FILE COPY

Sun Refining and Marketing Company
3144 Passyunk Avenue
Philadelphia PA 19145-5299
215 339 2000

September 23, 1993

Mr. Steve O'Neil
Chief, Operations Section
Commonwealth of Pennsylvania
Department of Environmental Resources
Lee Park, Suite 6010
555 North Lane
Conshohocken, PA 19428

RE: Sun Company, Inc. (R&M)
Philadelphia Refinery
Comprehensive Remedial Plan

Dear Mr. O'Neil:

This letter is written as a follow-up response to my letter of August 26, 1993. Both letters are written in response to your August 4, 1993 letter concerning the June 28, 1993 and July 15, 1993 supplements to the Comprehensive Remedial Plan for the Sun Company, Inc. (R&M) (Sun) Philadelphia Refinery. Only those items which Sun planned on submitting to the PaDER by September 24, 1993 are discussed in this letter; the numbering system used in your August 4, 1993 letter has been used to provide a consistent cross-reference.

A. **June 28, 1993 Supplement**

2. Appendix B - 26th Street Sewer

a. Attached, as Appendix I, is a Groundwater Assessment Report completed by Sun's consultant, Groundwater and Environmental Services, Inc. (GES), for three areas in the Refinery, including the 26th Street Sewer area. Unanticipated problems and additional field work to characterize this area caused a delay in the issuance of the Investigative Work Report from the originally planned date of August 31, 1993. A conceptual Remedial Action Plan is scheduled for completion and submittal to the PaDER by October 31, 1993.

4. Comment No. 4 of June 28, 1993 letter

a. Attached, as Appendix II, is a work plan completed by Sun's consultant, ENSR Consulting and Engineering, to evaluate the potential migration of

contaminants into the deep aquifer. Sun will initiate this work upon approval of the work plan by the PaDER.

5. Appendix D - Annual Groundwater Sampling and Analysis

a. As stated in Sun's August 26, 1993 letter, Sun does not see the need to complete the Modified Skinner List analysis for the annual groundwater samples since many of these parameters which were analyzed in 1985, 1986 and 1988 were not detected or were detected below conservative levels of concern (i.e., drinking water standards). Attached, as Appendix III, is an evaluation of the previous groundwater results which compares the Skinner List results to these levels. Based upon this analysis, Sun is proposing a reduced list of 19 parameters for all previously tested wells (13 wells), and a full Modified Skinner List for the wells which were not previously tested (7 wells).

B. **July 15, 1993 Supplement**

3. Jackson and Pollock Street Sewer Areas

a. The enclosed Appendix I, GES Groundwater Assessment report, contains investigative results for the Jackson and Pollock Street Sewer areas. A conceptual Remedial Action Plan is scheduled for completion and submittal to the PaDER by October 31, 1993.

If you have any questions or concerns on this information, please contact me at (215) 339-2215.

Very truly yours,

Charles D. Barksdale Jr., P.E.
Senior Environmental Consultant

Enclosures

cc: United States Environmental Protection Agency
841 Chestnut Building
Philadelphia, PA 19107
Attention: Ms. Christine Wagner (3HW33)

bcc: G. P. Rabik w/o enclosures
J. S. Brackin
T. M. Grabowski w/o enclosures
J. G. Harron w/o enclosures
R. R. Fleck
S. Coladonato
E. J. Ciechon
L. K. Cresson
Phl File: PaDER Groundwater

GROUNDWATER ASSESSMENT
JACKSON STREET SEWER, POLLOCK STREET SEWER, AND 26th STREET SEWER
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY
PHILADELPHIA, PENNSYLVANIA

23 SEPTEMBER 1993

Prepared for:

Mr. Charles D. Barksdale, P.E.
Sun Company, Inc. (R&M)
Philadelphia Refinery
3144 Passyunk Avenue
Philadelphia, Pennsylvania 19145-5299

Prepared by:

Edward G. Dziedzic
Senior Geologist

Reviewed by:

Sharon H. Roberts
Hydrogeologist/
Project Manager

Robert M. DiFilippo, P.G.
Principal Hydrogeologist

Groundwater and Environmental Services, Inc.
410 Eagleview Boulevard, Suite 110
Exton, Pennsylvania 19341
(215) 458-1077

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1.0 INTRODUCTION

Groundwater and Environmental Services, Inc. (GES) was retained by Sun Company, Inc. (R&M) (Sun) to complete a groundwater investigation and assessment of the Jackson Street Sewer, Pollock Street Sewer, and 26th Street Sewer, located in the North and South Yards of the Sun Philadelphia Refinery at 3144 Passyunk Avenue, Philadelphia, Pennsylvania. This investigation followed the elements of the workplan prepared by GES and submitted to Sun on 10 November 1992, with subsequent revisions and re-submittal on 28 April (Jackson Street Sewer and Pollock Street Sewer) and 23 June 1993 (26th Street Sewer).

The goals of this investigation are summarized as follows:

- Determine if any of the three sewers intercept the water table and identify the most likely areas of non-aqueous phase liquid (NAPL) infiltration, if occurring.
- More clearly define and delineate apparent NAPL plume configurations along the traces of the Jackson Street Sewer and Pollock Street Sewer.
- Determine true NAPL thicknesses along the traces of the Jackson Street Sewer and Pollock Street Sewer.
- Derive aquifer coefficients and parameters for preliminary determination of remedial feasibility near the Jackson Street Sewer and Pollock Street Sewer.
- Further investigate groundwater and NAPL recovery adjacent to the 26th Street Sewer to re-assess remedial feasibility in this area.

This report presents the findings of the completed workplan. The investigative methodology and findings are detailed in subsequent sections of this document.

2.0 BACKGROUND

The North and South Yards of the Philadelphia Refinery are situated on the east bank of the Schuylkill River, approximately 2.5 miles north of its confluence with the Delaware River (Figure 1). The refinery is located within the Atlantic Coastal Plain Physiographic Province. The topography at the refinery is nearly flat and is characterized by surface elevations ranging from approximately 10 to 40 feet above mean sea level.

Each of the three sewers is owned and maintained by the City of Philadelphia. The Jackson Street Sewer is a storm sewer traversing the North Yard of the refinery from east to west, entering refinery property at Vare Avenue and discharging at the Schuylkill River (Figure 2). The Pollock Street Sewer is also a storm sewer traversing the South Yard of the refinery from east to west, entering refinery property along 26th Street and discharging at the Schuylkill River (Figure 3). An oil skimmer is maintained by Sun at each

sewer outfall to the river. The 26th Street Sewer, also known as the Lower Schuylkill East Side Intercepting Sewer, parallels the eastern border of the refinery South Yard (Figure 4). The Lower Schuylkill East Side Intercepting Sewer carries both sanitary wastewater and stormwater within a single conduit to a treatment facility. No lateral sanitary or storm water connections exist from the refinery to any of the three sewers.

In 1980, surface-mounted blowers were installed along the 26th Street Sewer at the Belmont Terminal and at the intersection of the Pollock and 26th Street Sewers to vent hydrocarbon vapors. Recovery well S-84 (formerly PR-1) was installed in 1987 to impede NAPL infiltration into the 26th Street Sewer and reduce resultant vapor levels. In 1989, GES performed two groundwater pumping tests at PR-1 which determined that single-point water-table depression with an appropriately-sized recovery well would result in accumulation of recoverable NAPL. However, the pumping test was limited by the shallow construction depth of PR-1.

The scope of work completed for this investigation is nearly identical for the Jackson Street and Pollock Street sewers and is the first such investigation to address the soil and groundwater quality and aquifer characteristics specifically in these two areas. Due to the volume of available data from previous investigations, the scope of work completed at the 26th Street Sewer was designed to determine the viability of NAPL recovery.

Field activities to complete the scope of work for the three areas of concern were conducted concurrently from 22 February to 14 September 1993. Investigative methods and findings are presented in the following sections of this document.

3.0 INVESTIGATIVE METHODS

The methods employed during the groundwater investigations at the Jackson Street and Pollock Street Sewers are identical. Each investigation was initiated by collecting information regarding sewer construction and location. This information was cross-referenced with liquid level data from the existing monitoring well network to define the spatial relationship between the sewers and the water table. Intrusive methods, such as drilling and aquifer performance testing, were then implemented to assess apparent NAPL thickness, plume configuration, and remedial feasibility to complete the investigations.

The 26th Street Sewer investigation also employed drilling and aquifer performance testing to address remedial feasibility. The spatial relationship between the 26th Street Sewer and the water table was defined in previous studies, but was updated as part of this investigation.

The following sections detail the methods employed to complete each investigation. Methods are presented for the Jackson and Pollock Street Sewers collectively followed by the 26th Street Sewer methodology.

3.1 JACKSON STREET SEWER AND POLLOCK STREET SEWER METHODS

3.1.1 FIELD RECONNAISSANCE AND SEWER CROSS SECTION PREPARATION

Construction blueprints for the Jackson and Pollock Street Sewers were acquired from the City of Philadelphia Water Department. These blueprints were examined to accurately locate the sewers on the existing plan view figures of the refinery. These figures were expanded by conducting a field reconnaissance to accurately locate specific changes in the path of the sewer, pitch elevations, and to cross-reference sewer elevations and distances to nearby monitoring wells.

During the field reconnaissance effort, the sewer line was inspected for the presence of volatile organic compounds (VOCs) in the manholes. This was achieved by utilizing a Thermo Environmental Instruments® Model 580B Photoionization Detector Organic Vapor Meter (OVM) at each manhole location. A visual inspection of each sewer outfall was also made to determine the current condition of the outfall, the oil skimmers, and the nature of the river at each outfall.

A cross-sectional representation of each sewer was prepared by compiling the blueprint information, liquid level data, collected from adjacent wells in December 1992, and field reconnaissance data (Figures 5 and 6). The cross sections feature scaled depths of adjacent monitoring wells, depth to static water and NAPL, if present, locations of sewer manholes, and a representation of water table and areas of apparent NAPL occurrence in relation to the sewer.

3.1.2 SOIL BORING PROGRAM

Following completion of the field reconnaissance and sewer cross sections, a soil boring program was initiated to more clearly define the areal extent of apparent NAPL occurrences proximal to each sewer and to determine optimal locations for monitoring wells. Field placement of proposed soil boring locations was based on several factors, including plume geometry relative to each sewer, known overhead and underground obstructions, and refinery operations.

Eighty-two soil borings (45 along the Pollock Street Sewer and 37 along the Jackson Street Sewer) were field-located and approved by Sun to ensure underground obstruction clearance prior to drilling activities. Of the 82 proposed soil borings, 70 were completed (33 along the Pollock Street Sewer and 37 along the Jackson Street Sewer, Figures 7 and 8, respectively). Twelve soil borings were deleted from the Pollock Street Sewer study area due to proximity to sensitive refinery operations and field determination by GES personnel that adequate definition of apparent NAPL occurrence had been achieved by adjacent borings.

All drilling operations were completed by a Pennsylvania-licensed driller, B.L. Myers Brothers, Inc. (B.L. Myers) of Glenmoore, Pennsylvania, under the direct supervision of GES personnel. The soil boring program was conducted by utilizing a Mobile Drill® 40-L auger drilling rig to advance six-inch outer diameter hollow stem augers to a depth exceeding the bottom of the sewers, as determined by the sewer cross sections, or to auger refusal. Soil borings were advanced through the unsaturated zone and penetrated the water table. Soil cuttings were screened with an OVM to obtain a vertical profile of soil quality through the unsaturated zone. Split-spoon soil samples were collected beginning at ten feet below grade to identify the depth of the local water table and at five-foot intervals thereafter. At the water table, a saturated soil sample was collected for field head-space analysis (Section 3.1.3). GES personnel recorded composition, color, texture, odor, and moisture content of all split-spoon soil samples. Drilling logs were prepared detailing the lithology encountered at each boring location and are attached in Appendices A and B.

Following the completion of the soil borings, the auger flights were partially removed from the borings to a depth above the water table to allow the infiltration of groundwater into the open void, while effectively preventing the collapse of the boring sidewalls. Discrete groundwater samples were obtained from the open soil borings for qualitative visual inspection and semi-quantitative head-space analysis. A pre-cleaned bottom loading Teflon® bailer was lowered to a depth of approximately one foot below the water-table interface to collect each groundwater sample and insure interception of any floating NAPL layer. GES personnel visually inspected the groundwater samples, recording the color and qualitative viscosity of any floating NAPL layer, if present. The area of apparent NAPL occurrence was determined by the location of soil borings which produced water samples with a floating NAPL layer. At each boring, the drill cuttings were backfilled into the open void following the acquisition of a groundwater sample.

3.1.3 HEAD-SPACE ANALYSIS

Soil and groundwater samples collected during drilling activities were retained in laboratory-issued, 125 milliliter (ml) glass jars. Samples were placed in these containers to approximately two-thirds capacity with minimal agitation. A piece of aluminum foil was then tightly wrapped over each jar opening and the lid screwed on to create an adequate seal. The lid of each jar was removed after allowing sufficient time for the equilibrium of the vapor pressure within the jar. An OVM was then used to sample the vapors from the head space of the jar. This was performed by inserting the OVM probe through the aluminum foil seal to quantify total organic compound concentrations by means of photoionization. The OVM was calibrated daily utilizing a known concentration of isobutylene calibration gas. During the head-space analyses, the OVM was allowed to purge after each sample and return to ambient background readings prior to analyzing the next sample. In addition, the OVM was calibrated daily to ensure data integrity throughout the investigation. A clean, unused pair of nitrile sampling gloves was worn by GES personnel during all sampling activities. Results of these head-space analyses are summarized in Tables 1 and 2.

3.1.4 MONITORING WELL INSTALLATION

Upon completion of the soil boring program, three groundwater monitoring wells were installed along the trace of each sewer. These wells were designated as N-77, N-78, and N-79 along the Jackson Street Sewer and S-91, S-92, and S-93 along the Pollock Street Sewer (Figures 7 and 8). Four of the wells (N-77, N-78, S-92, and S-93) were installed at previous soil boring locations, and two wells (N-79 and S-91) were installed at undisturbed locations. The placement of these monitoring wells was based on the need for additional data points in the existing groundwater monitoring well network, apparent NAPL occurrence in the area of each sewer, and the need for potential aquifer testing locations along the trace of each sewer.

All drilling operations were conducted by B.L. Myers, under the direct supervision of GES personnel. Drilling was accomplished by advancing 8.5-inch outer diameter hollow stem augers to a depth of 30 feet below grade. During the drilling of N-77, N-78, S-92, and S-93, GES personnel routinely screened soil cuttings with an OVM to determine the presence and relative concentrations of VOCs. The installation of N-79 and S-91 in undisturbed locations required GES personnel to collect split-spoon soil samples with methodology consistent with the soil boring program (Section 3.1.2). When the local groundwater table was intercepted, a saturated soil sample was collected for field head-space analysis. GES personnel recorded composition, color, texture, odor, and moisture content of all split-spoon soil samples. Semi-quantitative and qualitative soil and groundwater sampling was also conducted with subsequent head-space analysis, as described in the previous sections.

Each monitoring well was constructed with appropriate lengths of Schedule 40 PVC screen (0.020-inch slot) and solid Schedule 40 PVC casing in the borehole. The screened interval was installed to ensure that the seasonal high groundwater level would be intercepted. The annular space between the borehole wall and the well screen was filled with a uniformly-graded sand filter pack to a depth two feet above the screened interval and capped with a

two-foot bentonite seal. The bentonite seal acts to prevent the infiltration of surface water into the well screen. Concrete slurry was added to the remaining annular space to fill the borehole to surface grade. A locking well plug and manhole were then fitted to each well to ensure data integrity. Details of well construction are summarized on Table 3. Monitoring Well Drilling Logs are provided in Appendix A and B.

3.1.5 MONITORING WELL DEVELOPMENT, SURVEYING, AND GAUGING

The development of each well was performed to dislodge and remove any sediment and/or residual drill cuttings that may have accumulated or been introduced to the screened interval and gravel pack during well installations. The development process is intended to enhance communication between the monitoring well and the aquifer. If not removed, the presence of such sediments could adversely influence the quality and recharge of groundwater to the well.

Well development was accomplished by surging and overpumping each well utilizing a surge block and a submersible pump. During the pumping of each well, GES personnel recorded groundwater flow rates and pumping levels at regular intervals in an effort to determine the approximate sustainable yield. All recovered groundwater/NAPL was containerized and disposed of via the refinery wastewater treatment plant.

The elevation of each well, referenced to the top of the PVC casing, was surveyed by GES personnel. Well elevations were surveyed relative to the existing vertical control monuments located throughout the refinery. The elevation of each well was measured to the nearest 0.01 foot.

Subsequent to well development, liquid level data, including depth to water and depth to NAPL, if present, were obtained from each newly-installed well (Appendix C). These measurements were obtained using an optical interface probe capable of distinguishing between water and NAPL levels to the nearest 0.01 foot.

3.1.6 BAILDOWN TESTING

NAPL baildown testing was performed on 11 selected NAPL-bearing wells along each sewer to determine true NAPL thickness. The 11 wells tested (Figures 7 and 8) included five wells along the Jackson Street Sewer (N-20, N-22, N-23, N-25, and N-71) and six wells along the Pollock Street Sewer (S-48, S-53, S-62, S-63, S-65, and S-93).

Prior to testing, each well was gauged with an optical interface probe to determine the apparent NAPL thickness. A top loading stainless steel bailer was lowered into each well just beneath the water table, allowing the NAPL to be skimmed off and removed. GES personnel gauged the recharge of NAPL to the wells until stabilization in NAPL thickness occurred. Baildown test data for each well is presented in Appendices D and E. All recovered groundwater/NAPL was containerized and disposed of via the refinery wastewater treatment plant.

3.1.7 SLUG TESTING

Rising head slug testing was performed on 14 selected non NAPL-bearing wells along each sewer to determine aquifer hydraulic coefficients (Figures 7 and 8). The slug tests were performed by gauging water-level response following the instantaneous removal of a volume of water from the well; the rate at which the water level rises (rebounds) is controlled by the aquifer hydraulic coefficients. The 14 wells tested included eight wells along the Jackson Street Sewer (N-24, N-26, N-27, N-28, N-37, N-77, N-78, and N-79) and six wells along the Pollock Street Sewer (S-45, S-46, S-48, S-49, S-92, and S-91)

Prior to testing, each well was gauged with an optical interface probe to determine the depth to static water. A pressure transducer, capable of sensing changes in hydraulic head to the nearest 0.01 foot, was then deployed in each well. The transducer was connected to an In-Situ Instruments, Inc., Hermit® Model SE1000B programmable water level recording device (Hermit). A PVC bailer was then placed into the well and a sufficient period of time was allowed for the water level to equilibrate. The test was initiated by manually extracting the bailer and allowing the Hermit to record the full rebound of water within the well. The Hermit recorded changes in water level continuously on a logarithmic schedule, initially every 0.2 second to a maximum every minute. Each well was also manually gauged to determine complete water-table rebound and stabilization. The slug testing data collected from each well was reduced utilizing Geraghty & Miller's AQTESOLV™ Aquifer Test Solver Version 1.1, calculating hydraulic conductivity values by the Bouwer and Rice Method. Slug testing data for each well is presented in Appendices F and G.

3.1.8 PUMPING TEST

An eight-hour groundwater pumping test was completed at a selected well along the trace of each sewer. The data collected during the tests were applied to the calculation of aquifer parameters. These parameters can provide a preliminary determination of the feasibility of groundwater/NAPL recovery in these areas. The wells selected for the pumping test, N-71 along the Jackson Street Sewer and S-93 along the Pollock Street Sewer, exhibited the greatest accumulation of NAPL as determined by the baildown tests. To complete these tests, a Grundfos® submersible pump was installed in each well. Recovered groundwater was discharged to an above-ground, 7,100-gallon purge water storage tank during the pumping test at N-71. Recovered groundwater was discharged directly to the S-10 Sump and subsequently to the refinery wastewater treatment system during the pumping test at S-93. A ball valve to regulate flow and a totalizing flow-meter, which recorded both total gallons pumped and the instantaneous flow rate, were installed in the discharge line. An explosion-proof NEPCCO Petropurge® product pump was also installed in each well to capture any NAPL accumulating in the wells during the pumping test. Recovered NAPL was containerized in 55-gallon steel drums. Monitoring wells in the vicinity of the pumping wells were manually gauged on regular intervals to record any water level changes related to pumping.

Well drawdowns and flow rates observed during the tests were also utilized to calculate the specific capacity for each well. These specific capacities were

then cross-referenced to tables presented in Driscoll's Groundwater And Wells to obtain a maximum theoretical specific capacity for each well (based on zero drawdown). This maximum theoretical specific capacity was then multiplied by 67% of the available drawdown in each well, resulting in a maximum theoretical flow rate to achieve this pumping level. This represents the best-case and most practical pumping conditions for each well, allowing ample space within the wells for pumping equipment.

Pumping test data were also reduced utilizing the AQTESOLV™ software package to derive aquifer coefficients (transmissivity and storativity) by the Cooper and Jacob Method and the Hantush Method (Appendices H and I). The Cooper and Jacob Method, which is intended for unconfined aquifer analysis, incorporates Jacob's correction factor for reduction in saturated thickness during pumping. The Hantush Method is used primarily for leaky or semi-confined aquifer analysis. Both methods assume similar conditions (i.e., homogeneity, isotropy, uniform aquifer thickness, constant pumping rate, fully penetrating pumping well, etc.) and are widely-accepted techniques for pumping test data reduction. The purpose of reducing the pumping test data by the two methods was to better determine the hydraulic characteristics of the shallow aquifer (i.e., completely unconfined and unbounded, or leaky semi-confined) by comparing the aquifer parameters derived by each method.

3.2 26th STREET SEWER INVESTIGATIVE METHODS

In addition to the scope of work submitted in the workplan, GES installed and developed a second recovery well (S-94) in this area. This effort was initiated following inconclusive results from feasibility testing of well S-90. Additional work included an 8-hour pumping test on W-10, a four-foot diameter oil recovery well installed in 1951 to a depth of 41.5 feet, situated adjacent to 26th Street. The activities undertaken to complete the workplan and the additional tasks related to S-94 and W-10 are detailed in the following sections.

3.2.1 RECOVERY WELL INSTALLATION AND DEVELOPMENT

Two recovery wells, designated as S-90 and S-94, were installed adjacent to the 26th Street sewer (Figure 4). The purpose of these recovery wells was to provide pumping locations with total depths and casing diameters large enough to accommodate groundwater and NAPL extraction equipment.

Installation of S-90 was completed with a Mobile Drill®, B-61 drilling rig, operated by B.L. Myers. Drilling of the well was completed by advancing 14-inch outside diameter, hollow-stem augers to a depth of 50 feet below grade. The depth of the recovery well was based on the drilling logs of adjacent monitoring wells, allowing ample space within the well for drawdown and pumping equipment. During the installation of this well, drill cuttings were collected, where possible, and scanned with an OVM for the present of volatile organic vapors. GES personnel visually inspected the drill cuttings and recorded the composition, color, texture, odor and moisture content. A drilling log was prepared detailing the lithology encountered at S-90 and is attached in Appendix J.

Following drilling activities, S-90 was constructed with 35 feet of six-inch diameter, galvanized, continuous wire wrap well screen, flush-joined to a 17-foot section of ductile iron riser pipe. After installation of the well screen and riser, a No. 2 sand gravel pack was installed around the well screen. The gravel pack was installed from 50 feet below grade to approximately 13 feet below grade, or 2 feet above the well screen. A one-foot thick bentonite seal was then added on top of the gravel pack. The remaining borehole annulus was grouted to grade with neat cement. The well was finally completed with a locking, watertight gripper plug.

Initial efforts to develop S-90 entailed lowering a vacuum truck suction hose into the well and evacuating all water and fine sediments. The well was evacuated twice with the vacuum hose; after each evacuation, the well recharged at a rate of approximately one-half gallon per minute.

Since well yield was lower than expected, a second attempt was made to develop the well by swabbing. This entailed using a drill rig to lower a 1/2-inch diameter pipe into the well. Attached to the end of the pipe were two rubber flanges, set approximately 2 feet apart, which are the approximate diameter of the inside of the well. The two rubber flanges were separated by a section of perforated pipe. High pressure air was injected through the 1/2-inch diameter pipe and directed out through the perforated pipe. The entire swabbing tool could be raised and lowered to develop all screened intervals of the well. After development, the well was evacuated with a submersible pump. Initial withdraw from the well was approximately 0.2 gallons per minute. The swabbing and pumping efforts were repeated four times. After the last development effort, the well produced approximately 0.6 gallons per minute.

A third attempt was made to develop the well and increase well yield. During this attempt, a modified swabbing method was used, which entailed lowering a 1/2-inch diameter pipe into the well, with similar rubber flanges as are described above. For this method, however, the two flanges were separated by a solid pipe which was fitted with water jets. To develop the well, pressurized water was pumped through the 1/2-inch pipe and out through the water jets. As with the previous development method, the entire tool could be raised and lowered and efforts could be concentrated to develop all intervals of the well. After development, the well was evacuated with a submersible pump. Well yield increased to one to two gallons per minute following this treatment.

Installation of S-94 was completed by a Pennsylvania licensed driller, Summit Drilling Co., of Bridgewater, New Jersey. Drilling activities were initiated by utilizing a Mobile Drill® B-59 drilling rig to advance five-inch outer diameter hollow stem augers to a depth of 50 feet below grade to accommodate split-spoon soil sampling at five-foot intervals. The depth of the recovery well was based on the drilling logs of adjacent monitoring wells, providing sufficient well depth for groundwater extraction equipment and drawdown during pumping tests. GES personnel visually inspected all split-spoon samples and recorded composition, color, texture, odor, and moisture content. Split-spoon soil samples were routinely screened with an OVM to determine the presence and relative concentration of VOCs. The soil sample collected from the water-table interface was retained for head-space analysis as defined in previous sections (Section 3.1.3). A drilling log was prepared detailing the lithology encountered at S-94 and is attached in Appendix J.

Completion of the borehole was achieved with a Mobile Drill® B-80 drilling rig utilizing the mud rotary method. This method involves recirculating drilling fluids to remove drill cuttings from the borehole while advancing a rotating drill bit through the substratum. Recirculation of drilling fluids also effectively prevents the collapse of the borehole and reduces smearing of clays and other fines which is inherent with auger drilling. The drilling fluids, comprised of a water/Revert® mixture to enhance the extraction of drill cuttings, were discharged to a settling pan equipped with baffles to allow gravity separation of the cuttings. The cuttings were then containerized in 55-gallon steel drums for subsequent disposal.

Following mud rotary drilling, S-94 was constructed with 35 feet of 6-inch diameter, galvanized, continuous wire wrap well screen, flush-joined to a 16-foot section of ductile iron riser pipe. After installation of the well screen and riser, a No. 2 sand gravel pack was installed around the well screen. The gravel pack was installed from 50 feet below grade to approximately 13 feet below grade, or 2 feet above the well screen. A two-foot thick bentonite seal was then added on top of the gravel pack. The remaining borehole annulus was grouted to grade with neat cement. The well was finally competed with a locking, watertight gripper plug.

Development of S-94 was conducted immediately following drilling activities. Chlorine pellets, added to the filter pack during well construction, were used to break down the residual filter cake deposited on the boring wall during development of S-94. Compressed air was injected into the well to air lift the entire water column. The water column was allowed to fall back through the well, creating a surging effect. Occasional purging was conducted to clear the well of sediments. All purged water generated during the development of S-94 was retained in the settling pan and pumped into 55-gallon steel drums pending disposal. The well yield was estimated to be between five and eight gpm.

The elevation of S-90, referenced to the top of the PVC casing, was surveyed by GES personnel. The elevation of S-90 was surveyed relative to the existing vertical control monuments located throughout the refinery. The elevation of S-90 was measured to the nearest 0.01 foot. The elevation survey of S-94 has not been completed at this time.

Subsequent to recovery well development, liquid level data, including depth to water and depth to NAPL, if present, were obtained from each newly-installed well. These measurements were obtained using an optical interface probe capable of distinguishing between water and NAPL levels to the nearest 0.01 foot.

3.2.2 SEWER CROSS-SECTION PREPARATION

Following the recovery well installations, the existing 26th Street Sewer cross-section was updated to include scaled depths of the new wells and the most recent liquid level gauging data (May 1993) from adjacent monitoring wells (Figure 4). The cross-section also features the current interpretation of the water table and areas of apparent NAPL occurrence configurations relative to the sewer.

3.2.3 PUMPING TESTS

Three separate groundwater pumping tests were completed at S-90, S-94, and W-10. The pumping tests were eight hours in duration at S-94 and W-10, and 24 hours in duration at S-90. Each well was equipped with a Grundfos® submersible pump. Recovered groundwater was discharged to an above-ground, 7,100-gallon purge water storage tank. A ball valve to regulate flow and a totalizing flow meter, which recorded both total gallons pumped and the instantaneous flow rate, were installed in the discharge line for each test performed. The data collected during the tests were applied to the calculation of aquifer parameters for preliminary determination of the feasibility of groundwater/NAPL recovery in these areas.

Prior to starting each test, static depth-to-water measurements were collected from a pre-designated monitoring well network. Wells S-79, S-82, S-83, S-84, S-85, S-86, S-87, S-88, and S-89 were gauged at regular intervals during the pumping test at S-90. The groundwater pumping test at W-10 included gauging data from S-75, S-80, S-81, S-82, and S-83. Similarly, the groundwater pumping test at S-94 included gauging data from S-79, S-81, S-82, S-83, and S-84. The gauged monitoring wells were used as distance-drawdown monitoring points throughout the duration of the tests. A summary of drawdown versus time data is included in Appendix L for each gauged monitoring well.

Pumping test data were also reduced utilizing the AQTESOLV™ software package to derive aquifer coefficients (transmissivity and storativity) by the Cooper and Jacob Method and the Hantush Method (Appendices H and I). The Cooper and Jacob Method was used for the unconfined aquifer analysis incorporating Jacobs correction factor for reduction in saturated thickness. The Hantush Method was used for the leaky or semi-confined aquifer analysis. Both methods assume similar conditions (i.e., homogeneity, isotropy, uniform aquifer thickness, constant pumping rate, fully penetrating pumping well, etc.) and are widely accepted techniques for pumping test data reduction. The purpose of reducing the pumping test data by the two methods was to better determine the hydraulic characteristics of the shallow aquifer (i.e., completely unconfined and unbounded, or leaky semi-confined) by comparing the aquifer parameters derived by each method.

4.0 INVESTIGATIVE FINDINGS/CONCLUSIONS

4.1 SITE GEOLOGY

Geologic maps for the general area indicate that the refinery is situated approximately one mile southeast of the Fall Line, a physiographic feature which manifests the contact between the crystalline basement rocks of the Piedmont Province to the northwest and the unconsolidated formations of the Atlantic Coastal Plain Province to the southeast. The competent basement rock, composed of mica schists and gneisses of the Wissahickon Formation, provided the surface on which the much younger unconsolidated deposits of the Coastal Plain were deposited.

A review of Groundwater In The Coastal Plain Of Pennsylvania, prepared by the Pennsylvania Geologic Survey (1961), reveals that the unconsolidated deposits of the Coastal Plain in the study area are stratigraphically broken down into four formations. The oldest deposits overlying the crystalline basement rocks belong to the Raritan Formation. The Raritan Formation represents three episodes of sedimentation related to sea level fluctuation, resulting in cyclic, alternating deposits of sand and clay. These deposits accumulated to great thicknesses to the east and wedge out to the west with increasing age toward the Fall Line. Overlying the Raritan is the Magothy Formation. It is closely related to the Raritan Formation since it is composed of sands and clays, but is a separate lithologic unit owing to its unique sedimentary environment and inclusion of plant remains.

The youngest deposits consist of the Cape May Formation and Recent alluvium. The Cape May Formation is composed of sands and gravels deposited as glacial outwash by the Delaware River and completely buries the older sediments of the Magothy and Raritan Formations. Alluvium of Recent age, consisting of fine sands, silts, and clays, was deposited over the Cape May Formation by the meandering of the Delaware and Schuylkill Rivers. The alluvium is reported to be thickest near the confluence of the Schuylkill and Delaware Rivers.

4.2 JACKSON STREET SEWER AND POLLOCK STREET SEWER FINDINGS

4.2.1 FIELD RECONNAISSANCE AND SEWER CROSS-SECTION PREPARATION

Construction blueprints reveal that the Jackson Street Sewer and Pollock Street Sewer intersect the 26th Street Sewer (known as the Lower Schuylkill East Side Intercepting Sewer) immediately inside refinery property, prior to their discharge at the Schuylkill River. Intercepting chambers are located at the sewer intersections to direct the combined wastewater flow from the Jackson Street Sewer and Pollock Street Sewer to the intercepting sewer. Essentially, these intercepting chambers prevent wastewater flow from the City to the river under normal operating conditions. During significant storm water runoff events, the intercepting chambers will allow the passage of combined flow through the Jackson and Pollock Street Sewers with discharge at the Schuylkill River.

JACKSON STREET SEWER

Construction blueprints acquired for the Jackson Street Sewer, dated between 1903 and 1917, indicate that it is a circular brick sewer, 6.5 feet in diameter where it first enters refinery property and increases to 7.5 feet in diameter where it outfalls to the Schuylkill River (Figure 5). The sewer has a grade of 0.0028 foot/foot for the entire run of 4,180 feet across the refinery, accounting for approximately 12 feet of vertical declivity from the eastern border of the refinery to the Schuylkill River.

GES personnel located five manholes along the Jackson Street Sewer. Thirteen additional manholes are believed to exist as indicated on the construction blueprints, but are apparently inaccessible due to the demolition of refinery structures in the North Yard in the early 1980s. Three of the five manholes are currently outfitted with venting apparatus and/or blowers and could only be partially accessed. For this reason, OVM data were collected from MH-1 (intercepting chamber) and MH-4 only. In each manhole, VOCs were non-detectable.

The outfall of the Jackson Street Sewer was also inspected during field reconnaissance activities. The appearance of the outfall facade confirmed the circular brick construction noted on the blueprints. Booms were in place between the outfall and the river. An oil skimmer was deployed between the sewer outfall and the booms to recover intermittent NAPL from the surface.

The completed sewer cross-sectional profile was studied to evaluate interception points of the sewer main and the water table, and the most likely areas of NAPL infiltration into the sewer. The cross section constructed for the Jackson Street Sewer (Figure 5) utilizing the December 1992 liquid level data confirms that the lower half of the sewer intercepts the water table and three localized areas of apparent NAPL occurrence centered around N-20, N-23, and N-71. There are no apparent water-table elevation anomalies or depressions indicative of leaks or structural failures in the sewer.

POLLOCK STREET SEWER

Construction blueprints acquired for the Pollock Street Sewer indicate that it is a rectangular concrete structure twelve feet in width and eight feet in height. The construction date of the Pollock Street Sewer could not be determined. The sewer has a grade of 0.0005 foot/foot for the entire run of 2,880 feet across the refinery accounting for approximately 1.5 feet of vertical declivity from the eastern border of the refinery to the Schuylkill River.

Ten of 11 manholes indicated on the blueprints were located by GES personnel along the Pollock Street Sewer. The OVM data collected during the manhole inspection reported VOC concentrations of 22 ppm, 23 ppm, and 16.7 ppm in MH-3, MH-4, and MH-5, respectively, in the eastern portion of the sewer in the tank farm. All other OVM data ranged between 0.7 ppm and 8 ppm. Sheens were reported on the water within the sewer at MH-8 and MH-9. Tidal influence on the sewer was visually confirmed by a flow reversal (eastward toward 26th Street) as far east as MH-7. The tidal study conducted by GES in

December 1992 confirmed that monitoring wells in the vicinity of the Pollock Street Sewer outfall were also tidally-influenced.

The outfall of the Pollock Street Sewer was also inspected during field reconnaissance activities. The rectangular concrete construction noted on the blueprints was obscured by corrugated steel portions of the South Yard bulkhead at the sewer outfall. Booms were in place between the outfall and the river, mounted on tracks which allow vertical movement with changing tides. According to refinery personnel, water is allowed to discharge through the boom and weir system. An oil skimmer was deployed between the booms and the sewer outfall to recover intermittent free-phase oil from the surface.

The cross-section constructed for the Pollock Street Sewer (Figure 6) incorporating the December 1992 liquid level data confirms that the lower half of the sewer intercepts the water table and two separate apparent NAPL plumes (Figure 3). One apparent NAPL plume, approximately 1,360 feet in length, is located between S-62 and S-48. The second apparent NAPL plume, of lesser areal extent, is located between the South Yard bulkhead and S-63. The sewer segment east of MH-3 is situated above the water table, which dips to the east beneath the sewer. There are no apparent water-table elevation anomalies or depressions indicative of leaks or structural failures in the sewer.

4.2.2 SOIL BORING PROGRAM FINDINGS

The soil boring program included a total of 70 completed soil borings, including 33 along the Pollock Street Sewer and 37 along the Jackson Street Sewer. Soil boring depths varied slightly along the Jackson and Pollock Street Sewers, but were generally on the order of 22 feet and 27 feet, respectively. Completed soil boring locations are presented on Figures 7 and 8.

The findings of the soil boring program indicate that, in both study areas, the subsurface lithology is highly variable. Encountered sediments consist of gravels, sands, silts, and clays. A layer of fill was initially encountered at most drilling locations. Most sands and gravels encountered were poorly-sorted and contained a significant portion of finer grained matrix material. Competent bedrock was not encountered in any soil boring. Clays encountered during drilling activities were rarely more than a few feet in thickness and discontinuous. Lithologic cross sections were prepared for each sewer based on drill log data from selected borings (immediately adjacent to each sewer and within a known area of apparent NAPL occurrence) [Figures 9 and 10]. The cross-sections suggest that the geology adjacent to each sewer comprises Recent alluvium and/or the Cape May Formation.

Depths to the water table observed during drilling activities along the Jackson and Pollock Street Sewers ranged between approximately 8 to 16 feet and 10 to 17 feet below grade, respectively. The shallow aquifer beneath the site exists in the unconsolidated sediments under unconfined (water table) conditions. In unconsolidated sediments, groundwater flow is primarily through open voids and pore spaces within the sediments.

Upon completion of the soil boring program, the areas of apparent NAPL occurrence interpretations were updated utilizing the qualitative data from

borings where water sampling was possible and the most recent liquid level data (May 1993). The results for both sewers reveal areas of apparent NAPL occurrences of larger areal extent when compared to the previous plume configurations based on the December 1992 gauging data. The May 1993 gauging data was utilized to update the sewer cross sections of the Jackson Street Sewer and Pollock Street Sewer, as depicted on Figures 11 and 12, respectively.

Figure 7 illustrates the current interpretation of the areas of apparent NAPL occurrence along the Jackson Street Sewer. The area extends approximately 1,440 feet along the sewer and up to 510 feet north and 440 feet south of the sewer. Two separate areas of apparent NAPL occurrence of lesser areal extent are also apparent, one localized around SB-1 near the eastern boundary of the North Yard, and a second located at the southwest portion of the Land Treatment Unit and north side of the railroad tracks.

Figure 8 presents the current interpretation of the areas of apparent NAPL occurrence along the Pollock Street Sewer. This figure illustrates a single area extending approximately 2,140 feet along the sewer and up to 560 feet north and 670 feet south of the sewer.

4.2.3 HEAD-SPACE ANALYSIS FINDINGS

The findings of the head-space analyses on soil and water samples confirmed the presence of VOCs in all samples collected. In both study areas, head-space results for soils and water generally appeared to be greater in magnitude nearest each sewer. Samples from the area around the South Yard Bulkhead reported consistently high head-space results, ranging from 1,154 ppm to 3,444 ppm for soils, and 1,180 ppm to 2,984 ppm for water samples. No clear correlation between the NAPL appearance and the head-space results could be determined.

4.2.4 BAILDOWN TESTING FINDINGS

The findings of the baildown testing were varied at the Jackson Street Sewer and Pollock Street Sewer, owing to the diversity observed in NAPL viscosity in the selected monitoring wells. Generally, NAPL that was reported to be highly viscous effectively coated the optical prism of the interface probe, and the determination of the NAPL/water interface was often ambiguous. NAPL that was reported to be less viscous typically allowed accurate gauging and data collection.

The data collected during baildown testing along the Jackson Street Sewer is presented in Table 4 and can be summarized as follows:

- N-22 and N-23 were reported to contain black, highly viscous NAPL with pre-test apparent NAPL thicknesses of 0.01 and 2.82 feet, respectively. NAPL thickness in N-23 is suspect, since bailing each of these wells produced mostly water. Gauging could not be accurately completed, but minimal amounts of NAPL were visually confirmed in each of these wells.

- N-20 reported a pre-test apparent NAPL thickness of 0.01 feet and did not recharge any measurable NAPL. Bailing this well produced mostly water, but minimal amounts of NAPL were visually confirmed.

- N-71 and N-25 reported pre-test apparent NAPL thicknesses of 1.51 and 0.89 feet, respectively, with less viscous dark amber NAPL. Subsequent to bailing and stabilization, these wells recharged 0.67 and 0.63 feet of NAPL, respectively.

The data collected during baildown testing along the Pollock Street Sewer is presented in Table 5 and can be summarized as follows:

- S-48 was reported to contain black, viscous NAPL with a sewage odor and a pre-test thickness of 0.04 feet. Following baildown and water table stabilization, no NAPL recharge occurred and true NAPL thickness was determined to be minimal.

- Low-viscosity dark amber NAPL was reported in S-93, S-53, and S-63 with pre-test thicknesses of 1.08, 3.32, and 1.27 feet, respectively. Subsequent to bailing and stabilization, these wells revealed true NAPL thicknesses of 1.11, 1.09, and 0.62 feet, respectively.

- S-65 and S-62 reported pre-test NAPL thicknesses of 0.24 and 1.02 feet, respectively. Fluids recovered from bailing these wells were almost entirely NAPL. Subsequent to bailing, NAPL recharge was not apparent and water levels failed to stabilize. Validity of this data is suspect, since these wells have been documented to experience water level variation in concert with tidal fluctuations.

Baildown test results for Jackson Street Sewer and Pollock Street Sewer have been graphically depicted and are included in Appendix D and E, respectively.

4.2.5 SLUG TESTING FINDINGS

Hydraulic conductivity values for the 14 tested wells were reduced from the slug testing data with the AQTESOLV™ software package. The resulting hydraulic conductivity values for the wells tested in the area of the Jackson Street Sewer range from 9.37×10^{-5} cm/sec at N-78 to 1.08×10^{-2} cm/sec at N-77, and average 2.07×10^{-3} cm/sec for six of the eight wells tested (Table 6). Anomalous data collected at wells N-26 and N-27 were not included in the average. The high conductivity calculated for N-77 was retained for the average; this is a reasonable value since the water table is shallow at N-77 and exists in sandy fill material.

The hydraulic conductivity values calculated for the wells tested in the area of the Pollock Street Sewer range from 7.80×10^{-5} cm/sec at S-92 to 1.51×10^{-4} cm/sec at S-48, and average 1.68×10^{-4} cm/sec for five of the six wells tested (Table 7). Anomalous data were collected at S-46 and were not included in the average.

Hydraulic conductivity values derived for aquifers in the vicinity of both sewers appear to be representative of the lithology at each testing location. Based on tables referenced in Driscoll's Groundwater And Wells, typical hydraulic conductivity values range from 10^{-6} to 10^{-4} cm/sec for sandy silts and clayey sands.

It should be noted that slug testing does have potential sources of error and/or anomaly. The test results may be biased by wellbore storage and filter pack problems. The slug test affects only a small portion of the aquifer, and the test results can be only applied to the area immediately around the tested well. The average hydraulic conductivity values given above are for comparative purposes only, and are not intended for estimating large-scale aquifer performance.

4.2.6 PUMPING TEST FINDINGS

Review of the gauging data collected during the eight-hour groundwater pumping tests completed at N-71 and S-93 reveals that drawdown was not observed at any monitoring well gauged during either test. The results of the pumping test at the Jackson Street Sewer conducted on N-71 can be summarized as follows:

- 2,586 gallons of groundwater and 12 gallons of NAPL were recovered.
- Constant flow was maintained at 5 gpm, resulting in 2.62 feet of drawdown in the well. The flow rate was stepped to 6 gpm after 120 minutes of pumping for the remainder of the test, resulting in an additional 0.56 feet of drawdown.
- The resulting specific capacity was 1.87 gpm per foot of drawdown
- High tide occurred during the test which may have caused rising water levels in nearby monitoring wells.

The results of the pumping test conducted on S-93 can be summarized as follows:

- 1,473 gallons of groundwater and 30 gallons of NAPL were recovered.
- A flow rate of 3 gpm was maintained throughout the test, resulting in 1.6 feet of drawdown in the well.
- The resulting specific capacity was 1.92 gpm per foot of drawdown.
- High tide occurred during the test which may have caused rising water levels in nearby monitoring wells.

Based on these data, maximum theoretical flow rates were estimated to be 14 gpm and 26 gpm for S-93 and N-71, respectively, at a pumping level equal to 67% of the maximum allowable drawdown in each well. It should be noted that as aquifer dewatering takes place during a pumping test, the area of well screen exposed to the saturated formation decreases, resulting in convergent

flow to the well and loss of hydraulic head. Head losses will create increased drawdowns and, in turn, will be manifested by decreasing specific capacities. The theoretical calculated estimates given above should therefore be considered optimistic.

An accurate estimate of the radius of pumping influence could not be determined for either test due to the lack of distance drawdown data. The information gathered during these tests are not sufficient to estimate distance drawdown relationships. These calculations cannot be completed due mainly to the inconsistent (fluctuating) water levels in monitoring wells and the minimal groundwater withdrawal rates observed during both pumping tests.

Tables 8 and 9 summarize two sets of transmissivity and storativity values derived for S-93 and N-71 with the AQTESOLV™ software package using the Cooper and Jacob Method, and the Hantush Method (Section 3.1.8). Each method produced similar transmissivity and storativity values for the individual wells.

The low transmissivity values, calculated using both methods, ranged from 1.49 cm^2/sec at N-71 to 3.85 cm^2/sec at S-93. These values suggest that groundwater cannot move through the formations well. The storativity values, ranging from 2.80 x 10^{-3} at N-71 to 8.55 x 10^{-2} at S-93, suggest limited available water to be withdrawn by pumping. According to Driscoll's Groundwater And Wells, storativity values generally range from 0.01 to 0.30 in unconfined aquifers and from 10^{-5} to 10^{-3} in confined aquifers.

4.3 26th STREET SEWER INVESTIGATIVE FINDINGS

4.3.1 RECOVERY WELL INSTALLATION

During the drilling of S-90 and S-94, the lithology was reported as layered sands, gravels, and clays encountered to a depth of approximately 40 feet below grade. Clay was encountered in both wells at 40 to 50 feet below grade. Competent bedrock was not encountered during the installation of S-90 or S-94. The depth to the water table during the drilling of S-90 and S-94 was approximately 17 feet below grade. Drilling logs for S-90 and S-94 are presented in Appendix J.

Head-space analysis conducted on the soil sample collected from S-94 indicated a VOC concentration of 508 ppm.

4.3.2 SEWER CROSS SECTION

The updated 26th Street Sewer cross section (Figure 4) reveals a slight water-table depression apparent where the 26th Street Sewer and the Pollock Street Sewer intersect. This water-table depression has been identified in previous investigations of the area, and may be the result of a large volume of more permeable backfill at the intersection of the two sewers. The apparent NAPL plume configuration relative to the 26th Street Sewer appears to have remained unchanged over the past five years.

4.3.3 PUMPING TEST FINDINGS

Review of the gauging data collected during the 24-hour and the eight-hour groundwater pumping tests completed at S-90 and S-94, respectively, reveals that drawdown was not observed at any monitoring well gauged during either test. The eight-hour pumping test conducted on W-10 affected drawdown on only one monitoring well (S-81).

The results of the pumping test conducted on S-90 can be summarized as follows:

- A total of 976 gallons of groundwater was recovered during the pumping test. No NAPL was recovered.
- S-90 has a sustainable yield of approximately 0.60 gpm, with a drawdown of approximately 15 feet.
- NAPL was not detected in S-90 at any time during the pumping test.
- Liquid levels fluctuated in the monitoring well network gauged during the pumping test.

The results of the pumping test conducted on S-94 can be summarized as follows:

- A total of 738 gallons of groundwater was recovered during the pumping test. No NAPL was recovered.
- S-94 has a sustainable yield of approximately 1.0 gpm, with a drawdown of approximately 15 feet.
- NAPL was not detected in S-90 at any time during the pumping test.
- Liquid levels fluctuated in the monitoring well network gauged during the pumping test.

The results of the pumping test conducted on W-10 can be summarized as follows:

- A total of 5,329 gallons of groundwater was recovered during the pumping test. No NAPL was recovered.
- W-10 has a sustainable yield of approximately 10 gpm, with a drawdown of approximately three feet. Following four hours of pumping, the flow rate was stepped to 13 gpm for the remainder of the test, creating one additional foot of drawdown.
- NAPL was not detected in W-10 at any time during the pumping test.
- Liquid levels fluctuated in the monitoring well network gauged during the pumping test.
- A drawdown of 0.62 feet was recorded at S-81.

An accurate estimate of the radius of pumping influence could not be determined for any of these tests due to the lack of distance-drawdown data. Due to the minimal separation of S-81 and W-10 (four feet), a comparatively small volume of undisturbed aquifer material is expected to exist between the two wells, and is insufficient to determine characteristics of the aquifer. The information gathered during these tests are not sufficient to estimate distance-drawdown relationships. These calculations cannot be completed due mainly to the inconsistent (fluctuating) water levels in monitoring wells and the minimal groundwater withdrawal rates observed during both pumping tests.

Table 10 summarizes two sets of transmissivity and storativity values derived for S-90, S-94, and W-10 with the AQTESOLV™ software package using Cooper and Jacob Method, and the Hantush Method (Section 3.2.3). A comparison of the transmissivity reported for each well reveals similar values for S-90 and S-94. The transmissivity values, calculated using both methods, ranged from 5.60 x 10^{-2} cm^2/sec (521 ft^2/day) at S-90 to 1.99 cm^2/sec (18,507 ft^2/day) at W-10. These values suggest that groundwater cannot move through the formations well. A comparison of the storativity reported for each well reveals similar values, ranging from 0.0562 at S-90 to 0.140 at W-10. According to Driscoll's Groundwater And Wells, storativity values generally range from 0.01 to 0.30 in unconfined aquifers and from 10^{-5} to 10^{-3} in confined aquifers.

5.0 SUMMARY

5.1 JACKSON STREET SEWER AND POLLOCK STREET SEWER SUMMARY

- The cross-section constructed for the Jackson Street Sewer utilizing the December 1992 and May 1993 liquid level data confirms that the lower half of the sewer fully intercepts the water table and apparent NAPL plumes. There are no apparent water-table elevation anomalies indicative of leaks or structural failures in the sewer.

- The cross-section constructed for the Pollock Street Sewer incorporating the December 1992 and May 1993 liquid level data confirms that the lower half of the the sewer is partially intercepted by the water table and apparent NAPL plumes. The sewer segment east of MH-3 is situated above the water table, which dips to the east beneath the sewer. There are no apparent water-table elevation anomalies indicative of leaks or structural failures in the sewer.

- The findings of the soil boring program indicate that, in both study areas, the lithology is highly variable and consists of gravels, sands, silts, and clays. Most sands and gravels encountered were poorly sorted and contained a significant portion of finer grained matrix material. Competent bedrock was not encountered in any soil boring.

- Upon completion of the soil boring program along Jackson Street Sewer, NAPL was observed in 31 of the 37 soil borings and appears to be localized within three discrete areas. The primary area extends approximately 1,440 feet along the sewer and up to 510 feet north and 440 feet south of the sewer. Two separate areas of apparent NAPL occurrence of lesser areal extent are also evident, one at SB-1 near the eastern boundary of the North Yard and a second located at the southwest portion of the Land Treatment Unit north of the railroad tracks. NAPL characterization (color, odor, and qualitative viscosity) varied widely within each area of apparent NAPL occurrence. Along Pollock Street Sewer, apparent NAPL was observed in 30 of the 33 soil boring completed during the soil boring program. The area that had visual impact of apparent NAPL, as indicated by the soil boring program, extends approximately 2,140 feet along the sewer and up to 560 feet north and 670 feet south of the sewer. NAPL characterization (odor, color, and qualitative viscosity) varies widely within this area.

- During baildown testing along the Jackson Street Sewer, N-71 and N-25 reported true NAPL thicknesses of 0.67 feet (44% of apparent NAPL thickness) and 0.63 feet (71% of apparent NAPL thickness), respectively. N-22, N-23, and N-20 reported minimal amounts of NAPL by visual confirmation.

- During baildown testing along the Pollock Street Sewer, S-93, S-53, and S-63 reported true NAPL thicknesses of 1.11, 1.09, and 0.62 feet, respectively. S-48 reported minimal amounts of NAPL by visual confirmation. The validity of the data collected at S-65 and S-62 is suspect, since these wells have been documented to experience water level variation in concert with tidal fluctuations.

- Hydraulic conductivity values as derived from the slug-tested wells in the area of the Jackson Street Sewer range from 9.37×10^{-5} cm/sec at N-78 to 1.08×10^{-2} cm/sec at N-77, and average 2.07×10^{-3} cm/sec.

- Hydraulic conductivity values as derived from the slug-tested wells in the area of the Pollock Street Sewer range from 7.80×10^{-5} cm/sec at S-92 to 1.51×10^{-4} cm/sec at S-48, and average 1.68×10^{-4} cm/sec.

- Hydraulic conductivity values derived for both sewers appear to be representative of the saturated zone lithology at each testing location.

- Two sets of transmissivity and storativity values were derived for S-93 and N-71 by the Cooper and Jacob Method and the Hantush Method. Each set of values compares closely for each respective well.

- The calculated transmissivity values, ranging from 1.49 cm^2/sec at N-71 to 3.85 cm^2/sec at S-93, suggest that groundwater cannot move through the formations well.

- The storativity values, ranging from 2.80×10^{-3} at N-71 to 8.55×10^{-2} at S-93, suggest available water to be withdrawn by pumping may be limited. These storativity values fall within the range of values that may be interpreted as being representative of either semi-confined or unconfined aquifer conditions.

- The variability in lithologic grain size and sorting documented in both study areas during drilling activities may account for the low storativity values. Unconfined aquifer conditions are expected due to the unconsolidated sediments composing the aquifer material, the depositional history of the unconsolidated aquifer materials, and the proximity of the study areas to the Delaware and Schuylkill Rivers.

- The hydrologic influence of localized clay and silt lenses may be manifested by the small areal extent of pumping influence observed during the pumping tests on N-71 and S-93.

5.2 26TH STREET SEWER SUMMARY

- A slight water-table depression is apparent where the 26th Street Sewer and the Pollock Street Sewer intersect. This water-table depression has been identified in previous investigations of the area, and may be the result of a large volume of more permeable backfill at the intersection of the two sewers. The apparent NAPL plume configuration relative to the 26th Street Sewer has remained unchanged over the past five years.

- An accurate estimate of the radius of pumping influence could not be determined for any test due to the lack of distance-drawdown data. These calculations cannot be completed due mainly to the inconsistent (fluctuating) water levels in monitoring wells and the minimal groundwater withdrawal rates observed during the pumping tests.

- S-90 has a sustainable yield of approximately 0.60 gpm, with a drawdown of approximately 15 feet.

- S-94 has a sustainable yield of approximately 1.0 gpm, with a drawdown of approximately 15 feet.

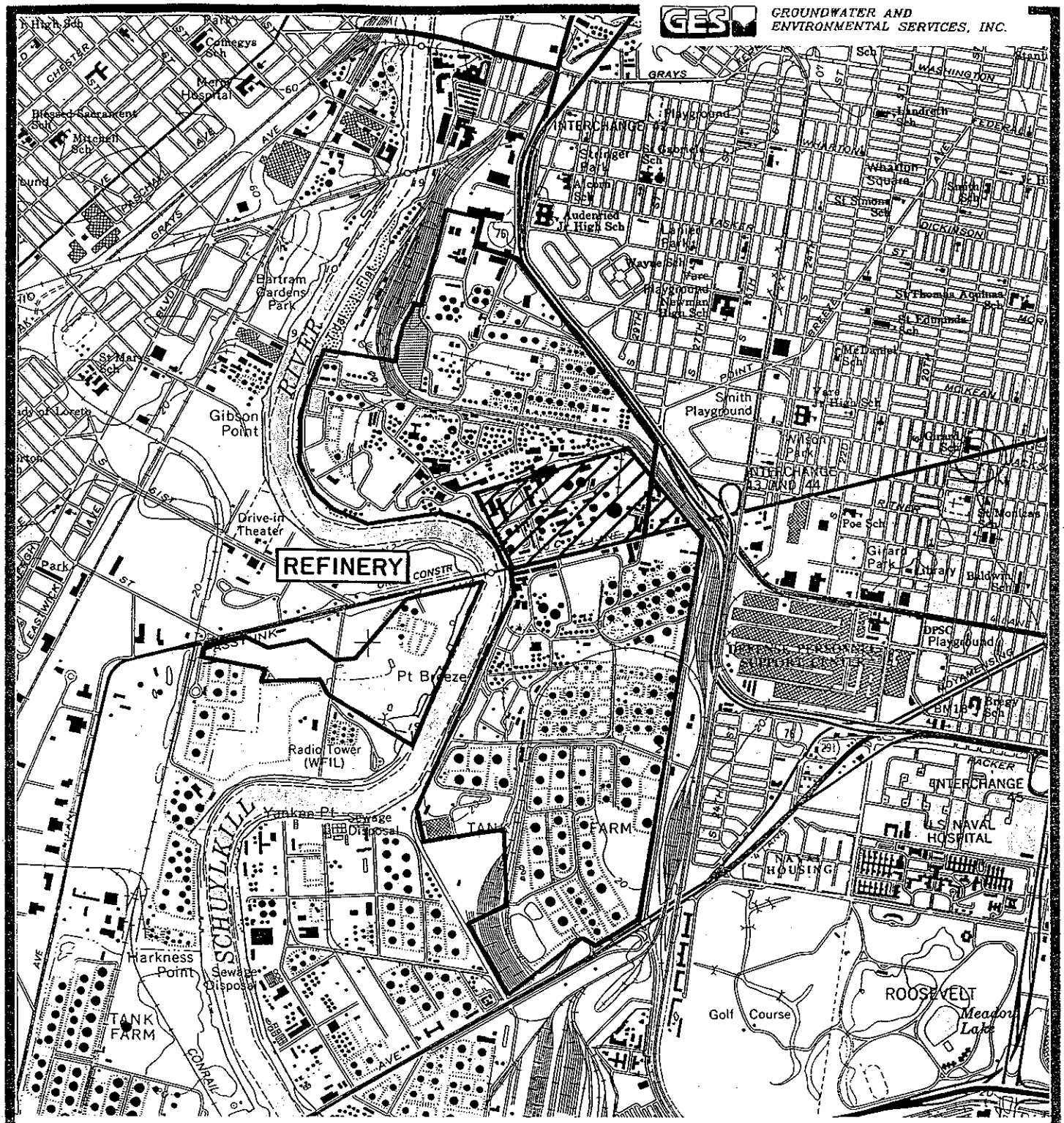
- W-10 has a sustainable yield of approximately 10 gpm, with a drawdown of approximately three feet. Following four hours of pumping, the flow rate was stepped to 13 gpm for the remainder of the test, creating one additional foot of drawdown.

- Two sets of transmissivity and storativity values were derived for S-90, S-94, and W-10 by the Cooper and Jacob Method and the Hantush Method. The calculated transmissivity values, ranging from 7.76×10^{-2} cm^2/sec (521 ft^2/day) at S-94 to 1.99 cm^2/sec (18,507 ft^2/day) at W-10, suggest that groundwater cannot move through the formations easily.

- Storativity coefficients reported for S-90, S-94, and W-10 range from 0.0764 at S-90 to 0.140 at W-10. These storativity values are indicative of unconfined conditions. Unconfined aquifer conditions are expected due to the unconsolidated sediments composing the aquifer material, the depositional history of the unconsolidated aquifer materials, and the proximity of the study areas to the Delaware and Schuylkill Rivers.

- The hydrologic influence of localized clay and silt lenses may be manifested by the small areal extent of pumping influence observed during the pumping tests on N-71 and S-93.

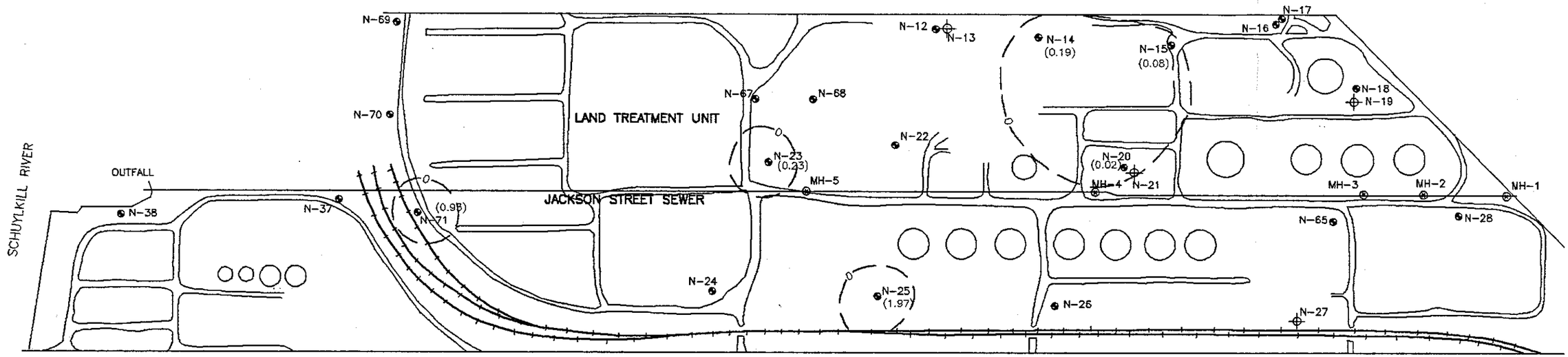
FIGURES



USGS 7.5 MINUTE SERIES
TOPOGRAPHIC QUADRANGLE
PHILADELPHIA, PA 1985
CONTOUR INTERVAL = 20'

FIGURE 1
SITE LOCATION
SUN REFINERY
PHILADELPHIA, PENNSYLVANIA

GES GROUNDWATER AND ENVIRONMENTAL SERVICES, INC.



LEGEND

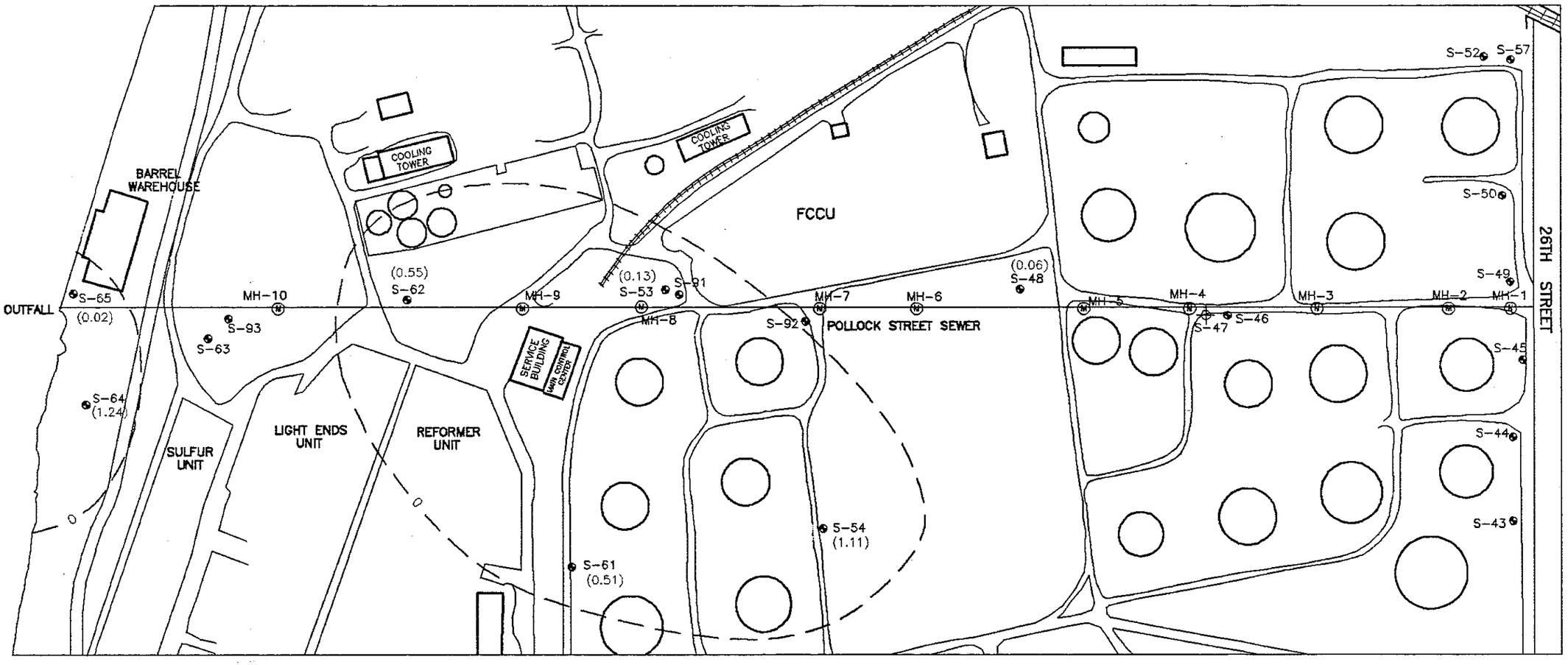
- MONITORING WELLS
- DEEP MONITORING WELLS
- SEWER MANHOLES
- (0.02) NAPL THICKNESS (feet)
- —0— NAPL CONTOUR (feet)

1993 WELL NUMBERING SCHEME

APPARENT NAPL THICKNESS
DECEMBER 1992 – GAUGING DATA
JACKSON STREET SEWER
SUN COMPANY, INC. (R & M)
PHILADELPHIA REFINERY
PHILADELPHIA, PENNSYLVANIA

NORTH	DATE: 14 SEPT 93	CK: SR	APPV: RD
	BY: MLB	REV: N-1292	
	SCALE IN FEET IS APPROXIMATE 0 320	FIGURE 2	

GES GROUNDWATER AND ENVIRONMENTAL SERVICES, INC.



LEGEND

- MONITORING WELLS
- DEEP MONITORING WELLS
- SEWER MANHOLES
- (0.02) NAPL THICKNESS (feet)
- — 0 — NAPL CONTOUR (feet)

1993 WELL NUMBERING SCHEME

APPARENT NAPL THICKNESS
DECEMBER 1992 – GAUGING DATA

POLLOCK STREET SEWER
SUN COMPANY, INC. (R & M)
PHILADELPHIA REFINERY
PHILADELPHIA, PENNSYLVANIA

NORTH

DATE: 14 SEPT 93 | CK: SR | APPV: RD

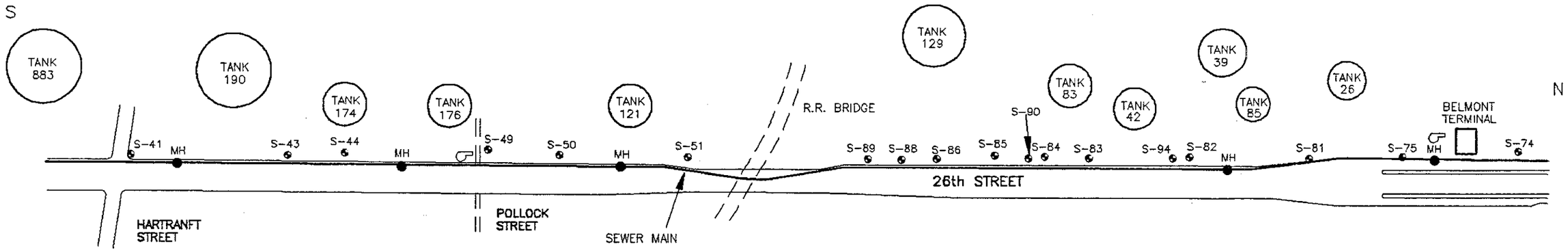
BY: MLB | REV: N-1292

SCALE IN FEET IS APPROXIMATE
0 225

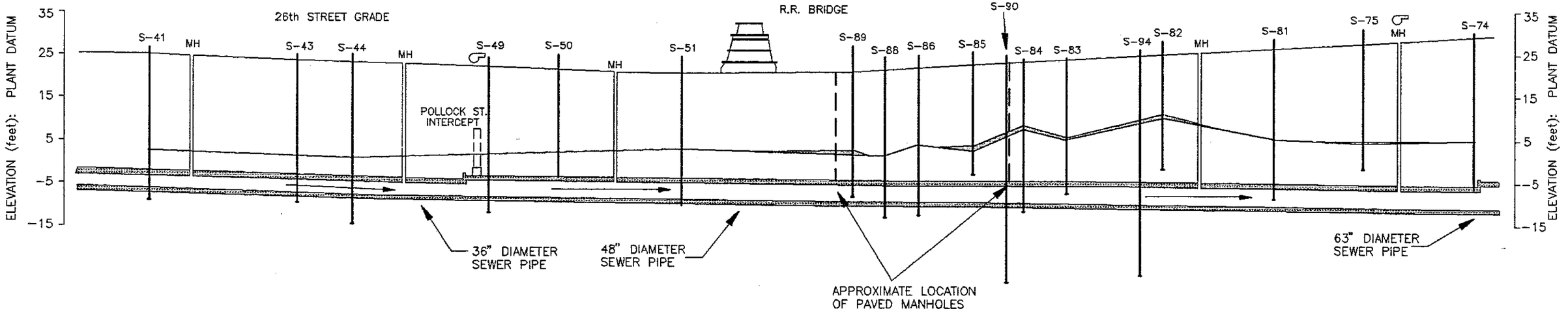
FIGURE 3

GES GROUNDWATER AND ENVIRONMENTAL SERVICES, INC.

PLAN VIEW



CROSS SECTION



LEGEND

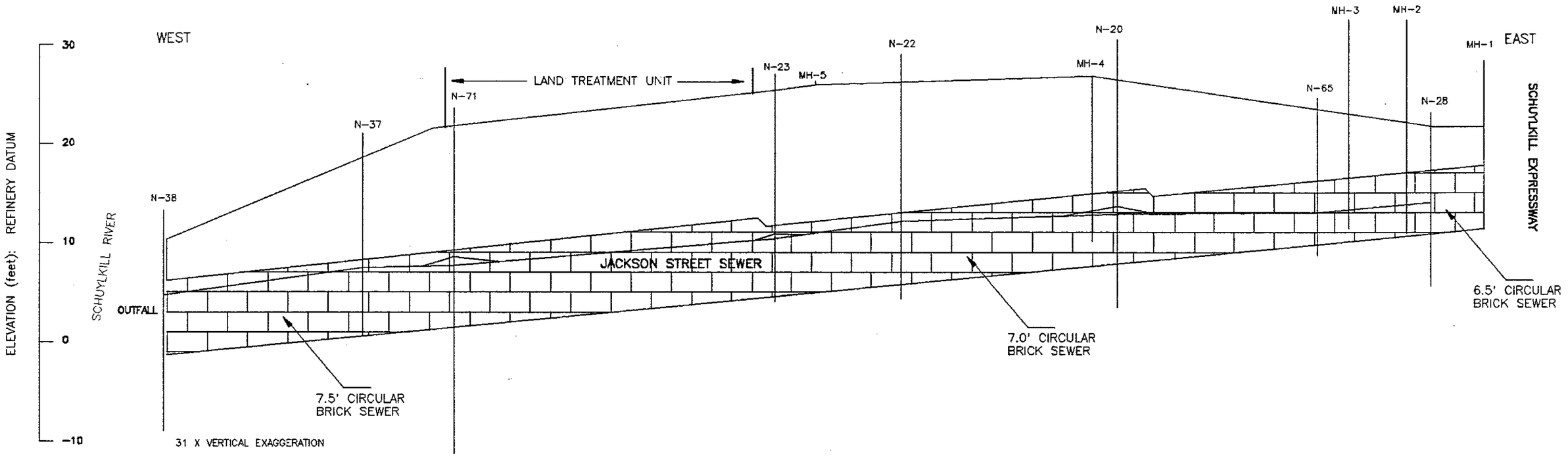
- BLOWER
- WATER TABLE
- APPARENT NAPL THICKNESS

1993 WELL NUMBERING SCHEME

SEWER CROSS SECTION
MAY 1993 GAUGING DATA
26th STREET SEWER
SUN COMPANY, INC. (R & M)
PHILADELPHIA, PENNSYLVANIA

NORTH	DATE: 9 SEPT 93	CK: SR	APPV: RD
	BY: MLB	REV:	
	SCALE IN FEET 0 220	FIGURE 4	

GES GROUNDWATER AND ENVIRONMENTAL SERVICES, INC.



LEGEND

WATER TABLE

NAPL

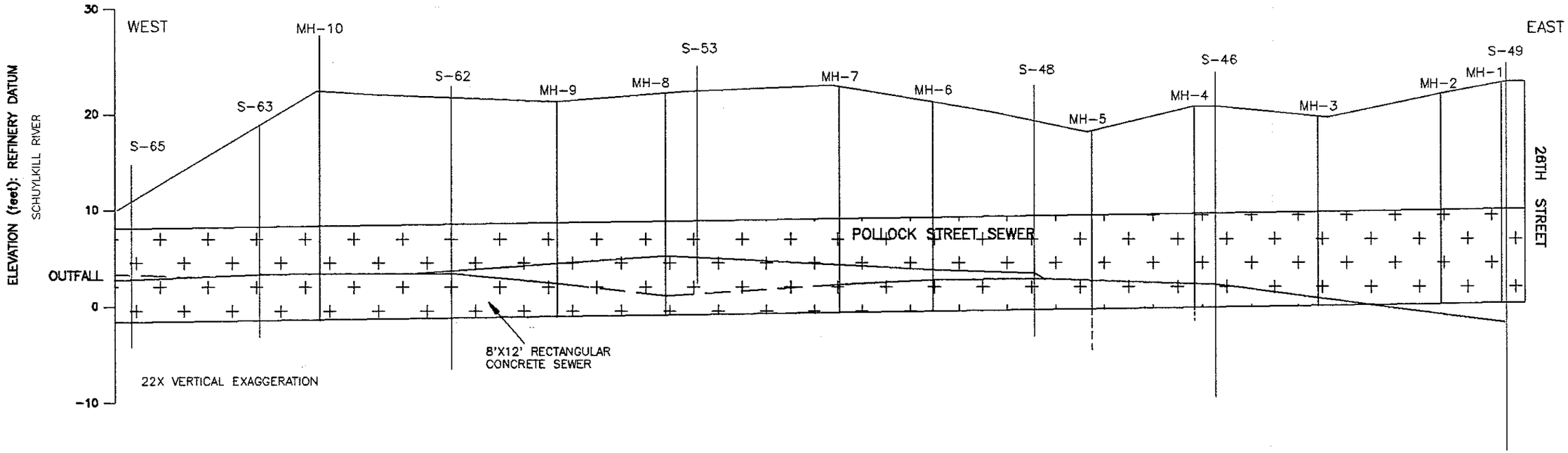
1993 WELL NUMBERING SCHEME

SEWER CROSS SECTION
DECEMBER 1992 – GAUGING DATA

JACKSON STREET SEWER
SUN COMPANY, INC. (R & M)
PHILADELPHIA REFINERY
PHILADELPHIA, PENNSYLVANIA

NORTH	DATE: 14 SEPT 93	CK: SR	APPV: RD
	BY: MLB	REV: NAPL	
NA	SCALE IN FEET IS APPROXIMATE 0 310	FIGURE 5	

GES GROUNDWATER AND ENVIRONMENTAL SERVICES, INC.



LEGEND

WATER TABLE

NAPL

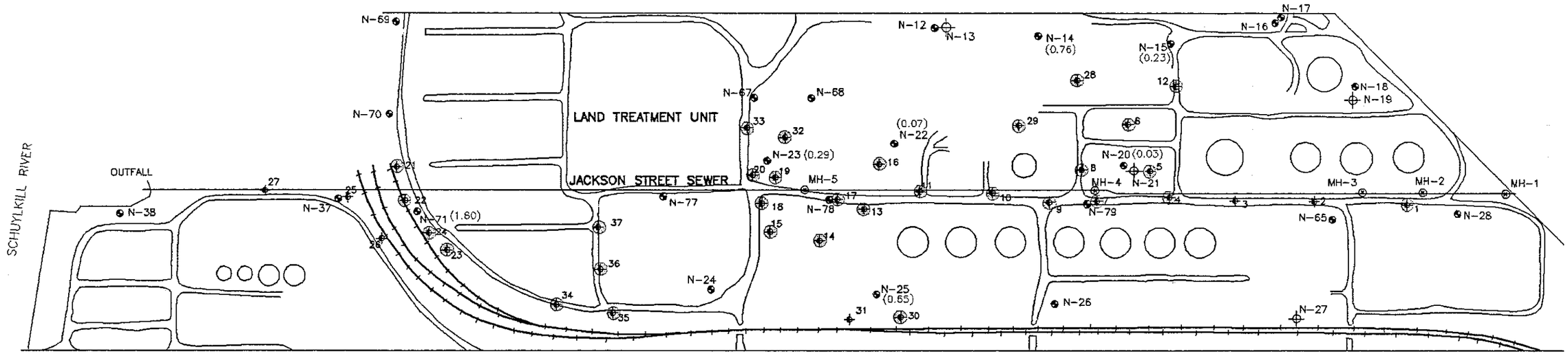
1993 WELL NUMBERING SCHEME

SEWER CROSS SECTION
DECEMBER 1992 – GAUGING DATA

POLLOCK STREET SEWER
SUN COMPANY, INC. (R & M)
PHILADELPHIA REFINERY
PHILADELPHIA, PENNSYLVANIA

NORTH	DATE: 14 SEPT 93	CK: SR	APPV: RD
	BY: MLB	REV: N-1292	
NA	SCALE IN FEET IS APPROXIMATE 0 270	FIGURE 6	

GES GROUNDWATER AND ENVIRONMENTAL SERVICES, INC.



NEW MONITORING WELLS	BAILDOWN TEST LOCATIONS	SLUG TEST LOCATIONS
N-77	N-20	N-24
N-78	N-22	N-26
N-79	N-23	N-27
	N-25	N-28
	N-71	N-37
		N-77
		N-78
		N-79

LEGEND

- MONITORING WELLS
- DEEP MONITORING WELLS
- SEWER MANHOLES
- SOIL BORING LOCATION
- (1.60) NAPL THICKNESS (feet) : MAY 1993
- NAPL PRESENCE IN GROUNDWATER GRAB SAMPLE FROM SOIL BORING

1993 WELL NUMBERING SCHEME

SOIL BORING AND MONITORING WELL LOCATIONS

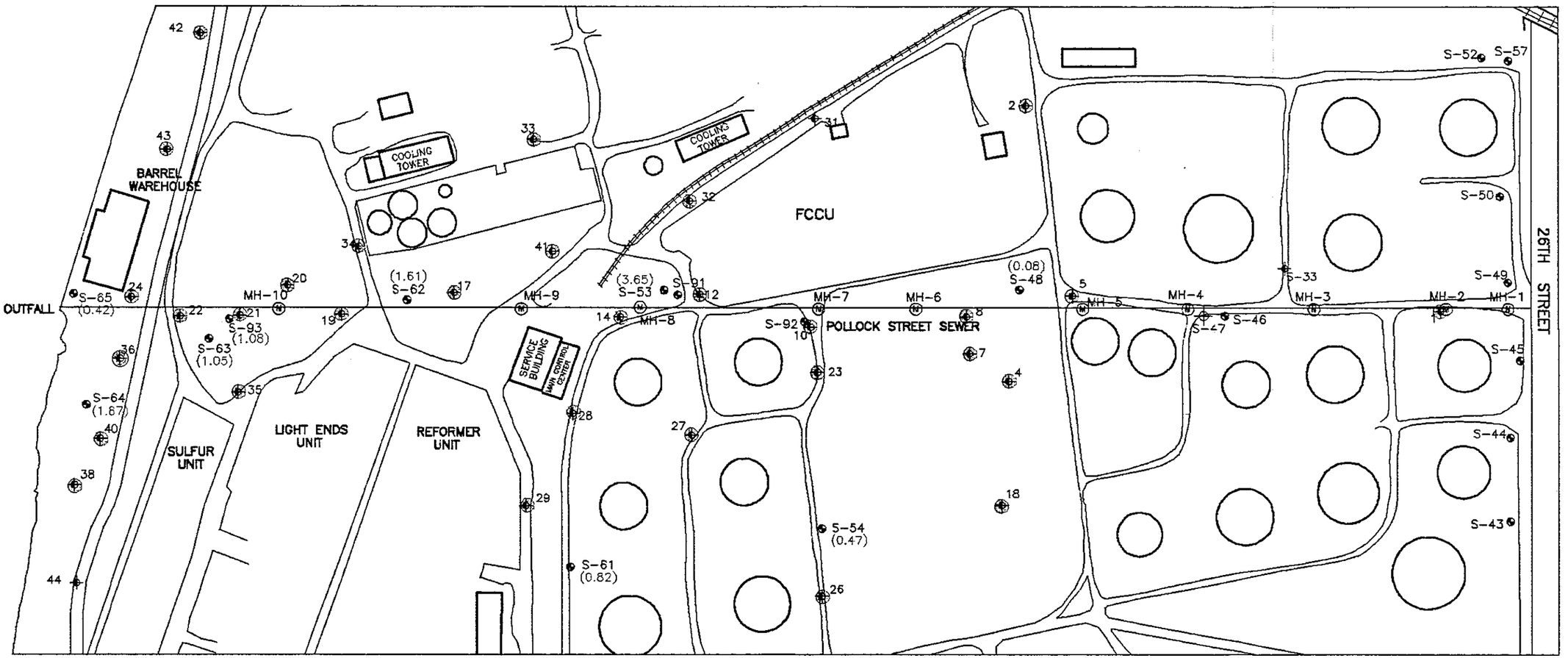
JACKSON STREET SEWER
SUN COMPANY, INC. (R & M)
PHILADELPHIA REFINERY
PHILADELPHIA, PENNSYLVANIA

NORTH

DATE:
CK: SR | APPV: RD
BY: MLB
REV: BORING/N-0593
SCALE IN FEET IS APPROXIMATE
0 320

FIGURE 7

GES GROUNDWATER AND ENVIRONMENTAL SERVICES, INC.



NEW MONITORING WELLS	BAILDOWN TEST LOCATIONS	SLUG TEST LOCATIONS
S-91	S-48	S-45
S-92	S-53	S-46
S-93	S-62	S-48
	S-63	S-49
	S-65	S-91
	S-93	S-92

LEGEND

- MONITORING WELLS
- DEEP MONITORING WELLS
- SEWER MANHOLES
- SOIL BORING LOCATIONS
- (0.82) NAPL THICKNESS (feet) : MAY 1993
- NAPL PRESENT IN GROUNDWATER GRAB SAMPLE FROM SOIL BORINGS

1993 WELL NUMBERING SCHEME

SOIL BORING AND MONITORING WELL LOCATIONS

POLLOCK STREET SEWER
SUN COMPANY, INC. (R & M)
PHILADELPHIA REFINERY
PHILADELPHIA, PENNSYLVANIA

NORTH

DATE:

CK: SR | APPV: RD

BY: MLB

REV: BORING

SCALE IN FEET IS APPROXIMATE

0 225

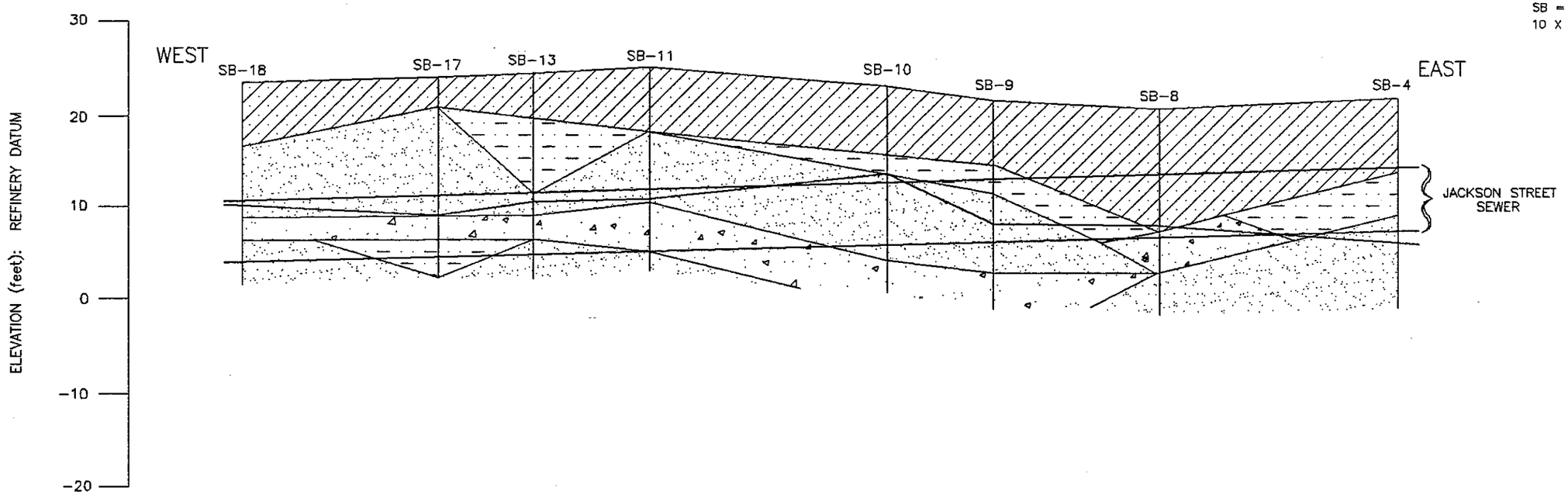
FIGURE 8

GES GROUNDWATER AND ENVIRONMENTAL SERVICES, INC.

LEGEND

- HETEROGENEOUS FILL
- GRAVEL
- SAND
- SILT
- INITIAL WATER IN SOIL BORING

SB = SOIL BORING
10 X VERTICAL EXAGGERATION



1993 WELL NUMBERING SCHEME

LITHOLOGIC CROSS-SECTION

JACKSON STREET SEWER
SUN COMPANY, INC. (R & M)
PHILADELPHIA REFINERY
PHILADELPHIA, PENNSYLVANIA

NORTH	DATE: 23 AUG 93	CK: SR	APPV: RD
	BY: MLB	REV:	
NA	SCALE IN FEET 0 125	FIGURE 9	

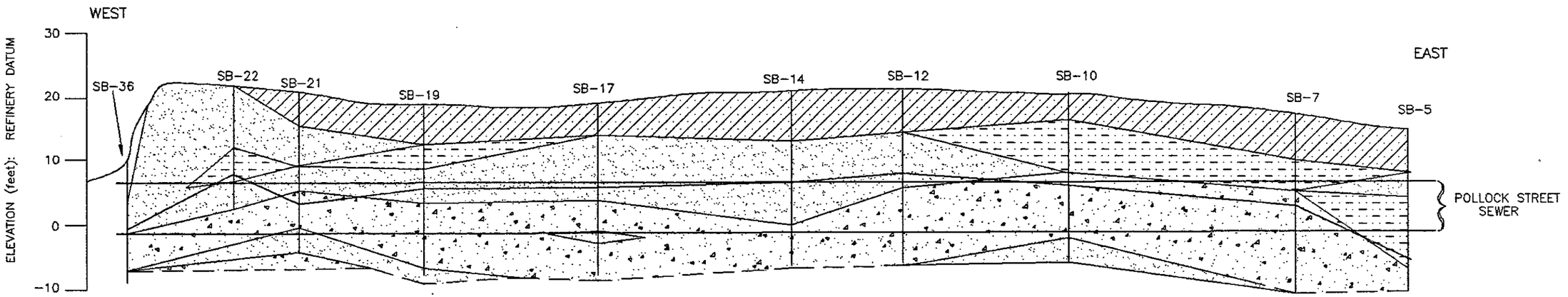
GES GROUNDWATER AND ENVIRONMENTAL SERVICES, INC.

LEGEND

- HETEROGENEOUS FILL
- GRAVEL
- SAND
- SILT
- INITIAL WATER IN SOIL BORING

SB = SOIL BORING

10 X VERTICAL EXAGGERATION

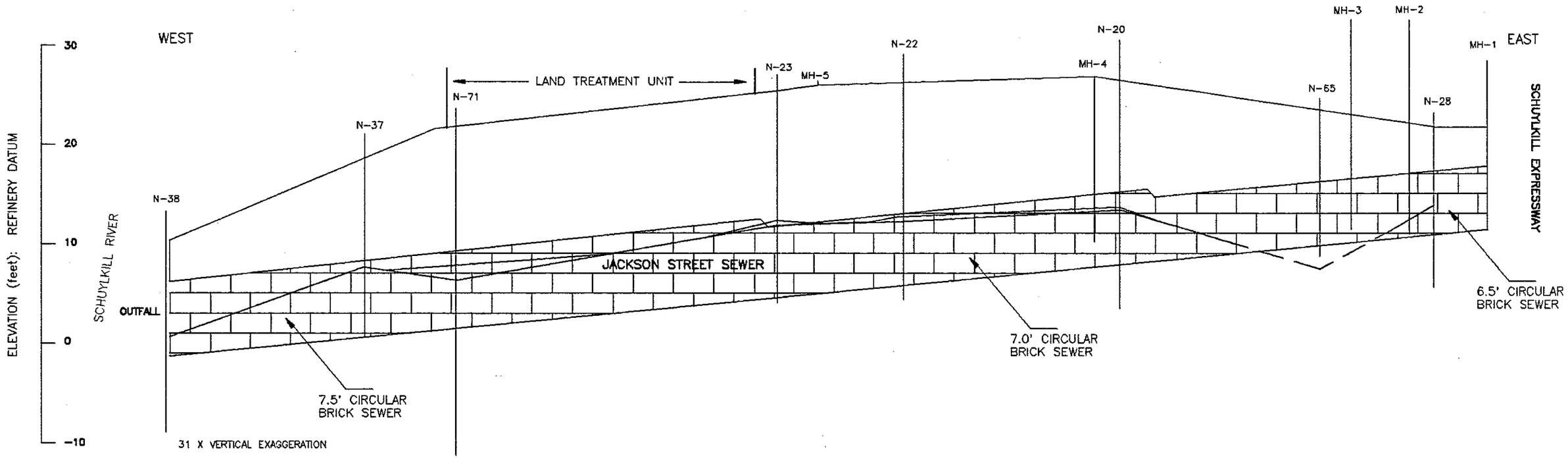


LITHOLOGIC CROSS-SECTION

POLLOCK STREET SEWER
SUN COMPANY, INC. (R & M)
PHILADELPHIA REFINERY
PHILADELPHIA, PENNSYLVANIA

NORTH	DATE: 14 SEPT 93	CK: SR	APPV: RD
	BY: MLB	REV:	
NA	SCALE IN FEET 0 163	FIGURE 10	

GES GROUNDWATER AND ENVIRONMENTAL SERVICES, INC.



LEGEND

WATER TABLE

NAPL

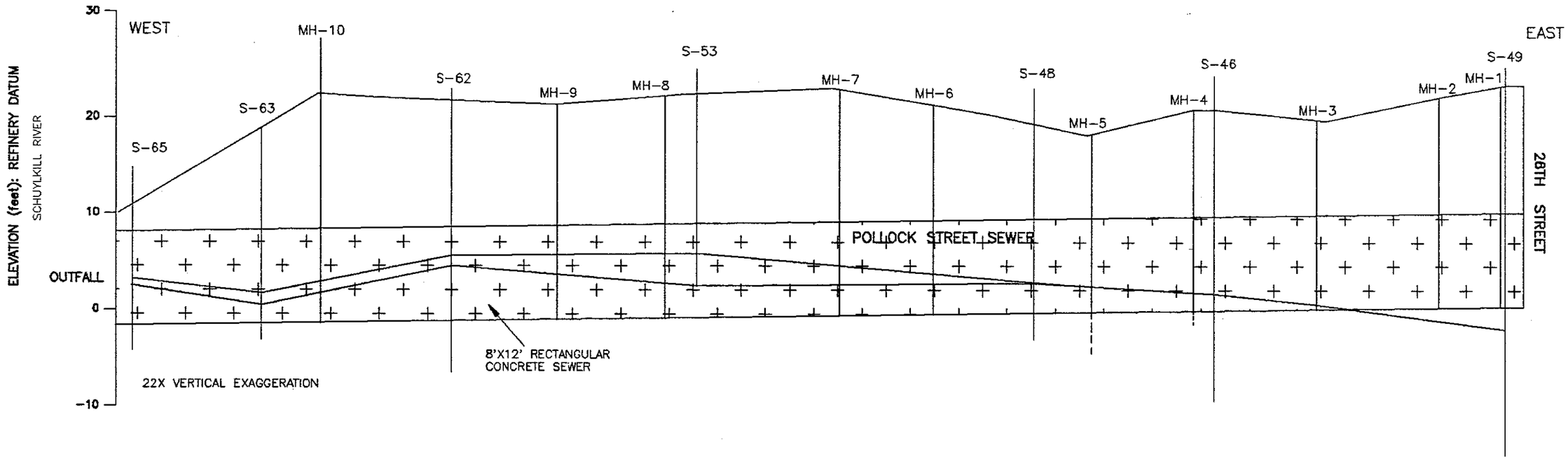
1993 WELL NUMBERING SCHEME

SEWER CROSS SECTION
MAY 1993 GAUGING DATA

JACKSON STREET SEWER
SUN COMPANY, INC. (R & M)
PHILADELPHIA REFINERY
PHILADELPHIA, PENNSYLVANIA

NORTH	DATE: 8 SEPT 93	CK: SR	APPV: RD
	BY: MLB	REV: N-593	
NA	SCALE IN FEET IS APPROXIMATE 0 310	FIGURE 11	

GES GROUNDWATER AND ENVIRONMENTAL SERVICES, INC.



LEGEND

WATER TABLE

NAPL

1993 WELL NUMBERING SCHEME

SEWER CROSS SECTION
MAY 1993 GAUGING DATE

POLLOCK STREET SEWER
SUN COMPANY, INC. (R & M)
PHILADELPHIA REFINERY
PHILADELPHIA, PENNSYLVANIA

NORTH	DATE: 8 SEPT 93	CK: SR	APPV: RD
	BY: MLB	REV: N-593	
NA	SCALE IN FEET IS APPROXIMATE 0 270	FIGURE 12	

TABLES

TABLE 1

SOIL BORING DATA SHEET
JACKSON STREET SEWER
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

BORING NUMBER	SOIL HEADSPACE (ppm)	WATER HEADSPACE (ppm)	MAXIMUM DEPTH OF BORING (feet)	NAPL APPEARANCE	COMMENTS
SB-1	248	411	20	Dark Amber NAPL	
SB-2	6	3	20	No NAPL	
SB-3	12	NA	20		Boring collapsed No water
SB-4	882	1,288	20	Dark Amber to Nearly Black NAPL	
SB-5	1,408	1,421	20	Thin Clear Layer with Sheen	
SB-6	569	1,275	20	Dark Amber NAPL	First boring of SB-6 collapsed to 12 feet
SB-7	18	1,068	20	Clear Fluid	Strong odors
SB-8	750	703	20	Dark Amber NAPL	
SB-9	46	887	20	Dark Amber NAPL	
SB-10	755	1,070	20	Dark Brown NAPL	Auger refusal at 20 feet
SB-11	1,383	1,174	20	Dark Brown NAPL	
SB-12	74	NA	NA		Boring collapsed No water
SB-13	1,396	1,346	20	Thin Light Amber NAPL	

TABLE 1

SOIL BORING DATA SHEET
JACKSON STREET SEWER
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

BORING NUMBER	SOIL HEADSPACE (ppm)	WATER HEADSPACE (ppm)	MAXIMUM DEPTH OF BORING (feet)	NAPL APPEARANCE	COMMENTS
SB-14	231	403	16	Dark Amber NAPL	
SB-15	106	1,218	20	Dark Brown NAPL	
SB-16	1,460	1,121	20	Dark Brown NAPL	
SB-17	1,048	903	20	Dark Brown to Amber NAPL	
SB-18	469	269	20	Brown NAPL	
SB-19	1,256	1,930	20	Dark Amber NAPL	
SB-20	1,057	777	20	Dark Brown NAPL	Strong odors
SB-21	3,558	1,590	30	Dark Amber NAPL	
SB-22	368	892	30	Dark Amber NAPL	
SB-23	1,525	764	30	Black NAPL	
SB-24	1,374	953	25	Black NAPL	
SB-25	189	256	20	Clear Floating Layer	Strong odors
SB-26	428	189	20	Clear Layer with Sheen	Auger resistance at 18 feet

TABLE 1

SOIL BORING DATA SHEET
JACKSON STREET SEWER
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

BORING NUMBER	SOIL HEADSPACE (ppm)	WATER HEADSPACE (ppm)	MAXIMUM DEPTH OF BORING (feet)	NAPL APPEARANCE	COMMENTS
SB-27	252	272	20	Clear Floating Layer with Light Sheen	Strong Odors
SB-28	2,404	1,240	20	Dark Brown NAPL	
SB-29	887	957	20	Dark Brown NAPL	
SB-30	1,066	421	21	Black NAPL	
SB-31	798	201	20	No NAPL	
SB-32	697	330	20	Clear Fluid	
SB-33	252	2,000+	20	Clear Floating Layer	
SB-34	634	417	25	Dark Brown NAPL	
SB-35	738	679	25	Black NAPL	
SB-36	1,293	753	25	Black NAPL	
SB-37	1,034	532	25	Trace Yellow NAPL	
N-77	275	241	30	No NAPL	

Note
* All NAPLS are floating light non-aqueous phase liquids
* Headspace measurements in ppm refer to OVM deflection units of Isobutylene calibration gas
* NA = Data not available

TABLE 2

SOIL BORING DATA SHEET
POLLOCK STREET SEWER
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

BORING NUMBER	SOIL HEADSPACE (ppm)	WATER HEADSPACE (ppm)	MAXIMUM DEPTH OF BORING (feet)	NAPL APPEARANCE	COMMENTS
SB-1	1,648	1,492	25	Light Brown NAPL	Turpentine odor
SB-2	813	1,102	20	Dark Brown NAPL	
SB-3	707	860	20		Auger refusal at 20 feet
SB-4	1,124	1,217	25	Amber NAPL	
SB-5	419	669	23	Black NAPL	Auger refusal at 23 feet
SB-6	NA	NA	NA		Deleted due to adequate plume definition
SB-7	547	813	25	Black NAPL	
SB-8	NA	NA	NA		Deleted due to Refinery safety concerns
SB-9	NA	NA	NA		Deleted due to Refinery safety concerns
SB-10	3,286	1,310	25	Dark Brown NAPL	
SB-11	NA	NA	NA		Deleted due to adequate plume definition
SB-12	719	1,147	25	Black NAPL	
SB-13	NA	NA	NA		Deleted due to adequate plume definition

TABLE 2 (cont.)

SOIL BORING DATA SHEET
POLLOCK STREET SEWER
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

BORING NUMBER	SOIL HEADSPACE (ppm)	WATER HEADSPACE (ppm)	MAXIMUM DEPTH OF BORING (feet)	NAPL APPEARANCE	COMMENTS
SB-14	2,460	1,213	25	Black NAPL	
SB-15	NA	NA	NA		Deleted due to adequate plume definition
SB-16	NA	NA	NA		Deleted due to adequate plume definition
SB-17	524	608	25	NAPL Adhered to Glass Jar	
SB-18	919	689	20	Amber NAPL	
SB-19	668	1,019	25	Black NAPL	
SB-20	224	585	25	Black NAPL	
SB-21	552	834	25	Black NAPL with Brown Froth	
SB-22	51	563	20	Yellowish - Brown NAPL	Auger refusal at 20 feet
SB-23	1,094	935	25	Slight NAPL Layer	
SB-24	2,220	2,094	20	Black NAPL	
SB-25	NA	NA	NA		Deleted due to adequate plume definition
SB-26	501	NA	19		No water

TABLE 2 (cont.)

SOIL BORING DATA SHEET
POLLOCK STREET SEWER
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

BORING NUMBER	SOIL HEADSPACE (ppm)	WATER HEADSPACE (ppm)	MAXIMUM DEPTH OF BORING (feet)	NAPL APPEARANCE	COMMENTS
SB-27	1,724	1,096	25	Dark Brown NAPL	
SB-28	847	430	20	Trace Amber NAPL	
SB-29	977	865	20	Trace Amber NAPL	
SB-30	NA	NA	NA	NA	Deleted due to utilties
SB-31	119	296	20	No apparent NAPL	Strong odors
SB-32	901	570	25	Black NAPL	
SB-33	370	532	25	Black NAPL	
SB-34	34	NA	25		No water Collapsed to 15 feet
SB-35	574	608	25	Black NAPL with Brown Layers	
SB-36	3,444	2,934	20	NAPL with Yellow Hue	
SB-37	NA	NA	NA		Deleted due to adequate plume definition
SB-38	2,426	2,800	20	Brown NAPL With Yellow Hue	

TABLE 2 (cont.)

SOIL BORING DATA SHEET
POLLOCK STREET SEWER
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

BORING NUMBER	SOIL HEADSPACE (ppm)	WATER HEADSPACE (ppm)	MAXIMUM DEPTH OF BORING (feet)	NAPL APPEARANCE	COMMENTS
SB-39	NA	NA	NA		Deleted due to adequate plume definition
SB-40	1,754	1,180	20	Black NAPL	
SB-41	249	797	25	Black NAPL	
SB-42	1,745	NA	22	Dark Amber NAPL	No water
SB-43	89	1,581	20	Dark Brown NAPL	
SB-44	303	62	30	No NAPL	
SB-45	NA	NA	NA		Deleted due to adequate plume definition
MW-91	948	NA	25		Auger resistance at 23 feet

Note
* All NAPLS are floating light non-aqueous phase liquids
* Headspace measurements in ppm refer to OVM deflection units of Isobutylene calibration gas
* NA = Data not available

TABLE 3
NEW MONITORING/RECOVERY WELL CONSTRUCTION SUMMARY
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

WELL NO.	WELL DIAMETER (inches)	WELL MATERIAL	REFERENCE ELEVATION (feet)	WELL DEPTH (feet)	CASING LENGTH: from grade (feet)	SCREEN LENGTH (feet)	WELL HEAD CONSTRUCTION	DATE DRILLED
MONITORING WELLS								
NORTH YARD								
N-77	4	PVC	20.74 ft	30	5	25	3 ft steel stick-up	11-Aug-93
N-78	4	PVC	24.29 ft	30	5	25	Flush mount manhole	10-Aug-93
N-79	4	PVC	23.97 ft	30	5	25	Flush mount manhole	10-Aug-93
SOUTH YARD								
S-91	4	PVC	26.02 ft	30	10	20	3 ft steel stick-up	11-Aug-93
S-92	4	PVC	22.32 ft	30	10	20	Flush mount manhole	9-Aug-93
S-93	4	PVC	24.65 ft	30	10	20	3 ft steel stick-up	9-Aug-93
RECOVERY WELLS								
SOUTH YARD								
S-90	6	STEEL	27.81 ft	50	15	35	3 ft steel stick-up	1-Jul-93
S-94	6	STEEL	NA	50	15	35	1 ft steel stick-up	10-Sep-93

TABLE 4

JACKSON STREET SEWER
BAILDOWN TEST DATA RESULTS
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Baildown Tests Conducted on 19 August 1993

WELL #	INITIAL NAPL THICKNESS (feet)	TRUE NAPL THICKNESS (feet)
N-20	0.01	< 0.01
N-22	0.01	CNR
N-23	2.82	CNR
N-25	0.89	0.63
N-71	1.51	0.67

CNR = Could not read. Interface probe could not reliably measure highly viscous NAPL thickness.

TABLE 5

POLLOCK STREET SEWER
BAILDOWN TEST DATA RESULTS
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Baildown Tests Conducted on 20 August 1993

WELL #	INITIAL NAPL THICKNESS (feet)	TRUE NAPL THICKNESS (feet)
S-48	0.04	< 0.01
S-53	3.32	1.09
S-62	1.02	0.03
S-63	1.27	0.62
S-65	0.24	0.02
S-93	1.08	1.11

TABLE 6

JACKSON STREET SEWER
SLUG TEST DATA RESULTS
HYDRAULIC CONDUCIVITY ANALYSIS
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Slug Test Analysis Data Reduced Utilizing the Bouwer and Rice Method

WELL #	HYDRAULIC CONDUCTIVITY K (cm/sec)
N-24	4.28E-04
N-26	NA
N-27	NA
N-28	6.29E-06
N-37	9.54E-04
N-77	1.08E-02
N-78	9.37E-05
N-79	1.77E-04

Average K Value = 2.07E-03

NA = Data Not Useable

TABLE 7

POLLOCK STREET SEWER
SLUG TEST DATA SUMMARY
HYDRAULIC CONDUCTIVITY ANALYSIS
SUN COMPANY, INC. (R &M)
PHILADELPHIA REFINERY

Slug Test Analysis Data Reduced Utilizing the Bouwer and Rice Method

WELL #	HYDRAULIC CONDUCTIVITY K (cm/sec)
S-45	5.53E-05
S-46	NA
S-48	1.51E-04
S-49	5.26E-04
S-91	3.17E-05
S-92	7.80E-05

Average K Value = 1.68E-04 1.68E-04

NA = Data Not Useable

TABLE 8

JACKSON STREET SEWER
PUMPING TEST ANALYSIS
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Pumping Test Conducted on 3 September 1993

PUMPING WELL: N-71

WELL #	TRANSMISSIVITY T (cm2/min)	STORATIVITY S (dimensionless)
Pumping Test Analysis performed by the Cooper and Jacob Method		
N-71	1.49	6.48E-03
Pumping Test Analysis performed by the Hantush Method		
N-71	2.02	2.80E-03

TABLE 9

POLLOCK STREET SEWER
PUMPING TEST ANALYSIS
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Pumping Test Conducted on 8 September 1993

PUMPING WELL: S-93

WELL #	TRANSMISSIVITY T (cm2/min)	STORATIVITY S (dimensionless)
Pumping Test Analysis performed by the Cooper and Jacob Method		
S-93	3.85	8.55E-02
Pumping Test Analysis performed by the Hantush Method		
S-93	3.85	6.98E-02

TABLE 10

26TH STREET SEWER
PUMPING TEST ANALYSIS
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

PUMPING WELL: S-90
11-Aug-93 to 12-Aug-93

WELL #	TRANSMISSIVITY T (cm2/sec)	STORATIVITY S (dimensionless)
Pumping Test Analysis performed by the Cooper and Jacob Method		
S-90	**2.46E-02**	**2.71E-01**
Pumping Test Analysis performed by the Hantush Method		
S-90	**5.60E-02**	**5.62E-02**

PUMPING WELL: S-94
14-Sep-93

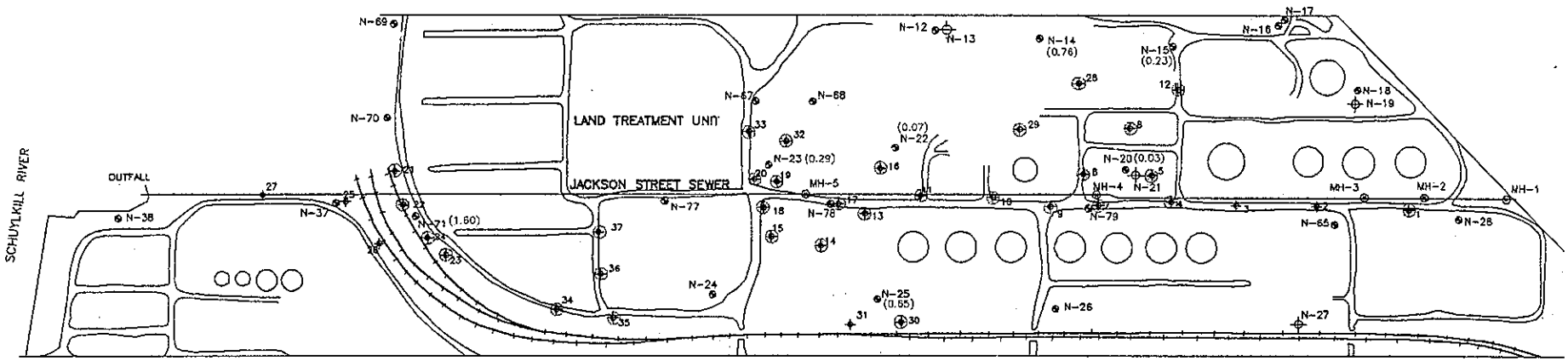
WELL #	TRANSMISSIVITY T (cm2/sec)	STORATIVITY S (dimensionless)
Pumping Test Analysis performed by the Cooper and Jacob Method		
S-94	**7.76E-02**	**7.64E-02**
Pumping Test Analysis performed by the Hantush Method		
S-94	**7.76E-02**	**7.64E-02**

PUMPING WELL: W-10
7-Sep-93

WELL #	TRANSMISSIVITY T (cm2/sec)	STORATIVITY S (dimensionless)
Pumping Test Analysis performed by the Cooper and Jacob Method		
W-10	**1.74**	**1.43E-01**
Pumping Test Analysis performed by the Hantush Method		
W-10	**1.99**	**1.40E-01**

APPENDIX A
DRILL LOGS - JACKSON STREET SEWER

GES GROUNDWATER AND ENVIRONMENTAL SERVICES, INC.



NEW MONITORING WELLS	BAILDOWN TEST LOCATIONS	SLUG TEST LOCATIONS
N-77	N-20	N-24
N-78	N-22	N-26
N-79	N-23	N-27
	N-25	N-28
	N-71	N-37
		N-77
		N-78
		N-79

LEGEND

- ⊕ MONITORING WELLS
- ⊕ DEEP MONITORING WELLS
- ⊛ SEWER MANHOLES
- ✦ SOIL BORING LOCATION
- (1.60) NAPL THICKNESS (feet) : MAY 1993
- Ⓖ NAPL PRESENCE IN GROUNDWATER GRAB SAMPLE FROM SOIL BORING

1993 WELL NUMBERING SCHEME

SOIL BORING AND MONITORING WELL LOCATIONS

JACKSON STREET SEWER
SUN COMPANY, INC. (R & M)
PHILADELPHIA REFINERY
PHILADELPHIA, PENNSYLVANIA

NORTH

DATE:
CK: SR APPV: RD
BY: MLB
REV: BORING/N-0593
SCALE IN FEET IS APPROXIMATE
0 320

FIGURE 7

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-1 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 15 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 14 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A	3		FILL	- Brown sandy fill with crushed stone, dry, slight odor.
			3			- Black sandy fill with crushed stone, odor.
5			0.0			- Black sandy fill, with crushed stone, odor, sticky.
						- Brown/grey sand with fill, dry, slight odor.
10						
			18		GRAVEL	- Black sandy gravel with pebbles, moist, odor.
15	Floating NAPL Layer			▽		
			60		SAND	- Tan/orange silty sand, moist, odor.
20						- Brown silty sand, wet, slight odor.
			0.0			
						BORING COMPLETED AT 22 FEET
25						
30						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-2 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 14 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			FILL
			0.0		SAND - Brown silty sand, dry, no odor.
5			0.0		
10					SILT - Brown/tan silt, moist, no odor.
			0.0		SAND - Silty sand with quartz pebbles, moist, no odor.
15			0.0		- Brown coarse sandwith gravel and quartz pebbles, some large, wet, no odor.
			0.0		- Brown med. grained sand, wet, no odor.
20					SILT - Tan sandy silt, wet, no odor.
			0.0		BORING COMPLETED AT 22 FEET
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company., Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-3 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 15 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 14 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	0.0		ASPHALT AND BALLAST STONE
					SILT - Brown clayey silt, dry, no odor.
5			0.0		- Tan clayey silt, dry, no odor.
			0.0		- Brown sandy silt, moist no odor.
10			0.0		
					GRAVEL - Brown gravel with quartz pebbles, moist, no odor.
15				▽	
			257		SAND - Brown med. grey sand, wet, sheen, odor.
20					GRAVEL - Grey and tan gravel, odor, wet.
			6		BORING COMPLETED AT 22 FEET
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-4 — Total Depth 22 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 15 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 14 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			ASPHALT AND BALLAST STONE
			15		FILL - Black sandy fill with stone, dry, slight odor.
5					
			0.0		SILT - Grey sandy silt, moist, no odor.
10					
			0.0		SAND - Greyish brown coarse sand with silt, moist, no odor.
15	Floating NAPL Layer			▽	
			357		
20			15		- Grey med. grained sand, wet, odor.
					BORING COMPLETED AT 22 FEET
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-5 — Total Depth 22 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 15 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 15 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A	10		FILL	- Brown sandy fill with crushed stones, dry.
						- Dark brown sandy fill with crushed stones, odor.
			7			
5						
			536		SAND	- Dark brown silty sand, stained, strong odor, moist.
			1883			- Black silty sand, moist, strong odor.
10						
			1521			- Black sand with quartz pebbles, strong odor, moist.
			1966			
15	Floating NAPL Layer			▽		- Brown/black coarse sand with quartz pebbles, wet, strong odor.
			2158			
20					CLAY	- Tan clay , wet, slight odor.
			7		SAND	- Green/gray coarse sand, wet, slight odor.
						BORING COMPLETED AT 22 FEET.
25						
30						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-6 — Total Depth 22 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 15 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 15 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	0.0		FILL - Sandy fill with stone, dry, no odor.
			85		
5			207		
			124		SILT - Brown clayey silt, odor, dry.
10			1310		- Sandy silt, dark brown, odor.
			1682		SAND - Silty sand with quartz pebbles, moist, dark brown, odor.
15	Floating Napl Layer			▽	
			140		SILT - Brown clayey silt, odor, wet, sheen.
20			38		- Tan silt with small pebbles and gravel, moist, odor.
					BORING COMPLETED AT 22 FEET.
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-7 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 14 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			ASPHALT AND BALLAST STONE
			3		SAND - Black sand with fill, slight odor, dry.
			9		- Dark brown silty sand, slight odor, dry.
5					
10					
			4		
			299		- Dark brown coarse sand with pebbles, moist, odor.
			372	▽	
15			18		- Grey coarse sand, wet, slight odor.
20			15		GRAVEL - Grey gravel changing to tan sandy silt (bottom), wet.
					BORING COMPLETED AT 22 FEET
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-8 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 13 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 14 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	29		FILL - Fill with large crushed stone.
					- Black sand with fill, dry, odor.
5					
			199		
10					
			287		
	Floating NAPL Layer		462	▽	
15			154		GRAVEL - Black gravel with large pebbles, wet, odor, sheen.
20			3		SAND - Tan medium grained sand, wet, slight odor.
					BORING COMPLETED AT 22 FEET.
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-10 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 9 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 15 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			ASPHALT AND BALLAST STONE
			28		FILL - Tan sandy fill with crushed stone, dry, slight odor.
5					
			78		SAND - Greyish tan silty sand, dry, odor.
	Floating NAPL Layer		12	▽	- Grey coarse sand with quartz pebbles, odor, wet.
10			146		- Fine brown sand, odor, moist.
15					
20					GRAVEL - Black gravel with quartz pebbles, wet, sheen, strong odor.
			373		
					BORING COMPLETED AT 22 FEET.
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-11 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 15 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	10		FILL - Tan sandy fill with large rocks, dry, no odor.
					- Dark brown sandy fill with crushed stone, dry, no odor.
5			57		
			39		SAND - Tan sand, some crushed stone, slight odor, dry.
			89		
10					
			207		
	Floating NAPL Layer		132	▽	- Dark grey sand, moist, odor.
15					GRAVEL - Black gravel with quartz pebbles, wet, sheen, slight odor.
			1252		
20			92		SAND - Reddish tan silty sand (top), brown fine sand, (bottom).
			14		
					BORING COMPLETED AT 22 FEET.
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-12 Total Depth 16 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial N/A Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 15 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	20		FILL - Fill, dry, slight odor.
			4		SILT - Brown clayey silt, dry, slight odor.
5					
			3		
10			5		
			3		SAND - Black silty sand, moist, odor.
15			3	▽	- Dark brown med. sand, wet, slight odor.
					AUGER REFUSAL AT 16 FEET.
20					
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-13 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 15 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A	85		FILL	- Dark brown fill with stones, odor, dry.
5			110		SILT	- Brown silt, dry, odor.
			128			
			35			- Dark brown silt, dry, strong odor.
			505			- Dark brown silt, moist, strong odor.
10			129			
	Floating NAPL Layer		409	▽	SAND	- Coarse brown sand with pebbles, odor.
15					GRAVEL	- Black gravel, wet, sheen, strong odor.
			146		SAND	- Reddish brown fine grained sand, wet, sheen.
					CLAY	- Tan silty clay, wet, sheen.
20					SAND	- Tan fine sand, wet.
			28			
25						BORING COMPLETED AT 22 FEET.
30						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-14 — Total Depth 16 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 13 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 22 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			FILL - Sandy fill with crushed stone, dry, no odor.
5					
			10		SAND - Black sand, moist, slight odor.
10					
	Floating NAPL Layer			▽	
			51		- Grey sand, wet, odor.
15					GRAVEL - Black gravel with pebbles, odor, wet.
			65		AUGER REFUSAL AT 16 FEET.
20					
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery | Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. | Permit No. N/A

Boring number SB-15 | Total Depth 22 ft. | Diameter 6.125 in.

Casing Elevation N/A | Water Level: Initial 15 ft. Static N/A

Screen Dia. N/A | Length N/A | Slot Size N/A

Casing Dia. N/A | Length N/A | Type N/A

Drilling Method Hollow-Stem Auger | Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. | Log By E. Dziedzic | Date 22 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	2		FILL - Brown sandy fill with stone, dry, slight odor.
5			17		GRAVEL - Black sticky gravel, moist, odor.
10			22		SAND - Dark grey sand, moist, odor.
15	Floating NAPL Layer		24	▽	GRAVEL - Black stained gravel with pebbles, odor, wet, sheen.
20			10		SILT - Grey and tan silt, wet, no odor.
25					BORING COMPLETED AT 22 FEET
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-16 — Total Depth 22 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 13 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 15 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			FILL - Brick, sand, stone fill.
			53		SAND - Dark brown sand with crushed stone, odor, dry.
			10		
5					
			182		GRAVEL - Black silty gravel with crushed stone, odor, dry.
10					
			1142	▽	SAND - Brown fine sand, strong odor, moist.
15					
			282		GRAVEL - Black gravel with pebbles, wet, sheen, odor.
20					- Brown/grey gravel with pebbles, strong odor, wet, sheen.
			7		
					BORING COMPLETED AT 22 FEET.
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-17 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 15 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 16 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A			ASPHALT AND BALLAST STONE	
			501		SAND	- Black sand, dry, strong odor.
			276			- Tan silty sand, dry, odor.
5			108			
			430			
10			1021			- Brown sand, medium grained, strong odor, moist.
			895			
15	Floating NAPL Layer		590	▽	GRAVEL	- Black gravel with pebbles, wet, strong odor.
					CLAY	- Tan silty clay, wet.
20			1		SILT	- Tan sandy silt, wet, no odor.
					BORING COMPLETED AT 22 FEET.	
25						
30						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-18 — Total Depth 22 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 13 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 16 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A	14		FILL	- Brown sandy fill with stones, dry, slight odor.
			4			- Black sandy fill, no odor.
5			46		SAND	- Black sand (stained), odor.
10			17	▽		- Black sand, moist.
	Floating NAPL Layer		40			- Dark grey sand with pebbles, wet, odor.
15			46		GRAVEL	- Black (stained), gravel with quartz pebbles amber NAPL, odor.
					SAND	- Brown fine grained sand, wet, sheen.
20			0.0			- Tan fine grained sand, wet, no odor.
						BORING COMPLETED AT 22 FEET.
25						
30						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-19 — Total Depth 22 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 11 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 16 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A			FILL	- Brown sandy fill with crushed stone.
			393			- Black sandy fill, odor, dry.
5			198			
			330			
10			49			
	Floating NAPL Layer			▽	SAND	- Black sand with pebbles, moist, odor.
15					GRAVEL	- Gravel with pebbles, wet, sheen, odor.
			381		SILT	- Brown silt, wet, sheen, odor.
20						- Sandy silt, grey at top, tan at bottom, slight odor, wet.
			4			
						BORING COMPLETED AT 22 FEET.
25						
30						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-20 — Total Depth 22 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 15 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 16 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	66		FILL - Dark brown sandy fill with stone, odor.
			0.0		
5					
			98		
10			29		
					SAND - Black sand, moist, stained, odor.
15	Floating NAPL Layer		487	▽	GRAVEL - Brownish grey gravel with small pebbles, wet, odor, sheen.
20			0.0		SAND - Light tan silty sand, wet, no odor.
					BORING COMPLETED AT 22 FEET.
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-21 Total Depth 27 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 16 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By S. Roberts Date 17 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			FILL - Brown silty sand with pebbles, damp.
5					SAND - Black coarse sand.
10			43		- Silty sand with pebbles, damp.
15	Floating NAPL Layer		2193	▽	- Dark grey/brown coarse sand and pebbles, moderate odor, wet, sheen.
20			460		- Coarse sand with pebbles, wet sheen.
					GRAVEL - Grey/Brown gravel with coarse sand, moderate odor.
25			243		SAND - Dark brown silty, coarse sand with gravel.
30					BORING COMPLETED AT 30 FEET.

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-22 Total Depth 31 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 12 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By S. Roberts Date 17 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			FILL - Brown fill silt with sand and gravel, damp.
					SAND - Black coarse sand with pebbles, no odor, moist.
10	Floating NAPL Layer			▽	- Brown silty sand, no odor, moist.
			575		- Coarse sand with gravel and cobbles.
20			139		- Grey/Brown coarse sand, modorate/strong odor.
			260		- Dark grey coarse sand, wet.
30			10		- Coarse grey/brown sand slight odor.
					BORING COMPLETED AT 31 FEET.
40					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-23 — Total Depth 31 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By S. Roberts — Date 17 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A				- Fill.
			0		SAND	- Brown silty coarse sand fill, damp.
						- Dark brown silty coarse sand with pebbles, damp.
						- Dark grey silty sand (coarse) with some clay, damp.
10			0			- Brown, medium sand with some silt and pebbles, no odor.
	Floating NAPL Layer			▽		
			1359		GRAVEL	- Gravel with coarse sand, strong odor, wet.
					SAND	- Coarse sand, strong odor.
20			214			
			322			- Coarse sand, gravel, wet, strong odor.
					SILT	- Grey/Brown clayey silt.
					SAND	- Coarse grey/brown sand and gravel, strong odor, wet.
30			368 314			- Coarse sand grey/brown strong odor, wet.
						BORING COMPLETED AT 31 FEET.
40						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-24 — Total Depth 27 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By S. Roberts — Date 17 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A			FILL	- Silty sand fill with pebbles, no odor, damp.
5			6		SAND	- Black coarse sand with pebbles, silty, slight odor, damp.
10			0.0		SILT	- Brown clayey silt, no odor, damp.
			0.0		SAND	- Grey silty sand with cobbles, damp, slight odor, with wood.
	Floating NAPL Layer		714	▽		- Coarse sand with cobbles, dark grey, strong odor, wet.
15			1184			- Dark brown-medium coarse sand with silt, wet, strong odor.
20						- Medium-coarse sand, grey/brown wet, strong odor.
			489			- Coarse sand and gravel, strong odor.
			1345			-Coarse sand, grey, slight odor, wet.
25			247			- Coarse sand with some silt, wet, strong odor.
30						BORING COMPLETED AT 27 FEET.

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-25 — Total Depth 22 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By S. Roberts — Date 17 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			FILL - Grey fill, gravel, dry.
			0		SILT - Dark brown silt and gravel, damp, no odor.
5					
			0		- Dark brown silt and cobbles, damp, no odor.
10					
			0		- Brown silt with poorly sorted gravels and cobbles, no odor.
	Floating NAPL Layer		110	▽	
15					GRAVEL - Brown poorly sorted gravel with coarse sand, moderate odor.
			189		
20			0		SAND - Coarse sand and rounded pebbles, no odor.
					BORING COMPLETED AT 22 FEET.
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-26 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By S. Roberts Date 17 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A			FILL	- Dark brown damp silty, sand, gravel fill mix, no odor.
10					SILT	- Brown silt with with some sand and pebbles, damp, no odor.
					GRAVEL	- Gravel with silty sand.
15	Floating NAPL Layer		428	▽	SAND	- Coarse sand and gravel with cobbles, strong odor, slight sheen, wet.
			285			- Grey/Brown coarse sand and gravel, poorly sorted, strong odor.
20			56			- Brown, coarse sand, slight odor, sheen, wet.
						BORING COMPLETED AT 22 FEET.
25						
30						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-27 — Total Depth 22 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By S. Roberts — Date 17 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			FILL - Grey/brown fill, silt with gravel, damp, no odor.
5					
			14		SAND - Dark brown coarse sand and pebbles, no odor.
10					
	Floating NAPL Layer			▽	
15			18		- Black coarse sand, slight odor.
			0		CLAY - Dark brown silty clay, no odor.
20			0		- Dark brown silty clay with wood and plant remains, wet, no odor.
					BORING COMPLETED AT 22 FEET.
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-28 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 16 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 15 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A			FILL	- Black sandy fill with crushed stone and large rocks, dry, odor.
			303			
5			145		SILT	- Black sandy silt, dry, odor.
			18			
10						
			132			- Brown/grey clayey silt, odor, moist.
15	Floating NAPL Layer		1727	▽	SAND	- Tan/grey coarse sand with gravel and pebbles, moist, slight odor.
20					GRAVEL	- Coarse gravel with quartz pebbles, wet sheen.
			480		CLAY	- Tan stiff clay, wet, sheen.
						BORING COMPLETED AT 22 FEET.
25						
30						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-29 — Total Depth 22 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 15 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A			FILL	- Black sandy fill, dry, odor.
5			124			
			24		SAND	- Tan grey silty sand, moist, slight odor.
10						
			1185			- Dark brown fine sand, moist, strong odor.
15	Floating NAPL Layer		1121	▽		- Coarse sand with pebbles and gravel, slight odor, wet, sheen.
20			328		GRAVEL	- Grey stained gravel with pebbles, strong odor, wet, sheen.
					CLAY	- Grey silty clay, slight odor, wet, sheen.
25						BORING COMPLETED AT 22 FEET.
30						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-30 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 10 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 29 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A	11		SILT	- Tan sandy silt, dry, no odor.
			265			
5			1094		SAND	- Black sand with pebbles, strong odor.
			501			- Black sand with pebbles, moist, sticky, strong odor.
	Floating NAPL Layer			▽		- Black sand with pebbles, wet, strong odor.
10			545		GRAVEL	- Black gravel, wet, strong odor.
			447		SAND	- Brown medium grained sand, wet, strong odor.
15						
20					CLAY	- Dark brown silty clay with peat, moist, no odor.
			3			BORING COMPLETED AT 22 FEET.
25						
30						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-31 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 8 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 16 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	120		FILL - Brown/black sandy fill, odor, dry.
5			104		- Black sandy fill, sticky, odor.
			40	▽	SAND - Dark grey silty sand, odor, wet.
10			42		CLAY - Grey sandy clay, moist, odor.
15					
20			14		- Grey/brown clay with pebbles, moist, odor.
25					BORING COMPLETED AT 22 FEET.
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-32 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 11 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 16 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	46		FILL - Black/brown sandy fill, dry, odor.
5			14		
10			736		GRAVEL - Black (stained) gravel, moist, strong odor.
			279	▽	SAND - Dark grey silty sand, odor, wet.
			4		SILT - Brown sandy silt with pebbles, wet, odor.
15					
20					GRAVEL - Tan sandy gravel, wet, no odor.
			2		CLAY - Dark brown silty clay, wet, no odor.
25					BORING COMPLETED AT 22 FEET.
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-33 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By S. Roberts Date 17 June 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A			FILL	- Gravel fill.
						- Brown gravel and silt fill.
						- Gray gravel and silt fill, dry, damp, no odor.
5			52		SILT	- Dark grey clay silt with coarse sand, strong odor, moist
10			218			- Medium grey coarse, sandy silt with pebbles, strong odor, moist.
15	Floating NAPL Layer		239		GRAVEL	- Wet grey gravel.
20			0		SAND	- Brown/Grey silty medium sand with pebbles, no odor, wet.
			0		SILT	- Brown/grey clayey silt, no odor, wet.
25						BORING COMPLETED AT 22 FEET.
30						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-34 Total Depth 27 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 11 August 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A	0.0		ASPHALT	- Asphalt and ballast stone
					SAND	- Black sandy fill, dry, no odor
5			17			
			1509			
			1533			
10					SILT	- Dark brown silt, moist, odor
			393			
	Floating NAPL Layer			▽		
15					SAND	- Sand with some gravel, moist
			714			
20					SILT	- Brown fine sandy silt, moist, no odor
			5			
25					CLAY	- Reddish brown clay, moist, no odor
			0			
30					BORING COMPLETED AT 27 FEET	

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-35 Total Depth 27 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 13 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 11 August 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A	0.0		ASPHALT	- Asphalt and ballast
					FILL	- Black sandy fill, dry, no odor
			11			
5						
			0			
			0		SILT	- Brown silt, moist, no odor
10					SAND	- Fine sand with gravel, moist, odor
			489			
	Floating NAPL Layer			▽		
15					SILT	- Black silt and fine sand with some gravel, wet, odor
			656			
20					GRAVEL	- Gravel with coarse to fine sand, wet, sheen, odor
			105			
25					SAND	- Dark grey fine sand, wet, sheen, odor
			144			
30					BORING COMPLETED AT 27 FEET	

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-36 Total Depth 27 ft. Diameter 6.25 in.

Casing Elevation N/A Water Level: Initial 13 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 11 August 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
0		N/A	0.0		FILL	- Black sandy fill, dry, no odor
			429			
5						
			584			
			273		SILT	- Black silt with same pebbles, moist, odor
10						- Brownish grey silt, moist, odor
			220			
	Floating NAPL Layer			▽		
15			2322		SAND	- Brownish grey coarse sand and gravel, wet, strong odor
20			220		GRAVEL	- Poorly sorted gravel with some sand and some silt, wet, odor,
25			284		SAND	- Coarse sand poorly sorted coarse sand with gravel and fine sand, wet, odor
30					BORING COMPLETED AT 27 FEET	

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company., Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-37 Total Depth 27 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 12 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 11 August 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A	13		ASPHALT	- Asphalt and ballast stone
					FILL	- Brown sandy fill, dry, no odor
5			542			- Brown/gray sandy fill, dry, odor
			117		SILT	- Brown/gray silt with pebbles, moist, odor
10				▽		
			344		GRAVEL	- Poorly sorted gravel with sand and silt, wet, sheen, odor
15						
20			177			
25			20		SAND	- Coarse sand with silt and fine sand
			13			- Brown silt with fine sand
30					BORING COMPLETED AT 27 FEET	

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Well number N-77 Total Depth 30 ft. Diameter 10 inch

Casing Elevation N/A Water Level: Initial 9 ft. Static N/A

Screen Dia. 4 inch Length 25 ft. Slot Size 0.02 inch

Casing Dia. 4 inch Length 8 ft. Type PVC Sch 40

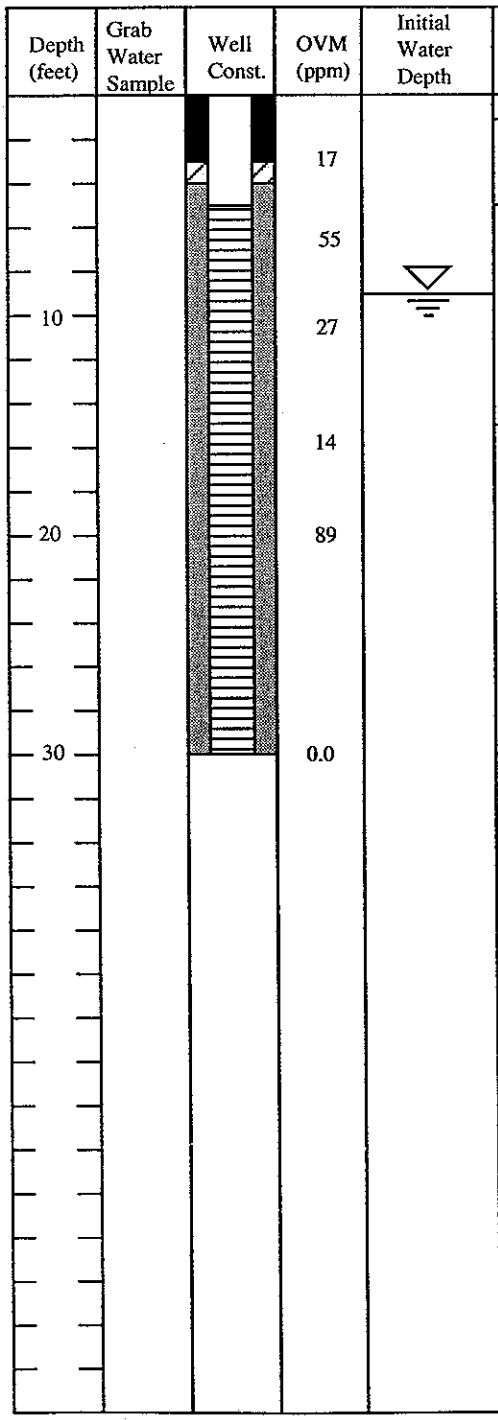
Drilling Method Hollow-Stem Auger Sample Method Split- Spoon

Completion Details Three foot protective steel stickup with locking cap.

Driller B.L. Myers Bros. Log By E. Dziedzic Date 11 August 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached



Lithology	
ASPHALT	- Asphalt and ballast stone.
FILL	- Black sandy fill with brick and stone, slight odor, dry.
SAND	- Black silty sand, slight odor, moist
	- Dark grey silty sand, strong odor
	- Same lithology, gobble stone fill
SILT	- Dark grey silt with some pebbles, odor
SILT	- Dark brown silt with organic matter, no odor
BORING COMPLETED AT 30 FEET	

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Well number N-78 Total Depth 30 ft. Diameter 10 inch

Casing Elevation N/A Water Level: Initial 12 ft. Static N/A

Screen Dia. 4 inch Length 25 ft. Slot Size 0.02 inch

Casing Dia. 4 inch Length 5 ft. Type PVC Sch 40

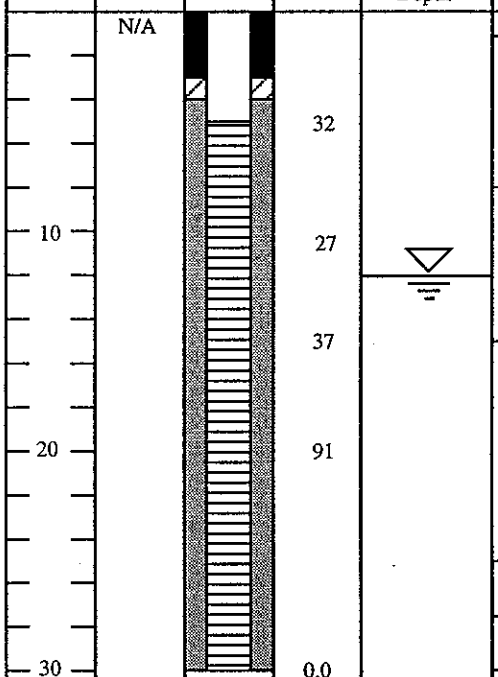
Drilling Method Hollow-Stem Auger Sample Method N/A

Completion Details Flush mount manhole with locking churney plug

Driller B.L. Myers Bros. Log By E. Schwartz Date 10 August 1993

Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached



Depth (feet)	Sample No.	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
	N/A				ASPHALT	- Asphalt and ballast stone.
			32		FILL	- Black sandy fill with brick and stone, no odor, dry.
10			27		SILT	- Brownish grey (stained) sandy, silt, dry.
			37		GRAVEL	- Grey gravel with pebbles (stained) odor, coarse sand matrix, poorly sorted.
20			91			- Black gravel with pebbles (stained), NAPL/ water saturated, strong odor.
					SAND	- Coarse sand, poorly sorted, black NAPL/water saturated, strong odor.
					CLAY	- Dark brown tight clay, some small pebbles, no odor, dry
30			0.0		BORING COMPLETED AT 30 FEET	

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Well number N-79 Total Depth 30 ft. Diameter 10 in.

Casing Elevation N/A Water Level: Initial 12 ft. Static N/A

Screen Dia. 4 inch Length 25 ft. Slot Size 0.02 in.

Casing Dia. 4 inch Length 5 ft. Type PVC Sch. 40

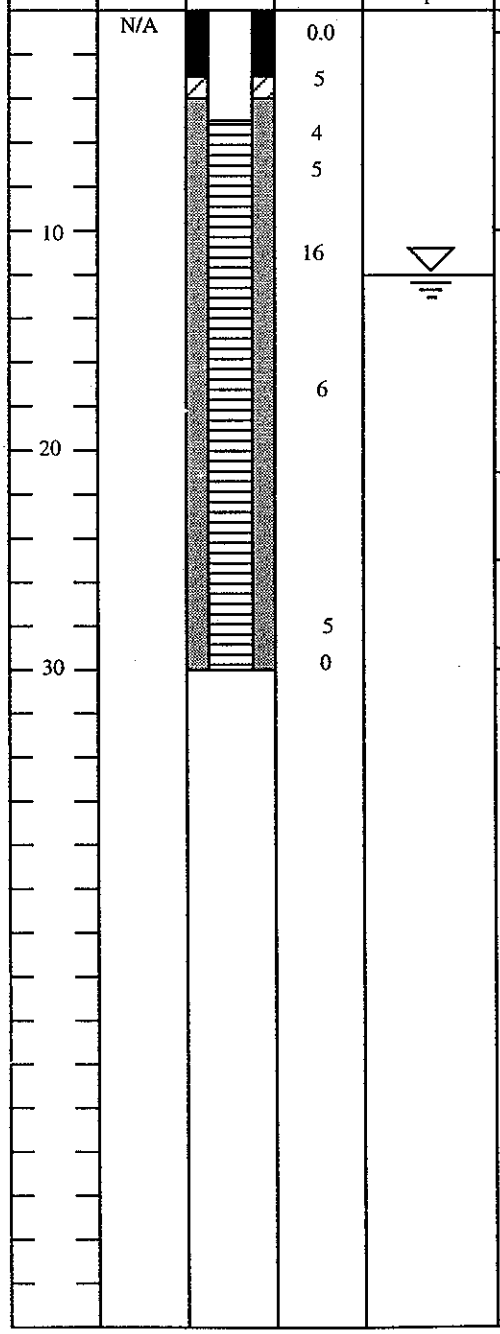
Drilling Method Hollow-Stem Auger Sample Method N/A

Completion Details Flush mount manhole with locking churney plug.

Driller B.L. Myers Bros. Log By E. Schwartz Date 10 August 1993

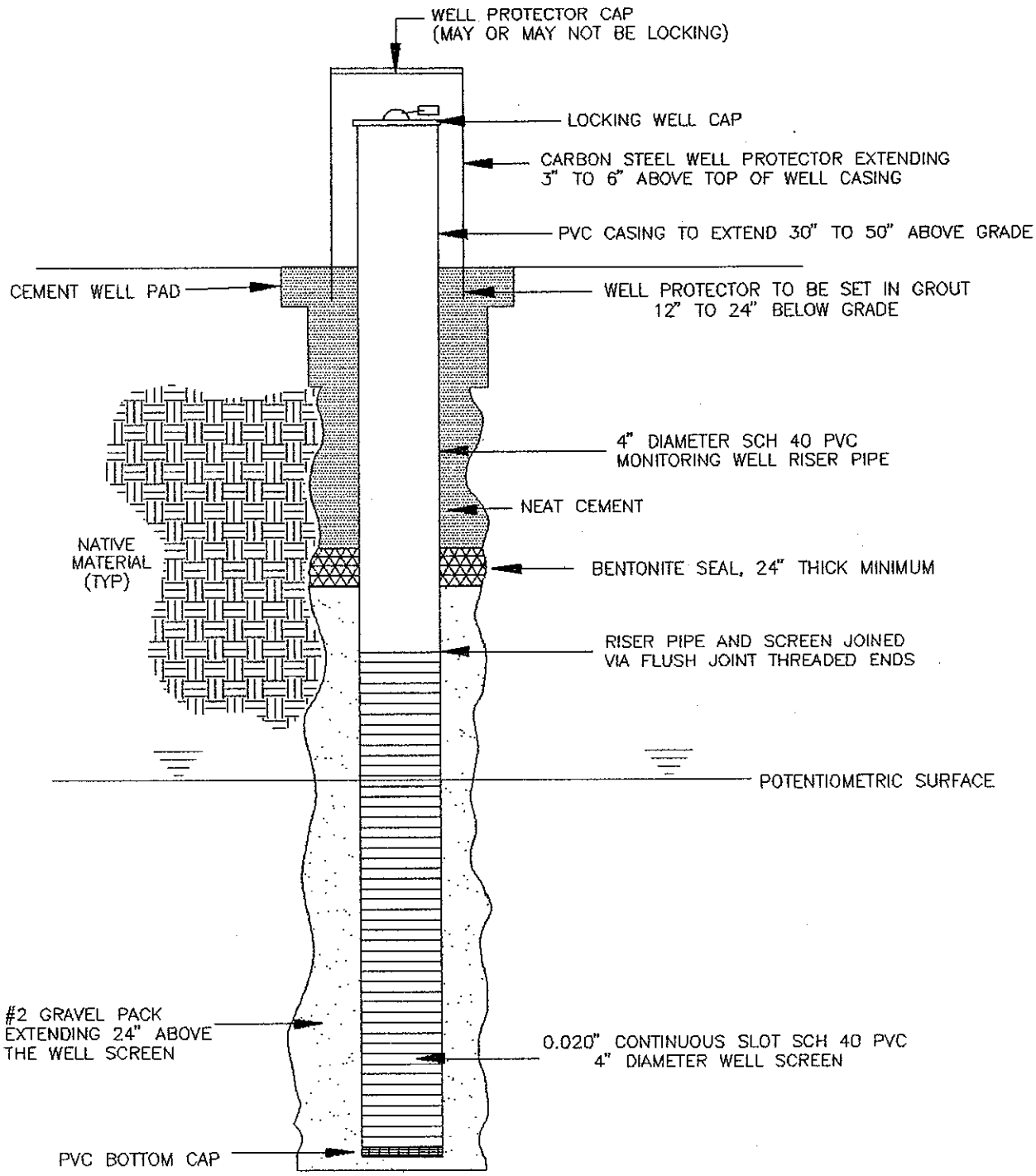
Sketch Map

Jackson Street Sewer Vicinity
North Yard Figure attached



Depth (feet)	Sample No.	Well Const.	OVA (ppm)	Initial Water Depth	Lithology	
	N/A		0.0		ASPHALT	- Asphalt and ballast stone.
			5		FILL	- Reddish/brown silty sand with fill, dry, slight odor.
						- Tan sandy silt with fill, dry, odor.
			4			- Sandy silt with fill, black stained, sticky, odor.
			5			
10			16	▽	GRAVEL	- Tan poorly sorted gravel with quartz pebbles, moist, stained, strong "turpentine" odor.
						- Same lithology, strong "turpentine" odor.
			6			
20						- Same lithology, wet, strong odor.
					SAND	- Dark brown med. grained sand, well sorted, wet, strong odor.
					SILT	- Tan sandy silt, saturated, odor, sheen.
			5			
30			0		SAND	- Tan silty sand, med. grained, saturated, sheen, odor.
					BORING COMPLETED AT 30 FEET	

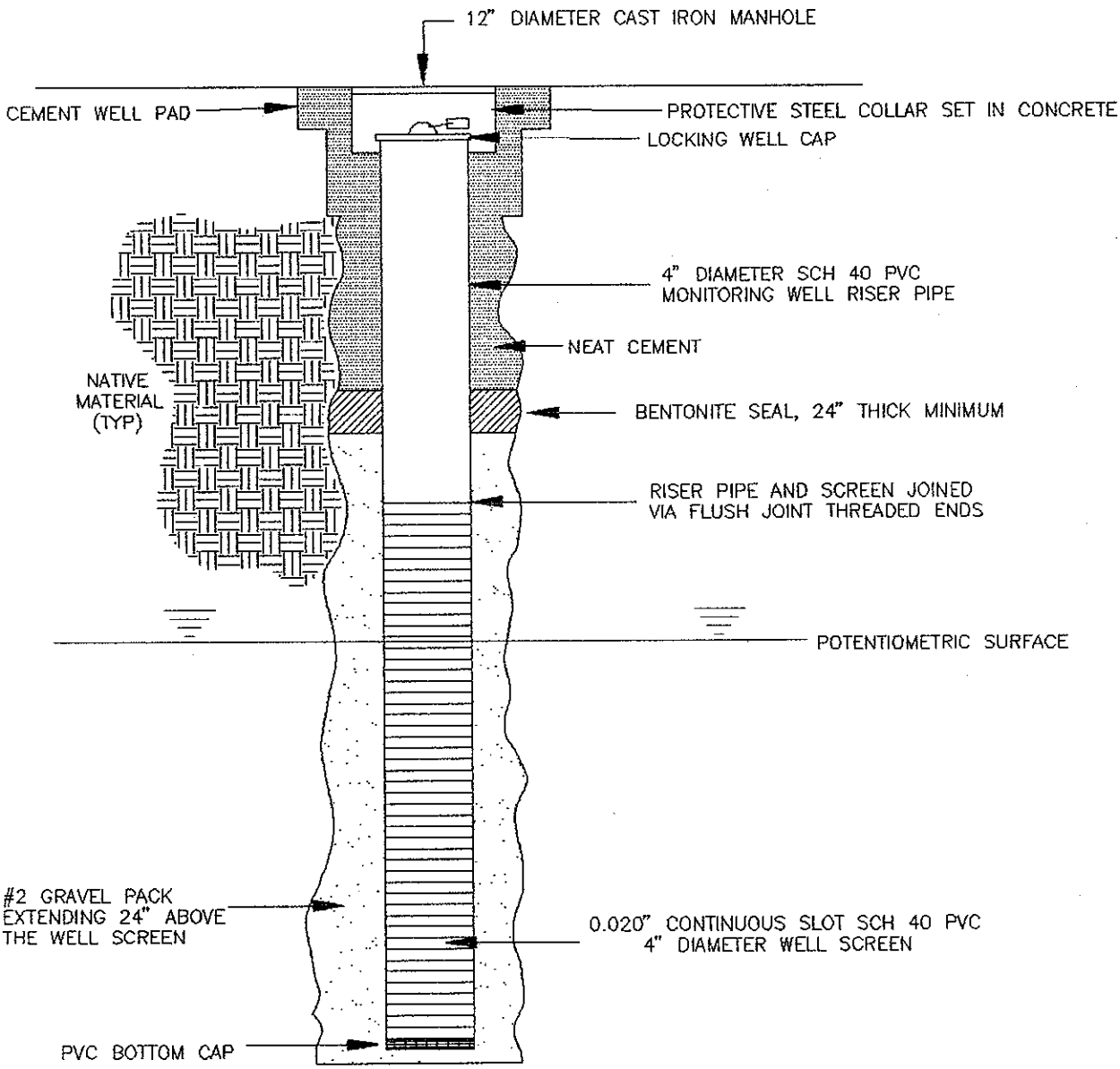
GES GROUNDWATER AND ENVIRONMENTAL SERVICES, INC.



GROUNDWATER MONITORING WELL SCHEMATIC
RISER STICK-UP COMPLETION
SUN PHILADELPHIA REFINERY

NORTH	DATE: 23 SEPT 93	CK: SR	APPV: RD
	BY: MLB	REV: MWELL2	
NA	NOT TO SCALE		
	0 000		

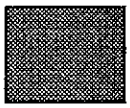
GES GROUNDWATER AND ENVIRONMENTAL SERVICES, INC.



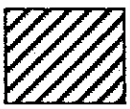
GROUNDWATER MONITORING WELL SCHEMATIC
FLUSH MOUNT COMPLETION
SUN PHILADELPHIA REFINERY

NORTH	DATE: 23 SEPT 93	CK: SR	APPV: RD
	BY: MLB	REV: MWELL	
NA	NOT TO SCALE		
	0 000		

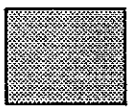
MONITORING WELL CONSTRUCTION LEGEND
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY



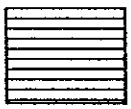
Neat cement



Bentonite clay



No. #2 Sand Gravel Pack

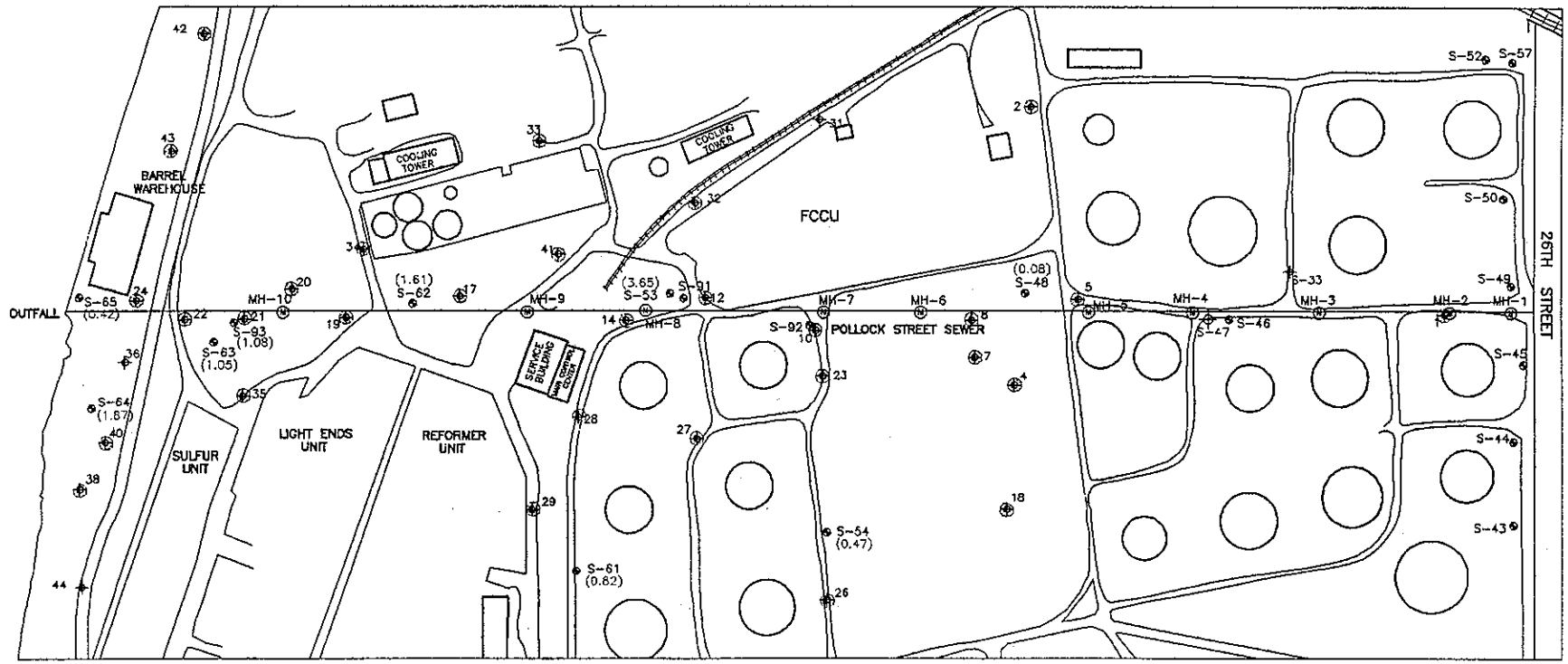


Monitoring Well Screen

APPENDIX B

DRILL LOGS - POLLOCK STREET SEWER

GES GROUNDWATER AND ENVIRONMENTAL SERVICES, INC.



NEW MONITORING WELLS	BAILDOWN TEST LOCATIONS	SLUG TEST LOCATIONS
S-91	S-48	S-45
S-92	S-53	S-46
S-93	S-62	S-48
	S-63	S-49
	S-65	S-91
	S-93	S-92

LEGEND

- MONITORING WELLS
- DEEP MONITORING WELLS
- SEWER MANHOLES
- SOIL BORING LOCATIONS
- (0.82) NAPL THICKNESS (feet) : MAY 1993
- NAPL PRESENT IN GROUNDWATER GRAB SAMPLE FROM SOIL BORINGS

1993 WELL NUMBERING SCHEME

SOIL BORING AND MONITORING WELL LOCATIONS

POLLOCK STREET SEWER
SUN COMPANY, INC. (R & M)
PHILADELPHIA REFINERY
PHILADELPHIA, PENNSYLVANIA

NORTH

DATE:
CK: SR | APPV: RD
BY: MLB
REV: BORING
SCALE IN FEET IS APPROXIMATE
0 225

FIGURE 8

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-1 — Total Depth 27 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 13 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 17 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			ASPHALT AND BALLAST STONE
			3		SAND - Dark brown silty sand, dry, slight odor.
5			63		
			23		
10			3		- Dark grey sand with pebbles, moist, slight odor.
	Floating NAPL Layer			▽	
15			1349		- Coarse sand with pebbles, grey, odor, wet.
			619		- Dark brown silty sand, wet, slight odor.
20					
			445		
25					GRAVEL - Grey gravel with pebbles, wet, sheen, odor.
			372		
					BORING COMPLETED AT 27 FEET.
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-2 — Total Depth 22 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 28 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	225		ASPHALT AND BALLAST STONE
					FILL - Brown sandy fill with crushed stone.
			99		SILT - Dark grey clayey silt, moist, odor.
5			174		- Tan silt, dry, odor.
			344		
10			48		
			196		
	Floating NAPL Layer			▽	- Brown silt with pebbles, moist, odor.
15			401		
					GRAVEL - Cobble and pebble sized gravel, auger resistance.
20					- Gravel with coarse sand and pebbles, wet, sheen, slight odor.
			270		
					BORING COMPLETED AT 22 FEET.
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-3 Total Depth 20 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 15 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 21 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	0.0		ASPHALT - Asphalt and ballast stone
					FILL - Tan sandy fill, dry, no odor.
5			16		
			23		SILT - Black sandy silt, moist, odor.
10			733		SAND - Medium grained sand with pebbles, moist, strong odor.
15			109	▽	GRAVEL - Brown silty gravel, wet, sheen, odor.
20					- Cobble-size gravel
					AUGER REFUSAL AT 20 FEET
25					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-4 — Total Depth 27 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 13 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 28 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
0		N/A	166		FILL - Brown sandy fill, dry, slight odor.
					- Black sandy fill, dry, slight odor.
			55		
5			4		
					SILT - Dark brown sandy silt, moist, no odor.
10					
	Floating NAPL Layer		255	▽	
				⏚	SAND - Dark brown silty sand, moist, odor.
15			401		- Dark brown silty sand, wet, odor
			3		CLAY - Tan clay, moist, no odor
20					
25			901		SAND - Greyish/Brown coarse sand, pebbles, and gravel, wet, slight odor.
					BORING COMPLETED AT 27 FEET.
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-5 — Total Depth 24 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 20 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 21 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A	29		ASPHALT	- Asphalt and ballast stone.
					FILL	- Fill with brown/black sand, dry, odor.
			209			
5						
			309			
			436		SAND	- Dark grey sand, moist, odor.
10						
			216			
			46		SILT	- Orange silt, moist, slight odor.
15						
20	Floating NAPL Layer			▽		- Grey/Brown silt, moist, odor.
			189			
			76		GRAVEL	- Brown gravel with small pebbles, wet, odor.
			56			- Brown gravel with large pebbles, wet, odor, sheen.
25					AUGER REFUSAL AT 24 FEET.	
30						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company., Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-7 Total Depth 27 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 28 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	3		FILL - Ballast stone (cobble size), large.
			33		
			11		- Dark grey gravel fill, dry, odor.
5					
			129		SILT - Greyish brown silt, dry, odor.
10					
			12		
	Floating NAPL Layer			▽	
15					- Pebbles in sandy matrix, moist, odor.
			218		
20					
25					GRAVEL - Grey gravel, wet, sheen, odor.
			277		
30					BORING COMPLETED AT 27 FEET.

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-10 Total Depth 27 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 29 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	0.0		ASPHALT - Asphalt and ballast stone.
					FILL - Black sandy fill, dry, no odor.
			15		
			24		SILT - Tan silt, dry, no odor.
5					
			265		
10			154		
					GRAVEL - Pebble-size gravel
			3421		SAND - Grey coarse sand with pebbles, slight odor, wet.
	Floating NAPL Layer			▽	
15					
20					GRAVEL - Cobble-size gravel
25			295		SAND - Greyish/Brown coarse sand, wet, sheen, odor.
					BORING COMPLETED AT 27 FEET.
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-12 — Total Depth 27 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 13 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 24 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			ASPHALT - Asphalt and ballast stone.
			27		FILL - Grey sandy fill, dry, slight odor.
5			265		
			88		SAND - Brown sand, moist.
10			11		- Brown silty sand, moist.
	Floating NAPL Layer			▽	
15			280		- Black coarse sand and gravel with pebbles, wet, odor.
20					
25			311		- Dark brown coarse sand, gravel and pebbles, slight odor, globs of NAPL, wet.
30					BORING COMPLETED AT 27 FEET.

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-14 Total Depth 27 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 29 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	263		FILL - Stone fill, dry, no odor. - Black sandy fill, odor.
5			180		
			19		SAND - Greyish/Brown silty sand, moist, odor.
10			260		
	Floating NAPL Layer			▽	- Brownish/Grey fine sand, wet, slight odor.
15			1310		
20			679		GRAVEL - Pebbles and cobbles, some sand, slight odor.
25			447		BORING COMPLETED AT 27 FEET.
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-17 — Total Depth 27 ft. Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 13 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 24 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			FILL - Grey sandy fill with stone, dry, odor.
			326		
5			2568		SAND - Black sticky sand, slight odor.
10			265		
	Floating NAPL Layer			▽	
15			459		GRAVEL - Black gravel with pebbles interbedded with silt, wet, sheen, stained, odor.
					- Cobble-size gravel.
20					SAND - Black sand, water/NAPL spooge, sheen, odor.
					GRAVEL - Cobble-size gravel.
					SAND - Dark grey coarse sand.
25			111		
					GRAVEL - Gravel with some pebbles, odor, wet
30					BORING COMPLETED AT 27 FEET

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-18 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 12 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 28 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			FILL - Large cobble size stone fill.
					- Brown sandy fill, dry, no odor.
5			70		
			3		
10					
	Floating NAPL Layer		78	▽	SAND - Brown sand with pebbles, moist.
			344		- Coarse sand and pebbles, wet, sheen, stained, slight odor.
15					
					- Pebbles and cobbles, no odor.
20			337		- Coarse sand, gravel and pebbles, wet, sheen, slight odor.
					BORING COMPLETED AT 22 FEET.
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-19 — Total Depth 27 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 13 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 23 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
0		N/A	10		FILL - Dark brown sandy fill with stone and wood, dry no odor.
5			72		
			24		SILT - Brown sandy silt, moist, no odor.
10			106		SAND - Dark grey sand with pebbles, moist, odor.
	Floating NAPL Layer			▽	
			403		
15			482		GRAVEL - Grey/brown gravel with pebbles, wet, sheen slight odor.
					SAND - Brown sand with pebbles and cobbles.
20					
25			58		- Coarse brown sand, some pebbles, wet, sheen, odor.
					BORING COMPLETED AT 27 FEET
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-20 Total Depth 27 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 16 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 23 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			FILL - Brown/Tan sandy fill with stones, dry, no odor.
5			97		SAND - Black (stained) sand, odor.
			10		CLAY - Dark brown silty clay, moist, slight odor.
10					
					SILT - Dark brown sandy silt, moist, no odor.
15					- Brown/Black sandy silt, moist, odor.
	Floating NAPL Layer		58	▽	
			51		SAND - Brown sand with pebbles.
20					
25			251		GRAVEL - Dark brownish/grey gravel with pebbles, wet, odor, sheen.
					BORING COMPLETED AT 27 FEET.
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-21 Total Depth 27 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 17 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 23 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	3		FILL - Tan sandy fill, dry, no odor.
5			17		SAND - Brown silty sand, dry, no odor.
10			14		
			106		- Brown fine sand with pebbles, moist, odor.
15					GRAVEL/SAND - Tan gravel and sand with large pebbles, moist, slight odor.
	Floating NAPL Layer		865	▽	
20					- Cobble-size gravel.
25			189		SAND - Dark brown/grey medium sand, wet, odor, sheen.
			72		GRAVEL - Gravel with pebbles, wet, odor, sheen.
30					BORING COMPLETED AT 27 FEET.

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-22 Total Depth 20 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 23 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
0		N/A			SAND - Brown silty sand, dry, no odor.
5					
			10		
10					SILT - Dark brown clayey silt, dry, no odor.
	Floating NAPL Layer			▽	
15			0.0		SAND - Brown silty sand with large pebbles, moist, no odor.
					GRAVEL - Cobble-size gravel.
20					AUGER REFUSAL AT 20 FEET
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-23 Total Depth 27 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 29 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A			ASPHALT	- Asphalt.
			157		FILL	- Black sandy fill, dry, slight odor.
			339			
5						
			14		SILT	- Black sandy silt, dry, no odor.
10						
			278			
		Floating NAPL Layer		▽		
15			515		SAND	- Coarse sand, gravel, and pebbles, moist, odor.
20			1039		SILT	- Tan clayey silt.
					GRAVEL	- Pebble-size gravel
					CLAY	- Greenish silty clay
25						
					BORING COMPLETED AT 27 FEET.	
30						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-24 — Total Depth 22 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 12 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 25 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	0.0		FILL - Dark brown sandy fill with crushed stone, dry, no odor.
			36		- Black sandy fill with crushed stone, dry, no odor.
5					
			0.0		
10			15		SAND - Black sand, moist, no odor
	Floating NAPL Layer		3145	▽	
					GRAVEL - Black gravel with quartz pebbles, wet, sheen, strong odor.
15					
					SAND - Grey coarse grained sand, wet, odor.
20			78		
					BORING COMPLETED AT 22 FEET.
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-26 Total Depth 20 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial N/A Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 29 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A			ASPHALT	- Asphalt.
			75		FILL	- Stone fill, dry, no odor.
						- Dark brown sandy fill, dry, odor.
5			0.0		SILT	- Brown silt, dry, no odor.
			5			
10					GRAVEL	- Gravel and pebbles with some silt, wet, no odor.
						- Cobble-size gravel.
15			15		SAND	- Brown sand, moist.
			33		SILT	- Brown silt, moist.
			3		GRAVEL	- Cobble-size gravel.
20					AUGER REFUSAL AT 20 FEET.	
25						
30						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-27 — Total Depth 27 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 15 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 29 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A	28		FILL	- Stone fill.
			229			- Black sandy fill, dry.
			77		SILT	- Grey/Brown sandy silt, dry, slight odor.
5						
10			122			
			315			
15	Floating NAPL Layer			▽	GRAVEL	- Pebble and cobble-size gravel
			515		SAND	- Brown sand with pebbles, moist, odor.
20			275			
25			1066		GRAVEL	- Gravel, coarse sand and pebbles, wet, sheen, odor.
					BORING COMPLETED AT 27 FEET.	
30						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company., Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-28 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 13 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 28 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			FILL - Brown sandy fill with crushed stone, dry, no odor.
			3		
5					SILT - Brown silt, dry, no odor.
					- Greyish/brown sandy silt, moist, no odor.
10					
	Floating NAPL Layer		11	▽	- Brown/grey sandy silt, wet, slight odor.
15					
20			4		- Dark brown sandy silt with organic peat, moist, no odor.
					BORING COMPLETED AT 22 FEET.
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-29 — Total Depth 22 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 13 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 28 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			FILL - Sandy fill with stone, dry, no odor.
			4		
5			0.0		SILT - Tan clayey silt, moist, no odor.
			0.0		
10					
			48		
	Floating NAPL Layer		18	▽	
15					GRAVEL/SAND - Black gravel and grey coarse sand, moist, odor.
			420		
20					SAND - Coarse sand (top), gravel with pebbles (bottom) black, wet, sheen, odor.
			99		
					BORING COMPLETED AT 22 FEET.
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-31 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 24 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A			ASPHALT	- Asphalt and ballast stone.
			11		FILL	- Grey sandy fill with crushed stone, dry, odor.
5			142 188		SILT	- Dark grey silt, dry, odor.
			65			
10						
			26	▽		- Brown silt, dry, odor.
15			11		CLAY	- Brown/Tan banded silty clay, wet, no odor.
20						- Gray clay, some oganic matter, wet, no odor
			0.0			
					BORING COMPLETED AT 22 FEET.	
25						
30						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-32 Total Depth 25 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 16 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 24 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	0.0		ASPHALT - Asphalt and ballast stone.
					SAND/GRAVEL - Black sand and gravel, dry. slight odor.
5			0.0		SILT - Brown banded silt, dry, no odor.
			3		
10					
					CLAY - Stiff clay
					GRAVEL - Pebble and cobble-size gravel.
15	Floating NAPL Layer		480	▽	SAND - Brown coarse sand, gravel, and pebbles, moist, strong odor.
20			465		
25			26		- Pebbles with coarse sand, wet, sheen, odor.
					BORING COMPLETED AT 25 FEET.
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-33 — Total Depth 27 ft. Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 20 ft. Static N/A

Screen Dia. N/A — Length N/A Slot Size N/A

Casing Dia. N/A — Length N/A Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic Date 23 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A	44		ASPHALT	- Asphalt and ballast
			464		SAND	- Black sand with fill, odor.
5						
			31			- Black/Dark brown silty sand, moist, odor.
10						
			10		SILT	- Dark grey sandy silt, moist, odor.
15			65			- Grey clayey silt, moist, no odor.
20	Floating NAPL Layer			▽		- Brown sandy silt, moist, slight odor, stained.
			1056		GRAVEL	- Grey gravel, wet, slight odor, stained.
25						
			608		SAND	- Brown sand with gravel and pebbles, wet, odor, no sheen.
30					BORING COMPLETED AT 27 FEET	

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-34 Total Depth 25 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 15 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 24 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			FILL - Brown sandy fill with stone, dry, no odor.
5			11		SAND - Black sticky silty sand with fill, slight odor.
			19		- Black silty sand, sticky, odor, moist.
10					
15	Floating NAPL Layer			▽	
			11		SILT - Brownish/grey sandy silt, wet, slight odor, sheen.
20					GRAVEL - Pebble and cobble size gravel.
25					BORING COMPLETED AT 25 FEET.
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-35 — Total Depth 27 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 23 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVA (ppm)	Initial Water Depth	Lithology
		N/A	3		FILL - Brown sandy fill with stones, dry, no odor.
			31		SILT - Brown silt, dry, slight odor.
5					
			65		
10					
			79		SAND - Brown fine sand, moist, odor.
	Floating NAPL Layer		1151	▽	
15			411		GRAVEL - Black (stained) gravel with pebbles, odor, wet.
20			608		- Dark brown (stained) gravel with pebbles, odor, wet.
25			17		CLAY - Tan silty clay, moist, no odor.
					BORING COMPLETED AT 27 FEET.
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-36 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 10 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 25 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
0		N/A	99		FILL - Crushed stone. - Black sandy fill, dry, odor.
5			121 1462		
			872		SAND - Brown sand with pebbles, moist, odor.
10	Floating NAPL Layer			▽	
			1462		- Brown coarse sand with gravel and pebbles, slight odor, wet.
15					
20			0.0		CLAY - Brown silty clay, wet, no odor.
					BORING COMPLETED AT 22 FEET.
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company., Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-38 — Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 10 ft. Static N/A

Screen Dia. N/A — Length N/A Slot Size N/A

Casing Dia. N/A — Length N/A Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic Date 25 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	173		FILL - Crushed stone. - Dark brown sandy fill, crushed stone and wood, dry, odor.
5			159		
			586		SAND - Brown silty sand, moist, slight odor.
10	Floating NAPL Layer		569	▽	- Interbedded sands, gravels and pebbles, wet, slight odor.
15					
20			0.0		SILT - Dark brown clayey silt, wet, sheen on water, no odor.
					BORING COMPLETED AT 22 FEET
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company., Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-40 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 11 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 25 June 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A	205		FILL - Brown sandy fill, dry, no odor.
			5		
5					SAND - Greyish/Brown sand, dry, no odor.
			89		
10			1246		
	Floating NAPL Layer			▽	
			657		- Brown coarse sand with gravel and pebbles, wet, slight odor.
15					
20					CLAY - Tan silty clay, moist, no odor.
					BORING COMPLETED AT 22 FEET.
25					
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery — Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. — Permit No. N/A

Boring number SB-41 — Total Depth 27 ft. — Diameter 6.125 in.

Casing Elevation N/A — Water Level: Initial 14 ft. Static N/A

Screen Dia. N/A — Length N/A — Slot Size N/A

Casing Dia. N/A — Length N/A — Type N/A

Drilling Method Hollow-Stem Auger — Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. — Log By E. Dziedzic — Date 24 June 1993

Sketch Map

North Yard southern perimeter
Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			ASPHALT - Asphalt and ballast stone.
			203		SAND - Black sand with fill, dry, odor.
5			496		
			634		
10					
			813	▽	GRAVEL - Gravel, black, moist, sticky, pebbles.
	Floating NAPL Layer				
15			34		CLAY - Grey and tan clay, stiff, wet.
			26		
20					
					GRAVEL - Cobble-size gravel.
25					CLAY - Grey clay, wet, odor.
					SAND - Brown sand and pebbles, wet, odor.
30					BORING COMPLETED AT 27 FEET

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-42 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 13 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 13 August 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
		N/A			FILL - Ballast stone (cobble size), large.
			12		SAND - Brown silty sand , some fill, dry
5			5		
			27		
10					
	Floating NAPL Layer		7	▽	GRAVEL - Gravel with large pebbles, moist, no odor
15			1774		- Gravel with coarse sand, wet, sheen, strong odor
20			1034		- Gravel with coarse sand, wet, sheen, strong odor
25					BORING COMPLETED AT 22 FEET.
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-43 Total Depth 22 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 13 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 13 August 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab. Water Sanmple	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A			ASPHALT	- Asphalt and ballast stone
			739		FILL	- Black sand fill, dry, odor
			62		SILT	- Greyish brown sandy silt, moist
5						
			96			
10						
			186		SAND	- Coarse tan sand, moist, odor
	Floating NAPL Layer			▽		
15			1477			- Coarse sand with some pebbles, wet, strong odor
20						
			376		GRAVEL	Gravel with coarse to medium sand, wet, sheen, odor
					BORING COMPLETED AT 22 FEET.	
25						
30						

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number SB-44 Total Depth 32 ft. Diameter 6.125 in.

Casing Elevation N/A Water Level: Initial 16 ft. Static N/A

Screen Dia. N/A Length N/A Slot Size N/A

Casing Dia. N/A Length N/A Type N/A

Drilling Method Hollow-Stem Auger Sample Method Split-Spoon

Completion Details N/A

Driller B.L. Myers Bros. Log By E. Dziedzic Date 13 August 1993

Sketch Map

Pollock Street Sewer Vicinity;
South Yard Figure attached

Depth (feet)	Grab Water Sample	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
		N/A			ASPHALT	- Asphalt and ballast stone.
			4		FILL	- Brown sandy fill, dry, no odor
5					SILT	Tan clayey silt, dry, no odor
			14		SAND	- Tan silty sand, dry, slight odor
10			6			
15			20	▽		- Reddish brown silty sand with peebles, moist, no odor
					GRAVEL	- Pebble-size gravel
20						- Cobble-size gravel
					SAND	- Brown medium sand, wet, no odor
25			31			
30			4			- Brown fine sand, wet, no odor
32					BORING COMPLETED AT 32 FEET.	

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Well number S-91 Total Depth 30 ft. Diameter 10 inch

Casing Elevation N/A Water Level: Initial 21 ft. Static N/A

Screen Dia. 4 inch Length Slot Size 0.02 inch

Casing Dia. 4 inch Length Type PVC Sch 40

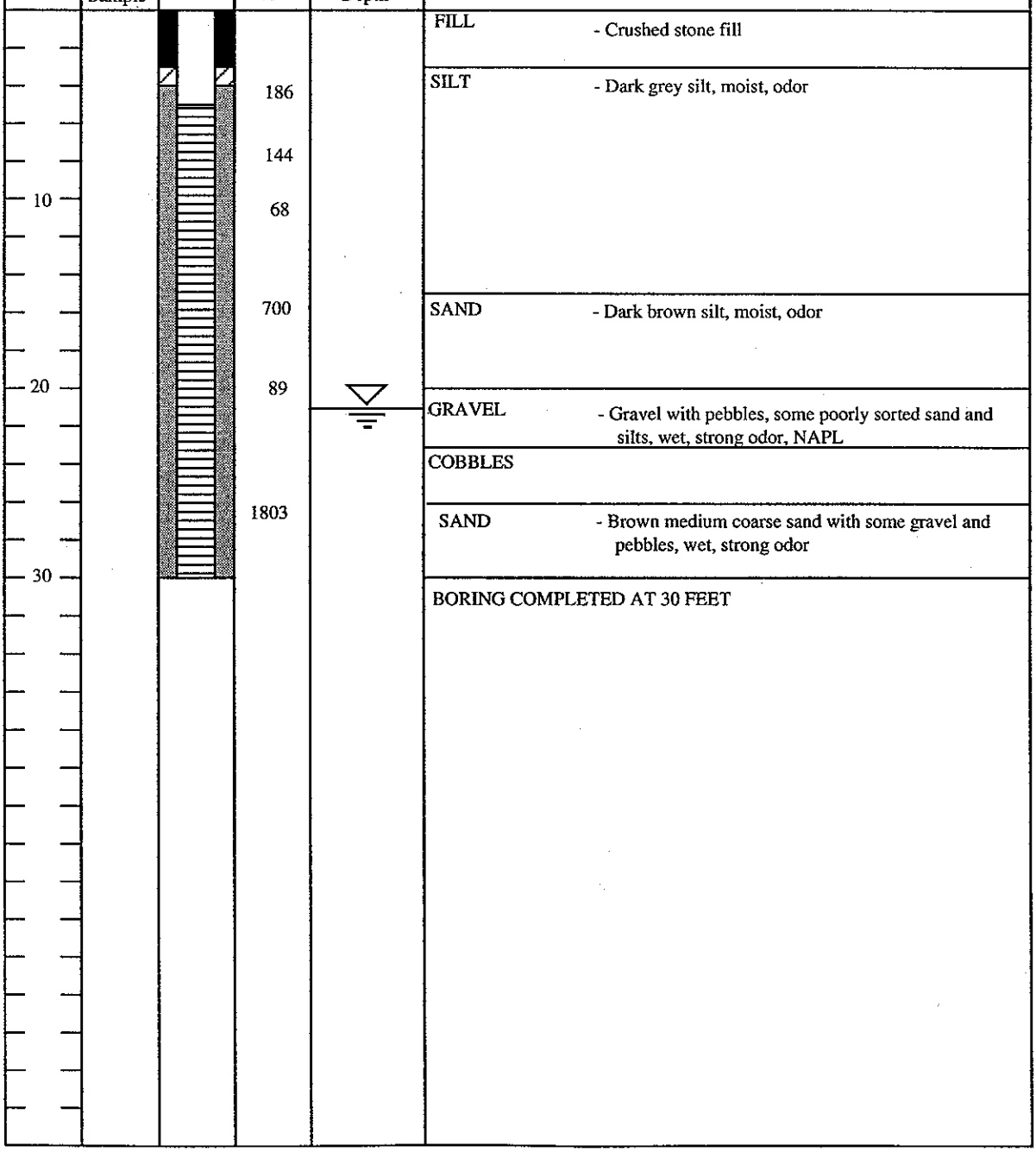
Drilling Method Hollow-Stem Auger Sample Method Split- Spoon

Completion Details Three foot protective steel stickup with locking cap.

Driller B.L. Myers Bros. Log By E. Dziedzic Date 11 August 1993

Sketch Map

Pollock Street Sewer Vicinity
South Yard Figure attached



Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Well number S-92 Total Depth 30 ft. Diameter 10 inch

Casing Elevation N/A Water Level: Initial 14 ft. Static N/A

Screen Dia. 4 inch Length 20 ft. Slot Size 0.02 inch

Casing Dia. 4 inch Length 10 ft. Type PVC Sch 40

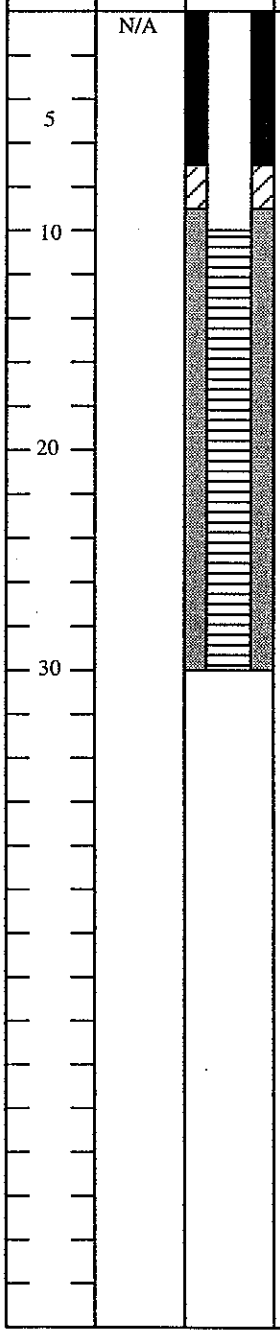
Drilling Method Hollow-Stem Auger Sample Method N/A

Completion Details Flush mount man hole with locking churney plug

Driller B.L. Myers Bros. Log By M.D. Haslett Date 9 Augsust 1993

Sketch Map

Pollock Street Sewer Vicinity
South Yard Figure attached



Depth (feet)	Sample No.	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
0	N/A					- Asphalt and ballast stone.
					FILL	- Tan sandy fill with crushed stone, dry, no odor.
5						- Dark brown fill with crushed stone, dry, no odor.
			70		SAND	- Tan sand, some crushed stone, slight odor, dry.
10				▽		
					GRAVEL	- Black gravel with quartz pebbles, wet, sheen, slight odor.
20					SAND	- Reddish tan silty sand (top), brown fine sand (bottom)
30					BORING COMPLETED AT 30 FEET	

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company, Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Well number S-93 Total Depth 30 ft. Diameter 10 inch

Casing Elevation N/A Water Level: Initial 13 ft. Static N/A

Screen Dia. 4 inch Length 20 ft. Slot Size 0.02 inch

Casing Dia. 4 inch Length 13 ft. Type PVC Sch. 40

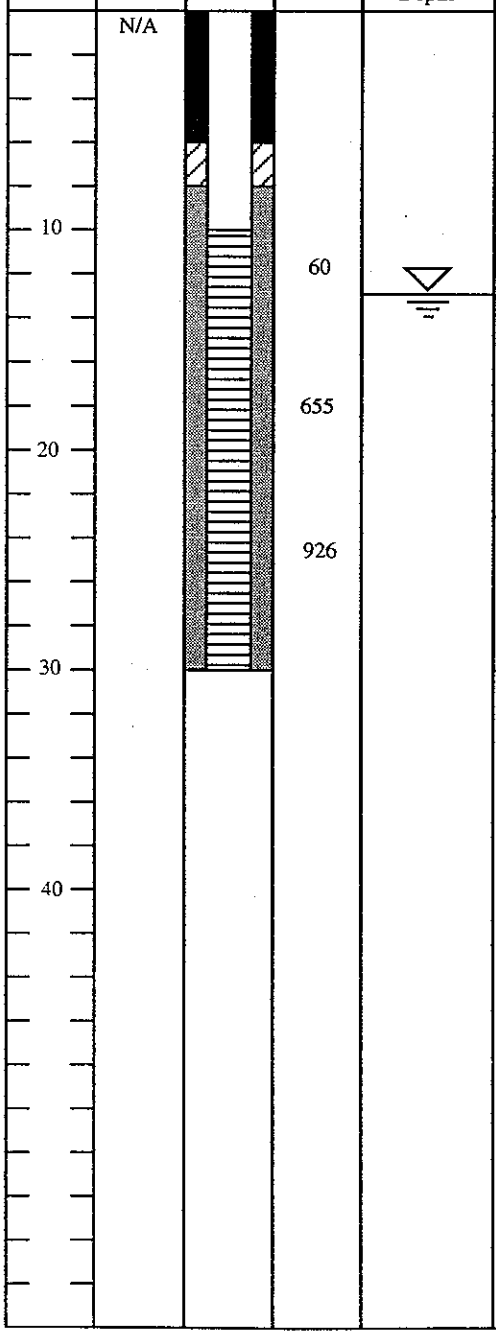
Drilling Method Hollow-Stem Auger Sample Method N/A

Completion Details 3 ft. protective steel stick -up with locking cap

Driller B.L. Myers Bros. Log By M.D. Haslett Date 9 August 1993

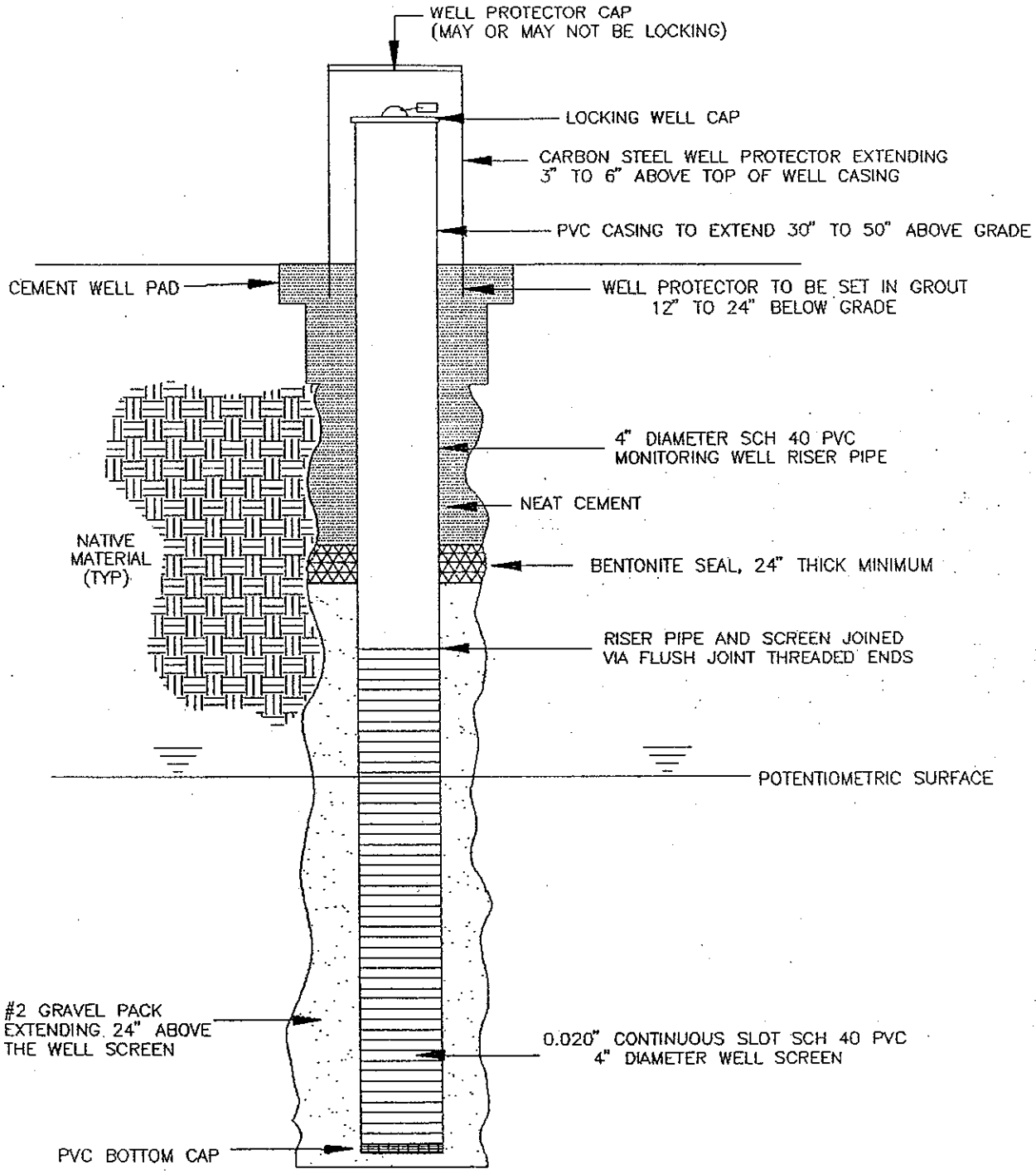
Sketch Map

Pollock Street Sewer Vicinity
South Yard Figure attached



Depth (feet)	Sample No.	Well Const.	OVM (ppm)	Initial Water Depth	Lithology	
	N/A				FILL	- Brown silty sand with pebbles, damp.
			60		SAND	- Black coarse sand.
						- Silty sand with pebbles, damp.
			655			- Dark grey/brown coarse sand and pebbles, moderate odor, wet, sheen.
						- Coarse sand with pebbles, wet sheen.
			926		GRAVEL	- Grey/Brown gravel with coarse sand, moderate odor.
					SAND	- Dark brown silty, coarse sand with gravel.
					BORING COMPLETED AT 30 FEET	

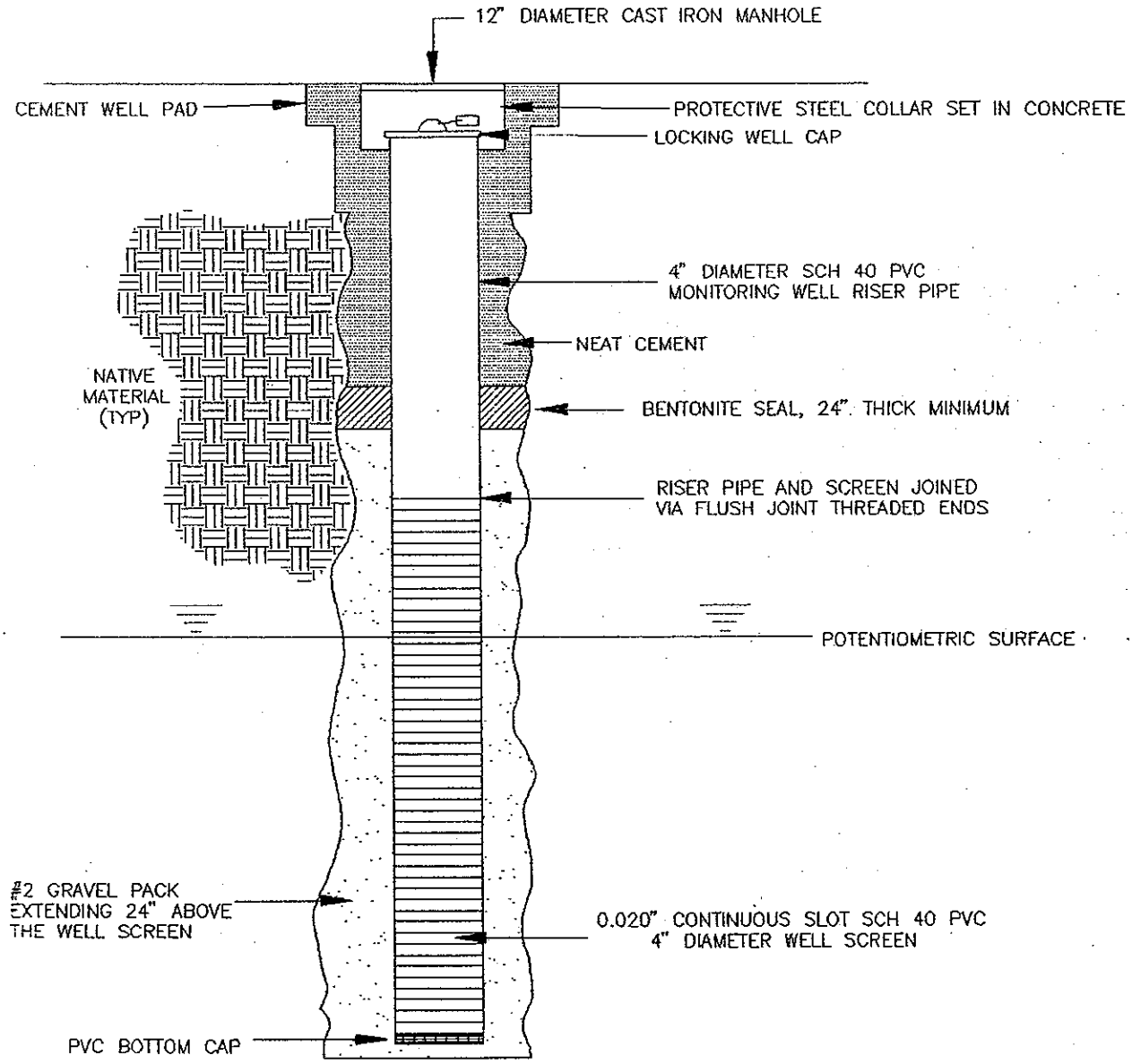
GES GROUNDWATER AND ENVIRONMENTAL SERVICES, INC.



GROUNDWATER MONITORING WELL SCHEMATIC
RISER STICK-UP COMPLETION
SUN PHILADELPHIA REFINERY

NORTH	DATE: 23 SEPT 93	CK: SR	APPV: RD
	BY: MLB	REV: MWELL2	
NA	NOT TO SCALE		
	0 000		

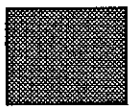
GES GROUNDWATER AND ENVIRONMENTAL SERVICES, INC.



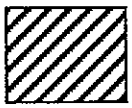
GROUNDWATER MONITORING WELL SCHEMATIC
FLUSH MOUNT COMPLETION
SUN PHILADELPHIA REFINERY

NORTH	DATE: 23 SEPT 93	CK: SR	APPV: RD
	BY: MLB	REV: MWELL	
NA	NOT TO SCALE		
	0 000		

MONITORING WELL CONSTRUCTION LEGEND
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY



Neat cement



Bentonite clay

No. #2 Sand Gravel Pack

Monitoring Well Screen

APPENDIX C
LIQUID LEVEL DATA SHEETS

LIQUID LEVEL DATA SHEET

CLIENT: SUN PHILADELPHIA REFINERY

DATE: 23 August 1993

LOCATION: North Yard

TIME:

PROJECT #: 0004-5270

RECORDED BY: E. Dziedzic

NEW WELL #	FORMER WELL #	REF. ELEV.	DTW	DTN	ANT	WATER ELEV.	ADJ. WATER ELEV.	COMMENTS
N-77	N/A	20.74	7.54			13.20		
N-78	N/A	20.29	14.10			6.19		
N-79	N/A	23.97	11.72			12.25		

WEATHER CONDITIONS: 80°, Cloudy, Humid

REF ELEV = Reference elevation (ft
DTW = Depth to top of water (ft)
DTP = Depth to top of product (ft)

APT = Apparent product thickness (ft)
BPT = Product thickness after bailing (ft)
WATER ELEV. = Top of water elevation
ADJ. WATER ELEV. = Top of water elevation corrected for free product presence

NP = Not present; NB = Not bailed; NR = Not recorded

LIQUID LEVEL DATA SHEET

CLIENT: SUN PHILADELPHIA REFINERY

DATE: 25 August 1993

LOCATION: South Yard

TIME:

PROJECT #: 0004-5270

RECORDED BY: E. Dziedzic/M. Haslett

NEW WELL #	FORMER WELL #	REF. ELEV.	DTW	DTN	ANT	WATER ELEV.	ADJ. WATER ELEV.	COMMENTS
S-90	N/A	27.81	25.97	25.84	0.13	1.84	1.94	Gauged 09/02/93
S-91	N/A	26.02	19.57			6.45		
S-92	N/A	22.32	14.11			8.21		
S-93	N/A	24.65	20.55	19.47	1.08	4.10	4.91	Black NAPL, low viscosity gauged 08/20/93
S-94	N/A	N/A	21.18					Gauged 09/14/93

WEATHER CONDITIONS: 90°, Sunny

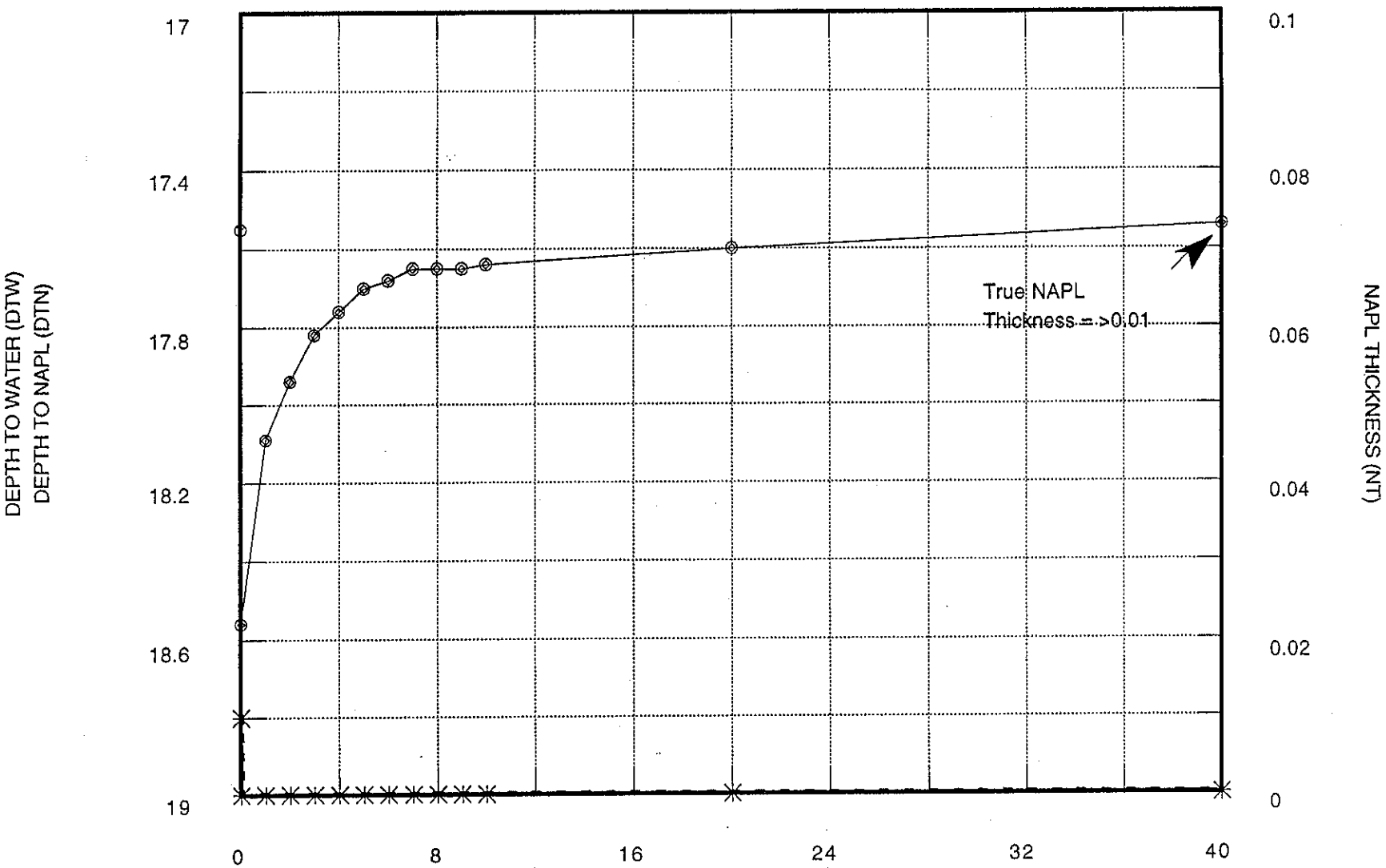
REF ELEV = Reference elevation (ft
DTW = Depth to top of water (ft)
DTP = Depth to top of product (ft)

APT = Apparent product thickness (ft)
BPT = Product thickness after bailing (ft)
WATER ELEV. = Top of water elevation
ADJ. WATER ELEV. = Top of water elevation corrected for free product presence

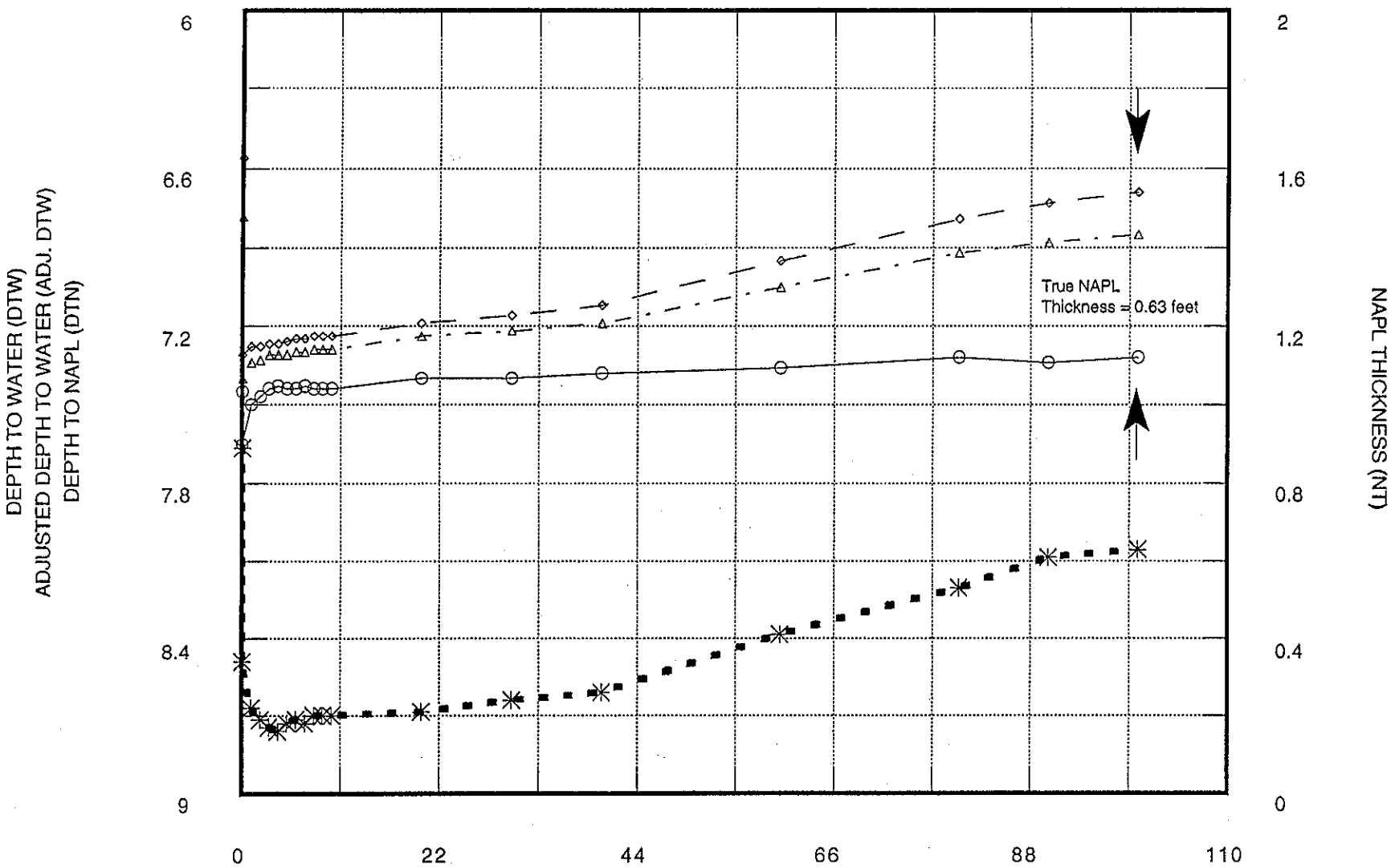
NP = Not present; NB = Not bailed; NR = Not recorded

APPENDIX D

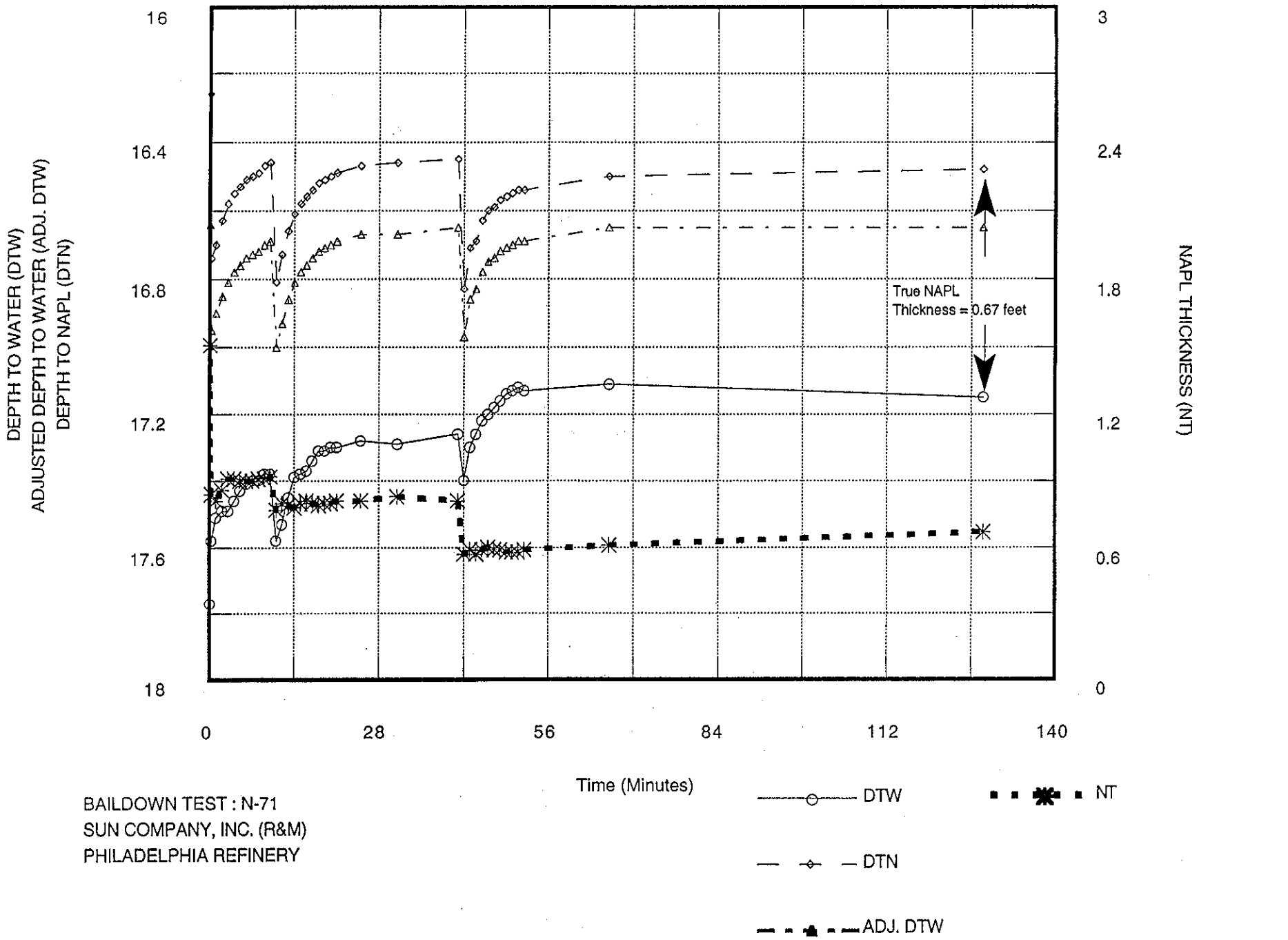
BAILDOWN TEST DATA - JACKSON STREET SEWER



BAILDOWN TEST : N-20
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY



BAILDOWN TEST : N-25
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY



BAILDOWN TEST : N-71
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY
JACKSON STREET SEWER
BAILDOWN TEST

N-20

Time (min)	DTW (feet)	DTN (feet)	NT (feet)	ADJ. DTW (feet)
0	17.55	17.54	0.01	17.54
0	18.56	::::	0.00	18.56
1	18.09	::::	0.00	18.09
2	17.94	::::	0.00	17.94
3	17.82	::::	0.00	17.82
4	17.76	::::	0.00	17.76
5	17.70	::::	0.00	17.70
6	17.68	::::	0.00	17.68
7	17.65	::::	0.00	17.65
8	17.65	::::	0.00	17.65
9	17.65	::::	0.00	17.65
10	17.64	::::	0.00	17.64
20	17.60	::::	0.00	17.60
40	17.54	::::	0.00	17.54

:::: = NAPL Not Detected

SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY
JACKSON STREET SEWER
BAILDOWN TEST

N-25

Time (min)	DTW (feet)	DTN (feet)	NT (feet)	ADJ. DTW (feet)
0	7.45	6.56	0.89	6.78
0	7.65	7.31	0.34	7.40
1	7.50	7.28	0.22	7.34
2	7.47	7.28	0.19	7.33
3	7.44	7.27	0.17	7.31
4	7.43	7.27	0.16	7.31
5	7.44	7.26	0.18	7.31
6	7.44	7.25	0.19	7.30
7	7.43	7.25	0.18	7.30
8	7.44	7.24	0.20	7.29
9	7.44	7.24	0.20	7.29
10	7.44	7.24	0.20	7.29
20	7.40	7.19	0.21	7.24
30	7.40	7.16	0.24	7.22
40	7.38	7.12	0.26	7.19
60	7.36	6.95	0.41	7.05
80	7.32	6.79	0.53	6.92
90	7.34	6.73	0.61	6.88
100	7.32	6.69	0.63	6.85

SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY
JACKSON STREET SEWER
BAILDOWN TEST

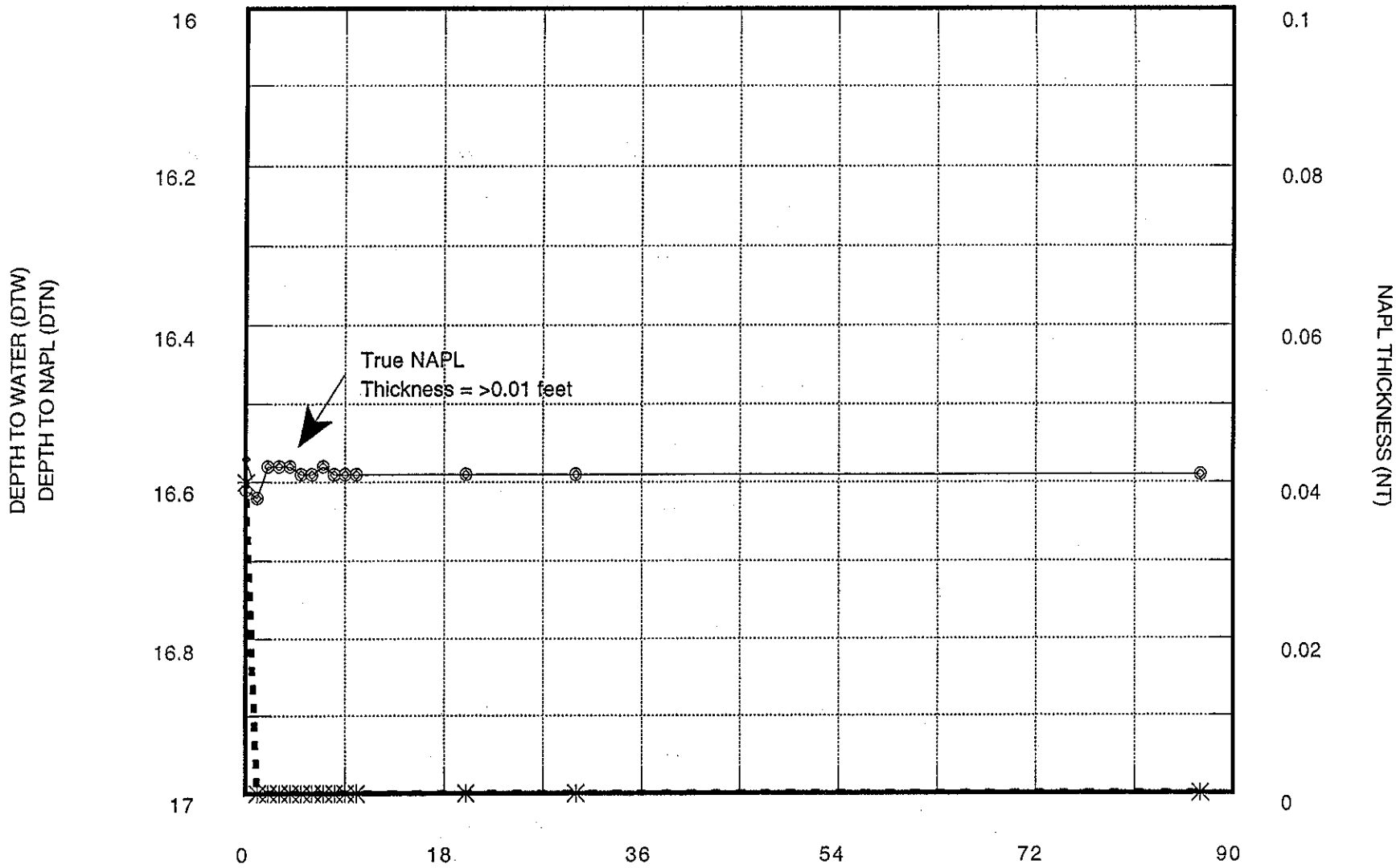
N-71

Time (min)	DTW (feet)	DTN (feet)	NT (feet)	ADJ. DTW (feet)
0	17.77	16.26	1.51	16.64
.25	17.58	16.74	0.84	16.95
1	17.51	16.70	0.81	16.90
2	17.49	16.63	0.86	16.85
3	17.49	16.58	0.91	16.81
4	17.46	16.55	0.91	16.78
5	17.43	16.53	0.90	16.76
6	17.41	16.51	0.90	16.74
7	17.40	16.50	0.90	16.73
8	17.40	16.49	0.91	16.72
9	17.38	16.47	0.91	16.70
10	17.38	16.46	0.92	16.69
11	17.58	16.81	0.77	17.00
12	17.53	16.73	0.80	16.93
13	17.45	16.66	0.79	16.86
14	17.39	16.61	0.78	16.81
15	17.38	16.58	0.80	16.78
16	17.37	16.56	0.81	16.76
17	17.34	16.54	0.80	16.74
18	17.31	16.52	0.79	16.72
19	17.31	16.51	0.80	16.71
20	17.30	16.50	0.80	16.70
21	17.30	16.49	0.81	16.69
25	17.28	16.47	0.81	16.67
31	17.29	16.46	0.83	16.67
41	17.26	16.45	0.81	16.65
42	17.40	16.83	0.57	16.97
43	17.30	16.71	0.59	16.86
44	17.26	16.69	0.57	16.83
45	17.22	16.63	0.59	16.78
46	17.20	16.60	0.60	16.75
47	17.18	16.59	0.59	16.74
48	17.16	16.57	0.59	16.72

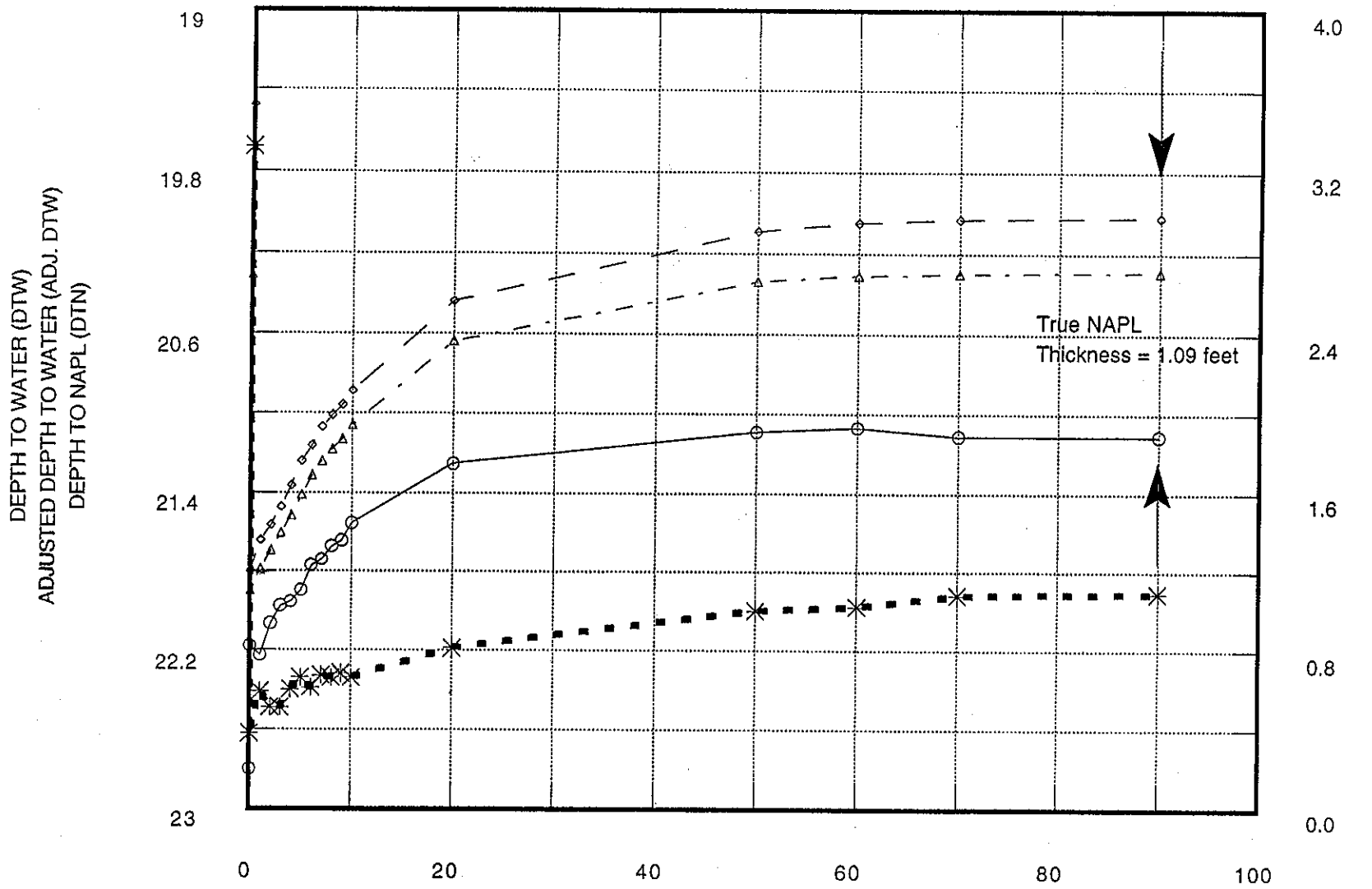
49	17.14	16.56	0.58	16.71
50	17.13	16.55	0.58	16.70
51	17.12	16.54	0.58	16.69
52	17.13	16.54	0.59	16.69
66	17.11	16.50	0.61	16.65
128	17.15	16.48	0.67	16.65

APPENDIX E

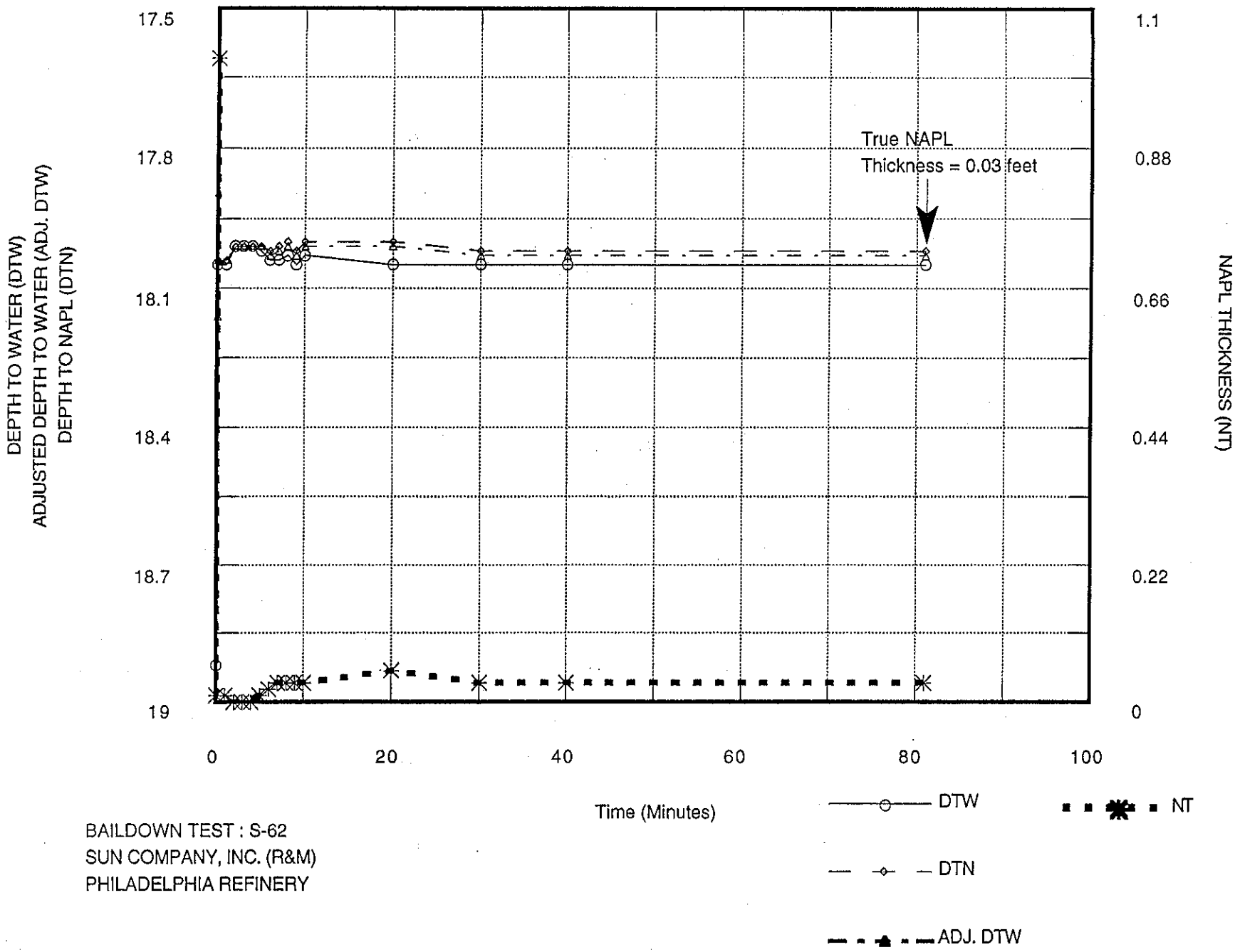
BAILDOWN TEST DATA - POLLOCK STREET SEWER



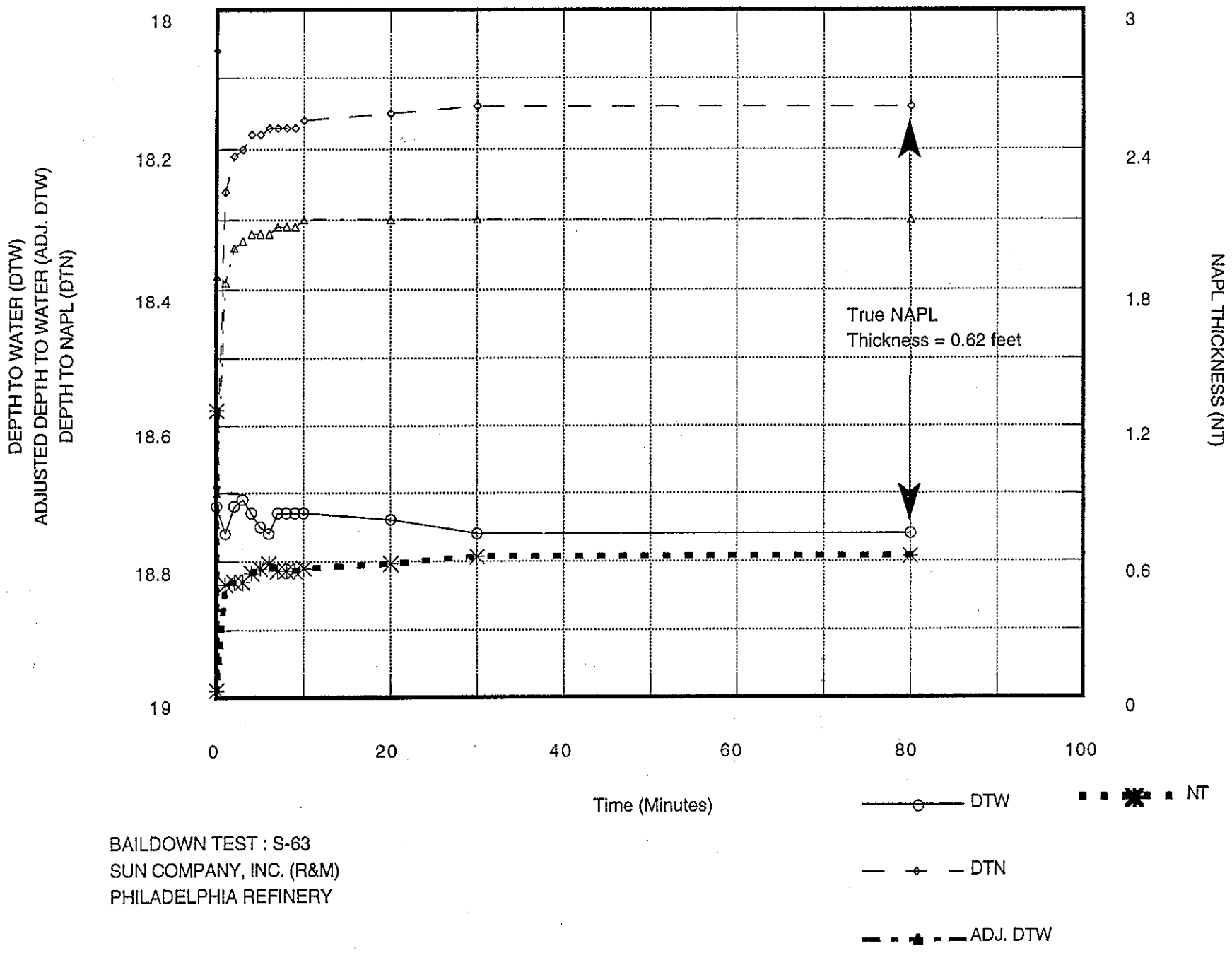
BAILDOWN TEST :S-48
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY



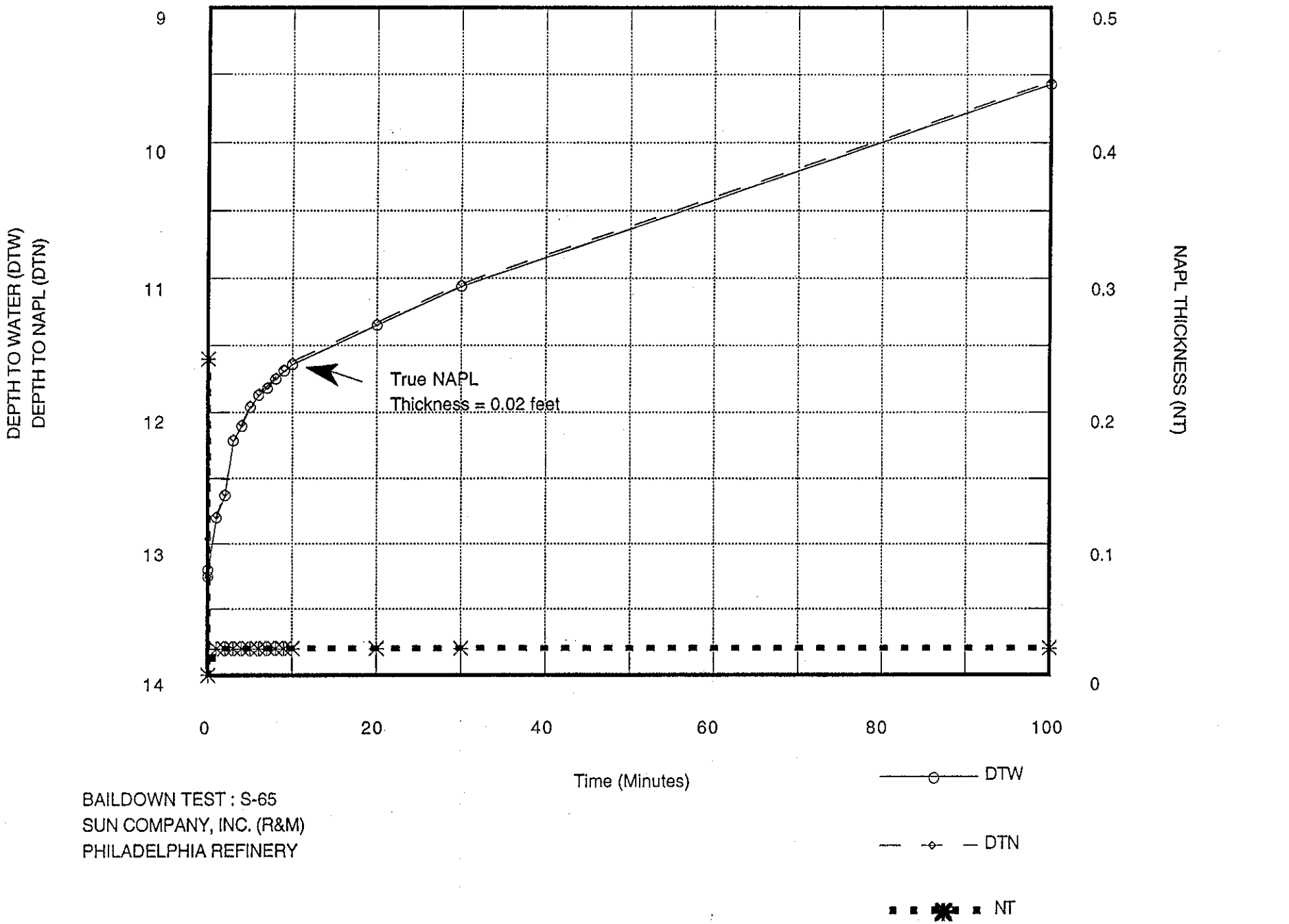
BAILDOWN TEST : S-53
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY



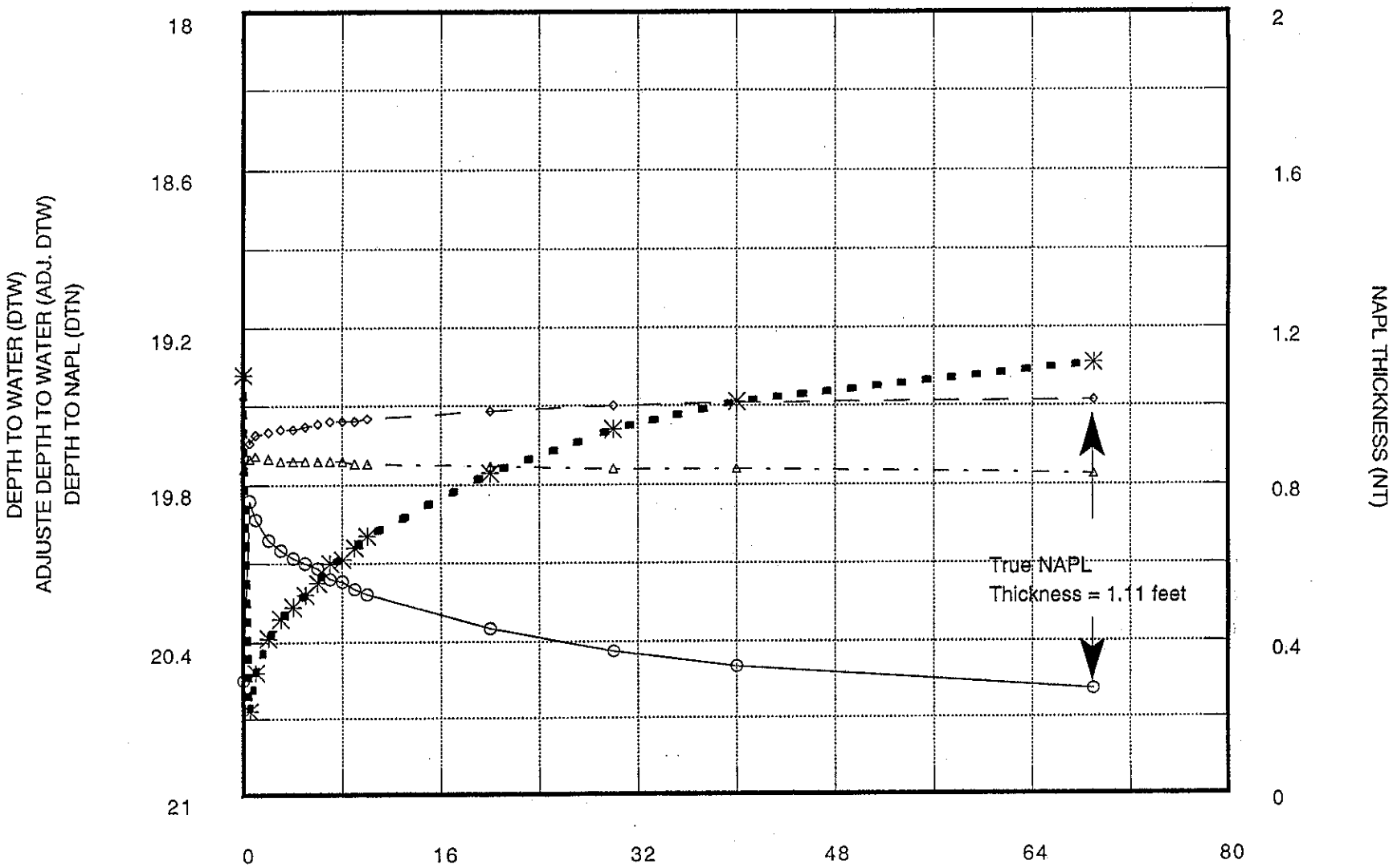
BAILDOWN TEST : S-62
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY



BAILDOWN TEST : S-63
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY



BAILDOWN TEST : S-65
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY



BAILDOWN TEST : S-93
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY
POLLOCK STREET SEWER
BAILDOWN TEST

S-48

Time (min)	DTW (feet)	DTN (feet)	NT (feet)	ADJ. DTW (feet)
0	16.61	16.57	0.04	16.58
1	16.62	::::	0.00	16.62
2	16.58	::::	0.00	16.58
3	16.58	::::	0.00	16.58
4	16.58	::::	0.00	16.58
5	16.59	::::	0.00	16.59
6	16.59	::::	0.00	16.59
7	16.58	::::	0.00	16.58
8	16.59	::::	0.00	16.59
9	16.59	::::	0.00	16.59
10	16.59	::::	0.00	16.59
20	16.59	::::	0.00	16.59
30	16.59	::::	0.00	16.59
87	16.59	::::	0.00	16.59

:::: = NAPL Not Detected

SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY
POLLOCK STREET SEWER
BAILDOWN TEST

S-53

Time (min)	DTW (feet)	DTN (feet)	NT (feet)	ADJ. DTW (feet)
0	22.80	19.48	3.32	20.31
0	22.18	21.80	0.38	21.90
1	22.23	21.64	0.59	21.79
2	22.07	21.56	0.51	21.69
3	21.98	21.47	0.51	21.60
4	21.96	21.36	0.60	21.51
5	21.90	21.24	0.66	21.41
6	21.77	21.16	0.61	21.31
7	21.74	21.07	0.67	21.24
8	21.67	21.01	0.66	21.18
9	21.64	20.96	0.68	21.13
10	21.55	20.89	0.66	21.06
20	21.25	20.44	0.81	20.64
50	21.09	20.09	1.00	20.34
60	21.07	20.05	1.02	20.31
70	21.11	20.03	1.08	20.30
90	21.11	20.02	1.09	20.29

SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY
POLLOCK STREET SEWER
BAILDOWN TEST

S-62

Time (min)	DTW (feet)	DTN (feet)	NT (feet)	ADJ. DTW (feet)
0	18.92	17.90	1.02	18.16
0	18.05	18.04	0.01	18.04
1	18.05	18.04	0.01	18.04
2	18.01	::::	0.00	18.01
3	18.01	::::	0.00	18.01
4	18.01	::::	0.00	18.01
5	18.02	18.01	0.01	18.01
6	18.04	18.02	0.02	18.03
7	18.04	18.01	0.03	18.02
8	18.03	18.00	0.03	18.01
9	18.05	18.02	0.03	18.03
10	18.03	18.00	0.03	18.01
20	18.05	18.00	0.05	18.01
30	18.05	18.02	0.03	18.03
40	18.05	18.02	0.03	18.03
81	18.05	18.02	0.03	18.03

:::: = NAPL Not Detected

SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY
POLLOCK STREET SEWER
BAILDOWN TEST

S-63

Time (min)	DTW (feet)	DTN (feet)	NT (feet)	ADJ. DTW (feet)
0	19.33	18.06	1.27	18.38
0	18.72	18.69	0.03	18.70
1	18.76	18.26	0.50	18.39
2	18.72	18.21	0.51	18.34
3	18.71	18.20	0.51	18.33
4	18.73	18.18	0.55	18.32
5	18.75	18.18	0.57	18.32
6	18.76	18.17	0.59	18.32
7	18.73	18.17	0.56	18.31
8	18.73	18.17	0.56	18.31
9	18.73	18.17	0.56	18.31
10	18.73	18.16	0.57	18.30
20	18.74	18.15	0.59	18.30
30	18.76	18.14	0.62	18.30
80	18.76	18.14	0.62	18.30

SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY
POLLOCK STREET SEWER
BAILDOWN TEST

S-65

Time (min)	DTW (feet)	DTN (feet)	NT (feet)	ADJ. DTW (feet)
0	13.20	12.96	0.24	13.02
0	13.25	::::	0.00	13.25
1	12.80	12.78	0.02	12.79
2	12.63	12.61	0.02	12.62
3	12.21	12.19	0.02	12.20
4	12.10	12.08	0.02	12.09
5	11.96	11.94	0.02	11.95
6	11.87	11.85	0.02	11.86
7	11.82	11.80	0.02	11.81
8	11.75	11.73	0.02	11.74
9	11.69	11.67	0.02	11.68
10	11.64	11.62	0.02	11.63
20	11.35	11.33	0.02	11.34
30	11.06	11.04	0.02	11.05
100	9.57	9.55	0.02	9.56

:::: = NAPL Not Detected

SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY
POLLOCK STREET SEWER
BAILDOWN TEST

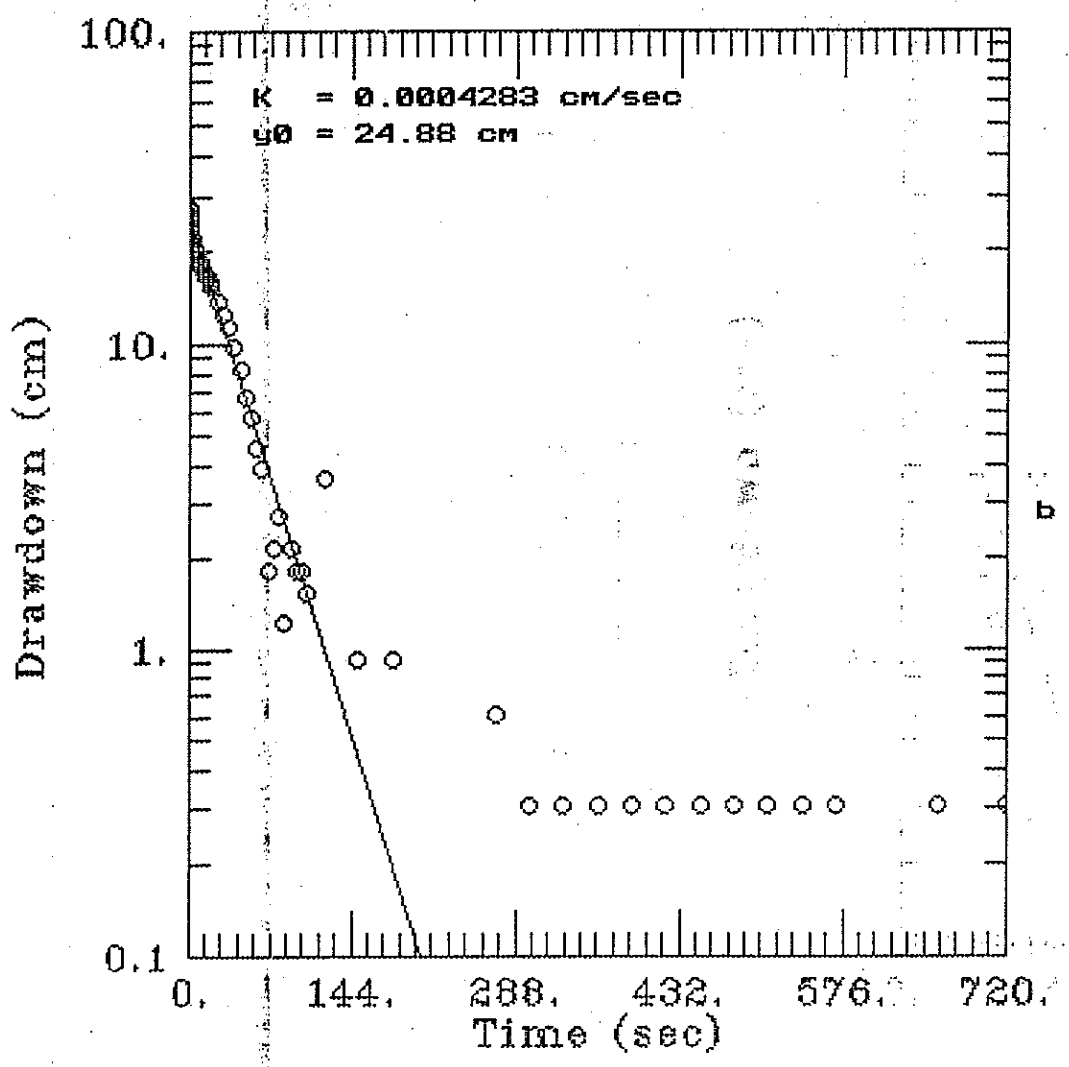
S-93

Time (min)	DTW (feet)	DTN (feet)	NT (feet)	ADJ. DTW (feet)
0	20.55	19.47	1.08	19.74
.5	19.86	19.64	0.22	19.70
1	19.93	19.61	0.32	19.69
2	20.01	19.60	0.41	19.70
3	20.05	19.59	0.46	19.71
4	20.08	19.59	0.49	19.71
5	20.10	19.58	0.52	19.71
6	20.12	19.57	0.55	19.71
7	20.16	19.56	0.60	19.71
8	20.17	19.56	0.61	19.71
9	20.20	19.56	0.64	19.72
10	20.22	19.55	0.67	19.72
20	20.35	19.52	0.83	19.73
30	20.44	19.50	0.94	19.74
40	20.50	19.49	1.01	19.74
69	20.59	19.48	1.11	19.76

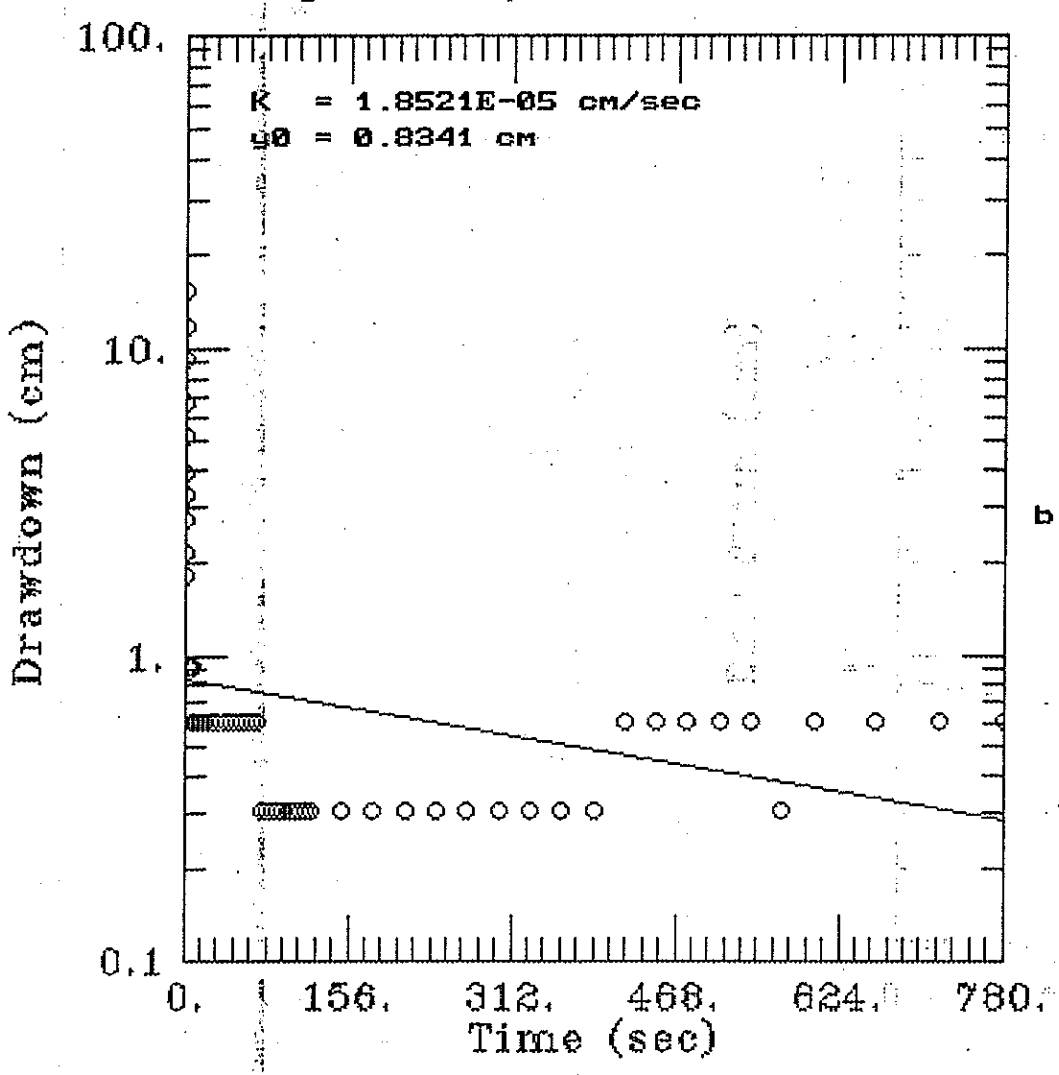
APPENDIX F

SLUG TEST DATA - JACKSON STREET SEWER

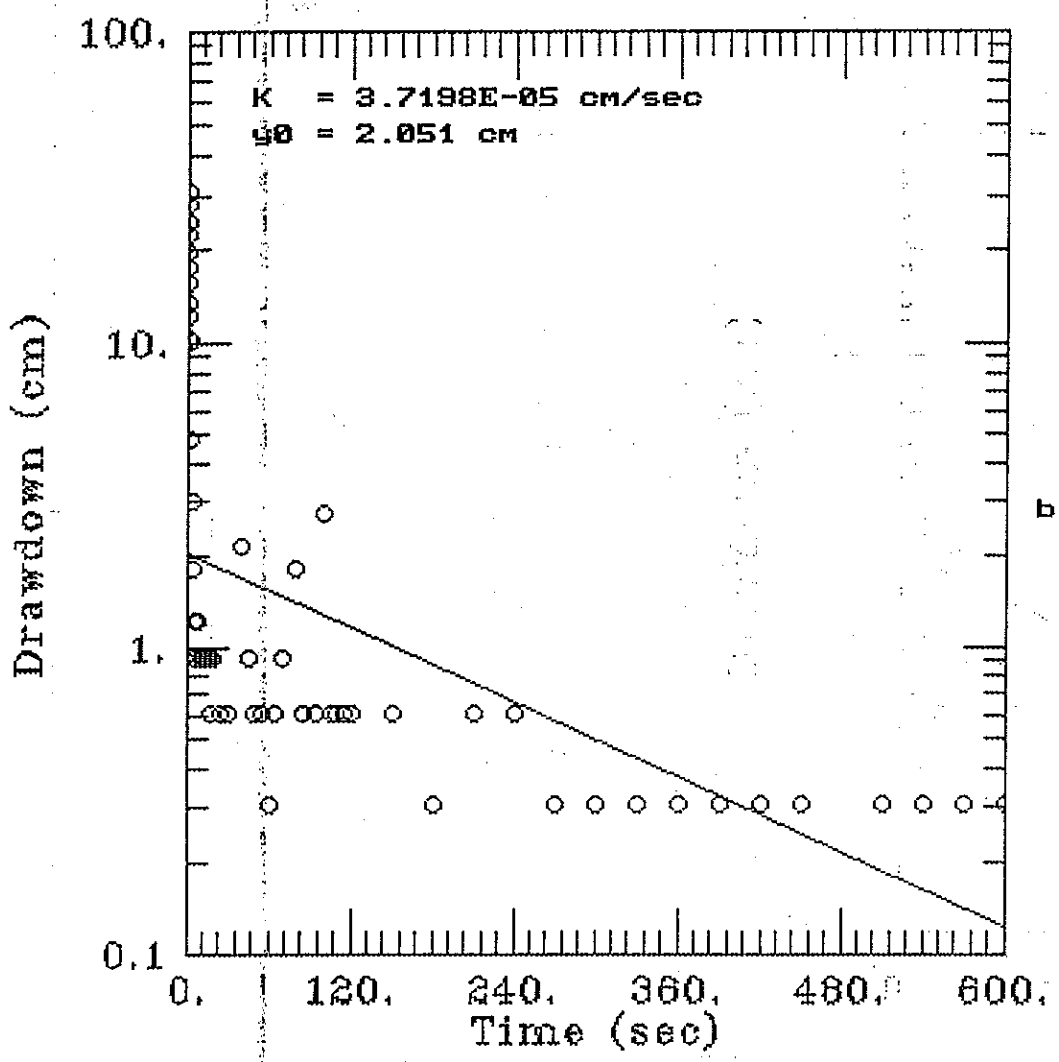
N-24 Slug Test by Bouwer - Rice Method



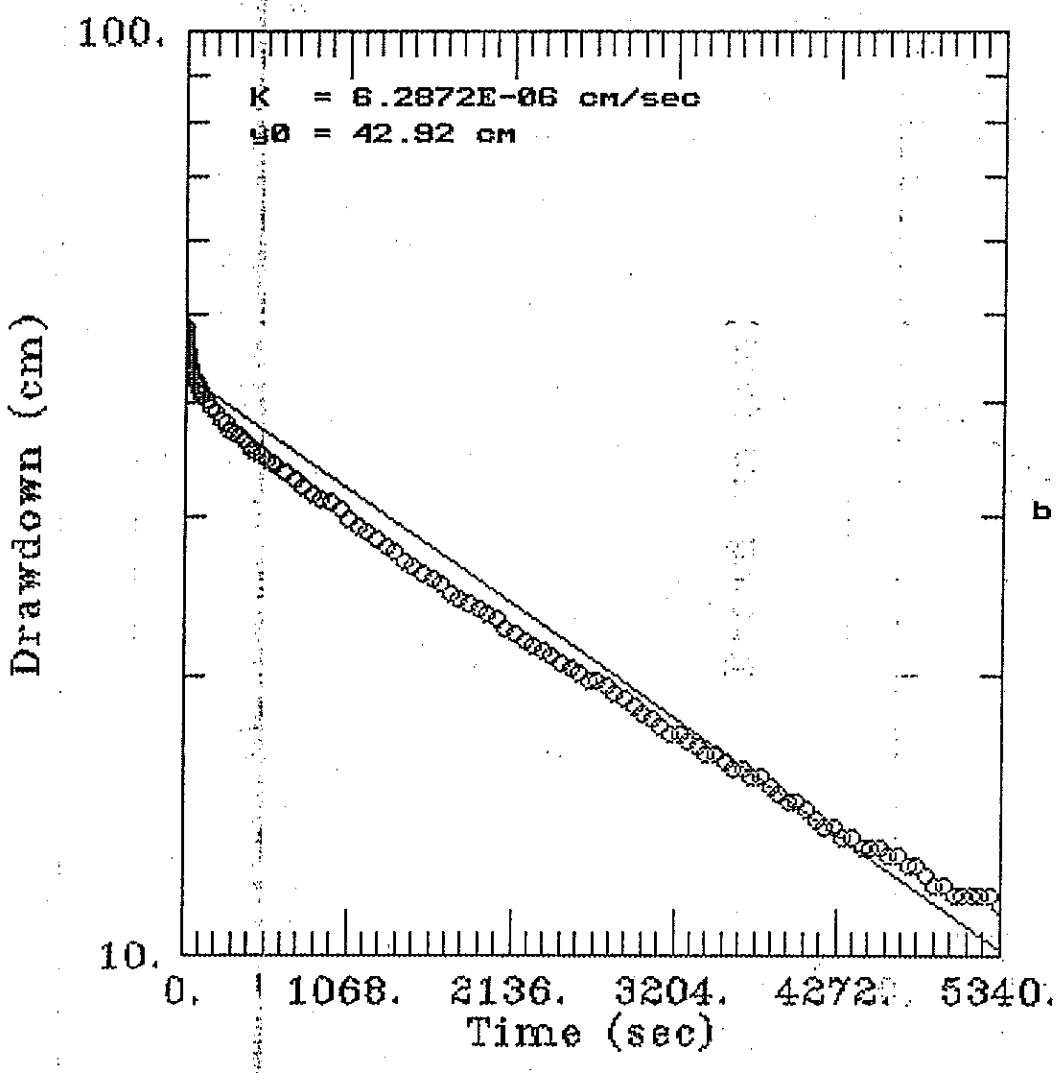
N-26 Slug Test by Bouwer - Rice Method



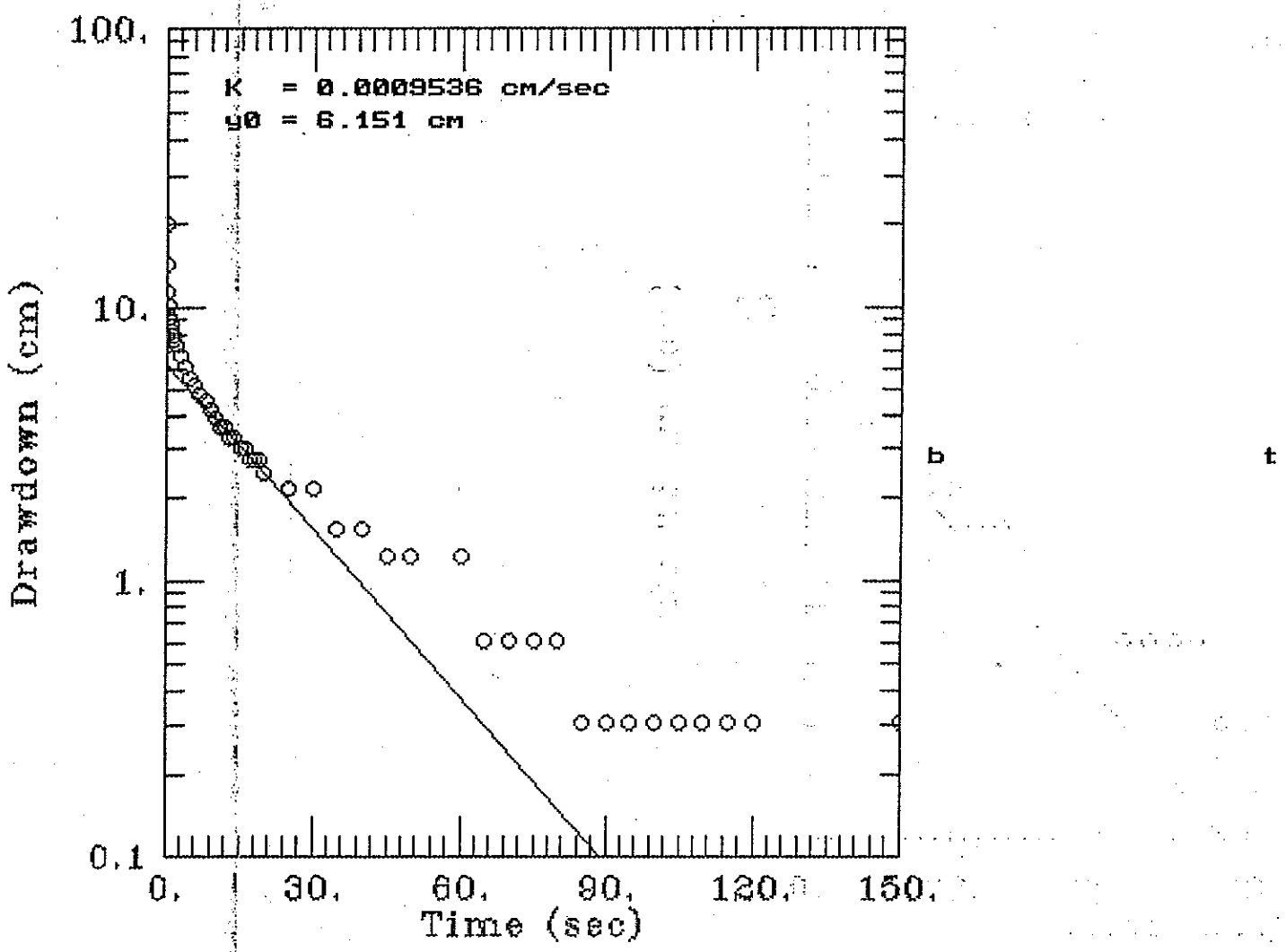
N-27 Slug Test by Bouwer - Rice Method



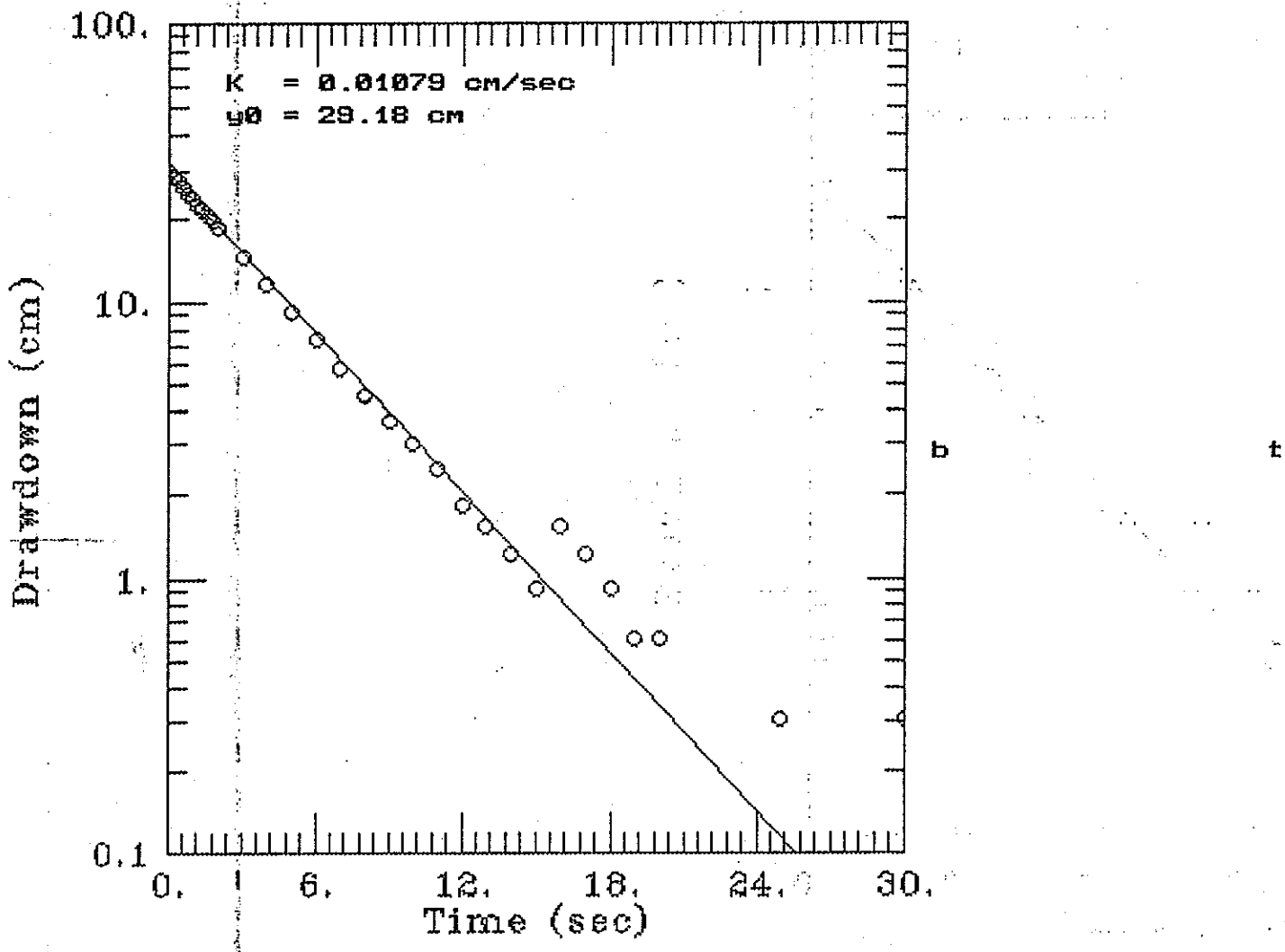
N-28 Slug Test by Bouwer - Rice Method



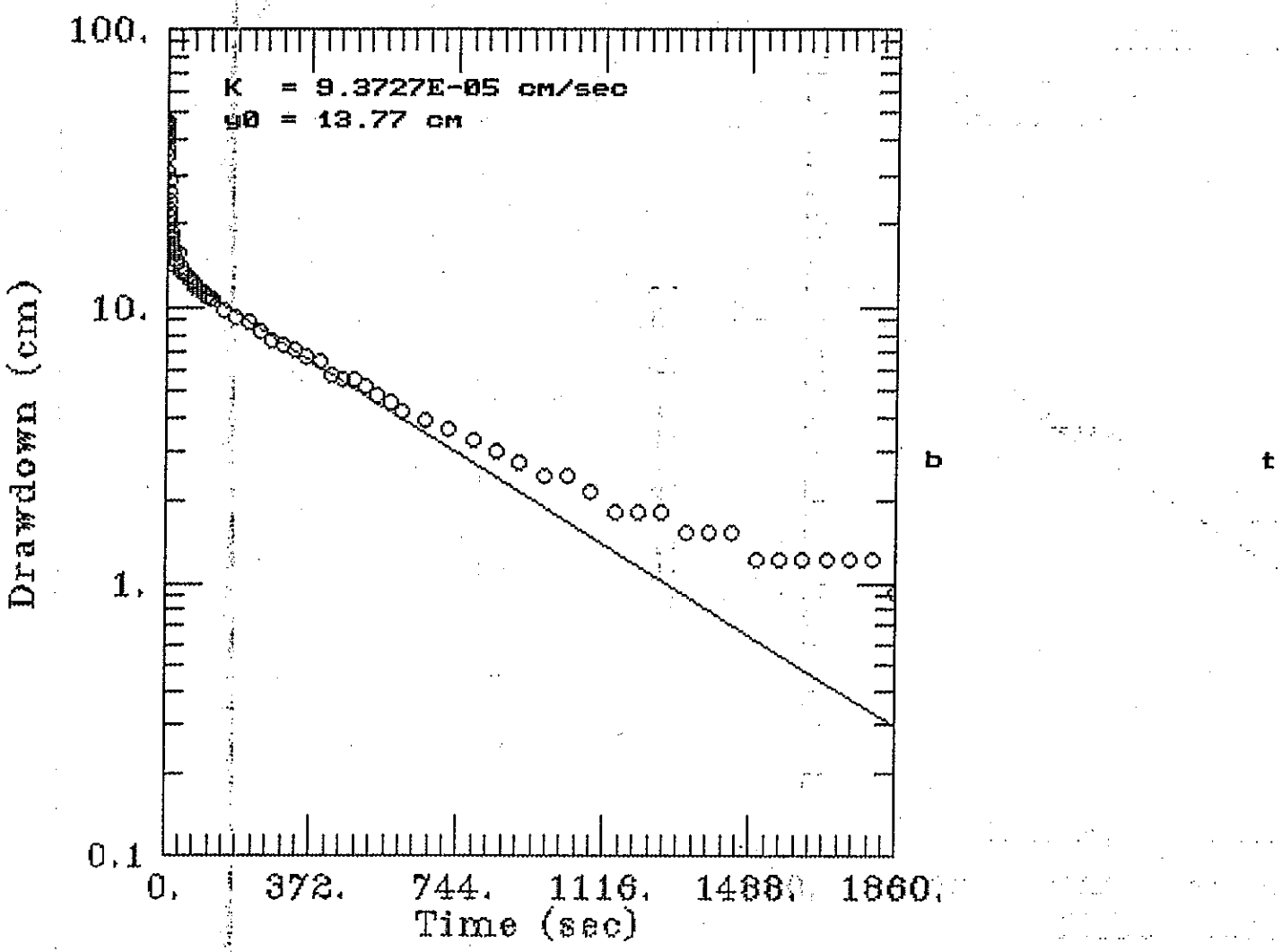
N-37 Slug Test by Bouwer - Rice Method



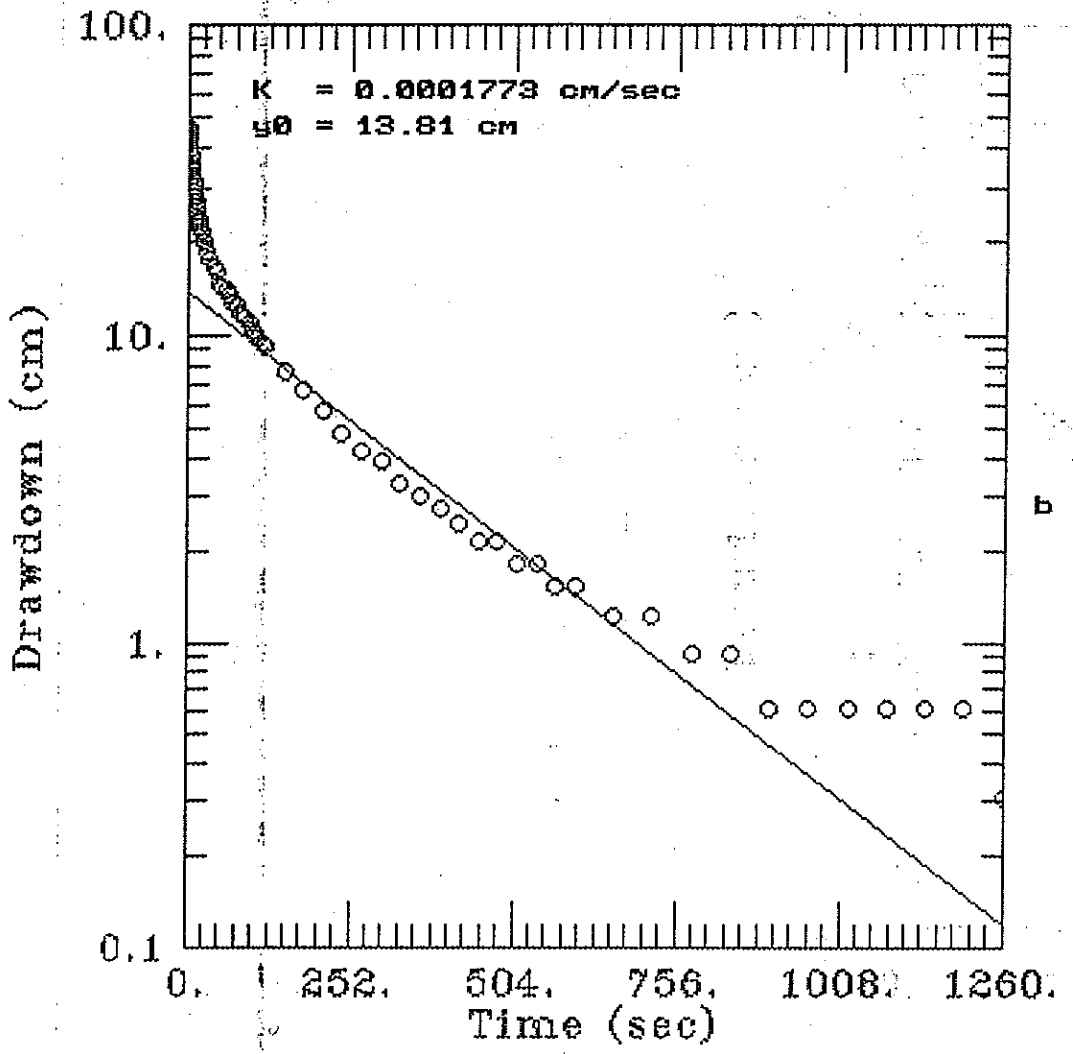
N-77 Slug Test by Bouwer - Rice Method



N-78 Slug Test by Bouwer - Rice Method



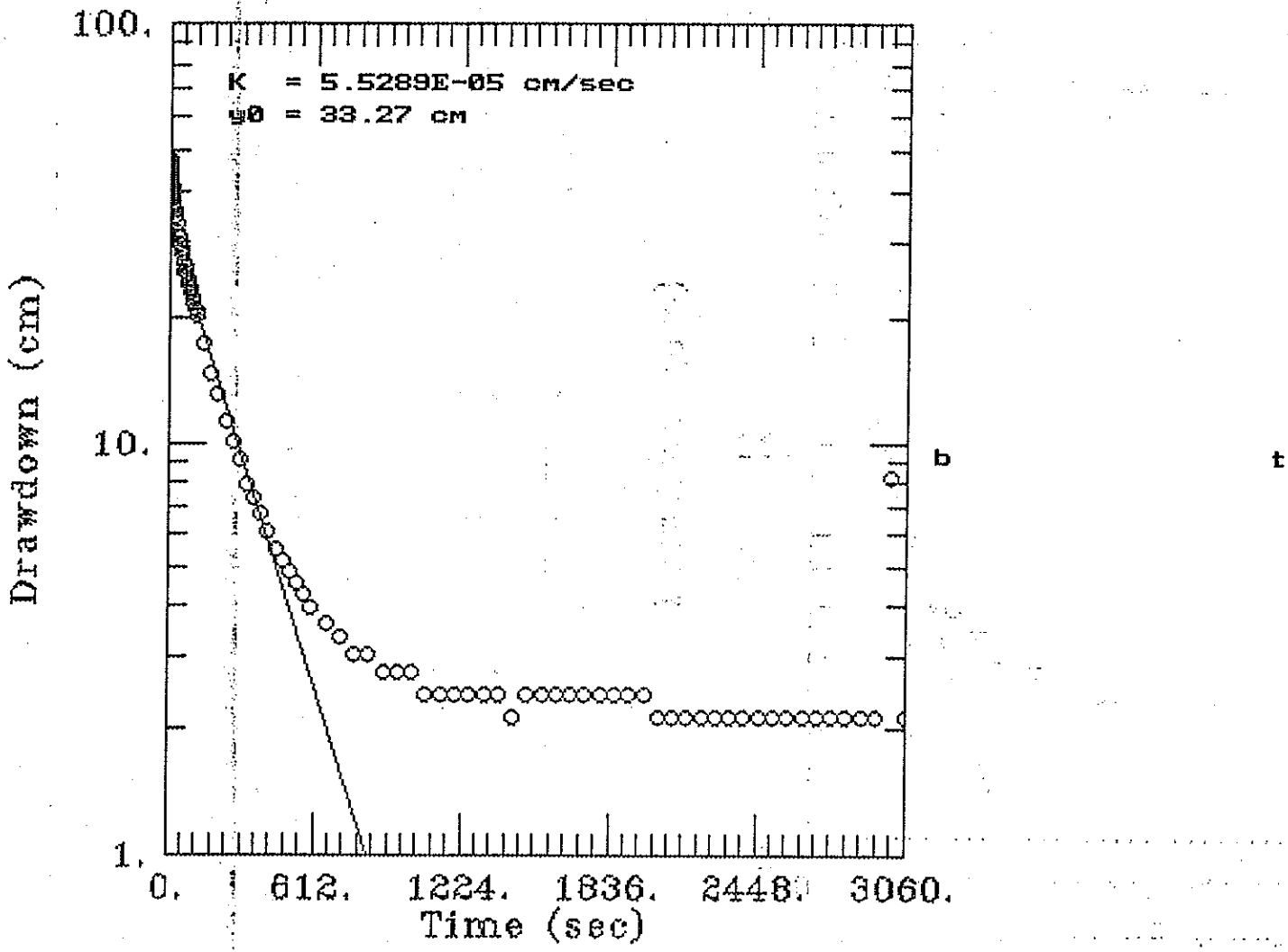
N-79 Slug Test by Bouwer - Rice Method



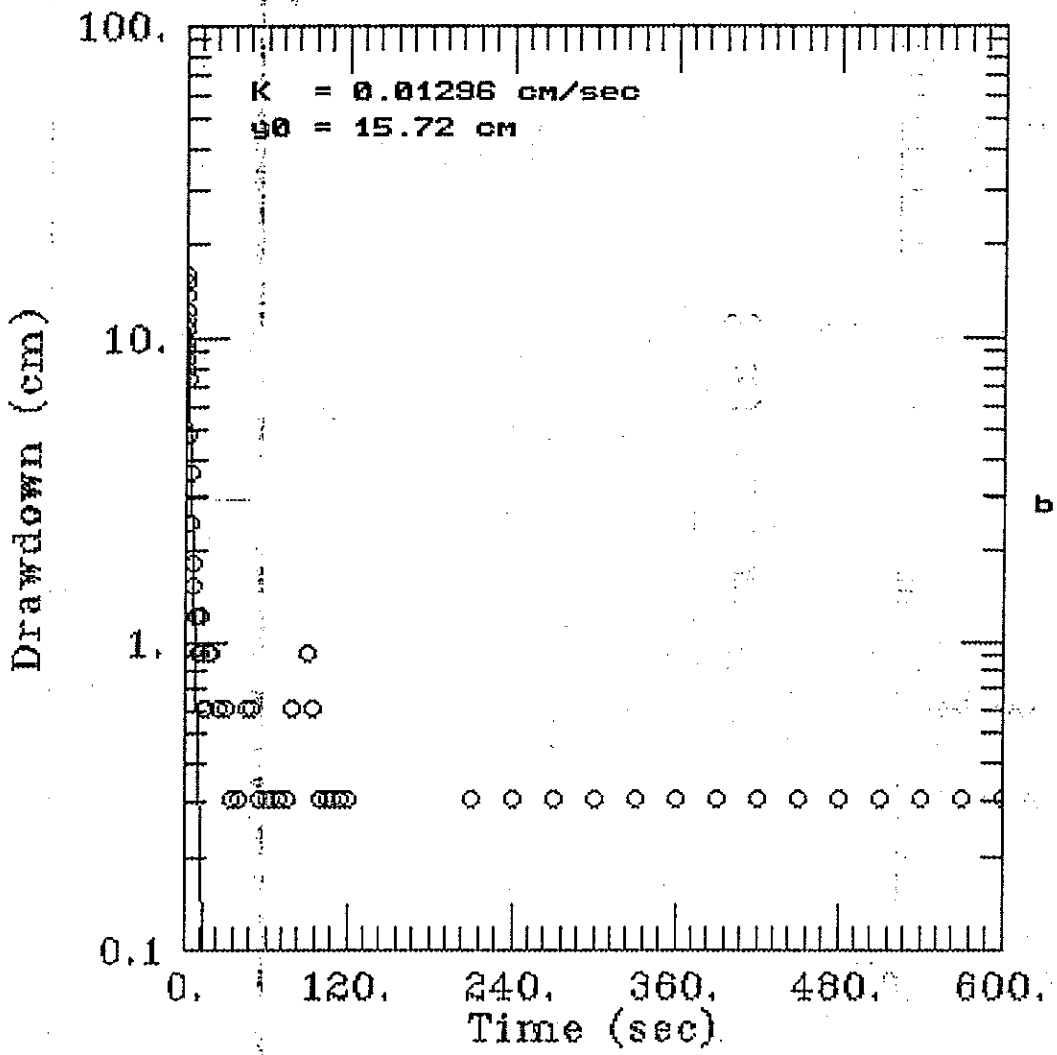
APPENDIX G

SLUG TEST DATA - POLLOCK STREET SEWER

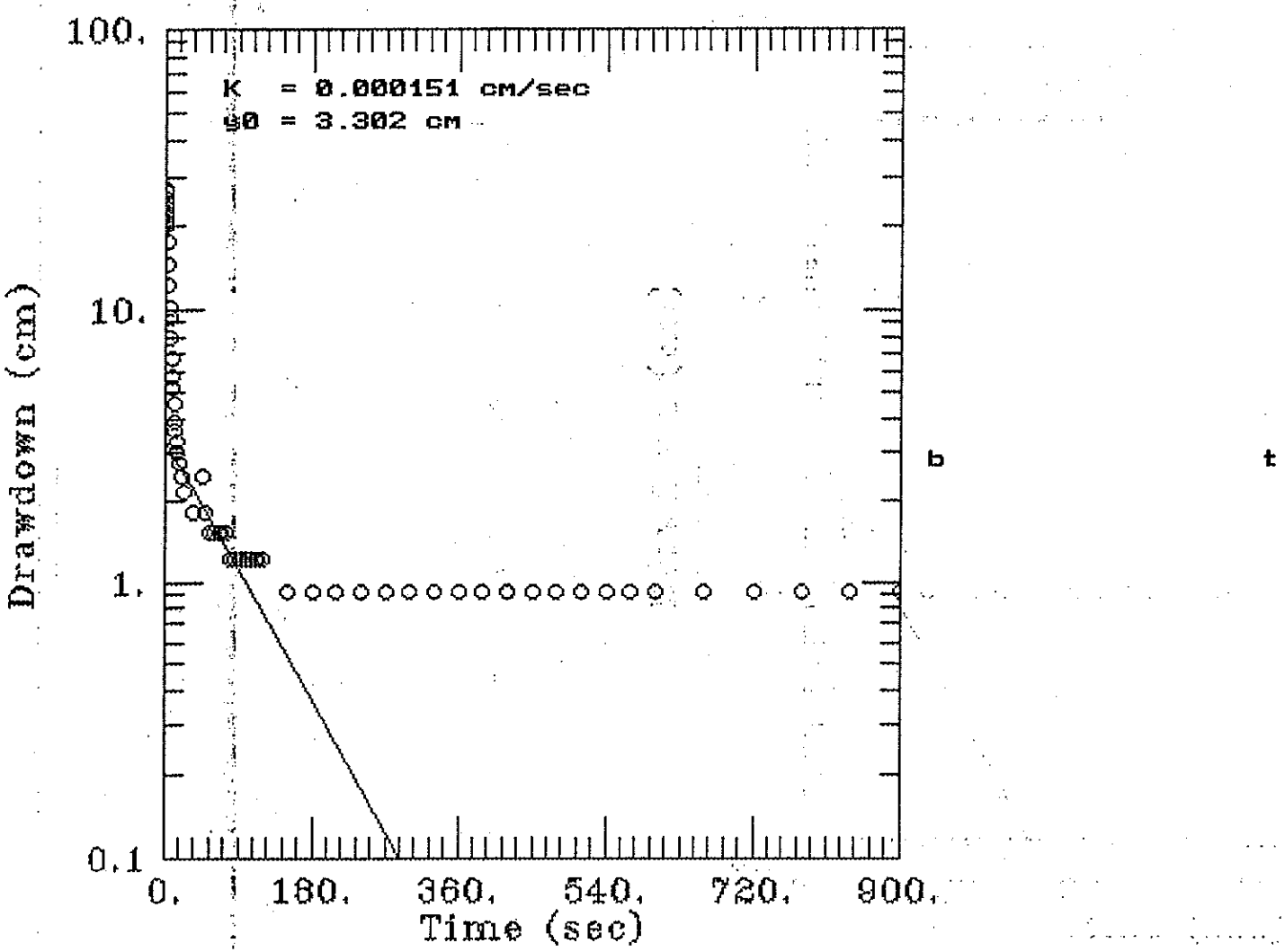
S-45 Slug Test by Bouwer - Rice Method



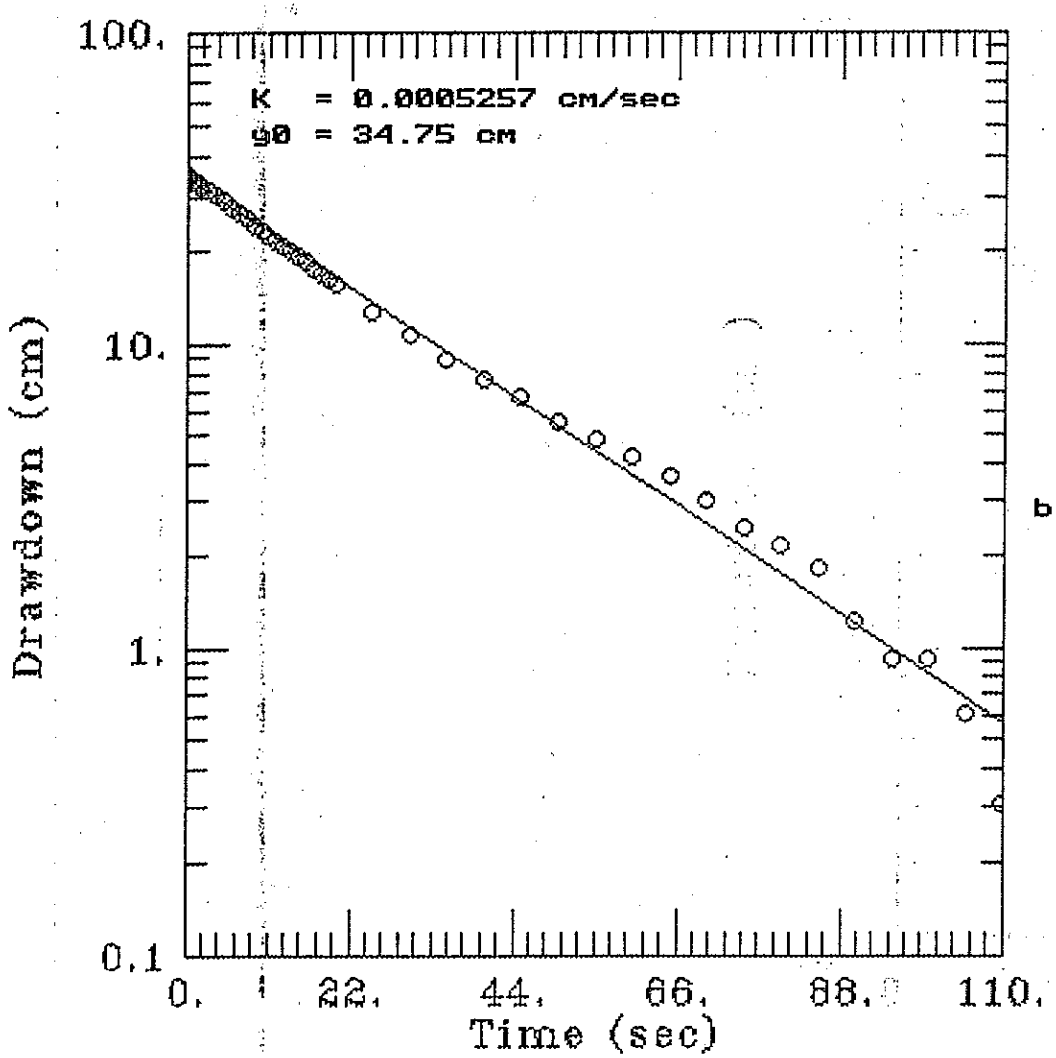
S-46 Slug Test by Bouwer - Rice Method



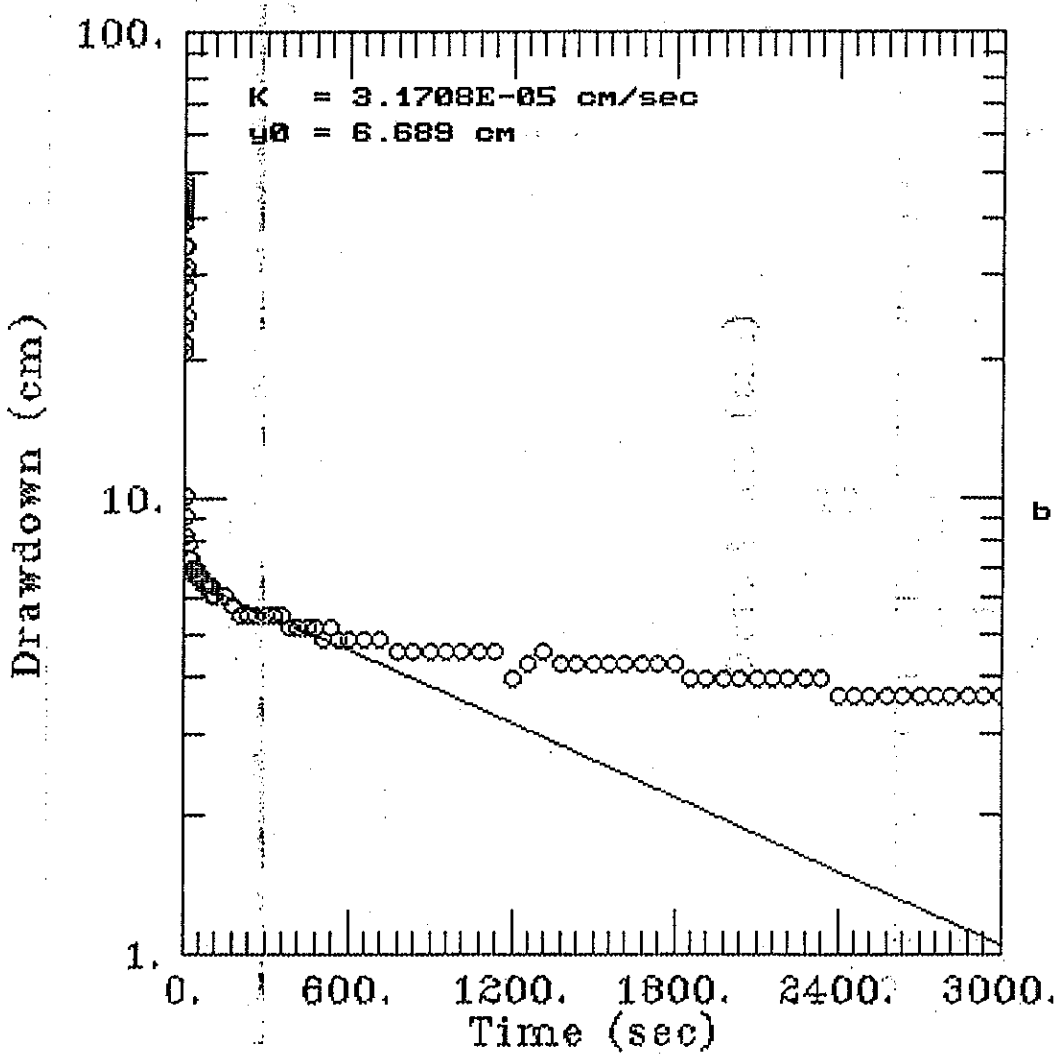
S-48 Slug Test by Bouwer - Rice Method



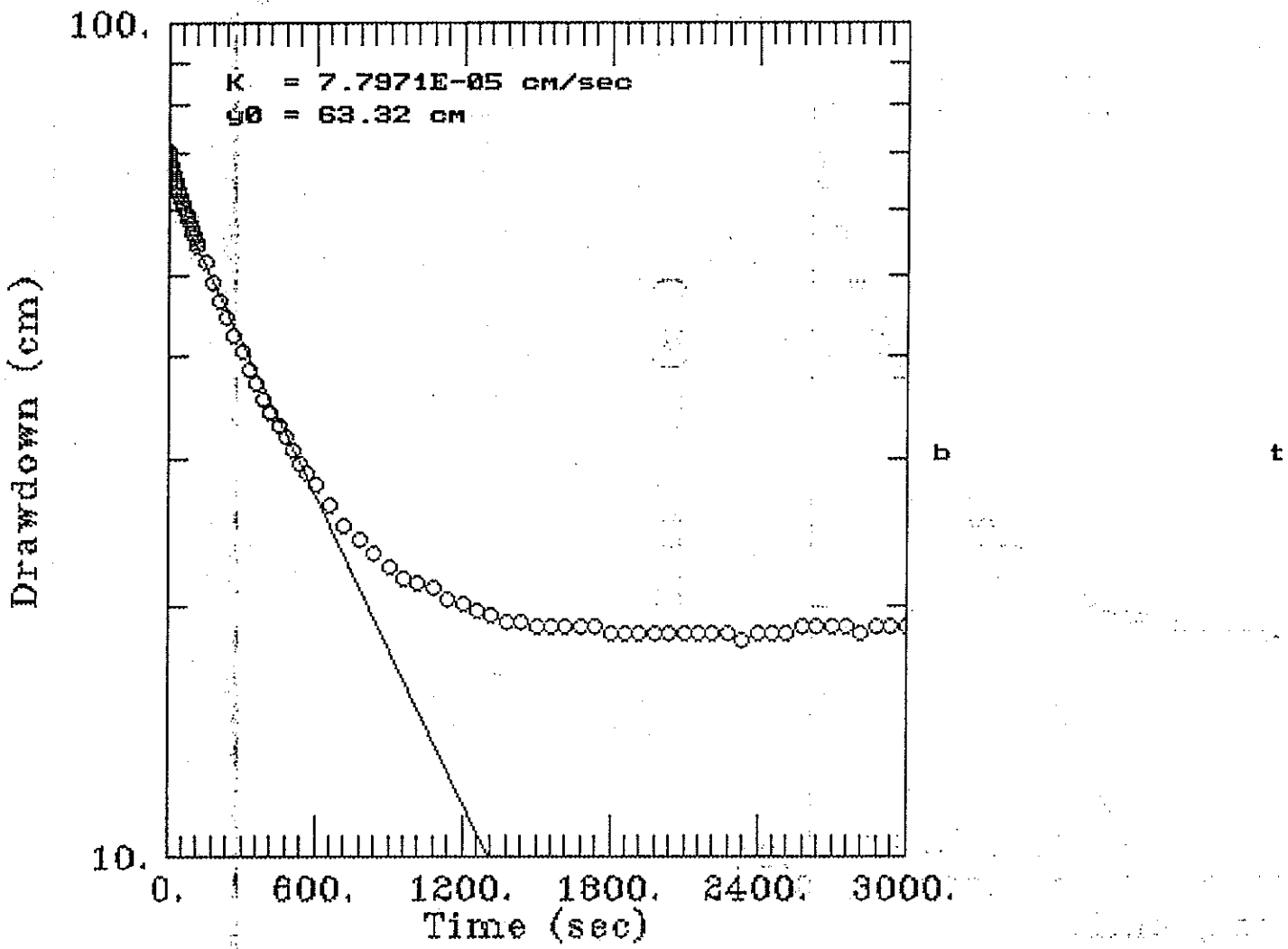
S-49 Slug Test by Bouwer - Rice Method



S-91 Slug Test by Bouwer – Rice Method



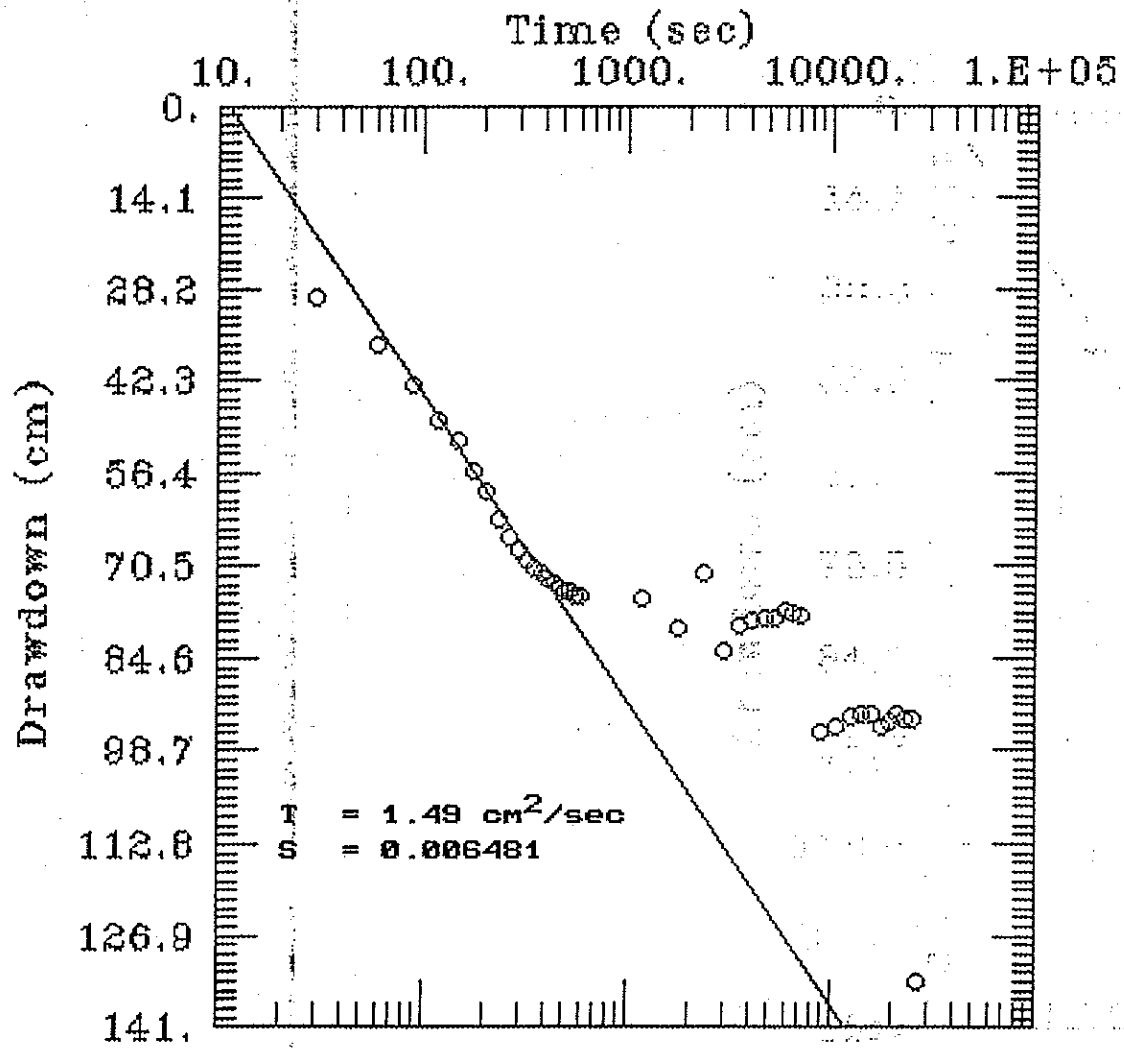
S-92 Slug Test by Bouwer - Rice Method

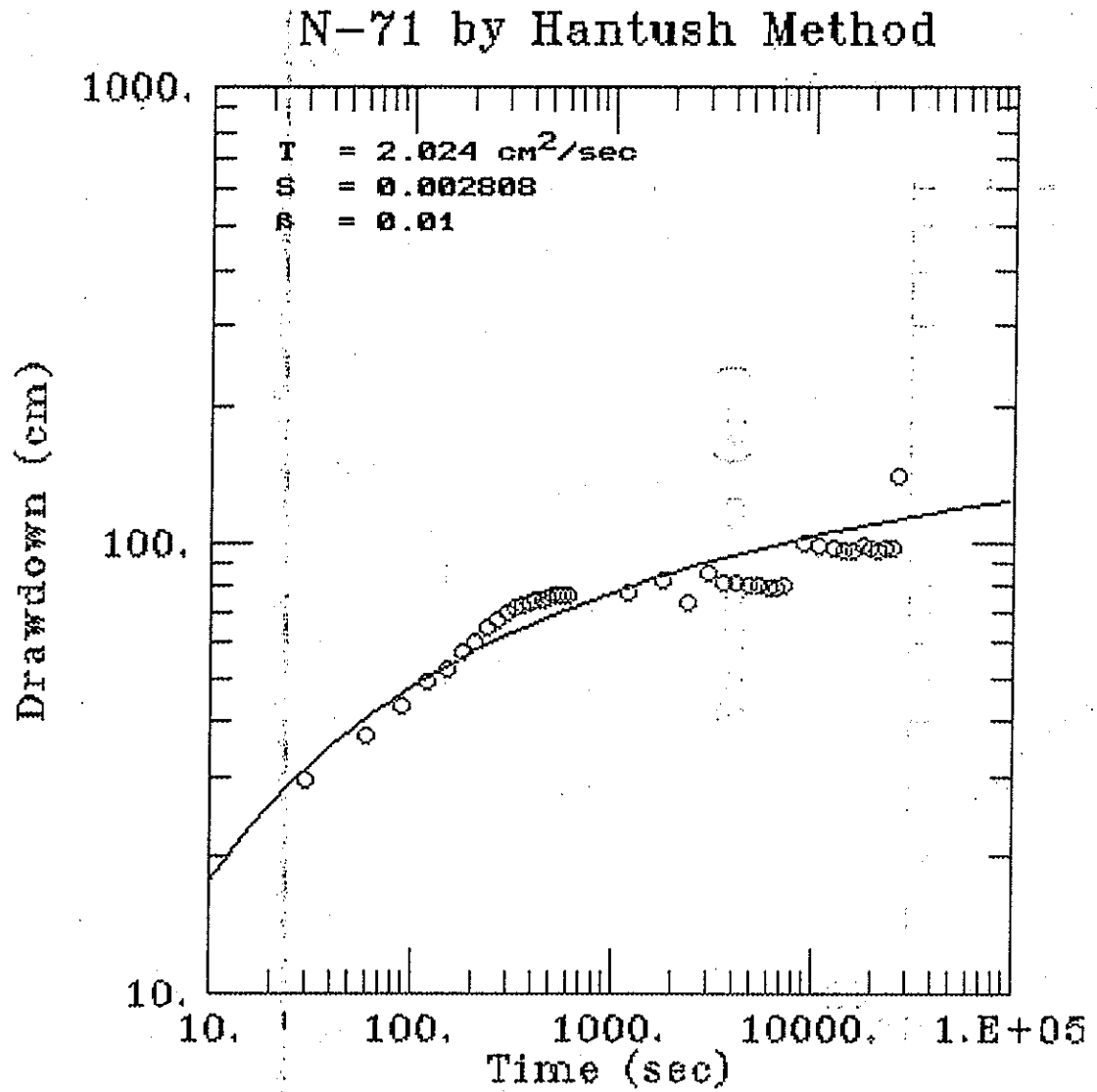


APPENDIX H

PUMPING TEST DATA - JACKSON STREET SEWER

N-71 by Cooper & Jacob Method




N-71 by Hantush Method
T = 2.024 cm²/sec
S = 0.002808
β = 0.01
1000.
100.
10.
Drawdown (cm)
10.
100.
1000.
10000.
1.E+05
Time (sec)

JACKSON STREET SEWER
PUMPING TEST AT N-71
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

N-71

Time (min)	DTW (feet)	DTN (feet)	NT (feet)	ADJ. DTW (feet)	Draw down (units)
0	16.37	15.63	0.74	15.82	0.00
.5	17.25	16.65	0.60	16.80	0.98
1	17.45	16.90	0.55	17.04	1.22
1.5	17.70	17.10	0.60	17.25	1.43
2	17.85	17.30	0.55	17.44	1.62
2.5	17.95	17.40	0.55	17.54	1.72
3	18.15	17.55	0.60	17.70	1.88
3.5	18.25	17.65	0.60	17.80	1.98
4	18.40	17.80	0.60	17.95	2.13
4.5	18.53	17.87	0.66	18.04	2.22
5	18.60	17.95	0.65	18.11	2.29
5.5	18.63	18.00	0.63	18.16	2.34
6	18.65	18.05	0.60	18.20	2.38
6.5	18.68	18.08	0.60	18.23	2.41
7	18.70	18.10	0.60	18.25	2.43
7.5	18.79	18.11	0.68	18.28	2.46
8	18.85	18.13	0.72	18.31	2.49
8.5	18.83	18.15	0.68	18.32	2.50
9	18.83	18.15	0.68	18.32	2.50
9.5	18.87	18.16	0.71	18.34	2.52
10	18.90	18.16	0.74	18.35	2.53
20	19.06	18.13	0.93	18.36	2.54
30	19.98	18.03	1.95	18.52	2.70
40	18.75	18.04	0.71	18.22	2.40
50	18.74	18.61	0.13	18.64	2.82
60	18.65	18.45	0.20	18.50	2.68
70	18.65	18.42	0.23	18.48	2.66
80	18.70	18.38	0.32	18.46	2.64
90	18.72	18.37	0.35	18.46	2.64
100	18.72	18.34	0.38	18.44	2.62
110	18.77	18.33	0.44	18.44	2.62
120	18.79	18.33	0.46	18.45	2.63
150	19.29	19.00	0.29	19.07	3.25
180	19.30	18.95	0.35	19.04	3.22
210	19.34	18.87	0.47	18.99	3.17
240	19.36	18.84	0.52	18.97	3.15

270	19.43	18.81	0.62	18.97	3.15
300	19.17	18.99	0.18	19.04	3.22
330	19.20	18.95	0.25	19.01	3.19
360	19.07	18.95	0.12	18.98	3.16
390	19.05	18.98	0.07	19.00	3.18
420	19.07	18.98	0.09	19.00	3.18
450	20.49	20.41	0.08	20.43	4.61

OBSERVATION WELL N-69

SE1000B
Environmental Logger
09/08 07:52

Unit# 00969 Test# 0

INPUT 1: Level (F) TOC

Reference 100.00
Scale factor 10.01
Offset - 0.02

Step# 0 09/03 12:32

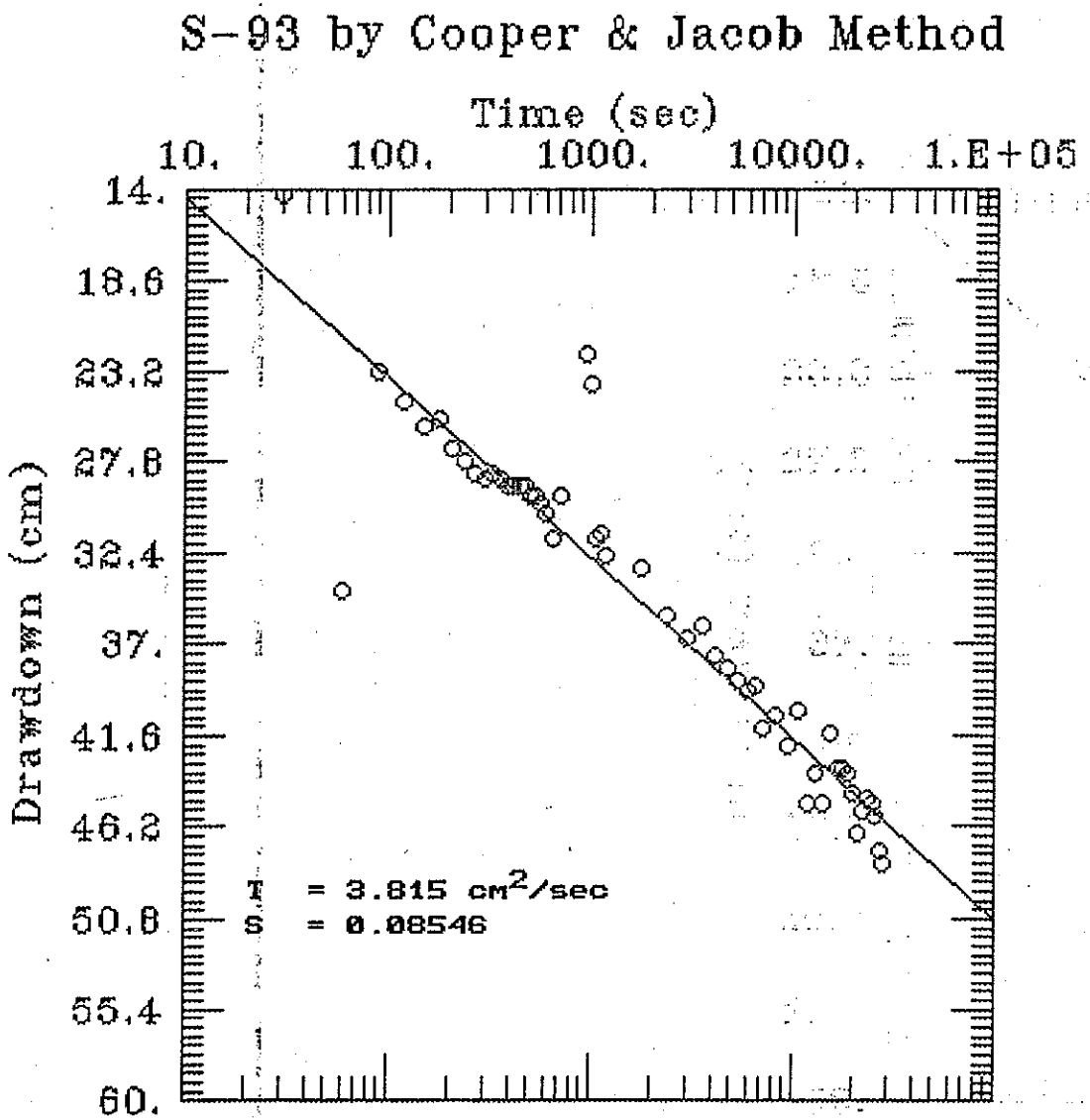
Elapsed Time	Value
0.0000	99.96
0.0033	99.96
0.0066	99.96
0.0099	99.96
0.0133	99.96
0.0166	99.96
0.0200	99.96
0.0233	99.96
0.0266	99.96
0.0300	99.96
0.0333	99.96
0.0500	99.96
0.0666	99.96
0.0833	99.96
0.1000	99.96
0.1166	99.96
0.1333	99.96
0.1500	99.96
0.1666	99.96
0.1833	99.96
0.2000	99.96
0.2166	99.96
0.2333	99.96
0.2500	99.96
0.2666	99.96
0.2833	99.96
0.3000	99.96
0.3166	99.96
0.3333	99.96
0.4167	99.95
0.5000	99.95
0.5833	99.96
0.6667	99.95
0.7500	99.96
0.8333	99.96
0.9167	99.96
1.0000	99.96
1.0833	99.96
1.1667	99.96
1.2500	99.96
1.3333	99.96
1.4166	99.96
1.5000	99.96

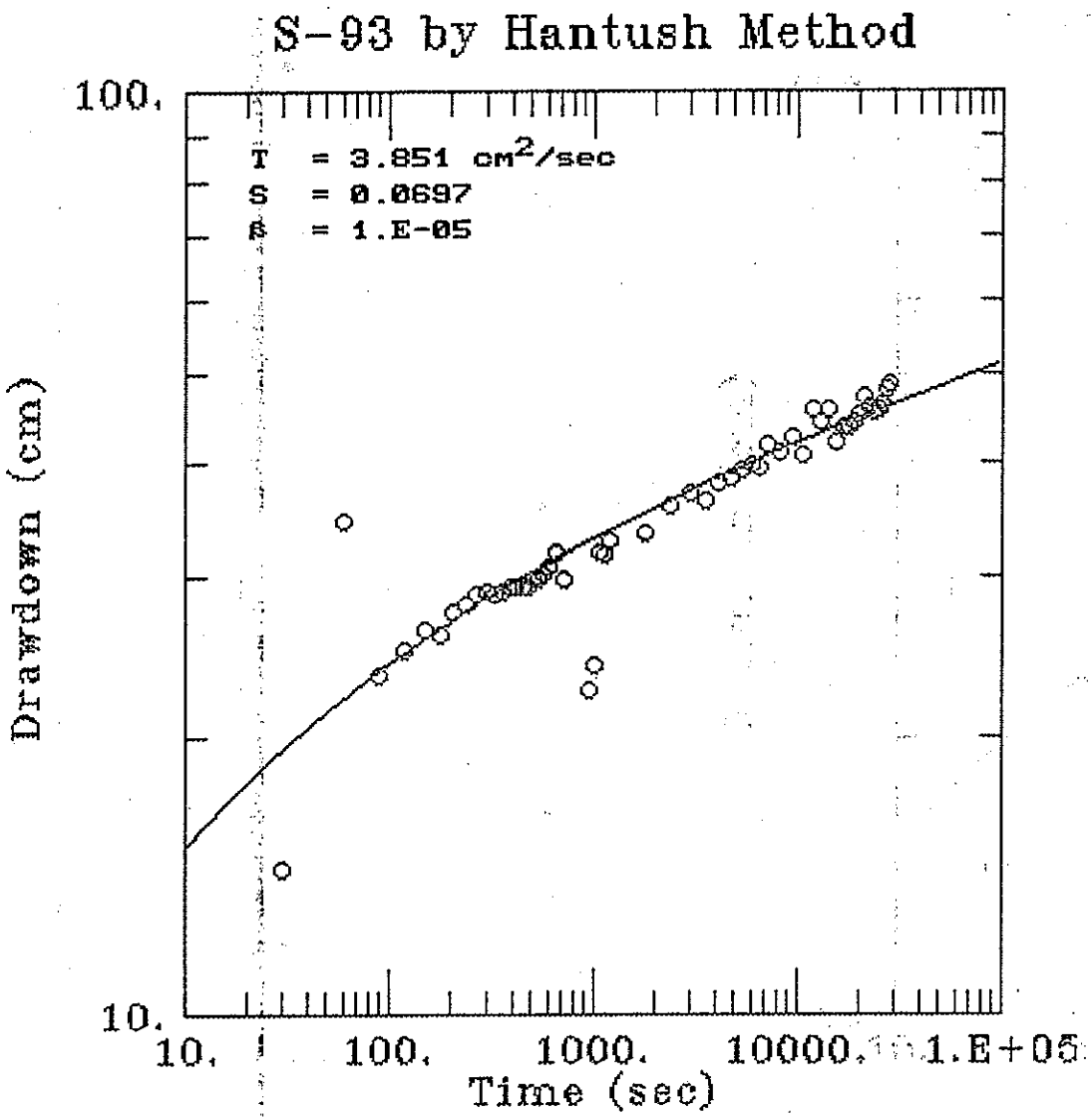
1.5833	99.96
1.6667	99.96
1.7500	99.96
1.8333	99.96
1.9167	99.96
2.0000	99.96
2.5000	99.95
3.0000	99.96
3.5000	99.96
4.0000	99.96
4.5000	99.95
5.0000	99.95
5.5000	99.95
6.0000	99.95
6.5000	99.95
7.0000	99.96
7.5000	99.95
8.0000	99.95
8.5000	99.95
9.0000	99.95
9.5000	99.95
10.0000	99.95
12.0000	99.95
14.0000	99.95
16.0000	99.96
18.0000	99.95
20.0000	99.95
22.0000	99.95
24.0000	99.95
26.0000	99.95
28.0000	99.95
30.0000	99.95
32.0000	99.95
34.0000	99.95
36.0000	99.94
38.0000	99.94
40.0000	99.95
42.0000	99.95
44.0000	99.94
46.0000	99.94
48.0000	99.94
50.0000	99.94
52.0000	99.94
54.0000	99.94
56.0000	99.94
58.0000	99.94
60.0000	99.94
62.0000	99.94
64.0000	99.94
66.0000	99.94
68.0000	99.94
70.0000	99.93
72.0000	99.93
74.0000	99.93
76.0000	99.93
78.0000	99.93
80.0000	99.93
82.0000	99.92
84.0000	99.92
86.0000	99.92

88.0000	99.92
90.0000	99.92
92.0000	99.92
94.0000	99.92
96.0000	99.92
98.0000	99.92
100.000	99.92
110.000	99.92
120.000	99.91
130.000	99.90
140.000	99.90
150.000	99.89
160.000	99.89
170.000	99.88
180.000	99.88
190.000	99.88
200.000	99.88
210.000	99.88
220.000	99.87
~~230.000~~	~~99.87~~
240.000	99.88
250.000	99.87
260.000	99.87
270.000	99.87
280.000	99.87
290.000	99.87
300.000	99.87
310.000	99.86
320.000	99.88
330.000	99.87
340.000	99.87
350.000	99.87
360.000	99.88
370.000	99.88
380.000	99.88
390.000	99.89
400.000	99.89
410.000	99.89
420.000	99.89
430.000	99.89
440.000	99.90
450.000	99.92
460.000	99.93

APPENDIX I

PUMPING TEST DATA - POLLOCK STREET SEWER


S-93 by Cooper & Jacob Method
Time (sec)
10.
100.
1000.
10000.
1.E+05
14.
18.6
23.2
27.8
32.4
37.
41.6
46.2
50.8
55.4
60.
Drawdown (cm)
T = 3.815 cm²/sec
S = 0.08546


S-93 by Hantush Method
T = 3.851 cm²/sec
S = 0.0697
ß = 1.E-05
100.
10.
Drawdown (cm)
10.
100.
1000.
10000.
1.E+05
Time (sec)

POLLOCK STREET SEWER
PUMPING TEST AT S-93
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

S-93

Time (min)	DTW (feet)	DTN (feet)	NT (feet)	ADJ. DTW (feet)	Draw down (feet)
0	20.86	19.58	1.28	19.90	0.00
.5	21.60	19.96	1.64	20.37	0.47
1	21.35	20.94	0.41	21.04	1.14
1.5	21.31	20.45	0.86	20.67	0.77
2	21.44	20.48	0.96	20.72	0.82
2.5	21.52	20.50	1.02	20.76	0.86
3	21.59	20.47	1.12	20.75	0.85
3.5	21.68	20.50	1.18	20.80	0.90
4	21.75	20.51	1.24	20.82	0.92
4.5	21.85	20.50	1.35	20.84	0.94
5	21.89	20.50	1.39	20.85	0.95
5.5	21.90	20.48	1.42	20.84	0.94
6	21.96	20.48	1.48	20.85	0.95
6.5	21.98	20.48	1.50	20.86	0.96
7	22.04	20.47	1.57	20.86	0.96
7.5	22.05	20.46	1.59	20.86	0.96
8	22.10	20.45	1.65	20.86	0.96
8.5	22.16	20.45	1.71	20.88	0.98
9	22.18	20.44	1.74	20.88	0.98
9.5	22.24	20.44	1.80	20.89	0.99
10	22.31	20.44	1.87	20.91	1.01
11	21.90	20.63	1.27	20.95	1.05
12	21.59	20.64	0.95	20.88	0.98
16	21.07	20.50	0.57	20.64	0.74
17	21.07	20.56	0.51	20.69	0.79
18	30.98	20.95	10.03	23.46	3.56
19	21.00	20.92	0.08	20.94	1.04
20	21.03	20.96	0.07	20.98	1.08
30	21.04	20.98	0.06	21.00	1.10
40	21.33	21.00	0.33	21.08	1.18
50	21.47	21.00	0.47	21.12	1.22
60	21.40	21.00	0.40	21.10	1.20
70	21.30	21.10	0.20	21.15	1.25
80	21.30	21.13	0.17	21.17	1.27
90	21.39	21.12	0.27	21.19	1.29
100	21.41	21.14	0.27	21.21	1.31
110	21.27	21.18	0.09	21.20	1.30
120	21.80	21.09	0.71	21.27	1.37
140	21.38	21.21	0.17	21.25	1.35
160	21.65	21.18	0.47	21.30	1.40
180	21.32	21.21	0.11	21.24	1.34
200	21.98	21.20	0.78	21.40	1.50

220	21.42	21.32	0.10	21.35	1.45
240	21.92	21.22	0.70	21.40	1.50
260	21.51	21.20	0.31	21.28	1.38
280	21.71	21.21	0.50	21.34	1.44
300	21.44	21.31	0.13	21.34	1.44
320	21.45	21.31	0.14	21.35	1.45
340	21.51	21.34	0.17	21.38	1.48
360	21.51	21.43	0.08	21.45	1.55
380	21.54	21.36	0.18	21.41	1.51
400	21.51	21.35	0.16	21.39	1.49
420	21.48	21.37	0.11	21.40	1.50
440	21.52	21.39	0.13	21.42	1.52
460	21.55	21.45	0.10	21.48	1.58
480	21.65	21.45	0.20	21.50	1.60

SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY
POLLOCK STREET SEWER
Pumping Test

S-62

Time (min)	DTW (feet)	DTP (feet)	NT (feet)	ADJ. DTW (feet)	Draw down (feet)
0	18.15	18.14	0.01	18.14	0.00
20	18.14	18.13	0.01	18.13	-0.01
30	18.14	18.13	0.01	18.13	-0.01
50	18.13	18.12	0.01	18.12	-0.02
70	18.12	18.12	0.00	18.12	-0.02
90	18.13	18.13	0.00	18.13	-0.01
110	18.12	18.12	0.00	18.12	-0.02
120	18.12	18.12	0.00	18.12	-0.02
200	18.11	18.11	0.00	18.11	-0.03
240	18.11	18.11	0.00	18.11	-0.03
320	18.11	18.11	0.00	18.11	-0.03
360	18.11	18.11	0.00	18.11	-0.03
400	18.12	18.12	0.00	18.12	-0.02
440	18.11	18.11	0.00	18.11	-0.03
480	18.11	18.11	0.00	18.11	-0.03

SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY
POLLOCK STREET SEWER
Pumping Test

S-63

Time (min)	DTW (feet)	DTP (feet)	NT (feet)	ADJ. DTW (feet)	Draw down (feet)
0	19.50	18.16	1.34	18.50	0.00
20	19.50	18.15	1.35	18.49	-0.01
30	19.47	18.15	1.32	18.48	-0.02
50	19.51	18.16	1.35	18.50	0.00
70	19.45	18.16	1.29	18.48	-0.02
90	18.51	18.17	0.34	18.26	-0.24
110	18.51	18.16	0.35	18.25	-0.25
120	18.53	18.17	0.36	18.26	-0.24
200	18.55	18.18	0.37	18.27	-0.23
220	18.55	18.18	0.37	18.27	-0.23
240	18.58	18.19	0.39	18.29	-0.21
280	18.59	18.19	0.40	18.29	-0.21
320	18.59	18.20	0.39	18.30	-0.20
360	18.63	18.20	0.43	18.31	-0.19
400	18.63	18.20	0.43	18.31	-0.19
440	18.64	18.22	0.42	18.33	-0.18
480	18.65	18.23	0.42	18.34	-0.16

SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY
POLLOCK STREET SEWER
Pumping Test

S-64

Time (min)	DTW (feet)	DTP (feet)	NT (feet)	ADJ. DTW (feet)	Draw down (feet)
0	9.64	8.18	1.46	8.55	-0.01
40	9.76	8.20	1.56	8.59	0.04
60	9.77	8.20	1.57	8.59	0.04
80	9.76	8.20	1.56	8.59	0.04
90	9.76	8.19	1.57	8.58	0.03
120	9.70	8.18	1.52	8.56	0.01
200	9.74	8.18	1.56	8.57	0.02
220	9.70	8.16	1.54	8.55	-0.01
240	9.69	8.17	1.52	8.55	0.00
280	9.70	8.16	1.54	8.55	-0.01
320	9.67	8.19	1.48	8.56	0.01
360	9.65	8.13	1.52	8.51	-0.04
400	9.63	8.13	1.50	8.51	-0.04
440	9.61	8.13	1.48	8.50	-0.05
480	9.62	8.13	1.49	8.50	-0.05

SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY
POLLOCK STREET SEWER
Pumping Test

S-65

Time (min)	DTW (feet)	DTP (feet)	NT (feet)	ADJ. DTW (feet)	Draw down (feet)
0	13.78	13.60	0.18	13.65	0.00
40	14.26	14.04	0.22	14.10	0.44
60	14.37	14.14	0.23	14.20	0.55
80	14.37	14.13	0.24	14.19	0.54
100	14.20	14.03	0.17	14.07	0.42
120	14.09	13.88	0.21	13.93	0.28
200	14.15	13.98	0.17	14.02	0.37
220	11.74	11.65	0.09	11.67	-1.98
240	11.25	11.15	0.10	11.18	-2.48
280	10.67	10.59	0.08	10.61	-3.04
320	10.01	9.95	0.06	9.97	-3.69
360	9.71	9.65	0.06	9.67	-3.99
400	9.46	9.43	0.03	9.44	-4.21
440	9.83	9.76	0.07	9.78	-3.87
480	10.18	10.03	0.15	10.07	-3.58

APPENDIX J

DRILL LOGS - 26TH STREET SEWER

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company., Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number S-90 Total Depth 50 ft. Diameter 14 in.

Casing Elevation 27.81 ft. Water Level: Initial 18.12 Static N/A

Screen Dia. 6 in. Length 35 ft. Slot Size 0.02

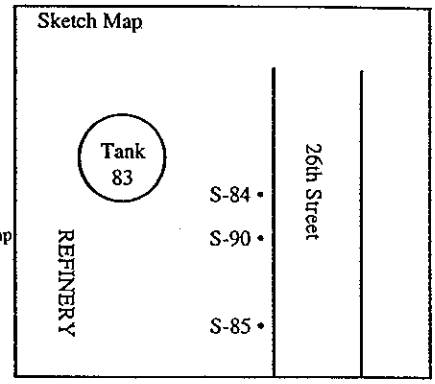
Casing Dia. 6 in. Length 17 ft. Type Galvanized wire wrap

Drilling Method Hollow-stem Auger Sample Method Split-spoon

Completion Details Three foot high steel riser stick-up.

Driller B.L. Myers Bros. Log By E. Dziedzic Date 1 July 1993

Sketch Map



Depth (feet)	Sample No.	Well Const.	OVA (ppm)	Initial Water Depth	Lithology
0	N/A		154		FILL - Dark brown sandy fill with some brick, odor.
5					
			52		GRAVEL - Black gravel, odor, sticky product, moist.
10					
15			230		- Gravel, saturated with product, black.
				▽	
20			576		
25			1183		PEBBLES/COBBLES
30					

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company., Inc.

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number S-90 Total Depth 50 ft. Diameter 14 in.

Casing Elevation 27.81 ft. Water Level: Initial 18.12 Static N/A

Screen Dia. 6 in. Length 35 ft. Slot Size 0.02

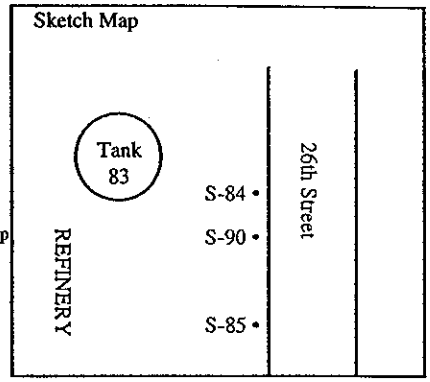
Casing Dia. 6 in. Length 17 ft. Type Galvanized wire wrap

Drilling Method Hollow-stem Auger Sample Method Split-spoon

Completion Details Three foot steel riser stick-up.

Driller B.L. Myers Bros. Log By E. Dziedzic Date 1 July 1993

Sketch Map



Depth (feet)	Sample No.	Well Const.	OVA (ppm)	Initial Water Depth	Lithology
30	N/A				PEBBLES/COBBLES
			1060		SAND - Black coarse sand and gravel, saturated, slight odor.
			27		SILT - Brown sandy silt, wet, slight odor.
35					
40			0		CLAY - Tan silty clay, moist, no odor.
45					
50					COMPLETED BORING AT 50 FEET.

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company., Inc. (R&M)

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number S-94 Total Depth 50 ft. Diameter 10 in.

Casing Elevation N/A Water Level: Initial 22.5 ft. Static N/A

Screen Dia. 6 in. Length 35 ft. Slot Size N/A

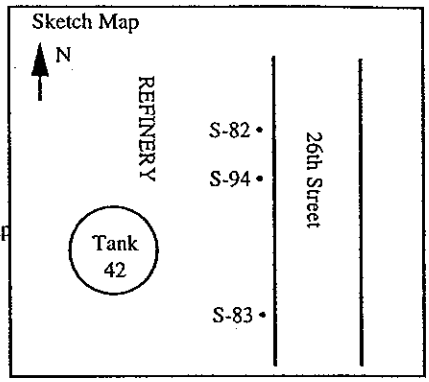
Casing Dia. 6 in. Length 16 ft. Type Galvanized wire wrap

Drilling Method Mud Rotary Sample Method Split-spoon

Completion Details One foot steel stick-up riser.

Driller Summit Drilling Co. Log By M. Haslett Date 9 September 1993

Sketch Map



Depth (feet)	Blow Count	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
					LIMESTONE BALLAST - Silty clay.
	4,2,3,4				
5			1403		CLAY - Silty clay, moist, stained.
					- Silty clay with angular stone fragments, stained, wet.
	6,11, 12,16		3		
			7		- Brown, thick clay, some silt, no odor.
10					- Dark gray, thick clay, odor.
	13,16, 18,24				- Light gray clay, some sand, wet, no odor.
15					
	7,10, 30,54				SAND - Light gray, silty fine sand, some medium gravel, moist odor.
20			119		
	52,50,-,-		711		GRAVEL - Gravel, coarse sand, some silt.
25			200		COBBLES - Heavy cobbles, odor.
30	50,-,-,-				

Groundwater & Environmental Services, Inc.

Drilling Log

Project Sun Philadelphia Refinery Owner Sun Company., Inc. (R&M)

Location 3144 Passyunk Ave., Phila. Permit No. N/A

Boring number S-94 Total Depth 50 ft. Diameter 10 in.

Casing Elevation N/A Water Level: Initial 22.5 ft. Static N/A

Screen Dia. 6 in. Length 35 ft. Slot Size N/A

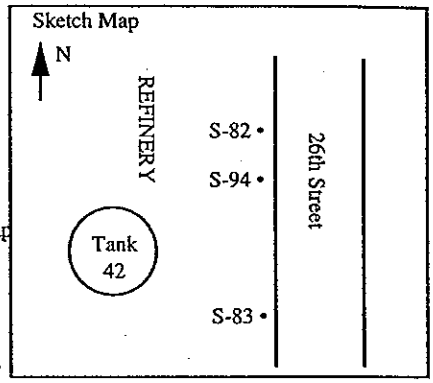
Casing Dia. 6 in. Length 16 ft. Type Galvanized wire wrap

Drilling Method Mud Rotary Sample Method Split-spoon

Completion Details One foot steel stick-up riser.

Driller Summit Drilling Co. Log By M. Haslett Date 9 September 1993

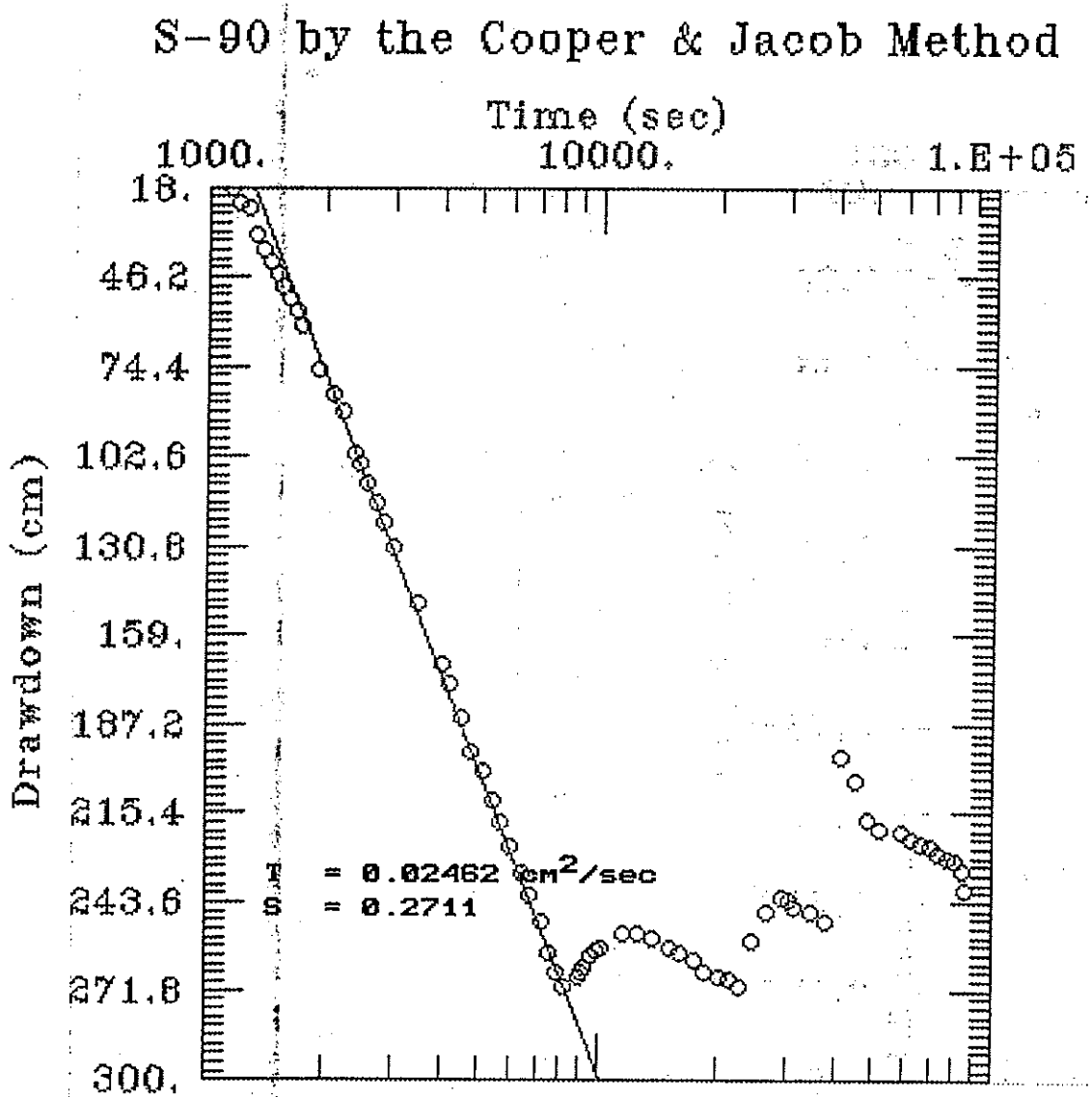
Sketch Map

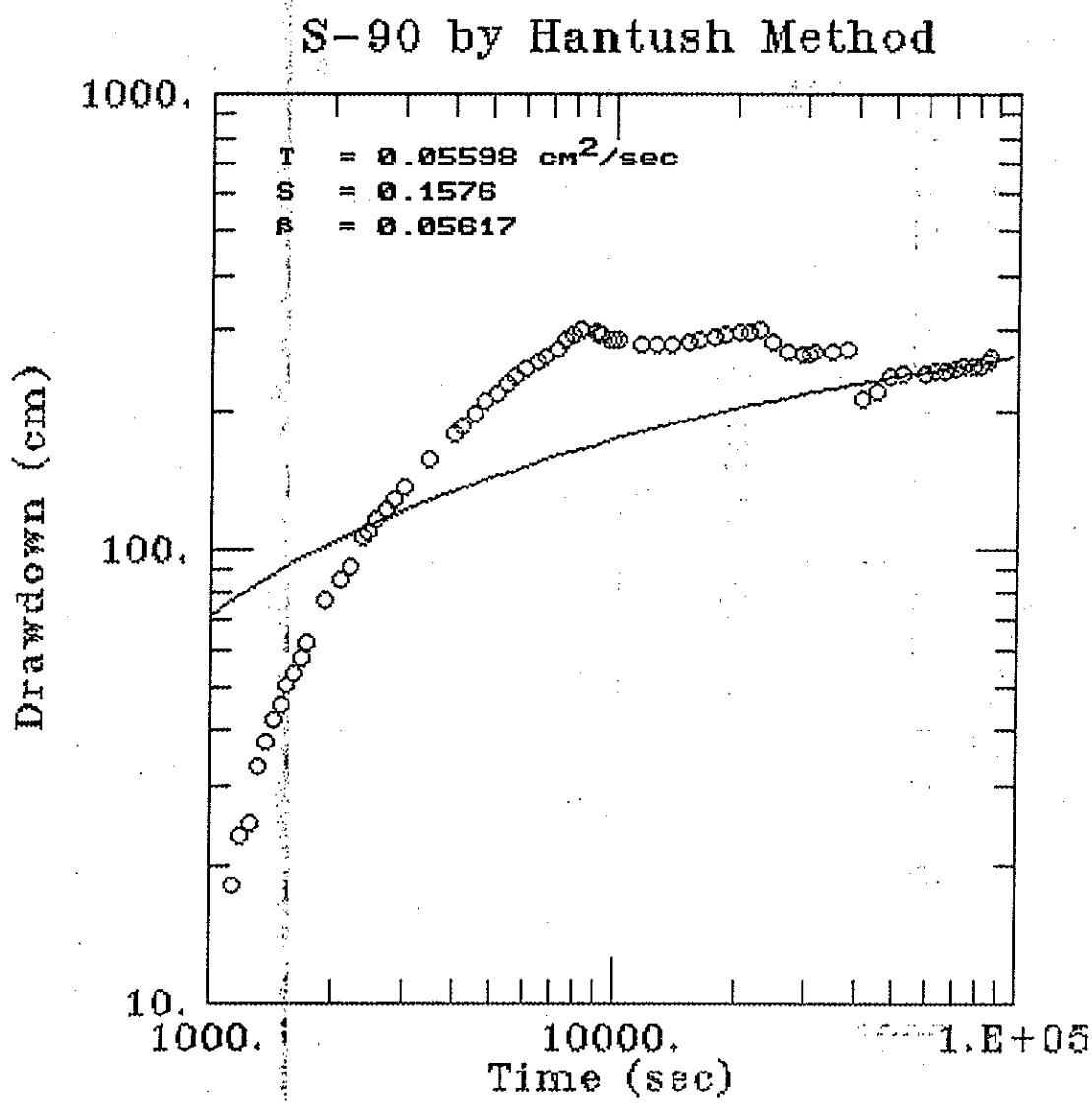


Depth (feet)	Blow Count	Well Const.	OVM (ppm)	Initial Water Depth	Lithology
30	N/A				COBBLES
			320		SAND - Medium sand, brown, moist.
35	15,26, 13,10		27		CLAY - Brown silty clay, moist, some fine sand, odor.
	7,14, 16,33				- Red/Orange silty clay, odor, moist.
40					SAND - Dark mauve sand, some silty clay, wet, strong odor.
	10,16, 16,25				CLAY - Dark mauve silty clay, moist, slight odor, some mica, black and fine sand.
45					
	7,12, 26,55				- Dark mauve clay, some silt, slight odor, moist.
50					COMPLETED BORING AT 50 FEET.

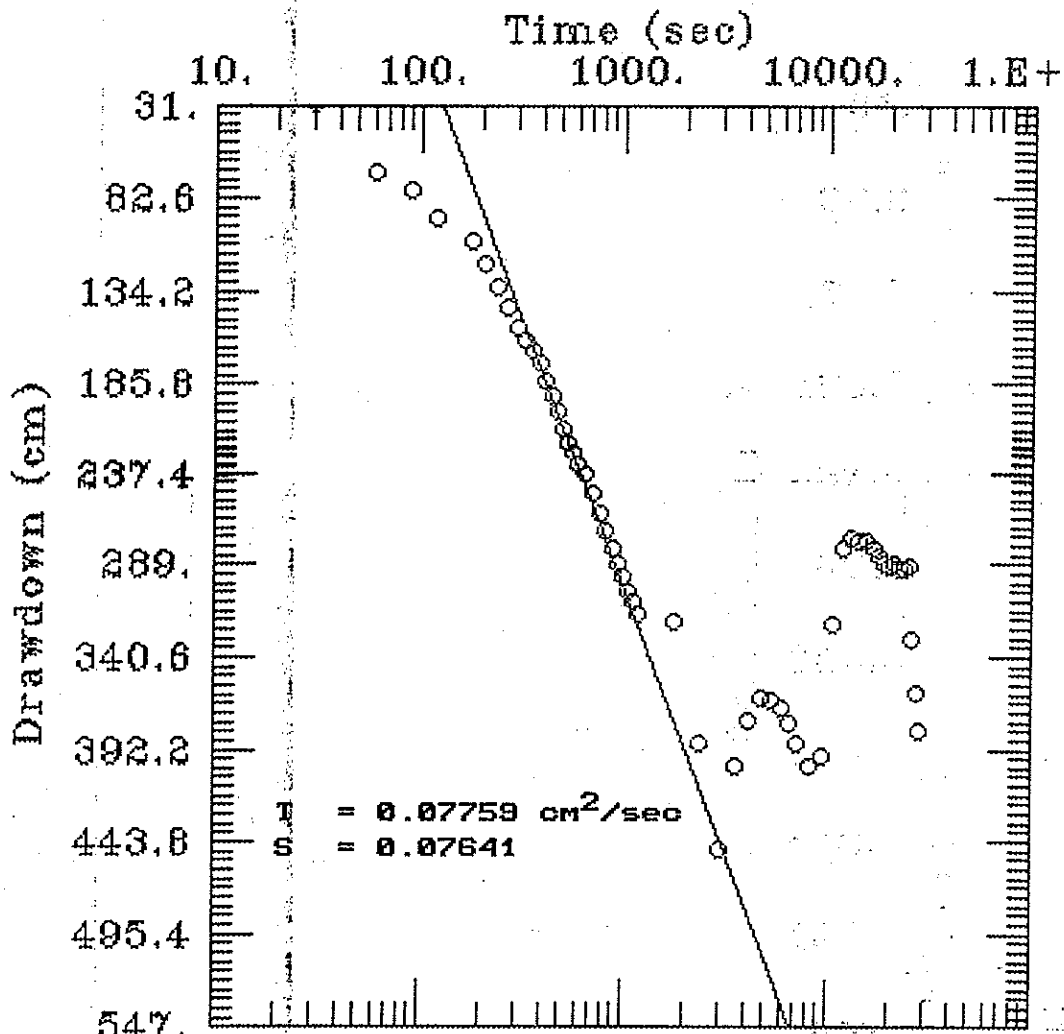
APPENDIX K

PUMPING TEST DATA - 26TH STREET SEWER

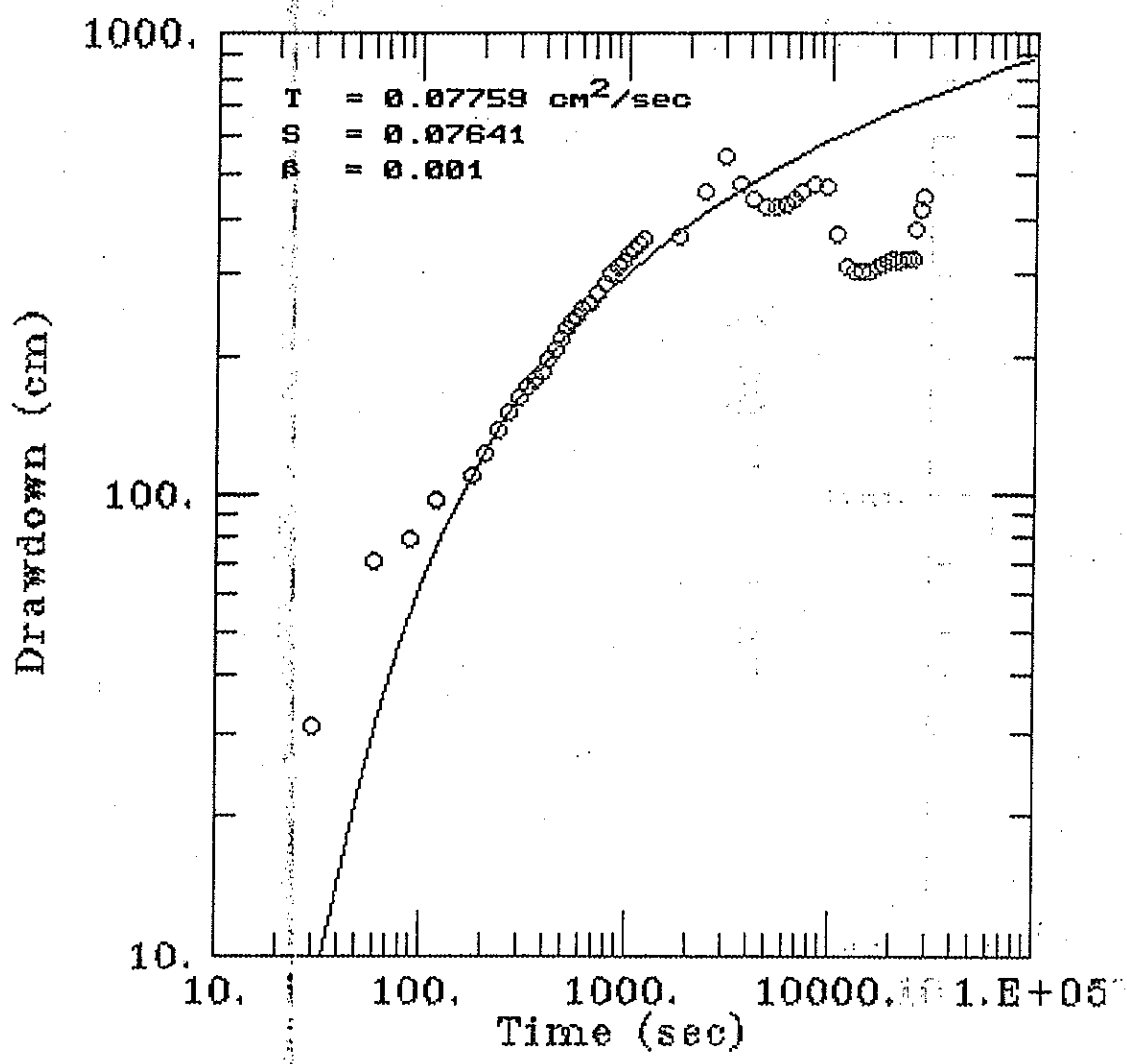

S-90 by the Cooper & Jacob Method
Time (sec)
1000.
10000.
1.E+05
Drawdown (cm)
18.
46.2
74.4
102.6
130.8
159.
187.2
215.4
243.6
271.8
300.
T = 0.02462 cm²/sec
S = 0.2711

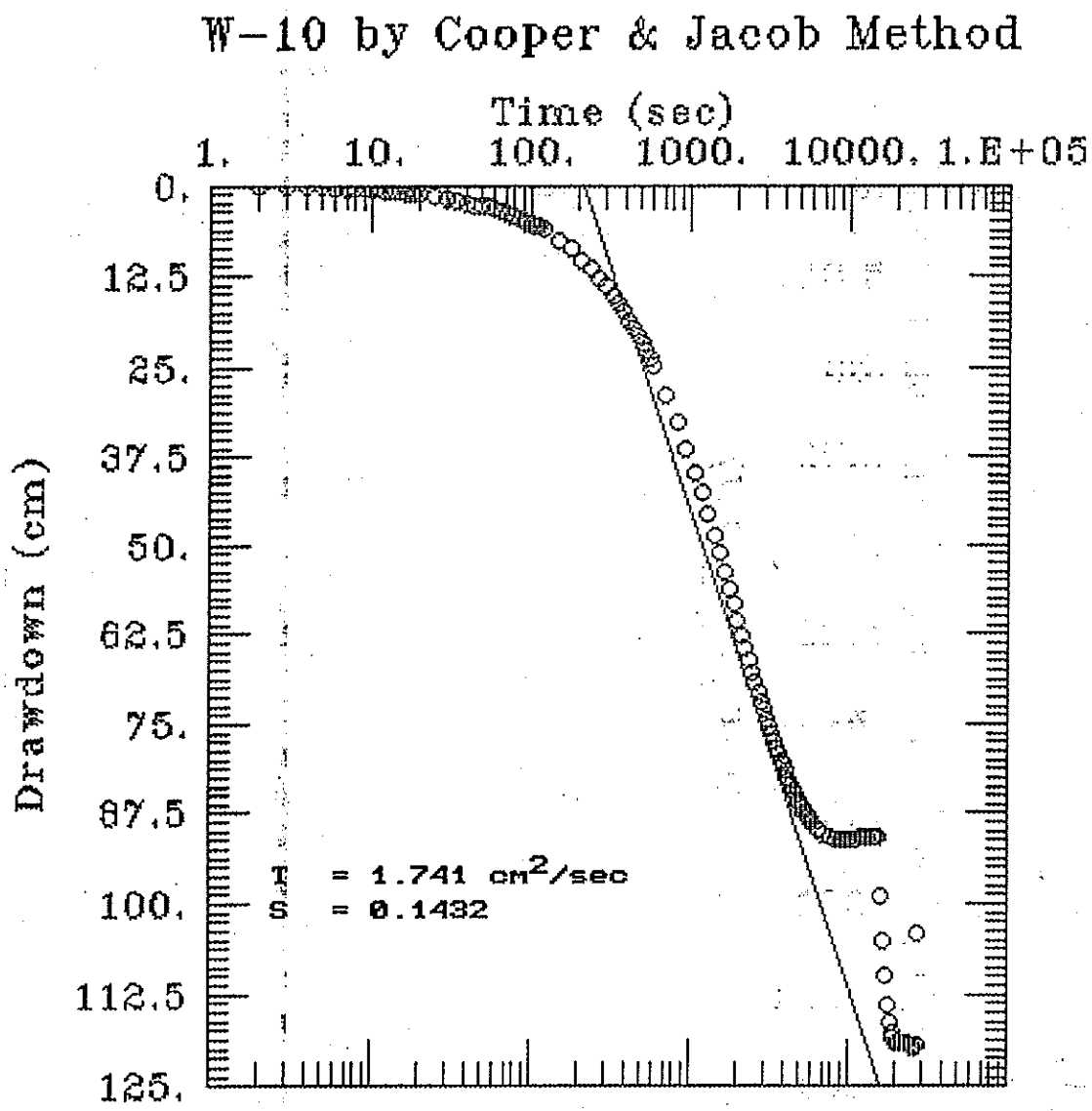

S-90 by Hantush Method
T = 0.05598 cm²/sec
S = 0.1576
r/B = 0.05617
1000.
100.
10.
Drawdown (cm)
1000.
10000.
1.E+05
Time (sec)

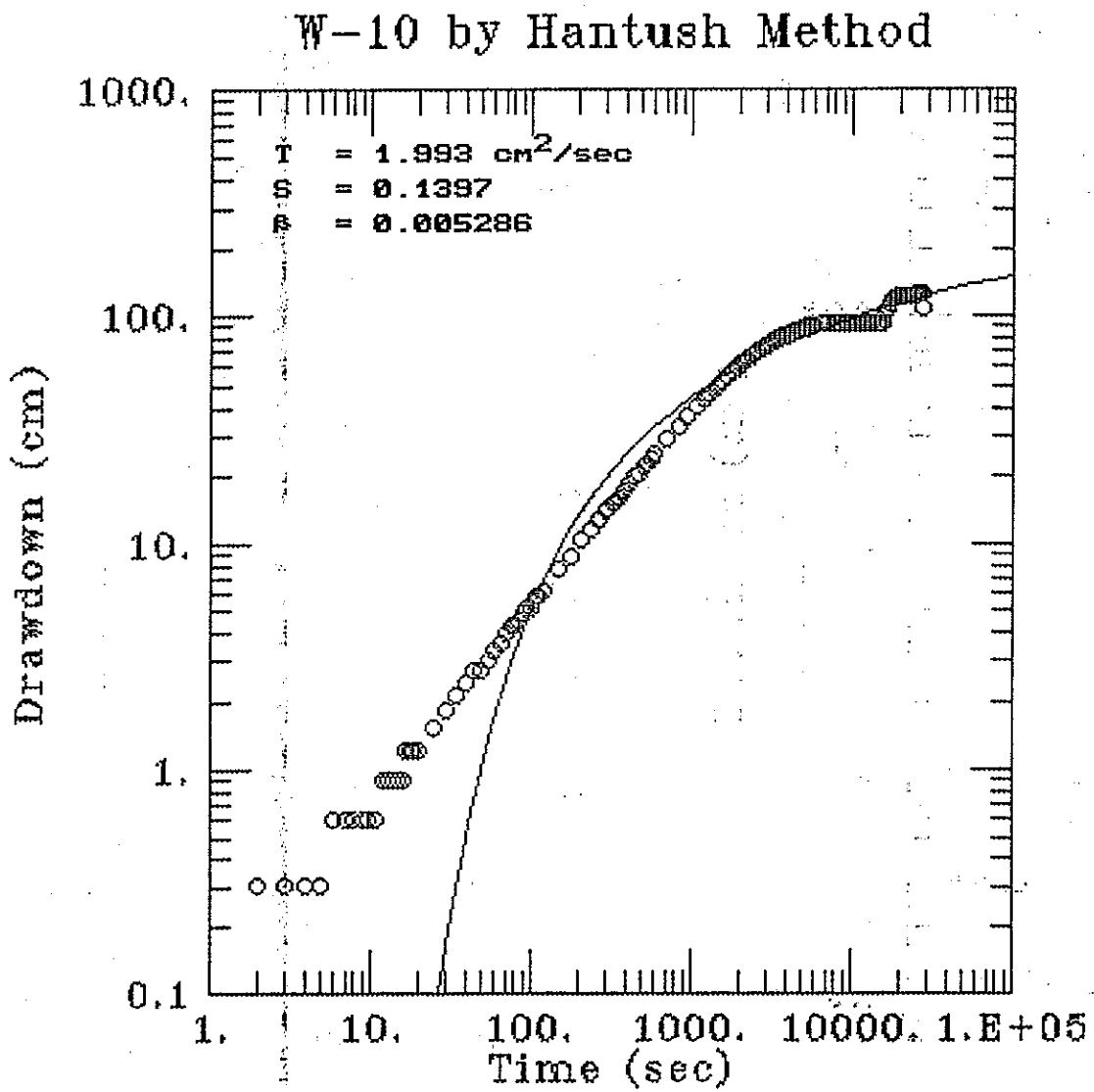
S-94 Analysis by Cooper & Jacob Method



S-94 Analysis by Hantush Method




W-10 by Cooper & Jacob Method
Time (sec)
1.
10.
100.
1000.
10000.
1.E+05
0.
12.5
25.
37.5
50.
62.5
75.
87.5
100.
112.5
125.
Drawdown (cm)
T = 1.741 cm²/sec
S = 0.1432


W-10 by Hantush Method
T = 1.993 cm²/sec
S = 0.1397
β = 0.005286
1000.
100.
10.
1.
0.1
Drawdown (cm)
1.
10.
100.
1000.
10000.
1.E+05
Time (sec)

26TH STREET SEWER
PUMPING TEST AT S-90
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Observation Well: S-82

TIME (min.)	DTN (ft)	DTW (ft)	NT (ft)	ADJ. DTW (ft)	DRAWDOWN (ft)
0	23.15	23.42	0.27	23.19	0.00
175	23.07	23.31	0.24	23.11	-0.08
235	23.04	23.28	0.24	23.08	-0.11
295	23.02	23.26	0.24	23.06	-0.13
355	23.00	23.24	0.24	23.04	-0.15
415	22.99	23.20	0.21	23.02	-0.17
505	22.97	23.20	0.23	23.01	-0.19
690	22.95	23.17	0.22	22.99	-0.21
750	22.95	23.17	0.22	22.99	-0.21
810	22.95	23.17	0.22	22.99	-0.21
870	22.95	23.17	0.22	22.99	-0.21
930	22.95	23.17	0.22	22.99	-0.21
990	22.91	23.16	0.25	22.95	-0.24
1050	22.92	23.15	0.23	22.96	-0.24
1110	22.93	23.14	0.21	22.96	-0.23
1170	22.92	23.15	0.23	22.96	-0.24
1230	22.92	23.14	0.22	22.96	-0.24
1290	22.91	23.12	0.21	22.94	-0.25
1350	22.92	23.12	0.20	22.95	-0.24
1410	22.92	23.13	0.21	22.95	-0.24
1470	22.92	23.12	0.20	22.95	-0.24

26TH STREET SEWER
PUMPING TEST AT S-90
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Observation Well: S-83

TIME (min.)	DTN (ft)	DTW (ft)	NT (ft)	ADJ. DTW (ft)	DRAWDOWN (ft)
0	19.26	20.00	0.74	19.38	0.00
60	19.26	19.94	0.68	19.37	-0.01
105	19.25	19.93	0.68	19.36	-0.02
130	19.25	19.92	0.67	19.36	-0.02
175	19.24	19.90	0.66	19.35	-0.03
235	19.21	19.85	0.64	19.31	-0.07
295	19.20	19.87	0.67	19.31	-0.07
355	19.20	19.87	0.67	19.31	-0.07
415	19.20	19.86	0.66	19.31	-0.07
505	19.20	19.85	0.65	19.30	-0.07
565	19.22	19.87	0.65	19.32	-0.05
625	19.21	19.89	0.68	19.32	-0.06
690	19.23	19.87	0.64	19.33	-0.05
750	19.23	19.87	0.64	19.33	-0.05
810	19.22	19.87	0.65	19.32	-0.05
870	19.20	19.85	0.65	19.30	-0.07
930	19.19	19.89	0.70	19.30	-0.08
990	19.18	19.83	0.65	19.28	-0.09
1050	19.18	19.83	0.65	19.28	-0.09
1110	19.18	19.84	0.66	19.29	-0.09
1170	19.19	19.83	0.64	19.29	-0.09
1230	19.19	19.85	0.66	19.30	-0.08
1290	19.20	19.86	0.66	19.31	-0.07
1350	19.21	19.87	0.66	19.32	-0.06
1410	19.21	19.87	0.66	19.32	-0.06
1470	19.21	19.84	0.63	19.31	-0.07

26TH STREET SEWER
PUMPING TEST AT S-90
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Observation Well: S-84

TIME (min.)	DTW (ft)	DTN (ft)	NT (ft)	ADJ. DTW (ft)	DRAWDOWN (ft)
0	15.9	15.74	0.16	15.78	0
105	15.77	15.66	0.11	15.69	-0.09
130	15.77	15.66	0.11	15.69	-0.09
175	16.14	16	0.14	16.04	0.26
215	16.12	15.97	0.15	16.01	0.23
235	16.2	16.05	0.15	16.09	0.31
270	16.2	16.05	0.15	16.09	0.31
295	16.1	16.05	0.05	16.06	0.28
355	16.32	16.1	0.22	16.16	0.38
415	16.3	16.15	0.15	16.19	0.41
505	16.4	16.22	0.18	16.27	0.49
565	16.4	16.26	0.14	16.3	0.52
625	16.42	16.28	0.14	16.32	0.54
690	16.43	16.25	0.18	16.3	0.52
750	16.35	16.32	0.03	16.33	0.55
810	16.42	16.34	0.08	16.36	0.58
870	16.45	16.3	0.15	16.34	0.56
930	16.33	16.2	0.13	16.23	0.45
990	16.24	16.1	0.14	16.14	0.36
1050	16.24	16.08	0.16	16.12	0.34
1110	16.24	16.06	0.18	16.11	0.33
1170	16.25	16.1	0.15	16.14	0.36
1230	16.29	16.13	0.16	16.17	0.39
1290	16.32	16.14	0.18	16.19	0.41
1350	16.32	16.15	0.17	16.19	0:41
1410	16.31	16.14	0.17	16.18	0.4
1455	16.3	16.13	0.17	16.17	0.39

26TH STREET SEWER
PUMPING TEST AT S-90
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Observation Well: S-85

TIME (min.)	DTW (ft)	DTN (ft)	NT (ft)	ADJ. DTW (ft)	DRAWDOWN (ft)
0	24.35	23.17	1.18	23.36	0.00
30	24.22	23.26	0.96	23.41	-0.05
37	24.23	23.17	1.06	23.34	-0.13
50	24.23	23.16	1.07	23.33	-0.13
60	24.16	23.16	1.00	23.32	-0.15
75	24.21	23.16	1.05	23.33	-0.14
105	24.17	23.15	1.02	23.31	-0.15
130	24.16	23.15	1.01	23.31	-0.15
175	24.16	23.14	1.02	23.30	-0.16
235	24.15	23.13	1.02	23.29	-0.17
255	24.14	23.11	1.03	23.27	-0.19
290	24.16	23.11	1.05	23.28	-0.19
315	24.15	23.10	1.05	23.27	-0.20
375	24.13	23.10	1.03	23.26	-0.20
415	24.12	23.12	1.00	23.28	-0.18
505	24.11	23.13	0.98	23.29	-0.18
690	24.19	23.17	1.02	23.33	-0.13
750	24.18	23.15	1.03	23.31	-0.15
810	24.20	23.17	1.03	23.33	-0.13
870	24.18	23.15	1.03	23.31	-0.15
930	24.16	23.13	1.03	23.29	-0.17
990	24.14	23.11	1.03	23.27	-0.19
1050	24.14	23.11	1.03	23.27	-0.19
1110	24.14	23.11	1.03	23.27	-0.19
1170	24.14	23.14	1.00	23.30	-0.16
1230	24.14	23.14	1.00	23.30	-0.16
1290	24.17	23.14	1.03	23.30	-0.16
1350	24.15	23.15	1.00	23.31	-0.16
1410	24.15	23.16	0.99	23.32	-0.15
1470	24.15	23.16	0.99	23.32	-0.15

26TH STREET SEWER
PUMPING TEST AT S-90
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Observation Well: S-86

TIME (min.)	DTW (ft)	DRAWDOWN (ft)
0	26.28	0.00
105	26.28	0.00
130	26.28	0.00
175	26.27	-0.01
235	26.25	-0.03
295	26.22	-0.06
355	26.24	-0.04
415	26.24	-0.04
5.5	26.25	-0.03
565	26.25	-0.03
625	26.26	-0.02
690	26.31	0.03
750	26.35	0.07
810	26.34	0.06
870	26.33	0.05
930	26.33	0.05
990	26.30	0.02
1050	26.28	0.00
1110	26.27	-0.01
1170	26.26	-0.02
1230	26.30	0.02
1290	26.31	0.03
1350	26.31	0.03
1410	26.32	0.04
1470	26.33	0.05
1515	26.33	0.05

26TH STREET SEWER
PUMPING TEST AT S-90
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Observation Well: S-87

TIME (min.)	DTW (ft)	DRAWDOWN (ft)
0	25.36	0.00
105	25.40	0.04
130	25.40	0.04
175	25.43	0.07
235	25.43	0.07
295	25.45	0.09
355	25.43	0.07
415	25.43	0.07
5.5	25.38	0.02
565	25.35	-0.01
625	25.33	-0.03
690	25.33	-0.03
750	25.33	-0.03
810	25.35	-0.01
870	25.35	-0.01
930	25.35	-0.01
990	25.36	0.00
1050	25.38	0.02
1110	25.40	0.04
1170	25.42	0.06
1230	25.41	0.05
1290	25.40	0.04
1350	25.40	0.04
1410	25.38	0.02
1470	25.36	0.00
1515	25.35	-0.01

26TH STREET SEWER
PUMPING TEST AT S-90
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Observation Well: S-88

TIME (min.)	DTW (ft)	DRAWDOWN (ft)
0	26.30	0.00
37	26.30	0.00
60	26.30	0.00
80	26.30	0.00
105	26.28	-0.02
130	26.28	-0.02
175	26.26	-0.04
235	26.24	-0.06
295	26.23	-0.07
355	26.25	-0.05
415	26.25	-0.05
5.5	26.26	-0.04
565	26.27	-0.03
625	26.28	-0.02
690	26.29	-0.01
750	26.25	-0.05
810	26.29	-0.01
870	26.27	-0.03
930	26.27	-0.03
990	26.26	-0.04
1050	26.25	-0.05
1110	26.25	-0.05
1170	26.24	-0.06
1230	26.27	-0.03
1290	26.28	-0.02
1350	26.29	-0.01
1410	26.30	0.00
1470	26.30	0.00
1515	26.30	0.00

26TH STREET SEWER
PUMPING TEST AT S-90
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Observation Well: S-89

TIME (min.)	DTN (ft)	DTW (ft)	NT (ft)	ADJ. DTW (ft)	DRAWDOWN (ft)
0	25.65	26.69	1.04	25.82	0.00
235	25.60	26.47	0.87	25.74	-0.08
255	25.60	26.46	0.86	25.74	-0.08
290	25.61	26.48	0.87	25.75	-0.07
315	25.62	26.45	0.83	25.75	-0.06
375	25.60	26.47	0.87	25.74	-0.08
415	25.65	26.51	0.86	25.79	-0.03
505	25.65	26.51	0.86	25.79	-0.03
690	25.66	26.52	0.86	25.80	-0.02
750	25.66	26.52	0.86	25.80	-0.02
810	25.64	26.50	0.86	25.78	-0.04
870	25.62	26.48	0.86	25.76	-0.06
930	25.61	26.47	0.86	25.75	-0.07
990	25.60	26.45	0.85	25.74	-0.08
1050	25.60	26.45	0.85	25.74	-0.08
1110	25.60	26.42	0.82	25.73	-0.09
1170	25.64	26.47	0.83	25.77	-0.04
1230	25.64	26.43	0.79	25.77	-0.05
1290	25.65	26.45	0.80	25.78	-0.04
1350	25.65	26.50	0.85	25.79	-0.03
1410	25.66	26.50	0.84	25.79	-0.02
1470	25.66	26.48	0.82	25.79	-0.03

26TH STREET SEWER
PUMPING TEST AT S-94
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

S-94

Time (min)	DTW (feet)	Draw down (feet)
0	21.18	0.00
.5	22.20	1.02
1	23.05	1.87
1.5	23.80	2.62
2	24.35	3.17
2.5	24.80	3.62
3	25.25	4.07
3.5	25.73	4.55
4	26.14	4.96
4.5	26.51	5.33
5	26.78	5.60
5.5	27.02	5.84
6	27.26	6.08
6.5	27.64	6.46
7	27.98	6.80
7.5	28.28	7.10
8	28.65	7.47
8.5	28.96	7.78
9	29.20	8.02
9.5	29.46	8.28
10	29.69	8.51
11	30.13	8.95
12	30.59	9.41
13	31.03	9.85
14	31.39	10.21
15	31.76	10.58
16	32.08	10.90
17	32.41	11.23
18	32.67	11.49
19	32.93	11.75
20	33.11	11.93
30	36.18	15.00
40	39.11	17.93
50	36.75	15.57
60	35.60	14.42
70	35.01	13.83
80	35.01	13.83
90	35.06	13.88
100	35.30	14.12
110	35.64	14.46
120	36.21	15.03
140	36.75	15.57

160	36.51	15.33
180	33.23	12.05
200	31.40	10.22
220	31.18	10.00
240	31.26	10.08
260	31.24	10.06
280	31.40	10.22
300	31.58	10.40
320	31.75	10.57
340	31.81	10.63
360	31.78	10.60
380	31.88	10.70
400	31.86	10.68
420	31.80	10.62
440	33.57	12.39
460	34.90	13.72
480	35.84	14.66

26TH STREET SEWER
PUMPING TEST AT S-94
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

S-79

Time (min)	DTW (feet)	Draw down (feet)
0	24.94	0.00
20.00	23.97	-0.97
40.00	23.98	-0.96
70.00	23.99	-0.95
90.00	24.02	-0.92
110.00	24.04	-0.90
160.00	24.04	-0.90
180.00	24.03	-0.91
200.00	24.03	-0.91
240.00	24.01	-0.93
280.00	24.00	-0.94
320.00	23.99	-0.95
360.00	23.98	-0.96
400.00	23.97	-0.97
440.00	23.97	-0.97
480.00	23.97	-0.97

26th STREET SEWER
PUMPING TEST AT S-94
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Observation Well: S-81

Time (min)	DTW (feet)	Draw down (feet)
0	23.50	0.00
20.00	23.49	-0.01
70.00	23.48	-0.02
90.00	23.48	-0.02
110.00	23.47	-0.03
160.00	23.46	-0.04
180.00	23.46	-0.04
200.00	23.45	-0.05
240.00	23.44	-0.06
280.00	23.43	-0.07
320.00	23.42	-0.08
360.00	23.43	-0.07
400.00	23.42	-0.08
440.00	23.42	-0.08
480.00	23.43	-0.07

26TH STREET SEWER
PUMPING TEST AT S-94
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Observation Well: S-82

Time (min)	DTW (feet)	DTN (feet)		NT (feet)	ADJ. DTW (feet)	Draw down (feet)
0	23.42	23.20		0.22	23.26	0.00
4	23.42	23.19		0.23	23.25	-0.01
4.5	23.42	23.19		0.23	23.25	-0.01
5	23.42	23.19		0.23	23.25	-0.01
5.5	23.42	23.19		0.23	23.25	-0.01
6	23.42	23.19		0.23	23.25	-0.01
6.5	23.42	23.19		0.23	23.25	-0.01
7	23.42	23.19		0.23	23.25	-0.01
7.5	23.42	23.19		0.23	23.25	-0.01
8	23.42	23.19		0.23	23.25	-0.01
8.5	23.42	23.19		0.23	23.25	-0.01
9	23.42	23.19		0.23	23.25	-0.01
10	23.42	23.19		0.23	23.25	-0.01
15	23.42	23.19		0.23	23.25	-0.01
16	0.00	0.00		0.00	0.00	-23.26
17	0.00	0.00		0.00	0.00	-23.26
18	23.42	23.19		0.23	23.25	-0.01
30	23.42	23.19		0.23	23.25	-0.01
40	23.42	23.19		0.23	23.25	-0.01
70	23.41	23.19		0.22	23.25	-0.02
80	0.00	0.00		0.00	0.00	-23.26
90	23.42	23.19	#	0.23	23.25	-0.01
110	23.39	23.20		0.19	23.25	-0.01
120	23.41	23.20		0.21	23.25	-0.01
140	23.43	23.21		0.22	23.27	0.00
160	23.42	23.21		0.21	23.26	0.00
180	23.42	23.21		0.21	23.26	0.00
200	23.42	23.21		0.21	23.26	0.00
220	23.42	23.21		0.21	23.26	0.00
240	23.42	23.21		0.21	23.26	0.00
260	23.42	23.21		0.21	23.26	0.00
280	23.42	23.21		0.21	23.26	0.00
300	23.41	23.21		0.20	23.26	0.00
320	23.40	23.20		0.20	23.25	-0.01
340	23.40	23.20		0.20	23.25	-0.01
360	23.40	23.20		0.20	23.25	-0.01
380	23.40	23.20		0.20	23.25	-0.01
400	23.40	23.20		0.20	23.25	-0.01
420	23.40	23.20		0.20	23.25	-0.01
440	23.40	23.20		0.20	23.25	-0.01
460	23.39	23.19		0.20	23.24	-0.02

26TH STREET SEWER
PUMPING TEST AT S-94
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Observation Well: S-83

Time (min)	DTW (feet)	DIN (feet)	NT (feet)	ADJ. DTW (feet)	Draw down (feet)
0	19.52	0.00	19.52	4.88	0.00
10	20.04	19.52	0.52	19.65	14.77
16	20.04	19.52	0.52	19.65	14.77
20	20.04	19.52	0.52	19.65	14.77
70	20.00	19.51	0.49	19.63	14.75
90	20.00	19.50	0.50	19.63	14.75
110	19.97	19.50	0.47	19.62	14.74
160	19.97	19.48	0.49	19.60	14.72
180	19.97	19.48	0.49	19.60	14.72
200	19.96	19.46	0.50	19.59	14.71
240	19.95	19.45	0.50	19.58	14.70
280	19.93	19.43	0.50	19.56	14.68
320	19.92	19.42	0.50	19.55	14.67
360	19.90	19.41	0.49	19.53	14.65
400	19.91	19.41	0.50	19.54	14.66
440	19.89	19.42	0.47	19.54	14.66
480	19.87	19.41	0.46	19.53	14.65

26TH STREET SEWER
PUMPING TEST AT S-94
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Observation Well: S-84

Time (min)	DTW (feet)	DIN (feet)	NT (feet)	ADJ. DTW (feet)	Draw down (feet)
0	17.67	17.66	0.01	17.66	0.00
20	17.43	17.42	0.01	17.42	-0.24
70	17.33	17.32	0.01	17.32	-0.34
90	17.30	0.00	0.00	17.30	-0.36
110	17.27	17.26	0.01	17.26	-0.40
160	17.30	17.29	0.01	17.29	-0.37
180	17.31	17.30	0.01	17.30	-0.36
200	17.30	0.00	0.00	17.30	-0.36
240	17.29	17.28	0.01	17.28	-0.38
280	17.20	0.00	0.00	17.20	-0.46
320	17.16	17.15	0.01	17.15	-0.51
360	17.08	17.07	0.01	17.07	-0.59
400	17.19	17.18	0.01	17.18	-0.48
440	17.21	17.20	0.01	17.20	-0.46
480	17.13	17.12	0.01	17.12	-0.54

SE1000B
Environmental Logger
09/08 07:54

Unit# 00969 Test# 1 ⇒ W-10

INPUT 1: Level (F) TOC

Reference	100.00
Scale factor	10.01
Offset	- 0.02

Step# 0 09/07 12:27

Elapsed Time	Value
0.0000	100.03
0.0033	100.02
0.0066	100.02
0.0099	100.02
0.0133	100.02
0.0166	100.02
0.0200	100.02
0.0233	100.02
0.0266	100.02
0.0300	100.02
0.0333	100.03
0.0500	100.03
0.0666	100.03
0.0833	100.03
0.1000	100.04
0.1166	100.04
0.1333	100.04
0.1500	100.04
0.1666	100.04
0.1833	100.04
0.2000	100.05
0.2166	100.05
0.2333	100.05
0.2500	100.05
0.2666	100.05
0.2833	100.06
0.3000	100.06
0.3166	100.06
0.3333	100.06
0.4167	100.07
0.5000	100.08
0.5833	100.09
0.6667	100.10
0.7500	100.11
0.8333	100.11
0.9167	100.12
1.0000	100.13
1.0833	100.14
1.1667	100.15
1.2500	100.16
1.3333	100.16
1.4166	100.17
1.5000	100.18

1.5833	100.19
1.6667	100.19
1.7500	100.20
1.8333	100.21
1.9167	100.21
2.0000	100.22
2.5000	100.27
3.0000	100.31
3.5000	100.36
4.0000	100.40
4.5000	100.44
5.0000	100.48
5.5000	100.52
6.0000	100.55
6.5000	100.59
7.0000	100.63
7.5000	100.67
8.0000	100.70
8.5000	100.74
9.0000	100.77
9.5000	100.80
10.0000	100.84
12.0000	100.98
14.0000	101.10
16.0000	101.23
18.0000	101.34
20.0000	101.44
22.0000	101.54
24.0000	101.64
26.0000	101.73
28.0000	101.82
30.0000	101.90
32.0000	101.97
34.0000	102.05
36.0000	102.12
38.0000	102.18
40.0000	102.24
42.0000	102.30
44.0000	102.35
46.0000	102.39
48.0000	102.44
50.0000	102.48
52.0000	102.52
54.0000	102.56
56.0000	102.59
58.0000	102.63
60.0000	102.66
62.0000	102.69
64.0000	102.72
66.0000	102.74
68.0000	102.77
70.0000	102.80
72.0000	102.82
74.0000	102.84
76.0000	102.86
78.0000	102.88
80.0000	102.89
82.0000	102.91
84.0000	102.93
86.0000	102.94

88.0000	102.95
90.0000	102.97
92.0000	102.98
94.0000	102.99
96.0000	103.00
98.0000	103.01
100.000	103.02
110.000	103.06
120.000	103.08
130.000	103.09
140.000	103.10
150.000	103.10
160.000	103.10
170.000	103.10
180.000	103.10
190.000	103.10
200.000	103.09
210.000	103.09
220.000	103.09
230.000	103.09
240.000	103.09
250.000	103.09
260.000	103.09
270.000	103.38
280.000	103.60
290.000	103.77
300.000	103.91
310.000	104.00
320.000	104.04
330.000	104.07
340.000	104.09
350.000	104.10
360.000	104.10
370.000	104.10
380.000	104.10
390.000	104.10
400.000	104.10
410.000	104.11
420.000	104.11
430.000	104.12
440.000	104.12
450.000	104.12
460.000	104.11
470.000	103.56

26TH STREET SEWER
PUMPING TEST AT W-10
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Observation Well: S-75

Time (min)	DTW (feet)	DTP (feet)	NT (feet)	ADJ. DTW (feet)	Drawdown (feet)
0	27.17	26.82	0.35	26.91	0.00
15	27.11	26.78	0.33	26.86	-0.05
60	27.12	26.77	0.35	26.86	-0.05
120	27.13	26.80	0.33	26.88	-0.03
140	27.13	26.80	0.33	26.88	-0.03
160	27.13	26.82	0.31	26.90	-0.01
220	27.14	26.82	0.32	26.90	-0.01
260	27.14	26.81	0.33	26.89	-0.02
300	27.15	26.83	0.32	26.91	0.00
360	27.15	26.83	0.32	26.91	0.00
420	27.17	26.85	0.32	26.93	0.02
480	27.17	26.85	0.32	26.93	0.02

26TH STREET SEWER
PUMPING TEST AT W-10
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Observation Well: S-81

Time (min)	DTW (feet)	Drawdown (feet)
0	23.52	0.00
0.5	23.51	-0.01
1.0	23.53	0.01
1.5	23.59	0.07
2.0	23.77	0.25
2.5	23.85	0.33
3.0	23.91	0.39
3.5	23.96	0.44
4.0	23.54	0.02
4.5	23.54	0.02
5.0	23.55	0.03
5.5	23.55	0.03
6.0	23.55	0.03
6.5	23.55	0.03
7.0	23.56	0.04
7.5	23.56	0.04
8.0	23.57	0.05
8.5	23.57	0.05
9.0	23.58	0.06
9.5	23.58	0.06
10.0	23.58	0.06
11	23.59	0.07
12	23.60	0.08
13	23.61	0.09
14	23.61	0.09
15	23.62	0.10
16	23.62	0.10
17	23.63	0.11
18	23.64	0.12
19	23.64	0.12
20	23.64	0.12
30	23.69	0.17
40	23.73	0.21

50	23.77	0.25
60	23.80	0.28
70	23.83	0.31
80	23.83	0.31
90	23.84	0.32
100	23.87	0.35
110	23.88	0.36
120	23.89	0.37
140	23.89	0.37
160	23.91	0.39
180	23.91	0.39
200	23.91	0.39
220	23.92	0.40
240	23.92	0.40
260		
280	23.95	0.43
300	24.00	0.48
320	24.04	0.52
340	24.08	0.56
360	24.09	0.57
380	24.09	0.57
400	24.11	0.59
420	24.11	0.59
440	24.12	0.60
460	24.12	0.60
480	24.13	0.61

26TH STREET SEWER
PUMPING TEST AT W-10
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Observation Well: S-82

Time (min)	DTW (feet)	DTP (feet)	NT (feet)	ADJ. DTW (feet)	Drawdown (feet)
0	23.50	23.21	0.29	23.28	0.00
.5	23.48	23.20	0.28	23.27	-0.01
20	23.50	23.20	0.30	23.28	-0.01
30	23.49	23.20	0.29	23.27	-0.01
60	23.48	23.20	0.28	23.27	-0.01
90	23.47	23.20	0.27	23.27	-0.01
120	23.46	23.19	0.27	23.26	-0.02
140	23.46	23.19	0.27	23.26	-0.02
160	23.45	23.19	0.26	23.26	-0.02
180	23.45	23.19	0.26	23.26	-0.02
200	23.44	23.18	0.26	23.25	-0.04
220	23.45	23.18	0.27	23.25	-0.03
240	23.45	23.17	0.28	23.24	-0.04
260	23.42	23.16	0.26	23.23	-0.05
280	23.41	23.16	0.25	23.22	-0.06
300	23.41	23.16	0.25	23.22	-0.06
320	23.40	23.16	0.24	23.22	-0.06
340	23.40	23.16	0.24	23.22	-0.06
360	23.40	23.16	0.24	23.22	-0.06
380	23.39	23.15	0.24	23.21	-0.07
400	23.39	23.15	0.24	23.21	-0.07
420	23.39	23.15	0.24	23.21	-0.07
440	23.38	23.15	0.23	23.21	-0.07
480	23.38	23.14	0.24	23.20	-0.08

26TH STREET SEWER
PUMPING TEST AT W-10
SUN COMPANY, INC. (R&M)
PHILADELPHIA REFINERY

Observation Well: S-83

Time (min)	DTW (feet)	DTP (feet)	NT (feet)	ADJ. DTW (feet)	Drawdown (feet)
0	20.15	19.52	0.63	19.68	0.00
6.5	20.17	19.46	0.71	19.64	-0.04
20	20.18	19.47	0.71	19.65	-0.03
30	20.10	19.47	0.63	19.63	-0.05
60	20.05	19.47	0.58	19.62	-0.07
90	20.14	19.48	0.66	19.65	-0.04
120	20.14	19.48	0.66	19.65	-0.04
140	20.08	19.47	0.61	19.62	-0.06
160	20.05	19.47	0.58	19.62	-0.07
180	20.05	19.47	0.58	19.62	-0.07
200	20.05	19.46	0.59	19.61	-0.07
220	20.02	19.46	0.56	19.60	-0.08
240	20.03	19.46	0.57	19.60	-0.08
260	20.05	19.46	0.59	19.61	-0.07
280	19.96	19.46	0.50	19.59	-0.09
300	20.10	19.46	0.64	19.62	-0.06
320	20.06	19.47	0.59	19.62	-0.06
340	20.04	19.48	0.56	19.62	-0.06
360	20.08	19.48	0.60	19.63	-0.05
380	20.12	19.48	0.64	19.64	-0.04
400	20.05	19.48	0.57	19.62	-0.06
420	20.14	19.49	0.65	19.65	-0.03
440	20.10	19.49	0.61	19.64	-0.04
480	20.08	19.49	0.59	19.64	-0.04

SUN Company, Inc. (R & M)

Philadelphia, PA

Workplan to Investigate Shallow and Deep Groundwater Quality at the Philadelphia Refinery

ENSR Consulting and Engineering

September 1993

Document Number 6445-041-300

CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Background

This workplan was prepared in response to a March 29,1993 Pennsylvania Department of Environmental Resources (PADER) letter to SUN Company, Inc. (R & M) (SUN). In this letter, PADER requested an assessment of the impact of the Philadelphia Refinery on deep groundwater quality. This request apparently resulted from studies of the Philadelphia area performed by the United States Geological Survey (USGS).

The most recent USGS report of this region, published in 1991, states that urbanization of the Philadelphia area has caused substantial degradation of groundwater quality (Paulachok 1991). In this report, the USGS documents increases in the concentrations of dissolved solids, iron, manganese, sulfate, trace elements, and volatile organic compounds in Philadelphia-area groundwater. Much of the groundwater mineralization can be attributed to microbial degradation of organic compounds which reduces dissolved oxygen levels and results in the dissolution and mobilization of redox-sensitive metals (e.g., iron and manganese). The degradation of shallow and deep groundwater quality has been clearly identified by the USGS as a regional issue related to the historical growth and urbanization of the Philadelphia area, including a long history of focused industrial activity as represented by the petroleum industry and the Philadelphia Naval Shipyard. The report also documents the changes in the groundwater flow system that have occurred since the development of groundwater supplies, and suggests that degraded groundwater from the Philadelphia area may be flowing under the Delaware River in the deep, confined aquifer toward pumping centers in New Jersey.

Further clarification of the USGS and PADER positions regarding SUN's potential contribution to this regional issue was obtained during the August 10, 1993 meeting in Conshohocken, PA, between SUN, ENSR, USGS, and PADER. In this meeting, the USGS maintained that the refineries along the Schuylkill River were major contributors to the regional groundwater quality degradation. This conclusion was based on the presence of an apparent zone of depressed sulfate (SO_4^{2-}) extending from the general vicinity of the refineries toward the US Naval Shipyard. The depressed concentrations were attributed to microbially-mediated SO_4^{2-} reduction induced by hydrocarbon releases to the water table aquifer at the refineries. However, it was also stated that the data were sparse, and that there was no direct evidence that such a process has occurred. In response to this speculation regarding SUN's contribution to the regional degradation of groundwater quality, the PADER reiterated their written request for an investigation of

groundwater quality at the facility, and the potential for off-site migration of contaminated groundwater.

Notwithstanding the previous discussion regarding the regional nature of this issue, Sun can only address the issue in the context of its own facility. Accordingly, this workplan was developed to address the PADER request for an on-site groundwater investigation. The workplan defined below addresses Comment 11e on page 3 of the March 1993 letter from PADER, which requests that SUN submit a work plan providing for the:

- Assessment of hydrocarbon-contaminated groundwater migration from the upper unconfined aquifer to the lower confined aquifer;
- Assessment of the water quality in these aquifers; and,
- Assessment of the potential for off-site migration of contaminated groundwater.

These objectives will be met through groundwater sampling and hydraulic head measurements at selected monitoring well clusters at the facility. This workplan utilizes the Quality Assurance Project Plan (QAPP, ENSR, January 1992) and Health and Safety Plan (HASP, ENSR January 1992 as amended May, 1993) written for the RCRA Facility Investigation (RFI, ENSR September 1992). The QAPP will be amended as appropriate to account for collection and analysis of the additional inorganic constituents in this workplan that were not analyzed in the RFI.

1.2 Summary of Existing Information

This section briefly summarizes regional and site-specific groundwater flow conditions and water quality. The regional aquifers underlying the Philadelphia area and the Coastal Plain of New Jersey have been studied extensively by the USGS and State Agencies. A list of publications reviewed in the development of this workplan are included in Section 7.0 of this document. Site specific hydrogeology and groundwater quality have been determined from the network of monitoring and supply wells and soil borings drilled at the facility.

Regional and Site-Specific Groundwater Flow

The regional unconsolidated aquifer system is comprised of Cretaceous and Quaternary age sediments that thicken to the east. The fall line (the boundary between the Coastal Plain and Piedmont Physiographic Provinces) where the coastal plain sediments pinch out lies just to the west of the Sun Refinery. Coastal Plain stratigraphy generally consists of interbedded sand and clay deposits, with the sands forming the aquifers, and the clays the aquitards. This aquifer

system is the well-known Potomac-Raritan-Magothy system of Cretaceous age. In Pennsylvania, the Cretaceous sediments belong chiefly to the Raritan Formation. Near the fall line, the complete Cretaceous section is generally not present. The Miocene-aged Bridgeton Formation or the Pleistocene-aged Cape May Formation (also referred to as the Trenton gravel) typically lie directly above the Raritan Formation in Pennsylvania. The Cape May Formation can be an important water table aquifer where the deposit is thick. Recent alluvium is present in the vicinity of the Schuylkill and Delaware rivers up to 80 feet thick. Due to the fine-grained texture of the alluvium, it does not form an important aquifer.

The lower sand unit (the Farrington sand) and the Middle clay unit of the Raritan formation have been recognized at the Sun Refinery on the east side of the Schuylkill River. These deposits are overlain unconformably by the Cape May Formation and recent alluvium. Greenman et al. (1961) and others have mapped the edge of the confined aquifer system as running through the Sun Refinery property. Additional drilling on-site has confirmed this regional mapping; the Middle clay and Farrington sand are not present beneath the West Yard and roughly the western half of the North Yard (ENSR 1992). The deposits beneath these areas are thought to consist entirely of the Pleistocene Cape May Formation and recent alluvium. The erosional removal of Cretaceous deposits was probably caused by the incision of a deep paleochannel of the Schuylkill during the Pleistocene. In some locations, the Pleistocene deposits are semi-confined by the fine-grained recent alluvium which acts as a leaky confining layer. In these areas, coarse fill forms the water table aquifer. A generalized east-to-west geologic cross-section across the site is included as Figure 1-1.

Withdrawal of groundwater in the Philadelphia area since the turn of the century has caused significant changes in the groundwater flow system (Sloto 1988; Greenman et al. 1961). Prior to groundwater development, groundwater in the lower sand probably discharged to the Delaware and Schuylkill Rivers. Hydraulic heads were estimated to be above sea level and horizontal hydraulic gradients were relatively flat. With the initiation of large-scale groundwater withdrawal, hydraulic heads were lowered, inducing downward flow from the water table aquifer and surface water bodies. During periods of peak pumpage in the 1960s, heads in the lower sand were as much as 60 feet lower than estimated predevelopment levels. With the decline of pumping in the Philadelphia area, heads have risen on the order of 20 to 40 feet near previous pumping centers but remain below sea level (Paulachok 1991). Heads remain below sea level because pumpage in New Jersey increased over the same time period. Currently groundwater in the lower sand unit flows toward pumping centers in New Jersey.

Hydraulic head data from numerous shallow and deep monitoring wells define the local groundwater flow system. Groundwater in the Farrington sand generally flows south-southeast. Hydraulic heads range from approximately 10 feet above mean sea level (msl) to 0 feet msl.

644503A

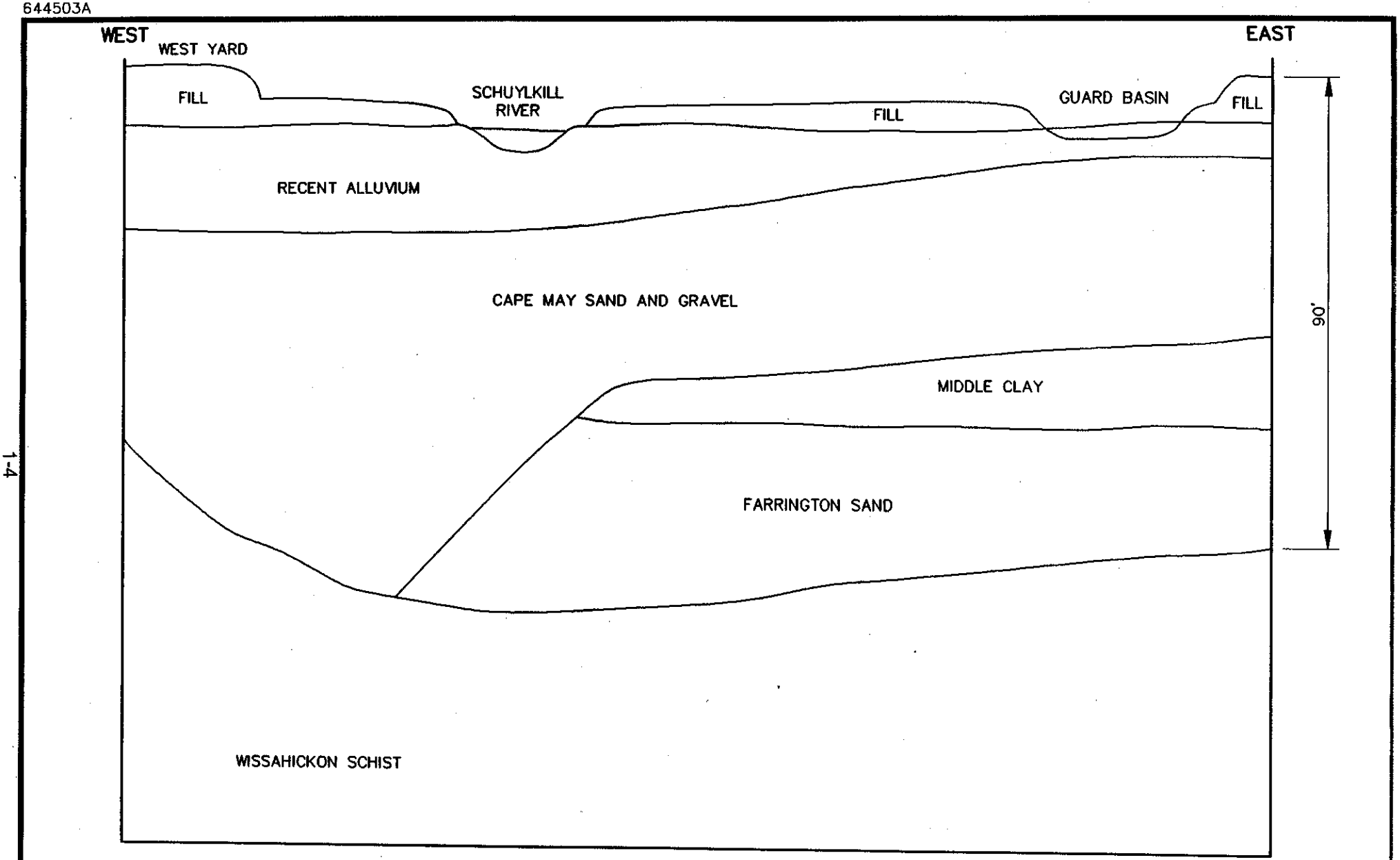


FIGURE 1-1
GENERALIZED REGIONAL WEST TO EAST GEOLOGIC CROSS-SECTION SUN COMPANY INC. (R&M)

NOT TO SCALE

ENSR

On the west side of the Schuylkill River, beneath the west yard, groundwater in the deep aquifer flows west. Heads range from roughly 0.5 feet msl to -0.5 ft msl. The hydraulic relationship between these two lower sand units is not well understood. Groundwater in the shallow aquifer generally flows south. Differences in river stage and hydraulic heads in shallow wells adjacent to the river suggest the river receives water from the shallow aquifer. Hydraulic heads in the shallow aquifer are on the order of 5 feet above heads in the deep aquifer. These differences indicate there is a downward component of flow.

The Schuylkill River and adjacent shallow aquifer are tidally influenced. ENSR estimated the tidal influence extended approximately 230 feet from the river. Low-amplitude cyclical fluctuations were also observed in the lower sand unit. However, because amplitudes did not decay with distance from the Schuylkill, ENSR speculated that these fluctuations were caused by earth tides. A detailed description of site hydrogeology is provided in the RFI report.

Regional and Site-Specific Groundwater Quality

The evolution of groundwater quality in the Philadelphia area has been documented in detail by Greenman et al. (1961). Urbanization has had a profound effect on groundwater quality. Predevelopment groundwater quality was estimated to be slightly mineralized with bicarbonate, sulfate, and calcium as the major ions. With urbanization, a significant increase in groundwater mineralization occurred. According to reports published by the USGS, the first phase of the regional water quality contamination occurred when water table aquifers were degraded from surficial activities. In response to increasing mineralization of the water table aquifer, groundwater supplies were developed in the deep aquifer. This initiated the second phase of contamination. Pumping the deep aquifer lowered hydraulic heads sufficiently to cause downward migration of degraded groundwater in the unconfined aquifer to the deep aquifer. Degradation of both aquifers was evident by 1945. Groundwater quality varies significantly within the regional degraded area in response to localized releases.

According to Greenman et al. (1961), groundwater contamination in the Philadelphia area is caused by direct release of both organic and inorganic substances to the water table aquifer. Substances that may have been released include industrial brines, sewage, inorganic industrial wastes, and organic wastes from industrial and residential sources. Microbial reactions involving organic compounds probably contribute significantly to the increased levels of iron and manganese in groundwater. These reactions deplete oxygen and lower pH which results in dissolution of iron- and manganese-bearing minerals from the aquifer. Under conditions of low Ph and dissolved oxygen, the reduced and soluble forms of these constituents accumulate in groundwater. Excessive iron is probably the most significant problem associated with groundwater quality degradation. Other parameters observed to change in response to

urbanization include other trace metals, total dissolved solids, chloride, sulfate, nutrients (species of nitrogen and phosphorous), bicarbonate, calcium, magnesium, industrial organic compounds, and groundwater temperature (Blickwedel and Wood 1989; Hem 1985). Changes in groundwater chemistry are aerially widespread in the Coastal Plain deposits of Pennsylvania (Paulachok 1991).

Groundwater quality data collected at the Sun Refinery indicates that the shallow water-table aquifer has been impacted by refinery activities (ENSR 1992). Free product is present on the water table in some locations. Soluble components of petroleum products have been detected in shallow groundwater. As indicated above, the lower sand unit is separated from the water table by two confining layers (the Middle clay and alluvium) across most of the facility. While the lower unit receives water from upper geologic units as indicated by the downward vertical hydraulic gradients, it may also receive water from upgradient unconsolidated deposits, and the underlying Wissahickon Formation. Less water quality data are available in the lower sand unit. Existing data indicate that detectable levels of organic compounds are generally not present in the lower unit.

2.0 GROUNDWATER SAMPLING AND ANALYSIS

As discussed in Section 1.0, the objectives of this field program are to investigate on-site groundwater quality and assess the potential for off-site migration of contaminated groundwater. These objectives will be met by sampling a group of existing shallow and deep monitoring wells located on SUN property. Water quality results and site-specific and previously-published hydraulic data (vertical and horizontal groundwater flow directions) will be used to assess the potential for off-site migration.

2.1 Monitoring Wells

A total of thirteen wells will be sampled from six existing well clusters. Well clusters were selected to provide water quality and hydraulic gradient data from the North, South, and West yards. Based on a south-southeast groundwater flow direction in the deep aquifer, both upgradient and downgradient wells will be sampled. Five well clusters contain a shallow and deep well. One cluster contains shallow, intermediate, and deep wells (guard basin). For the purpose of this workplan, "shallow wells" are considered to be wells that intersect, or are near, the water table, regardless of the lithology of the zone in which they are screened. Similarly, "deep wells" are those screened in the lower sand unit above bedrock, regardless of lithology (i.e, Pleistocene or Cretaceous sand), and "intermediate wells" are screened in the sand unit between the Middle clay and surficial deposits. Intermediate wells were only installed in the guard basin area. The wells selected for groundwater sampling are listed in Table 2-1, and shown on Figure 2-1. Boring logs and well construction diagrams (where available) are included in Appendix A.

Groundwater level measurements will also be collected during well sampling. These measurements will be used to calculate vertical hydraulic gradients at each cluster. Groundwater elevation measurements will not be corrected for tidal fluctuations because the wells selected for measurement are expected to be beyond the limit of measurable tidal influence (ENSR 1992). As discussed in Section 1.2 of this workplan and the RFI report, ENSR estimated that the tidal influence from the Schuylkill River extended approximately 230 feet from the river. Moreover, because the amplitude of the head fluctuations decays exponentially from the surface water body, any fluctuations that may be present in the selected wells will be small relative to the vertical head differences between shallow and deep wells. For these reasons, tidal fluctuations are not expected to significantly affect the vertical gradient measurements proposed in this workplan.

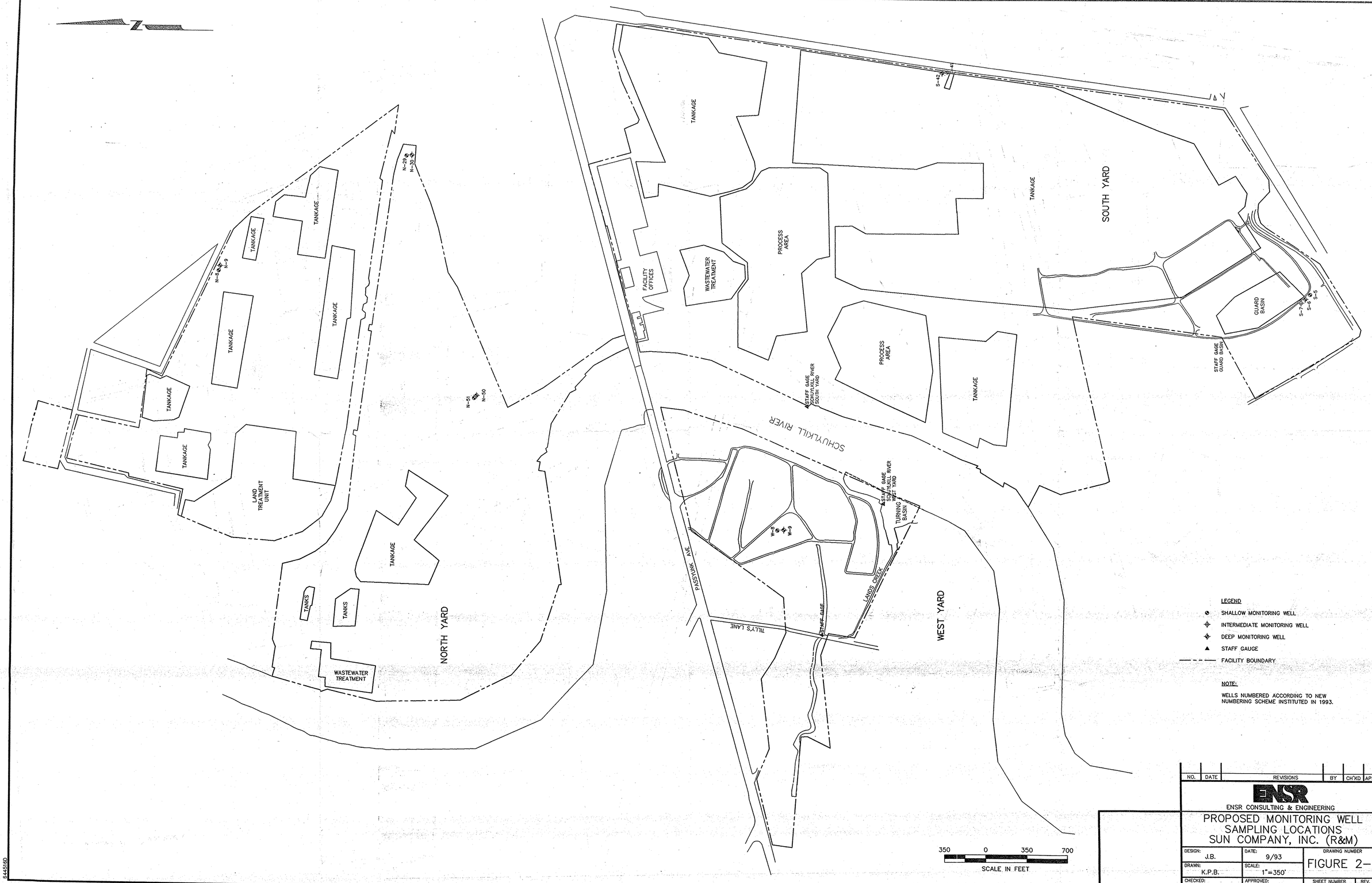
Groundwater samples will be submitted for laboratory analysis for the parameters listed on Table 2-2. This parameter list includes both organic and inorganic parameters. The organic

TABLE 2-1

Wells to be Sampled for Parameters Listed in Table 2-2

New Well ID	Old Well ID	Screen Location	Well Depth	Geologic Unit
N-8	N-11	Shallow	35	Cape May
N-9	N-12	Deep	63	Farrington Sand ?
N-29	N-36	Shallow	30	Cape May
N-30	N-37	Deep	60	Farrington Sand ?
N-50	N-57	Deep	60	Farrington Sand ?
N-51	N-56	Shallow	28	Cape May
S-5	MW-4	Shallow	9	Fill
S-6	MW-10	Deep	72	Farrington Sand
S-7	MW-22	Intermediate	26	Cape May
S-41	AS-1	Shallow	35	Cape May
S-42	AD-1	Deep	65	Farrington Sand ?
W-8	MW-14	Shallow	13	Alluvium
W-9	MW-20	Deep	60	Cape May

Depths are feet below ground surface.
Screen location designations defined in text.
Cape May also referred to as the Trenton Gravel.



LEGEND

- SHALLOW MONITORING WELL
- INTERMEDIATE MONITORING WELL
- DEEP MONITORING WELL
- STAFF GAUGE
- FACILITY BOUNDARY

NOTE:

WELLS NUMBERED ACCORDING TO NEW NUMBERING SCHEME INSTITUTED IN 1993.

NO.	DATE	REVISIONS	BY	CH'KD	APP'VD

ENSR CONSULTING & ENGINEERING

PROPOSED MONITORING WELL SAMPLING LOCATIONS SUN COMPANY, INC. (R&M)

DESIGN: J.B.	DATE: 9/93	DRAWING NUMBER: FIGURE 2-1
DRAWN: K.P.B.	SCALE: 1"=350'	
CHECKED: J.B.	APPROVED: X	SHEET NUMBER: 1 / REV. NO.: 0

6445160

TABLE 2-2

Analytical Parameters

Parameter	Analytical Method
Benzene	8020[1]
Toluene	8020
Ethylbenzene	8020
Xylenes	8020
Iron (dissolved)	6010[1]
Manganese (dissolved)	6010
Calcium	6010
Chloride	325.3[2]
Alkalinity as $CaCO_3$	310.1[2]
Sulfate	375.4[2]
Sulfide	376.1[2]
Nitrate	300.0[2]
Ammonia	350.1[2]
Bicarbonate	SM 407[3]
Dissolved Organic Carbon	415.2[2]
Total Dissolved Solids	160.2[2]
Dissolved Oxygen	Field
Temperature	Field
pH	Field
Specific Conductance	Field

Dissolved constituents will be field-filtered through a 0.45 μm filter.
Refer to QAPP for field parameter collection methodology.
1 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", USEPA, SW-846, 3rd Edition, November, 1990.
2 "Methods for Chemical Analysis of Water and Wastes", USEPA, EPA 600/4-79-020, Revised March 1983.
3 "Standard Methods for the Examination of Water and Wastewater", APHA-AWWA-WPCF, 17th Edition, 1989 and 1991 Supplement.

parameters will be measured to assess the presence of petroleum-hydrocarbon compounds in groundwater, particularly the deep aquifer, and the potential for migration from the water table region to the deep aquifer. Benzene, toluene, ethylbenzene, and xylene isomers (BTEX) were chosen for analysis because they are the most soluble and mobile constituents of both crude and refined petroleum products. The inorganic parameters will be measured to define other geochemical conditions, such as the redox state, of the groundwater at the facility.

Parameters such as temperature, pH, specific conductance, and dissolved oxygen will be measured in the field at the time of sampling. Sample collection procedures are described in detail in the following section.

3.0 SAMPLE COLLECTION PROCEDURES

Water levels measurements in each well will be collected from the surveyed elevation mark at the top of casing with an electric sounding device. Water levels will be measured to an accuracy of 0.01 feet. The time to the nearest minute will be recorded with each measurement. Static water levels will be recorded before purging and sampling.

To obtain a representative sample of the groundwater, a volume of stagnant water in the wellbore will first be purged. The recommended length of time required to purge or bail a well before a sampling event will depend on the well and aquifer characteristics, the type of sampling equipment being used, and the parameters being sampled. Wells will be pumped or bailed until the measurements of pH, temperature, and specific conductance have stabilized to within 10 percent of the previous reading or at least three well volumes have been removed, whichever is greater. Samples will be collected immediately after the wells are purged.

Wells yielding greater than one gallon per minute (gpm) will be purged with a centrifugal pump or a submersible pump. The centrifugal pump will use three-quarter to 1-inch dedicated polyethylene tubing as the downhole suction line. Pump discharge will be controlled with a normal 3/4-inch gate valve on the discharge side of the pump. The submersible pump will use 1/2-inch dedicated polyethylene tubing as a discharge line. Discharge rates will be held below four gpm to prevent agitation of the aquifer. Pump decontamination will be conducted as described in the RFI workplan, and the QAPP. The polyethylene suction tubing will be cut up and properly disposed of after sampling.

In wells yielding less than one gpm, purging will be conducted with a teflon or stainless steel bailer. Bailers will be dedicated to a particular well and decontaminated in accordance with EPA-approved procedures outlined in the RFI workplan, and the QAPP.

In the case of monitoring wells that will not yield water at a rate adequate for effective purging, several procedures will be attempted. The first procedure includes removing water to the top of the screened interval to prevent the exposure of the gravel pack or formation to atmospheric conditions. The sample is then collected at a rate that would not cause rapid drawdown. Wells may also be pumped dry and allowed to recover. Samples should be collected as soon as a volume of water sufficient for the intended analytical parameters recharge the well.

Exposure of water entering the well for periods longer than one to two hours may render samples unsuitable and unrepresentative of water contained within the aquifer system. In these cases,

it may be desirable to collect small volumes of water over a period of time, each time pumping the well dry and allowing it to recover.

Whenever full recovery exceeds two hours, samples will be collected in order of their volatility as soon as sufficient volume is available to completely fill the appropriate container. Parameters that are not pH- or oxygen-sensitive or subject to loss through volatilization will be collected last.

Samples will be collected with a teflon or stainless steel bailer with a 5-foot stainless steel leader. The bailers and leader will be decontaminated in accordance with procedures outlined in the QAPP. To ensure the integrity of the samples during collection, parameters will be collected in the following order:

- Volatile organic compounds
- oxygen-sensitive inorganic constituents
- other inorganic constituents

Samples will be analyzed for pH, specific conductance, temperature, and dissolved oxygen during purging. Dissolved oxygen will be determined with either a YSI or Hydrolab dissolved oxygen meter. Calibration of all field instruments will be in accordance with manufacturers protocols.

Samples collected for dissolved metal analysis (i.e., iron and manganese) will be field-filtered prior to preservation. A separate sample will be collected for metals that are not filtered. Dissolved metal samples will be filtered through a disposable 0.45-micron filter with an electric vacuum or peristaltic pump or directly from submersible pump discharge lines.

Purge water generated from well sampling will be transported to the facility's on-site wastewater treatment plant for disposal.

4.0 QUALITY ASSURANCE PROCEDURES

All groundwater samples will be collected, logged and handled in accordance with the RFI QAPP previously established for this site in January, 1992. Section 4.0 of the QAPP, entitled Sampling Procedures, specifies decontamination procedures, groundwater monitoring requirements, sample handling, and field documentation as they relate to quality assurance. Other field considerations such as sample labeling, chain of custody and sample disposal will be followed as discussed in Section 5.0, entitled Sample Custody, of the QAPP. Section 9.0 of the QAPP specifies the sample frequency of field blanks, trip blanks, field duplicates, matrix spikes and matrix spike duplicates. This information is also included in this workplan as Table 4-1.

TABLE 4-1

Collection Frequency for Quality Control Samples

Type	Frequency
Duplicate	1 per 10 samples per analyte
Field Blank	1 per day per analyte
Trip Blank	1 per cooler VOC only
Matrix Spike (MS)	1 per 20 per analyte
Matrix Spike Duplicate (MSD)	1 per 20 per analyte

5.0 REPORTING

Upon receipt, analytical data will be validated and entered into the project data base. A report, which presents the detected compounds, discusses the distribution of organic and inorganic constituents and the hydraulic relationships between the shallow, intermediate and deep aquifers, and discusses the potential for off-site migration of contaminated groundwater will be prepared from the data gathered under this workplan.

6.0 SCHEDULE

Field data collection will be initiated two weeks after PADER approval of this workplan. Well sampling and measurements will require approximately one week. Allowing four weeks for laboratory turnaround, and an additional eight weeks for data interpretation and report preparation, a final report will be submitted to PADER fifteen weeks after written authorization to proceed.

7.0 REFERENCES

Blickwedel, R.S. and C.R. Wood. 1989. Relation of ground-water quality to land use in the Philadelphia, Pennsylvania--Camden, New Jersey area. U.S. Geological Survey. Water-Resources Investigations Report 88-4211. 58 pp.

ENSR Consulting and Engineering. September 1992. Results of a RCRA facility investigation, SUN Refining and Marketing Company, Philadelphia Refinery. 3 Vol. ENSR Doc. No. 6445-017-018.

Greenman, D.W., D.R. Rima, W.N. Lockwood, and H. Meisler. 1961. Ground-water resources of the coastal plain area of southeastern Pennsylvania. Pennsylvania Geological Survey. Fourth Series. Bulletin W 13. 375 pp.

Hem, J.D. 1985. Study and Interpretation of the chemical characteristics of natural water, 3d ed. U.S. Geological Survey. Water-Supply Paper 2254. 263 pp.

Paulachok, G.N. 1991. Geohydrology and ground-water resources of Philadelphia, Pennsylvania. U.S. Geological Survey. Water-Supply Paper 2346. 79 pp.

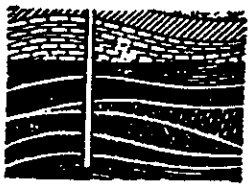
Sloto, R.A. 1988. Simulation of ground-water flow in the lower sand unit of the Potomac-Raritan-Magothy aquifer system, Philadelphia, Pennsylvania. U.S. Geological Survey. Water-Resources Investigations Report 86-4055. 51 pp.

APPENDIX A

BORING LOGS AND WELL CONSTRUCTION DIAGRAMS

N-8 (SRB)

C.V.M. industries



geotechnical division inc.

post office box 2 • huntingdon valley, pennsylvania

215-947-2555

Client ARCO
Project WELL INSTALLATION
Location PASSYUNK AVENUE, PHILADELPHIA PA
Project No. 9200
Boring No. B-11 Depth 35.0'
Elevation
Spoon Size — Casing Size CONVENTIONAL FLIGHT AUGERS
Core Size Bit No.
Hammers:
Spoon, weight — Drop —
Drive, weight Drop
Date Started 11-14-84

Driller S.A.
Helper W.H.
Inspector M.C.
Job No. 2890

Ground Water Data:
0 HOURS AFTER COMPLETION:
FIRST ENCOUNTERED 29.0'
11-27-84 - WATER AT 24'9"
TOTAL PIPE INSTALLED: 37.0'

Date Completed 11-14-84

Depth	Casing Blows	STRATA CLASSIFICATION	Depth	SAMPLING DATA No.	Blows per 6"	REMARKS
		BLACKTOP PAVING 0-2'				
		ASH AND CINDER WOOD, ETC. FILL. 16.0'				
		MULTI-COLORED FINE TO COARSE SAND AND GRAVEL. 30.0'				
		LIGHT ORANGE FINE SAND. 35.0'				
		COMPLETE AT 35.0'				

SHEET NO. ..... OF .....

N-9 (JN3)

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215-947-2555

Client ARCO
Project WELL INSTALLATION
Location PASSYUNK AVENUE, PHILADELPHIA PA
Project No. 9200
Boring No. B-12 Depth 78.0'
Elevation
Spoon Size — Casing Size CONDUCTOR FLIGHT AUGERS
Core Size Bit No.
Hammers:
Spoon, weight — Drop —
Drive, weight Drop
Date Started 11-26-84

Driller S.A.
Helper W.N.
Inspector M.C.
Job No. 2890

Ground Water Data:
0 HOURS AFTER COMPLETION:

TOTAL PIPE INSTALLED: 67.0'

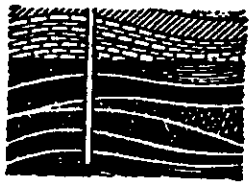
Date Completed 11-28-84

Depth	Casing Blows	STRATA CLASSIFICATION	Depth	SAMPLING DATA No.	Blows per 6"	REMARKS
		BLACKTOP PAVING 0.2'				
		ASH WOOD AND CINDER FILL. 13.0'				
		MULTI-COLORED FINE TO COARSE SAND AND GRAVEL. 24.0'				
		LIGHT ORANGE FINE SAND 30.0'				
		LIGHT ORANGE BROWN MEDIUM TO COARSE SANDS AND GRAVELS AND SILTY CLAYS.	40.0-42.0'	1		DAMP TO MOIST

SHEET NO. 1 OF 2

N-9 (1R3)

C.V.M. industries



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215-947-2555

Client ARCO
Project WELL INSTALLATION
Location PASSYUNK AVENUE, PHILADELPHIA PA
Project No. 9200
Boring No. B-12 (CONT'D) Depth 78.0'
Elevation
Spoon Size — Casing Size CONVEYOR FLIGHT AUGERS
Core Size Bit No.
Hammers:
Spoon, weight — Drop —
Drive, weight Drop
Date Started 11-26-84

Driller S.O.
Helper W.H.
Inspector M.C.
Job No. 2890

Ground Water Data:
0 HOURS AFTER COMPLETION:

TOTAL PIPE INSTALLED: 67.0'

Date Completed 11-28-84

Depth	Casing Blows	STRATA CLASSIFICATION	Depth	SAMPLING DATA No.	Blows per 6"	REMARKS
		LIGHT ORANGE BROWN MEDIUM TO COARSE SAND AND GRAVELS AND SILTY CLAYS. ± 45.0'				
		DARK GREY FINE TO COARSE SAND AND SILTY CLAYS. ± 51.0'	47.0 49.0	2		ATTEMPTED TO PUT PIPE DOWN TO 68.0' BUT WOULDN'T GO PAST APPROXIMATELY 63.0'.
		INTERBEDDED ORANGE TAN FINE SAND AND FINES. VERY FRIABLE WITH REDDISH BROWN FINE SANDS. BOTH SHOW SOME FINE MICA PARTICLES ± 63.0'	57.0 59.0	3	DRY SAMPLE	THE SAND AND GRAVEL INTERFACE. ATTEMPTED THIS PROCEDURE TWICE THEN MOVED ON TO ANOTHER HOLE.
		FINE TO COARSE GRAVELS AND SANDS MULTI-COLORED TRACE OF FINES ± 70.0'	65.0 67.0	4		
		COARSE SAND AND GRAVELS. MULTI-COLORED. PREDOMINATELY DARK REDDISH BROWN ± 78.0'	76.0- 78.0	5		
		COMPLETE AT 78'				

SHEET NO. ..... OF .....

N-29 (118)

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215-947-2555

Client ARCO
Project WELL INSTALLATION
Location PASSYUNK AVENUE, PHILADELPHIA
Project No. 9200 PA
Boring No. B-36 Depth 30.0'
Elevation
Spoon Size — Casing Size CONVENTIONAL FLIGHT AUGERS
Core Size Bit No.
Hammers:
Spoon, weight — Drop —
Drive, weight Drop
Date Started 11-19-84

Driller S.A.
Helper W.H.
Inspector M.C.
Job No. 2890

Ground Water Data:
0 HOURS AFTER COMPLETION:
WATER AT 28'6"
TOTAL PIPE INSTALLED: 33.0'

Date Completed 11-19-84

Depth	Casing Blows	STRATA CLASSIFICATION	Depth	SAMPLING DATA No.	Blows per 6"	REMARKS
		SOIL FILL 3.0'				
		ASH AND CINDER FILL. 14.0'				
		ORGANISH BROWN SAND AND FINE TO MEDIUM GRAVELS 26.0'				
		ORANGE - SILTS AND CLAY. 30.0'				
		COMPLETE AT 30.0'				

SHEET NO. ..... OF .....

N-30 (12R)

C.V.M. industries

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215-947-2555

Client ARCO
Project WELL INSTALLATION
Location PASSYUNK AVENUE, PHILADELPHIA PA
Project No. 9200
Boring No. B-37 Depth 60.0'
Elevation
Spoon Size 2" O.D. Casing Size HOLLOW STEM AUGERS
Core Size Bit No.
Hammers:
Spoon. weight 140# Drop 30"
Drive. weight Drop
Date Started 12-5-84

Driller S.E.
Helper W.H.
Inspector M.C.
Job No. 2370

Ground Water Data:
0 HOURS AFTER COMPLETION:

TOTAL PIPE INSTALLED: 63.5'

Date Completed 12-6-84

Depth	Casing Blows	STRATA CLASSIFICATION	Depth	SAMPLING DATA No.	Blows per 6"	REMARKS
		SOIL FILL 3.0'				
		ASH AND CINDER FILL 14.0'				
		ORANGE BROWN SAND AND FINE TO MEDIUM GRAVELS. 26.0'				
		ORANGE SILTS AND CLAY. 30.0'				
		MULTI-COLORED TO ORANGE SILTS AND CLAYEY SILTS.	40.0 - 42.0	1		

SHEET NO. 1 OF 2

N-30 (circled: JMB)

C.V.M. industries

geotechnical division inc.

post office box 2 • huntingdon valley, pennsylvania

215-947-2555

Client: ARCO
Project: WELL INSTALLATION
Location: PASSYUNK AVENUE, PHILADELPHIA PA
Project No.: 9200
Boring No.: B-37 (CONT'D) Depth: 60.0'
Elevation:
Spoon Size: 2" O.D. Casing Size: HOLLOW STEM AUGERS
Core Size: Bit No.:
Hammers:
Spoon, weight: 140# Drop: 30"
Drive, weight: Drop:
Date Started: 12-5-84

Driller: S.E.
Helper: W.H.
Inspector: M.C.
Job No.: 2310

Ground Water Data:
0 HOURS AFTER COMPLETION:

TOTAL PIPE INSTALLED: 63.5'

Date Completed: 12-6-84

Depth	Casing Blows	STRATA CLASSIFICATION	Depth	SAMPLING DATA No.	Blows per 6"	REMARKS
		MULTI-COLORED TO ORANGE SILTS AND CLAYEY SILTS. ±45.0'				
		DARK GREY AND BROWN SILTY CLAY WITH TRACE OF MICA CRYSTALS. ±55.0'	50.0-52.0	2		
		REDDISH-BROWN FINE TO MEDIUM SANDS. ±60.0'				
		COMPLETE AT 60.0'				

SHEET NO. .... OF ....

N-50 (9n3)

C.V.M. industries

geotechnical division inc.

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215-947-2555

Client: ARCO
Project: WELL INSTALLATION
Location: PASSYUNK AVENUE, PHILADELPHIA PA
Project No.: 9200
Boring No.: B-57   Depth: 60.0'
Elevation:
Spoon Size: 2" O.D.   Casing Size: HOLLOW STEM AUGERS
Core Size: Bit No.:
Hammers:
Spoon, weight: 140#   Drop: 30"
Drive, weight: Drop:
Date Started: 12-6-84

Driller: S. E.
Helper: W. H.
Inspector: M. C.
Job No.: 2390

Ground Water Data:
0 HOURS AFTER COMPLETION:

TOTAL PIPE INSTALLED: 64.0'

Date Completed: 12-7-84

Depth	Casing Blows	STRATA CLASSIFICATION	SAMPLING DATA Depth	SAMPLING DATA No.	Blows per 6"	REMARKS
		MISCELLANEOUS SOIL FILL (SANDS SILTS AND CLAY) 10.0'				
		MULTI-COLORED FINE TO COARSE SAND AND GRAVEL. 28.0'				STRONG HYDROCARBON AROMA
		DARK GREY SANDY SILTY CLAY COARSE SAND FINE GRAVEL.				

SHEET NO. 1 OF 2

N-50 (1 of 3)

c.v.m. industries

geotechnical division inc.

post office box 2 • huntingdon valley, pennsylvania

215-947-2555

Client: ARCO
Project: WELL INSTALLATION
Location: PASSYUNK AVENUE, PHILADELPHIA PA
Project No.: 9200
Boring No.: B-57 (CONT'D) Depth: 60.0'
Elevation:
Spoon Size: 2" O.D. Casing Size: HOLLOW STEM AUGERS
Core Size: Bit No.:
Hammers:
Spoon, weight: 140# Drop: 30"
Drive, weight: Drop:
Date Started: 12-6-84

Driller: S.E.
Helper: W.H.
Inspector: M.C.
Job No.: 2890

Ground Water Data:
O HOURS AFTER COMPLETION:

TOTAL PIPE INSTALLED: 64.0'

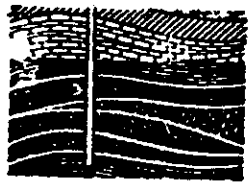
Date Completed: 12-7-84

Depth	Casing Blows	STRATA CLASSIFICATION	Sampling Depth	Sampling No.	Blows per 6"	REMARKS
		DARK GREY SANDY SILTY CLAY.	40.0' - 42.0'	1		
		COARSE SAND FINE GRAVEL. 55.0'	50.0 - 52.0'	2		
		FINE TO MEDIUM REDDISH BROWN SAND. 60.0'				
		COMPLETE AT 60.0'				

SHEET NO. .... OF ....

N-51 (123)

C.V.M. industries



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215-947-2555

Client ARCO
Project WELL INSTALLATION
Location PASSYUNK AVENUE, PHILADELPHIA
Project No. 9200 PA
Boring No. B-56 Depth 28.0'
Elevation
Spoon Size — Casing Size CONTINUOUS FLIGHT AUGERS
Core Size Bit No.
Hammers:
Spoon, weight — Drop —
Drive, weight Drop
Date Started 11-21-84

Driller S.O.
Helper W.H.
Inspector M.C.
Job No. 2890

Ground Water Data:
0 HOURS AFTER COMPLETION:
WATER AT 25'6"

TOTAL PIPE INSTALLED: 30.0'

Date Completed 11-21-84

Depth	Casing Blows	STRATA CLASSIFICATION	Depth	SAMPLING DATA No.	Blows per 6"	REMARKS
		SAND SILT AND CLAY. MISCELLANEOUS FILL. 10.0'				
		MULTI-COLORED FINE TO COARSE SAND AND GRAVEL. 28.0'				
		COMPLETE AT 28.0'				

SHEET NO. ..... OF .....

EMPIRE

Sheet 1 of 1

Project No. 6445-017 Date - Start 2-12-92 Finish 2-12-92 Boring B-4

Project Name Sun Oil

Drilling Co. EMPIRE

Location Gaviota Basin (SWMU-3)

Drilling Method 6 1/4 HSA

Total Depth 9' Inspector J. Rice Reviewer Charles E. Martin

Remarks

Depth Feet	Sample: Type & No.	Sample: Blows per 6 In.	Sample: Depth Range	Sample: Rec.	Graphic Log	Lithologic Description	Equipment Installed
5						No samples Taken	
10					9'	Total depth 9'	

M890278

ENSR

Sheet 1 of 3

Project No. 6445-017 Date - Start 2/27/92 Finish 3/2/92 Boring B-10

Project Name Sun Oil Drilling Co. Empire

Location Guard Basin (SWMU-3) Drilling Method Mud Rotary

Total Depth 90.3' Inspector BEM Reviewer Charles E Martin

Remarks

Depth Feet	Sample Type & No.	Sample Blows per 6 In.	Sample Depth Range	Sample Rec.	Graphic Log Sample	Lithologic Description	Equipment Installed
0						Asfalt Road	
	A		~~2-4~~			Drilled Through fill material (Ash, SiLT, Gravel, Sand)	
5	B		~~4-6~~				
					FI	FILL	
10	A	1-8 0-8	10-12	24"	310AA	SiLT, Trace Clay, Brown Grey, SOFT Oil odor, WET	Sample chemical + Geotech
	B	2-8 12-17	12-14	6"	ML	As Above Trace Med Gravel	
15							
20					CL/SP		
	C	8-9 12-29	20-22	10"	310BA	Gravel, Fine, and SiLT and F. Sand Loose, Brown, moist, Poorly Sorted Trace Cobbles	Chemical + Geotech
25	D	12-28 32-38	25-27	0"	GP	Large Gravel, Possibly Cobbles Rough Drilling	
30	E	7-4 4-10	30-32	9"	310CA CL	Clay, SOFT, med Plastic. Yellow WET. ~~NOT enough for sample SVOC~~	Chemical ~~VOC~~
	—	—	33-35	18"	Tube		Shelby Tube - Chemical ~~VOC~~
35	F	5-5 10-20	35-37	8"	310CA CL	As Above. Damp, Thin Colored stratagraphic layers	

M890278

ENSR Project 6445-017 Boring B-10 Sheet 2 of 3

Depth Feet	Sample Type & No.	Blows per 6 In.	Depth Range	Rec.	Graphic Log	Lithologic Description	Equipment Installed
						B-10 continued	
40	G	18-24 98/6"	41-43	14"	CL	Clay, STIFF, Low Plastic, Grey-Brown moist	
45	H	24-27 24/6"	45-47	10"		As Above	
50	I	24-28 27/3"	50-52	10"	CL	Clay, STIFF, mod. Plastic, Grey, moist	
55	J	56/6"	55-57	8"	CL	Clay, hard, Trace Coal Fragments, Dark Grey, damp.	
60	K	50/6	60-62	1"	SW	Sand, Fine to Coarse, Some F. Gravel and Clay, loose. wet, Brown	
65	L	50/6"	65-67	6"	310DA	Sand, Fine to Coarse, Some F.-M. Gravel Trace Clay, Dense, Brown to Yellow, wet	Chemical + GeoTech
70	M	50/8"	70-72	6"	SW	As Above	
75	N	50/8"	75/76	5"	SW	As Above	
80	O	50/2"	80-82	1"	GP	Gravel. med to Crse, Some F. Sand Dense, Brown, wet	

M890248

ENSR Project Sun Oil Boring B-10 Sheet 3 of 3

Depth Feet	Sample Type & No.	Sample Blows per 6 In.	Sample Depth Range	Sample Rec.	Graphic Log	Lithologic Description	Equipment Installed
85	P	50/8"	85-87	8"	SW	Sand, Fine, Well Sorted, Brown Loose, WET	
90	Q	50/4"	90-92	4"		90' Sand, Fine and Rock Fragments Trace Clay, Damp-Dry (Bedrock)	
						BOH = ~~92.0'~~ 90.3' (CM)	

M890248

ENSR

Sheet 1 of

Project No. 6445-017 Date - Start 3/13/92 Finish 3/16/92 Boring B-10I-22

Project Name Sun Oil Drilling Co. Empire

Location Guard Basin Drilling Method Mud Rotary

Total Depth 26' Inspector B. Miller/C. Martin Reviewer C. Martin

Remarks Next to B-10 and close to B-4. 6' N of B-10

Depth Feet	Sample: Type & No.	Sample: Blows per 6 In.	Sample: Depth Range	Sample: Rec.	Graphic Log	Lithologic Description	Equipment Installed
0						Drilled To 11 Feet. Pushed casing to 12 feet.	
5						(Fill) contaminated Strong Petro. Odor	
10							6" casing To 12.5'
12.5'						(6" casing at this depth)	
15							
20							
25							
26'						Total Depth 26'	
30						No samples collected. Refer to B-10 log for soil info.	
35							

M890278

NEW ID: S-42 (JRP)

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LOG of BORING No. AD-1

DATE 2/2-3/82 SURFACE ELEV. _____ LOCATION See Plate

DEPTH, FEET	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0			Cinders and gravel					
5		15	Stiff brown and gray mottled clayey SILT					
10		11						
15		45	Dense to very dense brown and gray coarse to fine SAND and GRAVEL					
20		64						
25		37						
30		35	less gravel encountered @ 30 feet					
35		50						
40		11						
		14	Red brown silty CLAY					
45		54	See next page for description					

COMPLETION DEPTH 67.0 feet FLUID Depth enc. @ 28 ft. Date 2/2/82

SAMPLER: 2" O.D. SPLIT BARREL SAMPLER

JOB NO 81 C 2256A

E 0 0 0 0 3 5 7 7

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LOG of BORING No. AD-1 (cont'd.)

DATE 2/2-3/82 SURFACE ELEV. _____ LOCATION See Plate

DEPTH, FEET	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
45								
50		25	Medium dense to very dense gray and tan silty coarse to fine SAND					
55		41						
60		100/5"						
65		36						
70								

COMPLETION DEPTH 67.0 feet FLUID Depth enc. @ 28 ft. Date 2/2/82

SAMPLER: 2" O.D. SPLIT BARREL SAMPLER

JOB NO 81 C 2256A

E 0 0 0 0 3 5 7 8

EMX

MW-D (12)

Sheet 1 of 1

Project No. 6445-017 Date - Start 2-24-92 Finish 2-24-92 Boring B-14

Project Name SUN OIL Drilling Co. EMPIRE

Location PDA 1-4 (WEST YARD) Drilling Method 6¼ HSA

Total Depth 13' Inspector S. Rice Reviewer S. Rice / C. Martin

Remarks

Depth Feet	Sample Type & No.	Sample Blows per 6 In.	Sample Depth Range	Sample Rec.	Graphic Log	Lithologic Description	HNU ~~Equipment installed~~ Readings
					▽		
5	S-1	4-4-8-4	5-7	14"	SW	Black and Brown fine to med SAND, some CS. sand and silt (wet) {Petro SOIL hydrocarbon stain}	1
10	S-2	4-9-9-4	10-12	12"	SW	(Same)	
				12"	CL	Gray CLAY (on auger head)	
15				13		EOB 13'	
20						(No env. samples)	

M890278

ENSR

Sheet 1 of 2

Project No. 6445-017 Date - Start 3/6/92 Finish 3/12/92 Boring B-20

Project Name SUN OIL Drilling Co. EMPIRE

Location West Yard (SUMW-1) Drilling Method Mud Rotary

Total Depth 79' Inspector SFS Reviewer Charles E. Martin

Remarks Log rewritten from field original (CM)

Depth Feet	Sample Type & No.	Blows per 6 In.	Depth Range	Rec.	Graphic Log	Lithologic Description	Equipment Installed HNU	SAMP
	S-1	5-10-8-7	0-2	14"	ML	black SILT, dry, hydrocarbon odor	32	
	S-2	5-8-10-	2-4	16"		-same-	44	120P
5	S-3	4-4-4-8	4-6	8"	▽	black SILT w/ sand, fr gravel (sat.) strong HC odor	36	
	S-4	6-6-5-7	6-8	24"	SP	black M-C SAND and GRAVEL (to 3/4" ø) strong HC odor	10	120B
	S-5	4-3-1-2	8-10	20"		-Same- w/ F Gravel seam	15	
10	S-6	2-7-13-9	10-12	20"	Pt	black PEAT, (HC sat) wood frag.	13	
	S-7	4-3-4-5	12-14	18"	OH/OL	gray-green SILT w/ CLAY (soft, plastic) strong HC odor	15	
15	S-8	1-2-2-1	14-16	3"		-same- w/ wood frags.	25	
	S-9	2-2-12	16-18	24"		"	36	
	S-10	1-2-1-1	18-20	24"			25	
20	S-11	3-2-2-3	20-22	20"	OH/OL	brown-grey SILT w/ CLAY and organics (peat-like)	20	
	S-12	1-1-1-2	22-24	22"		-same-	34	
25	S-13	1-1-2-2	24-26	24"		"	105?	
	S-14	1-1-1-1	26-28	22"		"	Meter broken	
	S-15	2-1-1-1	28-30	24"		"	"	GEOTE
30	S-16	NR	30-32	—		(no sample)	—	
	S-17	NR	32-34	—		(no sample)	—	
35	S-18	1-2-1-1	34-36	24"	OH	gray CLAY, some Silt, wood frags.	3	
	S-19	1-2-1-1	36-38	24"		"	2.1	
	S-20	2-2-3-2	38-40	24"		"	2.5	

M890278

ENSR Project 6445-017 Boring B-20 Sheet 2 of 2

Depth Feet	Sample Type & No.	Blows per 6 in.	Depth Range	Rec.	Graphic Log	Lithologic Description	Equipment Installed HNU
40	S-21	1-1-1-1	40-42	24"	ML	gray SILT and F SAND, some Clay	3.4
	S-22	2-2-1-2	42-44	0"		(no recovery)	—
45	S-23	1-1-1-1	44-46	24"	ML	gray SILT and F SAND, some Clay	5.6
	S-24	2-2-3-3	46-48	24"		- same - tr. Clay	10
	S-25	3-3-2-1	48-50	18"	48 OL	gray SILT and CLAY	11.2
50	S-26	1-1-1-1	50-52	0"		(no recovery)	—
	S-27	2-2-2-3	52-54	24"	ML	gray F SAND and SILT, tr. Clay	5
55	S-28	1-1-2-13	54-56	24"		- same -	16.4
	S-29	5-5-6-9	56-58	6"	55.5 SP	gray-brown M-C SAND, some Gravel	25
	S-30	44-6-10	58-60	6"		- same -	10.8
60	S-31	4-7-7-13	60-62	0"		(no recovery)	—
	S-32	7-8-9-11	62-64	18"	62 OL	dk. brown SILT, tr. Clay, peat	8.9
65	S-33	22-21-16-18	64-66	6"	64 SP	red-brown M-C SAND and GRAVEL, some Silt	11
	S-34	14-16-18-20	66-68	8"			9.8
	S-35	14-23-21-22	68-70	21"			12
70	S-36	21-17-17-17	70-72	12"	69.5 CL	gray-green CLAY, some Silt (dense) - same -	10.2
	S-37	14-17-80-100/4"	72-74	14"	SP 72 SP 73	gray-green M-C SAND / CLAY, some Silt / M-C SAND	11.8
75	S-38	5-7-7-10	74-76	24"	CL	gray CLAY, some Silt	NR
	S-39	7-10-17-42	76-78	24"	76 SP	gray M-C SAND, some Gravel	NR
	S-40	17-47-100/5"	78-80	15"	78.8	- same - ~~Refusal~~ green SCHIST	NR
80					79'	Bottom of boring @ 79'	

120CF

3-3 (KS)

Project No: 6445-017 Client: SUN OIL Site: Philadelphia

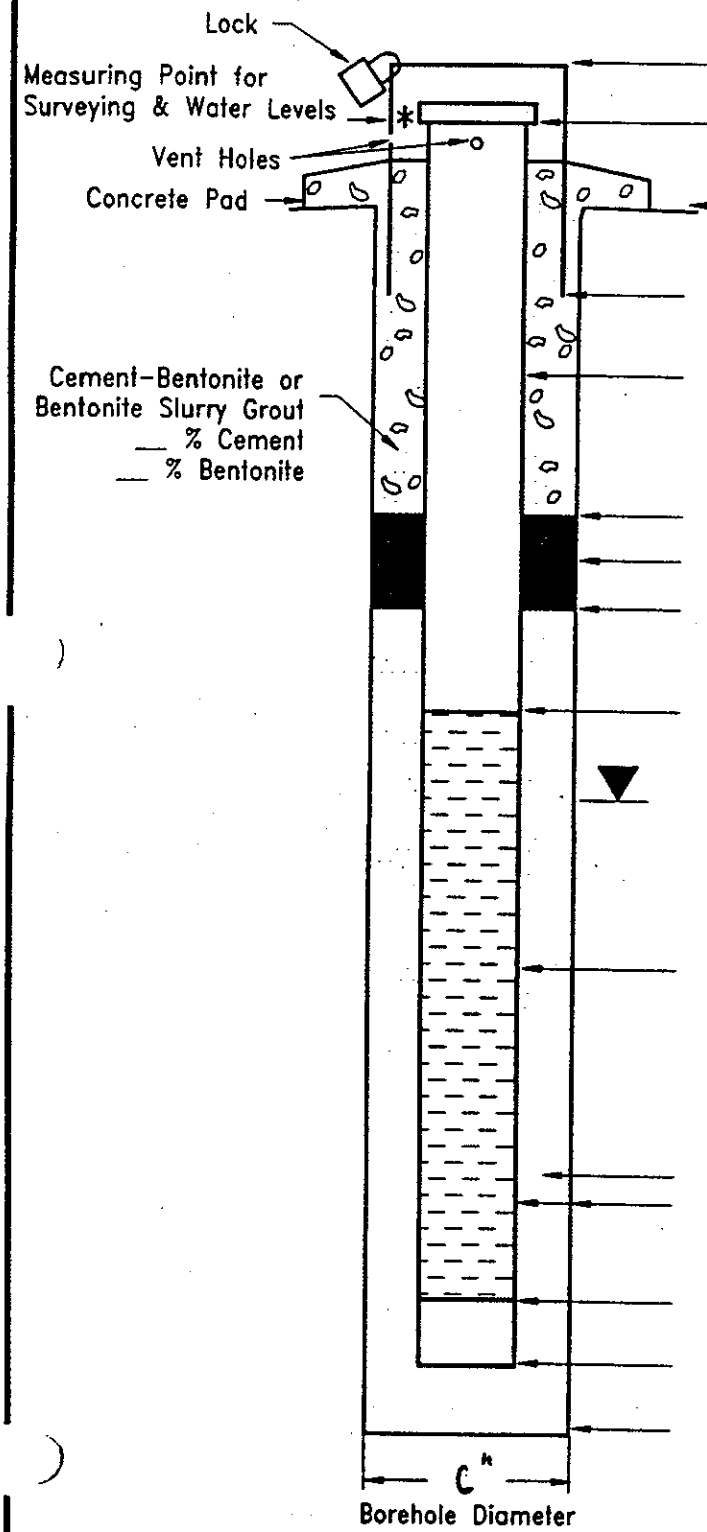
WELL No: MW-4

Well Location: Guard Basin

Date Installed: 2/15/93

Contractor: EMPIRE Method: 6 1/4 HSA Inspector: J. Rice

MONITORING WELL CONSTRUCTION DETAIL



		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe		0	
Top of Riser Pipe		0	
Ground Surface (G.S.)		0.00	
Bottom of Steel Guard Pipe		6"	
Riser Pipe:			
Length	4		
Inside Diameter (ID)	4"		
Type of Material	PVC		
Top of Bentonite Seal		2'	
Bentonite Seal Thickness	1		
Top of Sand		3'	
Top of Screen		4'	
Stabilized Water Level			
Screen:			
Length	5'		
Inside Diameter (ID)	4"		
Slot Size	0.020		
Type of Material	PVC		
Type/Size of Sand	Silica #1		
Sand Pack Thickness	1"		
Bottom of Screen		9'	
Bottom of Tail Pipe:			
Length			
Bottom of Borehole		9'	

Approved:

* Describe Measuring Point:

Signature Date

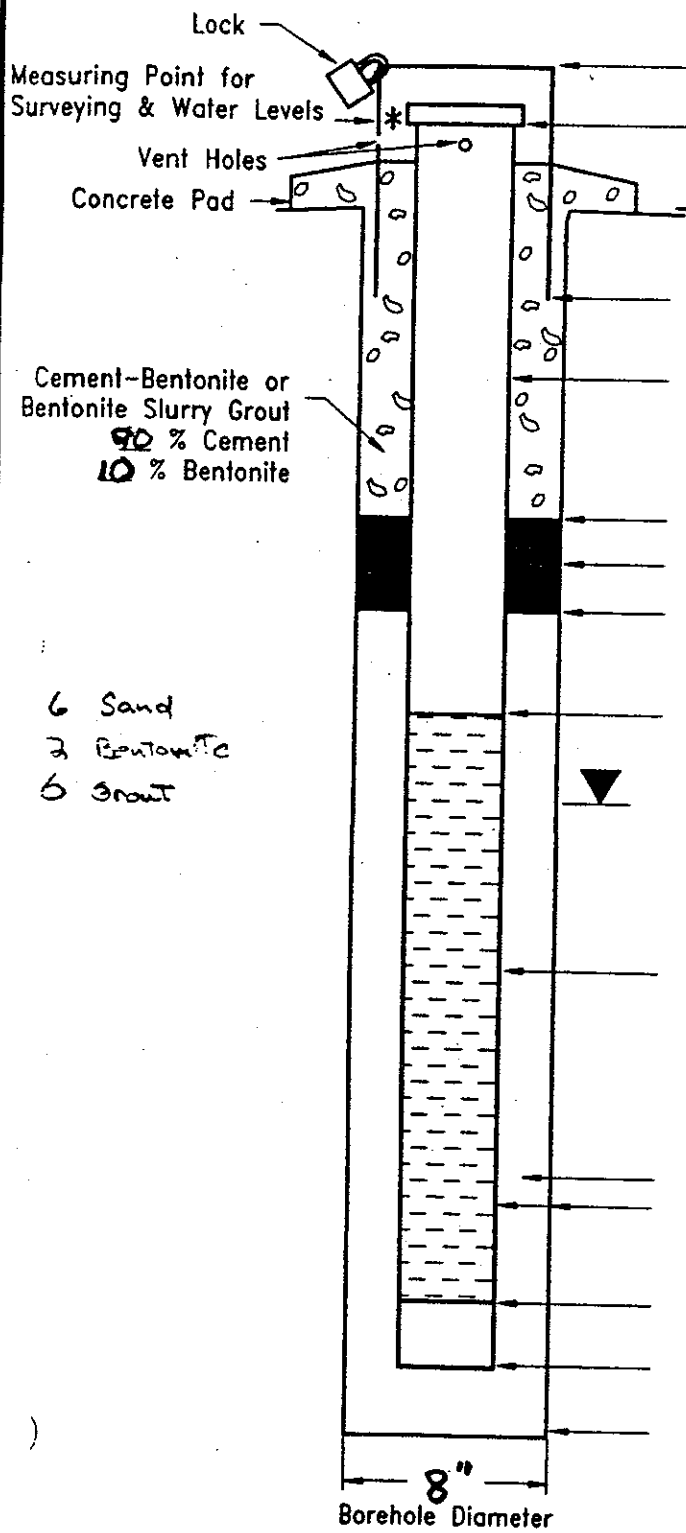
ENSR

Project No: _____ Client: Sun Oil Site: Sun Oil WELL No: MW-1C

Well Location: Guard Basin Date Installed: 3/2/9

Contractor: Empire Soil Method: Mud Rotary Inspector: BEM

MONITORING WELL CONSTRUCTION DETAIL



		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe		0'	
Top of Riser Pipe		0'	
Ground Surface (G.S.)		0.00	
Bottom of Steel Guard Pipe		0.5'	
Riser Pipe:			
Length	62.0'		
Inside Diameter (ID)	2"		
Type of Material	PVC		
Top of Bentonite Seal		54.0'	
Bentonite Seal Thickness	6.0'		
Top of Sand		60.0'	
Top of Screen		62.0'	
Stabilized Water Level			
Screen:			
Length	10'		
Inside Diameter (ID)	2"		
Slot Size	.020		
Type of Material	PVC		
Type/Size of Sand	#0 Morie		
Sand Pack Thickness	3"		
Bottom of Screen		72.0'	
Bottom of Tail Pipe:		72.0'	
Length			
Bottom of Borehole		92.0'	

Approved: _____

* Describe Measuring Point: Black Mark on Riser

Signature _____ Date _____

ENSR

Project No: 6445-017 Client: SUN OIL Site: PHIL., PA.

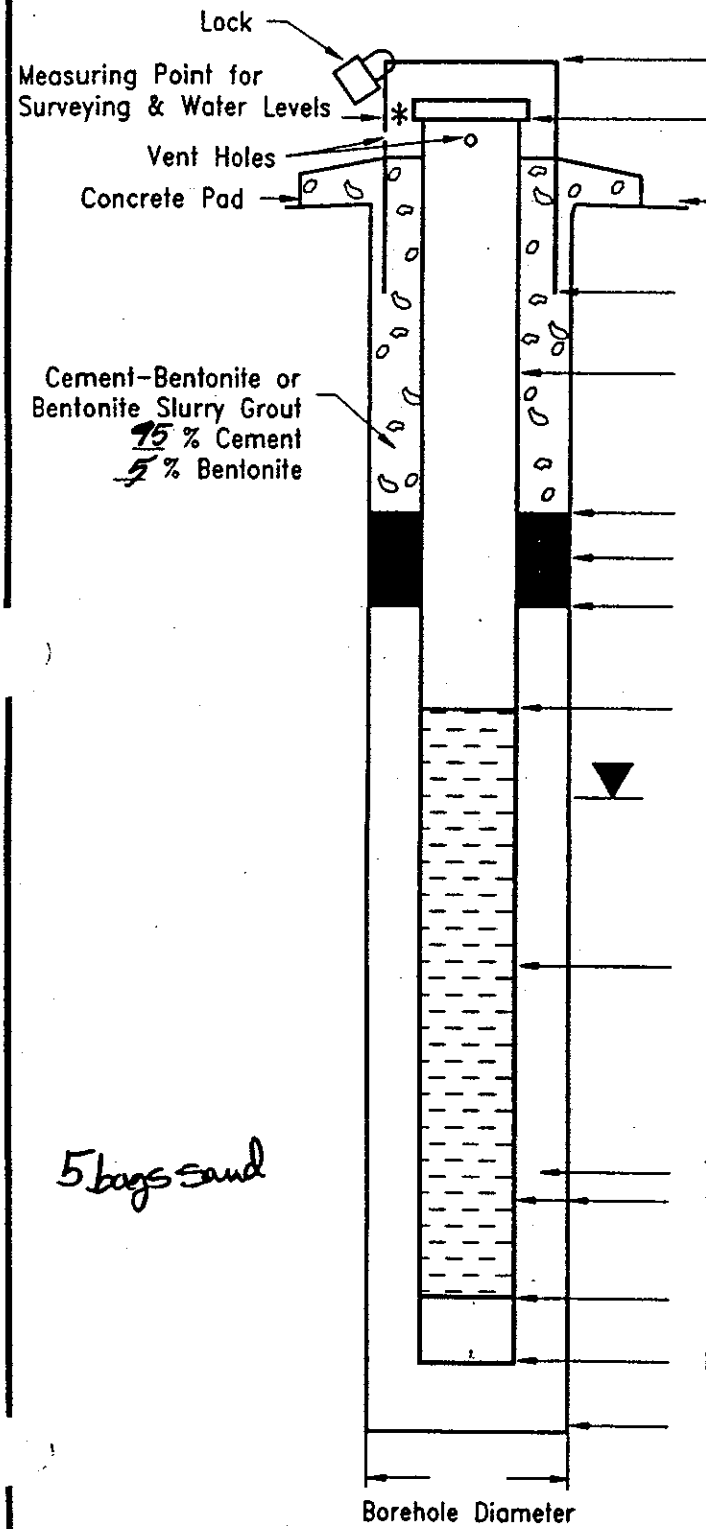
WELL No: MW-26

Well Location: Guard Basin (SWMU-3), N of B-10

Date Installed: 3/16/92

Contractor: EMPIRE Method: MUD ROTARY Inspector: C. MARTIN

MONITORING WELL CONSTRUCTION DETAIL



		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe		FLUSH	
Top of Riser Pipe		~0.3	
Ground Surface (G.S.)		0.00	
Bottom of Steel Guard Pipe		1.5'	
Riser Pipe:			
Length	12		
Inside Diameter (ID)	2"		
Type of Material	PVC		
Top of Bentonite Seal		12	
Bentonite Seal Thickness	3"		
Top of Sand		14	
Top of Screen		16	
Stabilized Water Level			
Screen:			
Length	10'		
Inside Diameter (ID)	2"		
Slot Size	#10, .020		
Type of Material	PVC		
Type/Size of Sand	#2		
Sand Pack Thickness	3"		
Bottom of Screen		25.75'	
Bottom of Tail Pipe:		26	
Length	.25'		
Bottom of Borehole		26'	

* Describe Measuring Point: top of PVC

Approved:

C. Martin 4/1/92
Signature Date

ENSR

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PIEZOMETER INSTALLATION REPORT

S-41 (JR3)

Project ARCO REFINERY

Project No. 81C2256 Installed By MHK

Method of Installation ~~Hollow stem auger~~

Piezometer No. AS-1

Location See Fig.

Date 2/6/82 Time

LOG OF BORING AND PIEZOMETER

BORING

Depth in ft.	Description	Symbol

PIEZOMETER

Type of Piezometer PVC

Ground Elev. 23.93'

Top of Riser Elev. 25.01'

Vented Cap

I.D. of Riser Pipe 3"

Type of Pipe PVC

Type of Backfill Around Riser concrete & bentonite slurry mixture

Top of Seal Elev. 8.93'

Type of Seal Material Bentonite slurry

Top of Filter Elev. 3.43'

Type of Filter Material sand

Size of Openings .010"

Diameter of Piezometer Tip 3"

Bottom of Piez. Elev. 9.57'

Bottom of Boring Elev. -11.07'

Diameter of Boring 12"

L_1 = 1.1'
L_2 = 15'
L_3 = ~~5.5'~~
L_4 = 13'
L_5 = 24.6'
L_6 = 10'
L_7 = 35'

Remarks

E 0 0 0 0 3 5 9 1

Inspected By MHK

Company Confidential

S-42 (103)

PIEZOMETER INSTALLATION REPORT

Project ARCO Refinery
Project No 81C2256 Installed By MHK
Piezometer No AD-1
Location See Figure
Date 2/5/82 Time

Method of Installation Hollow stem auger

LOG OF BORING AND PIEZOMETER

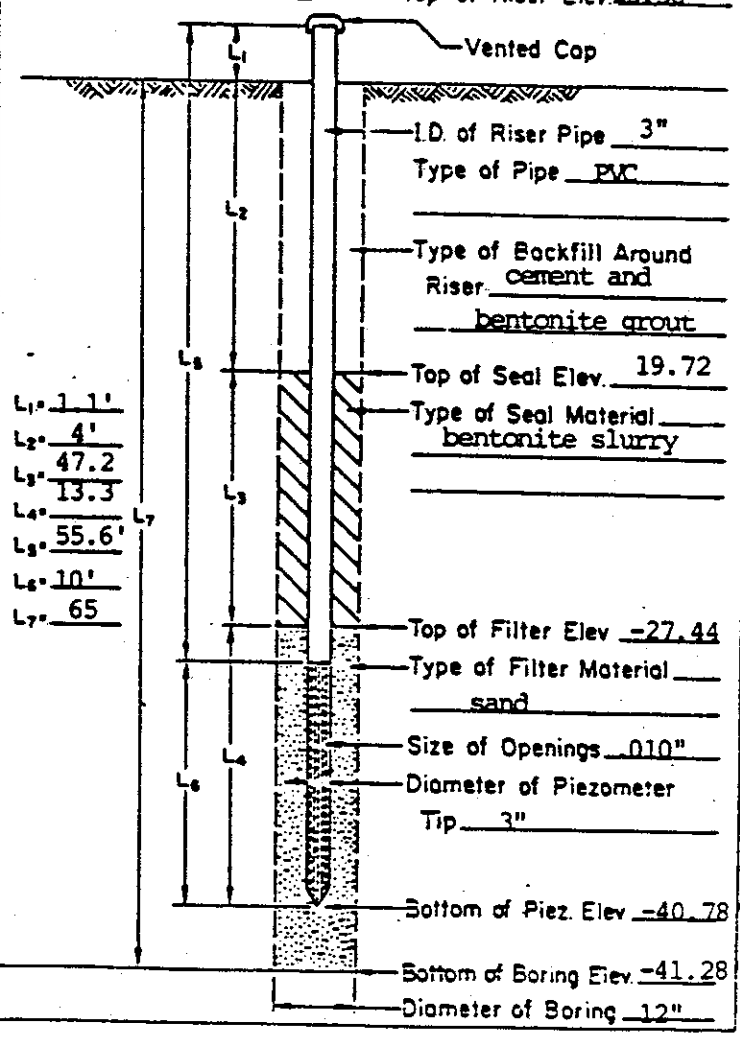
BORING

Depth in ft.	Description	Symbol

PIEZOMETER

Type of Piezometer PVC

Ground Elev. 23.72 Top of Riser Elev. 23.56'



L_1 = 1.1'
L_2 = 4'
L_3 = 47.2
L_4 = 13.3
L_5 = 55.6'
L_6 = 10'
L_7 = 65

- Vented Cap
- I.D. of Riser Pipe 3"
- Type of Pipe PVC
- Type of Backfill Around Riser cement and bentonite grout
- Top of Seal Elev. 19.72
- Type of Seal Material bentonite slurry
- Top of Filter Elev -27.44
- Type of Filter Material sand
- Size of Openings .010"
- Diameter of Piezometer Tip 3"
- Bottom of Piez. Elev -40.78
- Bottom of Boring Elev. -41.28
- Diameter of Boring 12"

Remarks

E 0 0 0 0 3 6 0 2

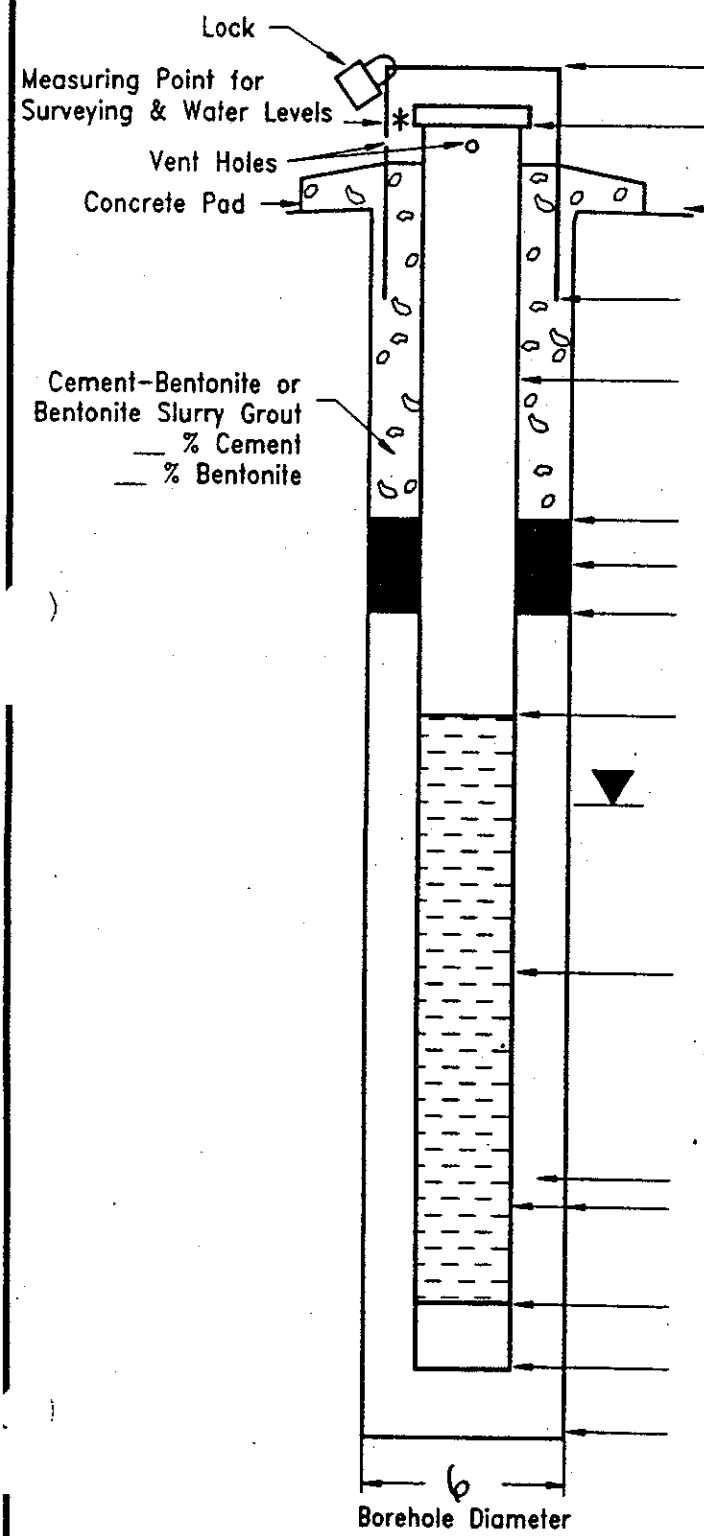
Inspected By MHK

Project No: 6445-017 Client: SUN OIL Site: Philadelphia, PA WELL No: MW-14

Well Location: West YARD (PAST DISPOSAL Area 1-4) Date Installed: 2/24/92

Contractor: EMPIRE Method: 6¼ HSA Inspector: J.Rua

MONITORING WELL CONSTRUCTION DETAIL



		Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe			
Top of Riser Pipe			
Ground Surface (G.S.)		0.00	
Bottom of Steel Guard Pipe			
Riser Pipe:			
Length	5'		
Inside Diameter (ID)	4"		
Type of Material	PVC		
Top of Bentonite Seal		1.5	
Bentonite Seal Thickness	1		
Top of Sand		2.5	
Top of Screen		3'	
Stabilized Water Level			
Screen:			
Length	10'		
Inside Diameter (ID)	4"		
Slot Size	0.010		
Type of Material	PVC		
Type/Size of Sand	#2/Silica		
Sand Pack Thickness	1"		
Bottom of Screen		13	
Bottom of Tail Pipe:			
Length			
Bottom of Borehole		13	

Approved:

* Describe Measuring Point:

Signature Date

ENSR

Annual Groundwater Sampling and Analysis
Evaluation of Need for Modified Skinner List

Purpose

The purpose of this evaluation is to determine the need to complete all Modified Skinner List parameters as part of the Sun Company, Inc. (R&M) Philadelphia Refinery annual groundwater sampling and analysis program. Many of these parameters have never been detected or have been detected at very low levels.

Background

In 1985, 1986, and 1988, eighteen refinery perimeter wells in the North and South Yard were analyzed for the Modified Skinner List parameters. In June, 1993, Sun's consultant, Groundwater and Environmental Services, Inc. (GES), prepared a work plan for Annual North and South Yard Perimeter Analysis for twenty wells. Thirteen of these wells were included in the previous investigations conducted in the 1980's. The Table 1 includes all results for each parameter for which a detectable value was obtained at least once in any well.

Evaluation of Data

Each of the thirteen previously sampled wells was analyzed for ten inorganic parameters, twenty metals, thirteen volatile organics, twenty-eight base/neutral organics, and seven acid organics, for a total of sixty-eight parameters. Only forty-one of these parameters were detected in any of the thirteen wells.

To assess whether any of the remaining forty-one parameters were present at a level of concern, the maximum and average values recorded in all wells were compared to action levels developed as part of Sun's RCRA Facility Investigation (RFI). The results of this comparison are included in the attached Table 2. Also attached is a table excerpted from the RFI report prepared by Sun's consultant, ENSR Consulting and Engineering (ENSR), which presents the actions levels and the method used to determine these levels. The ENSR table does not include levels for any inorganic parameters; EPA Secondary Drinking Water Standards are presented for these parameters, when available. Please note these action levels are very conservative and the exceedance of any of these levels do not necessarily indicate that the groundwater poses a risk to human health or the environment.

The maximum value recorded by any well for any of the three sampling periods exceeds the action level for fifteen parameters. The average value of all wells for all sampling period exceeds the action level for eight parameters. No action levels have been established for eight of the parameters.

Conclusions and Recommendations

1. Only fifteen of sixty-eight Modified Skinner List parameters have been detected above conservative action levels. Of these fifteen, only eight are present above the action levels at the average concentration.

2. Eight of the parameters do not have established action levels which can be used for comparison purposes.

3. A very conservative recommendation is to analyze for the fifteen parameters which exceeded the action levels at the maximum detected level, as well as the eight parameters for which no action level has been established. This is Sun's recommendation for the thirteen previously sampled wells. These parameters are:

   Total Dissolved Solids
   Specific Conductance
   Chloride
   Sulfate
   Total Alkalinity
   Fluoride
   pH
   Ammonia
   Nitrate and Nitrite as N
   Total Organic Carbon

   Arsenic
   Cobalt
   Lead

   Benzene
   Ethyl Benzene
   Total Xylenes

   Benzo(a)anthracene
   Benzo(b)fluoranthene
   Benzo(a)pyrene
   Bis(2-ethylhexyl)phthalate
   Chrysene
   Dibenz(a,h)anthracene
   Indene

4. Since no data is available on the other seven wells, these wells should be tested at least once for the complete Modified Skinner List. An analysis of these results should then be made to delete parameters from future analysis which are not detected or detected at very low levels.

Table 1
Philadelphia Refinery Groundwater Results

	Action Level	WELL N-1 (Old N-2)			WELL N-8 (Old N-11)		
INORGANIC PARAMETERS	or DWS	1985	1986	1988	1985	1986	1988
Total Dissolved Solids	500	345	340	310	845	900	720
Specific Conductance	NA	477	480	467	1180	1460	1040
Chloride	250	6.2	8	5	99	178	115
Sulfate	250	65	77	52	300	170	105
Total Alkalinity	NA	154	172	164	190	175	271
Fluoride	NA	0.2	0.1	0.3	0.2	0.2	0.1
pH	9	6.88	6.75	6.9	7.07	6.62	6.9
Ammonia	NA	ND	ND	ND	ND	16	14
Nitrate+Nitrite as N	NA	4.7	ND	5.7	14	35	28
Total Organic Carbon	NA	6.7	9.4	3.6	12	13	42
METALS, mg/l							
Antimony	0.006	ND	ND	ND	ND	ND	ND
Arsenic	0.05	0.002	ND	ND	0.007	ND	ND
Barium	1	0.041	0.042	0.03	0.099	0.061	0.095
Beryllium	0.004	ND	ND	ND	ND	ND	ND
Chromium	0.1	ND	ND	ND	ND	ND	ND
Cobalt	NA	0.004	0.005	ND	0.015	0.02	ND
Lead	0.015	ND	ND	ND	ND	ND	ND
Mercury	0.002	ND	ND	ND	ND	ND	0.0002
Nickel	0.1	ND	ND	ND	ND	ND	ND
Selenium	0.01	ND	ND	0.006	ND	ND	ND
Vanadium	0.245	0.003	ND	ND	ND	ND	ND
VOLATILE ORGANICS, ug/l							
Benzene	5	ND	ND	ND	ND	ND	ND
Methyl ethyl ketone	21000	ND	ND	ND	ND	ND	ND
Ethylene benzene	700	ND	ND	ND	ND	ND	ND
Toluene	1000	ND	ND	ND	ND	ND	ND
Total xylenes	10000	ND	ND	ND	ND	ND	ND
BASE/NEUTRAL ORGANICS							
Benzo(a)anthracene	0.1	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	0.2	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	0.2	ND	ND	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	6	ND	ND	ND	ND	ND	ND
Chrysene	0.2	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	0.3	ND	ND	ND	ND	ND	ND
Fluoranthene	1270	ND	ND	ND	ND	ND	ND
Indene	NA	ND	ND	ND	ND	ND	ND
1-Methylnaphthalene	1270	ND	10	ND	ND	ND	ND
Naphthalene	1270	ND	ND	ND	ND	ND	ND
Phenanthrene	9550	ND	ND	ND	ND	ND	ND
Pyrene	955	ND	ND	ND	ND	ND	ND
ACID ORGANICS, ug/l							
meta- & para-Cresols	2000	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	700	ND	ND	ND	ND	ND	ND
Phenol	1000	ND	6	ND	ND	ND	ND

CONCENTRATION UNITS:	
Specific Conductance	umhos/cm
pH	pH Units
All Other Inorganic Parameters	mg/l
All Metals	mg/l
All Volatile Organics	ug/l
All Base/Neutral Organics	ug/l
All Acid Organics	ug/l

Note: only compounds detected at least once are included
Action Levels based on RFI Report
DWS – EPA Drinking Water Standard

Table 1
Philadelphia Refinery Groundwater Results

	Action Level	WELL N-28 (Old N-30)			WELL N-37 (Old N-31)		
INORGANIC PARAMETERS	or DWS	1985	1986	1988	1985	1986	1988
Total Dissolved Solids	500	360	330	300	530	465	370
Specific Conductance	NA	510	488	489	843	686	575
Chloride	250	8.6	6	7	36	20	16
Sulfate	250	71	62	32	143	106	68
Total Alkalinity	NA	188	185	233	276	258	213
Fluoride	NA	0.8	0.3	0.2	0.2	0.3	0.3
pH	9	7.59	7.34	7.3	8.28	7	6.8
Ammonia	NA	ND	1.1	0.4	ND	1.5	0.6
Nitrate+Nitrite as N	NA	ND	ND	ND	ND	ND	ND
Total Organic Carbon	NA	12	28	6.7	4.7	16	5.5
METALS, mg/l							
Antimony	0.006	ND	ND	ND	ND	ND	ND
Arsenic	0.05	0.007	ND	ND	ND	ND	ND
Barium	1	0.081	0.078	0.12	0.18	0.15	0.08
Beryllium	0.004	ND	ND	ND	ND	ND	ND
Chromium	0.1	ND	ND	ND	ND	ND	ND
Cobalt	NA	ND	ND	ND	0.004	ND	ND
Lead	0.015	ND	ND	ND	ND	ND	ND
Mercury	0.002	ND	ND	ND	ND	ND	ND
Nickel	0.1	ND	ND	ND	ND	ND	ND
Selenium	0.01	ND	ND	ND	ND	ND	ND
Vanadium	0.245	0.002	ND	ND	ND	ND	ND
VOLATILE ORGANICS, ug/l							
Benzene	5	ND	ND	ND	ND	ND	ND
Methyl ethyl ketone	21000	ND	ND	ND	ND	ND	ND
Ethylene benzene	700	ND	ND	ND	ND	ND	ND
Toluene	1000	ND	ND	ND	ND	ND	ND
Total xylenes	10000	ND	ND	ND	ND	ND	ND
BASE/NEUTRAL ORGANICS							
Benzo(a)anthracene	0.1	ND	ND	ND	55	ND	28
Benzo(b)fluoranthene	0.2	ND	ND	ND	32	ND	ND
Benzo(a)pyrene	0.2	ND	ND	ND	49	ND	ND
Bis(2-ethylhexyl)phthalate	6	ND	ND	51	ND	ND	ND
Chrysene	0.2	ND	ND	ND	62	ND	21
Dibenz(a,h)anthracene	0.3	ND	ND	ND	28	ND	ND
Fluoranthene	1270	ND	ND	ND	ND	ND	ND
Indene	NA	ND	ND	ND	ND	ND	ND
1-Methylnaphthalene	1270	ND	ND	ND	ND	ND	ND
Naphthalene	1270	ND	ND	ND	ND	ND	ND
Phenanthrene	9550	ND	ND	ND	ND	ND	ND
Pyrene	955	ND	ND	ND	25	ND	13
ACID ORGANICS, ug/l							
meta- & para-Cresols	2000	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	700	ND	ND	ND	ND	ND	ND
Phenol	1000	ND	ND	ND	ND	ND	ND

CONCENTRATION UNITS:	
Specific Conductance	umhos/cm
pH	pH Units
All Other Inorganic Parameters	mg/l
All Metals	mg/l
All Volatile Organics	ug/l
All Base/Neutral Organics	ug/l
All Acid Organics	ug/l

Note: only compounds detected at least once are included
Action Levels based on RFI Report
DWS – EPA Drinking Water Standard

Table 1
Philadelphia Refinery Groundwater Results

	Action Level	WELL N-60 (Old N-47)			WELL N-57 (Old N-61)		
INORGANIC PARAMETERS	or DWS	1985	1986	1988	1985	1986	1988
Total Dissolved Solids	500	2030	1180	1110	950	845	820
Specific Conductance	NA	2650	1220	1790	1200	1180	1180
Chloride	250	230	62	66	13	8	7
Sulfate	250	40	67	7	100	63	24
Total Alkalinity	NA	1270	766	840	579	679	676
Fluoride	NA	0.5	0.5	0.7	0.4	0.4	0.5
pH	9	8.06	7.62	7.6	8.07	7.38	7.1
Ammonia	NA	ND	7.1	5.8	ND	10	10
Nitrate+Nitrite as N	NA	ND	ND	0.2	0.2	ND	ND
Total Organic Carbon	NA	180	90	99	89	92	108
METALS, mg/l							
Antimony	0.006	ND	ND	ND	0.005	ND	ND
Arsenic	0.05	0.053	0.037	0.02	0.075	0.059	0.034
Barium	1	0.73	0.37	0.6	0.13	0.28	0.2
Beryllium	0.004	ND	ND	ND	ND	ND	ND
Chromium	0.1	ND	ND	ND	0.01	ND	ND
Cobalt	NA	ND	ND	ND	0.004	ND	ND
Lead	0.015	ND	ND	0.008	0.04	ND	ND
Mercury	0.002	ND	0.0007	ND	ND	ND	ND
Nickel	0.1	ND	ND	ND	0.02	ND	ND
Selenium	0.01	ND	ND	ND	ND	ND	ND
Vanadium	0.245	0.004	ND	ND	0.017	ND	ND
VOLATILE ORGANICS, ug/l							
Benzene	5	ND	6	96	330	300	ND
Methyl ethyl ketone	21000	8100	ND	ND	2100	ND	ND
Ethylene benzene	700	ND	ND	ND	2100	1300	ND
Toluene	1000	ND	ND	ND	ND	ND	ND
Total xylenes	10000	ND	ND	ND	17100	10900	1600
BASE/NEUTRAL ORGANICS							
Benzo(a)anthracene	0.1	ND	ND	ND	ND	14	ND
Benzo(b)fluoranthene	0.2	ND	ND	ND	ND	16	ND
Benzo(a)pyrene	0.2	ND	ND	ND	ND	16	ND
Bis(2-ethylhexyl)phthalate	6	ND	ND	ND	ND	ND	ND
Chrysene	0.2	ND	ND	ND	ND	21	ND
Dibenz(a,h)anthracene	0.3	ND	ND	ND	ND	ND	ND
Fluoranthene	1270	ND	ND	ND	ND	ND	ND
Indene	NA	ND	ND	ND	ND	ND	ND
1-Methylnaphthalene	1270	ND	ND	ND	26	170	25
Naphthalene	1270	ND	ND	ND	21	43	ND
Phenanthrene	9550	ND	ND	ND	ND	30	ND
Pyrene	955	ND	ND	ND	ND	19	ND
ACID ORGANICS, ug/l							
meta- & para-Cresols	2000	ND	ND	ND	ND	ND	37
2,4-Dimethylphenol	700	ND	ND	15	ND	110	76
Phenol	1000	ND	ND	ND	ND	ND	ND

CONCENTRATION UNITS:	
Specific Conductance	umhos/cm
pH	pH Units
All Other Inorganic Parameters	mg/l
All Metals	mg/l
All Volatile Organics	ug/l
All Base/Neutral Organics	ug/l
All Acid Organics	ug/l

Note: only compounds detected at least once are included
Action Levels based on RFI Report
DWS – EPA Drinking Water Standard

Table 1
Philadelphia Refinery Groundwater Results

	Action Level	WELL S-66 (Old S-17)			WELL S-69 (Old S-26)		
INORGANIC PARAMETERS	or DWS	1985	1986	1988	1985	1986	1988
Total Dissolved Solids	500	925	630	910	345	265	320
Specific Conductance	NA	1510	1150	1620	538	504	479
Chloride	250	300	113	272	61	33	6
Sulfate	250	170	133	90	71	71	74
Total Alkalinity	NA	206	314	342	118	139	136
Fluoride	NA	0.3	1.1	1.2	0.2	0.2	0.6
pH	9	8.09	7.14	6.5	7.71	6.58	6.2
Ammonia	NA	ND	0.1	ND	ND	ND	ND
Nitrate+Nitrite as N	NA	4.4	ND	2.5	2.2	1	3.8
Total Organic Carbon	NA	7	48	65	7.8	18	50
METALS, mg/l							
Antimony	0.006	ND	ND	ND	ND	ND	ND
Arsenic	0.05	ND	ND	ND	ND	ND	ND
Barium	1	0.092	0.099	0.1	0.041	0.046	0.06
Beryllium	0.004	ND	ND	ND	ND	ND	ND
Chromium	0.1	ND	ND	ND	ND	ND	ND
Cobalt	NA	0.004	0.011	0.02	ND	ND	ND
Lead	0.015	ND	ND	ND	ND	ND	0.007
Mercury	0.002	ND	ND	ND	ND	ND	ND
Nickel	0.1	ND	ND	ND	ND	ND	ND
Selenium	0.01	ND	ND	ND	ND	ND	0.007
Vanadium	0.245	ND	0.017	0.03	ND	ND	ND
VOLATILE ORGANICS, ug/l							
Benzene	5	ND	ND	ND	ND	ND	ND
Methyl ethyl ketone	21000	ND	ND	ND	ND	ND	ND
Ethylene benzene	700	ND	ND	ND	ND	ND	ND
Toluene	1000	ND	ND	ND	ND	ND	ND
Total xylenes	10000	ND	ND	ND	ND	ND	ND
BASE/NEUTRAL ORGANICS							
Benzo(a)anthracene	0.1	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	0.2	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	0.2	ND	ND	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	6	ND	ND	72	ND	ND	38
Chrysene	0.2	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	0.3	ND	ND	ND	ND	ND	ND
Fluoranthene	1270	ND	ND	ND	ND	ND	ND
Indene	NA	ND	ND	ND	ND	ND	ND
1-Methylnaphthalene	1270	ND	ND	ND	ND	ND	ND
Naphthalene	1270	ND	ND	ND	ND	ND	ND
Phenanthrene	9550	ND	ND	ND	ND	ND	ND
Pyrene	955	ND	ND	ND	ND	ND	ND
ACID ORGANICS, ug/l							
meta- & para-Cresols	2000	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	700	ND	ND	ND	ND	ND	ND
Phenol	1000	ND	ND	ND	ND	ND	ND

CONCENTRATION UNITS:	
Specific Conductance	umhos/cm
pH	pH Units
All Other Inorganic Parameters	mg/l
All Metals	mg/l
All Volatile Organics	ug/l
All Base/Neutral Organics	ug/l
All Acid Organics	ug/l

Note: only compounds detected at least once are included
Action Levels based on RFI Report
DWS – EPA Drinking Water Standard

Table 1
Philadelphia Refinery Groundwater Results

	Action Level	WELL S-38 (Old S-31)			WELL S-25 (Old S-44)		
INORGANIC PARAMETERS	or DWS	1985	1986	1988	1985	1986	1988
Total Dissolved Solids	500	325	245	240	465	455	180
Specific Conductance	NA	491	420	368	717	595	270
Chloride	250	12	10	10	48	17	13
Sulfate	250	28	29	31	49	52	47
Total Alkalinity	NA	219	180	131	262	250	117
Fluoride	NA	0.5	1.5	2.8	0.5	0.8	3
pH	9	8.42	6.84	6.7	8.23	7.33	9.8
Ammonia	NA	ND	0.1	ND	ND	0.6	0.2
Nitrate+Nitrite as N	NA	ND	ND	0.2	0.3	ND	1.4
Total Organic Carbon	NA	7.1	14	35	14	25	23
METALS, mg/l							
Antimony	0.006	ND	ND	ND	ND	ND	ND
Arsenic	0.05	ND	ND	ND	ND	0.002	ND
Barium	1	0.061	0.042	0.039	0.074	0.037	0.007
Beryllium	0.004	ND	ND	ND	ND	ND	ND
Chromium	0.1	ND	ND	ND	ND	ND	0.03
Cobalt	NA	0.017	0.013	ND	0.012	ND	ND
Lead	0.015	ND	ND	ND	ND	ND	ND
Mercury	0.002	ND	ND	ND	ND	ND	ND
Nickel	0.1	ND	ND	ND	ND	ND	ND
Selenium	0.01	ND	ND	ND	ND	ND	0.002
Vanadium	0.245	ND	ND	ND	ND	0.008	0.09
VOLATILE ORGANICS, ug/l							
Benzene	5	1200	1300	930	ND	ND	ND
Methyl ethyl ketone	21000	750	210	ND	ND	ND	ND
Ethylene benzene	700	ND	ND	240	ND	ND	ND
Toluene	1000	ND	160	260	ND	ND	ND
Total xylenes	10000	ND	210	280	5	ND	ND
BASE/NEUTRAL ORGANICS							
Benzo(a)anthracene	0.1	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	0.2	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	0.2	ND	ND	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	6	100	ND	11	ND	ND	ND
Chrysene	0.2	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	0.3	ND	ND	ND	ND	ND	ND
Fluoranthene	1270	ND	ND	ND	ND	ND	ND
Indene	NA	ND	23	12	ND	ND	ND
1-Methylnaphthalene	1270	ND	11	11	ND	ND	ND
Naphthalene	1270	ND	56	120	ND	ND	ND
Phenanthrene	9550	ND	ND	ND	ND	ND	ND
Pyrene	955	ND	ND	ND	ND	ND	ND
ACID ORGANICS, ug/l							
meta- & para-Cresols	2000	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	700	ND	ND	ND	ND	ND	ND
Phenol	1000	ND	8	ND	ND	ND	ND

CONCENTRATION UNITS:	
Specific Conductance	umhos/cm
pH	pH Units
All Other Inorganic Parameters	mg/l
All Metals	mg/l
All Volatile Organics	ug/l
All Base/Neutral Organics	ug/l
All Acid Organics	ug/l

Note: only compounds detected at least once are included
Action Levels based on RFI Report
DWS – EPA Drinking Water Standard

Table 1
Philadelphia Refinery Groundwater Results

	Action Level	WELL S-3 (Old S-47)			WELL S-1 (Old S-51)		
INORGANIC PARAMETERS	or DWS	1985	1986	1988	1985	1986	1988
Total Dissolved Solids	500	900	730	480	1870	390	370
Specific Conductance	NA	1260	1340	736	4020	1100	572
Chloride	250	67	63	25	26	42	47
Sulfate	250	37	36	47	35	115	62
Total Alkalinity	NA	540	553	296	944	160	149
Fluoride	NA	0.4	0.5	0.9	1.1	1.1	1.1
pH	9	7.21	6.8	7.3	12.55	10.19	8.7
Ammonia	NA	ND	10	ND	ND	7.2	2.9
Nitrate+Nitrite as N	NA	ND	ND	3.2	3.3	ND	ND
Total Organic Carbon	NA	270	81	40	30	45	64
METALS, mg/l							
Antimony	0.006	ND	ND	ND	0.002	0.004	ND
Arsenic	0.05	ND	0.002	0.006	0.007	0.01	ND
Barium	1	ND	0.14	0.1	0.049	0.017	0.04
Beryllium	0.004	ND	ND	ND	ND	ND	ND
Chromium	0.1	ND	ND	ND	0.006	ND	ND
Cobalt	NA	ND	0.007	ND	0.004	ND	ND
Lead	0.015	ND	ND	0.007	0.03	ND	ND
Mercury	0.002	ND	ND	ND	ND	ND	ND
Nickel	0.1	ND	ND	ND	0.01	0.01	ND
Selenium	0.01	ND	ND	ND	ND	ND	ND
Vanadium	0.245	ND	ND	ND	0.005	0.027	ND
VOLATILE ORGANICS, ug/l							
Benzene	5	ND	ND	ND	ND	ND	ND
Methyl ethyl ketone	21000	ND	ND	ND	100	ND	ND
Ethylene benzene	700	ND	ND	ND	ND	ND	ND
Toluene	1000	ND	ND	ND	ND	ND	ND
Total xylenes	10000	ND	ND	ND	ND	ND	ND
BASE/NEUTRAL ORGANICS							
Benzo(a)anthracene	0.1	ND	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	0.2	ND	ND	ND	ND	ND	ND
Benzo(a)pyrene	0.2	ND	ND	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	6	ND	ND	ND	ND	ND	21
Chrysene	0.2	ND	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	0.3	ND	ND	ND	ND	ND	ND
Fluoranthene	1270	ND	ND	ND	ND	ND	ND
Indene	NA	ND	ND	ND	ND	ND	ND
1-Methylnaphthalene	1270	ND	ND	ND	ND	5	ND
Naphthalene	1270	ND	ND	ND	ND	ND	ND
Phenanthrene	9550	ND	ND	ND	ND	ND	ND
Pyrene	955	ND	ND	ND	ND	ND	ND
ACID ORGANICS, ug/l							
meta- & para-Cresols	2000	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	700	ND	ND	ND	ND	ND	ND
Phenol	1000	ND	ND	ND	ND	50	21

CONCENTRATION UNITS:	
Specific Conductance	umhos/cm
pH	pH Units
All Other Inorganic Parameters	mg/l
All Metals	mg/l
All Volatile Organics	ug/l
All Base/Neutral Organics	ug/l
All Acid Organics	ug/l

Note: only compounds detected at least once are included
Action Levels based on RFI Report
' DWS – EPA Drinking Water Standard

Table 1
Philadelphia Refinery Groundwater Results

	Action Level	WELL S-40 (Old S-55)		
INORGANIC PARAMETERS	or DWS	1985	1986	1988
Total Dissolved Solids	500	680	745	500
Specific Conductance	NA	1240	1070	1040
Chloride	250	273	135	172
Sulfate	250	13	16	6
Total Alkalinity	NA	226	348	263
Fluoride	NA	0.2	0.2	0.4
pH	9	7.49	7.46	6.8
Ammonia	NA	ND	1	ND
Nitrate+Nitrite as N	NA	0.2	ND	0.2
Total Organic Carbon	NA	140	27	52
METALS, mg/l				
Antimony	0.006	ND	ND	ND
Arsenic	0.05	0.017	0.006	ND
Barium	1	0.2	0.15	0.15
Beryllium	0.004	ND	ND	ND
Chromium	0.1	0.01	ND	ND
Cobalt	NA	0.02	0.01	ND
Lead	0.015	ND	ND	ND
Mercury	0.002	ND	ND	ND
Nickel	0.1	0.01	ND	ND
Selenium	0.01	ND	ND	ND
Vanadium	0.245	0.014	ND	ND
VOLATILE ORGANICS, ug/l				
Benzene	5	2800	600	2000
Methyl ethyl ketone	21000	9300	ND	ND
Ethylene benzene	700	1200	210	2900
Toluene	1000	ND	ND	ND
Total xylenes	10000	6100	1520	4100
BASE/NEUTRAL ORGANICS				
Benzo(a)anthracene	0.1	ND	ND	ND
Benzo(b)fluoranthene	0.2	ND	ND	ND
Benzo(a)pyrene	0.2	ND	ND	ND
Bis(2-ethylhexyl)phthalate	6	ND	ND	ND
Chrysene	0.2	ND	ND	ND
Dibenz(a,h)anthracene	0.3	ND	ND	ND
Fluoranthene	1270	ND	5	ND
Indene	NA	ND	ND	ND
1-Methylnaphthalene	1270	610	1000	69
Naphthalene	1270	1100	1100	190
Phenanthrene	9550	ND	55	ND
Pyrene	955	ND	6	ND
ACID ORGANICS, ug/l				
meta- & para-Cresols	2000	ND	ND	ND
2,4-Dimethylphenol	700	ND	ND	ND
Phenol	1000	ND	ND	ND

CONCENTRATION UNITS:	
Specific Conductance	umhos/cm
pH	pH Units
All Other Inorganic Parameters	mg/l
All Metals	mg/l
All Volatile Organics	ug/l
All Base/Neutral Organics	ug/l
All Acid Organics	ug/l

Note: only compounds detected at least once are included
Action Levels based on RFI Report
DWS – EPA Drinking Water Standard

Table 2
Philadelphia Refinery Groundwater Evaluation

	Action Level	Evaluation of Existing Data			
INORGANIC PARAMETERS	or DWS	Max	Exceed?	Avg	Exceed?
Total Dissolved Solids	500	2030	exceed	634	exceed
Specific Conductance	NA	4020	NA	999	NA
Chloride	250	300	exceed	68	OK
Sulfate	250	300	exceed	71	OK
Total Alkalinity	NA	1270	NA	338	NA
Fluoride	NA	3	NA	1	NA
pH	9	12.55	exceed	8	OK
Ammonia	NA	16	NA	2	NA
Nitrate+Nitrite as N	NA	35	NA	3	NA
Total Organic Carbon	NA	270	NA	48	NA
METALS, mg/l					
Antimony	0.006	0.005	OK	0.000	OK
Arsenic	0.05	0.075	exceed	0.009	OK
Barium	1	0.73	OK	0.126	OK
Beryllium	0.004	0	OK	0.000	OK
Chromium	0.1	0.03	OK	0.001	OK
Cobalt	NA	0.02	NA	0.004	NA
Lead	0.015	0.04	exceed	0.002	OK
Mercury	0.002	0.0007	OK	0.000	OK
Nickel	0.1	0.02	OK	0.001	OK
Selenium	0.01	0.007	OK	0.000	OK
Vanadium	0.245	0.09	OK	0.006	OK
VOLATILE ORGANICS, ug/l					
Benzene	5	2800	exceed	245	exceed
Methyl ethyl ketone	21000	9300	OK	527	OK
Ethylene benzene	700	2900	exceed	204	OK
Toluene	1000	260	OK	11	OK
Total xylenes	10000	17100	exceed	1072	OK
BASE/NEUTRAL ORGANICS					
Benzo(a)anthracene	0.1	55	exceed	2.5	exceed
Benzo(b)fluoranthene	0.2	32	exceed	1.2	exceed
Benzo(a)pyrene	0.2	49	exceed	1.7	exceed
Bis(2-ethylhexyl)phthalate	6	100	exceed	7.5	exceed
Chrysene	0.2	62	exceed	2.7	exceed
Dibenz(a,h)anthracene	0.3	28	exceed	0.7	exceed
Fluoranthene	1270	5	OK	0.1	OK
Indene	NA	23	NA	0.9	NA
1-Methylnaphthalene	1270	1000	OK	49.7	OK
Naphthalene	1270	1100	OK	67.4	OK
Phenanthrene	9550	55	OK	2.2	OK
Pyrene	955	25	OK	1.6	OK
ACID ORGANICS, ug/l					
meta- & para-Cresols	2000	37	OK	1	OK
2,4-Dimethylphenol	700	110	OK	5	OK
Phenol	1000	50	OK	2	OK

CONCENTRATION UNITS:	
Specific Conductance	umhos/cm
pH	pH Units
All Other Inorganic Parameters	mg/l
All Metals	mg/l
All Volatile Organics	ug/l
All Base/Neutral Organics	ug/l
All Acid Organics	ug/l

Note: only compounds detected at least once are included
Action Levels based on RFI Report
DWS – EPA Drinking Water Standard

TABLE 4-7
ACTION LEVELS FOR CHEMICALS IN GROUNDWATER
SUN REFINING & MARKETING COMPANY, PHILADELPHIA REFINERY
RCRA FACILITY INVESTIGATION

CHEMICAL	Groundwater AL (ug/l)	Reference
1-METHYLNAPHTHALENE	1270	(b)
2,4-DIMETHYLPHENOL	700	(b)
2-BUTANONE (MEK)	21000	(b)
2-METHYLNAPHTHALENE	1270	(b)
2-METHYLPHENOL	1750	(b)
4-METHYLPHENOL	1750	(b)
4-NITROPHENOL	280	(b)
6-METHYLCHRYSENE	955	(b)
ACENAPHTHENE	1910	(b)
ANTHRACENE	9550	(b)
ANTIMONY	6	(a)
ARSENIC	50	(a)
BENZENE	5	(a)
BENZO(A)ANTHRACENE	0.1	(c)
BENZO(A)PYRENE	0.2	(a)
BENZO(B)FLUORANTHENE	0.2	(c)
BENZO(G,H,I)PERYLENE	1670	(b)
BENZO(K)FLUORANTHENE	0.2	(c)
BERYLLIUM	4	(a)
BIS(2-ETHYLHEXYL)PHTHALATE	6	(a)
BUTYLBENZYLPHTHALATE	100	(a)
CADMIUM	5	(a)
CARBAZOLE	1.75	(b)
CARBON DISULFIDE	3500	(b)
CHLOROFORM	100	(a)
CHROMIUM III	NA	
CHROMIUM VI	NA	
CHROMIUM TOTAL	100	(a)
CHRYSENE	0.2	(c)
COPPER	1300	(d)
DIBENZ(A,H)ANTHRACENE	0.3	(c)
DIBENZOFURAN	147	(b)
ETHYLBENZENE	700	(a)
FLUORANTHENE	1270	(b)
FLUORENE	1270	(b)
INDENO(1,2,3-CD)PYRENE	0.4	(c)
LEAD	15	(e)
MERCURY	2	(a)
NAPHTHALENE	1270	(b)
NICKEL	100	(a)
PHENANTHRENE	9550	(b)
PYRENE	955	(b)
STYRENE	100	(a)
THALLIUM	2	(a)
TOLUENE	1000	(a)
TRICHLOROETHENE	5	(a)
VANADIUM	245	(b)
XYLENES	10000	(a)

NOTES:
NA - Not Analyzed.
(a) - MCL, U.S. EPA, 1992_.
(b) - Calculated assuming a 70 kg adult consumes 2 L water per day for a 70-yr lifetime.
(c) - Proposed MCL - the only officially promulgated MCL for PAH is for B(a)P.
(d) - Action level for copper is 1.3 mg/l, U.S. EPA, 1992.
(e) - Action level for lead is 0.015 mg/l, U.S. EPA, 1992 .

MCLS.WQ1 RN: 2 22-May-93

W-1 URS

Project No: 6445-017 Client: SUN OIL Site: Philadelphia, PA

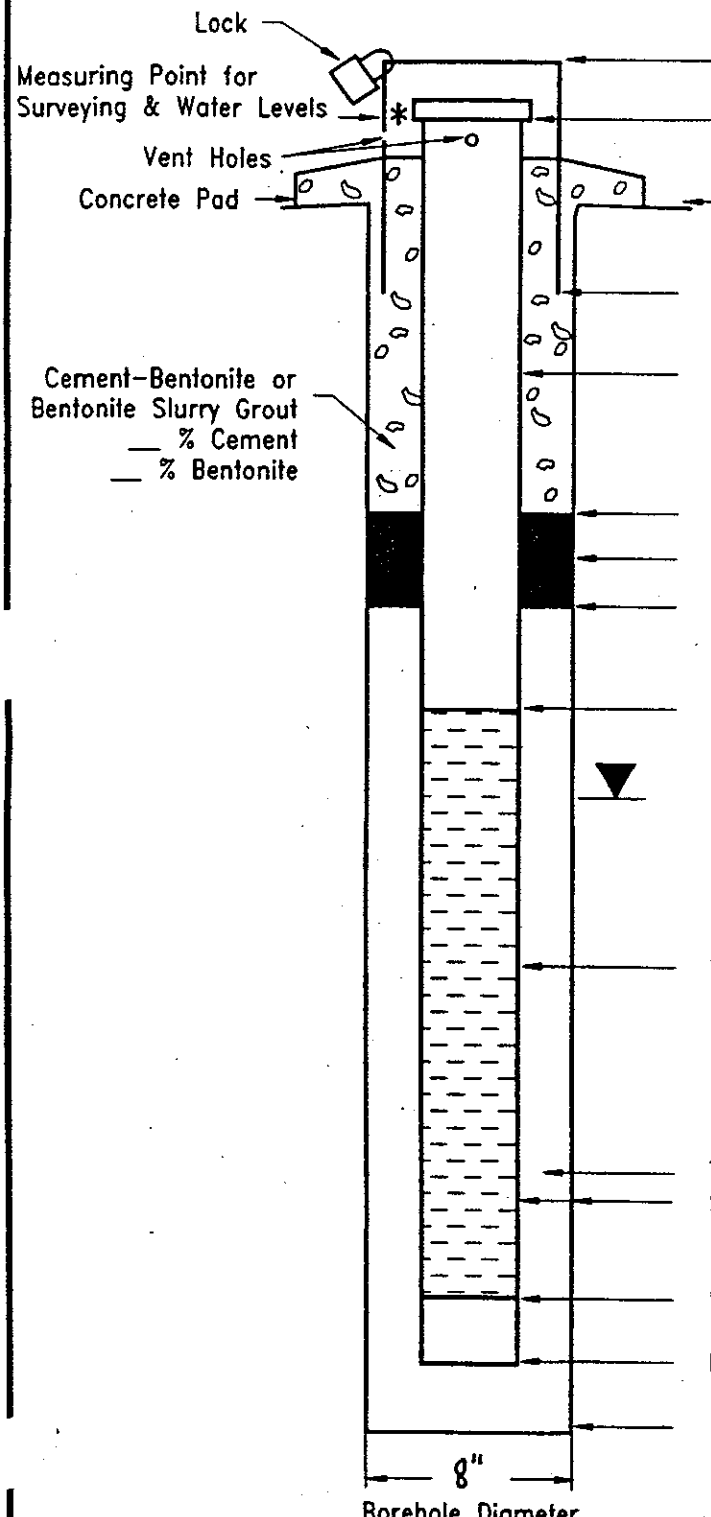
WELL No: MW-20

Well Location: WEST YARD

Date Installed: 3/12/92

Contractor: EMPIRE Method: MUD ROTARY Inspector: J. Rig

MONITORING WELL CONSTRUCTION DETAIL



	Depth from G.S. (feet)	Elevation (NGVD)
Top of Steel Guard Pipe		
Top of Riser Pipe		
Ground Surface (G.S.)	0.00	
Bottom of Steel Guard Pipe		
Riser Pipe: Length 52'		
Inside Diameter (ID) 2"		
Type of Material PVC		
Top of Bentonite Seal	46'	
Bentonite Seal Thickness 2'		
Top of Sand	48'	
Top of Screen	50'	
Stabilized Water Level		
Screen:		
Length 10'		
Inside Diameter (ID) 2"		
Slot Size 0.020		
Type of Material PVC		
Type/Size of Sand Silica/#2		
Sand Pack Thickness 3"		
Bottom of Screen	60'	
Bottom of Tail Pipe: Length ____		
Bottom of Borehole	79'	

Approved:

* Describe Measuring Point:

Signature Date

ENSR