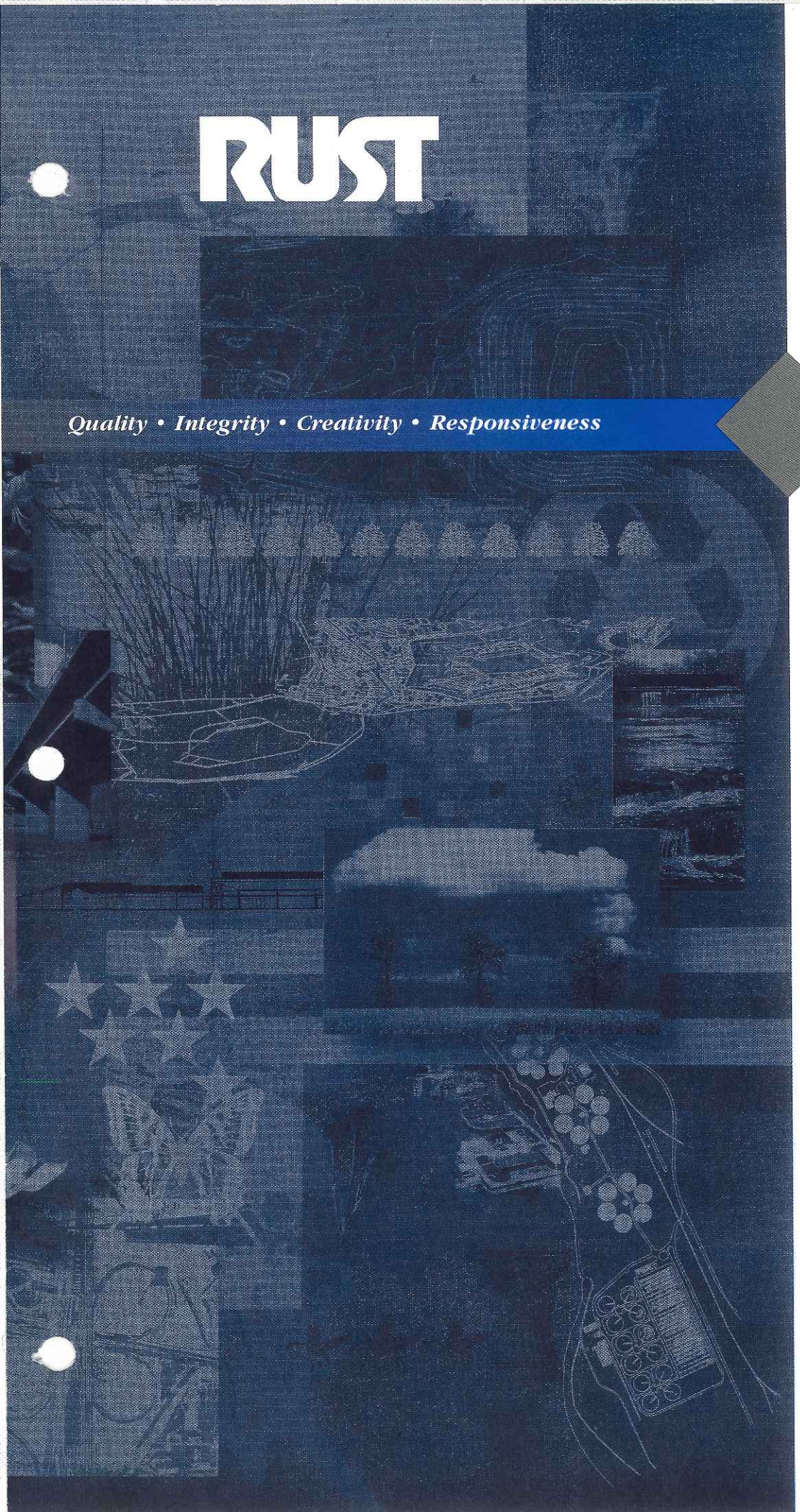

RCRA Facility Investigation (RFI) Phase I Workplan

Appendices C, D & E

Chemical Waste Management
Vickery, Ohio

U.S. EPA ID No.
OHD 020 273 819

Prepared for:

CWM - Vickery, Inc.

May 1996

RUST

Rust Environment & Infrastructure

APPENDIX C

Rust Environment & Infrastructure Inc.

A Rust International Company
3220 Tillman Drive, Suite 300
Bensalem, PA 19020

Phone 215.633.4500
Fax 215.633.4575

April 5, 1996

Dr. Wayne Pettyjohn
1502 Wildwood Drive
Stillwater, OK 74075

Dear Dr. Pettyjohn:

At your request, enclosed please find the following documents:

1. Water Level Hydrographs for all monitoring wells on site from 1986 to 1995.

2. Monitoring Well Construction Details.

3. Precipitation data from 1995

4. Review of the L-19 Investigation Potential Source of Groundwater Contamination Vickery, Ohio Facility, March 1992 (Golder Report discussing Tritium Analysis).

5. Water-Resources Investigations Report 91-4024 (U.S. Geological Survey Report discussing Tritium Concentration in the Aquifers in Northwestern Ohio).

The vertical flow nets are not completed at this time and we expect them to be available next week.

Sincerely,

Mitrofan Josan, P.G.
Senior Hydrogeologist

Enclosures: As Noted

c: Michael Curry
Thomas Matheson

O:\38627.WP\DRAFT\LETTERS\4-5REQ.LTR

Table 3
1995 CWM Vickery Precipitation Data (in)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3.74	1.08	1.88	5.21	4.54	4.62	2.91	4.13	1.54	3.82	3.02	2.54

GEOHYDROLOGY AND QUALITY OF WATER IN AQUIFERS IN LUCAS, SANDUSKY, AND WOOD COUNTIES, NORTHWESTERN OHIO

By Kevin J. Breen and Denise H. Dumouchelle

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 91-4024

Prepared in cooperation with
LUCAS COUNTY, SANDUSKY COUNTY
DEPARTMENT OF PUBLIC HEALTH,
WOOD COUNTY, AND THE CITIES OF
MAUMEE, OREGON, SYLVANIA, AND
TOLEDO, OHIO

Columbus, Ohio

1991

the extent of sand deposits in Sandusky County is described by Angle (1987). The thickest and most areally extensive sand deposits are the surficial sands in Lucas County. This belt of sand, with thicknesses generally less than 50 ft, is west of the Maumee River (fig. 4) and is known informally as the Oak Openings sands.

GEOHYDROLOGY

Unconsolidated Deposits

The geohydrology of the surficial sand deposits has been studied only in local areas (Trexler and Ruedisili, 1976; Hallfrisch, 1987). Sand deposits in Lucas County (fig. 4) yield enough water to be used for rural domestic water supplies. These deposits of sand, hereafter termed surficial sand aquifer, represent the only regionally extensive aquifer other than the underlying carbonate aquifer, in the three-county study area.

As shown in geologic section A-A' (fig. 5; line of section appears on pl. 1), the sand overlies till and forms a belt of hummocky and undulating topography. The surficial sand aquifer is recharged by precipitation; there are no natural impermeable barriers between the land surface and the water table. Water levels are generally between 2 and 8 ft below land surface, and figure 6 shows the magnitude and seasonal characteristics of water-table fluctuations at well LU-303-SW20, located in a wooded area of the Oak Openings Preserve Metropolitan Park in Swanton Township. (See pl. 1 for well location.) During the period October 1986 through April 1987, the water table rose rapidly and declined gradually as the water moved to discharge points at local streams. In May 1987, evapotranspiration increased, and the water table began a seasonal decline. The decline was interrupted by occasional rainstorms through July. In August and September, precipitation had only small effects on the seasonal decline until the end of the growing season. Precipitation during the fall recharged the aquifer, causing water levels to rise to levels of the previous winter and spring. At well LU-303-SW20, the fluctuation of the water table during the 1987 water year was a total of about 3.5 ft. Fluctuations in other areas are likely to be similar.

Measurements of tritium concentration in ground water can indicate the age of water in an aquifer: pre-1952 water is old, and water with a post-1952 component is young. The absence of tritium in ground water indicates that the water is precipitation that occurred before 1952, when atomic-bomb tests increased tritium levels in the atmosphere. Old water is sometimes termed dead because of the absence of radioactive tritium (Michel, 1989).

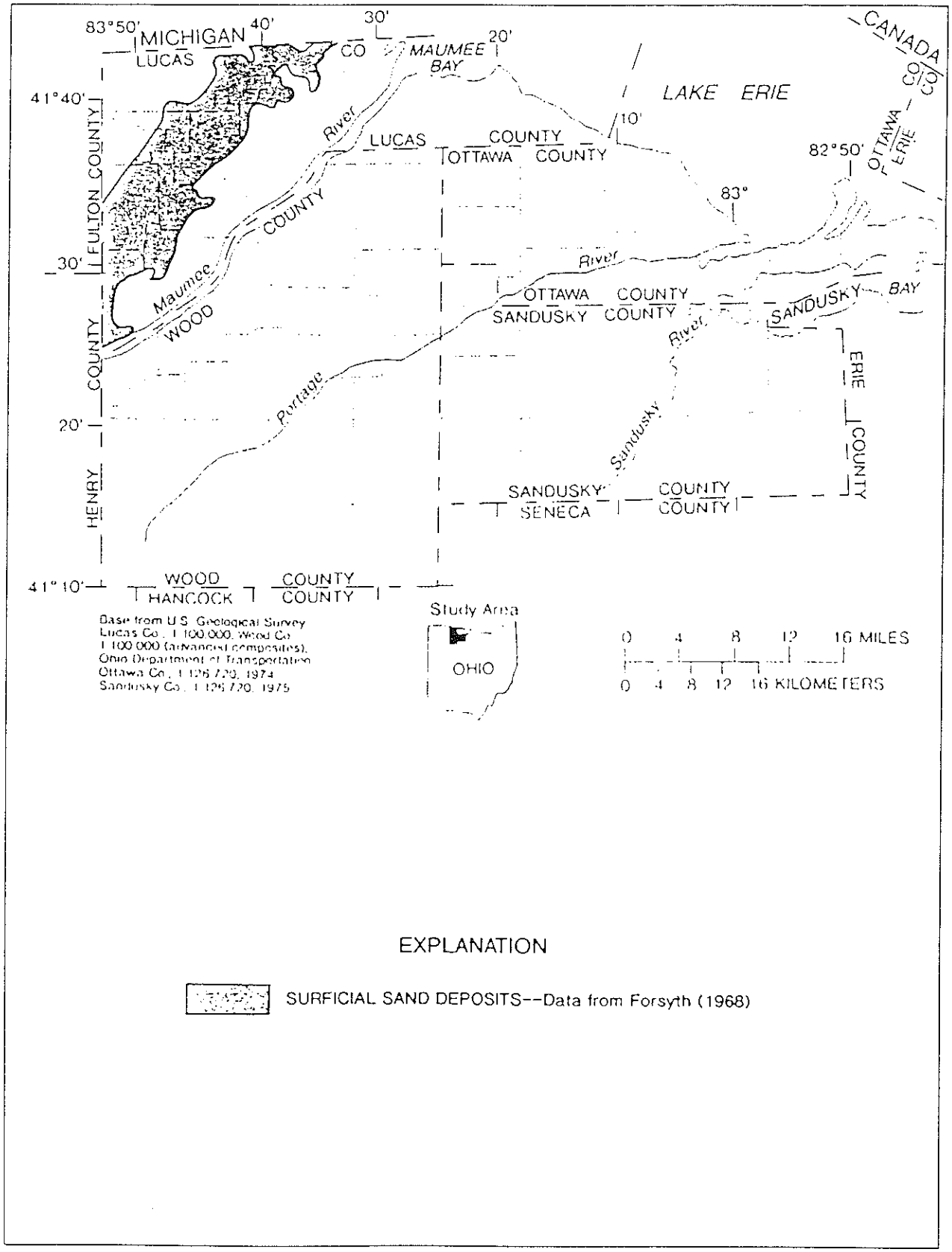

Figure 4.--Extent of surficial sand deposits in Lucas County.

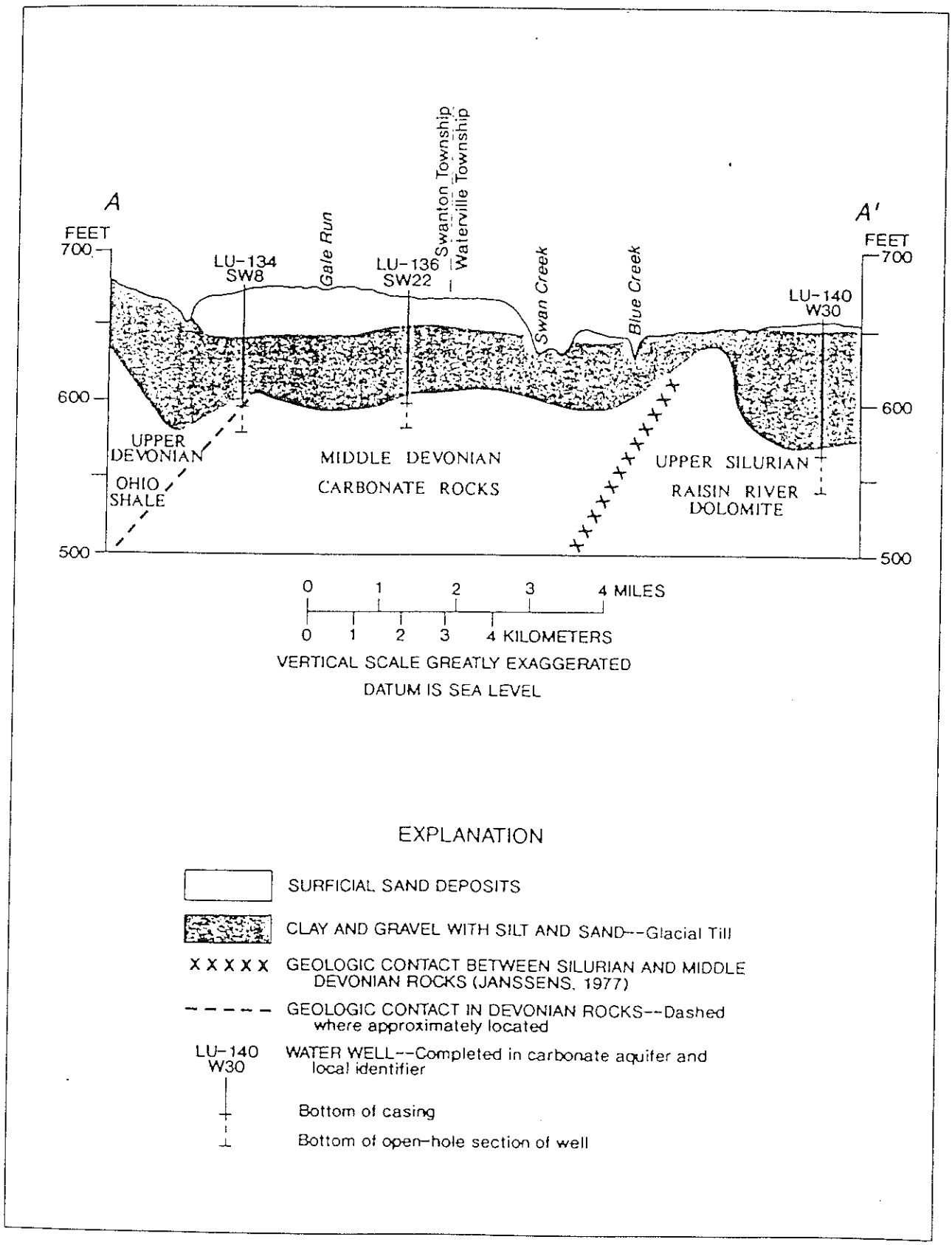

Figure 5.--Geologic section *A-A'*. (Trace of section shown on plate 1.)

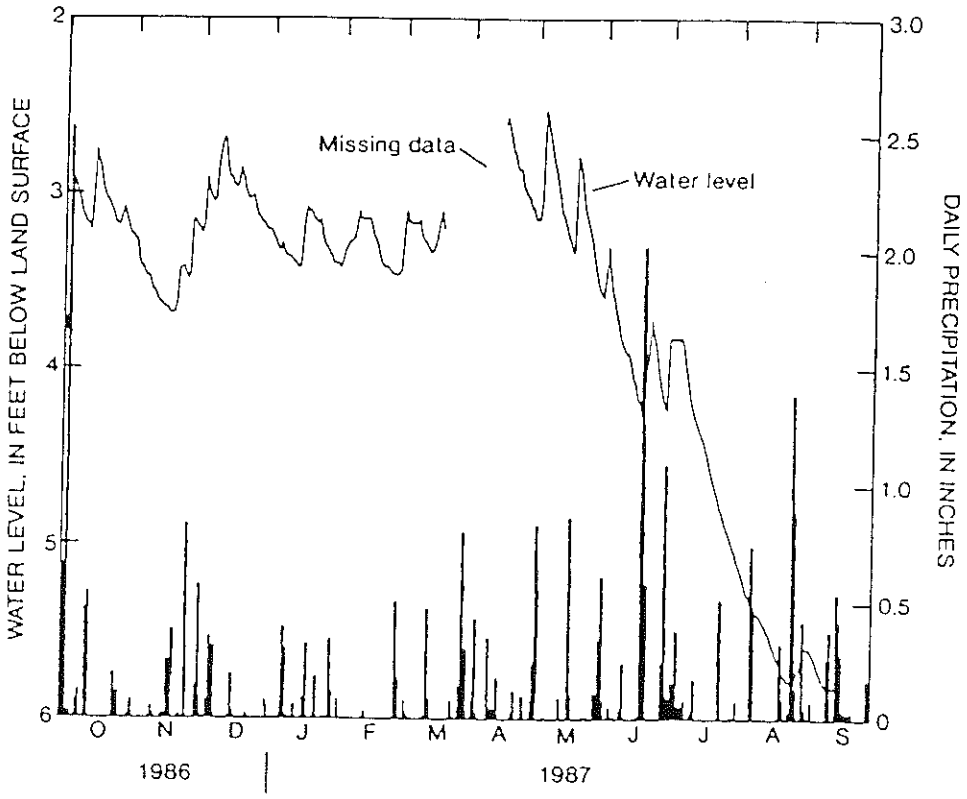

Figure 6.--Water levels in the surficial sand aquifer at well LU-303-SW20 and daily precipitation at Toledo Express Airport, 1987 water year.

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The sand is separated from the bedrock by about 50 ft or less of drift. The clay-rich drift, chiefly till, inhibits the vertical movement of water downward from the surficial sand aquifer. Thus, the top of the drift or till is considered the bottom of the sand aquifer.

Although the surficial sand aquifer is only in parts of Lucas County, the drift deposits are found throughout most of the study area. The drift seldom yields enough water to be considered an aquifer; however, the deposits are often saturated, and a seasonal water table is present (Kunkle, 1971). The drift is thinnest in the central part of the study area (western Sandusky County) and thickest in buried valleys incised in the carbonate bedrock. The two largest buried valleys, containing drift at least 100 ft in thickness (fig. 7), are (1) near the Maumee River, and (2) in east-central Sandusky County.

Sand and gravel deposits above the bedrock contact have been reported, but little information about the water-yielding capacity of these deposits is available. The sand and gravel deposits are developed as a water supply only in buried valleys in Lucas and Sandusky Counties (Hallfrisch, 1986a and Schmidt, 1980). A detrital zone or broken-rock zone is sometimes just above the bedrock. The broken-rock zone is generally saturated with ground water and commonly is a good source of water for domestic supplies (Forsyth, 1968, p. 85).

Bedrock

The hydrology of the bedrock aquifer was evaluated by use of the following:

1. Reviews of previous investigations;
2. Well-log inventories;
3. Mapping of the potentiometric surface; and
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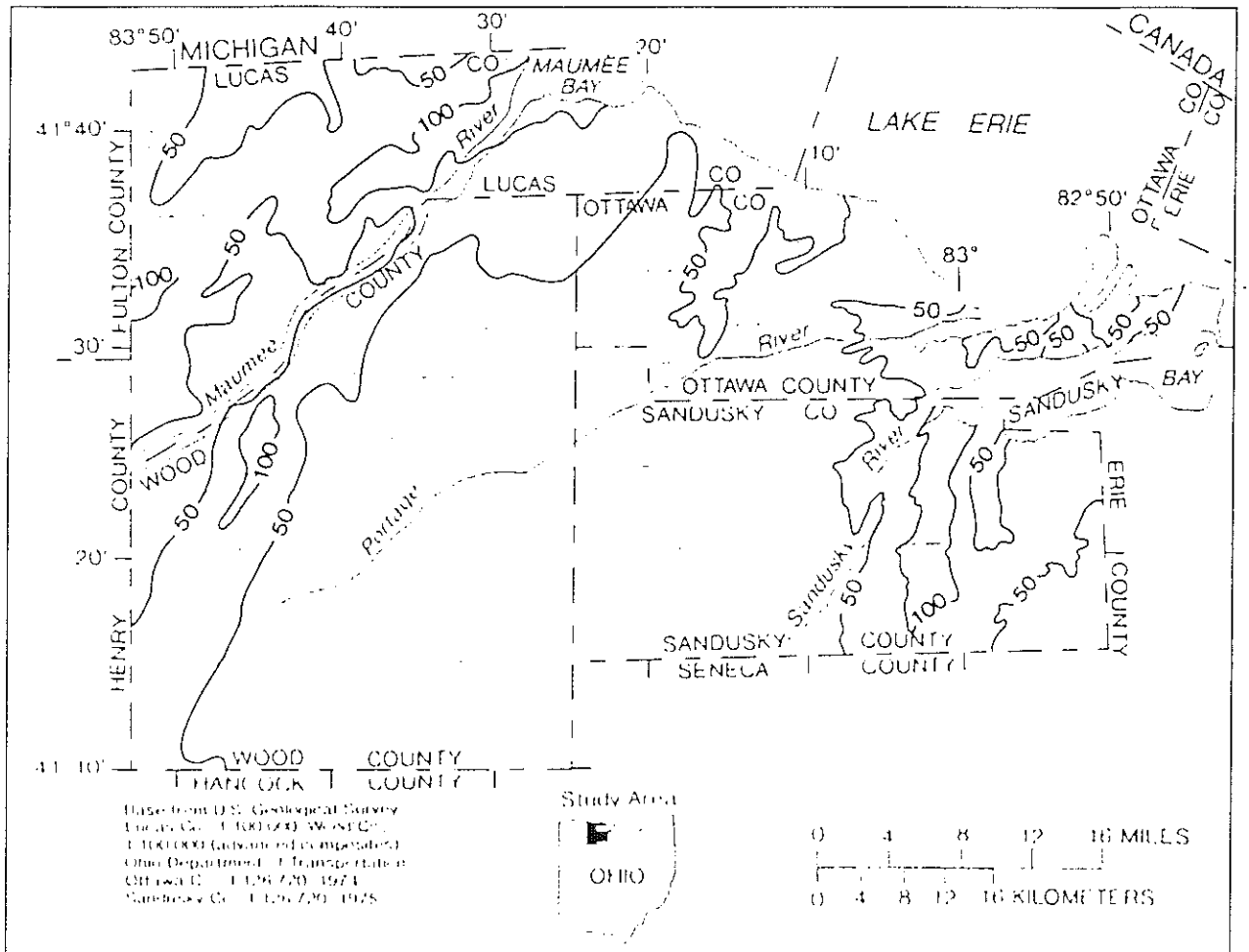
This information is used in combination with information on the geologic setting to define and describe the geohydrology, sources of recharge to the aquifer, directions of ground-water flow indicated by the potentiometric surface, and aquifer discharge.



EXPLANATION

— 50 — LINE OF EQUAL THICKNESS OF DRIFT DEPOSITS--Shaded areas indicate thickest deposits in buried bedrock valleys

Figure 7.--Thickness of drift in the study area (from Soller, 1986).

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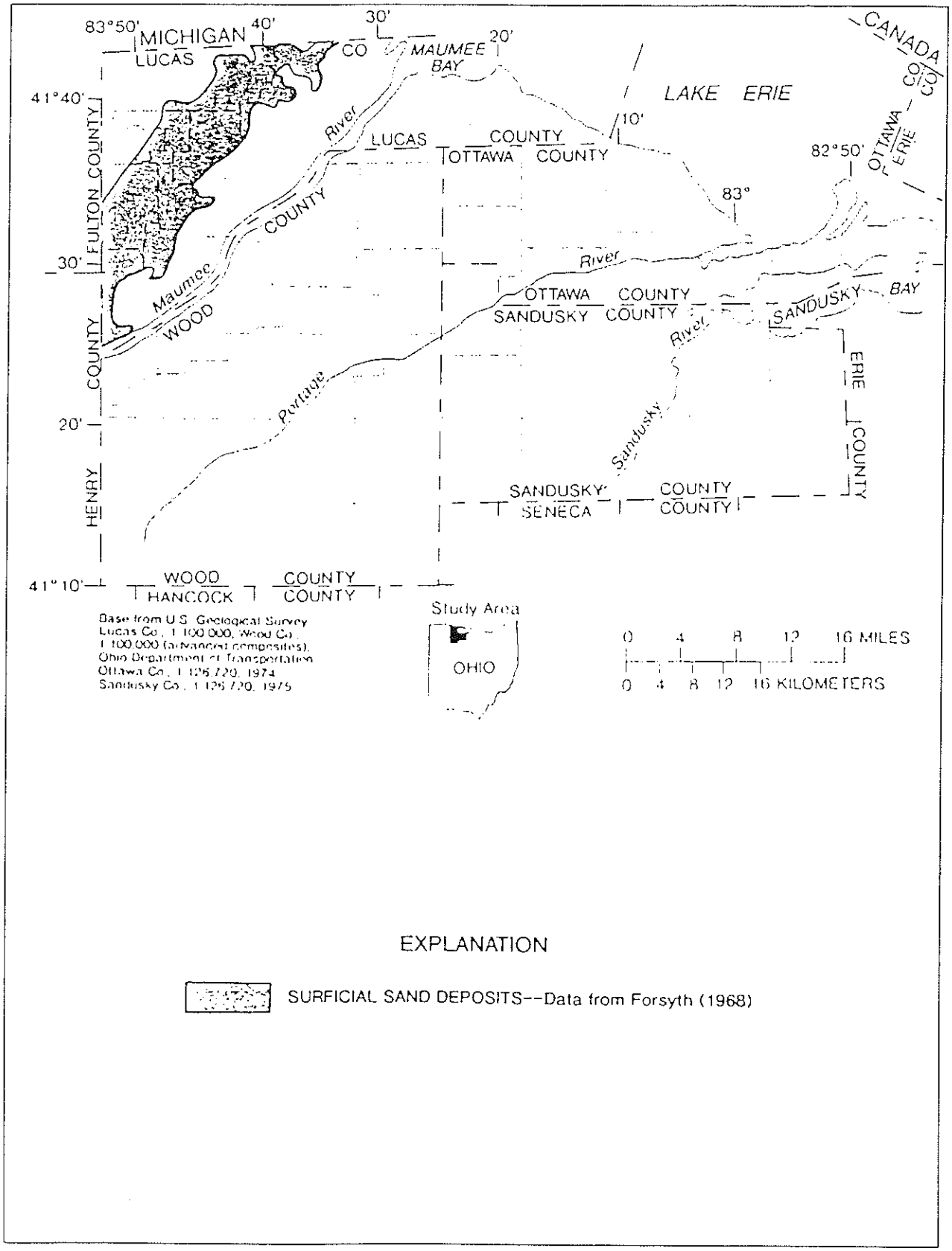

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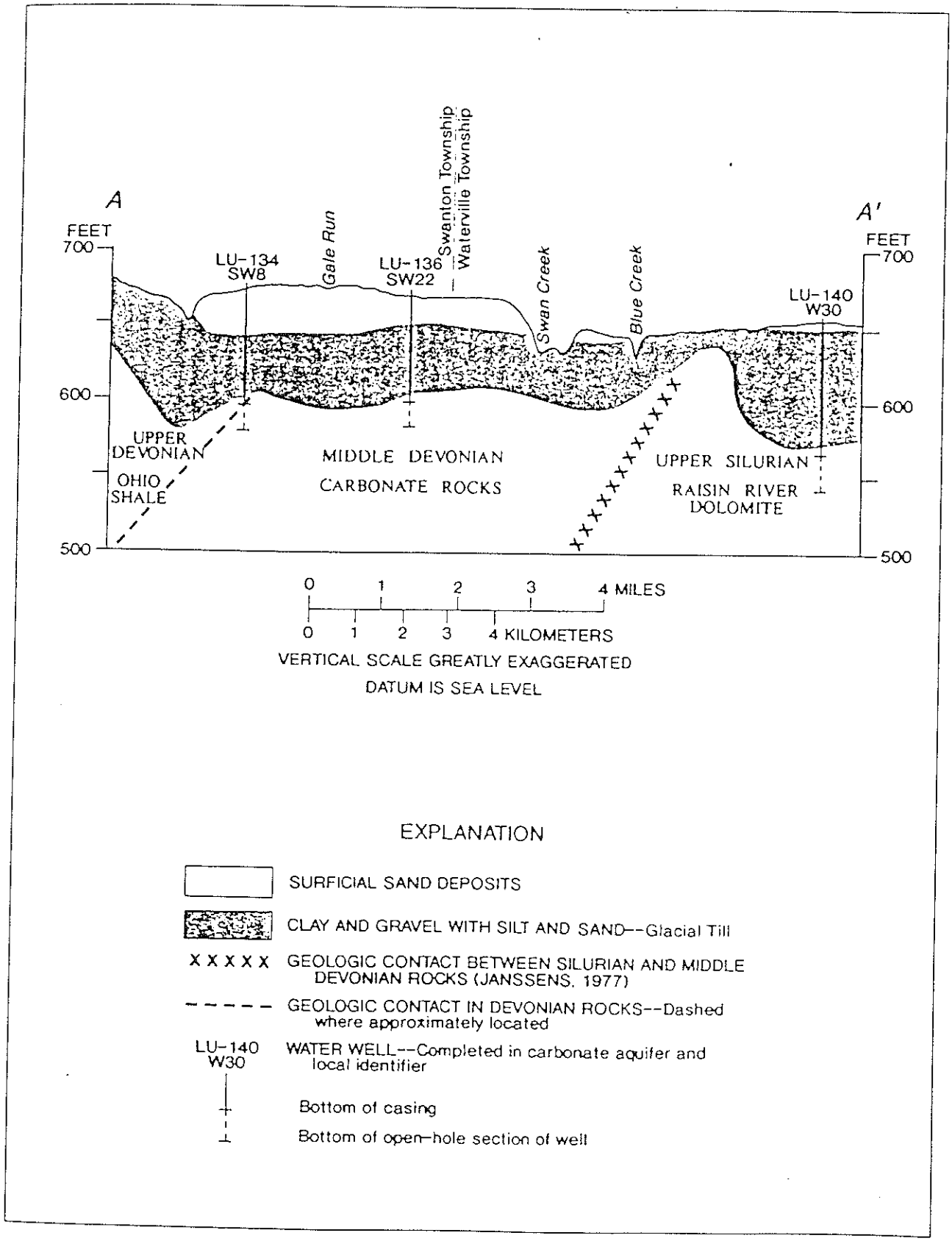

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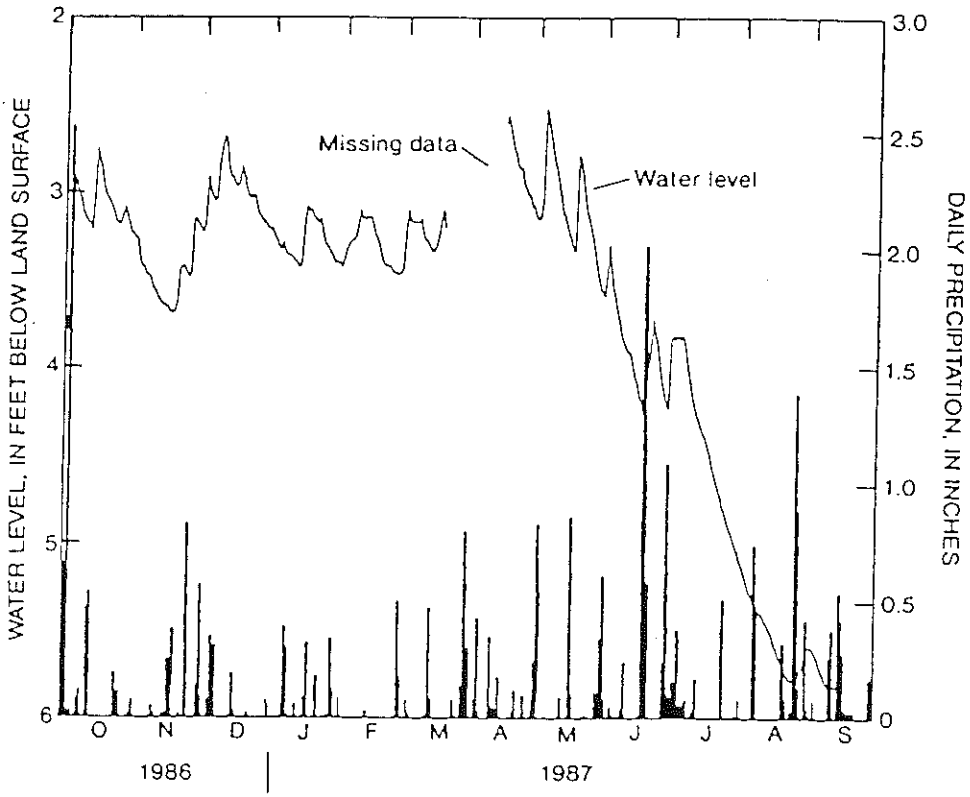

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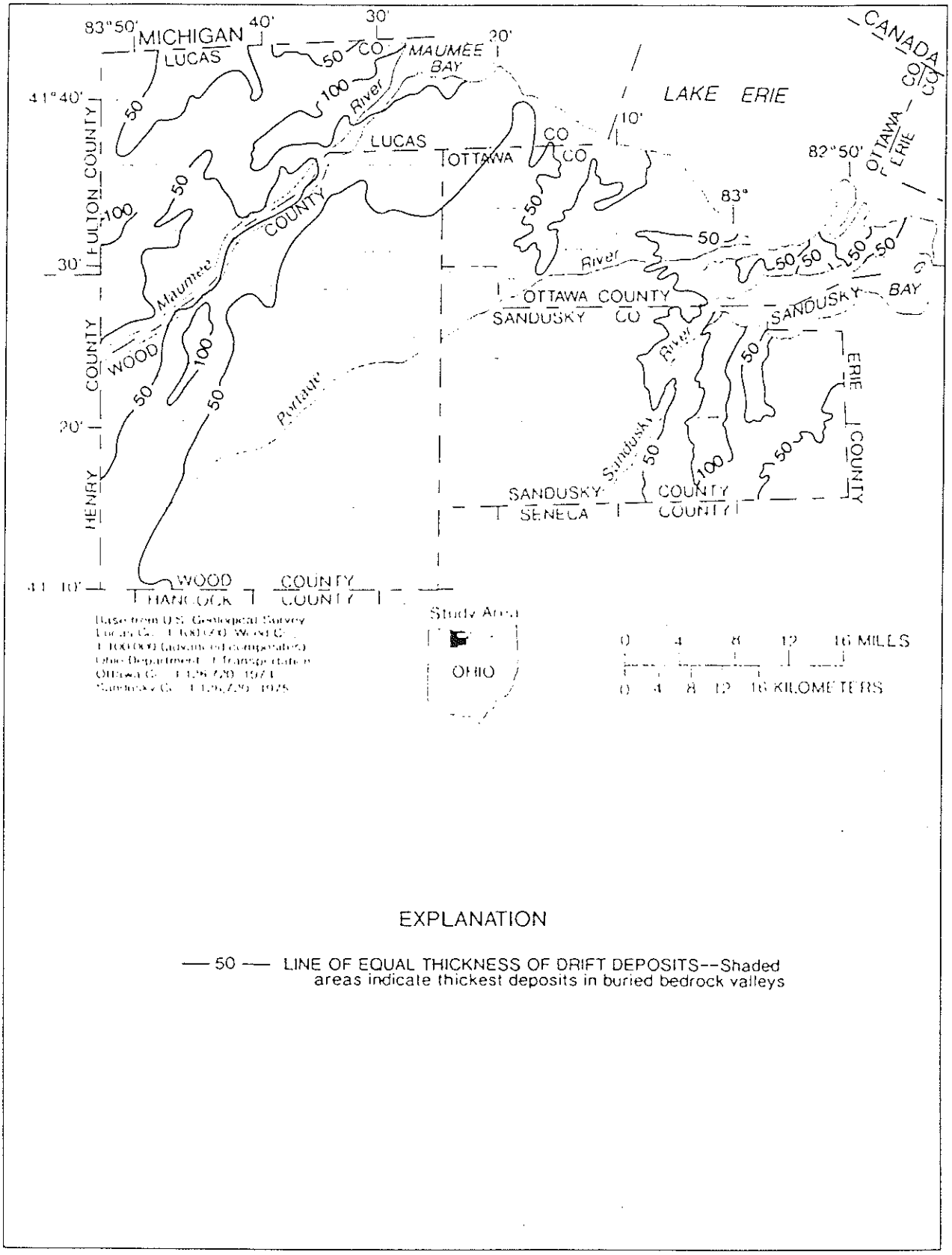


Figure 7.--Thickness of drift in the study area (from Soller, 1986).

Golder Associates Inc.

3730 Chamblee Tucker Road
Atlanta, GA USA 30341
Telephone (404) 496-1893
Fax (404) 934-9476

Golder Associates

LETTER REPORT ON

REVIEW OF THE L-19 INVESTIGATION
POTENTIAL SOURCE OF GROUNDWATER CONTAMINATION
VICKERY, OHIO FACILITY

Submitted to:

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

DISTRIBUTION:

3 Copies - Chemical Waste Management, Inc. - Vickery, Ohio
1 Copy - Ohio Environmental Protection Agency
2 Copies - Golder Associates Inc.

March 1992

923-3370

Golder Associates Inc.

3730 Chamblee Tucker Road
Atlanta, GA USA 30341
Telephone (404) 496-1893
Fax (404) 934-9476

Golder Associates

March 25, 1992

923-3370

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

RE: LETTER REPORT ON REVIEW OF THE L-19 INVESTIGATION
POTENTIAL SOURCE OF GROUNDWATER CONTAMINATION
VICKERY, OHIO FACILITY

Dear Mr. Lonneman:

As requested in your letter to Golder Associates Inc. (Golder Associates) dated March 13, 1992, Golder Associates has reviewed the data in the L-19 Investigation Report. The review was performed primarily to evaluate potential sources of the contamination identified from analyses of groundwater samples obtained from well L-19. The lacustrine soils tested around well L-19 did not have contamination detected in them. Therefore, as previously concluded, the probable source of contamination in well L-19 is water flowing through the fill, then downward through the desiccated zone to the well screen interval. This conclusion is based on information contained in the L-19 Investigation Report and previous reports submitted to OEPA. No new information has been included in this letter report.

Background

As part of the Consent and Final Order (CAFO) entered into between the United States Environmental Protection Agency (USEPA) and Chemical Waste Management, Inc. (CWM) on April 4, 1985, a groundwater monitoring program was developed and implemented for the Vickery, Ohio, facility. Subsequently, the Ohio Environmental Protection Agency (OEPA) conducted a groundwater monitoring operation and maintenance inspection in April 1989, with a report submitted on August 28, 1989. The OEPA report stated that since the groundwater samples from monitoring well L-19 had consistently indicated the presence of 1,2-dichloroethane (1,2-DCA), this well was considered contaminated. As a result, CWM conducted an investigation of the area around L-19. The report on this investigation, dated July 24, 1990, was prepared by Golder Associates.

The groundwater monitoring program for the Vickery Facility included wells in the lacustrine materials, till materials, and the underlying bedrock materials. Each of these wells were designated L-, T-, or MR-. Therefore, well L-19 is a lacustrine well. The general location for the Vickery Facility is shown on attached Figure 1 and the approximate locations of well L-19 and investigation borings are shown on the attached Figure 2. The boring log for well L-19 and the well construction notes are also included as Attachment A to this letter report.

Geology

The site geology and hydrogeology have been extensively evaluated at the Vickery Facility. Generally, the site is underlain by about 33 feet to 52 feet of glacial overburden materials, consisting of lacustrine clay and glacial till. Underlying these overburden materials is a dolomite bedrock about 500 feet thick, which constitutes the uppermost aquifer underlying the facility. The dolomite bedrock is subsequently underlain by a sequence of sedimentary rocks comprising shales, sandstone, limestone, and dolomite. Granite bedrock ("basement rock") is encountered at a depth of about 2,900 feet beneath the ground surface. The lacustrine soils are generally encountered in the area of the active facility and have been found to vary from a depth of 0 feet to 25 feet beneath the ground surface. The typical thickness of the lacustrine soils is about 15 feet.

Surficial soils at the facility have been subject to historic desiccation, possibly to depths of 10 feet to 20 feet below the ground surface, due to water level variations and alternate wetting and drying of these materials. Thus, the materials have been consolidated, with greater degrees of consolidation near the ground surface. The depth of desiccation has been delineated by lower moisture contents, stiffer consistency, higher strength, and lower unit weight than those encountered at deeper depths in the overburden, as illustrated from the data on the attached Figures 3 and 4. Also, as shown on Figure 3, this depth is transitional. Below the level of desiccation, the lacustrine and till soils are typically soft, have a relatively high moisture content and are near normally consolidated. The softer materials are indicated by much lower standard penetration resistance, or blow counts, which generally range from 4 to 10. Figure 5 shows that elevated concentrations of tritium only penetrated to a depth of 17 feet below the ground surface. This also illustrates some connection between surface water and the desiccated zone.

Evaluation

The L-19 investigation was performed in June 1990. During this program, four boreholes were drilled around L-19, at about the location shown on Figure 2. Each boring was advanced to a depth of about 22 feet using auger drilling methods. Copies of the borehole logs are included in Attachment B. During the investigation, soil samples were collected using split spoon samplers and tested in the

field for the occurrence of organics using a Foxboro Century 128 organic vapor analyzer. The samples with the ten highest total volatile organic compound readings were sent to Environmental Testing and Certification Corporation (ETC) for analysis for 1,2-DCA. In addition, the groundwater in each of the boreholes was allowed to recover, the borehole was bailed dry, and then allowed to recover again. Each recovery period was about 24 hours. Subsequently, samples of groundwater were collected for analyses for 1,2-DCA by ETC. Details of the investigation and sampling and analyses are provided in the "Investigation at Well L-19, Vickery, Ohio, Facility" report dated June 24, 1990.

As indicated in the "Monitoring Well System, Analytical Data Evaluation, Vickery, Ohio Facility" report dated April 22, 1988, Golder Associates believes that the occurrence of 1,2-DCA in groundwater samples from well L-19 are due to localized releases associated with spills or leaks due to past waste handling practices in the area. The data do not suggest that there is evidence of overall contamination or chemical plume. The results from the L-19 investigation do not alter this evaluation. In particular, analysis of the soil samples that were obtained in the boreholes drilled around well L-19 did not indicate the presence of 1,2-DCA above the detection limits. Therefore, the presence of this compound as a contaminant in the soil samples was not demonstrated. Water samples collected from these boreholes, however, did show some presence of 1,2-DCA; concentrations were encountered up to about two parts per million. Therefore, groundwater in the vicinity of well L-19 does contain 1,2-DCA.

Lacustrine soils in the vicinity of well L-19 were encountered at depths of 9 feet to 19 feet beneath the ground surface, beneath the fill, and generally within the zone of desiccation. Well L-19 has an open interval beginning about three feet beneath the top of the lacustrine soils which is partially, or completely, within this zone of desiccation. Further, each of the boreholes that were sampled was open to the fill above the lacustrine till. As indicated in attached borehole logs, the depth to water was between three feet and eight feet beneath the ground surface. In each of these holes, the depth to lacustrine material was about seven feet beneath the ground surface. Also, in each of these holes the material became softer at a depth of about 16 feet beneath the ground surface. Finally, as shown on the sampling sheets in Attachment C the depth to water at the time of sampling was also at about three feet to eight feet beneath the ground surface. These data suggest that the source of contaminated groundwater is likely the groundwater in the fill material above the lacustrine soils. The higher blow counts in the lacustrine material above the depth of 16 feet are consistent with past information suggesting desiccation of the surface materials. Therefore, the water that is being sampled in L-19, which was sealed about 3 feet into the lacustrine material, is likely due to the short circuiting or flow from the overlying fill material downward into the well interval, possibly through desiccation cracks.

The premise of hydraulic connection of L-19 with the overlying fill material is also substantiated by past water level data collected by the site indicating higher water levels in L-19 after rainfall events. This also indicates a higher degree of connection at well L-19 than observed elsewhere in the facility. This higher degree of connection with the surface could allow communication of contaminated water in the fill with the well screen interval.

Finally, an additional suggestion that the contamination is due to localized spills, rather than from the ponds or the waste piles, is indicated by the occurrence of 1,2-DCA in well L-19 only . Based on the proximity of the wells to the ponds or the stockpile area, flows through the ground into L-14, L-15, L-16, L-20, and L-28, would be indicative of releases from the ponds. Groundwater samples from none of these wells have had 1,2-DCA detected in them. Further, if the presence of 1,2-DCA at L-19 was due to releases from the stockpile area due to consolidation of the underlying material from the height of the stockpile, contaminants should also be found in L-16 and L-26. Again, groundwater from neither of these wells has contained 1,2-DCA. Therefore, the occurrence of 1,2-DCA in groundwater samples from well L-19 is still suspected to be due to contaminants in the overlying fill.

If you have any questions, please do not hesitate to contact us.

Very truly yours,

GOLDER ASSOCIATES INC.

James F. Durrett, P.G.
Project Hydrogeologist

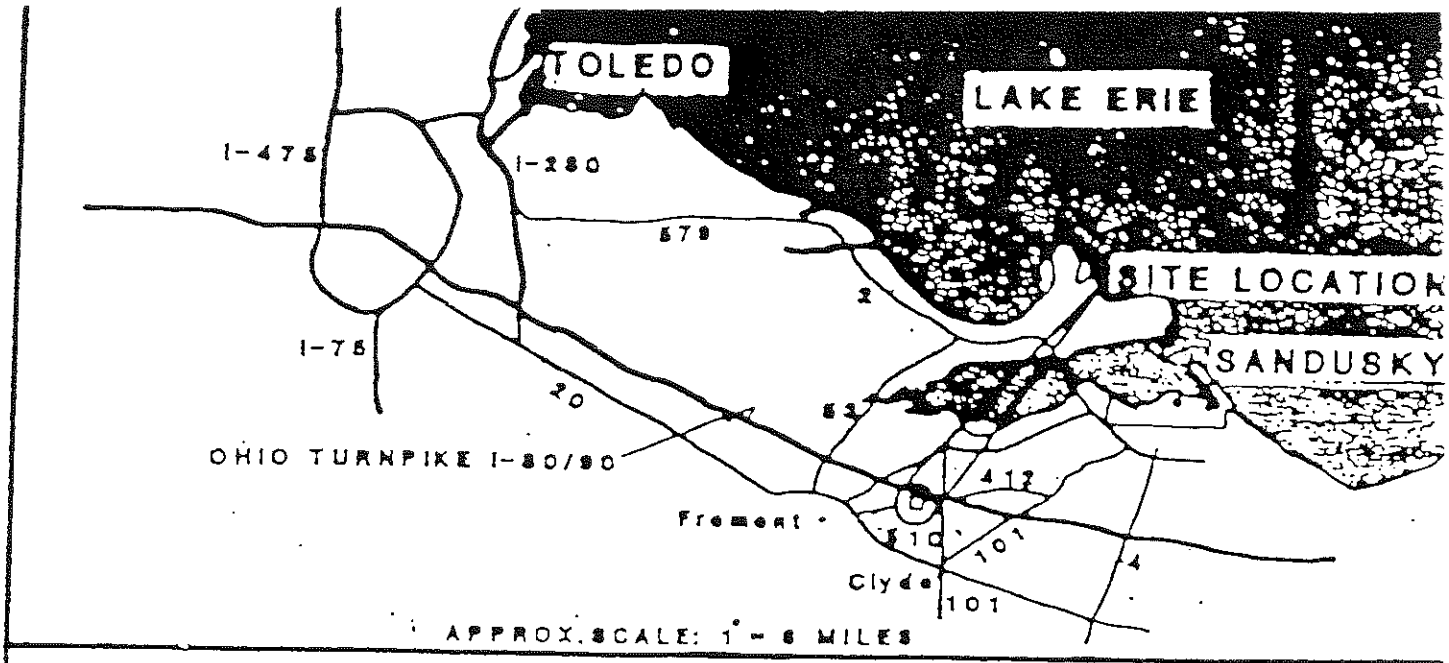
John F. Clerici, P.E.
Principal

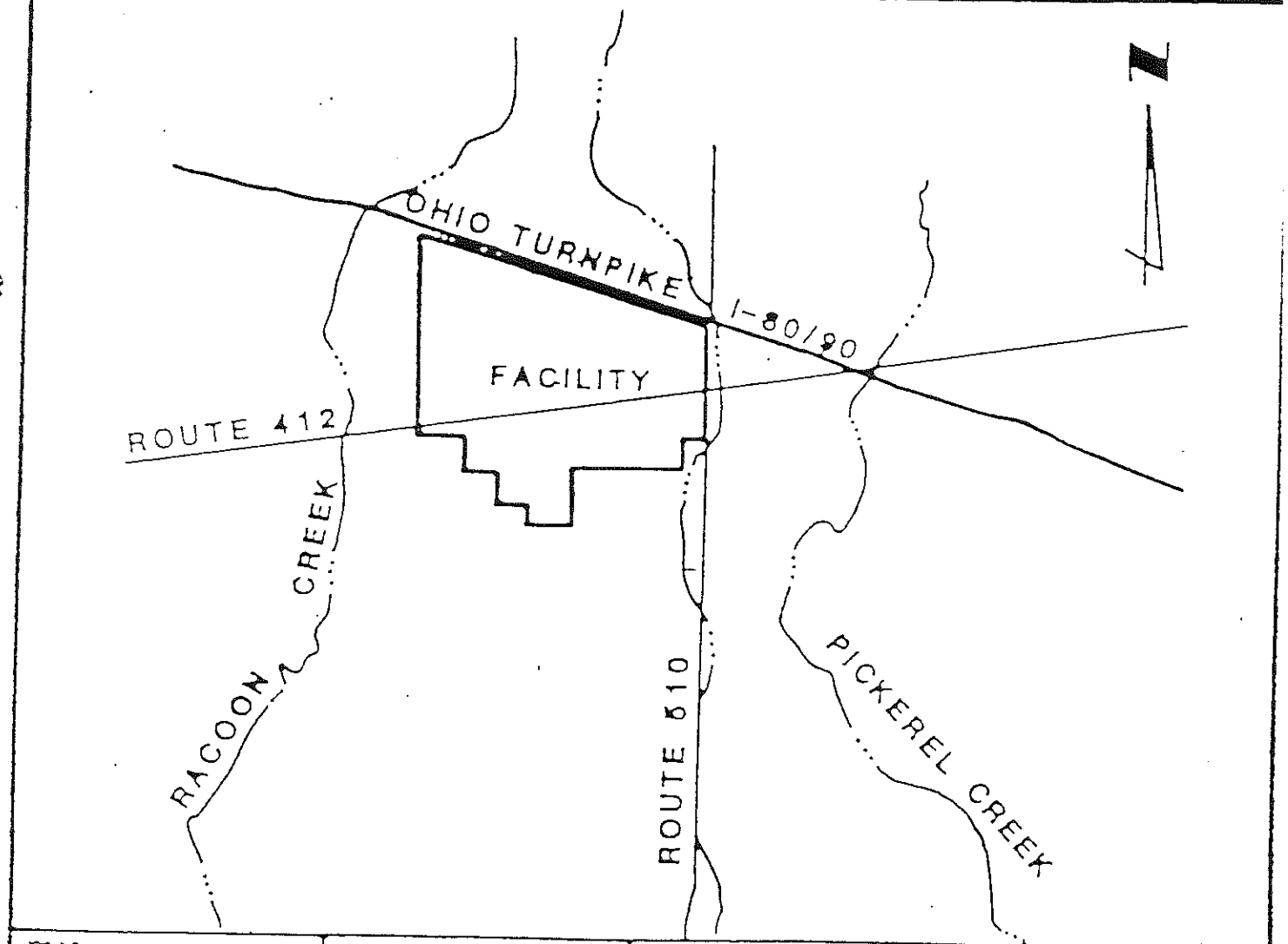
JFC:maa

ATTACHMENTS:

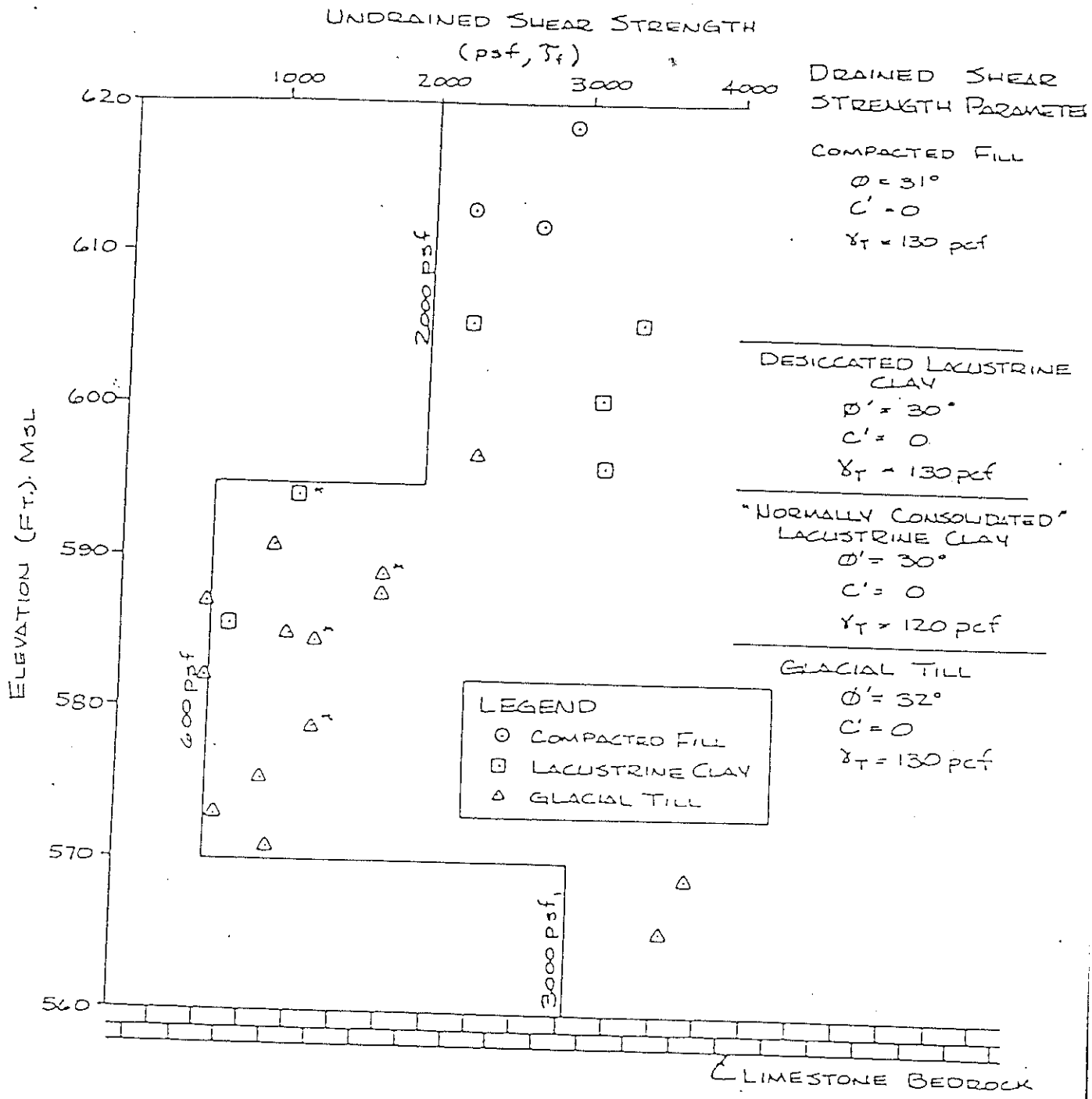
FIGURE 1 - Site Location Plan
FIGURE 2 - Well L-19 Investigation Location
FIGURE 3 - Engineering Properties of Glacial Deposits
FIGURE 4 - Shear Strength Profile for Closure Cell Area
FIGURE 5 - Tritium and Chloride Concentrations Versus Depth Below Ground Surface
ATTACHMENT A - Monitoring Well Installation Log
ATTACHMENT B - Borehole Logs
ATTACHMENT C - Chemical Analysis Data

FN: 3370REV.L19\15\MAA



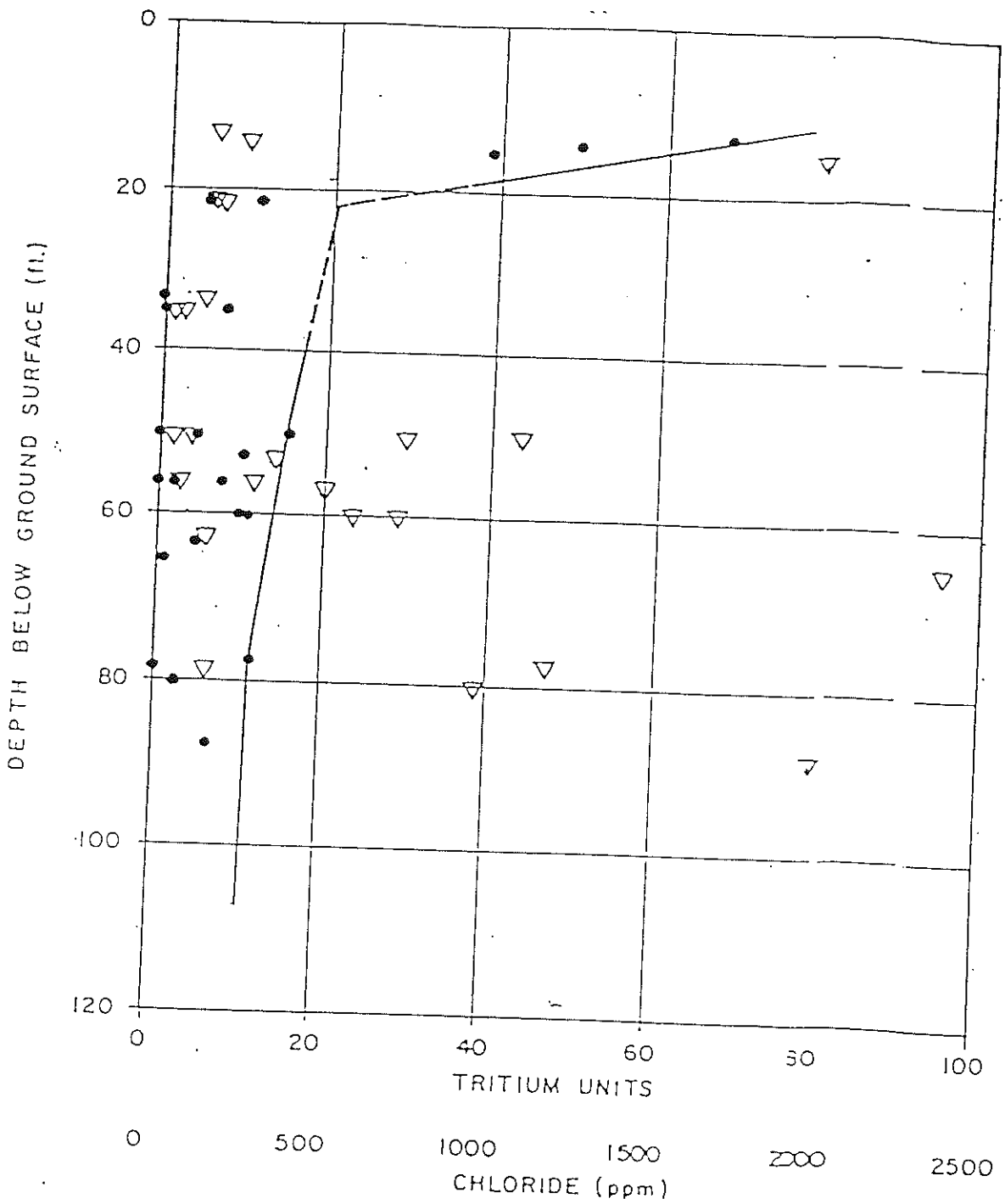


JOB NO. 834-1358	SCALE NO SCALE	SITE LOCATION PLAN
DRAWN JLW	DATE 3/13/86	
CHECKED WAD.	DWG. NO. 381	
Golder Associates	CHEMICAL WASTE MANAGEMENT, INC.	FIGURE 1



* FIELD VANE SHEAR TESTS DENOTED WITH AN ASTERISK MAY HAVE BEEN RUN AT A TOO STRAIN RATE YEILDING UNCONSERVATIVELY HIGH VALUES OF UNDRAINED SHEAR STRENGTH

JOB NO. 834-1358	SCALE AS SHOW	SHEAR STRENGTH PROFILE FOR CLOSURE CELL AREA
DRAWN SKB	DATE 8-23-84	
CHECKED MRB	DWG. NO. 178	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. — FIGURE 4



LEGEND

——— TREND OF H_3 VALUES

– – – INFERRED TREND OF H_3 VALUES

• TRITIUM

▽ CHLORIDE

JOB NO. 834-1358	SCALE AS SHOWN	TRITIUM AND CHLORDE CONCENTRATIONS VERSUS DEPTH BELOW GROUND SURFACE
DRAWN SKB	DATE 12-9-83	
CHECKED MTF	DWG. NO. 84	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. FIGURE 5

WMX

WMX Environmental Monitoring Laboratories, Inc.

A WMX Technologies Company
2100 Cleanwater Drive
Geneva, Illinois 60134

Phone 708.208.3100
Fax 708.208.9064

DATE: April 2, 1996

TO: Rick Toth
RUST E&I

FROM: Marti Pruhs Marti

SUBJECT: Vickery Graphs

Per the request of Sandy Clark, please find enclosed the groundwater elevation graphs for the "T", "MW" and "L" wells at Vickery.

If you have any questions regarding the enclosed information, please do not hesitate to call.

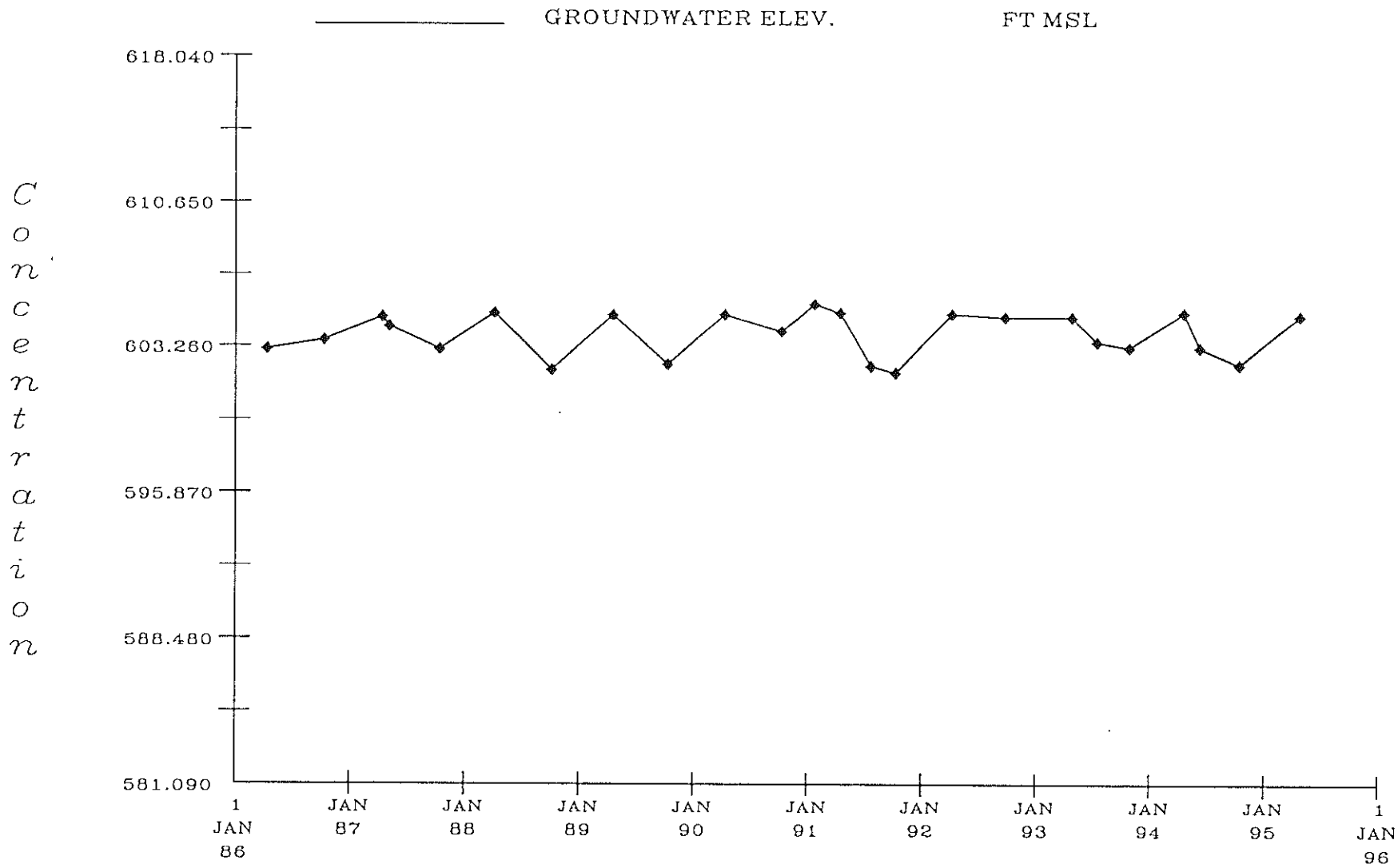
cc: Sandy Clark

Printed on recycled paper

Environmental Graphic System

Vickery

Site: 490 Sample Point:L14

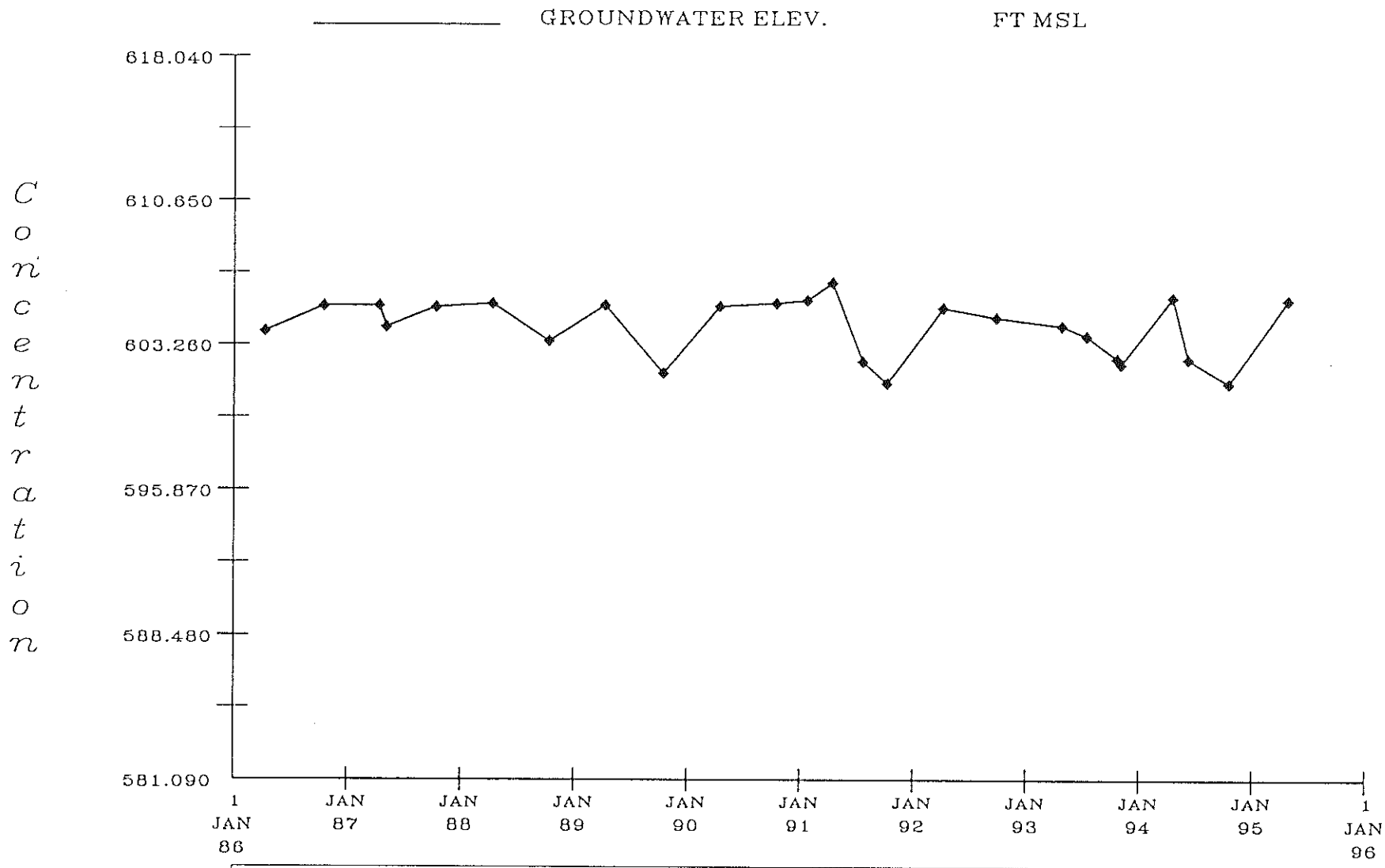


Start date : 04/12/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/24/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L15

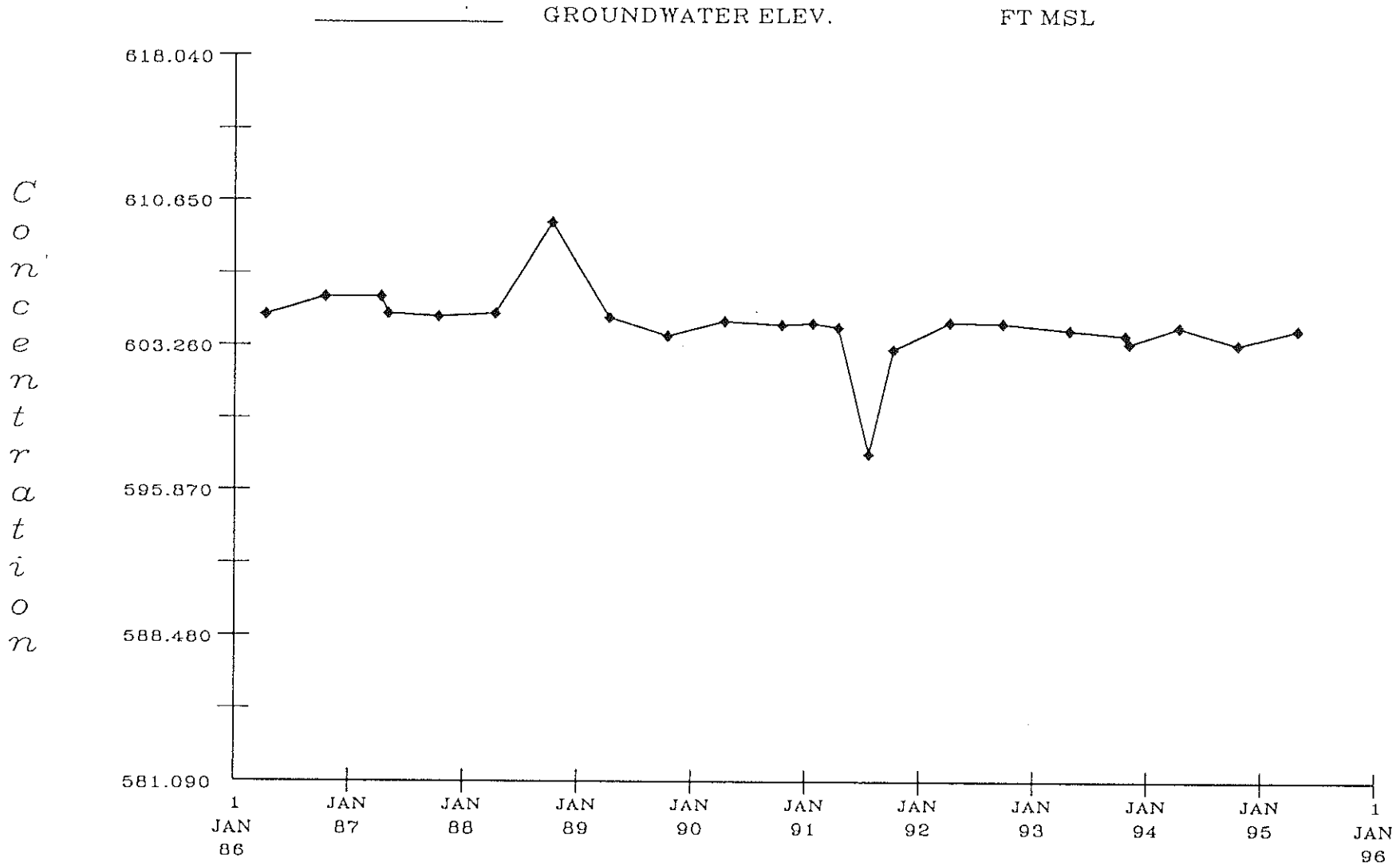


Start date : 04/11/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/25/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L16

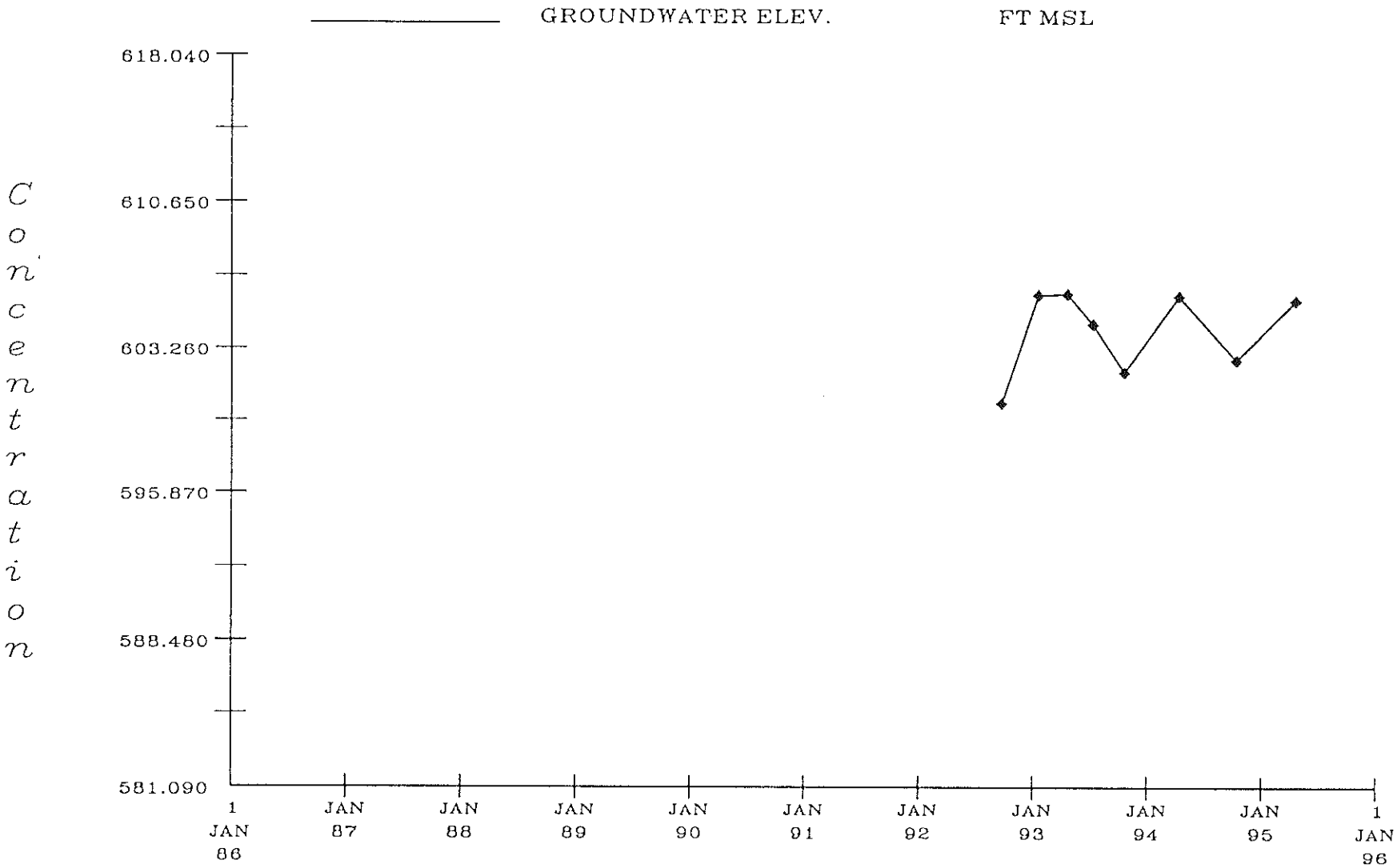


Start date : 04/11/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/25/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L17

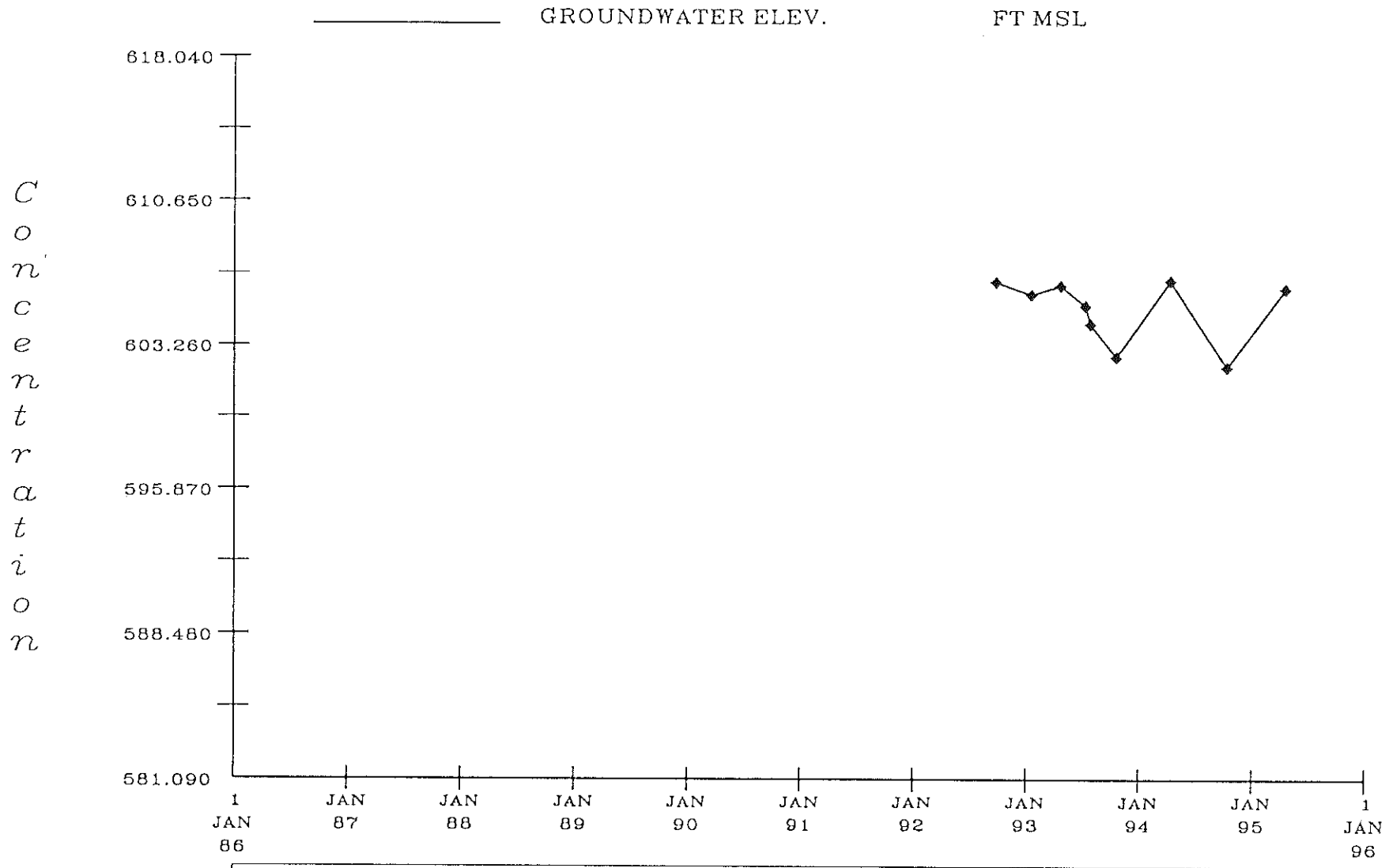


Start date : 09/22/92 ○ □ = ND ◆ ⋈ = Results
End date : 04/19/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L18

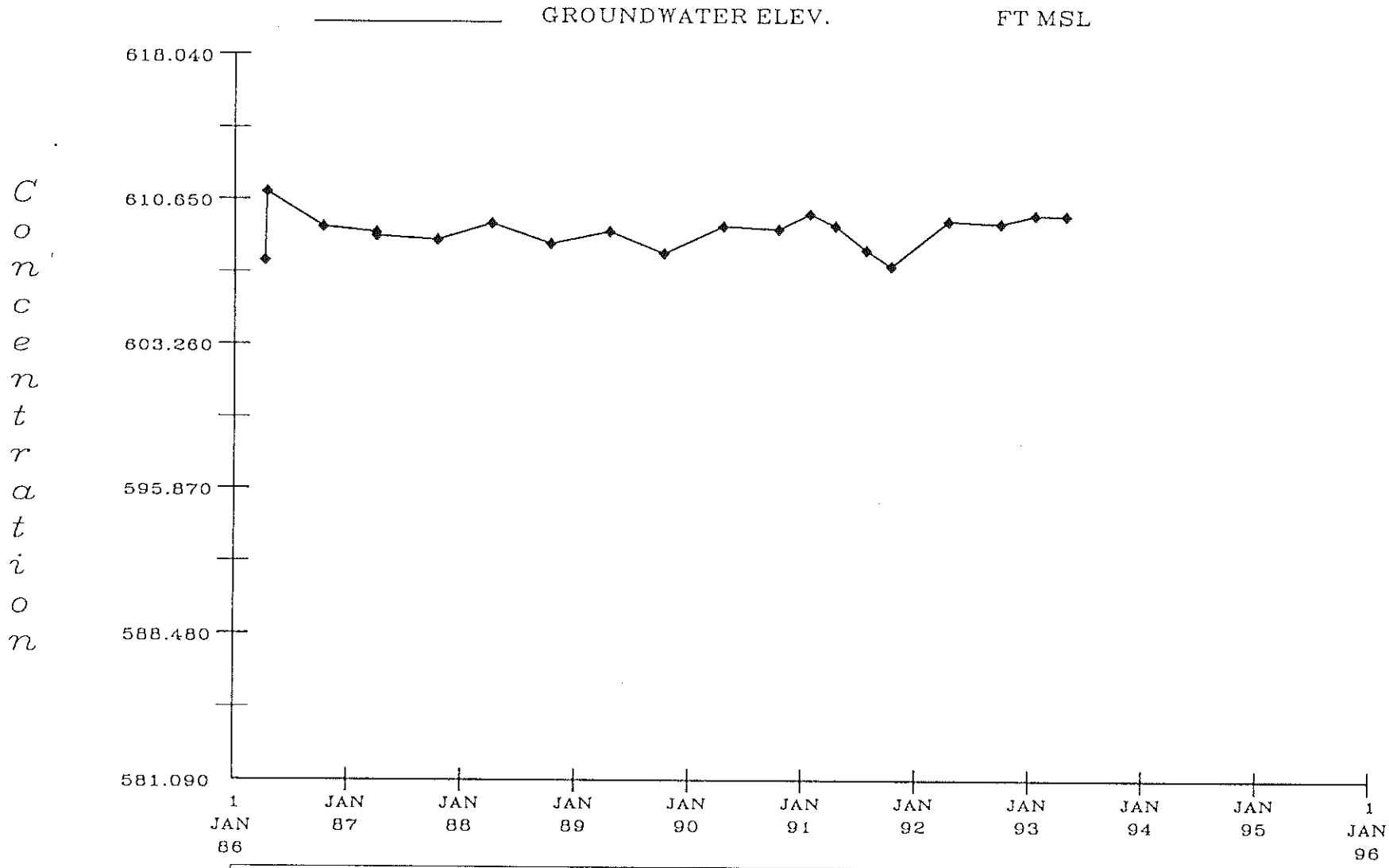


Start date : 09/25/92 ○ □ = ND ◆ ⋈ = Results
End date : 04/19/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L19

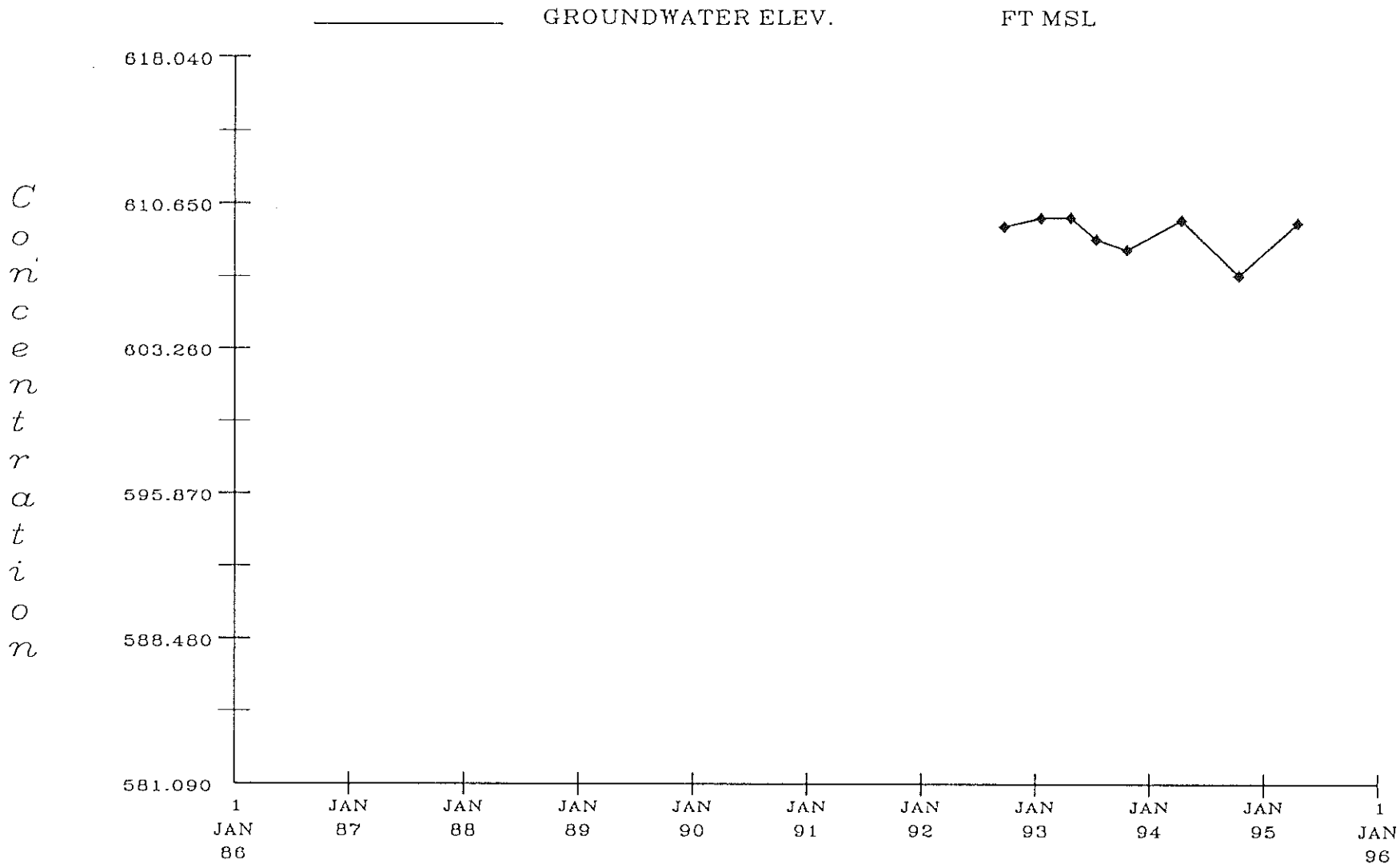


Start date : 04/09/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/27/93

Environmental Graphic System

Vickery

Site: 490 Sample Point:L19A

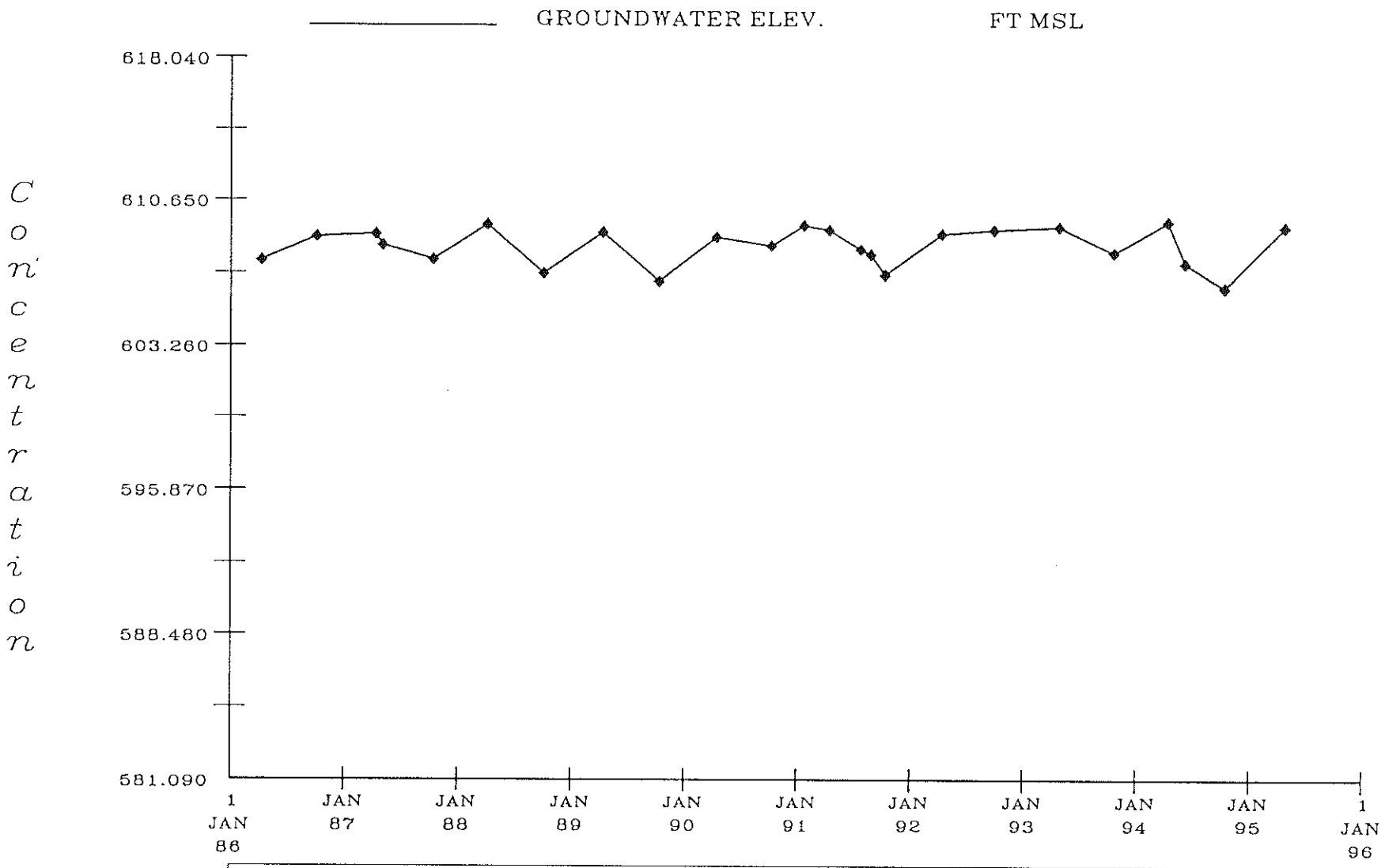


Start date : 09/22/92 ○ □ = ND ♦ ⋈ = Results
End date : 04/18/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L20

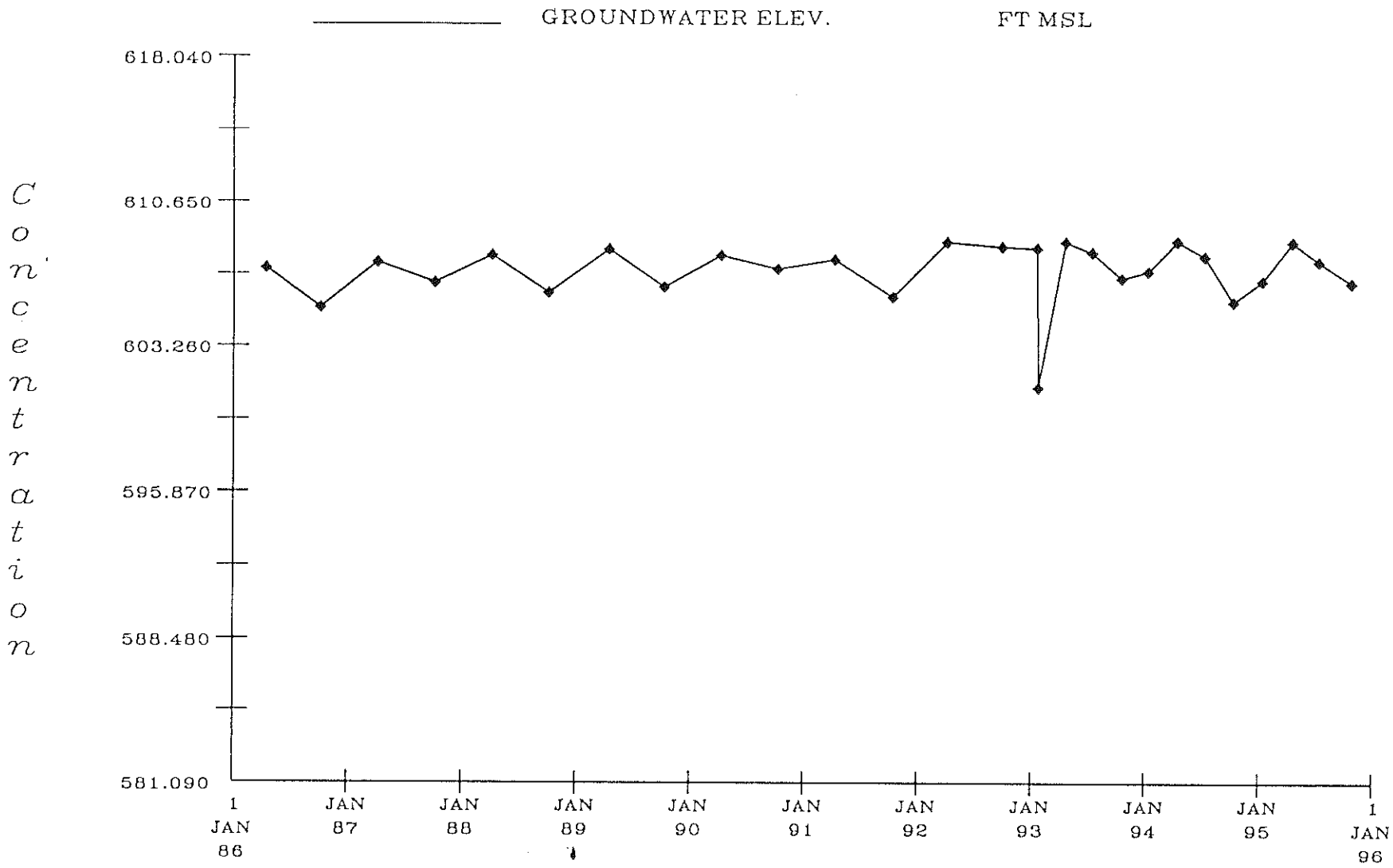


Start date : 04/11/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/26/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L21

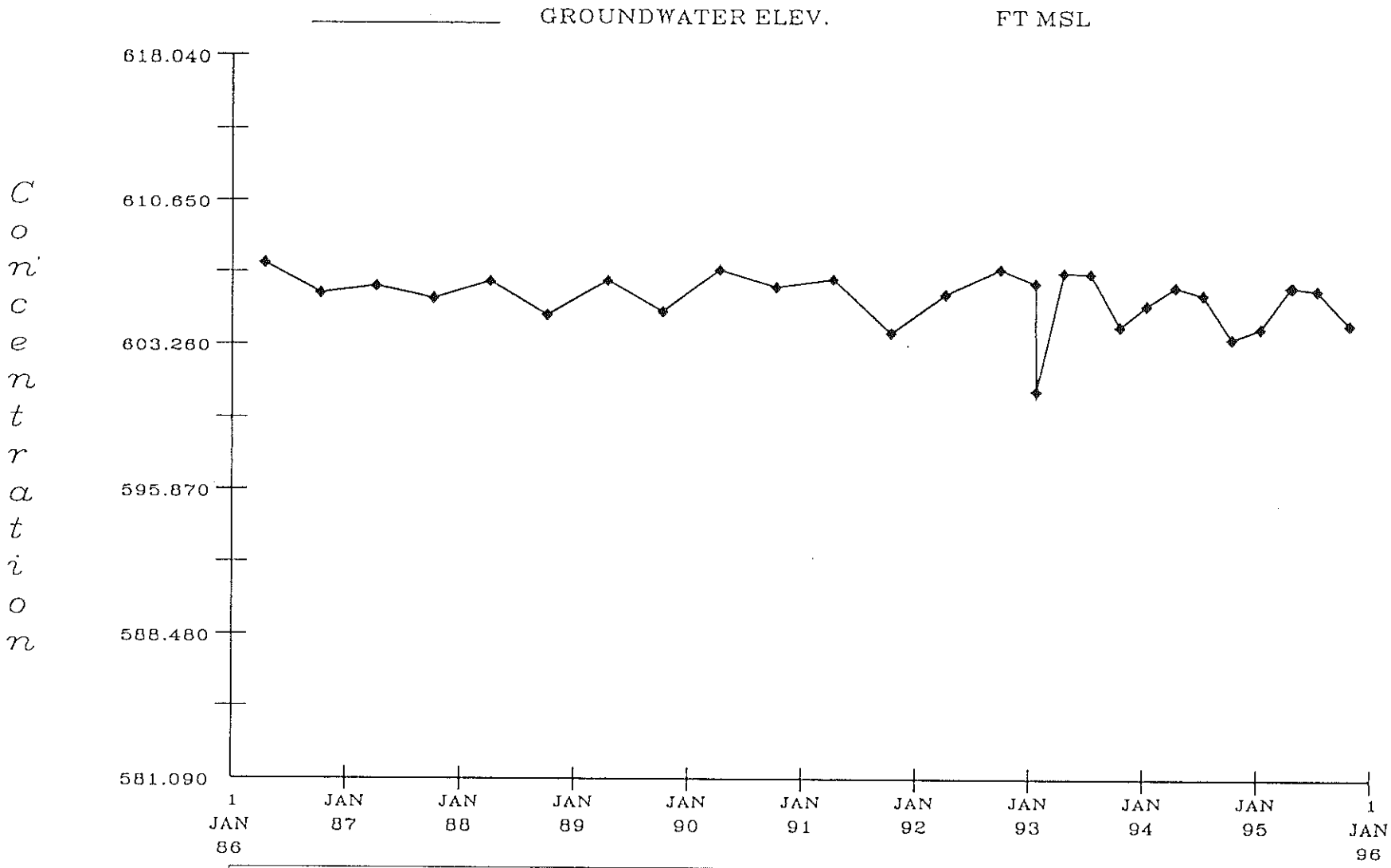


Start date : 04/15/86 ○ □ = ND ◆ ⋈ = Results
End date : 10/23/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L22

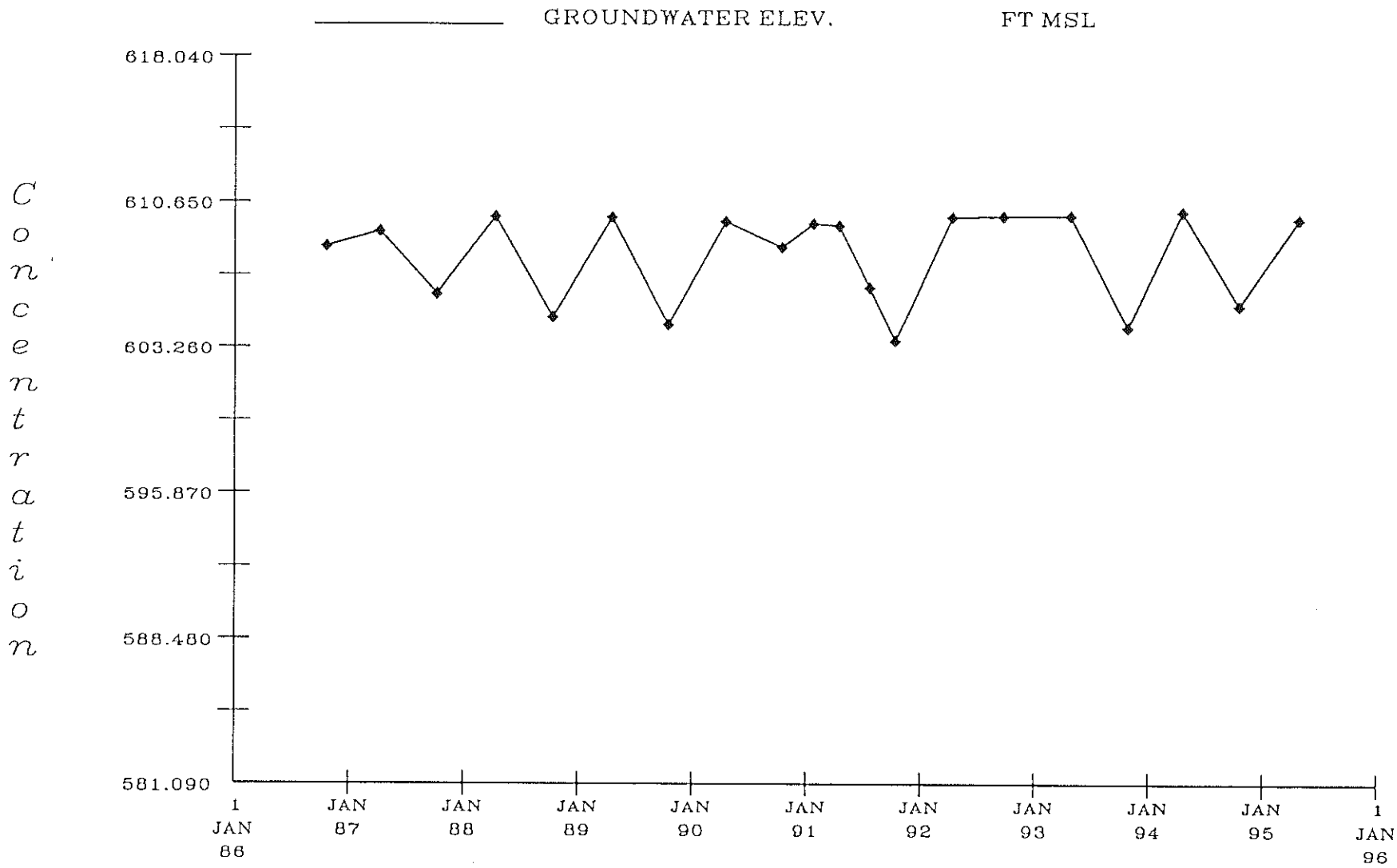


Start date : 04/15/86 ○ □ = ND ✦ ⋈ = Results
End date : 10/23/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L23A

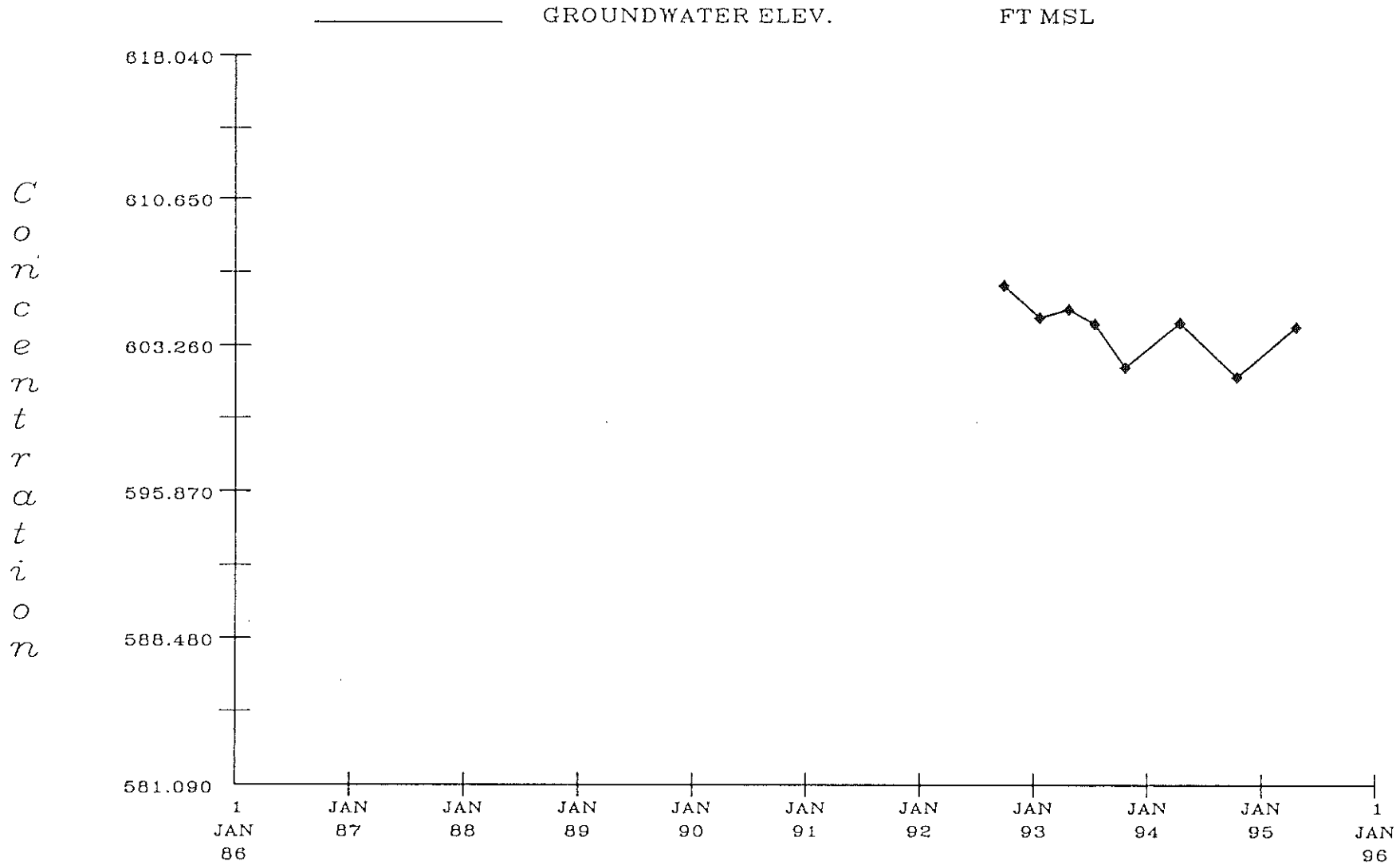


Start date : 10/20/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/25/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L25

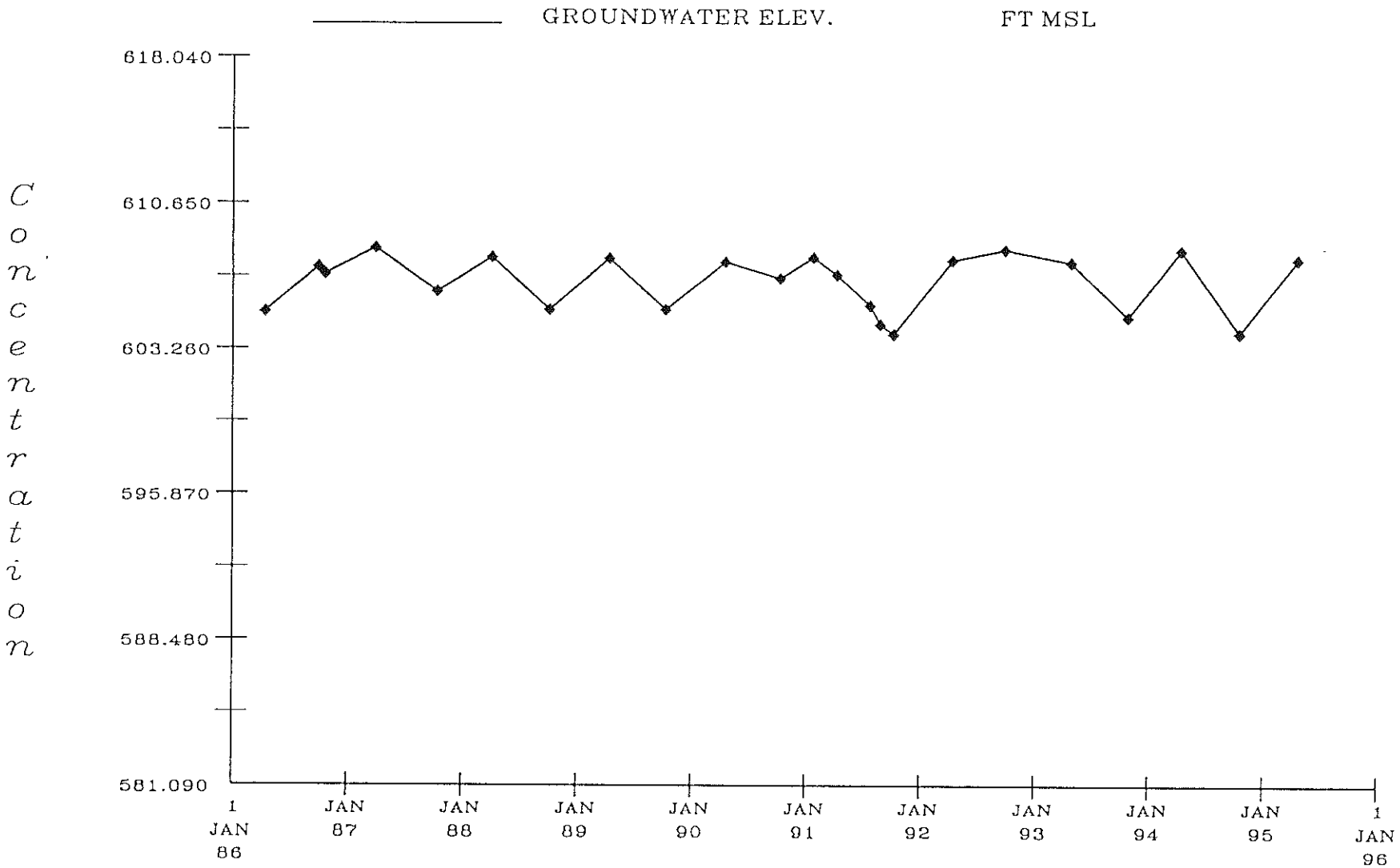


Start date : 09/25/92 ○ □ = ND ◆ ✕ = Results
End date : 04/19/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L26

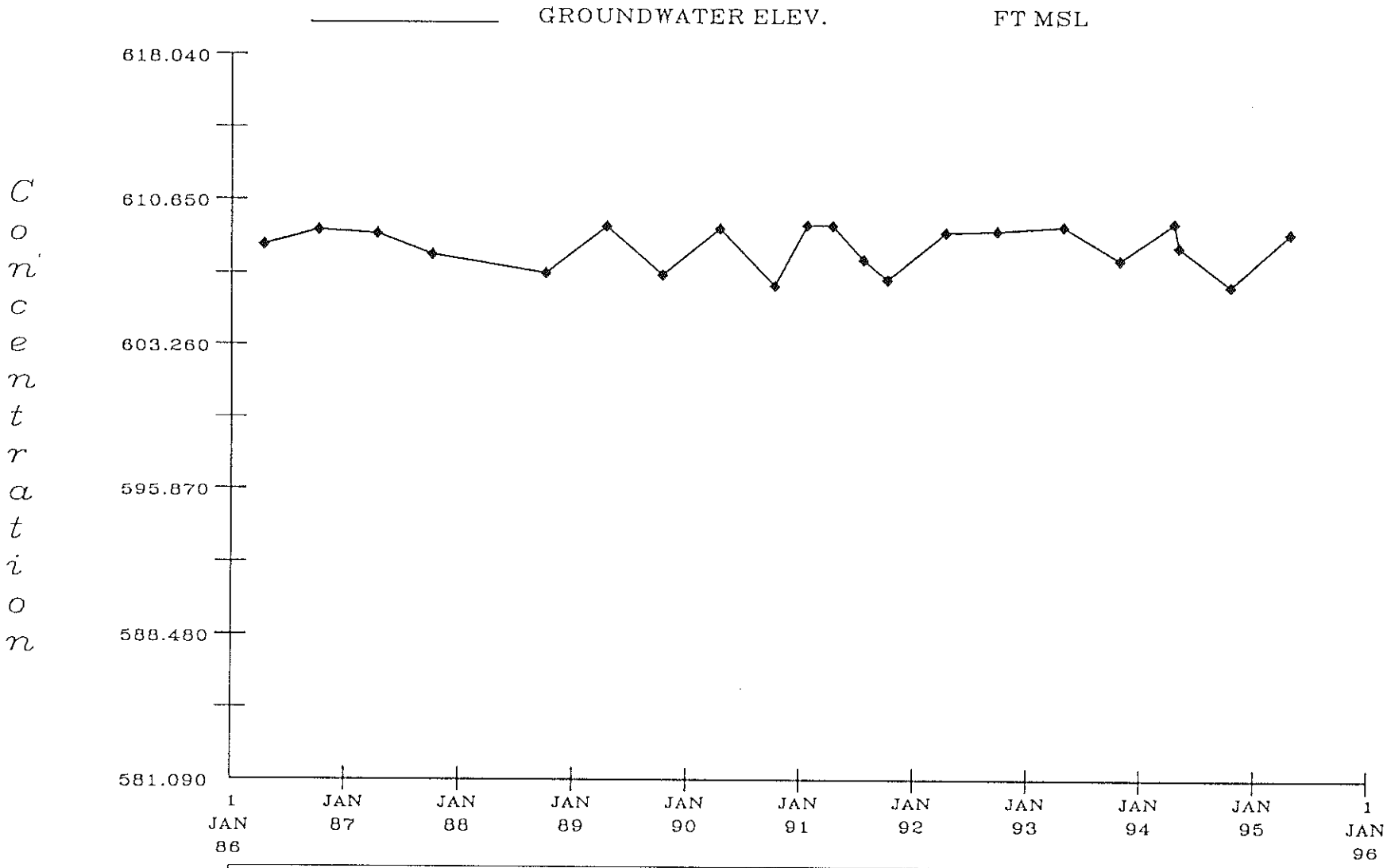


Start date : 04/14/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/20/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L27

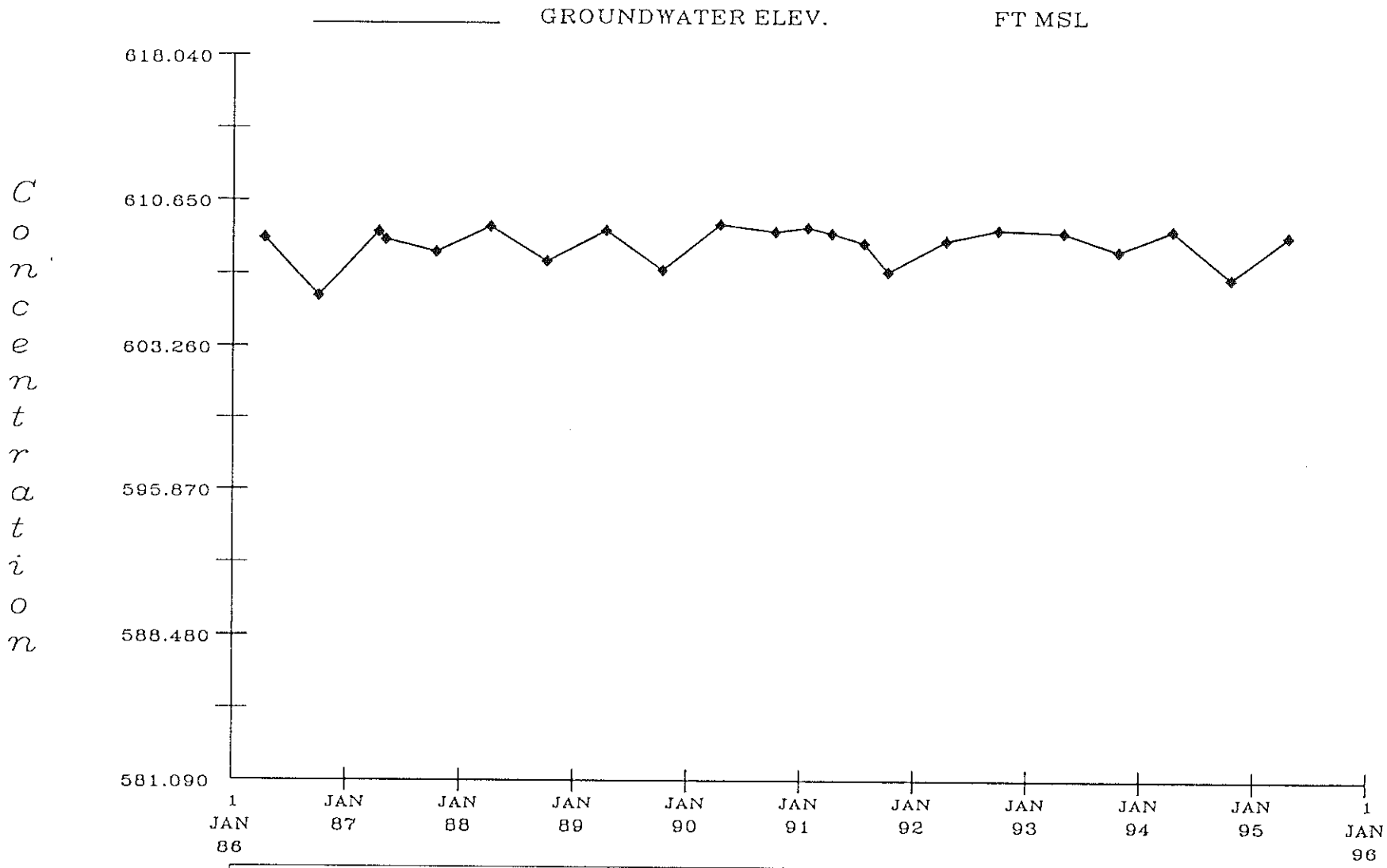


Start date : 04/16/86 O □ = ND ◆ ⋈= Results
End date : 04/26/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L28

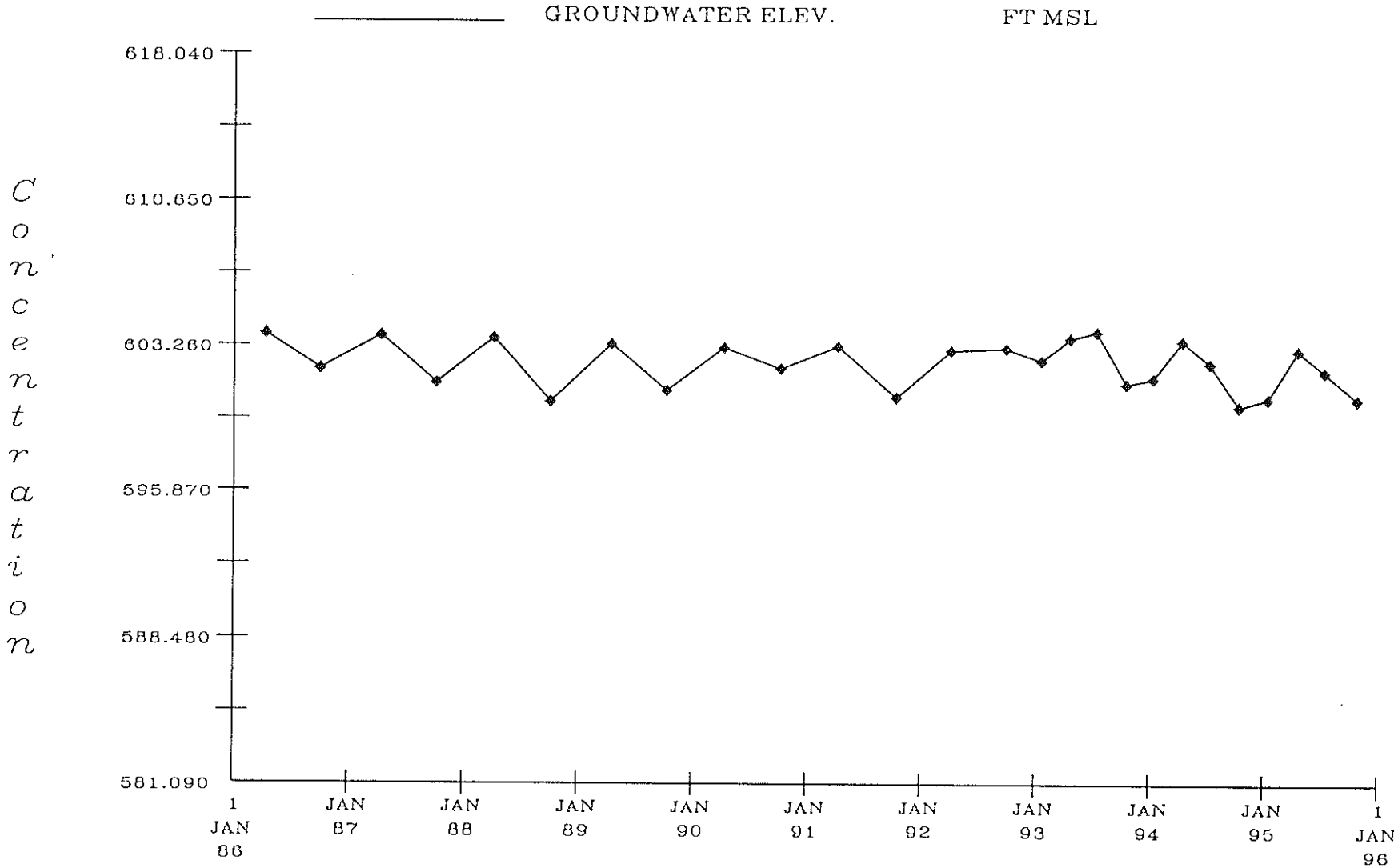


Start date : 04/12/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/20/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L29

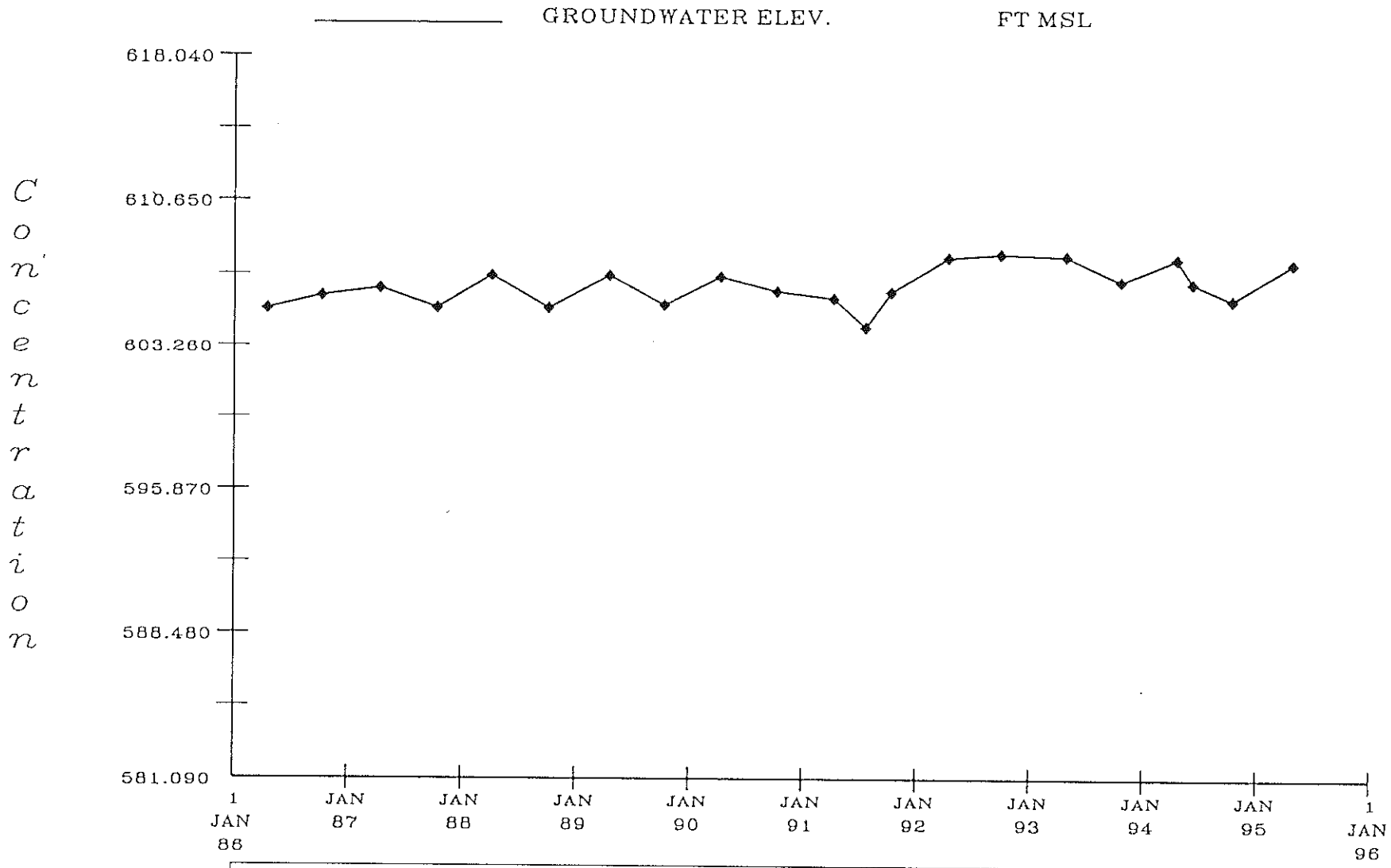


Start date : 04/12/86 ○ □ = ND ◆ ⋈ = Results
End date : 10/23/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L30

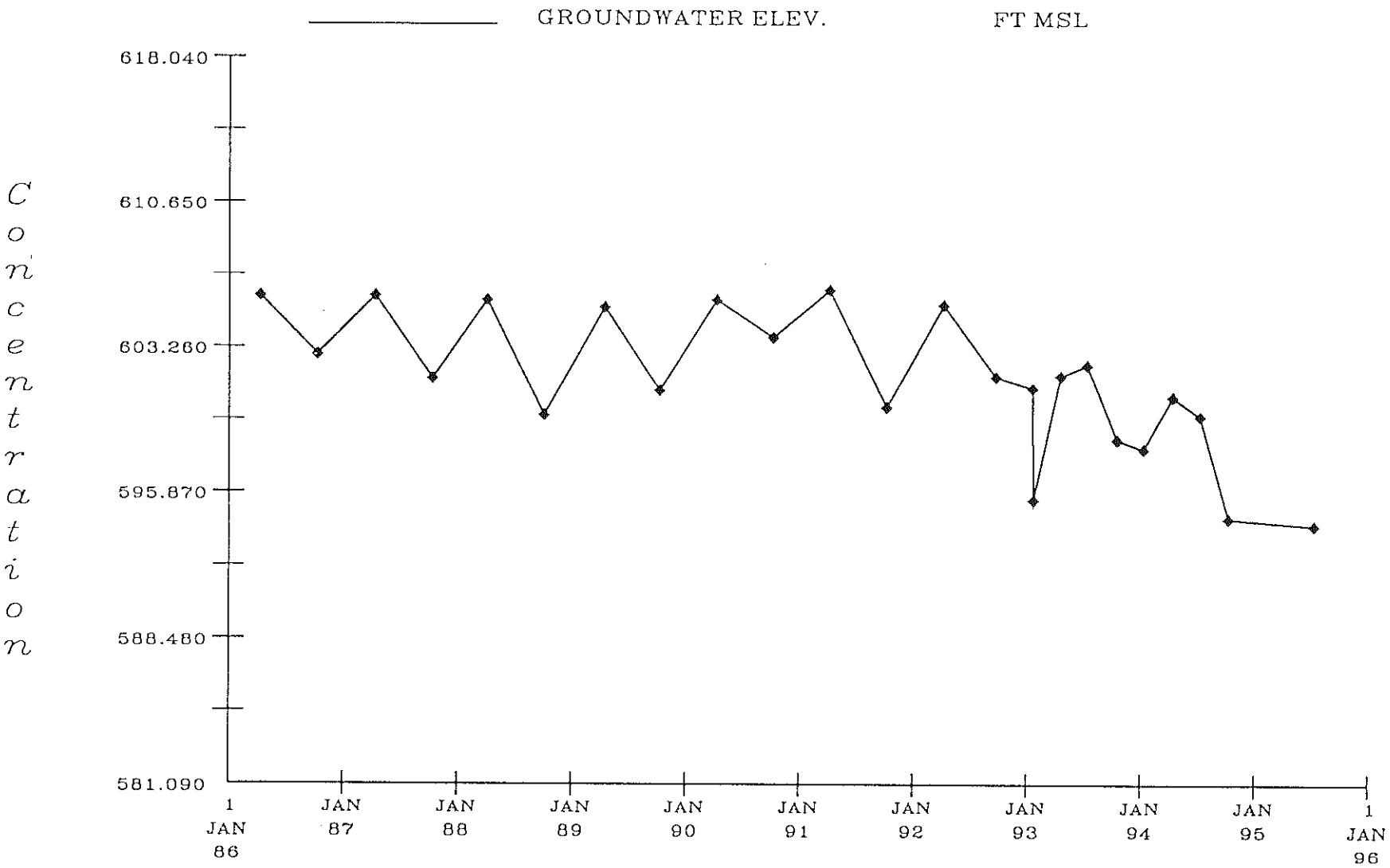


Start date : 04/17/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/25/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L31

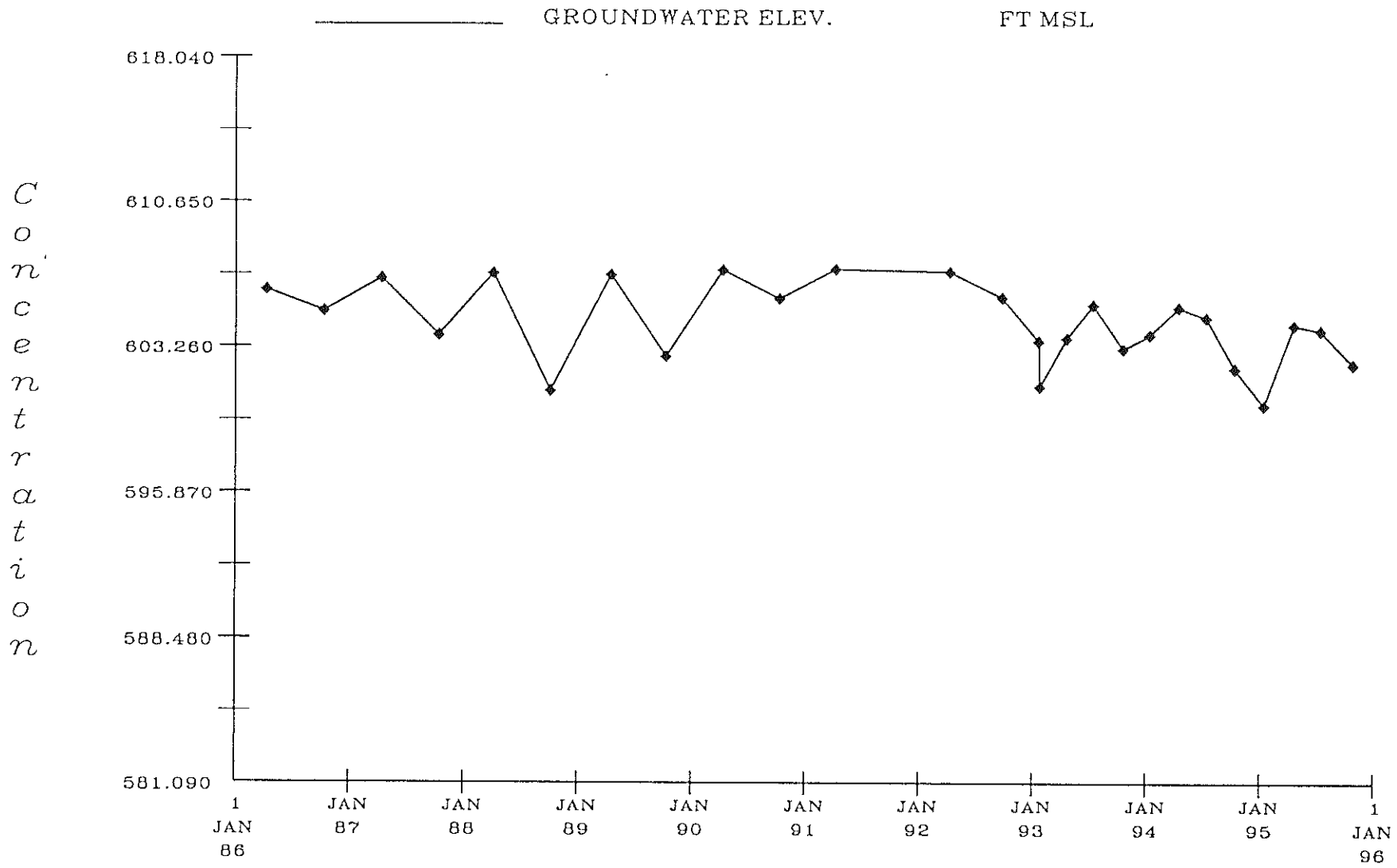


Start date : 04/11/86 ○ □ = ND ◆ ⋈ = Results
End date : 07/11/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L32

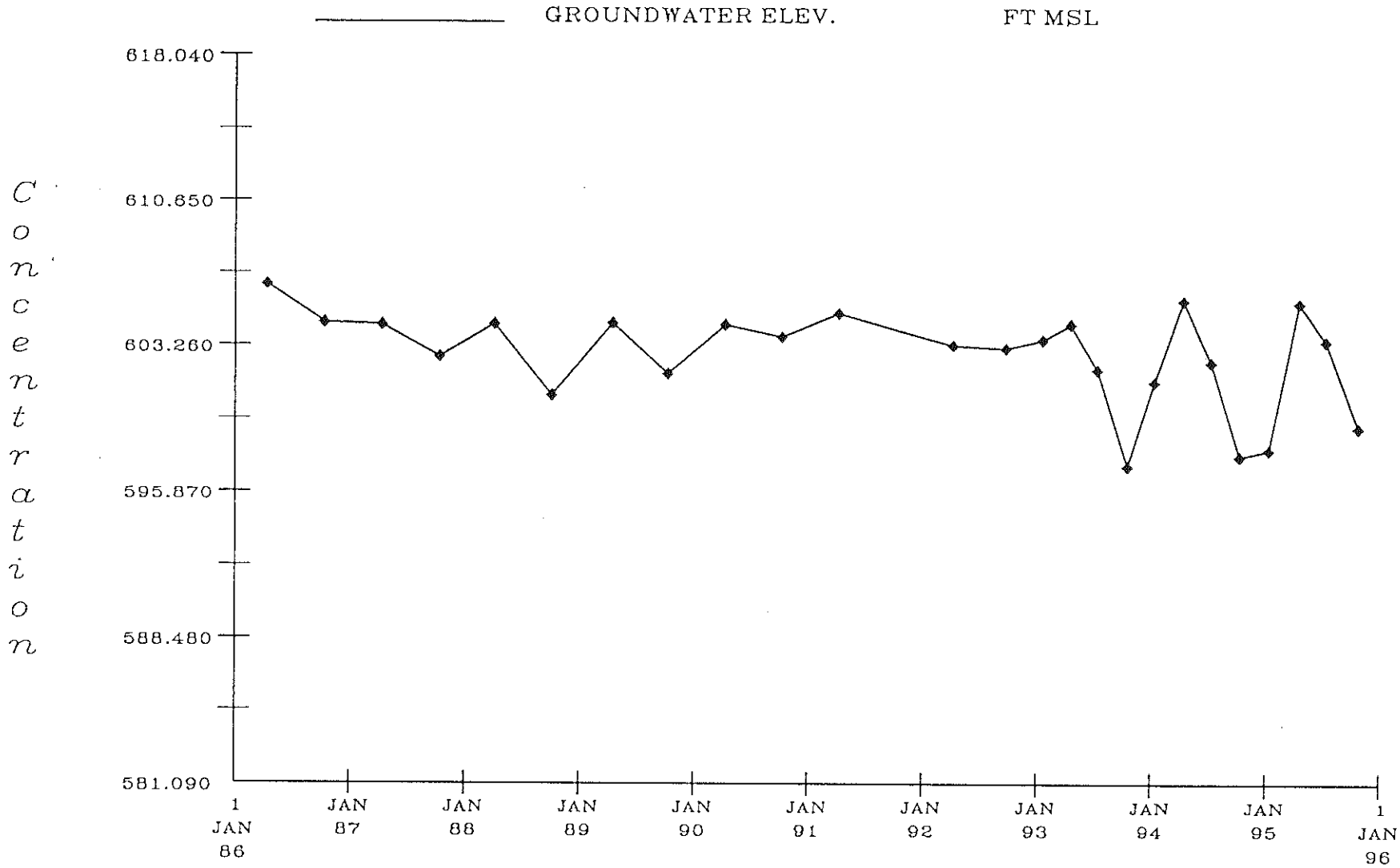


Start date : 04/11/86 ○ □ = ND ◆ ⋈ = Results
End date : 10/23/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L33

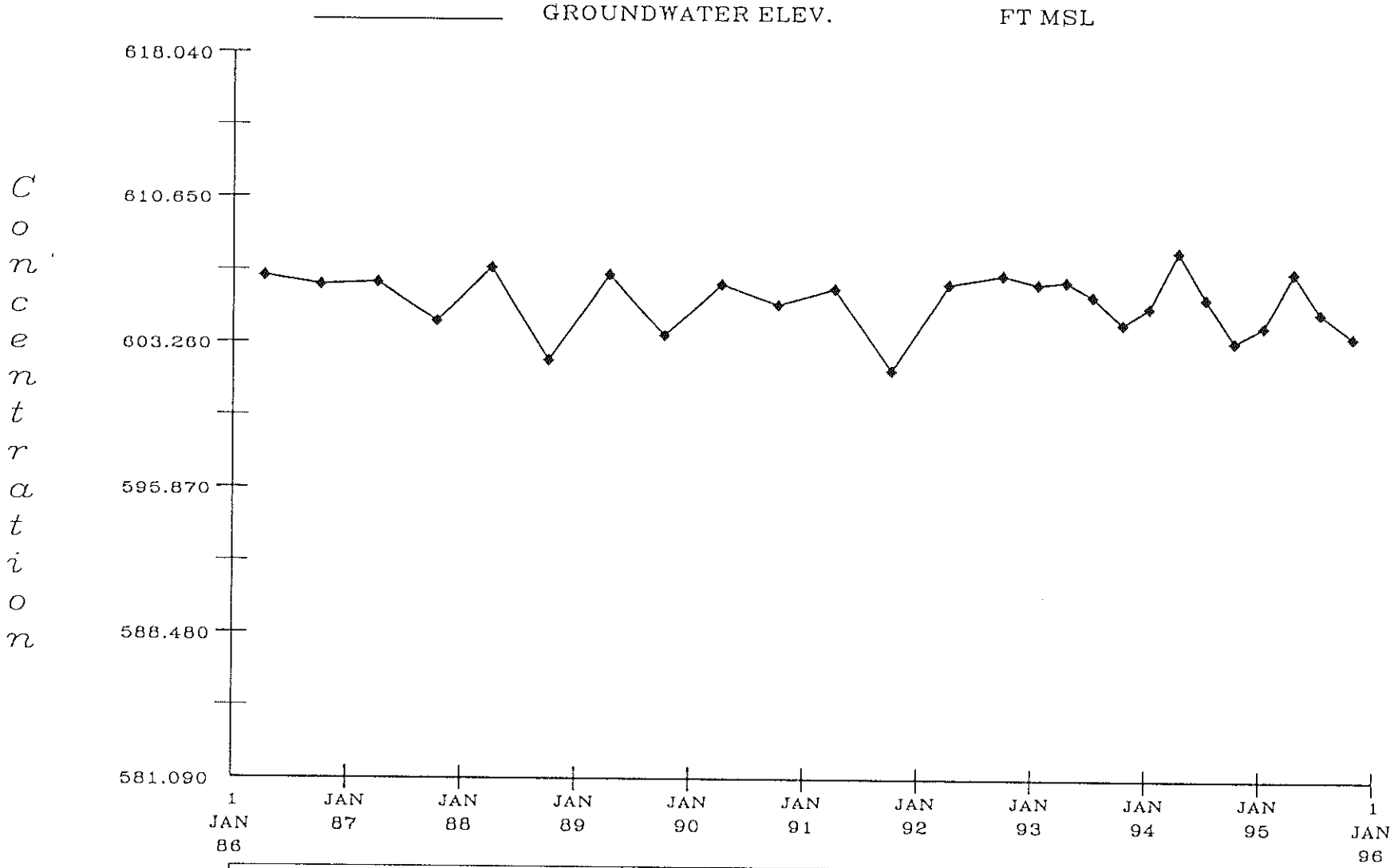


Start date : 04/12/86 ○ □ = ND ◆ ⋈ = Results
End date : 10/23/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L34

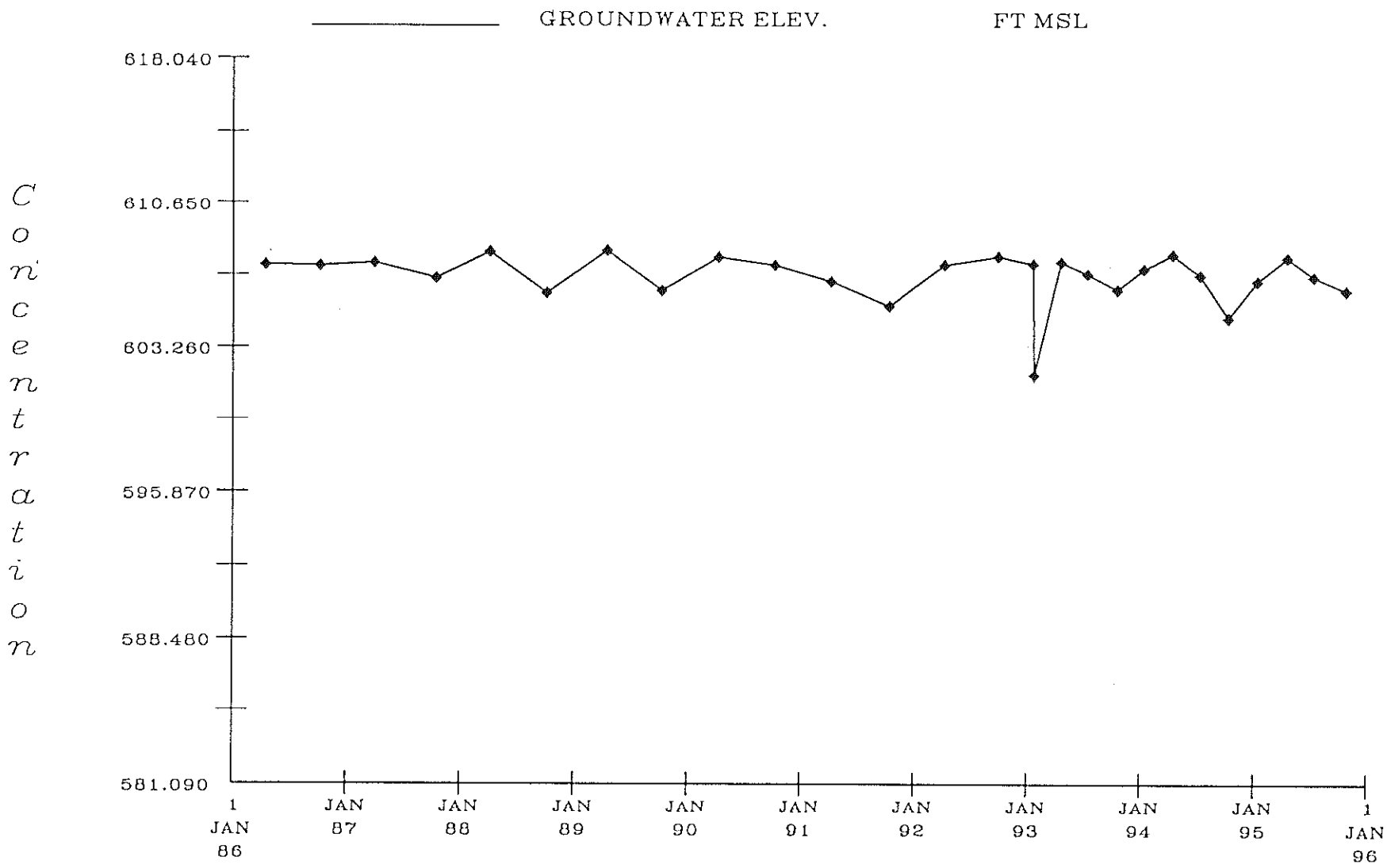


Start date : 04/11/86 ○ □ = ND ◆ ⋈ = Results
End date : 10/23/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L35

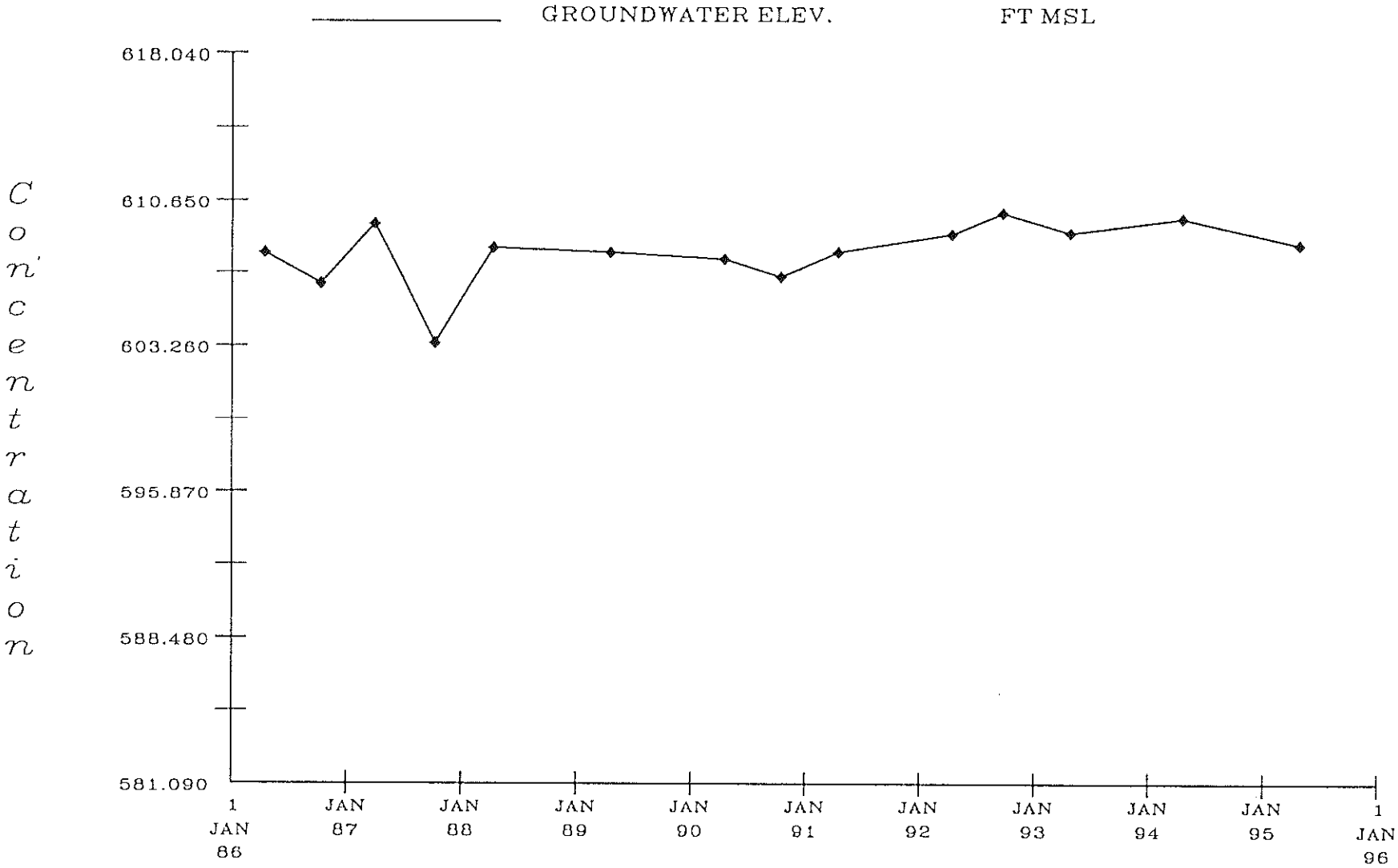


Start date : 04/15/86 ○ □ = ND ◆ ⋈ = Results
End date : 10/23/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:L39

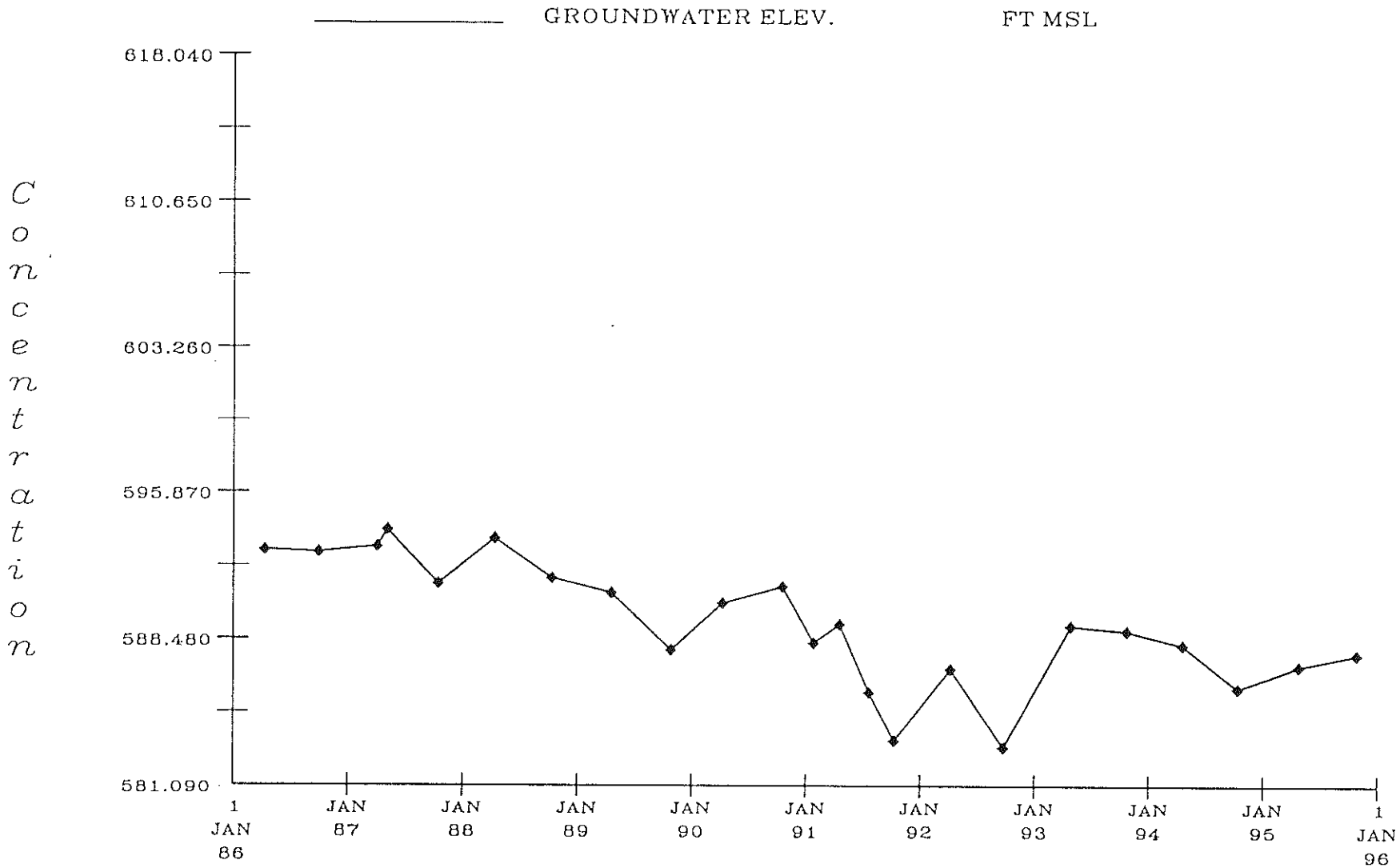


Start date : 04/16/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/25/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:MW14R

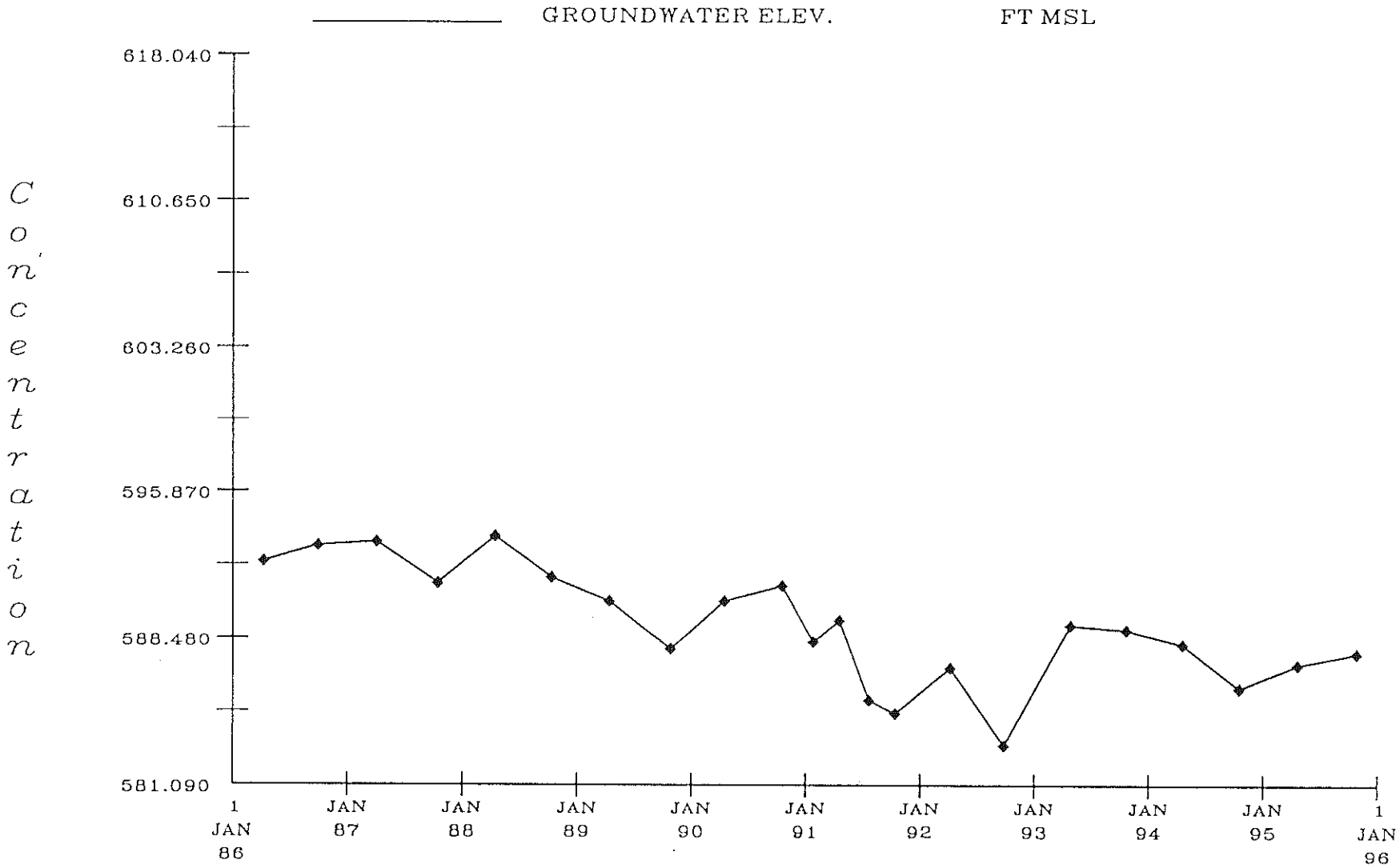


Start date : 04/11/86 ○ □ = ND ◆ ⋈ = Results
End date : 10/26/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:MW15R

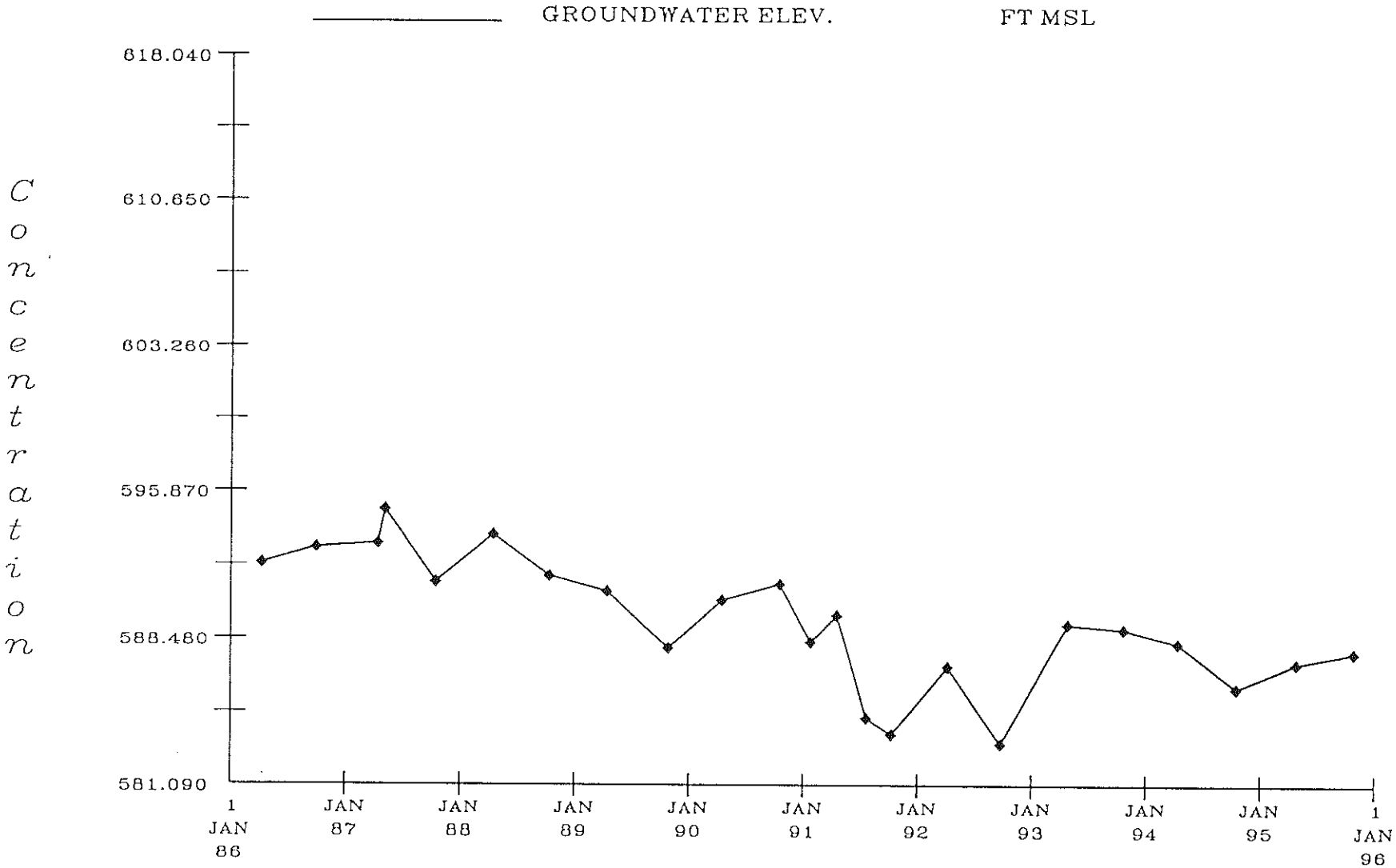


Start date : 04/10/86 ○ □ = ND ◆ ⋈ = Results
End date : 10/25/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:MW16R

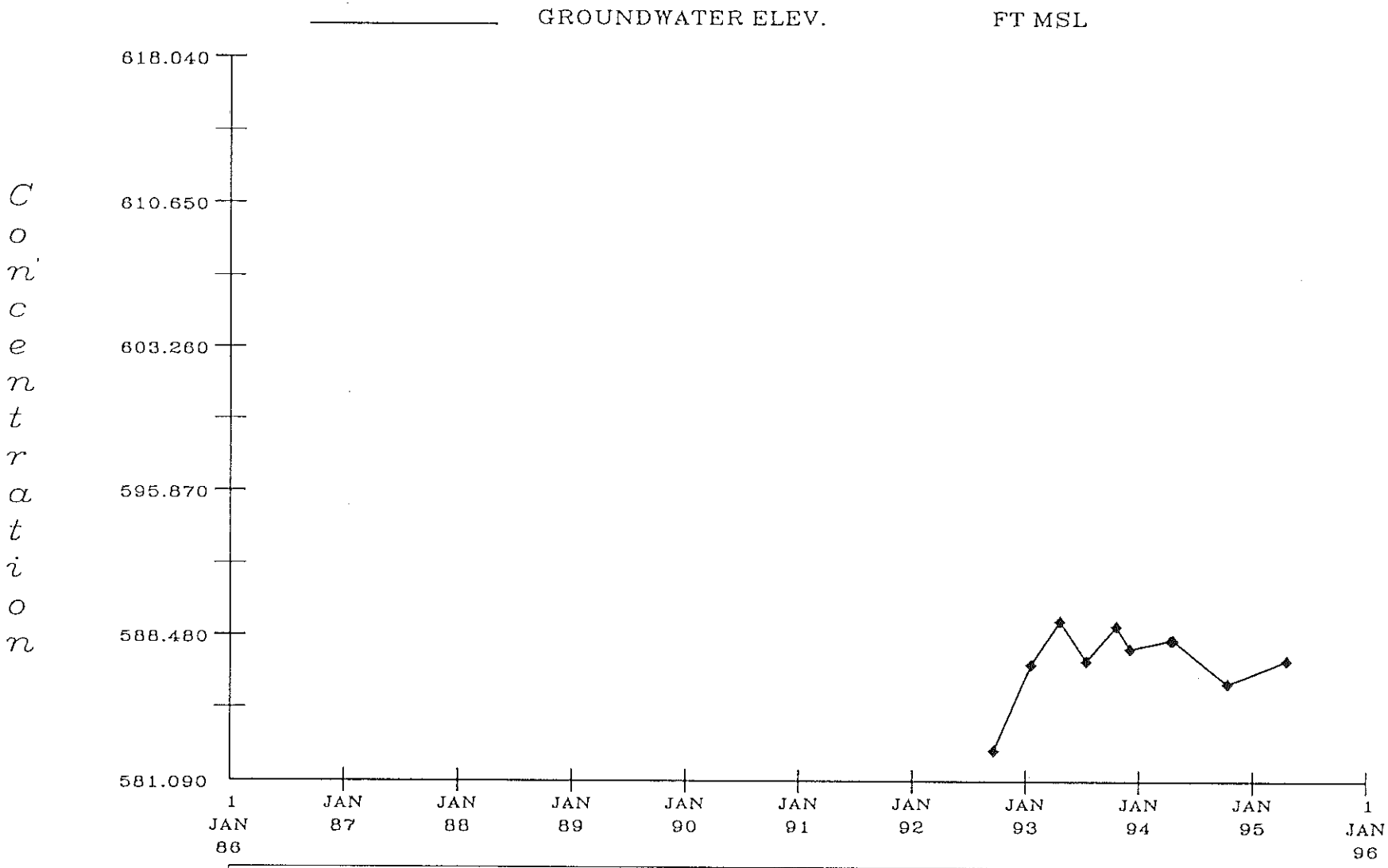


Start date : 04/10/86 ○ □ = ND ◆ ⋈ = Results
End date : 10/26/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:MW17R

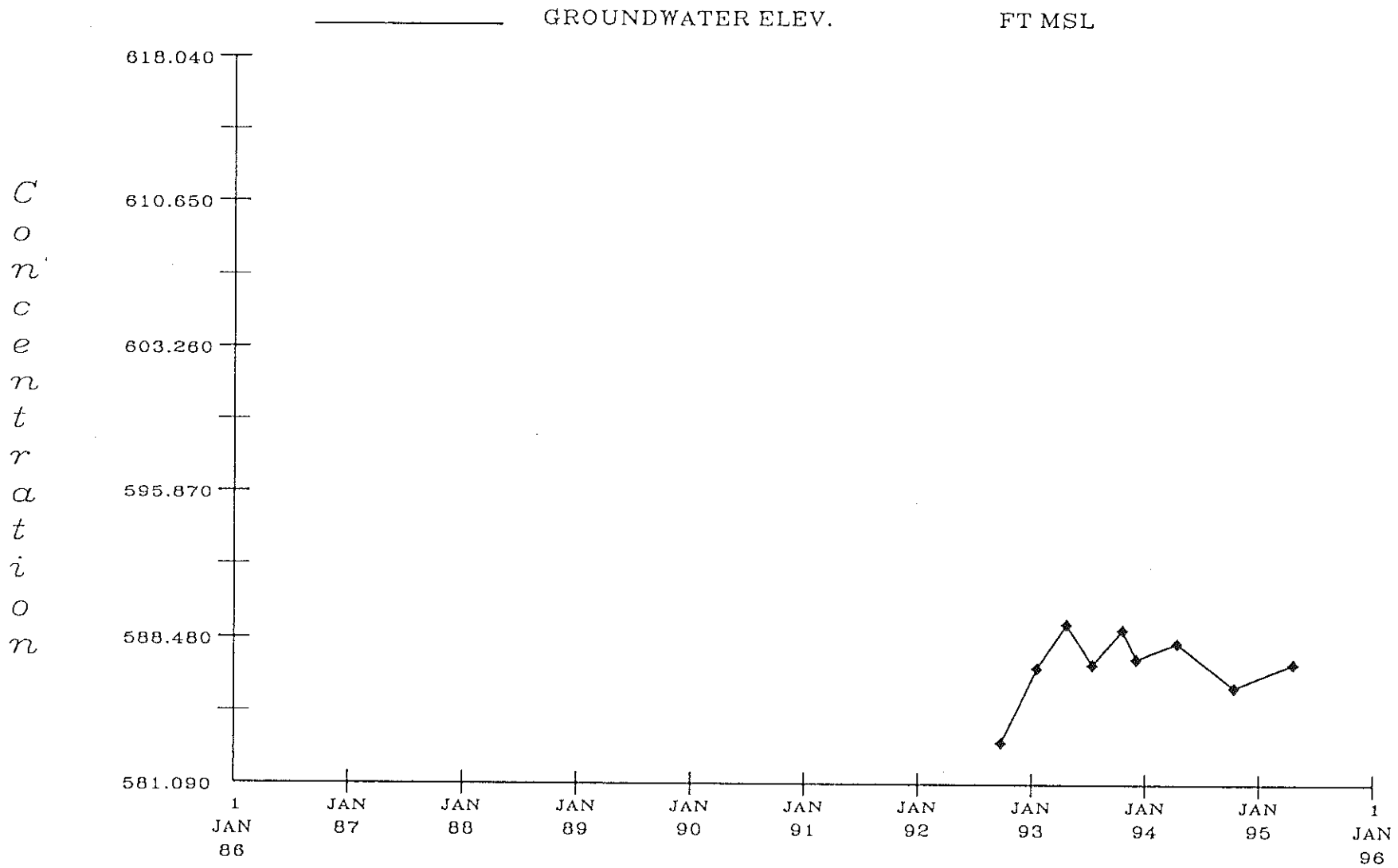


Start date : 09/21/92 ○ □ = ND ◆ ⋈ = Results
End date : 04/19/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:MW18R

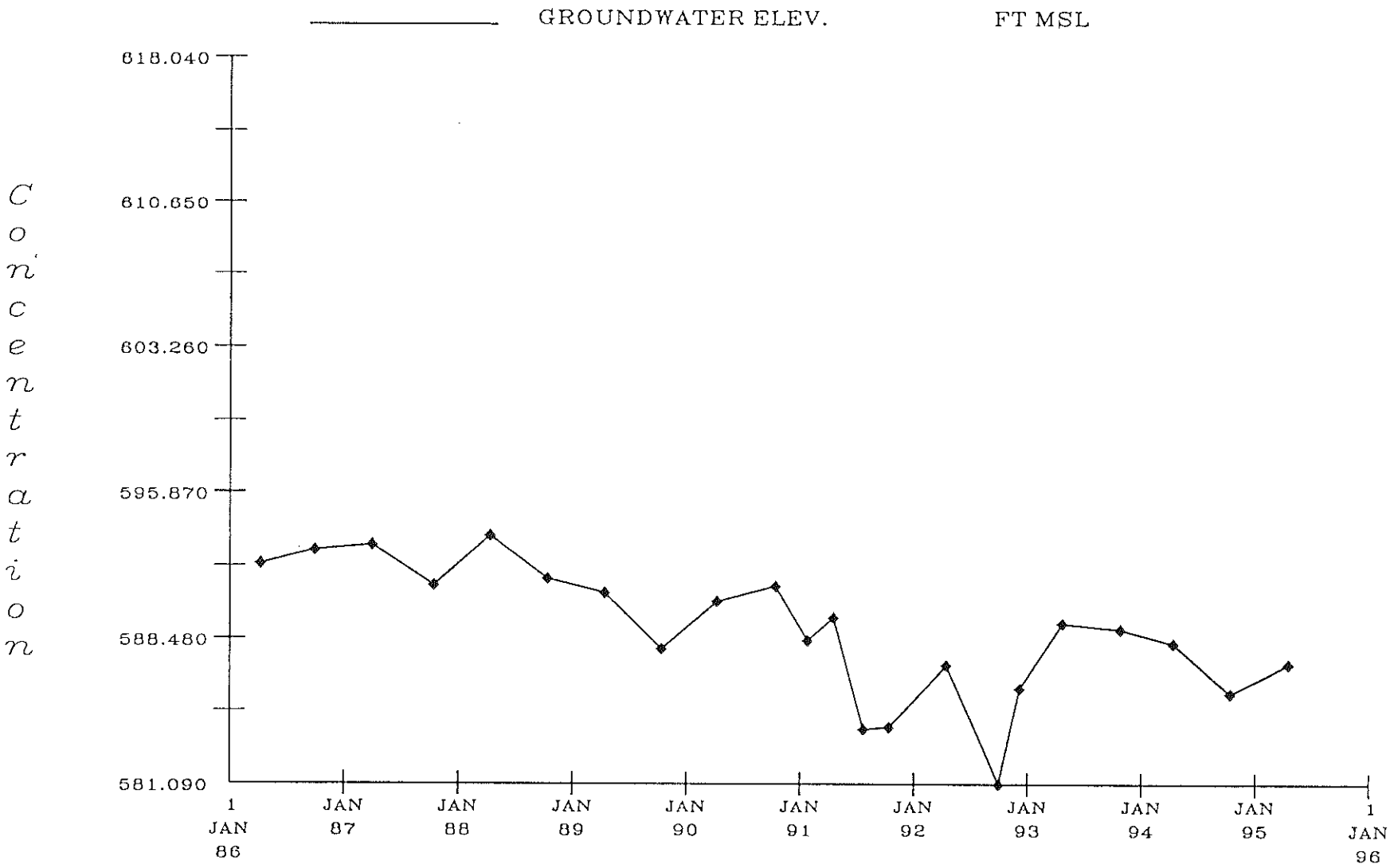


Start date : 09/25/92 ○ □ = ND ✦ ⋈ = Results
End date : 04/19/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:MW19R

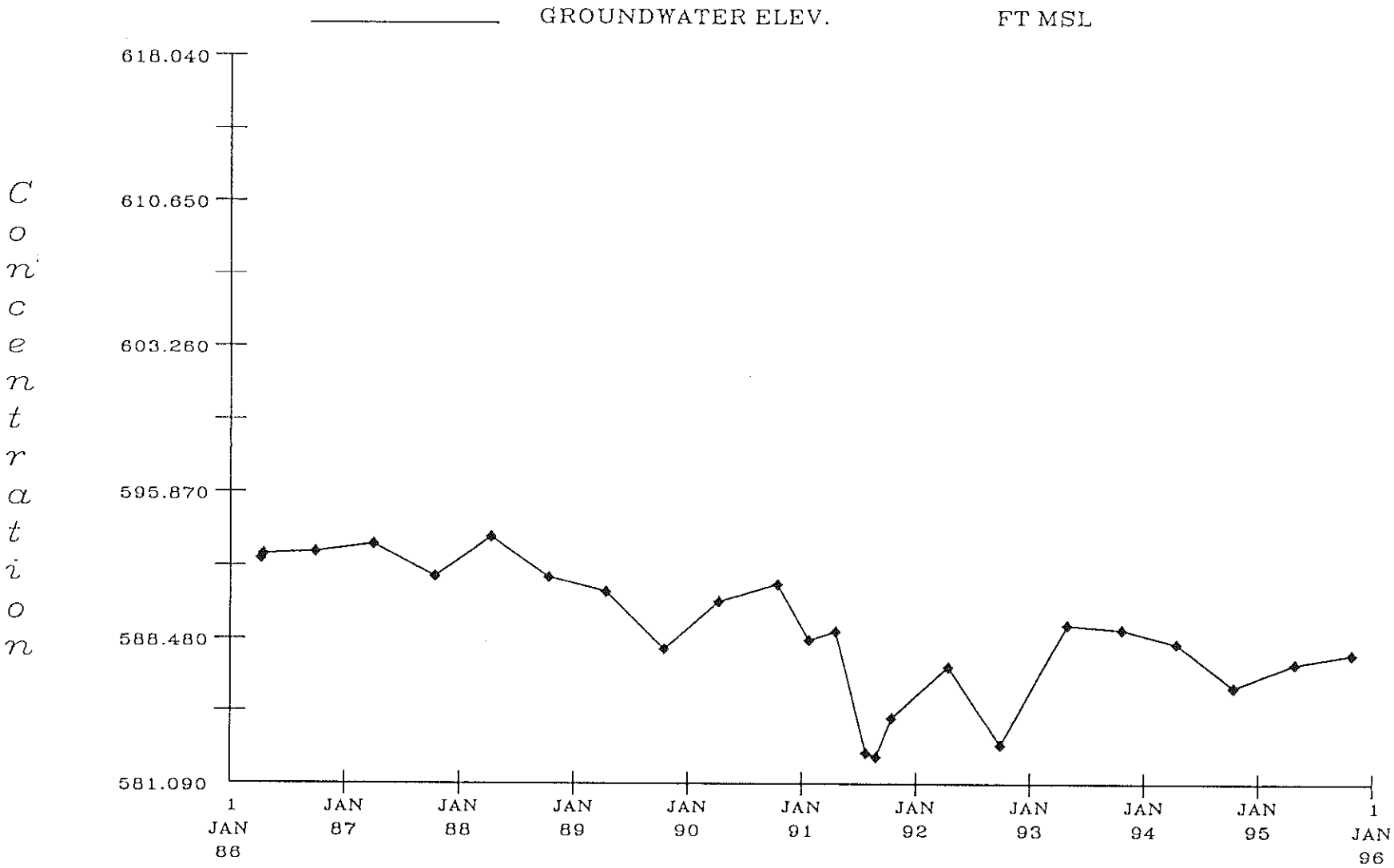


Start date : 04/09/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/18/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:MW20R

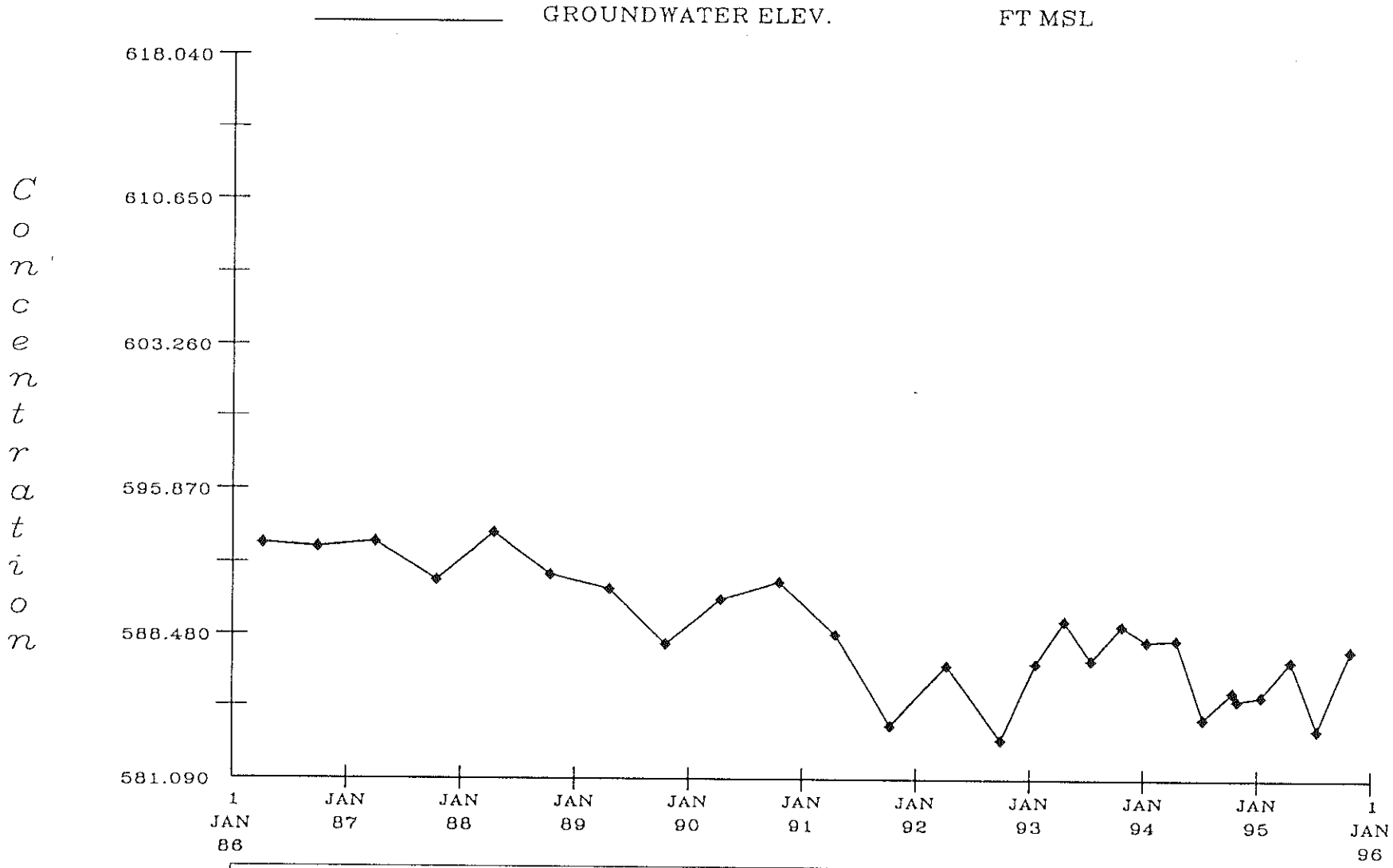


Start date : 04/09/86 ○ □ = ND ◆ ⋈ = Results
End date : 10/26/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:MW21R

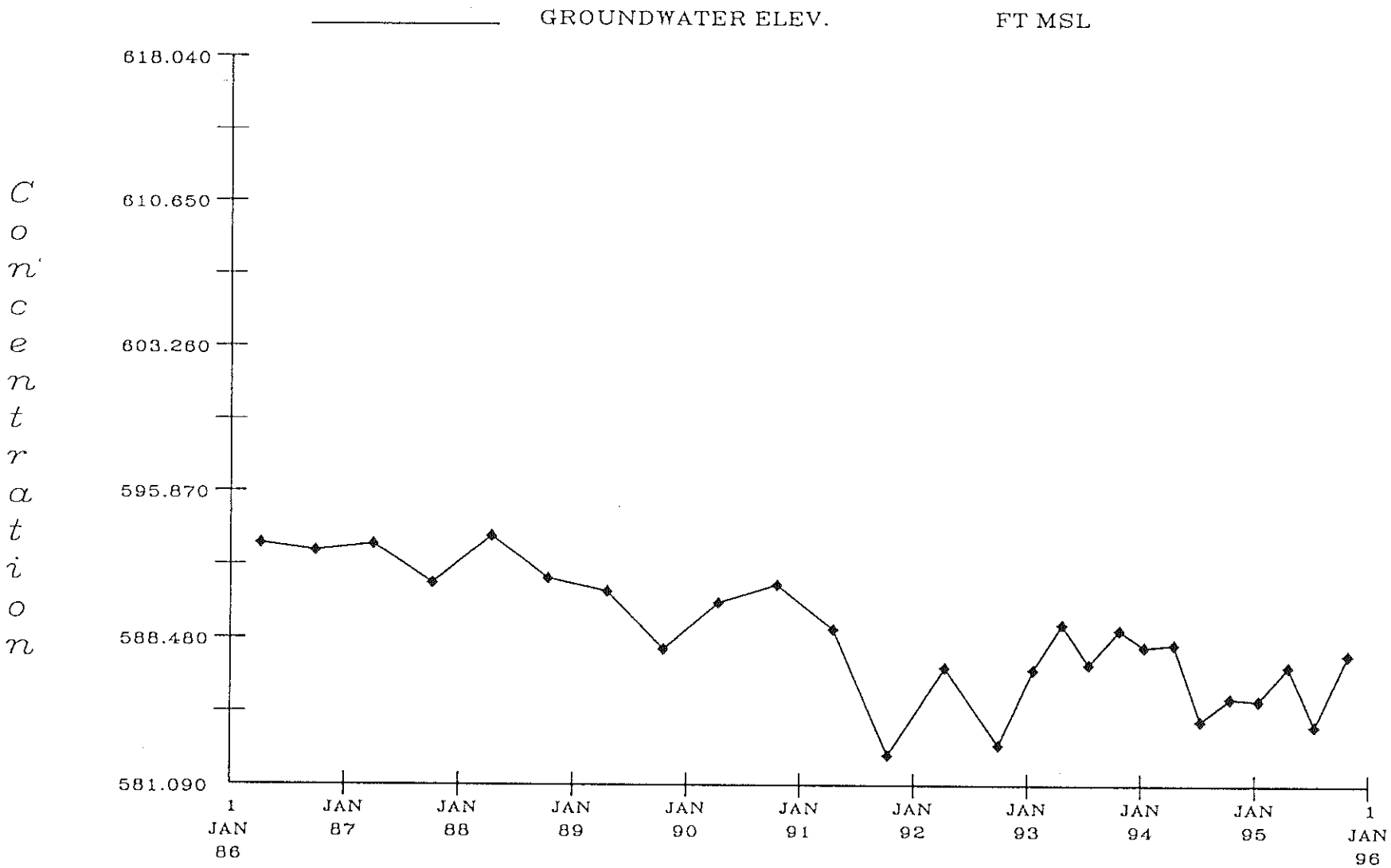


Start date : 04/08/86 ○ □ = ND ◆ ⋈ = Results
End date : 10/25/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:MW22R

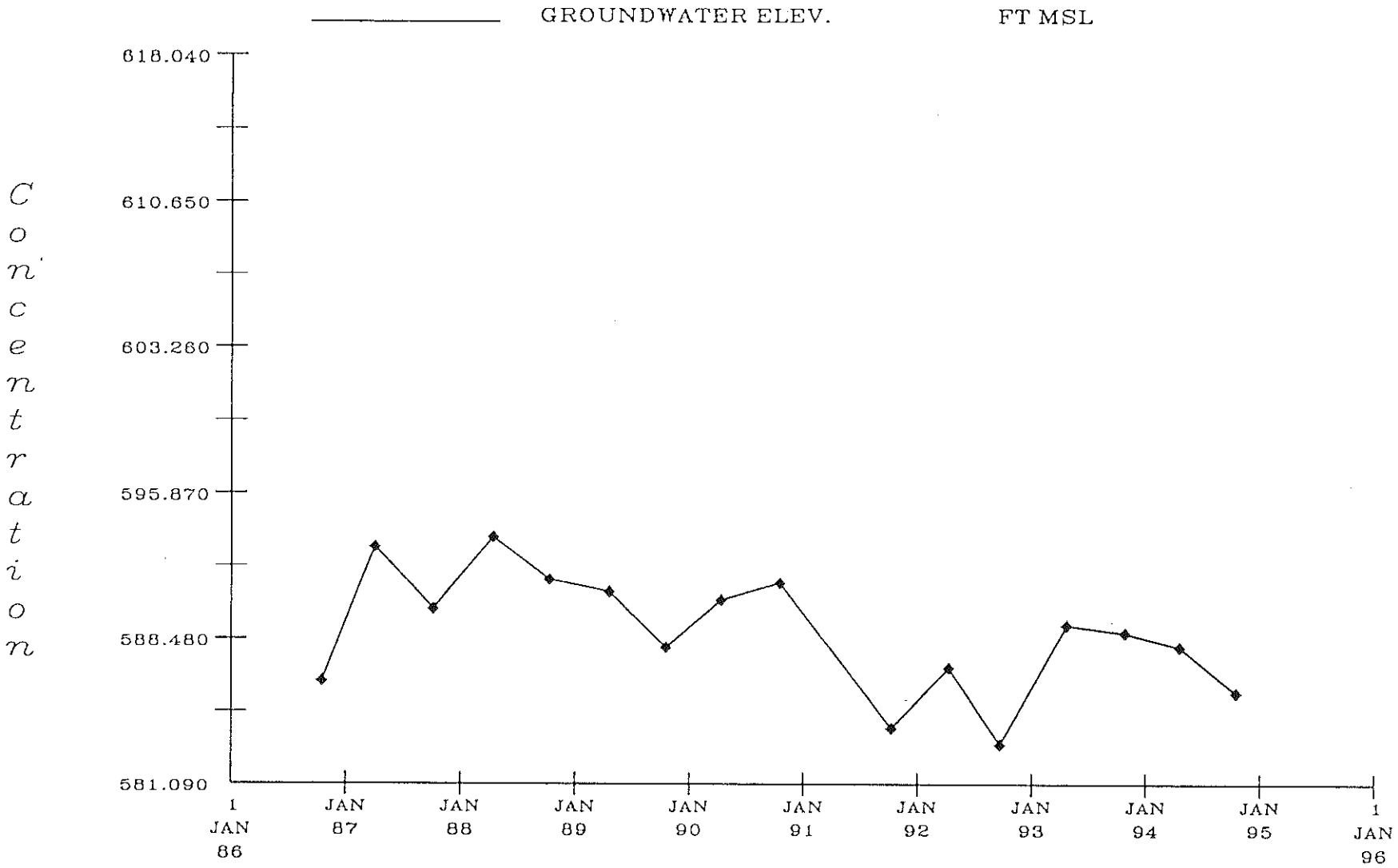


Start date : 04/08/86 ○ □ = ND ◆ ⋈ = Results
End date : 10/25/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:MW23RA

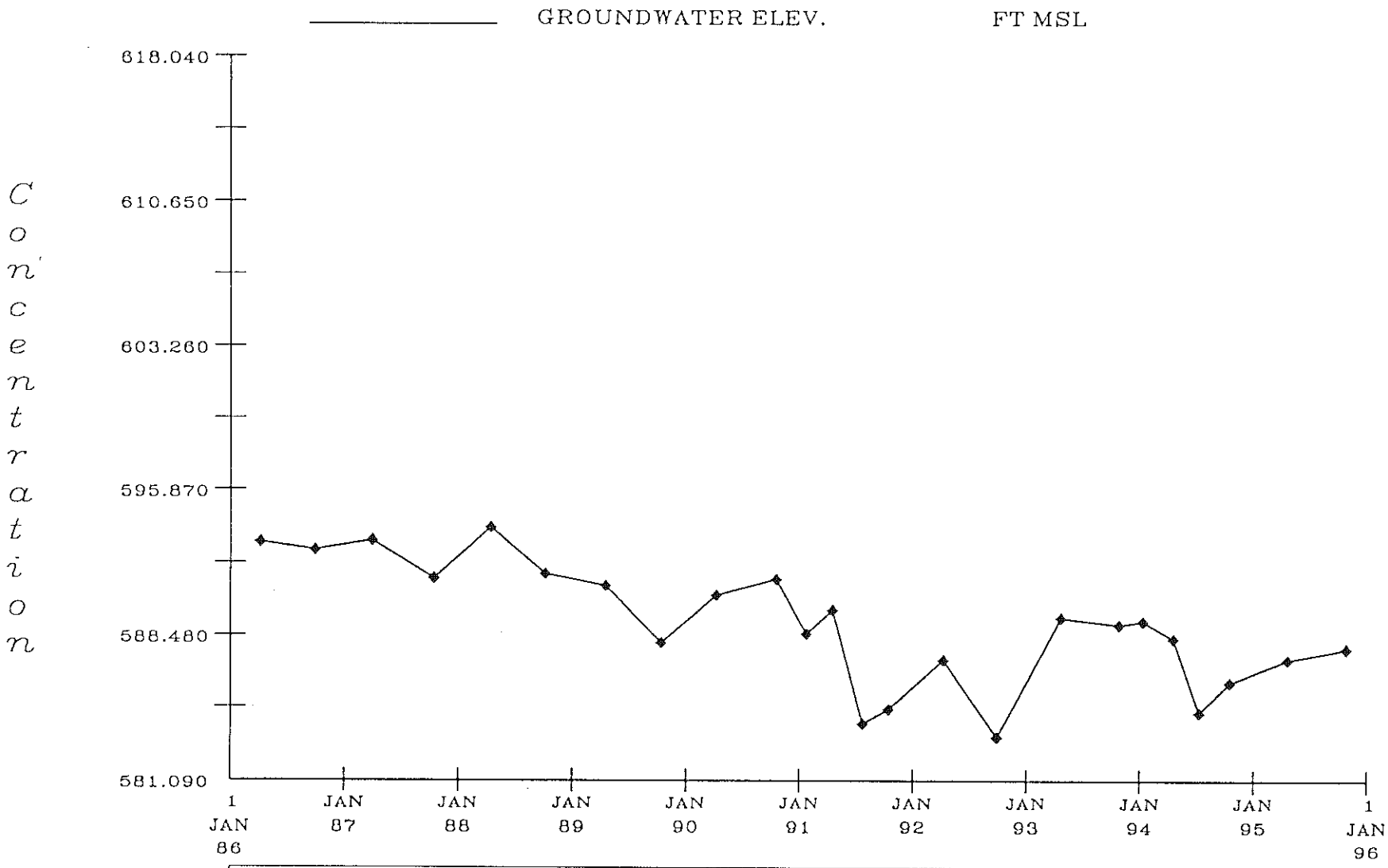


Start date : 10/18/86 ○ □ = ND ◆ ⋈ = Results
End date : 10/17/94

Environmental Graphic System

Vickery

Site: 490 Sample Point:MW24R

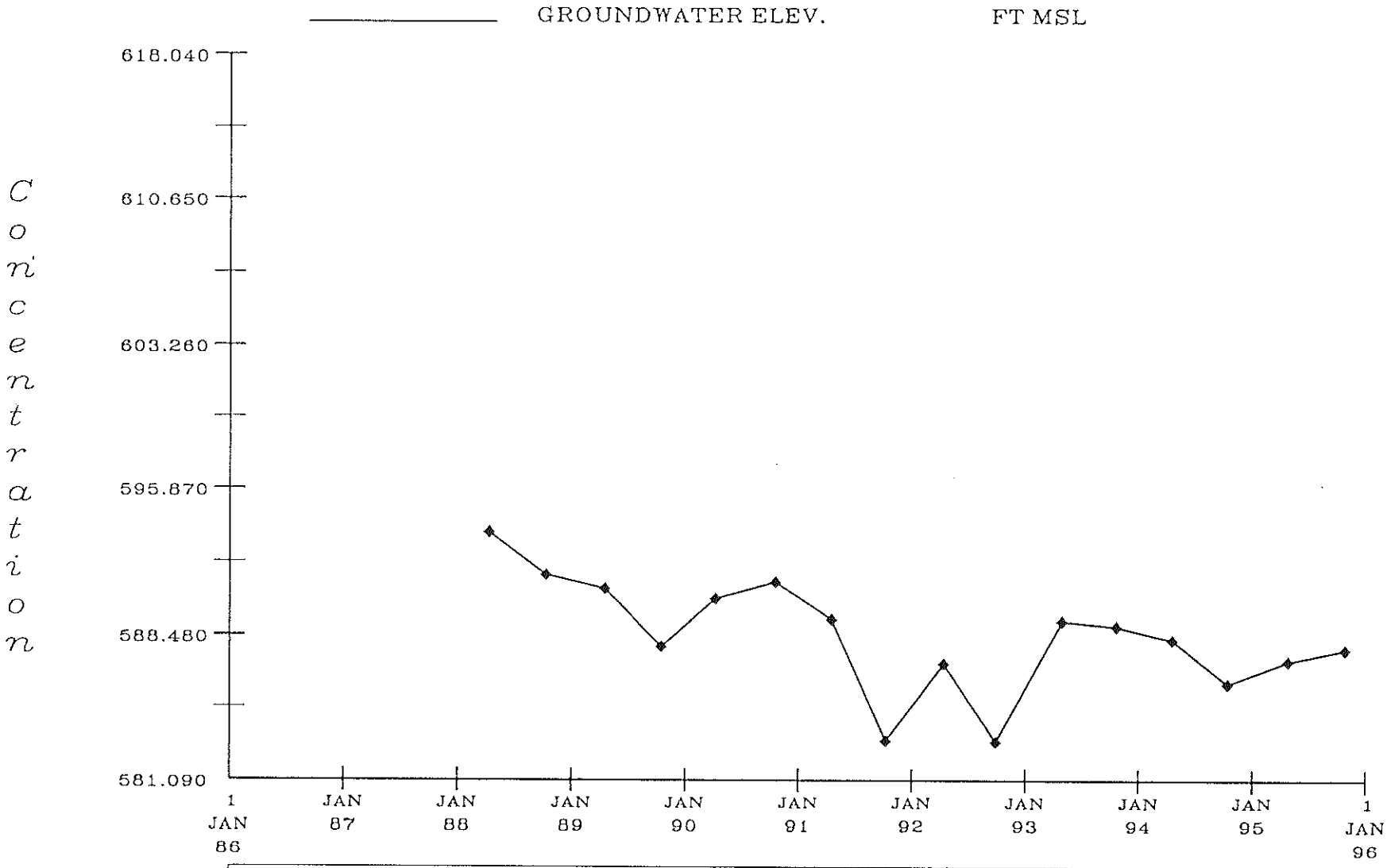


Start date : 04/08/86 ○ □ = ND ◆ ⋈ = Results
End date : 10/26/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:MW30R

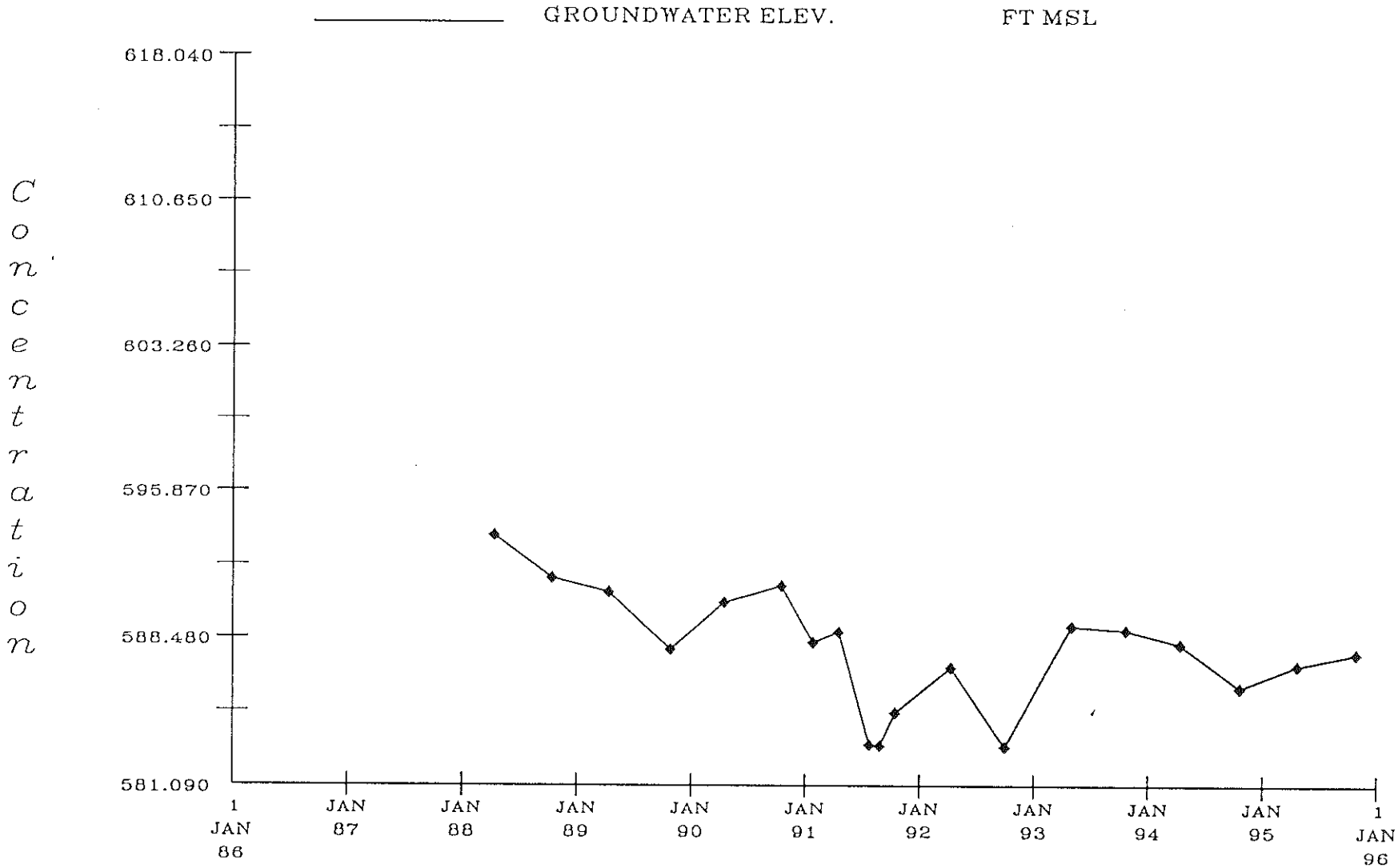


Start date : 04/12/88 ○ □ = ND ◆ ⋈ = Results
End date : 10/26/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:MW36R

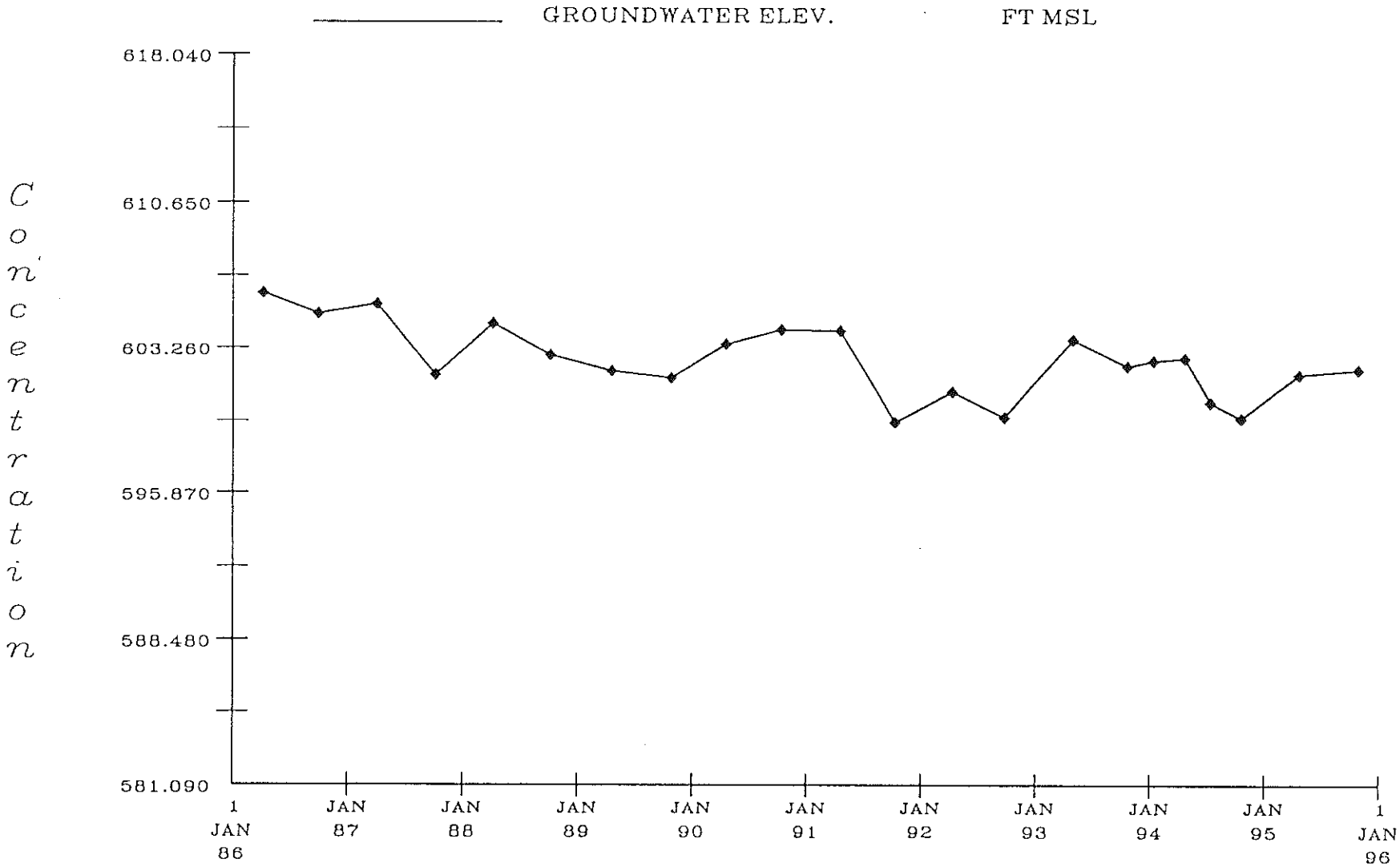


Start date : 04/12/88 ○ □ = ND ◆ ⊢= Results
End date : 10/25/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:MW37R

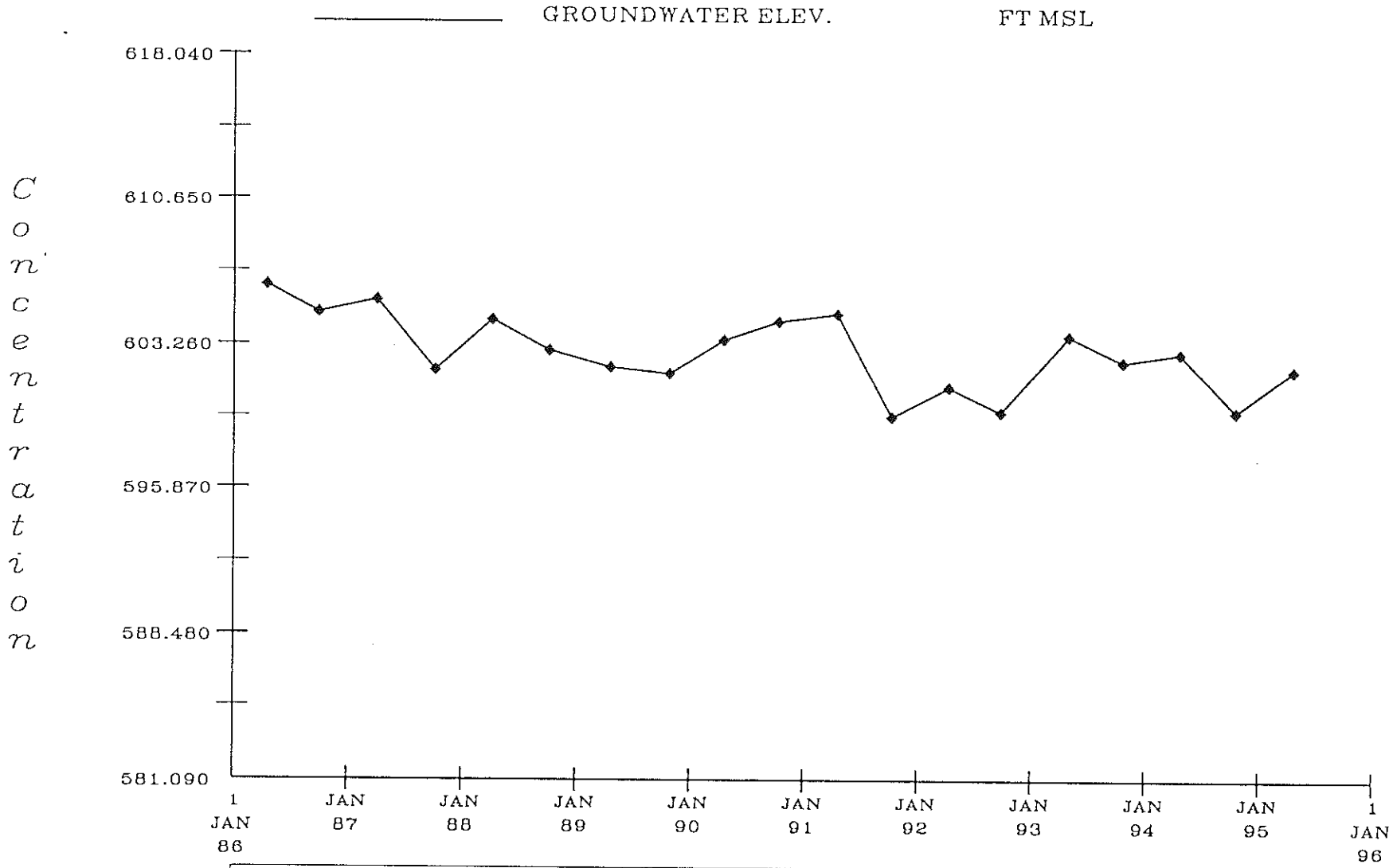


Start date : 04/08/86 ○ □ = ND ◆ ⋈ = Results
End date : 10/26/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:MW38R

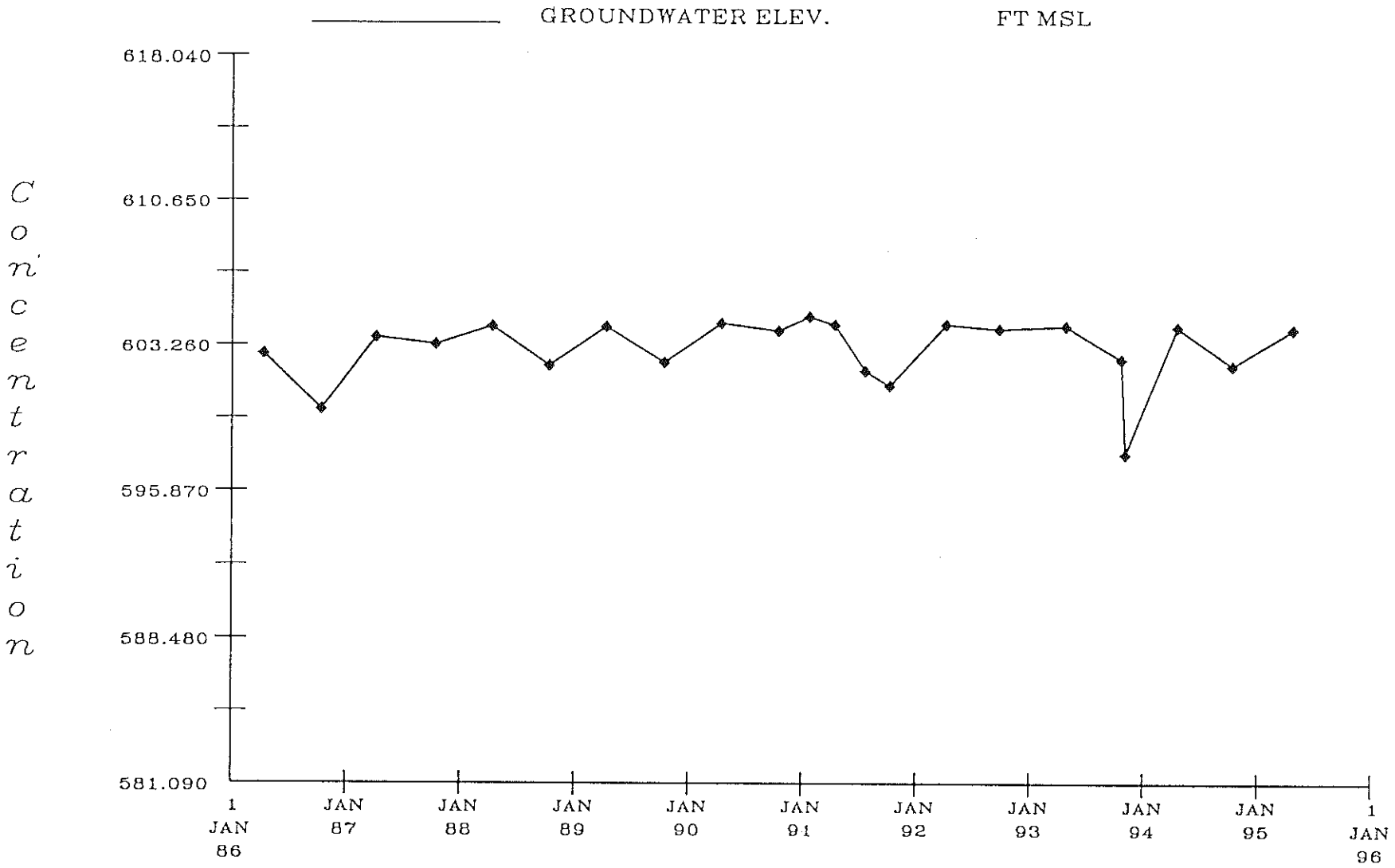


Start date : 04/17/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/20/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:T14

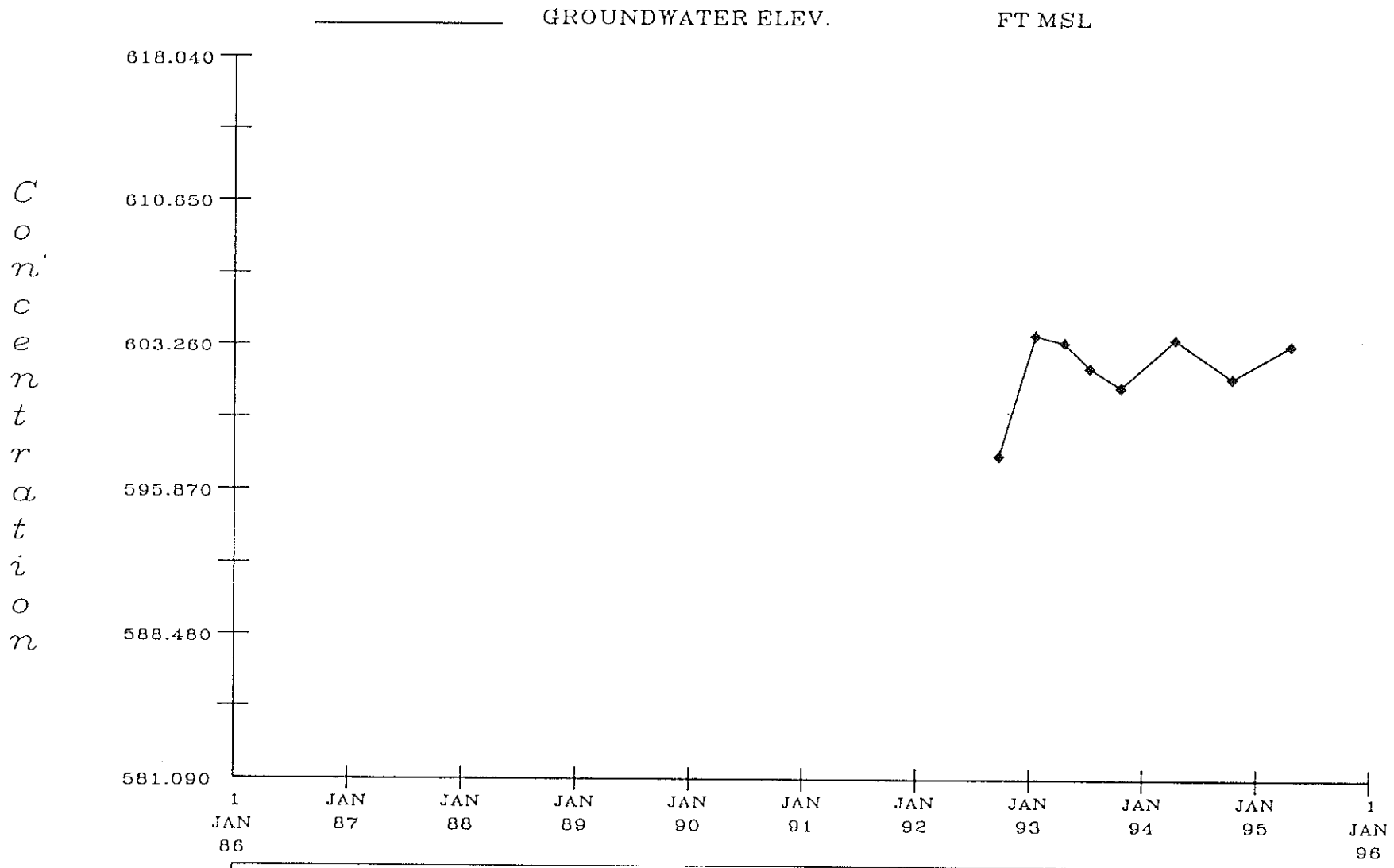


Start date : 04/13/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/24/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:T17

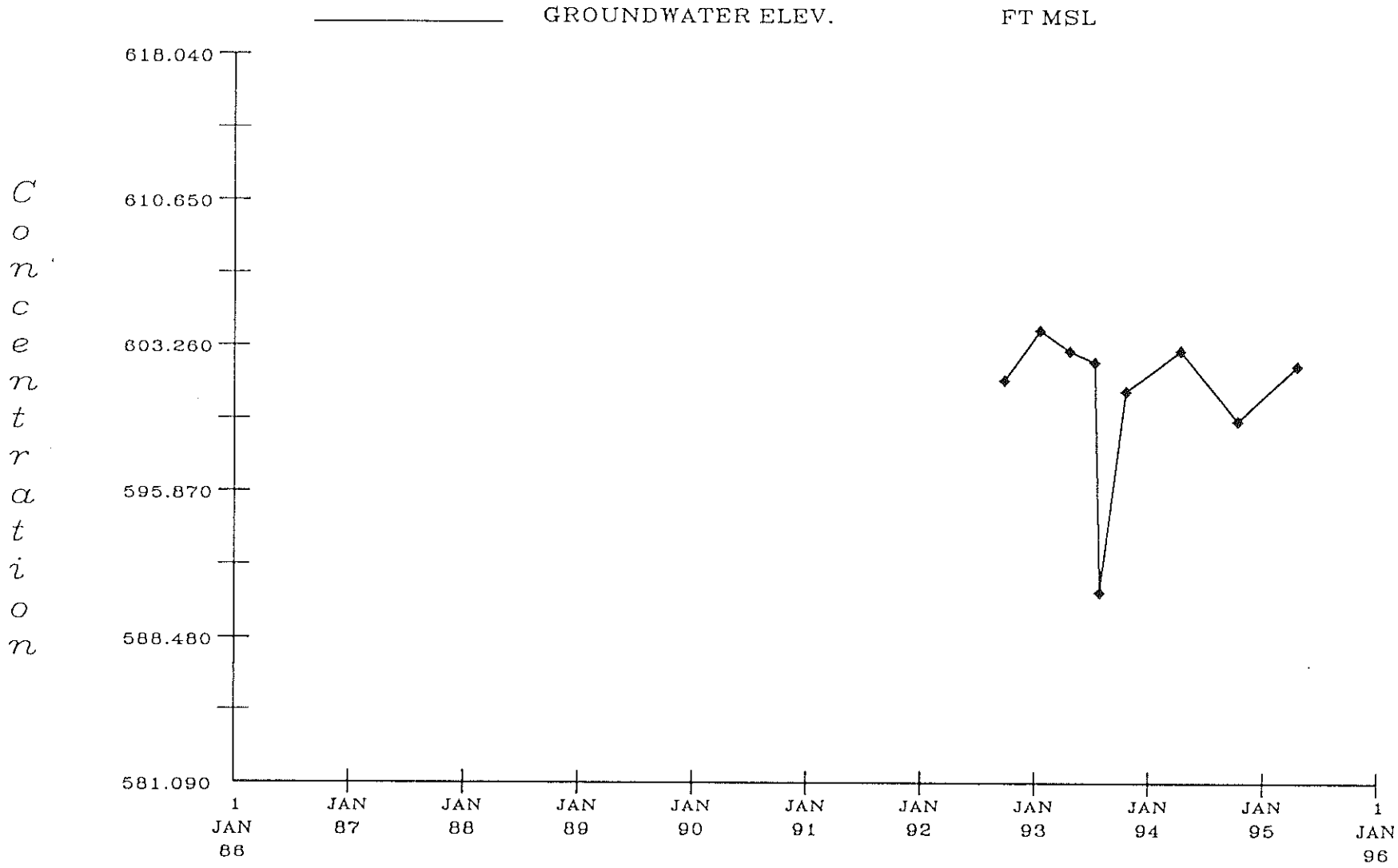


Start date : 09/22/92 ○ □ = ND ◆ ⋈ = Results
End date : 04/19/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:T18

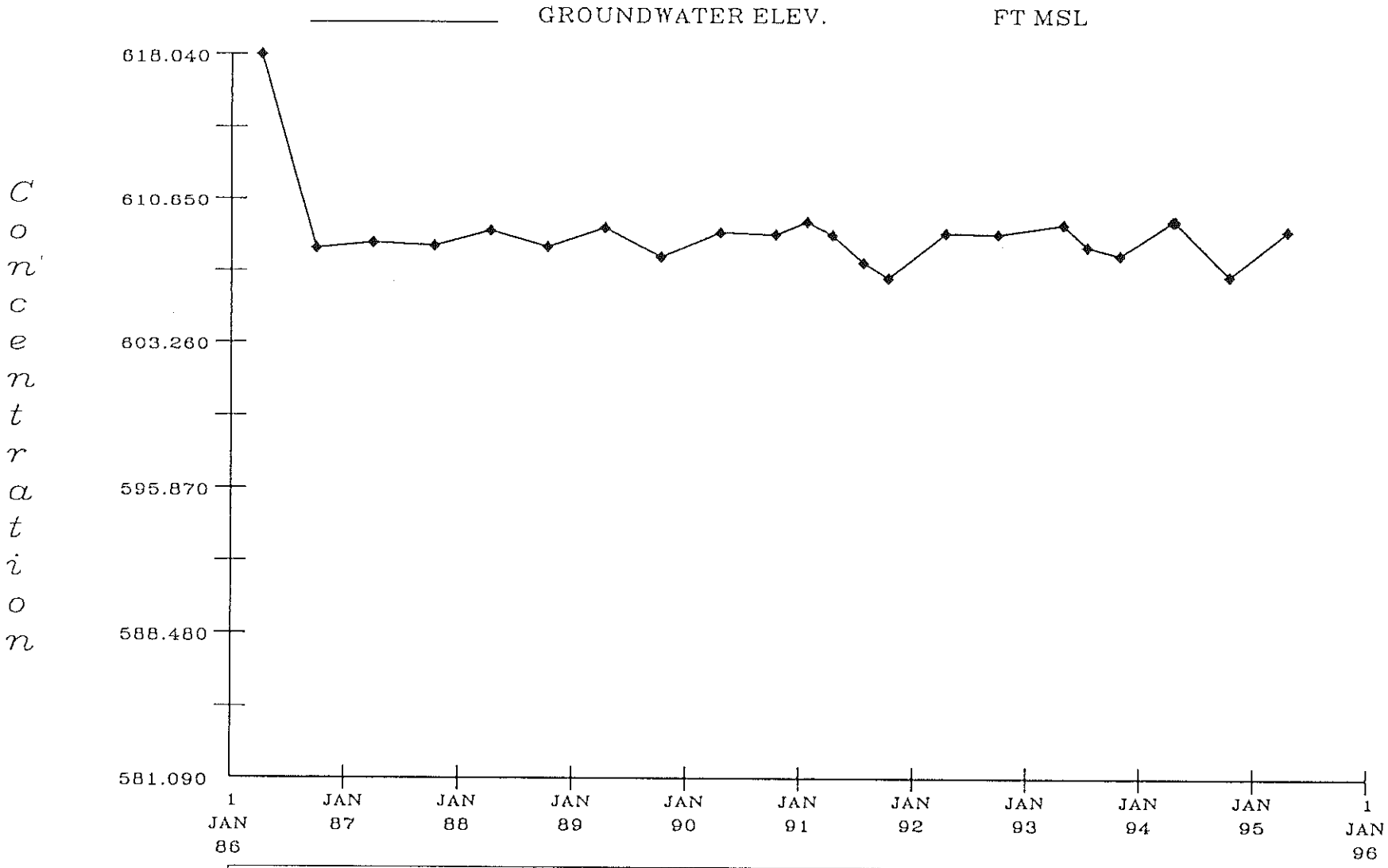


Start date : 09/25/92 ○ □ = ND ◆ ⋈ = Results
End date : 04/19/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:T19

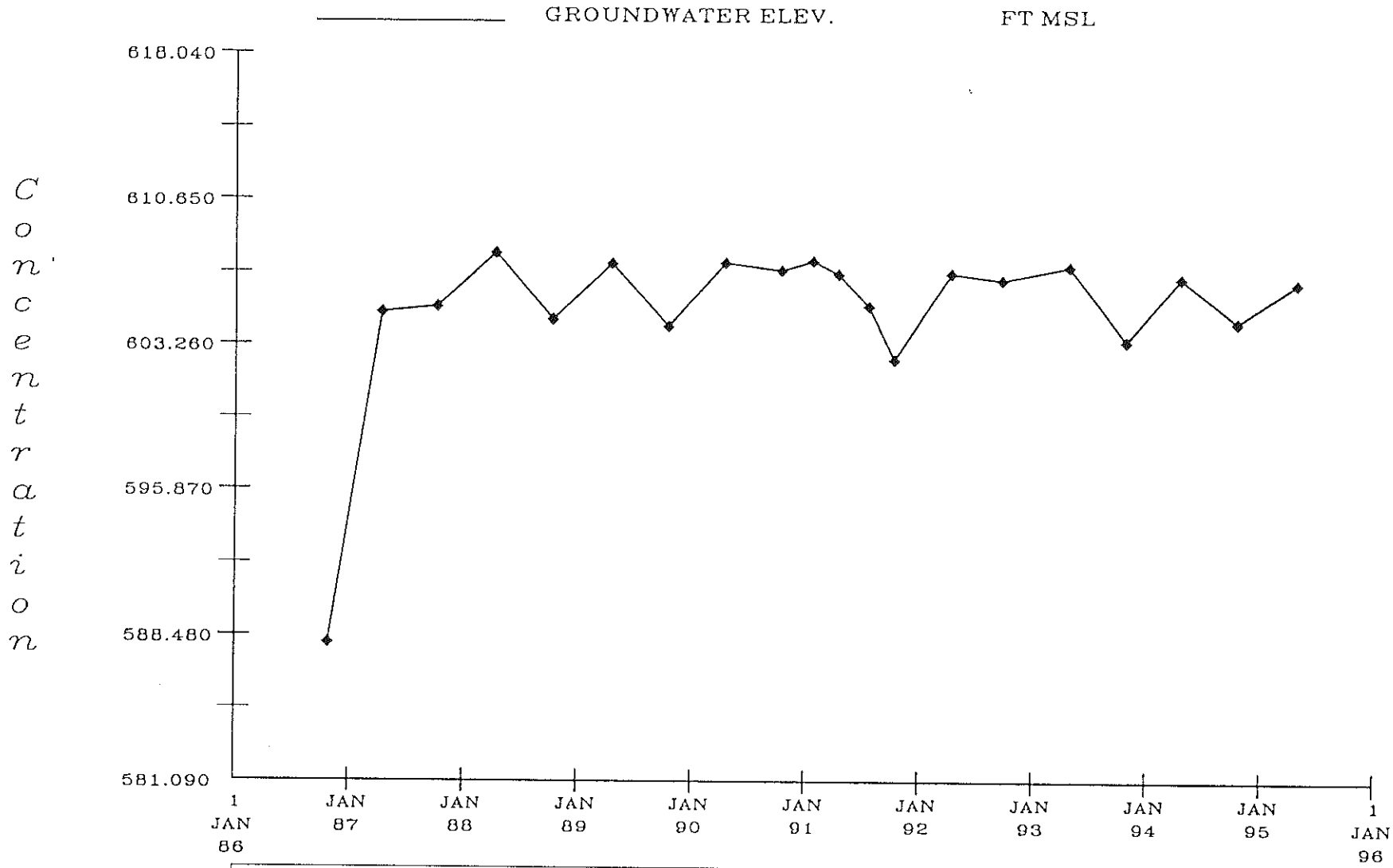


Start date : 04/09/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/18/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:T23A

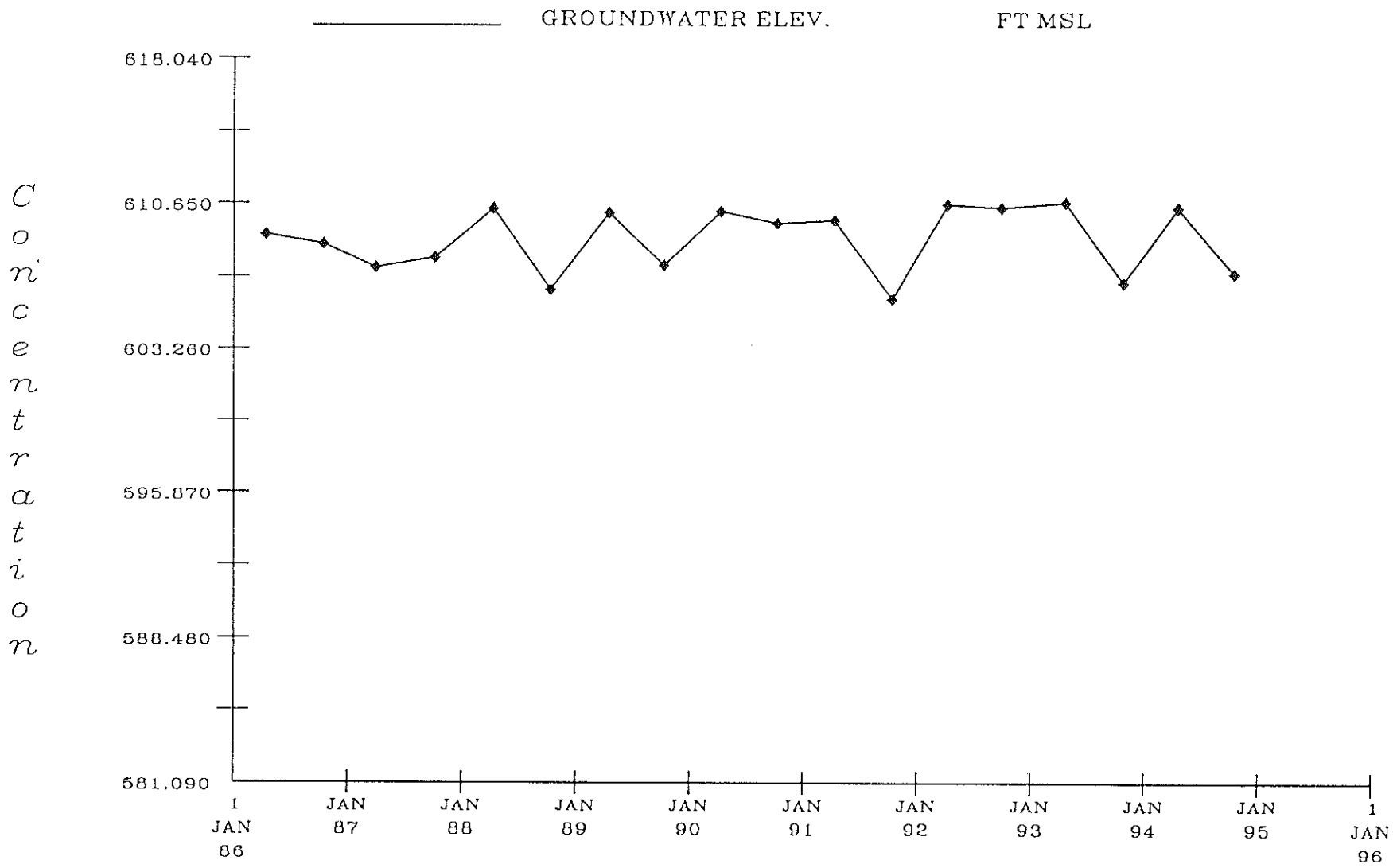


Start date : 10/27/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/25/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:T24

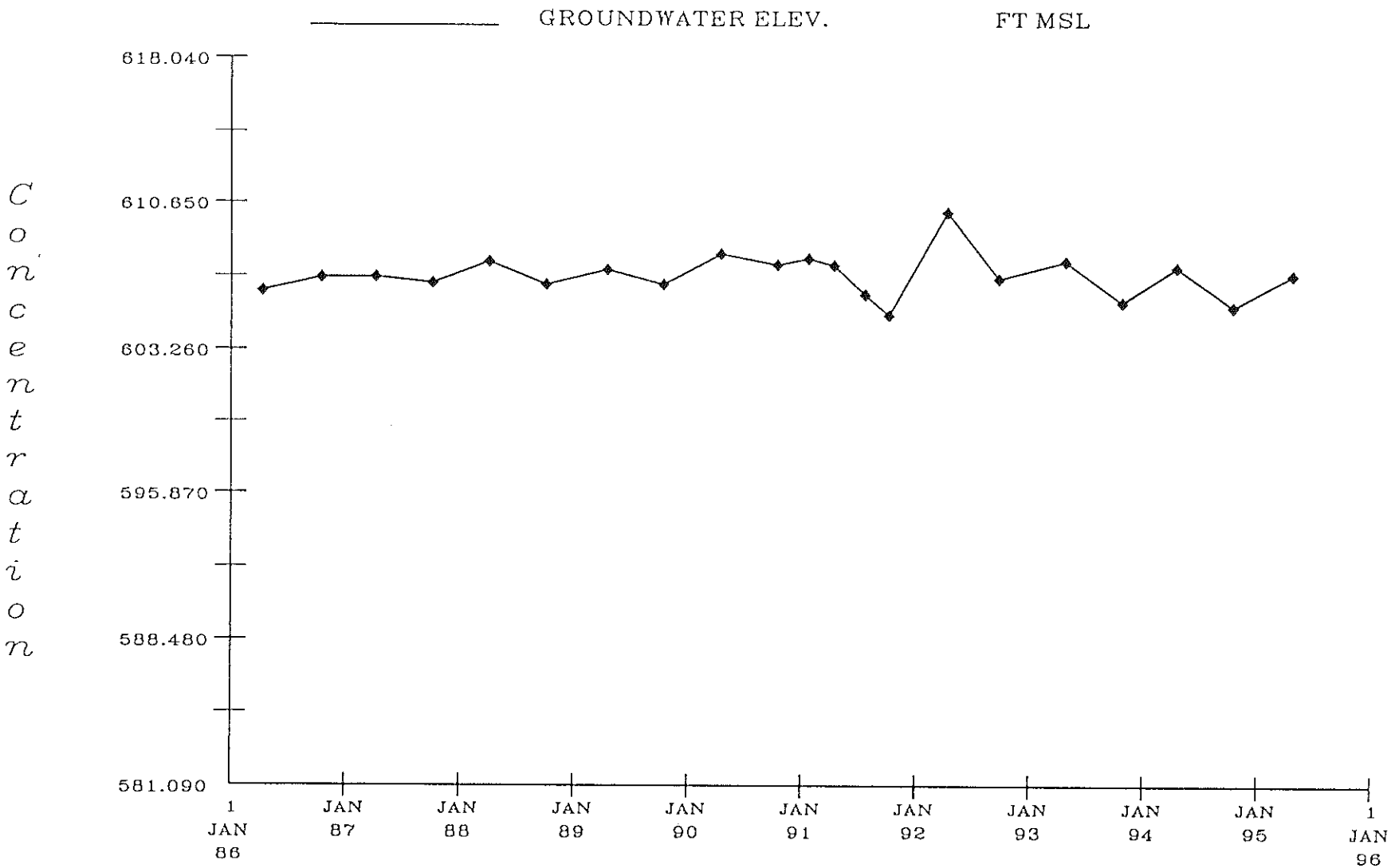


Start date : 04/14/86 ○ □ = ND ◆ ⋈ = Results
End date : 10/17/94

Environmental Graphic System

Vickery

Site: 490 Sample Point:T27

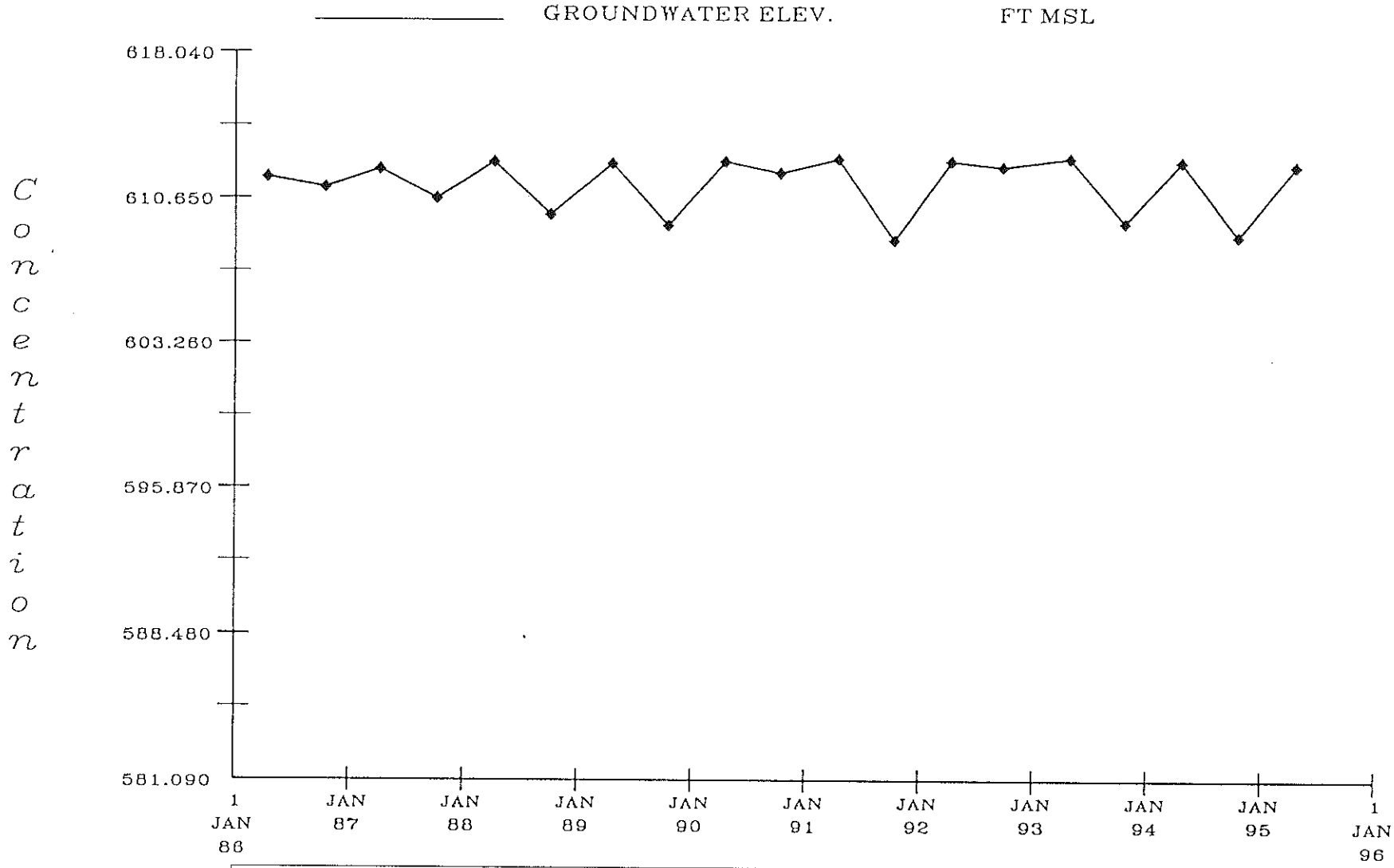


Start date : 04/13/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/26/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:T37

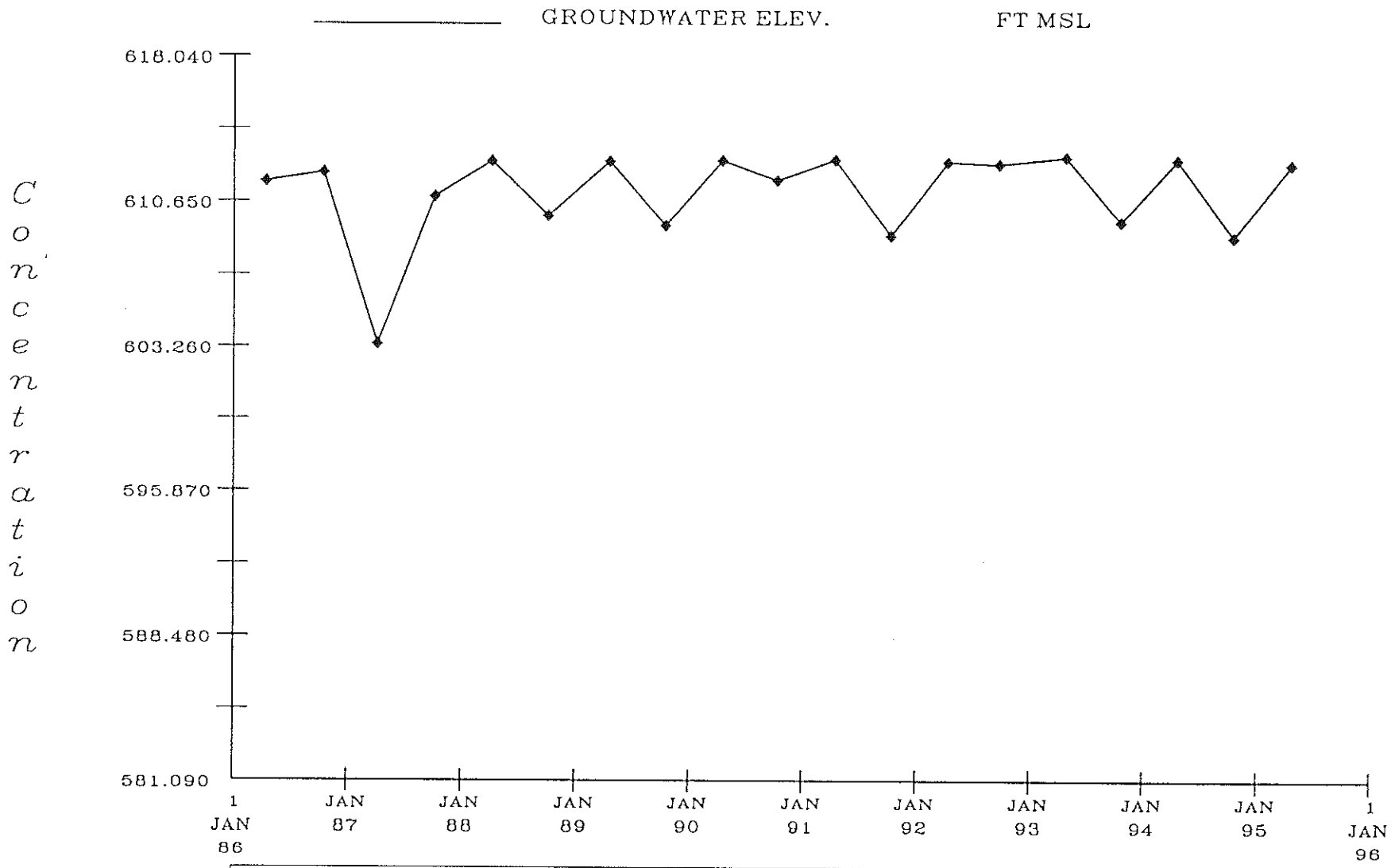


Start date : 04/14/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/20/95

Environmental Graphic System

Vickery

Site: 490 Sample Point:T38



Start date : 04/14/86 ○ □ = ND ◆ ⋈ = Results
End date : 04/20/95

APPENDIX B - BORING LOGS

SECDONOHUE
Environment & Infrastructure

TEST BORING REPORT
MONITORING WELL CONSTRUCTION

BORING: Testhole-17

JECT: Phase II Monitoring Well Installation Program
ENT: CWM – Vickery, Inc.
CONTRACTORS: Bowser-Morner
EQUIPMENT USED: Mobile B-61

JOB NO.: P-3102
LOCATION: VICKERY, OH.
ELEVATION: ------
DATE START: JULY 13, 1992
DATE FINISH: JULY 14, 1992
DRILLER: JW / HC
PREPARED BY: G. ALLEN

GROUND WATER		DEPTH TO:							CASING	SAMPLER	CORE BARREL
DATE	HRS AFTER COMP				WATER	BOTTOM OF CASING	BOTTOM OF HOLE	TYPE	Stainless Steel	Split Spoon	-
NE								SIZE ID	2 IN.	2 IN.	-
								HAMMER WT	-	140 LB.	-
								HAMMER FALL	-	30 IN.	-

DEPTH IN FEET	RECOVERY (FT.)	SAMPLER BLOWS PER 6 INCHES	SAMPLE NUMBER	SAMPLE DEPTH RANGE	PID/FID RESULTS (PPM)	FIELD CLASSIFICATION AND REMARKS
		4 5 8 8	S-1	0.0 TO 2.0		Stiff, Grey-brown Soil, with some organic debris, clay
		8 10 11 11	S-2	2.0 TO 4.0		Very Stiff, Grey-brown Soil, clay mottling bottom 3"
-5.0		7 9 9 15	S-3	4.0 TO 6.0		Very Stiff, Light-grey clay, with brown mottling, trace B/R – white
		7 9 12 15	S-4	6.0 TO 8.0		Very Stiff, Light-yellow-brown clay with varves
		9 14 17 21	S-5	8.0 TO 10.0		Very Stiff, Yellow-brown clay, mottled Hard, Brown Mottled clay, some silt, some sand.
		9 12 15 15	S-6	10.0 TO 12.0		Very Stiff, Brown-yellow clay, mottled -LACUSTRINE- Very Stiff, Grey Clay, trace rock fragments -TILL-
		5 9 9 13	S-7	12.0 TO 14.0		
-15		5 10 9 8	S-8	14.0 TO 16.0		Stiff to Very Stiff, Grey Clay, trace rock fragments
		4 4 6 6	S-9	16.0 TO 18.0		Hole Dry
		4 4 3 8	S-10	18.0 TO 20.0		Increase in moisture with depth
-20						

MONITORING WELL CONSTRUCTION DATA

BOREHOLE DIAMETER (IN.)	3 7/8
BOREHOLE DEPTH	60.5 ft.
CASING SCREEN TYPE	-
CASING DIAMETER	-
SLOT WIDTH	-
SCREEN INTERVAL	-
TYPE OF SEAL	-
TYPE OF FILTER PACK	-
TYPE OF GROUT	-

WELL DEVELOPMENT:

COMMENTS:
Testhole 17 drilled in general vicinity where Monitoring Wells L-17, T-17 and MW-17R were constructed. Testhole 17 used as a pilot hole for stratigraphical and well construction purposes.

BLOWS/FT. DENSITY		BLOWS/FT. CONSISTENCY		SAMPLE ID.		COMPONENT %		GROUND WATER ABBREV
-	VERY LOOSE	0-2	VERY SOFT	S	SPUT SPOON	MOSTLY	50-100%	WD - WHILE DRILLING
11-30	LOOSE MEDIUM DENSE	3-4 5-8	SOFT MEDIUM STIFF	T	TUBE	SOME	30-45%	NE - NOT ENCOUNTERED
31-50	DENSE	9-15	STIFF	U	UNDISTURBED PISTON	LITTLE	15-25%	NR - NOT READ
51+	VERY DENSE	16-30	VERY STIFF	G	GRAB SAMPLE	FEW	5-10%	
		31+	HARD	X	OTHER	TRACE	<5%	
				NR	NO RECOVERY			BORING NO: TH-17

SECDONOHUE
Environment & Infrastructure

TEST BORING REPORT

BORING: Testhole 17

DEPTH IN FEET	RECOVERY	SAMPLER BLOWS PER 6 INCHES	SAMPLE NUMBER	SAMPLE DEPTH RANGE	PID/FID RESULTS (PPM)	FIELD CLASSIFICATION AND REMARKS
		3 2 2 3	S-11	20.0 TO 22.0		Soft, Grey Clay, some silt, some rock fragments
		5 5 7 9	S-12	22.0 TO 24.0		
-25.0		5 9 9 12	S-13	24.0 TO 26.0		
		7 9 12 13	S-14	26.0 TO 28.0		Damp
-30.0		6 9 9 15	S-15	28.0 TO 30.0		Very Stiff, Light Grey to Grey, moist, Clay, trace Silt.
		7 5 9 12	S-16	30.0 TO 32.0		Stiff, Grey, moist, mostly Clay, some silt, rock fragments.
		3 4 7 8	S-17	32.0 TO 34.0		
-35.0		4 6 10 11	S-18	34.0 TO 36.0		
		5 5 7 9	S-19	36.0 TO 38.0		Stiff, Grey, moist, mostly Clay, some silt, rock fragments, inclusions gradually increase with size with depth.
-40.0		6 10 13 19	S-20	38.0 TO 40.0		Very Stiff, Dark Grey, moist, mostly Clay, some silt, rock fragments and inclusions.
		5 10 15 30	S-21	40.0 TO 42.0		
		9 17 21 28	S-22	42.0 TO 44.0		
-45.0		12 17 30	S-23			Hole dry towards bottom

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
[illegible]	DENSE
[illegible]	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
31+	HARD

SAMPLE ID.	
S	SPLIT SPOON
T	TUBE
U	UNDISTURBED PISTON
G	GRAB SAMPLE
X	OTHER
NR	NO RECOVERY

COMPONENT %
MOSTLY 50-100%
SOME 30-45%
LITTLE 15-25%
FEW 5-10%
TRACE <5%

GROUND WATER ABBREV

WD - WHILE DRILLING
NE - NOT ENCOUNTERED
UR - NOT READ

BORING NO.: TH-17

SECDONOHUE
Environment & Infrastructure

TEST BORING REPORT

BORING: Testhole 17

DEPTH IN FEET	RECOVERY	SAMPLER BLOWS PER 6 INCHES	SAMPLE NUMBER	SAMPLE DEPTH RANGE	PID/FID RESULTS (PPM)	FIELD CLASSIFICATION AND REMARKS
		30 / 98				Bottom 0.2 feet – Bedrock (Dolomite)
		100/6"				
		100/2"				
-50.0						
						Dolomite
-55.0						
						Dolomite
-60.0						
						Terminated Borehole at 60.5 feet
-65.0						
-70.0						

BLOWS/FT. DENSITY	
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
	VERY DENSE

BLOWS/FT. CONSISTENCY	
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
31+	HARD

SAMPLE ID.	
S	SPLIT SPOON
T	TUBE
U	UNDISTURBED PISTON
G	GRAB SAMPLE
X	OTHER
NR	NO RECOVERY

COMPONENT %	
MOSTLY	50-100%
SOME	30-45%
LITTLE	15-25%
FEW	5-10%
TRACE	<5%

GROUND WATER ABBREV
WD – WHILE DRILLING
NE – NOT ENCOUNTERED
UR – NOT READ

BORING NO.: TH-17

SECDONOHUE
Environment & Infrastructure

TEST BORING REPORT
MONITORING WELL CONSTRUCTION

BORING: Testhole-18

PROJECT:	Phase II Monitoring Well Installation Program
CLIENT:	CWM - Vickery, Inc.
CONTRACTORS:	Bowser-Morner
EQUIPMENT USED:	Mobile B-61

JOB NO.:	P-3102
LOCATION:	VICKERY, OH.
ELEVATION:	------
DATE START:	JULY 29, 1992
DATE FINISH:	JULY 29, 1992
DRILLER:	JW / HC
PREPARED BY:	G. ALLEN

GROUND WATER		DEPTH TO:						CASING	SAMPLER	CORE BARREL
DATE	HRS AFTER COMP				WATER	BOTTOM OF CASING	BOTTOM OF HOLE	TYPE	Stainless Steel	Split Spoon	-
NE								SIZE ID	2 IN.	2 IN.	-
								HAMMER WT	-	140 LB.	-
								HAMMER FALL	-	30 IN.	-

DEPTH IN FEET	RECOVERY (FT.)	SAMPLER BLOWS PER 6 INCHES	SAMPLE NUMBER	SAMPLE DEPTH RANGE	PID/FID RESULTS (PPM)	FIELD CLASSIFICATION AND REMARKS
		3 4 4 5	S-1	0.0 TO 2.0		Brown, Silty clay, some sand (0.0-0.8') -FILL-
						Brown, Red-brown to Light Grey Silty clay. -LACUSTRINE-
		7 9 9 9	S-2	2.0 TO 4.0		Very Stiff, Brown to Red-brown to Lt. Grey Silty clay, some very fine sand, trace gravel.
-5.0		6 7 7 12	S-3	4.0 TO 6.0		Stiff, Brown to Red-brown, Silty clay, trace Grey silty clay, trace very fine sand, well laminated.
		4 6 6 7	S-4	6.0 TO 8.0		
		3 4 5 6	S-5	8.0 TO 10.0		
		2 1 3 3	S-6	10.0 TO 12.0		
		3 3 4 5	S-7	12.0 TO 14.0		-LACUSTRINE-
-15		3 3 4 4	S-8	14.0 TO 16.0		Medium Stiff, Grey, wet, Silty clay, some black shale fragments. -TILL-
		2 2 3 6	S-9	16.0 TO 18.0		
-20		2 2 3 4	S-10	18.0 TO 20.0		

MONITORING WELL CONSTRUCTION DATA

BOREHOLE DIAMETER (IN.)	3 7/8
BOREHOLE DEPTH	45.3 ft.
CASING/SCREEN TYPE	-
CASING DIAMETER	-
SLOT WIDTH	-
SCREEN INTERVAL	-
TYPE OF SEAL	-
TYPE OF FILTER PACK	-
TYPE OF GROUT	-

WELL DEVELOPMENT:

COMMENTS:
Testhole 18 drilled in general vicinity where Monitoring Wells L-18, T-18 and MW-18R were constructed. Testhole 18 used as a pilot hole for lithological and well construction purposes.

BLOWS/FT. DENSITY		BLOWS/FT. CONSISTENCY		SAMPLE ID.		COMPONENT %		GROUND WATER ABBREV
	VERY LOOSE	0-2	VERY SOFT	S	SPUT SPOON	MOSTLY	50-100%	WO - WHILE DRILLING
	LOOSE	3-4	SOFT	T	TUBE	SOME	30-45%	NE - NOT ENCOUNTERED
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	U	UNDISTURBED PISTON	LITTLE	15-25%	NR - NOT READ
31-50	DENSE	9-15	STIFF	G	GRAB SAMPLE	FEW	5-10%	
51+	VERY DENSE	16-30	VERY STIFF	X	OTHER	TRACE	<5%	
		31+	HARD	NR	NO RECOVERY			BORING NO: TH-18

SECDONOHUE

Environment & Infrastructure

TEST BORING REPORT

BORING: Testhole 18

DEPTH IN FEET	RECOVERY	SAMPLER BLOWS PER 6 INCHES	SAMPLE NUMBER	SAMPLE DEPTH RANGE	PID/FID RESULTS (PPM)	FIELD CLASSIFICATION AND REMARKS
		2 1 2 5	S-11	20.0 TO 22.0		Soft, Dark Grey, Silty Clay, with black fine to medium size shale fragments.
		3 4 4 7	S-12	22.0 TO 24.0		Medium Stiff, Dark Grey, Silty Clay, with black shale fragments, some dolomite and granite fragments intermixed.
-25.0		4 4 5 6	S-13	24.0 TO 26.0		Stiff, Dark Grey, Silty Clay, with black shale fragments, 2 large dolomite fragments.
		3 3 3 5	S-14	26.0 TO 28.0		Medium Stiff, Dark Grey, damp, Silty Clay.
-30.0		4 6 6 9	S-15	28.0 TO 30.0		Stiff, Dark Grey, Silty Clay, fragment of Red-brown sandstone.
		4 6 5 7	S-16	30.0 TO 32.0		Stiff, Dark Grey, Silty Clay, fragment of black shale
		6 8 8 10	S-17	32.0 TO 34.0		Stiff, Dark Grey, Silty Clay, 2 fragments of Red-brown sandstone, smaller fragments of limestone-dolomite.
-35.0		6 8 10 14	S-18	34.0 TO 36.0		
		6 9 10 14	S-19	36.0 TO 38.0		
-40.0		6 6 10 14	S-20	38.0 TO 40.0		
		10 19 18 34	S-21	40.0 TO 42.0		
-45.0		10 20 34 65 34 100/3"	S-22	42.0 TO 44.0		Top 5' - Dark Grey, Silty Clay with large dolomite rock fragment.
						-TILL-
						Dolomite bedrock @ 45.3' -BEDROCK-
						Terminate borehole at 45.5 feet

BLOWS/FT.	DENSITY
0-4	VERY LOOSE
5-10	LOOSE
11-30	MEDIUM DENSE
31-50	DENSE
	VERY DENSE

BLOWS/FT.	CONSISTENCY
0-2	VERY SOFT
3-4	SOFT
5-8	MEDIUM STIFF
9-15	STIFF
16-30	VERY STIFF
31+	HARD

SAMPLE ID.	
S	SPLIT SPOON
T	TUBE
U	UNDISTURBED PISTON
G	GRAB SAMPLE
X	OTHER
NR	NO RECOVERY

COMPONENT %
MOSTLY 50-100%
SOME 30-45%
LITTLE 15-25%
FEW 5-10%
TRACE <5%

GROUND WATER ABBREV
WD - WHILE DRILLING
NE - NOT ENCOUNTERED
UR - NOT READ

BORING NO.: TH-18

SECDONOHUE
Environment & Infrastructure

TEST BORING REPORT
MONITORING WELL CONSTRUCTION

BORING: L-18

JECT: Phase II Monitoring Well Installation Program
..ENT: CWM – Vickery, Inc.
CONTRACTORS: Bowser–Morner
EQUIPMENT USED: Mobile B-61

JOB NO.: P-3102
LOCATION: VICKERY, OH.
ELEVATION: ------
DATE START: 1992
DATE FINISH: 1992
DRILLER: JW / HC
PREPARED BY: G. ALLEN

GROUND WATER		DEPTH TO:						CASING	SAMPLER	CORE BARREL
DATE	HRS AFTER COMP				WATER	BOTTOM OF CASING	BOTTOM OF HOLE	TYPE	Stainless Steel	Split Spoon	–
NE								SIZE ID	2 IN.	2 IN.	–
								HAMMER WT	–	140 LB.	–
								HAMMER FALL	–	30 IN.	–

DEPTH IN FEET	RECOVERY (FT.)	SAMPLER BLOWS PER 6 INCHES	SAMPLE NUMBER	SAMPLE DEPTH RANGE	PID/FID RESULTS (PPM)	FIELD CLASSIFICATION AND REMARKS
		4 3 3 2	S-1	0.0 TO 2.0		Reddish Brown – Brown with some Grey Silt clay
		3 3 4 4	S-2	2.0 TO 4.0		2" Tan Silt Clay, 4" Brown fill material, thin layers of Tan–reddish mottled clay, thin layer fine sand.
–5.0		4 6 6 8	S-3	4.0 TO 6.0		1" Black stained Silt clay, 2" Black clay mixed with grey silt clay, with slight organic odor.
		7 8 7 9	S-4	6.0 TO 8.0		Damp Lt. Brown Clay, 3" grey silt with fine sand, 3" brown fine sand mixed with reddish–bronw laminated lacustrine soil.
		4 5 8 10	S-5	8.0 TO 10.0		Laminated Reddish–brown silt clay with grey clay silt.
		3 3 4 5	S-6	10.0 TO 12.0		
		4 5 4 6	S-7	12.0 TO 14.0		Brown to Lt. brown to tan silt clay, laminated with some grey clay silt. Thin very fine sand @ 1.3',1.7' and 1.9'.
–15		3 2 2 3	S-8	14.0 TO 16.0		Thin very fine brown sand, interbedded with laminated grey clay silt. –LACUSTRINE–
		3 2 4 4	S-9	16.0 TO 18.0		–TILL– Grey silt clay.
–20						Terminated borehole @ 18'

MONITORING WELL CONSTRUCTION DATA

BOREHOLE DIAMETER (IN.)	3 7/8
BOREHOLE DEPTH	45.3 ft.
CASING/SCREEN TYPE	–
CASING DIAMETER	–
SLOT WIDTH	–
SCREEN INTERVAL	–
TYPE OF SEAL	–
TYPE OF FILTER PACK	–
TYPE OF GROUT	–

WELL DEVELOPMENT:

COMMENTS:
L-18 sampled for accurate placement of well screen.

BLOWS/FT. DENSITY		BLOWS/FT. CONSISTENCY		SAMPLE ID.		COMPONENT %		GROUND WATER ABBREV
	VERY LOOSE	0 – 2	VERY SOFT	S	SPUT SPOON	MOSTLY	50 – 100%	WD – WHILE DRILLING
–	LOOSE	3 – 4	SOFT	T	TUBE	SOME	30 – 45%	NE – NOT ENCOUNTERED
11 – 30	MEDIUM DENSE	5 – 8	MEDIUM STIFF	U	UNDISTURBED PISTON	LITTLE	15 – 25%	NR – NOT READ
31 – 50	DENSE	9 – 15	STIFF	G	GRAB SAMPLE	FEW	5 – 10%	
51 +	VERY DENSE	16 – 30	VERY STIFF	X	OTHER	TRACE	<5%	
		31 +	HARD	NR	NO RECOVERY			BORING NO: L-18

SECDONOHUE
Environment & Infrastructure

TEST BORING REPORT
MONITORING WELL CONSTRUCTION

BORING: L-19A

PROJECT: Phase II Monitoring Well Installation Program
CLIENT: CWM – Vickery, Inc.
CONTRACTORS: Bowser-Morner
EQUIPMENT USED: Mobile B-61

JOB NO.: P-3102
LOCATION: VICKERY, OH.
ELEVATION: ------
DATE START: September 10, 1992
DATE FINISH: September 10, 1992
DRILLER: JW / HC
PREPARED BY: G. ALLEN

GROUND WATER DATE	HRS AFTER COMP	DEPTH TO:			WATER	BOTTOM OF CASING	BOTTOM OF HOLE		CASING	SAMPLER	CORE BARREL
								TYPE	Stainless Steel	Split Spoon	–
NE								SIZE ID	2 IN.	2 IN.	–
								HAMMER WT	–	140 LB.	–
								HAMMER FALL	–	30 IN.	–

DEPTH IN FEET	RECOVERY (FT.)	SAMPLER BLOWS PER 6 INCHES	SAMPLE NUMBER	SAMPLE DEPTH RANGE	PID/FID RESULTS (PPM)	FIELD CLASSIFICATION AND REMARKS
		1 2 2 3	S-1	0.0 TO 2.0		Soft, Brown, Clay, some silt, trace mixed sand
		9 10 13 16	S-2	2.0 TO 4.0		
-5.0		8 8 9 12	S-3	4.0 TO 6.0		–FILL–
						–LACUSTRINE–
		10 12 14 18	S-4	6.0 TO 8.0		Very Stiff, Grey – brown, lacustrine soils, some fine sand with bedding separations.
		5 8 13 18	S-5	8.0 TO 10.0		Very Stiff, Grey – Brown, Lacustrine soils, with fine sand, interbedded with tills and black lacustrine soils
		7 10 12 12	S-6	10.0 TO 12.0		Very Stiff, Brown silt clay, some organic debris, some grey fine sand and silt.
		4 9 10 13	S-7	12.0 TO 14.0		
-15		6 8 10 12	S-8	14.0 TO 16.0		Very Stiff, Grey brown, Lacustrine soil, trace, fine sand, trace interbedded till sediments.
		3 4 7 9	S-9	16.0 TO 18.0		
-20		4 5 7 9	S-10	18.0 TO 20.0		

MONITORING WELL CONSTRUCTION DATA

BOREHOLE DIAMETER (IN.)	3 7/8
BOREHOLE DEPTH	45.3 ft.
CASING/SCREEN TYPE	–
CASING DIAMETER	–
SLOT WIDTH	–
SCREEN INTERVAL	–
TYPE OF SEAL	–
TYPE OF FILTER PACK	–
TYPE OF GROUT	–

WELL DEVELOPMENT:

COMMENTS:
L-19A continuously sampled in order to determine well screen location.

BLOWS/FT. DENSITY		BLOWS/FT. CONSISTENCY		SAMPLE ID.		COMPONENT %		GROUND WATER ABBREV
	VERY LOOSE	0-2	VERY SOFT	S	SPUT SPOON	MOSTLY	50-100%	WD - WHILE DRILLING
-	LOOSE	3-4	SOFT	T	TUBE	SOME	30-45%	NE - NOT ENCOUNTERED
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	U	UNDISTURBED PISTON	LITTLE	15-25%	NR - NOT READ
31-50	DENSE	9-15	STIFF	G	GRAB SAMPLE	FEW	5-10%	
51+	VERY DENSE	16-30	VERY STIFF	X	OTHER	TRACE	<5%	
		31+	HARD	NR	NO RECOVERY			BORING NO: TH-18

SECDONOHUE
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TEST BORING REPORT

BORING: L-19A

TH IN FEET	RECOVERY	SAMPLER BLOWS PER 6 INCHES	SAMPLE NUMBER	SAMPLE DEPTH RANGE	PID/FID RESULTS (PPM)	FIELD CLASSIFICATION AND REMARKS
		4 5 6 7	S-11	20.0 TO 22.0		Stiff, Brown, Silty clay, some silt, with thine silt lenses in interbedded discrete layers and increasing with depth, becomes grey at bottom
		4 4 3	S-12	22.0 TO 24.0		Medium stiff, Grey lacustrine soils with silt layers, grades to a grey till with bedding and discrete silt layers.
-25.0		3 2 3 2	S-13	24.0 TO 26.0		Medium stiff, grey clay, bedding structure, brown silt. -LACUSTRINE -TILL- Medium stiff, Grey, Till sediments, saturated, some shale fragments.
		1 2 3 3	S-14	26.0 TO 28.0		
-30.0						Terminated borehole @ 28.0 feet
-35.0						
-40.0						
-45.0						

BLOWS/FT. DENSITY		BLOWS/FT. CONSISTENCY		SAMPLE ID.		COMPONENT %	GROUND WATER ABBREV
0-4	VERY LOOSE	0-2	VERY SOFT	S	SPLIT SPOON	MOSTLY 50-100%	WD - WHILE DRILLING
5-10	LOOSE	3-4	SOFT	T	TUBE	SOME 30-45%	NE - NOT ENCOUNTERED
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	U	UNDISTURBED PISTON	LITTLE 15-25%	UR - NOT READ
31-50	DENSE	9-15	STIFF	G	GRAB SAMPLE	FEW 5-10%	
	VERY DENSE	16-30	VERY STIFF	X	OTHER	TRACE <5%	
		31+	HARD	NR	NO RECOVERY		BORING NO.: L-19A

SECDONOHUE
Environment & Infrastructure

TEST BORING REPORT
MONITORING WELL CONSTRUCTION

BORING: Testhole-25

JECT: Phase II Monitoring Well Installation Program
.ENT: CWM - Vickery, Inc.
CONTRACTORS: Bowser-Morner
EQUIPMENT USED: Mobile B-61

JOB NO.: P-3102
LOCATION: VICKERY, OH.
ELEVATION: ------
DATE START: JULY 27, 1992
DATE FINISH: JULY 27, 1992
DRILLER: JW / HC
PREPARED BY: G. ALLEN

GROUND WATER		DEPTH TO:						CASING	SAMPLER	CORE BARREL
DATE	HRS AFTER COMP				WATER	BOTTOM OF CASING	BOTTOM OF HOLE	TYPE	Stainless Steel	Split Spoon	-
NE								SIZE ID	2 IN.	2 IN.	-
								HAMMER WT	-	140 LB.	-
								HAMMER FALL	-	30 IN.	-

DEPTH IN FEET	RECOVERY (FT.)	SAMPLER BLOWS PER 6 INCHES	SAMPLE NUMBER	SAMPLE DEPTH RANGE	PID/FID RESULTS (PPM)	FIELD CLASSIFICATION AND REMARKS
		5 6 8 12	S-1	0.0 TO 2.0		Stiff, Brown Clayey Silt, some fine to coarse sand, trace gravel. Corn Cob Manure 0.4' - 0.7' -FILL-
		3 4 4 7	S-2	2.0 TO 4.0		-LACUSTRINE- Medium Stiff, Red-Brown to Grey Clay, mottled.
-5.0		6 8 8 12	S-3	4.0 TO 6.0		Very Stiff, Brown - Grey Silty Clay, some mottling, some lamination
		5 10 7 8	S-4	6.0 TO 8.0		Very Stiff, Brown to Grey, saturated, Silty clay, trace gravel; 0.7 ft fine to medium sand, interbedded with brown-red silt.
		7 8 10 7	S-5	8.0 TO 10.0		Very Stiff, Red-Brown to Grey, Silty Clay, moist, some interbedded grey-brown, silty clay.
		3 4 4 6	S-6	10.0 TO 12.0		Medium Stiff, Reddish-Brown, Silty Clay, Mottled, well defined lamination between 11.3 - 12.0 ft.
		3 3 6 6	S-7	12.0 TO 14.0		Stiff, Brown to Red-Brown Silty Clay, interbedded with grey silty clay.
-15		4 3 3 2	S-8	14.0 TO 16.0		Medium Stiff, Brown to Grey, Silty Clay, well laminated. -LACUSTRINE-
		3 2 2 1	S-9	16.0 TO 18.0		-TILL- Soft, Grey, saturated, Clay, trace interbedded, Red Clay.
-20			S-10	18.0 TO 20.0		Grey, saturated, Clay, some coarse sand & gravel, trace red clay.

MONITORING WELL CONSTRUCTION DATA

BOREHOLE DIAMETER (IN.)	3 7/8
BOREHOLE DEPTH	20.0 ft.
CASING/SCREEN TYPE	-
CASING DIAMETER	-
SLOT WIDTH	-
SCREEN INTERVAL	-
TYPE OF SEAL	-
TYPE OF FILTER PACK	-
TYPE OF GROUT	-

WELL DEVELOPMENT:

COMMENTS:
Monitoring well L-25 drilled constructed adjacent to TH-25.

BLOWS/FT. DENSITY		BLOWS/FT. CONSISTENCY		SAMPLE ID.		COMPONENT %		GROUND WATER ABBREV
	VERY LOOSE	0-2	VERY SOFT	S	SPLIT SPOON	MOSTLY	50-100%	WD - WHILE DRILLING
	LOOSE	3-4	SOFT	T	TUBE	SOME	30-45%	NE - NOT ENCOUNTERED
11-30	MEDIUM DENSE	5-8	MEDIUM STIFF	U	UNDISTURBED PISTON	LITTLE	15-25%	NR - NOT READ
31-50	DENSE	9-15	STIFF	G	GRAB SAMPLE	FEW	5-10%	
51+	VERY DENSE	16-30	VERY STIFF	X	OTHER	TRACE	<5%	
		31+	HARD	NR	NO RECOVERY			BORING NO: TH-25

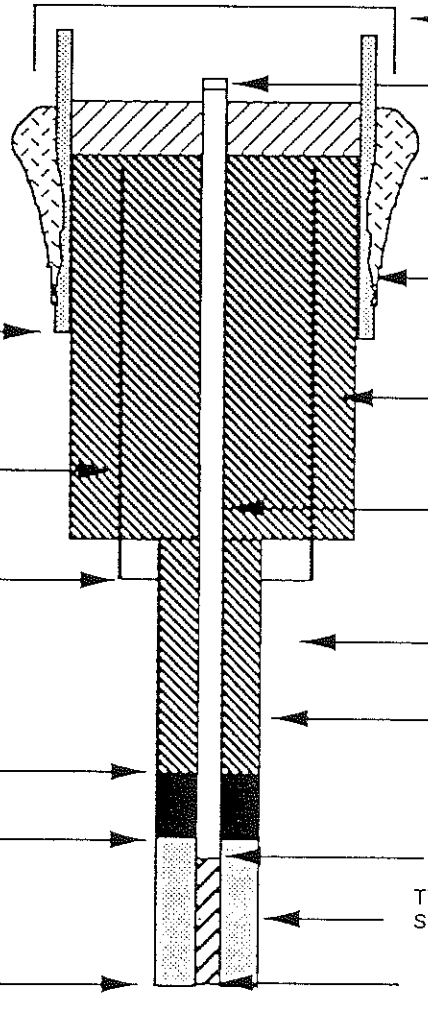
APPENDIX C - WELL CONSTRUCTION DETAILS

GROUND WATER MONITORING INSTALLATION DETAIL

PROJECT: PHASE II MONITORING WELL INSTALLATION	JOB NO. P-3120
LOCATION: VICKERY, OH	INSTALLATION NO.
CLIENT: CWM-VICKERY, INC.	TYPE OF INSTALLATION SOLID STEM AUGER/DRILL AND WASH
CONTRACTOR: BOWSER-MORNER	BORING NO: L- 17
DRILLER: JW/HC CERTIFICATION NO:	LOCATION: NORTH OF RETENTION AREA
SEC FIELD REPRESENTATIVE: G.ALLEN	INSTALLATION DATE: 7/24/92

SURVEY DATUM MSL

ELEVATION OF GROUND SURFACE 609.36



TOP OF ANODIZED ALUMINUM PROTECTIVE CASING

TOP OF WELL CASING OR RISER PIPE EL. 612.22 FT.

CONCRETE PAD

TYPE OF PROTECTIVE CASING ANODIZED ALUMINUM
INSIDE DIAMETER 10"
TOTAL LENGTH 5 FT

BOTTOM OF PROTECTIVE CASING

VOLCLAY GROUT

6" STEEL CASING

TYPE OF WELL CASING OR RISER Stainless Steel
PIPE INSIDE DIAMETER 2 in. type 316

Bottom of 6" Steel Casing 4.5 FT.
Driven 6" into lower unit.

VOLCLAY GROUT

BENTONITE PELLETS
Top of bentonite seal 4.4 ft.
El. 604.96

APPROXIMATE DIAMETER OF BOREHOLE 4 IN

FILTER PACK
Top of filter pack 6.0 ft.
(Bottom of seal)
El. 603.36

TOP OF SCREEN
EL. 601.86 DEPTH 7.5 FT.

TYPE OF WELL SCREEN: STAINLESS STEEL TYPE 316, NUMBER 6 SLOT.

BOTTOM OF BOREHOLE
EL.596.86 DEPTH 12.5 FT.

BOTTOM OF SCREEN
EL. 596.86 DEPTH 12.5 FT.

FIGURES ABOVE REFER TO DEPTH IN FEET

ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

KEY

- Concrete
- Pea Gravel
- Bentonite Pellets
- Volclay Grout
- Filter Sand Pack

SEC DONOHUE
Environment & Infrastructure

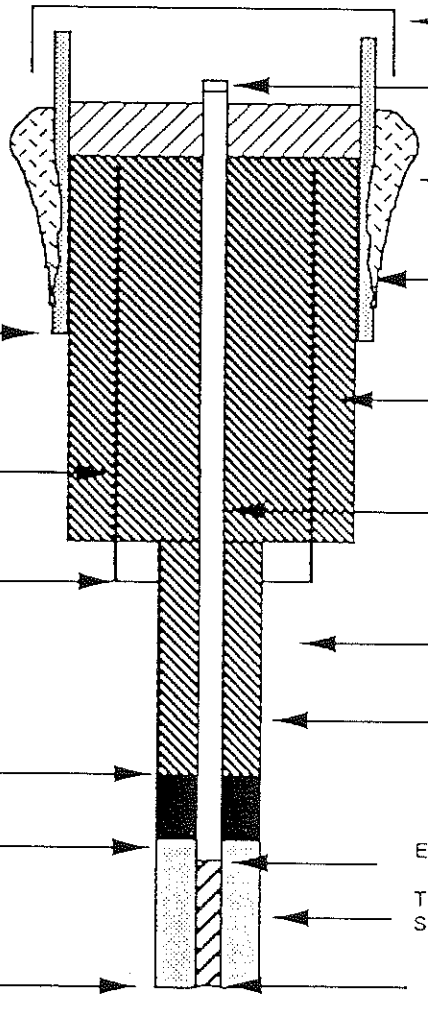
GROUND WATER MONITORING INSTALLATION DETAIL

PROJECT: PHASE II MONITORING WELL INSTALLATION
LOCATION: VICKERY, OH
CLIENT: CWM-VICKERY, INC.
CONTRACTOR: BOWSER-MORNER
DRILLER: JW/HC CERTIFICATION NO:
SEC FIELD REPRESENTATIVE: G.ALLEN

JOB NO. P-3120
INSTALLATION NO.
TYPE OF INSTALLATION SOLID STEM AUGER/DRILL AND WASH
BORING NO: T-17
LOCATION: North of Retention Area
INSTALLATION DATE: 7/22/92

SURVEY DATUM MSL

ELEVATION OF GROUND SURFACE 609.25



TOP OF ANODIZED ALUMINUM PROTECTIVE CASING

TOP OF WELL CASING OR RISER PIPE EL. 611.18 FT.

CONCRETE PAD

TYPE OF PROTECTIVE CASING ANODIZED ALUMINUM
INSIDE DIAMETER 10"
TOTAL LENGTH 5 FT

BOTTOM OF PROTECTIVE CASING

VOLCLAY GROUT

6" STEEL CASING

TYPE OF WELL CASING OR RISER PIPE INSIDE DIAMETER Stainless Steel 2 in. type 316

Bottom of 6" Steel Casing14. 5 FT. Driven 6" into lower unit.

VOLCLAY GROUT

BENTONITE PELLETS
Top of bentonite seal14.0 ft
EL. 595.25

APPROXIMATE DIAMETER OF BOREHOLE 4 IN

FILTER PACK
Top of filter pack16.5 ft.
(Bottom of Seal)
EL. 592.75

TOP OF SCREEN
EL.. 588.75 DEPTH 20.5 FT.

TYPE OF WELL SCREEN : STAINLESS STEEL TYPE 316, NUMBER 6 SLOT.

BOTTOM OF BOREHOLE
EL. 581.25 DEPTH 28.0 ft.

BOTTOM OF SCREEN
EL. 581.25 DEPTH 28.0 FT.

FIGURES ABOVE REFER TO DEPTH IN FEET

ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

KEY

- Concrete
- Pea Gravel
- Bentonite Pellets
- Volclay Grout
- Filter Sand Pack

SEC DONOHUE
Environment & Infrastructure

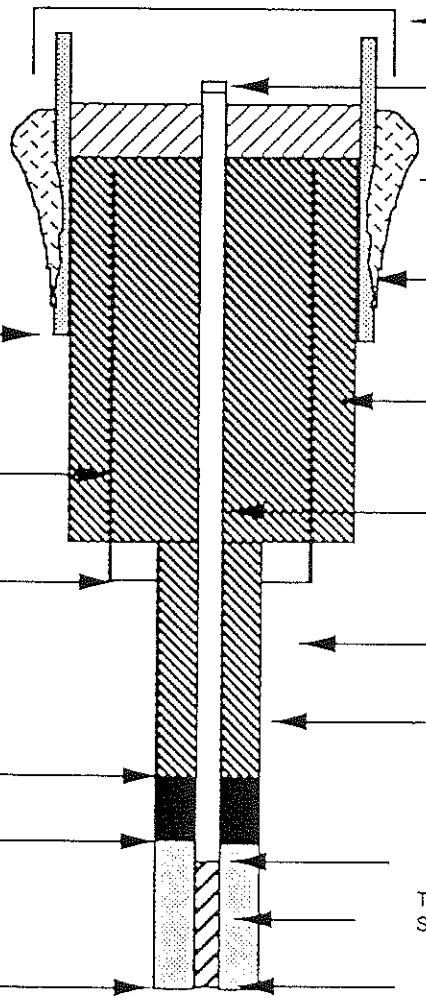
GROUND WATER MONITORING INSTALLATION DETAIL

PROJECT: PHASE II MONITORING WELL INSTALLATION
LOCATION: VICKERY , OH
CLIENT: CWM-VICKERY, INC.
CONTRACTOR: BOWSER-MORNER
DRILLER: JW/HC CERTIFICATION NO:
SEC FIELD REPRESENTATIVE: G.ALLEN

JOB NO. P-3120
INSTALLATION NO.
TYPE OF INSTALLATION SOLID STEM AUGER/DRILL AND WASH
BORING NO: MW-17R
LOCATION: North of Retention Area
INSTALLATION DATE: 7/21/92

SURVEY DATUM MSL

ELEVATION OF GROUND SURFACE 609.06



TOP OF ANODIZED ALUMINUM PROTECTIVE CASING

TOP OF WELL CASING OR RISER PIPE EL. 611.34 FT.

CONCRETE PAD

TYPE OF PROTECTIVE CASING ANODIZED ALUMINUM
INSIDE DIAMETER 10"
TOTAL LENGTH 5 FT

BOTTOM OF PROTECTIVE CASING

VOLCLAY GROUT

6" STEEL CASING

TYPE OF WELL CASING OR RISER Stainless Steel
PIPE INSIDE DIAMETER 2 in. type 316

Bottom of 6" Steel Casing 24.5 FT. Driven 6" into lower unit.

VOLCLAY GROUT

APPROXIMATE DIAMETER OF BOREHOLE 4 IN

BENTONITE PELLETS
Top of bentonite seal 43.5 ft
EL. 565.56

FILTER PACK
Top of filter pack47.7 ft.
(Bottom of Seal)
EL. 561.36

TOP OF SCREEN
EL.. 558.76 DEPTH 50.3 FT.

TYPE OF WELL SCREEN: STAINLESS STEEL TYPE 316, NUMBER 100 SLOT.

BOTTOM OF BOREHOLE
EL. 548.56 DEPTH 60.5 FT.

BOTTOM OF SCREEN
EL. 548.76 DEPTH 60.30 FT.

FIGURES ABOVE REFER TO DEPTH IN FEET

ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

KEY

- Concrete
- Pea Gravel
- Bentonite Pellets
- Volclay Grout
- Filter Sand Pack

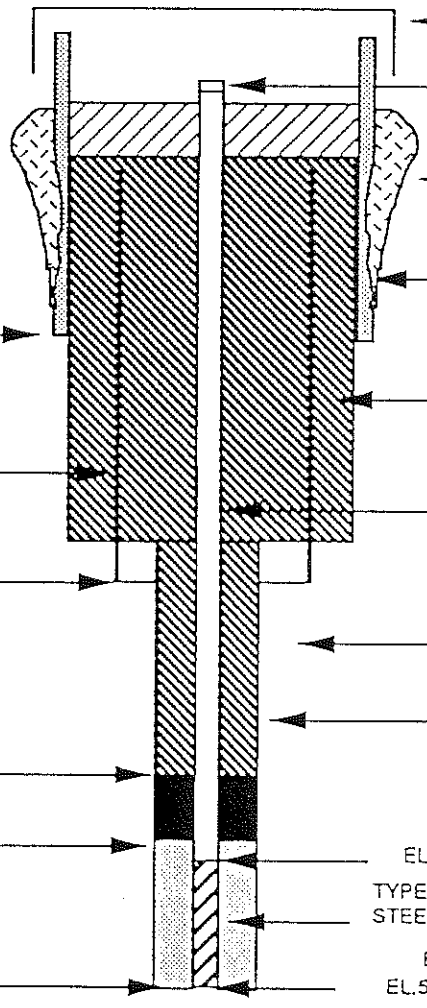
SEC DONOHUE
Environment & Infrastructure

GROUND WATER MONITORING INSTALLATION DETAIL

PROJECT: PHASE II MONITORING WELL INSTALLATION	JOB NO. P-3120
LOCATION: VICKERY, OH	INSTALLATION NO.
CLIENT: CWM-VICKERY, INC.	TYPE OF INSTALLATION SOLID STEM AUGER/DRILL AND WASH
CONTRACTOR: BOWSER-MORNER	BORING NO: L-18
DRILLER: JW/HC CERTIFICATION NO:	LOCATION: Retention Area
SEC FIELD REPRESENTATIVE: G.ALLEN	INSTALLATION DATE: 8/6/92

SURVEY DATUM MSL

ELEVATION GROUND SURFACE 609.82



TOP OF ANODIZED ALUMINUM PROTECTIVE CASING

TOP OF WELL CASING OR RISER PIPE EL. 611.74 FT.

CONCRETE PAD

TYPE OF PROTECTIVE CASING ANODIZED ALUMINUM

INSIDE DIAMETER 10"

TOTAL LENGTH 5 FT

BOTTOM OF PROTECTIVE CASING

VOLCLAY GROUT

6" STEEL CASING

TYPE OF WELL CASING OR RISER PIPE INSIDE DIAMETER Stainless Steel 2 in. type 316

Bottom of 6" Steel Casing 4.5 FT. Driven 6" into lower unit.

VOLCLAY GROUT

APPROXIMATE DIAMETER OF BOREHOLE 4 IN

BENTONITE PELLETS

Top of bentonite seal 5.5 ft.

EL. 604.32

FILTER PACK

Top of filter pack 7.5 ft. (Bottom of Seal)

EL. 602.32

TOP OF SCREEN EL. 601.32 DEPTH 8.5 FT.

TYPE OF WELL SCREEN: STAINLESS STEEL TYPE 316, NUMBER 6 SLOT.

BOTTOM OF BOREHOLE EL.591.82 DEPTH 18.0 FT.

BOTTOM OF SCREEN EL.593.82 DEPTH 16.0 FT.

FIGURES ABOVE REFER TO DEPTH IN FEET

ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

KEY

- Concrete
- Pea Gravel
- Bentonite Pellets
- Volclay Grout
- Filter Sand Pack

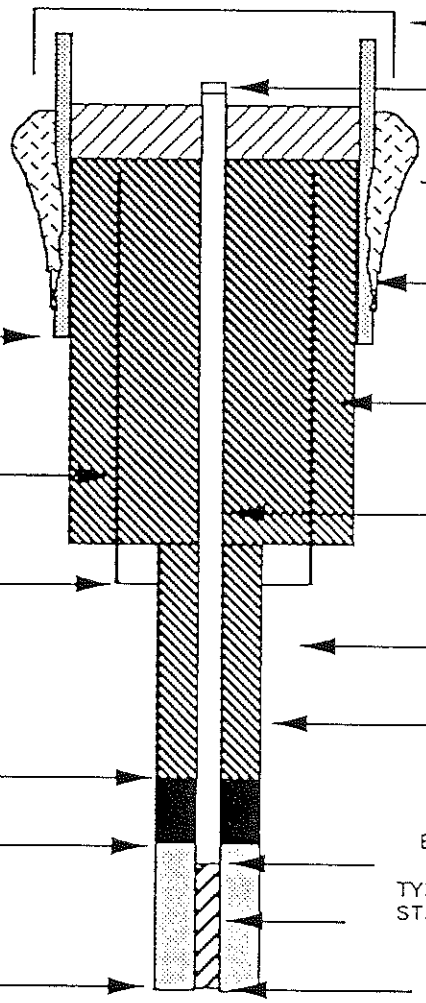
SEC DONOHUE
Environment & Infrastructure

GROUND WATER MONITORING INSTALLATION DETAIL

PROJECT: PHASE II MONITORING WELL INSTALLATION
LOCATION: VICKERY , OH
CLIENT: CWM-VICKERY, INC.
CONTRACTOR: BOWSER-MORNER
DRILLER: JW/HC CERTIFICATION NO:
SEC FIELD REPRESENTATIVE: G.ALLEN

JOB NO. P-3120
INSTALLATION NO.
TYPE OF INSTALLATION SOLID STEM AUGER/DRILL AND WASH
BORING NO: T-18
LOCATION: Retention Area
INSTALLATION DATE: 8/5/92

SURVEY DATUM MSL
ELEVATION OF GROUND SURFACE 609.64



TOP OF ANODIZED ALUMINUM PROTECTIVE CASING

TOP OF WELL CASING OR RISER PIPE EL. 612.31 FT.

CONCRETE PAD

TYPE OF PROTECTIVE CASING ANODIZED ALUMINUM
INSIDE DIAMETER 10"
TOTAL LENGTH 5 FT

BOTTOM OF PROTECTIVE CASING

VOLCLAY GROUT

6" STEEL CASING

TYPE OF WELL CASING OR RISER PIPE INSIDE DIAMETER Stainless Steel 2 in. type 316

Bottom of 6" Steel Casing14. 5 FT. Driven 6" into lower unit.

VOLCLAY GROUT

BENTONITE PELLETS
Top of bentonite seal16.0 ft.
EL. 593.64

APPROXIMATE DIAMETER OF BOREHOLE 4 IN

FILTER PACK
Top of filter pack18.0 ft.
(Bottom of Seal)
EL. 591.64

TOP OF SCREEN
EL. 589.64 DEPTH 20.0 FT.

TYPE OF WELL SCREEN:STAINLESS STEEL TYPE 316, NUMBER 6 SLOT.

BOTTOM OF BOREHOLE
EL. 579.64 DEPTH 30.0 FT.

BOTTOM OF SCREEN
EL. 579.64 DEPTH 30.0 FT.

FIGURES ABOVE REFER TO DEPTH IN FEET

ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

KEY

- Concrete
- Pea Gravel
- Bentonite Pellets
- Volclay Grout
- Filter Sand Pack

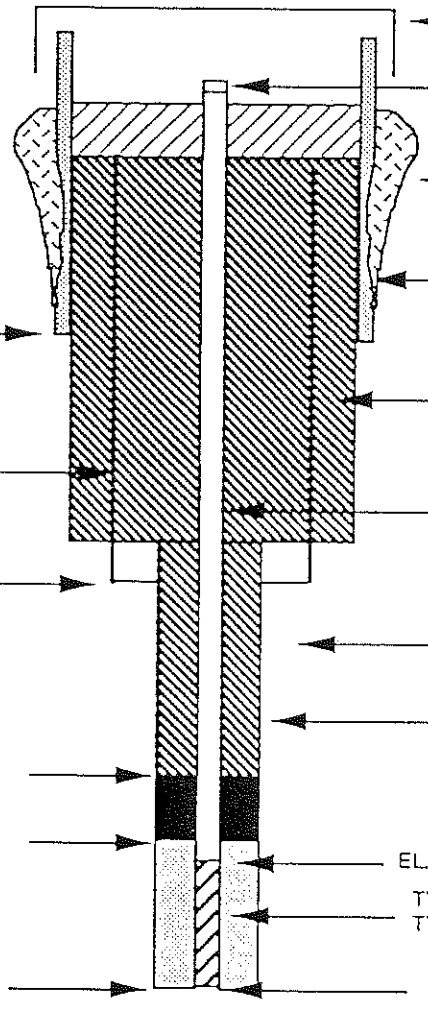
SEC DONOHUE
Environment & Infrastructure

GROUND WATER MONITORING INSTALLATION DETAIL

PROJECT: PHASE II MONITORING WELL INSTALLATION	JOB NO. P-3120
LOCATION: VICKERY, OH	INSTALLATION NO.
CLIENT: CWM-VICKERY, INC.	TYPE OF INSTALLATION SOLID STEM AUGER/DRILL AND WASH
CONTRACTOR: BOWSER-MORNER	BORING NO: MW-18R
DRILLER: JW/HC CERTIFICATION NO:	LOCATION: Retention Area
SEC FIELD REPRESENTATIVE: G.ALLEN	INSTALLATION DATE: 8/3/92

SURVEY DATUM MSL

ELEVATION OF GROUND SURFACE 608.94



TOP OF ANODIZED ALUMINUM PROTECTIVE CASING

TOP OF WELL CASING OR RISER PIPE EL. 611.00 FT.

CONCRETE PAD

TYPE OF PROTECTIVE CASING ANODIZED ALUMINUM

INSIDE DIAMETER 10"

TOTAL LENGTH 5 FT

BOTTOM OF PROTECTIVE CASING

VOLCLAY GROUT

6" STEEL CASING

TYPE OF WELL CASING OR RISER PIPE INSIDE DIAMETER Stainless Steel 2 in. type 316

Bottom of 6" Steel Casing 24.5 FT. Driven 6" into lower unit.

VOLCLAY GROUT

BENTONITE PELLETS

Top of bentonite seal 43.0 ft. EL. 565.94

APPROXIMATE DIAMETER OF BOREHOLE 4 IN

FILTER PACK

Top of filter pack 49.0 ft. (Bottom of Seal) EL. 559.94

TOP OF SCREEN EL. 557.94 DEPTH 51.0 FT.

TYPE OF WELL SCREEN: STAINLESS STEEL TYPE 316, NUMBER 100 SLOT.

BOTTOM OF BOREHOLE EL. 547.94 DEPTH 61.0FT.

BOTTOM OF SCREEN EL. 547.94 DEPTH 61.0 FT.

FIGURES ABOVE REFER TO DEPTH IN FEET

ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

KEY

- Concrete
- Pea Gravel
- Bentonite Pellets
- Volclay Grout
- Filter Sand Pack

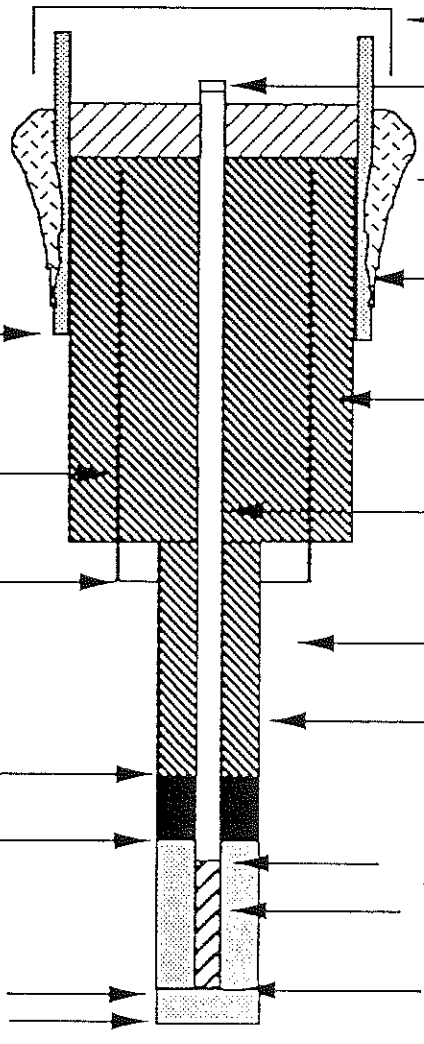
SEC DONOHUE
Environment & Infrastructure

GROUND WATER MONITORING INSTALLATION DETAIL

PROJECT: PHASE II MONITORING WELL INSTALLATION	JOB NO. P-3120
LOCATION: VICKERY, OH	INSTALLATION NO.
CLIENT: CWM-VICKERY, INC.	TYPE OF INSTALLATION SOLID STEM AUGER/DRILL AND WASH
CONTRACTOR: BOWSER-MORNER	BORING NO: L-19A
DRILLER: JW/HC CERTIFICATION NO:	LOCATION: 75' WEST OF L-19
SEC FIELD REPRESENTATIVE: G.ALLEN	INSTALLATION DATE: 9/11/92

SURVEY DATUM MSL

ELEVATION OF GROUND SURFACE 620.03



TOP OF ANODIZED ALUMINUM PROTECTIVE CASING

TOP OF WELL CASING OR RISER PIPE EL.621.25 FT.

CONCRETE PAD

TYPE OF PROTECTIVE CASING ANODIZED ALUMINUM
INSIDE DIAMETER 10"
TOTAL LENGTH 5 FT

BOTTOM OF PROTECTIVE CASING

VOLCLAY GROUT

6" STEEL CASING

TYPE OF WELL CASING OR RISER PIPE INSIDE DIAMETER Stainless Steel 2 in. type 316

Bottom of 6" Steel Casing 4.5 FT. Driven 6" into lower unit.

VOLCLAY GROUT

BENTONITE PELLETS

Top of bentonite seal 10.0 ft. EL. 610.03

APPROXIMATE DIAMETER OF BOREHOLE 4 IN

FILTER PACK

Top of filter pack12.5 ft. (Bottom of Seal) EL. 607.53

TOP OF SCREEN EL.606.03 DEPTH 14.0 FT.

TYPE OF WELL SCREEN:STAINLESS STEEL TYPE 316, NUMBER 6 SLOT.

Silica sand from 28.0 to 24.0
BOTTOM OF BOREHOLE EL.592.03 DEPTH 28.0 FT.

BOTTOM OF SCREEN EL.596.03 DEPTH 24.0 FT.

FIGURES ABOVE REFER TO DEPTH IN FEET

ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

KEY

- Concrete
- Pea Gravel
- Bentonite Pellets
- Volclay Grout
- Filter Sand Pack

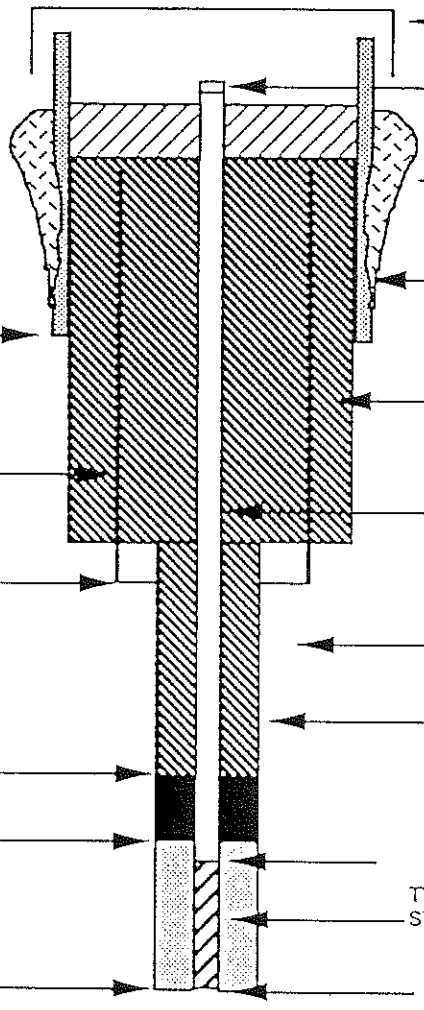
SEC DONOHUE
Environment & Infrastructure

GROUND WATER MONITORING INSTALLATION DETAIL

PROJECT: PHASE II MONITORING WELL INSTALLATION
LOCATION: VICKERY, OH
CLIENT: CWM-VICKERY, INC.
CONTRACTOR: BOWSER-MORNER
DRILLER: JW/HC CERTIFICATION NO:
SEC FIELD REPRESENTATIVE: G.ALLEN

JOB NO. P-3120
INSTALLATION NO.
TYPE OF INSTALLATION SOLID STEM AUGER/DRILL AND WASH
BORING NO: L-25
LOCATION: Retention Area
INSTALLATION DATE: 7/28/92

SURVEY DATUM MSL
ELEVATION OF GROUND SURFACE 610.96



TOP OF ANODIZED ALUMINUM PROTECTIVE CASING
TOP OF WELL CASING OR RISER PIPE EL. 612.95 FT.
CONCRETE PAD
TYPE OF PROTECTIVE CASING ANODIZED ALUMINUM
INSIDE DIAMETER 10"
TOTAL LENGTH 5 FT
BOTTOM OF PROTECTIVE CASING
VOLCLAY GROUT
6" STEEL CASING
TYPE OF WELL CASING OR RISER PIPE INSIDE DIAMETER Stainless Steel 2 in. type 316
Bottom of 6" Steel Casing 4.5 FT. Driven 6" into lower unit.
VOLCLAY GROUT
BENTONITE PELLETS
Top of bentonite seal 6.0 ft. EL. 604.96
APPROXIMATE DIAMETER OF BOREHOLE 4 IN
TOP OF SCREEN EL. 602.96 DEPTH 8.0 FT.
FILTER PACK
Top of filter pack 7.0 ft. (Bottom of Seal) EL. 603.96
TYPE OF WELL SCREEN: STAINLESS STEEL TYPE 316, NUMBER 6 SLOT.
BOTTOM OF BOREHOLE EL.592.96 DEPTH 18.0 FT.
BOTTOM OF SCREEN EL.592.96 DEPTH 18.0 FT.

FIGURES ABOVE REFER TO DEPTH IN FEET

ALL DEPTHS ARE REFERENCED TO GROUND SURFACE

KEY

- Concrete
- Pea Gravel
- Bentonite Pellets
- Volclay Grout
- Filter Sand Pack

SEC DONOHUE
Environment & Infrastructure

DATA INCLUDED IN APPENDIX A

MONITORING STATION	FIELD BORING LOG	ROCK CORE LOG	WELL(1) ROCK	WELL(1) TILL	WELL(1) LACUSTRINE
14	X	X	X	X	X
15	X	X	X	-	X
16	X	X	X	-	X
19	X	X	X	X	X
20	X	X	X	-	X
21	X	X	X	-	X
22	X	X	X	-	X
23	X(2)	X	X	X	X
24	X	X	X	X	-
26	X	-	-	-	X
27	X	-	-	X	X
28	X	-	-	-	X
29	X	-	-	-	X
30	X	-	-	-	X
31	X	-	-	-	X
32	X	-	-	-	X
33	X	-	-	-	X
34	X	-	-	-	X
35	X	-	-	-	X
37	X	X	X	X	-
38	-	-	X	X	-
39	X	-	-	-	X

(1) Well data includes installation sketch, installation notes, and development notes.
(2) Proposed well location was moved; therefore an additional boring G-23A was drilled.

CORE LOG

DEPTH: Depth from ground surface in feet.

Recovery: $\frac{\text{Length of core recovered}}{\text{Length of core run}} \times 100\%$

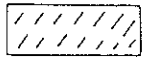
RQD: Rock Quality Designation =
Natural $\frac{\text{Length of core cylinders 4" long}}{\text{Length of core run}} \times 100\%$

Discontinuities: Any feature that interrupts the continuity of the rock, including bedding, joints, and fractures.

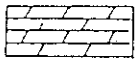
Angle w/axis: The acute angle between the discontinuity and the axis of the core.

Frequency: Typical spacing for the type of discontinuity described in the interval of core specified.

Lithology: Standard lithologic symbol for each rock type in the core, as shown below.



GYPSUM



DOLOMITE

Texture: Approximate grain size:
VC = very coarse, 1-2 mm
C = coarse, 0.5-1 mm
M = medium, 0.25-0.5 mm
F = fine, 0.125-0.25 mm
VF = very fine, less than 0.125 mm

Weathering: Degree of weathering or alteration of the sample, i.e.,
1. Unweathered: No evidence of any mechanical or chemical alteration. No discoloration evidenced.
2. Slightly weathered: Slight discoloration on surface, slight alteration along discontinuities, less than 10% of the volume is altered, strength is substantially unaffected.
3. Moderately weathered: Discoloring is evident, surface is pitted and altered with alteration penetrating well below rock surfaces, weathering "halos" evident, 10% to 50% of the rock is altered, strength is noticeably less than fresh rock.
4. Highly weathered: Entire mass is discolored, alteration pervades nearly all of the rock with some pockets of slightly weathered rock noticeable, some minerals leached away, retains only a fraction of original strength (with wet strength usually lower than dry strength).
5. Decomposed: Rock is reduced to a soil with relict rock texture (saprolite), can be generally molded and crumbled by hand.

Description: Lithologic description of samples, indicating the depth of each unit. A general description is given for each major rock type. Minor variations in lithology are noted. Minor variations in hardness, weathering, color, and texture are shown in the appropriate columns.

JOB NO. 853-3020	SCALE —	COREHOLE LOGGING LEGEND SHEET 1 OF 1
DRAWN FHW	DATE 2/20/86	
CHECKED	DWG NO —	
Golder Associates		Chemical Waste Management

Geiser Associates

Field Boring Log

DEPTH HOLE 43.8	JOB NO. 853-3013	PROJECT Cwm/Old/OH	BORING NO. G-14
DEPTH SOIL DRILL 43.8	QA INSP. PM/RSM	DRILLING METHOD CME Continuous Soil Sampler	SHEET 1 OF 2
DEPTH ROCK CORE NA	WEATHER CLR	DRILLING COMPANY Geomechanics	SURFACE ELEV. 606
NO. DIST. SA. 9 UD. SA. NA	TEMP. 35°F	DRILL RIG CME 55 DRILLER J. Selunski	DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA DROP NA	STARTED 0810 (TIME) 13-10-85 (DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA DROP NA	COMPLETED 1030 13-10-85

SAMPLE TYPES

A S	AUGER SAMPLE
C S	CHUNK SAMPLE
D D	DRIVE OPEN
D S	DENISON SAMPLE
P S	PITCHER SAMPLE
R C	ROCK CORE
S T	SLOTTED TUBE
T O	THIN WALLED, OPEN
T P	THIN WALLED, PISTON
W S	WASH SAMPLE
CSS	Continuous Soil Sampler

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" - 0-5%
"LITTLE" - 5-12%
"SOME" - 12-30%
"AND" - 30-50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
604.2 / 1.8	Firm to stiff, brown CLAYEY SILT, trace fine gravel, trace organics (FILL)		1	CSS		4.0 / 4.4		
603.8 / 2.2	TOPSOIL							
599.8 / 6.2	Firm brown-gray, mottled, SILTY CLAY, trace organics (LACUSTRINE)	4.4	2	CSS		4.2 / 5.0		
591.3 / 14.7	Firm, brown-gray, laminated, SILTY CLAY, trace fine sand (LACUSTRINE)	9.4	3	CSS		5.0 / 5.0		
586.4 / 19.6	Soft to firm, gray, SILTY CLAY, trace to little f-c sand, trace f-c gravel (TILL)	14.4	4	CSS		5.2 / 5.0		
585.6 / 20.4	Soft to firm, gray, f-c SAND and CLAYEY SILT (TILL)	19.4						
	Soft to firm, gray, SILTY CLAY, trace to little f-m sand, trace f-c gravel (TILL)		5	CSS		4.7 / 5.0		

Field Boring Log

DEPTH HOLE 43.8	JOB NO. 853-3015	PROJECT CWM/OLD OH			BORING NO. G-14
DEPTH SOIL DRILL 43.8	QA INSP. PAI/RSM	DRILLING METHOD CME CONTINUOUS SOIL SAMPLER			SHEET 2 OF 2
DEPTH ROCK CORE NA	WEATHER CLR	DRILLING COMPANY GEOMECHANICS			SURFACE ELEV. 606
NO. DIST. SA. 9 UD. SA.	TEMP. 35°F	DRILL RIG CME 55	DRILLER J. SOLWOSKI		DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA		STARTED 0810 (TIME) / 3-10-85 (DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA		COMPLETED 1030 (TIME) / 3-10-85 (DATE)

SAMPLE TYPES

AS	AUGER SAMPLE	CS	CHUNK SAMPLE
DO	DRIVE OPEN	DS	DENISON SAMPLE
PS	PITCHER SAMPLE	RC	ROCK CORE
ST	SLOTTED TUBE	TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON	WS	WASH SAMPLE
CSS	CONTINUOUS SOIL SAMPLER		

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NONPLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIT	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RK	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" – 0-5%
"LITTLE" – 5-12%
"SOME" – 12-30%
"AND" – 30-50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to firm gray SILTY CLAY, trace to little f-m sand, trace f-c gravel (TILL)		24.4	5	CSS		4.7/5.0		
			29.4	6	CSS		4.1/5.0		
			34.4	7	CSS		5.1/5.0		
			39.4	8	CSS		5.1/5.0		
				9	CSS		4.4/4.4		
563.0 / 43.0	Hard, gray, CLAYEY SILT, some f-c, little f-c gravel (TILL)								
562.2 / 43.8	AUGER REFUSAL								Upon completion the borehole was backfilled with thick bentonite slurry mixed at 1.5 to 2.0 lbs per gallon of water

PROJECT CWM/VICKERY/OHIO | JOB NO. 853-3020 | BORING NO. MW-14R | DATE 2/17/86 | SHEET 1 OF 1

BORING BEGAN 10/2/85 | BORING COMPLETED 10/3/85 | CORE HOLE LOCATION MW-14R

METHOD OF CORING ROTARY | DRILLING FLUID POTABLE WATER | ORIELEV. — | WEATHER —

CASING USED — | SIZE NX | INSPECT. WGG | OPERAT. TIM B. | WATER LEVEL TIME DATE —

DEPTH (FT.)	RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH	TYPE	INFILLING	ANGLE W/AXIS	FREQUENCY	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN./FT.
40.0													SEE BORING 6-M FOR SOIL DESCRIPTIONS. ALLUVIUM COVERED 46.0 FT BELOW G.S.				
46.0	1	2'/4' 50%	0%	46.0 to 46.10	FRACTURES	OPEN OPEN	15 to 20	<0.1' to 0.2'		white			WHITE CHALKY GYPSUM. THIN INTERLAYERS OF LAMINATED DOLOMITE @ ~49 FT BELOW G.S.				
50.0		2.5'/5' 13'/13' 95%	11%	51.0	FRACTURE	HEALED	VERT			Gray to dark gray	FINE TO VERY FINE	—	GRAY TO DARK GRAY GENERALLY LAMINATED DOLOMITE WITH ABUNDANT FRACTURES ⊥ TO BEDDING THAT ARE OFTEN COATED WITH GYPSUM.	—	—	—	—
				52.0	VUGS	OPEN	—						50.0 TO 52.6' - GYPSUM FILLED VUGS. WATER LOST @ 53.3 FT BELOW G.S. 52.0 FT - SOME OPEN VUGS.				
				52.4	FRACTURE	PARTIALLY HEALED	VERT										
				53.8	FRACTURE	—	VERT										
	2			54.9	FRACTURE		VERT					HIGH	54.6 TO 60.7 FT - "CLAY RICH" INTENSELY WEATHERED ARGILLACEOUS DOLOMITE.				
59.4	3	1.6'/1.6' 100%	(1.3'/1.3') 21%	60.0 to 60.6	FRACTURES	MIN	15 to 85	0.5' to 3'					60.0 TO 60.6 FT - THINLY BEDDED ARGILLACEOUS AND SILTY DOLOMITE WITH SEVERAL THIN LAYERS OF GYPSUM.				
61.0													CORING TERMINATED @ 61.0 FT BELOW G.S.				

SCALE: 1 DIVISION=0.2 FEET

CHECKED: WGG

DATE 2/3/85 LOGGED BY WGG

MONITORING WELL INSTALLATION LOG

JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO MW-14R	SHEET 1 OF 2
GA INSP. W.A.C.	DRILLING METHOD CORE / ROTARY	GROUND ELEV 606.1	WATER DEPTH 15.62'
WEATHER	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 607.64	DATE/TIME 12/3/85 13:20
TEMP.	DRILL RIG CME 55 DRILLER T. BOCHNER	STARTED 10/1/85 (TIME / DATE)	COMPLETED 10/5/85 (TIME / DATE)

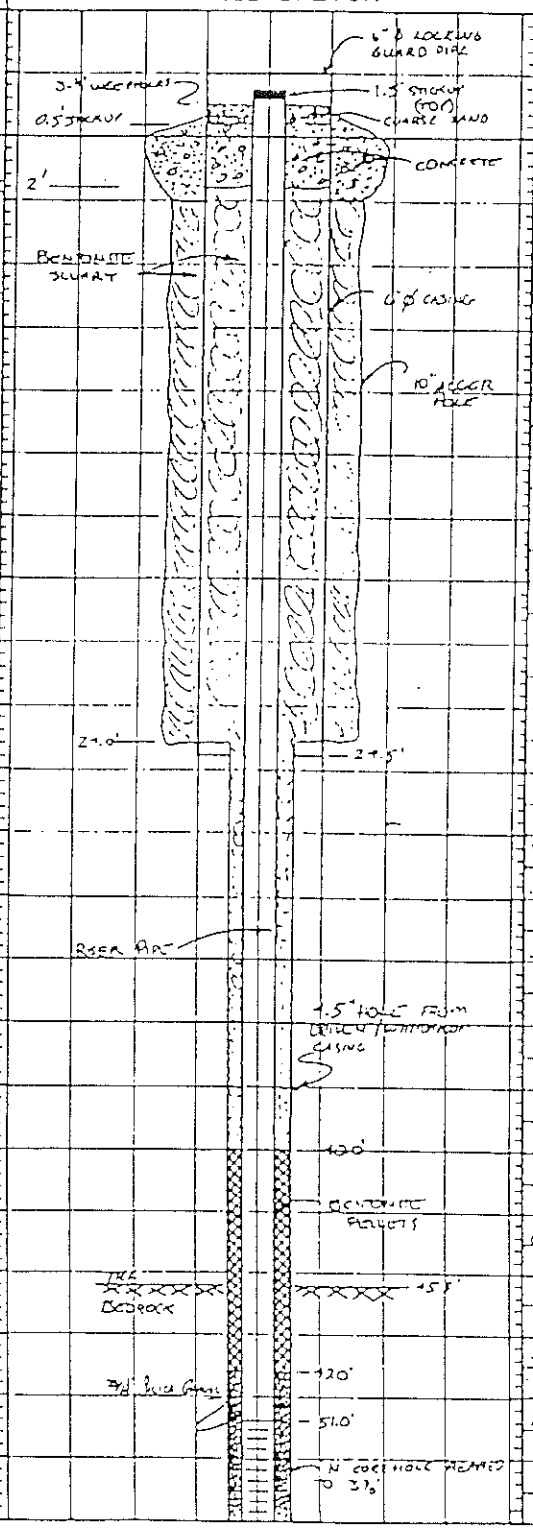
MATERIALS INVENTORY

WELL CASING 2 in. dia. 52.5' l.f.	WELL SCREEN 2 in. dia. 10.0' l.f.	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH COUPLED	SLOT SIZE 100 (.10 in.)	FILTER PACK QTY Approx. 5.0 gals
GROUT QUANTITY —	CENTRALIZERS None	FILTER PACK TYPE 3/8" Silica Gravel
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE None	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	FIRM TO STIFF, BROWN CLAYEY SILT, TRACE FINE GRAVEL, TRACE ORGANICS (FILL)
1.2	TOPSOIL
2.2	FIRM BROWN-GRAY, MOTTLED, SILTY CLAY, TRACE ORGANICS (LACUSTRINE)
6.2	FIRM, BROWN-GRAY, LAMINATED, SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
14.7	SOFT TO FIRM, GRAY, SILTY CLAY, TRACE TO LITTLE F-C SAND, TRACE F-C GRAVEL (TILL)
19.6	SOFT TO FIRM, GRAY, F-C SAND AND CLAYEY SILT (TILL)
20.4	SOFT TO FIRM, GRAY, SILTY CLAY, TRACE TO LITTLE F-M SAND, TRACE F-C GRAVEL (TILL)
43.0	HARD GRAY, CLAYEY SILT, SOME F-C, LITTLE F-C GRAVEL (TILL)
43.8	WHITE CHALKY GYPSUM WITH INTERLAYERS OF LAMINATED DOLOMITE
49.5	GRAY TO DARK GRAY LAMINATED DOLOMITE WITH ABUNDANT PARTINGS ALONG BEDDING

CONT ON PAGE 2

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

- TOTAL PURGED ≈ 12,040 GALS; TIME FOR REMOVAL WAS 20 hrs 45 min
- DEVELOPMENT EQUIPMENT: AIR LIFT 1" Ø PVC FOR INDUCTOR PIPE, 5 ft SECTION AT BOTTOM WAS PERFORATED
- AIR SOURCE WAS A DAYTON SCREWAIR 316-6455 COMPRESSOR

DATE DEVELOPED 10-28-85 to 10-30-85

DEPTH TO WATER BEFORE DEVEL @ 08:05 HRS 10-28-85 WAS 16.43 ft

MEASUREMENTS DURING DEVELOPMENT

GALLONS REMOVED

	STAB 1260	6,700	9,500	12,000	
SPECIFIC CONDUCTANCE	2,100	2,900	2,800	2,900	2,800
TEMP (°F)	53°	55°	55°	52°	52°
pH	6.6	6.6	6.9	6.7	6.6

CONT PAGE 2

MONITORING WELL INSTALLATION LOG

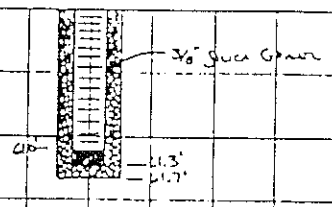
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO MW-14R	SHEET 2 OF 2
GA INSP W.G.G.	DRILLING METHOD CORE / ROTARY	GROUND ELEV —	WATER DEPTH 15.62'
WEATHER	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV —	DATE/TIME 10/5/85 15:20
TEMP	DRILL RIG CME 55 DRILLER T. BOEHNER	STARTED 10/1/85 (TIME / DATE)	COMPLETED 10/5/85 (TIME / DATE)

MATERIALS INVENTORY - SEE PAGE 1

WELL CASING ___ in dia ___ l.f	WELL SCREEN ___ in. dia. ___ l.f	BENTONITE SEAL
CASING TYPE	SCREEN TYPE	INSTALLATION METHOD
JOINT TYPE	SLOT SIZE	FILTER PACK QTY
GROUT QUANTITY	CENTRALIZERS	FILTER PACK TYPE
GROUT TYPE	DRILLING MUD TYPE	INSTALLATION METHOD

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
55.0	CONT. FROM PAGE 1 DARK GRAY ARGILLACEOUS DOLOMITE, THINLY PARTED
60.0	CORING TERMINATED @ 61.0'
65.0	

WELL SKETCH



INSTALLATION NOTES

WELL DEVELOPMENT NOTES

CONT. FROM PAGE 1

- pH/conductivity meter was calibrated before start of pumping; meter read 0.4 to high for pH.
- Water was turbid and silty the first 50 gals.
- Clear after 150 gals removed

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020 Ref. MW-14R	Made by W.G.G. Checked Reviewed JL	Date 11-6-95 Sheet 1 of 2

1. a) Drilled 10" ϕ hole with 8" ϕ augers and 10" bit to 24.0' bgs. Sounded hole @ 24.0'.
   b) Installed 6" ϕ flush-joint steel csg, all joints wrapped with teflon tape. 25.0 feet of casing installed.
   c) Drove and seated 6' ϕ csg to 24.5' bgs.
   d) Tremied bentonite grout down annular space using 1" ID pvc pipe. Bento grout slurry mixed @ ratio of ~ 1.5 lbs bent per gal of water. Used ~ 15 gals of grout mixture, lost ~ 15 gals flow out of annulus until thick and all water in borehole was displaced. Calculated volume of annular space to be filled is approximately 58 gals.
   e) 6" ϕ surface csg was reamed using a 5 7/8" roller bit until return water was clear. 6" casing was bailed to 0.5' of bottom of hole.

2. a) 4" ϕ flush joint steel casing was driven with 300 lb hammer to 45.8' bgs. Inside of 4" casing was reamed to 46.0' until water was clear. Noted alot of gypsum in the return water when reaming from 45.8' to 46.0' bgs. Top of rock estimated to be 45.5' bgs.
   b) Bailed 4" ϕ casing removing about 55 bails. Calculated that 28.0 gals of water needs to be removed, water was 3.0 feet below ground surface after flushing. Bailer had a capacity of .67 gals.

3. a) Rock cored with "N" size diamond bit from 46.0' to 50.0' bgs (Run 1) Water loss was ~ 160 gals. Stopped @ 50.0' due to core block. Had to replace bearings in catcher swivel. Recovery in run #1 was 50% (2'/4').
   b) Started core run #2 after fixing core catcher. Run #2 from 50.0 feet to 59.4 feet (9.4' run) stopped due to core block. Water loss zones @ 55.7', 56.0', 56.9', and 57.4'. Water loss in run #2 is estimated to be ~ 1,660 gals. Run #2 had 95% recovery (8.9'/9.4').
   c) Completed rock coring with run #3 from 59.4' to 61.0' bgs (1.6' run). Recovery was 100% (1.6'/1.6'). Water loss in run #3 was ~ 550 gals.
   d) Total water loss during coring was ~ 1,770 gals.

4. a) Reamed rock-core hole with 3 7/8" roller bit from 46.0' to 61.3' bgs. Water loss while reaming was ~ 430 gals. Sounded hole @ 56.8', 4.2 ft of debris in bottom of hole.
   b) Reflushed hole to remove debris, lost ~ 2,300 gals of water. Sounded hole @ 61.7 ft bgs. Reamed 0.4' extra during reflushing.
   c) Total water lost during coring and reaming rock was ~ 4,500 gals.

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020 Ref. MW-14 R	Made by W.G.G Checked Reviewed	Date 11-6-85 Sheet 2 of 2

5. a) Well screen (10.0') and solid riser pipe (52.5') was installed downhole after 0.4 feet of gravel pack was added. Bottom of screen @ 61.0 ft;

6. a) Addition of filter pack: 3/8" ϕ gravel was backfilled into the open annulus and sounded @ 1.0 foot increments to detect bridging or sloughing. Gravel was added to 49.0' bgs. Total volume used was ~ 5 gals. Calculated volume is 5.0 gals.

b) Bentonite seal: Borehole annulus was backfilled with bentonite pellets to 40.0 ft bgs. Pellets were added and tamped with a 1"-two feet long steel rod 6" at a time. When pellets were added to 45.5 feet bgs, rain stopped work and the pellets hydrated overnight. The next day the hole was sounded @ 44.5' bgs, one foot inside the 4" ϕ casing. The casing was pulled to 42.5' bgs. and the bent. bridge was knocked out with a steel tamping rod. Bent. was then backfilled, tamped, and sounded at 1.0' intervals as the 4" casing was lifted in one foot increments. Used 5 gals of bent. pellets, calculated volume is ~ 4.6 gals.

7. a) Tremie grouted borehole/well annulus using 1" ID clean pvc tremie pipe. Grout was mixed @ a ratio of ~ 1.5 lbs of bent. per gallon of water and ~ 45 gals of grout was used; Calculated volume is 39 gals. Lost some grout overflow from annulus during grouting ~ 5 gals.

8. a) Installed a 6" ID aluminum flush-joint protective pipe that was threaded on to the 6" surface casing. The protective pipe was secured with a lock.

9. a) A hole was dug 30" deep around the 6" surface casing and a sand-Portland cement mixture was poured into the hole. Cement was built up ~ 0.7 feet above ground surface and was sloped so that water would drain away from the well. Three 1/4" ϕ drain holes were drilled in the guard pipe just above the cement collar.

b) Bentonite grout was removed from inside the annulus of the 6-inch surface casing and cement was poured to replace the grout removed. The cement was poured to just below the drain holes.

c) Coarse sand was added inside the protective pipe to approx. 4 inches below the top of riser pipe.

10. a) A small ϕ hole was drilled in the well cap to serve as a vent hole.

b) W.L. on 10-5-85 @ 15:30 hrs is 15.62' below top of 2" riser

MONITORING WELL INSTALLATION LOG

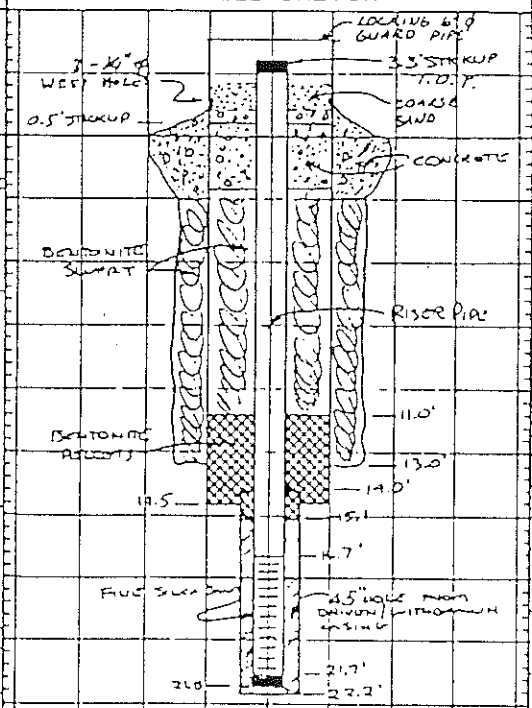
JOB NO. 853-3000	PROJECT GWM / VICKERY / OH	WELL NO. T-14	SHEET 1 OF 1
GA INSP. W.G.G.	DRILLING METHOD AUGER / ROTARY	GROUND ELEV 606.5	WATER DEPTH 14.92
WEATHER SUNNY	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 609.84	DATE/TIME 10/17/85 / 1910
TEMP. 40-70'	DRILL RIG CME 55 DRILLER T. BOEHNER	STARTED 10/16/85 (TIME / DATE)	COMPLETED 10/17/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 20.0 l.f.	WELL SCREEN 2 in. dia. 5.0' l.f.	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE .0060 in.	FILTER PACK QTY ~4.5 gals
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	FIRM TO STIFF, BROWN CLAYEY SILT, TRACE FINE GRAVEL, TRACE ORGANICS (FILL)
1.8	TOPSOIL
2.2	FIRM BROWN-GRAY, MOTTLED, SILTY CLAY, TRACE ORGANICS (LACUSTRINE)
6.2	FIRM, BROWN-GRAY, LAMINATED, SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
14.7	SOFT TO FIRM, GRAY, SILTY CLAY, TRACE TO LITTLE F-C SAND, TRACE F-C GRAVEL (TILL)
19.6	SOFT TO FIRM, GRAY, F-C SAND AND CLAYEY SILT (TILL)
20.4	SOFT TO FIRM, GRAY, SILTY CLAY, TRACE TO LITTLE F-M SAND, TRACE F-C GRAVEL (TILL)
22.2	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH STAINLESS STEEL BAILER. NEW POLYPROPYLENE ROPE WAS DESIGNATED TO T-14 FOR DEVEL.

BAILER WAS STEAM CLEANED THEN RINSED WITH DEIONIZED WATER BEFORE DEVELOPMENT

TOTAL VOLUME PURGED DURING DEVELOPMENT WAS 6.8 gallons. CALCULATED WELL VOLUME FROM STATIC W.L. (6.20') measured 1-14-86 is 3.1 gals

MEASUREMENTS DURING DEVEL.

DATE	GALLONS BAILED	pH	SPECIFIC COND	COMMENTS
11-13-85	3.5	6.1	1,600	SLIGHTLY TURBID
11-17-85	1.3	6.9	2,100	"
11-19-85	0.7	6.8	1,900	"
11-21-85	1.3	-	-	RECOVERY TEST PERFORMED

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 855-3020 Ref. T-14	Made by W.G.G. Checked Reviewed GS	Date 10-17-85 Sheet 1 of 2

1. a) A 10" diameter(ϕ) hole was augered to 13.0' using 8"ϕ solid stem augers with a 10" bit; pulled augers and sounded hole @ 12.7' bgs.

b) Inserted 15.0 ft. of 6"ϕ flush-joint steel surface casing down 10" auger hole; pushed surface casing (seated) to 14.5' bgs. All threaded joints of 6" casing were wrapped with teflon tape before installation.

c) Grouted annular space between 6" csg and 10" auger hole with bentonite grout slurry mixed @ a ratio of ≈ 1.5 lbs of bent per gal of water. Grout was tremied down annulus using 1" ID clear pvc tremie pipe. Sample of grout was taken. Approximately 35 gals of grout was used for grouting surface casing.

d) 6"ϕ surface csg was flushed to 14.0' with a 5 7/8" rollerbit until return water was clear. Casing was then bailed to within 0.3 feet of the flushed depth.

2 a). Four (4) inch ID temporary casing was driven to 22.2 feet (TD) and then flushed and reamed with 3 7/8" rollerbit until clear. Remaining water in the 4"ϕ csg was bailed to within 0.3' of TD.

3. a) Backfilling: The 4" casing was pulled to 21.7' bgs and fine filter pack sand was added to the bottom of casing (21.7'). The well screen (5.0') and riser pipe (20.0') were inserted down the 4" temporary casing and the riser stickup was measured @ 3.3' above ground surface. The 4" temporary casing was pulled with the winch cable @ 1.0 foot increments and sand was backfilled in the open annulus. The depth to the hole was sounded prior to adding the sand to ensure that sloughing had not occurred. Sand was added to 15.1' bgs (1.6' above to top of screen). Used ~4.5 gals of sand, calculated volume is 4.2 gals.

b) The 4"ϕ temporary casing was pulled from 15.1' to 14.8' and 0.3' of bentonite pellets was added. The hole was sounded @ 14.8'. The 4"ϕ csg was then pulled from the hole and the well was sounded @ 14.8'. Bentonite pellets were then added to 11.0' bgs.

c) The next day (10-17-85) the annular space above the bent. pellet seal was grouted using a bent. powder mixture of ~1.4 lbs/gal. Used ~15 gals of grout to fill annulus. Before grouting, the hole was sounded @ 10.7 and the bent. pellets were fully hydrated.

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020 Ref. T-14	Made by W.G.G. Checked Reviewed	Date Sheet 2 of 2

4. a) A water level taken upon completion measured 14.92' below the top of the 2" rise pipe @ 19:10 hrs on 10/17/85.

5. a) An aluminium protective flush joint guard pipe was threaded on the 6" surface casing and secured with a lock.

6. a) A 2.5' hole bgs was dug around the well and a Portland cement - sand mixture was poured in and formed to a cone shape so that water would drain away from the well.

7. a) Bentonite grout was removed from inside the annulus of the 6-inch surface csg and a cement sand mixture was poured in to replace the grout removed. The thickness of this cement annular seal was ~2.0 feet.

8. a) Three ¼" ϕ holes were drilled in the 6" ϕ protective csg just above the cement collar seal.

b) Coarse sand was poured in the 6" ϕ guard pipe to about 5 inches below the top of well pipe.

9. a) The 316 stainless steel well cap was vented by drilling a small ϕ hole.

MONITORING WELL INSTALLATION LOG

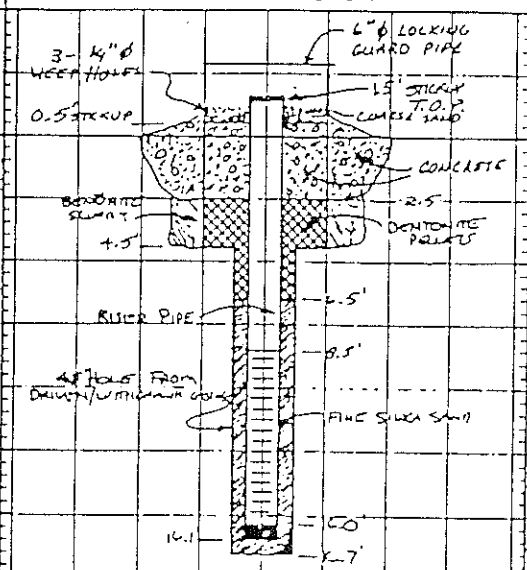
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO L-14	SHEET 1 OF 1
GA INSP. J. COLLIE	DRILLING METHOD AUGER / ROTARY	GROUND ELEV 606.4	WATER DEPTH 11.50'
WEATHER PTLY CLDY	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 607.92	DATE/TIME 10/18/85 14:45
TEMP.	DRILL RIG MOBILE B-61 DRILLER R. KIRKPATRICK	STARTED 10/17/85 (TIME / DATE)	COMPLETED 10/18/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 10.0' lt	WELL SCREEN 2 in. dia. 7.5' lt	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH COUPLED	SLOT SIZE 0.0060in	FILTER PACK QTY 5.0 gals
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	FIRM TO STIFF, BROWN CLAYEY SILT, TRACE FINE GRAVEL TRACE ORGANICS (FILL)
1.8	TOPSOIL
2.2	FIRM BROWN-GRAY, MOTTLED, SILTY CLAY, TRACE ORGANICS (LACUSTRINE)
6.2	FIRM, BROWN-GRAY, LAMINATED, SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
14.7	SOFT TO FIRM, GRAY, SILTY CLAY, TRACE TO LITTLE F-C SAND, TRACE F-C GRAVEL (TILL)
16.7	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH BAILER.

STAINLESS STEEL BAILER WITH TEFLON CHECK VALVE WAS USED. BAILER WAS STEAM CLEANED THEN RINSED WITH DEIONIZED WATER BEFORE DEVELOPMENT. A NEW PIECE OF POLYPROPYLENE ROPE WAS DESIGNATED TO THIS WELL AND KEPT IN A CLEAN PLASTIC BAG.

TOTAL VOLUME REMOVED DURING DEVELOPMENT WAS 10.3 GALS.

DEVEL. MEASUREMENTS:

DATE	pH	SPEC. COND	GALLONS BAILED	COMMENTS
11-13-85	7.0	2,600	2.8	
11-17-85	6.6	4,000	2.5	WATER SL. MILKY
11-19-85	6.7	4,200	2.5	SLIGHTLY MILKY
11-21-85	—	—	2.5	RECOVERY TEST PERFORMED

Golder Associates	SUBJECT INSTALLATION NOTES		
	Job No. 853-3020	Made by IDC	Date 11/6/85
	Ref. L-14	Checked	Sheet 1 of 2
		Reviewed JBZ	

1. a) Augered down to 4.5'. Some surface dirt fell in. Sounded well at 3.5'. Used 6" Ø casing to try and tamp it out. Sounded well after tamping and it's at 4.5'.

b) Installed 6" Ø steel surface casing. Bottom of 6" csg is at 4.5'.

c) Grouted borehole with bentonite slurry of about 20 gals. About 5 gals ran out of hole.

d) 6" Ø surface casing drilled and flushed till water ran clear. Bailed water out and sounded hole at 4.5'.

2. a) 4" Ø flush joint casing hammered from 4.5 to 1.2. Then drilled and flushed out to 1.2. Hammered down from 1.2' to 13.5. Then hammered casing to 16.6 and drilled and flushed out 4" csg till water ran clear. Sounded hole @ 16.7'. Hole bailed to within 0.5' from bottom.

3. a) Borehole backfilled with filter sand up to 16.1'

b) Well screen and riser pipe installed at 16.1'

c) Backfilling: The 4" Ø casing was pulled up approx 1' at a time then sounded to ensure that no slowdown of the hole had occurred.

Filter pack: screen borehole annulus backfilled with 5.0 gals. of sand up to 6.5' bgs.

Bentonite seal: Riser pipe borehole annulus backfilled with 2.1 gals. up to 2.5 bgs.

4. a) Water level @ 2:48" at 14:48 on 10-18-85

5. a) An aluminum protective flush joint casing was threaded on to 6" Ø casing.

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 833-3030 Ref. L-14	Made by JDC Checked Reviewed JPL	Date 11/6/83 Sheet 2 of 2

6. a) Cap was vented by drilling holes in it

7. a) A 30' hole was hand dug around 6" ϕ casing and was filled with cement and sloped so water would run away from well.

8 a) Three 1/4" drain holes was drilled in casing just above cement mound.

9. a) Cement was poured in the annular space between the 6" ϕ surface csg and the well pipe to a level even with the cement outside of the surface csg. Coarse sand was added in the remainder of the annular space, to about 5 inches below the well cap. The sand was added after the cement cured.

. Golder Associates

Field Boring Log

DEPTH HOLE 46.2 JOB NO. 853-3013 PROJECT CWM/OLA/OHIO BORING NO. G-15
DEPTH SOIL DRILL 46.2 QA INSP. P. INGRAM DRILLING METHOD CME CONTINUOUS SOIL SAMPLER SHEET 1 OF 3
DEPTH ROCK CORE NA WEATHER SNOW DRILLING COMPANY GEOMETHANICS SURFACE ELEV. 606
NO. DIST. SA. 0 UD. SA. 10 TEMP. 15°F DRILL RIG CME 55 DRILLER T. SELVAGGI DATUM MSL
DEPTH WL. ≈12' HRS. PROD. NA WT. SAMPLER HAMMER NA DROP NA STARTED 1300 (Time) 11-31-85 (Date)
TIME WL. AT TIME OF BORING HRS. DELAYED NA WT. CASING HAMMER NA DROP NA COMPLETED 1800 11-31-85

SAMPLE TYPES

AS	AUGER SAMPLE	BL	BLACK
CS	CHUNK SAMPLE	BR	BROWN
OD	DRIVE OPEN	C	COARSE
DS	DENISON SAMPLE	CA	CASING
PS	PITCHER SAMPLE	CL	CLAY
RC	ROCK CORE	CLY	CLAYEY
ST	SLOTTED TUBE	F	FINE
TO	THIN WALLED, OPEN	FRAG	FRAGMENTS
TP	THIN WALLED, PISTON	GL	GRAVEL
WS	WASH SAMPLE	LYD	LAYERED
CSS	CONTINUOUS SOIL SAMPLE	LI	LITTLE

ABBREVIATIONS

M	MEDIUM	SA	SAMPLE
MIC	MICACEOUS	SAT	SATURATED
MOT	MOTTLED	SD	SAND
NP	NON PLASTIC	SI	SILT
OG	ORANGE	SIT	SILTY
ORG	ORGANIC	SM	SOME
PH	PRESSURE HYDRAULIC	TR	TRACE
PM	PRESSURE MANUAL	WL	WATER LEVEL
R	RED	WH	WEIGHT OF HAMMER
RES	RESIDUAL	Y	YELLOW
RK	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" – 0-5%
"LITTLE" – 5-12%
"SOME" – 13-30%
"AND" – 30-60%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	DEPTH	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
605.5									AUGERED TO 0.95'. BEFORE SAMPLING DUE TO GRAVEL FILL
0.5 / 603.5	Firm to stiff, brown-black, CLAYEY SILT, trace organics (FILL)			1	CSS		3.9/3.9		
2.5 / 601.6	Firm to stiff tan-brown SILTY CLAY, some f-c sand, trace fine gravel (FILL)		4.4						
4.4 / 597.9	Firm to stiff, gray-tan, mottled SILTY CLAY, trace fine sand (LACUSTRINE)			2	CSS		5.0/5.0		
8.1 / 592.5	Stiff to soft, gray-tan laminated SILTY CLAY, trace fine sand (LACUSTRINE)		9.4	3	CSS		5.0/5.0		
13.5	Soft to hard, gray, SILTY CLAY, some f-c sand, trace f-c gravel (TILL)		14.4	4	CSS		1.1/5.0		Poor recovery due to soft soil
			19.4	5	CSS		4.5/5.0		

Golder Associates

Field Boring Log

DEPTH HOLE 46.2 JOB NO. 853-3013 PROJECT CWM/OLD/OHIO BORING NO. G-15
DEPTH SOIL DRILL 46.2 QA INSP. P. INGRAM DRILLING METHOD CME CONTINUOUS SOIL SAMPLER SHEET 2 OF 3
DEPTH ROCK CORE NA WEATHER SNOW DRILLING COMPANY GEOMECHANICS SURFACE ELEV. 606
NO. DIST. SA. 0 UD. SA. 10 TEMP. 15°F DRILL RIG CME 55 DRILLER J. SELVOSKI DATUM MSL
DEPTH WL. ≈12' HRS. PROD. NA WT. SAMPLER HAMMER NA DROP NA STARTED 1300 (TIME) 11-31-85 (DATE)
TIME WL. AT TIME OF BORING HRS. DELAYED NA WT. CASING HAMMER NA DROP NA COMPLETED 1200 11-1-85

SAMPLE TYPES
AS AUGER SAMPLE; CS CHUNK SAMPLE; DO DRIVE OPEN; DS DENISON SAMPLE; PS PITCHER SAMPLE; RC ROCK CORE; ST SLOTTED TUBE; TO THIN WALLED OPEN; TP THIN WALLED PISTON; WS WASH SAMPLE; CSS CONTINUOUS SOIL SAMPLE

ABBREVIATIONS
BL BLACK; BR BROWN; C COARSE; CA CASING; CL CLAY; CLY CLAYEY; F FINE; FRAG FRAGMENTS; GL GRAVEL; LYD LAYERED; LI LITTLE; M MEDIUM; MIC MICACEOUS; MOT MOTTLED; NP NON PLASTIC; OG ORANGE; ORG ORGANIC; PH PRESSURE HYDRAULIC; PM PRESSURE MANUAL; R RED; RES RESIDUAL; RX ROCK; SA SAMPLE; SAT SATURATED; SD SAND; SI SILT; SLY SILTY; SM SOME; TR TRACE; WL WATER LEVEL; WH WEIGHT OF HAMMER; Y YELLOW

BOIL DESCRIPTION - RANGE OF PROPORTION
"TRACE" — 0-5%; "LITTLE" — 5-12%; "SOME" — 12-30%; "AND" — 30-50%

CONSISTENCY
LS LOOSE; S SOFT; CP COMPACT; FM FIRM; DN DENSE; ST STIFF; V VERY; H HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to hard gray SILTY CLAY, some f-c sand, trace f-c gravel (TILL)		24.4	5	CSS				
			29.4	6	CSS		5.0/5.0		
			34.4	7	CSS		4.2/5.0		
			39.4	8	CSS		5.0/5.0		
			44.4	9	CSS		4.4/5.0		
563.0 / 43.0	Hard gray CLAYEY SILT, some f-c sand, trace f-c gravel			10	CSS		1.8/1.8		
560.2 / 45.8	Weathered Rock Shale and gypsum								

Golder Associates

Field Boring Log

DEPTH HOLE 46.2	JOB NO. 853-3013	PROJECT CWM/OLD/OHIO	BORING NO. G-15
DEPTH SOIL DRILL 46.2	QA INSP. P. INGRAM	DRILLING METHOD CME CONTINUOUS SOIL SAMPLER	SHEET 3 OF 3
DEPTH ROCK CORE 0	WEATHER SNOW	DRILLING COMPANY GEOMECHANICS	SURFACE ELEV. 606
NO. DIST. SA. 0 UD. SA. 10	TEMP. 15°F	DRILL RIG CME 55 DRILLER J. SENUSCI	DATUM MSL
DEPTH WL. ≈ 12'	HRS. PROD. NA	WT. SAMPLER HAMMER NA DROP NA	STARTED 1300 (TIME) 11-31-85 (DATE)
TIME WL. AT TIME OF BORING	HRS. DELAYED NA	WT. CASING HAMMER NA DROP NA	COMPLETED 1800 11-31-85

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED PISTON
WS	WASH SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RK	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0-6%
"LITTLE" — 6-12%
"SOME" — 12-30%
"AND" — 30-60%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. DEPTH	DESCRIPTION	BLOWS/FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC/ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
46.2	AUGER REFUSAL								Upon completion of boring, the borehole was backfilled with thick bentonite slurry mixed at 1.5 to 2.0 lbs per gallon of water
									Water level is based on sample moisture and cuttings rather than actual measurements and should therefore be considered approximate

Golder Associates

Field Boring Log

DEPTH HOLE 19.4	JOB NO. 853-3013	PROJECT Cuyahoga/Ohio		BORING NO. 15A	
DEPTH SOIL DRILL 19.4	QA INSP. P. INGRAM	DRILLING METHOD CME Continuous Soil Sampler		SHEET 1 OF 1	
DEPTH ROCK CORE NA	WEATHER SNOW	DRILLING COMPANY Geoconstructors		SURFACE ELEV. 606	
NO. DIST. SA. 0 UD. SA. 1	TEMP. 10°F	DRILL RIG CME 55	DRILLER J. Selvoski	DATUM MSL	
DEPTH WL. ≈12'	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA	STARTED TIME DATE 1-31-85	
TIME WL. AT TIME OF DRILLING	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA	COMPLETED TIME DATE 1-31-85	

SAMPLE TYPES

AS	AUGER SAMPLE	BL	BLACK
CS	CHUNK SAMPLE	BR	BROWN
DO	DRIVE OPEN	C	COARSE
DS	DENISON SAMPLE	CA	CASING
PS	PITCHER SAMPLE	CL	CLAY
RC	ROCK CORE	CLY	CLAYEY
ST	SLOTTED TUBE	F	FINE
TO	THIN WALLED, OPEN	FRAG	FRAGMENTS
TP	THIN WALLED, PISTON	GL	GRAVEL
WS	WASH SAMPLE	LYD	LAYERED
CSS	CONTINUOUS SOIL SAMPLE	LI	LITTLE

ABBREVIATIONS

M	MEDIUM	SA	SAMPLE
MIC	MICACEOUS	SAT	SATURATED
MOT	MOTTLED	SD	SAND
NP	NON PLASTIC	SI	SILT
OG	ORANGE	SIT	SILTY
ORG	ORGANIC	SM	SOME
PH	PRESSUREMYDRAULIC	TR	TRACE
PM	PRESSURE MANUAL	WL	WATER LEVEL
R	RED	WH	WEIGHT OF HAMMER
RES	RESIDUAL	Y	YELLOW
RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FOOT)	REC. / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
591.6									AUGERED TO 14.4 BEFORE SAMPLING - ATTEMPT TO PICK UP SAMPLE MISSED IN 6-15
14.4 / 590.0	Firm, brown-gray laminated SILTY CLAY, trace fine sand								
16.0 / 586.6	Soft to firm, gray SILTY CLAY, some f-c sand, trace f-c gravel (TILL)			1	CSS		4.0/5.0		
19.4	BORING TERMINATED								Upon completion of boring the bore-hole was backfilled with thick bentonite slurry mixed at 1.5 to 2.0 lbs per gallon of water. Water level is based on sample moisture and cuttings rather than actual measurements and should therefore be considered approximate

PROJECT CWM / VICKERY / OHIO — JOB NO. 8533020 — BORING NO. MW-15R — DATE 2/18/85 — SHEET 1 OF 1

BORING BEGAN 10/1/85 — BORING COMPLETED —

CORE HOLE LOCATION: MW-15R

METHOD OF CORING: ROTARY — DRILLING FLUID: POTABLE WATER — GR. ELEV. — — WEATHER —

CASING USED — — SIZE NX — INSPECT. L.F. — OPERAT. —

WATER LEVEL, TIME, DATE —

DEPTH (FT.)	RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH	TYPE	INFILLING	ANGLE W/AXIS	FREQUENCY	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN./FT.
465.0																	
478													BEGIN CORING AT 478 FT BELOW GS.				
										WHITE		SLIGHT	WHITE GYPSUM. 49.35 FT - GRADATION TO DOLOMITE				
		(87%/92%)	(13%/116.4%)	20 TO 31.5	FLATTINGS	GYPS	30-40 BEDDING	0.08' TO 0.25'			FINE TO VERY FINE		LIGHT GRAY TO DARK GRAY DOLOMITE				
	1	95%	12%	31.5 TO 35.5	FRACTURES	GYPS	30-40 BED	0.2' TO .25'					49.9 TO 51.5 FT - GYPSUM LAMINAE.				
										LIGHT GRAY TO DARK GREY			51.5 TO 55.5 FT - WOOLY DOLOMITE WITH GYPSUM INFILLING				
													52.75 FT - EST 0.2 FT CORE LOSS.				
				55.5 TO 61	FLATTINGS	GYPS	70 TO BED	4.0'				SLIGHT TO MOD	53.4 FT - TRANSITION TO ARGILLACEOUS DOLOMITE WITH SECONDARY GYPSUM INFILLINGS.	—	—	—	—
				62.0	JOINT	[illegible]	45°						57.0 FT - EST 0.1 FT CORE LOSS				
													57.1 FT - EST 0.2 FT CORE LOSS				
520													57.5 TO 61.1 FT - DARK GRAY ARGILLACEOUS LAMINATED DOLOMITE WITH TRACE FIBROUS GYPSUM.				
												MOD	58.1 FT - EST 0.25 FT CORE LOSS				
		(67%/70%)	(8%/64%)										58.1 TO 58.9 FT - CORE BROKEN.				
	2	96%	31%	60.0	JOINT	[illegible]	45°										
				62.5 TO 64.0	FRACTURES	GYPS	70 TO BED	0.08' TO 0.5'		WHITE		MOD TO HIGH	WHITE GYPSUM WITH SECONDARY DOLOMITE INFILLING				
										LIGHT GRAY		SLIGHT	LIGHT GRAY LAMINATED DOLOMITE WITH SECONDARY GYPSUM INFILLING AND FIBROUS GYPSUM LAMINAE.				
540													END OF CORING @ 64.0 FT BELOW G.S.				

SCALE: 1 DIVISION = 0.2 FEET

CHECKED: W.B.G. Jr.

DATE 10/1/85 LOGGED BY LF

MONITORING WELL INSTALLATION LOG

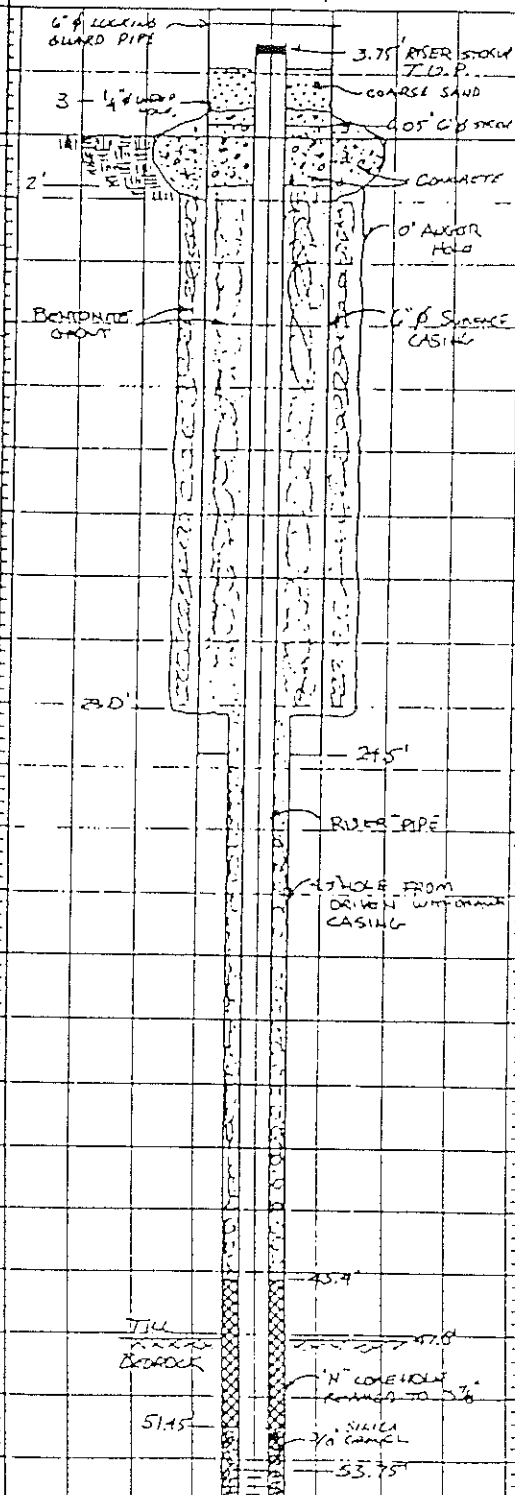
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO. TR	SHEET 1 OF 2
GA INSP. L. FROST	DRILLING METHOD CORE / ROTARY	GROUND ELEV 605.1	WATER DEPTH 10.0
WEATHER	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 608.97	DATE/TIME 10/2/85 10:42
TEMP.	DRILL RIG MOBILE B-61 DRILLER B. KIRKPATRICK	STARTED 10:45 9/30/85 (TIME / DATE)	COMPLETED 10/2/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 52.5 ft	WELL SCREEN 2 in. dia. 10.0 ft	BENTONITE SEAL PELLETS
CASING TYPE STAINLESS STEEL (316)	SCREEN TYPE STAINLESS STEEL WIRE WOUND (316)	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 100 (0.10in)	FILTER PACK QTY 5.5 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE 7/8" SILICA GRAVEL
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0 0.5	FIRM TO STIFF, BROWN-BLACK, CLAYEY SILT, TRACE ORGANICS (FILL)
2.5	FIRM TO STIFF TAN-BROWN SILTY CLAY, SOME F-C SAND, TRACE FINE GRAVEL (FILL)
4.4	FIRM TO STIFF, GRAY-TAN, MOTTLED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
8.1	STIFF TO SOFT, GRAY-TAN LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
13.5	SOFT TO HARD, GRAY, SILTY CLAY, SOME F-C SAND, TRACE F-C GRAVEL (TILL)
43.0	HARD GRAY CLAYEY SILT, SOME F-C SAND, TRACE F-C GRAVEL
43.5	
46.2	WEATHERED ROCK SHALE AND GYPSUM
	WHITE GYPSUM
	LIGHT GRAY LAMINATED DOLOMITE WITH GYPSUM LAMINAE
55.0	CONT. ON P. 2

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

- TOTAL VOLUME PURGE = 5,040 gals
- WATERLOSS DURING DRILLING WAS APPROX 1,800 GAS.
- TIME FOR REMOVAL OF 5,040 gals WAS 11 hr 50 min.
- DEVELOPMENT EQUIPMENT: AIR LIFT USING 1" ϕ PVC FOR AIR LINE. AIR SOURCE WAS A DAYTON SPEEDAIRE OIL-LESS COMPRESSOR.
- PARTIAL DEVELOPMENT WAS DONE ON THE DATE OF INSTALLATION (10-2-85) TO DETERMINE IF THE SAND PACK WOULD SETTLE.
- PARTIAL DEVELOPMENT DONE BEFORE ADDITION OF BENTONITE PELLETS. REMAINDER OF DEVELOPMENT DONE FROM 10-22-85 TO 10-23-85.

CONT. ON PAGE 2

MONITORING WELL INSTALLATION LOG

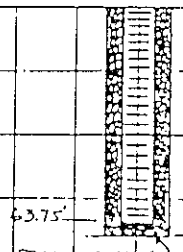
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO. [illegible]5R	SHEET 2 OF 2
GA INSP. L. FROST	DRILLING METHOD CORE / ROTARY	GROUND ELEV 605.1	WATER DEPTH 19.0'
WEATHER	DRILLING COMPANY BOLKER / MORNEIR	COLLAR ELEV 608.77	DATE/TIME 10/2/85 19:42
TEMP	DRILL RIG MOBILE B-61	DRILLER B. KIRKPATRICK	STARTED 10:45 / 10/30/85 (TIME / DATE) COMPLETED (TIME / DATE)

MATERIALS INVENTORY - SEE PAGE 1

WELL CASING ____ in. dia. ____ LF	WELL SCREEN ____ in. dia. ____ LF	BENTONITE SEAL PELLETS
CASING TYPE	SCREEN TYPE	INSTALLATION METHOD
JOINT TYPE	SLOT SIZE	FILTER PACK QTY
GROUT QUANTITY	CENTRALIZERS	FILTER PACK TYPE
GROUT TYPE	DRILLING MUD TYPE	INSTALLATION METHOD

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
55.0	CONT. FROM P. 1 LIGHT GRAY LAMINATED DOLOMITE
61.1	WHITE GYPSUM WITH SECONDARY DOLOMITE INFILLING
63.5	LIGHT GRAY LAMINATED DOLOMITE
65.0	CORING TERMINATED @ 64.0'

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

SUBSEQUENT DEVELOPMENT WAS DONE ON 11-19-85 WITH APPROX 2000 GALS REMOVED THIS DAY. ADDITIONAL DEVELOPMENT WAS DONE BECAUSE SURFACE WATER POOLED AROUND THE WELL AND A POSSIBILITY OF CONTAMINATION FROM SURFACE WATER DID EXIST.

MEASUREMENTS FROM DURING DEVELOPMENT:

DATE	GALS REMOVED	pH	SPECIFIC CONDUCTIVITY	Temp
10-2-85	~5	9.2	10,000	60°F
10-22-85	150	7.5	3,000	53°F
10-31-85	1600	7.3	3,100	55°F
11-13-85	2,200	7.5	3,200	53°F
11-19-85	5,040	–	–	–

Golder Associates	SUBJECT Installation Notes		
	Job No. 893-3020	Made by CF	Date
	Ref. MW-15R	Checked	Sheet 1 of 2
		Reviewed	

1. a) Drilled 10" ϕ hole to 23.0' bgs using solid stem augers
   b) Installed 6" ϕ flush-joint steel casing
   c) Drove 6" ϕ surface casing to 24.5' bgs
   d) Tremie grouted borehole annulus with bentonite slurry mixed @ 1.5 to 2.0 lbs/gal of water; calculated grout volume 53 gal. actual volume used ~60 gal.

2. a) 4" ϕ flush-joint casing hammered to 32' bgs
   b) Inside of 4" ϕ casing drilled out with 3 7/8" roller cone to 32' bgs
   c) Borehole flushed clean and bailed to within 0.5' of bottom of hole
   d) Borehole drilled to 47.8' bgs with 3 7/8" roller cone
   e) 4" ϕ casing hammered to 47.7' bgs, near refusal
   f) Inside of 4" ϕ casing drilled out with 3 7/8" roller cone to 47.8' bgs
   g) Inside of 4" ϕ casing flushed clean and bailed to within 0.5' of bottom of hole

3. a) Cored with 'N' size bit from 47.8'-57.0' bgs; water return ~50%; water loss ~375 gal
   b) Cored from 57.0'-64.0' bgs; poor circulation, water return ~10%; water loss ~425 gal
   c) Total water loss during coring ~800 gal.

4. a) Reamed with 3 7/8" ϕ roller cone from 47.8'-64.0' bgs; water recovery ~20%; water loss ~640 gal
   b) Hole flushed clean; water recovery ~25%; water loss ~335 gal; hole sounded @ 64.0' bgs
   c) Total water loss during reaming and flushing ~975 gal.

5. a) Well screen and riser pipe installed, well bottoming @ 64.0' bgs
   b) Filter pack: screen/borehole annulus backfilled with 3/8" gravel to 51.45' bgs; Calculated filter pack volume 5.4 gal, actual volume used ~5½ gal.
   c) Partially developed the well; pumped ~140 gal water, level of filter pack did not change

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020	Made by CF	Date
	Rel. MW-15R	Checked	Sheet 2 of 2
		Reviewed NPL	

d) Bentonite Seal: Riser pipe / borehole annulus backfilled with bentonite pellets to 48.3' bgs; pulled 5' of 4" ϕ casing; hole sloughed in from 46.5' - 48.3' bgs; lowered 1" PVC pipe down between 4" ϕ casing / riser pipe annulus and flushed sloughed material out; top of bentonite seal backfilled to 45.4' bgs; calculated bentonite volume 2.7 gal, actual volume used ~ 3 gal.

e) Tremie grouted borehole annulus to surface with bentonite slurry mixed @ 1.5 - 2.0 lbs / gal of water; calculated grout volume 4.12 gal, actual volume used ~ 5.0 gal.

6. a) Installed protective casing with hinged cap

7. a) Water level upon completion 19.00' at 19:42 on 10-2-95.

8. a) Vented steel well cap by drilling hole.

9. a) 6" ϕ aluminum threaded protective pipe with hinged lid was installed and locked.

b) A 30" hole was dug around the surface csg and filled with concrete to approximately 3 inches above the base of the protective pipe.

c) About 2' of bentonite grout was removed from the inside of the 6" ϕ surface csg and cement was added to a level even with the cement mound outside of the csg.

d) Three ¼" ϕ drain holes were drilled just above the cement seal that is inside and outside the protective pipe.

10 a) Sand was poured inside the 6" ϕ surface csg to within ~ 5 inches of the top of well pipe.

MONITORING WELL INSTALLATION LOG

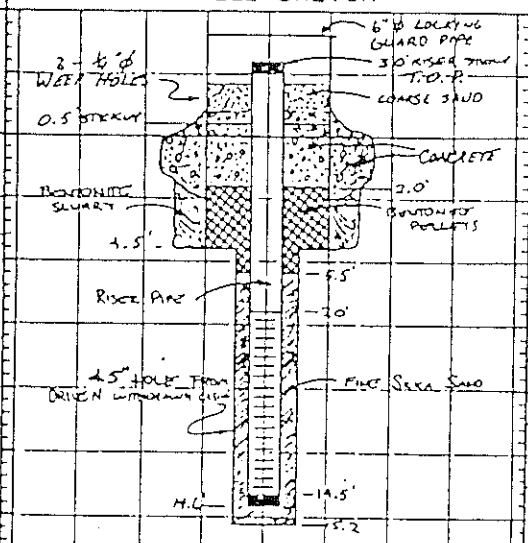
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO L-15	SHEET 1 OF 1
GA INSP. L. FROST	DRILLING METHOD AUGER / ROTARY	GROUND ELEV 604.8	WATER DEPTH 14.42'
WEATHER SUNNY	DRILLING COMPANY EXPLORATION TECHNOLOGY INC.	COLLAR ELEV 607.84	DATE/TIME 1/17/85 18:16
TEMP.	DRILL RIG CME 55 DRILLER C. BARTLE	STARTED 0945 / 1/17/85 (TIME / DATE)	COMPLETED 1810 / 1/17/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 100 LF	WELL SCREEN 2 in. dia. 7.5' LF	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH COUPLED	SLOT SIZE 0.0060 in.	FILTER PACK QTY ~5.0 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	GRAVEL FILL
.5	FIRM TO STIFF BROWN-BLACK CLAYEY SILT, TRACE ORGANICS (FILL)
2.5	FIRM TO STIFF TAN-BROWN SILTY CLAY, SOME F-C SAND, TRACE FINE GRAVEL (FILL)
4.4	FIRM TO STIFF, GRAY-TAN, MOTTLED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
8.1	STIFF TO SOFT, GRAY-TAN LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
13.5	SOFT TO HARD, GRAY SILTY CLAY SOME F-C SAND TRACE F-C GRAVEL (TILL)
15.2	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH STAINLESS STEEL BAILER.

BAILER WAS STEAM CLEANED AND RINSED WITH DEIONIZED WATER BEFORE BAILING. A NEW POLYPROPYLENE ROPE WAS DESIGNATED FOR THIS WELL

TOTAL VOLUME REMOVED DURING BAILING WAS 8.6 gals. Estimated CAPACITY OF WELL IF STATIC IS 4.8' BELOW TOP OF RISER IS 2.1 GALS.

CONVERSION FACTOR = 0.163 GALS PER FOOT

MEASUREMENTS DURING DEVEL.

DATE	GALLONS BAILED	pH	SPECIFIC COND	COMMENTS
11-13-85	2.5	7.0	2,300	
11-17-85	2.0	6.5	7,000	MILKY
11-19-85	2.8	6.4	9,800	SLIGHTLY MILKY
11-21-85	1.3	–	–	RECOVERY TEST

STATIC WATER LEVEL 1-14-86 was 4.82'

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020	Made by LF & W.G.G.	Date
	Ref. L15	Checked	Sheet 1 of 2
		Reviewed GEC	

1. a) Drilled 10" ϕ hole to 4.5' bgs using solid-stem augers; hole sounded @ 3.0' bgs, material sloughing in; hole reaugered, sounded @ 4.5' bgs
   b) Installed 6" ϕ flush-joint steel surface csg, bottom of 6" csg @ 4.5' bgs
   c) Grouted borehole annulus with bentonite slurry mixed @ 1.5-2.0 lb/gal water; grout poured into borehole annulus from ground surface; calculated grout volume 10.4 gal; actual volume used ~15 gal
   d) 6" ϕ surface csg drilled and flushed clean to 4.5' bgs; hole bailed to within 0.5' of bottom of hole

2. a) 4" ϕ flush-joint csg hammered from 4.5' to 9.5' bgs; inside of csg drilled out with 3 7/8" ϕ roller cone; hole flushed clean with water
   b) 4" ϕ csg hammered from 9.5' to 15.2' bgs; inside of csg drilled out with 3 7/8" ϕ roller cone; hole flushed clean; hole bailed to within 0.5' of bottom of hole

3. a) Borehole backfilled with filter sand to 14.5' bgs
   b) Well screen and riser pipe installed → well bottoming @ 14.5' bgs
   c) Backfilling: The 4" ϕ csg was pulled up approx 1' @ a time then sounded to ensure that no sloughing of the hole had occured. The open borehole annulus was then backfilled with sand or bentonite pellets depending on what interval of the hole was being backfilled.

   Filter Pack: screen / borehole annulus backfilled with sand to 5.5' bgs; calculated filter pack volume 6 gal, actual volume used ~5 gal

   Bentonite Seal: riser pipe / borehole annulus backfilled with bentonite pellets to 2.0' bgs; calculated bentonite volume 3.7 gal → actual volume used ~4 gal

4. a) Water level @ time of completion of well = 14.42' below top of 2" riser pipe

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 953-3020 Ref. L-15	Made by W.G.L Checked Reviewed	Date Sheet 2 of 2

5 a) An aluminum flush joint protective csg (6"ϕ) was threaded on the 6"ϕ surface csg and secured with a lock.

6 a) A 30" deep hole was hand dug around the well and a Portland Cement - sand mixture was poured in and formed to slope or drain away from the well.

b) Deionized water was added to the bentonite pellets to facilitate hydration.

c) Cement was added to the annular space above the bentonite pellet to a level even with the cement mound outside.

d) After the cement had cured, coarse sand was poured inside the protective csg. to about 5-inches below the top of 2"ϕ well pipe

7 a) The well cap was vented by drilling a small ϕ hole.

Golder Associates

Field Boring Log

DEPTH HOLE 49.1	JOB NO. 853-3013	PROJECT CWM/OLD/OHIO	BORING NO. G-16
DEPTH SOIL DRILL 49.1	QA INSP. P. INGRAM	DRILLING METHOD CME CONTINUOUS SOIL SAMPLER	SHEET 1 OF 3
DEPTH ROCK CORE NA	WEATHER SNOW	DRILLING COMPANY GEOMECHANICS	SURFACE ELEV. 609
NO. DIST. SA. 0 UD. SA. 10	TEMP. 20°F	DRILL RIG CME 55 DRILLER J. SELVOSKI	DATUM MSL
DEPTH WL. ≈ 12'	HRS. PROD. NA	WT. SAMPLER HAMMER NA DROP NA	STARTED 0900 (TIME) / 1-31-85 (DATE)
TIME WL. AT TIME OF BORING	HRS. DELAYED NA	WT. CASING HAMMER NA DROP NA	COMPLETED 1215 / 1-31-85

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DD	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	CONTINUOUS SOIL SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 60%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DH	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
608.6 / 0.5	Gravel to gray black SILTY CLAY with organics (FILL)		1	CSS		3.7/3.7		AUGERED TO 1.0 FOOT BEFORE SAMPLING DUE TO GRAVEL FILL
606.3 / 2.7	Firm to stiff, brown-gray mottled SILTY CLAY, trace organics (LACUSTRINE)		2	CSS		5.0/5.0	4.1	
602.3 / 6.7	Firm to stiff, gray-tan, laminated SILTY CLAY, trace fine sand (LACUSTRINE)		3	CSS		5.0/5.0	9.1	
598.6 / 10.4	Firm to stiff, brown SILTY CLAY (TILL)		4	CSS		5.0/5.0	14.1	
596.6 / 12.4	Soft to hard, gray SILTY CLAY, some f-c sand, trace f-c gravel (TILL)		5	CSS		5.0/5.0	19.1	

Golder Associates

Field Boring Log

DEPTH HOLE 49.1	JOB NO. 853-3013	PROJECT Carm/OLD/OHIO	BORING NO. G-16
DEPTH SOIL DRILL 49.1	GA INSP. P. Ingram	DRILLING METHOD CME Continuous Soil Sampler	SHEET 2 OF 3
DEPTH ROCK CORE NA	WEATHER Snow	DRILLING COMPANY Geomechanics	SURFACE ELEV. 609
NO. DIST. SA. 0 UD. SA. 10	TEMP. 20°F	DRILL RIG CME 55 DRILLER T. Selvoski	DATUM MSL
DEPTH WL. ≈12'	HRS. PROD. NA	WT. SAMPLER HAMMER NA DROP NA	STARTED 0900 (TIME) / 1-31-85 (DATE)
TIME WL. AT TIME OF BORING	HRS. DELAYED NA	WT. CASING HAMMER NA DROP NA	COMPLETED 1215 / 1-31-85

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE

CSS Continuous Soil Sample

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RK	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 60%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DH	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. DEPTH	DESCRIPTION	BLOWS/FT		SAMPLES NO.	TYPE	HAMM BLOWS PER 6 IN (FORCE)	REC/ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to hard, gray, SILTY CLAY, some f-c sand, trace f-c gravel (TILL)			5	CSS		5.0/5.0		
			24.1	6	CSS		0/5.0		Poor recovery due to soft soils
			29.1	7	CSS		2.4/5.0		Poor recovery due to soft soils
			34.1	8	CSS		1.5/5.0		Poor recovery due to soft soils
568.0 / 41.0	Hard, gray, CLAYEY SILT, some f-c sand, trace f-c gravel (TILL)		39.1	9	CSS		4.5/5.0		
			44.1	10	CSS		5.0/5.0		

Golder Associates

Field Boring Log

DEPTH HOLE 49.1	JOB NO. 853-3013	PROJECT CWM/OLD/OHIO	BORING NO. G-16
DEPTH SOIL DRILL 49.1	QA INSP. P. INGRAM	DRILLING METHOD CME Continuous Soil Sampler	SHEET 3 OF 3
DEPTH ROCK CORE NA	WEATHER SNOW	DRILLING COMPANY GEOMECHANICS	SURFACE ELEV. 609
NO. DIST. SA. 0 UD. SA. 10	TEMP. 20°F	DRILL RIG CME 55 DRILLER J. SERVOSKI	DATUM MSL
DEPTH WL. ≈12'	HRS. PROD. NA	WT. SAMPLER HAMMER NA DROP NA	STARTED 0900 1-31-85
TIME WL. AT TIME OF BORING	HRS. DELAYED NA	WT. CASING HAMMER NA DROP NA	COMPLETED 1445 1-31-85

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	CONTINUOUS SOIL SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SLT	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RK	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0-5%
"LITTLE" — 5-12%
"SOME" — 12-30%
"AND" — 30-50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Hard, gray, clayey silt, some f-c sand, trace f-c gravel (TILL)		10	CSS		5.0/5.0		
560.7 / 48.3	Weathered rock-shale and gypsum							
559.9 / 49.1	AUGER REFUSAL							Upon completion of boring the bore-hole was backfilled with thick bentonite slurry mixed at 1.5 to 2.0 lbs per gallon of water. Water level is based on sample moisture and cuttings rather than actual measurements and should therefore be considered approximate

Golder Associates

Field Boring Log

DEPTH HOLE 39.3	JOB NO. 853-3013	PROJECT Cwm Old Ohio	BORING NO. G-16A
DEPTH SOIL DRILL 39.3	GA INSP. P. Ingram	DRILLING METHOD CME Continuous Soil Sampler	SHEET 1 OF 1
DEPTH ROCK CORE NA	WEATHER Snow	DRILLING COMPANY Geomechanics	SURFACE ELEV. 600
NO. DIST. SA. 0 UD. SA. 3	TEMP. 10°F	DRILL RIG CME 55 DRILLER J Selvoski	DATUM MSL
DEPTH WL. ≈12'	HRS. PROD. NA	WT. SAMPLER HAMMER NA DROP NA	STARTED 0800 12-1-85 (TIME DATE)
TIME WL. AT TIME OF BORING	HRS. DELAYED NA	WT. CASING HAMMER NA DROP NA	COMPLETED 1430 12-1-85

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	CONTINUOUS SOIL SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0-5%
"LITTLE" — 5-12%
"SOME" — 12-30%
"AND" — 30-60%

CONSISTENCY

LX	LOOSE	X	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS/FT	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC/ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
								AUGERED TO 24.3 BEFORE SAMPLING - ATTEMPT TO PICK UP SAMPLES MISSED IN G-16
584.7 / 24.3	Soft to hard, gray, SILTY CLAY, some f-c sand, trace f-c gravel (TILL)		1	CSS		1.1/5.7		Poor recovery due to soft soils
			2	CSS		3.9/4.3		
			3	CSS		5.0/5.0		
569.7 / 39.3	BORING TERMINATED							Upon completion of boring, the bore-hole was backfilled with thick bentonite slurry mixed at 1.5 to 2.0 lbs per gallon of water. Water level is based on sample moisture and cuttings rather than actual measurements and should therefore be considered approximate

PROJECT LWM/VICKERY/OHIO JOB NO. 855-3020 BORING NO. MW-16R DATE 2/15/86 SHEET 1 OF 1

BORING BEGAN 9/22/85 BORING COMPLETED — CORE HOLE LOCATION MW-16R

METHOD OF CORING ROTARY DRILLING FLUID POTABLE WATER GR.ELEV. — WEATHER —

CASING USED — SIZE NX INSPECT. L.F. OPERAT. — WATER LEVEL,TIME,DATE —

DEPTH (FT.)	RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH	TYPE	INFILLING	ANGLE W/AXIS	FREQUENCY	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN./FT.
45.0																	
47.2													ROCK CORING @ 47.2 FT BELOW G.S.				
										GRAY			HARD GRAY TILL				
	1	64%	32%	47.7 TO 55.05	FRACTURES	—	II TO BED	0.02' TO 0.03'		WHITE	FINE TO VERY FINE	HIGH TO MODERATE	WHITE CHALKY GYPSUM EST. 30 FT CORE LOSS NEAR UPPER BEDROCK SURFACE				
				53.05 TO 56.15	FRACTURES	OVGS	II TO BED	0.03' TO 0.07'				UNWEATHERED	LIGHT GRAY TO GRAY ARGILLACEOUS DOLOMITE 53.05 TO 56.15 FT - GYPSUM LAMINAE AND VUGS WITH GYPSUM FILLED FRACTURES.	—	—	—	—
57.2	2	100%	67%	56.15 TO 57.7	FRACTURES	OVGS	II TO BED	0.03' TO 0.21'		LIGHT GRAY TO GRAY		MOD	56.15 TO 57.2 FT - SECONDARY GYPSUM FILLINGS. EST. 0.6 FT CORE LOSS.				
57.7				57.7 TO 63.9	FRACTURES	OVGS	II TO BED	0.01' TO 1.0'				SLIGHT TO MOD	57.7 TO 63.9 FT - OCCASIONAL GYPSUM FRACTURES. 59.2 TO 59.6 FT - TRACE GRAY CLAY RICH LIMESTONE, TRACE VUGS AND FIBROUS GYPSUM EST 0.3 FT CORE LOSS.				
	3	71%	82%														
				63.9 TO 67.4	FRACTURES	—	II TO BED	0.01' TO 0.3'		WHITE		SLIGHT	WHITE GYPSUM WITH SECONDARY DOLOMITE INFILLING. TRACE VUGS FILLED WITH SECONDARY FIBROUS GYPSUM.				
67.4													END OF CORING @ 67.4 FT BELOW G.S.				

SCALE: 1 DIVISION=0.2 FEET

CHECKED BY. WGL

DATE 9/24/85 LOGGED BY LF

MONITORING WELL INSTALLATION LOG

JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO MW-16R	SHEET 1 OF 2
GA INSP L. FROST	DRILLING METHOD CORE / ROTARY	GROUND ELEV 610.6	WATER DEPTH 21.92'
WEATHER	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 613.76	DATE/TIME 9/23/85 15:07
TEMP	DRILL RIG MOBILE B-61 DRILLER B. KRKLATRICK	STARTED 09:20 9/21/85 (TIME / DATE)	COMPLETED 1925 9/24/85 (TIME / DATE)

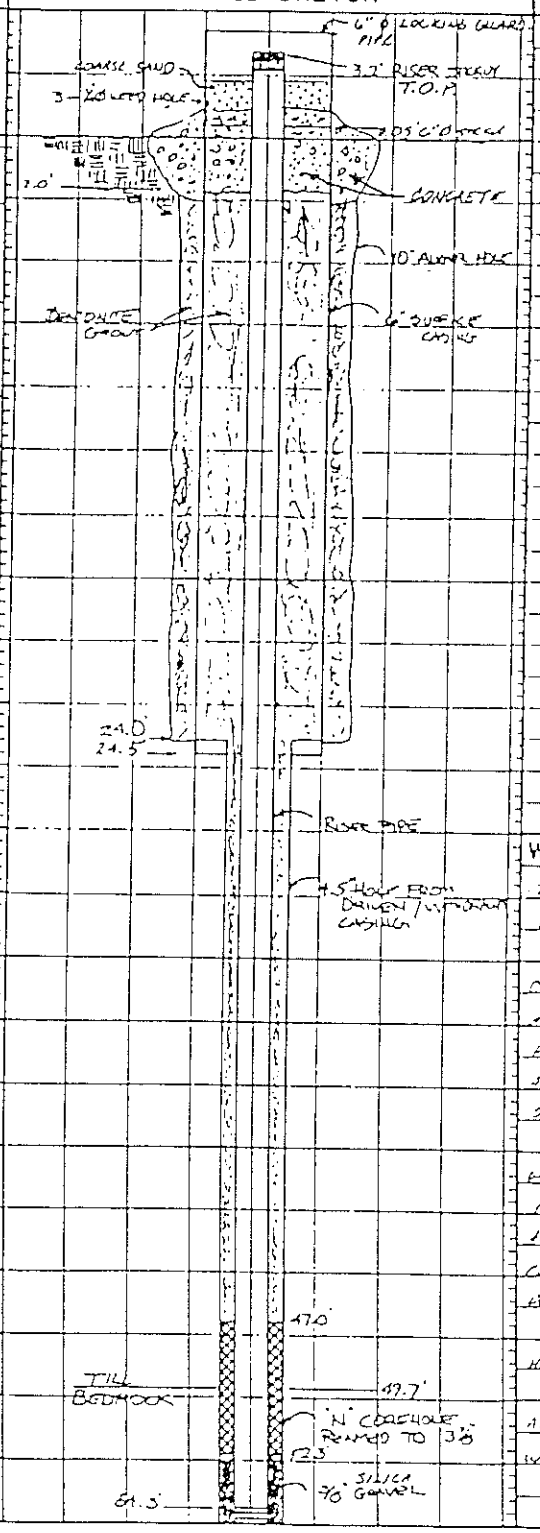
MATERIALS INVENTORY

WELL CASING 2 in dia 57.5 ft	WELL SCREEN 2 in. dia. 10.0 ft	BENTONITE SEAL PELLETS
CASING TYPE STAINLESS STEEL (316)	SCREEN TYPE (316) STAINLESS STEEL WIRE WOUND	INSTALLATION METHOD GRAVITY FALL, TAMPED
JOINT TYPE FLUSH-COUPLED	SLOT SIZE 100 (0.10 in)	FILTER PACK QTY ~5 gal.
GROUT QUANTITY ~35 gal	CENTRALIZERS NONE	FILTER PACK TYPE 7/8 SILICA GRAVEL
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0 / 0.5	GRAVEL TO GRAY BLACK SILTY CLAY WITH ORGANICS (FILL)
2.7	FIRM TO STIFF, BROWN-GRAY MOTTLED SILTY CLAY. TRACE ORGANICS (LACUSTRINE)
6.7	FIRM TO STIFF, GRAY-TAN, LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
10.4	FIRM TO STIFF, BROWN SILTY CLAY (TILL)
12.4	SOFT TO HARD, GRAY SILTY CLAY, SOME F-C SAND, TRACE F-C GRAVEL (TILL)
41.0	HARD, GRAY, CLAYEY SILT, SOME F-C SAND, TRACE F-C GRAVEL (TILL)
49.7	WHITE GYPSUM
53.4	LIGHT GRAY ARGILLACEOUS DOLOMITE

CONT. ON P. 2

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

TOTAL VOLUME PURGED ≅ 7,000 gal

TIME FOR REMOVAL WAS 14 HRS.

DEVELOPMENT EQUIPMENT: AIR LIFT METHOD USING 1" ϕ PVC INJECTOR PIPE WITH THE BOTTOM 5' PIPE. AIR SOURCE WAS A DAYTON SPEEDAIRE OIL-LESS COMPRESSOR

WELL DEVELOPED FROM 10-20-85 TO 10-22-85.

ALL EQUIPMENT WAS STEAM CLEANED BEFORE INSERTING DOWNHOLE. CLEAN LABORATORY GLOVES WERE ALWAYS WHEN HANDLING DEVELOPMENT EQUIPMENT

AFTER 140 GALS REMOVED WATER WAS CLEAR

CONT. PAGE 2

MONITORING WELL INSTALLATION LOG

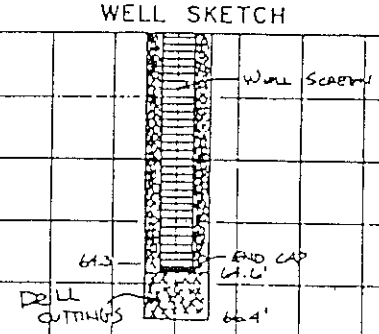
JOB NO 853-3020 PROJECT CWM / VICKERY / OH WELL NO MW-16R SHEET 2 OF 2
GA INSP. C. FROST & W. GIERKE DRILLING METHOD CORE / ROTARY GROUND ELEV 610.6 WATER DEPTH 21.92
WEATHER DRILLING COMPANY BOWSER / MORNER COLLAR ELEV 613.76 DATE/TIME 9/25/85 15:07
TEMP. DRILL RIG MOBILE B-61 DRILLER B. KIRKPATRICK STARTED 09:20 9/21/85 (TIME / DATE) COMPLETED 1925 9/24/85 (TIME / DATE)

MATERIALS INVENTORY - SEE PAGE 1

WELL CASING ____ in. dia. ____ l.f. WELL SCREEN ____ in. dia. ____ l.f. BENTONITE SEAL ____
CASING TYPE ____ SCREEN TYPE ____ INSTALLATION METHOD ____
JOINT TYPE ____ SLOT SIZE ____ FILTER PACK QTY ____
GROUT QUANTITY ____ CENTRALIZERS ____ FILTER PACK TYPE ____
GROUT TYPE ____ DRILLING MUD TYPE ____ INSTALLATION METHOD ____

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
55.0	CONT. FROM P.1 GRAY TO LIGHT GRAY ARGILLACEOUS LAMINATED DOLOMITE
63.9 65.0	WHITE GYPSUM SECONDARY INFILLING
65.4	CORING TERMINATED @ 65.4'
70.0	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

MEASUREMENTS DURING DEVELOPMENT:

DATE	GALLONS REMOVED	pH	SPEC COND	TEMP
10/20/85	START	6.8	2,700	—
10/21/85	1,850	7.4	3,000	53°F
"	2,750	7.2	3,000	53°F
10/22	7,000	7.2	3,000	53°F

WATER LOSS DURING DRILLING WAS APPROX. 4700 GALS.

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020	Made by LF	Date
	Ref. MW-16R	Checked	Sheet 1 of 2
		Reviewed QR	

1. a) Drilled 10" ϕ hole to 24.0' bgs using solid stem augers
b) Installed 6" ϕ flush-joint steel casing
c) Pressure grouted 6" ϕ surface casing with bentonite slurry
d) Drove 6" ϕ surface casing to 24.5' bgs
e) Inside of 6" ϕ surface casing flushed clean and bailed to within 0.5' of bottom of hole
mixed @ 1.5 to 2.0 lbs/gal of water ; calculated grout volume 63 gal, actual volume used gal

16 X

2. a) 4" ϕ flush-joint casing hammered to 34' bgs
b) Inside of 4" ϕ casing drilled out with 3 7/8" roller cone ; hole drilled to 45.5' bgs
c) 4" ϕ casing hammered to near refusal @ 47.0' bgs, assumed bedrock surface
d) Inside of 4" ϕ casing drilled out to 47.2' bgs
e) Inside of 4" ϕ casing flushed clean and bailed to within 1' of bottom of hole ; Water level could not be bailed any lower

3. a) Cored with 'N' size bit from 47.2' - 57.2' bgs ; Poor circulation, water return ~10% ; @ 50' bgs water recovery ~ 25% ; lost circulation @ 57.2' ; water loss ~720 gals
b) Observed till in core sample from 47.2' - 49.7' bgs, defined new bedrock surface @ 49.7' bgs
c) Cored with 'N' size bit from 57.2' - 57.7' bgs ; core catcher became loose @ 57.7' bgs ; water recovery ~25% ; water loss ~110 gal
d) Cored with 'N' size bit from 57.7' - 65.4' bgs ; Poor circulation water recovery ~5% ; lost circulation @ 59' ; water loss ~1280 gal
e) Total water loss during coring ~ 2110 gal

4. a) Rig mounted pump and 1½" 3 HP Teel pump hooked in line to allow a greater volume of water for flushing drill cuttings
b) Reamed with 3 7/8" ϕ roller cone from 47.2' - 65.4' bgs ; hole flushed clean ; water recovery ~30% ; water loss ~1050 gal ; hole sounded @ 62.3' bgs, drill cuttings from 62.3' - 65.4' bgs
c) Hole drilled to 66.4' bgs ; hole flushed clean ; water recovery ~25% ; water loss ~1500 gal ; hole sounded @ 64.6' bgs, drill cuttings from 64.6' - 66.4' bgs
d) Total water loss during reaming and flushing ~ 2550 gal

Golder Associates	SUBJECT Installation Notes		
	Job No. 953-3020 Ref. MW-16R	Made by LF Checked Reviewed GTL	Date Sheet 2 of 2

5. a) Well screen and riser pipe installed, well bottoming @ 64.6' bgs
   b) Filter pack: Screen / borehole annulus backfilled with 3/8" gravel to 52.3' bgs; Calculated filter pack volume 5.4 gal, actual volume used ~ 5 gals
   c) Bentonite seal: Riser pipe / borehole annulus backfilled with bentonite pellets to 48.0' bgs; bentonite bridge @ 19' bgs; tried breaking bridge by pushing 1" PVC pipe through the bridge, unsuccessful; tried breaking through the bridge by dropping a drop weight through the bridge, unsuccessful; Pulled 15' of 4" ϕ casing; bentonite bridge still @ 19' bgs, tried breaking through, as above, unsuccessful; pulled remainder of 4" ϕ casing from hole; hole stayed open; top of bentonite seal @ 47.0' bgs; Calculated bentonite volume 2.4 gal, actual volume used ≈ 5.± gals
   d) Tremie grouted borehole annulus to surface with bentonite slurry mixed @ 1.5 to 2.0 lbs/gal of water; calculated grout volume 34 gal, actual volume used ~ 50 gal

6. a) Installed protective casing with hinged cap
   b) Installed cement grout surface seal
   c) Drilled three 1/4" ϕ weepholes into the protective casing
   d) Placed gravel in riser pipe / protective casing annulus
   e) Vented cap by drilling hole
7. a) Water level upon completion was: 21.92' at 1507 on 9-25-97

MONITORING WELL INSTALLATION LOG

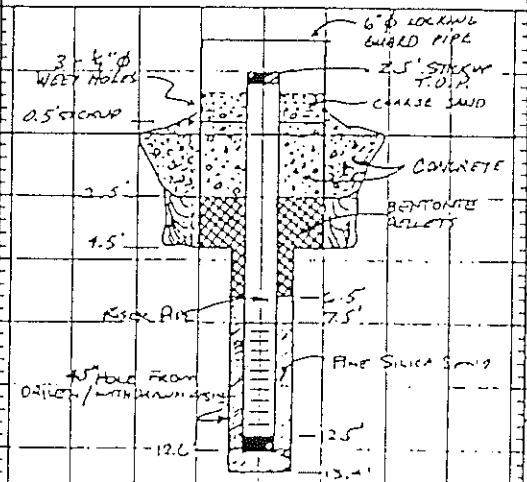
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO L-16	SHEET 1 OF 1
GA INSP [illegible]	DRILLING METHOD Auger / Rotary	GROUND ELEV 610.2	WATER DEPTH 7.75'
WEATHER Pty Cldy	DRILLING COMPANY Bowser / Morgan	COLLAR ELEV 612.7	DATE/TIME 10/7/95 [illegible]
TEMP.	DRILL RIG Mobile B-61 DRILLER B. Kirkpatrick	STARTED [illegible] TIME / DATE	COMPLETED 10/7/95 TIME / DATE

MATERIALS INVENTORY

WELL CASING 2 in. dia. 100' LF	WELL SCREEN 2 in. dia. 50' LF	BENTONITE SEAL Pellets
CASING TYPE 316 Stainless Steel	SCREEN TYPE 316 Stainless Wire Wound	INSTALLATION METHOD Gravity Fall
JOINT TYPE Flush Coupled	SLOT SIZE 0.0060 in.	FILTER PACK QTY 3.8 Gals
GROUT QUANTITY —	CENTRALIZERS None	FILTER PACK TYPE Fine Silica Sand
GROUT TYPE Bentonite Slurry	DRILLING MUD TYPE None	INSTALLATION METHOD Gravity Fall

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0 / 0.5	GRAVEL TO GRAY BLACK SILTY CLAY WITH ORGANICS (FILL)
2.7	FIRM TO STIFF, BROWN-GRAY MOTTLED SILTY CLAY, TRACE ORGANICS (LACUSTRINE)
6.7	FIRM TO STIFF, GRAY-TAN, LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
10.4	FIRM TO STIFF, BROWN SILTY CLAY (TILL)
12.4	SOFT TO HARD, GRAY SILTY CLAY, SOME F-C SAND, TRACE F-C GRAVEL (TILL)
13.4	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH STAINLESS STEEL BAILER WITH TEFLON CHECK VALVE

BAILER WAS STEAM CLEANED AND RINSED WITH DEIONIZED WATER BEFORE EACH PURGING EPISODE.

NEW POLYPROPYLENE ROPE WAS DESIGNATED AND ONLY FOR THIS WELL AND KEPT CLEAN IN PLASTIC BAG.

MEASUREMENTS OBTAINED DURING DEVELOPMENT:

DATE	pH	SPEC. COND.	GALLONS BAILED	COMMENTS
11-13-95	6.9	1,400	1.5	
11-13-95	6.6	4,100	1.0	
11-19-95	6.5	4,300	0.5	SLIGHTLY MILKY
11-21-95	–	–	0.5	RECOVERY TEST PERFORMED

TOTAL VOL. BAILED WAS 3.5 GALS.

Golder Associates	SUBJECT INSTALLATION NOTES		
	Job No. 853-3020	Made by JDC	Date
	Ref. L-16	Checked	Sheet 1 of 2
		Reviewed JFC	

1. a) Drilled down to 4.5' using solid stem auger. Some of the surface dirt fell into hole. Tried several times to it out by re-augering. Just didn't work. So we took the bit off and just used the auger. Sounded hole @ 4.3'
b) Installed 6" Ø casing into hole, bottoming at 4.3'
c) Mixed about 20 gal. bentonite slurry. Pumped grout from bottom of hole up. Had about 5 gallons run out.
d) Surface casing flushed out until water was clear and sounded hole at 4.5'. Bailed water out to within 0.5' from bottom of hole

2. a) 4" Ø flush joint casing hammered from 4.5' to 8.5'. Inside casing drilled out with 3 7/8" roller cone bit; flushed till water ran clear.
b) 4" Ø casing hammered from 8.5' to 13.4' inside casing drilled out and flushed clear. Water then bailed to within 0.5' from bottom of hole. Sounded hole @ 13.4'

3. a) Put filter sand base in and sounded @ 12.5'
b) Well screen and riser pipe installed @ 12.5'
c) Backfilling: The 4" Ø SS was pulled up approx. 1' @ a time then sounded to ensure that no sloughing of the hole had occured. The open borehole annulus was then backfilled with sand or bentonite pellets, depending on what interval of the hole was being backfilled.

Filter Pack: Screen borehole annulus backfilled with [illegible] pts. of sand to 6.5'. Calculated sand volume was 16.8 pts.

Bentonite seal: Riser pipe borehole annulus backfilled with bentonite pellets to 2.5' bgs. Amount of Bentonite used (25.5 pints). Calculated Volume = 29 pints.

4. a) Water level 6 hours after well completed = 9.75 below top of 2" riser pipe

Golder Associates

SUBJECT WELL INSTALLATION NOTES		
Job No. 853-3070	Made by JOC	Date
Ref. L-16	Checked	Sheet 2 of 2
	Reviewed JFC	

5. a) An aluminum protective first joint pipe was threaded onto 6" ϕ surface casing.

6. a) Cap was vented by drilling small ϕ holes in it

7. a) A 30" hole was dug around the 6" ϕ surface casing and filled with cement and sloped so water would run away from the well

8. a) Three 1/4" drain holes were drilled in casing near top of cement mound.

9. a) Added DI water to pellets to facilitate hydration

b) Annular space above bentonite pellets was cemented to the same level as the cement mound outside the wells.

Golder Associates

Field Boring Log

DEPTH HOLE 54.1	JOB NO. 853-3013	PROJECT CWM / OLD / OHIO			BORING NO. G-19
DEPTH SOIL DRILL 54.1	QA INSP. P. INGRAM	DRILLING METHOD CME CONTINUOUS SOIL SAMPLER			SHEET 1 OF 3
DEPTH ROCK CORE NA	WEATHER CLDY	DRILLING COMPANY GEOMECHANICS			SURFACE ELEV. 614
NO. DIST. SA. 0 UD. SA. 12	TEMP. 10°F	DRILL RIG CME 55	DRILLER J. SELVOSKI		DATUM MSL
DEPTH WL. ≈11'	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA		STARTED 0930 / 1-29-85 (TIME / DATE)
TIME WL. AT TIME OF BORING	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA		COMPLETED 1500 / 1-29-85

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	CONTINUOUS SOIL SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0-5%
"LITTLE" — 5-12%
"SOME" — 12-30%
"AND" — 30-50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
613.0									AUGERED TO 1.0 FOOT BEFORE SAMPLING DUE TO GRAVEL FILL
1.0	Firm to stiff, brown-tan, CLAYEY SILT, little f-c sand, little f-c gravel (FILL)			1	CSS		2.4 / 3.2		
			4.2	2	CSS		5.0 / 5.0		
605.5 / 8.5	Firm, black-brown-tan CLAYEY SILT, trace organics								
604.6 / 9.4	Firm to stiff, gray-tan, mottled, SILTY CLAY, trace fine sand (LACUSTRINE)		9.2	3	CSS		3.7 / 5.0		
602.8 / 11.2	Loose to compact brown SILT, some fine sand (LACUSTRINE)								
601.2 / 12.8	Soft to stiff, tan-gray, laminated SILTY CLAY, trace fine sand (LACUSTRINE)		14.2	4	CSS		4.8 / 5.0		
595.0 / 19.0	Soft to hard, gray SILTY CLAY, trace f-c sand, trace f-c gravel (TILL)		19.2	5	CSS		5.0 / 5.0		

Golder Associates

Field Boring Log

DEPTH HOLE 54.1	JOB NO. 853-3013	PROJECT CWM/OLD OHIO		BORING NO. G-19	
DEPTH SOIL DRILL 54.1	QA INSP. P. INGRAM	DRILLING METHOD CME CONTINUOUS SOIL SAMPLER		SHEET 2 OF 3	
DEPTH ROCK CORE NA	WEATHER CLDY	DRILLING COMPANY GEOMECHANICS		SURFACE ELEV. 614	
NO. DIST. SA. 2 UD. SA. 12	TEMP. 10°F	DRILL RIG CME 55	DRILLER J. SELVOSH	DATUM MSL	
DEPTH WL. ≈ 11'	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA	STARTED 0930 (TIME) / 11-29-85 (DATE)	
TIME WL. AT TIME OF BORING	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA	COMPLETED 1500 / 11-29-85	

SAMPLE TYPES

AS	AUGER SAMPLE	BL	BLACK
CS	CHUNK SAMPLE	BR	BROWN
DO	DRIVE OPEN	C	COARSE
DS	DENISON SAMPLE	CA	CASING
PS	PITCHER SAMPLE	CL	CLAY
RC	ROCK CORE	CLY	CLAYEY
ST	SLOTTED TUBE	F	FINE
TO	THIN WALLED OPEN	FRAG	FRAGMENTS
TP	THIN WALLED PISTON	GL	GRAVEL
WS	WASH SAMPLE	LYD	LAYERED
CSS	CONTINUOUS SOIL SAMPLE	LI	LITTLE

ABBREVIATIONS

M	MEDIUM	SA	SAMPLE
MIC	MICACEOUS	SAT	SATURATED
MOT	MOTTLED	SD	SAND
NP	NON PLASTIC	SI	SILT
OG	ORANGE	SIY	SILTY
ORG	ORGANIC	SM	SOME
PH	PRESSUREHYDRAULIC	TR	TRACE
PM	PRESSURE MANUAL	WL	WATER LEVEL
R	RED	WH	WEIGHT OF HAMMER
RES	RESIDUAL	Y	YELLOW
RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LO	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	DEPTH	SAMPLES NO.	TYPE	HAMMER BLOWS PER 6 IN (FOHCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to hard, gray, SILTY CLAY, trace f-c sand, trace f-c gravel (TILL)			5	CSS		5.0/5.0		
			24.2						
				6	CSS		5.0/5.0		
			29.2						
				7	CSS		4.0/5.0		
			34.2						
				8	CSS		4.4/5.0		
			39.2						
				9	CSS		4.8/5.0		
			44.2						
568.7 / 45.3	Hard gray CLAYEY SILT, some f-c sand, little f-c gravel (TILL)			10	CSS		4.4/5.0		

Golder Associates

Field Boring Log

DEPTH HOLE 54.1	JOB NO. 853-3013	PROJECT Cuyahoga Ohio		BORING NO. G-19	
DEPTH SOIL DRILL 54.1	QA INSP. P. Ingram	DRILLING METHOD CME Continuous Soil Sampler		SHEET 3 OF 3	
DEPTH ROCK CORE NA	WEATHER Clear	DRILLING COMPANY Geomechanics		SURFACE ELEV. 614	
NO. DIST. SA. 0 UD. SA. 12	TEMP. 10°F	DRILL RIG CME 55	DRILLER J. Sewski	DATUM MSL	
DEPTH WL. ≈ 11'	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA	STARTED 0930 (TIME) 1-29-85 (DATE)	
TIME WL. At Time of Boring	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA	COMPLETED 1500 (TIME) 1-29-85 (DATE)	

SAMPLE TYPES

AS AUGER SAMPLE; CS CHUNK SAMPLE; DO DRIVE OPEN; DS DENISON SAMPLE; PS PITCHER SAMPLE; RC ROCK CORE; ST SLOTTED TUBE; TO THIN WALLED OPEN; TP THIN WALLED PISTON; WS WASH SAMPLE; CSS CONTINUOUS SOIL SAMPLE

ABBREVIATIONS

BL BLACK; BR BROWN; C COARSE; CA CASING; CL CLAY; CLY CLAYEY; F FINE; FRAG FRAGMENTS; GL GRAVEL; LYD LAYERED; LI LITTLE; M MEDIUM; MIC MICACEOUS; MOT MOTTLED; NP NON PLASTIC; OG ORANGE; ORG ORGANIC; PH PRESSURE HYDRAULIC; PM PRESSURE MANUAL; R RED; RES RESIDUAL; RX ROCK; SA SAMPLE; SAT SATURATED; SD SAND; SI SILT; SLY SILTY; SM SOME; TR TRACE; WL WATER LEVEL; WH WEIGHT OF HAMMER; Y YELLOW

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0-5%; "LITTLE" — 6-12%; "SOME" — 12-30%; "AND" — 30-50%

CONSISTENCY

LS LOOSE; S SOFT; CP COMPACT; FM FIRM; DN DENSE; ST STIFF; V VERY; H HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMMER BLOWS PER 6 IN (FOHCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Hard, gray, CLAYEY SILT, some f-c sand, little f-c gravel (TILL)			10	CSS		4.4/5.0		
			49.2	11	CSS		2.2/2.2		
52.0			51.4						
52.0	Weathered rock WHITE GYPSUM and SHALE			12	CSS		2.7/2.7		
53.9									
54.1	AUGER REFUSAL								Upon completion of boring the borehole was backfilled with thick bentonite slurry mixed at 15 to 20 lbs per gallon of water. Water level is based on sample moisture and cuttings rather than actual measurements and should therefore be considered approximate

PROJECT CWM/VICKERY/OHIO | JOB NO. 853-3020 | BORING NO. MW-19R | DATE 2/15/86 | SHEET 1 OF 1

BORING BEGAN 10/7/85 | BORING COMPLETED 10/7/85 | CORE HOLE LOCATION MW-19R

METHOD OF CORING ROTARY | DRILLING FLUID POTABLE WATER | GR. ELEV. — | WEATHER —

CASING USED — | SIZE NX | INSPECT. WGG | OPERAT. BC | WATER LEVEL, TIME, DATE —

DEPTH (FT.)	RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH	TYPE	INFILLING	ANGLE W/AXIS	FREQUENCY	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
48.0													BEGIN CORING @ 50.6 FT BELOW GS.				
50.6	—	0%	—						—	—	—	—	VERY HARD LODGEMENT TILL. EST 1.9 FT CORE LOST IN TILL.				
52.5	1	(6.5/6.5') 77%	(9/7.8') 12%	52.5 TO 58.2	PARTINGS	STAIN	II TO BED	.02'-.7'		WHITE			WHITE GYPSUM WITH THIN PARTINGS II TO BEDDING				
										GRAY			GRAY SILTY DOLOMITE THINLY BEDDED WITH GYPSUM LAMINAE				
										WHITE AND GRAY		SLIGHT TO MOD	WHITE AND GRAY MOTTLED GYPSUM AND DOLOMITE. 55.5 TO 56.0 FT - BADLY BROKEN. GYPSUM HAS FEW PARTINGS				
71.0	2	(4.5/4.5') 92%	(14.5'/5.4') 26%							LIGHT TO DARK GRAY	FINE TO VERY FINE		LIGHT TO DARK GRAY THINLY BEDDED TO MASSIVE DOLOMITE OFTEN LAMINATED WITH OCCASIONAL GYPSUM FILLED FRACTURES AND PARTINGS.	—	—	—	—
				62.2	SLICKENSIDE	OPEN	45	.03'-.2'					62.2 FT - SLICKENSIDE COATED BY SECONDARY GYPSUM COATINGS.				
												HULT	62.8 ~ 63.2 FT - CLAY RICH AND HIGHLY WEATHERED ZONE.				
	3	(1.9/2.7') 35%	(3.5'/55.6') 15%									SLIGHT TO MOD					
65.8	4	(3.6/3.7') 97%	(2.1'/44.4') 47%							WHITE			WHITE TO GRAY MOTTLED GYPSUM. MORE PRO DOLOMITE AND SILTY DOLOMITE				
										DARK GRAY			DARK GRAY LAMINATED DOLOMITE WITH SECONDARY GYPSUM MINERALIZATION.				
				67.2	PARTINGS	TIGHT	II TO BED	.02'-.5'		VARY			WHITE TO GRAY LAMINATED GYPSUM				
69.5													END OF CORING @ 69.5 FT BELOW G.S.				

NOTE: TOTAL LOSS DURING DRILLING ~2000 GALLONS WATER.

SCALE: 1 DIVISION = 0.2 FEET

CHECKED: WGG

DATE 10/7/85 LOGGED BY WGG

MONITORING WELL INSTALLATION LOG

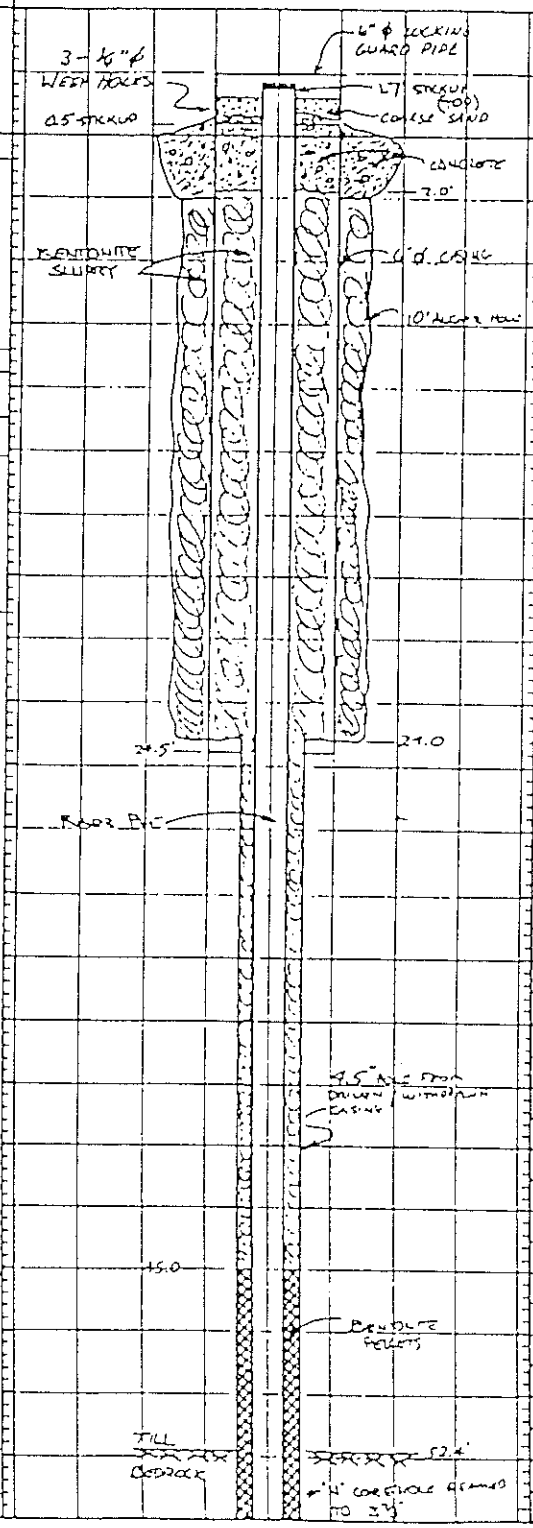
JOB NO 853-3020	PROJECT CWM/NICKERY/OH	WELL NO. MW-19R	SHEET 1 OF 2
GA INSP. W.G.S.	DRILLING METHOD CORE/ROTARY	GROUND ELEV 616.1	WATER DEPTH 23.02'
WEATHER PARTLY CLOUDY	DRILLING COMPANY BOWKER/MORINGER	COLLAR ELEV 617.79	DATE/TIME 10/6/95 13:30
TEMP ~65°	DRILL RIG CME 55	DRILLER B.C. TRAVINES	STARTED 01:50 / DATE — COMPLETED 10:15 / DATE

MATERIALS INVENTORY

WELL CASING 2 in. dia. 60.0 LF	WELL SCREEN 2 in. dia. 10.0' LF	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS STEEL	INSTALLATION METHOD GRAVITY FILL
JOINT TYPE FLUSH COUPLED	SLOT SIZE 100 (0.10")	FILTER PACK QTY 5 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE 3/4" SILICA GRAVEL
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FILL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	
1.0	FIRM TO STIFF, BROWN-TAN, CLAYEY SILT, LITTLE F-C SAND, LITTLE F-C GRAVEL (FILL)
8.5	FIRM, BLACK-BROWN-TAN CLAYEY SILT, TRACE ORGANICS
9.4	FIRM TO STIFF, GRAY-TAN, MOTTLED, SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
11.2	LOOSE TO COMPACT BROWN SILT, SOME FINE SAND (LACUSTRINE)
12.8	SOFT TO STIFF, TAN-GRAY, LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
19.0	SOFT TO HARD, GRAY SILTY CLAY, TRACE F-C SAND, TRACE F-C GRAVEL (TILL)
45.3	HARD GRAY CLAYEY SILT, SOME F-C SAND, LITTLE F-C GRAVEL (TILL)
52.4	WEATHERED ROCK WHITE GYPSUM AND SHALE
54.1	CONT. ON PAGE 2

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

TOTAL REMOVED ≅ 3,500 GALS
WATER LOSS DURING DRILLING ≅ 3,000 GALS.

DEVELOPMENT METHOD: AIR LIFT USING 1" ϕ PVC INDUCTOR PIPE. 5 FOOT SECTION PERFORATED.
AIR SOURCE: DAYTON SPECIALTY OIL-LESS COMPRESSOR.

WELL DEVELOPED FROM 10-9-95 to 10-15-95

INITIAL WATER PUMPED WAS THICK, GRAY, WITH A TRACE OF BENTONITE.
WATER WAS CLEAR AFTER REMOVING APPROX 700 GALS.

CONT. PAGE 2

MONITORING WELL INSTALLATION LOG

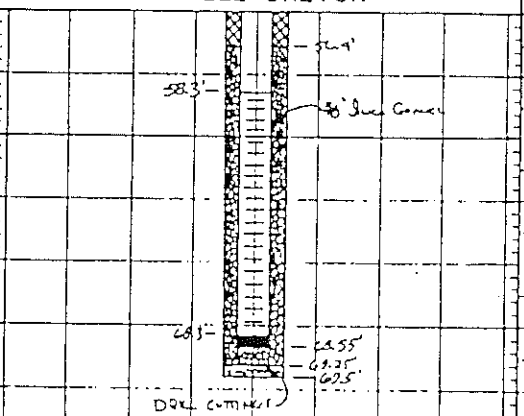
JOB NO. 853-3070	PROJECT CWM / VILLERY / OH	WELL NO MW-19R	SHEET 2 OF 3
GA INSP. WLC	DRILLING METHOD CORE / ROTARY	GROUND ELEV 616.1	WATER DEPTH 23.02'
WEATHER PARTLY CLOUDY	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 617.79	DATE/TIME 10/13/95 13:30
TEMP. ~65	DRILL RIG CME 55	DRILLER B.C. TOWNER	STARTED 9/5/95 (TIME / DATE) COMPLETED 10/4/95 (TIME / DATE)

MATERIALS INVENTORY - SEE PAGE 1

WELL CASING ____ in. dia. ____ LF	WELL SCREEN ____ in. dia. ____ LF	BENTONITE SEAL
CASING TYPE	SCREEN TYPE	INSTALLATION METHOD
JOINT TYPE	SLOT SIZE	FILTER PACK QTY
GROUT QUANTITY	CENTRALIZERS	FILTER PACK TYPE
GROUT TYPE	DRILLING MUD TYPE	INSTALLATION METHOD

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
55.0	CONT. FROM PAGE 1 WHITE AND GRAY MOTTLED GYPSUM AND DOLOMITE
58.2	DARK TO LIGHT GRAY THINLY BEDDED LAMINATED DOLOMITE WITH GYPSUM FILLED PARTINGS
62.8	INTENSELY WEATHERED CLAY RICH DOLOMITE
63.2	GRAY LAMINATED DOLOMITE WITH GYSUM FILLED PARTINGS
65.0	
66.0	WHITE AND GRAY MOTTLED GYSUM and DOLOMITE
67.6	DARK GRAY LAMINATED DOLOMITE
70.0	CORING TERMINATED @ 69.5'

WELL SKETCH



INSTALLATION NOTES

WELL DEVELOPMENT NOTES

WATER LEVEL BEFORE DEVELOPMENT WAS 25.38' BELOW TOP OF 2" PVC

MEASUREMENTS TAKEN DURING DEVELOPMENT:

DATE	GALLONS REMOVED	pH	SPECIFIC COND.	TEMP
10/3/95	START	7.2	2,900	58°F
10/4/95	500	7.2	3,200	57°F
10/4/95	1,200	6.8	3,200	56°F
"	2100	6.6	3,600	55°F
10/15/95	3,500	6.3	3,600	55°F

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020 Ref. MW-19R	Made by W.G.G. Checked Reviewed JTL	Date 11-7-85 Sheet 1 of 2

1. a) Augered 10" ϕ hole with solid stem augers to 24.0' bgs.

b) Pulled augers and sounded hole @ 24.0'.

c) Inserted 6" ϕ steel surface casing and pushed (seated) to 24.5 feet bgs.

d) Grouted annular space using tremie pipe. Used ~ 75 gals of grout and let about 15-20 gals overflow until it was thick and all water was displaced. Calculated grout volume was 58 gals.

e) 6" ϕ surface cog was flushed with 6 7/8" rollerbit until return was clear. Flushed to 24.5 feet.

2. a) Drove 4" ϕ surface casing to 49.8 feet then reamed and flushed to 50.6 ft. Flushed until return was clear. Sounded hole @ 50.6 ft.

b) Started coring rock @ 50.6 ft. Run #1 went from 50.6' to 59.0'. Recovered ~ 77% of run. Run #2 from 59.0' to 63.5' bgs. Core block @ 63.5'. Run #3 from 63.5' to 65.8', another core block @ 65.8'. Fourth and final core run was from 65.8' to 69.5'. Top of Rock estimated at 52.4' bgs.

c) Water loss during coring was ~ 2000 gals.

3. a) Reamed core hole with 3 7/8" rollerbit from 50.6 ft to 69.5 ft. Lost ~ 1000 gals reaming. Flushed until return water was clear. Total water loss ~ 3000 gals. Setting to hole to 69.25' bgs.

4. a) Installed well screen (20.0') and riser pipe downhole. Sand was added to 68.5' bgs before addition of well pipe.

b) Backfilled sand in one foot intervals to 56.4 ft bgs. Sand was sounded @ each interval. Calculated volume to fill annular space ≈ 4.9 gals. Actual volume added was about 5.0 gals.

c). Bentonite pellets were backfilled, tamped, and sounded @ 1.0 ft intervals to 45.0' bgs.

d) The remaining annular space was grouted with bentonite slurry from the top of bent. pellets 45.0' to ground surface.

5. a) A 6" ϕ protective casing was installed and locked, and a small ϕ hole was drilled in the well cap for a vent hole.

6. a Water level upon completion was 22.00' at 15:30 on 11/15/85

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020 Ref. MW-19R	Made by W.G.G Checked ~~Reviewed~~	Date Sheet 2 of 2

7. a) Bentonite grouted was removed from the annular space between the 6" surface cog & the well pipe to ~ 2.5' bgs. This space was cemented to just below the ¼ ϕ drain holes.

b) After the cement cured, coarse sand was poured in the annular space to about 5-inches from the top of 2" ϕ well pipe.

MONITORING WELL INSTALLATION LOG

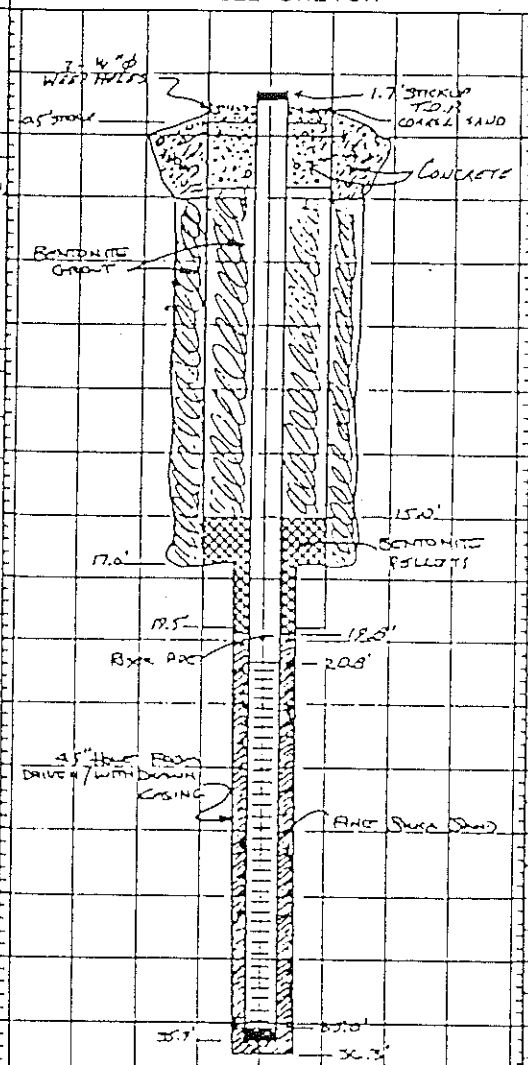
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO. T-19	SHEET 1 OF 1
GA INSP. W.G.G.	DRILLING METHOD AUGER / ROTARY	GROUND ELEV 616.3	WATER DEPTH 32.42'
WEATHER SUNNY	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 618.04	DATE/TIME 10/18/85 1616
TEMP 70°	DRILL RIG CME 55 DRILLER T. ROENNIER	STARTED 10/17/85 (TIME / DATE)	COMPLETED 10/18/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 22.5' l.f.	WELL SCREEN 2 in. dia. 15.0' l.f.	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE .0060 in.	FILTER PACK QTY ~ 8.0 gals
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	
1.0	FIRM TO STIFF, BROWN-TAN CLAYEY SILT, LITTLE F-C SAND, LITTLE F-C GRAVEL (FILL)
8.5	FIRM, BLACK-BROWN-TAN CLAYEY SILT, TRACE ORGANICS
9.4	FIRM TO STIFF, GRAY-TAN, MOTTLED, SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
11.2	LOOSE TO COMPACT BROWN SILT, SOME FINE SAND (LACUSTRINE)
12.8	SOFT TO STIFF, TAN-GRAY, LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
19.0	SOFT TO HARD, GRAY SILTY CLAY, TRACE F-C SAND, TRACE F-C GRAVEL (TILL)
36.3	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH STAINLESS STEEL BAILER. NEW POLYPROPYLENE ROPE WAS DESIGNATED TO T-19 FOR DEVELOPMENT.

BAILER WAS STEAM CLEANED THEN RINSED WITH DEIONIZED WATER BEFORE DEVEL.

TOTAL VOLUME PURGED DURING DEVELOPMENT WAS 15.8 gallons. CALCULATED WELL VOLUME FROM STATIC WATER LEVEL (11.86') MEASURED ON 1-14-86 IS 4.2 gallons.

MEASUREMENTS DURING DEVELOPMENT

DATE	GALLON BAILED	pH	SPECIFIC COND.	COMMENTS
11-15-85	5.3	6.9	1,000	WATER SL. TURBID
11-17-85	5.2	6.5	7,300	WATER MILKY COLORED
11-19-85	5.0	6.9	5,100	SLIGHTLY TURBID
11-20-85	0.3	—	—	RECOVERY TEST

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020 Ref. T-19	Made by W.L.L. Checked Reviewed JFC	Date 11-5-95 Sheet 1 of 2

1. a) Augered 10" ϕ hole to 17.0' bgs using 8" ϕ augers with a 10" bit; pulled augers and sounded hole @ 17.0' bgs.

b) Inserted 20.0 ft of 6" ID flush joint steel surface casing; casing was pushed and seated @ 19.5 ft bgs.

c) Grouted annular space between 6" csg and 10" auger hole with a bentonite grout slurry mixed @ a ratio of ~ 1.5 lbs bent. per gal of water. Sample of grout was taken. Used ~ 50 gals of bentonite slurry during grouting, letting ~ 7 gals overflow.

d) 6-inch ϕ csg was flushed and reamed using a 5 1/8" roller bit to 19.5' bgs until clean. Residual water in the 6" ϕ surface casing was bailed to within 0.3 feet of the bottom of hole.

2. a) Drove 4" ϕ temporary flush joint casing @ 5.0 foot intervals from 19.5 ft to 36.3 ft bgs. The casing was flushed clean @ each 5.0 ft interval. Sounded hole @ 36.3' bgs.

b) Pulled 4" temporary casing up 1.0 ft and sounded hole @ 36.3' bgs. Added fine sand to 35.9', sounded hole @ same depth. Inserted 15.0' of 0.0060 slotted 316 stainless steel screen and 22.5' of solid riser pipe of same material. Bottom cap was 0.4 ft in length. The well screen and riser pipe threads were wrapped with teflon tape before installation, all O-rings were removed before adding tape. Measured well stickup @ 1.7' above ground surface.

c) Backfilling: The 4" ϕ csg was pulled with the winch cable @ 1.0' increments adding 1.0 ft of sand in the open annulus for each interval. The hole was sounded @ each interval after the casing was pulled to ensure sloughing had not occured. Sand was added to 19.8' bgs. Total amount of sand used was ~ 8 gals. Calculated volume is 10 gals. Sample of fine filter sand was obtained.

d) The 4" ϕ temporary csg was pulled from 19.8' to 19.6' and 0.3 ft of bent. pellets were added. Hole sounded @ 19.6'. The 4" ϕ csg was then pulled from the 6" casing and bent. pellets were backfilled to 15.0' bgs. Used ~ 6 gals of bent. pellets were used - calculated volume is 4.2 gals.

e) Remaining annular space between 6" ϕ casing and 2 7/8" OD S.S. well pipe was grouted to surface with bentonite slurry. Approx. 20 gals of grout was used, mixed @ a ratio of ~ 1.5 gals bentonite to 1 gal water. Grout was tremied down annulus using 1" ID pvc tremie pipe.

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020 Ref. T-19	Made by W.C.C. Checked Reviewed JTC	Date 11-5-85 Sheet 2 of 2

3. a) Water level upon completion @ 16:16 hrs on 10-18-85 was 32.42' below the top of the 2" steel well riser pipe.

4. a) An aluminum 6" ϕ protective flush joint pipe was threaded on to the 6" ϕ surface casing and secured with a lock.

5. a) The top well cap was vented by drilling a small ϕ hole in the side of the cap. Drilling was done with the drill press in the maintenance shop. The well was covered with a clean bag during that period.

6. a) A 30" hole was hand dug around the 6" ϕ surface casing and was filled in with a Portland cement sand mixture. The cement was sloped in a manner to let water drain away from the well.

b) Three (3) 1/4" diameter drain holes were drilled near the top of the cement mixture. Bentonite grout was removed from with the 6" ϕ surface casing to 2.0 feet below ground surface. Concrete was added to replace this void up to the base of the 1/4" ϕ weep holes. Coarse sand was added over the concrete inside the protective pipe up to approx 4-6 inches from the top of riser pipe.

MONITORING WELL INSTALLATION LOG

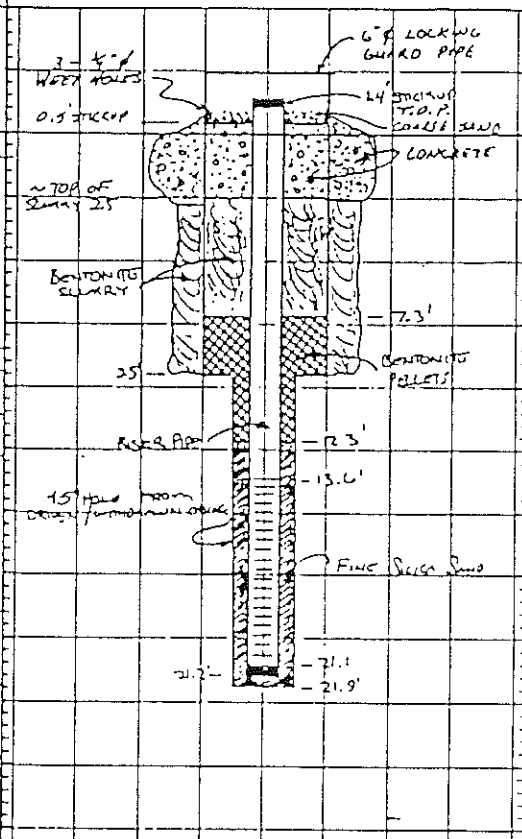
JOB NO. 853-2020	PROJECT CMA / VICKERY / OH	WELL NO. L-19	SHEET 1 OF 1
GA INSP. L.E. JDC	DRILLING METHOD AUGER / ROTARY	GROUND ELEV 616.5	WATER DEPTH 11.52'
WEATHER SUNNY	DRILLING COMPANY BOWSER MORNER	COLLAR ELEV 617.97	DATE/TIME 10/23/95 12:00
TEMP.	DRILL RIG CME 55	DRILLER T. ROEHNER	STARTED 10/23/95 (TIME / DATE) COMPLETED 1PM 10/23/95 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 15.0' LL	WELL SCREEN 2 in. dia. 7.5' LL	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 0.0060 in	FILTER PACK QTY ~5.5 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	
1.0	FIRM TO STIFF, BROWN-TAN, CLAYEY SILT, LITTLE F-C SAND, LITTLE F-C GRAVEL (FILL)
8.5	SILT, TRACE BROWN-TAN CLAYEY SILT, TRACE ORGANICS
9.7	FIRM TO STIFF, GRAY-TAN, MOTTLED, SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
11.2	LOOSE TO COMPACT, BROWN SILT, SOME FINE SAND (LACUSTRINE)
12.8	SOFT TO STIFF, TAN-GRAY, LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
19.0	SOFT TO HARD, GRAY SILTY CLAY, TRACE F-C SAND, TRACE F-C GRAVEL (FILL)
21.9	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH 1" ϕ STAINLESS STEEL BAILER.

SURGE AND TREATMENT CHECK VALVE WAS STEAM CLEANED AND RINSED WITH DEIONIZED WATER. SURGE DEVELOPMENT

TOTAL VOLUME REMOVED DURING DEVELOPMENT WAS APPROX. 8-4 gallons

CAPACITY OF WELL WHEN STATIC W.L. IS 11.47' (1-14-96) FROM TOP OF RISER IS 1.9 GALS.

MEASUREMENTS DURING DEVEL.

DATE	GALLONS BAILED	pH	SPECIFIC COND.	COMMENTS
11-15-95	2.0	6.4	7,500	
11-17-95	2.2	6.5	7,300	WATER MILKY
11-19-95	2.2	6.7	6,700	SLIGHTLY TURBID
11-21-95	2.0	–	–	RECOVERY TOO PROLONGED

STATIC W.L. 1-14-96 WAS 11.47'

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020	Made by JCC	Date 11-6-85
	Ref. L-19	Checked	Sheet 1 of 2
		Reviewed JFR	

1. a) Augered 10" Ø hole to 9.5' bgs. Sounded hole at 8.9'. Reaugered to 9.5'. Sounded hole at 9.5'

b) Set 10' 6" Ø surface casing bottoming at 9.5'.

c) Grouted borehole annulus (between 6" casing and 10" auger hole) with a bentonite grout slurry. Used 20 gallons of bentonite bitting ~5 gal overflow.

d) 6" Ø casing was drilled and flushed to 9.5 until clean. Bailed to within 0.5' of bottom of hole.

2. a) Drove 4" Ø casing from 9.5' to 15.0. Drilled and flushed clean. Sounded hole at 14.9'. Hammered casing from 14.9' to 21.9. Drilled and flushed clean. Bailed water to within 0.5 of bottom. Sounded @ 21.9

b) Pulled 4" Ø casing up a foot. Sounded at 21.9. Added 0.7' of sand. Set 7.5' screen and 13.0' of riser pipe. Stickup of riser pipe is 1.3' (0.1 ft at end cap on bottom of screen)

c) Backfilling: 4" Ø casing was pulled up a foot at a time and added sand. Sounded sand time to ensure no sloughing of hole or sand bridge had occurred. Backfilled sand to 12.3' bgs. Calculated amt. of sand used was ~5.7 gals. Sample of sand was taken.

d) 4" Ø casing was pulled up a foot and pellets were added up to 7.3, pulling up a foot at a time and sounded to ensure no sloughing or bridging had occurred. Volume of pellets used was ~4.4 gal. (calculated).

e) Remaining open borehole annulus was filled with bentonite slurry to ground surface.

3. a) Water level upon completion was 11.52' @ 1200 on 10/20/85.

4. a) Aluminum 6" Ø Protective flush joint pipe was threaded on to the 6" Ø surface casing and secured with a lock.

5. a) The well cap was vented by drilling a small hole in the cap.

6. a) A 30' hole was hand dug around the 6" Ø surface casing and was filled with concrete. Sloped so water would run away from well.

Golder Associates

SUBJECT WELL INSTALLATION NOTES		
Job No. 85s-3020	Made by JC	Date 11-6-85
Ref. L-19	Checked	Sheet 2 of 2
	Reviewed JSL	

7. a) Three 1/4 diameter drain holes were drilled near top of cement mound. Bentonite grout was taken out of the 6" Ø surface casing to 2.5' below ground surface. Cement was added to replace the grout removed.

b) Coarse sand was poured on top of the hardened cement to about 5 inches below the top of well pipe.

Golder Associates

Field Boring Log

DEPTH HOLE 47.7	JOB NO. 853-3013	PROJECT CWM/OLA/OH		BORING NO. G-20	
DEPTH SOIL DRILL 47.7	QA INSP. RMI/RSM	DRILLING METHOD CME Continuous Soil Sampler		SHEET 1 OF 3	
DEPTH ROCK CORE NA	WEATHER CLDY	DRILLING COMPANY Geomechanics		SURFACE ELEV. 607	
NO. DIST. SA. 10 UD. SA. 4A	TEMP. 35°	DRILL RIG CME 55	DRILLER I. Sellers	DATUM MSL	
DEPTH WL. 4.0	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA	STARTED 0930 / 3-6-85 (TIME / DATE)	
TIME WL. AT TIME OF BORING	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA	COMPLETED 1230 / 3-6-85 (TIME / DATE)	

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	Continuous Soil Sample

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIT	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LTD	LATERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RK	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 6 - 12%
"SOME" — 13 - 30%
"AND" — 30 - 50%

CONSISTENCY

LO	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	DEPTH	SAMPLES NO.	TYPE	HAMM BLOWS PER IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
606.2	Firm to stiff, brown, clayey SILT, some fine gravel (FILL)			1	CSS		3.8 / 4.3		
1.8 / 597.7	Soft to firm, gray, tan, mottled, SILTY CLAY, trace organics (LACUSTRINE)		4.3	2	CSS		5.3 / 5.0		
7.3 / 595.0	Soft to firm, gray-brown, laminated SILTY CLAY, trace fine sand (LACUSTRINE)		9.3	3	CSS		4.9 / 5.0		
12.0	Soft to stiff, gray, SILTY CLAY, some f-m sand, trace f-c gravel (TILL)		14.3	4	CSS		4.9 / 5.0		
			19.3	5	CSS		5.2 / 5.0		

Golder Associates

Field Boring Log

DEPTH HOLE 47.7	JOB NO. 853-3013	PROJECT CUM/OLO/OH		BORING NO. 6-20	
DEPTH SOIL DRILL 47.7	QA INSP. PMI/RSM	DRILLING METHOD CME CONTINUOUS SOIL SAMPLE		SHEET 2 OF 3	
DEPTH ROCK CORE NA	WEATHER CLDY	DRILLING COMPANY GEOMETHANICS		SURFACE ELEV. 607	
NO. DIST. BA. 10 UD. BA. NA	TEMP. 35°	DRILL RIG CME 55	DRILLER J. SOLUSKI	DATUM MSL	
DEPTH WL. 4.0'	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA	STARTED 0930 / 5-6-85 (TIME / DATE)	
TIME WL. AT TIME OF BORING	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA	COMPLETED 1230 / 5-6-85 (TIME / DATE)	

SAMPLE TYPES

AS	AUGER SAMPLE	BL	BLACK	M	MEDIUM
CS	CHUNK SAMPLE	BR	BROWN	MIC	MICACEOUS
DD	DRIVE OPEN	C	COARSE	MOT	MOTTLED
DS	DENISON SAMPLE	CA	CASING	NP	NON PLASTIC
PS	PITCHER SAMPLE	CL	CLAY	OG	ORANGE
RC	ROCK CORE	CLY	CLAYEY	ORG	ORGANIC
ST	SLOTTED TUBE	F	FINE	PH	PRESSURE HYDRAULIC
TO	THIN WALLED, OPEN	FRAG	FRAGMENTS	PM	PRESSURE MANUAL
TP	THIN WALLED, PISTON	GL	GRAVEL	R	RED
WS	WASH SAMPLE	LYD	LAYERED	RES	RESIDUAL
CSS	CONTINUOUS SOIL SAMPLE	LI	LITTLE	RK	ROCK

ABBREVIATIONS

SA	SAMPLE	WL	WATER LEVEL
SAT	SATURATED	WH	WEIGHT OF HAMMER
SD	SAND	Y	YELLOW
SI	SILT		
SLT	SILTY		
SM	SOME		
TR	TRACE		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 60%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to firm, gray, SILTY CLAY, some f-m sand, trace f-c gravel (TILL)		24.3	5	CSS		5.2 / 5.0		
			29.3	6	CSS		5.0 / 5.0		
			34.3	7	CSS		4.9 / 5.0		
			39.3	8	CSS		5.1 / 5.0		
			44.3	9	CSS		5.1 / 5.0		
562.8 / 44.2	Hard, gray, CLAYEY SILT, some little to f-c sand, trace f-c gravel (TILL)			10	CSS		3.0 / 3.4		

Golder Associates

Field Boring Log

DEPTH HOLE 47.7	JOB NO. 853-3013	PROJECT CWM/OLD/OH			BORING NO. G-20
DEPTH SOIL DRILL 47.7	GA INSP. PMI/RSM	DRILLING METHOD CME CONTINUOUS SAMPLER			SHEET 3 OF 3
DEPTH ROCK CORE NA	WEATHER CLDY	DRILLING COMPANY GEO MECHANICS			SURFACE ELEV. 607
NO. DIST. SA. 10 UD. SA. NA	TEMP. 35°	DRILL RIG CME 55	DRILLER J. SELVOSKI		DATUM MSL
DEPTH WL. 4.0'	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA		STARTED 0930/3-6-85 (TIME / DATE)
TIME WL. AT TIME OF BORING	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA		COMPLETED 1230/3-6-85

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	Continuous Soil Sample

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0-5%
"LITTLE" — 5-12%
"SOME" — 12-30%
"AND" — 30-50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. DEPTH	DESCRIPTION	BLOWS/FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC/ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
559.3	Hard gray CLAYEY SILT, little to some f-c sand, trace f-c gravel (TILL)			10	CSS		3.0/3.4		
47.7	AUGER REFUSAL								Upon completion the borehole was backfilled with thick bentonite slurry mixed at 1.5-2.0 lbs. per gallon of water

PROJECT CWM/ [illegible]		BORING NO. 20R DATE [illegible]	
BORING BEGAN 9/20/85	BORING COMPLETED —		CORE HOLE LOCATION MW-20R
METHOD OF CORING ROTARY	DRILLING FLUID POTABLE WATER	GR.ELEV. — WEATHER —	
CASING USED — SIZE NX		INSPECT. L.F. OPERAT. —	WATER LEVEL,TIME,DATE —

DEPTH (FT.)	RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH	TYPE	INFILLING	ANGLE W/AXIS	FREQUENCY	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
45.0													BEGIN CORING @ 47.4 FT BELOW G.S.				
47.4	1	(48'/59') 81%	11.4'/70.8' 20%							GRAY		HIGH	'GRAY' ARGILLACEOUS SLIGHTLY LAMINATED DOLOMITE WITH TRACE GYPSUM. EST 1.1 FT CORE LOSS FROM 47.4 TO 48.5 FT.				
													GRAY CLAY WITH TRACE GYPSUM AND DOLOMITE FRAGMENTS				
				51.9 TO 54.2	PARTINGS	GYPS	II TO BED	.08' TO .32'				SLIGHT	GRAY ARGILLACEOUS LAMINATED DOLOMITE WITH TRACE GYPSUM AND FIBROUS GYPSUM.				
53.3	2	(19'/41') 46%	0%							WHITE AND GRAY	FINE TO VERY FINE	MOD TO HIGH	WHITE GYPSUM AND GRAY DOLOMITE EST 2.2 FT CORE LOSS	—	—	—	—
57.4	3	(12'/15') 100%	17%	57.1 TO 57.9	PARTINGS	—	X TO BED	.05' TO .3'		GRAY TO DARK GRAY WHITE		UN-WEATHERED	GRAY TO DARK GRAY ARGILLACEOUS SLIGHTLY LAMINATED DOLOMITE WITH TRACE FIBROUS GYPSUM.				
59.2	4	(40'/63') 63%	12%	58.3 TO 64.8	PARTINGS	GYPS	X TO BED	.02' TO .35'		GRAY TO DARK GRAY		MOD TO HIGH	57.9 TO 58.3 FT - WHITE GYPSUM WITH TRACE DOLOMITE. 60.15 FT - TURNING GRAY AND LAMINATED WITH VERY WEAK PARTINGS. EST. 2.3 FT CORE LOSS				
										WHITE GRAY			WHITE GYPSUM AND GRAY DOLOMITE				
65.5													END OF CORING @ 65.5 FT BELOW G.S.				

SCALE: 1 DIVISION=0.2 FEET

CHECKED WGG. FAW

DATE 9/20/85 LOGGED BY LF

MONITORING WELL INSTALLATION LOG

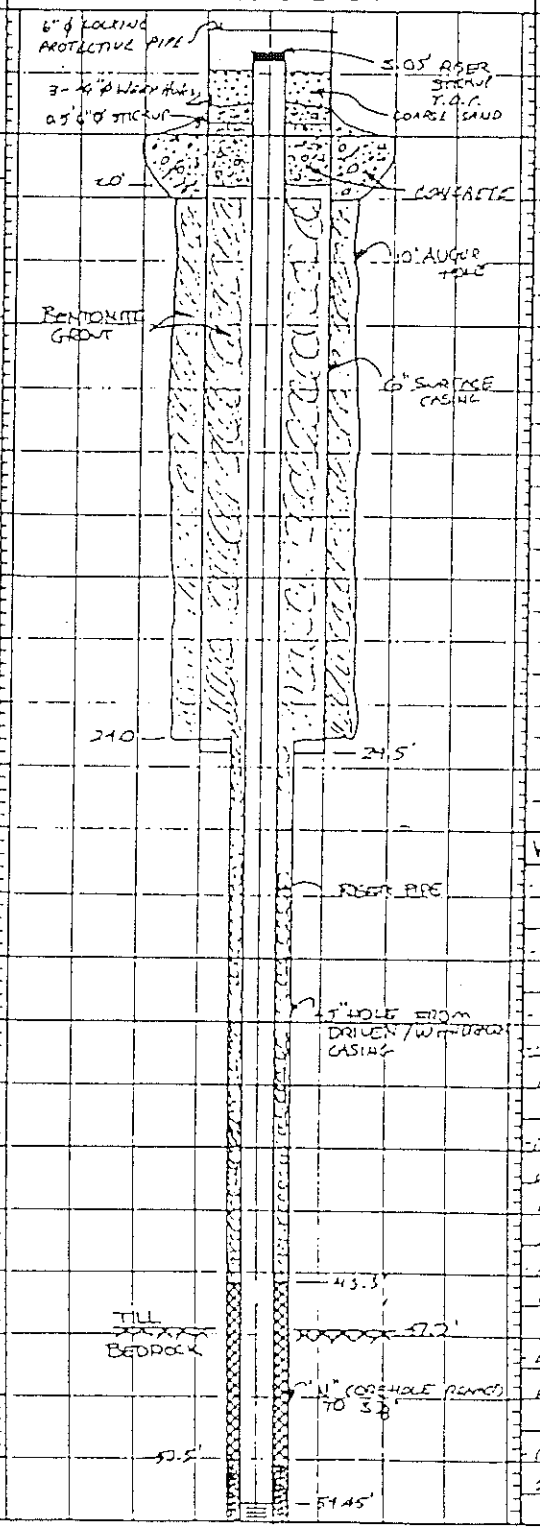
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO MW-20R	SHEET 1 OF 2
GA INSP. L. FROST	DRILLING METHOD CORE / ROTARY	GROUND ELEV 611.0	WATER DEPTH 22.68'
WEATHER	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 614.04	DATE/TIME 10/2/85 19:18
TEMP.	DRILL RIG MOBILE 61	DRILLER D. KIRKPATRICK / D.C. MANOS	STARTED 8/22/85 (TIME / DATE) COMPLETED 9/27/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 57.5 ft	WELL SCREEN 2 in. dia. 10 ft	BENTONITE SEAL PELLETS
CASING TYPE STAINLESS STEEL (316)	SCREEN TYPE STAINLESS STEEL WIRE WOUND (316)	INSTALLATION METHOD GRAVITY FALL, TAMPED
JOINT TYPE FLUSH COUPLED	SLOT SIZE 100 (.10 in)	FILTER PACK QTY 5.5 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE #8 SILICA GRAVEL
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	FIRM TO STIFF, BROWN CLAYEY SILT, SOME FINE GRAVEL (FILL)
1.8	SOFT TO FIRM, GRAY, TAN, MOTTLED, SILTY CLAY, TRACE ORGANICS (LACUSTRINE)
7.3	SOFT TO FIRM, GRAY-BROWN, LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
12.0	SOFT TO STIFF, GRAY, SILTY CLAY, SOME F-M SAND, TRACE F-C GRAVEL (TILL)
44.2	HARD, GRAY, CLAYEY SILT, SOME LITTLE TO F-C SAND, TRACE F-C GRAVEL (TILL)
47.4	GRAY ARGILLACEOUS SLIGHTLY LAMINATED DOLOMITE
51.4	GRAY CLAY WITH TRACE OF GYPSUM AND DOLOMITE
51.9	GRAY ARGILLACEOUS LAMINATED DOLOMITE
54.2	CONT. ON P.2

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

- TOTAL VOLUME REMOVED WAS APPROX 17,760 GALS.
- APPROX. WATER LOSS DURING DRILLING WAS 5,570 GALS.
- TIME FOR REMOVAL WAS 31 HRS 45 MIN
- WELL DEVELOPED FROM 10-31-85 TO 11-5-85.

- DEVELOPMENT METHOD: AIR LIFT USING 1" ϕ PVC INDUCTOR PIPE WITH APPROX 5' SECTION PERFORATED.
- AIR SOURCE: DAYTON SPEEDAIRE OIL-LESS COMPRESSOR.

- WATER LEVEL BEFORE DEVELOPING WAS 23.23' BELOW TOP OF 2" ϕ PVC
- WATER WAS CLOUDY THE FIRST 500 GALS PUMPED, THEN CLEARED

CONT. PAGE 2

MONITORING WELL INSTALLATION LOG

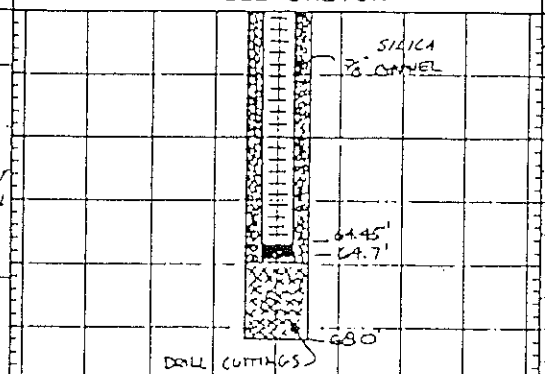
JOB NO. 852-3020	PROJECT CUM / KICKERY / OH	WELL NO MW-20R	SHEET 2 OF 2
GA INSP. L. FROST	DRILLING METHOD CORE / ROTARY	GROUND ELEV 611.0	WATER DEPTH 22.65'
WEATHER	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 614.04	DATE/TIME 10/3/85 15:15
TEMP.	DRILL RIG MOBILE B-61	DRILLER B. KIRKPATRICK, A.C. MANOS	STARTED 8/22/85 (TIME / DATE)	COMPLETED 8/22/85 (TIME / DATE)

MATERIALS INVENTORY - SEE PAGE 1

WELL CASING ____ in. dia. ____ ft	WELL SCREEN ____ in. dia. ____ ft	BENTONITE SEAL
CASING TYPE	SCREEN TYPE	INSTALLATION METHOD
JOINT TYPE	SLOT SIZE	FILTER PACK QTY
GROUT QUANTITY	CENTRALIZERS	FILTER PACK TYPE
GROUT TYPE	DRILLING MUD TYPE	INSTALLATION METHOD

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
55.0	CONT. FROM P.1 WHITE GYPSUM AND GRAY DOLOMITE
57.1	DARK GRAY LAMINATED DOLOMITE WITH ABUNDANT PARTINGS AND OCCASIONAL THIN BEDS OF GYPSUM
65.0	
65.5	CORING TERMINATED @ 65.5'
70	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

MEASUREMENTS TAKEN DURING DEVELOPMENT:

DATE	GALLONS REMOVED	pH	SPECIFIC COND.	TEMP
10-31-85	START	7.2	2,700	55°F
11-1-85	2,400	7.2	3,300	54°F
11-2-85	4,180	6.6	3,200	53°F
11-4-85	14,650	6.8	4,000	52°F
11-5-85	17,760	6.6	4,000	52°F

Golder Associates

SUBJECT Installation Notes		
Job No. 853 3020 Ref. MW-20R	Made by JFC for FM Checked Reviewed WMM	Date 11/6/85 Sheet 1 of 3

1. a) Augered 10"Ø hole w/ solid stem augers to 24.5' bgs. Hole sounded to 16' bgs.

b) Placed 25' of 6"Ø, flush threaded, carbon steel casing in hole.

c) Mixed clay grout and grouted well annulus by pressure grouting down the inside of the 6"Ø casing and up the annulus. Grout volume used was 102 gallons of mix with 1.5 # clay per gal. water.

d) Cleaned 6"Ø casing by washing via 5 7/8" Ø roller bit. Cleaning continued until return was only slightly turbid. Casing bailed to w/in 6" of bottom of hole

2. a) Drove 4" OD temporary well construction casing to 47.0' bgs. As drove 4" casing, the 6"Ø surface casing settled down to about 28.6' bgs.

b) Drilled out 4"Ø casing w/ roller bit and flushed with water until return was clear.

3. a) Cored rock and then reamed hole to 3 7/8" with tri-cone roller bit to 66' bgs. Water loss ~100 gallons

b) A Gorman-Rupp diaphram pump placed in hole to remove drill cuttings. Pump would not work - blew a seal.

c) Connected two drill rig pumps to try to remove drill cuttings. Water loss ~300 gal.

d) Oil observed in water from MW-20R. Pumping did not remove oil

4. Well grouted and rig moved 10' to drill MW-20AR

Golder Associates	SUBJECT Installation Notes		
	Job No. 953-3020	Made by L.F. & W.G.G.	Date
	Ref. MW-20AR	Checked	Sheet 2 of 3
		Reviewed	

5. a) Drilled 10" ϕ hole to 24.0' bgs using solid stem augers
b) Installed 6" ϕ flush-joint steel casing
c) Pressure grouted 6" ϕ surface casing using air generator and Warren bladder pump; bentonite slurry mixed at 1.5 to 2.0 lbs/gal water; calculated grout volume 98 gal, actual vol. used ~120 gal
d) Drove 6" ϕ surface csg to 24.5' bgs
e) Inside of 6" ϕ surface csg flushed clean (950 gal water used) and bailed to within 0.5' of bottom of hole

6. a) 4" ϕ flush joint csg hammered to 39' bgs
b) Inside of 4" ϕ csg drilled out with 3 7/8" roller cone; hole drilled to 47.2' bgs (bedrock)
c) 4" ϕ csg hammered to 47.2' bgs
d) Inside of 4" ϕ csg drilled out to 47.2' bgs
e) Inside of 4" ϕ csg flushed clean and bailed to within 0.5' of bottom of hole

7. a) The bedrock @ MW-20AR was not cored as coring with a 'N' size bit was completed in bedrock @ MW-20R which was located 10' North of MW-20AR (down-gradient of MW-20AR). Roller bit drilled from 47.2' to 66.0' bgs w/ ~60% water recovery (water-loss ~960 gal). Sounded hole depth was 61' bgs. Drilled cuttings in hole from 66' to 61' bgs.

b) Connected Rig Mayno pump & 1½" 3HP Tel pump to increase pump capacity for flushing – unable to flush cuttings (lost 450 gal)

c) Connected 2 rig Mayno pumps w/ min. success
50% water return, lost 1550 gal
Cuttings in hole from 66' to 62' bgs

Continued w/ 775 gal. water loss
hole sounded to 63.2' bgs

d) Drilled hole to 68' bgs. Flushed until clean return w/ 30% return and ~475 gal lost
Rx cored to 56' bgs

e) Redrilled to 68' bgs, flushed hole w/ 20% return (1360 gal lost) and hole sounded @ 67.7'
g) total water loss ~5570 gal

Golder Associates	SUBJECT Installation - Notes		
	Job No. 853 3020	Made by GJL	Date 11/6/85
	Ref. MW-20AR	Checked	Sheet 3 of 3
		Reviewed W.D.M.	

8. a) Sounded drill hole @ 67.7' bgs.

b) Placed 10' of #100 SS well screen and 57.5' of SS well pipe in hole with 0.1' bottom plug @ 67.7' and bottom of screen at 64.45' bgs and 3.05' of stickup.

c) Backfilled annulus around well screen with coarse sand to 52.5' bgs, about 2' above the top of the screen. Used about 5½ gal. of sand, while the calculated volume was 4.6 gals.

d) Placed a bentonite pellet seal above the filter sand from 52.5 bgs to 46.5 bgs (about 0.7' above the top of rock). 7 gallons of pellets were placed in the hole.

e) Pulled casing up 5' and sounded depth at 36' bgs

f) Pulled all 4" ø casing. Observed clay in casing from 36' ± 42'. Sounded well annulus at 45.3' bgs

g) Mixed clay grout at 1.6 # clay / gal water and grouted well to the ground surface. About 50 gallons of grout was used compared to a calculated volume of 43 gallons.

h) Re-estimate of pellet volume is 4 gallons in the well

9. a) Installed a 6" ø aluminum protective casing by threading it on the 6" ø surface casing.

b) Excavated 30" deep around the 6" ø casing and placed concrete mounded to keep water away from the well

c) Removed grout between the well pipe and the surface casing to 2.0' bgs and cemented the annulus to the level of the grout outside the 6" casing.

d) Drilled 3, ¼" ø, weep holes at the top of the cement

e) Installed a vented cap on the well pipe

f) Locked the well.

10. a) Water level upon completion was 22.65' at 13:18 on 10.2.85

MONITORING WELL INSTALLATION LOG

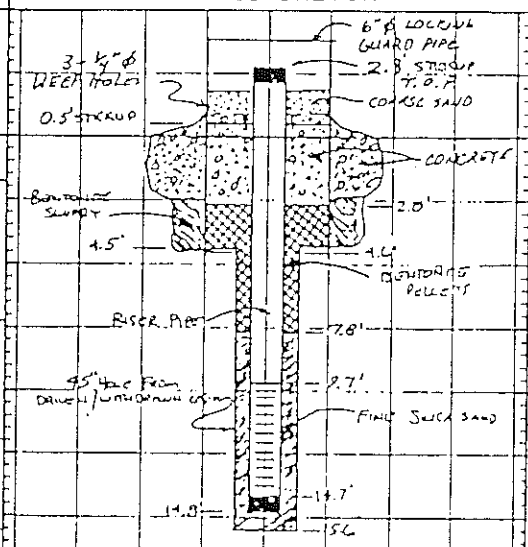
JOB NO. 853-3000	PROJECT CWM/VICKERY/OH	WELL NO. C-20	SHEET 1 OF 1
GA INSP J. COLLE	DRILLING METHOD AUGER / ROTARY	GROUND ELEV 611.2	WATER DEPTH 7.27'
WEATHER PTLY CLDY	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 614.04	DATE/TIME 10/21/85 10:00
TEMP	DRILL RIG MOBILE B-61 DRILLER B. KIRKPATRICK	STARTED 10/20/85 (TIME / DATE)	COMPLETED 10/21/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 12.5 ft.	WELL SCREEN 2 in. dia. 5.0 ft.	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 0.0060 in.	FILTER PACK QTY 5¼ BAGS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	FIRM TO STIFF, BROWN, CLAYEY SILT, SOME FINE GRAVEL (FILL)
1.8	SOFT TO FIRM, GRAY, TAN, MOTTLED, SILTY CLAY, TRACE ORGANICS (LACUSTRINE)
7.3	SOFT TO FIRM, GRAY-BROWN, LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
12.0	SOFT TO STIFF, GRAY, SILTY CLAY, SOME F-M SAND, TRACE F-C GRAVEL (FILL)
15.6	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH STAINLESS STEEL BAILER

BAILER AND TEFLON CHECK VALVE WAS STEAM CLEANED THEN RINSED WITH DEIONIZED WATER BEFORE BAILING. DESIGNATED (AFW) PIECE OF POLYPROPYLENE ROPE USE FOR BAILING

TOTAL VOLUME REMOVED DURING DEVEL WAS 8.8 gals. CAPACITY OF WELL FOR STATIC WL. OF 7.48' ON 1-14-86 IS 1.65 gals.

MEASUREMENTS DURING DEVELOPMENT

DATE	GALLONS BAILED	pH	SPECIFIC COND.	COMMENTS
1-13-85	2.5	6.4	6,600	
1-17-85	2.0	6.6	6,300	TURBID
1-14-85	2.0	6.8	6,100	TURBID
11-21-85	2.3	—	—	RECOVERY TEST PERFORMED

STATIC WATER LEVEL ON 1-14-86 WAS 7.47' BELOW TOP OF 2" RISER.

Golder Associates	SUBJECT INSTALLATION NOTES		
	Job No. 853-3020	Made by JDC	Date 10-23-85
	Ref. L-20	Checked	Sheet 1 of 2
		Reviewed JRC	

1. a) Drilled 10" Ø hole to 4.5' using solid stem, auger; surface dirt fell into hole, sounded at 4.0. Augered 3 times and it still 4.0. Tried to tamp it out with 6" Ø auger and got 4.3'. So tried again to tamp it out and it still 4.3.
   b) Installed 6" Ø casing at 4.3'.
   c) Grouted borehole with bentonite slurry. Volume used was about 18 gallons with about 2 gal overflow.
   d) Drilled and Flushed 6" Ø casing. Sounded at 4.2'. We redrilled and flushed. Sounded at 4.6'. Drilled within .5 of Bottom of hole.

2. a) Drove 4" Ø flush joint casing from 4.6' to 9.3'. Inside of casing drilled out with 5 1/8" Ø roller cone; hole flushed clean.
   b) 4" Ø casing hammered from 9.3' to 15.5'. Flushed clean and sounded at 15.6. Bailed water out to within .5' from bottom.

(0.1' End Cap results in screen bottom at 14.7')

3. a) Borehole backfilled to 14.8' with filter sand.
   b) Well screen and riser pipe installed at 14.9'.
   c) Backfilling: The 4" Ø was pulled up in 1.0' at a time then sounded to ensure no sloughing of the hole had occurred. The borehole was then backfilled with sand or bentonite pellets; depending on what interval of the hole was being backfilled.

4. Filter Pack: Screen/bore hole annulus backfilled with sand to 7.8'. Volume used 5.25 gallons. Estimated volume was 5.2 gallons.

5. Bentonite seal: Riser pipe/borehole annulus backfilled to 2.8'. Volume used 24 pints = 3.6 gal. Calculated volume was 4.4 gallons.

6. a) Water level after completion was 9.97 @ 10:00 hr on 10-21-85.

7. a) An aluminum protective casing was threaded on to 6" Ø surface casing and secured with a lock.

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020	Made by JDC	Date 10-23-85
	Ref. L-20	Checked	Sheet 2 of 2
		Reviewed GR	

8. a) Well cap was vented by drilling small ø hole in cap.

9. a) A 30" hole was hand dug around 6" ø surface casing and filled with cement and sloped so water would run away from well.

10. a) Three 1/4" diameter drain holes were drilled near top of cement mound.

11. a) Deionized water was added to the bentonite pellets to induce hydration.

12. a) Cement was poured over the bentonite seal to a level even with the cement mound outside of the surface cage.

b) After the cement cured, coarse sand was poured in the guard pipe to about 5 inches below the top of well pipe.

Golder Associates

Field Boring Log

DEPTH HOLE 53.9	JOB NO. 853-3013	PROJECT CWM/OLD/OH		BORING NO. G-21	
DEPTH SOIL DRILL 53.9	QA INSP. PAI/RJM	DRILLING METHOD CME CONTINUOUS SOIL SAMPLER		SHEET 1 OF 3	
DEPTH ROCK CORE NA	WEATHER CLDY	DRILLING COMPANY GEOMECHANICS		SURFACE ELEV. 607	
NO. DIST. SA. 11 UD. SA. 0	TEMP. 35	DRILL RIG CME 55	DRILLER J. SORVELLI	DATUM MSL	
DEPTH WL. 4.0'	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA	STARTED 1237 (TIME) / 3-6-85 (DATE)	
TIME WL. AT TIME OF BORING	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA	COMPLETED 1600 (TIME) / 3-6-85 (DATE)	

SAMPLE TYPES

AS	AUGER SAMPLE	CS	CHUNK SAMPLE
DO	DRIVE OPEN	DS	DENISON SAMPLE
PS	PITCHER SAMPLE	RC	ROCK CORE
ST	SLOTTED TUBE	TO	THIN WALLED OPEN
TP	THIN WALLED PISTON	WS	WASH SAMPLE
CSS	CONTINUOUS SOIL SAMPLER		

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SLT	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RK	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" ~ 0-5%
"LITTLE" ~ 6-12%
"SOME" ~ 12-30%
"AND" ~ 30-60%

CONSISTENCY

LO	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FOOTER)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
604.9									Augered to 2.1' before beginning sampling due to gravel fill
2.1	Firm to stiff, brown, CLAYEY SILT, some f-c sand, little fine gravel, trace organics (FILL)			1	CSS		2.2/2.2		
			4.3						
601.8									
5.2	Firm to stiff gray-tan-orange, mottled, SILTY CLAY, trace organics (LACUSTRINE)			2	CSS		4.4/5.0		
			9.3						
597.3									
9.7	Firm to stiff, tan-gray, laminated CLAYEY SILT, trace fine sand (LACUSTRINE)			3	CSS		5.3/5.0		
593.6									
13.4	Soft to firm gray SILTY CLAY, trace to little f-c sand, trace f-c gravel (TILL)		14.3	4	CSS		3.9/5.0		
			19.3						
				5	CSS		5.0/5.0		Sample was ribbon shaped due to rock in front of sampler

Golder Associates

Field Boring Log

DEPTH HOLE 53.9	JOB NO. 853-3013	PROJECT CWM/OLD/OH	BORING NO. G-21
DEPTH SOIL DRILL 53.9	GA INSP. PMI/RSM	DRILLING METHOD CME Continuous Soil Sampler	SHEET 2 OF 3
DEPTH ROCK CORE NA	WEATHER CLOY	DRILLING COMPANY Geomechanics	SURFACE ELEV. 607
NO. DIST. SA. 11 UD. SA. NA	TEMP. 35	DRILL RIG CME 55 DRILLER J. Selvoski	DATUM MSL
DEPTH WL. 4.0	HRS. PROD. NA	WT. SAMPLER HAMMER NA DROP NA	STARTED 1237 / 3-6-85 (TIME / DATE)
TIME WL. AT TIME OF BORING	HRS. DELAYED NA	WT. CASING HAMMER NA DROP NA	COMPLETED 1800 / 3-6-85

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DD	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	Continuous Soil Sampler

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0-5%
"LITTLE" — 5-12%
"SOME" — 12-30%
"AND" — 30-50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. DEPTH	DESCRIPTION	BLOWS/FT	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC/ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to firm, gray, SILTY CLAY, trace to little f-c sand, trace f-c gravel (TILL)		5	CSS		5.0/5.0		
		24.3	6	CSS		2.0/5.0		Poor recovery due to rock in front of sampler
		29.3						No Sample Attempted - Augered to move rock
		30.0	7	CSS		4.5/4.3		
		34.3	8	CSS		4.8/5.0		
		39.3	9	CSS		5.0/5.0		
565.3 / 41.5	Stiff to hard, gray SILTY CLAY, little to some f-c sand, trace f-c gravel (TILL)							
		44.3	10	CSS		5.0/5.0		

Golder Associates

Field Boring Log

DEPTH HOLE 53.9 JOB NO. 853-3013 PROJECT Cuyahoga OH BORING NO. G-21

DEPTH SOIL DRILL 53.9 QA INSP. PMI/RSM DRILLING METHOD CME Continuous Soil Sampler SHEET 3 OF 3

DEPTH ROCK CORE NA WEATHER CLOY DRILLING COMPANY GEOMECHANICS SURFACE ELEV. 607

NO. DIST. SA. 11 UD. SA. NA TEMP. 35° DRILL RIG CME 55 DRILLER J. Sowerski DATUM MSL

DEPTH WL. 4.0' HRS. PROD. NA WT. SAMPLER HAMMER NA DROP NA STARTED 1237 / 3-6-85 (TIME / DATE)

TIME WL. AT TIME OF BRING HRS. DELAYED NA WT. CASING HAMMER NA DROP NA COMPLETED 1400 / 3-6-85 (TIME / DATE)

SAMPLE TYPES

AS AUGER SAMPLE
CS CHUNK SAMPLE
DO DRIVE OPEN
DS DENISON SAMPLE
PS PITCHER SAMPLE
RC ROCK CORE
ST SLOTTED TUBE
TO THIN WALLED, OPEN
TP THIN WALLED, PISTON
WS WASH SAMPLE
CSS Continuous Soil Sample

ABBREVIATIONS

BL BLACK, BR BROWN, C COARSE, CA CASING, CL CLAY, CLY CLAYEY, F FINE, FRAG FRAGMENTS, GL GRAVEL, LYD LAYERED, LI LITTLE, M MEDIUM, MC MICACEOUS, MOT MOTTLED, NP NON PLASTIC, OG ORANGE, ORG ORGANIC, PH PRESSURE HYDRAULIC, PM PRESSURE MANUAL, R RED, RES RESIDUAL, RK ROCK, SA SAMPLE, SAT SATURATED, SD SAND, SI SILT, SLY SILTY, SM SOME, TR TRACE, WL WATER LEVEL, WH WEIGHT OF HAMMER, Y YELLOW

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" – 0-5%
"LITTLE" – 5-12%
"SOME" – 12-30%
"AND" – 30-50%

CONSISTENCY

LS LOOSE, S SOFT, CP COMPACT, FM FIRM, DN DENSE, ST STIFF, V VERY, H HARD

ELEV. DEPTH	DESCRIPTION	BLOWS/FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC/ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Stiff to hard, gray, silty clay, little to some f-c sand, trace f-c gravel (TILL)			10	CSS		5.0/5.0		
557.2			49.5						
49.8	Weathered shale			11	CSS		4.3/4.6		
557.1									
53.9	AUGER REFUSAL								Upon completion the hole was backfilled with thick bentonite slurry mixed at 1.5-2 lbs per gallon of water

PROJECT CWM/VICKERY/OHIO JOB NO. 853-3020 BORING NO. MW-21R DATE 2/18/86 SHEET 1 OF 1

BORING BEGAN —	BORING COMPLETED —		CORE HOLE LOCATION MW-21R
METHOD OF CORING ROTARY	DRILLING FLUID POTABLE WATER	GR. ELEV. — WEATHER —	
CASING USED — SIZE NX		INSPECT. FM OPERAT. B.K.	WATER LEVEL, TIME, DATE —

DEPTH (FT.)	RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH	TYPE	INFILLING	ANGLE W/AXIS	FREQUENCY	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN./FT.
50.0													BGOID CORING AT 50.5 FT BELOW G.S.				
50.5													NO CORE RECOVERY. ASSUMED CORE LOSS PROBABLY TILL AND/OR WEATHERED ROCK.				
			7.8/10	54.4 TO 54.8	FRACTURES	—	H TO 80°	.05' TO .2'		DARK GRAY		SLIGHT	DARK GRAY ARGILLACEOUS DOLOMITE CORE NOT INTACT 54.8-55.6 FT - GYPSUM LAMINAE AND SOME GYPSUM MOTTLING.				
	1	7.2	68%	54.8 TO 63.1	FRACTURES	—	H TO 80°	.05' TO .3'		WHITE AND GRAY			WHITE GYPSUM WITH GRAY ARGILLACEOUS DOLOMITE LAMINAE				
										DARK GRAY	VERY FINE TO FINE		DARK GRAY ARGILLACEOUS DOLOMITE. UPPER 0.1' has GYPSUM LAMINAE				
													58.8-59.1 FT - WHITE GYPSUM MOTTLED WITH GRAY ARGILLACEOUS DOLOMITE.				
60.5													59.1-63.1 FT - CRYSTALLINE GYPSUM LAMINAE.				
	2	7.2	68%	4.8/7.0 63.6 TO 67.5	FRACTURES	—	H TO 80°	0.1' TO 0.7'		WHITE			63.1-63.6 FT - WHITE GYPSUM WITH GRAY ARGILLACEOUS DOLOMITE. 63.6-67.5 FT - WHITE GYPSUM LAMINAE ALTERNATING WITH GRAY ARGILLACEOUS DOLOMITE LAMINAE. WHITE CHALKY GYPSUM				
67.5													END OF CORING @ 67.5 FT BELOW G.S.				

SCALE: 1 DIVISION = 0.2 FEET

CHECKED BY WLG

DATE — LOGGED BY FM

MONITORING WELL INSTALLATION LOG

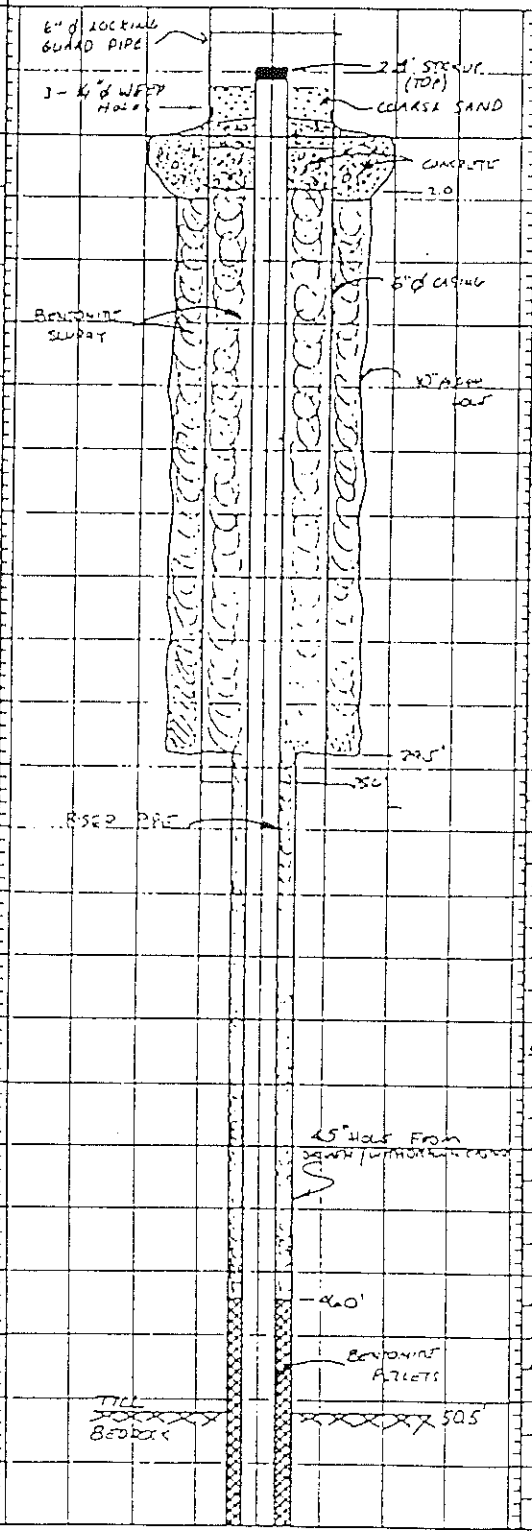
JOB NO 053-3020	PROJECT CWM/VICKERY-/OH	WELL NO MW-21R	SHEET 1 OF 2
GA INSP. WGC, FA	DRILLING METHOD CORE/ROTARY	GROUND ELEV 610.3	WATER DEPTH 21.50'
WEATHER	DRILLING COMPANY BOWSER/MORNER	COLLAR ELEV 613.10	DATE/TIME 9/27/85 1615
TEMP	DRILL RIG MOBILE B-61 DRILLER B. KIRKPATRICK	STARTED 9/26/85 (TIME / DATE)	COMPLETED 9/26/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 60.0' ft	WELL SCREEN 2 in. dia. 10.0' ft	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH COUPLED	SLOT SIZE 100 (.10")	FILTER PACK QTY ~6.0 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE #4 SILICA GRAVEL
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	
2.1	FIRM TO STIFF, BROWN, CLAYEY SILT, SOME F-C SAND, LITTLE FINE GRAVEL, TRACE ORGANICS (FILL)
5.2	FIRM TO STIFF GRAY-TAN-ORANGE, MOTTLED, SILTY CLAY, TRACE ORGANICS (LACUSTRINE)
9.7	FIRM TO STIFF, TAN-GRAY, LAMINATED CLAYEY SILT, TRACE FINE SAND (LACUSTRINE)
13.4	SOFT TO FIRM GRAY SILTY CLAY, TRACE TO LITTLE F-C SAND, TRACE F-C GRAVEL (TILL)
41.5	STIFF TO HARD, GRAY SILTY CLAY, LITTLE TO SOME F-C SAND, TRACE F-C GRAVEL (TILL)
	WEATHERED ROCK
53.4	DARK GRAY ARGILLACEOUS DOLOMITE CONT ON PAGE 2

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

TOTAL LOSSES REMOVED ≈ 2,100 GALS

WATER LOSS DURING DRILLING ≈ 6000 GALS.

WELL DEVELOPED FROM 9-22-85 to 9-24-85.

DEVELOPMENT METHOD: AIR LIFT USING 1" ϕ PVC INJECTOR PIPE AND NITROGEN FOR GAS SOURCE

WATER LEVEL BEFORE DEVEL WAS 21.2' BELOW TOP OF 2" WELL CSG.

INITIAL WATER PURGED (~100 GALS) WAS GRAY WITH TRACE OF BENTONITE

CONT. PAGE 2

MONITORING WELL INSTALLATION LOG

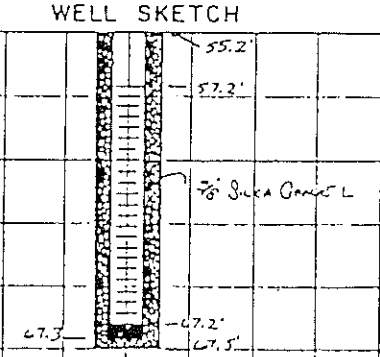
JOB NO A53-3020	PROJECT CWM / VICKERY / OH	WELL NO MW-21R	SHEET 2 OF 2
GA INSP. WGG, EM	DRILLING METHOD CORE / ROTARY	GROUND ELEV 610.3	WATER DEPTH 21.52'
WEATHER	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 613.10	DATE/TIME 9/24/85 & 25
TEMP	DRILL RIG MOBILE B-61 DRILLER B. KIRKPATRICK	STARTED 9/11/85 (TIME / DATE)	COMPLETED 9/11/85 (TIME / DATE)

MATERIALS INVENTORY - SEE PAGE 1

WELL CASING ___ in. dia. ___ ft	WELL SCREEN ___ in. dia. ___ ft	BENTONITE SEAL
CASING TYPE	SCREEN TYPE	INSTALLATION METHOD
JOINT TYPE	SLOT SIZE	FILTER PACK QTY
GROUT QUANTITY	CENTRALIZERS	FILTER PACK TYPE
GROUT TYPE	DRILLING MUD TYPE	INSTALLATION METHOD

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
55.0	CONT. FROM PAGE 1 DARK GRAY ARGILLACEOUS DOLOMITE WITH GYSUM LAMINAE AND OCCASIONAL THIN BEDS OF GYPSUM
63.1 65.0	WHITE GYPSUM WITH GRAY ARGILLACEOUS DOLOMITE LAMINAE
67.5 70.0	CURING TERMINATED @ 67.5'

WELL SKETCH



INSTALLATION NOTES

WELL DEVELOPMENT NOTES

MEASUREMENTS TAKEN DURING DEVELOPMENT:

DATE	VOLUME REMOVED	pH	SPECIFIC [illegible]	TEMP.
9-22-85	START	7.8	3,900	60°F
9-24-85	1,000	7.6	4,400	–
9-24-85	1,000	7.2	5,200	54°F
9-24-85	2,100	7.2	7,200	56°F

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-5020 Ref. MW-21R	Made by W.G.G. Checked Reviewed MTL	Date 11-7-85 Sheet 1 of 2

1. a) An 8" diameter (ϕ) hole was augered to 24.0 ft below ground surface (bgs) with 6"ϕ augers that had a 8" ϕ bit @ bottom. Augers were pulled and the hole was sounded @ 23.0 ft bgs. Put augers back down hole and cleaned hole to 24.5'.
Rig pump was flushed with municipal water since MW-21R was the 1st well to be drilled.

b) Installed 6"ϕ flush-joint steel csg (25.0') and pushed and seated 6" casing to 25.0 ft. The casing was pressure grouted in place to ensure a good seal. The casing was grouted in three batches using a total of ~ 120 gals. Casing sank to 25.6' during subsequent drilling.

c) The 6"ϕ surface csg was flushed and reamed with a 3 7/8" rollerbit. Did not have a larger bit. The casing was flushed until the return water was clear. The standing water in the 6" casing was bailed to with 0.5 ft of the bottom of hole.

2. a) 4"ϕ flush-joint temporary casing was driven to 33.5 ft. then was flushed and reamed using a 3 7/8" rollerbit until return water was clear. Completed driving casing to 50.5' and flushed and reamed until return water was clear.

b) Bailed ~ 65 bails from 4" casing; water was ~ 4' below surface so we needed to remove ~ 30 gals. Removed ~ 44 gals.

3. a) Rock cored from 50.5 ft to 60.5 ft (Run #1), water loss for run 1 was ~ 325 gals. Recovered ~ 71% of 10 foot run. Resumed coring @ 60.5' bgs and cored to 67.5' (Run #2). Recovered 97% of run. Water loss was ~ 175 gals. Total loss during coring was ~ 500 gals.

4. a) Reamed core hole with 3 7/8" rollerbit to 67.5'. Water loss during reaming was ~ 500 gals. Sounded hole @ 67.5'.

b) Total water loss during drilling for MW-21R was ~ 1000 gals.

5. a) Inserted well screen (10.0') and solid riser pipe (60.0') downhole and measured well stickup @ 2.8' above ground surface.

6. a) Filter pack (3/8"ϕ gravel) was backfilled and measured in 1.0 foot increments to ensure that bridging or sloughing had not occured. Filter pack was added to 55.2' bgs. About 5.0 gals of filter pack added. Calculated volume = 4.7 gals.

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020 Ref. MW-21R	Made by W.G.G. Checked Reviewed GJK	Date 11-7-85 Sheet 2 of 2

7. a) Bentonite pellets were added @ 1.0 ft increments and tamped and measured to the bottom of 4" temporary casing, 50.5'. The casing was bumped up 1.0 ft at a time and bentonite pellets were added in the same increments and tamped to 46.0' bgs.

8. a) Bentonite grout was tremied down the remaining annulus between the 4" csg and 2"ϕ well pipe. Mixed grout @ a ratio of ~ 1.6 lbs bent. per gal. of water. Used ~ 45 gals of grout, calculated volume is 44 gals.

9. a) Installed a 6"ϕ aluminum flush-joint protective pipe that was threaded on to the 6"ϕ surface casing. The protective pipe was secured with a lock.

10. a) A hole was dug at a later date, 30" deep around the 6" surface and was backfilled with cement and shaped in a manner that water will drain away from the well.

11 a) Approximately 2.0 feet of bent. grout was removed from the inner annulus between the 6" surface casing and 2"ϕ well; that gap 2.0 annular space was backfilled with concrete to roughly the same level as the top of cement collar on the outside.

b) Three (3) ¼"ϕ weep holes were drilled in the 6" protective casing at the top of the cement plugged interval described above.

c) Coarse sand was backfilled in the protective casing up to ~ 4 to 5" below the top of riser pipe.

12 a) A small diameter hole was drilled in the well cap to serve as a vent hole.

13 a) Water level upon completion was 21.45' @ 13:37 on 9-23-85

MONITORING WELL INSTALLATION LOG

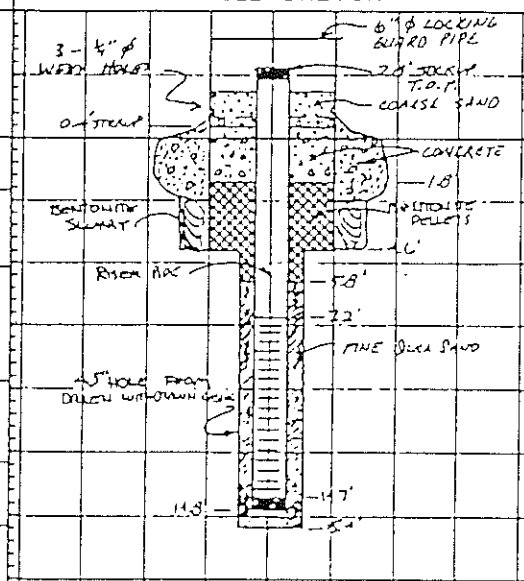
JOB NO. 893-3020	PROJECT CHEM / VICKERY / OH	WELL NO L-21	SHEET 1 OF 1
GA INSP. L. FROST	DRILLING METHOD AUGER / ROTARY	GROUND ELEV 609.3	WATER DEPTH 11.31'
WEATHER PTLY CLDY	DRILLING COMPANY EXPLORATION TECHNOLOGY INC	COLLAR ELEV 612.08	DATE/TIME 10/14/85 14:40
TEMP.	DRILL RIG CME 55	DRILLER C. BATTLE	STARTED 1630 / 10/15/85 (TIME / DATE) COMPLETED 1700 / 10/15/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 10.0 ft	WELL SCREEN 2 in. dia. 7.5' ft	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH (DOUBLE)	SLOT SIZE 0.0060 in	FILTER PACK QTY ~6.0 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	
2.1	FIRM TO STIFF, BROWN, CLAYEY SILT, SOME F-C SAND, LITTLE FINE GRAVEL, TRACE ORGANICS (FILL)
5.2	FIRM TO STIFF GRAY-TAN-ORANGE, MOTTLED, SILTY CLAY, TRACE ORGANICS (LACUSTRINE)
9.7	FIRM TO STIFF, TAN-GRAY, LAMINATED CLAYEY SILT, TRACE FINE SAND (LACUSTRINE)
13.4	SOFT TO FIRM GRAY SILTY CLAY, TRACE TO LITTLE F-C SAND, TRACE F-C GRAVEL (FILL)
15.7	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY PUMPING AND SURGING WITH STAINLESS STEEL BAILER AND A PIECE OF POLYPROPYLENE ROPE DEDICATED TO THIS WELL.

BAILER AND TEFLON CHECK VALVE WAS STEAM CLEANED THEN RINSED WITH DEIONIZED WATER BEFORE DEVELL.

TOTAL VOLUME REMOVED DURING DEVELOPMENT WAS 7.3 GALS. VOLUME OF WATER IN WELL @ STATIC 5.12' ON 1-14-86 WAS 2.0 GALS.

MEASUREMENTS DURING DEVEL.

DATE	VOLUME BAILED	pH	SPECIFIC COND.	COMMENTS
11-14-85	2.0	6.5	4,000	
11-19-85	2.0	6.6	4,600	HARD MILKY
11-20-85	1.5	6.9	4,500	
11-22-85	1.9	—	—	RECOVERY TEST

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020	Made by LF	Date
	Ref. L21	Checked	Sheet 1 of 2
		Reviewed	

1. a) Drilled 10" ϕ hole to 4.5' bgs using solid-stem augers; surface fill sloughing into hole, sounded @ 3.0' bgs; hole reaugered, sounded @ 4.6' bgs
   b) Installed 6" ϕ flush-joint steel surface csg, bottom of 6" csg @ 4.6' bgs
   c) Grouted borehole annulus with bentonite slurry mixed @ 1.5-2.0 lb/gal water; grout poured into borehole annulus from ground surface; calculated grout volume 10.6 gal, actual volume used ~ 15 gal
   d) 6" ϕ surface csg drilled and flushed clean to 4.6' bgs; hole bailed to within 0.5' of bottom of hole

2. a) 4" ϕ flush-joint csg hammered from 4.6' to 9.5' bgs; inside of csg drilled out with 3 7/8" ϕ roller cone; hole flushed clean
   b) 4" ϕ csg hammered from 9.5' to 15.4' bgs; inside of csg drilled out with 3 7/8" ϕ roller cone; hole flushed clean; hole bailed to within 0.5' of bottom of hole

3. a) Borehole backfilled with filter sand to 14.8' bgs
   b) Well screen and riser pipe installed, well bottoming @ 14.8' bgs
   c) Backfilling: The 4" ϕ csg was pulled up approx 1' @ a time then sounded to ensure that no sloughing of the hole had occured. The open borehole annulus was then backfilled with sand or bentonite pellets, depending on what interval of the hole was being backfilled.

   Filter Pack: screen / borehole annulus backfilled with sand to 5.8' bgs; calculated filter pack volume 5.7 gal, actual volume used ~ 6 gal

   Bentonite Seal: riser pipe / borehole annulus backfilled with bentonite pellets to 1.8' bgs; calculated bentonite volume 1.2 gal, actual volume used ~ 5 gal

4. a) Water level @ time of completion of well = 11.51' below top of 2" riser pipe

Golder Associates	SUBJECT INSTALLATION NOTES		
	Job No. 853-3020 Ref. L-21	Made by LF Checked Reviewed	Date Sheet 2 of 2

5. a) An aluminum 6" ϕ protective pipe was threaded on the 6" ϕ surface csg. 3- ¼ ϕ drain holes were drilled in the base of the guard pipe.

b) Deionized water (about 1.5 gals) was added to the bentonite pellets to facilitate hydration.

c) A 2.5' hole was dug around the surface csg and later filled in with cement above the threaded joint of the guard pipe.

d) The annular space above the bentonite pellets was filled with cement to a level even with the cement mounded outside the guard pipe.

e) After the cement cured, coarse sand was poured over the cement inside the protective pipe, to a level of about 5 inches below the top of well pipe.

6. a) A small diameter hole was drilled in the well cap to serve as a vent hole.

Golder Associates

Field Boring Log

DEPTH HOLE 45.5	JOB NO. 853-3015	PROJECT Cwmlordan			BORING NO. G-22
DEPTH SOIL DRILL 45.5	QA INSP. PM/RSM	DRILLING METHOD CME Continuous Soil Sampler			SHEET 1 OF 2
DEPTH ROCK CORE NA	WEATHER cldy	DRILLING COMPANY Geomechanics			SURFACE ELEV. 606
NO. DIST. SA. 9 UD. SA. NA	TEMP. 40°	DRILL RIG CME 55	DRILLER J. Selvski		DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA		STARTED 1815 / 3-4-85 (TIME / DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA		COMPLETED 0850 / 3-7-85 (TIME / DATE)

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
FS	FITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	Continuous Soil Sample

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SLT	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RK	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LO	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
601.5	ROADFILL - GRAVEL & COBBLES								Augered to 4.5' before beginning sampling due to gravel fill
4.5	FILL								
4.0	Firm, gray, tan-orange, mottled SILTY CLAY, trace fine sand, trace organics (LACUSTRINE)			1	CSS		4.7 / 5.0		
			9.5						
595.0									
11.0	Firm, brown-tan, laminated SILTY CLAY, trace fine sand (LACUSTRINE)			2	CSS		5.0 / 5.0		
			14.5						
590.0									
15.2	Soft to stiff, gray, SILTY CLAY, little f-c sand, trace f-c gravel (TILL)			3	CSS		4.8 / 5.0		
			19.5						
				4	CSS		5.0 / 5.0		

Golder Associates

Field Boring Log

DEPTH HOLE 45.5	JOB NO. 853-3013	PROJECT CWM/LOLO/04	BORING NO. G-22
DEPTH SOIL DRILL 45.5	GA INSP. RAL/RSM	DRILLING METHOD CONE CONTINUOUS SOIL SAMPLER	SHEET 2 OF 2
DEPTH ROCK CORE NA	WEATHER CLDY	DRILLING COMPANY GEOMECHANICS	SURFACE ELEV. 606
NO. DIST. SA. 9 UD. SA. NA	TEMP. 40°	DRILL RIG CME 55	DRILLER J. SEZVOFKI	DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA	STARTED 1115 / 3-6-85 (TIME / DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA	COMPLETED 0850 / 3-7-85

SAMPLE TYPES

AS	AUGER SAMPLE	BL	BLACK
CS	CHUNK SAMPLE	BR	BROWN
DO	DRIVE OPEN	C	COARSE
DS	DENISON SAMPLE	CA	CASING
PS	PISTON SAMPLE	CL	CLAY
RC	ROCK CORE	CLY	CLAYEY
ST	SLOTTED TUBE	F	FINE
TO	THIN WALLED, OPEN	FRAG	FRAGMENTS
TP	THIN WALLED, PISTON	GL	GRAVEL
WS	WASH SAMPLE	LYD	LAYERED
CSS	CONTINUOUS SOIL SAMPLE	LT	LITTLE

ABBREVIATIONS

M	MEDIUM	SA	SAMPLE
MIC	MICACEOUS	SAT	SATURATED
MOT	MOTTLED	SD	SAND
NP	NON PLASTIC	SI	SILT
OG	ORANGE	SLY	SILTY
ORG	ORGANIC	SM	SOME
PH	PRESSUREMETER HYDRAULIC	TR	TRACE
PM	PRESSUREMETER MANUAL	WL	WATER LEVEL
R	RED	WH	WEIGHT OF HAMMER
RES	RESIDUAL	Y	YELLOW
RK	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LO	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FOOTER)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
				4	CSS		5.0/5.0		
	Soft to stiff gray SILTY CLAY, little f-c sand, trace f-c gravel (TILL)		24.5						
				5	CSS		2.5/5.0		Rock lodged in end of sampler
			29.5						
				6	CSS		4.3/5.0		
			34.5						
				7	CSS		5.0/5.0		
567.1 / 38.9									
	Stiff to hard, gray SILTY CLAY, some f-c sand, trace f-c gravel (TILL)		39.5						
				8	CSS		5.0/5.0		
			44.5						Upon completion the borehole was backfilled with thick bentonite slurry mixed at 15 to 20 lbs per gallon of water
560.7 / 45.3				9	CSS		1.4/1.0		
560.5 / 45.5	TOP OF ROCK								
	AUGER REFUSAL								

PROJECT CWM/VICKERY/OHIO	JOB NO. 853-3020	BORING NO. 22R DATE 2/18/82 SHEET 1 OF 1	
BORING BEGAN —	BORING COMPLETED —	CORE HOLE LOCATION MW-22R	
METHOD OF CORING ROTARY	DRILLING FLUID POTABLE WATER	GR. ELEV. — WEATHER —	
CASING USED — SIZE NX		INSPECT. FM OPERAT. BC	WATER LEVEL TIME DATE —

DEPTH (FT.)	RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH	TYPE	INFILLING	ANGLE W/AXIS	FREQUENCY	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
40.0													BEGIN CORING @ 43.3 FT BELOW G.S.				
43.3			.75/5.0						—	—	—	—	ASSUMED CORE LOSS. PROBABLY TILL.				
	1	47%	15%	45.3 TO 48.2	PARTINGS	CLEAN GYPS	II TO BED	.05' TO .2'		DARK GRAY	FINE TO VERY FINE	SLIGHT	DARK GRAY ARGILLACEOUS DOLOMITE				
										WHITE			WHITE GYPSUM				
										GRAY			GRAY ARGILLACEOUS DOLOMITE WITH GYPSUM LAMINAE.				
48.3				48.2 TO 54.4	PARTINGS	CLEAN GYPS	II TO BED	.05' TO .3'		WHITE			WHITE GYPSUM MOTTLED WITH ARGILLACEOUS DOLOMITE				
			1.6/6.1	48.2 TO 51.9	FRACTURES	CLEAN GYPS	~60°	.3'		DARK GRAY			DARK GRAY ARGILLACEOUS DOLOMITE WITH GYPSUM LAMINAE AND SECONDARY GYPSUM ON SOME PARTINGS 49.5 TO 49.8 FT - WHITE GYPSUM 48.2 TO 51.9 FT - SEVERAL FRACTURES PRESENT THAT ARE CLOSED OR HAVE SECONDARY GYPSUM (NON-WATER BEARING)	—	—	—	—
	2	72%	26%							WHITE			WHITE GYPSUM				
										GRAY TO DARK GRAY			GRAY TO DARK GRAY ARGILLACEOUS DOLOMITE 51.9 TO 56.3 FT - WITH GYPSUM LAMINAE				
54.4													56.3 TO 57.1 FT - ALTERNATING WITH LIGHT GRAY MOTTLED GYPSUM				
	3	37%	21%	56.3 TO 58.2	PARTINGS	CLEAN GYPS	II TO BED	.05' TO .6'									
				58.2 TO 60.4	PARTINGS	CLEAN GYPS	II TO BED	.05' TO .15'		LIGHT GRAY			LIGHT GRAY GYPSUM WITH ARGILLACEOUS DOLOMITE LAMINAE. 57.1 TO 58.2 FT - MOTTLED				
57.4	4	72%	0%														
60.7										GRAY			GRAY ARGILLACEOUS DOLOMITE W/GYPSUM LAMINAE				
	5	0%	0%						—	—	—	—	60.7 TO 61.2 FT - NO RECOVERY				
61.2													END OF CORING AT 61.2 FT BELOW G.S.				

SCALE: 1 DIVISION=0.2 FEET

CHECKED: WGG FM

DATE — LOGGED BY FM

MONITORING WELL INSTALLATION LOG

JOB NO 853-3020	PROJECT CWM / VICKERY / OH	WELL NO. MW-22R	SHEET 1 OF 2
GA INSP. E. MARINELLI	DRILLING METHOD CORE / ROTARY	GROUND ELEV 606.4	WATER DEPTH 17.37'
WEATHER	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 608.49	DATE/TIME 7/21/85 13:11
TEMP.	DRILL RIG	DRILLER B.C. MANOS	STARTED 1110 (TIME) 8/8/85 (DATE) COMPLETED 1835 (TIME) 8/17/85 (DATE)

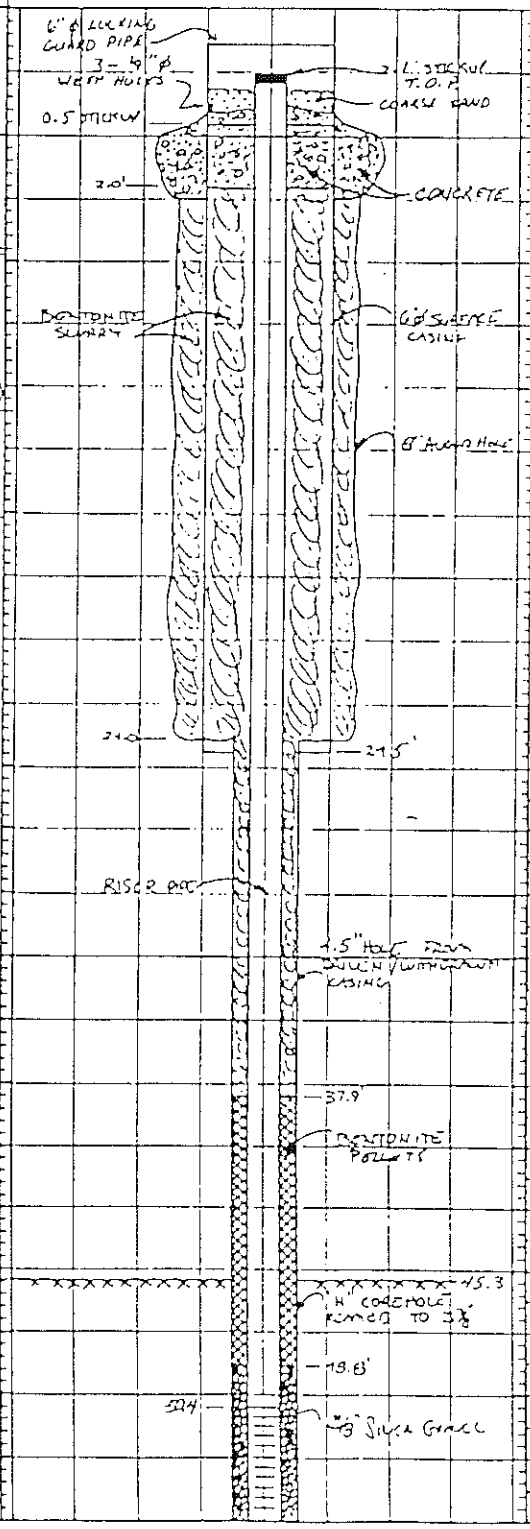
MATERIALS INVENTORY

WELL CASING 2 in. dia. 52.5 LF	WELL SCREEN 2 in. dia. 10.0' LF	BENTONITE SEAL Pellets
CASING TYPE STAINLESS STEEL (316)	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 100 (.10 in)	FILTER PACK QTY 0.67 ft^3 (5 GALS)
GROUT QUANTITY 35 gal	CENTRALIZERS NONE	FILTER PACK TYPE 3/8" SILICA GRAVEL
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	ROADFILL, GRAVEL AND COBBLES
4.5	FILL
4.8	FIRM, GRAY, TAN-ORANGE, MOTTLED SILTY CLAY, TRACE FINE SAND, TRACE ORGANICS (LACUSTRINE)
11.0	FIRM, BROWN-TAN, LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
15.2	SOFT TO STIFF, GRAY, SILTY CLAY, LITTLE F-C SAND, TRACE F-C GRAVEL (TILL)
38.7	STIFF TO HARD GRAY SILTY CLAY, SOME F-C SAND, TRACE F-C GRAVE (TILL)
45.3	~TOP OF ROCK DARK GRAY ARGILLACEOUS DOLOMITE ALTERNATING WITH THIN BEDS (0.5') OF WHITE AND MOTTLED GRAY AND WHITE GYPSUM

CONT. ON P. 2

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

TOTAL VOLUME REMOVED ≅ 3,080 GALS.

APPROX. WATER LOSS DURING DRILLING WAS 1,500 GALS.

DEVELOPED FROM 7-25-85 TO 10-3-85

DEVELOPMENT METHOD: AIR LIFT USING BOTH NITROGEN OR AIR FROM A DAYTON SPEEDAIRE OIL-LESS COMPRESSOR FOR AN AIR SOURCE. AIR OR INDUCTOR PIPE WAS 1" ϕ schedule 40 PVC pipe WITH THE BOTTOM 5 feet PERFORATED

STATIC WATER LEVEL BEFORE DEVEL. WAS 17.03' BELOW TOP OF 2" STEEL RISER ON 7-24-85

CONT. ON PAGE 2

MONITORING WELL INSTALLATION LOG

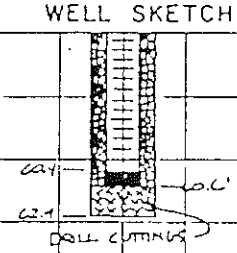
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO. MW-22R	SHEET 2 OF 2
GA INSP. E. MARINELLI	DRILLING METHOD CORE / ROTARY	GROUND ELEV 606.0	WATER DEPTH 17.37'
WEATHER	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 609.49	DATE/TIME 9/21/85 15:11
TEMP	DRILL RIG	DRILLER D.C. MANOS	STARTED 1110 9/8/85 (TIME / DATE) COMPLETED 1135 9/17/85 (TIME / DATE)

MATERIALS INVENTORY - SEE PAGE 1

WELL CASING ____ in. dia. ____ LF	WELL SCREEN ____ in. dia. ____ LF	BENTONITE SEAL
CASING TYPE	SCREEN TYPE	INSTALLATION METHOD
JOINT TYPE	SLOT SIZE	FILTER PACK QTY
GROUT QUANTITY	CENTRALIZERS	FILTER PACK TYPE
GROUT TYPE	DRILLING MUD TYPE	INSTALLATION METHOD

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
55.0	CONT. FROM A1 DARK GRAY DOLOMITE ALTERNATING WITH THIN BEDS OF WHITE AND MOTTLED GRAY AND WHITE GYPSUM
60.0	
61.2	CORING TERMINATED @ 61.2'
65.0	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WATER WAS INITIALLY GRAY AND MUDDY THE FIRST 500 GALS. DISTINCT SULFUR ODOR AND BLACK TINT COLOR THEREAFTER.

MEASUREMENTS OBTAINED DURING DEVELOPMENT:

DATE	GALLONS REMOVED	pH	SPECIFIC CONDUCTANCE	TEMP
9-22-85	START	7.2	8,200	56°F
10-1-85	1,000	7.2	8,400	50°F
10-2-85	2,000	7.4	8,400	54°F
10-3-85	3,000	7.6	8,800	62°F

NOTE: AN OILY FILM WAS NOTICED IN THE WATER DURING INITIAL DEVELOPMENT

Golder Associates	SUBJECT Installation Notes		
	Job No. 853 3020	Made by JFC for FM	Date 11/7/95
	Ref. MW-22R	Checked	Sheet 1 of 1
		Reviewed W.M.A.	

1. a) Drilled 8" Ø hole w/ solid stem auger to 24.0' bgs.
b) Installed 6" Ø carbon steel casing (25 ft) to depth of 24.0' bgs
c) Filled casing with grout of 1.5 # bentonite / gal water and used same mix to pressure grout up the annulus between the surface casing and the 8" Ø hole. Grouting continued until grout mix rose along the ground surface. Then seated the casing to 24.5' bgs.
d) Cleaned 6" Ø casing using water and a roller bit. Flushing continued until return was only slightly turbid.

2. a) Placed 4" Ø temporary well construction casing in hole down to 24.5' bgs. Drove casing w/ 300 # hammer in increments, flushing the casing in increments until return was clear. Drove casing to 43.5' bgs.

b) Cored rock from 43.5' to 61.0' bgs. Reamed hole with 3 7/8" Ø tricone bit to 62.4' bgs. Est. water loss @ 1,500 gals.

c) Drill cuttings settled in hole from 62.4' to 60.6' bgs

3. a) Placed well screen (#100) and riser pipe in well - 10' of screen and 52.5' of pipe w/ 0.2' end cap.

b) Backfilled around screen w/ fine grained to 48.8' bgs.

c) Bentonite pellet seal added from 48.8' bgs to 37.7' bgs.

d) Grouted hole w/ mix of of about 1.5 # bentonite / gal water. Grout tremied into the well annulus via 1" Ø PVC tremie pipe to the ground surface

4. a) Installed aluminum protective casing by threading casing onto the 6" Ø surface casing

b) Excavated 30" deep around 6" Ø casings and cemented casings in place - sloped for drainage

c) Removed grout inside the casing to about 2' bgs and cemented

d) Drilled 3 + 1/4" Ø weep hole in aluminum protective casing and added sand to about 15" below top of well pipe

e) Placed a vented cap on the well pipe

f) Locked the protective casing

MONITORING WELL INSTALLATION LOG

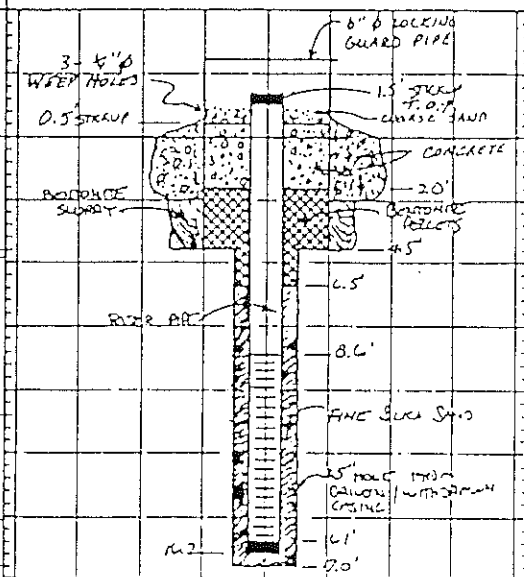
JOB NO 853-3070	PROJECT CWM / VICKERY / OH	WELL NO L-22	SHEET 1 OF 1
GA INSP. L COLLIE	DRILLING METHOD AUGER / ROTARY	GROUND ELEV 609.2	WATER DEPTH 5.66'
WEATHER	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 610.73	DATE/TIME 10/16/85 15:55
TEMP	DRILL RIG MOBILE B-61 DRILLER B KIRKPATRICK	STARTED 0972 10/14/85 (TIME / DATE)	COMPLETED 1130 10/14/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 10.0' lt	WELL SCREEN 2 in. dia. 7.5' lt	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 0.0060 in	FILTER PACK QTY 6.5 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	ROADFILL, GRAVEL AND COBBLES
4.5	FILL
4.8	FIRM, GRAY, TAN-ORANGE, MOTTLED SILTY CLAY, TRACE FINE SAND, TRACE ORGANICS (LACUSTRINE)
11.0	FIRM, BROWN-TAN, LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
15.2	SOFT TO STIFF, GRAY, SILTY CLAY, LITTLE F-C SAND, TRACE F-C GRAVEL (TILL)
17.0	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH STAINLESS STEEL BAILER AND A PIECE OF POLYPROPYLENE ROPE DESIGNATED TO THIS WELL.

BAILER STARTS CLEANED AND RINSED WITH DEIONIZED WATER BEFORE EACH BAILING PERIOD.

TOTAL VOLUME REMOVED DURING DEVELOPMENT WAS 7.1 GALS.

VOLUME OF WATER IN WELL COLUMN @ STATIC (4.80') on 1-14-86 was 2.1 gallons.

MEASUREMENTS DURING DEVEL.

DATE	GALLONS BAILED	PH	SPECIFIC COND	COMMENTS
11-14-85	2.0	6.6	3,200	
11-15-85	2.0	6.5	3,100	WATER MILKY COLORED
11-20-85	1.3	7.1	2,600	SLIGHTLY TURBID
11-22-85	1.7	–	–	RECOVERY TEST PERFORMED

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020	Made by JSC	Date 11 6 55
	Ref. L-22	Checked	Sheet 1 of 2
		Reviewed JPZ	

1. a) Augered 10" hole down to 4.5' using solid stem augers. Sounded hole at 4.1'. Some gravel fill in and they tamped it out. Sounded @ 4.5'

b) Installed 6" Ø casing. Bottom of casing at 4.5'

c) Grouted borehole with bentonite slurry of about 15 gallons with about a 2 gal. overflow

d) 6" Ø Surface casing drilled and flushed till clean. Bailed to within 0.5' of bottom.

2. a) Lowered 4" Ø casing and drove 5 feet to 9.5 and washed out till clean. Then hammered to 16.0' and washed out till clean. Sounded hole at 17.0' Bailed to within 0.5' of bottom

3. a) Borehole backfilled with filter sand up to 16.2'
b) Well screen and riser pipe lowered into hole.
c) Backfilling: The 4 Ø casing was pulled up ~1.0' at a time then sounded to ensure no sloughing of the hole had occurred.
d) While backfilling sand, we had a sandbridge at 13.9 ft. Tried to break it loose by using air compressor hooked up to a galvanized pipe and tried to blow it out. That didn't work. Tried to tamp it out. That didn't work either. Tamped it one more time and broke it free.

Filter Pack: Screen Borehole annulus backfilled with sand up to 6.5'. Calculated volume was 6.7 gal

Bentonite seal: Riser pipe borehole annulus was backfilled with bentonite pellet up to 2.5' bgs. Calculated volume was 31 pints (3.9 GALS)

4. a) Water level measured at 5.66'

5. a) An aluminum protective flush joint casing was threaded on to 6" Ø casing

6. a) Cap was vented by drilling holes in it

7) Cement placed around the protective casing 30" deep and sloped [illegible]

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 85-3020	Made by JRC	Date 11-6-85
	Ref. L-22	Checked	Sheet 2 of 2
		Reviewed JFC	

7. a) A 30" hole was dug by hand around the 6"Ø surface casing and was filled with cement and sloped so water would run away from the well

8. a) Three 1/4 drain holes were drilled in casing just above cement mound.

9. a) Deionized water was added to the bentonite pellets to facilitate hydration.

b). Cement was poured over the seal to a level that was even with the cement collar seal outside the well.

c) After the inner cement seal cured, coarse sand was poured in the guard pipe to about 5 inches from the top of riser pipe.

Golder Associates

Field Boring Log

DEPTH HOLE 42.0	JOB NO. 853-3013	PROJECT Cwm Llwchwr	BORING NO. G-23
DEPTH SOIL DRILL 42.0	QA INSP. Pollesch	DRILLING METHOD CME Continuous Soil Sampler	SHEET 1 OF 2
DEPTH ROCK CORE NA	WEATHER Partly cloudy	DRILLING COMPANY Geotechnics	SURFACE ELEV. 610
NO. DIST. S.A. 9 UD. S.A. NA	TEMP. 50°	DRILL RIG CME 55	DRILLER J. Selvoski	DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA	STARTED 1620 / 3-9-85 (TIME / DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA	COMPLETED 1630 / 3-9-85

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	CONTINUOUS SOIL SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIT	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RK	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" – 0 5%
"LITTLE" – 5 12%
"SOME" – 12 30%
"AND" – 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	DEPTH	SAMPLES NO.	TYPE	HAMM BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
609.5	TOPSOIL								
0.5	Firm, gray-tan, mottled, CLAYEY SILT, trace fine sand, trace organics (LACUSTRINE)		4.5	1	CSS		4.3 / 4.5		
604.8									
5.2	Firm, brown to gray, laminated SILTY CLAY, trace fine sand (LACUSTRINE)			2	CSS		4.7 / 5.0		
602.0									
8.0	Firm brown, SILTY CLAY, trace to little f-c sand, trace f-c gravel (TILL)		9.5	3	CSS		5.1 / 5.0		
	at 12' becoming								
	Soft to stiff, gray, SILTY CLAY, trace to little, f-c sand, trace f-c gravel (TILL)		14.5	4	CSS		5.0 / 5.0		
			19.5	5	CSS		5.1 / 5.0		

Golder Associates

Field Boring Log

DEPTH HOLE 42.0 JOB NO. 853-3013 PROJECT Cum Landfill BORING NO. 6-23
DEPTH SOIL DRILL 42.0 QA INSP. PMI/RSM DRILLING METHOD CME CONTINUOUS SOIL SAMPLER SHEET 2 OF 2
DEPTH ROCK CORE NA WEATHER Pt Cldy DRILLING COMPANY GEOMECHANICS SURFACE ELEV. 610
NO. DIST. SA. 9 UD. SA. ___ TEMP. 50° DRILL RIG CME 55 DRILLER J. Selvoski DATUM MSL
DEPTH WL. NA HRS. PROD. NA WT. SAMPLER HAMMER NA DROP NA STARTED 1620 / 3-9-85 (TIME / DATE)
TIME WL. NA HRS. DELAYED NA WT. CASING HAMMER NA DROP NA COMPLETED 1814 / 3-9-85

SAMPLE TYPES

AS	AUGER SAMPLE	BL	BLACK
CS	CHUNK SAMPLE	BR	BROWN
DO	DRIVE OPEN	C	COARSE
DS	DENISON SAMPLE	CA	CASING
PS	PITCHER SAMPLE	CL	CLAY
RC	ROCK CORE	CLY	CLAYEY
ST	SLOTTED TUBE	F	FINE
TO	THIN WALLED, OPEN	FRAG	FRAGMENTS
TP	THIN WALLED, PISTON	GL	GRAVEL
WS	WASH SAMPLE	LTD	LAYERED
CSS	CONTINUOUS SOIL SAMPLE	LI	LITTLE

ABBREVIATIONS

M	MEDIUM	SA	SAMPLE
MIC	MICACEOUS	SAT	SATURATED
MOT	MOTTLED	SD	SAND
NP	NON PLASTIC	SI	SILT
OG	ORANGE	SLY	SILTY
ORG	ORGANIC	SM	SOME
PH	PRESSUREHYDRAULIC	TR	TRACE
PM	PRESSURE MANUAL	WL	WATER LEVEL
R	RED	WH	WEIGHT OF HAMMER
RES	RESIDUAL	Y	YELLOW
RK	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 5%
"LITTLE" — 5 - 12%
"SOME" — 12 30%
"AND" — 30 - 50%

CONSISTENCY

LO	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMMER BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to stiff, gray SILTY CLAY, trace to little f-c sand, trace f-c gravel (TILL)		24.5	5	CSS		5.1 / 5.0		
				6	CSS		5.0 / 5.0		
			29.5	7	CSS		5.0 / 5.0		
	Becoming harder at 33.7'		34.5	8	CSS		5.3 / 5.0		
			39.5	9	CSS		2.5 / 2.5		
568.0 / 42.0	AUGER REFUSAL								Shale in end of sampler

Upon completion the borehole was backfilled with thick bentonite slurry mixed at 15 to 20 lbs per gallon of water

Golder Associates

Field Boring Log

DEPTH HOLE 46.5'	JOB NO. 853-3020	PROJECT CWM / VILLEREY / OH		BORING NO. 603A	
DEPTH SOIL DRILL 46.5	QA INSP. LF	DRILLING METHOD Split Spoon Continuous Sampling		SHEET 1 OF 1	
DEPTH ROCK CORE —	WEATHER Sunny	DRILLING COMPANY Bowser Morner		SURFACE ELEV. —	
NO. DIST. SA. 23 UD. SA. —	TEMP. —	DRILL RIG Mobile B-61	DRILLER D. Kirkpatrick	DATUM Ground surface	
DEPTH WL. —	HRS. PROD. —	WT. SAMPLER HAMMER 140 lb.	DROP 25 ft.	STARTED 1320 (Time) 11-03-95 (Date)	
TIME WL. —	HRS. DELAYED —	WT. CASING HAMMER —	DROP —	COMPLETED 0750 11-07-95	

SAMPLE TYPES

AS	AUGER SAMPLE	BL	BLACK
CS	CHUNK SAMPLE	BR	BROWN
DO	DRIVE OPEN	C	COARSE
DS	DENISON SAMPLE	CA	CASING
PS	PITCHER SAMPLE	CL	CLAY
RC	ROCK CORE	CLY	CLAYEY
ST	SLOTTED TUBE	F	FINE
TO	THIN WALLED, OPEN	FRAG	FRAGMENTS
TP	THIN WALLED, PISTON	GL	GRAVEL
WS	WASH SAMPLE	LYD	LAYERED
		LI	LITTLE

ABBREVIATIONS

M	MEDIUM	SA	SAMPLE
MIC	MICACEOUS	SAT	SATURATED
MOT	MOTTLED	SD	SAND
NP	NON PLASTIC	SI	SILT
OG	ORANGE	SLY	SILTY
ORG	ORGANIC	SM	SOME
PH	PRESSUREMETER/HYDRAULIC	TR	TRACE
PM	PRESSUREMANUAL	WL	WATER LEVEL
R	RED	WOH	WEIGHT OF HAMMER
RES	RESIDUAL	Y	YELLOW
RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0-5%
"LITTLE" — 5-12%
"SOME" — 12-30%
"AND" — 30-50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	DEPTH	SAMPLES NO.	TYPE	HAMMER BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
0.0	Loose light brown CLAY, trace organics (Topsoil)								
0.55	Stiff mottled brown-grey CLAY, some silt, trace org. matter (LACUSTRINE)	19		1A	DO	4 11 8 9	1.2 / 2.0		
		15	2.0	2A	DO	7 7 8 11	1.2 / 2.0		
4.0	Med. stiff mottled brown grey silty CLAY, trace fine sand @ 5.0' becoming moist (LACUSTRINE) @ 3.0 some silty-f sand seams	8	4.0	3A	DO	3 3 5 6	0.1 / 2.0		
		10	6.0	4A	DO	3 4 6 8	2.0 / 2.0		
		7	8.0	5A	DO	2 3 4 4	2.0 / 2.0		
7.7'	Soft grey silty CLAY, trace f sand, some brown silty-f sand seams (<<0.1') (LACUSTRINE)	5	10.0	6A	DO	1 2 3 4	2.0 / 2.0		
	@ 13.5' trace brown silt @ 17.5 V. soft	4	12.0	7A	DO	1 2 2 3	2.0 / 2.0		
		2	14.0	8A	DO	1 1 1 2	2.0 / 2.0		
17.0	Very soft grey SILTY CLAY, trace f-c sand (TILL)	2	16.0	9A	DO	0 1 1 2	1.8 / 2.0		'0' blows represents just the weight of the hammer pushing the split spoon down 6"
	Soft - firm grey SILTY CLAY, trace to little f-c sand (TILL)	2	18.0	10A	DO	0 1 1 3	1.5 / 2.0		
		8	20.0	11A	DO	1 3 5 7	1.2 / 2.0		
	at 22' becoming firm - stiff	14	22.0	12A	DO	4 6	1.6 / 2.0		

Golder Associates

Field Boring Log

DEPTH HOLE 46.5'	JOB NO. 153-3010	PROJECT CMA / VICKERY / OH	BORING NO. 6-23A
DEPTH SOIL DRILL 46.5	QA INSP. LF	DRILLING METHOD SPIT SPOON CONTINUOUS SAMPLING	SHEET 2 OF 2
DEPTH ROCK CORE —	WEATHER SUNNY	DRILLING COMPANY BOUSER MORNER	SURFACE ELEV. 610.5
NO. DIST. BA. 23 UD. BA. —	TEMP. —	DRILL RIG Mobil B-61 DRILLER B. Kirkpatrick	DATUM Ground surface
DEPTH WL. —	HRS. PROD. —	WT. SAMPLER HAMMER 140 lb DROP 2.5'	STARTED 1320 (TIME) 110-03-85 (DATE)
TIME WL. —	HRS. DELAYED —	WT. CASING HAMMER — DROP —	COMPLETED 0930 110-04-85

SAMPLE TYPES

AS	AUGER SAMPLE	BL	BLACK
CS	CHUNK SAMPLE	BR	BROWN
DO	DRIVE OPEN	C	COARSE
DS	DENISON SAMPLE	CA	CASING
PS	PITCHER SAMPLE	CL	CLAY
RC	ROCK CORE	CLY	CLAYEY
ST	SLOTTED TUBE	F	FINE
TO	THIN WALLED, OPEN	FRAG	FRAGMENTS
TP	THIN WALLED, PISTON	GL	GRAVEL
WS	WASH SAMPLE	LYD	LAYERED
		LI	LITTLE

ABBREVIATIONS

M	MEDIUM	SA	SAMPLE
MIC	MICACEOUS	SAT	SATURATED
MOT	MOTTLED	SD	SAND
NP	NON PLASTIC	SI	SILT
OG	ORANGE	SLY	SILTY
ORG	ORGANIC	SM	SOME
PH	PRESSURE HYDRAULIC	TR	TRACE
PM	PRESSURE MANUAL	WL	WATER LEVEL
R	RED	WH	WEIGHT OF HAMMER
RES	RESIDUAL	Y	YELLOW
RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
						9 7			
	Firm - stiff grey SILTY CLAY little f-c sand, trace f-c gravel (TILL)	8	7.5	13A	DO	2 3 5 7	2.2 / 2.0		
		12	12.5	14A	DO	2 5 7 9	2.0 / 2.0		
	at 28' becoming very stiff	15	20	15A	DO	3 6 9 12	2.0 / 2.0		
		21	25	16A	DO	5 8 13 16	1.7 / 2.0		
		19	30	17A	DO	5 9 10 11	2.0 / 2.0		
		22	35	18A	DO	5 9 13 16	2.0 / 2.0		
	at 38' becoming hard	29		19A	DO	6 11 15 28	1.8 / 2.0		@ 37' cobble encountered during augering
		59	40	20A	DO	7 19 40 50	1.7 / 2.0		
	Loose - firm grey SILTY CLAY, little f-c sand (TILL)	163		21A	DO	8 63 100	1.0 / 1.5		
41.0	Weathered bedrock - shale and gypsum	100/9"	41.5	22A	DO	57 50/3"	0.75 / 0.75		@ 42.25' trace water
			42.25						No sample attempted - augered to 43.5'
		100	43.5	23A	DO	44 56	1.0 / 1.0		@ 43.5', strong sulfur smell
			44.5						No sample attempted - augered refusal @ 46.5'
46.5	Auger refusal								Upon completion the borehole was backfilled with thick bentonite slurry mixed @ 1.5-2.0 lbs / gal water.

BORING BEGAN 10/5/85	BORING COMPLETED 10/6/85		BORING NO. 23R DATE 2/18/86 SHEET 1 OF 1
METHOD OF CORING ROTARY	DRILLING FLUID POTABLE WATER	GR. ELEV. — WEATHER —	CORE HOLE LOCATION MW-23R
CASING USED — SIZE NX		INSPECT. LF OPERAT. —	WATER LEVEL TIME DATE —

DEPTH (FT.)	RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH	TYPE	INFILLING	ANGLE W/AXIS	FREQUENCY	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
35.0													BEGAN CORING @ 39.9 FT BELOW G.S.				
39.9		(79"/10')	(21.3/120)	42.0 TO 42.5	PARTINGS	—	II TO BED	.03' TO .15'		GRAY AND WHITE		HIGH / SLIGHT MOD	GRAY DOLOMITE AND WHITE GYPSUM. CT. 2.1 FT CORE LOSS. 42.0 FT - GRAY LAMINATED DOLOMITE				
	1	79%	15%	42.5 TO 45.6	PARTINGS	GYP.	II TO BED	.02' TO .47'		WHITE AND LIGHT GRAY		UNWEATHERED TO SLIGHT	MOTTLED WHITE GYPSUM AND LIGHT GRAY DOLOMITE. 43.55 FT - LAMINATED				
				45.6 TO 50.5	PARTINGS	GYP.	II TO BED	.1' TO .2'		DARK GRAY		SLIGHT TO MOD	DARK GRAY ARGILLACEOUS LAMINATED DOLOMITE WITH TRACE GYPSUM PARTINGS ARE VERY WEAK.	—	—	—	—
50.9 / 50.0	2	50%	0%														
		(60"/60')	(4"/72)	50.5 TO 53.5	PARTINGS	GYP.	II TO BED	.01' TO .22'		GRAY AND WHITE		SLIGHT TO UNWEATHERED	50.5 TO 53.5 FT - LAMINATED DOLOMITE AND WHITE GYPSUM				
	3	100%	6%	53.5 TO 56.0	PARTINGS	GYP.	II TO BED	.01' TO .20'		GRAY		UNWEATHERED	53.5 TO 56.0 FT - DOLOMITE WITH WHITE GYPSUM LAMINAE.				
56.0													END OF CORING @ 56.0 FT BELOW G.S.				

SCALE: 1 DIVISION=0.2 FEET

CHECKED: WGG FHJ

DATE 10/6/86 LOGGED BY LF

MONITORING WELL INSTALLATION LOG

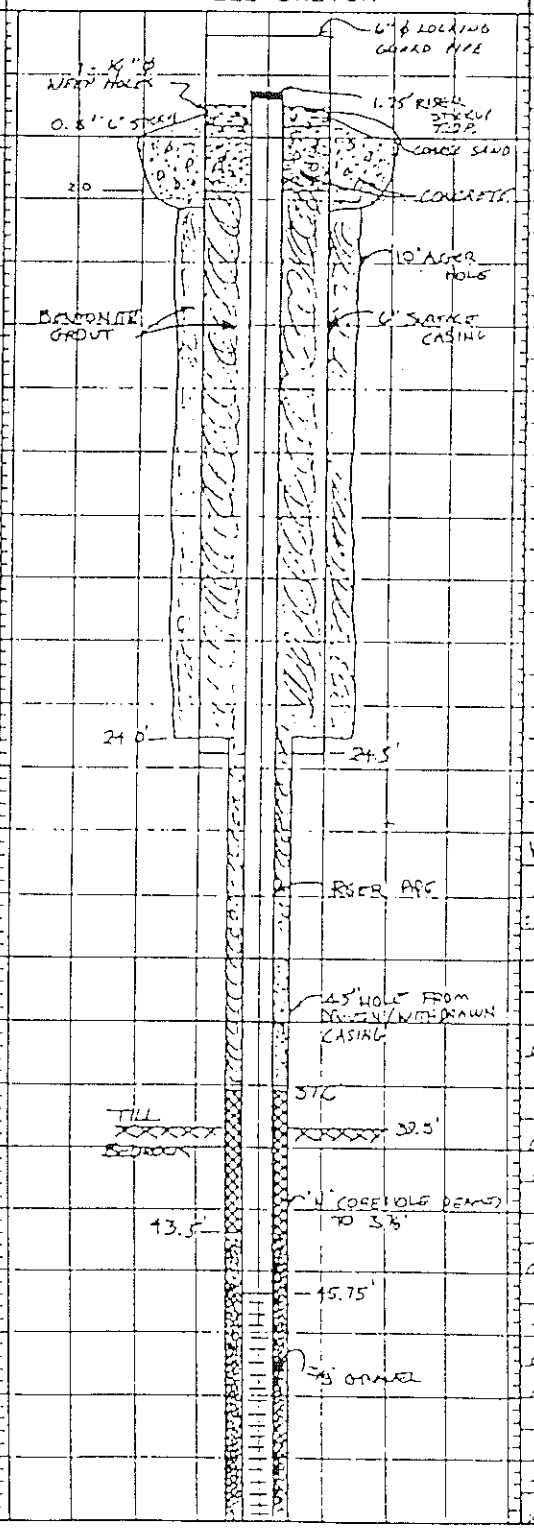
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO. MW-23R	SHEET 1 OF 2
GA INSP. L. FROST	DRILLING METHOD CORE / ROTARY	GROUND ELEV 610.5	WATER DEPTH 21.37'
WEATHER	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 612.26	DATE/TIME 10/3/85 20:00
TEMP	DRILL RIG MOBILE B-61 DRILLER D. KIRKPATRICK	STARTED 10/04/85 (TIME / DATE)	COMPLETED 10/04/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 47.5 LF	WELL SCREEN 2 in. dia. 100 LF	BENTONITE SEAL PELLETS
CASING TYPE STAINLESS STEEL (316)	SCREEN TYPE STAINLESS STEEL, WIRE WOUND (6x)	INSTALLATION METHOD GRAVITY FALL TAMPED
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 100 (0.10 in)	FILTER PACK QTY ~5 GALS (0.67 ft³)
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE 7/8 GRAVEL
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	TOPSOIL
0.5	FIRM, GRAY-TAN, MOTTLED, CLAYEY SILT, TRACE FINE SAND, TRACE ORGANICS (LACUSTRINE)
5.2	FIRM, BROWN TO GRAY, LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
8.0	FIRM BROWN, SILTY CLAY, TRACE TO LITTLE F-C SAND, TRACE F-C GRAVEL, (TILL)
	AT 12' BECOMING
	SOFT TO STIFF, GRAY, SILTY CLAY, TRACE TO LITTLE, F-C SAND, TRACE F-C GRAVEL (TILL)
	BECOMING HARDER AT 33.7'
34.3	WEATHERED BEDROCK DOLOMITE AND GYPSUM
43.0	MOTTLED WHITE GYPSUM AND GRAY DOLOMITE
45.6	DARK GRAY ARGILLACEOUS LAMINATED DOLOMITE TRACE OF GYPSUM, PARTINGS VERY WEAK
50.5	LAMINATED GRAY DOLOMITE AND WHITE GYPSUM
53.5	CONT. ON P.2

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

TOTAL VOLUME PURGED DURING DEVELOPMENT WAS APPROX. 4710 GALS

APPROX VOLUME LOST DURING DRILLING WAS 4100 GALS.

WELL DEVELOPED FROM 11-6-85 TO 11-12-85.

DEVELOPMENT METHOD: AIR LIFT USING 1" ϕ PVC INDUCTOR PIPE, BOTTOM 5 feet PERFORATED.

AIR SOURCE: DAYTON SPEEDAIRE OIL-LESS COMPRESSOR.

INITIAL WATER PURGED WAS CLOUDY ALTHOUGH CLEARED AFTER ABOUT 100 GALS REMOVED.

WATER HAD STRONG SULFUR ODOR.

TIME FOR REMOVING 4710 GALS WAS 11 HRS 30 MIN.

CONT PAGE 2

MONITORING WELL INSTALLATION LOG

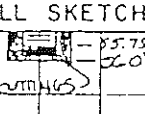
JOB NO. 883-3020	PROJECT CWM / VICKERY / OH	WELL NO. MW-23R	SHEET 2 OF 2
GA INSP. L. FROST	DRILLING METHOD CORE / ROTARY	GROUND ELEV 612.5	WATER DEPTH 21.37'
WEATHER	DRILLING COMPANY BOWSER MORNER	COLLAR ELEV 612.26	DATE/TIME 10/2/85 1000
TEMP	DRILL RIG MOBILE B-61	DRILLER B. KIRKPATRICK	STARTED 10/04/85 (TIME / DATE) COMPLETED 10/8/85 (TIME / DATE)

MATERIALS INVENTORY - SEE PAGE 1

WELL CASING ____ in. dia. ____ ft	WELL SCREEN ____ in. dia. ____ ft	BENTONITE SEAL
CASING TYPE	SCREEN TYPE	INSTALLATION METHOD
JOINT TYPE	SLOT SIZE	FILTER PACK QTY
GROUT QUANTITY	CENTRALIZERS	FILTER PACK TYPE
GROUT TYPE	DRILLING MUD TYPE	INSTALLATION METHOD

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
33.0	GRAY DOLOMITE WITH WHITE GYPSUM LAMINAE
56.0	CORING TERMINATED @ 56.0'
60.0	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

STATIC WATER LEVEL BEFORE DEVELOPMENT WAS 21.29 FT FROM TOP OF 2" PVC PIPE ON 11-5-85.

MEASUREMENTS OBTAINED DURING DEVELOPMENT:

DATE	GALLONS REMOVED	pH	SPECIFIC CONDUCTANCE	TEMP
11-6-85	START	7.2	9,400	52°F
11-6-85	990	7.2	11,000	52°F
11-8-85	1,770	7.5	10,000	51°F
11-11-85	3,450	7.4	10,000	51°F
11-12-85	4,710	7.6	10,000	53°F

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020 Ref. MW-23R	Made by CF Checked Reviewed	Date Sheet 1 of 2

1. a) Drilled 10" ϕ hole to 24.0' bgs using solid stem augers
   b) Installed 6" ϕ flush-joint steel csg
   c) Drove 6" ϕ csg to 24.5' bgs
   d) Tremie grouted borehole annulus with bentonite slurry mixed @ 1.5 to 2.0 lbs/gal water; calculated grout volume 63 gal, actual volume used ~ 65 gal
   e) 6" ϕ surface csg reamed to 24.0' bgs, flushed clean and bailed to within 0.5' of bottom of hole

2. a) 4" ϕ flush-joint csg hammered to 33.5' bgs
   b) Inside of 4" ϕ csg drilled out with 3 1/2" ϕ roller cone; hole drilled to 39.9' bgs; very rough drilling from 39.3'-39.7' bgs, fill cuttings and trace of dolomite and gypsum observed; hole flushed clean, then drilled from 37.7'-39.9' bgs, trace of dolomite and gypsum observed
   c) 4" ϕ csg hammered to 37.0' bgs
   d) Inside of 4" ϕ csg drilled out with 3 1/2" roller cone; hole drilled to 39.9' bgs
   e) Inside of hole flushed clean and bailed to within 0.5' of bottom of hole

3. a) Cored with 'N' size bit from 39.9'-49.9' bgs; soft material cored from 39.9'-42' bgs, solid material encountered @ 42' bgs; lost circulation @ 42.9'; water loss ~1100 gal
   b) Cored from 49.9'-50.0' bgs; core barrel not feeding due to caved in bedrock
   c) Cored from 50.0'-56.0'; solid material; no circulation; water loss ~ 900 gal.
   d) Total water loss during coring ~ 2000 gal

4. a) Reamed with 3 1/2" roller cone from 39.9'-45.0' bgs; no circulation; water loss ~ 200 gal
   b) Rig moyno pump and 1 1/2" 3 HP Briggs and Stratton pump hooked in line to allow a greater volume of water for flushing drill cuttings
   c) Reamed to 56.' bgs; water recovery ~ 25%; water loss ~ 450 gal
   d) Hole flushed clean; water recovery ~10-20%; water loss ~ 1450 gal; hole sounded @ 56.' bgs
   e) Total water loss during reaming and flushing ~ 2100 gal

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020	Made by LF	Date
	Ref. MW-23R	Checked	Sheet 2 of 2
		Reviewed JFC	

5. a) Well screen and riser pipe installed, well bottoming @ 56.0' bgs
b) Filter pack: During backfilling of screen / borehole annulus with 3/8" gravel it was discovered that a 3½"ϕ hole was reamed and not a 3 7/8"ϕ hole; ~ 0.6 gal of gravel was poured down the annulus; attempted to remove the screen and riser pipe from the borehole so that a 3 7/8"ϕ hole could be reamed, however the screen and rising pipe could not be removed; filter sand backfilled to 43.5' bgs; Calculated filter pack volume 3.4 gal, actual volume used ~ 5 gal
c) Bentonite Seal: Riser pipe / borehole annulus backfilled with bentonite pellets to 37.6' bgs; bentonite bridge formed in lower 1' of 4"ϕ csg; tried breaking through the bridge, unsuccessful. Pulled the 4"ϕ csg up 1.5', tried to break through the bridge, unsuccessful; Pulled 5' of 4"ϕ csg, tried to break through the bridge, unsuccessful; pulled remainder of 4"ϕ csg from hole; hole sounded @ 35.2' bgs, hole sloughed in from 35.2 - 37.6' bgs; Sloughed in material flushed from hole using 1"ϕ PVC pipe; hole sounded @ 37.6' bgs; Calculated bentonite volume 2.2 gal, actual volume used ~ 3.5 gal
d) Tremie grouted borehole annulus to surface with bentonite slurry mixed @ 1.5 to 2.0 lbs / gal water; calculated grout volume gal, actual volume used ~ 40 gal

6. a) Installed protective csg with hinged cap & locked
b) Installed cement grout surface seal
c) " Inner seal after removing ~ 2.5' of grout from inside the surface csg.
d) After cement cured, added coarse sand to the inside of guard pipe

7. a) Water level upon completion was 21.43' @ 16:45 on 10.8.95

8. a) 3 - ¼"ϕ holes were drilled just above the inner/outer cement seal for drainage.

b) A small ϕ hole was drilled in the well cap for venting.

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853 3020	Made by W.G.G	Date 10-21-85
	Ref. T-23	Checked	Sheet 1 of 2
		Reviewed	

1. a) Augered 10" ϕ hole to 14.0 ft bgs using 8" ϕ augers with 10" bottom bit; pulled augers and sounded hole @ 14.0' bgs.

b) Inserted 15.0 ft of 6" ID flush joint steel surface casing; bottom of csg seated @ 14.5' bgs. Joint on casing was taped with teflon tape before installation.

c) Grouted annular space between 6" csg and 10" auger hole with bentonite grout slurry. Sample of grout taken. Grout tremied down annulus using 15.0 feet of 1" ID clean pvc tremie pipe. Used ~36 gals of bentonite grout during process while letting roughly 5-10 gals of grout overflow to ensure good seal. Casing was seated to 14.5' bgs before grouting

d) 6-inch ϕ csg was flushed clean using a 5 7/8" roller bit to bottom of csg (14.5' bgs). Casing was bailed to within 0.2 ft of the bottom. Used ~300 gals to flush.

2 a) Drove 4" ϕ csg from 14.5' to 28.3' in 5.0 increments while flushing each 5 foot increment. Bailed 4" casing to within 0.3 ft of TD (28.2'). Sounded hole @ 28.2'. Used ~800 gals of water total to flush 4" casing.

b) Pulled 4" temporary casing up 1.0 ft and sounded hole @ 28.2' bgs. Added fine sand to 27.8' bgs and inserted well screen (7.5') and solid riser pipe (22.5') down hole. All O-rings were taken off the well pipe and teflon tape was wrapped around the threaded ends before installation. Measured well stickup @ 2.3 ft above ground surface.

c) Backfilling: the 4" ϕ csg was pulled with winch cable @ 1.0 ft increments to 24.3 ft and hole was sounded each increment. At 24.3 the sand bridged slightly in the 4" casing. Sounding weight had mud and sand mixture on end of weight. Decided that the 4" casing was not flushed clean enough so the well pipe was pulled (wearing clean latex gloves) and set on clean plastic. The 4" casing was pushed back to T.D. and reflushed. Hole sounded @ 28.2' bgs.
The 4" casing was bailed to within 0.2' of TD (28.2'). The casing was pulled 1.0 ft and sand was added to 27.9'.

d) The well pipe was inserted down hole and the stickup was measured @ 2.2' above ground surface.

e) The 4" ϕ casing was pulled @ 1.0 ft increments and sand was backfilled in the open annulus. The hole was sounded before the sand was added to identify if sloughing had occured. Sand was added to 17.3' bgs. Total amount of sand used was ~6 gals. Calculated volume is ~6.6 gals.

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020 Ref. T-23	Made by W.G.G Checked Reviewed	Date 10-21-85 Sheet 2 of 2

f) Bentonite pellets were backfilled with the same procedure used for backfilling sand. Bent. pellets backfilled from 17.3' to 13.0' bgs. 4" casing was pulled at 1.0 ft increments for backfilling of bentonite pellets.

g) Grouted and completed upper seal above the bentonite pellets with a bentonite slurry. Bentonite grout is from 13.0 to ground surface. Used ~ 15 gals of grout and let ~ 8 gals overflow during grouting. Grout was tremied in annulus using 1"ø clear pvc. Sample of grout was taken.

3. a) Water level upon completion of T-23 was 20.40 feet below the top of the 2" S.S. riser pipe. Water level taken on October 21, 1985 @ 18:07 hrs.

4. a) An aluminum protective flush joint protective casing was threaded on the 6"ø surface casing and was secured with a lock.

5. a) Excavated 30" deep hole around well and backfilled with cement, sloped to provide drainage away from well.

b) Removed about 2 feet of grout in annular space of surface csg and replaced with cement.

c) After inner cement seal cured, coarse sand was poured in protective csg to about 5-inches below top of riser pipe.

MONITORING WELL INSTALLATION LOG

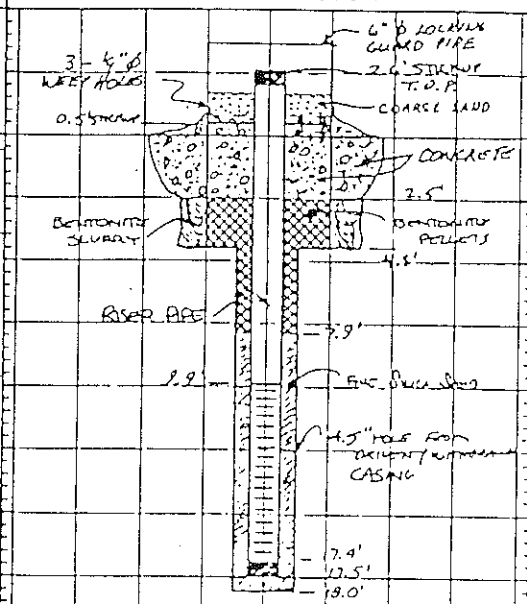
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO. L-23	SHEET 1 OF 1
GA INSP. L.F. JOC	DRILLING METHOD AUGER / ROTARY	GROUND ELEV 610.9	WATER DEPTH Dry
WEATHER PTLY CLDY	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 613.39	DATE/TIME 10/23/85 10:25
TEMP	DRILL RIG MOBILE B-61 DRILLER B KIRKPATRICK	STARTED 10/23/85 TIME / DATE	COMPLETED 1020 10/24/85 TIME / DATE

MATERIALS INVENTORY

WELL CASING 2 in. dia. 12.5' LL	WELL SCREEN 2 in. dia. 7.5' LL	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 0.0060 in	FILTER PACK QTY ~65 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	LOOSE LIGHT BROWN CLAY, TRACE ORGANICS (TOPSOIL)
0.65	STIFF, MOTTLED BROWN-GRAY CLAY, SOME SILT, TRACE ORG. MATTER (LACUSTRINE)
4.0	MEDIUM STIFF MOTTLED BROWN-GRAY SILTY CLAY, TRACE FINE SAND @ 5.0' BECOMING MOIST (LACUSTRINE) @ 8.0' SOME SILTY-F SAND SEAMS
7.7	SOFT GRAY SILTY CLAY, TRACE FINE SAND, SOME BROWN SILTY-F SAND SEAMS (<< 0.1') (LACUSTRINE) @ 13.8' TRACE BROWN SILT @ 14.6' VERY SOFT
17.0	VERY SOFT GRAY SILTY CLAY, TRACE F-C SAND (FILL)
18.0	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH STAINLESS STEEL BAILER

A NEW PIECE OF POLYPROPYLENE ROPE WAS DESIGNATED FOR USE ONLY IN L-23.

THE BAILER WAS STEAM CLEANED THEN RINSED WITH DEIONIZED WATER BEFORE BAILING.

TOTAL VOLUME REMOVED DURING DEVELOPMENT WAS 12.6 gals

VOLUME OF WATER IN WELL COLUMN WHEN STATIC W.L. WAS 4.96' (1-14-86)

CALCULATOR OF 2" PIPE (TOP) was 2.5 gals

MEASUREMENTS DURING DEVEL.

DATE	GALLONS BAILED	pH	SPECIFIC CONC.	COMMENTS
11-17-85	3.3	7.1	1,400	
11-19-85	3.3	6.6	1,200	MILKY COLOR
11-20-85	3.0	6.9	1,700	SLIGHTLY TURBID
11-22-85	3.0	—	—	RECOVERY TEST PERFORMED

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020	Made by LF	Date
	Ref. L23	Checked	Sheet 1 of 2
		Reviewed AFC	

1. a) Drilled 10" ϕ hole to 4.5' bgs using solid stem augers
   b) Installed 6" ϕ flush-joint steel csg, bottom of 6" csg @ 4.5' bgs
   c) Tremie grouted borehole annulus with bentonite slurry mixed @ 1.5-2.0 lb/gal water; calculated grout volume 10.4 gal, actual volume used ~ 13 gal.
   d) 6" ϕ surface csg drilled and flushed clean to 4.5' bgs; hole bailed to within 0.5' of bottom of hole

2. a) 4" ϕ flush-joint csg hammered from 4.5' to 9.0' bgs; inside of csg drilled out with 3 7/8" ϕ roller cone; hole flushed clean
   b) 4" ϕ csg hammered from 9.0' to 14.0'; inside of csg drilled out and flushed clean
   c) 4" ϕ csg hammered from 14.0' to 18.0' bgs; inside of csg drilled out and flushed clean; hole bailed to within 0.5' of bottom of hole

3. a) Hole backfilled with filter sand to 17.5' bgs
   b) Well screen and riser pipe installed, well bottoming @ 17.5' bgs
   c) Backfilling: The 4" ϕ csg was pulled up approx. 1' @ a time then sounded to ensure that no sloughing of the hole had occurred. The open borehole annulus was then backfilled with sand or bentonite pellets, depending on what interval of the hole was being backfilled.

   Filter Pack: screen/borehole annulus backfilled with sand to 7.9' bgs; calculated filter pack volume 6.2 gal, actual volume used ~ 6.2 gal

   Bentonite Seal: riser pipe/borehole annulus backfilled with bentonite pellets to 2.5' bgs; calculated bentonite volume 4.5 gal, actual volume used ~ 4 gal. Added ~ 1.5-2.0 gals of deionized water to pellets to induce hydration

4. a) Water level @ time of completion of well = 17.5' below top of 2" riser pipe
5. a) 6" ϕ aluminum protective pipe was threaded on surface csg and locked.
6. a) Excavated 30" deep around 6" ϕ csg and cemented csg in place sloped away from well for drainage.

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020 Ref. L-23	Made by WCL & L.F Checked Reviewed	Date Sheet 2 of 2

7. a) Cement was poured over the bentonite seal to a level even with the cement seal outside of the well.

b) After the cement cured, coarse sand was poured inside protective pipe to about 5 inches below the top of riser pipe.

Golder Associates

Field Boring Log

DEPTH HOLE 43.2	JOB NO. 853-3013	PROJECT CWM/OLD/OH	BORING NO. G-24
DEPTH SOIL DRILL 43.2	QA INSP. PMI/RSM	DRILLING METHOD CME Continuous Soil Sampler	SHEET 1 OF 2
DEPTH ROCK CORE NA	WEATHER Ptly cldy	DRILLING COMPANY Geomechanics	SURFACE ELEV. 6H
NO. DIST. SA. 9 UD. SA. NA	TEMP. 50°	DRILL RIG CME 55 DRILLER J. Selvaski	DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA DROP NA	STARTED 1610 (TIME) / 3-10-85 (DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA DROP NA	COMPLETED 0950 / 3-12-85

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	Continuous Soil Sample

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0-5%
"LITTLE" — 5-12%
"SOME" — 12-30%
"AND" — 30-50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
609.9 / 1.1	Topsoil with organics								
608.2 / 2.8	Firm, gray-tan, mottled, silty clay, trace fine sand, trace organics (Lacustrine)			1	CSS		4.3 / 4.5		
	Firm to stiff, gray-tan-maroon, silty clay, trace to little f-c sand, trace f-c gravel (Till)		4.5	2	CSS		4.9 / 5.0		
			9.5	3	CSS		4.8 / 5.0		
	at 14' becoming soft to stiff, gray, silty clay, trace to little f-c sand, trace gravel (Till)		14.5	4	CSS		4.5 / 5.0		
			19.5	5	CSS		5.0 / 5.0		

Golder Associates

Field Boring Log

DEPTH HOLE 43.2	JOB NO. 853-3013	PROJECT Cwm/Old/Oh	BORING NO. 6-24
DEPTH SOIL DRILL 43.2	QA INSP. PMI/RSM	DRILLING METHOD CME Continuous Soil Sampler	SHEET 2 OF 2
DEPTH ROCK CORE NA	WEATHER Pty cldy	DRILLING COMPANY Geomechanics	SURFACE ELEV. 611
NO. DIST. SA. 9 UD. SA. NA	TEMP. 50°	DRILL RIG CME 55 DRILLER J. Selvoski	DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA DROP NA	STARTED 1410 (TIME) / 3-10-85 (DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA DROP NA	COMPLETED 0950 / 5-12-85

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	Continuous Soil Sampler

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0-5%
"LITTLE" — 5-12%
"SOME" — 12-30%
"AND" — 30-50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to stiff, gray SILTY CLAY, trace to little f-c sand, trace f-c gravel (TILL)		5	CSS		5.0/5.0		
		24.5	6	CSS		4.6/5.0		
		29.5	7	CSS		3.2/5.0		
		34.5	8	CSS		5.0/5.0		
		39.5	9	CSS		2.5/2.5		
570.5 / 40.5	Hard, gray, CLAYEY SILT, some f-c sand, little fine gravel (TILL)							
568.6 / 42.4	Weathered rock - shale and gypsum							Shale in end of sampler
567.8 / 43.2	AUGER REFUSAL							Upon completion the borehole was backfilled with thick bentonite slurry mixed at 1.5 to 2.0 lbs. per gallon of water

PROJECT [illegible] JOB NO. [illegible] BORING NO. [illegible] DATE [illegible] SHEET 1 OF 1

BORING BEGAN — BORING COMPLETED — CORE HOLE LOCATION MW-24R

METHOD OF CORING ROTARY DRILLING FLUID POTABLE WATER GR. ELEV. — WEATHER —

CASING USED — SIZE NX INSPECT. WGG OPERAT. MIKE K. WATER LEVEL TIME DATE —

DEPTH (FT.)	RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH	TYPE	INFILLING	ANGLE W/AXIS	FREQUENCY	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN./FT.
													TOP OF WEATHERED ROCK ~ 41.5 TO 43.0 FT? BEGIN CORING @ 43.0 FT BELOW GS.				
43.0		(2.3'/4.2')		43.0 TO 44.5	PARTINGS	GYPS	II TO BED	<.1'		WHITE		MOD TO HIGH	WHITE GYPSUM WITH SECONDARY GYPSUM COATED PARTINGS. EST. 0.7 FT CORE LOSS				
	1	55%	0%									MOD	LIGHT GRAY TO DARK GRAY LAMINATED AND ARGILLACEOUS DOLOMITE. 44.5 TO 45.7 FT - WITH CLAY. (MUDDY WATER RETURN) EST. 0.8 FT CORE LOSS				
47.2										LIGHT GRAY TO DARK GRAY		SLIGHT	45.7 TO 47.2 FT - GYPSUM FILLED PARTINGS AND OCCASIONAL VUGGY ZONES. 47.2 TO 47.4 FT - LIGHT GRAY SILTSTONE WITH GYPSUM LAMINAE. 50.5 FT - SLICKENSIDED WITH OCC. VUGS				
		(4.1'/5.8')	(2.5'/6.4')	47.4 TO 53.0	PARTINGS	GYPS	II TO BED	.05' TO .4'									
	2	71%	36%	50.5	SLICKENSIDE	—	—				FINE TO VERY FINE						
												HIGH	51.0 TO 52.0 FT - INTENSELY WEATHERED CLAY RICH LIMESTONE ALTERNATING WITH DOLOMITE.	—	—	—	—
												SLIGHT	52.0 - 53.0 FT - LAMINATED AND SLIGHTLY MOTTLED ARGILLACEOUS DOLOMITE.				
53.0													53.0 - 54.5 FT - OCCASIONAL THIN LAYERS OF FIBROUS GYPSUM AND ARGILLACEOUS DOLOMITE.				
		(5.1'/5.6')	(3.9'/6.7')	53.0 TO 54.5	PARTINGS	GYPS	II TO BED	.05' TO .3'									
				54.5 TO 57.4	PARTINGS	—	II TO BED	.05' TO .2'				UNWEATHERED	WHITE AND GRAY LAMINATED AND MOTTLED GYPSUM WITH DOLOMITE STRINGERS AND LAMINAE.				
	3	91%	57%	57.4 TO 57.6	PARTINGS	—	II TO BED	.1'		WHITE AND GRAY							
				57.1'	FRACTURE	—	30°	.1' TO .2'		GRAY TO DARK GRAY		SLIGHT	GRAY TO DARK GRAY ARGILLACEOUS DOLOMITE. 56.4 - 57.4 FT - LAMINATED AND THINLY PARTED				
				58.0	FRACTURE	—	70°					UNWEATHERED	57.4 - 57.6 FT - WHITE GYPSUM WITH SECONDARY GYPSUM COATING AND PARTINGS. 58.5 - 58.6 FT - BROWN WHITE GYPSUM.				
58.6													END OF CORING AT 58.6 FT BELOW GS.				

SCALE: 1 DIVISION = 0.2 FEET

CHECKED BY WGG, FAW

DATE — LOGGED BY WGG

Golder Associates

MONITORING WELL INSTALLATION LOG

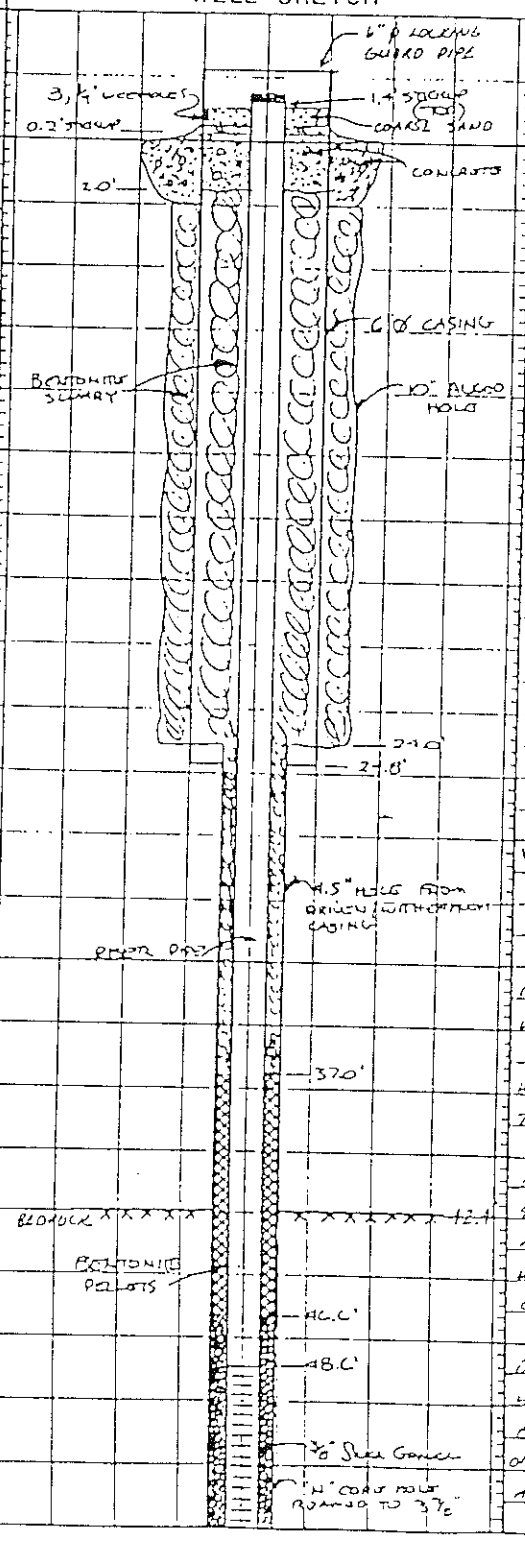
JOB NO. 853-3020	PROJECT CWA / VICKERY / OH	WELL NO MW-2AR	SHEET 1 OF 2
GA INSP. W.C.G.	DRILLING METHOD CORE / ROTARY	GROUND ELEV 612.6	WATER DEPTH 22.30'
WEATHER	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 614.04	DATE/TIME 9/23/85 17:49
TEMP.	DRILL RIG MOBILE B-61	DRILLER S. KIRKPATRICK	STARTED 9/10/85 (TIME / DATE) COMPLETED 9/10/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 500' LF	WELL SCREEN 2 in. dia. 10.0' LF	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 100 (.10 in.)	FILTER PACK QTY 5 BGS (0.67 FT³)
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE 3/8 SILICA GRAVEL
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	TOPSOIL WITH
1.1	FIRM, GRAY-TAN, MOTTLED, SILTY CLAY, TRACE FINE SAND, TRACE ORGANICS (LACUSTRINE)
2.8	FIRM TO STIFF, GRAY-TAN-MAROON, SILTY CLAY, TRACE TO LITTLE F-C SAND, TRACE F-C GRAVEL (TILL)
	AT 14' BECOMING SOFT TO STIFF, GRAY, SILTY CLAY, TRACE TO LITTLE F-C SAND, TRACE GRAVEL (TILL)
40.5	HARD, GRAY, CLAYEY SILT, SOME F-C SAND, LITTLE FINE GRAVEL (TILL)
42.4	WEATHERED ROCK, SHALE AND GYPSUM
43.2	WHITE GYPSUM
44.5	GRAY TO DARK GRAY DOLOMITE WITH OCC. GYPSUM FILLED PARTINGS
51.0	DARK GRAY WEATHERED (LATE) ARGILLACEOUS LIMESTONE
52.0	DARK GRAY LAMINATED DOLOMITE
57.5	CONT. ON PAGE 2

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

TOTAL WATER VOLUME RECEIVED WAS APPROX. 3,300 GALS.

WATER LOSS DURING DRILLING WAS APPROX. 1,000 GALS.

WELL DEVELOPED FROM 9-19-85 TO 10-17-85.

WELL PARTIALLY DEVELOPED ON 9-19-85 DURING WELL INSTALL. TO DETERMINE IF THE SAND PACK WOULD SETTLE - NO SETTLEMENT OCCURRED.

DEVELOPMENT METHOD: AIR LIFT USING 1" Ø PVC INSULATED AIR LINE & DAYTON SPEEDAIRE OIL-LESS COMPRESSOR FOR AN AIR SURGE

CONT. PAGE 2

MONITORING WELL INSTALLATION LOG

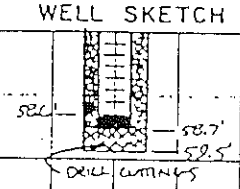
JOB NO. 853-3020 PROJECT CWM / VICKERY / OH WELL NO MW-2+R SHEET 2 OF 2
GA INSP. W.G.G. DRILLING METHOD CORE / ROTARY GROUND ELEV 612.6 WATER DEPTH 22.30'
WEATHER _____ DRILLING COMPANY BOWSER / MORNER COLLAR ELEV 614.04 DATE/TIME 9/23/85 13:49
TEMP. _____ DRILL RIG MOBILE D-61 DRILLER B. KIRKPATRICK STARTED 9/10/85 (TIME / DATE) COMPLETED 9/10/85 (TIME / DATE)

MATERIALS INVENTORY - SEE PAGE 1

WELL CASING _____ in. dia. _____ l.f. WELL SCREEN _____ in. dia. _____ l.f. BENTONITE SEAL _____
CASING TYPE _____ SCREEN TYPE _____ INSTALLATION METHOD _____
JOINT TYPE _____ SLOT SIZE _____ FILTER PACK QTY _____
GROUT QUANTITY _____ CENTRALIZERS _____ FILTER PACK TYPE _____
GROUT TYPE _____ DRILLING MUD TYPE _____ INSTALLATION METHOD _____

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	CONT. FROM PAGE 1
55.0	WHITE AND GRAY MOTTLED GYPSUM AND DOLOMITE
56.4	GRAY LAMINATED ARGILLACEOUS
57.4	DOLOMITE AND OCC. THIN LAYERS OF WHITE GYPSUM
58.6	CORING TERMINATED @ 58.6
60.0	

WELL SKETCH



INSTALLATION NOTES

WELL DEVELOPMENT NOTES

STATIC WATER LEVEL BEFORE DEVEL. WAS 21.93 BELOW TOP OF 2" STEEL RISER.

WATER INITIALLY GRAY AND TURBID, CLEAR WITH NO ODOR AFTER APPROX 50 TO 75 GALS.

MEASUREMENTS TAKEN DURING DEVELOPMENT:

DATE	VOLUME REMOVED	pH	SPECIFIC CONDUCTANCE	TEMP.
9-19-85	25	7.6	2,800	—
10-4-85	50	6.6	2,400	56°F
10-16-85	1,150	7.8	3,000	-
10-17-85	3,300	7.6	3,100	-

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020 Ref. MW-24R	Made by W.G.G. Checked Reviewed JFR	Date 11-6-85 Sheet 1 of 2

1. a) A 10" diameter (ϕ) hole was augered with 8" ϕ augers and a 10" bit to 24.0 feet below ground surface (bgs). Augers were pulled and hole sounded @ 24.0' bgs.

b) 25.0' of 6" ϕ flush-joint steel casing was inserted downhole. All threaded joints were wrapped with teflon tape before adding downhole. The casing was seated @ 24.8' bgs.

c) Bentonite grout was tremied down the annular space between the 6" ϕ casing and 10" auger hole. Two batches of grout were made totaling ~ 70 gals mixed @ a ratio of ~ 1.5 lbs bent. per gallon of water. Calculated volume required to fill annular space is ~ 58 gals. Sample of grout was taken

d) The 6" ϕ surface casing was flushed and reamed to 24.8' bgs until the return water was clear. The residual water from flushing was bailed to within 0.3' of the bottom of hole.

2. a) 4" ϕ flush-joint temporary casing was driven from 24.8 feet bgs to 30.0' then was reamed to 35.0' bgs until return water was clear. 4" casing was driven to 40.0 feet and then was rollerconed with 3 1/8" bit to 43.0 ft. Completed driving 4" temporary casing to 43.0' bgs. Flushed 4" casing until return was clear, used ~ 400 gals of water to flush all 4 inch casing driven.
Bailed 55 times, ~ 37 gals calculated that was removed. Calculated that ~ 28 gals (max) of water was standing inside 4" temporary casing.

3. a) Cored rock with "N" size bit from 43.0 to 47.2' bgs (4.2') until we had core block, 2.3' recovered (55%).
Started run #2 - 47.2' to 53.0' (5.8') until we had a core block, 4.1' recovered (71%). Total amount of water loss for run #1 and #2 was ~ 140 gals.
Run #3 from 53.0' to 58.6' bgs, 5.1' recovered (91%). Water loss during coring run 3 was ~ 640 gals.

b) Total water loss during coring was approx. 780 gals.

c) Reamed rock-core hole with 3 1/8" roller bit from 43.0' to 58.6'. Water loss was ~ 800 gals.

d) Total water loss is ~ 1,580 gals.

e) Sounded hole after reaming @ 59.5' bgs. Rollerconed .9' further than cored to account for cuttings in bottom.

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 953-3020 Ref. MW-24R	Made by W.G.G. Checked Reviewed	Date 11/6/85 Sheet 2 of 2

4 a) 0.8' of 3/8" gravel pack was added down the open borehole.

b) 316 stainless steel well screen (10.0') and 50 ft of riser pipe were installed down hole.

c) Filter pack (fine gravel) was added @ 1.0 foot intervals and sounded at each interval to check bridging or slowshing. Gravel pack was added to 46.6' bgs.

d) Added bentonite pellets to 43.0' - bottom of 4" ø temporary csg

e) Before completing bentonite seal, the well development equipment was inserted down the well and the well was developed partially using nitrogen gas in order to determine if the well would produce turbid water or remove any of the sand pack.
After pumping ~ 25 gals of water the discharge was very clear; a sample of the water yielded a pH of 7.6 and specific conductance of 2,800 umhos/cm. Sample was analysed after ~ 10 gals removed. Total of ~ 5 gals of gravel was added for filter pack; calculated volume is 5 gals.

f) The bentonite seal was completed by bumping the 4-inch casing up 1 foot at a time and adding pellets, tamping and sounding @ each interval. Bentonite pellet seal is from 46.6 ft to 37.0' bgs.

5 a) Grouted the borehole and casing annulus with bentonite grout using 1" ID PVC tremie pipe (clean). Used and mixed two batches of grout totaling ~ 70 gals, calculated volume is ~ 65 gals.

6 a) An aluminum 6" ID protective pipe was added and secured.

7 a) A 30" deep hole was dug arround the 6" ø casing and later filled in with a concrete/sand mixture. The cement was molded in order that rain water would drain away from the well.

8 a) Approximately 2.0' of bentonite grout was removed from inside the 6" guard pipe and replaced by 2.0 feet of cement.

b) The well cap was vented by drilling a small ø hole in the side of the cap.

c) After the cement cured, coarse sand was poured in the guard pipe to ~5" below T.O.P.

9 a) The depth to water measured on 9-23-85 @ 13:49 hrs was 22.30' below the top of the well riser pipe.

MONITORING WELL INSTALLATION LOG

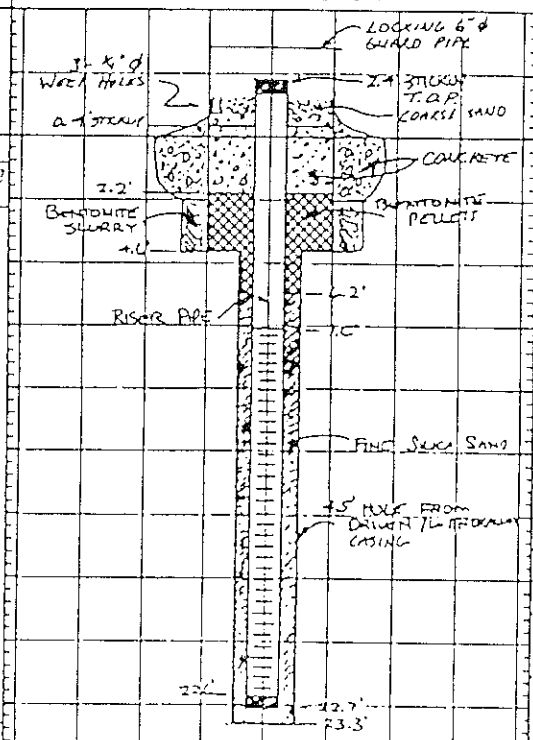
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO T-24	SHEET 1 OF 1
GA INSP. L FROST	DRILLING METHOD AUGER / ROTARY	GROUND ELEV 613.8	WATER DEPTH 9.44'
WEATHER CLDY	DRILLING COMPANY E.T.I.	COLLAR ELEV 615.25	DATE/TIME 10/22/85 18:20
TEMP.	DRILL RIG CME 55 DRILLER C. BARTLE	STARTED 0950 10/21/85 (TIME / DATE)	COMPLETED 1405 10/22/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 10.0' lt	WELL SCREEN 2 in. dia. 15.0' lt	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 0.0060 in.	FILTER PACK QTY ~9.0 gals
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE GROUT	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	TOPSOIL WITH ORGANICS
1.1	FIRM, GRAY-TAN, MOTTLED, SILTY CLAY, TRACE FINE SAND, TRACE ORGANICS (LACUSTRINE)
2.8	FIRM TO STIFF, GRAY-TAN-MAROON, SILTY CLAY, TRACE TO LITTLE F-C SAND, TRACE F-C GRAVEL (TILL)
	AT 14' BECOMING SOFT TO STIFF, GRAY, SILTY CLAY, TRACE TO LITTLE F-C SAND, TRACE GRAVEL (TILL)
23.3	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING WITH STAINLESS STEEL BAILER. NEW PILLS OF POLYPROPYLENE ROPE WAS DESIGNATED ONLY FOR USE IN DEVELOPMENT OF T-24. BAILER WAS STEAM CLEANED AND RINSED WITH DEIONIZED WATER BEFORE DEVELOPMENT.

TOTAL VOLUME BAILED DURING DEVELOPMENT WAS 6.3 gals. A CALCULATED WELL VOLUME FROM A STATIC W.L. (7.20') MEASURED 11-4-85 IS 2.9 gals.

MEASUREMENTS DURING DEVELOPMENT

DATE	GALLONS BAILED	pH	SPECIFIC COND.	COMMENTS
11-17-85	4.0	6.9	1,200	WATER MILKY COLOR
11-18-85	1.0	6.8	1,500	"
11-20-85	0.8	7.2	1,300	VERY TURBID
11-22-85	0.5	-	-	RECOVERY TEST

Golder Associates

SUBJECT Installation Notes		
Job No. 853-3020	Made by LF	Date 2/23/85
Ref. T24	Checked	Sheet 1 of 2
	Reviewed	

1. a) Drilled 10" ϕ hole to 45' bgs using solid-stem augers; hole sounded @ 3' bgs, material sloughing in; hole reaugered, sounded @ 46' bgs
   b) Installed 6" ϕ flush-joint steel surface csg, bottom of 6" csg @ 46' bgs
   c) Grouted borehole annulus with bentonite slurry mixed @ 1.5-2.0 lb/gal water; grout poured into borehole annulus from ground surface; calculated grout volume 10.6 gal, actual volume used ~11 gal
   d) 6" ϕ surface csg drilled and flushed clean to 46' bgs; hole bailed to within 0.5' of bottom of hole

2. a) 4" ϕ flush-joint csg hammered from 4.6' to 9.4' bgs, inside of csg drilled out with 3 7/8" ϕ roller cone; hole flushed clean
   b) 4" ϕ csg hammered from 9.4' to 14.5' bgs; insite of csg drilled out and flushed clean
   c) 4" ϕ csg hammered from 14.5' to 19.5' bgs; inside of csg drilled out and flushed clean
   d) 4" ϕ csg hammered from 19.5' to 23.3' bgs; inside of csg drilled out and flushed clean; hole bailed to within 0.5' of bottom of hole

3. a) 4" csg pulled up 1.5'; hole sloughed 0.5'; 4" csg driven back down to 23.3' bgs; inside of 4" csg drilled out and flushed clean; hole bailed to within 0.5' of bottom of hole
   b) 4" csg pulled up 0.5'; filter sand backfilled to 22.8' bgs; well screen and riser pipe installed, well bottoming @ 22.8' bgs; backfilled inside 4" ϕ csg to 21' bgs; 4" ϕ csg pulled up 0.5' @ a time and backfilled to 20' bgs; 4" ϕ csg pulled up ~1' @ a time and backfilled with filter sand, hole sloughed in from 18.1' to 18.6' bgs
   c) Water flushed down inside of riser pipe and screen; screen and riser pipe removed from the bore hole
   d) 4" ϕ csg driven back down to 23.3' bgs; inside of csg drilled out and flushed clean; hole bailed to within 0.5' of bottom of hole
   e) Filter sand backfilled to 22.7' bgs inside of 4" ϕ csg
   f) Well screen and riser pipe installed, well bottoming @ 22.7' bgs

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020 Ref. T24	Made by LF Checked Reviewed JR	Date Sheet 2 of 2

g) Backfilling: Filter sand and bentonite pellets were backfilled inside the 4"ϕ csg while the 4"ϕ csg was pulled up allowing the sand or pellets to fill the borehole annulus.

Filter Pack: Screen / borehole annulus backfilled with sand to 6.2' bgs; calculated filter pack volume 10.3 gal, actual volume used – 9 gal.

Bentonite Seal: riser pipe / borehole annulus backfilled with bentonite pellets to 2.2' bgs; calculated bentonite volume 4 gal, actual volume used ~ 5 gal. Hydrated bentonite pellets with ~ 2 gals of deionized water.

4. a) Water level @ time of completion of well = 9.94' below top of 2" riser pipe

5. a) Flush jointed 6" ID aluminum protective pipe threaded on 6"ϕ surface casing and casing locked.

6. a) Excavated 30" deep hole around the well and backfilled with cement. Sloped cement in order for water to drain away from well.

b) Added cement to the inside of the surface and protective casing to the same level as the cement outside the well.

c) Drilled 3 – ¼" drain holes in 6"ϕ protective pipe near the top of cement collar seal.

d) After cement has cured, coarse sand was backfilled in the guard pipe to approximately 5 inches below top of riser pipe.

7. a) The well cap was vented by drilling a small ϕ hole.

Golder Associates

Field Boring Log

DEPTH HOLE 49.0	JOB NO. 853-3012	PROJECT CWTP / OLD / OHIO	BORING NO. G-26
DEPTH SOIL DRILL 49.0	QA INSP. P. INGLAND	DRILLING METHOD CME Continuous Soil Sampler	SHEET 1 OF 3
DEPTH ROCK CORE NA	WEATHER CLDY-SNOW	DRILLING COMPANY GEOMECHANICS	SURFACE ELEV. 610
NO. DIST. SA. 0 UD. SA 11	TEMP. 20°F	DRILL RIG CME 55	DRILLER J. SELWOSKI	DATUM MSL
DEPTH WL. @14'	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA	STARTED 1130 (TIME) / 1-28-85 (DATE)
TIME WL. 1400	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA	COMPLETED 1512 (TIME) / 1-28-85 (DATE)

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	CONTINUOUS SOIL SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SLT	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" – 0-5%
"LITTLE" – 5-12%
"SOME" – 12-30%
"AND" – 30-60%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	DEPTH	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
609.0									AUGERED TO 1.0 FOOT BEFORE SAMPLING DUE TO GRAVEL FILL
1.0 / 607.7	Brown-tan CLAYEY SILT, trace organics (TILL)			1	CSS		2.5/3.0		
2.3 / 605.3	Black brown CLAY to CLAYEY SILT, trace organics (FILL)		4.0						
4.7 / 601.2	Soft to stiff, gray brown, mottled SILTY CLAY, trace fine sand (LACUSTRINE)			2	CSS		5.4/5.0		Recovered 0.4' from 1st run
8.8 / 593.4	Soft to firm brown-tan, laminated SILTY CLAY, trace fine sand (LACUSTRINE)		9.0	3	CSS		3.8/5.0		
			14.0	4	CSS		5.4/5.0		
16.6	Soft to hard, gray SILTY CLAY, trace to some f-c sand, trace f-c gravel (TILL)		19.0	5	CSS		2.0/5.0		Poor recovery due to soft soils

· Golder Associates

Field Boring Log

DEPTH HOLE 49.0	JOB NO. 852-3023	PROJECT CWM/OCC/OK			BORING NO. G-26
DEPTH SOIL DRILL 49.0	QA INSP. P. INGRAM	DRILLING METHOD CONE CONTINUOUS SOIL SAMPLE			SHEET 2 OF 3
DEPTH ROCK CORE NA	WEATHER CLOUDY-SNOW	DRILLING COMPANY GEOMECHANICS			SURFACE ELEV. 610
NO. DIST. SA. 0 UD. SA. 11	TEMP. 20°F	DRILL RIG CONE 55	DRILLER J. SELVOSKI		DATUM MSL
DEPTH WL. ≈14'	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA		STARTED 1130 (TIME) / 1-28-85 (DATE)
TIME WL. 1400	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA		COMPLETED 1517 / 1-28-85

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	Continuous Soil Sample

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE		
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED		
C	COARSE	MOT	MOTTLED	SD	SAND		
CA	CASING	NP	NON PLASTIC	SI	SILT		
CL	CLAY	OG	ORANGE	SIT	SILTY		
CLY	CLAYEY	ORG	ORGANIC	SM	SOME		
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE		
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL		
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER		
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW		
LI	LITTLE	RX	ROCK				

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0-5%
"LITTLE" — 5-12%
"SOME" — 12-30%
"AND" — 30-80%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to hard, gray, SILTY CLAY, trace to some f-c sand, trace f-c gravel			5	CSS		2.0/5.0		
			210						Poor recovery due to soft soils
				6	CSS		1.2/5.0		
			290						
				7	CSS		4.9/5.0		
			390						
				8	CSS		5.0/5.0		
			590						
				9	CSS		5.0/5.0		
567.5 / 42.5	Hard gray, CLAYEY SILT, little to some f-c sand, little f-c gravel		710						
				10	CSS		2.5/2.5		

Golder Associates

Field Boring Log

DEPTH HOLE 49.0	JOB NO. 853-3013	PROJECT Cuyahoga Falls			BORING NO. G-26
DEPTH SOIL DRILL 49.0	QA INSP. P. Inglehart	DRILLING METHOD CME Continuous Soil Sampler			SHEET 3 OF 3
DEPTH ROCK CORE NA	WEATHER Cloy-Snow	DRILLING COMPANY Geomechanics			SURFACE ELEV. 610
NO. DIST. SA. 0 UD. SA. 11	TEMP. 20°F	DRILL RIG CME 55	DRILLER J. Selvoski		DATUM MSL
DEPTH WL. ≈14'	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA		STARTED 1130 (Time) 11-28-85 (Date)
TIME WL. 1400	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA		COMPLETED 1517 (Time) 11-28-85 (Date)

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED OPEN
TP	THIN WALLED PISTON
WS	WASH SAMPLE
CSS	CONTINUOUS SOIL SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" – 0-5%
"LITTLE" – 5-12%
"SOME" – 12-30%
"AND" – 30-50%

CONSISTENCY

LO	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Hard, gray, CLAYEY SILT, little to some f-c sand, little f-c gravel		46.5	11	CSS		2.0/2.5		
561.5 / 48.5	Weathered Rock, SHALE and GYPSUM								
49.0	AUGER REFUSAL								Upon completion of boring, the bore hole was backfilled with thick bentonite slurry mixed at 1.5 to 2.0 lbs per gallon of water.

MONITORING WELL INSTALLATION LOG

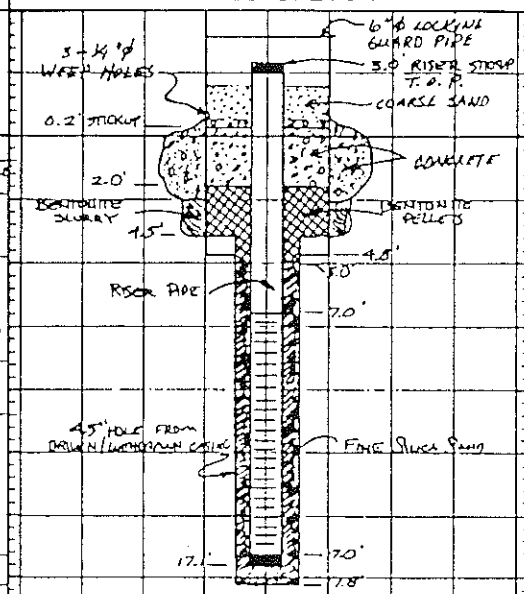
JOB NO. 853-3022	PROJECT CWM/VICKERY/OH		WELL NO L-26	SHEET 1 OF 1	
GA INSP. W.L.G.	DRILLING METHOD AUGER/ROTARY		GROUND ELEV 609.4	WATER DEPTH 14.50'	
WEATHER PTLY CLOUDY	DRILLING COMPANY BOWSER/MORNER		COLLAR ELEV 612.41	DATE/TIME 11/1/85 17:15	
TEMP. 50°-65°	DRILL RIG MOBILE B-61	DRILLER B. KIRKPATRICK	STARTED 11/1/85 (TIME / DATE)	COMPLETED 11/1/85 (TIME / DATE)	

MATERIALS INVENTORY

WELL CASING 2 in. dia. 10.0' ft	WELL SCREEN 2 in. dia. 10.0' ft	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 0.0060 in	FILTER PACK QTY ~ 7.0 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	
1.0	BROWN, TAN, CLAYEY SILT, TRACE ORGANICS (TILL)
2.5	BLACK BROWN CLAY TO CLAYEY SILT, TRACE ORGANICS (FILL)
4.7	SOFT TO STIFF, GRAY BROWN, MOTTLED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
8.8	SOFT TO FIRM, BROWN-TAN, LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
16.6	SOFT TO MED, GRAY SILTY CLAY, TRACE TO SOME F-C SAND, TRACE F-C GRAVEL (TILL)
17.8	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH STAINLESS STEEL BAILER.

A NEW PIECE OF POLYPROPYLENE ROPE WAS DESIGNATED FOR USE ONLY IN L-26.

THE BAILER AND TEFLON CHECK VALVE WAS STEAM CLEANED THEN RINSED WITH DEIONIZED WATER BEFORE USE.

TOTAL VOLUME REMOVED DURING DEVELOPMENT WAS 13.1 gals

VOLUME OF WATER IN WELL COLUMN FOR STATIC @ 6.02' BELOW T.O.P. (1-14-86) WAS 2.3 gals.

MEASUREMENTS DURING DEVEL.

DATE	GALLONS BAILED	pH	SPECIFIC COND	COMMENTS
11-15-85	3.0	6.6	3,500	
11-19-85	3.3	6.6	4,200	WATER TURBID
11-20-85	3.0	6.6	4,500	TURBID
11-22-85	3.8	—	—	RECOVERY TEST PERFORMED

Golder Associates	SUBJECT Installation Notes.		
	Job No. 853-3020 Ref. L-26	Made by W.G.G. Checked Reviewed AFC	Date 11/5/85 Sheet 1 of 2

1. a) Augered 10-inch ϕ hole to 4.5 feet bgs with solid stem augers; pulled augers to set surface casing and sounded hole @ 3.5' bgs, one foot of material sloughed in; hole reaugered and sounded @ 4.5' bgs.

b) Installed 6" ϕ flush-joint steel surface casing; bottom of 6" casing (csg) @ 4.5' bgs.

c) Grouted annulus between 6" csg and 10" borehole with bentonite grout @ ~1.6 lbs bent. per gal water; grout tremied down annulus with 5 foot section of PVC. Noted ~0.5 feet of water in bottom of borehole before grouting. Used ~20 gals of bent. grout.

d) 6-inch ϕ surface casing flushed clean using ~250 gals of water; casing bailed until less than 0.2 feet of water was in hole.

2. a) Drove 4" ϕ flush-joint temporary casing from 4.5' to 9.5' bgs; casing was reamed and flushed with 3 7/8" ϕ roller bit until clean.

b) 4" ϕ csg driven from 9.5' to 17.8' bgs; csg was reamed and flushed to T.D. with 3 7/8" bit until clean. Used a total of ~550 gals of water to flush 4" csg. Tim Fishball OEPA was present during the flushing and bailing of 6" surface casing and driving of the 1st 5' of 4" ϕ temporary casing. 4" ϕ casing was bailed to within ~0.3' of bottom of hole. Hole was drilled 0.3 feet too deep because the surface casing - used as the reference to ground surface - sunk 0.3 feet during reaming of 4" ϕ csg. 6" ϕ surface csg sunk to 4.8' bgs.

3. a) 4" ϕ hole backfilled with fine filter sand to 17.1 feet bgs.

b) Well screen (10.0') and riser pipe (10.0') installed; bottom of screen @ 17.0' bgs.

c) Backfilling: The 4" ϕ csg was pulled up 1.0 ft @ a time then sounded to ensure that no sloughing had occured. The open annulus was then backfilled with sand to 5.0' bgs. Bentonite pellets were backfilled with the same method to 2.0 ft bgs.

d) Filter pack: fine sand pack from 17.8' to 5.0' bgs. Calculated est. for filter pack volume is 7.8 gals. Actual volume used is ~7 gals.

e) Bentonite seal: riser pipe/borehole annulus backfilled with bentonite pellets to 2.0' bgs. Pulled 4" casing 0.3 ft from 5.0' to 4.7' and added 0.4 ft of pellets before pulling 4" out from 6" ϕ surface casing. Calculated volume of bent. is 3.4 gals. Used actual volume is ~4 gals. Bentonite pellets were hydrated with ~1.5 to 2.0 gals of deionized water.

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020	Made by W.G.G	Date 11/5/85
	Ref. L-26	Checked	Sheet 2 of 2
		Reviewed JTL	

4. a) Water level upon time of completion 17:15 hrs. on 11-1-85 was 14.50' from top of 2" riser pipe.

5. a) 3.5 foot aluminum protective guard pipe was threaded on to the 6"ϕ surface casing and a key-alike master lock was secured.

6. a) A 30" deep hole was excavated and backfilled with cement. The cement was sloped to drain away from well.

b) Cement was poured inside surface csg. to a level approximately even with the outside cement seal.

c). Three 1/4" ϕ drain holes were drilled just above the cement seal.

d) After cement cured, coarse sand was poured inside the 6"ϕ guard pipe to ~5 inches below the top of riser pipe.

7. a) Well cap was vented by drilling a small ϕ hole in side of cap.

Golder Associates

Field Boring Log

DEPTH HOLE 49.4	JOB NO. 853-3013	PROJECT CWM/OLD/OH		BORING NO. G-27	
DEPTH SOIL DRILL 49.4	GA INSP. PM/RSM	DRILLING METHOD CME Continuous Soil Sampler		SHEET 1 OF 3	
DEPTH ROCK CORE NA	WEATHER CLDY	DRILLING COMPANY Geotechnics		SURFACE ELEV. 610	
NO. DIST. SA. 10 UD. SA. NA	TEMP. 30°	DRILL RIG CME 55	DRILLER J. Selvoski	DATUM MSL	
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA	STARTED 0800 (TIME) 3-5-85 (DATE)	
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA	COMPLETED 1215 (TIME) 3-5-85 (DATE)	

SAMPLE TYPES

AS	AUGER SAMPLE	BL	BLACK
CS	CHUNK SAMPLE	BR	BROWN
DO	DRIVE OPEN	C	COARSE
DS	DENISON SAMPLE	CA	CASING
PS	PITCHER SAMPLE	CL	CLAY
RC	ROCK CORE	CLY	CLAYEY
ST	SLOTTED TUBE	F	FINE
TO	THIN WALLED, OPEN	FRAG	FRAGMENTS
TP	THIN WALLED, PISTON	GL	GRAVEL
WS	WASH SAMPLE	LYD	LAYERED
CSS	Continuous Soil Sampler	LI	LITTLE

ABBREVIATIONS

M	MEDIUM	SA	SAMPLE
MIC	MICACEOUS	SAT	SATURATED
MOT	MOTTLED	SD	SAND
NP	NON PLASTIC	SI	SILT
OG	ORANGE	SLY	SILTY
ORG	ORGANIC	SM	SOME
PH	PRESSURE-HYDRAULIC	TR	TRACE
PM	PRESSURE-MANUAL	WL	WATER LEVEL
R	RED	WH	WEIGHT OF HAMMER
RES	RESIDUAL	Y	YELLOW
RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 80%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FOHCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
609.0 / 1.0									Augered to 1.0 before beginning sampling due to gravel
	Firm to stiff, brown-tan, CLAYEY SILT, trace fine sand, trace fine gravel (FILL)			1	CSS		1.8 / 3.3		
604.7 / 5.3			4.3						
	Firm to stiff, gray-tan, mottled, SILTY CLAY, trace fine sand (LACUSTRINE)			2	CSS		4.9 / 5.0		
601.6 / 8.4									
	Firm to stiff brown laminated tan SILTY CLAY, trace fine sand (LACUSTRINE)		9.3	3	CSS		5.0 / 5.0		
	becomes more gray at 13.8'		14.3	4	CSS		4.6 / 5.0		
592.4 / 17.6									
	Soft to firm, gray, SILTY CLAY, trace f-c sand, trace f-c gravel (TILL)		19.3	5	CSS		5.0 / 5.0		

Golder Associates

Field Boring Log

DEPTH HOLE 49.4	JOB NO. 853-3013	PROJECT CWM/OLD/OH	BORING NO. G-27
DEPTH SOIL DRILL 49.4	GA INSP. PMI/RSM	DRILLING METHOD CME Continuous Soil Sampler	SHEET 2 OF 3
DEPTH ROCK CORE NA	WEATHER CLDY	DRILLING COMPANY Geomechanics	SURFACE ELEV. 610
NO. DIST. SA. 10 UD. SA. NA	TEMP. 30°	DRILL RIG CME 55 DRILLER J Selvoski	DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA DROP NA	STARTED 0800 (TIME) 3-5-85 (DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA DROP NA	COMPLETED 1215 3-5-85

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	CONTINUOUS SOIL SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE-HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 6 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 60%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to firm, gray SILTY CLAY, trace f-c sand, trace f-c gravel (TILL)		5	CSS		5.0 / 5.0		
		24.3						
583.7 / 26.3	26.3-26.9 Soft gray, SILTY CLAY and f-m SAND (TILL)		6	CSS		4.4 / 5.0		
	29.3-29.6 compact, gray, f-c SAND, some fine gravel, trace silt							
	29.6-29.9 soft, gray, CLAYEY SILT and f-m SAND (TILL)							
		29.3						
580.1 / 29.9	29.9-38.0 Soft to firm, gray, SILTY CLAY, trace f-c sand, trace f-c gravel (TILL)		7	CSS		4.2 / 5.0		
	At 38.0' becomes firm to stiff, gray SILTY CLAY, little to some f-c sand, trace f-c gravel (TILL)							
		34.3	8	CSS		4.8 / 5.0		
		39.3	9	CSS		4.9 / 5.0		
		44.3	10	CSS		5.1 / 5.1		

Golder Associates

Field Boring Log

DEPTH HOLE 49.4	JOB NO. 853-3013	PROJECT Cumberland	BORING NO. 27
DEPTH SOIL DRILL 49.4	QA INSP. PM/LSM	DRILLING METHOD CME: Continuous Solid Stem Auger	SHEET 3 OF 3
DEPTH ROCK CORE NA	WEATHER Cloudy	DRILLING COMPANY Geomechanics	SURFACE ELEV. 610
NO. DIST. SA. 10 UD. SA.	TEMP. 30°	DRILL RIG CME 55 DRILLER J. Sezvoski	DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA DROP NA	STARTED 0900 (TIME) 3-5-85 (DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA DROP NA	COMPLETED 1215 (TIME) 3-5-85 (DATE)

SAMPLE TYPES

A.S.	AUGER SAMPLE
C.S.	CHUNK SAMPLE
D.O.	DRIVE OPEN
D.S.	DENISON SAMPLE
P.S.	PITCHER SAMPLE
R.C.	ROCK CORE
S.T.	SLOTTED TUBE
T.O.	THIN WALLED, OPEN
T.P.	THIN WALLED, PISTON
W.S.	WASH SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LTD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
563.1									
46.9	Hard gray, CLAYEY SILT, some f-c sand, trace f-c gravel (TILL)			10	KSS		5.1/5.1		
561.5									
48.5	Weathered Rock Dolomite with gypsum								
560.6									
49.4									Upon completion the borehole was backfilled with thick bentonite slurry mixed at 1.5 to 2.0 lbs per gallon of water.

MONITORING WELL INSTALLATION LOG

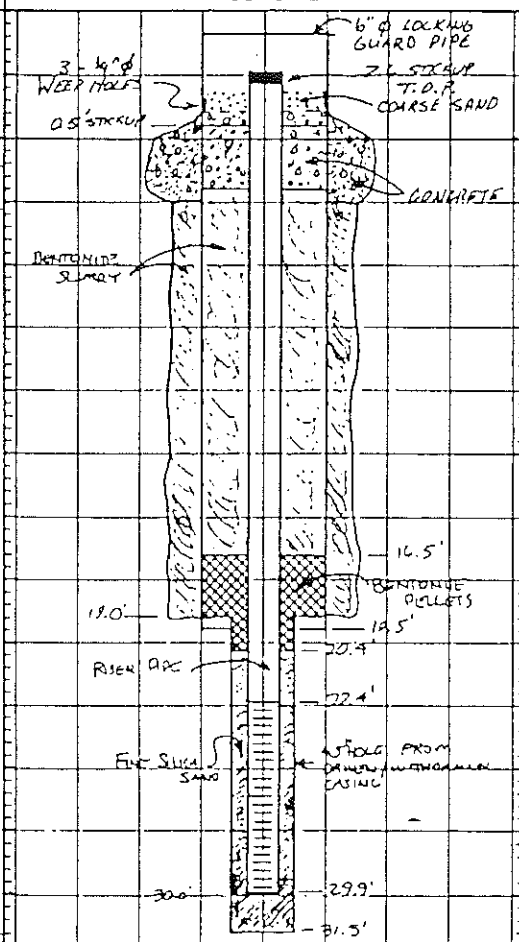
JOB NO. 823-3020	PROJECT CHM / VICKERY / OH	WELL NO. T-27	SHEET 1 OF 1
GA INSP. L. COLLIE	DRILLING METHOD AUGER / ROTARY	GROUND ELEV. 612.3	WATER DEPTH 17.70'
WEATHER PTLY CLDY	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV. 614.86	DATE/TIME 10/22/85 15:00
TEMP.	DRILL RIG CME 55	DRILLER T. GOEHNER	STARTED 10/22/85 (TIME / DATE) COMPLETED 10/23/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 25.0' Lf	WELL SCREEN 2 in. dia. 7.5' Lf	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 0.0060 in.	FILTER PACK QTY ~5.0 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	TOPSOIL WITH ORGANICS
1.1	FIRM, GRAY-TAN, MOTTLED, SILTY CLAY, TRACE FINE SAND, TRACE ORGANICS (LACUSTRINE)
2.8	FIRM TO STIFF, GRAY-TAN-MAROON, SILTY CLAY, TRACE TO LITTLE F-C SAND, TRACE F-C GRAVEL (TILL)
	AT 14' BECOMING SOFT TO STIFF, GRAY, SILTY CLAY, TRACE TO LITTLE F-C SAND, TRACE GRAVEL (TILL)
31.5	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING WITH STAINLESS STEEL BAILER. NEW POLYPROPYLENE ROPE WAS DESIGNATED ONLY FOR DEVELOPMENT OF T-27.

BAILER WAS STEAM CLEANED AND RINSED WITH DEIONIZED WATER BEFORE DEVELOPMENT.

TOTAL VOLUME BAILED DURING DEVELOPMENT WAS 7.3 GALS. CALCULATED WELL VOLUME FROM A STATIC WLL (8.67') MEASURED 1-14-85 FROM TOP OF RISER PIPE IS 3.9 GALS.

MEASUREMENTS DURING DEVELOPMENT

DATE	GALLONS BAILED	pH	SPECIFIC COND.	COMMENTS
11-14-85	4.3	7.2	600	WATER TURBID
11-18-85	1.5	6.9	1,700	
1-20-85	0.5	7.1	1,400	
11-27-85	1.0	–	–	RECOVERY TEST PERFORMED

Golder Associates	SUBJECT Well Installation Notes		
	Job No. 853 3020	Made by JDC	Date 11/7/05
	Ref. T-27	Checked	Sheet 1 of 1
		Reviewed GFZ	

1. a) Augered 10" ϕ hole with solid stem auger to 19.0 ft bgs.

b) Lowered 6" ϕ casing into hole at 19.0. Push casing to 19.5' bgs

c) Grouted borehole with bentonite slurry of about 75 gal with about a 6 gal overflow.

d) 6" ϕ casing washed out and drilled well clean. Then bailed to within 0.5' of bottom. Sounded at 19.5

2 a) Lowered 4" ϕ casing into hole, hammered and flushed at 5.0' intervals to 31.5'. Sounded hole at 31.6'

3. a) Borehole backfilled with filter sand to 30.0'
b) Well screen and riser pipe set at 30.0'.
c) Pulled casing up a foot at a time and sounded to ensure no sloughing had occurred.

Filter Pack: Screen borehole annulus was backfilled with sand. 4 to 22.5' bgs. Calculated filter pack volume is 6.6 gals
Actual volume added was about 5 gals.
Bentonite seal: Riser pipe borehole annulus was backfilled with pellets up to 16.5' bgs.

4. a) Grouted hole between 10" auger hole and 6" ϕ surface casing with 30 gals. of bentonite grout with 10 gal overflow.

5. a) Water level = 17.70' at 1500 on 10/23/87

6. a) An aluminum protective flush joint casing was threaded on to 6" ϕ casing.

7. a) Cap was vented by drilling holes in it.

8. a) A 30" hole was hand dug and filled with concrete. It was sloped so water would run away from well.

9. a) Three 1/4" drain holes were drilled in casing just above the concrete.

10 a) About 2' of grout was removed (bgs) from inside the surface csg and replaced by cement to the same level as cement outside the well. After cement cured, coarse sand was added to ~5" below top of riser pipe.

MONITORING WELL INSTALLATION LOG

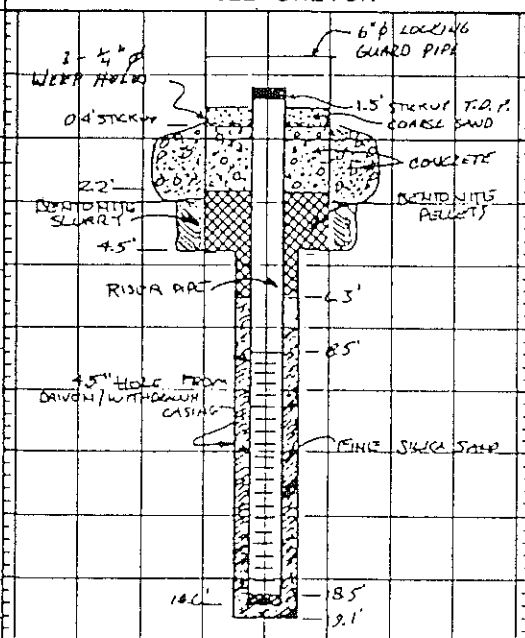
JOB NO. 853-3020	PROJECT CWM/VICKERY/OH	WELL NO L-27	SHEET 1 OF 1
GA INSP. W.R.B./L.E.	DRILLING METHOD AUGER/ROTARY	GROUND ELEV 612.2	WATER DEPTH 14.35'
WEATHER Clear & Cold	DRILLING COMPANY BOWSER/MORNER	COLLAR ELEV 613.70	DATE/TIME 10/29/85 13:45
TEMP.	DRILL RIG CME 55 DRILLER Tim Boehner	STARTED 10/28/85 (TIME / DATE)	COMPLETED 12:15 10/29/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 10.0' l.f.	WELL SCREEN 2 in. dia. 10.0 l.f.	BENTONITE SEAL Pellets
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH COUPLED	SLOT SIZE 0.0060 in.	FILTER PACK QTY ~7.0 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE CEMENT SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	
1.0	FIRM TO STIFF, BROWN-TAN, CLAYEY SILT, TRACE FINE SAND, TRACE FINE GRAVEL (FILL)
5.3	FIRM TO STIFF, GRAY-TAN, MOTTLED, SILTY CLAY. TRACE FINE SAND (LACUSTRINE)
8.4	FIRM TO STIFF BROWN LAMINATED TAN SILTY CLAY, TRACE FINE SAND (LACUSTRINE) BECOMES MORE GRAY AT 13.8'
17.6	SOFT TO FIRM, GRAY, SILTY CLAY, TRACE F-C SAND, TRACE F-C GRAVEL (TILL)
19.1	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH STAINLESS STEEL BAILER

A NEW PIECE OF POLYPROPYLENE ROPE WAS DESIGNATED FOR USE ONLY IN WELL L-27.

THE BAILER AND TEFLON CHECK VALVE WAS STEAM CLEANED THEN RINSED WITH DEIONIZED WATER BEFORE DEVELOPMENT

TOTAL VOLUME REMOVED DURING DEVELOPMENT WAS APPROX. 10.3 gals.

VOLUME OF WATER IN WELL COLUMN @ STATIC OF 6.44' BELOW T.O.P. ON 11-4-86 WAS 2.2 gals.

MEASUREMENTS DURING DEVELOPMENT

DATE	GALLONS BAILED	pH	SPECIFIC COND.	COMMENTS
11-13-85	3.0	7.0	1,100	
11-19-85	2.8	6.7	1,000	WATER TURBID
11-20-85	2.0	7.0	800	TURBID, MILKY
11-22-85	2.5	—	—	RECOVERY TEST PERFORMED

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020 Ref. L-27	Made by W.G.G. Checked Reviewed GBC	Date 10/30/85 Sheet 1 of 2

1. a) Augered 10-inch ϕ hole with solid stem augers to 4.5 feet bgs; pulled augers and sounded hole @ 4.5 feet, no slough in.

b) Inserted 5.0 feet of 6" ϕ flush-joint steel surface casing; bottom of 6" casing @ 4.5' bgs.

c) Grouted annular space between 10-inch hole and 6" ϕ surface casing with bentonite grout mixed at a ratio of ~ 1.5 lbs bent. per gal of water. Grout was tremied down annulus using a clean 5 foot section of 1" ID ϕ pvc pipe. Hole was dry before grouting. Used ~ 20 gals of bentonite grout.

d) 6-inch ϕ surface casing was flushed clean using water and a 5 7/8" rollerbit; 6" ϕ casing was bailed to within 0.3' of the bottom of hole.

2. a) Drove 4" ϕ temporary flush joint casing from 4.5 feet to 9.5' bgs; casing was reamed and flushed with 3 7/8" roller bit until clean.

b) Drove 4" ϕ casing from 9.5' bgs to 14.5' bgs and reamed and flushed. Completed driving casing from 14.5 to 19.1 ft bgs, flushed and reamed to 19.1 ft TD.

c) 4" ϕ temporary casing was bailed to within 0.3 feet of TD.

d) 4" ϕ casing was pulled 0.5 feet and sand was added to 18.6' bgs.

e) Well screen (10.0') and riser pipe (10.0') were inserted down hole. bottom of screen @ 18.5' bgs. (w/ 0.1' end cap).

3. a) Backfilling: The 4" ϕ casing was pulled up 1.0 ft @ a time and was sounded each time to ensure that no sloughing had occured. The open annulus was then backfilled with fine silica sand to 6.3' bgs, 2.2 feet above the top of screen. Used ~ 7 gals of sand; calculated volume is ~ 7.8 gals. Bentonite pellets were backfilled with the same method to 2.2' bgs. Used ~ 4.5 gals of bent. pellets to backfill; calculated volume was 4.1 gal. Hydrated pellets with ~ 2 gals of deionized water.

4. a) Water level upon completion @ 13:45 hrs on Oct. 29, 1985 was 14.35' below top of 2" well riser pipe.

5. a) Flush joint aluminum 6" protective pipe was threaded on the 6" ϕ surface casing and secured with lock.

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020 Ref. L-27	Made by W.G.G. Checked Reviewed	Date 10/30/85 Sheet 2 of 2

6. a) A 30" deep hole was excavated and backfilled with cement. The cement was sloped to drain away from well.

b) Cement was poured inside the surface csg to a level even with the outside cement seal.

c) Three 1/4" ϕ holes were drilled just above the cement seal.

d) Coarse sand was poured in the 6" ϕ protective csg to about 5 inches below the top of riser pipe.

7. a) The well cap was vented by drilling a small ϕ hole.

Golder Associates

Field Boring Log

DEPTH HOLE 46.3	JOB NO. 853-3013	PROJECT CWM/OCA/OH		BORING NO. G-28	
DEPTH SOIL DRILL 46.3	QA INSP. PMI/RSM	DRILLING METHOD CME CONTINUOUS SOIL SAMPLER		SHEET 1 OF 3	
DEPTH ROCK CORE NA	WEATHER CLDY	DRILLING COMPANY GEOMECHANICS		SURFACE ELEV. 612	
NO. DIST. SA. 10 UD. SA NA	TEMP. 40°	DRILL RIG CME 55	DRILLER J. SELWOSKI	DATUM MSL	
DEPTH WL. 3.5'	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA	STARTED 1700 (TIME) / 3-5-85 (DATE)	
TIME WL. 0700/3-6-85	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA	COMPLETED 0930 / 3-6-85	

SAMPLE TYPES

A.S.	AUGER SAMPLE	BL	BLACK
C.S.	CHUNK SAMPLE	BR	BROWN
D.O.	DRIVE OPEN	C	COARSE
D.S.	DENISON SAMPLE	CA	CASING
P.S.	PITCHER SAMPLE	CL	CLAY
R.C.	ROCK CORE	CLY	CLAYEY
S.T.	SLOTTED TUBE	F	FINE
T.O.	THIN WALLED, OPEN	FRAG	FRAGMENTS
T.P.	THIN WALLED, PISTON	GL	GRAVEL
W.S.	WASH SAMPLE	LYD	LAYERED
CSS	CONTINUOUS SOIL SAMPLE	LI	LITTLE

ABBREVIATIONS

M	MEDIUM	SA	SAMPLE
MIC	MICACEOUS	SAT	SATURATED
MOT	MOTTLED	SD	SAND
NP	NON PLASTIC	SI	SILT
OG	ORANGE	SLY	SILTY
ORG	ORGANIC	SM	SOME
PH	PRESSURE-HYDRAULIC	TR	TRACE
PM	PRESSURE-MANUAL	WL	WATER LEVEL
R	RED	WH	WEIGHT OF HAMMER
RES	RESIDUAL	Y	YELLOW
RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
611.0								Augered to 1.0' before beginning sampling
1.0 / 609.5	Firm to stiff, brown-gray CLAYEY SILT, little fine sand, trace organics (FILL)		1	CSS		3.3 / 3.3		
2.5 / 607.5	Firm gray-black CLAYEY SILT, organic (FILL)						4.5	
4.5 / 603.0	Firm to stiff gray tan, mottled, SILTY CLAY, trace fine sand (LACUSTRINE)		2	CSS		5.0 / 5.0		
9.0 / 592.4	Soft to firm, brown-tan, to gray, laminated SILTY CLAY, trace fine sand (LACUSTRINE)		3	CSS		5.0 / 5.0	9.5	
	becoming more gray at 15.8'		4	CSS		5.0 / 5.0	14.5	
19.6	Soft to stiff gray SILTY CLAY, trace f-c sand, little f-c gravel (TILL)		5	CSS		4.9 / 5.0	19.5	

Golder Associates

Field Boring Log

DEPTH HOLE 46.3	JOB NO. 853-3013	PROJECT Cuyahoga/OH	BORING NO. G-28
DEPTH SOIL DRILL 46.3	QA INSP. PM/RSM	DRILLING METHOD CME Continuous Soil Sampler	SHEET 2 OF 3
DEPTH ROCK CORE NA	WEATHER	DRILLING COMPANY Geomechanics	SURFACE ELEV. 612
NO. DIST. SA. 10 UD. SA. NA	TEMP.	DRILL RIG CME-55	DRILLER J. Selvoski	DATUM MSL
DEPTH WL. 3.5'	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA	STARTED 1700 (TIME) / 3-5-85 (DATE)
TIME WL. 0700/3-6-85	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA	COMPLETED 0930 / 3-6-85

SAMPLE TYPES

AS	AUGER SAMPLE	CS	CHUNK SAMPLE
DO	DRIVE OPEN	DS	DENISON SAMPLE
PS	PITCHER SAMPLE	RC	ROCK CORE
ST	SLOTTED TUBE	TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON	WS	WASH SAMPLE
CSS	Continuous Soil Sample		

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE		
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED		
C	COARSE	MOT	MOTTLED	SD	SAND		
CA	CASING	NP	NON-PLASTIC	SI	SILT		
CL	CLAY	OG	ORANGE	SIY	SILTY		
CLY	CLAYEY	ORG	ORGANIC	SM	SOME		
F	FINE	PH	PRESSURE-HYDRAULIC	TR	TRACE		
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL		
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER		
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW		
LI	LITTLE	RK	ROCK				

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to stiff, gray, SILTY CLAY, trace f-c sand, little f-c gravel (TILL)		24.3	5	CSS		4.9/5.0		
			21.3	6	CSS		5.1/5.0		
			34.3	7	CSS		5.0/5.0		
			39.3	8	CSS		5.0/5.0		
570.0 / 42.0	Hard, gray CLAYEY SILT, some f-c sand, trace f-c gravel (TILL)		44.3	9	CSS		5.0/5.0		
				10	CSS		1.3/2.0		

Golder Associates

Field Boring Log

DEPTH HOLE 46.3	JOB NO. 853-3013	PROJECT CWM / OLD / OH		BORING NO. G-28	
DEPTH SOIL DRILL 46.3	GA INSP. PM/ESM	DRILLING METHOD CME CONTINUOUS SOIL SAMPLER		SHEET 3 of 3	
DEPTH ROCK CORE NA	WEATHER P CLDY	DRILLING COMPANY GEOMECHANICS		SURFACE ELEV. 612	
NO. DIST. SA. 10 UD. SA. NA	TEMP. 40°	DRILL RIG CME 55	DRILLER J. SEZVOSKI	DATUM MSL	
DEPTH WL. 3.5'	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA	STARTED 1700 / 3-5-85 (TIME / DATE)	
TIME WL. 0700 / 3-6-85	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA	COMPLETED 0930 / 3-6-85	

SAMPLE TYPES

A S	AUGER SAMPLE	BL	BLACK
C S	CHUNK SAMPLE	BR	BROWN
D O	DRIVE OPEN	C	COARSE
D S	DENISON SAMPLE	CA	CASING
P S	PITCHER SAMPLE	CL	CLAY
R C	ROCK CORE	CLY	CLAYEY
S T	SLOTTED TUBE	F	FINE
T O	THIN WALLED, OPEN	FRAG	FRAGMENTS
T P	THIN WALLED, PISTON	GL	GRAVEL
W S	WASH SAMPLE	LYD	LAYERED
		LI	LITTLE

ABBREVIATIONS

M	MEDIUM	SA	SAMPLE
MIC	MICACEOUS	SAT	SATURATED
MOT	MOTTLED	SD	SAND
NP	NON PLASTIC	SI	SILT
OG	ORANGE	SIY	SILTY
ORG	ORGANIC	SM	SOME
PH	PRESSURE HYDRAULIC	TR	TRACE
PM	PRESSURE MANUAL	WL	WATER LEVEL
R	RED	WH	WEIGHT OF HAMMER
RES	RESIDUAL	Y	YELLOW
RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
565.7 / 46.3	AUGER REFUSAL								Upon completion the borehole was backfilled with thick bentonite slurry mixed at 1.5 to 2.0 lbs per gallon of water

MONITORING WELL INSTALLATION LOG

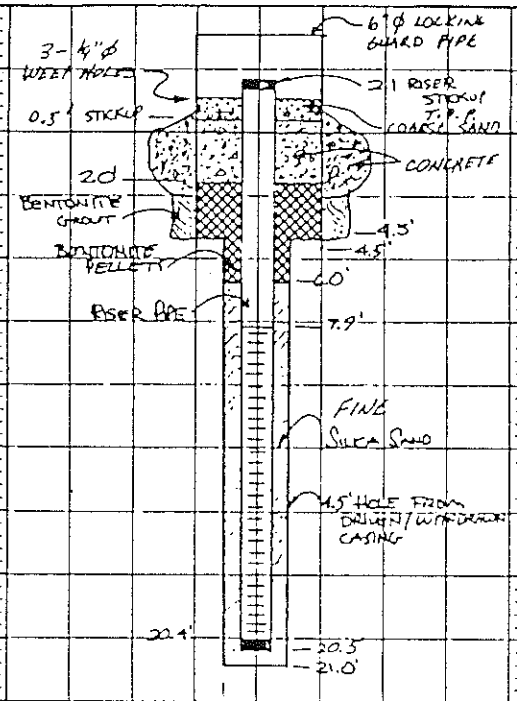
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO. L-28	SHEET 1 OF 1
GA INSP. W.G.G. / JC & LF	DRILLING METHOD AUGER / ROTARY	GROUND ELEV 611.3	WATER DEPTH 20.80'
WEATHER PTLY CLOUDY	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV. 613.40	DATE/TIME 10/23/85 11:25
TEMP. 45-55° F	DRILL RIG MOBILE B-61 DRILLER B. KIRKPATRICK	STARTED 13:35 (TIME) / 10/22/85 (DATE)	COMPLETED 1120 (TIME) / 10/20/85 (DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 10.0 l.f.	WELL SCREEN 2 in. dia. 12.5 l.f.	BENTONITE SEAL PELLETS
CASING TYPE STAINLESS STEEL (316)	SCREEN TYPE STAINLESS STEEL WIRE WOUND (316)	INSTALLATION METHOD GRAVITY DROP
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 0.0060"	FILTER PACK QTY ~ 8.0 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FILL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	
1.0	FIRM TO STIFF, BROWN-GRAY CLAYEY SILT, LITTLE FINE SAND, TRACE ORGANICS (FILL)
2.5	FIRM, GRAY-BLACK CLAYEY SILT, ORGANIC (FILL)
4.5	FIRM TO STIFF, GRAY TAN, MOTTLED, SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
9.0	SOFT TO FIRM, BROWN-TAN, TO GRAY, LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
	BECOMING MORE GRAY AT 15.8'
19.6	SOFT TO STIFF, GRAY SILTY CLAY, TRACE F-C SAND, LITTLE F-C GRAVEL (TILL)
21.0	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH STAINLESS STEEL BAILER.

A NEW PIECE OF POLYPROPYLENE ROPE WAS DESIGNATED FOR USE ONLY IN WELL L-28 AND WAS KEPT IN CLEAN BAG. THE BAILER AND TEFLON CHECK VALVE WAS STEAM CLEANED THEN RINSED WITH DEIONIZED WATER BEFORE DEVELOPMENT

TOTAL VOLUME REMOVED DURING DEVELOPMENT WAS APPROX. 13.5 gals

VOLUME OF WATER IN WELL COLUMN @ STATIC OF 5.97' BELOW TOP OF 2" RISER PIPE ON 1-14-86 WAS 2.7 gals.

MEASUREMENTS DURING DEVELOPMENT

DATE	VALUES BAILED	pH	SPECIFIC COND.	COMMENTS
11-15-85	3.5	6.5	7,400	WATER MILKY COLORED
11-18-85	3.5	6.3	9,700	"
11-20-85	3.0	6.7	11,700	WATER FAIRLY CLEAR
11-23-85	3.3	—	—	RECOVERY TEST PERFORMED

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-5020	Made by W.G.G.	Date 11/4/85
	Ref. L-28	Checked	Sheet 1 of 2
		Reviewed JFR	

1. a) Used solid stem augers 8" ϕ with 10" bit to auger 10" borehole to 4.5' bgs; pulled augers and sounded @ 4.5' bgs.

b) Inserted 5.0 feet of 6" ϕ flush joint steel surface casing; bottom of csg @ 4.5' bgs.

c) Grouted annular space between 6" csg and 10" auger hole using bentonite grout mixed at a ratio of ~1.5 lbs bent per gal of water. Grout was tremied down annulus using a clean 5 foot section of 1" ID PVC tremie pipe. Hole was dry before grouting. Used ~ 22 gals of grout with some overflow (~5 gals) to insure good seal.

d) 6-inch ϕ surface casing was flushed clean using water and a 5 7/8" rollerbit; 6" ϕ casing was then bailed to within 0.3' of bottom of hole.

2. a) Drove 4" ID temporary flush joint casing from 4.5 feet to 9.5' bgs then flushed and reamed with 3 7/8" roller bit until clean.

b) Continued driving 4" ID csg from 9.5' to 14.5' bgs. and then flushed and reamed until return was clean. Drove 4" ID csg from 14.5' to 21.0' bgs and reamed until clean. Bottom of hole (TD) is @ 21.0 ft, sounded same depth. Bailed 4" csg to with 0.3' of TD.

3. a) Backfilling: Pulled 4" ϕ casing up 1.0', hole sounded @ 21.0' bgs then sand was added to 20.5' bgs. Well screen (12.5') and solid riser (10.0') was inserted down hole, bottom of screen @ 20.4' bgs. Bottom cap length is 0.1 feet.

b) The 4" ϕ casing was pulled @ 1.0 ft intervals and sand was backfilled in the open annulus after sounding each time to ensure sloughing had not occured. Sand backfilled to 6.0' bgs. Total volume used was ~ 8 gals; calculated volume is ~ 9.1 gals.
Bentonite pellets were backfilled with the same method to 2.0' bgs. Used ~ 3.5 gals of pellets, calculated volume is ~ 3.9 gals. Pellets were hydrated with ~ 1.5 to 2.0 gals of deionized water.

4. a) Water level upon completion on October 23, 1985 @ 1120 hrs was 20.80' below the top of the 2" well riser pipe.

5. a) Flush joint aluminum 6" protective pipe was threaded on the 6" ϕ surface casing and secured with lock.

6 a) Vented cap installed on well pipe

7 a) 30" hole was dug around protective casing and filled with cement sloped to drain. Weep holes (3) 1/4" ϕ were drilled in protective casing at top of cement

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020 Ref. L-28	Made by W.G. Checked Reviewed	Date 11/4/85 Sheet 2 of 2

8. a) Cement was poured inside the 6" ϕ surface and protective casing to a level even with the outside cement seal.

b) After cement had cured, coarse sand was poured inside the guard pipe to about 5 inches below the top of riser pipe.

Golder Associates

Field Boring Log

DEPTH HOLE 44.7	JOB NO. 853-3013	PROJECT CWM/OLD/OH			BORING NO. G-29
DEPTH SOIL DRILL 44.7	GA INSP. PM/RSM	DRILLING METHOD CME Continuous Soil Sampler			SHEET 1 OF 2
DEPTH ROCK CORE NA	WEATHER PTly cldy	DRILLING COMPANY Geotechnics			SURFACE ELEV. 610
NO. DIST. SA. 10 UD. SA NA	TEMP. 50°	DRILL RIG CME 55	DRILLER J. Sezwski		DATUM MSL
EPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA		STARTED 1105 (TIME) / 3-10-85 (DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA		COMPLETED 1415 / 3-10-85

SAMPLE TYPES

AS	AUGER SAMPLE	BL	BLACK
CS	CHUNK SAMPLE	BR	BROWN
DO	DRIVE OPEN	C	COARSE
DS	DENISON SAMPLE	CA	CASING
PS	PITCHER SAMPLE	CL	CLAY
RC	ROCK CORE	CLY	CLAYEY
ST	SLOTTED TUBE	F	FINE
TO	THIN WALLED, OPEN	FRAG	FRAGMENTS
TP	THIN WALLED, PISTON	GL	GRAVEL
WS	WASH SAMPLE	LYD	LAYERED
CSS	Continuous Soil Sample	LI	LITTLE

ABBREVIATIONS

M	MEDIUM	SA	SAMPLE
MIC	MICACEOUS	SAT	SATURATED
MOT	MOTTLED	SD	SAND
NP	NON-PLASTIC	SI	SILT
OG	ORANGE	SLY	SILTY
ORG	ORGANIC	SM	SOME
PH	PRESSURE-HYDRAULIC	TR	TRACE
PM	PRESSURE-MANUAL	WL	WATER LEVEL
R	RED	WH	WEIGHT OF HAMMER
RES	RESIDUAL	Y	YELLOW
RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 6 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LB	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	DEPTH	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
607.0	Firm to stiff brown-tan CLAYEY SILT, some f-m sand, little fine gravel (FILL)			1	CSS		3.4 / 4.4		
3.0 / 606.9	TOPSOIL								
4.1	Soft to firm, gray-tan, mottled, SILTY CLAY, trace fine sand, trace organics (LACUSTRINE)		4.4	2	CSS		5.0 / 5.0		
600.4			9.4						
9.6	Firm, brown to gray, laminated SILTY CLAY, trace fine sand (LACUSTRINE)			3	CSS		4.7 / 5.0		
594.0			14.4						
16.0	Soft to stiff, gray SILTY CLAY, trace to little f-c sand, trace f-c gravel (TILL)			4	CSS		5.3 / 5.0		
			19.4						
				5	CSS		5.0 / 5.0		

Golder Associates

Field Boring Log

DEPTH HOLE 44.7	JOB NO. 853-3013	PROJECT Cuyahoga/OH				BORING NO. 6-29	
DEPTH SOIL DRILL 44.7	QA INSP. Rowlison	DRILLING METHOD CME Continuous Soil Sampling				SHEET 2 OF 2	
DEPTH ROCK CORE NA	WEATHER Hi, cldy	DRILLING COMPANY Geomechanics				SURFACE ELEV. 610	
NO. DIST. SA 10 UD. SA NA	TEMP. 50°	DRILL RIG CME 55	DRILLER T. Selvoski			DATUM MSL	
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA			STARTED 1105 / 3-10-85 (TIME / DATE)	
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA			COMPLETED 1415 / 3-10-85	

SAMPLE TYPES

AS	AUGER SAMPLE	BL	BLACK
CS	CHUNK SAMPLE	BR	BROWN
DO	DRIVE OPEN	C	COARSE
DS	DENISON SAMPLE	CA	CASING
PS	PITCHER SAMPLE	CL	CLAY
RC	ROCK CORE	CLY	CLAYEY
BT	BLOTTED TUBE	F	FINE
TO	THIN WALLED, OPEN	FRAG	FRAGMENTS
TP	THIN WALLED, PISTON	GL	GRAVEL
WS	WASH SAMPLE	LYD	LAYERED
CSS	CONTINUOUS SOIL SAMPLE	LI	LITTLE

ABBREVIATIONS

M	MEDIUM	SA	SAMPLE	WL	WATER LEVEL
MIC	MICACEOUS	SAT	SATURATED	WH	WEIGHT OF HAMMER
MOT	MOTTLED	SD	SAND	Y	YELLOW
NP	NON-PLASTIC	SI	SILT		
OG	ORANGE	SIY	SILTY		
ORG	ORGANIC	SM	SOME		
PH	PRESSURE-HYDRAULIC	TR	TRACE		
PM	PRESSURE-MANUAL				
R	RED				
RES	RESIDUAL				
RX	ROCK				

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to stiff, gray SILTY CLAY, trace to little f-c sand, trace f-c gravel (TILL)			5	CSS		5.0/5.0		
			24.4						
				6	CSS		5.0/5.0		
			29.4						
				7	CSS		5.0/5.0		
			34.4						
				8	CSS		5.0/5.0		
			39.4						
				9	CSS		4.9/4.9		
									Cobble in end of sample #9. Tried to drill deeper - went 0.4' with no recovery
565.3			44.3	10	CSS		0/0.4		
44.7	AUGER REFUSAL								Upon completion the borehole was backfilled with thick bentonite slurry mixed at 1.5 to 2.0 lbs. per gallon of water

MONITORING WELL INSTALLATION LOG

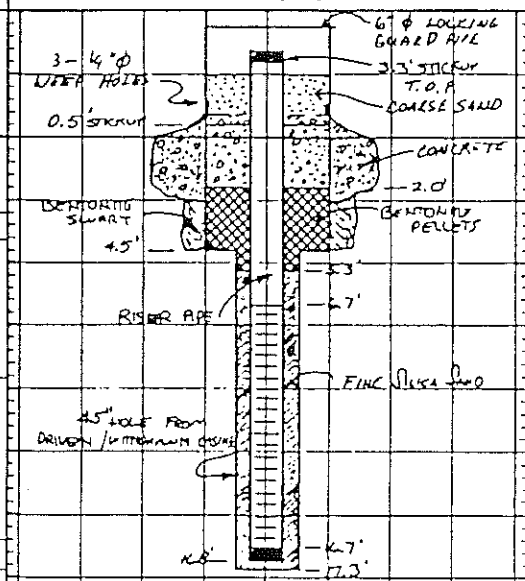
JOB NO. 853-3070	PROJECT CWM / NICKERT / OH	WELL NO L-29	SHEET 1 OF 1
GA INSP. W.C.G.	DRILLING METHOD AUGER / ROTARY	GROUND ELEV. 606.4	WATER DEPTH 10.61'
WEATHER CLDY COLD	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 609.65	DATE/TIME 10/31/95 10:55
TEMP.	DRILL RIG CME 55	DRILLER T. BOEHNER	STARTED 10/29/95 (TIME / DATE) COMPLETED 10/31/95 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 10.0' l.f.	WELL SCREEN 2 in. dia. 10.0' l.f.	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 0.0060 in.	FILTER PACK QTY 6.5 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	FIRM TO STIFF, BROWN-TAN CLAYEY SILT, SOME F-M SAND, LITTLE FINE GRAVEL (FILL)
3.0	TOPSOIL
4.1	SOFT TO FIRM, GRAY-TAN, MOTTLED, SILTY CLAY, TRACE FINE SAND, TRACE ORGANICS (LACUSTRINE)
9.6	FIRM, BROWN TO GRAY, LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
16.0	SOFT TO STIFF, GRAY SILTY CLAY, TRACE TO LITTLE F-C SAND, TRACE F-C GRAVEL (TILL)
17.3	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH STAINLESS STEEL BAILER.
A NEW PIECE OF POLYPROPYLENE ROPE WAS DESIGNATED FOR USE ONLY IN WELL L-29 AND WAS STORED IN A CLEAN BAG.
THE BAILER AND TEFLON CHECK VALVE WAS STEAM CLEANED THEN RINSED WITH DEIONIZED WATER BEFORE DEVELOPMENT.
TOTAL VOLUME REMOVED DURING DEVEL. WAS APPROX. 19.5 gals.
VOLUME OF WATER IN WELL COLUMN @ STATIC W.L. OF 6.65' FROM TOP OF 2" RISER (11-14-96) WAS 2.2 gals.

MEASUREMENTS DURING DEVELOPMENT

DATE	GALLONS BAILED	pH	SPECIFIC COND.	COMMENTS
11-14-95	2.5	6.9	1,100	WATER TURBID
11-19-95	3.0	7.0	1,100	TURBID
11-20-95	2.7	6.8	1,100	TURBID
11-27-95	2.3	—	—	FAIRLY CLEAR

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020 Ref. L-29	Made by W.6.6 Checked Reviewed JR	Date 11-2-85 Sheet 1 of 2

1. a) Augered 10" ϕ hole to 4.5' bgs using 8" ϕ augers with 10" bit; pulled augers and sounded hole @ 4.5' bgs.

b) Inserted 5.0 feet of 6" ϕ flush-joint steel surface casing; bottom of csg @ 4.5' bgs.

c) Grouted annular space between 6" csg and 10" auger hole with bentonite grout slurry. Sample of grout was taken. Grout was tremied down annulus using a clean 5 foot section of 1" ID pvc tremie pipe. Hole was dry before grouting. Used ~ 22 gals of bent. grout, letting ~5 gals overflow to ensure a good seal.

d) 6-inch ϕ surface casing was flushed clean using a 5 7/8" rollerbit; 6" ϕ csg was then bailed to within 0.3 feet of bottom of hole.

2. a) Drove 4" ID temporary flush-joint casing from 4.5 ft to 9.5 ft bgs and then flushed and reamed until clean. Drove 4" csg from 9.5 to 14.5' bgs and flushed until clean; Drove 4" csg from 14.5' to 17.3' and flushed clean. Sounded hole @ 17.3' bgs which is TD. Bailed water from 4" csg to within 0.3' of TD.

3 a) Backfilling: Pulled 4" ϕ csg up 1.0 foot and sounded hole @ 17.3'. Added sand to 16.8'; while pulling steel measuring tape from hole the tape broke, tape and weight were in hole. Tried to get weight out of hole with fishing tools with no success. Added sand downhole to bind weight in casing then pulled 4" csg to retrieve weight, attempt failed. Added galvanized steel pipe (steam cleaned) down hole with fishing tool on end. Retrieved all of the tape and the weight. Inserted 4" ϕ casing back downhole to TD - 17.3' bgs. Flushed 4" casing until clear.

b) Pulled 4" ϕ casing up 1.0 feet, hole sounded @ 17.3' bgs. added sand to 16.8' bgs. Well screen (10.0') and solid riser pipe was inserted down hole. Bottom of screen @ 16.7' bgs, bottom cap length 0.1'. Taped well pipe threads with teflon tape before installation.

c) The 4" ϕ csg was pulled @ 1.0 ft increments and sand was backfilled in the open annulus. The hole was sounded before the sand was added to ensure that sloughing had not occured. Total volume of sand used was ~ 6.5 gals. Calculated volume is 7.3 gals. Bentonite pellets were backfilled with the same procedure from 5.3' to 2.0' bgs. From 5.3' to 4.8' the 4" ϕ casing was lifted 0.5' to ensure that ~ 0.4 feet of bent. pellets were over the sand before the bottom of the 4" ϕ casing was pulled above the 6" ϕ surface casing.

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020 Ref. L-29	Made by W.G.G. Checked Reviewed GTC	Date Sheet 2 of 2

4. a) Water level upon completion of L-29 was 10.61' below the top of the 2" S.S. well riser pipe. Water level taken on @ 10:55 am on 10-31-85.

5. a) After water level was obtained, ~ 1.5 gals of demineralized water was added to the bent. pellets to hydrate seal.

6. a) Flush joint aluminum 6" ID protective pipe was threaded on the 6" ø surface casing and was secured with lock.

b) A 30" deep hole was excavated around the well and filled in with cement. The cement was sloped to drain away from the well.

c) Cement was poured over the bent. pellet seal until level with the outer cement seal.

d) After inner cement seal had cured, coarse sand was poured in the guard pipe to about 5 inch below the top of riser pipe.

7. a) Well cap was vented by drilling a small ø hole.

Golder Associates

Field Boring Log

DEPTH HOLE 48.2	JOB NO. 853-3013	PROJECT CWM/OLD/OH			BORING NO. 30
DEPTH SOIL DRILL 47.2	QA INSP. CMI/RSM	DRILLING METHOD CME Continuous Soil Sample			SHEET 1 OF 3
DEPTH ROCK CORE NA	WEATHER CHY	DRILLING COMPANY Geomechanics			SURFACE ELEV. 607
NO. DIST. SA. 10 UD. SA. NA	TEMP. 50°	DRILL RIG CME 55	DRILLER J. Selvski		DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA		STARTED 0800 (TIME) / 3-8-85 (DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA		COMPLETED 1200 / 3-8-85

SAMPLE TYPES

AS	AUGER SAMPLE	BL	BLACK
CS	CHUNK SAMPLE	BR	BROWN
DO	DRIVE OPEN	C	COARSE
DS	DENISON SAMPLE	CA	CASING
PS	PITCHER SAMPLE	CL	CLAY
RC	ROCK CORE	CLY	CLAYEY
ST	SLOTTED TUBE	F	FINE
TO	THIN WALLED, OPEN	FRAG	FRAGMENTS
TP	THIN WALLED, PISTON	GL	GRAVEL
WS	WASH SAMPLE	LYD	LAYERED
CSS	Continuous Soil Sample	LI	LITTLE

ABBREVIATIONS

M	MEDIUM	SA	SAMPLE
MIC	MICACEOUS	SAT	SATURATED
MOT	MOTTLED	SD	SAND
NP	NON PLASTIC	SI	SILT
OG	ORANGE	SIT	SILTY
ORG	ORGANIC	SM	SOME
PH	PRESSURE HYDRAULIC	TR	TRACE
PM	PRESSURE MANUAL	WL	WATER LEVEL
R	RED	WH	WEIGHT OF HAMMER
RES	RESIDUAL	Y	YELLOW
RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 6 - 12%
"SOME" — 13 - 30%
"AND" — 30 - 50%

CONSISTENCY

LO	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	DEPTH	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
603.9									Augered to 3.1' before beginning sampling due to gravel/cobble fill.
3.1	Firm, gray-tan to brown, mottled, SILTY CLAY, trace fine sand, trace organics (LACUSTRINE)		4.3	1	CSS		1.1 / 1.2		
				2	CSS		5.0 / 5.0		
598.0									
9.0	Soft to firm, brown, CLAYEY SILT, trace fine sand SILT at 9.8-9.9' (LACUSTRINE)		9.3	3	CSS		4.8 / 5.0		
596.0									
11.0	Soft to firm, gray SILTY CLAY, trace f-c, sand, trace f-c gravel (TILL)		14.3	4	CSS		5.0 / 5.0		
			19.3	5	CSS		5.0 / 5.0		

Golder Associates

Field Boring Log

DEPTH HOLE 48.2	JOB NO. 853-3013	PROJECT CWM/OLD/OH	BORING NO. G-30
DEPTH SOIL DRILL 48.2	QA INSP. Cml/RSM	DRILLING METHOD CME Continuous Soil Sampler	SHEET 2 OF 3
DEPTH ROCK CORE NA	WEATHER Cldy	DRILLING COMPANY Geomechanics	SURFACE ELEV. 607
NO. DIST. SA. 10 UD. SA. NA	TEMP. 50°	DRILL RIG CME 55 DRILLER J. Selvoski	DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA DROP NA	STARTED 0800 (TIME) / 3-8-85 (DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA DROP NA	COMPLETED 1200 / 3-8-85

SAMPLE TYPES

A S	AUGER SAMPLE
C S	CHUNK SAMPLE
D O	DRIVE OPEN
D S	DENISON SAMPLE
P S	PITCHER SAMPLE
R C	ROCK CORE
S T	SLOTTED TUBE
T O	THIN WALLED, OPEN
T P	THIN WALLED, PISTON
W S	WASH SAMPLE
C S S	Continuous Soil Sample

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE-HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE-MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DH	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to firm, gray SILTY CLAY, trace f-c sand, trace f-c gravel (TILL)		5	CSS		5.0 / 5.0		
		243	6	CSS		5.0 / 5.0		
		283	7	CSS		5.0 / 5.0		
		343	8	CSS		5.0 / 5.0		
		393	9	CSS		5.1 / 5.0		
562.5 / 44.5	Weathered Rock Shale and gypsum	443	10	CSS		3.9 / 3.9		

Golder Associates

Field Boring Log

DEPTH HOLE 48.2	JOB NO. 853-3013	PROJECT Chum Toulam	BORING NO. G-30
DEPTH SOIL DRILL 48.2	QA INSP. MI/RSM	DRILLING METHOD CME Continuous Soil Sampler	SHEET 3 OF 3
DEPTH ROCK CORE NA	WEATHER Cldy	DRILLING COMPANY Geomechanics	SURFACE ELEV. 607
NO. DIST. SA. 10 UD. SA. NA	TEMP. 50°	DRILL RIG CME 55 DRILLER J. Sowski	DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA DROP NA	STARTED 0900 (TIME) 3-8-85 (DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA DROP NA	COMPLETED 1200 (TIME) 3-8-85 (DATE)

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	Continuous Soil Sampler

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 80%

CONSISTENCY

LB	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Weathered Rock shale + gypsum			10	CSS		3.9 / 3.9		
558.8									
48.2	AUGER REFUSAL								Upon completion the borehole was backfilled with thick bentonite slurry mixed at 1.5 to 2.0 lbs per gallon of water

MONITORING WELL INSTALLATION LOG

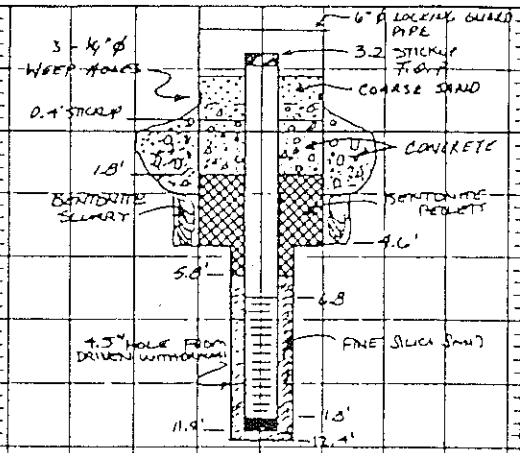
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO. L-30	SHEET 1 OF 1
GA INSP. L. FROST	DRILLING METHOD AUGER / ROTARY	GROUND ELEV. 607.6	WATER DEPTH 10.97'
WEATHER OVER CAST	DRILLING COMPANY E.T.I.	COLLAR ELEV 610.84	DATE/TIME 10/24/85 15:57
TEMP.	DRILL RIG CME 55 DRILLER C. BARTLE	STARTED 0855 10/20/85 (TIME / DATE)	COMPLETED 1555 10/20/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia 10.0' l.f.	WELL SCREEN 2 in. dia 5.0 l.f.	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH COUPLED	SLOT SIZE 0.0060 in	FILTER PACK QTY 4.5 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	GRAVEL / COBBLE (FILL)
3.1	FIRM, GRAY-TAN TO BROWN, MOTTLED, SILTY CLAY, TRACE FINE SAND, TRACE ORGANICS (LACUSTRINE)
9.0	SOFT TO FIRM, BROWN, CLAYEY SILT, TRACE FINE SAND, SILT AT 9.8-9.9' (LACUSTRINE)
11.0	SOFT TO FIRM, GRAY SILTY CLAY, TRACE F-C SAND, TRACE F-C GRAVEL (TILL)
12.4	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH A STAINLESS STEEL BAILER.

A NEW PIECE OF POLYPROPYLENE ROPE WAS DESIGNATED FOR USE ONLY IN WELL L-30. ROPE STORED IN CLEAN BAG. BAILER AND TEFLON CHECK VALVE WERE STEAM CLEANED AND RINSED WITH DEIONIZED WATER BEFORE DEVEL. TOTAL VOLUME REMOVED DURING DEVEL WAS APPROX. 10.5 GALS.

VOLUME OF WATER IN WELL COLUMN @ STATIC W.L. OF 5.78' MEASURED 1-14-86 FROM TOP OF RISER IS 1.5 gals.

MEASUREMENTS DURING DEVEL.

DATE	GALLONS BAILED	pH	SPECIFIC COND.	COMMENTS
11-12-85	2.0	6.5	5,800	MILKY COLOR
11-19-85	1.7	6.4	10,000	"
11-20-85	0.8	6.6	10,000	"
11-23-85	1.5	—	—	SLIGHTLY MILKY

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020	Made by L.F. (W.G.G.)	Date
	Ref. L30	Checked	Sheet 1 of 2
		Reviewed GTR	

1. a) Drilled 10" ϕ hole to 45' bgs with solid-stem augers; hole sounded @ 4' bgs, material sloughing in; hole reaugered, sounded @ 4.6' bgs.
   b) Installed 6" ϕ flush-joint steel surface csg, bottom of 6" csg @ 4.6' bgs.
   c) Grouted borehole annulus with bentonite slurry mixed @ 1.5-2.0 lb/gal water; grout poured into borehole annulus from ground surface, calculated grout volume 10.6 gal, actual volume used ~ 11 gal.
   d) 6" ϕ surface csg drilled and flushed clean to 46' bgs; hole bailed to within 0.5' of bottom of hole

2. a) 4" ϕ flush-joint csg hammered from 46' to 93' bgs; inside of csg drilled out with 3 7/8" ϕ roller cone; hole flushed clean
   b) 4" ϕ csg hammered from 93' - 124' bgs; inside of csg drilled out and hole flushed clean; hole bailed to within 0.5' of bottom of hole

3. a) Borehole backfilled with filter sand to 119' bgs
   b) Well screen and riser pipe installed, well bottoming @ 119' bgs
   c) Backfilling: The 4" ϕ csg was pulled up approx. 1' @ a time then sounded to ensure that no sloughing of the hole had occured. The open borehole annulus was then backfilled with sand or bentonite pellets, depending on what interval of the hole was being backfilled

   Filter Pack: screen / borehole annulus backfilled with sand to 58' bgs; calculated filter pack volume 4.2 gal, actual volume used ~ 4½ gal

   Bentonite Seal: riser pipe / borehole annulus backfilled with bentonite pellets to 18' bgs; calculated bentonite volume 4.8 gal, actual volume used ~ 4½ gal. Bentonite seal was hydrated with ~ 2 gals of deionized water.

4. a) Water level @ time of completion of well = 10.97' below top of 2" riser pipe

Golder Associates	SUBJECT INSTALLATION NOTES		
	Job No. 853-3020 Ref. L-30	Made by W.G. & L.F. Checked Reviewed	Date Sheet 2 of 2

5. a) A 6" ϕ aluminum protective pipe was threaded on the surface casing and secured with lock.

b) A 30" deep hole was excavated around the well and filled in with cement and sloped to drain away from well.

c) Cement was poured inside the guard pipe over the bent. pellet to approx. the same level as the outside cement seal.

d) Three ¼" ϕ weep holes were drilled just above the cement seal in the 6" ϕ guard pipe.

e) After the cement had cured, coarse sand was poured in the guard pipe to above 5 inches below the top of riser pipe.

6. a) The well cap was vented by drilling a small ϕ hole in the caps side.

Golder Associates

Field Boring Log

DEPTH HOLE 47.1	JOB NO. 853-3013	PROJECT Cwm/OLD/OH			BORING NO. G-31
DEPTH SOIL DRILL 47.1	QA INSP. PMI/RSM	DRILLING METHOD CME Continuous Soil Sampler			SHEET 1 OF 3
DEPTH ROCK CORE NA	WEATHER Pty cldy	DRILLING COMPANY Geomechanics			SURFACE ELEV. 608
NO. DIST. SA. 10 UD. SA. NA	TEMP. 50°	DRILL RIG CME 55	DRILLER J. Selucky		DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA		STARTED 1105 / 5-9-85 (TIME / DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA		COMPLETED 1505 / 5-9-85 (TIME / DATE)

SAMPLE TYPES

AS	AUGER SAMPLE		
CS	CHUNK SAMPLE		
DO	DRIVE OPEN		
DS	DENISON SAMPLE		
PS	PITCHER SAMPLE		
RC	ROCK CORE		
ST	SLOTTED TUBE		
TO	THIN-WALLED, OPEN		
TP	THIN WALLED, PISTON		
WS	WASH SAMPLE		
CSS	Continuous Soil Sample		

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LT	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" – 0 - 5%
"LITTLE" – 5 - 12%
"SOME" – 12 - 30%
"AND" – 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
605.4 / 2.6	Soft to firm, brown SILT, trace fine sand, trace organics (FILL)		1	CSS		3.8 / 4.2	4.2	
600.2 / 7.8	Firm to stiff, gray-tan, mottled, CLAYEY SILT, trace fine sand, trace organics (LACUSTRINE)		2	CSS		5.2 / 5.0	9.2	
594.9 / 13.1	Firm to stiff, gray to brown laminated SILTY CLAY, trace fine sand (LACUSTRINE)		3	CSS		4.7 / 5.0	14.2	
	Soft to stiff, gray, SILTY CLAY, trace to little f-c sand, trace f-c gravel (TILL)		4	CSS		5.0 / 5.0	19.2	
			5	CSS		5.1 / 5.0		

Golder Associates

Field Boring Log

DEPTH HOLE 47.1	JOB NO. 853-3013	PROJECT CWM/OLD/OH				BORING NO. G-31	
DEPTH SOIL DRILL 47.1	QA INSP. PM/RSM	DRILLING METHOD CME CONTINUOUS SOIL SAMPLER				SHEET 2 OF 3	
DEPTH ROCK CORE NA	WEATHER Pty cldy	DRILLING COMPANY GEOMECHANICS				SURFACE ELEV. 608	
NO. DIST. SA. 10 UD. SA. NA	TEMP. 50°	DRILL RIG CME 55		DRILLER J. SELVOSKI		DATUM MSL	
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA		DROP NA		STARTED 1105 / 3-9-85 (TIME / DATE)	
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA		DROP NA		COMPLETED 1500 / 3-9-85	

SAMPLE TYPES

AS	AUGER SAMPLE	BL	BLACK
CS	CHUNK SAMPLE	BR	BROWN
DO	DRIVE OPEN	C	COARSE
DS	DENISON SAMPLE	CA	CASING
PS	PITCHER SAMPLE	CL	CLAY
RC	ROCK CORE	CLY	CLAYEY
ST	SLOTTED TUBE	F	FINE
TO	THIN WALLED, OPEN	FRAG	FRAGMENTS
TP	THIN WALLED, PISTON	GL	GRAVEL
WS	WASH SAMPLE	LYD	LAYERED
CSS	CONTINUOUS SOIL SAMPLE	LI	LITTLE

ABBREVIATIONS

M	MEDIUM	SA	SAMPLE
MIC	MICACEOUS	SAT	SATURATED
MOT	MOTTLED	SD	SAND
NP	NON PLASTIC	SI	SILT
OG	ORANGE	SIT	SILTY
ORG	ORGANIC	SM	SOME
PH	PRESSURE HYDRAULIC	TR	TRACE
PM	PRESSURE MANUAL	WL	WATER LEVEL
R	RED	WH	WEIGHT OF HAMMER
RES	RESIDUAL	Y	YELLOW
RK	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to stiff, gray, SILTY CLAY, trace to little f-c sand, trace f-c gravel (TILL)		24½	5	CSS		5.1 / 5.0		
			29½	6	CSS		5.2 / 5.0		
			34½	7	CSS		4.6 / 5.0		
			39½	8	CSS		5.0 / 5.0		
			44½	9	CSS		5.0 / 5.0		
564.9 / 43.1	Hard, greenish gray CLAYEY SILT, some f-c sand, trace to little fine gravel (TILL)			10	CSS		2.6 / 2.9		

Golder Associates

Field Boring Log

DEPTH HOLE 47.1	JOB NO. 853-3013	PROJECT Cumberland	BORING NO. G-31
DEPTH SOIL DRILL 47.1	QA INSP. pmi/esm	DRILLING METHOD CME Continuous Soil Sampling	SHEET 3 OF 3
DEPTH ROCK CORE NA	WEATHER Pt. cldy	DRILLING COMPANY Geotechnics	SURFACE ELEV. 608
NO. DIST. SA. 10 UD. SA. NA	TEMP. 50°	DRILL RIG CME 55	DRILLER J. Selvoski	DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA	STARTED 1105 (Time) 13-9-85 (Date)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA	COMPLETED 1505 (Time) 13-9-85 (Date)

SAMPLE TYPES

AS	AUGER SAMPLE	BL	BLACK
CS	CHUNK SAMPLE	BR	BROWN
DO	DRIVE OPEN	C	COARSE
DS	DENISON SAMPLE	CA	CASING
PS	PITCHER SAMPLE	CL	CLAY
RC	ROCK CORE	CLY	CLAYEY
ST	SLOTTED TUBE	F	FINE
TO	THIN WALLED, OPEN	FRAG	FRAGMENTS
TP	THIN WALLED, PISTON	GL	GRAVEL
WS	WASH SAMPLE	LYD	LAYERED
CFS	Continuous Soil Sampling	LI	LITTLE

ABBREVIATIONS

M	MEDIUM	SA	SAMPLE
MIC	MICACEOUS	SAT	SATURATED
MOT	MOTTLED	SD	SAND
NP	NON PLASTIC	SI	SILT
OG	ORANGE	SIY	SILTY
ORG	ORGANIC	SM	SOME
PH	PRESSURE HYDRAULIC	TR	TRACE
PM	PRESSURE MANUAL	WL	WATER LEVEL
R	RED	WH	WEIGHT OF HAMMER
RES	RESIDUAL	Y	YELLOW
RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
560.9	Hard, greenish gray CLAYEY SILT, some sand, trace to little gravel (Till)			10	CU		2.4 / 2.9		
47.1	AUGER REFUSAL								Shale fragment in end of sample tube
									Upon completion the borehole was backfilled with thick bentonite slurry mixed at 1.5 to 2.0 lbs per gallon

MONITORING WELL INSTALLATION LOG

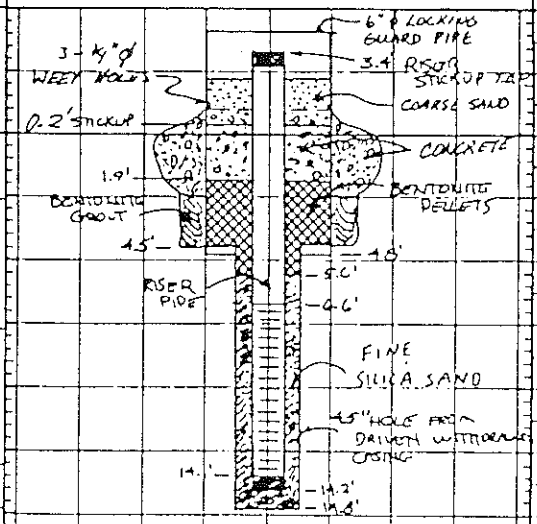
JOB NO. 053-3020	PROJECT CWM / VICKERY / OH	WELL NO. L-31	SHEET 1 OF 1
GA INSP. L FROST	DRILLING METHOD AUGER / ROTARY	GROUND ELEV 607.9	WATER DEPTH 18.57'
WEATHER CLOY	DRILLING COMPANY E.T.I.	COLLAR ELEV 611.32	DATE/TIME 10/31/85 18:57
TEMP.	DRILL RIG CME 55 DRILLER CHUCK BARTLE	STARTED 0800 10/30/85 (TIME / DATE)	COMPLETED 0870 10/31/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 10.0' l.f.	WELL SCREEN 2 in. dia. 7.5' l.f.	BENTONITE SEAL PELLETS
CASING TYPE 312 STAINLESS STEEL	SCREEN TYPE 312 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 0.0060 in	FILTER PACK QTY 5.0 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	SOFT TO FIRM, BROWN SILT, TRACE FINE SAND, TRACE ORGANICS (FILL)
2.6	FIRM TO STIFF, GRAY-TAN, MOTTLED, CLAYEY SILT, TRACE FINE SAND, TRACE ORGANICS (LACUSTRINE)
7.8	FIRM TO STIFF, GRAY TO BROWN LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
13.1	SOFT TO STIFF, GRAY, SILTY CLAY, TRACE TO LITTLE F-C SAND, TRACE F-C GRAVEL (TILL)
14.8	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH A STAINLESS STEEL BAILER.

A NEW PIECE OF POLYPROPYLENE ROPE WAS DESIGNATED FOR USE ONLY IN WELL L-31. ROPE STORED IN CLEAN BAG.

BAILER AND TEFLON CHECK VALVE WERE STEAM CLEANED AND RINSED WITH DEIONIZED WATER BEFORE DEVELOPMENT. TOTAL VOLUME REMOVED DURING DEVELOPMENT WAS APPROX 4.6 gals. CALCULATED VOLUME IN WELL COLUMN FOR STATIC W.L. MEASURED 11-18 @ 6.17' BELOW TOP OF RISER PIPE IS 1.9 gal.

MEASUREMENTS DURING DEVELOPMENT

DATE	GALLONS BAILED	pH	SPECIFIC COND	COMMENTS
11-14-85	2.0	6.9	1,100	TURBID
11-19-85	1.8	6.8	1,300	"
11-20-85	0.5	7.0	1,500	"
11-23-85	0.3	—	—	FAIRLY CLEAR

Golder Associates	SUBJECT WELL COMPLETION		
	Job No. 853-3020	Made by LF	Date
	Ref. L31	Checked	Sheet 1 of 2
		Reviewed	

1. a) Drilled 10" ϕ hole to 7.5' bgs using solid-stem augers; hole sounded @ 3' bgs, material sloughing in; hole reaugered, sounded @ 4.5' bgs
   b) Installed 6" ϕ flush-joint steel surface csg, bottom of 6" csg @ 4.5' bgs
   c) Grouted borehole annulus with bentonite slurry mixed @ 1.5-2.0 lb/gal water; grout poured into borehole annulus from ground surface; calculated grout volume 10.4 gal, actual volume used ~ 13 gal
   d) 6" ϕ surface csg drilled and flushed clean to 4.5' bgs; hole bailed to within 0.5' of bottom of hole

2. a) 4" ϕ flush-joint csg hammered from 4.5' to 9.5' bgs; inside of csg drilled out with 3 7/8" ϕ roller cone; hole flushed clean
   b) 4" ϕ csg hammered from 9.5 to 14.8' bgs; inside of csg drilled out and flushed clean; hole bailed to within 0.5' of bottom of hole
   c) During hammering of 4" ϕ csg, 6" ϕ surface csg sank 0.3'; bottom of 6" csg @ 4.8' bgs

3. a) Borehole backfilled with filter sand to 14.2' bgs
   b) Well screen and riser pipe installed, well bottoming @ 14.2' bgs
   c) Backfilling: The 4" ϕ csg was pulled up approx 1' @ a time then sounded to ensure that no sloughing of the hole had occured. The open borehole annulus was then backfilled with sand or bentonite pellets, depending on what interval of the hole was being backfilled.

   Filter Pack: screen / borehole annulus backfilled with sand to 5.6' bgs; calculated filter pack volume ~6.1 gal, actual volume used ~ 5 gal

   Bentonite Seal: riser pipe / borehole annulus backfilled with bentonite pellets to 1.9' bgs; calculated bentonite volume 3.6 gals, actual volume used ~ 5 gal. About 1.5 gals of deionized water was added to the pellets to induce hydration.

4. a) Water level @ time of completion of well = 6.69' below top of 2" riser pipe

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 953-3020 Ref. L-31	Made by W.G.G. + L.F. Checked Reviewed	Date Sheet 2 of 2

5. a) An aluminum 6" ID protective flush-joint pipe was threaded on the 6" ϕ surface casing and secured with a lock.

6. a) A small diameter hole was drilled in the well cap for venting.

7. a) A 30" deep hole was excavated around the well and filled in with cement and sloped for drainage away from the well.

b) Cement was poured inside the 6" casing at the same level as the outside cement seal.

c) After the cement had cured, coarse sand was poured inside the guard pipe to about 5 inches below the top of riser pipe.

8 a) The well cap was vented by drilling a small ϕ hole.

Golder Associates

Field Boring Log

DEPTH HOLE 44.4	JOB NO. 853-3013	PROJECT CWM/OSO/OH	BORING NO. G-32
DEPTH SOIL DRILL 44.4	GA INSP. PMI/RSM	DRILLING METHOD CME CONTINUOUS SOIL SAMPLER	SHEET 1 OF 2
DEPTH ROCK CORE NA	WEATHER CLDY	DRILLING COMPANY GEOMECHANICS	SURFACE ELEV. 608
NO. DIST. SA. 9 UD. SA. NA	TEMP. 50°	DRILL RIG CME 55 DRILLER J. SELVUSKI	DATUM MSL
DEPTH WL. 2.51	HRS. PROD. NA	WT. SAMPLER HAMMER NA DROP NA	STARTED 1720 / 3-8-85 (TIME / DATE)
TIME WL. 0830 / 3-9-85	HRS. DELAYED NA	WT. CASING HAMMER NA DROP NA	COMPLETED 1030 / 3-9-85

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DD	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	CONTINUOUS SOIL SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE-HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 13 - 30%
"AND" — 30 - 80%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
606.9 / 1.1	Firm, brown, CLAYEY SILT, trace fine sand, trace organics (FILL)								
603.9 / 4.1	Firm to stiff, brown-tan-gray, mottled, CLAYEY SILT, trace fine sand, trace organics (LACUSTRINE)		4.4	1	CSS		4.4 / 4.4		
600.0 / 8.0	Firm to stiff brown, gray, laminated, SILTY CLAY, trace fine sand (LACUSTRINE)		9.4	2	CSS		5.0 / 5.0		
	Firm to soft, brown to gray, SILTY CLAY, trace f-c sand, trace f-c gravel (TILL)		14.4	3	CSS		5.0 / 5.0		
			19.4	4	CSS		5.0 / 5.0		
				5	CSS		4.7 / 5.0		

Golder Associates

Field Boring Log

DEPTH HOLE 44.4	JOB NO. 853-3013	PROJECT CWM/OLD LOH				BORING NO. G-32	
DEPTH SOIL DRILL 44.4	QA INSP. LMI/RSM	DRILLING METHOD CME CONTINUOUS SOIL SAMPLER				SHEET 2 OF 2	
DEPTH ROCK CORE NA	WEATHER CLDY	DRILLING COMPANY GEOMECHANICS				SURFACE ELEV. 608	
NO. DIST. S.A. 9 UD. S.A. NA	TEMP. 50°	DRILL RIG CME 55		DRILLER J. SELVOSKI		DATUM MSL	
DEPTH WL. 2.5'	HRS. PROD. NA	WT. SAMPLER HAMMER NA		DROP NA		STARTED 1720 (TIME) / 3-8-85 (DATE)	
TIME WL. 0830/3-9-85	HRS. DELAYED NA	WT. CASING HAMMER NA		DROP NA		COMPLETED 1630 (TIME) / 3-9-85 (DATE)	

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED OPEN
TP	THIN WALLED PISTON
WS	WASH SAMPLE
CSS	CONTINUOUS SOIL SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 6 - 12%
"SOME" — 13 - 30%
"AND" — 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to firm, brown to gray, SILTY CLAY, trace f-c sand, trace f-c gravel (TILL)			5	CSS		4.7 / 5.0		
			24.4						
				6	CSS		4.9 / 5.0		
			29.4						
				7	CSS		5.0 / 5.0		
			34.4						
				8	CSS		4.9 / 5.0		
			39.4						
				9	CSS		5.0 / 5.0		
566.2 / 41.8	Hard gray, CLAYEY SILT, some f-c sand, little to trace f-c gravel (TILL)								
563.9 / 44.1	Weathered Rock								Upon completion the borehole was backfilled with thick bentonite slurry mixed at 1.5 to 2.0 lbs. per gallon of water
563.6 / 44.4	AUGER REFUSAL								

MONITORING WELL INSTALLATION LOG

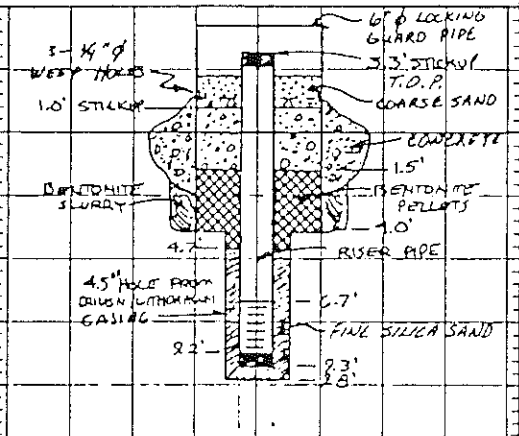
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO. L-32	SHEET 1 OF 1
GA INSP. L. FROST	DRILLING METHOD AUGER / ROTARY	GROUND ELEV 609.5	WATER DEPTH 6.67'
WEATHER PTLY CLDY	DRILLING COMPANY EXPLORATION TECHNOLOGY INC.	COLLAR ELEV 611.78	DATE/TIME 11/27/85 14:27
TEMP.	DRILL RIG CME 55	DRILLER C. BARTLE	STARTED 1000 / 10/29/85 (TIME / DATE) COMPLETED 1815 / 10/31/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 10.0' l.f.	WELL SCREEN 2 in. dia. 2.5' l.f.	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 0.0060 in	FILTER PACK QTY ~2.5 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	FIRM, BROWN, CLAYEY SILT, TRACE FINE SAND, TRACE ORGANICS (FILL)
1.1	FIRM TO STIFF, BROWN-TAN-GRAY, MOTTLED, CLAYEY SILT, TRACE FINE SAND, TRACE ORGANICS (LACUSTRINE)
4.1	FIRM TO STIFF BROWN, GRAY, LAMINATED, SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
8.0	FIRM TO SOFT, BROWN TO GRAY, SILTY CLAY, TRACE F-C SAND, TRACE F-C GRAVEL (TILL)
9.8	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH A STAINLESS STEEL BAILER.

A NEW PIECE OF POLYPROPYLENE ROPE WAS DESIGNATED FOR USE ONLY IN WELL L-32 AND WAS KEPT IN A CLEAN PLASTIC BAG.

BAILER AND TEFLON CHECK VALVE WERE STEAM CLEANED AND RINSED WITH DEIONIZED WATER BEFORE DEVELOPMENT.

CALCULATED VOLUME IN WELL COLUMN FOR STATIC W.L. MEASURED 11-14-86 @ 5.55' BELOW TOP OF RISER IS 1.2 gals.

MEASUREMENTS DURING DEVELOPMENT

DATE	GALLONS BAILED	pH	SPECIFIC COND.	COMMENTS
11-14-85	1.5	6.6	400	TURBID
11-19-85	0.3	7.0	1,200	SL. TURBID
11-20-85	0.3	7.0	1,500	"
11-25-85	0.3	—	—	SLIGHTLY TURBID

TOTAL VOLUME BAILED WAS 2.8 GALS.

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020	Made by CF	Date
	Ref. L32	Checked	Sheet 1 of 2
		Reviewed JSC	

1. a) Drilled 10" ϕ hole to 4.0' bgs using solid-stem augers; hole sounded @ 3.6' bgs, material sloughing in; hole reaugered, sounded @ 4.0' bgs.
   b) Installed 6" ϕ flush-joint steel surface csg, bottom of 6" csg @ 4.0' bgs
   c) Grouted borehole annulus with bentonite slurry mixed @ 1.5-2.0 lb/gal water; grout poured into borehole annulus from ground surface; calculated grout volume 9.2 gal, actual volume used ~ 10 gal.
   d) 6" ϕ surface csg drilled and flushed clean to 4.0' bgs; hole bailed to within 0.5' of bottom of hole

2. a) 4" ϕ flush-joint csg hammered from 4.0' to 9.8' bgs; inside of csg drilled out with 3 7/8" ϕ roller cone; hole flushed clean; hole bailed to within 0.5' of bottom of hole

3. a) Borehole backfilled with filter sand to 9.3' bgs
   b) Well screen and riser pipe installed, well bottoming @ 9.3' bgs
   c) Backfilling: The 4" ϕ csg was pulled up approx. 1' @ a time then sounded to ensure that no sloughing of the hole had occured. The open borehole annulus was then backfilled with sand or bentonite pellets, depending on what interval of the hole was being backfilled

   Filter Pack: screen / borehole annulus backfilled with sand to 4.7' bgs; calculated filter pack volume 3.2 gal, actual volume used ~ 2 1/2 gal

   Bentonite Seal: riser pipe / borehole annulus backfilled with bentonite pellets to 1.5' bgs; calculated bentonite volume 3.5 gal, actual volume used ~ 4 gal. About 1.5 to 2.0 gals of deionized water was added to the pellets for hydration.

4. a) Water level @ time of completion of well = 6.69' below top of 2" riser pipe

Golder Associates	SUBJECT INSTALLATION NOTES		
	Job No. 853-3020 Ref. L-32	Made by W.G.G. Checked Reviewed	Date Sheet 2 of 2

5 a) A 6" ϕ. flush joint aluminum guard pipe was threaded on the surface csg.

b) A 30" deep hole was excavated around the well and filled with cement. Cement shaped to drain away from well.

c) Cement was poured inside the 6" ϕ csg (above the pellet seal) to about the same level as the outside cement seal.

d) Three ¼" ϕ weep hole were drilled just above the cement seal.

e) After the cement had cured, coarse sand was poured in the guard pipe to about 5 inches below the top of riser pipe.

6 a) The well cap was vented by drilling a small ϕ hole.

Golder Associates

Field Boring Log

DEPTH HOLE 44.4	JOB NO. 853-3013	PROJECT CWM Lodi OH			BORING NO. G-33
DEPTH SOIL DRILL 44.4	QA INSP. PMI/RSM	DRILLING METHOD CME Continuous Soil Sampler			SHEET 1 OF 2
DEPTH ROCK CORE NA	WEATHER CLDY	DRILLING COMPANY GEOMECHANICS			SURFACE ELEV. 605
NO. DIST. SA. 9	UD. SA. NA	TEMP. 50°	DRILL RIG CME 55	DRILLER J. SELVOSKI	DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA		STARTED 1230 (TIME) / 3-8-85 (DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA		COMPLETED 1630 / 3-8-85

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	CONTINUOUS SOIL SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SLT	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE-HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE-MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LO	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
604.1	Firm to stiff, brown CLAYEY SILT, some sand (FILL)								
0.9	Firm to stiff, brown to gray-tan, mottled, SILTY CLAY, trace fine sand, trace organics 2.1-2.4 silt lense		4.4	1	CSS		4.4 / 4.4		
592.9				2	CSS		5.2 / 5.0		
7.1	Firm, brown to gray, laminated SILTY CLAY, trace fine sand (LACUSTRINE)		9.4						
595.0				3	CSS		4.4 / 5.0		
10.0	Soft to firm, gray SILTY CLAY, trace to little f-c sand, trace f-c gravel (TILL)		14.4	4	CSS		5.0 / 5.0		
			19.4	5	CSS		5.0 / 5.0		

Golder Associates

Field Boring Log

DEPTH HOLE 44.4	JOB NO. 853-3013	PROJECT Cwm Lolo/OH		BORING NO. G-33	
DEPTH SOIL DRILL 44.4	QA INSP. Pmilesm	DRILLING METHOD CME Continuous Soil Sampler		SHEET 2 OF 2	
DEPTH ROCK CORE NA	WEATHER Cloudy	DRILLING COMPANY Geomechanics		SURFACE ELEV. 605	
NO. DIST. SA. 9 UD. SA. NA	TEMP. 50°	DRILL RIG CME 55	DRILLER T. Selvoski	DATUM MSL	
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA	STARTED 1230 (TIME) / 3-8-85 (DATE)	
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA	COMPLETED 1430 / 3-8-85	

SAMPLE TYPES

AS	AUGER SAMPLE	BL	BLACK	M	MEDIUM	SA	SAMPLE
CS	CHUNK SAMPLE	BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
DO	DRIVE OPEN	C	COARSE	MOT	MOTTLED	SD	SAND
DS	DENISON SAMPLE	CA	CASING	NP	NON PLASTIC	SI	SILT
PS	PITCHER SAMPLE	CL	CLAY	OG	ORANGE	SIY	SILTY
RC	ROCK CORE	CLY	CLAYEY	ORG	ORGANIC	SM	SOME
ST	SLOTTED TUBE	F	FINE	PH	PRESSURE-HYDRAULIC	TR	TRACE
TO	THIN WALLED, OPEN	FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
TP	THIN WALLED, PISTON	GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
WS	WASH SAMPLE	LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
		LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" – 0 - 5%
"LITTLE" – 5 - 12%
"SOME" – 12 - 30%
"AND" – 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to firm, gray SILTY CLAY, trace to little f-c sand, trace f-c gravel (TILL)			5	CSS		5.0/5.0		
			24.4	6	CSS		5.0/5.0		
			29.4	7	CSS		4.6/5.0		
			34.4	8	CSS		5.0/5.0		
	Till becoming harder at 37.0'		39.4	9	CSS		4.9/5.0		
1.5 / 43.5	Weathered Rock								
560.6 / 44.4	AUGER REFUSAL								Upon completion the borehole was backfilled with thick bentonite slurry mixed at 1.5 to 2.0 lbs per gallon of water.

MONITORING WELL INSTALLATION LOG

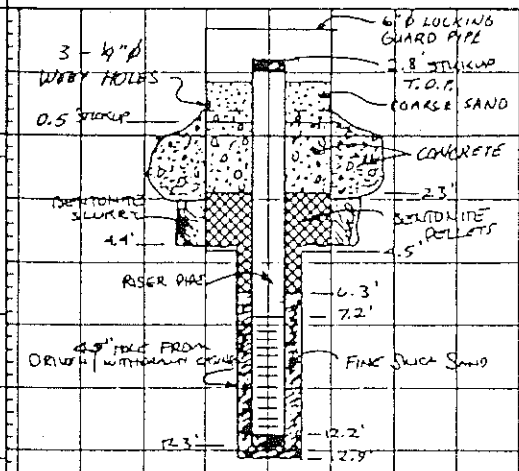
JOB NO. 853-3020	PROJECT CWM / KKERT / OHI	WELL NO. L-33	SHEET 1 OF 1
GA INSP. J. COLLIE	DRILLING METHOD ROTARY / AUGER	GROUND ELEV. 609.6	WATER DEPTH 14.35'
WEATHER CLEAR COLD	DRILLING COMPANY BOWSER MORNER	COLLAR ELEV. 612.41	DATE/TIME 10/29/85 7:10
TEMP.	DRILL RIG MOBILE B-61	DRILLER B. KIRKPATRICK	STARTED 10/20/85 (TIME / DATE) COMPLETED 1630 10/20/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 10.0 Lf.	WELL SCREEN 2 in. dia. 5.0' Lf.	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH COUPLED	SLOT SIZE 0.0060 in.	FILTER PACK QTY ~3.0 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	FIRM TO STIFF, BROWN CLAYEY SILT, SOME SAND (FILL)
0.9	FIRM TO STIFF, BROWN TO GRAY-TAN, MOTTLED, SILTY CLAY, TRACE FINE SAND, TRACE ORGANICS 2.1-2.4 SILT LENSE
7.1	FIRM, BROWN TO GRAY, LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
10.0	SOFT TO FIRM, GRAY SILTY CLAY, TRACE TO LITTLE F-C SAND, TRACE F-C GRAVEL (TILL)
12.9	

WELL SKETCH



INSTALLATION NOTES

A Hached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH STAINLESS STEEL BAILER. A NEW PIECE OF POLYPROPYLENE ROPE WAS DESIGNATED FOR USE ONLY IN WELL L-33 AND WAS KEPT IN A CLEAN PLASTIC BAG.

BAILER AND TEFLON CHECK VALVE WERE STEAM CLEANED AND RINSED WITH DEIONIZED WATER BEFORE DEVEL.

TOTAL VOLUME BAILED DURING DEVEL WAS 2.9 gals. CALCULATED WELL VOLUME FOR STATIC W.L (7.58') measured 11-14-85 FROM TOP OF RISER IS 1.2 gals.

MEASUREMENTS DURING DEVEL.

DATE	GALLONS BAILED	pH	SPECIFIC COND.	COMMENTS
11-14-85	1.3	6.4	7,400	WATER TURBID
11-19-85	1.0	6.5	7,400	SLIGHTLY CLEAR
11-20-85	0.3	6.6	8,500	"
11-25-85	0.3	—	—	SLIGHTLY TURBID

Golder Associates	SUBJECT Well Installation Notes		
	Job No.	Made by JFL	Date 11/6/85
	Ref. L-33	Checked	Sheet 1 of 1
		Reviewed W.M.A.	

1. a) Drilled with 10" ϕ hollow stem augers to 4.5' bgs. Surface material fell in the hole, so the hole was reaugered. Hole sounded to 4.4' bgs.

b) Placed 5' of 6" ϕ carbon steel surface casing in the hole to 4.5' bgs.

c) Grouted the surface casing in with clay grout of ~1.5 # clay/gal of water. Used 15 gal. of grout with ~4 gal. overflow. Therefore ~11 gal. grout in hole and cal. vol is 10.4 gal.

d) Washed 6" ϕ casing up water and roller bit until return clear. Then bailed water to w/in 0.5' at bottom of hole.

2. a) Drove 4" ϕ temporary well construction casing in increments and washed between increments until return was clear. Installation increments were: 4.5' to 7.7' and 7.7' to 12.8', bgs. Bailed the hole to about 0.5' from bottom and sounded hole 12.9 ft bgs.

b) Added sand to 12.3' bgs, pulling casing up 10 ft.

c) Lowered 2" ϕ SS well screen and well pipe (5' length and 10' length respectively) into the hole with 3.1' stickup. All joints were teflon taped and O rings were removed.

d) Pulled 4" ϕ casing in increments adding sand then bentonite. 3 gal. sand added to level of 6.3 bgs (cal. vol. was 3.5 gal). Bentonite added to 2.3' bgs. Hydrated pellets with ~1.5 gals DI water.

3. a) Threaded an aluminum protective casing onto 6" ϕ surface casing and locked the casing closed.

b) Excavated 30" deep hole around 6" ϕ casing and cement/sand mix placed w/ slope away from casing

c) Poured cement in 6" ϕ csg to same level as outside the well.

d) Sand was poured inside the protective csg to about 5" below the top of riser pipe.

4 a) Well cap was vented by drilling a small ϕ hole.

Golder Associates

Field Boring Log

DEPTH HOLE 43.4	JOB NO. 853-3013	PROJECT CWM/OLD/OH	BORING NO. G-34
DEPTH SOIL DRILL 43.4	GA INSP. PMI/RSM	DRILLING METHOD CME Continuous Soil Sampler	SHEET 1 OF 2
DEPTH ROCK CORE NA	WEATHER RAIN	DRILLING COMPANY Geomechanics	SURFACE ELEV. 610
NO. DIST. SA. 9 UD. SA. NA	TEMP. 45°	DRILL RIG CME 55 DRILLER T. Selvaski	DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA DROP NA	STARTED 1015 / 3-7-85 (TIME / DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA DROP NA	COMPLETED 1800 / 3-7-85

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	Continuous Soil Sample

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
608.2 / 1.8	Firm, brown-tan, clayey silt, trace fine sand, trace organics (FILL)							
603.8 / 6.2	Firm, gray-tan-orange, mottled, silty clay, trace fine sand		1	CSS		4.5 / 4.6		
		4.6						
	Firm to stiff, brown-tan to gray, laminated silty clay, trace to little fine sand (LACUSTRINE)		2	CSS		5.1 / 5.0		
		9.6						
			3	CSS		4.8 / 5.0		
	becoming gray	14.6						
			4	CSS		5.0 / 5.0		
591.5 / 18.5	Soft to stiff, gray to gray-purple, silty clay, trace to little f-c sand, trace f-c gravel	19.6						
			5	CSS		5.0 / 5.0		

Golder Associates

Field Boring Log

DEPTH HOLE 43.4	JOB NO. 853-3013	PROJECT CWM/OLD/OH	BORING NO. G-34
DEPTH SOIL DRILL 43.4	QA INSP. PMI/RSM	DRILLING METHOD CME CONTINUOUS SOIL SAMPLER	SHEET 2 OF 2
DEPTH ROCK CORE NA	WEATHER RAIN	DRILLING COMPANY GEOMECHANICS	SURFACE ELEV. 610
NO. DIST. SA. 9 UD. SA. NA	TEMP. 45°	DRILL RIG CME 55 DRILLER J. SELVOSKI	DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA DROP NA	STARTED 1015 (TIME) / 3-7-85 (DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA DROP NA	COMPLETED 1800 / 3-7-85

SAMPLE TYPES

AS	AUGER SAMPLE
CS	CHUNK SAMPLE
DO	DRIVE OPEN
DS	DENISON SAMPLE
PS	PITCHER SAMPLE
RC	ROCK CORE
ST	SLOTTED TUBE
TO	THIN WALLED, OPEN
TP	THIN WALLED, PISTON
WS	WASH SAMPLE
CSS	CONTINUOUS SOIL SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 6%
"LITTLE" — 6 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 60%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DH	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to stiff, gray to gray-purple, SILTY CLAY, trace to little f-c sand, trace f-c gravel		5	CSS		5.0 / 5.0		
		24.6	6	CSS		3.5 / 5.0		
	becoming more gray at 30' also change to little to some sand, little to trace gravel	29.6	7	CSS		4.6 / 5.0		
		34.6	8	CSS		5.1 / 5.0		
		39.6	9	CSS		3.8 / 3.8		
46.6 / 34	AUGER REFUSAL							Upon completion the borehole was backfilled with thick bentonite slurry mixed at 1.5 to 2.0 lbs per gallon of water.

MONITORING WELL INSTALLATION LOG

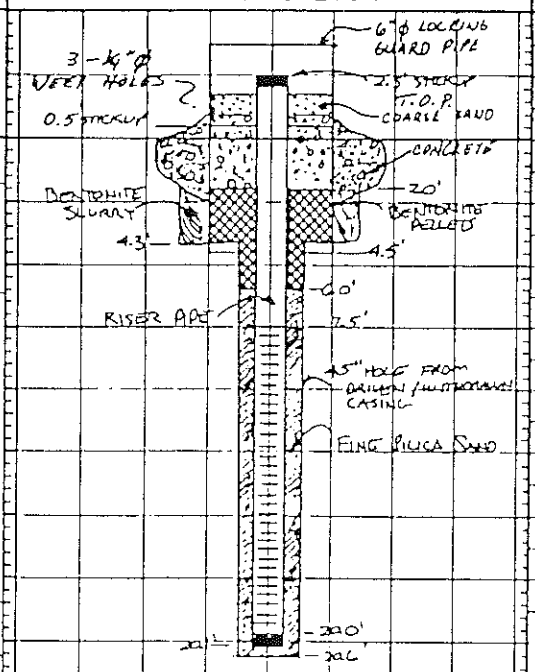
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO. L-39	SHEET 1 OF 1
GA INSP. L. FROST	DRILLING METHOD AUGER / ROTARY	GROUND ELEV 610.1	WATER DEPTH 22.38'
WEATHER CLOY	DRILLING COMPANY EXPLORATION TECHNOLOGY INC.	COLLAR ELEV 612.59	DATE/TIME 10/15/85 16:24
TEMP.	DRILL RIG CME 55	DRILLER C. BARTLE	STARTED 0930 / 10/15/85 (TIME / DATE) COMPLETED 1625 / 10/15/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 10.0' l.f.	WELL SCREEN 2 in. dia. 12.5 l.f.	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 0.0060 in	FILTER PACK QTY ~8.0 GALS.
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	FIRM, BROWN-TAN, CLAYEY SILT, TRACE FINE SAND, TRACE ORGANICS (FILL)
1.8	FIRM, GRAY-TAN-ORANGE, MOTTLED, SILTY CLAY, TRACE FINE SAND
6.2	FIRM TO STIFF, BROWN-TAN TO GRAY, LAMINATED SILTY CLAY, TRACE TO LITTLE FINE SAND (LACUSTRINE)
	BECOMING GRAY
18.5	SOFT TO STIFF, GRAY TO GRAY PURPLE, SILTY CLAY, TRACE TO LITTLE F-C SAND, TRACE F-C GRAVEL
20 +	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH STAINLESS STEEL BAILER. A NEW PIECE OF POLY-PROPYLENE ROPE WAS DESIGNATED FOR USE ONLY IN L-39 AND WAS STORED IN A CLEAN PLASTIC BAG.

BAILER AND TEFLON CHECK VALVE WERE STEAM CLEANED THEN RINSED WITH DEIONIZED WATER BEFORE USE.

TOTAL VOLUME BAILED DURING DEVELOPMENT WAS APPROX 12.3 gals. CALCULATED WELL VOL. FROM STATIC WL MEASURED 1-14-86 (6.27') IS 2.7 gals.

MEASUREMENTS DURING DEVELOPMENT

DATE	GALLONS BAILED	pH	SPECIFIC COND.	COMMENTS
11-14-85	3.0	6.5	1,600	MILKY WHITE
11-19-85	3.0	6.5	1,700	FAIRLY CLEAR
11-20-85	3.0	6.9	1,500	"
11-25-85	3.3	—	—	RECOVERY TEST

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020	Made by LF	Date
	Ref. L34	Checked	Sheet 1 of 2
		Reviewed QEL	

1. a) Drilled 10" ϕ hole to 4.5' bgs using solid stem augers; hole sounded @ 4.' bgs, material sloughing in; hole reaugered, sounded @ 4.3' bgs
   b) Installed 6" ϕ flush-joint steel surface csg, bottom of 6" csg @ 4.5' bgs
   c) Grouted borehole annulus with bentonite slurry mixed @ 1.5-2.0 lb/gal water; grout poured into borehole annulus from ground surface; calculated grout volume 9.9 gal, actual volume used ~ 11 gal.
   d) 6" ϕ surface csg drilled and flushed clean to 4.5' bgs; hole bailed to within 0.5' of bottom of hole

2. a) 4" ϕ flush-joint csg hammered from 4.5' to 9.5' bgs; inside of csg drilled out with 3 7/8" ϕ roller cone; hole flushed clean
   b) 4" ϕ csg hammered from 9.5' to 14.5' bgs; inside of csg drilled out; hole flushed clean.
   c) 4" ϕ csg hammered from 14.5' to 20.6' bgs; inside of csg drilled out; hole flushed clean; hole bailed to within 0.5' of bottom of hole

3. a) Borehole backfilled with filter sand to 20.1' bgs
   b) Well screen and riser pipe installed, well bottoming @ 20.1' bgs.
   c) Backfilling: The 4" ϕ csg was pulled up approx. 1' @ a time then sounded to ensure that no sloughing of the hole had occured. The open borehole annulus was then backfilled with sand or bentonite pellets, depending on what interval of the hole was being backfilled.

   Filter Pack: screen/borehole annulus backfilled with sand to 6.0' bgs; calculated filter pack volume 8.9 gal, actual volume used ~ 7.5 gal to 8 gal

   Bentonite Seal: riser pipe/borehole annulus backfilled with bentonite pellets to 2.0' bgs; calculated bentonite volume 4 gal, actual volume used ~ 3.5 gal to 4 gal. Hydrated bentonite seal with ~ 1.5 gals of deionized water.

4. a) Water level @ time of completion of well = 22.38' below top of 2" riser pipe

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020	Made by W.G.G & L.C	Date
	Ref. L-34	Checked	Sheet 2 of 2
		Reviewed	

5. a) An aluminum flush joint 6" ϕ protective csg was threaded on the surface casing and secured with a lock.

b) A 30" deep hole was excavated around the well and filled in with cement. Cement was sloped for drainage away from well.

c) The 6" ϕ casing was filled with cement to the same level as outside the well.

d) After the cement cured, coarse sand was poured inside the 6" ϕ pipe to about 5-6" below the top of riser pipe.

e) Three ¼" ϕ weep holes were drilled just above the cement seal

6 a) The well cap was vented by drilling a small ϕ hole.

Golder Associates

Field Boring Log

DEPTH HOLE 46.1	JOB NO. 853-3013	PROJECT Cwm Lavalon			BORING NO. G-35
DEPTH SOIL DRILL 46.1	QA INSP. RMI/RSM	DRILLING METHOD CME Continuous Soil			SHEET 1 OF 2
DEPTH ROCK CORE NA	WEATHER Cloy	DRILLING COMPANY Geomechanics			SURFACE ELEV. 611
NO. DIST. SA. 10 UD. SA. NA	TEMP. 30°	DRILL RIG CME 55	DRILLER J. Selvoski		DATUM MSL
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA		STARTED 1220 (TIME) 3-5-85 (DATE)
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA		COMPLETED 1400 (TIME) 3-5-85 (DATE)

SAMPLE TYPES

AS	AUGER SAMPLE	BL	BLACK
CS	CHUNK SAMPLE	BR	BROWN
OD	DRIVE OPEN	C	COARSE
DS	DENISON SAMPLE	CA	CASING
PS	PITCHER SAMPLE	CL	CLAY
RC	ROCK CORE	CLY	CLAYEY
ST	SLOTTED TUBE	F	FINE
TO	THIN WALLED, OPEN	FRAG	FRAGMENTS
TP	THIN WALLED, PISTON	GL	GRAVEL
WS	WASH SAMPLE	LYD	LAYERED
CSS	CONTINUOUS SOIL SAMPLE	LI	LITTLE

ABBREVIATIONS

M	MEDIUM	SA	SAMPLE
MIC	MICACEOUS	SAT	SATURATED
MOT	MOTTLED	SD	SAND
NP	NON PLASTIC	SI	SILT
OG	ORANGE	SIY	SILTY
ORG	ORGANIC	SM	SOME
PH	PRESSURE HYDRAULIC	TR	TRACE
PM	PRESSURE MANUAL	WL	WATER LEVEL
R	RED	WH	WEIGHT OF HAMMER
RES	RESIDUAL	Y	YELLOW
RK	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 6 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
610.0									Augered to 10' before beginning sampling due to gravel fill
1.0 / 609.3	Firm, dark brown CLAYEY SILT, some sand and gravel (FILL)								
1.7	Firm to stiff, dark gray-brown, mottled, SILTY CLAY, trace organics (LACUSTRINE)		4.5	1	CSS		3.3 / 5.3		
604.3 / 6.7				2	CSS		5.0 / 5.0		
	Firm to stiff, brown, laminated SILTY CLAY, trace fine sand (LACUSTRINE)		9.5	3	CSS		5.0 / 5.0		
595.5 / 15.5			14.5	4	CSS		5.0 / 5.0		
	Soft to firm, gray SILTY CLAY, trace f-c sand, trace f-c gravel (TILL)		19.5	5	CSS		4.4 / 5.0		

Golder Associates

Field Boring Log

DEPTH HOLE 46.1	JOB NO. 853-3013	PROJECT Cwm Idloloh				BORING NO. G-35	
DEPTH SOIL DRILL 46.1	QA INSP. PMI/RSM	DRILLING METHOD CME Continuous Soil Sampler				SHEET 2 OF 2	
DEPTH ROCK CORE NA	WEATHER Cldy	DRILLING COMPANY GEOMECHANICS				SURFACE ELEV. 611	
NO. DIST. SA. 10 UD. SA. NA	TEMP. 30°	DRILL RIG CME 55	DRILLER J. Sowell			DATUM MSL	
DEPTH WL. NA	HRS. PROD. NA	WT. SAMPLER HAMMER NA	DROP NA			STARTED 1220 (TIME) / 3-5-85 (DATE)	
TIME WL. NA	HRS. DELAYED NA	WT. CASING HAMMER NA	DROP NA			COMPLETED 1620 (TIME) / 3-5-85 (DATE)	

SAMPLE TYPES

AS	AUGER SAMPLE	BL	BLACK
CS	CHUNK SAMPLE	BR	BROWN
DO	DRIVE OPEN	C	COARSE
DS	DENISON SAMPLE	CA	CASING
PS	PITCHER SAMPLE	CL	CLAY
RC	ROCK CORE	CLY	CLAYEY
ST	SLOTTED TUBE	F	FINE
TO	THIN WALLED OPEN	FRAG	FRAGMENTS
TP	THIN WALLED, PISTON	GL	GRAVEL
WS	WASH SAMPLE	LYD	LAYERED
CSS	CONTINUOUS SOIL SAMPLE	LI	LITTLE

ABBREVIATIONS

M	MEDIUM	SA	SAMPLE
MIC	MICACEOUS	SAT	SATURATED
MOT	MOTTLED	SD	SAND
NP	NON PLASTIC	SI	SILT
OG	ORANGE	SIY	SILTY
ORG	ORGANIC	SM	SOME
PH	PRESSURE HYDRAULIC	TR	TRACE
PM	PRESSURE MANUAL	WL	WATER LEVEL
R	RED	WH	WEIGHT OF HAMMER
RES	RESIDUAL	Y	YELLOW
RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	DEPTH	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Soft to firm, gray, SILTY CLAY, trace f-c sand, trace f-c gravel (TILL)		24.5	5	CSS				
				6	CSS		4.5/5.0		
			29.5						
				7	CSS		5.0/5.0		
			34.5						
				8	CSS		5.0/5.0		
			39.5						
				9	CSS		4.5/5.0		
568.4 / 42.6	Weathered Rock? Broken shale and gypsum fragments, some clay matrix		44.5						
				10	CSS		1.7/1.8		Upon completion the borehole was backfilled with thick bentonite slurry mixed at 1.5 to 2.0 lbs per gallon of water
564.9 / 46.1	AUGER REFUSAL								

MONITORING WELL INSTALLATION LOG

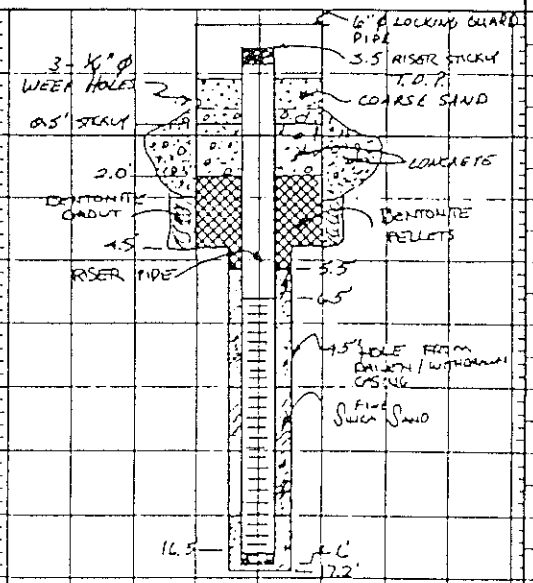
JOB NO. 883-3020	PROJECT CWM / VICKERY / OH	WELL NO L-35	SHEET 1 OF 1
GA INSP. L FROST	DRILLING METHOD AUGER / ROTARY	GROUND ELEV 609.6	WATER DEPTH 19.05'
WEATHER CLDY	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 612.15	DATE/TIME 10/31/85 15:15
TEMP.	DRILL RIG MOBILE B-61	DRILLER B KIRKPATRICK	STARTED 0700 10/31/85 (TIME / DATE) COMPLETED 1505 10/31/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 10.0' l.f.	WELL SCREEN 2 in. dia. 10.0' l.f.	BENTONITE SEAL PELLETS
CASING TYPE STAINLESS STEEL (316)	SCREEN TYPE STAINLESS STEEL WIRE WOUND (316)	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 0.0010 in	FILTER PACK QTY ~2.0 BAGS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY DROP

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	
1.0	FIRM, DARK BROWN CLAYEY SILT, SOME SAND AND GRAVEL (FILL)
1.7	FIRM TO STIFF, DARK GRAY-BROWN, MOTTLED, SILTY CLAY, TRACE ORGANICS (LACUSTRINE)
6.7	FIRM TO STIFF, BROWN, LAMINATED SILTY CLAY, TRACE FINE SAND (LACUSTRINE)
15.5	SOFT TO FIRM, GRAY SILTY CLAY, TRACE F-C SAND, TRACE F-G GRAVEL (TILL)
17.2	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH STAINLESS STEEL BAILER. WELL ROCK WAS DESIGNATED TO L-35 FOR BAILING.

BAILER WAS STEAM CLEANED THEN RINSED WITH DEIONIZED WATER BEFORE DEVELOPMENT

TOTAL VOLUME BAILED DURING DEVELOPMENT WAS APPROX. 11 gals. CALCULATED WELL VOLUME FROM STATIC WL (5.29') MEASURED 11-14-86 IS 2.7 gals.

MEASUREMENTS DURING DEVELOPMENT

DATE	BAILING BAILED	pH	SPECIFIC COND.	COMMENTS
11-14-85	3.0	7.1	1,000	WATER MILKY WHITE
11-15-85	2.8	6.8	1,000	"
11-20-85	2.8	7.0	1,300	WATER SLIGHTLY TURBID
11-25-85	2.8	–	–	RECOVERY TEST

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020	Made by JDC	Date 1/7/85
	Ref. L-35	Checked	Sheet 1 of 1
		Reviewed JFC	

1) a) dugged 10"Ø hole to 4.5' bgs using 8"Ø augers with a 10" bit, pulled augers up and we had some cave in. So we used 6"Ø casing to try and plunge the material out. Sounded hole after tamping and to 4.5' bgs.

b) Lowered 6"Ø casing into hole. Bottoming at 4.5'.
c) Grouted borehole with bentonite slurry of about 17 gals with a 2 gal. overflow.
d) 6"Ø casing was bailed and flushed clean, and sounded at 4.5'.

2 a) 4"Ø casing hammered in 5.0' ~~equal~~ intervals and flushed and bailed till clean. Sounded hole at 172' Bailed till within 0.5' of bottom

3. a) Borehole backfilled with filter sand to 166'
b) Well screen and riser pipe installed @ 166'
c) Pulled casing up a foot at a time and sounded to insure no sloughing had occured.

Filter pack: screen borehole annulus was backfilled with 8 gallons of sand up to 5.5' b.g.s.

Bentonite seal: Riser Pipe borehole annulus was backfilled with 5 gallons of pellets up to 2.0' bgs.

4. a) An aluminum protective casing was threaded on to 6"Ø

5 a) Cap was vented by drilling holes in it.

6. a) A 30" hole was dug by hand around 6"Ø and filled with cement. It was sloped so water would run away from well.

7. a) Three 1/4" drain holes were drilled in casing above cement mound.

8. a) Cement was added to 6"Ø guard pipe at the same level as the outer cement seal.
b) After cement has cured, coarse sand was poured in protective casing to about 5 inches below top of riser pipe.

Golder Associates

Field Boring Log

DEPTH HOLE 47.08'	JOB NO. 833-3020	PROJECT CWM / Vickery / 04	BORING NO. G-37
DEPTH SOIL DRILL 47.08'	GA INSP. LF	DRILLING METHOD Continuous split spoon sampling	SHEET 1 OF 3
DEPTH ROCK CORE —	WEATHER Ptly cldy	DRILLING COMPANY BOWSER MORNER	SURFACE ELEV. —
NO. DIST. SA 20 UD. SA —	TEMP. —	DRILL RIG Mobile B-61 DRILLER B Kirkpatrick	DATUM Ground surface
DEPTH WL. —	HRS. PROD. —	WT. SAMPLER HAMMER 140 lb DROP 2.5'	STARTED 1045 (TIME) 110-09-85 (DATE)
TIME WL. —	HRS. DELAYED —	WT. CASING HAMMER — DROP —	COMPLETED 1845 110-09-85

SAMPLE TYPES

A.S.	AUGER SAMPLE
C.S.	CHUNK SAMPLE
D.O.	DRIVE OPEN
D.S.	DENISON SAMPLE
P.S.	PITCHER SAMPLE
R.C.	ROCK CORE
S.T.	SLOTTED TUBE
T.O.	THIN-WALLED, OPEN
T.P.	THIN-WALLED, PISTON
W.S.	WASH SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON-PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE-HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE-MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0-5%
"LITTLE" — 5-12%
"SOME" — 12-30%
"AND" — 30-50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	Grey CLAY trace org. matter (Topsoil)							
0.5	Med stiff mottled grey-brown silty CLAY, trace sand (TILL)	10	1A	DO	4, 6, 4, 6	1.5' / 2.0'		
	@ 2.0' becoming stiff, some sand, trace gravel	11	2A	DO	4, 5, 6, 13	1.5' / 2.0'		
	@ 4.0' becoming v. stiff	36	3A	DO	7, 15, 21, 26	1.9' / 2.0'		
6.0 / 6.3	v. stiff brown silty CLAY, trace brown silty clay, some sand, little gravel (TILL)	31	4A	DO	4, 13, 18, 21	1.6' / 2.0'		
	@ 7.7' trace org. matter @ 8.0' little sand + gravel	21	5A	DO	6, 9, 12, 16	2.0' / 2.0'		
10.0	Stiff mottled purple grey-brown silty CLAY, little sand and gravel @ 11.6 fissured, trace org. matter (TILL)	13	6A	DO	4, 5, 8, 12	1.75' / 2.0'		
	@ 12.0' soft-med. stiff	18	7A	DO	4, 8, 10, 12	2.1' / 2.0'		grey silty clay is soft; brown silty clay is med. stiff, org. matter along grey-brown fissures; fissures are vertical
14.0	Soft grey silty CLAY, little sand and gravel (TILL)	10	8A	DO	3, 5, 5, 7	1.95' / 2.0'		
	@ 16' med.-stiff, little sand, trace gravel	8	9A	DO	2, 3, 5, 7	1.8' / 2.0'		
		12	10A	DO	4, 5, 7, 9	2.0' / 2.0'		
		9	11A	DO	3, 4, 5, 7	2.0' / 2.0'		
		11	12A	DO	2, 4	2.0' / 2.0'		

Golder Associates

Field Boring Log

DEPTH HOLE 47.08'	JOB NO. 853-3020	PROJECT CNH / VICKERY 10H	BORING NO. G-37
DEPTH SOIL DRILL 47.08'	QA INSP. LF	DRILLING METHOD Continuous Split Spoon Sampling	SHEET 2 OF 3
DEPTH ROCK CORE —	WEATHER Pty Cldy	DRILLING COMPANY BOWSER MORNER	SURFACE ELEV. —
NO. DIST. SA. 28 UD. SA. —	TEMP. —	DRILL RIG Mobile B-6' DRILLER B. Kirkpatrick	DATUM Ground surface
DEPTH WL. —	HRS. PROD. —	WT. SAMPLER HAMMER 140 lb DROP 2.5'	STARTED 1045 (TIME) 10-09-85 (DATE)
TIME WL. —	HRS. DELAYED —	WT. CASING HAMMER — DROP —	COMPLETED 1845 10-09-85

SAMPLE TYPES

A.S.	AUGER SAMPLE
C.S.	CHUNK SAMPLE
D.O.	DRIVE OPEN
D.S.	DENISON SAMPLE
P.S.	PITCHER SAMPLE
R.C.	ROCK CORE
S.T.	SLOTTED TUBE
T.O.	THIN-WALLED, OPEN
T.P.	THIN-WALLED, PISTON
W.S.	WASH SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON-PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE-HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE-MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. DEPTH	DESCRIPTION	BLOWS/FT	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC/ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
					7 9			
		11	13A	DO	1 5 6 7	2.0'/2.0'		
		7	14A	DO	2 3 4 7	2.0'/2.0'		
		9	15A	DO	0 4 5 6	2.0'/2.0'		'0' blows represents just the weight of the hammer pushing the split spoon down 6"
		10	16A	DO	2 3 7 7	2.0'/2.0'		
		14	17A	DO	3 7 7 9	2.0'/2.0'		
	@ 34' med. stiff - stiff	11	18A	DO	2 5 6 8	1.5'/2.0'		
		15	19A	DO	3 7 8 10	2.0'/2.0'		
	@ 38' stiff	17	20A	DO	4 7 10 12	2.0'/2.0'		
		27	21A	DO	4 8 19 22	2.0'/2.0'		
	@ 41.3' hard Lodgement TILL	89	22A	DO	16 73	1.0'/1.0'		
		106	23A	DO	37 69	1.0'/1.0'		
	@ 44.0' trace white gypsum	121	24A	DO	20 101	0.9'/1.0'		
	@ 45.0' cobble	100/2"	25A	DO	100/2"	2"/3"		Split spoon driven to 45.17', then augered to 45.5'
		100	26A	DO	42	1.0'/1.0'		

Golder Associates

Field Boring Log

DEPTH HOLE 47.08'	JOB NO. 953-3020	PROJECT CWM / VICKERY 104			BORING NO. G-37
DEPTH SOIL DRILL 47.08'	QA INSP. LF	DRILLING METHOD Continuous Split Spoon Sampling			SHEET 3 OF 3
DEPTH ROCK CORE —	WEATHER Pty cldy	DRILLING COMPANY Bowser Morner			SURFACE ELEV. —
NO. DIST. S.A. 28 UD. S.A. —	TEMP. —	DRILL RIG Mobile B-61	DRILLER B. Kirkpatrick		DATUM Ground surface
DEPTH WL. —	HRS. PROD. —	WT. SAMPLER HAMMER 140 lb	DROP 2.5'		STARTED 1045 (TIME) 10-09-85 (DATE)
TIME WL. —	HRS. DELAYED —	WT. CASING HAMMER —	DROP —		COMPLETED 1845 10-09-85

SAMPLE TYPES

A.B.	AUGER SAMPLE
C.S.	CHUNK SAMPLE
D.O.	DRIVE OPEN
D.S.	DENISON SAMPLE
P.S.	PITCHER SAMPLE
R.C.	ROCK CORE
S.T.	SLOTTED TUBE
T.O.	THIN WALLED, OPEN
T.P.	THIN WALLED, PISTON
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FRAG.	FRAGMENTS	PM	PRESSURE-MANUAL	WL	WATER LEVEL
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CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. / DEPTH	DESCRIPTION	BLOWS / FT		SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC / ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
					PO	58			
46.5	Weathered Bedrock - Shale	100/6" 100/1"	46.5	27A	DO	100	4"/6"		@ 46.5' trace water
47.08	End of Hole		47.08						

@ 17.00' WL measured @ ~36' bgs
@ 17.50' " " @ ~17.5' bgs

Upon completion the borehole was backfilled with thick bentonite slurry mixed @ 1.5-2.0 lbs/gal water

PROJECT CWR/VICKERY/OHIO JOB NO. 653-3020 BORING NO. 37 DATE 2/18/86 SHEET 1 OF 1

BORING BEGAN 10/10/85 BORING COMPLETED 11/10/85 CORE HOLE LOCATION MW37R

METHOD OF CORING ROTARY DRILLING FLUID POTABLE WATER GR.ELEV. — WEATHER —

CASING USED — SIZE NX INSPECT. L.F. OPERAT. — WATER LEVEL, TIME, DATE —

DEPTH (FT.)	RUN NUMBER	RECOVERY	RQD	DISCONTINUITIES: DEPTH	TYPE	INFILLING	ANGLE W/AXIS	FREQUENCY	LITHOLOGY	COLOR	TEXTURE	WEATHERING	DESCRIPTION	POINT LOAD TEST	HARDNESS	SAMPLES-LABORATORY TESTS	DRILLING RATE MIN/FT.
45.0													BEGAN CORING @ 46.5 FT BELOW GS				
46.5				46.5 TO 51.3	POROUS	GYPS	II TO BED	.01' TO .8'					GRAY ARGILLACEOUS LAMINATED DOLOMITE. 46.5 TO 51.3 FT - WITH WHITE CALCITE INFILLINGS				
		99'/100'	78"/120"							GRAY		SLIGHT	51.3 TO 53.8 FT - WITH TRACE GYPSUM LAMINAE AND FIBROUS GYPSUM LAMINAE.				
	1	99%	65%	51.3 TO 53.8	POROUS	GYPS	II TO BED	.25' TO .65'			FINE TO VERY FINE	UNWEATHERED					
				53.8 TO 55.1	POROUS	GYPS	II TO BED	.2' TO .34'		LIGHT GRAY TO WHITE			WHITE TO LIGHT GRAY GYPSUM WITH DOLOMITE LAMINAE.	—	—	—	—
55.5				55.1 TO 57.2	POROUS	GYPS	II TO BED	.02' TO .5'		GRAY		SLIGHT	GRAY ARGILLACEOUS DOLOMITE WITH LITTLE GYPSUM LAMINAE AND TRACE FIBROUS GYPSUM.				
		(57.2'/55')		57.2 TO 58.6	POROUS	GYPS	II TO BED	.25' TO .7'				UNWEATHERED	MOTLED WHITE GYPSUM AND GRAY DOLOMITE. 58.6 TO 60.0 FT - SLIGHTLY LAMINATED				
	2	95%	23%	58.6 TO 62.0	POROUS	GYPS	II TO BED	.02' TO .22'		WHITE AND GRAY		SLIGHT TO MOD	60.0 TO 62.0 FT - WITH TRACE FIBROUS GYPSUM. 61.2 TO 61.4 FT - HIGHLY WEATHERED				
62.0													END OF CORING @ 62.0 FT BELOW GS				

NOTES

SCALE: 1 DIVISION=0.2 FEET

CHECKED (U.G.) PAW

DATE 11/12/85 LOGGED BY LF

MONITORING WELL INSTALLATION LOG

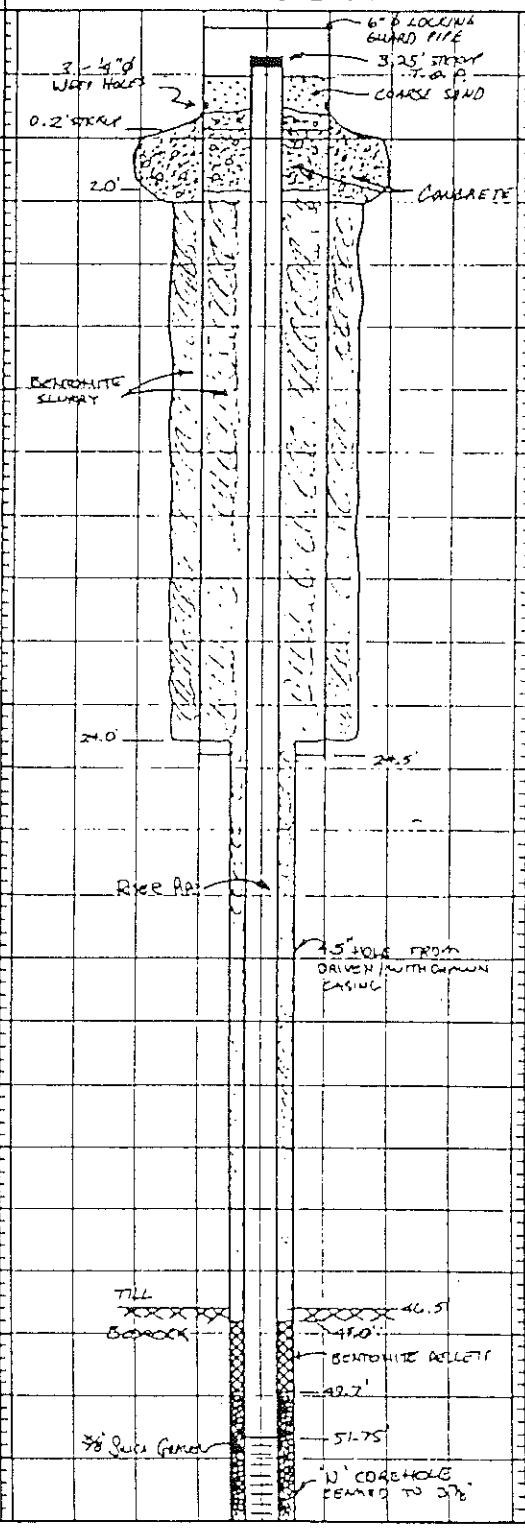
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO MW-37R	SHEET 1 OF 2
GA INSP. L. FROST	DRILLING METHOD CORE / ROTARY	GROUND ELEV 613.2	WATER DEPTH 11.22
WEATHER	DRILLING COMPANY BOWSER MORNER	COLLAR ELEV 616.40	DATE/TIME 10/17/85 1524
TEMP.	DRILL RIG CME-55	DRILLER T. Bochner	STARTED 1400 / 10/02/85 (TIME / DATE) COMPLETED 1340 / 10/17/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 55.0 ft	WELL SCREEN 2 in. dia. 10.0' ft	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS STEEL WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 100 (10 in)	FILTER PACK QTY 5 GALS (0.67 ft³)
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE #1 SILICA GRAVEL
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	GRAY CLAY, TRACE ORGANIC MATTER (TOPSOIL)
0.5	MEDIUM STIFF, MOTTLED GRAY-BROWN, SILTY CLAY, TRACE SAND (TILL) @ 2.0' BECOMING STIFF, SOME SAND, TRACE GRAVEL @ 4.0' BECOMING VERY STIFF
(6.0)	
6.3	VERY STIFF BROWN SILTY CLAY, SOME SAND, LITTLE GRAVEL (TILL) @ 7.7' TRACE ORGANIC MATTER @ 8.0' LITTLE SAND & GRAVEL
10.0	STIFF MOTTLED PURPLE GRAY-BROWN SILTY CLAY, LITTLE SAND AND GRAVEL @ 11.6 FISSURED, TRACE ORGANIC MATTER (TILL) @ 12.0 SOFT-MEDIUM STIFF
14.0	SOFT, GRAY SILTY CLAY, LITTLE SAND AND GRAVEL (TILL) @ 16' MEDIUM STIFF, LITTLE SAND, TRACE GRAVEL
	@ 34' MEDIUM STIFF - STIFF
	@ 38' STIFF
41.3	@ 41.3 HARD LODGEMENT TILL @ 44.0' TRACE WHITE GYPSUM @ 45.0' COBBLE
46.5	WEATHERED BEDROCK - SHALE
47.8	GRAY ARGILLACEOUS LAMINATED DOLOMITE WITH TRACE OF GYPSUM AS LAMINAE
	CONT. ON P.2

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

TOTAL WATER VOLUME REMOVED WAS APPROX. 3,400 GALS.

WATER LOSS DURING DRILLING WAS APPROX 2,160 GALS.

WELL DEVELOPED FROM 11-14-85 TO 11-15-85.

DEVELOPMENT METHOD: AIR LIFT USING 1" & AVG INDUCTOR PIPE. AIR SOURCE WAS A DAYTON SERGRAIRE OIL-LESS COMPRESSOR.

FIRST 300 TO 400 GALS THE WATER WAS VERY TURBID, GRAY WITH SOME BENTONITE. DISCHARGE WAS CLEAR AFTER REMOVING APPROX 1000 GALS.

CONT. PAGE 2

MONITORING WELL INSTALLATION LOG

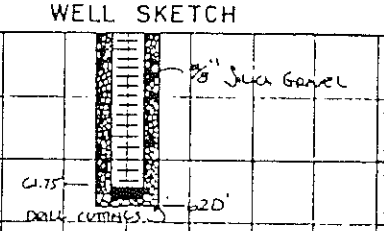
JOB NO. 853-3020 PROJECT CWM/VICKERY/OH WELL NO. MW-37R SHEET 2 OF 2
GA INSP L. FROST DRILLING METHOD CORE/ROTARY GROUND ELEV 613.2 WATER DEPTH 11.92'
WEATHER _____ DRILLING COMPANY BOWSER MORNER COLLAR ELEV 616.40 DATE/TIME 10/15/85 15:24
TEMP. _____ DRILL RIG CME 55 DRILLER T. Brehase STARTED 10/08/85 (TIME / DATE) COMPLETED 10/15/85 (TIME / DATE)

MATERIALS INVENTORY - SEE PAGE 1

WELL CASING _____ in. dia. _____ l.f. WELL SCREEN _____ in. dia. _____ l.f. BENTONITE SEAL _____
CASING TYPE _____ SCREEN TYPE _____ INSTALLATION METHOD _____
JOINT TYPE _____ SLOT SIZE _____ FILTER PACK QTY _____
GROUT QUANTITY _____ CENTRALIZERS _____ FILTER PACK TYPE _____
GROUT TYPE _____ DRILLING MUD TYPE _____ INSTALLATION METHOD _____

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	CONT. FROM P.1 GRAY ARGILLACEOUS DOLOMITE
57.3	MOTTLED WHITE GYPSUM AND GRAY DOLOMITE WITH TRACE OF FIBROUS GYPSUM
	CORING TERMINATED @ 62.0'
65.0	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

STATIC WATER LEVEL BEFORE DEVELOPMENT WAS 13.43 FEET BELOW TOP OF 2-INCH RISER PIPE MEASUREMENTS TAKEN DURING DEVELOPMENT:

DATE	GALLONS REMOVED	pH	SPEC. COND.	TEMP.
11-14-85	START	6.4	2,700	55°F
11-15-85	2,100	6.2	3,000	55°F
11-15-85	3,400	7.2	3,000	55°F

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020	Made by LF	Date
	Ref. MW-37R	Checked	Sheet 1 of 2
		Reviewed JFR	

1. a) Drilled 10" ϕ hole to 24.0' bgs using solid stem augers
   b) Installed 6" ϕ flush-joint steel csg
   c) Drove 6" ϕ csg to 24.5' bgs
   d) Tremie grouted borehole annulus with bentonite slurry mixed @ 1.5 to 2.0 lb/gal water; calculated grout volume 63 gal, actual volume used ~ 50 gal
   e) 6" ϕ surface csg reamed to 24.5' bgs, flushed clean and bailed to within 0.5' of bottom of hole

2. a) 4" ϕ flush-joint csg hammered to 44.0' bgs
   b) Inside of 4" ϕ csg drilled out with 3 7/8" ϕ roller cone; hole drilled to 46.5' bgs
   c) Inside of hole flushed clean and bailed to within 0.5' of bottom of hole

3. a) Cored with 'N' size bit from 46.5' - 56.5' bgs; @ 46.5' - 53.9' bgs, water recovery ~ 40%, water loss ~ 1050 gal; @ 53.9' - 56.5' bgs, water recovery ~ 25%, water loss ~ 410 gal; coring solid material
   b) Cored from 56.5' - 62.0' bgs, water recovery ~ 15%; water loss ~ 510 gal; coring solid material
   c) Total water loss during coring ~ 1970 gal

4. a) Reamed with 3 7/8" roller cone from 46.5' - 62.0' bgs; good circulation; water return ~ 80%; water loss ~ 60 gal
   b) Hole flushed clean; water recovery ~ 80%; water loss ~ 110 gal; hole sounded @ 62.0' bgs
   c) Total water loss during reaming and flushing ~ 190 gal

5. a) Well screen and riser pipe installed, well bottoming @ 62.0' bgs
   b) Filter pack: Screen / borehole annulus backfilled with 3/8" gravel to 49.7' bgs; Calculated filter pack volume 4.6 gal, actual volume used ~ 5 gal
   c) Bentonite seal: Riser pipe / borehole annulus backfilled with bentonite pellets to 47.0' bgs; bentonite bridge formed @ 35.5' bgs, tried breaking through with drop weight, unsuccessful; tried flushing bentonite bridge out with ½" galvanized pipe, un-

Golder Associates	SUBJECT Installion Notes		
	Job No. 853-3020 Ref. MW-37R	Made by LF Checked Reviewed	Date Sheet 2 of 2

successful, used ~650 gal water, full water recovery; pulled 4" ϕ csg from hole; 6" ϕ surface csg sank 0.3', 6" ϕ csg stick-up = 0.2'; hole sounded @ 25' bgs, sloughed material in open borehole annulus; tried flushing sloughed material with ½" galvinized pipe and 1" PVC pipe, unsuccessful, used ~1000 gal water, full water recovery; flushed sloughed material from hole using AW drill rods; 1400 gal water used, full water recovery; hole sounded @ 47.0' bgs.

d) Tremie grouted borehole annulus to surface with bentonite slurry mixed @ 1.5-2.0 lbs/gal water; calculated grout volume 55 gals, actual volume used ~65 gal.

6. g) Installed protective csg with hinged cap. Outside of csg was cemented and sloped for drainage after excavating a 30" deep hole.

7. a) Water level upon completion was 11.82' @ 1524 on 10-15-87

8. a) Cement was added into the 6" ϕ csg to a level even with the outside cement csg. After the inner cement seal cured, coarse sand was poured inside the 6" protective pipe to about 5 inches below the top of riser pipe.

b) Three ¼" ϕ drain holes were drilled in 6" ϕ protective pipe.

9. a) Well cap was vented by drilling small ϕ hole.

MONITORING WELL INSTALLATION LOG

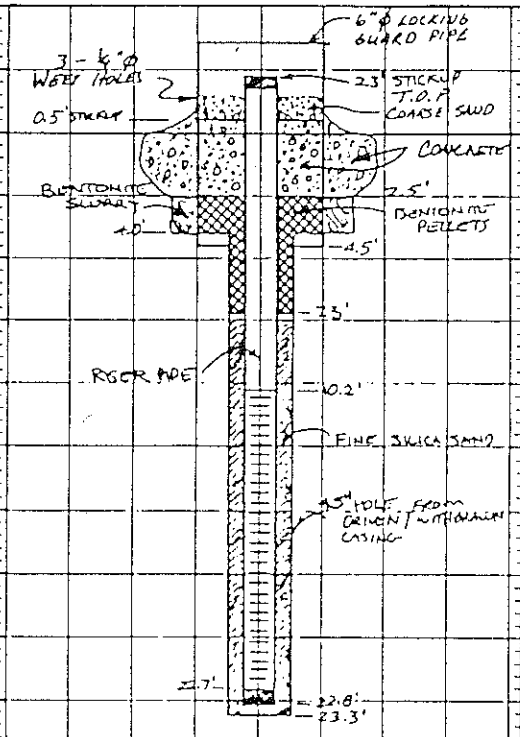
JOB NO. 823-3020	PROJECT CHEM / VICKERY / OH	WELL NO T-37	SHEET 1 OF 1
GA INSP. W.G.G. / L. FROST	DRILLING METHOD AUGER / ROTARY	GROUND ELEV. 612.9	WATER DEPTH 21.42'
WEATHER PTLY CLDY	DRILLING COMPANY E.T.I.	COLLAR ELEV 615.22	DATE/TIME 11/6/85 1940
TEMP.	DRILL RIG CME 55	DRILLER C. BARTLE	STARTED 10/23/85 (TIME / DATE) COMPLETED 1935 10/24/85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 12.5 ft.	WELL SCREEN 2 in. dia. 12.5 ft.	BENTONITE SEAL PELLETS
CASING TYPE STAINLESS STEEL (316)	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE 0.0060 in	FILTER PACK QTY ~9.0 GALS
GROUT QUANTITY —	CENTRALIZERS NONE	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE NONE	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0 / 0.5	GRAY CLAY, TRACE ORGANIC MATTER (TOPSOIL) / MEDIUM STIFF MOTTLED, GRAY-BROWN SILTY CLAY, TRACE SAND (TILL) @ 2.0' BECOMING STIFF, SOME SAND, TRACE GRAVEL @ 4.0' BECOMING VERY STIFF
6.0 / 6.3	VERY STIFF BROWN SILTY CLAY, TRACE BROWN SILTY CLAY, SOME SAND, LITTLE GRAVEL (TILL) @ 7.7' TRACE ORG. MATTER @ 8.0' LITTLE SAND & GRAVEL
10.0	STIFF MOTTLED PURPLE GRAY-BROWN SILTY CLAY, LITTLE SAND AND GRAVEL @ 11.6 FISSURED, TRACE ORG. MATTER (TILL) @ 12.0' SOFT-MED. STIFF
14.0	SOFT GRAY SILTY CLAY, LITTLE SAND AND GRAVEL (TILL) @ 16' MEDIUM-STIFF, LITTLE SAND, TRACE GRAVEL
23.3	

WELL SKETCH



INSTALLATION NOTES

Attached

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING WITH STAINLESS STEEL BAILER. NEW POLYPROPYLENE ROPE WAS DESIGNATED ONLY FOR DEVEL. OF T-37.

BAILER WAS STEAM CLEANED AND RINSED WITH DEIONIZED WATER BEFORE DEVELOPMENT.

TOTAL VOLUME BAILED DURING DEVELOPMENT WAS APPROX 5.3 GALS. CALCULATED WELL VOLUME FROM STATIC W.L. (3.77') MEASURED 11-14-85 IS 3.5 GALS.

MEASUREMENTS DURING DEVELOPMENT

DATE	GALLONS BAILED	pH	SPECIFIC COND.	COMMENTS
11-15-85	3.0	7.0	2,100	WATER TURBID
11-19-85	1.0	7.4	2,300	"
11-20-85	0.5	7.0	2,100	"
11-26-85	0.8	—	—	RECOVERY TEST

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020 Ref. T37	Made by LF Checked Reviewed	Date Sheet 1 of 2

1. a) Drilled 10" ϕ hole to 4.0' bgs using solid stem augers.
   b) Installed 6" ϕ flush-joint steel surface csg; casing pushed down 0.5', bottom of 6" ϕ csg @ 4.5' bgs.
   c) Grouted borehole annulus with bentonite slurry mixed @ 1.5-2.0 lb/gal water; grout poured into borehole annulus from ground surface; calculated grout volume 10.4 gals, actual volume used ~ 12 gals
   d) 6" ϕ surface csg drilled and flushed clean to 4.4' bgs; hole bailed to within 0.5' of bottom of hole.

2. a) 4" ϕ flush-joint csg hammered from 4.4' to 9.5' bgs; hammering 4" ϕ csg through the fill was very difficult; inside of csg drilled out with 3 7/8" ϕ roller cone; hole flushed clean
   b) Drilled with 3 7/8" ϕ roller cone from 9.5' to 14.5' bgs; 4" ϕ csg hammered to 14.5' bgs; inside of csg drilled out and flushed clean
   c) Drilled from 14.5' to 19.5' bgs; 4" ϕ csg hammered to 19.5' bgs; inside of csg drilled out and flushed clean
   d) Drilled from 19.5' to 23.3' bgs; 4" ϕ csg hammered to 23.3' bgs; inside of csg drilled out and flushed clean; hole bailed to within 0.5' of bottom of hole

3. a) Borehole backfilled with filter sand to 22.8' bgs
   b) Well screen and riser pipe installed; well bottoming @ 22.8' bgs
   c) Backfilling: The 4" ϕ csg was pulled up approx. 1' @ a time then sounded to ensure that no sloughing of the hole had occured. The open borehole annulus was then backfilled with sand or bentonite pellets, depending on what interval of the hole was being backfilled.

   Filter Pack: screen / borehole annulus backfilled with sand to 7.3' bgs; calculated filter pack volume 9.6 gals, actual volume used ~ 9 gal.

   Bentonite Seal: riser pipe / borehole annulus backfilled with bentonite pellets to 2.5' bgs; calculated bentonite volume 4.2 gal, actual volume used ~ 4 gal. Bentonite seal was hydrated with ~ 2 gals deionized water.

Golder Associates	SUBJECT Installation Notes		
	Job No. 853-3020 Ref. T37	Made by LF Checked Reviewed	Date Sheet 2 of 2

4. a) Water level @ time of completion of well = 21.42 below top of 2" riser pipe

5. a) A flush jointed 6" ID aluminum casing was threaded onto the 6" ϕ surface casing and the casing was locked.

6. a) A 30" deep hole was excavated around the well and filled with cement. The cement was sloped to drain away from the well.

b) Cement was added inside the 6" ϕ csg. to a level even with the outside cement collar.

c) After cement cured, sand was poured in guard pipe to a level about 5 inches below the top of riser pipe.

7. a) The cap was vented by drilling a small ϕ hole.

MONITORING WELL INSTALLATION LOG

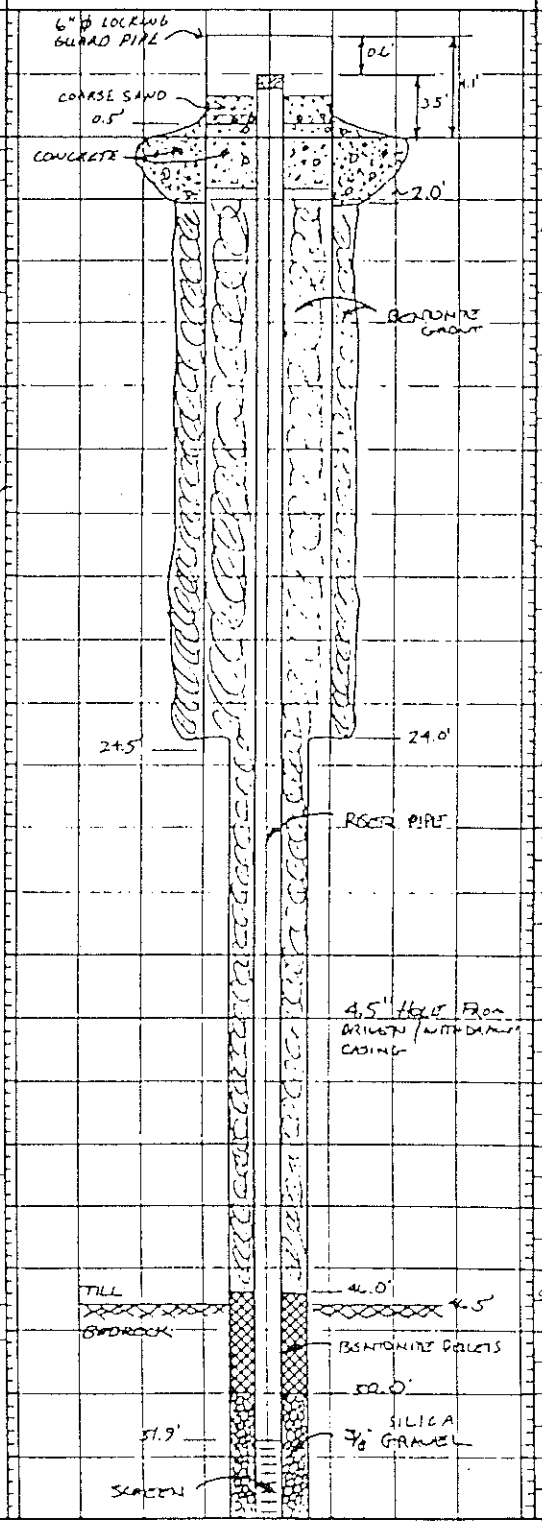
JOB NO. 853-3020 PROJECT CWM/VICKERY/OH WELL NO MW-38R SHEET 1 OF 2
GA INSP. W.C.C. DRILLING METHOD CORE/ROTARY GROUND ELEV 613.72 WATER DEPTH 14.03'
WEATHER Cloudy, Rainy DRILLING COMPANY BOWSER/MORNER COLLAR ELEV 617.22 DATE/TIME 11-12-85 18:15
TEMP. _____ DRILL RIG MORLE B-61 DRILLER B. KOSIATRCK STARTED 11-2-85 (TIME / DATE) COMPLETED 11-12-85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 55.4 ft. WELL SCREEN 2 in. dia. 10.0 ft. BENTONITE SEAL PELLETS
CASING TYPE SCHEDULE 40 PVC SCREEN TYPE PVC INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH SLOT SIZE .100 FILTER PACK QTY —
GROUT QUANTITY — CENTRALIZERS — FILTER PACK TYPE 3/8 SILICA GRAVEL
GROUT TYPE BENTONITE SLURRY DRILLING MUD TYPE — INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	GRAY CLAY, TRACE ORGANIC
0.5	MATTER (TOPSOIL)
	MEDIUM STIFF, MOTTLED GRAY-BROWN, SILTY CLAY, TRACE SAND (TILL)
	@ 2.0' BECOMING STIFF, SOME SAND, TRACE GRAVEL. @ 4.0' BECOMING VERY STIFF
6.3	VERY STIFF BROWN SILTY CLAY, SOME SAND, LITTLE GRAVEL (TILL)
	@ 7.7' TRACE ORGANIC MATTER @ 8.0' LITTLE SAND & GRAVEL
10.0	STIFF MOTTLED PURPLE GRAY-BROWN SILTY CLAY, LITTLE SAND AND GRAVEL (TILL)
	@ 11.6' HOLLOW, TRACE ORGANIC MATTER (TM) @ 12.0 SOFT-MED STIFF
14.0	SOFT, GRAY SILTY CLAY, LITTLE SAND AND GRAVEL (TILL)
20.0	@ 16' MEDIUM STIFF, LITTLE SAND, TRACE GRAVEL
25.0	(TILL)
30.0	
	@ 34' MEDIUM STIFF-
35.0	
	@ 38' STIFF
40.0	
41.3	@ 41.3 HARD LODGEMENT TILL (TILL)
	@ 44.0' TRACE WHITE GYPSUM
	@ 45.0' COBBLE
46.5	WEATHERED BEDROCK - SHALE
47.8	GRAY ARGILLACEOUS LAMINATED DOLOMITE WITH TRACE OF GYPSUM AS LAMINAE
50.0	
55.0	CONT. ON PAGE 2

WELL SKETCH



INSTALLATION NOTES

SEE MW-37R INSTALLATION NOTES.
WELL MW-38R WAS INSTALLED WITH THE SAME PROCEDURES AS DESCRIBED FOR MW-37R, EXCEPT AS NOTED BELOW.
NOTE: WELL MATERIAL IS 2" ϕ PVC
NO PROBLEMS WERE ENCOUNTERED FOR INSTALLATION OF THE BENTONITE PELLET SEAL

VOLUME OF SAND USED WAS APPROX 5.0 GALS. VOLUME CALCULATED IS APPROX 4.5 GALS.
VOLUME OF BENTONITE USED WAS APPROX 2.5 GAS. CALC. VOLUME IS APPROX 2.0 GALS.

WATER LEVEL UPON COMPLETION 11-12-85 @ 18:15 WAS 14.03 FT BELOW TOP OF 2" PVC RISER.
NOTE: ROCK DESCRIPTIONS FROM ROCK CORE OF MW-37R

WELL DEVELOPMENT NOTES

TOTAL WATER VOLUME REMOVED DURING DEVL WAS APPROX. 3,220 GALS

APPROX. WATER LOSS DURING DRILLING WAS 1,200 GALS.

TIME FOR REMOVAL OF 3,220 GALS WAS 11 HRS 30 MIN.

DEVELOPMENT METHOD: AIR LIFT USING 1" ϕ PVC INDUCTOR PIPE.
AIR SOURCE: DAYTON SPEEDAIRE OIL-LESS COMPRESSOR.

WELL DEVELOPMENT FROM 11-17-85 TO 11-18-85.

WATER LEVEL ON 11-20-85 WAS 13.78 FROM TOP OF 2" PVC RISER.

CONT. PAGE 2

MONITORING WELL INSTALLATION LOG

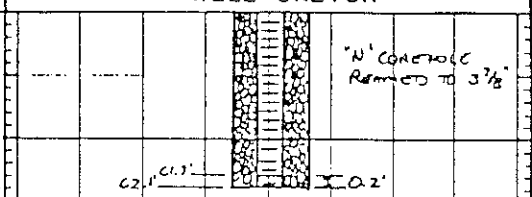
JOB NO. 853-3020 PROJECT CWM/VICKERY/DH WELL NO MW-38R SHEET 2 OF 2
GA INSP. W.G.G. DRILLING METHOD CORE/ROTARY GROUND ELEV. ____ WATER DEPTH ____
WEATHER Clear, Rainy DRILLING COMPANY BOWSER/MORNER COLLAR ELEV. ____ DATE/TIME ____
TEMP. ____ DRILL RIG MOBILE-B61 DRILLER ____ STARTED 11:2:85 (TIME / DATE) COMPLETED 11:12:85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. ____ l.f. WELL SCREEN 2 in. dia. 100 l.f. BENTONITE SEAL PELLETS
CASING TYPE PVC SCREEN TYPE PVC INSTALLATION METHOD GRAVITY FALL
JOINT TYPE ____ SLOT SIZE .100 FILTER PACK QTY —
GROUT QUANTITY ____ CENTRALIZERS — FILTER PACK TYPE #1 SILICA GRAVEL
GROUT TYPE BENTONITE SLURRY DRILLING MUD TYPE — INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	CONT. FROM PG. 1 GRAY ARGILLACEOUS DOLOMITE
57.3	MOTTLED WHITE GYPSUM AND GRAY DOLOMITE WITH TRACE OF FIBROUS GYPSUM
62.0'	CORING TERMINATED @ 62.0'
65.0	

WELL SKETCH



INSTALLATION NOTES

ATTACHED

WELL DEVELOPMENT NOTES

MEASUREMENTS OBTAINED DURING DEVELOPMENT:

DATE	GALLONS REMOVED	PH	SPECIFIC COND.	TEMP
11-17-85	450	7.0	2,500	55°F
11-19-85	1800	7.0	2,600	55°F

MONITORING WELL INSTALLATION LOG

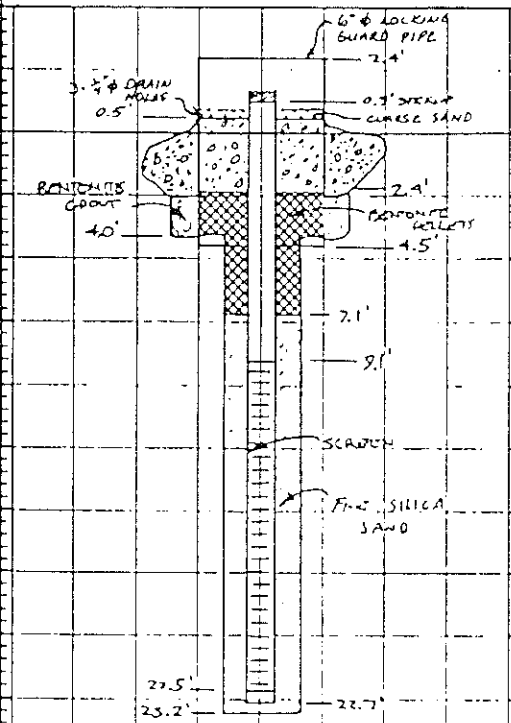
JOB NO. B53-3020	PROJECT CWM/HICKORY IOH	WELL NO T-38	SHEET 1 OF 1
GA INSP. W.G.C.	DRILLING METHOD ROTARY / AUGER	GROUND ELEV 613.6	WATER DEPTH 20.26
WEATHER Clear w/ wind	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 614.50	DATE/TIME 11-14-85 1730
TEMP.	DRILL RIG MOBILE B-61	DRILLER B. KIRKPATRICK	STARTED 11-13-85 (TIME / DATE) COMPLETED 11-14-85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 10.9 Lt	WELL SCREEN 2 in. dia. 12.5 Lt	BENTONITE SEAL PELLETS
CASING TYPE PVC SCHEDULE 40	SCREEN TYPE PVC	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH	SLOT SIZE .0060 in	FILTER PACK QTY
GROUT QUANTITY	CENTRALIZERS	FILTER PACK TYPE 1 LINE SILICA SAND
GROUT TYPE BENTONITE GROUT	DRILLING MUD TYPE —	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	GRAY CLAY, TRACE ORGANIC MATTER (TOPSOIL)
	MEDIUM STIFF, MOTTLED GRAY-BROWN, SILTY CLAY, TRACE SAND (TILL) @ 2.0' BECOMING STIFF, SOME SAND, TRACE GRAVEL
5.0	@ 4.0' BECOMING VERY STIFF
6.3	VERY STIFF BROWN SILTY CLAY, TRACE SAND, LITTLE GRAVEL (TILL) @ 7.7' TRACE ORGANIC MATTER. @ 9.0' LITTLE SAND & GRAVEL
10.0	STIFF, MOTTLED DARK GRAY-BROWN SILTY CLAY, LITTLE SAND AND GRAVEL (TILL) @ 11.6' FISSURED, TRACE ORGANIC MATTER (TILL)
14.0	SOFT, GRAY SILTY CLAY, LITTLE SAND AND GRAVEL (TILL)
	@ 16' MEDIUM STIFF, LITTLE SAND, TRACE GRAVEL
20.0	(TILL)
23.2	
25.0	

WELL SKETCH



INSTALLATION NOTES

INSTALLATION AND LISTED WELL QUANTITIES AND WELL DIMENSIONS FOR T-38 WERE NEARLY IDENTICAL TO THOSE DESCRIBED IN INSTALLATION NOTES FOR ACRO MONITORING WELL T-37.

NOTE: DATA DIFFERENCE IS THAT T-38 IS CONSTRUCTED OF SCHEDULE 40 PVC.

ANY DIFFERENCES IN WELL DIMENSIONS ARE NOTED ON THE WELL SKETCH.

VOLUME OF SAND USED WAS 8.5 TO 9.0 gals. VOLUME CALCULATED @ 9.4 gal.

WATER LEVEL UPON WELL COMPLETION WAS 20.26' BELOW TOP OF PVC RISER ON 11-14-85 @ 17:30 HRS.

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND PURGING WITH STAINLESS STEEL BAILER WITH TEFLON CHECK VALVE.

BAILER WAS STEAM CLEANED THEN RINSED WITH DEIONIZED WATER BEFORE DEVELOPMENT.

A NEW POLYPROPYLENE ROPE WAS DESIGNATED TO THIS WELL FOR DEVELOPMENT.

TOTAL VOLUME REMOVED DURING DEVELOPMENT WAS APPROX 1.5 GALS CALCULATED WELL VOLUME FOR WATER COLUMN MEASURED 1-14-86 W.L. 2.98 FEET BELOW TOP IS 3.8 GALLONS. THIS INDICATES THE WELL NEVER RECOVERED BEFORE DEVELOPMENT.

DATE	PH	SPEC. COND.	BAIL SIZE	COMMENTS
1-17-86	7.1	1,700	0.8	
1-21-86	6.8	1,700	0.5	SILTED
1-30-86	7.1	1,750	0.5	
1-30-86	-	-	0.5	

Golder Associates

Field Boring Log

DEPTH HOLE 12.0'	JOB NO. 853-3020	PROJECT CWM - VICKERY	BORING NO. 6-39
DEPTH SOIL DRILL 10.0	QA INSP. W.G.G.	DRILLING METHOD HOLLOW STEM AUGER	SHEET 1 OF 1
DEPTH ROCK CORE —	WEATHER Sunny, Cool	DRILLING COMPANY EXPLORATION TECHNOLOGY INC	SURFACE ELEV. —
NO. DIST. SA. 6 UD. SA. —	TEMP. —	DRILL RIG CME 55 DRILLER C. BARTLE	DATUM GROUND SURFACE
DEPTH WL. —	HRS. PROD. —	WT. SAMPLER HAMMER 140 lbs DROP 2.5'	STARTED 1 10 31-85 (TIME DATE)
TIME WL. —	HRS. DELAYED —	WT. CASING HAMMER — DROP —	COMPLETED 110-31-85

SAMPLE TYPES

A S	AUGER SAMPLE
C S	CHUNK SAMPLE
D O	DRIVE OPEN
D S	DENISON SAMPLE
P S	PITCHER SAMPLE
R C	ROCK CORE
S T	SLOTTED TUBE
T D	THIN-WALLED, OPEN
T P	THIN-WALLED, PISTON
W S	WASH SAMPLE

ABBREVIATIONS

BL	BLACK	M	MEDIUM	SA	SAMPLE
BR	BROWN	MIC	MICACEOUS	SAT	SATURATED
C	COARSE	MOT	MOTTLED	SD	SAND
CA	CASING	NP	NON-PLASTIC	SI	SILT
CL	CLAY	OG	ORANGE	SIY	SILTY
CLY	CLAYEY	ORG	ORGANIC	SM	SOME
F	FINE	PH	PRESSURE-HYDRAULIC	TR	TRACE
FRAG	FRAGMENTS	PM	PRESSURE-MANUAL	WL	WATER LEVEL
GL	GRAVEL	R	RED	WH	WEIGHT OF HAMMER
LYD	LAYERED	RES	RESIDUAL	Y	YELLOW
LI	LITTLE	RX	ROCK		

SOIL DESCRIPTION - RANGE OF PROPORTION

"TRACE" — 0 - 5%
"LITTLE" — 5 - 12%
"SOME" — 12 - 30%
"AND" — 30 - 50%

CONSISTENCY

LS	LOOSE	S	SOFT
CP	COMPACT	FM	FIRM
DN	DENSE	ST	STIFF
V	VERY	H	HARD

ELEV. DEPTH	DESCRIPTION	BLOWS/FT	SAMPLES NO.	TYPE	HAMM. BLOWS PER 6 IN (FORCE)	REC/ATT	DEPTH	SAMPLE DESCRIPTION AND BORING NOTES
	SOFT BLACK SLIGHTLY CLAYEY FINE SANDY SILT (TOPSOIL-ML)							DUG WITH SHOVEL TO DETERMINE THICKNESS OF TOPSOIL
0.6'	VERY STIFF BROWN AND GRAY MOTTLED SILTY CLAY. LITTLE COARSE SAND AND FINE GRAVEL (LACUSTRINE) POSSIBLY FILL		S-1	ML CL	3 5 6 10	1.1'/2.0'		
		2.0	S-2	CL	8 11 17 20	1.7'/2.0'		
4.0	DENSE GRAY-BROWN AND TAN FINE SAND, SOME CLAYEY SILT, LAMINATED. SAMPLE 4B FROM ~6.7 TO 7.4 FIRM TAN AND BROWN FINE SAND. SOME CLAYEY SILT AND ORGANIC MATTER (COAL) (LACUSTRINE)		S-3	SC	9 15 19 14	1.8'/2.0'		SAND HAS LAMINATED BEDDING FEATURES
		6.0	S-4A & S-4B	SC CH	S-4A S-4B 8 9 9 11 10 12 12 14	1.1'/2.0' S-4B 1.3'/2.0'		LOST HALF OF FIRST SAMPLE (ADDED SAND CATCHER FOR 4B)
7.4	FIRM DARK GRAY CLAY, TRACE FINE SAND (LACUSTRINE)	8.0						
8.6	FIRM DARK GRAY CLAY LITTLE MEDIUM TO COARSE SAND AND FINE GRAVEL (TILL)		S-5	CH	2 3 4 5	1.9'/2.0		BOTTOM OF LACUSTRINE @ ~ 8.6 Feet bgs.
		10.0	S-6	CH	1 3 4 5	1.9/2.0		AUGERING TERMINATED @ 10.0 Ft
12.0	BORING TERMINATED @ 12.0'	12.0						

MONITORING WELL INSTALLATION LOG

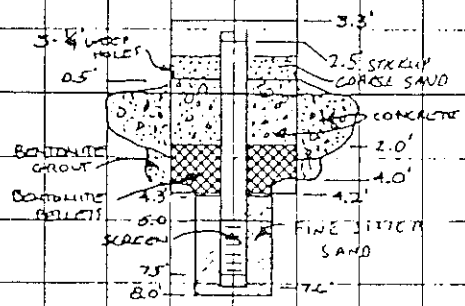
JOB NO. 853-3020	PROJECT CWM / VICKERY / OH	WELL NO L-39	SHEET 1 OF 1
GA INSP. WGG	DRILLING METHOD AUGER / ROTARY	GROUND ELEV 610.8	WATER DEPTH 6.93'
WEATHER CLOUDY	DRILLING COMPANY BOWSER / MORNER	COLLAR ELEV 613.28	DATE/TIME 11-17-85 10:51
TEMP	DRILL RIG MOBILE B-61 DRILLER B. KARPATHICK	STARTED 11-15-85 (TIME / DATE)	COMPLETED 11-17-85 (TIME / DATE)

MATERIALS INVENTORY

WELL CASING 2 in. dia. 75 l.f.	WELL SCREEN 2 in. dia. 25 l.f.	BENTONITE SEAL PELLETS
CASING TYPE 316 STAINLESS STEEL	SCREEN TYPE 316 STAINLESS WIRE WOUND	INSTALLATION METHOD GRAVITY FALL
JOINT TYPE FLUSH, COUPLED	SLOT SIZE .0060 in	FILTER PACK QTY
GROUT QUANTITY	CENTRALIZERS —	FILTER PACK TYPE FINE SILICA SAND
GROUT TYPE BENTONITE SLURRY	DRILLING MUD TYPE —	INSTALLATION METHOD GRAVITY FALL

ELEV./DEPTH	SOIL/ROCK DESCRIPTION
	GROUND SURFACE
0.0	SOFT BLACK SLIGHTLY CLAYEY FINE SANDY SILT (TOPSOIL)
0.6'	VERY STIFF BROWN AND GRAY MOTTLED SILTY CLAY. LITTLE COARSE SAND AND FINE GRAVEL
4.0	DENSE GRAY-BROWN AND TAN FINE SAND, SOME CLAYEY SILT. LAMINATED. (LACUSTRINE)
7.4	FIRM DARK GRAY CLAY. TRACE FINE SAND (LACUSTRINE)
9.6 / 10.0	FIRM DARK GRAY CLAY LITTLE MEDIUM TO COARSE SAND AND GRAVEL (TILL)
12.0	BORING TERMINATED @ 12.0 ft

WELL SKETCH



INSTALLATION NOTES

ATTACHED

WELL DEVELOPMENT NOTES

WELL DEVELOPED BY BAILING AND SURGING WITH STAINLESS STEEL BAILER.

BAILER WAS STEAM CLEANED THEN RINSED WITH DEIONIZED WATER BEFORE DEVELOPMENT.

A NEW ROPE WAS DESIGNATED TO THIS WELL FOR DEVELOPMENT.

TOTAL VOLUME REMOVED DURING DEVELOPMENT WAS APPROX. 2.6 GALS. CALC. WATER COLUMN ON 1-14-86 FROM S.W.L. OF 6.49' BELOW T.O.P. IS 0.6 GALLONS.

MEASUREMENTS DURING DEVEL.

DATE	pH	SPECIFIC COND.	GALLONS BAILED	COMMENTS
11-15-85	7.0	1,600	0.8	TURBID
11-20-85	7.3	1,700	0.8	TURBID
11-22-85	—	—	1.0	RECOVERY TEST [illegible]

Golder Associates	SUBJECT WELL INSTALLATION NOTES		
	Job No. 853-3020 Ref. L-39	Made by W.G.G. Checked Reviewed	Date 2-27-86 Sheet 1 of 2

1. a) A nominal 10" diameter (ϕ) hole was augered to 4.0' below ground surface (bgs) with solid stem augers and sounded @ 4.0' bgs.

b) 5.0 feet of 6" ϕ flush joint steel surface casing was inserted into the borehole. The casing sunk 0.2' after addition downhole.

c) The annular space between the 10" ϕ hole and 6" ϕ csg was tremie grouted with a bentonite grout slurry. Slurry was mixed using the rig Moyno pump. Used 1" ϕ PVC tremie pipe. Hole was dry before grouting. Used ~ gals of grout and allowed some overflow.

d) The 6-inch ϕ surface casing was flushed until return water was clear. Used a 5 7/8" roller bit for flushing. Bailed out residual water to within 0.5' of the bottom of hole.

2. a) Drove 4" ID temporary flush joint csg to 8.0' bgs. Flushed and reamed out csg to 8.0' bgs. until return water was clear.

3. a) Backfilling: Pulled 4" ϕ csg up to 7.5' bgs and added 0.4' of fine filter sand. Well screen (2.5' #6 slot) and solid 316 stainless steel riser pipe (7.5') was inserted down hole. Bottom of screen @ 7.5' bgs with 2.5' of riser extended above ground. Bottom cap length 0.1'.

b) The 4" ϕ csg was pulled @ 1.0' intervals and sand was backfilled in the open annulus to 4.3' bgs. Used ~ 2 gals of sand, calculated volume is ~ 2.1 gals.

c) The 4" ϕ csg was pulled out from within the 6" ϕ casing and bentonite pellets were poured on top the sand to 2.0' bgs. Total volume of pellets added was approx 1.5 gals, calculated volume is approx 1.4 gals.

4 a) Water level on the day of well completion (11-17-85) was 6.93' below top of 2" riser pipe @ 10:51 hrs.

5. a) Flush joint 6" ϕ aluminum protective pipe was threaded on the 6" ϕ surface csg and secured with a lock.

6. a) A 30" deep hole was hand dug and backfilled with cement. The cement was sloped to drain away from the well and extended to approx. 3" above the surface csg/protective pipe joint. Three 1/4" ϕ drain holes were drilled in the guard pipe just above the cement collar. Cement was poured inside the guard pipe to just below the drain holes. After the cement cured coarse sand was poured in the guard pipe

Golder Associates

SUBJECT WELL INSTALLATION NOTES.		
Job No. 853-3020 Ref. L-39	Made by W.G.G Checked Reviewed GTC	Date 2-27-86 Sheet 2 of 2

to approximately 5 inches below the top of 2" riser pipe.

7 a) The well cap was vented by drilling a small ¼ hole in the side of the cap.

Chemical Waste Management, Inc.

3956 State Route 412
Vickery, Ohio 43464
419-547-7791
Fax: 419-547-6144

FAX TRANSMISSION COVER SHEET

Date: *March 27, 1996*

To: *Rick Toth/Mitrofan Josan*

Fax:

Re: *Groundwater Information for Rich Zweig*

Sender: *Sandy Clark*

YOU SHOULD RECEIVE 13 PAGE(S), INCLUDING THIS COVER SHEET. IF YOU DO NOT RECEIVE ALL THE PAGES, PLEASE CALL 419-547-7791.

Following are the groundwater elevations for April 1995 and October 1995.

In regards to the hydrographs, I have requested those graphs from EML and will let you know when they will be sending them to you.

Any questions, call me at 419-547-3335.

WELL I.D. CHART

SITE: CWM - VICKERY
DATE: 4/17/95 to 4/27/95

WELL ID #	PURPOSE	GRADIENT	DEPTH OF WELL* (ft)	ELEVATION AT TOP OF CASING (msl)	INITIAL DEPTH TO WATER (ft) 4/17/95	GROUND WATER ELEVATION	MEASURED PURGE VOLUME (gal)	NORMAL RANGE RECHARGE TIME***	NORMAL RANGE pH** (std)	AVE/UPL SPECIFIC** CONDUCT (umhos) @ 25 C	COMMENTS
L 14	TSCA	Down	17.80	607.92	3.03	604.89	2.8	2 Days	5.6-7.9	3937/4720	Low yield
L 15	TSCA	Down	17.84	608.87	3.28	605.59	2.8	3 Days	5.2-8.0	6770/9420	Low yield; Very slow recovery
L 16	TSCA	Down	15.29	612.70	8.60	604.10	1.1	>3 Days	4.9-8.4	4995/7187	Low yield; Very slow recovery
L 17	TSCA	Down	15.31	612.22	6.47	605.75	2.0	>3 Days	6.2-6.8	3949/-----	Low yield; No recovery
L 18	TSCA	Down	17.85	611.74	5.53	606.21	2.8	<24 Hrs	6.8-7.2	2585/-----	Low yield
L 19	Not Sampled	Down	22.83	617.87	8.36	609.51	---	3 Days	5.7-7.2	6657/8792	Not sampled; Replaced by L19A
L 19A	TSCA	Down	25.30	621.25	11.53	609.72	2.9	<24 Hrs	6.2-6.8	5465/-----	Low yield
L 20	TSCA	Down	17.78	614.04	4.70	609.34	2.1	<24 Hrs	5.4-7.2	7833/10950	Well wizard
L 21	Pond 11&12	Down	17.83	612.08	3.47	608.61	2.5	<24 Hrs	5.9-7.5	3559/4665	Low yield
L 22	Pond 11&12	Down	17.83	610.73	4.52	606.21	2.5	<24 Hrs	6.0-7.8	3292/5487	Bailer stuck; Can' sample; Low yield
L 23A	TSCA	Up	20.32	613.49	3.66	609.83	3.0	2 Days	5.7-8.5	1355/1816	Low yield
L 25	TSCA	Down	20.30	612.95	8.70	604.25	2.4	2 Days	6.1-6.9	2830/-----	Low yield

* Depth of well for all wells manually measured and updated October 1994.
** Data from SMP Calculated Prediction Limit Table and Historical Data.
1) pH Range
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3) Specific Conductance Upper Prediction Limit (UPL)
***Recharge time may be less than in past because less sample volume required fewer analytes.
Part B - Permit 10/24/94
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TSCA-M - Not included in letter, but monitored for TSCA parameters
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WELL I.D. CHART

SITE: CWM - VICKERY

DATE: 4/17/95 to 4/27/95

WELL ID #	PURPOSE	GRADIENT	DEPTH OF WELL* (ft)	ELEVATION AT TOP OF CASING (msl)	INITIAL DEPTH TO WATER (ft) 4/17/95	GROUND WATER ELEVATION	MEASURED PURGE VOLUME (gal)	NORMAL RANGE RECHARGE TIME***	NORMAL RANGE pH** (std)	AVE/UPL SPECIFIC** CONDUCT (umhos) @ 25 C	COMMENTS
L 26	TSCA	Up	20.28	612.41	4.58	607.83	2.9	<24 Hrs	5.4-7.8	5141/7835	Well wizard
L 27	TSCA	Up	20.28	613.70	4.66	609.04	3.2	<24 Hrs	5.2-8.9	1631/8540	Low yield
L 28	TSCA	Down	22.82	613.40	4.53	608.87	3.1	<24 Hrs	5.4-7.5	6633/8859	Well wizard
L 29	Pond 11&12	Down	20.28	609.65	6.60	603.05	2.2	<24 Hrs	5.7-8.2	2204/10735	Well wizard
L 30	TSCA	Down	15.28	610.84	3.28	607.56	2.2	2 Days	5.2-7.7	7669/12234	Low yield
L 31	Pond 11&12	Down	17.80	611.32	dry	611.32	dry	>3 Days	5.3-8.8	1549/2036	Low yield; Slow recovery
L 32	Pond 11&12	Down	12.78	611.78	7.37	604.41	1.0	>3 Days	6.1-7.9	1451/1912	Low yield; Very slow recovery
L 33	Pond 11&12	Down	15.28	612.41	6.95	605.46	1.6	>3 Days	5.2-7.8	7588/10550	Low yield; Very slow recovery
L 34	Pond 11&12	Down	22.80	612.59	5.61	606.98	3.2	<24 Hrs	5.2-8.3	3494/20713	Low yield
L 35	Pond 11&12	Down	20.30	612.15	4.26	607.89	3.0	<24 Hrs	6.1-8.0	1190/1548	Low yield
L 39	TSCA-M	Up	10.30	613.28	4.87	608.41	0.9	2 Days	5.2-9.0	1557/2100	Low yield

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Rev 5/95
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WELL I.D. CHART

SITE: CWM - VICKERY
DATE: 4/17/95 to 4/27/95

WELL ID #	PURPOSE	GRADIENT	DEPTH OF WELL* (ft)	ELEVATION AT TOP OF CASING (msl)	INITIAL DEPTH TO WATER (ft) 4/17/95	GROUND WATER ELEVATION	MEASURED PURGE VOLUME (gal)	NORMAL RANGE RECHARGE TIME***	NORMAL RANGE pH** (std)	AVE/UPL SPECIFIC** CONDUCT (umhos) @ 25 C	COMMENTS
T 14	TSCA	Down	25.31	609.84	5.73	604.11	3.8	3 Days	5.9-8.3	1907/2420	Low yield; Slow recovery
T 17	TSCA	Down	30.39	611.18	7.87	603.31	4.2	3 Days	6.4-7.0	2475/-----	Low yield; No recovery
T 18	TSCA	Down	32.91	612.31	10.03	602.28	4.2	3 Days	6.8-7.2	1993/-----	Low yield; No recovery
T 19	D TSCA D'	Down	37.86	618.04	8.99	609.05	4.9	<24 Hrs	5.6-8.4	2375/9270	Well wizard
T 23A	TSCA	Up	30.65	613.05	6.58	606.47	4.9	2 Days	5.6-8.5	1748/2179	Low yield; Very slow recovery
T 24	D Not Sampled D'	Up	25.31	615.25	5.11	610.14	---	<24 Hrs	5.8-8.0	2103/2640	No Requirement To Sample
T 27	DB TSCA B'	Down	32.89	614.86	7.87	606.99	5.0	2 Days	5.2-9.3	1735/8558	Low yield; Very slow recovery
T 37	TSCA-M	Up	25.32	615.22	2.88	612.34	4.2	<24 Hrs	5.5-8.4	2615/3068	Low yield
T 38	PVC Well CWM Research TSCA-M	Up	23.75	614.50	1.91	612.59	4.0	<24 Hrs	5.4-8.3	2674/3327	Low yield

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WELL I.D. CHART

SITE: CWM - VICKERY

DATE: 4/17/95 to 4/27/95

WELL ID #	PURPOSE	GRADIENT	DEPTH OF WELL* (ft)	ELEVATION AT TOP OF CASING (msl)	INITIAL DEPTH TO WATER (ft) 4/17/95	GROUND WATER ELEVATION	MEASURED PURGE VOLUME (gal)	NORMAL RANGE RECHARGE TIME***	NORMAL RANGE pH** (std)	AVE/UPL SPECIFIC** CONDUCT (umhos) @ 25 C	COMMENTS
MW 14R	Part B 6W,9,10 TSCA	Down	63.35	607.64	20.52	587.12	21.0	<1 Hr	5.5-8.1	3009/3640	High yield; Well wizard
MW 15R	Part B 6W,9,10 TSCA	Down	65.35	607.84	20.70	587.14	22.5	<1 Hr	5.0-8.6	3023/3387	High yield; Well wizard
MW 16R	Part B 6W,9,10 TSCA	Down	67.82	613.76	26.54	587.22	20.0	<1 Hr	5.4-8.2	3053/3557	High yield; Well wizard
MW 17R	TSCA	Down	62.02	611.34	24.12	587.22	18.0	<1 Hr	6.6-7.1	3317/----	High yield; Well wizard
MW 18R	TSCA	Down	63.04	611.00	23.75	587.25	19.0	<1 Hr	6.3-7.1	3050/----	High yield; Well wizard
MW 19R	TSCA	Down	70.28	617.79	30.59	587.20	18.9	<1 Hr	5.7-7.9	3368/5440	High yield; Well wizard
MW 20R	Part B 6W,9,10 TSCA	Down	67.75	614.04	26.85	587.19	21.0	<1 Hr	5.1-8.5	3053/4038	High yield; Well wizard
MW 21R	Pond 11&12	Down	70.40	613.10	25.93	587.17	21.0	<1 Hr	5.0-8.7	3562/5928	High yield; Well wizard
MW 22R	Pond 11&12	Down	62.80	608.49	21.39	587.10	21.0	<1 Hr	5.0-8.6	6685/8984	High yield; Well wizard
MW 23RA	Not Sampled	Up	57.90	612.96	25.98	586.98	---	<1 Hr	5.6-7.9	10200/11932	No Requirement To Sample
MW 24R	Part B 6W,9,10 TSCA	Up	60.25	614.04	26.83	587.21	15.5	<1 Hr	5.8-7.9	2960/3787	High yield; Well wizard
MW 30R	Part B 6W,9,10 TSCA-M	Down	65.32	611.13	23.99	587.14	21.5	<1 Hr	5.3-8.1	2937/3576	High yield; Well wizard

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Rev 5/95
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WELL I.D. CHART

SITE: CWM - VICKERY

DATE: 4/17/95 to 4/27/95

WELL ID #	PURPOSE	GRADIENT	DEPTH OF WELL* (ft)	ELEVATION AT TOP OF CASING (msl)	INITIAL DEPTH TO WATER (ft) 4/17/95	GROUND WATER ELEVATION	MEASURED PURGE VOLUME (gal)	NORMAL RANGE RECHARGE TIME***	NORMAL RANGE pH** (std)	AVE/UPL SPECIFIC** CONDUCT (umhos) @ 25 C	COMMENTS
MW 36R	Part B 6W,9,10 TSCA	Down	65.64	612.90	25.80	587.10	18.8	<1 Hr	4.9-8.5	2892/3391	High yield; Well wizard
MW 37R	Part B 6W,9,10 TSCA-M	Up	65.44	616.40	14.49	601.91	27.5	<1 Hr	5.2-8.5	2860/3507	High yield; Well wizard
MW 38R	PVC WELL CWM Research TSCA-M	Up	65.77	617.22	15.23	601.99	25.3	<1 Hr	5.4-8.3	2813/3386	High yield; Well wizard

*. Depth of well for all wells manually measured and updated October 1994.

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Rev 5/95
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WELL ID #	PURPOSE	GRADIENT	DEPTH OF WELL* (ft)	ELEVATION AT TOP OF CASING (msl)	DEPTH TO WATER (ft) 10/18/95 ****	GROUND WATER ELEVATION	MEASURED PURGE VOLUME (gal)	NORMAL RANGE RECHARGE TIME***	NORMAL RANGE pH** (std)	AVE/UPL SPECIFIC** CONDUCT (mhos) @ 25 C	COMMENTS
MW 14R	Part B 6W,9,10 TSCA	Down	63.35	607.64	20.90	586.74		<1 Hr	5.5-8.1	3009/3640	High yield; Well wizard
MW 15R	Part B 6W,9,10 TSCA	Down	65.35	607.84	21.10	586.74		<1 Hr	5.0-8.6	3023/3387	High yield; Well wizard
MW 16R	Part B 6W,9,10 TSCA	Down	67.82	613.76	26.98	586.78		<1 Hr	5.4-8.2	3053/3557	High yield; Well wizard
MW 17R	TSCA	Down	62.02	611.34	24.54	586.80		<1 Hr	6.6-7.1	3317/----	High yield; Well wizard
MW 18R	TSCA	Down	63.04	611.00	24.22	586.78		<1 Hr	6.3-7.1	3050/----	High yield; Well wizard
MW 19R	TSCA	Down	70.28	617.79	31.00	586.79		<1 Hr	5.7-7.9	3368/5440	High yield; Well wizard
MW 20R	Part B 6W,9,10 TSCA	Down	67.75	614.04	27.26	586.78		<1 Hr	5.1-8.5	3053/4038	High yield; Well wizard
MW 21R	Pond 11&12	Down	70.40	613.10	26.34	586.76		<1 Hr	5.0-8.7	3562/5928	High yield; Well wizard
MW 22R	Pond 11&12	Down	62.80	608.49	21.75	586.74		<1 Hr	5.0-8.6	6685/8984	High yield; Well wizard
MW 23R	Not Sampled	Up	57.90	612.96	26.30	586.66		<1 Hr	5.6-7.9	10200/11932	No Requirement To Sample
MW 24R	Part B 6W,9,10 TSCA	Up	60.25	614.04	27.15	586.89		<1 Hr	5.8-7.9	2960/3787	High yield; Well wizard
MW 30R	Part B 6W,9,10 TSCA-M	Down	65.32	611.13	24.41	586.72		<1 Hr	5.3-8.1	2937/3576	High yield; Well wizard

* Depth of well for all wells manually measured and updated October 1994.

** Data from SMP Calculated Prediction Limit Table and Historical Data.
1) pH Range
2) Specific Conductance Average Value (AVE)
3) Specific Conductance Upper Prediction Limit (UPL)

*** Recharge time may be less than in past because less sample volume required fewer analytes.

Part B - Permit 10/24/94

Pond 11 & 12 - Closure Approval 3/31/88

TSCA - TSCA Approval Letter 7/22/88

TSCA-M - Not included in letter, but monitored for TSCA parameters

~~6W, 9, 10 - Closure Report for Ponds 6W, 9, & 10~~

****Groundwater elevation for Bedrock well with truck wash well on.

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WELL ID #	PURPOSE	GRADIENT	DEPTH OF WELL* (ft)	ELEVATION AT TOP OF CASING (msl)	*** DEPTH TO WATER (ft) 10/18/95	GROUND WATER ELEVATION	MEASURED PURGE VOLUME (gal)	NORMAL RANGE RECHARGE TIME***	NORMAL RANGE pH** (std)	AVE/UPL SPECIFIC** CONDUCT (umhos) @ 25 C	COMMENTS
MW 36R	Part B 6W,9,10 TSCA	Down	65.64	612.90	26.29	586.61		<1 Hr	4.9-8.5	2892/3391	High yield; Well wizard
MW 37R	Part B 6W,9,10 TSCA-M	Up	65.44	616.40	14.48	601.92		<1 Hr	5.2-8.5	2860/3507	High yield; Well wizard
MW 38R	PVC WELL CWM Research TSCA-M	Up	65.77	617.22	15.22	602.00		<1 Hr	5.4-8.3	2813/3386	High yield; Well wizard

* Depth of well for all wells manually measured and updated October 1994.
** Data from SMP Calculated Prediction Limit Table and Historical Data.
1) pH Range
2) Specific Conductance Average Value (AVE)
3) Specific Conductance Upper Prediction Limit (UPL)
*** Recharge time may be less than in past because less sample volume required fewer analytes.
Part B - Permit 10/24/94
Pond 11 & 12 - Closure Approval 3/31/88
TSCA - TSCA Approval Letter 7/22/88
TSCA-M - Not included in letter, but monitored for TSCA parameters
6W, 9, 10 - Closure Report for Ponds 6W, 9, & 10
**** Groundwater elevation for Bedrock well with truck wash well on.

Note

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WELL I.D. CHART

SITE: CWM - VICKERY

DATE: 10-23-95 - 10-26-95

WELL ID #	REQUIREMENT	GRADIENT	DEPTH OF WELL* (ft)	ELEVATION AT TOP OF CASING (msl)	INITIAL DEPTH TO WATER (ft) 10-23-95	GROUND WATER ELEVATION	MEASURED PURGE VOLUME (gal)	NORMAL RANGE RECHARGE TIME	NORMAL RANGE pH** (std)	AVE/UPL SPECIFIC** CONDUCT (umhos) @ 25 C	COMMENTS
L 14	TSCA-WL	Down	17.80	607.92	4.75	603.17	NA	2 Days	5.6-7.9	3937/4720	
L 15	TSCA-WL	Down	17.84	608.87	5.88	602.99	NA	3 Days	5.2-8.0	6770/9420	
L 16	TSCA-WL	Down	15.29	612.70	8.99	603.71	NA	>3 Days	4.9-8.4	4995/7187	
L 17	TSCA-WL	Down	15.31	612.22	8.98	603.24	NA	>3 Days	6.2-6.8	3949/----	
L 18	TSCA-WL	Down	17.85	611.74	8.6	603.14	NA	<24 Hrs	6.8-7.2	2585/----	
L 19	Not Monitored	Down	22.83	617.87	9.82	608.05	NA	3 Days	5.7-7.2	6657/8792	Replaced by L19A
L 19A	TSCA-WL	Down	25.30	621.25	13.18	608.07	NA	<24 Hrs	6.2-6.8	5465/----	
L 20	TSCA-WL	Down	17.78	614.04	6.96	607.08	NA	<24 Hrs	5.4-7.2	7833/10950	
L 21	Pond 11&12	Down	17.83	612.08	5.55	606.53	2.0	<24 Hrs	5.9-7.5	3559/4665	Low yield
L 22	Pond 11&12	Down	17.83	610.73	6.41	604.32	1.9	<24 Hrs	6.0-7.8	3292/5487	Low Yield
L 23A	Not Monitored	Up	20.32	613.49	7.42	606.07	NA	2 Days	5.7-8.5	1355/1816	
L 25	TSCA-WL	Down	20.30	612.95	9.39	603.56	NA	2 Days	6.1-6.9	2830/----	

* Depth of well for all wells manually measured and updated October 1994.

** Data from SMP Calculated Prediction Limit Table and Historical Data.

1) pH Range
2) Specific Conductance Average Value (AVE)
3) Specific Conductance Upper Prediction Limit (UPL)

Part B - Permit 10/24/94

Pond 11 & 12 - Closure Approval 3/31/88

TSCA - TSCA Approval Letter 7/22/88, as amended 9/25/95

TSCA-WL - Monitored for groundwater elevations only per TSCA letter

6W, 9, 10 - Closure Report for Ponds 6W, 9, & 10

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WELL I.D. CHART

SITE: CWM - VICKERY

DATE: 10-23-95 - 10-26-95

WELL ID #	REQUIREMENT	GRADIENT	DEPTH OF WELL* (ft)	ELEVATION AT TOP OF CASING (msl)	INITIAL DEPTH TO WATER (ft) 10-23-95	GROUND WATER ELEVATION	MEASURED PURGE VOLUME (gal)	NORMAL RANGE RECHARGE TIME	NORMAL RANGE pH** (std)	AVE/UPL SPECIFIC** CONDUCT (umhos) @ 25 C	COMMENTS
L 26	TSCA-WL	Up	20.28	612.41	6.44	605.97	NA	<24 Hrs	5.4-7.8	5141/7835	
L 27	TSCA-WL	Up	20.28	613.70	6.39	607.31	NA	<24 Hrs	5.2-8.9	1631/8540	
L 28	TSCA-WL	Down	22.82	613.40	5.68	607.72	NA	<24 Hrs	5.4-7.5	6633/8859	
L 29	Pond 11&12	Down	20.28	609.65	9.06	600.59	1.9	<24 Hrs	5.7-8.2	2204/10735	Well wizard
L 30	TSCA-WL	Down	15.28	610.84	4.52	606.32	NA	2 Days	5.2-7.7	7669/12234	
L 31	Pond 11&12	Down	17.80	611.32	Dry	NA ~~612.32~~	NA	>3 Days	5.3-8.8	1549/2036	Dry
L 32	Pond 11&12	Down	12.78	611.78	9.36	602.42	0.6	>3 Days	6.1-7.9	1451/1912	Low yield; Very slow recovery
L 33	Pond 11&12	Down	15.28	612.41	13.26	599.15	0.4	>3 Days	5.2-7.8	7588/10550	Low yield; Very slow recovery
L 34	Pond 11&12	Down	22.80	612.59	8.92	603.67	2.5	<24 Hrs	5.2-8.3	3494/20713	Low yield
L 35	Pond 11&12	Down	20.30	612.15	5.97	606.18	2.5	<24 Hrs	6.1-8.0	1190/1548	Low yield
L 39	TSCA-WL	Up	10.30	613.28	8.08	605.20	NA	2 Days	5.2-9.0	1557/2100	

* Depth of well for all wells manually measured and updated October 1994.

** Data from SMP Calculated Prediction Limit Table and Historical Data.

1) pH Range
2) Specific Conductance Average Value (AVE)
3) Specific Conductance Upper Prediction Limit (UPL)

Part B – Permit 10/24/94

Pond 11 & 12 – Closure Approval 3/31/88

TSCA – TSCA Approval Letter 7/22/88

TSCA-WL – Monitored for groundwater elevations only per TSCA letter

6W, 9, 10 – Closure Report for Ponds 6W, 9, & 10

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WELL I.D. CHART

SITE: CWM - VICKERY

DATE: 10-23-95 - 10-26-95

WELL ID #	REQUIREMENT	GRADIENT	DEPTH OF WELL* (ft)	ELEVATION AT TOP OF CASING (msl)	INITIAL DEPTH TO WATER (ft) 10-23-95	GROUND WATER ELEVATION	MEASURED PURGE VOLUME (gal)	NORMAL RANGE RECHARGE TIME	NORMAL RANGE pH** (std)	AVE/UPL SPECIFIC** CONDUCT (umhos) @ 25 C	COMMENTS
T 14	TSCA-WL	Down	25.31	609.84	7.03	602.81	NA	3 Days	5.9-8.3	1907/2420	
T 17	TSCA-WL	Down	30.39	611.18	9.37	601.81	NA	3 Days	6.4-7.0	2475/----	
T 18	TSCA-WL	Down	32.91	612.31	10.81	601.50	NA	3 Days	6.8-7.2	1993/----	
T 19	TSCA-WL	Down	37.86	618.04	10.31	607.73	NA	<24 Hrs	5.6-8.4	2375/9270	
T 23A	Not Monitored	Up	30.65	613.05	8.93	604.12	NA	2 Days	5.6-8.5	1748/2179	
T 24	TSCA-WL	Up	25.31	615.25	6.48	608.77	NA	<24 Hrs	5.8-8.0	2103/2640	
T 27	TSCA-WL	Down	32.89	614.86	8.76	606.10	NA	2 Days	5.2-9.3	1735/8558	
T 37	TSCA-WL	Up	25.32	615.22	4.49	610.73	NA	<24 Hrs	5.5-8.4	2615/3068	
T 38	PVC Well CWM Research Not Monitored	Up	23.75	614.50	3.59	610.91	NA	<24 Hrs	5.4-8.3	2674/3327	

* Depth of well for all wells manually measured and updated October 1994.

** Data from SMP Calculated Prediction Limit Table and Historical Data.

1) pH Range
2) Specific Conductance Average Value (AVE)
3) Specific Conductance Upper Prediction Limit (UPL)

Part B – Permit 10/24/94

Pond 11 & 12 – Closure Approval 3/31/88

TSCA – TSCA Approval Letter 7/22/88

TSCA-WL – Monitored for groundwater elevations only per TSCA letter

6W, 9, 10 – Closure Report for Ponds 6W; 9, & 10

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WELL I.D. CHART

SITE: CWM - VICKERY

DATE: 10-23-95 - 10-26-95

WELL ID #	REQUIREMENT	GRADIENT	DEPTH OF WELL* (ft)	ELEVATION AT TOP OF CASING (msl)	INITIAL DEPTH TO WATER (ft) 10-23-95	GROUND WATER ELEVATION	MEASURED PURGE VOLUME (gal)	NORMAL RANGE RECHARGE TIME	NORMAL RANGE pH** (std)	AVE/UPL SPECIFIC** CONDUCT (umhos) @ 25 C	COMMENTS
MW 14R	Part B 6W,9,10 TSCA	Down	63.35	607.64	19.94	587.70	25.0	<1 Hr	5.5-8.1	3009/3640	High yield; Well wizard
MW 15R	Part B 6W,9,10 TSCA	Down	65.35	607.84	20.14	587.70	23.0	<1 Hr	5.0-8.6	3023/3387	High yield; Well wizard
MW 16R	Part B 6W,9,10 TSCA	Down	67.82	613.76	25.99	587.77	21.5	<1 Hr	5.4-8.2	3053/3557	High yield; Well wizard
MW 17R	Not Monitored	Down	62.02	611.34	23.55	587.79	NA	<1 Hr	6.6-7.1	3317/----	
MW 18R	Not Monitored	Down	63.04	611.00	23.23	587.77	NA	<1 Hr	6.3-7.1	3050/----	
MW 19R	Not Monitored	Down	70.28	617.79	30.03	587.76	NA	<1 Hr	5.7-7.9	3368/5440	
MW 20R	Part B 6W,9,10 TSCA	Down	67.75	614.04	26.35	587.69	21.0	<1 Hr	5.1-8.5	3053/4038	High yield; Well wizard
MW 21R	Pond 11&12	Down	70.40	613.10	25.39	587.71	22.0	<1 Hr	5.0-8.7	3562/5928	High yield; Well wizard
MW 22R	Pond 11&12	Down	62.80	608.49	20.81	587.68	20.5	<1 Hr	5.0-8.6	6685/8984	High yield; Well wizard
MW 23RA	Not Monitored	Up	57.90	612.96	25.40	587.56	NA	<1 Hr	5.6-7.9	10200/11932	
MW 24R	Part B 6W,9,10 TSCA	Up	60.25	614.04	26.25	587.79	16.0	<1 Hr	5.8-7.9	2960/3787	High yield; Well wizard
MW 30R	Part B 6W,9,10 TSCA	Down	65.32	611.13	23.40	587.73	24.0	<1 Hr	5.3-8.1	2937/3576	High yield; Well wizard

* Depth of well for all wells manually measured and updated October 1994.

** Data from SMP Calculated Prediction Limit Table and Historical Data.

1) pH Range
2) Specific Conductance Average Value (AVE)
3) Specific Conductance Upper Prediction Limit (UPL)

Part B - Permit 10/24/94

Pond 11 & 12 - Closure Approval 3/31/88

TSCA - TSCA Approval Letter 7/22/88

TSCA-WL - Monitored for groundwater elevations only per TSCA letter

6W, 9, 10 - Closure Report for Ponds 6W, 9, & 10

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WELL I.D. CHART

SITE: CWM - VICKERY

DATE: 10-23-95 - 10-26-95

WELL ID #	REQUIREMENT	GRADIENT	DEPTH OF WELL* (ft)	ELEVATION AT TOP OF CASING (msl)	INITIAL DEPTH TO WATER (ft) 10-23-95	GROUND WATER ELEVATION	MEASURED PURGE VOLUME (gal)	NORMAL RANGE RECHARGE TIME	NORMAL RANGE pH** (std)	AVE/UPL SPECIFIC** CONDUCT (umhos) @ 25 C	COMMENTS
MW 36R	Part B 6W,9,10 TSCA	Down	65.64	612.90	25.21	587.69	21.0	<1 Hr	4.9-8.5	2892/3391	High yield; Well wizard
MW 37R	Part B 6W,9,10 TSCA	Up	65.44	616.40	14.23	602.17	25.5	<1 Hr	5.2-8.5	2860/3507	High yield; Well wizard
MW 38R	PVC WELL CWM Research Not Monitored	Up	65.77	617.22	14.99	602.23	NA	<1 Hr	5.4-8.3	2813/3386	

*: Depth of well for all wells manually measured and updated October 1994.
** Data from SMP Calculated Prediction Limit Table and Historical Data.
1) pH Range
2) Specific Conductance Average Value (AVE)
3) Specific Conductance Upper Prediction Limit (UPL)
Part B - Permit 10/24/94
Pond 11 & 12 - Closure Approval 3/31/88
TSCA - TSCA Approval Letter 7/22/88
TSCA-WL - Monitored for groundwater elevations only per TSCA letter
6W, 9, 10 – Closure Report for Ponds 6W, 9, & 10

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APPENDIX D

CWM-VICKERY GROUNDWATER SAMPLING AND ANALYSIS PLAN (ABBREVIATED FROM PART B PERMIT FOR INCLUSION INTO THE PHASE I RFI WORKPLAN)

Post Closure Cell Groundwater Sampling and Analysis Plan (OAC 3745-54-97(D))

~~These forms,~~ THE sampling procedures and equipment may be updated to reflect advances in sampling technology and newly promulgated regulations. The updated forms, procedures and equipment will be equivalent to those described or contained in this Sampling and Analysis Plan (SAP) and will normally not require a permit modification. When SAP revisions are planned, the Ohio EPA will be notified either verbally or in writing.

The Vickery Facility groundwater sampling system was originally designed to meet the requirements of the Consent Agreement and Final Order (CAFO) in implementing an initial groundwater and continuing groundwater program. The history of the system was described in Section E.4.0.

The Post Closure Groundwater Monitoring System will consist of eight bedrock monitoring wells, six downgradient and two upgradient, and the capillary drain monitoring system. The till and lacustrine wells have been removed from the monitoring program due to the fact that the flow in these zones is vertically, extremely low and the Capillary Barrier is creating an inward gradient from the lacustrine zone toward the Closure Cell. Previous analysis have not shown contamination from the Closure Cell in these zones.

Well Sampling System

The Vickery Facility groundwater sampling system dedicates all purging and sampling equipment to each monitoring well, thus, preventing any cross contamination between wells. The Well Wizards are gas driven positive displacement bladder pumps constructed of stainless steel and teflon. These pumps are used to purge and sample the wells. Appendix 14-C of the Vickery Ohio Facility Part B Permit contains the operating instructions, for the Well Wizard System.

Capillary Drain System

The capillary drain system underlies the Closure Cell. The system is described in Section E.1.3.

Dedicated Sampling Devices

Each well in the monitoring system has been equipped with dedicated sampling devices consisting of a Well Wizard T-1200 series bladder pumps. The dedicated sampling equipment for the capillary drain system consists of a stainless steel bucket and a series of extension poles.

Capillary Drain Sampling System

The samples will be taken from the capillary drain through the capillary drain piping system which discharges into a sump. The sump is located centrally on the north side of the cell. There are two pipes, one running west to east to the sump and one running east to west to the sump.
~~The volatile organic sample bottles will be filled directly from the two pipes. The other sample bottles will be filled by first collecting the sample in a stainless steel beaker and pouring the contents directly into the sample bottles. The order of sampling will be the same as described in Section 6.5.2. The samples to be filtered (dissolved metals) will be filtered in accordance with procedures described in Section 6.5.4.~~ All sample bottles will be filled from one pipe, alternating between the East and the West pipe between each sampling event. The sample location will be noted in the comment section on the Field Information Form.

Sampling Procedure Summary

The plan for sampling groundwater at the Vickery site is described below. The sampling plan includes procedures and techniques for:

1) sample collection,

2) preservation and shipment, and

3) sample documentation and proper Chain-of-Custody control.

Groundwater sample collection will be performed ~~in accordance with WMI procedures and~~ as discussed below. These procedures are revised periodically to reflect advances in groundwater sampling technology.

The following subsections describe general procedures and techniques for measurement of water levels, purging of wells, field measurements of pH, specific conductance and temperature, sample collection (bottles, preservation and shipping), sampling documentation, and Chain-of Custody control.

It is required per OAC 3745-54-97(D)(2) that, where applicable, the sampling and analysis plan should include procedures for detection of immiscible layers. Sampling for an immiscible layer is not necessary at the Vickery site due to the historical record of never having any concentration of organics detected which would begin to suggest that an immiscible layer could be present. In the event organics are detected in concentrations suggesting the possibility of immiscible layers, the sampling plan will be modified to incorporate the monitoring of their presence.

Procedure Prior to Sampling

Prior to purging and sampling monitoring wells, the following procedures will be performed to assure a quality sampling event: calibrate field equipment, as described in Section E.6.3.3, log in sample Aquapaks(TM), verify Statement of Work forms and clean and organize the equipment for sampling.

Sampling may be delayed due to inclement weather. This may occur if the integrity of the sample would be in jeopardy or if the health and safety of the sampling team would be in jeopardy if sampling were to continue.

Upon arrival at the well location, observe ~~and record~~ the condition of the well and its surrounding area. Record any problems on the Field Information Form, which is presented in Figure E-20. Information which can be noted includes, but is not limited to, the following:

- The condition of the well identification sign.
- Condition of the locking cap and key.
- Well integrity, including condition of well's cement footing and protective casing. In addition, note physical surroundings, obstructions or kinks in well casing, water in the annular space, grease around the top of well or threaded cap, etc.
- Weather conditions (e.g., wind direction when sampling for volatile organics and note sampling was performed downwind of an active area).
- Evidence of contamination.
- The condition of the well guard posts.

Water Level and Well Depth Measurement (OAC 3745-54-97(D)(1))

The depth to the static water surface will be measured to the nearest 0.01 foot each time a well is sampled prior to well purging. Initially, on the first day of the semi-annual sampling event, ~~all wells will be checked for water surface level before any well is purged~~ groundwater elevations will be taken. Water level measurements will be taken using electrical water level indicators. The Truck Wash Well must be shut down at

least 8 hours (Reference 13, pages 53-54) prior to taking levels, due to its significant effect on the aquifer when pumping.

The probe will be unrolled slowly until the light and buzzer of the indicator respond. The water level depth will be read and recorded, including the unit of measurement. After measurement of the depth to static water, the cable will be rinsed with deionized water and dried with a paper towel while reeling it back onto the spool. Excess water will be shaken off.

The depth to the bottom of the wells is measured during periodic maintenance check for wells equipped with bladder pumps using the water level indicator. Before use in each well the instrument is rinsed off as described above for water level measurements. The bottom of the well is found by lowering the probe and "sounding" for the bottom. Sounding consists of raising and lowering the probe to feel a difference in tension when the probe contacts the bottom. The depth is measured to the top of the stainless steel inner casing. A constant ~~of 0.30 feet~~ must be added to the measured well depth to compensate for the distance between the end of the indicator probe and the tip of the water level indicator. For Model #11876, add .30 feet to the measurement. For Model #10426 , add .03 feet to the measurement.

Well Purging (OAC 3745-54-97(D)(3)(a))

The following purging procedures are to be used for the groundwater monitoring wells at the Vickery site. The monitoring wells have been fitted with dedicated sampling equipment, a bladder pump ~~or a stainless steel bailer,~~ which will be used for purging and sampling the wells. The monitoring wells will be purged, by pumping or bailing, prior to sampling so that a representative groundwater sample can be collected. The water from purging will be collected and measured. All purged well water will be disposed of downgradient of the well head or contained if it is thought to be contaminated per OAC 3745-54-97(D)(6) and disposed of in one of the onsite deep ~~monitoring~~ injection wells or shipped offsite to an approved disposal facility.

Prior to purging the well the quantity of water in the well will be calculated. The wells will be purged until at least three (3) times the well volume has been removed, or until the well has been purged dry. Purge volume (in gallons) is calculated using the following equation:

$$1 \text{ Casing Volume} = 3.14r^2h \times 7.48$$

where

3.14 = pi
r = inside radius of well casing in feet
h = feet of water column in well

For a 2-inch diameter well casing, one casing volume equals 0.163h. For a 4-inch diameter well casing, one casing volume equals 0.652h.

Well Wizard bladder pumps will be used to purge the wells. The bladder pumps are actuated by nitrogen compressed gas cylinders connected to a control unit, which is described in Appendix 14-C. At the end of discharge cycle, the gas pressure will be vented. Pumping will continue until the appropriate volume has been removed.

The bladder pump discharge flow will be monitored for indications of malfunction such as presence of air bubbles or irregular flow rates. Malfunction of this type may indicate conditions which can effect the integrity of the sample. Irregular conditions will be noted on the Field Information Forms and reported to the site Environmental Manager.

Sample Collection Procedures (OAC 3745-54-97(D)(3)(b))

All groundwater samples shall be placed in appropriately prepared, laboratory-cleaned containers. The containers will be placed in an ice-packed container or shuttle at the time they are collected.

Monitoring Wells: Monitoring wells should be sampled immediately after purging. Volatile organics samples will be taken within three hours after they are purged. A sample will not be composited from two different sampling days.

The device used to sample a well, whether Well Wizard or stainless steel bailer, will be the same device used to purge the well. The bladder pumps operate in a continuous manner so that they do not produce pulsating samples that are aerated in the return tube or upon discharge. The flow rate for volatile samples will be decreased to approximately 100 ml/minute. The equipment used for sampling each well will remain dedicated to that well and the type of equipment will not change between sampling events.

In emergency cases when the Well Wizard pump will not operate, the well will be purged with a bailer. The bailer will be properly deconned using the following procedure:

When **organic** constituents are to be sampled for ~~of interest~~, the bailer will be washed with non-phosphate detergent, rinsed with tap water, rinsed with pesticide-grade hexane, rinsed with reagent-grade acetone, and rinsed with copious amounts of deionized water.

When **inorganic** constituents are of interest, the bailer will be washed with a non-phosphate detergent, rinsed with tap water, rinsed dilute (0.1N) hydrochloric acid and rinsed with copious amounts of deionized water. The bailer will be allowed to dry thoroughly before use.

The bailer will be lowered to just below the water level in the well. The bailer will be retrieved, and the water poured into a calibrated bucket. The cable from the bailer will be fed into a poly drum lined with a garbage bag. The garbage bag will be dedicated to that well for the entire sampling event. The procedure will be repeated until the required volume has been removed. During purging, equipment will not be laid on the ground. Powderless PVC, nitrile or latex gloves will be worn.

~~All groundwater samples shall be placed in appropriately prepared, laboratory cleaned containers. The containers will be placed in an ice-packed container or shuttle at the time they are collected.~~

Sample containers should be filled directly from the pump tube or bailer in a manner which minimizes agitation and aeration of the sample. Containers shall be filled to the top, leaving no air space for VOC's and TOX and minimizing air space for other parameters.

Capillary Drain: The volatile organic sample bottles will be filled directly from the pipe by lowering each bottle into the sump with an extended pole. The first volatile bottle collected will be utilized to fill the remaining volatile bottles, so as not to have any air bubbles in the sample bottle. The remaining sample bottles will be filled by lowering the stainless steel bucket into the sump and collecting the water as it drips from the pipe. The sample for filtered parameters will be poured into the field filter. The sample for non-filtered parameters will be poured directly into the bottles.

Sample containers shall be filled to the top, leaving no air space for VOC's and minimizing air space for other parameters.

Field Measurements for Wells and Capillary Drain

Field measurements will be taken for temperature, pH and specific conductance. A ~~glass jar or~~ plastic container will be rinsed with ~~well~~ sample water three (3) times and then filled for field measurements in a manner which minimizes aeration of the sample. The temperature, pH and specific conductance of the sample will be measured and recorded on the Field Information Form. Replicate measurements for pH and specific conductance shall be taken as quickly as possible after obtaining the sample. After field measurements are completed, the ~~glass jar or~~ plastic container will

be rinsed three (3) times with deionized water and saved for measurements at the next ~~well~~ sample point.

All meters used for field measurements of pH and specific conductance must be calibrated by the sampling team prior to initial sampling. The calibration of field meters will be checked every four (4) hours during sampling and recalibrated, if necessary.

Filtration (OAC 3745-54-97(D)(3)(f))

Samples will not be filtered for analysis of pH, specific conductance, temperature, volatile organics, and phenols. Samples for dissolved metals will be filtered.

For monitoring wells, ~~F~~filtration of appropriate samples will be performed ~~immediately after~~ during sample collection at the wellhead~~. Filtration will be done through~~ by using a 0.45 micron membrane pressure filter~~ and will be performed in the field~~. A minimum of three pump cycles of water must be allowed to pass through the filter before sampling. Only under emergency conditions will the samples be filtered in the on-site laboratory or by use of the field filtering apparatus. ~~Samples will not be filtered for analysis of pH, specific conductance, temperature, volatile organics, PCBs, and phenols. Samples for other analytical tests will be filtered including dissolved metals.~~

~~Wells containing Well Wizard bladder pumps use in line filters. A minimum of three pump cycles of water must be allowed to pass through the filter before sampling.~~

For the capillary drain, the field filtering apparatus will be used fro filtration of the appropriate samples.

When utilizing the field filter, samples will be filtered using the following procedure:

1) Make sure that the filtering apparatus has been completely cleaned with deionized water <u>only</u>, air dried or dried with white paper towels. Tighten pressure fittings.

2) Remove the top or reservoir portion of the filter holder and position a new 0.45um (142 mm diameter) filter on top of the filter support screen, making sure it is flush on

all edges. Care should be taken in handling the filter paper, as it is easily torn.

3) Place the top, or reservoir portion, of the filter holder back in place over the filter paper. Tighten down with the 3 wing-type clamps (finger tight only, with equal force on each clamp).

4) Unscrew the insert cover and fill the reservoir with the sample to be filtered using a clean and dry funnel.

5) Screw down the inlet cover and the reservoir securely.

6) Use appropriately labeled sample container.

7) Position the sample container under the outlet valve beneath the filter holder.

8) Open cylinder, regulate pressure to a maximum 40 psi and pressurize the reservoir. Use as little gas pressure as necessary for filtration of the sample.

9) When the sample bottle is full or the filtration flow ceases, turn the stopcock to the "off" position. Turn the pressure relief valve to the "on" position to release the pressure.

10) Between samples, disassemble the filter holder and it's components and thoroughly rinse a minimum of 3 times with deionized water only. Air dry completely or dry with white paper towels.

APPENDIX E

WMX TECHNOLOGIES, INC.

MANUAL

GROUNDWATER SAMPLING

WMX Technologies, Inc.
Environmental Monitoring Laboratories, Inc.
2100 Cleanwater Drive
Geneva, Illinois 60134

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August, 1995

PREFACE

PREFACE

This manual contains detailed procedures for sampling groundwater, surface water and leachate at both hazardous and solid waste facilities. These procedures are based on regulatory requirements, and on many years of experience by WMX Technologies, Inc. employees and contractors. They are to be followed by all WMX Technologies, Inc. Contractors, and personnel engaged in the collection of groundwater samples for the purpose of determining the groundwater quality in and around WMX facilities. Following these procedures and site specific procedures will ensure that groundwater samples are as representative as possible, and help produce analytical data that is of the highest quality and fully defensible. This manual is intended to be used in training personnel involved in sampling, and also as a reference for the proper procedures to be followed by experienced samplers.

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1.0 INTRODUCTION

1.0 Introduction

1.1 WMX Technologies, Incorporated (WMX) Groundwater Monitoring Program Overview

The objective of a WMX Groundwater Monitoring Program is to determine if a WMX facility may potentially affect the surrounding groundwater. Federal, state, and local regulatory agencies have established criteria that must be met for a facility to continue operating and to comply with closure and post closure requirements. These criteria involve standards that the groundwater must meet for the levels of chemical constituents. A groundwater monitoring program is required at all WMX facilities to ensure that these standards are met.

Regulations seldom completely specify the procedures required to carry out a comprehensive groundwater monitoring program; therefore, WMX requires that each applicable facility within its family of companies establish a site specific groundwater monitoring program that, when followed, will provide the most accurate data possible. This manual provides the necessary procedures to carry out the first and most critical element in a groundwater monitoring program--**THE SAMPLING.** Other elements of the groundwater monitoring program can be found in the WMI Site Assessment Manual (SAM), the Site-Specific Groundwater Monitoring Plans, and PAD ED-103. The WMX Groundwater Monitoring Program's structure is given schematically in Figure 1.1.

A Site Specific Groundwater Monitoring Program is developed for each WMX disposal facility and administered by the Group Environmental Management Department. (Refer to PAD ED-103). The plans include information on federal, state, and local regulatory monitoring requirements, as well as hydrogeological information. These plans and site-specific hydrogeological data aid the technical staff in determining the need for and location of sample collection points.

Groundwater samples are collected by consultants/contractors, or WMX environmental technicians at a frequency specified in the regulatory permits and described in the Site Specific Groundwater Monitoring Plan. The WMX Manual for Groundwater Sampling has been developed for use by WMX personnel and consultants/contractors.

WMX recognizes that sampling is a critical step in an effective monitoring program, and it has therefore incorporated the requirement for groundwater sampler training into PAD ED-103. PAD ED-103 requires that "Groundwater samplers must be trained by the EML as determined by Group EMD." Records of training are provided to Program Managers and copies are retained at the EML.

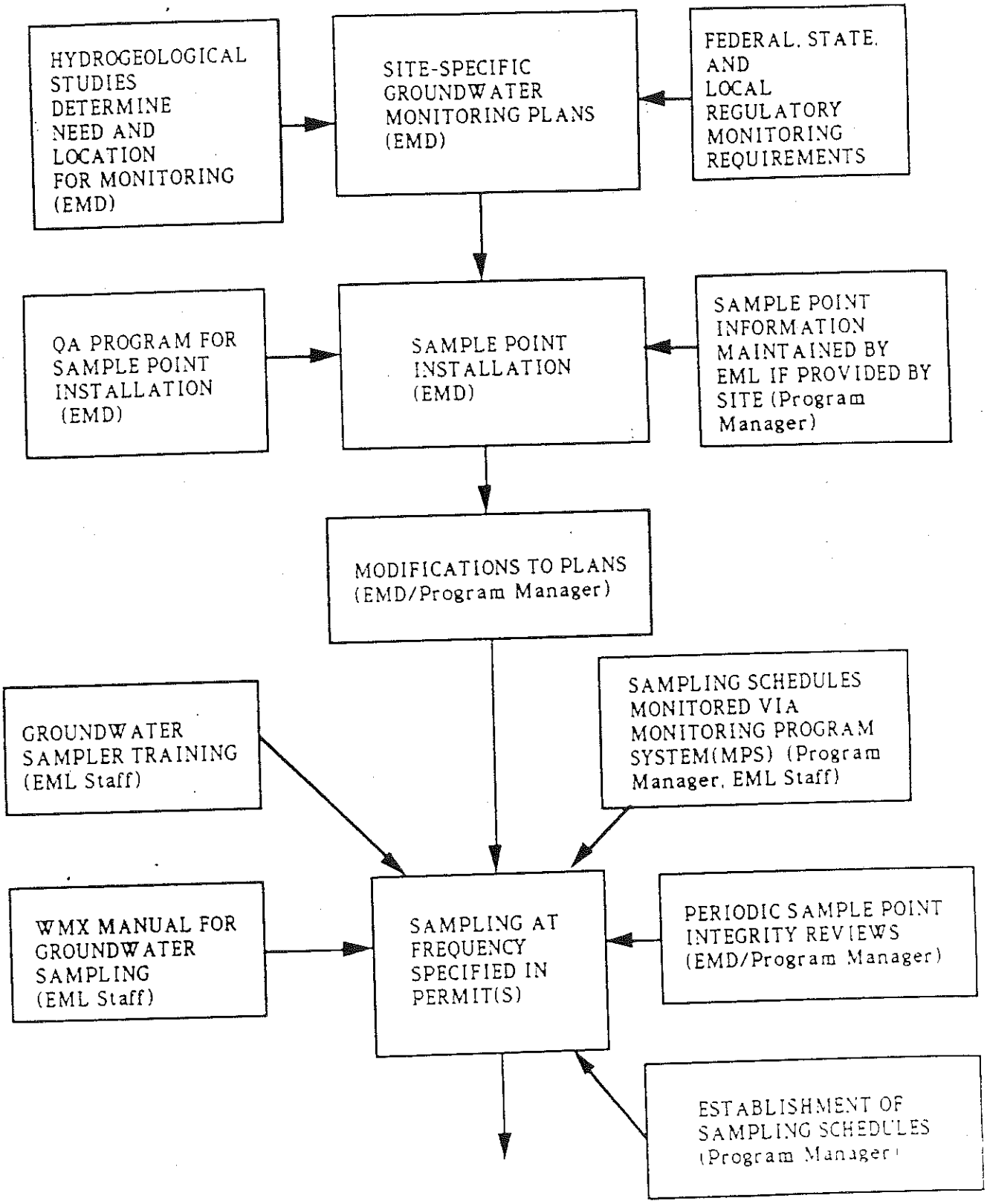
The WMX Environmental Monitoring Laboratories, Inc. (EML) provides laboratory analytical services to the WMX family of companies. The EML analyzes water matrices only (i.e., groundwater, leachate, surface waters). The EML also provides subcontract lab management for

matrices and methodologies not analyzed at the EML.

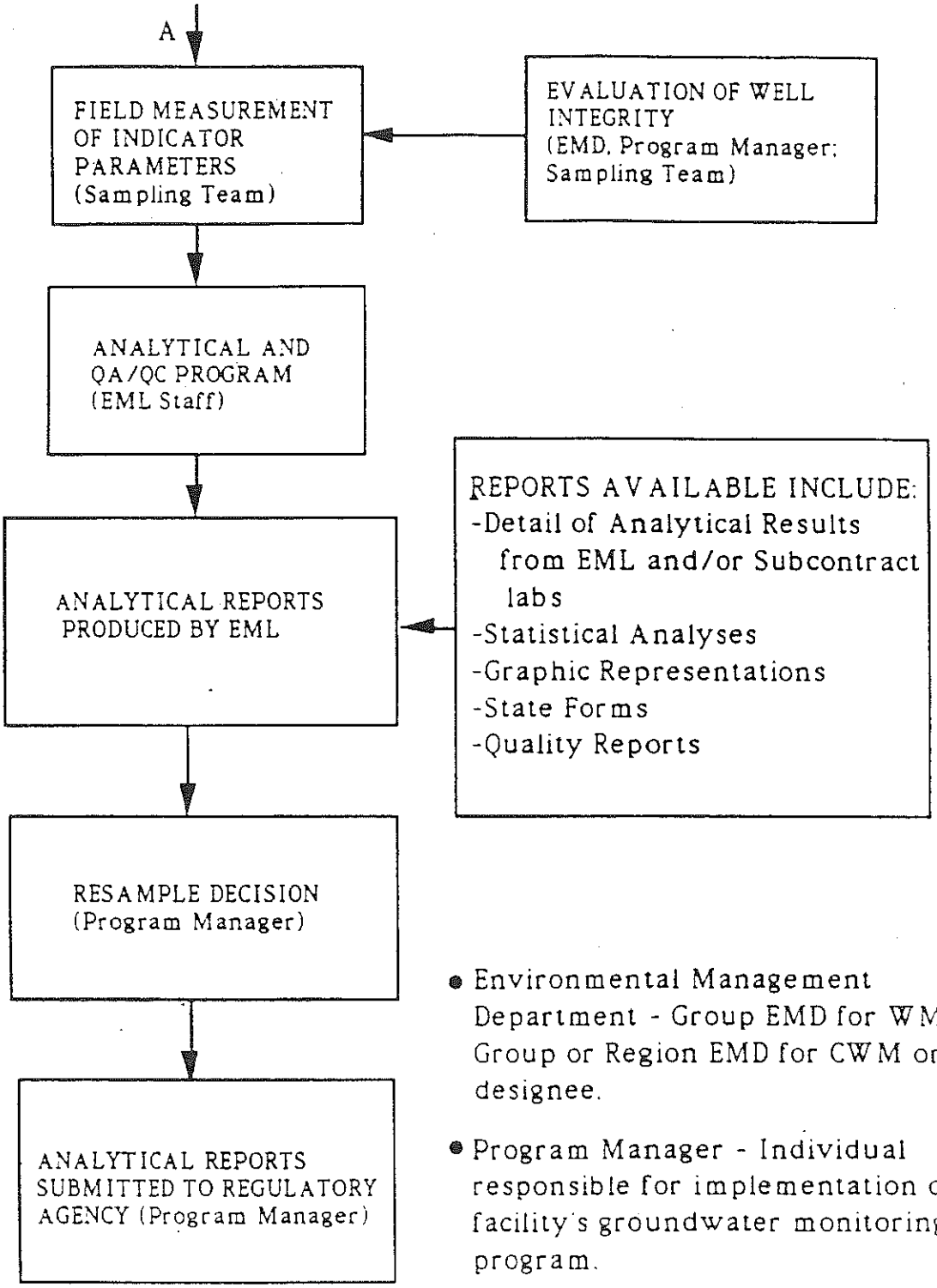
The EML is responsible for generating and ensuring the quality of the analytical data. All analytical data are entered into the EML's Laboratory Information Management System (LIMS) database and are available for retrieval by approved corporate, regional and site personnel. Hard copies of the data are provided by the EML, to the Program Manager, and/or directly to the regulatory agencies as required. Various hard copy and electronic data report formats are available from the EML.

GROUNDWATER MONITORING PROGRAM: STRUCTURE AND DESIGNATION OF RESPONSIBILITIES

Figure 1.1



GROUNDWATER MONITORING PROGRAM
STRUCTURE AND DESIGNATION OF RESPONSIBILITIES
(Figure 1.1 continued)



- Environmental Management Department - Group EMD for WMI; Group or Region EMD for CWM or their designee.
- Program Manager - Individual responsible for implementation of the facility's groundwater monitoring program.

1.2 WMX Sampling Program

The WMX Sampling and Analysis Program is outlined in Figure 1.2. The program begins and ends with the Program Managers, who act as administrators for their respective sites. Program Managers begin the sampling event process by defining the monitoring program with an EML Account Representative and by confirming sampling and analytical requirements prior to each sampling event.

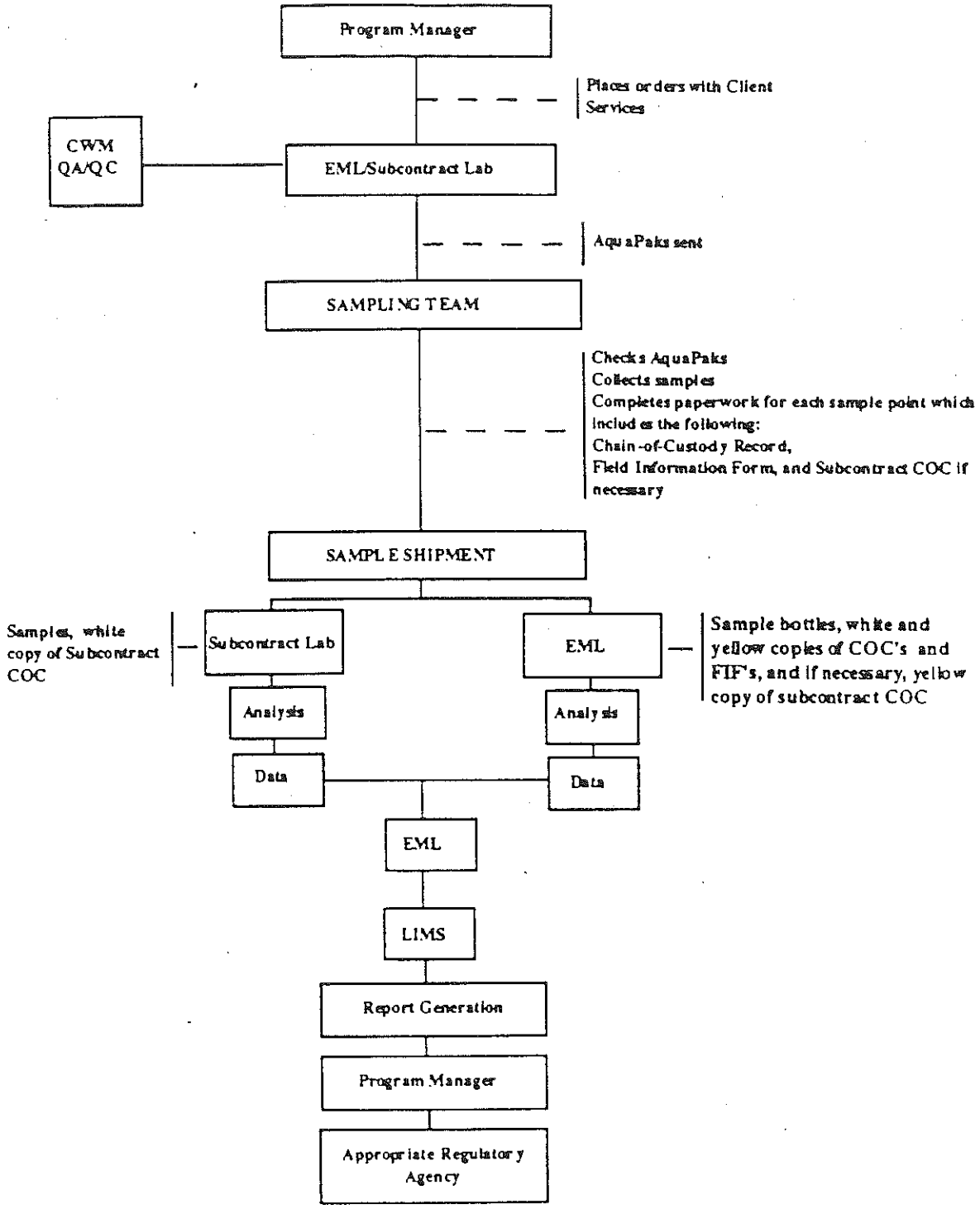
Once a sampling event is declared, the EML ships AquaPaks containing the necessary sample bottles, paperwork, and preservatives to the sampling team or WMX facility. EML also coordinates shipment of coolers for subcontracted analyses.

The sampling team checks the condition of the AquaPaks before sampling. If any problems exist, (e.g., missing bottles, etc.) , the sampling team immediately notifies the EML's Client Services Department (e.g. Account Representative). The Client Services Department, in turn, implements corrective actions to resolve the problem. Once the AquaPaks have been examined and any problems resolved, the sampling team collects the samples.

The sampling team completes a WMX Field Chain-Of-Custody Record and Field Information Form for each sample point during sampling. The proper completion of these forms is a critical aspect of legal field chain-of-custody and field QA/QC program. Together, these forms provide a comprehensive, consistent and accurate summary of field tests, measurements, and observations. They also document that the integrity of the samples has been maintained. Once samples have been collected, the sample and associated field forms are submitted to the EML.

Upon completion of sample analyses, the EML includes copies of Field Chain-of-Custody Records and Field Information Forms, along with the resultant analytical data, in a complete data package for each sampling event. This data package is sent to either the Program Manager or the regulatory agency for review.

GROUNDWATER SAMPLING PROGRAM
SEQUENCE FLOWCHART
Figure 1.2



2.0 RESPONSIBILITIES

2.0 Responsibilities

2.1 Program Manager

- Provides site-specific information for the Groundwater Monitoring Program.
- Work with the EML to set up a monitoring program that complies with applicable regulations and corporate policy, and obtain appropriate approval(s) for any changes before they are implemented.
- Notify the EML of any changes in sampling schedules or analytes, at the earliest possible convenience and confirm dates that AquaPaks will be sent to the sites and or sampling teams.
- Work with EML to set up a monitoring program event schedule.
- Notify the Site Manager, or other appropriate site personnel of maintenance required on wells or of any necessary replacements.
- Ensure that analytical results are reviewed and submitted to the proper agencies.
- Provide information for Well Id Charts.
- Oversee well drilling procedures, and review hydrogeological studies at the site.
- Annually update the Site Specific Groundwater Monitoring Plan where required.
- Schedule resampling, if necessary (e.g., holding times and temperature exceedances or confirmation of compliance level exceedances, etc).

2.2 Site Manager

- Ensure adequate well protection.
- Ensure that all wells are accessible.
- Provide maintenance for the wells where required, or when instructed to do so by the Program Manager or Regional and/or Site Engineer.
- Provide an isolated work area for sample preparation and equipment storage.
- Be the "keeper of the keys" for the monitoring wells, unless a designee has been assigned.

2.3 Sampling Team

- Follow all procedures specified in this Manual and in the Site-Specific Groundwater Monitoring Plan to ensure that all regulatory requirements are met and that representative samples are collected.

- Verify/confirm that a clean and secure area is available for storage of coolers and AquaPaks/sampling equipment.

- Review event schedule, and Statement of Work (SOW).

- AquaPak check-in;

  -Place ice packs in a sample dedicated freezer; ice packs usually take 24 hours to freeze.

  -Examine AquaPaks, bottles, preservatives and paperwork. Notify the EML immediately, if problems are found (e.g. broken/missing bottles, broken/missing preservatives, broken COC seal, etc.).

- Notify the Program Manager immediately if any problems are found.

- Obtain, maintain and inspect all required equipment, as necessary.

- Have spare working equipment available.

- Calibrate equipment and record calibrations in log note book.

- Purge and sample wells;

  - Determine whether water volume in the well is adequate for taking all samples.

  - Take all field required measurements, including at a minimum, pH, temperature, and specific conductance.

  - Prepare field blanks and obtain field duplicates.

  - Filter and preserve samples as necessary.

- Ensure that samples are correctly identified and packed securely with ice in the AquaPaks/coolers.

- Complete and sign the Field Chain-of-Custody Record and the Field Information Form for

each sample point, and enclose them in the appropriate AquaPaks/coolers before finally sealing.

- Contact courier for AquaPak/cooler pick-up.

2.4 EML

- Provide an environmental monitoring data base, including all analytical results, field measurements and selected field data.

- Ensure that all analytical data are supported by permanent records of lab QA/QC procedures, raw data, Chain-of-Custody Records, Field Information Forms, etc.

- Assist in the organization and documentation of the monitoring program for each site in the EML Monitoring Program System (computer database tables) in conjunction with the Program Manager.

- Provide AquaPaks and the appropriate contents, including sample bottles, preservatives, ice packs, and field forms.

- Establish a network of subcontract labs and serve as the primary contractor.

- Notify the Program Manager immediately of any confirmed analytical, chain-of-custody, or shipment problems which might require resampling.

- Provide all analytical services except where subcontract labs need to be employed.

A complete list of EML contacts, including telephone numbers and addresses, is listed in the Appendix .

3.0 ESTABLISHING THE SAMPLING EVENT

3.0 Establishing the Sampling Event

3.1 Permit Review

In order to establish any monitoring program and its subsequent sampling events, it is necessary to review all applicable regulatory and permit requirements. More than one regulatory program with specific requirements for sampling frequency and sample analysis may apply to a facility. For instance, a site may be subject to regulation under RCRA (Resource Conservation Recovery Act), city ordinances, sanitary districts, water quality boards, departments of health, departments of natural resources, or state EPA's.

It is therefore necessary to identify and understand each applicable requirement and to incorporate each into the Site Specific Groundwater Monitoring Plan. It is important to ensure that each requirement is met during all phases of the sampling and analysis procedures.

To assist the Program Manager in identifying and implementing any requirements specified to laboratory analytical methodology and reporting, the EML, upon request will evaluate the sampling and analytical requirements established in the appropriate regulatory permit(s). The EML is also available to assist facilities in negotiating analytical methods and reporting limits with the various regulatory agencies.

3.2 Verification and Initiation of a Sampling Event

The Program Manager coordinates with an EML Account Representative to establish a sampling event. This effort includes determining the required analytes, methodologies, QA/QC reporting limits, frequency, sampling schedules, turnaround time, and reporting mechanisms.

The EML can coordinate sampling events involving sample matrices and methodologies not performed by the EML (i.e., soils, air, TCLP, etc.). Subcontract labs that are utilized are chosen from the "Approved Non-WMX Laboratory List" published by WMI Quality Programs.

Sampling events are initiated by written or verbal communication with EML Account Representatives, who will create and forward a Program Manager's Checklist for confirmation of the event. For emergency events, this information can be provided verbally, but it must also be confirmed in writing, using the Program Manager's Checklist.

The Program Manager's checklist for routine events is used to verify the sampling event requirements. The checklist should be received by the Program Manager approximately 50 days prior to the sampling event. The Program Manager verifies and corrects the checklist, and returns it to the EML Account Representative no later than the 15th day of the month preceding the sampling event. (An example of a Program Manager's Checklist is given in Figure 3.1). When scheduling sampling events, consider that sample bottles and AquaPaks are sent via courier (e.g. Federal Express), which usually requires 2 days for delivery.

Figure 3.1

Date Printed 07/20 1995
Page #001

WMI
Monitoring Program Services - Administrative Information
Programs Manager's Checklist

Monitoring Program No: 418951-00000
Period covered: 01/1995 - 12/1995
Region: District:

Rev # 00 Type: R
Rev date: 07/20/1995
Month: AUG

Description:
ROUTINE GROUNDWATER MONITORING PROGRAM

PROGRAM STATUS = M
Revision History:
1/6/95: PER DB REQUEST|4/27: PER DP PHONE|7/20: PER DP PHONE|

		Correct? Y	N	Changes
Site #418 :	WMI Landfill	[ ]	[ ]	
Site Address:		[ ]	[ ]	
		[ ]	[ ]	
City:	Geneva	[ ]	[ ]	
State & Zip:	IL 60134	[ ]	[ ]	
Phone	(708) 208-3173	[ ]	[ ]	
rogram Manager:		[ ]	[ ]	
Address:	WMI LANDFILL	[ ]	[ ]	
		[ ]	[ ]	
City:	GENEVA	[ ]	[ ]	
State & Zip:	IL 601340000	[ ]	[ ]	
Phone	(708) 208-3100	[ ]	[ ]	
Sampling Team:		[ ]	[ ]	
Address:	WMI LANDFILL	[ ]	[ ]	
		[ ]	[ ]	
City:	GENEVA	[ ]	[ ]	
State & Zip:	IL 601340000	[ ]	[ ]	
Phone	(708) 208-3100	[ ]	[ ]	
Aquapak Shipment:		[ ]	[ ]	
Address:	WMI LANDFILL	[ ]	[ ]	
		[ ]	[ ]	
City:	GENEVA	[ ]	[ ]	
State & Zip:	IL 601340000	[ ]	[ ]	
Phone	(708) 208-3100	[ ]	[ ]	

WMI
Sampling and Analysis Requirements
Programs Manager's Checklist

Monitoring Program No: 418951-00000
Task: # 03
Description: 6 WELLS, 1 FIELD BLANK
QUARTERLY PROGRAM.

Rev # 00
Rev Date: 07/20/1995
Status: I

Sample Matrix Code: W Name: WELL

Sampling Instructions: Correct? Yes [ ] No [ ]

WMIS MANUAL FOR GROUND WATER SAMPLING IS TO BE FOLLOWED.
STATE FORMS TO BE COMPLETED.

Special Instructions: Correct? Yes [ ] No [ ]

TWO SAMPLE POINTS PER AQUAPAK.

Figure 3.1 continued

Date Printed 07 20 1995
Page #003

WMI
Sampling and Analysis Requirements
Programs Manager's Checklist

Monitoring Program No: 418951-00000
Task: # 03
Description: 6 WELLS, 1 FIELD BLANK
QUARTERLY PROGRAM.

Rev # 00
Rev Date: 07/20/1995
Status: I

Month #		Correct? Y	N	Changes
AUG 1	Fixed Sampling			
Report Due: / /	Date: 08/01/1995	[ ]	[ ]	_____
EML Turn Around Time (Days): 25		[ ]	[ ]	_____
Sample Priority Code: Y QA/QC Code: NO				
Sample Matrix Code: W Name: WELL				

Sample Points

01FB	MW01	MW02	MW03	MW04	[ ]	[ ]	_____
MW05	MW06				[ ]	[ ]	_____

Method Name	F	Report to	Lab			
ALKALINITY TOTAL METHYL O	N	STATE	EML	[ ]	[ ]	_____
CYANIDE, TOTAL AUTOMATED	Y	STATE	EML	[ ]	[ ]	_____
PHENOLS, HIGH RANGE AUTO	Y	STATE	EML	[ ]	[ ]	_____
SOLIDS,TOTAL DISSOLVED(RE	N	STATE	EML	[ ]	[ ]	_____
TOTAL ORGANIC CARBON DUPL	Y	STATE	EML	[ ]	[ ]	_____
FD/PH - SINGLE	N	STATE	EML	[ ]	[ ]	_____
FD/SP COND - SINGLE	N	STATE	EML	[ ]	[ ]	_____
FDW/DTW TOP OF CASING	N	STATE	EML	[ ]	[ ]	_____
FDW/GW ELEV/W DEPTH TOT	N	STATE	EML	[ ]	[ ]	_____
FDW/PURGING INFOMATION	N	STATE	EML	[ ]	[ ]	_____
FDW/PURGING/SAMPLING EQUP	N	STATE	EML	[ ]	[ ]	_____
FD/H2O TEMP IN DEG C	N	STATE	EML	[ ]	[ ]	_____
MERCURY BY COLD VAPOR AA-	Y	STATE	EML	[ ]	[ ]	_____
DISSOLVED K BY FLAME AA	Y	STATE	EML	[ ]	[ ]	_____
ARSENIC BY GFAA-DISSOLVED	Y	STATE	EML	[ ]	[ ]	_____
LEAD BY GFAA-DISSOLVED	Y	STATE	EML	[ ]	[ ]	_____
SELENIUM BY GFAA-DISSOLVE	Y	STATE	EML	[ ]	[ ]	_____
SILVER BY ICP-DISSOLVED	Y	STATE	EML	[ ]	[ ]	_____
CALCIUM BY ICP-DISSOLVED	Y	STATE	EML	[ ]	[ ]	_____
CADMIUM BY ICP-DISSOLVED	Y	STATE	EML	[ ]	[ ]	_____
CHROMIUM BY ICP-DISSOLVED	Y	STATE	EML	[ ]	[ ]	_____
SULFATE,COLORIMETIRC AUTO	Y	STATE	EML	[ ]	[ ]	_____
HEXAVALENT CHROMIUM	Y	STATE	NET	[ ]	[ ]	_____
SV ORGANOCHLOR.PEST.DW509	N	STATE	EML	[ ]	[ ]	_____
35 Volatile Compounds	N	STATE	EML	[ ]	[ ]	_____

WMI
Monitoring Program Services - Administrative Information
Programs Manager's Checklist

Monitoring Program No: 418951-00000
Period covered: 01/1995 - 12/1995
Region: District:

Rev # 00 Type: R
Rev date: 07/20/199
Month: AUG

If you are requesting an analysis for samples that may contain polychlorinated biphenyls ("PCBs"), do you know or have reason to believe that the samples you will send to EML for analysis are from a source that contains PCBs in a concentration greater than or equal to 50 parts per million?

Y/N

If yes, please explain.

Are you requesting an analysis of F039 leachate or any samples that should be coded as F039?

Y/N

Does your permit require the use of any specific EPA laboratory methods?

Y/N

If yes, please attach a copy of the relevant sections of your permit.

Signatures show approval of all charges associated with the analytical work outlined in this checklist.

Program Manager Approval:

_____ Date _____

EML Approval:

_____ Date _____

Figure 3.1 continued

A Report on Specified Methods

SITE NUMBER.....418
METHOD-ID.....SBHEXCRM01
METHOD DESCRIPTION..... SUB HEXAVALENT CHROMIUM
LIMS METHOD NAME..... SUB HEXAVALENT CHROMIUM

Analyte ID	Analyte Name	Units	Type	Calc
CHROMIUM-6	CHROMIUM-VI	MG/L	N	N

Figure 3.1 continued

A Report on Specified Methods

SITE NUMBER.....418
METHOD-ID.....SVGC1OCP01
METHOD DESCRIPTION..... SV ORGANOCHLORINE PESTICIDES DW/509A GC
LIMS METHOD NAME..... SV ORGANOCHLORINE PESTICIDES DW/509A GC

Analyte ID	Analyte Name	Units	Type	Calc
XREFIDXX01	BATCH SEQUENCE FILE NAME		C	N
72208	ENDRIN	UG/L	N	N
58899	LINDANE (GAMMA-BHC)	UG/L	N	N
72435	METHOXYCHLOR	UG/L	N	N
8001352	TOXAPHENE	UG/L	N	N

Figure 3.1 continued

A Report on Specified Methods

SITE NUMBER.....418
METHOD-ID.....VOMSAAO302
METHOD DESCRIPTION..... 35 VOLATILE COMPOUNDS
LIMS METHOD NAME..... 35 VOLATILE COMPOUNDS

Analyte ID	Analyte Name	Units	Type	Calc
71556	1,1,1-TRICHLOROETHANE	UG/L	N	N
79345	1,1,2,2-TETRACHLOROETHANE	UG/L	N	N
79005	1,1,2-TRICHLOROETHANE	UG/L	N	N
75343	1,1-DICHLOROETHANE	UG/L	N	N
75354	1,1-DICHLOROETHENE	UG/L	N	N
107062	1,2-DICHLOROETHANE	UG/L	N	N
78875	1,2-DICHLOROPROPANE	UG/L	N	N
78933	2-BUTANONE	UG/L	N	N
110758	2-CHLOROETHYLVINYL ETHER	UG/L	N	N
591786	2-HEXANONE	UG/L	N	N
108101	4-METHYL-2-PENTANONE	UG/L	N	N
67641	ACETONE	UG/L	N	N
XREFIDXX01	BATCH SEQUENCE FILE NAME		C	N
71432	BENZENE	UG/L	N	N
75274	BROMODICHLOROMETHANE	UG/L	N	N
75252	BROMOFORM	UG/L	N	N
74839	BROMOMETHANE	UG/L	N	N
75150	CARBON DISULFIDE	UG/L	N	N
235	CARBON TETRACHLORIDE	UG/L	N	N
108907	CHLOROBENZENE	UG/L	N	N
75003	CHLOROETHANE	UG/L	N	N
67663	CHLOROFORM	UG/L	N	N
74873	CHLOROMETHANE	UG/L	N	N
10061015	CIS-1,3-DICHLOROPROPENE	UG/L	N	N
124481	DIBROMOCHLOROMETHANE	UG/L	N	N
100414	ETHYLBENZENE	UG/L	N	N
75092	METHYLENE CHLORIDE	UG/L	N	N
100425	STYRENE	UG/L	N	N
127184	TETRACHLOROETHENE	UG/L	N	N
108883	TOLUENE	UG/L	N	N
156605	TRANS-1,2-DICHLOROETHENE	UG/L	N	N
10061026	TRANS-1,3-DICHLOROPROPENE	UG/L	N	N
79016	TRICHLOROETHENE	UG/L	N	N
108054	VINYL ACETATE	UG/L	N	N
75014	VINYL CHLORIDE	UG/L	N	N
1330207	XYLENE(TOTAL)	UG/L	N	N

When verifying a sampling event, reference should be made to the appropriate monitoring program. AquaPak shipment arrangements and any other special instructions should also be verified. Any changes should be noted verbally and confirmed in writing by sending the corrected Program Manager's Checklist to the appropriate EML Account Representative.

Special sampling events requiring immediate attention are accommodated on an as needed basis. For an emergency sampling event designated by the Program Manager, AquaPaks and bottles can be sent via overnight delivery at a surcharge. Insufficient notice of a sampling event increases costs, so as much notice as possible should be given to an EML Account Representative prior to the event.

The following information is to be provided/verified by completing the Program Manager's Checklist:

*Facility Name and Site Number

The facility name and site number must be provided. All analyses done for WMX by the EML are stored in the EML's LIMS (Laboratory Information Management System) system and under the site number. Site numbers are also used on all field chain-of-custody records, field information forms, and analytical reports. If a site is new or is being expanded, a three digit site number must be obtained from the EML Client Services Department.

*Monitoring Program Task Number

For regularly scheduled events, reference is given to the tasks to be included in the sampling event. Generally, samples having the same source code and requiring identical analyses will be grouped under a single task.

*Monitoring Program Month Number(s)

All samples having the same source code, requiring identical analyses, and having the same scheduled sampling start date, are grouped under a single month number within the task.

*ENS - Event Notification System

When the events are approved and finalized in the EML computer system (LIMS), each quarter's or month's event becomes a separate ENS number (Event Notification System Number). For each ENS number generated, a separate client report package is mailed from the EML. The ENS is the system the EML uses to track and document all phases of the sampling event/client report.

*Number of Samples and Matrix

The number of samples, sample types, and source codes (e.g. well, leachate, lake or ocean, etc.) to be collected and analyzed including duplicates and field blanks must be specified. Special instructions for the number of trip blanks may also be specified (See Section 4.3.5).

It is important to identify samples that may have a complex matrix or potential interferences, such as high sulfide or chloride or organic concentrations. These samples may require special preparation and/or cleanup procedures prior to analysis.

*Sample Point Designations

Sample point designations must be listed and should be standardized to avoid confusion. These designations are limited to six characters (alphabetic and/or numeric). The EML's Account Representatives can assist clients in determining sample point designation assignments as needed. The sample point designations established in LIMS are used by the sampling team, the EML, and the subcontract lab. As a quality check, the EML does not log samples for analysis that do not contain previously established sample point identifiers. If a new sample point designation must be established, or if a sample point designation must be modified, contact the EML's Client Services Department.

*Method Designations

The analytical method and parameters to be analyzed on a sample have been previously identified in the Program Manager's Checklist. (See Figure 3.1) Within the monitoring program checklist, the EML has assigned a 10 digit method designation code abbreviation to the analysis for internal tracking. These designations will be assigned by the EML upon review of the required analytical procedures.

The first two letters of the method designation code identify the section of the laboratory where the analysis will be performed. (e.g., CR = Chemical Methods & Robotics, IN = Inorganics, SV = Semi Volatiles, VO = Volatiles, SB = Subcontract, FD = Field Data). Other letters and numbers further identify the type of analysis to be performed. For example, with INICPDISFE: IN represents the inorganics lab group; ICP represents ICP (Inductively Coupled Plasma Atomic Emission Spectroscopy) methodology; DIS represents dissolved metal analysis and FE (iron) represents the analyte.

*Sampling Date(s)/Schedule

Specific dates for sample collection should be scheduled as accurately and as far in advance of the sampling event as feasible. If samples require an accelerated TAT (turn around time), it is suggested that the Program Manager contact the EML with estimated arrival times in order to help expedite the analyses. (Regulatory agencies should also be notified of scheduled dates as

required).

*Required Sampling Arrangements

The EML's Account Representative will maintain communications with those responsible for sampling and will work with the Program Manager in coordinating sampling schedules.

For special events, special expertise or equipment may be required, so as much information as possible should be provided to the sampling team.

*Delivery Address for AquaPaks and Sample Bottles

The delivery address for AquaPaks may be the site, the sampling team's office, or another WMX facility. Specific information should be given about the delivery location including the building and room. This will minimize the need to relocate AquaPaks for storage. The Program Manager's name and/or sampling team members name will be included on all AquaPaks. It may be necessary for the sampling team to have an on-site person to contact in order to allow the sampling team access to the site and to confirm arrival of AquaPaks and sample bottles, etc.

*Special Instructions

Special instructions must also be noted. For example:

- Special packing requirements (e.g., one sample point per AquaPak, or do not combine ENS#'s, etc.).
- Special report requirements (e.g., state forms, accelerated TAT, quality reports, various other report styles, etc.).
- Known interferences or known high levels of a compound from a specified sample point so special analytical procedures can be followed (e.g., all F039 leachates should be identified).
- Field filtering procedures (if required).
- Non-routine detection limits or methodologies required by a regulatory agency.

*Turnaround

The standard turnaround time (TAT) for analytical results from the EML is 25 days from receipt of the last sample in an ENS number. The EML will notify the Program Manager when the standard TAT cannot be met. Exceptions may be made for unusual detection limits, odd matrices, special compounds, and subcontracted analyses. Express or emergency TAT, (i.e.,<25 days)

when required, must be communicated to the Client Services Department at the EML. Surcharges will be added to express turn around time events.

After verification and signature by the Program Manager, a Statement of Work (SOW) is generated for the sampling event. An ENS number is assigned for each Task/Month number which comprises a Statement of Work. To confirm information concerning the sampling, copies of the SOW will be sent to the Program Manager, Sampling Team, and Subcontract laboratory. (See Figure 3.2 for an example of a Program Manager's SOW.)

Figure 3.2

Date Printed: 08/24/1995
Page: 01 of 02

PROGRAM MANAGER

STATEMENT OF WORK

Monitoring Program Information | TAT: 25 QA/QC: NO

MP no.	Rev	Rev date	Task	Month	ENS no.	Samp Date	No.SPs	est.Bots
418951	00	08/08/95	03	AUG1	95-13054	08/01/95	0007	000114

Sample Matrix Code: W | Sample Matrix Name: WELL

Site Information	Description
Number: 418 Name : WMI Landfill Location: Geneva , IL	6 WELLS, 1 FIELD BLANK QUARTERLY PROGRAM.

Sample Points:

01FB MW01 MW02 MW03 MW04 MW05 MW06

END SAMPLING REQUIREMENTS

Method ID	Method Description	F	# Size	Type	Report to	Lab
CRTOCDUP02	TOTAL ORGANIC CARBON DUPL	Y	01-0125	G	STATE	EML
CRPNHRAX01	PHENOLS, HIGH RANGE AUTO	Y	01-0500	G	STATE	EML
CRCNTTLX01	CYANIDE, TOTAL AUTOMATED	Y	01-0250	P	STATE	EML
CRALKMOT01	ALKALINITY TOTAL METHYL O	N	01-0125	P	STATE	EML
CRTDSXXX01	SOLIDS,TOTAL DISSOLVED(RE	N	01-0500	P	STATE	EML
FDWDTWTC01	FDW/DTW TOP OF CASING		-		STATE	EML
FDWGWELWDT	FDW/GW ELEV/W DEPTH TOT		-		STATE	EML
FDWPURINFO	FDW/PURGING INFOMATION		-		STATE	EML
FDWPURSAMP	FDW/PURGING/SAMPLING EQUP		-		STATE	EML
FDXTEMPC01	FD/H2O TEMP IN DEG C		-		STATE	EML
FDPHSING01	FD/PH - SINGLE		-		STATE	EML
FDSPCOND01	FD/SP COND - SINGLE		-		STATE	EML
INGFAADIAS	ARSENIC BY GFAA-DISSOLVED	Y	01-0125	P	STATE	EML
INGFAADIPB	LEAD BY GFAA-DISSOLVED		-		STATE	EML
INGFAADISE	SELENIUM BY GFAA-DISSOLVE		-		STATE	EML
INFAADISXK	DISSOLVED K BY FLAME AA	Y	01-0500	P	STATE	EML
INICPDISAG	SILVER BY ICP-DISSOLVED		-		STATE	EML
INICPDISCA	CALCIUM BY ICP-DISSOLVED		-		STATE	EML
INICPDISCD	CADMIUM BY ICP-DISSOLVED		-		STATE	EML
INICPDISCR	CHROMIUM BY ICP-DISSOLVED		-		STATE	EML
INCVAADIHG	MERCURY BY COLD VAPOR AA-		-		STATE	EML
INSULFAT01	SULFATE,COLORIMETIRC AUTO	Y	01-0250	P	STATE	EML
SVGC1OCP01	SV ORGANOCHLOR.PEST.DW509	N	02-1000	G	STATE	EML
VOMSAAO302	35 Volatile Compounds	N	04-0040	G	STATE	EML
SBHEXCRM01	HEXAVALENT CHROMIUM	Y	01-0250	P	STATE	THERMO
SVGC1OCP01	** SEMI-VOLATILE DUPS **	N	02-1000	G	STATE	EML
VOMSAAO302	****** TRIP BLANK ******	N	01-0040	G	STATE	EML

END BOTTLE REQUIREMENTS

Figure 3.2 continued

PROGRAM MANAGER

STATEMENT OF WORK

Sampling Instructions:

WMIS MANUAL FOR GROUND WATER SAMPLING IS TO BE FOLLOWED.
STATE FORMS TO BE COMPLETED.

Special Instructions:

TWO SAMPLE POINTS PER AQUAPAK.

---------- END STATEMENT OF WORK ----------

4.0 PROCEDURES

4.0 Procedures

4.1 Preliminary Procedures

Before any sampling is done at a facility, a number of preliminary tasks must be completed. These tasks include locating the well, identifying well characteristics, defining the sampling schedule, and identifying parameters to monitor. If these preliminary procedures are followed properly at the outset, they can ensure that subsequent sampling is accurate and cost effective.

4.1.1 Well Location and Characteristics

The first step in any monitoring program is the installation or location of the monitoring points. Certain information about each well is required, whether a new program or an existing one is involved. WMX employs the Monitoring Well Construction Summary and Well ID Chart to maintain pertinent well information.

4.1.1.1 Well Construction Summary and Well ID Chart

The Monitoring Well Construction Summary (Figure 4.1) is completed upon well installation. (See the WMX Site Assessment Manual (SAM)).

The Well ID Chart (Figure 4.2) is used to summarize and communicate key well characteristics to the Program Manager and sampling team. The Well ID Chart is also used to monitor well integrity. The sampling team compares historical values (i.e. "Normal Range") with the values collected when samples are taken. If any inconsistencies are observed between the Normal Range and new values, sampler(s) complete the sampling event and contact the Program Manager immediately.

The Well ID Chart should be reviewed periodically (at least once a year) and revised where necessary, and may include:

Site Name and Number:	Enter the name and number of the facility being monitored.
Date:	Enter the date the Well I.D. Chart is being completed or updated.
Well ID Number:	Enter the sample point identification number. Identification numbers assigned by state or local agencies should be shown in parentheses.
Well Status	Enter "A" if the well is active, "C" if the well is closed, and "I" if the well is inactive. If the Well ID is closed, note the date on which it was closed in the "comments" section.

Figure 4.1

Well No. _____

Boring No. X-Ref: _____

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: _____ Elevation Ground Level _____

Top of Casing _____

Drilling Summary:

Total Depth _____

Borehole Diameter _____

Casing Stick-up Height: _____

Driller _____

Rig _____

Bit(s) _____

Drilling Fluid _____

Protective Casing _____

Construction Time Log:

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling				
Geophys. Logging:				
Casing:				
Filter Placement:				
Cementing:				
Development:				

Well Design & Specifications

Basis: Geologic Log ____ Geophysical Log ____

Casing String (s): C = Casing S = Screen.

Depth	String(s)	Elevation
___ - ___	___	___ - ___
___ - ___	___	___ - ___
___ - ___	___	___ - ___
___ - ___	___	___ - ___
___ - ___	___	___ - ___

Casing: C1 _____

C2 _____

Screen: S1 _____

S2 _____

Filter Pack: _____

Grout Seal: _____

Bentonite Seal: _____

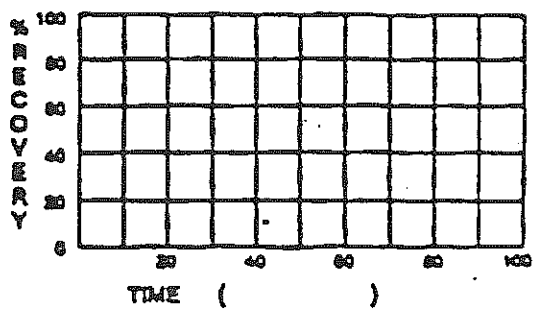
Well Development:

Stabilization Test Data:

Time	pH	Spec. Cond.	Temp (C)

Recovery Data:

Q= S_0=



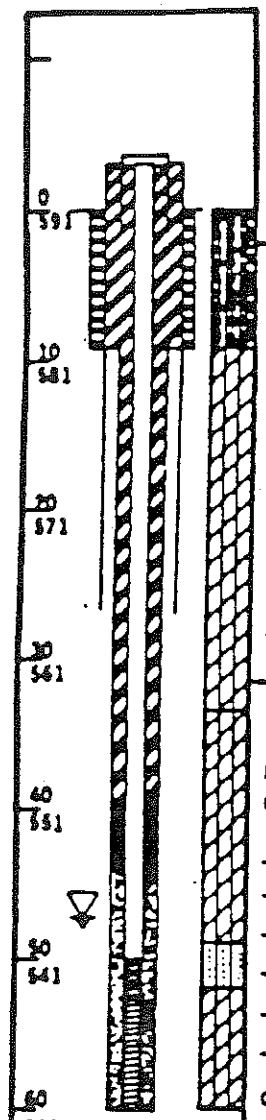
Comments:

SITE NAME _____

SUPERVISED BY _____

DATE _____

Figure 4.1.1



Project No. 88-034

Well No. G-123

Boring No. X-Ref: G-123

MONITOR WELL CONSTRUCTION SUMMARY

Survey Coords: S - 15.26 (1)
E - 2734.73

Elevation Ground Level 590.75

Top of Casing 594.11

Drilling Summary:

Total Depth 60.0 ft.
Borehole Diameter 8"/6"/4"
Casing Stick-up Height: 3.4 ft.
Driller Fox Drilling

Rig CME 75
Bit(s) 0 to 20' - 8" auger
20 to 60' - 6" tricone
Drilling Fluid Clean Water

Protective Casing 6" anodized aluminum locking

Construction Time Log: 1988

Task	Start Date	Start Time	Finish Date	Finish Time
Drilling	04/07	0800	04/11	1200
Well Install.	04/11	1030	04/11	1200
Geophys. Logging:				
Casing: C1	04/11	1030	04/11	1100
C2	04/07	0830	04/07	1130
S1	04/11	1030	04/11	1100
C3	04/13	0800	04/13	0900
Filter Placement:	04/11	1030	04/11	1100
Cementing:	04/11	1100	04/11	1200
Development:	05/19	1100	05/20	1340

Well Design & Specifications

Basis: Geologic Log X Geophysical Log ___
Casing String (s): C = Casing S = Screen.

Depth	String(s)	Elevation
+1.0 - 50.0	C1	593.75 - 540.75
+3.0 - 27.0	C2	593.75 - 563.75
+3.4 - 1.6	C3	594.11 - 589.11
50.0 - 60.0	S1	540.75 - 530.75
-		-

Casing: C1 2" dia. 316 stainless steel
C2 6" dia. steel
C3 4" dia., 5' long aluminum
Screen: S1 2" dia. 316 stainless steel wire wound screen.
S2

Filter Pack: #5 quartz sand
Depth 44.0 - 60.0 ft.
Secondary filter 39.5 - 40.0 ft.
Grout Seal: Volclay grout
Depth 3.0 - 39.5 ft.

Bentonite Seal: 1/4" bentonite pellets
Depth 40.0 - 44.0 ft.

Well Development: 1988

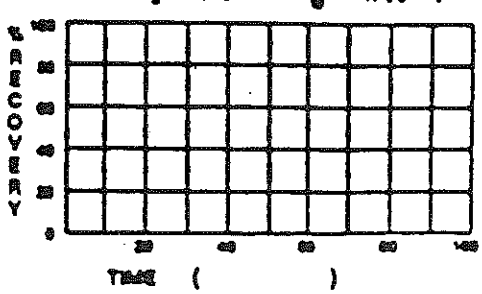
5/19 - 1100 to 1440 - Air jetted with compressed air.
5/20 - 1315 to 1340 - Bailed with PVC bailer.
Total water removed: 19 gallons

Stabilization Test Data: 1988

Time	pH	Spec. Cond.	Temp (F)
1100	8.00	2440	58.0 (5/19)
1340	7.87	1240	60.0 (5/20)

Recovery Data:

Q= 19 gallons S_0= 47.8'



Comments: (1)

SITE NAME WHI - xxx
LOCATION Anytown, USA
WC 0259
SUPERVISED BY MY - CANONIE
DATE 4 - 11 - 88

WELL I.D. CHART

FIGURE 4.2

Date:_____

Site :_____(_____)

Well I.D. Number	Well Status	Purpose	Gradient	Well Depth Feet	Elevation at Top of casing (MSL)	Normal Ranges: Purge Volume (Gallons)	Depth to Water (Feet)	Time Needed to Recharge (Hours)	Temp. *Celsius	pH (Std)	Specific Conduct. (Umhos/cm.at 25°C)	Comments

Completed by:_____

WELL I.D. CHART

FIGURE 4.2.1

Date: 3-10-95

Site : ABC Landfill

Well I.D. Number	Well Status	Purpose	Gradient	Well Depth Feet	Elevation at Top of casing (MSL)	Normal Ranges: Purge Volume (Gallons)	Depth to Water (Feet)	Time Needed to Recharge (Hours)	Temp. *Celsius	pH (Std)	Specific Conduct. (Umhos/cm.at 25°C)	Comments
	A	RCRA	DOWN	60	468.31	20.6-22.0	15'-18'	4	12	7.0-7.3	350-450	
	A	RCRA	DOWN	90	466.73	30.8-31.8	25'-27'	7	10	7.3-7.5	275-325	
	C	STATE	UP	45	465.11	2.5-4.9	35'-40'	48	13	7.5-7.7	350-370	Well abandoned 6/86
	A	RCRA	UP	50	495.81	21.6-22.0	5'-6'	72	14	6.5-6.8	1570-1800	Recharge time per R. Eng.
	A	RCRA	DOWN	120	495.76	52.8-53.8	10'-12'	24	19	6.1-6.4	970-110	Strong Odor
		RCRA	DOWN	70	515.81	18.6-19.6	30'-32'	<1	11	7.1-7.4	450-470	Good recharge rate

Calculations made based on Well casings. Purge volumes were calculated based on 3 well volumes being purged.

Completed by:_____

Purpose:	Note the type of regulatory program and/or agency for which the well is monitored (e.g., RCRA, TSCA, (Toxic Substances Control Act), state agency assessment, etc.).
Gradient:	Note whether the well is upgradient, downgradient, or lateral to the specific unit or formation being monitored.
Well Depth:	Note the total distance in feet from the top of the well casing or reference point to the bottom of the well.
Elevation at Top of Casing:	Note the elevation at mean sea level (msl), at the top of the well casing to the nearest hundredth of a foot. If elevations have been measured from another point, this variation should be noted on the Well ID Chart.
Normal Ranges:	These are ranges, that represent historic values, including seasonal variations. Check with the Program Manager, Site Specific Groundwater Monitoring plan, permit(s), and state/local agencies to determine a range. **NOTE**--These are not Alert Levels!
Purge Volume:	Note the approximate number of gallons purged from the well.
Depth to Water:	Note the depth to groundwater, to the nearest hundredth of a foot, from the top of the well casing (or reference point).
Time Needed To Recharge:	Note the time required for the well to recharge sufficiently to collect all samples.
Temperature:	Note the range of the water temperature in degrees Celsius.
pH:	Note the range of the water's pH in standard pH units.
Specific Conductance:	Note the range of the conductivity values, of the samples in umhos/cm at 25° C.
Comments:	In this section, document such things as well closure dates, specific monitoring requirements, or recharge information for Well Wizards.

A site map, which includes well locations and ID numbers, is available in the Site Specific Groundwater Monitoring Plan, and is available to sampling team members for use in locating and identifying the wells.

Both the Monitoring Well Construction Summary and the Well ID Chart are typically found in the facility's Site-Specific Groundwater Monitoring Plan.

4.2 Presampling Procedures

Once the sampling event has been scheduled and declared, a considerable amount of preplanning must be done to ensure that sampling will go smoothly. Presampling procedures include procuring and calibrating of field meters and equipment, inspecting AquaPaks, reviewing SOWs, and initiating Field Chain-of-Custody Records. These procedures are addressed in the following sections. It is suggested that preparation for the sampling event begin at least one week before the event, to ensure enough time to complete all of the steps and correct any problems that occur. For emergency events, contact the EML for assistance in expediting these procedures.

4.2.1 Organizing Equipment and Materials

All equipment necessary for a sampling event should be cleaned and/or decontaminated, checked and, if necessary, calibrated before going into the field. As much preparation as possible should be done ahead of time since the material required for equipment cleaning and calibration may not be available at the facility. Figure 4.3 is a checklist of equipment that may be required for a sampling event.

PRESAMPLING CHECKLIST

Figure 4.3

A. Nondedicated Equipment

1. Bailers

	PVC	Stainless	Teflon®
3/4 inch	_____	_____	_____
1 ½ inch	_____	_____	_____
3 inches	_____	_____	_____
Other	_____	_____	_____
S. Steel chain/ cable/line		_____	

2. Spare parts for equipment

_____ Stainless steel chain
_____ Tubing
_____ Elbows
_____ Air hoses
_____ Well Wizard® maintenance kit

3. _____ Gasoline compressor and controller

4. _____ Gas cylinder and regulator

B. Field Measurement Equipment

Primary

1._____pH
2._____Specific conductivity
3._____Temperature
4._____Temperature probe
5._____Depth to water probe
6._____Weighted tape with popper
7._____Surveyor's tape measure
8._____Specific conductivity standards
9._____pH Buffers

Backup

1._____pH
2._____Specific conductivity
3._____Temperature

C. Site-Specific Material

1._____Site map with well locations
2._____Well ID Chart
3._____Keys for wells and gates
4._____Frozen ice packs
5._____Laboratory grade deionized water
6._____Filtering equipment
7._____SOW (Statement of Work)
8._____Site-Specific Groundwater Monitoring Plan
9._____AquaPaks
10._____Extra bottles (e.g., pre-filtration bottles)

D. Other Sampling Equipment

1._____Personal protective equipment
2._____Preservative test kit
3._____Tools (e.g. pipe wrench)
4._____Funnels
5._____Calibrated 5-gallon bucket
6._____Disposable latex or PVC gloves (without powder)*
7._____Paper towels/Kim Wipes
8._____Flashlight
9._____Calculator
10._____Camera
11._____Conversion charts
12._____Black ink ball point pens
13._____Field meter log book
14._____WMX Manual for Groundwater Sampling
15._____Garbage Bags
16._____Ruler

* Powderless gloves are usually PVC or latex disposable, however, appropriate gloves may vary depending upon Health and Safety plans, matrix, and known constituents.

4.2.1.1 Deionized vs. Distilled

Deionized water or laboratory reagent quality water is water that has passed through a column containing both anion and cation exchange resins. Water having no concentrations of analytes of interest above the required reporting limits references: ASTM III or equivalent.

Distilled water is water that has been boiled and the steam condensed. The condensate is distilled water. Distillation - the act of purifying liquids through boiling, so that the steam condenses to a pure liquid and the biological pollutants remain in a concentrated residue. (United States Environmental Protection Agency Information Resources Doubleday, Fall 1989, OCPA19M-4001).

4.2.1.2 Pumps

The type of pump used depends on the site condition and nature of the analytes being tested. Dedicated, positive-displacement bladder pumps constructed of stainless steel, PVC, or Teflon® (e.g. Well Wizard®) are the preferred type of pump for most sampling programs. Before another type of pump is used, its advantages and disadvantages should be evaluated. For example, bladder pumps are preferred for volatile organic compounds because the use of suction-lift pumps may result in degassing and the loss of volatile compounds. Electrical submersible pumps are not suitable if lubricants are used in the pump, since they can cause the sample to be contaminated with organics. Air-lift sample pumps may result in degassing and the loss of volatile compounds. Air-lift sample pumps are also not suitable when sampling for pH-sensitive analytes, such as metals.

Non-dedicated pumps are necessary in limited cases. When non-dedicated pumps are used, stringent cleaning procedures must be followed between well locations. Sufficient amounts of laboratory grade deionized water must be flushed through the pump and tubing before and after purging a well. Figure 4.4 is a chart for non-dedicated pump cleaning documentation. Figure 4.4.1 is an example of a completed chart.

Decontamination procedures should be performed in a clean room or laboratory environment. Check with the Program Manager to determine proper disposal procedures for rinse water. To clean a non-dedicated pump, place it in a PVC or stainless steel standpipe, filled with laboratory grade deionized water. Initial specific conductance and amount of laboratory grade deionized water used should be accurately measured and recorded on Figure 4.4. Add a continual supply of water to the standpipe.

The pump and tubing should continue to be flushed until the specific conductance of the discharged laboratory grade deionized water is within ± 10 umhos (at 25° C) of the initial measurement. (See Figure 4.4.1 for an example). Once this figure is achieved, the pump and tubing should be properly stored and will be ready for use at the next well.

If decontamination procedures must be performed in the field, flush the pump and tubing with a minimum of 3 gallons of laboratory grade deionized water. The pump and tubing should be flushed before and after use at each well. As described in the previous paragraph, check the conductivity of the deionized water used to flush the pump to ensure that the pump has been thoroughly cleaned.

NONDEDICATED PUMPS: LABORATORY CLEANING DOCUMENTATION FIGURE 4.4

Date	Pump #	Pump/Mfg. Model #	Initial sp. cond. of deionized water at 25°C	Deionized Water					
				Number of Gallons Used	Sp. cond. at 25°C	Number of Gallons Used	Sp. cond. at 25° C	Number of Gallons Used	Sp. cond. At 25°C

NONDEDICATED PUMPS:
LABORATORY CLEANING DOCUMENTATION FIGURE 4.4.1 SAMPLE

				Deionized Water					
Date	Pump #	Pump/Mfg. Model #	Initial sp. cond. of deionized water at 25°C	Number of Gallons Used	Sp. cond. at 25°C	Number of Gallons Used	Sp. Cond. At 25°C	Number of Gallons Used	Sp. cond. at 25° C
5/16/90	#A	FULTZ #SP-202	12	10	40	10	15	N/R	N/R
5/30/90	#A	FULTZ #SP-202	10	10	100	10	65	25	17
6/30/90	#A	#5E12	9	10	15	N/R	N/R	N/R	N/R

4.2.1.3 Bailers

Dedicated bailers should be made of suitable inert materials when monitoring for organic compounds, (such as stainless steel, PVC or in some cases, Teflon®) as approved by the appropriate regulatory agency. Stainless steel bailers are often used for programs monitoring volatile organic compounds or where oily matrices commonly pose cleaning and durability concerns. PVC bailers with nonglued joints may also be used. The bailer may need to be decontaminated prior to dedicating a bailer to a well.

Non-dedicated equipment should only be used in emergencies. When non-dedicated bailers are used, they must be triple-rinsed with laboratory grade deionized water before and after sampling each well. Disposable bailers may be used at each well if preferred, but must be triple rinsed before each use.

4.2.1.4 The AquaPak and Sample Bottle Check-In Process

The Program Manager indicates on the Program Manager's checklist where to send the AquaPaks for the sampling event. (Note: It is important that AquaPaks be stored in buildings that do not contain solvents, cleaners, gasoline or diesel fuels.) The AquaPaks may be shipped to the sampling site, the sampling team, or another WMX facility depending on the location requested when the sampling event is created. The sampler or sampling team is responsible for checking all sample bottles, AquaPaks, and for preparing ice packs prior to the sampling event. This person must immediately notify the EML of any problems or questions. If AquaPaks are shipped to the site, the sampling team should communicate with those on or at the site to confirm arrival of AquaPaks. The sampling team must also communicate with site personnel to ensure access to the site before the sampling event so that equipment, AquaPaks, and supplies may be checked.

The EML provides AquaPaks, which are rotary molded, high-density plastic, insulated sample storage containers. Each AquaPak contains sample bottles, some of which may be securely packed in molded polyethylene foam holders. Chain-of-custody seals, preservatives, forms for documentation of the sampling event, and shipping paperwork are also provided with the AquaPak.

Ice packs that can thermally preserve samples for up to 40 hours are provided. To obtain this level of performance, the ice packs must be frozen for at least 24 hours prior to use.

If wet ice is used, please place the ice into zipper locking bags to prevent water splashing in the AquaPaks/coolers, and to prevent possible contamination of samples.

Note: The courier may open AquaPaks/coolers which leak water in an attempt to ascertain whether the leakage is potentially dangerous. This could delay or present untimely shipment of the AquaPaks/coolers to EML/subcontract lab. Custody of the AquaPak(s)/coolers may also be jeopardized.

When the use of a subcontract laboratory is necessary for any part of an event, all of the project specifications will be communicated to that lab by the Subcontract Management Department of the EML. The subcontract lab(s) will receive a Statement of Work from the EML as soon as an

event is declared. The subcontract lab is instructed to ship the cooler(s) and packing materials to the same location/person that the EML ships their AquaPaks to. These materials will arrive at the site approximately three days prior to the sampling event.

NOTE: The EML provides all sample containers, preservatives, and Field Chain-of-Custody Record Forms for subcontract samples.

It may be necessary to use bottles from more than one source. Some examples follow:

- When performing duplicate or split sample analysis;
- if breakage occurs;
- if the need for additional samples arises in the field.

If this is necessary, the source, type, and lot number of the bottles should be documented on the Field Chain-of-Custody Record and/or the Field Information Form.

Before the sampling event, the sampling team will receive information for the sampling event on the Sampling Team SOW (Figure 4.5). The SOW will be used in the AquaPak check-in process.

1. Upon receipt of the AquaPak, the gray numbered seal must be examined. If it is <u>not</u> intact, contact the EML immediately for instructions. If the seal <u>is</u> intact, use wire clippers to cut the seal, open the AquaPak, and remove the plastic field bag from inside. At this time, document the cut seal's number in Chronicle 1 of the Chain-of-Custody Record for each of the Field Chain-of-Custody Record(s) found in the plastic field bag. Refer to Section 4.2.2 and 4.2.2.1 for procedures regarding completion of the Field Chain-of-Custody Record.

The plastic field bag contains a Field Chain-of-Custody Record and a Field Information Form for each bottle set included in the AquaPak, red temporary seals, return labels, a Federal Express airbill, one unused gray numbered seal, polystrapping, and pertinent memos. The gray numbered seal is used as the final seal when the AquaPaks are returned to the lab. The red, unnumbered seals are used to temporarily seal the AquaPak if it is left unattended.

2. Note the arrangement of the bottles and ice packs inside the AquaPaks before removing them. Repack them in the same order when sampling is complete. AquaPaks are packed to comply with shipping regulations and for economy of space. Often, unless special attention is given, it is difficult to fit everything back in place.

3. New, properly cleaned sample bottles are provided in each AquaPak. The type of bottle will vary depending on the analysis required. An inventory of the bottles, and their condition should be noted. The bottle list, analyses required, and preservation requirements are preprinted on the Field Chain-of-Custody Record in the "AquaPak Contents" section, and on the Statement of Work.

   NOTE: Check to ensure that all bottles used for a particular sample point have the same bottle set number, since bottles for several sample points may be packed in the same AquaPak.

Figure 4.5

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SAMPLING TEAM

STATEMENT OF WORK

Monitoring Program Information

MP no.	Rev	Rev date	Task	Month	ENS no.	Samp Date	No.SPs	est.Bots	TAT: 25	QA/QC: NO
418951	00	07/20/95	03	AUG1	95-13054	08/01/95	0007	000114		

Sample Matrix Code: W | Sample Matrix Name: WELL

Site Information

Number: 418
Name : WMI Landfill
Location: Geneva , IL

Description

6 WELLS, 1 FIELD BLANK
QUARTERLY PROGRAM.

Sample Points:

01FB MW01 MW02 MW03 MW04 MW05 MW06

END SAMPLING REQUIREMENTS

Method ID	Method Description	F	#	Size	Type	Preservative	Lab
CRTOCDUP02	TOTAL ORGANIC CARBON DUPL	Y	01-0125	G		H2SO4/COOL 4 DEG C	EML
CRPNHRAX01	PHENOLS, HIGH RANGE AUTO	Y	01-0500	G		H2SO4/COOL 4 DEG C	EML
CRCNTTLX01	CYANIDE, TOTAL AUTOMATED	Y	01-0250	P		NAOH/COOL 4 DEG C	EML
CRALKMOT01	ALKALINITY TOTAL METHYL O	N	01-0125	P		NONE/COOL 4 DEG C	EML
CRTDSXXX01	SOLIDS,TOTAL DISSOLVED(RE	N	01-0500	P		NONE/COOL 4 DEG C	EML
FDWDTWTC01	FDW/DTW TOP OF CASING		-				EML
FDWGWELWDT	FDW/GW ELEV/W DEPTH TOT		-				EML
FDWPURINFO	FDW/PURGING INFOMATION		-				EML
FDWPURSAMP	FDW/PURGING/SAMPLING EQUP		-				EML
FDXTEMPC01	FD/H2O TEMP IN DEG C		-				EML
FDPHSING01	FD/PH - SINGLE		-				EML
FDSPCOND01	FD/SP COND - SINGLE		-				EML
NGFAADIAS	ARSENIC BY GFAA-DISSOLVED	Y	01-0125	P		HNO3	EML
NGFAADIPB	LEAD BY GFAA-DISSOLVED		-				EML
NGFAADISE	SELENIUM BY GFAA-DISSOLVE		-				EML
NFAADISXK	DISSOLVED K BY FLAME AA	Y	01-0500	P		HNO3	EML
NICPDISAG	SILVER BY ICP-DISSOLVED		-				EML
NICPDISCA	CALCIUM BY ICP-DISSOLVED		-				EML
NICPDISCD	CADMIUM BY ICP-DISSOLVED		-				EML
NICPDISCR	CHROMIUM BY ICP-DISSOLVED		-				EML
ICVAADIHG	MERCURY BY COLD VAPOR AA-		-				EML
ISULFAT01	SULFATE,COLORIMETIRC AUTO	Y	01-0250	P		NONE/COOL 4 DEG C	EML
GC1OCP01	SV ORGANOCHLOR.PEST.DW509	N	02-1000	G		NONE/COOL 4 DEG C	EML
MSAAO302	35 Volatile Compounds	N	04-0040	G		HCL/COOL 4 DEG C	EML
HEXCRM01	HEXAVALENT CHROMIUM	Y	01-0250	P		NONE/COOL 4 DEG C	EML
GC1OCP01	** SEMI-VOLATILE DUPS **	N	02-1000	G		NONE/COOL 4 DEG C	NET
MSAAO302	****** TRIP BLANK ******	N	01-0040	G		HCL/COOL 4 DEG C	EML

END BOTTLE REQUIREMENTS

SAMPLING TEAM

STATEMENT OF WORK

Sampling Instructions:

WMIS MANUAL FOR GROUND WATER SAMPLING IS TO BE FOLLOWED.
STATE FORMS TO BE COMPLETED.

Special Instructions:

TWO SAMPLE POINTS PER AQUAPAK.

EML LOGOUT SHIP AQUAPAKS TO:

Aquapak Shipment:
Address: WMI LANDFILL

City: GENEVA
State & Zip: IL 60134-0000
Phone: (708) 208-3100

---------- END STATEMENT OF WORK ----------

Each sample bottle is labeled. Information regarding the bottle I.D. number, (e.g. AB1234), the method I.D. code (e.g. AB1234-A0, INICPDISFE which refers to the lab grouped and analysis to be performed on the sample in the bottle), filtering information, preservation information, bottle type, and bottle size are included on the bottle label. When a sample bottle is to be sent to a subcontract laboratory, the name (or abbreviated name) of the subcontract laboratory will be printed at the bottom of the bottle label.

4. Check to ensure all required preservatives are present. For most samples requiring preservatives, premeasured amounts of preservatives are supplied in small labeled vials. The vials are positively closed and placed into secondary containment with absorbent material (See Section 4.4.3.1.1, and the Appendix for International Air Transport Association Dangerous Goods In Excepted Quantities Regulations (IATA) Shipping Guidance). The vials are sorted according to whether or not they are acidic or basic.

   The preservatives supplied in the vials are to be added to the required sample bottles **after** they have been filled with the sample water. Preservatives are added at a rate of one preservative vial per sample bottle.

   Some sample bottles are shipped prepreserved with the preservatives already in the sample bottle. These are also shipped in accordance with IATA Dangerous Goods In Excepted Quantities Regulations. Upon request, EML will supply the sampling team with extra preservatives. The requestor is responsible for their safe-keeping. The preservatives should not be stored for more than three months, and Material Safety Data Sheets (MSDS) are available upon request.

   Preservatives must not be put into bottles for methodologies that do not require preservation with acid/base. Verification that the appropriate preservatives have been included in the AquaPak and that the appropriate bottles are available is imperative. The preservative required for a particular bottle is listed on the bottle label itself, and on color coded preservative stickers that are also attached to the sample bottles. A list of preservatives required for each analysis is included in the Appendix.

5. AquaPaks that contain bottles for volatile organic analyses (VOA) also include a trip blank. Trip blanks are a standard part of the field sampling QA/QC program. A trip blank is a 40 ml. vial filled with reagent-free water, prepared headspace-free, and appropriately preserved. The trip blank is part of a bottle set, and is assigned to the numerically first bottle set in an AquaPak. The trip blank bottle(s) remain with the sample bottle set while in transit to the site, during sampling, and during the return trip to the EML. The purpose of the trip blank is to check for volatile organic contamination of samples during shipment. Most programs require the analysis of one trip blank per shipment per day. Trip blank sample bottles are not opened at any time during this process. They are analyzed following the same procedure upon return to the lab.

   When volatile organic analyses have been requested, the AquaPak will contain a trip blank regardless of whether a request has been placed for analysis of the trip\ blank. Prior to shipment, the EML checks each trip blank vial to ensure that it has no air bubbles. Occasionally, due to pressure and temperature changes during shipping, small bubbles will

appear in the bottle(s). Note the condition of the blanks (including the size of any bubbles) on the corresponding line in the Field Comments section of the Field Chain-of Custody Record. Also record any other relevant information about receipt of the AquaPak, on the Chain-of-Custody Record.

6. If a field blank is necessary, and it requires VOA analyses, the EML will supply five vials of laboratory grade deionized water for every four VOA vials required to be filled for the field blank bottle set. The sampling team will have to supply laboratory grade deionized water for the remaining bottles in the field blank bottle set. The purpose of a field blank is to check for analyte contamination during the sampling and shipping processes.

   Field blank water (laboratory grade deionized water) is poured into a sample bottle set in the field at a specific sample point (i.e., down wind of an active area of the landfill, etc.). The field blank is analyzed to determine whether or not contamination is present. The field blank captures what is in the "ambient air" at a specific location at a specific time. (Usually during the collection of a sample at the same sample point.)

   When purging and/or sampling devices/equipment are not dedicated to a sample point and the device is decontaminated before each sampling point, an equipment blank may be added to the program for QA/QC purposes. Laboratory grade deionized water is sent through the equipment after the equipment has been decontaminated. The blank is analyzed for the same set of parameters the other bottle sets in that ENS number are analyzed for. The equipment blank is representative of how thoroughly the instrument was decontaminated. If decontamination was not done properly, the constituents of concern may appear in the equipment blanks analytical results.

7. After steps 1-6 of the check-in procedures are conducted, complete Chronicle 1 of the Field Chain-of-Custody Record. The AquaPak should then be closed, and a red temporary seal placed through the brass chain of custody eyelets to temporarily seal the AquaPak. The red temporary seals are to be used whenever the AquaPak is left unattended. The gray seal is to be used after sample collection when returning the AquaPak to the EML. Procedures for Field Chain-of-Custody are located in Section 4.2.2, and 4.2.2.1. Also, see Figure 4.6, AquaPak and Sample Bottle Check-In Process/Field Chain-of-Custody Checklist.

   If any questions arise, or if there are any problems with the AquaPaks and their contents, call the EML before proceeding.

AquaPak and Sample Bottle Check-In Process/ Chain-of-Custody Checklist

Figure 4.6

Task	Completed
1. Check the integrity of the seal on the AquaPak.	_____
2. Using wire clippers, cut the custody seal off of the AquaPak.	_____
3. Document the number of the cut seal in Chronicle 1 of the Chain-of-Custody Chronicle portion of each of the Field Chain-of-Custody Record(s) in the AquaPak.	_____
4. Note the arrangement of the bottles and ice packs in the AquaPak before removing the bottles or ice packs from the AquaPak.	_____
5. Inventory AquaPak.	_____
6. Check trip blank and note its condition on the corresponding line in the Field Comments Section of the Field Chain-of Custody Record.	_____
7. Complete Chronicle 1 of the Field Chain-of-Custody Record.	_____
8. Record any other relevant information about the AquaPak and its contents on the Field Chain-of-Custody Record.	_____
9. If a field blank is required and VOA methods are present, check for VOA water provided by the EML.	_____
10. Freeze ice packs/obtain wet ice.	_____

4.2.1.5 Equipment Storage

If storage of sampling equipment is necessary, all AquaPaks, containers, and equipment must be stored in a designated, contaminant-free area. (i.e. a room free of solvents, cleaners, gasoline or where none of these products are ever used.) The area must be locked. All AquaPaks must be sealed (use the red temporary seals).

Occasionally, some bottle sets will not be used (for example, if the well was dry and no sample could be collected, etc.). These sets should be returned to the EML, in accordance with all applicable shipping regulations (i.e., IATA. See Section 4.4.3.1.1). Include documentation regarding why the sample point was not collected on the Field Chain-of-Custody Record and Field Information Forms so that the sample point can be logged into LIMS appropriately for that event.

Unused AquaPaks should be returned to the EML via air courier after the sampling event is completed, in accordance with all applicable shipping regulations (see section 4.4.3.1.1). When returning unused AquaPaks, please notify the EML. Two day economy service is preferred to reduce costs.

4.2.1.6 Calibration and Use of Field Meters

The proper measurement and documentation of field analytes are integral parts of a monitoring program. Before going to the field, all equipment must be cleaned and checked for any malfunctions.

The sampling team must calibrate and check all meters before using them in the field. This is necessary:

- to ensure the proper working order of the meters, and
- to ensure the integrity of the values measured.

Manufacturers' calibration procedures must be followed. Where the manufacturer has provided no calibration procedures, appropriate EPA procedures should be followed. (See the Appendix.)

NOTE: A COPY OF THE PROCEDURES USED IN THE CALIBRATION OF THE FIELD METERS SHOULD BE ATTACHED TO YOUR COPY OF THIS MANUAL.

The calibration of the field instruments must be checked every four hours or after every tenth sample (whichever occurs first), and at the end of the day. Each calibration check must be recorded in the field meter log book. If the result of the calibration check is not within the calibration limits, the meter must be recalibrated and noted in the log book. Additional information on calibration of redox potential (Eh), dissolved oxygen (DO) and turbidity meters may be found in the Appendix.

Sampling team members are responsible for maintaining log books for all field meters. These log

books contain the same information as those for permanent lab instruments (e.g., serial number, name and model of meter, year purchased, etc.). These books also contain quality control (QC) results, maintenance performed by the factory, and calibration notes for each day the equipment is used. Refer to Figures 4.7 and 4.7.1 for examples of a log book page.

Calibrate the pH meter using pH 7 and pH 10 buffers, and a pH 4 buffer as a check, or with pH 7 and pH 4 buffers, and a pH 10 buffer as a check. The choice depends on the expected pH values of the samples. The calibration for pH is temperature-corrected. Please note the actual pH of your buffers and their temperature at the time of calibration. A chart for this is usually provided on the buffer container. You may need to calibrate the pH 7 buffer to 6.95 or 7.03 or some point in between, depending on the temperature of your buffers. The second standard should also be within ±0.1 pH unit of the expected value (e.g., pH buffer, calibrated to within pH 3.90-4.10). If not, the meter must be recalibrated. Some states require that a double check be made. For example, if pH 7 and pH 4 buffers are used to calibrate the meter, and a pH 10 buffer is used as a check, an additional check should be made using the pH 4 buffer.

Calibrate the specific conductance meter using standards in the range of the conductivity expected at the site at (or converted to) 25° C. At least one additional standard must also be checked, of the same conductivity as the original standard, but cooled below room temperature (refrigerated). The cooled (refrigerated) standard should be approximately 10° C cooler than the room temperature standard. Checking the conductivity of this cooled standard checks the automatic temperature compensation of the meter (or conversion calculation). Specific conductance must be within ±5% of the expected value (e.g., 1,413 umhos standard, must read between 1,342-1,484). If the recheck of the cooled standard does not fall within these limits, the instrument must be recalibrated.

All thermometers must also be checked, at least once per quarter for accuracy against a traceable National Institute of Standards Technology (NIST) thermometer. Record this information in the Field Meter Log Book.

NOTE: For CWM personnel - log books may be obtained from WMI Quality Programs.

Measure and record the specific conductance of the laboratory grade deionized water being used in the field each day. Record the daily conductivity values in the log book of the meter that is used (field or lab). If the specific conductance of the deionized or laboratory reagent quality water is greater than 50 umhos/cm at 25°C the Program Manager should be contacted immediately. The suspect laboratory grade deionized water should not be used. Laboratory grade deionized quality water should be obtained from an alternate source (e.g., subcontract lab, vendor, etc.) until the problem can be corrected.

FIELD METER LOG BOOK FIGURE 4.7

		Temperature		pH Results						Specific Conductivity				Deionized Water
Date	Meter Serial #	NIST	Meter	Read 7	Calibrate 7	Read 10	Calibrate 10	Read 4	Calibrate 4	Std.	At 25°C	Refrigerate at X°C	°C	Specific Conduct.

FIELD METER LOG BOOK

FIGURE 4.7.1 Sample

		Tempera-ture		pH Results						Specific Conductivity (umhos/cm at 25°C)				Deionized Water
Date	Meter Serial #	NIST	Meter	Read 7	Calibrate 7	Read 10	Calibrate 10	Read 4	Calibrate 4	Std.	Refrigerate At 25°C	At X°C	°C	Specific Conduct.
3/6/85	II	24.7°	25°	-	-	-	-	-	-	-	-	-	-	-
3/6/85	I	-	-	7.06	7.00	10.03	10.00	(check) 4.01	N/R	-	-	-	-	-
3/6/85	III	-	-	-	-	-	-	-	-	707	715	700	10°	10
3/6/85	III	-	-	-	-	-	-	-	-	1413	1405	-	-	-
3/6/85	(backup) I(A)	24.3°	25°	7.04	7.00	10.08	10.00	(check) 4.03	N/R	707	700	723	10°	10
3/6/85	(backup) I(A)	-	-	-	-	-	-	-	-	1413	1405	-	-	-

4.2.2 Completing Field Records

Improper documentation or inadequate information regarding the circumstances of collection and/or subsequent disposition of the samples (e.g., field chain-of-custody) may render resultant data useless. Proper chain-of-custody documentation is a crucial part of the quality assurance and quality control (QA/QC) program. Comprehensive, consistent, and accurate documentation of field tests, measurements, and field observations is extremely important.

The EML will not analyze samples without proper Field Chain-of-Custody documentation. Any exceptions/errors noted at the time of sample log-in will be directed to the Program Manager for instruction on how the EML should proceed.

A field Chain-of-Custody Record and a Field Information Form must be completed for each sample point by the sampler. All paperwork should be completed using a **black ink ball point pen.**

When a subcontract lab is utilized, the EML will provide two Field Chain-of-Custody Records for each bottle set. There will be a master Field Chain-of-Custody Record that will contain all bottle information for the entire bottle set. The master Field Chain-of-Custody Record will travel with the samples being returned in the AquaPaks to the EML. The second Field Chain-of-Custody Record (the subcontract Field Chain-of-Custody Record) contains the name of the subcontract laboratory and the list of bottles to be sent to that subcontract laboratory. If there is more than one subcontract laboratory per event (ENS number) an additional Field Chain-of-Custody Record will be provided for each additional subcontract lab.

If sample bottles and paperwork are provided by the subcontract lab do not use them. Use only the bottles and paperwork supplied by the EML.

4.2.2.1 Field Chain-of Custody Record and Procedures (Figures 4.8 and 4.8.1)

To help maintain the integrity of the samples, strict chain-of-custody procedures are necessary. These procedures ensure that tampering with the samples does not occur. From the time the sample bottles leave the laboratory until the issuance of the analytical laboratory results, the samples and/or sample containers must be in the custody of assigned WMX personnel, or an assigned consultant or contractor. In order to maintain the chain-of-custody, the samples must be:

- in sight of the assigned custodian;
- locked in a tamper-proof location with limited access; or
- sealed with a red, temporary seal.

Figure 4.8

Subcontract To: _____

WMX Environmental Monitoring Laboratories, Inc.

FIELD CHAIN-OF-CUSTODY RECORD

AquaPak™ PREP
AquaPak™ # _____
Date Sealed ____ YY / MM DD
Seal # _____
By: _____

SITE/FACILITY # ____ SITE NAME: _____

Sample Point: ____ Source Code

SAMPLE DATE: - ____ YY / MM / DD

SAMPLE TIME: ____ : ____ (2400 HR) MATRIX CODE: _____

Water . . . (W) Leachate (C)
Soil . . . (S) Other (X)

Source Codes.

Well . . . . . (W) Leachate System . . . (C) Pretreatment Facility . . . (P) River Stream/Brook . . . (R) Soil . . . . . (S) Generation Pt . . . . . (G)
Dewatering/Pressure Relief . . . . (D) Gas Condensate . . . (M) Influent . . . . . (U) Lake or Ocean . . . . . (L) Bottom Sediment . . . (B) Other . . . . . (X)
Surface Water Impoundment . . . (I) Air . . . . . (A) Effluent . . . . . (T) Outfall . . . . . (O) Noise . . . . . (N) Specify _____

ENS #

AquaPak™ CONTENT

SAMPLE I.D.	# OF BOTTLES	BOTTLE TYPE	PRESERVATIVE TYPE	ANALYTES/LAB GROUPS	FILTER Y — N	FIELD COMMENTS	E.M.L. COMMENTS
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		
					Y / N		

CHAIN OF CUSTODY CHRONICLE

1. AquaPak™ Opened By: (print) _____ Date: / / Time: : 2400 HR
Signature: _____ Seal #: _____ Intact: _____

I have received these materials in good condition from the above person.

2. Name: _____ Signature: _____
Date: / / Time: : 2400 HR. Remarks: _____

I have received these materials in good condition from the above person.

3. Name: _____ Signature: _____
Date: / / Time: : 2400 HR Remarks: _____

4. AquaPak™/Sub Contr. # _____ Sealed By: _____ (Print) Date: / / Time : 2400 HR
Signature: _____ Seal #: _____ Intact: _____

LAB USE ONLY
Opened By: (Signature) _____ Date: / / Time: : 2400 HR

AquaPak™/Sub. Contr. # _____ Temp.°C _____ ORIGINAL LAB Seal # _____ Intact. _____

EML FF-1A 12/82

Subcontract To: _____

WMX Environmental Monitoring Laboratories, Inc.

FIELD CHAIN-OF-CUSTODY RECORD

AquaPak™ PREP
AquaPak™ # _____
Date Sealed _____ YY / MM / DD
Seal # _____
By: _____

E/FACILITY # 418 SITE NAME: WMI Landfill

Sample Point: _____ Source Code

SAMPLE DATE: - _____ YY / MM / DD

SAMPLE TIME: _____ (2400 HR)

MATRIX CODE: _____

Water (W) Leachate (C)
Soil (S) Other (X)

Source Codes

Well (W) Leachate System (C) Pretreatment Facility (P) River/Stream/Brook (R) Soil (S) Generation P (G)
Dewatering/Pressure Relief (D) Gas Condensate (M) Influent (U) Lake or Ocean (L) Bottom Sediment (B) Other (X)
Surface Water Impoundment (I) Air (A) Effluent (T) Outfall (O) Noise (N) Specify _____

ENS # #95-13054

AquaPak™ CONTENT

SAMPLE I.D.	# OF BOTTLES	BOTTLE TYPE	PRESERVATIVE TYPE	ANALYTES/LAB GROUPS	FILTER Y — N	FIELD COMMENTS	E.M.L. COMMENTS
AN3023-A	01	G	H2SO4 4C	CRTOCDUP02	Y/N	EML	
AN3023-B	01	G	H2SO4 4C	CRPNHRAX01	Y/N	EML	
AN3023-C	01	P	NaOH 4C	CRCNTTLX01	Y/N	EML	
AN3023-D	01	P	NONE 4C	CRALKMOT01	Y/N	EML	
AN3023-E	01	P	NONE 4C	CRTDSXXX01	Y/N	EML	SOLIDS
AN3023-F	01	P	HNO3	IN 03 METHODS	Y/N	EML	
AN3023-G	01	P	HNO3	IN 06 METHODS	Y/N	EML	
AN3023-H	01	P	NONE 4C	INSULFAT01	Y/N	EML	
AN3023-I	04	G	NONE 4C	SVGC10CP01	Y/N	EML	
AN3023-J	04	G	HCL 4C	VOMSAA0302	Y/N	EML	
AN3023-K	01	P	NONE 4C	SBHEXCRM01	Y/N	NET	
AN3023-L	01	G	HCL 4C	VOMSAA0302	Y/N	EML	TBK
					Y/N		
					Y/N		
					Y/N		
					Y/N		
					Y/N		

CHAIN OF CUSTODY CHRONICLE

1. AquaPak™ Opened By: (print) _____ Date: ___/___/___ Time: ___:___ 2400 HR
Signature: _____ Seal #: _____ Intact: _____

I have received these materials in good condition from the above person.

2. Name: _____ Signature: _____
Date: ___/___/___ Time: ___:___ 2400 HR. Remarks: _____

I have received these materials in good condition from the above person.

3. Name: _____ Signature: _____
Date: ___/___/___ Time: ___:___ 2400 HR Remarks: _____

4. AquaPak™/Sub Contr. # _____ Sealed By: _____ (Print) Date: ___/___/___ Time: ___:___ 2400 HR
Signature: _____ Seal #: _____ Intact: _____

LAB USE ONLY
Opened By: (Signature) _____ Date: ___/___/___ Time: ___:___ 2400 HR
AquaPak™/Sub. Contr. # _____ Temp.°C _____ Seal # _____ Intact. _____
ORIGINAL LAB

EML FF-1A 12/92

Subcontract To: _____

WMX Environmental Monitoring Laboratories, Inc.

FIELD CHAIN-OF-CUSTODY RECORD

AquaPak™ PREP
AquaPak™ # _____
Date Sealed _____ YY / MM DD
Seal # _____
By: _____

SITE/FACILITY # 41B SITE NAME: WMI Landfill

Sample Point: _____ Source Code

SAMPLE DATE: - _____ YY / MM / DD

SAMPLE TIME: _____ (2400 HR) MATRIX CODE: _____

Water (W) Leachate (C)
Soil (S) Other (X)

Source Codes

Well (W) Leachate System (C) Pretreatment Facility (P) River Stream/Brook (R) Soil (S) Generation Pr. (G)
Dewatering/Pressure Relief (D) Gas Condensate (M) Influent (U) Lake or Ocean (L) Bottom Sediment (B) Other (K)
Surface Water Impoundment (I) Air (A) Effluent (T) Outfall (O) Noise (N) Specify _____

ENS # *95-13054

AquaPak™ CONTENT

SAMPLE I.D.	# OF BOTTLES	BOTTLE TYPE	PRESERVATIVE TYPE	ANALYTES/LAB GROUPS	FILTER Y — N	FIELD COMMENTS	E.M.L. COMMENTS
	SHIP ALL BOTTLES LISTED BELOW TO NET				Y N		
AN3023-K	01	P	NONE 4C	SBHEXCRM01	Y N		
					Y N		
					Y N		
					Y N		
					Y N		
					Y N		
					Y N		
					Y N		
					Y N		
					Y N		
					Y N		
					Y N		
					Y N		
					Y N		
					Y N		
					Y N		
					Y N		
					Y N		

CHAIN OF CUSTODY CHRONICLE

1. AquaPak™ Opened By: (print) _____ Date: / / Time: : 2400 HR
Signature: _____ Seal # _____ Intact: _____

I have received these materials in good condition from the above person.

2. Name: _____ Signature: _____
Date: / / Time: : 2400 HR. Remarks: _____

I have received these materials in good condition from the above person.

3. Name: _____ Signature: _____
Date: / / Time: : 2400 HR Remarks: _____

4. AquaPak™/Sub Contr # _____ Sealed By: _____ (Print) Date: / / Time: : 2400 HR
Signature: _____ Seal #. _____ Intact. _____

LAB USE ONLY
Opened By: (Signature) _____ Date: / / Time: : 2400 HR
AquaPak™/Sub. Contr. # _____ Temp.°C _____ Seal # _____ Intact. _____

ORIGINAL LAB

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A written record of sample bottle possession and any transfers of samples must be maintained, and documented on the Field Chain-of-Custody Record. A Field Chain-of-Custody Record must be completed for each sample point, including dry wells.

The Field Chain-of-Custody Record is signed, dated, and time entered for the following activities:

* When the AquaPak is initially opened for inspection of its contents. The seal number and its integrity must also be recorded at this time.

* Each time the AquaPak is transferred to the custody of another person.

* Immediately before sealing the AquaPak for transport to the EML with the gray numbered seal. For EML AquaPaks, the seal number must also be recorded.

  Note: For samples being returned to the EML, the white and yellow copies of the Field Chain-of-Custody Record must be enclosed in the plastic field bag and placed in the AquaPak prior to the sealing of the AquaPak. The pink copy will be retained by the sampling team.

  The Field Chain-of- Custody Records which are placed in the AquaPaks or coolers will list only the bottles contained within that AquaPak/cooler. If sample bottles from the same sample point are placed in more than one AquaPak or cooler, each group of bottles requires a Field Chain-of-Custody Record in the AquaPak/cooler.

* When samples are to be shipped to a subcontract lab, send the white (original) copy of the Field Chain-of-Custody Record with the samples, to the subcontract lab, and the yellow portion of the Field Chain-of-Custody Record to the EML. Include the yellow portion of the Field Chain-of-Custody Record(s) for the subcontracted bottles in the AquaPaks. If all of the samples are being shipped to a subcontract laboratory, send the yellow copies to the EML standard overnight for delivery the next day. The sample team should retain the pink copy.

In addition, the sample point designation, source code, matrix code, date, and time (starting) for sampling must be recorded on the form. Use of prefiltration bottles, and any problems with the AquaPaks contents must also be noted on the form.

The Field Chain-of-Custody Record indicates by bottle and analysis group whether samples are to be preserved. If actual preservation and filtration procedures vary from the instructions provided in these spaces, the chain-of-custody information must be modified by a member of the sampling team by crossing out the incorrect information with one line, making the necessary corrections and dating and initialing the corrections.

Please note that failure to complete the Field Chain-of-Custody Record will render the data useless. Use the Chain-of-Custody Record Legend (Figure 4.8.2) to ensure that all pertinent information has been included.

Upon receipt of the AquaPak by the lab, the seal is broken. The date, time, temperature and condition of the samples are recorded in "Laboratory Use Only" section of the Field Chain-of-Custody Record by the log-in personnel receiving the AquaPaks.

Figure 4.8.2

WMX GROUNDWATER MONITORING PROGRAM

Field Chain-of-Custody Record Legend

Field Description

* Indicates items to be completed by sampler. Other information is preprinted or manually completed at the EML.

AquaPak Prep Box

AquaPak#:	The bar coded number on the AquaPak.
Date Sealed:	The date sealed at the EML for shipment out to the field.
Seal #:	The actual number recorded from custody seal.
By:	Initialed by the EML Log Out personnel responsible for packaging.
Site/Facility #:	The site code of facility being sampled.
Site Name:	The complete name of the site.
***Source Code:**	Enter (W) well, (R) river/stream/brook, etc., from source codes list in top portion of the Field Chain-of-Custody Record form.
***Sample Point:**	Enter the source code and sample point designation for the monitoring point.
***Sample Date:**	Enter the date (yy,mm,dd) that the monitoring point is sampled.
***Sample Time:**	Enter the time sampling begins (24-hour clock).
***Matrix Code:**	Enter water (W), soil (S), leachate (C), other (X).
ENS#:	The number assigned to a group of similar sample points and analyses together, for each sampling event. The grouping of sample points together by method id or method description.

AquaPak Content

Sample ID:	The bottle/sample id for each method to be analyzed. This consists of the bottle set number and a sequential code number for each analytical method.
# of Bottles:	The actual number of bottles for a sample/analysis.
Bottle Type:	The type of bottle: plastic (p) or glass (g).
Preservative Type:	The preservative required for this bottle.
Analytes/Lab Groups:	The laboratory method to be used to analyze the samples. The lab group is identified by the first two letters of the method.
***Filtered**	Circle yes (y) or no (n). Samples should be filtered in accordance with the information on the Statement of Work.
***Field Comments:**	Note condition of trip blank (i.e., Were bubbles observed in the trip blank? If so, what size were they? Pea sized, 2 mm diameter, etc.). Any additional problems with the AquaPaks should be noted on this form as well (e.g., the AquaPak integrity, broken Chain-of-Custody seal etc.). Also, note use of prefiltration bottles and their source, lot number, and vendor of these bottles.
EML Comments:	Entries made by the EML Log-In or Log-Out personnel regarding any problem with receipt of bottles (empty, broken, missing, leaking) bottle set split between AquaPaks.

***Chain-of-Custody Chronicle:**

1. To be completed by the person initially opening the AquaPak and checking its contents.

2 and 3. To be completed by someone other than the person who initially opened the AquaPak. The person who initially opened the AquaPak temporarily had custody of the AquaPak. Used when custody of the AquaPak is being relinquished from one sampler to another.

4. To be completed by the person sealing the AquaPak for shipment to the laboratory. The person who signs on Line 4 must be the same as that found on the previous line.

If additional spaces are needed, an additional Field Chain-of-Custody Record may be attached to the original form. Do not write on the back of the form.

4.2.2.2 Field Information Forms (Figures 4.9 and 4.9.1)

The Field Information Form contains information regarding site and well conditions, sampling and purging procedures used, field measurements and comments. The Field Information Form must be completed by the sampler for each sample point and enclosed in the AquaPak. If sample bottles are split between the EML and a subcontract lab, the white and yellow copies of the Field Information Form must be enclosed in the AquaPak transported to the EML. The sampling team retains the pink copy. Field Information Forms are not sent to the subcontract lab.

The following information must be documented:

***Site Number, Bottle Set, and Sample Point**

The site number, bottle set, source code and sample point designation should be completed with the same information provided on the Field Chain-of-Custody Record for the sample. Information regarding the site number, source code, and sample point information will be provided to the sampling team prior to sampling by the EML on the Statement of Work (Figure 3.2).

***Purging Information**

Complete this section if the sample points are wells. All wells must be purged prior to sampling. The date and time the well was purged, the elapsed time for purging, the volume of water in the casing (gallons), and the volume purged (gallons) must be documented.

The Field Chain-of-Custody Records and Field Information forms must indicate whether the well was dry or any other reason a sample was not collected.

***Purging and Sampling Equipment**

Document the types of equipment (purging and sampling devices) used for purging and sample collection, and the materials of which they are constructed. If Well Wizards® or pumps are used, the pump and tubing material must be documented. If a code letter does not correspond to the actual material being used, mark "x", and provide a written description in the far right column, where x-_____ appears. Filtration devices should also be identified in this section of the Field Information Form.

***Field Measurements**

The Site-Specific Groundwater Monitoring Plan and the Statement of Work indicate which measurements are to be taken for each sampling event. For groundwater sampling events, measurements of the groundwater elevation (depth to groundwater adjusted to msl), depth to water, temperature, pH, and specific conductance (at 25° C) are usually required. Additional field measurements such as dissolved oxygen, field turbidity, and redox potential (EH), may also be required if noted on the Statement of Work. Space is provided on the Field Information Form for these additional parameters, units, and values.

Figure 4.9

WMX Environmental Monitoring Laboratories, Inc.

FIELD INFORMATION FORM

Site #

Bottle Set:

Sample Point:

Source Code

PURG INFO

PURGE DATE (YY MM DD) | START PURGE (2400 Hr Clock) | ELAPSED HRS | WATER VOL IN CASING (Gallons) | ACTUAL VOLUME PURGED (Gallons)

PURG & SAMPLING EQUIP

Purging Equipment Dedicated | Y | | N | (circle one)

Sampling Equipment Dedicated | Y | | N | (circle one)

Purging Device		A-Submersible Pump	D-Gas Lift Pump	G-Bailer	X- (PURGING OTHER (SPECIFY))
Sampling Device		B-Peristaltic Pump	E-Venturi Pump	H-Scoop/Shovel	X- (SAMPLING OTHER (SPECIFY))
		C-Bladder Pump	F-Dipper/Bottle	I-Piston Pump	
Purging Material		A-Teflon	C-Polypropylene	E-Polyethylene	X- (PURGING OTHER (SPECIFY))
Sampling Material		B-Stainless Steel	D-PVC		X- (SAMPLING OTHER (SPECIFY))
Tubing-Purging		A-Teflon	D-Polypropylene	F-Silicon	X- (PURGING OTHER (SPECIFY))
Tubing-Sampling		B-Tygon C-Rope X- (SPECIFY)	E-Polyethylene	G-Combination teflon/ Polypropylene	X- (SAMPLING OTHER (SPECIFY))
Filtering Devices 0.45 µ		A-In-line Disposable	B-Pressure	C-Vacuum	

FIELD MEASUREMENTS

Well Elevation	(ft/msl)	Land Surface Elevation	(ft/msl)
Depth to water From top of well casing	(ft)	Depth to water From land surface	(ft)
Groundwater Elevation	(ft/msl)	Groundwater Elevation	(ft/msl)
Well Depth	(ft)	Stickup	(ft)

	pH	Spec Cond	Sample Temp.
1st	(STD)	µm/cm at 25° C	(° C)
2nd	(STD)	µm/cm at 25° C	(Other parameter) value units
3rd	(STD)	µm/cm at 25° C	(Other parameter) value units
4th	(STD)	µm/cm at 25° C	(Other parameter) value units

FIELD COMMENTS

Sample Appearance: _____ (if applicable) Odor: _____ Color: _____ Turbidity: _____

Weather Conditions: Wind Speed _____ Direction _____ Precipitation Y/N Outlook _____

Specific Comments: _____

I certify that sampling procedures were in accordance with applicable EPA, State and WMI protocols.

___/___/___ (Date) _____ (Signature) Employer: _____

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WMX Environmental Monitoring Laboratories, Inc.

FIELD INFORMATION FORM

FIGURE 4.9.1

Site # 4

Bottle Set: ANØ23

Sample Point: WMWØ1 (Source Code)

PURG INFO

Purge Date (YY MM DD)	Start Purge (2400 Hr Clock)	Elapsed Hrs	Water Vol in Casing (Gallons)	Actual Volume Purged (Gallons)
950728	1315	Ø5	56	171

PURG & SAMPLING EQUIP

Purging Equipment Dedicated (Y) | N | (circle one) Sampling Equipment Dedicated (Y) | N | (circle one)

Purging Device	C	A-Submersible Pump	D-Gas Lift Pump	G-Bailer	X- (Purging Other, Specify)
Sampling Device	C	B-Peristaltic Pump	E-Venturi Pump	H-Scoop/Shovel	X- (Sampling Other, Specify)
		C-Bladder Pump	F-Dipper/Bottle	I-Piston Pump	
Purging Material	A/B	A-Teflon	C-Polypropylene	E-Polyethylene	X- (Purging Other, Specify)
Sampling Material	A/B	B-Stainless Steel	D-PVC		X- (Sampling Other, Specify)
Tubing-Purging	G	A-Teflon	D-Polypropylene	F-Silicon	X- (Purging Other, Specify)
Tubing-Sampling	G	B-Tygon	E-Polyethylene	G-Combination teflon/ Polypropylene	X- (Sampling Other, Specify)
		C-Rope X- (Specify)			
Filtering Devices 0.45 µ	A	A-In-line Disposable	B-Pressure	C-Vacuum	

FIELD MEASUREMENTS

Well Elevation	* 654.01 (ft/msl)	Land Surface Elevation	
Depth to water From top of well casing	99.67 (ft)	Depth to water From land surface	(ft)
Groundwater Elevation	554.34 (ft/msl)	Groundwater Elevation	(ft/msl)
Well Depth	* 134.50 (ft)	Stickup	(ft)

1st	7.41 (STD)	1st	652 µm/cm at 25° C (spec cond)	Sample Temp.	12.8 (° C)
2nd	(STD) (pH)	2nd	µm/cm at 25° C (spec cond)	Well dia (other parameter)	20 (value) in (units)
3rd	(STD) (pH)	3rd	µm/cm at 25° C (spec cond)	(other parameter)	(value) (units)
4th	(STD) (pH)	4th	µm/cm at 25° C (spec cond)	(other parameter)	(value) (units)

FIELD COMMENTS

Sample Appearance: liquid (if applicable) Odor: none Color: light grey Turbidity: slight

Weather Conditions: Wind Speed 15 mph. Direction out of southwest Precipitation Y/N Outlook partly cloudy

Specific Comments: *Obtained from Well I.D. Chart (7/95)

Well condition is good, access good.

134.5 - 99.67 = 34.83 X .163 = 5.677 X 3 = 17.03

Good recharge rate; 3 casings obtained at 13:46 hrs.

Duplicate field readings: pH - 7.44 at 13.0 SC - 656

Well is located in N.W. corner of site - 10 yds. from haul road.

Certify that sampling procedures were in accordance with applicable EPA, State and WMI protocols

7/28/95 [illegible] Employer WMX - EML

*Field Comments

The section on field comments should include field observations such as:

Odor: If readily detected. Do not directly smell the sample or **odors**. Record only the odors that may be readily evident at the riser. (e.g., strong, moderate, slight, none.)

Color: True "color" is the color after the turbidity has been removed. The color observed immediately after sampling is usually an "apparent color," influenced by sediment in the sample. If possible, the color should be determined after the sediment has settled out of the sample or immediately after in-line filtration. If this is not possible, the color should be described as well as possible.

*Turbidity:

None: (sample is clear);

Trace: (sediment only slightly clouds or colors the sample; sediment does not accumulate at the bottom of the bottle);

Moderate: (definite cloudiness or color; sediment accumulates at the bottom of sample bottle);

High: (muddy appearance).

*Weather conditions, include field observations such as wind direction and speed, temperature, outlook (cloud cover), and barometric pressure (when needed for regulatory requirements). Any difference in weather conditions between purging and sampling should also be noted.

*Specific Comments

The section on specific comments should include field observations such as:

- Any problems with the well or dedicated sampling equipment.

- Reference point for where well measurements (top of inner casing well elevation, land surface elevation) were obtained.

- Sample point where the field blank or duplicate sample is prepared.

- All calculations for purge volumes and temperature conversions.

- Note when wells are purged dry, or

- Explain when less than three casing volumes are removed.

- Duplicate field measurement results.

•For samples composited in the field, the procedures and proportions of samples used, are to be described in the Field Comments section of the Field Information Form. (For example, "one quart obtained hourly by grab sampling over 8 hours".)

•Results pertaining to stabilization results for pH, specific conductivity, and temperature during the purging process of sampling a monitoring well.

•Other conditions, such as sample duplicates sent to regulatory agencies, samples split with an agency, and potential safety or health hazards (e.g., fire ants, presence of landfill gas in well, etc.).

•Note whether sampling occurred downwind from on-site activities which may potentially affect the samples.

Upon request, EML will provide extra Field Information Forms.

<u>*Observe Maintenance Conditions at Well</u>

The condition of, problems with, and changes to the well and its surrounding area must be observed and recorded on the Field Information Form upon arrival at the well location. The following information should be noted:

•The lack of, or poor condition of the well's identification sign.
•If the well was recently painted.
•If the well is not locked or the lock is broken.
•Any problems related to well integrity such as:
  -Physical surroundings (e.g., high weeds, standing water, cleanliness, nearby activities, etc.).
  -Condition of the Well Wizard® or dedicated bailer.
  -Condition of the protective casing.
  -Any obstructions or kinks in the well casing.
  -Condition of the cement footing (e.g., cracked, raised, etc.).
  -Any presence of water in the annular space.
  -Any grease around top of the well on the threaded caps.
  -Well guard posts' conditions.
  -Whether the cap fits securely so contaminants cannot enter the well.
  -Evidence of contamination (e.g., animal or insect parts in the well, etc.).

<u>*Sampling Certification</u>

At the bottom of the Field Information Form, the sampler must sign the form certifying that the sampling procedures were in accordance with applicable federal and state regulations, and corporate policy as outlined in the WMX Manual for Groundwater Sampling and the Site-Specific Groundwater Monitoring Plans. **The person signing the sampling certification must be present throughout the entire sampling process.**

4.2.3.2 Static Water level Measurements

If wells have not been equipped with Well Wizards which contain static head sensors to measure depth, a water level or slope indicator (or similar device) or weighted tape, is used to determine the static level of water in the well, as well as the total depth of the well. Water level indicators with lead weights or which have been taped, should not be used.

A slope indicator works on a conductivity principle. An alarm sounds and a red light is seen when the probe comes into contact with the water. The cable is permanently marked usually in increments of tenths of feet.

To measure the static water level with a slope indicator, the following procedures should be followed:

1. Rinse the slope indicator cable with laboratory grade deionized water . Shake off all excess water and/or wipe the cable clean using lint free paper towels. Additional cleaning procedures may be implemented if required.

2. Switch the sensitivity dial to 4-5. Depress the red button. The red light should be seen and a buzzing sound should be heard. This will ensure that the meter is working.

3. Slowly unreel the cable into the well until the buzzing sound can be heard and the red light is observed on the meter. The cable should be lowered through the vent hole without removing the cap, if possible.

4. Slowly raise and lower the cable to the point when the buzzer and light (together) just begin to activate. This indicates the static water level. Note: If equipment within the well interferes with the measurement of the water level (e.g. bailer at the water level), this should be noted on the Field Information Form.

5. Using the thumb and index finger, mark this position on the cable, using the point at which the elevation has been measured (e.g., top of inner casing, land surface elevation, etc.) as a reference.

6. The measured distance should be recorded to the nearest hundredth of a foot. If the slope indicator is not incremental, measure with a ruler the distance between the closest one foot increment and the point marked, and convert these units to hundredths of feet. All measurements taken in feet and inches should be converted to the nearest hundredth of a foot. Example: measure 10'8" = 10.67'. (See Appendix). Record this information on the Field Information Form.

7. Rinse the slope indicator off with laboratory grade deionized water after reeling the cable back onto the spool.

8. Shake off all excess water. Additional cleaning procedures may be implemented if required.

The use of an electronic slope indicator is preferred, however, if a weighted tape must be used, the following procedures should be used to determine the distance to the water.

1. Check to see that the weight (or popper) is securely fastened to the tape. Wire (Teflon® coat if possible) is the preferred method for attaching the weight to the tape.

2. Thoroughly rinse the tape and weight with laboratory grade deionized water.

3. Shake off any excess water.

4. Slowly lower the weighted tape into the well, until the weight can be heard hitting the water.

5. Raise and lower the tape to determine the precise location at which the weight comes into contact with the water. If the well casing is wet, the tape may cling to the sides of the well. If so, shaking the tape while lowering and raising may provide a more accurate measurement.

6. While holding the tape where the elevation has been measured, note the measured value.

7. Record the measurement on the Field Information Form in hundredths of a foot.

   If the end (bottom) of the weight has not been attached to the tape at the zero-inch mark, the original measurement will need to be recorded on the Field Information Form in the "comments" section. The additional distance, as measured from the end of the tape at the end of the weight, should be added to the original measurement. This final value should then be placed on the Field Information Form under "Field Measurements".

8. Reel the tape and weight out of the well, while wiping off any dirt or sediment.

9. Thoroughly rinse the tape and weight with laboratory grade deionized water.

10. Shake off any excess water.

4.2.3.3 Measurements to Determine Purge Volume

The water level within each monitoring well is determined for each sampling event. The static water level is measured before well purging and sample withdrawal. Some sites also require the static water level be measured after purging and before sampling (this requirement will be noted on the SOW). The elevation of the groundwater is then determined by the following equation:

Equation: $G_{EL} = E_{TC} - D_{TW}$

where:

G_{EL} = Groundwater Elevation (feet/mean sea level: (ft/msl))
E_{TC} = Measuring point elevation (usually at top of inner casing)
D_{TW} = Depth to water (ft) from the measuring point (top of inner casing)

*Obtained from the Well ID Chart; or as measured.

Note: All well measurements must be made from the point at which the elevation was measured (e.g., top of the inner casing; land surface elevation). This point must be noted in the Field Comments section of the Field Information Form.

Also see Section 4.2.4.1 - Calculating Purge Volume.

4.2.3.4 Depth of Well Measurements

The depth of well measurement is required every two years or as required by permit. This will be noted on the SOW provided to the sampling team. Wells with dedicated pumps installed may be exempt from this requirement. The depth of the well, when not measured, should be obtained from the Well ID Chart and noted on the Field Information Form in the Field Comments section. Indicate the information is "from Well ID Chart".

Use of the slope indicator or weighted tape for measuring the depth of the well is not as accurate as the water level measurement, as the bottom is determined entirely by "feel". This measurement should be reported to the nearest tenth or hundredth of a foot. This measurement is used in the calculation for the volume of water in the casing for purging operations:

1. After recording the static water level, slowly unreel the cable or tape until the probe or popper hits the bottom of the well.

2. Slowly pull up the slack until slight tension is felt on the cable.

3. Slowly raise up and down until a feel for the bottom is obtained.

4. Using the point at which the elevation has been measured as a reference point, mark the cable with a finger, and measure as for the water level.

5. Reel the cable back onto the spool, rinse it with laboratory grade deionized water, and shake off all excess water.

6. Record the measurement on the Field Information Form.

4.2.3.5 Additional Field Measurements

Stickup and casing size may also be required to be measured and recorded on the Field Information form (Figure 4.9). Additional sampling and purging information, should also be recorded (e.g., sampler type, material) as specified on the SOW.

4.2.4 Purging Procedures

Monitoring wells should be pumped or bailed prior to sample withdrawal to prevent collection of nonrepresentative stagnant water in a sample. As a general rule, pump or bail a minimum of three times the volume of water standing in the well for moderate to high yield formations, and at least

one casing volume for low yield formations - those with slow recharge. Required purge volumes are often specified in the facility permit. Well purging should be sufficient to increase the likelihood that the water collected is representative of the groundwater within the formation around the well.

Purging should continue, when possible, until field parameters (including pH, temperature, and specific conductivity) have stabilized. Measurements should be taken at short intervals during the purging process to determine stabilization. This method is most beneficial for initial determination of purge volume. After this initial determination, purge volumes can likely be set to those initially developed.

If a monitoring well is a very low-yield well, bail or pump the volume of water standing in the well and allow the well to recharge for up to 24 hours. If there is not sufficient water for sampling <u>any</u> parameter, then the well is considered dry for the purpose of sampling. If water is available to partially complete sampling requirements, samples should be taken wherever possible. Contact the EML for minimum testing volumes (see Appendix) for each analyte unless otherwise specified by the regulatory agency or the Program Manager. In any of these situations, notify the Program Manager immediately. If a well, which normally can be purged, is dry, contact the Program Manager immediately.

> Note: Low permeability formations may be allowed to recharge for a longer period of time as specified by the permit, Site Specific Groundwater Monitoring Plan, or Program Manager.

When purging a well with a double pump system (upper and lower), six screen volumes must be purged from the well, unless otherwise specified by the Program Manager. In all double pump wells, the upper (purge) pump must be left on while the lower pump is used for sampling.

4.2.4.1 <u>Calculating Purge Volume</u>

To determine the volume of water to be purged from the well, use one of the following processes:

<u>Process 1:</u>
The volume (in gallons) of water the column can be determined from the Purge Volume Charts (Figure) after the length of the water column in the well, in feet, has been determined as well as the diameter of the inner casing is also determined. Use the following equation:

Equation: $h = W_{DT} - D_{TW}$
where;

h = Length of water column in feet
W_{DT} = Well depth* in feet
D_{TW} = Depth to water from top of well casing in feet

Inner Diameter of inner casing of well is 2 inches.
*Obtained from the Well ID Chart, or as measured.

NOTE: Volumes in these charts must be multiplied by the number of casing volumes (or well bore

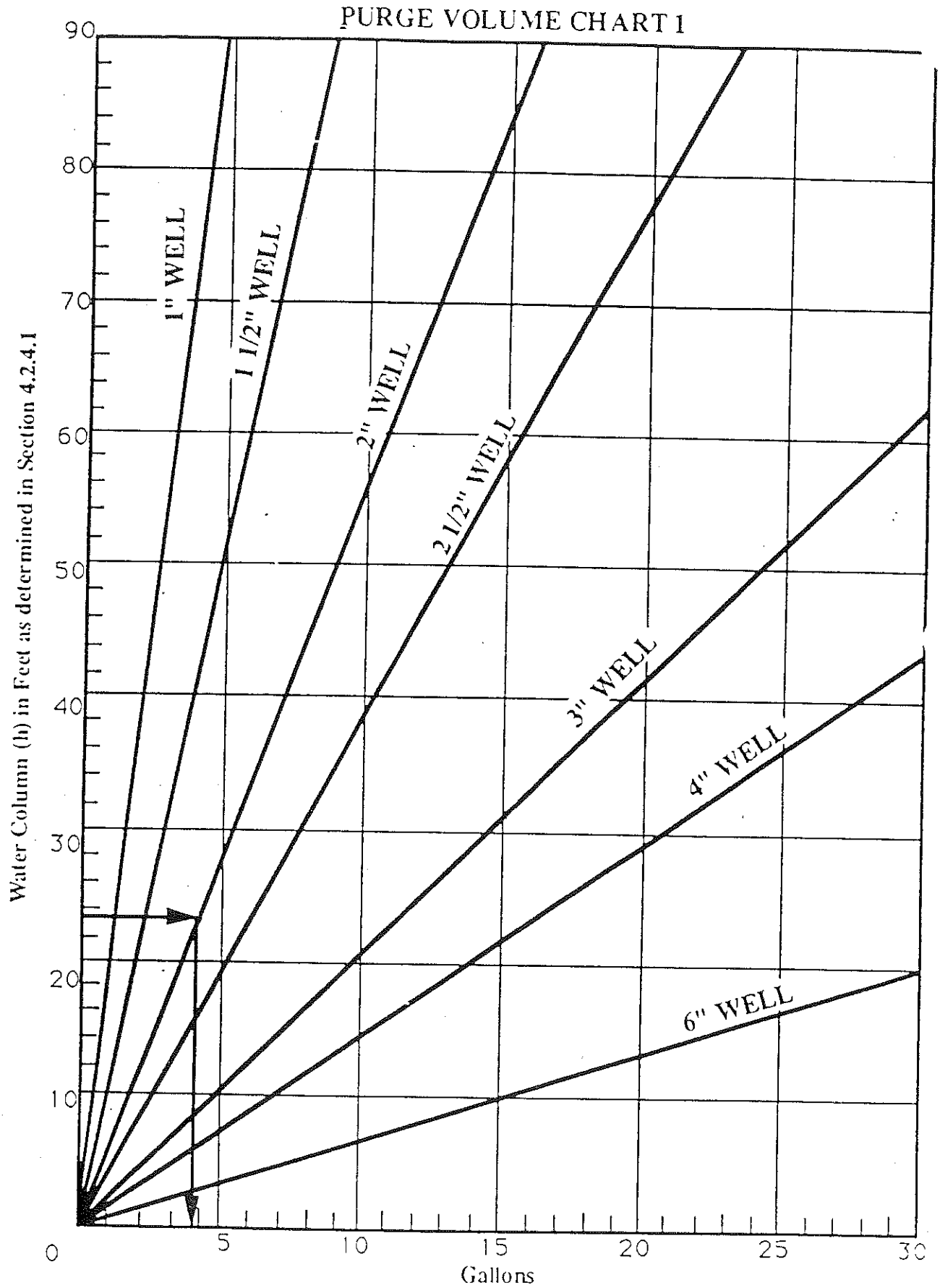
volumes where required) of water to be purged from the well (e.g., for moderate-to high-yield formations, multiply the value by at least 3).

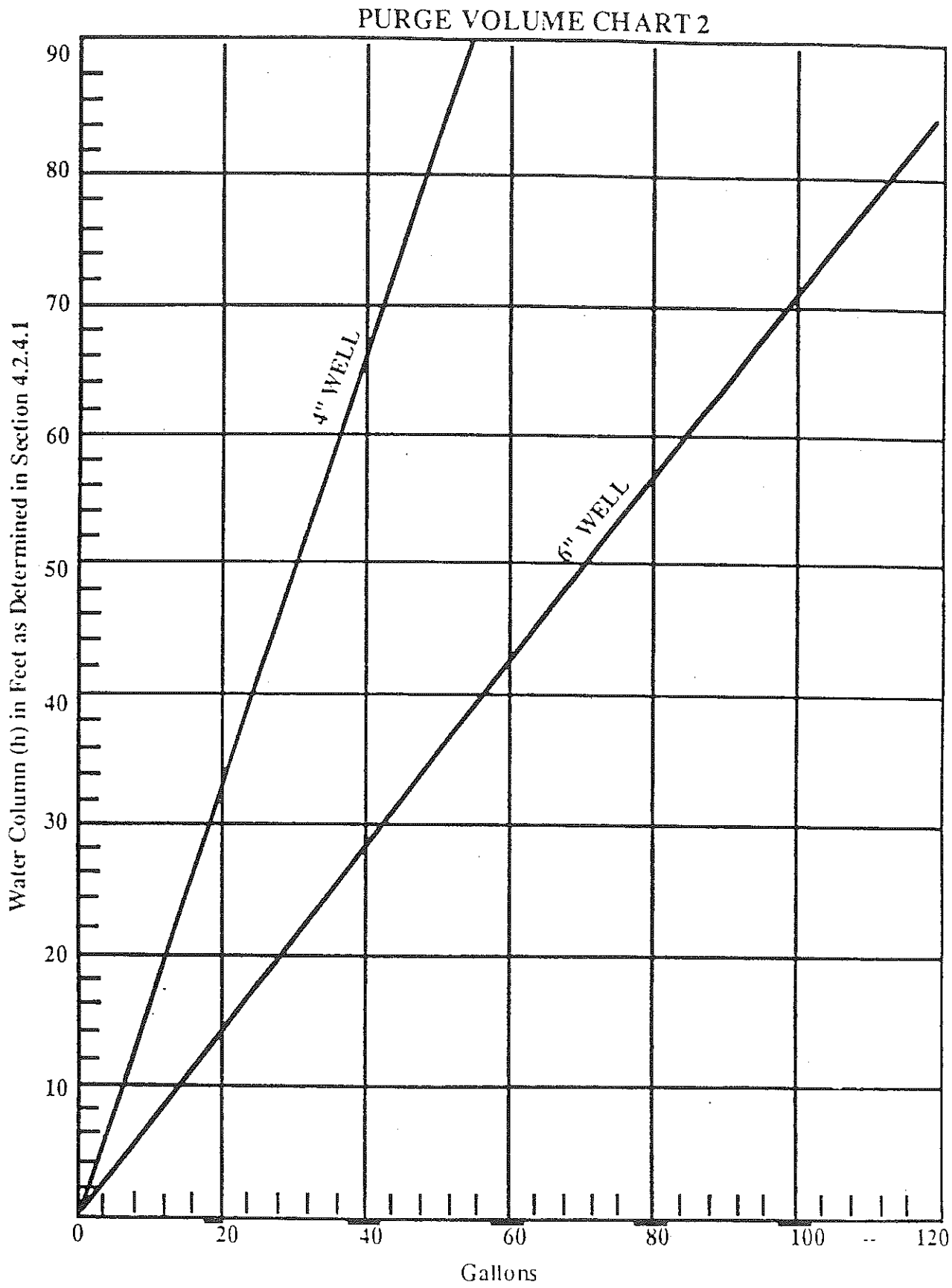
Example 1: Using the Purge Volume Charts:

(Measurements are recorded in the Field Measurements Section of the Field Information Form)
Well Depth* (W_{DT}) = 27.00 ft
Depth to water from top of well casing (DTW) = 3.63 ft

(Field Comments: recorded in Field Comments Section of Field Information Form.)
2 inch diameter inner well casing
Calculation: length of water column (h) = 27.00 ft - 3.63 ft = **23.37 ft**

From purge volume charts (in the WMX Manual for Groundwater Sampling pages 79 and 80):
3.8 gallons of water to be purged for one casing volume.
If 3 casing volumes had to be purged, then 3.8 gallons x 3 casings
= 11.4 gallons of water to be purged from well prior to sample collection.


PURGE VOLUME CHART 1
Water Column (h) in Feet as determined in Section 4.2.4.1
Gallons
0
5
10
15
20
25
30
10
20
30
40
50
60
70
80
90
1" WELL
1 1/2" WELL
2" WELL
2 1/2" WELL
3" WELL
4" WELL
6" WELL


PURGE VOLUME CHART 2
Water Column (h) in Feet as Determined in Section 4.2.4.1
90
80
70
60
50
40
30
20
10
4" WELL
6" WELL
0
20
40
60
80
100
120
Gallons

Process 2: Purge Volume

If the purge volume charts will not be used, use the following equation for determining how many gallons of water are "standing" in the well:

Equation: $\pi * (r)^2 * h * 7.48$

where;

$\pi = 3.14$
r = Radius (in feet) of inner well casing (convert inches into feet)
h = Length of water column in feet
7.48 gal/ft^3 = Value used to convert cubic feet into gallons

Example 2: Using the equation for determining how many **gallons** of water are "standing" in the well:
(Measurements are recorded in the Field Measurements Section of Field Information Form.)

Well Depth = 27.00 ft
Depth to Groundwater = 3.63 ft
h = 23.37 ft
2 inch diameter inner well casing

Then;

π (1"/12")^2 x 23.37 x 7.48 gal/ft^3

π (.083 ft)^2 x 23.37 ft x 7.48 gal/ft^3

π (.007) x 23.37 x 7.48 gal/ft^3

.022 x 23.37 x 7.48 gal/ft^3

(.514) x 7.48 gal/ft^3 = 3.84 gal/ standing in the well, or in 1 casing volume

3.84 x 3 = 11.52

If 3 casing volumes had to be purged, then, 3.84 * 3 = 11.5 gallons of water to be purged from the well prior to sample collection.

Process 3: This will allow the sampler to "shortcut" the equation listed in Process 2, by taking the value from the appropriate well radius conversion and multiplying it by the feet of the water in the well.

Using the $\pi * (r)^2 * 7.48$ gal/ft^3 conversion factor:

diameter : radius		radius in feet = r	r^2	so.(πr^2)		*(7.48)
2"	:1"	0.0833	0.0069	0.1631	=	.163
4"	:2"	0.1666	0.0277	0.6527	=	.653
6"	:3"	0.25	0.0625	1.46	=	1.46

where: h = Length of water column in feet

For a 2" diameter well use: 0.163 * h
For a 4" diameter well use: 0.653 * h
For a 6" diameter well use: 1.46 * h

Example 3

Depth to Groundwater (ft) = 3.63'
Well Depth (ft) = 27.00
h = 23.37 feet of water standing in the well.
23.37* .163 = 3.81 gallons in one casing volume

If 3 casing volumes had to be purged, then 3.81 * 3 = 11.43 gallons of water to be purged from the well prior to sample collection.

4.2.4.2 Purging the Well

After the necessary field measurements are made and the volume of water to be purged is determined, the purging process can begin. A key objective when purging a well is minimizing contamination. Equipment should never touch the ground or any other possible contamination sources.

Purged water should be discarded far enough away from the well footing to prevent the possibility of contaminating a shallow earth formation, surface water or soils. Permit conditions or results from previous sampling events may prevent on site disposal of purge water. The Program Manager will define the proper method for the disposal of purge water. If purge water is deemed hazardous by previous testing, it may be necessary to collect all purge water in drums and dispose of them in an approved manner. Procedures for disposal of hazardous waste are beyond the scope of this manual.

To measure the volume of water being removed from the well, a calibrated five-gallon bucket or a container of known volume should be used to collect the water.

4.2.4.2.1 Procedure Using Bailers

When using a bailer for purging, use the largest bailer that will fit into the well, and will still be manageable, in order to minimize purge time.

If a non-dedicated bailer is used, it must be triple rinsed inside and out with laboratory grade

deionized water before purging. Additional cleaning procedures may be required at some sites.

Disposable powderless gloves must be worn. Generally, powderless PVC or latex gloves are used, however, the permit and/or health and safety personnel or plan may recommend the use of another type of glove based upon knowledge of previous testing. New gloves should be used at each well, or more frequently (e.g., change them if they are dirty or torn). Gloves serve to protect the sampler from potential spills, and to preserve the sample integrity.

The rope should be securely tied onto the bailer and checked with each bail during the purging and sampling process to prevent losing the bailer in the well.

Nylon, stainless steel, Teflon® or polypropylene rope, preferably braided, is to be used (also, check the Site-Specific Groundwater Monitoring Plan). This rope must be new and should be triple rinsed with laboratory grade deionized water before use. In addition, the rope should be of adequate length and strength; thicker rope is easier to grip. The end of the rope should be fastened to the well cap. When this is not possible, the rope should be secured to a large spool to prevent losing the rope and bailer in the well. To prevent contamination of the rope during the bailing process, use a fiber drum lined with a new clean plastic bag to collect the rope.

The well is purged by a repetitive process of lowering, raising, and dumping of the water collected in the bailer:

1. Slowly lower the bailer into the well until the bailer contacts the water. Lowering the bailer slowly will help:

    - prevent contamination from rust or other sediment, which may accumulate around the top of the well casing;
    - minimize the upwelling of bottom sediment;
    - prevent degassing of the well by the sampler;
    - minimize the possibility of the bailer becoming lodged in the well due to a kink in the well casing; and
    - prevent damaging the bottom of the well

2. Allow the bailer to fill with water. The bailer will "gulp" when it is full and increased tension will be felt on the rope.

3. Pull the bailer out of the well while coiling the rope and dropping it into the clean plastic-bag-lined fiber drum. Never allow the bailer or rope to come into contact with any surface other than your gloved hands, the plastic-bag-lined drum, and the inside of the well.

4. Pour out water from the bailer into a calibrated bucket/container and observe the water's characteristics.

5. Repeat the process until the appropriate volume of water has been purged from the well. Always be conscious of possible contamination sources (e.g., grease on well cap).

4.2.4.2.2 Procedure Using Nondedicated Pumps

Nondedicated pumps are most often used for purging when large volumes of water must be removed from the well before sampling. The best (and most commonly used) pumps are submersible, centrifugal pumps. These pumps are generally used in wells of four inches diameter or larger, due to their size.

All of the equipment at a minimum must be thoroughly rinsed with laboratory grade deionized water and air dried before use. Additional cleaning procedures may be required. Powderless gloves must be worn. New gloves should be used at each well, or more frequently (e.g., change them when they are dirty or torn). Gloves serve to protect the sampler from potential spills and to preserve the sample integrity.

To purge with a non-dedicated purge pump:

1. Slowly lower the pump into the well to prevent possible jamming of the pump and attached tubing/power lines in the well.

2. Place the pump well below the static water level but above the well screen as damage to the pump may occur if the pump is run dry for even a few seconds.

3. Turn the pump on. When assuming a high recharge, remove 2-1/2 well columns at the initial pump position.

4. Continue purging while raising the pump, until the static water level is reached.

5. Turn off the pump.

6. Lower pump to just below the static water level and complete the purge.

7. Turn off the pump.

8. Remove the pump from the well when purging is complete

9. Rinse all equipment before reusing, according to the procedure for cleaning non-dedicated pumps in Section 4.2.1.1.

4.2.4.2.3 Dedicated Pump Procedures

Dedicated pump procedures involve the connection of the dedicated pump to its power source and turning on the pump. Electrical power sources are preferred where possible to minimize possible contamination sources.

4.3 Sampling the Well

You are now ready to begin work on the main objective of the sampling procedures: Collecting the samples. Groundwater samples should be collected in the shortest possible time, while still

maintaining sample integrity.

4.3.1 Field Measurements

At most facilities, three field measurements must be conducted at each sample point during and after purging: pH, specific conductance, and temperature. A separate container or beaker (not a labeled sample bottle) should be used for the required measurements as specified on the EML SOW and the Site Specific Groundwater Monitoring Plan. These containers or beakers may be reused, if thoroughly rinsed with laboratory grade deionized water after use, and at the next sample point rinsed thoroughly with the sample water prior to collection of field measurements. All results must be recorded on the Field Information Form, noting units to three significant figures. (All pH meters must provide a reading to the nearest hundredth [e.g., 7.14]).

When field measurements appear to be in error, all data must be discarded, new samples taken, and new measurements made. A single line should be drawn through any error or correction, and the new entry should be initialed and dated.

Duplicate field measurements must be taken for 1 out of every 10 samples, or at least once per day, whichever is more frequent (for quadruplicate samples, four measurements are made). The duplicate field measurements are recorded on the Field Information Form in the "field comments" section as duplicate readings.

If the values obtained are not within the normal ranges, as indicated on the Well ID Chart(s) in the Site-Specific Groundwater Monitoring Plan, notify the Program Manager immediately. Do not discard this sample, as regulatory requirements may indicate that it must be analyzed. Additional samples may be requested by the Program Manager to ascertain the cause of abnormal readings.

In some permits, pH and specific conductivity measurements may be required to be done in quadruplicate. This will be identified on the SOW. Where precision of an instrument is to be measured, four measurements are to be made from one sample container. Between measurements, the instrument should be turned off, rinsed and dried. If the stability of the sample water is of concern, then one measurement from each of four containers should be taken.

4.3.2 When Not to Sample

During a sampling event, all scheduled wells must be sampled, except in the following cases:

* If the well has been destroyed or otherwise rendered useless (e.g., casing broken off or severely bent so as to preclude sampling);

* If the well is dry (e.g., no water can be pumped within 24-72 hours of the end of purging). Note: Some regulatory agencies, may require a longer recharge time before sampling;

* If the well is new and has not been properly developed (pH and specific conductance must be stabilized);

* If the Program Manager states that the sampling should not be done.

4.3.3 Sampling Procedures

Procedures for sampling are the same as those for purging, with the exception that in sampling, the water removed from the well is placed in sample bottles rather than being discarded.

4.3.4 Filling Sample Bottles

4.3.4.1 General Sampling Requirements

Prior to sample collection, check to see if field filtering is necessary. Specific filtering instructions are included on the SOW from the EML. Where in-line filtration is not available, prefiltration bottles may be used to collect the samples. This collection method is to ensure that no sediment will be introduced into the filtered sample which could cause possible analytical errors. Note the source, manufacturer and lot numbers of the prefiltration bottles. Plastic prefiltration containers should only be used for inorganic analytes. Organic analytes to be filtered must be placed in glass prefiltration containers if in-line filters are not used. (See Section 4.3.7 - 4.3.7.2 for filtration procedures).

When filling the sample bottles, the following procedures and precautions are essential:

1. Samplers must wear appropriate powderless gloves, generally PVC or Latex disposable gloves unless otherwise specified.

2. Bottle caps should be removed carefully so that the inside of the cap is not touched. Caps should never be put on the ground. Caps for VOA vials contain a Teflon® lined septum. The Teflon® side of the septum must be facing the sample to prevent contamination of the sample through the septum.

3. AquaPaks should have cold ice packs or some type of a cooling mechanism in them before taking them into the field to aid in the cooling process of samples.

4. The sample bottles should be filled with a minimal amount of air contact, and without allowing the sampling equipment or personnel to touch the inside of the bottles or bottle caps.

   Tubing or hoses from Well Wizards or pumps must not touch or be placed in the sample bottles.

   Samplers should not place their gloved hands over the end of a leaking bailer. If the bailer leaks due to sediment or an improperly seated ball valve, the dripping water may be used to fill the sample bottles or the bailer may be jolted to try to reseat the ball valve. The bailer should not be returned to the well with water still inside.

   NOTE: All sample bottles are supplied from the EML. If a bottle from another source (i.e. prefiltration bottles) is used, document the source, type, and lot number of the bottle on the field forms.

5. Samples that are to be filtered using prefiltration bottles, should be filled completely to allow

for any loss of water from sediment during filtering.

After filtering, sufficient space should be available in the sample bottle(s) for the addition of required preservatives. The bottle caps should then be replaced tightly.

6. VOA, TOX, and TOC sample bottles must be filled so that they are headspace-free. These sample bottles, therefore, need to maintain a convex water surface in the bottle. The caps for these bottles should be replaced gently, to eliminate any air bubbles in the sample. These bottles must then be checked by inverting them and tapping them sharply with a finger. If any air bubbles appear, open the bottle, add more sample water, and repeat this process until all air bubbles are gone. Do not empty the bottle and refill it. For additional information on filling VOA vials, see the Appendix.

7. Air space should be left in coliform sample bottles, as these samples must be shaken before analysis.

8. All sample bottles after required filtering, filling, and preserving, must be placed in an AquaPak with ice until ready to be shipped. **Samples must be shipped for next day delivery (Federal Express - Priority Overnight) to the EML or to the subcontract lab the same day they are collected.** Due to the extremely short hold and extraction times involved with many of these methods, it is necessary to ship the same day as sampling occurs. Therefore, allow time at the end of the day to get the collected samples to the courier.

9. Never place glass bottles which have been prepared headspace-free (i.e., VOA, TOX, or TOC) in direct contact with ice packs as they may cause the sample to freeze and the bottle to break.

10. Sample bottles, caps, or septums that fall on the ground before filling should be thoroughly rinsed with sample water before being used. All circumstances regarding dropped bottles, caps or septums, and their subsequent rinsing and use, must be noted on the Field Information Form.

11. Sample bottles should not be opened after collection and preservation of the sample.

4.3.4.2 Anion Cation Sampling Requirements

At some sites, where calculation of cation/anion balance is a requirement, collection of the samples for parameters used to calculate cation/anion balance deviates from typical collection processes.

Generally, for the appropriate methods, a single homogeneous sample is collected, and is poured into sample containers for the appropriate methods. Some portions of the sample may require preservation, others may not. For specific sampling instructions see the Statement of Work (SOW) and other related sampling instructions.

4.3.4.3 Stormwater Sampling Requirements

Generally, for stormwater events, two types of samples are required for each sample pont: a grab

sample and a flow weighted composite sample. Typically, a grab sample is collected within the first 30 minutes of the runoff (or as soon thereafter as practicable). The flow weighted composite sample is a single sample intended to provide the average water quality for the entire runoff event, and is usually collected during either the entire runoff event (which may be less than 3 hours) or during at least the first three hours of the runoff. The sample can be collected using either automatic sampling equipment or by manually collecting and combining a series of discrete grab sample (aliquots) in an appropriate manner. Check site specific permit conditions and state regulatory information regarding stormwater sampling procedures.

4.3.5 Blanks

Trip, field, and equipment blanks are typical components of the field sampling QA/QC program; the type and number required are site specific. They are used to detect contamination that may be introduced in the field (either atmospheric or from sampling equipment), in transit to or from the sampling site, or in the bottle preparation, sample log-in, or sample storage stages at the lab. Lab or method blanks will also reflect any contamination that may occur during the analytical process.

Trip Blanks

Trip blanks are samples of organic-free water that are prepared at the EML. They remain with the sample bottles while in transit to the site, during sampling, and during the return trip to the EML. Trip blank sample bottles are not opened at any time during this process. Upon return to the lab, they are analyzed following the same procedures as for ordinary field samples.

If trip blank sample bottles are accidentally opened, note it on the Field Chain-of-Custody Record.

Field Blanks

Field blanks capture airborne contaminants that are not from the source where the sample is being collected. Field blanks should be collected at the specified frequencies, which will vary according to the probability of contamination or cross-contamination. Field blanks are prepared in the field (at the sampling site), using the bottle set dedicated to the field blank by the sampler, and the laboratory grade deionized water used for cleaning sampling equipment. Field blank water for VOA samples, which is the same as the GC/MS water (Millipore) used for trip blank creation, will be sent by the EML. All other field blank water must be supplied by the sampling team. Procedures may vary from site to site. Check with the Program Manager before sampling, and note on the Field Chain-of-Custody Record whether procedures other than those listed in this Manual are followed. The well at which the field blank is prepared must be identified in the "comments" section of the Field Information Form.

Equipment Blanks

Equipment blanks are aliquots of water that contact nondedicated sampling equipment under field conditions and are analyzed to detect any contamination from sampling equipment or cross-contamination from previously collected samples.

For non-dedicated equipment, the laboratory grade deionized water is poured into the sampling device (e.g., the bailer) after it has been cleaned, in preparation for the next sample point. If the analytes for the field blank would normally be filtered, this water should be placed into a prefiltration bottle and subsequently filtered. Note whether or not the sample bottles were filtered, this water should be placed into the field blank bottle set, and the proper preservative(s) added (as required).

For dedicated sampling equipment with no filtration, or in-line filtration, the laboratory grade deionized water should be exposed to the air, transferred to the field blank bottle set, and the proper preservative(s) added as required. If the required filtration is not done in-line, the water should be exposed to the air, poured into prefiltration bottles (if they are used), filtered (as required), and placed in the field blank bottles, and the proper preservative should be added as required.

The following guidelines/recommendations have been established by WMX for the use of trip and field blanks:

- For all WMX sites, with sampling programs involving volatile organic analyses, at least one trip blank should be analyzed per site, per day.

- For field blank and duplicate samples, EML recommends one of each should (field blank and one duplicate) be collected and analyzed for every ten samples collected.

Additional blanks and/or analytes may be tested if required by the permit. Field and trip blank results will be reported in the Client Report as separate samples, using the designations FB or TB in their sample point designation.

4.3.6 Duplicate Samples

The sampling team is responsible for submitting duplicate well samples to the lab where required. For each sampling event, a duplicate well sample is obtained from one of the wells, as selected by the program manager or sampling team. The sample is labeled "X-DUP" and sent to the lab with the other well samples. The actual sample point designation of the duplicate sample should be noted in the "Field Comments section of the Field Information Form.

On subsequent sampling events, a different well should be selected for obtaining the duplicate sample. All wells should be used as duplicates at some point (volume permitting), and a record of these duplicates must be maintained at the site.

Field measurements (pH, specific conductivity, temperature, etc.) of the duplicate sample should be obtained and recorded on the Field Information Form. The field measurements may be used for the duplicate field measurements required in Section 4.3.1.

Special procedures are required when samples are collected in duplicate. Aliquots of water are obtained from the well either from bailers or pump cycles. Aliquots should be alternated between like bottles in alternating bottle sets to provide samples to each group that will be as representative as possible. Examples of the bottle filling sequences for duplicate sampling follow:

Example 1: Duplicate Sample, using a bailer
Bailer 1, bottle set 1, VOA bottle
Bailer 2, bottle set 2, VOA bottle
Bailer 3, bottle set 1, TOX bottle
Bailer 4, bottle set 2, TOX bottle
Bailer 5, bottle set 1, TOC bottle
Bailer 6, bottle set 2, TOC bottle

Example 2: Duplicate Sample, using a Well Wizard Pump
Cycle 1, bottle set 1, sample VOA bottle
Cycle 2, bottle set 2, duplicate VOA bottle
Cycle 3, bottle set 1, sample TOX bottle
Cycle 4, bottle set 2, duplicate TOX bottle
Cycle 5, bottle set 1, sample TOC bottle
Cycle 6, bottle set 2, duplicate TOC bottle

4.3.6.1 Split Samples

Generally, split samples are a single field sample which is split into two separate bottle sets in the field. Each bottle set is then sent to a different laboratory for analysis.

4.3.7 Filtration

Regulatory guidelines and permit requirements for sample filtration in the field may vary from site to site. However, all samples requiring filtration must be filtered through a 0.45 micron membrane pressure filter, unless regulatory requirements specify otherwise. Historically, the EML recommends field filtering of all samples except those listed below.

Samples Not Requiring Filtration

Alkalinity
Turbidity
Total Suspended Solids (TSS)
Total Solids
Semi-Volatile Organics
Volatile Organics (VOA)
Total Organic Halides (TOX)
Total Metals
Any other analytes listed as Total refer to unfiltered samples (if it does not say Total, assume it is Dissolved) *Coliform
pH
Specific conductivity
Oil and grease

Note: Some samples require field filtration even when a "TOTAL" analysis is requested. Some

examples include Total Organic Carbon, total hardness, etc.

Site-Specific filtering requirements appear on the SOW as well as the bottle labels. The filtering information must be noted on the Field Chain-of-Custody Records in the column labeled "Filter, Y/N".

Regulatory and permit requirements will generally specify whether to analyze, for example, for total mercury as opposed to mercury or dissolved mercury. All heavy metals samples should be filtered unless otherwise specifically requested. Filtering is necessary to determine the ions and compounds that are dissolved in solution in the groundwater rather than those that are absorbed or adsorbed on particulates. Monitoring wells are not as fully developed as drinking-water wells and often contain silts and sediment that must be removed by filtration. If the water is not filtered, ions and compounds naturally present in, or absorbed onto, the suspended particles may be released when samples are preserved and analyzed. This release could result in much higher concentrations than are actually present in the groundwater.

Filtration and preservation of groundwater samples is an integral part of the monitoring program. Improper techniques during this process can destroy the integrity of the sample. All possible precautions should therefore be taken to ensure that no contamination is introduced during filtration or preservation.

Notes:

* Filtering should be performed immediately after or during (in line filters) sample collection and should be done in the field. When this is not possible, filtration should be completed as soon as possible after the sample has been collected (within <u>two</u> hours) and should be done under the most contaminant-free conditions available.

* Any sample suspected or known to have high contamination levels, as identified by the Program Manager is to be filtered last, to prevent any contamination of subsequent samples through the use of the same filtering equipment.

* Filtering equipment must be dedicated for groundwater use only. Do not use any filtering apparatus that is used for other procedures such as EP-TOX or TCLP.

* Surface water, private wells, and leachate samples are never filtered unless specifically required by permit.

* Prefiltration bottles are <u>not</u> to be reused. The material and use of prefiltration bottles must be noted on the Field Chain-of-Custody Record and/or Field Information Forms.

4.3.7.1 <u>Filtration Not Performed In-Line</u>

The following list delineates the equipment and requirements for proper filtering and preservation of groundwater samples when filtration is <u>not</u> performed in-line.

* Where field filtration is not possible, a clean bench space with a readily accessible sink, isolated

from possible contamination sources, including outside air and inside fumes should be used.

* Stainless steel pressure filter holder (1.5 liter reservoir). Note: In some EPA Regions, stainless steel is expressly forbidden. The Program Manager should specify the appropriate filtration media where this is true.

* 0.45 um filters (142 mm. diameter)unless otherwise specified by regulatory or permit requirements;

* Nitrogen (OSHA Class D) tank and regulator;

* Glass funnels

* Large supply of laboratory grade deionized water;

* Miscellaneous supplies (e.g., lint free paper towels, tools, etc.);

* Statement of Work form (SOW) to ensure there is a proper bottle and preservative for each analysis or series of analyses required for that particular sample;

* Designation of which samples are to be filtered for each sample point: (See SOW).

The following is the procedure for filtering and preserving a typical monitoring well sample when filtering is <u>not</u> performed in-line.

1. Make sure that all filtering apparatus has been completely cleaned with laboratory grade deionized water only and dried, and that all pressure fittings are tight.

2. Remove the top, or reservoir portion of the filter holder and position a new 0.45 um (142 mm. Diameter) filter on top of the filter support screen, making sure it is flush on all edges. Care should be taken in handling the filter paper, which is easily torn. A small amount of laboratory grade deionized water may be used to wet the filter and hold it on the filter screen, when excessively windy field conditions exist.

3. Replace the top or reservoir portion of the filter holder, over the filter paper, and tighten with the three wing-type clamps (finger tight only with equal force).

4. Unscrew the insert cover and fill the reservoir with the sample to be filtered, using a clean, dry funnel.

5. Screw down the inlet cover securely.

6. Position a new sample bottle under the outlet valve, beneath the filter holder.

7. Open the nitrogen cylinder, regulate pressure to a maximum of 40 psi, and pressurize the reservoir. Use the minimal amount of air pressure necessary for filtration. The filtration is now in process.

8. When the sample bottle is full or the filtration flow ceases, turn the stopcock to the "off" position. Turn the pressure relief valve to the "on" position to release the pressure.

9. Check the Field Chain-of-Custody Record for a list of appropriate preservatives, add the proper preservative to the filtered sample and recap the bottle. Invert the bottle gently several times to mix the sample. Refer to the Appendix for specific procedures on verifying that sufficient preservatives were added.

10. Record the necessary information of the Field Information Form and Field Chain-of-Custody Record after every filter change.

11. Between samples, disassemble the filter holder and its components, appropriately dispose the used filter, and thoroughly rinse (a minimum of three times) with laboratory grade deionized water. Air dry the filter holder completely or dry with lint free paper towels.

12. Reassemble the filter apparatus and begin the process again.

4.3.7.2 In-Line Filtration

When using an in-line filtration system (e.g., Well Wizard, Gelman, Millipore), a minimum of three pump cycles of water must be allowed to pass through the filter before obtaining a sample. These filters should only be used for filtering inorganic parameters, unless analytical data is available to support the conclusion that no sample contamination will occur.

4.4 Sample Preservation, Storage, and Shipment

4.4.1 Sample Preservation

Samples are to be preserved immediately after filtering or immediately after sample collection (if samples are not filtered).

Sample bottles for volatiles, Oil and Grease, and Method 531.1 SW846 have preservatives included in the sample bottle (the bottles are pre-preserved).

Volatiles, TOC (Total Organic Carbon), and TOX (Total Organic Halides) are samples which can have no headspace (no air bubbles trapped between the sample and bottle surfaces).

When collecting the volatile(s) portion of the sample, fill the bottle until a meniscus is obtained. A meniscus is defined as:

"In a container filled with liquid, the curved upper surface of the liquid".

Do not allow the sample to overflow out of the bottle. This will avoid the loss of preservative from the prepreserved sample bottles.

When filling sample bottles for TOC or TOX , fill the bottle with sample until a reverse meniscus is obtained. The reverse meniscus should leave enough room for adding the preservative. Add

the required preservative to obtain a meniscus and cap the bottle.

Premeasured amounts of preservatives are supplied with the sample bottles from the EML. The preservatives are provided in small vials and are taped shut, placed into secondary containment with absorbent material, then placed into cushioning material. (See the Appendix for IATA shipping procedures and regulations). The preservatives should be added to the sample bottle after it has been filled. Bottles must not be overfilled, and once capped they should be inverted gently to mix the preservative with the sample.

See Section 4.3.4.1 for General Sampling Requirements.

A listing of preservatives, by analysis, is included in the Appendix for reference only. It is recommended that the samplers use the preservatives provided by the EML since they are premeasured in the quantities appropriate for the bottle size and concentrations required by the analytical method. At no time should preservatives be kept for greater than three months. (Also see Section 4.2.1.3 and 4.) If substitutions are made (e.g., preservatives supplied by another laboratory) note it on the Chain-of-Custody Record.

All bottles filled from the same sample point at the same time must have identical sample designations and bottle set numbers (except field duplicates). Bottle-id labels should be reviewed for consistency between those being sent to the subcontract lab and those being sent to the EML. Sample duplicates or split samples with regulatory agencies should also be checked for consistent sample point designation numbers and for other methods of identification used by the agency.

For samples being analyzed for total and amenable cyanide analysis, oxidizing agents such as chlorine decompose most cyanides. When collecting samples **in the state of New York** for total and amenable cyanide analysis (EML method ID's: CRCNACLX01, CRCNAUTX01, CRCNFLAS01, CRCNFREE01, CRCNMANL01, CRCNTTLX01), follow these procedures:

1. To determine whether oxidizing agents are present, test a drop of the sample with acidified potassium iodide (KI)-starch test paper as soon as the sample is collected; a blue color indicates the need for treatment.

2. If no treatment is required, go to step 5.

3. If treatment is necessary, add ascorbic acid - a few crystals at a time until a drop of sample produces no color on the indicator.

4. Then add an additional 0.6 g of ascorbic acid for each liter of water.

5. Preserve the sample with sodium hydroxide (5 mL's of 10N). The pH of the sample should be greater than or equal to 12 at the time of collection. Cool the samples to 4 ° C and analyze as soon as possible.

6. Indicate on the Field Chain-of-Custody Record in the field comments section , if the sample required addition of ascorbic acid. If ascorbic acid was added, apply the colored label to the bottle. The colored label will notify the chemist that the sample did contain chlorine.

Notify the EML client services account representative prior to event declaration as to whether or not the samples are chlorinated. This will enable the account representative to queue the EML log-out department via the Statement of Work, that residual chlorine test kit(s) need to be asse,b;ed amd packed in the AquaPak for the appropriate number of sample points. If you do not know whether or not the sample is chlorinated or not, this will need to be determined. Order the appropriate number of residual chlorine test kit(s) and follow directions listed above.

The residual chlorine test kit for each sample point will consist of the following:

- Litmus paper (Potassium Iodide (KI) - starch test paper)
- Ascorbic acid - crystal form (# of grams to be determined)
- Ascorbic acid - 0.6 g
- Disposable small spoon
- Disposable eyedroppers (2 in each package)
- Colored Label (Color to be determined)

Note: The NaOH. preservative will not be supplied as a part of the residual chlorine test kit, but part of the preservatives that will be supplied with the AquaPak.

References:

Methods for Chemical Analysis of Water and Wastes. EPA 600/4-79020. Revised March, 1983

Test Methods for Evaluating Solid Waste - Physical / Chemical Methods, SW846, 3rd Edition, dated November 1986, "Final" Update I dated November, 1990, or Final Update I dated July, 1992.

USEPA Contract Laboratory Program, Document No. ILM020.0, 335.2 CLPM.

Several other methods require that the sample be dechlorinated prior to preserving. A brief list of those analytes follow:

-Fecal and Total Coliform
-Organic Tests
-Purgeable Organic Hydrocarbons
-Acrolein and Acrylonitrile
-Phenols
-Nitroaromatics and Isophorone
-Haloethers
-TCDD

4.4.1.1 Temperature Control

The samples should be cooled to 4°C from the time the sample is taken and until the sample is analyzed. Samples should be maintained in coolers or in AquaPaks containing frozen ice packs. Provisions must be made in advance for facilities to freeze the ice packs. If no such facilities exist it is recommended that prefrozen ice and/or dry ice be brought to the site. (**NOTE: Do Not Ship Dry Ice With the Samples!**). See Appendix for additional details on temperature preservation

procedures.

4.4.2 Sample Packing and Storage

4.4.2.1 Checking Sample Codes and Numbers

The sampler must record the sample designations in the appropriate spaces on the Field Chain-of-Custody Records and Field Information Forms. It is extremely important that the proper designations be recorded in the proper spaces on both forms (COC and FIF) and that they be reviewed before sealing the AquaPak (See Sections 4.2.1.4, 4.2.2, 4.2.2.1, 4.2.2.2, and the Appendix). Proper sample designations are included on the Statement of Work, which is sent to the site before the start of the sampling event.

In addition, the ENS numbers when assigned, must be indicated on all paperwork going to the subcontract lab.

WITHIN AN AQUAPAK OR COOLER, ALL BOTTLE SETS, CHAIN-0F-CUSTODY RECORDS, AND FIELD INFORMATION FORMS MUST MATCH.

All bottles filled from the same sample point at the same time must have identical sample designations and bottle set numbers (except field duplicates). Bottle-id labels should be reviewed for consistency between those being sent to the subcontract lab and those being sent to the EML. Sample duplicates or split samples with regulatory agencies should also be checked for consistent sample point designation numbers and for other methods of identification used by the agency.

4.4.2.2 Sample Packing

After the sample is collected and any required preservatives are added, the bottles and frozen ice packs are placed in the AquaPak. The Field Chain-of-Custody Records and Field Information Forms are reviewed to ensure that they have been completed correctly. All paperwork is placed in the plastic field bag, which is sealed and placed inside the AquaPak.

All bottles should be wiped clean with lint free paper towels before placement in the AquaPak. The bottles should be repacked in the same configuration as when received. When replacing a bottle into a foam holder after sampling, ensure that the bottle cap is upright in the foam holder. It is essential that glass bottles should never be placed directly on or against the ice packs. Check all bottle caps to ensure they are tight and will not become loose when inserted in the AquaPak. Bottle labels should be taped only if they are loose. Note this on the Chain-of-Custody Record or Field Information Form.

Samples extracted from F039 sources require additional packing steps:

1. Glass bottles are placed in molded polyethylene bottle holders. Each foam holder is placed and sealed in a zipper locking plastic bag which contains absorbent material.

2. Plastic bottles that are not in a foam bottle holder are individually placed and sealed in a zipper locking plastic bag which contains absorbent material.

3. The "bagged" bottles and holders are then packed into an AquaPak.

Containers and packing materials designed to prevent breakage and spills must be used for shipping. The AquaPak must be kept as clean as possible to minimize the potential for contamination. In AquaPaks, tight shock-resistant bottle holders are provided around each glass bottle. The AquaPaks must never be shipped without the ice packs or the bottle holders in place. After the AquaPak is repacked, the gray numbered seal is placed through the outside latches (brass eyelets) of the AquaPak and locked. Finally, a black poly strap should be placed through the center channel, and over the gray seal of the AquaPak, and fastened with a fastener.

Three important reminders for packing the AquaPaks:

1. Glass containers should not be placed in contact with each other. Bottle holders should be used for glass bottles to protect them from potential breakage.

2. In very cold weather, the ice packs should be unfrozen or slushy.

3. If the ice packs appear to be leaking, they should be replaced, or sealed into a plastic bag before being placed into the AquaPak. Additionally, a comment noting the condition of the ice pack is to be made on the appropriate Field Chain-of-Custody Record/Field Information Form.

4.4.3 Sample Shipment

4.4.3.1 AquaPak Transportation Arrangements

A member of the sampling team must be appointed to arrange sample pickup and transportation to the lab. AquaPaks and coolers should be returned to the appropriate lab (EML or subcontract) via Federal Express, if possible. AquaPaks should be received at the lab within 24 hours of when the samples were collected and when the frozen ice packs were placed in the AquaPak. This is necessary for temperature preservation and to meet required holding times for some analytes. If there are time lags, in the shipment of the samples from the site, this must be documented on the Field Chain-of-Custody Record by the sampler (e.g., slow recharging well where only a part of the bottle set could be sampled). The EML accepts AquaPaks for delivery six days per week. When shipping for delivery to the EML on a Saturday, specifically mark Priority Overnight and Saturday delivery on the airbill.

Friday shipment (for Saturday delivery) of samples to the subcontract lab should be avoided to ensure that holding times are not exceeded. If it becomes necessary to sample projects on Friday that contain subcontract analyses, please contact the Client Services department at the EML several days prior to the date of sampling. The EML will contact the subcontract laboratory to arrange for Saturday delivery and analyst availability. This is especially true for coliform analyses because few labs analyze these samples on the weekend.

4.4.3.1.1 IATA Shipping Guidance

AquaPaks and acid kits containing preservative vials and prepreserved sample bottles sent to and

from the EML are shipped by air. As such, their shipment is regulated under the International Air Transport Association (IATA) Dangerous Goods Regulations. The preservative vials and prepreserved sample bottles are regulated under the IATA Dangerous Goods In Excepted Quantities (DGIEQ) category.

Sampler Chooses Not to Return Preservative Vials/Unused Prepreserved Sample Bottles

If the sampler chooses not to return the full or empty preservative vials and/or the unused pre-preserved sample bottles to the EML, the vials must be appropriately disposed of in accordance with all applicable federal, state, and local environmental regulations.

Sampler Returns Vials/Unused Prepreserved Sample Bottles

If the sampler plans to return full or empty preservative vials and/or unused pre-preserved sample bottles with the return shipment to the EML, the instructions in the Appendix must be followed to comply with the IATA DGIEQ. The Sampler Procedures for International Air Transport Association Dangerous Goods Regulations - Dangerous Goods in Excepted Quantities memorandum is updated once a year. All samplers are required to complete the revised signature page and one revised quiz included with the IATA instructions for each revision . A copy of the completed quiz is to be maintained on file at the WMX facility, and another sent to the EML. See Appendix.

Please note that these instructions are specifically for the full or empty preservative vials and unused pre-preserved sample bottles that EML supplies to the field for the preservation of environmental samples. These instructions do not apply to the actual sample water being collected. Other IATA requirements, not discussed here, may apply to samples with high levels of contaminants. Samplers should work with the Program Manager to ascertain if shipping requirements apply prior to shipping samples to the EML.

4.4.3.2 Lab Notification

Information regarding the following should be communicated to the EML when the AquaPak is shipped:

1. The name of the carrier (generally, the EML utilizes Federal Express);

2. The number of AquaPaks shipped and applicable ENS numbers; and

3. The estimated arrival date and time.

4.4.3.3 Lab Sample Receipt

If all samples recorded on a Field Chain-of-Custody Record were received by the lab, and there were no problems observed with the sample shipment, lab personnel will sign and complete the 'Lab Use Only' portion of the Field Chain-of-Custody Record. If problems are observed with

sample bottles or AquaPaks, the discrepancy will be recorded on the Field Chain-of-Custody Record in the EML comments section and will be recorded in the log-in process. The following will be noted:

- Presence/absence of the custody seal(s)
- Condition of the custody seal (e.g., intact, broken);
- Presence/absence of air bills and/or bills of lading documentation for shipment of samples;
- Condition of the samples (e.g., intact, broken, bubbles in VOA/TOX samples or trip blanks, etc.);
- Presence/absence of sample point information and bar code labels, and job numbers (subcontract laboratories);
- Notation of discrepancies between numbers on bottles received and those listed on the Field Chain-of-Custody Record and Field Information Forms; and
- Temperature blank measurement of the AquaPak.

The lab will contact the Program Manager to resolve any discrepancies. It is essential to respond quickly so analyses will not be delayed beyond the allowable holding time. The sampling team is responsible for the completeness of the paperwork. If problems are encountered, the Program Manager must be notified. Sample results may be delayed by incomplete shipments that do not include all completed paperwork. All Field Information Forms and Field Chain-of-Custody Records must accompany samples.

Copies of the Field Chain-of-Custody Records and Field Information Forms are included in the analytical report provided by the EML. Documentation of sample condition or incomplete paperwork is also provided on these forms.

4.4.4 Resampling

Resampling of wells between regularly scheduled sampling events should be conducted only when required. The decision to resample, based on the analytical results, should always be reviewed with the Group/Regional EMD staff. However, when samples are, for example, received broken, or samples are missing, resampling should be done as soon as possible. The EML will notify the Program Manager promptly, should these problems occur, and a resampling decision can then be made.

All special sampling events should first be reviewed by the EML to determine whether the EML can perform the analyses required or whether they need to be subcontracted.

4.4.5 Special Instructions for Canadian Sites

Because of Toxic Substances Control Act (TSCA) and Polychlorinated biphenols (PCB) importation regulations, special requirements exist for shipment of environmental samples from Canadian sites. Please see Appendix.

5.0 PRIVATE WELL SAMPLING

5.0 Private Well Sampling

5.1 Purpose

Private well sampling is usually performed in response to requests from concerned residents in the area around the site, or in response to requests by the Board of Health or the local Water Quality Board. These samples may provide useful information on groundwater quality, but are usually more beneficial for maintaining a good working relationship with the area's residents. Those responsible for sampling should display a professional attitude when collecting samples from private wells.

Private wells are usually installed with little documentation of subsurface geologic conditions, and water is usually obtained through high volume, submersible pumps. It is therefore difficult to correlate results from these wells with those for groundwater monitoring wells.

5.2 Sampling Procedures

Some general procedures are included in this section. The procedures for private well sampling are similar to those used for groundwater sampling. Please refer to Section 4 of this Manual (e.g., procedures for measuring pH, specific conductance and temperature, and for sample collection) for further information.

Samples from private wells are taken from the tap. Therefore, it is necessary to evacuate the plumbing and storage tanks prior to taking a sample to ensure the sample is representative of the aquifer. This evacuation can be done a minimum of 15 minutes before sampling collection but a longer time is preferable. To purge the plumbing, open two faucets, flush the toilet, or otherwise use water in the pipes. To ensure the plumbing is being evacuated, listen for the well pump. Two-to-three cycles are preferred.

Samples should be taken from as close to the well source as possible, so basement faucets or outside faucets are preferable. (Note: Document on the Field Information form exactly where the samples were take from). The well owner should also be asked about any treatment equipment installed in the system. Softening, iron removal, pH adjustment, and other equipment are often used (e.g., home carbon filters for removal of organics). Basement and outside faucets will usually not produce such treated water. Contact the Program Manager if the sample must be taken from water affected by a treatment unit. At a minimum, the type, size, and purpose of the unit should be noted on the Field Information Form.

Be sure that an aeration screen has not been installed on the faucet being used. If a screen has been installed, this must be removed before sampling (especially for organics), since the screen tends to agitate the water, and some organics could be lost. If it can not be removed, this should be noted on the Field Information Form.

Private well samples should not be filtered unless regulatory requirements specify otherwise. Field measurements should be taken as requested on the Statement of Work. These values, and all sampling information, should be entered on the Field Information Form. All paperwork should be completed, and samples should be packed in ice for shipment to the lab.

6.0 SURFACE WATER SAMPLING

6.0 Surface Water Sampling

6.1 Purpose

The Surface Water Monitoring Program is designed to protect the environment, by detecting any adverse effect on surrounding waters from surface water leaving the site. Periodic monitoring of the surface water flow and surface water quality is performed to ensure that the surface water drainage systems are not affected by the facility. An effective monitoring system will help identify operational problems and permit early correction. Monitoring the surface water discharged from the site can provide valuable information for WMX should any nearby off-site surface water problems be detected.

Surface water drainage is regulated primarily through National Pollutant Discharges Elimination System (NPDES) permits. The NPDES permits generally require that periodic flow estimates be obtained from specific surface water discharge outlets and sampling points. In addition, periodic water quality samples of surface water discharges and outfalls are normally required.

6.2 Sampling Procedures

Some general procedures for sampling are included in this section. Many of the procedures used for surface water sampling also apply to groundwater sampling. For more detailed procedures, please refer to Section 4 of this Manual.

Little equipment is needed for surface water sampling. A specially designed surface water sampler should be used (see Figure 6.1), to help obtain a sample without excessively disturbing the sample location. The sampling device should be rinsed with laboratory grade deionized water before sampling, and only bottles supplied by EML or the subcontract lab should be used.

When sampling lakes, streams, or runoffs, it is essential to obtain a fresh, representative sample. Samples should be collected from the center of the stream or body of water, at mid-depth. This will ensure an average flow of water with minimal settling of solids. The sample container should be lowered into the water while still capped, uncapped under water to allow the sample bottle to fill, and then recapped before removal from the water. The mouth of the sample bottle should be facing into the flow of water, or facing the water surface. Always face upstream when sampling in the water.

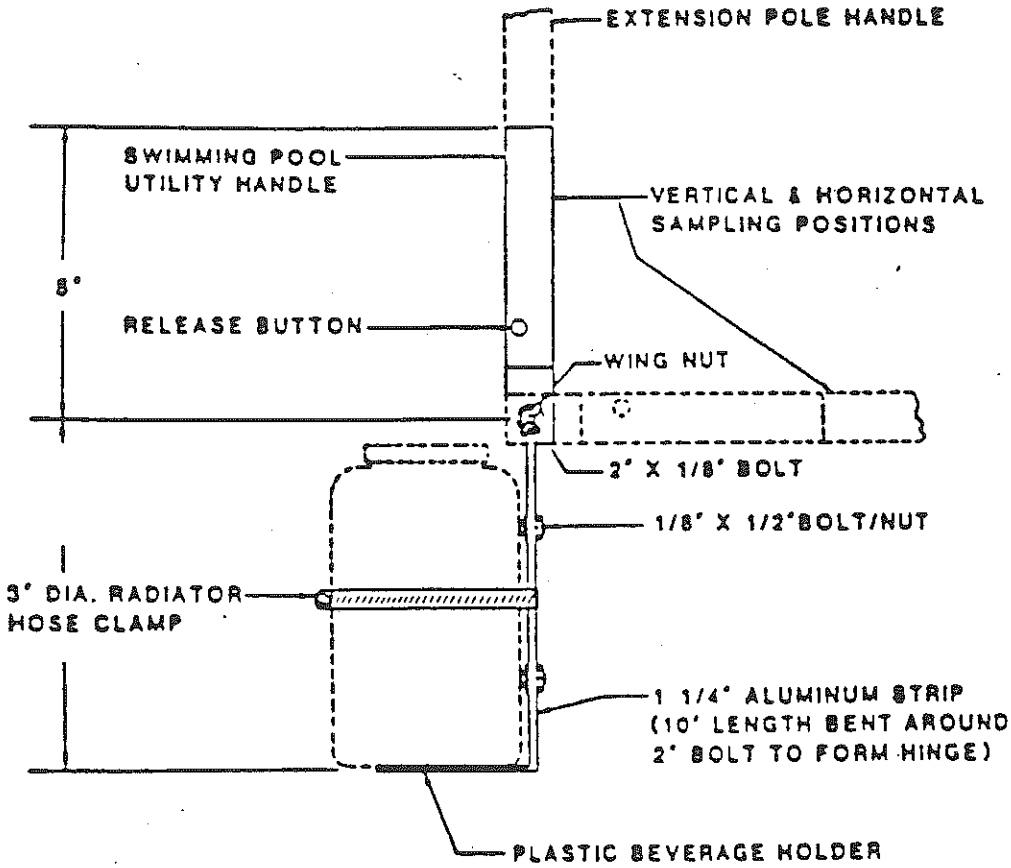
Once a sample is obtained, pH, specific conductance, and temperature measurements are usually made. The Statement of Work has a list of all required measurements. All values obtained should be recorded on the Field Information Form, along with a precise description of the sampling location.

Samples should be placed in the proper sample bottles and preserved. SURFACE WATER SAMPLES ARE NEVER FILTERED. All samples should be kept in ice or with ice packs in the sample AquaPaks or coolers.

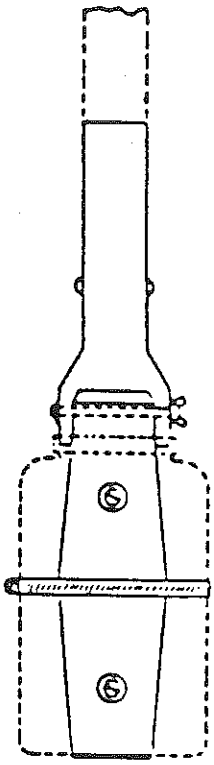
All necessary paperwork should be completed and included with the samples for shipment to the lab. See Section 4 of this Manual.

Surface Water Sampling Device

Figure 6.1



Front Elevation



Side Elevation

7.0 LEACHATE SAMPLES

7.0 Leachate Sampling

7.1 Purpose

The purpose of leachate monitoring is to provide data on the quantity and quality of leachate being generated within a landfill. Knowledge of the leachate quantity is often necessary to evaluate the effectiveness of the landfill design, particularly of the soil cover and liner performance. Therefore, periodic sampling of leachate risers and manholes is performed to evaluate leachate quality, quantity and degree of treatment required.

Leachate data also provides potential groundwater quality comparison data for the site monitoring wells to assist in determining any impact on the groundwater.

7.2 Sampling Procedures

Proper planning and preparation, as with groundwater monitoring, are necessary for problem-free leachate sampling. Refer to the Leachate Well ID Chart (where available) for information on the leachate wells, risers, and manholes to be sampled. The Statement of Work should be used for listing the required sampling points and analytes. Leachate sampling points do not need to be purged of stagnant liquids, so minimal field time is required before sampling. The analytical lab should be notified in advance of the sampling schedule, number and type (special lab handling requirements may exist if samples are extracted from an F039 source. See Section 7.3 of samples, and analytes to be sampled. Sampling personnel should have the following equipment ready before going to the field:

NOTE: Equipment used for leachate monitoring should not be used for any other type of environmental sampling or monitoring.

1. Leachate well, riser, manhole well location may;

2. Leachate Well ID Chart;

3. Sample Bottles and AquaPaks;

4. Separate cooler for storing samples and dedicated leachate monitoring equipment (as needed);

5. Dedicated electronic water (leachate) level indicator;

6. Dedicated (for leachate) pH, specific conductivity, and temperature meters;

7. Dedicated leachate bailer and rope, or pump, if required;

8. Dedicated container to collect deionized or laboratory reagent quality water from rinsing leachate sampling equipment;

9. Keys for wells and gates; and

10. Protective clothing including appropriate gloves, boots, hard hat, safety glasses, Tyvec suit, respirator, and other necessary items per site requirements. NOTE: Samplers must check with Safety Manager/Site Manager before sampling leachate wells, risers, and manholes, to ensure compliance with any pertinent confined space entry conditions.

There are six basic steps to obtaining a leachate sample.

1. Check with the Safety Manager/Site Manager.

2. Identify the sample point and analytes to be analyzed;

3. Obtain a leachate level, if required;

Leachate level measurements should be obtained and recorded on the Field Information Form line provided for "depth to water for top of well casing or other parameters". If a slope indicator is used, the sensitivity adjustment can be used to screen out false signals, often caused by moisture. To determine the proper setting, turn the sensitivity knob to the full setting (10th position), and lower the probe until it contacts the leachate (a buzzer will sound and the light will show). Raise the probe out of the leachate and turn the sensitivity knob to a lower setting until the light and buzzer turn off. Repeat, and adjust sensitivity knobs so the light and buzzer turn off promptly when withdrawing the probe from the leachate. Do not lower the sensitivity knob more than necessary, or accuracy will be reduced. The leachate level is measured at the point where the light first shows. Thoroughly rinse the tape and probe with deionized water. NOTE: Check with the Program Manager to determine if and how the rinse water has to be contained and disposed of.

4. Take a leachate sample;

5. Record all necessary information on the Field Information Forms and Field Chain-of-Custody Records; and

6. Before sampling rinse the dedicated leachate bailer with deionized or laboratory reagent quality water.

7. Each sample bottle should be filled according to the procedures listed in the Groundwater Sampling section of this manual (Section 4.3.4).

8. During sampling, observe the samples and provide a description of the color, odor (if readily detected - **Do not directly smell the sample!**) And any layers or phases present in the sample on the Field Information Form. The sampler should remember that leachate is a derivative of decomposed refuse and waste, and caution should be taken that the sample not be smelled directly from the riser or manhole, as gases may be escaping via this route.

9. The pH, temperature, and specific conductance measurements should be performed in the field. See section 4.3.1, paragraph 1. All results must be recorded on the Field Information form, with pH and specific conductivity results recorded to three significant figures.

10. After bottles are filled, preservatives should be added to each sample bottle (where required). Preservatives are added to stabilize the chemical composition of the sample.

SPECIAL CARE SHOULD BE TAKEN WHEN PRESERVING LEACHATE SAMPLES WITH ACID, SINCE A VIOLENT REACTION MAY OCCUR. ADD ACID SLOWLY AND CAREFULLY!!! LEACHATE SAMPLES SHOULD NOT BE FILTERED!!!!

11. Store and ship leachate samples in a dedicated AquaPak/cooler. The Field Chain-of-Custody Records and Field Information Forms should be placed in the plastic bag within the AquaPak, and the AquaPak should be sealed.

12. Once the sampling is completed, all equipment should be thoroughly cleaned and stored in a separate area until it is needed again. Where a sampling device (e.g., bailer) is not stored in the well or riser, it may be stored in a new, clean plastic bag, identified with the well or riser ID. All equipment must be marked for leachate sampling only!

7.3 F039 Leachates and Contaminated Samples

Leachates from hazardous waste disposal facilities are classified as wastes under RCRA.

Because of special handling and disposal requirements, it is imperative that Program Managers, when scheduling work with the EML, inform their Account Representative if the samples being scheduled are from an F039 source. See the Appendix for F039 shipping instructions.

GLOSSARY

GLOSSARY

Annular Space
The space between the well casing and protective casing. (Some wells have two casings and a protective casing.)

APSR
AquaPak Shipping and Receiving Report. The system used to track the shipment of AquaPaks and sample bottles to, and AquaPaks containing samples from, a site.

AquaPak
The specialized container used to store and ship samples and sample bottles to and from a site. The EML provides AquaPaks, which contain bottle holders, sampling bottles, paperwork and preservatives for each sampling event.

Aquifer
A geologic formation, group of formations, or part of a formation that is saturated, and contributes a significant quantity of water to wells or springs.

Bailer
A hollow tube with a check valve constructed of PVC, Teflon®, or stainless steel. Used to remove water from a well.

Bladder Pump
A gas-driven, positive-displacement purging and sampling device containing an internal flexible Teflon® bladder (with upper and lower check valves) that can pump water with no air contact and minimum turbulence.

Bottle Set
An eight-character alpha numeric sample identifier. For a sample taken at a given well, there is one designation number, and a different bottle set id code for each bottle. Example: AB2387-L0.

Casing
Tubular steel, finished in sections with either threaded connections or beveled edges to be field welded, which is installed to counteract caving of the drilled hole.

The static volume of water in a casing (if required, use well bore volume) before it is purged. Calculated using the following equation: Casing volume (gallons) = $(\pi r^2 h) \times 7.48$, where r = radius of the well casing in feet and h = height of the water column in the well in feet.

Chain-of-Custody
A record of possession maintained for each sample bottle. Used to document where and in whose possession a sample was, from the time of collection through analysis.

Conductivity Standard
Solution having a known conductance, prepared per "Standard Methods for the Examination of Water and Wastewater", 17th edition, and/or QA/QC Manual.

Contaminant-Free Area
Area known not to contain volatile organic contamination over the required reporting limit levels as measured in the trip blank.

Dedicated Equipment
Equipment dedicated for use with only one specific well. It is usually stored within the well.

Depth to Water Meter
An electronic probe that, on contact with water, registers a response. Used to determine the distance from the top of a well to the water.

Distilled Water
Water that has been boiled and the steam condensed. The condensate is distilled water.

EMLIS
Environmental Monitoring Laboratories Information System. The system incorporating all of EML's computerized modules.

ENS
Event Notification System. The system the EML uses to track and document all phases of a sampling event. A separate ENS number is used for each part of the event requiring different analyses.

Field Blank
A blank used to check for analyte contamination during the sampling and shipping processes. Field blank water (laboratory grade deionized) is poured into a sample bottle set and analyzed as an actual sample, to determine whether any contamination is present.

Field Information Form
The form used to check for analyte contamination during the sampling and shipping processes. Field blank water (laboratory grade deionized) is poured into a sample bottle set and analyzed as an actual sample, to determine whether any contamination is present.

Groundwater Elevation
The difference between the depth of well water and Mean Sea Level. (MSL)

Headspace
Air in a sample bottle. Generally, air trapped between the water and bottle surfaces.

LIMS
Laboratory Information Management System. The electronic data system the EML uses to process and store data.

Laboratory Grade Deionized Water or Laboratory Reagent Quality Water
Water that has passed through a column containing both anion- and cation-exchange resins. Water having no concentrations of analytes of interest above the required reporting limits reference: ASTM III or equivalent.

Lock
Marine lock made of brass stainless steel, used to ensure a sampling well remains secure when company (or designated) personnel are not taking samples.

Meniscus
In a container filled with liquid, the curved upper surface of the liquid.

MPS
Monitoring Program System. The system the EML uses to define specific sampling and analysis information for a site, including sampling points, sampling frequency, sampling dates, reporting requirements, and analytes.

MSL
Mean Sea Level

Nondedicated Equipment
Sampling equipment used to sample more than one sampling point. (Dedicated sampling equipment is preferred).

NPDES
National Pollution Discharge Elimination System.

PAD ED 103
The section of WMX's Policies and Directives Manual defining corporate groundwater monitoring policies. The EML, along with WMNA Groups, CWM and Corporate EMD is responsible for maintaining this document and revising it as necessary.

pH Buffer
A solution of known pH, used to calibrate a pH meter before using the meter.

pH Meter
The analytical equipment used to measure the pH of a liquid.

Preservatives
Chemical solutions added to a sample to help prevent the degradation of analytes between the time of sampling and analysis.

Private Wells
A well located on private property. These are often drinking-water wells, located on property not belonging to WMX or any governmental body.

Program Manager
The person responsible for setting up monitoring programs, ensuring correct sampling procedures are followed, and reviewing and assessing monitoring data.

Protective Casing
An outer steel or anodized aluminum, surrounding a well casing which is used to prevent contaminants from migrating into the well.

Purge
The removal of 3 to 5 well volumes (as required) of water from a well. This is done before collecting a sample, to ensure that the sample contains no stagnant water and that it is representative of the aquifer. (i.e. table measurements pH, and conductivity, if possible.)

QA
Quality Assurance. A program set in place to continually monitor the reliability of a process.

QAP
Quality Assurance Plan. A written protocol defining a laboratory's QA and QC requirements.

QC
Quality Control. Definite, required steps for monitoring a process, to ensure that the process results are correct.

RCRA
Resource Conservation and Recovery Act

Recharge Time
The amount of time between the end of purging and the point at which the well returns to the approximate prepurging level.

Statement of Work (SOW)
The system which, along with the APSR system, creates a template for each sampling event.

Sampling Composite
Samples taken over a period of time, which are mixed in equal volumes to form one sample.

Sample I.D.
A unique, six-character number used to identify samples. Samples are entered into the EML's LIMS system, along with resultant data. (See bottle set for further clarification.)

Sample Matrix
The major constituent of a sample. (e.g., water, soil, leachate)

Sample Point
The location from which a sample is taken.

Site-Specific Groundwater Monitoring Plan
The plan outlining a site's groundwater monitoring requirements. As is stated in PAD ED 103, each site is responsible for developing such a plan which must incorporate all applicable regulatory requirements.

Specific Conductance
The conductivity of water, measured at 25° C.

Static Water Level
The elevation of, or depth to, water before purging and sampling.

Stickup
The height of a well casing, from the top of the casing to its cement footing.

Trip Blank
A blank used to check for volatile organic contamination of samples during shipment. When sample bottles are initially prepared for shipment, one is completely filled with laboratory grade deionized water. This bottle remains with the other bottles during the shipment and sampling steps. The sample is then analyzed as if it were an actual sample.

TSCA
Toxic Substance Control Act

APPENDIX

IDENTIFICATION CODES

Facility/Site Codes:	Available through EML
Matrix Codes:	C - Leachate S - Soil W - Water X - Other
Source Codes:	A - Air B - Bottom Sediment C - Leachate System D - Dewatering/Pressure Relief G - Generation Point I - Surface Water Impoundment L - Lake or Ocean M - Gas Condensate N - Noise O - Outfall P - Pretreatment Facility R - River/Stream/Brook S - Soil U - Influent T - Effluent X - Other Z - Stormwater

CONVERSION CHARTS

Temperature (°F - 32) * 5/9 = °C)

°F	°C	°F	°C	°F	°C
40.0	4.44	51.0	10.6	61.0	16.1
41.0	5.00	52.0	11.1	62.0	16.7
42.0	5.56	53.0	11.7	63.0	17.2
43.0	6.11	54.0	12.2	64.0	17.8
44.0	6.67	55.0	12.8	65.0	18.3
45.0	7.22	56.0	13.3	66.0	18.9
46.0	7.78	57.0	13.9	67.0	19.4
47.0	8.33	58.0	14.4	68.0	20.0
48.0	8.89	59.0	15.0	69.0	20.6
49.0	9.44	60.0	15.6	70.00	21.1
50.0	10.0				

Length/Depth

Inches	Feet	Inches	Feet
1	0.08	7	0.58
2	0.17	8	0.67
3	0.25	9	0.75
4	0.33	10	0.83
5	0.42	11	0.92
6	0.50	12	1.00

Purge Volumes 1 Casing (or well-bore) Volume (Gallons) = $\pi * r^2 * h * 7.48$

where $\pi = 3.14$
r = radius of well casing (or well-bore) in feet
h = height of water column in well in feet
7.48 = value used to convert cubic feet into gallons

OR For a 1" diameter well casing - 1 casing volume (gal.) = 0.04th
For a 2" diameter well casing - 1 casing volume (gal.) = 0.163h
For a 4" diameter well casing - 1 casing volume (gal.) = 0653h

SPECIFIC CONDUCTIVITY CHART

$$K_{25} = K_m (0.002 (25 - T_m)) + K_m$$

T_m=10	$K_{25}=K_m(0.3) + K_m$
T_m=11	$K_{25}=K_m(0.28) + K_m$
T_m=12	$K_{25}=K_m(0.26) + K_m$
T_m=13	$K_{25}=K_m(0.24) + K_m$
T_m=14	$K_{25}=K_m(0.22) + K_m$
T_m=15	$K_{25}=K_m(0.20) + K_m$
T_m=16	$K_{25}=K_m(0.18) + K_m$
T_m=17	$K_{25}=K_m(0.16) + K_m$
T_m=18	$K_{25}=K_m(0.14) + K_m$
T_m=19	$K_{25}=K_m(0.12) + K_m$
T_m=20	$K_{25}=K_m(0.10) + K_m$
T_m=21	$K_{25}=K_m(0.08) + K_m$
T_m=22	$K_{25}=K_m(0.06) + K_m$
T_m=23	$K_{25}=K_m(0.04) + K_m$
T_m=24	$K_{25}=K_m(0.02) + K_m$
T_m=25	$K_{25}=K_m(0.00) + K_m$

NOTE: K_m = Conductivity Measurement
T_m = Temperature Measurement
K_{25} = Specific Conductance

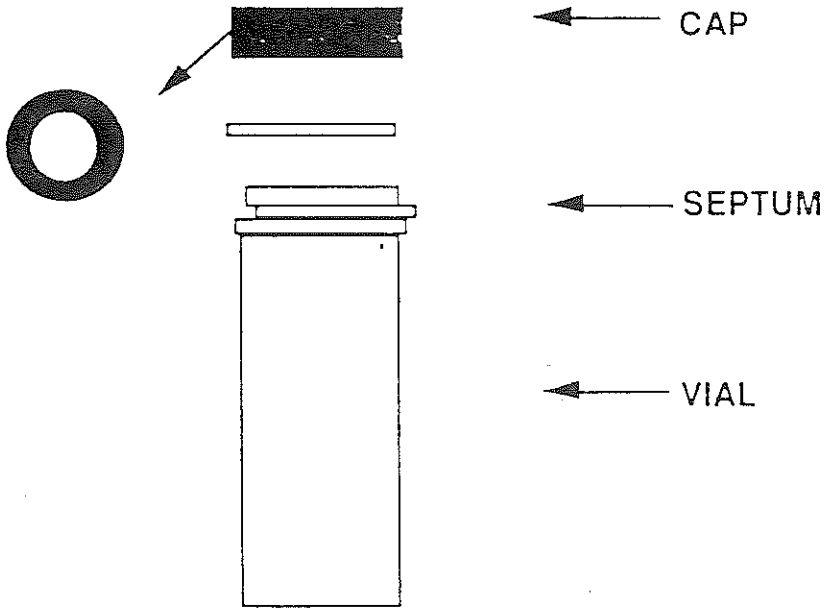
PROPER SAMPLING PROCEDURE
40 ML. VOA VIALS

Careful sampling techniques must be used to obtain a representative sample for the analysis of volatile organic compounds (VOAs). As the name suggests, these compounds will volatilize from the water sample upon exposure to air. Therefore, the exposure time must be minimized.

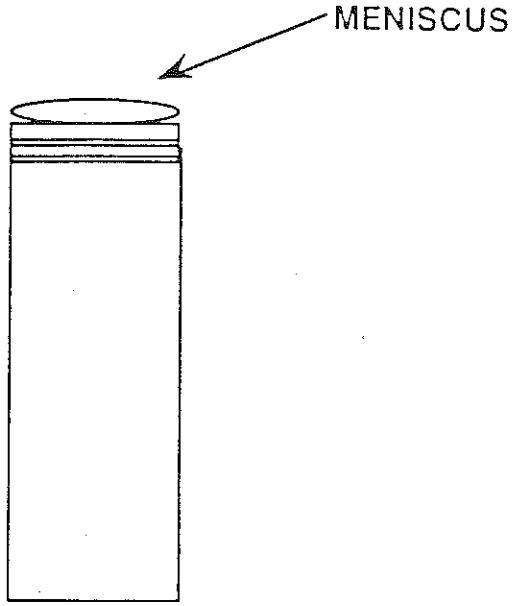
Sample contamination may easily occur if the samples are exposed to a source of volatile organics. Extra quality control procedures are used to avoid this possibility, and to detect contamination if it has occurred.

Step 1: Carefully remove teflon septum cap, being careful not to allow the cap to contact potential contaminants.

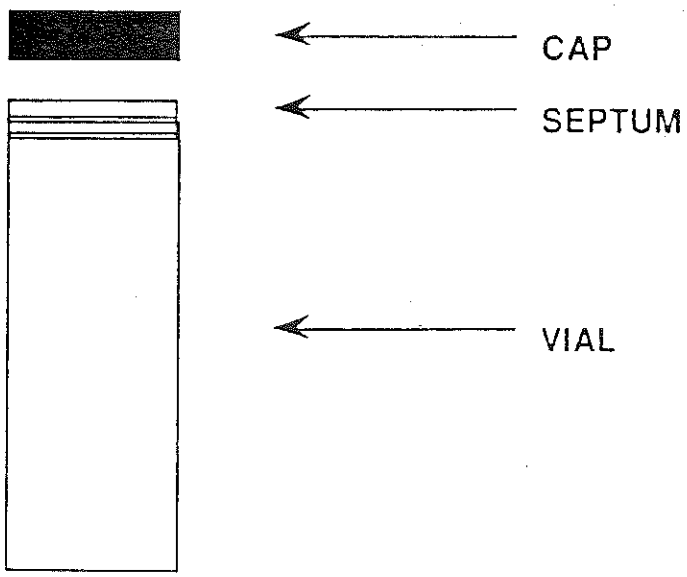
NOTE: Vial must not be opened before sampling. If the vial and/or cap appears defective, call EML. The vial should be open for a minimum amount of time (no longer than 3 minutes).



Step 2: Carefully fill vial with sample until a meniscus (mound of water) forms on top. Avoid shaking or agitating the sample, as this may cause volatiles to vaporize.



Step 3: Carefully replace the septum and cap on the meniscus. This will force a small amount of water off the top. Check the sample for air bubbles. If bubbles are present, remove the cap, top off the sample, and repeat Step 3. (generally to a maximum of 3 times.)



Field Information Form Checklist

_____1) Purge date	Complete.
_____2) Start purge	Complete (24-hour clock).
_____3) Elapsed hours	Record this in tenths of hours; the time from start of purge to the end of purge.
_____4) Casing volume	Actual volume present in well casing before purge in nearest ½ gallons.
_____5) Volume purged	The actual number of gallons to nearest ½ gallon of volume of water purged.

6) Purging and sampling equipment

_____ **Purging:**	Is equipment dedicated, what type of pump or device is it, what is the tubing constructed of?
_____ **Sampling:**	Is this equipment dedicated, what type of device or pump, what materials is it constructed of?
_____ **Filtering Devices:**	Indicate type of device used; in-line cartridge, pressure, vacuum (peristaltic pump).

7) Field measurements

_____ **Well Elevation:**	Must be recorded to the nearest hundredth of a foot, and must be asterisked (*) in the comments section, clearly referencing where the information was obtained.
_____ **Depth to Water:**	Recorded to the nearest hundredth of a foot.
_____ **Groundwater Elevation:**	Must be recorded to the nearest hundredth of a foot.
_____ **Well Depth:**	An asterisk notation (*) should be recorded in the Field Comments Section, clearly referencing where the information was obtained if it was not obtained in the field during that event.

_____	**pH/Spec. Conductivity Temperature:**	Record to 3 significant figures. SC must be read at 25° C or temperature compensated.

8) Field Comments

_____	**Sample Appearance:**	Should be descriptive. Note appearance (e.g., physical, liquid, aqueous etc.), odor and color.
_____	**Weather Conditions:**	Wind speed, direction, precipitation, outlook (cloud cover).
_____	**Other Comments:**	All sources of asterisked (*) information, purge conversions, duplicate field readings, etc..
_____	**Sampler Certification:**	Must be dated, complete, neat, printed employer, and signed.

Information on Chain-of-Custody Checklist

_____1) Sample Point	Source code first then sample point designation. Must be correct I.D. Designation must be legible and correct.
_____2) Sample Date	Complete year/month/date.
_____3) Sample Time	Complete (24 hr. clock).
_____4) Filtering Information	Should be circled and agree with S.O.W./bottle information.
_____5) ENS Number	Must be in agreement with S.O.W. and sample I.D.'s.
_____6) Chain-of-Custody Chronicle	Must sign, date, log AquaPak, condition and seal number.

USE OF A FLOW CELL AND ADDITIONAL REFERENCE PROCEDURES: Eh DO AND ALKALINITY

Additional measurements are required in different areas of the country for three additional field parameters: oxidation-reduction potential (Eh), alkalinity and dissolved oxygen. Oxidation reduction potentials (Eh) are useful for predicting the migration of contaminants in groundwater and surface water. Dissolved oxygen is necessary for the survival and growth of many aquatic organisms. Its absence promotes the production of toxic materials from anaerobic decay of organic matter. Alkalinity is a general indicator of groundwater quality. It is a quantitative measurement of the ability of a sample to react with strong acid to a designated pH.

ASTM procedures for these methods have been included for guidance in completing the analysis of these field parameters. In addition, a description of a recommended procedure for use of a flow cell has been included for those sites that want to use this procedure.

Use of a Flow Cell for Field Measurements

Use of a closed flow-through cell in obtaining reliable field measurements helps minimize such interferences as heating or cooling, turbulence and atmospheric gas exchange. Representativeness of groundwater's pH, Eh, conductivity, dissolved oxygen and temperature measurements may be improved by use of a flow cell. Fewer chemical and physical changes are thought to occur with the use of a flow cell.

Procedure:

1. The pump outlet is connected to the inlet of the flow cell.

2. Calibrated electrodes are inserted into the flow cell.

3. The pump is turned on and water pumped through into a container where calibrating solutions and buffers are submerged to allow them to reach sample water temperature. These solutions should be +/- 10 degrees of the sample temperature.

4. After temperature equilibrium has been achieved, the electrodes shall be recalibrated.

5. Flow rate through the cell should not be more than one liter per minute to prevent inaccurate pH readings caused by static charge effects of water moving through small openings.

6. Electrode calibration should be rechecked just before sampling.

7. The pump should be shut off, tubing disconnected and the electrodes removed from the

flow cell.

8. The flow cell should be cleaned with distilled water and then preparation for sample collection begun.

9. Use of a closed flow cell should be documented on the Field Information form comments section.

ALKALINITY

Method 310.1 (Titrimetric, pH 4.5)

STORET NO. 00410

Scope and Application

1.1 This method is applicable to drinking, surface, and saline waters, domestic and industrial wastes.

1.2 The method is suitable for all concentration ranges of alkalinity; however, appropriate aliquots should be used to avoid a titration volume greater than 50 ml.

1.3 Automated titrimetric analysis is equivalent.

Summary of Method

2.1 An unaltered sample is titrated to an electrometrically determined end point of pH 4.5. The sample must not be filtered, diluted, concentrated, or altered in any way.

Comments

3.1 The sample should be refrigerated at 4°C and run as soon as practical. Do not open sample bottle before analysis.

3.2 Substances, such as salts of weak organic and inorganic acids present in large amounts, may cause interference in the electrometric pH measurements.

3.3 For samples having high concentrations of mineral acids, such as mine wastes and associated receiving waters, titrate to an electrometric endpoint of pH 3.9, using the procedure in:

Annual Book of ASTM Standards, Part 31, "Water", p 115, D-1067, Method D, (1976).

3.4 Oil and grease, by coating the pH electrode, may also interfere, causing sluggish response.

Apparatus

4.1 pH meter or electrically operated titrator that uses a glass electrode and can be read to 0.05 pH units. Standardize and calibrate according to manufacturer's instructions. If automatic temperature compensation is not provided, make titration at 25 ±2° C.

4.2 Use an appropriate sized vessel to keep the air space above the solution at a minimum. Use a rubber stopper fitted with holes for the glass electrode, reference electrode (or combination electrode) and buret.

4.3 Magnetic stirrer, pipets, flasks and other standard laboratory equipment.

4.4 Burets, Pyrex 50, 25 and 10 ml.

Reagents

5.1 Sodium carbonate solution, approximately 0.05 N: Place 2.5 ±0.2 g (to nearest mg) Na_2CO_3 (dried at 250°C for 4 hours and cooled in desiccator) into a 1 liter volumetric flask and dilute to the mark.

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pH

Method 150.1 (Electrometric)

STORET NO.
Determined on site 00400
Laboratory 00403

1. Scope and Application
   1.1 This method is applicable to drinking, surface, and saline waters, domestic and industrial wastes and acid rain (atmospheric deposition).
2. Summary of Method
   2.1 The pH of a sample is determined electrometrically using either a glass electrode in combination with a reference potential or a combination electrode.
3. Sample Handling and Preservation
   3.1 Samples should be analyzed as soon as possible preferably in the field at the time of sampling.
   3.2 High-purity waters and waters not at equilibrium with the atmosphere are subject to changes when exposed to the atmosphere, therefore the sample containers should be filled completely and kept sealed prior to analysis.
4. Interferences
   4.1 The glass electrode, in general, is not subject to solution interferences from color, turbidity, colloidal matter, oxidants, reductants or high salinity.
   4.2 Sodium error at pH levels greater than 10 can be reduced or eliminated by using a "low sodium error" electrode.
   4.3 Coatings of oily material or particulate matter can impair electrode response. These coatings can usually be removed by gentle wiping or detergent washing, followed by distilled water rinsing. An additional treatment with hydrochloric acid (1 + 9) may be necessary to remove any remaining film.
   4.4 Temperature effects on the electrometric measurement of pH arise from two sources. The first is caused by the change in electrode output at various temperatures. This interference can be controlled with instruments having temperature compensation or by calibrating the electrode-instrument system at the temperature of the samples. The second source is the change of pH inherent in the sample at various temperatures. This error is sample dependent and cannot be controlled, it should therefore be noted by reporting both the pH and temperature at the time of analysis.
5. Apparatus
   5.1 pH Meter-laboratory or field model. A wide variety of instruments are commercially available with various specifications and optional equipment.

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Editorial revision 1978 and 1982

where:
A = ml standard acid
N = normality standard acid

7.2 Potentiometric titration of low alkalinity:

$$\text{Total alkalinity, mg/l } CaCO_3 = \frac{(2B - C) \times N \times 50{,}000}{\text{ml of sample}}$$

where:
B = ml titrant to first recorded pH
C = total ml titrant to reach pH 0.3 units lower
N = normality of acid

8 Precision and Accuracy

8.1 Forty analysts in seventeen laboratories analyzed synthetic water samples containing increments of bicarbonate, with the following results:

Increment as Alkalinity mg/liter, $CaCO_3$	Precision as Standard Deviation mg/liter, $CaCO_3$	Accuracy as Bias, %	Accuracy as Bias, mg/l, $CaCO_3$
8	1.27	+10.61	+0.85
9	1.14	+22.29	+2.0
113	5.28	- 8.19	-9.3
119	5.36	- 7.42	-8.8

FWPCA Method Study 1, Mineral and Physical Analyses)

8.2 In a single laboratory (EMSL) using surface water samples at an average concentration of 122 mg $CaCO_3$/l, the standard deviation was ±3.

Bibliography

1. Standard Methods for the Examination of Water and Wastewater, 14th Edition, p 278, Method 403, (1975).
2. Annual Book of ASTM Standards, Part 31, "Water", p 113, D-1067, Method B, (1976).

OXYGEN, DISSOLVED

Method 360.1 (Membrane Electrode)

STORET NO. 00299

1. Scope and Application
   1.1 The probe method for dissolved oxygen is recommended for those samples containing materials which interfere with the modified Winkler procedure such as sulfite, thiosulfate, polythionate, mercaptans, free chlorine or hypochlorite, organic substances readily hydrolyzed in alkaline solutions, free iodine, intense color or turbidity and biological flocs.
   1.2 The probe method is recommended as a substitute for the modified Winkler procedure in monitoring of streams, lakes, outfalls, etc., where it is desired to obtain a continuous record of the dissolved oxygen content of the water under observation.
   1.3 The probe method may be used as a substitute for the modified Winkler procedure in BOD determinations where it is desired to perform nondestructive DO measurements on a sample.
   1.4 The probe method may be used under any circumstances as a substitute for the modified Winkler procedure provided that the probe itself is standardized against the Winkler method on samples free of interfering materials.
   1.5 The electronic readout meter for the output from dissolved oxygen probes is normally calibrated in convenient scale (0 to 10, 0 to 15, 0 to 20 mg/l for example) with a sensitivity of approximately 0.05 mg/liter.
2. Summary of Method
   2.1 The most common instrumental probes for determination of dissolved oxygen in water are dependent upon electrochemical reactions. Under steady-state conditions, the current or potential can be correlated with DO concentrations. Interfacial dynamics at the probe-sample interface are a factor in probe response and a significant degree of interfacial turbulence is necessary. For precision performance, turbulence should be constant.
3. Sample Handling and Preservation
   3.1 See 4.1, 4.2, 4.3, 4.4 under Modified Winkler Method (360.2).
4. Interferences
   4.1 Dissolved organic materials are not known to interfere in the output from dissolved oxygen probes.
   4.2 Dissolved inorganic salts are a factor in the performance of dissolved oxygen probe.
      4.2.1 Probes with membranes respond to partial pressure of oxygen which in turn is a function of dissolved inorganic salts. Conversion factors for seawater and brackish waters may be calculated from dissolved oxygen saturation versus salinity data. Conversion factors for specific inorganic salts may be developed experimentally.

Approved for NPDES
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6.4.1 Prepare a series of standards by diluting suitable volumes of stock solution to 100.0 ml with distilled water. The following dilutions are suggested:

ml of Stock Solution	Conc., mg/l as $CaCO_3$
1.0	10
2.0	20
4.0	40
6.0	60
8.0	80
10.0	100
18.0	180
20.0	200

7. Procedure

7.1 No advance sample preparation is required. Set up manifold as shown in Figure 1.

7.2 Allow both colorimeter and recorder to warm up for 30 minutes. Run a baseline with all reagents, feeding distilled water through the sample line. Adjust dark current and operative opening on colorimeter to obtain stable baseline.

7.3 Place distilled water wash tubes in alternate openings on sampler and set sample timing at 2.0 minutes.

7.4 Place working standards in sampler in order of decreasing concentration. Complete filling of sampler tray with unknown samples.

7.5 Switch sample line from distilled water to sampler and begin analysis.

8. Calculation

8.1 Prepare standard curve by plotting peak heights of processed standards against known concentrations. Compute concentration of samples by comparing sample peak heights with standard curve.

9. Precision and Accuracy

9.1 In a single laboratory (EMSL), using surface water samples at concentrations of 15, 57, 154, and 193 mg/l as $CaCO_3$ the standard deviation was ±0.5.

9.2 In a single laboratory (EMSL), using surface water samples at concentrations of 31 and 149 mg/l as $CaCO_3$ recoveries were 100% and 99%, respectively.

Bibliography

1. Technicon Auto Analyzer Methodology, Bulletin 1261, Technicon Controls, Inc., Chauncey, N.Y. (1961).
2. Standard Methods for the Examination of Water and Wastewater, 14th Edition, p 278, Method 403 (1975).

CONDUCTANCE

Method 120.1 (Specific Conductance, µmhos at 25°C)

STORET NO. 00095

1. Scope and Application
   1.1 This method is applicable to drinking, surface, and saline wates, domestic and industrial wastes and acid rain (atmospheric deposition).
2. Summary of Method
   2.1 The specific conductance of a sample is measured by use of a self-contained conductivity meter, Wheatstone bridge-type, or equivalent.
   2.2 Samples are preferable analyzed at 25°C. If not, temprature corrections aremade and results reported at 25°C.
3. Comments
   3.1 Instrument must be standardized with KCl solution before daily use.
   3.2 Conductivity cell must be kept clean.
   3.3 Field measurements with comparable instruments are reliable.
   3.4 Temperature variations and corrections represent the largest source of potential error.
4. Sample Handling and Preservation
   4.1 Analyses can be performed either in the field or laboratory.
   4.2 If analysis is not completed within 24 hours of sample collection, sample should be filtered through a 0.45 micron filter and stored at 4°C. Filter and apparatus must be washed with high quality distilled water and pre-rinsed with sample before use.
5. Apparatus
   5.1 Conductivity bridge, range 1 to 1000 µmho per centimeter.
   5.2 Conductivity cell, cell constant 1.0 or micro dipping type cell with 1.0 constant. YSI #3403 or equivalent.
   5.4 Thermometer
6. Reagents
   6.1 Standard potassium chloride solutions, 0.01 M: Dissolve 0.7456 gm of pre-dried (2 hour at 105°C) KCl in distilled water and dilute to 1 liter at 25°C.
7. Cell Calibration
   7.1 The analyst should use the standard potassium chloride solution (6.1) and the table below to check the accuracy of the cell constant and conductivity bridge.

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Conductivity 0.01 m KCl

°C	Micromhos/cm
21	1305
22	1332
23	1359
24	1386
25	1413
26	1441
27	1468
28	1496

8. Procedure

8.1 Follow the direction of the manufacturer for the operation of the instrument.

8.2 Allow samples to come to room temperature (23 to 27°C), if possible.

8.3 Determine the temperature of samples within 0.5°C. If the temperature of the samples is not 25°C, make temperature correction in accordance with the instruction in Section 9 to convert reading to 25°.

9. Calculation

9.1 These temperature corrections are based on the standard KCl solution.

9.1.1 If the temperature of the sample is below 25°C, add 2% of the reading per degree.

9.1.2 If the temperature is above 25°C, subtract 2% of the reading per degree.

9.2 Report results as Specific Conductance, µmhos/cm at 25°.

10. Precision and Accuracy

10.1 Forty-one analysts in 17 laboratories analyzed six synthetic water samples containing increments of inorganic salts, with the following results:

Increment as Specific Conductance	Precision as Standard Deviation	Accuracy as Bias, %	Accuracy as Bias, µmhos/cm
100	7.55	-2.02	-2.0
106	8.14	-0.76	-0.8
808	66.1	-3.63	-29.3
848	79.6	-4.54	-38.5
1640	106	-5.36	-87.9
1710	119	-5.08	-86.9

(FWPCA Method Study 1, Mineral and Physical Analyses.)

10.2 In a single laboratory (EMSL) using surface water samples with an average conductivity of 536 µmhos/cm at 25°C, the standard deviation was ±6.

Bibliography

1. The procedure to be used for this determination is found in:
   Annual Book of ASTM Standards Part 31, "Water," Standard D1125-64, p. 120 (1976).
2. Standard Methods for the Examination of Water and Wastewater, 14th Edition, p. 71, Method 205 (1975).
3. Instruction Manual for YSI Model 31 Conductivity Bridge.
4. Peden, M. E., and Skowron. "Ionic Stability of Precipitation Samples," Atmospheric Environment, Vol. 12, p. 2343-2344, 1978.

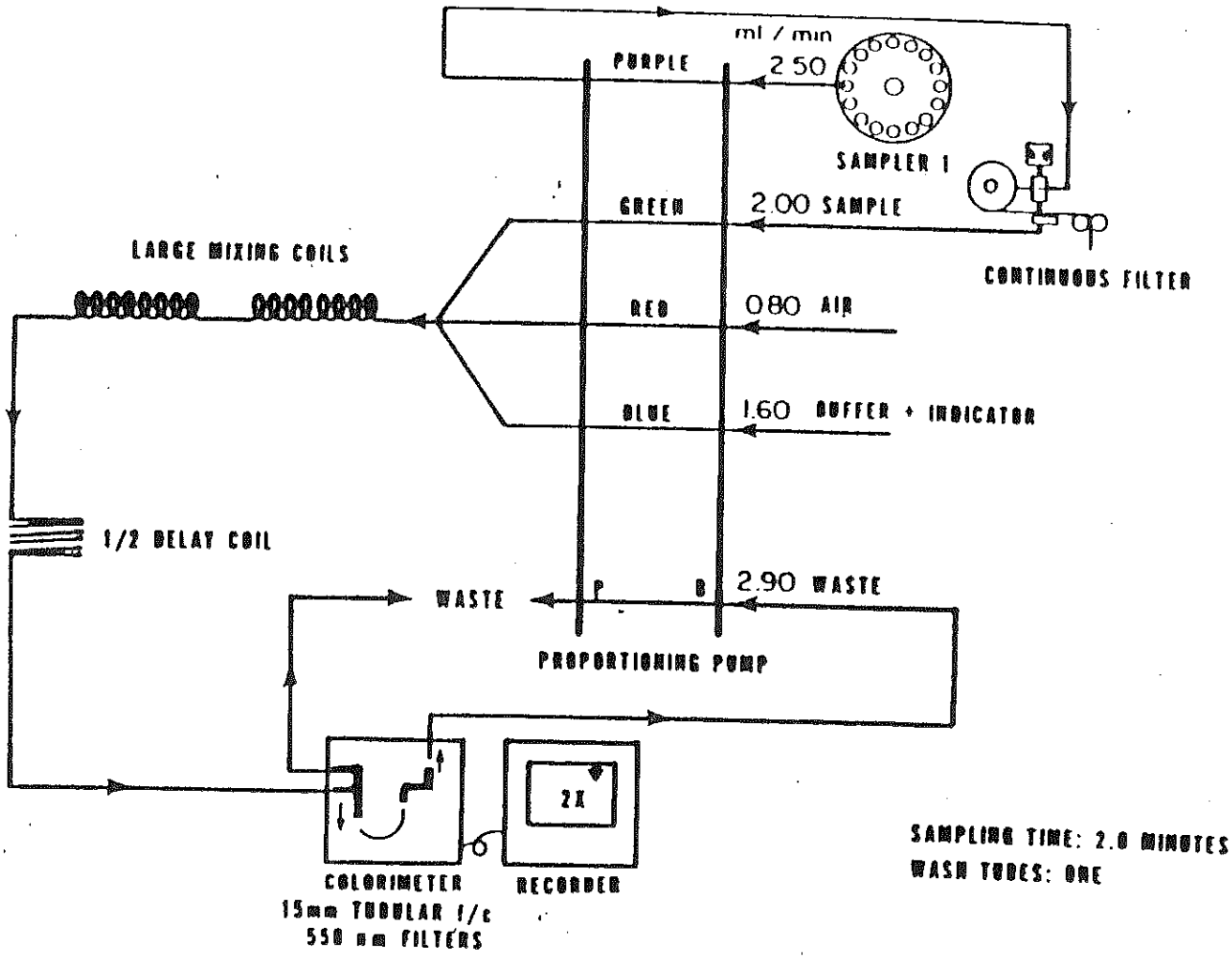

FIGURE 1. ALKALINITY MANIFOLD AA-I

ALKALINITY

Method 310.2 (Colorimetric, Automated, Methyl Orange)

STORET NO. 00410

Scope and Application

1.1 This automated method is applicable to drinking, surface, and saline waters, domestic and industrial wastes. The applicable range is 10 to 200 mg/l as $CaCO_3$.

1.2 This method is not an approved NPDES method as cited in the Federal Register December 1, 1976 for samples containing turbidity or color.

Summary of Method

2.1 Methyl orange is used as the indicator in this method because its pH range is in the same range as the equivalence point for total alkalinity, and it has a distinct color change that can be easily measured. The methyl orange is dissolved in a weak buffer at a pH of 3.1, just below the equivalence point, so that any addition of alkalinity causes a loss of color directly proportional to the amount of alkalinity.

Sample Handling and Preservation

3.1 Sample should be refrigerated at 4°C and run as soon as practical. Do not open sample bottle before analysis.

Interferences

4.1 Sample turbidity and color may interfere with this method. Turbidity must be removed by filtration prior to analysis. If sample is filtered, this method is not approved for NPDES monitoring. Sample color that absorbs in the photometric range used will also interfere.

Apparatus

5.1 Technicon AutoAnalyzer consisting of:

5.1.1 Sampler I.

5.1.2 Manifold.

5.1.3 Proportioning pump.

5.1.4 Colorimeter equipped with 15 mm tubular flow cell and 550 nm filters.

5.1.5 Recorder equipped with range expander.

Reagents

6.1 Methyl Orange: Dissolve 0.125 g of methyl orange in 1 liter of distilled water.

6.2 pH 3.1 Buffer: Dissolve 5.1047 g of potassium acid phthalate in distilled water and add 87.6 ml 0.1 N HCl and dilute to 1 liter. Stable for one week.

6.3 Methyl Orange-Buffered Indicator: Add 1 liter of pH 3.1 buffer (6.2) to 200 ml methyl orange solution (6.1) and mix well. Stable for 24 hours.

6.4 Stock Solution: Dissolve 1.060 g of anhydrous sodium carbonate (oven-dried at 250°C for 4 hours) in distilled water and dilute to 1000 ml. 1.0 ml = 1.00 mg $CaCO_3$.

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Editorial revision 1974

Broad variations in the kinds and concentrations of salts in samples can make the use of a membrane probe difficult.

4.3 Reactive compounds can interfere with the output or the performance of dissolved oxygen probes.

4.3.1 Reactive gases which pass through the membrane probes may interfere. For example, chlorine will depolarize the cathode and cause a high probe-output. Long-term exposures to chlorine will coat the anode with the chloride of the anode metal and eventually desensitize the probe. Alkaline samples in which free chlorine does not exist will not interfere. Hydrogen sulfide will interfere with membrane probes if the applied potential is greater than the half-wave potential of the sulfide ion. If the applied potential is less than the half-wave potential, an interfering reaction will not occur, but coating of the anode with the sulfide of the anode metal can take place.

4.4 Dissolved oxygen probes are temperature sensitive, and temperature compensation is normally provided by the manufacturer. Membrane probes have a temperature coefficient of 4 to 6 percent/°C dependent upon the membrane employed.

5. Apparatus

5.1 No specific probe or accessory is especially recommended as superior. However, probes which have been evaluated or are in use and found to be reliable are the Weston & Stack DO Analyzer Model 30, the Yellow Springs Instrument (YSI) Model 54, and the Beckman Fieldlab Oxygen Analyzer.

6. Calibration

Follow manufacturer instructions.

7. Procedure

Follow manufacturer instructions.

8. Calculation

Follow manufacturer instructions.

9. Precision and Accuracy

Manufacturer's specification claim 0.1 mg/l repeatability with ±1% accuracy.

Bibliography

1. Standard Methods for the Examination of Water and Wastewater, 14th Edition, p 450, Method 422F (1975).

5.2 Glass electrode.

5.3 Reference electrode–a calomel, silver-silver chloride or other reference electrode of constant potential may be used.

NOTE 1: Combination electrodes incorporating both measuring and reference functions are convenient to use and are available with solid, gel type filling materials that require minimal maintenance.

5.4 Magnetic stirrer and Teflon-coated stirring bar.

5.5 Thermometer or temperature sensor for automatic compensation.

6. Reagents

6.1 Primary standard buffer salts are available from the National Bureau of Standards and should be used in situations where extreme accuracy is necessary.

6.1.1 Preparation of reference solutions from these salts require some special precautions and handling[1] such as low conductivity dilution water, drying ovens, and carbon dioxide free purge gas. These solutions should be replaced at least once each month.

6.2 Secondary standard buffers may be prepared from NBS salts or purchased as a solution from commercial vendors. Use of these commercially available solutions, that have been validated by comparison to NBS standards, are recommended for routine use.

7. Calibration

7.1 Because of the wide variety of pH meters and accessories, detailed operating procedures cannot be incorporated into this method. Each analyst must be acquainted with the operation of each system and familiar with all instrument functions. Special attention to care of the electrodes is recommended.

7.2 Each instrument/electrode system must be calibrated at a minimum of two points that bracket the expected pH of the samples and are approximately three pH units or more apart.

7.2.1 Various instrument designs may involve use of a "balance" or "standardize" dial and/or a slope adjustment as outlined in the manufacturer's instructions. Repeat adjustments on successive portions of the two buffer solutions as outlined in procedure 8.2 until readings are within 0.05 pH units of the buffer solution value.

8. Procedure

8.1 Standardize the meter and electrode system as outlined in Section 7.

8.2 Place the sample or buffer solution in a clean glass beaker using a sufficient volume to cover the sensing elements of the electrodes and to give adequate clearance for the magnetic stirring bar.

8.2.1 If field measurements are being made the electrodes may be immersed directly in the sample stream to an adequate depth and moved in a manner to insure sufficient sample movement across the electrode sensing element as indicated by drift free (<0.1 pH) readings.

8.3 If the sample temperature differs by more than 2°C from the buffer solution the measured pH values must be corrected. Instruments are equipped with automatic or manual

[1] National Bureau of Standards Special Publication 260.

compensators that electronically adjust for temperature differences. Refer to manufacturer's instructions.

8.4 After rinsing and gently wiping the electrodes, if necessary, immerse them into the sample beaker or sample stream and stir at a constant rate to provide homogeneity and suspension of solids. Rate of stirring should minimize the air transfer rate at the air water interface of the sample. Note and record sample pH and temperature. Repeat measurement on successive volumes of sample until values differ by less than 0.1 pH units. Two or three volume changes are usually sufficient.

8.5 For acid rain samples it is most important that the magnetic stirrer is not used. Instead, swirl the sample gently for a few seconds after the introduction of the electrode(s). Allow the electrode(s) to equilibrate. The air-water interface should not be disturbed while measurement is being made. If the sample is not in equilibrium with the atmosphere, pH values will change as the dissolved gases are either absorbed or desorbed. Record sample pH and temperature.

9. Calculation

9.1 pH meters read directly in pH units. Report pH to the nearest 0.1 unit and temperature to the nearest °C.

10. Precision and Accuracy

10.1 Forty-four analysts in twenty laboratories analyzed six synthetic water samples containing exact increments of hydrogen-hydroxyl ions, with the following results:

pH Units	Standard Deviation pH Units	Accuracy as Bias, %	Accuracy as Bias, pH Units
3.5	0.10	–0.29	–0.01
3.5	0.11	–0.00	
7.1	0.20	+1.01	+0.07
7.2	0.18	–0.03	–0.002
8.0	0.13	–0.12	–0.01
8.0	0.12	+0.16	+0.01

(FWPCA Method Study 1, Mineral and Physical Analyses)

10.2 In a single laboratory (EMSL), using surface water samples at an average pH of 7.7, the standard deviation was ±0.1.

Bibliography

1. Standard Methods for the Examination of Water and Wastewater, 14th Edition, p 460, (1975).
2. Annual Book of ASTM Standards, Part 31, "Water", Standard D1293–65, p 178 (1976).
3. Peden, M. E. and Skowron, L. M., Ionic Stability of Precipitation Samples, Atmospheric Environment, Vol. 12, pp. 2343-2349, 1978.

5.2 Standard acid (sulfuric or hydrochloric), 0.1 N: Dilute 3.0 ml conc H_2SO_4 or 8.3 ml conc HCl to 1 liter with distilled water. Standardize versus 40.0 ml of 0.05 N Na_2CO_3 solution with about 60 ml distilled water by titrating potentiometrically to pH of about 5. Lift electrode and rinse into beaker. Boil solution gently for 3–5 minutes under a watch glass cover. Cool to room temperature. Rinse cover glass into beaker. Continue titration to the pH inflection point. Calculate normality using:

$$N = \frac{A \times B}{53.00 \times C}$$

where:
A = g Na_2CO_3 weighed into 1 liter
B = ml Na_2CO_3 solution
C = ml acid used to inflection point

5.3 Standard acid (sulfuric or hydrochloric), 0.02 N: Dilute 200.0 ml of 0.1000 N standard acid to 1 liter with distilled water. Standardize by potentiometric titration of 15.0 ml 0.05 N Na_2CO_3 solution as above.

6. Procedure

6.1 Sample size

6.1.1 Use a sufficiently large volume of titrant (> 20 ml in a 50 ml buret) to obtain good precision while keeping volume low enough to permit sharp end point.

6.1.2 For < 1000 mg $CaCO_3$/l use 0.02 N titrant

6.1.3 For > 1000 mg $CaCO_3$/l use 0.1 N titrant

6.1.4 A preliminary titration is helpful.

6.2 Potentiometric titration

6.2.1 Place sample in flask by pipetting with pipet tip near bottom of flask

6.2.2 Measure pH of sample

6.2.3 Add standard acid (5.2 or 5.3), being careful to stir thoroughly but gently to allow needle to obtain equilibrium.

6.2.4 Titrate to pH 4.5. Record volume of titrant.

6.3 Potentiometric titration of low alkalinity

6.3.1 For alkalinity of < 20 mg/l titrate 100–200 ml as above (6.2) using a 10 ml microburet and 0.02 N acid solution (5.3).

6.3.2 Stop titration at pH in range of 4.3–4.7, record volume and exact pH. Very carefully add titrant to lower pH exactly 0.3 pH units and record volume.

7. Calculations

7.1 Potentiometric titration to pH 4.5

$$\text{Alkalinity, mg/l } CaCO_3 = \frac{A \times N \times 50{,}000}{\text{ml of sample}}$$

TEMPERATURE

Method 170.1 (Thermometric)

STORET NO. 00010

1. Scope and Application
   1.1 This method is applicable to drinking, surface, and saline waters, domestic and industrial wastes.
2. Summary of Method
   2.1 Temperature measurements may be made with any good grade of mercury-filled or dial type centigrade thermometer, or a thermistor.
3. Comments
   3.1 Measurement device should be routinely checked against a precision thermometer certified by the National Bureau of Standards.
4. Precision and Accuracy
   4.1 Precision and accuracy for this method have not been determined.
5. Reference
   5.1 The procedure to be used for this determination is found in:
   Standard Methods for the Examination of Water and Wastewater, 14th Edition, p 125; Method 212 (1975).

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Issued 1971

TURBIDITY
Method 180.1 (Nephelometric)

STORET NO. 00076

1. Scope and Application
   1.1 This method is applicable to drinking, surface, and saline waters in the range of turbidity from 0 to 40 nephelometric turbidity units (NTU). Higher values may be obtained with dilution of the sample.
   NOTE 1: NTU's are considered comparable to the previously reported Formazin Turbidity Units (FTU) and Jackson Turbidity Units (JTU).
2. Summary of Method
   2.1 The method is based upon a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension. The higher the intensity of scattered light, the higher the turbidity. Readings, in NTU's, are made in a nephelometer designed according to specifications outlined in Apparatus. A standard suspension of Formazin, prepared under closely defined conditions, is used to calibrate the instrument.
      2.1.1 Formazin polymer is used as the turbidity reference suspension for water because it is more reproducible than other types of standards previously used for turbidity standards.
      2.1.2 A commercially available polymer standard is also approved for use for the National Interim Primary Drinking Water Regulations. This standard is identified as AMCO-AEPA-1 available from Amco Standard International, Inc.
3. Sample Handling and Preservation
   3.1 Preservation of the sample is not practical; analysis should begin as soon as possible. Refrigeration or icing to 4°C, to minimize microbiological decomposition of solids, is recommended.
4. Interferences
   4.1 The presence of floating debris and coarse sediments which settle out rapidly will give low readings. Finely divided air bubbles will affect the results in a positive manner.
   4.2 The presence of true color, that is the color of water which is due to dissolved substances which absorb light, will cause turbidities to be low, although this effect is generally not significant with finished waters.
5. Apparatus
   5.1 The turbidimeter shall consist of a nephelometer with light source for illuminating the sample and one or more photo-electric detectors with a readout device to indicate the intensity of light scattered at right angles to the path of the incident light. The turbidimeter should be so designed that little stray light reaches the detector in the

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Editorial revision 1978

absence of turbidity and should be free from significant drift after a short warm-up period.

5.2 The sensitivity of the instrument should permit detection of a turbidity difference of 0.02 unit or less in waters having turbidities less than 1 unit. The instrument should measure from 0 to 40 units turbidity. Several ranges will be necessary to obtain both adequate coverage and sufficient sensitivity for low turbidities.

5.3 The sample tubes to be used with the available instrument must be of clear, colorless glass. They should be kept scrupulously clean, both inside and out, and discarded when they become scratched or etched. They must not be handled at all where the light strikes them, but should be provided with sufficient extra length, or with a protective case, so that they may be handled.

5.4 Differences in physical design of turbidimeters will cause differences in measured values for turbidity even though the same suspension is used for calibration. To minimize such differences, the following design criteria should be observed:

5.4.1 Light source: Tungsten lamp operated at a color temperature between 2200–3000°K.

5.4.2 Distance traversed by incident light and scattered light within the sample tube: Total not to exceed 10 cm.

5.4.3 Detector: Centered at 90° to the incident light path and not to exceed ±30° from 90°. The Detector, and filter system if used, shall have a spectral peak response between 400 and 600nm.

5.5 The Hach Turbidimeter, Model 2100 and 2100 A, is in wide use and has been found to be reliable; however, other instruments meeting the above design criteria are acceptable.

6. Reagents

6.1 Turbidity-free water: Pass distilled water through a 0.45μ pore size membrane filter if such filtered water shows a lower turbidity than the distilled water.

6.2 Stock formazin turbidity suspension:

Solution 1: Dissolve 1.00 g hydrazine sulfate, $(NH_2)_2 \cdot H_2SO_4$, in distilled water and dilute to 100 ml in a volumetric flask.

Solution 2: Dissolve 10.00 g hexamethylenetetramine in distilled water and dilute to 100 ml in a volumetric flask.

In a 100 ml volumetric flask, mix 5.0 ml Solution 1 with 5.0 ml Solution 2. Allow to stand 24 hours at 25 ± 3°C, then dilute to the mark and mix.

6.3 Standard formazin turbidity suspension: Dilute 10.00 ml stock turbidity suspension to 100 ml with turbidity-free water. The turbidity of this suspension is defined as 40 units. Dilute portions of the standard turbidity suspension with turbidity-free water as required.

6.3.1 A new stock turbidity suspension should be prepared each month. The standard turbidity suspension and dilute turbidity standards should be prepared weekly by dilution of the stock turbidity suspension.

6.4 The AMCO-AEPA-1 standard as supplied requires no preparation or dilution prior to use.

7. Procedure

7.1 Turbidimeter calibration: The manufacturer's operating instructions should be followed. Measure standards on the turbidimeter covering the range of interest. If the instrument is already calibrated in standard turbidity units, this procedure will check the accuracy of the calibration scales. At least one standard should be run in each instrument range to be used. Some instruments permit adjustments of sensitivity so that scale values will correspond to turbidities. Reliance on a manufacturer's solid scattering standard for setting overall instrument sensitivity for all ranges is not an acceptable practice unless the turbidimeter has been shown to be free of drift on all ranges. If a pre-calibrated scale is not supplied, then calibration curves should be prepared for each range of the instrument.

7.2 Turbidities less than 40 units: Shake the sample to thoroughly disperse the solids. Wait until air bubbles disappear then pour the sample into the turbidimeter tube. Read the turbidity directly from the instrument scale or from the appropriate calibration curve.

7.3 Turbidities exceeding 40 units: Dilute the sample with one or more volumes of turbidity-free water until the turbidity falls below 40 units. The turbidity of the original sample is then computed from the turbidity of the diluted sample and the dilution factor. For example, if 5 volumes of turbidity-free water were added to 1 volume of sample, and the diluted sample showed a turbidity of 30 units, then the turbidity of the original sample was 180 units.

7.3.1 The Hach Turbidimeters, Models 2100 and 2100A, are equipped with 5 separate scales: 0–0.2, 0–1.0, 0–100, and 0–1000 NTU. The upper scales are to be used only as indicators of required dilution volumes to reduce readings to less than 40 NTU. NOTE 2: Comparative work performed in the MDQAR Laboratory indicates a progressive error on sample turbidities in excess of 40 units.

8. Calculation

8.1 Multiply sample readings by appropriate dilution to obtain final reading.

8.2 Report results as follows:

NTU	Record to Nearest:
0.0 - 1.0	0.05
1 - 10	0.1
10 - 40	1
40 - 100	5
100 - 400	10
400 - 1000	50
> 1000	100

9. Precision and Accuracy

9.1 In a single laboratory (EMSL), using surface water samples at levels of 26, 41, 75 and 180 NTU, the standard deviations were ±0.60, ±0.94, ±1.2 and ±4.7 units, respectively.

9.2 Accuracy data are not available at this time.

Bibliography

1. Annual Book of ASTM Standards, Part 31, "Water", Standard D1889–71, p 223 (1976).
2. Standard Methods for the Examination of Water and Wastewater, 14th Edition, p 1[illegible] Method 214A, (1975).

ENVIRONMENTAL MONITORING LABORATORIES (EML)

President	Dr. Deborah Hockman
Director, Administration	Barb Hill
Director, Laboratory Operations	Dr. Roy Gall
Director, Information Technology	Jean Holley
Senior Environmental Scientist	John Baker
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Group Leader	Diana Strode
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Groundwater Laboratory	EML 2100 Cleanwater Dr. Geneva, IL 60134 (708)208-3100

WMX Technologies
3003 Butterfield Road
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Program Manager:

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Site Manager:

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Name

Site Chemist:

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Name

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Company

Personnel:

_____
Name

_____
Name

_____
Company Address

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City, State, Zip Code

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Phone Number

Sampling Trainer:

_____
Name

_____
Company Name

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Address

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City, State, Zip Code

_____
Phone Number

Subcontract Lab:

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Company Name

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Contact

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Company Address

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City, State, Zip Code

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Phone Number

ECO:

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Company

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Phone Number

Well Wizard® Trouble Shooting (800) 624-2026

EML RECOMMENDATION FOR SAMPLING AND PRESERVATION OF SAMPLES ACCORDING TO ANALYTE[1]

Measurement	Minimum Vol. Req. (ml)	Container[2]	Preservative[3,4]	Holding Time[5]
100 Physical Properties				
Color	50	P	Cool, 4°C	48 hrs.
Conductance	100	P	Cool, 4°C	28 days
Hardness	50	P	HNO_3 to pH<2	6 mos.
Odor	200	G only	Cool, 4°C	24 hrs.
pH	25	P	Cool, 4°C	Analyze Promptly Upon Receipt
Residue				
Filterable (TDS)	500	P	Cool, 4°C	7 days
Nonfilterable (TDS)	500	P	Cool, 4°C	7 days
Total (TS)	500	P	Cool, 4°C	7 days
Settleable Matter	1000	P	Cool, 4° C	48 hrs.
Turbidity	100	P	Cool 4° C	48 hrs.
200 Metals				
Dissolved	500	P	Filter on site HNO_3 to pH<2	6 mos.
Total	500	P	HNO_3 to pH<2	6 mos.
Chromium VI	200	P	Cool, 4° C	24 hrs.

Mercury				
Dissolved	100	P	Filter HNO_3 to pH<2	28 days
Total	100	P	HNO_3 to pH<2	28 days
300	**Inorganics, Non-Metallics**			
Acidity	100	P	Cool, 4°C	14 days
Alkalinity	100	P	Cool, 4°C	14 days
Bromide	100	P	None Req.	28 days
Chloride	50	P	None Req.	28 days
Cyanides	500	P	Cool, 4°C NaOH to pH>12 ~0.6g ascorbic acid[6]	14 days
Fluoride	100	P	None Req.	28 days
Nitrogen				
Ammonia	100	P	Cool, 4°C H_2SO_4 to pH<2	28 days
Kjeldahl, total	100	P,G	Cool, 4°C H_2SO_4 to pH<2	28 days
Nitrate/Nitrite	100	P,G	Cool, 4°C H_2SO_4	28 days
Nitrate	100	P,G	Cool, 4°C	48 hours
Nitrite	100	P,G	Cool, 4°C	48 hours

Ascorbic should only be used in the presence of residual chlorine.

Phosphorus

Orthophosphate, dissolved	50	G	Filter on site Cool, 4°C	48 days
Total	50	P,G	Cool, 4°C H_2SO_4 to pH<2	28 days
Silica	50	P	Cool, 4°C	28 days
Sulfate	50	P	Cool, 4°C	28 days
Sulfide	500	P,G	Cool, 4°C add 2 ml. zinc acetate plus NaOH to pH>9	7 days

300 <u>SVOA Methods</u>

GC/MS SVOA organics: BNA PCBs, PAHs, and/or Pesticides	1000	G only w/Teflon®	Cool, 4°C	Extract within 7 days, analyze within 40 days
GC Pesticides/ herbicides	1000	G only w/Teflon®	Cool, 4°C	Extract within 7 days, analyze within 40 days
HPLC SVOA organics Ex: carbonates	1000	G only w/Teflon®	Cool, 4°C	Extract within 7 days, analyze within 40 days

400 <u>Organics</u>

BOD	1000	P,G	Cool, 4°C	48 hrs.
COD	50	P,G	Cool, 4°C H_2SO_4 to pH<2	28 days
Oil and grease	1000	G only	Cool, 4°C HCl to pH<2	28 days

Total Petroleum Hydrocarbon	1000	G only	Cool, 4°C HCl to pH>2	28 days
Organic carbon	25	P,G	Cool, 4°C H_2SO_4 or HCl to pH<2	28 days
Phenolics	500	G only	Cool, 4°C H_2SO_4 to pH<2	28 days
Total Organic Halogen	1000	G	Cool, 4°C HNO_3 to pH<2 or H_2SO_4	28 days

400 <u>VOA Methods</u>

Volatile organics (VOA)	4-40 ml vial Teflon® lined septum caps	G only	HCl and Cool, 4°C to pH<2	14 days
Purgeable Halocarbons only	4-40 ml vial w/ septum caps	G only	Cool, 4°C	14 days
Purgeable Aromatic Hydrocarbons	4-40 ml vial w/ septum caps	G only	HCl and Cool, 4°C to pH<2	14 days
Acrolein and acrylonitrite	4-40 ml vial w/ septum caps	G only	Cool, 4°C Adjust pH to 4-5	14 days

1. More specific instructions for preservation and sampling are found with each procedure as detailed in this manual. A general discussion on sampling water and industrial wastewater may be found in ASTM, Part 31, p. 72-81 (1976) Method D-3370 and 40 CFR Part 136.

2. Plastic (P) or Glass (G). For metals, polyethylene with a polypropylene cap (no liner) is preferred.

3. Sample preservation should be performed immediately upon sample collection. For composite samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then samples may be preserved by maintaining at 4° C until compositing and sample splitting is completed.

4. When any sample is to be shipped via air transportation, (e.g., Federal Express), the package must comply with the International Air Transportation Association (IATA) Dangerous Goods Regulations. The person offering such materials for transportation is responsible for ensuring such compliance. Specific instructions are included in each AquaPak.

5. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring lab, has data on file to show that the specific types of sample under study are stable for the longer time, and has received a variance from the Regional EPA Administrator. Some samples may not be stable for the maximum time period given in the table. A permittee, or monitoring lab, is obligated to hold the sample for a short time if information exists to show this is necessary to maintain sample stability.

6. Should only be used in the presence of residual chlorine.

7. Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before the pH adjustment in order to determine whether sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and the NaOH is added to pH 12.

SAMPLE PRESERVATION (ACID/BASE) PRESERVATIVES

Proper Preservation (acid/base)

In order to ensure that a sufficient amount of preservative (acid or base) has been added to a sample, a method has been established for checking the pH of a sample with as little disturbance as possible to the sample.

Required equipment includes:
- Capillary tubes
- pH paper (narrow range 0-6)
- Extra preservative vials (supplied by EML)

Once a sample has been preserved with preservative supplied by the EML, and inverted several times to mix the sample, the following procedures should be followed:

1. Open sample bottle.

2. Insert one capillary tube into the sample bottle, limiting the length of time of insertion into the sample until the tube is filled. Do not plug the end of the capillary tube. The water will rise into this tube on its own.

3. Remove the capillary tube and close the sample bottle.

4. Place the capillary tube end onto a piece of pH paper and determine the pH value.

5. Preservation Achieved:

   a. If the pH is less than 2 (for acid preservation) or greater than 12 (for base preservation), the sample has been adequately preserved.

Preservation Not Achieved:

   b. If the proper pH has not been achieved, an additional preservative vial, the same type as originally used, should be emptied into the sample and mixed, and steps 1-5 should be repeated.

FIELD PRESERVATIVES INFORMATION SHEET

Vol.	Preservative	Symbol	Concentration	Vial
CMR/INORGANICS				
1 ml	Sulfuric Acid	H_2SO_4	1:2	Glass
5 ml	Sodium Hydroxide	NaOH	10 Normal	Plastic or Glass
0.5 ml	Zinc Acetate		2 Normal	Glass
5 ml	Hydrochloric Acid	HCl	1:1	Glass
6 ml	Nitric Acid	HNO_3	1:3	Glass
1.2 ml	Monochloroacetic Acid/Potassium Acetate Buffer	MCA	Monochloroacetic Acid 14% by weight	Glass
7.5 ml	Monochloroacetic Acid/Potassium	MCA	Monochloroacetic Acid 14% by weight Potassium Acetate 10% by weight	Glass
8 ml	Nitric Acid/ $K_2Cr_2O_7$	$K_2Cr_2O_7$ + HNO_3	1:3 + pinch of $K_2Cr_2O_7$	Glass
VOA				
For HCLs .3 ml	Hydrochloric Acid	HCl	1:1	40 ml Amber Glass
For pH 4-5s .3ml	Hydrochloric Acid	HCl	1:13.5	40 ml Amber Glass

RECOMMENDED FIELD EQUIPMENT/SUPPLIES

Water Level Indicator

Slope Indicator Co.
3668 Alborn Place
P.O. Box C-30316
Seattle, WA 98103
(206)633-3073

Soiltest, Inc.
2205 Lee Street
Evanston, IL 60202
(708)869-5500

In-Situ, Inc.
209 Grand Avenue
Laramie, WY 82070
(307)742-8213

pH Meter

Beckman Instruments, Inc. Fullerton, CA (714)871-4848	*Model 10 pH Meter	12314
	*Epoxy body electrode	395420
	*Electrode cable	597578
	*ATC probe	598115
Baxter Scientific Products Division 1430 Waukegan Road McGaw Park, IL 60085-6787	*pH Meter Set	H4292-21
	*Conductivity/TDS Meter Set	H4292-22
	*DO Meter Set	H4292-23
	*Deluxe Field System	H4292-20
	*Meter Module Only	H4292-24

Combination Temp./pH/SC meter

Cambridge Scientific Industries
P.O. Box 265
Moose Lodge Road
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Comb. Temp./pH/SC meter	301353
pH electrode	102927

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Ann Arbor, MI 48017
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GeoTech Environmental Equipment, Inc.
1441 W. 46th Avenue
Denver, CO 80211
(303)433-7101

Pneumatic logic unit	5504
Electrical pneumatic logic unit	5505

Q.E.D. Environmental Systems
P.O. Box 3726
Ann Arbor, MI 48106

Sample Pro Electronic Controller	350
Pneumatic controller (automatic)	3013
Gasoline driven driver controller	3111

Bailers

Diedrich Drilling Equipment, Inc.
2008 Ohio Street
LaPorte, IN 46350
(800)348-8809

Timco manufacturing Co.
851 15th Street
Prairie du Sac, WI 53578
(608)643-8534

Galter Corporation
Johathon Industrial Center
Chasra, MN 55318
(612)448-6717

Submersible Pumps

GRUNDFOS Pumps Corporation
2555 Clouis Avenue
Clouis, CA 93612
(209)299-9741

Retrofitted with Teflon® by:

PFC Equipment, Inc.
7409 Jolly Lane
Minneapolis, MN 55470
(612)425-7890

Safety Equipment

Powder-Free Gloves
Glove Liners
Boots and Tyvek Suit

Shamrock Industrial Glove
920 West Byers Place
Denver, CO 80223
(303)778-0667

SAMPLING TEAM LAB AND STORAGE BUILDING

A designated sampling team lab and storage building is required for all facilities for environmental sampling. This building is intended to isolate the environmental samples and equipment from possible contamination sources, such as the site lab or site pollutants. Due to the low levels of detection required by regulatory agencies, every possible precaution must be taken to preserve the integrity of the samples from airborne or direct-contact contamination. The samples, as well as all sampling equipment and dedicated lab equipment, must be isolated. NO LEACHATE OR SALES SAMPLES ARE TO BE STORED OR PLACED IN THIS BUILDING.

The sampling team lab and storage building should have a "dirty" room and a "clean" room. This design is intended to minimize the risk of most contaminants, which are present on site from being introduced into the samples during filtration and preservation. It also provides for ample storage space for all sampling equipment and shuttles. All entry to the building is made through the "dirty" room, which acts as a filter for most site contaminants and dirt, by trapping these materials before entry into the "clean" room.

This lab and storage building will need to be cleaned thoroughly with deionized water before each use. Tap water may be used to remove the excess dirt, but it must then be thoroughly rinsed with laboratory grade deionized water.

SAMPLING TEAM LAB AND STORAGE BUILDING USE

The following list provides some of the uses for "dirty" rooms and "clean" rooms in lab and storage buildings.

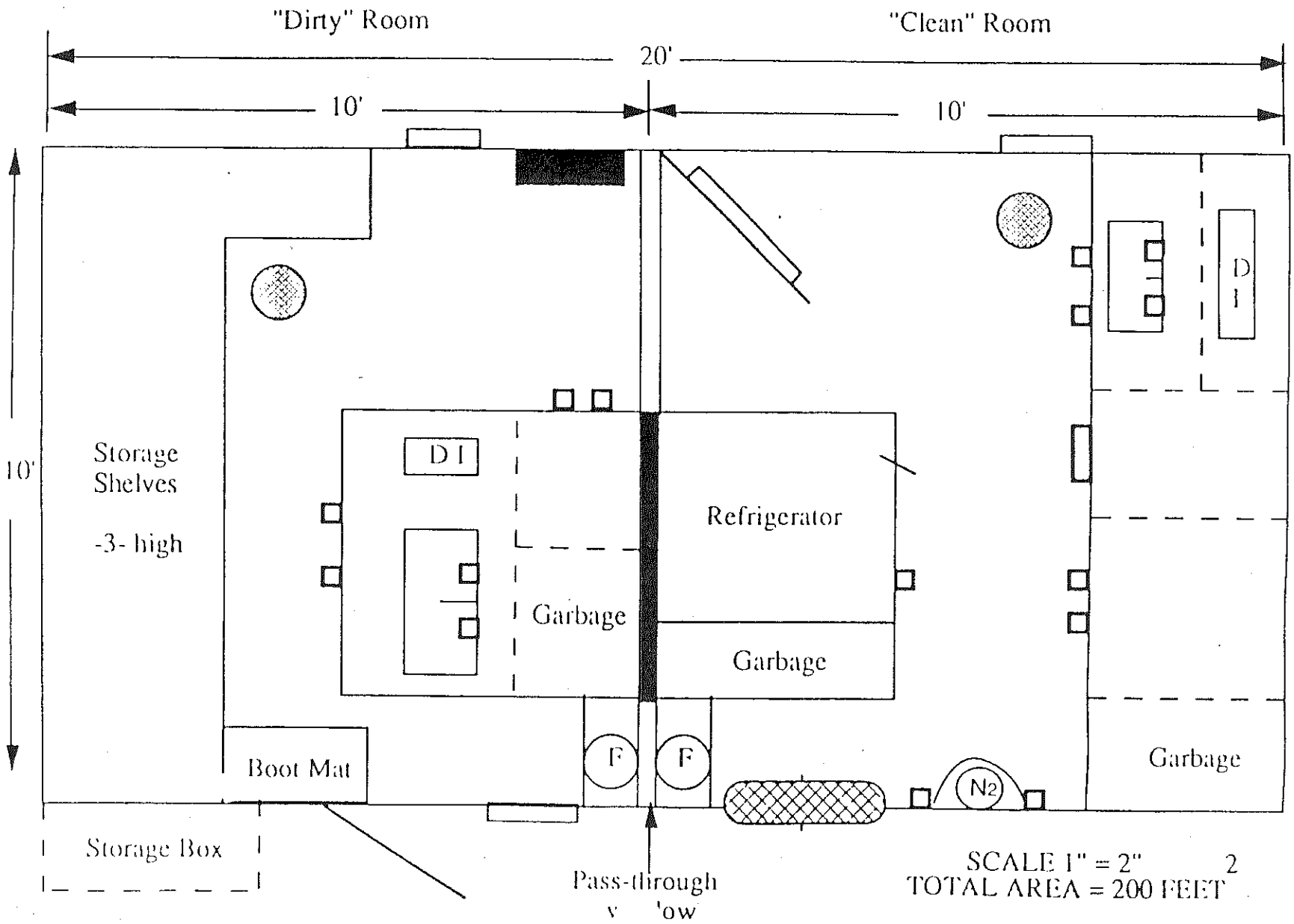
"Dirty" Room	"Clean" Room
Receive AquaPaks.	Place ice packs in sample dedicated freezer.
Open and inspect AquaPaks	Calibrate pH and specific conductivity meters.
Reseal AquaPaks and store	Store prefiltration bottles.until used.
Return AquaPaks after sampling.	Receive samples.
Clean AquaPaks.	Measure pH and specific Conductivity.
Clean sampling equipment.	Filter samples.
Store sampling equipment.	Preserve samples.
Store boots, rain gear, etc.	Place samples in refrigerator.
Repack AquaPaks.	Complete field form.
	Store filtering equipment
	Store extra preservatives and field forms.
	Store pH and specific conductivity meters.
	Store pH and specific conductivity standards.

SUGGESTED SAMPLING TEAM LAB AND STORAGE BUILDING

Key to Symbols

F	Fire Extinguisher
N_2	Nitrogen Tank or Compressed Air Source
D.I.	Deionized Water
	Sealed Window
	Drawers
	Cabinets with Shelves
	Emergency Exit
	Floor Drain
	First Aid Kit
	Sink

SUGGESTED SAMPLING TEAM AND STORAGE BUILDING



F039 SOURCE PACKING INSTRUCTIONS

Customers of the EML ship samples to us in an **AquaPak** which is a patented reusable plastic shipping container that has been performance tested for shipping Dangerous Goods In Excepted Quantities and is regularly used for that purpose.

These samples are packed by our clients for FedEx shipment to the EML for analysis as follows:

F039 Source Samples are collected and shipped in glass or plastic bottles.

Glass Bottles

Glass bottles are placed in molded polyethylene bottle holders.

The foam holder is then placed and sealed into a zipper locking plastic bag that contains absorbent material.

Plastic Bottles

Bottles that are not in a foam bottle holder are individually placed and sealed in a zipper locking plastic bag which contains absorbent material.

The 'bagged" bottles and holders are then packed into an AquaPak.

Shipping Canadian Samples:

TSCA PCB Shippers Declaration (Federal Express)

1) The Canadian site is the importer of the environmental sample.

2) PCBs should be below 2 ppm.

3) Sites should rely upon generator knowledge or testing to determine if they are below the 2 ppm level.

   a) Some sites may certify that the chemicals in the shipment are not subject to TSCA on the grounds that the site has never accepted anything but solid waste (from our database search of historical data on any site that had tested for PCBs, the 2 ppm level was not found at any strictly solid waste sites and there were only a couple of hazardous/codisposal sites above that level).

   b) Other sites may use representative historical data from background, routine or special testing indicating no levels of PCBs above 2 ppm as long as there have been no changes in disposal practices that might indicate the need to resample.

   c) Other sites may do composite sampling and test the sample for PCBs in Canada prior to shipping via laboratory GC or GC/MS analysis or field immuno assay screening.

4) After receiving indication from the Program Manager or responsible sampling leader that the PCB level is not a problem, the samplers should fill out "**THE TOXIC SUBSTANCES CONTROL ACT SHIPPERS DECLARATION**" by checking the statement "I certify that all chemicals in this shipment are not subject to TSCA". The sampler should also complete the company name, address, shipper's name, title and Fed Ex number.

AQUAPAK TEMPERATURE CONTROL

PROPER CHILLING

(WET ICE METHOD)

1. Samples are collected and preserved

2. In a separate clean AquaPak or cooler place 2-3 10 lb. bags of ice and add 2-3 gallons of deionized water.

3. Remove sample bottles from bottle holders and place each bottle into a separate zipper locking bag. Place each bottle into the AquaPak or cooler.

4. Place a temporary Chain-of-Custody seal on AquaPak or cooler.

5. Remove samples from AquaPak or cooler at end of the sampling day. Remove bottles from zipper locking bags. If necessary, dry the bottles using clean lint free paper towels, and repack into original AquaPak or cooler.

AQUAPAK TEMPERATURE CONTROL

PROPER CHILLING

(ICE PACK METHOD)

1. Samples are collected and preserved.

2. Line a separate AquaPak/cooler with 25-30 ice packs.

3. Remove samples from bottle holders and place into AquaPak/cooler.

4. Place a temporary Chain-of-Custody seal on AquaPak/cooler.

5. Remove samples from the AquaPak or cooler at the end of the sampling day and repack bottles into original AquaPak with a new supply of frozen ice packs.

AQUAPAK TEMPERATURE CONTROL

PROPER PACKING

- Repack the samples with adequate space to allow extra packing of ice packs.

- Repacking should include lining the AquaPak on the top and on all sides with a layer of ice packs.

- All ice packs should be COMPLETELY FROZEN prior to use.

  Note: Ice packs layered on the bottom of the AquaPaks/Coolers does not insure that the temperature of the sample bottle will arrive at the lab within the proper temperature range.

DATE: March 3, 1995

TO: All Samplers Shipping Samples to the WMX-Environmental Monitoring Laboratories, Inc.

FROM: Sample Management, WMX-EML

SUBJECT: **Revision 3**
Sampler Procedures for International Air Transport Association
Dangerous Goods Regulations - Dangerous Goods In Excepted Quantities

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AquaPaks containing preservative vials and prepreserved sample bottles sent to and from the EML are shipped by air transportation. As such, their shipment is regulated under the International Air Transport Association (IATA) Dangerous Goods Regulations. The preservative vials and prepreserved sample bottles are regulated under the IATA Dangerous Goods In Excepted Quantities category of the IATA Dangerous Goods Regulations.

Sampler Chooses Not to Return Preservative Vials/Unused Prepreserved Sample Bottles

If the sampler chooses not to return the full or empty preservative vials and/or unused pre-preserved sample bottles to the EML, the preservative vials and/or bottles must be appropriately disposed of in accordance with all applicable federal, state, and local environmental regulations. The used Dangerous Goods In Excepted Quantities Label must be removed from the AquaPak after sampling and prior to the return shipment to the EML. Please note that the smallest sized AquaPak may have the used label affixed to its side.

Sampler Chooses to Return Preservative Vials/Unused Prepreserved Sample Bottles

If the sampler plans to return full or empty preservative vials and/or unused prepreserved sample bottles with the return shipment to the EML, use the instructions that follow to comply with IATA. These instructions apply only to the preservative vials/prepreserved sample bottles supplied by the EML and do not apply to the actual samples being collected. Other IATA requirements not discussed here may apply to the samples.

Every AquaPak will contain a copy of this revised memo and a quiz. Each sampler must complete one revised signature page and one revised quiz (attached). The quiz is mandatory to the Dangerous Goods Regulations, and is required to be taken by all samplers involved with EML procedures. Although each AquaPak will contain these documents, **samplers need only complete one of each form per revision of the document. This is Revision 3.** For your records and/or the site records, make photocopies of the completed signature page and quiz. Sign, date, and return one set of completed original forms to: Deborah Paluch, WMX Environmental Monitoring Laboratories, Inc., 2100 Cleanwater Drive, Geneva, IL 60134.

These procedures are mandatory for you to remain in compliance with the IATA Dangerous Goods Regulations, and are required to be followed by all samplers involved with EML procedures.

Shipping Instructions for Preservative Vials/Prepreserved Sample Bottles

1) Remove the used Dangerous Goods In Excepted Quantities Label from the AquaPak **after sampling and prior to the return shipment to the EML.** Please note that the smallest sized AquaPak may have the used label affixed to its side.

2) To prepare the full or empty preservative vials and/or unused prepreserved sample bottles for shipment in the AquaPak to the EML, proceed as follows:

- Tape each vial/bottle shut to ensure positive closure.
- Place vials/bottles into the appropriate secondary containment bottle or bag (do not mix acids and bases) with the absorbent material.
- Place this secondary containment container into the cushioning material originally used when shipped from the EML.

3) Complete the Dangerous Goods In Excepted Quantities Label supplied in the field bag, inside the AquaPak, with a black ink ball point pen. All AquaPaks that will be shipped with full or empty preservative vials and/or unused prepreserved sample bottles must have a completed Dangerous Goods In Excepted Quantities Label attached for shipment. See Figure 1 for an example. Complete the Dangerous Goods In Excepted Quantities Label as follows:

a) Signature of Shipper - The Sampler (the person responsible for the shipment) signs their name here. The label must not be completed or signed by consolidator, a forwarder or an IATA cargo agent.

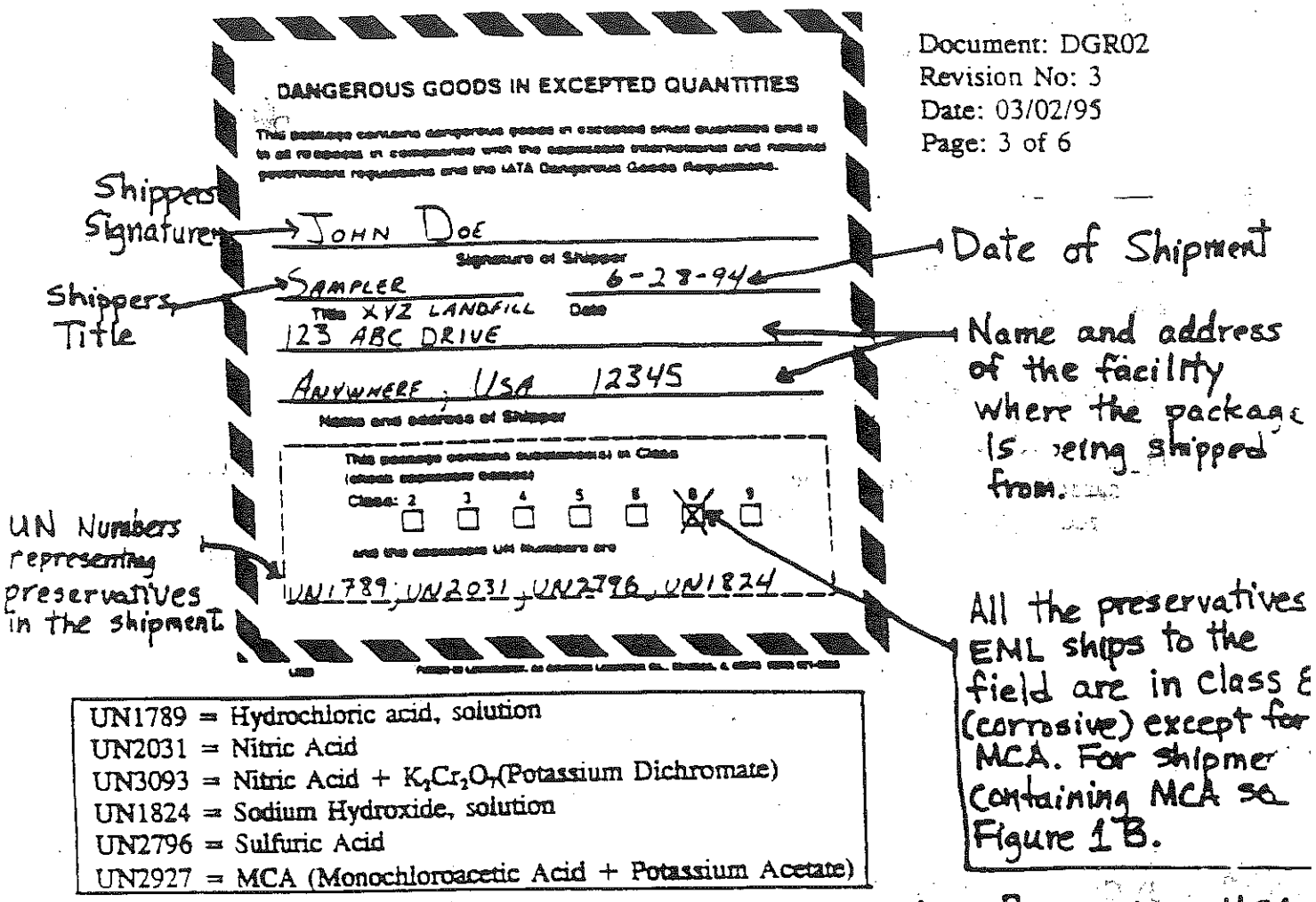
NOTE: By definition, the shipper is the person offering the package for shipment.

b) Title - Sampler prints their title here.

c) Date - Sampler completes the date the package is being shipped.

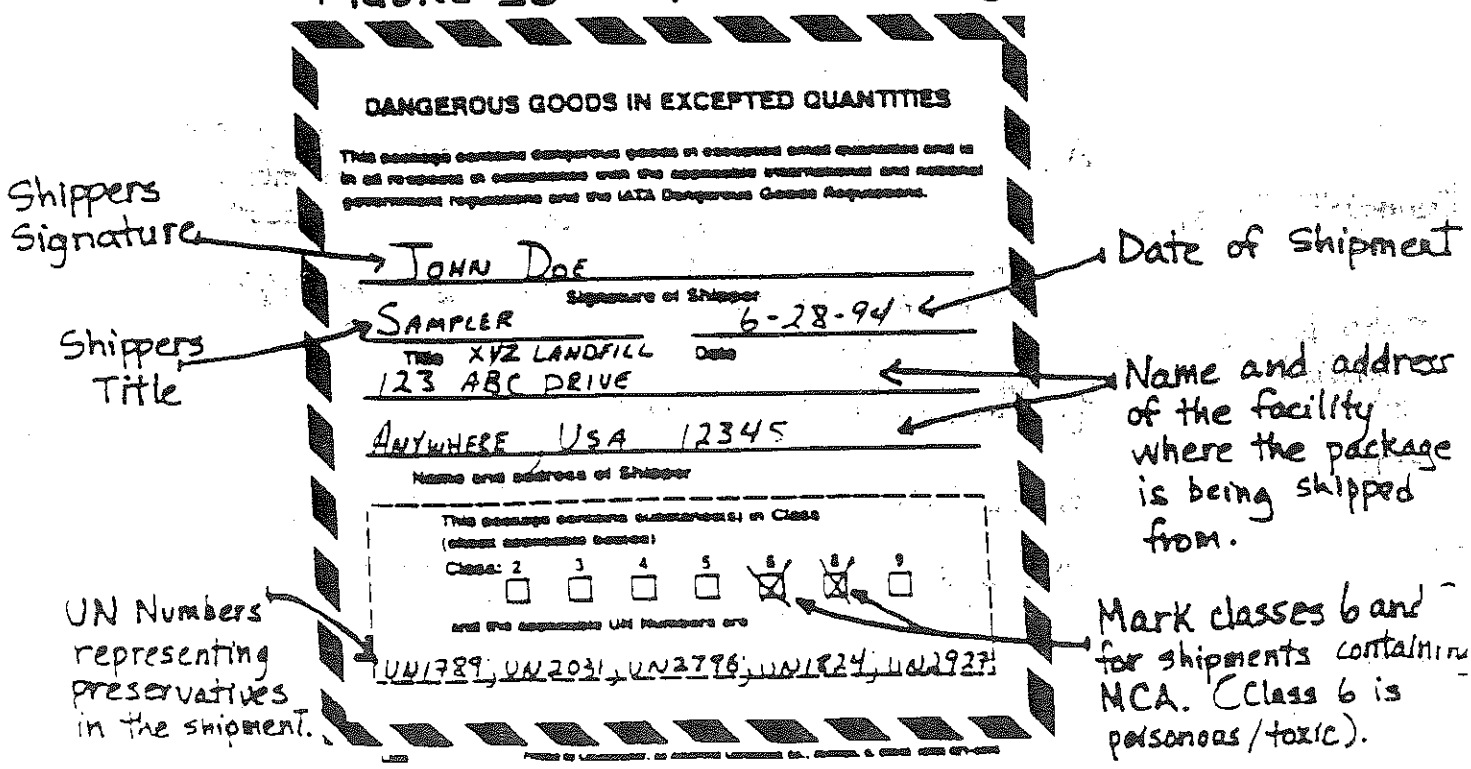
d) Name and address of the Shipper - Sampler prints the name of the facility and address that the package is being shipped from.

FIGURE 1A



UN1789	= Hydrochloric acid, solution
UN2031	= Nitric Acid
UN3093	= Nitric Acid + $K_2Cr_2O_7$(Potassium Dichromate)
UN1824	= Sodium Hydroxide, solution
UN2796	= Sulfuric Acid
UN2927	= MCA (Monochloroacetic Acid + Potassium Acetate)

FIGURE 1B – Shipments containing the Preservative MCA



QUIZ

Name: _____ Date: _____
(Print)

Region: _____ Employer/Location: _____

Please answer the following questions, sign the form and return to the EML.

1) What is IATA?

a) International Air Transport Association
b) Illinois Ambient Testing Association
c) Indiana Association of Transportation by Air
d) International Air Testing Alumni

2) True or False: When you receive an AquaPak from EML, leave the used DANGEROUS [illegible] IN EXCEPTED QUANTITIES LABEL on the AquaPak [illegible] after [illegible] prior to the shipment back to the EML.

3) True or False: Empty preservative vials and/or unused prepreserved sample bottles must be returned to the EML.

4) If the sampler is shipping all preservative types except MCA (Monochloroacetic Acid/Potassium Acetate Buffer), which of the following must be completed on the DANGEROUS GOODS IN EXCEPTED QUANTITIES LABEL to ship the AquaPak(s) back to the EML:

a) Signature of Shipper
b) Title (of the Shipper)
c) Date of the shipment
d) Name and address of the Shipper
e) Class (Class 8)
f) Applicable UN Numbers
g) All of the above
h) None of the above

5) Match the correct UN Numbers to the preservative names:

a) UN1789	1) Potassium Dichromate + Nitric Acid
b) UN1824	2) Sulfuric Acid
c) UN2031	3) Nitric Acid
d) UN2796	4) Sodium hydroxide, solution
e) UN3093	5) Monochloroacetic Acid/Potassium Acetate Buffer
f) UN2927	6) Hydrochloric acid, solution

6) True or False: If empty or full preservative vials and/or unused prepreserved sample bottles are returned to the EML, the DANGEROUS GOODS IN EXCEPTED QUANTITIES LABEL completed by the sampler must be affixed flat to the surface of the AquaPak.

7) True or False: The words, "Dangerous Goods In Excepted Quantities" must be written on the airbill for an AquaPak containing full or empty preservative vials/and or unused prepreserved sample bottles being returned to the EML.

8) True or False: The preservative vials being returned to EML must be positively closed (taped shut), and be contained within the secondary container they were received in with absorbent and cushioning material.

9) True or False: The DANGEROUS GOODS IN EXCEPTED QUANTITIES LABEL can be folded over onto two sides of the AquaPak.

10) True or False: When shipping Dangerous Goods in Excepted Quantities, the Dangerous Goods box on the Airbill should not be marked.

_____ _____ _____
Signature Date Employer