KERR-McGEE CORPORATION

APPLICANTS ENVIRONMENTAL REPORT

USAEC
DOCKET NO. 40-8027
URANIUM HEXAFLUORIDE PLANT

DECEMBER 1972

SUPPLEMENTAL #2

ENVIRONMENTAL REPORT
SEQUOYAH FACILITY
KERR-McGEE CORPORATION
SUPPLEMENTAL #2

(1) **Current and projected plant capacity is not clearly stated. We assume that license is for 5,000 TPY operation, yet 10,000 TPY rate is discussed in text. Please clarify.**

Design and current plant capacity is 5000 tons per year (4536 MTU) and operation will eventually reach that level. The wet end of the plant was built for a capacity of 10,000 tons per year and the dry end of the plant from boildown through fluorination was designed for 5000 tpy with sufficient space for addition of another module of equipment to raise the total to 10,000 tpy. In earlier exchanges, the AEC requested that we discuss 10,000 tpy, especially in regard to possible effluent effects in terms of the life of the plant. Therefore, this discussion is included where appropriate.

(2) **Maps provided (Figure 1 in particular) are not very clear. Suggest substituting following 8 x 10 1/2" drawings:**

(a) General map of State of Oklahoma pointing out plant site (scale about 50 miles per inch),

(b) Second map showing general area details i.e., towns, roads, rivers, etc. (scale about 10 miles per inch)

(c) Third map similar to insert in present Figure 1. (scale about 4 miles per inch)

(d) Plant area map (scale about 1500 feet per inch) up-dated to show all existing ponds, monitoring points, residences, etc. alone with distances from air-borne effluent release point to possible critical exposure points; e.g., school, homes, roads.

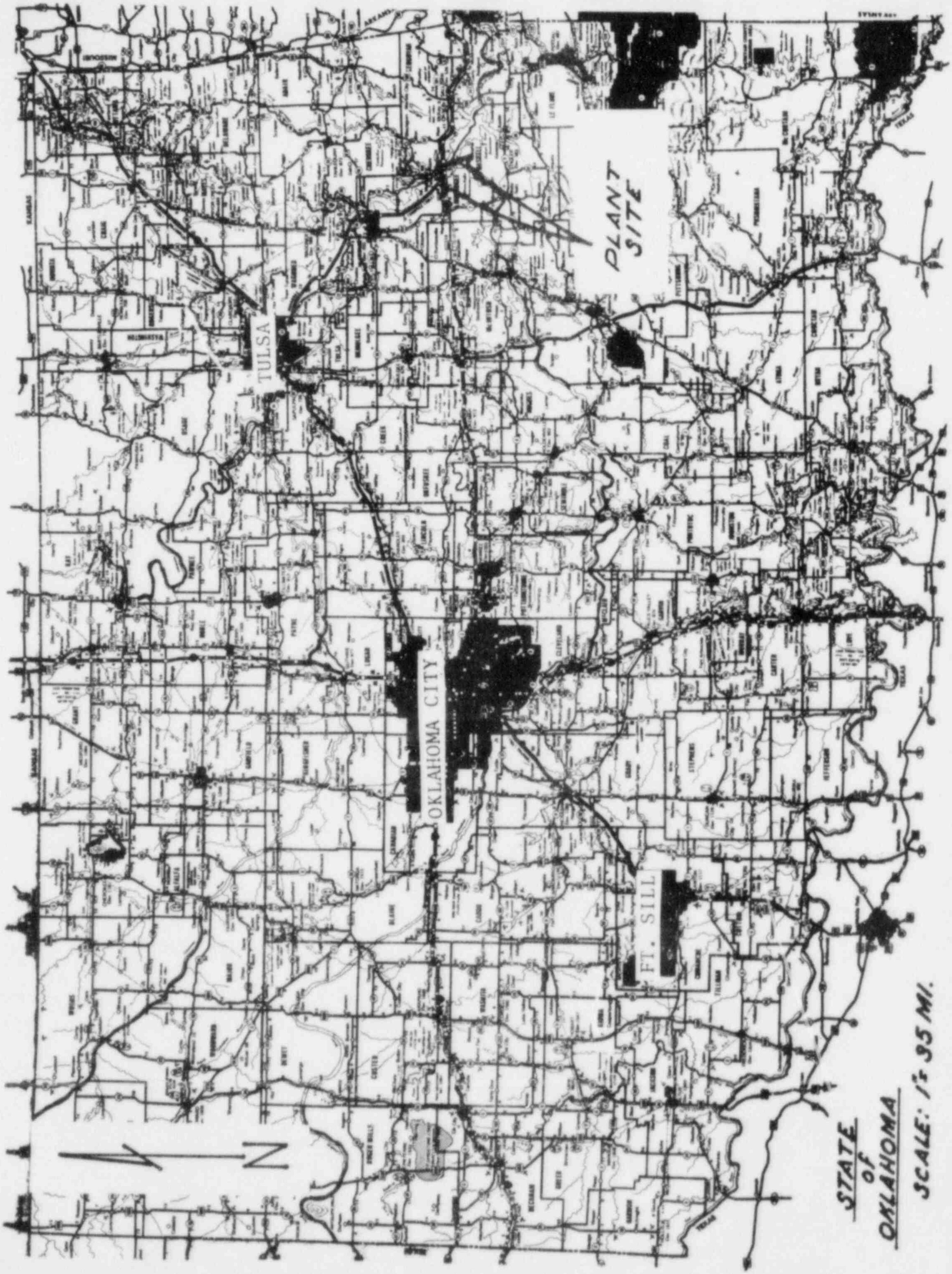
The maps requested are enclosed. We feel, however, that this request, if such fixed criteria for such reports exists, should be included in the guidelines for such reports. Figure 1 is a reduction of Drawing 110-C-151 included with the Revised Environmental Report. The location of the houses and school are circled and the distances tabulated.

(3) Page S-45. Process description covers disposal of sodium hydroxide solution used to wash lean organic. What is done with the ammonium sulfate solution used in the first stage lean organic wash?

The ammonium sulfate solution used in the first stage of organic washing is returned to the pumper decanters and the aqueous solution combined with the raffinate for discard at that point. We are currently developing the use of this ammoinium sulfate solution to provide sulfation of the UNH instead of using sulfuric acid. Initial results appear favorable.

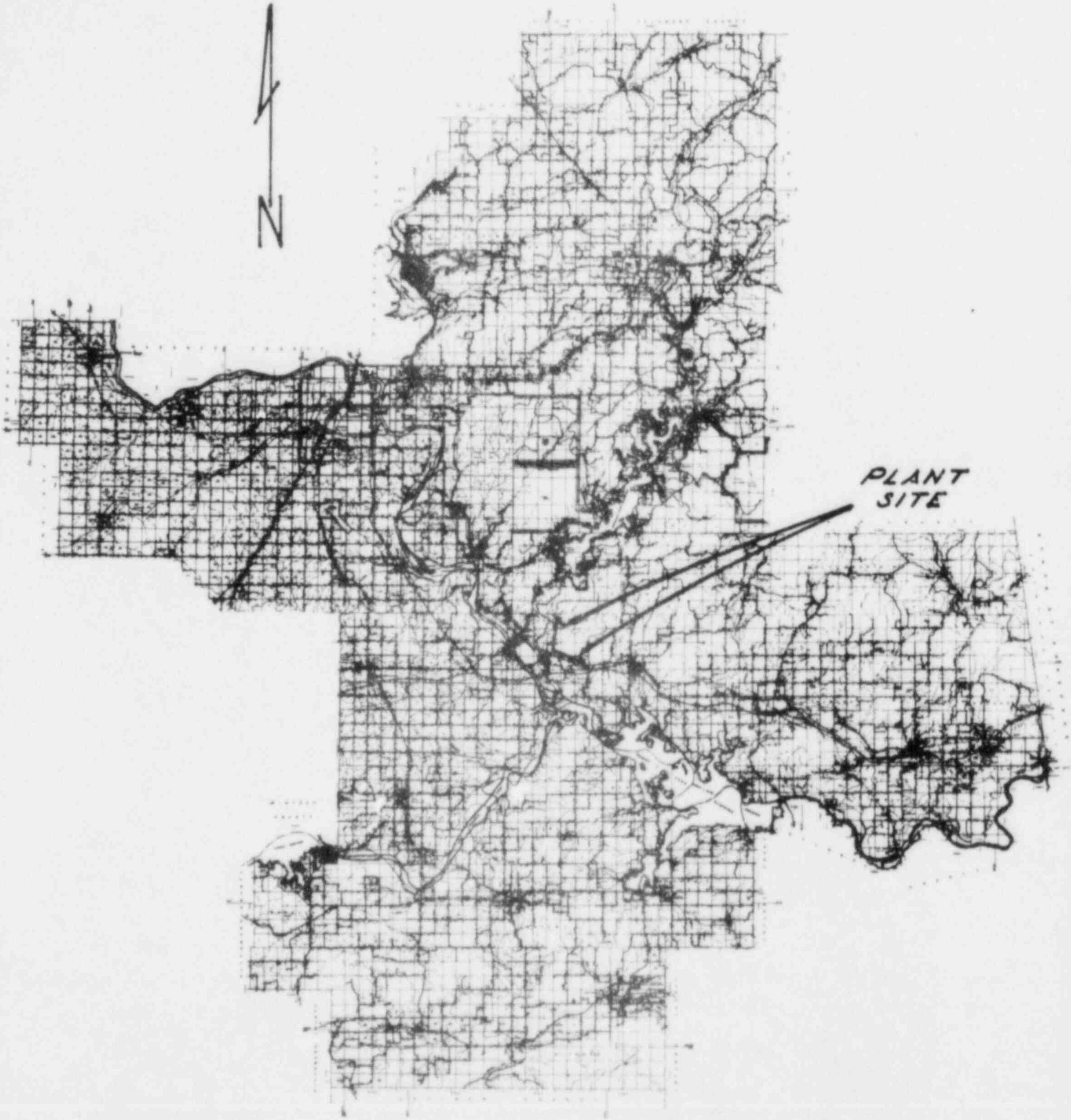
(4) Page S-45. Claim is made that raffinate stream is neutralized with ammonia and impounded for permanent storage while Revised Environmental Report (November 1971), page R-5, states that raffinate stream is neutralized with lime slurry precipitating U and daughter products, Th-230, Th-234 and Ra-226 along with heavy metals. Which procedure is used?

Initially, the raffinate stream was neutralized with lime slurry as described in the Revised Environmental Report and subsequently changed to ammonia in December 1971 in order to take advantage of the ammonia economics, more nearly stoichiometric neutralization, and to prevent filling the pond prematurely with solid calcium hydroxide. Pond No. 1 was essentially all neutralized with lime slurry while Pond No. 2 has only been neutralized with ammonia solution.



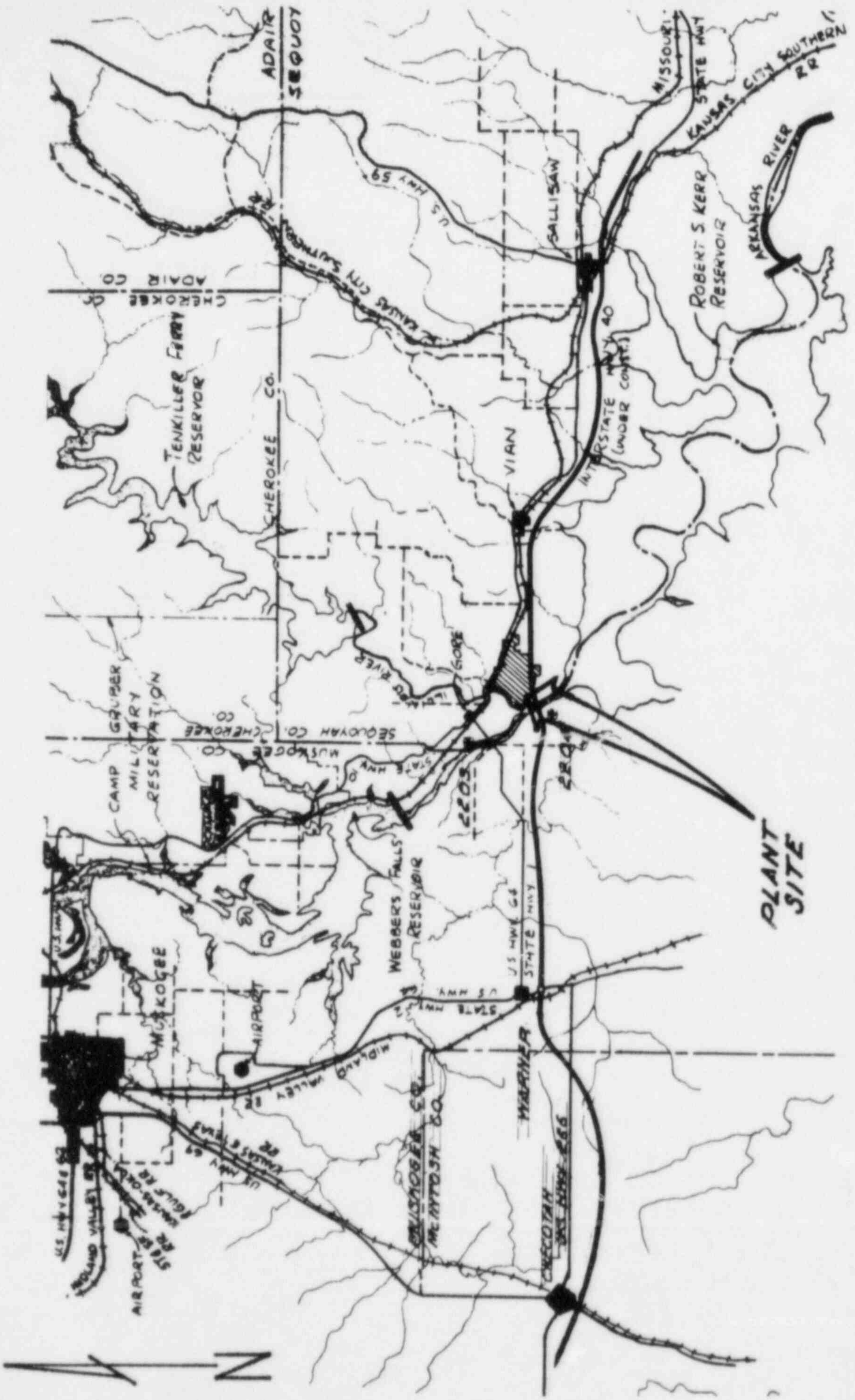
STATE of OKLAHOMA

SCALE: 1" = 35 MI.



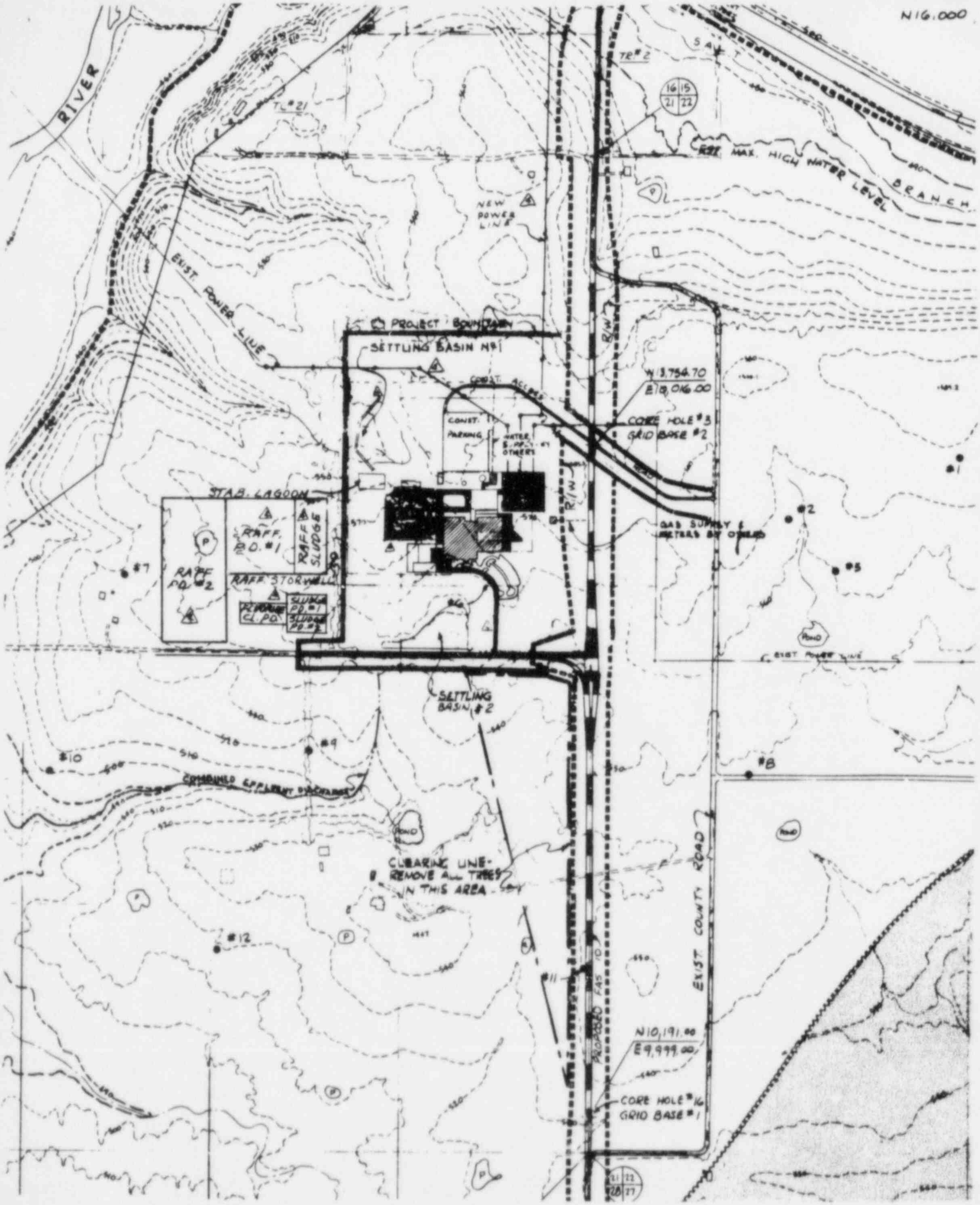
MAP of SEQUOYAH,
CHEROKEE, MUSKOGEE and
HASKELL COUNTIES

SCALE: 1" = 10 MI.

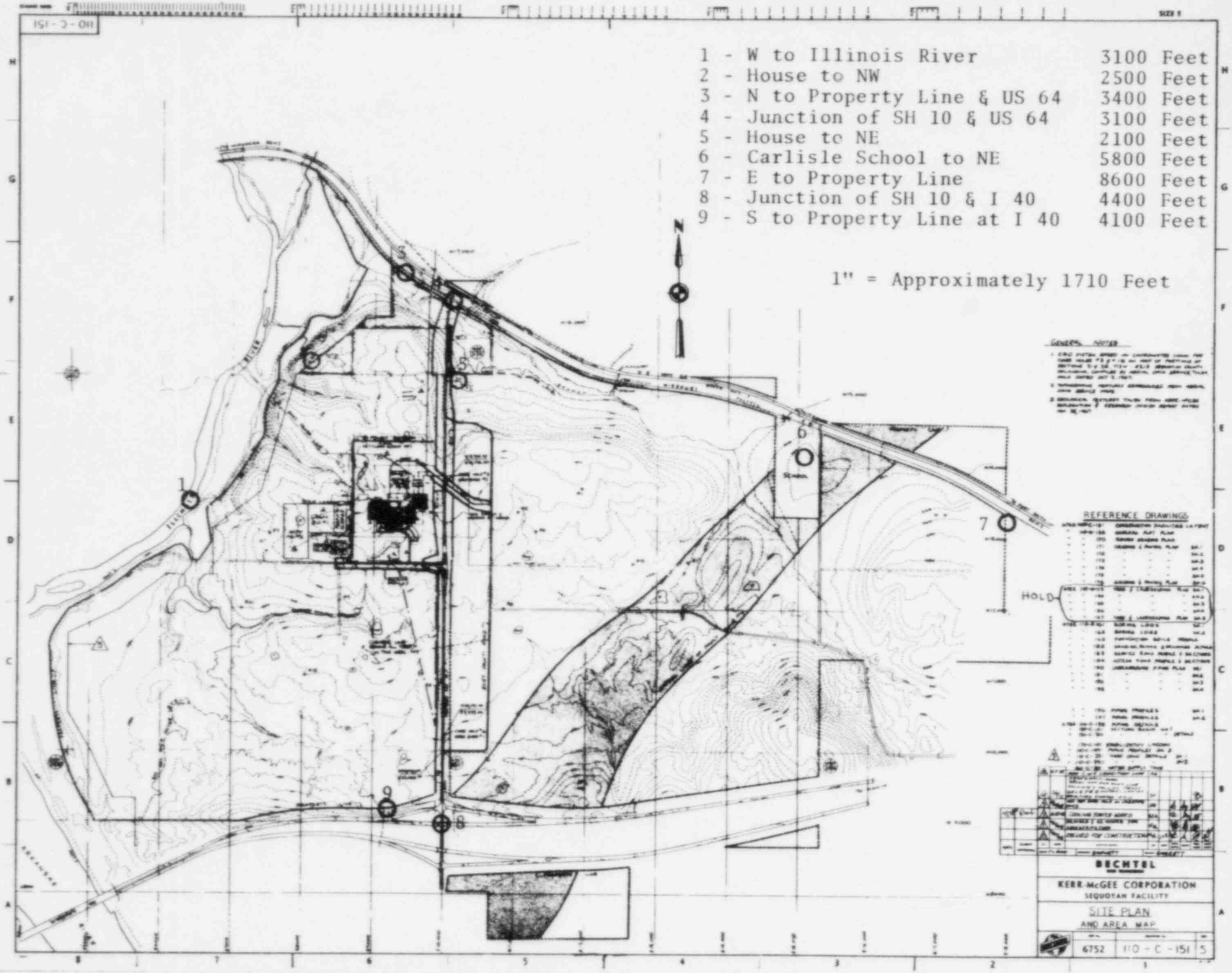


AREA MAP

SCALE: 1" = 4 MI.



ENLARGEMENT OF PLANT AREA 1" = Approx. 670 Ft.



1 -	W to Illinois River	3100 Feet
2 -	House to NW	2500 Feet
3 -	N to Property Line & US 64	3400 Feet
4 -	Junction of SH 10 & US 64	3100 Feet
5 -	House to NE	2100 Feet
6 -	Carlisle School to NE	5800 Feet
7 -	E to Property Line	8600 Feet
8 -	Junction of SH 10 & I 40	4400 Feet
9 -	S to Property Line at I 40	4100 Feet

1" = Approximately 1710 Feet

(5) Page S-47.

(a) Equation (iii) is not balanced; needs 3 U_3O_8.

(b) Equation is not balanced; insufficient oxygen and no hydrogen on right-hand side of equation. Expression "8 NO_3 not understood.

(Table IV) - Totals from ore digesters do not appear compatible with previous data, i.e., 5280 lb/day release rate of NO_2 for 2 shift operation processing 1717 lb/hr U does not appear to equate to 8350 lb/day release for 3 shift operation at 2686 lb/hr rate. Please clarify.

As you noted, (a) equation (iii) omitted 3 in front of U_3O_8. The corrected equation is given below:

$$3U_3O_8 + 20HNO_3 \rightarrow 9UO_2(NO_3)_2 + 2NO + 10H_2O$$

(b) Equation is not balanced. The corrected equation is given below:

$$UF_4 + 4Al(NO_3)_3 \rightarrow UO_2(NO_3)_2 + 4AlF(NO_3)_2 + 2NO_2$$

The rate of uranium throughput does not correlate with the rate of uranium digestion. As noted on Table IV, NO_2 rate is 660 lbs/hour (600 in error) because ore addition rate is 5150 lbs U/hour. The daily rate for 5000 TPY operation would require 8 digestions (200 days/year) while 12.5 digestions would be required for 10,000 TPY (310 days/year). Therefore, 8 x 660 = 5280 lbs NO_2/day. Similarly, 8250 lbs/NO_2 day for 12.5 (8350 in error).

(6) Page S-48, Paragraph 2. At 0.2 to 1.2% losses, the amount of NO_2 lost would range from ∿ 36 to 216 lb per day at the 5,000 TPY rate and from ∿ 68 to 406 lb per day at the 10,000 TPY rate based on values given in Table IV. Should specify 9 lb/hr loss is at 5,000 TPY rate. Letter WJS to CRB 1/21/72 indicates loss of 24.1 lb/hr NO_2. Please report measured or best estimate of NO_2 release at 5,000 TPY rate.

NO_2 released from the stack varies with several plant activities. Rate of generation is controlled by the rate of digestion and composition of feed material and the rate of denitration. The degree of absorption is controlled by the efficiency of the absorber at any given instant. In our total material balance, we show 4.6 metric tons released per month at 5000 tons per year or a rate of 14 pounds per hour which is our current best estimate. The measurements reported to Mr. Buchanan have not been redone though we now have a sampler in the stack which has measured from 100 to 300 ppm NO_2 in the stack effluent. This exact concentration, of course, may vary by the steam demand of the boilers. Nitrogen effluent on Table VII should be 1.4 MT/Mo.

(7) Page S-55, Paragraph 2. Claim is made that plant site is a licensed burial ground. We do not find this authorization in the license, license application or environmental reports. Please clarify.

Burial of plant generated solid waste material on the site is done in accordance with 10 CFR 20.304 which provides a general license for such disposal. Describing the plant site as a "licensed burial ground" should be eliminated. As stated, cumulative burials through November 1 have totalled 304 Kgs of natural uranium. In 1971, Mr. J. Hyder of Region IV Compliance Office answered certain questions as a routine part of his inspection, a copy of which is enclosed for your information.

(8) Pages S-61 and S-62. Tables X and XI should indicate that quantities are in metric tons <u>per month</u>. Please clarify method used to scale up losses.

Tables X and XI show quantities in metric tons per month. Losses were scaled up on an item by item basis since the higher production rate of 378.8 metric tons per month of uranium would permit higher efficiencies in handling of certain off-gas streams. Generally, plants designed for continuous operation produce their best efficiencies at the design rate rather than approximately 50% of design rate. The earlier exchange of information, however, emphasized that these data should be based upon measured experienced quantities and expanded with the best

QUESTIONNAIRE

BURIAL OF WASTE PURSUANT TO § 20.304

I. Licensee Name Kerr McGee

Address Sequoyah Facility

License No. SUB-1010

Date of Inspection 9/20-22/71

II. Does licensee generate radioactive waste during normal operations? Yes ✓ No ___

III. Does licensee bury waste pursuant to § 20.304? Yes ✓ No ___

If No, disregard rest of questionnaire.

IV. What were the principal types of waste buried?

Chemical laboratory waste	___
Animal carcasses	___
Contaminated equipment & scrap	✓

Other (describe briefly) ___

V. What were the principal isotopes and estimated amount of activity buried during 1970?

Nat U. 3960 u-ci in 22.0 lb

(12,000 gm U Nat)

VI. What alternative disposal methods were considered?

Transfer to a commercial disposal firm	___
Incineration	___
Storage for decay	___

Other (describe briefly) None

VII. What were the bases for choosing burial pursuant to § 20.304?

Economics ✓ Convenience ✓

Other (describe briefly) ___

VIII. In the licensee's opinion, would deletion of § 20.304 present a hardship? Yes ✓ No ___

Jo Hyder CO IV

Inspector

A.E.C.

engineering estimates which was the procedure followed. As mentioned, October 1972 provided one month of operation at slightly in excess of rated capacity. Additional measurements of effluents were made and Table XI has been reconstituted based upon these measurements. Table XI Revised is attached immediately following.

(9) Page S-65, Table XII. Design criteria used for a number of constituents appear substantially higher than EPA ambient air quality standards.

Constituent	Design Value Maximum Ground Level Beyond Site Fence	EPA Air Ambient Quality Standard (40 CFR 50)
Hexane	500 ppm	0.023 ppm (Hydrocarbon) maximum 3-hour concentration
SO_2	0.2 ppm	Primary Standard: (a) 0.03 ppm annual arithmetic mean. Secondary Standard (a) 0.02 ppm annual arithmetic mean.
NO_x	2 ppm	0.05 ppm nitrogen dioxide - annual arithmetic mean
Particulates	0.3 grain/ft^3 at point of release (equivalent to 6.87×10^5 μg/m^3)	Primary Standard: (a) 75μg/m^3 annual geometric mean Secondary Standard: (a) 60μg/m^3 annual geometric mean

$\frac{687 \times 10^3}{75}$ = 9160 minimum dilution required before reaching site boundary.

UF^4 concentration of 0.006 mg/m^3 ($\sim 1.15 \times 10^{-12}$μCi/ml) and UF_6 concentration of 0.009 mg/m^3 ($\sim 2.03 \times 10^{-12}$μCi/ml) appear to be slightly below the 10 CFR 20 allowable limits in unrestricted areas of 2×10^{-12}μCi/ml and 3×10^{-12} μCi/ml for insoluble and soluble natural uranium respectively.

While not stated in the report, the data given on Table XII was design criteria targets compiled from applicable standards at the time these criteria were set, July 1968, so as to provide the goal for the design contractor to perform calculations and select optimal processing methods. These criteria were generated (1968) well before the establishment of EPA ambient air quality standards. Effluent air quality is being monitored continuously to seek control methods to insure that offsite emissions never exceed air quality standards.

TABLE XI REVISED
ACTUAL, OCTOBER 1972
METRIC TONS OF EFFLUENTS IN ALL PROCESS STREAMS AT A PRODUCTION RATE OF 387.8 METRIC TONS PER MONTH OF URANIUM CONTENT AS URANIUM HEXAFLUORIDE[a]

	Stored					A	B	Air Stream					C	
	Neutralized Raffinate	Fluoride Retention Basin	Fluoride Cell Sludge	Emergency Basin No. 1	Burial	TOTAL STORED	Aqueous Combination Stream	Absorber Tail Gas	Reduction Off-Gas to Plant Stack	HF Scrubber	F_2 Cell Hood Rework Exhaust	Miscellaneous	TOTAL AIR STREAM	TOTAL LOSSES A+B+C
Uranium	0.05	0.05		.04	.004	0.14	.43			$2x10^{-4}$		.006	.006	.58
Hexane												8.8	8.8	8.8
Nitrate	180.1					180.1	.54							180.6
Water[b]	397.2	180				577.2	186,000	276	91	62			429	188,000
Ammonia	43.3					43.3								43.3
Fluoride	0.6	13.6	.06			14.3	.20			.006	.030	.047	.083	14.8
Hydrofluoride			.43			.43								.43
Nitrogen Oxide								4.6					4.6	4.6
Sulfur Dioxide									1.51				1.51	1.51
Fluorine												.048		.048
Nitrogen[b]								543.5	1690	3741				
Oxygen[b]								164.2	472	1104				
TOTAL						1815	186,000							

a. Matter such as sodium, potassium and calcium that is present in small amounts and is relatively innocuous has been left off this table.

b. These are diluents that serve to dilute pollutants.

c. 46 million cubic feet (930 metric tons) of natural gas are assumed to be burned in stoichimetric air, yielding 2557 metric tons of CO_2, 1278 metric tons of H_2O and 7958 metric tons of nitrogen. This is not a process stream but it contributes to dilution at the stack.

d. This effluent results from air exhausts from sample preparation, hexane vents, fluorine emergency vents, and roof vents.

(10) Page S-69, Table XIII

Combination stream at plant, average for last 12 months indicates:

$$\begin{array}{r} 18.6 \times 10^{-7}\ \mu Ci/ml\ \alpha \\ \underline{12.6 \times 10^{-7}\ \mu Ci/ml\ \beta} \\ \Sigma\ \alpha + \beta = 31.2 \times 10^{-7} = 3.12 \times 10^{-6}\ \mu Ci/ml \end{array}$$

Maximum allowable concentration for unidentified radioactive material (10 CFR 20, Appendix B, Note 3C, Table II, Column 2 (unrestricted) is given as 3×10^{-6} µCi/ml indicating 12 month average was in excess of MPC with monthly values of 4.48×10^{-6} for 4/71; 7.38×10^{-6} for 5/71; 4.80×10^{-6} for 10/71 and 5.10×10^{-6} µCi/ml for 11/71 all above MPC.

The observation made as to the data on Table XIII is correct. However, the interpretation of the use of 10 CFR 20, Appendix B, Note 3C, Table II, Column 2, is not in accordance with our understanding. Note 3C is only used for unidientified radioactive material not containing Radium_{226} which is separately recorded on Table XIII. The uranium component of this stream is also measured and is tabulated in the data submitted in answer to paragraph 11 below.

(11) Page S-71, Table XV and following tables:

While well Nos. 1, 2 and 3 do not show any significant trend in α and β levels with time, the Gross α in well Nos. 5 and 6 appears to have taken a sharp rise in the last two months reported. This trend is not seen in fluoride and nitrate analyses reported for these wells in Table XVI.

Page S-73, Table XVII indicates a significant increase in gross α and β in the Fault Well and Residence Well 1 while Table XVIII shows a rise in F and N concentrations in the Fault Well and a jump in fluoride in both the Carlisle School well as well as Residence Well 1.

In addition, as pointed out by Dr. Warner, the average nitrate concentrations and radioactivity in the six monitor wells appear to be substantially higher than in the four background wells indicating possible contamination of the ground water.

In view of these apparent anomalies, we are most interested in seeing more recent analyses for all of these wells and for monitor wells Nos. 10 through 15 if these data are available. Please resubmit data furnished on 11/20/72 in a form and using units that will permit direct comparison with analytical results provided in Tables XIII thru XXII of the Supplemental Environmental Report.

The additional data requested is attached. Additional information as to the construction, subsurface structure, analysis and conclusions as to the integrity of the storage ponds will be covered in detail later in this report.

It should be noted that in January 1972 we changed independent analysts from Controls for Environmental Pollution, Albuquerque, New Mexico, to U.S. Testing Company, Richland, Washington, on the basis that analytical control data could be furnished by UST thereby providing statistically sound results at these extremely low levels. However, these data have not been furnished and we currently plan to use the analysis of the Sequoyah Laboratory and the Kerr-McGee Technical Center upon certification by the Oklahoma Water Resources Board as an environmental laboratory. This certification is now being processed.

(12) Page S-71, Table XV. Well No. 1 on several occasions indicated Radium-226 concentrations of $3 \times 10^{-8} \mu Ci/ml$ and once (July 1971) showed $4 \times 10^{-8} \mu Ci/ml$. MPC (unrestricted) 10 CFR 20 value is $3 \times 10^{-8} \mu Ci/ml$.

It should be noted that this analysis has varied widely. In addition, Well No. 1 is not an unrestricted area and application of $4 \times 10^{-7} \mu Ci/ml$ is considered the appropriate 10 CFR 20 limit.

(13) Page S-72, Table XVI. Well No. 1 NO_3 as N avg. last 12 months reported as 14.0 ppm with 6 of 12 values exceeding recommended maximum of 10 ppm quoted in Table XXV Page S-84.

While Well No. 1 shows an average value of 14 ppm N as nitrate, you can see it is primarily due to high levels in April, May and June of 1971 and March of 1972. The data supplied under paragraph 11 again shows high levels from March through July. You will note that these levels are not correlatable with uranium levels. Well No. 15, which is down slope from No. 1, shows the same pattern. Again, we believe that these wells should not be considered available for public access and certainly not sources of drinking water to which the standard on Table XXV applies.

1972 ENVIRONMENTAL WATER SAMPLES
SURFACE
UNITED STATES TESTING RESULTS
RADIOACTIVE UNITS-$\mu Ci/ml x 10^{-8}$
CHEMICAL UNITS-ppm^{1}

LOCATION	ANALYSIS	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
2201	Nitrate	.1	< .1	.1	.3	.1	1.0	.3	.1	.2	< .1
	Fluoride	.4	.5	.6	.5	.8	.3	< .1	1.0	.6	1.1
Ill. River	Gross α	1.06	.41	1.67	.66	.38	.49	.41	.23	< .23	< .23
Upstream	Gross β	.87	.57	.92	.84	1.18	.51	.65	5.47	1.71	.53
	Uranium	.31	.32	.80	.26	.72	.84	.50	< .17	< .17	.50
	^{226}Ra			< .02			< .02			< .02	
2202	Nitrate	.2	.1	.4	< .1	.4	.5	.2	.1	.3	< .1
	Fluoride	.6	.5	.6	.4	1.0	.7	.2	1.1	.7	2.4**
Ill. River	Gross α	2.08	11.20	7.40	3.63	1.81	1.10	1.15	3.60	5.39	1.94
Downstream	Gross β	1.99	4.58	4.76	2.39	1.74	.97	.56	1.30	3.60	1.57
	Uranium	1.76	6.22	3.25	2.13	.72	1.13	.75	2.72	6.03	3.72
	^{226}Ra			< .02			< .02			< .02	
2203	Nitrate	.7	< .1	.1	.1	.1	.8	.3	.1	.4	< .1
	Fluoride	.6	.6	.7	.7	1.0	.6	.4	1.2	.9	1.4
Ark. River	Gross α	.30	.42	.34	.48	.48	.32	.74	.26	< .23	< .23
Upstream	Gross β	1.51	1.62	.53	2.30	2.46	1.30	1.52	.71	3.43	1.14
	Uranium	.14	.27	.11	.31	1.29	.54	.02	< .17	< .17	< .17
	^{226}Ra			< .02			< .02			< .02	
2204	Nitrate	.1	< .1	.3	< .1	.4	.4	.1	.1	.1	< .1
	Fluoride	.5	.8	.8	.6	1.0	1.0	.3	1.1	.9	1.0
Ark. River	Gross α	< .19	.60	.34	.96	.98		< .23	< .23	< .23	.39
Downstream	Gross β	.81	5.40	1.03	1.05	1.54	.55	.50	.41	4.18	.68
	Uranium	.19	.60	.13	.45	.67	.64	.54	.37	.91	1.93
	^{226}Ra			< .02			< .02			< .02	
22J5	Nitrate	.1	< .1	.1	< .1	.1	1.1	1.2	.3	.5	.4
	Fluoride	.4	.5	.8	.6	.8	.6	.3	.8	1.0	1.0
Farm Pond	Gross α	.50	1.06	.64	1.45	.33	.28	< .23	< .23	< .23	.33
East	Gross β	1.67	2.93	1.90	2.91	1.46	1.26	1.32	1.86	4.64	2.29
	Uranium	.18	1.01	.20	.65	.43	.39	.18	< .17	.31	< .17
	^{226}Ra			< .02			< .02			< .02	

SURFACE-CONTINUED

LOCATION	ANALYSIS	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT	OCT.
2206	Nitrate	.2	.3	.1	< .1	.1	.8	.2	.3	.3	.4
	Fluoride	.7	.7	1.0	.8	1.0	1.1	.6	1.0	1.0	1.3
Farm Pond	Gross α	3.94	2.87	8.17	4.07	2.00	2.58	1.39	.23	.37	.26
South	Gross β	6.21	6.64	5.83	2.41	2.92	1.76	1.69	1.68	2.66	1.18
	Uranium	3.39	3.57	2.72	2.00	3.57	.24	.04	.05	.32	.02
	^{226}Ra			< .02			< .02			< .02	
2207	Nitrate	.1	< .1	3.1	1.0	.9	2.4	.8	1.0	1.9	2.3
	Fluoride	1.1	1.1	.4	17.6*	.6	1.1	.4	.7	.7	.7
Facility	Gross α	130.92	186.57	173.17	69.01	22.44	115.72	90.96	100.42	101.03	123.24
Effluent	Gross β	80.05	115.27	90.97	84.63	83.02	58.09	22.57	11.52	18.36	14.37
	Uranium	70.88	164.29	30.62	61.15	94.54	102.38	86.71	63.62	92.15	72.90
	^{226}Ra			< .02			< .02			.05	
2208	Nitrate	.8	< .1	.3	.3	.6	1.1	.4	.1	.2	< .1
	Fluoride	.5	.6	.7	.5	.5	.6	.1	.7	.6	2.3**
Tenkiller	Gross α	15.02	.68	.71	1.07	.54	< .23	.46	.28	.83	< .23
Raw Water	Gross β	15.39	.62	.49	1.57	.75	.31	< .23	< .23	2.04	2.41
	Uranium	15.65	.46	.19	1.49	1.07	.22	.17	.28	.53	.58
	^{226}Ra			< .02			< .02			< .02	
2209	Nitrate	.1	< .1	.1	< .1	.2	.9	.7	.1	.2	< .1
	Fluoride	.2	.5	.6	.6	.5	.8	.2	.9	.8	2.2**
Salt Fork	Gross α	< .09	.70	< .15	1.17	.43	.65	.44	8.54	< .23	< .23
River	Gross β	1.24	1.49	1.06	1.59	.89	1.68	1.52	1.14	2.81	.96
	Uranium	.18	< .12	< .07	3.51	.85	.53	< .17	< .17	.89	< .17
	^{226}Ra			< .02			< .02			< .02	

*This sample was the composite of a continuous sampler for the month analyzed by U. S. Testing. Grab samples are taken each shift and analyzed by the Sequoyah lab. The average for the month was 1.4 ppm. On April 25, one high sample of 32 ppm was recorded when the acid addition system went out of control resulting in a pH of 5.5 for the same sample.

**These results are determined by U. S. Testing. Aliquots measured by Sequoyah lab tested < .1 ppm. Apparently, an example of sample contamination at some stage of handling.

[1] Nitrate reported as nitrogen on all tables.

1972 ENVIRONMENTAL WATER SAMPLES
SEEPAGE WELLS
UNITED STATES TESTING RESULTS
RADIOACTIVE UNITS-$\mu Ci/ml \times 10^{-8}$
CHEMICAL UNITS-ppm[1]

LOCATION	ANALYSIS	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
2301	Nitrate	.2	.1	24.0	212.0	273	200.0	180.0	15.5	14.0	66.0
	Fluoride	1.2	1.0	1.0	7.0	2.0	1.3	1.3	4.5	3.1	1.4
Basin No. 1	Gross α	1.34	14.04	13.85	21.61	51.61	65.84	6.86	166.27	5.26	4.05
North	Gross β	9.24	5.20	5.28	17.26	26.17	.15	9.18	25.57	8.50	6.98
	Uranium	8.38	.17	3.09	4.42	134.21	39.44	38.25	109.40	6.79	2.17
	^{226}Ra			< .02			< .02			< .02	
2302	Nitrate	< .1	1.0	.3	.7	.6	1.3	3.7	4.8	6.5	5.5
	Fluoride	1.0	1.1	1.2	6.8	1.3	1.1	.8	.7	.6	.6
Basin No. 1	Gross α	5.10	10.52	4.89	17.19	5.22	12.84	9.55	5.21	2.00	2.00
South	Gross β	4.29	4.54	2.66	13.19	3.55	3.61	2.36	1.38	1.78	1.37
	Uranium	4.36	5.86	.65	3.95	5.94	4.80	5.91	2.18	2.04	.86
	^{226}Ra			< .02			< .02			< .02	
2303	Nitrate	.1	< .1	.9	1.0	.1	.6	.6	2.3	1.1	5.1
	Fluoride	.9	.9	1.1	1.1	2.0	.9	.7	.8	.5	.5
Raffinate	Gross α	4.11	8.25	12.10	26.78	4.95	52.14	6.05	6.58	2.09	1.64
Pond No. 1	Gross β	.66	6.62	1.22	21.67	5.30	17.49	4.18	2.05	2.96	11.44
North	Uranium	3.64	6.49	3.37	8.61	7.44	9.97	3.93	3.04	1.52	.78
	^{226}Ra			< .02			< .02			< .02	
2305	Nitrate	.6	1.1	1.0	.9	.7	.8	.9	5.5	5.9	2.4
	Fluoride	1.2	.7	.8	1.4	1.1	1.0	1.1	.8	.5	.2
Raffinate	Gross α	3.34	10.18	13.95	21.02	6.86	10.46	9.47	9.43	1.07	.89
Pond No. 1	Gross β	.50	6.13	6.34	22.80	3.11	9.38	3.24	2.10	2.53	5.42
South	Uranium	3.37	3.97	2.33	4.52	5.22	17.10	3.88	1.41	.56	.51
	^{226}Ra			< .02			< .02				

SEEPAGE WELLS-Continued

LOCATION	ANALYSIS	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
2306	Nitrate	.2	< .1	.2	.5	0.2	< .1	.3	.1	< .1	.1
	Fluoride	1.0	.7	.5	2.6	1.2	.5	.3	.3	.2	< .1
Carlisle F.	Gross α	1.30	11.56	14.57	13.40	.87	1.36	3.02	5.67	1.96	1.51
Pond South	Gross β	9.44	6.25	2.24	3.88	1.21	1.49	.49	.89	1.40	5.07
	Uranium	7.25	5.88	3.61	5.16	1.59	2.12	.59	1.37	5.94	.90
	^{226}Ra			< .02			< .02			< .02	
2307	Nitrate	.9	.5	.5	< .1	.4	.5	.6	.3	.3	.3
	Fluoride	4.0	4.2	4.2	4.0	5.4	6.2	4.6	2.7	3.3	4.0
Fault Well	Gross α	3.27	7.08	4.15	5.39	4.18	< .23	3.21	3.25	2.74	< .23
	Gross β	.53	6.79	4.04	5.29	5.71	4.48	2.04	2.05	4.35	14.70
	Uranium	.23	.21	.12	1.18	.59	.38	.20	.18	.22	.21
	^{226}Ra			< .02			< .02			< .02	
2308	Nitrate	< .1	< .1	.1	< .1	< .1	.1	.1	.1	< .1	< .1
	Fluoride	1.1	.7	1.0	.8	1.1	.7	.4	.5	.4	.4
Residence	Gross α	2.09	4.23	3.83	4.76	1.34	1.38	2.51	.34	2.38	.72
Well	Gross β	1.46	1.84	2.97	4.50	1.21	1.25	.90	.34	2.56	.67
	Uranium	.62	1.48	1.52	.38	1.16	1.12	.62	.22	< .17	.36
	^{226}Ra			< .02			< .02			< .02	
2309	Nitrate	< .1	< .1	.3	.1	1.3	1.8	.7	.2	.1	< .1
	Fluoride	.9	.5	.6	.5	1.0	.6	.2	.2	.2	.2
Carlisle	Gross α	.09	.24	.17	< .23	.43	< .23	.23	< .23	.23	< .23
School Well	Gross β	1.24	.81	.96	.74	.89	.62	.65	.73	3.13	.91
	Uranium	.18	.12	< .06	3.51	.49	.12	< .17	< .17	< .17	< .17
	^{226}Ra			< .02			< .02			< .02	
2310	Nitrate	.1	1.1	2.4	1.3	.4	.8	1.2	.2	.2	.1
	Fluoride	1.3	1.0	1.1	1.2	2.0	1.1	1.0	.2	.8	.9
Raffinate	Gross α	3.11	2.06	11.98	9.11	3.31	6.93	2.58	< .23	2.52	.84
Pond No. 2	Gross β	4.26	5.06	6.05	4.81	1.62	2.17	.60	.67	1.70	.59
	Uranium	2.68	3.93	4.30	3.33	2.11	4.32	1.22	< .17	2.46	1.11
	^{226}Ra			< .02			< .02			< .02	
2311	Nitrate	.5	3.5	4.7	3.4	.1	1.3	.4	.3	.2	< .1
	Fluoride	1.0	.6	1.0	.9	2.2	.8	.5	.6	.5	.5
Raffinate	Gross α	4.01	4.49	4.82	13.24	4.99	3.06	7.05	3.24	3.05	3.39
Pond No. 2	Gross β	1.37	.15	3.87	10.03	2.47	3.53	1.69	1.25	1.32	1.22
	Uranium	3.37	2.95	3.46	6.52	6.83	4.52	3.30	1.16	2.10	1.75
	^{226}Ra			< .02			< .02			< .02	

SEEPAGE WELLS-Continued

LOCATION	ANALYSIS	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
2312	Nitrate	< .1	.3	.1	.8	1.0	1.2	1.8	.5	.7	.5
	Fluoride	1.0	.8	1.0	.7	1.0	.4	.4	.8	.3	.4
Raffinate	Gross α	7.34	1.79	6.45	17.77	2.45	5.24	2.43	10.67	2.53	3.80
Pond No. 2	Gross β	3.67	.24	5.81	11.15	2.34	1.21	.47	1.60	1.10	.74
	Uranium	3.37	1.95	2.74	4.58	8.74	2.39	.72	1.96	1.28	1.55
	^{226}Ra			< .02			< .02			< .02	
2313	Nitrate	.3	< .1	.1	.1	.2	.7	.4	4.5		.1
	Fluoride	.9	.6	1.1	.9	1.0	.6	.5	.6		.5
Raffinate	Gross α	1.89	.35	22.97	111.18	6.96	18.61	6.27	6.09		4.58
Pond No. 2	Gross β	2.09	2.09	10.67	116.12	5.52	3.17	1.22	1.79		1.33
	Uranium	.85	.98	3.93	52.69	3.93	7.10	2.88	2.32		1.78
	^{226}Ra			< .02			< .02				
2314	Nitrate	.3	1.6	1.9	.4	.3	10.4	.3	1.0	.2	< .1
	Fluoride	1.0	.9	.9	4.1	2.0	.7	.7	.7	.6	.6
Raffinate	Gross α	1.92	12.79	12.57	34.32	4.74	12.67	8.15	5.22	4.01	16.58
Pond No. 2	Gross β	2.23	6.60	5.83	21.26	4.74	4.19	1.80	.87	1.70	2.13
	Uranium	2.04	6.83	4.23	1.16	7.85	8.09	4.73	3.27	6.08	2.38
	^{226}Ra			< .02			< .02		.02		
2315	Nitrate	.1	16.0	48.0	97	.5	91.0	42.0	15.5	42.0	15.5
	Fluoride	.9	.7	.8	.3	2.4	.2	.2	.2	.3	.2
Raffinate	Gross α	1.23	1.63	1.44	9.85	1.90	1.64	6.66	2.40	.30	.61
Pond No. 2	Gross β	.89	1.74	1.92	2.43	1.89	.33	1.96	.82	1.73	< .23
	Uranium	1.01	.90	1.29	4.62	2.90	1.40	.79	.44	< .17	.34
	^{226}Ra			< .02			< .02			< .02	

[1] Nitrate reported as Nitrogen on all tables.

1972 ENVIRONMENTAL VEGETATION SAMPLES

UNITED STATES TESTING RESULTS

ALL UNITS-ppm

LOCATION	ANALYSIS	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
2501	Uranium			2025.0		69.2					
South	Fluoride			43.3	70.0*						
Security Fence	Nitrate			700.0	< 1.0*						
2502	Uranium			141.3		33.4					
North	Fluoride			11.9	90.7*						
Security Fence	Nitrate			200.0	< 1.0*						
2503	Uranium			33.21		51.27	< 5.0		< 5.0	22.13	< 5.0
South	Fluoride			11.7	19.5*	13.0	28.0	20.0	10.1	11.8	19.0
1000 Feet	Nitrate			700.0	< 1.0*	100.0	< 10.0	100.0	30.0	1200.0	475.0
2504	Uranium			607.8		7.0	< 5.0		< 5.0	18.3	5.0
West	Fluoride			326.0	147.0*	58.0	95.7	103.0	96.0	61.7	33.0
1000 Feet	Nitrate			400.0	60.0*	520.0	100.0	50.0	100.0	1200.0	515.0
2505	Uranium			13.1		5.2	< 5.0		< 5.0	4.0	209.0
North	Fluoride			11.2	20.9*	11.0	44.3	17.4	18.9	3.5	8.0
1000 Feet	Nitrate			500.0	< 1.0*	40.0	< 10.0	< 25.0	25.0	100.0	5.0
2506	Uranium			13.7		< 5.0	< 5.0		< 5.0	3.4	< 5.0
East	Fluoride			6.7	20.0*	7.0	30.5	11.8	19.1	12.7	6.0
1000 Feet	Nitrate			400.0	30.0*	180.0	< 10.0	< 25.0	25.0	300.0	5.0
2507	Uranium					5.5	< 5.0		< 5.0	6.6	< 5.0
South	Fluoride				8.9*	177.0	30.9	7.3	11.0	8.7	13.0
6000 Feet	Nitrate				10.0*	40.0	50.0	< 25.0	40.0	300.0	15.0
2508	Uranium					< 5.0	< 5.0		< 5.0	9.4	< 5.0
West	Fluoride				15.1*	13.1	11.5	14.4	10.4	17.9	9.0
6000 Feet	Nitrate				10.0*	100.0	< 10.0	< 25.0	80.0	800.0	7.0

1972 ENVIRONMENTAL VEGETATION SAMPLES-Cont.

LOCATION	ANALYSIS	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
2509 North 6000 Feet	Uranium					< 5.0	< 5.0		< 5.0	2.9	< 5.0
	Fluoride				10.7*	22.4	35.7	24.5	20.8	26.7	14.0
	Nitrate				30.0*	40.0	< 10.0	< 25.0	30.0	100.0	30.0
2510 East 6000 Feet	Uranium					< 5.0	< 5.0		< 5.0	4.6	< 5.0
	Fluoride				15.4*	19.0	32.5	21.0	15.9	38.1	15.0
	Nitrate				10.0*	40.0	< 10.0	< 25.0	25.0	400.0	40.0

*Samples were taken on May 5 and May 9, 1972

1972 ENVIRONMENTAL SOIL SAMPLES

UNITED STATES TESTING RESULTS
ALL UNITS-ppm

LOCATION	ANALYSIS	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
2401	Uranium			16.6							
South Security	Fluoride			280.0							
Fence	Nitrate			57.0							
2402	Uranium			23.8							
North Security	Fluoride			224.0							
Fence	Nitrate			20.0							
2403	Uranium			< 1.2			7.2			3.8	
South	Fluoride			116.0			96.0			44.0	
1000 Feet	Nitrate			8.0			35.0			45.0	
2404	Uranium			20.0			39.6			43.4	
West	Fluoride			160.0			91.0			73.0	
1000 Feet	Nitrate			3.0			55.0			8.5	
2405	Uranium			< 2.6			11.9			6.1	
North	Fluoride			176.0			71.0			96.0	
1000 Feet	Nitrate			5.0			4.0			1.0	
2406	Uranium			< 2.7			8.7			3.3	
East	Fluoride			100.0			70.0			86.0	
1000 Feet	Nitrate			2.0			6.0			16.5	

(14) Pages S-78 and S-78A, Table XXII. Analytical results reported indicate erratic control of fluoride emissions with a number of values at the security fence exceeding recommended maximum concentration of vegetation of 40 ppm. Please provide more recent data. (See Comment (11))

More recent data is supplied under question 11. From our examination of this data, we conclude that in the sample taken 1000 feet west of the plant there appears to be a single incident resulting in contamination which has gradually decreased until the October sample which is within recommended levels. All other samples appear to be within the normal limits of variability of this sampling and analysis procedure. As noted on Page S-78, no cattle are grazed north of the Port Facility Road nor west of State Highway 10.

(15) Page S-79 - Effective stack height is reported as 170 feet (∿ 51.8 meters) while calculated value shown in Appendix IV, Page 3 is 56.6 meters. Calculation shown in Appendix IV fails to clarify whether stack diameter is 8 feet or 3.25 feet. Calculation is also unclear as to whether barometric pressure is 960 mb or 920 mb.

Effective stack heighth is 54.82 meters based upon recent calculations of rate of discharge and using 960 for the pressure in milibars. The number on Page S-79 should be corrected. The confusion on stack diameter is due to the fact that the OD of the stack is 8 feet. However, it has a liner that restricts the effective diameter to 7 feet and also has a restriction at the discharge to 3.25 feet.

(16) Appendix IV, Page 3 indicates 475 ft/minute velocity out of 8 ft diam. stack for total flow of $(.785)(8)^2(475) = 2.38 \times 10^4$cfm. License application 9/3/69 Page V-11 indicates stack discharge volume of 1.9×10^5 cfm (normal) and 8.85×10^4 cfm during low loads. Letter, W. J. Shelley to C. R. Buchanan dated 1/31/72 estimates flow with two boilers operating at 25,000 cfm.

The measurement of 475 feet per minute should, of course, be used in conjunction with the 7 foot effective diameter resulting in a flow of 18,270 cubic feet per minute. The license application discharge volume was made based upon estimates during the design of the plant. The data supplied to Mr. Buchanan on 1/31/72 was based upon the gas consumption of the boilers as of January 1972.

Recent data calculated from gas consuption during an extended period and temperature measurements in the stack result in a calculated discharge of 24,200 cubic feet per minute.

(17) Page S-80, Table XXIII. Data presented are not clear or consistent with Figure 3.9 of "Workbook" Page 29. Table headings are confusing.

Table XXIII is mislabeled. All columns should be labeled "Maximum XU/Q".

(18) Page S-81, Table XXIV. Off-site concentrations presented do not appear to be consistent with dilution of 10.4 Values indicate dilution of 10 rather than 10,000. Headings on right should read <u>ppb</u>. Also, see comment (25) below:

Observation is accurate that the off-site levels assuming 10^4 dilution should be in ppb.

(19) Page S-84, Table XXV. Footnotes b and c are not shown in body of table. You compare concentrations in rivers with recommended maximum concentrations. Please note that 10 CFR Part 20.106 limits concentration of radioactive materials in the effluent stream and requires considerable additional information if Appendix B, Table II limits are to be exceeded.

Footnotes b and c apply to recommended maximum levels of fluoride and nitrate. We understand the application of 10 CFR 20.106 limits to effluent streams and do not intend to request exception to Appendix B, Table 2, limits.

(20) Page S-85, Paragraph 1. Dilution factor implies process water flow of 240,000/150 or 1600 gpm. Table VII indicates process water of 345,000 gal/metric ton of U. With production of 5,000 short tons/year (4.55×10^2 metric tons/year), total water used = $3.45 \times 10^5 \times 4.55 \times 10^3 = 15.7 \times 10^8$ gallons per year. This is equivalent to 2990 gpm. Please explain.

1600 gpm is the design capacity of the process water system. Actual flow varies from 1100 to 1450 gpm due to variations of the level of water in the lake, i.e. the static head on the pipe withdrawal system located in the dam penstock; the condition of the pipeline, i.e. scale or algae present; and the resistance of flow through the receiving station valves and meter. The amount of water received from the lake is metered and fed into a stilling and treatment basin shown on Figure 11, Page 54. At this point, water needed for the processing is withdrawn in three streams. The first is an emergency cooling water stream which feeds certain sensitive cooling needs in order to protect the plant equipment. This emergency cooling water flow is then fed to the cooling tower feed basin and a secondary cooling water system is used for less critical service and returned directly to the cooling tower. The second stream is a bypass stream which is excess to the needs of the plant and joins discard from the cooling water system and flows to the point of discharge into the natural drainage channel. The third stream is potable water which is treated by settling, filtering and chlorination. The quantity of water discharged from the plant does not vary significantly with processing rates.

(21) Page S-86, Paragraph 2. Ra-226 level of 1 x 10^{-8}µCi/ml is 33% of MPC which still provides some leeway but not a great deal. Also, 14 ppm nitrate level is in excess of recommended maximum per Table XXV, Page S-84.

Please see the answer to question 13 on nitrate level in Monitor Well No. 1. While Radium_{226} is 33% of the MPC, it can be recognized from Table XV that this level is approximately the level of detection and reliable values would only be seen above this level.

(22) Page S-86, Paragraph 3. Should refer to Table XVIII rather than XVII. Also fluoride level in Carlisle School well has also "increased slightly."

Your correction is noted. Paragraph 3 on Page S-86 should refer to Table XVIII instead of XVII. Fluoride analysis in these wells has shown very erratic data, especially between the two laboratories. We hope that with the certification program of the Oklahoma Water Resources Board this erratic variation will decrease.

(23) Page S-86, Last Paragraph. Please explain more fully how the data obtained establishes the potential path of pond seepage.

A complete description of the pond construction, the monitoring wells and the strata in the immediate area follows at the end of the questions.

(24) (deleted)

(25) Page S-97, Table XXVI - The data presented in this table represent releases to the atmosphere during plant operation at throughputs significantly below those expected at the normal production rate of 5000 tons per year. To permit an assessment of the environmental impact of the Sequoyah facility under normal operating conditions, the release data must be scaled up (with the bases for the calculations clearly shown) and as a minimum requirement, the annual average significant organ doses to individuals exposed to radioactive pollutants at the off-site point of maximum ground level concentration must be estimated. In addition, organ doses and chemical pollutant concentrations should be estimated for each of the following off-site locations: (a) Residence northwest of plant site. (b) Residence northeast of plant site. (c) Carlisle School. (d) Points of maximum ground level concentration on Oklahoma Highway 10, U. S. Highway 64, Interstate Highway 40, and the Missouri Pacific railroad, and (e) Other nearby points of permanent and transient habitation.

Total dosages attributable to radioactive effluents out to a distance of ten miles from the site should be estimated for both the transient as well as the permanent population.

During October, data shown in Table XXVI, Page S-97, was measured for the month of October 1972 wherein the production rate was 387.8 metric tons/month (5119 tons U/Yr). Air sampling and counting systems are those commonly employed throughout the nuclear industry for low specific activity material and have been inspected by the Division of Regulatory Operations, Region IV, for adequacy and accepted. Revised release data is shown on the attached table as compared to the measured and estimated releases shown originally. These new data were supplied to Dames & Moore who incorporated these data into the exposure computer program with the resulting data shown in their answer. As can be seen, radiological organ dose estimates in milirem/year are insignificant compared to natural background. As with the earlier calculations, the dose values are conservative since no allowance was made in the calculations for fallout between the release point and downwind locations.

Dames & Moore answer to question 25 appears after Table XXVI - Revised.

TABLE XXVI - REVISED

ATMOSPHERIC RELEASES
Uranium - gm/sec

	Supplement - Page 97		October 1972	
	Insoluble	Soluble	Insoluble	Soluble
150 Foot Stack				
1. HF Scrubber		.00047		.000066
7. Incinerator	.0000175		.0000175	
Ground Level Stacks				
1. Sampling Plant Dust Collector	.00034		.00064	
2. Plant Vacuum System	.000084	.0000092	.0000037	.00000046
3. UO$_3$ Dust Collector		.00000062		.0000005
4. Sample Preparation Hoods	.000007		.0000037	
5. Roof Vents	.00066	.000073	.00057	.00007
6. Lab Hoods		.000001		.000001
	.001109	.0005538	.001235	.0001380
µCi/sec x 10^{-4}	3.66	1.83	4.08	.46
µCi/month	947.9	474	1057	119
*µCi/month/acre	.471	.236	.526	.059
*µCi/month/M^2 x 10^{-6}	116	58.3	130	14.6

*Assume all effluent evenly deposited on circle one mile in diameter - 2010 acres or 8.13 x 10^6 M^2.

A.E.C. Question 25

Page S-97, Table XXVI - The data presented in this table represent releases to the atmosphere during plant operations at throughputs significantly below those expected at the normal production rate of 5000 tons per year. To permit an assessment of the environmental impact of the Sequoyah facility under normal operating conditions, the release data must be scaled up (with the bases for the calculations clearly shown) and as a minimum requirement, the annual average significant organ doses to individuals exposed to radioactive pollutants at the off-site point of maximum ground level concentration must be estimated. In addition, organ doses and chemical pollutant concentrations should be estimated for each of the following off-site locations: (a) Residence northwest of plant site. (b) Residence northeast of plant site. (c) Carlisle School. (d) Points of maximum ground level concentration on Oklahoma Highway 10, U. S. Highway 64, Interstate Highway 40, and the Missouri Pacific railroad, and (e) Other nearby points of permanent and transient habitation.

Total dosages attributable to radioactive effluents out to a distance of ten miles from the site should be estimated for both the transient as well as the permanent population.

Response:

Data collected on Uranium release in October 1972, during which the Sequoyal facility operated at a rate of 5119 TPY (387.8 metric tons) is tabulated below:

Summary of Gaseous Effluent Release Data

Radioactive Pollutants

Release Height	Release Rate (Ci/sec) Soluble U	Release Rate (Ci/sec) Insoluble U
Ground Level	2.4×10^{-11}	4.1×10^{-10}
150-foot Stack	2.2×10^{-11}	5.8×10^{-12}

Non-radioactive Pollutants

Release Height	Release Rate (g/sec) Fluoride
150-foot Stack	.0496

The values of the October operating releases are utilized in calculating the doses associated with these release levels. Tables IVa, Va, VIa, VIIa, VIIIa, IXa, Xa, XIa, XIIa, XIIIa, and XIVa represent the October operating data.

Specific radiological organ dose estimates (in mRem/yr) of primary interest locations are as follows:

	Bone	Lung	Kidney
25. (a) Residence NW (.5 miles)	1.57×10^{-2}	1.47	6.44×10^{-2}
(b) Residence NE (.5 miles)	1.98×10^{-2}	1.86	8.13×10^{-2}
(c) Carlisle School (NE 1 mile)	6.23×10^{-3}	5.73×10^{-1}	2.56×10^{-2}
(d) Highway Maximums			
1) I-40 (SW 1.5miles)	1.15×10^{-2}	1.05	4.70×10^{-2}
2) US-64/RR (NE.5 miles)	1.98×10^{-2}	1.86	8.13×10^{-2}
(e) Points of Interest			
1) Vian (E 4 miles)	4.63×10^{-4}	3.74×10^{-2}	1.90×10^{-3}
2) Gore (NW 2 miles)	1.81×10^{-3}	1.61×10^{-1}	7.43×10^{-3}
3) Weber Falls (W 3 mi.)	1.58×10^{-3}	1.33×10^{-1}	6.46×10^{-3}
4) [MAX] (SW.5 miles)	6.71×10^{-2}	6.37	2.75×10^{-1}

To evaluate the consequences of radiological releases upon transient population groups, population estimates by Dr. R. V. Garner were evaluated for two specific areas: I-40 and recreational doses. The US-64/RR dose (man-rem) is considered insignificant when compared to the high volume of the Interstate.

The transient I-40 population is given by Dr. Garner as 2.2 million cars per year. Each car is assumed to have two occupants and is exposed to the releases for five minutes. Assuming a maximum exposure distance selection of one mile NE for deposition and dose calculation, the annual lung dose to transient I-40 population groups is .044 man-rem/year.

The transient recreational population is given by Dr. Garner as 4 million visitors to the various reservoirs located on the ten-mile radius perimeter. Each visitor is assumed to stay 24 hours per visit and exposed to the ten-mile maximum dose. The annual lung dose to transient recreational population groups is .825 man-rem/year.

The radiological dose calculations have been tabulated for distances of 0-10 miles. Dose estimates have been evaluated for distances up to 50 miles. However, the 10-50 mile dose calculations are not included as the resultant doses are insignificant when compared to allowable dose levels.

TABLE IVA

KERR MCGEE

SEQUOYAH UF6 FACILITY NEAR GORE OKLAHOMA

METEOROLOGICAL DATA IS FROM FORT SMITH, ARKANSAS
FOR THE PERIOD OF RECORD; JANUARY 1960 THROUGH DECEMBER 1964
WITH A COMPOSITE OF 43847 HOURLY OBSERVATIONS

AVERAGE ANNUAL GROUND RELEASE RELATIVE
CONCENTRATIONS IN SECONDS PER CUBIC METER

PER DISTANCE IN MILES AND GEOGRAPHIC DIRECTION FROM PLANT SITE

	MILES				
DIRECTION	0.5	1.0	1.5	2.0	2.5
N	3.31E-06	1.01E-06	5.37E-07	3.59E-07	2.58E-07
NNE	3.12E-06	9.56E-07	5.06E-07	3.37E-07	2.43E-07
NE	5.63E-06	1.73E-06	9.22E-07	6.17E-07	4.45E-07
ENE	5.18E-06	1.59E-06	8.48E-07	5.67E-07	4.10E-07
E	3.02E-06	9.25E-07	4.90E-07	3.26E-07	2.34E-07
ESE	1.48E-06	4.49E-07	2.36E-07	1.56E-07	1.11E-07
SE	1.91E-06	5.86E-07	3.09E-07	2.06E-07	1.48E-07
SSE	1.58E-06	4.84E-07	2.56E-07	1.70E-07	1.22E-07
S	3.77E-06	1.16E-06	6.17E-07	4.13E-07	2.98E-07
SSW	8.35E-06	2.58E-06	1.38E-06	9.24E-07	6.68E-07
SW	1.93E-05	5.96E-06	3.18E-06	2.13E-06	1.54E-06
WSW	1.32E-05	4.07E-06	2.16E-06	1.44E-06	1.04E-06
W	6.77E-06	2.08E-06	1.10E-06	7.36E-07	5.29E-07
WNW	3.47E-06	1.07E-06	5.65E-07	3.77E-07	2.71E-07
NW	4.45E-06	1.37E-06	7.27E-07	4.86E-07	3.50E-07
NNW	2.22E-06	6.82E-07	3.61E-07	2.41E-07	1.74E-07

	MILES				
DIRECTION	3.0	4.0	5.0	7.5	10.0
N	1.96E-07	1.25E-07	8.72E-08	5.43E-08	3.76E-08
NNE	1.85E-07	1.18E-07	8.17E-08	5.08E-08	3.51E-08
NE	3.39E-07	2.17E-07	1.51E-07	9.41E-08	6.52E-08
ENE	3.12E-07	1.99E-07	1.39E-07	8.65E-08	6.00E-08
E	1.78E-07	1.13E-07	7.83E-08	4.86E-08	3.36E-08
ESE	8.41E-08	5.31E-08	3.66E-08	2.26E-08	1.55E-08
SE	1.12E-07	7.12E-08	4.93E-08	3.06E-08	2.11E-08
SSE	9.25E-08	5.87E-08	4.06E-08	2.52E-08	1.74E-08
S	2.26E-07	1.45E-07	1.01E-07	6.27E-08	4.35E-08
SSW	5.09E-07	3.26E-07	2.27E-07	1.42E-07	9.88E-08
SW	1.17E-06	7.52E-07	5.24E-07	3.27E-07	2.27E-07
WSW	7.88E-07	5.02E-07	3.49E-07	2.17E-07	1.50E-07
W	4.02E-07	2.56E-07	1.77E-07	1.10E-07	7.62E-08
WNW	2.06E-07	1.31E-07	9.13E-08	5.68E-08	3.93E-08
NW	2.66E-07	1.70E-07	1.18E-07	7.38E-08	5.11E-08
NNW	1.32E-07	8.41E-08	5.84E-08	3.64E-08	2.52E-08

TABLE VA

KERR MCGEE

SEQUOYAH UF6 FACILITY NEAR GORE OKLAHOMA

METEOROLOGICAL DATA IS FROM FORT SMITH, ARKANSAS
FOR THE PERIOD OF RECORD; JANUARY 1960 THROUGH DECEMBER 1964
WITH A COMPOSITE OF 43847 HOURLY OBSERVATIONS

AVERAGE ANNUAL ELEVATED RELEASE RELATIVE
CONCENTRATIONS IN SECONDS PER CUBIC METER

PER DISTANCE IN MILES AND GEOGRAPHIC DIRECTION FROM PLANT SITE

	MILES				
DIRECTION	0.5	1.0	1.5	2.0	2.5
N	1.29E-07	7.59E-08	5.21E-08	3.99E-08	3.28E-08
NNE	1.41E-07	8.05E-08	5.34E-08	4.00E-08	3.23E-08
NE	1.65E-07	9.38E-08	6.45E-08	5.01E-08	4.22E-08
ENE	1.46E-07	8.67E-08	6.21E-08	4.89E-08	4.15E-08
E	1.39E-07	9.24E-08	6.36E-08	4.78E-08	3.83E-08
ESE	1.18E-07	7.44E-08	4.85E-08	3.52E-08	2.72E-08
SE	1.04E-07	6.55E-08	4.34E-08	3.20E-08	2.53E-08
SSE	8.74E-08	5.65E-08	3.76E-08	2.78E-08	2.19E-08
S	1.03E-07	7.05E-08	5.07E-08	3.96E-08	3.31E-08
SSW	1.10E-07	8.48E-08	6.99E-08	5.91E-08	5.30E-08
SW	3.12E-07	2.25E-07	1.78E-07	1.48E-07	1.30E-07
WSW	5.01E-07	3.27E-07	2.27E-07	1.73E-07	1.41E-07
W	2.85E-07	1.87E-07	1.26E-07	9.43E-08	7.56E-08
WNW	1.40E-07	8.61E-08	5.83E-08	4.40E-08	3.57E-08
NW	1.48E-07	8.88E-08	6.08E-08	4.66E-08	3.86E-08
NNW	9.12E-08	5.43E-08	3.67E-08	2.77E-08	2.25E-08

	MILES				
DIRECTION	3.0	4.0	5.0	7.5	10.0
N	2.83E-08	2.24E-08	1.87E-08	1.25E-08	9.35E-09
NNE	2.74E-08	2.14E-08	1.76E-08	1.17E-08	8.75E-09
NE	3.74E-08	3.13E-08	2.73E-08	1.86E-08	1.42E-08
ENE	3.68E-08	3.06E-08	2.64E-08	1.79E-08	1.37E-08
E	3.21E-08	2.42E-08	1.94E-08	1.27E-08	9.35E-09
ESE	2.20E-08	1.56E-08	1.18E-08	7.50E-09	5.34E-09
SE	2.10E-08	1.56E-08	1.24E-08	8.09E-09	5.92E-09
SSE	1.81E-08	1.34E-08	1.06E-08	6.88E-09	5.02E-09
S	2.89E-08	2.35E-08	1.99E-08	1.35E-08	1.02E-08
SSW	4.91E-08	4.34E-08	3.90E-08	2.69E-08	2.09E-08
SW	1.19E-07	1.04E-07	9.20E-08	6.33E-08	4.89E-08
WSW	1.20E-07	9.35E-08	7.69E-08	5.11E-08	3.81E-08
W	6.37E-08	4.88E-08	3.97E-08	2.63E-08	1.95E-08
WNW	3.04E-08	2.38E-08	1.96E-08	1.31E-08	9.77E-09
NW	3.35E-08	2.72E-08	2.31E-08	1.56E-08	1.18E-08
NNW	1.92E-08	1.51E-08	1.25E-08	8.33E-09	6.24E-09

TABLE VIA

KERR MCGEE

SEQUOYAH UF6 FACILITY NEAR GORE OKLAHOMA

KIDNEY DOSE IS IN MILLI REM PER YEAR FROM BOTH
AN ELEVATED AND GROUND ROUTINE ANNUAL AVERAGE RELEASE

PER DISTANCE IN MILES AND GEOGRAPHIC DIRECTION FROM PLANT SITE

MILES

DIRECTION	0.5	1.0	1.5	2.0	2.5
N	4.81E-02	1.58E-02	8.21E-03	5.55E-03	4.05E-03
NNE	4.56E-02	1.45E-02	7.79E-03	5.25E-03	3.83E-03
NE	8.13E-02	2.56E-02	1.38E-02	9.31E-03	6.80E-03
ENE	7.47E-02	2.35E-02	1.27E-02	8.60E-03	6.29E-03
E	4.42E-02	1.42E-02	7.70E-03	5.19E-03	3.78E-03
ESE	2.23E-02	7.27E-03	3.94E-03	2.64E-03	1.91E-03
SE	2.82E-02	9.08E-03	4.90E-03	3.30E-03	2.40E-03
SSE	2.33E-02	7.53E-03	4.08E-03	2.75E-03	1.99E-03
S	5.43E-02	1.72E-02	9.33E-03	6.31E-03	4.61E-03
SSW	1.19E-01	3.73E-02	2.03E-02	1.37E-02	1.01E-02
SW	2.75E-01	8.67E-02	4.70E-02	3.19E-02	2.33E-02
WSW	1.92E-01	6.14E-02	3.33E-02	2.25E-02	1.64E-02
W	9.88E-02	3.17E-02	1.71E-02	1.16E-02	8.41E-03
WNW	5.06E-02	1.61E-02	8.69E-03	5.86E-03	4.27E-03
NW	6.44E-02	2.04E-02	1.10E-02	7.43E-03	5.42E-03
NNW	3.24E-02	1.03E-02	5.55E-03	3.74E-03	2.73E-03

MILES

DIRECTION	3.0	4.0	5.0	7.5	10.0
N	3.12E-03	2.05E-03	1.46E-03	9.23E-04	6.49E-04
NNE	2.94E-03	1.93E-03	1.37E-03	8.65E-04	6.06E-04
NE	5.24E-03	3.45E-03	2.47E-03	1.56E-03	1.10E-03
ENE	4.85E-03	3.20E-03	2.29E-03	1.45E-03	1.02E-03
E	2.91E-03	1.90E-03	1.35E-03	8.47E-04	5.93E-04
ESE	1.47E-03	9.47E-04	6.65E-04	4.14E-04	2.86E-04
SE	1.84E-03	1.20E-03	8.52E-04	5.34E-04	3.73E-04
SSE	1.53E-03	9.98E-04	7.06E-04	4.43E-04	3.09E-04
S	3.55E-03	2.33E-03	1.67E-03	1.05E-03	7.42E-04
SSW	7.78E-03	5.14E-03	3.69E-03	2.34E-03	1.66E-03
SW	1.80E-02	1.19E-02	8.54E-03	5.41E-03	3.82E-03
WSW	1.26E-02	8.26E-03	5.89E-03	3.71E-03	2.60E-03
W	6.46E-03	4.22E-03	3.00E-03	1.89E-03	1.32E-03
WNW	3.29E-03	2.15E-03	1.53E-03	9.66E-04	6.78E-04
NW	4.17E-03	2.74E-03	1.96E-03	1.24E-03	8.70E-04
NNW	2.10E-03	1.38E-03	9.82E-04	6.18E-04	4.34E-04

TABLE VIIA

KERR MCGEE

SEQUOYAH UF6 FACILITY NEAR GORE OKLAHOMA

LUNG DOSE IS IN MILLI REM PER YEAR FROM BOTH
AN ELEVATED AND GROUND ROUTINE ANNUAL AVERAGE RELEASE

PER DISTANCE IN MILES AND GEOGRAPHIC DIRECTION FROM PLANT SITE

	MILES				
DIRECTION	0.5	1.0	1.5	2.0	2.5
N	1.09E+00	3.35E-01	1.77E-01	1.19E-01	8.54E-02
NNE	1.03E+00	3.16E-01	1.67E-01	1.12E-01	8.03E-02
NE	1.86E+00	5.73E-01	3.04E-01	2.04E-01	1.47E-01
ENE	1.71E+00	5.26E-01	2.80E-01	1.87E-01	1.35E-01
E	9.96E-01	3.06E-01	1.62E-01	1.08E-01	7.74E-02
ESE	4.88E-01	1.49E-01	7.80E-02	5.16E-02	3.68E-02
SE	6.32E-01	1.94E-01	1.02E-01	6.80E-02	4.88E-02
SSE	5.22E-01	1.60E-01	8.45E-02	5.62E-02	4.03E-02
S	1.24E+00	3.83E-01	2.04E-01	1.36E-01	9.84E-02
SSW	2.76E+00	8.52E-01	4.55E-01	3.05E-01	2.21E-01
SW	6.37E+00	1.97E+00	1.05E+00	7.04E-01	5.09E-01
WSW	4.37E+00	1.34E+00	7.14E-01	4.76E-01	3.43E-01
W	2.24E+00	6.88E-01	3.65E-01	2.43E-01	1.75E-01
WNW	1.15E+00	3.52E-01	1.87E-01	1.25E-01	8.97E-02
NW	1.47E+00	4.52E-01	2.40E-01	1.61E-01	1.16E-01
NNW	7.34E-01	2.25E-01	1.19E-01	7.97E-02	5.74E-02

	MILES				
DIRECTION	3.0	4.0	5.0	7.5	10.0
N	6.50E-02	4.15E-02	2.88E-02	1.80E-02	1.24E-02
NNE	6.10E-02	3.89E-02	2.70E-02	1.68E-02	1.16E-02
NE	1.12E-01	7.17E-02	4.99E-02	3.11E-02	2.16E-02
ENE	1.03E-01	6.59E-02	4.59E-02	2.86E-02	1.99E-02
E	5.88E-02	3.74E-02	2.59E-02	1.61E-02	1.11E-02
ESE	2.79E-02	1.76E-02	1.21E-02	7.49E-03	5.14E-03
SE	3.71E-02	2.36E-02	1.63E-02	1.01E-02	6.99E-03
SSE	3.06E-02	1.94E-02	1.35E-02	8.35E-03	5.76E-03
S	7.49E-02	4.78E-02	3.33E-02	2.08E-02	1.44E-02
SSW	1.68E-01	1.08E-01	7.52E-02	4.70E-02	3.27E-02
SW	3.88E-01	2.49E-01	1.73E-01	1.08E-01	7.53E-02
WSW	2.61E-01	1.66E-01	1.15E-01	7.18E-02	4.97E-02
W	1.33E-01	8.47E-02	5.87E-02	3.65E-02	2.52E-02
WNW	6.82E-02	4.35E-02	3.02E-02	1.88E-02	1.30E-02
NW	8.81E-02	5.63E-02	3.92E-02	2.44E-02	1.69E-02
NNW	4.36E-02	2.78E-02	1.93E-02	1.20E-02	8.34E-03

TABLE VIIIA

KERR MCGEE

SEQUOYAH UF6 FACILITY NEAR GORE OKLAHOMA

BONE DOSE IS IN MILLI REM PER YEAR FROM BOTH
AN ELEVATED AND GROUND ROUTINE ANNUAL AVERAGE RELEASE

PER DISTANCE IN MILES AND GEOGRAPHIC DIRECTION FROM PLANT SITE

	MILES				
DIRECTION	0.5	1.0	1.5	2.0	2.5
N	1.17E-02	3.71E-03	2.00E-03	1.35E-03	9.88E-04
NNE	1.11E-02	3.53E-03	1.90E-03	1.28E-03	9.33E-04
NE	1.98E-02	6.23E-03	3.36E-03	2.27E-03	1.66E-03
ENE	1.82E-02	5.73E-03	3.10E-03	2.10E-03	1.53E-03
E	1.08E-02	3.46E-03	1.88E-03	1.27E-03	9.22E-04
ESE	5.42E-03	1.77E-03	9.59E-04	6.44E-04	4.66E-04
SE	6.88E-03	2.21E-03	1.20E-03	8.05E-04	5.85E-04
SSE	5.69E-03	1.84E-03	9.94E-04	6.69E-04	4.86E-04
S	1.32E-02	4.20E-03	2.27E-03	1.54E-03	1.12E-03
SSW	2.89E-02	9.10E-03	4.94E-03	3.35E-03	2.46E-03
SW	6.71E-02	2.11E-02	1.15E-02	7.77E-03	5.69E-03
WSW	4.69E-02	1.50E-02	8.11E-03	5.48E-03	3.99E-03
W	2.41E-02	7.72E-03	4.18E-03	2.82E-03	2.05E-03
WNW	1.23E-02	3.92E-03	2.12E-03	1.43E-03	1.04E-03
NW	1.57E-02	4.97E-03	2.68E-03	1.81E-03	1.32E-03
NNW	7.90E-03	2.51E-03	1.35E-03	9.12E-04	6.65E-04

	MILES				
DIRECTION	3.0	4.0	5.0	7.5	10.0
N	7.61E-04	5.00E-04	3.57E-04	2.25E-04	1.58E-04
NNE	7.18E-04	4.70E-04	3.35E-04	2.11E-04	1.48E-04
NE	1.28E-03	8.40E-04	6.02E-04	3.80E-04	2.68E-04
ENE	1.18E-03	7.79E-04	5.58E-04	3.53E-04	2.48E-04
E	7.09E-04	4.63E-04	3.29E-04	2.06E-04	1.44E-04
ESE	3.57E-04	2.31E-04	1.62E-04	1.01E-04	6.98E-05
SE	4.49E-04	2.93E-04	2.08E-04	1.30E-04	9.08E-05
SSE	3.74E-04	2.43E-04	1.72E-04	1.08E-04	7.52E-05
S	8.66E-04	5.69E-04	4.07E-04	2.57E-04	1.81E-04
SSW	1.90E-03	1.25E-03	9.01E-04	5.71E-04	4.04E-04
SW	4.39E-03	2.90E-03	2.09E-03	1.32E-03	9.32E-04
WSW	3.08E-03	2.01E-03	1.44E-03	9.03E-04	6.34E-04
W	1.58E-03	1.03E-03	7.32E-04	4.60E-04	3.22E-04
WNW	8.01E-04	5.25E-04	3.74E-04	2.35E-04	1.65E-04
NW	1.02E-03	6.68E-04	4.78E-04	3.01E-04	2.18E-04
NNW	5.12E-04	3.36E-04	2.39E-04	1.51E-04	1.06E-04

TABLE XIA

KERR MCGEE

SEQUOYAH UF6 FACILITY NEAR GORE OKLAHOMA

AVERAGE ANNUAL NITROGEN OXIDES CONCENTRATIONS IN
MICRO-GRAMS PER CUBIC METER FROM AN ELEVATED ROUTINE RELEASE

PER DISTANCE IN MILES AND GEOGRAPHIC DIRECTION FROM PLANT SITE

MILES

DIRECTION	0.5	1.0	1.5	2.0	2.5
N	2.56E-01	1.50E-01	1.03E-01	7.89E-02	6.50E-02
NNE	2.79E-01	1.59E-01	1.06E-01	7.91E-02	6.39E-02
NE	3.27E-01	1.86E-01	1.28E-01	9.92E-02	8.36E-02
ENE	2.90E-01	1.72E-01	1.23E-01	9.68E-02	8.22E-02
E	2.75E-01	1.83E-01	1.26E-01	9.47E-02	7.59E-02
ESE	2.34E-01	1.47E-01	9.61E-02	6.98E-02	5.39E-02
SE	2.07E-01	1.30E-01	8.58E-02	6.34E-02	5.01E-02
SSE	1.73E-01	1.12E-01	7.45E-02	5.50E-02	4.34E-02
S	2.03E-01	1.40E-01	1.00E-01	7.84E-02	6.55E-02
SSW	2.17E-01	1.68E-01	1.38E-01	1.17E-01	1.05E-01
SW	6.18E-01	4.46E-01	3.53E-01	2.92E-01	2.58E-01
WSW	9.91E-01	6.48E-01	4.50E-01	3.42E-01	2.79E-01
W	5.65E-01	3.70E-01	2.50E-01	1.87E-01	1.50E-01
WNW	2.78E-01	1.71E-01	1.15E-01	8.71E-02	7.06E-02
NW	2.93E-01	1.76E-01	1.20E-01	9.23E-02	7.64E-02
NNW	1.81E-01	1.08E-01	7.26E-02	5.49E-02	4.46E-02

MILES

DIRECTION	3.0	4.0	5.0	7.5	10.0
N	5.60E-02	4.44E-02	3.69E-02	2.47E-02	1.85E-02
NNE	5.43E-02	4.24E-02	3.49E-02	2.32E-02	1.73E-02
NE	7.41E-02	6.20E-02	5.40E-02	3.68E-02	2.82E-02
ENE	7.29E-02	6.06E-02	5.23E-02	3.55E-02	2.71E-02
E	6.36E-02	4.80E-02	3.83E-02	2.52E-02	1.85E-02
ESE	4.36E-02	3.08E-02	2.33E-02	1.48E-02	1.06E-02
SE	4.15E-02	3.09E-02	2.45E-02	1.60E-02	1.17E-02
SSE	3.59E-02	2.66E-02	2.09E-02	1.36E-02	9.93E-03
S	5.73E-02	4.65E-02	3.94E-02	2.66E-02	2.02E-02
SSW	9.73E-02	8.60E-02	7.71E-02	5.33E-02	4.14E-02
SW	2.36E-01	2.05E-01	1.82E-01	1.25E-01	9.68E-02
WSW	2.37E-01	1.85E-01	1.52E-01	1.01E-01	7.55E-02
W	1.26E-01	9.67E-02	7.87E-02	5.21E-02	3.87E-02
WNW	6.02E-02	4.70E-02	3.88E-02	2.59E-02	1.93E-02
NW	6.64E-02	5.38E-02	4.57E-02	3.08E-02	2.34E-02
NNW	3.81E-02	2.99E-02	2.47E-02	1.65E-02	1.24E-02

TABLE XA

KERR MCGEE

SEQUOYAH UF6 FACILITY NEAR GORE OKLAHOMA

AVERAGE ANNUAL SULFUR DIOXIDE CONCENTRATIONS IN
MICRO-GRAMS PER CUBIC METER FROM AN ELEVATED ROUTINE RELEASE

PER DISTANCE IN MILES AND GEOGRAPHIC DIRECTION FROM PLANT SITE

	MILES				
DIRECTION	0.5	1.0	1.5	2.0	2.5
N	3.36E-02	1.97E-02	1.35E-02	1.04E-02	8.53E-03
NNE	3.66E-02	2.09E-02	1.39E-02	1.04E-02	8.39E-03
NE	4.30E-02	2.44E-02	1.68E-02	1.30E-02	1.10E-02
ENE	3.80E-02	2.26E-02	1.61E-02	1.27E-02	1.08E-02
E	3.61E-02	2.40E-02	1.65E-02	1.24E-02	9.97E-03
ESE	3.07E-02	1.93E-02	1.26E-02	9.16E-03	7.07E-03
SE	2.71E-02	1.70E-02	1.13E-02	8.32E-03	6.57E-03
SSE	2.27E-02	1.47E-02	9.78E-03	7.23E-03	5.70E-03
S	2.67E-02	1.83E-02	1.32E-02	1.03E-02	8.60E-03
SSW	2.85E-02	2.21E-02	1.82E-02	1.54E-02	1.38E-02
SW	8.11E-02	5.86E-02	4.64E-02	3.84E-02	3.39E-02
WSW	1.30E-01	8.51E-02	5.91E-02	4.50E-02	3.66E-02
W	7.42E-02	4.85E-02	3.28E-02	2.45E-02	1.97E-02
WNW	3.64E-02	2.24E-02	1.52E-02	1.14E-02	9.28E-03
NW	3.84E-02	2.31E-02	1.58E-02	1.21E-02	1.00E-02
NNW	2.37E-02	1.41E-02	9.53E-03	7.20E-03	5.86E-03

	MILES				
DIRECTION	3.0	4.0	5.0	7.5	10.0
N	7.35E-03	5.83E-03	4.85E-03	3.24E-03	2.43E-03
NNE	7.13E-03	5.56E-03	4.58E-03	3.05E-03	2.28E-03
NE	9.73E-03	8.15E-03	7.09E-03	4.83E-03	3.70E-03
ENE	9.57E-03	7.96E-03	6.87E-03	4.66E-03	3.55E-03
E	8.36E-03	6.30E-03	5.03E-03	3.31E-03	2.43E-03
ESE	5.72E-03	4.05E-03	3.06E-03	1.95E-03	1.39E-03
SE	5.45E-03	4.06E-03	3.22E-03	2.10E-03	1.54E-03
SSE	4.72E-03	3.49E-03	2.74E-03	1.79E-03	1.30E-03
S	7.52E-03	6.11E-03	5.18E-03	3.50E-03	2.65E-03
SSW	1.28E-02	1.13E-02	1.01E-02	7.00E-03	5.43E-03
SW	3.10E-02	2.69E-02	2.39E-02	1.64E-02	1.27E-02
WSW	3.12E-02	2.43E-02	2.00E-02	1.33E-02	9.91E-03
W	1.66E-02	1.27E-02	1.03E-02	6.84E-03	5.08E-03
WNW	7.90E-03	6.18E-03	5.10E-03	3.40E-03	2.54E-03
NW	8.72E-03	7.07E-03	6.00E-03	4.05E-03	3.07E-03
NNW	5.00E-03	3.93E-03	3.25E-03	2.17E-03	1.62E-03

TABLE IXA

KERR MCGEE

SEQUOYAH UF6 FACILITY NEAR GORE OKLAHOMA

AVERAGE ANNUAL FLUORIDE CONCENTRATIONS
IN MICRO-GRAMS PER CUBIC METER FROM BOTH
AN ELEVATED AND GROUND ROUTINE RELEASE

PER DISTANCE IN MILES AND GEOGRAPHIC DIRECTION FROM PLANT SITE

	MILES				
DIRECTION	0.5	1.0	1.5	2.0	2.5
N	1.97E-02	7.85E-03	4.75E-03	3.43E-03	2.67E-03
NNE	1.95E-02	7.85E-03	4.69E-03	3.35E-03	2.59E-03
NE	3.08E-02	1.16E-02	6.91E-03	4.97E-03	3.89E-03
ENE	2.80E-02	1.07E-02	6.49E-03	4.72E-03	3.71E-03
E	1.90E-02	8.32E-03	5.14E-03	3.70E-03	2.85E-03
ESE	1.18E-02	5.52E-03	3.37E-03	2.38E-03	1.81E-03
SE	1.29E-02	5.62E-03	3.41E-03	2.42E-03	1.85E-03
SSE	1.07E-02	4.76E-03	2.90E-03	2.07E-03	1.58E-03
S	2.02E-02	8.17E-03	5.00E-03	3.63E-03	2.85E-03
SSW	3.89E-02	1.46E-02	9.01E-03	6.65E-03	5.33E-03
SW	9.28E-02	3.51E-02	2.16E-02	1.59E-02	1.27E-02
WSW	7.80E-02	3.27E-02	2.00E-02	1.44E-02	1.12E-02
W	4.14E-02	1.77E-02	1.07E-02	7.66E-03	5.90E-03
WNW	2.09E-02	8.57E-03	5.17E-03	3.71E-03	2.87E-03
NW	2.52E-02	9.92E-03	5.95E-03	4.27E-03	3.33E-03
NNW	1.35E-02	5.45E-03	3.28E-03	2.35E-03	1.82E-03

	MILES				
DIRECTION	3.0	4.0	5.0	7.5	10.0
N	2.20E-03	1.62E-03	1.28E-03	8.40E-04	6.18E-04
NNE	2.11E-03	1.54E-03	1.21E-03	7.89E-04	5.78E-04
NE	3.23E-03	2.43E-03	1.97E-03	1.31E-03	9.73E-04
ENE	3.09E-03	2.33E-03	1.88E-03	1.24E-03	9.23E-04
E	2.32E-03	1.66E-03	1.28E-03	8.30E-04	6.02E-04
ESE	1.44E-03	9.91E-04	7.34E-04	4.65E-04	3.29E-04
SE	1.50E-03	1.07E-03	8.16E-04	5.27E-04	3.81E-04
SSE	1.28E-03	9.05E-04	6.90E-04	4.45E-04	3.20E-04
S	2.35E-03	1.75E-03	1.40E-03	9.24E-04	6.84E-04
SSW	4.49E-03	3.48E-03	2.86E-03	1.91E-03	1.44E-03
SW	1.07E-02	8.19E-03	6.69E-03	4.47E-03	3.35E-03
WSW	9.15E-03	6.69E-03	5.24E-03	3.42E-03	2.51E-03
W	4.79E-03	3.47E-03	2.70E-03	1.76E-03	1.28E-03
WNW	2.34E-03	1.71E-03	1.35E-03	8.80E-04	6.46E-04
NW	2.74E-03	2.04E-03	1.63E-03	1.07E-03	7.95E-04
NNW	1.49E-03	1.09E-03	8.59E-04	5.62E-04	4.13E-04

TABLE XIIA

KERR MCGEE

SEQUOYAH UF6 FACILITY NEAR GORE OKLAHOMA

KIDNEY DOSE IS IN MANREM PER YEAR FROM BOTH
AN ELEVATED AND GROUND ROUTINE ANNUAL AVERAGE RELEASE

PER DISTANCE IN MILES AND GEOGRAPHIC DIRECTION FROM PLANT SITE

	MILES						
DIRECTION	0-1	1-2	2-3	3-4	4-5	5-10	TOTALS
N	1.44E-04	7.39E-05	1.22E-05	3.00E-05	7.23E-05	2.61E-04	5.94E-04
NNE	1.37E-04	4.68E-05	8.04E-05	2.12E-05	9.70E-06	1.16E-04	4.10E-04
NE	7.31E-04	4.13E-05	0.	2.52E-05	8.69E-06	4.51E-04	1.26E-03
ENE	8.96E-04	1.91E-04	1.89E-05	5.83E-05	1.61E-05	2.57E-04	1.44E-03
E	1.32E-04	2.08E-04	1.25E-04	5.57E-05	8.43E-05	1.12E-03	1.73E-03
ESE	0.	5.90E-05	6.88E-05	5.82E-05	2.37E-06	9.33E-05	2.82E-04
SE	0.	2.94E-05	7.20E-06	7.06E-05	1.51E-05	2.65E-05	1.49E-04
SSE	1.40E-04	3.67E-05	1.20E-05	0.	0.	1.37E-05	2.02E-04
S	1.63E-04	1.12E-04	0.	0.	2.35E-05	1.18E-05	3.10E-04
SSW	0.	6.08E-05	0.	1.87E-05	1.30E-04	2.60E-04	4.70E-04
SW	8.26E-04	0.	0.	1.74E-04	6.00E-05	8.09E-04	1.87E-03
WSW	5.77E-04	0.	9.83E-05	9.08E-05	2.08E-05	4.22E-04	1.21E-03
W	0.	0.	8.02E-04	1.04E-03	9.56E-05	3.11E-04	1.65E-03
WNW	1.52E-04	0.	7.26E-04	4.31E-04	9.03E-06	6.32E-05	1.38E-03
NW	1.93E-04	1.98E-04	2.65E-03	1.54E-04	6.21E-05	1.19E-04	3.38E-03
NNW	9.72E-05	1.66E-05	3.82E-05	8.23E-05	2.19E-05	7.05E-05	3.27E-04
TOTALS	4.19E-03	1.07E-03	4.04E-03	2.31E-03	6.31E-04	4.41E-03	1.67E-02
CUMULATIVE TOTALS	4.19E-03	5.26E-03	9.30E-03	1.16E-02	1.22E-02	1.67E-02	

TABLE XIIIA

KERR MCGEE

SEQUOYAH UF6 FACILITY NEAR GORE OKLAHOMA

LUNG DOSE IS IN MANREM PER YEAR FROM BOTH
AN ELEVATED AND GROUND ROUTINE ANNUAL AVERAGE RELEASE

PER DISTANCE IN MILES AND GEOGRAPHIC DIRECTION FROM PLANT SITE

	MILES						
DIRECTION	0-1	1-2	2-3	3-4	4-5	5-10	TOTALS
N	3.27E-03	1.60E-03	2.56E-04	6.16E-04	1.44E-03	4.99E-03	1.22E-02
NNE	3.09E-03	1.00E-03	1.69E-03	4.33E-04	1.93E-04	2.20E-03	8.61E-03
NE	1.67E-02	9.13E-04	0.	5.31E-04	1.78E-04	8.80E-03	2.72E-02
ENE	2.05E-02	4.20E-03	4.06E-04	1.22E-03	3.28E-04	4.98E-03	3.17E-02
E	2.99E-03	4.37E-03	2.55E-03	1.11E-03	1.64E-03	2.10E-02	3.37E-02
ESE	0.	1.17E-03	1.33E-03	1.09E-03	4.36E-05	1.66E-03	5.29E-03
SE	0.	6.14E-04	1.47E-04	1.40E-03	2.92E-04	4.93E-04	2.95E-03
SSE	3.13E-03	7.61E-04	2.42E-04	0.	0.	2.53E-04	4.39E-03
S	3.73E-03	2.45E-03	0.	0.	4.75E-04	2.28E-04	6.88E-03
SSW	0.	1.36E-03	0.	3.99E-04	2.68E-03	5.12E-03	9.56E-03
SW	1.91E-02	0.	0.	3.68E-03	1.24E-03	1.58E-02	3.99E-02
WSW	1.31E-02	0.	2.06E-03	1.85E-03	4.13E-04	8.03E-03	2.55E-02
W	0.	0.	4.20E-03	2.12E-02	1.89E-03	5.89E-03	3.32E-02
WNW	3.44E-03	0.	1.52E-02	8.83E-03	1.80E-04	1.21E-03	2.89E-02
NW	4.41E-03	4.32E-03	5.66E-02	3.20E-03	1.26E-03	2.30E-03	7.21E-02
NNW	2.20E-03	3.58E-04	8.03E-04	1.69E-03	4.38E-04	1.35E-03	6.83E-03
TOTALS	9.58E-02	2.31E-02	8.56E-02	4.72E-02	1.27E-02	8.44E-02	3.49E-01
CUMULATIVE TOTALS	9.58E-02	1.19E-01	2.04E-01	2.52E-01	2.64E-01	3.49E-01	

TABLE XIVA

KERR MCGEE

SEQUOYAH UF6 FACILITY NEAR GORE OKLAHOMA

BONE DOSE IS IN MANREM PER YEAR FROM BOTH
AN ELEVATED AND GROUND ROUTINE ANNUAL AVERAGE RELEASE

PER DISTANCE IN MILES AND GEOGRAPHIC DIRECTION FROM PLANT SITE

	MILES						
DIRECTION	0-1	1-2	2-3	3-4	4-5	5-10	TOTALS
N	3.52E-05	1.80E-05	2.96E-06	7.31E-06	1.76E-05	6.37E-05	1.45E-04
NNE	3.33E-05	1.14E-05	1.96E-05	5.17E-06	2.36E-06	2.82E-05	1.00E-04
NE	1.78E-04	1.01E-05	0.	6.14E-06	2.12E-06	1.10E-04	3.06E-04
ENE	2.18E-04	4.65E-05	4.60E-06	1.42E-05	3.93E-06	6.26E-05	3.50E-04
E	3.23E-05	5.07E-05	3.04E-05	1.36E-05	2.05E-05	2.74E-04	4.22E-04
ESE	0.	1.44E-05	1.68E-05	1.42E-05	5.78E-07	2.27E-05	6.87E-05
SE	0.	7.17E-06	1.75E-06	1.72E-05	3.68E-06	6.45E-06	3.63E-05
SSE	3.41E-05	8.94E-06	2.92E-06	0.	0.	3.33E-06	4.93E-05
S	3.97E-05	2.73E-05	0.	0.	5.73E-06	2.88E-06	7.56E-05
SSW	0.	1.48E-05	0.	4.57E-06	3.16E-05	6.35E-05	1.14E-04
SW	2.01E-04	0.	0.	4.23E-05	1.46E-05	1.97E-04	4.55E-04
WSW	1.41E-04	0.	2.40E-05	2.21E-05	5.07E-06	1.03E-04	2.95E-04
W	0.	0.	4.92E-05	2.54E-04	2.33E-05	7.58E-05	4.02E-04
WNW	3.70E-05	0.	1.77E-04	1.05E-04	2.20E-06	1.54E-05	3.37E-04
NW	4.71E-05	4.82E-05	6.46E-04	3.75E-05	1.51E-05	2.90E-05	8.23E-04
NNW	2.37E-05	4.06E-06	9.31E-06	2.01E-05	5.35E-06	1.72E-05	7.97E-05
TOTALS	1.02E-03	2.62E-04	9.84E-04	5.64E-04	1.54E-04	1.07E-03	4.06E-03
CUMULATIVE TOTALS	1.02E-03	1.28E-03	2.27E-03	2.83E-03	2.98E-03	4.06E-03	

(26) Page S-104. a. Estimated Uranium Uptakes and Effects - Checking calculations: Steer ingests total forage on one acre. Forage contains 16.6 μCi natural uranium. Fraction retained by kidney = 1.1×10^{-3} (ICRP #6 not ICRP #2 cited as reference 30). Total retained by steer kidney: $(16.6)(1.1 \times 10^{-3}) = 18.3 \times 10^{-3}$ μCi. Man ingests 1/2 kidney per year or 9.15×10^{-3} μCi and retains (1.1×10^{-3}) $(9.15 \times 10^{-3}) = 10.05 \times 10^{-6}$ μCi versus 1.2×10^{-6} μCi reported.

Organ Dose Calculations: Ref. Page 277 "Handbook of Laboratory Safety" 1967; 92.238 organ dose = 1.59×10^{8} rem/Ci.

$$\frac{1.5 \times 10^{8}\ \text{rem}}{\text{Ci}} \times \frac{10^{3}\ \text{mrem}}{\text{rem}} \times \frac{\text{Ci}}{10^{6}\ \mu\text{Ci}} = 1.59 \times 10^{5}\ \frac{\text{mrem}}{\mu\text{Ci}}$$

Using reported retention, kidney dose would be 1.2×10^{-6} μCi $\times 1.59 \times 10^{5}\ \frac{\text{mrem}}{\mu\text{Ci}} = 0.191$ mrem versus < 0.02 mrem reported.

At 10.05×10^{-6} μCi retained, kidney dose would be 1.59 mrem.

Estimated Uranium Uptake. Several errors were found in the calculations included on Page S-104 and data recalculated for effluent quantities shown on Page 29 (S-97) and quantities measured in October 1972.

The following assumptions were made for exposure from the food chain:

a. All effluent evenly deposited on circle one mile in diameter.

b. A steer ingests total forage on one acre each month.

c. Forage receives .471 μCi insoluble and .236 μCi soluble (October - .526 μCi insoluble and .059 μCi soluble). Uranium content of steer kidney results only from intake of soluble portion since insoluble uranium is excreted without uptake.

d. Total uranium retained by steer kidney is
$9 \times .236 \times 1.1 \times 10^{-3} = 2.34 \times 10^{-3}$ μCi
(October - $.585 \times 10^{-3}$ μCi).

e. Man ingests 1/2 kidney per year or
$2.34 \times 10^{-3} \times .5 \times 1.1 \times 10^{-3} = 1.28 \times 10^{-6}$ μCi
(October - $.322 \times 10^{-6}$ μCi).

f. Organ dose - Page 277 of "Handbook of Laboratory Safety", 1967:
1.59×10^{8} rem/Ci = 1.59×10^{5} mRem/μCi
$1.28 \times 10^{-6} \times 1.59 \times 10^{5} = .203$ mRem
(October - .051 mRem)

Kidney dose is consequently a negligible fraction of background dose.

(27) Page S-104. b. <u>External Exposure from Uranium Deposited on the Soil</u>: At 16.6 μCi/acre deposited and emission of 7.57×10^{4} d/s/μCi natural uranium, Σ Emission = $7.57 \times 10^{4} \times 16.6 \times 60 = 7.54 \times 10^{7}$ d/m/acre

Reported Value = 7.4×10^{7} d/m/acre

$$\frac{7.4 \times 10^{7}\ \text{d}}{\text{min - acre}} \times \frac{\text{acre}}{4047\text{m}^2} = 1.83 \times 10^{4}\ \text{d/min/m}^2$$

Reported Value = 1.8×10^{4} d/min/m^2

$$\frac{1.8 \times 10^{4}\ \text{d}}{\text{min - m}^2} \times \frac{\text{M}^2}{10^{4}\text{cm}^2} = 1.8\ \text{d/min/cm}^2$$

or 180 <u>d/min</u>/100 cm^2 vs <u>18d/m</u>/100 cm^2 reported

Cannot determine calculation method employed to arrive at quoted dose rate of .0032 mrem/yr. Please clarify.

We have recalculated external exposure in accordance with Table XXVI-Rev. and the correct level should be .924 (October - .76) disintegrations/minute/100 square centimeters. The method of calculation for dose rate is shown below:

Based on the data shown on Revised Table XXVI (Page S-97), total deposition = 174.3×10^{-4} μCi/Mo/M^2 = 2.09×10^{-3} μCi/yr/M^2 (October -

144.6×10^{-6} μCi/M^2 or 1.73×10^{-3} μCi/yr/M^2).

From "Radiological Health Handbook", Page 32:

Exposure rate from a <u>point source</u>-assuming dose is from all uranium in a 1 M^2 area:

$I_r = .156\ n\ E(10^5\ \mu a)$

where:

I_r = mR/hr at 1 meter/mCi
n = gamma quanta per disintegration = 1.0
E = energy of gamma quanta in MeV = .185
μa = energy absorption coefficient for gamma in air (S.T.P.) in cm^{-1} = 3.2×10^{-5} cm^{-1}

then:

$I_r = .156(1.0)(.185)(3.2 \times 10^{-5})(10^5)$
$I_r = .156(.592) = .09$ mR/hr/mCi @ 1 meter

External exposure:

$.09 \times 2.1 \times 10^{-6}$ mCi/yr/M^2 =
1.89×10^{-7} mR/hr/M^2
$1.89 \times 10^{-7} \times 8760 = 1.65 \times 10^{-3}$ or
.0016 mR/yr/M^2

(28) Page S-105, Paragraph 1. Cannot follow calculation for uranium buildup in the soil (.096 mrem/yr)or runoff by rainwater (.001 MPC). Please clarify.

Buildup in uranium in soil would equal 30 times the buildup calculated, .0016 mRem/yr x 30 = .048 mRem/yr dose rate after 30 years of operation.

Runoff of uranium by rainwater is calculated on the basis that 8.36 μCi/acre/yr is deposited with an assumed runoff of 50%, resulting in the following calculations:

$$\frac{8.36\ \mu Ci/acre \times .5}{43{,}560\ Ft^2/acre \times \frac{40''\ rain/yr}{12''/Ft} \times 28.32 \times 10^3\ ml/Ft^3} =$$

$1.02 \times 10^{-9}\ \mu Ci/ml$

or .00005 MPC for natural uranium (October - 7.02 μCi/acre/yr or approximately the same runoff).

(29) **Page S-112, Table XXXIII. MPC values used in calculations for Th-230** soluble and insoluble, and for Ra-226 soluble are not taken from 10 CFR 20. Apparently values used were 1×10^{-8} μCi/ml for Ra-226 (sol) instead of 3×10^{-8} μCi/ml and 1×10^{-6} μCi/ml for Th-230 soluble and insoluble instead of 2×10^{-6} μCi/ml for soluble Th-230 and 3×10^{-5} μCi/ml for insoluble Th-230. Use of proper MPC values would not appear to change the overall conclusion but would require considerably less dilution to attain MPC level than is indicated in paragraph one, page S-113. Reasoning behind adding dilution needed to reach Ra-226 MPC to that needed to reach Th-230 and U-Nat MPC appears to be in error since providing the required dilution for the Ra-226 would more than take care of that needed for the Th-230 and U-Nat. **Table and text should be corrected. Values shown in table for raffinate sludge pond are all in error as are most of values reported for natural uranium.**

Table XXXIII. Calculations on this table have been checked and a revised table is attached. As noted, the incorrect MPC value for Radium_{226} was used in the calculation of the required dilution volume. This calculation has been redone as follows:

Total Volume: 14.2×10^6 gallons x 35.6 =
5.05×10^8 gallons required for dilution

At 540 cps, the Illinois River would supply 3.49×10^8 gallons daily or 1.4 days would be required to dilute the entire soluble contents of the retention ponds to 1 MPC. Observations as to the probable effect of chemical concentrations on fish life in the reservoir do not change.

TABLE XXXIII

RADIOACTIVITY - WASTE RETENTION PONDS

	Raffinate Pond #1	Raffinate Pond #2	Raffinate Sludge Pond
Volume-mℓ	$2.27x10^{10}$ (8 Million Gallons)	$1.32x10^{10}$ (3.5 Million Gallons)	$.757x10^{10}$ (2.7 Million Gallons)
Ra-226 Activity-µCi/mℓ			
Soluble	$107x10^{-8}$	$106x10^{-8}$	$1.07x10^{-6}$
MPC	35.6	35.0	35.6
Insoluble	$.356x10^{-5}$	$4.59x10^{-6}$	$3.5x10^{-6}$
MPC	0.12	0.15	0.12
Total Th Activity-µCi/mℓ			
Soluble	$1.1x10^{-8}$	$1.1x10^{-8}$	$1.1x10^{-8}$
MPC	.01	.01	.01
Insoluble	$1.94x10^{-6}$	$1.1x10^{-6}$	$2.0x10^{-6}$
MPC	.19	0.11	.20
Natural Uranium Activity-µCi/mℓ			
Soluble	$1.2x10^{-6}$	$1.2x10^{-6}$	$1.0x10^{-6}$
MPC	0.06	0.06	0.06
Insoluble	$5.9x10^{-5}$	$5.77x10^{-5}$	$5.76x10^{-5}$
MPC	3.0	2.88	2.88

(30) Page S-115. Analysis of HF tank rupture indicates that limestone provided is more than adequate if the HF doesn't vaporize. With a boiling point of 19.4°C, it appears that more of the HF would probably vaporize than would react with the limestone. Need new analysis considering atmospheric pollution effect of HF release.

Acid Tank Rupture. While the capability of the limestone contained in the curbed area under the HF tanks was calculated to demonstrate its capability for neutralizing HF in the event of a tank rupture, it seems unlikely that such an accident would happen.

The acid tanks are 3/4" carbon steel tanks mounted on scales with no bottom opening. Acid is charged to the tank and removed through the top. The tank is pressurized to 30 psig in order to discharge acid through a dipleg reaching to within 6" of the bottom. The tank is equipped with two rupture discs. The first, set at 55 psi, discharging into the scrubber system; the second, set at 75 psi, discharging into the atmosphere. The tanks are inspected each three years at the welds, heads and circumferentially with an audiogauge to determine the thickness. The most probable accident would be the accidental rupture of a discharge line or valve containing liquid HF. By quickly venting the tank to the scrubber system to reduce the pressure and localized absorption with water sprays and neutralizing lime for liquid spillage, such line or valve ruptures have been contained with very little loss of HF and no measurable escape from the plant site.

Rupture discs installed are subject to occasional rupture due to gradual fatigue of the discs. Such accidental releases have occurred but have been quickly controlled by venting the tank to the scrubber and replacing the disc.

The worst accident of this nature known of by Kerr-McGee was the loss of a flange while unloading an acid tank car at the AEC's Weldon Springs site where approximately 11,000 pounds of HF were lost before the tank car pressure could be reduced and flow valved off. In this instance, the plume rose almost vertically and drifted past a building whose ventilation system pulled the HF into the building forcing its evacuation. The bulk of the plume continued to rise and drifted approximately 1000 feet before disappearing due to atmospheric dilution. No ground level exposure occurred. Trees in the immediate path were defoliated as would be expected but recovered during the next growing season.

In examining the remote probability of a complete tank rupture, several simplifying assumptions had to be made in order to calculate the size of the plume. The assumptions were as follows:

1. Temperature - 100°F. Atmospheric Pressure - 29.5" mercury.
2. Sufficient limestone available to neutralize the entire tank and reaction of HF with limestone instantaneously.
3. No atmospheric effect influences the diffusion and dispersion of the vaporized HF.
4. The HF tank contains the normal working inventory of 60,000 pounds.
5. The tank contents empty instantaneously onto the area of the limestone contained within the curb.
6. The ratio of HF vaporized to HF reacted is equal to the ratio of the heat of reaction to the heat of vaporization.

    Heat of reaction = 12,384 BTU/lb mol
    Heat of vaporization = 3,950 BTU/lb mol
    Ratio = 3, i.e. 25% of the HF reacts
      and 75% vaporizes

7. The HF diffuses uniformly into the shape of a half sphere from the point of release.
8. An acceptable concentration of HF for temporary exposure is 100 mg/M^3 or 6.239×10^{-6} lbs HF/Ft^3.

With these assumptions, we can calculate as follows:

$.75 \times 60{,}000$ lbs = 45,000 lbs vaporized
$45{,}000/6.24 \times 10^{-6} = 7.2 \times 10^{9}$ Ft^3
Radius = $(3 \times \text{Volume}/8\pi)^{1/3}$. The radius, therefore, equals 1500 feet.

Therefore, we conclude that under these assumptions, breathing zone tolerable levels are reached 1500 feet from the location of the storage tank while localized defoliation would occur and immediate onsite air concentrations would exceed the tolerable levels. We believe that, in view of the procedural and equipment precautions, excessive airborne exposure would not be a credible accident from the unlikely event of an HF tank rupture.

(31) Page S-117. Burning of uranium loaded organic should result in dispersing particulates in the resulting smoke. An assessment of the amount of airborne uranium and dispersion to off-site areas should be made.

We have not been able to locate or generate a thorough technical assessment of the result of burning uranium-loaded organic solutions. Four experiments were made in the laboratory with plant solutions of hexane-TBP solvent. Upon ignition, these solutions burned until all hexane disappeared. Combustion of the loaded TBP, however, was dependent on conducting the test in a thin aluminum shallow pan providing maximum temperature generation and conduction of heat to the TBP residual. Under this circumstance, a residual tar remained containing some uranium. When the TBP-hexane mixture was burned in a heavy nickel crucible or a glass beaker, combustion ceased with complete removal of the hexane. We conclude that, in order to burn uranium-loaded TBP, a special consideration for the maximum conduction of heat to the TBP must be made. We consider the probability that, in the event of a fire in the solvent extraction plant, such special conditions would not be present, i.e. no large amounts of material to conduct heat to the TBP and containment in concrete (poor heat conducting) curbing. Based upon these tests and conclusions, we do not believe excessive dispersion of uranium in resulting smoke a credible accident.

In the "Environmental Survey of the Nuclear Fuel Cycle", November 1972, published by the Directorate of Licensing, the results of two fires in uranium concentration mills are reported. No "appreciable release of uranium to unrestricted environment" was determined as a result of investigations into these fires.

(32) Page S-117, Paragraph 4. Do not understand meaning of last sentence.

It is calculated that the effective curb volume is 10,564 gallons and the time to fill the curb with foam and water discharge is 14.9 minutes. The quantity of foam available for discharge will only run for 8 minutes. Therefore, the last sentence says, in effect, that the amount of foam and water will only fill the curb area to the extent of 8/15 or approximately 55% with no allowance made for the bulk buildup characteristics of the foam.

(33) Page S-118. Safety factor provided to contain maximum possible Sx tankage spill within curbed area (17091/17000) is extremely small.

While the safety factor provided on the solvent extraction curbing appears to be small by the calculation, note that it is provided that the pulse column and the tankage located in the rework side could conceivably spill into the solvent extraction area. These areas also have curb volumes to protect from tankage collapse or total spillage with adequate safety factors. As noted, this is a maximum but "improbable spill".

(34) Page S-123, Last Paragraph and Page S-125. Cannot follow reasoning that only 2/3 of the fluoride is available because 1/3 is tied up as insoluble UO_2F_2 formed by UF_6 hydrolysis while all of the uranium is considered to be soluble. Please explain.

The consultant's calculations assume that personnel present in the downind plume are exposed to elemental fluorine which is not true. Upon exposure to air, UF_6 hydrolyzes to UO_2F_2 and HF as shown at the bottom of Page 123. Individuals in the plume, therefore, are exposed to gaseous HF and particulate, probably respirable, UO_2F_2. Therefore, we must deal with two separate toxic chemical exposures. The first, HF; the second, UO_2F_2, with its accompanying radiological and toxicological exposure to uranium and accompanying fluoride. The fluoride present in UO_2F_2 is not free fluorine nor HF when solubilized in the lung and proceeds promptly to the blood stream. Therein, if it became an available fluorine contamination for subsequent flurosis of the skeletal bones, an exchange reaction would be required with chloride ions in the blood stream. Based upon the 19.9 (20 rem exposure), total inhalation would be

$$\frac{20 \text{ Rem}}{80 \text{ Rem}/\mu\text{Ci inhaled}} \times .33\mu\text{Ci/g} \times 40/238 =$$

.012 gram fluorine absorbed with the uranium dose

This amount of fluorine is below that causing fatality in animals as reviewed by Dr. Sternhagen in the letter immediately following.

35. Answer by Dames & Moore.

36. Answer by Dames & Moore.

SCHOOL OF MEDICINE | DEPARTMENT OF RADIOLOGY | (505) 265-4411 Ext. 2424

THE UNIVERSITY OF NEW MEXICO | ALBUQUERQUE, NEW MEXICO 87106

13 Dec 72

William J. Shelley
Nuclear Division
Kerr-McGee Corporation
Kerr-McGee Building
Oklahoma City, Oklahoma 73102

Dear Mr. Shelley:

The Following information was requested by you per our phone conversation regarding fluorine toxicology and its effects which we discussed this morning.

Animal experiments (W. F. Machle, et al, J. Ind. Hyg. Toxicol., 16, 129 (1934); and 17, 223 (1935)) showed that rabbits and guinea pigs died within five minutes in air containing hydrogen fluoride 1500 mg/cu. meter. But inhaling air with 1000 mg/cu. meter for 30 minutes caused no fatalities in these animals. 500 mg/cu. meter for 15 minutes caused some signs of ill health; below 100 mg/cu meter no deaths occurred in five hours and 24 mg/cu meter caused no deaths after 41 hours. It is necessary to discuss hydrogen fluoride since this becomes one of the chemical products in the possible exposures of interest due to presence of hydrogen ions in the hydrated alveolar lung tissue or other respiratory epithelial lining areas.

The dose causing fatality of sodium fluoride given orally to rabbits is 200 mg/kg of body weight (C. W. Muehlberger, J. Pharmacol. Exptl. Therap., 39, 346 (1930))and when injected intraperitoneally it is 250 mg/kg (P. Handler, J. Biol. Chem., 161, 55 (1945)). But Na_3AlF_6, cryolite, cannot be given orally to rats in high enough doses to cause deaths because of lower toxicity, secondary to lower solubility (E. J. Largent, J. Ind. Hyg. Toxicol., 30, 92 (1948)). The basic process of fluoride action is as an inhibitor of some intracellular enzymatic processes in anaerobic glucolysis, and the therapy has been published in the work by J. H. Peters, Am. J. Med. Sci., 216, 278 (1948) and is beyond the scope of a toxicology presentation such as this.

In humans, in industrial exposures to fluorine in an aluminum plant (G. H. Agate, et al, Med. Res. Council Brit., Mem. No. 22,1948) it was noted that there were no disabling symptoms even though some had radiographic changes on X-ray Roentgenograms of bones consistent with the diagnosis of skeletal fluorosis. The urinary fluoride mean daily output was 9.03 mg in the most heavily exposed group in that study. It is also now known that very slight bone changes can be seen in a small number of workers with chronic exposures causing urinary concentrations of six mg/liter (F. F. Heyroth, Am. J. Public Health, 42, 1568 (1952)).

Some industrial physicians regard the maximum permissible exposure as that causing less than 4 mg mean daily urinary output.

If there is any further way I may be of assistance to you in this, please do not hesitate to let me know.

Respectfully,

C. J. Sternhagen, M.D.

Charles J. Sternhagen, M. D.
Asst. Professor of Radiology

CJS/cs

cc. P. A. Puttroff

A.E.C. Question 35

Appendix IV Dames & Moore Report Page 8. Accident doses calculated as follows:

$$\frac{\chi}{Q}_{\substack{\text{Ground}\\\text{Accident}}} = \frac{1.0}{U\ (\Pi\ SZ(K)\ SY(K) + CA)}$$

where $SZ(K) = \sigma_z$; $SY(K) = \sigma_y$

CA = 1/2 minimum cross sectional area of containment building = 334.5 M^2

I question validity of using the "CA" term in the equation and believe that the basic equation for atmospheric diffusion from a ground level point source is applicable here. ie $\frac{\chi}{Q} = \frac{1}{\Pi U \sigma_y \sigma_z}$

Use of the CA term was adopted from Reactor Safety Guide 4 dealing with a PWR accident.

Response:

The utilization of the "CA" term was made to incorporate accepted standard effects caused by "wake entrainment" associated with ground level releases. The omission of the "CA" term causes increased dispersion of the atmospheric ground release. By incorporating the "CA" term, a more realistic and more conservative estimate of the effects of the ground release are made. Even though the CA term is associated with Safety Guide 4's PWR accident it is used to evaluate a ground level release that is influenced by a building wake which is a model used by Safety Guide 4 and its use is not restricted to either pressurized water reactors or accidents per se. An additional reference would be "Atmospheric Dispersion Calculations Using the Generalized Gaussian Plume Model" by F. A. Gifford, Jr. of the Weather Bureau Research Station, Oak Ridge, Tennessee, published in the USAEC quarterly NUCLEAR SAFETY.

AEC Question 35 (continued):

Dosage calculations at nearest residence ie 762 meters northwest of plant:

$$\frac{\chi}{Q}_{\substack{\text{Ground}\\\text{Accident}}} = \frac{1.0}{U\ (\Pi\ SZ(K)\ SY(K) + CA)}$$

Where: $U = 1.0$ mps for 6.67 hour duration (assumed) (stability F)

$SZ(K)$ @ $x = 762\text{m} \cong 11.5\text{m}$

$SY(K)$ @ $x = 762\text{m} \cong 26.5\text{m}$

$$\frac{\chi}{QGA} = \frac{1.0}{(1)(3.14)(11.5)(26.5) + 334.3} = \frac{1}{1291.5} = 7.73 \times 10^{-4}$$

$$\text{Soluble Uranium Dose} = \frac{\chi}{QGA}\ (Q)(BR)(DF)(TIME)$$

Response:

The values to SZ(K) and SY(K) were obtained from Figures 3.10 and 3.11 in "Meteorology and Atomic Energy 1968," published by the Division of Technical Information, USAEC. Some other references contain copying discrepancies in the use of these tables.

AEC Question 35 (continued):

Where: Dose is in rem to kidney for accident time of 6.67 hr.

Time = 2.4×10^{4} seconds

BR = $3.47 \times 10^{-4}\ \text{m}^{3}/\text{sec}$ (Safety Guide #, p. 4.2)

DF = Dose factor to kidney (80 rem/µCi inhaled)

Value indicated in Ref (7), (page 6 of D & M Report) ie IDO-12054 indicates inh. dose for 92.238 to kidney at 4.45×10^{6} rad/Ci or 4.45 rad/µCi.

Source of 80 rem/µCi used in calculations is IAEA Safety Series No. 7 (1961) p. 50. Value of 4.45 rem/µCi given in Handbook of Laboratory Safety 1967, p. 277. Calculations of this value was checked from equation given in both IDO-12054 and HLS-1967 as

$$\text{Dose} = \frac{AfET_E}{m} \left(1 - \exp. \frac{-1.26 \times 10^4}{T_E}\right) \times \frac{1.6 \times 10^{-6} \times 3.2 \times 10^{15}}{0.693 \times 10^2}$$

With $A = 1.0$; $f = 0.028$; $E = 43.0$ MeV; $T_E = 15.0$ days
and $m = 300.0$ grams, Dose = 4.45×10^6 rem/Ci

D. F. Bunch, author of IDO-12054, claims IAEA value of 80 rem/μCi is incorrect.

Response:

Reference (7) in the Dames & Moore Report is incorrect for that report; it should be IAEA Safety Series No. 7 "Regulations for the Safe Transport of Radioactive Materials: Notes on Certain Aspects of the Regulations," SPI/Pub/32, which is more applicable for this type of an evaluation. The reference also includes chemical toxicity, and although the 80 rem/μCi is not the most rigorous value, it is the more conservative.

AEC Question 35 (continued):

In soluble uranium dose expression, Q is calculated to be:

$$\frac{4800 \text{ lb. } UF_6}{400 \text{ min}} \times \frac{1 \text{ min}}{60 \text{ sec}} \times \frac{238 \text{ lb. U}}{352 \text{ lb. } UF_6} \times \frac{454g}{\text{lb.}} = 61.5 \text{ gU/sec.}$$

With D & M using Q = 39.6 μCi/sec, specific activity being used is;

$$\frac{39.6 \ \mu\text{Ci/sec}}{61.5 \text{ gU/sec}} = 0.644 \ \mu\text{Ci/gU}$$

This does not agree with ∿ 1/3 μCi/gU given for U_{238} on p. 104, Jan. 1970 edition of Radiological Health Handbook or for U-nat. in 10 CFR 20.5(c).

Response:

The value of 1/3 μCi/gU is the commonly-agreed upon value for natural Uranium and therefore was used in the Dames & Moore calculations.

AEC Question 35 (continued):

Using D & M Values, checking arithmetic

Soluble Uranium Dose = $\frac{\chi}{QGA}$ (Q) (BR) (DF) (TIME)

= (7.73×10^{-4}) (39.6) (3.47×10^{-4}) (80) (2.4×10^{4}) = 20.4 rem

versus 20.1 rem reported.

Using DF of 4.45 rem/µCi and specific activity of 1/3 µCi/gram U, dosage would be:

$$20.1 \times \frac{4.45}{80} \times \frac{0.333}{0.644} = 0.58 \text{ rem}$$

indicating D & M calculations to be conservative.

Fluoride concn. = $\frac{\chi}{Q}$ Ground Accident (Q) $\times 1 \times 10^{6}$

@ 1600 lb F^-/400 minute release,

$$Q = \frac{1600 \text{ lb}}{400 \text{ min}} \times \frac{1 \text{ min}}{60 \text{ sec}} \times \frac{454 \text{ g}}{\text{LB}} \cong 30.3 \text{ g/sec}$$

F^- Concn = (7.73×10^{-4}) (30.3) (10^{6}) = 23422 µg/m^3 checking 23000 µg/m^3 reported

Response:

The above AEC checks on reported values are in good agreement and it is assumed these checks do not reflect any concern with the analyses reported.

AEC Question 36

Page S-125

Correcting exposures for 4550 LB UF_6 released in 40 minutes vs 4800 lb released in 400 minutes: (using D & M values for DF and specific activity)

$\frac{X}{QGA}$ remains the same @ 7.73×10^{-4}

Soluble U Dose:

$$Q = \frac{4550}{40} \times \frac{1}{60} \times \frac{238}{352} \times 454 \times 0.644 \cong 374 \ \mu Ci/sec$$

$$Dose = (7.73 \times 10^{-4})\ (374)\ (3.47 \times 10^{-4})\ (80)\ (2.4 \times 10^{3}) = 19.3 \text{ rem}$$

vs. 19.9 rem reported

Fluoride concn (basis 2/3 of total available)

$$Q = \frac{1600 \text{ lb}}{40 \text{ min}} \times \frac{2}{3} \times \frac{1}{60} \times 454 \cong 201.8 \text{ g/sec}$$

$$F^{-} \text{ Concn} = (7.73 \times 10^{-4})\ (2.018 \times 10^{2})\ (10^{6}) = 15.6 \times 10^{4}\ \mu\ g/m^{3}$$

or 156 mg/m^3 checking
153 mg/m^3 reported

Response:

The values obtained by the AEC and D & M are in good close agreement for the Soluble Uranium dose and the Fluoride concentrations, as cited above.

AEC Question 36 (continued):

Method is OK but values questioned based on foregoing discussion.

Checking Ref. 35, ie "Safety Evaluation by DML, USAEC in the Matter of MFRP, Docket No. 50-268, October 6, 1967." The presumed acceptable 75 rem kidney dose appears to have been calculated using the guideline basis described on page 44 of the document where it is stated that "we have used an intake guideline which we believe is equivalent to the whole body exposure guideline of 25 rem set forth in 10 CFR 100. This guideline is that the intake of long-lived radionuclides shall not be greater than 50 times the annual intake by individual members of the general public which could occur under the provisions of 10 CFR 20." The rationale appears to be as follows:

(a) The whole body occupational annual permissible dose is 5 rems.

(b) The whole body annual permissible dose for individuals in the general population is 10 percent of this level or 0.5 rem.

(c) The permissible "other organ" (i.e., kidney) emergency dose (occupational) is 15 rem.

(d) Therefore, the permissible emergency kidney dose for individuals in the general population is 10% of 15 rem or 1.5 rem (50 year integrated dose).

At 50 times the permissible dose an acceptable kidney dose for accidental exposure would appear to be 1.5 x 50 or 75 rem.

While this rationale appears reasonable, it should be pointed out that permissible emergency exposures are covered in ICRP-6, p. 30, rather than 10 CFR 20.

Response:

The acceptance of the rationale by the AEC in the evaluation of Docket No. 50-268 formed the basis for the 75 rem kidney accidental exposure dose. The reference to the ICRP-6, p. 30, was not considered as the USAEC has not expressed the adoption of these levels for emergency exposures. Since the AEC accepted limits for emergency exposures, as developed in Ref. 35, other limits were not considered.

AEC Question 36 (continued):

Checking Reference 37 "Dangerous Properties of Industrial Materials", 1968 edition, page 823, referring to hydrofluoric acid, "Inhalation of the vapor may cause ulcers of the upper respiratory tract. Concentrations at 50 to 250 ppm are dangerous, even for brief exposures" (50 to 250 ppm = 41 to 204 mg/m^3). Statement on page S-125 reads, Sax permits brief exposure to 33 - 165 mg/m^3". Please resolve this apparent discrepancy.

Response:

In reference 36 and the cited reference 37, the term "brief exposures" and "dangerous" provide unfortunate latitude in interpretation. It is apparent from ref. 36 and 37 that a potential lethal hazard exists for HF. It is inferred from Sax reference, however, that a "non-lethal" exposure (33-165 mg/M^3) could be tolerated by an individual for "brief" periods.

36. Kerr-McGee answer.

Reference 37, "Dangerous Properties of Industrial Materials", 1968 Edition, Page 823, is quoted accurately for ppm. Conversion from ppm to mg/M^3 is given as 2/3 on page 13-5, "Industrial Ventilation", Tenth Edition, American Conference of Industrial Hygienists, resulting in the numbers of 33-165 mg/M^3 shown in the report. The difference in calculated concentration in mg/M^3 is probably due to the use of the above reference which is probably not an exact calculation.

Persons in the plume at this concentration would be uncomfortable during the period of exposure. In view of the conservative assumptions used on diffusion calculations and the procedural and equipment precautions, we do not believe even this temporary exposure is a credible accident.

(37) You state (top page S-130) that a satisfactory process will be developed to handle the raffinate storage pond contents. To support this statement, you should provide a detailed status report of investigations underway to cope with this problem. This is particularly important in view of the apparent raffinate pond seepage being experienced.

Three methods exist for the concentration and eventual disposal of raffinate generated by the Sequoyah process:

1. Concentration. The fertilizer industry produces solid ammonium nitrate by reacting ammonia with HNO_3 and subsequently concentrating the solution to approximately 80% NH_4NO_3. This molten salt is then solidified in a prilling tower to an appropriate form for distribution.

   This process can be halted at any appropriate salt concentration and the solution sold for fertilizer as a solution. This same process could be used on the neutralized raffinate solution to either partially concentrate so as to maintain freeboard in the ponds and overcome the natural dilution of rainwater or concentration be continued and the material allowed to solidify for disposal by burial.

In 1971 and early 1972, tests were made with a submerged combustion evaporator which achieved more concentrated solutions without undue operating difficulty. These tests were run on a batch basis concentrating step-wise to examine operating difficulties and effluent concentrations. From these tests it was concluded that a large unit installed to process raffinate on a once-through basis returning the concentrate to the ponds would meet emission criteria and avoid the construction of additional ponds until resolution of the proposed deep well disposal or the installation of one of the alternate processes described below.

2. Removal of Radionuclides. The radionuclides contained in the raffinate can be removed by chemical treatment as solids resulting in a solution of essentially ammonium nitrate contaminated by trace amounts of metallic impurities.

   It has been demonstrated in the laboratory and on a small scale in pilot plant equipment that the radium content can be reduced to approximately $.05 \times 10^{-8}$ µCi/ml or 1/30 of MPC, the thorium to $.4 \times 10^{-8}$ µCi/ml or 1/250 of MPC, and uranium to 1.2×10^{-7} µCi/ml or approximately 6/1000 of MPC. This treatment involves the neutralization of the raffinate with ammonia which essentially removes all uranium and thorium and then treatment with a soluble barium content to the extent of approximately 2 g/l barium. The barium sulfate forms a precipitate and serves as a carrier for radium sulfate removal. The resulting solution radium concentration reaches the limit of detection for measuring Radium_{226}.

Work is planned to determine the feasibility of treating raw raffinate directly by this system so as to produce a more concentrated ammonium nitrate solution which then could be disposed of as fertilizing solution.

The solid precipitated would be separated by settling or filtration and buried in accordance with 10 CFR 20.304 or at a licensed burial ground.

3. Decomposition. The third method of disposal of the raffinate would involve decomposition to stable metallic salts, nitrate and ammonia or nitrogen and water. Two processes have been technically described but, as yet, neither has been tested in the laboratory.

   The first involves the neutralization with magnesium oxide with evolution of ammonia and its collection, evaporation of the magnesium nitrate solution, kiln firing of the resultant magnesium nitrate hydrate and fractionation of the evolved nitric and hydrochloric acid vapor for recycle. The stream of solids consisting of uranium, radium, magnesium oxide and sodium sulfate would be packaged as waste material for burial.

The second process is the neutralization of raffinate with ammonia and subsequent evaporation and solidification of the concentrated ammonium nitrate solution. This solid is then fed to a fluidized bed reactor for decomposition to nitrous oxide and water which is decomposed by a catalytic burner to nitrogen, oxygen and water vapor. Solids recovered from the fluid bed are separated by screening and buried. These solids would contain uranium, thorium, radium oxides and sodium sulfate.

It is planned to commence laboratory evaluation of these processes early in 1973.

(38) Supplemental Environmental Report: Appendix I, Item 11, Waste Disposal System Ponds. While design and installation of both the fluoride and raffinate ponds may meet all requirements of AEC licensing guide, the soluble salts in the raffinate stream may in time destroy the effectiveness of the "impervious" clay liner through ion exchange mechanisms. We suggest a laboratory study be performed to determine resistance of pond clays to attack by raffinate solutions.

Soil permeability tests were performed on samples of the clay liners from Ponds 1 and 2. Fresh water Pond 1 and Pond 2 and raw raffinate was used as the fluid for these tests. After 21 days of testing, no permeability of the clay used as liners was detected. The test used was that described on Page 63 of "The Mechanics of Engineering Soils" by P. Leonard Capper and W. Fisher Cassie.

(39) Supplemental Environmental Report: Appendix IV, Page 6. Max downwind concns - Fig. 3-9. Stability F,X_{max} occurs @ ~5.2 Km rather than 4 Km. Also under "Conc." 1/3 stability F should be 0.5×10^{-5} making total 3.5×10^{-5} x. Under "Dist." 1/3 stability F should read 1.73 making maximum downwind distance 2.26 Km, changing statement in next paragraph. Maximum concentration occurs 2260 meters downwind.

The corrections noted were checked and the last sentence on Page 6 of Appendix 4 should read: "At 2260 meters downwind, the maximum ground level concentration, 3.5×10^{-5} x the stack level concentration, would occur."

(40) Supplemental Environmental Report: Appendix IV, Page 7. Small errors in picking values off Figure 3-9 of "Workbook" result in final sentence change to read "maximum downwind concentration of $5.5 \times 10^{-4} \frac{Q}{\upsilon}$ at .340 Km or 1114 ft.

Table is labeled incorrectly and should read:

	$\frac{X\upsilon}{Q}$ Max m^{-2}	Distance, Km
Stability F	4.5×10^{-4}	0.63
Stability D	5.7×10^{-4}	0.25
Stability C	6.2×10^{-4}	0.15
$\Sigma(F + D + C)$	16.4×10^{-4}	1.03
$\Sigma(F + D + C)/3$	5.5×10^{-4}	0.34

The questions were noted and the calculations rechecked. The last sentence on Page 7 of Appendix 4 should read: "Roof top release at 45 feet would have a downwind concentration of 5.5×10^{-4} at 340 meters."

41. Answer by Dames & Moore.

42. Answer by Dames & Moore.

AEC Question 41

Supplemental Environmental Report: Appendix IV, Dames & Moore Report, Page 3. Summary Table of gaseous effluent release data should have been obtained from data shown in Table XXVI; Page 97.

ΣF^- (stack) = 0.1152518 g/sec = 0.12 g/sec

ΣF^- (ground level) = 0.0040923 = 0.004

ΣNO_x (stack) = 1.98 g/sec

ΣSO_2 (stack) = 0.26 g/sec

(a) Σ Soluble Uranium (ground level) = .00008382 or 8.382×10^{-5} g/sec

(b) Σ Soluble Uranium (stack) = .00047 or 4.7×10^{-4} g/sec

(c) Σ Insol Uranium (ground level) = .001091 or 1.091×10^{-3} g/sec

(d) Σ Insol Uranium (stack) = .0000175 or 1.75×10^{-5} g/sec

Appendix IV, p. 3, summary table gives uranium release rate in Ci/sec. i.e., Sol U (stack) = 3.0×10^{-10} Ci/sec or 3.0×10^{-4} μCi/sec.

$$\text{Specific Activity} = \frac{3.0 \times 10^{-4}\ \mu\text{Ci/sec}}{4.7 \times 10^{-4}\ \text{g/sec}} = 0.639\ \frac{\mu\text{Ci}}{\text{gram}}$$

This agrees substantially with 0.644 μCi/g value calculated previously in these comments, but does not agree with 1/3 μCi/gU value cited in the literature.

Response:

Reference AEC Question 35.

AEC Question 41 (continued):

However, apparent specific activity used was not constant:

		μCi/gram U Specific Activity
Sol U Stack:	$\frac{3.0 \times 10^{-4}}{4.7 \times 10^{-4}} =$	0.639
Sol U Ground:	$\frac{5.0 \times 10^{-5}}{8.382 \times 10^{-5}} =$	0.597

Insol U Stack: $\frac{1.0 \times 10^{-5}}{1.75 \times 10^{-5}}$ = 0.571

Insol U Ground: $\frac{7.2 \times 10^{-4}}{10.91 \times 10^{-4}}$ = 0.659

This would imply that data furnished by K-M to Dames and Moore; Reference (4) written correspondence between I. Spickler of D & M and A. Valentine of K-M; May 1972 may not have been obtained from Table XXVI, page 97. Please clarify this apparent discrepancy. Also see comment (25) above; release data may need revision.

Response:

Reference AEC Question 35.

AEC Question 42

Supplemental Environmental Report: Appendix IV, D & M Report, Page 6.

Dose factor for uranium affecting the kidney in reference (7) "IDO-12054" is listed as 4.45×10^6 rad/Ci = 4.45 rad/μCi for inhaled soluble U-238 versus value of 80 rem/μCi used by D & M.

Response:

Reference AEC Question 35.

AEC Question 42 (continued):

Dose factor for lungs is given as 110 rem/ Ci by D & M quoting IDO-12054. Lung data are not included in this publication.

Response:

Reference should be to revised reference #7.

AEC Question 42 (continued):

Dose factor for bones is given as 20 rem/μCi by D & M. IDO-12054 gives value as 19.5 rad/μCi.

Response:

The revision from 20 rem/μCi to 19.5 rad/μCi was made in the tables under question 25.

(43) Environmental Report (revised), dated November 1941.

Page 23-R: Calculations for discharge data are in error. Basis for conclusions drawn on page 24, §1 not understood.

(a) N as NO_3 shown as 2 ppm with NO_3 shown as 8.4 ppm.

$$\frac{NO_3}{N} = \frac{14 + 48}{14} \times 2 \text{ ppm N} = 8.85 \text{ ppm } NO_3$$

(b) Illinois River: 1462 cfs.

Σ NO_3 @ 2.4 ppm given as 2290 lbs/day

$$\frac{1462 \text{ CF}}{\text{sec}} \times \frac{62.4 \text{ lbs}}{\text{CF}} \times \frac{8.64 \times 10^4 \text{ sec}}{\text{day}} \times \frac{2.4 \text{ Parts } NO_3}{1 \times 10^6 \text{ Parts } H_2O} = 18900 \frac{\text{lbs}}{\text{day}} NO_3$$

F^- @ 0.1 ppm would be $\frac{18900}{24}$ or 788 $\frac{\text{lbs}}{\text{day}}$ F^-

in place of 95 lbs/day shown

(c) Arkansas River: 19500 cfs

@ NO_3 = 4.8 ppm, Σ = 64000 lbs/day shown

Should be $\frac{19500}{1462} \times \frac{4.8}{2.4}$ (18900) = 505,000 lbs/day

F^- @ 0.3 ppm would be $\frac{50500}{16}$ = 31500 lbs/day

versus 4680 lbs/day shown

The calculational errors noted under this comment should be incorporated in the Environmental Report-Revised dated November 1971.

(44) K-M application dated 9/23/69; Page IV-7 § 3.

UF_6 normal release rate of .00074 lb-mol/hour along with 3.3 lb-mol/hour of inert gases.

$$7.4 \times 10^{-4} \frac{\text{lb-mol } UF_6}{\text{Hour}} \times \frac{352 \text{ lb } UF_6}{\text{lb-mol } UF_6} \times \frac{454 \text{g}}{\text{lb}} \times \frac{1000 \text{ mg}}{\text{g}}$$

$$UF_6 \text{ Release} = (7.4 \times 10^{-4})\ (3.52 \times 10^{2})\ (4.54 \times 10^{2})\ (10^{3})$$

$$= 118 \times 10^{3} \text{ mg } UF_6\text{/hour}$$

$$\text{Gas flow} = 3.3\ \frac{\text{lb-mol}}{\text{hour}} \times \frac{359 \text{ CF}}{\text{lb/mol}}\ (\text{@STP}) \times \frac{1 \text{ M}^3}{35.31 \text{ CF}}$$

$$= 33.6 \text{ M}^3\text{/hour}$$

$$UF_6 \text{ concn} = \frac{118 \times 10^{3} \text{ mg } UF_6\text{/hr}}{33.6 \text{ M}^3\text{/hr}} = 3.51 \times 10^{3} \text{mg/M}^3$$

versus 0.004 mg/M^3 cited.

$$3.51 \times 10^{3} \text{ mg/M}^3 = 3.51 \times 10^{-6} \text{ g } UF_6\text{/ml or } \left(\frac{238}{352}\right)\ (3.51 \times 10^{-6}) =$$

$$2.37 \times 10^{-6}\ \frac{\text{gU}}{\text{ml}}$$

@ specific activity of 1/3 µCi/g, this represents a concentration of 0.79 x 10^{-6} µCi/ml

At an MPC value of 3 x 10^{-12} µCi/ml for soluble U-238 per 10 CFR 20, a dilution factor of $\frac{0.79 \times 10^{-6}}{3 \times 10^{-12}}$ or about 2.6 x 10^{5} is required to meet the permissible site boundary concentration.

The reference to the Kerr-McGee license application dated September 23, 1969, Page IV-7, Paragraph 3, is not complete in that the paragraph states further that this material is released from the cold traps and is further processed by scrubbing prior to release to the atmosphere at the top of the 150-foot stack. In any event, as noted earlier, the dilution factor (corrected) is 3.5 x 10^{5} (question 39).

45. Answer by Dames & Moore.

AEC Question 45

Supplemental Environmental Report: Appendix IV, Dames and Moore Report, Table I. Please dscribe meteorological conditions corresponding to Pasquill Stability Category "G" along with source of this information.

Response:

The references to Pasquill Stability Category "G" can be obtained from the AEC Safety Guide 23 and IDO-12048 "Climatography of the National Reactor Testing Station" Idaho Operations Office, USAEC.

Answer to comments of Colorado State University Environmental Resources Center

Part 1, No. 1. See attached discussion on storage ponds.

Part 1, No. 2. Monitor wells are described in more detail in the attached discussion.

Part 1, No. 3. Study of the hydrological atlas of Oklahoma, Fort Smith quadrangle, demonstrates that Atoka formations lack a well defined water table or piezometric surface. The residence well northeast of the plant has a water surface of 475 feet, well below current pond levels. The well formerly serving the Carlile homestead, approximately 1000 feet south of the plant, has a natural water level of about 516 feet. This well was not sufficient, according to the former owners, to maintain a flow of water for domestic use. A cistern was relied upon for the domestic water supply.

As can be seen from the elevations shown on the cross section of the storage pond locations, these water depths in the referenced wells are well below the 532 foot elevation of the No. 2 Pond.

Comments by U.S. Department of Commerce

As noted, Kerr-McGee manual calculations are less precise than those made by Dames & Moore in their computer calculations and are 100 times more conservative than the Dames & Moore results.

The wording on Page 29 of the Environmental Report-Revised is not clear when it uses the "100% deposition". The calculations were made assuming 100% deposition of the uranium content of the material inhaled in the lung without an allowance of deposition efficiency.

Comments of Dr. Don L. Warner, Rolla, Missouri

Dr. Warner again raises questions as to the integrity of the raffinate ponds and the apparent contamination of monitoring well water. Please see the attached discussion for more detailed explanation.

No discussion was given of burying solid wastes resulting from raffinate treatment methods because it is still contemplated that the deep disposal well will be approved. All of the alternate methods of raffinate disposal described under question 37 would require burial of a solid. The first alternate would require the burial of solidified raffinate in containers at a commercial burial site. Alternates 2 and 3 would require that solids be buried in accordance with 10 CFR 20.304 or packaged for commercial burial.

RAFFINATE STORAGE PONDS

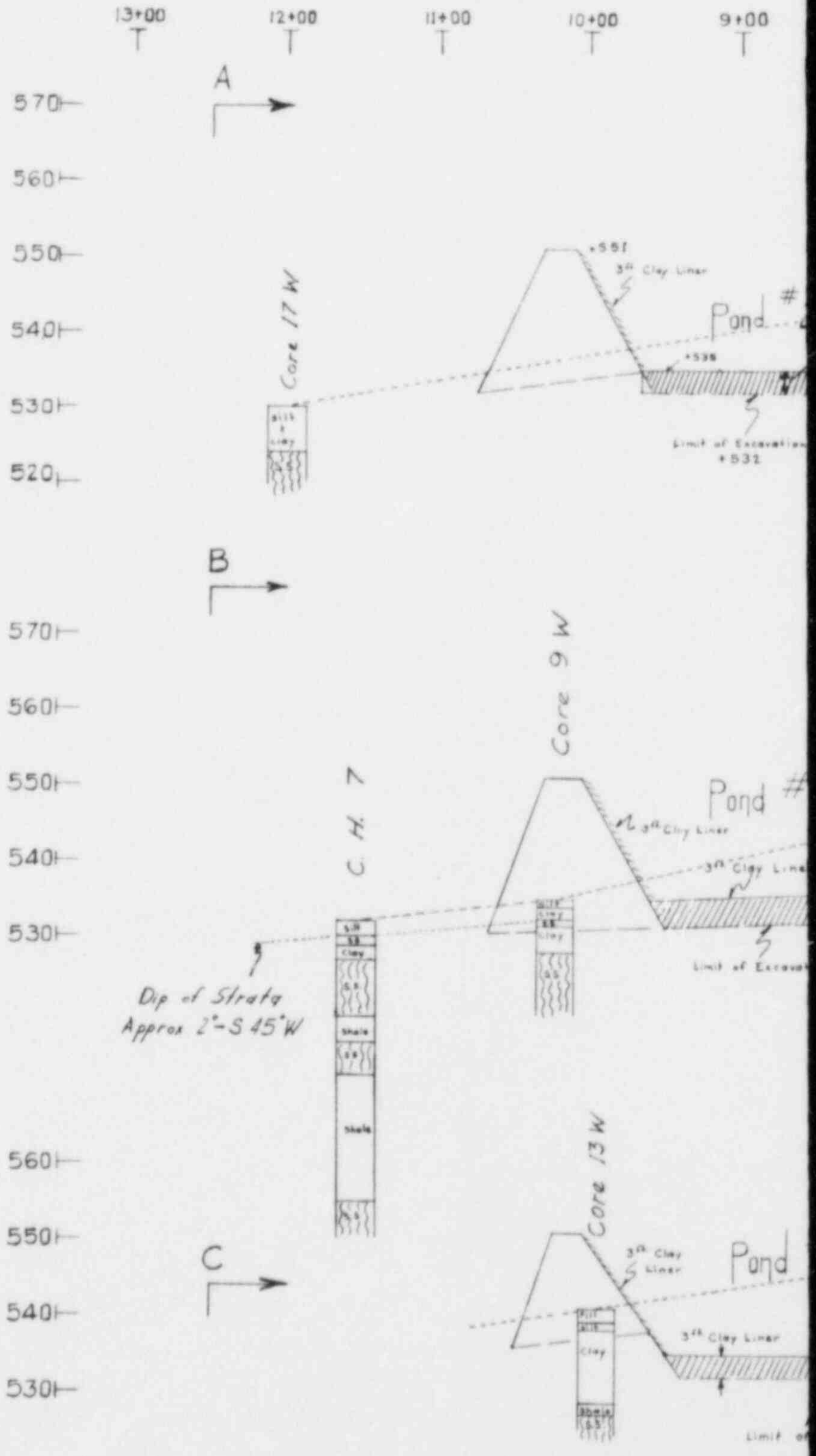
Questions relating to the raffinate pond construction (University of Colorado report) and levels of various analyses in monitoring wells (questions 11, 23, 36, D. L. Warner comments and University of Colorado comments) demonstrate concern that the raffinate storage ponds have leaked chemicals into the nearby monitoring wells.

This discussion describes more fully the examinations made, the construction of the ponds, and the monitoring well analysis so as to provide assurance that these ponds are not leaking contaminated material into the ground.

Pond Construction

The ponds were constructed as described in the Supplementary Environmental Report. All construction was supervised by a well-qualified civil engineer specializing in such construction. Inspection of the placement of the liner and dikes was conducted on a daily basis by an on-site inspector. Density tests of compacted bottom and levy liners were conducted routinely. Areas that did not meet specified compaction requirements were scarified and recompacted. A cross section of the ponds is given on Page 79. The exact layout of the ponds and the location of monitoring wells is shown on Page 80. A site map showing approximate location of monitor wells can be seen on Page 81. As can be seen from the cross section, only on the east wall of Pond No. 2 was the excavation made to the level of a sandstone strata. Subsequent installation of the clay liner provides adequate assurance of no leakage of the pond contents into this sandstone. In view of the demonstrated dip of the strata, location of monitoring wells appears to be appropriate.

As described briefly under question 38, clay linings and dike facings were subjected to permeability tests by standard methods


13+00
12+00
11+00
10+00
9+00
A
570
560
550
540
530
520
Core 17 W
Silt & Clay
S.S.
+551
3ft Clay Liner
Pond #
+536
Limit of Excavation
+532
B
570
560
550
540
530
Core 9 W
C. H. 7
Pond #
3ft Clay Liner
3ft Clay Liner
Limit of Excavat
Silt
S.S.
Clay
S.S.
Shale
S.S.
Shale
S.S.
Silt
Clay
S.S.
Clay
S.S.
Dip of Strata
Approx 2°-S 45°W
560
550
540
530
C
Core 13 W
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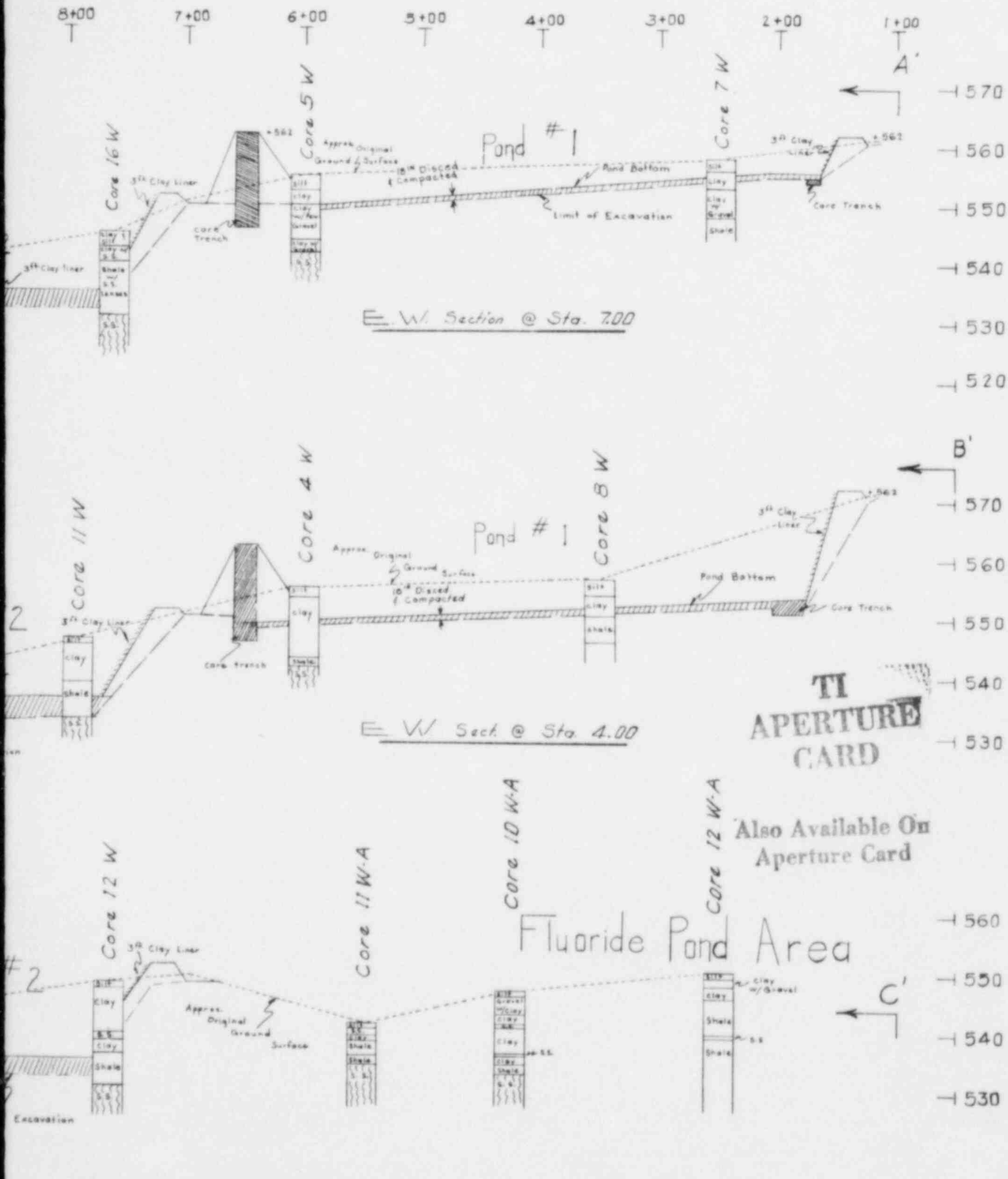
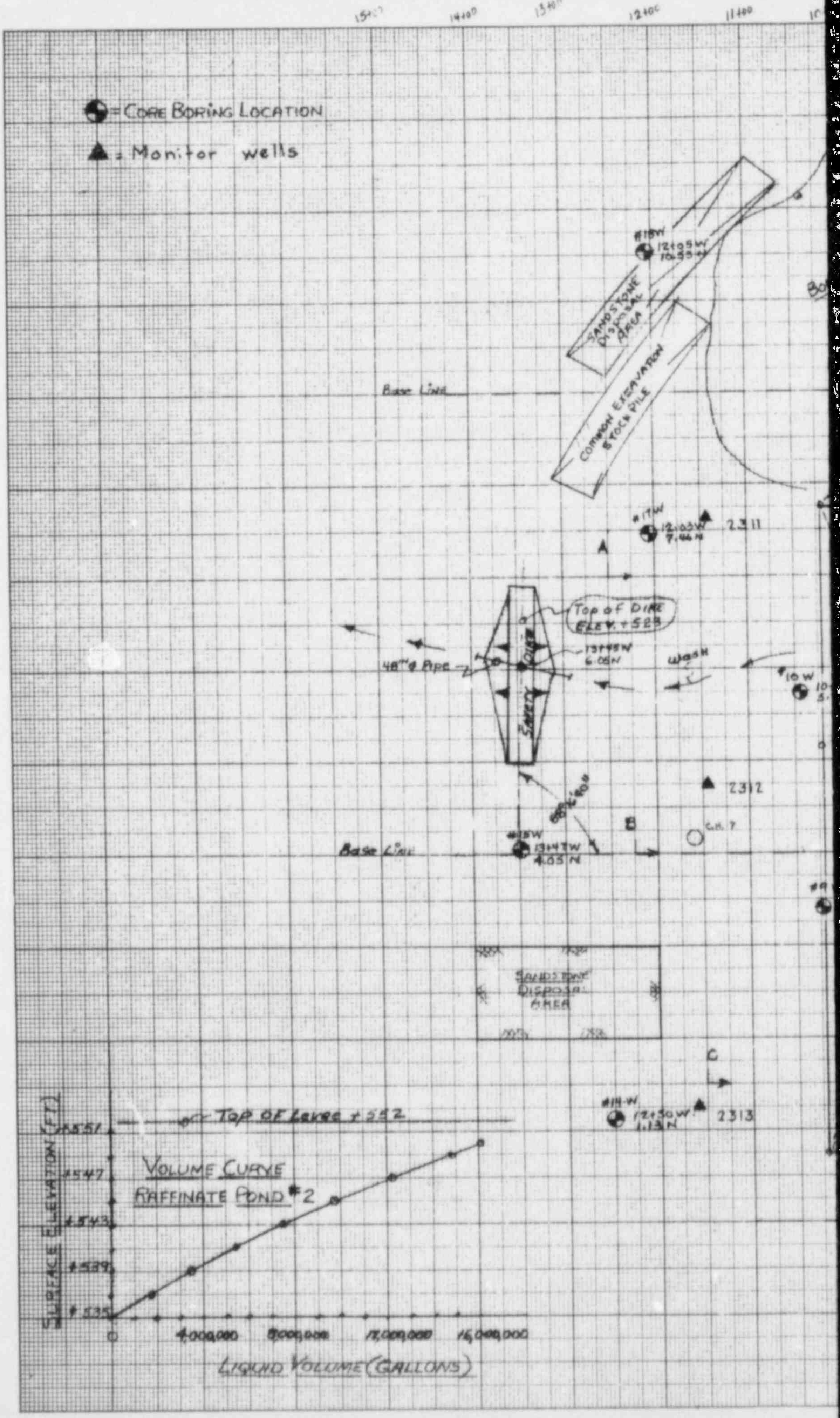
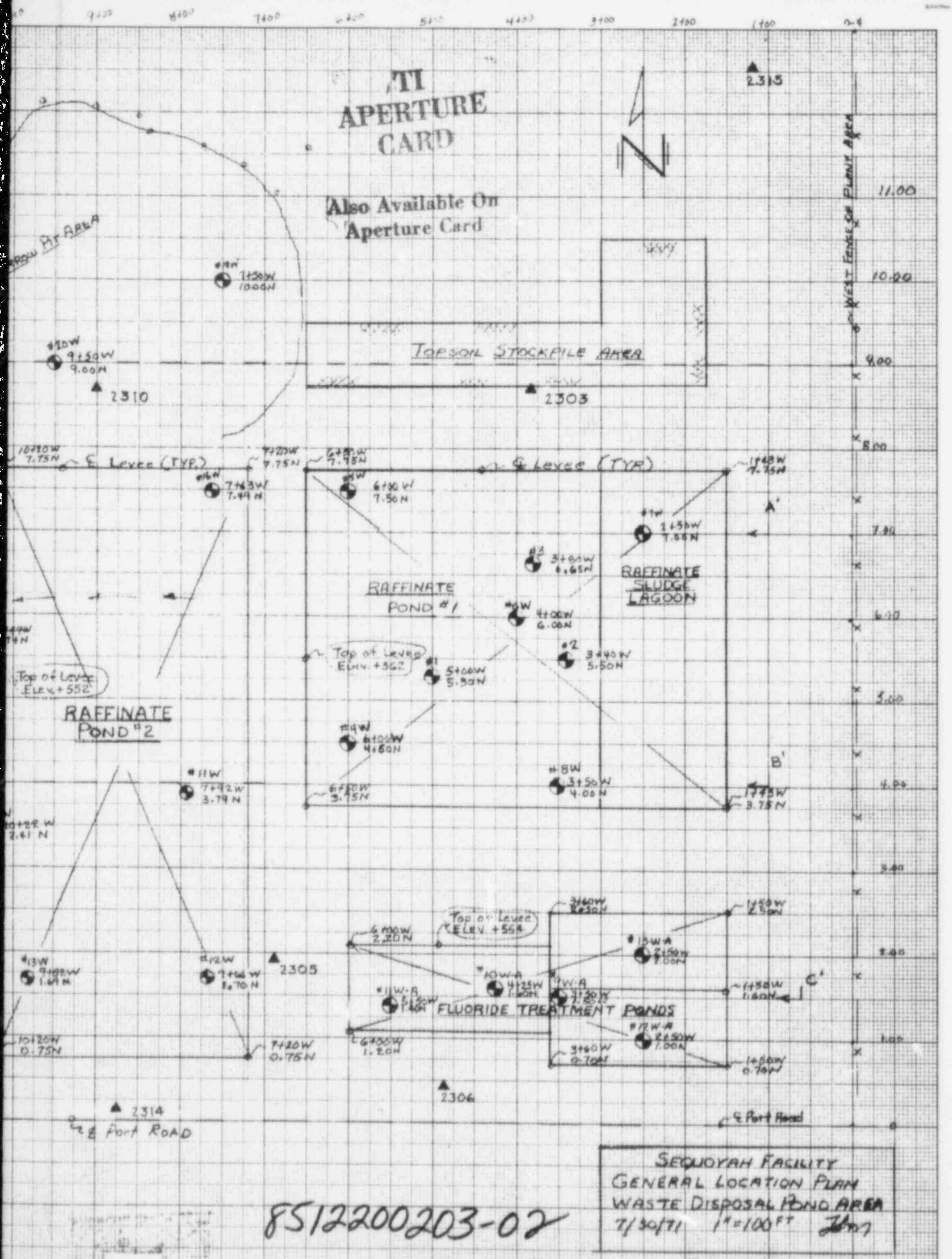
Fill
Silt
Clay
Shale
S.S.
Limit of



SEQUOYAH FACILITY
X - SECTION
THROUGH HOLDING PONDS
NOTE: VERT.-EXAG. 5:1
12/72

8512200203-01

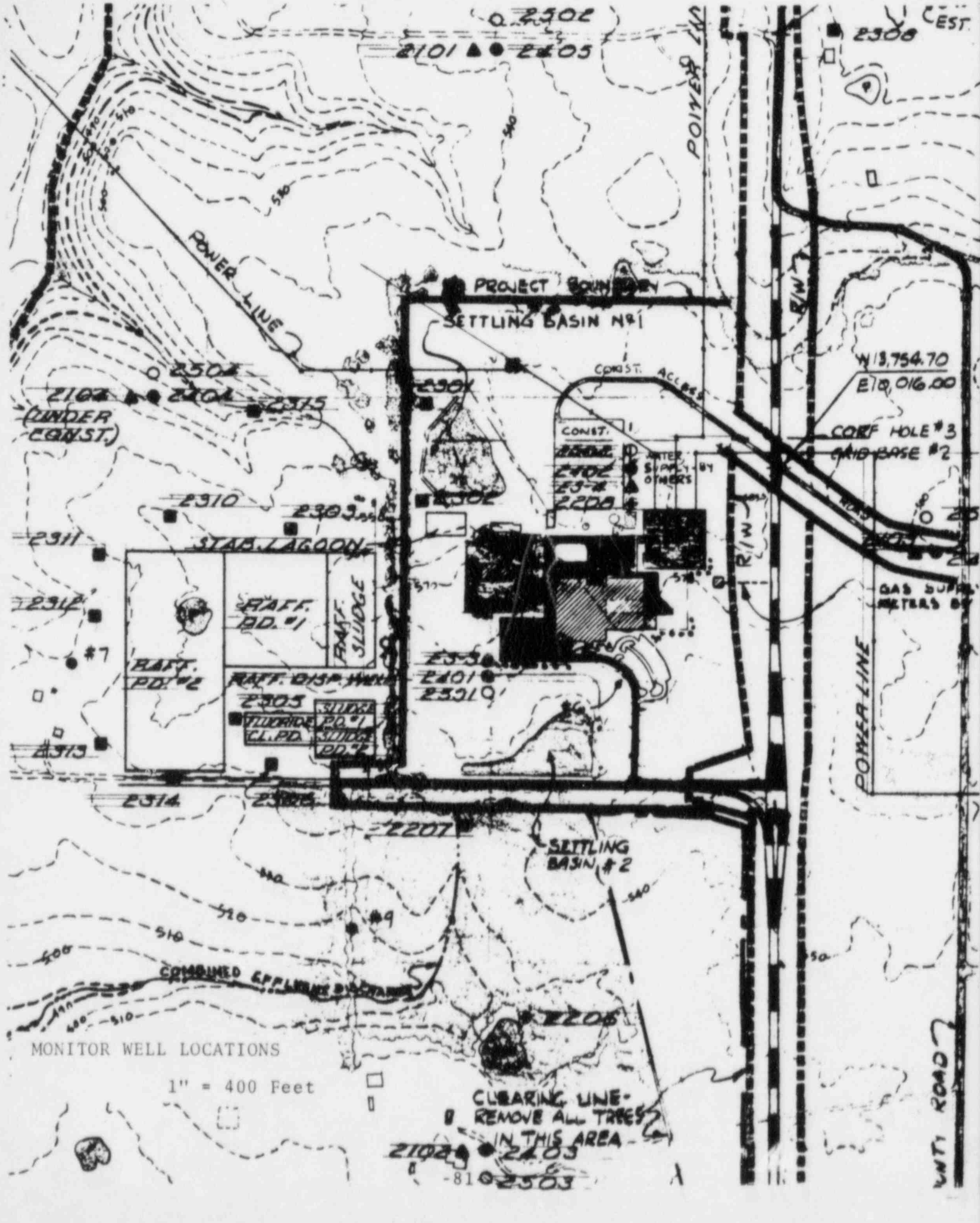

15+00
14+00
13+00
12+00
11+00
= Core Boring Location
= Monitor wells
#18W
12+05W
10.55 N
Sandstone Disposal Area
Common Excavation Stock Pile
Base Line
#17W
12+03W
7.44 N
2311
A
Top of Dike Elev. +528
13+45W
6.05N
48"⌀ Pipe
Spillway Dike
Wash
#10 W
2312
B
C.H. 7
#15W
13+47W
4.05 N
Base Line
Sandstone Disposal Area
C
#14-W
12+50W
1.13 N
2313
Top of Levee +552
Volume Curve
Raffinate Pond #2
Surface Elevation (FT)
+551
+547
+543
+539
+535
0
4,000,000
8,000,000
12,000,000
16,000,000
Liquid Volume (Gallons)



SEQUOYAH FACILITY
GENERAL LOCATION PLAN
WASTE DISPOSAL POND AREA
7/30/71 1" = 100 FT

FILE M-375

8512200203-02



MONITOR WELL LOCATIONS

1" = 400 Feet

employed by soil engineers, demonstrating essentially no permeability to raffinate fluids exists as shown on the attached report by Hemphill Drilling Co.

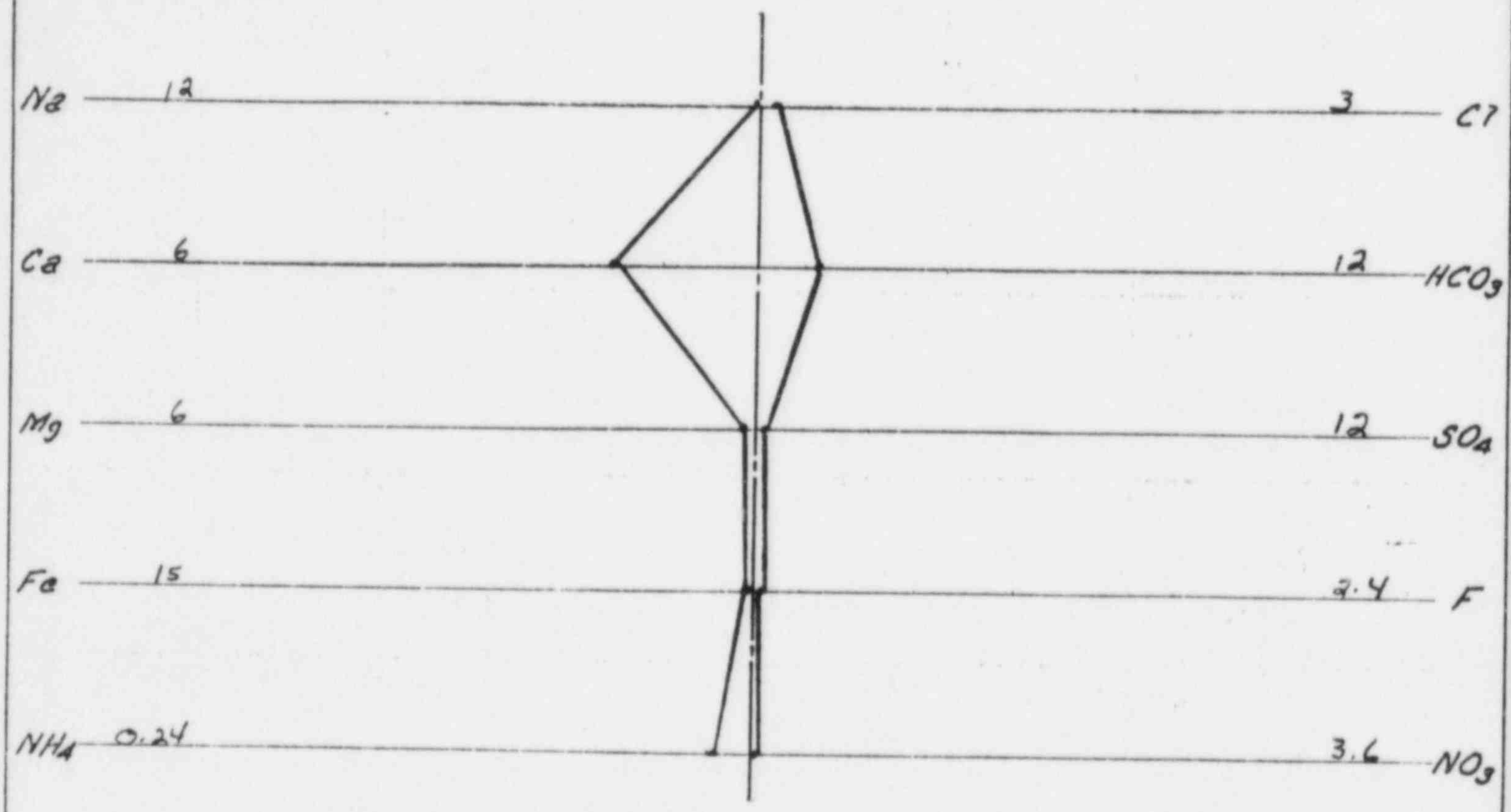
Monitoring Well Analysis

In an effort to determine if raffinate solutions have migrated into ground water entering monitoring wells, a "pattern analysis" was performed of monitoring well and raffinate pond contents. The use of these analyses is described in "The Interpretation of Water Analysis by Means of Patterns", Petroleum Transactions, AIME, Volume 192, 1951. These analyses are shown on the attached graphs*and were made on samples taken in October 1972. The first graph, labeled raw water and combination stream, demonstrates the relation of the two analyses from essentially the same water. It should be noted that the calcium level of the combination stream and the bicarbonate level has increased slightly as has the ammonium and nitrate above incoming raw water. The next graph, labeled 2301 and 2315, is samples taken from the well north of the No. 1 retention basin shown on page 54 of the Supplementary Environmental Report. 2315 is located downslope from that and it is conceivable that ground water would progress from 2301 to 2315. As can be seen by the comparison of the patterns, it is reasonable to conclude that except for additional dilution such migration has occurred. The third graph shows 2308 which is the residence well to the northeast of the plant which may be considered as typical Atoka formation water but may contain a slightly increased amount of sodium chloride than water taken from higher in the structure. Patterns from 2311 through 2314 are prepared from well samples taken immediately around the No. 2 raffinate pond.

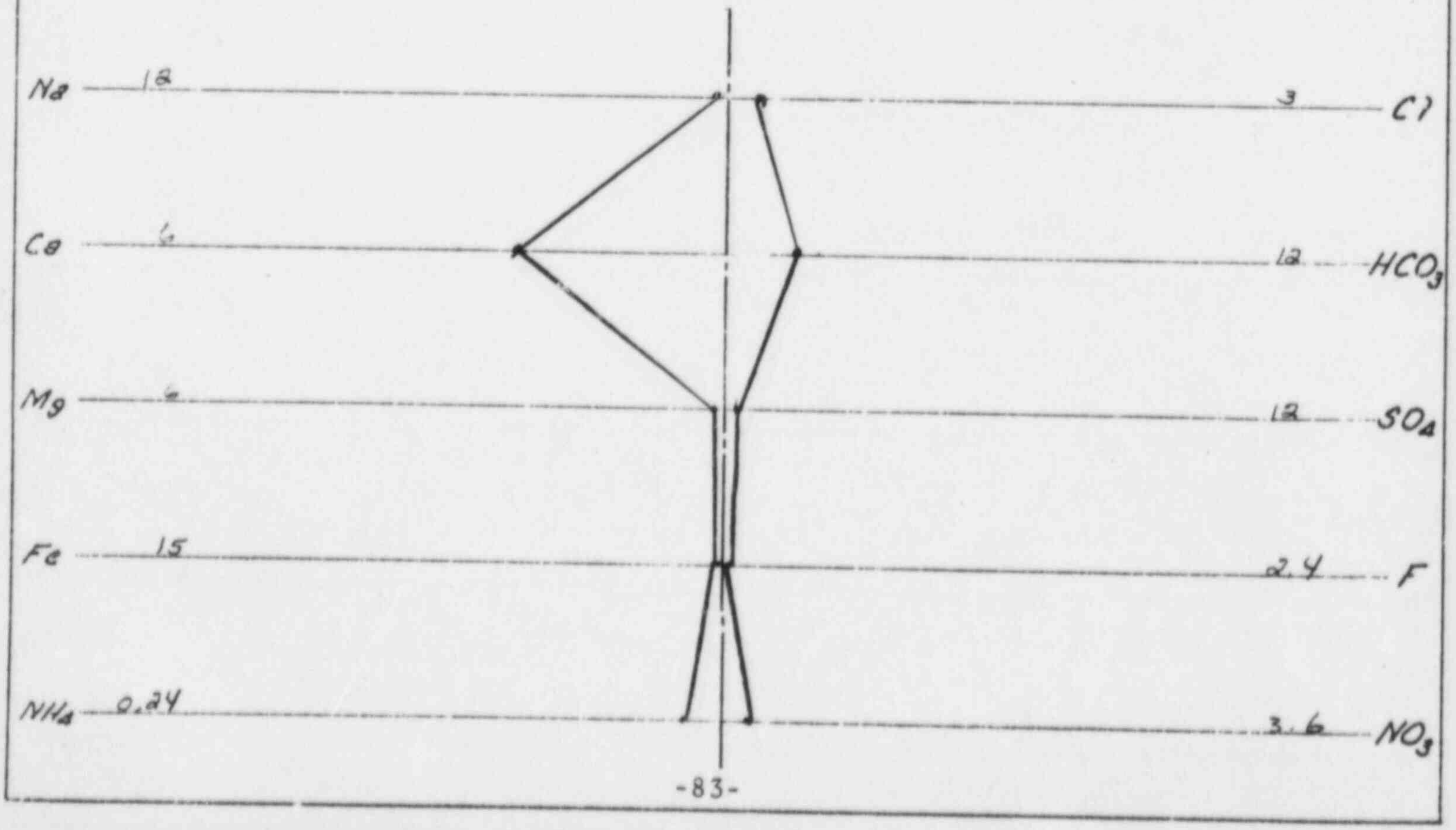
In studying these patterns resulting from these analyses, one is first struck by the relation between calcium and sodium ion as it appears in the wells as contrasted to the relation

*Horizontal axis shows miligram equivalents/liter of ion of interest.

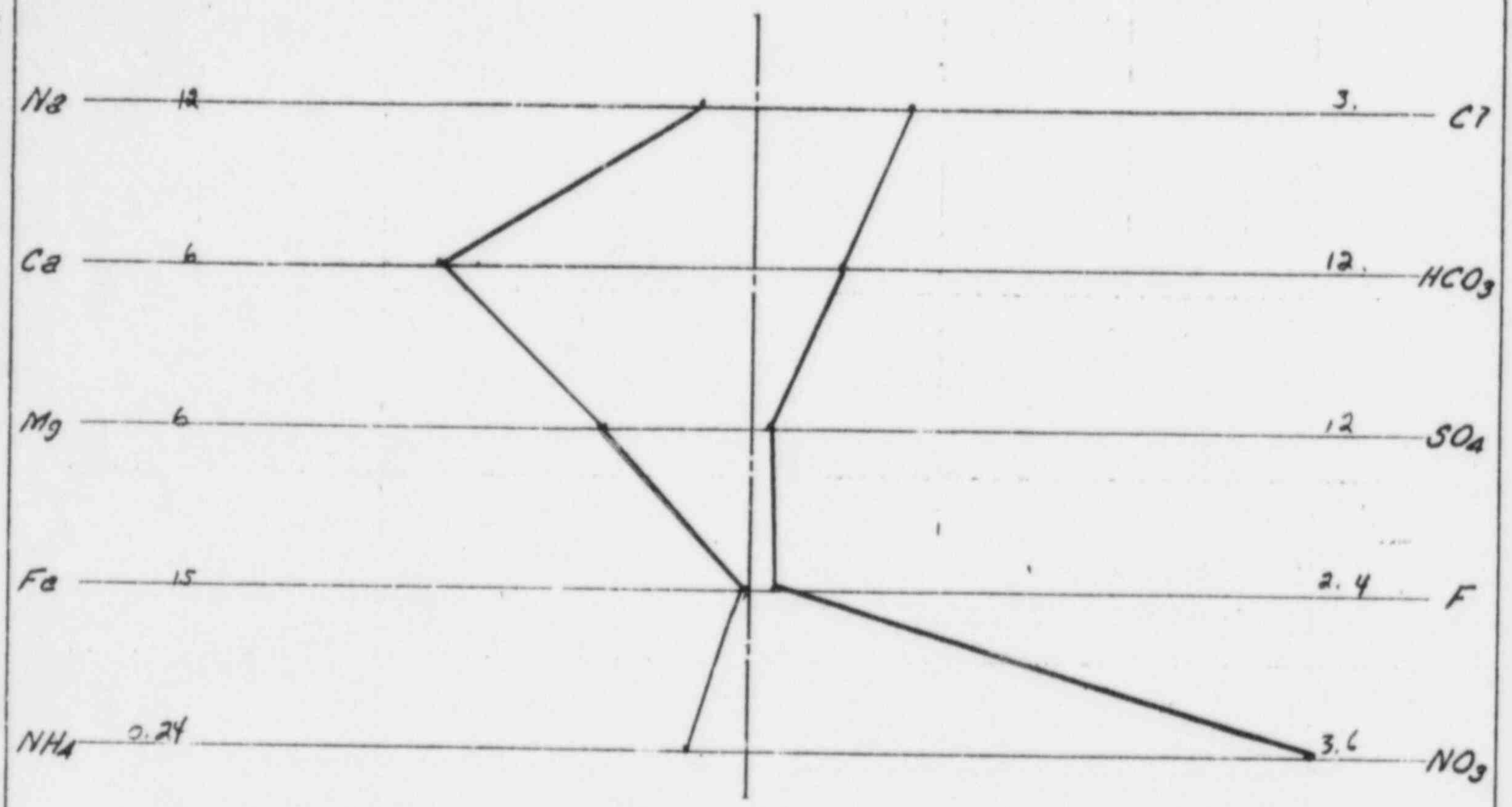
NINE MONTHS RAW WATER



NINE MONTHS COMB. STR.



2301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Mg
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Fe
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3.
Cl
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HCO3
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SO4
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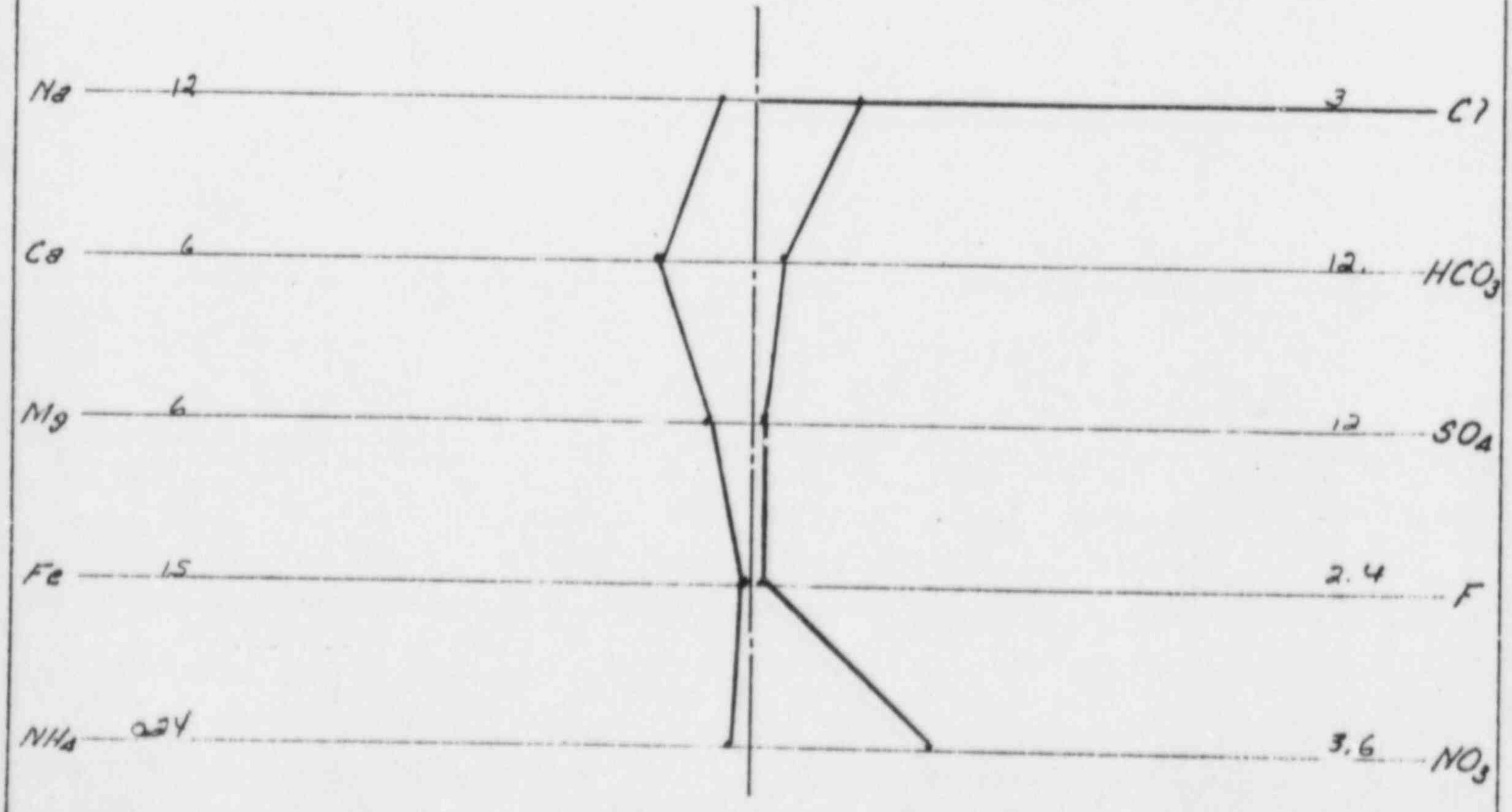
F
3.6
NO3

2315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Mg
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Cl
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HCO3
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SO4
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F
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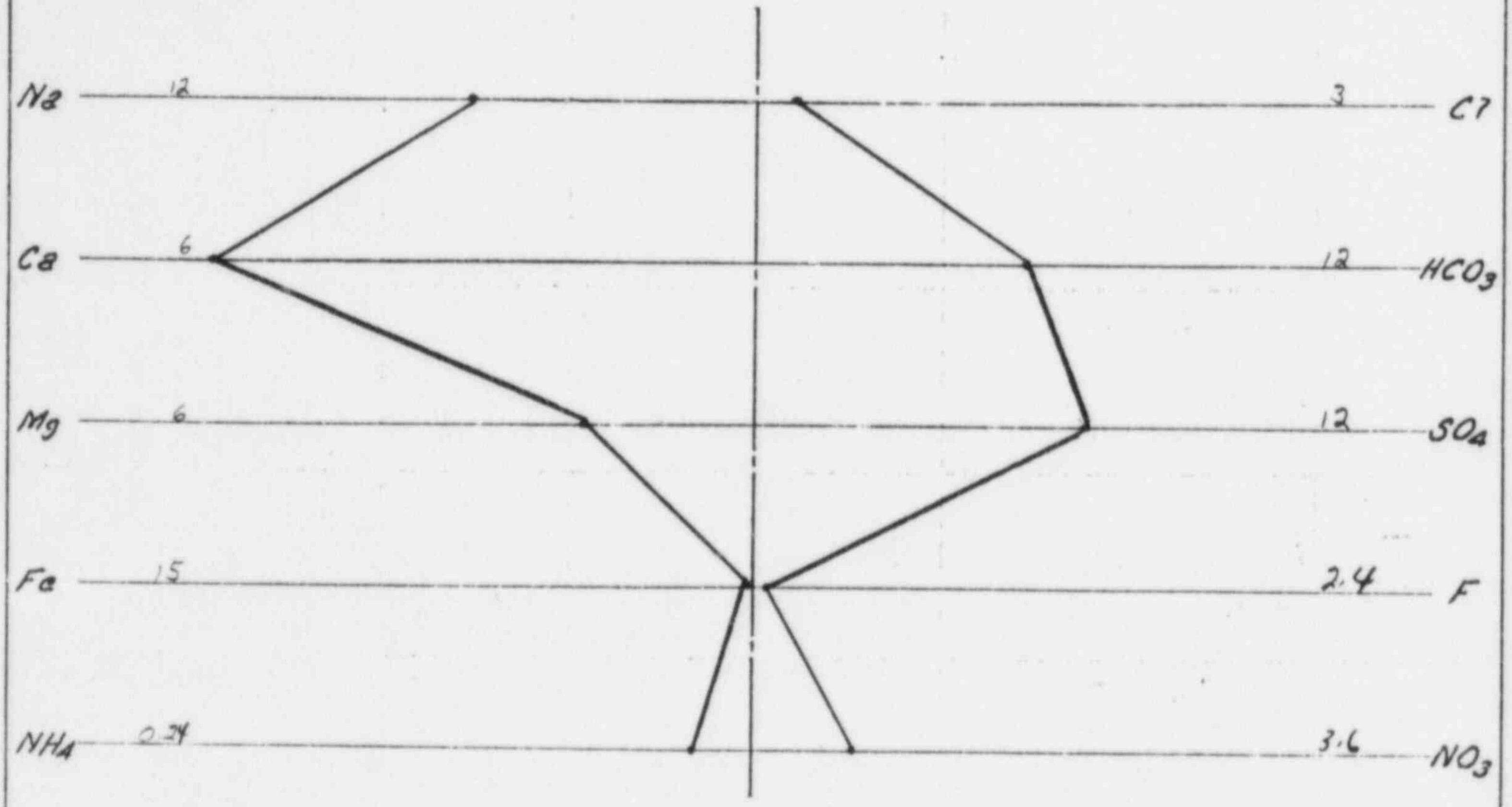
NO3

2303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Mg
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Fe
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Cl
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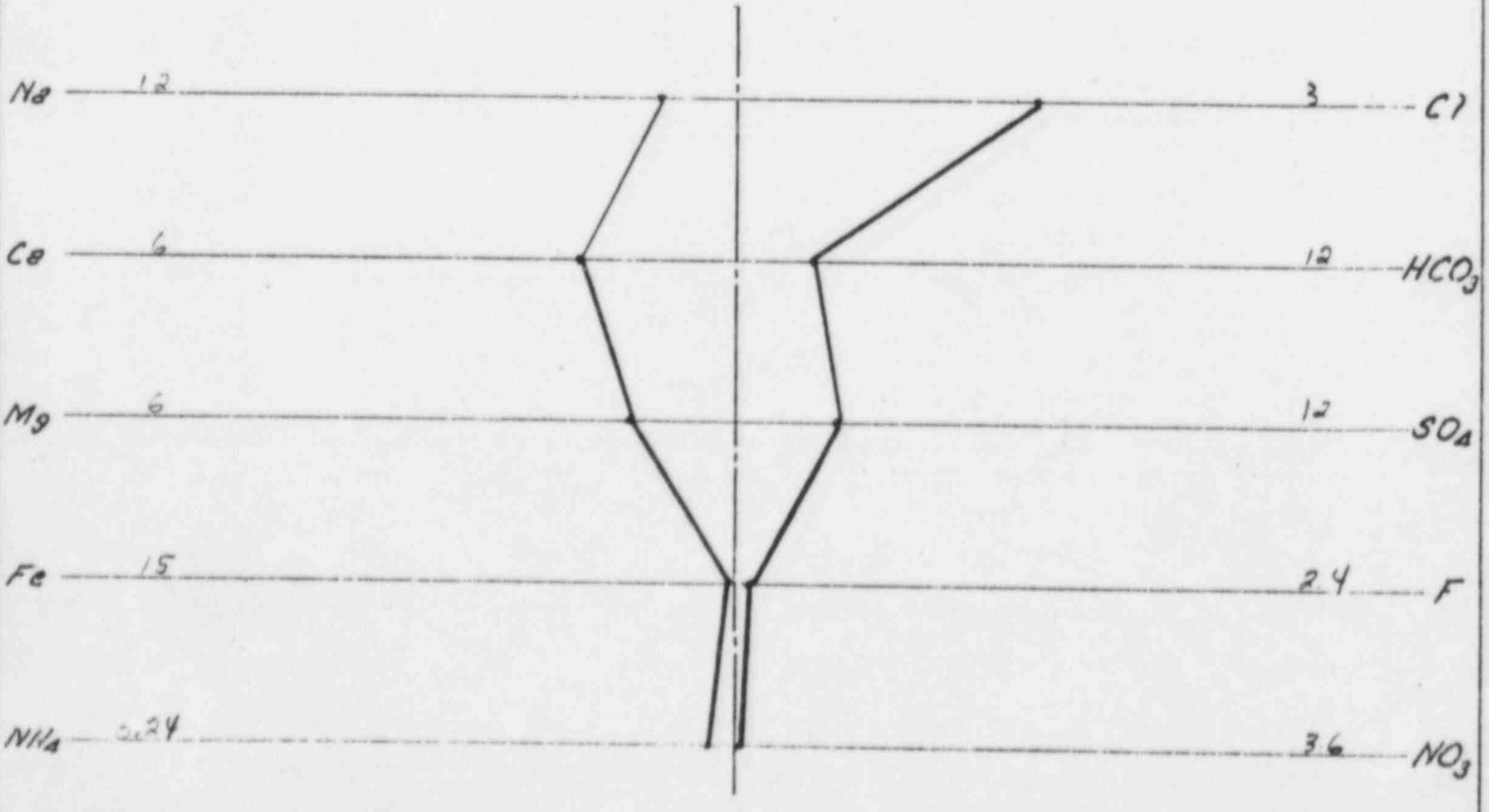
HCO_3
12
SO_4
2.4
F
3.6
NO_3

2308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Mg
6
Fe
15
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3
Cl
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HCO_3
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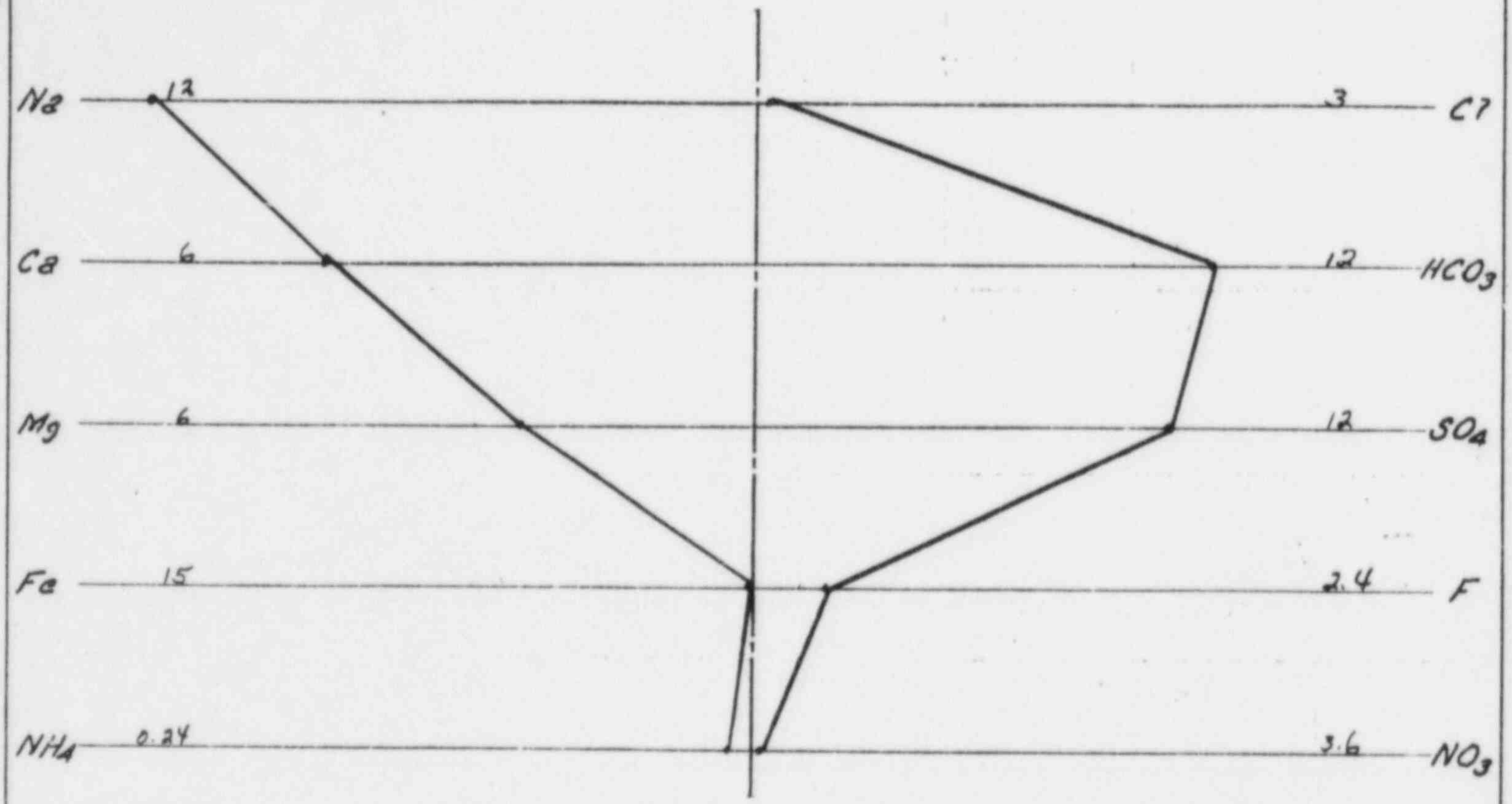
SO_4
2.4
F
3.6
NO_3

2311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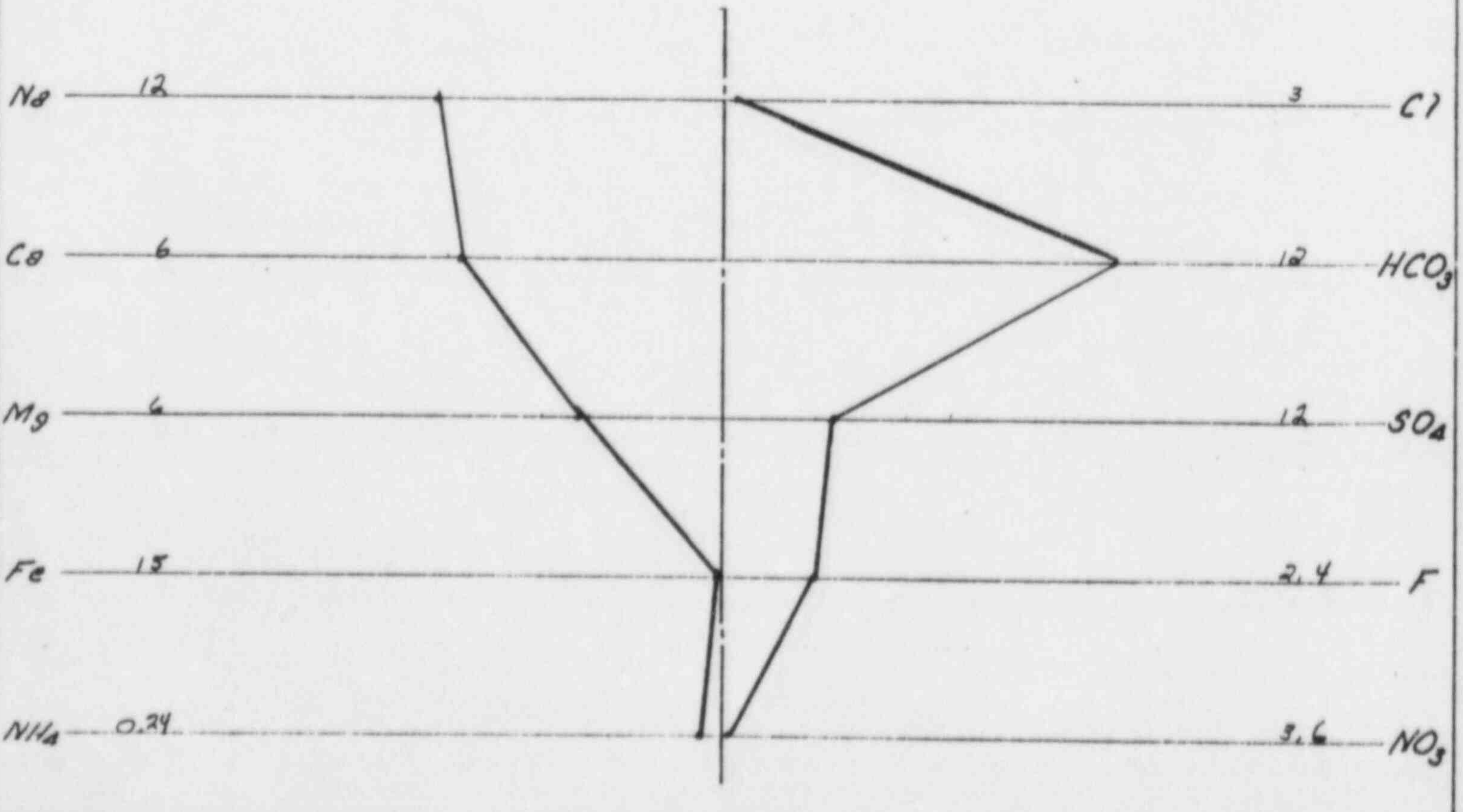
3
Cl
Ca
6
12
HCO3
Mg
6
12
SO4
Fe
15
2.4
F
NH4
0.24
3.6
NO3

2312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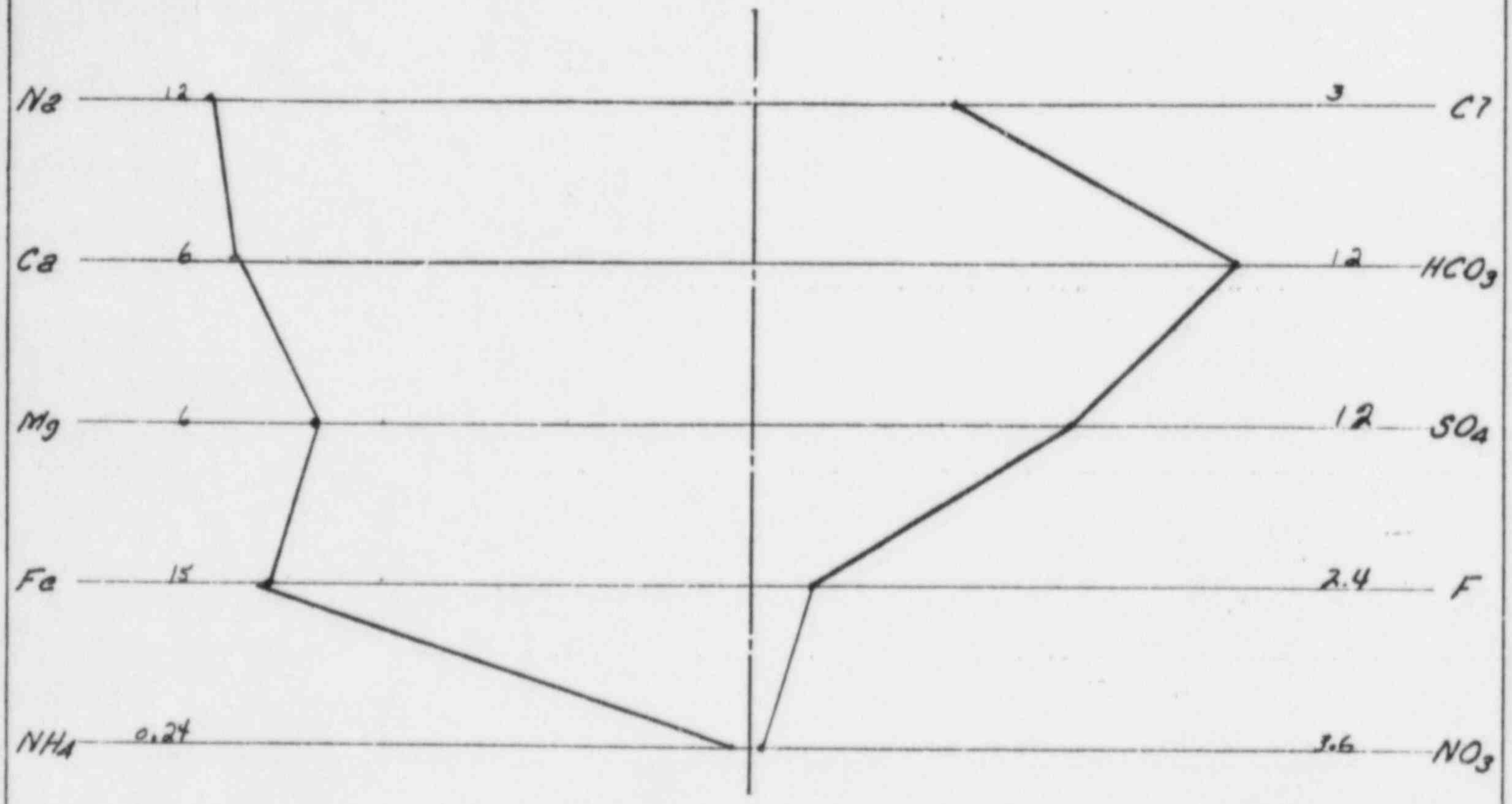
3.6
NO3

2313



Na
12
3
Cl
Ca
6
12
HCO$_3$
Mg
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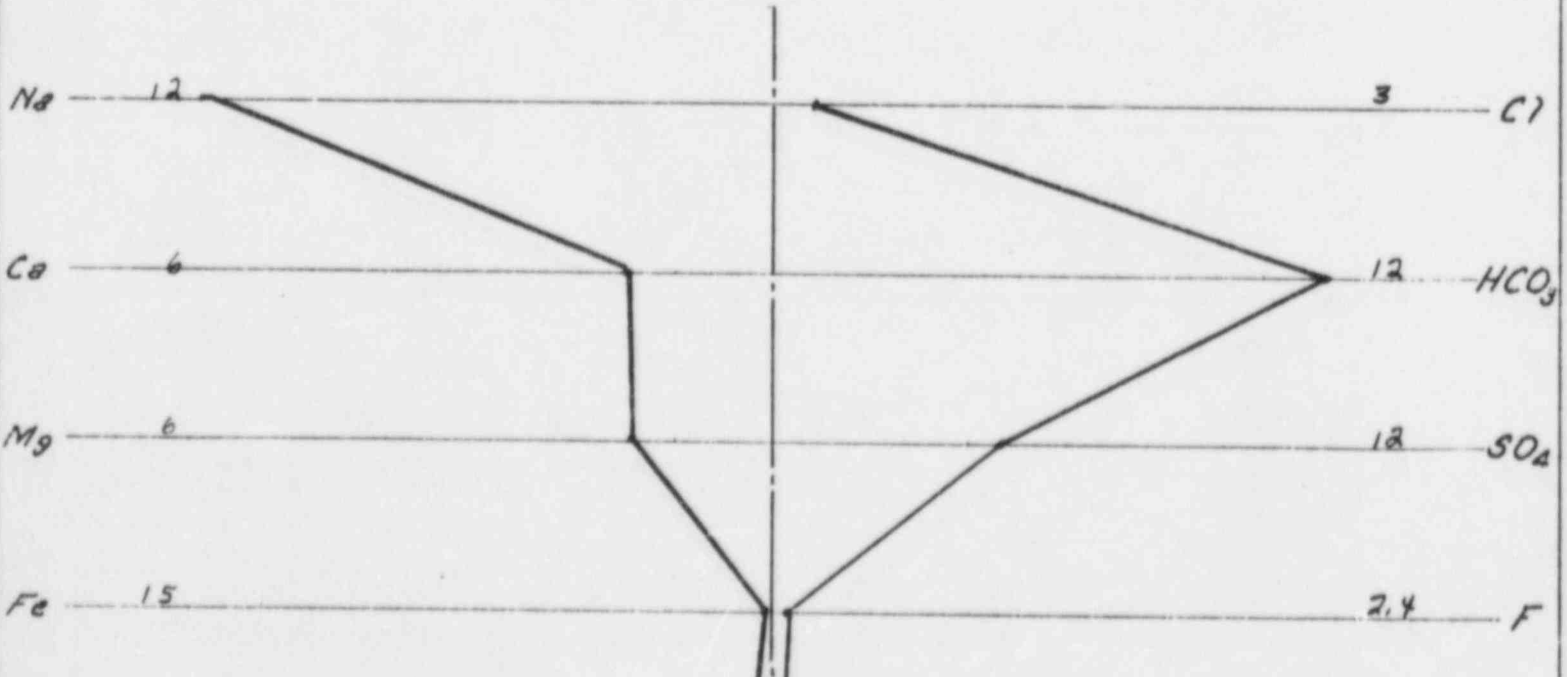
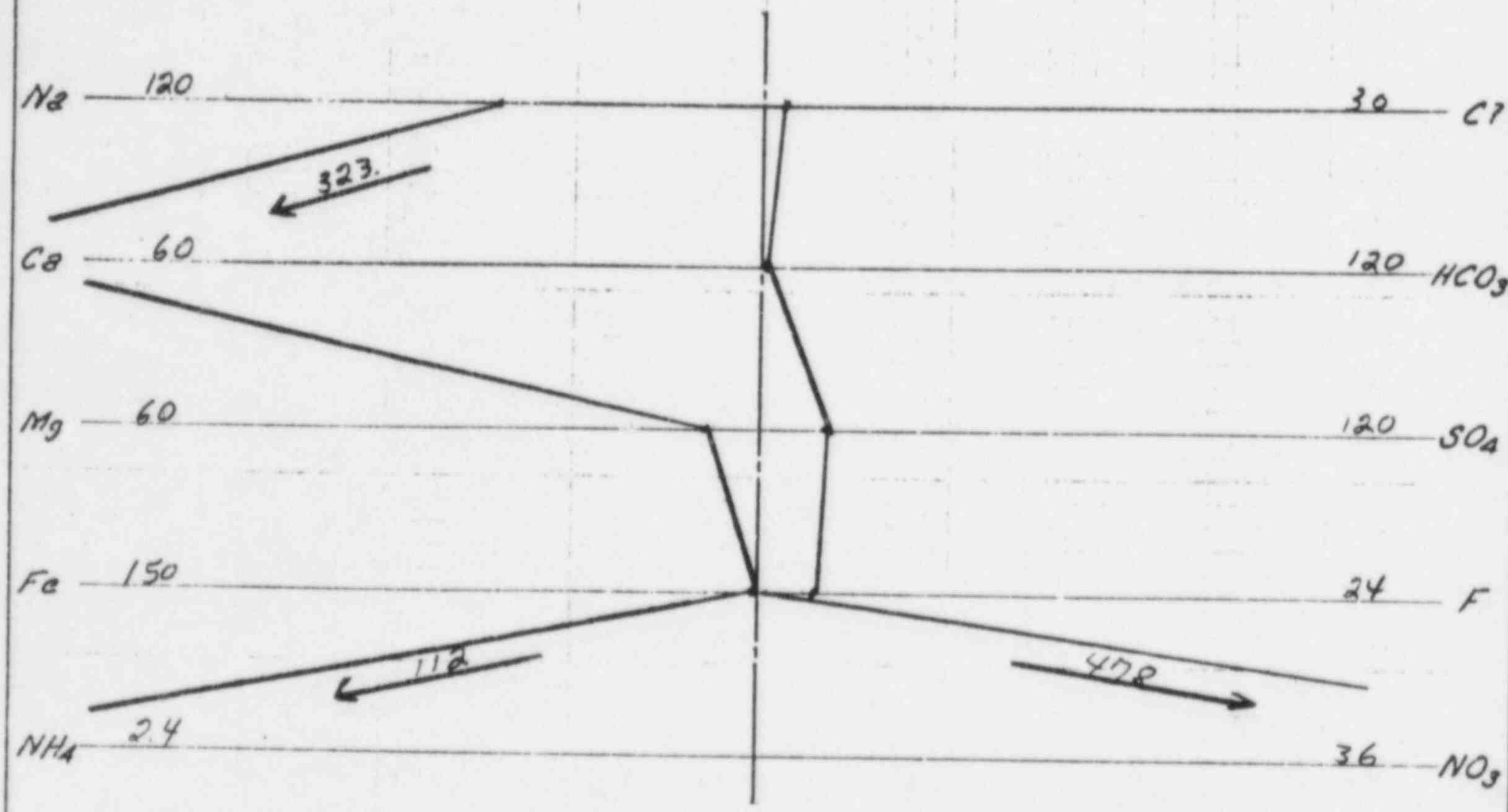
12
SO$_4$
Fe
15
2.4
F
NH$_4$
0.24
3.6
NO$_3$

2314



Na
12
3
Cl
Ca
6
12
HCO$_3$
Mg
6
12
SO$_4$
Fe
15
2.4
F
NH$_4$
0.24
3.6
NO$_3$

#1 RAFF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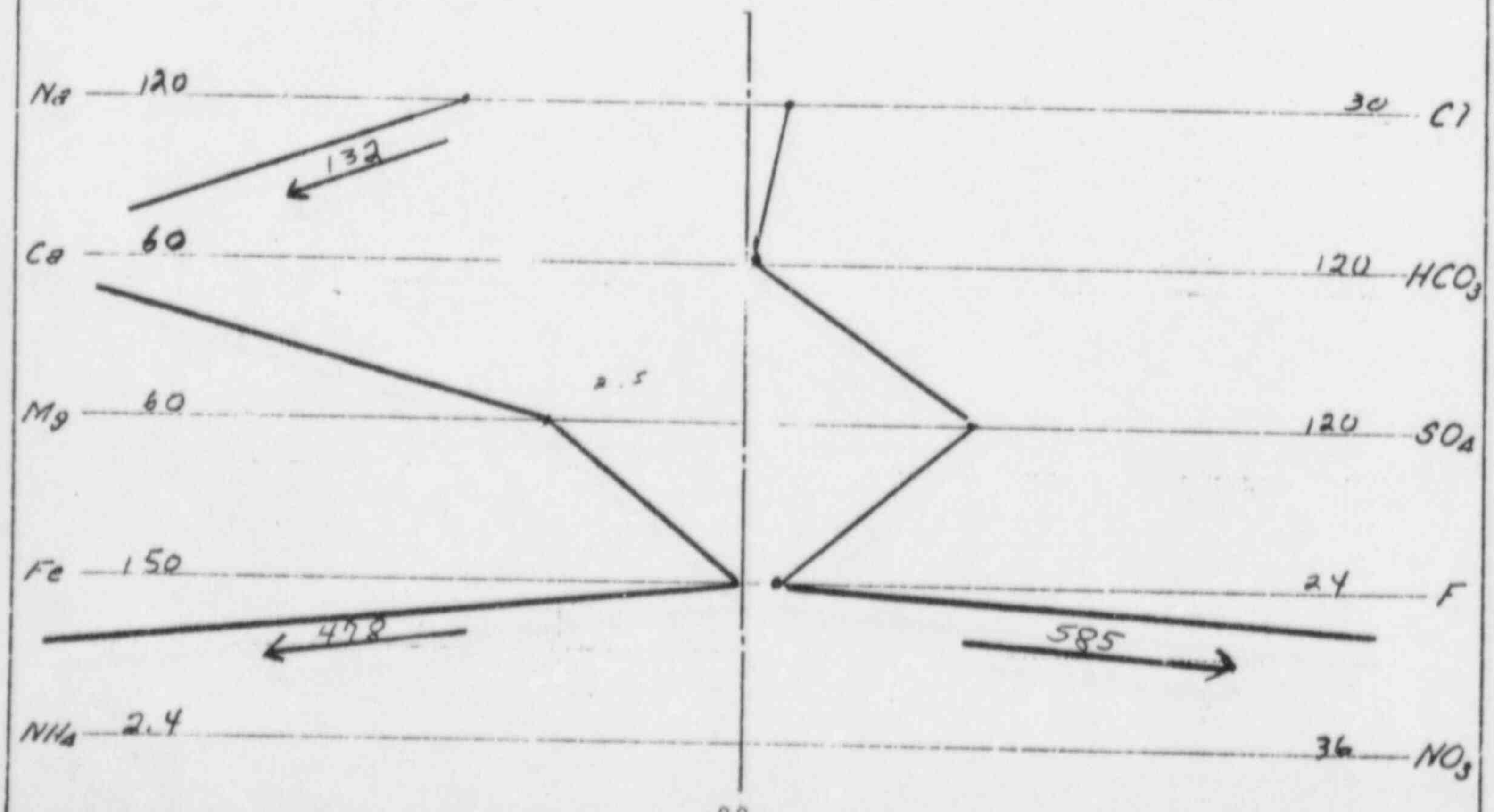
Ca
60
Mg
60
Fe
150
NH_4
2.4
323.
112
Cl
30
HCO_3
120
SO_4
120
F
24
NO_3
36
478

#2 RAFF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Mg
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Fe
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Cl
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HCO_3
120
SO_4
120
F
24
NO_3
36
585

appearing in the ponds. In the wells, the ratio of sodium to calcium is approximately 2/1 with the exception of 2304 and 2314 where they appear to be 1/1 and 6/1, respectively, while the raffinate solutions have the reverse ratio of 1/5 and 1/2.

The same anomaly exists in the levels of bicarbonate and sulfate appearing in the well waters as compared to low concentrations in the raffinate pond. Bicarbonate seems to be a major component in the case of the wells with the exception of 2303 while, in the raffinate solutions, it is not present. The most outstanding absence in the wells is the absence of either ammonium ion or nitrate ion which are present in high concentrations in the raffinate solutions. It has been argued by some that ammonium ion absorption would occur in passage through the soils; but, since most nitrates are soluble, it would seem apparent that, if the ammonium ion was trapped, another balancing ion would replace it, such as calcium. From study of these patterns, it is concluded that no contamination of the wells has resulted by seepage of material from the raffinate pits into the ground water.

In the monitor wells, themselves, no single source of ground water is apparent, which is typical of Atoka formation water. Most ground water in such a formation is in pockets and noncommunicating layers rather than any contiguous interconnected field.

In the monitor well results shown under paragraph 11, the most probable ground water contamination occurs in Well No. 1, sample 2301, which is located immediately to the north of settling basin No. 1 shown on page 54 of the Supplementary Environmental Report. Previous and continued contamination of this well led us to examine the probable cause of such contamination.

When the deep disposal well was first disapproved, it was necessary to provide temporary holding capcity for raffinate. This was provided by the use of settling basin No. 1 while the first two raffinate ponds were being constructed. Upon the completion of the raffinate ponds in 1971, holding basin No. 1 was pumped to the raffinate sludge pond which overflows to raffinate pond No. 1. Subsequently, the dike at the east end of the settling pond was constructed so that the settling pond could be used in an emergency and to prevent any washing of sediment into the watercourse. When the dike was constructed, it was located too far to the west to include the soil covered by the level of liquid reached when the settling pond was originally used. As a consequence, measurable amounts of raffinate materials exist to the east of the new dike. Also, the dike provided a barrier to surface water draining to the west. It has been noticed that surface water collects against the dike and, when reaching a high enough level, flows to the north around the end of the dike and directly into monitoring well No. 1. Upon this discovery, an additional wing was added (August 1972) to the north end of the dike so that this material would be held and, as it collects, it is pumped to the raffinate pond or into the combination stream, as appropriate, depending upon the uranium and nitrate concentrations contained. Subsequent to the installation of this new wing to the dike, September and October analyses demonstrate very low levels of uranium and nitrate content in Well No. 1.

Conclusion

As a result of these detailed examinations, we believe that the integrity of the raffinate ponds has been demonstrated. It is concluded that any contamination appearing in the monitor wells is incidental to surface contamination and, at current low levels of airborne release, a substantial reduction in contamination in all future analyses will be observed.

ELMER L. HEMPHILL
Res. (918) 587-5822
CLARENCE A. HEMPHILL
Res. (918) 836-1925

hemphill
DRILLING COMPANY
4834 South 83rd East Ave. • Tulsa, Oklahoma 74145

OFFICE — (918) 622-5133

ENGINEERS
GEOLOGISTS
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CONSULTING ENGINEERING • GEOLOGICAL INVESTIGATION • ENGINEERING INSPECTION • SOILS MECHANICS • CONCRETE TESTING • ASPHALT TESTING • METAL TESTING • CONTRACT DRILLING • WATER WELL CONSTRUCTION • BARGE DRILLING • PRESSURE GROUTING

January 11, 1973

Tom S. Moore
Kerr - McGee Corporation
Kerr - McGee Bldg.
Room 521
Oklahoma City, Okla. 73102

Re: Permeability Tests
Kerr - McGee
Sequoyah Facility
Gore, Oklahoma

Gentlemen:

The soils testing requested by Mr. Tom S. Moore for the subject site has been completed. Five (5) soil samples from two retention ponds were tested for permeability characteristics when exposed to certain solutions from the Gore Plant. All test data is attached.

The permeability test specimens were recompacted to optimum moisture and maximum density as shown in the test results. A pressure of 5 psi was applied to the test specimen as a constant head. The samples tested, material source, and the respective solution used for the test are listed below in Table 1.

TABLE 1

TEST SPECIMEN DATA

SAMPLE NO.	MATERIAL SOURCE	SOLUTION USED
1	Pond 2	Tap Water
2	Pond 2	Raffinate from Pond 2
3	Pond 2	Raffinate (fresh)
4	Pond 1	Raffinate (fresh)
5	Pond 1	Raffinate from Pond 1

The permeability test results are shown in Table 2.

TABLE 2

PERMEABILITY TEST RESULTS

SAMPLE NO.	DEPTH (Inc.)	MATERIAL SOURCE	SOLUTION	PERMEABILITY COEFFICIENT GPD/sq/ft.
1	3-9	Pond 1	Tap Water	Impermeable
2	3-9	Pond 2	Raffinate from Pond 2	Impermeable
3	3-9	Pond 2	Raffinate (fresh)	Impermeable
4	3-9	Pond 1	Raffinate (fresh)	Impermeable
5	3-9	Pond 1	Raffinate from Pond 1	Impermeable

Since all samples tested indicate an impermeable soil, it appears the variation of a fresh or non-fresh solution of Raffinate causes no difference in the permeability of the soils.

If you have any questions please feel free to call.

Very truly yours,

HEMPHILL DRILLING COMPANY

Jerry D Shepherd

Jerry D. Shepherd, PE
Consulting Engineer

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1 File