31E-04

TABLE 3.5-19 (contd.)

Nuclide	Normal Operation
Ba-140	4.74E-13
La-140	1.02E-41
Ce-141	6.19E-11
Ce-143	*
Ce-144	3.41E-06
Pr-143	2.06E-13
Pr-144	*
Np-239	1.86E-31
Cr-51	9.37E-10
Mn-54	7.96E-08
Fe-55	6.38E-08
Fe-59	2.80E-09
Co-58	1.94E-07
Co-60	9.92E-07
Total	4.56E-05

(a) Based on 6-months decay of input activities and mixed with one-third volume of solidification material.
(b) * denotes activity less than 1.0E-20.

TABLE 3.5-20

RADIOLOGICAL PROCESS AND EFFLUENT MONITORS

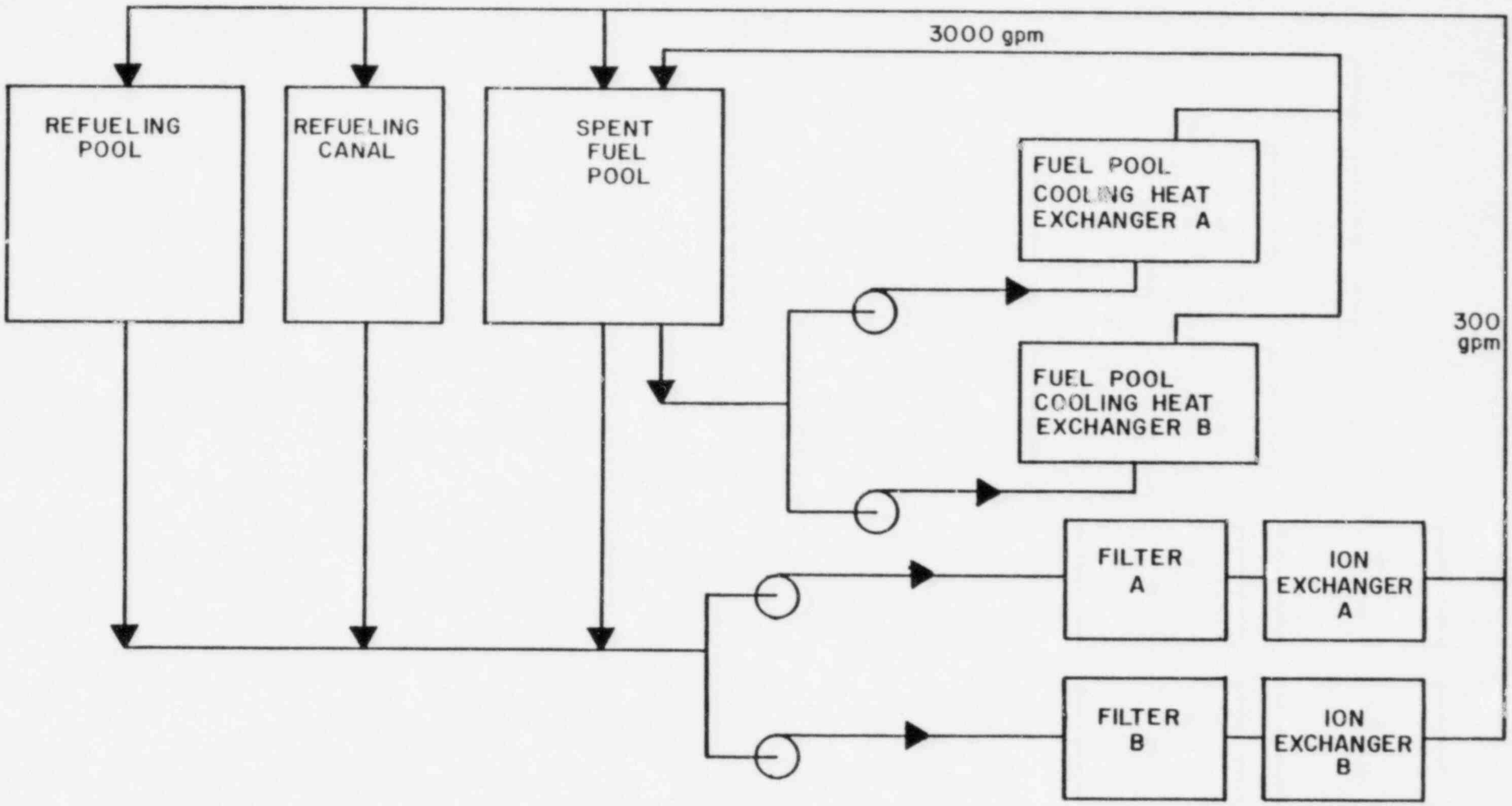
Monitor	Function
Component Cooling Water Monitor (2 ea) 335-ft (elev) level of Fuel Handling Bldg (FHB)	Detect leakage into component cooling water system. Diagnostic, indicating need for addition surveys.
Service Water Monitor (2 ea) 335-ft level of FHB	Detect leakage from component cooling water system. Diagnostic, indicating need for addition surveys.
Steam Generator Blowdown Monitor 402-ft level of RAB	Detect small primary to secondary leakage through steam generators. Diagnostic tool.
CVCS Preholdup Monitor 362-ft level of RAB	Indicates activity reactor coolant from gas stripper before routing to holdup tanks. Exceedence of setpoints indicates need for additional surveys.
CVCS Letdown Monitor 373.5-ft level of RAB	Detect increased activity in reactor coolant. Exceedence of setpoints indicates need for additional surveys.
FHB Airborne Radiation Monitor 417-ft level of FHB	Detects activity in FHB indicating need for verification or additional surveys on set point exceedence.
Containment Atmosphere/Purge Airborne Radiation Monitor (2 ea) 362.5-ft level of RB	Detect activity in either containment atmosphere or containment purge to identify leakage sources.
Steam Generator Blowdown Area Monitors (2 ea) 417.5-ft level of RAB	Detect primary to secondary leakage. Setpoint exceedence indicates need for additional surveys. Indicates need to isolate steam generator with high leak rate.
Refueling Pool Area Monitors (4 ea) on walls of refueling pool	Provides alarm for evacuation of refueling pool area and automatically isolates containment purge lines.

TABLE 3.5-20 (contd.)

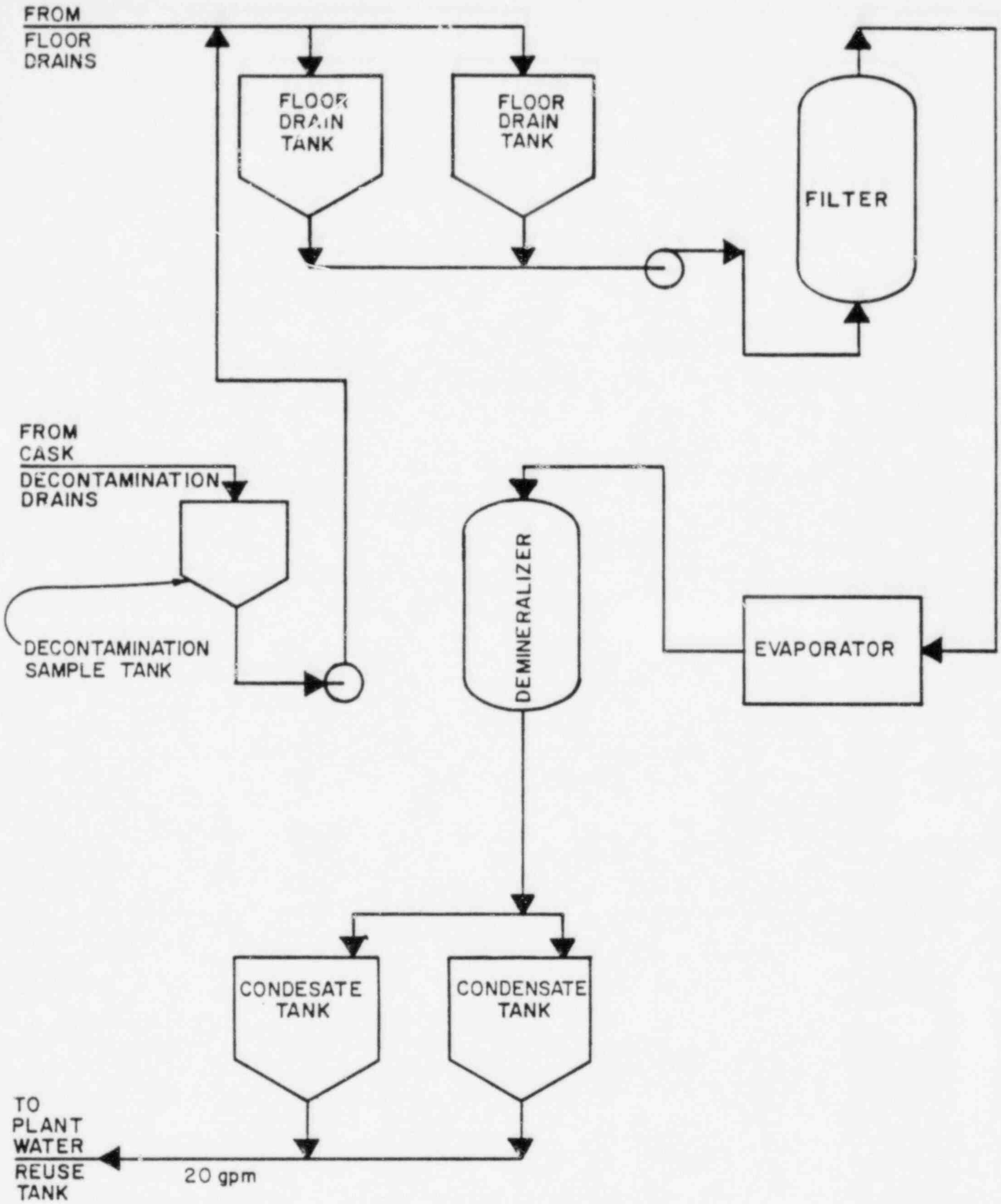
Monitor	Function
Spent Fuel Pool Area Monitors (4 ea) 425-ft level of FHB	Provides alarm for evacuation of spent fuel pool area and isolates FHB ventilation system.
Plant Vent Radiation Monitors 1 for each of 4 plant vents	Sample and monitor particulates, sample halogens (iodine), and monitor radioactive gases in effluent air. Alarm setpoints to prevent concentrations in excess of 10 CFR 20 limits. Alarm indicates need for additional surveys.
Administration Building Discharge Monitor 362.5-ft level of Admin Bldg	Same as vent radiation monitors.
Condenser Mechanical Vacuum Pump Discharge Monitor 390-ft level of Turbine Bldg	Samples for particulates and halogens and monitors radioactive gas content. Alarm setpoints to prevent concentration in excess of 10 CFR 20 limits.
Waste Gas Discharge Monitor 362.5-ft level of RAB	Provide record of activity released during waste gas discharge. High alarm terminates discharge. Setpoints established to prevent concentrations in excess of 10 CFR 20 limits.
Auxiliary Condensate Flash Tank Monitor	Detect in-leakage to auxiliary steam system and alert to the need for additional sampling.
Waste Management System Discharge Monitor 390-ft level of TB	Provide record of activity released from waste management system. If activity exceeds setpoint, established to prevent concentrations in excess of 10 CFR 20 limits, discharge is automatically terminated.
Common Plant Effluent Monitor outside building	Provides record of radioactivity in common liquid effluents. Alarm indicates need for additional analyses and/or cessation of discharge.

TABLE 3.5-20 (contd.)

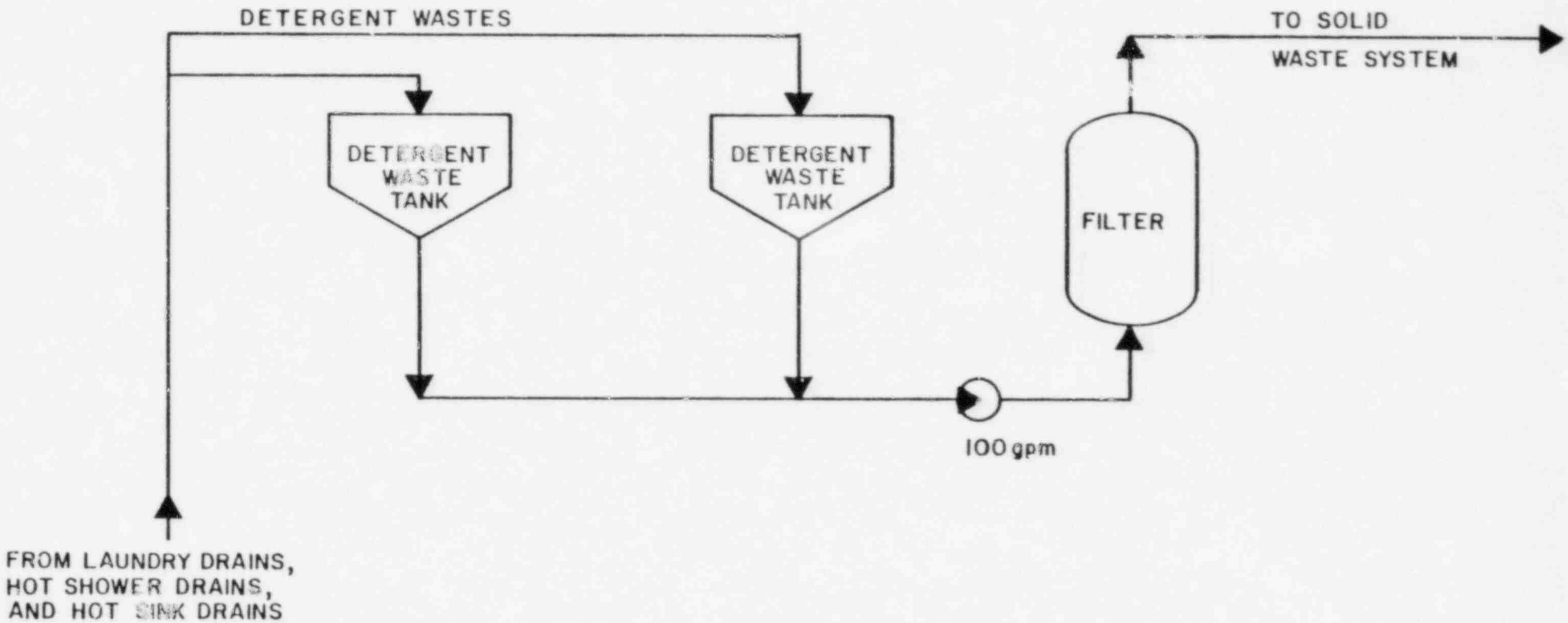
Monitor	Function
Sump and Secondary High Purity Discharge Monitor outside building	Provides record of activity in Sumps Nos. 2 and 10 and the secondary high purity water discharge. Alarm setpoints established to prevent concentrations from exceeding 10 CFR 20 limits.
Neutralization Pond Influent Monitor 362.5-ft level of RAB	Provides record of activity in discharge to neutralization pond. Alarm, with setpoints to prevent concentrations in excess of 10 CFR 20 limits, indicates need for additional sampling. High radiation alarm terminates discharge to pond.
Groundwater Drain Area Monitor	Provides record of activity in the RAB foundation drain. Setpoints as close as practicable to natural background. Alarm indicates need for additional samples to determine reason for alarm.



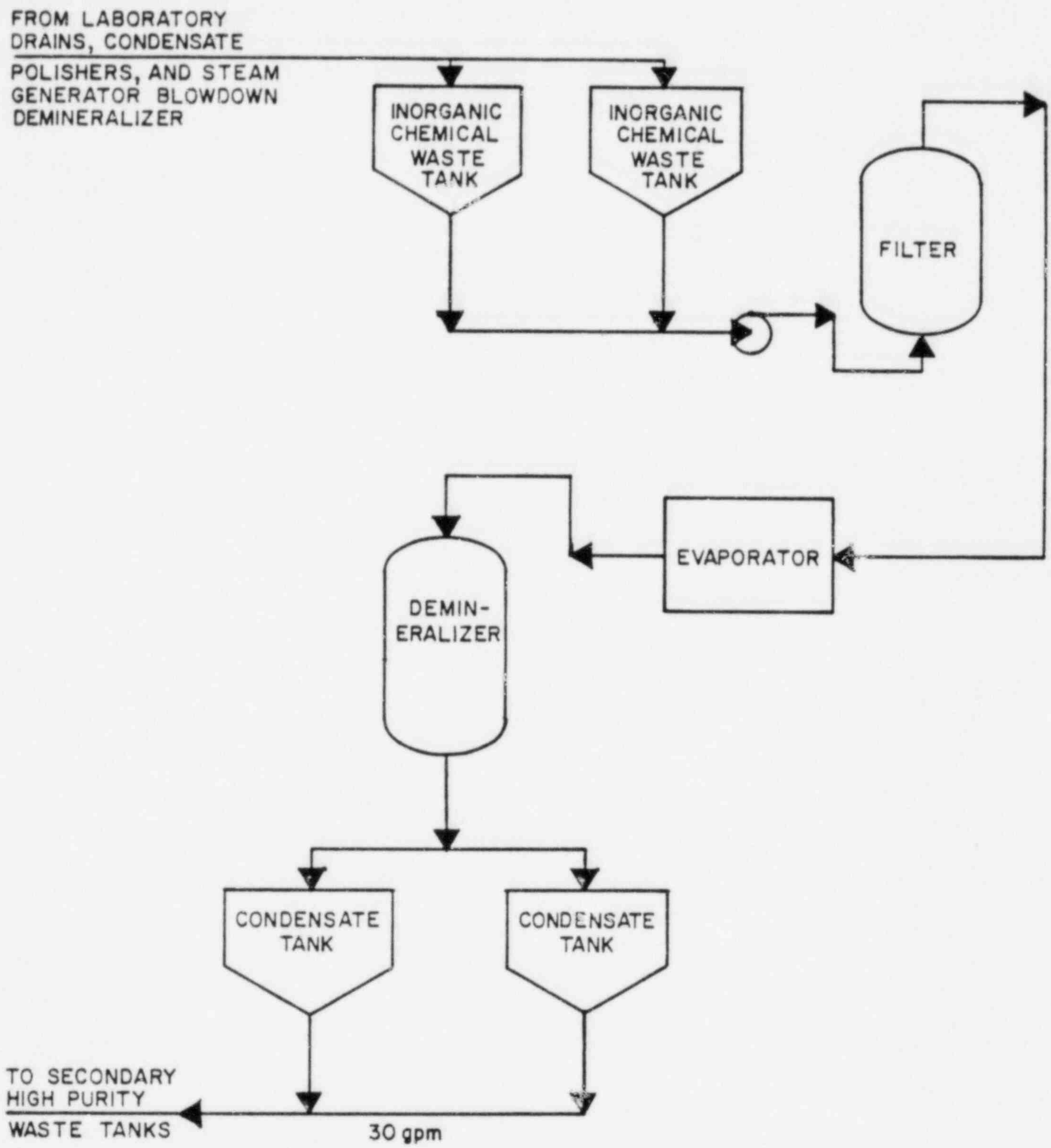
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	FUEL POOL COOLING AND CLEAN-UP SYSTEM BLOCK FLOW DIAGRAM	FIGURE 3.5-1



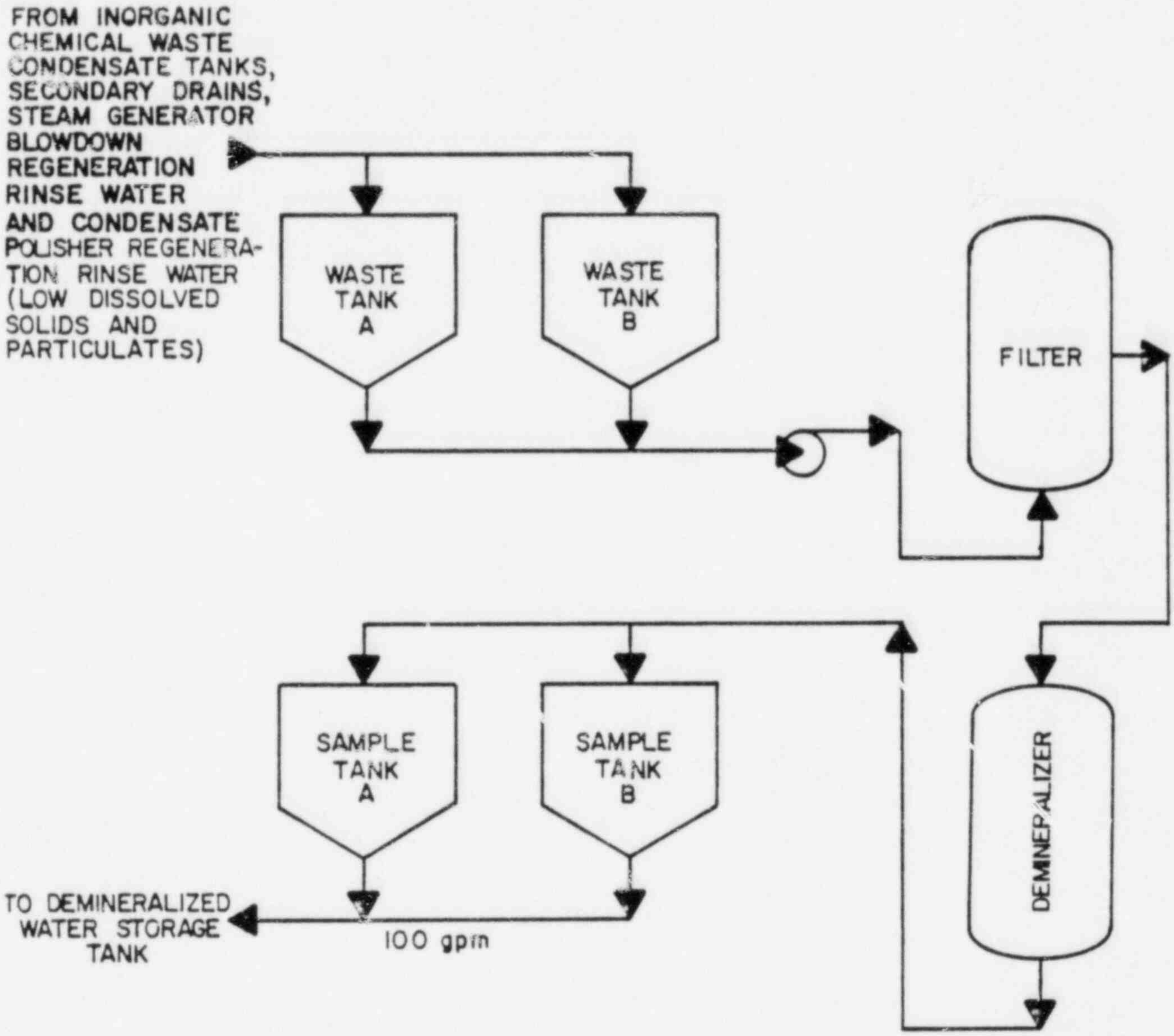
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	FLOOR DRAIN SYSTEM BLOCK FLOW DIAGRAM	FIGURE 3.5-2



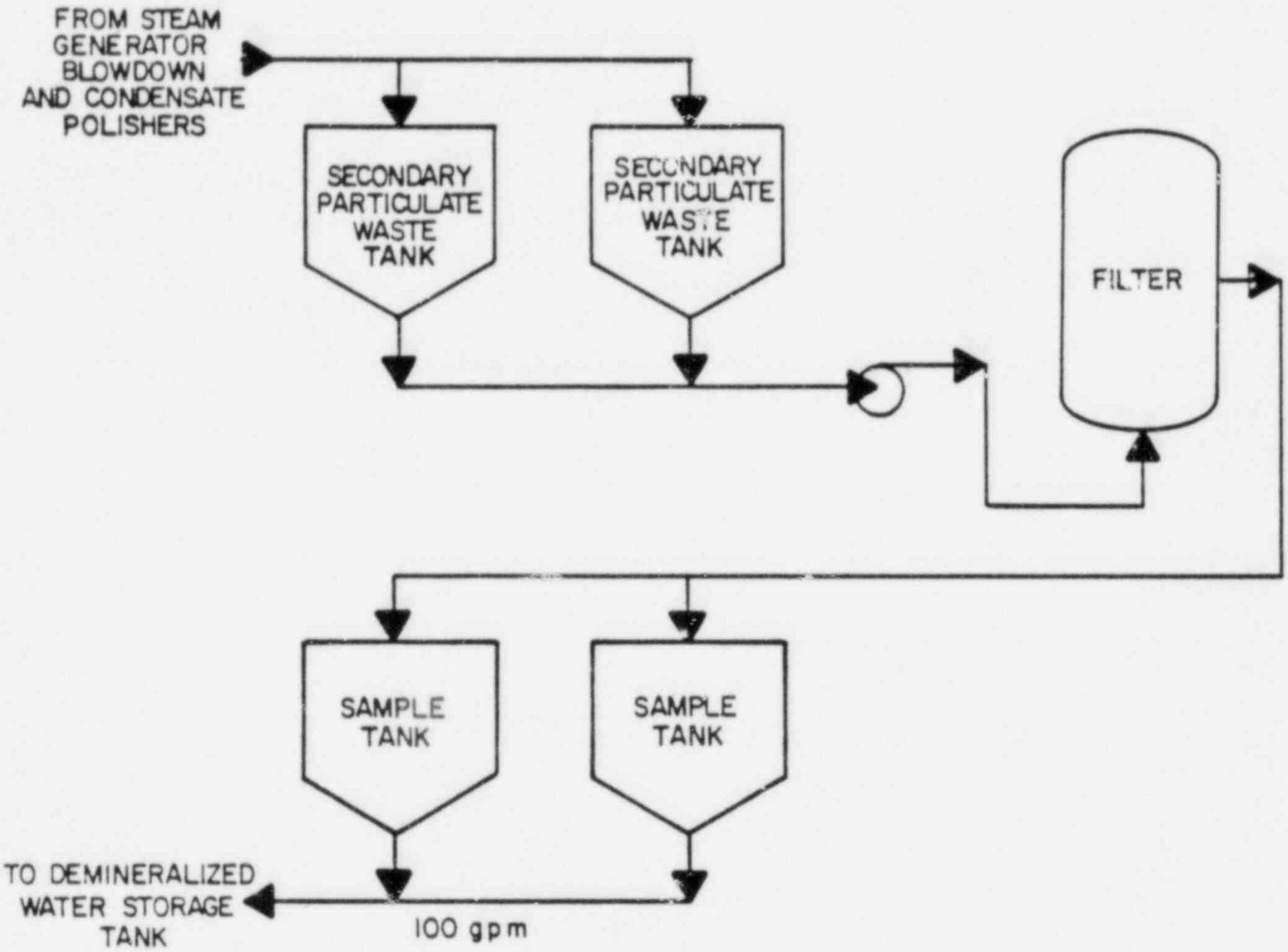
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	DETERGENT WASTE SYSTEM BLOCK FLOW DIAGRAM	FIGURE 3.5-3



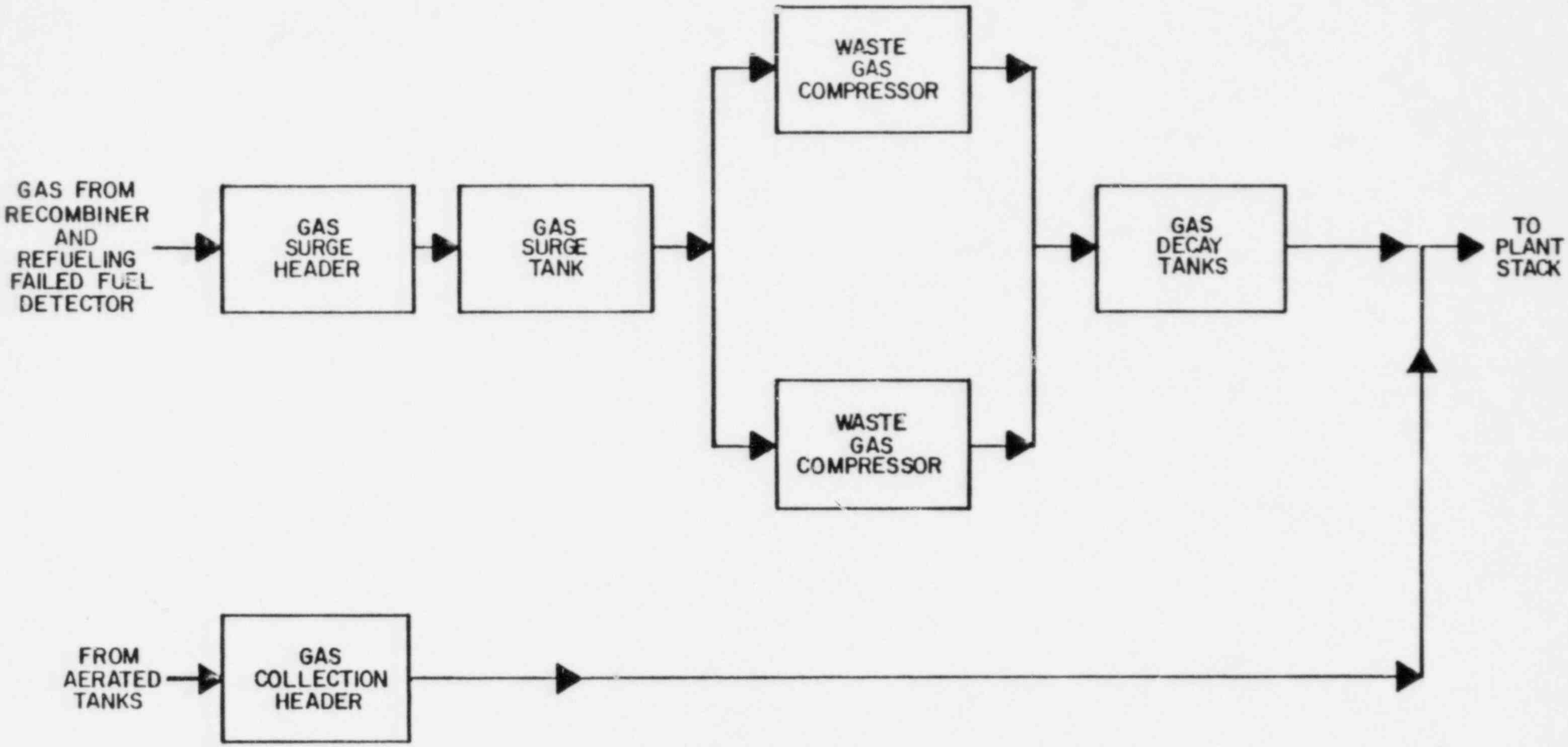
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	INORGANIC CHEMICAL WASTE SYSTEM BLOCK FLOW DIAGRAM	FIGURE 3.5-4



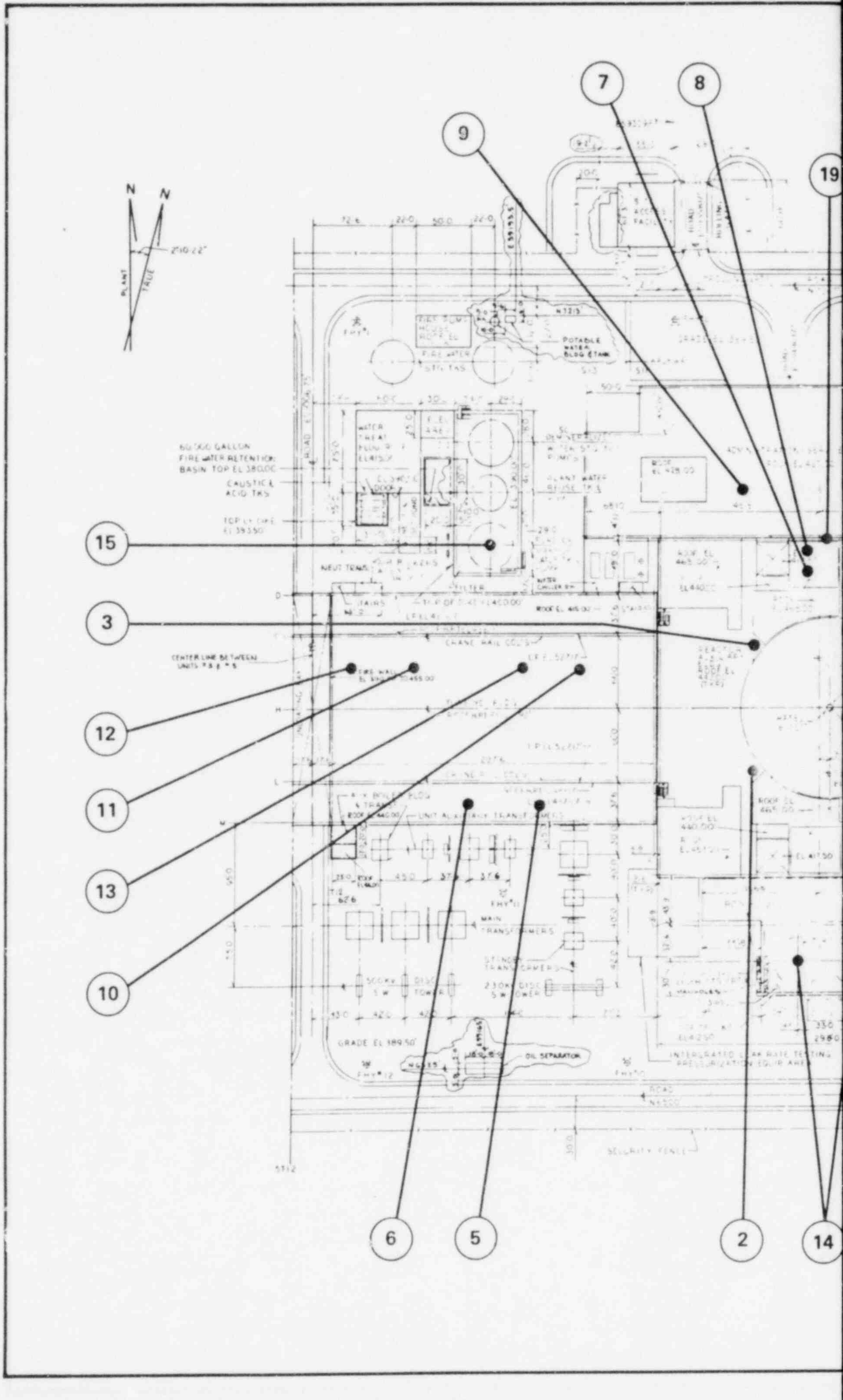
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	SECONDARY HIGH PURITY WASTE SYSTEM BLOCK FLOW DIAGRAM	FIGURE 3.5-5



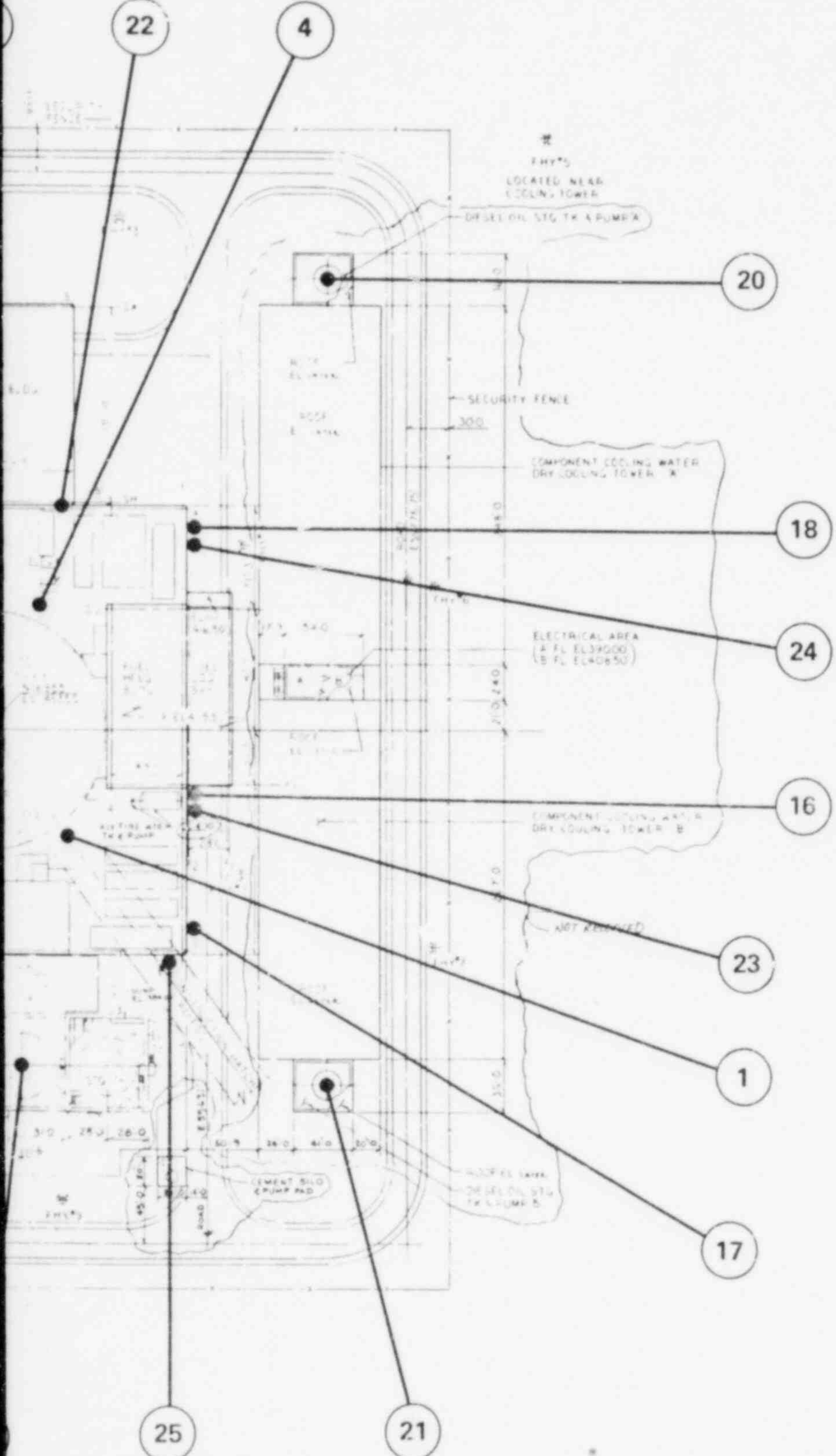
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	SECONDARY PARTICULATE WASTE SYSTEM BLOCK FLOW DIAGRAM	FIGURE 3.5-6



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	GASEOUS WASTE MANAGEMENT SYSTEM BLOCK FLOW DIAGRAM	FIGURE 3.5-7


N
N
PLANT
TRUE
7
8
9
19
15
3
12
11
13
10
6
5
2
14
60,000 GALLON FIRE WATER RETENTION BASIN TOP EL 380.00
CAUSTIC & ACID TKS
POTABLE WATER BLDG & TANK
CENTER LINE BETWEEN
CRANE RAIL COLS
UNIT AUXILIARY TRANSFORMERS
MAIN TRANSFORMERS
GRADE EL 389.50
OIL SEPARATOR
INTEGRATED LEAK RATE TESTING PRESSURIZATION EQUIP AREA
SECURITY FENCE

UNIT 3



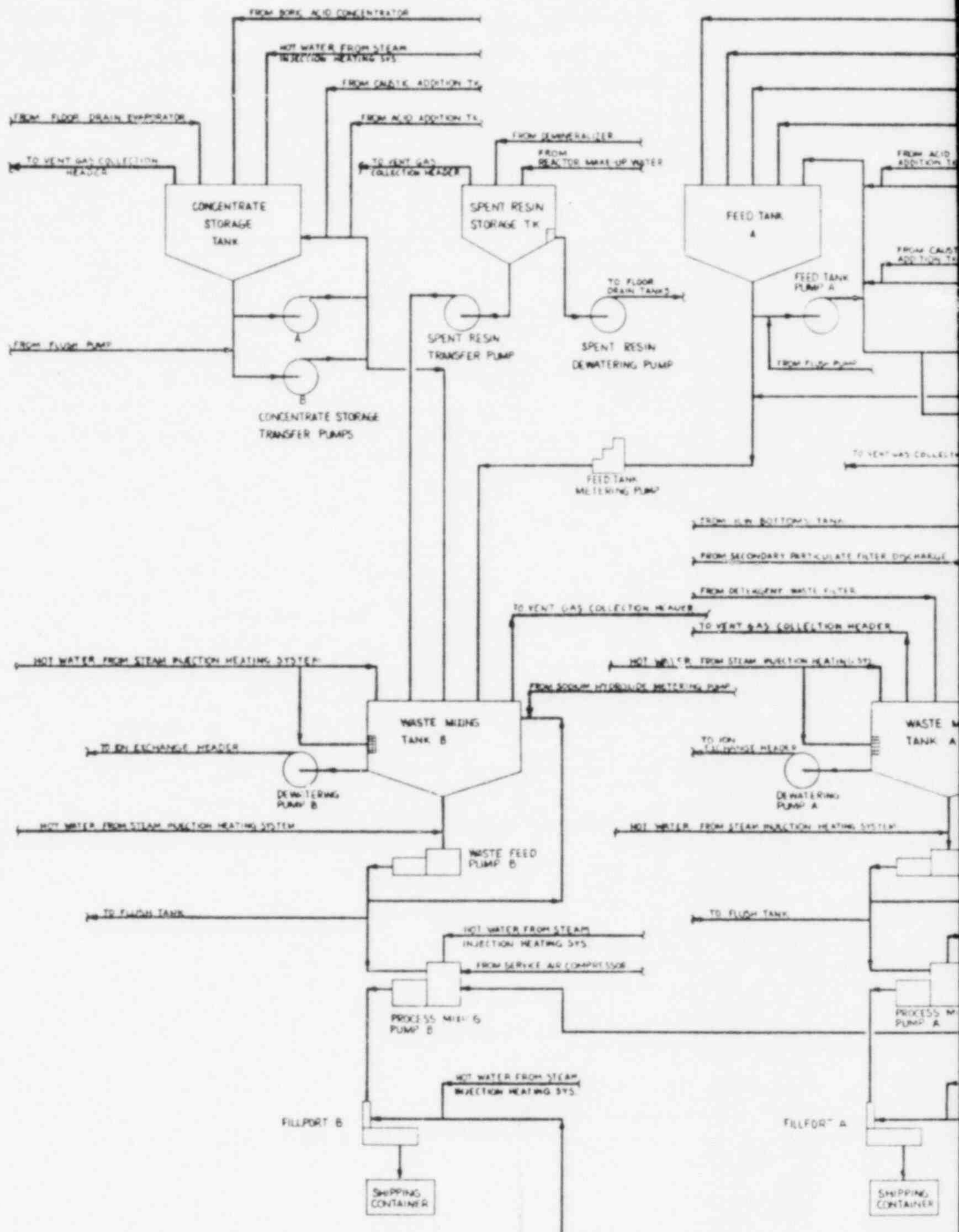
NOTES:

RELEASE POINTS ARE DESCRIBED ON SHEET 2

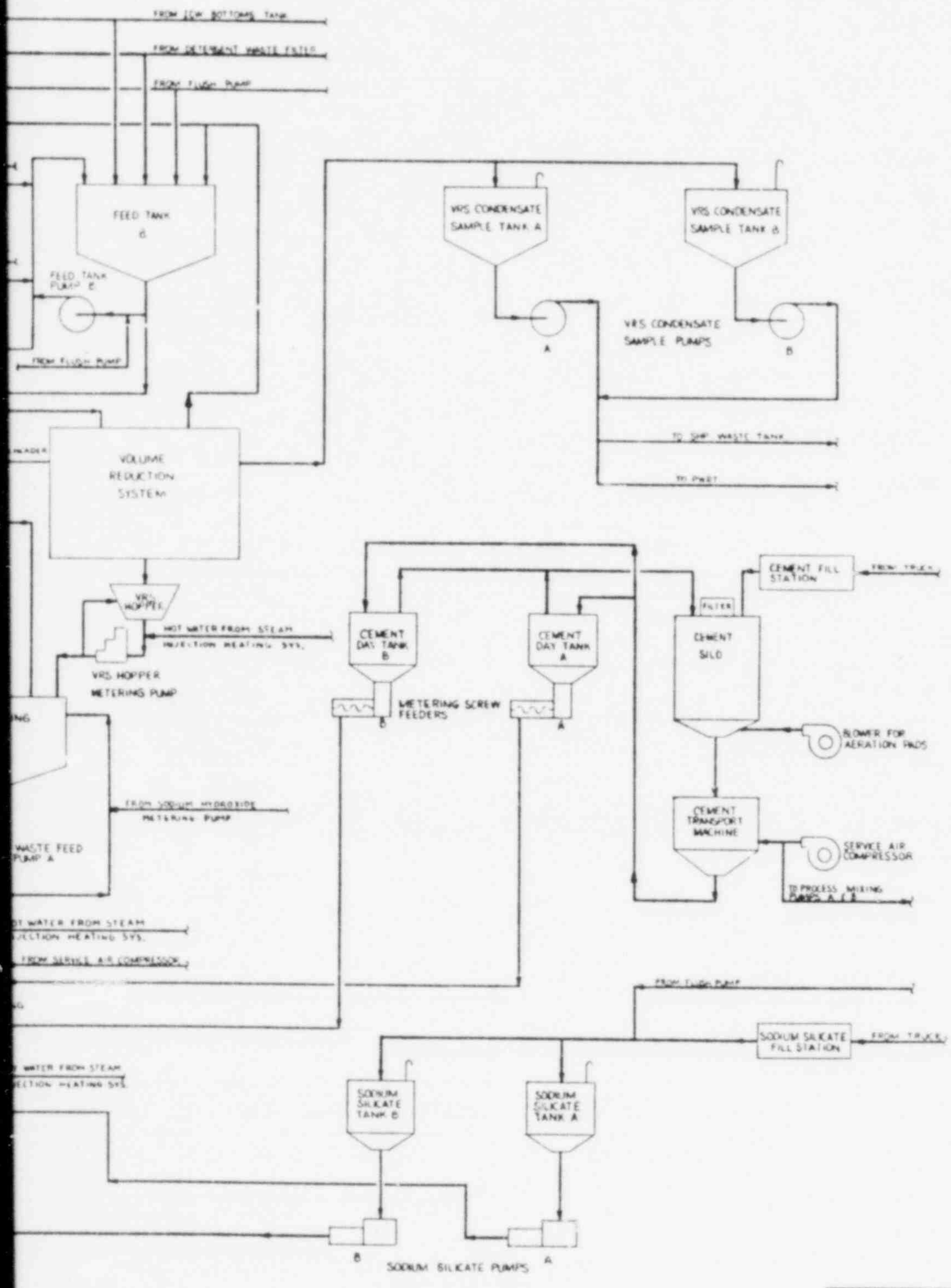
WASHINGTON PUBLIC POWER SUPPLY SYSTEM WNP-3 ER-OL
WNP-3 GASEOUS EFFLUENT RELEASE POINTS (SHEET 1 OF 2)
FIGURE 3.5-8

Release Point	Release Point Elevation (Ft. MSL)	Normal Flow Rate (cfm)	Systems/Components Exhausted
1	501.0	67,150	RAB Main Ventilation System, Diesel Generator Area Ventilation System. (ECCS/FHB Filtered exhaust, SBVS)
2	483.3	4,800	Control Room and Electric Battery Room Air Conditioning Vent Train B
3	483.3	4,800	Control Room and Electric Battery Room Air Conditioning Vent Train A
4	502.8	105,635	RAB Main Ventilation System, Fuel Handling Bldg Ventilation System, Diesel Generator Area Ventilation System (ECCS/FHB Filtered Exhaust, SBVS)
5	485.0	140,000	Turbine Building Ventilation System
6	485.0	140,000	Turbine Building Ventilation System
7	470.0	1,565	Administration Building Air Conditioning Vent
8	470.0	5,165	Administration Building Air Conditioning Vent
9	425.0	19,600	Administration Building Vent (CU-51)
10	497.0	1,510	Vent from the Main Turbine Lube Oil Reservoir
11	497.0	100 (each)	Feed Pump Lube Oil System Vent (2 release points next to each other)
12	497.0	70	Turbine Generator Loop Seal Tank
13	497.0	Natural Ventilation	Lube Oil Batch Tank Vent
14	435.0	Natural Ventilation	Refueling Water Storage Tanks A and B
15	432.0	Natural Ventilation	Reactor Makeup Storage Tank
16	485.0	79,300	Diesel Generator Exhaust-B (Normal Path)
17	409.3	79,300	Diesel Generator Exhaust-B (Alternate Path)
18	409.3	79,300	Diesel Generator Exhaust-A (Alternate Path)
19	485.0	79,300	Diesel Generator Exhaust-A (Normal Path)
20	429.0	Natural Ventilation	Diesel Oil Storage Tank A
21	429.0	Natural Ventilation	Diesel Oil Storage Tank B
22	413.0	Natural Ventilation	Diesel Generator Day Tank A
23	413.0	Natural Ventilation	Diesel Generator Day Tank B
24	404.3	Natural Ventilation	Diesel Generator Lube Oil Tank A
25	404.3	Natural Ventilation	Diesel Generator Lube Oil Tank B

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	WNP-3 GASEOUS EFFLUENT RELEASE POINTS (SHEET 2 OF 2)	FIGURE 3.5-8



FROM BORIC ACID CONCENTRATOR
HOT WATER FROM STEAM INJECTION HEATING SYS
FROM CAUSTIC ADDITION TK
FROM FLOOR DRAIN EVAPORATOR
FROM ACID ADDITION TK
FROM DEMINERALIZER
TO VENT GAS COLLECTION HEADER
TO VENT GAS COLLECTION HEADER
FROM REACTOR MAKE-UP WATER
CONCENTRATE STORAGE TANK
SPENT RESIN STORAGE TK
FEED TANK A
FEED TANK PUMP A
TO FLOOR DRAIN TANKS
A
FROM FLUSH PUMP
SPENT RESIN TRANSFER PUMP
SPENT RESIN DEWATERING PUMP
FROM FLUSH PUMP
B
CONCENTRATE STORAGE TRANSFER PUMPS
FEED TANK METERING PUMP
TO VENT GAS COLLECTION
FROM SECONDARY PARTICULATE FILTER DISCHARGE
TO VENT GAS COLLECTION HEADER
TO VENT GAS COLLECTION HEADER
HOT WATER FROM STEAM INJECTION HEATING SYSTEM
HOT WATER FROM STEAM INJECTION HEATING SYS
FROM SODIUM HYDROXIDE METERING PUMP
WASTE MIXING TANK B
WASTE M TANK A
TO ION EXCHANGE HEADER
TO ION EXCHANGE HEADER
DEWATERING PUMP B
DEWATERING PUMP A
HOT WATER FROM STEAM INJECTION HEATING SYSTEM
HOT WATER FROM STEAM INJECTION HEATING SYSTEM
WASTE FEED PUMP B
TO FLUSH TANK
TO FLUSH TANK
HOT WATER FROM STEAM INJECTION HEATING SYS
FROM SERVICE AIR COMPRESSOR
PROCESS MIXING PUMP B
PROCESS M PUMP A
HOT WATER FROM STEAM INJECTION HEATING SYS
FILLPORT B
FILLPORT A
SHIPPING CONTAINER
SHIPPING CONTAINER



WASHINGTON PUBLIC POWER SUPPLY SYSTEM
WNP-3 ER-OL

SOLID WASTE SYSTEM FLOW DIAGRAM

FIGURE 3.5-9

3.6 CHEMICAL AND BIOCIDE SYSTEMS

This section discusses the sources and treatment of chemical wastes resulting from plant operation. The anticipated water quality of the makeup and discharge is described in Table 3.6-1 and water treatment additives used in plant systems are listed in Table 3.6-2. The applicable discharge limitations are stipulated by the NPDES Permit included in Appendix A.

3.6.1 Makeup Demineralizer System

The Makeup Demineralizer System processes raw water from the plant Makeup Water System to produce high quality demineralized water. The demineralized water is required for Primary and Secondary System makeup and other miscellaneous plant uses.

The Makeup Demineralizer System consists of two cross-connected demineralizer trains, each with a normal capacity of 250 gpm and a maximum capacity of 375 gpm. Each demineralizer train consists of a cation exchange unit, an anion exchange unit, and a mixed-bed ion exchange unit. The cation exchange units are followed by a forced-draft deaerator.

The demineralizer trains are regenerated on the basis of ionic exhaustion or throughput. Each train is expected to have a throughput of about 280,000 gallons. The resins are first backflushed to remove suspended material. Cation resin is regenerated with dilute sulfuric acid (2 to 4 weight percent). Anion resin is regenerated with dilute sodium hydroxide (4 weight percent). After regeneration the resins are rinsed to remove excess regenerant solution. The backflush water, spent regenerant solution, and rinse water are transferred to the low volume waste treatment system. The waste will contain suspended material, ionic inpurities originating from the plant makeup water and excess regeneration reagents. The low-volume waste treatment system is described in Subsection 3.6.7 below.

3.6.2 Condensate Demineralizer System

The Condensate Demineralizer System processes secondary system feedwater to remove suspended material and ionic impurities. The system consists of 12 mixed-bed demineralizer units with 10 in service and 2 in standby as spares. The demineralizer units are removed from service based on throughput, pressure drop across the beds, or ionic exhaustion. The resins are transferred to a separate facility for regeneration. In the cation regeneration tank the resins are first backflushed to remove suspended matter. The anion resin is separated from the cation resin by classification and transferred to the anion regeneration tank for regeneration. The cation resin is regenerated [illegible]h dilute sulfuric acid, and the anion resin is regenerated with dilut[illegible]um hydroxide. The resins are then rinsed to remove excess regenerar[illegible]tion. The anion resin is additionally treated with dilute ammonium [illegible]ide to prevent sodium ion leakage during service. Following regen[illegible]he resins are transferred to the resin mixing tank where they are [illegible]tored until required.

The waste will contain suspended material, consisting primarily of corrosion products from plant heat transfer surfaces, excess regenerants and rinse water. The waste is normally transferred to the low-volume waste treatment system for treatment and subsequent disposal. During normal operations portions of the waste, including the backflush and the rinse water, can be processed in the SHP and SPWS (see Subsection 3.5.2.1) for reuse in the plant. Additionally, when primary to secondary system leakage occurs resulting in radioactive contamination of the condensate demineralizer system the waste is processed in the radwaste system.

3.6.3 Corrosion Control

Hydrazine is used in several plant systems to remove residual oxygen and as a corrosion inhibitor. During normal operation the concentration of hydrazine in the Secondary System feedwater is maintained in the range of 10 to 50 ppm. Hydrazine reacts with oxygen to yield nitrogen and water. Hydrazine decomposes to nitrogen and ammonia at higher temperatures. Essentially all of the hydrazine reacts or decomposes such that only trace quantities are released from the system.

Hydrazine is similarly used in the Primary System and the Auxiliary Boiler. The hydrazine concentration in the primary coolant is maintained in the range of 30 to 50 ppm at any time the temperature of the coolant is less than 150°F.

Most of the hydrazine utilized in the above applications decomposes or is oxidized. Any hydrazine released from these systems as a result of leakage or other mode of release is removed by subsequent treatment in the radwaste or secondary high purity waste treatment systems. Since hydrazine is a strong reducing agent its residual time is limited.

Ammonia is used to control pH in the Secondary Feedwater System, the Component Cooling Water System and the Auxiliary Boiler. The corrosion rate for steel is less at higher pH. In the Auxiliary Boiler System, ammonia provides the required conductivity for proper operation. As with hydrazine, any leakage from these systems is removed by subsequent treatment.

3.6.4 Biocide Control

Biocide control for the plant circulating water systems is provided by the addition of sodium hypochlorite. Sodium hypochlorite solution is injected at the intake to the circulating water pumps to produce a maximum concentration of 3 ppm (as chlorine) in the circulating water. Treatment periods vary from 20 to 30 minutes in duration. The treatment may be repeated up to twice daily depending on the biological activity in the cooling tower and the circulating water system. The maximum daily requirements for sodium hypochlorite will be approximately 800 pounds (as chlorine). The estimated average daily requirements will be less than 200 pounds (as chlorine).

Any residual chlorine (from sodium hypochlorite) remaining in the cooling tower blowdown is neutralized with sulfur dioxide before discharge from the plant. Since the residual chlorine concentration is expected to be about 0.02 ppm the contribution of sulfate to the blowdown will be minimal.

3.6.5 Scaling Control

Sulfuric acid is added to the Circulating Water System (cooling tower) make-up, to prevent scaling. The acid injection system includes two positive displacement acid injection pumps, each with a maximum capacity of 35 gallons per hour. The quantity of acid required will depend upon the analysis of the makeup water.

Sulfuric acid is also used to control scaling in the HVAC cooling towers. Blowdown from the HVAC cooling towers is transferred to the Low-Volume Waste Treatment System for additional treatment prior to disposal. The combined blowdown from the HVAC cooling towers is approximately 15 gpm.

3.6.6 Low-Volume Waste Treatment

The Low-Volume Waste Treatment System receives regeneration waste from the Condensate Demineralizer System and the Makeup Demineralizer System. Smaller quantities of waste may be received from the radwaste system and the secondary high-purity waste treatment system. During normal operation treated liquid radwaste is recycled for use in the primary system. This waste is treated by filtration, demineralization, and evaporation to produce high quality water. Infrequently, because of excess plant water inventory, small quantities of this waste water along with secondary high-purity waste may be discharged to the Low-Volume Waste Treatment System.

The low-volume waste is treated in the neutralization basin where the waste is neutralized to a pH in the range of 6 to 8.5, by the addition of sodium hydroxide. A substantial amount of sedimentation also occurs in the neutralization basin. The waste is discharged to the cooling tower blowdown line at a rate of approximately 300-400 gpm.

3.6.7 Miscellaneous Chemicals Released

During construction, storm drainage and construction water runoff was treated by flocculation and sedimentation prior to discharge from the site. The pH of the drainage and runoff was adjusted with sulfuric acid. Flocculation and sedimentation was aided by the addition of polyelectrolyte flocculation reagents. It is expected that use of the equalization and sedimentation basins will not be needed during the plant operation phase.

Prior to startup, plant piping and equipment is cleaned by flushing with plant makeup or demineralized water. Flushing water will contain small quantities of hydrazine, metal oxides (rust), and other suspended material. Following any required treatment and analysis, the waste is pumped to the equalization basin and released through the sedimentation basin.

Chemical reagents used in plant laboratories are routed from the laboratory drains to the Radwaste System for processing. The drains are segregated as follows: primary sample drains, secondary sample drains, hot laboratory drains, and cold laboratory drains. There are no normal releases from the Radwaste System which is discussed in Section 3.5.

TABLE 3.6-1

WATER QUALITY PARAMETERS - INTAKE AND DISCHARGE

	Intake Well		Total Combined Discharge	
	Ave	Max	Ave	Max
	mg/l		mg/l	
Calcium	12.0	13.1	72.0	97.1
Magnesium	4.3	4.8	25.8	35.4
Sodium	6.0	6.5	36.0	164
Potassium	0.70	0.77	4.08	5.67
Chloride	4.2	4.2	25.2	31.7
Fluoride	0.113	0.122	[illegible].68	0.90
Sulfate	2.8	2.8	300	560
Phosphorus	0.142	0.240	0.85	1.66
Ammonia N	0.014	0.028	0.08	0.19
NO_3 and NO_2 N	0.51	0.54	3.06	4.02
Oil and Grease	<1.0	<1.0	<1.0	<1.0
Chlorine (tot. residual)				<0.05
Alkalinity (as $CaCO_3$)	56	64	76	86
Hardness (as $CaCO_3$)	54	60	324	360
TDS	134		1150	1356
TSS	1		6	8
pH	6.9	7.5	7.1	8.5
	µg/l		µg/l	
Barium	4.0	12.0	24.0	78.2
Cadmium	< 0.1	0.2	0.6	1.4
Chromium	0.6	1.2	23.1	28.4
Copper	<1.0	7.0	21.5	61.3
Iron	16.0	90	183	655
Lead	<1.0	<1.0	<6.0	7.5
Manganese	1.0	4.0	8.2	27.8
Mercury	<0.2	0.7	1.2	4.5
Nickel	<1.0	10.0	18.6	74.1
Zinc	<5.0	7.0	31.2	56.9

(a) Compiled from Environmental Monitoring Program reports 1978-1980 (References 2.2-2, 2.2-3, and 2.2-4) and Metals Monitoring Program report (Reference 2.4-6.)

(b) Includes concentrated makeup water, corrosion products, treatment additives, and low-volume waste.

TABLE 3.6-2

WATER TREATMENT ADDITIVES

Additive	Systems Served	Purpose	Annual Quantities (lbs/yr) Ave	Max
Hydrazine (As 35 wt % solution)	Primary Coolant Condensate and Feedwater Component Cooling Water Auxiliary Boiler System	Oxygen Scaverging and Corrosion Inhibitor	10,000	16,000
Ammonia (As 29 wt % solution)	Condensate and Feedwater Component Cooling Water Auxiliary Boiler	pH Control and Corrosion Inhibitor	300,000	400,000
Sodium Hydroxide (As 50 wt % solution)	Makeup Demineralizer Condensate Polishing Low Volume Waste Treatment Chemical and Volume Control Radwaste System	Resin Regeneration pH Control and Adjustment	175,000	250,0[illegible]
Sulfuric Acid (As 93 wt % solution)	Makeup Demineralizer Condensate Polishing Circulating Water System Storm and Construction Runoff	Resin Regeneration pH Control and Adjustment	2,700,000	3,000,000
Polyelectrolyte (Magnafloc 573C liquid)	Storm and Construction Runoff	Flocculation and Sodimentation	20,000	42,000
Sodium Hypochlorite (As 15 wt % solution)	Circulating Water Potable Water	Biocide Treatment	160,000	250,000
Sulfur Dioxide (Compressed Gas)	Circulating Water	Chlorine Neutralization	10,000	12,000
Hydrogen (Liquefied Gas)	Primary System Turbine-Generator	Oxygen Scavenger Coolant	3,000	4,000
Nitrogen (Liquefied Gas)	Chemical and Volume Control Gaseous Waste System	Cover Gas Purge Gas	15,000	20,000
Carbon Dioxide (Liquefied Gas)	Turbine-Generator Fire Protection	Purge Gas Fire Retardant	4,000	6,000
Boric Acid (Crystalline Powder)	Primary Coolant	Chemical Shim	1,000	2,000

3.7 SANITARY AND OTHER WASTE SYSTEMS

3.7.1 Sanitary Waste Treatment

The Sanitary Waste Treatment System consists of two packaged sewage treatment plants, a drainfield and all necessary forwarding (lift) stations. The sewage treatment units utilize the extended aeration - activated sludge process. One unit has a nominal capacity of 20,000 gpd; the other unit has a nominal capacity of 30,000 gpd. The units were sized in this manner to provide adequate treatment during the construction phase of the plant and for the greatly reduced loadings expected to occur later during plant operation. The design basis for sanitary waste treatment facility is 40 gallons per capita day and 0.07 pounds per capita day of 5-day BOD.

Sanitary waste is transferred from its sources to the sewage treatment plants by gravity and by wet pit type lift stations. Five lift stations have been provided for this purpose and will be used as required during plant operation.

In the sewage treatment plant the waste is first processed through a comminuter where the larger solids are reduced in size by maceration. The effluent from the comminuter section is course screened and discharged to the effluent basin. From the influent basin the waste is transferred via the surge tank to the aeration tank. The influent basin and surge tank provide a means of flow equalization and control.

The aeration tank provides a minimum of 24 hours waste retention time under aerated conditions. Air for mixing, biological treatment, and air operated components is supplied by two positive displacement air blowers (per unit). Air is supplied to the aeration tank to maintain the solids in suspension and provide a dissolved oxygen concentration of approximately 2.0 mg/l. The aeration tank is also equipped with a surface froth and foam control system.

Effluent from the aeration tank is processed through a grease trap and discharged to the clarifier tank. The clarifier tank provides a minimum retention period of three hours, adequate to allow effective sludge separation and removal. A portion of the sludge, sufficient to produce the required purification in the available aeration time, is returned to the aeration tank. The remaining sludge is transferred to the digester tank (aerated sludge holding tank).

One digester tank serves both sewage treatment units. The digester has a capacity of approximately 3000 gallons. The digester tank design includes a cover and flame arresting gas vent. Air diffusers are provided to promote mixing and to supply air for sludge digestion. Supernatent liquid is returned to the clarifier through an overflow pipe. Accumulated sludge (about 3500 gallons) is removed for off-site disposal once every three months (construction phase experience with less frequent removal expected during operation phase).

Overflow from the clarifier tank flows by gravity to a forwarding station and is pumped to the drain field for disposal. The drainfield consists of three separate component drainfields each capable of handling 16,000 gpd, all dosed in sequence to provide rest periods. The drainfield design includes the capability to isolate component drainfields during low-flow periods. Each field consists of twenty-seven 100-foot laterals in groups of nine and served by distribution boxes which provide equal flow.

3.7.2 Emergency Diesel Engines Exhaust

The Emergency Diesel Engines are tested on a monthly basis. During the test, each engine is operated for approximately two hours. Two Emergency Diesel Engines and one diesel driven fire pump has been provided for the plant. The following emmissions are estimated for these units:

a) Nitrous Oxides - 2.9 lbs/10^6 Btu
b) Sulfur - 0.3 lbs/10^6 Btu
c) Ash - 0.1 lbs/10^6 Btu

Since these units are operated infrequently they will not contribute to atmospheric pollution problems.

3.8 REPORTING OF RADIOACTIVE MATERIAL MOVEMENT

The transportation of cold fuel to the reactor, irradiated fuel from the reactor to a fuel reprocessing plant, and solid radioactive wastes from the reactor to waste burial grounds is within the scope of 10 CFR Part 51.20(g). The environmental impacts of such transportation are described by Table S-4 of 10 CFR Part 51.

3.9 TRANSMISSION FACILITIES

3.9.1 Transmission Line Description

3.9.1.1 Location

Two transmission lines will be constructed between WNP-3 and the Bonneville Power Administration (BPA) Satsop substation. System requirements beyond the Satsop substation are evaluated, designed and built by BPA. The substation (Elev 310 ft MSL) is located approximately 3000 feet north of WNP-3 and adjacent to the BPA Olympia-Aberdeen transmission corridor. One transmission line will be a 500kV line from the 500kV disconnect switches on the plant island to the 500kV bus in the substation. The other line will be a 230kV line from the substation to the 230kV disconnect switches at the plant. The 230kV line will be an underground low-pressure oil-filled cable. Figure 2.1-1 shows the relative locations of the plant and the BPA substation. The right-of-way lies completely within the project boundaries and crosses no public roads.

3.9.1.2 Routing

The transmission lines between the plant and BPA's Satsop substation will satisfy the requirements of NRC General Design Criteria 17. These lines and their interconnection with the BPA system are shown in Figure 3.9-1.

The 500kV line for WNP-3 will be connected, via the 500kV switchyard bus, to a new 500kV BPA transmission line which will extend approximately 46 miles to BPA's Paul switchyard. This line will parallel the existing Aberdeen-Olympia-Paul corridor. It will be single-circuit except for a six mile double-circuit section located west of Olympia. The double-circuit section will be shared with the Satsop-Olympia 230kV #2 line (see Figure 3.9-1).

The two existing Olympia-Aberdeen 230kV lines will be looped into the Satsop 230kV switchyard and connected in a modified breaker and a half bus configuration to the 230kV lines feeding each plant. The length of each of these lines from Satsop to Olympia is approximately 27 miles (see Figure 3.9-1).

The Olympia-Aberdeen corridor, which passes north of the plant, will contain the following transmission facilities:

the Cosmopolis - South Elma	115kV line
the Satsop - Olympia No. 2	230kV line
the Satsop - Olympia No. 3	230kV line
the Satsop - Aberdeen No. 2	230kV line
the Satsop - Aberdeen No. 3	230kV line
the Satsop - Paul	500kV line

Although there will be crossings of the transmission lines and some multiple circuits, no single contingency will leave less than two power sources feeding the Satsop substation. This is due to the routing and the spacing of the transmission lines. Further reliability is provided by interconnection through an auto transformer of the 500 and 230kV buses in the Satsop substation.

3.9.1.3 Structures

The transmission line structures between the plant and the Satsop substation will be constructed of lattice steel in a single circuit delta configuration. The towers will be about 120 feet high and 40 feet wide. Land requirements for each tower will average 400 square feet.

3.9.2 Environmental Parameters

The environmental parameters associated with the transmission system beyond the Satsop substation have been evaluated by BPA as owner/operator.(1) The environmental effects of a transmission system were also evaluated generically by the BPA in its Draft Role EIS.(2) The following discussion addresses principally the lines between the plant and the substation.

3.9.2.1 Land Use

The transmission lines are located in a previously forested area which was cleared to make laydown area for plant construction. Because the lines are within the project boundaries, use of the land will continue to be limited to activities associated with plant operation.

3.9.2.2 Aesthetics

That portion of transmission lines on higher ground near the plant may be visible from State Route 12. However, the transmission structures will not be seen in isolation from the much larger plant structures.

3.9.2.3 Corona Effects

Corona loss is the loss of energy to the atmosphere caused by localized electrical discharges from an energized conductor; these usually result from small irregularities or foreign particles (e.g., dust or water droplets) on the conductor surface. The result is a breakdown of the air immediately adjacent to the conductors and effects associated with this highly stressed air include audible noise, radio interference, and ozone production.

Audible noise due to the corona phenomenon may be evident in the area immediately beneath and adjacent to the 500kV line. It will be most noticeable in fog or drizzling rain, however, it will not be detectable off-site. Electrical noise causing radio and television interference may also be a consideration in low signal strength areas. Since the lines are completely within the project boundaries, the public will not be affected by electrical noise.

The corona discharge may also produce ozone by chemical reaction in the small volume of air surrounding the conductor. Reported research has shown the ozone concentrations around high voltage (765 kV and higher) to be a neglible contribution to ambient levels.(2)

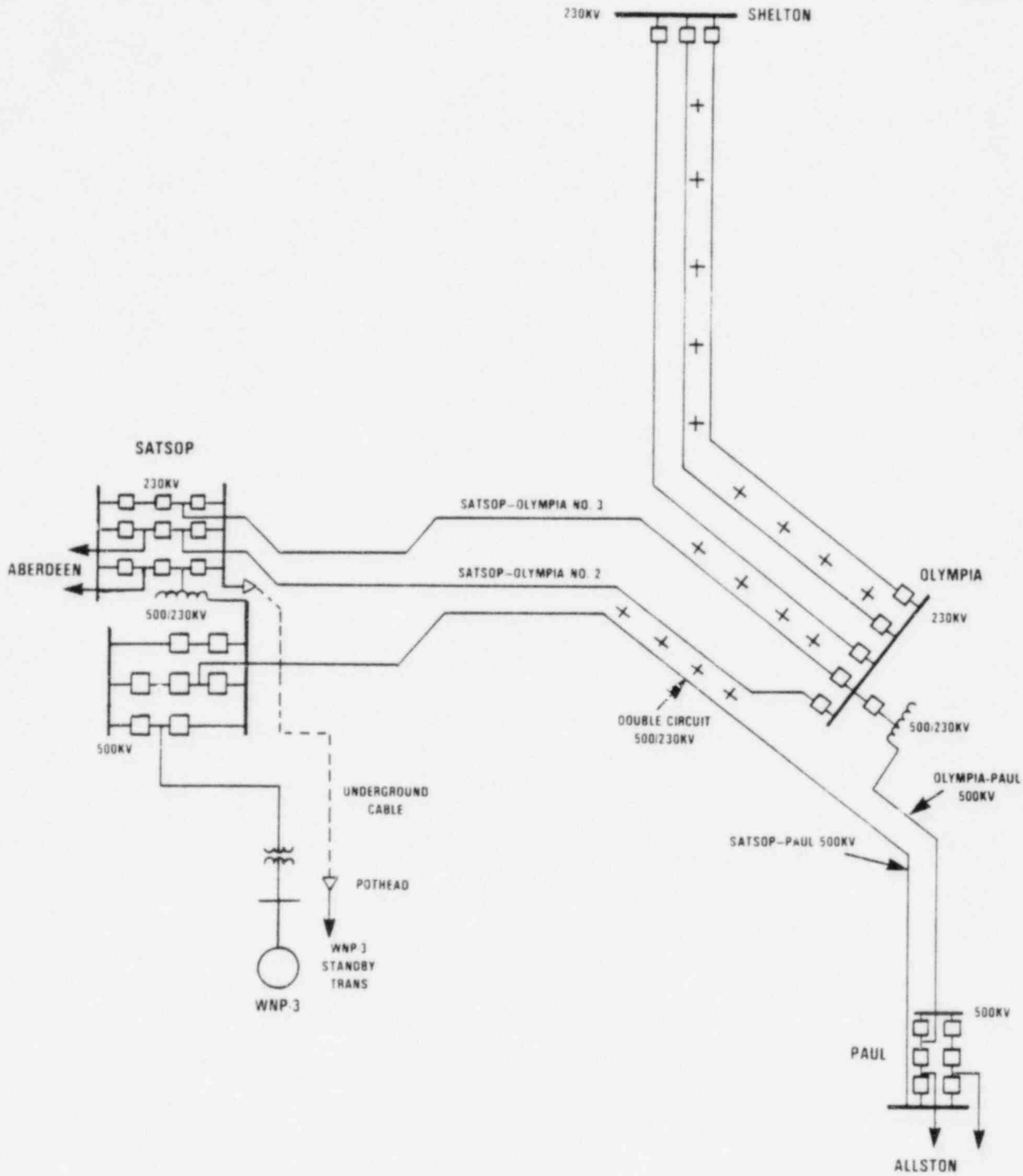
3.9.2.4 Electric Currents and Magnetic Fields

Field effects from transmission lines stem from electric and magnetic fields in the proximity of high-voltage conductors carrying electric currents; high voltage creates the electric field and currents in the conductors create the magnetic field. The magnitude of the induced voltage and associated ground-discharge current due to the electrostatic field depend on the the line voltage, the size of the object being charged, and the object's distance from the line conductors. The magnitude of induced current due to the electromagnetic field depends on the load current in the conductors, the orientation and length of the object, and its distance from the conductors. While research on the possible effects of magnetic fields and induced currents is continuing, available information does not provide any expectation of quantifiable impacts resulting from the lines serving WNP-3.(2)

References for Section 3.9

1. Environmental Statement, Fiscal Year 1976 Proposed Program, Bonneville Power Administration, Department of the Interior, 1976.

2. The Role of the Bonneville Power Administration in the Pacific Northwest Power Supply System, Appendix B, BPA Power Transmission, Bonneville Power Administration, Department of the Interior, July 22, 1977, pp VII-46 through VII-74.



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	SATSOP SUBSTATION INTEGRATION	FIGURE 3.9-1

ENVIRONMENTAL EFFECTS OF SITE PREPARATION

The anticipated environmental effects of site preparation and plant and transmission line (switchyard to plant) construction were described in Chapter 4 of both the Environmental Report-Construction Permit Stage (ER-CP)[1] and the Final Environmental Statement.[2] Site preparation was initiated with receipt of a Limited Work Authorization (LWA) from the NRC in April 1977. As construction proceeded, decisions were made to add or delete facilities and modify construction practices. Some of these decisions were in response to construction requirements; others were in response to natural conditions. The following discussion highlights the changes in plant construction, and the related environmental impacts, relative to the expectations at the Construction Permit stage.

The ER-CP (Subsection 4.1.2.1) described plans to control erosion from disturbed areas. The State of Washington considered these plans and imposed an effluent limitation of 50 mg/l total suspended solids from the construction site. To meet this limitation, a 15.6 acre equalizing reservoir and 5 acre settling pond (using a polyelectrolyte flocculant) were constructed, instead of a planned series of retention basins, the largest of which was 17.8 acres. Temporary ditches around the site perimeter were constructed in the summer of 1977 to deliver site runoff to the equalization pond. A record rainfall in late August 1977 (5.1 inches for month vs. 1.5 inches long-term average) necessitated significantly greater measures than were planned to control the resultant erosion. Initially, settling ponds were constructed on the Hyatt and Purgatory Creek watersheds and these ponds quickly filled with sediment. It was later necessary to suspend construction work on the site in November 1977, and apply all energies to erosion control until into January 1978. The ultimate solution was a series of ponds on the watersheds with upper ponds to collect suspended sediment and a downstream pond which was pumped to the large equalization pond at the north of the central site area (see Figure 3.1-3). Critical slopes on the site totaling approximately 25 acres were covered with reinforced plastic. Both Stein Creek to the south of the plant island and Fuller Creek to the north experienced siltation impacts.[3, 4] A fish mitigation effort was later implemented with the cooperation of the State Departments of Fish and Game. The lessons learned during the fall/winter of 1977-1978 have been applied in subsequent construction activities.

The ER-CP discusses the compact site and coordinated construction scheduling. Early in the construction effort it became clear that additional laydown area was needed beyond what the central site area could provide. Two alternatives were developed. One 12-acre laydown area called Saginaw was developed adjacent to an existing railroad spur approximately three miles east of the site along the South Bank Road. The South Bank Road was upgraded with the cooperation of Grays Harbor County. When no longer required, the Saginaw laydown area gravel surfacing will be removed and the area returned to approximately its original condition as pasture.

Such rehabilitation is stipulated in the lease with the land owner. He may also opt to leave it in its present condition. An additional 79 acres of laydown area was developed onsite on the terrace west of Fuller Creek. This area includes six warehouses which may be maintained to support the operations phase.

At the CP stage a railroad was proposed to extend from the plant island west along Hyatt Creek to the Union Pacific Railroad in the vicinity of Elizabeth Creek. To minimize earthwork, a crawler haul road was constructed and used instead of the railroad to deliver the NSSS components to the site. The same right-of-way is used for the makeup water line and provides a maintenance access road to Ranney collectors (see Subsection 3.4.5).

To facilitate access to the plant, the Supply System and the County agreed to substantially upgrade Keyes Road. Keyes Road has provided a secondary access for construction workers and also provides secondary access to the Emergency Operations Facility (EOF). The EOF is a new NRC requirement since the CP was issued in April 1978. The WNP-3 EOF is located about 0.8 mi NNW of the plant as shown on Figure 2.1-1. Construction is expected to begin in September 1982.

As part of the design to place Ranney collectors in the Chehalis aquifer (see Figures 3.4-5 and 3.4-6) limited bank protection features have been constructed. Features constructed have not been entirely successful. The objective is to provide minimum protection for the immediate well areas without substantially affecting flood flows. It is anticipated that additional riprap protection will be placed during the summers of 1982 and 1983.

At the time of the CP, the Supply System proposed an environmental control program which relied heavily on the Architect-Engineer's Construction Management Organization. During the 1977-1978 erosion episode the Supply System substantially upgraded the control program and brought it within the Supply System organization. During critical earthwork years, the staffing level peaked at seven and site inspections were conducted twice daily with environmental staff onsite anytime earthwork activities were being conducted. This effort has tapered-off substantially as earthwork scope has decreased. In April 1982 the onsite full-time environmental staff numbered three. Their responsibilities include operation of water and waste treatment facilities as well as the control program.

The ER-CP estimated a peak site construction work force of 2100 to 2300 construction workers. In April 1982 there were 2650 craftworkers and 2100 non-manual onsite. The site work force was then near the peak for the single-unit construction.

References for Chapter 4

1. Environmental Report-Construction Permit Stage, WPPSS Nuclear Project Number 3, Docket Nos. 50-508/509, Washington Public Power Supply System, Richland, Washington, 1974.

2. Final Environmental Statement, Washington Public Power Supply System Projects 3 and 5, Docket Nos. 50-508/509, NUREG-75/053, U. S. Nuclear Regulatory Commission, Washington, D.C., June 1975.

3. Jeane II, G. S. and L. L. King, Erosion Control at Satsop, WNP-3 and WNP-5, August 1977 to March 1978, WPPSS-EPO-81, Washington Public Power Supply System, Richland, Washington, December 1978.

4. Siltation Impact Evaluation in the Vicinity of Washington Public Power Supply System Nuclear Projects Nos. 3 and 5, Envirosphere Co., Bellevue, Washington, 1978.

ENVIRONMENTAL EFFECTS OF STATION OPERATION

5.1 EFFECTS OF OPERATION OF HEAT DISSIPATION SYSTEM

The heat dissipation system is described in Section 3.4. This section discusses the physical and biological effects of system operation.

5.1.1 Effluent Limitations and Water Quality Standards

The Water Quality Standards of the State of Washington(1) classify the reach of the Chehalis River in the vicinity of the plant as "Class A (Excellent)". The standards specify that the increase in water temperature outside a specified mixing zone shall not exceed $t = 28/(T + 7)$, where t is the permissible increase and T is the existing water temperature in ^{o}C. When the ambient water temperature exceeds 18.0^{o}C the maximum permissible increase is 0.3^{o}C.

Discharges from WNP-3 are controlled to comply with the National Pollutant Discharge Elimination System (NPDES) Permit (see Appendix A) issued by the State of Washington in compliance with Chapter 155, laws of 1973 (RCW 90.48), as amended, and the Clean Water Act (PL 95-217), as amended. This permit incorporates the Water Quality Standards and establishes a dilution zone with longitudinal boundaries 50 feet upstream and 100 feet downstream from the diffuser and lateral boundaries 25 feet from the midpoint of the diffuser. Vertically, the dilution zone extends from the surface to the river bottom. Consistent with the applicable guideline of 40 CFR Part 432, the permit limits the temperature of the blowdown to the lowest temperature of the recirculated cooling water prior to the addition of makeup water. In addition, the permit specifies that when ambient river temperatures are 20^{o}C or less, the discharge temperature shall be 20^{o}C or less and shall not exceed the ambient temperature by more than 15^{o}C; and when the ambient river temperatures are greater than 20^{o}C, the discharge temperature shall be equal to or less than the ambient temperature. No discharge is permitted when downstream velocities are less than 0.3 feet per second (fps).

5.1.2 Physical Effects

The thermal dispersion characteristics of the multiport blowdown diffuser were studied using a hydraulic model with a scale of 1:12.(2) The studies were conducted to support the dilution zone definition in the NPDES Permit and, consequently, focused on abnormal conditions. These conditions included minimum recorded daily flowrates for the Chehalis River and temperatures which are exceeded 99 percent of the time. These conditions are shown in Tables 2.4-1 and 2.4-5 and may be compared with the average data listed in the same tables. It should be noted that the summer low flows which were used are less than the once-in 10-yr, 7-day low flow of 530 cfs reported in Figure 2.4-3. The plant operating parameters that were modelled are shown in Table 3.4-1.

Additional conservatism is provided by the fact that the above-mentioned model tests were conducted primarily for two-unit (both WNP-3 and WNP-5) operation. Some results are shown in Figures 5.1-1 through 5.1-3. Figures 5.1-1 and 5.1-2 are for two-unit operation in January and August, respectively. Figure 5.1-2 can be compared with Figure 5.1-3 which depicts the August isotherms with only a single unit operating. A critical period for meeting water quality standards is expected to be October when the flows are low and the initial temperature differences are greatest. However, as shown in Table 5.1-1, dilution zone boundary temperatures are predicted to meet water quality standards in every month.

The river reach in the vicinity of the discharge is subject to flow stagnation and reversal during the infrequent coincidence of low river flow and extreme high tides. Several cases (e.g., river flow @ 440 cfs, Aberdeen tide @ 5.6 ft MSL) resulting in the stagnation or reversal phenomena were studied using the hydraulic model. However, the results are not discussed here because, as noted in Subsection 5.1.1, the NPDES Permit prohibits discharges when downstream river velocities go under 0.3 fps.

The unidirectional flow examples discussed above provide predictions of the seasonal variation of blowdown plume temperatures under severe conditions (low river flow, large initial temperature differences). The near- and intermediate-field temperatures of the dilution zone are seen to comply with water quality standards (see Table 5.1-1). Bulk river temperatures in the far-field will be increased no more than 0.05°C in any season due to the maximum incremental addition of approximately 10,000 Btu/sec of heat in the blowdown from WNP-3.

5.1.3 Biological Effects

5.1.3.1 Intake Structure Effects

Two subsurface infiltration-type intake structures (Ranney collector wells) located on the south bank of the Chehalis River near River Mile 18 will supply makeup water for WNP-3. Impingement and entrainment of aquatic organisms is precluded by the use of the collector wells.[3] Loss of aquatic habitat and benthic macroinvertebrates due to drawdown of the river channel (0.1 ft or less in an area with tidal fluctuations of 2 or more ft) will be negligible. Nearby Elizabeth Creek may become dry in the fall blocking the stream to both anadromous and resident fish. The number of annual juvenile coho and chum that would be lost as a result of this blockage was estimated to be 0.1% of the total run and is considered an acceptable loss.[3] The actual impact on coho and chum is probably less than previously estimated because of clearcutting in the upper Elizabeth Creek watershed during 1973 to 1976.[4] This has increased siltation, and along with numerous other obstacles (eg. fallen trees), has decreased the spawning potential from approximately 47 redds in 1968-1969 to 4 in 1980-1981.[5]

5.1.3.2 Effects of Thermal Effluents

Thermal effects of the WNP-3 blowdown discharge are expected to be negligible from either a temperature increase or from "cold shock". Thermal effects involve two factors: (1) the change in water temperature above or below ambient and (2) the duration of exposure of the organisms to the change in temperature. Temperature, because of its direct and/or indirect effects, is a principal factor determining the suitability of a habitat for aquatic organisms. The introduction of heated water into an aquatic ecosystem may cause some biological changes that will affect metabolism, development, growth, reproduction, and mortality. These effects are documented in the literature.[6-8] The tolerance of organisms to any temperature change is species specific and depends on the magnitude of the change and the duration of the exposure, as well as previous temperature acclimation.

Periphyton and Phytoplankton

The compositions of the periphyton and phytoplankton communities in the Chehalis River are typically at a subclimax level of growth because of the turbulent river flow, seasonal low water temperature and high turbidity. The periphyton and phytoplankton population in the Chehalis River is dominated by diatoms and blue-green algae, particularly in the warm summer months. Table 5.1-2 shows the thermal tolerance limits of periphyton and phytoplankton species typical of the Lower Chehalis River Basin. As shown in Figure 5.1-2, under an extremely low river flow, the temperature rise above ambient will be less than 1.0°C within a few feet of the diffuser ports. This rapid dilution of the discharge ensures that species inhabiting the area near the diffuser will not be affected. Nor will there be a significant long-term effect on the periphyton and phytoplankton community of the river. These organisms are abundant throughout the river system and their rate of productivity is high. Thus, losses, if any, would probably be rapidly compensated by upstream sources with no measureable effect on the entire ecosystem.

Benthic Macroinvertebrates

The upper temperature limits for the majority of benthic organisms reported to occur in the Chehalis River appear to be in the range of 29.0 to 34.5°C, with tolerance somewhat dependent on the species, stage of development, and acclimation temperature (see Table 5.1-3). Curry[13] found the upper thermal tolerance of several families of aquatic dipterans to be in the range of 30 to 33°C. Caddisfly larvae, and stonefly and mayfly nymphs acclimated to 10°C had a 96-hour median tolerance to temperatures ranging from 21.1 to 30.5°C, with mayflies being the most sensitive.[14] Becker[15] reported that caddisfly larvae acclimated to a river temperature of 19.5°C had a 50% mortality after a 68-hour exposure to a 10°C increment, whereas, mortality at 7.5°C above ambient was insignificant. Becker also reported that stepped thermal increases up to a differential of 10°C resulted in welldefined increases in growth for all of the species tested.[15]

The ecological consequences of thermal discharges on benthic macroinvertebrates are expected to be negligible with the potential for lethal effects being restricted to sessile organisms in the immediate area at the diffuser. Any sublethal effects [16,17], if they occur, will probably occur within the isotherms with a delta-T $\geq 0.6^{o}C$. Even with two units operating, these isotherms would cover an area of less than 0.012 acres. The magnitude of these changes should have no measureable effect on the benthic community and thus no impact on the fish resources.

Fish

Temperature is one of the important parameters influencing the fishery resources in the Chehalis River. Anadromous fish, particularly salmonids, have the greatest sport and commercial value. A review of the tolerance and thermal requirements of fish [18] indicates that, in the Chehalis River, salmonids are the species most sensitive to thermal discharges. Thus, protecting one of the most thermally sensitive group of species (i.e., juvenile salmonids) in the Chehalis River should adequately protect the remaining fish as well. Tables 5.1-4 and 5.1-5 provide data on thermal stress limits for juvenile salmonids.

No salmonid spawning has been documented in the vicinity of the WNP-3 discharge.[19] Thus, there will be no effect of the thermal discharges on salmonid embryogenesis and early development. Juvenile salmon and trout do migrate downstream through the discharge area, with peak movement occurring in March through July. During this time, river currents are greater than 1 fps in the discharge area.[19] In general, juvenile salmonids cannot maintain their position in currents greater than 1 fps. Therefore, the juvenile salmonids would probably be passively swept through the dilution zone, and would be exposed to elevated temperatures in the mixing zone for less than two minutes. (This assumes the fish passively drift through the area at 1 fps.) Based on the short exposures to elevated temperatures and the thermal stress limits shown in Table 5.1-4 and 5.1-5, no adverse effect to juvenile outmigrant salmonids is expected.

Adults salmonids migrate upstream through the discharge area. Thermal tolerances of adult salmonids are similar to or greater than juveniles; therefore, the adults are not expected to suffer any adverse effects from the discharge temperature. Site-specific ultrasonic tracking studies by Thorne et. al.[20] show that the adult upstream migrants tend to travel near the river bank rather than midstream where the discharge is located. In addition, adult salmonids are expected to avoid the thermal plume. Cherry et. al.[21] reported that adult rainbow trout avoided temperatures of $19^{o}C$. Also, ambient water temperatures which exceed $21.1^{o}C$ are reported to impede or block adult salmonid migration.[22,23] As noted previously in Subsection 5.1.1, when ambient river temperatures are greater than $20^{o}C$, the discharge temperature will be equal to or less than ambient and therefore will not add any additional thermal stress to the fish.

The resident populations in the Chehalis River consist of suckers, bass, shiners, catfish and minnows. Field-measured upper preference temperatures for these species at other locations were in the range of 23 to 36°C.[18] Based on this information, it is judged that these species will not be affected by the WNP-3 thermal discharge.

The discharge limitations described in Subsection 5.1.1, which are based on extreme ambient Chehalis River temperatures and physiological thermal limits for juvenile salmonids, will insure that no acute mortality or other significant adverse chronic effects will occur as a result of the thermal discharge.

Cold Shock

Cold shock is an additional concern at some power plants, particularly those using natural bodies of water for once-through cooling. Cold shock problems stem from the sudden cessation of thermal discharge when the plant is shut down. Since the thermal plume attracts certain aquatic organisms, particularly fish, these organisms become acclimated to the elevated temperatures and, in fact, dependent on them for survival. Fish mortalities have occured at a few plants following shutdowns and much effort has recently gone into devising ways to eliminate these fish kills. Cold shock is never expected to occur at WNP-3 because during the months when it is a potential problem (i.e., winter) river flow will be high enough to prohibit prolonged occupation in the discharge area. For fish to become acclimated to the warmer temperatures of the plume, they would have to occupy these waters for several days, which is not expected to happen in the strong river currents. Fish populations downstream from the mixing zone, where the river has become thermally homogenous, will experience temperatures that are essentially natural.

The benthic community is the only other aquatic community that might be continuously exposed to the effluent and thus become acclimated to the higher temperatures. However, any impact on the benthic population from cold shock would be minimal in terms of the aquatic community in the vicinity of the site because the potentially affected area is so small (i.e., area with a $\Delta T \geq 0.6°C$ is < 0.012 acres).

5.1.3.3 Effects on Water Quality and Aquatic Habitat

The effects of changes in water quality parameters other than temperature on the aquatic biota have also been considered. Included are dissolved oxygen, nutrients and suspended sediments. (The effects of chemical discharges are considered in Section 5.3).

The dissolved oxygen concentration in the Chehalis River should not be decreased by operation of the proposed plant. Temperature affects the solubility of oxygen; the warmer the water, the less soluble is the oxygen. Although the slightly warmer discharge may have a slightly lower oxygen concentration than the receiving water, its small volume coupled with rapid mixing induced by the diffuser should not result in any measurable change in the oxygen concentration of the river.

During normal plant operation, little or no nutrients will be added and no effect on the aquatic ecosystem will occur.

Little siltation or bottom scouring will result from the diffuser discharge because of the low volumes of water involved and because of the diffuse design (i.e., individual ports 1 ft above the bottom and oriented downstream and upward). Any siltation will stabilize and will have no long-term impact.

The thermal discharge is not expected to have any significant impact on aquatic wildlife habitat. The volume of the dilution zone is very small (Figure 5.1-1). Since the diffuser will be located approximately 100 feet from either river bank, this zone will have no effect on the shoreline. Therefore, wildlife such as amphibians, aquatic mammals, wading birds or migratory fowl that might use these areas will not be adversely affected by the discharge.

5.1.4 Atmospheric Effects

As noted in Section 3.4, the closed-cycle cooling system will dissipate approximately 8.7×10^9 Btu/hr of waste heat at full load. This rejected heat is transferred to the atmosphere both as sensible heat (by raising the temperature of air drawn through the cooling tower) and as latent heat (by evaporating water into the air). This process results in saturation of the exhausted air and subsequent formation of visible plumes. The air drawn through the tower will also entrain drops of cooling water which will be deposited near the site as drift. The effects of these phenomena are discussed in this subsection.

5.1.4.1 Plume and Fog Formation

The condensation of emitted water vapor results in the formation of tiny water droplets which have a negligible fall velocity and are effectively suspended in the air and transported with the wind as they evaporate. The nature and degree of nuisances caused by this plume depend, to a large extent, on whether it remains elevated or interacts with the ground.

At operating power plants in the 500 MWe to 2500 MWe range, the observed visible plumes may extend 5 km downwind under extreme conditions.[25-28] These observations have been used to characterize both the height and the downwind extension of visible plumes.

Results of plume model calculations (Subsection 6.1.3.2) for two units (WNP-3 and WNP-5) are presented in Table 5.1-6. The table shows the amount of time in any one year during which the plume lengths are greater than or equal to the indicated distances. Note that plume lengths will be less than 1 km for roughly 54 percent of the time. No lengths greater than 7 km (4.3 mi) were determined in this analysis. Plume lengths tend to be the longest during the fall and shortest during the summer. Plumes also tend to be longest when conditions are near saturation (i.e., during cloudy weather). The cloud cover will substantially reduce the visual impact of the plume.

The effects of the plume interacting with the ground (fogging and icing) are not expected to be a problem with the cooling tower plume from WNP-3. The vapor plume exits the tower at about 870 ft MSL. The nearest commercial highway, SR 12, is about 2.6 miles north at an elevation less than 50 ft MSL. Residential areas are at approximately the same elevations. The elevation difference (800 to 850 ft) and the momentum and buoyancy of the plume will combine to keep the plumes well removed from populated areas and commercial activities.

Operations from the Elma Airport (3 mi NE) may suffer minimal disruption as takeoffs and landings are parallel both to valley air flow and to valley ridges upon which the cooling towers are sited. However, the occurence of stratus/stratocumulus is so common to the Elma area that elevated clouds are normally encountered during aircraft operations. Although air traffic could possibly be disrupted, the extent and duration will be localized and extremely limited. As shown in Table 5.1-6, visible plumes longer than 4 km (2.5 mi) are expected to occur only 33 hrs/yr in the NNE and NE sectors.

5.1.4.2 Drift Deposition

In addition to the water vapor exhausted to the atmosphere, the cooling towers will lose a small fraction (0.003 percent, see Subsection 3.4.2) of the recirculating cooling water as drift. The water droplets become mechanically separated from the recirculating water and are entrained into the tower's updraft. This drift contains the dissolved solids, or salts, which are normally carried by the cooling water. (In contrast, the normal plume droplets are composed of pure water resulting from evaporation and condensation of the cooling water in the towers.) A large percentage of the drift droplets have a measurable fall velocity such that they fall to the ground immediately surrounding the plant. In dry weather, the drift droplets may actually evaporate in the atmosphere, leaving crystals of salts which will essentially disperse or fall to the surface, depending on their size.

The deposition of these salts on the surrounding landscape depends greatly on the local atmospheric conditions and the concentration of salts in the droplets. The onsite meteorological data and the methods identified in Subsection 6.1.3.2 were used to estimate the average annual deposition patterns around the site. Figure 5.1-4 presents the mean annual salt deposition from the cooling tower assuming year-round full-power operation.

Deposition rates within 500 feet of the tower are quite uncertain, but beyond this distance, maximum total deposition is expected to be below about 20 lb/acre-yr. Heaviest deposition rates are expected in the northern sectors. Beyond 2 miles from tower the estimated deposition drops below 1 lb/acre-yr.

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TABLE 5.1-1

PREDICTED DILUTION ZONE BOUNDARY TEMPERATURES
VS. WATER QUALITY STANDARD

	Temperatures (°C)			
Month	River	Discharge	Dilution Zone[a]	WQS[b]
January	0.0	10.3	0.9	4.0
February	1.1	9.7	1.9	4.3
March	3.9	8.6	4.3	6.5
April	5.0	8.9	5.3	7.3
May	10.0	10.8	10.1	11.6
June	11.1	13.1	11.3	12.5
July	14.4	16.1	14.6	15.7
August	15.6	17.5	15.8	16.8
September	11.7	18.3	12.4	13.2
October	5.0	17.5	6.1	7.3
November	4.4	15.3	5.4	6.9
December	0.6	12.8	1.7	4.3

(a) Two units operating. Peak surface temperature 100 ft downstream from diffuser, from Reference 5.1-2.

(b) Water quality standards from Reference 5.1-1. See Subsection 5.1.1.

TABLE 5.1-2

RESPONSE OF PERIPHYTON AND PHYTOPLANKTON
IN THE VICINITY OF WNP-3 TO TEMPERATURE

Organism	Maximum or Optimum Temperature or Range	Miscellaneous Temperature Response	Reference
Cocconeis schlettum	Range 34°C - 36°C		(9)
Diatoms Green Algae Blue-Green Algae	Most abundant at 20°-30°C Most abundant at 30°-35°C Most prolific at > 35°C		(10)
Stigoclonium tenius	Maximum temperature for living = 27°C		(9)
Nitzschia filiformis Gomphonema paruulum	Optimum growth between 22°-26°C Maximum 31°-35°C		(9)
Phytoplankton	An increase in temperature of approximately 8° C stimulated photosynthesis when natural water temparature was 16°C or cooler and inhibited photosynthesis when water was 20°C or warmer		(11)
Algae		Not injured passing through condensers if temperature does not exceed 34°-34.5°C	(9)
Nitzschia, Oscillatoria, Ankistrodesmus		Incubated microecosystems for 20 weeks at 26°C then cooled to 12°C at 1-5 day intervals. No significant difference in species present between 26 and 12°C.	(12)

TABLE 5.1-3

RESPONSE OF AQUATIC INVERTEBRATES IN THE VICINITY OF WNP-3 TO TEMPERATURE

Organism	Range or Optimum	Upper-Lethal	Misc. Temperature Response
Coelenterata			
Hydra littoralis			Animals acclimated to 5°C were twice as large as those acclimated to 21°C
Anneida			33°C - Optimum temperature for activity of choline-acetyl-transferase in nervous tissue
Hirudo medicinales			
Arthropoda Crustacea			Eggs developed most rapidly between 14°C to 20°C
Cyclops scutiper			
Cyclops abyssorum			Egg rate development doubled every 5°C between 5° and 25°C
Cladocerans		The least resistant species	
Eurycercus lamellatus		Eurycercus and Chydorus perished at 35.0° to 35.5°C	
Chydorous globosus			
Gammarus pseudolimnaeus		24-hr lethal temp - 29.9°C	
Astacus		35°C lethal temperature	
Insecta			
Diptera Tendipedidae Chironomus			Increased larval maturation rate when temperature was raised from 21°C to 31°C
Chironomus Plumosus	Largest number of emerging adults 23°C		
Chironomous hiparius			Adult midge larger when larvae raised @ 10°C than @ 20°C
Chironomidae		Most die at 35° C after an exposure of 13 to 16 hrs.	
Tendipedidae		Upper limit of 30°C to 33°C	

TABLE 5.1-3 (contd.)

Organism	Range or Optimum	Upper-Lethal	Misc. Temperature Response
Tendipedidae		22-hr LD_{50}	
Tanytarsus		29.2°C	
Prodiamesa		30.2°C	
Anatopynia		30.7,39.1°C	
Chironomous		34.8-35.8°C	
Ephemeroptera (Mayfly)			At 26°C to 28°C emergence not affected
Plecoptera (Stonefly)	10.1° - 15.7°C Optimum temperature		When temperature rose above 15.7°C stoneflies became sensitive to low dissolved oxygen levels
Pteronarcys sp (Dorsata)	Egg production optimum at 15°C		
Pteronarcys californica			Emerged 6 months earlier when maintained at a constant temperature of 18°C
Pteronarcys dorsata	Emergence optimum at 15°C		Early emergency of a species seemed to correlate with warmer water
Trichoptera Hydropsychidae (Caddisfly)	Emergence temperature 11° - 12°C		Caddisflies emerged two weeks earlier in heated zones of Columbia River as compared with area upstream of the discharge
Trichoptera	"Warm Water" Streams - well distributed up to 95°F (35°C) greatest diversity at 28°C		
Simulidae			Pupae development 2.7 to 7.2 day @ 10.4° C - 23.6°C
Arachnoidea Hydracarina limnesia			Found similar sized samples From both inflowing water of power station (22.8°C) and outflowing (31.3°C) - apparently alive and unharmed
Riffle Macro-Invertebrates (Delaware River)		Tolerance Limit less than 32.5°C	
Ichthyophthirius multifilis (Skin parasite of freshwater fish)	Favorable temp 20° - 25°C		
Chondrococcus columnaris	Closely related to temp above 13°C		

TABLE 5.1-4

CRITICAL TEMPERATURES FOR SELECTED SALMONIDS[a]

Species	Acclimation Temperature (°C)	Upper Lethal Limit [b] (°C)	Lower Lethal Limit (°C)
Chinook	5	21.5	-
	10	24.3	0.8
	15	25.0	2.5
	20	25.1	4.5
	24	25.1	-
Chum	5	21.8	-
	10	22.6	0.5
	15	23.1	4.7
	20	23.7	6.5
	23	23.8	7.3
Coho	5	22.9	0.2
	10	23.7	1.7
	15	24.3	3.5
	20	25.0	4.5
	23	25.0	6.4

(a) Source: Reference 5.1-24.

(b) Limits are 50 percent mortality at one week exposure. Ultimate upper lethal limits (the highest temperature regardless of acclimation temperature) are: chinook = 25.1°C, coho = 25.0°C, chum = 23.8°C.

TABLE 5.1-5

ACCEPTABLE PHYSIOLOGICAL LIMITS FOR
REPRESENTATIVE THERMALLY SENSITIVE SPECIES[a]

Acclimation Temperature (°C)	Upper Acceptable Physiological Limit (°C)	Lower Acceptable Physiological Limit (°C)
5	20.5	1.2
10	21.6	2.7
15	22.1	5.7
20	22.7	7.5
23	22.8	8.3

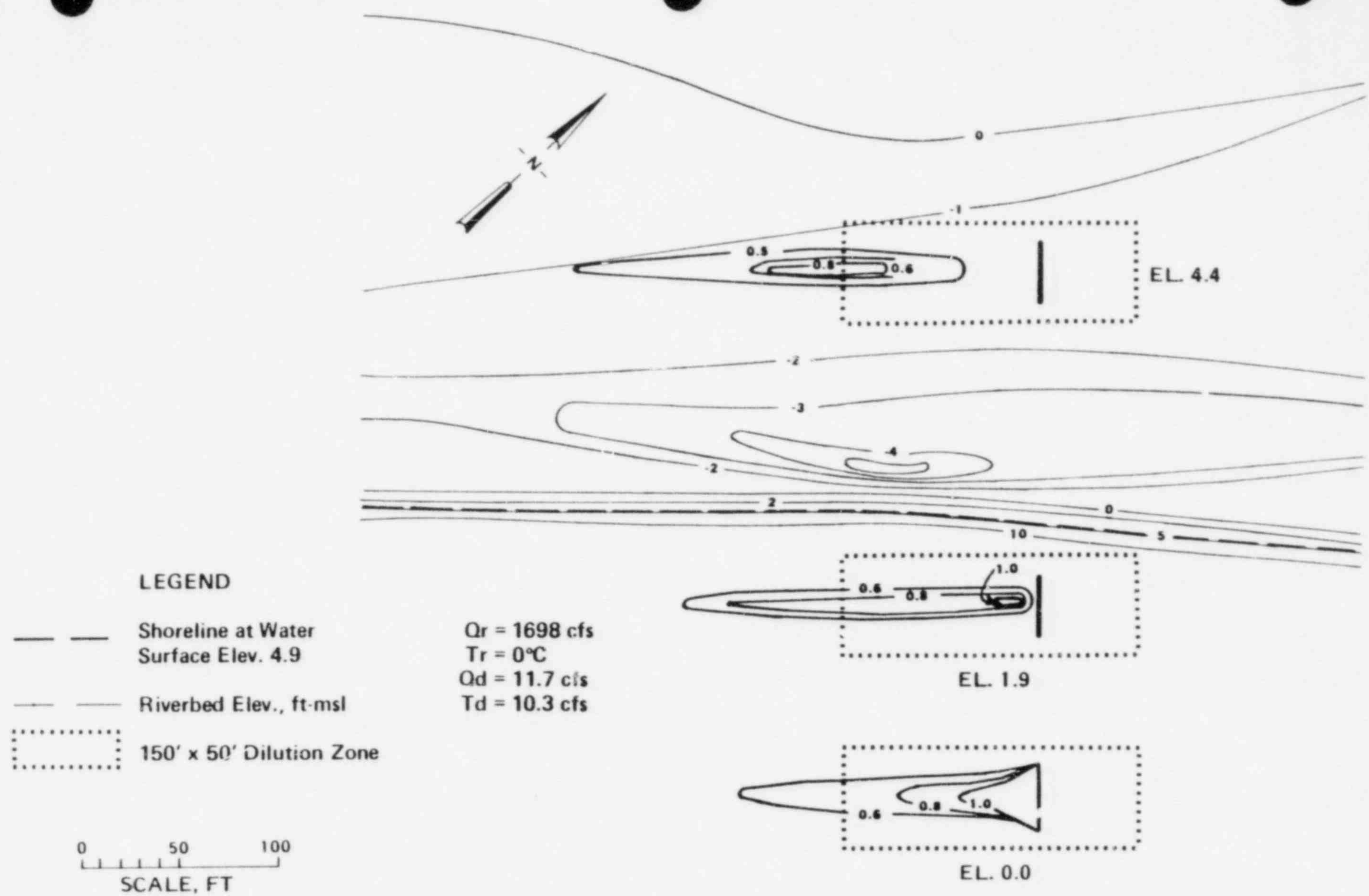
(a) Acceptable physiological limit is defined as the temperature at which no mortalities or other significant adverse effects would be expected in the dilution zone. To obtain these limits, a 1°C safety margin was applied to the upper or lower lethal limit of the least tolerant of the three species (tolerance varies with acclimation temperature) in Table 5.1-4.

TABLE 5.1-6

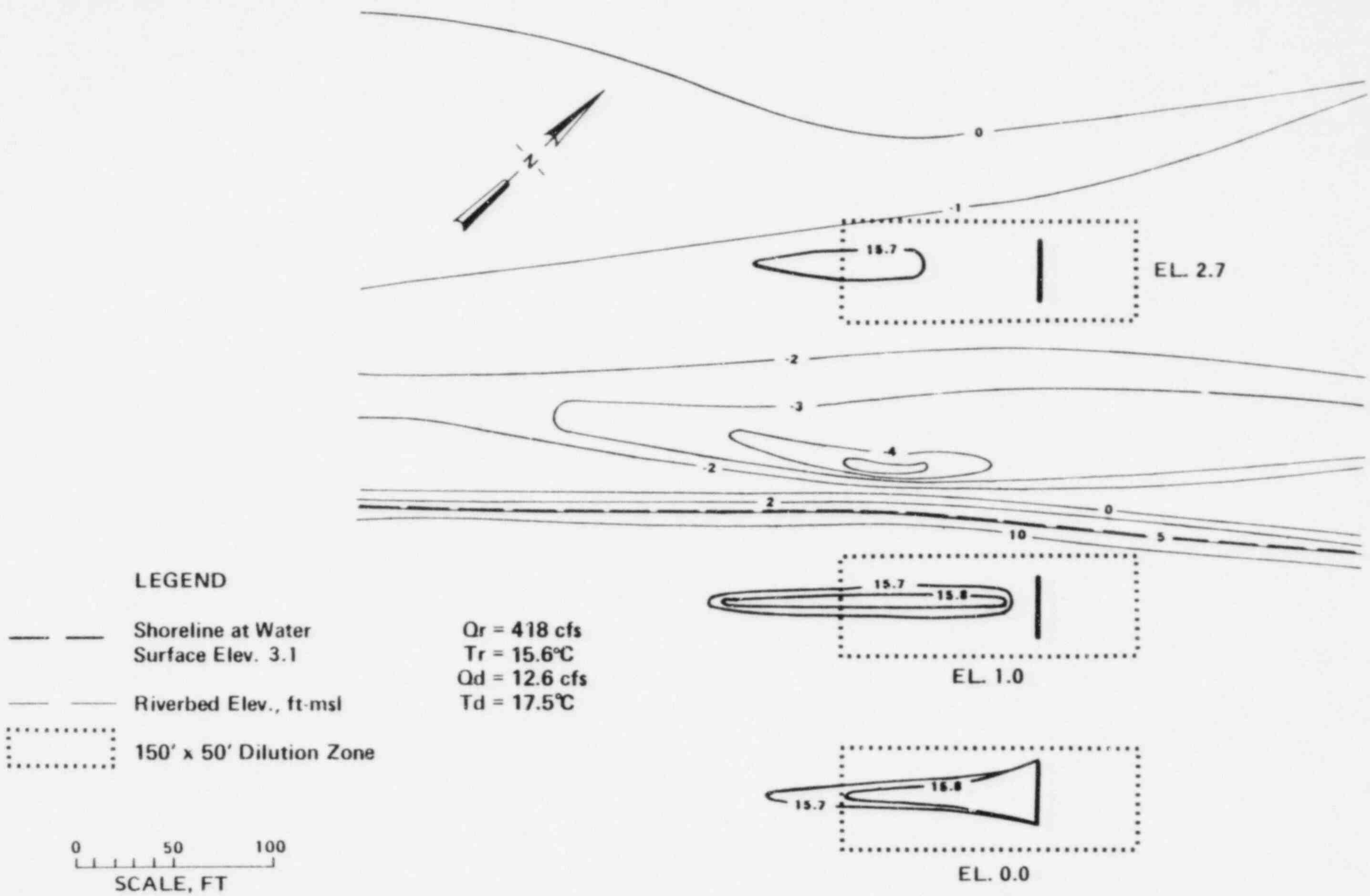
FREQUENCY OF COOLING TOWER PLUME LENGTHS VS. DIRECTION[(a)]

Direction From Towers	Distances (km) from Towers 1	2	3	4	5	6	7
S	20	18	14	10	5	3	0
SSW	37	32	24	11	7	3	0
SW	197	142	59	32	15	8	0
WSW	242	153	67	23	11	9	0
W	158	100	47	17	8	4	0
WNW	224	134	48	18	10	5	0
NW	166	103	39	15	8	3	0
NNW	107	73	27	13	8	4	0
N	185	108	40	11	6	2	0
NNE	206	93	28	9	6	3	0
NE	191	75	24	8	4	3	0
ENE	187	58	17	6	5	2	0
E	56	26	16	8	5	3	0
ESE	12	10	8	6	4	2	0
SE	13	11	8	6	4	2	0
SSE	9	8	7	4	3	2	0
Total Hrs	2,010	1,144	473	197	109	58	0

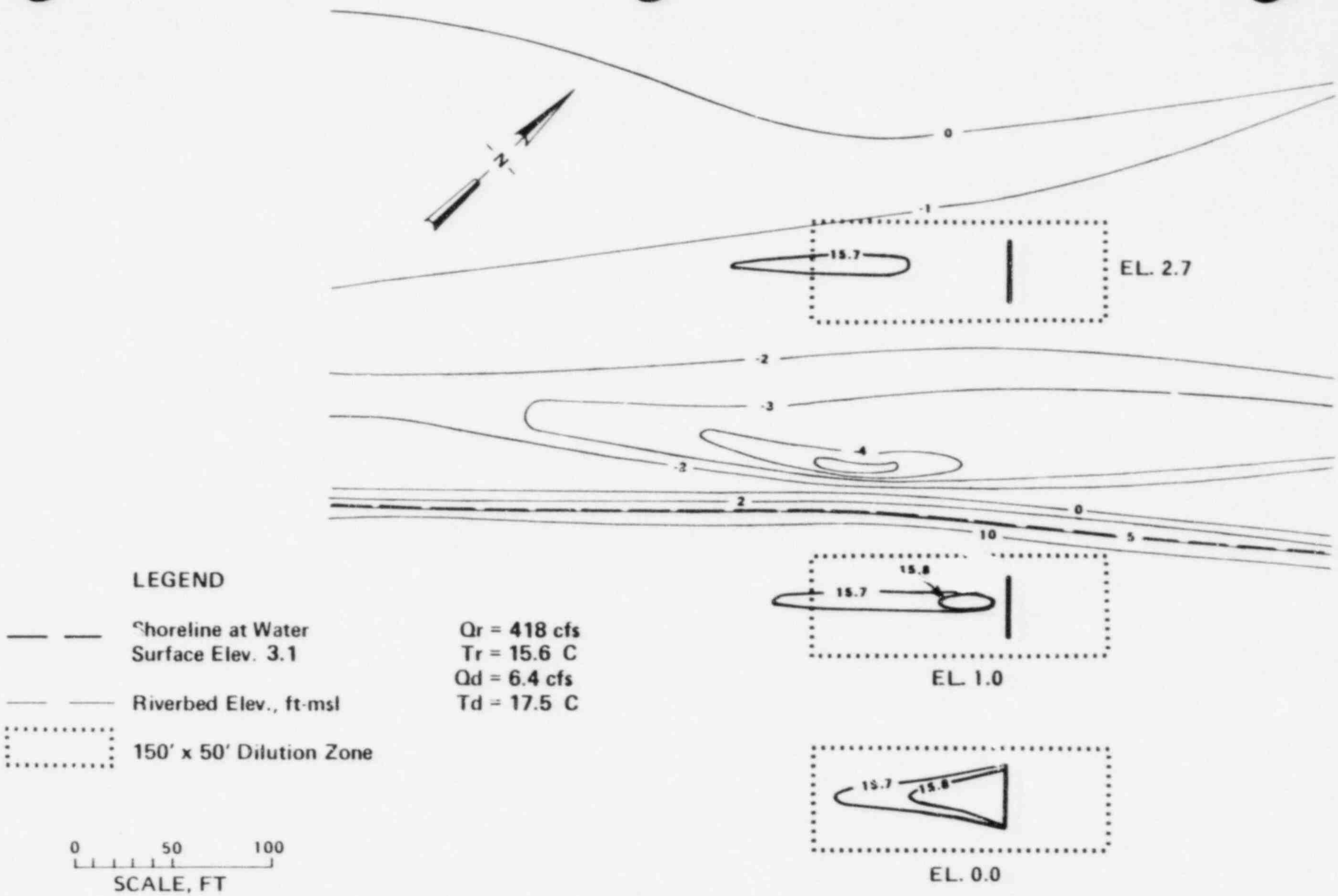
(a) Frequency (hr/yr) that a visible vapor plume equals or exceeds indicated distance.



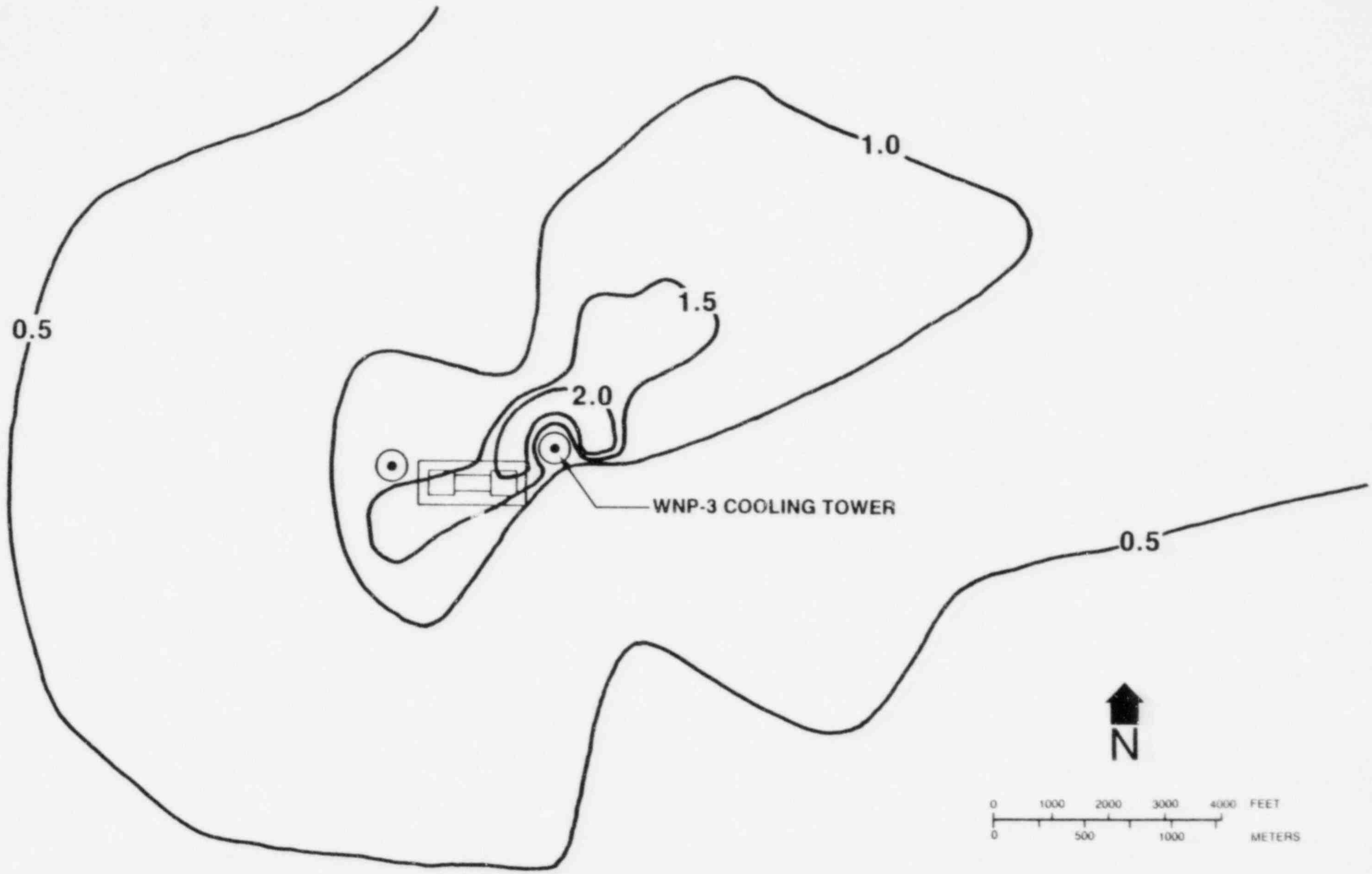
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	BLOWDOWN PLUME ISOTHERMS (^{o}C) IN JANUARY WITH TWO-UNIT OPERATION	FIGURE 5.1-1



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	BLOWDOWN PLUME ISOTHERMS ($^{\circ}C$) IN AUGUST WITH TWO-UNIT OPERATION	FIGURE 5.1-2



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	BLOWDOWN PLUME ISOTHERMS (^{o}C) IN AUGUST WITH TWO-UNIT OPERATION	FIGURE 5.1-3



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OP[illegible]ATING LICENSE ENVI[illegible]MENTAL REPORT	PREDICTED COOLING TOWER DRIFT DEPOSITION PATTERN (LB/AC)	FIGURE 5.1-4

5.2 RADIOLOGICAL IMPACT OF ROUTINE OPERATION

Radioactive materials are routinely generated in nuclear plants. The WNP-3 radwaste treatment system described in Section 3.5 is designed to maximize recycle and retention of radioactive wastes such that routine releases are not anticipated. In this section potential, or hypothetical, radionuclide releases and exposure pathways are identified and evaluated to assure plant operation within the design criteria of 10 CFR Part 50, Appendix I, and applicable limits of 10 CFR Part 20.

5.2.1 Exposure Pathways

The potential exposure paths considered in evaluating the impacts of WNP-3 include releases to the atmosphere as a gas or vapor and release to the river. Radionuclides released to the atmosphere would be primarily noble gases, which would not be taken up by vegetation or animals. However, any radioiodine and particulates released may be deposited on or taken up by vegetation, from which they may enter into a food chain.

Radionuclides in liquid effluents would be available for uptake in algae and other water plants, fish, clams, and crustaceans living in the river. Radionuclides may be accumulated by these organisms to concentrations greater than in the surrounding water. Predators of the more simple organisms, such as small animals, fish and birds, may concentrate these nuclides still further. In addition, some radionuclides may be deposited with the silt on the river bottom and shoreline and lead to external exposure of biota; Figure 5.2-1 illustrates generalized exposure pathways to biota.

Radionuclides in liquid effluents can reach man through a variety of pathways, involving both external exposure and internal exposure. Possible pathways of external exposure include such activities as swimming, boating and skiing on waters downstream from the plant, also hiking, fishing, etc., along the river shore. Pathways leading to internal exposure include the consumption of drinking water, fish and waterfowl from the river, produce from gardens irrigated with river water, and animal products such as meat, eggs and milk from animals which eat irrigated feed or pasture grass.

Exposure via the airborne pathways includes both external exposure to skin and total body from the noble gases and internal exposure from inhalation of tritium, radioiodines and particulates released from the plant. Also, internal exposures may be received from the consumption of foods produced from vegetation on which radionuclides of plant origin may be deposited. Such foods include fresh leafy vegetables from local gardens and milk from cows foraging pasture grass. In addition, direct exposure may be received from the transportation of fuel and radioactive wastes outside the plant boundary and from the plant itself. Figure 5.2-2 shows generalized exposure pathways to man.

5.2.2 Radioactivity in the Environment

Radionuclide quantities in liquid and gaseous effluents are listed in Tables 3.5-6 and 3.5-9, respectively. Concentration of the important radionuclides in the liquid effluent, based on an average annual cooling system blowdown of 6 cfs, are provided in Table 5.2-1. Table 5.2-1 also lists the concentrations after full mixing in the Chehalis River (assuming average annual river flow of 6600 cfs).

The concentrations of gaseous releases at the plant vents and six critical locations on the exposure pathways are listed in Table 5.2-2. These concentrations were determined using the methodology of Regulatory Guide 1.111[1] and computer code XOQDOQ.[2] Table 5.2-3 is summary of the relative concentrations (X/Q in sec/m^3) for each sector at distance intervals out to 50 miles from the plant site. Table 5.2-4 provides the relative annual deposition (D/Q in Ci/m^2-yr) factors for each direction and distance sector.

5.2.3 Dose Rate Estimates For Biota Other Than Man

Potential doses to biota other than man are estimated for the liquid pathway using the NRC LADTAP Code.[3] All liquid effluents will be filtered prior to discharge. Hence, sedimentation and exposure due to sediments is negligible. Table 5.2-5 summarizes the dose received by several types of biota living in or near the Chehalis River from liquid effluents.

Animals such as deer, coyotes, and field mice that do not consume aquatic food or spend much time near the rivershore will receive their radiation exposure through direct radiation from the plant's gaseous effluent plume, inhalation, ingestion of terrestrial vegetation, and external doses to exposure from contaminated ground. The total dose received from all of these pathways will be very small. An animal such as a deer, spending 50 per cent of its time at the river near the plant, would receive an annual dose of less than 0.5 mrad/year from external radiation. Additional exposure would be received from inhalation and ingestion. However, the total annual dose from all pathways would still be less than 1.0 mrad/year.

Studies at the Department of Energy's Hanford Reservation have shown that irradiation of salmon eggs at a rate of 500 mrad/day did not affect the number of adult fish returning from the ocean or their ability to spawn.[4] When all the Hanford production reactors, with single-pass cooling, were operating, studies were made on the effect of the released radionuclides on spawning salmon. These studies have shown no discernible effect to these salmon by dose rates in the range of 100 to 200 mrad/-week.[5] The estimated doses to biota from WNP-3 effluents will be orders of magnitude less than the doses experienced by biota from operation of the Hanford production reactors. Considering that no distinguishable effect on the biota from radiation was observed during operation of those reactors over many years, no perceptible effect from WNP-3 operation is expected.

5.2.4 Dose Rate Estimates For Man

Estimated doses to the population within 50 miles of WNP-3 and to individuals subject to maximum exposure because of their place of residence or life-style were calculated using the methodology of Regulatory Guides 1.109[6] and 1.111,[1] and NRC Codes XOQDOQ,[2] LADTAP[3] and GASPAR.[7] Detail on the calculation model input parameters is included in Appendix B. These input parameters are summarized in Tables 5.2-6 and 5.2-7 for the liquid and gaseous pathways, respectively. Table 5.2-8 summarizes the annual radiation doses to an individual from WNP-3 effluents included in Tables 5.2-1 and 5.2-2. Table 5.2-9 provides the estimates of doses to the general population.

5.2.4.1 Liquid Pathways

People may be exposed to the radioactive material in the liquid effluent by drinking water, eating fish, eating irrigated farm products and by participating in recreational activities on or along the Chehalis River.

Although there is no drinking water withdrawal downstream, it was assumed, for calculation purposes, that a household located 2 miles downstream of the discharge withdraws drinking water from the Chehalis River. The postulated doses are listed in Table 5.2-8 and were obtained using the LADTAP Code.[3]

Because fish will concentrate most radionuclides from the water they inhabit, the potential radiation dose from consumption of Chehalis River fish was estimated for both an individual and the general population within 50 miles of the plant. The dose to an individual by this pathway is included in Table 5.2-8. The dose potentially received from consumption of waterfowl which had consumed contaminated fish or aquatic plants is considered negligible.

Swimming, boating, and picnicking along the shores of the Chehalis River downstream of the Site could result in very small doses to the local population. Doses to individuals from these activities and the irrigated foodstuff pathway are included in Table 5.2-8.

5.2.4.2 Gaseous Pathways

People may be exposed to radioactive material released to the atmosphere via inhalation, external radiation and ingestion of farm products. The maximum ground level concentration at the nearest residence offsite is approximately 1.0 mile from the plant in the north sector.

An individual living at the nearest resident (1.0 mi N) would potentially receive a very small dose due to inhalation of tritium, radioiodines and particulates as well as absorption of tritium through the skin. This dose is included in Table 5.2-8. All other dose estimates to people offsite would be less than this estimate.

External radiation from the plume or ground contamination would contribute an additional very small dose to the individual as shown in Table 5.2-8.

Radiation doses potentially received from ingestion of foodstuffs contaminated with radionuclides deposited on the soil or foliage were calculated using the GASPAR Code.[7] Food products considered in the analysis were vegetables, meat, cow milk and goat milk. Factors necessary to calculate the transfer of radionuclide from air to ground or foliage, foliage to animal, and animal to meat or milk are given in Appendix B. The individual dose potentially received from farm products is included in Table 5.2-8.

5.2.4.3 Direct Radiation From Facility

Direct radiation from the reactor facilities to individuals beyond the site boundary is extremely low and does not add measurably to doses estimated in Subsections 5.2.4.1 and 5.2.4.2. The nearest residences are one mile from the plant in the N and NNW sections. The nearest significant public facilities are in Elma about four miles northwest.

5.2.4.4 Annual Population Doses From Liquid and Gaseous Effluents

Using the GASPAR and LADTAP computer codes, the population total body and thyroid doses to the people living within an approximate 50-mile radius were calculated for several pathways. The population distribution for the year 2000 (see Table 2.1-2) was used in the calculations. Other input parameters are shown in Appendix B. Table 5.2-9 lists the calculated annual thyroid and total body doses to the population within 50 miles of the site. Dose received by the population beyond 50 miles would be an immeasurable increment to the dose already received from natural background radiation. Table 5.2-10 compares the population dose from WNP-3 with doses attributable to other sources.

5.2.5 Summary of Annual Radiation Doses

The estimated individual and population doses attributable to the operation of WNP-3 are given in Tables 5.2-8 and 5.2-9, respectively. Individual doses are within the design objectives of 10 CFR Part 50, Appendix I, shown in Table 5.2-11.

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TABLE 5.2-1

LIQUID RADIONUCLIDE RELEASES

Radionuclide	WNP-3 Annual Release (Ci/yr)	Concentration (uCi/ml) at: Discharge Point[a]	Chehalis River[b]
H-3	1.1E+02	2.0E-05	1.9E-08
Cr-51	6.7E-04	1.2E-10	1.1E-13
Mn-54	2.2E-04	4.1E-11	3.7E-14
Fe-55	5.9E-04	1.1E-10	1.0E-13
Fe-59	3.6E-04	6.7E-11	6.1E-14
Co-58	6.2E-03	1.1E-12	1.1E-12
Co-60	1.6E-03	3.0E-10	2.7E-13
Zr-95	1.6E-04	3.0E-11	2.7E-14
Nb-95	2.2E-04	4.1E-11	3.7E-14
Np-239	3.1E-04	5.8E-11	5.2E-14
Br-83	4.0E-05	7.4E-12	6.8E-15
Rb-86	5.0E-05	9.3E-12	8.5E-15
Sr-89	1.3E-04	2.4E-11	2.2E-14
Sr-91	5.5E-05	9.3E-12	8.5E-15
Y-91M	3.0E-05	5.6E-12	5.1E-15
Y-91	2.0E-05	3.7E-12	3.4E-15
Mo-99	2.3E-02	4.3E-09	3.9E-12
Tc-99M	2.1E-02	3.9E-09	3.6E-12
Ru-103	3.0E-05	5.6E-12	5.1E-15
Rh-103M	2.0E-05	3.7E-12	3.4E-15
Ru-106	2.4E-04	4.5E-11	4.1E-14
Ag-110M	4.0E-05	7.5E-12	6.8E-15
Te-127M	1.0E-04	1.9E-11	1.7E-14
Te-127	1.4E-04	2.6E-11	2.4E-14
Te-129M	5.0E-04	9.3E-11	8.5E-14
Te-129	3.2E-04	6.0E-11	5.5E-14
I-130	2.2E-04	4.1E-11	3.7E-14
Te-131M	5.0E-04	9.3E-11	8.5E-14
Te-131	9.0E-05	1.7E-11	1.5E-14
I-131	9.1E-02	1.7E-08	1.5E-11
Te-132	7.6F-03	1.4E-09	1.3E-12
I-132	8.6E-03	1.6E-09	1.5E-12
I-133	6.2E-02	1.2E-08	1.0E-11
I-134	2.0E-02	3.7E-09	3.3E-12
Cs-134	2.3E-02	4.2E-02	3.9E-12
I-135	9.7E-03	1.8E-09	1.6E-12
Cs-136	7.0E-03	1.3E-09	1.2E-12
Cs-137	1.8E-02	3.4E-09	3.0E-12
Ba-137M	1.5E-02	2.8E-09	2.5E-12

TABLE 5.2-1 (contd.)

Radionuclide	WNP-3 Annual Release (Ci/yr)	Concentration (uCi/ml) at: Discharge Point[a]	Chehalis River[b]
Ba-140	7.0E-05	1.3E-11	1.2E-14
La-140	6.0E-05	1.1E-11	1.0E-14
Ce-141	2.0E-05	3.7E-12	3.4E-15
Pr-143	2.0E-05	3.7E-12	3.4E-15
Ce-144	5.3E-04	9.9E-11	9.0E-14
Pr-144	1.0E-05	1.9E-12	1.7E-15

(a) Average discharge flow of 6 cfs.

(b) River dilution factor of 1:1100 based on average river flow of 6600 cfs.

TABLE 5.2-2

GASEOUS RADIONUCLIDE RELEASES

Radionuclide	WNP-3 Annual Release (Ci)	Concentration (μCi/cc)[a] Restricted Area Boundary	Vegetable Garden	Milk Cow	Milk Goat	Meat Cattle	North Resident
H-3	1.4E+03	1.8E-10	3.6E-11	1.0E-10	6.2E-11	1.2E-10	1.3E-10
C-14	8.0E+00	1.0E-12	2.1E-13	5.8E-13	3.5E-13	7.1E-13	3.5E-13
Ar-41	2.5E+01	3.2E-12	6.5E-13	1.8E-12	1.1E-12	2.2E-12	2.4E-12
Kr-83m	2.0E+00	2.5E-13	5.2E-14	1.5E-13	8.7E-14	1.8E-13	1.9E-13
Kr-85m	1.7E+01	2.2E-12	4.4E-13	1.2E-12	7.5E-13	1.5E-12	1.6E-12
Kr-85	2.7E+02	3.4E-11	7.0E-12	2.0E-11	1.2E-11	2.4E-11	2.6E-11
Kr-87	5.0E+00	6.3E-13	1.3E-13	3.6E-13	2.2E-13	4.4E-13	4.7E-13
Kr-89	2.6E+01	3.3E-12	6.7E-13	1.9E-12	1.2E-12	2.3E-12	2.5E-12
Xe-131m	5.0E+00	6.3E-13	1.3E-13	3.6E-13	2.2E-13	4.4E-13	4.7E-13
Xe-133	2.7E+01	3.4E-12	7.0E-13	2.0E-12	1.2E-12	2.4E-12	2.6E-12
Xe-135m	1.3E+03	1.6E-10	3.4E-11	9.5E-11	5.8E-11	1.2E-10	1.2E-10
Xe-137	6.5E+01	8.2E-12	1.7E-12	4.7E-12	2.9E-12	5.8E-12	6.2E-12
Xe-138	3.0E+00	3.8E-13	7.8E-14	2.2E-13	1.3E-13	2.7E-13	2.8E-13
I-131	5.8E-02	7.3E-15	1.5E-15	4.2E-15	2.6E-15	5.1E-15	5.5E-1[illegible]
I-133	6.7E-02	8.5E-15	1.7E-15	4.9E-15	3.0E-15	5.9E-15	6.4E-15
Mn-54	4.4E-04	5.6E-17	1.1E-17	3.2E-17	1.9E-17	3.9E-17	4.2E-17
Fe-59	1.5E-04	1.9E-17	3.9E-18	1.1E-17	6.6E-18	1.3E-17	1.4E-17
Co-58	1.5E-03	1.9E-16	3.9E-17	1.1E-16	6.6E-17	1.3E-16	1.4E-16
Co-60	6.7E-04	8.5E-17	1.7E-17	4.9E-17	3.0E-17	5.9E-17	6.4E-17
Sr-89	3.3E-05	4.2E-18	8.6E-19	2.4E-18	1.5E-18	2.9E-18	3.1E-18
Cs-134	4.4E-04	5.6E-17	1.1E-17	3.2E-17	1.9E-17	3.9E-17	4.2E-17
Cs-137	7.4E-04	9.4E-17	1.9E-17	5.4E-17	3.3E-17	6.5E-17	7.0E-17

(a) Based on χ/Q values:

Restricted area boundary	- 4.0E-06 sec/m^3
Vegetable garden	- 8.2E-07 sec/m^3
Milk cow	- 2.3E-06 sec/m^3
Milk goat	- 1.4E-06 sec/m^3
Meat cattle	- 2.8E-06 sec/m^3
Resident (north)	- 3.0E-06 sec/m^3

TABLE 5.2-3

AVERAGE ANNUAL DISPERSION FACTORS (CHI/Q in sec/m^3)

No Decay, Undepleted

Distance (miles)

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	3.461E-06	1.171E-06	5.738E-07	3.648E-07	2.636E-07	1.419E-07	6.053E-08	3.219E-08	2.134E-08	1.573E-08
SSW	3.717E-06	1.270E-06	6.185E-07	3.958E-07	2.846E-07	1.530E-07	6.514E-08	3.459E-08	2.291E-08	1.688E-08
SW	3.795E-06	1.347E-06	6.711E-07	4.190E-07	3.002E-07	1.573E-07	6.452E-08	3.329E-08	2.168E-08	1.577E-08
WSW	3.649E-06	1.326E-06	6.517E-07	4.114E-07	2.330E-07	1.512E-07	6.054E-08	3.067E-08	1.974E-08	1.424E-08
W	3.[illegible]E-06	1.302E-06	6.3[illegible]E-07	4.031E-07	2.875E-07	1.492E-07	6.031E-08	3.078E-08	1.991E-08	1.441E-08
WNW	3.035E-06	1.071E-06	5.374E-07	3.407E-07	2.437E-07	1.269E-07	5.156E-08	2.640E-08	1.710E-08	1.240E-08
NW	3.421E-06	1.234E-06	6.096E-07	3.869E-07	2.768E-07	1.439E-07	5.831E-08	2.978E-08	1.926E-08	1.395E-08
NNW	3.694E-06	1.325E-06	6.602E-07	4.210E-07	3.018E-07	1.571E-07	6.371E-08	3.255E-08	2.105E-08	1.523E-08
N	4.773E-06	1.755E-06	8.741E-07	5.541E-07	3.961E-07	2.035E-07	8.087E-08	4.064E-08	2.601E-08	1.867E-08
NNE	8.497E-06	3.165E-06	1.555E-06	9.760E-07	6.899E-07	3.489E-07	1.354E-07	6.686E-08	4.233E-08	3.017E-08
NE	4.611E-06	1.711E-06	8.430E-07	5.306E-07	3.760E-07	1.910E-07	7.466E-08	3.706E-08	2.355E-08	1.682E-08
ENE	3.076E-06	1.122E-06	5.530E-07	3.495E-07	2.488E-07	1.279E-07	5.094E-08	2.567E-08	1.647E-08	1.185E-08
E	3.060E-06	1.095E-06	5.419E-07	3.439E-07	2.460E-07	1.279E-07	5.185E-08	2.650E-08	1.715E-08	1.242E-08
ESE	2.312E-06	8.240E-07	4.056E-07	2.573E-07	1.839E-07	9.556E-08	3.868E-08	1.975E-08	1.277E-08	9.247E-09
SE	2.134E-06	7.524E-07	3.680E-07	2.332E-07	1.672E-07	8.790E-08	3.624E-08	1.878E-08	1.226E-08	8.939E-09
SSE	2.372E-06	8.182E-07	3.985E-07	2.531E-07	1.824E-07	9.747E-08	4.116E-08	2.172E-08	1.434E-08	1.053E-08

2.26 Day Decay, Undepleted

Distance (miles)

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	3.427E-06	1.157E-06	5.544E-07	3.477E-07	2.478E-07	1.285E-07	5.003E-08	2.360E-08	1.401E-08	9.313E-09
SSW	3.675E-06	1.243E-06	5.969E-07	3.747E-07	2.670E-07	1.301E-07	5.342E-08	2.502E-08	1.475E-08	9.748E-09
SW	3.748E-06	1.329E-06	6.394E-07	4.030E-07	2.828E-07	1.428E-07	5.339E-08	2.436E-08	1.415E-08	9.255E-09
WSW	3.618E-06	1.304E-06	6.331E-07	3.980E-07	2.781E-07	1.389E-07	5.122E-08	2.324E-08	1.350E-08	8.842E-09
W	3.572E-06	1.278E-06	6.150E-07	3.838E-07	2.718E-07	1.361E-07	5.024E-08	2.269E-08	1.309E-08	8.510E-09
WNW	3.007E-06	1.068E-06	5.195E-07	3.240E-07	2.284E-07	1.142E-07	4.184E-08	1.865E-08	1.061E-08	6.809E-09
NW	3.384E-06	1.207E-06	5.875E-07	3.673E-07	2.589E-07	1.291E-07	4.709E-08	2.088E-08	1.184E-08	7.568E-09
NNW	3.652E-06	1.298E-06	6.347E-07	3.984E-07	2.811E-07	1.401E-07	5.087E-08	2.241E-08	1.262E-08	8.023E-09
N	4.727E-06	1.722E-06	8.461E-07	5.305E-07	3.735E-07	1.851E-07	6.717E-08	2.990E-08	1.709E-08	1.104E-08
NNE	8.414E-06	3.110E-06	1.510E-06	9.366E-07	6.542E-07	3.202E-07	1.144E-07	5.056E-08	2.890E-08	1.873E-08
NE	4.571E-06	1.682E-06	8.189E-07	5.055E-07	3.568E-07	1.755E-07	6.323E-08	2.813E-08	1.615E-08	1.049E-08
ENE	3.048E-06	1.102E-06	5.364E-07	3.349E-07	2.355E-07	1.170E-07	4.272E-08	1.917E-08	1.103E-08	7.172E-09
E	3.030E-06	1.077E-06	5.240E-07	3.280E-07	2.314E-07	1.159E-07	4.266E-08	1.918E-08	1.102E-08	7.147E-09
ESE	2.282E-06	8.092E-07	3.933E-07	2.464E-07	1.740E-07	8.732E-08	3.241E-08	1.475E-08	8.571E-09	5.617E-09
SE	2.113E-06	7.377E-07	3.560E-07	2.226E-07	1.575E-07	7.980E-08	3.000E-08	1.375E-08	8.017E-09	5.259E-09
SSE	2.345E-06	7.946E-07	3.832E-07	2.306E-07	1.700E-07	8.701E-08	3.304E-08	1.516E-08	8.795E-09	5.731E-09

TABLE 5.2-3 (Continued)

8 Day Decay, Depleted

Distance (miles)

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	3.043E-06	1.102E-06	4.612E-07	2.811E-07	1.960E-07	9.783E-08	3.598E-08	1.631E-08	9.501E-09	6.249E-09
SSW	3.322E-06	1.573E-06	4.969E-07	3.033E-07	2.114E-07	1.054E-07	3.843E-08	1.745E-08	1.013E-08	6.645E-09
SW	3.382E-06	1.142E-06	5.315E-07	3.239E-07	2.233E-07	1.036E-07	3.839E-08	1.685E-08	9.621E-09	6.233E-09
WSW	3.241E-06	1.126E-06	5.246E-07	3.177E-07	2.184E-07	1.048E-07	3.628E-08	1.569E-08	8.887E-09	5.730E-09
W	3.221E-06	1.105E-06	5.137E-07	3.110E-07	2.141E-07	1.032E-07	3.597E-08	1.561E-08	8.855E-09	5.708E-09
WNW	2.715E-06	9.553E-07	4.318E-07	2.624E-07	1.810E-07	8.743E-08	3.052E-08	1.323E-08	7.480E-09	4.805E-09
NW	3.056E-06	1.046E-06	4.896E-07	2.978E-07	2.055E-07	9.987E-08	3.447E-08	1.489E-08	8.403E-09	5.388E-09
NNW	3.235E-06	1.126E-06	5.255E-07	3.237E-07	2.238E-07	1.080E-07	3.754E-08	1.619E-08	9.119E-09	5.835E-09
N	[illegible]	1.465E-06	7.629E-07	4.282E-07	2.947E-07	1.407E-07	4.822E-08	2.062E-08	1.158E-08	7.408E-09
NNE	7.542E-06	2.586E-06	1.252E-06	7.576E-07	5.142E-07	2.419E-07	8.117E-08	3.418E-08	1.904E-08	1.212E-08
NE	4.115E-06	1.452E-06	6.786E-07	4.008E-07	2.803E-07	1.325E-07	4.478E-08	1.897E-08	1.061E-08	6.774E-09
ENE	2.748E-06	9.521E-07	4.449E-07	2.638E-07	1.954E-07	8.858E-08	3.045E-08	1.308E-08	7.369E-09	4.730E-09
E	2.734E-06	9.319E-07	4.356E-07	2.651E-07	1.829E-07	8.829E-08	3.081E-08	1.337E-08	7.570E-09	4.873E-09
ESE	2.057E-06	6.932E-07	3.263E-07	1.985E-07	1.370E-07	6.612E-08	2.310E-08	1.005E-08	5.715E-09	3.692E-09
SE	1.946E-06	6.382E-07	2.949E-07	1.798E-07	1.244E-07	6.070E-08	2.156E-08	9.506E-09	5.443E-09	3.534E-09
SSE	2.119E-06	6.936E-07	3.159E-07	1.947E-07	1.353E-07	6.695E-08	2.426E-08	1.084E-08	6.248E-09	4.071E-09

TABLE 5.2-4

AVERAGE ANNUAL DEPOSITION FACTORS (D/Q, rel. dep./m^2)

Ground Level Release

Distance (miles)

DIRECTION FROM SITE	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.993E-11	7.898E-12	4.217E-12	2.610E-12
SSW	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7.141E-11	2.215E-11	8.777E-12	4.687E-12	2.901E-12
SW	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.376E-11	1.338E-11	7.146E-12	4.423E-12
WSW	7.593E-09	2.372E-09	[illegible]	[illegible]	[illegible]	1.411E-10	4.375E-11	1.734E-11	9.260E-12	5.732E-12
W	[illegible]	[illegible]	[illegible]	[illegible]	2.980E-10	[illegible]	3.979E-11	1.573E-11	8.402E-12	5.201E-12
WNW	[illegible]	1.510E-09	[illegible]	3.283E-10	2.037E-10	8.963E-11	2.779E-11	1.102E-11	5.882E-12	3.641E-12
NW	[illegible]	[illegible]	[illegible]	3.449E-10	[illegible]	9.413E-11	2.919E-11	1.157E-11	6.178E-12	3.824E-12
NNW	4.689E-09	1.448E-09	[illegible]	[illegible]	[illegible]	8.599E-11	2.666E-11	1.057E-11	5.643E-12	3.493E-12
N	8.418E-09	[illegible]	[illegible]	[illegible]	3.595E-10	1.544E-10	4.788E-11	1.898E-11	1.013E-11	6.272E-12
NNE	[illegible]	6.565E-09	[illegible]	[illegible]	9.073E-10	3.897E-10	1.208E-10	4.790E-11	2.558E-11	1.583E-11
NE	1.034E-08	3.348E-09	1.332E-09	[illegible]	4.627E-10	1.987E-10	6.163E-11	2.443E-11	1.304E-11	8.074E-12
ENE	[illegible]	[illegible]	7.391E-10	[illegible]	2.567E-10	1.103E-10	3.419E-11	1.355E-11	7.237E-12	4.480E-12
E	[illegible]	[illegible]	6.601E-10	3.607E-10	2.293E-10	9.848E-11	3.054E-11	1.210E-11	6.463E-12	4.000E-12
ESE	[illegible]	1.309E-09	5.211E-10	2.847E-10	1.810E-10	7.773E-11	2.411E-11	9.554E-12	5.102E-12	3.158E-12
SE	3.285E-09	1.015E-09	4.038E-10	2.207E-10	1.402E-10	6.024E-11	1.868E-11	7.404E-12	3.954E-12	2.447E-12
SSE	[illegible]	[illegible]	2.862E-10	[illegible]	9.941E-11	4.270E-11	1.324E-11	5.248E-12	2.802E-12	1.735E-12

TABLE 5.2-5

ANNUAL DOSE TO BIOTA FROM WNP-3 LIQUID EFFLUENTS

Biota	Dilution Factor	Dose (mrad/yr) Internal	External	Total
Fish	1/1100	8.8E-02	7.3E-02	1.6E-01
Invertebrate	1/1100	3.8E-01	1.5E-01	5.3E-01
Algae	1/1100	6.4E-02	3.6E-04	6.4E-02
Muskrat	1/1100	4.4E-01	4.9E-02	4.9E-01
Raccoon	1/1100	7.5E-02	3.7E-02	1.1E-01
Heron	1/1100	2.7E+00	4.9E-02	2.7E+00
Duck	1/1100	3.8E-01	7.3E-02	4.6E-01

TABLE 5.2-6

PARAMETERS TO CALCULATE MAXIMUM INDIVIDUAL DOSE FROM LIQUID EFFLUENTS

Drinking Water

River Dilution:	1100	
River Transit Time:[a]	1 hr	
Water Treatment and Delivery Time:	24 hrs	
Usage Factors:	Adult = 730 l/yr	Teenager = 510 l/yr
	Child = 510 l/yr	Infant = 570 l/yr

Fish

River Dilution:	1100	
Time to Consumption:	24 hours	
Usage Factors:	Adult = 21 kg/yr	Teenager = 16 kg/yr
	Child = 7 kg/yr	Infant = 0

Recreation

River Dilution:	1:1100	
Shoreline Width Factor:	0.2	
Usage Factors:	Shoreline Activities:	Adult = 12 hr/yr
		Teenager = 67 hr/yr
		Child = 14 hr/yr
		Infant = 0
	Swimming:	Adult = 40 hr/yr
		Teenager = 40 hr/yr
		Child = 40 hr/yr
	Boating:	Adult = 200 hr/yr
		Teenager = 40 hr/yr
		Child = 40 hr/yr
		Infant = 0

Irrigated Foodstuffs

River Dilution:	1100
River Transit Time:	12 hours

	Vegetables	Milk	Meat	Leafy Vegetable
Food Delivery Time:	24 hours	24 hours	24 hours	24 hours
Usage Factors:				
Adult	520 kg/yr	310 l/yr	110 kg/yr	64 kg/yr
Teenager	630 kg/yr	400 l/yr	65 kg/yr	42 kg/yr
Child	520 kg/yr	330 l/yr	41 kg/yr	26 kg/yr
Infant	0	330	0	0
Monthly Irrigation Rate:	110 l/m^2	110 l/m^2	110 l/m^2	110 l/m^2
Annual Yield:	1.1 kg/m^2	0.7 kg/m^2	0.7 kg/m^2	2.0 kg/m^2
Annual Growing Period:	70 days	365 days	365 days	70 days
Annual 50-mile Production:	2.5E+07 kg	1.5E+08 l	8.9E+06 kg	7.9E+05 kg

(a) Two miles downstream
(b) Assumed to be used for fishing

TABLE 5.2-7

PARAMETERS TO CALCULATE INDIVIDUAL AND POPULATION DOSES FROM GASEOUS EFFLUENTS

Meteorology

GASPAR (Reference 5.2-7) meteorological input from XOQDOQ (Reference 5.2-2) is shown in Tables 5.2-3 and 5.2-4.

Source Terms

GALE-Gaseous (Reference 3.5-1) output data shown in Table 5.2-2.

Demography

As shown in Table 2.1-2.

Usage Factors

Usage factors used in GASPAR code are listed in Table 5.2-6.

Transfer Factors

As given in Reference 5.2-7.

Dose Factors

Dose factors used in GASPAR code are as listed in Reg. Guide 1.109.

Foodstuff Production Within 50 Miles

Vegetation (Leafy Vegetables Included) 2.6E+07 kg/yr
Milk 1.5E+08 liters/yr
Meat 8.9E+06 kg/yr

TABLE 5.2-8

ESTIMATED MAXIMUM ANNUAL DOSE TO AN INDIVIDUAL FROM WNP-3

Pathway	Annual Exposure	Location	Dilution Factor	Annual Dose (mRem) to an Adult				
				Skin	Total Body	GI-LLI	Thyroid	Bone
Liquid								
Drinking Water	730 l	2.0 mile downstream	1/1100		2.3E-03	2.0E-03	2.1E-02	3.9E-04
Fish	21 kg	2.0 mile downstream	1/1100		3.0E-02	2.2E-03	9.4E-03	2.1E-02
Shoreline	12 hr	2.0 mile downstream	1/1100	2.3E-05	2.0E-05	2.0E-05	2.0E-05	2.0E-05
Food Products								
Vegetables	520 kg	2.0 mile downstream	1/1100		1.4E-03	1.3E-03	1.3E-03	1.1E-04
Leafy Vegetation	64 kg	2.0 mile downstream	1/1100		1.7E-04	1.6E-04	1.6E-04	1.3E-05
Milk	310 l	2.0 mile downstream	1/1100		9.5E-04	7.6E-04	3.4E-03	1.5E-04
Meat	110 kg	2.0 mile downstream	1/1100		2.9E-04	3.0E-04	3.5E-04	1.7E-05
			Total(a)	2.3E-05	3.5E-02	6.7E-03	3.6E-02	2.2E-02
Air								
Submersion	8766 hr	1.0 mile N	3.0E-06	1.6E-01	5.2E-02	5.2E-02	5.2E-02	5.2E-02
Inhalation	8000 m^3	1.0 mile N	3.0E-06	1.7E-01	1.7E-01	1.7E-01	2.4E-01	2.7E-04
Ground Contamination	8766 hr	1.0 mile N	3.0E-06	5.0E-03	4.3E-03	4.3E-03	4.3E-03	4.3E-03
Food Products								
Vegetables	520 kg	2.0 mile NW	8.2E-07	1.3E-01	1.3E-01	1.3E-01	1.5E-01	1.7E-01
Cow Milk	310 l	1.0 mile NNW	2.3E-06	1.4E-01	1.4E-01	1.4E-01	4.7E-01	2.2E-01
Infant(b)	330 l	1.0 mile NNW	2.3E-06	7.2E-01	7.2E-01	7.2E-01	3.2E+00	1.9E+00
Goat Milk	310 l	1.7 mile NE	1.4E-06	1.5E-01	1.5E-01	1.5E-01	5.2E-01	1.3E-01
Infant(b)	330 l	1.7 mile NE	1.4E-06	6.4E-01	6.4E-01	6.4E-01	2.8E+00	1.2E+00
Meat	110 kg	1.6 mile NNE	2.8E-06	1.0E-01	1.0E-01	1.0E-01	1.2E-01	2.4E-01
			Total(a)	7.1E-01	6.0E-01	6.0E-01	1.0E+00	6.9E-01

(a) Adult cumulative dose from all pathways, excluding goat milk.
(b) Consumption of goat milk by an infant is assumed to be the same as the consumption of cow milk. It is also assumed that infant milk consumption is the same as child consumption.

TABLE 5.2-9

ESTIMATED ANNUAL POPULATION DOSES FROM WNP-3

Pathway	Thyroid Dose (thyroid-rem)	Total Body Dose (man-rem)
Air		
Submersion	1.4E-01	1.4E-01
Ground Contamination	8.7E-03	8.7E-03
Inhalation	1.5E+00	1.1E+00
Farm Products		
Milk	2.1E+00	1.0E+00
Meat	1.3E-01	1.2E-01
Vegetation	6.1E-01	4.7E-01
Total:	4.6E+00	2.9E+00
Water		
Drinking Water	1.4E-05	1.1E-06
Fish[a]	6.1E-03	3.1E-02
Water Recreation[b]	4.6E-05	4.6E-05
Farm Products		
Milk	8.7E-02	2.1E-02
Meat	1.3E-02	1.1E-02
Vegetation[c]	2.8E-02	3.0E-02
Total:	1.3E-01	9.3E-02

(a) Sport and commercial fishing.
(b) Shoreline activities, swimming and boating combined.
(c) Vegetation and leafy vegetables combined.

TABLE 5.2-10

TOTAL BODY DOSES FROM TYPICAL SOURCES OF RADIATION

Source	Individual Dose (mrem)	Population Dose (man-rem)
Natural Background Radiation in Vicinity of WNP-3	100	75,580[a]
Typical Per Capita Medical Dose in U.S. (G.I. dose)	72	54,418[a]
Transcontinental U.S. Commercial Jet Flight	5	3,779[a]
WNP-3 Operation	0.004[b]	3.0[c]

(a) Total 50-mile population of 755,800 in the year 2000 multiplied by average individual doses for this source.

(b) Cumulative dose from all pathways in Table 5.2-9 divided by the total population.

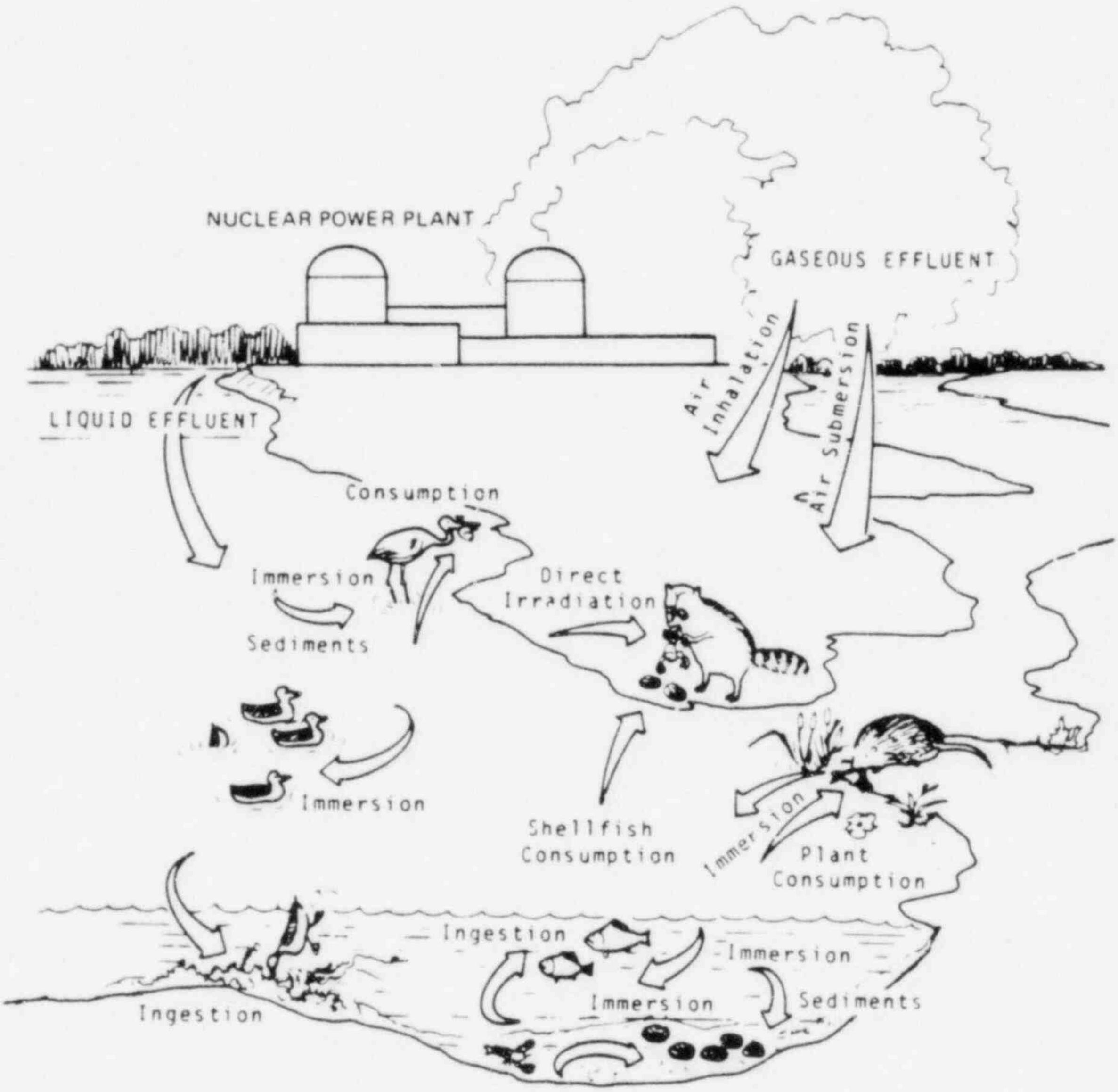
(c) Cumulative dose from all pathways in Table 5.2-9.

TABLE 5.2-11

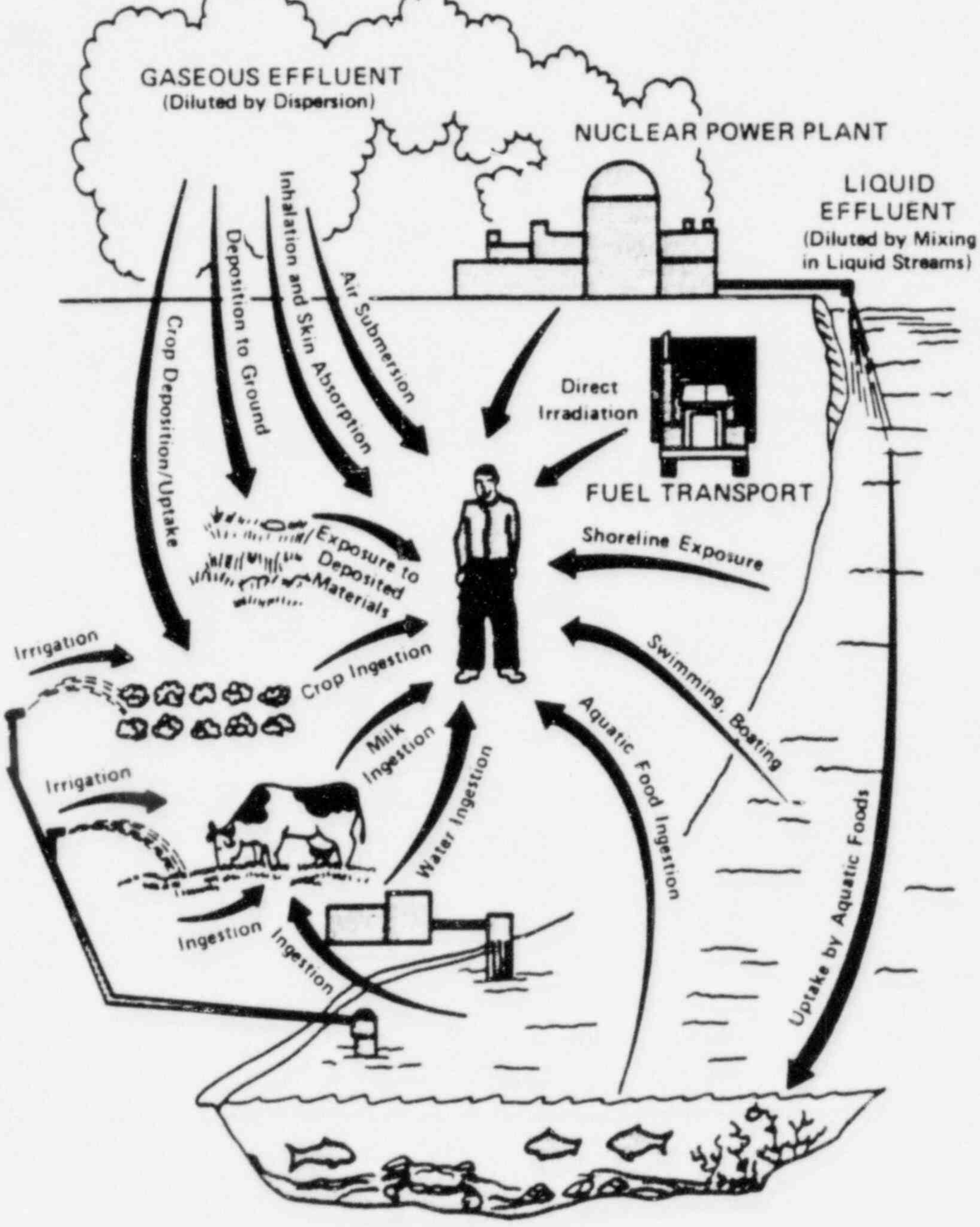
SUMMARY OF ANNUAL DOSES

Individuals	WNP-3	App I 10CFR50
Air Pathway		
Total Body (mrem/yr)	0.6	5
Skin (mrem/yr)	0.7	15
Any Organ (mrem/yr)	1.0	15
Gamma Air Dose (mrad/yr)	0.08	10
Beta Air Dose (mrad/yr)	0.2	20
Liquid Pathway		
Total Body (mrem/yr)	0.035	3
Any Organ (mrem/yr)	0.036	10

Population	
Total Body, liquid pathway	0.1 man-rem/yr
Total Body, gaseous pathway	3.0 man-rem/yr
Thyroid, radioiodines and particulates, gaseous pathway	4.6 thyroid-rem/yr



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	EXPOSURE PATHWAYS FOR ORGANISMS OTHER THAN MAN	FIGURE 5.2-1



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	EXPOSURE PATHWAYS TO MAN	FIGURE 5.2-2

5.3 EFFECTS OF LIQUID CHEMICAL AND BIOCIDAL DISCHARGES

The expected impacts of chemical and biocidal discharges at the construction permit stage were presented in the ER-CP in Subsections 5.4.3 and 5.4.4 and in the NRC Final Environmental Statement (FES). Since that time additional water quality data have been collected and are presented in Sections 2.4 and 3.6. The expected chemical releases to the Chehalis River via the cooling tower blowdown are described in Section 3.6 and summarized in Table 3.6-1. This section covers the effects of such discharges on aquatic life.

Table 5.3-1 presents the potential discharge concentrations and changes in concentration of chemical constituents in the Chehalis River at the downstream mixing zone boundary (see Subsection 5.1.1) for the low river flow condition.[a] The table shows that the expected discharge concentrations are less than the effluent limitation guidelines (40 CFR Part 423) and the NPDES Permit limitations. An exception is the maximum value for nickel which results primarily from a high concentration (10 µg/l) in the makeup water (see Table 3.6-1).

A comparison between the present Environmental Protection Agency (EPA) water quality criteria[1,2] and the chemical concentrations at the edge of the mixing zone reveals that all parameters for which criteria exist are less than the criteria with the exception of average values (at 440 cfs river flow) for cadmium, lead and mercury and the maximum value for copper. In regard to the concentration of cadmium, lead and mercury, operation of WNP-3 does not include the chemical addition of these parameters; however, they may be present due to concentration of the makeup water. Moreover, the average upstream ambient Chehalis River values for these metals may exceed water quality criteria (Table 5.3-1). In fact, the concentrations of average cadmium, lead and mercury at the edge of the mixing zone are all less than 0.2 µg/l above ambient levels upstream of the discharge.

5.3.1 Copper

Some of the WNP-3 auxiliary heat exchangers (totaling 90,000 sq ft) are made with copper and nickel alloy tubes. Therefore, copper and nickel releases in the discharge come from two sources: the makeup water, and corrosion and/or erosion of the heat-exchange tubes. Copper levels in the Chehalis River upstream of the intake wells range from 1.0 to 8.0 µg/l(see Section 2.4). The discharge level for copper may range from 21.5 to 61.3 µg/l (Table 5.3-1). The copper concentrations at the edge of the mixing zone are greatly reduced by dilution; the concentration ranges from 3.9 to 13.3 µg/l at the edge of the mixing zone with the river at the very low flow of 440 cfs.

(a) Thermal and chemical dilution studies assumed a once-in-10-yr, 7-day low flow of 440 cfs as reported in Subsection 2.5.1 of the ER-CP. Reanalysis, including the most recent flow data for the site area, has shown this flow to be 530 cfs as noted in Subsection 2.4.1.1.

A literature review on the biological effects of copper in aquatic environments was prepared in 1978 by Chu et.al.[3] In assessing the impacts of chemical discharges the salmonids are the most important species economically and recreationally. A review of copper toxicity data indicates that the salmonids, particularly steelhead/rainbow trout (Salmo gairdneri), are among the most sensitive and most frequently tested species.[3]

Most toxicity studies on salmonids have been performed within the early life stages, ranging from egg to juvenile. However, the discharge plume from the WNP-3 cooling tower blowdown does not intersect any known spawning areas. Therefore, the discharge is not expected to affect the incubation success of salmonids in the Chehalis River. Nevertheless, the toxicity studies of the early life stages are described below.

Shaw and Brown[4] observed that rainbow trout eggs could hatch after fertilization in a solution containing 1000 ug/l copper; however, this exposure level increased time to hatching. Grande[5], in studying the effects of copper sulfate on eggs and fry in the yolk-sac stage for rainbow trout, brown trout (Salmo trutta) and Atlantic salmon (Salmo salar), found that copper reduced egg hatching. Furthermore, copper inhibited egg development at about the same concentration that it was toxic to fry--40 to 60 µg/l at 21 days. Concentrations as low as 20 µg/l appeared to have a sublethal effect (i.e., unwillingness to feed). In another study that compared eggs and yolk-sac fry, Hazel and Meith[6] concluded that eggs were more resistant than fry to the toxic effects of copper. By using a continuous-flow bioassay system and using chinook salmon, the authors reported that copper concentrations of 80 µg/l had little effect on the hatching success of eyed eggs; acute toxicity to fry was observed at 40 µg/l, while increased mortality and inhibition of growth was shown at 20 µg/l.

Chapman[7], also using a continuous-flow bioassay method, tested the relative resistance to copper, zinc, and cadmium of newly-hatched alevins, swim-up fry, parr and smolts of chinook salmon and steelhead trout. Chapman found that steelhead trout were consistently more sensitive to these metals than were chinook salmon. His results are summarized in Table 5.3-2.

Finlayson and Verrue[8] determined an 83-day LC_{10} (lethal concentration to 10 percent of the organisms) of 64 µg/l copper for chinook salmon eggs, alevins and swim-up fry. Similar studies by Finlayson and Ashuckian[9] determined a 60-day LC_{10} of 33 µg/l copper for steelhead trout eggs, alevins and swim-up fry.

A number of studies have demonstrated that copper toxicity is related to water hardness and alkalinity. In general, copper toxicity is roughly inversely proportional to water hardness[6,10-13]. The work of Lloyd and Herbert[14] illustrates the relationship between lethality and total hardness or alkalinity (see Figure 5.3-1). When hardness increases over a range of 15 to 320 mg/l, a corresponding increase in the LC_{50} is observed with rainbow trout and chinook salmon.

Based upon the rapid dilution of the discharge, the minimal increases in copper predicted at the edge of the dilution zone, the relative hardness of the river water, and the absence of the early life stages near the discharge, no chronic mortalities are expected.

Because juvenile salmonids are not strong swimmers, they may be passively carried through the plume and therefore may be exposed to copper concentrations higher than ambient. Assuming the fish are passively carried through the plume with the downstream velocity (0.7 and 0.3 feet per second at average and minimum river flow rates), they would be exposed to copper concentrations greater than 1.9 µg/l above ambient for less than 6 minutes under low-flow conditions. Under these conditions, 20 percent or less of the surface area in the 100 feet downstream of the discharge may have copper concentrations above ambient. Juveniles most likely to be exposed to these concentrations are salmon and steelhead trout migrating downstream. Studies performed on other river systems have shown that most 0-age chinook salmon migrating downstream are found near shore;[15] however, some may pass center stream through the plume.[16] Other studies indicate migrating juvenile spring chinook, sockeye (Oncorhynchus nerka) and coho salmon (Oncorhynchus kisutch) and steelhead trout are more abundant in deeper water.[17,18]

A few studies have been performed on short exposures (1-30 minutes) of fish to higher copper concentrations (200 to 1000 µg/l). Holland et. al.[10] studied juvenile chinook salmon and reported that, after 24 hours of exposure to cupric nitrate, 0, 21 and 46 percent mortality occurred at ionic copper concentrations of 178, 563 and 1,000 µg/l, respectively. Unpublished data by Chapman[19] indicate that the 90-minute LC_{10} for juvenile salmonids exposed to copper is approximately forty times the 96-hour LC_{50} (19.3 µg/l), or a total copper concentration of 770 µg/l. Under the most extreme conditions, the highest copper concentration predicted for the discharge is 61.3 ug/l (Table 5.3-1). Based on this information, no direct mortality is predicted for salmonids that would passively drift through the WNP-3 discharge plume.

Larger juvenile and adult salmonids have the swimming ability to maintain their position in the river and thus the potential exists for their presence in or near the discharge plume for longer periods (i.e., greater than 2 minutes). However, avoidance of copper by salmonids has been observed in both laboratory and field situations.[20-22] Chapman[22] observed that eighty percent of the nonacclimated juvenile steelhead trout he tested avoided copper at 10 to 20 µg/l. Laboratory tests have demonstrated olfactory response of Atlantic salmon parr to both copper and zinc in a continuously flowing system.[20] Strength of avoidance was measured by the relative length of time in both control waters and waters modified by the metal. An avoidance threshold of 2.3 µg/l was estimated for copper; 53 µg/l for zinc; and 0.42 µg/l copper plus 6.1 µg/l of zinc in a mixture.

The probability of adult salmonids encountering the WNP-3 discharge plume is low because chinook salmon and steelhead trout naturally migrate close to shore and would thereby pass the mid-river discharges unaffected.[23] Other tracking studies confirm this natural shoreline movement.[24-28]

In addition to fish, the sessile, benthic biota may be affected by copper discharges. The maximum area of river bottom potentially exposed to copper concentrations greater than or equal to 1.9 ug/l above ambient is approximately 5,000 square feet (50 ft wide by 100 ft long = 0.1 acres). Resistant organisms can be expected to survive within this area, but the more sensititive will not be protected. However, the 0.1 acres potentially impacted is a relatively small area compared to the total available habitat within the Chehalis River. Consequently, such a change should have no measurable effect on the abundance and composition of benthic organisms.

5.3.2 Nickel

The concentration of nickel discharged from WNP-3 may range from 18.6 to 74 ug/l (see Table 5.3-1). As a result of dilution, the concentrations at the edge of the mixing zone are reduced to 2.7 to 20.0 ug/l. Limited data exist for the biological effects of nickel in aquatic environments. Anderson et. al.[29], using rainbow trout, found that the 96-hour LC_{50} for nickel ranged from 22,000 to 24,000 ug/l and that zero mortality occurred at concentrations from 4,000 to 8,500 ug/l.[30] Hale,[31] using rainbow trout, found that the 96-hour LC_{50} for nickel nitrate was 35,500 ug/l. Brown and Dalton[32] found, for nickel sulfate in hard groundwater (total hardness = 240 mg/l), that the 48-hour LC_{50} to juvenile rainbow trout was 32,000 ug/l. It is unlikely that nickel discharged from WNP-3 will have any measurable impact because the nickel concentrations and duration of exposure are less than those reported to have any direct lethal effect.

5.3.3 Chlorine

Chlorine (from sodium hypochlorite) is the biocide used in the treatment of the WNP-3 circulating water. As described in Subsection 3.6.4, a dechlorination system is used to remove residual chlorine. The fresh water quality criteria for total residual chlorine (TRC) is 0.002 mg/l.[1] With a river flow of 440 cfs and a discharge less than 0.05 mg/l (detectable level), the TRC concentration in the plume will be reduced to 0.002 mg/l in 22 minutes at a distance 400 feet downstream from the discharge. Figure 5.3-2, adapted from Mattice and Zittel[33], shows that all aquatic life traveling through the plume will be protected.

The area of the river bottom potentially exposed to chlorine concentrations greater than 0.002 mg/l is approximately 0.5 acres. In this area, not all benthic organisms will be protected, although the more resistant organisms can be expected to survive. Also, this area is small relative to the total benthic habitat and therefore the aquatic community will not be adversely affected.

5.3.4 Sulfates

Sulfates occur in the WNP-3 discharge as a result of concentration of river water, dechlorination with sulfur dioxide, and the use of sulfuric acid to regenerate ion exchange resins and to neutralize alkaline water. Sulfate concentrations in the Chehalis River average 4.0 mg/l with maximums near 5 mg/l (Table 5.3-1). At the edge of the mixing zone, maximum sulfate levels are estimated to be about 60 mg/l. Becker and Thatcher[34] have compiled data on the toxicity of certain sulfates to aquatic life, and state that sulfates exhibit low toxicity to aquatic organisms. Based on comparison of research to date[34] and the expected WNP-3 mixing zone concentrations, no significant impact on Chehalis River biota is predicted.

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TABLE 5.3-1

POTENTIAL CHANGE IN CHEHALIS RIVER WATER QUALITY RESULTING FROM WNP-3 DISCHARGES

	River Ambient (a)		Discharge		Edge of Mixing Zone (River @ 440 cfs)		Effluent Limitations (b)		Water Quality Criteria (c)	
	Ave	Max	Ave	Max	Ave	Max	Ave	Max	Ave	Max
Chemical in ppm										
Calcium	6.6	8.4	72.0	97.1	13.1	17.3				
Magnesium	1.9	2.4	25.8	35.4	4.3	5.7				
Sodium	4.4	5.4	36.0	164	7.6	21.3				
Potassium	0.55	0.76	4.08	5.67	0.90	1.25				
Chloride	5.6	7.9	25.2	31.7	7.6	10.3				
Fluoride	--	--	0.68	0.90						
Sulfate	4.0	5.1	300	560	33.6	60.6				
Phosphorus	0.039	0.073	0.85	1.66	0.12	0.23	5.0	5.0		
Ammonia N	0.016	0.026	0.08	0.19	0.02	0.04				
NO_3 and NO_2 -N	0.63	1.15	3.06	4.01	0.87	1.44				
Oil and Grease	2.5	14.0	<1.0	<1.0	2.3	12.7				
T.R. Chlorine	--	--		<0.05		0.005		0.05		0.002
Alkalinity (as $CaCO_3$)	28	38	76	86	33	43				
Hardness (as $CaCO_3$)	29	38	324	360	58	70				
TDS	75	89	1150	1356	182.5	216				
TSS	18	370	6	8	16.8	334				
pH	7.0	7.5	7.1	8.5			6.5-8.5			
Metals in ppb										
Barium	10.0	22.0	24.0	78.2	11.4	27.6				
Cadmium	< 0.1	0.5	0.6	1.4	0.2	0.6			0.007	1.0
Chromium	1.2	10.8	23.1	28.4	3.4	12.6		100		
Copper	2.0	8.0	21.3	61.3	3.9	13.3	30	65	5.6	8.5
Iron	860	7400	183	665	792	6726		1000		
Lead	4.0	36.0	< 6.0	7.5	4.2	33.1			0.2	49.5
Manganese	29.0	80.0	8.2	27.8	27.0	74.8				
Mercury	0.4	1.3	1.2	4.5	0.5	1.6			0.2	4.1
Nickel	1.0	14.0	18.6	74.1	2.7	20.0		65	36	849
Zinc	< 5.0	37.0	31.2	56.9	7.6	39.0		75	47	138

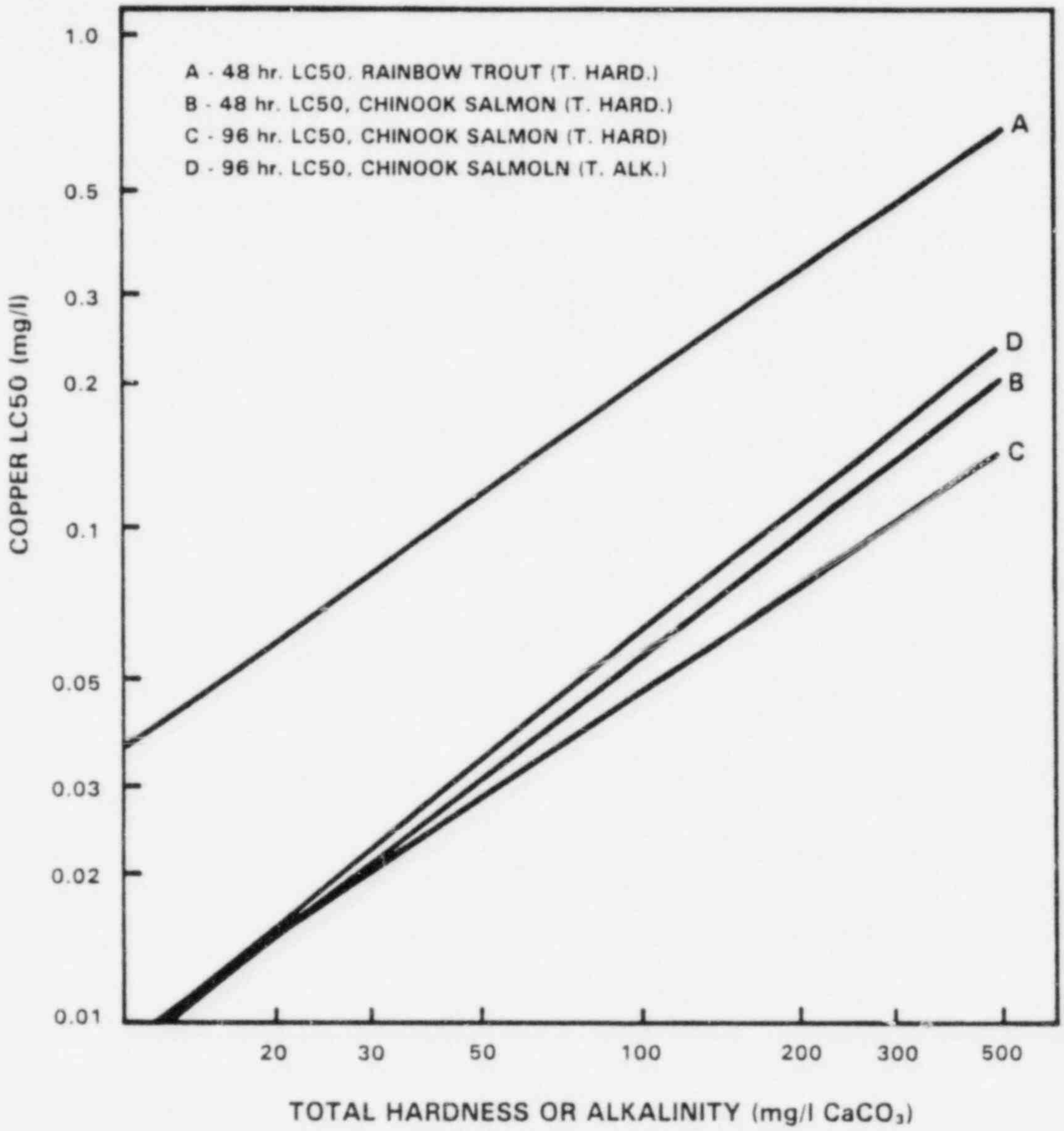
(a) Complied from 1980 Environmental Monitoring Program (Reference 2.2-4) and 1980-1981 Metals Monitoring Program (Reference 2.4-6)
(b) From EPA Effluent Guidelines (40 CFR Part 423) or WNP-3 NPDES Permit (see Appendix A)
(c) References 5.3-1 and 5.3-2

TABLE 5.3-2

LETHAL CONCENTRATIONS OF COPPER AND ZINC FOR VARIOUS LIFE STAGES OF STEELHEAD TROUT AND CHINOOK SALMON[(a)]

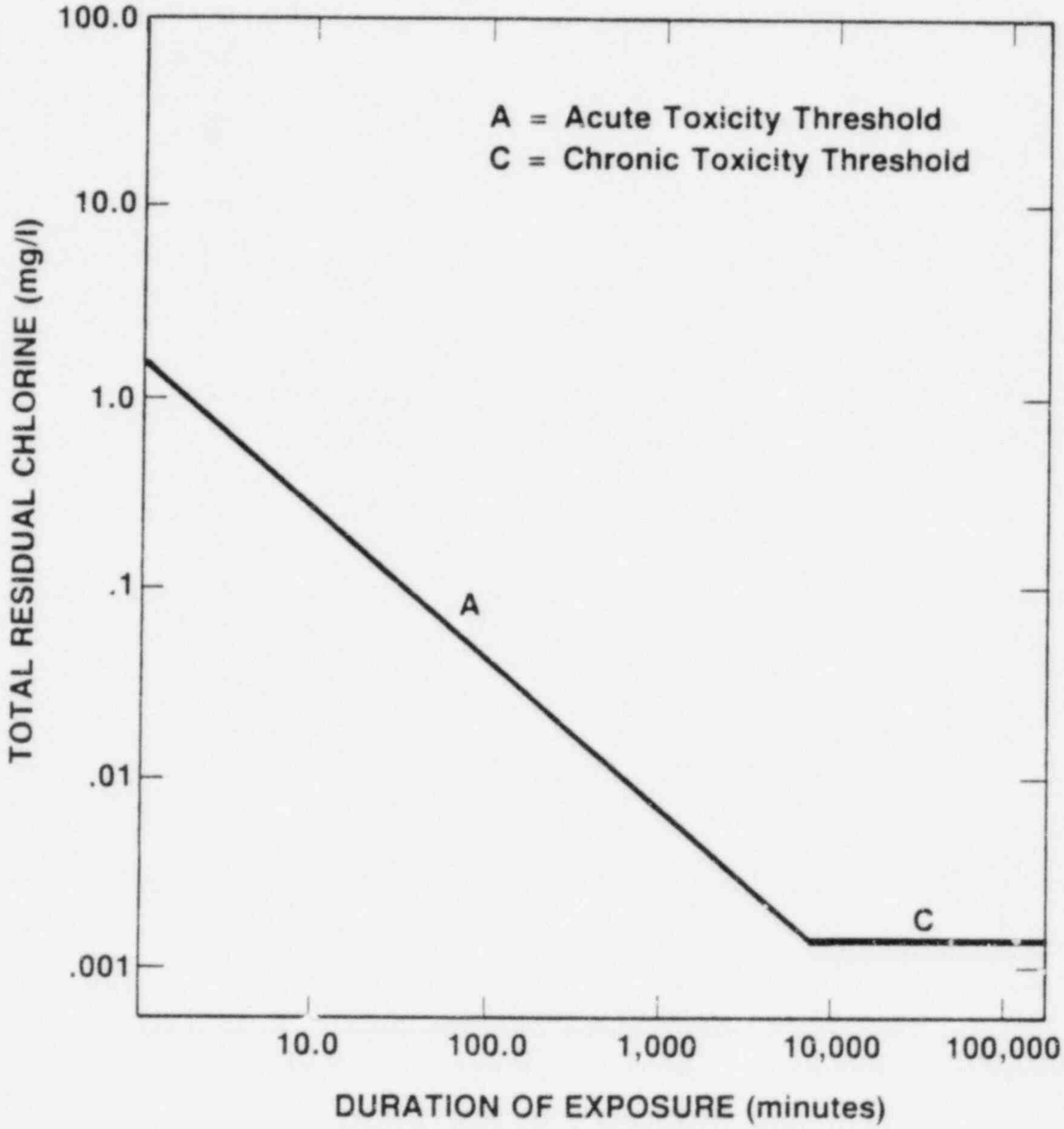
		Copper (ug/l)			Zinc (ug/l)		
		LC50		LC10	LC50		LC10
Species	Life Stage	96 hr	200 hr	200 hr	96 hr	200 hr	200 hr
Steelhead Trout	Alevin	28	26	19	815	555	256
	Swim-up	17	17	9	93	93	54
	Parr	18	15	8	136	120	61
	Smolt	29	21	7	651	278	84
Chinook Salmon	Alevin	26	20	15	661	661	364-661
	Swim-up	19	19	14	97	97	68
	Parr	38	30	17	463	395	268
	Smolt	26	26	18	701	367	170

(a)From Reference 5.3-7



Source: Reference 5.3-14

WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	RELATIONSHIP BETWEEN HARDNESS OR ALKALINITY AND COPPER TOXICITY	FIGURE 5.3-1



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	TOXICITY OF CHLORINE TO FRESHWATER ORGANISMS	FIGURE 5.3-2

5.4 EFFECTS OF SANITARY WASTE DISCHARGES

The extended aeration-activated sludge unit described in Subsection 3.7.1 removes about 85 percent of the influent BOD and 95 percent of the influent suspended solids. The effluent to the drainfield averages between 10 and 20 mg/l for both BOD and suspended solids. During construction the effluent flow averages about 35,000 gallons per day. During normal operation the effluent is expected to range from 5,000 to 10,000 gpd so that only the 20,000 gpd capacity unit will be operated. Disposal of the sewage plant effluent to the ground (i.e., drainfield) has proven environmentally acceptable and effective during the construction phase. This mode of disposal is also planned for the operation phase with the lower flows noted above. However, the option of discharging the effluent to the Chehalis River via the blowdown line has been retained in the NPDES Permit (Appendix A). Though disposal by this route is not anticipated, the sewage effluent diluted with the cooling system blowdown would have no discernible effect on aquatic biota or future uses of the water resource.

5.5 EFFECTS OF OPERATION AND MAINTENANCE OF THE TRANSMISSION SYSTEM

As discussed in Section 3.9, only two short transmission lines will be required to tie in the plant with the regional BPA transmission network, the environmental effects of which have been evaluated by BPA. One will be a 500kV line from the main transformer bank to the 500kV bus in the Satsop substation, the other a 230kV line between the Satsop substation 230kV bus and the 230kV bus at the plant to which the three standby transformers are connected. The two lines are entirely within the project site boundaries and the right-of-way passes through the area cleared for laydown and construction activities. As described in Section 3.9, the lines are remote from areas frequented by the public and operation of these line will have no significant effects on the people or natural resources of the area.

5.6 OTHER EFFECTS

The makeup water intake system described in Subsection 3.4.5 uses subsurface horizontal collectors. As noted in Subsection 2.4.2, replenishment is mostly from the river. Drawdown, at distances from the wells, has been estimated from preliminary pump tests (see Subsection 6.1.2) the results of which are detailed in Subsection 2.4.13 of the WNP-3 Final Safety Analysis Report. These studies project drawdowns of less than two feet at the nearest offsite wells (about 1200 feet) at design pumping rates.

No effects associated with plant operation, other than those considered in Sections 5.1 to 5.5, are anticipated.

5.7 RESOURCES COMMITTED

The estimated irreversible and irretrievable commitments of resources due to operation of WNP-3 have not changed significantly since they were evaluated in the Environmental Report-Construction Permit Stage[1] and the NRC's Final Environmental Statement.[2] A summary of these resource commitments follows.

Uranium fuel is the principal natural resource irretrievably consumed in plant operation. Between 150 and 200 tonnes of uranium in the form of U_3O_8 will be used each year to operate WNP-3.

Operation of WNP-3 will render materials used in construction, but still retrievable for other uses, essentially irretrievably committed by irradiation. Subsequent decontamination could make some materials and components available. The materials which remain irretrievably committed are a small fraction of the like resources available.

Land uses in approximately 2200 acres will be limited to accommodate power plant operation. Timber production and harvest is one use which is compatible with plant operation. Between 100 and 150 acres (including area occupied by WNP-5) will be used exclusively for plant operation. At the end of plant life, decommissioning (see Section 5.8) may make a portion of the site area available. However, the land dedicated for the plant structures represents an irreversible commitment.

Plant operation will consume about 30 cfs of water, mostly by cooling tower evaporation (see Sections 3.3 and 3.4). This represents about 0.5 percent of the mean annual flow of the Chehalis River.

Occupation of land by the plant and supporting facilities during the plant life represents a semipermanent loss of terrestrial biotic habitat. The conservative assessments of the biological impacts of plant operation (see Sections 5.1 and 5.3) disclose no irreversible commitments of biota to plant operation.

References for Section 5.7

1. Environmental Report-Construction Permit Stage, WPPSS Nuclear Project Number 3, Docket Nos. 50-508/509, Washington Public Power Supply System, Richland, Washington, 1974.

2. Final Environmental Statement, Washington Public Power Supply System Projects 3 and 5, Docket Nos. 50-508/509, NUREG-75/053, U. S. Nuclear Regulatory Commission, Washington, D.C., June 1975.

5.8 DECOMMISSIONING AND DISMANTLING

At the end of its useful life, WNP-3 will be decommissioned in a manner which is acceptable to the Nuclear Regulatory Commission (NRC). Selection of the specific decommissioning mode will depend upon the regulatory requirements at that time, the interests of the ratepayers of the Pacific Northwest, and the needs of the facility owners.

5.8.1 Site Ownership Considerations

Because the Supply System owns the land occupied by WNP-3, there are no contractual requirements that the site be restored to its original condition. Complete dismantling of the reactor complex and return of the site to its former appearance may be both unnecessary and impracticable.

The site was originally selected for its isolation, adequate cooling water supply, and proximity to important transmission networks and the primary Pacific Northwest electric load centers. Therefore, it would likely be a logical candidate site for the installation of future power stations, whether nuclear, fossil, or an alternative energy source. It is a site too valuable to abandon.

5.8.2 Decommissioning Options

The NRC recognizes four acceptable alternatives for retirement of nuclear reactor facilities. They are:

- Mothballing/Protective Custody

  This procedure is initiated by partial decontamination and removal of radioactive material from the facility after shutdown. Barriers are installed as appropriate to prevent entry and exposure to radiation, and continuous surveillance of the facility is established to prevent intrusion by the general public.

- Entombment

  After shutdown the facility is decontaminated. Then the residual radioactivity is entombed in a concrete monolith designed to have a life consistent with the half-life of the residual activity and to withstand anticipated accident conditions. Non-radioactive buildings and materials may be removed from the site as per normal salvage procedures. Infrequent surveillance is utilized, and the site is usually considered open to the public.

- o Dismantlement

  This procedure requires demolition and off-site burial of contaminated and activated systems and structures. Components and structures left on-site are decontaminated to background levels. At the conclusion of this process, no surveillance is required and the site can be opened to the public.

- o Conversion

  The least utilized option to date, this procedure involves conversion of the facility to a new power plant or to a power plant of different design. The one outstanding example is the conversion of the Pathfinder power plant to a coal-fired unit. In the future a nuclear power plant may be refurbished to extend its operating period.

Each of the decommissioning options has been demonstrated on one or more nuclear power plants. Therefore, the technology for these methods has been developed and tested, and is readily available. In addition to this background of experience, there is an ongoing research, development, demonstration and application effort by the U.S. Department of Energy (DOE). A significant part of this program is decommissioning in excess of 600 nuclear facilities owned by the DOE. This program, which will stretch many years into the future, will provide a constant flow of technology and expertise into the non-governmental area. Therefore, the situation is not only one of developing technology, it also consists of selecting the most applicable and cost-effective approach from among the several options.

A choice exists between prompt and delayed final decommissioning of a nuclear power plant. If decommissioning is delayed, the plant is either mothballed or placed in protective custody for a number of years before it is finally decommissioned. The advantages of delay include a significant decrease in radioactivity levels due to radioactivity decay. This results in significant cost savings and reduction of the health hazard to the workers. The disadvantages of delay include the rising costs due to inflation and the cost of the interim surveillance. Studies to date show marked economic, health and safety advantages for delaying decommissioning with the optimum delay time being at least fifty years.

Some or all of the following activities could take place in the decommissioning process:

a. Remove the structural steel framing and metal siding of the turbine-generator building, salvage the crane and equipment, leave massive turbine-generator foundation, and block all entrances.

b. In the General Services Building, salvage the equipment as practicable, raze the structural walls and block the entrances. The disposition of other auxiliary structures will depend upon the future use to be made of the site.

c. In the containment and fuel storage area, remove all fuel, control rods and accessories, and salvage the cranes and other equipment. For these buildings, detailed plans will have to be established immediately preceding the decommissioning to allow maximum reuse of site land areas while eliminating any radioactive hazard. The degree and method of building demolition, the extent of practicable decontamination, the possible reuse of certain equipment or structures, and the subsequent use to be made of the site must be evaluated in establishing these plans.

In the above operations, equipment would be decontaminated where necessary and practicable or transported with suitable precautions.

5.8.3 Decommissioning Program

An overall work plan, including cost estimates, will be prepared near the end of the reactor's useful life. The decommissioning operations would be conducted in accordance with detailed procedures, specifications and schedules. The specifications would define the scope, methods and sequence of accomplishing major tasks. Where detailed work procedures are required to supplement the specifications they would be developed to meet the existing field conditions, state-of-the-technology, and shipping and burial ground requirements.

Prior to decommissioning, certain preparatory work would be initiated. This includes:

a. Preparation of detailed plans and accumulation of tools and equipment.

b. Selection and qualification (if required) of necessary personnel.

c. Maintaining security precautions to keep out unauthorized personnel.

d. Construction of an enlarged change room and personnel decontamination area.

e. Establishing storage areas for contaminated and uncontaminated wastes.

f. Establishing personnel and area radioactivity monitoring procedures for the additional personnel and areas involved.

All spent fuel will be withdrawn and transported to a licensed nuclear fuel processing plant or permanent storage site. Steam generators and other components contaminated by "detectable radioactivity" would be decontaminated, cut if necessary, or shipped whole with protective coverings. Shipments of radioactive materials would be governed by applicable NRC and DOT regulations. Radioactive components would be cut, with monitoring, within containment. Immediate work areas would be enclosed within a contamination control envelope to prevent release of activity to the environment.

Tanks, machines and other components capable of being decontaminated would be decontaminated and shipped to salvage dealers. Solid wastes would be packaged in approved containers which would be sealed and thoroughly surveyed for external contamination before they were removed. The sub-grade levels of all buildings would be decontaminated and sealed to prevent inleakage of ground water.

Typical plant systems which would be kept activated during decommissioning are: demineralizer, gaseous waste disposal, fuel element storage pool, ventilation, air conditioning and heating, service water, emergency electrical, service air and plant communication systems, as well as radwaste treatment systems.

After program completion, a thorough radiation survey of the plant site would be made to verify that residual radioactivity does not represent a source of contamination and is within established regulatory limits. The plant would be inspected as needed to insure that the buildings remain sealed.

5.8.4 Costs of Decommissioning

The plant decommissioning costs occur at the end of the project life, currently estimated to be 40 years. Cost calculations if made now, would be highly speculative. Certain pieces of equipment, such as water tanks and pumps, if only slightly radioactive, could probably be decontaminated and sold for a price covering their costs of removal. Other equipment, more radioactive, would probably be shipped to the closest burial ground, the cost of removal and delivery being a total loss. Demolition of concrete buildings is a significant cost. Shipping and burial of concrete, if necessary, would contribute additional costs.

5.8.5 Environmental Impacts of Decommissioning

Decommissioning the plant would have many of the same impacts on the environment as the original site preparation and station construction, but the degree of impact would be less. Automobile, truck, rail traffic and associated noise would increase. Some land would be used temporarily for laydown area and additional land may be required for permanent storage of irradiated materials. The amount of land irretrievably committed by this action will be minimal; the exact amount awaits development of a detailed decommissioning plan. Radiological impacts would be characteristic of transporting irradiated fuel and radioactive wastes from the site. After decommissioning is complete, however, it is expected that the proposed action would have no further significant radiological impact on the environment.

EFFLUENT AND ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAM

6.1 PREOPERATIONAL ENVIRONMENTAL PROGRAM

The Supply System has conducted extensive preconstruction and construction phase monitoring programs which have helped to define the composition, structure, and function of the site environment. The results of many of these studies are referenced in Chapter 2. This section provides additional detail on the methods of collection and the analyses used in these various preoperational programs.

6.1.1 Surface Water

The aquatic monitoring program concentrated on obtaining baseline data from which impacts of plant construction and operation could be measured if they should occur. The program was significantly reduced in January 1981 and January 1982 per agreements with the State of Washington Energy Facility Site Evaluation Council (EFSEC).(1-4) A recommended preoperational and operational monitoring program will be presented to EFSEC thirty months prior to fuel load for WNP-3.(2)

6.1.1.1 Physical and Chemical Parameters

Field and laboratory studies relating to the physical characteristics of the Chehalis River were conducted in 1977 and 1978 to predict the occurrence of low velocity and flow reversal conditions in the river and to ascertain the performance of the blowdown diffuser under those conditions. These studies are described below.

A computerized analytical model, calibrated to site-specific hydraulic characteristics and historical flow data (1943-1976 for the Chehalis and Satsop Rivers), was developed and used to project the frequency of tidal propagation to the diffuser area and the associated conditions.(5) The model allowed quantitative prediction of stagnation and flow reversal due to coincident high tides and low flow conditions at the diffuser.

A physical model (1:12 scale) of the Chehalis River was constructed to simulate diffuser performance under variable river hydraulic and plant operating conditions.(6) A range of severe conditions was simulated using, as input, the results of computerized flow modeling, historic river observations, and projected blowdown flows and temperatures. The physical modeling allowed the determination of blowdown plume behavior under a range of environmental and plant operational conditions.

A field program was conducted during the 1977 low-flow season to monitor hydrologic features of the Chehalis River below the Satsop River confluence.(7) The purpose was to assess tidal effects in the vicinity of the diffuser during low river flows. The monitoring program included continuous in situ current measurements, river stage level measurements both upstream and downstream of the diffuser location, and river bottom topographic profiling.

Water quality studies were performed near WNP-3 from 1977 through 1980. The objectives of the studies were to monitor the effects of site construction on the Chehalis River and site streams, and to provide baseline water quality information for evaluating the impacts of plant operation. The Chehalis River was sampled at five stations, 1977-1978[9,10] and four stations 1979-1980.[11,12] Satsop River samples were collected from one of two possible locations. Samples from six site streams were collected at ten locations in 1977 and 1978, seven locations in 1979, and five locations in 1980 (Figure 6.1-1). Sample collection and analysis was by predetermined procedures.[13,14]

The 1978-1980 water quality monitoring program involved weekly measurements of pH, temperature, turbidity, suspended sediments, conductivity, dissolved oxygen, oil and grease, and fecal coliforms. The 1977 weekly monitoring program was the same, except dissolved oxygen and conductivity were not included. Monthly measurements, 1977-1978, included gas saturation, alkalinity, total hardness, total dissolved solids, sulfate, ammonia, Kjeldahl nitrogen, nitrate plus nitrite, total phosphorus, total coliforms, dissolved oxygen, conductivity, total organic carbon and biochemical oxygen demand. Measurements, 1979-1980, were the same except nitrite, orthophosphate, chemical oxygen demand were added and dissolved oxygen, conductivity, total organic carbon and biochemical oxygen demand were deleted. Table 6.1-1 provides a summary of the 1980 program.

Additional samples were taken throughout the construction phase from the site erosion control facilities and analyzed for pH, turbidity, suspended sediments and settleable solids in accordance with the NPDES Permit (see Appendix A).

In November 1980, a one year monitoring program for heavy metals was initiated to satisfy a condition of the NPDES Permit.[15] Weekly samples were collected from a water well and from the river near the makeup water wells. The samples were analyzed for alkalinity, hardness and total and dissolved forms of chromium, nickel, iron, copper and zinc. Other parameters were analyzed less frequently and are summarized in Table 6.1-2.

Between April 1977 and April 1978 samples were collected from five river sites and two wells near WNP-3.[16] The samples were analyzed for total copper and total zinc. During this time a literature review was also prepared that addressed copper in the aquatic environment.[17] From June through October 1978 samples were collected from the Chehalis River and wells near WNP-3.[18] The samples were analyzed for labile copper concentration and copper binding capacities of the water.

During early phases of construction in late summer and fall of 1977, record rainfall caused erosion of site soils and above normal turbidity and concentrations of suspended sediment in the site streams and the Chehalis River. A study was undertaken from August 1977 through March 1978 to determine the effects of the increased turbidity and suspended sediment on the aquatic environment of the site streams and Chehalis River.(19) The specific objectives of this study were: 1) to determine if any short-term or long-term impacts to the Chehalis River aquatic resources had occurred; 2) to estimate the number of sport-fishing days lost; 3) to estimate the effects on salmonid spawning potential of the site streams; and 4) to estimate the number of rearing salmonids in the site streams that were lost or displaced, as well as any long-term effects on rearing potential.

The water temperature regime at the discharge area reflects the combined temperatures and flows of the Satsop and Chehalis Rivers upstream of the site. Extensive water temperature data have been collected by the U.S. Geographical Survey at the Satsop monitoring station and at the Porter station on the Chehalis River upstream of the confluence. Daily measurements at Porter were initiated in 1959 and terminated in 1972, providing a 12-year record (with some gaps). Measurements have been taken at irregular intervals at Satsop since 1960. The 12-year Porter record was analyzed statistically for the 1 and 99 percentile temperatures and used as extreme river temperatures in the aforementioned hydrothermal model studies (see also Subsections 2.4.1 and 5.1.2). In addition, temperatures were monitored continuously _in situ_ near the discharge from June to October 1978.

6.1.1.2 Aquatic Ecological Parameters

The major task of the aquatic ecological program was to monitor periphyton, benthic macroinvertebrates, and fish in site streams and the Chehalis and Satsop Rivers.

Periphyton

Periphyton communities are generally good indicators of water quality. Beginning in 1973, periphyton communities were sampled to establish baseline values and to monitor the impacts resulting from plant construction. Intensive studies began in 1976 and continued through 1980 (Table 6.1-3). The program has characterized the composition, density and seasonal abundance of periphyton near WNP-3.(8-12) Starting in 1978, samples were collected using both artificial and natural substrates. Natural substrates consisted of three replicate groups of rocks each between 3 and 6 cm in diameter collected by SCUBA divers. Samples of periphyton were scrapped from the rocks into prelabeled vials for mounting and identification. Artificial substrate samples consisted of ten glass slides mounted in a wood and plastic frame.

Stations that have been sampled through the years include the Discharge Area, Intake Area, Upstream Discharge Area, Holding Area and Greenbanks (see Figure 6.1-1). At each station two samples were taken, one on the north side and one on the south side of the river at a depth of one to two meters. Samples were generally taken monthly, May through October.

Benthic macroinvertebrates

Aquatic macroinvertebrates have been historically used as indicators of the quality of their environment because they are sensitive to many *in situ* stresses. Impacts are determined by changes in number of taxa, number of individuals per taxa, or total biomass measurements. Chehalis River macroinvertebrates have been sampled using both natural and artificial substrates from 1976 to 1980 (Table 6.1-4). Natural substrates were used to determine composition, abundance, and distribution patterns while artifical substrates were used to determine colonization rates.

Six natural substrate samples were generally collected monthly per station (three replicates per substation; Table 6.1-4). The substations correspond to those used for the periphyton program. Samples were generally collected from March through September when the river velocity allowed. A SCUBA diver used a 12.5-cm metal corer to collect each sample to a depth of 13 cm (approximately a volume equal to 1.6 liters). Samples were sieved through a series of screens with six mesh sizes. Substrate composition was determined by weighing the contents of each screen. Macroinvertebrates were defined in this study as organisms retained on a 0.5-mm or larger mesh. Taxonomic identifications were to family or genus except during 1976 when order or family were the lowest level identified.

Artifical substrates consisted of eight 15-cm x 15-cm tempered hardboard plates assembled on a stainless eyebolt with 6 mm spacers. These samplers were then attached to a metal structure projecting above the river bed to prevent smothering from sediments moving downstream. At collection, each sampler was carefully removed and placed in a fine mesh bag. At the laboratory each sampler was disassembled, scraped, wet-sieved on a 0.5-mm sieve, sorted, and preserved. All organisms were identified to family or genus level and counted.

Stations sampled were the Holding Area, Discharge Area, Intake Area, and Greenbanks Area. These stations are shown on Figure 6.1-1.

Fish

Fish communities in the Chehalis and Satsop Rivers near WNP-3 were intensively studied during 1976 through 1980.[8-12] The objectives of these fish studies were to: 1) collect data to detect impacts caused by plant construction; 2) collect preoperational data for future assessments of potential operational impacts (e.g. cooling tower blowdown); 3) determine the composition, abundance and distribution of species in the study area; 4) determine community characteristics, which include age, condition factors, food habits, growth patterns, incidence of disease and salmonid migratory patterns; and 5) determine angler use of the study area.

River fish were collected by using electroshocking and beach seining techniques. Generally, electroshocking was performed once per month from March through October. In some years, samples were collected in the winter months and/or at greater frequencies.[10,11] From 1976 to 1979 electroshocking was conducted along both shores of the Fuller Bridge, Satsop River, Holding Area, Discharge Area and Intake Area sampling stations. The upstream and downstream Discharge and Greenbanks stations were sampled in 1977 and 1978. (See Figure 6.1-1.)

At a minimum, beach seining was performed once per month, from May through October at three locations: Holding Area (north shore), Intake Area and Discharge Area. The Fuller Bridge and Greenbanks Areas and Satsop River Area were also sampled in 1976-1977 and 1978, respectively.

In general, fish collected were separated by species and counted; lengths and weights were recorded for up to 50 specimens per species per station per month. All fish greater than 150 mm in fork length were tagged with numbered dart tags.[11] In addition, the age of selected fish specimens was determined from microscopic examination of scales, and the mean condition factors were calculated for salmonids and the four most abundant nonsalmonids.

Supplemental studies to the annual monitoring programs have included: 1) ultrasonic fish tracking to study the behavior of migrating adult salmon in the vicinity of the discharge;[20] 2) determination of food habits for selected species via stomach content analysis;[9,10] 3) a study of juvenile salmonid outmigrant patterns using inclined plane traps, beach seining and dye-marking techniques;[10] 4) documentation of angler use of a 16-km section of the Chehalis River between South Elma bridge and the mouth of Smith Canal.[10-12]

Fish communities in the tributary streams in the site area were studied from 1976 through 1980.[8-12] The objectives of these studies were: 1) document the use of site streams for salmonid spawning and determine the effect of construction activities on these areas; 2) determine the species composition, density, size and age class of fish in the site streams; and 3) estimate the fish populations in site streams.

Stream fish were collected by using an electroshocker. Initially, 15 stations were sampled[8], and in 1979-1980 eight of the original locations were still being sampled.[12] The eight stations included three on Workman and Fuller Creeks and one each on Stein and Ein Creeks (see Figure 6.1-1).

Electroshocking and mark-recapture methods were used from 1977 to 1980 to estimate fish populations and other fishery characteristics (e.g., species composition) at each sampling location. Each sampling station was 200 m in length; to isolate the sample population, block nets were placed at both ends of the sampling station. Two passes were made at each station. Sampling was performed in August 1980 and 1979, from August to October 1978, and from December 1977 through February 1978.

Surveys of salmonid potential have been conducted intermittently on Fuller, Workman, Elizabeth and Hyatt Creeks since 1968.[19] Methods of assessing potential spawning areas were adopted from Burner.[21] At least two surveys were conducted on each stream from November 1977 through January 1978.[9] Six biweekly surveys were made of Fuller Creek and at least one in each of the other streams November 1978 through January 1979, October 1979 through January 1980, and December 1980 through January 1981.[10-12]

Because the cooling tower blowdown may contain concentrations of copper and zinc as corrosion products and concentrated constituents of the makeup water and because these metals are toxic to aquatic biota under certain water quality conditions, the potential impact of the discharge was investigated using standard static 96-hour bioassays with three species of salmonids (rainbow trout, coho salmon, and chinook salmon).[22] Bioassays were conducted with ambient Chehalis River water (simulated cooling tower blowdown). Atomic absorption spectrophotometry (AAS) and differential pulse anodic stripping voltammetry (DPASV) were used to determine total and labile concentrations, respectively of copper and zinc. In addition, hardness, alkalinity, and pH were determined for all test waters.

A special condition of the NPDES Permit requires that thorough flow-through bioassays be performed to determine sensitivities of resident salmonids to concentrations of copper and zinc in the effluent. These bioassays are scheduled for the 1982-1983 time period.

6.1.2 Groundwater

A series of tests were performed on the alluvial aquifer to determine its characteristics relative to operation of the makeup water well system (see Subsection 3.4.5). The most significant test was performed in November 1980 when the first Ranney Collector was pumped at a constant rate of 18,500 gpm for 48 hours.[23] Water levels were recorded continuously in the collector caisson, three observation wells, and the Chehalis River, and were recorded at four-hour intervals in four observation wells.

Water levels in the collector well and the seven observation wells stabilized rapidly (within the first hour of the test) and followed the cyclic fluctuations of the Chehalis River throughout the remainder of the test period. In a similar manner, water levels recovered rapidly after the end of the test, returning to static conditions within one hour. This rapid stabilization indicates excellent recharge from the Chehalis River and an assured continuous replenishment of the aquifer.

6.1.3 Air

6.1.3.1 Meteorology

The preoperational onsite meteorological program was designed to evaluate the dispersive characteristics of the site for both the routine operational and the hypothetical accidental releases of radionuclides to the atmosphere. This program was conducted in accordance with Regulatory Guide 1.23.(24)

The meteorological station consists of an instrumented 60-m monitoring tower, an instrument shelter housing all required electronic and recording equipment. The station is located in a clear, relatively flat pasture on Fuller Hill 0.7 mile NNW of the plant. This pasture is about 90 m above MSL and is sufficiently large to provide the monitoring tower with adequate separation from the fir trees surrounding the pasture.

The meteorological program was conducted in two phases: the first was initiated in May 1973 and continued through February 1975; the second was initiated in September 1979 and continued through September 1981. The two phases are essentially the same, but there were some minor changes as discussed below. Although the formal preoperation program ended in September 1981, the system continues to operate and record meteorological data.

The following parameters were (and are) measured by the instruments mounted on the tower:

a) The ambient air temperature at the 10-meter level is measured using a Meteorology Research Incorporated (MRI) Model 809-3 temperature sensor. The sensor consists of a linear composite thermistor probe mounted in a motor-aspirated radiation shield. The range of temperature measurement is from -30°C to +50°C with an overall system accuracy of ±0.4°C.

b) During the first data collection effort, the relative humidity at the 10-m level was measured continuously using an MRI Model 908 relative humidity sensor. The sensor was a Xeritron unit manufactured by Hygromtrix Inc. and was mounted in an aspirated radiation shield. The probe itself operated on the principle of the hygromechanical arch and, as such, is essentially independent of temperature. The relative humidity measurement range was 0 to 100 percent with an overall accuracy of 1.1 percent.

c) In December 1974, the relative humidity sensor was replaced with a dew point sensor. The dew point temperature of the atmosphere is measured at the 60-m level using an EG&G Model 110S dew point measuring set. The measuring set consists of a transmitter unit that contains aspirated temperature and dew point sensors, and a control unit that contains the sensor amplifier and signal conditioning equipment, as well as an interconnecting cable. The accuracy of this sensor is $\pm 0.5^{o}F$.

d) Wind speed and wind direction are measured at both the 10-m and 60-m levels. Measurements at both levels are made using MRI 1074-2 wind sensors. The starting speed of this wind equipment is less than 0.45-m/sec while the wind speed accuracy is ± 0.4-m/sec. The wind direction accuracy is $\pm 3.1^{o}$.

e) Temperature difference measurements are made between the 10-m and 60-m levels using MRI 809-3 and 809-2 sensors, respectively. The sensors consist of matched pairs of linear composite thermistor probes mounted in aspirated radiation shields. Two temperature difference sensor systems are operated simultaneously to provide redundant monitoring. The range of each temperature-difference measurement is $\pm 5^{o}C$ scaled to 5 V with an overall system accuracy of $\pm 0.1^{o}C$.

In addition to the tower-mounted instruments referred to above, an MRI Model 301 tipping bucket rainguage is also in use at this site. The rainguage is located at ground level about 8-m south of the base of the tower.

Two independent data recording systems operate in a temperature-controlled instrument shelter located 15-m from the base of the tower. The primary system is digital and uses a data logger (MRI Model 1751) and a magnetic tape recorder (Kennedy Model 1600/3600). The voltage outputs of six sensors are passed through an electronic circuit which provides continuous averages of the last minute's observations. The six parameters are temperature, delta-T, and the upper and lower wind directions and speeds. The averaged signals and the direct signals of other parameters are passed through a digital data logger which converts the voltages to a digital output. The digital output is automatically recorded on a magnetic tape recorder at one-minute intervals. Hourly average values are determined by arithmetically averaging the one-minute recordings for all parameters except wind direction and rainfall. Wind directions are determined by computing a vector average of the one-minute average direction for each hour. Rainfall data are recorded as incremental one-minute values and subsequently totaled for the hourly precipitation amounts.

The second mode of data acquisition is the backup analog recording system. In this system, the sensor signals are not averaged but are connected to analog, or strip-chart, recorders. The signals or traces are visually averaged for the entire hour of data. In periods when less than a complete hour's data are available, the available data are used. If the amount of recoverable data in any hour is less than 15 minutes, the entire observation is reported as missing. Under proper operation of the primary system, these backup traces are not used. The strip charts are simply checked, marked, and stored. If the digital system fails, data from the analog system are reduced and incorporated into the overall data base.

The sensors and electronic circuitry were calibrated quarterly. During the first period, the vendor, Meteorology Research, Inc. (MRI) of Altadena, California, performed the calibrations, while during the second program, Envirosphere Company performed the calibrations. Meteorology Research, Inc. does not recommend and does not perform field calibration of wind speed sensors. In March of 1973, the 10-m wind direction sensor failed and it was necessary to replace the entire speed/direction sensor with a new unit. To insure consistency and accuracy, MRI provided documentation indicating that the two aforementioned wind directions/speed sensors were tested and conformed to the accuracy specifications.

During the second monitoring period, the wind speed sensors were first calibrated on a semiannual basis at the University of Washington wind tunnel in Seattle. Subsequently, the sensors were shipped to the vendor semiannually for calibration and refurbishing.

A second, small meteorological station was established during the first phase approximately 9-km southeast of the plant at about 520 m above MSL. This station operated from May 1973 through October 1973. Instrumentation at this site consisted of a single, self-contained MRI Model 1077 Mechanical Weather Station. The parameters measured were wind speed, wind direction, relative humidity, ambient air temperature, and precipitation.

6.1.3.2 Models

Short-Term Diffusion Model

Formulations for calculating short-term X/Q values have been developed for licensing of nuclear power plants and are discribed in Regulatory Guide 1.145.[25] For the WNP-3 configuration, it is assumed that accidental releases are made at ground level. This assumption provides a conservative estimate of downwind X/Q values. Based on the guidance given in Regulatory Guide 1.145, the X/Q values are calculated using three separate equations. The particular equation which is used depends upon the existing meteorological conditions. The equations are:

$$X/Q = \frac{1}{U_{10}(\pi \sigma_y \sigma_z + A/2)} \qquad \text{Equation 1}$$

$$X/Q = \frac{1}{U_{10}(3\pi \sigma_y \sigma_z)} \qquad \text{Equation 2}$$

$$X/Q = \frac{1}{U_{10}\pi \Sigma_y \sigma_z} \qquad \text{Equation 3}$$

where:

X/Q is relative concentration (sec/m^3)

U_{10} is the hourly average wind speed at the 10-m level (m/sec)

σ_y is the horizontal diffusion parameter (m) determined from downwind distance and stability category

σ_z is the vertical diffusion parameter (m) determined from downwind distance and stability category

Σ_y represents plume meander and building wake effects (m) and is a function of stability category, wind speed and down wind distance

A is the smallest vertical plane cross-sectional area of the reactor building (m^2).

During neutral or stable atmospheric stability conditions, the results of all three equations are used to determine dosages. The values from Equations 1 and 2 are compared and the larger is selected. This value is compared with that computed in Equation 3 and the lower value is selected as the appropriate X/Q value.

During all other meteorological conditions (unstable and/or wind speeds of 6 m/sec or more), only Equations 1 and 2 are considered. The appropriate X/Q value is the larger of the two.

Values of σ_y and σ_z, the horizontal and vertical diffusion parameters are taken from Regulatory Guide 1.145 for the applicable stability category and downwind distance. For extremely stable conditions (Category G), the following relationships are applied: σ_y at Category G = 2/3 σ_y at Category F and σ_z at Category G = 3/5 σ_z at Category F.

The hourly average wind speeds and data were taken from the nearly three years of onsite data. Wind directions were grouped and classified into 16 azimuthal direction sectors of 22.5° each centered on true north, north-northeast, etc. Calms were defined as hourly average windspeeds below 0.4 m/sec and are assigned a wind speed of 0.3 m/sec. Wind directions during calm conditions were assigned with the same distributional patterns as wind directions in the next three-highest (0.4-1.5 m/sec) speed category classes. The hourly stability category classifications were also determined in accord with procedures described in Subsection 2.3.3.

Because of the plant vent location, no credit was taken for plume rise in any of the diffusion calculations. It is unlikely that any of the plant's gaseous effluents will mix with vapor plumes from the cooling systems. Even if such mixing did occur, the resultant ground-level X/Q values would be lower than those presented in Subsection 5.2.2. The two-hour concentrations are assumed to be identical to the one-hour values described above. Interpolation of a log-log plot of the two-hour and annual average values (discussed below) was used in the estimation of the 8-hour, 16-hour, 3-day, and 26-day distributions.

Long-Term Diffusion Model

The method used to estimate annual average relative concentrations (X/Q) of routinely released radionuclides assumes that a constant mean wind transports and dilutes the effluent in a single direction from the plant site. The wind speed, direction, and stability category are assumed to prevail over the site vicinity at all distances downwind for the complete hour ascribed to each observation. The modified Gaussian diffusion model is used in this analysis to determine dilution of the effluent.

Since the heights of the effluent stacks are below the height of the reactor building, a ground level release is assumed for these routine releases. This represents a conservative assumption for relative concentrations at all points downwind regardless of the precise nature of the topography. These releases are generally entrained into the building wake, and the size of the building must also be incorporated into an estimate of downwind concentrations. Within one mile of the release point, the assumptions about the release mode are very important. Beyond several miles from the plant, the concentrations are essentially independent of the release mode.

Besides the methods that dilute concentrations of released effluents through diffusion, there are several mechanisms that reduce these concentrations by removing them from the atmosphere. One mechanism is dry deposition, which involves the adsorption of gases or particles on the ground or vegetation that is downwind of the release. A relative plume depletion rate due to dry deposition, based on the scientific literature, is suggested in Regulatory Guide 1.111.[26]

A second removal mechanism is wet deposition, which occurs when the atmospheric effluents are washed out by rain. Wet deposition is particularly applicable to locations with a distinct rainy season, i.e., a high percentage of hours with measurable rainfall. It is also generally applied to sites where an elevated release is assumed. Since ground-level releases are assumed for the WNP-3 site and because the dry deposition curve[26] is sufficiently conservative, wet deposition has not been specifically considered here.

The hourly average data referred to previously also forms the data base for the development of the long-term X/Q estimates. The hourly average values of wind speed, wind direction, and temperature differences are used to generate joint frequency distribution tables for wind speed intervals and wind direction for each of the atmospheric stability classes (see Subsection 2.3.3). Calms were treated as a separate wind speed category and distributed among the various wind direction sectors according to the directional distrubution of the lowest wind speed class. Using these frequencies, and the assumption of a ground-level release, average long-term X/Q values were calculated for various downwind distances out to 80 km (50 mi) using the following equation:(26,27)

$$(X/Q)_D = 2.032 \sum_{ij} \frac{N_{ij}}{N x u_i \Sigma_{zj}(x)}$$

where:

X/Q = relative concentration (sec/m^3)

i = index for wind speed

D = index for wind speed direction sector

j = index for Pasquill stability class

Σ_{zj} = vertical dispersion coefficient (m) of the plume for the given Pasquill stability class

x = downwind distance (m)

u = average wind speed for given wind speed class (m/sec)

n_{ij} = number of hours that wind speed interval i, Pasquill stability class j, and wind direction sector D occur simultaneously

N = total hours of valid data.

For a ground-level release, the building wake will increase dilution of the effluent. This can be accounted for by modifying the term Σ_{zj} in the equation above to:

$$\Sigma_{zj}(x) = (\sigma^2_{zj}(x) + D^2_z/2\pi)^{1/2}$$

subject to the restriction that

$$\Sigma_{zj}(x) \leq 3\sigma_{zj}(x)$$

where:

$\Sigma_{zj}(x)$ = the vertical diffusion parameter at distance x for stability class j

D_z = the vertical height above ground level of the tallest nearby structure (assumed to be 84.6 m for the reactor building)

The WNP-3 site is situated above a river valley in an area of gently rolling terrain. The potential for recirculation was evaluated by examining the monthly wind roses which are displayed in Tables 2.3-7a through 2.3-7l. During the spring and summer months, the prevailing wind is from the southwest quadrant with little indication of a recirculating wind direction from the northeast quadrant. During late fall and winter, however, there is a distinct secondary prevailing wind from the easterly sectors. An examination of wind directions under very light winds for the winter months wind rose data indicates a strong southerly component. The directional bias for light winds is not significantly different from that of stronger winds and indicates that the topographical influence of terrain to the south produces little recirculation. Thus, the constant mean wind model specified in Regulatory Guide 1.111[26] may be used to predict annual average dilution effects.

Cooling Tower Plume Model

A modification of a parametric thermodynamic plume model developed by Hanna[28] was used to estimate plume lengths and heights. The model computes the plume dimensions in two separate segments: a plume rise segment and a downwind segment. Both segments are one-dimensional and steady-state.

The first segment of the model, which determines the final plume rise, is identical to that developed by Hanna. The plume is injected into an atmosphere whose wind speed, temperature, and moisture content are allowed to vary with height. The effects of momentum, buoyancy, and cloud microphysics are included in the model. Changes in the plume parameters are calculated on a step-by-step basis until the liquid water in the plume has evaporated or until the vertical momentum and buoyancy forces have been neutralized. At this point, the final plume rise is achieved.

If the plume is still saturated at final plume rise, the second segment of the model is used. In this case, the model calculates the downwind dispersion of the plume according to Gaussian plume formulas. As the plume expands, the concentration of water vapor and liquid diminishes. At the distance where the water concentration (including that in the atmosphere) drops below the saturation level, the plume is assumed to disappear. If the relative humidity is already at 100 percent, it is assumed that a cloud or fog exists and that the plume is not visible.

Drift Deposition Model

The cooling tower drift deposition estimates presented in Subsection 5.1.4 are based on the method developed by Hosler et al.[29] The method graphically estimates the drift deposition pattern as a function of the salt concentration, plume rise, wind speed, relative humidity, and drop size. Plume rise was estimated using equations developed by Briggs[30] and Hanna.[28]

6.1.4 Land

6.1.4.1 Geology and Soils

Geologic and soils studies in support of plant design and safety analyses are described in Section 2.5 of the WNP-3 FSAR. The only studies undertaken specifically to evaluate the effects of plant operation are some soil chemistry analyses discussed in Subsection 6.1.4.3.

6.1.4.2 Demography and Land Use

Sources of demographic data and methods employed to use this data for population projections are outlined in Subsection 2.1.2. Land use data sources are identified in Subsection 2.1.3. Field verification was made for selected portions of the land use data (e.g., locations of vegetable gardens and groundwater users).

6.1.4.3 Terrestrial Ecological Parameters

WNP-3 construction and operation may impact the adjacent terrestrial environments in a variety of ways. Potential impacts of construction resemble those associated with logging activities. Deforestation may alter microclimatic conditions and consequently may affect the quality of the adjacent environment. Human disturbance due to construction may alter the quality of adjacent habitat for wildlife. During operation, cooling tower drift and vapor plumes may alter the quantity and quality of atmospheric inputs and solar radiation received by neighboring watersheds.

The construction-phase terrestrial ecology monitoring program used intensive sampling within four watersheds as a basis for evaluating potential impacts. Watersheds were selected to be representative of the two major habitats surrounding the site: maturing second-growth coniferous forests and recent clearcuts. They were selected in matched pairs so that areas adjacent to the plant site could be compared with areas outside the influence of the plant. The study plots are shown in Figure 2.2-2.

In humid regions, chemical cycling is intimately linked with the hydrologic cycle.[31] As a result, the use of watersheds as study areas permits the analysis of biogeochemical cycles. This analysis contributes to understanding both the function of terrestrial ecosystems and the types and quantities of terrestrial inputs to aquatic ecosystems. Vegetation composition, litter production and decomposition, bird, small mammal and deer populations were also studied from 1978 through 1980[9-12] in accordance with predetermined procedures.[13]

The construction-phase program was significantly reduced at the end of January 1981 and January 1982 per agreements with the State of Washington Energy Facility Site Evaluation Council (EFSEC).[1-4] A recommended preoperational and operational monitoring program will be presented to EFSEC thirty months before fuel load for WNP-3.[2]

Watershed Biogeochemistry

The watershed biogeochemistry study provided baseline data (1978-1980) on the seasonal concentrations of sodium, calcium, chloride, and sulfate (four ions expected to be in high concentrations in cooling tower drift) in bulk precipitaton, foliar leachate, and stream water.[9-12]

Baseline data were also collected for potassium, fluoride, nitrate and nitrite, orthophosphate, dissolved organic carbon, and total organic carbon concentrations in the watershed streams. In addition, bimonthly measurements were made of discharge, temperature, pH, turbidity, suspended sediment, and conductivity for the watershed streams. In 1978, soil samples were analyzed for sodium, calcium, chloride, sulfate, chromium, copper, zinc and mercury. The soil samples were collected at ten locations in each watershed.

Leachate and bulk precipitation collectors used in this study were similar to those described by Likens et. al.[32] The collectors consisted of an 18-cm diameter polyethylene funnel connected by Tygon tubing to a stoppered 20-liter polyethylene bottle filled with water that acted as a vapor barrier. The funnel was fitted with fiberglass screening to minimize entry of particulate matter. The carboys were rinsed with 30 percent nitric acid followed by several deionized water rinses prior to placement in the field. Ten to fifteen milliliters of reagent grade concentrated nitric acid were added to each carboy to prevent microbiological growth and to enhance metal solubility. Three collectors were placed in each watershed. Precipitation leached through the forest canopy (foliar leachate) was collected in the two clearcut watersheds.

Once a month the carboy was returned to the field laboratory where sample volumes were measured and a 1-liter aliquot was stored for analysis. Samples were analyzed for sodium, calcium, chloride, and sulfate. References used and detection limits for laboratory analyses are presented in Table 6.1-5.

Chemical and physical parameters were measured at the mouth of each of the watershed streams. Water samples, collected as surface grab samples, and *in situ* temperature and discharge measurements were taken twice monthly.

Samples were analyzed for turbidity, pH, and conductivity at the field laboratory immediately after collection. Suspended sediment concentrations were determined at the field laboratory within 7 days after collection. Upon receipt of the samples at the field laboratory, preservation and pooling were performed. Pooled samples were analyzed for fluoride, chloride, sulfate, sodium, potassium, calcium, orthophosphate, nitrate plus nitrite, and total and dissolved organic carbon. With the exception of total and dissolved organic carbon analyses, which were conducted on only the last sample collected during the month, all analyses were performed on pooled samples. Methods of analysis, detection limits, and references are presented in Table 6.1-5. Replicate analyses were made regularly to assess reproducibility of the data.

Vegetation Composition

Vegetation quadrats, each 10 x 20 m were established at ten sampling stations in each experimental clearcut watershed during the summer of 1978. The quadrats were resampled in 1979 and 1980. The long sides of these quadrats are parallel with the elevation contour to reduce within quadrat variability. Ten of the 20, permanently marked mini-plots within each quadrat were sampled. A 20 x 50 cm frame was placed parallel to the ground to outline the mini-plot and the cover class of each plant species in the mini-plot was estimated. Cover class was also determined for two additional groups: bare ground and litter, and lower plants (i.e., mosses, liverworts, mushrooms). Cover was recorded independently for each species as one of six coverage classes: 0 to 5, 5 to 25, 25 to 50, 50 to 75, 75 to 95, and 95 to 100 percent.[33] The midpoints of these classes were used to calculate mean percent coverage of each taxa. Coverage was defined as the percentage of the ground included in a vertical projection of imaginary lines drawn about the total natural spread of foliage for each species. If a species which could not be identified in the field, specimens were collected (outside the vegetation quadrat) and identified in the laboratory. In addition, the total number of Douglas-fir seedlings in each 10 x 20 m quadrat was counted. From these counts, the mean number of seedlings per hectare for each clearcut watershed was calculated.

In 1978, sampling in the forested watersheds included: 1) tall shrubs and trees greater than 1 m in height and less than 5 cm dbh (diameter at breast height) were sampled for density and frequency; 2) trees 5 cm dbh or greater were sampled for density, frequency and basal area; and 3) selected trees representative of watershed stands were sampled for age, height, and basal area.

Species and dbh were recorded for all trees and shrubs in each quadrat with stems greater than 5 cm in dbh. Trees and shrubs less than 5 cm in dbh but greater than 1 m in height were identified and counted in the quadrat. Mean forest stand height, age, and diameter were determined in each watershed using representative trees. These subjectively selected trees were permanently tagged, identified to species, and measured by dbh. A 36-cm increment corer was used to determine tree age. Tree cores were stored for later reference. Tree height was measured with a clinometer.

Litter Production and Decomposition

Litter production and decomposition are two watershed processes that reflect biological responses to chemical and physical inputs. These studies were performed in the forested watersheds from 1978 through 1980.

Litter traps were used to collect litter from the forest canopy at ten stations in each of the two forested watersheds. Each trap was 1 m square and 9 cm deep, with a 1.5-mm mesh screen on the bottom. Litter was generally collected once at the end of each month. Litter samples were placed in large plastic bags and transported to the laboratory where they were dried to constant weight. Each sample was hand-sorted into 11 litter categories and weighed.

Litter taken from the screen collectors was used as the source material for the litter decomposition study. Litter material from each forest was kept separate so that it could later be returned to the forest of origin. Coniferous leaves were sorted into groups of about 15 each. Coniferous twigs were broken into 1-cm pieces and sorted into groups of 6 g. Deciduous leaves were sorted into groups of about 10 g. Each litter group was dried, weighed, and placed inside a nylon mesh bag which was sewn closed with an inside area of about 360 cm^2. The entire sample was dried to constant weight at 65°C and weighed to the nearest 0.01 g.

Two samples of coniferous leaves and one sample of coniferous twigs were placed at each of the three intensive terrestrial sampling stations and the two aquatic stations in each forest watershed to monitor decomposition rates. Approximately 12 months later, the amount of dry weight loss was calculated for each sample, and the percent of dry weight loss relative to the initial dry weight of the litter was determined.

Birds

Watershed bird populations were studied in the breeding season and in winter. Spot-mapping (territory-mapping) techniques[34,35] were used to count breeding birds in the experimental watersheds in 1978 through 1980. The technique is based on locating and recording territorial males and other birds (not strongly territorial) on watershed maps during repeated walking censuses of the watersheds. Territorial males are identified by observing breeding behavior (e.g., singing from conspicuous perches and aggressive behavior between males) and the presence of a female, their nest, or both. Bird locations were recorded in relation to watershed boundary markers, internal station markers, topography, and stream drainage patterns. At the end of the census period, cumulative spot-maps for each species were constructed from the original census maps. The number of different males present was indicated by separated clusters of locations with territorial or breeding significance in the census area. If a single cluster of observations overlapped a watershed boundary, it was counted as belonging within the watershed only if half or more of the observations were inside. All species that were observed flying over or perched outside the census area were recorded as present. Six censuses of each watershed were conducted between 0400 and 1200 hours on days with little or no precipitation or wind in April through June.

The winter bird population study provided an index of winter bird abundance in the experimental watersheds. The procedure(36) was similar to the spot-mapping technique except that, since winter birds are not strongly territorial, only an index of abundance (i.e., mean number of birds observed per survey) could be obtained.

Roadside bird breeding surveys were conducted in 1979 through 1980 following procedures developed by the U.S. Fish and Wildlife Service for the Cooperative Breeding Bird Survey of North America. Surveys were conducted six times, April through June, during the spring breeding season and six times, November through February, during the winter. Habitats sampled were agricultural lands, riparian lands, coniferous and deciduous forest lands, recent clearcuts, and the plant site. Survey locations are shown in Figure 2.2-3.

A single, 50-stop census route with permanently marked census points 0.5 mi (0.8 km) apart was used for both winter and spring surveys. Counts began at dawn and lasted approximately 6 hours. Each census was conducted on calm, clear to partly cloudy mornings under atmospheric conditions that were expected to remain stable during the census period.

Birds heard or observed that could be identified within an estimated 0.25-mi (0.4-km) radius of each station were counted and recorded during a 3-minute period. An effort was made to avoid duplicate counts of individual birds. The number of species observed, the number of stops at which each species was observed, and the number of individuals of each species observed were calculated for each survey.

Ruffed and blue grouse were surveyed in 1978 through 1980 (six censuses per year) during the breeding season along routes near the site (treatment) and further away (control). Two observers simultaneously conducted auditory and visual counts at 15 roadside stations spaced at approximately 0.5-mi (0.8-km) intervals along each route (Figure 2.2-3). Each census began 30 minutes before sunrise and was conducted on calm, clear-to-partly-cloudy mornings under conditions expected to remain stable. At each stop, a 3-minute waiting period was used before a 4-minute counting period began. A compass was used to determine the azimuth to each grouse; the distance to each bird was estimated. The azimuth and distance helped to differentiate individual grouse.

Weekly surveys of the aquatic bird community along the Chehalis River were conducted by boat (Figure 2.2-3). All aquatic birds observed between South Elma Bridge and Smith Canal were identified, counted, and recorded. Aquatic birds were defined as those actually using river and shoreline habitats for foraging, breeding or resting. Surveys were conducted under all weather and river conditions, begining about 0930 hours and lasting about 4 hours. Surveys were usually conducted in conjunction with scheduled weekly water quality sample collections.

Small Mammals

Small mammals (mice and shrew) were counted at 169 trap stations in each watershed in 1978 using live trapping and multiple mark-recapture methods. The traps were checked daily for four consecutive days. This technique provided population estimates.

Deer

Black-tailed deer are common to habitats of the site and adjoining lands. The 1975 and 1978 through 1980 investigations were designed to monitor deer populations in the experimental watersheds to evaluate the effects of plant construction and operation on this important herbivore.

Pellet-group counting[37] was used for estimating deer population densities on the experimental watersheds in 1978 through 980. The technique involves clearing old fecal pellet groups and later counting the number of new pellet groups deposited during a known period on fixed plots distributed throughout the study area.

Pellet-group plots were searched in April/May and in October. Five (in the forested watersheds) or six (in the clearcut watersheds) circular plots, each 25 m^2 in size, were surveyed at each sampling station. To be reasonably certain all pellet groups were found, each plot was searched twice within a 3-day period. The total number of groups found on each plot was used as the observation for each plot. Mean deer densities were estimated for the two periods, assuming a mean defecation rate of 13 pellet groups per deer per day.[38]

6.1.5 Radiological Environmental Monitoring

United States Nuclear Regulatory Commission (NRC) regulations require that nuclear power plants be designed, constructed and operated to keep levels of radioactive materials in effluents to unrestricted areas as low as reasonably achievable (ALARA) (10 CFR 50.36a). To assure that such releases are kept as low as practicable, each license authorizing reactor operation includes technical specifications governing the release of radioactive effluents. In-plant monitoring is used to assure that these predetermined release limits are not exceeded. However, as a precaution against unexpected and undefined processes that might allow undue accumulation of radioactivity in any sector of the environment, a radiological environmental monitoring program (REMP) is also included.

The regulations governing the quantities of radioactivity in reactor effluents allow nuclear power plants to contribute, at most, only a few percent increase above normal background radioactivity. Background levels at any one location are not constant but vary with time as they are influenced by external events such as cosmic ray bombardment, weapons test fallout, and seasonal variations. These levels also can vary spatially within relatively short distances reflecting heterogeneity in geological compositions. Because of these spatial and temporal variations, the radiological surveys of the plant environs are divided into preoperational and operational phases. The preoperational phase of the REMP permits a general characterization of the radiation levels and concentrations prevailing before plant operation along with an indication of the degree of natural variation to be expected. The operational phase of the program obtains data which, when considered along with the information obtained in the preoperational phase, assist in the evaluation of the radiological impact of plant operation.

The preoperational monitoring provides the following:

- o identification of potentially important dose pathways to be monitored after the plant is in operation;
- o measurement of background radiation levels/concentrations and their variation along anticipated important pathways in the area surrounding the plant;
- o establishment of a preoperational baseline for statistical comparison of operational environmental data;
- o personnel training;
- o evaluation of procedures, equipment and techniques.

The early stages of the program will be flexible to accommodate changes in plant planning, land use, and demography and advances in monitoring and radioanalytical laboratory technology. The preoperational REMP is designed to correspond closely with the requirements of the operational monitoring program. Sampling locations were selected on the basis of local ecology, meteorology, and physical, demographic, and cultural characteristics of the region. The frequency of sampling for the preoperational program and the duration of the sampling period will, as a minimum, incorporate the parameters outlined in the NRC Branch Technical Position of November 1979[39] on the radiological portion of Regulatory Guide 4.8.

The specific instrumentation and radioassay techniques and associated minimum detectable levels for the analyses of the sample will depend on the laboratory performing the analyses. However, the laboratory will be required, at the minimum, to meet lower limit of detection (LLD) requirements as defined and outlined by the NRC.[39] The laboratory will also adhere to strict quality control procedures and participate in the Environmental Protection Agency's cross-check program, or its equivalent, to provide assurance of the accuracy of the analyses. When necessary for sensitivity of detection, radiochemical procedures will be used. Radiochemical procedures in this type of program serve mainly to separate or concentrate the radionuclide of interest from the inorganic or organic matrix in preparation for counting.

The following paragraphs describe the general program to be instituted, including the expected types of samples, collection frequency, and analysis to be accomplished on each sample type. The preoperational (i.e., prior to loading of fuel) phase of the REMP is summarized in Table 6.1-7. Planned sample locations are shown in Figure 6.1-2. Final details of the program will not be determined until just prior to implementation.

6.1.5.1 Airborne Radiation

Airborne iodine and particulates will be sampled by continuous low-volume air samplers with a flow rate of approximately 1 ft^3/min. Radioiodine will be collected via charcoal canisters fitted in series with a glass fiber filter for particulate collection.

The particulate filters will be changed weekly and analyzed for gross beta (beta analysis will occur no sooner than 24 hours from time of collection to allow for radon and thoron daughter decay). Filters composited quarterly by location, will be analyzed for gamma emitting nuclides. Individual weekly filters will have gamma isotopic analysis performed only if gross beta results are ten times the mean of the control location. Charcoal canisters will be analyzed weekly for ^{131}I.

The air sampling network will consist of seven stations. Three of the stations will be located near the site boundary north of the plant. Stations will also be located in the communities of Montesano, Elma, and Malone. A control station will be located in the community of Chehalis, which is about 30 miles southeast of the plant.

Particulate sampling will be initiated at least one year before fuel load and radioiodine analysis will begin at least six months before fuel load.

6.1.5.2 Direct Radiation

Direct radiation levels will be measured by a TLD (thermoluminescent dosimeter) system consisting of 31 stations. The TLDs will be located as follows:

- An inner ring of stations in 14 sectors where there is road access at a radius of approximately one mile. The SW and SSW sectors are omitted due to inaccessability.
- An outer ring of 13 stations in the sectors where there is road access at a radius of four to five miles.

- Three stations at the air sampling stations in Montesano, Elma and Malone.

- A control station at the Chehalis air sampling station.

Duplicate TLD sets will be placed at each location. One set will be exchanged on a quarterly basis; the other set of dosimeters will be collected annually. At least two years of preoperational TLD data will be collected.

6.1.5.3 Waterborne Radiation

River water will be sampled at the intake and discharge. These water samples will be collected using an automatic sampler; small volumes will be collected intermittently and composited over a one-month period. The composite sample will receive a gamma isotopic analysis monthly and will be composited for tritium analysis quarterly. Water monitoring will begin at least one year before fuel loading.

Groundwater will be sampled on a quarterly grab-sample basis from a domestic well of a nearby resident south of the Chehalis River. This sample will receive gamma isotopic and tritium analysis.

Sediment samples will be collected semi-annually from a fishing area on the north bank of the Chehalis River about 1½ miles downstream from the discharge diffuser. Gamma isotopic analysis will be performed on the samples.

6.1.5.5 Ingestible Products

Milk samples will be collected from four locations. Three locations will be in the sectors north of the site inside a three-mile radius. One of these will be from the nearest milk animal, presently a distance of just over one mile NNW. A control sample will be collected from a milk animal in the vicinity of Chehalis, Washington. The milk samples will be collected twice a month during pasture season and once a month during the remainder of the year. Gamma isotopic analysis will be performed on all samples; ^{131}I analysis will be performed by radiochemical separation on all samples collected during the pasture season. Milk sampling will begin one year prior to WNP-3 operation, and analyses of ^{131}I will start six months before operation.

Three fish samples will be collected semi-annually. Two will be taken near the plant discharge and one at a control location on either the Wynoochee River or Wishkah River. Gamma isotopic analysis will be performed on the edible portions of the fish.

One sample of each principal class of food products (fruit, root vegetable, leafy vegetable) from areas up to five miles downstream (which are irrigated by surface water from the Chehalis River) will be taken monthly or at harvest times when available. A control sample of a similar fruit/vegetable will be collected in the community of Chehalis.

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TABLE 6.1 - 1

SUMMARY OF RIVER AND STREAM WATER QUALITY PARAMETERS, STATIONS,[a] AND SAMPLING FREQUENCIES, NOVEMBER 1979 - JANUARY 1981

		Chehalis River Stations							Satsop River Sta.	Site Stream Stations							
Parameter	Sampling Frequency	R01	R02	R03	R04	R08	R09	R05	R11 R12	C11 C12	C13	C21	C31 C32	C41	C51 C52	C53	C61
Alkalinity	Monthly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
Ammonia-N	Monthly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
COD	Monthly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
Coliforms, fecal	Weekly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
Coliforms, total	Monthly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
Conductivity	Weekly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
Dissolved solids, total	Monthly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
Gas saturation	Monthly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
Hardness, total	Monthly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
Kjeldahl-N	Monthly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
Nitrate + Nitrite-N	Monthly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
Nitrite-N	Monthly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
Oil and grease	Weekly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
Oxygen, dissolved	Weekly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
pH	Weekly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
Phosphorus, dissolved orthophosphate	Monthly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
Phosphorus, total	Monthly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
Settleable solids	Weekly [b]	X[c]	X[c]		X[c]	X[c]	X[c]	X[c]	X[c]	X[c]	X[c]	X[c]	X[d]	X[d]	X[c]	X[c]	X[c]
Sulfate	Monthly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
Suspended sediment	Weekly	X	X	X	X[e]	X[e]	X[e]	X	X	X	X	X	X	X	X[e]	X[e]	--
Temperature	Weekly	X	X	X	--	--	--	X	X	X	X	X	X	X	--	--	--
Turbidity	Weekly	X[d]	X[d]	X	X[de]	X[de]	X[de]	X[d]	X[d]	X[d]	X	X[d]	X[d]	X[d]	X[de]	X[de]	X[c]

a/ Stations

C11/C12	Workman Creek (Lower)	C61	Stein Creek
C13	Workman Creek (Upper)	R01	South Elma Bridge
C21	Purgatory Creek	R02	Fuller Bridge
C31/C32	Fuller Creek	R03	Upstream Discharge
C41	Hyatt Creek	R04	Downstream Discharge
C51/C52	Elizabeth Creek (Lower)	R05	Below Barge Facility
C53	Elizabeth Creek (Upper)	R08	Intake Area
		R09	Stevens Creek
		R11/R12	Satsop River Mouth

b/ Determined only if turbidity was greater than 75 NTU.
c/ Only sampled in accordance with supplemental turbidity monitoring program.
d/ Also sampled in accordance with supplemental turbidity monitoring program. (Additional turbidity samples collected when 24-hour rainfall exceeded 1.0 in. or when stream turbidity measurements exceeded 75 NTU.)
e/ Sampling began in 1980.

TABLE 6.1-2

SUMMARY OF METALS MONITORING PROGRAM, 1980-1981

Station [a]	1			2			3			4		
Frequency [b]	W	M	Q	W	M	Q	W	M	Q	W	M	Q
Parameters [c]	Cr	Cd	Ca*			Cr			Cr	Cr	Cd	Ca*
	Ni	Pb	Mg*			Ni			Ni	Ni	Pb	Mg*
	Fe	Ba	K*			Fe			Fe	Fe	Ba	K*
	Cu	Mn	Na*			Cu			Cu	Cu	Mn	Na*
	Zn	Hg**				Zn			Zn	Hg**		
		Se				Ca*			Ca*		Se	
						Mg*			Mg*			
						K*			K*			
						Na*			Na*			

(a) Station 1 = Chehalis River at the Intake Area
2 = Chehalis River at the Discharge Area
3 = Chehalis river at the South Elma Bridge
4 = Makeup Water Well

(b) W = Weekly, M = Monthly, Q = Quarterly

(c) Samples analyzed for total and dissolved metals except as indicated by (*) for dissolved only and (**) for total only.

TABLE 6.1-3

SUMMARY OF PERIPHYTON STUDIES, 1976-1980

Sample Station	Sample Frequency and Substrate				
	1976	1977	1978	1979	1980
Green Banks	N				
Intake Area		N	NA	NA	A
Holding Area	N	N			
Upstream Discharge Area			NA	N	
Discharge Area	N	N	NA	NA	NA

N = Natural substrates

A = Artificial substrates

TABLE 6.1-4

SUMMARY OF BENTHIC MACROINVERTEBRATE STUDIES, 1976-1980

	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.
Holding Area [a]	76-C	X	X	X	X	X	X	X	
	77-C	X	X	X	X	X	X	X	
Upstream Discharge Area	78-C	X	X	X	X	X	X	X	
				78-MP		X			
	79-C	X	X	X	X	X	X	X	
Discharge Area	76-C	X	X	X	X	X	X	X	
	77-C	X	X	X	X	X	X	X	
	MP		X		X		X		
	78-C	X	X	X	X	X	X	X	
				78-MP		X			
	79-C	X	X	X	X	X	X	X	
				79-MP			X		X
	80-C		X		X		X		X
	MP		X		X		X		X
Intake Area	77-C	X	X	X	X	X	X	X	
	78-C	X	X	X	X	X	X	X	
				78-MP		X			
				B		X			
	79-C	X	X	X	X	X	X	X	
				79-MP			X		X
	80-MP		X		X		X		X
Greenbanks Station	76-C	X	X	X	X	X	X	X	

(a)Each station generally included a North and South substation.

B = Rock filled baskets/artificial substrates
C = Cores/natural substrate
MP = Multiple plates/artificial substrates
Example: 76-C means in 1976 core samples were collected beginning in March. Each following month marked with an X was similarly sampled.

TABLE 6.1-5

SUMMARY OF BULK PRECIPITATION, FOLIAR LEACHATE, AND WATERSHED
STREAM ANALYSIS METHODOLOGIES

Parameter	Units	Method	Detection Limit[a]	Reference [b]
Calcium	mg/l	Atomic Absorption	0.003 mg/l	EPA Manual p. 215.1
Chloride	mg/l	Colorimetric titration	1.0 mg/l	Standard Methods p. 304 EPA Manual p. 325.3
Conductivity	umho/cm	Wheatstone Bridge	10 umho/cm	Standard Methods p. 71
DOC	mg/l	Chromatographic	2 mg/l	Envirotech Corporation
Fluoride	mg/l	Potentiometric, ion selective electrode	0.01 mg/l	EPA Manual p. 340.1
Nitrate + Nitrite N	mg/l as N	Colorimetric - manual cadmium reduction	0.01 mg/l	EPA Manual p. 353.3
pH	pH units	Electrometric	NA	Standard Methods p. 461
Phosphorus, dissolved orthophosphate	mg/l as P	Colorimetric, ascorbic	0.005 mg/l	EPA Manual p. 365.2
Potassium	mg/l	Atomic Absorption	0.01	EPA Manual p. 258.1
Sodium	mg/l	Atomic Absorption	0.5 mg/l	EPA Manual p. 273.1
Sulfate	mg/l	Turbidimetric	1.0 mg/l	Standard Methods p. 496 EPA Manual p. 375.4
Suspended sediment	mg/l	Gravimetric	1.0 mg/l	Standard Methods p. 94 EPA Manual p. 160.2
Temperature	°C	Mercury thermometer	NA	Standard Methods p. 125
TOC	mg/l	Chromatgraphic	2 mg/l	Envirotech Corporation
Turbidity	NTU	Nephelometric	0.05 NTU	EPA Manual p. 180.1

(a) NA: Not applicable
(b) Standard Methods, 14th Edition, American Public Health Association 1975, 1193 pages
EPA Manual: Reference 6.1-14

TABLE 6.1-6

COOLING TOWER DRIFT DROP SIZE DISTRIBUTION[a]

Drift Droplet Size Range (Diameter, μm)	Percent of Drift Mass in Droplet Size Range
0-10	0.57
10-20	8.02
20-30	10.51
30-40	10.50
40-50	4.93
50-70	7.99
70-90	3.76
90-120	3.98
120-150	2.30
150-200	10.83
200-250	10.87
250-300	15.74

[a] Data supplied by Zurn, Inc.

TABLE 6.1-7

RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

Sample Media	Location	Sampling Frequency[a]	Analysis Type	Analysis Frequency
Airborne				
Radioiodine[b] Particulates[c]	Samples from 7 locations: 3 at site boundary or nearest residence in the N, NNW, and WNW sectors.	Continuous sampling with weekly collection	Radioiodine: ^{131}I	Weekly
	1 each in the vicinity of Elma, Montesano and Malone.		Particulates: Gross Beta[d]	Weekly
	1 control in Chehalis, 30 miles SE of the site		Gamma Isotopic [e]	Weekly Composite by location, quarterly
Direct Radiation[f]	There will be 31 stations as follows:	Quarterly and Annually	Gamma dose	Quarterly and Annually
	An inner ring of stations in each of 14 sectors (SW and SSW excluded due to inac cesibility) at a radius of approximately 1 mile.			
	An outer ring of 13 stations in the sectors where there is road access at a radius of four to five miles (SW, SSE and SE sectors excluded).			
	Three stations at the air sampling stations in Montesano, Elma, and Malone. There will be a control station at the Chehalis air sample station.			

TABLE 6.1-7 (contd.)

Sample Media	Location	Sampling Frequency[a]	Analysis Type	Analysis Frequency
Waterborne[c]				
River Water	Intake Discharge	Composite[g] for month	^{3}H	Quarterly composite
			Gamma Isotopic[e]	
Monthly				
Groundwater	Nearby resident domestic well NNW	Quarterly grab sample	^{3}H	Quarterly
			Gamma Isotopic	Quarterly
Sediment	1.5 miles downstream from discharge	Semi-annually	Gamma Isotopic	Semi-annually
Ingestion				
Milk[c,h]	4 locations as follows: in different sectors north of the plant site inside a 3-mile radius. One of these will be the nearest milk animal.	Semi-monthly during grazing season; monthly at other times	Gamma Isotopic ^{131}I [b]	Semi-monthly; monthly
	A control to be collected near Chehalis.			
Fish	2 in vicinity of discharge.	Semi-annually	Gamma Isotopic (edible portion)	Semi-annually
	1 control - Wynoochee or Wishkah River			
Fruit and Vegetables	Within 5 miles downstream of WNP-3 discharge and a control in the vicinity of Chehalis	Monthly during growing season	Gamma Isotopic	Monthly

TABLE 6.1-7 (contd.)

---

[a]Deviation may be required if samples are unobtainable due to hazardous conditions, seasonal availability, malfunction of automatic sampling equipment, or other legitimate reasons. All deviations will be documented in the annual report.

[b]Minimum six month preoperational sampling.

[c]Minimum one year preoperational sampling.

[d]Particulate sample filters will be analyzed for gross Beta after at least 24 hours decay. If gross Beta activity is greater than 10 times the mean of the control sample, gamma isotopic analysis should be performed on the individual sample.

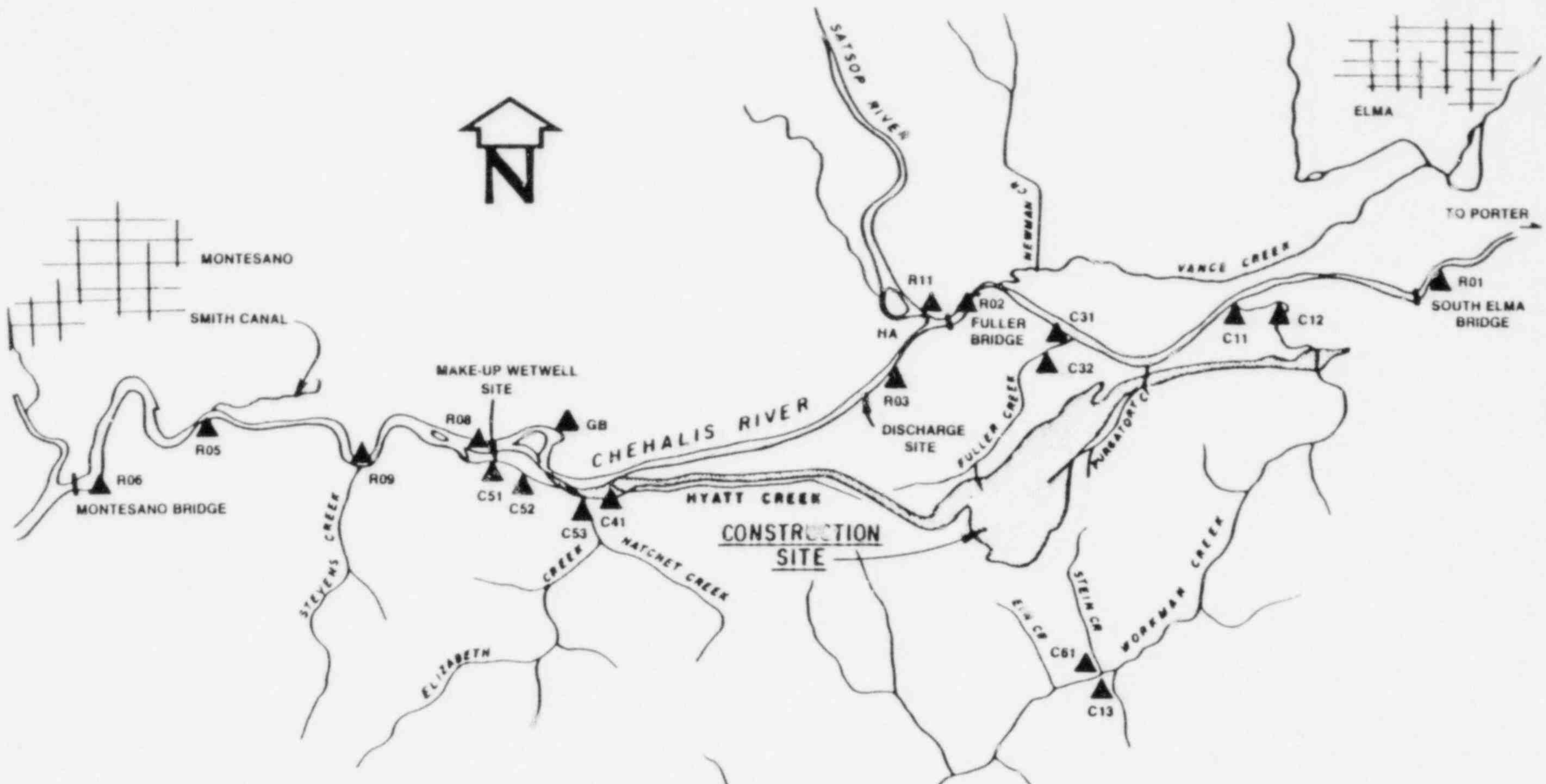
[e]Gamma isotopic means identifications and quantification of gamma emitting radionuclides that may be attributable to the effluents of the facility.

[f]Minimum two years preoperational monitoring.

[g]Composite samples will be collected with equipment which is capable of collecting an aliquot at time intervals which are short relative to the compositing period.

[h]Milk samples will be obtained from farms or individual milk animals which are located in sectors with the higher calculated annual average ground-level D/Q's. If Cesium-134 or Cesium-137 is measured in an individual milk sample in excess of 30 pCi/l, then Strontium 90 analysis should be performed.

[i]Fruit and vegetables will be obtained from farms or gardens which use Chehalis River water, if possible, for irrigation and different varieties will be obtained as they are in season. One sample each of root food, leafy vegetables, and fruit should be collected each period.



STATION CODE	STATION ▲
C11 / C12	WORKMAN CREEK MOUTH
C13	WORKMAN CREEK UPSTREAM OF CONSTRUCTION RUNOFF
C21	PURGATORY CREEK
C31 / C32	FULLER CREEK
C41	HYATT CREEK
C51 / C52	ELIZABETH CREEK (LOWER)
C53	ELIZABETH CREEK (UPPER)
C61	STEIN CREEK
R01	CHEHALIS RIVER AT SOUTH ELMA BRIDGE
R02	CHEHALIS RIVER AT FULLER BRIDGE
R03	CHEHALIS RIVER UPSTREAM OF PROPOSED PLANT DISCHARGE
R04	CHEHALIS RIVER DOWNSTREAM OF PROPOSED PLANT DISCHARGE
R05	CHEHALIS RIVER BELOW BARGE FACILITY
R08	CHEHALIS RIVER AT INTAKE AREA
R09	CHEHALIS RIVER AT STEVENS CREEK
R11 / R12	SATSOP RIVER NEAR MOUTH
GB	GREENBANKS
HA	HOLDING AREA

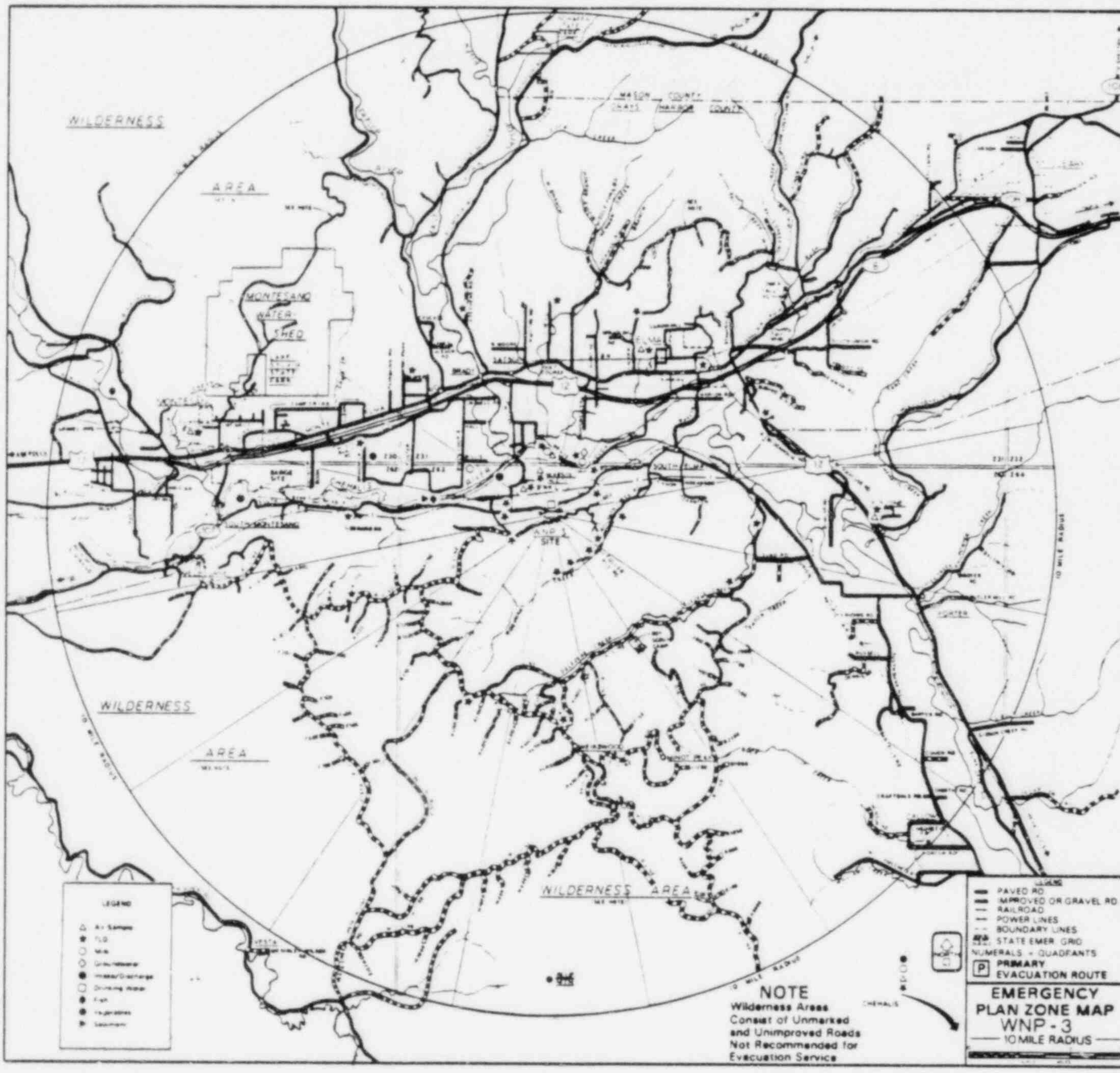
0 1/2 1 2 Miles

0 1 2 3 Kilometers

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
WNP-3 ER-OL

LOCATIONS OF WATER QUALITY AND AQUATIC ECOLOGY SAMPLING STATIONS

FIGURE 6.1-1



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	RADIOLOGICAL ENVIRONMENTAL SAMPLING LOCATIONS	FIGURE 6.1-2

6.2 OPERATIONAL ENVIRONMENTAL PROGRAM

The scope and general content of the operational environmental monitoring program and special topical studies are described in the following subsections. In all cases these programs may be modified based on the results of the preoperational programs and the first year of operational data.

6.2.1 Water Quality

The operational water quality monitoring program will be designed based upon the results of the construction and preoperational programs described in Subsection 6.1.1.1. At a minimum the monitoring will include the parameters and monitoring requirements imposed by NPDES Permit (see Appendix A).

6.2.2 Aquatic Environment

The operational aquatic monitoring program will be designed based upon results of the construction and preoperational programs described in 6.1.1.2.

6.2.3 Metorological

The operational meteorological monitoring program will provide wind speed, wind direction, and temperature at 60 meters and 10 meters on an open lattice tower. Temperature difference will be provided between 60 and 10 meters. Dewpoint temperature will be measured at 60 meters. Precipitation is measured at the surface near the tower. Backup meteorological parameters will be obtained from a 10 meter tower beyond collapse range of the 60 meter tower. Backup parameters will include wind speed and direction, a stability indicator, temperature, and precipitation (surface). Both primary and backup parameters will be routed to the Control Room and the Emergency Response Facility, as required for execution of the Atmospheric Dispersion Model. The equipment utilized in the preoperational monitoring program will be utilized to the maximum extent possible to meet a system non-availability design of 0.01.

6.2.4 Land

The first year operational terrestrial monitoring program will continue the preoperational programs described in 6.1.4.3 unless preoperational results indicate changes are necessary. The operational REMP (Subsection 6.2.5) will include an annual census of land uses that relate to important pathways (e.g., milk animals and gardens). This census will be to the detail and extent necessary to conform to the NRC guidance of Reference 6.1-39.

6.2.5 Radiological

The operational radiological environmental monitoring program (REMP) will be the same as the preoperational program described in Subsection 6.1.5 for the first year of operation. The scope of monitoring in subsequent years will be determined based upon the results of the two-year preoperational program and the first year's operational program.

6.3 RELATED ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAMS

Projected impact evaluations presented in this report have relied in part on data and information from past and ongoing programs in the vicinity of WNP-3.

Climatological and meteorological conditions have been defined with historical data obtained from the National Weather Service office at Olympia, Washington. All first order station parameters are continuously monitored at Olympia. In addition, wind, temperature, rainfall measurements and precipitation and weather observations are made by National Weather Service Cooperative Observers at Aberdeen, Elma, Montesano, and Oakville.

Ambient air quality data for nonradioactive pollutants was monitored in the project vicinity by the Olympia Air Pollution Control Authority and the Washington State Department of Ecology. Data collected at a suspended particulate monitor in Elma, sulfation monitors in Elma and Aberdeen, and a sulfur dioxide monitor in Hoquiam were used in evaluating background ambient air quality for this project.

The Washington Department of Ecology (DOE) is monitoring surface water levels, quality, and withdrawal rates in the Chehalis River Basin. This program evaluates the present and future status of water rights in light of regional changes as monitored by the DOE.

The United States Geological Survey (USGS) is monitoring various physical and chemical water quality parameters in the Chehalis River at Porter and the Satsop River at Satsop. Parameters monitored by the USGS include instantaneous discharge, temperature, pH, dissolved solids, disolved oxygen, bicarbonate, calcium, magnesium, sulfate, hardness, sodium, chloride, potassium, nitrate, silica and coliform. This program provides a historical record of water quality in the Chehalis and Satsop Rivers.

The Washington Department of Fisheries has conducted a number of studies on the status of salmon in the Chehalis River Basin including the Chehalis and Satsop Rivers. These studies included evaluation of natural and hatchery reared fish population, pollution studies in Grays Harbor, and the development of stream catalogs which consolidate all available physical description and data concerning individual rivers and tributaries within the Chehalis River Basin.

The Washington Department of Game has engaged in studies on game fish populations in the Chehalis and Satsop Rivers such as the evaluation of annual steelhead trout catch, the eradication of fish populations such as squawfish that prey upon the more desirable game fish, and the assessment of small and big game population in the game management unit (10 GN) within which the site is located.

The Washington Department of Natural Resources (DNR) maintains periodic resource inventories of State owned land. These inventories include land ownership, cover type, forest species data, physical characteristics, etc. One plot inventoried by DNR is located near the plant site in Section 16, T17N, R6W.

ENVIRONMENTAL EFFECTS OF ACCIDENTS

7.1 STATION ACCIDENTS INVOLVING RADIOACTIVITY

Numerous barriers and features are provided which guard against accidental or uncontrolled releases of radioactive materials to the environment. These barriers include 1) the sealed metal cladding tubes which contain the fuel pellets, 2) the Reactor Coolant System which encloses the reactor, and 3) the Containment which houses the Reactor Coolant System. Additional protection of the public is provided by safety features which control the release of radioactivity in the event of an accident. The site location further mitigates the potential effects to the public of an accidental release of radioactivity.

Various postulated incidents and accidents have been analyzed and reported in Chapter 15 of the Final Safety Analysis Report (FSAR). These analyses demonstrate that the plant can be operated safely and that maximum radiation exposures from credible accidents would be within the guidelines of 10 CFR Part 100. To provide a high degree of assurance that the radiation doses will be within these guidelines under any credible circumstances, the analyses have been performed using very conservative calculations and assumptions. Because of the degree of conservatism, the doses calculated and reported in the FSAR are far in excess of what would be realistically expected.

To facilitate the assessment of the impact of possible incidents and accidents in a realistic manner, and therefore to allow a judgment as to the potential environmental risk inherent to the operation of WNP-3 further analyses have been made. As compared to the FSAR analyses, the environmental risk analyses are intended to be more realistic. For example, realistic values have been assigned to such parameters as filter efficiencies and atmospheric diffusion.

Table 7.1-1 summarizes the events which were considered. These represent a spectrum of accidents from trivial (Class 1) to the most severe within the realm of probability (Class 9).[1,2] For accident Classes 1-8 the impacts of the postulated events (discussed in Subsections 7.1.1 through 7.1.8) are evaluated in terms of radiation doses to an individual at the exclusion area boundary and the population within 50 miles of WNP-3. The calculated doses are limited to whole body and thyroid gland because these are the critical organs of exposure for the radionuclides of potential concern. Table 7.1-2 provides the core inventory and conversion factors which were used. Calculations used the 50 percent X/Qs and assumptions consistent with Regulatory Guide 1.4.[3]

The impacts (e.g., acute fatalities, costs) of Class 9 accidents are evaluated in terms of probability distributions for the population at risk within 200 miles in the year 2010. Specific assumptions for Class 9 accidents are given in Subsection 7.1.9.

7.1.1 Trivial Incidents (Class 1 Accidents)

These low level releases are evaluated as routine releases and are included in the plant release source terms discussed in Section 3.5. The environmental consequences of these low-level releases are, therefore, included in Section 5.2.

7.1.2 Small Releases Outside Containment (Class 2 Accidents)

Pipes, valves and flanges of systems containing fluids or gases with potentially significant radioactive concentrations are designed, fabricated and installed to minimize leakage during normal plant operations. However, wear and use-related activities can cause small amounts of leakage. These low-level releases are evaluated as routine releases and are included in the source terms discussed in Section 3.5 and the associated environmental consequences are given in Section 5.2.

7.1.3 Radwaste System Failure (Class 3 Accidents)

Class 3 accidents are initiated by equipment failure or operator error that result in the release of radioactive contaminants to the atmosphere of the Reactor Auxiliary Building (RAB). Four accidents that are considered in this category: equipment leakage or malfunction of a waste gas decay tank; equipment leakage or malfunction of a liquid radwaste holdup tank; rupture of a waste gas decay tank; and rupture of a liquid radwaste holdup tank.

7.1.3.1 Equipment Leakage or Malfunction of a Waste Gas Decay Tank

Because of the design of the waste gas decay tanks and the quality control during fabrication, the probability of a release of the stored radioactive gases in the waste gas decay tanks as a result of component failure and inadvertent venting is considered small.

For the purposes of this analysis it is assumed that an inadvertent venting occurs in which 25 percent of the radioactivity contained in a waste gas decay tank is released unfiltered to the environment via the plant vent. This event could result from an operator error.

The estimated release is listed in Table 7.1-3 and the resulting doses are given in Table 7.1-8.

7.1.3.2 Equipment Leakage or Malfunction of a Liquid Waste Holdup Tank

Postulated events that could result in the release of a portion of the radioactive inventory of a liquid holdup waste tank are cracks in the steel tanks and operator error. The probability of cracks is very small because the tanks are not subject to high pressures or unusually high stresses. Ths possibility of liquid radwaste release initiated by an operator error is also considered remote. Operating techniques and administrative procedures will emphasize detailed system and equipment operating instruction and will minimize the potential for operator error. In the unlikely event that a release of liquid radioactive wastes does occur, floor drain sump pumps located in the RAB will automatically activate and remove the spilled liquid upon receipt of a high water level alarm in the sump pump floor drains.

For this evaluation it is postulated that an unspecified leak or malfunction results in the release of 25 percent of the average inventory of the tank containing the largest quantities of significant isotopes in the waste management system. The airborne radioactivity released from this tank during the accident is then vented directly to the environment. It is also assumed that the iodine partition factor for air to water is 0.001 and that the airborne radioactivity released to the RAB is released unfiltered to the environment via a plant vent.

The releases associated with this accident are shown in Table 7.1-3 and the resulting doses are given in Table 7.1-8.

7.1.3.3 Rupture of a Waste Gas Decay Tank

The radioactive gases stored in the decay tanks will consist of fission product gases, hydrogen, and nitrogen cover gases. The nitrogen will be added in the various collection and holdup tanks to preclude the possibility of obtaining a flammable mixture of hydrogen gas. Hence, a tank rupture as a result of ignition of hydrogen in the decay tank is considered remote. The system is designed to appropriate industry and seismic Category I component standards. In addition, a system monitor with associated alarm, isolation valves, and system surveillance assures that the possibility of this type of accident is small.

For this evaluation it is assumed that an unspecified event initiates the complete rupture of a waste gas decay tank and results in the release of 100 percent of the average tank inventory. The airborne radioactivity released from this tank during the accident is then vented directly to the environment via the plant vent. The activity released by this event is listed in Table 7.1-3.

The doses associated with the waste gas decay tank rupture are shown in Table 7.1-8.

7.1.3.4 Rupture of a Liquid Radwaste Holdup Tank

This postulated accident is an unspecified event that initiates the complete rupture (with 100 percent inventory release) of the tank containing the largest quantities of significant isotopes in the waste management system. The airborne radioactivity released from this tank to the RAB is then vented unfiltered to the environment via the plant vent assuming an iodine partition factor of 0.001. The released radioactivity is given in Table 7.1-3.

The associated doses are presented in Table 7.1-8.

7.1.4 Fission Products to BWR Primary System (Class 4 Accidents)

This class of accidents is not applicable to WNP-3.

7.1.5 Fission Products to PWR Primary and Secondary Systems (Class 5 Accidents)

7.1.5.1 Fuel Cladding Defects and Steam Generator Leaks

Releases from these events are included in design and are evaluated as routine releases in Section 5.2.

7.1.5.2 Off-design Transient that Induces Fuel Failure Above Those Expected and Steam Generator Leaks (Such as Flow Blockage and Flux Maldistributions)

An off-design transient that could induce fuel rod failures is the seizure of a reactor coolant pump shaft. Components and materials used to construct the reactor coolant pumps are of the type that have been used successfully in other nuclear power plants. The equipment is designed to seismic Category I requirements. In addition, the reactor coolant pumps are designed, fabricated, and constructed under a comprehensive quality asssurance program to assure compliance with all applicable specifications and codes. Considering these precautions, the probability of an accident of this type occurring during the lifetime of the plant is considered remote.

Nonetheless, in this analysis the instantaneous seizure of the pump shaft is postulated. The reactor coolant flow following such an event would be rapidly reduced. Since a rapid reduction in coolant flow results in a rapid reduction to the margin to departure from nucleate boiling (DNB), a low DNB ratio trip occurs.

To assess the radiological consequences of this accident, the reactor coolant radionuclide inventory has been adjusted to account for the additional fission product release resulting from failure of the fuel cladding due to the accident. For the purposes of this analysis, the quantity of noble gases and radioiodines released from the secondary system have been considered to be proportional to the amount of steam that passes through the condenser hotwell during the cooldown period, the condenser hotwell iodine partition factor, and the concentration of radioiodine in the turbine steam.

It is assumed that cooldown is effected by dumping 1,400,000 lb of steam to the main condenser with the aid of the turbine bypass valves. After the plant is sufficiently cooled, the main condenser is shutdown and the condenser vacuum pump discharge to the atmosphere is determined. Specific assumptions are:

a) of the core inventory, 0.02 percent of the noble gases and 0.02 percent of the halogens are released into the reactor coolant;

b) the reactor coolant inventory prior to the accident is based on 0.5 percent failed fuel;

c) secondary system equilibrium radioactivity prior to the transient is based on a 20 gal/day steam generator leak rate and 10 gpm steam generator blowdown rate; and

d) the main consdenser iodine partition factor is 0.001.

The released activity is given in Table 7.1-3 and the offsite exposures and are shown in Table 7.1-8.

7.1.5.3 Steam Generator Tube Rupture

Experience with nuclear steam generators indicates the probability of complete severance of the Inconel vertical U-tubes is remote. No such double-ended tube rupture has ever occurred and is not expected to occur in the WNP-3 steam generators. The more probable modes of failure result in much smaller penetrations of the pressure barrier. They involve the formation of etch pits, small cracks in the U-tubes, or cracks in the welds joining the tubes to the tube sheet. These releases are evaluated under normal plant operations in Section 5.2.

A steam generator tube rupture accident assumed here causes a penetration of the barrier between the reactor coolant system and the main steam system. Radioactivity contained in the reactor coolant then mixes with shell-side water in the affected steam generator and then passes to the turbine and condenser. The noncondensible radioactive materials in the condenser hotwell are discharged to the environment through a charcoal bed absorber by the condenser air ejectors.

It is assumed that the operator has diagnosed the problem and has closed the main steam and feedwater isolation valves for the leaking steam generator. Radioactivity levels in the steam generator blowdown lines from the damaged steam generator are the main indicator. Plant cooldown is initiated by dumping steam from the intact steam generator. After the temperature of the reactor coolant is sufficiently reduced, the operator initiates shutdown cooling and isolates both steam generators. During the plant cooldown period the operator manually regulates safety injection and charging flow rates to maintain a measurable pressurizer water level.

Assumptions for calculating doses include:

a) fifteen percent of the reactor coolant leaks from the primary to secondary system;

b) failed fuel prior to the accident is 0.5 percent;

c) the equilibrium reactor coolant radionuclide concentration prior to the rupture is based on a primary-to-secondary steam generator leak rate of 20 gallons per day and a steam generator blowdown rate of 10 gpm;

d) during the plant cooldown 1,400,000 lb of steam pass through the condenser hotwell from the intact and faulted steam generators;

e) the quantity of noble gases and radioiodines released are proportional to the flow rate of steam through the condenser; and

f) the iodine partition factors for the steam generators and condenser hotwell are 0.01 and 0.001, respectively.

The radioactivity released by this accident is given in Table 7.1-3 and the offsite doses are shown in Table 7.1-8.

7.1.6 Refueling Accidents (Class 6 Accidents)

Class 6 accidents are postulated to occur during refueling operations in the Reactor Building. These accidents are the dropping of a fuel bundle assembly and dropping a heavy object onto the reactor core.

7.1.6.1 Fuel Bundle Drop

The possibility of damage to a fuel assembly as a consequence of equipment failure or mishandling is minimized through equipment design, detailed refueling procedures and personnel training. The reliability of the fuel handling equipment, including the bridge and trolley, the lifting mechanism, the transfer mechanism and all associated instrumentation and controls, is ensured through adoption of preoperational check-out tests. The maximum elevation to which the fuel assemblies can be raised is limited by the design of the handling hoists and manipulators. The refueling equipment platform assembly is constructed to seismic Category I requirements is considered remote.

The accident that has been postulated is an equipment failure or mishandling event that results in the dropping of a spent fuel assembly into the upper refueling pool during refueling operations. It is further assumed that the assembly falls from a height sufficient to rupture one row of fuel rods, whose gap activity is subsequently released to the refueling pool water. The radioactive gases then bubble through the water which entrains most of the iodine. The remainder escapes to the Reactor Building atmosphere. The airborne radioactivity is then passed through charcoal filters before being released to the environment. Specific assumptions are:

a) the accident occurs one week after reactor shutdown;

b) the equilibrium gap activity (noble gases and halogens) in one row of fuel rods (16 fuel rods) is released into the refueling pool water;

c) gas gap activity is one percent of the total activity of a fuel pin;

d) the iodine decontamination factor (initial activity/final activity) is 500;

e) one percent of the airborne radioactivity released into the Reactor Building leaks to the environment unfiltered prior to isolation of the containment;

f) 99 percent of the airborne radioactivity released into the Reactor Building is released to the environment via charcoal filters;

g) the efficiency of the charcoal filters is 99 percent.

The amount of activity released by this postulated accident is given in Table 7.1-3 and the offsite doses are shown in Table 7.1-8.

7.1.6.2 Heavy Object Drop Onto Fuel In Core

The probability of a heavy object drop accident is considered even less than the fuel handling accident. For this evaluation it is postulated that a heavy object is dropped onto the reactor core as a result of equipment failure or mishandling. It is further postulated that the heavy object is dropped from a height sufficient to rupture one fuel assembly whose gap activity is subsequently released to the reactor core coolant. The radioactive gases then bubble through the reactor coolant with most of the iodine being entrained. The remainder is then released to the containment atmosphere. The airborne radioactivity is then passed through charcoal and HEPA filters before being released to the environment. Specific assumptions are the same as for the fuel handling accident except for the following:

a) the accident occurs 100 hours after reactor shutdown; and

b) the equilibrium gap activity (noble gases and halogens) in one average fuel assembly (236 fuel rods) is released into the reactor coolant.

The estimated releases to the environment are given in Table 7.1-3 and the calculated offsite doses are presented in Table 7.1-8.

7.1.7 Spent Fuel Handling Accidents (Class 7 Accidents)

Class 7 accidents involve the handling of spent fuel during yearly refueling operations in the Fuel Handling Building (FHB). Three accidents are considered in this class: dropping of a fuel assembly in the fuel storage pool; dropping of a heavy object onto the fuel storage rack; and the dropping of a loaded spent fuel shipping cask. As with refueling accidents (Class 6), the possibility of these accidents is minimized by equipment design, operating procedures, and personnel training.

7.1.7.1 Fuel Assembly Drop in Fuel Storage Pool

This event postulates that a spent fuel assembly is dropped in the refueling pool from an unspecified height by the fuel handling crane and falls through the pool onto the spent fuel storage rack. Upon impact, the fuel rods fail and release their gas gap activity into the spent fuel pool. The released radioactive gases then bubble through the spent fuel storage water with most of the iodine being entrained and the remainder being released to the FHB atmosphere. Upon receipt of a signal for high radioactivity, the isolation dampers of the ventilation system will close and the release is passed through charcoal filters to the environment. Specific assumptions are:

a) the accident occurs one week after reactor shutdown;

b) it is assumed that one row (16) of fuel rods fail;

c) an average of one percent of the noble gas activity and one percent of the halogen core activity is in each fuel rod gap and is available for release;

d) the iodine decontamination factor in the refueling pool water is 500; and

e) the airborne radioactivity is passed through 99 percent efficient charcoal filters before being released to the environment.

The resulting release is given in Table 7.1-3 and the offsite doses are shown in Table 7.1-8.

7.1.7.2 Heavy Object Drop Onto Fuel Rack

The design of the spent fuel handling area and fuel handling equipment is such that no identifiable heavy objects can be lifted or carried over the spent fuel storage racks. However, to provide an upper limit estimate for the maximum hypothetical release for an accident of this type, it is postulated that an unspecified heavy object is dropped onto the spent fuel storage rack and results in the release of radioactive gases from the damaged fuel elements. The released radioactive gases then bubble through the spent fuel storage pool water, with the iodine gases undergoing a scrubbing process as the gas bubbles rise to the surface of the water. The noble gases and remaining iodine gas are then released to the FHB atmosphere where the same ventilation procedures, enacted during a fuel assembly drop accident (Subsection 7.1.7.1) apply. The same assumptions for calculating consequences also are applicable except for the following:

a) the accident occurs 30 days after reactor shutdown; and

b) the gas gap activity in one average fuel assembly (236 fuel rods) is released into the spent fuel pool.

The released radioactivity is given in Table 7.1-3 and the resulting offsite doses and are presented in Table 7.1-8.

7.1.7.3 Fuel Cask Drop Accident

The design of the Fuel Handling Building is such that the only transfer operation that could involve the dropping of a loaded spent fuel cask a significant distance is the transfer of the cask from the spent fuel cask storage area pool to the decontamination area. Assumptions used to calculate releases include:

a) the fuel shipping cask contains seven fuel assemblies;

b) an average of one percent of the noble gas core activity is in each fuel rod gap and is available for release;

c) all of the noble gas gap activity from one fully-loaded fuel shipping cask (120 days cooling) is released;

d) activity is released instantaneously and unfiltered, to the environment.

The estimated released activity is given in Table 7.1-3 and the calculated offsite doses are given in Table 7.1-8.

7.1.8 Accident Initiation Events Considered in Design Basis Evaluation in the Safety Analysis Report (Class 8 Accidents)

This class of accidents is considered in detail in Chapter 15 of the FSAR and are outlined in the following paragraphs.

7.1.8.1 Loss-of-Coolant Accident: Break in a Small Pipe

A loss-of-coolant accident (LOCA) is a malfunction of the Reactor Coolant System that interrupts normal cooling operations and results in the release of reactor coolant, containing radioactive fission products, to the containment. The activity is then released to the atmosphere via leakage from the containment. The probability of such an accident is considered remote.

The plant has been designed, fabricated and constructed under a comprehensive quality assurance program to assure compliance with all applicable specifications and codes. All reactor coolant system components are designed, fabricated and inspected in accordance with ASME Section III, Code Class 1 and Section XI. The major reactor coolant system components are designed for a 40-year operating life. Components are of materials that are compatible with coolant chemistry. Fatigue analyses based on conservative design cyclic transients and primary stress combinations have been evaluated in accordance with the applicable codes. Overpressure protection is assured by ASME Code III safety valves. Technical Specifications, operating procedures and other administrative controls assure plant operating conditions within limits previously determined to be acceptable.

Nonetheless, for the purposes of consequence evaluation a LOCA is postulated with the following assumptions:

a) the average radioactivity inventory in the primary coolant (at 0.5 percent failed fuel) is released into the containment;

b) the Shield Building Ventilation System (SBVS) filter has an efficiency of 99 percent for the iodines;

c) the containment leak rate is 0.20 percent/day for the first 24 hours and 0.10 percent/day for the duration of the accident; and

d) five percent of the halogens and all of the noble gases remain airborne and available for leakage from the containment.

The releases to the environment are presented in Table 7.1-4 and offsite exposures are presented in Table 7.1-8.

7.1.8.2 Loss-of-Coolant Accident: Large Pipe Break

The large pipe break accident is considered less probable than the small pipe break LOCA (Subsection 7.1.8.1). This accident is postulated as an unspecified event that results in the break of a large reactor coolant pipe and subsequent release of the reactor coolant inventory. The average radioactivity inventory in the primary coolant (based on 0.5 percent failed fuel) plus two percent of the core inventory of halogens and noble gases are assumed to be released into the containment. Other assumptions are the same as for Subsection 7.1.8.1. A portion of the halogens and all of the noble gases from this release have been assumed to become airborne in the containment and available for leakage.

The released activity is listed in Table 7.1-5 for different durations and the offsite doses are given in Table 7.1-8.

7.1.8.3 Break in Instrument Line from Primary System that Penetrates the Containment (Lines not Provided with Isolation Capabilities Inside Containment)

Instrument lines which are part of the reactor coolant system pressure boundary have one automatic isolation valve inside and one automatic isolation valve outside the containment. Accordingly, there are no instrument lines containing significant quantities of radionuclides from the primary system that penetrate the containment that are not provided with isolation capabilities inside the containment. This accident is, therefore not, applicable to WNP-3.

7.1.8.4 Control Rod Ejection Accident

Rapid ejection of a Control Element Assembly (CEA) from the core would require a complete circumferential break of the Control Element Drive Mechanism (CEDM) housing, and of the CEDM nozzle on the reactor vessel head. The CEDM housing and CEDM nozzle are an extension of the reactor coolant system boundary and are designed, fabricated and inspected to ASME Section III, Code Class 1. Considering the design precautions, such a CEA ejection has a very low probability.

A Control Element Assembly (CEA) ejection accident would have the following sequence of activities. After ejection of a CEA, the core power would rise rapidly for a break period until terminated by the Doppler effect. Reactor shutdown would be initiated by the high linear power level trip and the power transient would then be completed. The core is protected against severe fuel damage by the allowable CEA patterns and by the high power trip; the maximum enthalpy in the fuel during the transient is limited to an acceptable value.

Since offsite power is assumed to be available, the only significant doses due to this postulated accident would result from activity released via the SBVS. The radioactivity of the primary coolant is assumed to consist of the radioactivity contained in the coolant (based on 0.5 percent failed fuel) prior to the accident, plus 0.2 percent of the core inventory of noble gases and halogens released from the fuel rods upon rod perforation. The noble gases released from the damaged fuel rods have been assumed to be immediately and completely released to the containment. The released iodines will volatilize and be partially scrubbed out by the reactor coolant. Assumptions regarding containment leak rates and filter efficiency are the same as those used in Subsection 7.1.8.1.

The releases for the fuel rod ejection accident are given in Table 7.1-6 and offsite doses are given in Table 7.1-8.

7.1.8.5 Small Steamline Break Accident

A small steamline break accident is postulated as the rupture of a main steamline (no larger than the throat diameter of the main steam safety valves) outside containment. The worst situation for such a break is upstream of the main steam isolation valve whereby the release is stopped only by termination of feedwater flow to the steam generator.

The release rates of radionuclides as a function of time have been considered to be proportional to the amount of steam released via the minor secondary system pipe break. All the mass leaving the break is assumed to be in the steam phase. The volume of one steam generator has been assumed to be released. Specific assumptions are as follows:

a) primary reactor coolant activities are based on 0.5 percent failed fuel;

b) secondary system equilibrium radionuclide concentrations prior to the incident are based on a 20 gal/day steam generator leak rate and a 10 gpm steam generator blowdown rate;

c) during the course of the accident, a halogen reduction factor of 0.1 is applied to the primary coolant source in the steam generator; and

d) the total integrated quantity steam leaving the break during the accident is 1.67×10^5 lb, with an iodine partition factor of 0.1.

The radioactivity released to the environment by the small steamline break is given in Table 7.1-7 and the calculated offsite exposures are given in Table 7.1-8.

7.1.8.6 Large Steamline Break Accident

This analysis postulates that a circumferential rupture of a steamline occurs upstream of the main steam isolation valve outside the containment. Assumptions are the same as for the small steamline break (Subsection 7.1.8.5) except for the halogen reduction factor is taken as 0.5 rather than 0.1.

The large steamline break releases are listed in Table 7.1-7 and the offsite doses are given in Table 7.1-8.

7.1.9 Accidents More Severe Than Design Basis Events

Accidents in this category (Class 9) result from the possible degradation or failure of one or more redundant emergency safety systems and, hence, are beyond the design basis limits for the plant. These accidents involve substantial deterioration (including melting) of the reactor fuel and failure of the containment structure to perform its intended function of limiting the release of radioactive materials. The probabilities associated with these events are extremely low but the consequences of an individual occurrence are greater than the other accident categories.

7.1.9.1 Assessment Methods

The methodology employed to assess the impacts of a severe accident at WNP-3 is based on the methods employed in the NRC's Reactor Safety Study(RSS).(4) Calculations were performed using the CRAC2 Code(5) which is a revised version of the CRAC (Calculation of Reactor Accident Consequences) Code developed for the RSS. There are five basic sets of input data for the CRAC2 analysis: accident release data, weather data, population data, land use data, and evacuation data. The calculation methodology is summarized in Figure 7.1-1.

The calculation of reactor accident consequences starts with a postulated breach of containment and release of radioactivity. Following the postulated release, the dispersion of the radioactivity, cloud depletion, and ground contamination are calculated from atmospheric dispersion models. Using the resulting air and ground contamination, the dosimetric models determine the doses to individuals. Early and chronic doses to individuals are determined from a number of exposure pathways. Early doses accrue from exposure to the passing cloud (direct radiation and inhalation), and early exposure to the ground contamination. Chronic doses accrue from exposure accumulated at later times including doses from ingestion of contaminated food and/or milk products, inhalation of resuspended ground contamination, and long-term (greater than 7 days) direct exposure to ground contamination.

The health effects are then determined based on the calculated doses and the population distribution around the plant. Several mitigation measures including population evacuation/relocation and, food/land interdiction are considered in the determination of the population doses and health effects. The health effects estimated in CRAC2 are divided into two categories: acute and latent. Acute health effects refer to injuries and fatalities occurring within a year of the accident. The latent effects refer to the somatic effects which later are manifested in the form of cancer during a plateau period assumed to be about 30 years. Genetic effects are about twice the number of latent cancers. Lastly, the economic impacts are calculated in terms of property damage and costs. Property damage is specified in terms of interdicted areas of land, crops, and/or milk, while costs include the estimated costs of such interdiction, as well as the direct costs of ground decontamination, and population evacuation or relocation.

The results of the CRAC2 consequence model are displayed as a set of cumulative probability distribution functions for specific consequences. These distributions are determined from the calculated magnitude of each consequence for a number of combinations of postulated accident release, weather, and population, as well as the probability of each such combination.

7.1.9.2 Accident Release Categories

The accident sequences which were evaluated are revisions of sequences used for the prototype PWR in the RSS. The four postulated accidents are defined as EVENT V, TMLB, PWR-3, and PWR-7 and represent the spectrum of severe accidents considered possible for a plant such as WNP-3.[6] The radioactive source inventory was based on the core isotopic composition of a 3412 MWth unit[7] multiplied by 1.1 to reflect the larger capacity of WNP-3. The release categories and accident parameters are shown in Table 7.1-9.

All four PWR accidents lead to total or partial core melt. Accident PWR-7 postulates the melt-through of the base mat as the containment failure mode. Release of the radioactive material from containment could result in its introduction into the hydrosphere and, through contact with groundwater, could lead to potential water exposure pathways. Since the rate of travel of these materials through the aquifer to a downstream discharge or withdrawal point is much slower than the air transport of the accompanying atmospheric release, exposures by the liquid pathway are not included in the consequences. This is consistent with the approach used in the RSS. Also a generic study of liquid pathway impacts noted that substantial holdup and mitigation in the vicinity of the containment would be expected in the event of core melt-through at land-based nuclear plants.[8]

7.1.9.3 Atmospheric Dispersion

Data for CRAC2 input consisted of one year of hourly-averaged measurements of the following parameters: wind speed, wind direction (vector-averaged), Pasquill-Gifford stability class, and precipitation. The 8760 hours of data were sorted into 29 distinct weather categories which are randomly sampled by the code. This results in an accurate and economical approximation of annual average conditions.

7.1.9.4 Population

Population doses were based on the projected resident population for the year 2010 out to 200 miles from the plant. The data in Table 2.1-2 was used inside 50 miles with minor redistribution to accomodate the CRAC2 calculation intervals. Population for the eight intervals between 50 and 200 miles was obtained from 1980 city and county census data. Data were assigned to sectors based on areal distribution of the census unit (e.g., city or county) relative to the grid sector. Canadian population were included in the five sectors which encompassed parts of British Columbia. Projections to the year 2010 for the 50 to 200 mile area were based on the composite growth factor of 1.43 applied to the 1980 numbers.

7.1.9.5 Land Use and Economic Data

Land use and economic data are based on regional averages. Economic information includes decontamination costs (for farms and residential, business, and public areas), relocation costs, property value, and food costs (dairy and non-dairy). Farm information specific to the WNP-3 region included planting/harvest months, fraction of state land devoted to farming, fraction of farm revenue from dairy production, annual average farm sale, and average farm land value. Also the state and land/water fraction for each area element were specified.

7.1.9.6 Evacuation Measures

Evacuation of inhabitants within ten miles of the plant is considered in the accident consequence assessment. An evacuation speed (corresponding to adverse weather conditions) of 7.5 mph was assumed. The time delay for evacuation ranges between 0 and 2 hours. A delay of 0.75 hours which corresponds to the time when 77 percent of the people have begun evacuation was used as CRAC2 input. The distance to the evacuation shelters was also used as input.

7.1.9.7 Accident Consequences and Risk Measures

The health and economic impacts calculated for the various postulated accidental releases from WNP-3 are presented in the form of probability distributions. Calculated health effects include early fatalities and latent cancer deaths resulting from potential radiological exposures. Economic effects include the direct costs of emergency action undertaken during the accident and the estimated costs of mitigation actions that might be taken following the accident. All four release categories contribute to the results, with the consequences from each being weighted by the associated probability of occurrence.

The probability distribution for acute fatalities is shown in Figure 7.1-2 and is determined entirely by release category EVENT V. Table 7.1-9 shows that EVENT V has the largest core inventory release fractions of the four accidents and therefore produces the greatest radioactive release. The amount of radioactivity released is particularly critical to the prediction of acute fatalities because the CRAC2 code uses a threshold exposure of 200 rem for acute deaths. Only EVENT V produces exposures near the 200 rem threshold and, therefore, only it results in significant contribution to early fatalities. The early fatalities are predicted to occur within five miles of the plant.

The latent cancer fatalities in the population within 50 miles and the entire population within 200 miles (based on a dose-cancer conversion factor of 142 per million man-rem) are plotted in Figure 7.1-3. The curves have similar contributions from all accident sequences except PWR-7 which contributes significantly less than the others. The population within 50 miles experiences the majority of the latent cancer fatalities.

The latent cancers and nodules occurring in the thyroid in the population within 50 miles as well as the entire population are plotted in Figure 7.1-4. All PWR sequences contribute to these effects, the majority of which are experienced by people within 50 miles. In contrast to acute fatalities which have a 200 rem threshold, latent effects have no threshold. Latent effects are integral effects over a large area and are accumulated over long periods of time after the accident. Continued exposure to contaminated land would contribute to the long-term doses. These long-term doses would therefore depend on the interdiction strategy. For population groups that would be located relatively close to the reactor, the interdiction strategy may require permanent relocation. Therefore, no long-term exposure to contaminated land would occur for these persons. Only the inhaled radionuclides would determine their dose commitment, and in such cases, only persons who were directly exposed to the plume would contribute to the latent cancer fatalities.

The total economic costs include the costs of evacuation or relocation of the population, as well as decontamination of land and interdiction of agricultural products and/or land. The probability distribution (Figure 7.1-5) of the economic costs is composed of contributions from all accident sequences except PWR-7. The radiological consequences of PWR-7 are so small that the economic consequences are significantly smaller than in the other accidents. The interdiction cost is the greatest contributor to the cost curve. The economic and interdiction consequences are also partially sensitive to the amount of radioactivity released. The choice of an interdiction criterion can control the economic costs. This is because the cost of interdicting land is very high if no decontamination is done. CRAC2 assumes a decontamination factor of greater than 20 before permanent interdiction of land is calculated. The interdiction levels used in these calculations are basically those which were used in the Reactor Safety Study.(4)

The total person-rem whole body dose for the population within 50 miles and the entire exposed population is plotted in Figure 7.1-6. The increasing dose to the people beyond 50 miles separates the curves on the low probability and high consequence end. All accident sequences contribute to the person-rem curves with PWR-7 contributing only to the low consequences with higher probabilities.

Curves showing the number of persons receiving doses to the thyroid in the range of 300-1,000,000 rem and to the whole body in two ranges (25-200 rem and 200-300 rem) are plotted in Figure 7.1-7. EVENT V and TMLB accident sequences contribute to both whole body ranges. PWR-3 contributes only to the 25-200 rem whole body rem curve. PWR-7 contributes to neither curve, since the resultant PWR-7 doses are less than those plotted. All accident sequences except PWR-7 contributed to the thyroid dose curve.

A whole body dose versus distance curve is given in Figure 7.1-8. A reduction of over three orders of magnitude is evident over the 200 mile distance.

7.1.9.8 Uncertainties

The discussions in the preceding subsection provide insight into the risk associated with hypothetical severe accidents at WNP-3. The methodology has been based on the Reactor Safety Study.(4) The study has been reviewed subsequently, and several findings and recommendations concerning the RSS were issued. The most significant finding was that the methodology is sound. The source of uncertainties in the accident probabilities have been outlined in the RSS, and uncertainties in the consequence analysis are discussed in this section.

In the RSS, uncertainties were considered in two broad groups: the dispersion-dosimetric model, and the dose-response criteria. The first group includes uncertainties in the release fractions, probabilities, and physical characteristics of the accidents and the atmospheric dispersion. The second group includes individual dose-response and cost parameters. These factors affect only their corresponding consequences. The various uncertainties are discussed as they apply to the plant.

In general, the calculation of early fatalities is most sensitive to the first group of uncertainties, especially the release magnitude. The release fractions and other accident parameters were based on an accident analysis of another older PWR design. The mitigating effects of improvements in the engineered safety features of WNP-3 were not considered; the actual risks associated with WNP-3 would be less than the calculated values discussed in Subsection 7.1.9.7.

The other consequences, latent cancer fatalities and property damage, appear to be less sensitive to the first group of uncertainties. These constitute integral effects over a large area and are more a function of the total population and cost parameters than of accident characteristics.

References for Section 7.1

1. "Discussion of Accidents in Applicants' Environmental Reports: Assumptions", Federal Register, 36:22851, December 1, 1971.

2. "Nuclear Power Plant Accident Considerations Under the National Environmental Policy Act of 1969", Federal Register, 45(116):40101, June 13, 1980.

3. Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors, Regulator Guide 1.4, U.S. Nuclear Regulatory Commission, Washington, D.C., June 1974.

4. Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants, Appendix 6: Calculation of Reactor Accident Consequences, WASH-1400, U.S. Nuclear Regulatory Commission, Washington, D.C., October 1975.

5. Calculations of Reactor Accident Consequences, Version 2-CRAC2, SAND 81-1994 (Draft Report), NUREG/CR-2326, Sandia National Laboratories, Albuquerque, New Mexico, July 1981.

6. Final Environmental Statement, Comanche Peak Steam Electric Station Units 1 and 2, NUREG-0775, U.S. Nuclear Regulatory Commission, Washington, D.C., September 1981.

7. "Ostmeyer, R.M., Radionuclide Inventory Impacts on Reactor Accident Consequences", ANS Transactions, November 1981.

8. Liquid Pathway Generic Study, NUREG-0440, U.S. Nuclear Regulatory Commission, Washington, D.C., February 1978.

TABLE 7.1-1

ACCIDENT CLASSIFICATION

1.0 Trivial Incidents

2.0 Small Release Outside Containment

3.0 Radwaste System Failure

3.1 Equipment Leakage or Malfunction (Waste Gas Decay Tank)
3.2 Equipment Leakage or Malfunction (Liquid Waste Holdup Tank)
3.3 Rupture of a Waste Gas Decay Tank
3.4 Rupture of a Liquid Waste Holdup Tank

4.0 Fission Products to Primary System (BWR)

5.0 Fission Products to Primary and Secondary Systems (PWR)

5.1 Fuel Cladding Defects and Steam Generator Leak
5.2 Off-Design Transient that Induces Fuel Failure above that Expected and Steam Generator Leak
5.3 Steam Generator Tube Rupture

6.0 Refueling Accidents

6.1 Fuel Bundle Drop Onto Fuel in Core
6.2 Heavy Object Drop Onto Fuel in Core

7.0 Spent Fuel Handling Accident

7.1 Fuel Assembly Drop in Fuel Storage Pool
7.2 Heavy Object Drop Onto Fuel Rack
7.3 Fuel Cask Drop

8.0 Accidents Considered in Design Basis Evaluation in the Safety Analysis Report

8.1 Small Loss-of-Coolant Accident (LOCA), Pipe Break
8.2 Large LOCA, Pipe Break
8.3 Break in Instrument Line from Primary System that Penetrates the Containment (lines not provided with isolation capability inside containment)
8.4 Rod Ejection Accident
8.5 Small Steamline Break
8.6 Large Steamline Break

9.0 Accidents more Severe than Design Basis Accidents

9.1 Interfacing System LOCA
9.2 Loss and Nonrestoration of Onsite and Offsite Power with Failure of Steam Turbine - Driven Auxiliary Feedwater Pump
9.3 PWR-3 Sequence
9.4 PWR-7 Sequence (basemat melt-through)

TABLE 7.1-2

CORE INVENTORY AND ISOTOPE PROPERTIES

Isotope	Radioactive Decay Constant (per sec)	Total Core Activity (Ci)	Thyroid Dose Conversion Factor (rem/Ci-Inhaled)	Direct Dose Conversion Factor[(a)] $\left(\frac{\text{rems-m}^3}{\text{sec-Ci}}\right)$
Kr-85m	4.41(-5)[(b)]	2.95(7)	-[(c)]	3.61(-2)
Kr-85	2.21(-9)	9.36(5)	-	6.11(-4)
Kr-87	1.48(-4)	5.41(7)	-	3.61(-1)
Kr-88	6.95(-5)	7.73(7)	-	4.17(-1)
Xe-131m	6.68(-7)	8.24(5)	-	7.78(-4)
Xe-133	1.52(-6)	2.37(8)	-	6.94(-3)
Xe-135m	7.42(-4)	4.78(7)	-	9.72(-2)
Xe-135	2.11(-5)	4.24(7)	-	5.83(-2)
Xe-138	8.04(-4)	1.89(8)	-	3.33(-1)
I-131	9.96(-7)	1.17(8)	1.48(6)	8.61(-2)
I-132[(d)]	2.46(-6)	1.71(8)	5.35(4)	5.56(-1)
I-133	9.20(-6)	2.36(8)	4.0(5)	1.22(-1)
I-134	2.20(-4)	2.55(8)	2.5(4)	5.56(-1)
I-135	2.86(-5)	2.20(8)	1.24(5)	4.17(-1)

(a) Atomic Energy Commission, Final Environmental Statement Concerning: Numerical Guides for Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low as Practicable" for Light-Water Cooled Nuclear Power Reactor Effluents, Volume 2, July 1973, Table A-4, Pg 3, F-53.

(b) Number in parentheses denotes power of 10.

(c) Dash denotes no dose, as these isotopes do not reach the thyroid.

(d) Decay constant of precursor used.

TABLE 7.1-3

ACTIVITY (CURIES) RELEASED TO THE ENVIRONMENT BY ACCIDENT CLASSES 3-7

	Accident Class[a]										
Isotope	3.1	3.2	3.3	3.4	5.2	5.3	6.1	6.2	7.1	7.2	7.3
Kr-85m	3.5(2)[b]		1.4(3)		1.87(0)	2.87(2)	2.22(-12)	2.51(-4)	4.43(-10)		
Kr-85	3.3(1)		1.3(4)		5.89(-2)	6.31(0)	1.21(-2)	3.88(1)	2.42(0)	3.86(1)	3.82(2)
Kr-87	5.8(1)		2.3(2)		3.35(0)	1.54(2)					
Kr-88	3.5(2)		1.4(3)		4.82(0)	4.42(2)		5.73(-8)			
Xe-131m	3.0(3)		1.2(4)		6.00(-2)	3.89(1)	7.10(-3)	2.68(1)	1.42(0)	5.89(0)	2.99(-1)
Xe-133	1.4(5)		5.4(5)		1.56(1)	4.07(3)	1.23(0)	5.68(3)	2.45(2)	1.90(2)	1.38(-2)
Xe-135	1.7(3)		6.8(3)		2.75(0)	6.94(2)	1.62(-6)	8.96(-1)	3.24(-4)		
Xe-138	1.1(1)		4.2(1)		1.16(1)	1.06(2)					
I-131	3.0(0)	2.44(-4)	1.2(1)	9.8(-4)	7.28(-5)	5.77(-3)	1.70(-5)	6.78(-2)	3.32(-3)	7.34(-3)	
I-132	7.5(-3)	3.98(-6)	3.0(-2)	1.6(-5)	7.43(-5)	1.16(-3)					
I-133	3.5(-1)	1.31(-4)	1.4(0)	5.2(-4)	1.47(-4)	6.27(-3)	1.97(-7)	6.44(-3)	3.94(-5)	4.10(-12)	
I-134	2.5(-3)	7.10(-7)	1.0(-2)	2.8(-6)	1.58(-4)	9.48(-4)					
I-135	7.8(-2)	2.22(-5)	3.1(-1)	8.9(-5)	1.36(-4)	4.24(-3)	1.53(-12)	5.70(-6)	3.06(-10)		

[a] Accident Class as in Table 7.1-1. Also corresponds to text subsection as 7.1.x.x.

[b] Numbers in parentheses denote power of 10.

TABLE 7.1-4

ACTIVITY (CURIES) RELEASED TO THE ENVIRONMENT BY A SMALL PIPE BREAK ACCIDENT

Isotope	Duration of Release 0-8 hr	8-24 hr	1-4 day	4-30 day
Kr-85m	*(a)	*	*	*
Kr-85	*	*	*	*
Kr-87	*	*	*	*
Kr-88	*	*	*	*
Xe-131m	*	*	*	*
Xe-133	2.11	3.95	7.02	13.9
Xe-135	*	*	*	*
Xe-138	*	*	*	*
I-131	*	*	*	*
I-132	*	*	*	*
I-133	*	*	*	*
I-134	*	*	*	*
I-135	*	*	*	*

(a)*Indicates release is less than 1.0 Ci for noble gas and 10^{-4} for iodine.

TABLE 7.1-5

ACTIVITY (CURIES) RELEASED TO THE ENVIRONMENT
BY A LARGE PIPE BREAK ACCIDENT

Isotope	Duration of Release			
	0-8 hr	8-24 hr	1-4 day	4-30 day
Kr-85m	2.32(2)[a]	8.00(1)	3.42(0)	*[b]
Kr-85	1.28(1)	2.56(1)	5.74(1)	4.89(2)
Kr-87	1.67(2)	2.38(0)	*	*
Kr-88	4.46(2)	6.84(1)	*	*
Xe-131m	1.09(1)	2.11(1)	4.28(1)	1.74(2)
Xe-133	3.09(3)	5.78(3)	1.03(4)	2.04(4)
Xe-135	4.24(2)	3.56(2)	7.47(1)	*
Xe-138	1.09(2)	*	*	*
I-131	7.69(-3)	1.47(-2)	2.84(-2)	8.50(-2)
I-132	1.10(-2)	1.98(-2)	3.06(-2)	3.39(-2)
I-133	1.38(-2)	1.87(-2)	1.21(-2)	1.23(-3)
I-134	2.68(-3)	*	*	*
I-135	9.99(-3)	6.30(-3)	7.50(-4)	*

(a) Numbers in parentheses denote power of 10.

(b) *Indicates release is less than 1.0 Ci for noble gas and 10^{-4} for iodine.

TABLE 7.1-6

ACTIVITY (CURIES) RELEASED TO THE ENVIRONMENT BY A CONTROL EJECTION ACCIDENT

Isotope	Duration of Release: 0-8 hr	8-24 hr	1-4 day	4-30 day
Kr-85m	2.31(1)[a]	8.31(0)	*[b]	*
Kr-85	1.3(0)	2.6(0)	5.7(0)	4.9(1)
Kr-87	1.68(0)	*	*	*
Kr-88	4.46(1)	6.84(0)	*	*
Xe-131m	1.29(0)	2.51(0)	5.08(0)	2.06(1)
Xe-133	3.30(2)	6.17(2)	1.10(3)	2.18(3)
Xe-135	4.51(1)	3.79(1)	7.95(0)	*
Xe-138	1.09(1)	*	*	*
I-131	7.82(-4)	1.50(-3)	2.88(-3)	8.64(-3)
I-132	7.82(-4)	1.41(-3)	2.17(-3)	2.41(-3)
I-133	1.40(-3)	1.89(-3)	1.23(-3)	1.24(-4)
I-134	2.72(-4)	*	*	*
I-135	1.01(-3)	6.34(-4)	*	*

(a) Numbers in parentheses denote power of 10.

(b) *Indicates release is less than 1.0 Ci for noble gas and 10^{-4} for iodine.

TABLE 7.1-7

ACTIVITY (CURIES) RELEASED TO THE ENVIRONMENT
BY A STEAMLINE BREAK ACCIDENT

Isotope	Small Steamline Break	Large Steamline Break
Kr-85m	8.37(-3)[a]	8.37(-3)
Kr-85	2.01(-4)	2.01(-4)
Kr-87	4.45(-3)	4.45(-3)
Kr-88	1.28(-2)	1.28(-2)
Xe-131m	1.13(-3)	1.14(-3)
Xe-133	1.20(-1)	1.20(-1)
Xe-135	2.02(-2)	2.02(-2)
Xe-138	3.05(-3)	3.07(-3)
I-131	1.99(-4)	9.95(-4)
I-132	4.33(-5)	2.12(-4)
I-133	2.22(-4)	1.11(-3)
I-134	2.99(-5)	1.50(-4)
I-135	1.41(-4)	7.05(-4)

[a] Numbers in parentheses denote power of 10.

TABLE 7.1-8

SUMMARY OF OFFSITE DOSES FROM PLANT ACCIDENTS (CLASSES 3-8)

Class[a]	Accident	Whole Body Dose (rems) at Exclusion Area Boundary	Thyroid Dose (rems) at Exclusion Area Boundary	Whole Body Population Dose (man-rems)	Thyroid Population Dose (man-rems)
3.1	Waste Gas Decay Tank Malfunction	1.46×10^{-1}	1.84×10^{-1}	2.14×10^{1}	2.70×10^{1}
3.2	Liquid Waste Storage Tank Malfunction	5.67×10^{-9}	1.68×10^{-5}	8.31×10^{-7}	2.46×10^{-3}
3.3	Waste Gas Decay Tank Rupture	5.68×10^{-1}	7.39×10^{-1}	8.32×10^{1}	1.08×10^{2}
3.4	Liquid Waste Holdup Tank Rupture	2.26×10^{-8}	6.70×10^{-5}	3.32×10^{-6}	9.82×10^{-3}
5.2	Off-Design Transient that Induces Fuel Failure and Steam Generator Leak	9.15×10^{-4}	7.70×10^{-6}	1.34×10^{-1}	1.13×10^{-3}
5.3	Steam Generator Tube Rupture	4.11×10^{-2}	4.69×10^{-4}	6.02×10^{0}	6.88×10^{-2}
6.1	Fuel Bundle Drop Onto Core	9.92×10^{-7}	1.02×10^{-6}	1.45×10^{-4}	1.49×10^{-4}
6.2	Heavy Object Drop Onto Core	4.58×10^{-3}	4.14×10^{-3}	6.72×10^{-1}	6.07×10^{-1}
7.1	Fuel Assembly Drop in Fuel Storage Pool	1.98×10^{-4}	1.98×10^{-4}	2.90×10^{-2}	2.91×10^{-2}
7.2	Heavy Object Drop Onto Fuel Rack	1.55 x 1[illegible]	4.37×10^{-4}	2.29×10^{-2}	6.41×10^{-2}
7.3	Fuel Cask Drop	2.70×10^{-5}	----(b)	3.96×10^{-3}	-----
8.1	Small Loss-Of-Coolant Accident[c]	3.96×10^{-6}	3.06×10^{-8}	1.65×10^{-3}	1.46×10^{-4}
8.2	Large Loss-Of-Coolant Accident[d]	2.05×10^{-2}	2.02×10^{-4}	2.42	7.55×10^{-1}
8.4	Rod Ejection Accident[e]	2.07×10^{-3}	2.03×10^{-5}	2.58×10^{-1}	7.65×10^{-2}
8.5	Small Steamline Break	1.21×10^{-6}	1.63×10^{-5}	1.77×10^{-4}	2.38×10^{-3}
8.6	Large Steamline Break	1.28×10^{-6}	8.13×10^{-5}	1.87×10^{-4}	1.19×10^{-2}

[a] From Table 7.1-1. Also corresponds to text subsection as 7.1.x.x.

[b] Denotes no thyroid dose from this accident.

[c] 2-hr accident. Doses of LPZ for 30-day accident are: whole body - 1.3×10^{-6} rem and thyroid - $< 1.0 \times 10^{-10}$ rem.

[d] 2-hr accident. Doses of LPZ for 30-day accident are: whole body - 2.9×10^{-4} rem and thyroid - 4.5×10^{-5} rem.

[e] 2-hr accident. Doses of LPZ for 30-day accident are: whole body - 6.6×10^{-4} rem and thyroid - 2.3×10^{-5} rem.

TABLE 7.1-9

REBASELINED RSS PWR ACCIDENT RELEASE CATEGORIES

Accident Sequence	Probability Per Reactor Year	Time[(a)] (hr)	Duration[(b)] (hr)	Warning[(c)] (hr)	Energy (10^6 Btu/hr)	Fraction of Core Inventory Released: Xe-Kr	I[(d)]	Cs-Rb	Le-Sb	Ba-Sr	Ru[(e)]	La[(f)]
Event V	2×10^{-6}	1.0	1.0	0.5	0.5	1.0	0.64	0.82	0.41	0.1	0.04	0.006
TMLB	3×10^{-6}	2.5	0.5	1.0	170	1.0	0.31	0.39	0.15	0.04	0.02	0.002
PWR-3	3×10^{-6}	5.0	1.5	2.0	6	0.8	0.2	0.2	0.3	0.02	0.03	0.003
PWR-7 Melt	4×10^{-5}	10.0	10.0	1.0	N/A	6×10^{-3}	2×10^{-5}	1×10^{-5}	2×10^{-5}	1×10^{-6}	1×10^{-6}	2×10^{-7}

(a)Time interval between start of hypothetical accident (shutdown) and release of radioactive material to the atmosphere.

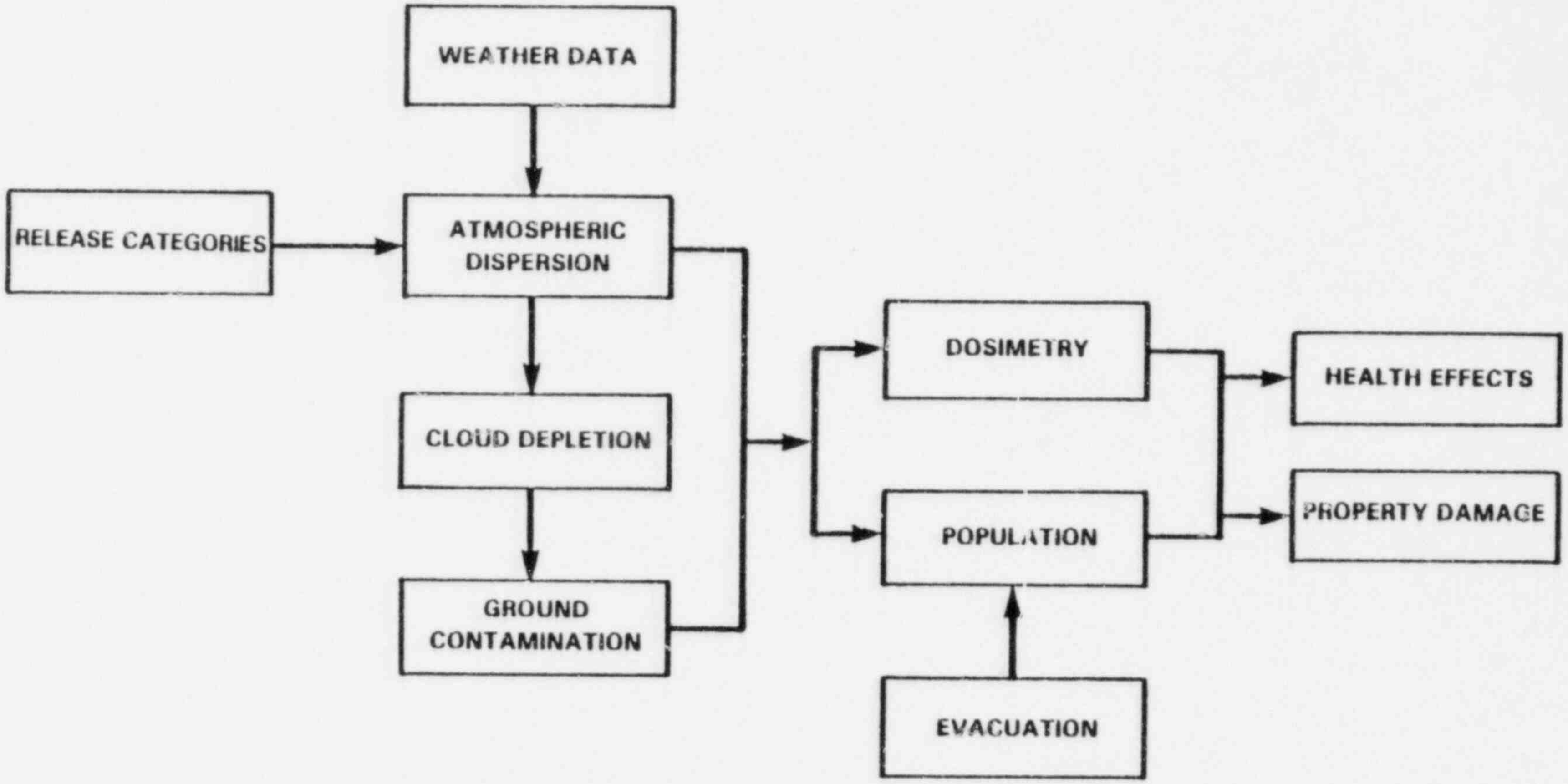
(b)Total time during which the major portion of the radioactive material is released to the atmosphere.

(c)Time interval between recognition of impending release (decision to initiate public protective measures) and the release of radioactive material to the atmosphere.

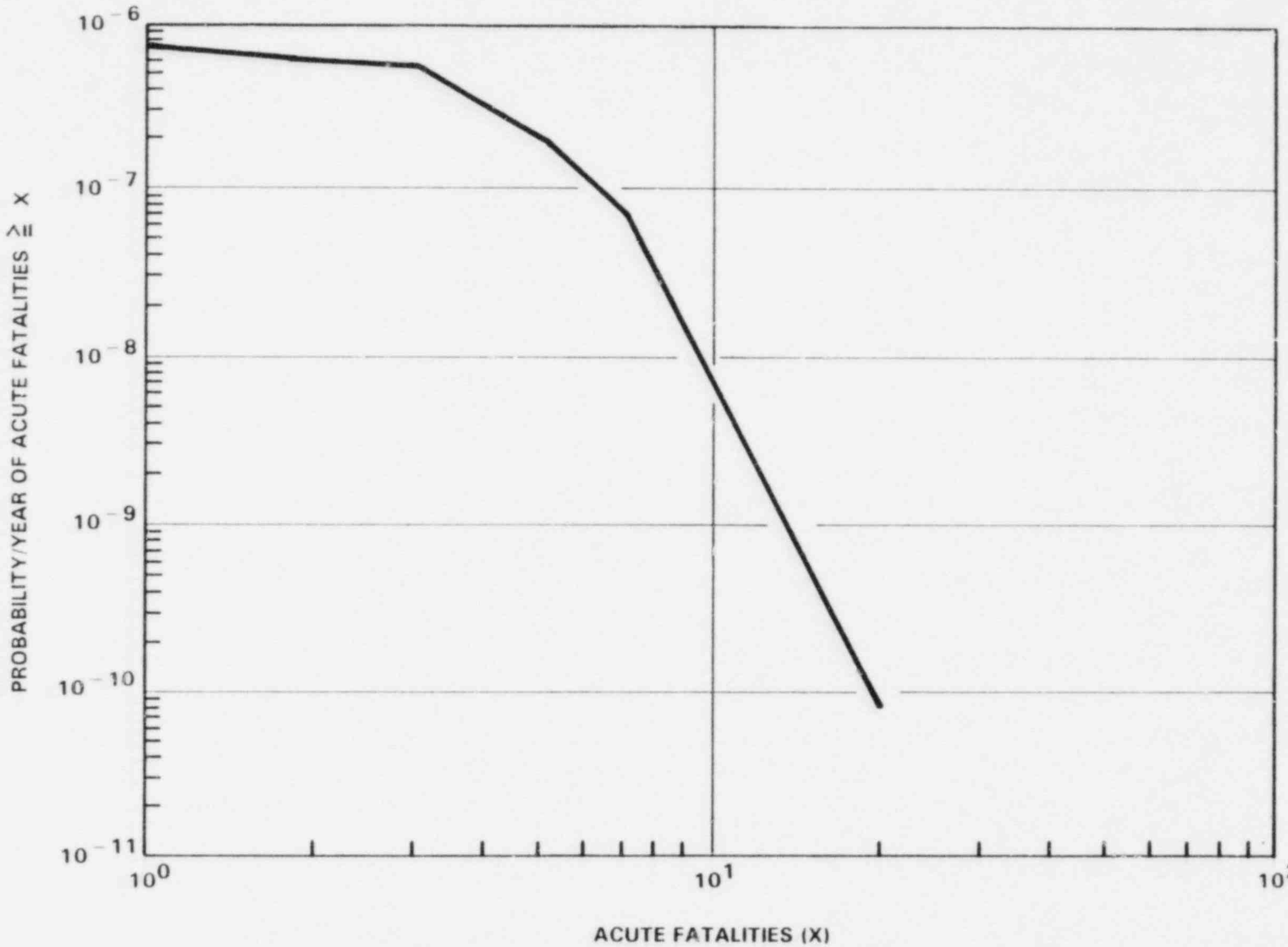
(d)Organic iodine is combined with elemental iodines in the calculations. Any error is negligible since the release fraction is relatively small for all large release categories.

(e)Includes Ru, Rh, Co, Mo, Tc.

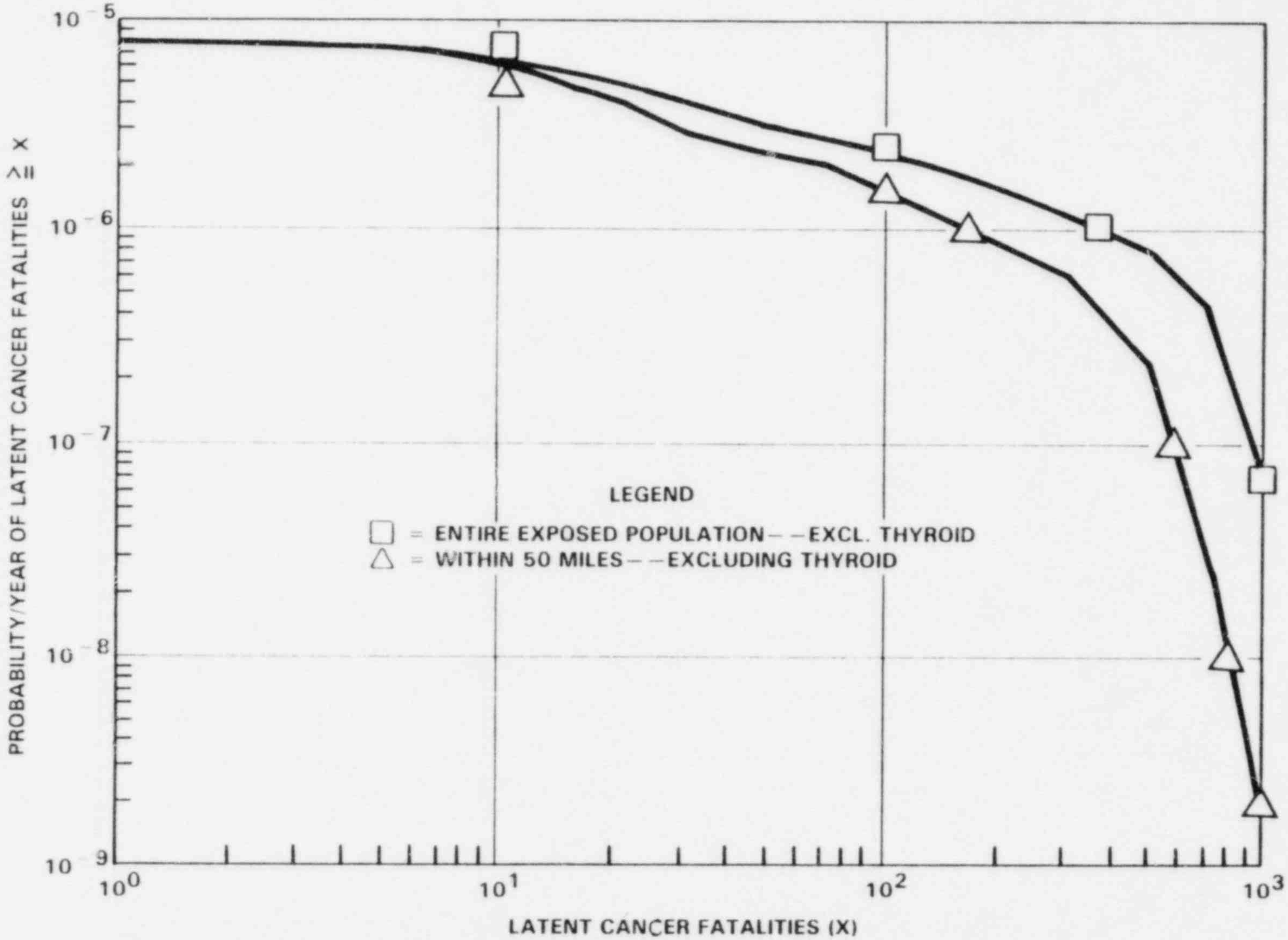
(f)Includes Y, La, Zr, Nb, Ce, Pr, Nd, Np, Pu, Am, Cm.



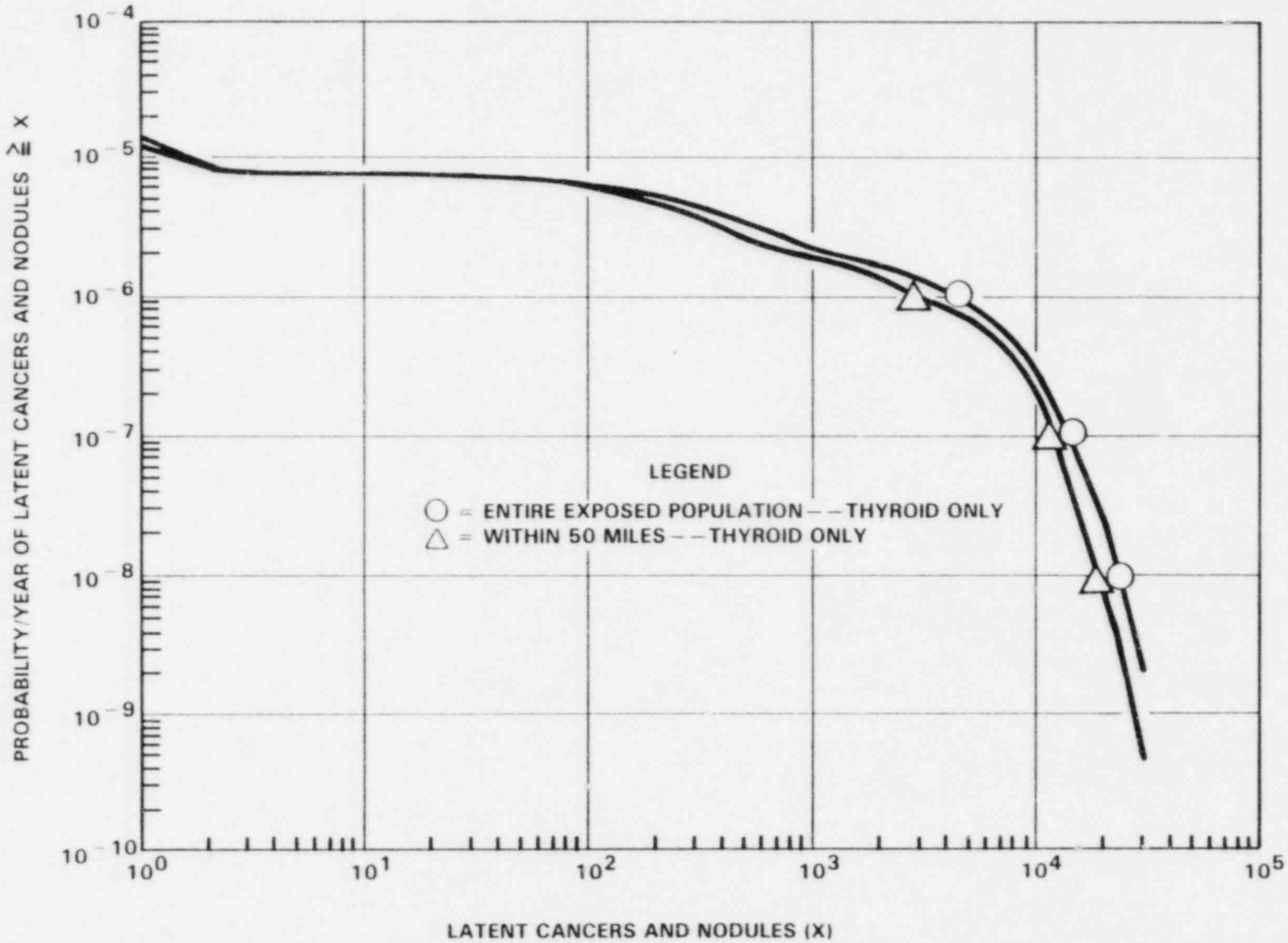
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	BLOCK DIAGRAM OF SEVERE ACCIDENT CONSEQUENCE MODEL	FIGURE 7.1-1



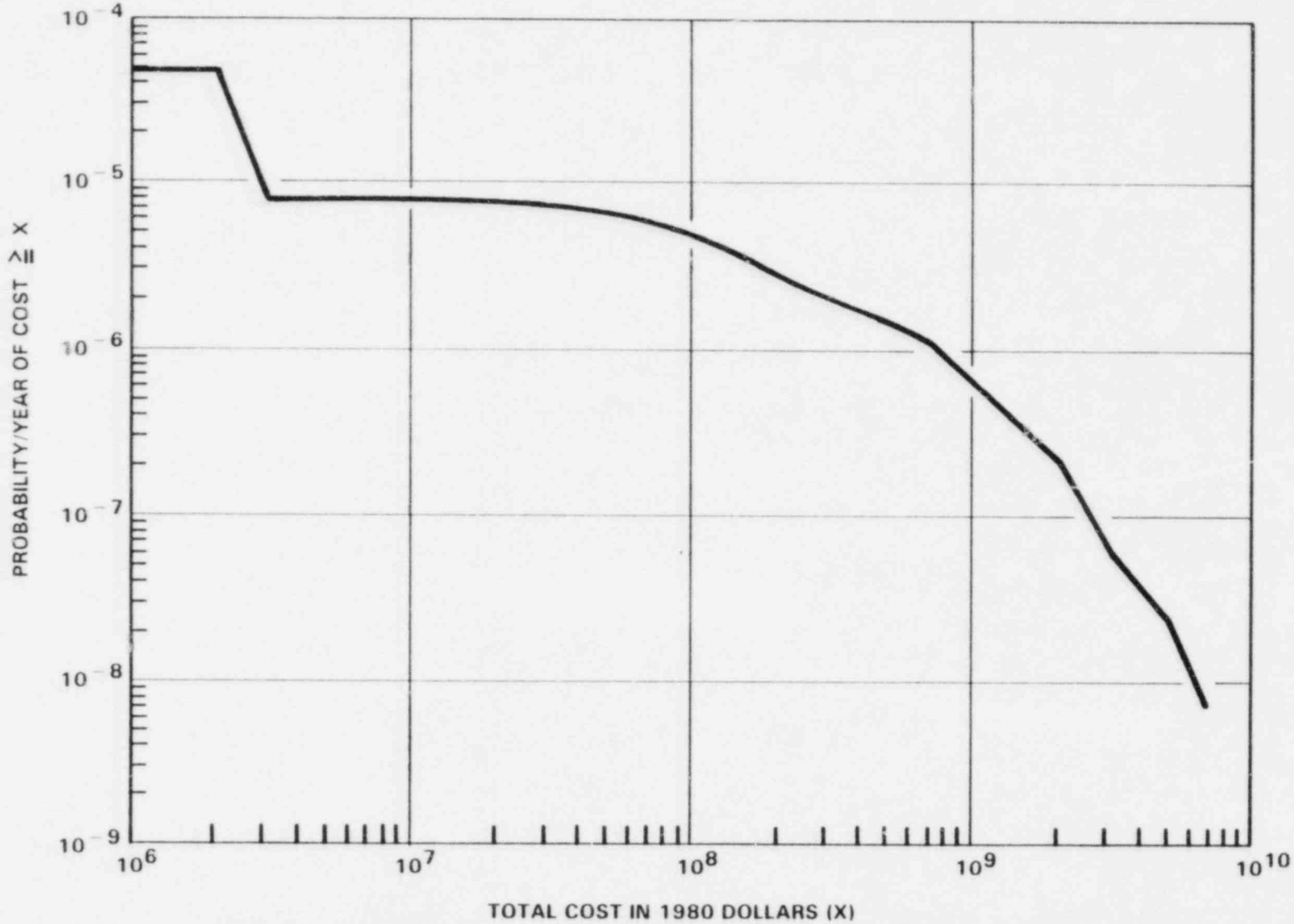
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	PROBABILITY VS. ACUTE FATALITIES	FIGURE 7.1-2



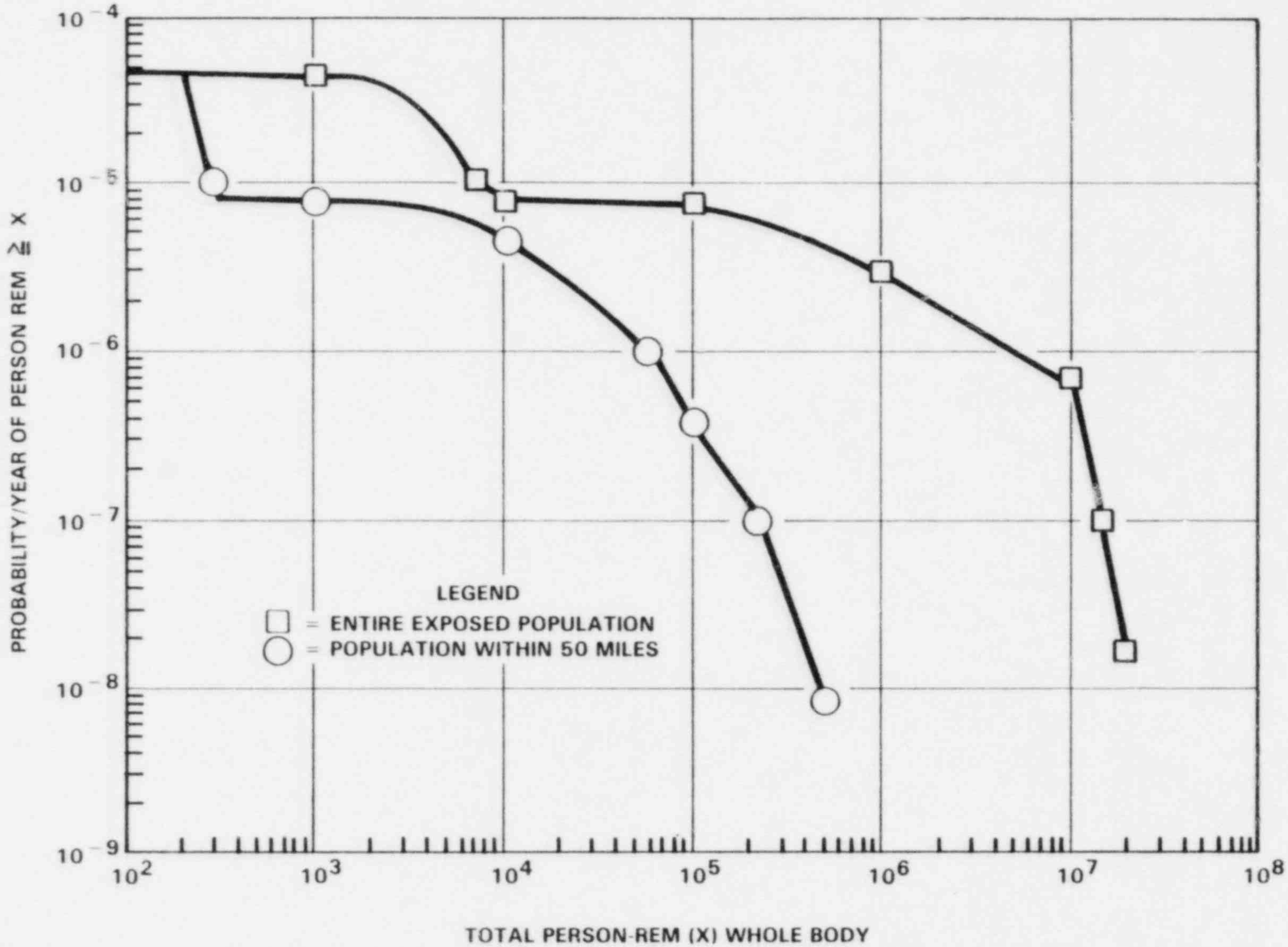
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	PROBABILITY VS. LATENT CANCER FATALITIES	FIGURE 7.1-3



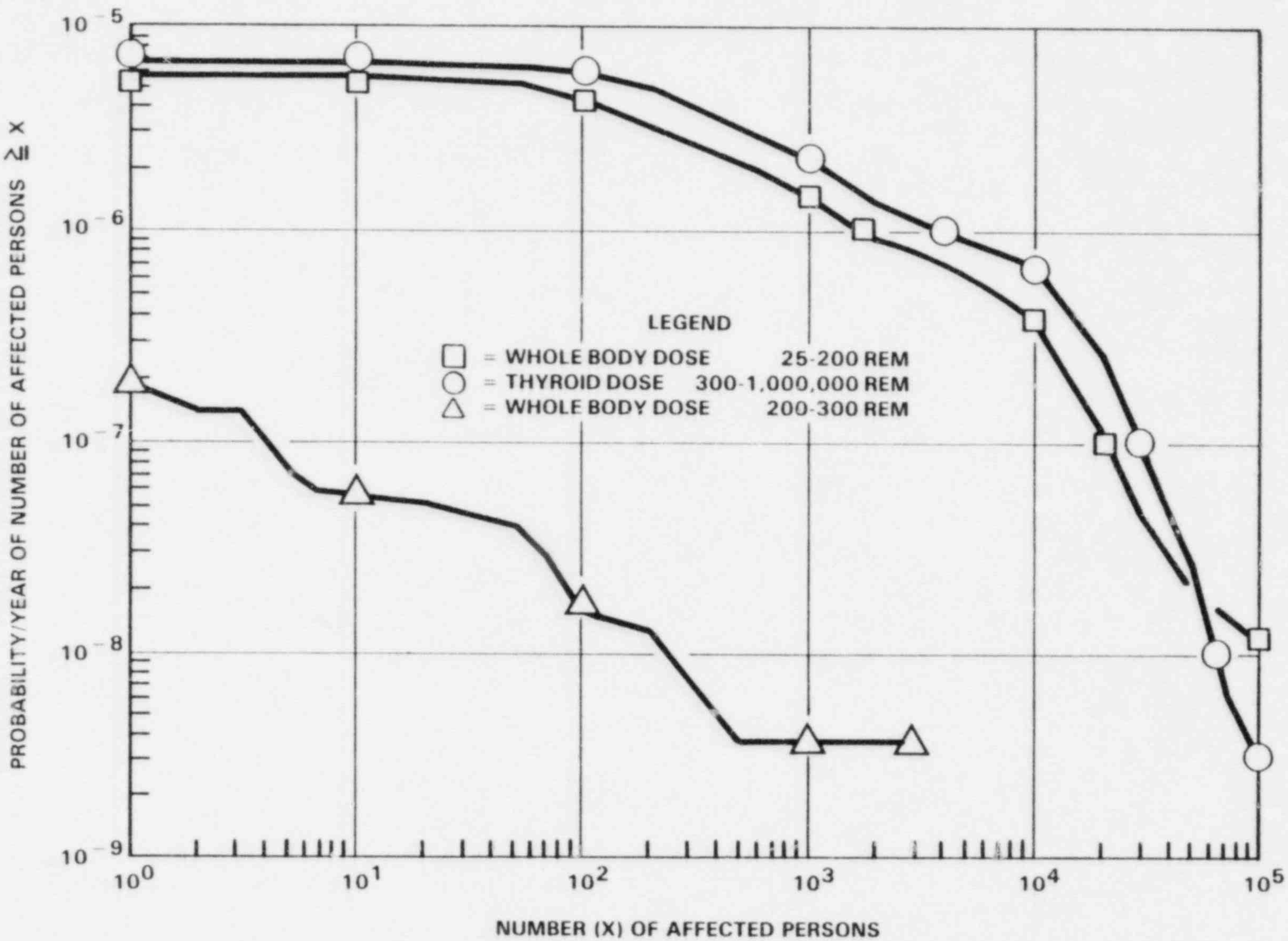
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	PROBABILITY VS. LATENT CANCERS AND NODULES	FIGURE 7.1-4



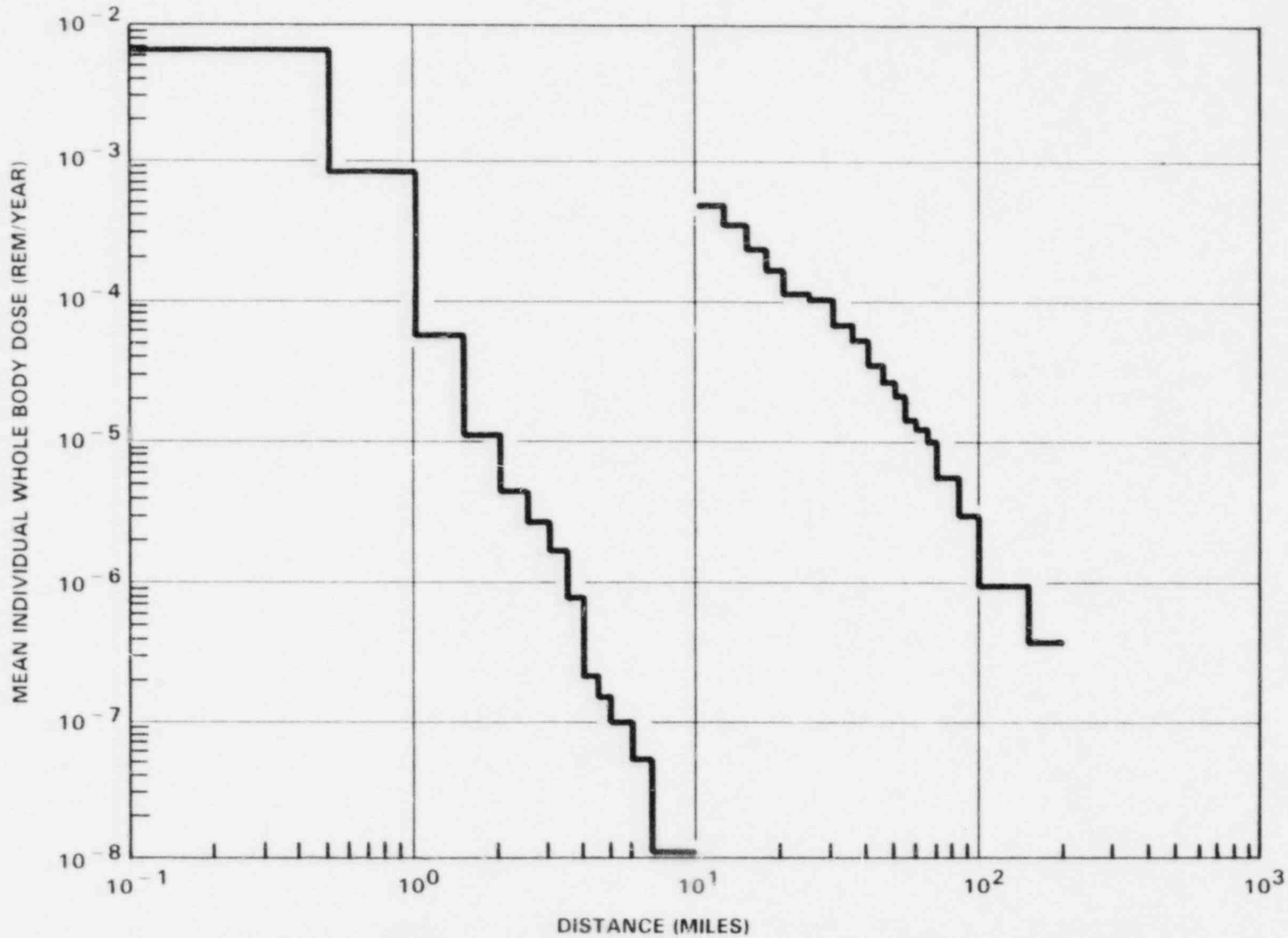
WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	PROBABILITY VS. TOTAL COST	FIGURE 7.1-5



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	PROBABILITY VS. POPULATION WHOLE BODY DOSE	FIGURE 7.1-6



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	PROBABILITY VS. POPULATION EXPOSED	FIGURE 7.1-7



WASHINGTON PUBLIC POWER SUPPLY SYSTEM NUCLEAR PROJECT No. 3 OPERATING LICENSE ENVIRONMENTAL REPORT	WHOLE BODY DOSE VS. DISTANCE	FIGURE 7.1-8

7.2 STATION ACCIDENTS INVOLVING RADIOACTIVITY

The transportation of cold fuel to the reactor, irradiated fuel from the reactor to a reprocessing plant, and solid radioactive wastes to waste burial grounds is within the scope of 10 CFR Part 51.20(g). The environmental risks of the transportation of radioactive materials to and from WNP-3 are as described by Table S-4 of 10 CFR Part 51.20.

7.3 OTHER ACCIDENTS

The WNP-3 project, like other large industrial plants, could experience non-nuclear industrial accidents. Possible accidents are small electrical fires, chemical spills, etc. The administrative procedures and safety equipment at WNP-3 will limit accidents of this type so that the associated environmental consequences will be minimal. The types, quantities and storage locations of the major chemicals that will be stored on site are given in Table 7.3-1.

7.3.1 Sodium Hypochlorite

Sodium Hypochlorite solution (15 percent) is stored in above-ground diked storage tanks. In the unlikely event that the contents of a tank are spilled, chlorine gas will evolve. Because of the quantity of chlorine available and the slow evolution of this gas from solution, such a spill would not adversely impact the environment outside the plant boundary.

7.3.2 Diesel Oil

The above-ground storage tank has a curb high enough to contain the entire contents of the tank in an event of a tank rupture. Should an oil fire occur, sulfur dioxide, carbon monoxide, hydrocarbons, nitrogen oxides and particulates would be emitted to the air until the fire is extinguished. The environmental impact of such a fire would be similar to that caused by any typical small oil fire and would result in a short-term localized degradation of the ambient air quality.

The diesel fuel stored underground is of a relatively small quantity and a rupture of such a tank would not adversely impact the environment outside the plant boundary.

7.3.3 Sulfuric Acid and Sodium Hydroxide

Solutions of sulfuric acid and sodium hydroxide do not present any significant threat to the environment because of their low volatility.

7.3.4 Bulk Gases (Hydrogen, Nitrogen, Carbon Dioxide and Oxygen)

The failure of tanks containing these pressurized gases will not result in adverse environmental effects. Hydrogen, nitrogen and carbon dioxide are asphyxiants and must be present in such high quantities that there is insufficient oxygen in the air to support life. It is highly unlikely that these concentrations could be reached in an open atmosphere. Hydrogen is a flammable gas which presents a fire hazard similar in its effects to that of diesel fuel. Oxygen is a strong oxidizer but is stored onsite in insufficient quantities to cause environmental harm.

7.3.5 Aqua Ammonia

The accidental spillage of aqueous solutions of ammonia could result in the emission of ammonia vapors that are irritating to the eyes and lungs of exposed personnel. Because of the slow evolution of this gas from solution, such a spill would not adversely impact the environment outside the plant boundary. Ammonia vapor in air has explosive limits of 16 to 25 percent NH_3 by volume. However, these concentrations are seldom encountered in the handling of ammonia; accordingly, the relative fire and explosion hazards are small.

TABLE 7.3-1

CHEMICALS STORED ONSITE

Type	Quantity	Storage Location
Sodium Hypochlorite Solution	Two 7,500 gallon containers	Near Cooling Towers (outside)
Diesel Oil	75,000 gallons 550 gallons	Reactor Auxiliary Building Underground adjacent to Fire Pump House Structure
Sulfuric Acid	one 10,000 gallon container one 5,000 gallon container	Outside Water Treatment Building
Sodium Hydroxide	one 10,000 gallon container	Inside Water Treatment Building
Bottled Hydrogen Gas	8,000 gallons	Outside Northeast Wall of Turbine Building
Nitrogen Gas	20,000 ft^3	Outside Northeast Wall of Turbine Building
Oxygen Gas	12,000 ft^3	Outside Northeast Wall of Turbine Building
Carbon Dioxide	8 tons liquid	Outside Northeast Wall of Turbine Building
Aqua Ammonia	15,000 gallons	Outside Reactor Auxiliary

ECONOMIC AND SOCIAL EFFECTS OF STATION OPERATION

8.1 BENEFITS OF OPERATION

The primary benefits of WNP-3 are those inherent in the value of the generated electricity which is delivered to consumers throughout the Pacific Northwest as well as adjacent regions which may need to rely on Pacific Northwest power. The importance of WNP-3 to the region's power pool was presented in Section 1.1 of the Environmental Report-Construction Permit Stage.[1] Tangible benefits to be gained by operation of WNP-3 are shown in Table 8.1-1.

8.1.1 Employment and Income Benefits

The WNP-3 operating staff represents industrial jobs for the area. The plant will have approximately 485 permanent employees to operate the facilities plus a Supply System headquarters staff of approximately 215 persons. Nearly all operating personnel will reside in the Aberdeen to Olympia area; most of the staff personnel will reside in the Tri-City area.

At an initial average salary of $40,000 per year, the permanent staff of 700 has an associated payroll of $28,000,000 annually.[a] Each industrial worker is estimated to generate employment for 1.5 related indirect workers.[2] Total payroll income attributable to WNP-3 will be about $60 million annually.

Assuming 45% of payroll is spent in retail trade and an estimated future 5% tax rate, the associated annual sales tax is $1,300,000. These sales tax revenue estimates are conservative since they do not include revenue from gasoline or liquor taxes whose rates are relatively high in Washington State.

A privilege tax will be paid on the energy generated for the public utilities. This tax (0.2 mills/kwhr) will total about $1,000,000 per year. Of this total, 62.4 percent is returned to the local taxing districts and the state receives 37.6 percent.

Purchases of fuel plus other materials and services also will be subject to the 5% retail trade or use tax. Annual tax payments are estimated to be about $2,000,000.

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[a] Operation costs and benefits are stated as escalated costs for the first full year of operation of both plants at design power level. The assumed cost escalation until that first year of operation is 8% per year.

About 60 percent of the energy generated by the facility will be delivered to consumers within the State. These sales are taxed at the point of use by a State public utility tax of 3.6 percent of the utilities' gross revenues and would generate $9,400,000 of annual taxes on the generation cost. If energy were available to meet demands this tax revenue would be generated with or without the plant (although the taxes could be different depending on cost of electricity). Only if demands would not be met without WNP-3 could incremental tax revenue be associated with the project. Since the plant is needed to meet energy demand, all of these tax revenues could be directly associated with the generation costs for the energy from the plant. About 40 percent of the energy will be delivered outside the State, and the State imposes a manufacturing tax on this portion at a 0.44 percent rate resulting in an annual tax of about $800,000.

8.1.2 Regional Benefits of an Adequate Energy Supply

The consequences of not meeting load growth requirements are as important to the residents of the region as are the benefits to be derived from operation of WNP-3. These consequences would depend, of course, upon the method used to shed load or to curtail availability of electrical power. Most of the socioeconomic consequences are difficult to evaluate in quantitative or qualitative terms. As an example, reduced street and highway lighting would most certainly have adverse effects on public safety, highway accidents and crime rates. If power shortages result in rationing of electricity to the consumer, the region's standard of living will deteriorate because comforts, conveniences, and the very necessities are dependent upon a dependable supply of electricity. In light of these consequences and the demonstrated need for resources to meet projected load growth, the alternative of project delay is not desirable.

If WNP-3 is not operated, the Pacific Northwest energy deficits would increase by about 930 MWe after 1988. The actual effects of that increase would probably be distributed throughout the Pacific Northwest. There probably would be a general reduction in electricity usage equivalent to the amount used in a large city such as Portland or Seattle. Expansion of industrial activities probably would be slowed, resulting in migration to other states and possibly a general reduction of the standard of living.

The consequences of failure to meet load growth demands would depend upon the method used to curtail the supply of electricity. A permanent deficiency in electric power generating sources would result first in a shutdown of large industrial loads. Long-term shutdown of these facilities would undoubtedly reduce the residential demand as a result of reduced employment and income in the area.

Because the electroprocess industries use large quantities of electricity per employee, they probably would be among the first industries shut down if there is a permanent electricity shortage. The electroprocess industrial load is approximately 3500 MWe. The amount of energy produced by WNP-3 corresponds to about two thousand direct electroprocessing employees, and about 6,000 indirect employees.(3) In addition, on a nationwide basis, the aluminum produced in these plants creates employment of another 19,000 persons. If other industries were shut down because of insufficient electricity, the reduction of employment would be much larger per unit of electric load curtailment.

Every facet of this region's economy, standard of living, and public welfare depends upon reliable electric service and any blackout of any significant length of time is an emergency. Uninterrupted service of 100 percent reliability in the low voltage distribution system is not attainable. Even to attempt such an objective, if technically feasible, would be economically prohibitive since it would involve essentially a duplication of facilities to every consumer. It is not feasible to attain 100 percent reliability for low voltage systems, and it is also very difficult to attain 100 percent reliability at the higher voltages where power is transmitted with complicated and costly equipment. Failures in high voltage systems with their corresponding large release of energy are quite often devastating and difficult to quickly repair. Providing adequate generating capacity to meet anticipated loads reduces the possibility of overloading existing transmission and generating sources, causing premature component failures. Operation of WNP-3 will provide diversification of the Pacific Northwest energy supply which is presently two-thirds hydro.

Moreover, failure of generating sources, particularly when there is a shortage of generating capacity, usually has the most impact because of the regional effects in comparison to local effects from failures of load distribution systems. The estimated cost for regional blackouts is about \$21,000,000 per hour of outage.(3)

References for Section 8.1

1. Environmental Report-Construction Permit stage, WPPSS Nuclear Project Number 3, Docket Nos. 50-508/509, Wahsington Public Power Supply System, Richland, Washington, 1974.

2. Siting Energy Facilities at Camp Gruber, Oklahoma, Federal Energy Administration, Washington, D.C., 1975, pp. B.1-B.4.

3. The Role of the Bonneville Power Administration in the Pacific Northwest Power Supply System, Appendix C, BPA Power Marketing, Bonneville Power Administration, Department of the Interior, July 22, 1977, pp. IV-118 and IV-261.

TABLE 8.1-1

ANNUAL BENEFITS ASSOCIATED WITH OPERATION OF WNP-3

Direct Benefits	
Expected generation in kilowatt-hours	7.5×10^9
Capacity in kilowatts	1.24×10^6
Proportional distribution of delivered electrical energy (kwhrs)	
Industrial	3700×10^6
Commercial	1110×10^6
Residential	2350×10^6
Other	340×10^6
Expected average annual Btu (in millions) of steam sold from the facility.	NONE
Expected delivery of other beneficial products	NONE
Revenues from delivered benefits:	
Electrical energy generated	NA[(a)]
Steam sold	NONE
Other products	NONE
Employment (payroll)	\$28,000,000
Employment (persons)	700
Indirect Benefits (as appropriate)	
Taxes during operation	\$14,500,000
Regional product as man-hours per year[(b)]	220×10^6
Education	NONE
Others	NONE

(a) The Supply System is empowered to design, construct, and operate generation and transmission facilities but does not make retail sales of electric power.

(b) The total of industrial plus commercial power distribution divided by 22 kwhr/man-hr.

8.2 COSTS OF OPERATION

8.2.1 Internal Costs

The internal costs associated with WNP-3 can be separated into two categories: (1) the capital costs for constructing the facility and (2) the annual costs of operation. Tables 8.2-1 and 8.2-2 show those costs, respectively. Table 8.2-2 also includes levelized annual costs for the cost items and the present worth of the electricity. All annual costs, except for the interest and depreciation, are subject to approximately the same degree of inflation.

8.2.1.1 Capital Costs of Construction

The capital costs associated with WNP-3 construction have several components as listed below.

Item	($ in thousands)
Direct Construction Costs	$1,566,875
Escalation and Contingencies	693,917
Sales Tax	99,579
Engineering and Construction Mgmt	292,763
Owners Direct Cost (a)	366,813
Interest During Construction, Net	1,093,330
Other Net Costs	14,609
Total Plant Cost	$4,127,886

The Supply System cost of constructing the transmission facilities (Satsop Substation to WNP-3), exclusive of the main step-up transformer, is estimated to be $1,440,000.

8.2.1.2 Operating and Maintenance Costs

The initial core fuel scheduled for loading in June 1986 is estimated to cost $75.2 million exclusive of applicable capitalized interest. The Supply System presently estimates that fuel valued at $2,300,000 will be consumed during test and startup activities prior to commercial operation. The annual fuel costs after startup vary with the energy output from the plants.

(a)All Supply System costs that can be attributed directly to the project.

The estimated costs for operating WNP-3 Projects are listed in Table 8.2-2. Such costs were determined in a manner consistent with generally accepted accounting principles and conventional public utility practices.

8.2.1.3 Plant Decommissioning Costs

The plant decommissioning will occur at the end of the project life - currently estimated to be 40 years. The Supply System presently estimates $160 million in 1988 dollars will be sufficient to provide for dismantlement 50 years after final shutdown. Funding will be provided by a uniform annual charge to the power purchasers; collections will be deposited in a segregated fund and reinvested until needed.

8.2.2 External Costs

No adverse socioeconomic impact is expected from operation of WNP-3. Because adequate housing and public services were available for the construction force, the permanent operations staff will not create incremental demands.

The Supply System has conducted a program to monitor and mitigate socioeconomic impacts associated with construction of WNP-3. This program has been successful in alleviating potential impacts and it will continue through the balance of construction. The in-migrating operational staff, coming after the two-unit construction peak (1981), is not expected to create incremental demands for services or have a major impact on the local economy. The addition of operations personnel (scheduled for 60 in 1982 and 320 in 1986) will not occur at a time or location where communities are experiencing severe socioeconomic impacts.

The increased costs to local governments for services required by the permanent operational staff and their families are expected to be compensated for by local taxes paid by individual workers who become permanent residents. In addition, the project will provide abundant tax revenues to the area taxing districts from the privilege (generation) tax ($1 million/yr) and from the sales tax on fuel reloads (approximately $2-3 million/yr of which 8-10% goes to local areas) during plant operation.

Long-term external costs associated with land use in the site area will be minimal. Restricted area previously open to hunters will not be available during operation. Fishing on the Chehalis River will not be limited by plant operation. Land occupied by the plant and support facilities was primarily used for timber production. The timber produced was neither unique nor significant in the total regional product. Continued displacement of this use on about 150 acres during operation represents a negligible reduction of the regional product. Timber management will continue on the majority of the approximately 2,200 acres owned or leased by the Supply System for the project.

TABLE 8.2-1

ESTIMATED COSTS PRIOR TO OPERATION OF WNP-3[a]

FERC Account		10^3 \$
320	Land & Land Rights	12,478
321	Structures & Improvements	1,386,615
322	Reactor Plant Equipment	1,275,818
323	Turbogenerator Unit	606,726
324	Accessory Electric Equipment	362,810
325	Miscellaneous Power Plant Equipment	164,756
	Total Nuclear Production Plant	3,809,203
353	Station Equipment	54,766
399	Other Tangible Property	263,917
	Total	\$4,127,886

[a] Total capital costs including private owners' share.

TABLE 8.2-2

ESTIMATED ANNUAL COST OF OPERATION OF WNP-3[a]

	FY 1988 Cost (10^3\$)
Fixed Annual Costs:	
Interest	228,269
Depreciation	72,351
Operation and Maintenance	53,439
Other Net Costs	6,316
Total Fixed Annual Costs . .	360,375
Variable Annual Costs:	
Fuel Cost[c]	93,118
Other Net Costs	(18,393)
Total Variable Annual Costs	74,725
Total Annual Costs	\$435,100
Generation (kWh x 10^6)[c]	4,783
Generation Cost: (mills per kwh)	91
Generation Cost Present Worth (mills/kwh) .	39

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[a]Based on estimated Supply System costs of operation; payments under Net-Billing Agreements and Project Exchange Agreements will differ from amounts shown.

[b]Based on assumed escalation rate of 9% per annum for 30 years.

[c]@ 63% capacity factor.

ALTERNATIVE ENERGY SOURCES AND SITES

Alternative sources for the energy to be supplied by WNP-3 and alternative sites for the plant were considered in the Construction Permit proceedings. Conclusions reached at that stage remain valid and, consistent with NRC rulemaking (References 1.0-3 and 1.0-4), no discussion of such alternatives is warrented at the Operating License stage.

STATION DESIGN ALTERNATIVES

Station design alternatives were detailed in Chapter 10 of the Environmental Report-Construction Permit Stage (ER-CP). With very few exceptions, WNP-3 is designed and constructed, and will be operated, as described therein. One such exception involves the supplemental cooling system. A heat exchanger using the cooler makeup water and designed to a $3^{o}F$ approach will be used to provide additional cooling of the natural-draft cooling tower blowdown (see Subsection 3.4.3). A mechanical-draft cooling tower had been selected at the CP stage (ER-CP Subsection 10.3.6). The only other exception of note involves the circulating water biocide system (ER-CP Subsection 10.5.5). Rather than use gaseous chlorine as planned, WNP-3 will use sodium hypochlorite and a dechlorination system (see Subsection 3.6.4). Both of these changes will reduce the environmental impact of plant operation and allow operation in compliance with the restrictive limitations of the NPDES Permit (see Appendix A).

BENEFIT-COST SUMMARY

11.1 Benefits

The primary benefits to be derived from the operation of WNP-3 include about 7.5 billion kwhr of baseload electrical energy that the plant will produce annually (assuming operation at 70% capacity factor). The benefits will also include the improved reliability of the Pacific Northwest generating system with the 1240 MWe of capacity contributed by WNP-3.

Secondary benefits are related to employment of operating personnel (totaling between 25,000 and 30,000 man-yrs over plant life) and taxes paid to the State and local taxing districts.

Benefits are summarized on Table 11.1-1.

TABLE 11.1-1

BENEFITS OF OPERATING WNP-3

Benefit	Magnitude	Section
Primary		
Electrical Energy	7.5×10^9 kwhr/yr	8.1
Addition Capacity	1240 MWe	8.1
Diversity of Fuel Supply		8.1
Secondary		
Employment	700 jobs	8.1
Payroll	\$28 million/yr	8.1
Taxes	\$14.5 million/yr	8.1

11.2 COSTS

The economic costs of plant operation include fuel costs and operation and maintenance costs. The cost of decommissioning is an additional cost of operation.

No significant socioeconomic costs are expected from routine operation of the plant. Costs in this category attributable to the project are associated almost exclusively with plant construction.

Environmental costs of a nonradiological nature are mostly associated with the disruption and/or occupation of terrestrial habitat. The only such disturbance due to operation, as opposed to construction, relates to the deposition of cooling tower drift. Design of the makeup water intake and discharge diffuser and the restrictions on effluents are such that no significant aquatic impacts are expected.

The radiological environmental costs associated with WNP-3 are detailed in Section 5.2 for routine operation and Sections 7.1 and 7.2 for accidents. These analyses show that the health risks attributable to operation of the plant are exceedingly small.

The costs of operating WNP-3 are summarized in Table 11.2-1.

TABLE 11.2-1

COSTS OF OPERATING WNP-3

Cost	Magnitude	Section
Economic		
Fuel	19 mills/kwhr (1988$)	8.2
Operation/Maintenance	11 mills/kwhr (1988$)	8.2
Decommissioning	$160 million (1988)	8.2
Socioeconomic		
Historic Sites	none	2.6
Other	negligible	8.2
Environmental (nonrad)		
Land Resources	150 acres	5.7
Water Consumption	30 cfs	3.3 & 5.7
Water Quality	small	5.1 & 5.3
Uranium	< 200 tonnes/yr	5.7
Terrestrial Habitat	small	5.1 & 5.7
Aquatic Habitat	negligible	5.1
Aquatic Biota		
Impingment/Entrainment	negligible	5.1
Thermal Effect	very small	5.1
Chemical Effect	small	5.3
Meteorology		
Visible Plume	2,000 hrs/yr	5.1
Drift	< 16 gpm	5.1
Combustion Gases	very small	3.7
Environmental (rad)		
Individuals	very small	5.2
General Population	negligible	5.2
Accidental risk	very small	7.1

ENVIRONMENTAL APPROVALS AND CONSULTATION

The 1970 Washington State Legislature adopted an act creating a Thermal Power Plant Site Evaluation Council (TPPSEC) to consolidate state approval and oversight of thermal power plant siting and operation. In 1976 the authority of this council was extended to all energy sources and facilities and it was renamed the Energy Facilities Site Evaluation Council (EFSEC). The Council consists of the Directors (or their designees) of the various departments of State government which have an interest in or are affected by the construction of energy facilities. The legislation creates a means by which a utility proposing to build and operate a generating plant with capacity in excess of 250 MWe can, through one proceeding, obtain certification from the State for a proposed site of such a generating facility. The issuance of the certificate is in lieu of any permit, license or similar document required for any department, agency, commission or board of the State and has therefore been termed a "one stop" licensing procedure for energy facilities. The original statute and amendments are codified in the Revised Code of Washington. The regulations adopted to implement the legislation are in Chapter 463 of the Washington Administrative Code.

As an initial step in obtaining the required approvals the Supply System filed a Site Certification Application for WNP-3 with TPPSEC in December of 1973. This application was amended in July 1974 to include a duplicate unit (WNP-5). Site Certification hearings were commenced in April 1975 and the Site Certification Agreement was signed by the Governor on October 27, 1976.

Federal licensing began with the docketing of the Construction Permit applications for WNP-3 and WNP-5 in August 1974. A Limited Work Authorization was issued for both units in April 1977 and Construction Permits were issued in April 1978. As noted in Chapter 1, construction of WNP-5 was terminated in January 1982.

Table 12.0-1 lists the permits and approvals required relative to the protection of the environment. The Bonneville Power Administration is constructing the transmission lines and will operate the Satsop Substation serving the plants. BPA has responsibility for all approvals and NEPA requirements associated with the transmission facilities.

TABLE 12.0-1

ENVIRONMENTAL PERMITS AND APPROVALS REQUIRED FOR CONSTRUCTION AND OPERATION OF WNP-3

Agency	Authority	Permit/Approval	Date of Approval
Nuclear Regulatory Comm.	42 U.S.C. 2131 et seq., 42 U.S.C. 4321	Construction Permit No. CPPR-154 Operating License	4/78 (6/85)
Corps. of Engineers	33 U.S.C. 403 (Sec. 10) 33 U.S.C. 1251 (Sec. 404)	Construction Permits Nos. 071-OYB-4-003881 071-OYB-4-003880 071-OYB-4-004456 071-OYB-2-004359 071-OYB-2-006179 071-OYB-2-006180 071-OYB-2-007109	 4/77 5/77 3/80 5/80 7/80 9/80 5/81
Washington State Energy Facility Site Evaluation Council (EFSEC)	Chap. 80.5 R.C.W.	Site Certification	10/76
EFSEC	33 U.S.C. 466 et seq. Chap. 463-38 W.A.C.	Certification of Compliance with Water Quality Regulations (401)	4/76
		National Pollutant Discharge Elimination System Permit (402)	9/81
State Department of Natural Resources	EFSEC Cert. Agreement Article II.A.2	Public Land Leases Nos. 11660 11661 11687 11753	 9/80 9/80 10/80 7/81

APPENDIX A

WATER QUALITY CERTIFICATION

and

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT

JOHN SPELLMAN
Governor

NICHOLAS D. LEWIS
Chairman

STATE OF WASHINGTON

ENERGY FACILITY SITE EVALUATION COUNCIL

Mail Stop PY-11 • Olympia, Washington 98504 • (206) 459-6490 • (SCAN) 585-6490

April 1, 1982

Mr. Robert L. Ferguson
Managing Director
Washington Public Power
Supply System
P.O. Box 968
Richland, WA 99352

Dear Mr. Ferguson:

This is to reaffirm the certification issued by the State of Washington pursuant to Section 401(a)(1) of the Federal Water Pollution Control Act (FWPCA), as amended, to the Washington Public Power Supply System for Nuclear Projects Nos. 3 and 5 (WNP-3/5).

The state's 401 Certification was issued by the Council on April 27, 1976, copy enclosed, and stipulates that any discharges resulting from the construction or operation of WNP-3/5 will comply with the applicable provisions of the FWPCA. The original certificate is also applicable to any and all Federal licenses or permits required for WNP-3/5 where Section 401 certification is necessary.

This letter will also serve to certify that the state, acting by and through the Council, did issue a renewal of the NPDES Permit (No. WA-002496-1) for WNP-3/5 on September 14, 1981.

Sincerely,

Nicholas D. Lewis
Chairman

NDL:se

Enclosure

THERMAL POWER PLANT SITE EVALUATION COUNCIL
820 EAST FIFTH AVENUE, OLYMPIA, WASHINGTON 98504 PHONE 753-7384

GOVERNOR DANIEL J. EVANS
~~XXXXXXXXXXXXXXXXXXXX~~
Acting Chairman
Thomas C. Stacer

April 27, 1976

Mr. J. J. Stein, Managing Director
Washington Public Power Supply System
P. O. Box 968
Richland, Washington 99352

Dear Mr. Stein:

This is in response to the request of the Washington Public Power Supply System for certification pursuant to Section 401(a)(1) of the Federal Water Pollution Control Act (FWPCA; 33 U.S.C. 1341) with respect to the Washington Public Power Supply System's Nuclear Projects Nos. 3 and 5.

The Washington State Energy Facility Site Evaluation Council certifies that:

1. The Applicant is the Washington Public Power Supply System, 3000 George Washington Way, Richland, Washington, 99352, which proposes to construct Nuclear Projects Nos. 3 and 5, nuclear powered steam electric plants situated in Grays Harbor County, Washington.

2. This Council has adopted an NPDES Permit for Nuclear Projects Nos. 3 and 5 and makes this certification after examination of information furnished by the Applicant and others which has enabled this Council to make this certification.

3. Public Notice of the Washington Public Power Supply System's request for this certification and the public hearings held thereon at Elma, Washington on or after April 10, 1975, was given on March 6, 1975, and on July 10, 1975, in the Daily World, Aberdeen, Washington, in accordance with the law.

4. Any discharge from the construction or operation of Nuclear Projects Nos. 3 and 5 will comply with the applicable provisions of Sections 301, 302, 306 and 307 of the FWPCA and

will not violate the applicable Water Quality Standards of the State of Washington as approved by the United States Environmental Protection Agency pursuant to the FWPCA. and the conditions and limitations of the NPDES Permit as presently approved or as later modified or renewed, for the Project, the provisions of which are, by this reference, made a part hereof.

This certification is applicable to any and all Federal licenses and permits for the proposed Washington Public Power Supply System Nuclear Projects Nos. 3 and 5 as to which Section 401 of the FWPCA requires such certification, including but not limited to those for which Applicant has made application to the United States Nuclear Regulatory Commission.

Sincerely,

Thomas C. Stacer

Thomas C. Stacer
Acting Chairman

TCS:lf

ccb: Council Members and
Interested Parties

JOHN SPELLMAN
Governor

NICHOLAS D. LEWIS
Chairman

STATE OF WASHINGTON
ENERGY FACILITY SITE EVALUATION COUNCIL
Mail Stop PY-11 • Olympia, Washington 98504 • (206) 753-7384 • (SCAN) 234-7384

September 25, 1981

P.K. Shen, Ph.D.
Technical Director
Washington Public Power
Supply System
P.O. Box 968
Richland, WA 99352

Lloyd A. Reed, Director
Enforcement Division
U.S. Environmental Protection
Agency
1200 Sixth Avenue
Seattle, WA 98101

Re: WNP-3&5, NPDES Permit Reissuance

Gentleman:

During the regular meeting of September 14, 1981 and pursuant to all that is right and proper, good and fair; the Energy Facility Site Evaluation Council reissued NPDES Permit No. WA-002496-1, copy enclosed, to the Washington Public Power Supply System for subject facility.

Sincerely,

George H. Hansen

George H. Hansen, P.E.
Chief, Operations Division

GHH:mg

Enclosure

cc: Fred Hahn
Roger Stanley
Carl Van Hoff

Permit No. WA-002496-1
Issuance Date: 9/14/81
Expiration Date: 9/14/86

NATIONAL POLLUTANT DISCHARGE ELIMINATION
SYSTEM WASTE DISCHARGE PERMIT

State of Washington
Energy Facility Site Evaluation Council
Olympia, Washington 98504

In Compliance With the Provisions of
Chapter 155, Laws of 1973, (RCW 90.48) as Amended,

and

The Clean Water Act, as Amended,
Public Law 95-217

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
3000 George Washington Way
Richland, Washington 99352

Plant Location: Section 17
T 17N, R 6W W.M.
South of Satsop
Grays Harbor County,
Washington

Receiving Water:
Chehalis River

Discharge Location:
Outfall 001 Lat. 46° 58'26"N
Lo. 123° 29'19"W
Outfall 002 Lat. 46° 58'30"N
Lo. 123° 27'15"W

Industry Type: Nuclear Steam
Electric Generating
Plant (WPPSS Nos. 3&5)

Waterway Segment Number: 10-22-12

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is authorized to discharge in accordance with the special and general conditions which follow.

Nicholas D. Lewis

Nicholas D. Lewis, Chairman
Energy Facility Site
Evaluation Council

SPECIAL CONDITIONS

S.1 DILUTION ZONE BOUNDARIES, EFFLUENT LIMITATIONS, AND MONITORING REQUIREMENTS FOR OUTFALL DISCHARGE SERIAL NUMBER 001

The dilution zone for Outfall 001 shall have the following boundaries:

a. The vertical boundaries shall be the surface and the bottom of the river.

b. The longitudinal boundaries shall be 50 feet upstream from the diffuser and 100 feet downstream from the diffuser.

c. The lateral boundaries shall be 25 feet, respectively, from the midpoint of the diffuser.

During the period beginning with the issuance of this permit and lasting until the expiration date of this permit, the permittee is authorized to discharge effluents from Outfall 001 subject to the following limitations and monitoring requirements:

A. LOW VOLUME WASTE SOURCES PORTION OF DISCHARGE SERIAL NUMBER 001 PER UNIT(1)

PARAMETER	EFFLUENT LIMITATIONS		MONITORING REQUIREMENTS (2)	
	Daily Maximum	Daily Average	Minimum Frequency	Sample Type
Total Suspended Solids (lb/day)	70	12.5	3 times per week	Grab
(mg/l)	100			
pH	Between 6.0 and 8.5 at all times		3 times per week	Grab
Oil and Grease (lb/day)	10.5	6.5	Weekly	Grab
(mg/l)	15			
Flow (GPD)	8.4×10^4	$5. \times 10^4$	Continuous while discharging	N/A

Note (1) Permittee shall mix effluent from this source with cooling water blowdown when either cooling tower is operational. When neither cooling tower is operational, low volume wastes must be retained or a minimum dilution flow of 2000 gpm must be provided from the recirculated cooling water inventory or plant makeup water supply. Alternatively, during metal cleaning operations, the associated low volume wastes flows may be discharged into the equalizing reservoir.

Note (2) Permittee shall monitor the low volume wastes prior to mixing the effluent with cooling tower blowdown or other in-plant streams.

B. RECIRCULATED COOLING WATER BLOWDOWN PORTION OF DIFFUSER DISCHARGE SERIAL NUMBER 001 PER UNIT (1)

PARAMETER	EFFLUENT LIMITATIONS		MONITORING REQUIREMENTS (2)	
	Daily Maximum	Daily Average	Minimum Frequency	Sample Type
Temperature	Note (3)		Continuous	Instantaneous
Total Residual Chlorine (mg/l)	No detectable amount		Continuous (4)	Instantaneous
pH	Between 6.0 and 8.5 at all times		Continuous (4)	Instantaneous
Flow (GPD) (CFS)	4.18×10^6 6.47	4.12×10^6 6.38	Continuous	Instantaneous
Copper (mg/l)	0.030 See Note (5)		Weekly (6)	Grab
Chromium (mg/l	0.1		Weekly (6)	Grab
Zinc (mg/l)	0.075		Weekly (6)	Grab
Iron (mg/l	1.0		Weekly (6)	Grab
Nickel (mg/l)	0.065		Weekly (6)	Grab

Special Chlorine Limitation

Permittee shall be deemed to have satisfied the "no-detectable chlorine limitation" if chlorine is continuously monitored by mechanical amperometric analysis with no concentration above .05 mg/l being shown by the monitor (if monitoring equipment malfunctions, grab samples every four hours shall be substituted). A grab sample shall be taken and analyzed under laboratory controls using standard amperometric titration techniques at least weekly to demonstrate continuous monitor performance. Dechlorination facilities shall be started at the same time chlorination begins, and the dechlorination facilities shall be operated for 15 minutes after the dechlorinator influent is monitored at .05 mg/l or less of total residual chlorine.

RECIRCULATED COOLING WATER BLOWDOWN PORTION OF DIFFUSER DISCHARGE SERIAL NUMBER 001 PER UNIT (Cont.)

Note (1) No discharge is permitted from this source at any time when instantaneous river velocities are slower than 0.3 feet per second at the diffuser, in a downstream direction.

Note (2) Permittee shall monitor the blowdown prior to mixing with other in-plant streams.

Note (3) The discharge temperature shall be such that the applicable Water Quality Standards for temperature will be complied with at the edge of the dilution zone described at page 2. The temperature of the blowdown for recirculated cooling water systems shall not exceed at any time the lowest temperature of the recirculated cooling water prior to addition of the makeup water. Additionally, when ambient river temperatures are 20°C or less, the temperature of the effluent at the point of discharge shall be 20°C or less and shall not exceed the ambient river temperature by more than 15°C; and when ambient river temperatures are greater than 20°C, the temperature of the effluent at the point of discharge shall be equal to or less than the ambient river temperature.

Note (4) Permittee shall include alarm systems for pH control and for total residual chlorine to provide indication of any variance from established limits.

Note (5) Permittee is authorized to discharge total copper up to a daily maximum of 0.065 mg/l for 180 days after initial startup of a unit and for 30 days after a unit is shut down for maintenance, exept in the period from August 1 to November 1. During the three months of August, September and October, the maximum allowed daily discharge of copper is 0.030 mg/l.

Note (6) Monitoring for copper, chromium, zinc, iron and nickel may be discontinued or the frequency reduced, subject to the concurrence of the Council, upon demonstration of compliance with the effluent limitations for a period of one year.

C. METAL CLEANING WASTES PORTION OF DISCHARGE SERIAL NUMBER 001 PER UNIT(1)

PARAMETER	EFFLUENT LIMITATIONS		MONITORING REQUIREMENTS(2)	
	Daily Maximum	Daily Average	Minimum Frequency	Sample Type
Total Iron (lb/day) (mg/l)	0.42 1.0	0.17	Each discharge	Grab
Total Copper (lb/day) (mg/l)	0.03 0.065(3)	0.01	Each discharge	Grab
Nickel (mg/l)	0.065		Each discharge	Grab
Chromium (mg/l)	0.1		Each discharge	Grab
Total Suspended Solids (lb/day) (mg/l)	42 100	5	Each discharge	Grab
pH	Between 6.0 and 8.5 at all times		Each discharge	Grab
Oil and Grease (lb/day) (mg/l)	6.3 15	2.5	Each discharge	Grab
Flow (GPD)	5×10^4	2×10^4	Each discharge	Calculated Total Volume

METAL CLEANING WASTES PORTION OF DISCHARGE SERIAL NUMBER 001 PER UNIT (1) (Cont.)

Note (1) The metal cleaning wastes may be discharged from outfall 001 to the river only at times when river flow at the outfall exceeds 6600 cfs. Metal cleaning wastes flows may be discharged into the equalizing reservoir; discharge of metal cleaning wastes from Outfall 002 shall occur only when there is a dilution factor of at least 10 to 1 available from site runoff.

Note (2) Permittee shall monitor the metal clenaing wastes prior to mixing with other in-plant streams.

Note (3) Under no circumstances will more than a daily maximum of .030 mg/l of copper be discharged during the period from August 1 to November 1 in any year.

D. SANITARY SERVICE PORTION OF DISCHARGE SERIAL NUMBER 001(1)

PARAMETER	EFFLUENT LIMITATIONS		MONITORING REQUIREMENT (2)	
	Daily Maximum	Daily Average	Minimum Frequency	Sample Type
Biochemical Oxygen Demand (5 day) (lb/day) (mg/l)	7.5 45	5.0 30	Weekly	Composite
Total Suspended Solids (lb/day) (mg/l)	7.5 45	5.0 30	Weekly	Composite
Fecal Coliform Bacteria	400 per 100 ml	100 per 100 ml	Weekly	Day shift grab
pH	Betwen 6.0 and 8.5 at all times		3 Times weekly	Day shift grab
Flow (GPD)	2×10^4	2×10^4	Continuous	Instantaneous
Total Residual Chlorine (mg/l)	0.5 mg/l maximum prior to mixing with cooling tower blowdown		3 times weekly	Grab

Note (1) Permittee shall mix effluent from this source with cooling water blowdown when either cooling tower is operational. When neither cooling tower is operational, sanitary wastes must be retained or a minimum dilution flow of 2000 gpm must be provided from the recirculated cooling water inventory or plant makeup water supply.

Note (2) Permittee shall monitor the effluent prior to mixing with other in-plant streams.

S.2 DILUTION ZONE BOUNDARIES, EFFLUENT LIMITATIONS, AND MONITORING REQUIREMENTS FOR OUTFALL DISCHARGE SERIAL NUMBER 002

The dilution zone for Outfall 002 shall have the following boundaries:

a. The vertical boundaries shall be the surface and bottom of the river

b. The longitudinal boundaries shall be 10 feet upstream from the discharge and 75 feet downstream from the discharge.

c. The lateral boundaries shall be the south bank of the river and 25 feet from the south bank toward the center of the river.

During the period beginning with the issuance of this permit and lasting until the expiration date of this permit, the permittee is authorized to discharge effluents from Outfall 002 subject to the following limitations and monitoring requirements:

A. COLLECTED STORM RUN-OFF DRAINAGE OF DISCHARGE SERIAL NUMBER 002

PARAMETER	EFFLUENT LIMITATIONS (1)	MONITORING REQUIREMENTS	
		Minimum Frequency	Sample Type
Total Suspended Solids (mg/l)	50	Once per ½ day when there is discharge from the storm collector basins	Grab 2 hours after discharge begins
Settleable Solids (ml/l)	0.1		
pH	Between 6.0 and 8.5 at all times	Once per ½ day when there is discharge from the storm collector basins	Grab 2 hours after discharge begins

Note (1) Any untreated overflow from facilities designed, constructed and operated to treat the volume of material storage runoff and construction runoff which results from a 10-year 24-hour rainfall event (5.5 inches per 24 hours) shall not be subject to the limitations above for total suspended solids, settleable solids, and pH.

GENERAL CONDITIONS

General Discharge Limitations

G1. No discharge of polychlorinated biphenyl compounds such as transformer fluid is permitted. There shall be no discharge of water treatment chemicals which contain the priority pollutants listed in 40 CFR, Part 122, Appendix D, Tables II, III, and V. The discharge of water treatment additives which were not identified in the permit application shall be subject to Council approval.

G2. All discharges and activities authorized herein shall be consistent with the terms and conditions of this permit. Permittee is authorized to discharge those pollutants which are: (1) contained in the untreated water supply, (2) entrained from the atmosphere, or (3) quantitatively identified in the permit application; except as modified or limited by the special or general conditions of this permit. However, the effluent concentrations in the permittee's waste water shall be determined on a gross basis and the effluent limitations in this permit mean gross concentrations and not net additions of pollutants. The discharge of any pollutant more frequently than or at a level in excess of that authorized by this permit shall constitute a violation of the terms and conditions of this permit.

G3. Permittee shall notify the Council no later than 120 days before the date of anticipated first discharge from Outfall 001 under this permit.

G4. Notwithstanding any other condition of this permit, the permittee shall not discharge any effluent which shall cause a violation of State of Washington Water Quality Standards, as they exist now or hereafter are amended, at the edge of the applicable dilution zone.

G5. Notwithstanding any other condition of this permit, permittee shall handle and dispose of all solid waste material from plant operations including settled silts, sludges and any other source in such a manner as to prevent any pollution of ground or surface water. Prior to the production of nonradioactive solid wastes, the permittee shall obtain Council approval of the proposed method of handling and disposing of solid wastes. The disposal of radioactive solid wastes shall be in accordance with the facility operating license issued by the NRC.

Operation/Maintenance Provisions

G6. The permittee shall provide an adequate staff which is qualified and shall carry out the operation, maintenance, testing and reporting activities required to ensure compliance with the conditions of this permit. The permittee shall at all times properly operate and maintain all treatment and control facilities or systems which are installed or used to achieve compliance with the conditions of this permit.

G7. The permittee shall, upon failure of the treatment or control facilities, control production or reduce discharges or, alternatively, employ back-up or auxiliary facilities as necessary to comply with the conditions of this permit.

G8. The intentional diversion of any discharge or bypass of any facilities utilized by the permittee to comply with the conditions of this permit is prohibited except:

(a) When the bypass does not cause effluent limitations to be exceeded and it is necessary to perform essential maintenance to assure efficient operation;

(b) Where the bypass was unavoidable to prevent loss of life or severe property damage; or

(c) Where excessive storm runoff (see Special Condition 2(A), Note (1)) would clearly damage any facilities necessary for compliance with the conditions of this permit.

Anticipated bypasses, other than those in (a) above, shall be reported to the Council as far in advance as possible for the Council's approval. Unanticipated bypasses shall be reported to the Council in accordance with the procedure specified in General Condition G9.

G9. If for any reason the permittee does not comply with, or will not be able to comply with, any effluent limitations specified in this permit, the permittee shall:

(a) Immediately take appropriate action to stop, contain and clean up the unauthorized discharge and correct the problem;

(b) Notify the Council within 24 hours of becoming aware of any noncompliance which may endanger health or the environment;

(c) Provide the Council with a written report of any noncompliance within five days of becoming aware of its occurrence. This submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including dates and times, and if not corrected, the anticipated time the noncompliance is expected to continue; and steps being taken to reduce, eliminate, and prevent recurrence of the noncompliance.

Monitoring

G10. The results of monitoring required by Special Conditions S.1 and S.2 shall be summarized by month and reported quarterly on a Discharge Monitoring Report Form (EPA 3320-1), postmarked no later than the 28th day of the month following the end of the quarter. Duplicate signed copies of these and all other reports required herein shall be submitted to the Council, EPA and DOE at the following addresses:

U.S. EPA Region X
1200 6th Avenue
Seattle, WA 98101
Attn: Permits Branch
M/S 521

Dept. of Ecology
Attn: Industrial Waste Section
M/S PV-11
Olympia, WA 98504

EFSEC
Attn: Executive Secretary
Mail Stop PY-11
Olympia, WA 98504

G11. The permittee shall retain for a minimum of three years all records of monitoring activities and results, including all reports of recordings from continuous monitoring instrumentations, records of analyses performed, and calibration and maintenance of instrumentation. This period of retention shall be extended during the course of any unresolved litigation regarding the discharge of pollutants by the permittee or when requested by the Council.

G12. All samples and measurements required by Special Conditions S.1 and S.2 shall be representative of the monitored discharge and all analytical test procedures shall be approved under 40 CFR Part 136, unless other procedures are specifi d in this permit.

G13. The permittee shall record for such measurements of samples taken pursuant to the requirements of this permit the following information: (1) the date, place and time of sampling; (2) the dates the analyses were performed; (3) who performed the analyses; (4) the analytical techniques or methods used; and (5) the results of the analyses.

G14. As used in this permit, the following terms are as defined herein:

(a) The "daily maximum" discharge means the total pollutant discharge by weight during any calendar day and where specified, the maximum permissible pollutant concentration.

(b) The "daily average" discharge means the total discharge by weight, and where specified the average pollutant concentration, during a calendar month divided by the number of days in the month that the discharges occur. Where less than daily sampling is required by the permit, the daily average discharge shall be determined by the summation of the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.

(c) "Composite sample" is a sample consisting of a minimum of six grab samples collected at regular intervals over a normal operating day and combined proportional to flow, or a sample continuously collected proportional to flow over a normal collecting day.

(d) "Grab sample" is an individual sample collected in a time span of less than 15 minutes.

G15. Prior to the commencement of discharges from Outfall 001, the permittee shall initiate a program to monitor river flow and velocity and water quality. This program shall be submitted to the Council for review and approval sufficiently in advance of the commencement of discharges. Modifications to the program shall be subject to the Council's approval.

Administrative Requirements and Other Provisions

G16. Whenever a facility expansion, associated construction operation, production increase, or process modification is anticipated which will result in a new or increased discharge or which will cause any of the conditions of this permit to be exceeded, appropriate notification must be submitted to the Council with reports and engineering plans for the proposed changes. The Council may, in addition, require submittal of an updated permit application. No such change shall be made until plans have been approved and a new permit or permit modification has been issued. If such changes will not violate the effluent limitations specified in this permit, permittee shall notify the Council of such changes prior to such facility expansion, production increase, or process modification.

G17. If a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under state law or under Section 307(a) of the Federal Act for a toxic pollutant which is present in the permittee's discharge and such standard or prohibition is more stringent than any limitation upon such pollutant in this permit, this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition and the permittee shall be so notified.

G18. Except for data determined confidential under Section 308 of the Federal Act, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the office of the Council and the Regional Administrator. As required by the Federal Act, effluent data shall not be considered confidential. Knowingly making a false statement on any such report may result in the imposition of criminal penalties as provided in Section 309 of the Federal Act.

G19. After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part duirng its term for cause, including, but not limited to, the following:

(a) Violation of any terms or conditions of this permit;

(b) Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts;

(c) A change in conditions of the receiving waters that requires either a temporary or permanent reduction or elimination of the authorized discharge;

(d) If any provision of this permit is declared invalid by the courts.

G20. The permittee shall, at all reasonable times, allow authorized representatives of the Council upon the presentation of credentials:

(a) To enter upon the permittee's premises for the purposes of inspecting and investigating conditions relating to the pollution of, or possible pollution of, any of the waters of the State, or for the purpose of investigating compliance with any of the terms of this p..it;

(b) To have access to and copy any records required to be kept under the terms and conditions of this permit;

(c) To inspect any monitoring equipment or monitoring method required by this permit; or

(d) To sample any discharge of pollutants.

G21. Nothing in this permit shall be construed as excusing the permittee from compliance with any applicable Federal, State, or local statutes, ordinances, or regulations.

G22. 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 the subject.

G23. In addition to the conditions of this permit, the Council may require adherence to appropriate standards of practice and performance committed to by the permittee in the course of hearings on this matter.

G24. Prior to the on-site storage of oil and hazardous waste materials, the permittee shall obtain Council approval of a spill prevention containment and counter-measure plan which shall include:

(a) A description of the reporting system which will be used to alert responsible facility management and appropriate legal authorities;

(b) A description of preventive facilities (including overall facility plot) which prevent, contain, or treat spills and unplanned discharges and a compliance schedule to install any necessary facilities in accordance with the approved plan;

(c) A list of all hazardous materials used, processed, or stored at the facility which may be spilled directly or indirectly into state waters.

Submittal of this plan in accordance with this requirement does not relieve the permittee from compliance with, nor ensure compliance with, the Federal spill prevention requirement contained in 40 CFR Part 112. Oil Spill Prevention Containment and Counter-Measure Plans prepared in accordance with the above federal requirement may be used in partial fulfillment of this permit requirement.

G25. The permittee shall notify and afford the Council reasonable opportunity to review and comment on completed design drawings, specifications, and operational procedures for facilities including, but no limited to, the following:

(a) Liquid radioactive waste discharge prevention;

(b) Sanitary sewage treatment;

(c) Low volume waste treatment, including frequency of discharges;

(d) Construction run-off ponds;

(e) Outfalls and diffusers;

(f) River flow measuring stations and tidal effect measuring stations;

(g) Metal cleaning waste discharges;

(h) Water composition and condition stations.

The Council reserves the right to reject any drawing or procedural manuals for failure to conform to conditions stated in this permit. The Council further reserves the right to require amendments to any drawings or procedural manuals to produce conformance with conditions stated in this permit. Nothing contained herein shall be construed to relieve permittee from any liability arising from deficiencies or omissions in drawings, specifications, or operating procedures.

G26. The permittee shall initiate actions and implement measures necessary to eliminate surface runoff problems threatening to cause discharge of pollutants in quantities or concentrations greater than those authorized by this permit. Prior to the commencement of activities which could result in the discharge of suspended solids the permittee shall submit sedimentation and erosion control plans to the Council for review and approval. The Council will assure that best management practices are being applied and may impose discharge limitations as appropriate. Permittee must promptly notify the Council of problems in erosion control.

Special Studies

G27. Within 14 months after the startup of each unit, permittee shall conduct special studies directed toward determining the temperature and levels and forms of copper and zinc in the receiving water both inside and outside the dilution zone during critical low flow periods as may be approved by the Council.

G28. Studies shall be commenced as soon as practicable and as may be approved by the Council to determine the background levels of heavy metals in the Chehalis River.

Matters to be considered should include, but may not be limited to, the following: sampling should occur once a week for fifty-two weeks, commencing from the taking of first samples. Sampling should occur at least in the following areas: the diffuser site, upstream immediately above the confluence of the Satsop River, and downstream in the intake area. Analysis should be by heated graphite tube method of atomic absorption. No concentration of samples will occur and analysis in each instance shall be direct. Sampling should occur for each constituent metal limited by this permit.

G29. Thorough bioassays, as may be approved by the Council, shall be commenced as soon as practicable to determine sensitivities of resident salmonids to potential toxicants in the effluent, specifically, copper and zinc. Matters to be considerd should include, but may not be limited to, the following:

The bioassays should conform as closely as possible to the procedures set out in Standard Methods for the Examination of Water and Wastewater. Specifically, the bioassays should use nonaerated continuous flow sampling of sensitive resident salmonids, using measured amounts of toxicants with strict laboratory controls. The bioassays should be performed on-site and use Chehalis River water as the test medium. A complete record of water quality, particularly pH, hardness, and alkalinity, should be kept for each replicate. A 96-hour LC50 should be reported for each species tested. The incipient lethal threshold should be established for each species tested. Long-term exposures, at least 60 days, should be tested. Sublethal effects should be studied and assessed. An in-stream "no effect" level should be estimated for each species tested. Species chosen should be within the meaning of "sensitive resident species" as that term is used in the EPA Redbook. Wherever possible, strains and families for the Chehalis System should be used for test purposes. There should be assessment of additive and synergistic effects of toxicants at varying seasonal river temperatures . Various life stages should be studied, if practical, and some effort to assess the sublethal effects of the toxicants on migrating adult salmon should be attempted. The toxicants to be tested should be zinc and copper.

APPENDIX B

RADIOLOGICAL DOSE CALCULATION PARAMETERS

Parameters for Calculating Doses from Liquid Effluents Using LADTAP Code (Reference 5.2-3)

Parameter	Value	Source/Comment
Liquid Discharge (blowdown)	6 cfs	Figure 3.4-1
Population Downstream	50,000	Estimated from Table 2.1-2 and Figure 2.1-4
Source Terms		Tables 3.5-6 and 5.2-1
Shorewidth Factor	0.2	Reg. Guide 1.109 (Reference 5.2-6), Table A-2
River Dilution Factor	1100	Average river flow = 6600 cfs, Page 2.4-1
Transit Time (hr)		
Maximum individual, drinking (hypothetical)	1	2 mi downstream at average velocity = 2.6 fps
Maximum and average individual, water activities	2.8	5 mi at average velocity
Water Consumption (l/yr)		
Average individuals	Adult - 370 Teen - 260 Child - 260 Infant - 260	Reg. Guide 1.109, Table E-4. Assumed population of Montesano (3,200 per Subsection 2.1.2.1).
Maximum individuals	Adult - 730 Teen - 510 Child - 510 Infant - 330	Reg. Guide 1.109, Table E-5. Assumed household 2 mi downstream
Fish Consumption (kg/yr)		
Average individual	Adult - 6.9 Teen - 5.2 Child - 2.2 Infant - 0	Reg. Guide 1.109, Table E-4
Maximum individual	Adult - 21.0 Teen - 16.0 Child - 6.9 Infant - 0	Reg. Guide 1.109, Table E-5

Parameter	Value	Source/Comment
Invertebrate (seafood) Consumption (kg/yr)		
Average individual	Adult - 1.0 Teen - 5.2 Child - 2.2 Infant - 0	Reg. Guide 1.109, Table E-4
Maximum individual	Adult - 5.0 Teen - 3.8 Child - 1.7 Infant - 0	Reg. Guide 1.109, Table E-5
Algae Consumption	0	
Shoreline Usage		
Average individual (hr/yr)	Adult - 8.3 Teen - 47.0 Child - 9.5 Infant - 0	Reg. Guide 1.109, Table E-4
Maximum individual (hr/yr)	Adult - 23.0 Teen - 67.0 Child - 14.0 Infant - 0	Reg. Guide 1.109, Table E-5
Population (man-hr/yr)	27,000	Montesano population x average adult (8.3 hr/yr)
Swimming Usage		
Average individual (hr/yr)	4	PSAR, Page 11.6-10a
Maximum individual (hr/yr)	40	Assumed 10 times average.
Population (man-hr/yr)	12,800	Montesano population x 4 hr/yr.
Boating Usage		
Average individual (hr/yr)	4	PSAR, Page 11.6-10a
Maximum individual (hr/yr)	Adult - 200 Teen - 40 Child - 40	Assumed adult spent 200 hrs fishing, others 10 times average.
Population (man-hr/yr)	12,800	Montesano population x 4 hr/yr.
Fish Harvest (kg/yr)		
Sport	23,200	Chehalis catch (2,900 per Subsection 2.1.3) x 8 kg/fish average.
Commercial	50,000	Table 2.1-10, Chehalis and Lower Chehalis

Parameter	Value	Source/Comment
Invertebrate Harvest (kg/yr)		
Sport	0	Supply System telecon April 5, 1982, with Washington Dept. of Fisheries
Commercial	0	
Food Yield (kg/m^2)		
Vegetation	1.06	Table 2.1-9
Leafy vegetables	1.99	Table 2.1-9
Milk and meat (cow feed)	0.7	Reg. Guide 1.109, Table E-15
Total 50-Mile Yield		
Vegetation (kg/yr)	2.5×10^7	Table 2.1-9
Leafy vegetables (kg/yr)	7.4×10^5	Table 2.1-9
Milk (l/yr)	1.5×10^8	Table 2.1-9
Meat (kg/yr)	8.8×10^6	Table 2.1-9
Irrigation Rate (l/m^2/month)	110	ER-CP, Page A5 2.4

Parameters for Calculating Doses from Gaseous Effluents Using GASPAR Code (Reference 5.2-7)

Parameter	Value	Source/Comment
Population within 50-miles in year 2000	755,800	Table 2.1-2
Source Terms		Tables 3.5-9 and 5.2-2
X/Q by Sector		Table 5.2-3
D/Q by Sector		Table 5.2-4
Fraction Of The Year:		
Leafy vegetables grown	0.4	PSAR, Subsection 2.1.4.2
Cows or goats on pasture	1.0	Supply System telecon with Grays Harbor Co. Extension Agent, April 5, 1982
Fraction of Cow or Goat Intake From Pasture	1.0	Reg. Guide 1.109, Table E-15
Fraction of Crop From Garden	0.76	Grays Harbor Co. Extension
Total Food Production		As for liquid pathway
Annual Average Humidity (%)	64	PSAR, Subsection 2.3.2
Annual Average Temperature (^{o}F)	50.7	PSAR, Subsection 2.3.2
Number of Special Locations	6	
Location (name)	Vegetable Garden	Information from computer run of Reference 5.2-2
Distance/Direction	2 mi NW	
X/Q no decay, undepleted (Sec/m^3)	8.2 E-07	
X/Q 2.26 days decay, undepleted (Sec/m^3)	7.9 E-07	
X/Q 8.0 days decay, depleted (Sec/m^3)	6.7 E-07	
D/Q ($1/m^2$)	9.2 E-10	

Parameter	Value	Source/Comment
Location (name)	Milk Cow	Information from computer run of Reference 5.2-2
Distance/Direction	1 mi NNW	
X/Q no decay, undepleted (Sec/m^3)	2.3 E-06	
X/Q 2.26 days decay, undepleted (Sec/m^3)	2.2 E-06	
X/Q 8.0 days decay, depleted (Sec/m^3)	2.0 E-06	
D/Q (1/m^2)	2.8 E-09	
Location (name)	Resident	Information from computer run of Reference 5.2-2
Distance/Direction	1 mi N	
X/Q no decay, undepleted (Sec/m^3)	3.0 E-06	
X/Q 2.26 days decay, undepleted (Sec/m^3)	2.9 E-06	
X/Q 8.0 days decay, depleted (Sec/m^3)	2.6 E-06	
D/Q (1/m^2)	5.0 E-09	
Location (name)	Site Boundary	Information from computer run of Reference 5.2-2
Distance/Direction	0.8 mi NE	
X/Q no decay, undepleted (Sec/m^3)	4.0 E-06	
X/Q 2.26 days decay, undepleted (Sec/m^3)	3.9 E-06	
X/Q 8.0 days decay, depleted (Sec/m^3)	3.5 E-06	
D/Q (1/m^2)	9.4 E-09	
Location (name)	Milk Goat	Information from computer run of Reference 5.2-2
Distance/Direction	1.7 mi NE	
X/Q no decay, undepleted (Sec/m^3)	1.4 E-06	
X/Q 2.26 days decay, undepleted (Sec/m^3)	1.4 E-06	
X/Q 8.0 days decay, depleted (Sec/m^3)	1.2 E-06	
D/Q (1/m^2)	2.6 E-09	

Parameter	Value	Source/Comment
Location (name)	Meat Cattle	Information from computer run of Reference 5.2-2
Distance/Direction	1.6 mi NNE	
X/Q no decay, undepleted (Sec/m^3)	2.8 E-06	
X/Q 2.26 days decay, undepleted (Sec/m^3)	2.8 E-06	
X/Q 8.0 days decay, depleted (Sec/m^3)	2.4 E-06	
D/Q (1/m^2)	5.6 E-09	