Groundwater Monitoring Plan
Hidden Valley Landfill

Pierce County Recycling, Composting
& Disposal, LLC dba LRI
17925 Meridian East
Puyallup, Washington 98375

SCS ENGINEERS

04218002.03 | October 18, 2018

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1.0 INTRODUCTION

This document updates the August 8, 2014 Groundwater Monitoring Plan (GWMP) and provides an Alternate Groundwater Monitoring Program as allowed under WAC 173-351-450 for the Hidden Valley Landfill located in central Pierce County at 17925 Meridian East, Puyallup, Washington (Figure 1)..

The updated GWMP reduces the frequency of groundwater monitoring to semi-annually, reduces the number of monitoring wells from 23 to 21, removes from further monitoring bicarbonate as a redundant parameter with alkalinity, and reduces the frequency of monitoring for Appendix I WAC 173-351 total metals to every five years.

1.1 SITE DESCRIPTION

The Hidden Valley Landfill is a closed municipal solid waste (MSW) landfill that began operations in the mid-1960s and accepted waste until December 31, 1998. The landfill accepted over 8 million cubic yards of solid waste from private and municipal collection and transfer vehicles. Prior to 1985, small quantities of bulk liquids, sludges, and larger volumes of industrial waste were reportedly accepted at the landfill.

The landfill includes approximately 56 acres of unlined fill and a 30-acre lined cell, referred to as the East Lined Area. The East Lined Area was constructed in 1991 and began accepting waste in April 1992. The East Lined Area includes a 13-acre bottom liner with a leachate collection sump (main sump) and a hydraulic gradient control system, and an 18-acre side-slope liner with a leachate collection sump (side-slope sump) and a side-slope leak detection system. Leachate collected from the East Lined Area is pre-treated on-site and discharged to the Pierce County sewer system.

The unlined portion of the landfill was closed in phases during the summer construction seasons of 1989 (approximately 13 acres), 1992 (approximately 26 acres), and 1993 (approximately 17 acres) under WAC 173-304 (Minimum Functional Standards for Solid Waste Handling [MFS]). The lined portion of the landfill was closed in phases during the summer construction seasons of 1998 (approximately 11.4 acres), 1999 (approximately 20.4 acres), and 2000 (approximately 1.5 acres) under WAC 173-351 (Criteria for MSW Landfills).

1.2 REGULATORY BACKGROUND

Groundwater quality investigations at the Hidden Valley Landfill began in 1982. The Hidden Valley Landfill was placed on the National Priority List in April 1989 due to groundwater detections of nitrate, manganese and volatile organic compounds. Listing on the federal National Priorities List and later on the state Hazardous Sites List required LRI to perform an extensive, multi-phase, Remedial Investigation (RI), Feasibility Study (FS) and Risk Assessment (RA) of the unlined portion of the landfill. Most of the work was performed under Consent Order DE 86-S173 which was executed in 1987 and amended by agreement of the parties in 1988. The RI/FS and RA were finalized in 1992.

The remedial investigation showed the landfill had impacted groundwater downgradient of the site. Contaminants include iron, manganese, chloride, ammonia, nitrate, sulfate, dissolved solids, and low intermittent levels of volatile organic compounds (VOCs), including benzene, chlorobenzene, 1,1-dichloroethane, and 1,4-dichlorobenzene.

LRI, Pierce County, Washington Department of Ecology (Ecology) and the Tacoma-Pierce County Health Department (TPCHD) continued to meet over a period of years in the late 1990's and early 2000's to discuss remedial action alternatives, groundwater monitoring results, and data gaps. These discussions led Ecology to require an additional hydrogeologic evaluation to further confirm the RI and consider off-site groundwater quality, time trends, and results for both wet and dry seasons. The results of this study were presented in the Hidden Valley Landfill Hydrogeologic Report Addendum (December 1998), which provides extensive discussion of the hydrogeologic features and geochemistry of the Hidden Valley Landfill site.

In January 2004, Consent Decree No. 032146876 was finalized and signed by Ecology, Pierce County, and LRI. Post-closure activities are performed consistent with the Consent Decree. The Consent Decree and associated Cleanup Action Plan address long-term maintenance and monitoring activities at the landfill, establish groundwater points of compliance and cleanup levels, and tie together the cleanup requirements of WAC 173-340 (Model Toxics Control Act [MTCA]) with the closed landfill requirements of WAC 173-304 and WAC 173-351. The Post-Closure Plan and Landfill Gas Management Plan also address long-term maintenance and monitoring activities at the landfill.

In April 2014, the Consent Decree was amended (First Amendment) to revise the groundwater monitoring plan. In August 2014, the Groundwater Monitoring Plan (GWMP) was modified to include Appendix I WAC 173-351 metals testing. This requirement included eight rounds of total and dissolved metals testing for 15 metals from 23 monitoring wells. The testing began in July 2014 and was completed in April 2016. Following completion of the required monitoring, a Groundwater Monitoring Optimization Report was submitted to Ecology and the TPCHD on December 2, 2016. Proposed modifications to the GWMP were conditionally approved by Ecology on March 24, 2017.

The updates included in this GWMP were discussed in the August 8, 2014 Plan, and upon regulatory approval, agreed changes to the GWMP shall be adopted and implemented without further amendment to the Consent Decree.

1.3 GROUNDWATER QUALITY

Groundwater impacts downgradient of the Hidden Valley Landfill have occurred within the Shallow Perched Aquifer and the Upper Regional Aquifer. These impacts have included dissolved iron and manganese, chloride, ammonia, nitrate, specific conductance, total dissolved solids, and low levels of volatile organic compounds (VOCs) including chlorobenzene, 1,4-dichlorobenzene, and tetrachloroethene.

Groundwater cleanup levels were established for the Hidden Valley Landfill Cleanup Action Plan using MTCA Method B. Cleanup levels include nitrate (10 mg/L), chloride (250 mg/L), sulfate (250 mg/L), total dissolved solids (500 mg/L), specific conductance (700 µmhos/cm), iron (0.30 mg/L), manganese, (0.05 mg/L), and 1,4-dichlorobenzene (1.82 µg/L).

In recent years, water quality results greater than the site-specific cleanup levels have included nitrate, total dissolved solids (TDS), dissolved iron, and dissolved manganese. In addition, tetrachloroethene has slightly exceeded the WAC 173-200 groundwater quality criteria of 0.80 µg/L on several occasions at MW-11D(2).

1.4 GROUNDWATER MONITORING PROGRAM DEVELOPMENT

The groundwater monitoring program at the Hidden Valley Landfill has provided over 35 years of groundwater monitoring data.

After completion of the RI/FS and the subsequent Hydrogeologic Report Addendum, a Groundwater Compliance Monitoring Plan (GWMP) was submitted to and approved by Ecology and the TPCHD in February 2001 in conjunction with the Consent Decree and Cleanup Action Plan. The GWMP was prepared for the Hidden Valley Landfill in accordance with WAC 173-304 Section 490, WAC 173-351 Sections 400 through 450 and 730(1)(b)(iii), and WAC 173-340 Sections 410 and 820.

In April 2003, minor modifications to the GWMP were approved by Ecology and the TPCHD (see TPCHD letter dated April 21, 2003).

In August 2014, the GWMP was modified to include Appendix I WAC 173-351 metals testing. This requirement included eight rounds of total and dissolved metals testing for 15 metals from 23 monitoring wells. The testing began in July 2014 and was completed in April 2016.

Following completion of eight rounds of total and dissolved metals testing, a Groundwater Monitoring Optimization Report was submitted to Ecology and the TPCHD on December 2, 2016. The proposed GWMP modifications were subsequently conditionally approved by Ecology (see Ecology letter dated March 24, 2017).

Consistent with the Groundwater Monitoring Optimization Report and the approval received from Ecology the following changes were made to the groundwater monitoring program:

- The groundwater monitoring frequency was changed from quarterly to semi-annual;
- Appendix I metals testing was changed to a frequency of every five years, beginning in 2021;
- One (1) new groundwater monitoring well was installed in the Shallow Perched Aquifer (MW-29S);and
- Seven (7) monitoring wells that were no longer being used for groundwater monitoring were decommissioned (MW-23S, MW-23D, MW-25S, MW-25D, MW-27S, MW-27D, and MW-28S, see letter report dated January 24, 2018).

New well MW-29S replaces former wells MW-23S and MW-28S and provides a point-of-compliance downgradient monitoring point on the west property boundary.

In 2017, groundwater monitoring was conducted on a semi-annual basis in January and July, and the testing frequency for Appendix I metals was changed to every five years. The next Appendix I metals monitoring events will occur in 2021 (both semi-annual monitoring events).

Beginning in 2018, the GWMP will continue on a semi-annual monitoring schedule, with monitoring events in January and August each year. This schedule will provide wet season (January) and dry season (August) water quality data.

1.5 PURPOSE OF THE GWMP

The purposes and objectives of the GWMP are to:

- Specify procedures that will provide an accurate representation of groundwater quality at background and downgradient wells
- Identify quality control (QC) procedures to be implemented during sampling activities and laboratory testing
- Specify data analysis and reporting requirements

- Maintain a database of accurate groundwater information in order to evaluate water quality trends, regulatory compliance, and the effectiveness of remedial actions at the landfill
- Satisfy the provisions of an Alternate Groundwater Monitoring Program (WAC 173-351-450) and Cleanup Monitoring (WAC 173-340-410).

1.6 SCOPE OF WORK

The work to be performed under the GWMP includes:

- Groundwater sample collection
- Water level measurements
- Water supply well sampling
- Leak detection and leachate sampling
- Data validation, evaluation, and reporting
- Project database maintenance
- Department of Ecology Environmental Information Management (EIM) System uploads

1.7 PROJECT ORGANIZATION

Ecology is the lead agency designated to oversee cleanup of the site under MTCA. LRI is responsible for ensuring that the required monitoring program is implemented. Pierce County serves as the Trustee of the HVL post-closure fund. The TPCHD assists Ecology with data review.

1.8 DOCUMENT ORGANIZATION

The document is divided into the following sections:

Section 1: Introduction

Section 2: Background and Site Setting

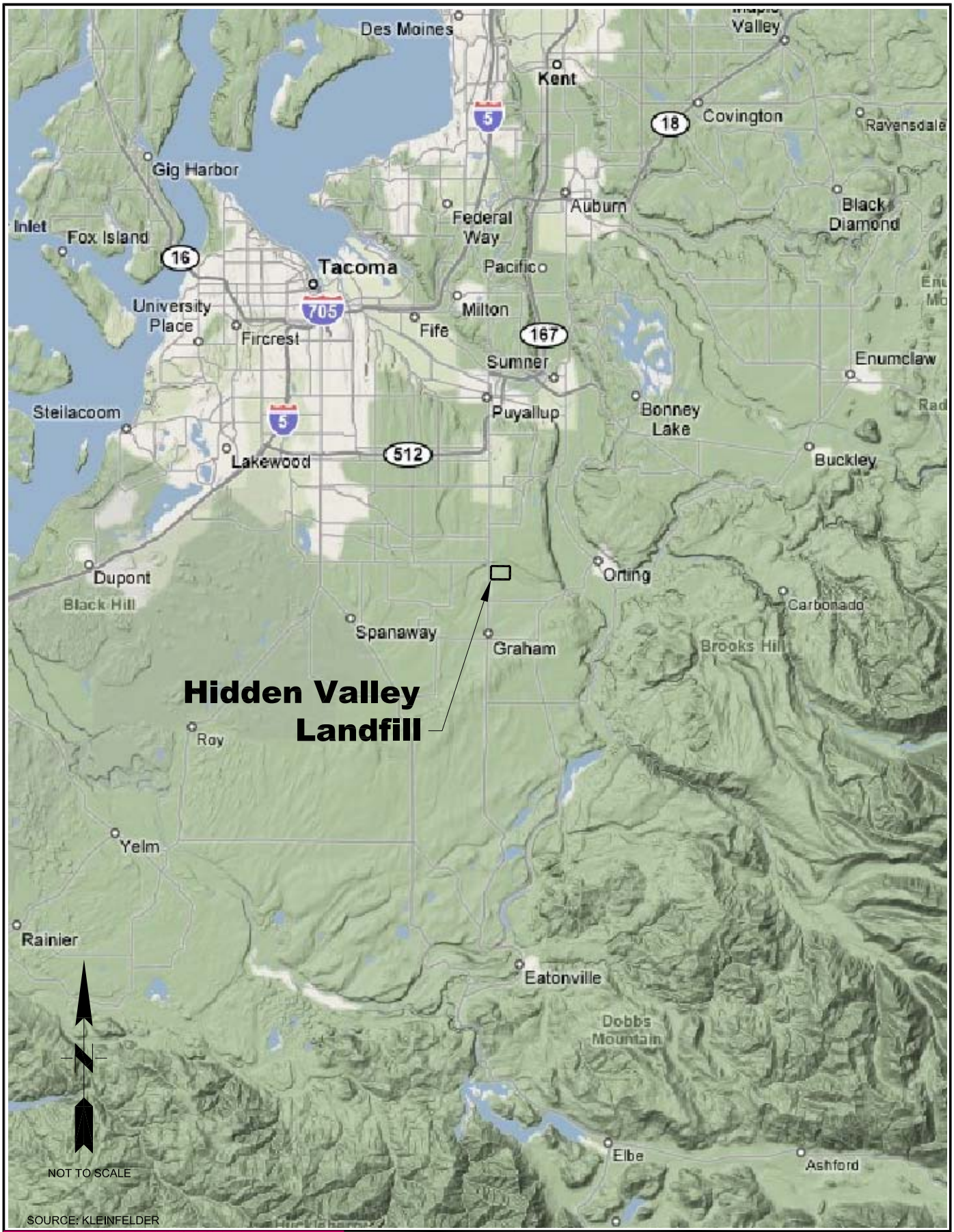
Section 3: Compliance Monitoring Program

Section 4: Project Quality Assurance

Section 5: Data Evaluation and Reporting

Section 6: Monitoring Program Optimization

Section 7: References



SOURCE: KLEINFELDER

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FIGURE 1	KGL

SITE LOCATION MAP

HIDDEN VALLEY LANDFILL
PIERCE COUNTY, WASHINGTON

DATE: MARCH 2014

FIGURE: 1

2.0 HYDROGEOLOGY

2.1 INTRODUCTION

This section provides an overview of regional and local geology and hydrogeology. Additional detail is presented in Final Remedial Investigation Report, Hidden Valley Landfill Site (EMCON 1992), and the Hydrogeologic Addendum, Hidden Valley Landfill (EMCON 1998). For the most recent discussion of groundwater quality refer to the Hidden Valley Landfill Annual Report for 2017 (SCS Engineers 2018).

2.2 REGIONAL GEOLOGY AND HYDROGEOLOGY

The geology of central Pierce County consists of Pleistocene glacial and glaciofluvial deposits that include ground moraine, till, and outwash, and interglacial deposits of clay, silt, sand, and gravel. Deposits from the most recent period of glaciation are designated as the Vashon Drift. A thin cover of recent alluvial clay, silt, sand, and gravel locally overlie the Pleistocene glacial deposits. The Pleistocene deposits are locally underlain by Miocene fluvial and lacustrine deposits.

The occurrence and movement of groundwater in Central Pierce County is largely controlled by the local and regional stratigraphy. Permeable glacial outwash (sand and gravel) generally forms excellent aquifers. Low permeability glacial till and interglacial silt generally restrict groundwater flow. Groundwater recharge is generally from the infiltration of precipitation. Groundwater flow directions generally follow surface topography with groundwater discharge to lakes, rivers, and to Puget Sound.

2.3 LOCAL GEOLOGY

Hidden Valley Landfill is underlain by recessional glacial outwash (sand and gravel) of Vashon age. The site lies within a former glacial melt-water channel that trends in an east-west direction. The northern boundary of the channel appears to lie just north of the landfill. The southern boundary of the channel appears to lie several hundred feet south of the landfill. Northwest of the landfill (and the outwash channel), the recessional outwash is overlain by an upper unit of Vashon till. The recessional outwash is underlain by successive layers of Vashon till (lower till unit) and advance glacial outwash. The Vashon deposits are underlain by successive layers of Salmon Springs till and interglacial deposits, and Salmon Springs advance outwash. Summary descriptions of the geologic units are presented below.

Upper Vashon Till

The upper Vashon till forms the uppermost deposit in the northwest corner of the site. The till is a compacted mixture of gravel, sand, and silt up to 75 feet thick. This unit is unsaturated, has low permeability, and appears to restrict the vertical and horizontal movement of water.

Vashon Recessional Outwash

Recessional outwash deposits consist primarily of silty fine to gravelly sand encountered at elevations ranging from 480 to 425 feet above mean sea level (AMSL). These deposits average approximately 70 feet in thickness with a maximum thickness of 120 feet in the northwestern portion of the site.

Lower Vashon Till

The lower Vashon till is composed of dense, silty sand, gravelly sandy silt, and silty sandy gravel. It underlies the Vashon recessional outwash deposits and ranges in thickness from 9 to 32 feet with an average thickness of 18 feet at the site.

Vashon Advance Outwash

The Vashon advance outwash is an 11- to 50-foot-thick deposit of well-graded, medium dense to dense, fine-grained sand and gravel present at elevations ranging from 400 to 350 feet AMSL.

Salmon Springs Till

The Salmon Springs till is typically dense to very dense, gravelly silty sand to silty sandy gravel. It averages 25 feet in thickness and was encountered at elevations ranging from 360 to 340 feet AMSL.

Salmon Springs Interglacial

Loose to dense interbedded sandy gravels, gravelly sands, and silty sands make up the Salmon Springs interglacial unit. The interglacial unit ranges from 48 to 65 feet in thickness and includes wood debris and other organic material. It was encountered at elevations between 340 and 265 feet AMSL.

Lower Salmon Springs Till

The Lower Salmon Springs till consists of dense, silty sandy gravel and silty gravelly sand approximately 45 feet thick. The unit was encountered at 280 feet AMSL in the southern portion of the site.

Salmon Springs Advance Outwash

The Salmon Springs advance outwash consists of loose, permeable fine to medium-fine gravelly sands to silty sands that make up the lower regional aquifer. The top of this unit was encountered at an elevation of 225 feet AMSL. The base of the outwash has not been encountered at this site.

2.4 LOCAL HYDROGEOLOGY

The landfill site is located in the Clover/Chambers Creek (CCC) sub-basin within which local and intermediate groundwater flow systems dominate. Regional recharge occurs east of the CCC sub-basin and regional discharge occurs to Puget Sound and the Puyallup and Nisqually River valleys. Local and intermediate systems occur in smaller basins within the CCC area.

Three aquifers underlie the Hidden Valley Landfill. The aquifers are referred to as the Shallow Perched Aquifer, the Upper Regional Aquifer, and the Lower Regional Aquifer. The aquifers are separated by aquitards, which are referred to as the lower Vashon Till aquitard and the Salmon Springs aquitard.

The Shallow Perched Aquifer is an unconfined (water table) aquifer that occurs within the Vashon recessional outwash deposit. The Shallow Perched Aquifer is the uppermost-saturated unit at the site. Groundwater flow in the Shallow Perched Aquifer at the site is to the northwest with local

components to the north and west. The downgradient extent of the Shallow Perched Aquifer appears to be limited.

The Upper Regional Aquifer is present within Vashon advance outwash deposits. An intermittent aquitard, referred to as the Vashon till aquitard, is present between the Shallow Perched Aquifer and the Upper Regional Aquifer. Groundwater flow, water level gradients, and seasonal water level fluctuations in the Upper Regional Aquifer are similar to the Shallow Perched Aquifer.

The Lower Regional Aquifer is present within the Salmon Springs advance outwash deposits. The Lower Regional Aquifer is confined and is separated from the Upper Regional Aquifer by a thick section of low permeability deposits referred to as the Salmon Springs aquitard.

Primary recharge to all three aquifers occurs off site from infiltration of precipitation, surface runoff, and snowmelt. Recharge also occurs to the shallow perched and upper regional aquifers on-site via precipitation and infiltration of runoff. Minimal, if any, recharge to the lower regional aquifer occurs at the landfill site.

Shallow Perched Aquifer

The shallow perched aquifer is present within the Recessional Outwash deposits of permeable sands and gravel in the vicinity of the landfill and is not known to be used as a source of drinking water. The shallow perched aquifer appears to be of limited extent. Groundwater flow in this unconfined aquifer is generally to the northwest at a gradient of 0.008 to 0.01 ft/ft, with local components to the north and west. The shallow perched aquifer is not present within about 800 feet northwest of the landfill. The aquifer is recharged from infiltration of precipitation both on-site and off-site. Seasonal water level fluctuations are as much as 15 to 20 feet.

Permeability data obtained from single-well hydraulic tests performed in 10 wells screened in the shallow perched aquifer indicate that the horizontal hydraulic conductivity is typically about 1×10^{-1} cm/sec. The porosity of the aquifer is assumed to be 35 percent, based on values documented in the scientific literature (Freeze and Cherry, 1979; Fetter, 1988).

Vashon Till Aquitard

The shallow perched and upper regional aquifers are separated by a poorly defined, and possibly intermittent, layer of Vashon till between 10 to 30 feet thick. The vertical hydraulic conductivity of the till is estimated to range from approximately 1×10^{-3} to 1×10^{-4} cm/sec (based on aquifer test data). Vertical hydraulic gradients between the lower Vashon till and the upper regional aquifer are downward with a gradient of 0.001 to 0.18 ft/ft in the area of the landfill. Northwest of the landfill, vertical hydraulic gradients between the lower Vashon till and the upper regional aquifer are upward, possible reflecting the confining nature of the aquitard and a lack of direct recharge from precipitation.

Upper Regional Aquifer

The upper regional aquifer is present within the Vashon advance outwash deposits of sand and gravel. This aquifer is confined beneath the lower Vashon till aquitard and is continuous across the site. Groundwater flow is generally to the northwest at gradients ranging from 0.04 to 0.003 ft/ft, with local components both to the north and the west. The aquifer is recharged primarily from infiltration of precipitation off-site. On-site recharge to the upper regional aquifer is from the leakage of the shallow perched through till and/or through areas where the till is not present. Seasonal fluctuations in the potentiometric surface elevation have, at times, exceeded 12 feet.

Permeability data obtained from an aquifer test conducted at a pumping well on site and from single-well hydraulic tests performed in 11 wells screened in the upper regional aquifer indicate that the horizontal hydraulic conductivity ranges from 5.4 x 10-2 cm/sec to 1.9 x 10-3 cm/sec. The porosity of the aquifer is assumed to be 35 percent, based on values documented in the scientific literature (Freeze and Cherry, 1979; Fetter, 1988).

Salmon Springs Aquitard

The upper and lower regional aquifers are hydraulically separated by a sequence of glacial till and interglacial deposits (Salmon Springs Aquitard) between 55 and 138 feet thick.

Lower Regional Aquifer

The lower regional aquifer is located in Salmon Springs advance outwash deposits. The aquifer is confined and appears to be continuous beneath the site. Water level data obtained from wells MW-14R, MW-20R and BC-4D indicate that the groundwater flow direction in the lower regional aquifer is to the northeast. The porosity of the lower regional aquifer is estimated to be approximately 35 percent. The horizontal hydraulic conductivity of the lower regional aquifer has not been directly tested, but is estimated to be approximately 1 x10-2 to1 x 10-3 cm/sec. These estimates are based on data obtained from installing monitoring wells in the lower regional aquifer and on values documented in the scientific literature for silty sand to sandy gravel deposits (Freeze and Cheery 1979, Fetter 1998). The recharge area for the lower regional aquifer is primarily off-site. Little to no recharge occurs to the lower regional aquifer from on-site sources.

3.0 GROUNDWATER MONITORING PROGRAM

3.1 MONITORING FREQUENCY

Groundwater sampling will occur on a semi-annual basis during January (wet season) and August (dry season) of each year. If sampling activities fall outside the planned sampling schedule, Ecology will be notified in advance.

3.2 MONITORING NETWORK

The groundwater monitoring network includes 21 monitoring wells; eleven (11) wells within the shallow perched aquifer, seven (7) wells within the upper regional aquifer, and three (3) wells within the lower regional aquifer. In addition, seven (7) water level only wells are included. The groundwater monitoring network is summarized in Table 1. The well locations are shown on Figure 2. Copies of the well completion details for wells in the monitoring network are included in Appendix A.

Table 1. Groundwater Monitoring Network

Shallow Perched Aquifer	Upper Regional Aquifer	Lower Regional Aquifer
Semi-Annual Monitoring		
MW-10S*	MW-10D*	MW-14R
MW-11S	MW-11D(2)	MW-20R
MW-12S	MW-12D	MW-26R
MW-13S	MW-13D	
MW-14S	MW-14D	
MW-15S	MW-15D	
MW-17S	MW-18D	
MW-18S		
MW-29S		
FMMW-01		
FMMW-02		
Water Level Measurements Only		
MW-19S	MW-11D	BC-4R
BC-4S	MW-19D	
	MW-22U	
	MW-22L	

* Background well location

3.3 MONITORING PARAMETERS

The following parameters will be included for long-term monitoring:

Appendix I, Volatile Organic Compounds:
as listed in WAC 173-351

Appendix I, Inorganic Constituents:
nitrate

Appendix II, Field Parameters:
pH, specific conductance, temperature, static water level

Appendix II, Geochemical Indicator Parameters:
alkalinity, chloride, sulfate, total suspended solids (TSS), calcium, sodium, magnesium, potassium, iron, and manganese (elimination of bicarbonate alkalinity)

Appendix II, Leachate Indicator Parameters:
ammonia, total dissolved solids, and total organic carbon

In addition, Appendix I total metals will be monitored every five years beginning in 2021.

3.4 LEACHATE AND LEAK DETECTION MONITORING

Samples of untreated leachate from the East Lined Area main sump and side-slope liner sump, and samples of liquids that accumulate in the side-slope leak detection system, will be collected on an annual basis in January each year. In addition, samples of liquid that accumulates within the hydraulic gradient control system beneath the main sump will be collected when liquids are present. Samples will be collected using dedicated electric submersible pumps from sampling ports located near the leachate riser pipes.

Samples collected from the leachate collection system, leak detection system, and hydraulic gradient control system, will be analyzed for the same parameters as the groundwater monitoring wells, including Appendix I total metals every five years beginning in year 2021.

3.5 WATER SUPPLY WELL MONITORING

Two water supply wells, located in the vicinity of Hidden Valley Landfill, will be sampled at the same frequency as the monitoring wells. The wells are located at Corliss Sand and Gravel (designated WS-Corliss) south of the landfill and at the Paul Bunyan Rifle Range (designated WS-Paul Bunyan) west of the landfill (see Figure 3). The contact person at Corliss Sand and Gravel is Denny Long, 253-845-7584. The contact person at the Paul Bunyan Rifle Range is Doug, 253-846-6767.

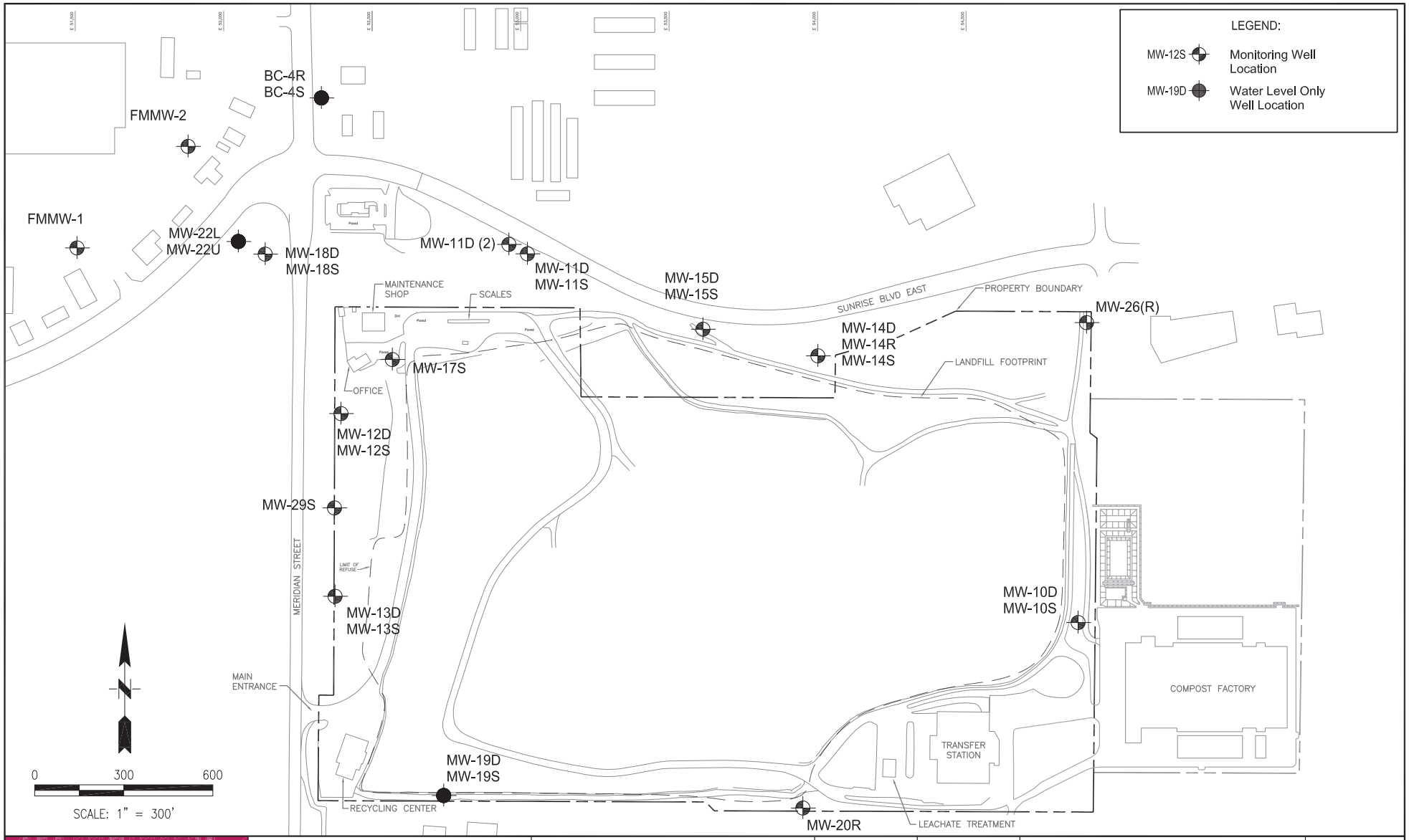
Samples will be collected from the outside faucet located closest the well head. Each well will be pumped for a minimum of 5 minutes and/or until pH, conductivity, and temperature have stabilized. Samples will be collected directly from the tap with water flowing at a slow rate to avoid sample aeration.

Groundwater samples collected from the water supply wells will be analyzed for field parameters (pH, conductivity, and temperature), inorganic parameters (chloride, ammonia, nitrate, nitrite,

sulfate, chemical oxygen demand, and total organic carbon), color, total metals (arsenic, iron, manganese, and zinc), and VOCs as listed in Appendix I of WAC 173-351. Recommended sample containers, sample preservatives, and method hold-times are shown on Table 2.

3.6 WATER LEVEL MEASUREMENT LOCATIONS

Groundwater elevations will be measured in monitoring wells within the monitoring network shown on Table 2 during the routine monitoring events (see Figure 2 for well locations).



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SCALE AS SHOWN	CHK BY KGL
CAD FILE FIGURE 2	APP BY KGL

GROUNDWATER MONITORING WELL LOCATIONS

HIDDEN VALLEY LANDFILL
PIERCE COUNTY, WASHINGTON

DATE OCTOBER 2018

FIGURE 2

0 400 800

APPROX SCALE IN FEET

LEGEND

WATER SUPPLY WELL LOCATION

SOURCE: KLEINFELDER

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FIGURE 4	KGL

WATER SUPPLY WELL LOCATION

HIDDEN VALLEY LANDFILL
PIERCE COUNTY, WASHINGTON

DATE: MARCH 2014

FIGURE: 3

4.0 SAMPLE COLLECTION AND HANDLING

4.1 WATER LEVEL MEASUREMENTS

Groundwater elevations will be measured in each well prior to purging. Depth-to-water measurements will be obtained with an electric water level tape. Depth-to-water will be measured to the nearest 0.01 foot from a surveyed notch in the well casing and recorded on a dedicated water level summary sheet or field sampling data sheet (FSDS). Water level measurements will include date, time, and sampler's name. Efforts will be made to collect each round of water level measurements within an 8-hour period. The water level probe will be rinsed with distilled water prior to use in each well.

4.2 EQUIPMENT CALIBRATION

Field meters will be calibrated daily before measurements are taken and re-calibrated approximately every four hours during the course of sampling. Calibration dates, times, procedures, and results will be recorded using calibration-specific field sheets.

4.3 FIELD MEASUREMENTS

Accurate documentation of field activities, measurements, and collected samples will be maintained using field sampling and data forms. Entries will be made in sufficient detail to provide an accurate record of field activities without reliance on memory. Information contained on the field data forms will include field measurements (see Table 2); the type, number, and size(s) of container(s), and preservative used (if any), a description of task activities, names of individuals collecting the sample, names of visitors, and weather conditions. All entries will be legibly entered in ink, dated, and signed.

Field parameter measurements will be collected from a portable multiparameter meter and in-line flow-through cell (if using low flow sampling techniques). Field parameter measurements will be recorded to the following standards:

- Depth to water within ±0.01 feet
- Temperature to ±0.1 C
- Conductivity to ±1 μS/cm (measured specific conductance ≤1,000 μS/cm).
- pH to ±0.01 units

4.4 WELL PURGING

Monitoring wells will be purged and sampled according to the sampling methods, which include the following:

- Dedicated submersible pneumatic positive displacement bladder pump with dedicated tubing.
- Deployable stainless steel submersible positive displacement bladder pump with disposable polyethylene tubing and bladder that are replaced between monitoring locations.
- Disposable polyethylene bailer secured with disposable nylon cord.
- Dedicated electric submersible pump.
- Peristaltic pump fitted with disposable silicon and polyethylene tubing.

Low-flow purging and sampling using dedicated equipment is used for most of the groundwater wells at the Hidden Valley Landfill. Each dedicated or deployed bladder pump will be positioned with its inlet located within the screened interval of the well. Each well's optimal pumping rate (between 100 mL/min and 500 mL/min) will result in minimal drawdown of the initial static water level. Low-flow purging of the well will continue until field parameters have stabilized. Field parameters will be considered stable when three consecutive readings are as follows:

- pH and dissolved oxygen = +-0.20
- Temperature = +-0.5 deg C
- Conductivity = +- 10%
- Turbidity = +- 10% when greater than 5 NTU.

The frequency of readings will be based on the time required to purge the flow-through cell. For example, a 500-ml flow cell purged at a rate of 250 ml/minute will be purged in two minutes, so readings should be at least two minutes apart. If the flow rate is 100 ml/min, the readings should be at least five minutes apart. USEPA Guidance suggests that readings be obtained between three and five minutes apart.

The use of a peristaltic pump is acceptable as an alternative low-flow sampling technique, where conditions allow. Peristaltic pumps will be fitted with disposable silicon and polyethylene tubing. The discharge end of the tubing will be fitted to an in-line flow-through cell used to monitor field parameters of pH, temperature, and conductivity. Purging will continue until field parameters have stabilized as discussed above.

If groundwater monitoring wells require sampling using deployable equipment, due to access restrictions, pump failures, or insufficient water for pump operation, three well casing volumes of water will be purged (if recharge allows within a reasonable timeframe) before collecting groundwater samples for chemical testing. During purging with deployable equipment, field measurements will be recorded after the removal of each well casing volume (at a minimum).

4.5 SAMPLE COLLECTION

Samplers will wear new nitrile or chemical resistant-type gloves at each sampling location and replace as needed during purging and sample collection. All samples will be transferred in the field from the sampling equipment into containers prepared and provided by the laboratory for the given parameters. The recommended order to fill sample bottles is largest to smallest, unpreserved followed by preserved, and unfiltered followed by filtered. This approach will allow flexibility to prioritize laboratory testing in the event that a pump failure or low recharge volume results in the collection of an incomplete sample bottle set.

4.6 FIELD FILTRATION

Groundwater samples that require field filtration, as directed by the laboratory, will be filtered at the time of sample collection. A disposable 0.45-micron, in-line filter will be attached directly to the discharge tube of the pump and allowed to flush (approximately 3 filter volumes), prior to sample collection. Each in-line filter will be used only once. The sampler will select a filter with a high enough purge volume capacity to collect the required sample volume without the use of multiple filters. If a well is purged and sampled with a bailer, an in-line filter will be directly attached to the bailer and allowed to flush before filling the appropriate laboratory prepared container.

4.7 SAMPLE LABELING

Each sample will be assigned a unique alphanumeric identification code that will be used to identify the site, date, and sample location. The prefix "HVL" will be used to identify the site. A six-digit date identifier (MMDDYY) will be used to identify the sample collection date. The final two digits will be used to designate the sample location. For example, "HVL-012004-01" would indicate the first sample was collected on January 20, 2004 at the Hidden Valley Landfill site.

An FSDS will be filled out at the time of sample collection and kept for each sample, except trip blanks. The FSDS will identify the site, date, location, method(s) used to purge and collect the sample, the sample code, and field measurements and observations.

Sample container labels will be completed before or immediately after sample collection. Container labels will at a minimum include the following information:

- Project name and number
- Sample identification code
- Name of collector
- Date and time of collection
- Analyses requested
- Bottle type and preservative (if any)

4.8 SAMPLE PRESERVATION AND SHIPMENT

Collected samples will be shipped or delivered to the laboratory the same day as collected using the following procedure:

- Sample containers will be transported in a sealed, iced cooler or other suitable shipping container
- Glass bottles will be separated by shock-absorbing material to prevent breakage and leakage
- Sufficient ice or chemical ice to maintain sample container temperatures less than 4 degrees centigrade will be placed into each shipping container, sealed in separate bags from the sample containers
- A Chain-of-Custody/Laboratory Analysis Request Form will accompany each sample shipment in a sealed plastic bag taped to the inside lid of the shipping container
- The laboratory's name and address and sampler's return address will be placed on each container before shipping

4.9 CHAIN-OF-CUSTODY PROTOCOL

Sample handling will follow formal chain-of-custody procedures. Once a sample is collected, it will remain in the custody (possession, under control, or in a secure area) of the sampler or other qualified personnel until shipment or delivery to the laboratory. Upon transfer of sample container(s) to subsequent custodian, a Chain-of-Custody/Laboratory Analysis Request Form will be signed by the persons transferring custody of the sample container(s). A signed and dated custody seal will be placed on each shipping container prior to shipping. Upon receipt of samples at the laboratory, the shipping container seal will be broken, and the condition of the samples will be recorded by the receiver. Chain-of-custody records will be included in the final analytical report prepared by the laboratory.

4.10 EQUIPMENT DECONTAMINATION

Non-dedicated/non-disposable groundwater sampling equipment will be decontaminated before each use with the following procedure:

- Non-phosphate detergent (Liquinox or Alconox) and tap water wash
- Tap water rinse
- Distilled water rinse

The electric groundwater level tape will be rinsed with distilled water between each well use. For locations where a peristaltic pump or bailer is used, new polyethylene tubing and new bailer cord (monofilament nylon) will be used at each well. For locations where a dedicated pump is used, no decontamination of the pump or tubing is required.

4.11 RESIDUALS MANAGEMENT

Residual water and other liquids generated from purging and sampling of monitoring wells, and the decontamination of non-dedicated sampling equipment will be collected and be taken to the Hidden Valley Landfill leachate pre-treatment plant for disposal.

Used disposable personal protective equipment (PPE) will be placed in plastic bags and disposed of as solid waste.

4.12 WELL MAINTENANCE

Monitoring wells will be maintained to meet well integrity, security, and design performance standards throughout the duration of the monitoring program. Monitoring well conditions related to security, vandalism, or maintenance issues will be noted during each monitoring event.

4.13 SURVEYING

Monitoring wells will be surveyed by a registered surveyor. Each location will be surveyed for ground surface elevation (to the nearest 0.1 foot), horizontal position (to the nearest 1.0 foot), and well casing rim (to the nearest 0.01 foot). A small notch will be filed into the well casing rim indicating the surveyed point. Vertical surveys will be of third-order accuracy. The horizontal datum will be the Washington State Plane Coordinate System, and the vertical datum will be the North American vertical datum of 1988 (NAVD88). Existing groundwater monitoring well elevation data will be converted to NAVD88 for continued use.

4.14 EMPLOYEE HEALTH AND SAFETY

A site specific health and safety plan will be followed during sample collection activities to protect workers from potential site hazards WAC 173-351-410(1)(g). This plan will be updated periodically as site conditions change.

5.0 ANALYTICAL PROCEDURES AND DATA HANDLING

5.1 ANALYTICAL PROCEDURES

Samples collected for laboratory analysis will be collected in containers prepared and provided by a State of Washington accredited laboratory. Analytical methods, recommended sample containers, sample preservatives, and method hold-times are shown on Table 2.

Table 2. Summary of Analytical Methods

Parameter	Units	Method	Container	Sample Preservation	Maximum Hold Time
Appendix I					
Nitrate (NO_3-N)	mg/L	EPA 352.1/EPA 300.0	Plastic/Glass	Unpreserved, <6^{0}C	48 hours
VOC's	µg/L	SW 8260B/C	40 mil glass	pH<2, HCl, <6^{0}C	14 days
Appendix I Metals (every 5 years beginning in 2021)					
Antimony	µg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Arsenic	µg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Barium	µg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Beryllium	µg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Cadmium	µg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Chromium	µg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Cobalt	µg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Copper	µg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Lead	µg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Nickel	µg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Selenium	µg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Silver	µg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Thallium	µg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Vanadium	µg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Zinc	µg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Appendix II					
Alkalinity ($CaCO_3$)	mg/L	SM 2320B	Plastic/Glass	Unpreserved, <6^{0}C	14 days
Ammonia (NH_3-N)	mg/L	EPA 350.1	Plastic/Glass	pH<2, H_2SO_4, <6^{0}C	28 days
Chloride	mg/L	EPA 300.0	Plastic/Glass	Unpreserved, <6^{0}C	28 days
Sulfate (SO_4)	mg/L	EPA 300.0	Plastic/Glass	Unpreserved, <6^{0}C	28 days
Total Organic Carbon (TOC)	mg/L	SM 5310	Glass	pH<2, HNO_3	28 days
Total Dissolved Solids (TDS)	mg/L	SM 2540C	Plastic/Glass	Unpreserved, <6^{0}C	7 days
Total Suspended Solids (TSS)	mg/L	SM 2540D	Plastic/Glass	Unpreserved, <6^{0}C	7 days
Calcium	mg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Iron	mg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Magnesium	mg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Manganese	mg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Potassium	mg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months
Sodium	mg/L	SW6010/SW6020	Plastic	pH<2, HNO_3	6 months

Additional Analyses for Water Supply Wells					
Nitrite (NO_2)	Plastic	EPA 300.0	EPA 300.0	Unpreserved, <6^{0}C	48 hours
Chemical Oxygen Demand (COD)	Plastic	SM 5220B	EPA 300.0	pH<2, H_2SO_4, <6^{0}C	28 Days
Color	PCU	SM 2120B	EPA 300.0	Unpreserved, <6^{0}C	48 hours

5.2 DATA VALIDATION

Laboratory reports will be reviewed in a manner consistent with the USEPA 2017 Functional Guidelines for Inorganic Data Review and the USEPA 2017 Functional Guidelines for Organic Data Review. Laboratory data will be assessed at level 2, with a Tier 1 data validation summary report. Data that do not meet quality metrics will either be assigned qualifiers to restrict or modify use, or will be rejected. Modification of use and rejection of data will be documented in data validation summary reports. A validation summary will be included with each report.

5.3 QUALITY ASSURANCE AND QUALITY CONTROL

Documentation of Field Activities

Accurate documentation of field activities will be maintained using field logbooks, FSDS forms, correspondence records, and photographs. Written records will be made in sufficient detail to provide an accurate record of field activities without reliance on memory, will be legibly entered in ink, dated, and signed. Field documentation will be reviewed upon completion of each monitoring event.

Field Quality Control Samples

Field quality control samples consisting of field blanks, trip blanks, and duplicate samples will be included in each sampling event. Quality control samples, except trip blanks, will be labeled such that they are "blind" to the laboratory in accordance with Section 4.1.5.

Duplicate groundwater samples will be obtained by alternately filling like sample bottles for two sample sets until the containers are full. Duplicate sample collection locations will be chosen at random to represent the anticipated range of groundwater chemistry likely to be found. At least one duplicate groundwater sample will be included with each semi-annual monitoring event.

Trip blanks for VOC analyses will be provided and analyzed by the laboratory. Pre-filled sample bottles containing VOC-free water will accompany the shipment of sample bottles and will return to the laboratory for analysis with the sample shipment. At least two trip blanks will be included with each semi-annual monitoring event.

If non-dedicated sampling equipment is used, field equipment rinsate blanks will be collected at a frequency of approximately 10 percent of the samples collected with non-dedicated equipment. An equipment rinsate sample will be collected by rinsing distilled water over and/or through decontaminated reusable or disposable sampling equipment.

Laboratory Quality Control Samples

Laboratory quality control samples consisting of method blanks, matrix spikes/matrix spike duplicates, surrogate spikes, and duplicate samples will be analyzed during each sampling event at the following frequencies as defined in Test Methods for Evaluation Solid Waste, Physical/Chemical (SW 846) Methods (USEPA 1996).

- Laboratory duplicate analyses will be analyzed at a rate of approximately 5 percent of the samples per event. Organic compounds will be analyzed as matrix spike duplicates. Metals and inorganic parameters will be analyzed as laboratory duplicates.
- Approximately five percent of the samples will be spiked with selected target analytes and analyzed to assess potential matrix effects.
- One method blank will be analyzed for every 20 samples (at a minimum), and for each sample batch.
- A laboratory control sample will be included with each sample batch.

Laboratory Reporting Requirements

The laboratory will be required to submit the following summary data and QC information:

- Cover letter for each sample batch that includes a summary of any quality control, sample, shipment, analytical problems, and documentation of internal decisions regarding data quality (if made). Data concerns will be outlined and final solutions documented
- A copy of the signed chain-of-custody form for each batch of samples
- Sample concentrations reported consistently using appropriate units and to the appropriate number of significant figures
- For samples where concentrations were not detected based on the method, the method reporting limit, or practical quantification level, of detection for each compound will be reported for each sample
- Dates of sample receipt, preparation, and analysis
- Results of all laboratory quality control samples

Laboratory Accreditation

Laboratory analyses will be performed by an accredited laboratory in accordance with WAC Chapter 173-35, accreditation of environmental laboratories.

5.4 CORRECTIVE ACTION

Corrective actions consist of handling nonconformance or noncompliance issues with either the laboratory or field activities with the established quality assurance requirements, and alterations to sampling procedures or locations due to uncontrollable circumstances. Deviations from the sampling plan will be documented on the appropriate field forms and stored in the project file. These deviations will be noted as part of the reporting program.

Laboratories must adhere to standard operating procedure guidelines and specifications. When instrument response, quality control sample results, or blank analyses indicate exceedances of control limits, the cause of the exceedance must be determined and documented as part of the laboratory reporting process.

6.0 DATA EVALUATION AND REPORTING

6.1 DATA MANAGEMENT

Field measurements and laboratory data will be validated upon reciept, verified for consistency and correctness, and entered into a database (MS Access or equivalent), and verified for consistency and correctness. Copies of analytical laboratory reports will be distributed to the TPCHD upon completion of the report for the monitoring period. Electronic and/or hardcopy printouts of the database will be available to Ecology and the TPCHD upon request. Groundwater monitoring data will be uploaded into Ecology's EIM system once the monitoring reports are finalized.

6.2 STATISTICAL EVALUATION

A statistical summary of groundwater data will be performed on an annual basis. The evaluation will include a comparison of the compliance levels specified in the Cleanup Action Plan (CAP) for the Hidden Valley Landfill. The Consent Decree established a cleanup level for 1,4-dichlorobenzene at 1.82 micrograms per liter (µg/L). No other VOCs have Consent Decree defined cleanup levels for the Hidden Valley Landfill. However, the distributions of data will also be determined for chlorobenzene and tetrachloroethene for tracking purposes.

An 8-year record of data will be evaluated for statistical calculations. The data distribution for individual constituents that are detected in at least 50 percent of samples within the evaluation period, will be evaluated to determine if the data shows a normal, lognormal, or non-parametric distribution. One-half the MRL will be used when a parameter was not detected at a concentration above the MRL. If the distribution is neither normal or lognormal, the upper confidence limit of the mean (UCL95) will be calculated using MTCAStat, version 3.0 (or newer) obtained from Ecology. The calculation of the UCL95 will be determined using the Van der Parren (1970) method as described in the Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities-Unified Guidance (Unified Guidance, USEPA 2009).

6.3 GEOCHEMICAL EVALUATION

A geochemical evaluation of Appendix II parameters will be conducted for each well following each monitoring event. The geochemical evaluation will include a cation-anion balance expressed in milliequivalents per liter (meq/L), and a plot of cations and anions for each well on Trilinear diagrams. In accordance with WAC 173-351-430(5)(a), each monitoring report will note well locations with greater than 5 to 10 percent difference in cation-anion balance. A ten percent difference threshold will be used if the total cation-anion sums are less than 5.0 meq/L, and a five percent difference threshold will be used if the total cation-anion sums are greater than or equal to 5.0 meq/L.

6.4 REPORTING

Semi-Annual Reporting

A semi-annual groundwater monitoring report will be submitted to Ecology and the TPCHD no later than sixty days after completion of the semi-annual monitoring period. The report will include the following:

- Groundwater leachate analysis results
- Identification of groundwater concentrations above the WAC 173-200 water quality criteria
- Static water level readings and potentiometric surface elevation maps depicting estimated groundwater flow directions
- Cation-anion balances
- Trilinear diagrams
- Leachate volumes
- Landfill gas monitoring results
- Site inspection results

Annual Reporting

An annual groundwater report will be included with the facility annual report as required in WAC 173-351-200(11) and due by April 1 of each year. The following information (as outlined in WAC 173-351-415) will be included in the annual reporting effort:

- A brief summary of statistical results and/or statistical trends
- A brief summary of estimated groundwater flow rates and directions, noting any trends or changes
- A copy of the potentiometric surface maps developed for each monitoring period
- A summary geochemical evaluation noting changes or trends in the cation-anion balances, Trilinear diagrams, and general water chemistry for each well

7.0 REFERENCES

EMCON. 1992. Final Remedial Investigation Report, Hidden Valley Landfill Site.

EMCON. 1994. Leak Detection Response Action Plan, Hidden Valley Landfill. March

EMCON. 1998. Hydrogeologic Addendum, Hidden Valley Landfill.

Freeze, A. R., and Cherry, J. A. 1979. Groundwater. Prentice Hall. May 18.

Fetter, C.W. 1998. Contaminant Hydrogeology. Prentice Hall PTR. July 13.

SCS Engineers. 2018. Hidden Valley Landfill Annual Report for 2017.

United States Environmental Protection Agency (US EPA). 1996. Test Methods for Evaluating Solid Waste (SW-846), Physical/Chemical Methods. Office of Solid Waste, Economic, Methods, and Risk Analysis.

US EPA. 2017. National Functional Guidelines for Superfund Inorganic Methods Data Review. USEPA Contract Laboratory Program. Office of Superfund Remediation and Technology Innovation, Washington, DC. January.

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Washington State Department of Ecology (Ecology). 2012. Guidance for Groundwater Monitoring at Landfills and Other Facilities Regulated under Chapters 173-304, 173-306, 173-350, and 173-351 WAC. Publication No. 12-07-072. December.

Kleinfelder, Inc. 2000. Cleanup Action Plan for the Hidden Valley Landfill.

Appendix A

Well Logs

Sweet, Edwards & Associates, Inc.

PROJECT THUN FIELD LANDFILL

Location Eastern Gate of Landfield

Boring No. TF-10

Surface Elevation 454.56' a.m.s.l.

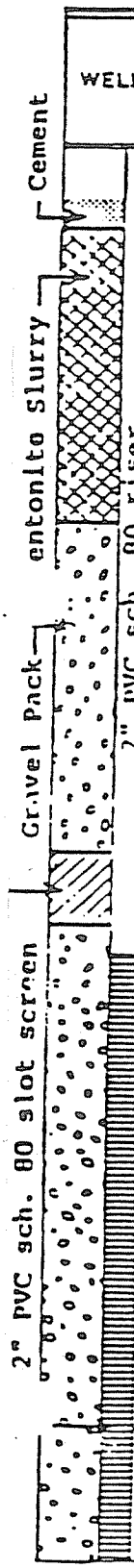
Drilling Method Air Rotary

Total Depth 98 feet

Drilled By Johnson Drilling Co.

Date Completed 6/26/85

Logged By K.G.Rattue



WELL DETAILS	PENETRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
	3m/ft. Avr	0		Grab Sampling Throughout At 5 Feet Intervals	Not Undretaken To Date		0-5' SAND and GRAVEL, light brown, illsorted, loose, very dry with few boulders.	
		5					5-10' SAND and GRAVEL, yellowish brown, medium to coarse, sand loose, very dry with occasional pebbles	
	2m/ft.	10					10-15' SAND and GRAVEL, as above becoming slightly moist.	
		15					15-20' SAND and GRAVEL, light brown, medium to coarse sand, weakly cohesive, few pebbles, slightly moist.	
		20					20-25' SAND and GRAVEL, as above becoming coarser and very moist.	
	3m/ft.	25					25-30' SAND and GRAVEL, light brown to gray, illsorted, very pebbly, saturated.	RWL 27'
		30					30-35' SAND and GRAVEL, as above.	EC=190
	2m/ft.	35					35-40' SAND and GRAVEL, as above with increasing medium sand content, saturated.	EC=125
		40						

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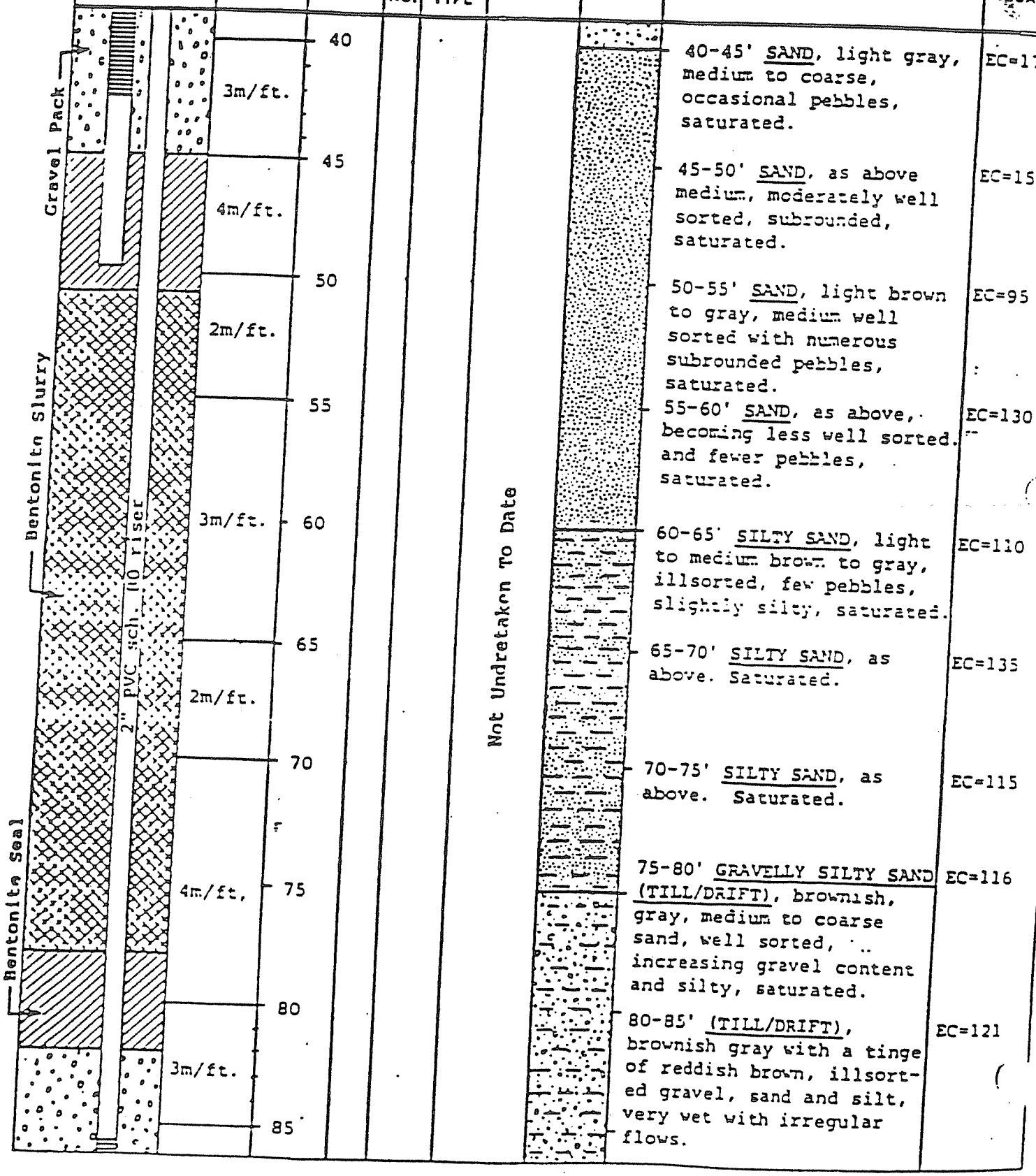
PROJECT THUN FIELD

Boring No. TF-10



WELL DETAILS	PENETRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALIT
		40					40-45' SAND, light gray, medium to coarse, occasional pebbles, saturated.	EC=177
	3m/ft.	45					45-50' SAND, as above medium, moderately well sorted, subrounded, saturated.	EC=152
	4m/ft.	50					50-55' SAND, light brown to gray, medium well sorted with numerous subrounded pebbles, saturated.	EC=95
	2m/ft.	55					55-60' SAND, as above, becoming less well sorted and fewer pebbles, saturated.	EC=130
	3m/ft.	60					60-65' SILTY SAND, light to medium brown to gray, illsorted, few pebbles, slightly silty, saturated.	EC=110
	2m/ft.	65					65-70' SILTY SAND, as above. Saturated.	EC=135
	4m/ft.	70					70-75' SILTY SAND, as above. Saturated.	EC=115
		75					75-80' GRAVELLY SILTY SAND (TILL/DRIFT), brownish, gray, medium to coarse sand, well sorted, increasing gravel content and silty, saturated.	EC=116
	3m/ft.	80					80-85' (TILL/DRIFT), brownish gray with a tinge of reddish brown, illsorted gravel, sand and silt, very wet with irregular flows.	EC=121
		85						

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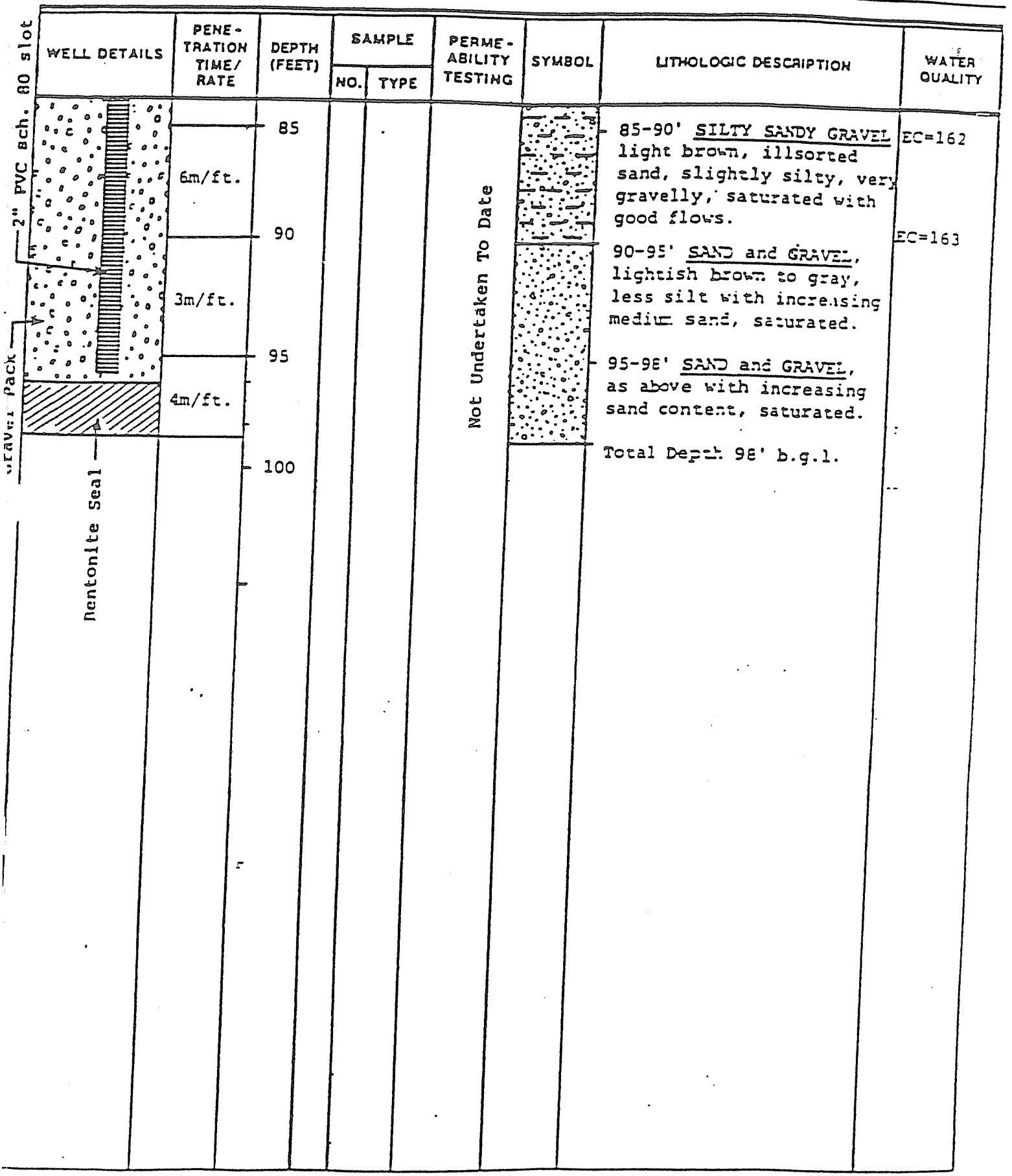
BORING LOG

PROJECT THUN FIELD

Boring No. TF-10



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BORING LOG

PROJECT THUN FIELD

Location Corliss Property

Boring No. TF-11

Surface Elevation 500-16' a.m.s.l.

Drilling Method Air Rotary

Total Depth 138 feet

Drilled By Johnson Drilling Co.

Date Completed 7/10/85

Logged By K.G. Rattue

WELL DETAILS	PENE-TRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERME-ABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite/Cement Slurry; 2" PVC sch. 80 riser; 2" PVC sch. 80 riser; Bentonite Slurry; Bentonite Seal	1.5m/ft; 2m/ft.; 3m/ft.; 2m/ft.; 2.5m/ft	0; 5; 10; 15; 20; 25; 30; 35; 40	Grab Sampling Throughout At 5 Feet Intervals				0-5' SANDY GRAVEL, brownish gray, illsorted, loose, slighty silty, dry. 5-10' SANDY GRAVEL, as above with few pebbles, dry. 10-15' SAND and GRAVEL, light brownish to yellowish, illsorted, cohesive, few pebbles slighty moist. 15-20' SAND and GRAVEL, as above, slighty moist. 20-25' SAND and GRAVEL, as above, dry. 25-30' SAND and GRAVEL, as above, dry. 30-35' SAND and GRAVEL, as above with increasing medium to coarse sand, slighty moist. 35-40' SAND and GRAVEL, as above, dry.	

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT THUN FIELD

Boring No. TF-11

WELL DETAILS	PENETRATION TIME/RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Backfilled with sand and gravel; 2" PVC sch. 80 riser		40					40-45' SAND and GRAVEL, as above, dry.	
	3m/ft.	45					45-50' SAND and GRAVEL, as above, dry.	
	4m/ft.	50					50-55' SAND and GRAVEL, as above, dry.	
		55					55-60' GRAVELLY SAND, brownish gray, medium sand, sub-angular gravel, weakly cohesive, few pebbles, dry.	
		60					60-65' GRAVELLY SAND, as above, dry.	
Bentonite Seal	3m/ft.	65					65-70' GRAVELLY SAND, lightish gray, poorly sorted, cohesive, slightly silty, moist.	
Gravel Pack	high wl April 90	70			Not Undertaken To Date		70-75' SILTY GRAVELLY SAND, as above with increasing silt, moist.	
2" PVC sch. 80 SL screen	4m/ft.	75					75-80' SILTY GRAVELLY SAND, as above, cohesive and wet.	
	3m/ft.; low oct 90	80					80-85' SAND and GRAVEL, light gray, medium to coarse sand, cohesive, saturated.	RWL 82'
		85						

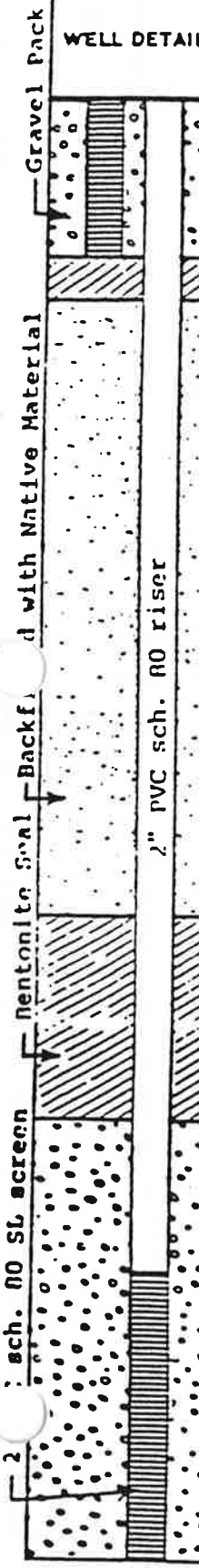
SEA-300-02b

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT THUN FIELD

Boring No. TF-11



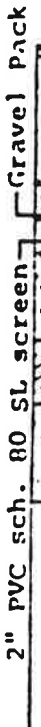
WELL DETAILS	PENETRATION TIME/RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		85			Not Undertaken To Date		85-90' SAND and GRAVEL, light gray, well sorted, medium sand, less gravel, saturated.	EC=1300
	2m/ft.	90					90-95' SAND and GRAVEL, as above, saturated.	EC=1240
		95					95-100' GRAVELLY SAND, lightish gray, illsorted, loose, few pebbles, saturated.	EC=1110
	3m/ft.	100					100-105' GRAVELLY SAND, as above, saturated.	EC=1150
		105					105-110' SAND, light brownish gray, medium to coarse, loose, few pebbles, saturated.	EC=1410
	4m/ft.	110					110-115' SAND, as above, saturated.	EC=1310
		115					115-120' TILL/DRIFT, brownish gray, illsorted, few pebbles, loose, silty saturated.	EC=660
	3m/ft.	120					120-125' TILL/DRIFT, brownish gray, illsorted, increasing pebbles, silty, saturated, decreasing flows.	EC=440
	6m/ft.	125					125-130' SAND and GRAVEL, light gray, illsorted, less pebbles, decreasing silt, saturated, (boulders?)	EC=230
		130						

Sweet, Edwards & Associates, Inc.

BORING LOG

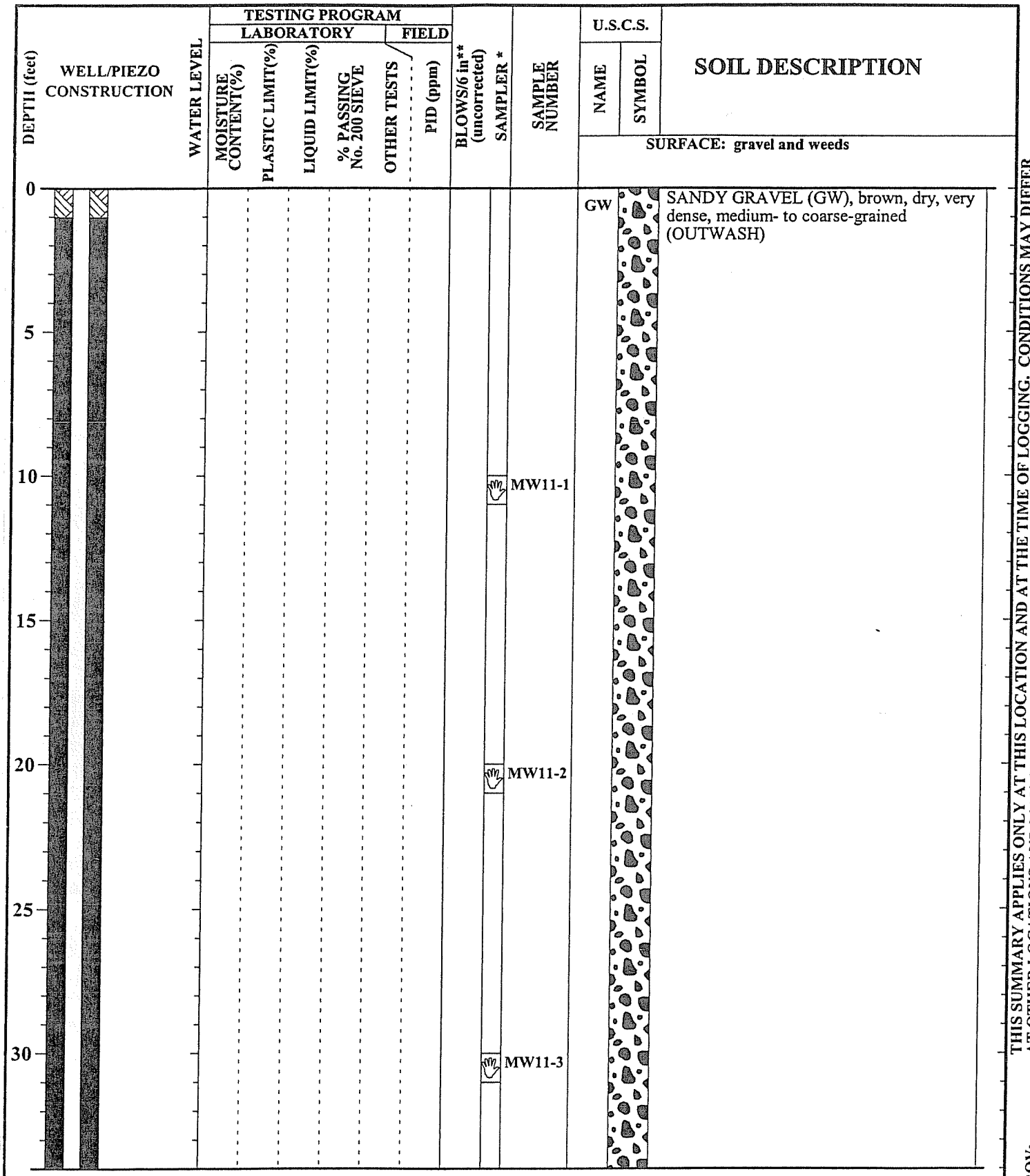
PROJECT THUR FIELD

Boring No. TF-11



WELL DETAILS	PENETRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		130					130-138' SAND, light to medium gray, medium to coarse, few pebbles, little silt, loose, saturated.	EC=270
	5m/ft.							
Bentonite Seal		135						EC=390
		140					Total Depth 138'	

SEA-300-02b



DATE DRILLED: 5-24-00
LOGGED BY: R. Yates
REVIEWED BY: Kevin Lakey

SURFACE ELEVATION (feet):
TOTAL DEPTH (feet): 147.0
DIAMETER OF BORING (in): 6

DRILLING METHOD: Air Rotary
DRILLER: Tacoma Pump & Drilling
CASING SIZE: 6

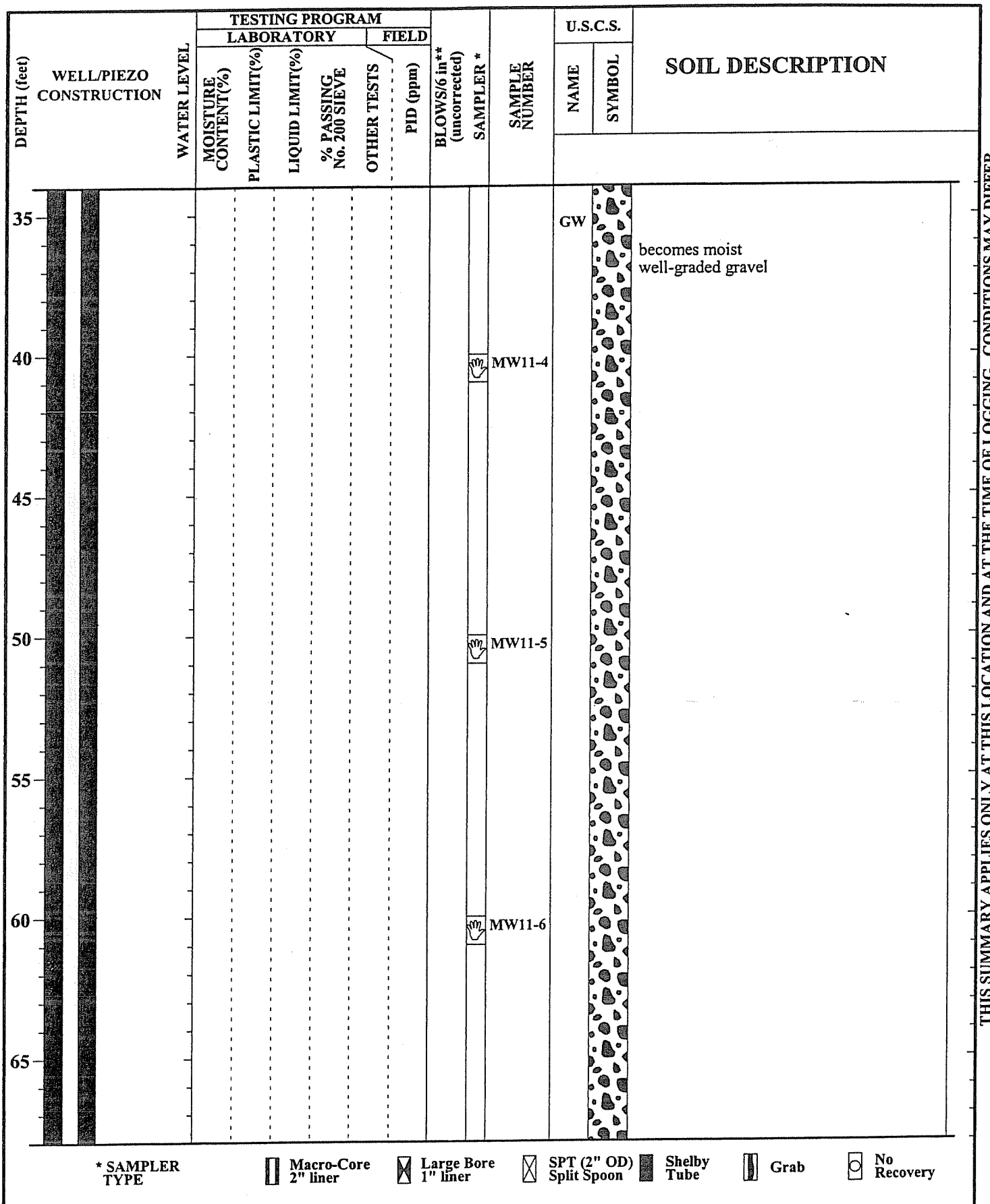
THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

BY: _____ APPROV: _____

KLEINFELDER
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
SOILS AND MATERIALS TESTING

PROJECT NUMBER: 60-3050-07

MW-11D (2)
MONITORING WELL
Hidden Valley Landfill
Pierce County, WA



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BY: _____ APPROV: _____

KLEINFELDER

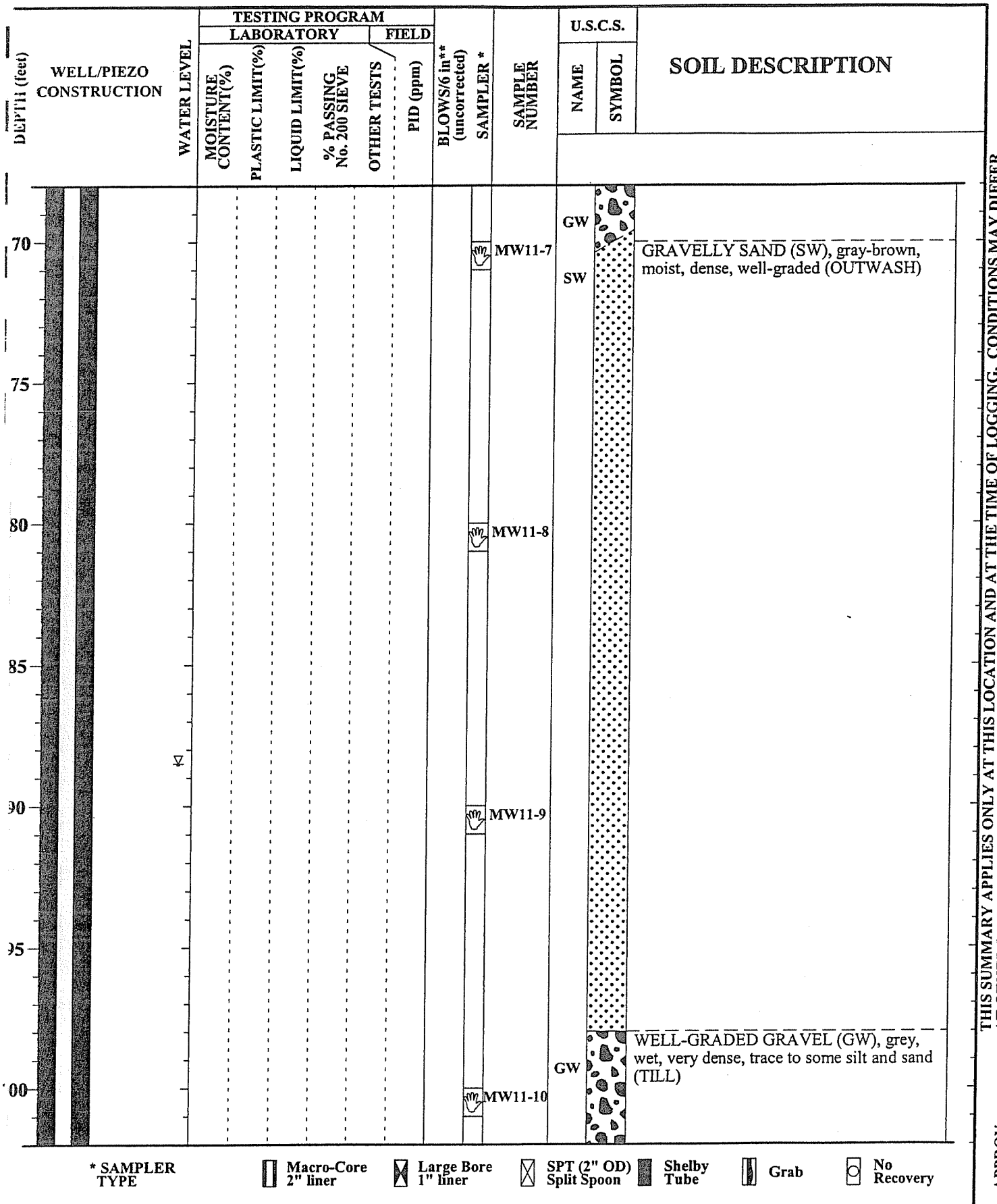
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
SOILS AND MATERIALS TESTING

PROJECT NUMBER: 60-3050-07

MW-11D (2)
MONITORING WELL

Hidden Valley Landfill
Pierce County, WA

(CONT.)



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BY: _____ APPROV: _____

KLEINFELDER

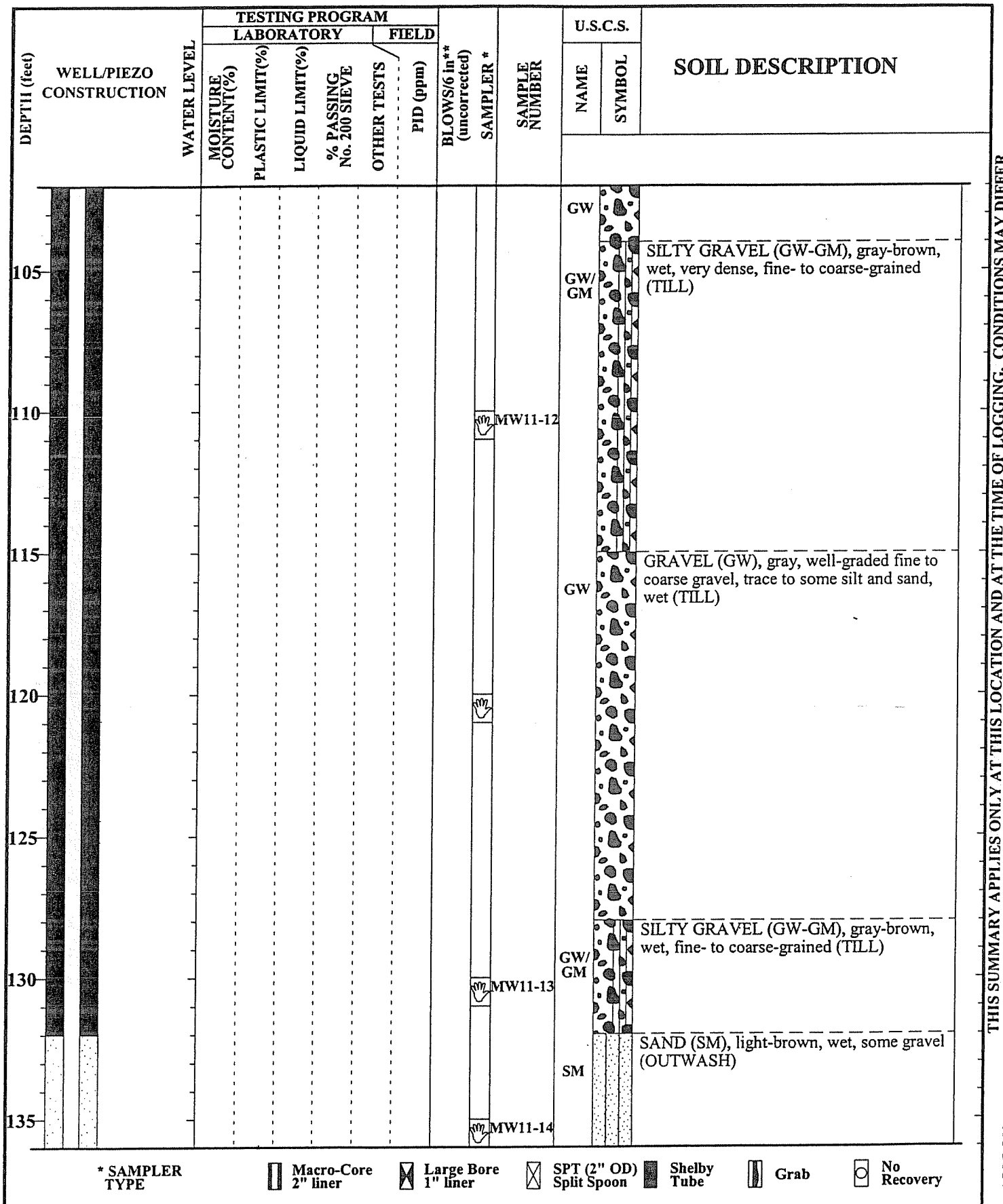
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
SOILS AND MATERIALS TESTING

PROJECT NUMBER: 60-3050-07

MW-11D (2)
MONITORING WELL

Hidden Valley Landfill
Pierce County, WA

(CONT.)



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BY: _____ APPROV: _____

KLEINFELDER

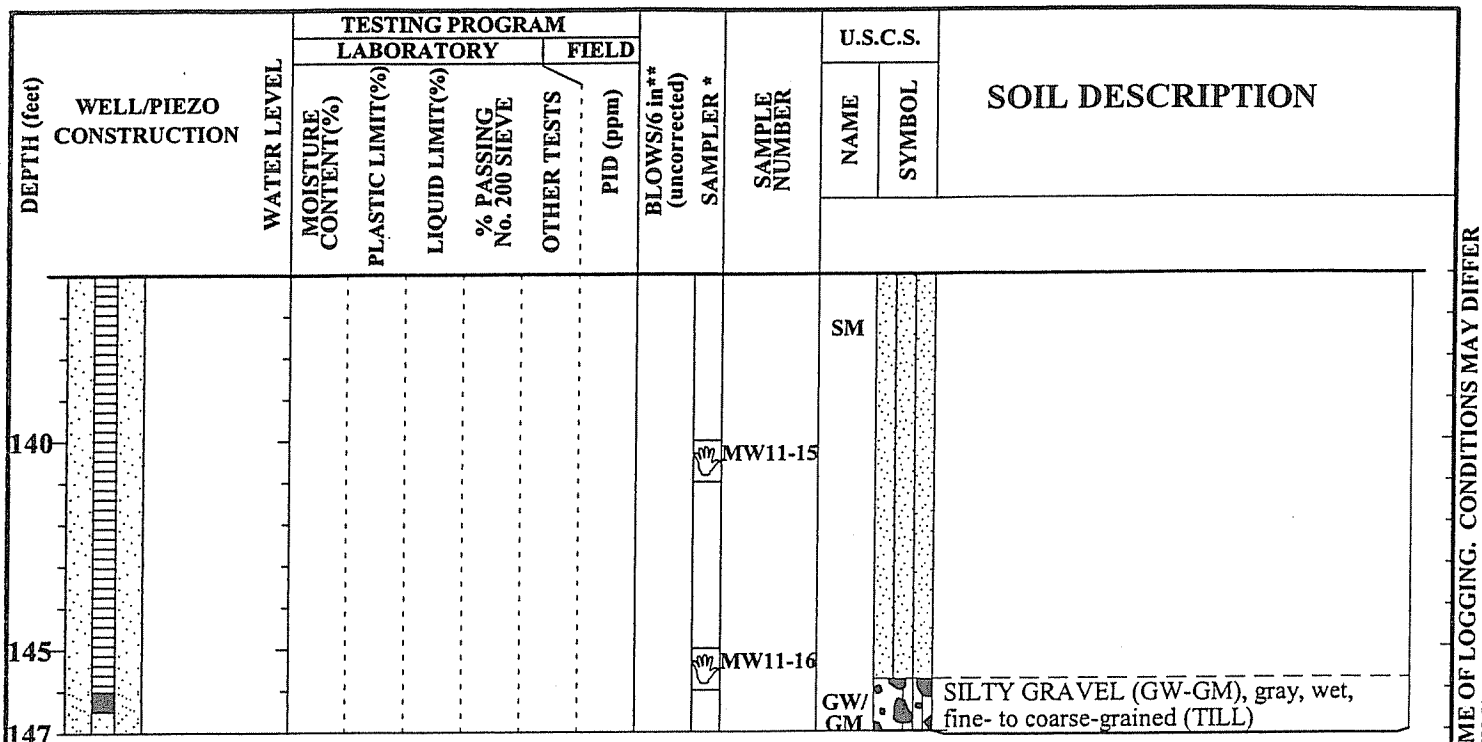
GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
SOILS AND MATERIALS TESTING

PROJECT NUMBER: 60-3050-07

MW-11D (2)
MONITORING WELL

Hidden Valley Landfill
Pierce County, WA

(CONT.)



Boring terminated at 147' bgs on 5/24/00. Boring was converted into monitoring well on 5/24/00. Groundwater was encountered at 88.5' bgs during drilling.

WELL COMPLETION DETAILS:

0 to 136.5 feet: 2-inch diameter, flush-threaded schedule 40 PVC blank rises pipe.

136.5 to 146.5 feet: 2-inch diameter, flush-threaded schedule 40 PVC well screen with 0.020-inch machine-cut slots.

146.5 to 147.0 feet: 2-inch diameter, flush-threaded schedule 40 PVC end cap.

Flush-grade well monument.

0 to 1.0 feet: concrete.

1.0 to 133.0 feet: coarse bentonite chips (Hole plug).

147.0 to 133.0 feet: 8 x 12 Colorado Silica Sand.

* SAMPLER TYPE — Macro-Core 2" liner; Large Bore 1" liner; SPT (2" OD) Split Spoon; Shelby Tube; Grab; No Recovery

THIS SUMMARY APPLIES ONLY AT THIS LOCATION AND AT THE TIME OF LOGGING. CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH TIME. DATA PRESENTED IS A SIMPLIFICATION.

BY: _____ APPROV: _____

KLEINFELDER

GEOTECHNICAL AND ENVIRONMENTAL ENGINEERS
SOILS AND MATERIALS TESTING

PROJECT NUMBER: 60-3050-07

MW-11D (2)
MONITORING WELL

Hidden Valley Landfill
Pierce County, WA

(CONT.)

Sweet, Edwards & Associates, Inc.

BORING LOG

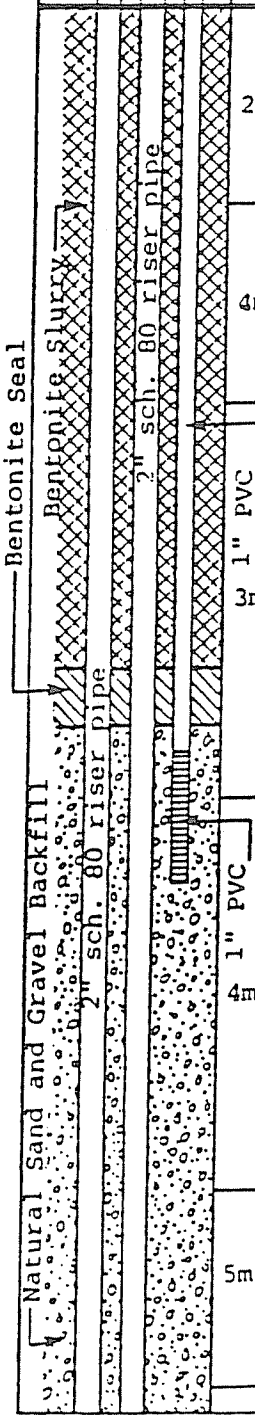
PROJECT THUN FIELD LANDFILL SITE

Location West of Offices. Boring No. TF-12(S)(D)

Surface Elevation _____ Drilling Method Air Rotary

Total Depth 124 feet Drilled By Johnson Drilling

Date Completed 4/86 Logged By K.G. Rattue



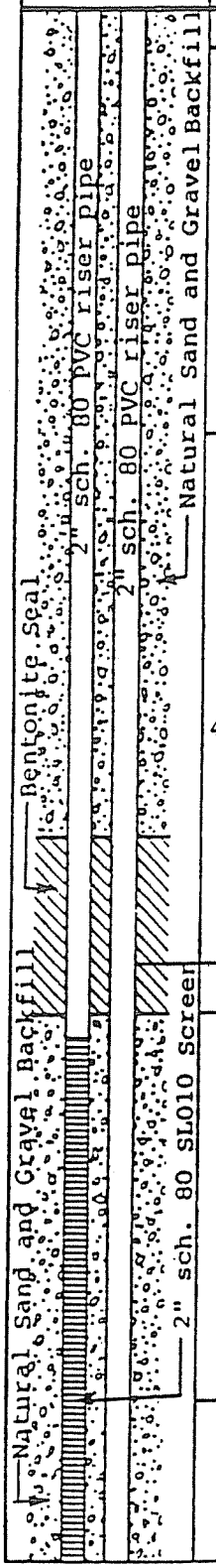
PENETRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
2m/ft.	5	1	Grab		SM	0-7' SILTY SAND, (Recessional Outwash), light brown, fine to medium sand, trace coarse sand, damp.	
4m/ft.	10	2	Grab		SW	7-21' SILTY GRAVELLY SAND, (Till?), dark brown, fine to coarse, damp.	
3m/ft.	15	3	Grab			-increasing sand, decreasing silt, damp.	
	20	4	Grab			-increasing fine sand, silt, damp.	
4m/ft.	25	5	Grab		GW	21-37' SANDY GRAVELS, (Outwash), light gray, fine to coarse sand, angular gravels, dry.	
	30	6	Grab			-becoming medium to dark gray, damp.	
5m/ft.	35	7	Grab				

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT THUN FIELD LANDFILL SITE

Boring No. TF-12(S)(D)



WELL DETAILS	PENETRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		35	7	Grab		GW	GRAVELLY SAND, medium brown, slightly silty, fine to coarse, dry.	
	4m/ft.	40	8	Grab		GM	31-53' SILTY GRAVELLY SAND, medium dark grayish brown, fine to coarse sand, moist.	
		45	9	Grab			-same.	
		50	10	Grab			-same.	
	4-5m/ft.	55	11	Grab		GM	53-60' GRAVELLY SILTY SAND, (Till), dark brown, fine to medium sand, cohesive silt, very moist.	
		60	12	Grab		GM	60-74' SILTY GRAVELLY SAND, (Outwash), light gray, fine to coarse sand, angular gravel, saturated.	SWL 62' While drilling conductivity = 1100.
	3m/ft.	65	13	Grab			-same - saturated.	
		70	14	Grab			-same.	
	2m/ft.							

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT THUN FIELD LANDFILL SITE

Boring No. TF-12(S)(D)

WELL DETAILS	PENETRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		70	14	Grab		GM	60-74' See page 2 for description.	
Bentonite Seal; 2" sch. 80 PVC riser pipe; Natural Sand and Gravel Backfill	2m/ft.	75	15	Grab		SP	74-83.5' GRAVELLY SAND, (Advance Outwash), gray, medium coarse sand, angular gravels (1 cm), trace silt, saturated, (increased flows).	
		80	16	Grab			--same - saturated.	
	3m/ft.	85	17	Grab			83.5-107' SILTY GRAVELLY SAND, (Till), light brown, buff, fine to medium sand, gravel (2cm) wet. Minor flows, sparadic.	
		90	18	Grab			--(no flows), samples wet.	
	2m/ft.					GM	SANDY GRAVELLY SILT, (Till) tan, slight brown, wet, (no flows).	
		95	19	Grab				
Bentonite Seal	3m/ft.	100	20	Grab			--same.	
		105	21	Grab			--same.	

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT THUN FIELD LANDFILL SITE

Boring No. TF-12(S)(D)

WELL DETAILS	PENETRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Natural Sand and Gravel Backfill; Bentonite Seal; 2" sch. 80 SL010 screen		105	30	Grab		GM		
	3m/ft.	110	31	Grab			107-124' GRAVELLY SAND, (Outwash), light gray, fine to medium sand, same silt, saturated. Scattered coarse sand, trace silt.	107'SWL While drilling conductivity = 550.
		115	32	Grab		SW	--same - saturated. with increasing coarse sand and gravel.	
	2m/ft.	120					--same. Bottom of hole at 124 ft.	Good flows.
		125						

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Location See figure

Boring No. TF-13

Surface Elevation 446 ft. (MSL)

Drilling Method Air Rotary

Total Depth 120 feet

Drilled By Hayes Well Drilling Co.

Date Completed 6/6/86

Logged By K. G. Rattue

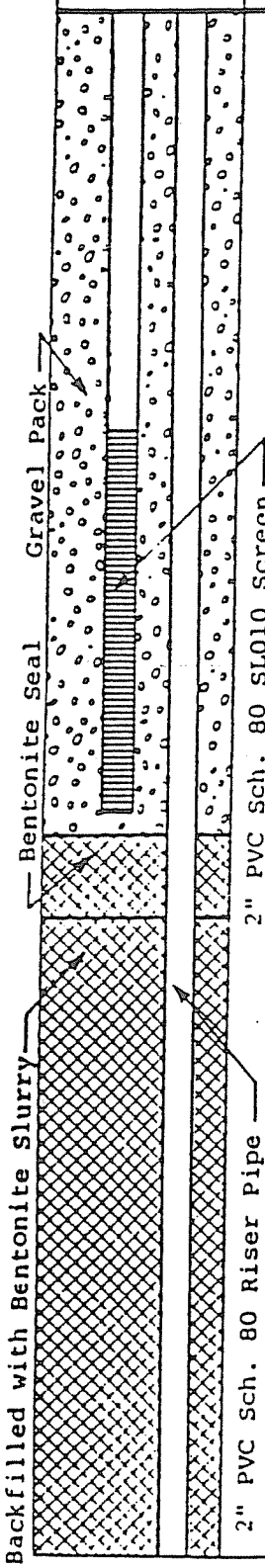
WELL DETAILS	PENETRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Concrete seal; Bentonite; Bentonite Seal; Gravel Pack; Backfilled; 1/2" PVC Sch. 80 Riser Pipe; 1/2" PVC Sch. 80 SL010 Screen; 1/2" PVC Sch. 80 Riser Pipe; 2" PVC Sch. 80 Riser Pipe		5	1	Grab		SP	GRAVELLY SAND, light brown, fine to medium, angular gravels (1/2") moist.	
		10	2	Grab		GP	SANDY GRAVELS, medium to dark gray, medium-coarse sand, sub-rounded to sub-angular gravels (1") moist.	
		15	3	Grab				
		20	4	Grab				
		25	5	Grab		SP	GRAVELLY SAND, medium to dark gray, medium with trace coarse sand, rounded gravels (1"), saturated.	SWL 26' Specific Conducting (S.C.) = 307 S.C.=342
		30	6	Grab				
		35	7	Grab				

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. _____



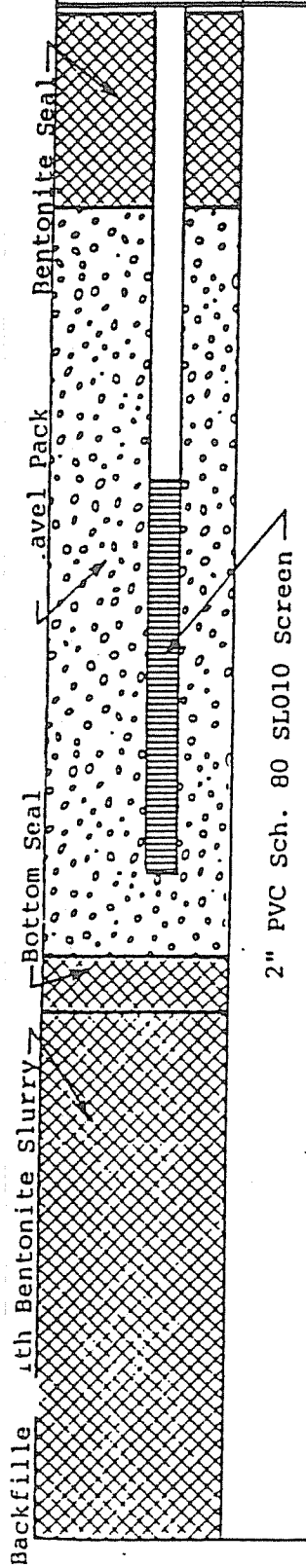
WELL DETAILS	PENE-TRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERME-ABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		35	7	Grab				S.C.=518
		40	8	Grab				
							--increasing silt.	S.C.=597
		45	9	Grab		GM	SILTY SANDY GRAVEL, dark gray, fine sand with trace medium sand, slightly oxidized, saturated.	S.C.=894
		50	10	Grab				Flows 150+ gpm
		55	11	Grab				
		60	12	Grab				S.C.=859
		65	13	Grab			--increasing medium sand.	S.C.=840
		70	14	Grab		SP	GRAVELLY SAND, medium to dark gray, medium to coarse, trace of silt, angular gravels (3/4"), saturated.	Flows 210+ gpm

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. _____



WELL DETAILS	PENE-TRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERME-ABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		75	15	Grab			---decreasing gravels with increasing well graded sands.	S.C.=760
		80	16	Grab				S.C.=756
		85	17	Grab			---increasing coarse sand becoming very close.	Flows 230+ gpm
		90	18	Grab		GM	SILTY SANDY GRAVEL, brown, medium to coarse sand, "dirty", saturated sub-angular gravels.	S.C.=687
		95	19	Grab			---decreasing silt becoming clean.	S.C.=747
		100	20			GP	SANDY GRAVEL, light to medium gray, medium coarse sand, sub-rounded-sub-angula gravels (1"), saturated.	S.C.=716
		105	21	Grab			---increasing fine sands, very clean.	
		110	22	Grab				S.C.=595

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. TF-13

WELL DETAILS	PENE-TRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERME-ABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Backfilled with Bentonite Slurry		115	23	Grab			--- increasing very fine sand and some silt.	S.C.=714
						SM	SANDY SILT, light brownish gray very fine sand, "sticky", very wet.	Low flow
		120	24	Grab			Terminals at 120 feet	

Sweet, Edwards & Associates, Inc.

BORING LOG

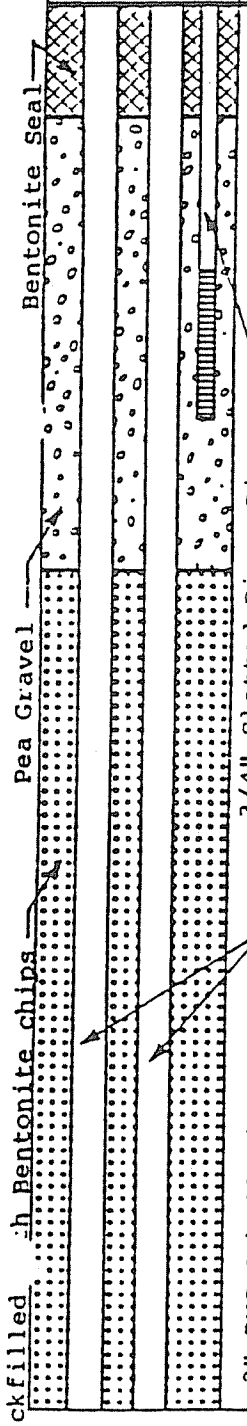
PROJECT Thun Field Landfill Site — Page 1 of ___

Location Northern Property Line — **Boring No.** TF-14

Surface Elevation 475 ft. (msl) — **Drilling Method** Air Rotary

Total Depth 98 feet — **Drilled By** Haves Well Drilling Co.

Date Completed 6/6/86 — **Logged By** F.G. Rattue



WELL DETAILS	PENETRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		5	1	Grab		SP	GRAVELLY SAND, (Recessional outwash), light brown medium sand, scattered cobbles, angular gravels (1/2"), moist.	
		10	2	Grab				Gaseous odor at approx. 10 feet
		15	3	Grab			---increasing gravels (1"), sub-angular to sub-rounded, moist. ---trace silt.	
		20	4	Grab				
		25	5	Grab			---increasing medium and medium fine sand.	
		30	6	Grab			---grading to brownish gray, some fine sands, very moist.	
		35	7					

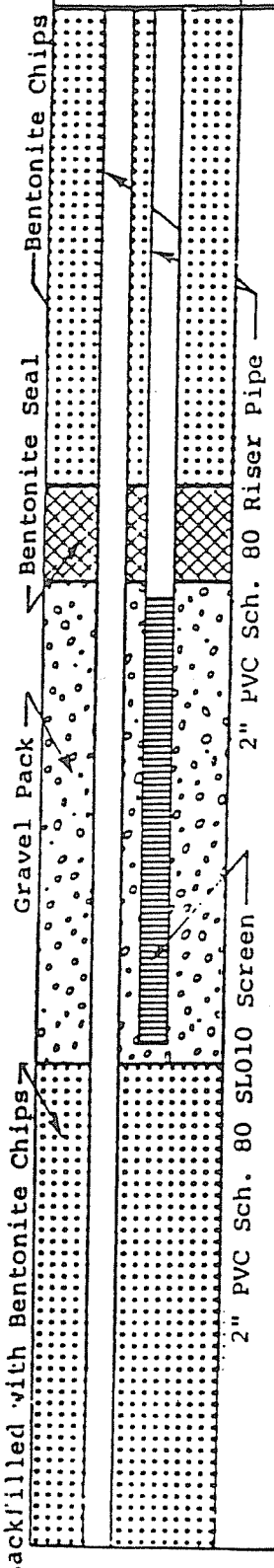
SEA-300-02a

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. TF-14



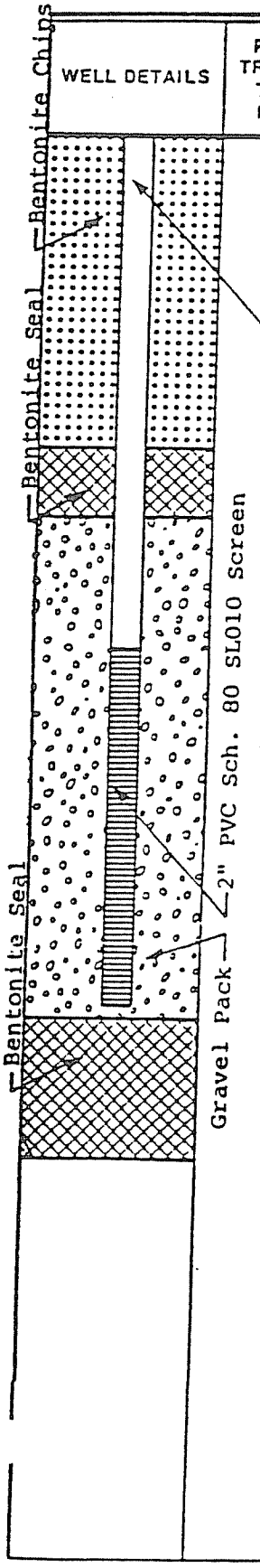
WELL DETAILS	PENETRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		40	8	Grab		GP	SANDY GRAVELS, (Recessional outwash), medium to dark gray, medium coarse, moist.	
		45	9	Grab			---increasing fine sand.	
		50	10	Grab			---less fine sand increasing medium sand, moist to wet.	
		55	11	Grab		GM	SILTY SAND GAVEL, (Recessional outwash), brownish gray, fine to coarse sand, "sticky", very wet.	SWL while drilling S.C.= 2700
		60	12	Grab		GM	SILTY SANDY GRAVEL, (till), light brownish gray, fine to coarse sand, "sticky", very wet.	No flaw
		65	13	Grab				
		70	14	Grab			---increasing silt.	

Sweet, Edwards & Associates, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. TF-14



WELL DETAILS	PENETRATION TIME/ RATE	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	PERMEABILITY TESTING	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		75	15	Grab			SANDY SILTY GRAVELS, (till), brownish gray, fine to medium sand, angular gravels (2"), very silty, wet.	SWL while drilling S.C. = 1769
		80	16	Grab		GP	SANDY GRAVEL , (outwash), dark gray, coarse sand, gravels, (3/4"), some silt, saturated.	
		85	17	Grab				
		90	18	Grab		GM	SILTY SANDY GRAVELS, (outwash), brown, medium to coarse sand, sub-rounded gravels (1"), saturated.	
		95	19	Grab				S.C.= 290 good flow
		100	20	Grab			Terminals at 98 feet	S.C.= 268

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Location (See Figure)

Boring No. MW-14 Regional

Surface Elevation 474.5 ft. (MSL)

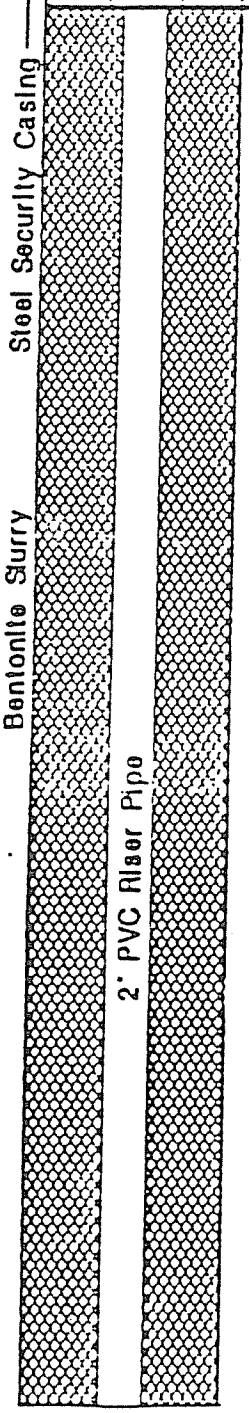
Drilling Method Cable Tool - 8"

Total Depth 273 ft. below ground surface

Drilled By Ramlo Drilling

Date Completed 2/12/88

Logged By P.Dunn/K.Lakey/K.Rattue



OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
				GW	SANDY GRAVEL (0-70'); medium to dark gray; well graded gravels from fine to cobbles; sub-angular, to subrounded; 10-20% of silt; fine to coarse sand; dry.	
Trace	5	1	Grab			
	10				@ 12': increasing silt and fine sand.	
Trace	15	2	Grab		@ 15-50': well graded sands and gravels; 10-35% fine to coarse sand; gravels up to 1 inch subrounded to subangular; 10-20% cobbles to 4 inches; loose ; dry.	
	20					
	25	3	Grab			
	30					
	35	4	Grab			

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-14R

WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite Chips / 2" PVC Riser Pipe		40	5	Grab	GP	SANDY GRAVELS (continued).	
	Trace	45	6	Grab			
		50	7	Grab		@ 50': scattered cobbles to 5 inches diameter.	
	Trace	55	8	Grab		@ 55-70': well graded gravels and sand; trace silt; increasing fine to medium sand; rounded gravel to 2 inches; loose.	
	2 ppm	60	9	Grab		@ 60': wet.	1/25/88
	10 ppm	65	10	Grab			
	Trace	70	11	Grab	GM/ SM	SILTY SAND GRAVEL to SITLY SAND (70-84'); gray to brownish gray; coarse grained; gravels to 2 inches, rounded; trace to 15% silt; trace cobbles to 4 inches; loose then dense. (TILL)	
	Trace	75	12	Grab		@ 75-80': finer grained; fine to medium; very dense; some water.	

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-14R

WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite Chips / 2" PVC Riser Pipe	Trace	80	13	Grab	GM/ SM	SILTY SANDY GRAVEL to SILTY SAND (continued).	Conductivi 2200 umhos/cm
					SM	SILTY GRAVELLY SAND (84-91'); brown, medium grained; 10-25% gravel; to 3 inches; dense; making water. (OUTWASH)	
	Trace	85	14	Grab			Conductivi 1160 umhos/cm
		90	15	Grab	GW	SANDY GRAVEL (91-107'); brown; 35-40% fine to medium sand; fine gravel grained, 1 inch diameter; trace cobbles to 4 inches; medium dense; wet. (OUTWASH)	Conductivi 1550 umhos/cm
		95	16	Grab			
	15 ppm	100	17	Grab			Conductivi 841 umhos/cm
		105	18	Grab	SW	GRAVELLY SAND (107-115'); medium to coarse grained; 10-25% fine sand; 10-15% gravels, 3/4 inch size; well rounded; trace coarse gravels, saturated. (OUTWASH)	Conductivi 580 umhos/cm
		110	19	Grab			
		115	20	Grab	SM	SILTY GRAVELLY SAND (116-120'); fine to coarse grained; 10-25% gravel 1/2 inch. (TILL)	Conductivi 478 umhos/cm

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-14R

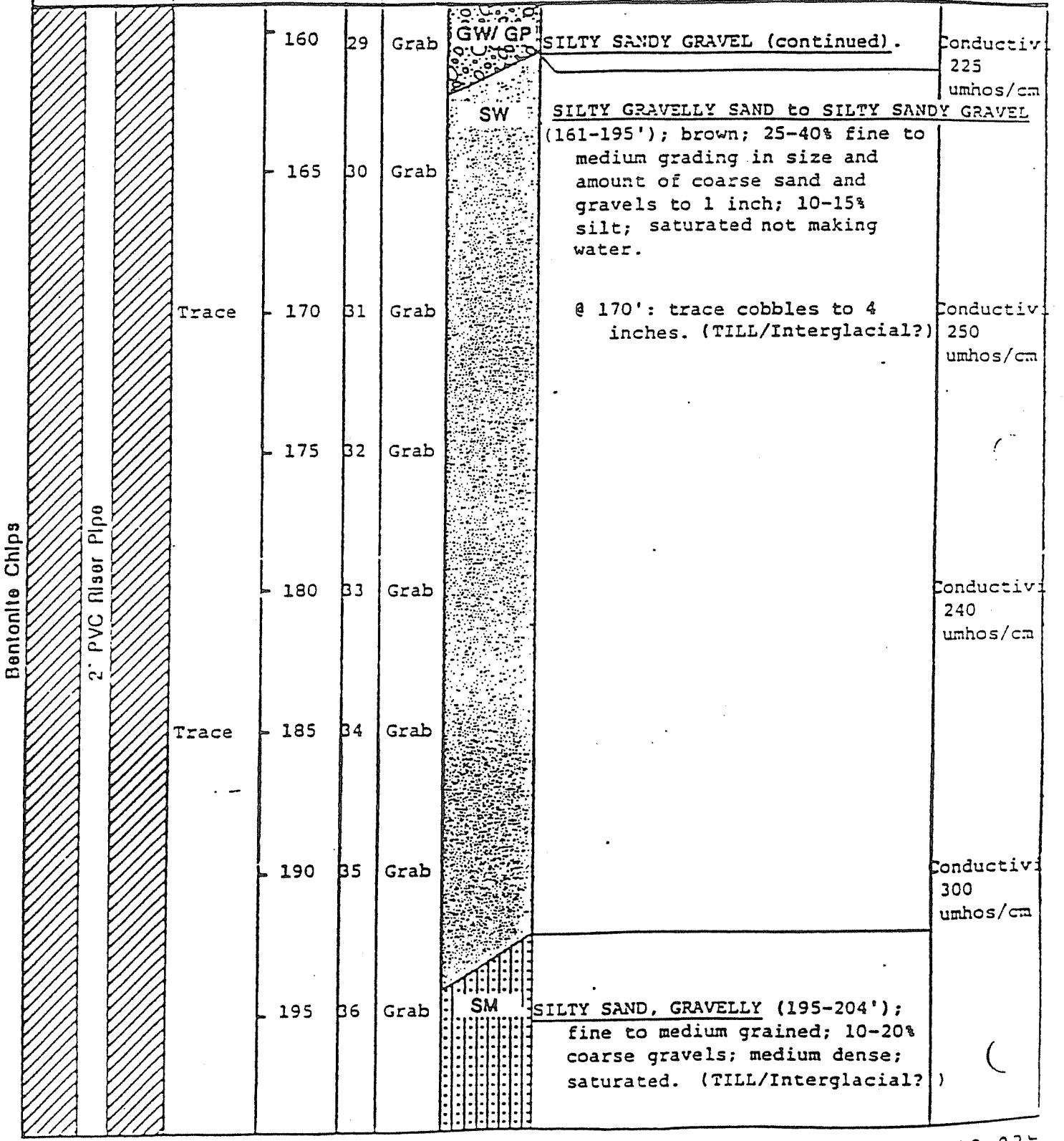
WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite Chips / 2" PVC Riser Pipe		120	21	Grab	SW/ GM	GRAVELLY SITLY SAND to SANDY GRAVEL (120-147'); light gray; 10-20% silt; fine to medium grained sand; gravels broken 3/4 inch in size; intact cuttings show till; saturated. (TILL)	
	Trace	125	22	Grab			Conducti- 420 umhos/cm
	Trace	130	23	Grab			
		135	24	Grab			Conduc i 385 umhos/cm
	Trace	140	25	Grab		@ 140': large boulders, unable to drill open hole.	
		145	26	Grab			Conductivit 334 umhos/cm
	Trace	150	27	Grab	GW/ GP	SILTY SAND GRAVEL (147-161'); medium gray; intact sample retrieved; saturated. (TILL/Interglacial)	
	Trace	155	28	Grab			Conduc' 301 umhos/cm

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-14R



WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		160	29	Grab	GW/ GP	SILTY SANDY GRAVEL (continued).	Conductivi 225 umhos/cm
					SW	SILTY GRAVELLY SAND to SILTY SANDY GRAVEL (161-195'); brown; 25-40% fine to medium grading in size and amount of coarse sand and gravels to 1 inch; 10-15% silt; saturated not making water.	
		165	30	Grab			
	Trace	170	31	Grab		@ 170': trace cobbles to 4 inches. (TILL/Interglacial?)	Conductivi 250 umhos/cm
		175	32	Grab			
		180	33	Grab			Conductivi 240 umhos/cm
	Trace	185	34	Grab			
		190	35	Grab			Conductivi 300 umhos/cm
		195	36	Grab	SM	SILTY SAND, GRAVELLY (195-204'); fine to medium grained; 10-20% coarse gravels; medium dense; saturated. (TILL/Interglacial?)	

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-14R

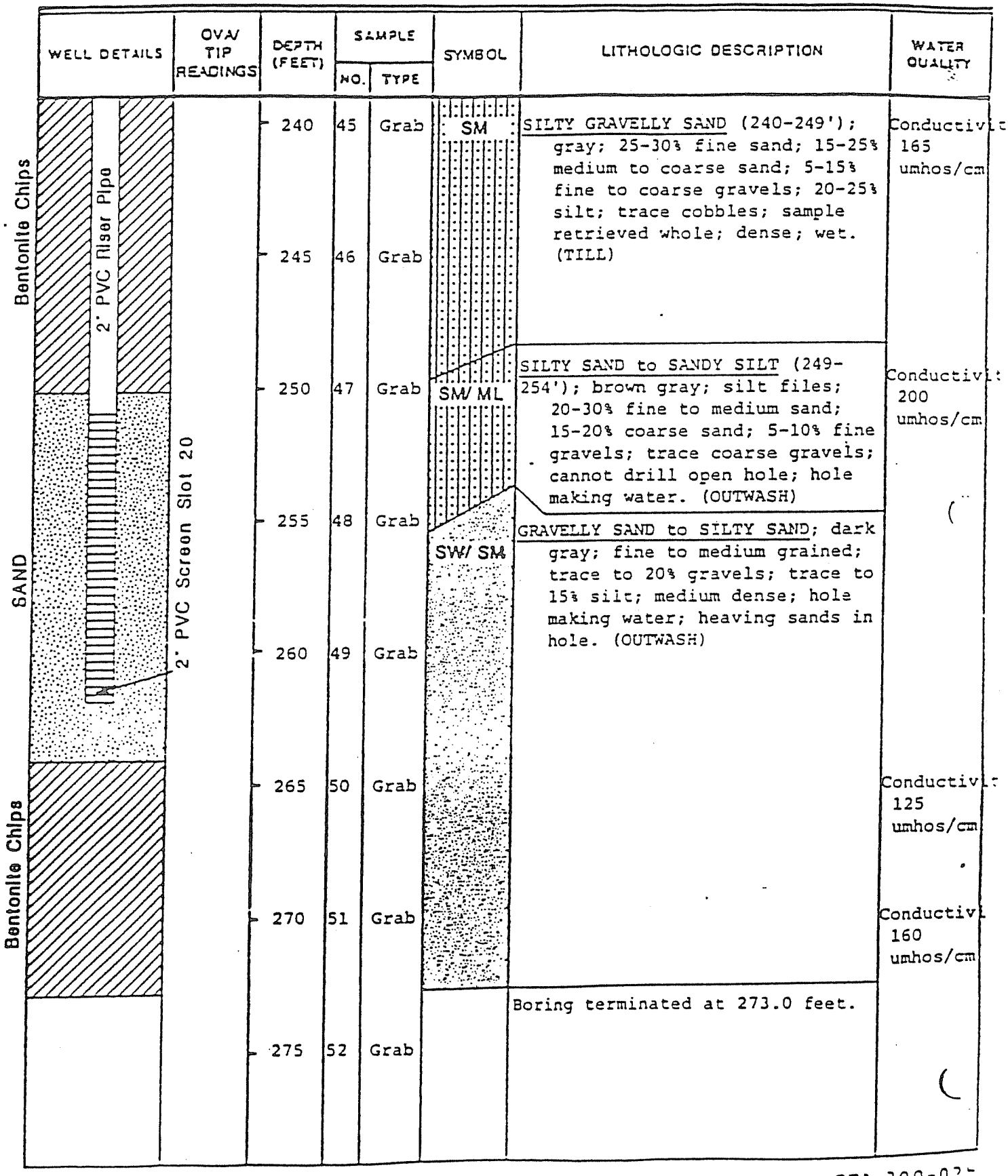
WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite Chips; 2" PVC Riser Pipe		200	37	Grab	SM	SILTY SAND (continued); 10-20% fines; hole making some water.	
		205	38	Grab	GP	SANDY GRAVELS (204-210'); gray; gravel and cobbles; well consolidated; dense; saturated.	Conductivi 215 umhos/c
		210	39	Grab	GM	SILTY SANDY GRAVELS (210-240'); gray; 40-50% fine to coarse sand; 20-30% fine to coarse gravels, subrounded; 5-10% cobbles; open hole drilling; making some water. (TILL)	
		215	40	Grab			Conduc...v 136 umhos/
		220	41	Grab			
		225	42	Grab		@ 225': decreasing amount of fines and increasing coarse gravels.	Conducti 202 umhos/cm
		230	43	Grab			
		235	44	Grab			Conductiv 195 umhos

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-14R



WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		240	45	Grab	SM	SILTY GRAVELLY SAND (240-249'); gray; 25-30% fine sand; 15-25% medium to coarse sand; 5-15% fine to coarse gravels; 20-25% silt; trace cobbles; sample retrieved whole; dense; wet. (TILL)	Conductivit 165 umhos/cm
		245	46	Grab			
		250	47	Grab	SM/ ML	SILTY SAND to SANDY SILT (249-254'); brown gray; silt files; 20-30% fine to medium sand; 15-20% coarse sand; 5-10% fine gravels; trace coarse gravels; cannot drill open hole; hole making water. (OUTWASH)	Conductivit 200 umhos/cm
		255	48	Grab	SW/ SM	GRAVELLY SAND to SILTY SAND; dark gray; fine to medium grained; trace to 20% gravels; trace to 15% silt; medium dense; hole making water; heaving sands in hole. (OUTWASH)	
		260	49	Grab			
		265	50	Grab			Conductivit 125 umhos/cm
		270	51	Grab			Conductivi 160 umhos/cm
		275	52	Grab		Boring terminated at 273.0 feet.	

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Location Northern Property Line

Boring No. MW-15 S (GP-4)

Surface Elevation 487

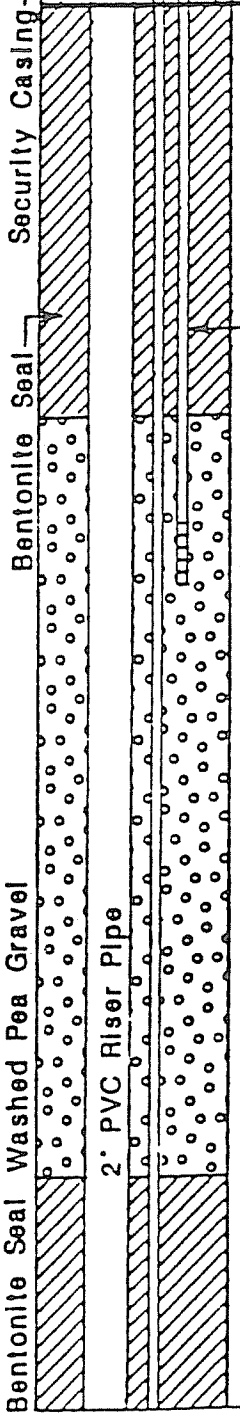
Drilling Method Air Rotary

Total Depth 80 feet

Drilled By Hayes Well Drilling Co.

Date Completed June 24, 1987

Logged By Kevin G. Rattue



WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
	Average 1 min/ft	5			GW	SANDY GRAVEL (0-80'); medium brown; medium to coarse sand; some fine sand; angular to subangular gravels; 1/4 inch to 3/4 inch diameter; damp OUTWASH	
		10					
		15				@ 15': increasing medium coarse sand.	
		20					
		25				@ 25': grading to olive brown with trace of fine sand; moist.	
		30					
		35				@ 35': becoming wet.	

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-15

WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite Seal; Washed Pea Gravel; 2" PVC Riser Pipe; 1/2" Slot 20 Screen; 2" PVC Slot Screen	Average 2 min/ft	35			GW	@ 36': very wet.	
		40					
		45					
		50				@ 51': scattered boulders.	
		55				@ 55': increasing coarse gravels and cobbles	
		60				@ 62': saturated; medium gray sandy coarse gravel; minimum trace fine sand.	S.W.L.
		65					
		70					

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-15

WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bottom Seal		75			GW	--- same	
		80				Boring terminated at 80.0 feet.	Conductivi =1440 pH=7.7 T=22°C
Drive Shoe		85					

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Location (See figure)

Boring No. MW-15 Deep

Surface Elevation 488.5'(MSL)

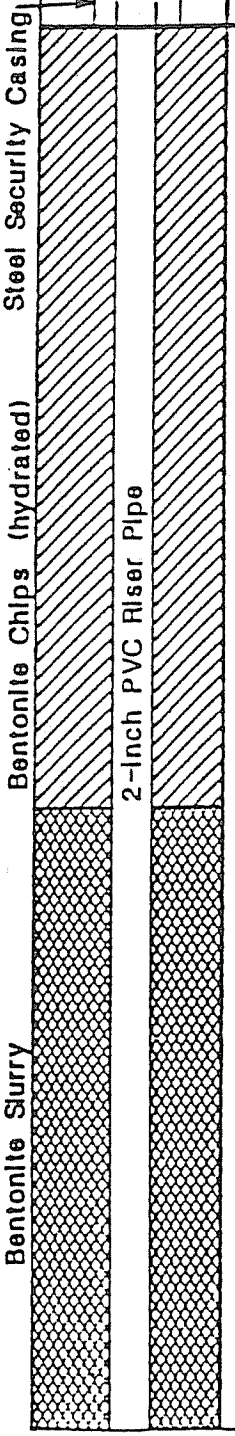
Drilling Method Cable Tool

Total Depth 115 feet

Drilled By Tacoma Pump and Drilling

Date Completed 1/12/88

Logged By K.Lakey/K.Rattue



OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
				GW	SANDY GRAVEL (0-18'); brown; subrounded; trace cobbles; 6 inches in diameter; medium sand; trace silt; dense; moist.	
10%	5	1	Grab		@ 3': 35% LEL gas tech reading.	
.03%	10	2	Grab		@ 10': increasing silt; 205 LEL gas tech reading.	
	15	3	Grab			
	20	4	Grab	SM	SILTY SAND, GRAVELLY (18-26'); light gray brown; fine grained; medium dense; moist.	
	25	5	Grab			
				GM	SILTY SAND GRAVEL (26-35'); brown; gravels to cobbles; fine to coarse sand; dense. (TILL)	
	30	5	Grab		@ 27-29': boulders.	
	35	7	Grab	GP	SANDY GRAVELS (35-42.5'); (continued on next page)	

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-15D

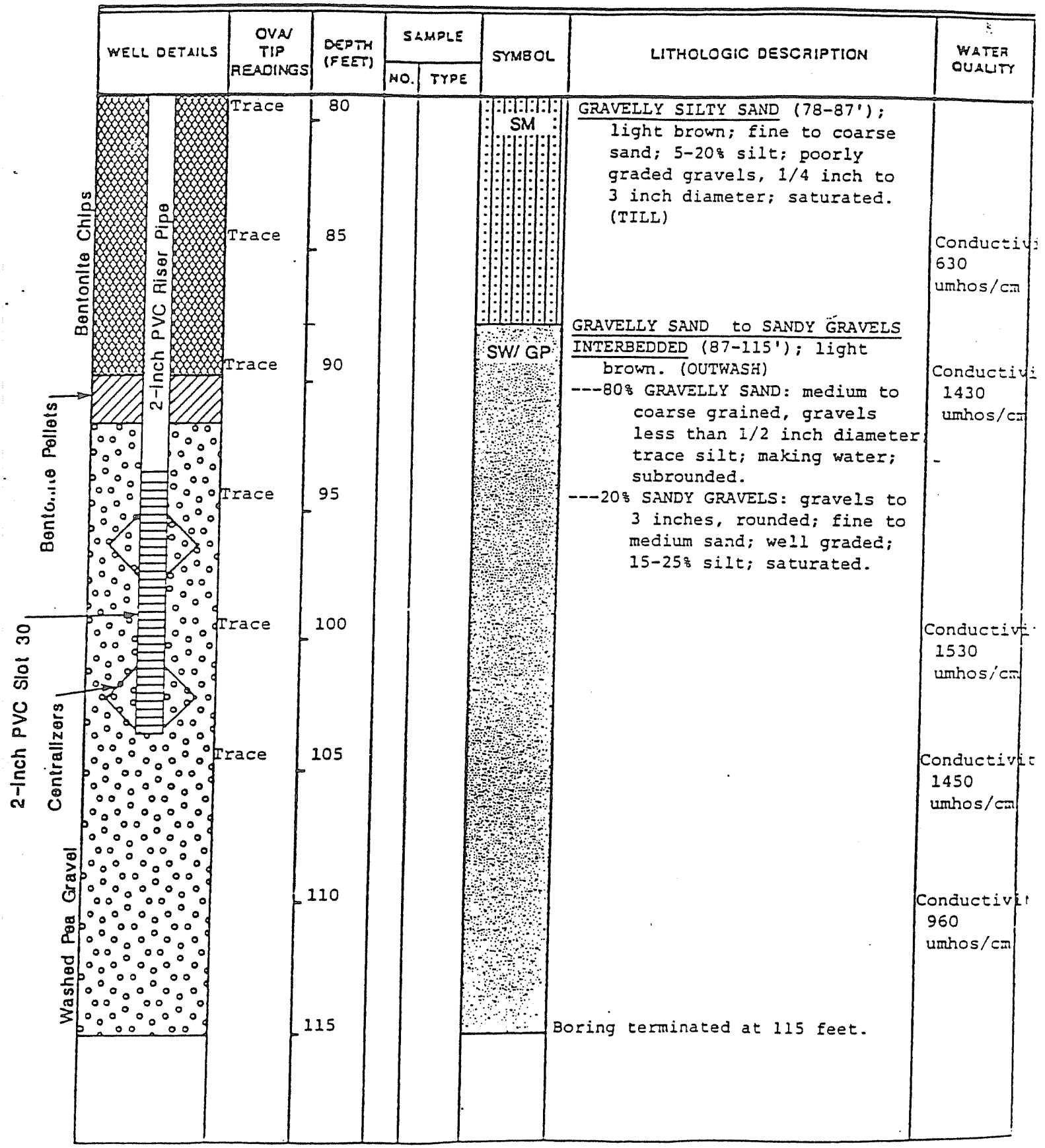
WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite Slurry / 2-Inch PVC Riser Pipe		40	8	Grab	GP	SANDY GRAVELS (continued); light brown; poorly graded gravels; 1/4 to 1/8 inch in diameter; fine to coarse sand; trace silt; dense. (TILL)	
	Trace	45	9	Grab	SW	GRAVELLY SAND (42.5-48'); gray; fine to coarse sand; 15-25% silt; 15-25% gravel, angular; loose.	
	Trave	50	10	Grab	GP	SANDY GRAVELS (48-62'); gray; 1 inch in diameter gravels; subrounded; poorly graded; medium to coarse sand. (OUTWASH)	
	Trace	55	11	Grab			
	Trace	60	12	Grab		@ 62': encounter water, odor.	
	Trace	65	13	Grab	SW	GRAVELLY SAND (62-78'); medium to coarse sand; well graded; 1/4 inch gravels; 5-15% silt; saturated.	1/15/87 Conductiv 810 umhos/cm
	Trace	70	14	Grab		@ 70': increasing gravels, 1/2 inch diameter. (OUTWASH)	Conductiv 952 umhos/cm
	Trace	75	15	Grab			Conductiv 710 umhos/
					SM	(Refer to next page)	

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-15D



WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
	Trace	80			SM	GRAVELLY SILTY SAND (78-87'); light brown; fine to coarse sand; 5-20% silt; poorly graded gravels, 1/4 inch to 3 inch diameter; saturated. (TILL)	
	Trace	85					Conductivi 630 umhos/cm
	Trace	90			SW/ GP	GRAVELLY SAND to SANDY GRAVELS INTERBEDDED (87-115'); light brown. (OUTWASH) ---80% GRAVELLY SAND: medium to coarse grained, gravels less than 1/2 inch diameter; trace silt; making water; subrounded. ---20% SANDY GRAVELS: gravels to 3 inches, rounded; fine to medium sand; well graded; 15-25% silt; saturated.	Conductivi 1430 umhos/cm
	Trace	95					
	Trace	100					Conductivi 1530 umhos/cm
	Trace	105					Conductivit 1450 umhos/cm
		110					Conductivit 960 umhos/cm
		115				Boring terminated at 115 feet.	

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Location Northern Property Line

Boring No. MW-17S (GP-1 a, b, c)

Surface Elevation 548 ft. (MSL)

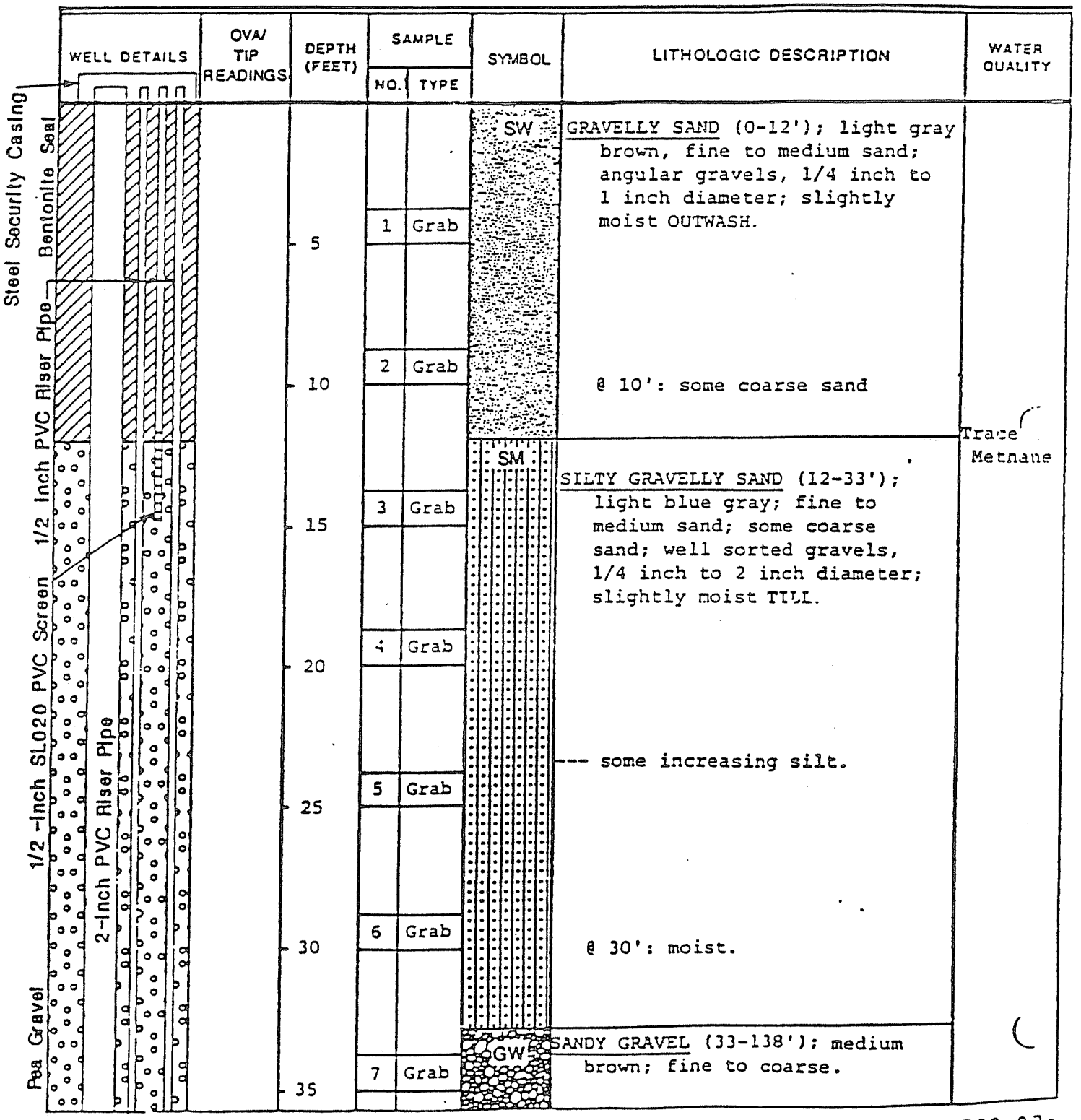
Drilling Method Air Rotary - 6"

Total Depth 154 feet.

Drilled By Haves Well Drilling Co.

Date Completed 6/30/87

Logged By Kevin G. Rattue



WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		5	1	Grab	SW	GRAVELLY SAND (0-12'); light gray brown, fine to medium sand; angular gravels, 1/4 inch to 1 inch diameter; slightly moist OUTWASH.	
		10	2	Grab		@ 10': some coarse sand	Trace Metnane
		15	3	Grab	SM	SILTY GRAVELLY SAND (12-33'); light blue gray; fine to medium sand; some coarse sand; well sorted gravels, 1/4 inch to 2 inch diameter; slightly moist TILL.	
		20	4	Grab			
		25	5	Grab		--- some increasing silt.	
		30	6	Grab		@ 30': moist.	
		35	7	Grab	GW	SANDY GRAVEL (33-138'); medium brown; fine to coarse.	

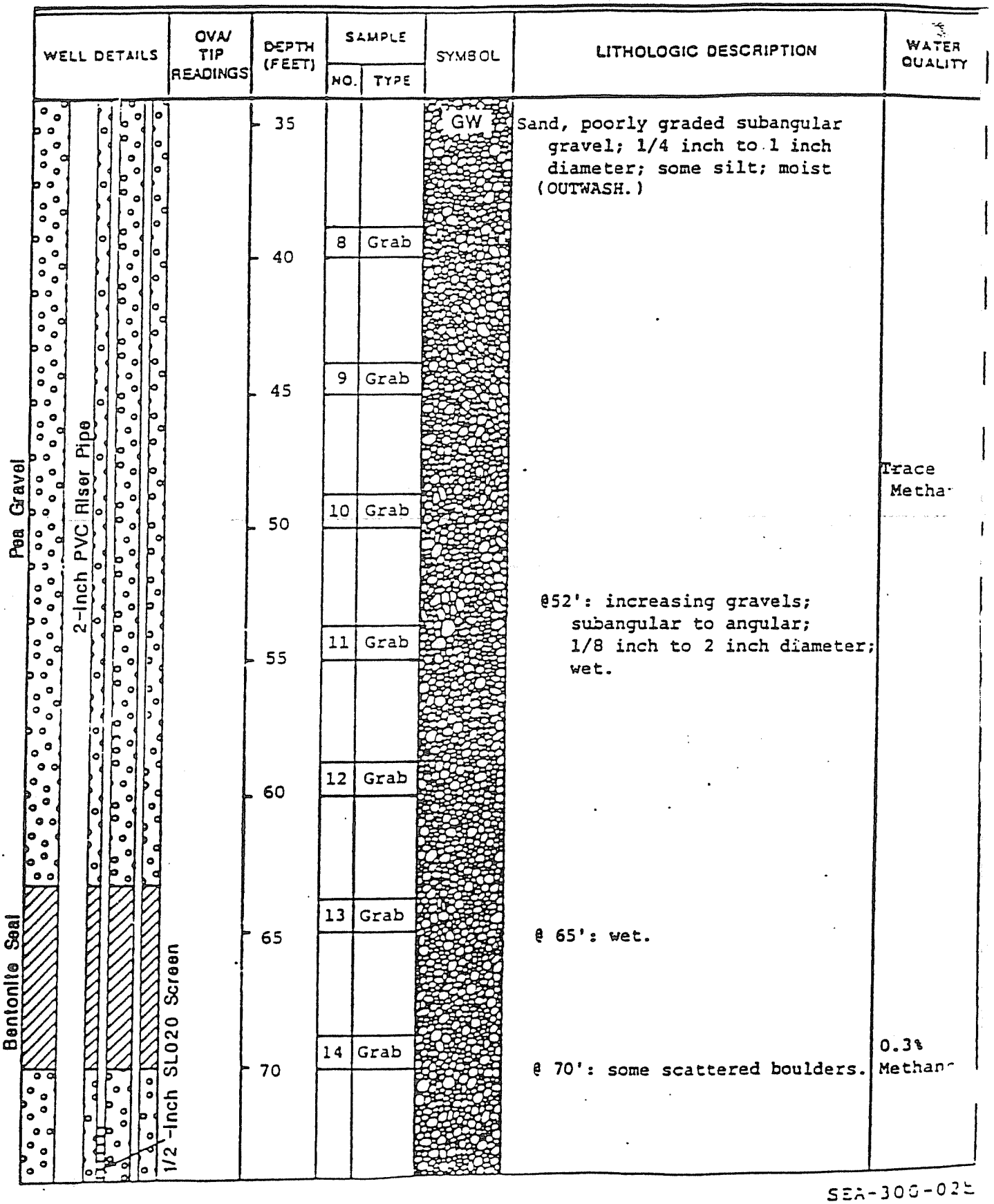
SEA-300-02a

Sweet-Edwards/EMCON, Inc.

BORING LOC

PROJECT Thun Field Landfill Site

Boring No. MW-17S



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BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-17S

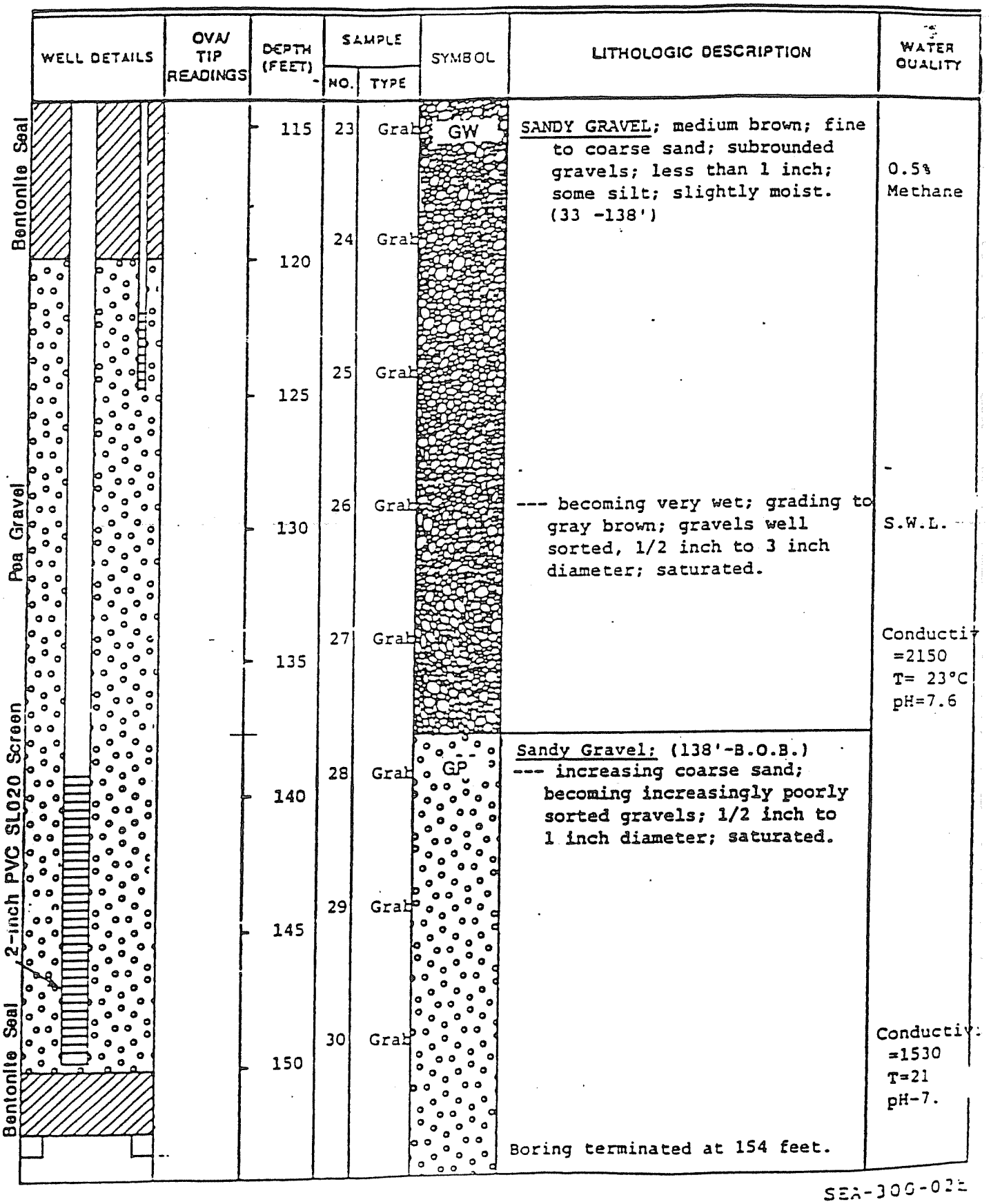
WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite Seal / Pea Gravel / 2-Inch PVC Riser Pipe		75			GW		
		80	16	Grab		@ 80': increasing silt	Trace Methane
		85	17	Grab			
		90	18	Grab		@ 90': becoming wet.	
		95	19	Grab			
		100	20	Grab		@ 100': becoming moist.	0.1% Methane
		105	21	Grab			
		110	22	Grab			

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-17S



WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		115	23	Grab	GW	SANDY GRAVEL; medium brown; fine to coarse sand; subrounded gravels; less than 1 inch; some silt; slightly moist. (33 -138')	0.5% Methane
		120	24	Grab			
		125	25	Grab			
		130	26	Grab		--- becoming very wet; grading to gray brown; gravels well sorted, 1/2 inch to 3 inch diameter; saturated.	S.W.L.
		135	27	Grab			Conductiv =2150 T= 23°C pH=7.6
		140	28	Grab	GP	Sandy Gravel: (138'-B.O.B.) --- increasing coarse sand; becoming increasingly poorly sorted gravels; 1/2 inch to 1 inch diameter; saturated.	
		145	29	Grab			
		150	30	Grab		Boring terminated at 154 feet.	Conductiv =1530 T=21 pH-7.

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Location (See Figure)

Boring No. MW-18 Shallow (6P-20A,B,C)

Surface Elevation 546 ft. (MSL)

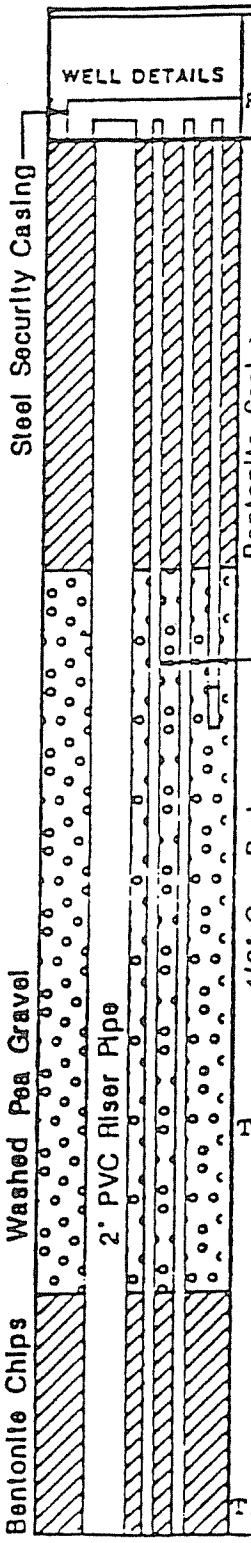
Drilling Method Air Rotary - 6"

Total Depth 160 feet below ground surface

Drilled By Hayes Well Drilling Co.

Date Completed 3/2/88

Logged By Patrick Dunn



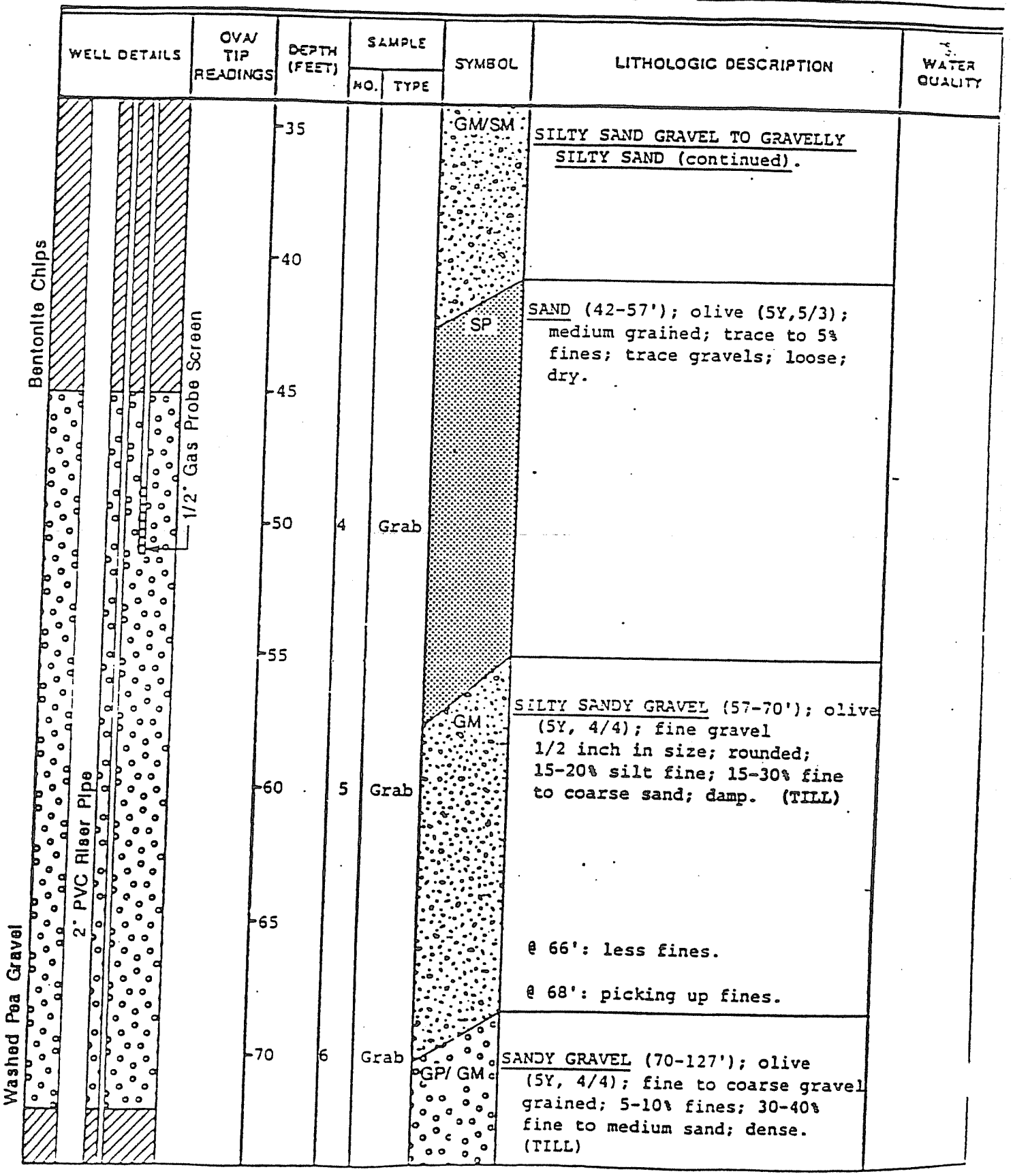
WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
	Trace	5			SM	SILTY SAND (0-16'); light olive brown (2.5Y, 5/4); fine grained 20-30% low plasticity fines; 10-15% coarse gravel; loose; dry. (TILL)	
		10	1	Grab		@ 13-13.5': color change to gray.	
		15			GM/ SM	SILTY, SANDY GRAVEL to GRAVELLY SILTY SAND (16-42'); light olive brown to grayish brown; medium gravel grained; 1 inch rounded; 15-30% low plasticity fines; 15-30% fine to coarse grained sand; loose; dry. (TILL)	
		20	2	Grab			
	Trace	25					
		30	3	Grab		@ 30': lenticular quartz sands; harder.	
	Trace	35				@ 34-35.5': less fines coarser grained; damp.	

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-18S



WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		35			GM/SM	SILTY SAND GRAVEL TO GRAVELLY SILTY SAND (continued).	
		40			SP	SAND (42-57'); olive (5Y,5/3); medium grained; trace to 5% fines; trace gravels; loose; dry.	
		45					
		50	4	Grab			
		55			GM	SILTY SANDY GRAVEL (57-70'); olive (5Y, 4/4); fine gravel 1/2 inch in size; rounded; 15-20% silt fine; 15-30% fine to coarse sand; damp. (TILL)	
		60	5	Grab		@ 66': less fines.	
		65				@ 68': picking up fines.	
		70	6	Grab	GP/ GM	SANDY GRAVEL (70-127'); olive (5Y, 4/4); fine to coarse gravel grained; 5-10% fines; 30-40% fine to medium sand; dense. (TILL)	

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-18S

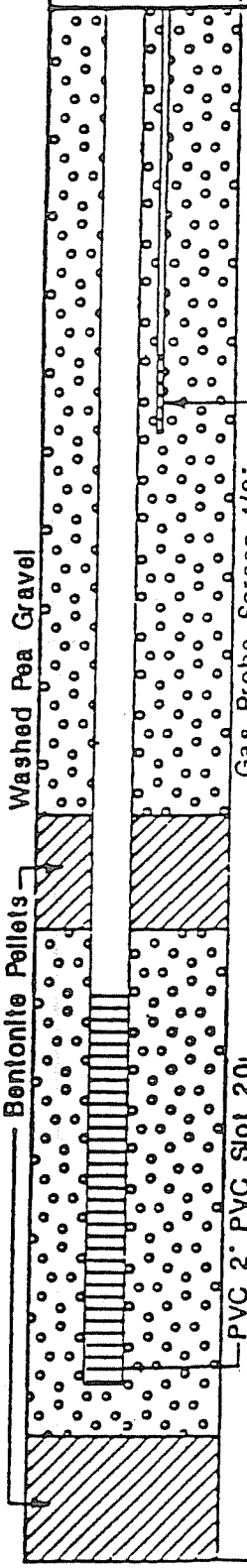
WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite Chips; 2" PVC Riser Pipe		75			GP/ GM	SANDY GRAVELS to SILTY SANDY GRAVELS (continued). @ 72': change in color to gray, due to basaltic composition of rock. (OUTWASH)	
		80	7	Grab			
		85					
		90	8	Grab			
		95					
		100	9	Grab		SANDY GRAVELS to SILTY SANDY GRAVELS (72-127'); olive gray (5Y, 4/2); fine to coarse gravels; 1/2 inch to 1 inch rounded; 10-20% fines; 15-30% fine to coarse sand; dense; damp. (OUTWASH)	
		105					
		110	10	Grab			

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thorn Field Landfill Site

Boring No. MW-18S



WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		115			GP/ GM	SANDY GRAVELS to SILTY SANDY GRAVES (continued).	
		120	11	Grab			
		125			SM	SILTY SAND (127-150'); olive gray (5Y, 4/2); fine to coarse grained; 20-25% low plasticity fines; 5-15% fine gravels; up to 1/2 inch, rounded; drill hole staying open; dense; damp. (TILL) @ 133': Brighter olive color.	
		130	12	Grab			
		135					
		140	13	Grab		@ 139': dark andesitic boulders. @ 142': damp.	
		145				@ 145': wet.	3/2/88 Conductiv: 980 umhos/cm
		150	14	Grab	GM/ SW	SANDY SILTY GRAVELS to GRAVELLY SAND (150- BOB); olive brown (2.5Y, 5/4); coarse grained to fine gravel grained; 10-20% fine to medium sand; (continued-)	

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-18S

WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite Pellets		155			GM/ SW	SANDY SILTY GRAVELS to GRAVELLY SAND (continued); 5-10% fines; trace to 10% cobbles, angular; dense; wet. (TILL)	
		160				Boring terminated at 160 feet.	

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Location (See Figure)

Boring No. MW-18 Deep

Surface Elevation 545.5 ft. (MSL)

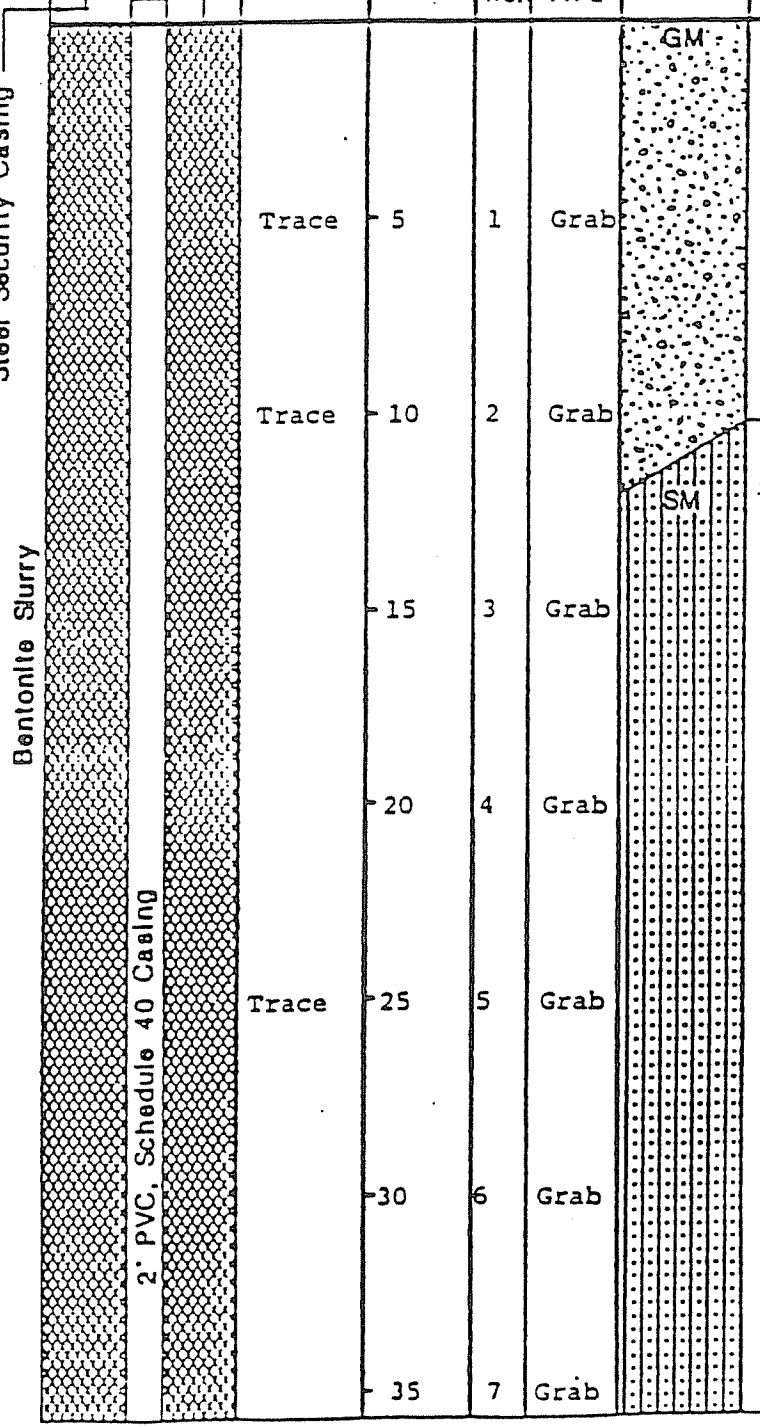
Drilling Method Cable Tool - 6"

Total Depth 179.5' below Surface

Drilled By Tacoma Pump and Drilling

Date Completed 2/2/88

Logged By K.Rattue/Kevin Lakey



WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
	Trace	5	1	Grab	GM	SANDY SILTY GRAVEL (0-11'); Light brown; fine to coarse grained; 10-30% cobbles, angular, loose; dry. (TILL)	
	Trace	10	2	Grab			
		15	3	Grab	SM	SILTY SAND; Gravelly (11-49'); light brown gray; fine to medium grained; silt present; 10-30% gravels; 1/2" diameter; in-situ samples of material; moist. (TILL)	
		20	4	Grab			
	Trace	25	5	Grab			
		30	6	Grab		@30-47': coarser gravels, 1 inch diameter.	
		35	7	Grab			

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-18D

WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite Slurry; 2" PVC Riser Pipe	Trace	40	8	Grab	SM	SILTY SAND (continued) @ 40': increasing gravels and sands; silty sand, gravelly, moist. (TILL)	
	Trace	45	9	Grab			
	Trace	50	10	Grab	SP	SAND (49-61'); brownish gray; medium grained; 5-15% silt; gravels present at 1/2 inch diameter; loose; dry. (OUTWASH)	
	Trace	55	11	Grab		@ 55': increasing gravel.	
	Trace	60	12	Grab		@ 61': becoming fine.	
	Trace	65	13	Grab	SM	SILTY SAND (61-75'); brown gray; fine grained; medium dense; dry; drills open hole.	
	Trace	70	14	Grab		@ 70': 10-30% gravels.	
	Trace	75	15	Grab	ML	SANDY SILT (75-87'); brownish gray; fine to medium sand present; trace to 30% gravel; low plasticity fines; firm; drills open hole 1 ft.; moist. (Interglacial?)	

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-19D

WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite Slurry / 2" PVC Riser Pipe		80	16	Grab	ML	SANDY SILT (continued)	
	Trace	85	17	Grab	GM	SILTY SANDY GRAVEL (87-100'); brownish gray; broken gravel to 1 inch in diameter. (TILL?)	
	Trace	90	18	Grab			
	Trace	95	19	Grab			
	Trace	100	20	Grab	GW	SANDY GRAVEL (100-128'); fine gravel; less than 1/2 inch; no water. (OUTWASH)	
	3 ppm	105	21	Grab			
		110	22	Grab			
		115	23	Grab			

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-18D

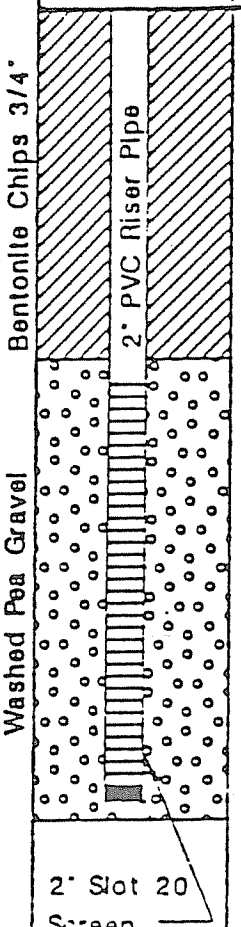
WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite Slurry	Trace	120	24	Grab	GW	SANDY GRAVELS (continued) gravels to 1 inch diameter; medium to coarse sand; clean well sorted; no water.	
		125	25	Grab			
	Trace	130	26	Grab	SM	GRAVELLY SILTY SAND (128-152'); light brown; fine to medium grained; 10-30% coarse sand; gravels present to 1/2 inch diameter; dense; drilling 1-2 ft. open hole; moist. (TILL)	
		135	27	Grab			
		140	28	Grab			1/31/88
		145	29	Grab		@145': increasing silt.	
Bentonite Chips 3/4" 2" PVC Riser Pipe	Trace	150	30	Grab	GW/ SM	SANDY GRAVELS and Interbedded SILTY GRAVELLY SAND (154-164'); light brown gray. SANDY GRAVELS (154-158'); medium to fine gravels; gravels up to 1 1/2 inch in diameter; angular to sub-angular. (continued on next page)	Conductiv 475 umhos, cm
		155	31	Grab			

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-18D



WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		160	32	Grab	GW/SM	SANDY GRAVELS and SILTY SAND INTERBEDDED (continued); SILTY SAND; fine to coarse grained; gravels; 1 inch, angular; able to drill open hole; wet. (TILL/ OUTWASH)	
		165	33	Grab	GW	SANDY GRAVELS (165-BOB); light brown; fine to coarse gravel grained, up to 3 inches, subangular to rounded; trace fine sand; loose; wet. (OUTWASH)	
		170	34	Grab		@174': incrasing silt, color change to medium dark brown; saturated.	
		175	35	Grab		@ 177': increasing silt interbeds of SILTY SAND and SANDY Gravel; saturated.	
		180	36	Grab		Boring Terminated at 179.5 feet.	

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Location (See Figure)

Boring No. MW-20 Regional (GP-12) 8"-30'

Surface Elevation 464.5 ft. (MSL)

Drilling Method Cable Tool 6"-265'

Total Depth 265 feet

Drilled By Tacoma Pump and Drill

Date Completed 3/3/88

Logged By Patrick Dunn

WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		5			GM	SANDY GRAVELS (0-7'); light olive brown; coarse gravel grained; 5-10% fines; 15-30% fine to medium sand; 15-20% coarse sand to fine gravel; gravels sub-rounded to maximum size of 8 inches; medium dense; dry. (OUTWASH)	
	Trace	10	1	Grab	SM	SILTY GRAVELLY SANDS (7-20'); Brown; 30-40 % silt fines; medium to coarse grained; 10-15% fine gravels; trace cobbles; medium density; dry.	
	Trace	20			GM	SILTY SANDY GRAVELS (20-50'); light brownish gray (2.5 Y, 6/2); 25-35% silt fines; 10-20% fine to medium sand; 20-30% coarse sand to fine gravel; 15-25% coarse gravel; trace to 5% cobbles; medium dense; some open hole; dry.	
	Trace	25	2	Grab		@ 25': in-situ sample of 1/2 inch rounded gravels with sand silt binder.	
		30					
		35					

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-20R

WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite Slurry; 2" PVC Riser Pipe		35			GM	SILTY SANDY GRAVELS (continued).	
		40	3	Grab		@ 40-43': olive (5Y, 5/3)	
						@ 43-48': yellowish brown (10 YR, 5/4). (OUTWASH)	3/12/88 Conducti 300 umhos/cm
		50			SM/ SP	SILTY SAND to SAND (50-59'); yellowish brown (10 YR, 5/4); fine to medium grained; 10-15% silt to clay fines; 5-15% fine gravels; subrounded; loose; wet. (TILL)	
	Trace	55	4	Grab			Conducti 245 umhos/cm
		60	5	Grab	SW/ SM	GRAVELLY SILTY SAND to SILTY SAND (57-63'); some color; medium to coarse grained; 15-20% silt fines; 20-25% fine sand; 10-15% fine gravel; 5-10% coarse gravel to cobbles; medium density; making water. (TILL)	Conducti 230 umhos/cm
		65			GM	SITLY GRAVELS (63-68'); yellowish brown; prominent gravels; 20-30% fines; dense; saturated. (TILL)	
	Trace	70	6	Grab	SW	GRAVELLY SAND (69-77'); light olive brown (2.5 Y, 5/4); coarse grained; 5-10% fines; 20-25% fine to medium sand; 15-20% fine to gravels; subrounded; saturated. (OUTWASH)	Conducti 230 umhos/cm

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-20R

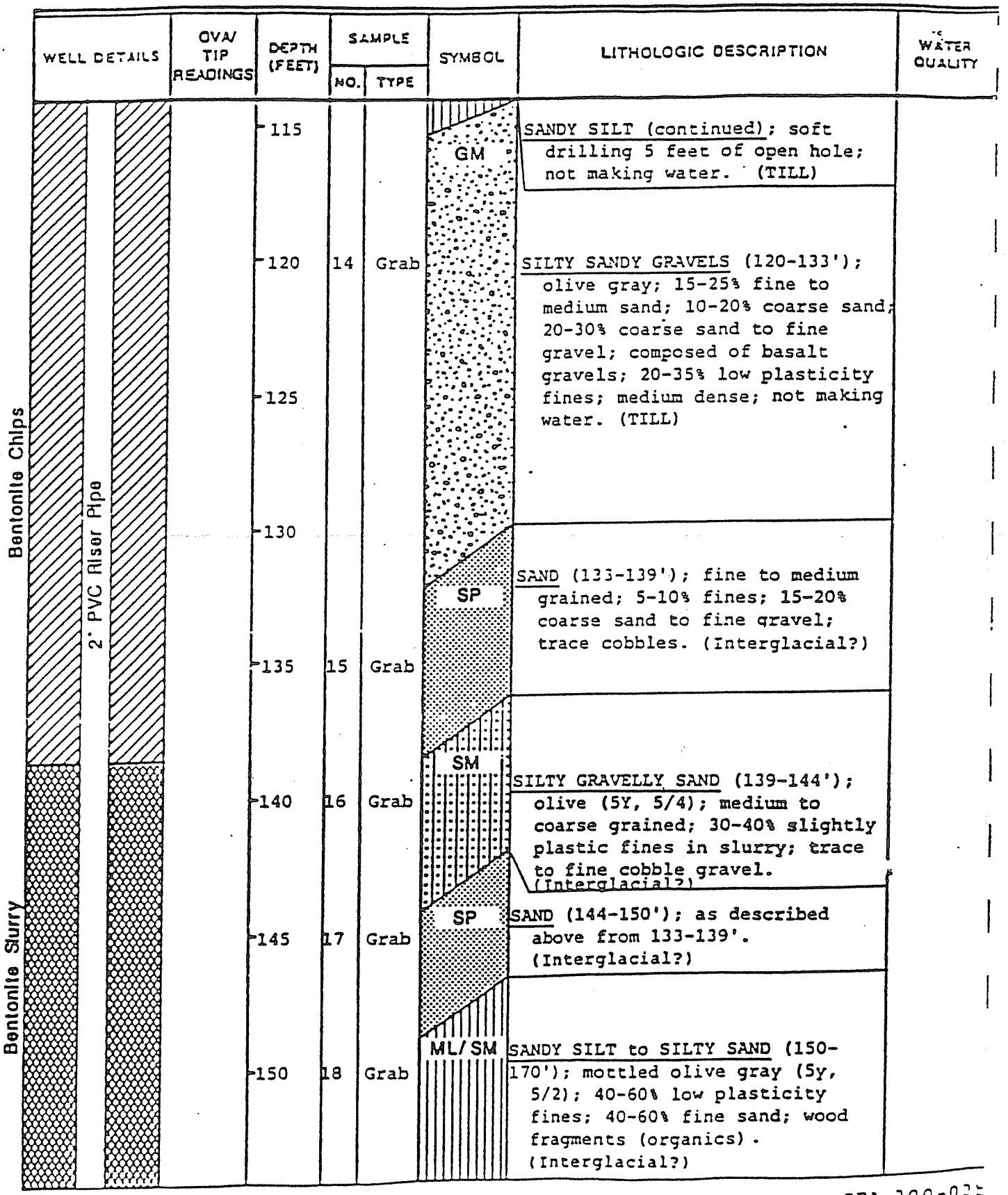
WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite Chips; 2" PVC Riser Pipe					SW	GRAVELLY SAND (continued)	
		75			GM	SILTY SANDY GRAVEL (77-83'); light olive brown (5Y, 5/4); fine gravel grained; 20-30% silt fines; 30-40% fine to medium sand; 15% coarse sand; dense; not making water. (TILL Interbed)	
		80	7	Grab	SW	GRAVELLY SAND (83-90'); olive brown (2.5Y, 4/4); medium grained; 5-10% silt fines; 15-20% fine to medium gravels; rounded composed of granitic rocks; 5-10% cobbles, subrounded to rounded; dense; making water. (OUTWASH)	
		85	9	Grab			
		90	10	Grab	GP		
		95	11	Grab		SANDY SILTY GRAVELS (90-110'); olive brown; fine gravel to cobble grained; 10-20% fine to medium sand; hard drilling; saturated. (TILL)	Conductivi 185 umhos/cm
		100					
		105	12	Grab		@ 106-110': 30-40% low plasticity fines; color change to yellowish-brown.	
		110			ML	SANDY SILT (110-115'); olive gray (5Y, 5/2); low plasticity fines; 15-20% fine to medium sand; 10-15% coarse sand to fine gravel; (continued on next page) -	3/3/

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-20R



Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-20R

WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite Slurry; 2" PVC Riser Pipe		155			ML/SM	SANDY SILT to SILTY SAND (continued); very loose drilling; making some water. (Interglacial?)	
		160					
		165					
		170	19	Grab	SW/GP	GRAVELLY SAND to SANDY GRAVEL; (169-179'); black; coarse sand to fine gravel grained; 5-10% fines; 15-20% fine to medium sand; trace cobbles; dense; not making water. (Interglacial?)	
		175					
		180	20	Grab	SW/ML	GRAVELLY SAND to SANDY SILT Interbedded (179-185'); gray. (Interglacial?)	
		185			SM	SILTY SAND (185-198'); very dark grayish brown (2.5 Y, 3/2); medium graied; 10-20% fines; trace gravels; loose; making little water. (Interglacial?)	
		190	21	Grab			Conductivi 135 umhos

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-20R

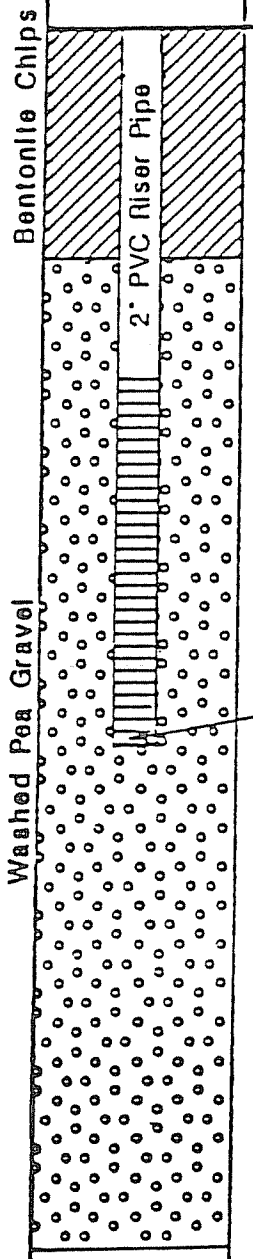
WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
Bentonite Slurry; 2" PVC Riser Pipe; Bentonite Chips		195			SM	SILTY SAND (continued). (Interglacial?)	
		200			SW	GRAVELLY SAND (198-210'); very dark brown (2.5Y, 3/2); medium coarse grained; trace to 10% fines; 10-20% gravels, sub-rounded; 1 inch diameter; dense. (OUTWASH)	
		205					
		210	24	Grab	GW/SM	SILTY SANDY GRAVEL to SILTY GRAVELLY SAND (210-247'); very dark grayish brown; 10-20% low plasticity fines; 15-30% fine sand; 20-30% coarse sand; 15-30% fine to coarse gravel; rounded rhyolitic in composition; dense; hole staying open 15 ft. (TILL)	
		215					
		220					
		225				@225-230': finer grained a lot more silt.	
		230					

Sweet-Edwards/EMCON, Inc.

BORING LOG

PROJECT Thun Field Landfill Site

Boring No. MW-20R



WELL DETAILS	OVA/ TIP READINGS	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SYMBOL	LITHOLOGIC DESCRIPTION	WATER QUALITY
		235			GW/ SM	SILTY SANDY GRAVEL to SILTY GRAVELLY SAND (continued). @ 235-250': increasing amount of silty sand stringers which make good water. (OUTWASH)	
		240					
		245	25	Grab		@ 245': losing open hole.	
					GW	SAND AND GRAVEL (247-255'); olive coarse sand to fine gravel grained; trace fines; 10-20% fine to medium sand; 15-20% cobbles and boulders; composed of mafic to felsic rock; rounded; up to 4 inches in size; loose; making water. (OUTWASH)	
		250	26	Grab			
		255	27	Grab	SM	SILTY SAND (255-265'); olive gray (2.5Y, 4/2); fine grained; 25-35% low plasticity fines; 5-15% medium to coarse grained sand; trace gravels; medium dense; making water ; saturated. (OUTWASH)	
		260	28	Grab			
		265	29	Grab		Boring terminated at 265 feet.	

LOG OF EXPLORATORY BORING

PROJECT NAME	Phase II Remedial Investigation	BORING NO.	MW-26R
LOCATION	Hidden Valley Landfill	PAGE	1 OF 10
DRILLED BY	Hayes Drilling	REFERENCE ELEV.	
DRILL METHOD	Air-Rotary	TOTAL DEPTH	199.00'
LOGGED BY	John North	DATE COMPLETED	12/22/89

SAMPLE NUMBER	SAMPLE METHOD	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOLOGIC COLUMN	WELL DETAILS	LITHOLOGIC DESCRIPTION
							0 - 1 foot: FILL GRAVEL.
			5				— @ 5 feet: large cobbles.
S-1	GRAB		10				10 - 57 feet: GRAVELS: fine to 0.5"; subrounded to subangular; 10-15% silts; moist.
			15				
			20				

REMARKS

Well construction materials: 2" sch 40 flush-threaded PVC blank, 2" sch 40 0.010" factory slotted PVC screen, FILTER PACK = washed pea gravel, SEAL MATERIAL = medium and coarse bentonite chips. Locking steel monument cemented in place at surface.

LOG OF EXPLORATORY BORING

PROJECT NAME	Phase II Remedial Investigation	BORING NO.	MW-26R
LOCATION	Hidden Valley Landfill	PAGE	2 OF 10
DRILLED BY	Hayes Drilling	REFERENCE ELEV.	
DRILL METHOD	Air-Rotary	TOTAL DEPTH	199.00'
LOGGED BY	John North	DATE COMPLETED	12/22/89

SAMPLE NUMBER	SAMPLE METHOD	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHO-LOGIC COLUMN	WELL DETAILS	LITHOLOGIC DESCRIPTION
S-2	GRAB						
			25				— @ 28 feet: very rocky. — scattered fine to coarse sand.
S-3	GRAB		30				
			35				
			40				

REMARKS

Well construction materials: 2" sch 40 flush-threaded PVC blank, 2" sch 40 0.010" factory slotted PVC screen, FILTER PACK = washed pea gravel, SEAL MATERIAL = medium and coarse bentonite chips. Locking steel monument cemented in place at surface.

LOG OF EXPLORATORY BORING

PROJECT NAME	Phase II Remedial Investigation	BORING NO.	MW-26F
LOCATION	Hidden Valley Landfill	PAGE	3 OF 10
DRILLED BY	Hayes Drilling	REFERENCE ELEV.	
DRILL METHOD	Air-Rotary	TOTAL DEPTH	199.00'
LOGGED BY	John North	DATE COMPLETED	12/22/89

SAMPLE NUMBER	SAMPLE METHOD	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHO-LOGIC COLUMN	WELL DETAILS	LITHOLOGIC DESCRIPTION
S-4	GRAB		45				— 45 - 53 feet: very rocky, drilling hard.
S-5	GRAB		50				
			55				56 - 90 feet: SILTY SANDY GRAVEL; browns; sand fine to medium; scattered coarse; gravel fine to 0.5", subrounded to subangular; 10-20% silt; moist. (RECESSIONAL) — @ 57 feet; gravel fining, silt increasing.
			60				

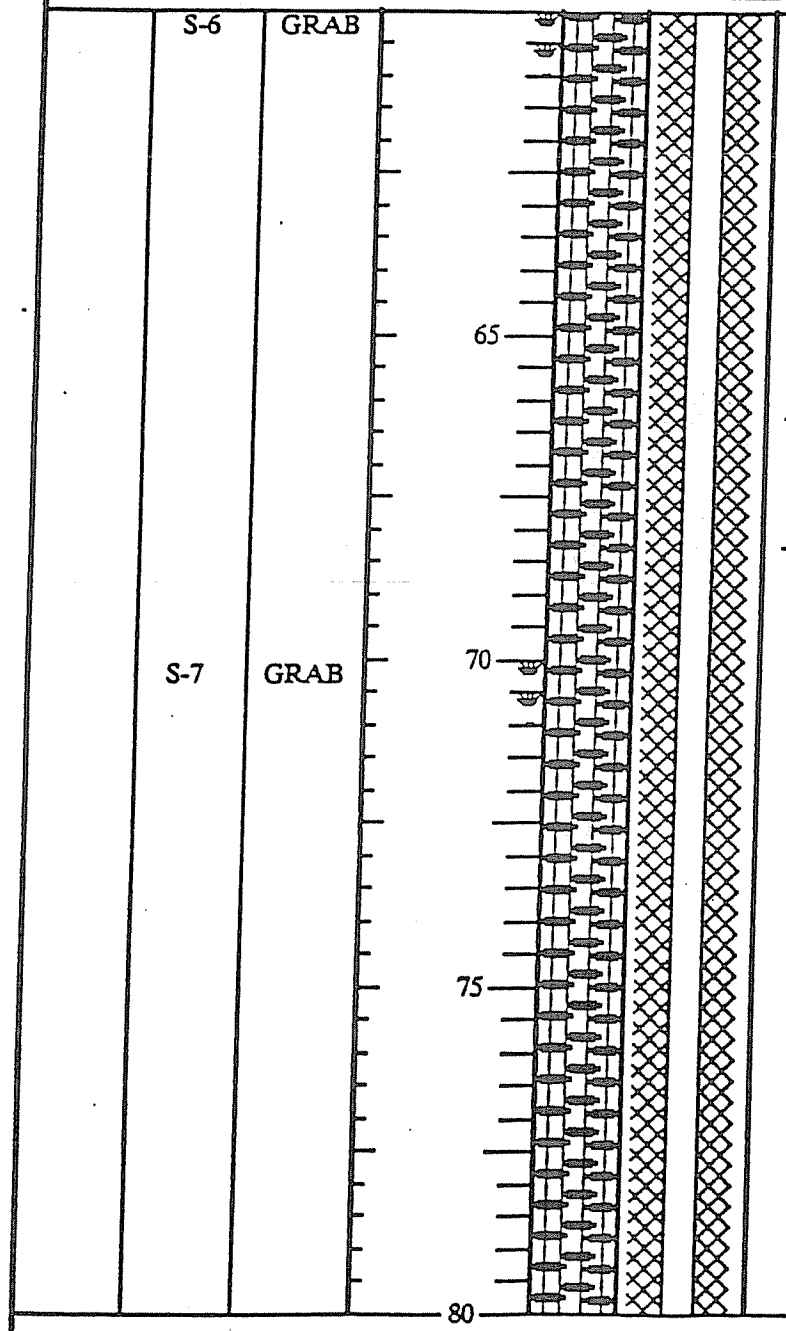
REMARKS

Well construction materials: 2" sch 40 flush-threaded PVC blank, 2" sch 40 0.010" factory slotted PVC screen, FILTER PACK=washed pea gravel, SEAL MATERIAL=medium and coarse bentonite chips. Locking steel monument cemented in place at surface.

LOG OF EXPLORATORY BORING

PROJECT NAME	Phase II Remedial Investigation	BORING NO.	MW-26R
LOCATION	Hidden Valley Landfill	PAGE	4 OF 10
DRILLED BY	Hayes Drilling	REFERENCE ELEV.	
DRILL METHOD	Air-Rotary	TOTAL DEPTH	199.00'
LOGGED BY	John North	DATE COMPLETED	12/22/89

SAMPLE NUMBER	SAMPLE METHOD	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHO-LOGIC COLUMN	WELL DETAILS	LITHOLOGIC DESCRIPTION
S-6	GRAB		65				— @ 66 feet: very moist.
							— @ 68 feet: wet.
S-7	GRAB		70				
			75				
			80				



REMARKS

Well construction materials: 2" sch 40 flush-threaded PVC blank, 2" sch 40 0.010" factory slotted PVC screen, FILTER PACK = washed pea gravel, SEAL MATERIAL = medium and coarse bentonite chips. Locking steel monument cemented in place at surface.

LOG OF EXPLORATORY BORING

PROJECT NAME	Phase II Remedial Investigation	BORING NO.	MW-26R
LOCATION	Hidden Valley Landfill	PAGE	5 OF 10
DRILLED BY	Hayes Drilling	REFERENCE ELEV.	
DRILL METHOD	Air-Rotary	TOTAL DEPTH	199.00'
LOGGED BY	John North	DATE COMPLETED	12/22/89

SAMPLE NUMBER	SAMPLE METHOD	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHO-LOGIC COLUMN	WELL DETAILS	LITHOLOGIC DESCRIPTION
S-8	GRAB		85				— @ 80 feet: water, 10-20 gpm at surface increasing sand, decreasing silt.
S-9	GRAB		90				90 - 102 feet; GRAVELLY SAND; orange; sand fine to medium; gravel fine to 0.5"; saturated, water 10-20 gpm at surface.
			95				
			100				

REMARKS

Well construction materials: 2" sch 40 flush-threaded PVC blank, 2" sch 40 0.010" factory slotted PVC screen, FILTER PACK = washed pea gravel, SEAL MATERIAL = medium and coarse bentonite chips. Locking steel monument cemented in place at surface.

LOG OF EXPLORATORY BORING

PROJECT NAME	Phase II Remedial Investigation	BORING NO.	MW-26R
LOCATION	Hidden Valley Landfill	PAGE	6 OF 10
DRILLED BY	Hayes Drilling	REFERENCE ELEV.	
DRILL METHOD	Air-Rotary	TOTAL DEPTH	199.00'
LOGGED BY	John North	DATE COMPLETED	12/22/89

SAMPLE NUMBER	SAMPLE METHOD	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOLOGIC COLUMN	WELL DETAILS	LITHOLOGIC DESCRIPTION
S-10	GRAB						
							102 - 104 feet: SAND; medium; scattered fine gravel.
			105				104 - 112 feet: SANDY GRAVEL; browns; sand medium to coarse; gravel fine to medium; 10-15% silt.
S-11	GRAB		110				
S-12	GRAB						112 - 114 feet: SILT; dark brown; very dark; non-saturated. (TILL)
			115				114 - 121 feet: SANDY GRAVEL; (ADVANCE)
							— @ 118 feet: water, approximately 100 gpm at surface.
			120				

REMARKS

Well construction materials: 2" sch 40 flush-threaded PVC blank, 2" sch 40 0.010" factory slotted PVC screen, FILTER PACK = washed pea gravel, SEAL MATERIAL = medium and coarse bentonite chips. Locking steel monument cemented in place at surface.

LOG OF EXPLORATORY BORING

PROJECT NAME	Phase II Remedial Investigation	BORING NO.	MW-26R
LOCATION	Hidden Valley Landfill	PAGE	7 OF 10
DRILLED BY	Hayes Drilling	REFERENCE ELEV.	
DRILL METHOD	Air-Rotary	TOTAL DEPTH	199.00'
LOGGED BY	John North	DATE COMPLETED	12/22/89

SAMPLE NUMBER	SAMPLE METHOD	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHO-LOGIC COLUMN	WELL DETAILS	LITHOLOGIC DESCRIPTION
S-13	GRAB						
S-14	GRAB						121 - 124 feet: SILTY CLAY; orange; trace coarse sand, fine gravel; non-saturated, medium plasticity. (TILL)
			125				124 - 165 feet: GRAVEL; browns and greys; gravels dark grey, subangular, fine to 0.75"; scattered fine to medium sand and silt; saturated; approximately 100 gpm at surface. (INTERGLACIAL)
S-15	GRAB		130				
			135				
			140				

REMARKS

Well construction materials: 2" sch 40 flush-threaded PVC blank, 2" sch 40 0.010" factory slotted PVC screen, FILTER PACK = washed pea gravel, SEAL MATERIAL = medium and coarse bentonite chips. Locking steel monument cemented in place at surface.

LOG OF EXPLORATORY BORING

PROJECT NAME	Phase II Remedial Investigation	BORING NO.	MW-26R
LOCATION	Hidden Valley Landfill	PAGE	8 OF 10
DRILLED BY	Hayes Drilling	REFERENCE ELEV.	
DRILL METHOD	Air-Rotary	TOTAL DEPTH	199.00'
LOGGED BY	John North	DATE COMPLETED	12/22/89

SAMPLE NUMBER	SAMPLE METHOD	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOLOGIC COLUMN	WELL DETAILS	LITHOLOGIC DESCRIPTION
S-16	GRAB		145				
S-17	GRAB		150				
			155				
			160				

REMARKS

Well construction materials: 2" sch 40 flush-threaded PVC blank, 2" sch 40 0.010" factory slotted PVC screen, FILTER PACK = washed pea gravel, SEAL MATERIAL = medium and coarse bentonite chips. Locking steel monument cemented in place at surface.

LOG OF EXPLORATORY BORING

PROJECT NAME	Phase II Remedial Investigation	BORING NO.	MW-26F
LOCATION	Hidden Valley Landfill	PAGE	9 OF 10
DRILLED BY	Hayes Drilling	REFERENCE ELEV.	
DRILL METHOD	Air-Rotary	TOTAL DEPTH	199.00'
LOGGED BY	John North	DATE COMPLETED	12/22/89

SAMPLE NUMBER	SAMPLE METHOD	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOLOGIC COLUMN	WELL DETAILS	LITHOLOGIC DESCRIPTION
S-18	GRAB						
			165				165 - 174 feet: FINE SANDY SILTY CLAY; blue-grey; sand fine to medium; moist. (TILL)
S-19	GRAB						
			170				
S-20	GRAB						
			175				174 - 198 feet: GRAVEL; dark green/black; scattered sand; trace silt; trace red porous rock fragments. (ADVANCE)
			180				

REMARKS

Well construction materials: 2" sch 40 flush-threaded PVC blank, 2" sch 40 0.010" factory slotted PVC screen, FILTER PACK = washed pea gravel, SEAL MATERIAL = medium and coarse bentonite chips. Locking steel monument cemented in place at surface.

LOG OF EXPLORATORY BORING

PROJECT NAME	Phase II Remedial Investigation	BORING NO.	MW-26R
LOCATION	Hidden Valley Landfill	PAGE	10 OF 10
DRILLED BY	Hayes Drilling	REFERENCE ELEV.	
DRILL METHOD	Air-Rotary	TOTAL DEPTH	199.00'
LOGGED BY	John North	DATE COMPLETED	12/22/89

SAMPLE NUMBER	SAMPLE METHOD	GROUND WATER LEVELS	DEPTH IN FT.	SAMPLES	LITHOLOGIC COLUMN	WELL DETAILS	LITHOLOGIC DESCRIPTION
S-21	GRAB		185				
S-22	GRAB		190				
S-23	GRAB		195				— @ 196 feet: water, 30 to 40 gpm at surface.
S-24	GRAB		200				Boring terminated at 198 feet.

REMARKS

Well construction materials: 2" sch 40 flush-threaded PVC blank, 2" sch 40 0.010" factory slotted PVC screen, FILTER PACK = washed pea gravel, SEAL MATERIAL = medium and coarse bentonite chips. Locking steel monument cemented in place at surface.

SCS ENGINEERS

BORING LOG

2405 140th Avenue NE, Suite 107
Bellevue, Washington 98005-1877

BORING NUMBER: MW-29S

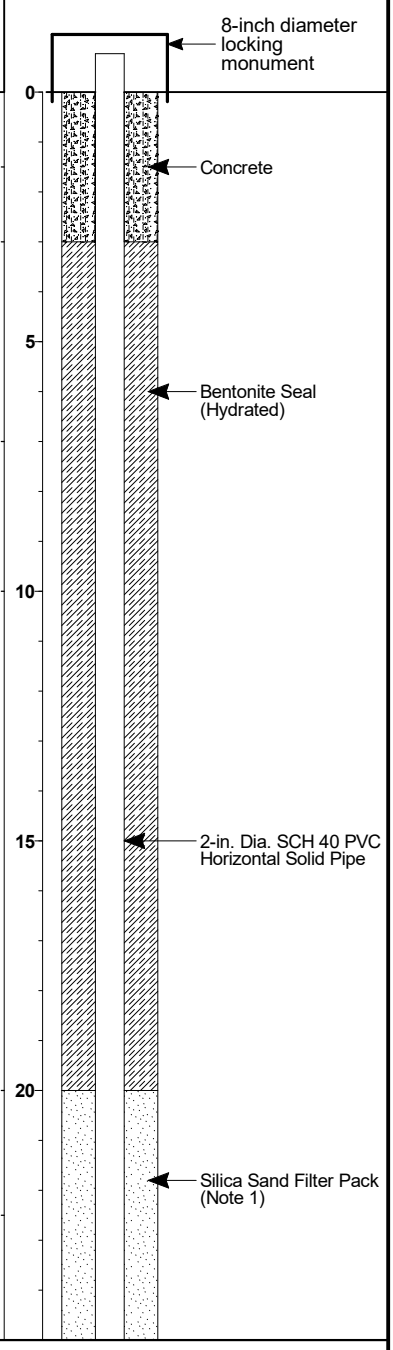
Hidden Valley Landfill, 2017 GW Well
17925 Meridian East
Puyallup, Washington

JOB NUMBER: 04217003.03

REMARKS:
Start Card BJP-898

Depth (meters)	Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Graphic Log	Description
0	0					ML		SILT with clay and few angular gravel. Brown. Moist. (Topsoil)
						GW		Well-graded, angular GRAVEL with fine to medium sand. Light brown-gray. Moist.
1						SW		Fine to medium SAND with well-graded, angular to sub-rounded gravel (0.5" to 3" dia.). Light brown. Dry to moist.
	5							
2						GW		Well-graded, sub-rounded GRAVEL (0.5"-3" dia.) with sand and silt. Brown. Moist. (Outwash)
3	10					GW-GM		SILTY SANDY GRAVEL. Well-graded, sub-angular gravel (0.25"-3" dia.). Gray-brown. Moist to wet. (Outwash)
4								▽ Encountered groundwater at 13.5 ft-bgs while drilling on 11/30/2017 at 11:40 AM.
	15							
5								Decreasing silt with depth.
6	20					GW		Well-graded, sub-angular GRAVEL (0.5"-3" dia.) with little medium-grained sand. Light brown. Wet. (Outwash)
7						SW-SM		Medium to coarse-grained GRAVELLY SAND, well-graded to sub-rounded gravel, trace silt. Brown. Wet. (Outwash)
	25							

Completion Detail



Drilling Company: **Cascade Drilling**
Drilling Method: **Sonic**
Logged By: **Sam Graber**

Date Started: **11/30/17**
Date Ended: **12/4/17**
Boring Diameter: **6-inch**
Well Diameter: **2-inch**
Total Depth: **37.5 ft.**

STANDARD_LOG 04217003.03 HVL GW WELLS 2017.GPJ STD_LOG.GDT 1/19/18

2405 140th Avenue NE, Suite 107
Bellevue, Washington 98005-1877

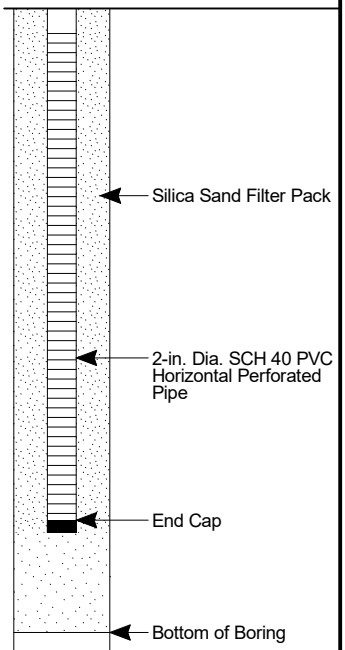
BORING NUMBER: MW-29S

Hidden Valley Landfill, 2017 GW Well

JOB NUMBER: 04217003.03

Depth (meters)	Depth (feet)	Sample Location	Sample Number	Blow Counts	OVM (ppm)	USCS Soil Class.	Graphic Log	Description
8	25					SW-SM		Medium to coarse-grained GRAVELLY SAND cont.
						ML		GRAVELLY SILT, sub-rounded gravel (1" dia.). Gray-brown. Moist.
9	30					GW		Well graded, sub-angular SANDY GRAVEL (0.5"-2" dia.), coarse sand, trace silt. Light brown-gray. Wet. (Outwash)
10								
11	35					GM		Well-graded, sub-angular GRAVEL with silt and trace sand. Brown. Moist. Very dense.(Till)
12	40							Notes: 1: Well material from 20' to 22.5' is a mixture of slough and silica sand filter pack. 2: A continuous core sample of subsurface soil was collected during drilling. 3: This boring was re-drilled to the original depth on December 4, 2017.
13								
14	45							
15								
16	50							
	55							

Completion Detail



Boring & Well Construction Log

Kennedy/Jenks Consultants

BORING LOCATION	SOUTH HILL FRED MEYER		
DRILLING COMPANY	CASCADE DRILLING INC.	DRILLER	MIKE COLBERT
DRILLING METHOD	AIR ROTARY	DRILL BIT(S) SIZE:	9 5/8" O.D.
ISOLATION CASING	N.A.	FROM	TO FT.
BLANK CASING	4" SCH 40 PVC	FROM 0.0	TO 123.0 FT.
PERFORATED CASING	4" SCH 40 PVC, 0.010 FACTORY SLOTTED	FROM 123.0	TO 153.0 FT.
SIZE AND TYPE OF FILTER PACK	#2/12 LONESTAR SAND	FROM 120.0	TO 154.0 FT.
SEAL	BENTONITE CHIPS	FROM 2.0	TO 54.0 FT.
GROUT	VOLCLAY GROUT	FROM 54.0	TO 120.0 FT.

Boring/Well Name	FMMW-1
Project Name	FRED MEYER
Project Number	966064.00
ELEVATION AND DATUM	TOTAL DEPTH 158.0
DATE STARTED 08/20/1996	DATE COMPLETED 08/20/1996
INITIAL WATER DEPTH (FT) 141.0	
LOGGED BY T. MORIN	
SAMPLING METHODS GRAB (CYCLONE)	WELL COMPLETION ■ SURFACE HOUSING ▭ STAND PIPE ____ FT.

SAMPLES TYPE	RECOVERY (FEET)	PENETRATION RESIST (BLOWS/6 IN.)	DEPTH (FEET)	SAMPLE NO.	WELL CONSTRUCTION	LITHOLOGY	USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
			0					**SILT with gravel; light gray, dry to** damp, hard; mostly silt, 15–30% fine to coarse subrounded gravel, trace fine sand
								dark gray, numerous rock fragments
			5				ML	
								sandier (15%) w/ clay (10%); plastic fines (1/8" worm)
			10					**Silty GRAVEL with sand; dark gray, damp** to moist, very dense; mostly fine to coarse subrounded gravel, some silt (~25%), some fine sand (~15%), some clay (10%); appears grain-supported
							GM	
S	1.0	40 60	15					**Silty SAND with gravel; lt. olive brown** damp to moist, mostly medium sand, some fine to medium subrounded gravel, minor plastic fines; 0.0 ppmv PID
							SM	
S	0.8	70 100/4	20					clay fraction increases (10–15%); 0.0 ppmv
								Poorly graded GRAVEL with silt; lt. gray dense, moist; mostly fine to medium subrounded gravel, some fine to medium sand, some silt, trace clay; grain-supported w/ sand dominated matrix
			25				GP/ GM	
								increase in relative % grains to matrix; gravel becomes more well-graded; 0.0 ppmv
			30					

Boring & Well Construction Log

Kennedy/Jenks Consultants

Project Name FRED MEYER **Project Number** 966064.00 **Boring/Well Name** FMMW-1

SAMPLES TYPE	SAMPLES RECOVERY (FEET)	SAMPLES PENETRATION RESIST (BLOWS/6 IN.)	DEPTH (FEET)	SAMPLE NO.	WELL CONSTRUCTION	LITHOLOGY	USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
S	0.4	72 105					GP/ GM	
			35					**Poorly graded SAND with gravel; dark** gray, damp, dense; mostly coarse sand (70%), some fine gravel, some (15%) fines
							SP	
S	0.2	100/2	40					
			45					**Poorly graded GRAVEL; dark gray, moist** dense; mostly medium to coarse subangular gravel, some fine to medium sand, up to 15% cohesive fines
								sandier, less cohesive fines
S	0.2	100/1	50					
			55				GP	"tag-on" air compressor required to overcome air losses to formation (highly conductive) having trouble transporting cuttings up casing
S		100	60					
			65					mostly (90%) small rock frags./drilling as cobble zone
			70					

Boring & Well Construction Log

Kennedy/Jenks Consultants

Project Name FRED MEYER **Project Number** 966064.00 **Boring/Well Name** FMMW-1

SAMPLES TYPE	SAMPLES RECOVERY (FEET)	SAMPLES PENETRATION RESIST (BLOWS/6 IN.)	DEPTH (FEET)	SAMPLE NO.	WELL CONSTRUCTION	LITHOLOGY	USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
S		100					GP	
			75				GW	**Well-graded GRAVEL; buff gray, damp,** very dense; mostly subrounded to subangular gravel, some minor sandy/silty matrix
S	0.2	100/2	80					
			85				GP	**Poorly graded GRAVEL; gray, damp to** moist; mostly fine subangular gravel, some fine sand & silt matrix gravel coarsens, increase in % sand/fines cobbly zone from 85 to 87.5
S	0.1	100/1	90					
			95					grades to possible Poorly Graded GRAVEL with SAND (sand fraction increases to ~20%) possible perched water from 94.5 to 104.0
S	0.3	100/3	100				GP	**Poorly graded GRAVEL with sand; gray,** wet, very dense; mostly fine to medium subrounded gravel, sand matrix with minor clay; cobbly from 102 to 104
			105				GP/ GC	**Poorly graded GRAVEL with clay; grey,** wet, very dense; mostly fine to medium subrounded gravel, silty/clayey matrix
S	0.8	7 8 15	110				GP	**Poorly graded GRAVEL with sand; grey,** moist, very dense; mostly fine to medium subrounded gravel, sand matrix; cobbly from 112 to 114; some non-plastic fines in matrix (possibly "rock flour")

Boring & Well Construction Log

Kennedy/Jenks Consultants

Project Name FRED MEYER **Project Number** 966064.00 **Boring/Well Name** FMMW-1

SAMPLES TYPE	SAMPLES RECOVERY (FEET)	SAMPLES PENETRATION RESIST (BLOWS/6 IN.)	DEPTH (FEET)	SAMPLE NO.	WELL CONSTRUCTION	LITHOLOGY	USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
			115					very cobbly from 116 to 127, hammer is grinding rock and casing is driving very hard; temporarily switched to Tri-cone bit but formation was too hard and ruined rollers
S	0.2	100	120					
S	0.2	100/1	125				GP	
S	0.1	100/1	130					grey, damp, very dense, mostly medium to coarse subangular gravel, coarse sand matrix w/ 25% non-plastic fines
S	0.2	100/1	135					
			140					continues as cobbles with sand/gravel matrix
			145					fewer cobbles, moist at 143
			150				GP/GM	**Poorly graded GRAVEL with silt and sand** brown, moist to wet, dense; mostly coarse subrounded to subangular gravel with coarse angular sand, minor cohesive fines in matrix; cuttings become wet at 149

Boring & Well Construction Log

Kennedy/Jenks Consultants

Project Name FRED MEYER **Project Number** 966064.00 **Boring/Well Name** FMMW-1

SAMPLES TYPE	SAMPLES RECOVERY (FEET)	SAMPLES PENETRATION RESIST (BLOWS/6 IN.)	DEPTH (FEET)	SAMPLE NO.	WELL CONSTRUCTION	LITHOLOGY	USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
S	0.2	100/2						
			155				GM	Silty GRAVEL; brown, moist to wet, mostly medium to coarse subrounded gravel w/ sandy silt matrix (70% silt, 30% sand)
			160					
			165					
			170					
			175					
			180					
			185					
			190					

Boring & Well Construction Log

Kennedy/Jenks Consultants

BORING LOCATION	SOUTH HILL FRED MEYER
DRILLING COMPANY	CASCADE DRILLING INC.
DRILLER	MIKE COLBERT
DRILLING METHOD	AIR ROTARY
DRILL BIT(S) SIZE:	9 5/8" O.D.

		FROM	TO	FT.
ISOLATION CASING	N.A.			
BLANK CASING	4" SCH 40 PVC	0.0	118.0	FT.
PERFORATED CASING	4" SCH 40 PVC, 0.010 FACTORY SLOTTED	118.0	148.0	FT.
SIZE AND TYPE OF FILTER PACK	#2/12 LONESTAR SAND	115.0	149.0	FT.
SEAL	BENTONITE CHIPS	2.0	115.0	FT.
GROUT	CONCRETE	0.0	2.0	FT.

Boring/Well Name	FMMW-2
Project Name	FRED MEYER
Project Number	966064.00
ELEVATION AND DATUM	
TOTAL DEPTH	157.0
DATE STARTED	08/22/1996
DATE COMPLETED	08/23/1996
INITIAL WATER DEPTH (FT)	134.0
LOGGED BY	T. MORIN
SAMPLING METHODS	GRAB (CYCLONE)
WELL COMPLETION	■ SURFACE HOUSING; ▭ STAND PIPE _____ FT.

SAMPLES TYPE	SAMPLES RECOVERY (FEET)	SAMPLES PENETRATION RESIST (BLOWS/6 IN.)	DEPTH (FEET)	SAMPLE NO.	WELL CONSTRUCTION	LITHOLOGY	USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
			0				ML	**SILT with gravel; lt. gray, dry to** damp, hard; mostly silt, 30% fine to coarse subrounded gravel, trace fine sand
			5					dark gray
			10				GP/ GC	**Poorly graded GRAVEL with clay;** bluish gray,damp, dense; mostly medium to coarse gravel, matrix consists primarily of plastic fines and fine sand, minor coarse sand/fine gravel (1/8" worm possible with matrix)
			15					
S	0.8	40 48 60/4	20				SM	**Silty SAND with gravel; lt. olive brown** damp, dense; mostly medium to fine sand (~60%), some non-plastic fines (30%), minor fine to coarse gravel
			25				GP/ GM	**Poorly graded GRAVEL with silt; brown** damp, dense; mostly fine to medium subrounded gravel, some fine to medium sand, up to 30% silt
			30					gravel fines, fines become more plastic

Boring & Well Construction Log

Kennedy/Jenks Consultants

Project Name FRED MEYER **Project Number** 966064.00 **Boring/Well Name** FMMW-2

SAMPLES TYPE	SAMPLES RECOVERY (FEET)	SAMPLES PENETRATION RESIST (BLOWS/6 IN.)	DEPTH (FEET)	SAMPLE NO.	WELL CONSTRUCTION	LITHOLOGY	USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
S	0.4	50 100/4					GP/ GM	decrease in % fines, moist
			35					
								Poorly graded SAND with gravel; gray, damp to moist, dense; mostly coarse subangular sand, some fine to coarse gravel, some plastic fines
S	0.7	20 24 42	40				SP	
								Poorly graded GRAVEL with sand; gray, damp to moist, mostly fine to medium gravel, some fine to medium sand (matrix), some/minor plastic fines
			45				GP	
								Poorly graded GRAVEL; gray, damp to dry very dense; 85% coarse to medium subrounded gravel, little matrix
S	0.2	100/2	50					gravel fines at 50
			55					
							GP	
S	0.2	100/2	60					
								minor variations in matrix composition
			65					
			70					

Boring & Well Construction Log

Kennedy/Jenks Consultants

Project Name FRED MEYER **Project Number** 966064.00 **Boring/Well Name** FMMW-2

SAMPLES TYPE	SAMPLES RECOVERY (FEET)	SAMPLES PENETRATION RESIST (BLOWS/6 IN.)	DEPTH (FEET)	SAMPLE NO.	WELL CONSTRUCTION	LITHOLOGY	USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
S		100/1	75				GP	gravel fines, olive gray color, some fines in matrix
S	0.2	100/2	80				GW	**Well-graded GRAVEL; gray, damp to moist** dense, subrounded to subangular gravel, silt and clay matrix w/ 30% sand
S	0.9	50 50 100/4	90				GP	**Poorly graded GRAVEL with sand; gray** damp, very dense; mostly fine to medium subrounded gravel, some sand matrix, trace fines
S	0.3	100	100				SP	**Poorly graded SAND; olive gray, damp** medium dense; 90% medium sand, trace silt, trace fine gravel
			105					
			110					

Boring & Well Construction Log

Kennedy/Jenks Consultants

Project Name FRED MEYER **Project Number** 966064.00 **Boring/Well Name** FMMW-2

SAMPLES TYPE	SAMPLES RECOVERY (FEET)	SAMPLES PENETRATION RESIST (BLOWS/6 IN.)	DEPTH (FEET)	SAMPLE NO.	WELL CONSTRUCTION	LITHOLOGY	USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
S	0.8	20 26 29						
			115					Well-graded GRAVEL with sand; gray, damp, dense; mostly subrounded gravel w/ up to 40% sand matrix (same sand as above but with 60-80% gravel)
								large cobbles from 117 to 121
S	0.2	100	120					
								matrix material appears to be coarse sand and very fine gravel
			125				GW	
S		100	130					
			135					
S	0.1	100/1	140					
			145				GP/GM	Poorly graded GRAVEL with silt and sand gray, damp to moist, mostly fine to medium subrounded to rounded gravel, some coarse sand and silt matrix
								moist to wet, occasional cobble; wet at 147
			150					

Boring & Well Construction Log

Kennedy/Jenks Consultants

Project Name FRED MEYER **Project Number** 966064.00 **Boring/Well Name** FMMW-2

SAMPLES TYPE	SAMPLES RECOVERY (FEET)	SAMPLES PENETRATION RESIST (BLOWS/6 IN.)	DEPTH (FEET)	SAMPLE NO.	WELL CONSTRUCTION	LITHOLOGY	USCS LOG	SAMPLE DESCRIPTION AND DRILLING REMARKS
S	0.2	100/2						
			155				GP/ GM	brown, matrix becomes more plastic, continues wet
			160					
			165					
			170					
			175					
			180					
			185					
			190					