Golder Associates
CONSULTING GEOTECHNICAL AND MINING ENGINEERS

Report on

SUMMARY AND CHARACTERIZATION OF SITE HYDROGEOLOGIC CONDITIONS CHEMICAL WASTE MANAGEMENT, INC. VICKERY, OHIO FACILITY

Submitted to:

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1.0 INTRODUCTION

1.1 Terms of Reference

Golder Associates was retained by Chemical Waste Management, Inc. (CWM) to undertake an assessment of hydrogeologic conditions at their liquid disposal facility near Vickery, Ohio. A preliminary review of site hydrogeologic conditions was originally provided in Golder Associates' report entitled "Geotechnical and Geohydrologic Data Review", dated June 1983. The purpose of this report is to present a more detailed discussion and interpretation of site hydrogeology, based on the results of further review of published data and previous studies at the site by others, and the most recent results of field investigations at the site.

1.2 Site Description

The CWM facility is located in Sandusky County, near Vickery, Ohio (Figure 1). The facility comprises about 280 acres and is essentially bounded by the Ohio Turnpike to the north, State Routes 512 and 410 to the east and south, and County Road 403 to the west. The surrounding land use is primarily agricultural. The site topography is quite flat and, apart from man-made features such as drainage ditches and fills, exhibits less than 4 ft. of relief.

The facility was used for the reclamation of waste oil products and is currently disposing acid waste products. A series of lagoons, contained by perimeter dikes, have been constructed for temporary storage of these products (Figure 2).

The fluids from the lagoons are ultimately settled, filtered, and injected into the bedrock beneath the site at a depth of over 2,800 ft., through a series of five active injection wells (Figure 2).

2.0 PROCEDURE

2.1 Review of Background Information

The following background information was reviewed in order to gain a further appreciation of site geologic and hydrogeologic conditions:

- Various geologic and hydrogeologic summary maps prepared by the Ohio Department of Natural Resources (ODNR), and the U.S.G.S. (Ref. 2 and 3).
- Drilling logs and in situ testing for the deep injection wells at the site.
- A groundwater use planning studies of carbonate aquifers in northwest Ohio, prepared by the ODNR (Ref. 4 and 5).
- The results of groundwater quality and elevation monitoring at the site, conducted by CWM and previous site operators.

A complete list of these references is presented at the end of the text of this report.

2.2 Field Investigation Program

A field investigation of hydrogeologic conditions at the Vickery facility is currently being conducted by Golder Associates. The following aspects of the investigation are included in this report.

- The results of 14 sampled boreholes and piezometer installations primarily in the overburden materials in the vicinity of the existing lagoons. These boreholes (denoted as D-1 to D-9B) were drilled to assess the stability at the lagoon containment dikes and to obtain data regarding piezometric conditions. The locations of these borings are shown on Figures 2, 3 and 4 and the borehole logs are presented in Appendix D.

- The results of 10 piezometer installations in the berock and overburden materials at various locations at the site. These piezometers are denoted as P-1 to P-10, and were installed primarily to allow further assessment of groundwater elevations and gradients. Their locations are shown on Figures 2, 3 and 4 and their logs are included in Appendix D.

- Water level measurements from frequent groundwater elevation monitoring in all accessible piezometers and monitoring wells over a period of two months, in order to assess groundwater gradients and fluctuations. These measurements are listed on Tables A-1 to A-3 in Appendix A of this report and plotted on Figures 11 through 16.

- Results of in situ and laboratory testing of the hydraulic conductivity of the overburden and bedrock materials, to allow estimation of approximate groundwater flow velocities in the various strata. These results are summarized on Tables A-4 to A-6 in Appendix A, and on the Record of Borehole Sheets.

The locations of the borings, piezometers, and monitoring wells are shown on Figure 2. The piezometers and monitoring wells completed in the overburden are shown on Figure 3 and those completed in the bedrock aquifer are shown on Figure 4. A discussion of the field procedures used during the field investigation is presented in Appendix B.

3.0 SUBSURFACE CONDITIONS

A brief description of geology, primarily as it affects hydrogeologic conditions in the vicinity of the site, is presented below. A complete description of site geology with respect to glacial history, bedrock structure, and engineering properties of the overburden and bedrock materials is presented in Golder Associates' report "Assessment of Perimeter Containment Dyke Stability", July 1983, and Bowser-Morner's report "Hydrogeologic Assessment - Northern Ohio Treatment Facility", May 1983.

3.1 Site Geology

In summary, the site is underlain by about 40 ft. to 50 ft. of glacial overburden materials, comprising lacustrine clay and glacial till, overlying dolomite bedrock. The water bearing zone of the dolomite bedrock beneath the site is about 500 ft. to 550 ft. in thickness. This dolomite is underlain by a complex sequence of sedimentary rocks comprising shale, sandstone, limestone, and dolomite. Precambrian granitic bedrock (often referred to as "basement" rock) is encountered at a depth of about 2,900 ft. below the ground surface.

Cross sections of typical site geology in the overburden and shallow bedrock zones are presented on Figure 5. A section of the bedrock stratigraphy from the ground surface to the Precambrian basement rock is shown on Figure 6.

3.1.1 Overburden Materials

The overburden at the site consists of a deposit of glacio-lacustrine silty clay which ranges in thickness from 5 ft. to 25 ft. at the borehole locations; the typi-

cal thickness of this unit is about 15 ft. The material is uniformly graded and comprises silty clay to clayey silt with a trace of sand. Distinct horizontal laminations of 1/4 in. to 1 in. thicknesses are noted in this unit and silty sand partings are often found between the laminations.

The upper 5 ft. to 10 ft. of the lacustrine materials is likely to be fractured as the result of shrinkage due to previous desiccation; although open fractures were not directly observed in any of the samples obtained.

Underlying the lacustrine materials, deposits of glacial till were encountered to bedrock. The till deposits consist of an upper unit of 10 ft. to 45 ft. thickness which appears to be continuous across the site, and a lower unit which is generally less than 5 ft. in thickness. The lower unit was encountered directly above the bedrock, and is not continuous across the site.

The upper till is fairly well graded and comprises silty clay to clayey silt, with some sand and gravel. It is relatively homogeneous in composition and exhibits no lamination, bedding, or other distinct depositional structure, and appears to be intact (i.e., unfractured) throughout. The lower till is somewhat coarser in gradation, and comprises a silt with some sand, clay, and gravel.

3.1.2 Bedrock Conditions

The bedrock beneath the site is situated on the southeastern arm of an anticlinal structure (the Findley Arch) which strikes to the northeast. The axis of the anticline is located about 20 miles west of the site. A

major north trending, near vertical faulting system (Bowling Green Fault) is located about 35 miles to the west of the site. The site is underlain by approximately 550 ft. of predominantly carbonate rocks of Middle and Upper Silarian age. As will be noted later in this report, these strata are the most significant with respect to regional water supply and are locally referred to as the "Big Lime" formation. Beneath these carbonate rocks is a sequence of shale, limestone, sandstone, and dolomite approximately 2,350 ft. thick, which extends to the Precambrian granitic rock (Ref. 6).

The bedrock directly beneath the site is identified as Tymochtee dolomite of the Bass Island Group. Based on logs of water wells drilled in the general vicinity of the site, this unit is about 150 ft. in thickness. This stratum is typically described as thin bedded, grey-brown, very fine grained dolomite, with numerous argillaceous zones and evaporate (gypsum, arhydrite) beds. The Tymochtee dolomite was cored at the site to depths of about 125 ft. below ground surface (Ref. 1). This core contained frequent highly weathered zones and some small (tpyically less than 1 in.) solution cavities and voids. Gypsum was often noted as a coating on the open fractures or cavities in the rock.

The Tymochtee dolomite is underlain by a more uniform, fine grained dolomite known as the Greenfield. The Greenfield dolomite was not penetrated by any of the cored test borings at the site. However, drilling records from nearby water wells suggest that the thickness of this formation is approximately 40 ft. in the vicinity of the site. This strata is reported to comprise uniform dolomite with few shale or evaporate beds.

The lowermost member of the upper carbonate sequence beneath the site is the dolomite of the Lockport Group. The thickness of this unit is about 120 ft. to 190 ft. in the vicinity of the site.

The remaining bedrock units encountered beneath the upper carbonate rocks at the site are shown graphically on Figure 6. Core samples of these deposits were generally not obtained, and the descriptions are based on recovery of drill cuttings and geophysical logging of the deep injection wells.

3.2 Site Hydrogeology

The following sections of the report present an overview of site hydrogeologic conditions, with respect to the hydraulic properties, groundwater use, and typical groundwater levels for the various strata. The results of on-site monitoring of groundwater levels in the overburden and upper carbonate bedrock is presented in Section 6.3 of this report.

3.2.1 Overburden

The hydraulic conductivity of the lacustrine materials was determined as approximately 2×10^{-8} cm/s on the basis of six laboratory tests conducted by Bowser-Morner, Inc. These tests measured the hydraulic conductivity in a vertical direction. A Single test conducted in the horizontal direction yielded a hydraulic conductivity of 9×10^{-8} cm/s.

The results of in situ rising head tests conducted by Golder Associates in piezometers installed in the lacus-

trine deposit indicate that the hydraulic conductvitiy may be on the order of $1x10^{-6}$ cm/s. The greater hydraulic conductivity measured in situ may arise from two factors: 1) the in situ measurements are likely dominated by hydraulic conductivity in the horizontal direction, which is expected to be greater than in the vertical direction due to the layered nature of the soil and the presence of sandy partings; and 2) the presence of open fractures in the desiccated crust of the soil. Although fractures were not directly observed in samples of the lacustrine materials from the site, experience with similar soils suggests that a fracture "porosity" (i.e. ratio of the volume of open fractures to total volume) may typically be on the order of 0.001.

On the basis of these laboratory and field tests, it is estimated that the hydraulic conductivity of the lacustrine soils is about $1x10^{-6}$ cm/s in the fractured (desiccated) zone. Beneath this zone, it is estimated that the hydraulic conductivity in the vertical direction is about $2x10^{-8}$ cm/s, and in the horizontal direction, about $1x10^{-7}$ cm/s.

The results of laboratory testing of the upper glacial till soil by Bowser-Morner, Inc. (Ref. 1) indicates that the hydraulic conductivity ranges from about $3x10^{-8}$ cm/s to $6x10^{-9}$ cm/s. The in situ rising head tests are in close agreement, indicating that the hydraulic conductivity is about $2x10^{-8}$ cm/s. The close agreement between the laboratory and in situ tests is suggests uniformity in composition and lack of depositional structure in the soil.

For the purposes of calculations, the hydraulic conductivity of the upper till unit has been estimated to be is $2x10^{-8}$ cm/s. The effective porosity of the till has been estimated to be 0.1. Testing of the hydraulic conductivity of the lower till unit was not undertaken.

Groundwater levels measured in the overburden materials were typically within 5 ft. of the ground surface. This water level represents an unconfined water table in the soil, and all of the soil beneath this water table is in a saturated condition. Although most of the overburden is saturated, it is not considered to be a local aquifer since its very low hydraulic conductivity would result in insufficient well yields for water supply purposes.

3.2.2 Upper Carbonate Bedrock

The carbonate bedrock sequence beneath the site comprising the "Big Lime" formation is considered to be the uppermost local aquifer. This aquifer consists of the Tymochtee, Greenfield, and Lockport members as previously discussed.

A detailed regional study of the hydrogeology of these carbonate aquifers in Northwestern Ohio was conducted by the Ohio Department of Natural Resources (Ref. 5). This study included characterization of water levels, water quality, and the hydraulic properties of the aquifer. The study indicates that most of the groundwater occurrence and flow in the aquifer takes place in the fractures, joints, solution cavities, and other rock mass discontinuities, rather than in the intergranular pore spaces of the rock.

In the vicinity of the site, the carbonate aquifer is confined by the overlying glacial deposits. Although these overlying deposits have a low hydraulic conductivity and form an effective confining layer, much of the recharge to the aquifer is the result of downward flow through the overburden. It should be emphasized that the rate of flow through the overburden is very slow. However, due to the large areal extent, downward flow through the overburden provides the majority of recharge to the aquifer. Because of the infiltration of water through the overburden, groundwater withdrawal caused by local pumping is often balanced by groundwater infiltration such that a relatively steady state cone of depression is produced and permanent depletion of storage in the aquifer does not occur.

The water level in the Tymochtee dolomite beneath the site is typically 15 ft. to 20 ft. below ground surface; about 10 ft. to 15 ft. lower than the water table in the overburden materials. Annual regional water level fluctuations in the carbonate aquifer are reported to be on the order of 3 ft. to 5 ft. (Ref. 5), but measurements in site monitoring wells have shown fluctuations on the order of 5 ft. to 10 ft.

The data from the test wells completed in the Tymochtee dolomite as reported by the ODNR (Ref. 5) indicates that the most significant water bearing zones occur in the upper 30 ft. to 70 ft. of the formation. This report also indicates the underlying Greenfield formation generally does not yield significant volumes of water, except near the base of the formation, but the Lockport dolomite generally yields water through the entire thickness of the formation. As previously noted, groundwater flow through

the upper carbonate bedrock is primarily due to fractures, joints, solution cavities, and other discontinuities. Since the occurrence of these structures is often highly variable, the hydraulic properties of the bedrock may also be expected to be highly variable. For this reason, the hydraulic properties are most representative if they are obtained through test methods which affect a large volume of the bedrock.

The hydraulic properties of the bedrock have been estimated by several methods as follows:

1. Large scale pump tests conducted by ODNR in 3 wells completed in the carbonate aquifer at locations about 3 to 10 miles from the site;

2. A small scale pump test at the site conducted by Bowser-Morner, Inc.;

3. Pressure-packer tests accomplished by Golder Associates in 3 boreholes at the site;

4. The results of drawdown (specific capacity) tests performed by Dames & Moore in the site monitoring wells during water quality sampling; and

5. Calculation of hydraulic properties from empirical relationships.

The results of the hydraulic properties estimated by each of these methods is presented below and is summarized on Table A-7. It should be noted that much of the data obtained is for the upper Tymochtee dolomite.

The approximate location of the wells used for the ODNR pumping tests is shown on Figure 7 (a complete description of the test procedures and results is given in Ref. 5). The wells were pumped at rates of about 500 gpm

for a period of at least 24 hours. The values of transmissivity obtained from the tests ranged from about 20,000 gpd/ft. for a well completed in the Lockport dolomite to 100,000 gpd/ft. for two wells completed in the Tymochtee and Greenfield dolomites. The values of specific capacity (defined as well yield in gallons per minute per foot of well drawdown per foot of well penetration) obtained from the testing ranged from 0.027 gpm/ft./ft. (Lockport) to 1.84 gpm/ft./ft. (Tymochtee and Greenfield).

A small scale pump test was undertaken at the site by Bowser-Morner, Inc., in the pumphouse well, #10, (Figure 2) which is completed in the Tymochtee dolomite. The test was conducted for about 5 hours at a pumping rate of 11 gpm. The drawdown data obtained from the test is somewhat erratic, and it is suspected that the results may not be representative due to the low pumping rate and short duration of the test. The value of transmissivity obtained from analysis of the test results was approximately 3,000 gpd/ft.

Pressure packer tests were conducted in the Tymochtee dolomite by Golder Associates in boreholes P-6, P-9, and P-10, in order to assess the relative changes in hydraulic conductivity in the strata with depth. The tests were conducted at 5 ft. intervals to depths of 30 ft. to 40 ft. below the top of the rock. The results of the tests are presented in the Record of Borehole sheets and in Table A-6. The average value of hydraulic conductivity obtained in the tests is about 2×10^{-3} cm/s. The uniformity of the results suggests that there is little change in hydraulic conductivity with depth in the upper 30 ft. of the Tymochtee dolomite.

Drawdown measurements were made in the site monitoring wells when they were pumped (flushed) by Dames & Moore prior to groundwater sampling. With the exception of Well #2 and Well #1N, all of the wells are completed in the upper 20 ft. of the Tymochtee dolomite. Well #2 is about 150 ft. deep in the Tymochtee dolomite. It is the main water supply well at the site, but because of its construction water levels could not be monitored during pumping. Monitoring Well #5 is also not accessable for water level monitoring. Well #1N is about 200 ft. deep and is open through the Tymochtee and Greenfield dolomites. The pumping rates used during the flushing were about 10 gpm to 13 gpm. The values of specific capacity obtained for the wells completed in Tymochtee dolomite was about 0.03 gpm/ft./ft. to 1.2 gpm/ft./ft.; while the value obtained from Well #1N for the Tymochtee and Greenfield dolomite was about 0.17 gpm/ft./ft. The results of these tests are summarized on Table A-8. The wide range of the results indicates that the hydraulic properties of the bedrock may be highly variable.

The hydraulic conductivity of the bedrock may also be estimated by dividing the transmissivity of the formation by it's effective thickness (i.e., that portion of the formation which transmits significant quantities of water). If the effective thickness of the Tymochtee dolomite is taken as 30 ft. to 70 ft., and the range of transmissivity values as 3,000 gpd/ft. to 100,000 gpd/ft., then the resulting range of hydraulic conductivities is about 10^{-1} cm/s to 10^{-3} cm/s.

Based on Golder Associates' review of the foregoing data and experience with similar geologic materials, the

following hydraulic parameters are considered to be representative of the Tymochtee dolomite beneath the site:

Transmissivity	20,000 gpd/ft.
Hydraulic Conductivity	$1x10^{-2}$ cm/s (210 gpd/ft.^{2})
Storativity	$2x10^{-4}$

3.2.3 Underlying Sedimentary Rock Sequence

There is little information available concerning the hydraulic properties or piezometric levels in the sedimentary rocks underlying the Big Lime formation. Generally, it is thought that there is a tendency for lower water levels with depth in these formations. Drill stem tests performed during the installation of the injection wells indicate that the static groundwater level in the Mt. Simon sandstone is approximately 325 ft. beneath ground surface (EL 280 ft. MSL).

The drill stem tests also suggest that the hydraulic conductivity of the Mt. Simon sandstone is on the order of $3x10^{-5}$ cm/s. There is no data available concerning the hydraulic conductivity of the overlying, less permeable strata such as the Ordovician Shale sequence (Figure 6). However, based on previous experience with similar geologic materials, it is estimated to be very low, probably on the order of 10^{-8} cm/s to 10^{-10} cm/s.

3.3 Ambient Groundwater Quality

3.3.1 Upper Carbonate Aquifers

The ambient groundwater quality in the upper carbonate aquifers has been studied by th ODNR, and is reported in Ref. 5. This study indicates that the groundwater quality may be highly variable and is largely dependent on the occurrence of evaporate minerals in the bedrock (such

as gypsum and anhydrite). The groundwater in the vicinity of the site has generally been exposed to evaporate minerals, and consequently is high in total dissolved solids, sulphates, and hardness (as Ca^{++}). The typical range of selected mineral constituents in the groundwater from nearby ODNR wells (Figure 7) is summarized below. Complete data for the wells is presented in References 1 and 5.

Constituent	Range mg/l
Iron (Fe)	.02 - 19
Calcium (Ca)	109 - 577
Magnesium (Mg)	71 - 177
Sodium (Na)	7 - 35
Sulfate (SO_4)	128 - 1831
Chloride (Cl)	5 - 46
Total Solids (TS)	340 - 8124
Total Hardness	280 - 3598
pH	7.0 - 7.4 (not mg/l)

Note: Data obtained from samples taken from Tymochtee, Greenfield, and Lockport dolomites.

Due to the high total solids and hardness values, the groundwater from the dolomite aquifer is generally not used locally (i.e., in the vicinity of the site) for domestic purposes. Potable water is generally trucked in and groundwater use is commonly limited to livestock and agricultural uses.

3.3.2 Underlying Sedimentary Rock Sequence

The base of the Big Lime formation (i.e., base of the Lockport dolomite in the vicinity of the site) is considered to be the lowest formation yielding groundwater suitable for domestic or agricultural purposes. The underlying Rochester Shales are known to contain saline

waters with elevated total dissolved solids (TDS) and chloride contents, although exact water quality figures are not available.

Generally, there is a tendency for increased TDS and chloride content with depth through the sedimentary sequence, due to leaching of evaporate salts, and in exchange processes in the shale formations. This process results in an evaluation of groundwater chemistry with depth as illustrated below:

	Shallow Carbonate Aquifer (Big Lime)	With Increasing Depth	Deep Sedimentary Formations (Mt. Simon)
Predominant Cations	Ca, Mg	Ca, Na	Na, Ca
Predominant Anions	HCO_3^-, SO_4^{-2}	SO_4^{-2}, Cl	Cl^-
Typical TDS Content	1,000 mg/l	increasing	100,000 mg/l

The groundwater in the deep dolomite and sandstone formations, such as the Mt. Simon and Rome formations, is typically a brine with TDS values of over 100,000 mg/l (Ref. 7). The predominant ions in this water are sodium and chloride.

4.0 GROUNDWATER PUMPING

There are seven water supply wells on and in the immediate vicinity of the site which draw water from the carbonate aquifer. There is currently little available quantitative data regarding the pumping rate or pumping duration for these wells. However, reasonable estimates of expected water usage from each well can be made, based on the wells' intended purpose and discussions with site operations staff. The identification, purpose, and estimated pumping rates for each of the wells is listed below. The locations of the wells is provided on Figure 2.

Well No.	Purpose	Estimated Monthly Rate (gal.)
10 (Pump-house Well)	Occasional Washing	50
1N	Backwash Sand Filters	4,000 - 5,000
2	Truck Washing	500,000*
OEPA 4, 5, 6, 8	Domestic Supply	6,000 - 10,000

This data indicates that Well #2 is the only major source of groundwater withdrawal at the site. A recording device has recently been fitted to the well to permit further evaluation of actual pumping rates. This data will be reported as it becomes available.

*Volume based on the number of trucks washed per month multiplied by an estimated 1,000 gallons of water per truck.

5.0 DEEP INJECTION WELLS

There are currently five active deep injection wells at the site, as shown on Figure 2. There is also one inactive injection well and one abandoned injection well which has been cement-grouted to the surface. All of the injection wells extend into the Mt. Simon sandstone formation, located immediately above the Precambrian basement rock (Figure 6). The injection well logs are included in Appendix C. A typical cross-section of the construction of the wells is illustrated on Figure 8. The wells were installed between 1972 and 1981, as noted in the summary table below:

Well No.	Date Installed	Date Operational	Date Taken Out of Operation	Date Closed	Current Status
Injection Well 1	3/72	1976	1979	1980	Closed
Injection Well 1A	9/79	1980			Active
Injection Well 2	6/76	1977	1982		Inactive
Injection Well 3	7/76	1977			Active
Injection Well 4	7/76	1977			Active
Injection Well 5	1981	1982			Active
Injection Well 6	11/81	1982			Active

In general, the injection well construction comprises a series of three concentric casings, with the largest (outermost) casing terminated at the base of the Big Lime formation. The remaining casings extend to the Mt. Simon formation with a cement seal provided between the intermediate (or 'long-string') casing and the bedrock. The tip of the intermediate casing is grout sealed into the Shady dolomite bedrock immediately above the Mt. Simon using an epoxy type grout seal. A diesel fuel column is maintained between the intermediate and innermost (injector tube) casing, to allow detection of pressure differences in the event of leakage of one of the casings.

The typical operating injection pressure, as measured at the ground surface, is reported by CWM staff as about 500-600 psi (equivalent to 1,150 to 1,380 ft. of water). The maximum allowable operating pressure as set out by the operating license requirements for the wells is about 825 psi at the ground surface (equivalent to 1,900 ft. of water). The average injection rate for the wells is about 40 to 45 gpm.

6.0 GROUNDWATER LEVEL MONITORING

6.1 Regional Groundwater Levels

The regional groundwater level contours in the upper carbonate aquifer are plotted on Figure 9. These groundwater level contours were derived from a series of test wells which were monitored as part of a regional study of the aquifer (Ref. 5). These contours indicate that the regional groundwater flow in the area is generally toward Lake Erie in a north or northwesterly direction with a gradient of about 1.6×10^{-3} ft./ft. The flow system in the carbonate aquifer appears to discharge beneath Lake Erie. It should be noted that these groundwater contours represent an average value of hydraulic head obtained from wells which are completed at different depths and in different formations within the Big Lime strata. For this reason, some local variation in flow direction and gradient may be expected. Further, the data was intended primarily to indicate horizontal flow patterns; and variations in head with depth throughout the Big Lime were not considered. Since the site is located near the discharge area of the flow system, there may be an upward component to the gradient in the vicinity of the site. However, there is currently no data to confirm such an upward gradient which would be indicated by increasing head levels with depth in the formation.

6.2 Background Data from Site Monitoring Wells

A number of monitoring wells have been installed in the overburden and upper carbonate bedrock, as shown on Figure 2. The details of the monitoring well installations are presented in Appendix C; the overburden wells are generally completed in the upper portion of the glacial till deposits, while the bedrock wells are generally

completed in the upper portion of the Tymochtee formation. Water levels in seven of these wells have been measured periodically by site operations staff since 1976. The measurements were generally reported to the nearest 1/2 ft. or 0.1 meter; however, the actual accuracy of the measurements is not known. This data is plotted on Figure 10. These plots indicate that the groundwater levels may fluctuate considerably over a short period of time. The magnitude of the fluctuations, ignoring the extremes in the data, is on the order of 5 ft. to 10 ft. These fluctuations also tend to occur in unison, such that all water levels change by about the same amount at the same time.

The background water level plots (Figure 10) show four obvious spikes in the data; June 1976, late August 1977, early September 1979, and mid-July 1981. The data sheets provided by CWM included a notation that Well #2 was pumped from August 26 to 29, 1977 (reason, rate and quantity unknown). No similar notations were made for the other three dates, but the severe drawdown spikes in the monitoring wells are similar. It is instructive to note that the three severe drawdown spikes in the historical water level data approximately coincide with the installation of deep injection wells. From the injection well logs the following dates are noted:

Injection Well No.	Installation Date
2	6/17/76 to 11/23/76
3	7/1/76 yo 11/22/76
4	7/15/76 to 11/24/76
1A	9/10/79 to 9/27/79
5	After 6/11/80
6	Completed 11/17/81

It is probable that Well #2 was pumped for the purpose of providing drilling and/or development water during installation of the injection wells. This cannot be precisely correlated but the time frames bracket the severe drawdown spikes.

6.3 Current Monitoring of Groundwater Levels

Based on the historic groundwater level data, it is evident that significant fluctuations of water level can occur over short periods of time. Accordingly, to allow determination of local groundwater gradients and flow directions, the water levels in all of the accessible wells and piezometers on the site were monitored on the same day on a frequent basis between April and July, 1983. The results of this monitoring are presented on Figures 11 to 16, and the data is tabulated in Tables A-1, A-2, and A-3.

6.4 Interpretation of Results

A series of groundwater level contours in the Tymochtee dolomite on selected dates are shown on Figures 17 to 23. Although there is no data available for the extreme northeast corner of the site, the contours strongly suggest a radial flow pattern in the bedrock. This pattern could result if significant groundwater withdrawal were occurring near the center of the site, such as from Well #2. Since Well #2 is used primarily for washing of trucks, an approximation of daily water usage was obtained by examining site records of the number of trucks washed over a two week period. A plot of daily water usage during this period was made, assuming that about 1,000 gallons was used to wash each truck. The plot is presented on Figure 24, along with water levels in selected wells.

It is noted that lower water levels are associated with those days of high estimated water usage.

The groundwater levels in the shallow overburden zone (lacustrine materials) were found to vary by about 3 ft. to 5 ft. over the site. It appears that these water levels are affected by surface topograhic features such as drainage ditches. Slightly lower water levels were noted in the vicinity of deep drainage ditches, such as near P-7 and Well #3A, and slightly higher levels were noted in some of the piezometers installed in the dikes, such as D-6a. However, there is no evidence to suggest significant mounding of groundwater in the dikes or beneath the ponds.

As indicated by the plots shown on Figure 12, the groundwater levels in the deep glacial till deposits had generally not stabilized as of the date of this report. However, the groundwater levels in the till are generally lower than those in the overlying lacustrine deposits. This substantiates downward vertical flow through the overburden to the dolomite aquifer as discussed in Section 3.2.2.

An estimate of the expected drawdown caused by Well #2 was made using the parameters for bedrock hydraulic properties presented in Section 3.2.2, and an estimated pumping rate obtained from CWM operations staff. The purpose of the estimate is primarily to determine whether the observed radial flow pattern, or "cone of depression", could be the result of pumping from Well #2. The estimate was made using a conventional Theis type analysis. The results are summarized as follows:

Assumed Pumping Rate	500,000 gallons/month for a period of one year (average rate of 12 gpm)
Assumed Aquifer Properties (Tymochtee dolomite)	$T = 20,000$ gpd/ft.^{2} $S = 2x10^{-4}$

Calculated drawdown at radius of 1,000 ft. is about 0.8 ft.

Calculated drawdown at radius of 2,000 ft. is about 0.7 ft.

Since groundwater occurrence and flow in the rock is primarily through fractures, joints, and other rock mass discontinuities it is expected that the drawdowns will not form a cone of depression which is symmetrical about Well #2. Further, the analysis does not consider the effects of recharge to the aquifer or the effects of cyclic pumping of the well. Since a pumping rate of 500,000 gallons/month is equivalent to an average rate of only 12 gpm, the results of the analysis tend to under estimate the actual drawdown which may occur during the operating cycle of the pump when the pumping rate may reach 250 gpm. For example, if the pump were operated at 250 gpm for one-half hour, the calculated drawdowns would be approximately 2.5 ft. at a radius of 1,000 ft. and 1 ft. at a radius of 2,000 ft. Despite the use of these simplifying assumptions, the analysis indicated that Well #2 is probably responsible for creating the core of depression observed at the site.

The typical yearly fluctuation of groundwater levels in the bedrock aquifer at the site is on the order of 5 ft. to 10 ft. These fluctuations can be attributed to several causes as listed below:

1. Changes in barometric pressure may result in fluctuations of approximately ± 0.5 ft.

2. Recharge due to rainfall may result in fluctuations on the order of ±3 ft., as evidenced by the records of observation wells in the area, such as U.S.G.S. Well #S-3 (Figure 5).

3. Changes in pumping rate and duration of on-site wells.

As indicated on the water level contour plots (Figures 17 to 23) the changes in water level due to recharge and barometric effects are superimposed on the changes due to the pumping rate. Thus, the entire cone of depression may rise and fall even if pumping rates are relatively constant. This phenomenon was also noted by ODNR in their study of the carbonate aquifer (Ref. 5).

7.0 GROUNDWATER GRADIENTS AND FLOW RATES

7.1 Overburden Materials

The gradient in the overburden materials was observed to be primarily downward. A small component of flow in the lacustrine materials is directed laterally, toward drainage ditches at the site. The groundwater levels in the glacial till have not stabilized sufficiently to allow assessment of horizontal flow components.

The rate of downward flow through the overburden into the bedrock will be governed by the low hydraulic conductivity of the glacial till. Using Darcy's relationship, the flow rate through the till is calculated as:

$$v \text{ (velocity)} = ki/n = 0.07 \text{ ft./yr.}$$

where: k (hydraulic conductivity) = 2×10^{-8} cm/s (2×10^{-2} ft./yr.)
i (gradient) = 0.33 ft./ft.
n (porosity) = 0.1

This indicates that the downward flow through the overburden is very slow.

The horizontal flow rate through the fractured, upper lacustrine deposit is calculated in a similar fashion:

$$v = ki/n = 2 \text{ ft./yr.}$$

where: $k = 1 \times 10^{-6}$ cm/s (1 ft./yr.)
$i = 2 \times 10^{-3}$ ft./ft.
$n = 0.001$

In this case, the horizontal gradient ($i = 2 \times 10^{-3}$ ft./ft.) accounts for flow from the central portion of the site to the drainage ditches. The horizontal gradient can vary

widely depending on local topography and surface drainage features which have been excavated below the overburden groundwater levels.

7.2 Upper Carbonate Bedrock

Under static conditions (i.e., neglecting the influence of pumping), the regional groundwater gradient is about 1.6×10^{-3} in a northeasterly direction. Thus, the horizontal flow rate in the bedrock may be approximated with Darcy's relationship.

$$v = ki/n = 1{,}600 \text{ ft./yr.}$$

where: $k = 1 \times 10^{-2}$ cm/s (10^4 ft./yr.)
$i = 1.6 \times 10^{-3}$ ft./ft.
$n = 0.01$ (fracture porosity)

This calculation indicates that the average horizontal component of groundwater flow through the upper dolomite bedrock is about 1,700 ft./yr. It should be emphasized that this velocity is a very approximate estimate of flow velocities in the rock, since there will be considerable areal variations in hydraulic conductivity (k) and fracture porosity (n).

There is currently no available data regarding fluctuations of hydraulic head with depth in the Big Lime formation, hence estimates of the vertical component of groundwater flow were not made.

7.3 Underlying Sedimentary Bedrock Sequence

As previously noted, it is expected that there is a drop in potentiometric levels from the upper carbonate aquifer into the underlying sedimentary rocks. This would result in a component of downward flow from the carbonate rocks into the underlying rocks under static conditions.

8.0 SUMMARY AND CONCLUSIONS

Based on the foregoing data, the following summary of hydrogeologic conditions at the site is made:

1. The site is underlain by some 40 ft. to 50 ft. of lacustrine clay and glacial till overburden. A series of carbonate deposits known as the Big Lime formation extend from the overburden to depths of about 600 ft. Underlying the Big Lime is a sequence of sedimentary rocks which extends to the Precambrian basement rock at a depth of about 2,900 ft.

2. The water table in the overburden is close to the ground surface. Although all of the overburden below the water table is saturated, it is not considered an aquifer because of its very low hydraulic conductivity.

3. The uppermost aquifer at the site is the Big Lime formation. The Big Lime is a confined aquifer and the potentiometric surface is about 10 ft. to 15 ft. below ground surface.

4. The ambient water quality in the Big Lime formation is poor due to naturally high TDS and sulfate contents. The base of the Big Lime is considered to be the base of potable water in Ohio. The groundwater in the sedimentary rocks beneath the Big Lime is generally a brine water.

5. Groundwater level monitoring at the site indicates that on-site pumping has created a cone of depression in the upper portion of the shallow dolomite aquifer. This cone of depression may impede off-site migration of water in the upper portions of the dolomite.

6. The direction of groundwater flow in the overburden is generally downward. The rate of flow to the underlying dolomite is less than 0.07 ft./yr. and is controlled by the low hydraulic conductivity of the soil.

7. The natural groundwater gradient in the dolomite aquifer (disregarding the effects of on-site pumping) is thought to be directed to be northwest. There is currently no data available

regarding the vertical gradients within the dolomite, but it is possible that there is a slight upward flow component.

GOLDER ASSOCIATES

Paul W. Bowen, P. Eng.
Hydrogeologist

Gary H. Collison, P.E.
Principal

PWB:GHC:dpc

REFERENCES

1. Bowser-Morner Testing Laboratories, Inc., May 3, 1983, "Hydrogeologic Assessment Northern Ohio Treatment Facility, Vickery, Ohio", Report No. T-20356.

2. Goldthwait, R. P., G. W. White, J. L. Forsyth, 1961, "Glacial Map of Ohio", Scale 1:500,000, Department of the Interior, U.S.G.S.

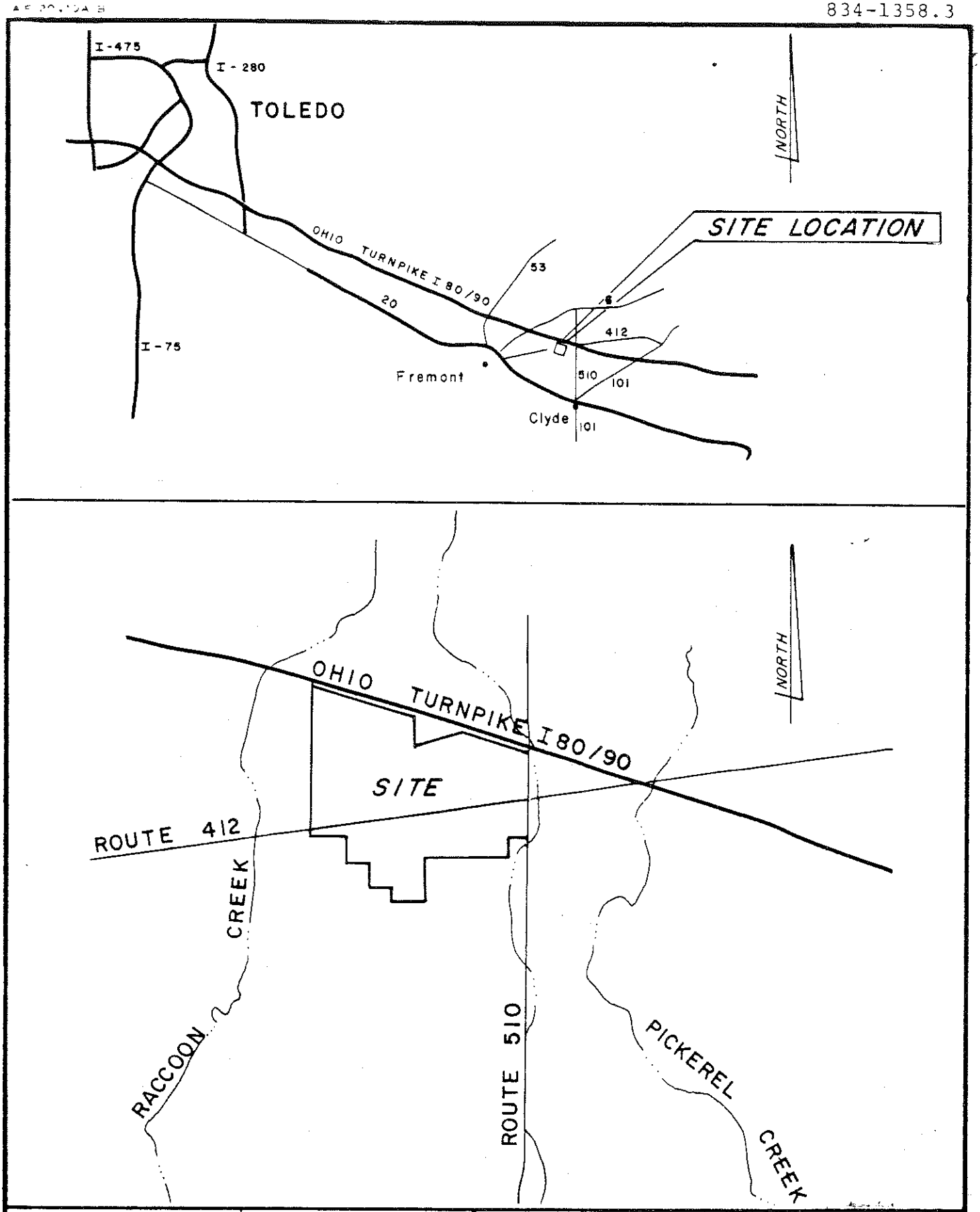
3. Janssens, A., 1977, "Silurian Rocks in the Subsurface of Northwestern Ohio", Report of Investigations No. 100, ODNR.

4. Norris, S. E., R. E. Fidler, 1971, "Availability of Groundwater from Limestone and Dolomite Aquifers in Northwest Ohio and its Relation to Geologic Structure", U.S.G.S. Professional Paper 750-B, pages B229-B235.

5. Ohio Department of Natural Resources, 1970, "Groundwater for Planning Northwest Ohio - A Study of the Carbonate Rock Aquifers", Ohio Water Plan Inventory Report Number 22, Columbus, Ohio.

6. Ohio Department of Natural Resources, 1974, "Oil and Gas Fields of Ohio", Scale 1:500,000.

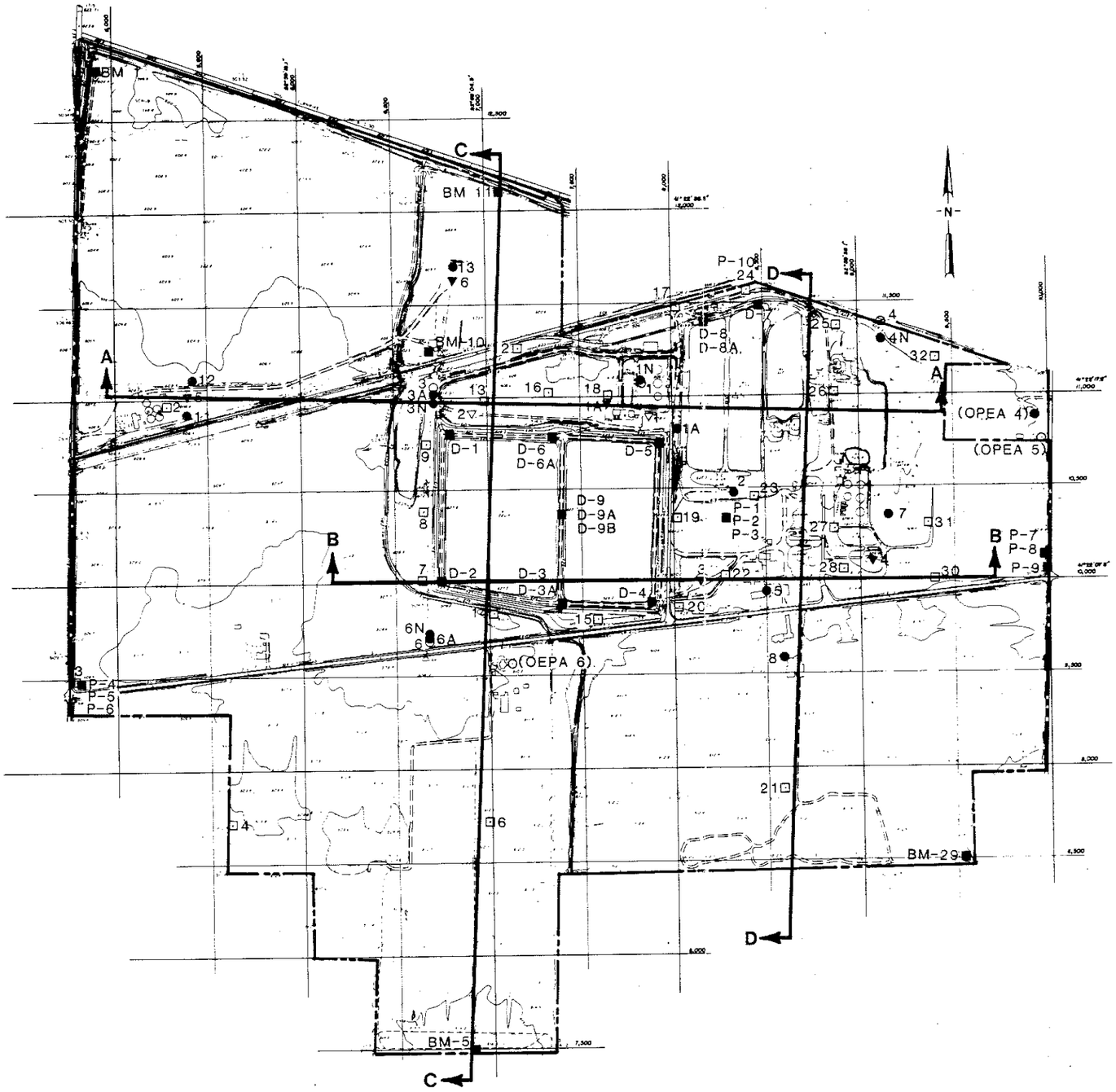
7. Sedan, A. C. and R. B. Stein, 1970, "Saline Ground-Water Resources of Ohio", Hydrologic Investigations Atlas HA-366, Department of the Interior, U.S.G.S.



JOB NO. 834-1358	SCALE NOT TO SCALE	SITE LOCATION PLAN
DRAWN CAB	DATE 8-3-83	
CHECKED FC	DWG NO 42	
Golder Associates	CHEMICAL WASTE MANAGEMENT, INC	FIGURE 1

DRAFTING MEDIA

FIGURE 2



LEGEND

- PROPERTY LINE
- TEST BORING WITHOUT PIEZOMETER
- TEST BORING WITH PIEZOMETER
- ACTIVE MONITNORING WELL
- INACTIVE MONITORING WELL
- ACTIVE INJECTION WELL
- INACTIVE INJECTION WELL
- A A CROSS SECTION LOCATIONS

NOTES:

1. BORING, PIEZOMETER, AND WELL LOCATIONS ARE APPROXIMATE.

0 300 600 900 1200
SCALE IN FEET

PHOTOGRAPHIC REDUCTION

REVISIONS		
DESCRIPTION	BY	DATE

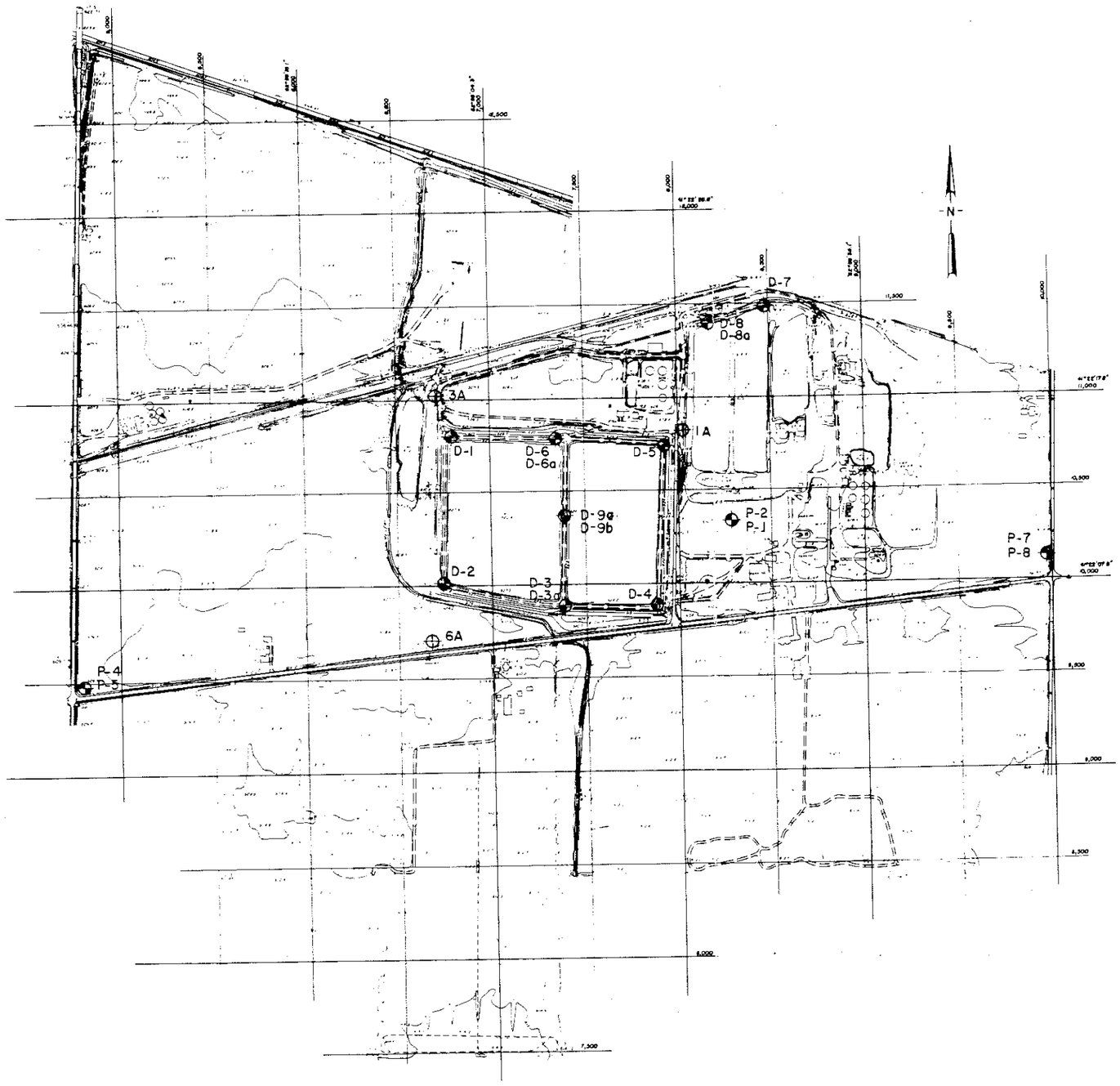
CHEMICAL WASTE MANAGEMENT, INC.
VICKERY, OHIO DISPOSAL FACILITY

TITLE: BORING, PIEZOMETER, AND WELL LOCATION PLAN

DRAWN SKB	SCALE AS SHOWN	DATE 9-16-83	
CHECKED MRB	REVIEWED [illegible]	JOB NO. 834-1356	
Golder Associates		DWG NO. 64	FIGURE 2

DESIGN PRODUCTS CO.

FIGURE 3



LEGEND

6 A	SOIL MONITORING WELL
D-8 D-8a	DIKE INVESTIGATION BORING WITH PIEZOMETER
P-4	SOIL PIEZOMETER INSTALLATION

0 300 600 900 1200
SCALE IN FEET

PHOTOGRAPHIC REDUCTION

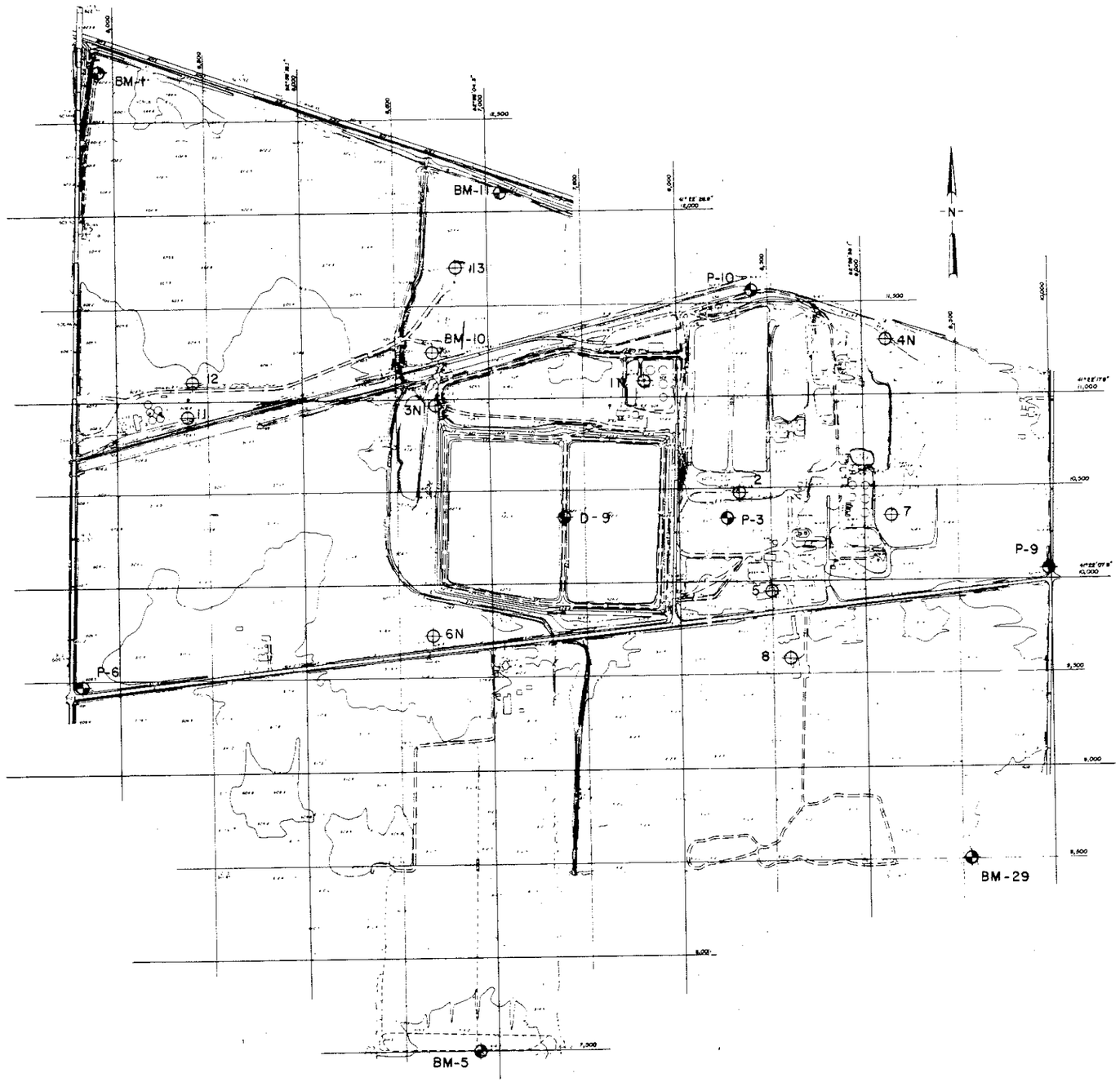
REVISIONS		
DESCRIPTION	BY	DATE

CHEMICAL WASTE MANAGEMENT, INC.
VICKERY, OHIO DISPOSAL FACILITY

TITLE: OVERBURDEN WELL AND PIEZOMETER LOCATION PLAN

DRAWN SKB	SCALE AS SHOWN	DATE 6-24-83
CHECKED MLB	REVIEWED HAC	JOB NO. 834-1358
Golder Associates		DWG NO. 25
		FIGURE 3

FIGURE 4



LEGEND

6N	MONITORING WELL
BM-1	PIEZOMETER (BOWSER-MORNER)
P-9	PIEZOMETER (GOLDER ASSOCIATES)

NOTE:

Monitoring Wells 2 and 5 are not accessible for water level measurements.

0 300 600 900 1200

SCALE IN FEET

PHOTOGRAPHIC REDUCTION

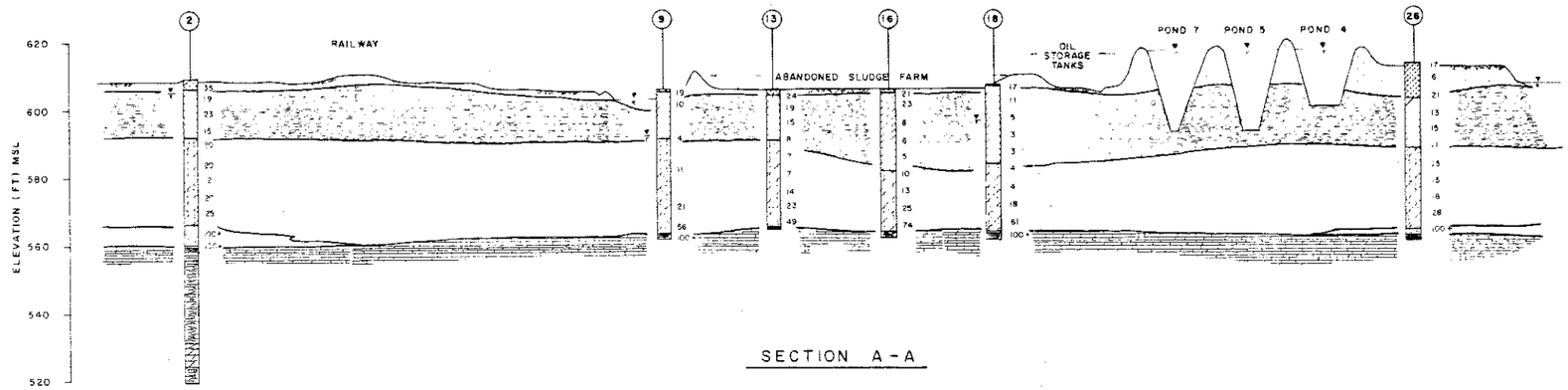
REVISIONS		
DESCRIPTION	BY	DATE

CHEMICAL WASTE MANAGEMENT, INC.
VICKERY, OHIO DISPOSAL FACILITY

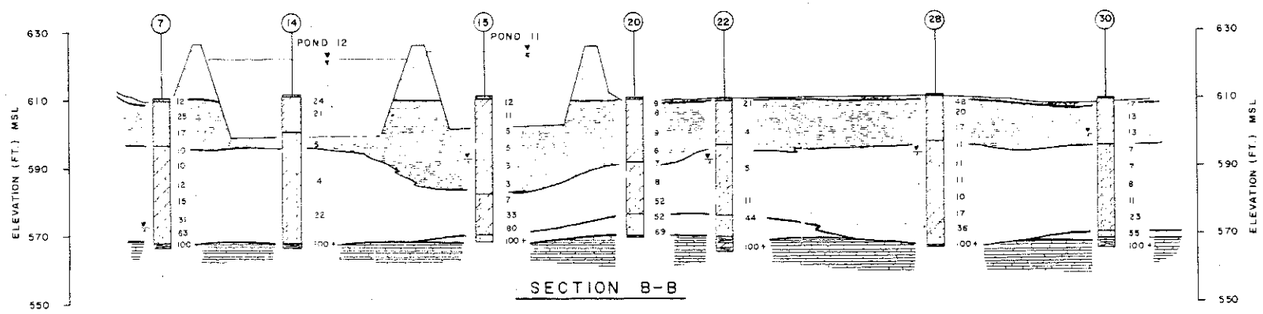
TITLE: BEDROCK WELL AND PIEZOMETER LOCATION PLAN

DRAWN SKB	SCALE AS SHOWN	DATE 6-24-83	
CHECKED	REVIEWED	JOB NO 834-1358	
Golder Associates		DWG NO 24	FIGURE 4

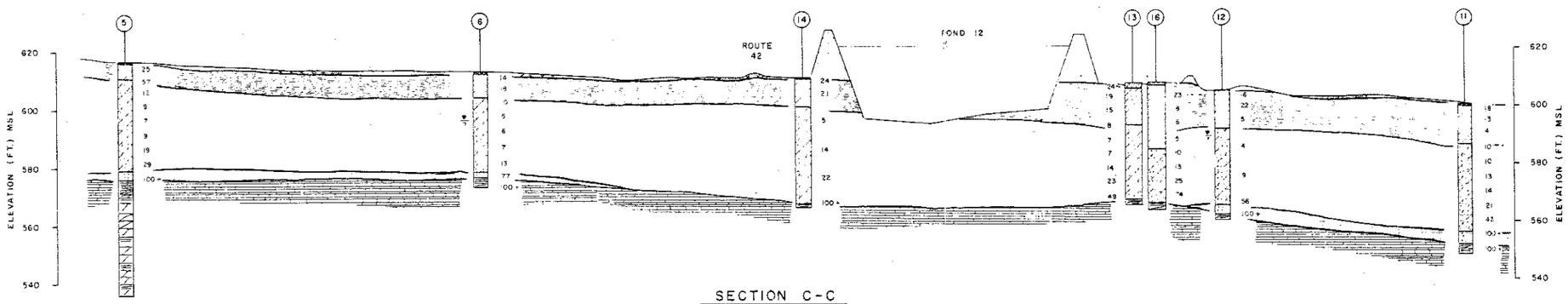
FIGURE 5



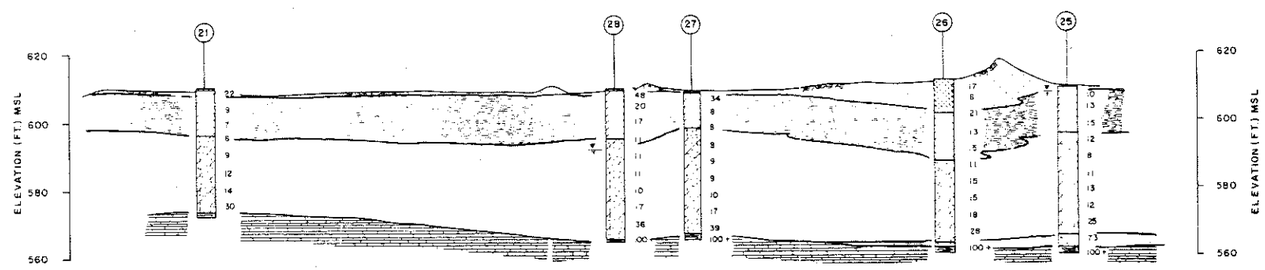
SECTION A-A



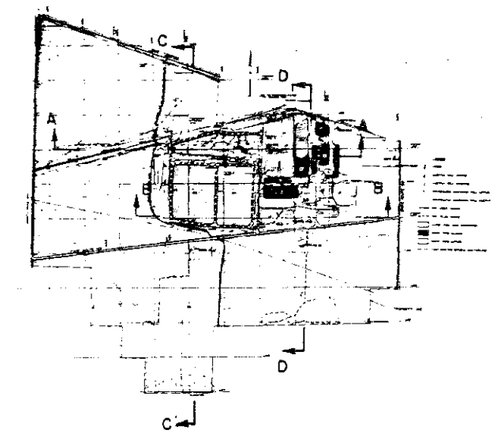
SECTION B-B



SECTION C-C



SECTION D-D



PLAN VIEW

SCALE 1" = 1000'

SEE FIGURE 2 FOR LARGER SCALE PLAN

LEGEND

(12) — BOREHOLE NUMBER

24 — STANDARD PENETRATION RESISTANCE (N)

STRATIGRAPHY

WATER LEVEL DURING DRILLING

SOIL CLASSIFICATIONS	GEOLOGIC DESCRIPTIONS
GRAVEL TO CLAYEY SILT (FILL)	SURFICAL DEPOSITS (FILL)
VERY STIFF TO SOFT BROWN TO GREY CLAY TO CLAYEY SILT, TRACE SAND	LACUSTRINE DEPOSITS
SOFT TO HARD GREY CLAYEY SILT, SOME SAND, TRACE GRAVEL	LOW TO MODERATELY DENSE TILL (UPPER)
HARD GREY SILT, SOME SAND AND GRAVEL AND CLAY	DENSE TILL (LOWER)
GREY TO BROWN TO WHITE SHALE AND DOLOMITE WITH GYPSUM (BEDROCK)	BEDROCK

BORING DATA PROVIDED BY BOWSER - MORNER

NOTE: SECTIONS A-A, B-B, C-C & D-D ARE SHOWN AS VERTICAL 1" = 20' HORIZONTAL 1" = 200'.

NOTE

Data concerning the various strata have been obtained at borehole locations only. The soil strata shown between the boreholes has been inferred from geological evidence and may vary from that shown.

For detailed stratigraphy at each borehole location refer to the records of borehole sheets.

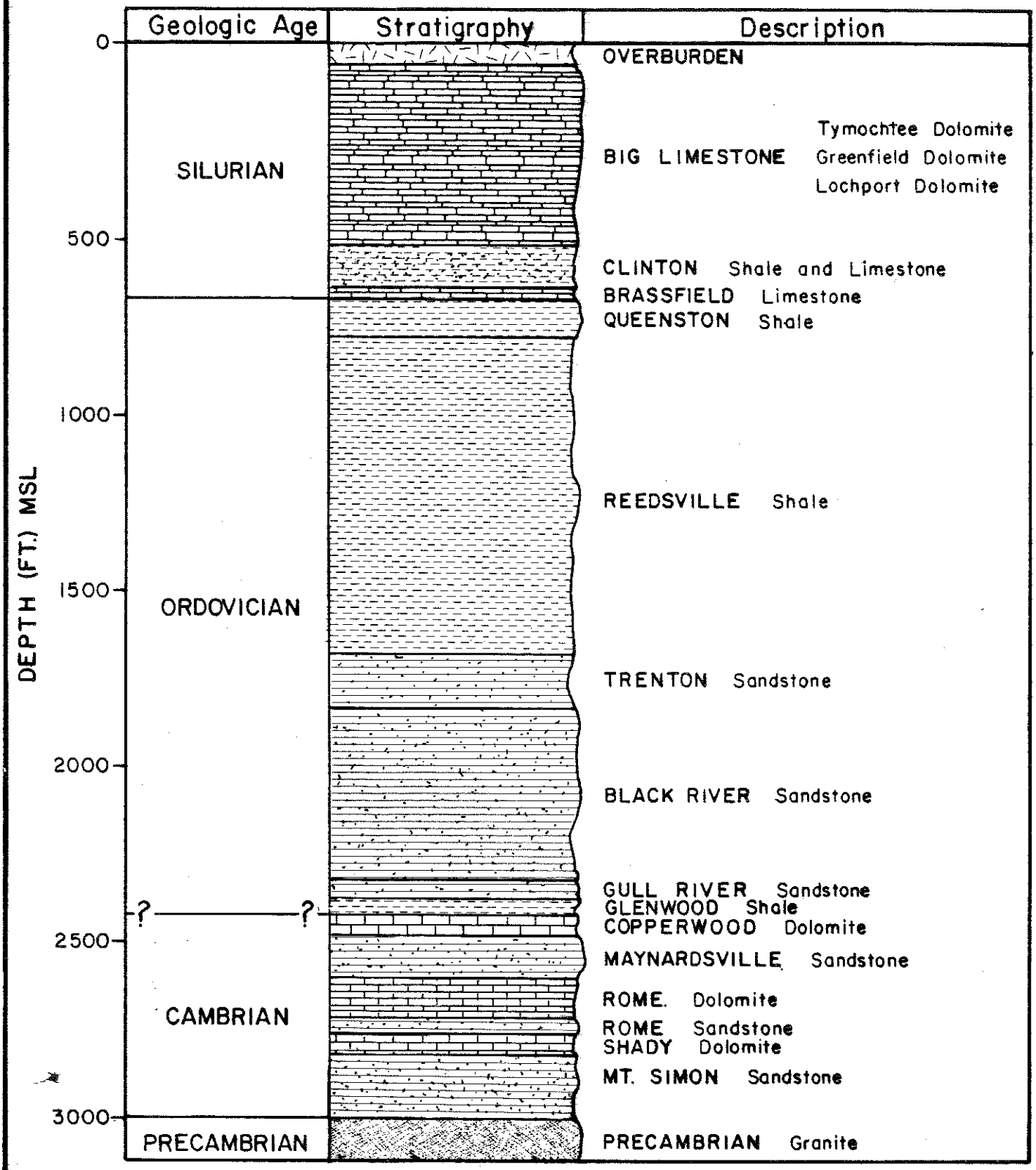
PHOTOGRAPHIC REDUCTION

REVISIONS		
DESCRIPTION	BY	DATE

CHEMICAL WASTE MANAGEMENT, INC.
VICKERY, OHIO DISPOSAL FACILITY

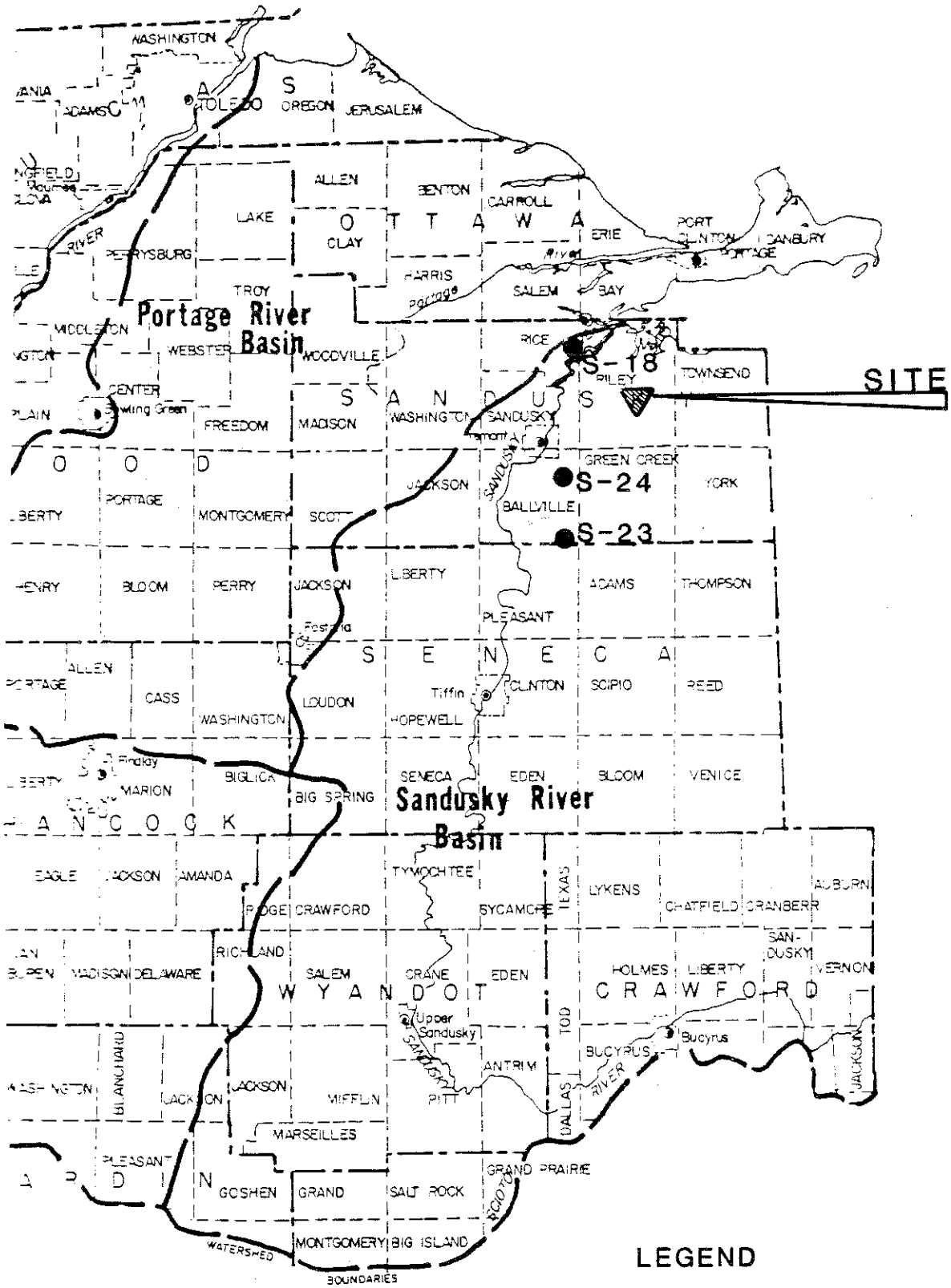
TITLE: GEOLOGIC SECTIONS

DRAWN CAB	SCALE AS SHOWN	DATE 4-26-83
CHECKED	REVIEWED	JOB NO. 834-1358
Golder Associates		DWG NO. 8
		FIGURE 5



JOB NO. 834-1358	SCALE 1" = 400', Vertical	GEOLOGIC SECTION AT INJECTION WELL 2
DRAWN SKB	DATE 7-22-83	
CHECKED	DWG. NO. 60	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. FIGURE 6

OZALID DRAFTING MEDIA



LEGEND

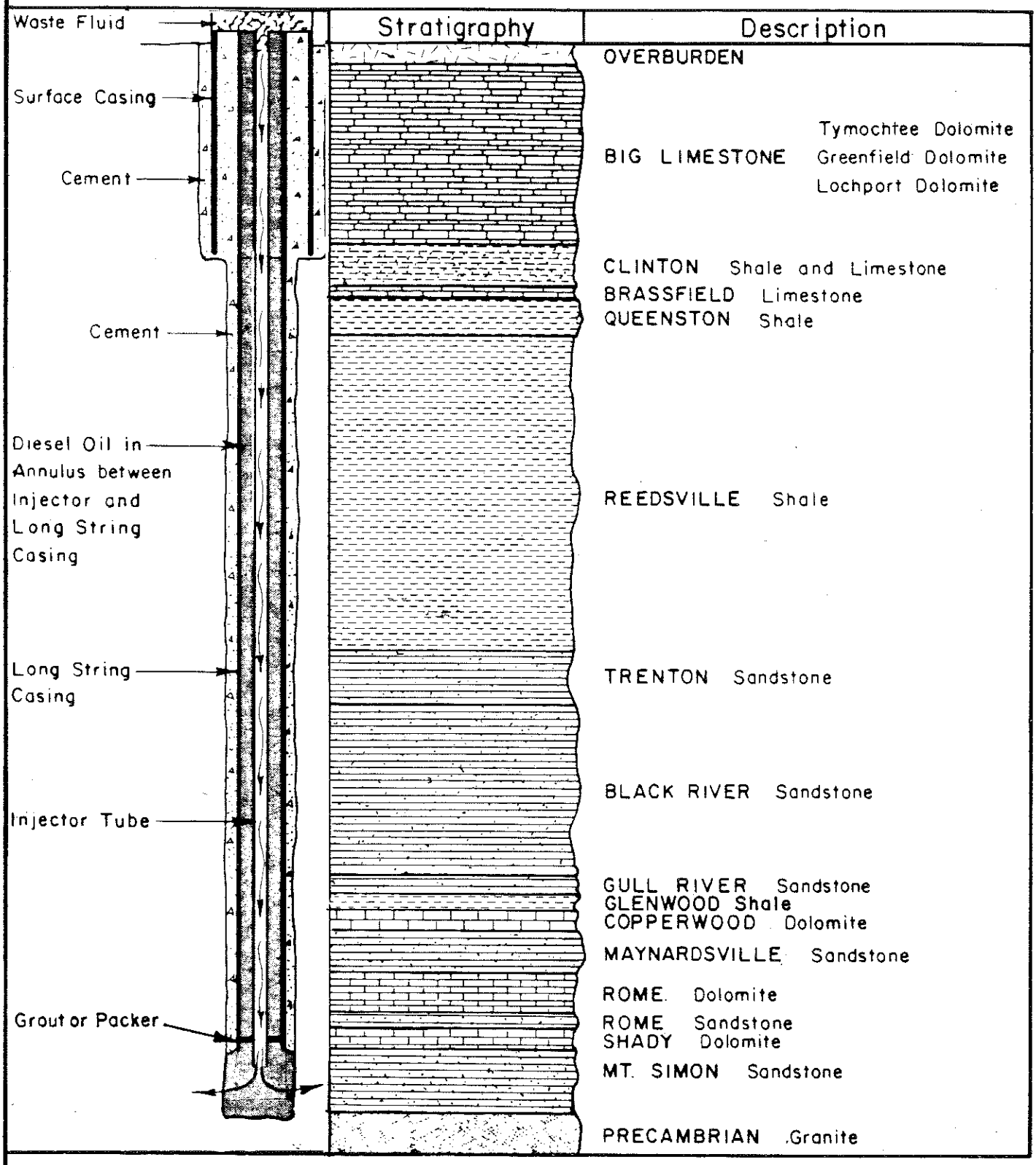
● S-23 ODNR TEST WELLS

LOCATION PLAN FROM REFERENCE 5

JOB NO 834-1358	SCALE NOT TO SCALE	LOCATION OF ODNR TEST WELLS	
DRAWN SKB	DATE 8-3-83		
CHECKED [signature]	DWG NO 44		
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC.	FIGURE 7

GRAPHIC DRAFTING MEDIA

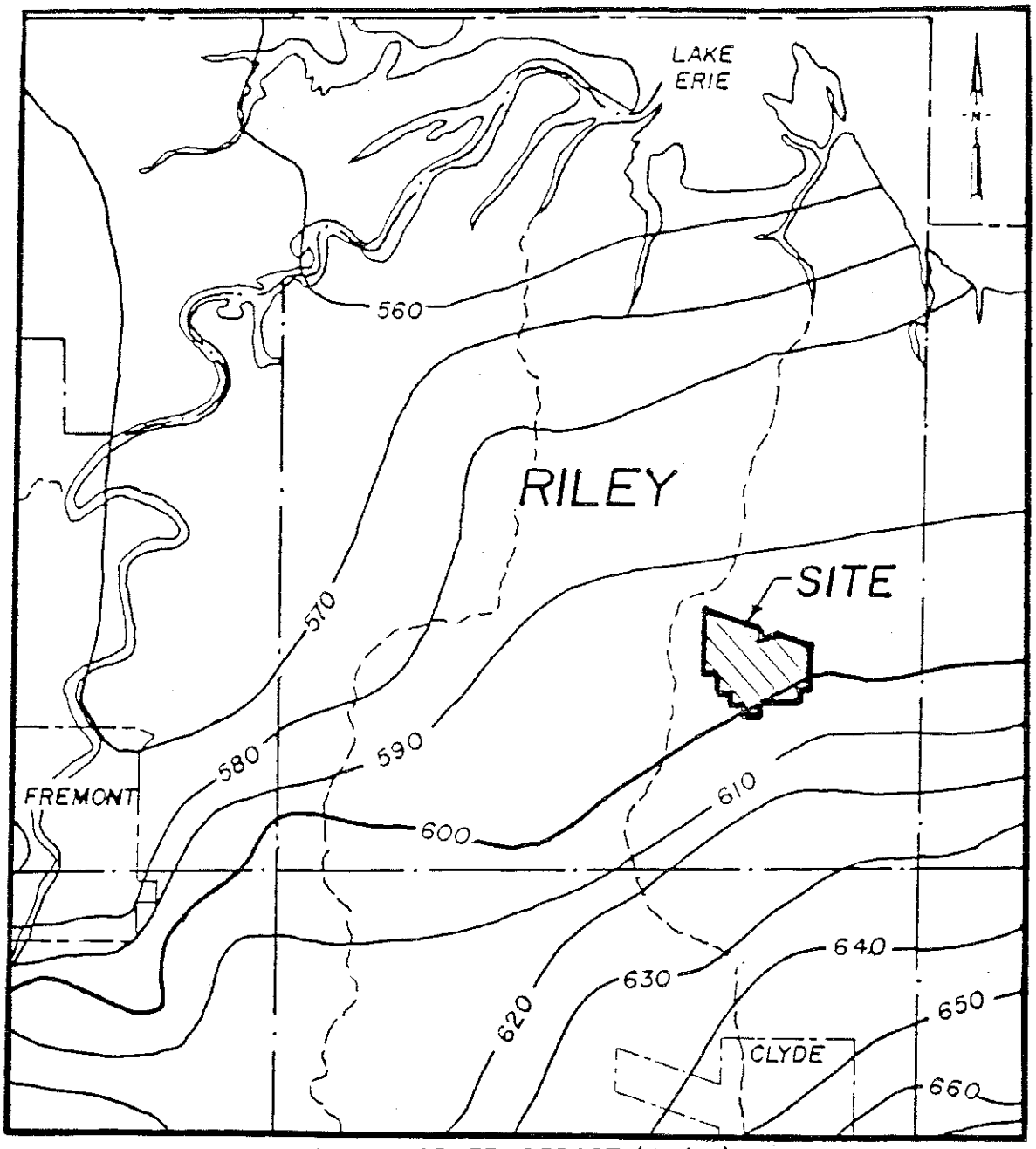
AF 20440A B



JOB NO 834-1358	SCALE 1" = 400', Vertical	TYPICAL INJECTION WELL INSTALLATION
DRAWN SKB	DATE 7-22-83	
CHECKED	DWG NO —	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. FIGURE 8

DRAFTING MEDIA

AF 20440A-B



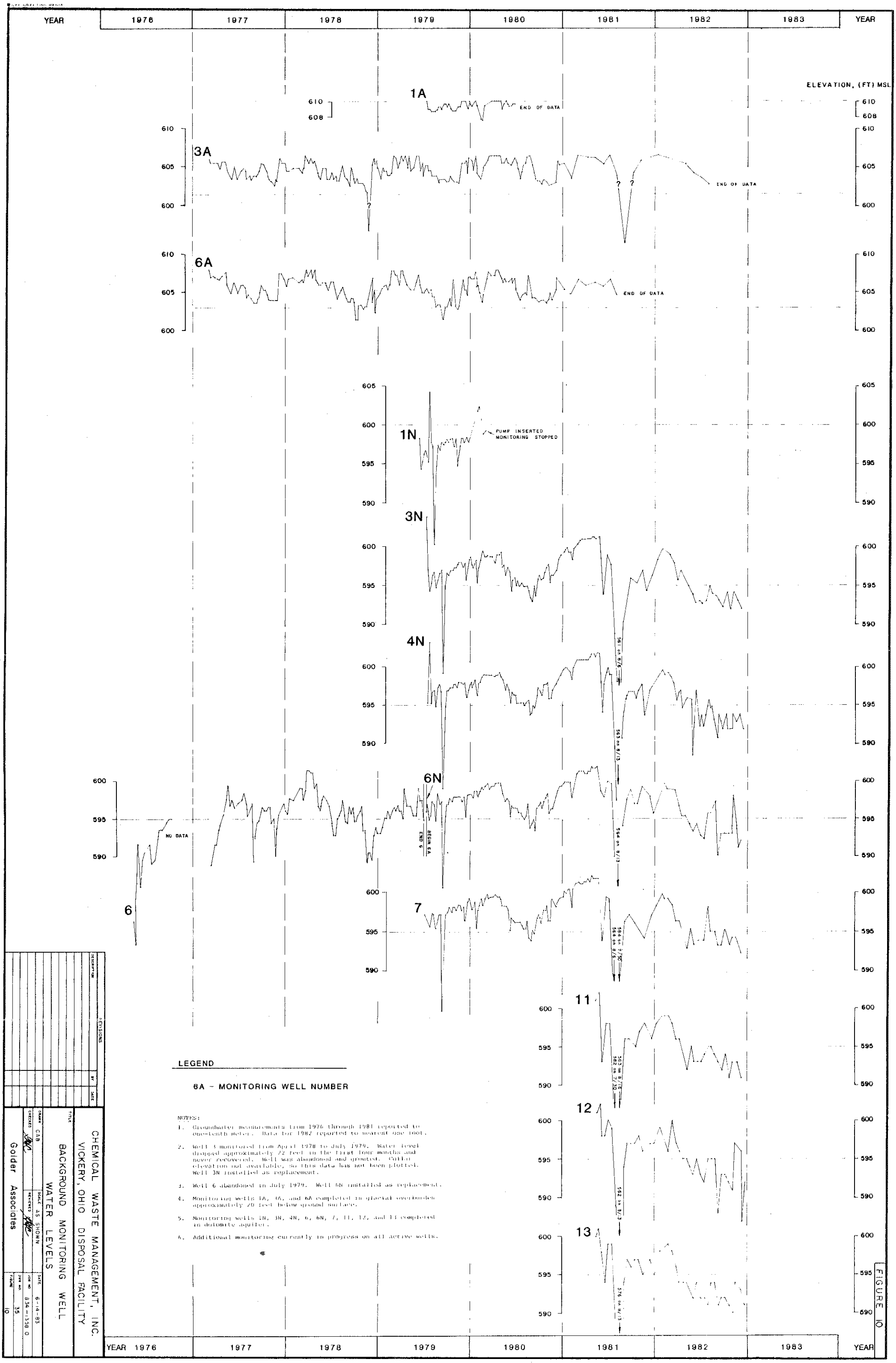
MAP TAKEN FROM BOWSER – MORNER REPORT (Ref. 1)

LEGEND

——610—— GROUNDWATER SURFACE CONTOUR LINE

JOB NO. 834-1358	SCALE 1" = 8250' (Approx.)	REGIONAL POTENTIOMETRIC SURFACE IN UPPER CARBONATE BEDROCK
DRAWN SKB	DATE 8-3-83	
CHECKED [signature]	DWG NO 43	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC — FIGURE 9

OZALID DRAFTING MEDIA



LEGEND

6A - MONITORING WELL NUMBER

NOTES:

1. Groundwater measurements from 1976 through 1981 reported to one-tenth meter. Data for 1982 reported to nearest one foot.
2. Well 3 monitored from April 1978 to July 1979. Water level dropped approximately 22 feet in the first four months and never recovered. Well was abandoned and grouted. Collar elevation not available, so this data has not been plotted. Well 3N installed as replacement.
3. Well 6 abandoned in July 1979. Well 6N installed as replacement.
4. Monitoring wells 1A, 3A, and 6A completed in glacial overburden approximately 20 feet below ground surface.
5. Monitoring wells 1N, 3N, 4N, 6, 6N, 7, 11, 12, and 13 completed in dolomite aquifer.
6. Additional monitoring currently in progress on all active wells.

REVISIONS		
DESCRIPTION	BY	DATE

TITLE: BACKGROUND MONITORING WELL WATER LEVELS

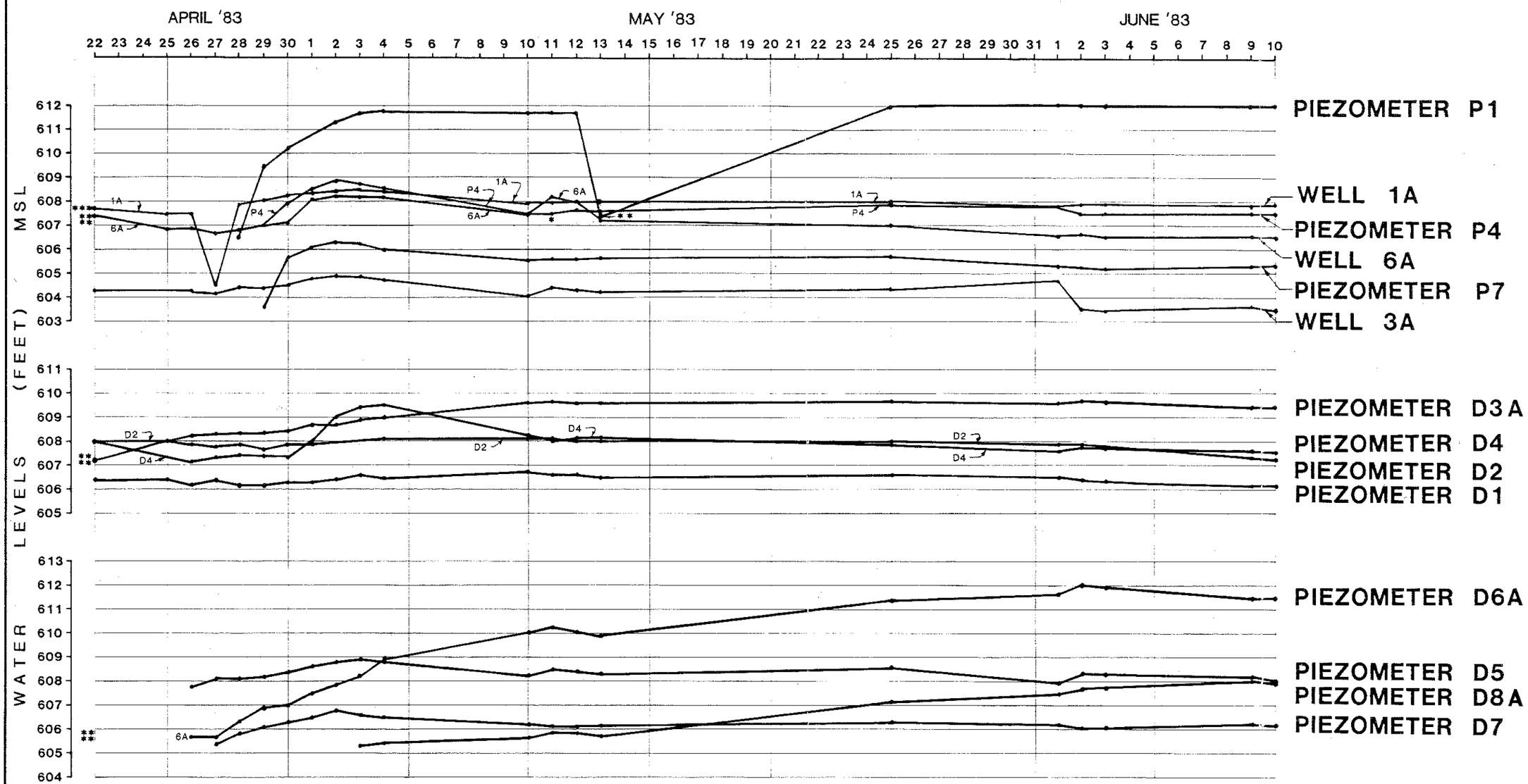
CHEMICAL WASTE MANAGEMENT, INC.
VICKERY, OHIO DISPOSAL FACILITY

Golder Associates

DRAWN: C.A.B.
CHECKED:
REVIEWED:
SCALE: AS SHOWN
DATE: 6-14-83
JOB NO: 834-1538 0
DWG NO: 35
FIGURE 10

FIGURE 10

FIGURE 11



NOTES:

1. WELL 2 PUMPED AT APPROXIMATELY 150 gpm FOR 70 MINUTES ON MAY 13, 1983.
* 2. PIEZOMETER P4 PUMPED AFTER MEASUREMENT ON MAY 11, 1983.
** 3. PIEZOMETER P1 PUMPED AFTER MEASUREMENT ON MAY 12, 1983.
*** 4. MONITORING WELL 1A PURGED FOR SAMPLING ON APRIL 20, 1983.
**** 5. MONITORING WELLS 3A and 6A PURGED FOR SAMPLING ON APRIL 21, 1983.

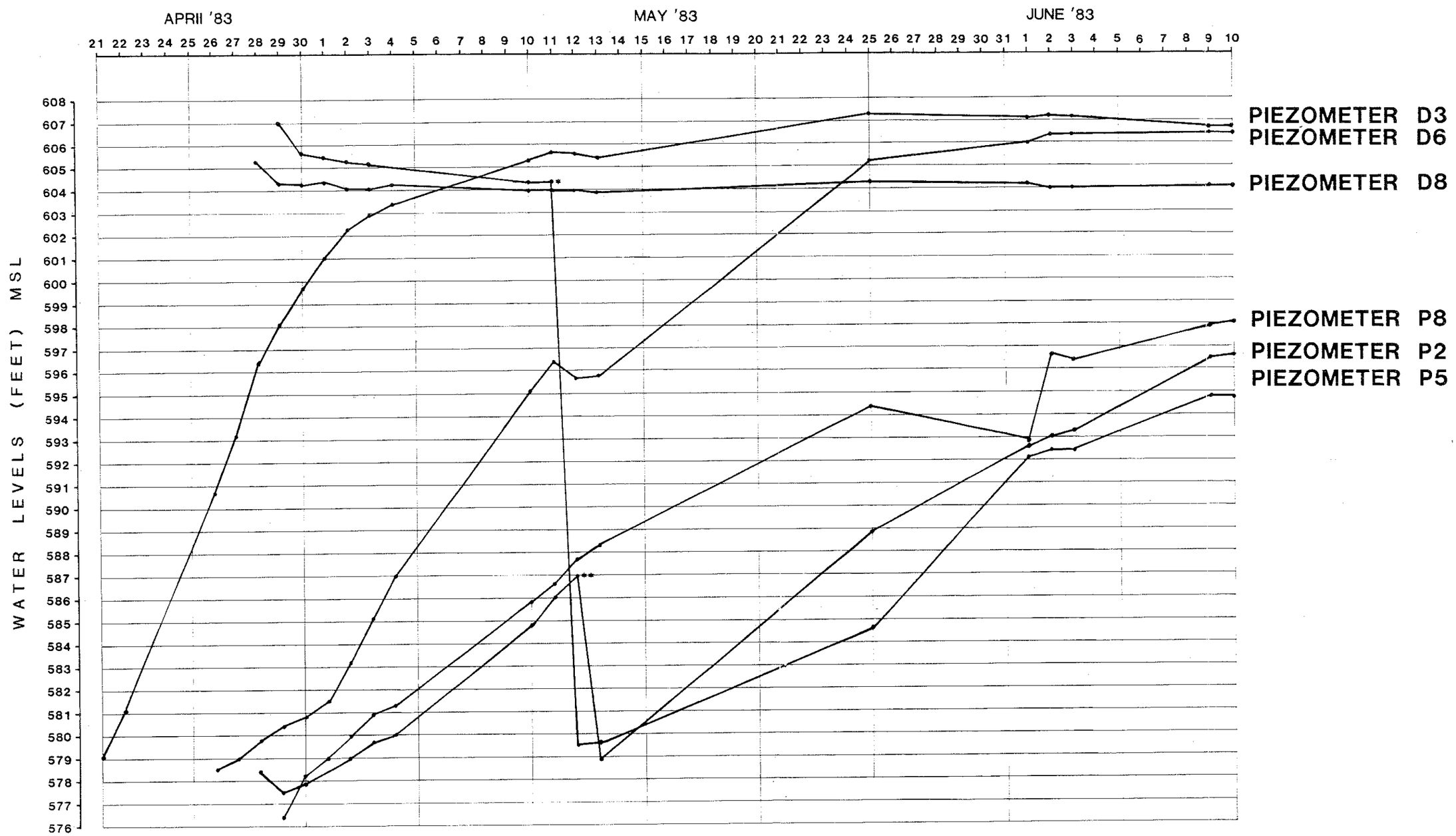
REVISIONS		
DESCRIPTION	BY	DATE

CHEMICAL WASTE MANAGEMENT, INC.
VICKERY, OHIO DISPOSAL FACILITY

TITLE: OVERBURDEN POTENTIOMETRIC LEVELS APRIL TO JUNE, 1983

DRAWN	SXB	SCALE AS SHOWN	DATE 7-15-83
CHECKED	MRB	REVIEWED	JOB NO 834-358
Golder Associates			DWG NO 35
			FIGURE 11

FIGURE 12



NOTES:

1. WELL 2 PUMPED AT APPROXIMATLY 150 gpm FOR 70 MINUTES ON MAY 13, 1983.

* 2. PIEZOMETER P5 PUMPED AFTER MEASUREMENT ON MAY 11, 1983

**3. PIEZOMETER P2 PUMPED AFTER MEASUREMENT ON MAY 12, 1983.

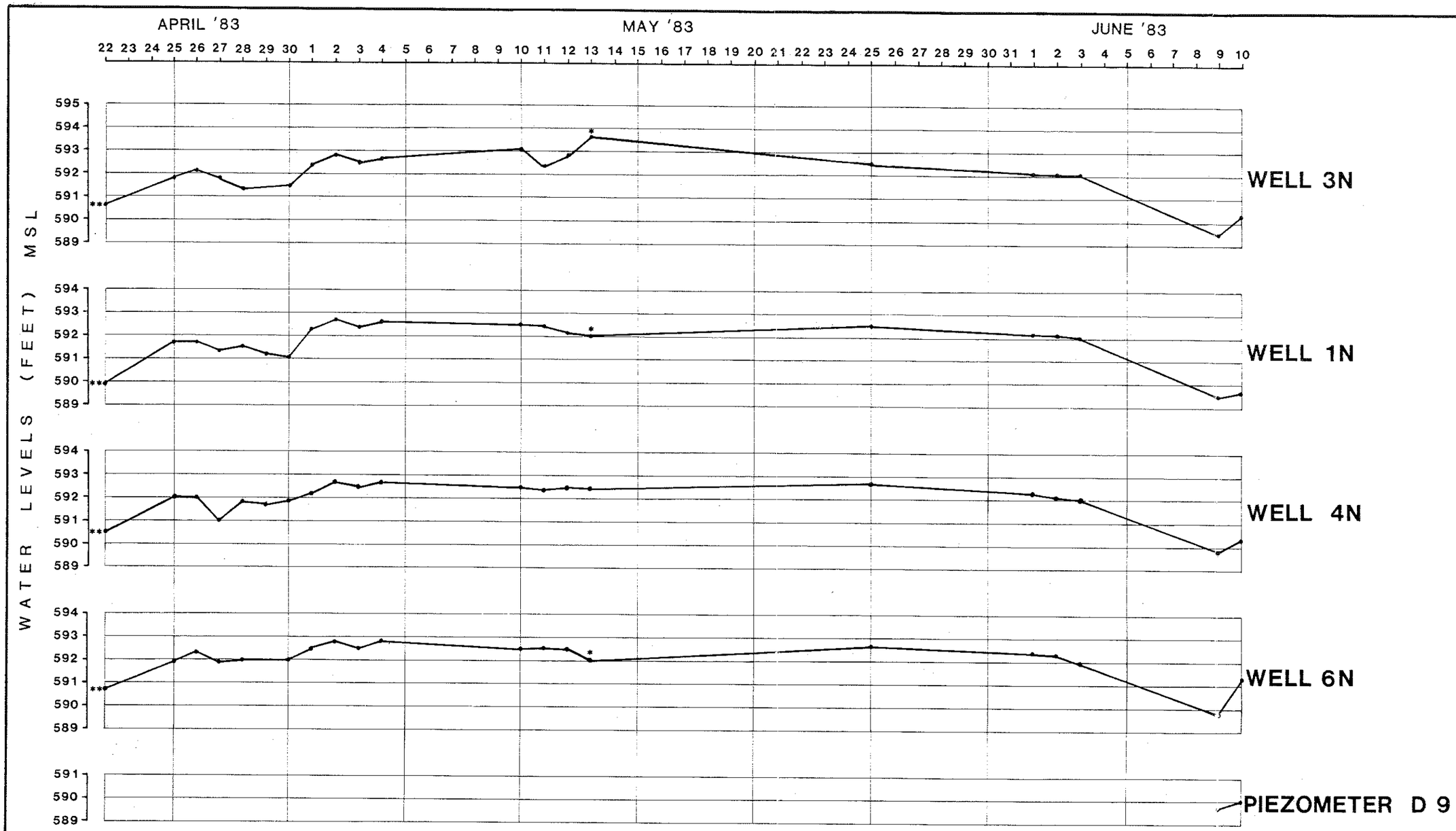
REVISIONS		
DESCRIPTION	BY	DATE

CHEMICAL WASTE MANAGEMENT, INC.
VICKERY, OHIO DISPOSAL FACILITY

TITLE: OVERBURDEN POTENTIOMETRIC LEVELS APRIL TO JUNE, 1983

DRAWN SKB	SCALE AS SHOWN	DATE 6-25-83	
CHECKED MRB	REVIEWED	JOB NO. 834-1358	
Golder Associates		DWG NO. 37	FIGURE 12

FIGURE 13



NOTES:

1. WELL 2 PUMPED AT APPROXIMATELY 150 gpm FOR 70 MINUTES ON MAY 13, 1983.

* 2. WELLS 1N, 3N, and 6N BAILED FOR DYE TEST SAMPLE ON MAY 13, 1983

**3. MONITORING WELLS PURGED FOR SAMPLING ON THE FOLLOWING DATES:
APRIL 18, 1983 – 1N
APRIL 20, 1983 – 1N and 4N
APRIL 21, 1983 – 3N and 6N

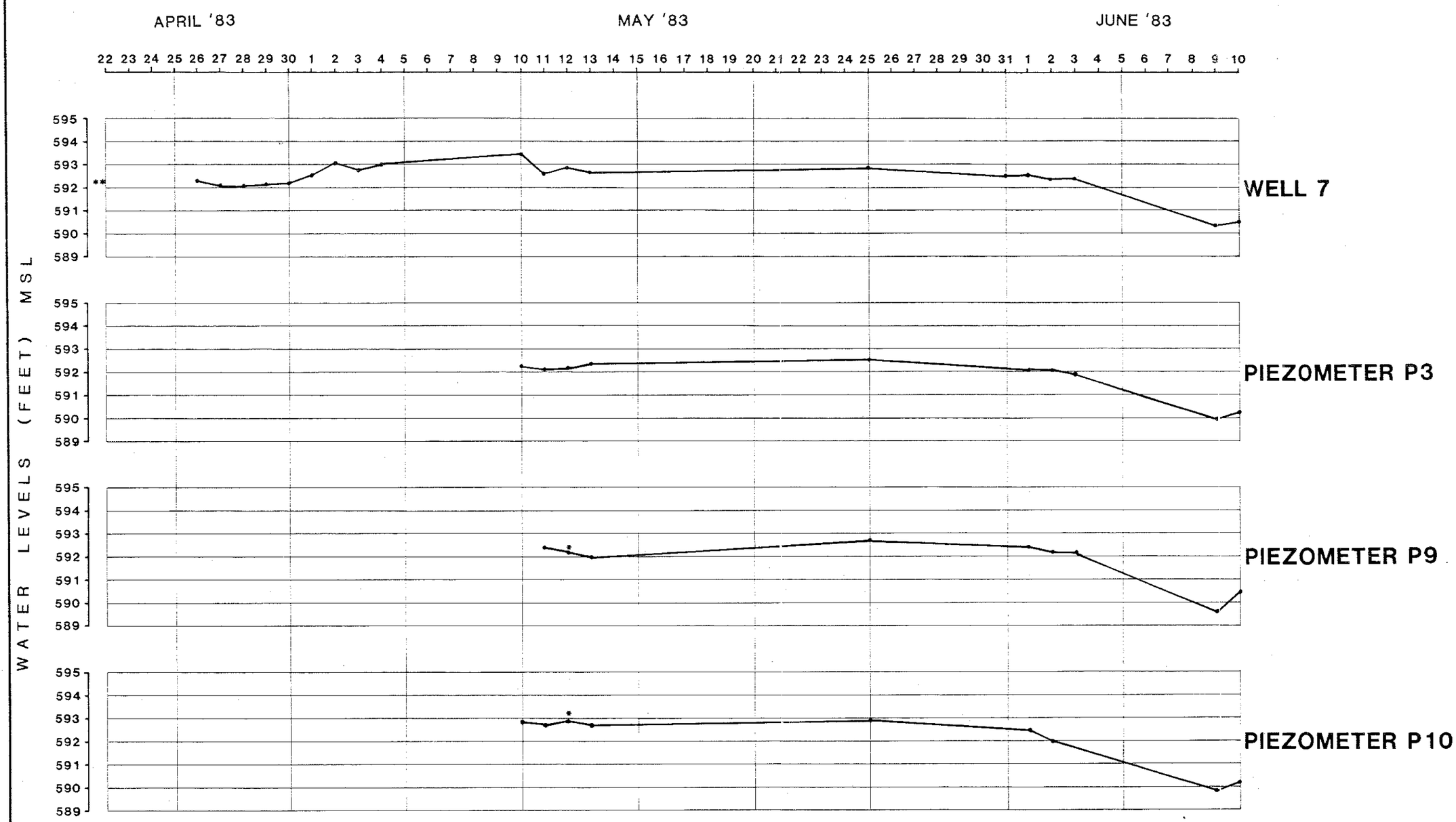
REVISIONS		
DESCRIPTION	BY	DATE

CHEMICAL WASTE MANAGEMENT, INC.
VICKERY, OHIO DISPOSAL FACILITY

TITLE: AQUIFER POTENTIOMETRIC LEVELS APRIL TO JUNE, 1983

DRAWN SKB	SCALE AS SHOWN	DATE 9-13-83	
CHECKED MRB	REVIEWED [illegible]	JOB NO. 834-1358	
Golder Associates		DWG NO. 62	FIGURE 13

FIGURE 14



NOTES:

1. WELL 2 PUMPED AT APPROXIMATELY 150 gpm FOR 70 MINUTES ON MAY 13, 1983.

* 2. PIEZOMETERS P9 and P10 PUMPED AFTER MEASUREMENT ON MAY 12, 1983.

** 3. MONITORING WELL 7 PURGED FOR SAMPLING ON APRIL 21, 1983.

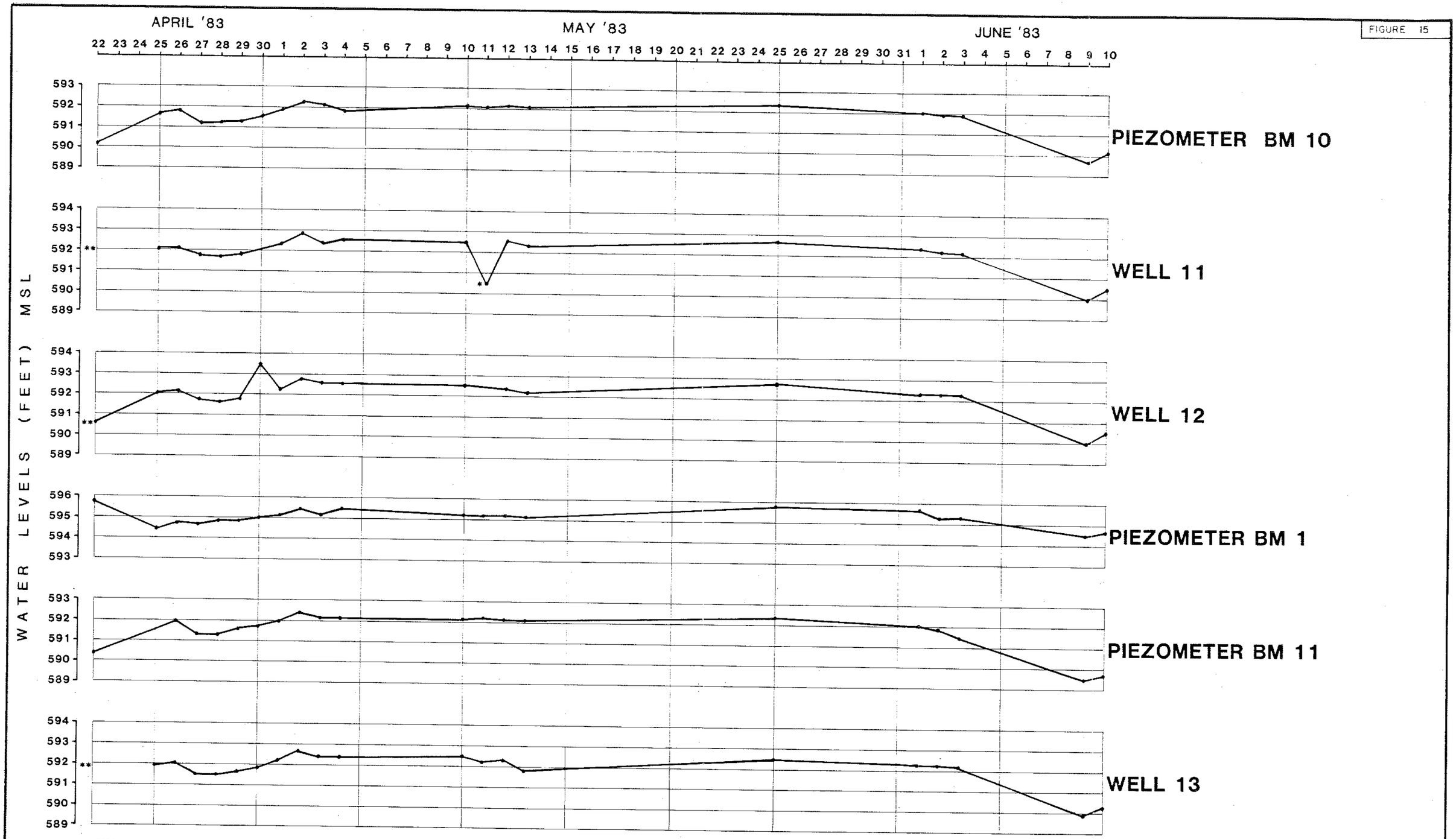
REVISIONS		
DESCRIPTION	BY	DATE

CHEMICAL WASTE MANAGEMENT, INC.
VICKERY, OHIO DISPOSAL FACILITY

TITLE: AQUIFER POTENTIOMETRIC LEVELS APRIL TO JUNE, 1983

DRAWN SKB	SCALE AS SHOWN	DATE 9-13-83	
CHECKED MRB	REVIEWED	JOB NO. 834-1358	
Golder Associates		DWG NO 63	
		FIGURE 14	

FIGURE 15



NOTES:

1. WELL 2 PUMPED AT APPROXIMATELY 150 gpm FOR 70 MINUTES ON MAY 13, 1983.

* 2. WELL 11 PURGED FOR SAMPLING ON MAY 11, 1983.

** 3. MONITORING WELLS 11, 12, and 13 PURGED FOR SAMPLING ON APRIL 21, 1983.

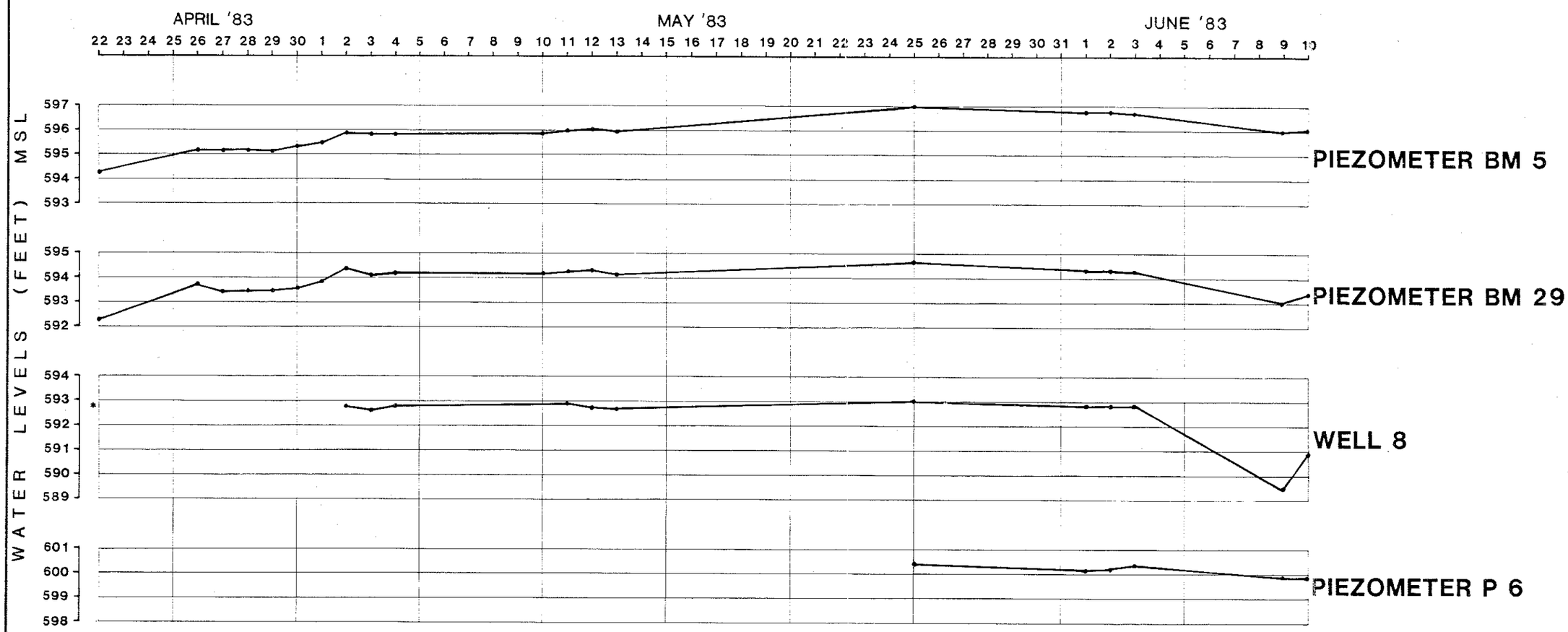
REVISIONS		
DESCRIPTION	BY	DATE

CHEMICAL WASTE MANAGEMENT, INC.
VICKERY, OHIO DISPOSAL FACILITY

TITLE: AQUIFER POTENTIOMETRIC LEVELS APRIL TO JUNE, 1983

DRAWN SKB	SCALE AS SHOWN	DATE 9-14-83	
CHECKED MRB	REVIEWED	JOB NO. 834-1358	
Golder Associates		DWG NO. 64	FIGURE 15

FIGURE 16



NOTES:

1. WELL 2 PUMPED AT APPROXIMATELY 150 gpm FOR 70 MINUTES ON MAY 13, 1983.

* 2. MONITORING WELL 8 PURGED FOR SAMPLING ON APRIL 20, 1983.

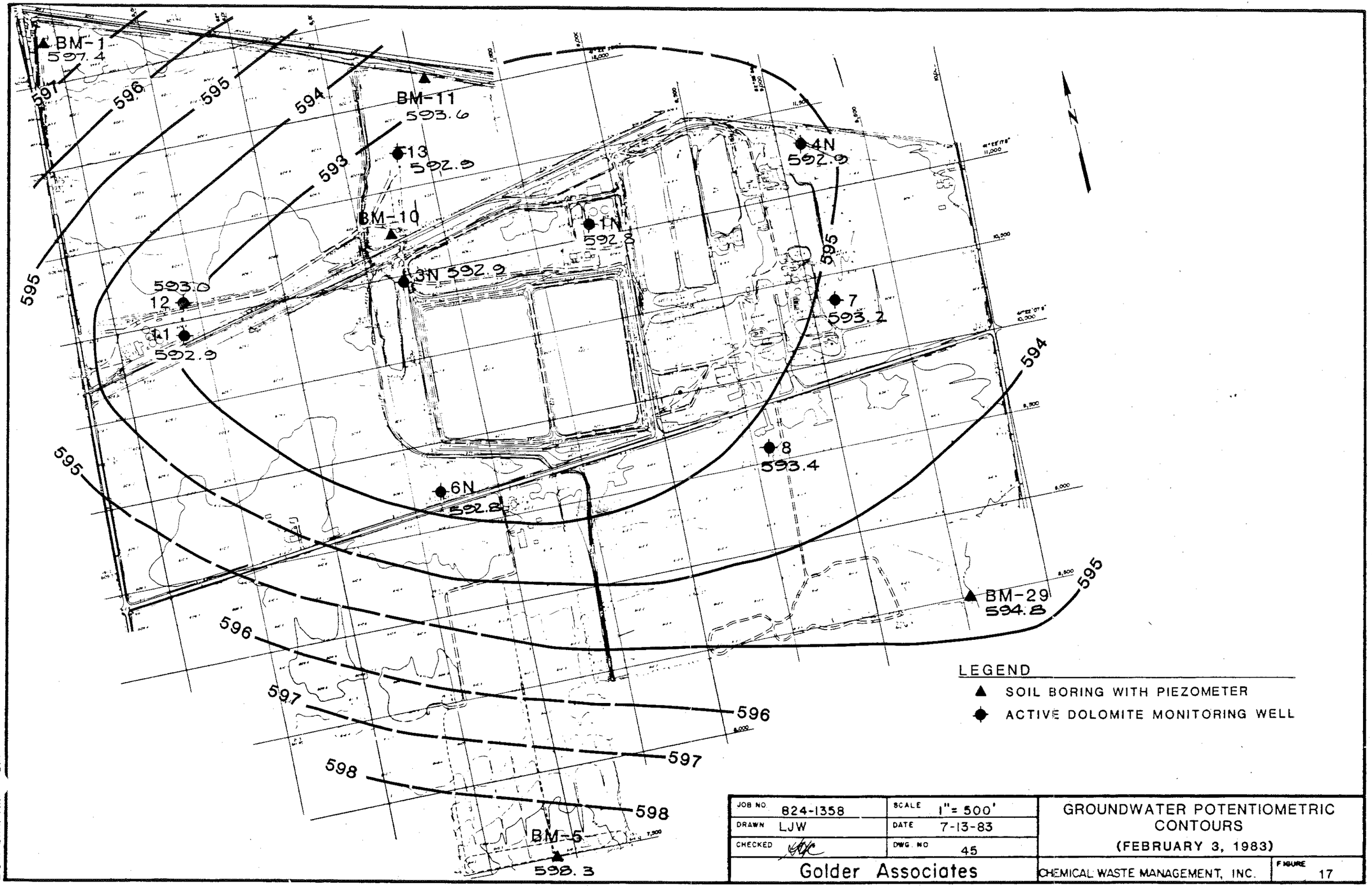
REVISIONS		
DESCRIPTION	BY	DATE

CHEMICAL WASTE MANAGEMENT, INC.
VICKERY, OHIO DISPOSAL FACILITY

TITLE: AQUIFER POTENTIOMETRIC LEVELS APRIL TO JUNE, 1983

DRAWN SKB	SCALE AS SHOWN	DATE 6-25-83
CHECKED MRB	REVIEWED	JOB NO 834-1358
Golder Associates		DWG NO 40 / FIGURE 16

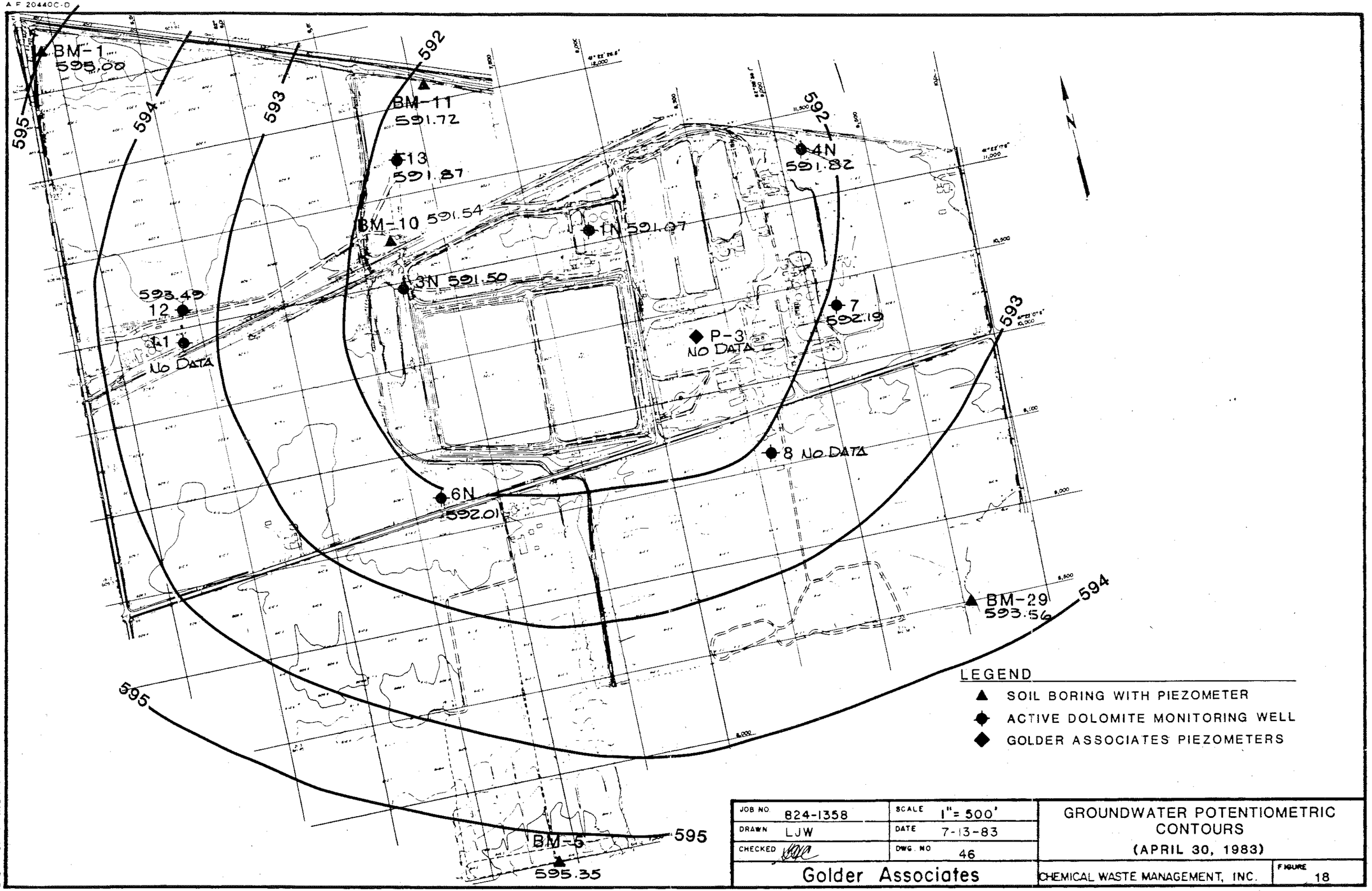
A F 20440C-D



JOB NO. 824-1358	SCALE 1" = 500'	GROUNDWATER POTENTIOMETRIC CONTOURS (FEBRUARY 3, 1983)	
DRAWN LJW	DATE 7-13-83		
CHECKED	DWG. NO 45		
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC.	FIGURE 17

GAF DRAFTING DIA

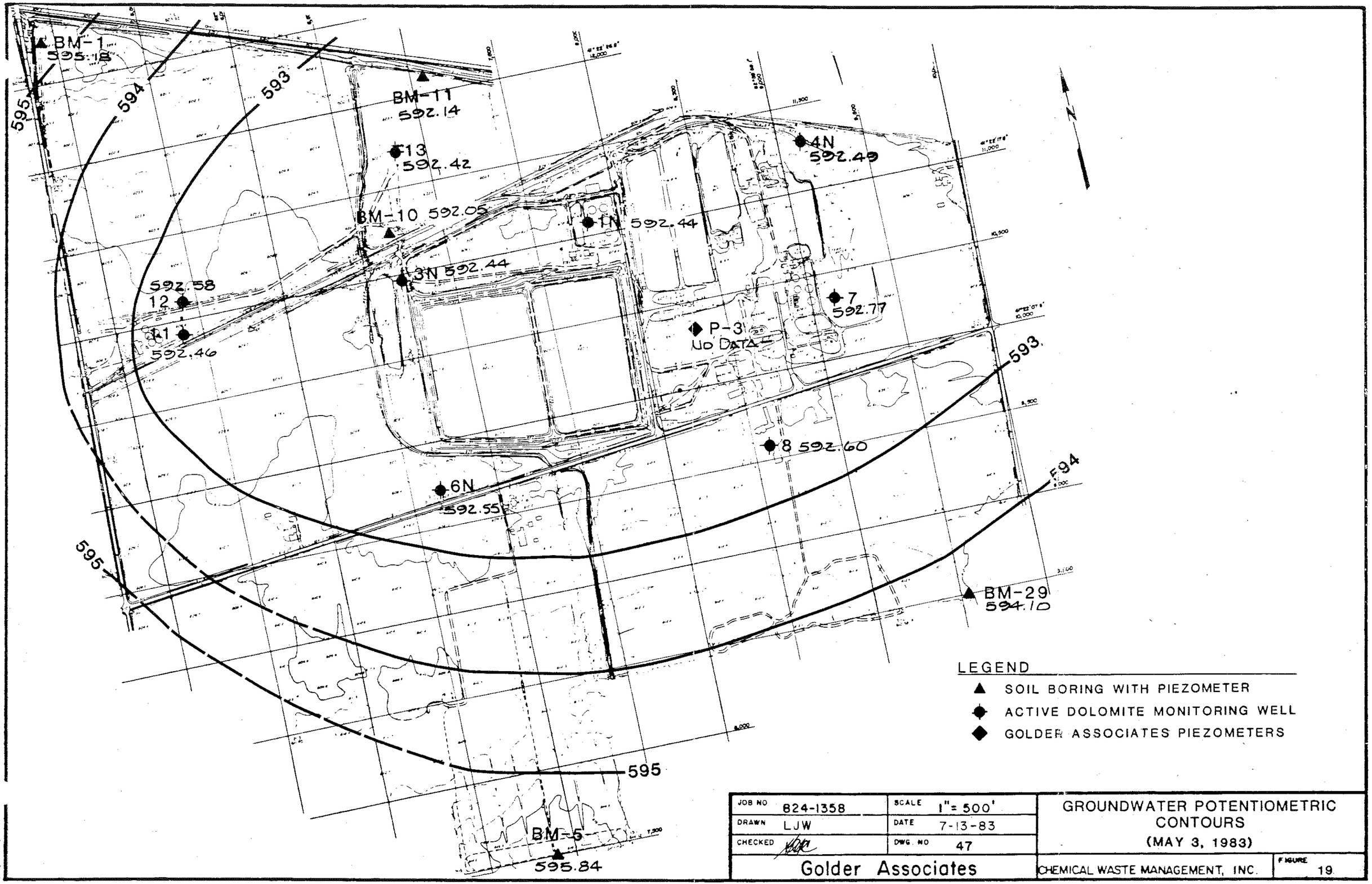
A F 20440C-D



JOB NO 824-1358	SCALE 1"= 500'	GROUNDWATER POTENTIOMETRIC CONTOURS (APRIL 30, 1983)	
DRAWN LJW	DATE 7-13-83		
CHECKED	DWG. NO 46		
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC.	FIGURE 18

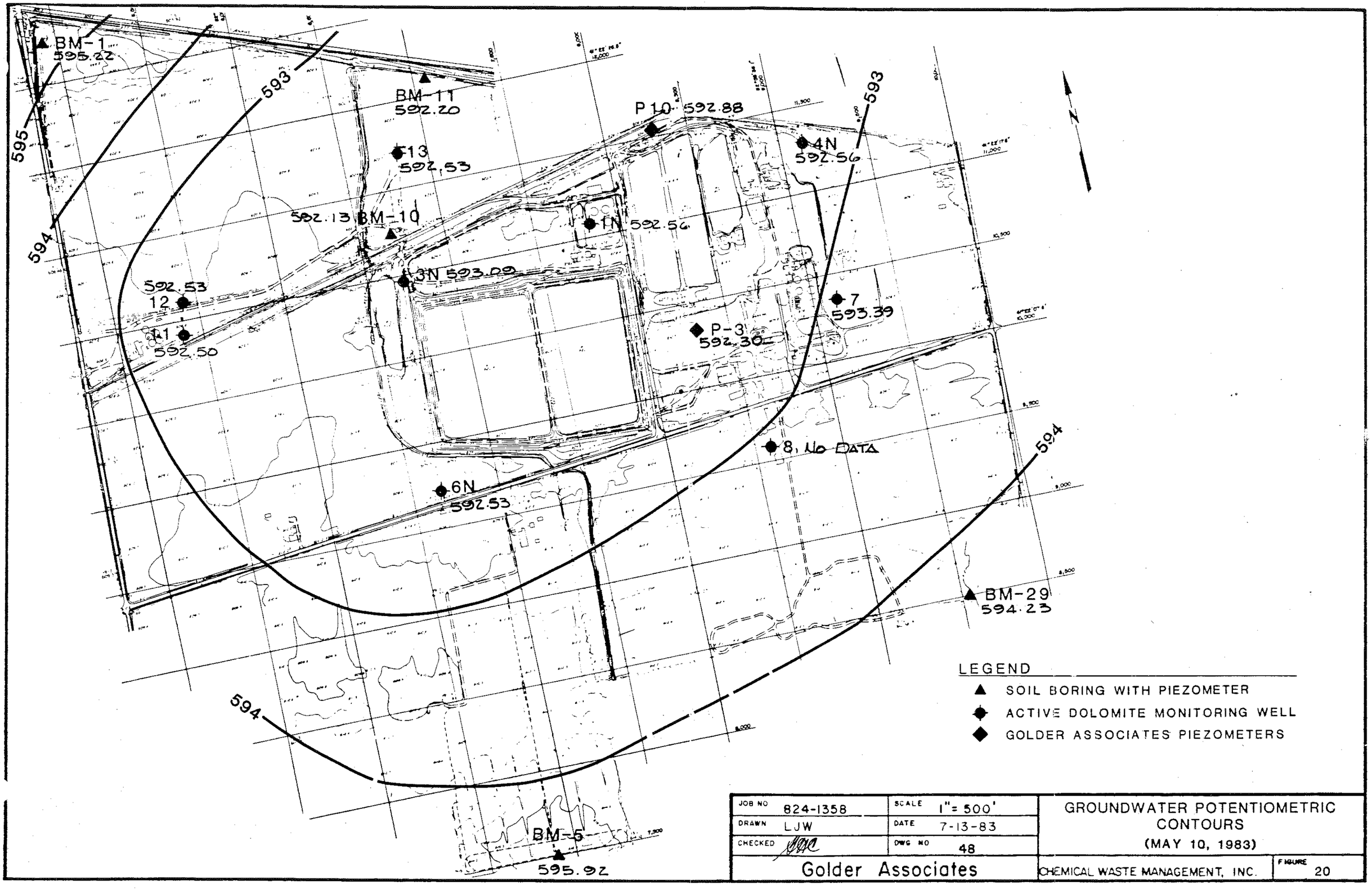
GAF DRAFTING MEDIA

A F 20440C-D



JOB NO 824-1358	SCALE 1" = 500'	GROUNDWATER POTENTIOMETRIC CONTOURS (MAY 3, 1983)	
DRAWN LJW	DATE 7-13-83		
CHECKED	DWG. NO 47		
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC.	FIGURE 19

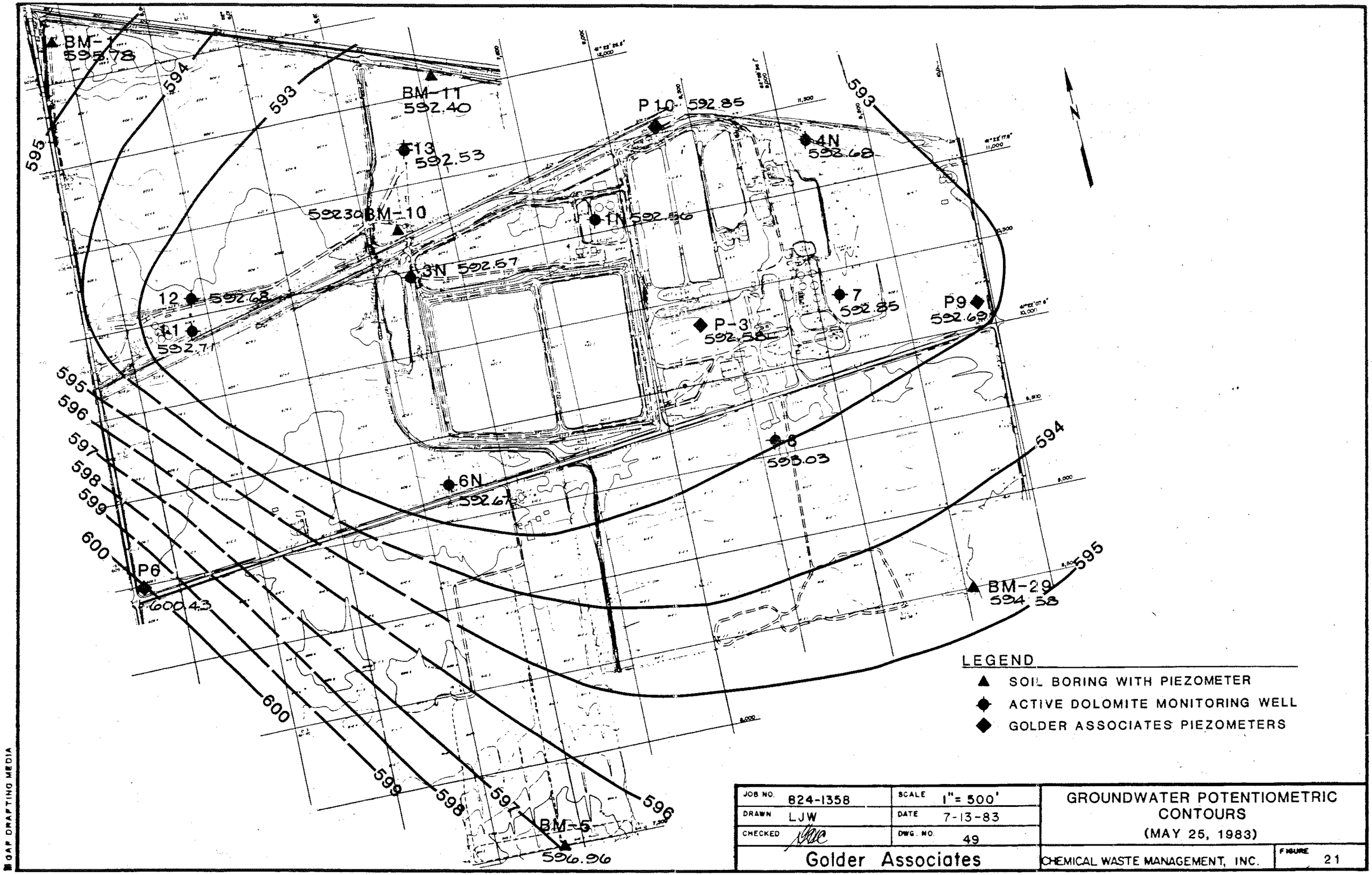
A F 20440C-D



JOB NO 824-1358	SCALE 1" = 500'	GROUNDWATER POTENTIOMETRIC CONTOURS (MAY 10, 1983)	
DRAWN LJW	DATE 7-13-83		
CHECKED	DWG NO 48		
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC.	FIGURE 20

GAF DRAFT II EDIA

A F 20440C-D



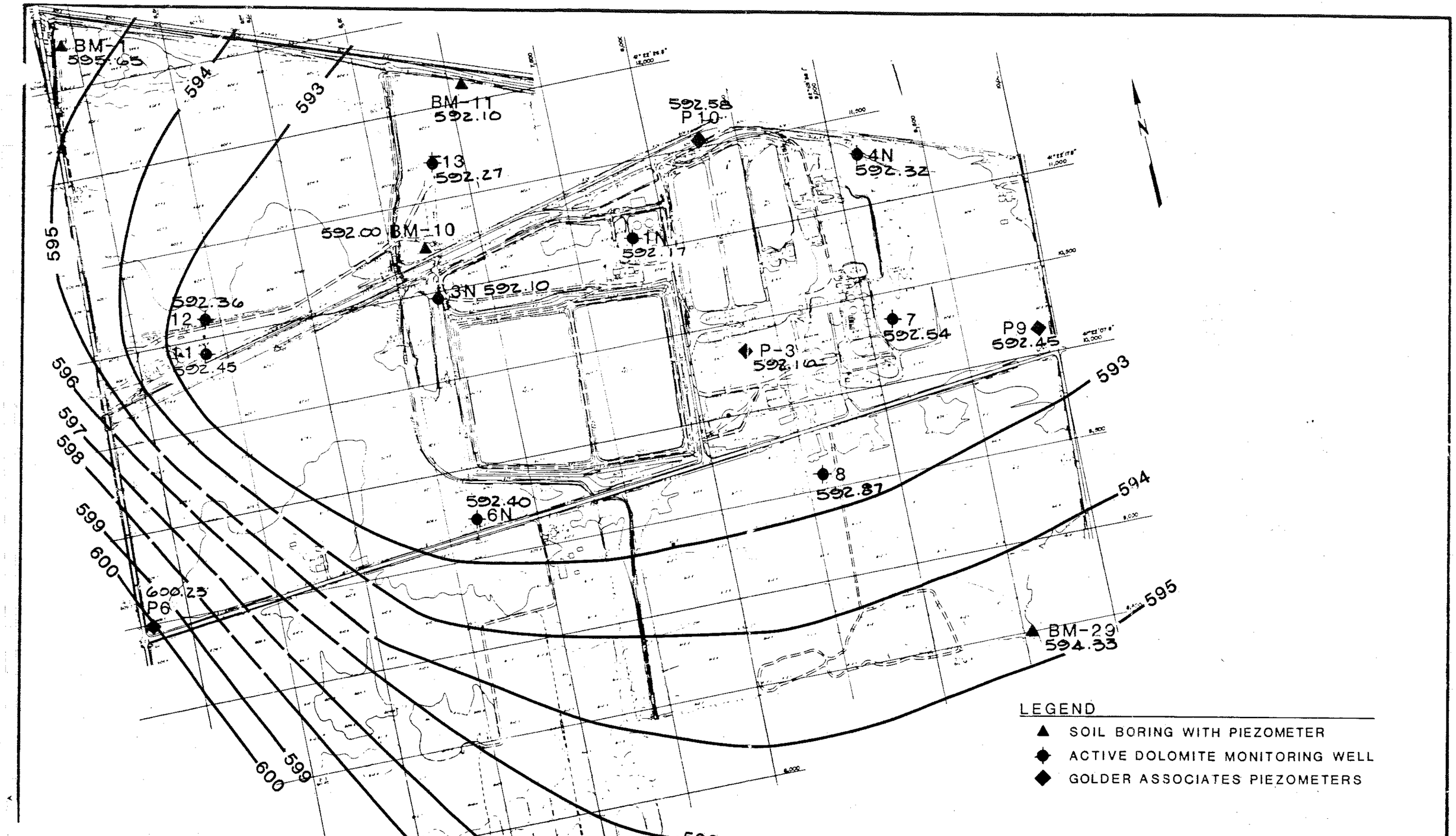
LEGEND

- ▲ SOIL BORING WITH PIEZOMETER
- ◆ ACTIVE DOLOMITE MONITORING WELL
- ◆ GOLDER ASSOCIATES PIEZOMETERS

JOB NO. 824-1358	SCALE 1" = 500'	GROUNDWATER POTENTIOMETRIC CONTOURS (MAY 25, 1983)	
DRAWN LJW	DATE 7-13-83		
CHECKED	DWG. NO. 49		
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC.	FIGURE 21

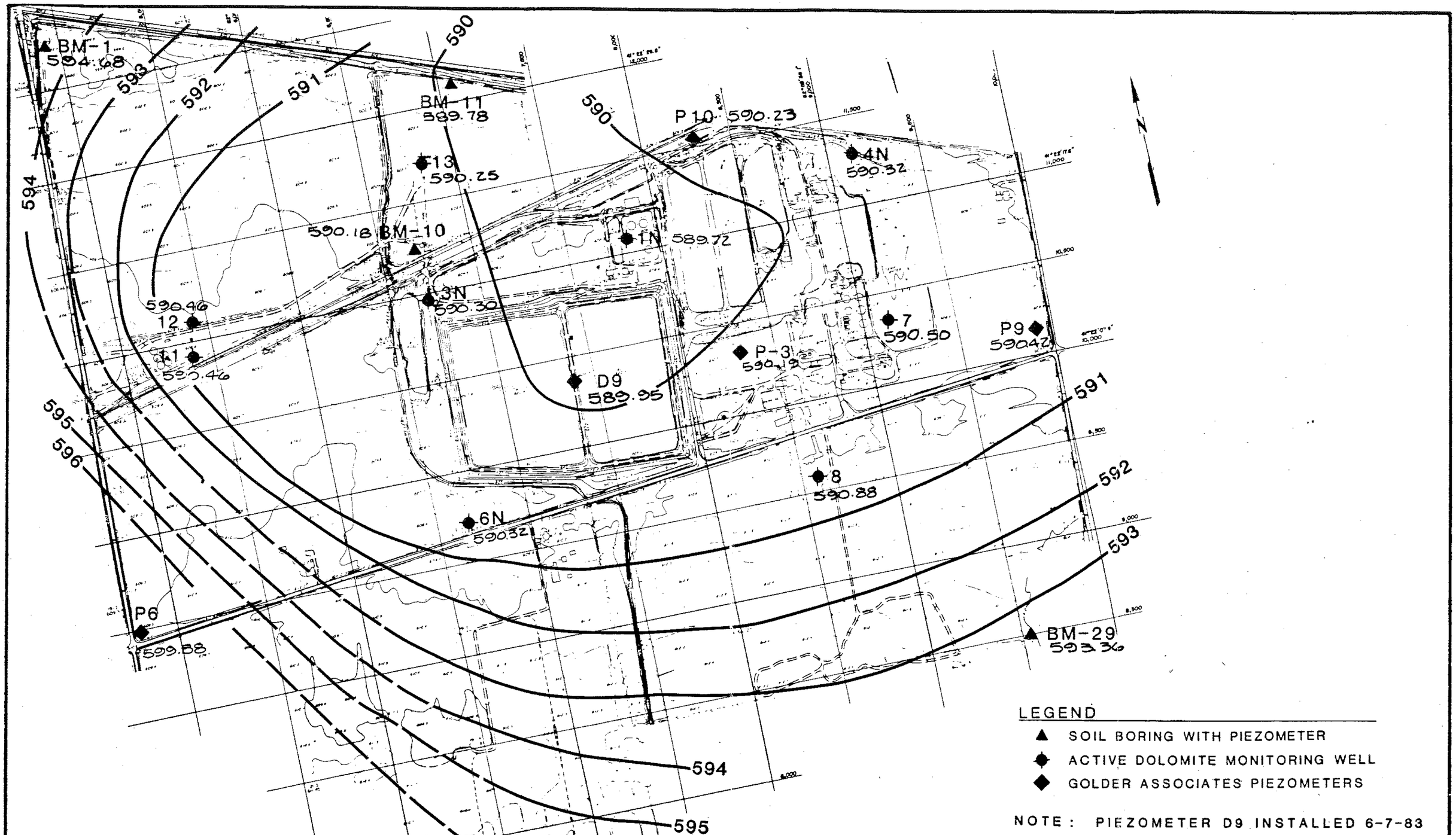
GAF DRAFTING MEDIA

A F 20440C-D



JOB NO 824-1358	SCALE 1" = 500'	GROUNDWATER POTENTIOMETRIC CONTOURS (JUNE 1, 1983)	
DRAWN LJW	DATE 7-13-83		
CHECKED	DWG NO 50		
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC.	FIGURE 22

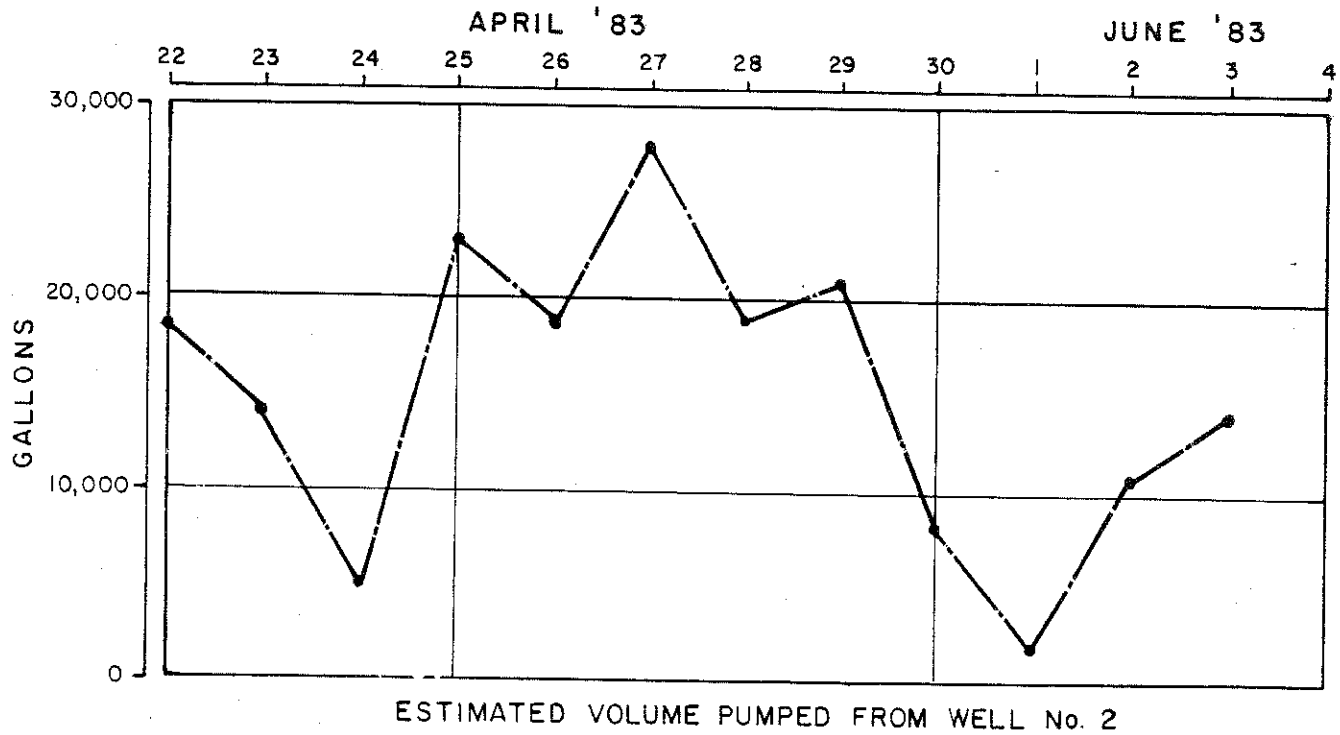
A F 20440C-D

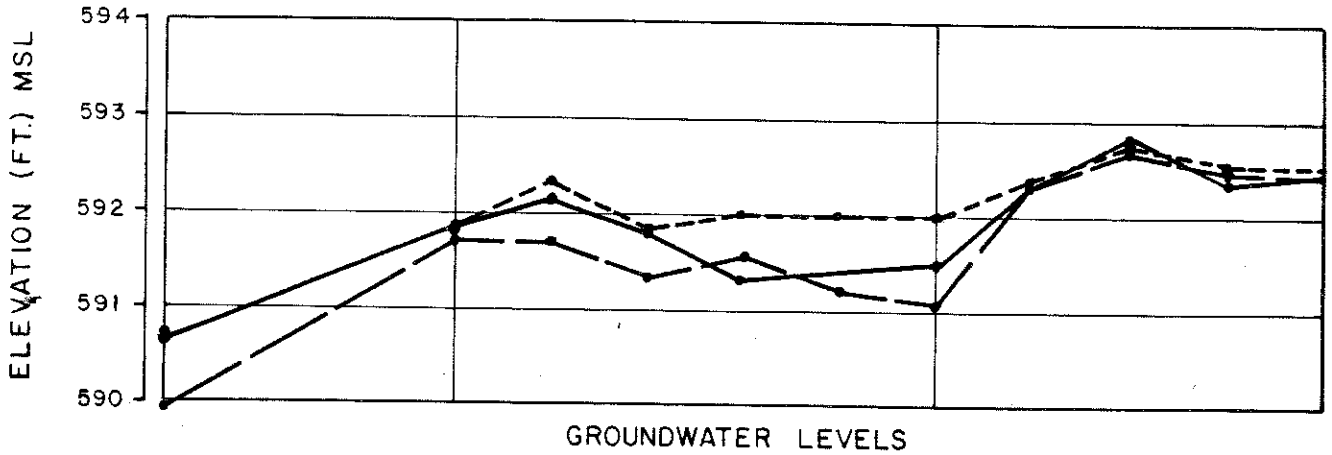


JOB NO 824-1358	SCALE 1" = 500'	GROUNDWATER POTENTIOMETRIC CONTOURS (JUNE 10, 1983)	
DRAWN LJW	DATE 7-13-83		
CHECKED	DWG NO 51		
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC.	FIGURE 23

GAF DRAFT MEDIA

AF 20440A-B





LEGEND

- WELL 2
- WELL 3N
- WELL 1N
- WELL 6N

JOB NO. 834-1358	SCALE AS SHOWN	GROUNDWATER LEVELS vs. ESTIMATED WATER USUAGE
DRAWN SKB	DATE 8-3-83	
CHECKED	DWG. NO. 61	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. — FIGURE 24

OZALID DRAFTING MEDIA

APPENDIX A

Data Summary Tables

TABLE A-1
MONITORING WELL AND 'BM' SERIES PIEZOMETER WATER LEVELS

Well/Piezometer Number	Date Installed	Open Interval Elevation	Completion Strata	Ground Surface Elevation	Measurement Date (1983) and Water Level Elevation										
					4/22	4/25	4/26	4/27	4/28	4/29	4/30	5/1	5/2	5/3	5/4
1A	1979	Unknown	Lacustrine	608.4	607.78[3]	607.56	607.48	604.44	607.99	608.03	608.27	608.30	608.36	608.35	608.24
1N	7/2/79	407.0-547.0	Dolomite	607.4	589.97[3]	591.76	591.77	591.42	591.55	591.22	591.07	592.38	592.72	592.44	592.57
3A	1976	Unknown	Lacustrine	604.7	604.32[3]	—	604.31	604.20	604.46	604.40	604.57	604.79	604.87	604.82	604.77
3N	7/3/79	555.0-557.0	Dolomite	605.3	590.59[3]	591.85	592.15	591.84	591.39	—	591.50	592.41	592.82	592.44	592.65
4N	7/2/79	558.0-560.0	Dolomite	608.0	590.53[3]	592.04	592.02	591.02	591.84	591.74	591.82	592.22	592.75	592.49	592.69
6A	1976	—	Lacustrine	608.7	607.38[3]	606.86	606.85	606.67	606.84	—	607.18	608.09	608.22	608.22	608.22
6N	7/2/79	558.5-562.5	Dolomite	608.5	590.70[3]	591.89	592.33	591.88	592.01	—	592.01	592.42	592.80	592.55	592.83
7	7/3/79	553.0-562.0	Dolomite	608.1	—[3]	—	592.32	592.14	592.14	592.16	592.19	592.54	593.10	592.77	593.01
8	6/12/79	562.0-565.0	Dolomite	611.8	—[3]	—	—	—	—	—	—	—	592.77	592.60	592.82
11	5/6/81	548.0-561.0	Dolomite	608.4	—[3]	592.01	592.14	591.78	591.68	591.85	—	592.40	592.81	592.46	592.58
12	5/6/81	541.0-559.0	Dolomite	606.1	590.60[3]	592.06	592.19	591.71	591.63	591.82	593.49	592.38	592.77	592.58	592.57
13	5/6/81	544.0-556.0	Dolomite	603.7	586.22[3]	591.99	592.06	591.51	591.49	591.68	591.87	592.26	592.62	592.42	592.42
BM-1	10/14/82	537.3-557.3	Dolomite	601.3	595.79[3]	594.49	594.68	594.62	594.85	594.81	595.00	595.12	595.46	595.18	595.46
BM-5	10/14/82	536.0-576.0	Dolomite	616.5	594.23	—	595.19	595.19	595.18	595.11	595.35	595.48	595.87	595.84	595.86
BM-10	11/16/82	544.2-554.2	Dolomite	604.2	590.20	591.66	591.77	591.14	591.20	591.29	591.54	591.85	592.23	592.05	591.83
BM-11	10/6/82	549.9-555.9	Dolomite	600.9	590.44	—	591.92	591.29	591.30	591.55	591.72	591.95	592.40	592.14	592.12
BM-29	10/19/82	546.3-566.3	Dolomite	610.3	592.29	—	593.73	593.44	593.46	593.48	593.56	593.81	594.39	594.10	594.21

NOTES:
1. Elevations in feet, MSL.
2. See Appendix B for discussion of measurement procedures.
3. Monitoring Wells purged for sampling on the following dates:
   April 18 - Well #1N
   April 20 - Wells #1A, 1N, 4N, 8
   April 21 - Wells #3A, 3N, 6A, 6N, 7, 11, 12, 13

TABLE A-1 (Continued)
MONITORING WELL AND 'BM' SERIES PIEZOMETER WATER LEVELS

Well/Piezometer Number	Measurement Date (1983) and Water Level Elevation									
	5/10	5/11	5/12	5/13	5/25	6/1	6/2	6/3	6/9	6/10
1A	607.95	607.97	608.00	608.03	608.04	607.86	607.90	607.89	607.84	607.87
1N	592.56	592.50	592.22	591.99[4]	592.56	592.17	592.17	592.06	589.51	589.72
3A	604.07	604.44	604.32	604.27	604.37	603.74	603.52	603.46	603.65	603.49
3N	593.09	592.39	592.84	593.65[4]	592.57	592.10	592.09	592.04	589.48	590.30
4N	592.56	592.38	592.45	592.42	592.68	592.32	592.13	592.01	589.82	590.32
6A	607.42	608.19	608.02	607.22	607.07	606.57	606.67	606.57	606.57	606.58
6N	592.53	592.58	592.55	592.06[4]	592.67	592.40	592.34	591.98	589.80	590.32
7	593.39	592.65	592.86	592.71	592.85	592.54	592.37	592.35	590.36	590.50
8	—	592.88	592.73	592.68	593.03	592.87	592.88	592.85	589.47	590.88
11	592.50	590.46[5]	592.57	592.38	592.71	592.45	592.28	592.17	589.96	590.46
12	592.53	—	592.48	592.20	592.68	592.36	592.34	592.25	589.96	590.46
13	592.53	592.27	592.33	591.84	592.53	592.27	592.23	592.20	589.86	590.25
BM-1	595.22	595.24	595.20	595.14	595.78	595.65	595.34	595.35	594.50	594.68
BM-5	595.92	596.00	596.04	595.99	596.96	596.84	596.80	596.74	595.89	596.00
BM-10	592.13	592.07	592.12	592.03	592.30	592.00	591.98	591.88	589.68	590.18
BM-11	592.20	592.25	592.19	592.14	592.40	592.10	591.91	591.54	589.53	589.78
BM-29	594.23	594.35	594.38	594.22	594.58	594.33	594.30	594.27	593.01	593.36

NOTES:
1. Elevations in feet, MSL.
2. See Appendix B for discussion of measurement procedures.
3. Well #2 pumped at approximately 150 gpm for 70 minutes on May 13, 1983.
4. Wells #1N and #3N pumped, and Well #6N bailed for dye test sample on May 13, 1983.
5. Well #11 purged for sampling on May 11, 1983.

TABLE A-2 (Continued)
'D' SERIES PIEZOMETER WATER LEVELS

Piezometer Number		Measurement Date (1983) and Water Level Elevation									
		5/10	5/11	5/12	5/13	5/25	6/1	6/2	6/3	6/9	6/10
D-1	606.7	606.6	606.6	606.5	606.6	606.5	606.4	606.3	606.1	606.1	
D-2	608.1	608.1	608.0	608.0	608.0	607.9	607.9	607.8	607.3	607.2	
D-3	605.3	605.7	605.6	605.4	607.3	607.1	607.2	607.1	606.7	606.7	
D-3a	609.6	609.7	609.6	609.6	609.7	609.6	609.7	609.6	609.4	609.4	
D-4	608.2	608.0	608.1	608.1	607.9	607.6	607.8	607.8	607.6	607.5	
D-5	608.2	608.5	608.4	608.3	608.6	607.9	608.3	608.3	608.1	608.0	
D-6	595.1	596.4	595.7	595.8	605.2	606.0	606.3	606.3	606.4	606.3	
D-6a	610.0	610.2	610.0	609.9	611.4	611.6	612.0	612.0	611.4	611.5	
D-7	606.2	606.1	606.1	606.1	606.3	606.1	606.0	606.1	606.2	606.1	
D-8	604.0	604.0	604.0	603.9	604.3	604.2	604.0	604.0	604.0	604.0	
D-8a	605.7	605.9	605.8	605.7	607.1	607.5	607.6	607.7	608.0	607.9	
D-9	—	—	—	—	—	—	—	—	589.7	590.0	
D-9a	—	—	—	—	—	—	—	—	620.3[4]	618.0[4]	
D-9b	—	—	—	—	—	—	—	—	Dry	Dry	

NOTES:
1. Elevations in feet, MSL.
2. See Appendix B for discussion of measurement procedures.
3. Well #2 pumped at approximately 150 gpm for 70 minutes on May 13, 1983.
4. Water used to flush hole when sand filter jammed piezometer during installation. These water levels have not stabilized. Water level measured at completion of drilling was 604.6.

TABLE A-3
'P' SERIES PIEZOMETER WATER LEVELS

Piezometer Number	Date Installed	Open Interval Elevation	Ground Completion Strata	Surface Elevation	Measurement Date (1983) and Water Level Elevation										
					4/22	4/25	4/26	4/27	4/28	4/29	4/30	5/1	5/2	5/3	5/4
P-1	4/27/83	595.4-603.0	Fill/Till	610.9	—	—	—	—	606.57	609.42	610.22	—	611.27	611.62	611.78
P-2	4/28/83	576.0-583.0	Till	611.0	—	—	—	—	578.40	577.49	577.94	—	579.05	579.65	580.00
P-3	4/29/83	534.1-548.0	Dolomite	611.1	—	—	—	—	—	—	—	—	—	—	—
P-4	4/28/83	576.1-582.5	Till	609.1	—	—	—	—	—	607.06	607.93	608.54	608.83	608.74	608.49
P-5	4/29/83	595.3-605.0	Lacustrine	609.3	—	—	—	—	—	607.01	605.77	605.45	605.29	605.14	605.04
P-6	5/16/83	531.3-547.0	Dolomite	609.3	—	—	—	—	—	—	—	—	—	—	—
P-7	4/29/83	597.9-606.0	Lacustrine	609.9	—	—	—	—	—	603.64	605.73	606.10	606.30	606.23	606.03
P-8	4/29/83	574.7-582.0	Till	609.7	—	—	—	—	—	576.43	578.13	579.05	579.92	580.93	581.30
P-9	5/10/83	530.4-543.3	Dolomite	609.9	—	—	—	—	—	—	—	—	—	—	—
P-10	5/6/83	517.4-531.5	Dolomite	604.9	—	—	—	—	—	—	—	—	—	—	—

NOTES: 1. Elevations in feet, MSL.
2. See Appendix B for discussion of measurement procedures.

TABLE A-3 (Continued)
'P' SERIES PIEZOMETER WATER LEVELS

Piezometer Number	Measurement Date (1983) and Water Level Elevation									
	5/10	5/11	5/12	5/13	5/25	6/1	6/2	6/3	6/9	6/10
P-1	611.67	611.67	611.67	607.37[5]	611.99	612.08	612.07	612.06	612.07	612.07
P-2	584.80	586.08	587.00	578.90[5]	588.92	592.64	593.06	593.35	596.50	596.60
P-3	592.30	592.11	592.21	592.41	592.58	592.16	592.07	591.89	589.90	590.19
P-4	607.54	607.54[5]	607.64	607.59	607.91	607.68	607.50	607.49	607.46	607.49
P-5	604.33	604.34[5]	579.54	579.64	584.66	592.10	592.46	592.41	594.74	594.79
P-6	—	—	—	—	600.43	600.23	600.35	600.40	599.88	599.88
P-7	605.58	605.64	605.66	605.68	605.77	605.35	605.28	605.17	605.33	605.38
P-8	585.93	586.63	587.73	588.29	594.39	592.78	596.58	596.37	597.93	597.97
P-9	—	592.43	592.20	592.00[5]	592.69	592.45	592.19	592.18	589.59	590.42
P-10	592.88	592.70	592.88	592.68[5]	592.85	592.58	592.46	591.97	589.88	590.23

NOTES:
1. Elevations in feet, MSL.
2. See Appendix B for discussion of measurement procedures.
3. Well #2 pumped at approximately 150 gpm for 70 minutes on May 13, 1983.
4. P-4 and P-5 pumped after measurement on May 11, 1983.
5. P-1, P-2, P-9, and P-10 pumped after measurement on May 12, 1983.

TABLE A-4

SUMMARY OF LABORATORY HYDRAULIC CONDUCTIVITY MEASUREMENTS IN OVERBURDEN
(From Bowser-Morner, Inc.)

Bowser-Morner* Borehole No.	Depth/Elevation (ft.)	Strata	Hydraulic Conductivity (cm./sec.)
1	12.4 - 12.6	Lacustrine	7.0×10^{-9}
5	28.0 - 28.2	Till	1.5×10^{-8}
9	10.0 - 10.2	Lacustrine	6.1×10^{-9}
9	30.0 - 30.2	Till	1.6×10^{-8}
12	14.2 - 14.4	Lacustrine	2.6×10^{-8}
12	35.0 - 35.2	Till	1.6×10^{-8}
14	10.3 - 10.5	Lacustrine	3.5×10^{-8}
14	20.2 - 20.4	Till	2.2×10^{-8}
14	40.4 - 40.6	Till	8.4×10^{-9}
19	8.3 - 8.5	Lacustrine	1.5×10^{-8}
19	28.0 - 28.2	Till	3.1×10^{-8}
22	25.0 - 25.2	Till	2.4×10^{-8}
25	8.0 - 8.2	Lacustrine	8.6×10^{-8}**

* Bowser-Morner borehole numbers do not correspond to monitoring well or piezometer numbers.
**Test performed in horizontal direction

TABLE A-5

SUMMARY OF IN SITU HYDRAULIC CONDUCTIVITY
MEASUREMENTS IN OVERBURDEN
(By Golder Associates)

Borehole No.	Open Interval Elev. (ft.)	Strata	Hydraulic Conductivity (cm./sec.)
D-3	576.6-585.5	Till	2×10^{-8}
D-6	575.9-585.0	Till	1×10^{-8}
P-1	595.4-603.0	Fill/Lacustrine	7×10^{-7}
P-2	576.0-583.0	Till	3×10^{-8}
P-4	576.1-582.5	Lacustrine	1×10^{-6}
P-5	595.3-605.0	Till	2×10^{-8}
P-8	574.7-582.0	Till	2×10^{-8}

TABLE A-6

SUMMARY OF PACKER TEST RESULTS IN BEDROCK
(By Golder Associates)

Borehole No.	Depth (ft.)	Hydraulic Conductivity (cm./sec.)
P-6	50.0 - 55.0	3×10^{-3}
	54.0 - 59.0	2×10^{-3}
	58.0 - 63.0	2×10^{-3}
	62.0 - 67.0	2×10^{-3}
	66.0 - 71.0	2×10^{-3}
	70.0 - 75.0	1×10^{-3}
P-9	47.5 - 51.5	1×10^{-3}
	51.5 - 55.5	No Take - 10^{-5}
	55.5 - 59.5	1×10^{-3}
	59.5 - 63.5	1×10^{-3}
	63.5 - 67.5	2×10^{-3}
	67.5 - 71.5	1×10^{-3}
	71.5 - 75.5	1×10^{-3}
P-10	48.0 - 53.0	3×10^{-3}
	52.0 - 57.0	3×10^{-3}
	56.0 - 61.0	3×10^{-3}
	60.0 - 65.0	3×10^{-3}
	64.0 - 69.0	2×10^{-3}
	68.0 - 73.0	No Take - 10^{-5}

Note: All tests conducted in the Tymochtee Dolomite.

TABLE A-7

SUMMARY OF HYDRAULIC PROPERTIES OF BEDROCK

Formation	Hydraulic Conductivity (cm./sec.)	Transmissivity gpd/ft.	Storativity	Reference Test Method	(see Appendix A)
Tymochtee and Greenfield	—	65,150	—	500 gpm pump test	4 - test well S-23
Lockport	—	22,270	—	500 gpm pump test	4 - test well S-18
Tymochtee and Greenfield	—	10,300	—	500 gpm pump test	4 - test well S-24
Tymochtee	$5x10^{-3}$	2,830	$4x10^{-3}$	11 gpm pump test	1 - site well #10
Tymochtee	$1x10^{-3}$ to $3x10^{-3}$	—	—	Packer Testing	Borehole P-6
Tymochtee	$2x10^{-3}$ to 10^{-5}	—	—	Packer Testing	Borehole P-9
Tymochtee	$3x10^{-3}$ to 10^{-5}	—	—	Packer Testing	Borehole P-10
Tymochtee	—	—	$1x10^{-4}$	Empirical Relationship; S = aquifer thickness x $1x10^{-6}$ $ft.^{-1}$	—

TABLE A-8

SUMMARY OF SPECIFIC CAPACITY DATA

Well	Formation	Pump Rate Location	(gpm)	Specific Gravity gpm/ft./ft.
1N	Tymochtee/ Greenfield	On site, see Figure 2	10.0	0.17
3N	Tymochtee	On site, see Figure 2	12.4	1.2
6N	Tymochtee	On site, see Figure 2	13.3	0.86
7	Tymochtee	On site, see Figure 2	13.3	0.1
8	Tymochtee	On site, see Figure 2	10.9	0.8
11	Tymochtee	On site, see Figure 2	13.3	0.5
12	Tymochtee	On site, see Figure 2	13.3	0.2
13	Tymochtee	On site, see Figure 2	13.3	0.05
OEPA 4	Tymochtee	On site, see Figure 2	6.8	0.03
S-18	Lockport	Off site, see Figure 7	503	0.02
S-23	Tymochtee/ Greenfield	Off site, see Figure 7	503	1.8
S-24	Tymochtee/ Greenfield	Off site, see Figure 7	503	0.6

APPENDIX B

Field Work Procedures

An investigation of subsurface conditions at the site was undertaken by Golder Associates, between April 19 and June 1, 1983. The investigation was performed in two stages:

1. An investigation of subsurface conditions and installation of piezometers in the vicinity of the existing containment dikes. The borings completed for this portion of the investigation were denoted as D-1 to D-9b, respectively.

2. The installation of piezometers at various locations around the site, for the purpose of monitoring local groundwater levels. These borings and installation are denoted as P-1 to P-10, respectively.

The subsurface conditions encountered in each boring and details of piezometer installations are summarized on the Record of Borehole sheets in Appendix D.

All of the borings were advanced with a truck mounted power auger drill rig operated by Bowser-Morner, Inc., Toledo, Ohio.

The D-series borings were advanced to depths ranging from 15.5 ft. to 73.0 ft. below ground surface. Representative samples of the overburden materials were obtained at 1.5 ft. to 5.0 ft. intervals using 2 inch diameter split spoon or 3 inch diameter thin wall (Shelby) tube samplers. Standard penetration tests were conducted in conjunction with the split spoon sampling. The thin wall tubes were hydraluically pushed and extracted from the soil in order to minimize sample disturbance. The in situ undrained shear strength was determined at selected depths using a field vane shear apparatus.

A 1 inch diameter PVC standpipe type piezometer was sealed into each of the D-series borings following completion of the hole. A single piezometer was placed in each hole to insure the quality of the installation. At borehole locations D-3, D-6, D-8 and D-9, a second shallow piezometer installation was placed in an unsampled boring drilled adjacent to the sampled boring. These unsampled piezometer installations are denoted as boreholes D-3a, D-6a, D-9a, and D-9b, respectively.

The piezometers were fitted with a 5 ft. screened section with 0.010 inch slot width openings. A silica sand filter was packed around the screen, and bentonite or bentonite-cement grout was used to seal the hole to surface.

The P-series borings were advanced to depths ranging from 12.0 ft. to 87.5 ft. below ground surface. These holes were generally not sampled through the overburden materials. Continuous diamond coring of the bedrock was undertaken in borings P-3, P-6, P-9 and P-10, to depths of 30 ft. to 40 ft. below the bedrock surface.

Pressure packer testing was conducted in the bedrock at continuous depth intervals of approximately 5 ft. using an inflatable rubber packer device. The tests were generally carried out at a single injection pressure, and were conducted for approximately 5 minutes after stabilization of pressure and flow rates into the hole. The hydraulic conductivity of the bedrock, as calculated from the packer tests, is presented on Table A-6. The packer device became lodged in borehole P-6, as the result of caving of the fractured rock materials around the packer. Accordingly, the hole and packer were grouted shut with cement-

bentonite grout, and a new boring was drilled about 15 ft. to the north to permit piezometer installation.

The piezometer installation techniques used for the P-series borings were similar to those described above for the D-series holes, except that 2 inch diameter PVC standpipes and screens were used.

The water levels in the piezometers in all of the borings were monitored frequently following installation. These levels are listed in Tables A-1, A-2 and A-3, and plotted on Figures 11 through 16. Selected piezometers were bailed or pumped dry, and the rate of recovery of water levels was observed in order to allow calculation of the in situ hydraulic conductivity of the soils. The results of this testing are summarized on Table A-5.

Water levels were measured in the monitoring wells (4 in. diameter) by lowering a tape down the hole until it touched the water surface. This was determined very easily by visual observation and the accuracy of these measurements is considered to be to the nearest 0.01 ft. Water levels in the smaller diameter piezometers, D and P series piezometers (1 in. and 2 in. diameter) were measured with an electric water level indicator. These measurements are considered accurate to the nearest 0.1 ft.

Water level elevations listed in Tables A-1, A-2, and A-3 were calculated by subtracting the water level depth measured from the top of the standpipe from the standpipe elevation. These elevations are accurate to within 0.01 ft. However, the ground surface elevations listed in Tables A-1, A-2, and A-3 are only considered accurate to within 0.1 ft.

The split spoon samples obtained during the investigation were placed in glass sample jars and the thin wall tube samples were tightly capped in order to minimize changes in moisture content.

Laboratory index (classification) testing including water content, Atterberg limits, grain size determination, and bulk density was performed on selected samples by Bowser-Morner Testing Laboratories, Inc., of Toledo, Ohio. Selected thin wall tube samples were shipped to Golder Associates laboratory for consolidated undrained triaxial shear strength testing (R tests). The results of the laboratory testing of the soil samples is reported in Golder Associates' report "Assessment of Perimeter Containment Dike Stability", dated June, 1983.

The bedrock cores obtained during the investigation were logged by a member of Golder Associates engineering staff on the site, and are presently in the custody of Bowser-Morner, Inc., of Toledo, Ohio.

The field work was directed by a member of Golder Associates' engineering staff who located and logged the borings in the field, and directed the drilling and sampling operations. The locations and elevations of the D-series borings (with the exception of D-9, D-9a and D-9b) were surveyed by Farnham, Wirries, and Bernings. The location and elevation of the remaining borings were surveyed by Golder Associates staff. All elevations refer to U.S.G.S. MSL datum.

APPENDIX C

Monitor Well Construction Summary
Injection Well Logs

MONITOR WELL CONSTRUCTION SUMMARY

CWM No.	OEPA No.	Depth (feet)	Casing	Year Drilled	CWM Dates Sampled	Date Abandoned	ODNR Log Number	Mean Sea Level Elev. 1983 Survey TOC	TOG	Remarks
1	--	--	3" galvanized steel	1978	4/79 - 6/79	6/79 - Filled with cement	--	606.33	606.2	--
1N	--	200	6" PVC cased to 60'	1979	7/79 - present	--	554277	609.17	607.4	--
1A	--	18.5	6" PVC perforated	1979	6 Months	1980	--	609.95	608.4	--
2	--	150	4" galvanized steel	1976	2/76 - present Gap 12/80-6/81			Buried under drive		Used for washing trucks
3	--	--	3" galvanized steel	1976	6/76 - 9/76	6/79 - Filled with cement	--	605.76	604.8	--
3N	--	50	6" PVC cased to 48'	1979	7/79 - present	--	554276	606.75	605.3	--
3A	--	14'or18'?	4" PVC perforated	1976	4/76 - present Gap 1/82-3/82	--	--	606.37	604.7	--
4	1	55	6" galvanized steel	1972	CWM 8/74-6/79 OEPA '72-6/79	June, 1979	425054	609.43	608.2	Hand pump
4N	1	50	6" PVC cased to 48'	1979	CWM 7/79-present OEPA 7/79-present	--	554274	608.84	608.0	--
5	2	56'or51'?	4" galvanized steel cased to 50'	Unknown	CWM 7/74-present OEPA '72-present	--	--	Location Uncertain		Lab well
6	--	--	3" galvanized steel	1976	4/76 - 6/79	6/79 - Filled with cement	--	609.36	608.4	
6N	--	50	6" PVC cased to 46'	1979	7/79 - present	--	554273	610.65	608.5	--
6A	--	12'or18'?	4" PVC perforated	1976	4/76 - 1/81 Gap 12/76-2/77		--	608.67	608.67	Mower broke casing off 1982
7	--	55	6" PVC cased to 45.5'	1979	7/79 - present	--	554275	610.26	608.1	--
8	3	50	4" galvanized steel cased to 47'	1979	CWM 9/79-present OEPA '72-present	--	405085	612.88	611.8	Eckhart home empty since 1981

MONITOR WELL CONSTRUCTION SUMMARY (Continued)

--	4	54	4" galvanized steel cased to 44.5'	1957	OEPA '74-'80	--	199085	--	605±	Emery house
--	5	77	Galvanized steel	Unknown	OEPA '72-'74	1974, pump broke	--	--	605±	Hand pump
--	6	56	4 1/4" cased to 43.5'	1956	OEPA '75-'79	1979	182754	--	610±	Gertensberger home
11	--	60	6" PVC cased to 47.5'	1981	1/82-present	--	602224	609.79	608.4	--
12	--	65	6" PVC cased to 47'	1981	1/82-present	--	602225	608.38	606.1	--
13	--	60	6" PVC cased to 48'	1981	1/82-present	--	602222	605.27	603.7	--
Pump house well	--	75	6" PVC cased to 48'	1981	--	--	602223	606.43	604.7	Not a monitor well

LEGEND

CWM - Chemical Waste Management

OEPA - Ohio Environmental Protection Agency

TOC - Top of Casing

TOG - Top of Ground

September 1983 C-3 [redacted] 834-1358.3

Schl.GR, [illegible]

Ohio Division Of Geological Survey

S- 2745

Permit No. 210
Permit Issued 2-24-72
Quadrangle Clyde
Twp. Quarter

County Sandusky Township Riley
Section 26 Lot Tract
Measured 250' NL & 2123' EL of Sec. 26
20 Acres

PE - Strat Test - R.

Land Owner Ohio Liquid Disposal Well No. 1 Date Commenced 3-1-72
Operator Ohio Liquid Disposal, Inc. Well No. Date Completed 3-16-72
Elevation Bar S.L. Total Depth 2933' Plugged Back
Formation Drld. To. Prod. Form. Prod. Nat.
I.P.
Init. Rock Press.
Casing Record 8" 643'. 5½" 2809' Abandoned 7-23-80

Formation	Top	Bottom	Remarks	Formation	Top	Bottom	Remarks
X= 1,867,877				Conasauga	2481	2606	
Y= 621,400				Rome	2606	2748	
				Shady	2748	2810	
Overburden	0	65		Mt. Simon	2810	2932	
				Granite	2932	2933	TD
PLUGGING REPORT 12-22-80							
Big lime	65	605					
Trenton	1667	1828					
Black river	1828	2312					
Gull river	2312	2363					
Glenwood	2363	2366					
Knox	2366	2481					

Formation	Top	Bottom	Remarks	Formation	Top	Bottom	Remarks
	0	[illegible]		NSR 11-2-72			
				Csg. 8-5/8"-643';5½"-2809'			
				B.Lm.	65	604	
				Tren.	1666	1828	
				B.Riv.	1828	2323	
				Glen.	2362	2366	
				L.Copper Ridge	2366	2481	
				Maynardsville	2481	2606	
				Rome	2606	2748	
				Shady	2748	2810	
				Mt.Simon	2810	2931	
				TD 2932			

[redacted]

SCHL:GRN,Cal,D,CB,L I.W.D.W. #19

SIRD:3DV

Permit No. 235
Permit Issued 9-5-79
Quadrangle Clyde
Twp. Quarter

County SANDUSKY Township RILEY

Section 26 Lot Tract

Measured 124.20' NL & 2377.95' EL of Sec. 26

20 acres Mt. Simon - IWDW - R.T.

Land Owner Ohio Liquid Disposal, Inc. Well No. 1A Date Commenced 9-10-79

Operator Ohio Liquid Disposal, Inc. Well No. Date Completed 9-27-79

Elevation Bar 606.11' 616.11'KB Total Depth 2980' Plugged Back

Formation Drld. To Pre-Cambrian Prod. Form. Mt. Simon Prod. Nat.

A/W 1M gal 15% HCl 10-18-79; A/W 4M gal 15% HCl 10-23-79 I.P.

Init. Rock Press.

Casing Record 16" 43' 125sks, 10 3/4" 632' 500sks, 7" 2342' Abandoned

Formation	Top	Bottom	Remarks	Formation	Top	Bottom	Remarks
Date: COMPLETION 3-12-80				X= 1,867,600			
Big lime	50	600	wtr	Y= 621,450			
Clinton	600	700		Rome	2594	2656	
Brassfield	700	743		Rome	2656	2746	wtr
Queenston	743	840		Shady	2746	2808	
Reedsville	840	1672		Mt. Simon	2808	2936	
Trenton	1672	1820		Granite	2936	2980	TD
Black river	1820	2307	s/gas 1850'	COMPLETION 8-6-80			
Gull river	2307	2360		Added treatment information.			
Glenwood	2360	2366					
Copper ridge	2366	2450					
Maynardville	2450	2594	wtr				

[redacted] S-3405

SCHL:GR,Cal,D,L,I,CB
BIRD:3DV,Tr

OHIO DIVISION GEOLOGICAL SURVEY #12

Permit No. 224
Permit Issued 1-28-76

County SANDUSKY Township RILEY Quadrangle Clyde
Section 26 Lot Tract Twp. Quarter
Measured 232' NL & 2635' EL of Sec. 26
25 Acres PE - IWDW - R.T.
Land Owner Ohio Liquid Disposal, Inc. Well No. 2 Date Commenced 6-17-76
Operator Ohio Liquid Disposal, Inc. Well No. Date Completed 11-23-76
Elevation Bar 607'G 615'DF 616'KB (618'KB) Total Depth 2961' Plugged Back
Formation Drld. To Pre-Cambrian Prod. Form. Prod. Nat.
A/W 5M gal. I.P.
Init. Rock Press. IWDW
Casing Record 10 3/4" 629'500sks, 7" 2371', 3½" 2800' Abandoned

Formation	Top	Bottom	Remarks	Formation	Top	Bottom	Remarks
Date: COMPLETION 3-20-78				X= 1,867,397			
Glacial deposits	0	60		Y= 621,418			
Big Lime	60	600		Glenwood	2360	2370	
Shale	600	690		Glenwood	2370	2380	
Dolomite	690	700		Knox	2380	2440	
Shale	700	710		Sandstone	2440	2590	
Dolomite	710	720		Rome	2590	2820	
Shale	720	880		Mt. Simon	2820	2930	
Dolomite	880	910		Basement	2930	2961	
Limestone	910	960					
Trenton	960	1560					
Black, Gull river	1560	2360					

[redacted] S-3416

SCHL:GR,Cal,D,CB,L,I
BIRD:GR,Cal,D,3DV,Tr * #13

Permit No. 225
Permit Issued 1-28-76

County SANDUSKY Township RILEY Quadrangle Clyde
NE¼ Section 26 Lot Tract Twp. Quarter
Measured 1270' NL & 1878'EL of NE¼ Sec. 26
25 Acres PG - IWDW - R.T.
Land Owner Ohio Liquid Disposal, Inc. Well No. 3 Date Commenced 7-1-76
Operator Ohio Liquid Disposal, Inc. Well No. Date Completed 11-22-76
Elevation Bar (608.8' SL) 607' 618'KB Total Depth 2960' Plugged Back
Formation Drld. To Pre-Cambrian Prod. Form. Prod. Nat.
A/W 5M gal. 15% HCL I.P.
Init. Rock Press. I.W.D.W.
Casing Record 10 3/4" 663', 7" 2369', 3½" 2800' Abandoned

Formation	Top	Bottom	Remarks	Formation	Top	Bottom	Remarks
Date COMPLETION 3-30-78				X= 1,868,122			
Glacial deposits	0	67		Y= 620,380			
Big Lime	67	665		Dolomite	2500	2570	
Shale	665	1700		Sandstone	2570	2600	
Trenton	1700	1820		Dolomite	2600	2700	
Black, Gull river	1820	2360		Sandstone	2700	2720	
Glenwood	2360	2370		Dolomite	2720	2740	
Glenwood	2370	2400		Sandstone	2740	2750	
Knox	2400	2440		Dolomite	2750	2820	
Sandstone	2440	2450		Mt. Simon	2820	2890	
Dolomite	2450	2460		Basement	2890	2900	
Sandstone	2460	2500		*DIA-LOG COMPANY - Casing Profile Calipher log			

[redacted] S-3417

BTRC: GR,Cal,D,CCL,I,3DV,Tr #14

Permit No. 226
Permit Issued 1-28-76

County SANDUSKY Township RILEY Quadrangle Clyde

NE¼ Section 26 Lot Tract Twp. Quarter

Measured 1165' NL & 935' EL of NE¼ Sec.26

25 Acres P6 - IWDW - R.T.

Land Owner Ohio Liquid Disposal, Inc. Well No. 4 Date Commenced 7-15-76

Operator Ohio Liquid Disposal, Inc. Well No. Date Completed 11-24-76

Elevation Bar 609.1' SL 618'KB Total Depth 2905' Plugged Back

Formation Drld. To Pre-Cambrian Prod. Form. Prod. Nat.

A/W 5M gal. 15% HCL I.P.

Init. Rock Press. I.W.D.W.

Casing Record 10 3/4" 637' 500sks, 7" 2388', 3½" 2823' Abandoned

Formation	Top	Bottom	Remarks	Formation	Top	Bottom	Remarks
Date: COMPLETION 3-30-78				X= 1,869,065			
Glacial deposits	0	67		Y= 620,485			
Big Lime	67	665		Sandstone	2481	2509	
Shale	665	1680		Shale	2509	2519	
Trenton	1680	1830		Dolomite	2519	2520	
Limestone	1830	2370		Shale	2520	2529	
Glenwood	2370	2420		Sandstone	2529	2694	
Knox	2420	2426		Dolomite	2694	2711	
Sandstone	2426	2432		Sandstone	2711	2712	
Dolomite	2432	2435		Dolomite	2712	2797	
Sandstone	2435	2446		Mt. Simon	2797	2905	
Dolomite	2446	2481		Basement	2905	2910	

I.W.D.W.

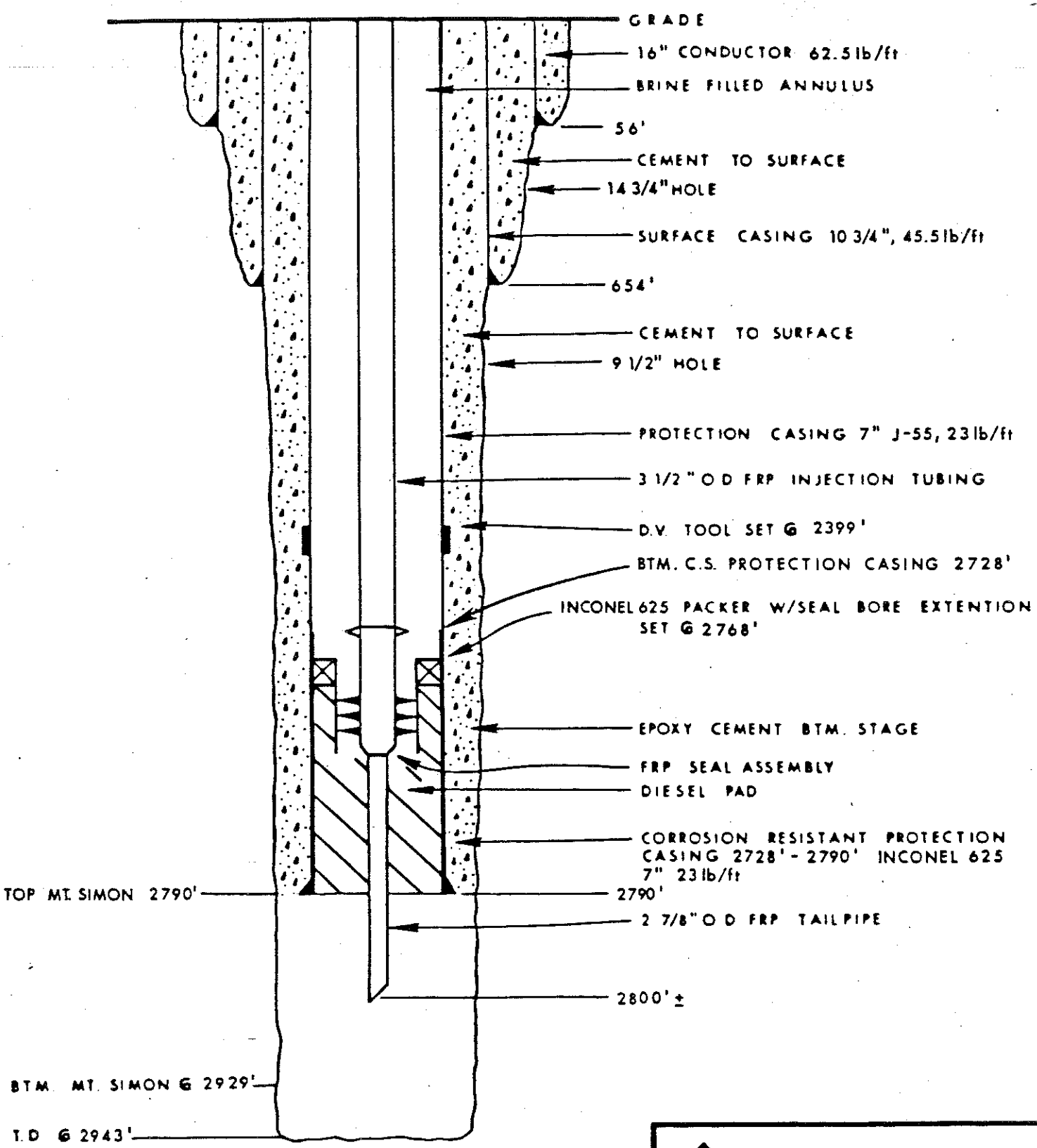
Permit No. 237
Permit Issued 6-11-80
Quadrangle Clyde

County SANDUSKY Township RILEY
Section 26 Lot Tract
Twp. Quarter
Measured 59.53' NL & 612.11' WL of Sec. 26
"Mt. Simon" - IWDW- R.T.

Land Owner Ohio Liquid Disposal, Inc. Well No. 5 Date Commenced
Operator Ohio Liquid Disposal, Inc. Well No. Date Completed
Elevation Bar 512' Total Depth Plugged Back
Formation Drld. To Prod. Form. Prod. Nat.
I.P.
Init. Rock Press
Casing Record Abandoned

Formation	Top	Bottom	Remarks	Formation	Top	Bottom	Remarks
				X=1,865,375 Y= 621,520			

(See Attached Schedule)



FRP - FIBERGLASS REINFORCED PLASTIC
C.S. - CARBON STEEL

GOLDEN STRATASERVICES, INC.
HOUSTON, TEXAS

CHEMICAL WASTE MANAGEMENT
VICKERY, OHIO

SKETCH SK-5
PROPOSED COMPLETION PLANT
WELL NO. 5

SCALE: NONE DATE: AUG. 83

compl

I.W.D.W. 11-17-81

Permit No. 238
Permit Issued 6-11-80
Quadrangle Clyde

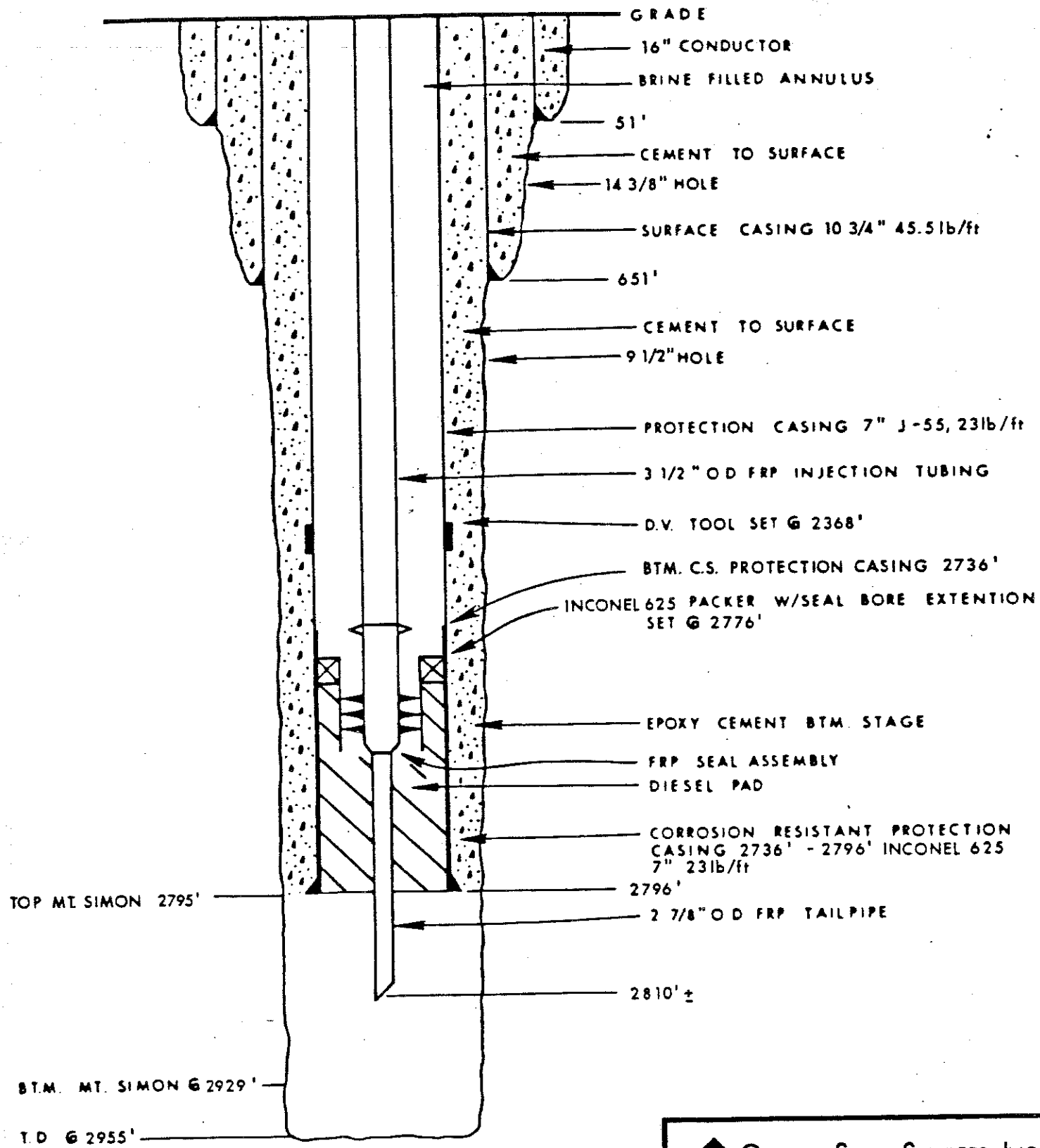
County SANDUSKY Township RILEY
Section 23 Lot Tract Twp. Quarter
Measured 546.98' SL & 3219.84' EL of Sec. 23
"Mt. Simon" - IWDW- R.T.

Land Owner Ohio Liquid Disposal, INc. Well No. 6 Date Commenced
Operator Ohio Liquid Disposal, INc. Well No. Date Completed
Elevation Bar 605' Total Depth Plugged Back
Formation Encl. To Prod. Form. Prod. Not.
I.P.
Init. Rock Press.
Casing Record Abandoned

Formation	Top	Bottom	Remarks	Formation	Top	Bottom	Remarks
				X=1,866,780 Y= 622,100			

FEB 1982 RECEIVED TOLEDO

(See Attached Schedule)



GOLDEN STRATASERVICES, INC.
HOUSTON, TEXAS

CHEMICAL WASTE MANAGEMENT
VICKERY, OHIO

SKETCH SK-6

PROPOSED COMPLETION PLANT
WELL NO. 6

FRP - FIBERGLASS REINFORCED PLASTIC
C.S. - CARBON STEEL

APPENDIX D

D and P Series Borehole Logs

Form G A.-D-1.

Project No. 831-1089-1

RECORD OF BOREHOLE D-1

LOCATION See Figure 2 BORING DATE APRIL 19, 1983 DATUM M S L

SAMPLER HAMMER WEIGHT 140 lb. DROP 30 in. PENETRATION TEST HAMMER WEIGHT DROP

BORING METHOD: POWER AUGER, 8.5 in. DIAM. HOLLOW STEM

ELEV'N. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLE NUMBER	TYPE	BLOWS/FT.
628.4 / 0.0	DIKE CREST				
	STIFF TO VERY STIFF BROWN SILTY CLAY, TRACE SAND AND GRAVEL (DIKE FILL)		1	2" D.O.	11
			2	"	10
			3	"	8
			4	"	14
			5	"	15
			6	3" T.W.	PH
			7	2" D.O.	16
			8	"	15
			9	"	17
			10	3" T.W.	PH
603.4 / 25.0	HARD BROWN SILTY CLAY TRACE ROOTS		11	2" D.O.	26
601.9 / 26.5	VERY STIFF GREY BROWN SILTY CLAY DISTINCT HORIZONTAL LAMINATIONS, OCCAS. SAND PARTINGS (DESICCATED CRUST)		12	"	16
596.9 / 31.5	END OF HOLE		13	"	17

ELEVATION SCALE: 630, 625, 620, 615, 610, 605, 600, 595, 590

DYNAMIC PENETRATION RESISTANCE, BLOWS/

SHEAR STRENGTH Cu — NAT V - + Q - ● REM V - ● U - O

COEFFICIENT OF PERMEABILITY, k, CM / SEC — 1x10 1x10 1x10 1x10

WATER CONTENT, PERCENT — Wp W Wl — 10 20 30 40

ADDITIONAL LAB TESTING: γ = 124.5 lb/cu ft

PIEZOMETER OR STANDPIPE INSTALLATION: 1-1/4" Ø PVC

PROTECTIVE CAP
GROUND SURFACE
CEMENT SEAL
NATIVE CLAY BACKFILL
CEMENT-BENTONITE GROUT
SAND FILTER
PIEZOMETER

WATER LEVEL IN PIEZOMETER AT ELEV 606.7 ft ON MAY 10, 1983
ELEV 606.4 ft ON JUNE 2, 1983

15 0 5 Percent axial strain at failure 10

VERTICAL SCALE 1 INCH TO 5 FEET

Golder Associates

DRAWN D.M.
CHECKED J&D

Form G A - D-1

Project No. 831-1089-1

RECORD OF BOREHOLE D-2

LOCATION See Figure 2 BORING DATE APRIL 20, 1983 DATUM M S L

SAMPLER HAMMER WEIGHT 140 lb DROP 30 in PENETRATION TEST HAMMER WEIGHT DROP

BORING METHOD	ELEV'N / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FT	ELEVATION SCALE
	627.9 / 0.0	DIKE CREST					630
POWER AUGER, 8.5" DIAM HOLLOW STEM		STIFF TO VERY STIFF GREY BROWN SILTY CLAY, TRACE SAND AND GRAVEL (DIKE FILL)	1	1	2" DO	21	625
				2	"	9	
				3	"	9	620
				4	3" TW	-	
				5	2" DO	20	615
				6	"	16	
				7	"	22	610
	607.9 / 20.0	VERY STIFF TO STIFF MOTTLED GREY BROWN SILTY CLAY DISTINCT HORIZONTAL LAMINATIONS, OCCAS FINE SAND PARTINGS (DESICCATED CRUST)	2A	8	3" TW	-	
				9	2" DO	25	605
				10	"	21	
	599.9 / 28.0	FIRM TO STIFF GREY BROWN SILTY CLAY LAMINATED, OCCAS FINE SAND PARTINGS	2	11	"	10	600
	597.4 / 30.5	END OF HOLE					595

DYNAMIC PENETRATION RESISTANCE, BLOWS/

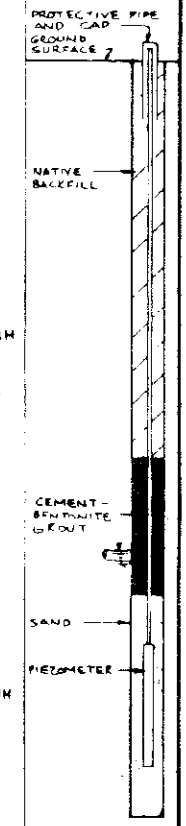
SHEAR STRENGTH Cu NAT V - + Q - ● REM V - ● U - O

COEFFICIENT OF PERMEABILITY, k_m, CM / SEC 1x10 1x10 1x10 1x10

WATER CONTENT, PERCENT W_P W W_L 10 20 30 40

ADDITIONAL LAB TESTING: R TEST; MH; MH

PIEZOMETER OR STANDPIPE INSTALLATION 1-1/4" Ø PVC



WATER LEVEL IN PIEZOMETER AT ELEV 608.1 ft ON MAY 10, 1983
ELEV 607.9 ft ON JUNE 2, 1983

15 5 Percent axial strain at failure

VERTICAL SCALE 1 INCH To 5 FEET

Golder Associates

DRAWN DM

CHECKED JAD

Form G.A.-D-1.

Project No. 831-1089-1

RECORD OF BOREHOLE D-3

LOCATION See Figure 2 BORING DATE APRIL 20, 1983 DATUM M S L

SAMPLER HAMMER WEIGHT 140 lb. DROP 30 in. PENETRATION TEST HAMMER WEIGHT DROP

BORING METHOD: POWER AUGER 8.5" DIAM HOLLOW STEM

ELEV'N / DEPTH	DESCRIPTION
627.1 / 0.0	DIKE CREST
	STIFF TO VERY STIFF GREY BROWN SILTY CLAY TRACE SAND AND GRAVEL (DIKE FILL)
610.6 / 16.5	STIFF DARK BROWN SILTY CLAY TR. ORGANIC MATTER
609.1 / 18.0	STIFF GREY BROWN SILTY CLAY, DISTINCT HORIZONTAL LAMINATIONS OCCASIONAL FINE SAND PARTINGS (DESICCATED CRUST)
599.1 / 28.0	SOFT TO FIRM GREY SILTY CLAY, LAMINATED, OCCAS. FINE SAND PARTINGS (LACUSTRINE CLAY)
581.8 / 45.3	STIFF TO VERY STIFF GREY SILTY CLAY WITH SAND, TRACE GRAVEL (TILL)
576.6 / 50.5	END OF HOLE

SAMPLE NUMBER	TYPE	BLOWS/FT
1	2" D.O.	12
2	"	24
3	"	13
4	3" TW	PH
5	2" D.O.	15
6	"	13
7	3" TW	PH
8	2" D.O.	11
9	"	4
10	3" TW	PH
11	2" D.O.	4
12	"	6
13	"	18

ELEVATION SCALE: 625, 620, 615, 610, 605, 600, 595, 590, 585, 580

DYNAMIC PENETRATION RESISTANCE, BLOWS/

SHEAR STRENGTH Cu lb/sq ft — NAT V - + Q - ● REM V - ● U - O — 500, 1000, 1500, 2000

COEFFICIENT OF PERMEABILITY, k, CM / SEC — 1x10, 1x10, 1x10, 1x10

WATER CONTENT, PERCENT — Wp, W, WL — 10, 20, 30, 40

ADDITIONAL LAB. TESTING: MH

PIEZOMETER OR STANDPIPE INSTALLATION: 1-1/4" Ø PVC

PROTECTIVE PIPE — GROUND SURFACE — CEMENT-BENTONITE GROUT — SAND — PIEZOMETER

WATER LEVEL IN PIEZOMETER AT ELEV. 605.3 ON MAY 10, 1983 ELEV. 607.1 ON JUNE 7, 1983

Percent axial strain at failure

VERTICAL SCALE 1 INCH TO 5 FEET

Golder Associates

DRAWN DNI

CHECKED JAD

Form G A -D-1

Project No. 831-1089-1

RECORD OF BOREHOLE D-3A

LOCATION See Figure | BORING DATE APRIL 21, 1983 | DATUM M S L

SAMPLER HAMMER WEIGHT 140 lb. DROP 30 in | PENETRATION TEST HAMMER WEIGHT — DROP —

BORING METHOD	SOIL PROFILE: ELEV'N / DEPTH	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/	ELEVATION SCALE	ADDITIONAL LAB. TESTING
	627.3 / 0.0	DIKE CREST					630	
POWER AUGER 8.5 in DIAM. HOLLOW STEM		(DIKE FILL)		UNSAMPLED			625, 620, 615	
	610.8 / 16.5	SILTY CLAY (DESICCATED CRUST)	2A				610	
	606.8 / 20.5	END OF HOLE					605, 600	

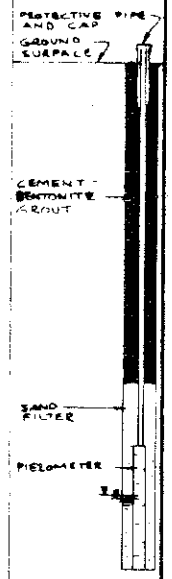
DYNAMIC PENETRATION RESISTANCE, BLOWS/

SHEAR STRENGTH Cu — NAT V - + Q - ● REM V - ● U - O

COEFFICIENT OF PERMEABILITY, k, CM / SEC — 1x10 1x10 1x10 1x10

WATER CONTENT, PERCENT — Wp W Wl

PIEZOMETER OR STANDPIPE INSTALLATION 1-1/4" Ø PVC



WATER LEVEL IN PIEZOMETER AT ELEV 609.6 ON MARCH 10, 1983 ELEV 609.7 ON JUNE 2, 1983

15 - 5 Percent axial strain at failure

VERTICAL SCALE 1 INCH TO 5 FEET

Golder Associates

DRAWN DM

CHECKED JGD

Form G.A.-D-1.

Project No. 831-1089

RECORD OF BOREHOLE D-4

LOCATION See Figure 2 BORING DATE APRIL 21, 1983 DATUM M.S.L.

SAMPLER HAMMER WEIGHT 140 lb. DROP 30 in. PENETRATION TEST HAMMER WEIGHT DROP

BORING METHOD	SOIL PROFILE ELEV'N / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FT
POWER AUGER 6" DIAM HOLLOW STEM	626.0 / 0.0	DIKE CREST				
		VERY STIFF TO STIFF GREY BROWN SILTY CLAY OCCASIONAL TRACES OF SAND AND GRAVEL (DIKE FILL)	1	1	2" D.O.	18
				2	"	14
				3	"	9
				4	3" T.O.	PH
				5	2" D.O.	13
				6	"	18
	610.0 / 16.0	DARK BROWN SILTY CLAY TR ORGANIC MATERIAL				
	609 / 17.0			7	"	23
		VERY STIFF MOTTLED GREY-BROWN SILTY CLAY DISTINCTLY LAMINATED (DESICCATED CRUST)	2A	8	3" T.O.	PH
	603.0 / 23.0			9	2" D.O.	16
		FIRM GREY BROWN SILTY CLAY LAMINATED (LACUSTRINE CLAY)	2	10	"	6
	600.5 / 25.5	END OF HOLE				

ELEVATION SCALE: 630, 625, 620, 615, 610, 605, 600, 595

DYNAMIC PENETRATION RESISTANCE, BLOWS/

SHEAR STRENGTH Cu lb/sq.ft. NAT V - + Q - ● REM V - ● U - O

500 1000 1500 2000

COEFFICIENT OF PERMEABILITY, k, CM / SEC 1x10 1x10 1x10 1x10

WATER CONTENT, PERCENT Wp X Wl

10 20 30 40

ADDITIONAL LAB TESTING

PIEZOMETER OR STANDPIPE INSTALLATION 1-1/4" Ø PVC

WATER LEVEL IN PIEZOMETER AT ELEV 608.2 ft ON MAY 10, 1983
ELEV 607.8 ft ON JUNE 2, 1983

15 0 5 10 Percent axial strain at failure

VERTICAL SCALE 1 INCH TO 5 FEET

Golder Associates

DRAWN D.M.

CHECKED J.A.D.

Form 6 A - D - 1.

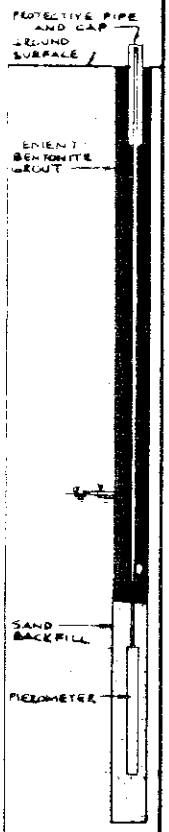
Project No. 831-1089

RECORD OF BOREHOLE D-5

LOCATION See Figure 2 BORING DATE APRIL 22, 1983 DATUM M.S.L.

SAMPLER HAMMER WEIGHT 140 lb DROP 30 in. PENETRATION TEST HAMMER WEIGHT DROP

BORING METHOD	SOIL PROFILE: ELEV'N. / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/FT	ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/	COEFFICIENT OF PERMEABILITY, k, CM / SEC (1x10 1x10 1x10 1x10) / WATER CONTENT, PERCENT	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION 1-1/4"Ø PVC
	625.4 / 0.0	DIKE CREST					630				
POWER AUGER 6 in DIAM - HOLLOW STEM		STIFF GREY BROWN SILTY CLAY OCCAS TRACES OF SAND AND GRAVEL (DIKE FILL)		1	2" D.O.	12	625				PROTECTIVE PIPE AND CAP; GROUND SURFACE
				2	"	10	620				CEMENT BENTONITE GROUT
			1	3	3" T.W.	PH	615			γ = 127.6 lb/cu ft	
				4	2" D.O.	11					
							610				
				5	3" T.W.	PH					
				6	2" D.O.	13	605				
	604.4 / 21.0	STIFF TO VERY STIFF MOTTLED GREY BROWN SILTY CLAY, DISTINCT HORIZONTAL LAMINATIONS, OCCAS FINE SAND PARTINGS (DESICCATED CRUST)	2A	7	3" T.W.	PH					SAND BACKFILL
				8	"	PH	600			R TEST; MH	PIEZOMETER
	597.4 / 28.0	FIRM TO STIFF GREY-BROWN SILTY CLAY, LAMINATED (LACUSTRINE CLAY)	2	9	2" D.O.	7	595			γ = 125.4 lb/cu ft	
	594.9 / 30.5	END OF HOLE					590				WATER LEVEL IN PIEZOMETER AT ELEV 608.2 ON MAY 10, 1982 ELEV 608.3 ON JUNE 2, 1983.



Percent axial strain at failure

VERTICAL SCALE 1 INCH TO 5 FEET

Golder Associates

DRAWN D.M.

CHECKED JAD

Form G.A.-D-1.

Project No. 831-1089

RECORD OF BOREHOLE D-6

LOCATION See Figure 2 BORING DATE APRIL 22 to 25, 1983 DATUM M.S.L.

SAMPLER HAMMER WEIGHT 140 lb. DROP 30 in. PENETRATION TEST HAMMER WEIGHT DROP

BORING METHOD: POWER AUGER 6" DIAM. HOLLOW STEM

ELEV'N / DEPTH	DESCRIPTION
626.4 / 0.0	DIKE CREST
	VERY STIFF GREY BROWN SILTY CLAY TRACES OF SAND AND GRAVEL (DIKE FILL)
607.4 / 19.0	HARD DARK BROWN CLAYEY SILT, TRACE ORG. MAT.
603.4 / 23.0	VERY STIFF TO HARD GREY BROWN SILTY CLAY, DISTINCT HORIZONTAL LAMINATIONS, OCCAS. SAND PARTINGS (DESICCATED CRUST)
597.4 / 29.0	FIRM GREY-BROWN SILTY CLAY LAMINATED (LACUSTRINE CLAY)
592.4 / 34.0	FIRM TO STIFF GREY SILTY CLAY SOME SAND, TRACE GRAVEL (TILL)
573.9 / 50.5	END OF HOLE

SAMPLES NUMBER	TYPE	BLOWS/FT
1	2" D.O.	15
2	"	15
3	3" TW	PH
4	2" D.O.	18
5	3" TW	PH
6	2" D.O.	30
7	3" TW	PH
8	2" D.O.	20
9	"	14
10	"	6
11	"	3
12	3" TW	PH
13	2" D.O.	8
14	"	11

STRAT PLOT: 1, 2A, 2, 3

ELEVATION SCALE: 625, 620, 615, 610, 605, 600, 595, 590, 585, 580

DYNAMIC PENETRATION RESISTANCE, BLOWS/ — SHEAR STRENGTH Cu. lb./sq. ft. — NAT V - + Q - ● REM.V - ● U - O — 500, 1000, 1500, 2000

COEFFICIENT OF PERMEABILITY, k, CM./SEC. — 1x10, 1x10, 1x10, 1x10

WATER CONTENT, PERCENT — 10, 20, 30, 40

>3000 (COULD NOT TURN)

ADDITIONAL LAB TESTING: MH, MH

PIEZOMETER OR STANDPIPE INSTALLATION: 1-1/4" Ø PVC

PROTECTIVE PIPE AND CAP

CEMENT-BENTONITE GROUT

SAND BACKFILL

PIEZOMETER

WATER LEVEL IN PIEZOMETER AT ELEV. 595.1 ON MAY 19, 1983 ELEV. 606.3 ± ft ON JUNE 2, 1983

Δ/D ± 5 Percent axial strain at failure

VERTICAL SCALE 1 INCH TO 5 FEET

Golder Associates

DRAWN D.M.

CHECKED JBS

Form G A -0-1

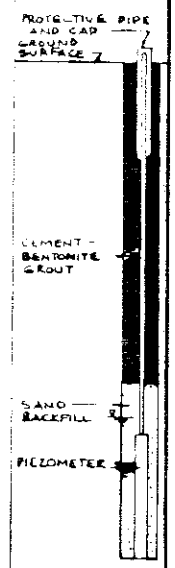
Project No. 331-1089

RECORD OF BOREHOLE D-6a

LOCATION See Figure 2 BORING DATE APRIL 25, 1983 DATUM M.S.L.

SAMPLER HAMMER WEIGHT 140 lb. DROP 30 in. PENETRATION TEST HAMMER WEIGHT DROP

BORING METHOD	SOIL PROFILE: ELEV'N DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/FT	ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/ / SHEAR STRENGTH Cu NAT V · + Q · ● REM V · ● U · O	COEFFICIENT OF PERMEABILITY, k, CM / SEC 1x10 1x10 1x10 1x10 / WATER CONTENT, PERCENT	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION 1-1/4" Ø PVC
							630				
	626.2 / 0.0	DIKE CREST									
POWER AUGER 6 in DIAM HOLLOW STEM		(DIKE FILL)		UNSAMPLED			625				
							620				
							615				
							610				
	607.2 / 19.0	SILTY CLAY	2A								
	606.2 / 20.0	END OF HOLE					605				
							600				



WATER LEVEL IN PIEZOMETER AT ELEV 610.0 ft ON MAY 10, 1983 ELEV. 612 OHON JUNE 2, 1983.

15 0 5 10 Percent axial strain at failure

VERTICAL SCALE 1 INCH TO 5 FEET

Golder Associates

DRAWN D.M.

CHECKED JAD

Form G.A.-D-1.

Project No. 831-1089

RECORD OF BOREHOLE D-7

LOCATION See Figure 2 BORING DATE APRIL 25 To 26, 1983 DATUM M.S.L.

SAMPLER HAMMER WEIGHT 140 lb. DROP 30 in. PENETRATION TEST HAMMER WEIGHT DROP

BORING METHOD	ELEV'N. / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	BLOWS/FT	ELEVATION SCALE
	620.0 / 00.0	DIKE CREST					625
POWER AUGER 6" DIAM HOLLOW STEM		VERY STIFF TO HARD GREY BROWN SILTY CLAY, OCCASIONAL TRACES OF SAND AND GRAVEL (DIKE FILL)	1	1	2" D.O.	28	620
				2		30	615
				3	3" T.O.	PH	610
	608.5 / 11.5	VERY STIFF DARK BROWN SILTY CLAY TR ORGANIC MATERIAL		4	2" D.O.	17	
	607.0 / 13.0	VERY STIFF TO STIFF MOTTLED GREY BROWN SILTY CLAY DISTINCT HORIZONTAL LAMINATIONS OCCAS FINE SAND PARTINGS (DESICCATED CRUST)	2A	5	3" TO	PH	605
				6	2" D.O.	17	600
	599.0 / 21.0	FIRM TO STIFF GREY BROWN SILTY CLAY, LAMINATED OCCAS FINE SAND PARTINGS (LACUSTRINE CLAY)	2	7	3" TO	PH	
				8	2" DO	8	595
	594.5 / 25.5	END OF HOLE					590

DYNAMIC PENETRATION RESISTANCE, BLOWS/

SHEAR STRENGTH Cu lb/sq ft NAT V - + Q - ● REM V - ● U - O

500 1000 1500 2000

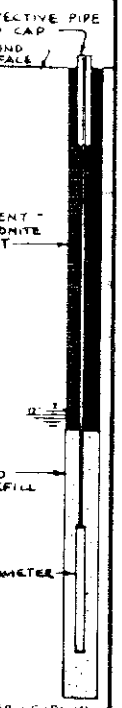
COEFFICIENT OF PERMEABILITY, k, CM / SEC 1x10 1x10 1x10 1x10

WATER CONTENT, PERCENT W_P W W_L 10 20 30 40

2700

ADDITIONAL LAB TESTING: γ=134.3 lb/cu. ft; MH

PIEZOMETER OR STANDPIPE INSTALLATION 1-1/4" Ø PVC



WATER LEVEL IN PIEZOMETER AT ELEV 600.2 ON MAY 10, 1983 ELEV. 600.0 ft. ON JUNE 2, 1983.

Percent axial strain on failure

VERTICAL SCALE 1 INCH TO 5 FEET

Golder Associates

DRAWN DM

CHECKED JDB

Form G A.-D-1

Project No. 831-1089

RECORD OF BOREHOLE D-8

LOCATION See Figure 2 BORING DATE APRIL 26 To 27, 1983 DATUM M S L

SAMPLER HAMMER WEIGHT 140 lb DROP 30 ins. PENETRATION TEST HAMMER WEIGHT DROP

BORING METHOD: POWER AUGER 6 in DIAM HOLLOW STEM

ELEV'N / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLE NUMBER	TYPE	BLOWS/FT
620.0 / 0.0	DIKE CREST				
	STIFF TO VERY STIFF GREY BROWN SILTY CLAY (DIKE FILL)	1	1	2" D.O.	12
			2	"	19
609.0 / 11.0	BROWN SILTY CLAY TRACE ORGANIC MATTER		3	3" T.O.	PH
608 / 11.9			4	2" D.O.	15
	VERY STIFF TO HARD GREY BROWN SILTY CLAY, DISTINCT HORIZONTAL LAMINATIONS, OCCAS. FINE SAND PARTINGS (DESICCATED CRUST)	2A	5	3" T.O.	PH
			6	2" D.O.	15
			7	3" T.O.	PH
595.0 / 25.0	FIRM TO STIFF GREY BROWN SILTY CLAY, LAMINATED, OCCAS. FINE SAND PARTINGS (LACUSTRINE CLAY)	2	8	2" D.O.	11
			9	"	8
588.0 / 32.0	STIFF TO VERY STIFF GREY SILTY CLAY WITH SAND, TRACE GRAVEL (TILL)	3	10	"	7
			11	3" T.O.	PH
574.5 / 45.5	END OF HOLE		12	2" D.O.	18

ELEVATION SCALE: 620, 615, 610, 605, 600, 595, 590, 585, 580, 575

DYNAMIC PENETRATION RESISTANCE, BLOWS/

SHEAR STRENGTH Cu lb/sq ft — NAT V - + Q - ● REM V - ● U - O — 500, 1000, 1500, 2000

COEFFICIENT OF PERMEABILITY, k, CM / SEC — 1x10, 1x10, 1x10, 1x10

WATER CONTENT, PERCENT — PL, W, LL — 10, 20, 30, 40

ADDITIONAL LAB TESTING: MH, MH

PIEZOMETER OR STANDPIPE INSTALLATION: 1-1/4" Ø PVC

PROTECTIVE PIPE AND CAP; GROUND SURFACE; CEMENT-BENTONITE GROUT; SAND BACKFILL; PIEZOMETER

WATER LEVEL IN PIEZOMETER AT ELEV 604.0 ON MAY 10, 1983 AND JUNE 2, 1983

19 — 5 Percent axial strain at failure

VERTICAL SCALE 1 INCH TO 5 FEET

Golder Associates

DRAWN D.M.

CHECKED JSD

Form G A -0-1

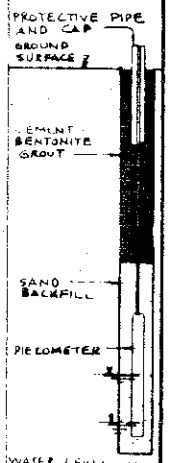
Project No. 831-1089

RECORD OF BOREHOLE D-8A

LOCATION See Figure 2 BORING DATE APRIL 27, 1983 DATUM M.S.L.

SAMPLER HAMMER WEIGHT 140 lb DROP 30 in PENETRATION TEST HAMMER WEIGHT DROP

BORING METHOD	SOIL PROFILE: ELEV'N / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/FT	ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/ / SHEAR STRENGTH Cu NAT V · + Q · ● REM V · ● U · O	COEFFICIENT OF PERMEABILITY, k, CM / SEC 1x10 1x10 1x10 1x10 / WATER CONTENT, PERCENT	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION 1-1/4" Ø PVC
							625				
	619.9 / 0.0	DIKE CREST					620				
POWER AUGER 6 in DIAM HOLLOW STEM		DIKE FILL		UNSAMPLED			615				
	608.9 / 11.0	SILTY CLAY					610				
	604.4 / 15.5	END OF HOLE					605				
							600				



WATER LEVEL IN PIEZOMETER AT ELEV 605.7 ON MAY 10, 1983. ELEV 607.6 ft ON JUNE 2, 1983

m 0 10 s Percent axial strain at failure

VERTICAL SCALE
1 INCH TO 5 FEET

Golder Associates

DRAWN D.M.
CHECKED JAD

Form G A -D-1

Project No. 83-1089-1

RECORD OF BOREHOLE D-9

LOCATION See Figure BORING DATE MAY 31 AND JUNE 1, 1983 DATUM M.S.L.

SAMPLER HAMMER WEIGHT 140 lb. DROP 30 in. PENETRATION TEST HAMMER WEIGHT DROP

BORING METHOD: POWER AUGER 7.5 DIAM HOLLOW STEM; ROTARY DRILLING, NQ ROCK CORE

ELEV'N / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	BLOWS/
626.4 / 0.0	DIKE SURFACE			
	STIFF TO HARD GREY BROWN CLAYEY SILT, TRACE TO SOME SAND TRACE GRAVEL (DIKE FILL)	1	2" D.O.	7
		2	"	7
		3	"	9
		4	3" T.O.	P.H
		5	2" D.O.	10
		6	"	7
		7	"	12
		8	3" T.O.	P.H
		9	2" D.O.	17
603.4 / 23.0	HARD GREY BROWN CLAYEY SILT, TRACE SAND, HORIZONTAL LAMINATIONS (DESICCATED CRUST)	10	"	14
599.4 / 27.0		11	"	24
	HARD GREY BROWN SILTY CLAY TO CLAYEY SILT, SOME SAND, TRACE GRAVEL (TILL)	12	3" T.O.	P.H
		13	2" D.O.	13
592.4 / 34.0	BECOMING GREY AT ELEV 592.4	14	"	P.H
586.4 / 40.0	BECOMING STIFF BELOW ELEV 586.4	15	"	8
		16	"	9
		17	3" T.O.	6
		18	"	P.H
	HARD GREY SILTY CLAY, SOME GRAVEL AND SAND (TILL)	19	2" D.O.	>100
566.2 / 60.2	HIGHLY WEATHERED BEDROCK (NO SAMPLES)			
563.4 / 63.0	MODERATELY TO SLIGHTLY WEATHERED GREY DOLOMITE, OCCASIONAL SHALE AND GYPSUM LAYERS (TYMOCHTEE MEMBER OF BASS ISLAND FORMATION)	20	NQ RC	—
		21	"	—
		22	"	—
553.4 / 73.0	END OF HOLE			

ELEVATION SCALE: 625, 620, 615, 610, 605, 600, 595, 590, 585, 580, 575, 570, 565, 560, 555, 550

DYNAMIC PENETRATION RESISTANCE, BLOWS/

SHEAR STRENGTH Cu — NAT V - +, Q - ●; REM V - ●, U - O

COEFFICIENT OF PERMEABILITY, k, CM / SEC — 1x10 1x10 1x10 1x10

WATER CONTENT, PERCENT — Wp, X, Wl — 10 20 30 40

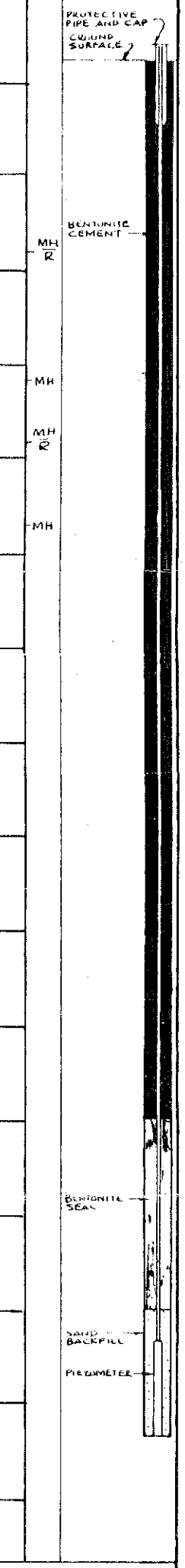
ADDITIONAL LAB TESTING: MH, R, MH, MH/R, MH

NQ RC	RQD (%)	Percent axial strain at failure
20	75	0
21	83	27
22	74	0

ROCK QUALITY DESIGNATION, PERCENT

PERCENT CORE RECOVERY

PIEZOMETER ON STANDPIPE INSTALLATION 2"Ø PVC



VERTICAL SCALE 1 INCH TO 5 FEET

Golder Associates

DRAWN D.M.

CHECKED E.W.S.

Form G A - 0 - 1

Project No. 831-1089-1

RECORD OF BOREHOLE D-9a

LOCATION See Figure | BORING DATE JUNE 1, 1983 | DATUM M.S.L.

SAMPLER HAMMER WEIGHT 140 lb. DROP 30 in. | PENETRATION TEST HAMMER WEIGHT DROP

BORING METHOD	SOIL PROFILE: ELEV'N / DEPTH	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/	ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/	COEFFICIENT OF PERMEABILITY, k, CM./SEC (1x10 1x10 1x10 1x10)	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
POWER AUGER 7 in DIAM HOLLOW STEM	626.4 / 0.0	GROUND SURFACE					625				1-1/4" Ø PVC
							620				
							615				
							610				
							605				
							600				
							595				
							590				
							585				
	581.4 / 45.0	END OF HOLE					580				

SHEAR STRENGTH Cu. NAT V. - + Q - ● REM.V. - ● U - O

WATER CONTENT, PERCENT

15 0 5 10 Percent axial strain at failure

VERTICAL SCALE
1 INCH TO 5 FEET

Golder Associates

DRAWN D.M.
CHECKED P.W.B.

Form U A - D - 1

Project No. 831-1089-1

RECORD OF BOREHOLE D-9b

LOCATION See Figure

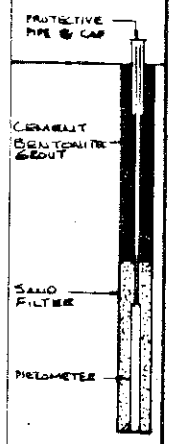
BORING DATE JUNE 1, 1983

DATUM M.S.L.

SAMPLER HAMMER WEIGHT 140 lb. DROP 30 in.

PENETRATION TEST HAMMER WEIGHT DROP

BORING METHOD	SOIL PROFILE: ELEV'N / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/FT	ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/ / SHEAR STRENGTH Cu. NAT V. - + Q. - ● REM V. - ● U. - ○	COEFFICIENT OF PERMEABILITY, K, CM./SEC. 1x10 1x10 1x10 1x10 / WATER CONTENT, PERCENT	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION 1-1/4" Ø PVC
							630				
	626.4 / 0.0	GROUND SURFACE									
POWER AUGER 7 in DIAM HOLLOW STEM							625				
							620				
							615				
	611.4 / 15.0	END OF HOLE									
							610				
							605				



0 10 Percent axial strain at failure

VERTICAL SCALE
1 INCH TO 5 FEET

Golder Associates

DRAWN D.M.

CHECKED P.W.B.

Form 6 A.-D-1.

Project No. _____

RECORD OF BOREHOLE P-1

LOCATION See Figure | BORING DATE APRIL 27, 1983 | DATUM LOCAL

SAMPLER HAMMER WEIGHT 140 lb. DROP 30 in. | PENETRATION TEST HAMMER WEIGHT — DROP —

BORING METHOD	SOIL PROFILE: ELEV'N / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/	ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/	SHEAR STRENGTH Cu (NAT V - +, Q - ●, REM V - ●, U - O)	COEFFICIENT OF PERMEABILITY, k, CM / SEC (1x10 1x10 1x10 1x10)	WATER CONTENT, PERCENT (Wp, W, WL)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION 2"Ø PVC
	610.9 / 0.0	GROUND SURFACE					620						
POWER AUGER 7 in. DIAM. HOLLOW STEM		STIFF GREY BROWN SILTY CLAY, TRACE SAND, GRAVEL, ORGANIC MATTER (FILL FOR CLOSED POND 10)					615						
							610						
							605						
	597.4 / 13.5			1	2" D.O.	7	600						
	595.4 / 15.5	SILTY CLAY, TRACE SAND, GRAVEL (TILL)		2	"	4							
		END OF HOLE					595						
							590						

15 0 10 Percent axial strain at failure

VERTICAL SCALE
1 INCH to 5 FEET

Golder Associates

DRAWN D.M.
CHECKED P.W.B.

Form G A -D-1

Project No. _____

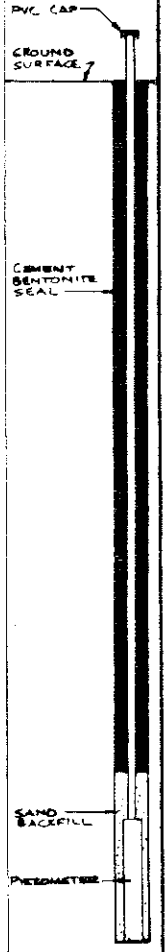
RECORD OF BOREHOLE P-2

LOCATION See Figure | BORING DATE APRIL 28, 1983 | DATUM LOCAL

SAMPLER HAMMER WEIGHT 140 lb. DROP 30 in. | PENETRATION TEST HAMMER WEIGHT — DROP —

BORING METHOD	SOIL PROFILE: ELEV'N. / DEPTH	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/	ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/	COEFFICIENT OF PERMEABILITY, k_v, CM / SEC (1x10 1x10 1x10 1x10)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION 2"Ø PVC
	611.0 / 0.0	GROUND SURFACE		UNSAMPLED - STRATIGRAPHY INFERRED	FROM BOREHOLE P-1		615				PVC CAP; GROUND SURFACE
POWER AUGER; 7 in. DIAM HOLLOW STEM	597.5 / 13.5	SILTY CLAY, TRACE SAND, GRAVEL, ORGANIC MATTER (FILL FOR CLOSED POND 10)					610; 605; 600				CEMENT BENTONITE SEAL
	576.0 / 35.0	SILTY CLAY, TRACE SAND AND GRAVEL (TILL)		UNSAMPLED - STRATIGRAPHY INFERRED	FROM NEAR BY BOREHOLE 19 & 23 PUT DOWN	BY BOWSER - MORNER INC. OCT. - NOV. 1982	595; 590; 585; 580				SAND BACKFILL; PIEZOMETER
		END OF HOLE					575; 570				

Percent axial strain at failure



VERTICAL SCALE 1 INCH TO 5 FEET

Golder Associates

DRAWN D.M.

CHECKED P.W.B.

Form G A -D-1.

Project No. 831-1089

RECORD OF BOREHOLE P-3

LOCATION See Figure BORING DATE APRIL 28 TO MAY 3, 1983 DATUM LOCAL

SAMPLER HAMMER WEIGHT 140 lb. DROP 30 in. PENETRATION TEST HAMMER WEIGHT — DROP —

BORING METHOD	ELEV'N / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS/	ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/	SHEAR STRENGTH Cu (NAT V - + Q - ● REM V - ● U - O)	COEFFICIENT OF PERMEABILITY, k, CM/SEC (1x10 1x10 1x10 1x10)	WATER CONTENT, PERCENT (Wp W WL)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION 2" Ø PVC
	611.1 / 0.0	GROUND SURFACE											PVC CAP; GROUND SURFACE
POWER AUGER 7.5 DIAM HOLLOW STEM	597.6 / 13.5	SILTY CLAY, TRACE SAND, GRAVEL, ORGANIC MATTER (FILL FOR CLOSED POND)		UNSAMPLED - STRATIGRAPHY INFERRED FROM BOREHOLE P-1			610, 605, 600						
	568.1 / 43.0	SILTY CLAY, TRACE SAND AND GRAVEL (GLACIAL TILL)		UNSAMPLED - STRATIGRAPHY INFERRED FROM NEAR BOREHOLES 101 & 23 PUT DOWN BY BOUSER - MORNER INC. OCT - NOV 1982			595, 590, 585, 580, 575, 570						CEMENT BENTONITE SEAL
ROTARY DRILLING N.Q. ROCK CORE	564.1 / 47.0	HIGHLY WEATHERED GREY DOLOMITE AND SHALE (CHECKED FROM AUGER CUTTINGS AND APPEARANCE)		1	NQ RC	-	565	57	0				
		MODERATELY TO HIGHLY WEATHERED GREY SHALE AND DOLOMITE, OCCASIONAL GYPSUM PARTINGS AND CRYSTALS		2	"	-	560	64	10				
				3	"	-	555, 550	74	0				
				4	"	-	545						SAND BACKFILL
				5	"	-	540	100	43				
	534.1 / 77.0	END OF HOLE					535						PIEZOMETER

PERCENT CORE RECOVERY ROCK QUALITY DESIGNATION, PERCENT

15 0 5 10 Percent axial strain at failure

VERTICAL SCALE 1 INCH TO 5 FEET

Golder Associates

DRAWN P.M.

CHECKED P.W.D.

Form G.A.-0-1.

Project No. B31-1989

RECORD OF BOREHOLE P-4

LOCATION See Figure BORING DATE APRIL 29, 1983 DATUM LOCAL

SAMPLER HAMMER WEIGHT 140 lb. DROP 30in. PENETRATION TEST HAMMER WEIGHT — DROP —

BORING METHOD	SOIL PROFILE: ELEV'N DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/	ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/ / SHEAR STRENGTH Cu. NAT V. - + Q - ● REM.V. - ● U. - O	COEFFICIENT OF PERMEABILITY, k, CM / SEC 1x10 1x10 1x10 1x10 / WATER CONTENT, PERCENT	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION 2" Ø PVC
	609.1 / 0.0	GROUND SURFACE		UNSAMPLED - STRATIGRAPHY INFERRED FROM NEARBY	SAMPLED BOREHOLE 3, PUT DOWN BY BOWSER -	MORNER, INC. JAN 1983	610				PROTECTIVE PIPE AND CAP; GROUND SURFACE
POWER AUGER 4.5 in DIAM. SOLID AUGER		SILTY CLAY (LACUSTRINE DEPOSIT)					605				
							600				CEMENT BENTONITE GROUT
	595.1 / 14.0	SILTY CLAY, TRACE SAND AND GRAVEL (GLACIAL TILL)					595				
							590				
							585				
							580				SAND BACKFILL; PIEZOMETER
	576.1 / 33.0	END OF HOLE					575				
							570				

15 0 5 10 Percent axial strain at failure

VERTICAL SCALE
1 INCH TO 5 FEET

Golder Associates

DRAWN D.M.
CHECKED P.W.P.

Form G.A.-D-1.

Project No. _____

RECORD OF BOREHOLE P-5

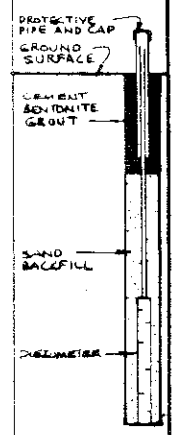
LOCATION See Figure BORING DATE APRIL 28, 1983 DATUM LOCAL

SAMPLER HAMMER WEIGHT 140 lb. DROP 30 in. PENETRATION TEST HAMMER WEIGHT — DROP —

BORING METHOD	SOIL PROFILE: ELEV'N / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/	ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/	COEFFICIENT OF PERMEABILITY, k_h, CM./SEC (1x10 1x10 1x10 1x10)	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
							615				2" Ø PVC
	609.3 / 0.0	GROUND SURFACE					610				
POWER AUGER 4.5 in DIAM SOLID AUGER		SILTY CLAY (LACUSTRINE DEPOSIT)		UNSAMPLED - STRATIGRAPHY INFERRED	FROM NEARBY SAMPLED BOREHOLE	3, PUT DOWN BY BOWSER-MORNER INC. JAN. 1983	605				
							600				
	595.3 / 14.0	END OF HOLE					595				
							590				

SHEAR STRENGTH Cu NAT V - + Q - ● REM.V. - ● U - O

WATER CONTENT, PERCENT Wp W Wl



0 5 10 Percent axial strain at failure

VERTICAL SCALE 1 INCH TO 5 FEET

Golder Associates

DRAWN D.M.

CHECKED P.W.B.

Form G A - D - 1

Project No 831-1089-1

RECORD OF BOREHOLE P 6

LOCATION See Figure

BORING DATE MAY 10 to 16, 1983

DATUM M.S.L.

SAMPLER HAMMER WEIGHT 140 lb. DROP 30 in.

PENETRATION TEST HAMMER WEIGHT DROP

BORING METHOD	SOIL PROFILE: ELEV'N / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	BLOWS/FT.	ELEVATION SCALE
	609.3 / 0.0	GROUND SURFACE					610
MOBILE B-61 POWER AUGER, 4.5 in. DIAM. SOLID AUGER		SILTY CLAY (LACUSTRINE DEPOSIT)		UNSAMPLED - STRATIGRAPHY INFERRED FROM NEARBY SAMPLED BOREHOLES PUT DOWN BY BOWSER - MOELNER INC. JAN. 1983			605, 600
	595.3 / 14.0	SILTY CLAY, TRACE SAND AND GRAVEL (GLACIAL TILL)					595, 590, 585, 580, 575
ROTARY DRILLING, 2" WIRELINE	569.8 / 39.5	MODERATELY TO HIGHLY WEATHERED FINE GRAINED HARD GREY DOLOMITE SOME SHALE PARTINGS		1	2" ROCK CORE		570
	565.8 / 43.5	MODERATELY TO HIGHLY WEATHERED THINLY BEDDED GREY SHALE WITH FREQUENT GYPSUM ZONES		2, 3			565, 560, 555
	553.3 / 56.0	MODERATELY TO SLIGHTLY WEATHERED GREY DOLOMITE, SOME GYPSUM AND SHALE PARTINGS		4			550, 545
	542.8 / 66.5	SLIGHTLY WEATHERED SHALY DOLOMITE WITH HIGHLY WEATHERED ZONE FROM 71' to 77'		5			540, 535
	531.3 / 78.0	END OF HOLE					530

PERCENT CORE RECOVERY	ROCK QUALITY DESIGNATION
45	0
89	0
100	0
100	72
59	24

DYNAMIC PENETRATION RESISTANCE, BLOWS/

SHEAR STRENGTH Cu — NAT V - + Q - ● REM V - ● U - O

COEFFICIENT OF PERMEABILITY, k, CM / SEC — 1x10⁻⁴ 1x10⁻³ 1x10⁻² 1x10⁻¹

WATER CONTENT, PERCENT — Wp W Wl

ADDITIONAL LAB TESTING

PIEZOMETER OR STANDPIPE INSTALLATION

2" Ø PVC

NOTE: PIEZOMETER INSTALLED IN UNSAMPLED BORING 15' TO NORTH OF BOREHOLE P6.

15 0 10 5 Percent axial strain at failure

VERTICAL SCALE 1 INCH TO 5 FEET

Golder Associates

DRAWN D.M.

CHECKED P.W.G.

Form G.A.-D-1

Project No. 831-1089

RECORD OF BOREHOLE P-7

LOCATION See Figure

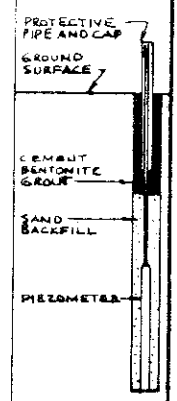
BORING DATE APRIL 29, 1983

DATUM LOCAL

SAMPLER HAMMER WEIGHT 14 DROP

PENETRATION TEST HAMMER WEIGHT DROP

BORING METHOD	SOIL PROFILE: ELEV'N / DEPTH	SOIL PROFILE: DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/	ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/ / SHEAR STRENGTH Cu NAT V. + Q. ● REM V. ● U. O	COEFFICIENT OF PERMEABILITY, k, CM./SEC. 1x10 1x10 1x10 1x10 / WATER CONTENT, PERCENT W_p W W_l	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION 2" Ø PVC
				UNSAMPLED - STRATIGRAPHY INFERRED FROM NEARBY BOREHOLE 30, PUT DOWN BY BOWSER - MORNER INC., NOV. 1983			615				
	609.9 / 0.0	GROUND SURFACE					610				
POWER AUGER 4.5 in. DIAM. SOLID AUGER		SILTY CLAY (LACUSTRINE DEPOSIT)					605				
	597.9 / 12.0	END OF HOLE					600				
							595				



15 0 5 10 Percent axial strain at failure

VERTICAL SCALE
1 INCH TO 5 FEET

Golder Associates

DRAWN D.M.

CHECKED R.W.B.

Form G.A.-0-1.

Project No. 831-1089

RECORD OF BOREHOLE P-8

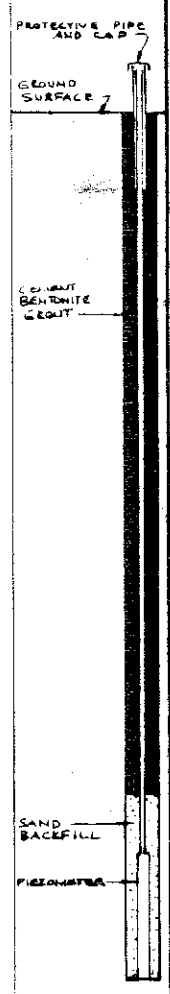
LOCATION See Figure | BORING DATE APRIL 29, 1983 | DATUM LOCAL

SAMPLER HAMMER WEIGHT 140 lb. DROP 30 in. | PENETRATION TEST HAMMER WEIGHT — DROP —

BORING METHOD	SOIL PROFILE: ELEV'N. / DEPTH	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/	ELEVATION SCALE	DYNAMIC PENETRATION RESISTANCE, BLOWS/	COEFFICIENT OF PERMEABILITY, k, CM./SEC. 1x10 1x10 1x10 1x10	ADDITIONAL LAB TESTING	PIEZOMETER OR STANDPIPE INSTALLATION 2" Φ PVC
	609.7 / 0.0	GROUND SURFACE		UNSAMPLED - STRATIGRAPHY INFERRED FROM NEARBY SAMPLED	BOREHOLE SO PUT DOWN BY BOWSER-MOENER, INC. NOV. 1983		615				
POWER AUGER 4.5 in DIAM. SOLID AUGER		SILTY CLAY (LACUSTRINE DEPOSIT)					610				
							605				
	595.7 / 14.0	SILTY CLAY, TRACE SAND AND GRAVEL (GLACIAL TILL)					600				
							595				
							590				
							585				
							580				
	574.7 / 35.0	END OF HOLE					575				
							570				

SHEAR STRENGTH Cu. NAT V. - + Q. - ● REM V. - ● U. - O

WATER CONTENT, PERCENT W_P W W_L



15 0 5 10 Percent axial strain at failure

VERTICAL SCALE

Golder Associates

DRAWN D.M.

CHECKED P.W.B.

Form G A - D - 1

Project No. 831.1089-1

RECORD OF BOREHOLE P 9

LOCATION See Figure | BORING DATE MAY 9 & 10, 1983 | DATUM M.S.L.

SAMPLER HAMMER WEIGHT 140 lb DROP 30 in. | PENETRATION TEST HAMMER WEIGHT DROP

BORING METHOD: POWER AUGER 4.5 in. DIAM SOLID AUGER; ROTARY DRILLING A.Q. WIRELINE

SOIL PROFILE — ELEV'N / DEPTH | DESCRIPTION | STRAT PLOT

SAMPLES — NUMBER | TYPE | BLOWS/

ELEVATION SCALE

DYNAMIC PENETRATION RESISTANCE, BLOWS/

SHEAR STRENGTH Cu — NAT V - + Q - ● REM V - ● U - O

COEFFICIENT OF PERMEABILITY, k_s, CM / SEC — 1×10^{-4} 1×10^{-3} 1×10^{-2} 1×10^{-1}

WATER CONTENT, PERCENT — W_P W W_L

ADDITIONAL LAB TESTING

PIEZOMETER OR STANDPIPE INSTALLATION — 2" ϕ PVC

Elev'n / Depth	Description
622.2 / 0.0	GROUND SURFACE
	SILTY CLAY (LACUSTRINE DEPOSIT)
608.2 / 14.0	
	SILTY CLAY, TRACE SAND AND GRAVEL (GLACIAL TILL)
582.2 / 40.0	
	MODERATELY TO HIGHLY WEATHERED GREY DOLOMITE AND SHALE, NUMEROUS GYPSUM LAMINAE AND MASSIVE GYPSUM ZONES
552.4 / 70.0	END OF HOLE

UNSAMPLED - STRATIGRAPHY INFERRED FROM NEARBY BOREHOLE

30 PUT DOWN BY BOWSER - MORNER INC. - NOV. 1982

ROCK CORE

Run	Elevation	Per Cent Core Recovery	Rock Quality Designation
1	575	96	21
2	560	99	27
3	550	90	16
4	540	100	14
5	555	100	0

Elevation scale: 610, 605, 600, 595, 590, 585, 580, 575, 570, 565, 560, 555, 550, 545, 540, 535

NO TAKE $K < 10^{-5}$ cm/sec.

PROTECTIVE PIPE AND CAP — CEMENT BENTONITE GROUT — SAND FILTER — PIEZOMETER

15 ✦ 5 Percent axial strain at failure

VERTICAL SCALE 1 INCH TO 5 FEET

Golder Associates

DRAWN D.M.

CHECKED P.W.B.

Form G A - D - 1

Project No 831-1089-1

RECORD OF BOREHOLE P 10

LOCATION See Figure

BORING DATE May 4 to 6, 1983

DATUM M S L

SAMPLER HAMMER WEIGHT 140 lb DROP 30 in.

PENETRATION TEST HAMMER WEIGHT DROP

BORING METHOD	SOIL PROFILE: ELEV'N / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	BLOWS/FT	ELEVATION SCALE
	604.9 / 0.0	GROUND SURFACE					605
POWER AUGER 4.5 in. DIAM. SOLID AUGER		SILTY CLAY (LACUSTRINE DEPOSIT)		UNSAMPLED - STRATIGRAPHY INFERRED FROM NEARBY BOREHOLE 24 PUT DOWN BY BOWSER-MORNER, INC. 2 Nov. 1982			600
	594.4 / 10.5						595
		SILTY CLAY, TRACES OF SAND AND GRAVEL (GLACIAL TILL)					590
							585
							580
							575
							570
	567.9 / 37.0	HIGHLY WEATHERED GREY SHALE (INFERRED FROM AUGER CUTTINGS AND ADVANCE)					565
	560.9 / 44.0	REFUSAL TO AUGERS					560
ROTARY DRILLING 3 in. WIRELINE		MODERATELY TO HIGHLY WEATHERED GREY SHALE AND SHALY DOLOMITE. NUMEROUS GYPSUM CRYSTALS AND PARTINGS. OCCASIONAL VOIDS.		1	NQ ROCK CORE	80 / 14	555
	549.4 / 55.5						550
		MODERATELY WEATHERED GREY SHALE WITH GYPSUM PARTINGS. MASSIVE GYPSUM ZONE 60.5 to 62.0. SOME HIGHLY WEATHERED ZONES		2		96 / 0	545
				3		85 / 18	540
							535
							530
	527.9 / 77.0	SLIGHTLY TO MODERATELY WEATHERED GREY SHALY DOLOMITE WITH GYPSUM PARTINGS		4		92 / 0	525
							520
	517.4 / 87.5	END OF HOLE					

PER CENT CORE RECOVERY

ROCK QUALITY DESIGNATION

$K < 10^{-5}$ cm/sec

PIEZOMETER OR STANDPIPE INSTALLATION: 2" Φ PVC

Protective pipe & cap

CEMENT BENTONITE GROUT

SAND FILTER

PIEZOMETER

Percent axial strain at failure

VERTICAL SCALE

Golder Associates

DRAWN D.M.

CHECKED P.W.R.

HYDROGEOLOGIC ASSESSMENT

NORTHERN OHIO TREATMENT FACILITY
VICKERY, OHIO

Chemical Waste Management, Inc.
3956 State Route 412
Vickery, Ohio 43464

Attention: Mr. Gary Brown

Laboratory Job No. 33767

Report No. T-20356

May 3, 1983

BOWSER-MORNER
Testing Laboratories, Inc.

BOWSER-MORNER Testing Laboratories, Inc.

Founded 1911

TOLEDO DISTRICT • 122 S. St. Clair St. • P.O. Box 838 • Toledo, Ohio 43696 • 419/255-8200

May 3, 1983

Chemical Waste Management, Inc.
3956 State Route 412
Vickery, Ohio 43464

Attention: Mr. Gary Brown

REF: Hydrogeologic Assessment
Northern Ohio Treatment Facility
Vickery, Ohio
Laboratory Job No. 33767
Report No. T-20356

Gentlemen:

The following report summarizes the results of a hydrogeologic assessment for the Northern Ohio Treatment Facility. The purpose of this work was to perform a hydrogeologic study and analysis of existing groundwater quality data. The work was to be done in accordance with the special terms and conditions set forth by the Hazardous Waste Facilities Approval Board (H.W.F.A.B.) in the site permit issued December, 1981. The work was specifically to follow the "Hydrogeological Investigation Plan" dated February 19, 1982 and subsequently approved by the HWFAB in a letter dated September 14, 1982.

A preliminary report summarizing this study was issued March 21, 1983. At that time it was recommended that this final report be delayed until additional work could be performed. Based on discussions between Chemical Waste Management and the Ohio Environmental Protection Agency (OEPA), it was decided to issue this final report before completing the additional studies. Please note that this report is based on data obtained prior to March 15, 1983. The current work items are listed in separate correspondence from Chemical Waste Management.

For your convenience, samples recovered will be retained at this laboratory for a period of 60 days, unless we are otherwise advised. If

CORPORATE ADDRESS • 420 Davis Ave. • P.O. Box 51 • Dayton, Ohio 45401 • 513/253-8805
KENTUCKY DISTRICT • Route 8 West • P.O. Box 636 • Maysville, Kentucky 41056 • 606/564-5508

there are any questions or if we can be of further service, please contact us.

STATE OF OHIO
J. RICHARD HOPPENJANS
36850
REGISTERED
PROFESSIONAL ENGINEER

Respectfully submitted,

BOWSER-MORNER, INC.

J. Richard Hoppenjans

J. Richard Hoppenjans, P.E.
Chief Engineer, Toledo District

Julie K. Kampa

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EXECUTIVE SUMMARY

A hydrogeologic investigation and a statistical analysis of accumulated groundwater quality data has been performed for the Northern Ohio Treatment Facility. The hydrogeologic investigation was based on a comprehensive soil boring and superficial rock coring program integrated with data available in published and unpublished literature. The primary emphasis was upon the glacial soil deposits. Water quality data was summarized and evaluated utilizing regression analysis.

The natural soil under the site is 40 to 50 feet thick, is clay-rich, and has permeabilities on the order of 1×10^{-8} and 1×10^{-9}. No aquifer or significant pockets of water were found in the soil profile. No natural connections are known to exist between the surface and the bedrock aquifer. In our opinion, the natural soil conditions are good to excellent for the containment of the types of waste handled at the site.

The statistical analysis of the groundwater quality data indicates that most parameters except for hardness, sulfates, and chlorides are below federal drinking water standards. The natural groundwater, as a consequence of the mineralogy of the rock formation through which it flows, is very high in sulfates and hardness. The chloride level under the site is significantly different from the background water quality data. However, the reasons for this high level are not known at this time. Furthermore, groundwater levels under the site indicate that a cone of depression is present around the pumping wells and, therefore, the general flow of the groundwater apparently is into the site. At this time, therefore, a zone of groundwater apparently exists which is

not leaving the site boundaries due to the apparent purging of the groundwater by supply wells used at the site. Note that a comprehensive study was not made of the bedrock aquifer and that the apparent cone of depression may not be present at all times. Additional testing, analysis, and installation of new monitoring wells is recommended.

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INTRODUCTION

The Hazardous Waste Facility Approval Board in 1982, as a permit special condition, required Chemical Waste Management to perform a hydrogeologic assessment and to analyze the existing groundwater quality test data from the Northern Ohio Treatment Facility site. BOWSER-MORNER was retained to perform the hydrogeologic assessment and analysis in accordance with approved plans contained in Appendix J. The following report summarizes the results of this work.

The following items are included in this report:

1. Historical summary of site operations and a current site facilities map.

2. Field testing records developed during this study including soil boring logs, monitoring well logs, rock core logs, and groundwater pump test records.

3. Laboratory test data developed during this study including soil classification data (grain size and Atterberg limits), CEC values and permeability values.

4. Historical records of background regional water quality.

5. Summaries of existing groundwater quality records.

6. Miscellaneous research data such as local water well logs.

The report has been organized in the following manner.

SECTION I describes the physical testing and test procedures used during this project.

SECTION II presents a broad regional overview of the site's hydrogeology, climate, and topography.

SECTION III presents the detailed on-site hydrogeologic conditions including the soil and rock profile and groundwater conditions. Also included in this section is a detailed site history and details of the on-site topography and hydrology.

SECTION IV presents an analysis of the existing groundwater quality data.

SECTION V is an assessment of the site in light of the results of this study.

The following summary indicates the location of the required maps and illustrations.

Item	Location of Required Information
I - Location Information	
Legal Description	Appendix I
Map with grid coordinates	Sheet 2
Name of owner	Text, page 22
Narrative of site location	Text, page 5
Map showing location:	
-- at scale of 1"=200'	Sheet 2
-- on quadrangle	Figure 1, page 6
II - Site Description	
Dimensions and elevations of facilities	Sheets 1 and 2
Narrative description of facilities	Text pages 22-28
Map of all wells within 2000'	
-- water	Appendix C, page C-27 (as available from ODNR records)
-- oil and gas	Figure 6, page 17
-- injection	Sheet 2
-- brine	None known to exist
Description of current operating status and use of each well	
-- water	Table 3, pages 29 and 30
-- oil and gas	Text, page 16
-- injection	Text, pages 23, 25, 26, Table 2, pg. 24
Map of location of all strip mines, quarries, and deep mines with 2000'	None known to exist
Map of all known pipelines within 1000' and within property boundaries	Sheet 2 Figure 1, page 6 Text, page 26 (note only major features shown)
Map location of all borings, test pits, monitoring devices, and sumps within the boundaries	
-- test borings	Sheet 1
-- test pits	None performed
-- monitoring devices (wells)	Sheet 2
-- sumps	None known to exist
-- monitoring devices (surface water)	Figure 11, page 49
Map location of all known springs within 1000' of facility	Figure 1, page 6 Figure 11, page 49 Text, page 7

Item	Location of Required Information
III - Hydrogeologic Description	
Map of site topography	Sheet 1
Narrative description of topography	Text, page 5
Map of site drainage	Sheet 9
Narrative of site drainage	Text, pages 7 and 8, 32 and 33
Location of facility relative to 100-year flood plain	Figure 2, page 9
Description of glacial geology	Text, pages 1-4, 13-16, 35-42 Figure 5, page 14; Figure 9, page 38; Appendix A; Sheets 3, 4, 5
Description of bedrock geology	Text, pages 8-13, 33-35 Figure 3, page 10; Figure 4, page 12; Figure 8, page 34
Identification of all known fresh water bearing aquifers	Text, pages 16-21, 43-47, 61-65 Figures 7, page 18; Figure 10, page 45; Appendix C, D, E Sheets 3, 4, 5

SECTION I

WORK PERFORMED

SECTION I

WORK PERFORMED

Thirty-two (32) borings were made in the relative positions shown on the boring location plan (see Sheet 1). These borings and resulting data are included in Appendix A. The borings were made with a truck-mounted boring rig using hollow stem augers and employing standard penetration resistance methods (140 pound hammer, 30 inch drop, 2 inch O.D. split spoon sampler) at maximum intervals of five (5) feet or at major changes in stratum, whichever occurred first. The disturbed samples recovered by the split spoon sampler were visually classified, logged, sealed in moisture-proof jars, and brought to the laboratory for inspection. The position at which a split spoon sample was obtained is indicated on the boring logs by an "A" type sample. Each boring was completed by fully grouting the bore hole with a cement-bentonite grout.

Five (5) water observation level piezometers for the purpose of continuously monitoring the groundwater depth were installed at borings 1, 5, 10, 11, and 29. Piezometers 1, 10, 15 and 29 consist of 1 1/4" diameter PVC pipe that was installed into rock and set at the depth indicated on the Piezometric Log of the various borings. These borings are included in Appendix A. A plug was installed in the annular space between the PVC pipe and the bore hole at the top of the rock and cement-bentonite grout was then pumped into the annular space above the plug, filling the annular space from the plug to the surface. Piezometer 11 was installed through casing at the top of rock, sand packed around the screen, and the annular space filled to the surface with cement-bentonite grout.

Seven (7) "NX" size rocks were was taken at boring locations 1, 2, 5, 10, 17, 19, and 29. These cores were taken to confirm the presence of solid rock at the site and to allow determination of the physical characteristics of the rock. The core was made with "NX" size, diamond coring equipment with a specially designed core barrel for maximum core recovery. The position at which this core was taken is indicated on the boring log by a "B" type sample.

Thirty (30) Shelby tube samples were taken by hydraulically pressing, at a constant rate, 3 inch O.D. thin-walled samplers through the soil strata. The thin-walled samples were sealed and brought to the laboratory for tests and inspection. The position at which a thin-walled sample was taken is shown on the boring logs by a "C" type sample.

One pump test was performed utilizing an existing water well and piezometer No. 10. Drawdown in both the well and piezometer were measured with an electric tape. Discharge was measured utilizing a 55 gallon drum and a stopwatch. The data was analyzed using a computer program designed for a Hewlett-Packard-97 hand-held calculator (Raynor 1980). The results are as follows:

Transmissivity	=	2830 gpd/ft^2
Storage coefficient	=	4.05×10^{-3}
Permeability	=	113.5 gpd/ft^2

Seven (7) Unified Soil Classification tests were performed. All soil samples recovered were visually separated into general groups. Typical samples from each group were then classified according to the Unified Soil Classification System. Each sample is shown in its respective group on the Laboratory Summary Sheet included in Appendix A.

Seventeen (17) sieve and hydrometer tests were performed. The samples were dried and dissaggrated, then sieved. The portion that passed the 200 sieve was retained for the hydrometer tests. The results are shown in Appendix A.

Thirteen (13) constant head permeability tests were performed on samples obtained from Shelby tubes. Twelve of the tests measured vertical permeability and one measured horizontal permeability. The samples were enclosed in rubber membranes and placed in conventional triaxial chambers with chamber pressure then applied. Back pressure, slightly less than the chamber pressure, was applied at one end of the specimen while the other end was open to atmosphere. Water was flushed through the specimen from the high pressure end to the low pressure (atmosphere) end until a stabilized flow was achieved. The coefficient of permeabilities so determined are listed below:

Sample No.	Coefficient of Permeability (cm./sec.)
1 - 2C	7.0×10^{-9}
5 - 3C	1.5×10^{-8}
9 - 1C	6.1×10^{-9}
9 - 3C	1.6×10^{-8}
12 - 2C	2.6×10^{-8}
12 - 4C	1.6×10^{-8}
14 - 1C	3.5×10^{-8}
14 - 2C	2.2×10^{-8}
14 - 4C	8.4×10^{-9}
19 - 1C	1.5×10^{-8}
19 - 2C	3.1×10^{-8}
22 - 3C	2.4×10^{-8}
25 - 1C	$8.6 - 10^{-8}$

Twenty-one (21) cation exchange capacity tests were performed. The results are as follows:

Boring and Sample No.	Depth (feet)	Material	CEC	pH
1 - 2A	6.0- 7.5	Lacustrine	28.2	8.0
2 - 3A	9.0-10.5	Till	29.2	8.1
5 - 4A	15.0-16.5	Till	25.8	7.9
7 - 2A	4.0- 5.5	Lacustrine	29.0	8.0
7 - 5A	19.0-20.5	Till	26.7	7.9
9 - 2A	4.0- 5.5	Lacustrine	27.2	7.9
10 - 6A	24.5-26.0	Till	28.3	8.1
11 - 4A	14.0-15.5	Till	27.0	7.8
12 - 1A	1.0- 2.5	Lacustrine	26.0	7.7
15 - 3A	9.0-10.5	Lacustrine	24.3	8.1
18 - 4A	14.0-15.5	Lacustrine	23.2	7.7
18 - 7A	29.0-30.5	Till	26.5	7.8
19 - 2A	4.0- 5.5	Lacustrine	22.5	7.6
22 - 5A	34.5-36.0	Till	26.0	7.8
23 - 4A	14.5-16.0	Lacustrine	25.4	7.9
24 - 4A	14.5-16.0	Lacustrine	27.7	7.8
25 - 6A	24.0-25.5	Till	27.6	7.9
28 - 2A	4.5- 6.0	Lacustrine	27.6	8.1
29 - 3A	9.0-10.5	Till	26.6	7.8
31 - 4A	14.0-15.5	Till	27.3	7.8
32 - 2A	4.0- 5.5	Lacustrine	25.6	7.9

Three hundred twelve (312) natural moisture content of each sample recovered were determined. The results of these tests are shown on the Laboratory Summary Sheet included in Appendix A.

Twelve (12) carbonate content determinations were performed on soil samples from various locations and depths. The results are included in Appendix A.

SECTION II

AREA DESCRIPTION

SECTION II

AREA DESCRIPTION

Location

The Northern Ohio Treatment Facility site is located in the southwest one-half of Section 23, and the north one-half of Section 26, Riley Township, Sandusky County, T5N, R16E (see Figure 1). The site is approximately six miles east of Fremont and three miles north of Clyde. Sheets 1 and 2 attached to this report show the latitude and longitude of the site on a grid coordinate system. The legal description is given in Appendix I.

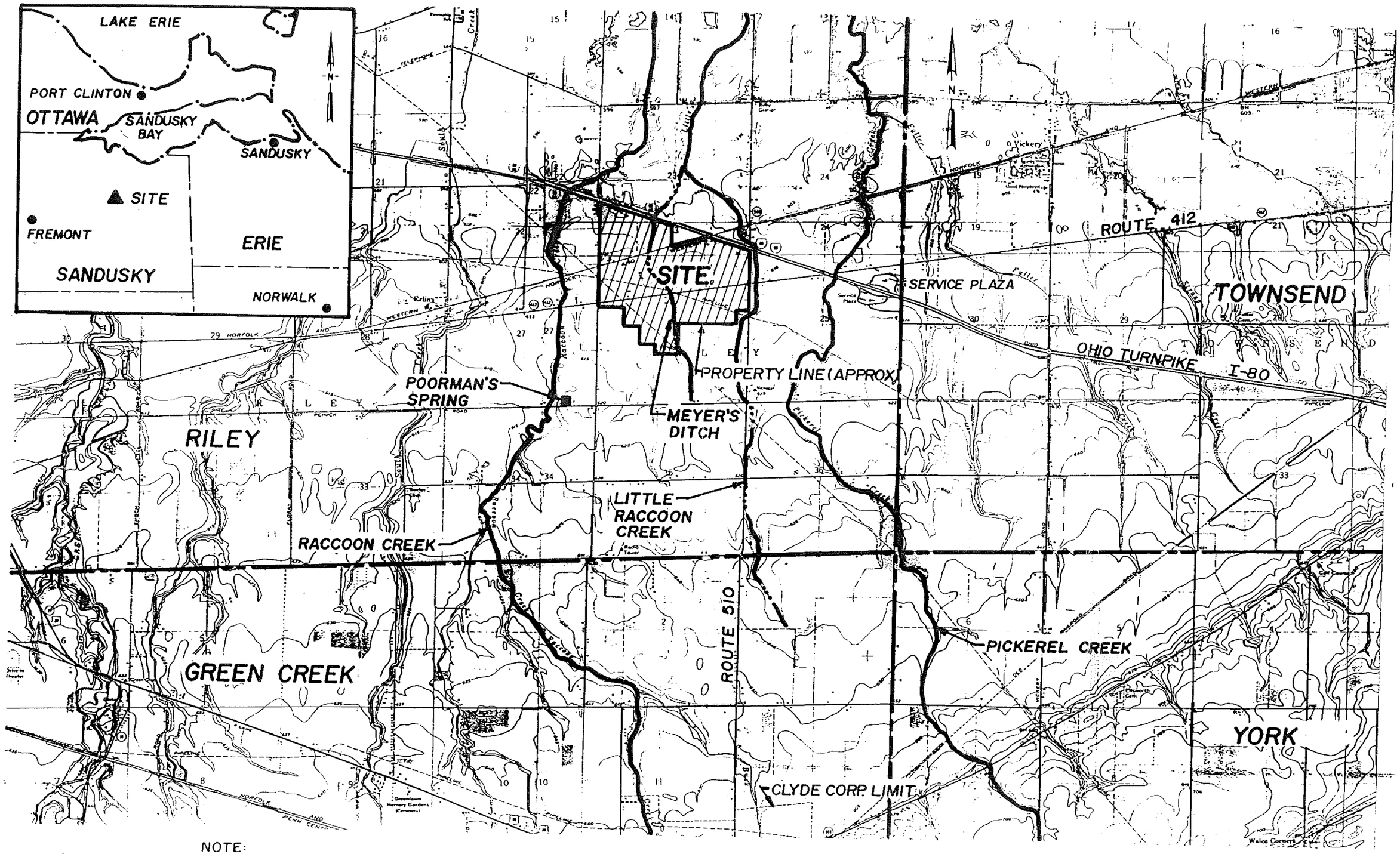
Topography

The regional topography is very flat with a gentle slope to the north towards Sandusky Bay (see Figure 1). The flatness is broken only by steep-walled streams which flow almost directly north towards Sandusky Bay. All of the streams in the area tend to run parallel to each other for some distance before converging.

A detailed map of the site topography is shown on Sheet 1.

Climate

The climate of the site and of Sandusky County is classified as continental. The area has large annual and daily ranges of temperature. Summers are warm and humid with several days having temperatures exceed 89°F. Winters are cold and cloudy with occasional days having sub-zero temperatures. Temperatures in the area of the site have ranged from a high of 105°F in 1953, to -16°F in 1963. The mean temperature is approximately 50°F. The warmest month of the year is usually July, with an average temperature of approximately 74°. The coldest month of the



SCALE: 1" = 3125'

NOTE:
TAKEN FROM USGS CLYDE, VICKERY, FREMONT EAST AND WIGHTMANS GROVE QUADRANGLES.

SITE LOCATION MAP

JOB NO. 33767
DATE 2-4-83

FIG. 1

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year is usually January, with an average temperature of approximately 25°F.

Precipitation in the area varies widely from year-to-year; however, it is normally abundant and well-distributed throughout the year with winter being the driest season. The mean annual precipitation is approximately 30.3 inches. The mean average snowfall is 31.1 inches. On the average, there are five days per year with one inch or more of precipitation. The two-year, 24-hour storm is 2.0 inches. The ten-year, 24-hour storm is 3.7 inches. The 50-year, 24-hour storm is 5.2 inches. The 100-year, 24-hour storm is 5.8 inches.

Surface Hydrology

The site lies between Raccoon and Little Raccoon creeks (see Figure 1). Little Raccoon Creek lies about 250 feet east of the eastern boundary of the site. Raccoon Creek lies approximately one-quarter mile west of the western boundary. Little Raccoon Creek is a small perennial stream that is subject to highly seasonal flow. In fact, the U.S.G.S. map shows that the stream becomes an intermittent stream approximately one-quarter of a mile upstream from the southeast corner of the site. Raccoon Creek is a large perennial stream that originates in Seneca County, south of Clyde. Clyde, which is upstream of the site, uses Raccoon Creek for water supply and also discharges the final effluent from their waste water treatment plant. One spring is known to flow into Raccoon Creek. This spring is located in the southeast one-quarter of Section 27, Riley Township, and is locally known as "Poorman's Spring." The spring is noted for its very high content of sulfate.

The Chemical Waste Management site proper is bisected by the Charles E. Meyer ditch, which ultimately flows into Little Raccoon Creek.

Sandusky County has been evaluated by the U.S. Department of Housing and Urban Development for flood insurance. The 100-year flood boundaries that were determined are shown in Figure 2. As can be seen, no 100-year flood plain exists on the Chemical Waste Management site.

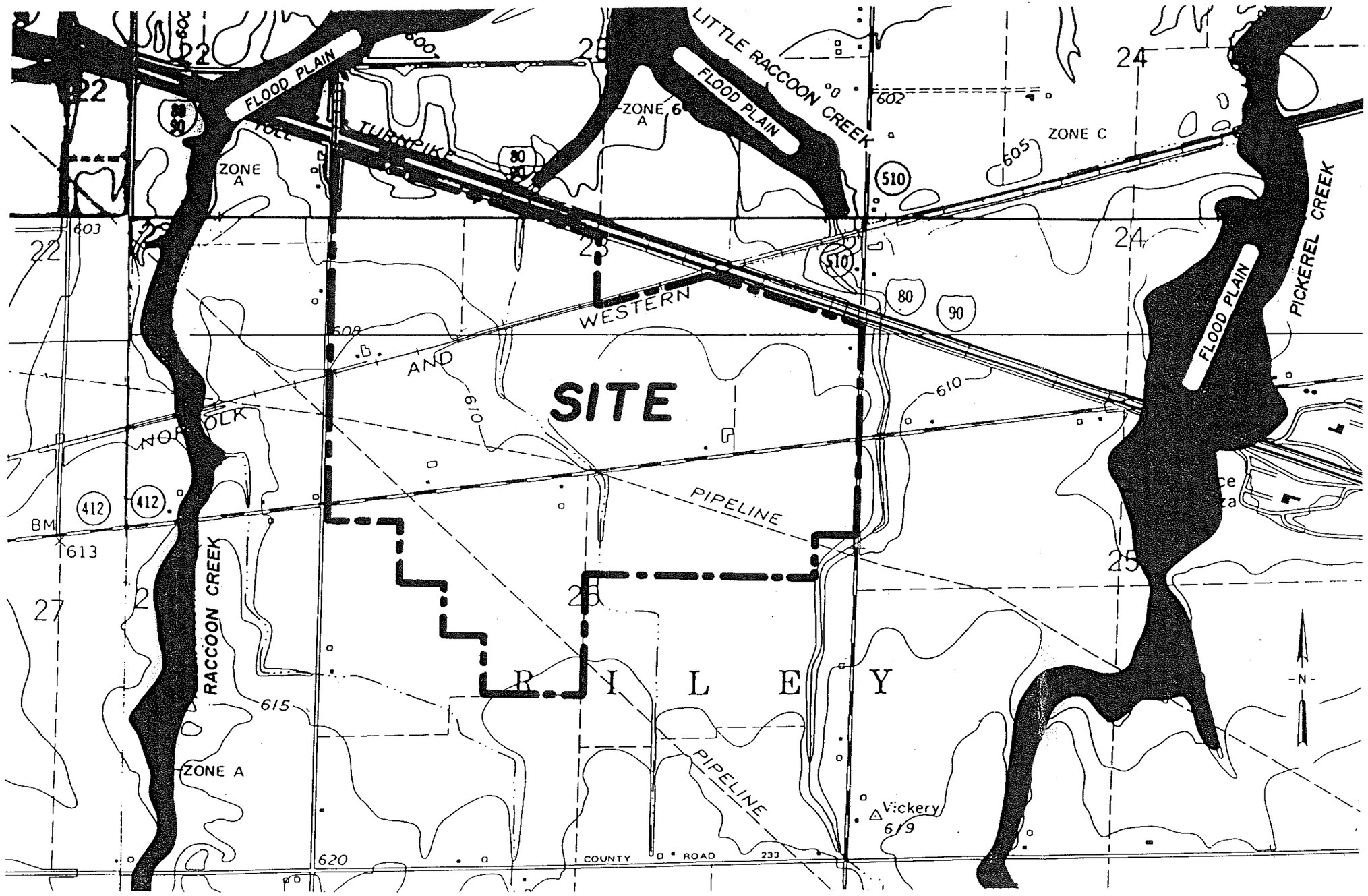
Regional Geology

General Bedrock Geology

The site is located on the east flank of the Findlay Arch which separates the Michigan and Appalachian basins (see Figure 3). The bedrock under the site dips gently in an easterly direction, towards the center of the Appalachian basin. Older rocks are found to the west and northwest on top of the Findlay Arch, while younger rocks are found to the east towards the center of the basin.

The Findlay Arch, because it was topographically higher than the basins on either side, often acted as a barrier to flow between the bodies of water contained in the two basins. At various times, depending on the regional tectonic activity, the arch was either covered by shallow seas or was exposed to the air.

The bedrock under the site consists of the Tymochtee dolomite (Sparling, 1970). The Tymochtee is a middle member of the Bass Islands Formation which is upper Silurian in age. The Tymochtee is basically a dolomite, however, in different areas it contains various amounts of shale and the two calcium sulfate evaporite minerals, gypsum ($CaSO_4 \cdot 2H_2O$) and anhydrite ($CaSO_4$). The presence of the large amount of evaporites indicates that the rock was deposited under hypersaline conditions with restricted flow of water.



100 YEAR FLOOD PLAIN

FROM HUD FLOOD INSURANCE RATE MAP (1979)

SCALE: 1" = 1250' APPROX.
DATE: 2-15-83
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FIG.2

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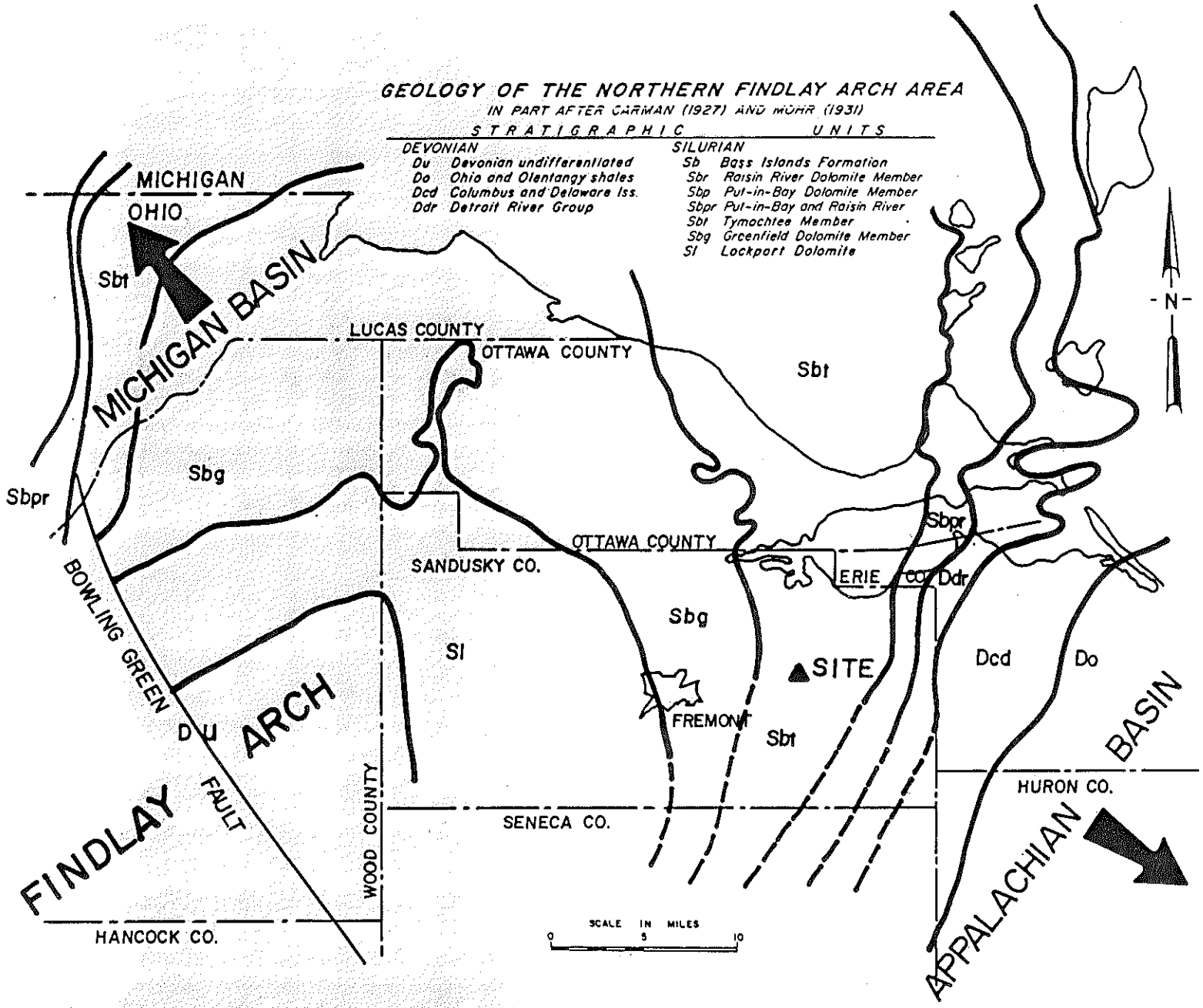


BEDROCK & GEOLOGIC STRUCTURE MAP

(AFTER SPARLING 1970)

JOB NO. 33767
DATE: 2-21-83

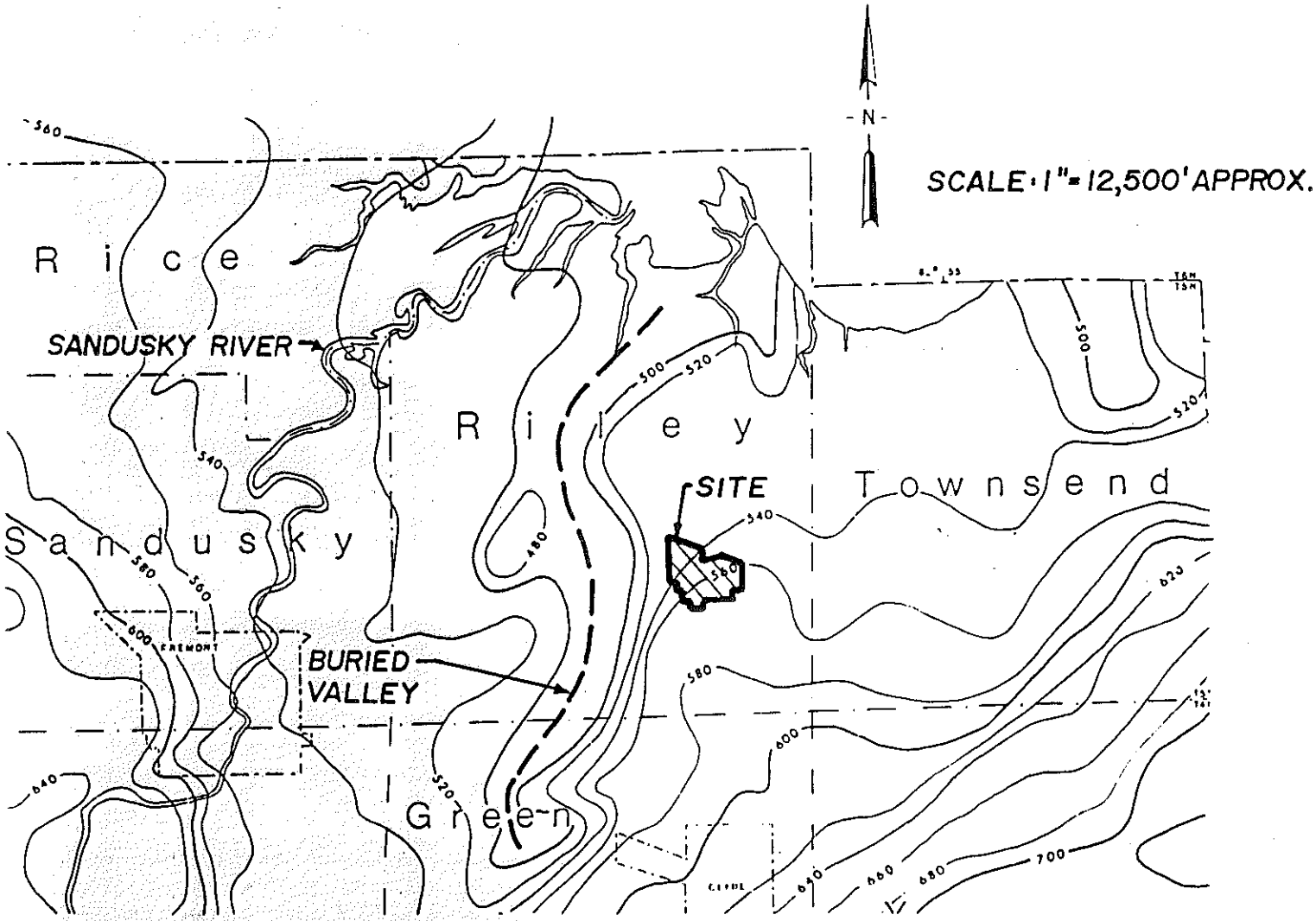
FIG. 3

The Tymochtee is underlain by the Greenfield dolomite member of the Bass Islands Formation. The Greenfield lacks the evaporites of the overlying Tymochtee, however, fossil evidence shows that the Greenfield also had salinities higher than normal marine conditions.

The entire Bass Islands Formation is underlain by the Lockport Dolomite, sometimes known as the "Guelph" dolomite, which is a normal marine deposit. The entire sequence represents a transition from a normal marine environment during the middle Silurian to a hypersaline condition in the upper Silurian.

The bedrock surface is marked by a major valley trending north/south through the center of Riley Township (see Figure 4). Although this buried valley and the modern Sandusky River parallel each other, their stream valleys are unrelated to each other. The east side of the buried valley, over which the Chemical Waste Management site is located, is relatively steeper than the western side of the valley. The slope, however, appears to be uniform without any major feeder valleys. The difference in elevation between the bedrock under the site and the center of the valley west of the site is about 80 feet.

In addition to visual descriptions of cores and outcrop by many authors, Norris and Fiddler (1971) describe the characteristic differences between the Lockport, Greenfield, and Tymochtee formations as shown on gamma, self-potential, and Resistivity logs. The logs for the Lockport Dolomite are characteristically smooth, reflecting the formation's uniform consistency, while the members of the Bass Islands Formation have a "ragged" appearance, reflecting their highly variable composition.



BEDROCK TOPOGRAPHY

FROM HOOVER(1982)

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DATE: 2-11-83

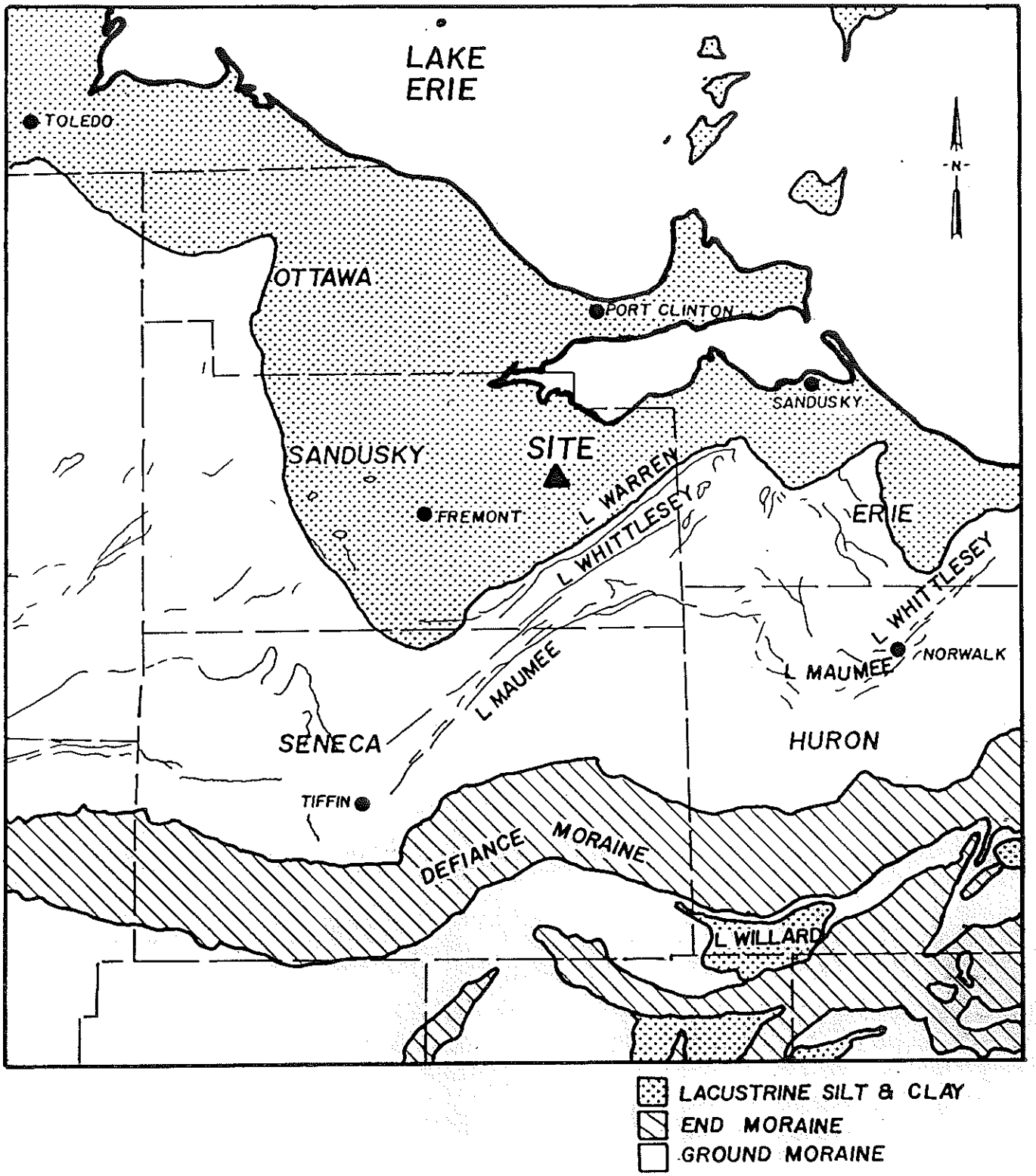
FIG. 4

BOWSER-MORNER, INC.

Geophysical logging of the bore holes for the deep injection wells at the site indicates that the Tymochtee is approximately 140 feet thick under the site and the underlying Greenfield is approximately 50 feet thick. The logs of both of these rock units exhibit the "ragged" appearance characteristic of the Bass Islands Formation. The remaining approximately 400 feet of the logs show the characteristic uniform measurements of the Lockport Dolomite.

General Glacial Geology

The bedrock surface, as previously described, was altered and buried by the advance of the Pleistocene glaciers. Several different ice sheets advanced and retreated over the area, but only the youngest series of ice sheets, those that grew and retreated during the Wisconsinan stage, are recorded in the soil deposits. Figure 5 shows the the surficial geology of the area. The site lies along the southern edge of an ice lobe that came out of the Lake Erie basin from the north. As the ice from this advance retreated, the soil and rock material trapped with in the ice was deposited as an unsorted till and also as sorted outwash deposits. Sandusky County, as a whole, lies within the ground moraine behind the Defiance end moraine which marks one of the last major stillstands of the ice. As the ice retreated, the meltwaters were dammed between the high ground of the Defiance moraine to the south and the ice which still existed to the north and the east, forming a series of pro-glacial lakes. The existence of these lakes is recorded in the forms of shorelines which developed along the margins of the water and the silt and clay deposits that were formed in areas of the quiet water. Table 1 lists the various lake stages that are recognized in the Sandusky County area



SURFICIAL GLACIAL GEOLOGY

0 10 MILES

FROM GOLDTHWAIT ET AL (1961)

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DATE: 2-14-83

FIG. 5

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TABLE 1

ELEVATIONS OF THE GLACIAL GREAT LAKES
(from Dorr & Eschman, 1970)

Approximate Date	Lake Stage	Elevation (feet)
	Modern Lake Erie	573
11,850	Kirkfield	565 (?)
	"Early Algonquin"	605
	Lundy	620
	Grassmere	640
	Lowest Warren	675
	Wayne	660 (brief)
	Warren	690-680
13,000	Whittlesey	738
	Lowest Arkona II	695
13,300	Cary-Port Huron low water stage	
	Arkona	710, 700, 695
	Maumee III	780
	Maumee II	760
	Maumee I	800

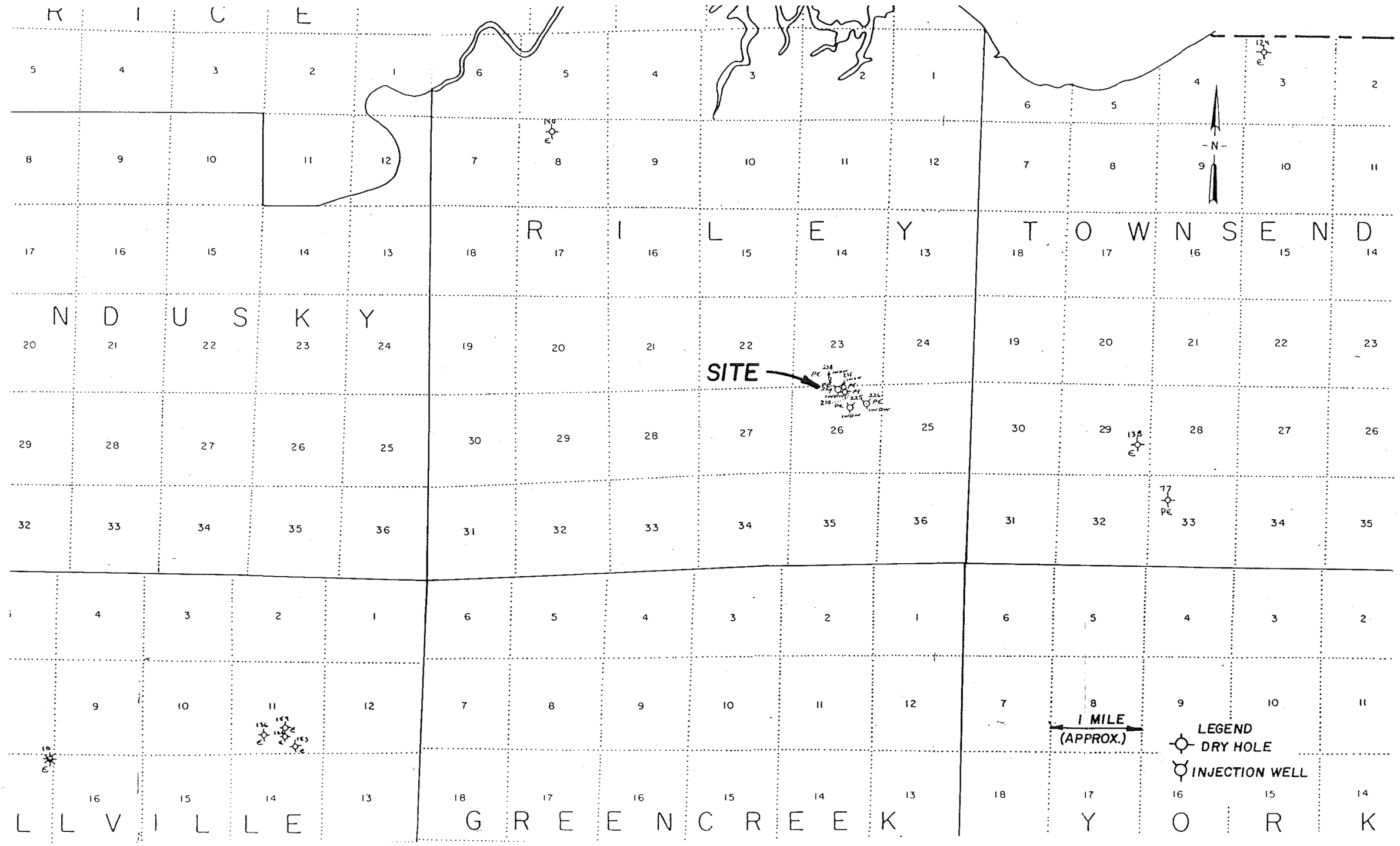
and their associated elevations. The last major lake to have covered the site area was probably Lake Lundy, whose shoreline was at elevation 620. This lake was probably in existence at about 12,000 years ago.

Oil and Gas Resources

Information from the Ohio Geologic Survey indicates that no oil and gas wells have been drilled in either sections 23 or 26 of Riley Township (see Figure 6). The only deep wells in this area are the injection wells at the Chemical Waste Management site. The Ohio Division of Geological Survey logs the injection wells are contained in Appendix B. The nearest oil or gas well is located some three miles east of the site in Section 29 of Townsend Township. This, however, was closed as a dry hole. A second well, also dry, was drilled approximately one-half mile further to the southeast in Section 33, Townsend Township. A third well, also dry, lies approximately four miles northwest of the site in Section 8, Riley Township. No other wells exist for at least six miles. A map of the oil and gas fields of Ohio (Debrosse and Vohwinkel, 1974) does not show any oil or gas fields located under eastern Sandusky County.

General Regional Groundwater

Regional groundwater flow for the area is north to northwest towards Lake Erie (see Figure 7). Studies of the groundwater by Ohio DNR (1970); Hoover (1982), and others indicate that the Tymochtee, the Greenfield and the Lockport formations are the major sources of groundwater, due to their high degree of solutioning and jointing. Very little water is available from the glacial overburden, except in areas where a buried valley, such as the one previously mentioned, is filled with gravels and sands.



OIL AND GAS WELL LOCATION MAP

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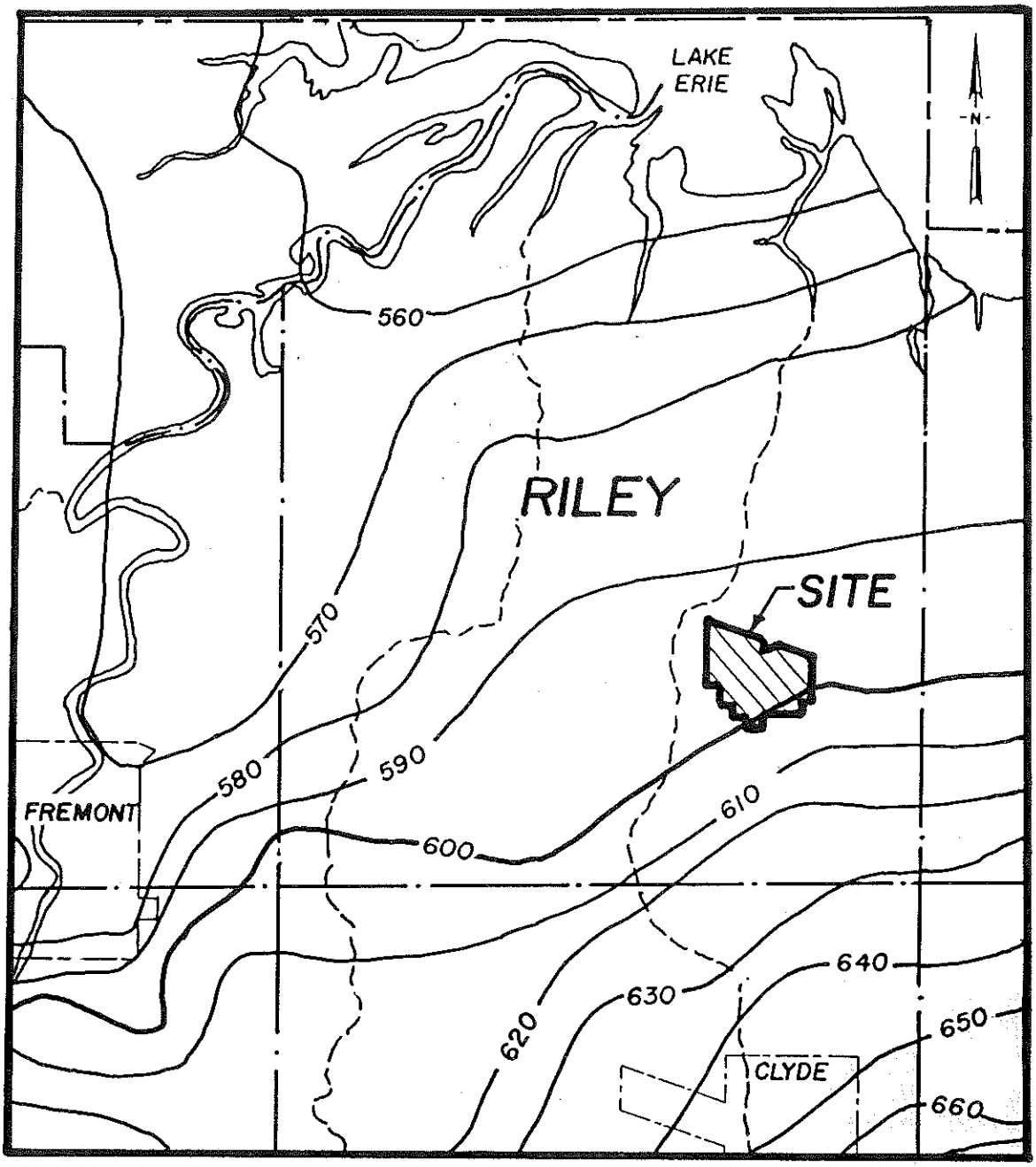
DATE: 2-4-83

FIG. 6

BOWSER-MORNER, INC.



POTENTIOMETRIC SURFACE MAP OF THE BEDROCK AQUIFER

AFTER HOOVER (1982)

— 610 — GROUND WATER SURFACE CONTOUR LINE

SCALE: 1" = 8250' (APPROX.)
JOB NO. 33767
DATE: 2-16-83

FIG. 7

The recharge area for the groundwater in this area is found to the southeast, where the bedrock surface rises to within several feet of the ground surface. The recharge area is known for having sinkholes and other karstic features that allow surface runoff to easily enter the bedrock. The glacial overburden thickens to the northwest and acts as a confining layer. Schaefer and Walton (1956) estimate that the groundwater flow rate for the region is on the order of less than one foot per year.

Flowing artesian conditions exist in eastern Riley, northeastern Green Creek, and central Townsend townships from the bedrock aquifer. This is a result of interplay between the hydraulic gradient, the surface topography, and the bedrock topography. The southern boundary of the flowing artesian area parallels a bedrock escarpment that runs northeast/southwest through Clyde and Castalia. The surface soils are draped over the bedrock surface, preserving, to some extent, the abrupt change in the slope of the rock surface. The hydraulic gradient does not drop as fast as the ground surface, which results in the piezometric surface intersecting and rising above the ground surface. This results in flowing artesian conditions in wells in this area. It should be noted that not all wells in this area are flowing wells, however. This is a consequence of very subtle changes in surface topography which raise the ground surface above the piezometric surface. No flowing wells exist on the site or within 1000 feet of it. There are, however, several flowing wells and at least one spring found in close proximity outside the 1000-foot boundary. (See Appendix C.)

General Groundwater Quality

The existing groundwater contains extreme amounts of sulfate material which renders the water practically unusable for human drinking purposes.

The source of sulfates is the gypsum and anhydrite in the Bass Islands Formation, particularly the Tymochtee dolomite. A study by Sedam and Stein (1970) placed the base of the potable water zone at about around elevation 600 which, in this area, is essentially the ground surface. The water is used locally for agricultural and livestock purposes. Most residents of the area, including the Chemical Waste Management facility, utilize cisterns for drinking and household use water.

Background water quality data was obtained from several sources. The Ohio Department of Natural Resources, Division of Water published a comprehensive study in 1970 of the groundwater in northwest Ohio, including Sandusky County. The remaining sources are unpublished reports or theses, the most important of which are several studies made for the Ohio Turnpike Commission regarding the groundwater quality of service plaza No. 5 on Interstate 80, about one mile east of the Chemical Waste Management site. The complete data is presented in Appendix D. In general, the data shows the following ranges for selected constituents:

Element	Range mg/l	
Iron (Fe)	.02 - 19	
Calcium (Ca)	109 - 577	
Magnesium (Mg)	71 - 177	
Sodium (Na)	7 - 35	
Sulfate (SO_4)	128 - 1831	
Chloride (Cl)	5 - 46	
Total Solids (TS)	340 - 8124	
Total Hardness	280 - 3598	
pH	7.0 - 7.4	(not mg/l)

The chemical content of the water is highly dependent on the mineral content of the rock formation through which the water moves. Sulfate content, Total Solids, and Total Hardness values all increase to the north/northwest, parallel with the hydraulic gradient.

SECTION III

SITE DESCRIPTION

SECTION III

SITE DESCRIPTION

Introduction

Waste recovery and disposal operations at the Northern Ohio Treatment Facility site began in 1958 under the name of Don's Oil Service. The site changed ownership and became Ohio Liquid Disposal in 1970. Chemical Waste Management, Inc. acquired the site in June, 1978 and is the present owner.

Primary methods of waste handling and disposal have involved temporary storage lagoons, storage tanks and processing facilities, and deep well injection for ultimate disposal of wastes. The following sections discuss the history and construction of the physical facilities and the specific hydrogeology of the site.

Waste Ponds

The waste ponds were constructed by excavating the clay down to the proposed bottom elevation and using the excavated clay to construct the containment dikes around the ponds. The dikes range in elevation from 10 to 20 feet above the original ground surface. The dikes were keyed into undisturbed clay and the clay fill was compacted. A two to three foot high perimeter dike was similarly constructed in 1979 around the north and east perimeter of the site (see sheet 2) with clay excavated from the borrow pit located west of Pond No. 12 and east of the Charles E. Meyer ditch. The dikes on the site appear to be in good condition with no seeps or slumps visible.

Chemical Waste Management is in the process of phasing out the older ponds. The ponds are closed by pumping them as dry as possible

and mixing the bottom sludge with sand, clay and lime in a pugmill to fill the pit. The fill is covered with clay from the borrow pit and graded to drain.

There are currently four active waste ponds Nos. 5, 7, 11, and 12. (See sheet 2.) Pond No. 7 was formerly divided into Pond No. 8 on the north and No. 7 on the south. As the dike separating ponds 7 and 8 is now submerged, the ponds are considered as one.

There are seven inactive ponds, Nos. 1, 2, 3, 4, 5, 9, and 10, and all but two, Nos. 4 and 9, of them have been closed. Pond No. 4 is approximately 25 percent closed and Pond No. 9 is approximately 75 percent closed. Pond No. 6 was formerly divided into two ponds (6 east and 6 west), and was used only to hold water used to wash out the waste delivery trucks.

The dates of construction and closure of the ponds are shown in Table 2, Summary of Facility History.

Liquid Waste Injection Wells

At the time of this study incoming liquid waste intended for deep well disposal was first emptied into Pond 7, where solids were allowed to settle out. The liquid was then pumped into Pond 11 for additional settling and then into Pond 12. Liquid from Pond 12 is filtered prior to injection into the deep wells.

All the injection wells were constructed in a fashion similar to deep well No. 1 (Ohio Division of Geologic Survey permit No. 210). The following is a description of the construction of that well from Norling (1972):

TABLE 2

SUMMARY OF FACILITY HISTORY

FACILITY	DATE OF CONSTRUCTION	DATE PUT IN OPERATION	DATE TAKEN OUT OF OPERATION	DATE OF CLOSURE	CURRENT STATUS
Pond 1	1961	1961	1979	1979	Closed
Pond 2	1962	1962	1979	1979	Closed
Pond 3	1962	1962	1980	1980	Closed
Pond 4	1963	1963	1982	**	25% Closed
Pond 5	1968	1968			Active
Pond 6	1966	1966 *	1980	1980	Closed
Pond 7	1968	1968			Active
Pond 8	1968	1968			Combined with #7
Pond 9	1969	1969	1981	**	75% Closed
Pond 10	1971	1971	1982	1982	Closed
Pond 11	1973	1973			Active
Pond 12	1973	1973			Active
Injection Well 1 ***	3/72	1976	1979	1980	Closed
Injection Well 1A	9/79	1980			Active
Injection Well 2	6/76	1977			Active
Injection Well 3	7/76	1977			Active
Injection Well 4	7/76	1977			Active
Injection Well 5	1981	1982			Active
Injection Well 6	11/81	1982			Active
Oil Recovery	1977	1977			Active
Sludge Farm	1978	1978	1978	1978	Closed

* Pond 6 was split into Pond 6 East and Pond 6 West in 1976.

** Pond 4 and Pond 9 are scheduled to be closed in the spring of 1983. However, Chemical Waste Management plans to ask for a two-year extension on the closing period for Pond 4.

*** Drillers logs for the injection wells are contained in Appendix B.

"...Examination of the drilling records of this well reveal that 8 and 5/8 inch surface casing was set at 642 feet, 38 feet below the base of the 'Big Lime' and in Ordovician shales, and cemented to the surface. The water-bearing zones in the 'Big Lime,' from which the groundwater wells are supplied, are cased off and protected. The long casing string, 5-1/2 inch, was set at 2,809 feet, 1 foot above the Mt. Simon sandstone and in the basal portion of the Cambrian carbonate section. Examination of the casing cementing records reveals that this casing was cemented to the surface. Thus, all strata above the depth of 2,809 feet have been cased off, and the 'Big Lime' groundwater-bearing zones have a double protection of casing and cement sheaths."

The procedure that will be used to close abandoned injection wells involves the following steps:

1) the injection zone will be filled with "epseal" grout to a point approixmately 50 feet above the injection zone;
2) a 10 foot cavity will be created above the "epseal" grout by blasting;
3) the cavity and the next approximately 300 feet of the bore hole will be filled with a class A cement grout;
4) the next approximately 2000 feet of the bore hole will be filled with drilling mud to a point approximately 100 feet below the bottom of the Niagaran Lockport Dolomite ("Big Lime"). This will be about 750 feet below the surface;
5) a second cavity will be blasted above the mud plug;

6) the cavity and the next approximately 100 feet of the bore hole will be filled with a class A cement grout;

7) the remaining portion of the bore hole will be filled with drilling mud to within 25 feet of the surface; and

8) the last 25 feet of the bore hole will be filled with cement.

This is the procedure that was used to close injection well No. 1 in 1980.

At the present time there are six active injection wells, Nos. 1A, 2, 3, 4, 4 and 6, on the site. (See sheet 2.) The original test well (injection well No. 1) was officially abandoned in 1980. The dates of operation of the wells are shown in Table 2, Summary of Facility History.

Piping

The liquids contained on-site are piped through schedule 80 PVC. (See sheet 2 for locations.) The pipes from ponds 5 to 7, 7 to 11, and 11 to 12 are above-ground. The pipes from Pond 12 to the filter house, as well as the pipes from the filter house to injection wells 3 and 4, are underground. The pipes from the filter house to injection wells 1A, 2, 5, and 6 are above-ground. There is also an above-ground pipe from the railroad spur north of the oil storage area to Pond 5 for discharging waste from railroad cars to Pond 5. This particular pipe segment is presently inactive.

Chemical and Physical Treatment of Waste

Up until 1980 this facility disposed of cyanide and sulfide wates. These wastes were stabilized by oxidation with the application of hydrogen peroxide at a treatment facility formerly located between Pond 6 east and Pond 6 west in the middle of the site. (See sheet 2.) In

the same time period and at the same location a lime slurry was also used to stabilize wastes before they were discharged from the trucks into the ponds.

The facility presently disposes of organic and inorganic acids and caustics used for metal processing and cleaning. There are no forms of chemical treatment presently in use.

The liquid waste is filtered at the filter house north of Pond 11 prior to injection. Rapid sand filters used in the past have been replaced with a diatemaceous earth filtration system.

Oil Recovery Facility

The oil recovery facility on the eastern side of the site is used to recover No. 5 fuel oil for resale from used machinery oils, hydraulic oils, water soluble oils, motor oils, rolling mill stock oils, etc. Relatively clean used oils are transferred directly from the trucks to the oil storage tanks west of Pond 7. Oil is also skimmed from the ponds either periodically by three inch pumps, or in the case of Pond 5, continuously by a rope skimmer and transferred to the oil storage tanks. The oil in the storage tanks is periodically trucked to the on-site oil recovery facility for processing.

Sludge Farm

Oily sludges were incorporated into the clay for a biological degradation experiment in the sludge farm area north of ponds 11 and 12 in 1978. The project was not successful and was abandoned after two months. The clay and oily sludge were excavated and transferred to the waste ponds.

Site Access

Access to the site is presently by road from State Route 412 and

State Route 510. Wastes were also delivered to the site by railroad between 1975 and 1981. The rail line has since been abandoned. All wastes are presently delivered in tankers of various sizes. On-site access roads are gravel except for the paved entrance and parking areas near the laboratory building.

Laboratory Analyses

Chemical Waste Management has had on-site laboratory testing facilities since 1974. The laboratory is used for both waste analysis and ground and surface water quality monitoring. Incoming wastes are tested for compatibility and to ensure only licensed wastes are accepted. Groundwater samples are tested bi-weekly, and surface water samples are tested monthly for detection of contaminants escaping from the site. Results of the water quality testing program are submitted monthly to the Ohio EPA and the Sandusky County Health Department.

Groundwater Monitoring Wells

A groundwater monitoring program was begun by the Ohio EPA in 1972. This initial monitoring program made use of two on-site wells and two neighboring wells. These wells are presently identified as Chemical Waste Management monitoring wells number 4 (OEPA #1), 5 (OEPA #2), 8 (OEPA #3), and OEPA No. 5. Specific details of each well are given in Table 3 and their locations are shown on Sheet 2. In 1974 the monitoring well system was revised when Chemical Waste Management established an on-site testing laboratory. Also, Chemical Waste Management began monitoring wells number 4 (OEPA #1) and 5 (OEPA #5) and added OEPA #4. In 1975 the OEPA added OEPA #6 to the system.

TABLE 3

MONITOR WELL CONSTRUCTION SUMMARY

CWM No.	OEPA No.	Depth (feet)	Casing	Year Drilled	CWM Dates Sampled	Date Abandoned	ODNR Log Number	Mean Sea Level Elev. 1983 Survey TOC	TOC	Remarks
1	--	--	3" galvanized steel	1978	4/79 - 6/79	6/79 - Filled with cement	--	606.33	606.2	--
1N	--	200	6" PVC cased to 60'	1979	7/79 - present	--	554277	609.17	607.4	--
1A	--	18.5	6" PVC perforated	1979	6 Months	1980	--	609.95	608.4	--
2	--	150	4" galvanized steel	1976	2/76 - present Gap 12/80-6/81			Buried under drive		Used for washing trucks
3	--	--	3" galvanized steel	1976	6/76 - 9/76	6/79 - Filled with cement	--	605.76	604.8	--
3N	--	50	6" PVC cased to 48'	1979	7/79 - present	--	554276	606.75	605.3	--
3A	--	14'or18'?	4" PVC perforated	1976	4/76 - present Gap 1/82-3/82	--	--	606.37	604.7	--
4	1	55	6" galvanized steel	1972	CWM 8/74-6/79 OEPA '72-6/79	June, 1979	425054	609.43	608.2	Hand pump
4N	1	50	6" PVC cased to 48'	1979	CWM 7/79-present OEPA 7/79-present	--	554274	608.84	608.0	--
5	2	56'or51'?	4" galvanized steel cased to 50'	Unknown	CWM 7/74-present OEPA '72-present	--	--	Location Uncertain		Lab well
6	--	--	3" galvanized steel	1976	4/76 - 6/79	6/79 - Filled with cement	--	609.36	608.4	
6N	--	50	6" PVC cased to 46'	1979	7/79 - present	--	554273	610.65	608.5	--
6A	--	12'or18'?	4" PVC perforated	1976	4/76 - 1/81 Gap 12/76-2/77		--	608.67	608.67	Mower broke casing off 1982
7	--	55	6" PVC cased to 45.5'	1979	7/79 - present	--	554275	610.26	608.1	--
8	3	50	4" galvanized steel cased to 47'	1979	CWM 9/79-present OEPA '72-present	--	405085	612.88	611.8	Eckhart home empty since 1981

Table 3 continued -

--	4	54	4" galvanized steel cased to 44.5'	1957	OEPA '74-'80	--	199085	--	605±	Emery house
--	5	77	Galvanized steel	Unknown	OEPA '72-'74	1974, pump broke	--	--	605±	Hand pump
--	6	56	4 1/4" cased to 43.5'	1956	OEPA '75-'79	1979	182754	--	610±	Gertensberger home
11	--	60	6" PVC cased to 47.5'	1981	1/82-present	--	602224	609.79	608.4	--
12	--	65	6" PVC cased to 47'	1981	1/82-present	--	602225	608.38	606.1	--
13	--	60	6" PVC cased to 48'	1981	1/82-present	--	602222	605.27	603.7	--
Pump house well	--	75	6" PVC cased to 48'	1981	--	--	602223	606.43	604.7	Not a monitor well

LEGEND

CWM - Chemical Waste Management

OEPA - Ohio Environmental Protection Agency

TOC - Top of Casing

TOG - Top of Ground

Water Consumption For On-Site Wells

Pump house well - Approximate usage - 50 gal/month
Flow test rate - 10 gpm

Well No. 1N - Approximately 4000 to 5000 gal/month
Flow test rate - 10 gpm

Well No. 2 - Approximately 2000 to 20,000 gal/month
Flow test rate - 275 gpm

In 1976 the monitoring program underwent a major expansion when Chemical Waste Management added monitoring wells number 2, 3, 3A, 6 and 6A. Well No. 3, however, was monitored for only three months in 1976.

Another expansion occurred in 1978 when No. 3 was returned to the program as an active monitoring well and well No. 1 was added.

In 1979 another major revision occurred when it was decided to replace the steel-cased monitor wells with PVC-cased wells. Well numbered 1, 3, 4, and 6 were abandoned and replaced by 1N, 3N, 4N and 6N. A fifth well, number 7, was also drilled at this time. Conversations with the well driller who installed the new wells indicates that they were constructed in following manner:

Step 1: an approximately 8 inch diameter open hole was drilled to rock;

Step 2: a 6 inch PVC casing was installed in the hole by fusing 20-foot sections together, and

Step 3: the drill stem was then lowered through the PVC casing and the rock portion of the well was drilled through the PVC casing. The rock cuttings from the drilling operation were flushed to the surface through the inside of the PVC casing and allowed to gravity-settle into the annular space outside the PVC casing. No bentonite was used, nor were any screens installed.

A shallow monitoring well, 1A, was also installed but abandoned six months later. Chemical Waste Management also began monitoring well No. 8 (OEPA #3). The Ohio EPA discontinued monitoring OEPA #6 during this same year.

The most recent expansion of the program occurred in 1981 when three new monitoring wells (Nos. 11, 12 and 13), and supply well, were installed in the north expansion area.

At the present time Chemical Waste Management regularly monitors wells 1N, 2, 3N, 4N, 5, 6N, 7 and 8. The OEPA monitors 4N (OEPA #1), 5 (OEPA #2), and 8 (OEPA #3) on a sporadic basis.

Site Drainage

All surface water around the ponds and the processing facilities is contained by perimeter dikes as shown on sheet 9. Water ponds on the site in many areas. The runoff from the main site area drains to a storm water retention ditch south of the railroad where it is retained by a sluice gate. This retained water is discharged to the Charles E. Meyer ditch through a sluice gate once or twice a year after quality testing and approval by OEPA. Water retained by the containment dikes north of the railroad tracks around injection wells 5 and 6, is allowed to pond and evaporate.

Drainage outside of the perimeter diked area flows into Little Raccoon Creek via the roadside ditches along State Route 510, or into the Charles E. Meyer ditch. Surface runoff in the extreme northwest corner of the property enters Raccoon Creek via the roadside ditches for Interstate 80.

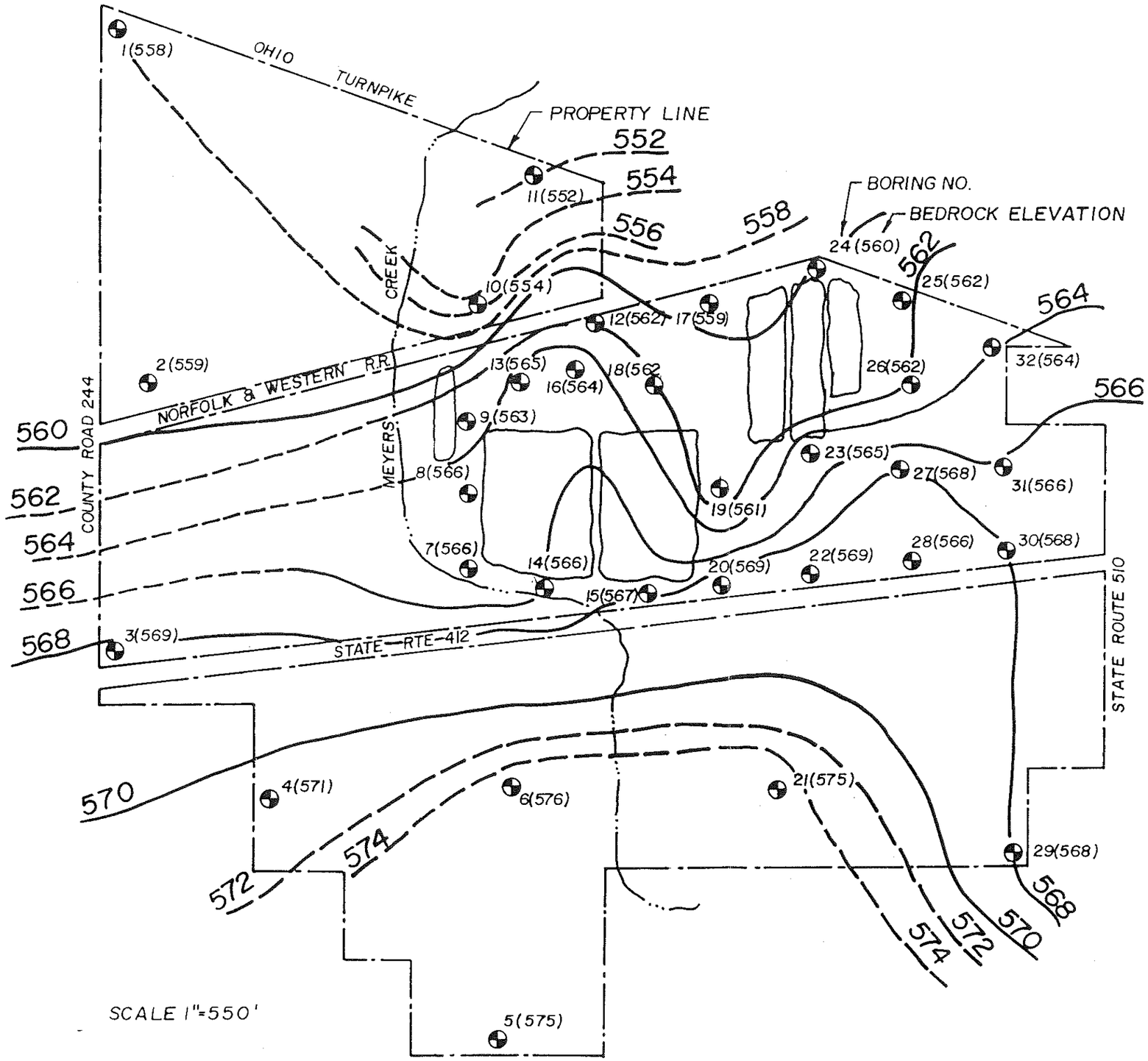
The Charles E. Meyer ditch was apparently relocated when ponds 11 and 12 were constructed. The original alignment appears to have been through part of the area that is now Pond 12. There is a sluice gate, which is normally open, located on the Charles E. Meyer ditch where it leaves the site at the northern boundary and crosses under the Ohio Turnpike. This gate can be shut, preventing water from leaving the site and entering Little Raccoon Creek.

Site Bedrock Geology

Bedrock at the site is composed of the Tymochtee dolomite. The Tymochtee is found from 40 to 50 feet below the surface at elevations ranging from 552 to 576 feet (see Figure 8). The boring information indicates that the bedrock topography is somewhat variable, although for the most part it is sloping gently towards the north. In the rock surface there is an apparent small valley or, perhaps more properly, a gully running approximately north/south through the center of the site. It has a maximum depth of about ten feet. Detailed rock core logs have been prepared and are included with the soil boring logs in Appendix A. Seven rock cores were taken ranging in length from 10 to 80 feet. In general, the Tymochtee here is a mixture of shale, dolomite, gypsum, and anhydrite. The variability of the rock type makes it difficult to correlate strata from one boring to the next, however, it appears that black shale appears below elevation 550 feet in all cores except No. 5. This black shale is interbedded with gypsum layers of varying thickness. The dolomite that is present is very shaley and also contains gypsum.

Gypsum occurs in all possible forms under this site. Its dehydrated form (anhydrite) is also present in some rock cores. The gypsum is found as crystals lining open voids, veins that both parallel and crosscut bedding as massive white or gray units, and as very small brown crystalline spheres. These brown spheres were found only in the deepest boring, No. 17, at or below elevation 510 feet.

Solutioning is evident in all of the cores, however, none of the borings encountered any large cavities or caverns. Most open voids are



SITE
BEDROCK TOPOGRAPHY

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FIG. 8

between one-quarter and one-half inch in maximum observable dimensions. These open voids are most common below elevation 560. In addition to open voids, bedding planes appeared to have offered easy avenues for solutioning, as zones containing much weathered shale but no gypsum were common. These weathered zones were on the order of one-half foot to one foot in thickness. It is apparent that groundwater is moving along fractures and joints within the rock. The groundwater flow has probably dissolved out much of the gypsum along these fractures and is continuing to do so.

Glacial Geology

The glacial geology of the Chemical Waste Management site is relatively simple. Only two types of deposits are found. These deposits were profiled on sheets 3-5. At the surface is a silty clay or clayey silt lacustrine deposit, approximately 10 to 20 feet thick. The lacustrine material is everywhere underlain by glacial till approximately 30 feet thick, which lies directly on top the bedrock. These two basic soil deposits, the lacustrine material and the glacial till, can be subdivided further.

The till unit actually consists of two separate tills; a thin (zero to 10 feet thick) lowermost unit consisting of material derived from the bedrock, and a thick clay-rich upper unit. The lower till contains considerable amounts of sand and gravel sized clasts, many of which are composed of soft weathered gypsum. This lowermost unit is not found everywhere across the site. It represents an early glaciation and apparently was partially eroded away by a subsequent glacial readvance.

The remaining upper till deposit consists of a silty clay with some sand and traces of gravel. The average sample consists of 42 percent

clay, 30 percent silt, 24 percent sand, and 4 percent gravel. Permeabilities are in the range of 1×10^{-8} and 1×10^{-9}. The material was derived from lacustrine silts and clays that had been deposited in a proglacial lake during a previous retreat of the glacial ice. The upper surface of this silty clay till was probably rather undulatory with a relief of probably five to 20 feet. The upper few feet of the till material, although texturally identical to the lower portion, appears to be slightly different structurally in that there is a suggestion of lacustrine lamination. This agrees with Forsyth's (1965) description of water modified till which she noted in several places in northern Ohio, sandwiched between a till and overlying lacustrine material. The water modified till consists of till material that was deposited into or through water and, therefore, can contain some of the characteristics of a lacustrine deposit. Transport distances, however, would be very short, as shown by the lack of sorting.

The lacustrine material overlying the till material can also be subdivided into two portions. The lower approximately five feet contains some fine sand and silt layers alternating with clay layers, however, even the fine sand and silt layers contain considerable amounts of clay. The thicknesses range from very thin up to one-half inch. A composite grain-size analysis of a sample from this unit has a composition of 3 percent sand, 55 percent silt, and 42 percent clay. The same sample also had a horizontal permeability of 8.6×10^{-8} cm./sec. Other samples from this unit may contain better sorted fine sand and silt layers and, therefore, would have higher permeabilities. Some of these layers are brown rather than gray, indicating oxidation has occurred sometime during the postdepositional history of the soil.

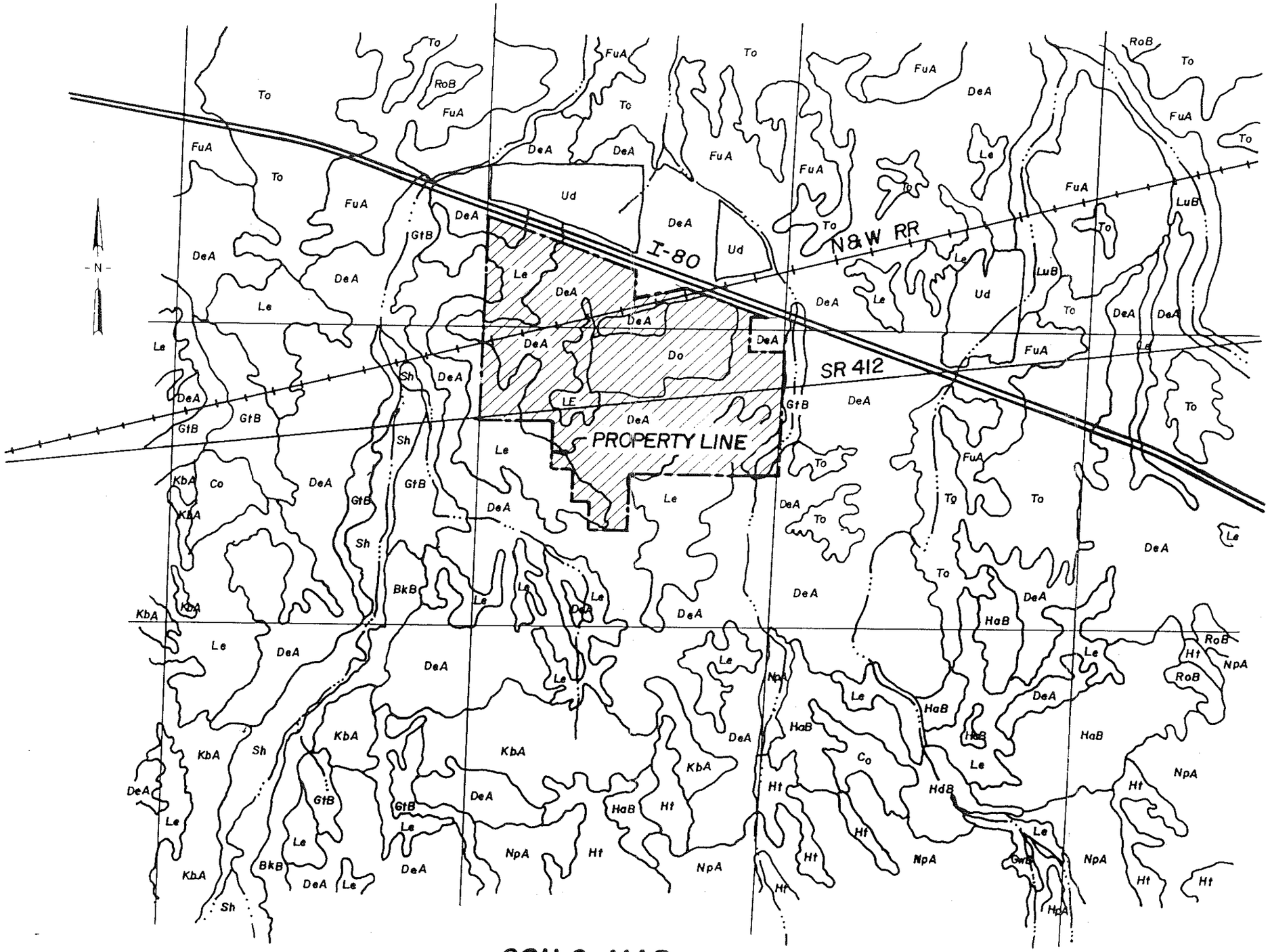
This lower stratified portion is not found everywhere across the site, however appears somewhat continuously over the active portion of the site where the lagoons are located. It most probably represents a time period shortly after de-glaciation when the proglacial lake was first formed in front of the ice. The varve-like lamina may be caused by seasonal fluctuations in sediment input from the nearby melting ice, or may represent periodic but not seasonal influxes.

The remaining upper lacustrine material consists of an average of 49 percent clay, 46 percent silt, and 5 percent sand. The percentages of any individual sample, however, can vary by as much as 15 percent from the average. A few samples even contain a few percent gravel. The material is very homogeneous with almost no indication of fine sand or silt layers present, although most samples are laminated along bedding planes.

Vertical permeabilities are on the order of 1×10^{-8} and 1×10^{-9} cm./sec. Horizontal permeabilities are expected to be similar because of the high clay content and the lack of well-sorted sand lamina. The single low horizontal permeability on material that is expected to have a higher permeability would also support this. The deposit was laid down in relatively quiet water some distance from the ice front. The small amounts of gravel present may have been rafted in on melting icebergs.

Surface Soils

The surface soils on the site consist of the Del Ray and Lenawee series (see Figure 9). Both soils formed in lacustrine deposits. The Lenawee series contains more clay than the Del Ray series, otherwise



SCALE: 1" = 1760'

SOILS MAP

SEE NEXT PAGE FOR LEGEND

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FIG. 9

Figure 9 (continued)

SOIL DESCRIPTION (USDA Unpublished)

BkB Bixler loamy fine sand 2 - 6% slopes

The Bixler series consists of deep, somewhat poorly drained two-story soils developed on outwash plains, beach ridges and deltas. Bixler soils formed in sandy and loamy material 20 to 35 inches thick over stratified lacustrine silty loan. Permeability is rapid in the sandy material and moderate in the lower part.

Co Colwood fine sandy loam

The Colwood series consists of deep, very poorly drained soils formed in stratified loamy and sandy material in areas of former lake beds. Permeability is moderate.

DeA Del Ray silt loam 0 - 2% slopes

The Del Ray series consists of deep, somewhat poorly drained soils on outwash plains and deltas in areas of former lake beds. Del Ray soils formed in silty clay loam and silty clay lacustrine material underlain by stratified silt loam and silty clay loam at a depth of 34 to 60 inches. Permeability is slow. The Del Ray series is distinguished from the Lenawee series by a lighter surface layer and a lesser amount of clay.

FuA Fulton silty clay loam 0 - 2% slopes

The Fulton series consists of deep somewhat poorly drained soils that formed in clayey lake-laid sediment on lake plains and deltas. Permeability is very slow.

GtB Glenford silt loam 2 - 6% slopes

The Glenford series consists of moderately well drained soils on lake plains, terraces, and outwash plains. Glenford soils formed in silt loam and silty clay loam lacustrine material. Permeability is moderately slow.

GwB Glynwood silt loam 2 - 6% slopes

The Glynwood series consists of moderately well drained soils on till areas of lake plains. Glynwood soils formed in silt and silty clay loams. In some areas the subsoil contains more sand and gravel and is better drained. Permeability is slow.

HaB Haskins silt loam

The Haskins series consists of deep, somewhat poorly drained two-story soils on outwash plains, terraces, and beach ridges. Haskins soils formed in loamy material 20 to 40 inches thick over fine-textured till or lacustrine material. Permeability is moderate in the loamy material and slow or very slow in the underlying material.

Ht Hoytville silty clay loam

The Hoytville series consists of deep, very poorly drained soils on till plains in areas of former lake beds. The upper portion of the soil has been modified by water action.

KbA Kibbe fine sandy loam 0 - 2% slopes

The Kibbe series consists of somewhat poorly drained soils that formed in lake-laid silt and fine sand. The soil becomes stratified at a depth of 40 to 60 inches. Permeability is moderate.

Le Lenawee silty clay loam

The Lenawee series consists of deep, very poorly drained soils on outwash plains and deltas. Lenawee soils formed in silty clay and silty clay loam material underlain by stratified silt loam and silty clay loam at a depth of 40 to 60 inches. Permeability is moderately slow. The Lenawee series is distinguished from the Del Ray series by a darker surface layer and a greater amount of clay.

LuB Lucas silty clay 2 - 6% slopes

The Lucas series consists of deep, well or moderately drained soils on lake plains. Lucas soils formed in silty clay and silty clay loam. Permeability is slow or very slow.

NpA Nappanee silt loam

The Nappanee series consists of deep, somewhat poorly drained soils on till plains in areas of former lake beds. Nappanee soils formed in calcareous glacial till whose upper part was modified by water action. Permeability is very slow.

Figure 9 (continued)

Sh Shoals silt loam, occasionally flooded

The Shoals series consists of deep, somewhat poorly drained soils that formed in loamy alluvium on flood plains. Permeability is moderate.

To Toledo silty clay 0 - 2% slopes

The Toledo series consists of deep, very poorly drained soils that formed in clayey lake-laid sediment on lake plains and deltas. Permeability is slow.

they are very similar. Both contain stratified silts and clays in their lower portions, as was shown by the borings.

Post Glacial History

The last of the great proglacial lakes that covered the Chemical Waste Management site area was Lake Lundy whose shorelines occur at approximate elevation 620 feet. The Lake Lundy shoreline is suggested by a strip of Kibbe and Haskins sand loams and silt loams, as shown on the soils map, approximately one-half mile south of the Chemical Waste Management site. A more marked set of shorelines, the various Warren beaches, occupy the ridge that passes through Clyde approximately four miles to the south. The Warren Beach here is actually a series of beaches, the oldest of which occur between elevation 680 and 690, and the youngest is at elevation 675 feet. These have been dated by Forsyth (1961) to approximately 10,000 years ago.

Subsequent to the melting of the glacial ice, the water level gradually receded to the present shoreline now occupied by modern Lake Erie. Postglacial developments included the development of dune deposits, the incising of the surface by postglacial streams, and the revegetation and reinhabitation of the area by flora and fauna. A collection of mammalian bones from a sand deposit in Washington Township, approximately 10 miles west of the Chemical Waste Management site, indicates that among the animals present after the retreat of the ice were peccaries (*Platygonus compressus*) and horses (*Equus* sp.). The sand dune in which the bones were found belonged to the Lake Warren shoreline, however the bones were dated at approximately 4290 $\pm$ 250 years. This probably indicates that the dunes were active for approximately 5000 years after their original formation.

Site Groundwater

The behavior of the aquifer was investigated from several different aspects including pump tests and readings of the static water level. The purpose of running a pump test at the site was to determine general aquifer characteristics. The well selected for the pump test was the pump house well located north of the railroad tracks. This well was 75 feet deep (approximately 25 feet into rock), and has a 6 inch PVC casing. Piezometer 10 was installed within 30 feet of the well for use as an observation well in the pump test. The piezometer penetrated the top 10 feet of the bedrock aquifer.

On December 9, 1982, a hydrogeologist and a technician from BOWSER-MORNER performed a pump test. Water levels were measured in both the pumping well and observation well using electric tapes. Static levels were measured prior to starting the pump. Subsequent measurements were recorded at gradually increasing time intervals. Discharge measurements were made periodically using a 55 gallon drum and timing the rate for filling the drum. The recorded data can be seen on the pump test data sheets in Appendix E.

The water within the bedrock dolomite aquifer is transmitted via secondary porosity avenues such as open joints and bedding planes. Typical aquifer analyses techniques, derived for unconsolidated deposits, were not applicable when applied to this data. Both the Theis and Jacobs Methods failed because the data did not respond in a general manner typical of intergranular porosity aquifers. The data, when plotted on log rhythmic scales, is bimodal.

Due to the complexity of the data obtained, a computer program was used for determining the transmissivity and storage coefficient of the upper portion of the bedrock. The program used was "Pumping Test Analyses

with a Hand-Held Calculator" by Frank A. Rayner. This program takes into consideration data plots where drawdown data will not plot as a straight line on semi-log paper.

The results of the pump test analysis utilizing the Rayner method give a value for transmissivity of $T = 2{,}838\ gpd/ft^2$ and a storage coefficient of 4.05×10^{-3}. A storage coefficient with a magnitude of the one determined in this study is typical of a confined aquifer such as is present under the site. The overlying glacial till is the confining strata.

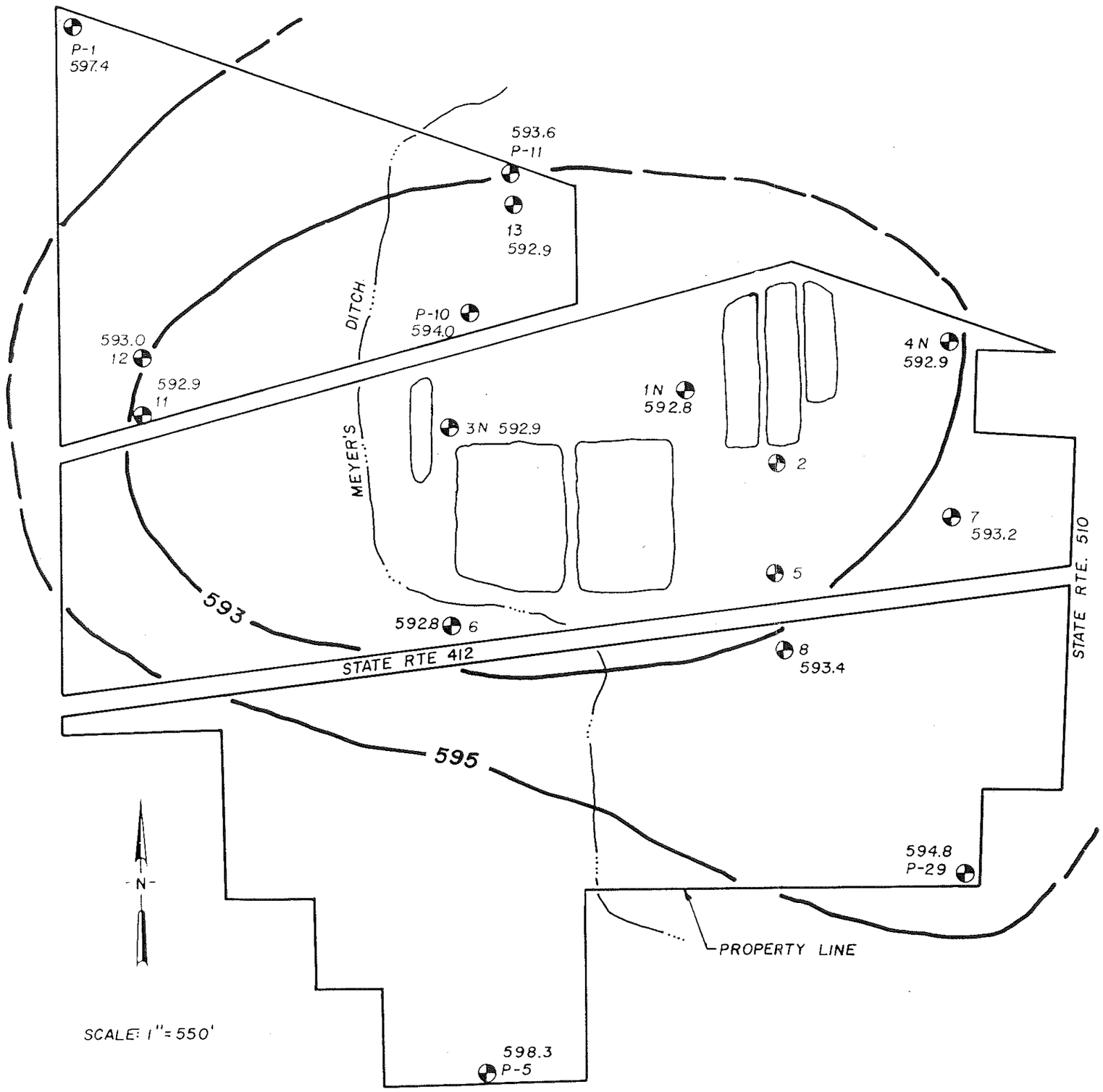
Given a transmissivity of $T = 2{,}838\ gpd/ft^2$, the permeability can be estimated. Although the aquifer was only partially penetrated by the pumping well, the test yielded data on the near-surface part of the unit, which is the most permeable portion of the upper 50 to 100 feet of this unit. Using a penetration of 25 feet, the permeability can be estimated using the equation:

$$\frac{T}{m} = K = 113.5\ gpd/ft^2$$

where $T = 2{,}838\ gpd/ft$

$m = 25$ feet

Analyses of available well information and static water level readings were used to determine the groundwater flow direction at the site. Static water level elevations were measured on February 3, 1983 in all the monitor wells and piezometers at the site. These values were used in contouring the static water level in the areas shown on Figure 10. The contour pumping map shows a cone of depression at the site centered around the most active pumping wells. Wells 1N and 2 are water supply



13 MONITORING WELL

P-1 PIEZOMETER

592.8 WATER LEVEL ELEVATION

SITE GROUND WATER CONTOUR MAP

WATER LEVEL READINGS TAKEN ON 2-3-83

JOB NO. 33767
DATE: 2-18-83

FIG. 10

wells using 6000 to 25,000 gallons per month. Their primary use is for cleaning trucks. Well 5 is the water supply well for the office building and may also contribute to drawdown. Groundwater flow in this local area then appears to be toward the pumping wells. The hydraulic gradient from piezometer 5 to Well 8 (maximum drop at the site) is 0.0014 ft/ft. Note that a similar drawdown pattern was observed in another set of water readings taken during this study.

The regional groundwater flow direction has been delineated by Hoover (1982) (see Figure 7). His computer map of the potentiometric surface for the carbonate aquifer indicates a regional flow direction in the site area slightly west of due north. A hydraulic gradient can be estimated from this map as 0.0016 ft/ft.

The measured hydraulic gradient was very similar so the maximum gradient of 0.0016 ft/ft and was used in calculating the flow rate. The flow rate was calculated using Darcy's Law which states:

$$Q = KAi$$

where Q = flow rate,

A = cross-sectional area of the porous medium

i = hydraulic gradient

K = coefficient of permeability.

All flow across the site was assumed to be through the carbonate aquifer. For the cross-sectional area A we used a width of 2,800 feet across the site by 25 feet thickness of the uppermost porous part of the aquifer most likely affected by surface events, to get A = 70,000 $ft.^2$. The hydraulic gradient has previously been discussed and the value used was i = 0.0016 ft/ft. The coefficient of permeability has been estimated

previously to be K = 113.5 gpd/ft^2. Placing these values in the equation for flow rate we get:

$$Q = 113.5 \times 70{,}000 \times 0.0016 = 12{,}700 \text{ gpd}$$

Using a variation of Darcy's Law to determine the flow velocity we find:

$$v = Ki$$

where $K = 5.0 \times 10^{-4}$ cm/sec

$v = 8.0 \times 10^{-7}$ cm/sec

or 25.2 cm/year (approximately 10 inches/year).

The calculated flow velocity compares favorably with the previously referenced estimate of less than 12 inches per year made by Schaefer and Walton (1956).

Based on calculations of flow rate and velocity, it can be seen that lateral water movement in the site area is fairly slow. The apparent cone of depression in the water level which exists at the site indicates that most of the water in the upper part of the carbonate aquifer will remain within the site area and flow toward the pumping wells.

The pumping test documented above was only intended to be a superficial examination of the aquifer characteristics. The data, however, seems to fit with regional studies. Definition of the onsite groundwater levels are based on two sets (only one reported above) of water level data taken on each monitoring well within a few hours time. Even though both sets of data indicate a cone of depression, the effect may be temporary. Additional studies are needed to better define the aquifer characteristics and flow directions.

SECTION IV

DATA ANALYSIS

SECTION IV

DATA ANALYSIS

Analysis of Surface Water Quality Data

Chemical Waste Management has surface water quality data beginning in 1975 and continuing to the present. Monitoring points have been established on Raccoon and Little Raccoon creeks (both upstream and downstream), as well as the Charles E. Meyer ditch. The monitoring points are shown on Figure 11. These points are sampled monthly and tested for pH, suspended solids (SS), total solids (TS), COD, oil and gas, phenols, chlorides, sulfates, iron, chrome, zinc nickel, cadmium, and conductivity. In addition, the pond water contained in the borrow pit on the west side of the site is sampled periodically.

The information was inspected to determine if there were significant increases in indicator chemical parameters over the period of the monitoring record, to detect any seasonal variations, and to evaluate relative changes in concentrations of indicator chemicals between monitoring points in order to determine if the water quality had been affected by the site.

A regression analysis of chlorides data since 1975 at sampling points on Raccoon and Little Raccoon creeks indicated that the chlorides concentrations were always below 100 mg/l and showed virtually no significant variation in concentration trend over the period of record.

Analysis of Groundwater Quality Data

Introduction

Groundwater data from analysis by Chemical Waste Management dates back to 1974, however, not all of the present monitoring wells were

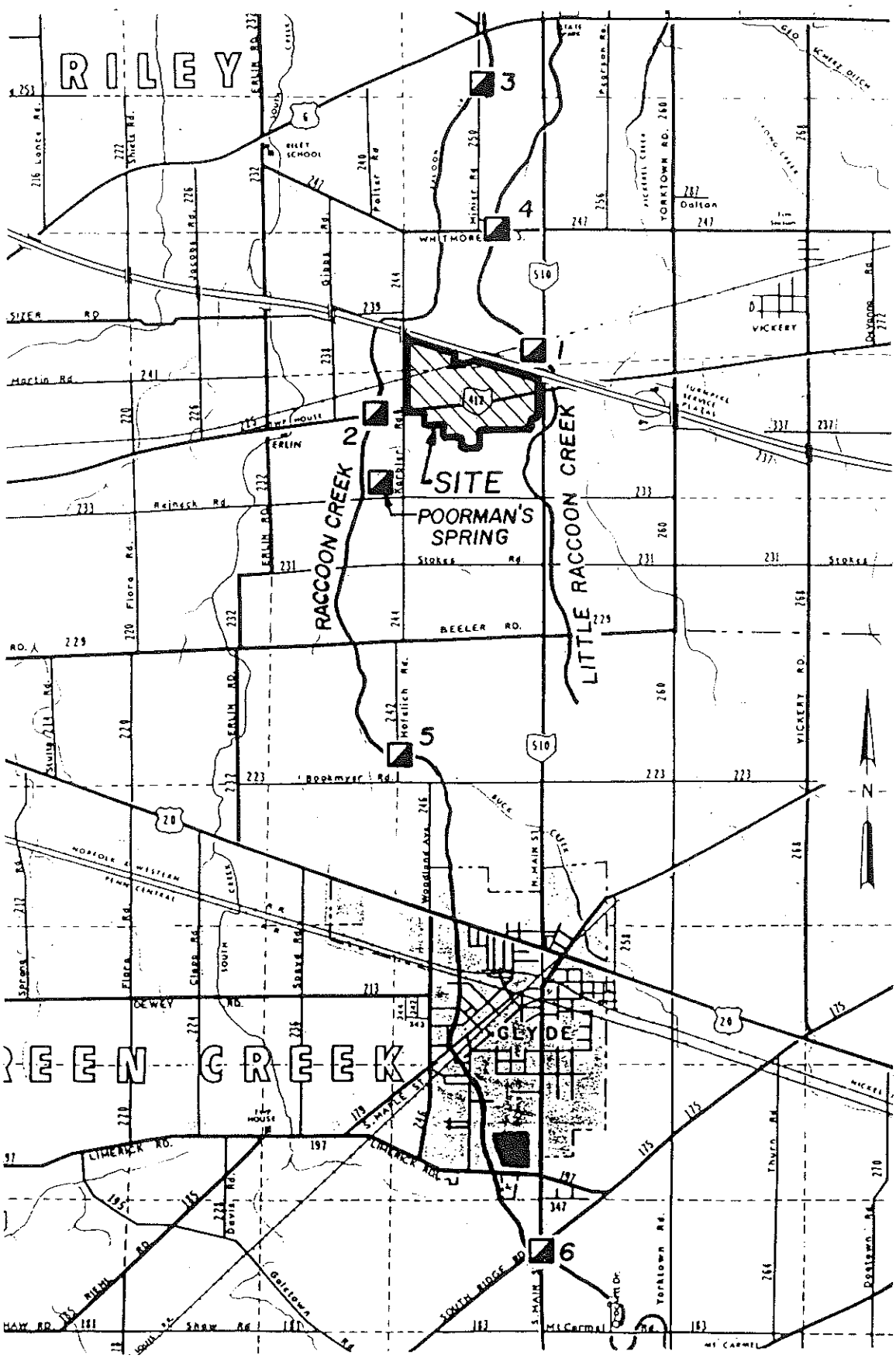


FIG. 11

SURFACE WATER MONITORING POINTS

JOB NO. 33767 DATE: 2-15-83 SCALE: 1" = 1.1 MI. (APPROX.)

BOWSER-MORNER, INC.

installed at that date. For example, the most recently installed wells have only one year of record. The data available was analyzed statistically to determine if 1) there have been significant increases in indicator chemical parameters over the period of the monitoring record, 2) to detect any seasonal variations, and 3) to evaluate relative changes in concentrations of indicator chemicals between monitoring wells in order to determine if the subsurface aquifer has been affected by this site.

The monitoring wells which were used in the statistical analysis are 1N, 2, 3N, 4N, 5, 6N, 7, 12, and 13. These wells were selected either because of the length of monitoring record available or because they are the newer wells (denoted by the "N") which replaced older wells and are believed to have more representative data. A regression analysis was done for indicator parameters in those wells that had at least four years of consistently collected data, in order to see if there were any significant trends. It should be noted that the period of record used for the regression analysis was still quite short (approximately one to four years), except in the case of wells 2 and 5 (approximately six to eight years).

The data available for all wells was entered into the IBM statistical computer model. Means, standard deviations and variances were determined for each chemical parameter for the total period for each year of record, and seasonally for each year of complete record (the seasons selected were January through March, April through June, July through September, and October through December).

Selection of Chemical Indicators

A number of chemical indicators were analyzed during the period of monitoring at the Chemical Waste Management site, but not all were suitable for use in the statistical analysis. Some indicators, particularly the metals, were recorded in terms of "less than" some value, apparently because of a restriction in the capability of the laboratory equipment to measure lower concentrations. Other parameters, such as solids and chemical oxygen demand, are more suited to evaluation of surface waters and in the case of total or suspended solids in particular, changes in those values would not normally be expected to be caused by the waste disposal ponds unless other chemical indicator values were also quite high and total failure of the pond and overburden system had occurred.

For these reasons, the following indicators were selected for use in the statistical analysis: pH, phenols, sulfates, chlorides, zinc, and chrome. The pH was of questionable use as an indicator because of the high buffering capacity of the underlying rock strata but was evaluated nevertheless because of the extremely low pH levels present in the disposal ponds. Chrome and zinc were selected since there were a number of groundwater data readings reporting true concentrations rather than something that was "less than" a limiting concentration, although this was not always true in the case of chrome.

Phenols were selected because there are high quantities of phenols present in the settling ponds. The use of phenols as an indicator of well contamination from the settling ponds is somewhat questionable, however, because of the short period of record available. Additionally,

some of the chemical analysis data on phenol contains unreconcilable discrepancies which made this data unusable for parts of the analysis.

Sulfates and chlorides were selected because of the long period of record available from the well monitoring data and because there is also a long period of record for these two parameters available from background information on the groundwater. Furthermore, chlorides are considered to be perhaps the best indicator of any pollution problems at any site. Although not necessarily objectionable by themselves, chlorides are a highly mobile ion, even in fairly impermeable materials, and since they are present in very high concentrations in the disposal ponds, they may provide an indication of whether or not there is movement of chemical constituents from the ponds into the surrounding substrata.

Description of Statistical Analyses

The annual means and standard deviations were computed for each well and parameter. Detailed computer printout sheets of the full statistical analysis performed are attached as Appendix F. A summary of annual means and standard deviations for 1979 and 1982 for the selected indicator parameters is shown in Table 4. These are the earliest and most recent years during which there was monitoring of all parameters in all wells.

Linear regression analysis was used to analyze the selected parameters. The annual means for each year of record were used. The results of this analysis is shown in Table 5. The correlation coefficients are given as well as the slope of the regression line. The closer the correlation coefficient is to $\pm$ 1.0, the more distinct the trend exhibited by the data. A low correlation coefficient, generally less than 0.5, usually

TABLE 4

SUMMARY OF MEANS & STANDARD DEVIATIONS (mg/l)

Well No.	CHLORIDES 1979 $\bar{x}$	CHLORIDES 1979 σ^2	CHLORIDES 1982 $\bar{x}$	CHLORIDES 1982 σ^2	SULFATES 1979 $\bar{x}$	SULFATES 1979 σ^2	SULFATES 1982 $\bar{x}$	SULFATES 1982 σ^2	ZINC 1979 $\bar{x}$	ZINC 1979 σ	ZINC 1982 $\bar{x}$	ZINC 1982 σ^2
1N	561	184	1540	581	1735	344	1670	380	0.0118	0.0187	0.0542	0.0607
2	226	69	353	254	1847	59	1869	116	0.0234	0.0446	0.1302	0.1742
3N	571	531	435	245	1687	231	1520	20	0.0138	0.0322	0.0211	0.0145
4N	467	182	63	84	489	202	1916	102	0.0075	0.0072	0.0381	0.0574
5	55	33	43	6	1774	95	1809	64	0.0863	0.2882	0.0974	0.1155
6N	1180	148	1431	169	1807	74	1823	54	0.0088	0.0086	0.0245	0.0103
7	209	80	93	124	1835	84	1792	54	0.0045	0.0022	0.0197	0.0080

Well No.	CHROMIUM 1979 $\bar{x}$	CHROMIUM 1979 σ^2	CHROMIUM 1982 $\bar{x}$	CHROMIUM 1982 σ^2	Ph 1979 $\bar{x}$	Ph 1979 σ^2	Ph 1982 $\bar{x}$	Ph 1982 σ^2
1N	0.0300	-0-	0.0267	0.0082	7.26	0.3344	7.19	0.3232
2	0.0304	0.0028	0.0212	0.0034	7.29	0.2470	7.31	0.0857
3N	0.0018	0.0018	0.0212	0.0033	7.11	0.2093	7.14	0.13110
4N	0.0300	-0-	0.0216	0.0051	6.96	0.2451	7.31	0.1335
5	0.0300	-0-	0.0219	0.0066	7.23	0.2142	7.23	0.0990
6N	0.0300	-0-	0.0241	0.0071	7.48	0.3452	7.30	0.1641
7	0.0300	-0-	0.0212	0.0034	7.28	0.2575	7.30	0.0692

$\bar{x}$ = Mean

σ^2 = Standard Deviation

TABLE 5

SUMMARY OF REGRESSION ANALYSIS

CHEMICAL PARAMETERS

Well No.	pH *		CHLORIDES		SULFATES		ZINC		CHROMIUM	
	m	r	m	r	m	r	m	r	m	r
2	-0.003	-0.07	30.5	0.81	-0.14	-0.03	-0.12	-0.70	-0.003	-0.80
5	-0.006	-0.23	-0.65	-0.19	3.96	0.25	-0.03	-0.84	-0.002	-0.74
1N	-0.025	-0.71	377	0.92	-25	-0.71	0.01	0.67	-0.001	-0.90
3N	0.012	0.47	-23.7	-0.15	-48	-0.64	0.0035	0.71	-0.003	-0.93
4N	0.116	0.68	-134	-0.73	475	0.90	0.012	0.93	-0.003	-0.92
6N	-0.051	-0.59	93	0.93	4	0.48	0.0056	0.87	-0.002	-0.92
7	0.009	0.77	-37	-0.77	-14	-0.57	0.005	0.97	-0.003	-0.88

m = slope of regression line in mg/liter/year of record

r = correlation coefficient

* Not mg/l

means that there is little trend evident from the available data. This can mean either that there is no significant change through time or that the data is so widely scattered, or over so short a period of record, that any possible trends are not evident. A low correlation coefficient may be the result of the number of significant figures supplied to the computer. A good case inpoint is the pH data. If the pH data is rounded to only one decimal place, the correlation coefficient will tend to converge on 1.0. The analysis, however, was run with three decimal places and a poor correlation was obtained. Note the very small slope of most of the correlations.

In addition to the straight-forward statistical analysis mentioned above, the data was also inspected for other significant features. It was noted that sodium and chlorides during 1982 showed a significant correlation when plotted together. Sodium was only recently added to the parameter list and therefore could not be compared further back in time. The values for both sodium and chlorides in well 1N changed at the same time and in the same proportions throughout the 1982 period of record. Furthermore, the proportion between Na^+ and Cl^- was close enough to that of sodium chloride (salt) to raise some questions about the source of high chloride concentrations which exist in most wells. Because of this apparent connection between these ions, which are normally associated with one another in nature, similar plots were made of sodium and chloride concentrations in the other wells. The correlation between the two ions did appear to be present in the other wells although in varying degrees. Complete plots of the chloride levels in all wells for the period of record are shown on sheets 6 through 8. The sodium

versus chloride plots are not included. Further study of this relation is indicated, however.

The seasonal values developed for the grouped data did not detect seasonal variations. The static water level data for well No. 7 was plotted against time and did, however, exhibit cyclic seasonal variations, generally rising to a peak in February and March and falling during drier periods (August and September). The plot of chloride concentrations in well No. 7 for the same period (1979-1981) showed occasional isolated peaks but no correlation with a seasonal cycle.

Results of Statistical Analysis

For the selected parameters, analysis has been performed as indicated above. The results are reported below in terms of changes in concentrations of constituents within a given well over time. Also, absolute values of parameters for the wells are compared to background water quality values.

a. pH

The pH levels were found to remain fairly constant in any given well and were at all times in the generally neutral range without any undue low readings or unusually high values. The lowest annual mean was 6.8 and the highest about 8. This is to be expected because of the high buffering capacity provided by the dolomite in the rock. Most of the means are well within the background pH levels of the historical data. As indicated previously, the regression analysis showed poor correlation, however, the slope (m) was very small. The data suggests no effects as related to the site.

b. Sulfates

Sulfates showed little significant change over time in any particular

well except for well 4N, and although there were some trends, there was no definite pattern. All the on-site sulfate means are within or very close to the range of the background sulfate levels. In general, sulfate concentrations at any given time increase slightly to the northwest, parallel to the regional groundwater flow. This same downgradient increase was observed in 1954 by Schaefer and Walton in their report to the Ohio Turnpike Commission and is a function of the bedrock mineralogy and time. There is no indication that any additional sulfate concentrations are reaching the wells.

c. Zinc

Zinc showed definite trends and a reasonably high correlation factor in all of the wells tested. The slope of the regression line, however, was generally very low. Further investigation showed that the wells with the highest zinc values either had galvanized steel casing (wells 2, 5, and 8), or are adjacent to an abandoned steel casing (wells 1N and 3N). Wells with lower values have PVC casings. Wells 5 and 2 showed steadily decreasing values of zinc. All the remainder of the wells showed gradually increasing concentrations of zinc, although in all cases the concentrations were extremely low. This could mean that the natural deterioration of the steel well casings is a contributing factor to the zinc levels. The only background information available on zinc is from Poorman's Spring. The two samples taken show zinc levels of 0.008 and less than 0.003 mg/l. Similar analysis would be true for iron.

d. Chrome

Chrome showed a fairly significant correlation factor in all wells and a consistent decrease of concentration with time, although the

chrome concentrations at all times were extremely low. It should be noted that significant amounts of the chrome values which have been reported during the monitoring period were reported in terms of "less than" some limiting value which probably makes the chrome data suspect, and the values shown in the statistical analysis may actually be higher values than are actually present in the field, even though they are still quite low. Background information from Poorman's Spring indicates that the natural levels present are less than 0.03 mg/l. The chrome at the concentrations shown could be present in the background.

e. Phenols

Phenols showed no definite trends, either increasing or decreasing, across the entire range of wells. The usefulness of the phenol data is limited by the fact that only recently have phenols been monitored regularly and that most values were also reported in terms of "less than" limitations, usually 0.10 mg/l, particularly in 1982. Actual values may be much lower.

f. Chlorides

The changes and trends in the chloride levels are significant and complex. With the exception of well 6N, all wells indicated a lower level of chlorides than well 1N and a higher level of chlorides than well 5. In general, the wells to the southeast of the site (numbers 5, 7, and 8) have lower concentrations of chlorides and the concentration of chlorides increases to the northwest (direction of regional groundwater flow). The individual records for each well indicate through time that the chloride levels in some wells have remained steady, some have dropped, and some have risen. Sheets 6 through 8 presents plots of the chloride levels vs. time and show the complex variation in the chloride levels.

Existing data seems to clearly indicate background chloride levels well below levels measured in on-site wells. Wells 1N, 2, 3(3N), 4N, 6(6N), 11, 12, and 13 show elevated chloride levels with some data dating back to at least 1976. The chloride levels in wells 1N, 3N, 4N, and 6N seem to have significantly changed (generally increased) in 1979. Since 1979, well No. 1N has shown an immediate drop in concentration and has then increased to near maximum levels. Chloride levels in well 3N also initially dropped and have since increased, but not to previous maximum levels. The level in well 4N has decreased and returned to pre-1979 levels which were approximately equivalent to background levels. Levels in well 6N have remained high and seem to be steadily increasing. Wells 11, 12, and 13 seem to be holding at steady chloride levels, however, there is only one year of record available. Generally wells further downgradient from the center of the site show lower elevated chloride levels than those wells close to the center. Well 7 is an apparent upstream well, however, has had high chloride levels in the past and currently appears to have slightly elevated levels (70 to 100 mg/l). All wells seem to have at least one or more spiked readings above background levels.

General Conclusions

The short period of record, different well installation methods, and the precision of the equipment used to measure the chemical concentrations, all must be taken into consideration when comparing the on-site data with the background water quality data. The only parameter that exhibits trends with large deviations from the background levels is chloride. Because the purpose of this study was to develop trends in

the data, no further analysis of the existing data was performed. Carefully monitored additional purging, sampling, and testing of the groundwater is indicated.

SECTION V

SITE ASSESSMENT

SECTION V

SITE ASSESSMENT

This study has provided detailed site and regional data from which an assessment of the acceptability of the current site operations can be made. The soil boring data has revealed that the overlying soil profile at the site is 40 to 50 feet thick and is composed almost entirely of uniformly clay-rich deposits with permeabilities on the order of 10^{-8} to 10^{-9} cm./sec. The bedrock under the site which is the only known aquifer is highly fractured and contains large amounts of gypsum. As a consequence of the soluable material present in this rock, the natural groundwater is very highly mineralized and is naturally of low quality. Furthermore, the flow rate of the water through the rock is relatively slow, on the order of less than one foot per year. Because the clay-rich soils should prevent migration of waste constituents into the groundwater, and because the existing groundwater is already of low quality, thereby lessening the potential effect of a possible spill, it appears that the site represents a relatively good geological location for management of hazardous wastes. Furthermore, the site is generally far removed from dense population centers, further limiting possible negative effects.

The high levels of chlorides in the groundwater under the site indicate that some groundwater quality change is occurring across the site. However, parameters other than chloride do not provide any indication of groundwater quality degradation. In fact, all parameters tested are below the federal drinking water standards, except for coliform levels. High chloride levels are found near the center of the site, with intermediate chloride levels downgradient of the site. The waste liquids at the site

are high in chlorides content and, therefore, it may be logical to conclude that the changing chloride levels in the groundwater are the result of liquids escaping from the site. This study, however, has not identified any natural mechanism through which such escape of liquids could be occurring.

Natural sources for the chloride have been considered. The Tymochtee dolomite, although an evaporative deposit, is not known to contain salt deposits. Furthermore, based on existing knowledge of the location of high chloride brine, and because of the apparent careful construction of the injection wells, it does not seem likely that the chloride level is the result of contamination from deep salty brines. Surface sources for the chlorides also have been considered. For example, road salt utilized on the turnpike and local roads could be adding to the chloride level in the groundwater. Apparently, sodium chloride has also been used on-site as a dust suppressant. Chloride contamination could also be the result of normal drilling and reworking of the deep wells. (In order to prevent escape of waste fluids which have been injected, salt brine is used to "kill" the well prior to reworking. Reworking of the deep wells can occur several times per year. Salt and acid brine is spilled onto the ground surface during this process.)

By carefully researching the construction records relative to monitoring well installation on the site, it has been determined that the existing monitoring well system may be providing a conduit through which high chloride runoff, such as road salt, may be entering the local groundwater. Information on the construction of the monitoring wells indicates that the monitoring wells may not have been adequately sealed,

leaving a permeable annular space around the outside of the casing. Indeed, some of the groundwater monitoring records would indicate that high chloride levels appeared immediately after installing new monitoring wells in 1979 in an area where chloride levels had historically been low.

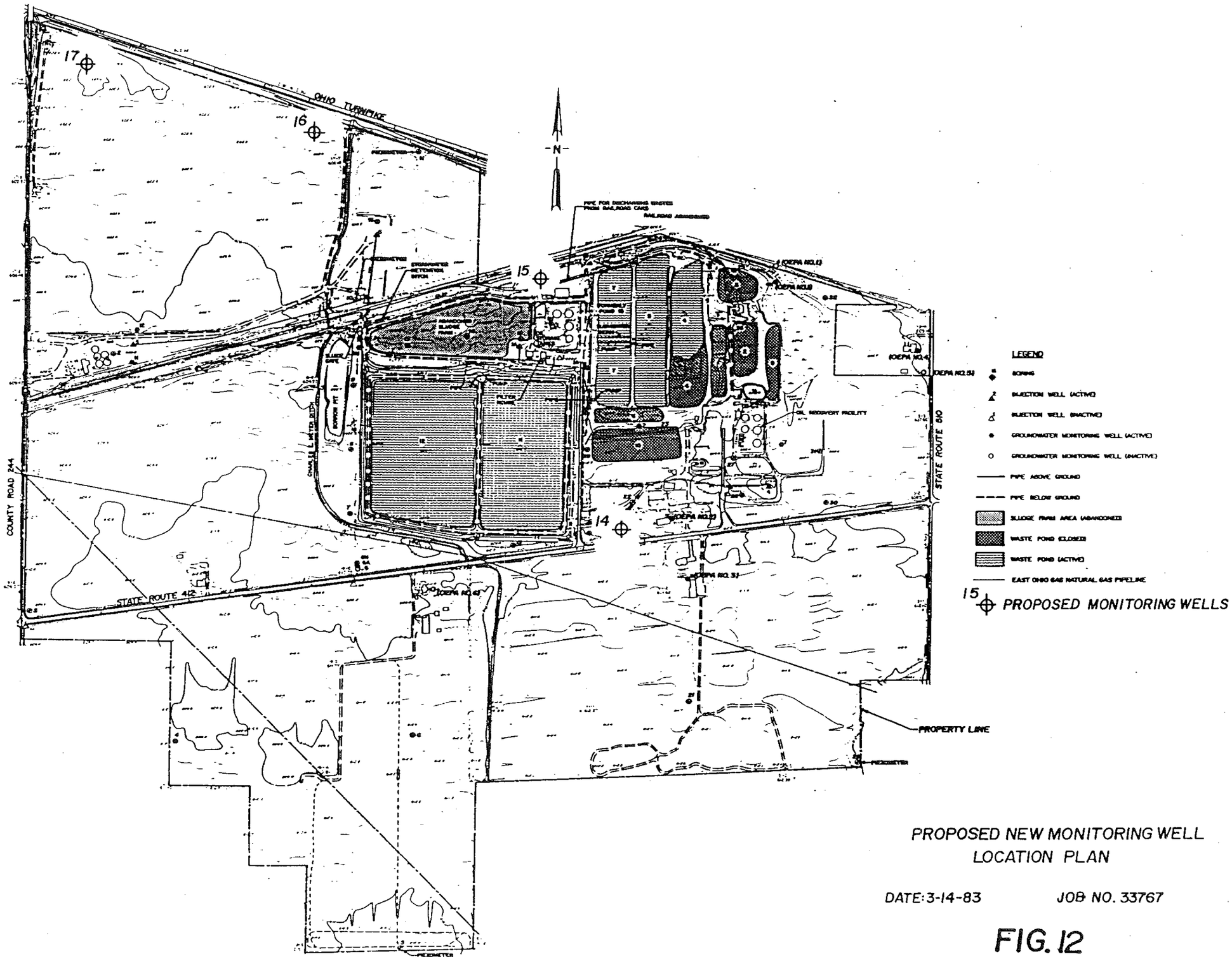
Another possible source for chloride migration is through soils affected by the storage of the liquids in open lagoons. The liquids stored at the site are high in chlorides and heavy metals, and also are highly acidic. The on-site natural soils tend to contain carbonaceous materials which could, theoretically, be attacked by the highly acidic liquids. In fact, there is some evidence to suggest that the stored liquid does react with the natural soil. This reaction, however, appears to be definitely limited. Boring No. 26 penetrated an abandoned closed waste pond. A 6- to 9-foot thick zone beneath the bottom of this lagoon was found to be leached of carbonate material. Neither this boring nor any other boring appeared to show any such affects beyond the indicated limited zone. This data plus the permeability data would suggest that liquids are not escaping the lagoon system.

The study has shown that the site is hydrogeologically suited for management of hazardous wastes by methods which use landfarming, landfilling, and lagoon systems. The area is underlain by naturally impermeable soil which should prevent the migration of waste constituents into the underlying aquifer. In addition, the existing groundwater quality is poor and moves across the site at a very slow rate. Finally, the normal operational pumping at the site has apparently developed a cone of depression which should further limit movement of the site

groundwater. The combination of all these factors minimizes the possibility of negative impacts on the groundwater.

The study has identified an apparent problem with the existing monitoring well system. In order to better define the nature of this problem and to correct the situation, additional work must be performed at the site. It is recommended that four new monitoring wells be established at the site at the locations shown on Figure 12. These wells should have minimum 4 inch inside diameter casings and be equipped with permanent submersible pumps. These wells should be immediately monitored for chloride levels and new RCRA quarterly monitoring established. In order to assess the condition of the existing wells, each should be checked with Fluorescein dye to determine the integrity of the casing and the well seal. Should the seals prove to be improper, the wells will need to be properly sealed and/or abandoned.

Groundwater quality analysis from the new wells should confirm the results of this study. In general, the proposed downstream wells are removed from the areas where previous well installations may have contaminated the groundwater. Wells numbered 16 and 17 have been located to show that high chloride levels present in wells 11, 12, and 13 are not migrating downstream. Furthermore, their location will indicate the extent of the contamination if, for some reason, migration has taken place. Wells numbered 15, 16, and 17 will be downstream monitoring wells and well No. 14 will be the upstream monitoring well (for natural water gradient conditions). Considering the pumping being done at the site, all four new wells may be upstream of the waste management facilities.



PROPOSED NEW MONITORING WELL
LOCATION PLAN

DATE: 3-14-83 JOB NO. 33767

FIG. 12

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APPENDIX A

FIELD AND LABORATORY TEST DATA

LOG OF BORING NO. 1

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-13-82

SURFACE ELEVATION: 602' **DATE COMPLETED:** 10-14-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
0.5'	Hard brown silt and clay, some sand, trace of organic, damp	1A	1.0- 2.5	15-16-17	33
5'		1C	4.0- 6.0		24"
6.0'	Very stiff brown and gray silt, some clay, traces of sand and gravel; moist	2A	6.0- 7.5	7- 8-15	23
8.5'	Stiff gray silt and clay, trace of sand, moist	3A	9.0-10.5	3- 6- 5	11
10'		2C	12.0-14.0		18"
	(Becomes soft with 3" wet brown silt and sand layer at 14.0')	4A	14.0-15.5	2- 2- 2	4
15'					
20'		5A	19.0-20.5	2- 2- 2	4
	(Becomes medium stiff at 24.0')	6A	24.0-25.5	2- 3- 3	6
25.0'	Stiff gray clay, some silt, traces of sand and gravel, damp				
30'		7A	29.0-30.5	3- 5- 6	11

METHOD: Hollow Auger

TECHNICIAN: TA and RF

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: 43.0' (heavy)

COMPLETION DEPTH: 39.0'

DEPTH AFTER: 24 HRS: 7.3'

TYPE SAMPLER:

X A. SPLIT SPOON

X B. NX wire

X C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

2B15

LOG OF BORING NO. 1 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-13-82

SURFACE ELEVATION: 602' **DATE COMPLETED:** 10-14-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'		3C	34.0-36.0		24"
36.0'	Hard gray silt, some clay, some sand, trace of gravel, moist	8A	36.0-37.5	6-18-29	47
40'		9A	39.0-40.5	66-34/2"	100+
44.0'		10A	44.0	100/0"	100+
45'	Hard gray shaley dolomite				
		1B	44.0-49.0		55"
50'					
		2B	49.0-59.0		90"
55'					
60'					

METHOD: Hollow Auger

TECHNICIAN: TA and RF

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: 43.0' (heavy)

COMPLETION DEPTH: 39.0'

DEPTH AFTER: 24 HRS. 7.3'

TYPE SAMPLER:

X A. SPLIT SPOON

X B. NX wire

X C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

2B15

LOG OF BORING NO. 1 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-13-82

SURFACE ELEVATION: 602' **DATE COMPLETED:** 10-14-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
60'		3B	59.0-64.0		56"
	Bottom of boring at 64.0'				

METHOD:	Hollow Auger	**WATER OBSERVATIONS**	**TYPE SAMPLER:**	
TECHNICIAN:	TA and RF	INITIAL DEPTH: 43.0' (heavy)	X	A. SPLIT SPOON
		COMPLETION DEPTH: 39.0'	X	B. NX wire
JOB NO.:	33767 (jl)	DEPTH AFTER: 24 HRS. 7.3'	X	C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

2B15

ROCK CORE LOG

Job No. 33767

Boring No. 1

Date Logged 11-1-82

Core Top Elevation 558'

Observer JKK

Core Recovery 201"

Surface Elevation 602'

Age(s)/Formation(s) Silurian/Tymochtee member of Bass Islands Formation

TOTAL Rock Quality Designation (RQD) 44%

TOTAL Fracture Frequency (FF) 5+ per foot

Depth(ft)	Description	Sample	Recovery
44.0	Hard gray and white shale with gypsum, occasional voids with crystalline gypsum, occasional clastic zone.	1B RQD =	55" 32%
48.5	Hard gray and black shale, occasional voids lined with gypsum crystals.		
49.0		2B RQD = FF =	90" 46% 5/ft.
52.1	Hard gray and white shale with gypsum, occasional voids.		
59.0		3B RQD =	56" 53%
64.0	Bottom of boring.	FF =	5/ft.

BOWSER-MORNER
Testing Laboratories, Inc.

LOG OF WELL NO. 1

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan.
DATE INSTALLED: 10-14-82

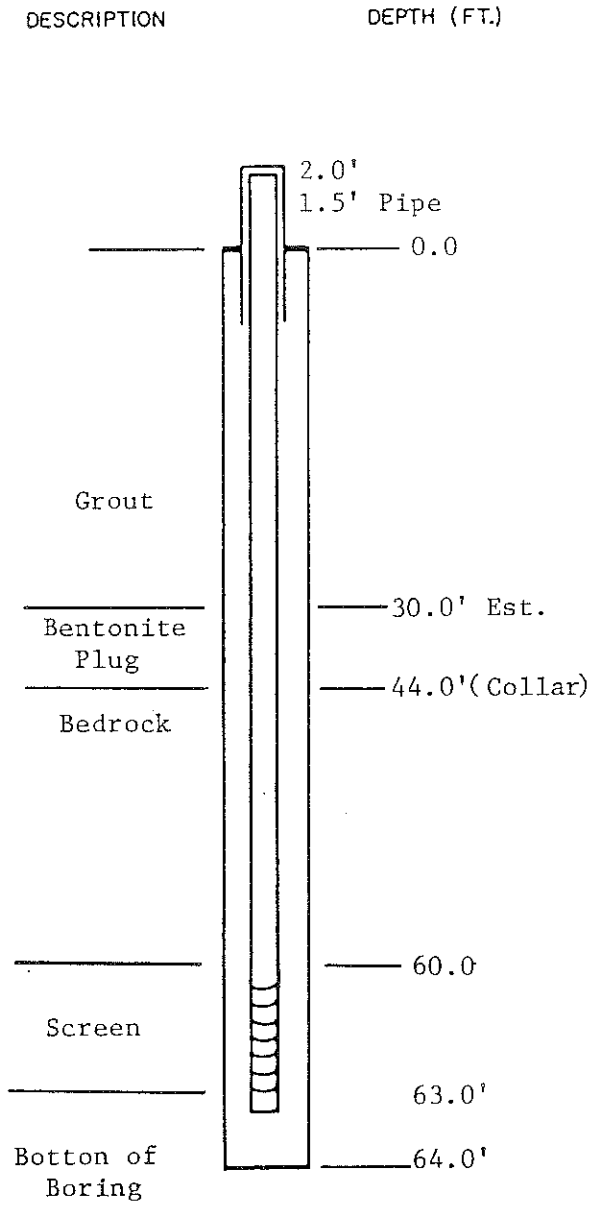
SURFACE ELEVATION: 601.3'
TOP OF PIPE ELEVATION: 603.04'

TYPE OF PIEZOMETER: 1 1/4" SCH 40 1 1/4" x 3' 0.010 slot.

DATE	WATER SURFACE DEPTH (FT.)	WATER SURFACE ELEV. (FT.)
10-14-82	7.3	595.7
10-14-82	6.4 *	596.6
10-19-82 AM	8.5	594.5
10-19-82 PM	7.4	595.6
10-20-82	7.3	595.7
1-19-83	5.68	595.6
2-3-83	3.9	597.4

* After 6 hours.

INSTALLATION DESCRIPTION



TECHNICIAN TA-RF

JOB NO. 33767 (j1)

Guard pipe with locking cap installed.

LOG OF BORING NO. 2

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-11-82

SURFACE ELEVATION: 609' **DATE COMPLETED:** 10-12-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Topsoil				
0.5'	(FILL) Hard brown silt and clay, traces of sand, gravel and organic material, damp	1A	1.0- 2.5	12-21-14	35
3.0'	Very stiff brown and gray clay and silt, traces of sand and gravel, damp	2A	4.0- 5.5	6- 8-11	19
5'		1C	7.0- 9.0		24"
10'		3A	9.0-10.5	6-11-12	23
15.0'	(Becomes stiff at 14.0')	4A	14.0-15.5	6- 5-10	15
18.0'	Stiff brown and gray silt and clay, trace of silt, wet				
20'	Very stiff gray silt, some clay, traces of sand and gravel, damp	5A	19.0-20.5	7- 9-11	20
25'		6A	24.0-25.5	6- 9-11	20
30'	(Becomes stiff at 29.5')	7A	29.0-30.5	3- 6- 6	12

METHOD: Hollow Auger

TECHNICIAN: TA and RF

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH:

DEPTH AFTER: 24 HRS. 5.3'

TYPE SAMPLER:

X A. SPLIT SPOON

X B. NX wire

X C. SHELBY TUBE

* 9.0'(light); 48.0'(heavy)

BOWSER – MORNER
TESTING LABORATORIES, INC.

2B15

LOG OF BORING NO. 2 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-11-82

SURFACE ELEVATION: 609' **DATE COMPLETED:** 10-12-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(Becomes very stiff at 34.0')	8A	34.0-35.5	7- 9-11	20
40'		9A	39.0-40.5	7-10-15	25
43.0'					
45'	Hard gray silt, some sand, some clay, trace of gravel, damp	10A	44.0-45.0	78-22/1"	100+
49.3'		11A	49.0-49.5	100/5"	100+
50'	Gray weathered limestone				
51.0'	Medium-hard gray shaley dolomite with gypsum	1B	50.0-59.0		108"
55'					
60'					

METHOD: Hollow Auger

TECHNICIAN: TA and RF

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH:

DEPTH AFTER: 24 HRS. 5.3'

TYPE SAMPLER:

X A. SPLIT SPOON

X B. NX wire

X C. SHELBY TUBE

* 9.0'(light); 48.0'(heavy)

BOWSER – MORNER
TESTING LABORATORIES, INC.

2B15

LOG OF BORING NO. 2 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-11-82

SURFACE ELEVATION: 609' **DATE COMPLETED:** 10-12-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
60'					
		2B	59.0-69.0		93"
65'					
		3B	69.0-70.0		12"
70'					
		4B	70.0-80.0		80"
80'					
85'		5B	80.0-90.0		120"
90'					
	Bottom of boring at 90.0'				

METHOD: Hollow Auger

TECHNICIAN: TA and RF

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH:

DEPTH AFTER: 24 HRS. 5.3'

TYPE SAMPLER:

X A. SPLIT SPOON

X B. NX wire

X C. SHELBY TUBE

* 9.0'(light); 48.0'(heavy)

BOWSER – MORNER
TESTING LABORATORIES, INC.

2B15

ROCK CORE LOG

Job No. 33767

Boring No. 2

Date Logged 11-1-82

Core Top Elevation 559'

Observer JKK

Core Recovery 413"

Surface Elevation 609'

Age(s)/Formation(s) Silurian/Tymochtee member of Bass Islands Formation

TOTAL Rock Quality Designation (RQD) 39%

TOTAL Fracture Frequency (FF) 5+ per foot

Depth(ft)	Description	Sample	Recovery
50	Hard gray and white shale with gypsum, occasional voids and weathered zones	1B RQD = FF =	108" 36% 5/ft.
59		2B RQD = FF =	93" 30% 5/ft.
59.5	Hard gray and black shale, occasional voids (especially upper part) and weathered zones		
62.2	Hard gray and white shale with gypsum, occasional voids and weathered zones.		
69.0		3B RQD = FF =	12" 41% 4/ft.
70.0		4B* RQD = FF =	80" 16% 8/ft.
78.5	Hard massive fine grained gray dolomite with gypsum in fillings, carbonaceous partings		
80.0		5B RQD = FF =	120" 63% 3/ft.
86.0	Hard gray and white shale with gypsum, occasional voids		

* Inner barrel came loose and ground core up.

ROCK CORE LOG

Job No. 33767

Boring No. 2 - continued

Date Logged 11-1-82

Core Top Elevation 559'

Observer JKK

Core Recovery 413"

Surface Elevation 609'

Age(s)/Formation(s) Silurian/Tymochtee member of Bass Islands Formation

TOTAL Rock Quality Designation (RQD) 39%

TOTAL Fracture Frequency (FF) 5+ per foot

Depth(ft)	Description	Sample	Recovery
89.0	Hard black shale		
	Bottom of boring at 90.0'		

LOG OF BORING NO. 3

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 1-18-83

SURFACE ELEVATION: 610' **DATE COMPLETED:** 1-18-83

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Stiff brown and gray clay and silt, traces of sand and gravel, moist	1A	1.0- 2.5	5- 6- 7	13
5'	(Becomes medium stiff at 4.0')	2A	4.0- 5.5	4- 4- 5	9
9.0'	Medium stiff gray clay and silt, traces of sand and gravel, with 1" brown silt seam, moist	3A	9.0-10.5	2- 3- 4	7
14.0'	Medium stiff gray silt, some clay, some sand, trace of gravel, wet	4A	14.0-15.5	3- 3- 3	6
20'		5A	19.0-20.5	2- 3- 4	7
25'		6A	24.0-25.5	3- 3- 4	7
30'	(Becomes moist at 29.0')	7A	29.0-30.5	3- 5- 8	13

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 19.0' (medium)

COMPLETION DEPTH: None

DEPTH AFTER: 0.75 HRS. 26.0'

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 3 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 1-18-83

SURFACE ELEVATION: 610' **DATE COMPLETED:** 1-18-83

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(Becomes very stiff at 34.5')	8A	34.0-35.5	7-11-18	29
38.5'					
40'	Gray silt, some sand, some clay, trace of gravel, contains gypsum (Auger refusal at 40.5')	9A	39.0-40.0	50-50/3"	100+
	Bottom of boring at 40.5'				

METHOD:	Hollow Auger	WATER OBSERVATIONS	TYPE SAMPLER:
TECHNICIAN:	BK and CL	INITIAL DEPTH: 19.0' (medium)	X A. SPLIT SPOON
JOB NO.:	33767 (j1)	COMPLETION DEPTH: None	B.
		DEPTH AFTER: 0.75 HRS. 26.0'	C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 4

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 1-26-83

SURFACE ELEVATION: 611' **DATE COMPLETED:** 1-26-83

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Stiff brown and gray silt, some clay, some sand, trace of gravel, moist	1A	1.0- 2.5	4- 5- 6	11
5'	(Becomes soft at 4.0')	2A	4.0- 5.5	2- 1- 3	4
9.0'	Medium stiff gray silt, some clay, some sand, trace of gravel, moist	3A	9.0-10.5	2- 3- 5	8
10'					
15'	(Becomes stiff at 14.5')	4A	14.0-15.5	3- 7- 7	14
20'	(Becomes medium stiff at 19.0')	5A	19.0-20.5	3- 3- 6	9
25'		6A	24.0-25.5	3- 4- 4	8
30'	(Becomes very stiff at 29.5')	7A	29.0-30.5	6- 8-13	21

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH: 36.3' **

DEPTH AFTER: 0.5 HRS. 32.0'

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

* 4.0'(trace); 9.0'(heavy)

** Taken in augers.

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 4 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 1-26-83

SURFACE ELEVATION: 611' **DATE COMPLETED:** 1-26-83

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(Becomes hard at 34.5')	8A	34.0-35.5	10-16-19	35
38.5'	Gypsum and weathered shale	9A	39.0-39.5	100/2"	100+
	Bottom of boring at 39.5'				

METHOD:	Hollow Auger	**WATER OBSERVATIONS**	**TYPE SAMPLER:**	
TECHNICIAN:	BK and CL	INITIAL DEPTH: *	X	A. SPLIT SPOON
JOB NO.:	33767 (jl)	COMPLETION DEPTH: 36.3'**		B.
		DEPTH AFTER: 0.5 HRS. 32.0'		C. SHELBY TUBE

* 4.0'(trace); 9.0'(heavy)

** Taken in augers.

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 5

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-14-82

SURFACE ELEVATION: 616' **DATE COMPLETED:** 10-14-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
0.5'	Very stiff brown clay, some silt, traces of sand and gravel, damp	1A	1.0- 2.5	6-12-13	25
5'		1C	4.0- 6.0		24"
6.0'	Very stiff brown and gray clay, some silt, some sand, trace of gravel, moist	2A	6.0- 7.5	17-28-29	57
	(Becomes stiff and gray at 8.0')	3A	9.0-10.5	4- 5- 7	12
10'					
		2C	13.0-15.0		24"
15'	(Becomes medium stiff at 15.0')	4A	15.0-16.5	3- 4- 5	9
20'		5A	19.0-20.5	3- 3- 4	7
25'		6A	24.0-25.5	3- 4- 5	9
		3C	27.5-29.5		0"
30'	(Becomes very stiff at 30.0')	7A	29.5-31.0	5- 9-10	19

METHOD: Hollow Auger

TECHNICIAN: TA and RF

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH: 4.0'

DEPTH AFTER: _____ HRS. _____

TYPE SAMPLER:

X A. SPLIT SPOON

X B. NX wire

X C. SHELBY TUBE

* 37.5'(light); 39.5'(medium)

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 5 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-14-82

SURFACE ELEVATION: 616' **DATE COMPLETED:** 10-14-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
60'					
		3B	58.0-68.0		118"
65'					
70'					
		4B	68.0-78.0		120"
75'					
80'		5B	78.0-80.5		30"
	Bottom of boring at 80.5'				

METHOD: Hollow Auger

TECHNICIAN: TA and RF

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH: 4.0'

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

X B. NX wire

X C. SHELBY TUBE

* 37.5'(light); 39.5'(medium)

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 5 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-14-82

SURFACE ELEVATION: 616' **DATE COMPLETED:** 10-14-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'		8A	34.0-35.5	10-13-16	29
37.5'	Hard gray sand, some gravel, some clay, some silt (contains gypsum), damp	9A	39.0-40.0	85-15/1"	100+
40' 40.5'	Medium to hard shale	1B	40.5-48.0		84"
45'					
48.5'	Medium to hard shaley dolomite				
50'					
		2B	48.0-58.0		120"
55'					
60'					

METHOD: Hollow Auger

TECHNICIAN: TA and RF

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH: 4.0'

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

X B. NX wire

X C. SHELBY TUBE

* 37.5'(light); 39.5'(medium)

BOWSER – MORNER
TESTING LABORATORIES, INC.

ROCK CORE LOG

Job No. 33767

Boring No. 5

Date Logged 11-1-82

Core Top Elevation 576'

Observer JKK

Core Recovery 472"

Surface Elevation 616'

Age(s)/Formation(s) Silurian/Tymochtee member of Bass Islands Formation

TOTAL Rock Quality Designation (RQD) 43%

TOTAL Fracture Frequency (FF) 3+ per foot

Depth(ft)	Description	Sample	Recovery
40.5	Hard black fine-grained dolomite	1B RQD =	84" 0
41.0	Hard black thin-bedded shale		
42.0	Soft gypsum and weathered black shale: highly fractured, some solutioning of gypsum		
48.0	Hard massive white, gray and black shales with some thin massive gypsum, appears clastic in part	2B RQD =	120" 30%
57.0 58.0	Begin finding open voids with crystalline gypsum	3B	118"
		RQD = FF =	51% 4/ft.
67.5	Carbonaceous partings		
68.0		4B RQD = FF =	120" 47% 3/ft.
78.0	Bottom of boring at 80.5'	5B RQD = FF =	30" 53% 4/ft.

LOG OF WELL NO. 5

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

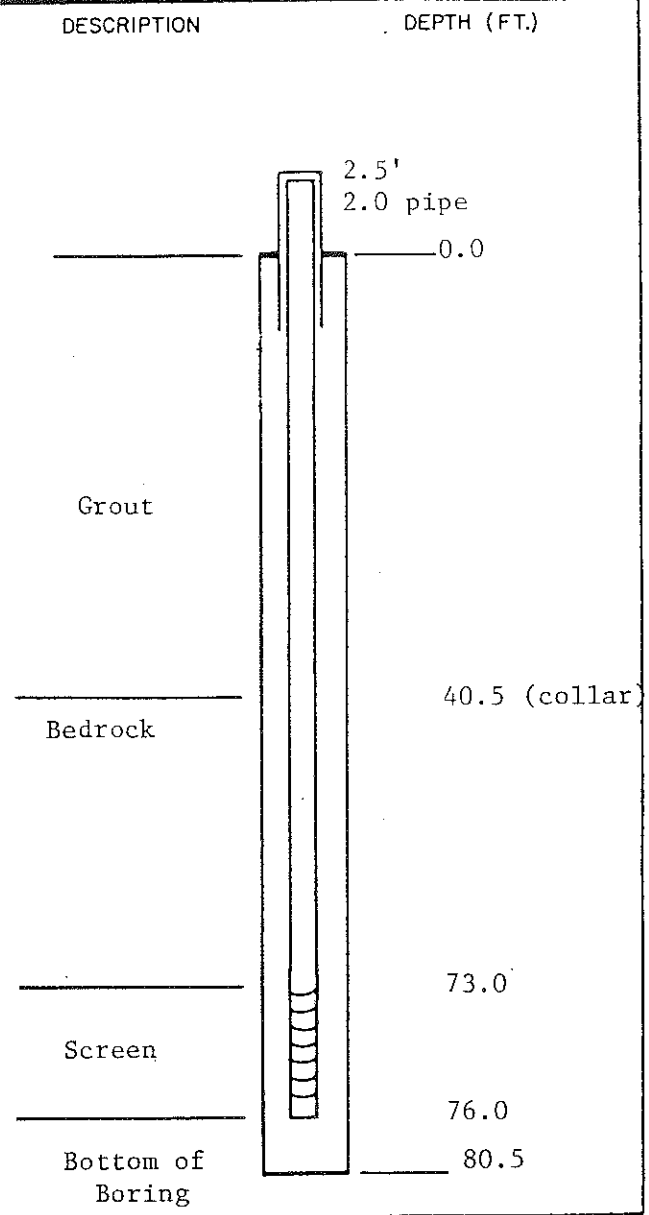
BORING LOCATION: As shown on boring location plan
DATE INSTALLED: 10-15-82

SURFACE ELEVATION: 616.5
TOP OF PIPE ELEVATION: 619

TYPE OF PIEZOMETER: 1 1/4" PVC SCH 40 with 1 1/4" x 3' screen, 0.010 slot

DATE	WATER SURFACE DEPTH (FT.)	WATER SURFACE ELEV. (FT.)	Remarks
10-15-82	4.0		After coring
10-18-82	21.2	595.3	
	62.0		After air flush
	57.0		After 5 min.
	53.0		After 15 min.
	64.0		Flushed again
	61.0		After 10 min.
10-19-82	20.7	595.8	
10-20-82	21.2	595.3	
2-3-83	18.3	598.2	

INSTALLATION DESCRIPTION



TECHNICIAN TA and RF

JOB NO. 33767 (j1)

Could not get well to bottom, collar was hanging up at sand layer above core hole. Pulled auger after pipe locked up for sand cave-in before grouting. Guard pipe with locking cap installed.

LOG OF BORING NO. 6

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 1-19-83

SURFACE ELEVATION: 612' **DATE COMPLETED:** 1-19-83

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Stiff brown and gray clay, some silt, traces of sand and gravel, moist	1A	1.0- 2.5	3- 6- 8	14
5'	(Becomes very stiff at 4.5')	2A	4.0- 5.5	6-11- 7	18
9.0'					
10'	Medium stiff brown and gray silt and clay, trace of sand, moist	3A	9.0-10.5	3- 5- 5	10
14.0'					
15'	Soft gray clay, some silt, some sand, trace of gravel, moist	4A	14.0-15.5	2- 2- 3	5
20'	(Becomes medium stiff at 19.5')	5A	19.0-20.5	2- 3- 3	6
25'		6A	24.0-25.5	2- 3- 4	7
30'	(Becomes stiff at 29.5')	7A	29.0-30.5	4- 6- 7	13

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 9.0' (heavy)

COMPLETION DEPTH: 39.0' *

DEPTH AFTER: 2.0 HRS. 17.2'

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

* Taken in augers.

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 6 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-19-83

SURFACE ELEVATION: 612' **DATE COMPLETED:** 11-19-83

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
	(Becomes hard at 34.0')				
35' 35.5'		8A	34.0-35.5	11-24-53	77
	Gray shale				
		9A	39.0-39.5	100/1"	100+
	Bottom of boring at 39.5'				

METHOD:	Hollow Auger	**WATER OBSERVATIONS**	**TYPE SAMPLER:**
TECHNICIAN:	BK and CL	INITIAL DEPTH: 9.0' (heavy)	X A. SPLIT SPOON
		COMPLETION DEPTH: 39.0' *	B.
JOB NO.:	383767 (j1)	DEPTH AFTER: 2.0 HRS. 17.2'	C. SHELBY TUBE

* Taken in augers.

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 7

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-22-82

SURFACE ELEVATION: 609' **DATE COMPLETED:** 11-22-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Stiff brown and gray clay and silt, trace of sand, moist	1A	1.0- 2.5	4- 5- 7	12
		2A	4.0- 5.5	6-11-14	25
5'					
9.0'	Very stiff brown and gray clay, some silt, traces of sand and gravel, moist	3A	9.0-10.5	4- 8- 9	17
10'					
14.0'	Medium stiff gray clay, some silt, some sand, trace of gravel, moist	4A	14.0-15.5	3- 4- 6	10
15'					
		5A	19.0-20.5	3- 4- 6	10
20'					
25'	(Becomes stiff at 24.5')	6A	24.0-25.5	4- 5- 7	12
		7A	29.0-30.5	3- 6- 9	15
30'					

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 43.5 (medium)

COMPLETION DEPTH: 41.5'

DEPTH AFTER 0.25 HRS. 38.5'

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 7 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-22-82

SURFACE ELEVATION: 609' **DATE COMPLETED:** 11-22-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(Becomes hard at 35.0')	8A	34.0-35.5	5-12-19	31
40'		9A	39.0-40.5	12-24-39	63
42.5'	Weathered dolomite	10A	43.5-44.0	100/3"	100+
	Bottom of boring at 44.0'				

METHOD:	Hollow Auger	**WATER OBSERVATIONS**	**TYPE SAMPLER:**
TECHNICIAN:	BK and CL	INITIAL DEPTH: 43.5' (medium)	X A. SPLIT SPOON
JOB NO.:	33767 (jl)	COMPLETION DEPTH: 41.5'	B.
		DEPTH AFTER: 0.25 HRS. 38.5'	C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 8

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-23-82

SURFACE ELEVATION: 607' **DATE COMPLETED:** 11-23-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Very stiff brown and gray clay and silt, trace of sand, moist	1A	1.0- 2.5	5- 9-14	23
5'		2A	4.0- 5.5	5- 8-12	20
9.0'	Very stiff brown clay, some silt, some sand, trace of gravel, moist (With 1/2" brown sand seam at 10')	3A	9.0-10.5	5-10-19	29
10'					
14.0'	Medium stiff gray clay, some silt, some sand, trace of gravel, moist	4A	14.0-15.5	3- 3- 6	9
15'					
20'		5A	19.0-20.5	3- 4- 6	10
25'	(Becomes stiff at 24.5')	6A	24.0-25.5	4- 5- 8	13
30'		7A	29.0-30.5	3- 5- 6	11

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 8 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-23-82

SURFACE ELEVATION: 607' **DATE COMPLETED:** 11-23-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(Becomes hard at 34.5' with trace of rock fragments)	8A	34.0-35.5	6-15-22	37
40'		9A	39.0-40.5	9-19-43	62
	(Apparent rock at 40.5')				
	(Auger refusal at 41.5')				
	Bottom of boring at 41.5'				

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 9

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-11-82

SURFACE ELEVATION: 606' **DATE COMPLETED:** 10-11-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Very stiff gray and brown clay, some silt, trace of sand, moist	1A	1.0- 2.5	7- 8-11	19
5'	(Becomes medium stiff at 4.0')	2A	4.0- 5.5	3- 4- 6	10
9.0'	Medium stiff brown silt, some clay, trace of sand, moist	1C	9.0-11.0		24"
10'					
14.6'	Soft gray clay, some silt, some sand, trace of gravel, moist	3A	14.0-15.5	2- 2- 2	4
15'					
20'		2C	19.0-21.0		24"
	(Becomes stiff at 24.5')				
25'		4A	24.0-25.5	3- 5- 6	11
30'		3C	29.0-31.0		24"

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH: 34.0' **

DEPTH AFTER: 0.25 HRS. 14.2'

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

X C. SHELBY TUBE

* 41.0'(medium); 43.0'(heavy)

** Taken in augers.

BOWSER – MORNER
TESTING LABORATORIES, INC.

2B15

LOG OF BORING NO. 9 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-11-82

SURFACE ELEVATION: 606' **DATE COMPLETED:** 10-11-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(Becomes very stiff at 34.5')	5A	34.0-35.5	5- 8-13	21
40'		4C	39.0-41.0		0"
	(Becomes hard at 41.0')	6A	41.0-42.5	20-26-30	56
43.0'	Weathered dolomite and gypsum	7A	44.0-44.5	100/6"	100+
	Bottom of boring 44.5'				

METHOD:	Hollow Auger	**WATER OBSERVATIONS**	**TYPE SAMPLER:**	
TECHNICIAN:	BKand CL	INITIAL DEPTH: *	X	A. SPLIT SPOON
JOB NO.:	33767 (jl)	COMPLETION DEPTH: 34.0'		B.
		DEPTH AFTER: 0.25 HRS. 14.2'	X	C. SHELBY TUBE

* 41.0'(medium); 43.0'(heavy)
** Taken in augers.

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 10

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-16-82

SURFACE ELEVATION: 604' **DATE COMPLETED:** 11-16-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
0.5'	Hard gray and brown silt and clay, trace of sand, damp	1A	1.0- 2.5	9-14-22	36
5'	(Becomes stiff and moist at 4.5')	2A	4.5- 6.0	3- 5- 9	14
10'	(Becomes very stiff at 9.5')	3A	9.5-11.0	5- 7-10	17
15'		4A	14.5-16.0	5- 7- 8	15
19.5'	Medium stiff gray clay, some silt, trace of sand, moist	5A	19.5-21.0	4- 4- 5	9
20'					
24.5'	Medium stiff gray clay, some silt, some sand, trace of gravel, moist	6A	24.5-26.0	4- 4- 5	9
25'					
30'		7A	29.5-31.0	5- 7- 7	14

METHOD: Hollow Auger

TECHNICIAN: RG and TA

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH: 15.3'

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

X B. NX wireline

___ C. SHELBY TUBE

* 14.5'(trace); 49.5'(heavy)

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 10 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-16-82

SURFACE ELEVATION: 604' **DATE COMPLETED:** 11-16-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'		8A	34.5-36.0	5- 7- 8	15
40'		9A	39.5-41.0	10-20-22	42
	(With trace of limestone fragments from 42.0')				
45.0'	Hard gray silt, some clay, some sand, trace of gravel, moist	10A	44.5-45.5	40-60/3"	100+
49.5' 50'	Medium hard weathered gray shale with gypsum	11A	49.5-50.0	100/2"	100+
55'		1B	50.0-60.0		108"
	Bottom of boring at 60.0'				

METHOD: Hollow Auger

TECHNICIAN: RG and TA

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH: 15.3'

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

X B. NX wireline

___ C. SHELBY TUBE

* 14.5'(trace); 49.5'(heavy)

BOWSER – MORNER
TESTING LABORATORIES, INC.

ROCK CORE LOG

Job No. 33767

Boring No. 10

Date Logged 12-1-82

Core Top Elevation 554'

Observer JKK

Core Recovery 108"

Surface Elevation 604'

Age(s)/Formation(s) Silurian/Tymochtee member of Bass Islands Formation

TOTAL Rock Quality Designation (RQD) 0%

TOTAL Fracture Frequency (FF) Too highly fractured to count.

Depth(ft)	Description	Sample	Recovery
50.0	Medium hard white and gray gypsum and anhydrite shaly dolomite	1B RQD = FF =	108" 0% infinite
51.3'	Hard black fissile shale with some interbedded gypsum and anhydrite, a few highly weathered zones		
	Bottom of boring at 60.0'		

LOG OF WELL NO. 10

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan

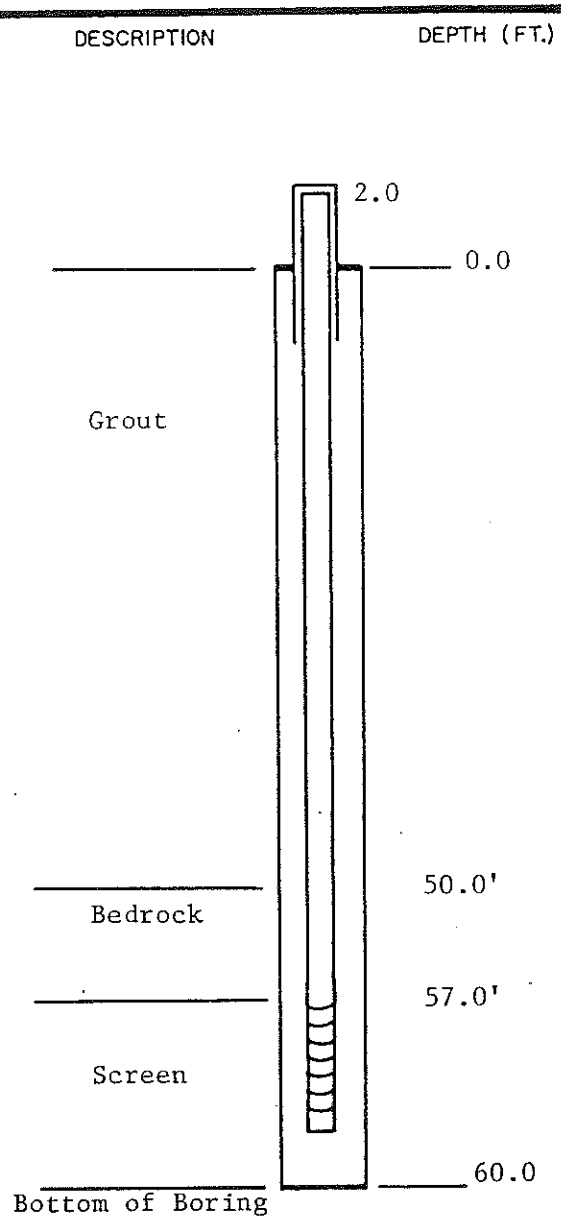
DATE INSTALLED:

SURFACE ELEVATION: 604.2

TOP OF PIPE ELEVATION: 605.98

TYPE OF PIEZOMETER: 1 1/4" SCH 40 PVC with 0.010 1 1/4" x 3" point

DATE	WATER SURFACE DEPTH (FT.)	WATER SURFACE ELEV. (FT.)		INSTALLATION DESCRIPTION
11-16-82	14.3	589.9		
1-19-83	12.3	591.9		
2-3-83	10.2	594.0		



TECHNICIAN RG and TA

JOB NO. 33767

Guard pipe with locking cap installed.

LOG OF BORING NO. 11

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-6-82

SURFACE ELEVATION: 600' **DATE COMPLETED:** 10-6-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Very stiff gray and brown silt and clay, traces of sand, gravel and organic material, moist	1A	1.0- 2.5	5- 7-11	18
4.0'	Stiff brown and gray clay and silt, trace of sand, moist	2A	4.0- 5.5	4- 5- 8	13
5'					
	(Becomes soft at 9.0')	3A	9.0-10.5	2- 1- 3	4
10'					
		4A	14.0-15.5	3- 4- 6	10
15.0'	Medium stiff gray silt, some clay, some sand, trace of gravel, moist				
		5A	19.0-20.5	3- 4- 6	10
20'					
	(Becomes stiff at 24.5')	6A	24.0-25.5	3- 5- 8	13
25'					
30'		7A	29.0-30.5	4- 6- 8	14

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH: 41.5'

DEPTH AFTER: 19.0 HRS. 9.2'

TYPE SAMPLER:

X A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

* 14.0' & 19.0'(trace); 49.0'(heavy)

BOWSER – MORNER
TESTING LABORATORIES, INC.

2B15

LOG OF BORING NO. 11 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-6-82

SURFACE ELEVATION: 600' **DATE COMPLETED:** 10-6-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(Becomes very stiff at 35.0')	8A	34.0-35.5	4- 7-14	21
40'	(Becomes hard at 39.5')	9A	39.0-40.5	8-15-28	43
44.0' 45'	Hard gray silt, some sand, some gravel (gypsum), some clay, moist (With trace of cobbles from 42-43')	10A	44.0-45.5	30-45-55/4"	100+
48.0' 50'	Gray weathered shale, wet (Auger refusal at 51.0')	11A	49.0-49.5	100/5"	100+
	Bottom of boring at 51.0'				

METHOD: Hollow Auger

TECHNICIAN: BKand CL

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH: 41.5'

DEPTH AFTER: 19.0 HRS. 9.2'

TYPE SAMPLER:

X A. SPLIT SPOON

B.

C. SHELBY TUBE

* 14.0' & 19.0'(trace); 49.0'(heavy)

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2B15

LOG OF WELL NO. 11

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan

DATE INSTALLED: 10-8-82

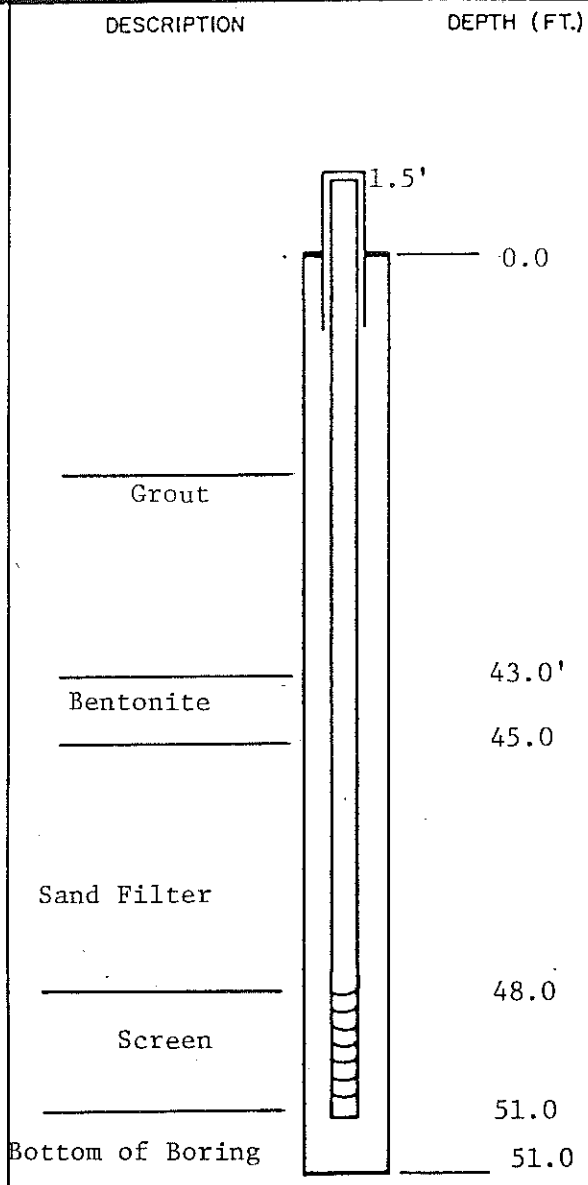
SURFACE ELEVATION: 600.9

TOP OF PIPE ELEVATION: 602.35

TYPE OF PIEZOMETER: 1 1/4" PVC, 3' well point

DATE	WATER SURFACE DEPTH (FT.)	WATER SURFACE ELEV. (FT.)	Remarks
10-8-82	9.2	591.8	
10-11-82	9.3	591.7	
10-13-82	12.0	588.9	
10-14-82	11.0	589.9	
11-18-82	9.7	591.3	
1-19-83	8.65	592.2	
2-3-83	7.3	593.6	

INSTALLATION DESCRIPTION



TECHNICIAN BK and CL

JOB NO. 33767 (jl)

Set well inside casing. Guard pipe set with flip top and lock. Placed cap on top of water pipe.

LOG OF BORING NO. 12

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-12-82

SURFACE ELEVATION: 605' **DATE COMPLETED:** 10-12-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
0.5'	Very stiff gray and brown silt and clay, traces of sand and organic material, moist	1A	1.0- 2.5	4- 6-10	16
5'		1C	4.0- 6.0		22
9.0'	Soft brown clay and silt, trace of sand, moist	2A	9.0-10.5	2- 2- 3	5
14.0'	Soft gray clay, some silt, some sand, trace of gravel, moist	2C	14.0-16.0		24"
20'		3A	19.0-20.5	1- 2- 2	4
25'		3C	24.0-26.0		24"
30'	(Becomes medium stiff at 29.5')	4A	29.0-30.5	2- 3- 6	9

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH: 16.2'

DEPTH AFTER: 0.25 HRS. 16.2 **

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

X C. SHELBY TUBE

* 19.0'(trace); 42.0'(medium); 43.0'(heavy)

** Taken in augers.

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 12 -continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-12-82

SURFACE ELEVATION: 605' **DATE COMPLETED:** 10-12-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'		4C	34.0-36.0		24"
40'	(Becomes hard at 39.5')	5A	39.0-40.5	11-21-35	56
	(With sand and gravel seam at 42.0')				
43.0'	Weathered dolomite	6A	44.0-44.5	100/3"	100+
	Bottom of boring at 44.5'				

METHOD:	Hollow Auger	**WATER OBSERVATIONS**	**TYPE SAMPLER:**
TECHNICIAN:	BK and CL	INITIAL DEPTH: *	X A. SPLIT SPOON
JOB NO.:	33767 (j1)	COMPLETION DEPTH: 16.2'	B.
		DEPTH AFTER: 0.25 HRS: 16.2'**	X C. SHELBY TUBE

* 19.0'(trace); 42.0'(medium); 43.0'(heavy)

** Taken in augers.

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 13

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 1-26-83

SURFACE ELEVATION: 606' **DATE COMPLETED:** 1-26-83

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, some sand,				
0.3'	(FILL) Gray clay, some silt, traces of sand and gravel, moist	1A	1.0- 2,5	6-12-12	24
2.2'	Very stiff brown and gray clay, some silt, traces of sand and gravel, moist	2A	4.0- 5.5	5- 8-11	19
5'					
9.0'		3A	9.0-10.5	4- 7- 8	15
10'	Stiff brown and gray silt, some clay, some sand, trace of gravel, moist				
15'		4A	14.0-15.5	4- 4- 4	8
15.4'	Medium stiff gray silt, some clay, some sand, trace of gravel, moist				
19.0'		5A	19.0-20.5	2- 3- 4	7
20'	Medium stiff gray clay, some silt, some sand, trace of gravel, moist				
25'		6A	24.0-25.5	3- 3- 4	7
30'	(Becomes stiff at 29.5')	7A	29.0-30.5	4- 6- 8	14

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: 14.0' (heavy)

COMPLETION DEPTH: None

DEPTH AFTER: 0.25 HRS. None

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 13 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 1-26-83

SURFACE ELEVATION: 606' **DATE COMPLETED:** 1-26-83

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(Becomes very stiff at 34.5')	8A	34.0-35.5	6-10-13	23
40'		9A	39.0-40.5	11-20-29	49
41.0'	(With trace of rock fragments at 39.0 to 40.5')				
	Apparent rock (Auger refusal at 42.0')				
	Bottom of boring at 42.0'				

METHOD:	Hollow Auger	**WATER OBSERVATIONS**	**TYPE SAMPLER:**
TECHNICIAN:	BK and CL	INITIAL DEPTH: 14.0' (heavy)	X A. SPLIT SPOON
		COMPLETION DEPTH: None	B.
JOB NO.:	33767 (jl)	DEPTH AFTER: 0.25 HRS. None	C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 14

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-13-82

SURFACE ELEVATION: 610' **DATE COMPLETED:** 10-14-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
0.5'	Very stiff brown silt and clay, traces of sand and organic material, moist	1A	1.0- 2.5	6-10-14	24
4.0'	Very stiff brown and gray silt and clay, trace of sand, moist	2A	4.0- 5.5	5-10-11	21
5'					
10'		1C	9.0-11.0		20"
11.0'	Soft gray clay, some silt, some sand, trace of gravel, moist				
15'		3A	14.0-15.5	1- 2- 3	5
20'		2C	19.0-21.0		24"
25'	(Becomes stiff at 24.0')	4A	24.0-25.5	5- 6- 8	14
30'		3C	29.0-31.0		24"

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 43.5' (trace)

COMPLETION DEPTH: None

DEPTH AFTER: 0.25 HRS. None

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

X C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 14 -continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-13-82

SURFACE ELEVATION: 610' **DATE COMPLETED:** 10-14-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(Becomes very stiff at 34.5')	5A	34.0-35.5	6- 8-14	22
40'		4C	39.0-41.0		24"
43.5'	Gray weathered shale and gypsum	6A	44.0-44.5	100/5"	100+
	Bottom of boring at 44.5'				

METHOD: Hollow Auger

TECHNICIAN: BKand CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 43.5' (trace)

COMPLETION DEPTH: None

DEPTH AFTER: 0.25 HRS. None

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

X C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 15

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-19-82

SURFACE ELEVATION: 610' **DATE COMPLETED:** 11-19-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Stiff brown and gray clay and silt, trace of sand, moist	1A	1.0- 2.5	4- 5- 7	12
5'		2A	4.0- 5.5	4- 5- 6	11
10'	(Becomes soft at 9.0')	3A	9.0-10.5	2- 2- 3	5
14.0'	Soft gray clay and silt, trace of sand, moist	4A	14.0-15.5	2- 2- 3	5
15'					
20'	(Becomes very soft at 19.0')	5A	19.0-20.5	1- 2- 1	3
24.0'	Soft gray clay, some silt, trace of sand, moist	6A	24.0-25.5	1- 1- 2	3
25'					
29.0'	Medium stiff gray clay, some silt, some sand, trace of gravel, moist	7A	29.0-30.5	2- 3- 4	7
30'					

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 42.0' (heavy)

COMPLETION DEPTH: 33.0'

DEPTH AFTER: 0.5 HRS. 18.0'

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 15 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-19-82

SURFACE ELEVATION: 610' **DATE COMPLETED:** 11-19-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(Becomes hard at 35.5')	8A	34.0-35.5	7-13-20	33
40'	(With rock fragments at 40.0')	9A	39.0-40.5	12-25-55	80
41.5'		10A	41.5-42.5	70-30/2"	100+
	Hard gray silt, some clay, some sand, trace of gravel (with gypsum and limestone fragments), moist (Auger refusal at 42.5')				
	Bottom of boring at 42.5'				

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 43.0' (heavy)

COMPLETION DEPTH: 33.0'

DEPTH AFTER: 0.5 HRS. 18.0'

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 16

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 1-26-83

SURFACE ELEVATION: 606' **DATE COMPLETED:** 1-27-83

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Gray clay, some silt, some sand, trace of gravel, moist				
1.5'	Very stiff brown and gray clay and silt, traces of sand and gravel, moist	1A	1.0- 2.5	6- 8-13	21
4.0'	Very stiff brown and gray silt, some clay, some sand, trace of gravel, moist	2A	4.0- 5.5	7-10-13	23
5'	(Becomes medium stiff at 9.0')	3A	9.0-10.5	3- 4- 4	8
10'		4A	14.0-15.5	2- 3- 3	6
15'					
19.0'	Soft gray clay and silt, traces of sand, and gravel, wet	5A	19.0-20.5	2- 2- 3	5
20'					
24.0'	Medium stiff gray clay, some silt, some sand, trace of gravel, moist	6A	24.0-25.5	2- 4- 6	10
25'					
30'	(Becomes stiff at 29.5')	7A	29.0-30.5	3- 5- 8	13

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH: 15.0'**

DEPTH AFTER: 0.5 HRS. 15.0'**

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

* 14.0'(trace); 41.0'(heavy)

** Taken in augers

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 16 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 1-26-83

SURFACE ELEVATION: 606' **DATE COMPLETED:** 1-27-83

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(Becomes very stiff at 34.5')	8A	34.0-35.5	6- 9-16	25
40'		9A	39.0-40.5	19-34-40	74
42.0'	Apparent rock (Auger refusal at 44.0')				
	Bottom of boring at 44.0'				

METHOD:	Hollow Auger	WATER OBSERVATIONS		TYPE SAMPLER:	
TECHNICIAN:	BK and CL	INITIAL DEPTH:	*	X	A. SPLIT SPOON
JOB NO.:	33767 (jl)	COMPLETION DEPTH:	15.0'**		B.
		DEPTH AFTER: 0.5 HRS.	15.0'**		C. SHELBY TUBE

* 14.0'(trace); 41.0'(heavy)
** Taken in augers.

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 17

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-16-82

SURFACE ELEVATION: 604' **DATE COMPLETED:** 11-18-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
0.5'	Very stiff gray and brown clay and silt, traces of sand and organic material, moist	1A	1.0- 2.5	6- 9-13	22
5'		2A	4.5- 6.0	6- 9- 8	17
6.5'	Medium stiff gray and brown silt and clay, trace of sand, moist				
10'		3A	9.5-11.0	2- 3- 3	6
14.5'	Soft gray clay, some silt, traces of sand and gravel, moist	4A	14.5-16.0	2- 2- 3	5
15'					
19.5'	Soft gray clay, some silt, some sand, trace of gravel, moist	5A	19.5-21.0	1- 2- 2	4
20'					
25'		6A	24.5-26.0	4- 4- 5	9
30'		7A	29.5-31.0	4- 5- 5	10

METHOD: Hollow Auger

TECHNICIAN: RG and TA

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH: 14.0'

DEPTH AFTER: 12 HRS: 15.8'

TYPE SAMPLER:

X A. SPLIT SPOON

X B. NX wireline

___ C. SHELBY TUBE

* 9.0'(light); 43.0'(heavy)

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 17 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-16-82

SURFACE ELEVATION: 604' **DATE COMPLETED:** 11-18-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(Becomes stiff at 34.5')	8A	34.5-36.0	6- 6- 7	13
39.5' 40'	Hard gray clay, some silt, some sand, trace of gravel, moist	9A	39.5-41.0	11-14-18	32
44.5'		10A	44.5-45.0	100/4"	100+
45.0'	Hard gray silt, some clay, some sand, trace of gravel (with gypsum), moist	1B	45.0-50.0		45"
	Medium hard gray shaley dolomite				
50'					
55'		2B	50.0-60.0		114"
60'					

METHOD: Hollow Auger

TECHNICIAN: RG and TA

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH: 14.0'

DEPTH AFTER: 12 HRS. 15.8'

TYPE SAMPLER:

X A. SPLIT SPOON

X B. NX wireline

___ C. SHELBY TUBE

* 9.0'(light); 43.0'(heavy)

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 17 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-16-82

SURFACE ELEVATION: 604' **DATE COMPLETED:** 11-18-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
60'					
65'		3B	60.0-70.0		100"
70'					
75'		4B	70.0-80.0		120"
80'					
85'		5B	80.0-90.0		120"
90'					

METHOD: Hollow Auger

TECHNICIAN: RG and TA

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH: 14.0'

DEPTH AFTER: 12 HRS. 15.8'

TYPE SAMPLER:

X A. SPLIT SPOON

X B. NX wireline

___ C. SHELBY TUBE

* 9.0'(light); 43.0'(heavy)

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 17 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-16-82

SURFACE ELEVATION: 604' **DATE COMPLETED:** 11-18-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
90'					
95'		6B	90.0-100.0		120"
100'					
105'		7B	100.0-110		120"
110'					
115'		8B	110.0-120		118"
120'					

METHOD:	Hollow Auger	**WATER OBSERVATIONS**	**TYPE SAMPLER:**	
TECHNICIAN:	RG and TA	INITIAL DEPTH: *	X	A. SPLIT SPOON
JOB NO.:	33767 (j1)	COMPLETION DEPTH: 14.0'	X	B. NX wireline
		DEPTH AFTER: 12 HRS. 15.8'		C. SHELBY TUBE

* 9.0'(light); 43.0'(heavy)

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 17 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-16-82

SURFACE ELEVATION: 604' **DATE COMPLETED:** 11-18-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
120'		9B	120.0-125		60"
	Bottom of boring at 125.0'				

METHOD:	Hollow Auger	**WATER OBSERVATIONS**	**TYPE SAMPLER:**
TECHNICIAN:	RG and TA	INITIAL DEPTH: *	X A. SPLIT SPOON
JOB NO.:	33767 (jl)	COMPLETION DEPTH: 14.0'	X B. NX wireline
		DEPTH AFTER: 12 HRS. 15.8'	C. SHELBY TUBE

* 9.0'(light); 43.0'(heavy)

BOWSER – MORNER
TESTING LABORATORIES, INC.

ROCK CORE LOG

Job No. 33767

Boring No. 17

Date Logged 12-1-82

Core Top Elevation 559'

Observer JKK

Core Recovery 917"

Surface Elevation 604'

Age(s)/Formation(s) Silurian/Tymochtee member of Bass Islands Formation

TOTAL Rock Quality Designation (RQD) 33% (from 50 to 125 feet)

TOTAL Fracture Frequency (FF) from 85 to 125' only, 7.5 fractures/ft.

Depth(ft)	Description	Sample	Recovery
45.0	Medium hard gray and white shale, gypsum and anhydrite, some highly weathered zones	1B RQD =	45" 0%
50.0	Hard gray fine grained dolomite with occasional interbeds of gypsum and anhydrite	2B RQD =	114" 14%
52.5	(0.5'± thick weathered zone)		
55.0	Hard black fissile shale, occasional interbeds of gypsum and anhydrite and weathered zones		
56.0'	(1 foot weathered zone)		
60.0'		3B RQD =	100" 16%
62.0	Hard weathered black fissile shale with occasional interbeds of gypsum and anhydrite		
70.0'		4B RQD = FF =	120" 6% 10/ft.
80.0		5B RQD =	120" 35%

ROCK CORE LOG

Job No. 33767

Boring No. ~~17 - continued~~

Date Logged 12-1-82

Core Top Elevation 559'

Observer JKK

Core Recovery 917"

Surface Elevation 604'

Age(s)/Formation(s) Silurian/Tymochtee member of Bass Islands Formation

TOTAL Rock Quality Designation (RQD) 33% (from 50 to 125 feet)

TOTAL Fracture Frequency (FF) from 85 to 125' only 7.5 fractures/ft.

Depth(ft)	Description	Sample	Recovery
84.0	Hard massive gray and white dolomite with shale partings, occasional thin gypsum		
90.0		6B RQD = FF =	120" 55% 5/ft.
99.0	Hard gray and brown dolomite with gypsum partings		
100.0		7B RQD = FF =	120" 63% 4/ft.
101.3	(2' zone of dark brown gypsum spheres)		
103.0	Hard gray fine-grained massive dolomite with occasional shale partings		
109.5	Alternating thin hard black fissile shale, gray dolomites and soft white gypsum with some weathered zones		
110.0		8B RQD = FF =	118" 44% 5/ft.
116.0	(Begin 2' zone of very small dark brown gypsum spheres)		

ROCK CORE LOG

Job No. 33767

Boring No. 17 - continued

Date Logged 12-1-82

Core Top Elevation 559'

Observer JKK

Core Recovery 917"

Surface Elevation 604'

Age(s)/Formation(s) Silurian/Tymochtee member of Bass Islands Formation

TOTAL Rock Quality Designation (RQD) 33% (from 50 to 125 feet)

TOTAL Fracture Frequency (FF) from 85 to 125' only 7.5 fractures/ft.

Depth(ft)	Description	Sample	Recovery
120.0		9B RQD = FF =	60" 26% 8/ft.
	Bottom of boring at 125.0'		

BOWSER-MORNER
Testing Laboratories, Inc.

LOG OF BORING NO. 18

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-12-82

SURFACE ELEVATION: 607' **DATE COMPLETED:** 10-13-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Crushed stone				
1.0'	Very stiff brown and gray silt and clay, traces of sand, gravel and organic material, moist (Becomes stiff at 4.5')	1A	1.0- 2.5	3- 7-10	17
		2A	4.0- 5.5	3- 5- 6	11
5'					
10'		3A	9.0-10.5	2- 2- 3	5
14.0'					
15'	Very soft gray clay, some silt, trace of sand, (with 1/2" brown silt seams throughout sample), moist	4A	14.0-15.5	1- 1- 2	3
19.0'					
20'	Very soft gray clay, traces of silt and sand, wet	5A	19.0-20.5	1- 1- 2	3
24.0'					
25'	Soft gray clay, some silt, traces of sand and gravel, wet	6A	24.0-25.5	2- 1- 3	4
30'	(Becomes moist at 29.0')	7A	29.0-30.5	1- 2- 2	4

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 24.0' (heavy)

COMPLETION DEPTH: 22.0' *

DEPTH AFTER: 15.5 HRS. 12.2'**

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

** Taken in augers at 19.0'

* Taken in augers.

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 18 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-12-82

SURFACE ELEVATION: 607' **DATE COMPLETED:** 10-13-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
34.0' 35'	Very stiff gray clay and silt, some sand, trace of gravel, moist	8A	34.0-35.5	4- 7- 11	18
40'	(Becomes hard at 39.5')	9A	39.0-40.5	11-22-39	61
44.0' 45.0'	Hard gray silt, some clay, some sand, traces of gravel and gypsum, moist	10A	44.0-45.0	70-30/1"	100+
	Weathered dolomite (Auger refusal at 46.0')				
	Bottom of boring at 46.0'				

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 24.0' (heavy)

COMPLETION DEPTH: 22.0'*

DEPTH AFTER: 15.5 HRS. 12.2'**

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

**Taken in augers at 19.0'

* Taken in augers.

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 19

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-19-82

SURFACE ELEVATION: 611' **DATE COMPLETED:** 10-20-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Very stiff brown and gray clay and silt, traces of sand and organic material, moist	1A	1.0- 2.5	4- 9- 9	18
5'		2A	4.0- 5.5	9-13-14	27
		1C	7.0- 9.0		24"
9.0'					
10'	Medium stiff brown silt and clay, trace of sand, wet	3A	9.0-10.5	3- 4- 5	9
		4A	14.0-15.5	3- 3- 3	6
15.0'					
	Medium stiff gray silt and clay, trace of sand, moist				
19.0'					
20'	Soft gray clay, some silt, some sand, trace of gravel, moist	5A	19.0-20.5	0- 1- 3	4
25'		6A	24.0-25.5	2- 3- 5	8
		2C	27.0-29.0		24"
30'		7A	29.0-30.5	0- 4- 5	9

METHOD: Hollow Auger

TECHNICIAN: TA and RF

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 7.0'

COMPLETION DEPTH: 5.5'

DEPTH AFTER: _____ HRS. _____

TYPE SAMPLER:

X A. SPLIT SPOON

X B. NX wire

X C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 19 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-19-82

SURFACE ELEVATION: 611' **DATE COMPLETED:** 10-20-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'		8A	34.0-35.5	5- 6- 8	14
40'		9A	39.0-40.5	3- 5- 8	13
44.0'					
45'	Hard gray silt, some clay, traces of sand and gravel, moist	10A	44.0-45.5	12-21-35	56
50.0'		11A	49.0-49.5	100/3"	100+
	Medium hard broken brown shaley dolomite	1B	50.0-53.0		33"
55'		2B	53.0-58.0		54"
60'					

METHOD: Hollow Auger

TECHNICIAN: TA and RF

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 7.0'

COMPLETION DEPTH: 5.5'

DEPTH AFTER: _____ HRS. _____

TYPE SAMPLER:

X A. SPLIT SPOON

X B. NX wire

X C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 19 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-19-82

SURFACE ELEVATION: 611' **DATE COMPLETED:** 10-20-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
60'					
		3B	58.0-68.0		117"
65'					
		4B	68.0-70.0		24"
	Bottom of boring at 70.0'				

METHOD: Hollow Auger

TECHNICIAN: TA and RF

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 7.0'

COMPLETION DEPTH: 5.5'

DEPTH AFTER: _____ HRS. _____

TYPE SAMPLER:

X A. SPLIT SPOON

X B. NX wire

X C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

ROCK CORE LOG

Job No. 33767

Boring No. 19

Date Logged 11-1-82

Core Top Elevation 561'

Observer JKK

Core Recovery 228"

Surface Elevation 611'

Age(s)/Formation(s) Upper Silurian/Tymochtee

TOTAL Rock Quality Designation (RQD) 29%

TOTAL Fracture Frequency (FF) Not calculated

Depth(ft)	Description	Sample	Recovery
50.0	Hard weathered black shale with gypsum along bedding planes	1B RQD =	33" 0%
52.5	Soft massive white gypsum with shale partings		
53.0		2B RQD =	54" 27%
53.5	Hard black shale, occasional gypsum, occasional weathered zones		
58.0'	Hard interbedded black and white shale and gypsum, appears clastic in zones, small scale faults with offset	3B RQD = FF =	117" 32% 6/ft.
68.0		4B RQD = FF =	24" 58% 2/ft.
	Bottom of boring at 70.0'		

LOG OF BORING NO. 20

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-24-82

SURFACE ELEVATION: 610' **DATE COMPLETED:** 11-24-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Medium stiff brown clay and silt, trace of sand, moist	1A	1.0- 2.5	2- 4- 5	9
4.0'	Medium stiff brown and gray clay and silt, trace of sand, moist	2A	4.0- 5.5	3- 3- 5	8
5'					
10'		3A	9.0-10.5	3- 4- 5	9
12.0'	Medium stiff gray clay, some silt, trace of sand, moist				
15'		4A	14.0-15.5	2- 3- 3	6
19.0'	Medium stiff gray clay, some silt, some sand, trace of gravel, moist				
20'		5A	19.0-20.5	2- 3- 4	7
	(With trace of gravel at 24.0')				
25'		6A	24.0-25.5	2- 4- 4	8
30'		7A	29.0-30.5	11-22-30	52

METHOD: Hollow Auger

TECHNICIAN: BK and DU

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: 9.0' (heavy)

COMPLETION DEPTH: 20.0'

DEPTH AFTER: 1.75 HRS. 0.4'

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 20 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-24-82

SURFACE ELEVATION: 610' **DATE COMPLETED:** 11-24-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'	(Becomes stiff at 30.5')				
35'	(Becomes hard at 35.0')	8A	34.0-35.5	11-22-30	52
40'		9A	39.0-40.5	12-28-41	69
41.0'	Apparent rock (Auger Refusal at 41.5')				
	Bottom of boring at 41.5'				

METHOD: Hollow Auger

TECHNICIAN: BK and DU

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 9.0' (heavy)

COMPLETION DEPTH: 20.0'

DEPTH AFTER: 1.75 HRS. 0.4'

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 21

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-19-82

SURFACE ELEVATION: 612' **DATE COMPLETED:** 11-19-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
0.5'	Very stiff gray and brown silt and clay, traces of sand and organic material, moist	1A	1.0- 2.5	8-10-12	22
5'		2A	4.5- 6.0	4- 4- 5	9
10' 9.5'	Medium stiff gray clay and silt, trace of sand with intermittent 1/16"-1/8"wet fine sand seams from 10.5'), moist	3A	9.5-11.0	2- 3- 4	7
15' 14.5'	Medium stiff gray clay, some silt, traces of sand and gravel, moist	4A	14.5-16.0	2- 3- 3	6
19.5' 20'	Medium stiff gray clay, some silt, some sand, trace of gravel, moist	5A	19.5-21.0	3- 4- 4	8
25'	(Becomes stiff at 24.5')	6A	24.5-26.0	4- 5- 7	12
30'		7A	29.5-31.0	4- 6- 8	14

METHOD: Hollow Auger

TECHNICIAN: RG and TA

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 10.5' (light)

COMPLETION DEPTH: None

DEPTH AFTER: _____ HRS. _____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 21 -continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-19-82

SURFACE ELEVATION: 612' **DATE COMPLETED:** 11-19-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(Becomes very stiff at 34.5')	8A	34.5-36.0	10-14-16	30
37.0'	Gray weathered dolomitic shale (Auger refusal at 38.0')				
	Bottom of boring at 38.0'				

METHOD:	Hollow Auger	**WATER OBSERVATIONS**	**TYPE SAMPLER:**
TECHNICIAN:	RG and TA	INITIAL DEPTH: 10.5' (light)	X A. SPLIT SPOON
		COMPLETION DEPTH: None	B.
JOB NO.:	33767 (j1)	DEPTH AFTER: ____ HRS. ____	C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 22

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-11-82

SURFACE ELEVATION: 610' **DATE COMPLETED:** 10-11-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Very stiff brown and gray silt and clay, traces of sand and organic material, moist	1A	1.0- 2.5	7- 8-13	21
5'		1C	4.0- 6.0		24"
9.0'					
10'	Soft gray clay and silt, trace of sand (with 1/2" brown silt seams throughout sample), moist	2A	9.0-10.5	1- 2- 2	4
14.0'					
15'	Soft gray clay, some silt, some sand, trace of gravel, moist	2C	14.0-16.0		24"
20'		3A	19.0-20.5	1- 2- 3	5
25'		3C	24.0-26.0		24"
30'	(Becomes stiff at 29.5')	4A	29.0-30.5	3- 5- 6	11

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 11.0' (heavy)

COMPLETION DEPTH: 19.8'

DEPTH AFTER: 1.0 HRS. 18.5'

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

X C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

2815

LOG OF BORING NO. 22 -continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-11-82

SURFACE ELEVATION: 610' **DATE COMPLETED:** 10-11-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(With cobbles at 34.5 to 35.0')	4C	34.0-34.5		6"
	(Becomes hard at 35.0')	5A	34.5-36.0	7-34-10	44
40'		6A	39.0-40.5	15-25-75/5"	100+
41.0'	Weathered dolomite, wet				
		7A	44.0-45.5	100/9"	100+
	Bottom of boring at 45.0'				

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 11.0' (heavy)

COMPLETION DEPTH: 19.8'

DEPTH AFTER: 1.0 HRS. 18.5'

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

X C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

2B15

LOG OF BORING NO. 23

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-18-82

SURFACE ELEVATION: 618' **DATE COMPLETED:** 11-19-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Stiff brown and gray silt and clay, traces of sand, gravel and organic material, moist	1A	1.0- 2.5	7- 8-11	19
3.5'	(FILL) Medium stiff gray and brown clay and silt, trace of sand, moist	2A	4.5- 6.0	3- 4- 5	9
5' 6.5'	(FILL) Medium stiff dark gray clay and silt, traces of sand and organic material, moist	3A	9.5-11.0	2- 3- 4	7
10' 11.0'	Very stiff gray and brown clay and silt, trace of sand, moist	4A	14.5-16.0	7-14-15	29
15' 20.0'	(With 6-8" wet black organic matter at 19.5')	5A	19.5-21.0	4- 4- 4	8
24.5'	Medium stiff gray and brown clay and silt, trace of sand with 1/16" fine sand seams, moist	6A	24.5-26.0	0- 3- 2	5
25' 29.5'	Soft gray clay, some silt, with intermittent 1/16-1/8" gray fine to coarse sand seams, moist				
30'	Medium stiff gray clay, some silt, some sand, trace of gravel, moist	7A	29.5-30.0	3- 3- 3	6

METHOD: Hollow Auger

TECHNICIAN: RG and TA

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 19.5' (light)

COMPLETION DEPTH: 24.4'

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 23 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-18-82

SURFACE ELEVATION: 618' **DATE COMPLETED:** 11-19-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'		8A	34.5-36.0	2- 4- 3	7
40'		9A	39.5-41.0	3- 4- 4	8
45'	(Becomes hard at 44.5')	10A	44.5-46.5	8-13-19	32
50'		11A	49.5-51.0	8-16-18	34
53.0'	Medium-hard gray weathered gypsiferous shale	12A	54.5-55.0	110/6"	110+
	Bottom of boring at 55.0'				

METHOD: Hollow Auger

TECHNICIAN: RG and TA

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: 19.5' (light)

COMPLETION DEPTH: 24.4'

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 23 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-18-82

SURFACE ELEVATION: 618' **DATE COMPLETED:** 11-19-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'		8A	34.5-36.0	2- 4- 3	7
40'		9A	39.5-41.0	3- 4- 4	8
45'	(Becomes hard at 44.5')	10A	44.5-46.5	8-13-19	32
50'		11A	49.5-51.0	8-16-18	34
53.0'	Medium-hard gray weathered gypsiferous shale	12A	54.5-55.0	110/6"	110+
	Bottom of boring at 55.0'				

METHOD:	Hollow Auger	**WATER OBSERVATIONS**	**TYPE SAMPLER:**
TECHNICIAN:	RG and TA	INITIAL DEPTH: 19.5' (light)	X A. SPLIT SPOON
JOB NO.:	33767 (jl)	COMPLETION DEPTH: 24.4'	___ B.
		DEPTH AFTER: ___ HRS. ___	___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 24

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-18-82

SURFACE ELEVATION: 605' **DATE COMPLETED:** 11-18-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
0.5'	Very stiff gray and brown clay and silt, trace of sand, moist	1A	1.0- 2.5	6- 8-12	20
4.5'	Very stiff gray and brown silt, some clay, trace of sand, moist	2A	4.5- 6.0	7-11-14	25
5'					
10'	(Becomes medium stiff at 9.5')	3A	9.5-11.0	3- 4- 5	9
10.5'	Medium stiff gray clay, some silt, traces of sand and gravel, moist				
15'		4A	14.5-16.0	1- 3- 5	8
20'		5A	19.5-21.0	2- 4- 5	9
24.5'	Stiff gray clay, some silt, some sand, trace of gravel, moist				
25'		6A	24.5-26.0	4- 5- 6	11
30'		7A	29.5-31.0	4- 5- 7	12

METHOD: Hollow Auger

TECHNICIAN: RG and TA

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: 4.5' (trace)

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 24 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-18-82

SURFACE ELEVATION: 605' **DATE COMPLETED:** 11-18-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'		8A	34.5-36.0	6- 8-11	19
40'		9A	39.5-41.0	7-10-14	24
42.5'	Hard gray silt, some clay, some sand, trace of gravel, contains gypsum, moist				
45.0'		10A	44.5-45.5	50-50/3"	100+
	Gray weathered shale with gypsum				
	Bottom of boring at 45.5'				

METHOD:	Hollow Auger	**WATER OBSERVATIONS**	**TYPE SAMPLER:**
TECHNICIAN:	RG and TA	INITIAL DEPTH: 4.5' (trace)	X A. SPLIT SPOON
JOB NO.:	33767 (jl)	COMPLETION DEPTH: None	B.
		DEPTH AFTER: ____ HRS. ____	C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 25

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-13-82

SURFACE ELEVATION: 610' **DATE COMPLETED:** 10-13-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, trace of sand, moist				
0.5'	Medium stiff brown and gray silt and clay, traces of sand and gravel, moist	1A	1.0- 2.5	2- 4- 6	10
4.0'	Stiff brown and gray silt and clay, traces of sand and organic material, moist	2A	4.0- 5.5	3- 5- 8	13
5'					
7.0'	Stiff gray and brown clay and silt, trace of sand, moist	1C	7.0- 9.0		20"
10'		3A	9.0-10.5	2- 7- 8	15
14.0'	Stiff gray silt, some clay, some sand, trace of gravel, moist	4A	14.0-15.5	3- 5- 7	12
15'					
		2C	17.0-19.0		24"
	(Becomes medium stiff at 19.5')	5A	19.0-20.5	2- 3- 5	8
20'					
	(Becomes stiff at 24.5')	6A	24.0-25.5	3- 5- 6	11
25'					
		3C	27.0-29.0		24"
30'		7A	29.0-30.5	3- 6- 7	13

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: 17.0' (heavy)

COMPLETION DEPTH: 30.7' *

DEPTH AFTER: 0.25 HRS. 22.4 *

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

X C. SHELBY TUBE

* Taken in augers.

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 25 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-13-82

SURFACE ELEVATION: 610' **DATE COMPLETED:** 10-13-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'		8A	34.0-35.5	4- 5- 7	12
40'	(Becomes very stiff at 39.5')	9A	39.0-40.5	5-10-15	25
45'	(Becomes hard at 44.0')	10A	44.0-45.5	20-26-47	73
47.5'	Weathered dolomite and gypsum, wet	11A	49.0-49.5	100/1"	100+
	Bottom of boring at 49.5'				

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 17.0' (heavy)

COMPLETION DEPTH: 30.7'*

DEPTH AFTER 0.25 HRS. 22.4'*

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

X C. SHELBY TUBE

* Taken in augers.

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 26

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 1-27-83

SURFACE ELEVATION: 613' **DATE COMPLETED:** 1-27-83

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, some sand, some clay, traces of gravel and organic material, moist	1A	1.0- 2.5	6- 5-12	17
1.0'	(FILL) Very stiff gray and brown clay, some silt, some sand, trace of gravel, moist	2A	4.0- 5.5	17- 4- 2	6
4.0'	(FILL) Medium stiff brown silt, some sand, traces of gravel and organic material, moist (Becomes very stiff at 8.5')	3A	9.0-10.5	7- 8-13	21
5'	Stiff brown and gray clay and silt, traces of sand, gravel and organic material, moist	4A	14.0-15.5	4- 6- 7	13
10.0'	Stiff gray clay and silt, some sand, moist	5A	19.0-20.5	5- 7- 8	15
15'	Stiff gray silt, some clay, some sand, trace of gravel, moist	6A	24.0-25.5	3- 4- 7	11
19.7'		7A	29.0-30.5	5- 7- 8	15
20'					
25.0'					
30'					

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: 24.0' (trace)

COMPLETION DEPTH: None

DEPTH AFTER: 0.25 HRS. None

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 26 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 1-27-83

SURFACE ELEVATION: 613' **DATE COMPLETED:** 1-27-83

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'		8A	34.0-35.5	5- 6- 9	15
	(Becomes very stiff at 39.5')	9A	39.0-40.5	5- 8-10	18
40'					
45'		10A	44.0-45.5	5-10-18	28
49.0'		11A	49.0-49.5	100/6"	100+
50'	Hard gray silt, some sand, some clay, trace of gravel, moist				
50.5'	Apparent rock (Auger refusal at 51.5')				
	Bottom of boring at 51.5'				

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 24.0' (trace)

COMPLETION DEPTH: None

DEPTH AFTER: 0.25 HRS. None

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 27

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-11-82

SURFACE ELEVATION: 610' **DATE COMPLETED:** 11-15-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
0.5'	Hard dark brown silt and clay, traces of sand and organic material, moist	1A	1.0- 2.5	9-16-18	34
2.0'	Hard gray and brown clay and silt, traces of sand and gravel, moist (Becomes medium stiff at 4.5')	2A	4.5- 6.0	4- 4- 4	8
5'					
10'		3A	9.5-11.0	3- 4- 4	8
10.5'	Medium stiff gray clay, some silt, some sand, trace of gravel, moist				
15'		4A	14.5-16.0	4- 4- 4	8
20'		5A	19.5-21.0	3- 4- 5	9
25'		6A	24.5-26.0	4- 4- 5	9
30'		7A	29.5-31.0	4- 5- 5	10

METHOD: Hollow Auger

TECHNICIAN: RG and RA

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH: 42.5'

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

* 4.5'(trace); 29.5'(medium)

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 27 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-11-82

SURFACE ELEVATION: 610' **DATE COMPLETED:** 11-15-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(Becomes very stiff at 34.5')	8A	34.5-36.0	4- 8- 9	17
40'		9A	39.5-41.0	26-28-31	59
42.0'	Gray shaley dolomite with gypsum.	10A	43.0-43.5	100/2"	100+
	Bottom of boring at 43.5'				

METHOD:	Hollow Auger	**WATER OBSERVATIONS**	**TYPE SAMPLER:**
TECHNICIAN:	RG and TA	INITIAL DEPTH: *	X A. SPLIT SPOON
JOB NO.:	33767 (j1)	COMPLETION DEPTH: 42.5'	B.
		DEPTH AFTER: ____ HRS. ____	C. SHELBY TUBE

* 4.5'(trace); 29.5'(medium)

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 28

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-10-82

SURFACE ELEVATION: 611' **DATE COMPLETED:** 11-11-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
0.5'	Hard gray and brown clay and silt, trace of sand, moist	1A	1.0- 2.5	15-23-25	48
5'	(Becomes very stiff at 4.5')	2A	4.5- 6.0	5- 8-12	20
10'	(With trace of 1/16" fine sand lenses at 9.0')	3A	9.5-11.0	5- 7-10	17
14.5' 15'	Stiff gray clay, some silt, some sand, trace of gravel, moist	4A	14.5-16.0	4- 4- 7	11
20'		5A	19.5-21.0	4- 5- 6	11
25'		6A	24.5-26.0	4- 5- 6	11
30'	(Becomes medium stiff at 29.5')	7A	29.5-31.0	2- 5- 5	10

METHOD: Hollow Auger

TECHNICIAN: RG and TA

JOB NO.: 33767 (j10

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH: 23.0'

DEPTH AFTER: 16.25 HRS. 18.0'

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

* 4.5'(light); 44.5'(heavy)

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 28 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-10-82

SURFACE ELEVATION: 611' **DATE COMPLETED:** 11-11-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(Becomes very stiff at 34.5')	8A	34.5-36.0	6- 8- 9	17
40'	(Becomes hard at 40.0')	9A	39.5-41.0	8-17-19	36
44.5'	Gray weathered shale with gypsum and 1" sand seam, wet)	10A	44.5-45.0	100/5"	100+
	Bottom of boring at 45.0'				

METHOD:	Hollow Auger	**WATER OBSERVATIONS**	**TYPE SAMPLER:**
TECHNICIAN:	RG and TA	INITIAL DEPTH: *	X A. SPLIT SPOON
JOB NO.:	33767 (jl)	COMPLETION DEPTH: 23.0'	B.
		DEPTH AFTER: 16.25 HRS. 18.0'	C. SHELBY TUBE

* 4.5'(light); 44.5'(heavy)

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 29

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-18-82

SURFACE ELEVATION: 611' **DATE COMPLETED:** 10-19-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.5'	Very stiff brown silt, some clay, some sand, damp	1A	1.0- 2.5	7-10-19	29
5'		1C	4.0- 6.0		18"
6.0'	Hard gray and brown silt, some clay, some sand, trace of gravel, damp	2A	6.0- 7.5	17-19-13	32
10'		3A	9.0-10.5	5- 6-11	17
14.0'	Stiff gray silt and clay, some sand, trace of gravel, moist	4A	14.0-15.5	3- 6- 6	12
20'		5A	19.0-20.5	3- 4- 6	10
		2C	23.0-25.0		24"
25'		6A	25.0-26.5	4- 5- 6	11
30'		7A	29.0-30.5	3- 5- 6	11

METHOD: Hollow Auger

TECHNICIAN: TA and RF

JOB NO.: 33767 (i1)

WATER OBSERVATIONS

INITIAL DEPTH: 42.5' (heavy)

COMPLETION DEPTH: 13.0' *

DEPTH AFTER: 5 min. HRS. 11.0' **

TYPE SAMPLER:

X A. SPLIT SPOON

X B. NX wire

X C. SHELBY TUBE

* After coring

** Taken in augers at 44' depth before coring.

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 29 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-18-82

SURFACE ELEVATION: 611' **DATE COMPLETED:** 10-19-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'		8A	34.0-35.5	3- 3- 5	8
39.5'		9A	39.0-40.5	10-60-30/3"	90+
40'	Hard brown silt, some clay, some sand, trace of gravel, damp				
42.5'	Gray fractured dolomite				
45'		1B	44.0-48.0		48"
50'		2B	48.0-58.0		120"
55'					
60'					

METHOD: Hollow Auger	**WATER OBSERVATIONS**		**TYPE SAMPLER:**	
TECHNICIAN: TA and RF	INITIAL DEPTH: 42.5' (heavy)		X	A. SPLIT SPOON
	COMPLETION DEPTH: 13.0' *		X	B. NX wire
JOB NO.: 33767 (jl)	DEPTH AFTER: 5 min. HRS. 11.0' **		X	C. SHELBY TUBE

* After coring

** Taken in augers at 44' depth before coring.

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 29 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-18-82

SURFACE ELEVATION: 611' **DATE COMPLETED:** 10-19-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
60'		3B	58.0-64.0		64"
	Bottom of boring at 64.0'				

METHOD:	Hollow Auger	**WATER OBSERVATIONS**	**TYPE SAMPLER:**	
TECHNICIAN:	TA and RF	INITIAL DEPTH: 42.5' (heavy)	X	A. SPLIT SPOON
		COMPLETION DEPTH: 13.0' *	X	B. NX wire
JOB NO.:	33767 (j1)	DEPTH AFTER: 5 min HRS. 11.0'**	X	C. SHELBY TUBE

* After coring

** Taken in augers at 44' depth before coring.

BOWSER – MORNER
TESTING LABORATORIES, INC.

ROCK CORE LOG

Job No. 33767

Boring No. 29

Date Logged 10-29-82

Core Top Elevation 567'

Observer JKK

Core Recovery 232"

Surface Elevation 611'

Age(s)/Formation(s) Silurian/Tymochtee member of Bass Islands Formation

TOTAL Rock Quality Designation (RQD) 40%

TOTAL Fracture Frequency (FF) 5 per foot

Depth(ft)	Description	Sample	Recovery
44.0'	Hard black shale with massive gypsum in fractures and voids	1B RQD = FF =	48" 60% 3/ft.
47.2	Soft massive buff shaley gypsum		
48.0		2B RQD = FF =	120" 55% 4.5/ft.
49.0	Hard black shale with massive gypsum veins		
50.7	Soft massive white gypsum interbedded with black shale, appears clastic in part		
54.2 57.5	Becomes hard Hard fine grained buff dolomite with thin gypsum laminae		
58.0		3B RQD = FF =	64" 0% 7/ft.
58.7	Begin finding open voids parallel with bedding lined with crystalline gypsum		
63.3	Hard massive black shale with flow structures Bottom of boring at 64.0'		

LOG OF WELL NO. 29

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

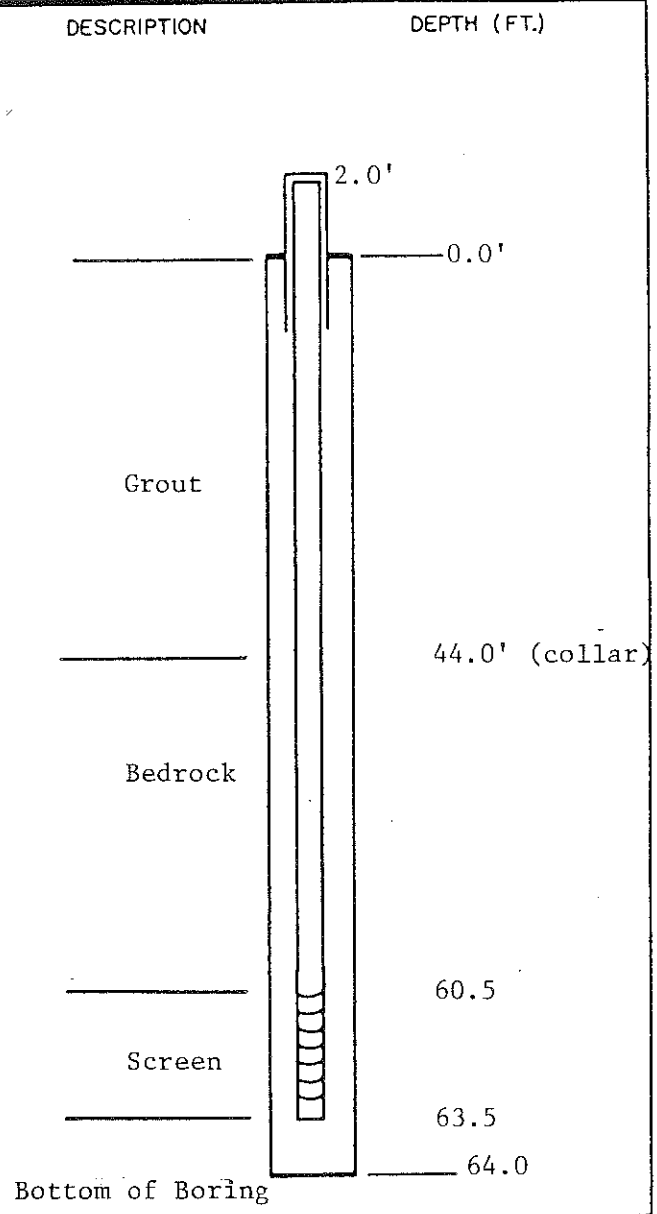
BORING LOCATION: As shown on boring location plan.
DATE INSTALLED: 10-19-82

SURFACE ELEVATION: 610.3
TOP OF PIPE ELEVATION: 612.68

TYPE OF PIEZOMETER: 1 1/4" SCH 40 PVC with 1 1/4" x 3', 0.010 slot screen

DATE	WATER SURFACE DEPTH (FT.)	WATER SURFACE ELEV. (FT.)	
10-19-82	Flushed after setting.		
10-20-82	19.3	591.0	
1-19-83	16.25	594.0	
2-03-83	15.5	594.8	

INSTALLATION DESCRIPTION



TECHNICIAN TA and RF

JOB NO. 33767 (j1)

Guardpipe with locking cap installed

LOG OF BORING NO. 30

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-18-82

SURFACE ELEVATION: 610' **DATE COMPLETED:** 11-18-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Very stiff brown clay and silt, trace of sand, moist	1A	1.0- 2.5	5- 7-10	17
4.0'	Stiff brown and gray clay and silt, traces of sand and gravel, moist	2A	4.0- 5.5	4- 6- 7	13
5'					
10'		3A	9.0-10.5	4- 7- 6	13
14.0'	Medium stiff gray clay, some silt, some sand, trace of gravel, moist	4A	14.0-15.5	3- 3- 4	7
15'					
20'		5A	19.0-20.5	2- 3- 4	7
25'		6A	24.0-25.5	3- 4- 4	8
30'	(Becomes stiff at 30.0')	7A	29.0-30.5	3- 4- 7	11

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 43.0' (heavy)

COMPLETION DEPTH: 24.6'

DEPTH AFTER: 1.0 HRS. 10.8'

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 30 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-18-82

SURFACE ELEVATION: 610' **DATE COMPLETED:** 11-18-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'		8A	34.0-35.5	4- 8-15	23
40'	(Becomes hard at 39.5')	9A	39.0-40.5	10-18-37	55
42.0'	Weathered shale with gypsum (Auger refusal at 43.5')	10A	43.0-43.5	100/1"	100+
	Bottom of boring at 43.5'				

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: 43.0' (heavy)

COMPLETION DEPTH: 24.6'

DEPTH AFTER: 1.0 HRS. 10.8'

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 31

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-14-82

SURFACE ELEVATION: 609' **DATE COMPLETED:** 10-14-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, some clay, some sand, moist				
1.0'	Very stiff brown and gray silt and clay, trace of sand, moist	1A	1.0- 2.5	4- 8- 8	16
4.0'	Very stiff brown silt and clay, trace of sand, moist	2A	4.0- 5.5	6- 8- 8	16
5'					
9.0'	Medium stiff gray silt and clay, trace of sand, moist	3A	9.0-10.5	3- 3- 3	6
10'					
15.0'	Medium stiff gray clay, some silt, some sand, trace of gravel, moist	4A	14.0-15.5	3- 3- 4	7
20'		5A	19.0-20.5	3- 3- 5	8
25'		6A	24.0-25.5	3- 4- 6	10
30'		7A	29.0-30.5	4- 4- 6	10

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (j1)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: 0.75 HRS. None

TYPE SAMPLER:

X A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 31 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 10-14-82

SURFACE ELEVATION: 609' **DATE COMPLETED:** 10-14-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(Becomes very stiff at 34.5')	8A	34.0-35.5	5- 7-11	18
43.0'	Weathered dolomite	9A	39.0-40.5	5- 9-19	28
40'		10A	44.0-44.5	100/3"	100+
	Bottom of boring at 44.5'				

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: 0.75 HRS. None

TYPE SAMPLER:

X A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 32

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-18-82

SURFACE ELEVATION: 606' **DATE COMPLETED:** 11-18-82

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Stiff brown and gray clay and silt, trace of sand, moist	1A	1.0- 2.5	6- 6- 9	15
5'		2A	4.0- 5.5	4- 6- 9	15
9.0'					
10'	Stiff brown clay and silt, trace of sand, moist (With 2" brown sand and gravel seam at 9.8')	3A	9.0-10.5	2- 7- 5	12
14.0'					
15'	Soft gray clay, some silt, some sand, trace of gravel, moist	4A	14.0-15.5	1- 2- 3	5
20'	(Becomes medium stiff at 19.0')	5A	19.0-20.5	3- 4- 4	8
25'		6A	24.0-25.5	3- 3- 5	8
30'	(Becomes stiff at 29.5')	7A	29.0-30.5	4- 5- 7	12

METHOD: Hollow Auger

TECHNICIAN: BK and CL

JOB NO.: 33767 (jl)

WATER OBSERVATIONS

INITIAL DEPTH: *

COMPLETION DEPTH: 30.0'

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

* 9.0'(medium); 19.0'(heavy)

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 32 - continued

NORTHERN OHIO TREATMENT FACILITY - VICKERY, OHIO

BORING LOCATION: As shown on boring location plan **DATE STARTED:** 11-18-82

SURFACE ELEVATION: 606' **DATE COMPLETED:** 11-18-82

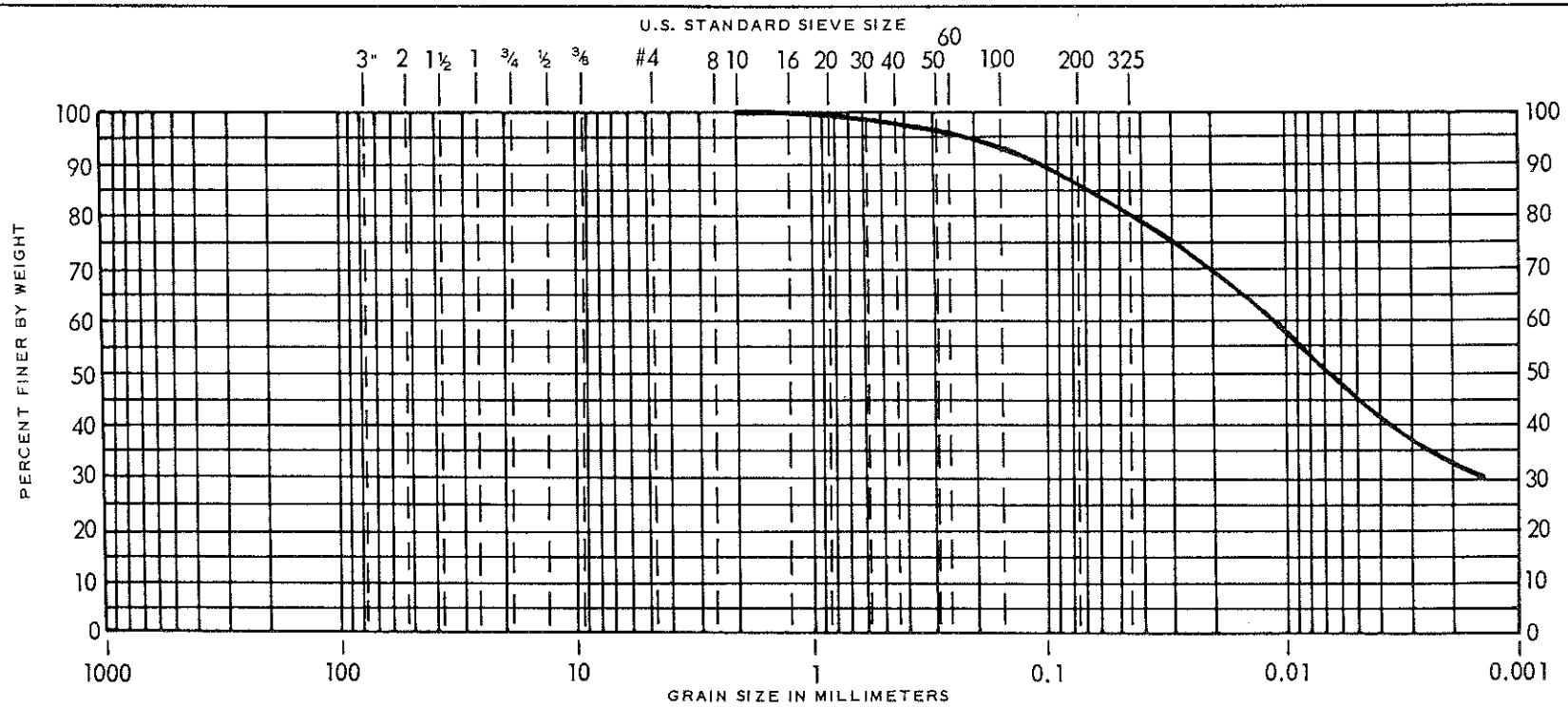
STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
30'					
35'	(Becomes very stiff at 35.0')	8A	34.0-35.5	6- 7- 9	16
40'		9A	39.0-40.5	5-10-17	27
42.0'	Apparent rock (Auger refusal at 42.5')				
	Bottom of boring at 42.5'				

METHOD: Hollow Auger	**WATER OBSERVATIONS**	**TYPE SAMPLER:**	
TECHNICIAN: BK and CL	INITIAL DEPTH: *	X	A. SPLIT SPOON
JOB NO.: 33767 (jl)	COMPLETION DEPTH: 30.0'		B.
	DEPTH AFTER: ____ HRS. ____		C. SHELBY TUBE

* 9.0'(medium); 19.0'(heavy)

BOWSER – MORNER
TESTING LABORATORIES, INC.

SOIL CLASSIFICATION SHEET



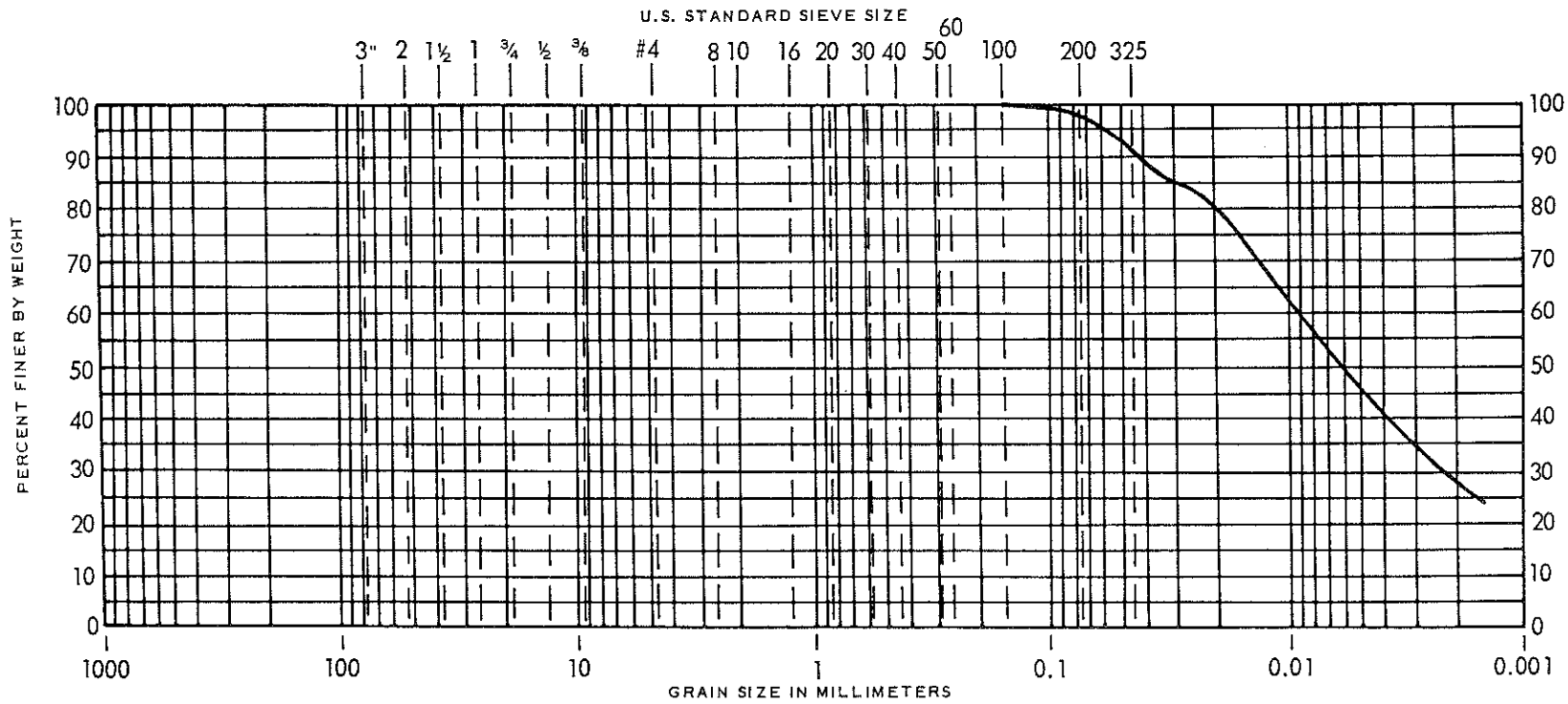
COBBLES	GRAVEL 0%		SAND 14%			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	41%	45%

PROJECT	33767	NATURAL % MOISTURE	14.4
		LIQUID LIMIT	--
BORING NO.	1	PLASTIC LIMIT	--
SAMPLE NO.	1A	PLASTICITY INDEX	--
DEPTH	1.0-2.5'	COLOR	Brown
CLASSIFICATION		REMARKS	

BOWSER-MORNER
TESTING LABORATORIES, INC.

2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 0%		SAND 2%			SILT 52%	CLAY 46%
	COARSE	FINE	COARSE	MEDIUM	FINE		

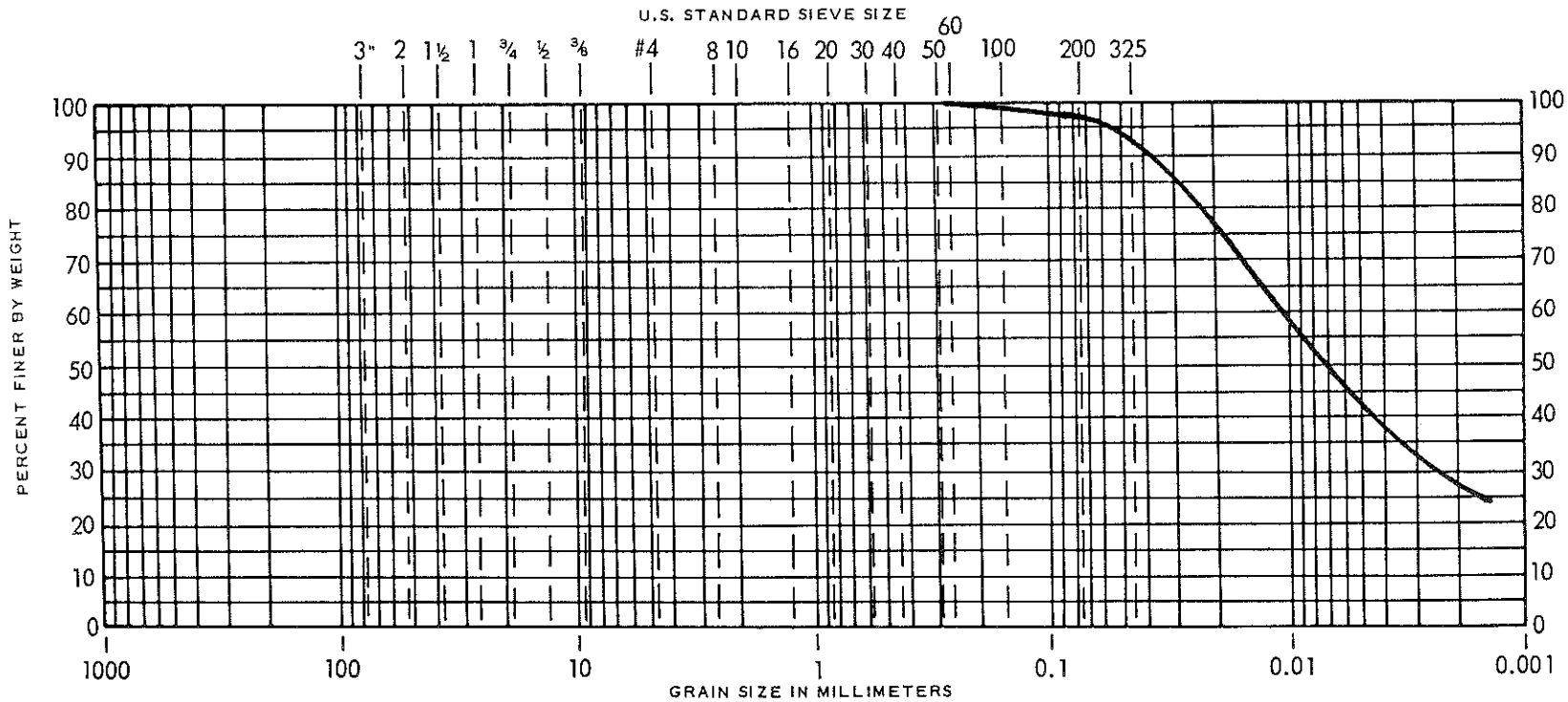
PROJECT	33767	NATURAL % MOISTURE	27.7
		LIQUID LIMIT	28
BORING NO.	1	PLASTIC LIMIT	18
SAMPLE NO.	2C	PLASTICITY INDEX	10
DEPTH	12.0-14.0'	COLOR	Gray
CLASSIFICATION	Silty clay, "CL"	REMARKS	U.S.C.S.
	A-4(9)		A.A.S.H.T.O. M145-73

BOWSER-MORNER

TESTING LABORATORIES, INC.

2A-34R

SOIL CLASSIFICATION SHEET



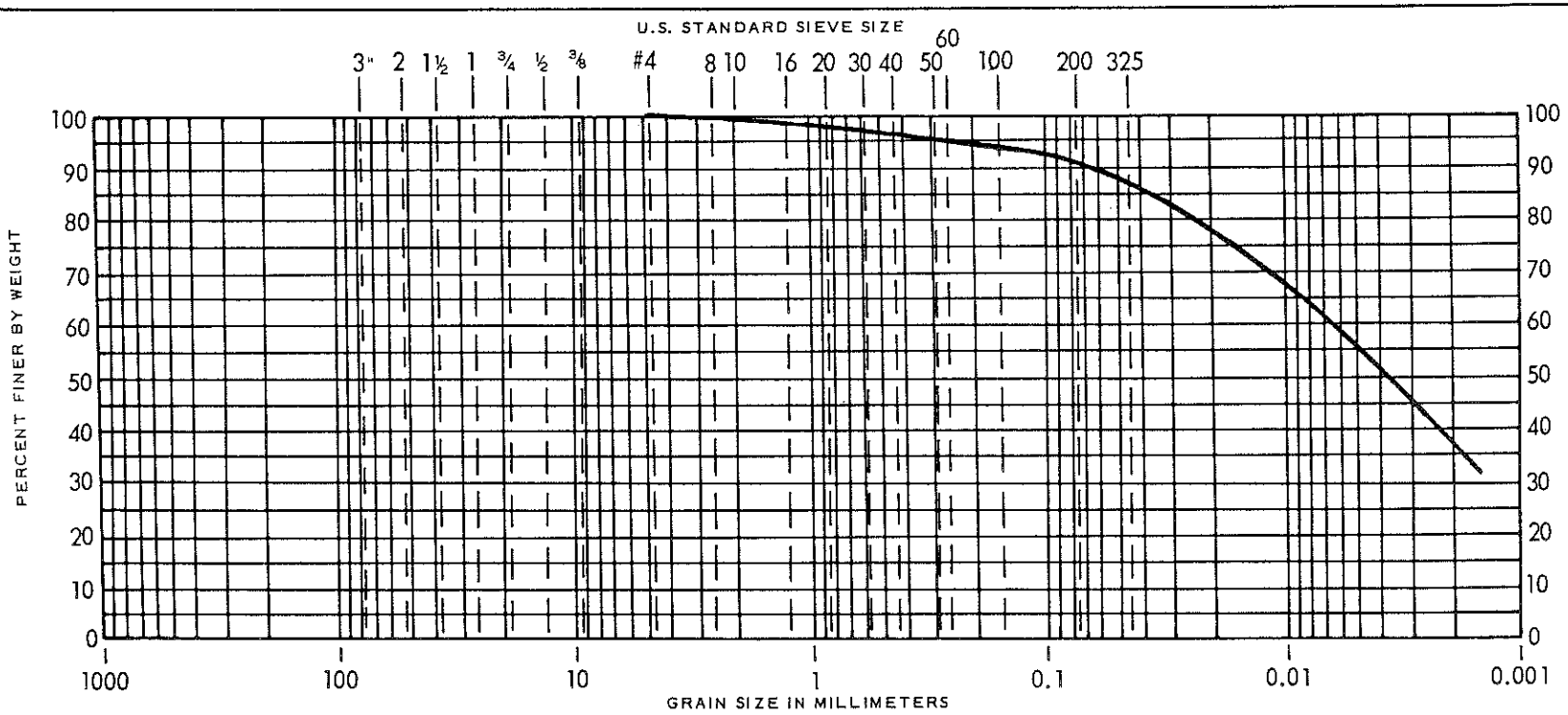
COBBLES	GRAVEL 0%		SAND 3%			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	54%	43%

PROJECT	33767	NATURAL % MOISTURE	29.2
		LIQUID LIMIT	--
BORING NO.	1	PLASTIC LIMIT	--
SAMPLE NO.	5A	PLASTICITY INDEX	--
DEPTH	19.0-20.5'	COLOR	Gray
CLASSIFICATION		REMARKS	

BOWSER-MORNER
TESTING LABORATORIES, INC.

2A-34R

SOIL CLASSIFICATION SHEET



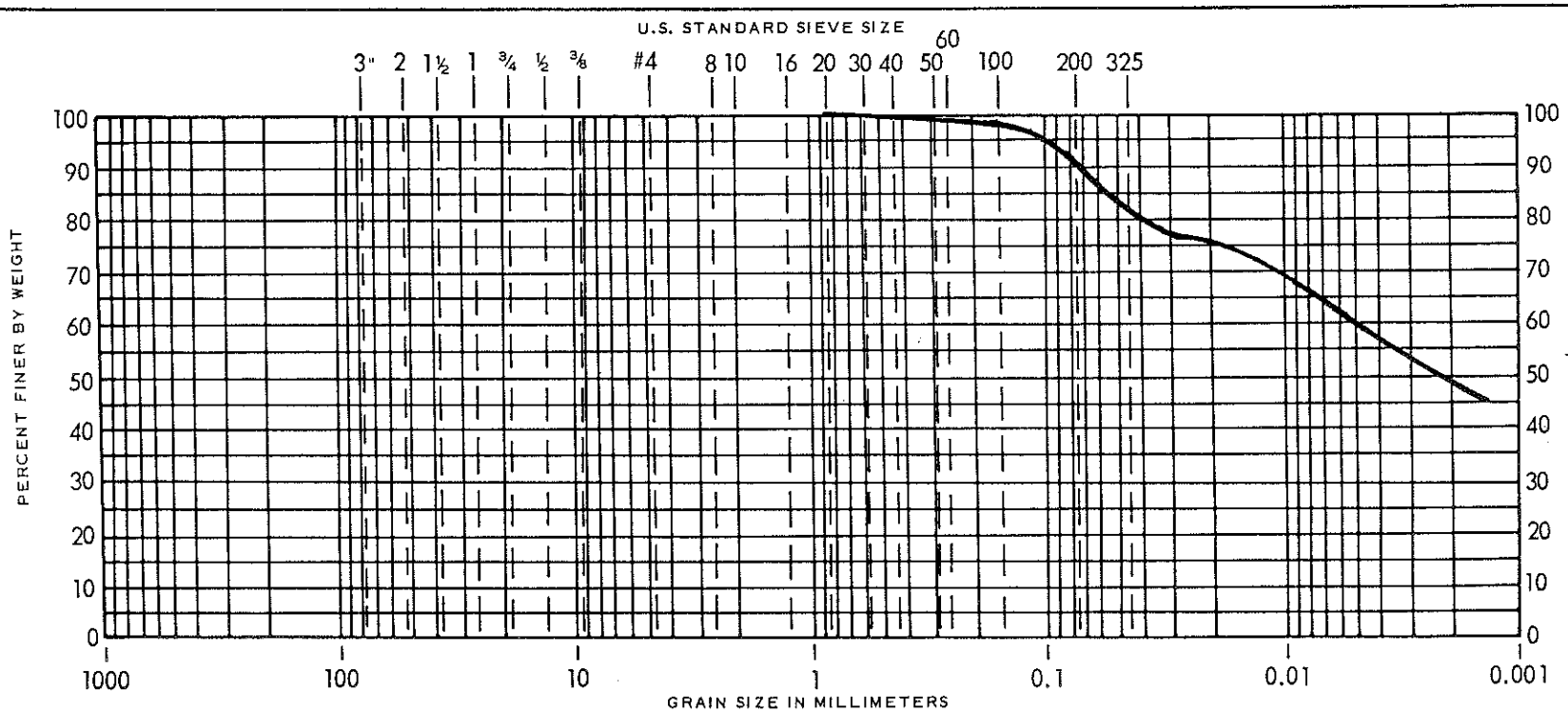
COBBLES	GRAVEL 0%		SAND 9%			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	36%	55%

PROJECT	33767	NATURAL % MOISTURE	26.0
BORING NO.	2	LIQUID LIMIT	--
SAMPLE NO.	3A	PLASTIC LIMIT	--
DEPTH	9.0-10.5	PLASTICITY INDEX	--
CLASSIFICATION		COLOR	Brown
		REMARKS	

BOWSER-MORNER
TESTING LABORATORIES, INC.

2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 0%		SAND 9%			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	31%	60%

PROJECT	33767	NATURAL % MOISTURE	17.6
		LIQUID LIMIT	--
BORING NO.	5	PLASTIC LIMIT	--
SAMPLE NO.	1A	PLASTICITY INDEX	--
DEPTH	1.0-2.5'	COLOR	Brown
CLASSIFICATION		REMARKS	

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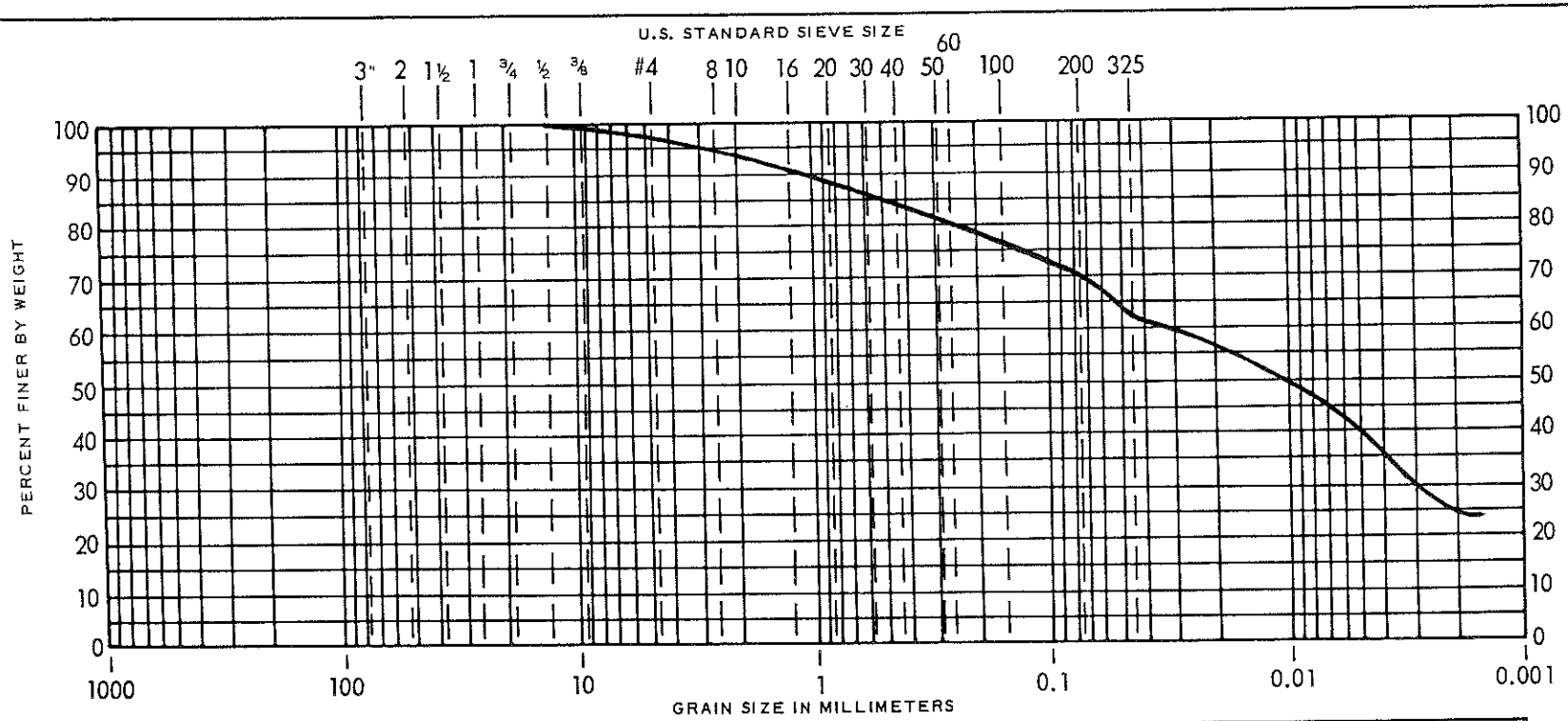
2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 3%		SAND 27%			SILT	CLAY
0%	COARSE	FINE	COARSE	MEDIUM	FINE	30%	40%

PROJECT	33767	NATURAL % MOISTURE	19.4
		LIQUID LIMIT	--
BORING NO.	5	PLASTIC LIMIT	--
SAMPLE NO.	3C	PLASTICITY INDEX	--
DEPTH	27.5-29.5'	COLOR	Gray

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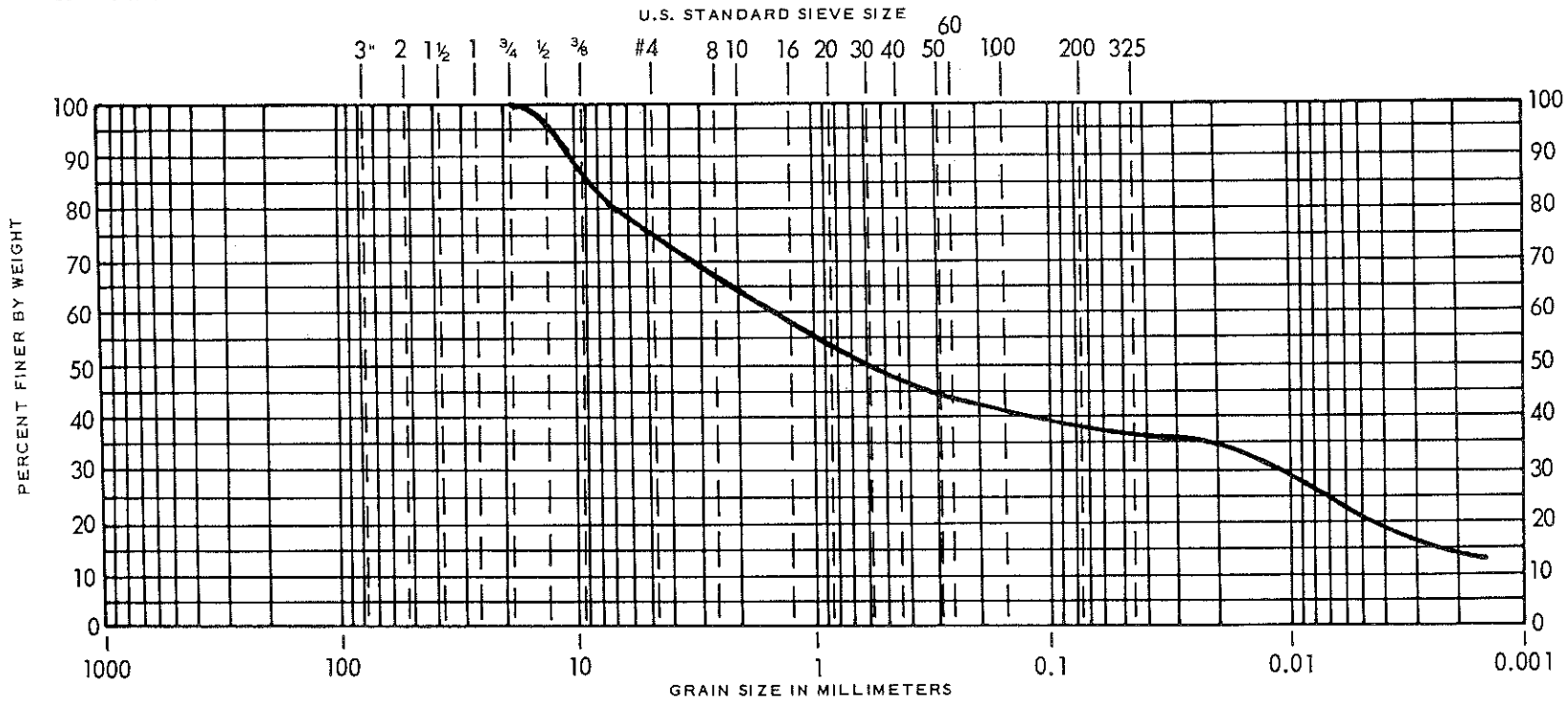
2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 25%		SAND 37%			SILT	CLAY
0%	COARSE	FINE	COARSE	MEDIUM	FINE	17%	21%

PROJECT	33767	NATURAL % MOISTURE	12.4
BORING NO.	5	LIQUID LIMIT	--
SAMPLE NO.	9A	PLASTIC LIMIT	--
DEPTH	39.0-40.0'	PLASTICITY INDEX	--
CLASSIFICATION		COLOR	Gray
		REMARKS	Sample contained considerable gypsum.

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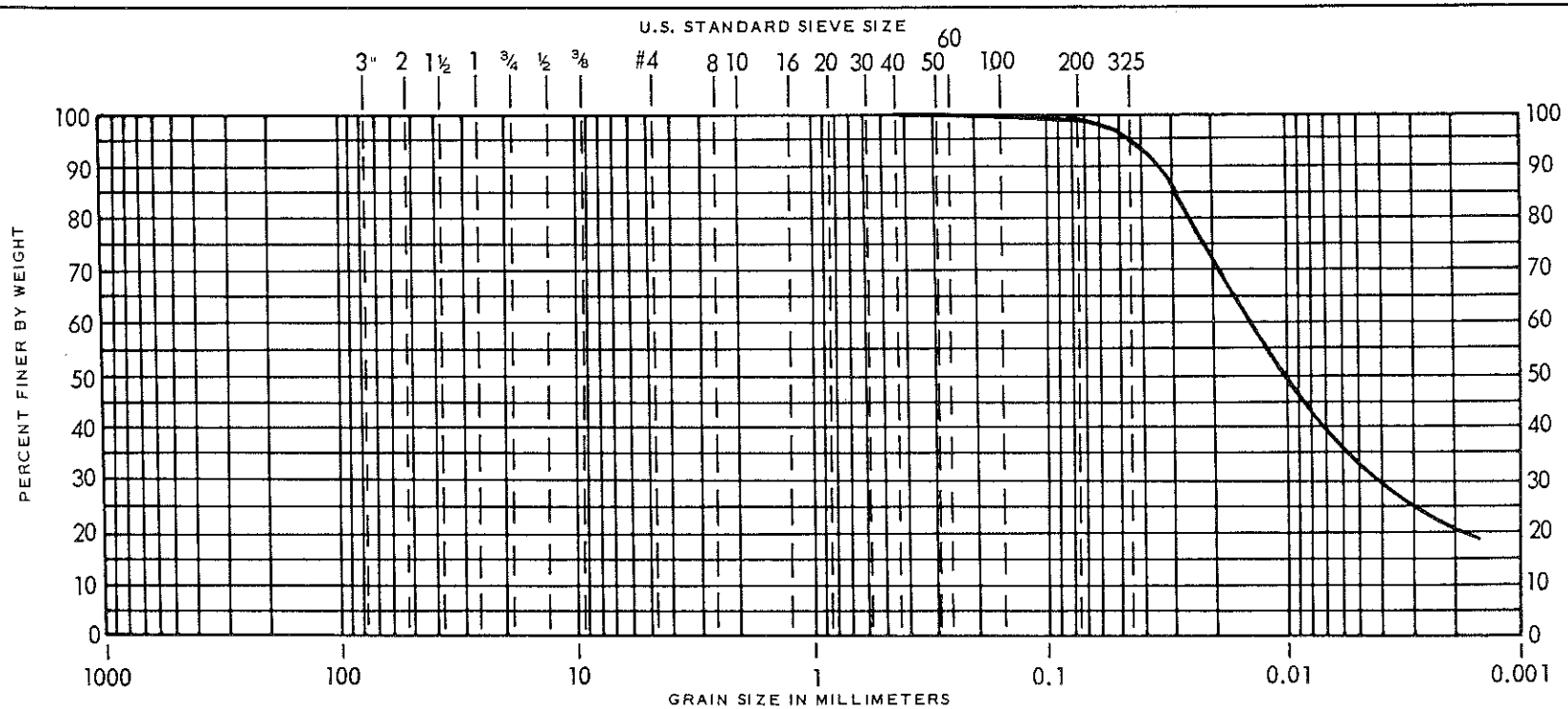
SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 0%		SAND 1%			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	66%	33%

PROJECT	33767	NATURAL % MOISTURE	26.2
		LIQUID LIMIT	--
BORING NO.	9	PLASTIC LIMIT	--
SAMPLE NO.	1C	PLASTICITY INDEX	--
DEPTH	9.0-11.0'	COLOR	Brown

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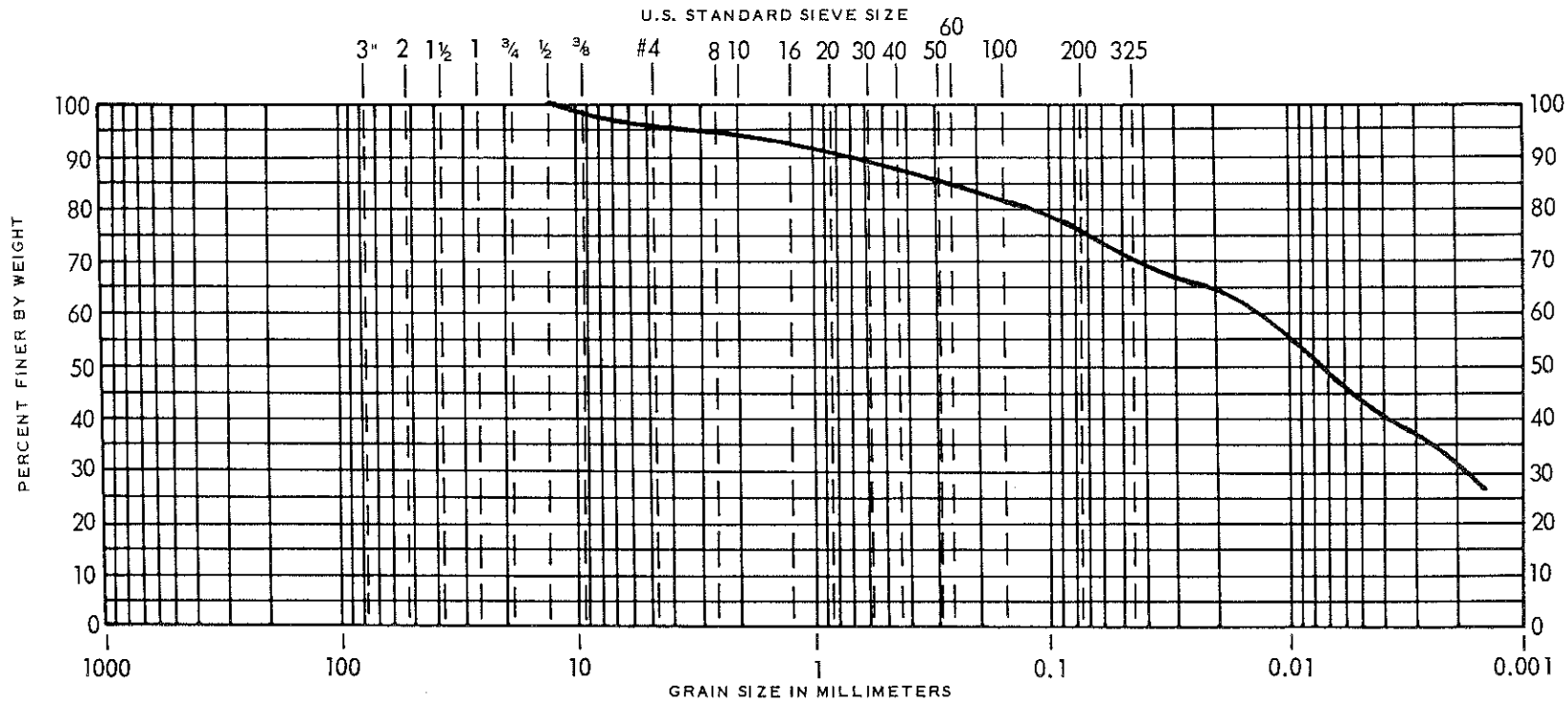
TESTING LABORATORIES, INC.

2A-34R

SOIL CLASSIFICATION SHEET

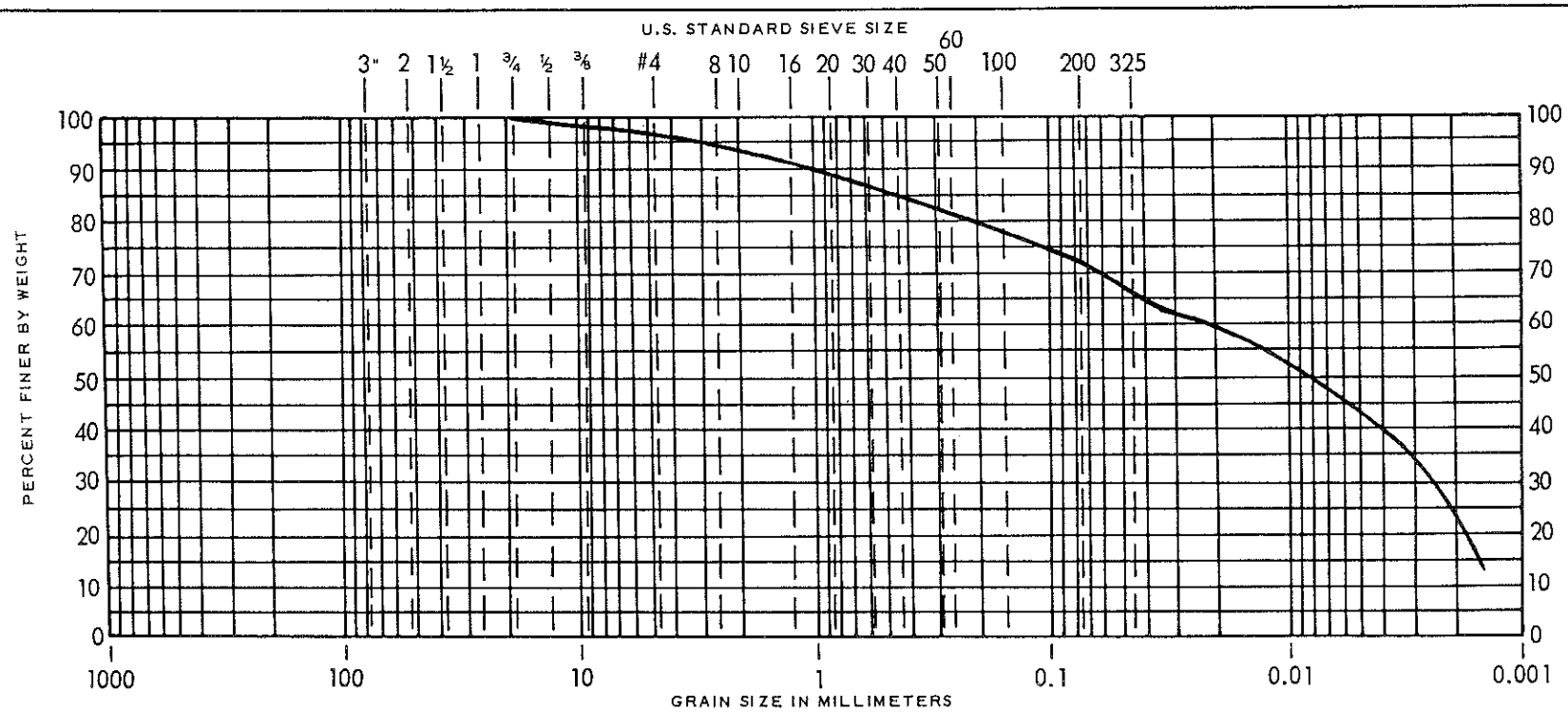


COBBLES	GRAVEL 4%		SAND 20%			SILT	CLAY
0%	COARSE	FINE	COARSE	MEDIUM	FINE	32%	44%

PROJECT	33767	NATURAL % MOISTURE	28.2	**BOWSER-MORNER**
		LIQUID LIMIT	--	TESTING LABORATORIES, INC.
BORING NO.	9	PLASTIC LIMIT	--	
SAMPLE NO.	3A	PLASTICITY INDEX	--	
DEPTH	14.0-15.5'	COLOR	Gray	

2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 3%		SAND 25%			SILT	CLAY
0%	COARSE	FINE	COARSE	MEDIUM	FINE	29%	43%

PROJECT	33767	NATURAL % MOISTURE	17.6
		LIQUID LIMIT	--
BORING NO.	9	PLASTIC LIMIT	--
SAMPLE NO.	3C	PLASTICITY INDEX	--
DEPTH	29.0-31.0'	COLOR	Gray

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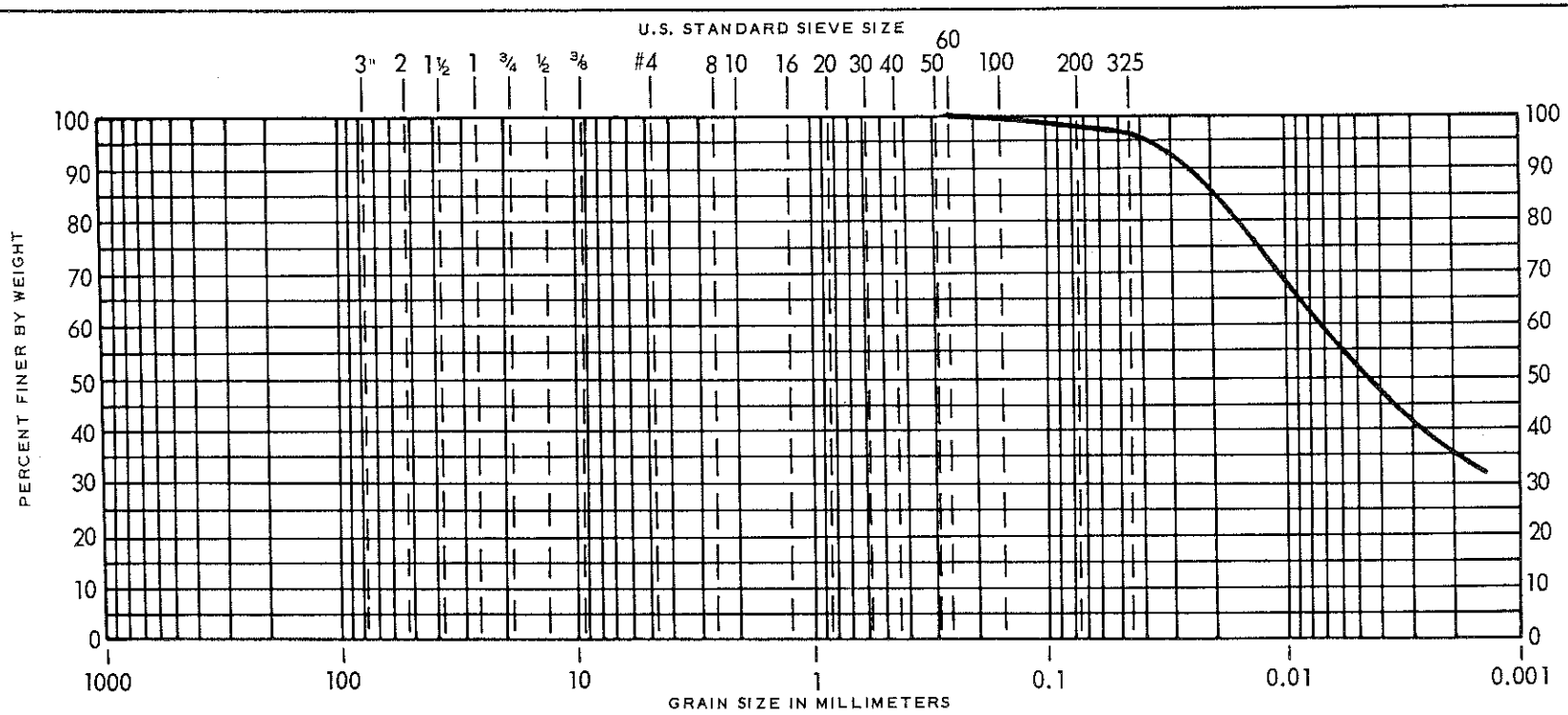
TESTING LABORATORIES, INC.

2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 0%		SAND 2%			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	45%	52%

PROJECT	33767	NATURAL % MOISTURE	25.3
		LIQUID LIMIT	--
BORING NO.	11	PLASTIC LIMIT	--
SAMPLE NO.	3A	PLASTICITY INDEX	--
DEPTH	9.0-10.5'	COLOR	Brown
CLASSIFICATION		REMARKS	

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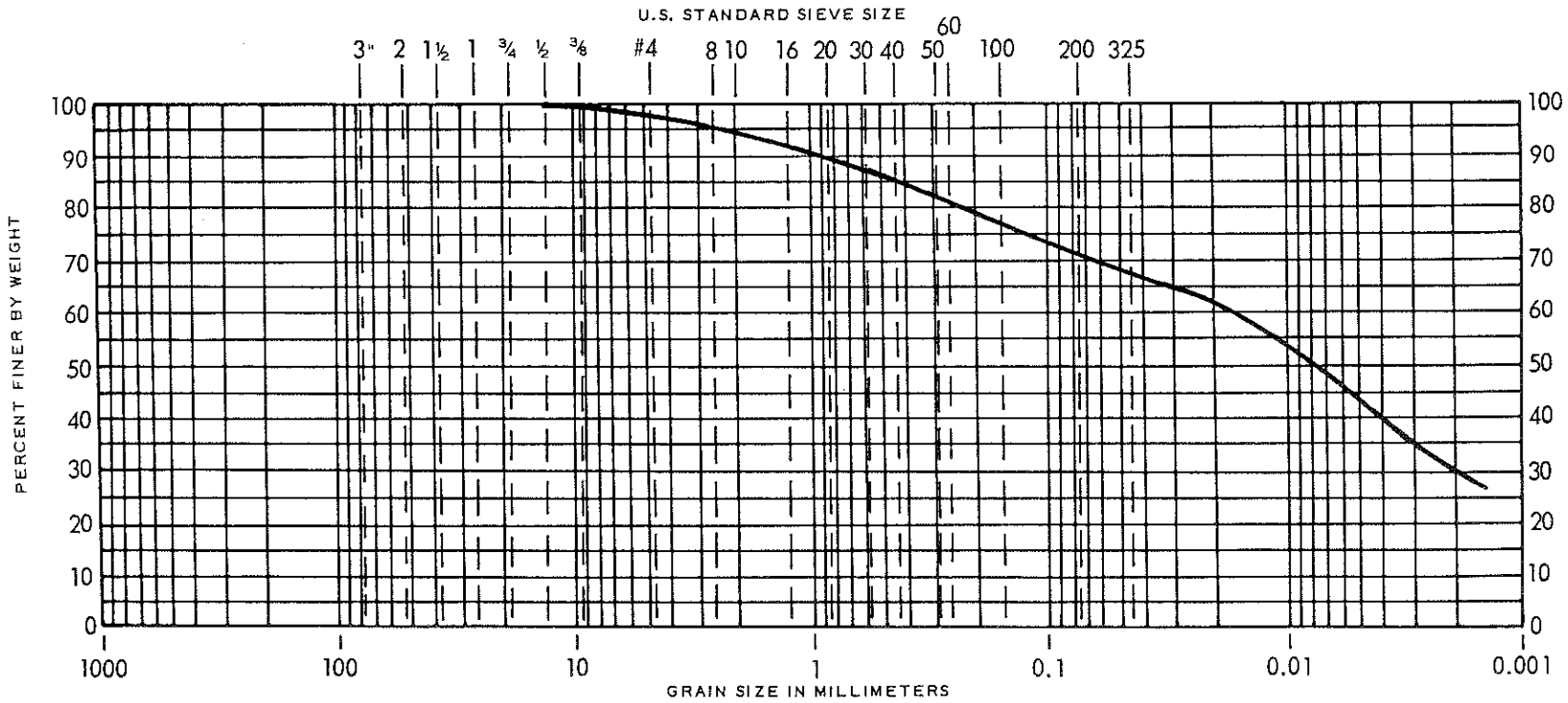
TESTING LABORATORIES, INC.

2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 2%		SAND 27%			SILT	CLAY
0%	COARSE	FINE	COARSE	MEDIUM	FINE	27%	44%

PROJECT	33767	NATURAL % MOISTURE	18.5
		LIQUID LIMIT	--
BORING NO.	11	PLASTIC LIMIT	--
SAMPLE NO.	6A	PLASTICITY INDEX	--
DEPTH	24.0-25.5'	COLOR	Gray
CLASSIFICATION		REMARKS	

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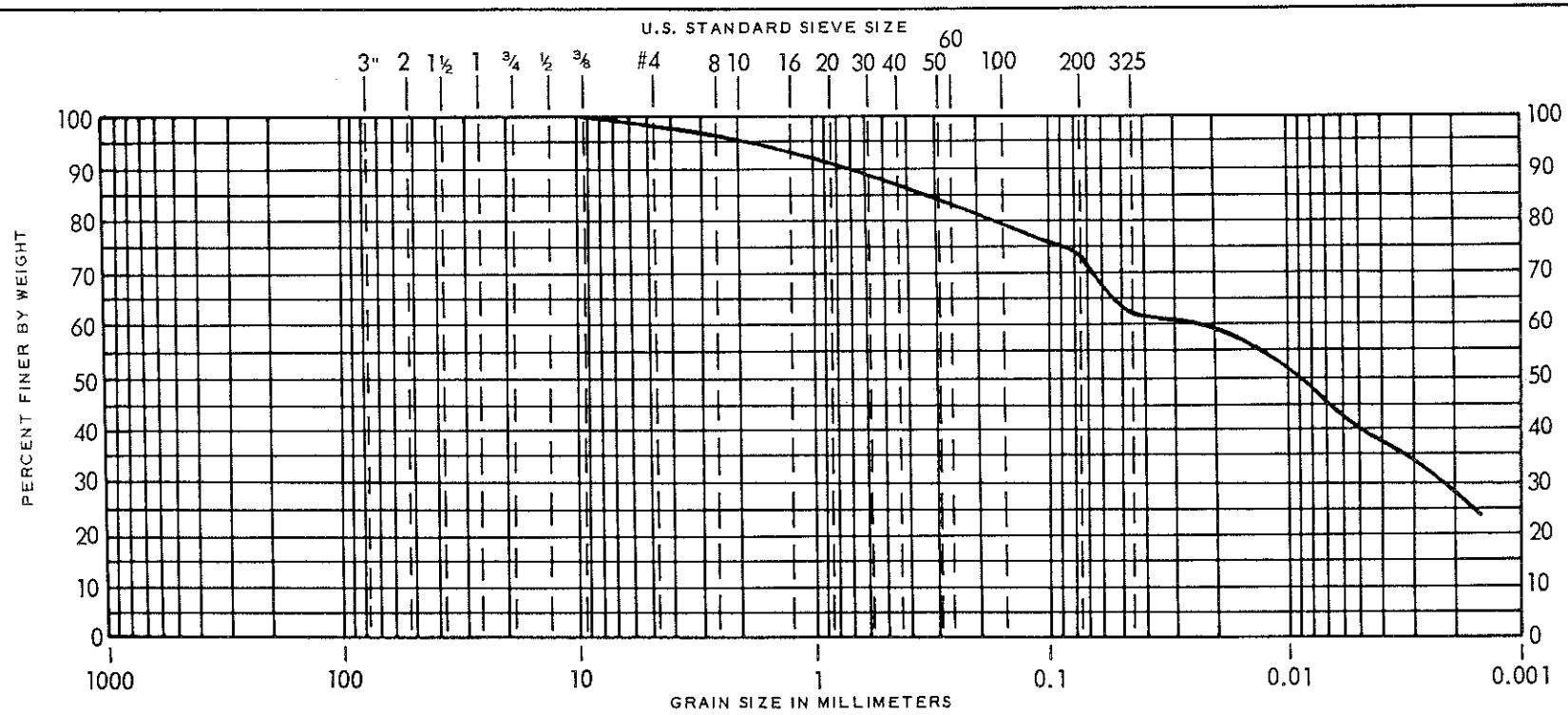
TESTING LABORATORIES, INC.

2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 2%		SAND 25%			SILT	CLAY
0%	COARSE	FINE	COARSE	MEDIUM	FINE	33%	40%

PROJECT	33767	NATURAL % MOISTURE	20.2
		LIQUID LIMIT	26
BORING NO.	12	PLASTIC LIMIT	17
SAMPLE NO.	2C	PLASTICITY INDEX	9
DEPTH	14.0-16.0'	COLOR	Gray
CLASSIFICATION	Sandy clay, "CL"	REMARKS	U.S.C.S.
	A-4(4)		A.A.S.H.T.O. M145-73

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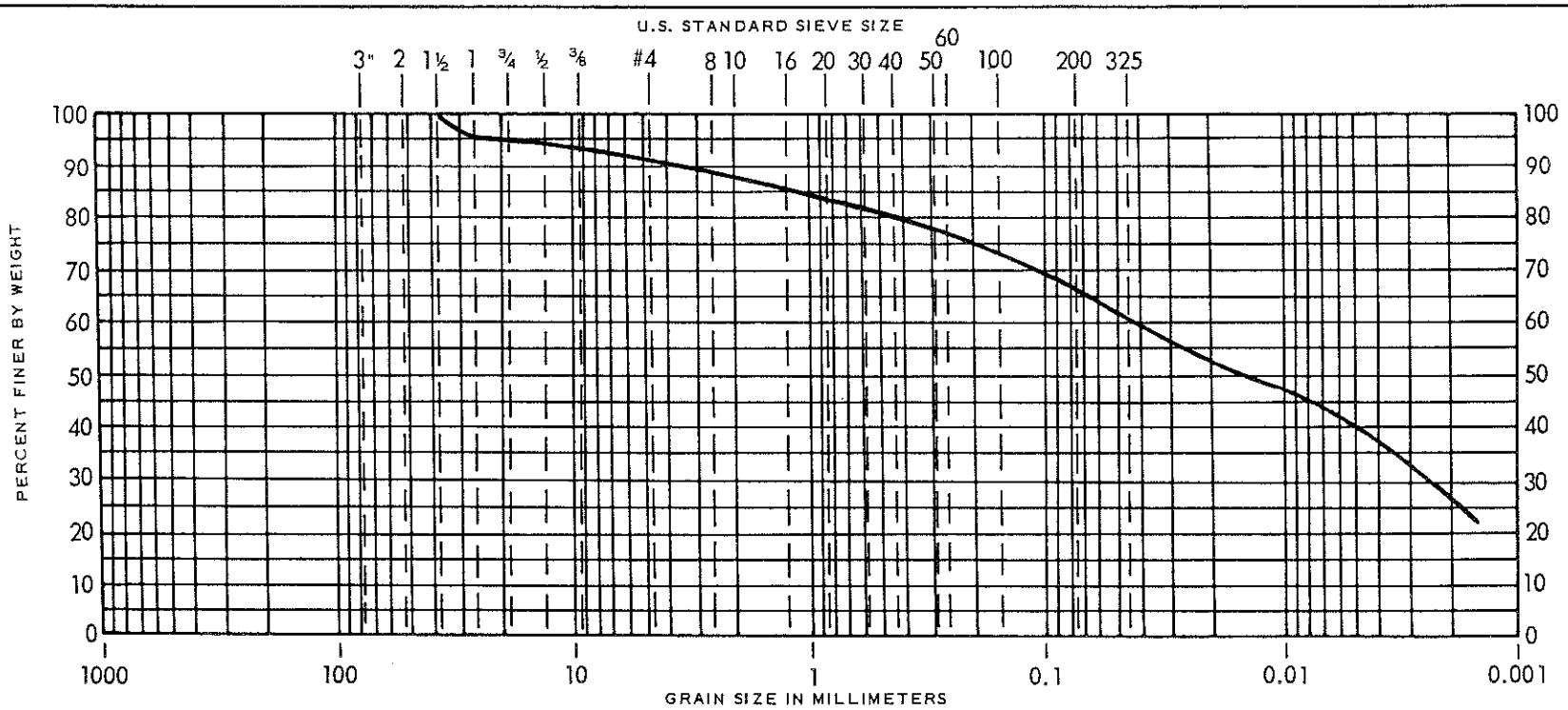
TESTING LABORATORIES, INC.

2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 8%		SAND 25%			SILT	CLAY
0%	COARSE	FINE	COARSE	MEDIUM	FINE	27%	40%

PROJECT	33767	NATURAL % MOISTURE	15.6
		LIQUID LIMIT	--
BORING NO.	12	PLASTIC LIMIT	--
SAMPLE NO.	4C	PLASTICITY INDEX	--
DEPTH	34.0-36.0'	COLOR	Gray

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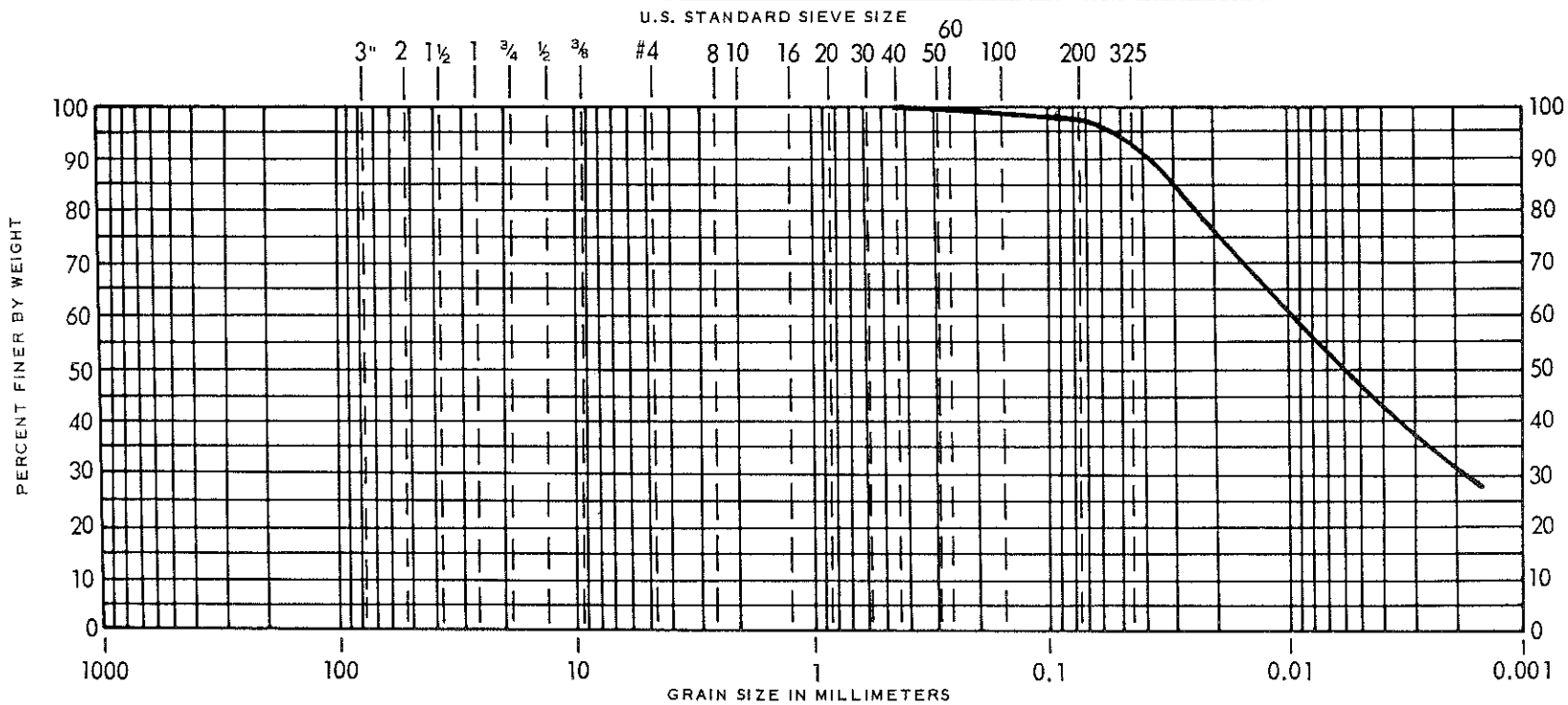
TESTING LABORATORIES, INC.

2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 0%		SAND 3%			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	50%	47%

PROJECT	33767	NATURAL % MOISTURE	25.6
		LIQUID LIMIT	--
BORING NO.	14	PLASTIC LIMIT	--
SAMPLE NO.	2A	PLASTICITY INDEX	--
DEPTH	4.0-5.5'	COLOR	Brown
CLASSIFICATION		REMARKS	

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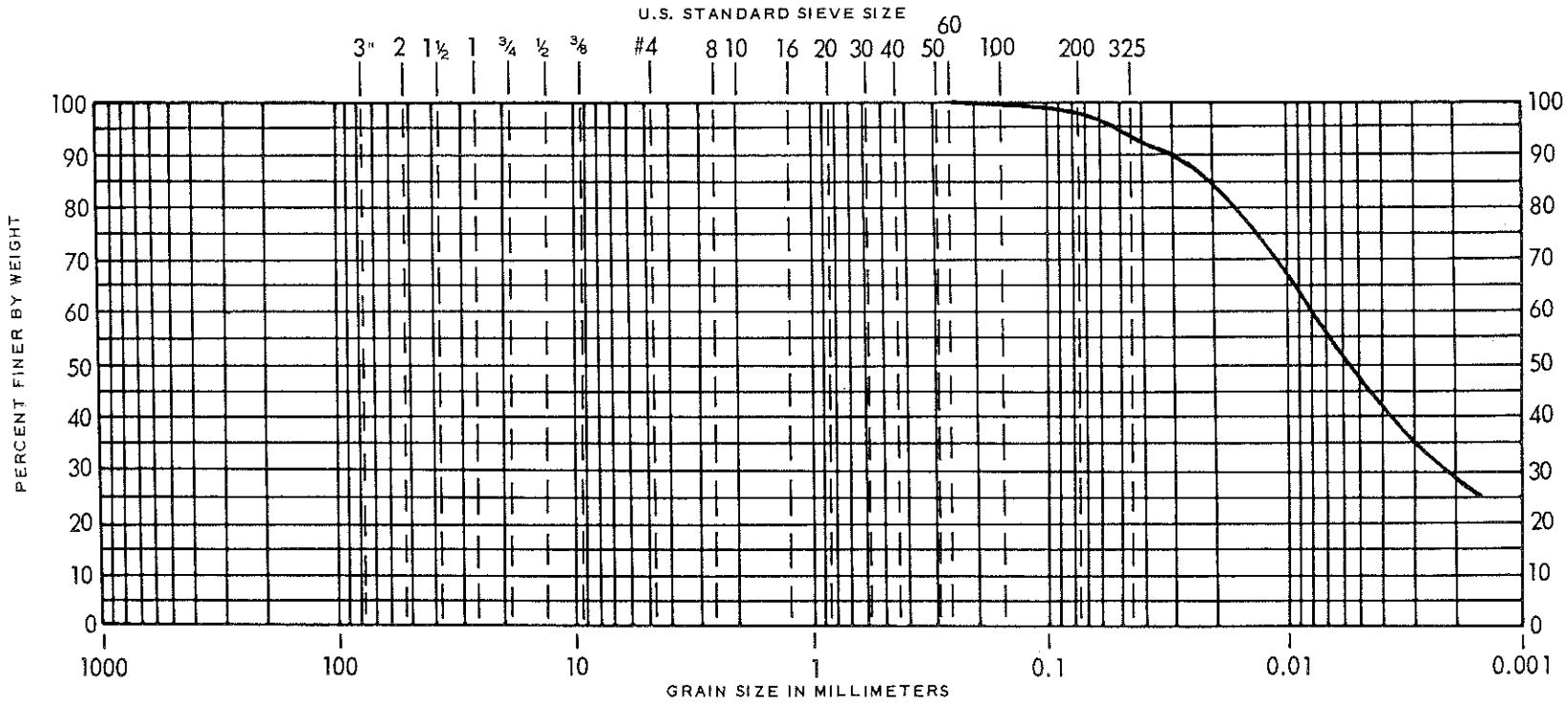
TESTING LABORATORIES, INC.

2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 0%		SAND 2%			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	50%	48%

PROJECT	33767	NATURAL % MOISTURE	27.3
		LIQUID LIMIT	--
BORING NO.	14	PLASTIC LIMIT	--
SAMPLE NO.	1C	PLASTICITY INDEX	--
DEPTH	9.0-11.0'	COLOR	Brown

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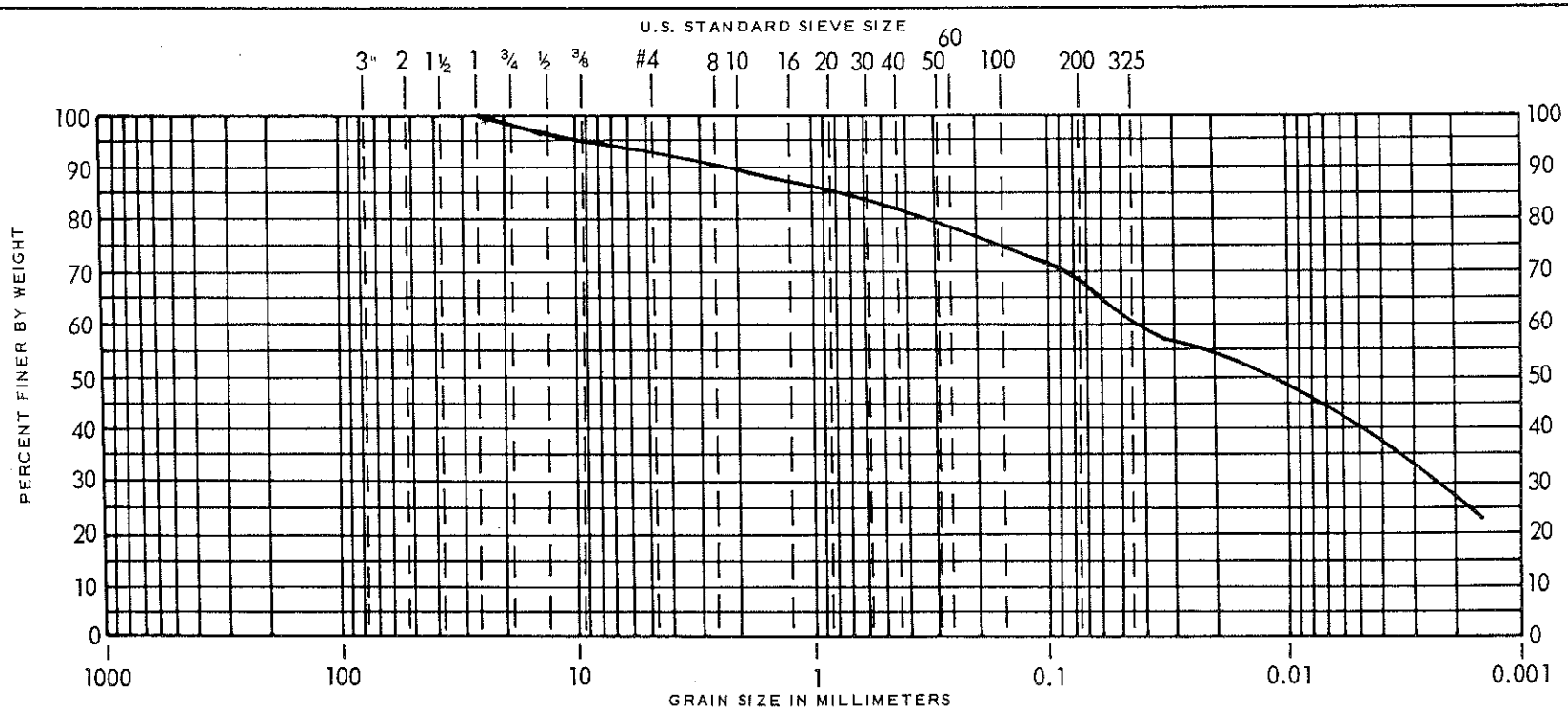
TESTING LABORATORIES, INC.

2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 8%		SAND 24%			SILT	CLAY
0%	COARSE	FINE	COARSE	MEDIUM	FINE	28%	40%

PROJECT	33767	NATURAL % MOISTURE	18.3
BORING NO.	14	LIQUID LIMIT	25
SAMPLE NO.	2C	PLASTIC LIMIT	16
DEPTH	19.0-21.0'	PLASTICITY INDEX	9
CLASSIFICATION	Sandy clay, "CL"	COLOR	Gray
	A-4(4)	REMARKS	U.S.C.S.
			A.A.S.H.T.O. M145-73

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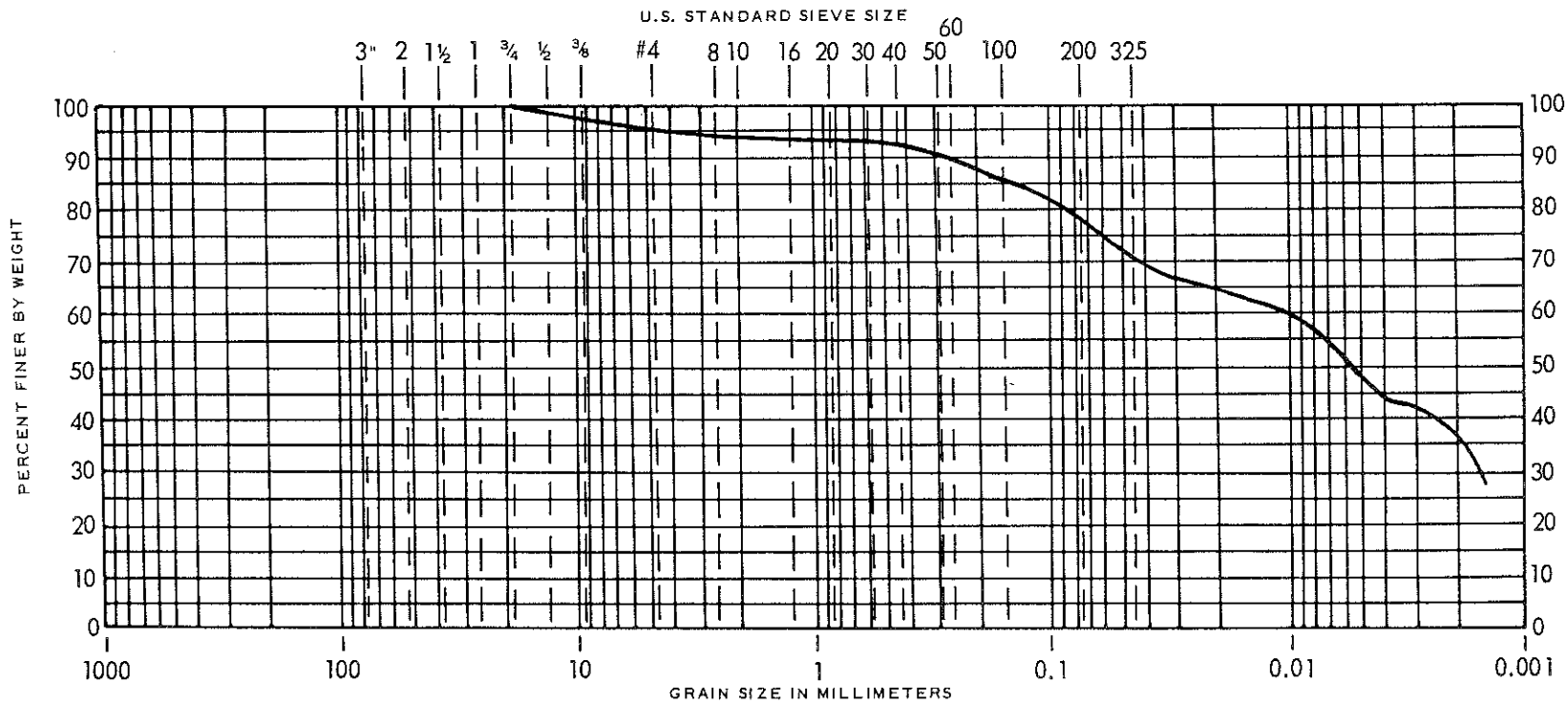
TESTING LABORATORIES, INC.

2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 5%		SAND 17%			SILT	CLAY
0%	COARSE	FINE	COARSE	MEDIUM	FINE	30%	48%

PROJECT	33767	NATURAL % MOISTURE	15.2
		LIQUID LIMIT	29
BORING NO.	14	PLASTIC LIMIT	17
SAMPLE NO.	4C	PLASTICITY INDEX	12
DEPTH	39.0-41.0'	COLOR	Gray
CLASSIFICATION	Lean clay, "CL"	REMARKS	U.S.C.S.
	A-6(7)		A.A.S.H.T.O. M145-73

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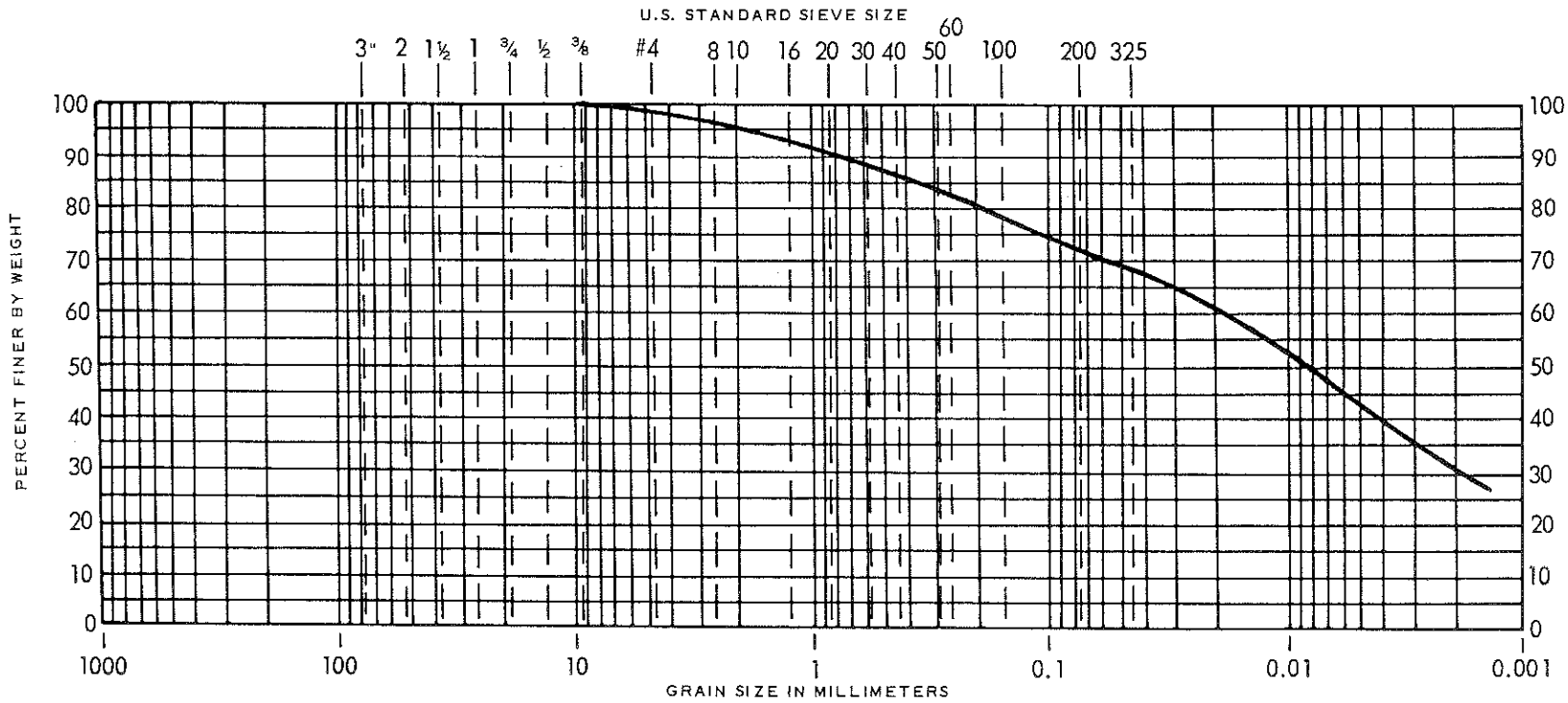
TESTING LABORATORIES, INC.

2A-34R

SOIL CLASSIFICATION SHEET



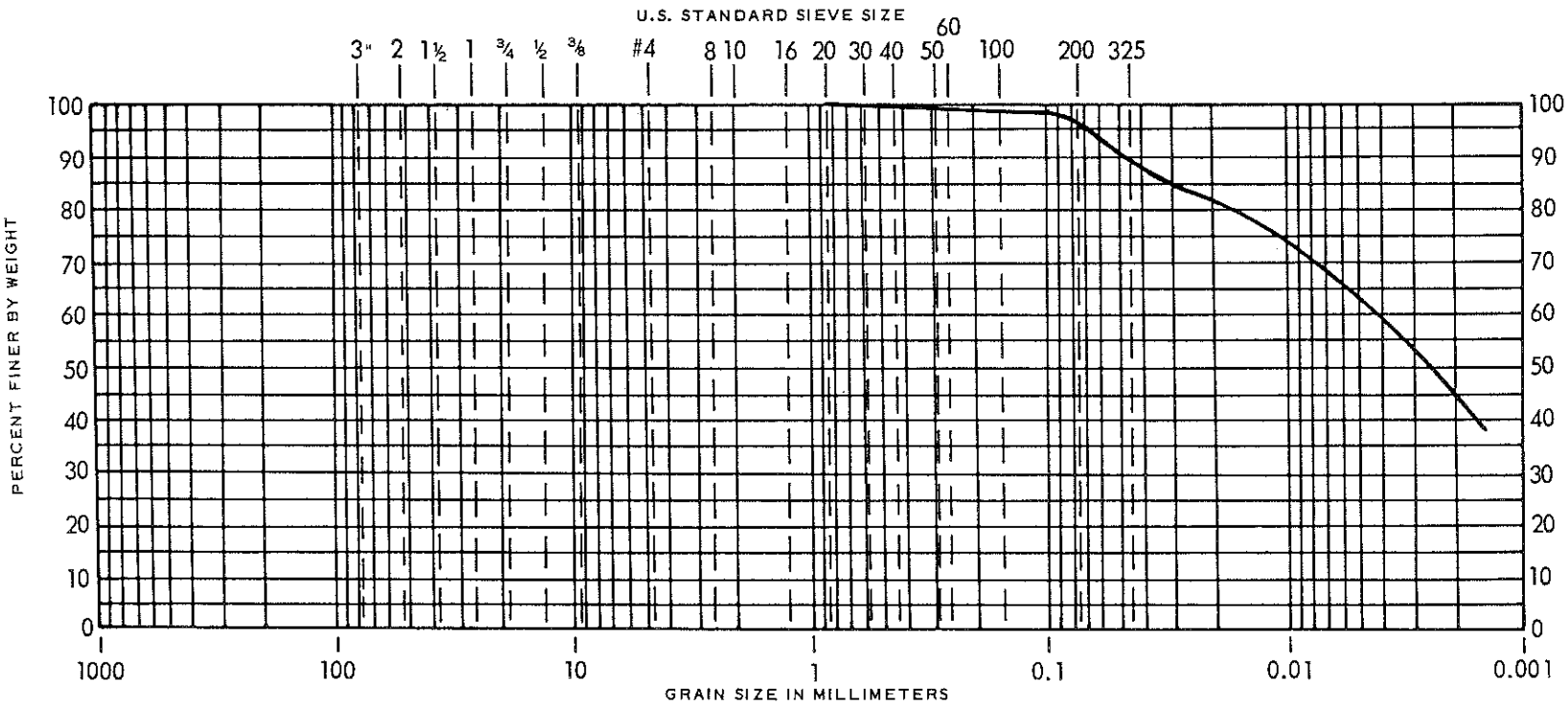
COBBLES	GRAVEL 2%		SAND 26%			SILT	CLAY
0%	COARSE	FINE	COARSE	MEDIUM	FINE	29%	43%

PROJECT	33767	NATURAL % MOISTURE	17.9
BORING NO.	18	LIQUID LIMIT	--
SAMPLE NO.	8A	PLASTIC LIMIT	--
DEPTH	34.0-35.5'	PLASTICITY INDEX	--
CLASSIFICATION		COLOR	Gray
		REMARKS	

BOWSER-MORNER
TESTING LABORATORIES, INC.

2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 0%		SAND 3%			SILT 34%	CLAY 63%
	COARSE	FINE	COARSE	MEDIUM	FINE		

PROJECT	33767	NATURAL % MOISTURE	28.9
		LIQUID LIMIT	42
BORING NO.	19	PLASTIC LIMIT	24
SAMPLE NO.	1C	PLASTICITY INDEX	18
DEPTH	7.0-9.0'	COLOR	Gray/Brown
CLASSIFICATION	Silty clay, "CL"	REMARKS	U.S.C.S.
	A-7-6(20)		A.A.S.H.T.O. M145-73

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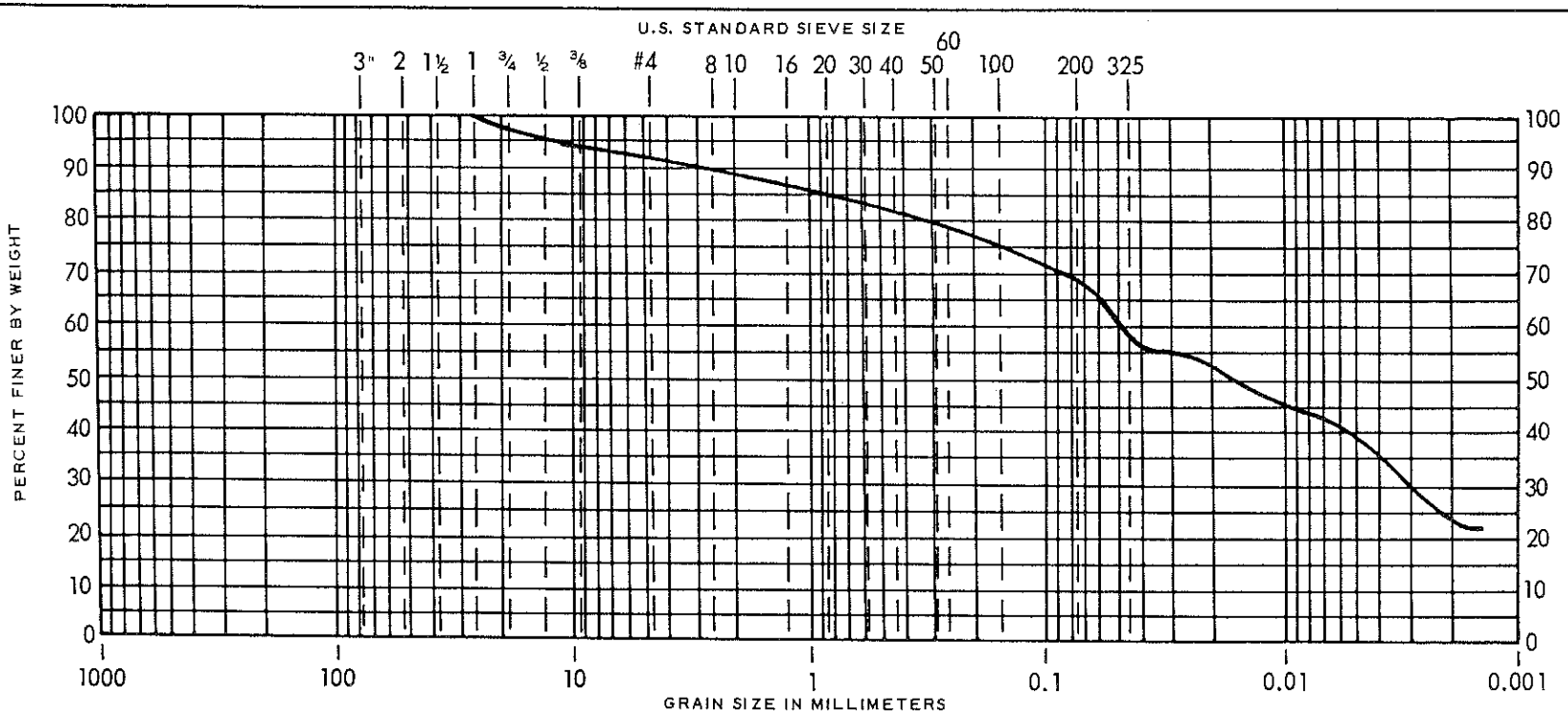
2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 8%		SAND 23%			SILT	CLAY
0%	COARSE	FINE	COARSE	MEDIUM	FINE	29%	40%

PROJECT	33767
BORING NO.	19
SAMPLE NO.	2C
DEPTH	27.0-29.0'
CLASSIFICATION	Sandy clay, "CL"
	A-4(3)

NATURAL % MOISTURE	17.3
LIQUID LIMIT	25
PLASTIC LIMIT	17
PLASTICITY INDEX	8
COLOR	Gray
REMARKS	U.S.C.S.
	A.A.S.H.T.O. M145-73

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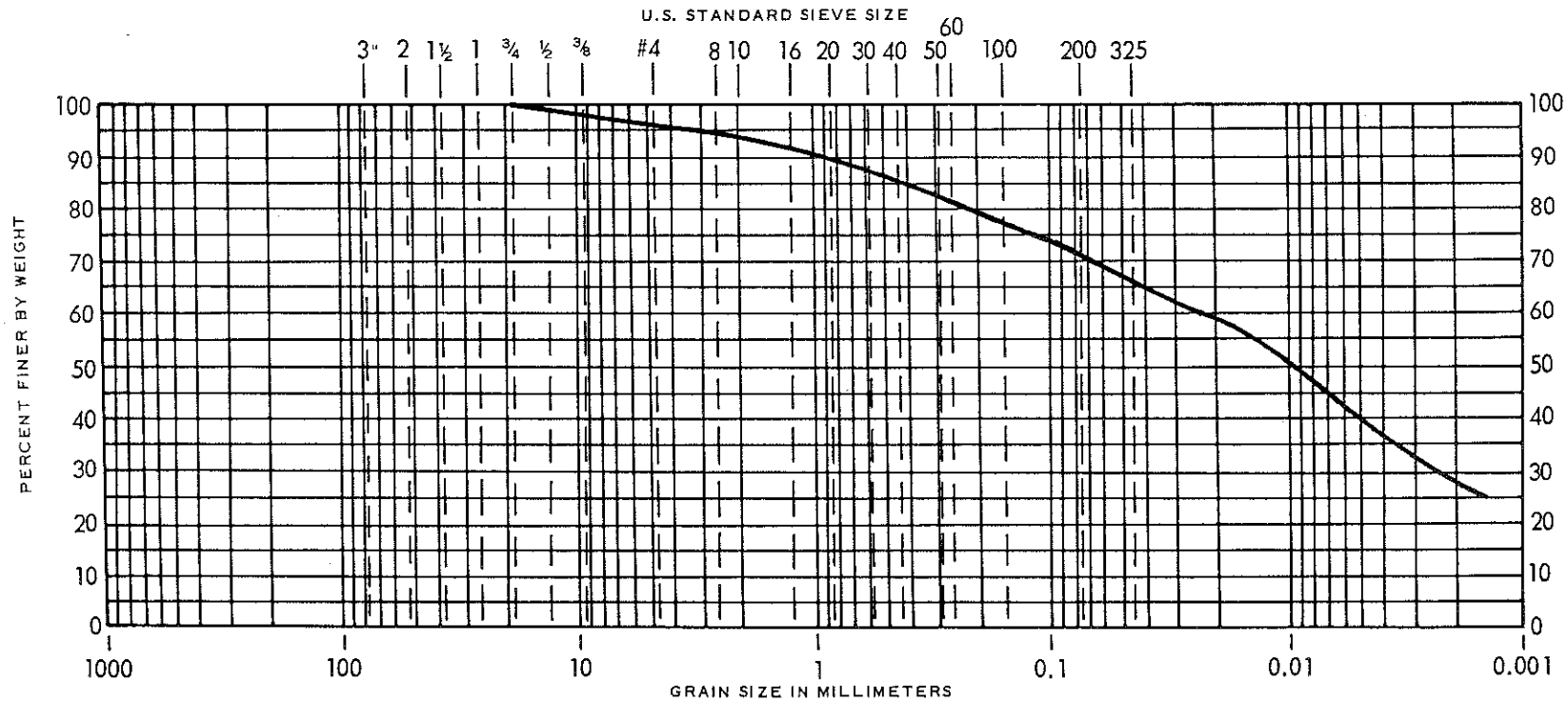
TESTING LABORATORIES, INC.

2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 4%		SAND 25%			SILT	CLAY
0%	COARSE	FINE	COARSE	MEDIUM	FINE	31%	40%

PROJECT	33767	NATURAL % MOISTURE	16.3
		LIQUID LIMIT	--
BORING NO.	19	PLASTIC LIMIT	--
SAMPLE NO.	10A	PLASTICITY INDEX	--
DEPTH	44.0-45.5'	COLOR	Gray
CLASSIFICATION		REMARKS	

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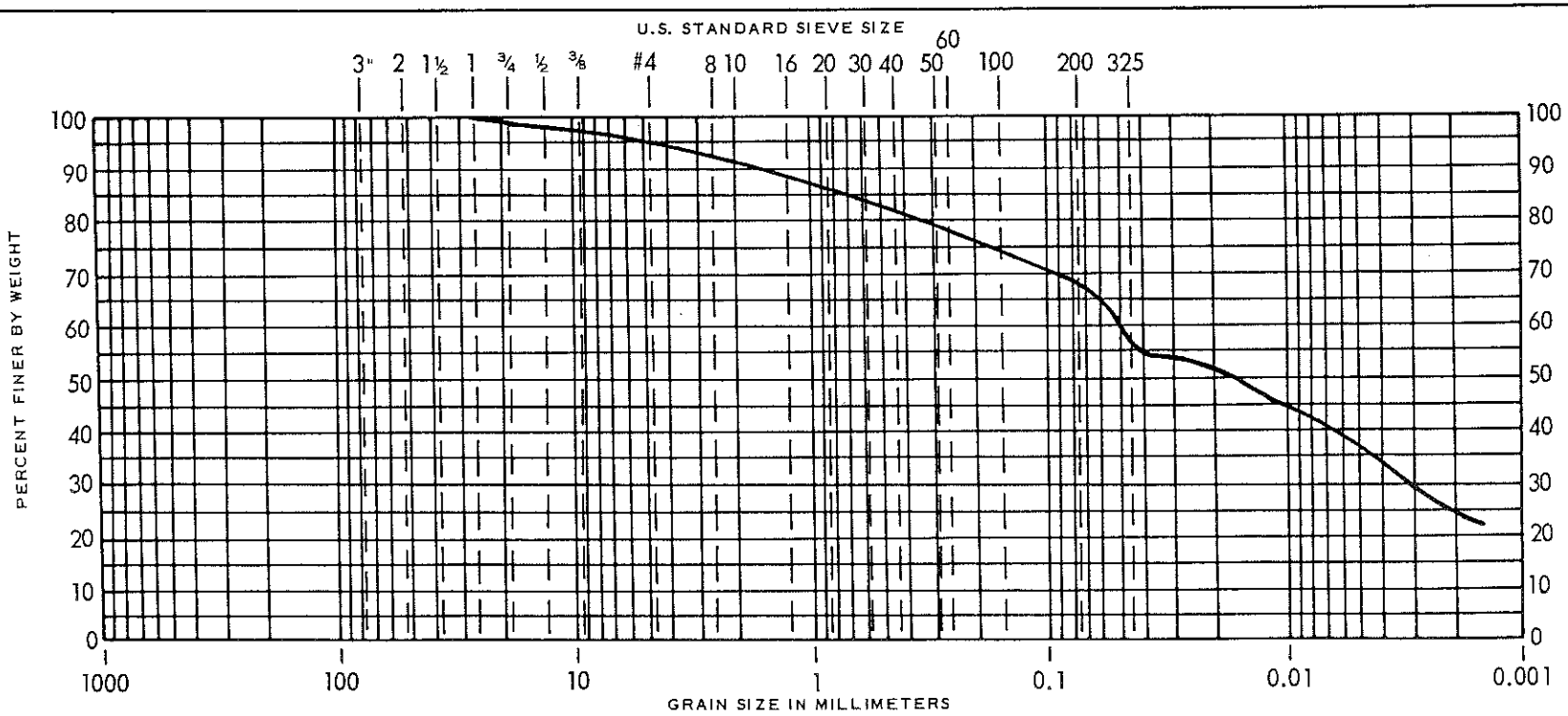
2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 5%		SAND 27%			SILT	CLAY
0%	COARSE	FINE	COARSE	MEDIUM	FINE	31%	37%

PROJECT	33767	NATURAL % MOISTURE	19.4
		LIQUID LIMIT	--
BORING NO.	22	PLASTIC LIMIT	--
SAMPLE NO.	3C	PLASTICITY INDEX	--
DEPTH	24.0-26.0'	COLOR	Gray

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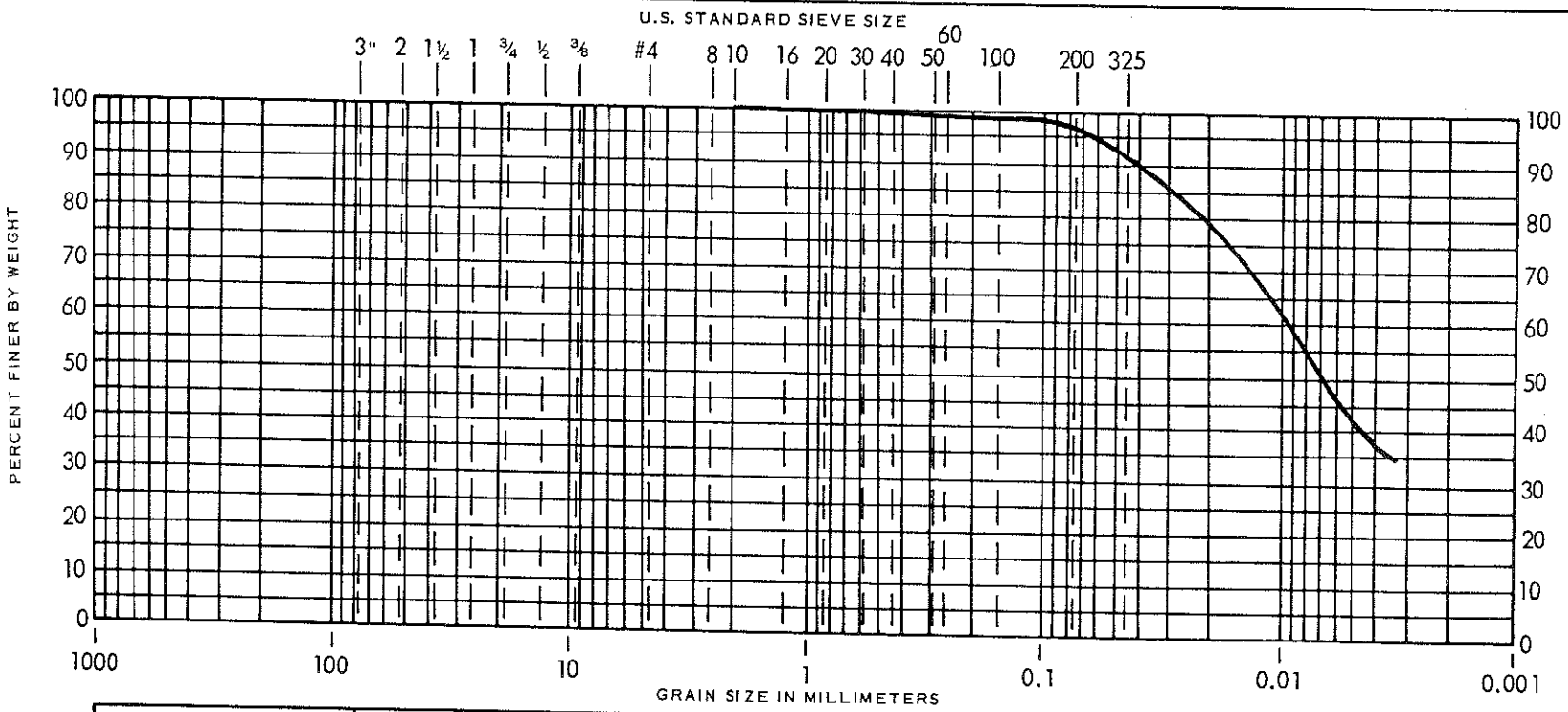
2A-34R

SOIL CLASSIFICATION SHEET



COBBLES	GRAVEL 0%		SAND 3%			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	55%	42%

PROJECT	33767	NATURAL % MOISTURE	--
BORING NO.	25	LIQUID LIMIT	32
SAMPLE NO.	1C	PLASTIC LIMIT	21
DEPTH	7.0-9.0'	PLASTICITY INDEX	11
CLASSIFICATION	Silty clay, "CL"	COLOR	Gray and brown mottled
	A-6(11)	REMARKS	U.S.C.S.
			A.A.S.H.T.O. M145-73

BOWSER-MORNER
TESTING LABORATORIES, INC.

2A-34R

Constant Head
Permeability Test

Project:	33767
Boring No:	1
Sample No:	2C
Depth Interval of Sample:	12.0'-14.0'
Depth Interval of Test Specimen:	12.4'-12.6'
Material Description:	Gray silt and clay, trace sand

SPECIMEN DATA:

Dimensions, inches,	
Height:	2.077
Diameter:	2.796
Weight, lbs.,	
Initial:	0.919
Moisture Content, %:	
Initial:	28.1
Final:	27.5
Wet Unit Weight, pcf,	
Initial:	124.5
Final:	123.9
Dry Unit Weight, pcf,	
Initial:	97.2
Back Pressure Saturation, psi,	
Pressures:	10.0
Permability, cm/sec,	
k:	7.0×10^{-9}

Constant Head
Permeability Test

Project:	33767
Boring No:	5
Sample No:	3C
Depth Interval of Sample:	27.5'-29.5'
Depth Interval of Test Specimen:	28.0'-28.2'
Material Description:	Gray clay, some silt, some sand, trace gravel

SPECIMEN DATA:

Dimensions, inches,	
Height:	2.000
Diameter:	2.766
Weight, lbs.,	
Initial:	0.961
Moisture Content, %:	
Initial:	18.8
Final:	18.0
Wet Unit Weight, pcf,	
Initial:	138.1
Final:	137.1
Dry Unit Weight, pcf,	
Initial:	116.2
Back Pressure Saturation, psi,	
Pressures:	10.0
Permability, cm/sec,	
k:	1.5×10^{-8}

Constant Head
Permeability Test

Project:	33767
Boring No:	9
Sample No:	1C
Depth Interval of Sample:	9.0'-11.0'
Depth Interval of Test Specimen:	10.0'-10.2'
Material Description:	Gray silt, some clay, trace sand

SPECIMEN DATA:

Dimensions, inches,	
Height:	2.229
Diameter:	2.848
Weight, lbs.,	
Initial:	0.993
Moisture Content, %:	
Initial:	27.0
Final:	28.4
Wet Unit Weight, pcf,	
Initial:	120.9
Final:	122.2
Dry Unit Weight, pcf,	
Initial:	95.1
Back Pressure Saturation, psi,	
Pressures:	10.0
Permability, cm/sec,	
k:	6.1×10^{-9}

Constant Head
Permeability Test

Project:	33767
Boring No:	9
Sample No:	3C
Depth Interval of Sample:	29.0'-31.0'
Depth Interval of Test Specimen:	30.0'-30.2'
Material Description:	Gray clay, some silt, some sand, trace gravel

SPECIMEN DATA:

Dimensions, inches,	
Height:	2.000
Diameter:	2.787
Weight, lbs.,	
Initial:	0.948
Moisture Content, %:	
Initial:	18.0
Final:	18.1
Wet Unit Weight, pcf,	
Initial:	134.2
Final:	134.2
Dry Unit Weight, pcf,	
Initial:	113.7
Back Pressure Saturation, psi,	
Pressures:	10.0
Permability, cm/sec,	
k:	1.6×10^{-8}

Constant Head
Permeability Test

Project:	33767
Boring No:	12
Sample No:	2C
Depth Interval of Sample:	14.0'-16.0'
Depth Interval of Test Specimen:	14.2'-14.4'
Material Description:	Gray clay, some silt, some sand, trace gravel

SPECIMEN DATA:

Dimensions, inches,

Height:	2.025
Diameter:	2.803

Weight, lbs.,

Initial:	0.916

Moisture Content, %:

Initial:	23.2
Final:	22.6

Wet Unit Weight, pcf,

Initial:	126.7
Final:	126.1

Dry Unit Weight, pcf,

Initial:	102.8

Back Pressure Saturation, psi,

Pressures:	10.0

Permability, cm/sec,

k:	2.6×10^{-8}

Constant Head
Permeability Test

Project:	33767
Boring No:	12
Sample No:	4C
Depth Interval of Sample:	34.0'-36.0'
Depth Interval of Test Specimen:	35.0'-35.2'
Material Description:	Gray clay, some silt, some sand, trace gravel

SPECIMEN DATA:

Dimensions, inches,	
Height:	2.086
Diameter:	2.809
Weight, lbs.,	
Initial:	1.019
Moisture Content, %:	
Initial:	17.7
Final:	17.8
Wet Unit Weight, pcf,	
Initial:	136.1
Final:	136.3
Dry Unit Weight, pcf,	
Initial:	115.7
Back Pressure Saturation, psi,	
Pressures:	10.0
Permability, cm/sec,	
k:	1.6×10^{-8}

Constant Head
Permeability Test

Project:	33767
Boring No:	14
Sample No:	1C
Depth Interval of Sample:	9.0'-11.0'
Depth Interval of Test Specimen:	10.3'-10.5'
Material Description:	Gray clay and silt, trace sand, trace gravel

SPECIMEN DATA:

Dimensions, inches,	
Height:	2.000
Diameter:	2.828
Weight, lbs.,	
Initial:	0.894
Moisture Content, %:	
Initial:	29.9
Final:	30.8
Wet Unit Weight, pcf,	
Initial:	123.0
Final:	123.8
Dry Unit Weight, pcf,	
Initial:	94.7
Back Pressure Saturation, psi,	
Pressures:	10.0
Permability, cm/sec,	
k:	3.5×10^{-8}

Constant Head
Permeability Test

Project:	33767
Boring No:	14
Sample No:	2C
Depth Interval of Sample:	19.0'-21.0'
Depth Interval of Test Specimen:	20.4'-20.2'
Material Description:	Gray clay, some silt, some sand, trace gravel

SPECIMEN DATA:

Dimensions, inches,	
Height:	2.000
Diameter:	2.780
Weight, lbs.,	
Initial:	0.923
Moisture Content, %:	
Initial:	19.5
Final:	18.9
Wet Unit Weight, pcf,	
Initial:	131.4
Final:	130.7
Dry Unit Weight, pcf,	
Initial:	110.0
Back Pressure Saturation, psi,	
Pressures:	10.0
Permability, cm/sec,	
k:	2.2×10^{-8}

Constant Head
Permeability Test

Project:	33767
Boring No:	14
Sample No:	4C
Depth Interval of Sample:	39.0'-41.0'
Depth Interval of Test Specimen:	40.4'-40.6'
Material Description:	Gray clay, some silt, some sand, trace gravel

SPECIMEN DATA:

Dimensions, inches,	
Height:	2.116
Diameter:	2.855
Weight, lbs.,	
Initial:	1.044
Moisture Content, %:	
Initial:	12.1
Final:	16.2
Wet Unit Weight, pcf,	
Initial:	133.2
Final:	138.1
Dry Unit Weight, pcf,	
Initial:	118.8
Back Pressure Saturation, psi,	
Pressures:	10.0
Permability, cm/sec,	
k:	8.4×10^{-9}

Constant Head
Permeability Test

Project:	33767
Boring No:	19
Sample No:	1C
Depth Interval of Sample:	7.0'-9.0'
Depth Interval of Test Specimen:	8.3'-8.5'
Material Description:	Gray clay, some silt, trace sand

SPECIMEN DATA:

Dimensions, inches,	
Height:	2.050
Diameter:	2.811
Weight, lbs.,	
Initial:	0.888
Moisture Content, %:	
Initial:	15.6
Final:	25.8
Wet Unit Weight, pcf,	
Initial:	120.6
Final:	131.2
Dry Unit Weight, pcf,	
Initial:	104.3
Back Pressure Saturation, psi,	
Pressures:	10.0
Permability, cm/sec,	
k:	1.5×10^{-8}

Constant Head
Permeability Test

Project:	33767
Boring No:	19
Sample No:	2C
Depth Interval of Sample:	27.0'-29.0'
Depth Interval of Test Specimen:	28.0'-28.2'
Material Description:	Gray clay, some silt, some sand, trace gravel

SPECIMEN DATA:

Dimensions, inches,	
Height:	2.000
Diameter:	2.826
Weight, lbs.,	
Initial:	0.959
Moisture Content, %:	
Initial:	19.1
Final:	18.3
Wet Unit Weight, pcf,	
Initial:	132.1
Final:	131.2
Dry Unit Weight, pcf,	
Initial:	110.9
Back Pressure Saturation, psi,	
Pressures:	10.0
Permability, cm/sec,	
k:	3.1×10^{-8}

Constant Head
Permeability Test

Project:	33767
Boring No:	22
Sample No:	3C
Depth Interval of Sample:	24.0'-26.0'
Depth Interval of Test Specimen:	25.0'-25.2'
Material Description:	Gray clay, some silt, some sand, trace gravel

SPECIMEN DATA:

Dimensions, inches,	
Height:	2.150
Diameter:	2.784
Weight, lbs.,	
Initial:	0.991
Moisture Content, %:	
Initial:	27.5
Final:	24.6
Wet Unit Weight, pcf,	
Initial:	130.8
Final:	127.9
Dry Unit Weight, pcf,	
Initial:	102.6
Back Pressure Saturation, psi,	
Pressures:	10.0
Permability, cm/sec,	
k:	2.4×10^{-8}

Constant Head
Permeability Test

Project:	33767
Boring No:	25
Sample No:	1C
Depth Interval of Sample:	7.0'-9.0'
Depth Interval of Test Specimen:	8.0'-8.2'
Material Description:	24"

SPECIMEN DATA:

Orientation of Flow:	Horizontal
Dimensions, inches,	
Height:	
Diameter:	2.254
	2.814
Weight, lbs.,	
Initial:	1.014
Moisture Content, %	
Initial:	23.4
Final:	24.4
Dry Unit Weight, pcf,	
Initial	125.0
Final:	126.0
Dry Unit Weight, pcf,	
Initial:	101.3
Back Pressure Saturation, psi,	
Pressures:	45.0
Permeability, cm/sec,	
k:	8.6×10^{-8}

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Fill:							
2	1A	1.0- 2.5					17.3			
13	1A	1.0- 2.5					29.4			
23	1A	1.0- 2.5					25.4			
	2A	4.5- 6.0					29.3			
	3A	9.5-11.0					26.4			
26	1A	1.0- 2.5					20.0			
	2A	4.0- 5.5					54.8			
	3A	9.0-10.5					28.7			
			Lucustrine deposits: Brown and/or Gray silty clay or clay ey silt with varying amounts of sand and occasional traces of gravel.							
1	1A	1.0- 2.5					14.4			CL
	1C	4.0- 6.0					Not Taken			
	2A	6.0- 7.5					24.7			
	3A	9.0-10.5					27.2			
	2C	12.0-14.0					27.7	97.2		CL
	4A	14.0-15.5					29.8			
	5A	19.0-20.5					29.2			ML-CL
	6A	24.0-25.5					21.3			

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Lacustrine deposits (Continued)							
2	2A	4.0- 5.5					22.9			
	1C	7.0- 9.0					Not Taken			
	3A	9.0-10.5					26.0			CL
	4A	14.0-15.5					25.1			
3	1A	1.0- 2.5					26.6			
	2A	4.0- 5.5					28.1			
	3A	9.0-10.5					26.0			
5	1A	1.0- 2.5					17.6			CL
	1C	4.0- 6.0					Not Taken			
6	1A	1.0- 2.5					26.5			
	2A	4.0- 5.5					27.8			
	3A	9.0-10.5					25.5			
7	1A	1.0- 2.5					23.2			
	2A	4.0- 5.5					23.0			
	3A	9.0-10.5					22.6			

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Lacustrine deposits (Continued)							
8	1A	1.0- 2.5					25.0			
	2A	4.0- 5.5					22.2			
9	1A	1.0- 2.5					18.3			
	2A	4.0- 5.5					24.2			
	1C	9.0-11.0					26.2	95.1		ML
10	1A	1.0- 2.5					20.2			
	2A	4.5- 6.0					22.3			
	3A	9.5-11.0					24.7			
	4A	14.5-16.0					25.4			
	5A	19.5-21.0					16.3			
11	1A	1.0- 2.5					21.3			
	2A	4.0- 5.5					26.6			
	3A	9.0-10.5					25.3			ML-CL
	4A	14.0-15.5					28.6			
12	1A	1.0- 2.5					19.9			
	1C	4.0- 6.0					Not Taken			
	2A	9.0-10.5					24.6			

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Lacustrine deposits (Continued)							
13	2A	4.0- 5.5					26.1			
	3A	9.0-10.5					23.9			
	4A	14.0-15.5					25.0			
14	1A	1.0- 2.5					12.6			
	2A	4.0- 5.5					25.6			ML-CL
	1C	9.0-11.0					27.3	94.7		ML-CL
15	1A	1.0- 2.5					18.7			
	2A	4.0- 5.5					26.2			
	3A	9.0-10.5					31.7			
	4A	14.0-15.5					29.6			
	5A	19.0-20.5					26.8			
	6A	24.0-25.5					46.0			
16	1A	1.0- 2.5					27.0			
	2A	4.0- 5.5					23.1			
	3A	9.0-10.5					25.3			
	4A	14.0-15.5					29.5			
	5A	19.0-20.5					29.7			

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Lacustrine deposits (Continued)							
17	1A	1.0- 2.5					25.3			
	2A	4.5- 6.0					25.9			
	3A	9.5-11.0					28.6			
	4A	14.5-16.0					41.6			
18	1A	1.0- 2.5					22.0			
	2A	4.0- 5.5					25.5			
	3A	9.0-10.5					28.4			
	4A	14.0-15.5					31.9			
	5A	19.0-20.5					27.8			
19	1A	1.0- 2.5					22.2			
	2A	4.0- 5.5					21.9			
	1C	7.0- 9.0					28.9	104.3		CL
	3A	9.0-10.5					34.9			
	4A	14.0-15.5					31.6			
20	1A	1.0- 2.5					22.1			
	2A	4.0- 5.5					26.6			
	3A	9.0-10.5					26.8			
	4A	14.0-15.5					31.1			

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Lacustrine deposits (Continued)							
21	1A	1.0- 2.5					22.7			
	2A	4.5- 6.0					23.8			
	3A	9.5-11.0					25.0			
22	1A	1.0- 2.5					17.2			
	1C	4.0- 6.0					Not Taken			
	2A	9.0-10.5					28.0			
23	4A	14.5-16.0					25.0			
24	1A	1.0- 2.5					25.1			
	2A	4.5- 6.0					24.0			
	3A	9.5-11.0					28.7			
	4A	14.5-16.0					37.5			
	5A	19.5-21.0					36.1			
25	1A	1.0- 2.5					19.5			
	2A	4.0- 5.5					28.3			
	1C	7.0- 9.0					23.4	101.3		CL
	3A	9.0-10.5					19.8			

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plasticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classification
			Lacustrine deposits (Continued)							
26	4A	14.0-15.5					26.3			
	5A	19.0-20.5					24.8			
	6A	24.0-25.5					30.5			
27	1A	1.0- 2.5					20.8			
	2A	4.5- 6.0					29.0			
	3A	9.5-11.0					21.1			
28	1A	1.0- 2.5					20.3			
	2A	4.5- 6.0					24.5			
	3A	9.5-11.0					28.8			
29	1A	1.0- 2.5					17.1			
	1C	4.0- 6.0					Not Taken			
30	1A	1.0- 2.5					21.0			
	2A	4.0- 5.5					21.9			
	3A	9.0-10.5					22.6			
31	1A	1.0- 2.5					19.5			
	2A	4.0- 5.5					22.6			
	3A	9.0-10.5					27.1			
	4A	14.0-15.5					26.2			

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Lacustrine deposits (Continued)							
32	1A	1.0- 2.5					28.4			
	2A	4.0- 5.5					26.3			
	3A	9.0-10.5					29.7			
			Glacial Till Brown and/or Gray, silty clay or clay-ey silt, some sand, trace of gravel:							
1	7A	29.0-30.5					18.8			
	3C	34.0-36.0					Not Taken			
2	5A	19.0-20.5					26.1			
	6A	24.0-25.5					17.9			
	7A	29.0-30.5					19.4			
	8A	34.0-35.5					19.7			
	9A	39.0-40.5					17.0			
3	4A	14.0-15.5					20.8			
	5A	19.0-20.5					18.2			
	6A	24.0-25.5					19.7			
	7A	29.0-30.5					19.6			
	8A	34.0-35.5					16.8			
4	1A	1.0- 2.5					21.4			
	2A	4.0- 5.5					19.2			

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Glacial Till deposits (Continued)							
4	3A	9.0-10.5					17.3			
	4A	14.0-15.5					17.6			
	5A	19.0-20.5					18.9			
	6A	24.0-25.5					19.9			
	7A	29.0-30.5					20.0			
	8A	34.0-35.5					16.4			
5	2A	6.0- 7.5					14.7			
	3A	9.0-10.5					17.0			
	2C	13.0-15.0					Not Taken			
	4A	15.0-16.5					18.5			
	5A	19.0-20.5					19.8			
	6A	24.0-25.5					19.2			
	3C	27.5-29.5					18.8	116.2		CL
	7A	29.8-31.0					No Sample			
	8A	34.0-35.5					17.9			

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Glacial Till deposits (Continued)							
6	4A	14.0-15.5					26.8			
	5A	19.0-20.5					18.7			
	6A	24.0-25.5					20.3			
	7A	29.0-30.5					16.0			
	8A	34.0-35.5					14.4			
7	4A	14.0-15.5					16.3			
	5A	19.0-20.5					18.6			
	6A	24.0-25.5					17.8			
	7A	29.0-30.5					19.8			
	8A	34.0-35.5					16.8			
	9A	39.0-40.5					14.9			
8	3A	9.0-10.5					13.0			
	4A	14.0-15.5					18.9			
	5A	19.0-20.5					19.1			
	6A	24.0-25.5					18.5			
	7A	29.0-30.5					19.2			
	8A	34.0-35.5					17.9			
	9A	39.0-40.5					15.4			

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Glacial Till deposits (Continued)							
9	3A	14.0-15.5					28.2			CL
	2C	19.0-21.0					Not Taken			
	4A	24.0-25.5					18.0			
	3C	29.0-31.0					17.6	113.7		CL
	5A	34.0-35.5					17.3			
	4C	39.0-41.0					Not Taken			
	6A	41.0-42.5					14.1			
10	5A	19.5-21.0					16.3			
	6A	24.5-26.0					18.2			
	7A	29.5-31.0					18.4			
	8A	34.5-36.0					18.3			
	9A	39.5-41.0					16.7			
11	5A	19.0-20.5					18.5			
	6A	24.0-25.5					18.5			CL
	7A	29.0-30.5					18.8			
	8A	34.0-35.5					18.0			
	9A	39.0-40.5					15.5			

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Glacial Till deposits (Continued)							
12	2C	14.0-16.0					20.2	102.8		CL
	3A	19.0-20.5					34.9			
	3C	24.0-26.0					Not Taken			
	4A	29.0-30.5					19.0			
	4C	34.0-36.0					15.6	115.7		CL
	5A	39.0-40.5					14.8			
13	5A	19.0-20.5					38.3			
	6A	24.0-25.5					20.4			
	7A	29.0-30.5					19.8			
	8A	34.0-35.5					18.2			
	9A	39.0-40.5					15.6			
14	3A	14.0-15.5					28.1			
	2C	19.0-21.0					18.3	110.0		CL
	4A	24.0-25.5					18.3			
	3C	29.0-31.0					Not Taken			
	5A	34.0-35.5					16.8			
	4C	39.0-41.0					15.2	118.8		CL

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Glacial Till deposits (Continued)							
15	7A	29.0-30.5					20.1			
	8A	34.0-35.5					18.4			
	9A	39.0-40.5					15.4			
16	6A	24.0-25.5					26.8			
	7A	29.0-30.5					19.0			
	8A	34.0-35.5					18.9			
	9A	39.0-40.5					15.2			
17	5A	19.5-21.0					19.1			
	6A	24.5-26.0					20.6			
	7A	29.5-31.0					19.4			
	8A	34.5-36.0					18.8			
	9A	39.5-41.0					15.2			
18	6A	24.0-25.5					32.9			
	7A	29.0-30.5					20.0			
	8A	34.0-35.5					17.9			CL
	9A	39.0-40.5					15.7			

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Glacial Till deposits (Continued)							
19	5A	19.0-20.5					20.0			
	6A	24.0-25.5					23.2			
	2C	27.0-29.0					17.3	110.9		CL
	7A	29.0-30.5					20.0			
	8A	34.0-35.5					19.1			
	9A	39.0-40.5					17.7			
20	5A	19.0-20.5					19.7			
	6A	24.0-25.5					20.2			
	7A	29.0-30.5					19.9			
	8A	34.0-35.5					17.5			
	9A	39.0-40.5					17.1			
21	4A	14.5-16.0					21.9			
	5A	19.5-21.0					19.6			
	6A	24.5-26.0					19.1			
	7A	29.5-31.0					18.8			
	8A	34.5-36.0					13.8			

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Glacial Till deposits (Continued)							
22	2C	14.0-16.0					Not Taken			
	3A	19.0-20.5					18.6			
	3C	24.0-26.0					19.4	102.6		CL
	4A	29.0-30.5					19.4			
	4C	34.0-34.5					Not Taken			
	5A	34.5-36.0					17.2			
	6A	39.0-40.5					16.6			
23	5A	19.5-21.0					25.3			
	6A	24.5-26.0					21.0			
	7A	29.5-30.0					21.0			
	8A	34.5-36.0					20.9			
	9A	39.5-41.0					19.1			
	10A	44.5-46.0					17.2			
	11A	49.5-51.0					18.7			
24	6A	24.5-26.0					20.5			
	7A	29.5-31.0					21.5			
	8A	34.5-36.0					17.9			
	9A	39.5-41.0					18.4			

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Glacial Till deposits (Continued)							
25	3A	9.0-10.5					19.8			
	4A	14.0-15.5					16.1			
	2C	17.0-19.0					Not Taken			
	5A	19.0-20.5					18.3			
	6A	24.0-25.5					18.0			
	3C	27.0-29.0					Not Taken			
	7A	29.0-30.5					19.0			
	8A	34.0-35.5					18.7			
	9A	39.0-40.5					16.3			
	10A	44.0-45.5					16.0			
26	7A	29.0-30.5					18.4			
	8A	34.0-35.5					18.3			
	9A	39.0-40.5					18.3			
	10A	44.0-45.5					17.0			

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Glacial Till deposits (Continued)							
27	4A	14.5-16.0					19.0			
	5A	19.5-21.0					19.4			
	6A	24.5-26.0					14.3			
	7A	29.5-31.0					19.8			
	8A	34.8-36.0					18.8			
	9A	39.5-41.0					17.5			
28	4A	14.5-16.0					20.5			
	5A	19.5-21.0					19.1			
	6A	24.5-26.0					19.7			
	7A	29.5-31.0					19.1			
	8A	34.5-36.0					18.9			
	9A	39.5-41.0					15.5			
29	2A	6.0- 7.5					15.7			
	3A	9.0-10.5					17.5			
	4A	14.0-15.5					17.3			
	5A	19.0-20.5					19.2			
	2C	23.0-25.0					Not Taken			

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plasticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classification
			Glacial Till deposits (Continued)							
29	6A	25.0-26.5					18.8			
	7A	29.0-30.5					17.3			
	8A	34.0-35.5					18.7			
30	4A	14.0-15.5					16.8			
	5A	19.0-20.5					21.0			
	6A	24.0-25.5					18.5			
	7A	29.0-30.5					17.9			
	8A	34.0-35.5					18.2			
	9A	39.0-40.5					15.6			
31	5A	19.0-20.5					18.5			
	6A	24.0-25.5					19.1			
	7A	29.0-30.5					19.2			
	8A	34.0-35.5					19.5			
32	4A	14.0-15.5					24.7			
	5A	19.0-20.5					25.6			
	6A	24.0-25.5					19.3			
	7A	29.0-30.5					19.1			
	8A	34.0-35.5					20.2			
	9A	39.0-40.5					15.9			

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Glacial Till Grey silt, some sand, some clay, trace gravel, usually contains gypsum.							
1	8A	36.0-37.5					14.3			
	9A	39.0-40.5					8.6			
2	10A	44.0-45.0					8.6			
	11A	49.0-49.5					*			
3	9A	39.0-40.5					Rock			
5	9A	39.0-40.0					12.4			SM-SC
10	10A	44.5-45.5					9.1			
11	10A	44.0-45.5					10.2			
15	10A	41.5-42.5					12.0			
17	10A	44.5-45.0					Rock			
18	10A	44.0-45.0					14.5			
19	10A	44.0-45.5					16.3			CL
	11A	49.0-49.5					---			
24	10A	44.5-45.5					14.1			
26	11A	49.0-49.5					7.9			
29	9A	39.0-40.5					9.6			

* Saturated

LABORATORY SUMMARY SHEET

Boring No.	Sample No.	Depth (Feet)	Material	Liquid Limits	Plastic Limits	Plas-ticity Index	Moisture Content (%)	Dry Unit Weight (pcf)	Unconfined Compressive Strength (psf)	U.S.C.S. Soil Classi-fication
			Tymochtee Formation							
1	10A	44.0-					No Sample			
2	11A	49.0-49.5					*			
4	9A	39.0-39.5					Rock			
6	9A	39.0-39.5					No Sample			
7	10A	43.5-44.0					24.8			
9	7A	44.0-44.5					Rock			
10	11A	49.5-50.0					Rock			
11	11A	49.0-49.5					*			
12	6A	44.0-44.5					Rock			
14	6A	44.0-44.5					9.1			
22	7A	44.0-45.5					*			
23	12A	54.5-55.0					16.9			
25	11A	49.0-49.5					Rock			
27	10A	43.0-43.5					Rock			
28	10A	44.5-45.0					Rock			
30	10A	43.0-43.5					8.2			
31	9A	39.0-40.5					16.8			
	10A	44.0-44.5					Rock			

* Saturated

BOWSER-MORNER Testing Laboratories, Inc.

CORPORATE ADDRESS • 420 Davis Ave. • P.O. Box 51 • Dayton, Ohio 45401-0051 • 513/253-8805
TOLEDO DISTRICT • 122 S. St. Clair St. • P.O. Box 838 • Toledo, Ohio 43696-0838 • 419/255-8200
KENTUCKY DISTRICT • Route 8 West • P.O. Box 636 • Maysville, Kentucky 41056-0636 • 606/564-6711

LABORATORY REPORT

Report to: Chemical Waste Management
% BOWSER-MORNER, Inc.
P. O. Box 838
Toledo, Ohio 45696
Attn: Ms. Julie Kampa

Date: March 16, 1983
Laboratory No.: N 022840
Authorization:

Report on: Twelve (12) samples of soil received February 28, 1983 for determination of carbonate content.

SAMPLE INFORMATION:

The samples were identified as;

Boring #14 3A, 4A
Boring #16 3A, 5A, 7A
Boring #21 3A, 5A
Boring #26 4A, 5A, 6A
Boring #32 4A, 6A

TEST PROCEDURES:

1) Determination of the neutralization potential by acid consumption per EPA "Field and Laboratory Methods Applicable to Overburdens and Minesoils" 600/2-78-054.

2) Determination of the neutralization equivalency of calcium carbonate ($CaCO_3$) by reaction with hydrochloric acid and subsequent back-titration with sodium hydroxide.

3) Determination of the total moisture @103°C.

TEST RESULTS:

Parameter	Boring 14 3A	Boring 14 4A
Moisture, %	19.9	14.8
% Carbonate *#1		
As Received	16.3	20.3
Dry Basis	20.4	24.0
% Carbonate *#2		
As Received	16.7	20.9
Dry Basis	20.8	24.5

- continued -

As a Mutual Protection to Clients, the Public and Ourselves, All Reports Are Submitted as the Confidential Property of Clients, and Authorization for Publication of Statements, Conclusions or Extracts from or Regarding Our Reports is Reserved Pending Our Written Approval.

TEST RESULTS (continued):

Parameter	Boring 16 3A	Boring 16 5A	Boring 16 7A
Moisture, %	18.7	22.7	14.2
% Carbonate *#1			
As Received	17.0	15.4	18.1
Dry Basis	20.9	19.9	21.1
% Carbonate *#2			
As Received	17.5	15.7	19.3
Dry Basis	21.5	20.3	22.5

Parameter	Boring 21 3A	Boring 21 5A
Moisture, %	19.7	12.1
% Carbonate *#1		
As Received	16.7	18.4
Dry Basis	20.8	20.9
% Carbonate *#2		
As Received	17.1	18.9
Dry Basis	21.3	21.5

Parameter	Boring 26 4A	Boring 26 5A	Boring 26 6A
Moisture, %	17.8	19.6	14.1
% Carbonate *#1			
As Received	4.6	14.5	19.3
Dry Basis	5.6	18.0	22.5
% Carbonate *#2			
As Received	2.1	14.9	19.6
Dry Basis	2.5	18.5	22.8

Parameter	Boring 32 4A	Boring 32 6A
Moisture, %	12.8	14.5
% Carbonate *#1		
As Received	18.9	19.8
Dry Basis	21.7	23.1
% Carbonate *#2		
As Received	19.2	20.1
Dry Basis	22.0	23.5

- continued -

Notes:

*#1 Percent carbonate calculated by procedure 1) neutralization potential.

*#2 Percent carbonate calculated by procedure 2) calcium carbonate equivalency.

Respectfully Submitted,

BOWSER-MORNER, Inc.

Mark A. Bingman
Project Chemist
Organic Chemistry Laboratory

1-Client
2-File
MAB/pc

APPENDIX B

INJECTION WELL LOGS

Schl.GR,Sch.D

Ohio Division Of Geological Survey

[redacted] S- 2745

Permit No. 210
Permit Issued 2-24-72
Quadrangle Clyde
Twp. Quarter

County Sandusky Township Riley
Section 26 Lot Tract
Measured 250' NL & 2123' EL of Sec. 26
20 Acres

PG - Strat Test - R.T.

Land Owner Ohio Liquid Disposal Well No. 1 Date Commenced 3-1-72
Operator Ohio Liquid Disposal, Inc. Well No. Date Completed 3-16-72
Elevation Bar S.L. Total Depth 2933' Plugged Back
Formation Drld. To. Prod. Form. Prod. Nat.
I.P.
Init. Rock Press.
Casing Record 8" 643'. 5½" 2809'
Abandoned 7-23-80

Formation	Top	Bottom	Remarks	Formation	Top	Bottom	Remarks
X= 1,867,877				Conasauga	2481	2606	
Y= 621,400				Rome	2606	2748	
				Shady	2748	2810	
Overburden	0	65		Mt. Simon	2810	2932	
				Granite	2932	2933	TD
PLUGGING REPORT 12-22-80							
Big lime	65	605					
Trenton	1667	1828					
Black river	1828	2312					
Gull river	2312	2363					
Glenwood	2363	2366					
Knox	2366	2481					

Formation	Top	Bottom	Remarks	Formation	Top	Bottom	Remarks
				NSR 11-2-72			
	0	2315		Csg. 8-5/8"-643';5½"-2809'			
				B.Lm.	65	604	
				Tren.	1666	1828	
				B.Riv.	1828	2323	
				Glen.	2362	2366	
				L.Copper Ridge	2366	2481	
				Maynardsville	2481	2606	
				Rome	2606	2748	
				Shady	2748	2810	
				Mt.Simon	2810	2931	
				TD 2932			

[redacted]

SCHL:GRN,Cal,D,CB,L

BIRD:3DV

I.W.D.W. #19

Permit No. 235

Permit Issued 9-5-79

County SANDUSKY Township RILEY Quadrangle Clyde

Section 26 Lot Tract Twp. Quarter

Measured 124.20' NL & 2377.95' EL of Sec. 26

20 acres Mt. Simon - IWDW - R.T.

Land Owner Ohio Liquid Disposal, Inc. Well No. 1A Date Commenced 9-10-79

Operator Ohio Liquid Disposal, Inc. Well No. Date Completed 9-27-79

Elevation Bar 606.11' 616.11'KB Total Depth 2980' Plugged Back

Formation Drld. To Pre-Cambrian Prod. Form. Mt. Simon Prod. Nat.

A/W 1M gal 15% HCl 10-18-79; A/W 4M gal 15% HCl 10-23-79 I.P.

Init. Rock Press.

Casing Record 16" 43' 125sks, 10 3/4" 632' 500sks, 7" 2342' Abandoned

Formation	Top	Bottom	Remarks	Formation	Top	Bottom	Remarks
Date: COMPLETION 3-12-80				X= 1,867,600			
Big lime	50	600	wtr	Y= 621,450			
Clinton	600	700		Rome	2594	2656	
Brassfield	700	743		Rome	2656	2746	wtr
Queenston	743	840		Shady	2746	2808	
Reedsville	840	1672		Mt. Simon	2808	2936	
Trenton	1672	1820		Granite	2936	2980	TD
Black river	1820	2307	s/gas 1850'	COMPLETION 8-6-80			
Gull river	2307	2360		Added treatment information.			
Glenwood	2360	2366					
Copper ridge	2366	2450					
Maynardville	2450	2594	wtr				

[redacted] S-3405

SCHL:GR,Cal,D,L,I,CB
BIRD:3DV,Tr

OHIO DIVISION OF GEOLOGICAL SURVEY #12

Permit No. 224
Permit Issued 1-28-76

County SANDUSKY Township RILEY Quadrangle Clyde

Section 26 Lot Tract Twp. Quarter

Measured 232' NL & 2635' EL of Sec. 26

25 Acres PC - IWDW - R.T.

Land Owner Ohio Liquid Disposal, Inc. Well No. 2 Date Commenced 6-17-76

Operator Ohio Liquid Disposal, Inc. Well No. Date Completed 11-23-76

Elevation Bar 607'G 615'DF 616'KB (618'KB) Total Depth 2961' Plugged Back

Formation Drld. To Pre-Cambrian Prod. Form. Prod. Nat.

A/W 5M gal. I.P.

Init. Rock Press. IWDW

Casing Record 10 3/4" 629'500sks, 7" 2371', 3½" 2800' Abandoned

Formation	Top	Bottom	Remarks	Formation	Top	Bottom	Remarks
Date: COMPLETION 3-20-78				X= 1,867,397			
Glacial deposits	0	60		Y= 621,418			
Big Lime	60	600		Glenwood	2360	2370	
Shale	600	690		Glenwood	2370	2380	
Dolomite	690	700		Knox	2380	2440	
Shale	700	710		Sandstone	2440	2590	
Dolomite	710	720		Rome	2590	2820	
Shale	720	880		Mt. Simon	2820	2930	
Dolomite	880	910		Basement	2930	2961	
Limestone	910	960					
Trenton	960	1560					
Black, Gull river	1560	2360					

[redacted] S-3416

SCHL:GR,Cal,D,CB,L,I

BIRD:GR,Cal,D,3DV,Tr * [illegible] #13

Permit No. 225

Permit Issued 1-28-76

County SANDUSKY Township RILEY Quadrangle Clyde

NE¼ Section 26 Lot Tract Twp. Quarter

Measured 1270' NL & 1878'EL of NE¼ Sec. 26

25 Acres PG - IWDW - R.T.

Land Owner Ohio Liquid Disposal, Inc. Well No. 3 Date Commenced 7-1-76

Operator Ohio Liquid Disposal, Inc. Well No. Date Completed 11-22-76

Elevation Bar (608.8' SL) 607' 618'KB Total Depth 2960' Plugged Back

Formation Drld. To Pre-Cambrian Prod. Form. Prod. Nat.

A/W 5M gal. 15% HCL I.P.

Init. Rock Press. I.W.D.W.

Casing Record 10 3/4" 663', 7" 2369', 3½" 2800' Abandoned

Formation	Top	Bottom	Remarks	Formation	Top	Bottom	Remarks
Date:COMPLETION 3-30-78				X= 1,868,122			
Glacial deposits	0	67		Y= 620,380			
Big Lime	67	665		Dolomite	2500	2570	
Shale	665	1700		Sandstone	2570	2600	
Trenton	1700	1820		Dolomite	2600	2700	
Black, Gull river	1820	2360		Sandstone	2700	2720	
Glenwood	2360	2370		Dolomite	2720	2740	
Glenwood	2370	2400		Sandstone	2740	2750	
Knox	2400	2440		Dolomite	2750	2820	
Sandstone	2440	2450		Mt. Simon	2820	2890	
Dolomite	2450	2460		Basement	2890	2900	
Sandstone	2460	2500		*DIA-LOG COMPANY - Casing Profile Calipher log			

[redacted] S-3417

BIRC:GR,Cal,D,CCL,I,3DV,Tr #14

Permit No. 226
Permit Issued 1-28-76

County SANDUSKY Township RILEY Quadrangle Clyde

NE¼ Section 26 Lot Tract Twp. Quarter

Measured 1165' NL & 935' EL of NE¼ Sec.26

25 Acres PE - IWDW - R.T.

Land Owner Ohio Liquid Disposal, Inc. Well No. 4 Date Commenced 7-15-76

Operator Ohio Liquid Disposal, Inc. Well No. Date Completed 11-24-76

Elevation Bar 609.1' SL 618'KB Total Depth 2905' Plugged Back

Formation Drld. To Pre-Cambrian Prod. Form. Prod. Nat.

A/W 5M gal. 15% HCL I.P.

Init. Rock Press. I.W.D.W.

Casing Record 10 3/4" 637' 500sks, 7" 2388', 3½" 2823' Abandoned

Formation	Top	Bottom	Remarks	Formation	Top	Bottom	Remarks
Date: COMPLETION 3-30-78				X= 1,869,065			
Glacial deposits	0	67		Y= 620,485			
Big Lime	67	665		Sandstone	2481	2509	
Shale	665	1680		Shale	2509	2519	
Trenton	1680	1830		Dolomite	2519	2520	
Limestone	1830	2370		Shale	2520	2529	
Glenwood	2370	2420		Sandstone	2529	2694	
Knox	2420	2426		Dolomite	2694	2711	
Sandstone	2426	2432		Sandstone	2711	2712	
Dolomite	2432	2435		Dolomite	2712	2797	
Sandstone	2435	2446		Mt. Simon	2797	2905	
Dolomite	2446	2481		Basement	2905	2910	

I.W.D.W.

Permit No. 237
Permit Issued 6-11-80
Quadrangle Clyde

County SANDUSKY Township RILEY
Section 26 Lot Tract
Twp. Quarter
Measured 59.63' NL & 612.11' WL of Sec. 26
"Mt. Simon" - IWDW- R.T.

Land Owner Ohio Liquid Disposal, Inc. Well No. 5 Date Commenced
Operator Ohio Liquid Disposal, Inc. Well No. Date Completed
Elevation Bar 612' Total Depth Plugged Back
Formation Drld. To Prod. Form. Prod. Nat.
I.P.
Init. Rock Press
Casing Record Abandoned

Formation	Top	Bottom	Remarks	Formation	Top	Bottom	Remarks
				X=1,865,375 Y= 621,520			

Compl

I.W.D.W. 11-17-81

Permit No. 238
Permit Issued 6-11-80

County SANDUSKY Township RILEY Quadrangle Clyde

Section 23 Lot Tract Twp. Quarter

Measured 546.98' SL & 3219.84' EL of Sec. 23

"Mt. Simon" - IWDW- R.T.

Land Owner: Ohio Liquid Disposal, INc. Well No. 6 Date Commenced

Operator Ohio Liquid Disposal, INc. Well No. Date Completed

Elevation Bar 605' Total Depth Plugged Back

Formation Drill To Prod. Form. Prod. Nat.

I.P.

Init. Rock Press.

Casing Record Abandoned

Formation	Top	Bottom	Remarks	Formation	Top	Bottom	Remarks
				X=1,866,780 Y= 622,100			

FEB 1982 RECEIVED TOLEDO

APPENDIX C

WATER WELL LOGS

NOTE: Well log numbering is not necessarily consecutive. All well logs collected were re-numbered at the lower right hand corner with numbers that were assigned by ODNR during their logging procedures.

Additional information such as elevations of the ground surface, identification numbers, and miscellaneous comments is often added to the original copies by BOWSER-MORNER, INC. personnel to facilitate analysis. Examples of such additions are shown on the next page.

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

No. 11
602224
87i

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

COUNTY Sandusky TOWNSHIP Riley SECTION OF TOWNSHIP #3

OWNER O. L. D. Inc. ADDRESS 504 Liberty Fremont O

LOCATION OF PROPERTY St Rt 412 - 510

CONSTRUCTION DETAILS

Casing diameter 6" plastic Length of casing 47½

Type of screen — Length of screen —

Type of pump

Capacity of pump

Depth of pump setting

Date of completion 5-6-81

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 50 gpm Duration of test 1 hrs

Drawdown 10 ft Date 5-6-81

Static level (depth to water) 10 ft

Quality (clear, cloudy, taste, odor) Black Sulfur

Pump installed by

WELL LOG*

607

Formations: sandstone, shale, limestone, gravel, clay	From	To
Yellow Clay	0 ft	15 ft
Blue Clay	15	45
Blue Limestone - Eggers	45	60

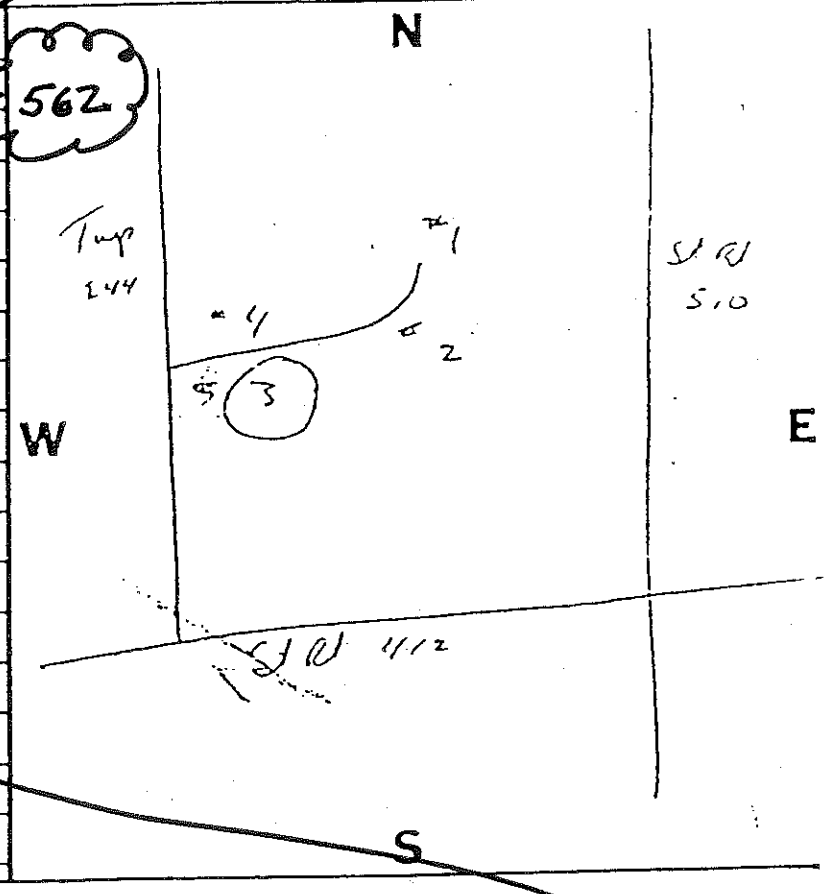
562

Monitor Well #11

DATA ADDED by Bowser Morner

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM TIBBOLES WELL DRILLING, INC.

ADDRESS 8377 No. St. Rt. 18
RR3 Bellevue, Ohio 44811

DATE 5-6-81

SIGNED [signature]

87i

*If additional space is needed to complete well log, use next consecutive numbered form.

LOCATED WELL LOG AND DRILLING REPORT

23 2
location uncertain

NO. 71620

County Sandusky Township Riley Section of Township

Owner Arnold Staschke Address Vickery O

Location of property 1st house N of 12 on 510

CONSTRUCTION DETAILS	BAILING OR PUMPING TEST
Casing diameter 4 1/4 Length of casing 47	Pumping rate G.P.M.
Type of screen Length of screen	Duration of test hrs.
Type of pump	Drawdown ft. Date 9-10-99
Capacity of pump	Developed capacity
Depth of pump setting	Static level - depth to water 11 ft.
Date of completion	Pump installed by

WELL LOG			SKETCH SHOWING LOCATION
Formation	From	To	N.
clay	0	36	
hardpan		44	
gravel		46	
ls.		58	W. E.
			S.

Drilling Firm Permanter Drilling Co Date 2-19-60

Address Copied by RS

23
NOT LOCATED

E)

LOCATED

WELL LOG AND DRILLING REPORT

NO. 24

County Sandusky Township Riley Section of Township 26

Owner Bates + Rogers Const. Co. Address Chicago, Ill.

Location of property Reid jct 510 + 12 (northwest corner)

CONSTRUCTION DETAILS	BAILING OR PUMPING TEST
Casing diameter 6 Length of casing 43	Pumping rate 45 G.P.M.
Type of screen ____ Length of screen ____	Duration of test ____ hrs.
Type of pump ____	Drawdown 2 ft. Date 1-9-59
Capacity of pump ____	Developed capacity ____
Depth of pump setting ____	Static level - depth to water 8 ft.
Date of completion ____	Pump installed by ____

610'

WELL LOG	From	To
Formation		
yel. clay	0	14
bl. clay		32
tough bl. clay		40½ 570
gr. Ls. soft layers.		78
br. Ls.		80
water 50', 60', 70'		
(House burned down)		
Probably plugged		

SKETCH SHOWING LOCATION

N.

W. E.

S.

Drilling Firm Dunbar Drilling Date 3-19-60

Address ____ Copied by RS

24

NO CARBON PAPER NECESSARY— SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
65 S. Front St., Rm. 815 Phone (614) 469-2646
Columbus, Ohio 43215

No. 405085 1
Eckart

County [illegible] Township Riley Section of Township

Owner [illegible] Address 615 [illegible]

Location of property St. Rt. # 412 - 2 mi East of Erlin Ohio

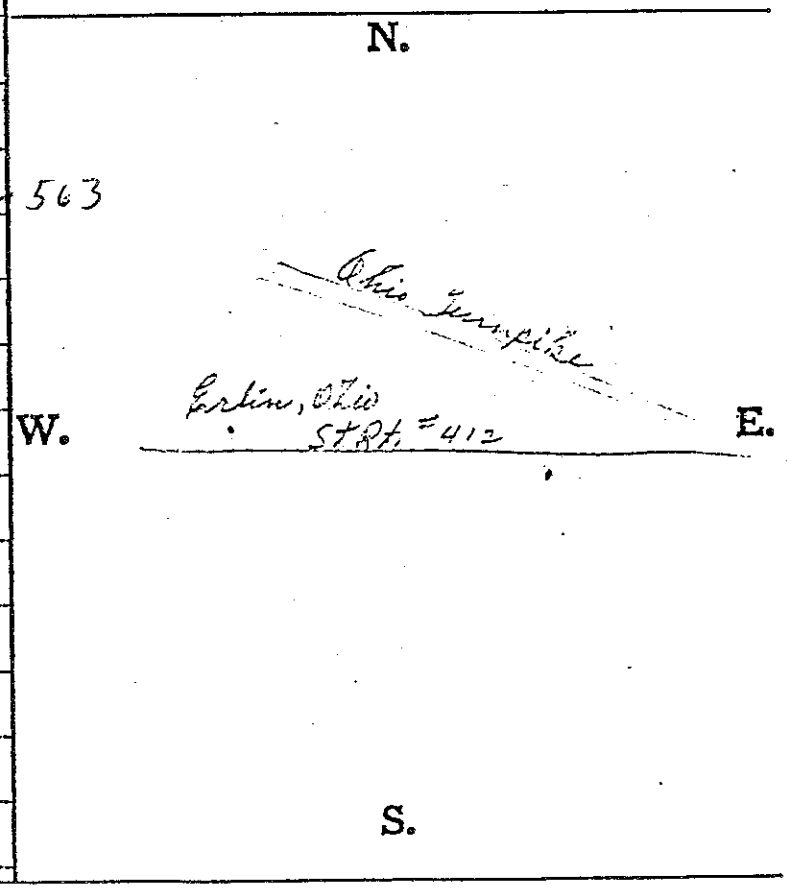
CONSTRUCTION DETAILS	BAILING OR PUMPING TEST (Specify one by circling)
Casing diameter [illegible] Length of casing 47'	Test Rate ..... G.P.M. Duration of test ..... hrs.
Type of screen ..... Length of screen	Drawdown [illegible] ft. Date .....
Type of pump	Static level-depth to water 16' ft.
Capacity of pump	Quality (clear, cloudy, taste, odor) .....
Depth of pump setting	
Date of completion	Pump installed by .....

WELL LOG* 610

Formations Sandstone, shale, limestone, gravel and clay	From	To
Clay	0 Feet	9' Ft.
Shale	9'	42'
Hardpan	42'	47' 563
Limestone	47'	50'
OEPA well # 3		
Don Eckart house		

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



Drilling Firm [illegible] Date June 12/70

Address [illegible] Signed [illegible]

1

*If additional space is needed to complete well log, use next consecutive numbered form.

WELL LOG AND DRILLING REPORT

ORIGINAL

PLEASE USE PENCIL
OR TYPEWRITER
DO NOT USE INK.

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus 12, Ohio

Nº 318483

County Sandusky Township Riley Section of Township 22

Owner Wayne Fiber (Builder) Address Fremont, Ohio

Location of property East of Fremont on Co. Rd. #238

CONSTRUCTION DETAILS

Casing diameter 4 1/4" Length of casing 52'

Type of screen Length of screen

Type of pump

Capacity of pump

Depth of pump setting

Date of completion

BAILING OR PUMPING TEST

Pumping Rate G.P.M. Duration of test hrs.

Drawdown 28' ft. Date

Static level-depth to water 12' 593 ft.

Quality (clear, cloudy, taste, odor) sulphur

Pump installed by

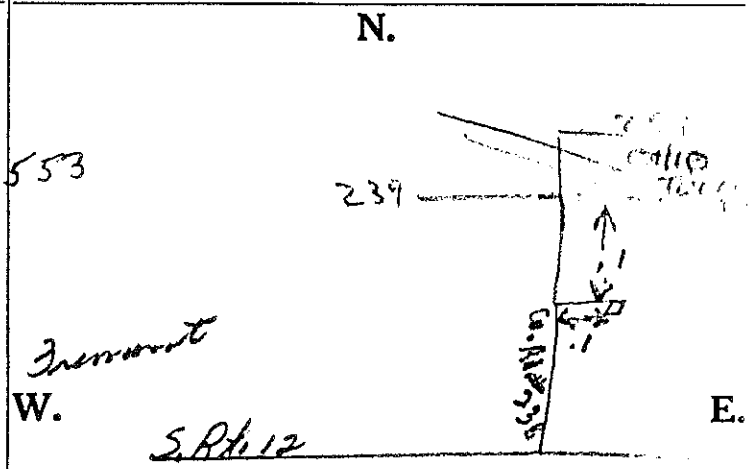
WELL LOG

605

Formations Sandstone, shale, limestone, gravel and clay	From	To
Clay	0 Feet	7 Ft.
Blue Clay	7	45
Sand	45	52
Limestone	52	86

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



Drilling Firm M & G Well Drilling Date May 2 1965

Address 717 O'Donnell St. Signed Arnold F. Green

Upper Sandusky, Ohio

(68)

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio

PLEASE USE PENCIL OR TYPEWRITER. DO NOT USE INK.

No. 244877

County Sandusky Township Riley Section of Township 23

Owner M. Gullett Address R.R. 1 Victory, O.

Location of property 5 mi. North of Clyde on State 510

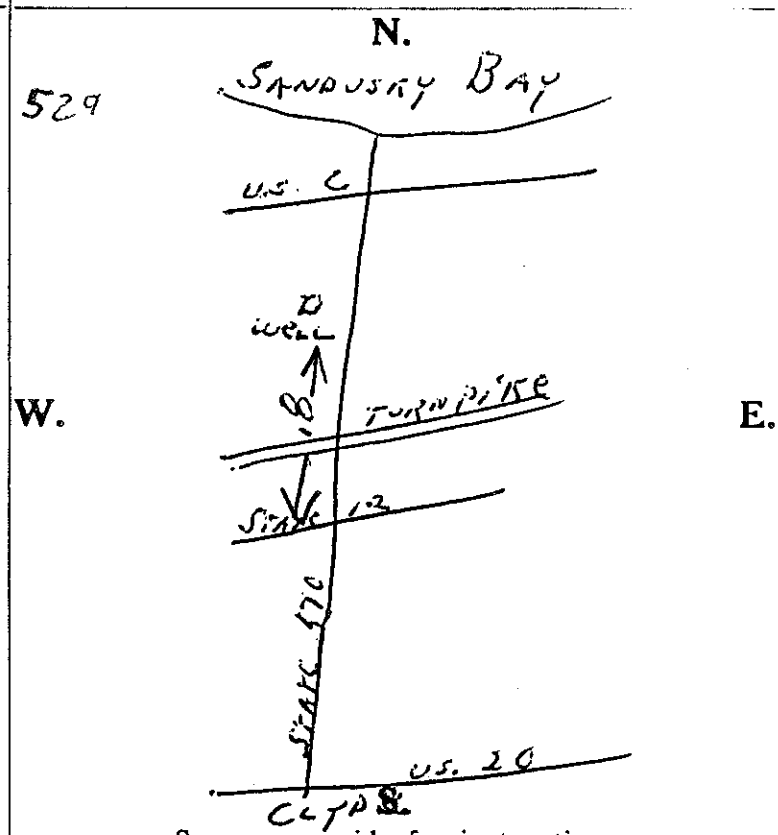
CONSTRUCTION DETAILS	BAILING OR PUMPING TEST
Casing diameter 4¼ Length of casing 71½	Pumping rate 10 G.P.M. Duration of test 1 hrs.
Type of screen — Length of screen —	Drawdown 70 ft. Date 10-10-60
Type of pump —	Developed capacity 10 GPM
Capacity of pump —	Static level—depth to water ft.
Depth of pump setting —	Pump installed by —
Date of completion 10-10-60	

WELL LOG 600'

Formations Sandstone, shale, limestone, gravel and clay	From	To
Clay	0 Feet	50 Ft.
Shale & Clay	50	71½
Limestone	71½	118

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

Drilling Firm Robertson's Date 10-10-60

Address Bellevue, O. Signed [signature]

69

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio

PLEASE USE PENCIL OR TYPEWRITER. DO NOT USE INK.

No. 266815

County SANDUSKY Township TOWNSEND Section of Township 23

Owner C. R. GRIFFAW Address R. D. VICTORY, O.

Location of property 5 mi. NORTH OF CLYDE ON ST. RT. 510

CONSTRUCTION DETAILS

Casing diameter 4 Length of casing 57

Type of screen — Length of screen —

Type of pump Sub

Capacity of pump 10 GPM

Depth of pump setting 60 FEET

Date of completion 7-1-62

BAILING OR PUMPING TEST

Pumping rate 10 G.P.M. Duration of test 1 hrs.

Drawdown 40 ft. Date 7-1-62

Developed capacity 10 GPM

Static level—depth to water 19 FEET ft.

Pump installed by Robertson's

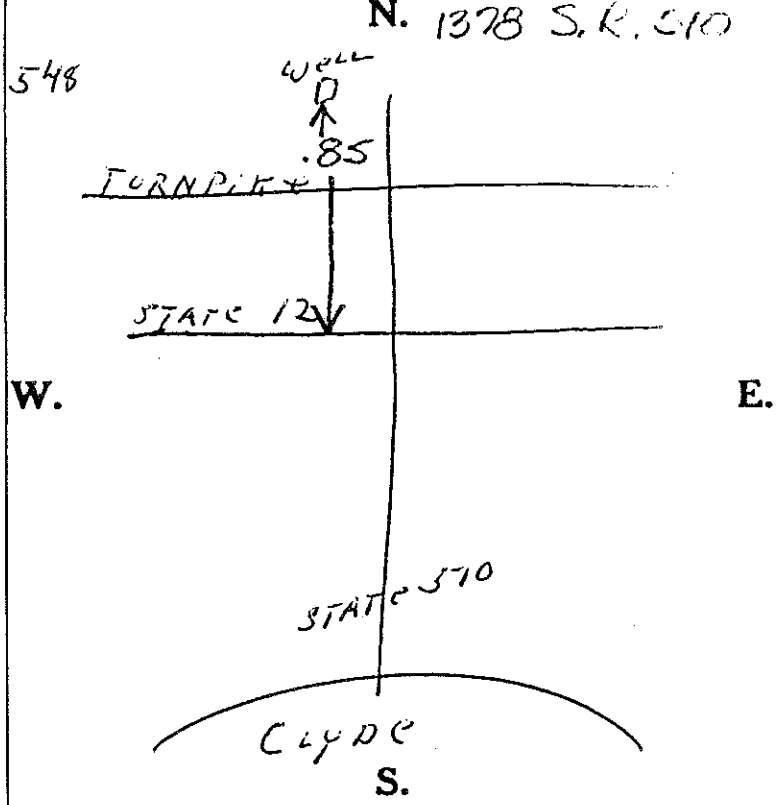
WELL LOG

600

Formations Sandstone, shale, limestone, gravel and clay	From	To
Top Soil	0 Feet	2 Ft.
HARDPAN	2	52
LIMESTONE	52	62

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

Drilling Firm Robertson Date

Address Bellevue, O. Signed

C - 8

70

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio

PLEASE USE PENCIL OR TYPEWRITER. DO NOT USE INK.

No. 272052

County Sandusky Township Riley Section of Township 23 24

Owner Maynard Wetosky Address R4 Fremont Ohio

Location of property N-E of Erlin Ohio

CONSTRUCTION DETAILS

Casing diameter 4 1/4 Length of casing 46'

Type of screen Length of screen

Type of pump

Capacity of pump

Depth of pump setting

Date of completion

BAILING OR PUMPING TEST

Pumping rate 2.3 G.P.M. Duration of test 1 hrs.

Drawdown 14 ft. Date 1-3-62

Developed capacity

Static level—depth to water 10 ft.

Pump installed by

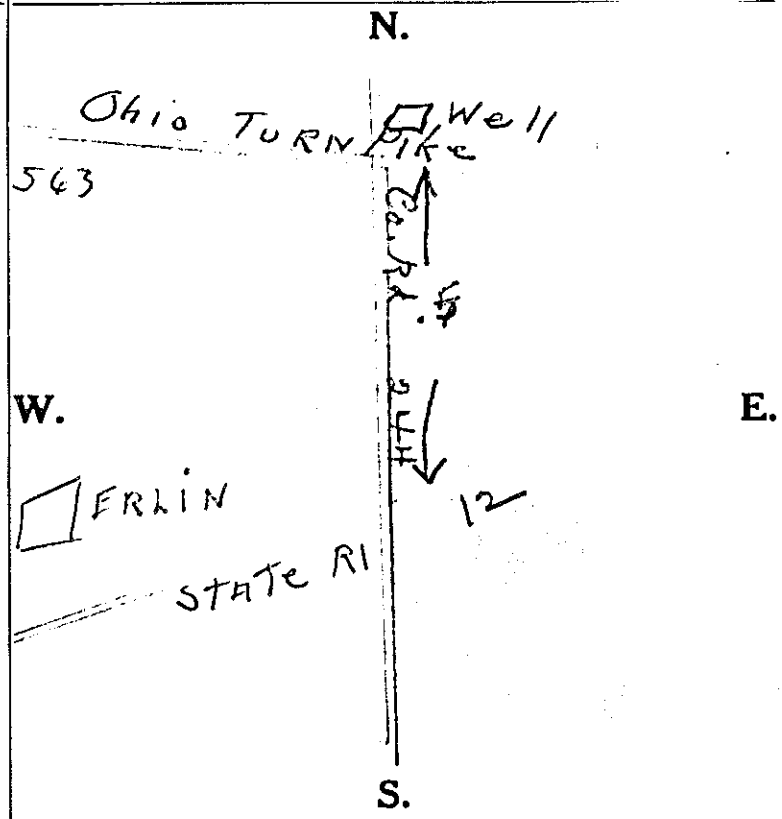
WELL LOG

605

Formations Sandstone, shale, limestone, gravel and clay	From	To
	0 Feet	Ft.
Clay		18
Sand	18	35
Hard Pan	35	42
Rock	42	82

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

Drilling Firm C & O Drilling Co Date 1-3-62

Address R1 Fremont Ohio Signed T. J. Dolan

71

WE . LOG AND DRILLING REPO

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1500 Dublin Road
Columbus, Ohio

OK

No. 199092

County Sandusky Township Riley Section of Township #24

Owner John W. Sims Address Erlin Ohio R.7 H.

Location of property On St. Rt. #510 - North off St. Rt. #12

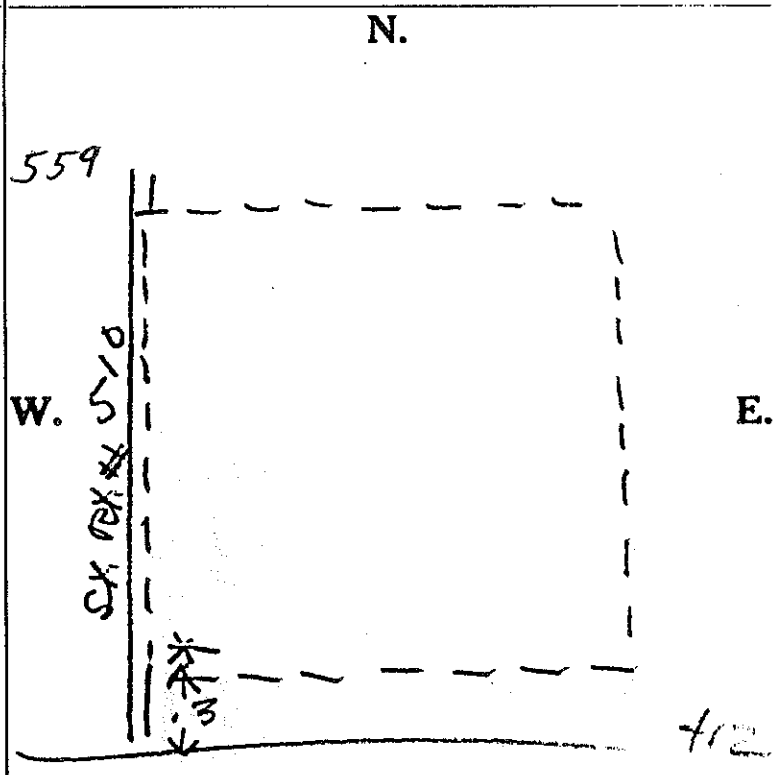
CONSTRUCTION DETAILS	BAILING OR PUMPING TEST
Casing diameter 4 1/4 Length of casing 47	Pumping rate 6 G.P.M. Duration of test ... hrs.
Type of screen ... Length of screen ...	Drawdown ... ft. Date ...
Type of pump ...	Developed capacity ...
Capacity of pump ...	Static level—depth to water 12 ft.
Depth of pump setting ...	Pump installed by ...
Date of completion ...	

WELL LOG 605

Formations Sandstone, shale, limestone, gravel and clay	From	To
Top soil	0 Feet	1 Ft.
Yellow Clay	1	12
Blue "	12	46
Rock	46	48
Water at 47-48		

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

Drilling Firm FORREST JONES Date Mar-58

Address Hamden Ohio Signed Forrest Jones

78

PLEASE USE PENCIL OR TYPEWRITER

DO NOT USE INK.

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1562 W. First Avenue
Columbus, Ohio 43212

Nº 354498

83

County SANDUSKY Township RILEY Section of Township

Owner GERALD W. GNEPPER Address R.R. #4, FREMONT OHIO

Location of property 3 RD House North of P.P. on Cor. # 232, Erlin, Ohio

CONSTRUCTION DETAILS

Casing diameter 4 1/4 Length of casing 135'

Type of screen Length of screen

Type of pump

Capacity of pump

Depth of pump setting

Date of completion

BAILING OR PUMPING TEST

Pumping Rate G.P.M. Duration of test hrs.

Drawdown ft. Date

Static level-depth to water ft.

Quality (clear, cloudy, taste, odor) CLEAR SULPHUR ODOR

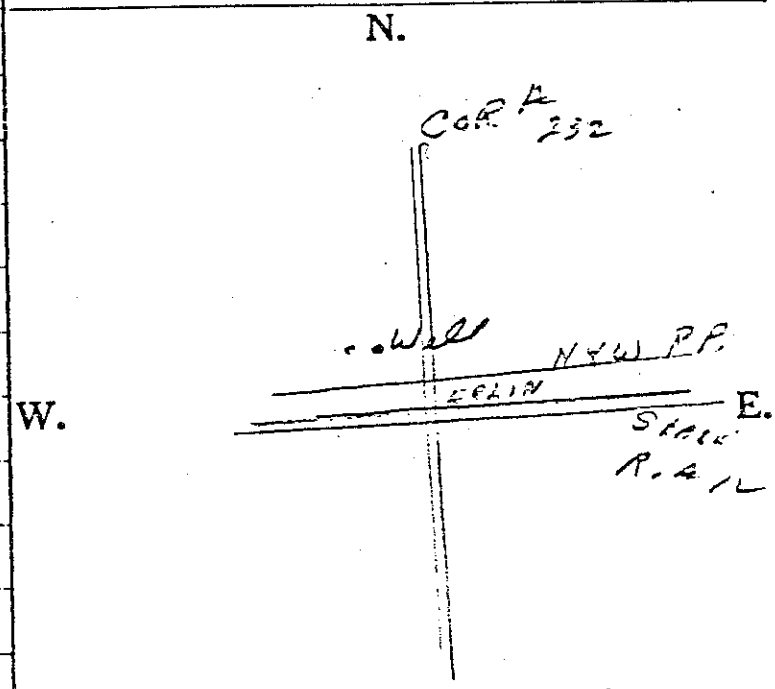
Pump installed by

WELL LOG* 605

Formations Sandstone, shale, limestone, gravel and clay	From	To
CLAY	0 Feet	84 Ft.
SAND	84	88
SHALE	88	97
LIMESTONE	97	152
Water at 148 ft		

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

Drilling Firm [illegible]

Address [illegible]

Date [illegible]

Signed W. R. [illegible]

*If additional space is needed to complete well log, use next consecutive numbered form.

83

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1500 Dublin Road
Columbus, Ohio

84 R

No. 195709

County Sandusky Township Green Creek Section of Township

Owner Paul Widman Address Fremont, Ohio R.E.

Location of property 3 mi. East + 1 mi. North of Fremont, O.

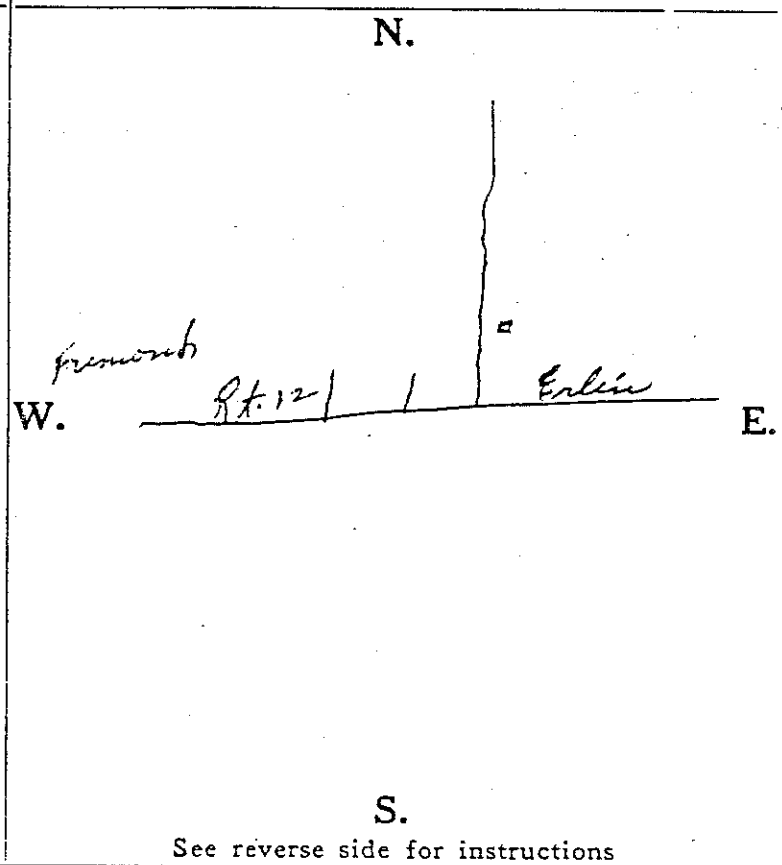
CONSTRUCTION DETAILS	BAILING OR PUMPING TEST
Casing diameter 4 1/4 Length of casing 108'	Pumping rate ..... G.P.M. Duration of test ..... hrs.
Type of screen ..... Length of screen	Drawdown none ft. Date .....
Type of pump	Developed capacity .....
Capacity of pump	Static level—depth to water 3 ft.
Depth of pump setting	Pump installed by .....
Date of completion	

WELL LOG 6107

Formations Sandstone, shale, limestone, gravel and clay	From	To
Clay	0 Feet	3 Ft.
B. Shale	3	66
Gravel	66	74
B. shale	74	97
sand & Gravel	97	108
Limestone	108	110

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

Drilling Firm Magnus + Green Date 3/29/57

Address 317 W. Hicks St. Signed Amel F. Green

Upper Sandusky, O.

C - 12

84

County Permit No. 1.1

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

ORIGINAL

554273

OK

COUNTY Sandusky TOWNSHIP Riley SECTION OF TOWNSHIP Well # 1 2h

OWNER OHIO Liquid Disposal Inc. ADDRESS 504 Liberty St. Fremont, O

LOCATION OF PROPERTY St Rt 412 - 1/8 mi W of St Rt 510

CONSTRUCTION DETAILS

Casing diameter 6" Plastic Length of casing 46'

Type of screen — Length of screen —

Type of pump

Capacity of pump

Depth of pump setting

Date of completion 7-2-79

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 25 gpm Duration of test 1 hrs

Drawdown 20 ft Date 7-2-79

Static level (depth to water) 14 ft

Quality (clear, cloudy, taste, odor) Black Sulfur

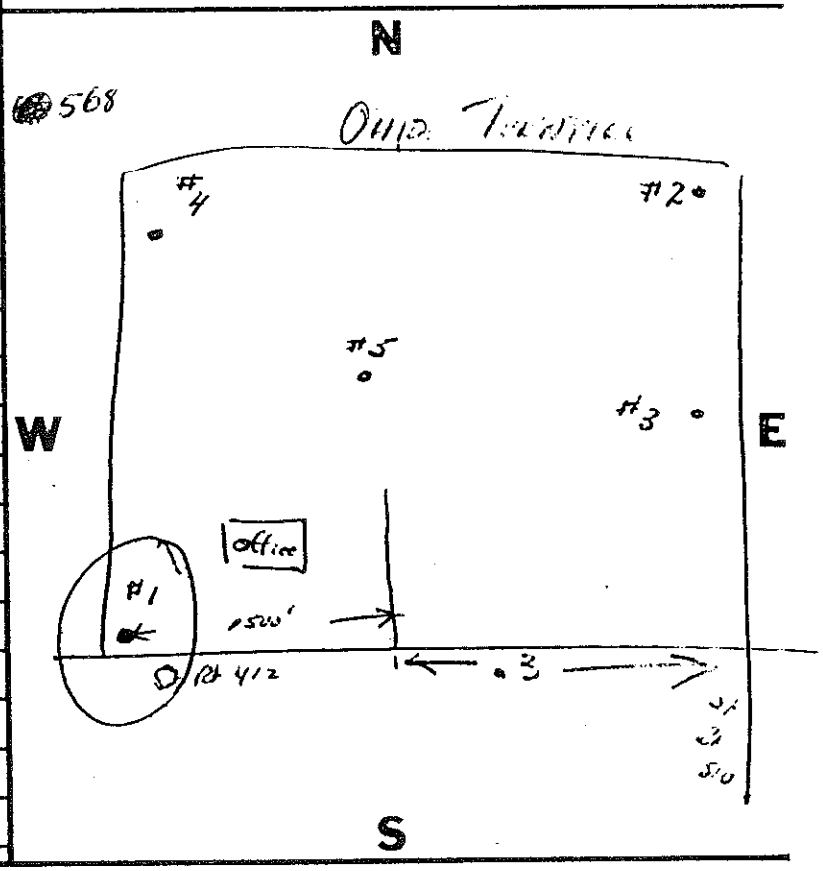
Pump installed by

WELL LOG* 610

Formations: sandstone, shale, limestone, gravel, clay	From	To
Yellow Clay	0 ft	14 ft
Blue Clay	14	42
Limestone	42	50
This is a observation	well	#6N
Top of casing elevation 608.55		

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM

ADDRESS

DATE 7-2-79

SIGNED Wm Tiffels

*If additional space is needed to complete well log, use next consecutive numbered form.

87 a

County Permit No. _____

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

ORIGINAL

554274

COUNTY Sandusky TOWNSHIP Riley SECTION OF TOWNSHIP Well #2 .26

OWNER Ohio Liquid Disposal Inc ADDRESS 504 Liberty St Fremont, O

LOCATION OF PROPERTY 3956 St Rt 412 Lindsey, O

CONSTRUCTION DETAILS

Casing diameter 6" Plastic Length of casing 48'

Type of screen — Length of screen _____

Type of pump _____

Capacity of pump _____

Depth of pump setting _____

Date of completion 7-2-79

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 25 gpm Duration of test 1 hrs

Drawdown 15 ft Date 7-2-79

Static level (depth to water) 14 ft

Quality (clear, cloudy, taste, odor) Appears Good

Pump installed by _____

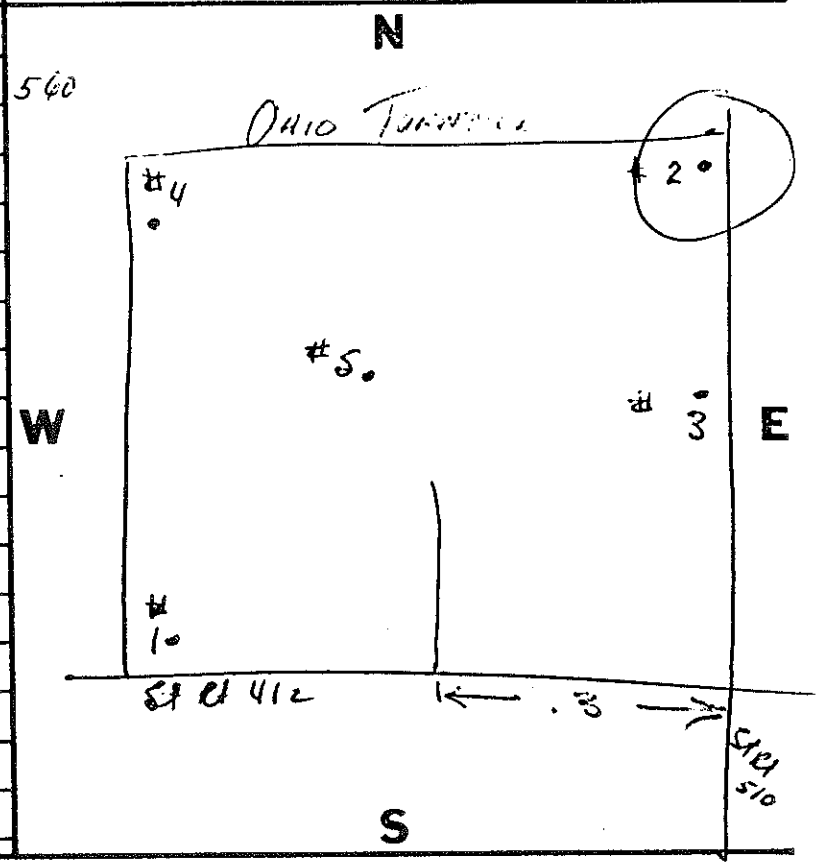
WELL LOG*

605

Formations: sandstone, shale, limestone, gravel, clay	From	To
Yellow Clay	0 ft	14 ft
Blue Clay	14	45
Limestone	45	50
This is a observation well		#4N
OEPA #1		
Top of casing 606.87		

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM _____ DATE 7-2-79

ADDRESS _____ SIGNED W. Fisher

*If additional space is needed to complete well log, use next consecutive numbered form.

County Permit No. _____

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

ORIGINAL

554275
OK

COUNTY Sandusky TOWNSHIP Riley SECTION OF TOWNSHIP Well # 3 .26

OWNER Ohio Liquid Disposal Inc ADDRESS 504 Liberty St Fremont, O

LOCATION OF PROPERTY 3956 St Rt 412 Wickery, O

CONSTRUCTION DETAILS

Casing diameter 6" Plastic Length of casing 45½'

Type of screen _____ Length of screen _____

Type of pump _____

Capacity of pump _____

Depth of pump setting _____

Date of completion 7-3-79

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 15 gpm Duration of test 1 hrs

Drawdown 40 ft Date 7-3-79

Static level (depth to water) 14 ft

Quality (clear, cloudy, taste, odor) Appears Good

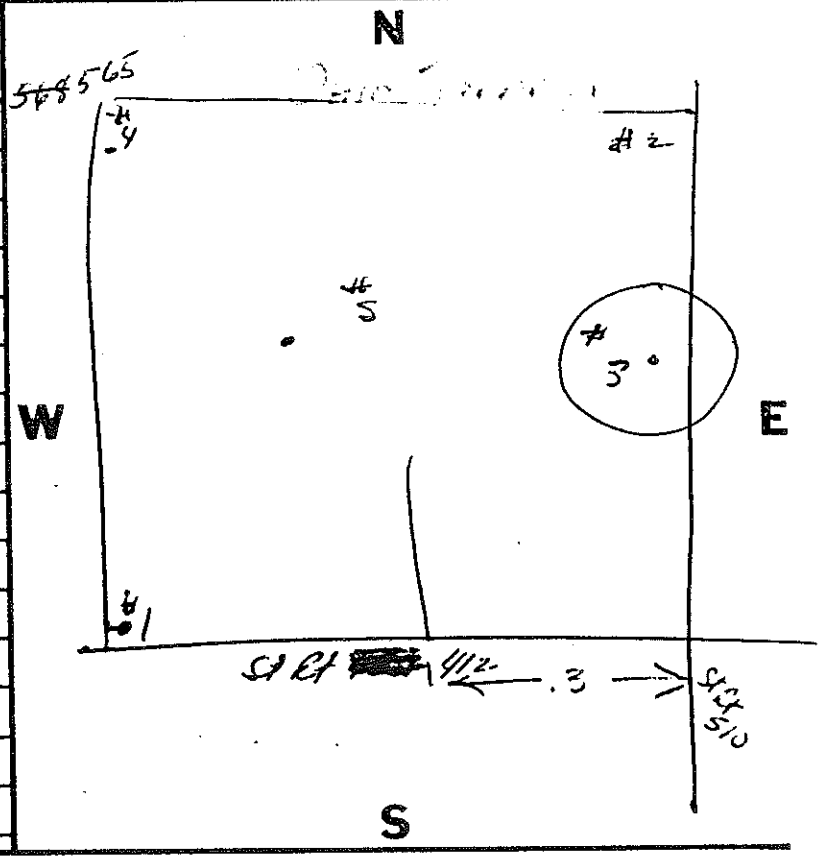
Pump installed by _____

WELL LOG* 607

Formations: sandstone, shale, limestone, gravel, clay	From	To
Yellow Clay	0 ft	14 ft
Blue Clay	14	42½
Limestone	42½	55'
This is a observation well		#7
Top of casing elevation 607.91		

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM _____ DATE 7-3-79

ADDRESS _____ SIGNED W. Tibbals

*If additional space is needed to complete well log, use next consecutive numbered form.

80 C

County Permit No. _____

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

ORIGINAL

554276

OK

COUNTY Sandusky TOWNSHIP Riley SECTION OF TOWNSHIP Well #4 2

OWNER Ohio Liquid Disposal Inc ADDRESS 504 Liberty St Fremont, O

LOCATION OF PROPERTY 3956 SR 412 Vickery, O

CONSTRUCTION DETAILS

Casing diameter 6" Plastic Length of casing 118'

Type of screen — Length of screen _____

Type of pump _____

Capacity of pump _____

Depth of pump setting _____

Date of completion 7-3-79

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 25 gpm Duration of test 1 hrs

Drawdown 10 ft Date 7-3-79

Static level (depth to water) 12 ft

Quality (clear, cloudy, taste, odor) Appears Good

Pump installed by _____

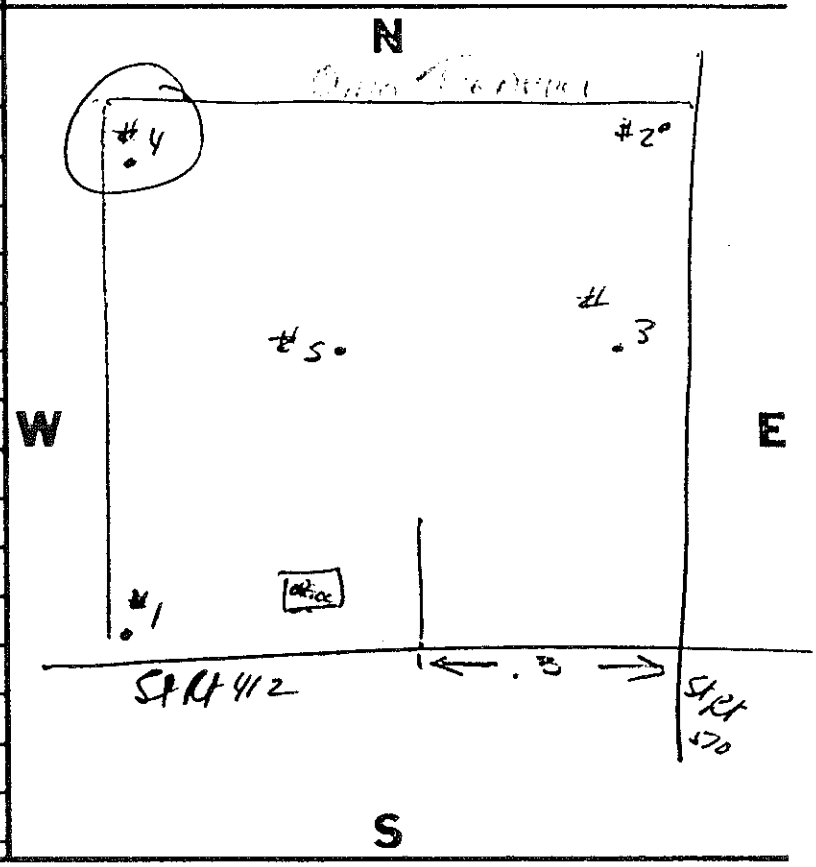
WELL LOG*

605

Formations: sandstone, shale, limestone, gravel, clay	From	To
Yellow Clay	0 ft	14 ft
Blue Clay	14	45
Limestone	45	50
This is a observation well #3N		

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM _____ DATE 7-3-79

ADDRESS _____ SIGNED [signature]

*If additional space is needed to complete well log, use next consecutive numbered form.

County Permit No. _____

NO CARBON PAPER NECESSARY – SELF-TRANSCRIBING

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

ORIGINAL

554277

OK

COUNTY Sandusky TOWNSHIP Riley SECTION OF TOWNSHIP Well #5 76

OWNER Ohio Liquid Disposal Inc ADDRESS 504 Liberty St Fremont, O

LOCATION OF PROPERTY 3956 St Rt 412 Vickery, O

CONSTRUCTION DETAILS

Casing diameter 6" Plastic Length of casing 56½

Type of screen _____ Length of screen _____

Type of pump _____

Capacity of pump _____

Depth of pump setting _____

Date of completion 7-6-79

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 75 gpm Duration of test 1 hrs

Drawdown 150 ft Date 7-6-79

Static level (depth to water) 10 ft

Quality (clear, cloudy, taste, odor) Black Sulfur

Pump installed by _____

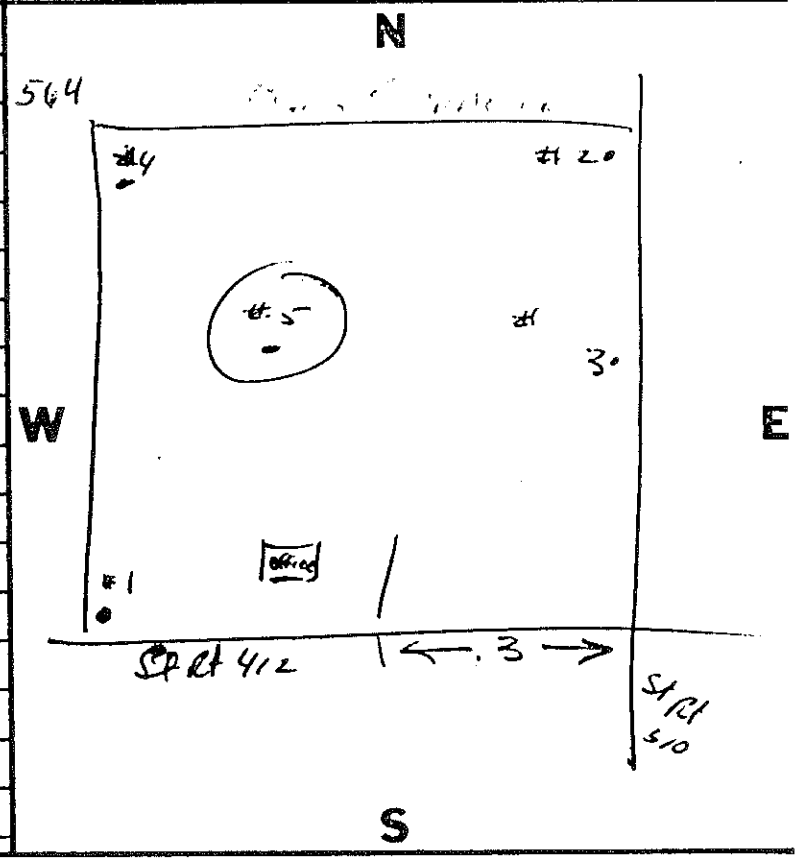
WELL LOG*

610

Formations: sandstone, shale, limestone, gravel, clay	From	To
Yellow Clay	0 ft	14 ft
Blue Clay	14	46
Limestone	46	200
This is a observation well.		#1
Sulfur		
Gas was encountered in last		
25' of hole		

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM _____ DATE 7-8-79

ADDRESS _____ SIGNED [signature]

*If additional space is needed to complete well log, use next consecutive numbered form.

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

602222
87f

COUNTY Sandusky TOWNSHIP Riley ~~SECTION OF TOWNSHIP~~ #1

OWNER O.L.D. Inc ADDRESS 504 Liberty St Fremont O 43420

LOCATION OF PROPERTY St Rt 412 - P 510

CONSTRUCTION DETAILS

Casing diameter 6" plastic Length of casing 48'

Type of screen — Length of screen —

Type of pump

Capacity of pump

Depth of pump setting

Date of completion 5-1-81

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 30 gpm Duration of test 1 hrs

Drawdown 30 ft Date 5-1-81

Static level (depth to water) 5' ft

Quality (clear, cloudy, taste, odor) Black Sulfur

Pump installed by

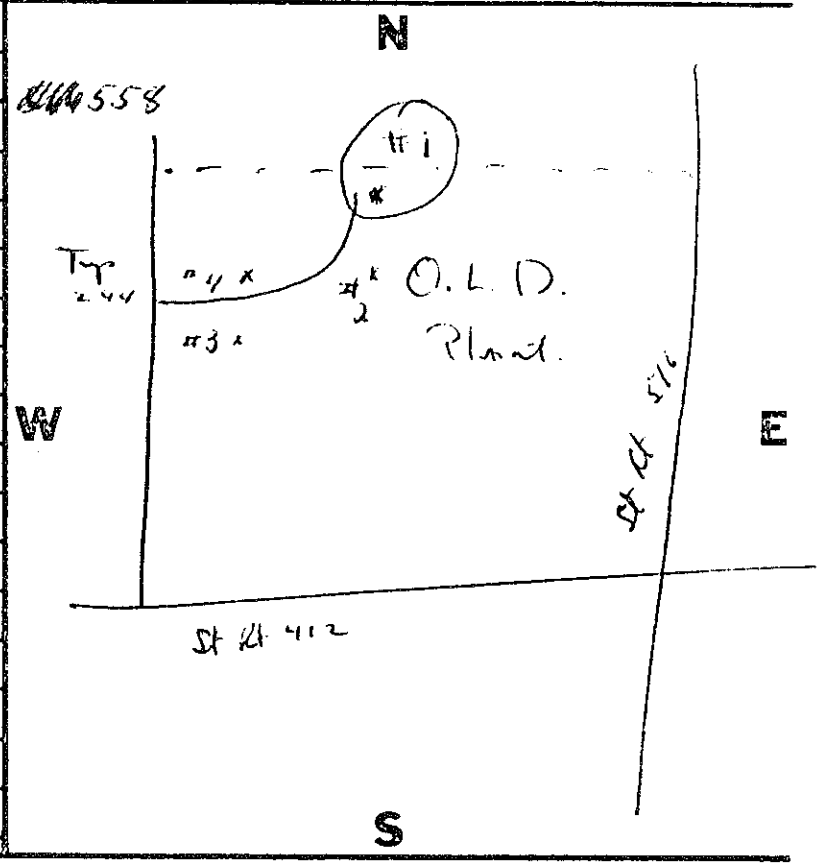
WELL LOG*

~~[illegible]~~ 602

Formations: sandstone, shale, limestone, gravel, clay	From	To
Yellow Clay	0 ft	15 ft
Bl Clay & Gravel	15	44½
Blue Limestone & Gypsum	44½	60
Monitor well #13		

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM TIBBOLES WELL DRILLING, INC.

ADDRESS 8377 Ab. St. R R 3 Bellevue, Ohio 44811

DATE 5-1-81

SIGNED [signature]

*If additional space is needed to complete well log, use next consecutive numbered form.

87f

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WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

602223
87~~8~~9

COUNTY Sandusky TOWNSHIP Riley ~~SECTION OF TOWNSHIP~~ #2

OWNER O.L.D. Inc ADDRESS 504 Liberty St. Fremont O

LOCATION OF PROPERTY St Rt 412 & 510

CONSTRUCTION DETAILS

Casing diameter 6" plastic Length of casing 48'

Type of screen — Length of screen —

Type of pump

Capacity of pump

Depth of pump setting

Date of completion 5-1-81

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 28 gpm Duration of test 1 hrs

Drawdown 30 ft Date 5-1-81

Static level (depth to water) 6' ft

Quality (clear, cloudy, taste, odor) Black Sulfur

Pump installed by

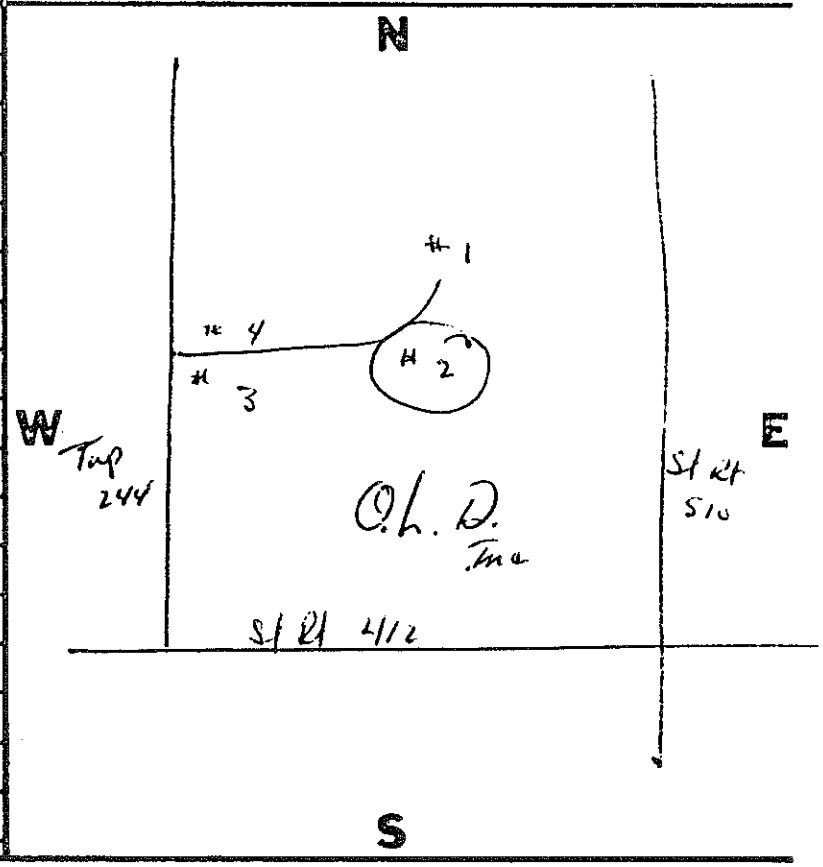
WELL LOG*

604 ~~[illegible]~~

Formations: sandstone, shale, limestone, gravel, clay	From	To
Yellow Clay	0 ft	15 ft
Blue Clay & Gravel	15	45
Blue Limestone & Gypsum	45	75
Not a monitor well		
Industrial water supply		

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM TIBBOLES WELL DRILLING, INC.
ADDRESS 8377 No. St. Rt. 18 RR3 Bellevue, Ohio 44811

DATE 5-1-81
SIGNED Wm Tibbles

*If additional space is needed to complete well log, use next consecutive numbered form.

ORIGINAL COPY - ODNR, DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224

879

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

602225
87h

COUNTY Sandusky TOWNSHIP Riley ~~SECTION OF TOWNSHIP~~ #4

OWNER O. L. D. Inc ADDRESS 5004 Liberty Fremont O

LOCATION OF PROPERTY St Rt 412 n 510

CONSTRUCTION DETAILS

Casing diameter 6" plastic Length of casing 41'

Type of screen — Length of screen —

Type of pump

Capacity of pump

Depth of pump setting

Date of completion 5-6-81

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 30 gpm Duration of test 1 hrs

Drawdown 30 ft Date 5 6 81

Static level (depth to water) 8 ft

Quality (clear, cloudy, taste, odor) Black Sulfur

Pump installed by

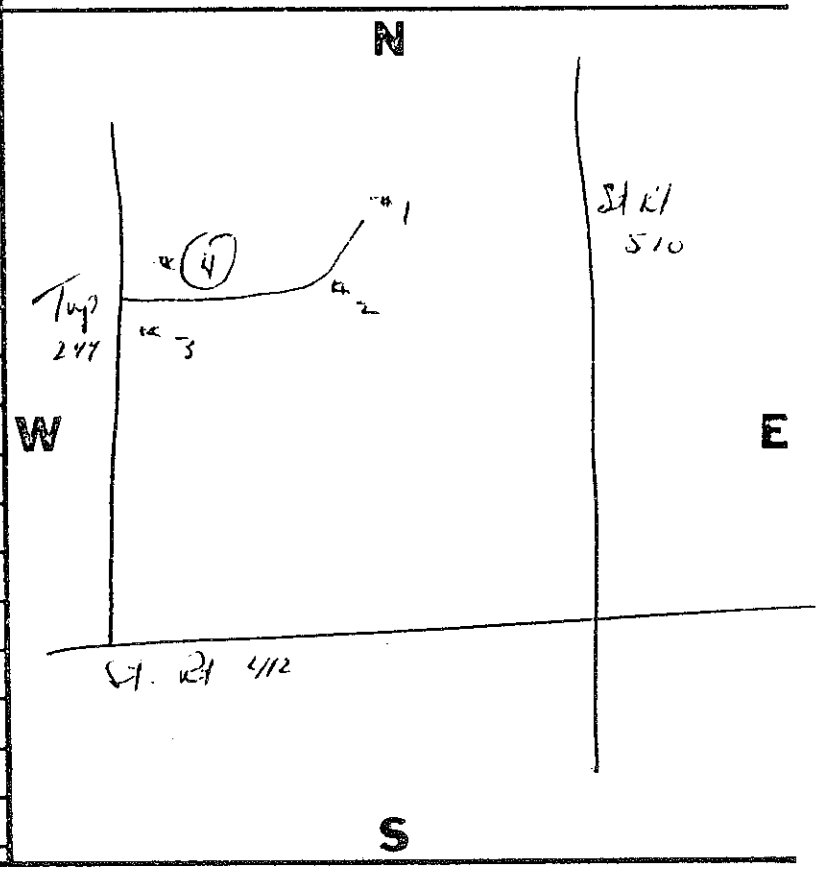
WELL LOG*

610

Formations: sandstone, shale, limestone, gravel, clay	From	To
Yellow Clay	0 ft	15 ft
Blue Clay	15	113½
Blue Limestone, Gypsum	113½	610
Monitor well #12		

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



TIBBOLES WELL DRILLING, INC.

DRILLING FIRM ~~8377 No. St. Rt. 18~~

ADDRESS RR 3 Bellevue, Ohio 44811

DATE 5 6 81

SIGNED W. J. Tibbles

*If additional space is needed to complete well log, use next consecutive numbered form.

87h

ORIGINAL COPY - ODNR, DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224

WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY– SELF-TRANSCRIBING

No. 11
602224
87i

COUNTY Sandusky TOWNSHIP Riley SECTION OF TOWNSHIP #3

OWNER M. L. D' Inc. ADDRESS 504 Liberty Fremont, O

LOCATION OF PROPERTY St Rt 412 + 510

CONSTRUCTION DETAILS

Casing diameter 6" plastic Length of casing 47½

Type of screen — Length of screen —

Type of pump

Capacity of pump

Depth of pump setting

Date of completion 5-6-81

BAILING OR PUMPING TEST
(specify one by circling)

Test rate 50 gpm Duration of test 1 hrs

Drawdown 10 ft Date 5-6-81

Static level (depth to water) 10' ft

Quality (clear, cloudy, taste, odor) Black Sulfur

Pump installed by

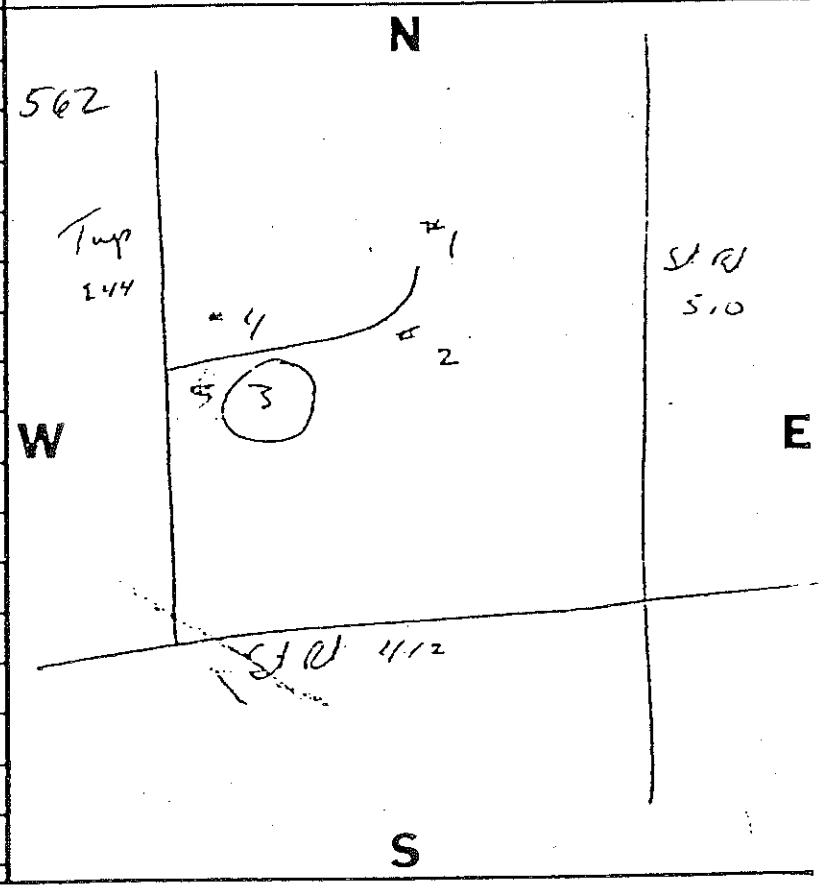
WELL LOG*

607

Formations: sandstone, shale, limestone, gravel, clay	From	To
Blue Clay	0 ft	15 ft
Blue Clay	15	45
Blue Limestone - Erosion	45	60
Monitor Well #11		

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM TIBBOLES WELL DRILLING, INC.

ADDRESS 8377 No. St. Rt. 18
RR3 Bellevue, Ohio 44811

DATE 5-6-81

SIGNED W. Tibbles

*If additional space is needed to complete well log, use next consecutive numbered form.

87i

CUSTOMER'S COPY

ORIGINAL

WELL LOG AND DRILLING REPORT

NO CARBON PAPER NECESSARY— SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
65 S. Front St., Rm. 815 Phone (614) 469-2646
Columbus, Ohio 43215

425054

OK

County Sandusky Township Riley Section of Township 26

Owner Don's Oil Service Address Clyde Ohio

Location of property St. Rt. 412 Clyde Ohio

CONSTRUCTION DETAILS

Casing diameter 6" Length of casing 45'

Type of screen None Length of screen —

Type of pump —

Capacity of pump —

Depth of pump setting —

Date of completion —

BAILING OR PUMPING TEST
(Specify one by circling)

Test Rate 25 G.P.M. Duration of test 1/2 hrs

Drawdown 2 ft. Date 5-23-72

Static level-depth to water 8 ft.

Quality (clear, cloudy, taste, odor) Cloudy No Sulphur Taste or Odor

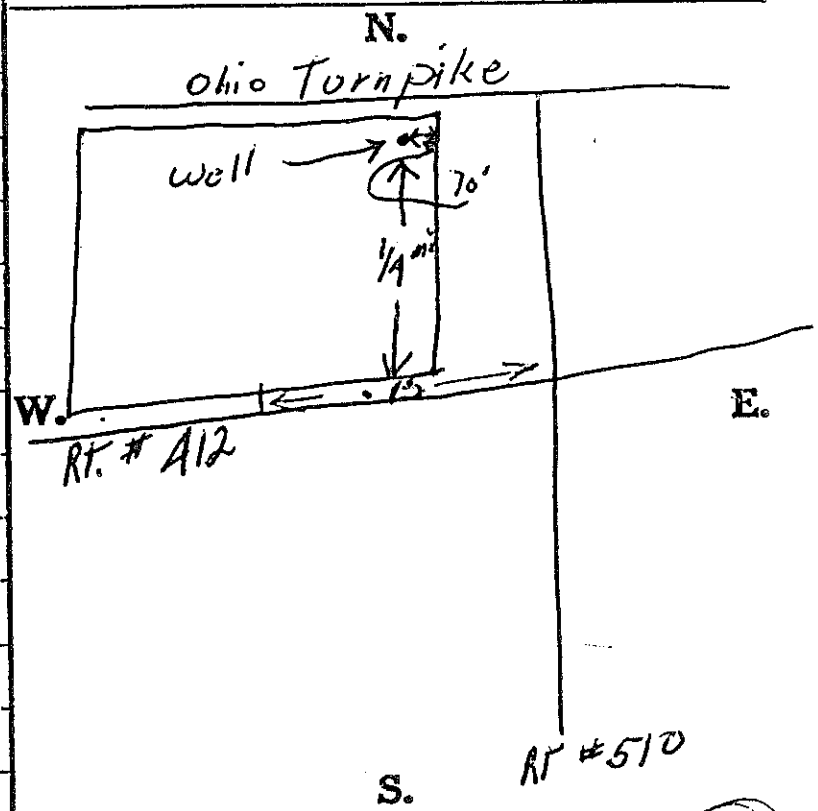
Pump installed by —

WELL LOG*

Formations Sandstone, shale, limestone, gravel and clay	From	To
Top Soil	0 Feet	5 Ft.
Clay	5	40
Sandstone + Clay	40	45'
Bed Rock	45'	55'
Well	55'	
Monitoring well # 4 ?		
OEPA #1		

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



Drilling Firm Whittaker + Son Date 5-24-72

Address 920 Garrison St Fremont, Ohio Signed John Whittaker

*If additional space is needed to complete well log, use next consecutive numbered form.

LOCATE

CNL

Division of Water
1500 Dublin Road
Columbus, Ohio

No. 182754
89

County Sandusky Township Riley Section of Township

Owner Arnold Staschke Address Rural Rt. Fremont

Location of property On State Rte 12 - ½ Mile ½ of Erlin

CONSTRUCTION DETAILS	BAILING OR PUMPING TEST
Casing diameter 4" Length of casing 43'6	Pumping rate ..... G.P.M. Duration of test ..... hrs.
Type of screen ..... Length of screen	Drawdown 6 ft. Date May 3
Type of pump	Developed capacity .....
Capacity of pump	Static level—depth to water 18 ft.
Depth of pump setting	Pump installed by .....
Date of completion May 3, 56	

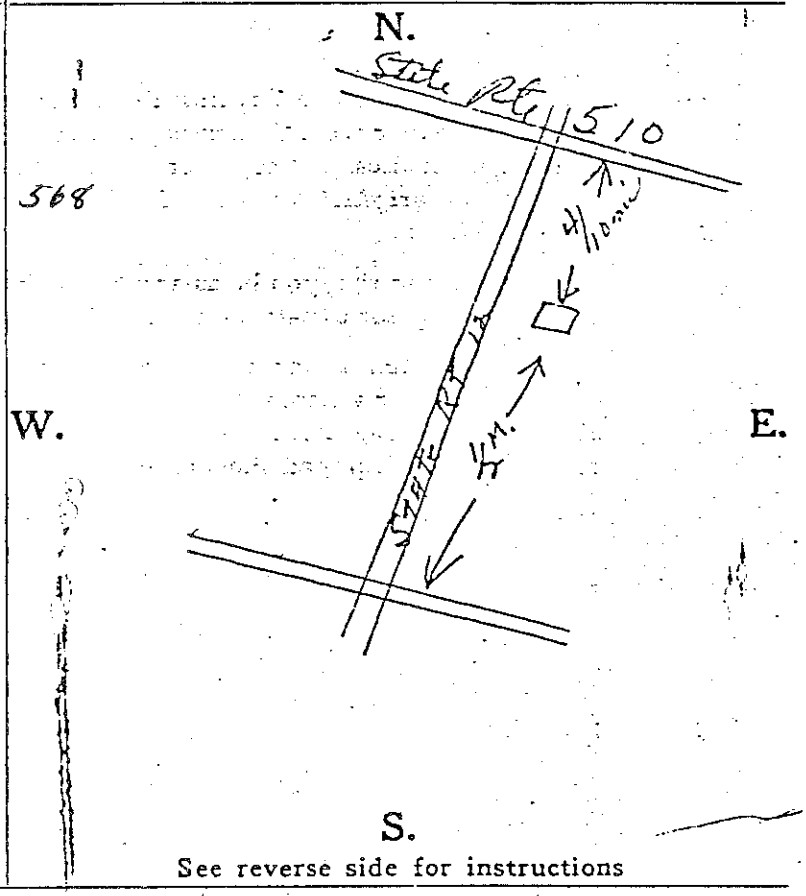
WELL LOG 610

Formations Sandstone, shale, limestone, gravel and clay	From	To
Sand.	0 Feet	18 Ft.
Clay	18	32
Sand.	32	37
gray Clay & Gravel	37	42
Limestone 42 ft.	42	56
Water 50'		

OEPA #6
Gerstenberger well
6-75

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

Drilling Firm Thomas Bros.
Address 622 Arthur Ave.
Fremont, Ohio

Date Aug. 22, 56
Signed [illegible]

C - 23

89

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1500 Dublin Road
Columbus, Ohio

No. 199085
OK

County [illegible] Township [illegible] Section of Township 26

Owner [illegible] Address [illegible]

Location of property [illegible]

CONSTRUCTION DETAILS	BAILING OR PUMPING TEST
Casing diameter 5 Length of casing 44'	Pumping rate 7 G.P.M. Duration of test ..... hrs.
Type of screen ..... Length of screen	Drawdown ..... ft. Date .....
Type of pump	Developed capacity .....
Capacity of pump	Static level—depth to water 10 595 ft.
Depth of pump setting	Pump installed by .....
Date of completion	

WELL LOG 605

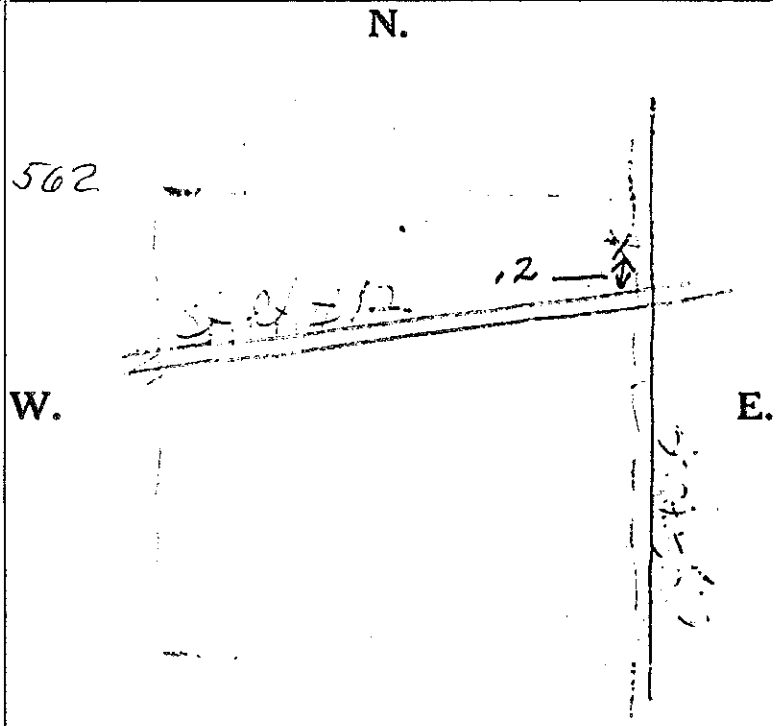
Formations Sandstone, shale, limestone, gravel and clay	From	To
	0 Feet	1 Ft.
Topsoil	1	12
Yellow Clay	12	43
Blue "	43	54
Rock		

Water at 52-54

OEPA #4

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



See reverse side for instructions

Drilling Firm [illegible] Date [illegible] 57

Address [illegible] Signed [illegible]

90

WELL LOG AND DRILLING REPORT

NO CARBON PAPER NECESSARY— SELF-TRANSCRIBING

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
65 S. Front St., Rm. 815 Phone (614) 469-2646
Columbus, Ohio 43215

No. 417706

County Sandusky Township Riley Section of Township 25

Owner Albert Meyers Address Clyde, Ohio

Location of property St Rt 412 - ½ mi. East of St Rt 510

CONSTRUCTION DETAILS

Casing diameter 4¼" Length of casing 66'

Type of screen _____ Length of screen _____

Type of pump _____

Capacity of pump _____

Depth of pump setting _____

Date of completion _____

BAILING OR PUMPING TEST
(Specify one by circling)

Test Rate _____ G.P.M. Duration of test _____ hrs.

Drawdown none ft. Date _____

Static level-depth to water 15' ft.

Quality (clear, cloudy, taste, odor) _____

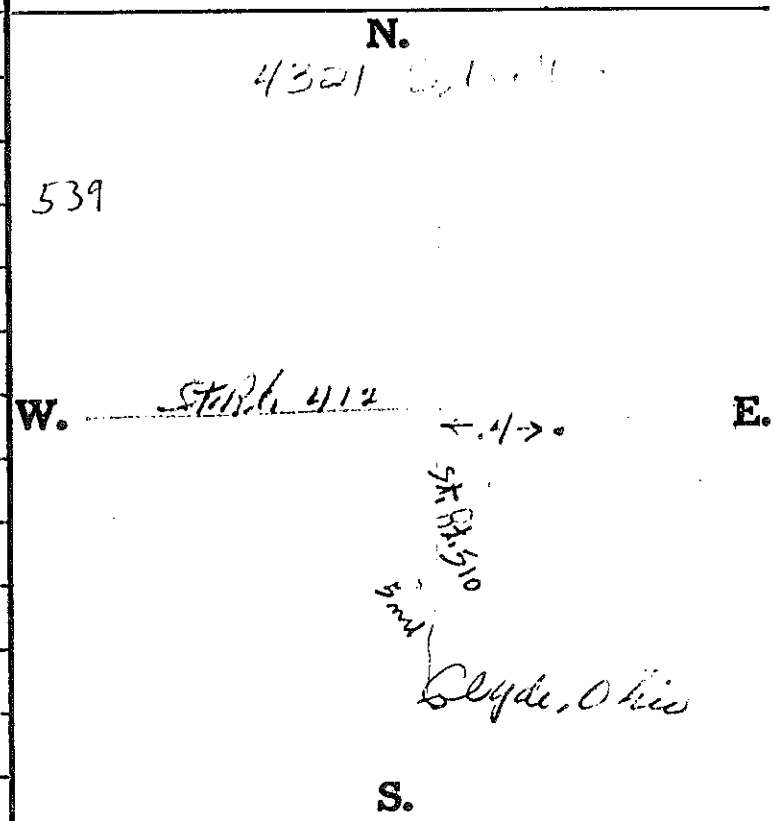
Pump installed by _____

WELL LOG* 605

Formations Sandstone, shale, limestone, gravel and clay	From	To
Clay	0 Feet	6' Ft.
Shale	6'	51'
Sand	51	66'
Limestone	66'	100'

SKETCH SHOWING LOCATION

Locate in reference to numbered State Highways, St. Intersections, County roads, etc.



Drilling Firm Amel F. Green (Well Drilling) Date Mar 18/71

Address 712 - O'Donnell St. Upper Sandusky, Ohio Signed Amel F. Green

*If additional space is needed to complete well log, use next consecutive numbered form.

SERVICE PLAZA WELLS

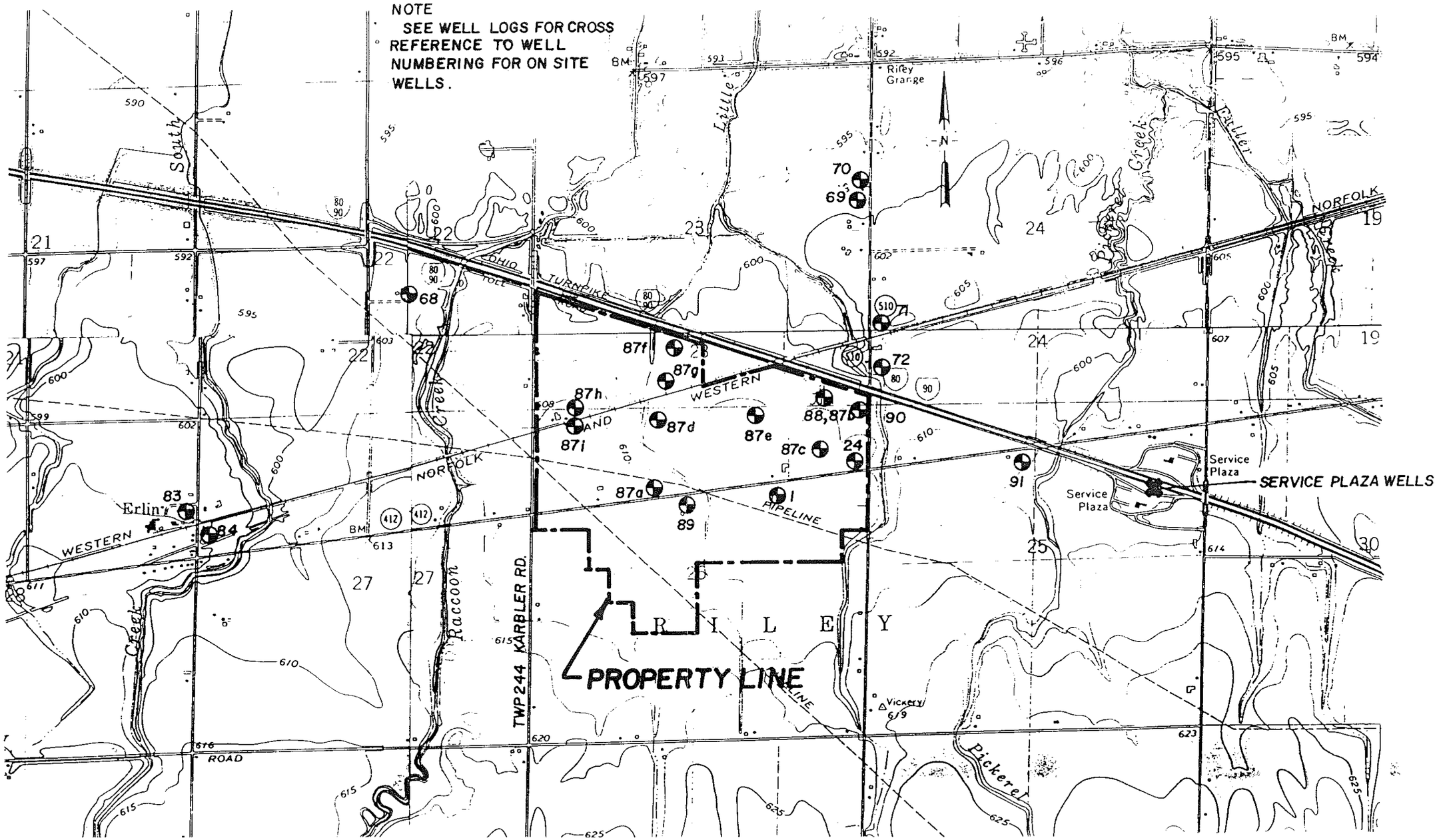
Test Well (from Schaefer 1954)

Depth (feet)	Materials Encountered
0-65	Clay, sand and gravel
65-78	Sand and gravel, wet, sulphurous odor
78-89	Sand, gravel and clay
89-95	Boulders, clay and gravel
95-103	Brown limestone
103-136.6	White limestone, water 110 ft. to 123 ft., flowing

14 feet of flowing artesian head

Production Wells (from Schaefer & Walton 1956)

	Kind of Material penetrated	Depth (feet) From	To
West Well	Clay, sand and gravel	0	65
	Sand and gravel	65	78
	Sand, gravel and clay	78	89
	Boulders, clay and gravel	89	95
	Brown limestone	95	103
	White limestone	103	136.6
East Well	Yellow clay	0	10
	Blue clay	10	40
	Hardpan	40	72-1/2
	Fine sand	72-1/2	73
	Hardpan	73	75
	Gray shaley limestone	75	82
	Gray limestone	82	99



WELL LOCATION PLAN

JOB NO. 33767
DATE: 2-4-83

BOWSER-MORNER, INC.

APPENDIX D

BACKGROUND WATER QUALITY DATA

NOTE: The information contained in this appendix was collected from various sources. The references are listed below.

The water quality data on Poorman's Spring given on pages D-13 and D-14 was run by the lab at the Northern Ohio Treatment Facility.

Hoover, J.A. (1982), "Groundwater Resources of Sandusky County, Ohio." Unpublished, University of Toledo Masters' Thesis.

Ohio Department of Natural Resources, Division of Water (1970), "Groundwater for Planning in Northwest Ohio - A Study of the Carbonate Rock Aquifers: Ohio Water Plan Inventory Report; Number 22, Columbus, Ohio."

Schaefer, E.J. and Walton, W.C. (1956), Report to the Ohio Turnpike Commission on Developing a New Groundwater Supply for Service Plaza 5: June, 1956.

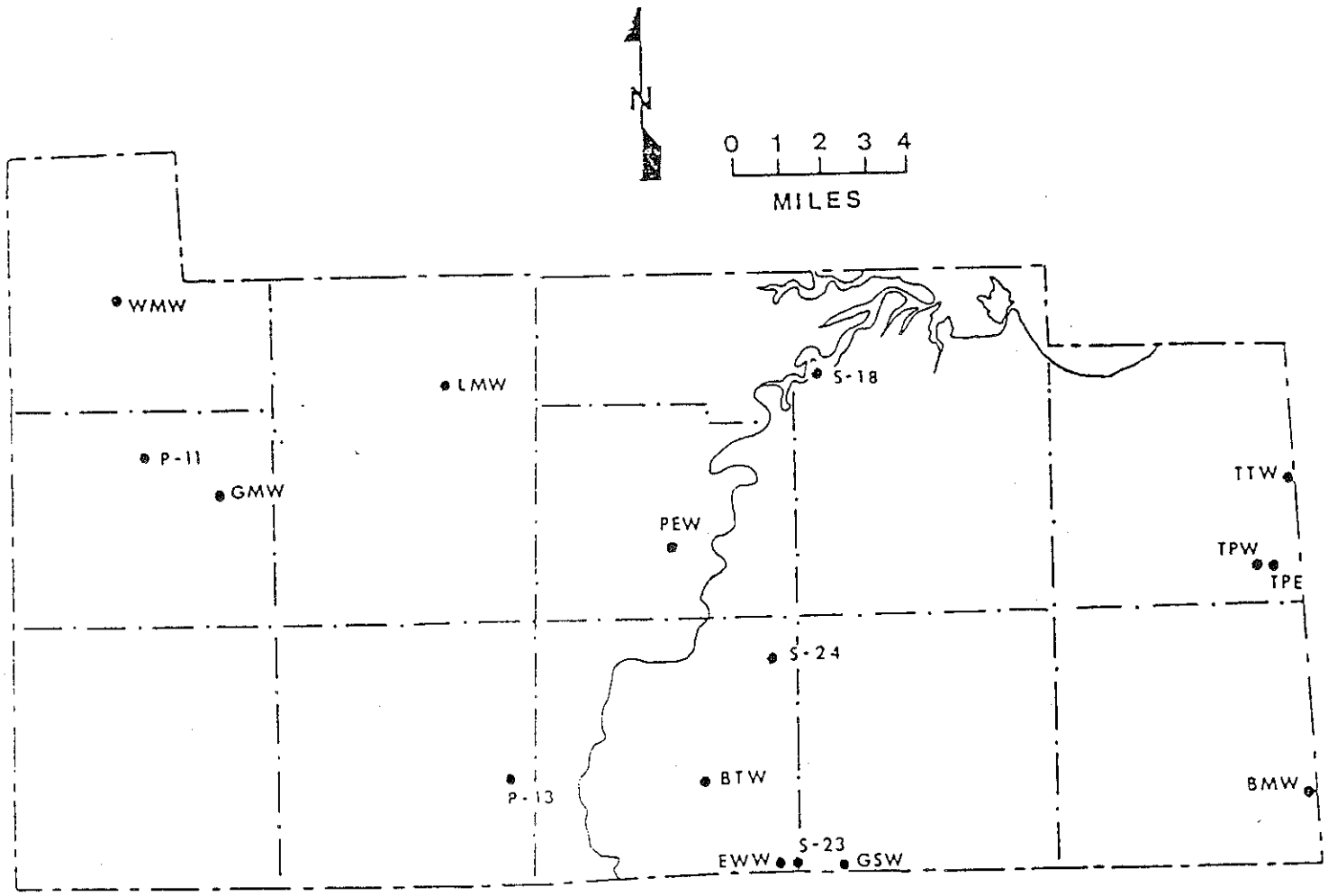


FIGURE 18. Location of wells analyzed for ground-water quality in Sandusky County, Ohio.

from Hoover 1982

TABLE 11. Ground-water quality from 16 wells in Sandusky County, Ohio. All values in mg/l, except pH (data from Ohio Department of Natural Resources, Division of Water, 1956, 1966, and 1970).

Well	Date	Location and well depth	Tot. dissolved solids	Carbonate hardness	pH	SO_4	Cl	F	Fe	Mn	H_2S
TPE	1956	Turnpike well east, NW ,NW ,Sec. 16, T5N, R17E, Townsend Twp., 150 ft (45.7 m)	2386	1622	---	571	25	---	13	---	---
TPW	1956	Turnpike well west, NE ,NE ,Sec. 15, T5N, R17E, Townsend Twp., 150 ft (45.7 m)	2582	1680	---	672	37	---	14	---	---
LMW	8/62	Lindsey, municipal well, 315 ft (96 m)	490	370	7.4	76	0	0.9	0.1	0.1	---
WMW	10/62	Woodville, municipal well, 225 ft (68.6 m)	575	420	7.9	101	17	0.3	0.05	0.05	---
GMW	4/63	Gibsonburg, municipal well, 301 ft (91.7 m)	495	390	8.2	101	8	0.6	0.0	0.0	---
BTW	5/63	SW ,SW ,Sec. 22,T4N, R15E, Ballville Twp., 73 ft (22.2 m)	1380	853	7.2	796	18	0.7	0.8	0.06	---
EWW	1/65	SE ,SE ,Sec. 36, T4N, R15E, Ballville Twp., 180 ft (54.8 m)	1680	1250	7.0	1030	7	1.0	19	0.1	---

from Hoover 1982

TABLE 11. (continued)

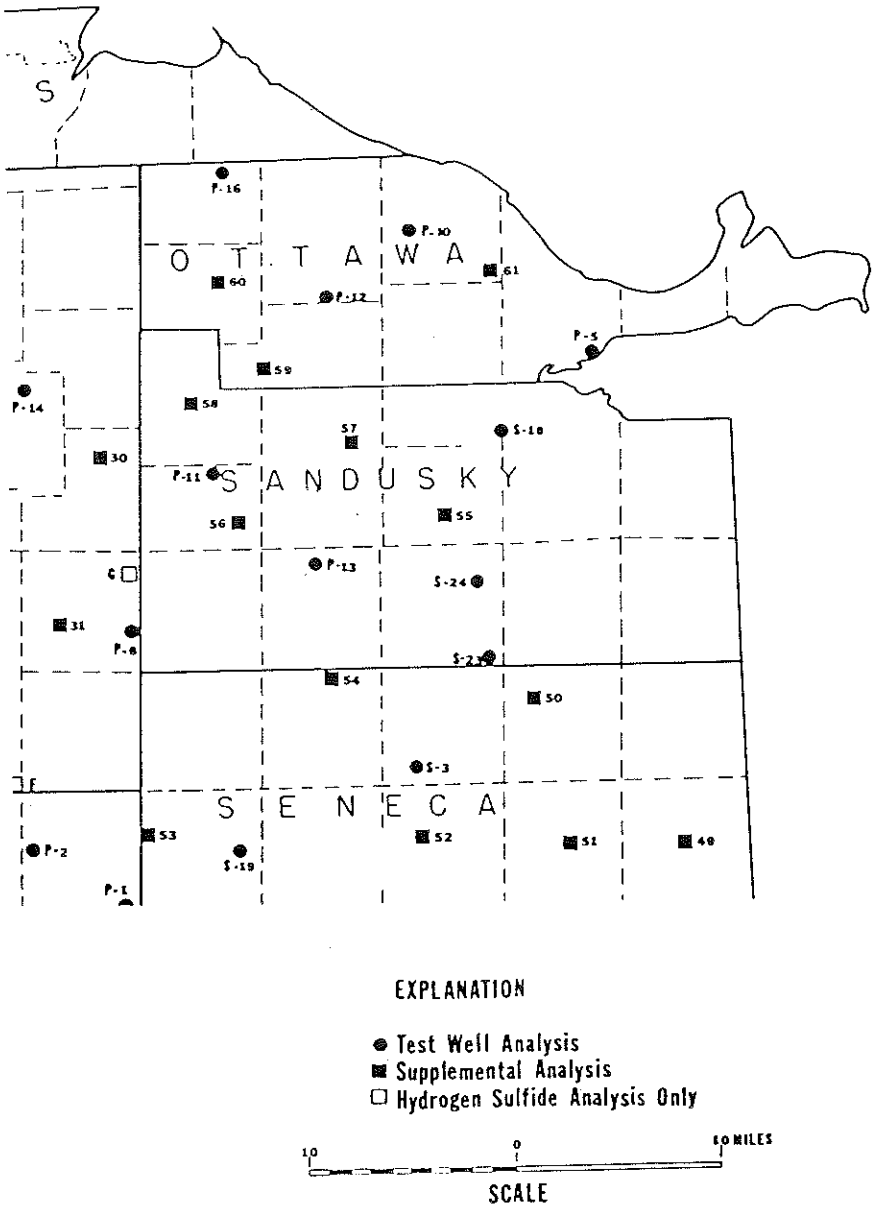
Well	Date	Location and well depth	Tot. dissolved solids	Carbonate hardness	pH	SO_4	Cl	F	Fe	Mn	H_2S
PEW	11/65	Peter Echrich & Sons, Fremont, 380 ft (115.7 m)	542	461	7.4	128	9	1.2	1.0	1.0	---
GSW	1966	Green Springs, municipal well west, 96 ft (29.3m)	1900	1360	---	1080	7	1.2	4.5	---	---
BMW	1966	Bellevue, municipal well (auxillary), 212 ft (64.6 m)	696	497	---	244	29	0.3	5.0	---	---
TTW	1966	NE ,NE ,Sec. 24, T5N, R17E, Townsend Twp., 99 ft (30.2 m)	2130	1560	---	1220	12	1.2	0.8	---	---
P-11	8/69	NW ,NW ,Sec. 15, T5N, R13E, Madison Twp., 250 ft (76.2 m)	408	345	7.6	71	10	0.6	0.7	0.7	1.8
S-24	10/69	NE ,SW ,Sec. 12, T4N, R15E, Ballville Twp., 92 ft (28 m)	1570	1080	7.3	876	12	1.5	1.3	1.3	0.2
S-18	10/69	NW ,NW ,Sec. 6, T5N, R16E, Riley Twp., 280 ft (85.3 m)	2590	1850	7.2	1520	39	1.5	0.4	0.4	1.2

from Hoover 1982

TABLE 11. (continued)

Well	Date	Location and well depth	Tot. dissolved solids	Carbonate hardness	pH	SO_4	Cl	F	Fe	Mn	H_2S
S-23	11/69	SW ,SE ,Sec. 36, T4N R15E, Ballville Twp., 108 ft (32.9 m)	1700	1230	7.2	878	5	1.0	2.2	2.2	0.3
P-13	11/69	NE ,SW ,Sec. 24, T4N, R14E, Jackson Twp., 280 ft (85.3 m)	823	447	7.3	116	8	1.6	0.8	0.8	0.8

from Hoover 1982



Well Location Map after ODNR (1970)

TABLE 8A (Continued)

WATER ANALYSES OF TEST WELLS

Well number	County	Date analyzed (month, year)	Depth of well (feet)	Water-bearing units	Milligrams per liter: Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue at 180°C.)	Hardness $CaCO_3$: Total	Hardness $CaCO_3$: Noncarbonate	Hydrogen Sulfide (H_2S)	pH	Remarks
M-32	Defiance	4-68	580	D R	7.7	6.8	.07	69	56	94	15	389	116	120	2.2	.1	676	403	76	69.	7.5	Sample turbid
M-33	Paulding	8-69	385	D R	14	12	.05	98	53	69	8.7	426	93	115	2.3	.7	682	463	114	27.	7.4	Sample turbid
M-35	Henry	5-70	340	R T	13	.74	.08	130	47	160	2.2	86	740	11	1.2	.1	1170	518	448	---	7.7	Not pumped. H_2S present
M-36	Henry	7-69	220	R	20	.18	0	159	56	102	2.8	144	620	53	1.3	0	1140	628	510	3.7	7.8	Plugged back from 265'
M-37	Henry	6-69	300	D R	11	.42	.03	283	133	72	5.6	240	1050	107	1.9	.1	1900	1250	1060	29.	7.4	
M-38	Wood	10-69	500	R T	8.2	.32	.08	552	180	62	3.8	180	1910	48	1.7	0	3110	2120	1970	6.1	7.3	Double-cased to 410'
M-39	Lucas	6-69	250	D	8.6	.22	.03	67	27	38	2.7	247	152	6.0	2.3	0	452	278	76	5.1	7.6	
M-40	Lucas	8-69	335	D	11	---	---	114	33	13	2.2	330	180	4.5	1.8	.1	580	420	150	7.5	7.5	
M-41	Auglaize	5-70	260	L	16	2.2	.05	141	47	56	3.6	264	381	24	1.2	2.7	810	546	329	0	7.9	Not pumped
M-42	Mercer	4-69	280	G L	16	2.9	.04	189	100	39	4.3	430	566	8.0	1.2	0	1230	884	531	1.5	7.2	
P-1	Hancock	12-69	220	L	17	---	---	186	90	72	3.4	188	734	14	.8	0	1310	835	680	0	7.7	Not pumped
P-2	Hancock	12-69	220	L	18	---	---	295	86	84	3.8	132	1080	20	1.6	.3	1760	1090	982	.3	7.5	
P-3	Wood	11-69	230	L	9.7	1.6	.05	227	95	91	6.0	150	888	63	2.1	0	1590	958	835	---	7.8	Not pumped
P-4	Hancock	5-70	230	L	10	16	.05	132	57	96	3.6	146	560	30	1.3	.1	996	564	445	0	7.4	Not pumped. Sample turbid
* P-5	Ottawa	10-69	350	T G L	13	.30	0	577	130	21	3.6	284	1620	36	1.4	0	2720	1980	1740	5.1	7.2	Double-cased to 180'
P-6	Hancock	6-69	420	R T G L	11	.57	.02	236	79	92	4.2	180	885	20	1.3	0	1410	915	767	8.7	7.1	
P-8	Wood	11-69	260	L	16	.36	.02	94	31	7.1	1.6	370	50	8.7	.7	.1	399	362	59	0	7.4	
P-9	Wood	11-69	235	G L	22	3.1	.05	480	136	23	4.1	305	1410	18	1.6	0	2420	1760	1510	0	7.2	
P-10	Ottawa	9-69	300	G L	12	.90	0	400	146	22	3.2	198	1290	47	1.7	.03	2270	1600	1440	3.9	7.2	Double-cased to 120'
P-11	Sandusky	8-69	250	L	14	.73	0	87	31	8.8	1.9	332	71	10	.6	0	408	345	72	1.8	7.6	
P-12	Ottawa	9-69	360	G L	8.9	.79	0	104	55	42	2.4	190	375	18	1.4	.03	782	486	330	14	7.1	
P-13	Sandusky	11-69	280	L	15	.79	0	105	45	7.5	1.8	398	116	8.0	1.6	0	533	447	121	.8	7.3	
P-14	Wood	8-69	250	L	11	1.3	.03	67	23	24	1.7	186	136	12	1.0	.1	390	262	109	1.7	7.7	
P-16	Ottawa	8-69	360	L	9.2	.25	.01	108	32	5.0	1.4	354	114	1.0	1.9	0	465	401	111	2.2	7.4	
P-18	Wood	5-69	300	G L	16	.41	.03	203	116	63	4.8	258	840	25	1.0	0	1540	984	773	20.	7.1	
S-1	Crawford	4-70	285	D R	13	.12	0	248	74	24	5.3	362	642	6.0	1.5	0	1240	924	628	7.5	7.1	
S-3	Seneca	11-69	360	G L	16	.86	.04	103	49	14	2.0	345	181	6.0	1.5	0	600	459	176	.3	7.5	
S-4	Marion	5-70	320	R T G	15	.34	0	146	38	9.7	2.5	371	217	1.0	1.6	0	644	520	216	.8	7.7	
S-5	Wyandot	3-70	320	T G L	9.4	.35	.08	553	146	33	3.8	304	1670	55	1.8	1.6	2790	1980	1730	5.4	6.8	
S-6	Wyandot	3-70	300	T G L	12	1.3	.08	247	70	49	3.4	230	760	20	1.8	0	1340	905	716	0	7.8	

Water-bearing units: D - Devonian System; R - Raisin River Formation; T - Tymochtee Formation; G - Greenfield Formation; L - Lockport Group

* analysis relevant to this study
from ODNR 1970

TABLE 8A (Continued)

WATER ANALYSES OF TEST WELLS

Well number	County	Date analyzed (month, year)	Depth of well (feet)	Water-bearing units	Milligrams per liter: Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved Solids (residue at 180°C.)	Hardness $CaCO_3$: Total	Hardness $CaCO_3$: Noncarbonate	Hydrogen Sulfide (H_2S)	pH	Remarks
S-7	Wyandot	5-70	290	T G L	15	4.5	.02	240	83	41	4.0	246	780	14	1.6	.1	1270	941	740	.8	7.4	
S-8	Hardin	4-70	330	G L	8.9	1.4	0	179	78	55	4.4	285	580	34	1.7	.2	1180	768	534	.7	7.4	
S-9	Wyandot	2-70	220	G L	17	2.4	.01	533	93	67	5.8	188	1590	23	2.0	.7	2600	1710	1560	1.5	7.0	
S-10	Wyandot	2-70	200	G L	18	3.5	.05	429	91	48	6.4	246	1260	18	1.8	0	2160	1440	1240	1.4	6.8	
S-11	Wyandot	2-70	180	G L	10	---	---	420	195	368	24	230	1250	780	1.3	0	3440	1850	1660	0	7.4	Not pumped
S-12	Crawford	3-70	330	D R	14	.64	0	94	22	3.6	1.8	338	53	1.0	1.1	.1	363	325	48	0	7.1	
S-13	Crawford	2-70	340	D R	10	3.4	1.2	641	141	47	6.8	376	1800	62	1.8	.1	3060	2180	1870	40	7.3	Not pumped. Sample turbid.
S-14	Wyandot	2-70	120	R	17	1.2	0	193	64	6.3	2.7	324	436	1.5	1.6	.1	962	745	479	.2	7.0	Plugged back from 200'
S-15	Hardin	4-70	250	R T G L	15	3.4	.04	150	53	21	2.2	480	239	4.3	1.4	0	735	592	199	.7	7.5	
S-16	Seneca	1-70	310	G L	13	2.3	.08	250	58	65	3.8	170	780	15	.9	0	1410	863	748	.7	7.1	
S-17	Seneca	2-70	395	T G L	14	.88	.03	156	56	12	4.1	386	302	7.0	1.4	0	775	620	303	1.1	6.9	
S-18	Sandusky	10-69	340	T G L	12	.37	.02	484	156	24	3.9	267	1520	39	1.5	.2	2590	1850	1630	1.2	7.2	Double-cased to 180'
S-19	Seneca	1-70	375	L	13	1.6	.07	215	60	64	4.6	152	716	16	.9	.2	1300	784	660	0	7.2	
S-23	Sandusky	11-69	108	T G	19	2.2	.05	375	71	15	2.6	416	878	5.0	1.0	0	1700	1230	887	.3	7.2	
S-24	Sandusky	10-69	163	T G	16	1.3	.03	282	91	35	2.8	232	876	12	1.5	.1	1570	1080	868	.2	7.3	

Water-bearing units: D - Devonian System; R - Raisin River Formation; T - Tymochtee Formation; G - Greenfield Formation; L - Lockport Group

* analysis relevant to this study
from ODNR 1970

* * *

TABLE 8B (Continued)

WATER ANALYSES OF SUPPLEMENTAL WELLS

Number	County	Location	Date analyzed (month, year)	Depth of well (feet)	Water-bearing units	Milligrams per liter: Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue at 180°C.)	Hardness $CaCO_3$: Total	Hardness $CaCO_3$: Noncarbonate	Hydrogen Sulfide[b] (H_2S)	pH	Remarks
51	Seneca	Republic	9-62	123	R	.40	0	114	50	9.0	335	225a	1.0	.6	.4	685	490	215	0	7.6	c
52	Seneca	Tiffin	5-62	150	L	.98	.11	102	36	16	354	134	8.0	1.3	.2	507	403	113	0	6.8	
53	Seneca	Fostoria, 1 mi S	5-63	153	L	2.9	.04	115	34	18	352	136	28	.2	.3	541	427	139	0	8.0	
54	Seneca	Bettsville	5-66	230	G L	.40	0	116	31	8.0	461	28	19	1.6	0	500	414	36	.2	8.1	c
55	Sandusky	Fremont	11-65	389	G L	1.0	.18	109	46	7.0	410	128	9.0	1.2	.4	542	461	125	0	7.4	
56	Sandusky	Gibsonburg	4-63	301	L	0	0	102	33	5.0	348	101a	8.0	.6	0	495	390	105	0	8.2	c
57	Sandusky	Lindsey	8-62	315	G L	.10	0	100	29	5.0	366	76a	0	.9	.4	490	370	70	0	7.4	c
58	Sandusky	Woodville	10-62	225	L	.05	0	104	39	8.0	378	101a	17	.3	0	575	420	110	0	7.9	c
59	Ottawa	Elmore	1-68	375	L	.20	0	236	72	22	340	591	28	1.6	.7	1186	878	599	0	7.7	c
60	Ottawa	Genoa	6-69	350	L	.10	0	138	21	7.0	381	91	17	.7	0	585	432	120	.5	7.2	c
61	Ottawa	Oak Harbor, 3 mi E	8-54	137	T G	.05	----	544	177	26	246	1831	46	1.8	0	3018	2090	1884	3.9	7.2	
A	Putnam	Ottoville	10-69	450	G L	----	----	---	---	----	---	-----	----	---	---	----	----	----	0.2	---	Double-cased to 160'
B	Allen	Delphos	2-70	450	R T G L														9.2		North well field
C	Auglaize	St. Marys	2-70	270	L														0		New well field
D	Hardin	Kenton	11-69	358	T G L														0		
E	Wood	Cygnet	10-69	170	G L														4.1		
F	Wood	Bloomdale	10-69	181	L														1.2		
G	Wood	Bradner	9-69	315	L														0		

a -- SO_4 calculated
b -- H_2S analyzed, 1969-70
c -- Analysis by Ohio Department of Health

Water-bearing units: R - Raisin River Formation; T - Tymochtee Formation; G - Greenfield Formation; L - Lockport Group

* analysis relevant to this study
from ODNR 1970

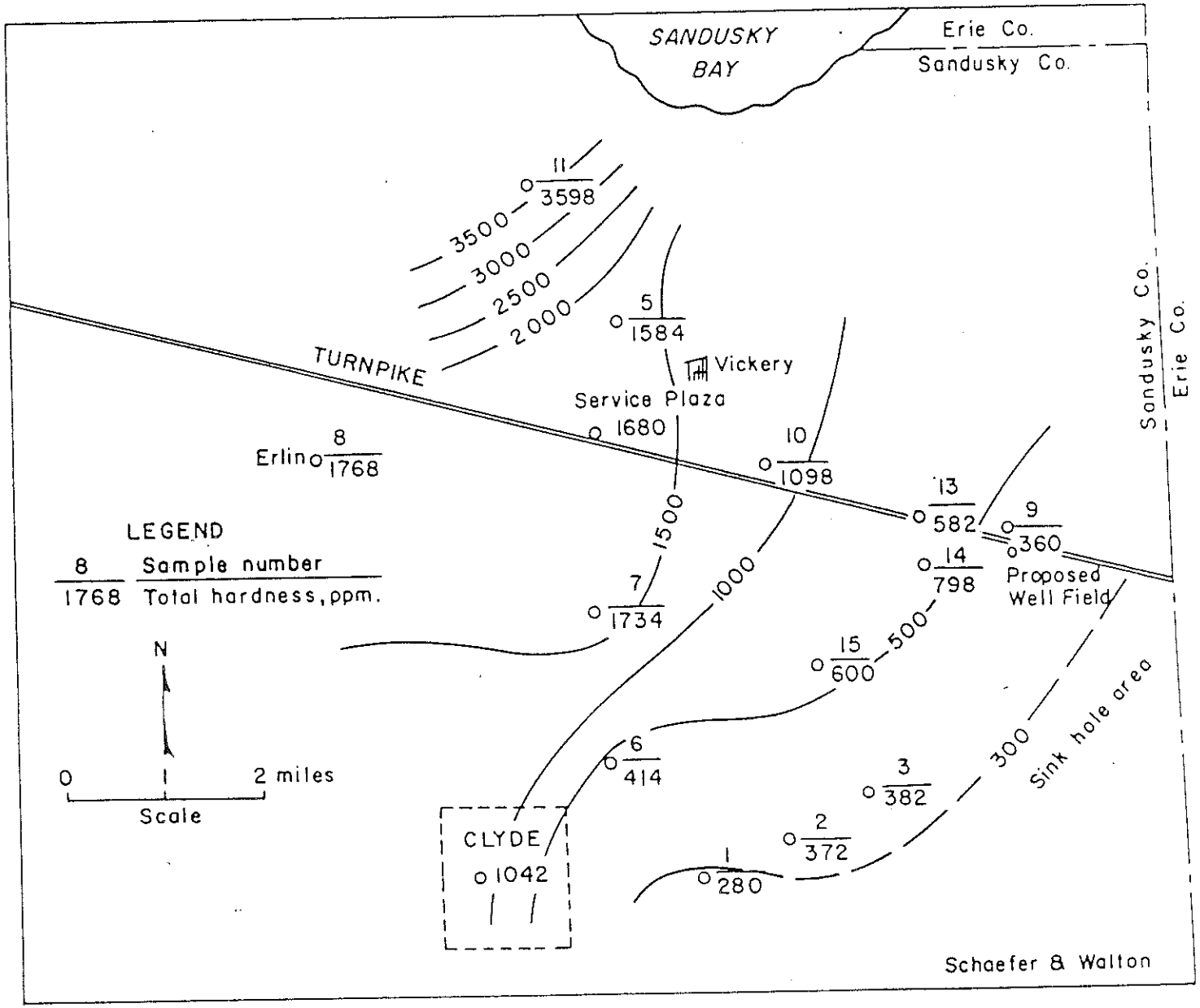


FIGURE 5.- MAP SHOWING TOTAL HARDNESS OF GROUND WATER.

from Schaefer and Walton (1956)

from Schaefer and Walton (1956)

Table 1

Chemical quality of the ground water

pumped at the Service Plaza

	Parts per million	
	East well	West well
Calculated carbon dioxide as Co_2	33.0	32.0
Phenol alkalinity as $CaCo_3$	0	0
Total alkalinity as $CaCo_3$	252.	240.
Total hardness as $CaCo_3$	1622.	1680.
Carbonate hardness as $CaCo_3$	252.	240.
Noncarbonate hardness as $CaCo_3$	1370.	1440.
Calcium hardness as $CaCo_3$	1312.	1424.
Calcium as Ca	524.8	569.6
Magnesium hardness as $CaCo_3$	310.	256.
Magnesium as Mg	89.3	73.7
Chlorides as Cl	25.	37.
Total iron as Fe	13.	14.
Sulfates as SO_4	571.	672.
Dissolved silica as SiO_2	18.	21.
Corrosion factor	minus 36	minus 56
Total solids	2386.	2582.
Volatile solids	347.	466.
Fixed solids	2039.	2116.
pH value	7.19	7.17

Table 2

Chemical quality of the ground waters in the area under investigation

Parts per million

Sample No.	1	2	3	5	6	7	8	9	10	11	13	14	15
Total alkalinity as $CaCo_3$	230	254	292	266	198	228	226	254	258	222	206	260	350
Total hardness as $CaCo_3$	280	372	382	1584	414	1734	1768	360	1098	3598	582	798	600
Carbonate hardness as $CaCo_3$	230	254	292	266	198	228	226	254	258	222	206	260	350
Noncarbonate hardness as $CaCo_3$	50	118	90	1318	216	1506	1542	106	840	3376	376	538	250
Total solids	340	610	482	2332	710	2518	2622	462	1546	8124	866	1138	820

from Schaelfer and Walton (1956)

POORMAN'S SPRING

Date Sampled: 10-21-80

Date Tested: 10-22-80

Sampling Point : Sulfur spring draining into Raccoon Creek, 1/2 mile south of State Route 412, off Twp. Road 233

NW # L-10-50 Color: Clear, strong sulfide odor

CHEMICAL ANALYSIS

PH	7.17		PHENOL	0.013	mg/l
TOTAL AL OR AC	--	meg/l	CL	19	mg/l
SS	10	mg/l	SO_4	1148	mg/l
DS	--		COND.	1850	umhos/cm^2
TS	265.5	mg/l	SpGR	--	
ASH	--	mg/l	Total Fe:	0.04	mg/l
COD	36	mg/l	Total Cr:	< 0.03	mg/l
O & G (F)	3	mg/l	Total Ni:	< 0.03	mg/l
FLASH	--		Total Cd:	< 0.006	mg/l
			Total Zn:	0.008	mg/l
			Total Ca:	528	
OTHER TESTS:			Total Mg:	92	mg/l

Sampling temp: 10.5°C; Dissolved O_2: 1.3 mg/l

REMARKS: TS and Fe not as high as artesian aquifer farther north.

ANALYST: BB

POORMAN'S SPRING

Date Sampled: 2-24-81

Date Tested: 2-26-81

Sampling Point : Subsurface water

NW # L-2-37

Color: Clear, lt suspended solids, strong sulfide odor

CHEMICAL ANALYSIS

PH	7.23		PHENOL	0.003	mg/l
TOTAL AL OR AC	--	meg/l	CL	22	mg/l
SS	40	mg/l	SO_4	1484	mg/l
DS	--		COND.	1650	umhos/cm^2
TS	2495	mg/l	SpGR	--	
ASH	--	mg/l	Total Fe:	0.13	mg/l
COD	8	mg/l	Total Cr:	< 0.03	mg/l
O & G (F)	7	mg/l	Total Ni:	< 0.03	mg/l
~~XXXXXX~~	questionable		Total Cd:	< 0.006	mg/l
			Total Zn:	< 0.003	mg/l
			TOC:	N/A	mg/l

OTHER TESTS: Sampling Temperature: 9.0°C - Dissolved Oxygen: 30 mg/l

REMARKS:

ANALYST: BB

APPENDIX E

PUMP TEST DATA

AQUIFER PUMPING TEST

LOCATION: North of Clyde, Ohio DATE OF TEST: 12/9/82 TIME: 8:00 AM

BOREHOLE #1 Pumping TOTAL DEPTH 75 ft.

CLIENT (NAME): Chemical Waste Management LENGTH OF STANDPIPE: 1'10.5"

TECHNICIAN: Richard Hosfeld DISTANCE FROM PUMPING WELL: N/A

TIME AFTER PUMPING STARTED (MINUTES) Interval	Actual	PUMPING RATE (GPM)	DEPTH TO WATER (FROM TOP OF PIPE)	DRAWDOWN (FT)
0	9:00 AM	0	14.96	0
1	3	11 gpm	22.50	7.54
2	4		22.70	7.74
3	5		22.70	7.74
5	7		22.80	7.84
7	9		22.83	7.87
10	11		22.85	7.89
15	15		22.87	7.91
20	20		22.92	7.96
25	25		22.92	7.96
30	30		22.98	8.02
40	40		22.96	8.00
50	50		23.00	8.04
60	60	$\frac{55 \text{ gallons}}{4'55''} \cong 11$ gpm	23.04	8.08
75	75		23.08	8.12
100	100		22.96	8.00
160	120	$\frac{55 \text{ gallons}}{4'55''} \cong 11$ gpm	23.04	8.08

BOWSER MORNER

AQUIFER PUMPING TEST — CONTINUED

TIME AFTER PUMPING STARTED (MINUTES)		PUMPING RATE (GPM)	DEPTH TO WATER (FROM TOP OF PIPE)	DRAWDOWN (FT)
Interval	Actual			
220	180		23.40	8.44
280	255	$\frac{55 \text{ gallons}}{4'55''} \cong 11$ gpm	24.08	9.12
340	301		24.63	9.67
400	360	$\frac{55 \text{ gallons}}{5'} \cong 11$ gpm	24.96	10.00
460	422		24.96	10.00
520	476		24.96	10.00
580	480	0 gpm	17.33	7.63

/mjj(#29, Tracks #17 & #18)

BOWSER MORNER

AQUIFER PUMPING TEST

LOCATION: North of Clyde, Ohio DATE OF TEST: 12/9/82 TIME: 8:00 AM

BOREHOLE #2 Observation TOTAL DEPTH 60 ft.

CLIENT (NAME): Chemical Waste Management LENGTH OF STANDPIPE: 1'5"

TECHNICIAN: Richard Hosfeld DISTANCE FROM PUMPING WELL: 24.73 feet

TIME AFTER PUMPING STARTED (MINUTES) Interval	Actual	PUMPING RATE (GPM)	DEPTH TO WATER (FROM TOP OF PIPE)	DRAWDOWN (FT)
0		0	14.47	0
1	2	11 gpm	14.55	0.08
2	3		14.65	0.18
3	4		14.73	0.26
5	6		14.80	0.33
7	8		15.30	0.83
10	11		15.40	0.93
15	15		15.45	0.98
20	20		15.13	0.66
25	25		15.00	0.53
30	30		15.00	0.53
40	40		15.00	0.53
50	50		15.00	0.53
60	60	11 gpm	15.00	0.53
75	75		15.00	0.53
100	100		15.00	0.53
160	123	11 gpm	15.00	0.53

BOWSER MORNER

AQUIFER PUMPING TEST -- CONTINUED

TIME AFTER PUMPING STARTED (MINUTES)		PUMPING RATE (GPM)	DEPTH TO WATER (FROM TOP OF PIPE)	DRAWDOWN (FT)
Interval	Actual			
220	181		15.78	1.31
280	257	11 gpm	16.78	2.31
340	304		17.05	2.58
400	360	11 gpm	17.05	2.58
460	420		17.05	2.58
520	475		17.05	2.58
580	481	0 gpm	16.95	

/mjj(#29, Tracks #19 & #20)

BOWSER MORNER

APPENDIX F

STATISTICAL ANALYSES OF MONITORING WELL DATA

NOTE: The following pages contain the means and standard deviations of seven constituents. The data was compiled annually for the period of record available as of October, 1982. All values, with the exception of pH and phenols, are in milligrams per liter (mg/l). Phenols were not consistently recorded in mg/l, and for many samples it was uncertain whether the units were recorded in parts per million (ppm) or parts per billion (ppb). No effort was made to correct the raw data before the values were entered into the computer. The statistical data for phenols, therefore, is incorrect and is unreliable. Also, many values for parameters were recorded as "less than" some number. These values were entered into the computer at a concentration level equal to the limiting value and, therefore, may suggest the presence of a greater concentration than actually exists.

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=1 YEAR=78						
PH	36	7.0172	0.3136	6.5500	7.9000	0.0983
CL	18	1730.0000	1411.4599	144.0000	5671.0000	1992219.0588
PHENOL	5	0.2044	0.4448	0.0010	1.0000	0.1978
ZN	32	35.2556	199.0382	0.0060	1126.0000	39616.1862
SULFATES	19	1835.3158	122.8613	1408.0000	2009.0000	15094.8947
IRON	36	7.3981	33.4273	0.0300	202.0000	1117.3817
CROMIUM	36	0.0300	0.0000	0.0300	0.0300	0.0000
WELL=1 YEAR=79						
PH	24	7.0137	0.1741	6.6000	7.3600	0.0303
CL	24	2205.2917	2187.1695	1001.0000	9161.0000	4783710.3025
PHENOL	11	3.7424	10.8025	0.0020	36.0000	116.6948
ZN	24	0.0398	0.0456	0.0040	0.2040	0.0021
SULFATES	23	1830.9130	45.8485	1744.0000	1897.0000	2102.0830
IRON	24	0.8295	1.1909	0.0300	5.7500	1.4183
CROMIUM	24	0.0300	0.0000	0.0300	0.0300	0.0000

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=1N YEAR=79						
PH	24	7.2608	0.3344	6.3800	7.8800	0.1118
CL	22	561.0455	184.0746	141.0000	877.0000	33883.4740
PHENOL	20	9.8121	29.0213	0.0000	100.0000	842.2351
ZN	24	0.0118	0.0187	0.0020	0.0870	0.0003
SULFATES	24	1735.2083	344.0121	156.0000	1897.0000	118344.3460
IRON	24	0.2793	0.3057	0.0140	1.4200	0.0934
CROMIUM	24	0.0300	0.0000	0.0300	0.0300	0.0000
WELL=1N YEAR=80						
PH	45	7.1938	0.1799	6.6200	7.8700	0.0324
CL	45	748.3556	164.3924	274.0000	1153.0000	27024.8707
PHENOL	45	2.2350	14.9052	0.0000	100.0000	222.1649
ZN	45	0.0098	0.0094	0.0030	0.0590	0.0001
SULFATES	45	1779.1556	96.3681	1429.0000	1976.0000	9286.8162
IRON	45	0.6049	0.5675	0.0500	3.2800	0.3221
CROMIUM	45	0.0300	0.0000	0.0300	0.0300	0.0000
WELL=1N YEAR=81						
PH	31	7.1523	0.1096	6.9000	7.3500	0.0120
CL	31	1588.4516	923.6365	701.0000	4810.0000	853104.3892
PHENOL	31	0.0017	0.0020	0.0010	0.0100	0.0000
ZN	30	0.0114	0.0106	0.0040	0.0530	0.0001
SULFATES	31	1726.9032	277.9364	296.0000	2120.0000	77248.6237
IRON	30	1.7027	2.5168	0.3500	9.4200	6.3343
CROMIUM	30	0.0290	0.0071	0.0200	0.0600	0.0001
WELL=1N YEAR=82						
PH	15	7.1907	0.3232	6.7000	8.2100	0.1045
CL	15	1539.5333	580.6465	443.0000	2720.0000	337150.4095
PHENOL	15	0.0100	0.0000	0.0100	0.0100	0.0000
ZN	15	0.0542	0.0607	0.0030	0.2200	0.0037
SULFATES	15	1670.2000	379.5419	320.0000	1910.0000	144052.0286
IRON	15	1.5873	2.2903	0.1300	7.7600	5.2454
CROMIUM	15	0.0267	0.0082	0.0100	0.0400	0.0001

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=2 YEAR=77						
PH	40	7.1132	0.3495	6.6000	8.4100	0.1221
CL	11	183.5455	38.3832	143.0000	280.0000	1473.2727
PHENOL	3	0.0073	0.0046	0.0020	0.0100	0.0000
ZN	41	0.2592	0.3634	0.0060	2.1000	0.1320
SULFATES	12	1854.5833	74.0006	1728.0000	2017.0000	5476.0833
IRON	40	2.0357	2.0734	0.0200	9.6500	4.2991
CROMIUM	41	0.0296	0.0072	0.0200	0.0700	0.0001
WELL=2 YEAR=78						
PH	49	7.3216	0.1574	6.9100	7.6700	0.0248
CL	22	224.6818	31.0213	183.0000	305.0000	962.3225
PHENOL	8	0.0064	0.0081	0.0010	0.0220	0.0001
ZN	49	0.1966	0.4687	0.0050	2.2300	0.2197
SULFATES	22	1871.0000	48.0506	1769.0000	1973.0000	2308.8571
IRON	49	1.2172	0.8710	0.0220	4.4700	0.7587
CROMIUM	49	0.0431	0.0570	0.0200	0.4000	0.0032
WELL=2 YEAR=79						
PH	50	7.2934	0.2470	6.4900	7.8800	0.0610
CL	48	226.2917	69.1711	63.0000	430.0000	4784.6365
PHENOL	31	3.7279	17.8962	0.0010	100.0000	320.2741
ZN	50	0.0234	0.0446	0.0040	0.3250	0.0020
SULFATES	49	1846.9796	58.6567	1699.0000	1962.0000	3440.6037
IRON	49	1.6509	1.1246	0.0800	5.0200	1.2648
CROMIUM	50	0.0304	0.0028	0.0300	0.0500	0.0000
WELL=2 YEAR=80						
PH	48	7.2496	0.1144	6.8200	7.4300	0.0131
CL	48	202.8750	32.4494	100.0000	277.0000	1052.9628
PHENOL	46	2.1904	14.7418	0.0010	100.0000	217.3193
ZN	48	0.0376	0.0269	0.0100	0.1200	0.0007
SULFATES	48	1867.6042	75.9644	1520.0000	2063.0000	5770.5847
IRON	48	1.5200	1.3059	0.1360	5.3000	1.7055
CROMIUM	48	0.0300	0.0000	0.0300	0.0300	0.0000

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=2 YEAR=81						
PH	15	7.1807	0.1327	6.9000	7.4000	0.0176
CL	15	383.6667	222.6582	250.0000	1130.0000	49576.6667
PHENOL	15	0.0010	0.0000	0.0010	0.0010	0.0000
ZN	14	0.0703	0.0464	0.0090	0.1870	0.0022
SULFATES	15	1867.9333	25.6305	1820.0000	1910.0000	656.9238
IRON	14	1.8664	0.9471	0.4700	3.2500	0.8969
CROMIUM	14	0.0243	0.0085	0.0100	0.0400	0.0001
WELL=2 YEAR=82						
PH	16	7.3131	0.0857	7.1800	7.4800	0.0073
CL	16	352.6875	254.3868	245.0000	1300.0000	64712.6292
PHENOL	16	0.0100	0.0000	0.0100	0.0100	0.0000
ZN	16	0.1302	0.1742	0.0200	0.5700	0.0303
SULFATES	16	1869.3125	115.5720	1750.0000	2290.0000	13356.8958
IRON	16	1.3294	0.4236	0.5000	2.4200	0.1794
CROMIUM	16	0.0212	0.0034	0.0200	0.0300	0.0000

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=3 YEAR=76						
PH	5	10.0080	0.6290	9.2300	10.7000	0.3957
CL	2	84.0000	12.7279	75.0000	93.0000	162.0000
PHENOL	0	.	.	.	.	.
ZN	1	0.0250	.	0.0250	0.0250	.
SULFATES	3	747.3333	388.5027	299.0000	985.0000	150934.3333
IRON	5	92.1800	202.8278	0.0400	455.0000	41139.1203
CROMIUM	5	0.0420	0.0110	0.0300	0.0500	0.0001
WELL=3 YEAR=78						
PH	38	9.4832	0.6560	7.0700	10.1000	0.4303
CL	20	167.9500	245.7512	20.0000	1201.0000	60393.6289
PHENOL	5	0.1124	0.2073	0.0010	0.4800	0.0430
ZN	9	5.7270	6.5441	0.0240	18.6000	42.8252
SULFATES	20	1423.8000	148.0685	1114.0000	1593.0000	21924.2737
IRON	38	0.4014	1.1507	0.0300	6.9700	1.3241
CROMIUM	38	0.0276	0.0085	0.0200	0.0700	0.0001
WELL=3 YEAR=79						
PH	25	9.0272	0.4611	7.7600	9.6200	0.2126
CL	24	128.7917	131.2982	19.0000	684.0000	17239.2156
PHENOL	9	0.0922	0.1703	0.0040	0.5400	0.0290
ZN	0	.	.	.	.	.
SULFATES	22	1390.0909	88.7334	1244.0000	1727.0000	7873.6104
IRON	25	0.0633	0.0656	0.0050	0.2900	0.0043
CROMIUM	25	0.0300	0.0000	0.0300	0.0300	0.0000

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=3A YEAR=78						
PH	47	7.4253	0.3681	7.0200	9.5600	0.1355
CL	22	21.1000	14.1816	7.0000	44.0000	201.1190
PHENOL	4	0.0045	0.0040	0.0010	0.0100	0.0000
ZN	47	0.0558	0.0972	0.0090	0.6570	0.0095
SULFATES	22	250.0000	421.6535	67.0000	1623.0000	177791.7143
IRON	46	0.2433	0.3403	0.0200	1.7800	0.1158
CROMIUM	47	0.0300	0.0000	0.0300	0.0300	0.0000
WELL=3A YEAR=79						
PH	49	7.4249	0.2848	6.3800	8.3200	0.0811
CL	49	43.6531	153.9473	7.0000	1095.0000	23699.7730
PHENOL	31	3.7578	17.8925	0.0020	100.0000	320.1425
ZN	49	0.0311	0.0405	0.0030	0.2800	0.0016
SULFATES	48	141.0625	63.8690	59.0000	388.0000	4079.2513
IRON	49	0.7156	0.9599	0.0200	2.7300	0.9214
CROMIUM	49	0.0300	0.0000	0.0300	0.0300	0.0000
WELL=3A YEAR=76						
PH	37	7.4089	0.2398	7.0200	8.0000	0.0575
CL	9	9.6111	8.1078	1.0000	30.0000	65.7361
PHENOL	0	.	.	.	.	.
ZN	13	0.0692	0.0404	0.0200	0.1550	0.0016
SULFATES	10	83.4000	24.7665	44.0000	121.0000	613.3778
IRON	33	0.6176	1.1124	0.0200	5.6000	1.2375
CROMIUM	34	0.0378	0.0114	0.0200	0.0500	0.0001
WELL=3A YEAR=77						
PH	38	7.1882	0.2437	6.7000	8.1500	0.0594
CL	10	6.8600	2.2677	3.0000	9.0000	5.1427
PHENOL	2	0.0100	0.0000	0.0100	0.0100	0.0000
ZN	38	0.0335	0.0194	0.0070	0.0960	0.0004
SULFATES	10	120.8000	32.4681	88.0000	202.0000	1054.1778
IRON	38	0.1415	0.1714	0.0200	0.7580	0.0294
CROMIUM	38	0.0284	0.0031	0.0250	0.0400	0.0000

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=3 A YEAR=80						
PH	50	7.3088	0.1313	6.9600	7.5700	0.0172
CL	50	13.4400	12.5229	8.0000	99.0000	156.8229
PHENOL	48	2.0995	14.4314	0.0010	100.0000	208.2658
ZN	50	0.0117	0.0120	0.0030	0.0300	0.0001
SULFATES	50	132.7600	44.1013	45.0000	274.0000	1944.9208
IRON	50	0.0737	0.1115	0.0300	0.6200	0.0124
CROMIUM	50	0.0300	0.0000	0.0300	0.0300	0.0000
WELL=3 A YEAR=81						
PH	11	7.2945	0.1621	7.1100	7.6500	0.0263
CL	11	18.1818	9.3789	5.0000	42.0000	87.9636
PHENOL	11	0.0010	0.0000	0.0010	0.0010	0.0000
ZN	11	0.0154	0.0114	0.0030	0.0390	0.0001
SULFATES	11	136.6364	46.4549	19.0000	210.0000	2158.0545
IRON	11	0.9627	1.1535	0.0300	4.1200	1.3305
CROMIUM	11	0.0291	0.0030	0.0200	0.0300	0.0000
WELL=3 A YEAR=82						
PH	6	7.2583	0.1007	7.1700	7.4500	0.0101
CL	6	11.7833	4.3037	6.0000	18.0000	18.5217
PHENOL	6	0.0100	0.0000	0.0100	0.0100	0.0000
ZN	6	0.0340	0.0472	0.0100	0.1300	0.0022
SULFATES	6	148.3333	46.7062	78.0000	220.0000	2181.4667
IRON	6	1.0317	0.5920	0.1200	1.6300	0.3505
CROMIUM	6	0.0217	0.0041	0.0200	0.0300	0.0000

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=3N YEAR=79						
PH	25	7.1116	0.2093	6.5100	7.4900	0.0438
CL	25	570.5600	531.1973	28.0000	1848.0000	282170.5900
PHENOL	21	5.3035	21.7260	0.0020	100.0000	472.0174
ZN	25	0.0138	0.0322	0.0030	0.1620	0.0010
SULFATES	25	1686.6400	230.9661	1437.0000	2459.0000	53345.3233
IRON	25	0.7189	0.6090	0.0300	2.9500	0.3709
CROMIUM	25	0.0319	0.0018	0.0300	0.0370	0.0000
WELL=3N YEAR=80						
PH	65	7.0769	0.1032	6.7800	7.3400	0.0106
CL	65	105.7538	149.4828	52.0000	935.0000	22345.0947
PHENOL	61	1.6524	12.8020	0.0010	100.0000	163.8920
ZN	65	0.0085	0.0064	0.0030	0.0270	0.0000
SULFATES	65	1473.5538	130.3121	1206.0000	2061.0000	16981.2510
IRON	65	0.0596	0.0577	0.0300	0.3100	0.0033
CROMIUM	65	0.0296	0.0033	0.0030	0.0300	0.0000
WELL=3N YEAR=81						
PH	42	7.0843	0.1275	6.8300	7.3500	0.0163
CL	42	276.5714	261.8330	84.0000	1230.0000	68556.4948
PHENOL	42	0.0011	0.0006	0.0010	0.0040	0.0000
ZN	41	0.0220	0.0306	0.0030	0.1940	0.0009
SULFATES	42	1491.7619	57.1510	1380.0000	1652.0000	3266.2346
IRON	41	0.1688	0.1883	0.0300	0.6600	0.0355
CROMIUM	41	0.0283	0.0038	0.0200	0.0300	0.0000
WELL=3N YEAR=82						
PH	17	7.1482	0.1310	6.9600	7.3800	0.0172
CL	17	435.0588	245.0810	330.0000	1380.0000	60064.6838
PHENOL	17	0.0100	0.0000	0.0100	0.0100	0.0000
ZN	17	0.0211	0.0145	0.0080	0.0700	0.0002
SULFATES	17	1519.7647	19.9985	1490.0000	1570.0000	399.9412
IRON	17	0.1076	0.0434	0.0300	0.2200	0.0019
CROMIUM	17	0.0212	0.0033	0.0200	0.0300	0.0000

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=4 YEAR=74						
PH	11	7.9545	0.1128	7.7000	8.1000	0.0127
CL	2	77.5000	60.1041	35.0000	120.0000	3612.5000
PHENOL	0	.	.	.	.	.
ZN	0	.	.	.	.	.
SULFATES	2	1619.5000	314.6625	1397.0000	1842.0000	99012.5000
IRON	0	.	.	.	.	.
CROMIUM	0	.	.	.	.	.
WELL=4 YEAR=75						
PH	36	7.7706	0.3770	6.6900	8.5200	0.1421
CL	10	33.0000	5.0990	28.0000	46.0000	26.0000
PHENOL	0	.	.	.	.	.
ZN	0	.	.	.	.	.
SULFATES	12	1773.3333	124.2434	1567.0000	1989.0000	15436.4242
IRON	0	.	.	.	.	.
CROMIUM	0	.	.	.	.	.
WELL=4 YEAR=76						
PH	51	7.5147	0.3627	6.2000	8.2400	0.1315
CL	12	31.5000	5.3172	27.0000	43.0000	28.2727
PHENOL	0	.	.	.	.	.
ZN	16	3.4594	1.1539	1.7000	6.5000	1.3314
SULFATES	12	1852.8333	183.5399	1317.0000	1995.0000	33686.8788
IRON	39	0.7713	0.4597	0.0400	1.8200	0.2114
CROMIUM	37	0.0368	0.0132	0.0050	0.0500	0.0002
WELL=4 YEAR=77						
PH	39	7.3892	0.3019	6.7500	7.9700	0.0912
CL	11	32.0909	9.3537	26.0000	60.0000	87.4909
PHENOL	2	0.0100	0.0000	0.0100	0.0100	0.0000
ZN	18	3.9606	1.3952	1.6600	5.6000	1.9467
SULFATES	11	1927.1818	136.4389	1573.0000	2067.0000	18615.5636
IRON	40	0.8503	0.5674	0.0600	1.9500	0.3220
CROMIUM	40	0.0285	0.0030	0.0250	0.0400	0.0000

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=4 YEAR=78						
PH	48	7.5294	0.2108	7.1300	7.9700	0.0444
CL	23	32.4783	9.6430	22.0000	65.0000	92.9881
PHENOL	5	0.0130	0.0174	0.0010	0.0430	0.0003
ZN	17	124.4376	497.4972	1.5600	2055.0000	247503.5124
SULFATES	22	1957.0909	55.7494	1868.0000	2102.0000	3107.9913
IRON	48	0.8110	0.4712	0.1400	1.5400	0.2220
CROMIUM	48	0.0269	0.0051	0.0200	0.0400	0.0000
WELL=4 YEAR=79						
PH	25	7.7008	0.1772	7.2900	8.0900	0.0314
CL	25	34.4800	10.1658	8.0000	50.0000	103.3433
PHENOL	11	0.5612	0.9243	0.0010	2.0000	0.8544
ZN	0	.	.	.	.	.
SULFATES	22	1899.7727	92.1422	1538.0000	2021.0000	8490.1840
IRON	25	0.3293	0.3064	0.0300	1.2400	0.0939
CROMIUM	25	0.0436	0.0680	0.0300	0.3700	0.0046

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=4N YEAR=79						
PH	25	6.9648	0.2451	6.2100	7.4800	0.0601
CL	25	467.4000	181.6409	69.0000	803.0000	32993.4167
PHENOL	21	5.3013	21.7265	0.0020	100.0000	472.0418
ZN	25	0.0075	0.0072	0.0030	0.0280	0.0001
SULFATES	25	488.8000	201.5757	354.0000	1370.0000	40632.7500
IRON	25	0.2381	0.2141	0.0300	0.7610	0.0458
CROMIUM	25	0.0300	0.0000	0.0300	0.0300	0.0000
WELL=4N YEAR=80						
PH	50	6.7974	0.1210	6.3900	7.0500	0.0146
CL	50	609.9000	144.5674	337.0000	1044.0000	20899.7245
PHENOL	48	2.0998	14.4314	0.0010	100.0000	208.2643
ZN	50	0.0080	0.0067	0.0030	0.0300	0.0000
SULFATES	50	440.5600	228.2087	193.0000	1513.0000	52079.2310
IRON	50	0.3471	0.4532	0.0300	3.3500	0.2054
CROMIUM	50	0.0300	0.0000	0.0300	0.0300	0.0000
WELL=4N YEAR=81						
PH	51	6.9080	0.1402	6.6200	7.2000	0.0196
CL	50	482.7400	260.0024	76.0000	800.0000	67601.2576
PHENOL	51	0.0011	0.0006	0.0010	0.0050	0.0000
ZN	50	0.0337	0.1402	0.0010	1.0000	0.0197
SULFATES	50	909.6600	603.0432	348.0000	1884.0000	363661.0453
IRON	49	0.9500	0.8259	0.0400	2.7600	0.6821
CROMIUM	49	0.0269	0.0047	0.0200	0.0300	0.0000
WELL=4N YEAR=82						
PH	32	7.3109	0.1335	7.0100	7.6900	0.0178
CL	32	63.0313	83.9134	21.0000	510.0000	7041.4506
PHENOL	32	0.0100	0.0000	0.0100	0.0100	0.0000
ZN	32	0.0381	0.0574	0.0100	0.2600	0.0033
SULFATES	32	1916.4063	101.9196	1740.0000	2340.0000	10387.6038
IRON	32	0.3150	0.2554	0.0400	1.3200	0.0652
CROMIUM	32	0.0216	0.0051	0.0100	0.0300	0.0000

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=5 YEAR=74						
PH	20	7.9250	0.2511	7.3000	8.2000	0.0630
CL	5	50.0000	33.5932	33.0000	110.0000	1128.5000
PHENOL	0	.	.	.	.	.
ZN	0	.	.	.	.	.
SULFATES	5	1437.8000	727.8473	150.0000	1892.0000	529761.7000
IRON	0	.	.	.	.	.
CROMIUM	0	.	.	.	.	.
WELL=5 YEAR=75						
PH	37	7.2968	0.2633	6.6700	7.8800	0.0693
CL	11	33.8182	11.6689	1.0000	43.0000	136.1636
PHENOL	0	.	.	.	.	.
ZN	0	.	.	.	.	.
SULFATES	12	1515.4167	489.8954	69.0000	1817.0000	239997.5379
IRON	0	.	.	.	.	.
CROMIUM	0	.	.	.	.	.
WELL=5 YEAR=76						
PH	52	7.2162	0.3125	6.1400	7.9000	0.0977
CL	12	42.4167	13.4127	25.0000	66.0000	179.9015
PHENOL	0	.	.	.	.	.
ZN	15	0.2829	0.2369	0.0900	0.9600	0.0561
SULFATES	12	1794.6667	89.9043	1569.0000	1887.0000	8082.7879
IRON	38	2.9047	1.7125	1.1900	7.4000	2.9327
CROMIUM	39	0.0383	0.0159	0.0100	0.1000	0.0003
WELL=5 YEAR=77						
PH	44	7.1480	0.1889	6.6600	7.8200	0.0357
CL	11	50.6364	23.2563	29.0000	98.0000	540.8545
PHENOL	3	0.0100	0.0000	0.0100	0.0100	0.0000
ZN	43	0.1661	0.1264	0.0210	0.6880	0.0160
SULFATES	11	1746.5455	90.6337	1588.0000	1840.0000	8214.4727
IRON	40	2.0650	0.4058	0.7600	3.4800	0.1647
CROMIUM	44	0.0285	0.0023	0.0250	0.0300	0.0000

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=5 YEAR=78						
PH	48	7.2177	0.1542	6.6500	7.5600	0.0238
CL	23	63.5217	29.8692	29.0000	156.0000	892.1700
PHENOL	6	0.0117	0.0192	0.0010	0.0500	0.0004
ZN	48	0.1641	0.2994	0.0270	1.6700	0.0896
SULFATES	23	1837.9565	189.6304	1706.0000	2679.0000	35959.6798
IRON	46	1.9654	0.6276	0.1800	3.8700	0.3939
CROMIUM	48	0.0265	0.0048	0.0200	0.0300	0.0000
WELL=5 YEAR=79						
PH	50	7.2296	0.2142	6.3600	7.7700	0.0459
CL	49	55.2449	32.6200	18.0000	221.0000	1064.0638
PHENOL	32	3.5477	17.6272	0.0020	100.0000	310.7187
ZN	35	0.0863	0.2882	0.0030	1.7200	0.0831
SULFATES	49	1774.3061	94.9768	1413.0000	1933.0000	9020.5918
IRON	50	1.8202	0.6642	0.0400	3.2000	0.4412
CROMIUM	50	0.0300	0.0000	0.0300	0.0300	0.0000
WELL=5 YEAR=80						
PH	50	7.0872	0.0930	6.7400	7.2800	0.0086
CL	50	47.1200	10.4874	30.0000	67.0000	109.9853
PHENOL	48	2.0993	14.4314	0.0010	100.0000	208.2665
ZN	50	0.0530	0.1190	0.0090	0.8400	0.0142
SULFATES	50	1841.0600	47.4279	1651.0000	1948.0000	2249.4045
IRON	50	2.0326	1.2233	0.0400	9.1500	1.4965
CROMIUM	50	0.0300	0.0000	0.0300	0.0300	0.0000
WELL=5 YEAR=81						
PH	34	7.1109	0.0899	6.9500	7.3300	0.0081
CL	34	48.7059	13.8379	31.0000	90.0000	191.4866
PHENOL	34	0.0011	0.0003	0.0010	0.0030	0.0000
ZN	33	0.0478	0.0371	0.0110	0.1550	0.0014
SULFATES	34	1780.0882	220.4144	629.0000	1924.0000	48582.5071
IRON	33	2.6327	0.6834	0.1900	3.6400	0.4671
CROMIUM	33	0.0276	0.0044	0.0200	0.0300	0.0000

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=5 YEAR=82						
PH	16	7.2306	0.0990	7.1000	7.4500	0.0098
CL	16	43.0000	6.1319	33.0000	51.0000	37.6000
PHENOL	16	0.0100	0.0000	0.0100	0.0100	0.0000
ZN	16	0.0974	0.1155	0.0100	0.4500	0.0133
SULFATES	16	1809.1250	63.5860	1700.0000	1960.0000	4043.1833
IRON	16	2.6987	0.8966	1.5000	5.5100	0.8039
CROMIUM	16	0.0219	0.0066	0.0100	0.0300	0.0000

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=6 YEAR=76						
PH	32	8.0478	0.3954	7.4200	9.1200	0.1563
CL	5	434.8000	244.1848	1.0000	587.0000	59626.2000
PHENOL	0	.	.	.	.	.
ZN	13	2.5085	1.6792	0.5500	5.0100	2.8198
SULFATES	7	1242.8571	746.9753	77.0000	1853.0000	557972.1429
IRON	30	0.4364	0.5389	0.0200	2.6300	0.2905
CROMIUM	30	0.0362	0.0108	0.0200	0.0500	0.0001
WELL=6 YEAR=77						
PH	38	8.0487	0.3793	7.2500	8.9300	0.1438
CL	10	557.3000	37.5472	491.0000	627.0000	1409.7889
PHENOL	4	0.0100	0.0000	0.0100	0.0100	0.0000
ZN	38	2.0393	1.0430	0.0320	4.6200	1.0878
SULFATES	10	1790.3000	59.3147	1668.0000	1879.0000	3518.2333
IRON	38	0.2201	0.2138	0.0200	0.8300	0.0457
CROMIUM	38	0.0287	0.0035	0.0250	0.0440	0.0000
WELL=6 YEAR=78						
PH	49	8.1486	0.4546	6.4500	9.1800	0.2067
CL	26	494.8080	210.5981	0.0070	642.0000	44351.5644
PHENOL	2	0.1905	0.2680	0.0010	0.3800	0.0718
ZN	19	1.7953	2.1777	0.0250	9.5800	4.7424
SULFATES	25	1804.3200	60.9650	1671.0000	2000.0000	3716.7267
IRON	49	0.2947	0.3010	0.0300	1.4500	0.0906
CROMIUM	49	0.0267	0.0047	0.0200	0.0300	0.0000
WELL=6 YEAR=79						
PH	25	8.0600	0.2186	7.6000	8.6300	0.0478
CL	25	667.4400	381.6381	91.0000	1865.0000	145647.6733
PHENOL	9	0.6751	0.9937	0.0020	2.0000	0.9875
ZN	0	.	.	.	.	.
SULFATES	24	1669.3750	386.6178	529.0000	2399.0000	149473.2880
IRON	25	0.1138	0.0663	0.0200	0.3100	0.0044
CROMIUM	25	0.0300	0.0000	0.0300	0.0300	0.0000

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=6A YEAR=76						
PH	37	7.4351	0.2303	7.1000	7.9200	0.0530
CL	9	34.4444	15.5251	5.0000	50.0000	241.0278
PHENOL	0	.	.	.	.	.
ZN	13	0.1986	0.3123	0.0200	1.1700	0.0975
SULFATES	10	278.7000	565.3532	65.0000	1887.0000	319624.2333
IRON	35	0.6446	0.8288	0.0200	3.2200	0.6868
CROMIUM	35	0.0373	0.0111	0.0200	0.0500	0.0001
WELL=6A YEAR=77						
PH	38	7.3974	0.2478	7.0200	7.9000	0.0614
CL	10	50.5000	14.8941	24.0000	72.0000	221.8333
PHENOL	2	0.0100	0.0000	0.0100	0.0100	0.0000
ZN	38	0.0783	0.2557	0.0050	1.5600	0.0654
SULFATES	10	106.4000	28.4183	48.0000	146.0000	807.6000
IRON	38	0.2452	0.3616	0.0200	1.8400	0.1307
CROMIUM	38	0.0288	0.0022	0.0250	0.0300	0.0000
WELL=6A YEAR=78						
PH	47	7.4711	0.2492	7.0600	8.0100	0.0621
CL	23	65.7391	118.4273	10.0000	605.0000	14025.0198
PHENOL	6	0.0013	0.0008	0.0010	0.0030	0.0000
ZN	46	0.1487	0.3582	0.0050	1.5600	0.1283
SULFATES	23	166.0435	296.6276	57.0000	1515.0000	87987.9526
IRON	45	0.2898	0.4501	0.0300	1.7500	0.2026
CROMIUM	46	0.0278	0.0042	0.0200	0.0300	0.0000
WELL=6A YEAR=79						
PH	49	7.5047	0.3256	6.1900	8.3100	0.1060
CL	49	49.7551	31.1960	10.0000	218.0000	973.1888
PHENOL	31	3.5323	17.9279	0.0020	100.0000	321.4081
ZN	49	0.0204	0.0194	0.0030	0.1010	0.0004
SULFATES	48	117.1875	51.2552	54.0000	276.0000	2627.0918
IRON	48	0.9278	1.2328	0.0300	5.0000	1.5199
CROMIUM	49	0.0300	0.0000	0.0300	0.0300	0.0000

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=6A YEAR=80						
PH	50	7.3784	0.1721	6.5100	7.8300	0.0296
CL	50	46.4800	17.8099	13.0000	100.0000	317.1935
PHENOL	48	2.0995	14.4314	0.0010	100.0000	208.2659
ZN	50	0.0039	0.0024	0.0030	0.0130	0.0000
SULFATES	50	161.7600	99.1757	39.0000	630.0000	9835.8188
IRON	50	2.4276	16.2474	0.0300	115.0000	263.9793
CROMIUM	50	0.0300	0.0000	0.0300	0.0300	0.0000
WELL=6A YEAR=81						
PH	2	7.2950	0.0495	7.2600	7.3300	0.0024
CL	1	84.0000	.	84.0000	84.0000	.
PHENOL	2	0.0030	0.0028	0.0010	0.0050	0.0000
ZN	2	0.0045	0.0021	0.0030	0.0060	0.0000
SULFATES	2	203.5000	44.5477	172.0000	235.0000	1984.5000
IRON	2	0.1500	0.1697	0.0300	0.2700	0.0288
CROMIUM	2	0.0300	0.0000	0.0300	0.0300	0.0000

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=6 N YEAR=79						
PH	25	7.4784	0.3452	6.3800	8.1600	0.1192
CL	25	1180.0800	148.3158	744.0000	1678.0000	21997.5767
PHENOL	21	5.2573	21.7366	0.0030	100.0000	472.4802
ZN	25	0.0088	0.0086	0.0030	0.0350	0.0001
SULFATES	25	1807.1600	74.0139	1600.0000	1968.0000	5478.0567
IRON	25	0.0760	0.0887	0.0300	0.4000	0.0079
CROMIUM	25	0.0300	0.0000	0.0300	0.0300	0.0000
WELL=6 N YEAR=80						
PH	50	7.2274	0.0946	6.9700	7.5800	0.0089
CL	50	1162.8800	103.3837	892.0000	1486.0000	10688.1894
PHENOL	46	2.1935	14.7413	0.0010	100.0000	217.3054
ZN	50	0.0055	0.0040	0.0010	0.0250	0.0000
SULFATES	50	1832.5400	61.0935	1518.0000	1946.0000	3732.4167
IRON	50	0.0606	0.0556	0.0300	0.3300	0.0031
CROMIUM	50	0.0300	0.0000	0.0300	0.0300	0.0000
WELL=6N YEAR=81						
PH	34	7.2606	0.1311	7.0400	7.7000	0.0172
CL	34	1344.2647	212.6751	1048.0000	1840.0000	45230.6854
PHENOL	34	0.0025	0.0081	0.0010	0.0480	0.0001
ZN	33	0.0142	0.0157	0.0010	0.0870	0.0002
SULFATES	34	1822.0588	33.1077	1760.0000	1907.0000	1096.1176
IRON	33	0.0588	0.0465	0.0300	0.2500	0.0022
CROMIUM	33	0.0279	0.0048	0.0200	0.0400	0.0000
WELL=6 N YEAR=82						
PH	17	7.2994	0.1641	7.1500	7.8000	0.0269
CL	17	1431.1765	168.5186	1090.0000	1740.0000	28398.5294
PHENOL	17	0.0100	0.0000	0.0100	0.0100	0.0000
ZN	17	0.0245	0.0103	0.0100	0.0500	0.0001
SULFATES	17	1823.8824	53.9524	1770.0000	1980.0000	2910.8603
IRON	17	0.1018	0.0265	0.0700	0.1600	0.0007
CROMIUM	17	0.0241	0.0071	0.0100	0.0400	0.0001

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=7 YEAR=76						
PH	1	7.9800	.	7.9800	7.9800	.
CL	1	516.0000	.	516.0000	516.0000	.
PHENOL	0	.	.	.	.	.
ZN	0	.	.	.	.	.
SULFATES	1	1698.0000	.	1698.0000	1698.0000	.
IRON	1	0.0500	.	0.0500	0.0500	.
CROMIUM	1	0.0500	.	0.0500	0.0500	.
WELL=7 YEAR=79						
PH	25	7.2848	0.2575	6.2700	7.7500	0.0663
CL	25	209.4000	80.1613	109.0000	414.0000	6425.8333
PHENOL	21	5.2569	21.7367	0.0020	100.0000	472.4849
ZN	25	0.0045	0.0022	0.0030	0.0110	0.0000
SULFATES	25	1835.6000	83.6516	1537.0000	1935.0000	6997.5833
IRON	25	0.1345	0.1536	0.0300	0.6800	0.0236
CROMIUM	25	0.0300	0.0000	0.0300	0.0300	0.0000
WELL=7 YEAR=80						
PH	50	7.2732	0.0934	7.0200	7.5500	0.0087
CL	50	93.6600	57.6140	55.0000	372.0000	3319.3718
PHENOL	48	2.0975	14.4317	0.0010	100.0000	208.2740
ZN	49	0.0063	0.0045	0.0030	0.0270	0.0000
SULFATES	50	1772.7800	119.8190	1466.0000	2237.0000	14356.5833
IRON	49	0.1761	0.1247	0.0300	0.5800	0.0156
CROMIUM	50	0.0300	0.0000	0.0300	0.0300	0.0000

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=7 YEAR=81						
PH	35	7.2969	0.1175	7.0500	7.5500	0.0138
CL	35	74.0571	25.7076	35.0000	136.0000	660.8790
PHENOL	35	0.0010	0.0000	0.0010	0.0010	0.0000
ZN	34	0.0129	0.0086	0.0030	0.0420	0.0001
SULFATES	35	1767.8000	79.7152	1493.0000	1876.0000	6354.5176
IRON	34	0.3909	0.2642	0.0600	1.2400	0.0698
CROMIUM	34	0.0279	0.0041	0.0200	0.0300	0.0000
WELL=7 YEAR=82						
PH	16	7.3000	0.0692	7.1400	7.4200	0.0048
CL	16	93.1875	124.1613	15.0000	450.0000	15416.0292
PHENOL	16	0.0106	0.0025	0.0100	0.0200	0.0000
ZN	16	0.0197	0.0080	0.0030	0.0300	0.0001
SULFATES	16	1791.8750	54.1872	1630.0000	1880.0000	2936.2500
IRON	16	0.1531	0.0903	0.0300	0.3600	0.0082
CROMIUM	16	0.0212	0.0034	0.0200	0.0300	0.0000

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=8 YEAR=79						
PH	16	7.3550	0.1924	7.0700	7.7800	0.0370
CL	16	26.1250	1.7464	23.0000	30.0000	3.0500
PHENOL	12	8.6068	28.7846	0.0020	100.0000	828.5537
ZN	16	6.0766	2.1655	0.9050	8.9500	4.6892
SULFATES	16	1842.3125	57.6931	1733.0000	1938.0000	3328.4958
IRON	16	2.2181	0.3583	1.8000	2.8900	0.1283
CROMIUM	16	0.0300	0.0000	0.0300	0.0300	0.0000
WELL=8 YEAR=80						
PH	50	7.3072	0.1278	6.9500	7.6500	0.0163
CL	50	25.6800	2.7586	17.0000	32.0000	7.6098
PHENOL	48	2.0994	14.4314	0.0010	100.0000	208.2661
ZN	49	4.8549	1.7165	1.7700	9.9000	2.9464
SULFATES	50	1845.8200	56.6492	1583.0000	1991.0000	3209.1302
IRON	50	2.2024	1.0088	0.0300	4.8000	1.0177
CROMIUM	50	0.0300	0.0000	0.0300	0.0300	0.0000
WELL=8 YEAR=81						
PH	33	7.2488	0.1212	7.0600	7.4800	0.0147
CL	33	42.6364	35.2206	24.0000	232.0000	1240.4886
PHENOL	33	0.0012	0.0014	0.0010	0.0090	0.0000
ZN	32	4.9513	1.6390	0.0030	8.8500	2.6864
SULFATES	33	1783.1515	41.5189	1620.0000	1870.0000	1723.8201
IRON	32	2.5794	2.4997	0.0500	9.3300	6.2483
CROMIUM	32	0.0606	0.1806	0.0200	1.0500	0.0326
WELL=8 YEAR=82						
PH	15	7.1800	0.1043	7.0200	7.4000	0.0109
CL	15	41.8667	39.6806	10.0000	180.0000	1574.5524
PHENOL	15	0.0100	0.0000	0.0100	0.0100	0.0000
ZN	15	2.1533	3.3596	0.1700	13.1000	11.2872
SULFATES	15	1797.0667	14.5576	1770.0000	1830.0000	211.9238
IRON	15	1.8520	1.7774	0.4000	7.9600	3.1592
CROMIUM	15	0.0213	0.0035	0.0200	0.0300	0.0000

VARIABLE	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=11 MONTH=1					
PH	7.3300	0.1414	7.2300	7.4300	0.0200
PHENOLS	0.0100	0.0000	0.0100	0.0100	0.0000
CL	607.5000	67.1751	560.0000	655.0000	4512.5000
SULFATES	2030.0000	0.0000	2030.0000	2030.0000	0.0000
ZN	0.0145	0.0078	0.0090	0.0200	0.0001
CROMIUM	0.0300	0.0000	0.0300	0.0300	0.0000
WELL=11 MONTH=2					
PH	7.3500	.	7.3500	7.3500	.
PHENOLS	0.0100	.	0.0100	0.0100	.
CL	590.0000	.	590.0000	590.0000	.
SULFATES	2040.0000	.	2040.0000	2040.0000	.
ZN	0.0270	.	0.0270	0.0270	.
CROMIUM	0.0200	.	0.0200	0.0200	.
WELL=11 MONTH=3					
PH	7.3850	0.0919	7.3200	7.4500	0.0084
PHENOLS	0.0100	0.0000	0.0100	0.0100	0.0000
CL	555.0000	77.7817	500.0000	610.0000	6050.0000
SULFATES	2060.0000	14.1421	2050.0000	2070.0000	200.0000
ZN	0.0110	0.0127	0.0020	0.0200	0.0002
CROMIUM	0.0200	0.0000	0.0200	0.0200	0.0000
WELL=11 MONTH=4					
PH	7.3250	0.0354	7.3000	7.3500	0.0012
PHENOLS	0.0100	0.0000	0.0100	0.0100	0.0000
CL	610.0000	28.2843	590.0000	630.0000	800.0000
SULFATES	2045.0000	7.0711	2040.0000	2050.0000	50.0000
ZN	0.0250	0.0071	0.0200	0.0300	0.0001
CROMIUM	0.0200	0.0000	0.0200	0.0200	0.0000

VARIABLE	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=11 MONTH=5					
PH	7.3200	.	7.3200	7.3200	.
PHENOLS	0.0100	.	0.0100	0.0100	.
CL	2610.0000	.	2610.0000	2610.0000	.
SULFATES	2070.0000	.	2070.0000	2070.0000	.
ZN	0.0030	.	0.0030	0.0030	.
CROMIUM	0.0300	.	0.0300	0.0300	.
WELL=11 MONTH=6					
PH	7.4400	0.0283	7.4200	7.4600	0.0008
PHENOLS	0.0100	0.0000	0.0100	0.0100	0.0000
CL	615.0000	21.2132	600.0000	630.0000	450.0000
SULFATES	2040.0000	28.2843	2020.0000	2060.0000	800.0000
ZN	0.0100	0.0000	0.0100	0.0100	0.0000
CROMIUM	0.0200	0.0000	0.0200	0.0200	0.0000
WELL=11 MONTH=7					
PH	7.4267	0.0208	7.4100	7.4500	0.0004
PHENOLS	0.0100	0.0000	0.0100	0.0100	0.0000
CL	554.6667	43.8786	520.0000	604.0000	1925.3333
SULFATES	2032.3333	10.7858	2020.0000	2040.0000	116.3333
ZN	0.0133	0.0058	0.0100	0.0200	0.0000
CROMIUM	0.0200	0.0000	0.0200	0.0200	0.0000
WELL=11 MONTH=8					
PH	7.2400	.	7.2400	7.2400	.
PHENOLS	0.0100	.	0.0100	0.0100	.
CL	610.0000	.	610.0000	610.0000	.
SULFATES	2061.0000	.	2061.0000	2061.0000	.
ZN	0.0100	.	0.0100	0.0100	.
CROMIUM	0.0200	.	0.0200	0.0200	.

VARIABLE	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=11 MONTH=9					
PH	7.1350	0.2333	6.9700	7.3000	0.0544
PHENOLS	0.0100	0.0000	0.0100	0.0100	0.0000
CL	596.5000	19.0919	583.0000	610.0000	364.5000
SULFATES	2055.0000	7.0711	2050.0000	2060.0000	50.0000
ZN	0.0100	0.0000	0.0100	0.0100	0.0000
CROMIUM	0.0200	0.0000	0.0200	0.0200	0.0000
WELL=11 MONTH=10					
PH	7.3900	.	7.3900	7.3900	.
PHENOLS	0.0100	.	0.0100	0.0100	.
CL	609.0000	.	609.0000	609.0000	.
SULFATES	2040.0000	.	2040.0000	2040.0000	.
ZN	0.0200	.	0.0200	0.0200	.
CROMIUM	0.0200	.	0.0200	0.0200	.

VARIABLE	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=12 MONTH=1					
PH	7.2800	.	7.2800	7.2800	.
PHENOLS	0.0100	.	0.0100	0.0100	.
CL	1410.0000	.	1410.0000	1410.0000	.
SULFATES	1870.0000	.	1870.0000	1870.0000	.
ZN	0.0340	.	0.0340	0.0340	.
CROMIUM	0.0300	.	0.0300	0.0300	.
WELL=12 MONTH=2					
PH	7.1900	.	7.1900	7.1900	.
PHENOLS	0.0100	.	0.0100	0.0100	.
CL	910.0000	.	910.0000	910.0000	.
SULFATES	1890.0000	.	1890.0000	1890.0000	.
ZN	0.0240	.	0.0240	0.0240	.
CROMIUM	0.0300	.	0.0300	0.0300	.
WELL=12 MONTH=3					
PH	7.0750	0.1768	6.9500	7.2000	0.0312
PHENOLS	0.0100	0.0000	0.0100	0.0100	0.0000
CL	765.0000	148.4924	660.0000	870.0000	22050.0000
SULFATES	1950.0000	141.4214	1850.0000	2050.0000	20000.0000
ZN	0.0160	0.0057	0.0120	0.0200	0.0000
CROMIUM	0.0250	0.0071	0.0200	0.0300	0.0001
WELL=12 MONTH=4					
PH	6.8900	0.0141	6.8800	6.9000	0.0002
PHENOLS	0.0100	0.0000	0.0100	0.0100	0.0000
CL	488.0000	31.1127	466.0000	510.0000	968.0000
SULFATES	1935.0000	7.0711	1930.0000	1940.0000	50.0000
ZN	0.0200	0.0141	0.0100	0.0300	0.0002
CROMIUM	0.0250	0.0071	0.0200	0.0300	0.0001

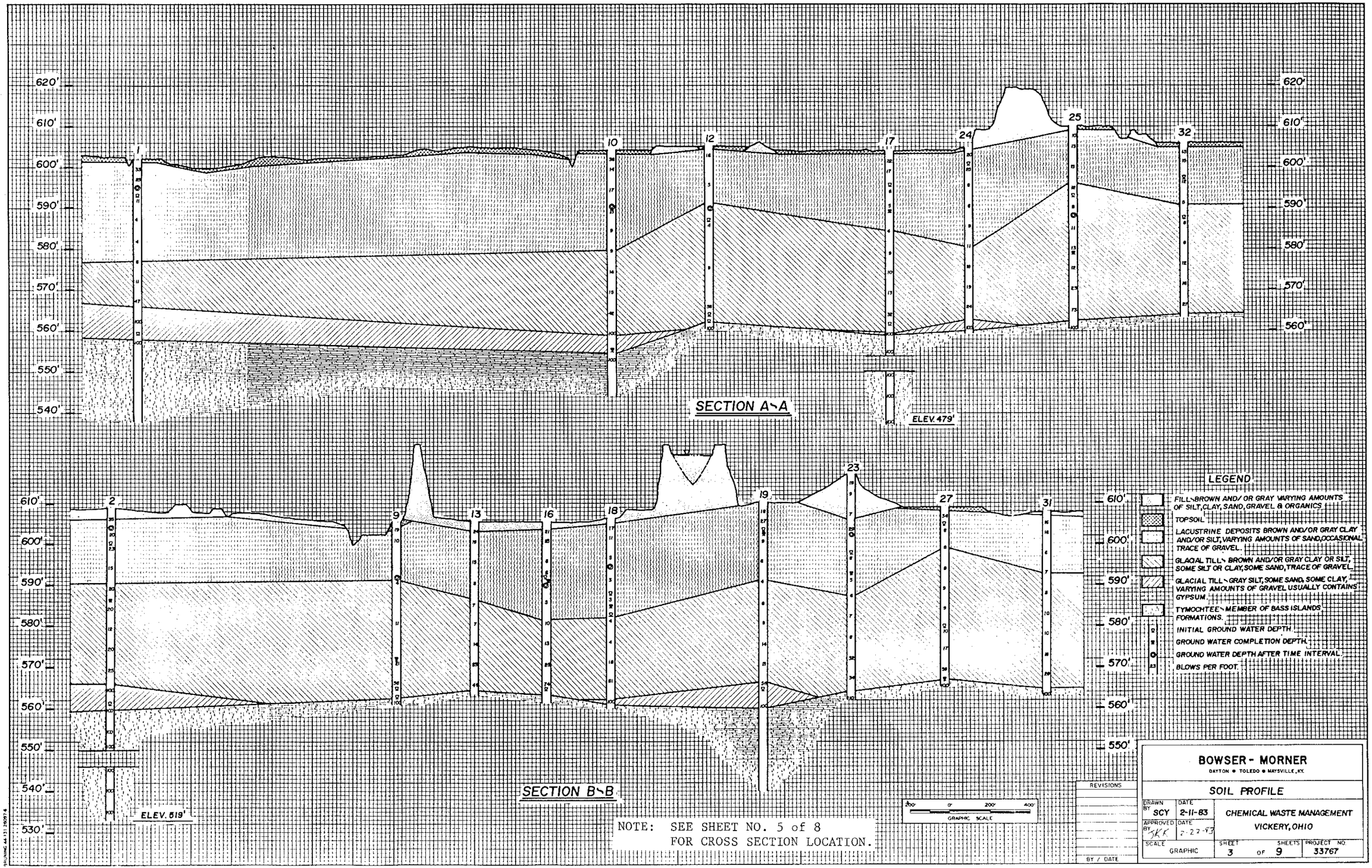
VARIABLE	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=12 MONTH=6					
PH	7.0500	0.0990	6.9800	7.1200	0.0098
PHENOLS	0.0100	0.0000	0.0100	0.0100	0.0000
CL	508.0000	31.1127	486.0000	530.0000	968.0000
SULFATES	1971.0000	57.9828	1930.0000	2012.0000	3362.0000
ZN	0.0250	0.0071	0.0200	0.0300	0.0001
CROMIUM	0.0200	0.0000	0.0200	0.0200	0.0000
WELL=12 MONTH=7					
PH	7.1333	0.2485	6.9800	7.4200	0.0617
PHENOLS	0.0100	0.0000	0.0100	0.0100	0.0000
CL	518.3333	7.6376	510.0000	525.0000	58.3333
SULFATES	1948.3333	27.5379	1920.0000	1975.0000	758.3333
ZN	0.0233	0.0153	0.0100	0.0400	0.0002
CROMIUM	0.0200	0.0000	0.0200	0.0200	0.0000
WELL=12 MONTH=8					
PH	6.9200	.	6.9200	6.9200	.
PHENOLS	0.0100	.	0.0100	0.0100	.
CL	490.0000	.	490.0000	490.0000	.
SULFATES	1980.0000	.	1980.0000	1980.0000	.
ZN	0.0300	.	0.0300	0.0300	.
CROMIUM	0.0300	.	0.0300	0.0300	.
WELL=12 MONTH=9					
PH	6.9533	0.0351	6.9200	6.9900	0.0012
PHENOLS	0.0100	0.0000	0.0100	0.0100	0.0000
CL	507.3333	6.4291	500.0000	512.0000	41.3333
SULFATES	1956.6667	15.2753	1940.0000	1970.0000	233.3333
ZN	0.0200	0.0173	0.0100	0.0400	0.0003
CROMIUM	0.0167	0.0058	0.0100	0.0200	0.0000

VARIABLE	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=12 MONTH=10					
PH	6.9800	.	6.9800	6.9800	.
PHENOLS	0.0100	.	0.0100	0.0100	.
CL	510.0000	.	510.0000	510.0000	.
SULFATES	1970.0000	.	1970.0000	1970.0000	.
ZN	0.0200	.	0.0200	0.0200	.
CROMIUM	0.0200	.	0.0200	0.0200	.

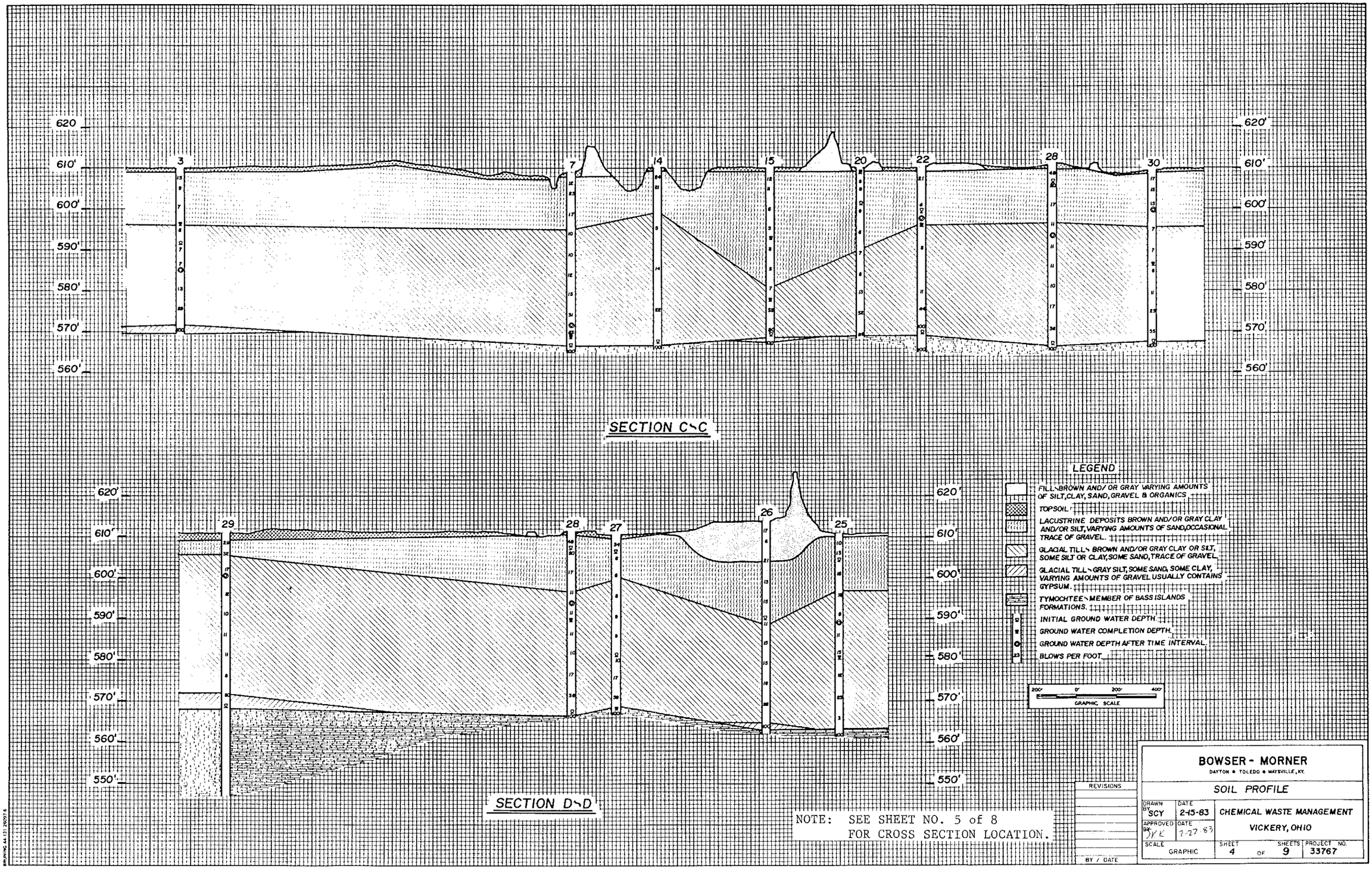
VARIABLE	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=13 MONTH=1					
PH	7.6000	.	7.6000	7.6000	.
PHENOLS	0.0100	.	0.0100	0.0100	.
CL	620.0000	.	620.0000	620.0000	.
SULFATES	1890.0000	.	1890.0000	1890.0000	.
ZN	0.0340	.	0.0340	0.0340	.
CROMIUM	0.0300	.	0.0300	0.0300	.
WELL=13 MONTH=2					
PH	7.2300	.	7.2300	7.2300	.
PHENOLS	0.0100	.	0.0100	0.0100	.
CL	610.0000	.	610.0000	610.0000	.
SULFATES	1880.0000	.	1880.0000	1880.0000	.
ZN	0.0320	.	0.0320	0.0320	.
CROMIUM	0.0300	.	0.0300	0.0300	.
WELL=13 MONTH=3					
PH	7.3600	0.0566	7.3200	7.4000	0.0032
PHENOLS	0.0100	0.0000	0.0100	0.0100	0.0000
CL	670.0000	98.9949	600.0000	740.0000	9800.0000
SULFATES	2015.0000	233.3452	1850.0000	2180.0000	54450.0000
ZN	0.0380	0.0028	0.0360	0.0400	0.0000
CROMIUM	0.0250	0.0071	0.0200	0.0300	0.0001
WELL=13 MONTH=4					
PH	7.6300	0.3394	7.3900	7.8700	0.1152
PHENOLS	0.0200	0.0141	0.0100	0.0300	0.0002
CL	1275.0000	940.4520	610.0000	1940.0000	884450.0000
SULFATES	1900.0000	14.1421	1890.0000	1910.0000	200.0000
ZN	0.0300	0.0000	0.0300	0.0300	0.0000
CROMIUM	0.0250	0.0071	0.0200	0.0300	0.0001

VARIABLE	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=13 MONTH=6					
PH	7.4200	0.0000	7.4200	7.4200	0.0000
PHENOLS	0.0100	0.0000	0.0100	0.0100	0.0000
CL	615.0000	77.7817	560.0000	670.0000	6050.0000
SULFATES	1922.5000	45.9619	1890.0000	1955.0000	2112.5000
ZN	0.0300	0.0000	0.0300	0.0300	0.0000
CROMIUM	0.0150	0.0071	0.0100	0.0200	0.0000
WELL=13 MONTH=7					
PH	7.4267	0.2419	7.2400	7.7000	0.0585
PHENOLS	0.0100	0.0000	0.0100	0.0100	0.0000
CL	588.3333	7.6376	580.0000	595.0000	58.3333
SULFATES	1889.6667	19.5021	1870.0000	1909.0000	380.3333
ZN	0.0333	0.0058	0.0300	0.0400	0.0000
CROMIUM	0.0200	0.0000	0.0200	0.0200	0.0000
WELL=13 MONTH=8					
PH	7.2300	.	7.2300	7.2300	.
PHENOLS	0.0100	.	0.0100	0.0100	.
CL	570.0000	.	570.0000	570.0000	.
SULFATES	1920.0000	.	1920.0000	1920.0000	.
ZN	0.0040	.	0.0040	0.0040	.
CROMIUM	0.0300	.	0.0300	0.0300	.
WELL=13 MONTH=9					
PH	7.2267	0.0808	7.1400	7.3000	0.0065
PHENOLS	0.0100	0.0000	0.0100	0.0100	0.0000
CL	588.0000	7.2111	580.0000	594.0000	52.0000
SULFATES	1883.3333	5.7735	1880.0000	1890.0000	33.3333
ZN	0.0300	0.0173	0.0200	0.0500	0.0003
CROMIUM	0.0167	0.0058	0.0100	0.0200	0.0000

VARIABLE	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE	VARIANCE
WELL=13 MONTH=10					
PH	7.2800	.	7.2800	7.2800	.
PHENOLS	0.0100	.	0.0100	0.0100	.
CL	580.0000	.	580.0000	580.0000	.
SULFATES	1910.0000	.	1910.0000	1910.0000	.
ZN	0.0300	.	0.0300	0.0300	.
CROMIUM	0.0200	.	0.0200	0.0200	.



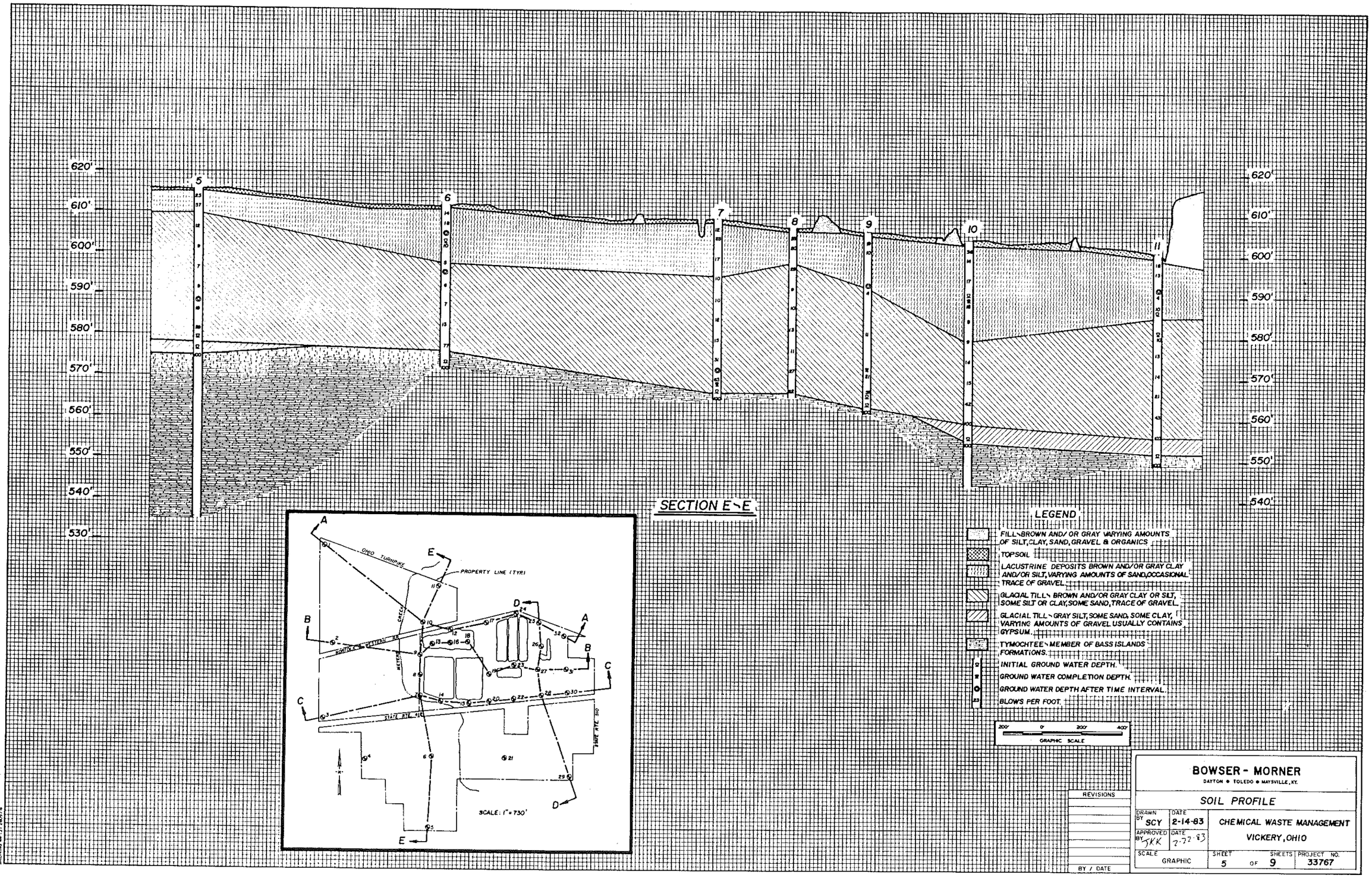
NOTE: SEE SHEET NO. 5 of 8
FOR CROSS SECTION LOCATION.



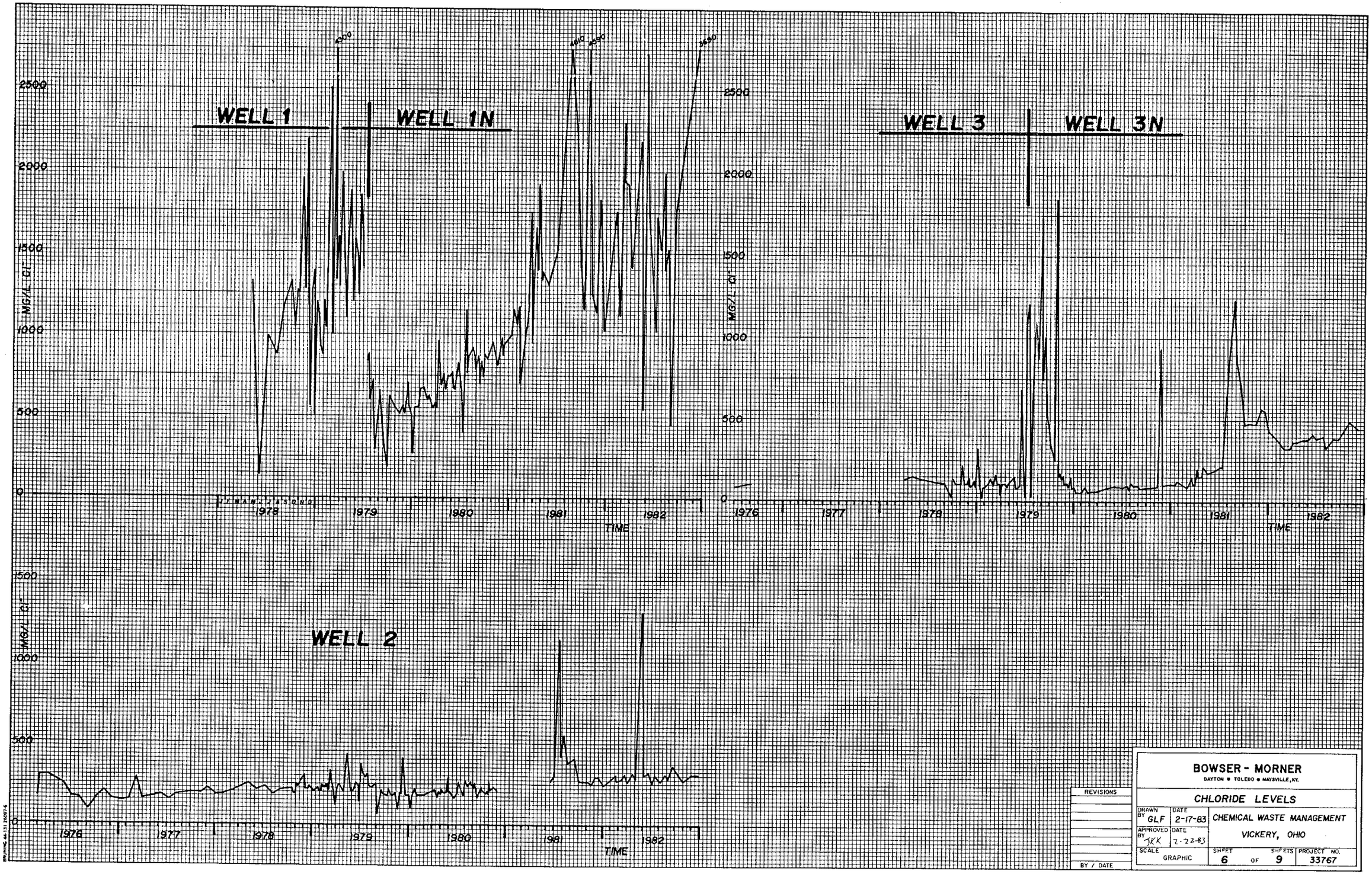
NOTE: SEE SHEET NO. 5 of 8 FOR CROSS SECTION LOCATION.

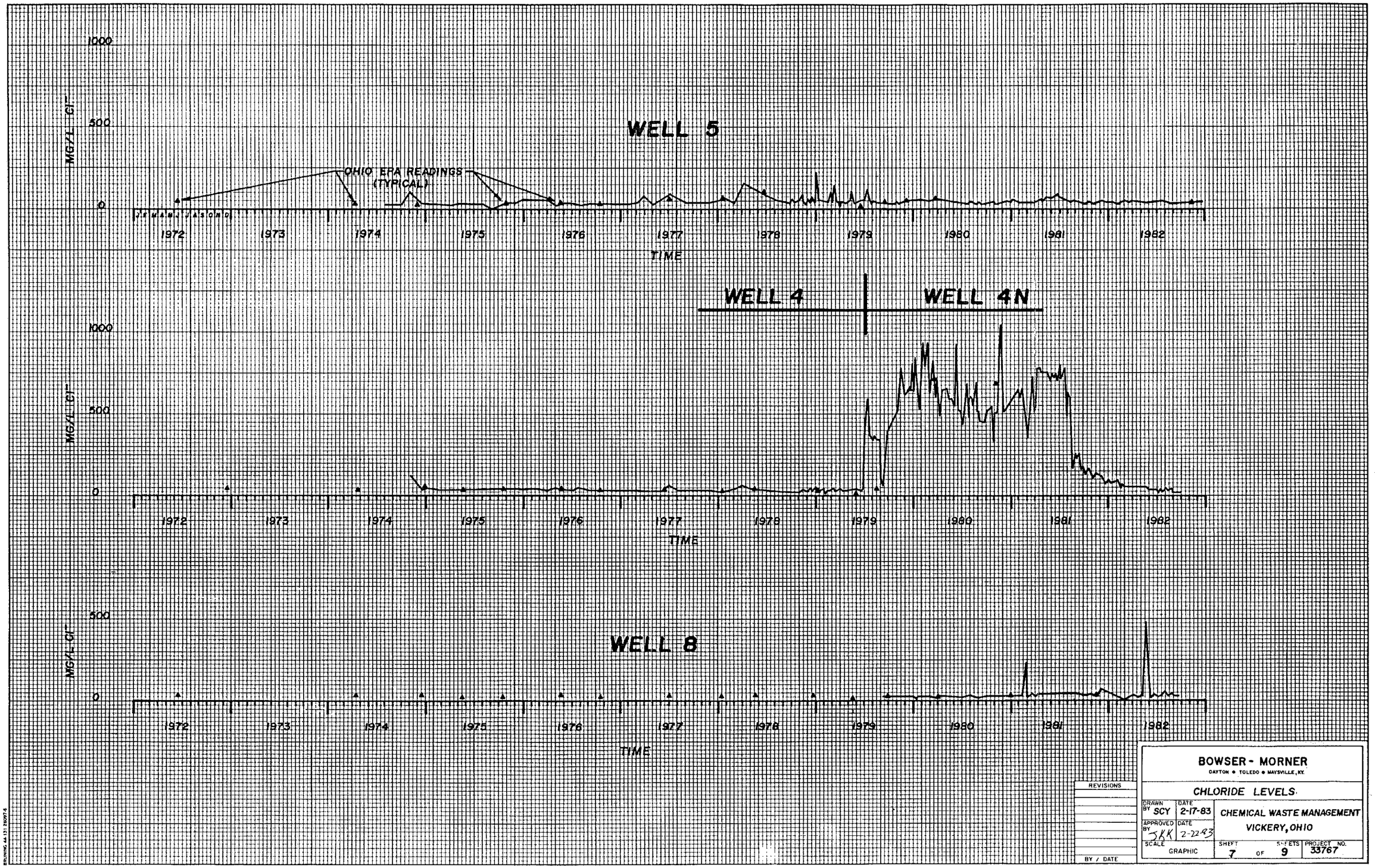
REVISIONS	BOWSER - MORNER DAYTON • TOLEDO • MAYSVILLE, KY.	
	SOIL PROFILE	
DRAWN BY SCY / DATE 2-15-83	CHEMICAL WASTE MANAGEMENT VICKERY, OHIO	
APPROVED BY JKK / DATE 2-22-83		
SCALE GRAPHIC	SHEET 4 OF SHEETS 9	PROJECT NO. 33767
BY / DATE		

BRUNING 44-131 26097-6



620'
610'
600'
590'
580'
570'
560'
550'
540'
530'
5
6
7
8
9
10
11
SECTION E-E
OHIO TURNPIKE
PROPERTY LINE (TYP.)
NORFOLK & WESTERN RR
METERS CREEK
STATE RTE. 41
STATE RTE. 510
SCALE: 1" = 730'
LEGEND
FILL-BROWN AND/OR GRAY VARYING AMOUNTS OF SILT, CLAY, SAND, GRAVEL & ORGANICS
TOPSOIL
LACUSTRINE DEPOSITS BROWN AND/OR GRAY CLAY AND/OR SILT, VARYING AMOUNTS OF SAND, OCCASIONAL TRACE OF GRAVEL.
GLACIAL TILL-BROWN AND/OR GRAY CLAY OR SILT, SOME SILT OR CLAY, SOME SAND, TRACE OF GRAVEL.
GLACIAL TILL-GRAY SILT, SOME SAND, SOME CLAY, VARYING AMOUNTS OF GRAVEL USUALLY CONTAINS GYPSUM.
TYMOCHTEE-MEMBER OF BASS ISLANDS FORMATIONS.
INITIAL GROUND WATER DEPTH.
GROUND WATER COMPLETION DEPTH.
GROUND WATER DEPTH AFTER TIME INTERVAL.
BLOWS PER FOOT.
200' 0' 200' 400'
GRAPHIC SCALE
REVISIONS
BY / DATE
BOWSER - MORNER
DAYTON • TOLEDO • MAYSVILLE, KY.
SOIL PROFILE
DRAWN BY SCY
DATE 2-14-83
APPROVED BY JKK
DATE 2-22-83
CHEMICAL WASTE MANAGEMENT
VICKERY, OHIO
SCALE GRAPHIC
SHEET 5 OF 9 SHEETS
PROJECT NO. 33767


WELL 1
WELL 1N
WELL 3
WELL 3N
WELL 2
MG/L Cl
2500
2000
1500
1000
500
0
1976
1977
1978
1979
1980
1981
1982
TIME
F M A M J J A S O N D
REVISIONS
BY / DATE
BOWSER - MORNER
DAYTON • TOLEDO • MAYSVILLE, KY.
CHLORIDE LEVELS
DRAWN BY GLF
DATE 2-17-83
APPROVED BY JKK
DATE 2-22-83
CHEMICAL WASTE MANAGEMENT
VICKERY, OHIO
SCALE GRAPHIC
SHEET 6 OF 9 SHEETS
PROJECT NO. 33767



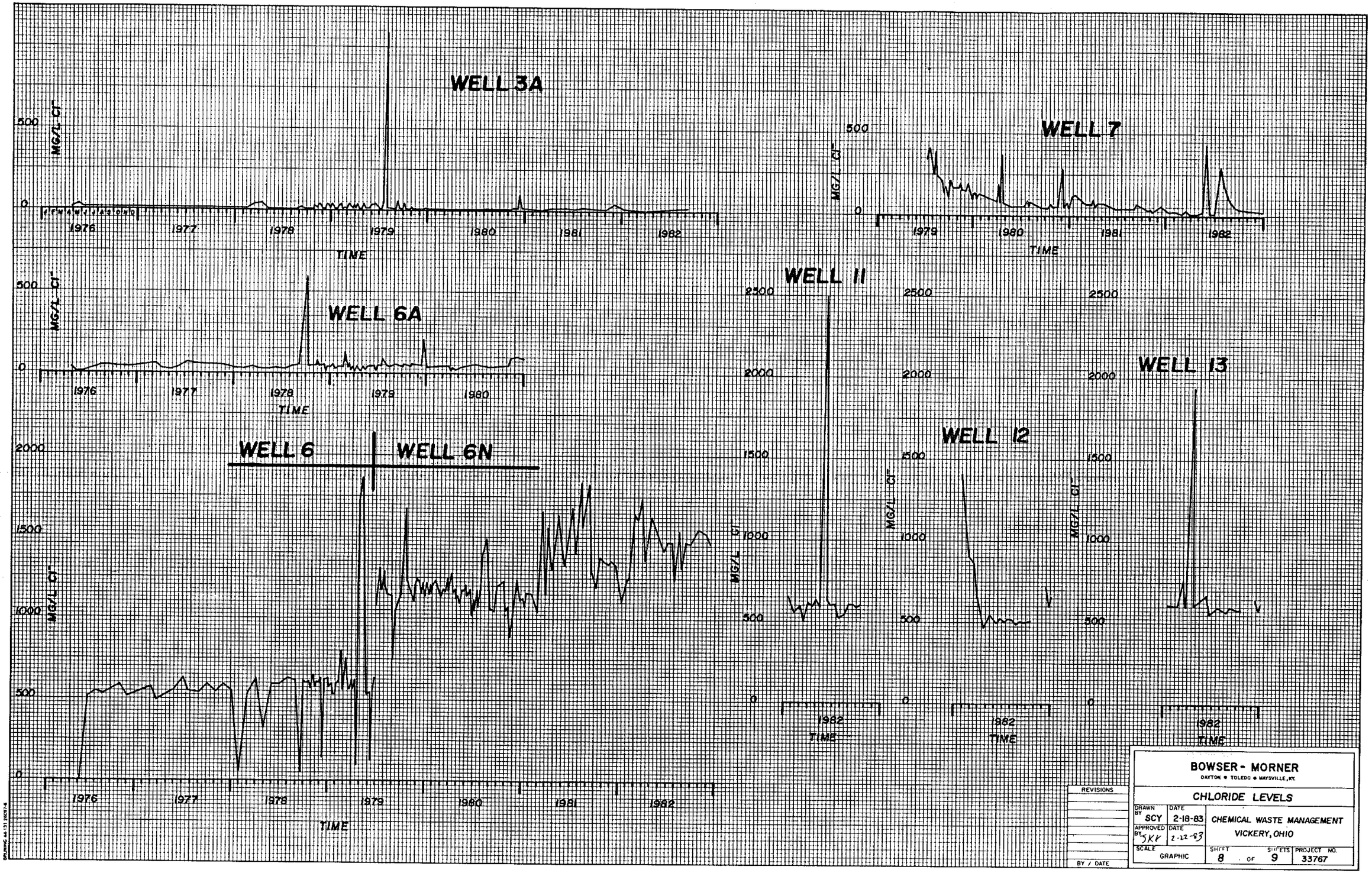
REVISIONS	BY / DATE

BOWSER - MORNER
DAYTON • TOLEDO • MAYSVILLE, KY.

CHLORIDE LEVELS

DRAWN BY SCY	DATE 2-17-83	CHEMICAL WASTE MANAGEMENT VICKERY, OHIO
APPROVED BY SKK	DATE 2-22-83	
SCALE GRAPHIC	SHEET 7 OF SHEETS 9	PROJECT NO. 33767

BRUNING 44 131 260974


WELL 3A
WELL 6A
WELL 6
WELL 6N
WELL 7
WELL 11
WELL 12
WELL 13
MG/L Cl⁻
TIME
1976
1977
1978
1979
1980
1981
1982
0
500
1000
1500
2000
2500
BOWSER - MORNER
DAYTON • TOLEDO • MAYSVILLE, KY.
CHLORIDE LEVELS
DRAWN BY SCY
DATE 2-18-83
APPROVED BY SKK
DATE 2-22-83
CHEMICAL WASTE MANAGEMENT
VICKERY, OHIO
SCALE GRAPHIC
SHEET 8 OF 9 SHEETS
PROJECT NO. 33767
REVISIONS
BY / DATE