INTER-OFFICE MEMORANDUM

To: F. J. Haydel and R. L. Alboucq - Mead
A. H. Scott - Mead
R. L. Humphrey - 677 OB
TIC - Library - CFT
R. O. Gunderson - 664 OB
J. B. Todd - 676 OB
Environmental Control - KC 762

Date: May 2, 1978
From: W. B. Eastman
At: Mead
Subject: See Attached Report

Attached please find completed report on the Phase I investigation of, "Effect of Waste Disposal Practices on Ground-Water Quality at Kaiser Aluminum & Chemical Corporation, Mead, Washington", April 14, 1978.

Phase II of this investigation has been initiated.

If you have any questions regarding this report, please feel free to contact me.

WBE:eb
att.

CONTENTS

ILLUSTRATIONS

EFFECT OF WASTE DISPOSAL PRACTICES ON GROUND-WATER QUALITY At KAISER ALUMINUM & CHEMICAL CORPORATION Mead, Washington

December, 1977

SUMMARY

This report addresses the solid waste disposal practices of Kaiser Aluminum & Chemical Company, Mead, in relation to the possible effect on the aquifer underlying the plant site.

Two principal questions are involved:

1. Are pollutants entering the aquifer? *yes but not quantified*
2. If so, are the concentrations sufficient to pose as potential health hazard? *questionable.* *moot.*

This study shows evidence that several potentially hazardous constituents, present in the disposal sites, have migrated into the soil column and are present in the aquifer. The true concentrations in the soil columns are not evaluated by the methods employed.

One water sample from one well (Production Well 3) showed cyanide concentration of 0.06 mg/l. Numerous subsequent samples showed cyanide concentration of 0.01 or less.

★★ *Micro-gram M/g*

All other water quality data from the plant production wells meets all U.S.P.H.S. and E.P.A. criteria. Water from the uppermost part of the same aquifer, as penetrated by two test wells, show fluoride above the recommended limits. The sulfate ion concentration approaches these limits. Compared to earlier analyses, sulfate and nitrate concentrations have definitely increased, however, this increase may be from an overall increase throughout the aquifer. Concentrations of other constituents may have also increased, but no comparative data is available.

The variation in concentration of all of these pollutants as seen among Test Hole 1 and 2, the plant production wells and the south plant wells may be due to:

a) variation in solubility, dilution and dispersion

b) anisotropy in the aquifer

c) the geographic position of these points in relation to the ground water gradient.

It is certainly possible, and perhaps likely that concentrations greater than those measured are present elsewhere in the aquifer. The possibility of migrations of these pollutants into the water supplies of other users such as the Town of Mead, the State Fish Hatchery, the Golf Course and other private and public water supplies is real but undefined. It is also likely that without modification of disposal practices, concentrations of these pollutants will continue to increase with time.

This report recommends methods to reduce the mobilization of pollutants, and further investigation to define the distribution of concentration of these pollutants.

INTRODUCTION

Robinson & Noble, Inc. was retained by Kaiser Aluminum to investigate the effect of solid waste disposal practices on the aquifer at their facility near Mead, Washington. In particular, there are two sites judged to be potential sources of contaminants.

The largest site is the wet scrubber sludge pit, an area approximately 10 acres in size at the northeast corner of the plant. This area was used for disposal by-products from the wet scrubbers from 1952 to 1975. It is no longer used for this purpose but is used to receive effluent from the sewage treatment plant. At the east end of the impoundment, a 10-foot thickness of the spoil materials can be observed. The by-products present in this disposal area are reported to be calcium sulfate and calcium fluoride. Fluoride and sulfate are both potential sources of contamination to ground water. Increased concentrations of calcium caused by leaching from the disposal area would not be considered particularly hazardous.

The smaller of the two sites is the pot-lining disposal area. This area continues to be used for disposal of pot brick and other scrap material. Chemical constituents in the material disposed in this area includes C, Al_2O_3, NaOH, Na_2CO_3, Fe, Al_2N_2, F and CN.

Any leachate containing cyanide or fluoride that entered the ground water system would be considered hazardous. Other leachate containing concentrations of Fe, Al, Na or other elements within this disposal area would be more of a nuisance than actually harmful to health.

GEOLOGIC-HYDROLOGIC SETTING

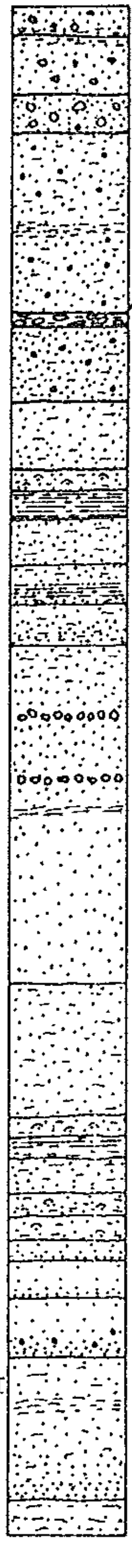
The disposal sites are both located immediately north of the Kaiser facility, which is situated on a broad alluvial plateau, drained by the Little Spokane River. The hydrologic gradient across the site is northwest of the Little Spokane River. There is no specific information on local definition of the gradient in the area of the plant.

Climate of this area is semi-arid, with 15 to 20 inches of precipitation per year. Below freezing temperatures prevail from December through February, which is also the period of maximum precipitation. Effective precipitation (precipitation minus evapotranspiration) is available for infiltration from October through March.

The geologic section at the plant site is represented by a succession of fluvial and fluvial-lacustrian sediments to a depth of approximately 500 feet. The upper 50 feet of these sediments are exposed to the south of the plant in the Cunningham Gravel Pit. Here, large scale features of cross-bedding and channelization can be observed. The uppermost 200 feet of the sediments are poorly to moderately permeable and highly anisotropic. The sediments below 200 feet consist of impermeable clay horizons, and highly permeable sands and gravels. These lower sands and gravels constitute the major aquifer penetrated by the plant production wells. The entire sedimentary sequence overlies granitic basement, which may be locally fractured. Figures 1, 2 and 3 show the generalized subsurface geology.

FIGURE 1

DESCRIPTIVE LOG



0 GROUND SURFACE
3 FT. SILT, SAND AND GRAVEL GRAY WITH ORGANIC MATTER
9 FT. SAND AND GRAVEL, SILTY TO 3 FEET - BROWN 3 FEET TO 9 FEET
13 FT. COARSE SAND AND GRAVEL
32 FT. SAND, SILT AND FINE GRAVEL LIGHT BROWN (VERY SILTY AT 22.5 FEET TO 23 FEET
33 FT. COBBLES AND SILT
41 FT. SAND, GRAVEL AND SILT
48 FT. FINE TO MEDIUM SAND AND SILT
50 FT. MEDIUM TO COARSE SAND AND SILT - CEMENTED
53 FT. CLAY (PLASTIC) AND SAND BROWN
58 FT. FINE TO MEDIUM SAND AND SILT
62 FT. SILT, CLAY AND SAND, YELLOW BROWN DARKER WITH DEPTH
66 FT. FINE TO COARSE SAND AND SILT
70 FT.
78 FT.
80 FT.
101 FT. FINE TO MEDIUM SAND, SILT TAN (CLEANER AND DIRTIER STREAKS AS SHOWN)
115 FT. FINE TO COARSE SAND AND SILT, LIGHT BROWN
117 FT. FINE TO MEDIUM SAND AND SILT, BROWN CEMENTED
119 FT. CLAY AND SILT, BROWN PLASTIC
123 FT. MEDIUM SAND AND SILT, CLEANER AT 123 FEET
125 FT. FINE TO COARSE SAND AND SILT, CEMENTED
128 FT. SILT, FINE TO MEDIUM SAND, CEMENTED
130 FT. MEDIUM TO COARSE SAND - CLEAN
134 FT. FINE TO COARSE SAND AND SILT
140 FT. FINE TO COARSE SAND AND SOME FINE GRAVEL
155 FT. MEDIUM TO COARSE SAND AND SILT, WITH FINE GRAVEL (CLEANER AND SILTY ZONES AS SHOWN)
158.5 FT. FINE TO MEDIUM SAND, AND SILT FLUID

STATIC WATER LEVEL 144.6 FT

TOTAL DEPTH 158.5 FEET

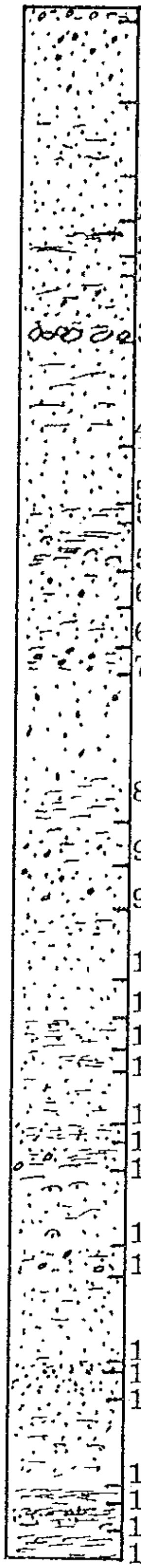
KAISER MEAD PROJECT NO. 177-4
TEST HOLE 1

ROBINSON AND NOBLE 4/13/78

DESCRIPTIVE LOG

FIGURE 2

TEST HOLE #2



	Ground Surface
1.5 ft.	Silt, sand and fine gravel
10	Coarse sand and fine gravel - black-brown
17.5	Silt, medium to coarse sand - tan
22	Medium to coarse sand - black-tan
26	Medium sand with streaks of clay
28	Medium to coarse sand, and granules - clean
	Silt, fine sand, and small pebbles
35	(cobbles at 35 feet)
46	Fine to medium sand and silt - gray-tan
52	Fine to medium sand, gray-tan - clean
54	Silt, sand cemented, light brown
59	Silt, sand, clay cemented
63	Medium to coarse sand, silt and fine gravel
67	Silt, fine to coarse sand & fine gravel - gray
70	Silt and gravel (pebbles) tan
	Fine to coarse sand, fine gravel silt increasing toward 86 feet
86	
90	Silt, fine to coarse sand and gravel - gray
94.5	Medium to coarse sand and pebbles - gray
102	Silt, fine to medium sand, cemented - tan
106	Medium to coarse sand - gray
109.5	Silt and sand, fine to medium - tan-gray
111.5	Fine to medium sand, silt & clay, tan-gray, cemented
117	Fine to medium sand and silt - tan-gray
119	Silt, fine to medium sand
122	Silt, fine to medium sand w/clay & pebbles, cemented
130	Medium sand and silt cemented - light brown
133	Silt, fine to medium sand and fine gravel
141	Medium sand and silt - gray-brown
143	Silt, medium to coarse sand - dark gray
146	Medium to coarse sand, green, clean, water-bearing
	Medium to coarse sand and silt, water-bearing fluid (some cemented layers)
155	
157	Clay, silt gray-blue - plastic
160	Clay, silt, with sand
163ft.	Clay, gray - plastic

Static Water Level 139.7 ft.

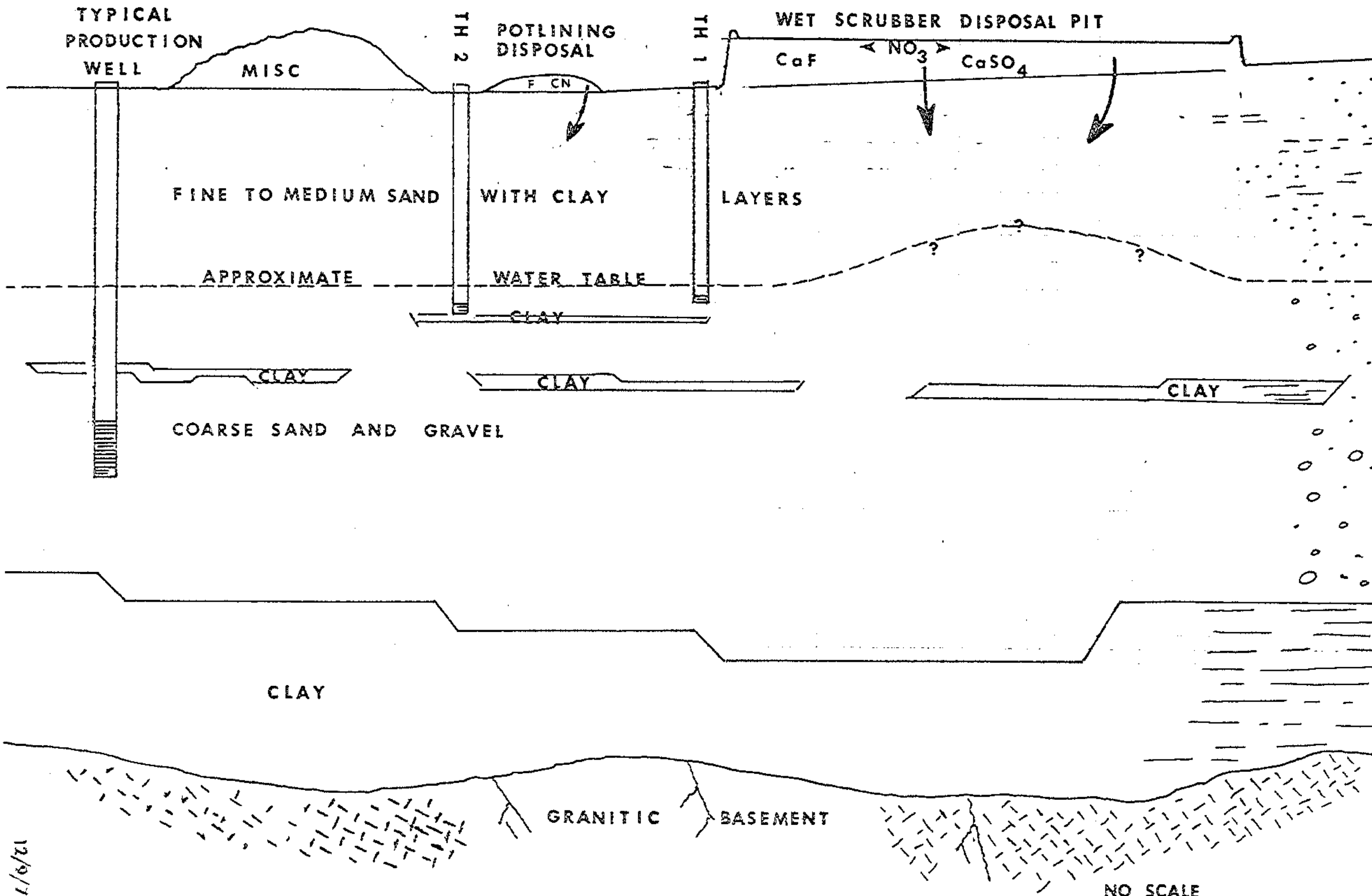
Total Depth 163 ft.

Kaiser Mead

Project No. I77-4

ROBINSON & NOBLE, INCORPORATED
GROUND WATER GEOLOGISTS

SCHEMATIC SECTION



12/9/77

FIGURE 3

The regional water table, below which all materials are saturated, is about 140 feet below land surface. As noted later, there may be very localized perched water tables at shallower depths.

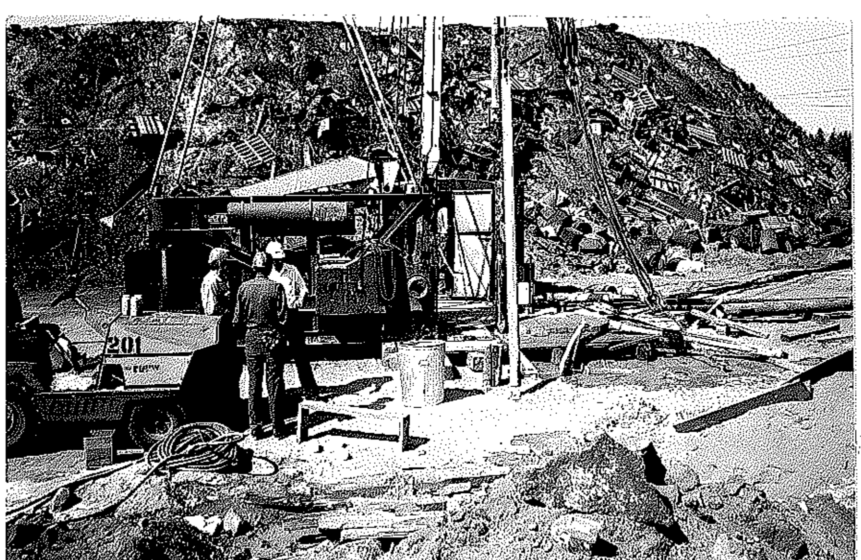
Under natural conditions, excess precipitation percolates through the unsaturated sedimentary materials until it reaches the water table. In passing through the unsaturated soils, the water will tend to dissolve all available chemical constituents be they "natural" or "artificial" and transport them to the water table. The route of the percolating waters is complicated by the anisotropy of the soils. Once the water reaches the water table it moves down-gradient as laminar flow and mixes with the underflow of the aquifer system. This flow, too, may be highly complex as determined by aquifer anisotropy.

The quantity of excess precipitation determines the natural recharge to this type of aquifer. The sewage effluent placed on the abandoned wet-scrubber sludge pit constitutes a definite source of artificial recharge which will form a "mound" on the water table. Natural recharge may occur for only 7 months per year and probably total about 9 inches per year. The artificial recharge is continuous and may constitute as much as 250 inches per year as averaged over the 10-acre site. Thus, the artificial recharge may be 20 to 30 times greater than the natural recharge.

TEST DRILLING PROCEDURES

To examine the possibility that chemical constituents of the waste disposal area might be entering the local aquifer, it was decided that two test holes should be drilled. Test Hole 1 was located near the northwest corner of the wet scrubber sludge pit. Test Hole 2 was located on the northwest side of the pot lining disposal area, between the pot lining and the brick disposal sites.

Holman Drilling Company of Spokane was selected to perform the drilling. Cable tool drilling equipment was used on both test holes. The photos show the rig at TH-2.



Construction was begun at each site by placing a 10-foot x 10-foot crib to a depth of 10 feet below ground surface. Eight-inch casing was then advanced to a depth of 30 feet. Drilling was completed with 6-inch casing in both test holes.

To insure that accurate samples were obtained, a number of unusual drilling techniques were employed. To protect the samples from possible contamination the contractor was not allowed to use any water in the drilling operation. Drilling tools and materials were also cleaned and protected to prevent surficial contamination. Continuous samples were taken with a 5-inch drive-core sampler throughout the full depth of drilling both test holes. Casing was driven with drill stem and jars as the hole was advanced by sample removal. This sampling method has also been used by other researchers on a ground water pollution project in the Spokane Valley.

Sample quality was excellent and recovery was near 100%. Sieve analysis of selected samples are included in Appendix I. The contractor is to be commended for a very professional performance, under unusual drilling circumstances. Drilling was begun on July 20, 1977 and completed on August 23, 1977.

On completion of each test hole, a 5-foot length of Johnson, 6-inch telescope 304ss 10 slot (0.010 inches) well screen was installed. The screens were fitted with a neoprene packer top and closed bottom. The exposed interval in both TH-1 and -2 was from 153 feet to 157 feet below ground surface.

After the screens were exposed, one hundred bailers of water were removed. Each bailer contained approximately 3½ gallons, thus, about 350 gallons was removed from each test hole. Chemical analyses were made of the 1st, 10th and 50th bailers in TH-1 and from the 1st, 10th, 50th and 100th bailer in TH-2. All water samples were collected in plastic containers.

Both test holes were completed by filling the space between the cribbing and the 8-inch casing, and grouting the annulus between the 6-inch and 8-inch casings as the 8-inch casing was withdrawn. A positive surface seal results, and the 6-inch cased test hole remains.

TESTING AND ANALYSIS PROCEDURES

As each core sample was brought from the hole, it was removed from the core barrel and representative portions were sealed in plastic bags. The samples were then taken immediately to the Kaiser Mead Laboratory for analysis. The formation samples were analyzed by selecting 10 grams of sample and mixing with 500 ml of distilled water. This mixture was brought to the threshold of boiling, to dissolve the soluble constituents and was then tested by various methods shown in Appendix II.

Although this method is essentially arbitrary, it is well suited to the purpose of identifying soluble chemical constituents which are present in the soil columns. It is recognized that the measured concentrations probably are not the true ionic concentrations, but rather an indication of their presence.

Analysis of the core samples included:

A. Sieve analysis of selected samples (TH-1).

B. Moisture content of samples at approximately 3-foot intervals (TH-1 and -2).

C. Chemical analysis of samples at approximately 3-foot intervals (TH-1 and -2).

For:

1. pH
2. Sodium

3. Calcium
4. Fluoride
5. Sulfate
6. Nitrate
7. Cyanide *

Two sand samples collected from the Cunningham Sand and Gravel Company pit south of the pit were also analyzed.

Water samples bailed from TH-1 and -2, and pumped from Plant Production Wells 1, 2, 3, 5 and 6, and the two south plant wells were analyzed chemically for Items 1 through 7 as shown above. Water samples were submitted to Kaiser Center for Technology analysis, and the Spokane County Engineers' office for comparison of results. A comparison of these results is shown in Appendix III.

Complete data of the Mead analyses are included in Appendix II (envelope). K.C.F.T. data for cyanide analyses follows cyanide section (Page 19).

A sample of the 10th bailer from TH-1 was submitted to Bennett Chemical Laboratories for analysis. Their initial analyses were discovered to be in error and were subsequently checked and corrected. These results and methodology are included in Appendix III. Bennett's evaluation of cyanide is judged to be artificially high because of the methods employed.

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* Because the concentrations of cyanide were below this limit of detectability of the method, the Mead cyanide data is in error. The K.C.F.T. cyanide data is considered reliable and is used as the basis for all recommendations and conclusions regarding cyanide in this report. The only inconsistency in the K.C.F.T. data in the analysis of TH-1, 10th bailer of .011mg/ml. This analysis was reported and confirmed by K.C.F.T. The source of the inconsistency may have been extraneous, and is therefore not considered significant.

COMPLICATING FACTORS

Several other factors should be recognized before attempting an evaluation of the chemical analyses.

1. The drilling and physical character of the samples in TH-1 and -2 reveal a number of relatively impermeable zones in the section. These silty and clayey layers significantly retard the downward infiltration of water as shown by the relatively high moisture content at these horizons. Mineralogy of the sediment tests is primarily granitic in character. However, in some horizons basaltic rock types predominate. In Test Hole 1, caliche was observed in the samples from a depth of approximately 20 feet to 40 feet. Caliche is a deposit of calcium carbonate deposited as a coating on particles in the capillary zone in arid and semi-arid regions.

2. Discharge from the domestic sewage treatment plant, discharges over the wet scrubber disposal pit after aeration. This discharge is approximately 185,000 gpd and therefore represents a potential infiltration of over 67 million gallons per year. The effect of such infiltration is of significance in analysis of nitrate. The writer observed the full discharge of effluent to be infiltrating into the sludge pit.

3. The temperature of the water bailed from TH-1 was 55°F and 67°F from TH-2. Ground-water temperature is normally about the same as the mean annual temperature. <u>Water</u>

Supply Bulletin 27 reports the mean annual temperature at 50°F, and the average ground-water temperature at 54°F, or 4°F above the mean annual temperature. The temperature in TH-1 is therefore near normal, but the temperature in TH-2 is obviously anamolous. The 67°F was verified with several thermometers and in repeated bailers pulled from the hole. The higher temperature may result from thermal influence of the baking pits.

EVALUATION OF RESULTS

The following discussion considers the results of each laboratory determination. Analytical determination of soil samples and bailed water from Test Holes 1 and 2 are considered, as well as soil samples from Cunningham Pit, and water samples from Production Wells 1, 2, 3, 5 and 6, and South Plant well - east and west.

Moisture Content

Moisture content in TH-1 and -2 is relatively low (less than 5%) throughout most of the section, except for a number of higher zones which correlate with the more impermeable horizons within the section. These impermeable zones retard the migration of infiltrating water and thus create wetter or perched aquifers. TH-1 shows a number of relatively wet zones, whereas TH-2 reveals only two such zones at 52 and 53 feet and 125 to 130 feet. Since the lithologic logs are very similar, the presence of a greater number of moist zones in TH-1 may be a result of greater infiltration from the sewage effluent infiltration over the wet scrubber disposal area near TH-1.

The moisture content below the water tables is 14% to 22% in both test holes, and thus parallels the void ratio in that part of the aquifer. The moisture content of the samples from the Cunningham Pit showed only 0 and 1.8%. This low moisture content is normal for samples from an exposed face during warm weather.

In the soil-sample analyses there is a suggestion of an inverse relationship between moisture content and the concentration of the various tested elements. Apparently, these concentrations are reduced and mobilized in the high moisture to the next lower stratum.

Hydrogen-Ion Concentration (pH)

Analysis of pH for the soil samples fall generally in the range of 7.6 to 7.8. There is some suggestion that the less impermeable zones have a slightly higher pH than the more permeable zones. The lowest soil pH (6.80 and 6.98) was observed in the near-surface samples in TH-2, and is probably a result of extraneous low pH material deposited at that site.

The pH of all water samples analyzed is in the range of 7.6 to 8.12.

Sodium

The high sodium content apparent in the upper 45 feet of TH-2 results from the proximity of available sodium. In TH-2, sodium content decreases rather gradually with depth.

In Test Hole 1, sodium values in soil samples are much more irregular. Analyses show the lowest values below the capillary zone (140 feet) and from 13 feet to 28 feet, and 49 feet to 61 feet. Sodium values below the capillary zone in TH-1 are twice as high as in TH-2. Thus, more sodium has reached the water table near TH-1 than near TH-2, even though the higher concentration source of sodium is closer to TH-2. Greater irregularity of sodium concentration in section TH-1 also indicates more sodium in transit at that location.

Sodium should be highly mobile where solute is available, unless base-exchanged or clay-absorbed. Thus, sewage effluent again is suspect as the transporter for sodium.

Values for sodium in the samples collected at Cunningham Pit are below surface values at the test sites -- indicating decreased surficial contamination at the pit.

Concentration of sodium in the water is higher in TH-1 than in TH-2. Concentration of sodium in the Production Wells 1, 2, 3, 5 and 6 is less than 1/5th of the concentration for water from TH-2. Concentration of sodium in the South Plant Wells is even lower (approximately 4 mg/l in South Plant Wells vs. 5.7 mg/l average in Wells 1, 2, 3, 5 and 6.) This suggests that sodium infiltration either has not penetrated the main aquifer or is diluted by underflow in the lower and more permeable part of the aquifer.

Calcium

Analyses of calcium concentration in soil samples from TH-1 and -2 does not readily correlate with any other data such as moisture content or lithology. The calcium ion is a major cation(+) of these analyses and may result from the presence of caliche.

Caliche is normally present only in the capillary zone and was obvious in TH-1 to a depth of 40 feet, but it may be present throughout the section. Samples from the Cunningham Pit show calcium concentrations in the range of those from TH-1 and -2, which also related to the presence of caliche.

Concentration of calcium in the water bailed from TH-1 is approximately two times as high as the concentration in the Production Wells. Again indicating lack of communication or dilution in the deeper part of the aquifer.

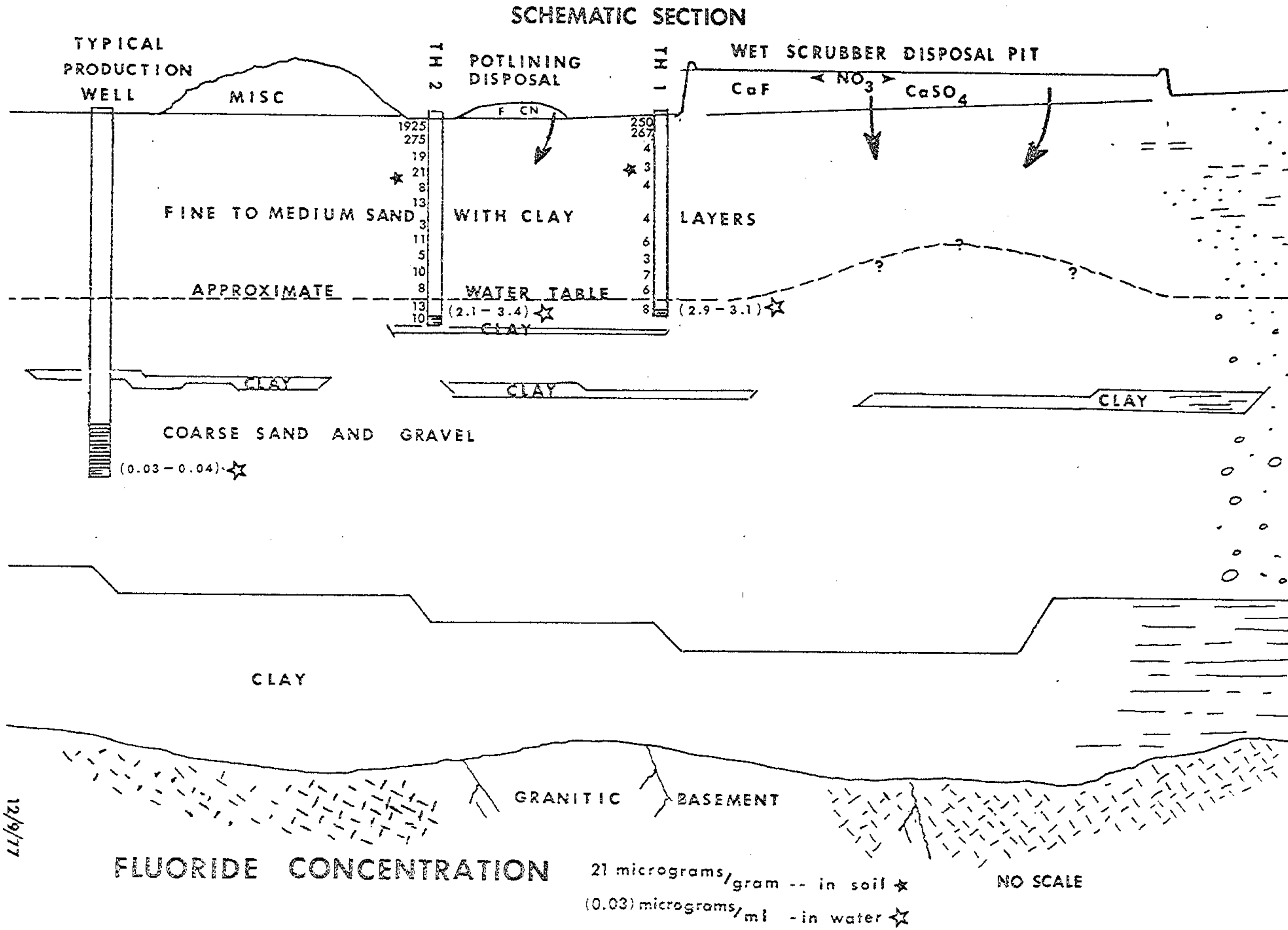
Fluoride

Fluoride concentration in the sediment columns is high in both test holes, particularly near the surface. There is also a suggestion of higher concentration at the less permeable horizons in TH-1. Concentration in the column is greater at the top and bottom particularly in TH-1, indicating a rather rapid migration of high fluoride leachate.

Fluoride concentration in the bailed water from TH-1 and -2 exceeds the E.P.A. limit. Concentration in the production wells, however, is within the allowable limit and again illustrates dilution, lack of direct connection, or a migration pattern away from the production wells.

Washington State Bulletin No.27 reports fluoride in Production Well 6 (26/43-16F2) at .0 mg/l in 1959. Analyses of the present study indicate .03 microgram/ml (mg/l) Kaiser Mead, and .04 microgram/ml (mg/l) Kaiser Center For Technology. This difference from 1959 is within the range attributable to the more accurate analytical methods of this report, and does not necessarily reflect an increase in fluoride concentration. Available analyses from other wells in the aquifer show concentrations of up to 0.2 mg/l fluoride. Therefore, at the Mead site, fluoride migration either has not penetrated the productive part of the aquifer, or concentrations are being effectively reduced by dilution from underflow.

FIGURE 3A



12/9/77

Sulfate

Concentration of sulfate in water bailed from TH-1 and -2 approaches the U.S.P.H.S. limit of 250 mg/1. Concentration of sulfate in water pumped from the plant production wells is less than 1/4th the concentration of water bailed from the test holes. However, concentration of sulfate in plant production wells has increased from earlier analyses.

Plant Production Well	Current SO_4 Concentration	Earlier Concentration	Date
1	19.3 microgram/ml = mg/l	8.8 mg/l	6/8/42
2	40.8 " = "	12.0 "	8/3/42
3	18.0 " = "	9.5 "	8/15/42
6	22.2 " = "	13.	10/22/59

This data clearly indicates that sulfate is entering the aquifer.

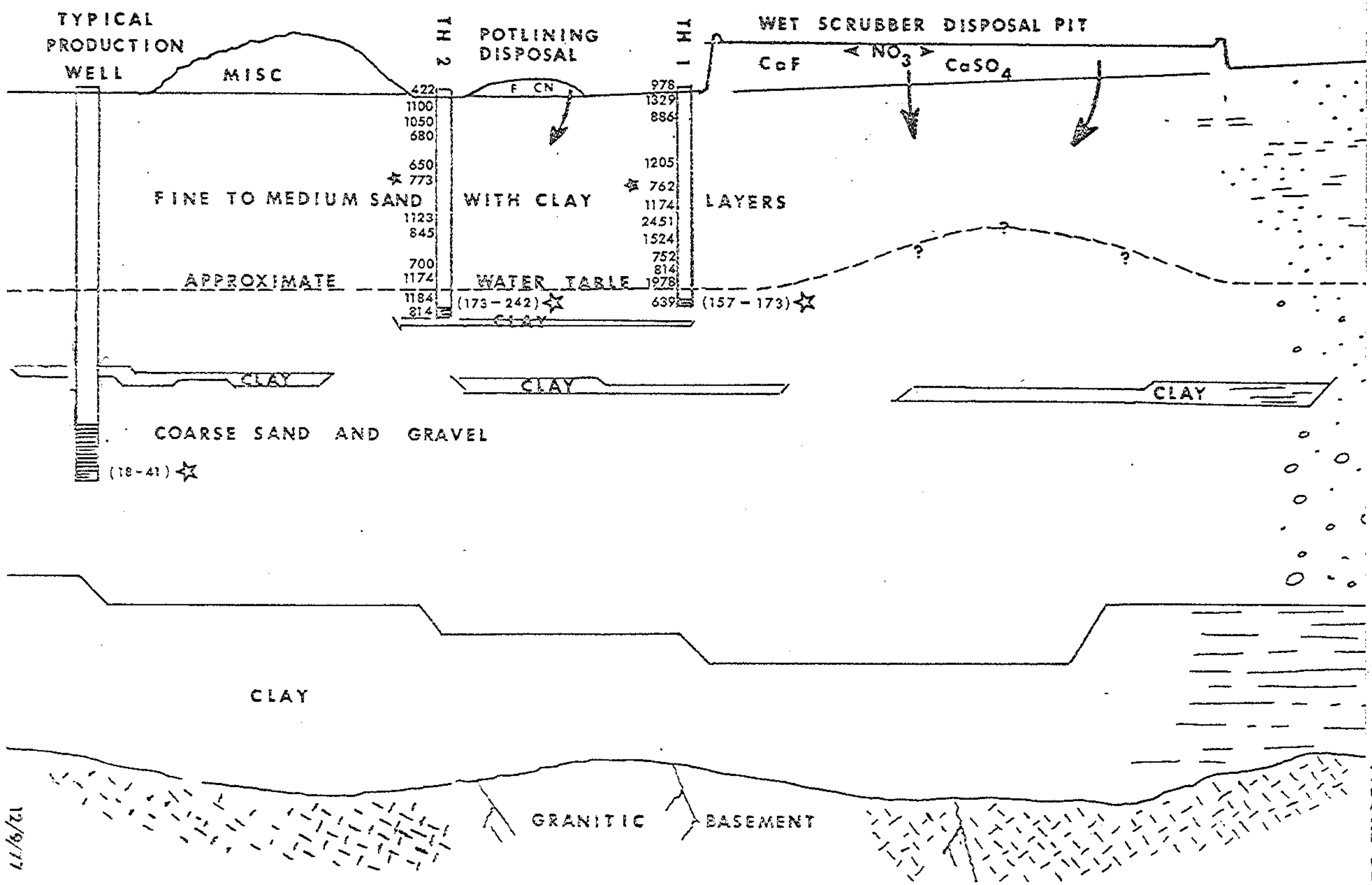
Background data on water quality throughout the Spokane aquifer is very limited, but there appears to have been an overall increase in sulfate ion concentration.

Nitrate

Concentration of nitrate in both soil columns is relatively high and nearly uniformly distributed in TH-1. Concentrations are higher in TH-2, probably indicating less infiltration and greater shallow accumulation.

Concentration of nitrate in the bailed samples is two times that in the production well water. This variation may be the result of causes similar to those discussed under fluoride above.

FIGURE 3B



SULPHATE CONCENTRATION

422 micrograms/gram - in soil ★
(173) micrograms/ml - in water ☆

NO SCALE

12/9/77

Concentrations of nitrate in the plant production wells apparently has increased since 1959. Limited chemical analysis from other wells tapping the Spokane aquifer indicate widely fluctuating nitrate concentrations and an overall increase from earlier data.

The presence of abnormal nitrate is generally taken as an indication of contamination. Spokane County is currently investigating the overall water quality in the aquifer. Considerable effort is being focused on nitrate, so that possible sources of contamination such as fertilizers and septic effluent in the East Valley can be identified and evaluated.

Cyanide

K.C.F.T. analysis show 0.06 mg/ml** in water pumped from Production Well 3, and 0.007 mg/ml in water bailed from Test Hole 2. These concentrations indicate a possible migration of cyanide from the disposal area to the water table. *Additional analyses of water from Production Well 3 showed decreased concentrations of from 0.001 to 0.004. The decrease in cyanide concentration may be due to dilution from pumping, or due to the instability of cyanide at such low concentration.

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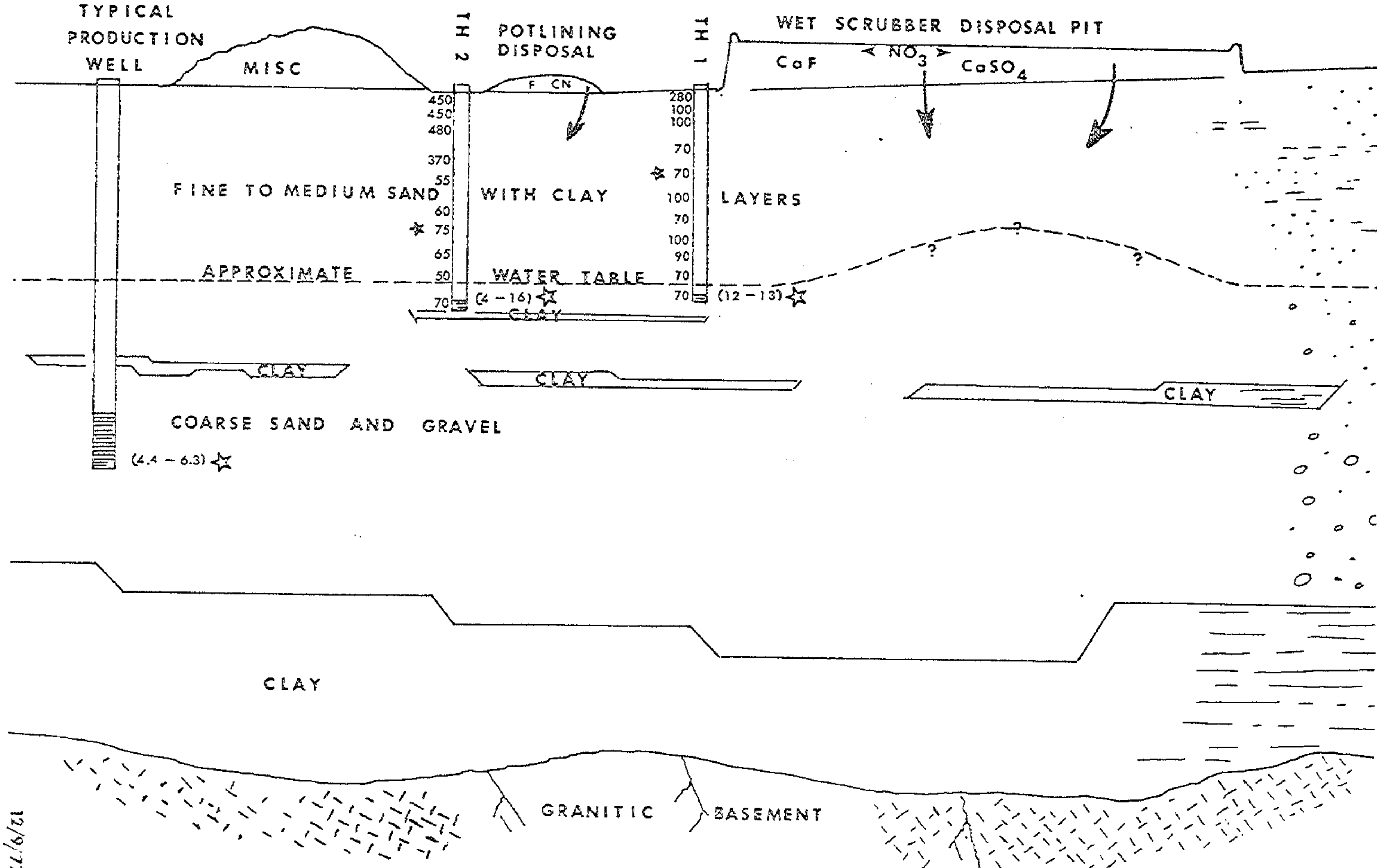
* Production Well 3 is located very near the disposal area. Such low cyanide concentration could be from direct migration of the pollutant down the exterior of the well casing.

** micro-gram

FIGURE 3C

SCHEMATIC SECTION



NITRATE CONCENTRATION

70 micrograms/gram - in soil ✱

(4) micrograms/ml - in water ☆

NO SCALE

12/9/77

INTER-OFFICE MEMORANDUM

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Date: June 13, 1978

From: W. B. Eastman W. B. Eastman

At: Mead

Subject: Corrections on Page 19 - Phase I Investigation of, "Effect of Waste Disposal Practices on Ground-Water Quality at Kaiser Aluminum & Chemical Corporation, Mead, Washington"

On your copy of subject report, please change grams per gram concentration of soil sample to micrograms per gram, and grams per milliliter of water to micrograms per milliliter of water. Thanks. = PPM

Reported as:	Should be:
Analysis - CN	Analysis - CN
g/g (soil), g/ml (water)	μg/g (soil), μg/ml (water)

Enclosed are the following 28 soil samples, and 16 water samples:

Soil Samples

Test Well	Mead Lab. No.	Depth	Analysis - CN µg/g (soil), µg/ml (water)	
1	1517	9.5 - 10.0	0.13	CFT Analysis
1	1523	22.5 - 23.0	0.02	
1	1535	33.0 - 33.5	0.17	
1	1549	49.5 - 50.0	0.04	
1	1557	68.0 - 69.0	0.04	
1	1561	83.5 - 84.5	0.02	
1	1567	88.5 - 89.0	0.02	
1	1582	116.0 - 117.0	0.03	
1	1584	124.0 - 125.0	0.03	
1	1606	136.0 - 137.0	0.01	
1	1607	140.0 - 141.0	0.04	
1	1619	155.0 - 156.5	0.02	
2	1694	4.0 - 4.5	0.69	
2	1703	40.0 - 41.0	0.01	
2	1706	52.0 - 53.0	0.04	
2	1709	64.0 - 65.0	0.18	
2	1716	88.0 - 89.0	0.04	
2	1719	100.5 - 101.5	0.05	
2	1743	112.5 - 113.0	0.11	
2	1746	125.0 - 126.0	0.01	
2	1747	129.0 - 130.0	0.02	
2	1748	133.0 - 134.0	0.02	
2	1751	144.0 - 145.0	0.01	
2	1752	148.0 - 149.0	0.02	

Blank Soil Sample #1	Less Than	0.01
Blank Soil Sample #2	" "	0.01
Failed Pot Lining Sample #1		4,470
Failed Pot Lining Sample #2		12,035

Water Samples

Production Well #1	Less Than	0.001 ppm
Production Well #2	" "	0.001
Production Well #3 (Duplicate)		0.064
Production Well #3 (Duplicate)		0.060
Production Well #5	Less Than	0.001
Production Well #6	" "	0.001
South Plant E. Production Well	" "	0.001
South Plant W. Production Well	" "	0.001
TH-1 1st Bailer		0.010
TH-1 50th Bailer	Less Than	0.001
TH-2 1st Bailer	" "	0.001
TH-2 1st Bailer from Screen		0.009
TH-2 10th Bailer		0.007
TH-2 50th Bailer		0.007
TH-2 100th Bailer		0.007
Distilled Water	Less Than	0.001

R. J. Schlager
1-9-78

CONCLUSIONS

1. The water table at the site is about 140 feet below ground surface. Ground water does not directly contact the material in the disposal areas.

2. Water from natural and unnatural sources has been sufficient to mobilize some objectionable chemicals into the "dry" sediments above the water table and into part of aquifer itself.

3. Specifically, the test results indicate that fluoride, sulfate, cyanide and nitrate have all entered the aquifer. However, none of the concentrations in the production wells are above the allowable maximum limits of the E.P.A. or U.S.P.H.S.

4. Comparison of earlier data from plant production wells, with data from this study, show that sulfate and nitrate concentrations have increased. However, similar increases have been observed in the aquifer in other parts of the valley.

5. Fluoride concentration in bailed water from TH-1 and -2 exceeds the E.P.A. limit of 2.4 mg/l. However, concentration in the deeper production wells averages less than 0.04 mg/l. Non-hazardous pollutants of sodium and calcium have also entered the aquifer.

6. The concentration of pollutants is generally greater in the upper part of the aquifer than in the lower horizon tapped by the plant production wells. The lower concentrations in

the production wells may be in part due to dilution, isolation by an impermeable zone of unknown continuity, and by the direction of ground water flow.

7. High ground temperatures, caused by heat from the baking pits, could possibly influence the solubility of some of the chemical constituents of the leachate and soil.

8. A plume of leachate around the wet scrubber disposal pit, caused by discharge of sewage effluent over the pit is likely to enhance the infiltration of pollutants.

9. Determination of the shape, size and direction of flow of such leachate plumes are beyond the scope of this study. However, we can recognize that the sediments in and overlying the aquifer are highly anisotropic, and therefore that leachate flow in these sediments would be similarly irregular.

10. While Test Hole sites 1 and 2 were chosen to be down-gradient from the two most obvious sources of contamination, it is probably optimistic to assume that the two test hole sites represent the highest concentration of pollutants in the area.

11. Further studies are required to identify the bulk quantity of pollutants, the dilution potential direction of leachate movement throughout the system.

RECOMMENDATIONS

I. Stop disposing of sewage effluent in the wet scrubber disposal pit.

II. Evaluate the benefit of grading and covering the disposal areas with an impermeable material such as bentonite.

III. Initiate further studies to further evaluate the impact of the contaminants on the aquifer. The goals of the study should be to:

   A. Quantify the amount of leachate that may be entering the aquifer system.

   B. Determine the degree of connection between the upper and lower aquifer horizons.

   C. Determine the amount of underflow in the aquifer system.

   D. Define and describe the plume of influence, and the migration pattern of contaminants, subject to limitations of test wells drilled.

   E. Evaluate and compare ground-water quality of other wells in the aquifer.

   F. Determine the relationship between the soil chemistry and the leachate and its effect on leachate mobility.

To complete the above described study a number of activities will be required. Among these are:

1. Drill four to six additional test wells.

2. Install a temporary water level recorder in Test Hole 2.

3. Install a low capacity (1 gpm) pump in TH-1 and eventually in Test Hole 2.

4. Coordinate additional drilling with geochemical and elutriate tests.

5. Research of existing water quality information, as well as collection and analysis of all wells in the aquifer -- with particular emphasis on down-gradient points. impractical

Respectfully submitted,

ROBINSON & NOBLE, INC.
Ground Water Geologists

By James R. Carr

22

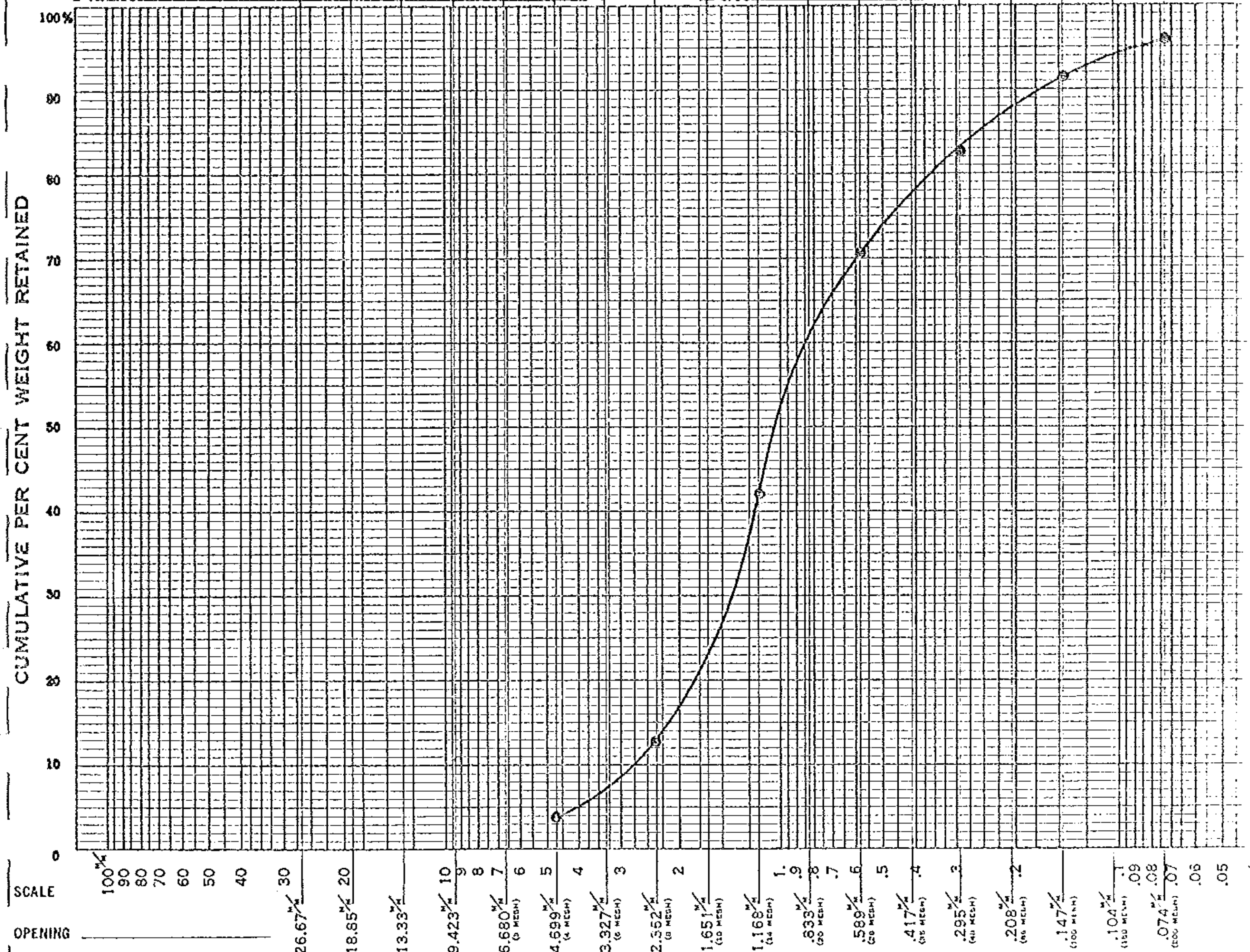
APPENDIX I

The Tyler Standard Screen Scale

Form No. L-6
Please mention above when ordering

Cumulative Logarithmic Diagram of Screen Analysis on Sample of Test Well #1 Soil

Name 17' - 18' Depth (Lab.#1623,Sample#27)   Date



SCREEN SCALE RATIO 1.414				Duplicate			Samples			Average		
Openings		Tyler Mesh	U. S. No.	Sample Weights	Per Cent	Per Cent Cumulative Weights	Sample Weights	Per Cent	Per Cent Cumulative Weights	Sample Weights	Per Cent	Per Cent Cumulative Weights
Milli-meters	Inches											
26.67	1.050											
18.85	.742											
13.33	.525											
9.423	.371											
6.680	.263	3										
4.699	.185	4	4	5.7	5.7	5.7	2.0	2.0	2.0	3.8	3.8	3.8
3.327	.131	6	6									
2.362	.093	8	8	9.0	9.0	14.7	8.5	8.5	10.5	8.8	8.8	12.6
1.651	.065	10	12									
1.168	.046	14	16	28.0	27.9	42.6	31.1	31.1	41.6	29.6	29.5	42.1
.833	.0328	20	20									
.589	.0232	28	30	28.7	28.6	71.2	27.9	27.9	69.5	28.3	28.2	70.4
.417	.0164	35	40									
.295	.0116	48	50	11.8	11.8	83.0	12.4	12.4	81.9	12.1	12.1	82.4
.208	.0082	65	70									
.147	.0058	100	100	9.2	9.2	92.2	8.7	8.7	90.6	8.9	8.9	91.4
.104	.0041	150	140									
.074	.0029	200	200	4.5	4.5	96.7	4.5	4.5	95.1	4.5	4.5	95.9
Pass .074	.0029	200	200	3.4	3.4	100.1	5.0	5.0	100.1	4.2	4.2	100.1
			Totals,	100.3	100.1		100.1	100.1		100.2	100.0	

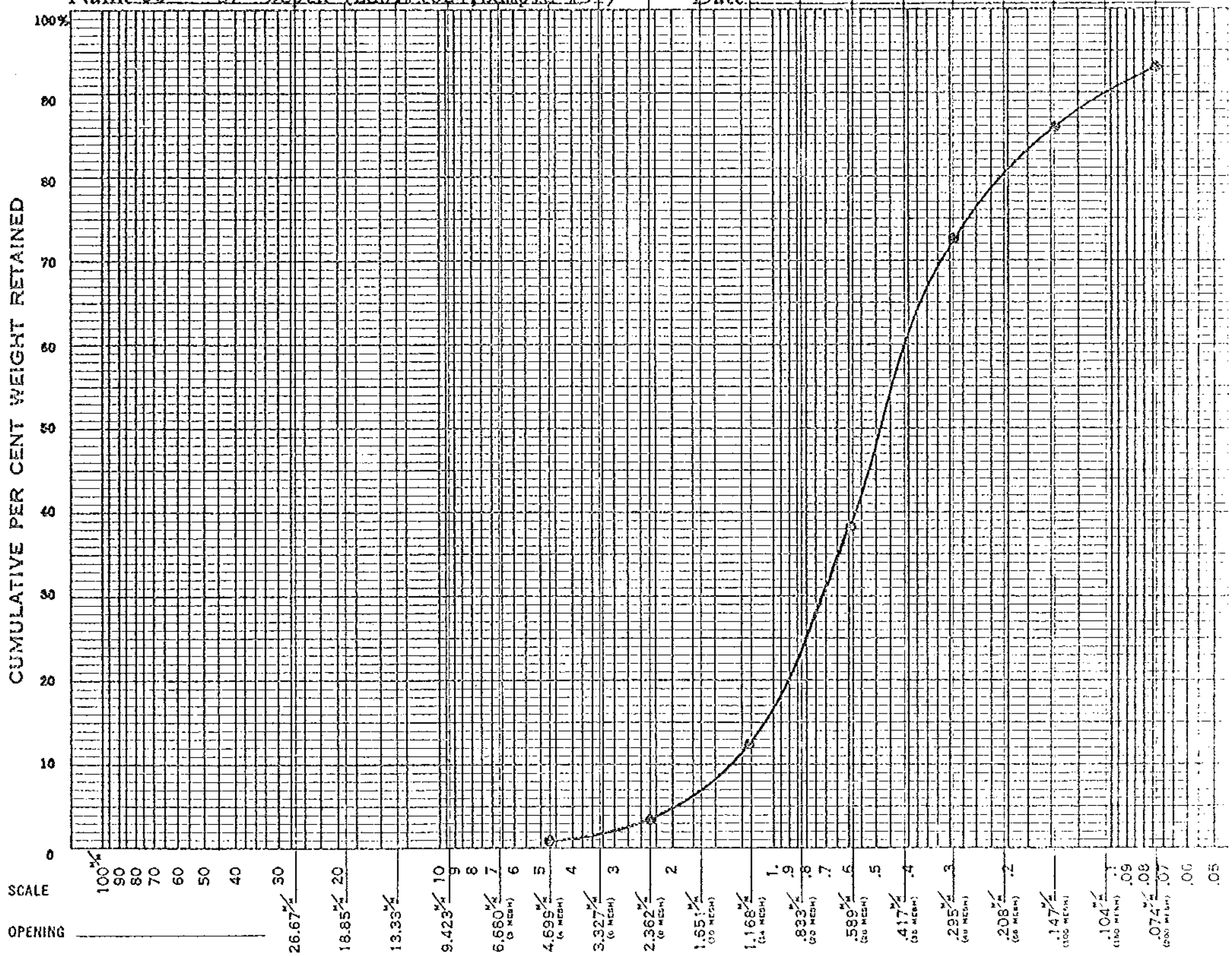
THE W. S. TYLER COMPANY, MENTOR, OHIO 44060, U.S.A

The Tyler Standard Screen Scale

Form No. L-4
Please mention above when ordering

Cumulative Logarithmic Diagram of Screen Analysis on Sample of Test Well #1 Soil

Name 36' - 37' Depth (Lab.#1624, Sample #51) Date



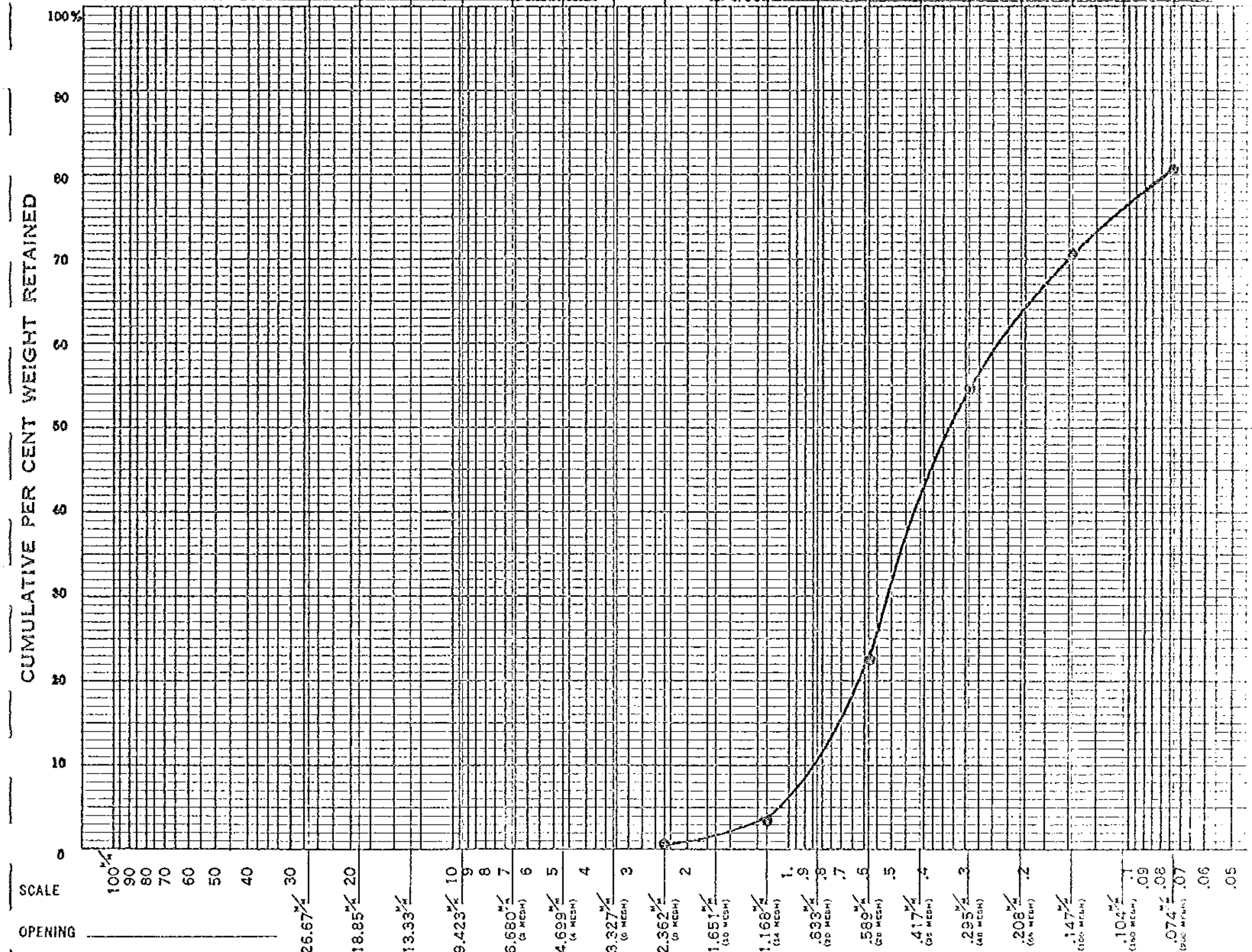
				Duplicate			Samples			Average		
SCREEN SCALE RATIO 1.414												
Openings: Milli-meters	Openings: Inches	Tyler Mesh	U. S. No.	Sample Weights	Per Cent	Per Cent Cumulative Weights	Sample Weights	Per Cent	Per Cent Cumulative Weights	Sample Weights	Per Cent	Per Cent Cumulative Weights
26.67	1.050											
18.85	.742											
13.33	.525											
9.423	.371											
6.680	.263	3										
4.699	.185	4	4	1.5	1.5	1.5	0.7	0.7	.7	1.1	1.1	1.1
3.327	.131	6	6									
2.362	.093	8	8	2.4	2.4	3.9	2.4	2.4	3.1	2.4	2.4	3.5
1.651	.065	10	12									
1.168	.046	14	16	9.8	9.8	13.7	8.6	8.6	11.7	9.2	9.2	12.7
.833	.0328	20	20									
.589	.0232	28	30	23.6	23.6	37.3	28.5	28.4	40.0	26.0	26.0	38.7
.417	.0164	35	40									
.295	.0116	48	50	34.3	34.4	71.7	34.0	33.9	74.0	34.2	34.2	72.8
.208	.0082	65	70									
.147	.0058	100	100	11.6	11.6	83.3	15.0	14.9	88.9	13.2	13.2	86.1
.104	.0041	150	140									
.074	.0029	200	200	7.6	7.6	90.9	7.0	7.0	95.9	7.3	7.3	93.4
Pass .074	.0029	200	200	9.0	9.0	99.9	4.1	4.1	100.0	6.6	6.6	100.0
			Totals,	99.8	99.9		100.3	100.0		100.0	100.0	

The Tyler Standard Screen Scale

Form [illegible] Please mention [illegible] when ordering

Cumulative Logarithmic Diagram of Screen Analysis on Sample of Test Well #1 Soil

Name 41.5' - 42.5' (Lab.#1625, Sample #57) Date



	SCREEN SCALE RATIO 1.414				Duplicate			Samples			Average		
	Openings		Tyler Mesh	U.S. No.	Sample Weights	Per Cent	Per Cent Cumulative Weights	Sample Weights	Per Cent	Per Cent Cumulative Weights	Sample Weights	Per Cent	Per Cent Cumulative Weights
	Millimeters	Inches											
	26.67	1.050											
	18.85	.742											
	13.33	.525											
	9.423	.371											
	6.680	.263	3										
	4.699	.185	4	4									
	3.327	.131	6	6									
	2.362	.093	8	8	0.4	0.4	0.4	0.3	0.3	0.3	0.4	0.4	0.4
	1.651	.065	10	12									
	1.168	.046	14	16	2.8	2.8	3.2	3.0	3.0	3.3	2.9	2.9	3.2
	.833	.0328	20	20									
	.589	.0232	28	30	19.0	19.1	22.3	19.3	19.3	22.6	19.1	19.2	22.4
	.417	.0164	35	40									
	.295	.0116	48	50	31.5	31.6	53.9	32.2	32.3	54.9	31.8	31.9	54.4
	.208	.0082	65	70									
	.147	.0058	100	100	16.1	16.1	70.0	16.0	16.0	70.9	16.1	16.1	70.4
	.104	.0041	150	140									
	.074	.0029	200	200	10.3	10.3	80.3	10.3	10.3	81.2	10.3	10.3	[illegible].8
Pass	.074	.0029	200	200	19.6	19.7	100.0	18.7	18.7	99.9	19.2	19.2	100.0
				Totals,	99.7	100.0		99.8	99.9		99.8	100.0	

A cross check was made to validate the sodium and calcium standards used in the test well project. This was done by independently recalculating the amount of dried NaCl and dried $CaCO_3$ to make the 1000 μg/ml stock solutions, remaking the solutions, aliquoting as necessary to make the standard solutions and cross checking each of the new standard solutions with the old standards used for analysis in the test well projects. These results are shown below.

Na (Units)		Na μg/ml	Ca (Units)		Ca μg/ml
Old	New		Old	New	
500	500	1.0	500	500	10
235	245	0.5	247	249	5
60	53	0.1	45	57	1

A further correlation on the Ca method is shown below.

micrograms
1000

	Conc. Ca μg/ml
Tap H_2O	22.8
#1 Well	21.4
#2 Well	22.5
#3 Well	22.7
#5 Well	23.5
#6 West Well South Plant	24.5
#7 East Well South Plant	22.5

micrograms/milliliter
10^{-6} g / 10^{-3} liter
10^{-3} g / liter
= mg/l

Test Well Kaiser 26/43 16 D2 when tested prior to 1952 showed 24 parts per million calcium (Ca) which agrees well with our data on the Kaiser-Mead well water. The investigation "Record of Wells, Water Levels, and Quality of Ground Water in the Spokane Valley, Spokane County, Washington", by Weigle and Mundorff, 1952, identifies 26/43 16 D2 as Kaiser Well #1 as numbered above.

Cyanide standards were run at various times during the course of the project. These standards were made by freshly preparing a stock solution with a calculated amount of KCN, diluting this to a standard solution and pipeting varying quantities of the standard solution to 25 ml volumetrics.

The results of these standard runs agree well with the original curve data as replicated several times over the past 3 years.

Nitrate is a more complex situation for validation than most of the methods employed in this project. The method employed was a selective ion electrode method which seems prone to some drifting problems. Nitrate can also be determined by an ultraviolet method but the method is prone to severe interference by organic material which is normally present in soil. Brucine indicator is on order and has not been received so we cannot yet employ the alternate Brucine spectrophotometric method. Duplicate samples were sent to Spokane County Laboratories and to our Research Center in Pleasanton, California, and returned results agree $\pm$ 20% which may be as good as the available methodology.

I believe the analytical results on the project as a whole are accurate and represent the samples as received in the Chemical Laboratory.

INTER-OFFICE MEMORANDUM

TO W. B. Eastman

AT Mead

COPIES TO R. J. Schlager
R. L. Alboucq

DATE October 27, 1977

FROM F. G. Doolittle

AT Mead

SUBJECT Method Confirmation Checks and Standards Verification

REFERRING TO

The fluoride in well water and the fluoride in the soil leachate were run on the Technicon Autoanalyzer using the same method that we use for analyzing the low fluoride tape sample leachate. The 3 standards used for these analyses were the regular .25 μg/ml, .50 μg/ml and .75 μg/ml which are used to set up the 0.00 μg/ml to 1.00 μg/ml curve. These standards were remade at least once during the period that the fluoride analyses were performed and these standards cross checked with each other very closely.

The sulfate (SO_4) method was confirmed by submitting 3 unknowns to the analyst. These unknowns were prepared by taking varying aliquots from a standard copper sulfate solution prepared by the chemist. The results are shown in the table below.

ml Cupric Sulfate Standard Solution	SO_4 Present (gms)	SO_4 Reported (gms)	Δ Grams	% Difference
5	.0679	.0690	.0011	1.6
10	.1358	.1523	.0165	12.1
20	.2716	.2784	.0068	2.5

We feel these results confirm the accuracy of the gravimetric method used to determine the sulfate in the soil samples and the well water.

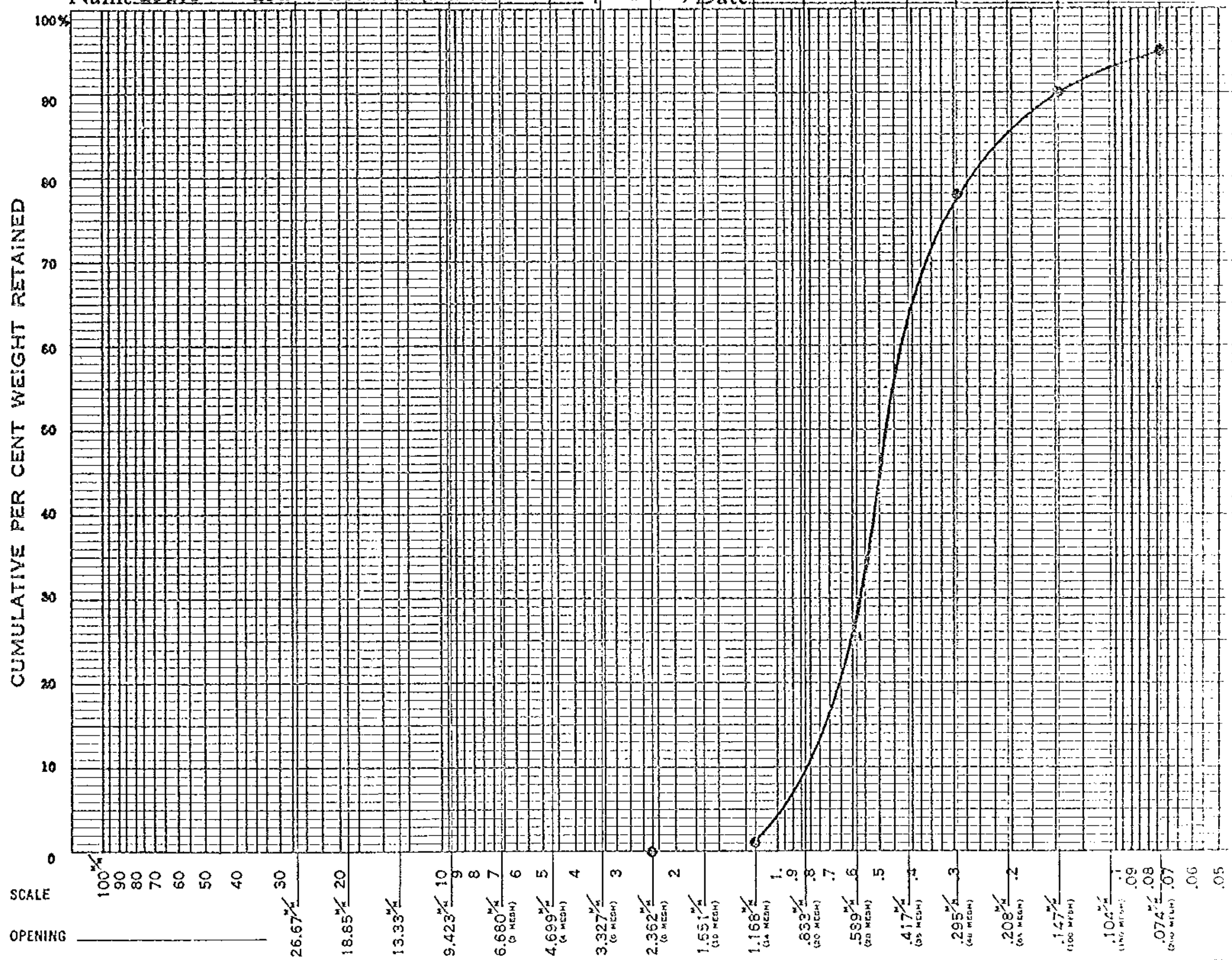
APPENDIX II

Form No. 1-6
Please mention ab.
when ordering

The Tyler Standard Screen Scale

Cumulative Logarithmic Diagram of Screen Analysis on Sample of Test Well #1 Soil

Name 151.5' - 152' Interval (Lab. #1630, Sample #173) Date



SCREEN SCALE RATIO 1.414				Duplicate			Samples			Average		
Openings: Milli-meters	Openings: Inches	Tyler Mesh	U. S. No.	Sample Weights	Per Cent	Per Cent Cumulative Weights	Sample Weights	Per Cent	Per Cent Cumulative Weights	Sample Weights	Per Cent	Per Cent Cumulative Weights
26.67	1.050											
18.85	.742											
13.33	.525											
9.423	.371											
6.680	.263	3										
4.699	.185	4	4									
3.327	.131	6	6									
2.362	.093	8	8	0.1	0.1	0.1				0.1	0.1	0.1
1.651	.065	10	12									
1.168	.046	14	16	1.3	1.1	1.2	0.9	0.9	0.9	1.1	1.0	1.1
.833	.0328	20	20									
.589	.0232	28	30	28.6	25.1	26.3	23.3	24.3	25.2	26.0	24.7	25.8
.417	.0164	35	40									
.295	.0116	48	50	59.6	52.3	78.6	50.0	52.1	77.3	54.8	52.2	78.0
.208	.0082	65	70									
.147	.0058	100	100	13.0	11.4	90.0	11.7	12.2	89.5	12.4	11.8	89.8
.104	.0041	150	140									
.074	.0029	200	200	5.5	4.8	94.8	4.5	4.7	94.2	5.0	4.8	94.6
Pass .074	.0029	200	200	5.8	5.1	99.9	5.5	5.7	99.9	5.7	5.4	100.0
			Totals,	113.9	99.9		95.9	99.9		104.9	99.9	

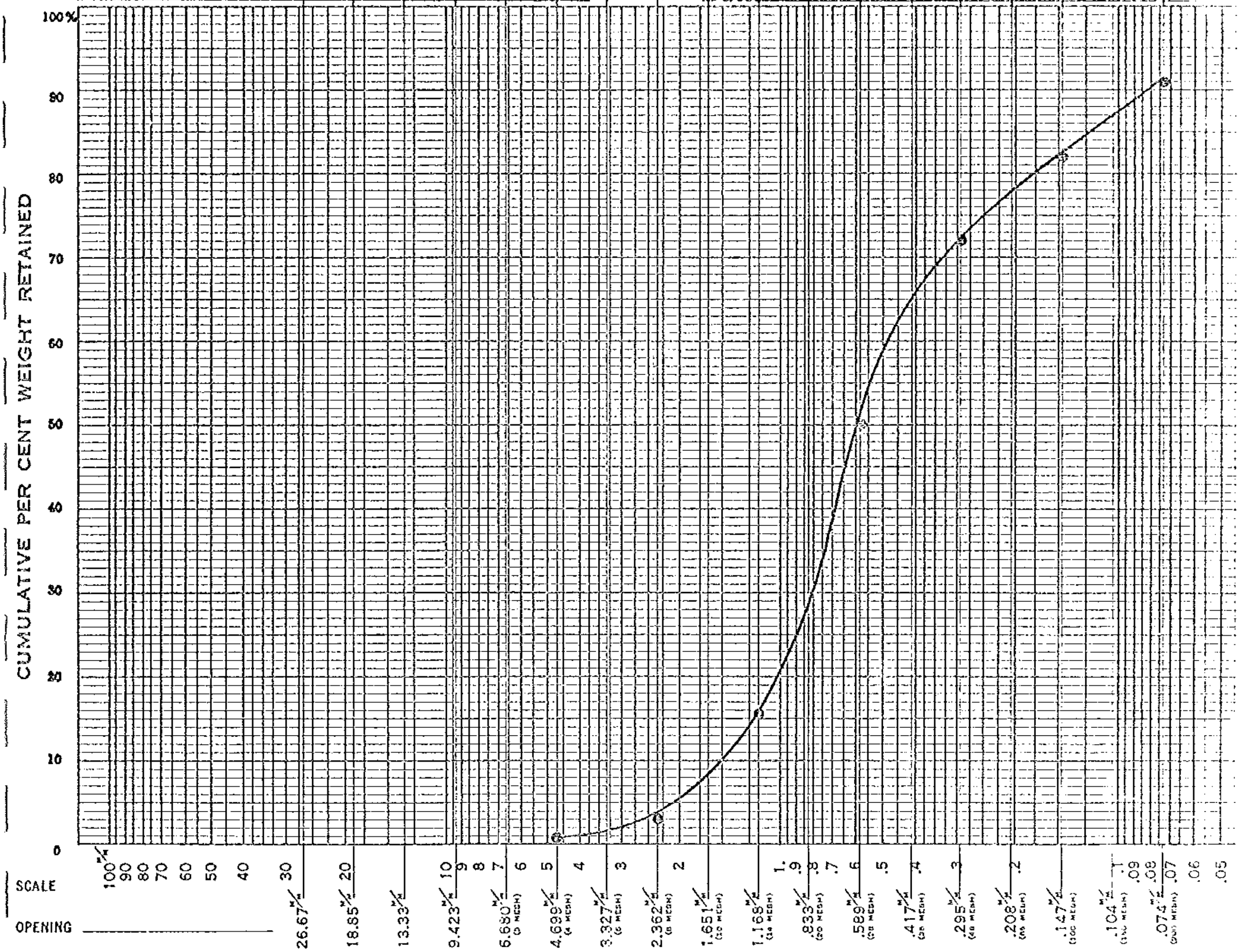
THE W. S. TYLER COMPANY, MENTOR, OHIO 44060, U.S.A. 7-

Form No. 1-6
Please mention th
when ordering

The Tyler Standard Screen Scale

Cumulative Logarithmic Diagram of Screen Analysis on Sample of Test Well #1 Soil

Name 144' - 145' Interval (Lab. #1629, Sample #165)   Date



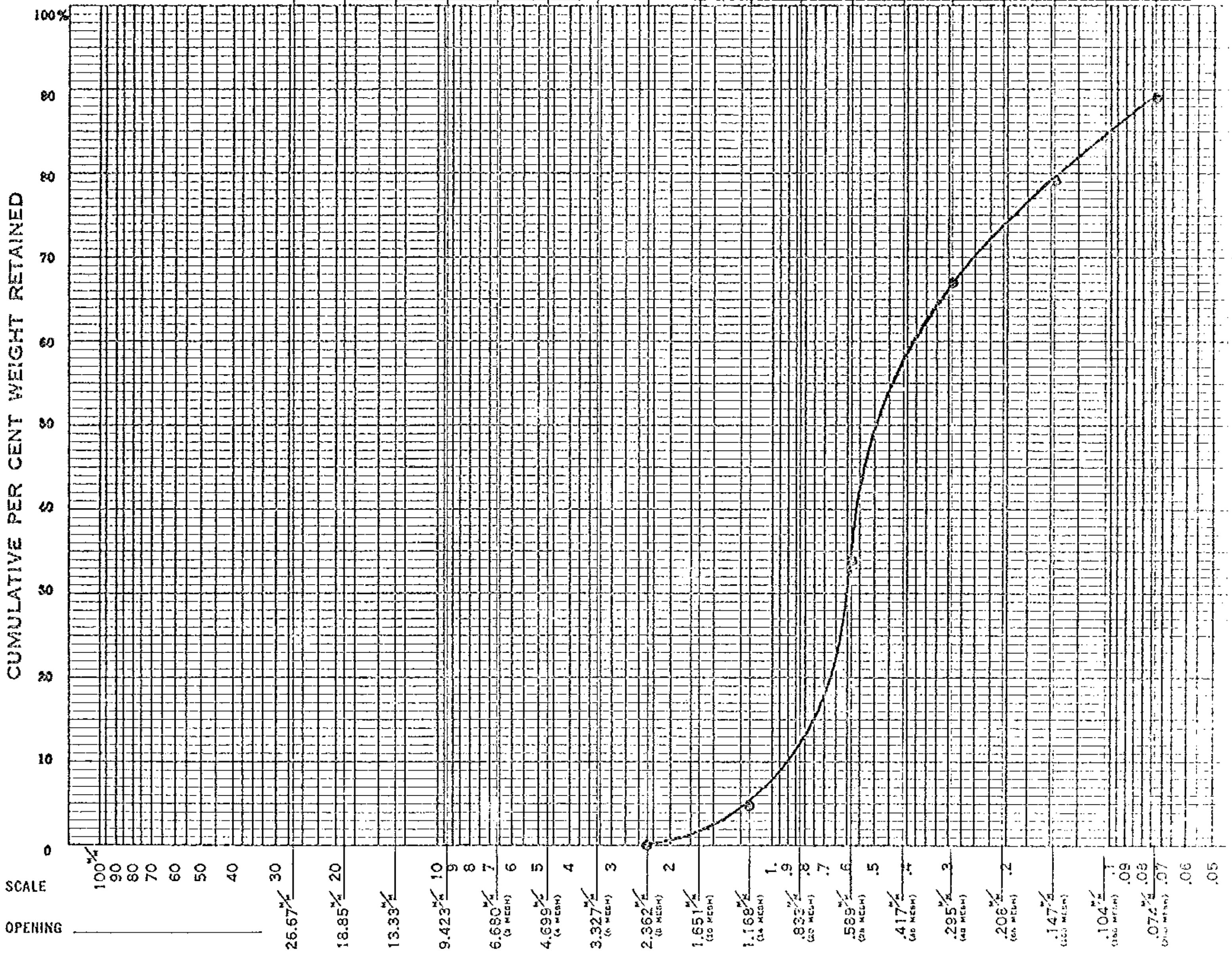
SCREEN SCALE RATIO 1.414				Duplicate			Samples			Average		
Openings: Millimeters	Openings: Inches	Tyler Mesh	U. S. No.	Sample Weights	Per Cent	Per Cent Cumulative Weights	Sample Weights	Per Cent	Per Cent Cumulative Weights	Sample Weights	Per Cent	Per Cent Cumulative Weights
26.67	1.050											
18.85	.742											
13.33	.525											
9.423	.371											
6.680	.263	3										
4.699	.185	4	4	0.8	0.7	0.7	1.0	0.9	0.9	0.9	0.8	0.8
3.327	.131	6	6									
2.362	.093	8	8	2.1	1.8	2.5	2.4	2.2	3.1	2.3	2.0	2.8
1.651	.065	10	12									
1.168	.046	14	16	14.0	12.3	14.8	14.1	12.9	16.0	14.1	12.6	15.4
.833	.0328	20	20									
.589	.0232	28	30	39.8	35.0	49.8	37.1	34.0	50.0	38.4	34.5	49.9
.417	.0164	35	40									
.295	.0116	48	50	25.9	22.8	72.6	24.3	22.3	72.3	25.1	22.5	72.4
.208	.0082	65	70									
.147	.0058	100	100	10.0	8.8	81.4	10.2	9.4	81.7	10.1	9.1	81.5
.104	.0041	150	140									
.074	.0029	200	200	10.7	9.4	90.8	10.6	9.7	91.4	10.6	9.6	91.1
Pass .074	.0029	200	200	10.4	9.1	99.9	9.3	8.5	99.9	9.8	8.8	99.9
			Totals,	113.7	99.9		109.0	99.9		111.3	99.9	

The Tyler Standard Screen Scale

Form No. L-3
Please mention at when ordering

Cumulative Logarithmic Diagram of Screen Analysis on Sample of Test Well #1 Soil

Name 112.5' - 113.5' Interval(Lab.#1628,Sample #134) Date



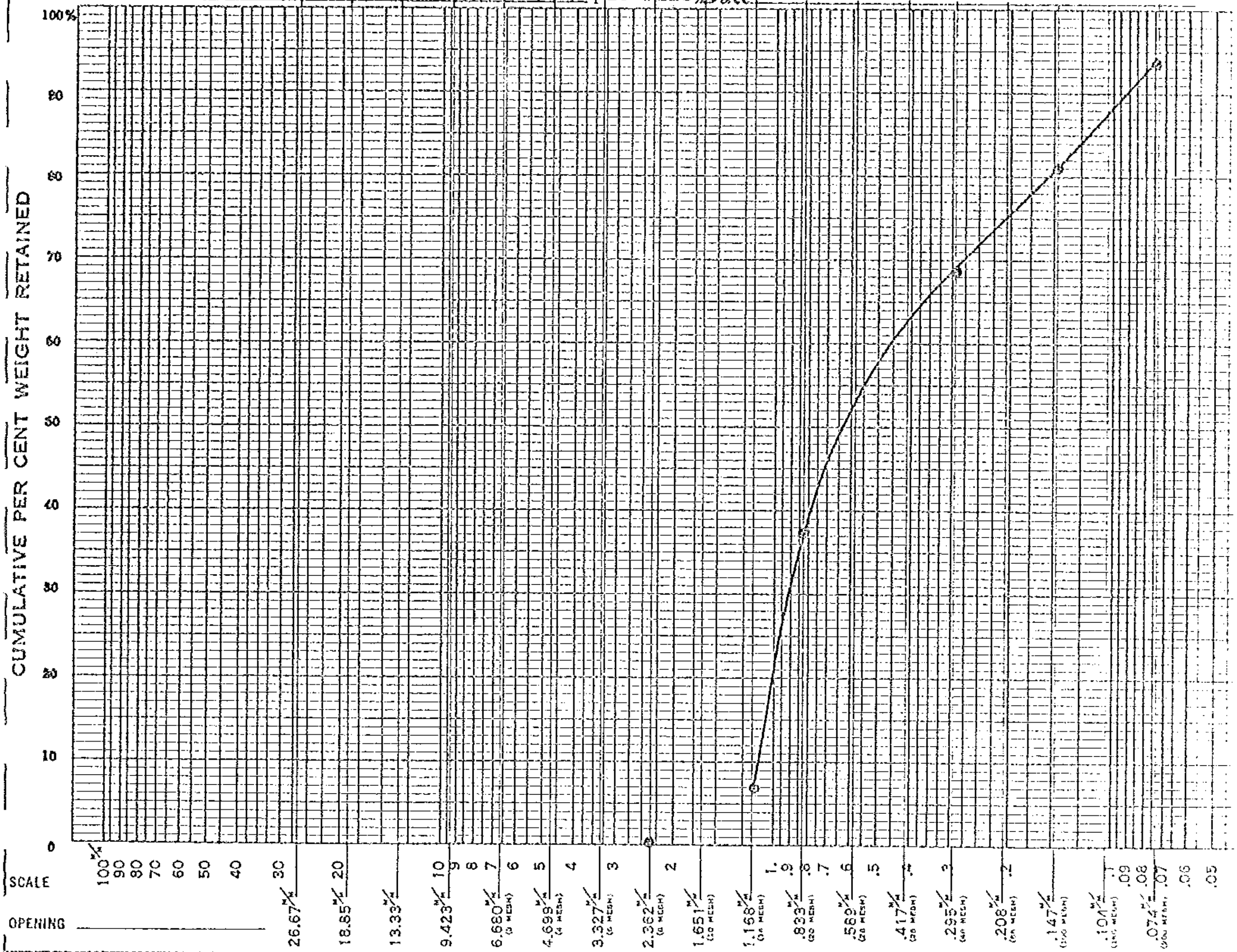
	SCREEN SCALE RATIO 1.414				Duplicate			Samples			Average		
	Openings		Tyler Mesh	U. S. No.	Sample Weights	Per Cent	Per Cent Cumulative Weights	Sample Weights	Per Cent	Per Cent Cumulative Weights	Sample Weights	Per Cent	Per Cent Cumulative Weights
	Milli-meters	Inches											
	26.67	1.050											
	18.85	.742											
	13.33	.525											
	9.423	.371											
	6.680	.263	3										
	4.699	.185	4	4									
	3.327	.131	6	6									
	2.362	.093	8	8				0.5	0.4	0.4	0.3	0.2	0.2
	1.651	.065	10	12									
	1.168	.046	14	16	5.3	4.7	4.7	5.5	4.5	4.9	5.4	4.6	4.8
	.833	.0328	20	20									
	.589	.0232	28	30	33.2	29.2	33.9	36.7	30.1	35.0	34.9	29.7	34.0
	.417	.0164	35	40									
	.295	.0116	48	50	36.9	32.5	66.4	39.2	32.1	67.1	38.6	32.3	66.7
	.208	.0082	65	70									
	.147	.0058	100	100	14.1	12.4	78.8	15.2	12.4	79.5	14.6	12.4	79.2
	.104	.0041	150	140									
	.074	.0029	200	200	10.4	9.2	88.0	12.0	9.8	89.3	11.2	9.5	88.7
Pass	.074	.0029	200	200	13.7	12.1	100.1	13.0	10.6	99.9	13.4	11.3	100.0
				Totals,	113.6	100.1		122.1	99.9		117.8	100.0	

The Tyler Standard Screen Scale

Form No. L-6
Please mention above when ordering

Cumulative Logarithmic Diagram of Screen Analysis on Sample of Test Well #1 Soil

Name 97' - 98' Interval (Lab. #1627, Sample #118) Date



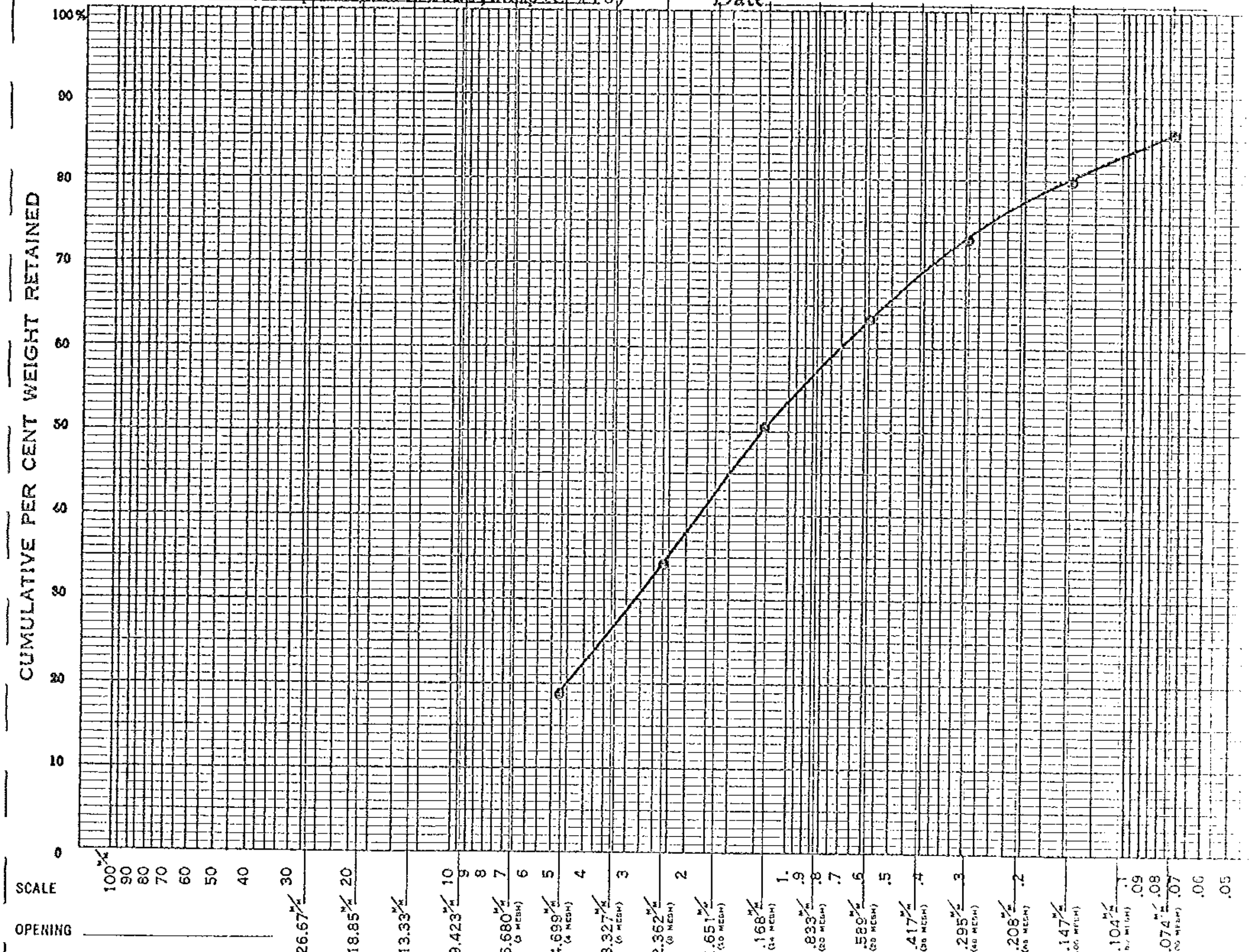
SCREEN SCALE RATIO 1.414				Duplicate			Samples			Average		
Openings		Tyler Mesh	U.S. No.	Sample Weights	Per Cent	Per Cent Cumulative Weights	Sample Weights	Per Cent	Per Cent Cumulative Weights	Sample Weights	Per Cent	Per Cent Cumulative Weights
Millimeters	Inches											
26.67	1.050											
18.85	.742											
13.33	.525											
9.423	.371											
6.680	.263	3										
4.699	.185	4	4									
3.327	.131	6	6									
2.362	.093	8	8				0.1	0.1	0.1	0.1	0.1	0.1
1.651	.065	10	12									
1.168	.046	14	16	6.7	6.5	6.5	7.5	7.5	7.6	7.1	7.0	7.0
.833	.0328	20	20									
.589	.0232	28	30	31.4	30.4	36.9	30.0	30.2	37.8	30.7	30.3	37.4
.417	.0164	35	40									
.295	.0116	48	50	31.9	30.9	67.8	31.4	31.6	69.4	31.7	31.3	68.6
.208	.0082	65	70									
.147	.0058	100	100	13.4	13.0	80.8	10.9	11.0	80.4	12.1	12.0	80.6
.104	.0041	150	140									
.074	.0029	200	200	10.9	10.6	91.4	15.5	15.6	96.0	13.2	13.1	[illegible]
.074	.0029	200	200	9.0	8.7	100.1	4.1	4.1	100.1	6.6	6.4	100.1
			Totals,	103.3	100.1		99.5	100.1		101.5	100.2	

The Tyler Standard Screen Scale

Form No. L-6
Please mention at... when ordering

Cumulative Logarithmic Diagram of Screen Analysis on Sample of Test Well #1 Soil

Name 58' - 59' Depth (Lab. #1626, Sample #76) Date



	SCREEN SCALE RATIO 1.414				Duplicate			Samples			Average		
	Openings		Tyler Mesh	U. S. No.	Sample Weights	Per Cent	Per Cent Cumulative Weights	Sample Weights	Per Cent	Per Cent Cumulative Weights	Sample Weights	Per Cent	Per Cent Cumulative Weights
	Milli-meters	Inches											
	26.67	1.050											
	18.85	.742											
	13.33	.525											
	9.423	.371											
	6.680	.263	3										
	4.699	.186	4	4	14.1	14.3	14.3	23.5	23.8	23.8	18.8	19.0	19.0
	3.327	.131	6	6									
	2.362	.093	8	8	16.2	16.4	30.7	15.0	15.2	38.0	15.6	15.8	34.4
	1.651	.065	10	12									
	1.168	.046	14	16	15.7	15.9	46.6	15.8	16.0	55.0	15.7	16.0	50.8
	.833	.0328	20	20									
	.589	.0232	28	30	13.9	14.1	60.7	11.9	12.0	67.0	12.9	13.0	63.8
	.417	.0164	35	40									
	.295	.0116	48	50	10.0	10.1	70.8	9.1	9.2	76.2	9.6	9.7	73.5
	.208	.0082	65	70									
	.147	.0058	100	100	7.1	7.2	78.0	5.5	5.6	81.8	6.3	6.4	79.9
	.104	.0041	150	140									
	.074	.0029	200	200	6.5	6.6	84.6	5.0	5.1	86.9	5.7	5.8	85.8
Pass	.074	.0029	200	200	15.4	15.6	100.2	13.0	13.2	100.1	14.2	14.4	100.2
				Totals,	98.9	100.2		98.8	100.1		98.8	100.1	

APPENDIX II

RFI M 854

Well #1 Tharpe Lake

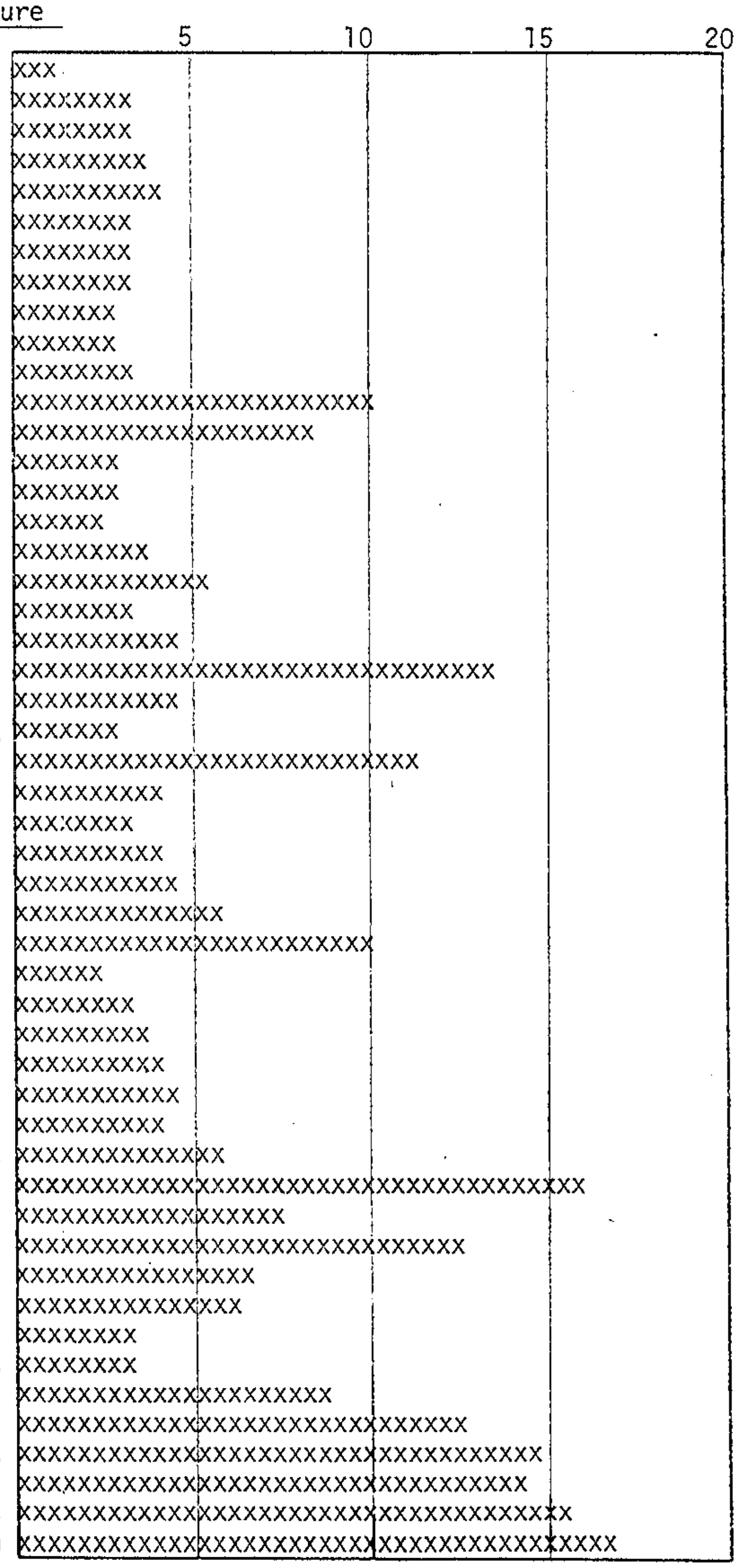
Date: 2-1-77

WELL CORING LOG

Depth vs. Concentration

Moisture
(Percent by Weight)

Lab. No.	Depth Feet	Moisture
1512	0.0 - .5	1.4
1513	2.0 - 2.5	3.6
1514	4.0 - 4.5	3.5
1515	6.0 - 6.5	3.7
1516	8.0 - 8.5	4.1
1517	9.5 - 10.0	3.6
1518	12.0 - 12.5	3.3
1519	13.5 - 14.5	3.3
1520	16.5 - 17.5	3.0
1521	18.5 - 19.0	3.1
1522	20.0 - 21.5	3.3
1523	22.5 - 23.0	10.3
1524	24.0 - 25.0	8.4
1525	26.0 - 27.0	2.8
1526	27.0 - 28.0	3.0
1535	33.0 - 33.5	2.7
1536	36.0 - 37.0	3.7
1537	39.0 - 39.5	5.7
1538	42.5 - 43.5	3.5
1539	44.5 - 45.5	4.6
1549	49.5 - 50	13.8
1550	53.0 - 53.5	4.8
1551	56.0 - 57.0	2.8
1552	60.0 - 61.0	11.6
1553	64.0 - 65.0	4.3
1557	68.0 - 69.0	3.6
1558	72.0 - 73.0	4.3
1559	76.0 - 77.0	4.7
1560	80.0 - 80.5	6.1
1561	83.5 - 84.5	10.0
1567	88.5 - 89.0	2.7
1568	92.0 - 93.0	3.3
1569	95.0 - 96.0	3.9
1570	100.0 - 101.0	4.3
1571	103.0 - 104.0	4.6
1580	108.0 - 109.0	4.3
1581	112.0 - 113.0	5.8
1582	116.0 - 117.0	16.1
1583	120.0 - 121.0	7.6
1584	124.0 - 125.0	12.6
1604	128.0 - 129.0	6.7
1605	132.0 - 133.0	6.5
1606	136.0 - 137.0	3.2
1607	140.0 - 141.0	3.4
1608	144.0 - 145.0	8.9
1616	147.0 - 148.0	12.6
1617	150.0 - 151.5	14.8
1618	152.0 - 153.0	14.3
1619	155.0 - 156.5	15.6
1620	157.0 - 158.5	17.0
1640	Soil Blank #1	1.8
1641	Soil Blank #2	0.0



Blank soil samples were taken from the Cunningham Sand and Gravel Co. sand pit south of the South Plant

RFI M 854

Well #1 Tharpe Lake

ELL CORING LOG

Depth vs. Concentration

pH of soil

Date: 2-1-77

Lab. No.	Depth Feet	pH
1512	0.0 - .5	7.37
1513	2.0 - 2.5	7.62
1514	4.0 - 4.5	7.02
1515	6.0 - 6.5	7.37
1516	8.0 - 8.5	7.50
1517	9.5 - 10.0	7.64
1518	12.0 - 12.5	7.71
1519	13.5 - 14.5	7.74
1520	16.5 - 17.5	7.70
1521	18.5 - 19.0	7.72
1522	20.0 - 21.5	7.73
1523	22.5 - 23.0	7.72
1524	24.0 - 25.0	7.76
1525	26.0 - 27.0	7.76
1526	27.0 - 28.0	7.79
1535	33.0 - 33.5	7.86
1536	36.0 - 37.0	7.73
1537	39.0 - 39.5	7.79
1538	42.5 - 43.5	7.79
1539	44.5 - 45.5	7.80
1549	49.5 - 50	7.69
1550	53.0 - 53.5	7.75
1551	56.0 - 57.0	7.52
1552	60.0 - 61.0	7.81
1553	64.0 - 65.0	7.74
1557	68.0 - 69.0	7.70
1558	72.0 - 73.0	7.70
1559	76.0 - 77.0	7.71
1560	80.0 - 80.5	7.72
1561	83.5 - 84.5	7.71
1567	88.5 - 89.0	7.66
1568	92.0 - 93.0	7.73
1569	95.0 - 96.0	7.79
1570	100.0 - 101.0	7.52
1571	103.0 - 104.0	7.51
1580	108.0 - 109.0	7.53
1581	112.0 - 113.0	7.74
1582	116.0 - 117.0	7.70
1583	120.0 - 121.0	7.72
1584	124.0 - 125.0	7.64
1604	128.0 - 129.0	7.68
1605	132.0 - 133.0	7.60
1606	136.0 - 137.0	7.59
1607	140.0 - 141.0	7.58
1608	144.0 - 145.0	7.64
1616	147.0 - 148.0	7.34
1617	150.0 - 151.5	7.36
1618	152.0 - 153.0	7.59
1619	155.0 - 156.5	7.68
1620	157.0 - 158.5	7.63
1640	Soil Blank #1	7.66
1641	Soil Blank #2	7.36

Blank soil samples were taken from the Cunningham Sand and Gravel Co. sand pit south of the South Plant

Lab. No.	Identification	pH of Water
1634	Test Well #1 1st Bail	7.74
1636	Test Well #1 10th Bail	7.59
1637	Test Well #1 50th Bail	7.66
	North Plant Production Well #1	7.76
	North Plant Production Well #2	7.96
	North Plant Production Well #3	7.99
	North Plant Production Well #5	8.04
	North Plant Production Well #6	8.01
	South Plant Production Well East	7.91
	South Plant Production Well West	8.12

RFI M 854

WELL CORING LOG

Depth vs. Concentration

Date: 2-1-77

Well #1 Tharpe Lake

Na

(Conc. Expressed in Micrograms per gram of as-received soil)

Lab. No.	Depth Feet	Na µg/gm	100 — 1,000
1512	0.0 - .5	280	xxxxxxxxxxxxxxxxxxxxx
1513	2.0 - 2.5	81	xxxxxxxxxxxxxxx
1514	4.0 - 4.5	300	xxxxxxxxxxxxxxxxxxxxxx
1515	6.0 - 6.5	163	xxxxxxxxxxxxxxxxxx
1516	8.0 - 8.5	150	xxxxxxxxxxxxxxxxxx
1517	9.5 - 10.0	550	xxxxxxxxxxxxxxxxxxxxxxxxxx
1518	12.0 - 12.5	195	xxxxxxxxxxxxxxxxxxx
1519	13.5 - 14.5	63	xxxxxxxxxxx
1520	16.5 - 17.5	45	xxxxxxxx
1521	18.5 - 19.0	40	xxxxxxx
1522	20.0 - 21.5	30	xxxxx
1523	22.5 - 23.0	35	xxxxxx
1524	24.0 - 25.0	24	xxxx
1525	26.0 - 27.0	18	xx
1526	27.0 - 28.0	25	xxxx
1535	33.0 - 33.5	340	xxxxxxxxxxxxxxxxxxxxxxx
1536	36.0 - 37.0	100	xxxxxxxxxxxxxxxxx
1537	39.0 - 39.5	61	xxxxxxxxxxx
1538	42.5 - 43.5	27	xxxx
1539	44.5 - 45.5	135	xxxxxxxxxxxxxxxxxx
1549	49.5 - 50	30	xxxxx
1550	53.0 - 53.5	32	xxxxx
1551	56.0 - 57.0	23	xxxx
1552	60.0 - 61.0	23	xxxx
1553	64.0 - 65.0	110	xxxxxxxxxxxxxxxxx
1557	68.0 - 69.0	580	xxxxxxxxxxxxxxxxxxxxxxxxxxx
1558	72.0 - 73.0	345	xxxxxxxxxxxxxxxxxxxxxxx
1559	76.0 - 77.0	155	xxxxxxxxxxxxxxxxxx
1560	80.0 - 80.5	111	xxxxxxxxxxxxxxxxx
1561	83.5 - 84.5	55	xxxxxxxxxx
1567	88.5 - 89.0	330	xxxxxxxxxxxxxxxxxxxxxxx
1568	92.0 - 93.0	66	xxxxxxxxxxx
1569	95.0 - 96.0	92	xxxxxxxxxxxxxxxxx
1570	100.0 - 101.0	133	xxxxxxxxxxxxxxxxxx
1571	103.0 - 104.0	176	xxxxxxxxxxxxxxxxxxx
1580	108.0 - 109.0	198	xxxxxxxxxxxxxxxxxxx
1581	112.0 - 113.0	33	xxxxx
1582	116.0 - 117.0	98	xxxxxxxxxxxxxxxxx
1583	120.0 - 121.0	135	xxxxxxxxxxxxxxxxxx
1584	124.0 - 125.0	170	xxxxxxxxxxxxxxxxxxx
1604	128.0 - 129.0	475	xxxxxxxxxxxxxxxxxxxxxxxxx
1605	132.0 - 133.0	390	xxxxxxxxxxxxxxxxxxxxxxxx
1606	136.0 - 137.0	520	xxxxxxxxxxxxxxxxxxxxxxxxxx
1607	140.0 - 141.0	40	xxxxxxx
1608	144.0 - 145.0	30	xxxxx
1616	147.0 - 148.0	30	xxxxx
1617	150.0 - 151.5	25	xxxx
1618	152.0 - 153.0	27	xxxxx
1619	155.0 - 156.5	27	xxxxx
1620	157.0 - 158.5	27	xxxxx
1640	Soil Blank #1	154	
1641	Soil Blank #2	15	

Blank soil samples were taken from the Cunningham Sand and Gravel Co. sand pit south of the South Pl.

Lab. No.	Identification	Sodium in Water (Conc. Expressed in Micrograms per ml)
1634	Test Well #1 1st Bail	48
1636	Test Well #1 10th Bail	42
1637	Test Well #1 50th Bail	45
	North Plant Production Well #1	6.2
	North Plant Production Well #2	6.3
	North Plant Production Well #3	4.2
	North Plant Production Well #5	5.7
	North Plant Production Well #6	6.3
	South Plant Production East	4.1
	South Plant Production West	4.2

RFI M 854

Well #1 Tharpe Lake

WELL CORING LOG

Depth vs. Concentration

Date: 2-1-77

Ca
(Conc. Expressed in Micrograms per gram of as-received soil)

Lab. No.	Depth Feet	Ca μg/gm
1512	0.0 - .5	830
1513	2.0 - 2.5	800
1514	4.0 - 4.5	40
1515	6.0 - 6.5	90
1516	8.0 - 8.5	240
1517	9.5 - 10.0	560
1518	12.0 - 12.5	950
1519	13.5 - 14.5	920
1520	16.5 - 17.5	550
1521	18.5 - 19.0	670
1522	20.0 - 21.5	800
1523	22.5 - 23.0	760
1524	24.0 - 25.0	730
1525	26.0 - 27.0	770
1526	27.0 - 28.0	840
1535	33.0 - 33.5	870
1536	36.0 - 37.0	560
1537	39.0 - 39.5	730
1538	42.5 - 43.5	830
1539	44.5 - 45.5	810
1549	49.5 - 50	720
1550	53.0 - 53.5	630
1551	56.0 - 57.0	710
1552	60.0 - 61.0	860
1553	64.0 - 65.0	630
1557	68.0 - 69.0	700
1558	72.0 - 73.0	740
1559	76.0 - 77.0	550
1560	80.0 - 80.5	650
1561	83.5 - 84.5	630
1567	88.5 - 89.0	680
1568	92.0 - 93.0	750
1569	95.0 - 96.0	590
1570	100.0 - 101.0	530
1571	103.0 - 104.0	330
1580	108.0 - 109.0	670
1581	112.0 - 113.0	550
1582	116.0 - 117.0	770
1583	120.0 - 121.0	780
1584	124.0 - 125.0	750
1604	128.0 - 129.0	670
1605	132.0 - 133.0	550
1606	136.0 - 137.0	630
1607	140.0 - 141.0	750
1608	144.0 - 145.0	710
1616	147.0 - 148.0	560
1617	150.0 - 151.5	670
1618	152.0 - 153.0	600
1619	155.0 - 156.5	670
1620	157.0 - 158.5	770
1640	Soil Blank #1	770
1641	Soil Blank #2	350

Blank soil samples were taken from the Cunningham Sand and Gravel Co. sand pit south of the South Plant.

Lab. No.	Identification	Calcium in Water (Conc. Expressed in Micrograms per ml)
1634	Test Well #1 1st Bail	41
1636	Test Well #1 10th Bail	59
1637	Test Well #1 50th Bail	43
	North Plant Production Well #1	21.4
	North Plant Production Well #2	22.5
	North Plant Production Well #3	22.7
	North Plant Production Well #5	24.3
	North Plant Production Well #6	23.5
	South Plant Production Well East	22.5
	South Plant Production Well West	24.5

RFI M 854

-Well # 1 Tharpe Lake

WELL CORING LOG
Depth vs. Concentration

Date: 2-1-77

FLUORIDE
(Conc. Expressed in Micrograms per gram of as-received soil)

Lab. No.	Depth Feet	Fluoride μg/gm
1512	0.0 - .5	259.0
1513	2.0 - 2.5	201.0
1514	4.0 - 4.5	21.5
1515	6.0 - 6.5	11.5
1516	8.0 - 8.5	11.5
1517	9.5 - 10.0	6.5
1518	12.0 - 12.5	267.5
1519	13.5 - 14.5	37.5
1520	16.5 - 17.5	2.5
1521	18.5 - 19.0	2.0
1522	20.0 - 21.5	4.0
1523	22.5 - 23.0	39.5
1524	24.0 - 25.0	18.5
1525	26.0 - 27.0	4.0
1526	27.0 - 28.0	7.5
1535	33.0 - 33.5	3.5
1536	36.0 - 37.0	3.0
1537	39.0 - 39.5	2.5
1538	42.5 - 43.5	1.5
1539	44.5 - 45.5	3.0
1549	49.5 - 50	5.0
1550	53.0 - 53.5	5.0
1551	56.0 - 57.0	3.5
1552	60.0 - 61.0	3.5
1553	64.0 - 65.0	5.0
1557	68.0 - 69.0	5.0
1558	72.0 - 72.0	3.5
1559	76.0 - 77.0	3.5
1560	80.0 - 80.5	3.5
1561	83.5 - 84.5	3.5
1567	88.5 - 89.0	3.5
1568	92.0 - 93.0	6.0
1569	95.0 - 96.0	6.0
1570	100.0 - 101.0	3.0
1571	103.0 - 104.0	3.5
1580	108.0 - 109.0	2.5
1581	112.0 - 113.0	2.5
1582	116.0 - 117.0	5.0
1583	120.0 - 121.0	7.0
1584	124.0 - 125.0	6.0
1604	128.0 - 129.0	6.5
1605	132.0 - 133.0	6.0
1606	136.0 - 137.0	7.0
1607	140.0 - 141.0	6.0
1608	144.0 - 145.0	8.5
1616	147.0 - 148.0	7.5
1617	150.0 - 151.5	8.0
1618	152.0 - 153.0	9.0
1619	155.0 - 156.5	8.5
1620	157.0 - 158.5	8.5

Lab. No.	Identification	Fluoride μg/gm
1640	Soil Blank #1	6.0
1641	Soil Blank #2	5.5

Blank soil samples were taken from the Cunningham Sand and Gravel Co. sandpit sout. of the South Plant

Lab. No.	Identification	Fluoride in Water (Conc. Expressed in Micrograms per ml)
1634	Test Well #1 1st Bail	3.07
1636	Test Well #1 10th Bail	2.90
1637	Test Well #1 50th Bail	3.10
	North Plant Production Well #1	0.04
	North Plant Production Well #2	0.03
	North Plant Production Well #3	0.03
	North Plant Production Well #5	-
	North Plant Production Well #6	0.03
	South Plant Production Well East	0.03
	South Plant Production Well West	0.04

RFI M 854

WELL CORING LOG

Date: 2-1-77

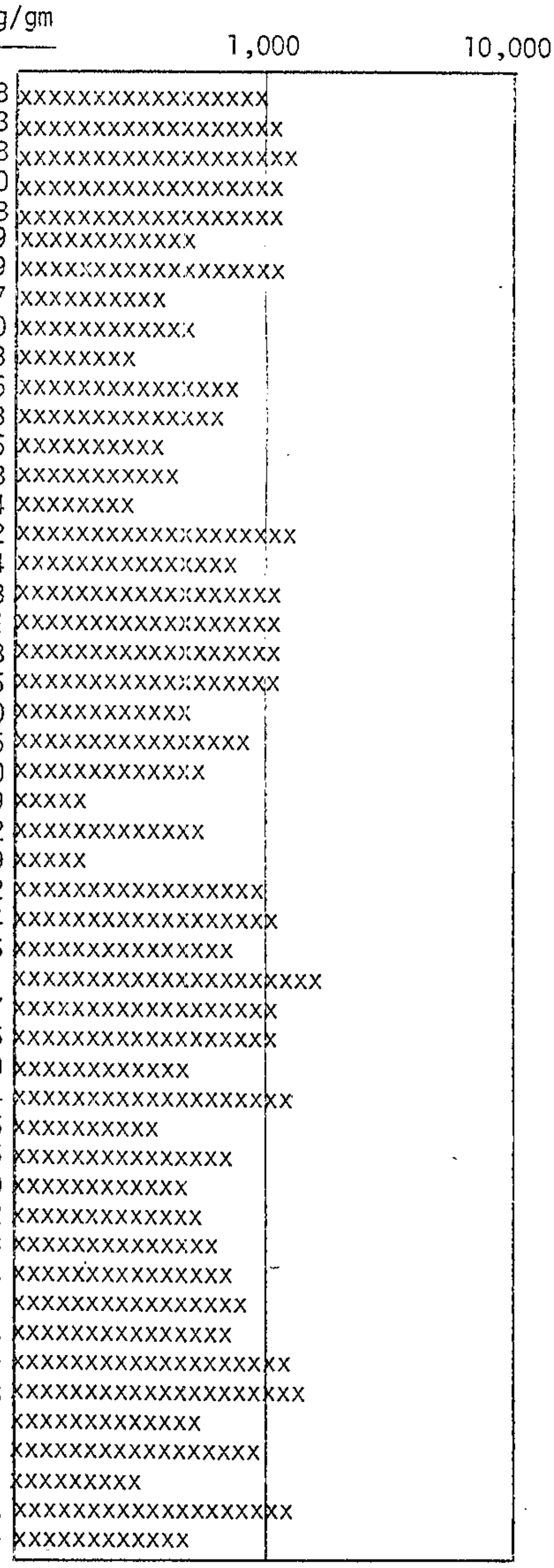
Depth vs. Concentration

Well #1 Tharpe Lake

SO_4

(Conc. Expressed in Micrograms per gram of as-received soil)

Lab. No.	Depth Feet	SO_4 µg/gm
1512	0.0 - .5	978
1513	2.0 - 2.5	1,123
1514	4.0 - 4.5	1,638
1515	6.0 - 6.5	1,360
1516	8.0 - 8.5	1,318
1517	9.5 - 10.0	639
1518	12.0 - 12.5	1,329
1519	13.5 - 14.5	577
1520	16.5 - 17.5	700
1521	18.5 - 19.0	443
1522	20.0 - 21.5	886
1523	22.5 - 23.0	793
1524	24.0 - 25.0	556
1525	26.0 - 27.0	628
1526	27.0 - 28.0	474
1535	33.0 - 33.5	1,792
1536	36.0 - 37.0	834
1537	39.0 - 39.5	968
1538	42.5 - 43.5	1,421
1539	44.5 - 45.5	1,318
1549	49.5 - 50	1,205
1550	53.0 - 53.5	670
1551	56.0 - 57.0	906
1552	60.0 - 61.0	700
1553	64.0 - 65.0	299
1557	68.0 - 69.0	762
1558	72.0 - 73.0	319
1559	76.0 - 77.0	1,092
1560	80.0 - 80.5	1,174
1561	83.5 - 84.5	855
1567	88.5 - 89.0	2,451
1568	92.0 - 93.0	1,257
1569	95.0 - 96.0	1,185
1570	100.0 - 101.0	680
1571	103.0 - 104.0	1,524
1580	108.0 - 109.0	566
1581	112.0 - 113.0	845
1582	116.0 - 117.0	690
1583	120.0 - 121.0	752
1584	124.0 - 125.0	793
1604	128.0 - 129.0	834
1605	132.0 - 133.0	917
1606	136.0 - 137.0	814
1607	140.0 - 141.0	1,679
1608	144.0 - 145.0	1,978
1616	147.0 - 148.0	721
1617	150.0 - 151.5	1,102
1618	152.0 - 153.0	515
1619	155.0 - 156.5	1,576
1620	157.0 - 158.5	639
1640	Soil Blank #1	1,545
1641	Soil Blank #2	1,390



Blank soil samples were taken from the Cunningha[m] Sand and Gravel Co. sand pit south of the South Plant

Lab. No.	Identification	Sulfate in Water (Conc. Expressed in Micrograms per ml)
1634	Test Well #1 1st Bail	173.4
1636	Test Well #1 10th Bail	171.6
1637	Test Well #1 50th Bail	157.0
	North Plant Production Well #1	19.3
	North Plant Production Well #2	40.8
	North Plant Production Well #3	18.0
	North Plant Production Well #5	
	North Plant Production Well #6	22.2
	South Plant Production Well East	25.7
	South Plant Production Well West	33.3

RFI M 854

WELL CORING LOG

Date: 2-1-77

Well # 1 Tharpe Lake

Depth vs. Concentration

NO_3

(Conc. Expressed in Micrograms per gram of as-received soil)

Lab. No.	Depth Feet	NO_3 µg/gm
1512	0.0 - .5	280
1513	2.0 - 2.5	140
1514	4.0 - 4.5	70
1515	6.0 - 6.5	90
1516	8.0 - 8.5	100
1517	9.5 - 10.0	100
1518	12.0 - 12.5	90
1519	13.5 - 14.5	90
1520	16.5 - 17.5	85
1521	18.5 - 19.0	85
1522	20.0 - 21.5	100
1523	22.5 - 23.0	85
1524	24.0 - 25.0	85
1525	26.0 - 27.0	100
1526	27.0 - 28.0	
1535	33.0 - 33.5	85
1536	36.0 - 37.0	70
1537	39.0 - 39.5	70
1538	42.5 - 43.5	85
1539	44.5 - 45.5	85
1549	49.5 - 50	70
1550	53.0 - 53.5	70
1551	56.0 - 57.0	70
1552	60.0 - 61.0	70
1553	64.0 - 65.0	70
1557	68.0 - 69.0	65
1558	72.0 - 73.0	55
1559	76.0 - 77.0	47
1560	80.0 - 80.5	100
1561	83.5 - 84.5	85
1567	88.5 - 89.0	100
1568	92.0 - 93.0	90
1569	95.0 - 96.0	90
1570	100.0 - 101.0	70
1571	103.0 - 104.0	60
1580	108.0 - 109.0	100
1581	112.0 - 113.0	90
1582	116.0 - 117.0	90
1583	120.0 - 121.0	90
1584	124.0 - 125.0	100
1604	128.0 - 129.0	85
1605	132.0 - 133.0	85
1606	136.0 - 137.0	70
1607	140.0 - 141.0	70
1608	144.0 - 145.0	70
1616	147.0 - 148.0	75
1617	150.0 - 151.5	70
1618	152.0 - 153.0	55
1619	155.0 - 156.5	70
1620	157.0 - 158.5	70
1640	Soil Blank #1	380
1641	Soil Blank #2	205

Blank soil samples were taken from the Cunningham Sand and Gravel Co. sand pit south of the South Plant.

Lab. No.	Identification	Nitrate in Water (Conc. Expressed in Micrograms per ml)
1634	Test Well #1 1st Bail	12
1636	Test Well #1 10th Bail	24
1637	Test Well #1 50th Bail	13
	North Plant Production Well #1	5.4
	North Plant Production Well #2	6.3
	North Plant Production Well #3	4.4
	North Plant Production Well #5	5.6
	North Plant Production Well #6	6.3
	South Plant Production Well East	11.0
	South Plant Production Well West	11.7

RFI M 854

Well #2 Dump Site

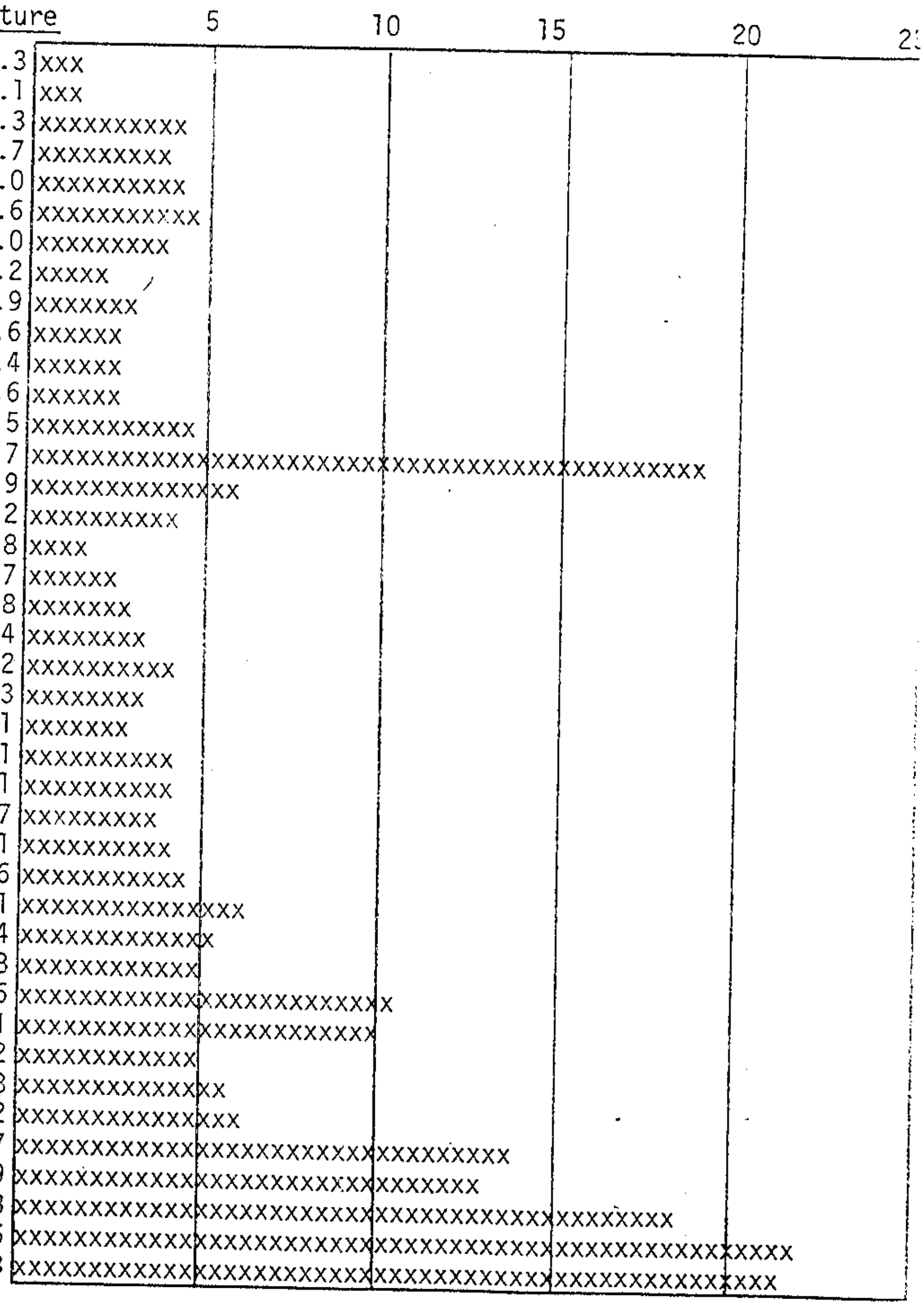
WELL CORING LOG

Depth vs. Concentration

Moisture
(Percent by Weight)

Date: 2-1-77

Lab. No.	Depth Feet	Moisture
1693	0.0 - 0.5	1.3
1694	4.0 - 4.5	1.1
1695	8.0 - 8.5	4.3
1696	12.0 - 12.5	3.7
1697	15.5 - 16.5	4.0
1698	20.0 - 21.0	4.6
1699	24.0 - 25.0	4.0
1700	28.0 - 29.0	2.2
1701	32.0 - 33.0	2.9
1702	36.0 - 37.0	2.6
1703	40.0 - 41.0	2.4
1704	44.0 - 45.0	2.6
1705	48.0 - 49.0	4.5
1706	52.0 - 53.0	18.7
1707	56.0 - 57.0	5.9
1708	60.0 - 61.0	4.2
1709	64.0 - 65.0	1.8
1710	68.0 - 69.0	2.7
1711	72.0 - 73.0	2.8
1712	76.0 - 77.0	3.4
1714	80.0 - 81.0	4.2
1715	84.0 - 85.0	3.3
1716	88.0 - 89.0	3.1
1717	92.0 93.0	4.1
1718	96.5 - 97.0	4.1
1719	100.5 - 101.5	3.7
1741	104.5 - 105.5	4.1
1742	108.0 - 109.0	4.6
1743	112.5 - 113.0	6.1
1744	116.5 - 117.0	5.4
1745	120.0 - 121.0	4.8
1746	125.0 - 126.0	10.6
1747	129.0 - 130.0	10.1
1748	133.0 - 134.0	5.2
1749	137.0 - 138.0	5.8
1750	141.0 - 142.0	6.2
1751	144.0 - 145.0	13.7
1752	148.0 - 149.0	12.9
1753	152.0 - 153.0	18.3
1754	156.0 - 157.0	21.5
1755	157.0 - 158.0	21.3
1640	Soil Blank #1	1.8
1641	Soil Blank #2	0.0



Blank soil samples were taken from the Cunningham Sand and Gravel Co. sand pit south of the South Plant.

RFI M 854

WELL CORING LOG
Depth vs. Concentration

Date: 2-1-77

Well #2 Dump Site

pH of Soil

Lab. No.	Depth Feet	pH
1693	0.0 - 0.5	6.80
1694	4.0 - 4.5	6.98
1695	8.0 - 8.5	7.66
1696	12.0 - 12.5	9.17
1697	15.5 - 16.5	7.90
1698	20.0 - 21.0	7.81
1699	24.0 - 25.0	7.79
1700	28.0 - 29.0	7.95
1701	32.0 - 33.0	7.92
1702	36.0 - 37.0	7.83
1703	40.0 - 41.0	7.77
1704	44.0 - 45.0	7.79
1705	48.0 - 49.0	7.76
1706	52.0 - 53.0	7.73
1707	56.0 - 57.0	7.69
1708	60.0 - 61.0	7.80
1709	64.0 - 65.0	7.71
1710	68.0 - 69.0	7.66
1711	72.0 - 73.0	7.74
1712	76.0 - 77.0	7.69
1714	80.0 - 81.0	7.81
1715	84.0 - 85.0	7.78
1716	88.0 - 89.0	7.69
1717	92.0 - 93.0	7.54
1718	96.5 - 97.0	7.74
1719	100.5 - 101.5	7.72
1741	104.5 - 105.5	7.64
1742	108.0 - 109.0	7.55
1743	112.5 - 113.0	7.67
1744	116.5 - 117.0	7.68
1745	120.0 - 121.0	7.55
1746	125.0 - 126.0	7.63
1747	129.0 - 130.0	7.70
1748	133.0 - 134.0	7.67
1749	137.0 - 138.0	7.63
1750	141.0 - 142.0	7.67
1751	144.0 - 145.0	7.67
1752	148.0 - 149.0	7.48
1753	152.0 - 153.0	7.61
1754	156.0 - 157.0	7.61
1755	157.0 - 158.0	7.54
1640	Soil Blank #1	7.66
1641	Soil Blank #2	7.36

Blank soil samples were taken from the Cunningham Sand and Gravel Co. sand pit south of the South Plan

Lab. No.	Identification	pH of Water
1768	Test Well #2 1st Bail	7.78
1769	Test Well #2 1st Sample from Screen	7.88
1770	Test Well #2 10th Bail	7.76
1851	Test Well #2 50th Bail	7.82
1852	Test Well #2 100th Bail	7.81
	North Plant Production Well #1	7.76
	North Plant Production Well #2	7.96
	North Plant Production Well #3	7.99
	North Plant Production Well #5	8.04
	North Plant Production Well #6	8.01
	South Plant Production Well East	7.91
	South Plant Production Well West	8.12

RFI M 854

WELL CORING LOG

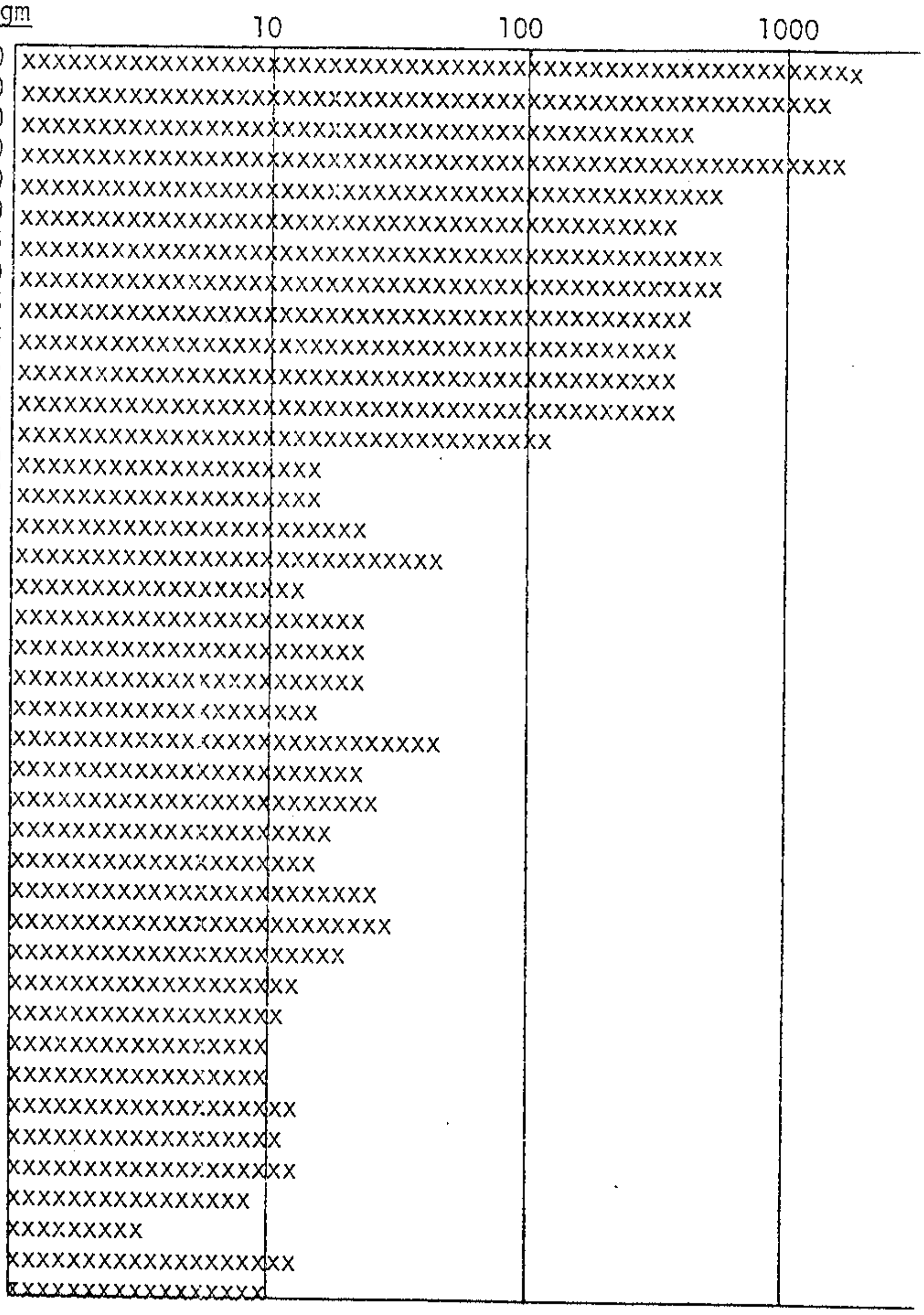
Date: 2-1-77

Well #2 Dump Site

Depth vs. Concentration

Na
(Conc. Expressed in Micrograms per gram of as-received soil)

Lab. No.	Depth Feet	Na µg/gm
1693	0.0 - 0.5	2,700
1694	4.0 - 4.5	1,940
1695	8.0 - 8.5	710
1696	12.0 - 12.5	2,150
1697	15.5 - 16.5	700
1698	20.0 - 21.0	540
1699	24.0 - 25.0	725
1700	28.0 - 29.0	690
1701	32.0 - 33.0	585
1702	36.0 - 37.0	543
1703	40.0 - 41.0	505
1704	44.0 - 45.0	505
1705	48.0 - 49.0	165
1706	52.0 - 53.0	20
1707	56.0 - 57.0	20
1708	60.0 - 61.0	35
1709	64.0 - 65.0	60
1710	68.0 - 69.0	18
1711	72.0 - 73.0	35
1712	76.0 - 77.0	35
1714	80.0 - 81.0	35
1715	84.0 - 85.0	22
1716	88.0 - 89.0	67
1717	92.0 - 93.0	37
1718	96.5 - 97.0	39
1719	100.5 - 101.5	27
1741	104.5 - 105.5	23
1742	108.0 - 109.0	39
1743	112.5 - 113.0	45
1744	116.5 - 117.0	32
1745	120.0 - 121.0	17
1746	125.0 - 126.0	11
1747	129.0 - 130.0	10
1748	133.0 - 134.0	10
1749	137.0 - 138.0	18
1750	141.0 - 142.0	12
1751	144.0 - 145.0	16
1752	148.0 - 149.0	9
1753	152.0 - 153.0	5
1754	156.0 - 157.0	15
1755	157.0 - 158.0	10



1640	Soil Blank #1	154	Blank soil samples were taken from the Cunningham Sand and Gravel Co. sand pit south of the South Plant
1641	Soil Blank #2	15	

Lab. No.	Identification	Sodium in Water (Conc. Expressed im Micrograms per ml)
1768	Test Well #2 1st Bail	35.0
1769	Test Well #2 1st Sample from Screen	25.0
1770	Test Well #2 10th Bail	33.0
1851	Test Well #2 50th Bail	32.0
1852	Test Well #2 100th Bail	33.0
	North Plant Production Well #1	6.2
	North Plant Production Well #2	6.3
	North Plant Production Well #3	4.2
	North Plant Production Well #5	5.7
	North Plant Production Well #6	6.3
	South Plant Production Well East	4.1
	South Plant Production Well West	4.2

RFI M 854

WELL CORING LOG

Date: 2-1-77

Well #2 Dump Site

Depth vs. Concentration

Ca

(Conc. Expressed in Micrograms per gram of as-received soil)

Lab. No.	Depth Feet	Ca µg/gm
1693	0.0 - 0.5	80
1694	4.0 - 4.5	50
1695	8.0 - 8.5	480
1696	12.0 - 12.5	250
1697	15.5 - 16.5	450
1698	20.0 - 21.0	670
1699	24.0 - 25.0	560
1700	28.0 - 29.0	790
1701	32.0 - 33.0	870
1702	36.0 - 37.0	790
1703	40.0 - 41.0	670
1704	44.0 - 45.0	730
1705	48.0 - 49.0	830
1706	52.0 - 53.0	880
1707	56.0 - 57.0	760
1708	60.0 - 61.0	900
1709	64.0 - 65.0	730
1710	68.0 - 69.0	750
1711	72.0 - 73.0	850
1712	76.0 - 77.0	820
1714	80.0 - 81.0	920
1715	84.0 - 85.0	920
1716	88.0 - 89.0	840
1717	92.0 - 93.0	840
1718	96.5 - 97.0	390
1719	100.5 - 101.5	270
1741	104.5 - 105.5	230
1742	108.0 - 109.0	390
1743	112.5 - 113.0	450
1744	116.5 - 117.0	320
1745	120.0 - 121.0	660
1746	125.0 - 126.0	830
1747	129.0 - 130.0	780
1748	133.0 - 134.0	820
1479	137.0 - 138.0	780
1750	141.0 - 142.0	770
1751	144.0 - 145.0	770
1752	148.0 - 149.0	760
1753	152.0 - 153.0	730
1754	156.0 - 157.0	790
1755	157.0 - 158.0	770
1640	Soil Blank #1	770
1641	Soil Blank #2	350

Blank soil samples were taken from the Cunningham Sand and Gravel Co. sand pit south of the South Plant

Calcium in Water

Lab. No.	Identification	(Conc. Expressed in Micrograms per m
1768	Test Well #2 1st Bail	48.0
1769	Test Well #2 1st Sample from Screen	41.4
1770	Test Well #2 10th Bail	41.0
1851	Test Well #2 50th Bail	40.0
1852	Test Well #2 100th Bail	39.0
	North Plant Production Well #1	21.4
	North Plant Production Well #2	22.5
	North Plant Production Well #3	22.7
	North Plant Production Well #5	24.3
	North Plant Production Well #6	23.5
	South Plant Production Well East	22.5
	South Plant Production Well West	24.5

RFI M 854

WELL CORING LOG

Date: 2-1-77

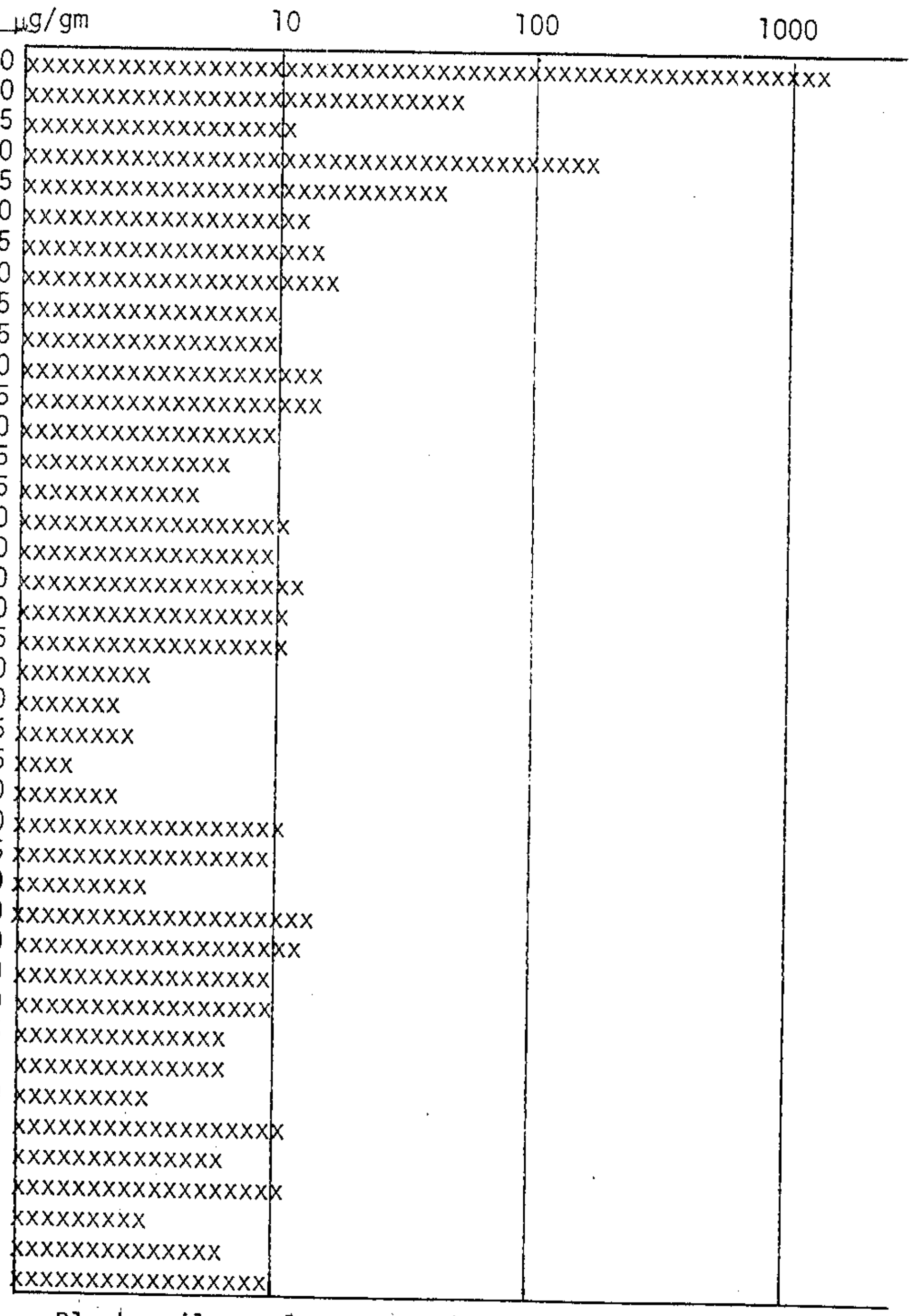
Well #2 Dump Site

Depth vs. Concentration

FLUORIDE

(Conc. Expressed in Micrograms per gram of as-received soil)

Lab. No.	Depth Feet	Fluoride µg/gm
1693	0.0 - 0.5	1,925.0
1694	4.0 - 4.5	70.0
1695	8.0 - 8.5	12.5
1696	12.0 - 12.5	275.0
1697	15.5 - 16.5	63.5
1698	20.0 - 21.0	15.0
1699	24.0 - 25.0	23.5
1700	28.0 - 29.0	26.0
1701	32.0 - 33.0	18.5
1702	36.0 - 37.0	18.5
1703	40.0 - 41.0	21.0
1704	44.0 - 45.0	21.5
1705	48.0 - 49.0	9.0
1706	52.0 - 53.0	7.5
1707	56.0 - 57.0	6.5
1708	60.0 - 61.0	13.0
1709	64.0 - 65.0	10.0
1710	68.0 - 69.0	15.0
1711	72.0 - 73.0	11.0
1712	76.0 - 77.0	10.5
1714	80.0 - 81.0	5.0
1715	84.0 - 85.0	4.0
1716	88.0 - 89.0	4.5
1717	92.0 - 93.0	2.5
1718	96.5 - 97.0	4.0
1719	100.5 - 101.5	11.0
1741	104.5 - 105.5	18.5
1742	108.0 - 109.0	5.0
1743	112.5 - 113.0	20.0
1744	116.5 - 117.0	15.0
1745	120.0 - 121.0	10.0
1746	125.0 - 126.0	10.0
1747	129.0 - 130.0	7.5
1748	133.0 - 134.0	7.5
1749	137.0 - 138.0	5.0
1750	141.0 - 142.0	12.5
1751	144.0 - 145.0	7.5
1752	148.0 - 149.0	12.5
1753	152.0 - 153.0	5.0
1754	156.0 - 157.0	7.5
1755	157.0 - 158.0	10.0
1640	Soil Blank #1	6.0
1641	Soil Blank #2	5.5



Blank soil samples were taken from the Cunningham Sand and Gravel Co. sand pit south of the South Plant

Lab. No.	Identification	Fluoride in Water (Conc. Expressed in Micrograms per ml)
1768	Test Well #2 1st Bail	2.1
1769	Test Well #2 1st Sample from Screen	3.4
1770	Test Well #2 10th Bail	3.9
1851	Test Well #2 50th Bail	2.4
1852	Test Well #2 100th Bail	2.4
	North Plant Production Well #1	0.04
	North Plant Production Well #2	0.03
	North Plant Production Well #3	0.03
	North Plant Production Well #5	-
	North Plant Production Well #6	0.03
	South Plant Production Well East	0.03
	South Plant Production Well West	0.04

RFI M 854

WELL CORING LOG

Date: 2-1-77

Well #2 Dump Site

Depth vs. Concentration

SO_4

(Conc. Expressed in Micrograms per gram of as-received soil)

Lab. No.	Depth Feet	SO_4 µg/gm	1,000 — 10,000
1693	0.0 0.5	422.3	xxxxxxxxx
1694	4.0 - 4.5	679.8	xxxxxxxxxxxxx
1695	8.0 - 8.5	1,102.1	xxxxxxxxxxxxxxxxxxx
1696	12.0 - 12.5	741.6	xxxxxxxxxxxxxx
1697	15.5 - 16.5	267.8	xxxxxx
1698	20.0 - 21.0	1,050.6	xxxxxxxxxxxxxxxxxxx
1699	24.0 - 25.0	1,133.0	xxxxxxxxxxxxxxxxxxx
1700	28.0 - 29.0	679.8	xxxxxxxxxxxxx
1701	32.0 - 33.0	865.2	xxxxxxxxxxxxxxxx
1702	36.0 - 37.0	999.1	xxxxxxxxxxxxxxxxxx
1703	40.0 - 41.0	824.0	xxxxxxxxxxxxxxxx
1704	44.0 - 45.0	339.9	xxxxxx
1705	48.0 - 49.0	648.9	xxxxxxxxxxxxx
1706	52.0 - 53.0	525.3	xxxxxxxxxx
1707	56.0 - 57.0	442.9	xxxxxxxx
1708	60.0 - 61.0	772.5	xxxxxxxxxxxxxx
1709	64.0 - 65.0	999.1	xxxxxxxxxxxxxxxxxx
1710	68.0 - 69.0	659.2	xxxxxxxxxxxxx
1711	72.0 - 73.0	1,462.6	xxxxxxxxxxxxxxxxxxx
1712	76.0 - 77.0	772.5	xxxxxxxxxxxxxx
1714	80.0 - 81.0	638.6	xxxxxxxxxxxxx
1715	84.0 - 85.0	844.6	xxxxxxxxxxxxxxxx
1716	88.0 - 89.0	1,122.7	xxxxxxxxxxxxxxxxxxx
1717	92.0 - 93.0	659.2	xxxxxxxxxxxxx
1718	96.5 - 97.0	957.9	xxxxxxxxxxxxxxxxxx
1719	100.5 - 101.5	844.5	xxxxxxxxxxxxxxxx
1741	104.5 - 105.5	453.2	xxxxxxxxx
1742	108.0 - 109.0	1,318.4	xxxxxxxxxxxxxxxxxxx
1743	112.5 - 113.0	422.3	xxxxxxxxx
1744	116.5 - 117.0	587.1	xxxxxxxxxxx
1745	120.0 - 121.0	700.4	xxxxxxxxxxxxxx
1746	125.0 - 126.0	422.3	xxxxxxxxx
1747	129.0 - 130.0	1,174.2	xxxxxxxxxxxxxxxxxxx
1748	133.0 - 134.0	494.4	xxxxxxxxxx
1749	137.0 - 138.0	288.4	xxxxx
1750	141.0 - 142.0	360.5	xxxxxx
1751	144.0 - 145.0	875.5	xxxxxxxxxxxxxxxx
1752	148.0 - 149.0	1,297.8	xxxxxxxxxxxxxxxxxxx
1753	152.0 - 153.0	1,184.5	xxxxxxxxxxxxxxxxxxx
1754	156.0 - 157.0	556.2	xxxxxxxxxxx
1755	157.0 - 158.0	813.7	xxxxxxxxxxxxxxxxxxxx

1640	Soil Blank #1	1,545	Blank soil samples were taken from the Cunnigham Sand and Gravel Co. sand pit south of the South Plant
1641	Soil Blank #2	1,390	

Lab. No.	Identification	Sulfate in Water (Conc. Expressed in Micrograms per ml)
1768	Test Well #2 1st Bail	241.6
1769	Test Well #2 1st Sample from Screen	172.8
1770	Test Well #2 10th Bail	177.1
1851	Test Well #2 50th Bail	175.9
1852	Test Well #2 100th Bail	182.1
	North Plant Production Well #1	19.3
	North Plant Production Well #2	40.3
	North Plant Production Well #3	18.0
	North Plant Production Well #5	
	North Plant Production Well #6	22.2
	South Plant Production Well East	25.7
	South Plant Production Well West	33.3

RFI M 854

WELL CORING LOG

Date: 2-1-77

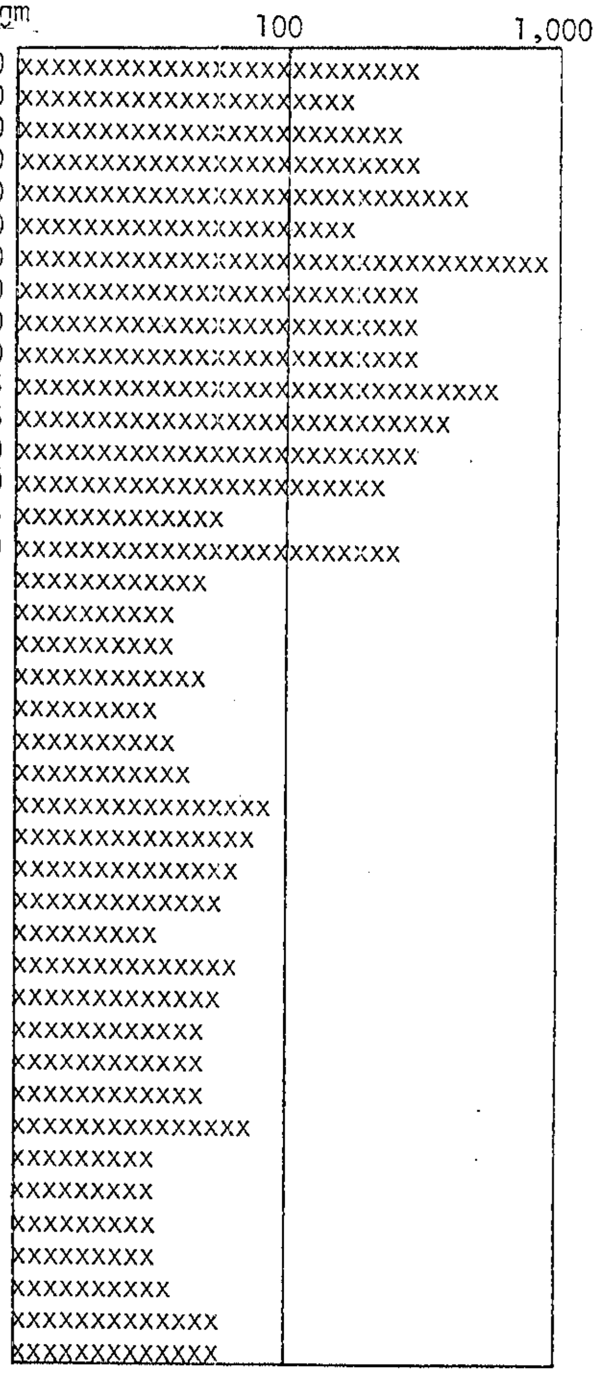
Depth vs. Concentration

Well #2 Dump Site

NO_3

(Conc. Expressed in Micrograms per gram of as-received soil)

Lab. No.	Depth Feet	NO_3 µg/gm
1693	0.0 - 0.5	450
1694	4.0 - 4.5	280
1695	8.0 - 8.5	410
1696	12.0 - 12.5	450
1697	15.5 - 16.5	650
1698	20.0 - 21.0	280
1699	24.0 - 25.0	950
1700	28.0 - 29.0	480
1701	32.0 - 33.0	460
1702	36.0 - 37.0	450
1703	40.0 - 41.0	775
1704	44.0 - 45.0	575
1705	48.0 - 49.0	460
1706	52.0 - 53.0	370
1707	56.0 - 57.0	75
1708	60.0 - 61.0	410
1709	64.0 - 65.0	65
1710	68.0 - 69.0	55
1711	72.0 - 73.0	55
1712	76.0 - 77.0	65
1714	80.0 - 81.0	50
1715	84.0 - 85.0	57
1716	88.0 - 89.0	59
1717	92.0 - 93.0	90
1718	96.5 - 97.0	85
1719	100.5 - 101.5	75
1741	104.5 - 105.5	70
1742	108.0 - 109.0	60
1743	112.5 - 113.0	75
1744	116.5 - 117.0	70
1745	120.0 - 121.0	65
1746	125.0 - 126.0	65
1747	129.0 - 130.0	65
1748	133.0 - 134.0	85
1749	137.0 - 138.0	60
1750	141.0 - 142.0	50
1751	144.0 - 145.0	50
1752	148.0 - 149.0	50
1753	152.0 - 153.0	55
1754	156.0 - 157.0	70
1755	157.0 - 158.0	70
1640	Soil Blank #1	380
1641	Soil Blank #2	205



Blank soil samples were taken from the Cunningham Sand and Gravel Co. sand pit south of the South Plant

Lab. No.	Identification	Nitrate in Water (Conc. Expressed in Micrograms per ml)
1768	Test Well #2 1st Bail	4
1769	Test Well #2 1st Sample from Screen	11
1770	Test Well #2 10th Bail	16
1851	Test Well #2 50th Bail	16
1852	Test Well #2 100th Bail	16
	North Plant Production Well #1	5.4
	North Plant Production Well #2	6.3
	North Plant Production Well #3	4.4
	North Plant Production Well #5	5.6
	North Plant Production Well #6	6.3
	South Plant Production Well East	11.0
	South Plant Production Well West	11.7

APPENDIX III

BENNE .S CHEMICAL LABORATO . , INC.
ANALYTICAL CHEMISTS & ASSAYERS
901 SOUTH 9th STREET TACOMA, WASHINGTON 98405
(206) 272-4507 or 272-7969

September 6, 1977

Mr. Jim Carr
Robinson and Noble
10318 Gravelly Lake Drive, S.W.
Tacoma, WA 98499

Dear Mr. Carr: Re: Sample submitted on 8/6/77

In answer to your inquiry as to the methods used in analyzing the above sample, we would like to inform you that our procedures are taken from the "Standard Methods for the Examination of Water and Wastewater", 13th and 14th editions published by APHA-AWWA and WPCF.

Specifically, calcium, iron, and sodium were determined by atomic absorption methods; Section 311, 14th edition. The remaining ions were analyzed as follows.
Cyanide - Section 207C, 13th edition. We made this determination directly on the sample without distillation. We are aware of negative interferences due to refractory heavy metal complexes but do not know of anything that gives positive errors. Incidentally, the decimal is placed incorrectly in our report for the cyanide. Enclosed, please find our corrected copy.
Nitrate - Section 419D, 14th edition.
Sulfate - Section 427C, 14th edition.
Fluoride - Section 414B, 14th edition.
Aluminum - Section 103B, 13th edition./
Bicarbonate Alkalinity - Section 102, 13th edition, using mixed indicator.
Total Dissolved Solids - Section 148B, 13th edition.

In addition, whenever possible we check the ionic balance to confirm our accuracy. For instance in this series of tests we also determined the total hardness by titration (Section 122B, 13th edition), magnesium (atomic absorption), and chloride by titration (Section 112A, 13th edition). Then some calculations confirmed our analysis. Namely, total hardness by titration checked the calculated result and the anion equivalents check the cation equivalents. Therefore, we feel our results are reasonably accurate and reflect the values in the water.

Yours truly,

BENNETT CHEMICAL LABORATORIES, INC.

Galen B. Prine H.B.

GBP:hb

Galen B. Prine

BENNETTS CHEMICAL LABORATORIES, INC.
ANALYTICAL CHEMISTS & ASSAYERS
901 SOUTH 9th STREET TACOMA, WASHINGTON 98405
(206) 272-4507 or 272-7969

REPORT OF ANALYSIS

September 7, 1977

Our analysis of the sample of Water

From Robinson and Noble
Received sample on August 5, 1977

Marked: As shown above

CORRECTED COPY

pH - 7.9

Calcium	74.3 mg/liter
Sodium	27.0 mg/liter
Iron	0.23 mg/liter
Cyanide	0.032 mg/liter
Nitrate	3.94 mg/liter
Sulfate	158.0 mg/liter
Fluoride	0.09 mg/liter
Aluminum	0.01 mg/liter*
Bicarbonate Alkalinity	178.0 mg/liter**
Total Dissolved Solids	411.0 mg/liter

*Less than **As Calcium Carbonate

To Robinson and Noble
10318 Gravelly Lake Drive, S.W.
Tacoma, WA 98499

BENNETTS CHEMICAL LABORATORIES, INC.

By [signature]

INTER-OFFICE MEMORANDUM

TO W. B. Eastman

AT Mead

COPIES TO

DATE October 13, 1977

FROM F. G. Doolittle F. G. Doolittle

AT Mead

SUBJECT Methods Used for Analyzing Soil and Water Samples in Test Well Project

REFERRING TO

The following analyses were performed on the well water samples and the 500 ml soil leachate

Water	Soil
Suspended Solids	
pH	pH
CN^-	CN^-
F^-	F^-
NO_3^-	NO_3^-
$SO_4^=$	$SO_4^=$
Na^+	Na^+
Ca^{++}	Ca^{++}

The methods used and references to these methods (when applicable) are as follows:

A. Nitrate method used was 419B from "Standard Methods for the Examination of Water and Waste Water", Fourteenth Edition.

B. Cyanide Methods used were all glass distillation into NaOH followed by analysis using cyanide colorimetric method B pages 448-457 of "Standard Methods for the Examination of Water and Waste Water", Twelfth Edition.

C. The pH of the well waters and of the soil extract solution was determined using an 801A orion research Digital Ion Analyzer.

D. Sulfate was determined using method 427B "Standard Methods for the Examination of Water and Waste Water", Fourteenth Edition.

E. Fluoride was determined using method 203 Tentative Method of Analysis for Fluoride content of the Atmosphere and Plant Tissues. "Methods of Air Sampling and Analysis" published by the APHA, 1972 edition.

This is a Technicon Autoanalyzer method and several minor modifications are used with the Mead routine analytical procedure.

F. The suspended solids were determined using method 208D "Standard Methods for the Examination of Water and Waste Water", Fourteenth Edition.

G. The calcium and sodium were run by Atomic Absorption (AA) methods found in the 1968 edition of "Analytical Methods for AA Spectrophotometry published by Perkin-Elmer. The methods are titled "Extractable Calcium in Soils" and "Extractable Sodium in Soils".

WELL WATER CHECK SAMPLES

	µg CN^-/ml		µg NO_3^-/ml				µg F^-/ml		
Sample Identification	Mead[1]	CFT[2,9]	Mead[1]	CFT[2,4]	CFT[2,5]	Spokane[3,6]	Mead[1]	CFT[2,7]	CFT[2,8]
South Plant East Well	.002	<.001	11.0	13.00	13.40	13.5	.03	.03	<.05
North Plant Well #6	.003	<.001	6.3	8.20	8.25	8.3	.03	.04	<.05
Test Well #1, 10th Bail	.000	.011	24.0	11.80	12.10	-	2.90	3.68	3.40
Distilled Water	-	<.001	-	<.05	<.05	-	-	<.01	<.05

Notes:

1) KACC Mead Lab. analysis.
2) Kaiser Center for Technology analysis.
3) Spokane County Engineers' Office analysis.
4) Chromotropic acid, spectrophotometric.
5) Cd reduction, $NO_2 + NO_3$, diazo spectrophotometric.
6) Same as Mead NO_3 method.
7) Technicon Auto Analyzer.
8) Zr:SPADNS spectrophotometric.
9) UV irradiation, distillation, pyridine-barbituric acid, Auto Analyzer.

R. J. Schlager
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