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General Manager
Philadelphia Refinery

Hand Delivered

December 30, 1992

U. S. EPA (Region III)
841 Chestnut Street
Philadelphia, PA 19107

Attention: Mr. Robert L. Allen, Chief
RCRA Programs Branch

Dear Mr. Allen:

RCRA Verification Investigation Final Report

As outlined under RCRA Corrective Action Permit PAD 049-791-098, we are enclosing (3) three copies of the subject report for your information and review.

If you should have any further questions regarding this information, please call Mr. John Harris, Environmental Specialist at (215) 339-7466.

Very truly yours,

G. R. Moffitt

SJH/tml
enclosure(s)
cc: Mr. Lawrence H. Lunsk (PaDER - Waste Mgmt. Branch)
PaDER - Water Quality Branch w/o Attach.

Received By
EPA
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RCRA VERIFICATION INVESTIGATION REPORT
CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

DECEMBER 30, 1992

DAMES & MOORE

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# 1.0 EXECUTIVE SUMMARY

This report presents the results of the Resource Conservation and Recovery Act (RCRA) Verification Investigation (VI) conducted by Dames & Moore, on behalf of Chevron USA, Inc., at the Chevron Refinery in Philadelphia, Pennsylvania. The VI was performed in accordance with the document entitled *Verification Investigation Work Plan,* developed by Dames & Moore (dated July 2, 1991) and Chevron's September 27, 1989, RCRA Corrective Action Permit (EPA I.D. No. PAD 049 791 098). The United States Environmental Protection Agency (USEPA) approved the Work Plan in its conditional acceptance letter dated July 1, 1992.

The Chevron Refinery is located approximately 5 miles southwest of the center of Philadelphia in Philadelphia County, southeastern Pennsylvania. The Refinery is located at 30th Street and Penrose Avenue in a heavily industrialized area (primarily petrochemical) adjoining the Schuylkill River. This area of southern Philadelphia County is characterized by level topography composed of unconsolidated sediments of the Atlantic Coastal Plain Physiographic Province. According to the USGS Philadelphia 7.5-minute topographic quadrangle map, the site is situated at an elevation of approximately 10 feet above mean sea level. It is bounded to the north, west, and south by the Schuylkill River. The land surface gently increases in elevation to the east.

The VI conducted at the Refinery consisted of a series of tasks at each of 15 Solid Waste Management Units (SWMUs) to evaluate whether detailed investigation is warranted. These tasks included physical integrity evaluation (SWMU Nos. 2 and 9), soil gas sampling and analysis (SWMU Nos. 11/12, 29, and 71A), surface and subsurface soil sample collection and analysis, and ground water sampling and analysis.

Based on the analytical results obtained from the above-referenced tasks, each SWMU was evaluated on an individual basis to assess whether further investigation is warranted. These evaluations were conducted in a phased approach using the data derived from the VI conducted at each SWMU. The phased approach consisted of a preliminary risk evaluation and a screening risk assessment. The preliminary risk evaluation consisted of comparing the analytical data to risk-based action levels. The screening risk assessment involved calculating carcinogenic and non-carcinogenic risks associated with the detected concentrations of hazardous constituents. The criteria for evaluating the data support the objective of the investigation by determining whether hazardous waste constituents detected in each SWMU pose a risk to human health.

The preliminary risk evaluation indicated that hazardous constituents were present at each of the SWMUs at concentrations that exceed action levels. The screening risk assessment performed for each VI SWMU indicated that for non-carcinogenic health risks, the Hazard Index was less than 1.0 for all of the VI SWMUs, indicating that adverse health effects from detected non-carcinogens are unlikely to occur. Cumulative risks from carcinogens in soil at all SWMUs range between $3 \times 10^{-6}$ and $1 \times 10^{-4}$. Risks from hazardous constituents at a SWMU falling within this range indicate further investigation is not warranted. Therefore, these SWMUs do not require additional investigation regarding the presence of carcinogenic and non-carcinogenic constituents in soil. Lead was detected in the soil within SWMU Nos. 1/2, 6, and 30 at concentrations that exceed the 1,000-mg/kg USEPA cleanup level. The detected

concentrations of lead in SWMU Nos. 1/2, 6, and 30 were 2,260 mg/kg, 3,760 mg/kg, and 2,270 mg/kg, respectively. These concentrations indicate that additional investigation is warranted at these SWMUs with regard to lead in soil.

Based on the results of the VI conducted at each SWMU, Dames & Moore's recommendations are:

- Additional investigation of soil within the VI SWMUs is not warranted based on risks posed by carcinogens and non-carcinogens.

- Additional investigation of soil within SWMU Nos. 1/2, 6, and 30 should be conducted for lead in soil based on detected soil-lead concentrations.

- Additional investigation should be conducted within SWMU Nos. 11 and 30 to evaluate the extent of free-phase hydrocarbon floating on the water table within these units.

- Additional investigation of dissolved constituents in ground water at the VI SWMUs should be addressed as part of the RCRA Facility Investigation (RFI).

## 2.0 INTRODUCTION

Dames & Moore has prepared this Verification Investigation Report on behalf of Chevron USA, Inc. (Chevron), in accordance with the document entitled *Verification Investigation Work Plan,* dated July 2, 1991, developed by Dames & Moore for the Chevron Refinery in Philadelphia, Pennsylvania. In addition, Dames & Moore incorporated revisions to this Work Plan based upon the conditional Work Plan acceptance letter, dated July 1, 1992, forwarded to Chevron by the United States Environmental Protection Agency (USEPA).

On September 27, 1989, the USEPA issued a Resource Conservation and Recovery Act (RCRA) Corrective Action Permit (EPA I.D. No. PAD 049 791 098) to Chevron for the Philadelphia Refinery with an effective date of October 27, 1989. *Part II - Specific Conditions* of this permit set forth certain requirements regarding "corrective action for all releases of hazardous waste or constituents from any solid waste management unit" as provided under Section 3004 (u) of RCRA (Section 206 of the Hazardous and Solid Waste Amendments of 1984) and regulations promulgated in 40 CFR Section 264.101. Pursuant to and in compliance with Part II, Section (A), subsections (1), (2), (3), and (4) of that permit and the relevant USEPA guidance documents referenced therein, Chevron submitted the required Verification Investigation (VI) Work Plan.

This report presents the results of the VI conducted within 15 Solid Waste Management Units (SWMUs) at the Refinery. The 15 SWMUs are:

- SWMU No. 1 - Empty Lube Oil Drum Storage Area
- SWMU No. 2 - Empty Lube Area Sump
- SWMU No. 6 - Trash Incinerator
- SWMU No. 9 - Product Storage Sump
- SWMU No. 11 - Past Lagoon A
- SWMU No. 12 - Crude Oil Topping Unit
- SWMU No. 13 - Tank 355
- SWMU No. 16 - Tank 357
- SWMU No. 17 - Tank 358
- SWMU No. 29 - Tank 200 Past Lagoon
- SWMU No. 30 - Additive Plant Drum Storage Area
- SWMU No. 45 - Empty Drum Storage Area
- SWMU No. 71 - Past Lagoon B
- SWMU No. 71A - Past Lagoon B Addition
- SWMU No. 79 - Drum Storage Area

The Refinery and surrounding vicinity are shown on Figure 2-1. The locations and approximate extent of each SWMU are shown on Figure 2-2.

The remainder of this chapter outlines the objectives and scope of work for the project, and discusses criteria for further investigation at the SWMUs. Chapter 3.0 of this report reviews site background information of the Refinery, including the location, description, regional and site hydrogeology, and environmental setting. Chapter 4.0 presents the results of the VI conducted at the 15 SWMUs. For convenience, several of the SWMUs are discussed

collectively because of the superposition of one SWMU on another SWMU. Chapter 4.0 also contains the results of the preliminary risk-based evaluation conducted for each SWMU. The results of the screening risk assessment performed for each SWMU are summarized in Chapter 5.0. Conclusions related to the future environmental status of each SWMU, based on the VI results, and recommendations regarding further investigation at each SWMU, are presented in Chapter 6.0. Chapter 7.0 lists the references used to prepare this report.

## 2.1 OBJECTIVES AND SCOPE OF WORK

The overall objective of the VI was to evaluate whether detailed investigation is necessary at each of the above-referenced SWMUs. The remainder of this report details the results of VIs conducted at each of the SWMUs to achieve the objective.

The specific objectives of the VI conducted at the subject SWMUs were to:

- Establish the physical integrity of SWMU Nos. 2 and 9.
- Establish the presence or absence of hazardous waste or hazardous waste constituents in the area of each unit.
- Establish whether there has been migration or continuing releases of hazardous wastes or constituents from the units.
- Evaluate whether further investigation is warranted at each SWMU.

To achieve these objectives, a series of tasks were performed at each SWMU, including physical integrity evaluation (SWMU Nos. 2 and 9), soil gas sampling and analysis (SWMU Nos. 11/12, 29, and 71A), surface and subsurface soil sample collection and analysis, and ground water sampling and analysis. These tasks were performed in accordance with the VI Work Plan, Health and Safety Plan, Data Quality Assurance Plan, and Sampling Plan.

## 2.2 RISK-BASED CRITERIA

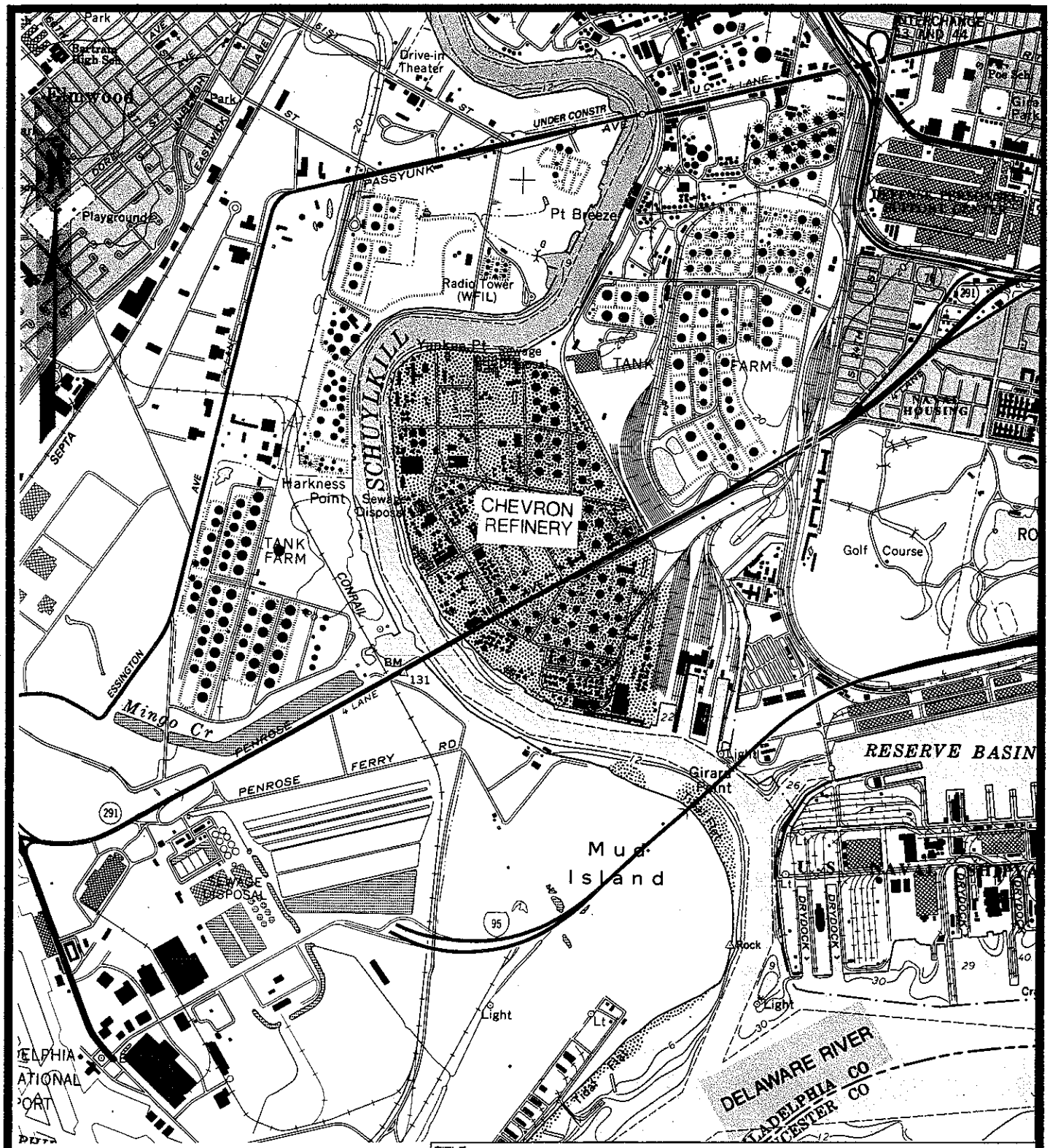
Each SWMU was evaluated on an individual basis to determine whether further investigation is warranted. These evaluations were conducted by a phased approach using the data derived from the VI conducted at each SWMU. The phased approach involved a preliminary risk evaluation and a screening risk assessment. The preliminary risk evaluation consisted of comparing the analytical data to risk-based action levels. The screening risk assessment consisted of calculating carcinogenic and non-carcinogenic risks associated with the detected concentrations of hazardous constituents. The criteria for evaluating the data support the objective of the investigation by determining whether hazardous waste constituents detected in each SWMU pose a risk to human health. This phased data evaluation, conducted to determine whether additional investigation is warranted at a SWMU, involved:

- Concentrations of parameters detected in soil and ground water were compared with the risk-based action levels specified in the RCRA 3004(u) draft Corrective Action Rule, published in the July 27, 1990, Federal Register (55 CFR 30798). If the concentrations of detected waste constituents in all samples were below the respective action levels in the July 27, 1990, Federal Register, no further action is warranted at that SWMU. These action levels are risk-based, using highly conservative exposure assumptions.

- If analytes detected in a specific media at the Refinery were not listed in the July 27, 1990, corrective action rule, detected concentrations of these constituents were compared to the risk-based concentrations listed in the April 14, 1992, USEPA Region III memorandum prepared by Roy L. Smith (Senior Toxicologist). Dr. Smith's risk-based concentrations are also considered preliminary risk evaluation action levels. If the concentrations of detected constituents in all samples were below their respective action levels in the April 14, 1992, memorandum, no further action is warranted at that SWMU.

- If concentrations of waste constituents in any sample from a SWMU were above the risk-based level in the RCRA Corrective Action Rule or the USEPA's previously referenced memorandum, a screening risk assessment was performed based on the highest concentration detected at the SWMU. If the highest concentration detected within a SWMU results in a risk that is below the acceptable risk levels specified in the screening risk assessment methods, no further action is warranted at that SWMU. If the highest concentration detected at a SWMU results in an estimated risk that is above the acceptable risk level, a RCRA Facility Investigation (RFI) is indicated for that SWMU.

The procedures and results of the screening risk assessment are presented in Appendix A. Chapter 4.0 presents the risk-based criteria (preliminary risk evaluation action levels) and the results of the preliminary risk evaluation that compares the criteria to the analytical data obtained during the VI. The results of the screening risk assessment are summarized in Chapter 5.0. The results of the screening risk assessment are not intended to determine whether corrective measures are required at a given SWMU. Rather, the purpose of the screening risk assessment was to establish whether further investigation is required at a specific SWMU. Risk estimates generated by the risk assessment should not be construed as the expected rate of adverse effects in exposed populations, but are merely estimates of a risk based on current knowledge and a large number of assumptions. As such, the risk levels generated in the screening risk assessment are useful to compare one SWMU to another and set priorities for further investigations.




0 1000 2000 3000 FEET

GRAPHIC SCALE

CONTOUR INTERVAL = 20 FEET

REFERENCE:

A PORTION OF USGS 7.5 TOPOGRAPHIC MAP; PHILADELPHIA QUADRANGLE, PA © 1967, PHOTOREVISED 1985

TITLE

# SITE VICINITY MAP

PROJECT

CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

**DAMES & MOORE**
WILLOW GROVE, PENNSYLVANIA

| | | | |
|---|---|---|---|
| SCALE AS SHOWN | DWN. BY EM² | JOB NO. 16000-383 | |
| DATE 12/1/92 | APPR. BY T.J.G. | FIG. NO. 2-1 | |

LEGEND

- PROPERTY BOUNDARY
- A137 MONITORING WELL LOCATION (VI)
- A120 MONITORING WELL LOCATION (RFI)
- A40 EXISTING MONITORING WELL LOCATION
- WP-1 WELL POINT LOCATION (RFI)
- PROCESS SEWERS
- SANITARY SEWERS
- OUTFALLS
- XXX LOADING AREAS & EGRESS POINTS
- XXX STORAGE AREAS
- SOLID WASTE MANAGEMENT UNIT (VI)
- LOADING RACK

0 100 200 300 400 FEET

GRAPHIC SCALE

200 FOOT GRID BASED ON PENNSYLVANIA STATE RECTANGULAR COORDINATE SYSTEM, SOUTH ZONE 1927 N.A. DATUM

REFERENCE:
BASE MAP PROVIDED BY CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA.

10 C:\ACAD\CHEVRON\GRPH-108 12/21/92 15:50

| | |
|---|---|
| TITLE | LOCATIONS AND EXTENTS OF SOLID WASTE MANAGEMENT UNITS VERIFICATION INVESTIGATION |
| PROJECT | CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA |
| | DAMES & MOORE WILLOW GROVE, PENNSYLVANIA |
| SCALE | AS SHOWN |
| DWN. BY | R.G.B. |
| JOB NO. | 16000-383 |
| DATE | 12-21-92 |
| APPR. BY | T.J.G. |
| FIG. NO. | 2-2 |

# 3.0 BACKGROUND

This chapter reviews the background information related to location, description, regional and site hydrogeology, and environmental setting of the Refinery. The background information was compiled from the fact sheet of the referenced permit, a review of site aerial photographs, interviews with Chevron employees, and various reference documents. The discussion on regional and site hydrogeology is primarily based on previous work at the Refinery. This information will be supported by data obtained during the VI and ongoing RFI. A more detailed analysis of the hydrogeologic conditions at the site will be presented in the RFI report.

## 3.1 SITE LOCATION AND PHYSIOGRAPHY

The Chevron Refinery is located approximately 5 miles southwest of the center of Philadelphia in Philadelphia County, southeastern Pennsylvania, as shown on Figure 2-1. The Refinery is located at 30th Street and Penrose Avenue in a heavily industrialized area (primarily petrochemical) adjoining the Schuylkill River. This area of southern Philadelphia County is characterized by level topography composed of unconsolidated sediments of the Atlantic Coastal Plain Physiographic Province. The site lies within the Philadelphia 7.5-minute quadrangle at an approximate elevation of 10 feet above mean sea level. It is bounded to the north, west, and south by the Schuylkill River. The land surface gently increases in elevation to the east.

## 3.2 SITE DESCRIPTION

The Refinery occupies approximately 350 acres along the Schuylkill River. For purposes of site evaluation, the Refinery has been divided into three areas, designated Areas A, B, and C, as shown on Figure 2-2.

Area A, which lies south of the George Platt Bridge, is the oldest area of the refinery, dating back to the 1920s. This area, referred to as the "terminal," contains a gasoline tank truck loading rack, a petrochemicals tank truck and rail loading rack, a lube oils rail loading area, a package and grease plant, a marine loading dock, and associated piping and tankage.

Area B, which is located north of the George Platt Bridge and south of Pennypacker Avenue, contains the petrochemical process plants, wastewater-treatment system maintenance and laydown yards, and associated piping and tankage. Area B formerly contained the original refining units, most of which have been removed except for their foundations. This area also includes office buildings and a laboratory.

Area C, which is located north of Pennypacker Avenue, contains the primary refining units, several separators, and the associated piping and storage tanks. The refining units were constructed during the 1940s.

The Refinery appears to have been constructed by placing non-indigenous fill over a salt marsh. Typically, the marsh deposits are composed of plastic, low permeability clays. These clays often contain peat or seams high in organic content that may have higher

permeabilities than the clay. Some permeable alluvial materials, sand or gravel, may also be interbedded with the marsh deposits. To Dames & Moore's knowledge, the origin and composition of the fill materials at the Refinery are not documented.

## 3.3 REGIONAL HYDROGEOLOGY

### 3.3.1 Regional Geology

The Chevron Philadelphia Refinery is located just east of the Fall Line, a physiographic feature separating the Piedmont Physiographic Province from the Atlantic Coastal Plain. The Piedmont Province is underlain by bedrock composed of weathered crystalline metamorphic and igneous rocks, and sedimentary rocks. The Piedmont-type geologic regime extends eastward under the Atlantic Coastal Plain, where it is overlain by a wedge of Cretaceous and younger unconsolidated sediments. These unconsolidated sediments, upon which the Refinery is situated, dip gently to the east and contain regional confined and semi-confined aquifers, including the lower portion of the Cretaceous Raritan Formation.

The bedrock beneath the refinery is primarily an oligoclase-mica schist, which is a part of the Lower Paleozoic Wissahickon Formation. The bedrock surface slopes toward the southeast, and ranges in depth from approximately 60 to 120 feet at the Refinery, as shown on Figure 3-1.

The bedrock surface is unconformably overlain by the Cretaceous Farrington Sand, which is a member of the Raritan Formation. The Farrington Sand may be absent near the northern boundaries of the Refinery and is approximately 20 feet thick along the southern boundary of the Refinery, as shown on Figure 3-2. The top of the Farrington Sand dips toward the southeast. The elevation of the Farrington ranges from approximately 50 feet below mean sea level (MSL) near the northern boundary of the Refinery to approximately 70 feet below MSL near the southern boundary of the Refinery, as shown on Figure 3-3.

The Farrington is typically overlain by a clay layer that is also a member of the Raritan Formation. However, in the vicinity of the Refinery, this clay member is absent and the Farrington Sand is directly overlain by the Pleistocene Trenton gravel. The Trenton gravel is composed of gravel, sand, silt, and clay, which are overlain by a thin veneer of Recent unconsolidated sediments.

### 3.3.2 Regional Hydrology

The Farrington Sand of the Raritan Formation is an important aquifer and supplies industrial and drinking water to parts of Pennsylvania and New Jersey. Typically, this aquifer is overlain by thick Cretaceous clay deposits, which act as confining beds, separating the Farrington Sand from the overlying aquifer and allowing it to operate as a separate hydrologic unit. In a few places, such as in the vicinity of the northern boundaries of the Refinery, the overlying Cretaceous clay is absent, and the Farrington Sand is in hydraulic connection with the overlying aquifer.

Ground water flow measured during 1987 in the vicinity of the Refinery is primarily toward the southwest. This flow direction is based upon measurements from wells screened within the Farrington and other sand members of the Raritan Formation, and the Trenton gravel. Information concerning ground water usage in the area is provided in subsection 3.3.2.1. Information regarding the Mingo Creek Flood Control Basin is presented in subsection 3.3.2.2.

### 3.3.2.1 Well Inventory Survey

Based on the available information (U.S. Geological Survey, 1984), there does not appear to be significant use of ground water from the sand members of the Raritan Formation within a 1.5-mile radius of the Refinery. Twenty-two wells are identified in the U.S. Geological Survey document (1984) within a 1.5-mile radius of the Refinery: 8 within the Raritan formation, 13 within the Trenton gravel, and 1 in the Wissahickon Formation. The pumping schedule for these wells is summarized as follows:

| LOCATION | FORMATION | NO. OF WELLS | PUMPING SCHEDULE |
|---|---|---|---|
| Chevron Refinery<br>U.S. Naval Shipyard | Raritan<br>Raritan<br>Farrington Sand | 2<br>2 | Unused<br>Unused |
| Philadelphia Sewage Treatment Plant | Sayreville and Old Bridge Sands | 4 | Observation wells |
| Philadelphia Sewage Treatment Plant | Trenton gravel | 7 | Dewatering wells |
| Philadelphia Sewage Treatment Plant | Trenton gravel | 5 | Observation wells |
| Roosevelt Park | Trenton gravel | 1 | Unused |
| Mingo Creek Flood Control Sump Pumps | Trenton gravel | | Pump during storm events only @ 5,000 gpm |
| Unknown | Wissahickon | 1 | Unused |

Eight wells are completed in the sand members of the Raritan Formation. Four of the eight wells are not currently in use; two of the inactive wells are located at the Refinery and two are located approximately 1.5 miles southeast of the Refinery at the U.S. Naval Shipyard. All of the unused wells are screened in the Farrington Sand. The remaining four wells are located approximately 1 mile southwest of the Refinery near the City of Philadelphia's sewage treatment plant. These wells are owned by the City of Philadelphia, are screened in the Sayreville Sand and Old Bridge Sand, and are listed as observation wells.

There are 13 wells completed in the Pleistocene Trenton gravel. Twelve of the wells are owned by the City of Philadelphia and are located at the sewage treatment plant southwest of the Refinery. Seven of the wells are used for dewatering operations at the plant and the other five wells are listed as observation wells. The other well completed in the Trenton gravel is located at Roosevelt Park, approximately 1 mile southeast of the Refinery, and was not in use at the time of this study.

In addition, one well screened in the Wissahickon Formation is located approximately 1.5 miles north of the Refinery, and was listed as not in use.

Table 3-1 provides the well owner, date of installation, well type, well usage, surface elevation, and static water level for each of the wells discussed above. Well locations are shown on Figure 3-4.

### 3.3.2.2 Mingo Creek Flood Control Basin

The Mingo Creek Flood Control Basin is a large excavation that was constructed to contain peak surface water flows during periods of storm water run-off in the urban Philadelphia area. The basin was excavated to a depth that was sufficient to intersect the underlying Trenton gravel. In some locations, the basin may penetrate the top of the Farrington Sand of the Raritan Formation. Also, the Lower Clay member of the Raritan Formation (silt/clay layer) may be absent between the Trenton gravel and the underlying Farrington Sand in the vicinity of the basin.

The basin accepts water from:

1) Mingo Creek
2) Storm water run-off from Philadelphia
3) Ground water leakage

The ground water leakage is reported as being slight. Most of the water originates as urban storm water run-off. Pumps situated in sumps within the basin operate only during and after a storm event. The ground water seepage rate is not known, but is not sufficient to activate the pumping system between rainfall events. The sump pumps have a pumping capacity of 5,000 gallons per minute (gpm). In 1990, the system discharged a total of 2,564 million gallons of water. Water pumped from the Mingo Creek Flood Control Basin is discharged to the Schuylkill River adjacent to the George Platt Bridge.

## 3.4 SITE HYDROGEOLOGY

The geology and hydrogeology of the Refinery were investigated by Dames & Moore in 1986 and 1987 during our Site Assessment. The data were derived from the installation of 62 shallow wells (ranging from 12 to 20 feet in depth) and 6 deep wells (ranging from 25 to 85 feet in depth). Descriptive boring logs and monitoring well construction logs are presented in Appendix B. The results of the previous investigations are presented in this section. The geology of the site is introduced first, followed by a discussion of site hydrogeology.

### 3.4.1 Site Geology

The geologic units relevant to this investigation are the unconsolidated sediments of the Pleistocene-age Trenton gravel and Cretaceous-age Raritan Formation (Lower Clay and Farrington Sand members). These sediments are underlain by the Paleozoic-age Wissahickon Schist (bedrock).

To illustrate the spatial relationship of these units, lines of cross section were selected (Figure 3-5) and cross sections A-A'-A'' (Figure 3-6), B-A-B' (Figure 3-7), A-C (Figure 3-8), A-A'-A''' (Figure 3-9), and C-A''' (Figure 3-10) were constructed using data developed during the 1986/87 Dames & Moore investigation. None of the on-site monitoring wells illustrated in the cross sections penetrate the underlying bedrock. However, the contour map of the underlying bedrock surface (Figure 3-1), which is based on regional geologic data, illustrates that the site is underlain by unconsolidated sediments that increase in thickness to the southeast. These geologic units are discussed individually in the remainder of this section.

3.4.1.1 Trenton Gravel and Fill Material

Directly underlying the Refinery is the Pleistocene Trenton gravel, which is composed of gravel, sand, silt, and clay. These sediments have been mixed with or underlie demolition debris used to fill low-lying areas. Specifically, the northwestern corner of the Refinery was a swampy area filled in the 1930s.

The cross sections (Figures 3-6, 3-7, 3-8, 3-9, and 3-10) show the fill material and the Trenton gravel as being undifferentiated. In some locations, depending on the nature of the fill material, the contact between the Trenton gravel/fill material unit and the underlying Raritan Formation is uncertain, as indicated in cross section C-A''' (Figure 3-10) by the question marks on the cross section.

3.4.1.2 Raritan Formation

The Raritan Formation underlies the relatively thin veneer of Trenton gravel. It is composed of the Lower Clay and Farrington Sand. The formation thickens to the southeast, as depicted by the structure contour map of the underlying bedrock surface shown in Figure 3-1.

The thickness of the Lower Clay Member varies from 20 feet in the eastern area of the Refinery to 70 feet at the Schuylkill River. The clay is first encountered at a depth of 5 to 10 feet.

The Farrington Sand underlies the Lower Clay Member in the area of the Refinery. The Farrington is composed of sand, gravel, and clay, and varies in thickness from 0 to 40 feet beneath the Refinery, as shown on the isopach contour map (Figure 3-2). The Farrington Sand generally dips to the south and northeast, as shown by the structure contour map of the top of the Farrington Sand on Figure 3-3.

3.4.1.3 Wissahickon Formation

The Wissahickon Formation is a mica schist with an upper surface that dips to the southeast (Figure 3-1). The contact between the Farrington Sand and the underlying Wissahickon Formation is unconformable.

### 3.4.2 Site Hydrology

#### 3.4.2.1 General

Ground water beneath the Refinery exists in two distinct zones within the unconsolidated sediments overlying the bedrock. These ground-water-bearing zones are designated as the Upper Unconsolidated Aquifer (UUA) and the Lower Unconsolidated Aquifer (LUA). The UUA is approximately 10 feet thick, and primarily consists of fill material and the Trenton gravel. The LUA is generally thicker, ranging from a maximum thickness of approximately 55 feet in the vicinity of the Ballfields to approximately 10 feet adjacent to the Schuylkill River, and consists of the Farrington Sand of the Raritan Formation. The two aquifers are separated by the Lower Clay Member of the Raritan Formation, a wedge-shaped layer of silt and clay. The silt and clay layer acts as an aquitard, causing the ground water in the UUA to exist under water table conditions and the ground water in the LUA to exist under semi-confined conditions. The silt and clay layer is approximately 70 feet thick along the Schuylkill River and thins to approximately 20 feet along the eastern boundary of the Refinery at Lanier Avenue, as shown in the cross section $A_{SR}$-$A_{MP}$-$A'''_{BF}$ (Figure 3-11). The location of the cross section is shown on Figure 3-12.

The structural relationship between the two unconsolidated aquifers at the Refinery is shown on cross sections A-A'-A'' (Figure 3-6), B-A-B' (Figure 3-7), A-C (Figure 3-8), A-A'-A''' (Figure 3-9), and C-A''' (Figure 3-10). The locations of the cross sections are shown on Figure 3-5.

Tidal Effects

Dames & Moore conducted a tidal effects study in 1986. A tidal fluctuation of approximately 4.5 feet was measured in a stilling well in the Schuylkill River near 4th Street. Slight water level fluctuations were recorded in two nearby monitoring wells (A8 and A9). These fluctuations were not systematic and did not correlate with tidal fluctuations in the river. The stilling well was constructed specifically for the test, and was dismantled after completion of the test.

#### 3.4.2.2 Upper Unconsolidated Aquifer

*1986/87 Site Assessment*

The Upper Unconsolidated Aquifer consists primarily of man-made fill that was deposited on top of the silty-clay. A swampy environment was present at the time of filling, based upon the elevations of the top of the clay layer and the organic material found at the top of the clay in the soil boring samples.

Elevations of the top of the silty clay layer range from approximately 5 to 10 feet above mean sea level, as shown on Figure 3-13. The surface of the silty clay is irregular, and a natural deposit of silty clay is difficult to distinguish from a man-made fill deposit of silty clay on the basis of a soil sample. Therefore, some of the shallow silty clay may be fill. Saturated silty and clayey sands of the UUA overlie this silty clay. The saturated thickness of the sand ranges from 0 to approximately 10 feet, as shown on Figure 3-14.

The general direction of ground water flow in the UUA, based on the 1986/87 Site Assessment, is shown on Figure 3-15. Ground water in the UUA originates from direct recharge by rainfall on the Refinery land surface. The general pattern of ground water flow is radially away from an elongated ground water mound in the central area of the Refinery. Ground water flows in northerly, westerly, and southerly directions away from the ground water mound and discharges into the Schuylkill River. Ground water flows from the ground water mound in an easterly direction toward the Ballfields and toward a surface water basin immediately south of the Ballfields.

Based on ground water elevations calculated during the 1986/87 Site Assessment, a downward hydraulic gradient from the UUA to the LUA exists throughout the Refinery. The difference in water levels between the upper and lower aquifers ranges from approximately 6.29 feet at A13D to 7.48 feet at A19D.

The vertical hydraulic conductivity of the silty clay ranges from $7.91 \times 10^{-7}$ cm/sec ($2.24 \times 10^{-3}$ feet/day) to $3.96 \times 10^{-8}$ cm/sec ($1.12 \times 10^{-4}$ feet/day). With the intervening clay thicknesses between the well pairs of 40 to 62 feet, the hydraulic gradients range from 0.115 to 0.19. The estimated maximum vertical leakage rate is approximately 0.15 foot/year using the largest vertical gradient and the largest vertical hydraulic conductivity. With an estimated porosity of approximately 35 percent, the ground water velocity would be approximately 0.43 foot/year.

*December 1992 Measurements*

The general direction of ground water flow in the UUA, based on the depth to water measurements collected on December 10, 1992, is shown on Figure 3-16. Surveying activities related to the RFI/VI at the site have not been completed. Thus, this ground water flow map was constructed using elevations from monitoring wells installed during previous investigations.

Based on the December 1992 data, the general pattern of ground water flow is radially away from an elongated ground water mound in the north-central area of the Refinery and a less pronounced mound in the southern area of the Refinery. Ground water flows in northerly, westerly, and southerly directions away from both ground water mounds and discharges into the Schuylkill River. Ground water flows from the north-central ground water mound in an easterly direction toward the Ballfields, and from both mounds toward a surface water basin immediately south of the Ballfields.

### 3.4.2.3 Lower Unconsolidated Aquifer

*1986/87 Site Assessment*

The LUA is composed of sand and gravel, which is overlain by the silty clay unit and underlain by mica schist bedrock. The thickness of the LUA varies from approximately 10 feet near the Schuylkill River to more than 55 feet in the vicinity of the Ballfields.

Based on the 1986/87 Site Assessment, ground water recharges the lower aquifer in the area east of the Refinery and migrates in a southwesterly direction toward the Schuylkill River (Figure 3-17). Part of the recharge occurs in the Ballfields as ground water flowing from the upper aquifer. In addition, recharge occurs from the upper aquifer by vertical leakage through the overlying clay.

Ground water in the lower aquifer migrates from the vicinity of the Ballfields under the Schuylkill River to the area of the Schuylkill River Tank Farm. Because the piezometric head in the lower aquifer is less than the water level in the Schuylkill River, there is also recharge from the river into the lower aquifer. A cross section showing these relationships is shown on Figure 3-11. The location of this cross section is shown on Figure 3-12.

Cross section $A_{SR}$-$A_{MP}$-$A'''_{BF}$ (Figure 3-11) illustrates the connection between the local ground water in the UUA on the site and the regional ground water in the LUA. Because of the downward hydraulic gradient from the UUA to the LUA on-site, leakage of ground water is expected to take place from the UUA to the LUA in the area of the Refinery. Because of the wedge-shaped thickness of the intervening silt and clay layer, the maximum leakage is expected to occur in the northeast area of the Refinery near the Ballfields, where the silty clay layer is thin and discontinuous. Likewise, the minimum downward leakage is expected to occur in the area of the western boundary of the Refinery, where the silt/clay layer is approximately 70 feet thick. Figure 3-18 is an isopach contour map showing the thickness of the silty clay.

Published specific capacity data for water production wells screened in the LUA in the South Philadelphia area indicate that the hydraulic conductivity of the lower aquifer material is in the range of 110 to 1,200 feet per day. With an estimated porosity of 25 percent, and a hydraulic gradient of 0.00194, the estimated ground water velocity in the LUA under the Refinery is in the range of 1 to 9 feet per day.

*December 1992 Measurements*

Based on depth to water measurements collected on December 10, 1992, ground water recharges the lower aquifer in the area east of the Refinery and migrates in a southwesterly direction toward the Schuylkill River (Figure 3-19). Part of the recharge occurs in the Ballfields where the silty clay is thin and discontinuous by ground water flowing from the upper aquifer. In addition, recharge occurs from the upper aquifer by vertical leakage through the overlying clay. Because the piezometric head in the lower aquifer is less than the water level in the Schuylkill River, recharge also occurs from the river into the lower aquifer.

## 3.5 OTHER ENVIRONMENTAL CHARACTERISTICS

### 3.5.1 Soil

The soil that underlies the Refinery is classified as Urban Land Series, which consists of artificial fill that overlies coastal plain and marsh deposits. The artificial fill consists of sand, gravel, silt, and clay with various debris.

### 3.5.2 Surface Water

The Refinery is located along the east bank of the Schuylkill River. Originally, uncontrolled surface water could potentially flow to the river. In the 1950s, the perimeter of the facility along the Schuylkill River was walled with 8,400 feet of interlocking steel sheet piling. As described in Section 3.1, the site is relatively level. Storm water run-off is controlled by a series of surface drains and underground drain lines that discharge to the oil/water separator units. All flow is then routed to the Refinery waste water treatment plant (WWTP). This storm water drainage system is depicted on Figure 2-2. Roof drainage from Warehouse Nos. 1 and 2, and from the Storehouse Building, discharges directly to the Schuylkill River. These roof drains are the only direct discharges of surface water from the Refinery to the Schuylkill River.

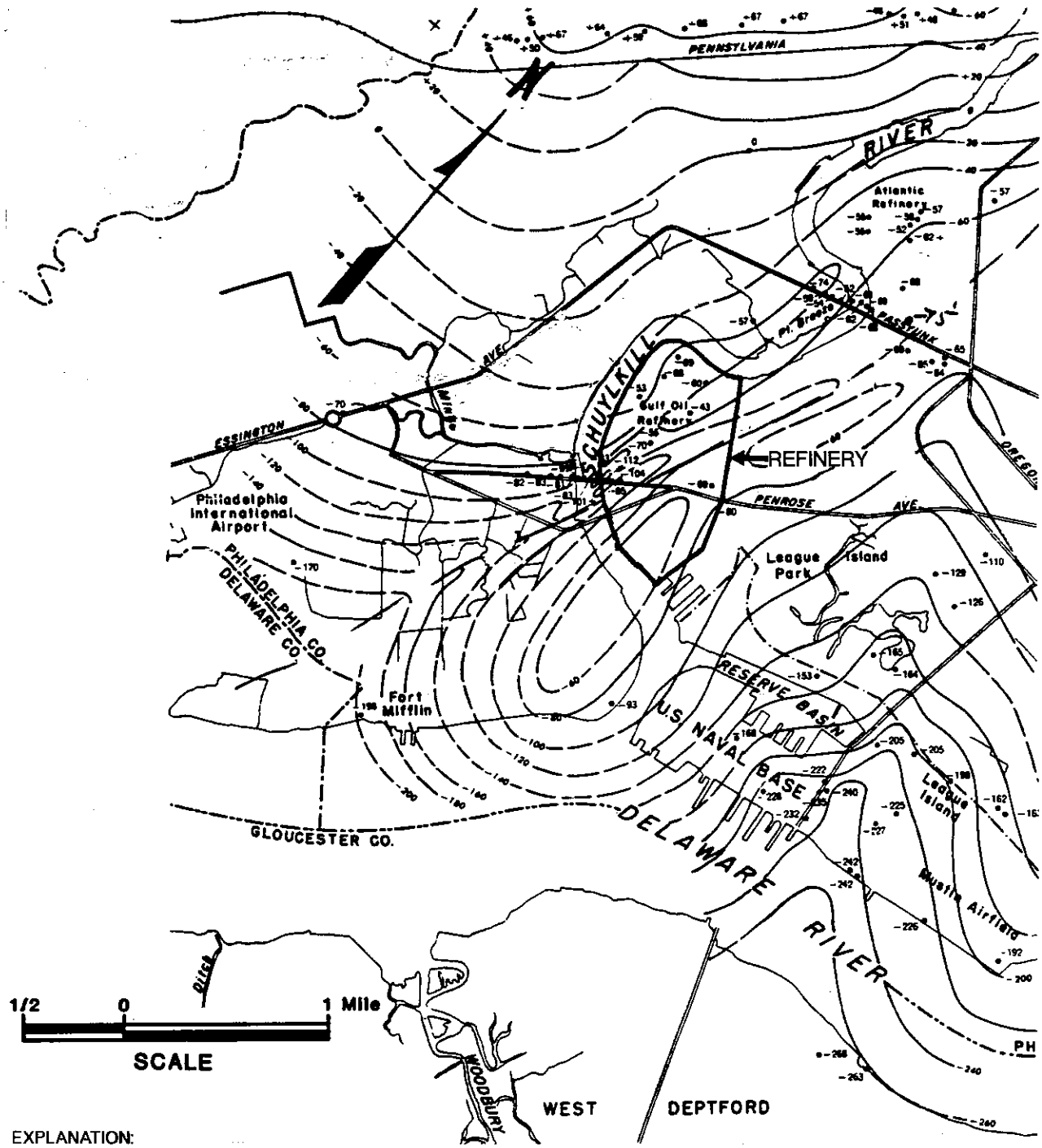
A topographic survey of the Refinery was completed by Chevron in 1981. However, the purpose of the survey required a scale of 1 inch equals 40 feet. The survey is contained on a series of twenty-two 24-inch by 36-inch sheets. Because all surface water from the site is directed to the WWTP (with the exception of the aforementioned warehouse roof drains), the topographic survey is not included in this report.

## TABLE 3-1

## WELLS SCREENED IN THE WISSAHICKON FORMATION, RARITAN FORMATION, AND TRENTON GRAVEL WITHIN A 1.5-MILE RADIUS OF THE CHEVRON PHILADELPHIA REFINERY

| Well I.D. No. | Owner | Installation Date | Well Usage | Well Depth (feet) | Surface Elevation (NGVD) | Depth to Static Water Level (feet) | Ground Water Surface Elevation (NGVD) | Geologic Unit |
|---|---|---|---|---|---|---|---|---|
| 32 | Phil. Gas Works | 1915 | Unused | 360 | 33.60 | 29.39 11/15/78 | 4.21 | Wissahickon Fm. |
| 5 | U.S. Navy | May 1940 | Unused | 173 | 14.76 | 28.41 11/1/78 | -13.65 | Lower sand unit Raritan-Magothy Fm. |
| 6 | U.S. Navy | June 20, 1942 | Unused | 163 | 10.19 | 19.22 10/31/78 | - 9.03 | Lower sand unit Raritan-Magothy Fm. |
| 43 | Chevron | January 1946 | Unused | 82 | 10.40 | 11.88 11/8/78 | - 1.48 | Lower sand unit Raritan-Magothy Fm. |
| 44 | Chevron | March 1946 | Unused | 82 | 10.50 | 11.60 11/8/78 | - 1.10 | Lower sand unit Raritan-Magothy Fm. |
| 809 | City of Philadelphia | January 1981 | Observation | 80 | 4.60 | 13.98 2/4/81 | - 9.38 | Upper sand unit Raritan-Magothy Fm. |
| 810 | City of Philadelphia | January 1981 | Observation | 100 | 10.70 | 19.46 2/4/81 | - 8.76 | Upper sand unit Raritan-Magothy Fm. |
| 812 | City of Philadelphia | January 1981 | Observation | 110 | 11.90 | 20.63 2/4/81 | - 8.73 | Upper sand unit Raritan-Magothy Fm. |
| 814 | City of Philadelphia | January 1981 | Observation | 130 | 7.50 | 15.69 2/4/81 | - 8.19 | Middle sand unit Raritan-Magothy Fm. |
| 64 | Roosevelt Park | 1919 | Unused | 82 | 3.40 | 9.40 11/1/78 | - 6.0 | Trenton Gravel |
| 784 | City of Philadelphia | March 1980 | Dewatering | 27 | 10.00 | NA | NA | Trenton Gravel |
| 785 | City of Philadelphia | March 1980 | Dewatering | 29 | 10.00 | NA | NA | Trenton Gravel |
| 786 | City of Philadelphia | March 1980 | Dewatering | 32 | 10.00 | NA | NA | Trenton Gravel |
| 787 | City of Philadelphia | March 1980 | Unused | 25 | 10.00 | NA | NA | Trenton Gravel |
| 788 | City of Philadelphia | March 1980 | Dewatering | 40 | 10.00 | NA | NA | Trenton Gravel |
| 789 | City of Philadelphia | March 1980 | Dewatering | NA | 10.00 | NA | NA | Trenton Gravel |
| 790 | City of Philadelphia | March 1980 | Dewatering | 40 | 10.00 | NA | NA | Trenton Gravel |
| 791 | City of Philadelphia | March 1980 | Dewatering | 40 | 10.00 | NA | NA | Trenton Gravel |
| 808 | City of Philadelphia | January 1981 | Observation | 23 | 4.70 | 14.08 2/4/81 | - 9.38 | Trenton Gravel |
| 811 | City of Philadelphia | January 1981 | Observation | 30 | 10.90 | 18.37 2/4/81 | - 7.47 | Trenton Gravel |
| 813 | City of Philadelphia | January 1981 | Observation | 30 | 11.90 | 20.63 2/4/81 | - 8.73 | Trenton Gravel |
| 815 | City of Philadelphia | January 1981 | Observation | 40 | 7.80 | 14.32 2/4/81 | - 6.52 | Trenton Gravel |

Notes:
1) For well locations, see Figure 3-4.
2) Data obtained from: Hydrologic Data for Aquifers in Philadelphia, Pennsylvania; U.S. Geological Survey Open-File Report 83-149, 1984.
3) NA - Not Available
4) NGVD - National Geodetic Vertical Datum




EXPLANATION:

•–52

Water well or boring

Number is altitude of the top of the bedrock surface, in feet, referred to mean sea level.

Contour line on bedrock surface, dashed where approximate. Contour interval—20 feet.

REFERENCE:

Ground Water Resources of the Coastal Plain Area of Southeastern Pennsylvania, Pennsylvania Geologic Survey Bulletin W-13; Plate 5.

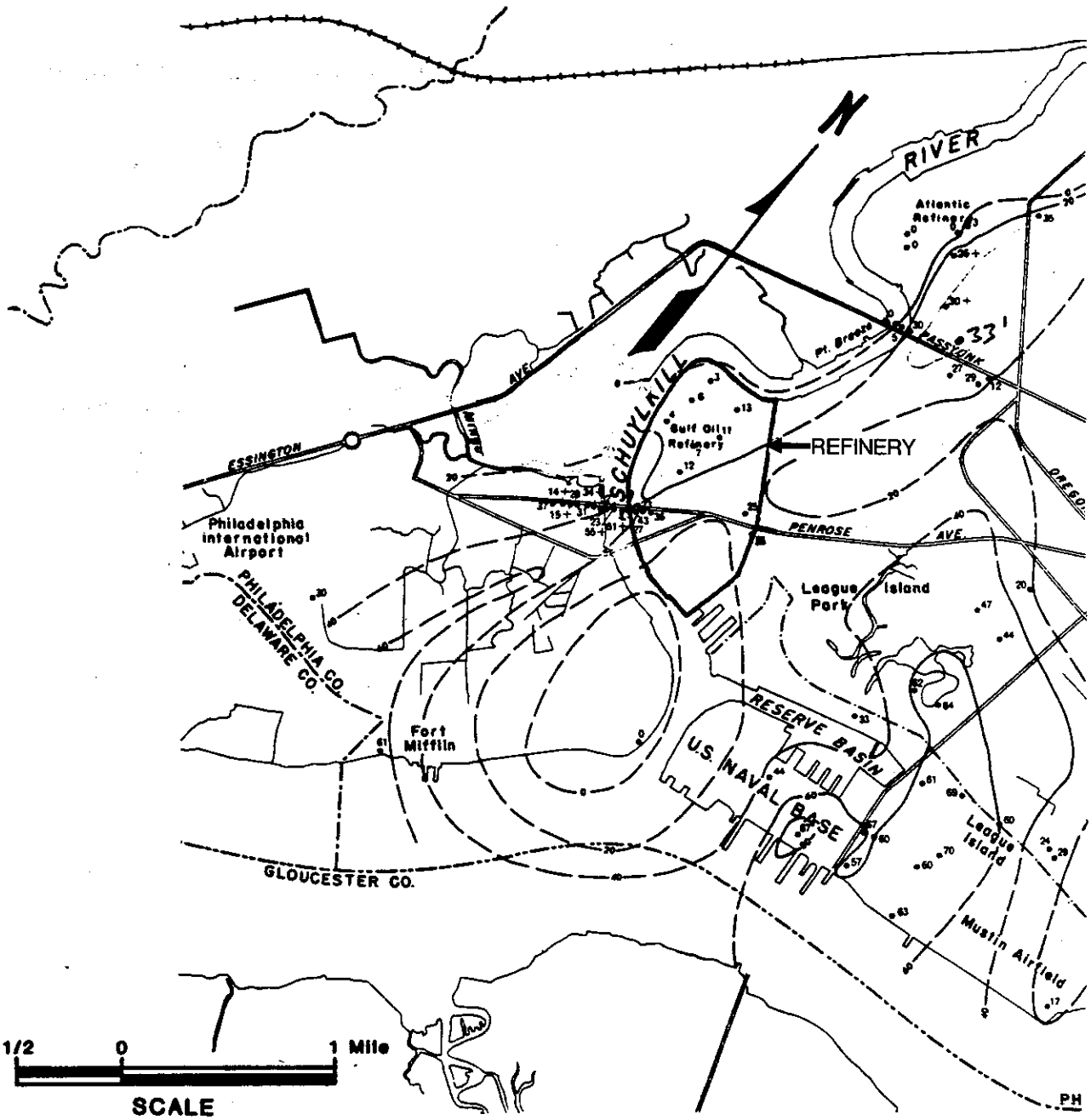
(2) CHEVRON\TG2 11/12/92 19:45

TITLE CONTOUR MAP OF BEDROCK SURFACE BENEATH THE COASTAL PLAIN SEDIMENTS

PROJECT CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE
WILLOW GROVE, PENNSYLVANIA

| SCALE | AS SHOWN | DWN. BY | R.G.B. | JOB NO. | 16000–383 |
|---|---|---|---|---|---|
| DATE | 11–23–92 | APPR. BY | T.J.G. | FIG. NO. | 3-1 |




EXPLANATION:

•12

Water well or boring
Number is the thickness of the Farrington sand member in feet.

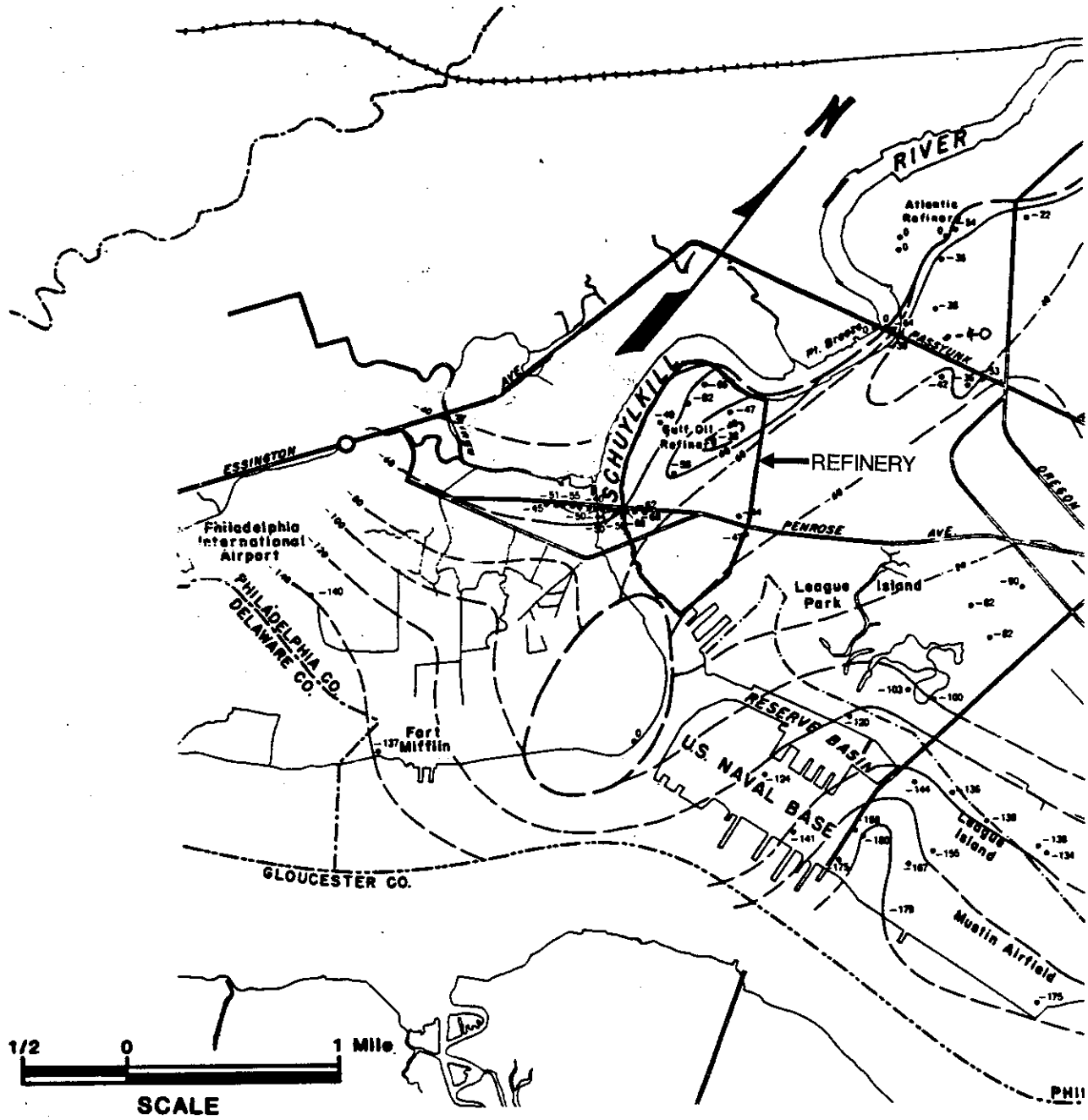
Isopachous line, dashed where approximate. Contour interval—20 feet.

REFERENCE:

Ground Water Resources of the Coastal Plain Area of Southeastern Pennsylvania, Pennsylvania Geologic Survey Bulletin W-13;Plate 9.

(1) CHEVRON\TG3 11/12/92 19:52

| | | | |
|---|---|---|---|
| TITLE | ISOPACH CONTOUR MAP FARRINGTON SAND MEMBER RARITAN—MAGOTHY FORMATION | | |
| PROJECT | CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA | | |
| | DAMES & MOORE WILLOW GROVE, PENNSYLVANIA | | |
| SCALE AS SHOWN | DWN. BY R.G.B. | JOB NO. 16000—383 | |
| DATE 11—13—92 | APPR. BY T.J.G. | FIG. NO. 3-2 | |




EXPLANATION:

•–24

Water well or boring

Number is altitude of the top of the Farrington sand member, in feet, referred to mean sea level.

Contour line on top of the Farrington sand member, dashed where approximate. Contour interval—20 feet.

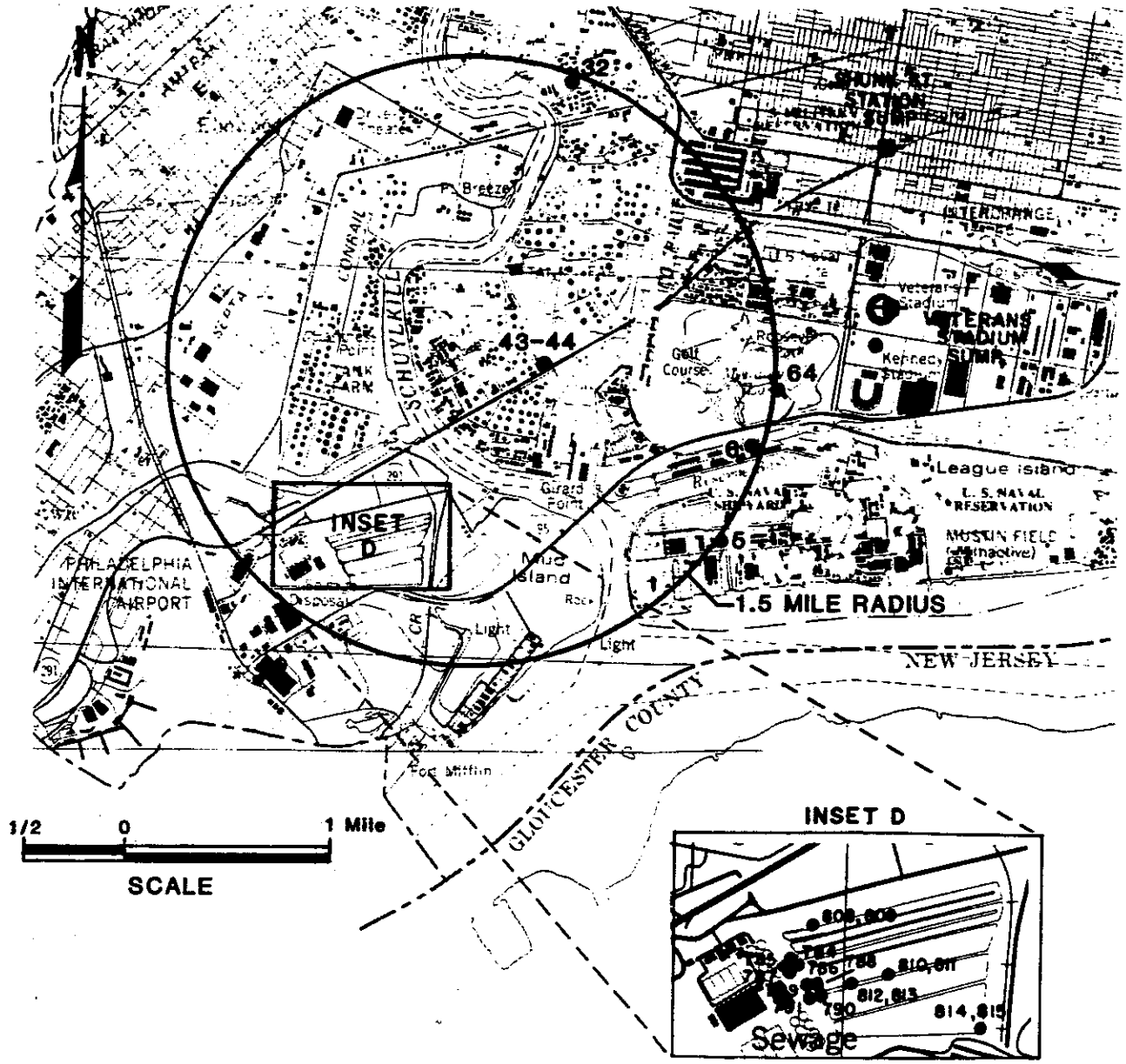
Line showing the limit of the Farrington sand member, dashed where approximate.

REFERENCE:

Ground Water Resources of the Coastal Plain Area of Southeastern Pennsylvania, Pennsylvania Geologic Survey Bulletin W-13; Plate 7.

| | | | |
|---|---|---|---|
| TITLE | STRUCTURE CONTOUR MAP FARRINGTON SAND MEMBER RARITAN–MAGOTHY FORMATION | | |
| PROJECT | CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA | | |
| | DAMES & MOORE WILLOW GROVE, PENNSYLVANIA | | |
| SCALE AS SHOWN | DWN. BY R.G.B. | JOB NO. 16000–383 | |
| DATE 11–13–92 | APPR. BY T.J.G. | FIG. NO. 3-3 | |

(1) CHEVRON\TG4 11/12/92 19:52







REFERENCE:

Hydrologic data for aquifers in Philadelphia, Pennsylvania, United States Geological Survey Open-File Report 83-149, 1984.

(1) CHEVRON\TG5 11/12/92 19:54

| | | | |
|---|---|---|---|
| TITLE | WELLS WITHIN A 1.5 MILE RADIUS OF THE REFINERY | | |
| PROJECT | CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA | | |
| | DAMES & MOORE WILLOW GROVE, PENNSYLVANIA | | |
| SCALE AS SHOWN | DWN. BY R.G.B. | JOB NO. 16000-383 | |
| DATE 11-13-92 | APPR. BY T.J.G. | FIG. NO. 3-4 | |

KEY:

B48 ● Phase 1 monitoring wells (installed February, 1986)

B94 ◇ Phase 2 monitoring wells (installed Oct./Nov., 1986)

A37 ■ Culverts

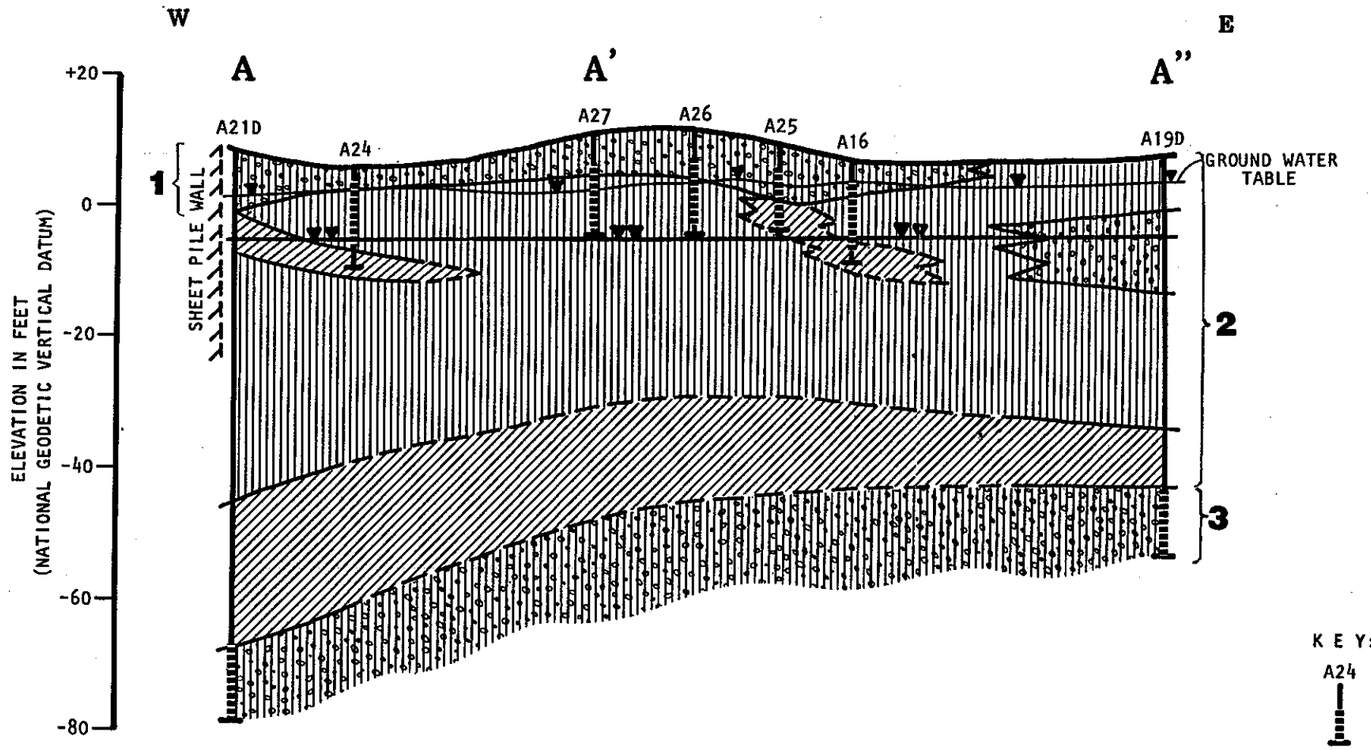
A A' Geologic cross section location

0 200 400 600 FEET

N

(1) CHEVRON\TG17 11/12/92 20:27

| | | |
|---|---|---|
| TITLE: GEOLOGIC CROSS SECTION LOCATIONS | | |
| PROJECT: CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA | | |
| DAMES & MOORE, WILLOW GROVE, PENNSYLVANIA | | |
| SCALE: AS SHOWN | DWN. BY: R.G.B. | JOB NO.: 16000-383 |
| DATE: 11-13-92 | APPR. BY: T.J.G. | FIG. NO.: 3-5 |




1 FILL AND TRENTON GRAVEL, UNDIFFERENTIATED UPPER UNCONSOLIDATED AQUIFER

2 LOWER CLAY MEMBER RARITAN FORMATION

3 FARRINGTON SAND MEMBER RARITAN FORMATION LOWER UNCONSOLIDATED AQUIFER

NOTE: THE SUBSURFACE SECTION SHOWN REPRESENTS OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.

0 400 800 FEET
(HORIZONTAL SCALE)
VERTICAL EXAGGERATION = 20 X

KEY:

A24 MONITORING WELL

MONITORING WELL SHOWING SCREENED INTERVAL

LITHOLOGIC BOUNDARIES; DASHED WHERE ESTIMATED

SILTY SANDS, SAND-SILT-GRAVEL MIXTURES

INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY

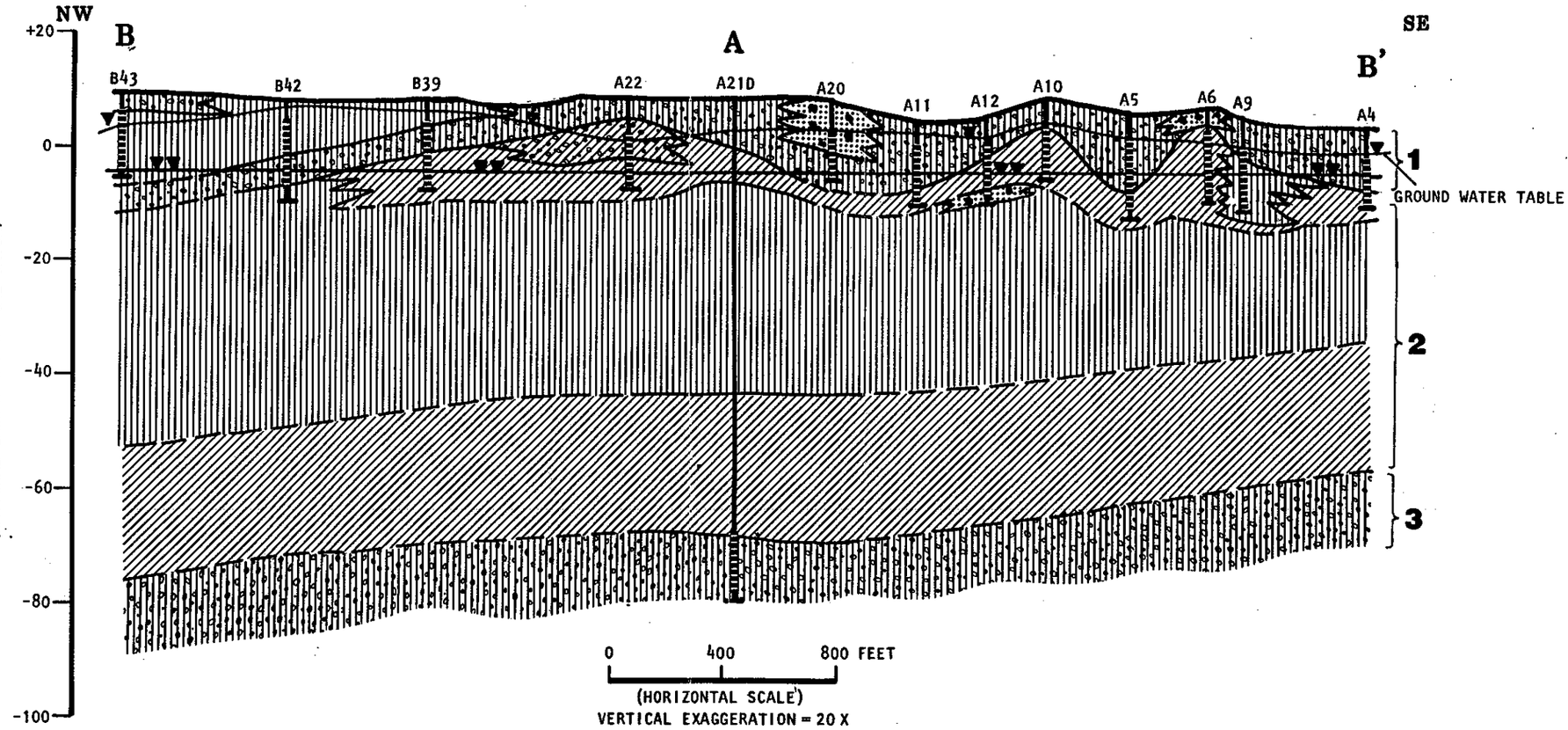
INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, SILTY CLAYS

WATER TABLE IN UPPER UNCONSOLIDATED AQUIFER (1986/87 SITE ASSESSMENT)

PIEZOMETRIC SURFACE IN LOWER UNCONSOLIDATED AQUIFER (1986/87 SITE ASSESSMENT)

| | | |
|---|---|---|
| TITLE: GENERALIZED GEOLOGIC CROSS SECTION A – A' – A'' | | |
| PROJECT: CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA | | |
| DAMES & MOORE WILLOW GROVE, PENNSYLVANIA | | |
| SCALE: AS SHOWN | DWN. BY: R.G.B. | JOB NO.: 16000-383 |
| DATE: 11-13-92 | APPR. BY: T.J.G. | FIG. NO.: 3-6 |

(1) CHEVRON\TG16 11/12/92 20:26




**1** FILL AND TRENTON GRAVEL, UNDIFFERENTIATED UPPER UNCONSOLIDATED AQUIFER

**2** LOWER CLAY MEMBER RARITAN FORMATION

**3** FARRINGTON SAND MEMBER RARITAN FORMATION LOWER UNCONSOLIDATED AQUIFER

K E Y:

A11 — MONITORING WELL

MONITORING WELL SHOWING SCREENED INTERVAL

LITHOLOGIC BOUNDARIES; DASHED WHERE ESTIMATED

POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES

SILTY SANDS, SAND-SILT-GRAVEL MIXTURES

CLAYEY SANDS, SAND-CLAY MIXTURES

INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY

INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, SILTY CLAYS

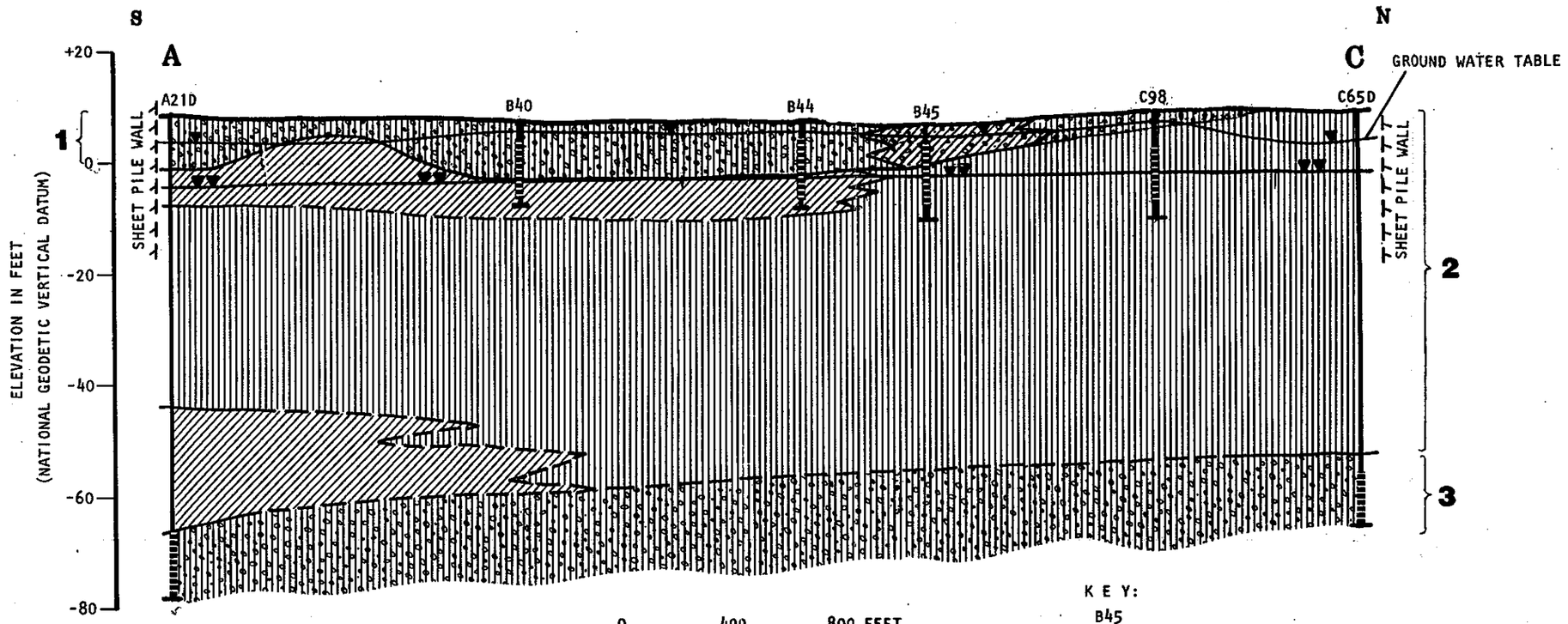
WATER TABLE IN UPPER UNCONSOLIDATED AQUIFER (1986/87 SITE ASSESSMENT)

PIEZOMETRIC SURFACE IN LOWER UNCONSOLIDATED AQUIFER (1986/87 SITE ASSESSMENT)

**NOTE: THE SUBSURFACE SECTION SHOWN REPRESENTS OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.**

(1) CHEVRON\TG15 11/12/92 20:25

| | | |
|---|---|---|
| TITLE: GENERALIZED GEOLOGIC CROSS SECTION B – A – B' | | |
| PROJECT: CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA | | |
| DAMES & MOORE WILLOW GROVE, PENNSYLVANIA | | |
| SCALE: AS SHOWN | DWN. BY: R.G.B. | JOB NO.: 16000-383 |
| DATE: 11-13-92 | APPR. BY: T.J.G. | FIG. NO.: 3-7 |




**1** FILL AND TRENTON GRAVEL, UNDIFFERENTIATED UPPER UNCONSOLIDATED AQUIFER

**2** LOWER CLAY MEMBER RARITAN FORMATION

**3** FARRINGTON SAND MEMBER RARITAN FORMATION LOWER UNCONSOLIDATED AQUIFER

K E Y:

B45 MONITORING WELL

MONITORING WELL SHOWING SCREENED INTERVAL

LITHOLOGIC BOUNDARIES; DASHED WHERE ESTIMATED

SILTY SANDS, SAND-SILT-GRAVEL MIXTURES

CLAYEY SANDS, SAND-CLAY MIXTURES

INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY

INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, SILTY CLAYS

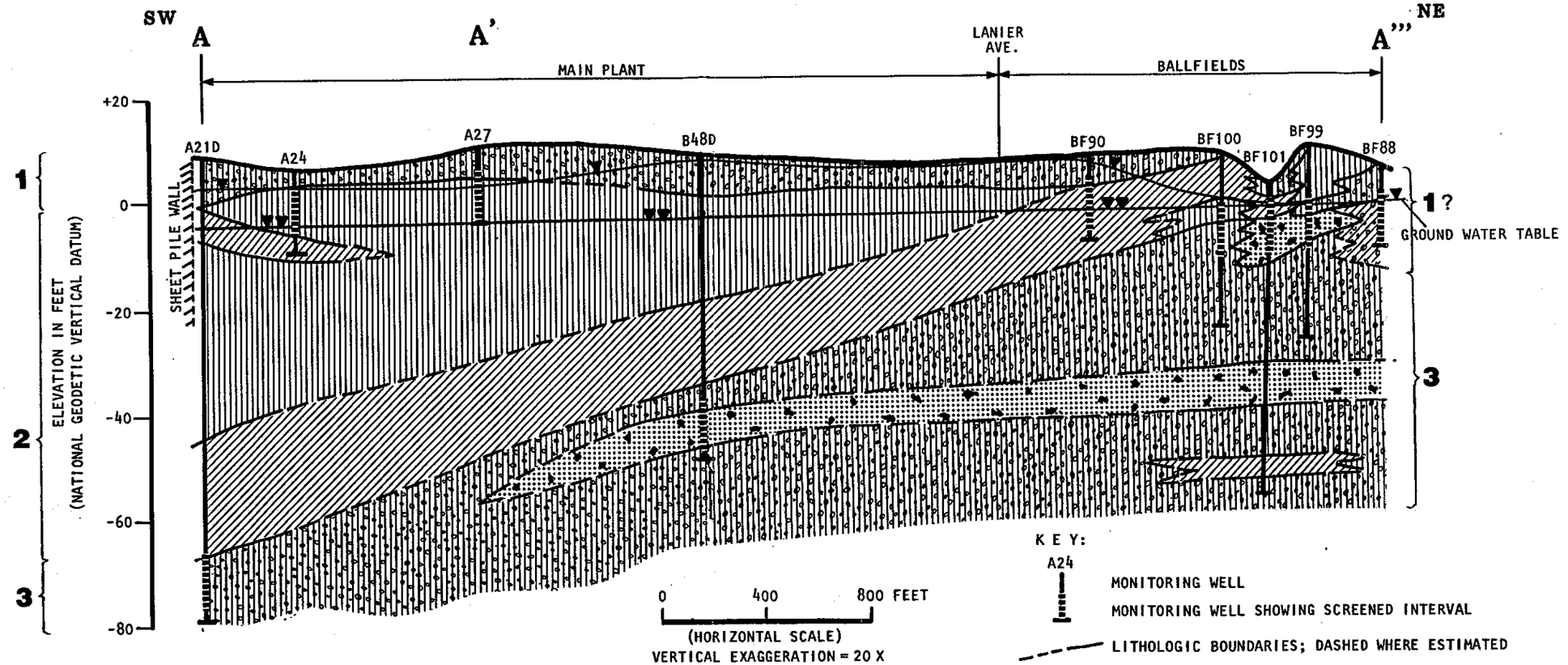
WATER TABLE IN UPPER UNCONSOLIDATED AQUIFER (1986/87 SITE ASSESSMENT)

PIEZOMETRIC SURFACE IN LOWER UNCONSOLIDATED AQUIFER (1986/87 SITE ASSESSMENT)

**NOTE: THE SUBSURFACE SECTION SHOWN REPRESENTS OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.**

(1) CHEVRON\TG14 11/12/92 20:24

| | | |
|---|---|---|
| TITLE: GENERALIZED GEOLOGIC CROSS SECTION A – C | | |
| PROJECT: CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA | | |
| DAMES & MOORE WILLOW GROVE, PENNSYLVANIA | | |
| SCALE: AS SHOWN | DWN. BY: R.G.B. | JOB NO.: 16000-383 |
| DATE: 11-13-92 | APPR. BY: T.J.G. | FIG. NO.: 3-8 |




**1** FILL AND TRENTON GRAVEL, UNDIFFERENTIATED UPPER UNCONSOLIDATED AQUIFER

**2** LOWER CLAY MEMBER RARITAN FORMATION

**3** FARRINGTON SAND MEMBER RARITAN FORMATION LOWER UNCONSOLIDATED AQUIFER

K E Y:

A24 MONITORING WELL

MONITORING WELL SHOWING SCREENED INTERVAL

LITHOLOGIC BOUNDARIES; DASHED WHERE ESTIMATED

POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES

SILTY SANDS, SAND-SILT-GRAVEL MIXTURES

CLAYEY SANDS, SAND-CLAY MIXTURES

INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY

INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, SILTY CLAYS

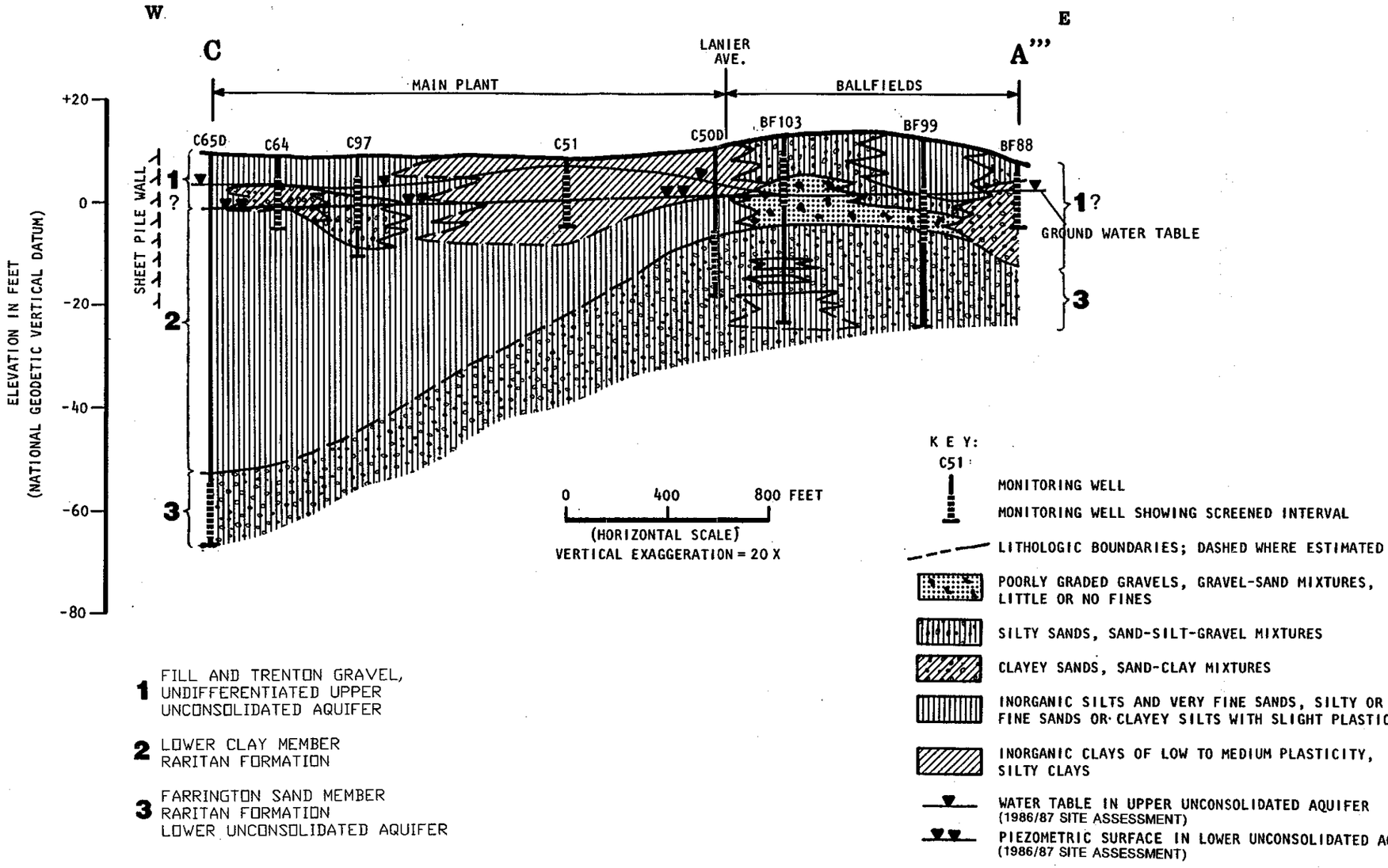
WATER TABLE IN UPPER UNCONSOLIDATED AQUIFER (1986/87 SITE ASSESSMENT)

PIEZOMETRIC SURFACE IN LOWER UNCONSOLIDATED AQUIFER (1986/87 SITE ASSESSMENT)

NOTE: THE SUBSURFACE SECTION SHOWN REPRESENTS OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.

(1) CHEVRON\T613 11/12/92 20:23

| | | |
|---|---|---|
| TITLE: GENERALIZED GEOLOGIC CROSS SECTION A – A' – A''' | | |
| PROJECT: CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA | | |
| DAMES & MOORE WILLOW GROVE, PENNSYLVANIA | | |
| SCALE: AS SHOWN | DWN. BY: R.G.B. | JOB NO.: 16000-383 |
| DATE: 11-13-92 | APPR. BY: T.J.G. | FIG. NO.: 3-9 |




**1** FILL AND TRENTON GRAVEL, UNDIFFERENTIATED UPPER UNCONSOLIDATED AQUIFER

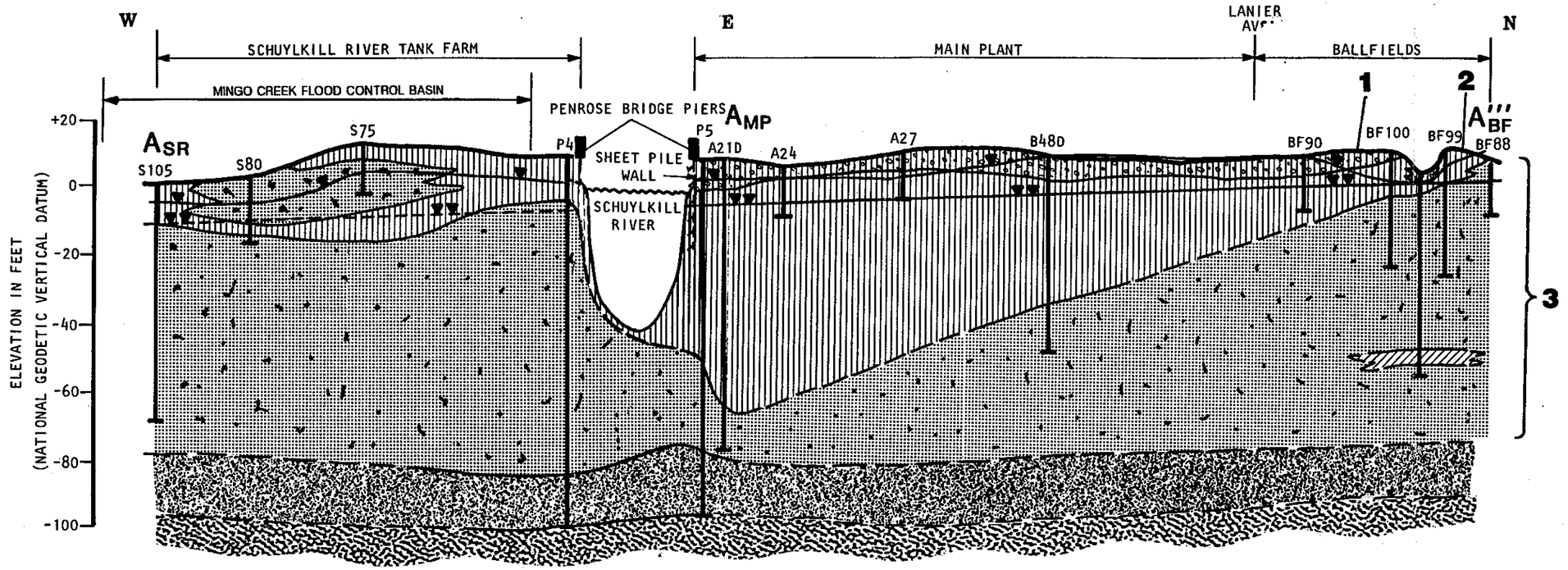
**2** LOWER CLAY MEMBER RARITAN FORMATION

**3** FARRINGTON SAND MEMBER RARITAN FORMATION LOWER UNCONSOLIDATED AQUIFER

**NOTE: THE SUBSURFACE SECTION SHOWN REPRESENTS OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.**

(1) CHEVRON\TG7 11/13/92 09:08

| | | |
|---|---|---|
| TITLE: GENERALIZED GEOLOGIC CROSS SECTION C – A''' | | |
| PROJECT: CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA | | |
| DAMES & MOORE WILLOW GROVE, PENNSYLVANIA | | |
| SCALE: AS SHOWN | DWN. BY: R.G.B. | JOB NO.: 16000-383 |
| DATE: 11-13-92 | APPR. BY: T.J.G. | FIG. NO.: 3-10 |




0 620 1240 FEET

(HORIZONTAL SCALE)

VERTICAL EXAGGERATION = 22 X

**1** FILL AND TRENTON GRAVEL, UNDIFFERENTIATED UPPER UNCONSOLIDATED AQUIFER

**2** LOWER CLAY MEMBER RARITAN FORMATION

**3** FARRINGTON SAND MEMBER RARITAN FORMATION LOWER UNCONSOLIDATED AQUIFER

K E Y:

A24 — MONITORING WELL

MONITORING WELL SHOWING SCREENED INTERVAL

LITHOLOGIC BOUNDARIES; DASHED WHERE ESTIMATED

SAND AND GRAVEL, LITTLE OR NO FINES

SILTY SANDS, SAND-SILT-GRAVEL MIXTURES

SILT AND CLAY, LITTLE OR NO SAND

INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, SILTY CLAYS

WEATHERED MICA SCHIST

UNWEATHERED MICA SCHIST

WATER TABLE IN UPPER UNCONSOLIDATED AQUIFER (1986/87 SITE ASSESSMENT)

PIEZOMETRIC SURFACE IN LOWER UNCONSOLIDATED AQUIFER (1986/87 SITE ASSESSMENT)

NOTE: THE SUBSURFACE SECTION SHOWN REPRESENTS OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.

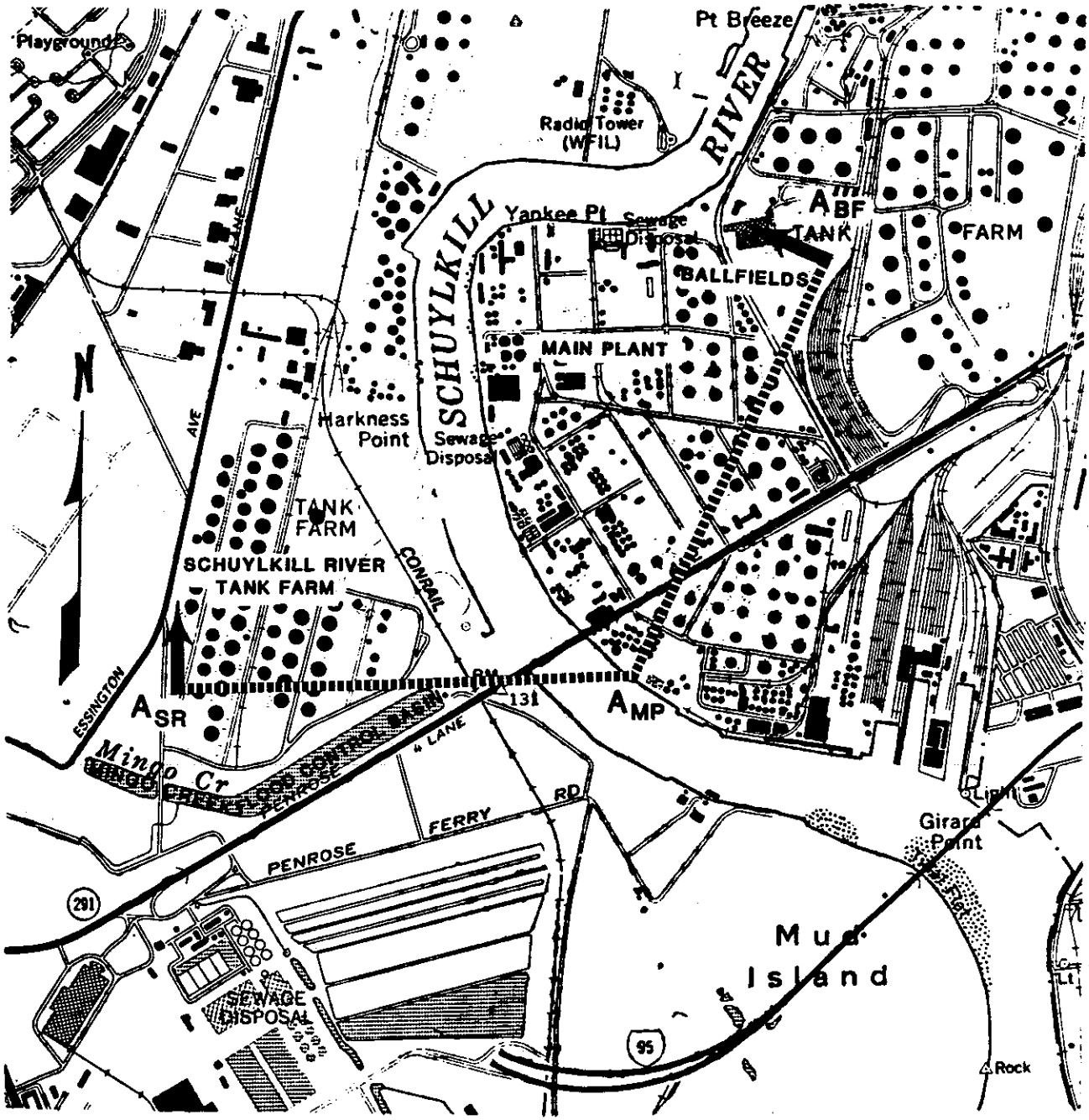
(1) CHEVRON\TG12 11/13/92 08:49

TITLE: GENERALIZED GEOLOGIC CROSS SECTION $A_{SR} - A_{MP} - A'''_{BF}$

PROJECT: CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE
WILLOW GROVE, PENNSYLVANIA

| SCALE | DWN. BY | JOB NO. |
|---|---|---|
| AS SHOWN | R.G.B. | 16000-383 |
| DATE 11-13-92 | APPR. BY T.J.G. | FIG. NO. 3-11 |




**KEY:**

$A_{SR}$ $A'''_{BF}$ **Cross-section location**

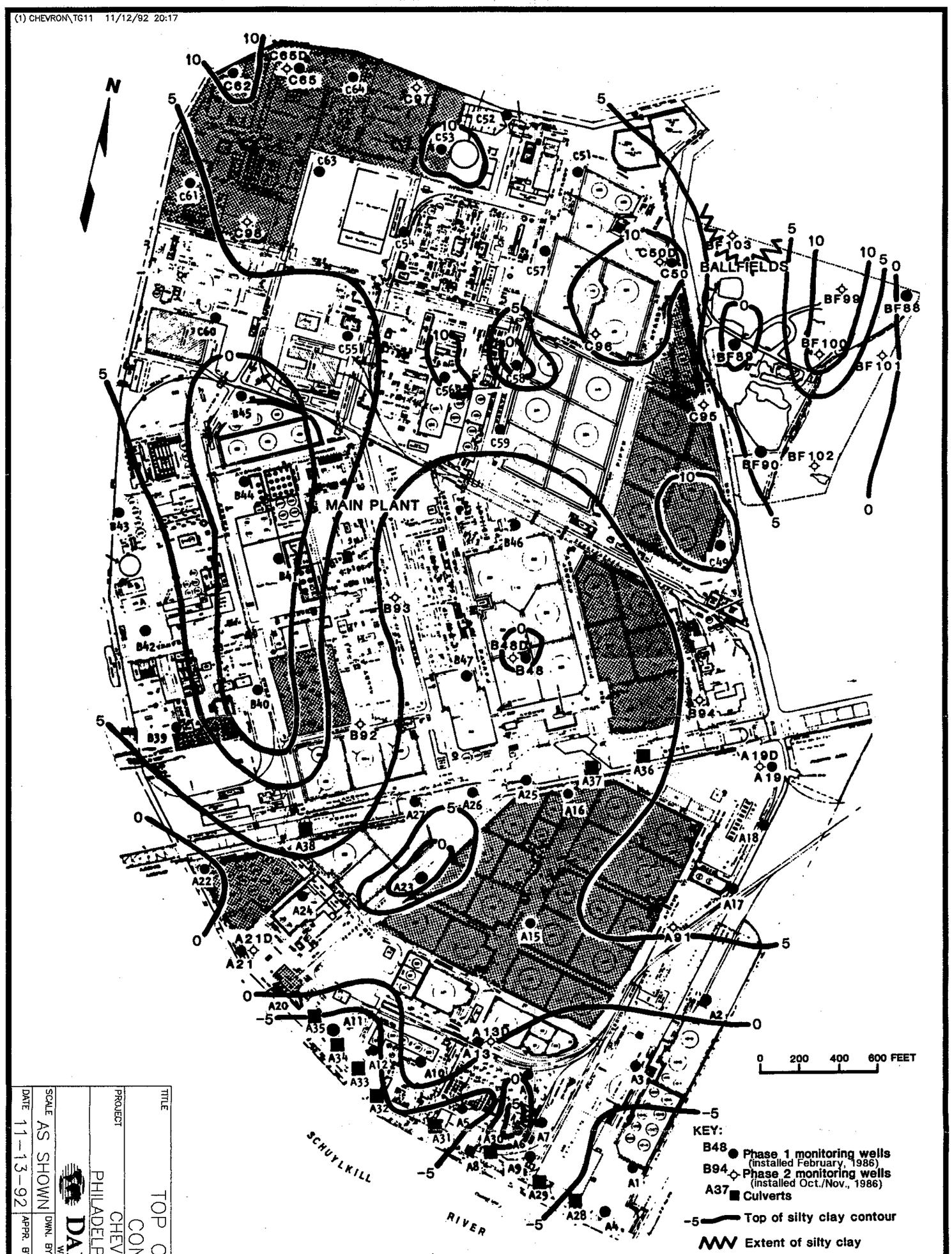
0 1000 2000 3000 4000 FEET

NOTE:

CROSS-SECTION SHOWN ON FIGURE 3-11.

| | | |
|---|---|---|
| TITLE: GEOLOGIC CROSS SECTION LOCATION | | |
| PROJECT: CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA | | |
| DAMES & MOORE WILLOW GROVE, PENNSYLVANIA | | |
| SCALE: AS SHOWN | DWN. BY: R.G.B. | JOB NO.: 16000-383 |
| DATE: 11-13-92 | APPR. BY: T.J.G. | FIG. NO.: 3-12 |

(1) CHEVRON\TG1 11/12/92 19:41




TITLE: TOP OF SILTY CLAY CONTOUR MAP

PROJECT: CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE WILLOW GROVE, PENNSYLVANIA

| | | | |
|---|---|---|---|
| SCALE AS SHOWN | DWN. BY R.G.B. | JOB NO. 16000-383 | |
| DATE 11-13-92 | APPR. BY T.J.G. | FIG. NO. 3-13 | |

KEY:
B48● Phase 1 monitoring wells (installed February, 1986)
B94◇ Phase 2 monitoring wells (installed Oct./Nov., 1986)
A37■ Culverts
5 — Saturated sand thickness contours, dashed where estimated
Upper and lower unconsolidated aquifers hydraulically connected in this area

0 200 400 600 FEET

(CONTOUR INTERVAL = 5 FEET)

MAIN PLANT

SCHUYLKILL RIVER

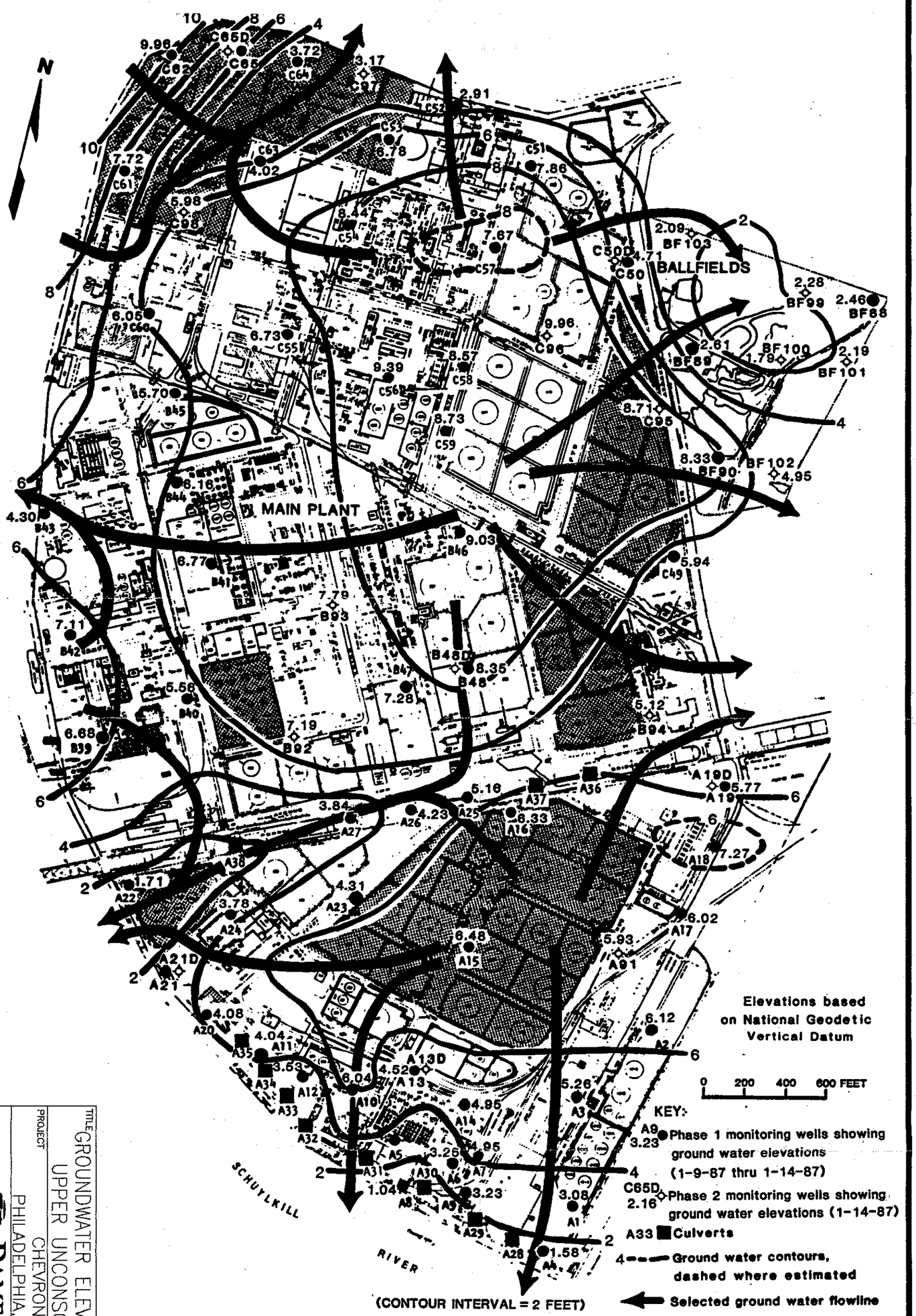
BALLFIELDS

N

(1) CHEVRON\TG10 11/12/92 20:13

| | | | |
|---|---|---|---|
| TITLE | SATURATED SAND THICKNESS CONTOUR MAP | | |
| PROJECT | CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA | | |
| | DAMES & MOORE WILLOW GROVE, PENNSYLVANIA | | |
| SCALE AS SHOWN | DWN. BY R.G.B. | JOB NO. 16000-383 | |
| DATE 11-13-92 | APPR. BY T.J.G. | FIG. NO. 3-14 | |

(1) CHEVRON\TG9 11/12/92 20:09




TITLE GROUNDWATER ELEVATION CONTOUR MAP
UPPER UNCONSOLIDATED AQUIFER

PROJECT
CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE
WILLOW GROVE, PENNSYLVANIA

| SCALE | DWN. BY | JOB NO. |
|---|---|---|
| AS SHOWN | R.G.B. | 16000-383 |
| DATE | APPR. BY | FIG. NO. |
| 11-13-92 | T.J.G. | 3-15 |

SCHUYLKILL RIVER

EBB FLOW

SWMU 71

SWMU 71A

SWMU 79

SWMU 30

SWMU 29

SWMU 45

SWMU 11

SWMU 12

SWMU 17

SWMU 13

SWMU 16

SWMU 6

SWMU 9

SWMU 1

SWMU 2

ATLANTIC REFINING CO. PROPERTY

UNIT No 1231 FLARE

UNIT No 2031 FLARE

UNIT No 1231 FLARE

UNIT No 433 FLARE

UNIT No 137

UNIT No 2031

UNIT No 1231 PRECIPITATOR

CO BOILER UNIT No 1232

UNIT No 532

UNIT No 1431

UNIT No 1231 BOILER HOUSE

UNIT No 1231 COMPRESSOR HOUSE 412

UNIT 433

UNIT No 8735

UNIT No 136

450 STOREHOUSE STORAGE

RCRA HAZARDOUS WASTE TANKS

EAST & WEST SLUDGE BASINS - RCRA TANK

STOREHOUSE BLDG No 450

MAINTENANCE BLDG No 440

FIRE HOUSE GARAGE BLDG No 442

BLDG No 714

SEPARATOR No 4

SEWER SEPARATOR No 4A

SEWER SEPARATOR No 4B

No 3 SEPARATOR

COOLING TOWER 459

COOLING TOWER 490

COOLING TOWER 491

CHLORINATOR BLDG

FIRE TRAINING AREA

NORTH PUMP ROOM

SOUTH PUMP ROOM

VACUUM HEATER F-1

VACUUM HEATER F-2

ATMOSPHERIC HEATER F-3

ASPHALT HEATER

DISPHENOL HEATER

ATHLETIC FIELD

ATHLETIC FIELD

PENNYPACKER AVENUE

ETHYL PUMPHOUSE

WATER TREATING PLANT No 3

BOILER HOUSE No 1 POWER PLANT No 1

MAINTENANCE STORAGE AREA

PUMP HOUSE No 27 175

BUILDING 179

TREATING PLANT

SPENT CAUSTIC STORAGE TANKS

SLOP TANK

CHEVRON PIPE LINES CROSSING RIVER

STOREHOUSE 590

CONDUIT 172

TWO 8" P.E. LINES CROSSING RIVER

TWO 8" SLUDGE LINES CROSSING RIVER

CONCRETE WHARF No 2

CONCRETE WHARF No 1

CONCRETE WHARF No 3

GEORGE PLATT BRIDGE

MAIN OFFICE BLDG 650

163 REFINERY LABORATORY

HUMAN RESOURCES BLDG 651

CANTEEN & LOCKER BLDG 625

LOCKER HOUSE 624

SALES OFFICE 91

BULK STATION

PUMP HOUSE No 1 7

PUMP HOUSE No 2 62

WAREHOUSE No 1 621

WAREHOUSE No 2 620

J.H. TERRY & Co. FACILITY

BF88 1.12

BF99 1.02

BF107 -0.19

BF103R -0.37

BF106 -0.35

BF101 1.09

BF105 0.39

BF100 0.61

BF104 3.94

BF102 4.31

BF90 7.60

BF89

C49 6.26

C95 8.10

C58 7.84

C57 7.80

C56 8.80

C55 6.37

C54 8.75

C64 3.67

C97 3.19

C52 3.48

C51 7.15

C65 5.30

C62 8.72

C61 7.67

C98 5.92

C60 6.33

C63

C96

C50

C110

C111

C109

C113

C112

C114

B45 5.84

B44 5.40

B43 4.52

B42 5.96

B41 6.49

B40 5.64

B39 6.27

B46 8.62

B47

B48 7.89

B93

B94 3.86

B92 6.60

B123

B124

B125

B126

B130

B131

B115

B116

B117

A25 4.04

A26 4.33

A27 3.37

A24 3.10

A22 2.07

A23

A15 5.57

A91 5.03

A49 4.52

A3 4.57

A10 5.18

A46 5.26

A47 2.42

A48 1.94

A45 0.89

A5

A6 2.83

A7 4.05

A9 3.08

A8 1.18

A41 1.80

A42 1.60

A4 1.85

A39 1.39

A1 2.03

A40

A43 4.05

A44R

A46 4.04

A11

A12

A20

A21

A210

A132

A133

A134

A135

A136

A137

A17

A18

A19

A190

A118

A119

WP-1

WP-2

WP-3

WP-4

WP-5

WP-6

WP-7

WP-8

WP-10

N

E 2,711,200 E 2,711,400 E 2,711,600 E 2,711,800 E 2,712,000 E 2,712,200 E 2,712,400 E 2,712,600 E 2,712,800 E 2,713,000 E 2,713,200 E 2,713,400 E 2,713,600 E 2,713,800 E 2,714,000 E 2,714,200 E 2,714,400 E 2,714,600 E 2,714,800 E 2,715,000 E 2,715,200 E 2,715,400

N 220,400 N 220,200 N 220,000 N 219,800 N 219,600 N 219,400 N 219,200 N 219,000 N 218,800 N 218,600 N 218,400 N 218,200 N 218,000 N 217,800 N 217,600 N 217,400 N 217,200 N 217,000 N 216,800 N 216,600 N 216,400 N 216,200 N 216,000 N 215,800 N 215,600 N 215,400 N 215,200 N 215,000 N 214,800 N 214,600

LEGEND

- PROPERTY BOUNDARY
- A137 MONITORING WELL LOCATION (VI)
- A120 MONITORING WELL LOCATION (RFI)
- BF90D -0.92 EXISTING MONITORING WELL LOCATION SHOWING GROUND WATER ELEVATION
- WP-1 WELL POINT LOCATION (RFI)
- -4- LINE OF EQUAL GROUND WATER ELEVATION (DASHED WHERE INFERRED)
- GROUND WATER FLOW DIRECTION
- SOLID WASTE MANAGEMENT UNIT (VI)

NOTES:

1. 200 FOOT GRID BASED ON PENNSYLVANIA STATE RECTANGULAR COORDINATE SYSTEM, SOUTH ZONE 1927 N.A. DATUM.
2. THIS MAP WAS CONSTRUCTED USING DEPTH TO WATER MEASUREMENT DATA COLLECTED FROM ON-SITE MONITORING WELLS ON DECEMBER 10, 1992.
3. SURVEYING ACTIVITIES RELATED TO THE RFI/VI HAVE NOT BEEN COMPLETED. THEREFORE, THIS MAP PRESENTS GROUND WATER FLOW BASED ON GROUND WATER ELEVATIONS AT MONITORING WELLS INSTALLED DURING PREVIOUS INVESTIGATIONS.

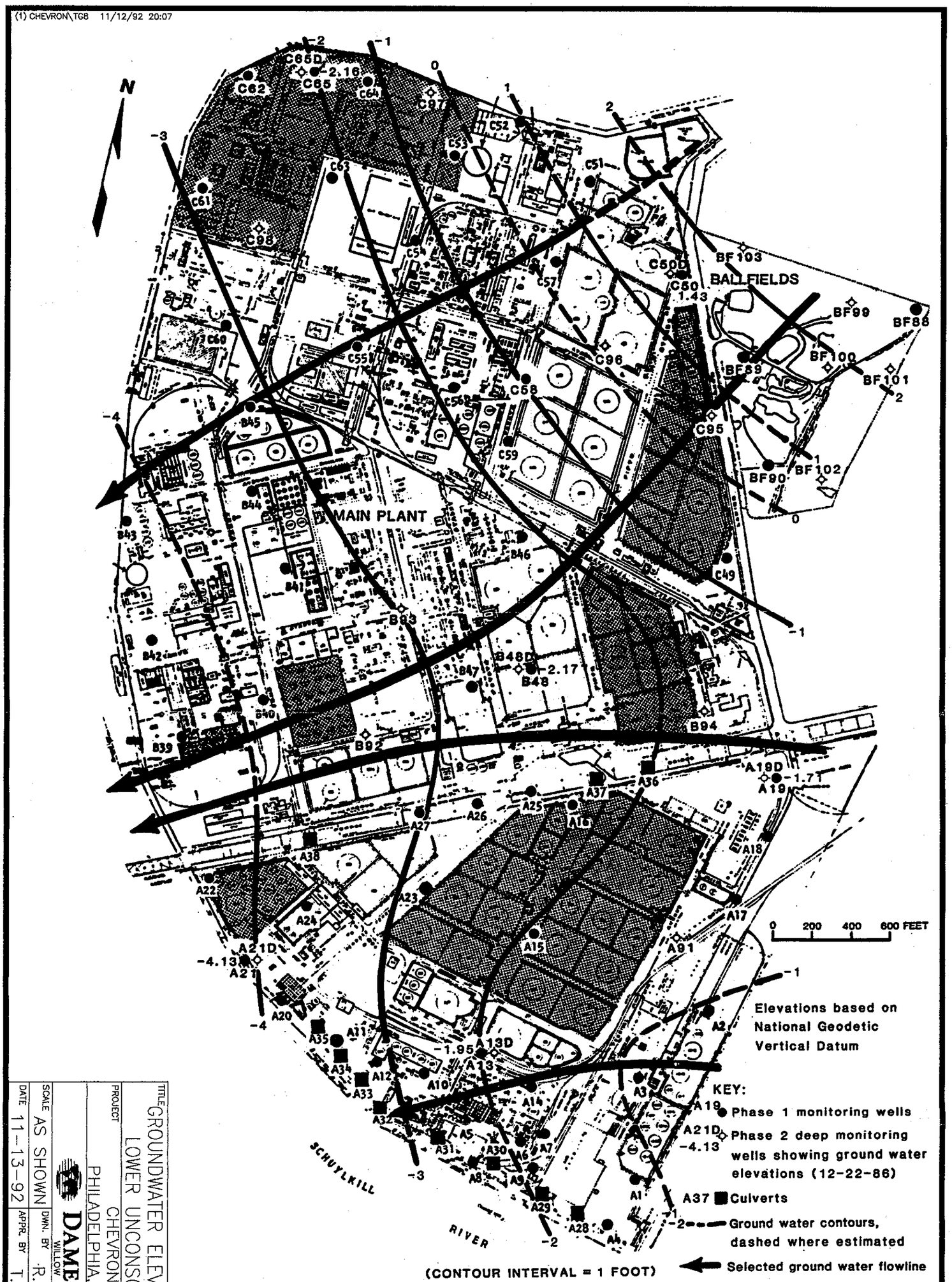
REFERENCE:
BASE MAP PROVIDED BY CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA.

0 100 200 300 400 FEET

GRAPHIC SCALE

| | |
|---|---|
| TITLE | GROUND WATER ELEVATION CONTOUR MAP – UPPER UNCONSOLIDATED AQUIFER (12-10-92) |
| PROJECT | CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA |
| | DAMES & MOORE WILLOW GROVE, PENNSYLVANIA |
| SCALE AS SHOWN | DWN. BY R.G.B. / JOB NO. 16000-383 |
| DATE 12-17-92 | APPR. BY T.J.G. / FIG. NO. 3-16 |

(S) C:\ACAD\CHEVRON\GWC-UUA 12/18/92 13:54

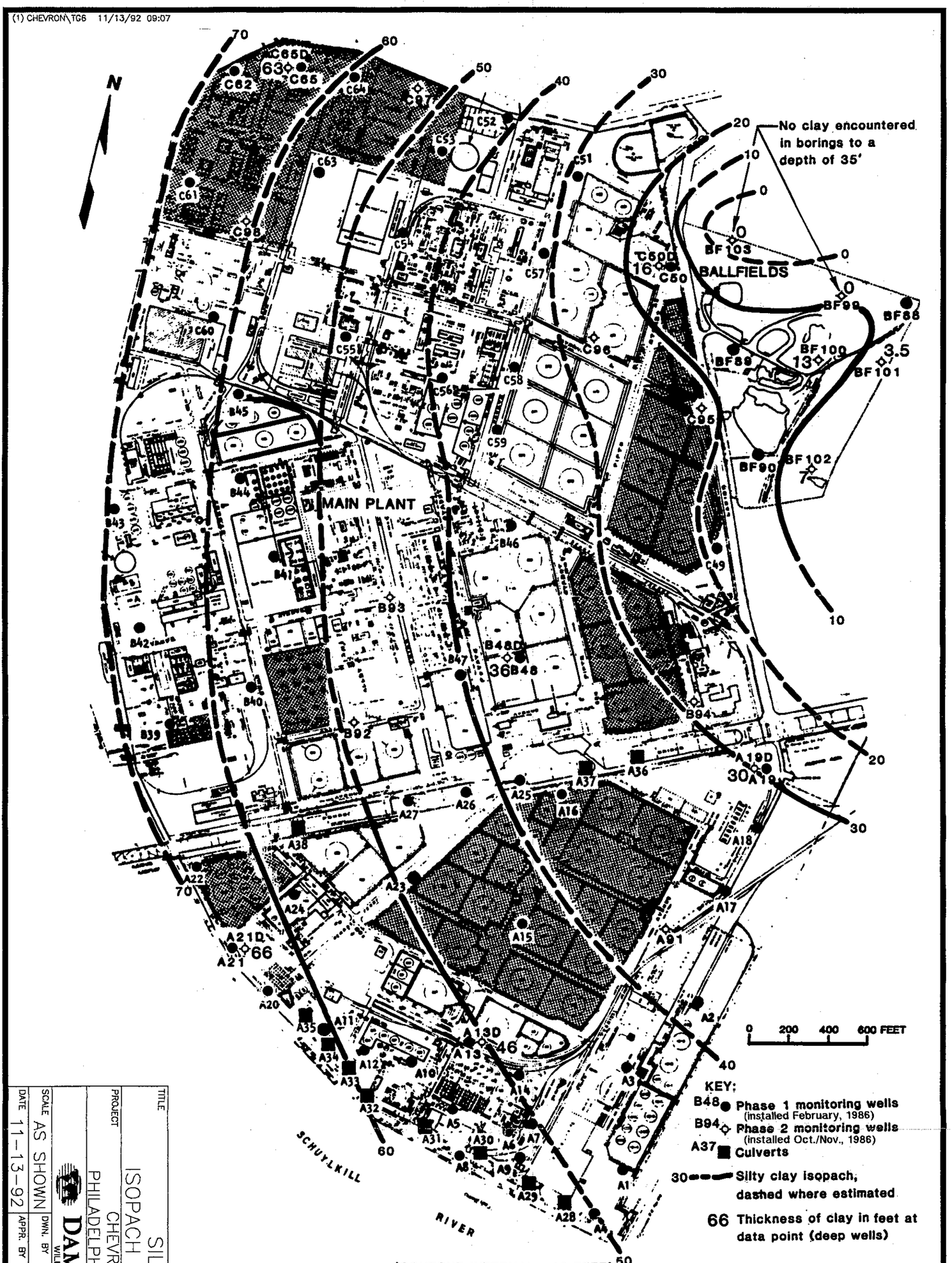



TITLE GROUNDWATER ELEVATION CONTOUR MAP
LOWER UNCONSOLIDATED AQUIFER

PROJECT CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE
WILLOW GROVE, PENNSYLVANIA

| | | | |
|---|---|---|---|
| SCALE AS SHOWN | DWN. BY R.G.B. | APPR. BY T.J.G. | DATE 11-13-92 |
| JOB NO. 16000-383 | | | FIG. NO. 3-17 |

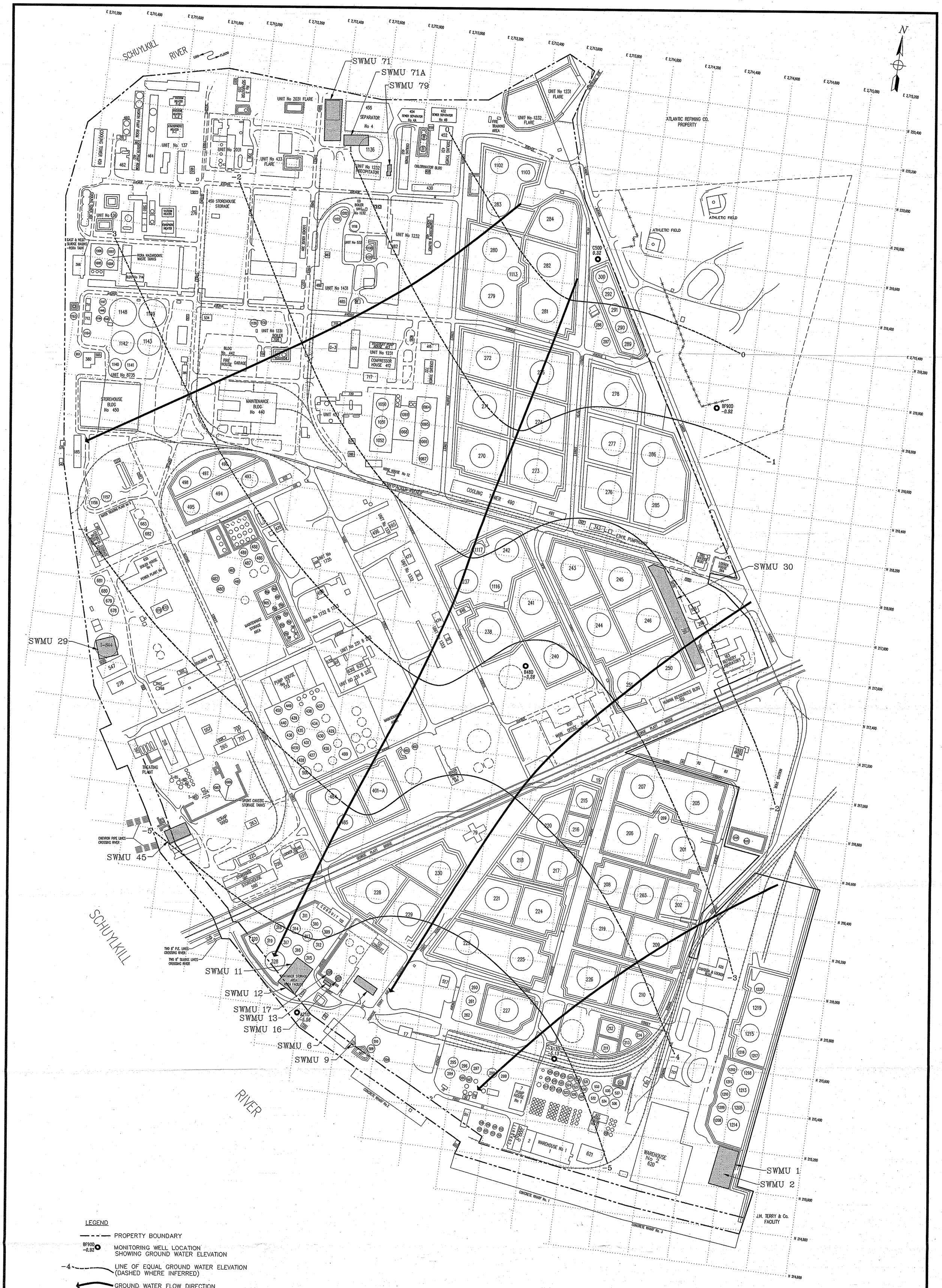



TITLE
SILTY CLAY
ISOPACH CONTOUR MAP

PROJECT
CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE
WILLOW GROVE, PENNSYLVANIA

| SCALE | DWN. BY | JOB NO. |
|---|---|---|
| AS SHOWN | R.G.B. | 16000-383 |
| DATE | APPR. BY | FIG. NO. |
| 11-13-92 | T.J.G. | 3-18 |




LEGEND

- PROPERTY BOUNDARY
- BF90D -0.92 — MONITORING WELL LOCATION SHOWING GROUND WATER ELEVATION
- -4 — LINE OF EQUAL GROUND WATER ELEVATION (DASHED WHERE INFERRED)
- GROUND WATER FLOW DIRECTION
- SOLID WASTE MANAGEMENT UNIT (VI)

NOTES:

1. 200 FOOT GRID BASED ON PENNSYLVANIA STATE RECTANGULAR COORDINATE SYSTEM, SOUTH ZONE 1927 N.A. DATUM.
2. THIS MAP WAS CONSTRUCTED USING DEPTH TO WATER MEASUREMENT DATA COLLECTED FROM ON-SITE MONITORING WELLS ON DECEMBER 10, 1992.

REFERENCE:
BASE MAP PROVIDED BY CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA.

0 100 200 300 400 FEET

GRAPHIC SCALE

| | | |
|---|---|---|
| TITLE | GROUND WATER ELEVATION CONTOUR MAP – LOWER UNCONSOLIDATED AQUIFER (12-10-92) | |
| PROJECT | CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA | |
| DAMES & MOORE WILLOW GROVE, PENNSYLVANIA | | |
| SCALE AS SHOWN | DWN. BY R.G.B. | JOB NO. 16000-383 |
| DATE 12-16-92 | APPR. BY T.J.G. | FIG. NO. 3-19 |

(2) C:\ACAD\CHEVRON\GWC-LUA 12/22/92 11:02

# 4.0 RCRA VERIFICATION INVESTIGATION

## 4.1 INTRODUCTION AND SAMPLING METHODOLOGY

Dames & Moore conducted a RCRA Verification Investigation (VI) at the Chevron Refinery between July and September 1992. The investigative tasks consisted of physical integrity evaluations (SWMU Nos. 2 and 9), soil gas surveys (SWMU Nos. 11/12, 29, and 71A), surface soil investigation, subsurface soil investigation, and ground water investigation. These tasks and sampling activities were completed in accordance with the Chevron VI Work Plan (Dames & Moore, July 2, 1991). A summary of specific tasks completed for each SWMU is presented in Table 4-1.

This Chapter presents the scope and results of the VI. Section 4.1 describes the sample labelling methodology, and the procedures used to complete the soil gas survey, surface soil, subsurface soil, and ground water investigations. Section 4.2 through 4.13 present the scope and results of the VI at each SWMU.

### 4.1.1 Unique Sample Code Identifications

Each sample collected as part of the VI was assigned a unique identification number. These identification numbers were assigned prior to the commencement of field operations. Sample codes contain the following components:

1. Sample media [surface soil, subsurface soil, ground water (1 digit)]

2. Sample point (SWMU) location number (3 digits)

3. Identification numbers to indicate sample number or the collection of replicate samples, field blanks, and other quality control samples (2 digits)

The coding sequence was used on the sample labels and chain of custody forms to ensure proper entry into all data management systems. The unique sample code was logged into the field book when a sample was collected.

#### 4.1.1.1 Sample Media

The sample media appears as the initial sample code designation. This single-digit code employs letter designations to define the media as follows:

S - Surface soil sample
B - Subsurface boring sample
G - Ground water sample

The sample media portion of the sample code corresponds to those used for chain-of-custody procedures.

4.1.1.2 Sample Location

The sample location is designated by three digits. The sample point location number was assigned as part of the investigations of each media prior to commencement of field work. Each sample location number corresponds to the SWMU from which the sample originates.

4.1.1.3 Identification Number

The two-digit sample identification number was used to define the sample in terms of the precise location within the SWMU, or to define the sample as a field quality control sample. The identification number was assigned by the field personnel and was clearly defined in the field records. Identification numbers were assigned an alphabetical code that begins with A1 - A9, followed by B1 - B9, etc. through Z9.

Quality control samples were assigned identification numbers so that they existed as blind samples to the laboratory. The identification of quality control samples were assigned by the field personnel and were clearly defined in the field records. For field duplicates, the same sample location number was assigned with a unique identification number. Field blanks were collected adjacent to the sample location believed to be the most contaminated based on previous investigations or field measurements. A unique identification number was then assigned to designate the field blank. The sample location number was the same location number as the collected sample. The trip blank was assigned any sample location number that was sampled that day for which the trip blank was present. Again, a unique identification number was assigned.

4.1.1.4 Code Sequence and Recording

The media, sample location, and unique identification numbers were denoted in the following sequence:

| Media | Sample Location | ID No. |
|---|---|---|

The sample code appeared as noted above on all sample containers and chain of custody forms that accompanied the samples for laboratory analysis. Each space was filled in completely and dashes were not used to separate the media, sample location, and identification numbers. For example, sample S001A1 was a surface soil sample collected at SWMU No. 1.

### 4.1.2 Soil Gas Surveys

Soil gas surveys were performed at SWMU Nos. 11/12, 29, and 71A to evaluate the extent and degree of volatile organic compounds (VOCs) in the subsurface soil gas. In addition, the results of the soil gas surveys were used to refine boring locations and were considered in the screening risk assessment. The soil gas surveys were performed at these SWMUs between July 27, 1992 and July 28, 1992. The data derived from these surveys was used to evaluate the potential for hazardous waste releases from the SWMUs and aid in the placement of soil borings. The specific procedures for the soil gas surveys are detailed in Appendix C.

A borehole was advanced with a 7/8-inch-diameter stainless steel rod to a depth of 4 or 6 feet below ground surface (BGS). At some locations, where ground water or obstructions precluded the collection of soil gas samples at these depths, samples were collected from shallower depths ranging from 1.5 to 3 feet BGS.

When the desired depth was reached, the stainless steel rod was removed and a 3/16-inch-diameter steel tube was lowered into the hole to approximately 6 inches above the bottom of the borehole. The annular space between the borehole wall and the steel tube was plugged at the ground surface to prevent the influx of atmospheric air that could alter the analytical results of the sample.

Soil gas vapors were extracted from the borehole using a peristaltic pump, connected to the steel tube by teflon tubing. The discharge vapors were monitored using an organic vapor analyzer (OVA) equipped with a flame ionization detector (FID). The maximum, constant, and background OVA concentrations were recorded. When the OVA measurement reached its maximum concentration, soil gas vapors were collected in a 1-liter Tedlar bag. An aliquot of the soil gas sample was extracted from the Tedlar bag using a 500-microliter (ul) syringe. The sample was then injected into a Photovac 10S50 gas chromatograph (GC) equipped with a photoionization detector (PID). After collecting each soil gas sample, the sampling apparatus was purged with atmospheric air until OVA measurements from the interior of the soil vapor sampling tube reached background concentrations. Each Tedlar bag was purged a minimum of three times with ultra zero air (less than 0.1 parts per million (ppm) total hydrocarbons).

Several apparatus blanks were collected by drawing atmospheric air through the sampling apparatus. These blanks were analyzed by the GC as previously described to evaluate the potential for cross-contamination.

Calibrations of the GC were performed at the beginning and end of each day and after every 2 hours of GC operation. Calibrations were performed by injecting 200 ul of certified laboratory standards of benzene, toluene, ethylbenzene, and o-xylene (2.6 ppm each) into the GC. The concentrations of unidentified compounds were calculated relative to the sensitivity of benzene and included in the calculation of total VOCs. However, the sensitivity of the GC to the unidentified compounds relative to benzene is not known.

### 4.1.3 Surface Soil Investigation

The surface soil investigations consisted of collecting discrete soil samples from 0 to 6 inches below ground surface (BGS) at locations within the designated SWMU. Surface soil sampling was conducted between August 4, 1992 and August 12, 1992.

The sample locations were determined in the field by Dames & Moore personnel based on the proximity to suspected contaminant sources or visibly stained surface soil. Samples were field-screened using a PID and an OVA for the presence of VOCs in accordance with the procedures described in Appendix C. Each retrieved surface soil sample was visually described and logged by an on-site geologist in accordance with the Unified Soil Classification System (equivalent to ASTM D 2487-69). All data, including qualitative observations regarding the soil conditions, were recorded by the Dames & Moore on-site geologist in the daily field logbook. Table 4-2 contains a summary of field observations recorded during surface soil sampling activities. The specific procedures for surface soil sampling are included in Appendix C.

The surface soil samples were analyzed for Skinner List (40 CFR 264) constituents (Table 4-3) with the exception of samples collected at SWMU 45 and 79 which were analyzed for Appendix IX (40 CFR 264) constituents (Table 4-4). In either case, analytical testing did not include volatile organic compounds (VOCs) due to the likelihood that these compounds have volatilized from the shallow soil.

### 4.1.4 Subsurface Soil Investigation

The subsurface soil investigation conducted at each SWMU consisted of drilling soil borings and collecting soil samples at locations identified in the VI Work Plan. Subsurface soil sampling was conducted between August 3, 1992 and August 13, 1992.

The borings were completed using a drill rig. Where physical constraints rendered the area inaccessible to a drill rig, a portable tripod rig was used. Continuous split-spoon samples were collected at each boring location from the ground surface to the top of the water table, encountered at depths ranging from 1 to 6 feet. The split-spoon samples were field-screened using a PID and an OVA for the presence of VOCs. Each retrieved soil sample was visually described and logged by an on-site geologist in accordance with the Unified Soil Classification System (equivalent to ASTM D 2487-69). All data, including qualitative observations regarding the soil conditions, were recorded by the Dames & Moore on-site geologist in the daily field logbook. Table 4-5 contains a summary of field observations recorded during soil sampling activities. Soil boring logs are included in Appendix D.

A soil sample was collected in each boring from the 2-foot interval immediately above the water table. Soil samples were submitted to the analytical laboratory for Skinner List constituent analysis (Table 4-3). Soil samples collected at SWMU 45 and 79 were submitted for Appendix IX constituent analysis (Table 4-4).

### 4.1.5 Ground Water Investigation

Eleven new monitoring wells were installed as part of the VI ground water investigation. These wells are shallow, with total depths ranging from 14 to 16.5 feet BGS. Monitoring well drilling and installation was conducted between August 3, 1992 and August 20, 1992.

Each well was drilled and installed using a drill rig, except at SWMU No. 9 where physical constraints precluded the drilling and installation of monitoring well A136 with a drill rig. Monitoring well A136 was drilled and installed using a tripod rig. Table 4-6 contains a summary of field observations recorded during the monitoring well installation program.

The monitoring wells are constructed of 4-inch nominal inside diameter Schedule 40 PVC casing. The well screens are generally 10 feet in length, and consist of 10 feet of factory-slotted threaded, flush-joint PVC casing with 0.020-inch openings (20 slot), and the riser casing of 4-inch nominal inside diameter Schedule 40 PVC casing with threaded flush-joints. Monitoring well A136 (SWMU No. 9) is constructed of 2-inch-diameter PVC riser and casing.

The annular space around the well screen was backfilled with clean quartz sand (No. 2 Morie) to a height of approximately 1 foot above the top of the screen. A 2-foot-thick pure bentonite pellet seal was placed above the sand filter in each well. The remaining annular space was grouted with a 10-percent bentonite/90-percent cement mixture. A concrete anti-percolation collar was poured above the grout mixture to grade. Each well was finished with a stick-up protective steel casing. Monitoring well installation procedures are provided in Appendix C. Monitoring well construction diagrams are included in Appendix E.

Following installation, each well was developed by centrifugal pump in accordance with the procedures described in Appendix C. An attempt was made to pump each well until the purge water was clean and free of sediment. However, most of the on-site wells were not able to produce sustainable yields. Therefore, total removal of sediment from the water was not possible at most well locations. Most of the wells were pumped for a total of approximately one hour during development.

Ground water samples were collected between September 2, 1992 and September 4, 1992 in accordance with the procedures described in Appendix C. Table 4-7 contains a summary of field observations obtained during ground water sampling activities. Ground water samples were submitted to the analytical laboratory for analysis of Skinner List constituents (Table 4-3), with the exception of monitoring wells B131 (SWMU No. 45) and C128 (SWMU No. 79), which were analyzed for Appendix IX constituents (Table 4-4) as specified in RCRA corrective action permit.

## 4.2 EMPTY LUBE STORAGE AREA (SWMU NO. 1) AND EMPTY LUBE AREA SUMP (SWMU NO. 2)

### 4.2.1 Location and Background

The Empty Lube Storage Area (SWMU 1) is located east of Warehouse No. 2 (Figure 4-1), in the southeastern section of the facility. SWMU No. 1 is underlain by gravel and has approximate dimensions of 100 by 200 feet, and is completely above ground. Commonly, empty lube oil drums were stored on the gravel for later reclamation. Storage activity is believed to have been concentrated in the northern section of the unit. Surface run-off is directed to the Empty Lube Area Sump (SWMU No. 2). Currently, drums are not stored in this area, but discolored gravel and drum bungs (threaded 2-inch-diameter caps for drums) are present.

The Empty Lube Area Sump (SWMU No. 2) is located east of Warehouse 2 and is contained within SWMU No. 1 (Figure 4-1). The top of this unit is approximately even with the ground surface. The unit receives surface water run-off from SWMU No. 1, the Empty Lube Drum Storage Area. Surface water run-off flows from SWMU No. 2 to the Refinery wastewater treatment system via an underground 6-inch-diameter pipe. At times, the sump is surrounded by standing water, indicative of the shallow ground water table in this area. This unit was constructed in 1967 and consists of a cast, topless, 3-foot deep concrete box (as shown on the cross-section insert of Figure 4-1) with the horizontal dimensions of 4 feet by 4 feet. Two courses of 16-inch by 8-inch by 8-inch concrete block lain around the top of the cast box. The entire structure is approximately 4 feet deep (including the 3-foot deep box and overlaying 1-foot brick structure) with horizontal dimensions of 4 feet by 4 feet. Cracks in the concrete block were repaired in June 1991.

### 4.2.2 Physical Integrity Evaluation

A Dames & Moore professional engineer (P.E.) registered in Pennsylvania conducted a visual inspection of SWMU No. 2 on December 21, 1992 to evaluate the physical integrity of this unit. A description of this unit is provided in subsection 4.2.1.

The concrete block sidewalls and bottom of this unit appear to be coated with an asphalt pitch or tar. The sump was empty at the time of the evaluation, but because of the asphalt coating, the construction material for the bottom of the sump could not be discerned during the inspection. As described in subsection 4.2.1, a 6-inch-diameter cast-iron pipe enters the sump from the southwest at approximately 12 inches above the bottom of the sump.

No visible indications of structural failure, such as cracks or holes, on the sidewalls or bottom of the sump were observed. The pitch/tar liner did not appear to be breached or otherwise deteriorated at any location along the sidewalls or on the bottom of the sump. In addition, the 6-inch-diameter pipe did not appear to be cracked and the asphalt liner in this area was intact.

### 4.2.3 Surface Soil Investigation

Three surface samples, designated S001A0, S001A1, and S001A2, were collected within SWMU No. 1 at locations S1-1, S1-2, and S1-3, respectively. The sampling locations are shown on Figure 4-1.

One of the samples (S001A0) was collected from underneath the gravel in an area of visible discoloration. The second sample (S001A1) was collected in an area that did not display visible discoloration. The third sample (S001A2) was collected in the southern portion of SWMU No. 1 in an area of visible discoloration to evaluate the surface soil immediately downgradient of SWMU No. 2. The USEPA's request for additional soil sampling (in a direction not south [downgradient] of SWMU No. 2) is addressed by the investigative program for SWMU No. 1. Based on surface water flow directions, all surface soil samples collected from SWMU No. 1 are essentially upgradient of SWMU No. 2. However, the USEPA identified the area north of SWMU No. 2 as being upgradient. A summary of field observations recorded during surface soil sampling is presented in Table 4-2.

The surface soil samples were analyzed for Skinner List constituents (Table 4-3) with the exception of volatile organic compounds (VOCs). The laboratory results derived from analysis of surface soil samples are presented in Tables 4-8 and 4-9.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-10). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

#### Semi-Volatile Organic Compounds

Several semi-volatile organic compounds (SVOCs) were detected in two of the three surface soil samples (S001A1 and S001A2) collected within SWMU Nos. 1 and 2. The concentrations of the detected compounds, primarily phthalate and naphthalene esters, do not exceed the action levels based on the preliminary risk evaluation. Thus, a screening risk assessment was not performed for SVOCs in surface soil within SWMU Nos. 1 and 2, and no further investigation is warranted regarding SVOCs in surface soil within these SWMUs.

#### Inorganic Analytes

Skinner List metals, with the exception of cadmium, cyanide, and sulfide were detected in the three surface soil samples (S001A0, S001A1, and S001A2). The detected concentrations of beryllium, chromium, and lead exceed preliminary risk evaluation action levels for these analytes. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

### 4.2.4 Subsurface Soil Sampling

Three soil borings (designated B1-1, B1-2, and B1-3) were drilled within SWMU No. 1. One boring was placed in the approximate center of the unit (B1-2), as depicted on Figure 4-1. Another boring (B1-1) was placed 75 feet north of the center boring. The third boring (B1-3) was located in the southern portion of SWMU No. 1, immediately downgradient, as defined by USEPA, of SWMU No. 2. These boring locations were selected in order to develop a spatial distribution that allowed for an initial assessment of the entire unit, including SWMU No. 2. Boring B1-3 was drilled to evaluate the subsurface soil quality immediately downgradient of SWMU No. 2 and to assess the potential for contaminant migration from this unit. Shallow ground water flow in this area is in a generally southerly direction as shown on Figure 3-16. Because the borings are within the interior of the SWMU, each boring is located downgradient from at least part of SWMU No. 1. Boring logs are included in Appendix D. A summary of field observations recorded during subsurface soil sampling is presented in Table 4-5.

A discrete soil sample was collected from the 2-foot interval directly above the water table in each boring. The samples were analyzed for Skinner List constituents (Table 4-3). The laboratory results derived from analysis of subsurface soil samples are presented in Tables 4-11 through 4-13.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-14). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

Volatile organic compounds (VOCs) were detected in the soil samples collected from soil borings B1-1, B1-2, and B1-3. The detected compounds included benzene, 2-butanone (MEK), carbon disulfide, cumene, 1,2-dichloropropane, methylene chloride, n-propylbenzene, toluene, and xylenes, with the highest concentrations occurring in the sample B001A0 collected from soil boring B1-1. Based on the preliminary risk evaluation, the VOC concentrations do not exceed the action levels. Thus, a screening risk assessment was not performed for VOCs in subsurface soil in SWMU Nos. 1 and 2, and additional investigation is not warranted regarding VOCs in the subsurface soil within these SWMUs.

Semi-Volatile Organic Compounds

SVOCs were detected in the soil samples collected from soil borings B1-1, B1-2, and B1-3. The detected compounds were primarily polycyclic aromatic hydrocarbons (PAHs) and phthalate esters. The highest concentrations were detected in sample B001A0 collected from boring B1-1, but the greatest number of detected compounds occurred in sample B001A1 collected from boring B1-2. Benzo(a)pyrene was detected in sample B001A1 at a concentration (540 micrograms per kilogram [ug/kg]) that exceeds the preliminary risk evaluation action level for this compound. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

Inorganic Analytes

Skinner List metals were detected in the three subsurface soil samples collected from borings B1-1, B1-2, and B1-3. Beryllium (0.74 mg/kg) and lead (2,260 mg/kg) were detected in sample B001A0 collected from boring B1-1 at concentrations that exceed their respective preliminary risk evaluation action levels. Sample B001A1 (boring B1-2) contained lead at a concentration (549 mg/kg) that exceeds the action level. Beryllium (0.65 mg/kg), chromium (1,140 mg/kg), and lead (98.7 mg/kg) were detected at concentrations in sample B001A2 (boring B1-3) that exceed their respective action levels. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

4.2.5 Ground Water Investigation

Monitoring well A137 was installed to evaluate ground water quality immediately downgradient of SWMU No. 2. The location of this monitoring well is shown on Figure 4-1. The monitoring well construction diagram is included in Appendix E.

One ground water sample was collected from existing well A40 to evaluate ground water quality in the central part of SWMU No. 1 (Figure 4-1), and one ground water sample was collected from newly installed monitoring well A137 to evaluate ground water quality immediately downgradient of SWMU No. 2. A summary of field observations recorded during ground water sampling is presented in Table 4-7.

Both of the ground water samples were analyzed for the Skinner List constituents (Table 4-3). The laboratory results derived from analysis of ground water samples are presented in Tables 4-15 through 4-18.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-19). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

VOCs were detected in ground water samples G001A1 (well A40) and G002A1 (well A137) collected within SWMU Nos. 1 and 2. The replicate ground water sample (G002A3) collected from monitoring well A137 did not contain VOCs. Sample G001A1 (A40) contained 0.2 micrograms per liter (ug/l) of methyl ethyl ketone (MEK). Acetone, MEK, and vinyl acetate were detected in sample G002A1. None of the detected VOC concentrations exceed the preliminary risk evaluation action levels. Thus, a screening risk assessment was not performed for VOCs in ground water within SWMU Nos. 1 and 2, and further investigation regarding VOCs in ground water within these units is not warranted.

Semi-Volatile Organic Compounds

SVOCs were detected in ground water samples G001A1 (well A40), G002A1 (well A137), and G002A3 (replicate; well A137). The compounds bis(2-ethylhexyl)phthalate and dimethyl phthalate were detected in each of the three ground water samples collected from wells within SWMU Nos. 1 and 2. The compound di-n-octylphthalate was detected in sample G001A1 (well A40) within SWMU No. 1. The detected concentrations of bis(2-ethylhexyl)phthalate in each of the three samples exceed the preliminary risk evaluation action level for this compound.

Inorganics - Unfiltered

Skinner List metals and cyanide were detected in the unfiltered ground water samples collected from wells A40 (SWMU No. 1) and A137 (SWMU No. 2). Detected metals included arsenic, barium, chromium, lead, mercury, and vanadium. Sulfide was not detected in the SWMU 1/2 unfiltered ground water samples. The detected concentrations of lead in ground water samples G001A1 (well A40), G002A1 (well A137), and G002A3 (replicate; well A137) exceed the preliminary risk evaluation action level for this analyte.

Inorganics - Filtered

Few Skinner List metals were detected in the filtered ground water samples collected from wells A40 and A137. Sample G001A2 (well A40) contained antimony and mercury. Samples G002A2 and G002A4 (replicate) collected from well A137 contained barium. Arsenic was only detected in sample G002A2. The detected concentration (19.8 ug/l) of antimony in sample G001A2 (well A40) exceeds the preliminary risk evaluation action level for this analyte. However, antimony was not detected above laboratory detection limits (10 ug/l) in the unfiltered sample G001A1 collected from well A40, and was also detected at a concentration of 11.2 ug/l in the field blank sample (6006A4) associated with the filtered ground water samples. According to the USEPA's *Functional Guidelines for Evaluating Inorganic Analysis* (USEPA, 1988), sample results falling above the instrument detection limit (IDL) but less than five times the concentration detected in an associated blank sample, should be qualified as non-detect. According to the USEPA Region III *Modification to the Inorganic Functional Guidelines* (USEPA, 1990), sample results falling between these values should be qualified with a "B" indicating that the analyte was detected in a blank sample. In either case, any sample result falling within this range should not be considered a detection. Therefore, antimony is not considered to be present in sample 600A2.

## 4.3 TRASH INCINERATOR (SWMU NO. 6)

### 4.3.1 Location and Background

SWMU No. 6, the Trash Incinerator, is located northwest of Penrose Ferry Avenue in the southern part of the facility. The trash incinerator is a metal building 60 feet long by 30 feet wide. The location of the incinerator building is shown on Figure 4-2. During operation, the waste was placed onto a conveyor that moved it to the main flame of the incinerator. Ash was removed by an ash hopper. The feed end and main frame of the

incinerator are located on a concrete pad. The date of start up is not known; operation was stopped in approximately 1974. This unit incinerated oily sludges, oily debris, tank bottoms, and paper. This unit is aboveground and is located partially on concrete and gravel.

### 4.3.2 Surface Soil Investigation

Two surface soil samples, designated S006A0 and S006A1, were biased discrete samples collected in areas of visible discoloration within SWMU No. 6 at locations S6-1 and S6-2, respectively. These sample locations are presented on Figure 4-2. A summary of field observations recorded during surface soil sampling is presented in Table 4-2.

The surface soil samples were analyzed for Skinner List constituents (Table 4-3), with the exception of VOCs. The laboratory results derived from analysis of surface soil samples are presented on Tables 4-8 and 4-9.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-10). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

#### Semi-Volatile Organic Compounds

Several SVOCs were detected in the two surface soil samples (S006A0 and S006A1) collected within SWMU 6. The concentrations of the detected compounds, primarily phthalates and PAHs, do not exceed the action levels based on the preliminary risk evaluation with one exception. Benzo(a)pyrene was detected in sample S006A0 at a concentration (2,400 ug/kg) that exceeds the preliminary risk evaluation action level for this compound. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

#### Inorganic Analysis

Skinner List metals, cyanide and sulfide were detected in the two surface soil samples (S006A0 and S006A1). The detected concentrations of beryllium, chromium, and lead in both samples exceed preliminary risk evaluation action levels. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

### 4.3.3 Subsurface Soil Investigation

Four soil borings (designated B6-1 through B6-4) were drilled within SWMU No. 6. The borings were located in the central area along each of the sides of the unit and beyond any surrounding concrete pad, as depicted on Figure 4-2. It was not physically possible to enter the incinerator building with a drilling rig to provide the interior boring requested by EPA, therefore, each boring was situated as close to the exterior walls of the incinerator building as physically possible with a drilling rig. As shown on Figure 3-16, ground water flows generally

to the west/southwest in the vicinity of SWMU No. 6. Two of the borings (B6-1 and B6-4) were drilled in a downgradient direction from the unit. Boring logs are included in Appendix D. A summary of field observations recorded during subsurface soil sampling is presented in Table 4-5.

A discrete soil sample for laboratory analysis was collected from the 2-foot interval directly above the water table in each boring. The samples were analyzed for Skinner List constituents (Table 4-3). The laboratory results derived from analysis of subsurface soil samples are presented in Tables 4-11 through 4-13.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-14). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

VOCs were detected in the soil samples collected from soil borings B6-1, B6-2, B6-3, and B6-4. The detected compounds included 2-butanone, carbon disulfide, cumene, methylene chloride, n-propylbenzene, and xylenes, with the highest concentrations occurring in the sample B006A4 collected from soil boring B6-4. Based on the preliminary risk evaluation, the VOC concentrations do not exceed the action levels. Thus, a screening risk assessment was not performed for VOCs in subsurface soil in SWMU 6, and additional investigation is not warranted regarding VOCs in the subsurface soil within this SWMU.

Semi-Volatile Organic Compounds

SVOCs were detected in the soil samples collected from soil borings B6-1, B6-2, B6-3, and B6-4. The detected compounds were primarily phthalates and PAHs. The highest concentrations were detected in sample B006A3 collected from boring B6-3. Benzo(a)pyrene was detected at concentrations in samples B006A1 (650 ug/kg) and B006A3 (2,800 ug/kg), that exceed the preliminary risk evaluation action level for this compound. Benzo(a)anthracene (3,600 ug/kg) and dibenz(a,h)anthracene (700 ug/kg) were detected at concentrations in sample B006A3 that exceed preliminary risk evaluation action levels. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

Inorganic Analytes

Skinner List metals, with the exception of cadmium, were detected in the four subsurface soil samples collected from borings B6-1, B6-2, B6-3, and B6-4. Cyanide and sulfide were also detected. Lead concentrations ranged from 223 mg/kg (B006A2) to 3,760 mg/kg (B006A4). Lead concentrations detected in each sample exceed the preliminary risk evaluation action level. Beryllium was detected in samples B006A1 (0.87 mg/kg), B006A3 (1.30 mg/kg), and B006A4 (0.84 mg/kg) at concentrations that exceed the action level for this analyte. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

### 4.3.4 Ground Water Investigation

Initially, it was thought that existing well A24 was close to, and directly downgradient from, SWMU No. 6. However, during VI field activities it was found that well A24 was not situated to detect ground water contamination related to SWMU No. 6. Thus, one monitoring well (A135) was installed to evaluate ground water quality immediately downgradient of SWMU No. 6. The location of this monitoring well is shown on Figure 4-2. The monitoring well construction diagram is included in Appendix E.

A ground water sample was collected from well A135 and analyzed for the Skinner List constituents (Table 4-3). A summary of field observations recorded during ground water sampling is presented in Table 4-7. The laboratory results derived from analysis of ground water samples are presented in Tables 4-15 through 4-18.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-19). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

VOCs, including benzene (120 ug/l), toluene (32 ug/l), and xylenes (17 ug/l), were detected in sample G006A1 collected from well A135 within SWMU No. 6. The detected concentration of benzene exceeds the preliminary risk evaluation action level (0.49 ug/l) for this compound.

Semi-Volatile Organic Compounds

SVOCs, including 1-methylnaphthalene (38 ug/l), bis(2-ethylhexyl)phthalate (19 ug/l), and dimethyl phthalate (4 ug/l) were detected in sample G006A1, collected from well A135. The detected concentrations of bis(2-ethylhexyl)phthalate in sample G006A1 exceeds the preliminary risk evaluation action level for this compound.

Inorganics - Unfiltered

Skinner List metals were detected in the unfiltered ground water sample G006A1, collected from well A135. Detected metals included arsenic, barium, chromium, cobalt, lead, nickel, and vanadium. Cyanide and sulfide were not detected. The detected lead concentration (318 ug/l) in sample G006A1 exceeds the preliminary risk evaluation action level for this analyte.

Inorganics - Filtered

The only Skinner List metals detected in the filtered ground water sample G006A2 (collected from well A135) were arsenic and barium. The detected concentrations of these analytes in G006A2 do not exceed preliminary risk evaluation action levels.

Unfiltered ground water samples were slightly turbid to turbid with high sediment content. Filtered samples were generally clear in appearance with little to no color. The detected concentrations of inorganic analytes in the unfiltered ground water samples were generally greater than dissolved concentrations of these same analytes. This observation suggests that the concentration of inorganic analytes is directly related to the suspended sediment load in the ground water sample. Due to the low yield of the shallow aquifer, it is difficult to remove this sediment during well development. Additionally, the shallow, water table aquifer beneath the refinery consists primarily of silts and clays with small amounts of sand. In this fine-grained matrix, transport of suspended sediment would be minimal. Thus, the unfiltered ground water analytical data is not representative of ground water quality. The data derived from analysis of the filtered samples better represent the quality of the ground water beneath the site.

Because the unfiltered ground water analytical data is not representative of ground water quality, it was not used to evaluate risk. Based on the preliminary risk evaluation of the filtered ground water samples, concentrations of inorganic constituents in ground water do not exceed action levels.

## 4.4 PRODUCT STORAGE SUMP (SWMU NO. 9)

### 4.4.1 Location and Background

SWMU No. 9 (Product Storage Sump) is located within the No. 8 Oil/Water Separator and has approximate dimensions of 30 feet by 15 feet, and extends to a depth of 15 feet below ground surface (Figure 4-3). This active unit that began operation in 1977 is constructed of concrete and is equipped with a water-control level instrument. The unit receives run-off from the product (gasoline, petrochemicals, home heating oil, and jet fuel) storage area of the terminal and discharges to the No. 2B Separator.

### 4.4.2 Physical Integrity Evaluation

Because this operating unit lies within No. 8 Separator, direct integrity evaluation (i.e., volumetric analysis) cannot be performed. The integrity of SWMU No. 9 was assessed by indirect methods. A Dames & Moore Professional Engineer (P.E.) registered in Pennsylvania visually inspected the SWMU to evaluate the physical integrity of this unit. A description of this unit is provided in subsection 4.4.1.

Because this unit is constructed below-grade within the confines of the No. 8 API Separator, we were only able to observe the northern (30 feet in length) and western (15 feet in length) sidewalls of the unit. The total depth of the Separator is approximately 15 feet, but because of liquid contained in the separator, only the top 10 feet of the sidewalls were visible during the evaluation. These sidewalls are contained within the No. 8 separator so that seeps resulting from breaches in the concrete would empty directly into the Separator.

A horizontal hairline fracture that runs along the entire length of the northern sidewall (at approximately 6 feet below the top of the Separator) was observed during the inspection. At several locations along the fracture, there was evidence that leakage may have occurred in the past, but we were not able to ascertain whether this leaking was from the storage sump or residual liquid from the Separator. In addition, it appeared that at several locations along the fracture repairs had been performed.

The western sidewall of the unit did not contain visible fractures or other evidence of deterioration. In addition, there was no indication of leakage from this sidewall.

### 4.4.3 Surface Soil Investigation

One surface sample (S009A1) was collected near SWMU No. 9 from a visually discolored area. This sampling location (S9-1) is shown on Figure 4-3. A summary of field observations recorded during surface soil sampling is presented in Table 4-2. This biased discrete sample was analyzed for Skinner List constituents (Table 4-3), with the exception of VOCs. The laboratory results derived from analysis of surface soil samples are presented on Tables 4-8 and 4-9.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-10). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

#### Semi-Volatile Organic Compounds

SVOCs detected in the surface soil samples S009A1 and S009A2 (replicate) collected at SWMU No. 9 consisted of phthalate compounds and PAHs. Benzo(a)anthracene was detected in sample S009A1 at a concentration (810 ug/kg) that exceeds the preliminary risk evaluation action level for this compound. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

#### Inorganic Analytes

Skinner List metals and sulfide were detected in surface soil samples S009A1 and S009A2 (replicate) collected at SWMU No. 9. The concentration of lead in samples S009A1 (49.3 ug/kg) and S009A2 (72.9 ug/kg) exceeds the preliminary risk evaluation action level. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

### 4.4.4 Subsurface Soil Investigation

One soil boring (B9-1) was drilled with a tripod rig within SWMU No. 9. This boring was located along the southwestern side of the unit in a direction hydraulically downgradient of SWMU No. 9 (Figure 4-3). This sampling method was selected due to limited site access. Boring logs are included in Appendix D. A summary of field observations recorded during subsurface soil sampling is presented in Table 4-5.

A discrete soil sample for laboratory analyses was obtained from the 2-foot interval directly above the water table, and analyzed for Skinner List constituents (Table 4-3). The laboratory results derived from analysis of the subsurface soil sample are presented in Tables 4-11 through 4-13.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-14). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

VOCs were detected in soil sample B009A1 collected from soil boring B9-1. The detected compounds included benzene, 2-butanone (MEK), carbon disulfide, cumene, methylene chloride, n-propylbenzene, toluene, and xylenes. Based on the preliminary risk evaluation, the VOC concentrations do not exceed action levels. Thus, a screening risk assessment was not performed for VOCs in subsurface soil in SWMU No. 9, and additional investigation is not warranted regarding VOCs in the subsurface soil within this SWMU.

Semi-Volatile Organic Compounds

SVOCs were detected in the soil sample collected from soil boring B9-1. The detected compounds were primarily phthalates and PAHs. Benzo(a)pyrene was detected at a concentration (2,200 ug/kg) in sample B009A1 that exceeds the preliminary risk evaluation action level for this compound. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

Inorganic Analytes

Skinner List metals, with the exceptions of antimony, cadmium, and selenium, were detected in subsurface soil sample B009A1 collected from boring B9-1. Cyanide and sulfide were not detected in the soil sample. Beryllium (0.77 ug/kg) and lead (106 ug/kg) were detected at concentrations that exceed their respective preliminary risk evaluation action levels. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

### 4.4.5 Ground Water Investigation

One monitoring well (A136) was installed to evaluate ground water quality immediately downgradient of SWMU No. 9. Due to limited access, monitoring well A136 was drilled and installed with a tripod rig. The well is constructed of 2-inch diameter schedule 40 PVC screen and riser pipe. The location of this monitoring well is shown on Figure 4-3. The monitoring well construction diagram is included in Appendix E.

One ground water sample was collected from newly installed monitoring well A136. The ground water sample was collected by the procedures described in Appendix C and analyzed for the Skinner List constituents (Table 4-3). A summary of field observations recorded during ground water sampling is presented in Table 4-7. The laboratory results derived from analysis of ground water samples are presented in Tables 4-15 through 4-18.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-19). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

VOCs were not detected in ground water sample G009A1 collected from well A136. Thus, a screening risk assessment was not performed for VOCs in ground water within SWMU No. 9, and further investigation regarding VOCs in ground water within this unit is not warranted.

Semi-Volatile Organic Compounds

Several SVOCs, including 1-methylnaphthalene (11 ug/l), anthracene (3 ug/l), and phenanthrene (9 ug/l), were detected in the ground water sample G009A1 at estimated concentrations below method detection limits. The SVOC concentrations do not exceed preliminary risk evaluation action levels. Thus, a screening risk assessment was not performed for SVOCs in ground water within SWMU No. 9, and further investigation regarding SVOCs in ground water within this unit is not warranted.

Inorganics - Unfiltered

Skinner List metals and cyanide were detected in the unfiltered ground water sample G009A1 collected from well A136. Detected metals included arsenic, barium, chromium, cobalt, lead, mercury, nickel, and vanadium. Sulfide was not detected. The detected concentrations of lead (346 ug/l) and mercury (3.60 ug/l) in sample G009A1 exceed preliminary risk evaluation action levels.

Inorganics - Filtered

The only Skinner List metals detected in the filtered ground water sample G009A2 (A136) were barium, cobalt, and nickel. The detected concentrations of these analytes in G009A2 do not exceed preliminary risk evaluation action levels.

Unfiltered ground water samples were brown to black in color and turbid with high sediment content. Filtered samples were generally clear in appearance with little to no color. The detected concentrations of inorganic analytes in the unfiltered ground water samples were generally greater than dissolved concentrations of these same analytes. This observation suggests that the concentration of inorganic analytes is directly related to the suspended sediment load in the ground water sample. Due to the low yield of the shallow aquifer, it is difficult to remove this sediment during well development. Additionally, the shallow, water table aquifer

beneath the refinery consists primarily of silts and clays with small amounts of sand. In this fine-grained matrix, transport of suspended sediment would be minimal. Thus, the unfiltered ground water analytical data is not representative of ground water quality. The data derived from analysis of the filtered samples better represent the quality of the ground water beneath the site.

Because the unfiltered ground water analytical data is not representative of ground water quality, it was not used to evaluate risk. Based on the preliminary risk evaluation of the filtered ground water samples, concentrations of inorganic constituents in ground water do not exceed action levels.

## 4.5 PAST LAGOON A (SWMU NO. 11) AND PREVIOUS CRUDE OIL TOPPING UNIT (SWMU NO. 12)

### 4.5.1 Location and Background

SWMU No. 11 (Past Lagoon A) and SWMU No. 12 (Previous Crude Oil Topping Unit) are addressed jointly in this section, as they existed in approximately the same area (Figure 4-4) in the southern portion of the refinery. This area is currently overlain by the Container Storage Area (SWMU No. 10).

SWMU No. 11 was an unlined lagoon with approximate dimensions of 200 feet by 100 feet, based on analysis of an aerial photograph of 1975. The depth of this lagoon below ground surface is not known. The lagoon was used to separate and recovery oil. The oil was pumped off, leaving the solids in the unit. The origin of the waste it not known. The composition of the waste is not known. However, it is suspected that the unit received tank bottoms, sewer sludge, and spill cleanup material. The unit began operation in 1946 and stopped receiving waste in 1979. It is not known if there were any release controls. No records regarding history of releases are available.

SWMU No. 12 is believed to be located under SWMU No. 11 and predates SWMU No. 11. The previous crude oil topping unit consisted of several small buildings and tanks. SWMU No. 12 had approximate dimensions of 200 feet by 100 feet. The depth of this unit below ground surface is not known. The start up date of this facility is not known. Documents reveal that this unit existed in 1946. The closure date is not known. The exact nature of the waste that was managed is also not known. It is not known if there were any release controls. No records regarding history of releases are available.

The area of former SWMU Nos. 11 and 12 is now covered by gravel and the Container Storage Area.

### 4.5.2 Soil Gas Survey

A soil gas survey was conducted to evaluate the extent and degree of VOCs in the subsurface soil gas related to SWMU Nos. 11 and 12. Due to the superposition of these units, the results of the soil gas survey were used to evaluate the potential for hazardous constituent release from both units and the placement of soil borings. The ten sample points were arranged in a grid pattern with a 50-foot spacing, along the perimeter of the container storage area.

Soil gas sampling locations SG11-1, SG11-8, SG11-9, and SG11-10 were situated in an area where the surface elevation is approximately 3 to 4 feet lower than the other locations, and outside the perimeter of the concrete retaining wall surrounding the Container Storage Area. Soil gas sampling locations SG11-3 through SG11-7 were located in gravel outside the limits of the concrete pad, but within the boundaries of the concrete retaining wall. Soil gas sampling location SG11-2 was situated in the asphalt driveway about 5 feet from the western boundary of the concrete pad.

Soil gas samples were typically collected from a depth of 4 feet below ground surface (BGS). At sampling locations SG11-4 through SG11-7, attempts were made to collect soil gas samples at a depth of 7 feet BGS so that all the soil gas samples within these SWMUs would be collected at similar stratigraphic horizons. However, refusal was encountered at 6 feet BGS in SG11-4 and SG11-5, and at 4 feet BGS in SG11-6. The presence of perched water in SG11-7 at a depth of 3 feet BGS, prevented the collection of a soil gas sample at this location.

The results of the soil gas survey within SWMU Nos. 11 and 12 are summarized in Table 4-20. The maximum OVA concentrations were at least 10,000 parts per million (ppm) at each sampling location except for SG11-4, which produced maximum OVA concentrations of 50 ppm at 4 feet BGS and 3000 ppm at 6 feet BGS.

Toluene and xylenes were detected in each sample (with the exception of SG11-7, which did not contain xylenes). Benzene and ethylbenzene were not detected in any of the samples. The concentration of total VOCs ranged from 1.88 parts per million (ppm) at SG11-4 (4 feet BGS) to 854 ppm at SG11-1 (4 feet BGS).

A review of the gas chromatograph (GC) chromatograms indicated that petroleum compounds were detected in each of the sampling location at varying concentrations. The petroleum compounds were primarily light hydrocarbons with boiling points lower than that of toluene.

As shown in Table 4-20, the detected concentrations of toluene and xylenes were converted from ppm to micrograms per cubic meter ($ug/m^3$). The detected concentrations of toluene in the soil gas samples do not exceed the action level for this compound. The concentrations of xylenes detected in the soil gas at locations SG11-1 (2,030 $ug/m^3$), SG11-2 (1,186 $ug/m^3$), and SG11-10 (2,279 $ug/m^3$) exceed preliminary risk evaluation action levels (Table 4-21). Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

### 4.5.3 Surface Soil Investigation

Surface soil samples were not collected in the area of SWMU Nos. 11 and 12, as the soil in this area has been disturbed and is overlain by the current Container Storage Area. Thus, the current surface soil is not representative of the conditions that existed during operation of SWMU Nos. 11 and 12.

### 4.5.4 Subsurface Soil Investigation

Four soil borings (B11-1, B11-2, B11-3, and B11-4) were drilled in the area of SWMU Nos. 11 and 12. These borings were located along each of the four sides of the Container Storage Area along the edge of the concrete containment pad (Figure 4-4). The shallow ground water flow direction in the vicinity of SWMU Nos. 11 and 12 is in a generally westerly direction as shown on Figure 3-16. Because of the siting of the soil borings around the periphery of the units, two soil borings (B11-1 and B11-4) are situated downgradient of the SWMUs. Boring logs are included in Appendix D. A summary of field observations recorded during subsurface soil sampling is presented in Table 4-5.

A discrete soil sample was collected for laboratory analysis from the 2-foot interval directly above the water table in each boring. The samples were analyzed for Skinner List Constituents (Table 4-3). The laboratory results derived from analysis of subsurface soil samples are presented in Tables 4-11 through 4-13.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-14). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

#### Volatile Organic Compounds

VOCs were detected in the soil samples collected from soil borings B11-1, B11-2, B11-3, and B11-4. Xylenes and methylene chloride were detected in each of the soil samples. The compounds 2-butanone (MEK), cumene, and n-propylbenzene were also detected in samples B001A3 (B11-3) and B011A4 (B11-4). Benzene and toluene were detected in sample B011A3 (B11-3). The highest concentrations of VOCs were detected in sample B011A3 (B11-3). Based on the preliminary risk evaluation, the VOC concentrations do not exceed action levels. Thus, a screening risk assessment was not performed for VOCs in subsurface soil in SWMU Nos. 11 and 12, and additional investigation is not warranted regarding VOCs in the subsurface soil within these SWMUs.

#### Semi-Volatile Organic Compounds

SVOCs were detected in the soil samples collected from soil borings B11-1, B11-2, B11-3, B11-4, and B11-5 (replicate of the sample collected from B11-2). The detected compounds were primarily PAHs and phthalate esters. The highest SVOC concentrations were detected in sample B011A4 collected from boring B11-4. Benzo(a)anthracene (30,000 ug/kg), benzo(a)pyrene (25,000 ug/kg), benzo(b,k,j)fluoranthene (81,000 ug/kg), indeno(1,2,3-cd)pyrene (8,400 ug/kg) and pyrene (25,000 ug/kg) were detected in sample B011A4 (B11-4) at

concentrations that exceed preliminary risk evaluation action levels. Benzo(a)pyrene was also detected in sample B011A3 (B11-3) at a concentration (670 ug/kg) that exceeds the preliminary risk evaluation action level for this compound. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

Inorganic Analytes

Skinner List metals, with the exceptions of cadmium and selenium, were detected in subsurface soil samples B011A1, B011A2, B011A3, and B011A4 collected from borings B11-1, B11-2, B11-3, and B11-4, respectively. A replicate soil sample, B011A5, was collected from B11-2.

Beryllium was detected in the soil samples at concentrations ranging from 0.59 mg/kg (B011A3) to 2.6 mg/kg (B011A1), and lead was detected at concentrations ranging from 140 mg/kg (B011A2) to 507 mg/kg (B011A4), respectively. Each of the detected concentrations of beryllium and lead exceed preliminary risk evaluation action levels for these analytes. Chromium was detected in samples B011A1 (648 mg/kg), B011A2 (774 mg/kg), and B011A5 (946.0 mg/kg) at concentrations that exceed the preliminary risk evaluation action level for this parameter. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

### 4.5.5 Ground Water Investigation

One monitoring well (A133) was installed to evaluate ground water quality immediately downgradient of SWMU Nos. 11 and 12. The location of this monitoring well is shown on Figure 4-4. The monitoring well construction diagram is included in Appendix E.

A ground water sample was not collected from newly installed well A133 because of the presence of free-phase hydrocarbon liquid within the well. A sample of the free-phase hydrocarbon (G011A1) was collected and analyzed using gas chromatograph (GC) techniques.

The results of GC analysis on the hydrocarbon sample were compared to GC standards for kerosene, gasoline, and fuel oil. The GC results indicate that the free-phase liquid contained 680,000 milligrams per liter (mg/l) of total petroleum hydrocarbons (TPH). However, the laboratory was not able to evaluate whether the free-phase hydrocarbon was a degraded form of kerosene, gasoline, or fuel oil. Therefore, the reported concentration is an estimated value, and represents a rough approximation of the TPH concentration.

Dames & Moore reviewed the GC chromatogram for hydrocarbon sample G011A1 collected from well A133. Based on this review, it appears that the hydrocarbon is not gasoline. The retention time of the baseline peak is similar to that of No. 2 fuel oil or diesel fuel. However, the baseline on the chromatogram was flatter and longer than is typically seen with these two fuels, indicating that the hydrocarbon is possibly a less-refined or degraded (weathered) combination of the two.

The presence of free-phase hydrocarbon warrants further action regarding ground water within this SWMU. The extent and degree of free-phase hydrocarbon floating on the water table should be defined. In addition, potential hydrocarbon sources should be evaluated.

## 4.6 TANK 355 (SWMU NO. 13)

### 4.6.1 Location and Background

SWMU No. 13 (Tank 355) was located east of "F" Avenue in the southern part of the facility (Figure 4-5). This unit was a concrete basin and had approximate dimensions of 21 feet by 23 feet with a 10-foot depth below ground surface. A steel grate covered the unit. The walls were approximately 1.5 feet thick. The bottom was 2.5 feet thick. The gross capacity of the unit was 38,500 gallons. During operation, this unit received waste oil from vacuum trucks, oil spill cleanup operations, and oil skimmings from API separators. The waste oil was conveyed by pipeline from SWMU No. 13 to Tanks 357 (SWMU No. 16) and 358 (SWMU No. 17). The operational start up date of the subject unit is unknown.

In October 1989, SWMU No. 13 was modified. A fiberglass basin was installed within the original concrete unit. Furthermore, a steel basin was installed within the fiberglass basin creating a double-lined tank. This modified tank is currently governed by underground storage tank (UST) regulations.

### 4.6.2 Surface Soil Investigation

Surface samples were not collected within former SWMU No. 13. Surface soil around this former unit was disturbed during modification to the concrete basin. Therefore, a surface sample would not be representative of conditions at the time of the operation of SWMU No. 13.

### 4.6.3 Subsurface Soil Investigation

Two soil borings (B13-1 and B13-2) were drilled within former SWMU 13. Shallow ground water flow is generally westerly in direction, as shown on Figure 3-16. Both of these borings were located hydraulically downgradient near the western boundary of the former unit as shown on Figure 4-5. Boring logs are included in Appendix D. A summary of field observations recorded during subsurface soil sampling is presented in Table 4-5.

A discrete soil sample was collected from the 2-foot interval directly above the water table in each boring. The samples were analyzed for Skinner List constituents (Table 4-3). The laboratory results derived from analysis of subsurface soil samples are presented in Tables 4-11 through 4-13.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-14). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

VOCs, including 2-butanone, chlorobenzene, cumene, and n-propylbenzene, were detected in soil samples B013A1 and B013A2 collected from soil borings B13-1 and B13-2, respectively. The detected concentrations of VOCs do not exceed action levels, based on the preliminary risk evaluation. Thus, a screening risk assessment was not performed for VOCs in subsurface soil within SWMU No. 13, and additional investigation is not warranted regarding VOCs in the subsurface soil within this unit.

Semi-Volatile Organic Compounds

SVOCs were detected in soil samples B013A1 and B013A2 collected from soil borings B13-1 and B13-2. Detected compounds include PAHs, phthalates, and phenols. Benzo(a)pyrene was detected in samples B013A1 (1,400 ug/kg) and B013A2 (910 ug/kg) at concentrations that exceed the preliminary risk evaluation action level for this compound. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

Inorganic Analytes

Skinner List metals, with the exception of cadmium, and cyanide were detected in subsurface soil samples B013A1 and B013A2 collected within SWMU No. 13. Sulfide was not detected in sample B013A2. Beryllium concentrations 1.40 mg/kg (B013A1) and 0.90 mg/kg (B013A2), and lead concentrations 229.0 mg/kg (B013A1) and 580.0 mg/kg (B013A2) detected in subsurface soil samples exceed preliminary risk evaluation action levels for these analytes. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

### 4.6.4 Ground Water Investigation

One monitoring well (A134) was installed to evaluate ground water quality immediately downgradient of SWMU No. 13 (Figure 4-5). The location of this monitoring well is shown on Figure 4-5. The monitoring well construction diagram is included in Appendix E.

One ground water sample was collected from the newly installed monitoring well (A134). The ground water sample was collected using the procedures described in Appendix C, and analyzed for Skinner List constituents (Table 4-3). The laboratory results derived from analysis of ground water samples are presented in Tables 4-15 through 4-18.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-19). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

Three VOCs, including benzene (23 ug/l), toluene (9 ug/l), and xylenes (40 ug/l), were detected in the ground water sample G013A1 collected from well A134. The detected concentration of benzene in this sample exceeds the preliminary risk evaluation action level for this compound.

Semi-Volatile Organic Compounds

SVOCs were not detected in the ground water sample G013A1. Thus, a screening risk assessment was not performed for SVOCs in the ground water at SWMU No. 13, and further investigation regarding SVOCs in ground water within this unit is not warranted.

Inorganic Analytes - Unfiltered

Eight Skinner List metals (arsenic, barium, chromium, cobalt, lead, mercury, nickel, and vanadium) and cyanide were detected in ground water sample G013A1 collected from well A134. The detected concentration of lead (167 ug/l) in sample G013A1 exceeds the preliminary risk evaluation action level for this analyte.

Inorganic Analytes - Filtered

Three Skinner List metals (arsenic, barium, and chromium) were detected in filtered ground water sample G013A2 collected from well A134. The detected concentrations of these analytes do not exceed their respective preliminary risk evaluation action levels.

Unfiltered ground water samples were slightly turbid with high sediment content. Filtered samples were generally clear in appearance with little to no color. The detected concentrations of inorganic analytes in the unfiltered ground water samples were generally greater than dissolved concentrations of these same analytes. This observation suggests that the concentration of inorganic analytes is directly related to the suspended sediment load in the ground water sample. Due to the low yield of the shallow aquifer, it is difficult to remove this sediment during well development. Additionally, the shallow, water table aquifer beneath the refinery consists primarily of silts and clays with small amounts of sand. In this fine-grained matrix, transport of suspended sediment would be minimal. Thus, the unfiltered ground water analytical data is not representative of ground water quality. The data derived from analysis of the filtered samples better represent the quality of the ground water beneath the site.

Because the unfiltered ground water analytical data is not representative of ground water quality, it was not used to evaluate risk. Based on the preliminary risk evaluation of the filtered ground water samples, concentrations of inorganic constituents in ground water do not exceed action levels.

## 4.7 TANK 357 (SWMU NO. 16) AND TANK 358 (SWMU NO. 17)

### 4.7.1 Location and Background

SWMU Nos. 16 and 17 lie adjacent to each other and are located east of "E" Avenue in the southern part of the facility (Figure 4-5). These units are above ground. These tanks are constructed of steel according to API Standard 12-C and are supported by six legs each that rest on concrete blocks. They are underlain by gravel. A 6-inch-high concrete curb surrounds the units. Each has a capacity of 3,600 barrels and is part of the slop oil treatment system. The tanks receive a mixture of oil and water from Tank 355 (SWMU No. 13). The oil and water are gravity-separated, with the water settling into the conical bottom and the oil remaining overhead. An emulsion phase settles at the interface. The recovered water is discharged to the process sewer and the oil is used in the refinery. The remaining oil emulsion layer is transferred to the refinery's waste oil system or disposed off-site.

The start up date for these units is unknown. These units are currently active, with the tanks managing refinery slop oils.

### 4.7.2 Surface Soil Investigation

Two surface samples (S016A1 and S016A2) were collected within SWMU Nos. 16 and 17 in areas of visible surface staining. Surface soil sampling locations (S16-1 and S16-2) are shown on Figure 4-5. A summary of field observations recorded during surface soil sampling is presented in Table 4-2.

The surface soil samples were analyzed for Skinner List constituents (Table 4-3), with the exception of VOCs. The laboratory results derived from analysis of surface soil samples are presented on Tables 4-8 and 4-9.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-10). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

#### Semi-Volatile Organic Compounds

Several SVOCs were detected in the two surface soil samples (S016A1 and S016A2) collected within SWMU Nos. 16 and 17. The concentrations of the detected compounds, primarily phthalates and PAHs, do not exceed the action levels based on the preliminary risk evaluation with one exception. The concentration of benzo(a)pyrene in sample S016A1 (1,400 ug/kg) exceeds the preliminary risk evaluation action level for this compound. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

Inorganic Analytes

Skinner List metals, with the exceptions of cadmium and selenium, were detected in the two surface soil samples (S016A1 and S016A2). Sulfide was detected in S016A2. The detected concentrations of beryllium, chromium, and lead exceed preliminary risk evaluation action levels. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

### 4.7.3 Subsurface Soil Investigation

Eight soil borings (B16-1 through B16-4, and B17-1 through B17-4) were drilled within SWMU Nos. 16 and 17 (Figure 4-5). The soil borings were located along perimeter of each of the units. These locations were selected to develop a spatial relationship of the resulting data to assess the entire unit. The shallow ground water flow direction in the vicinity of SWMU Nos. 16 and 17 is generally westerly in direction as shown on Figure 3-16. Because of the spatial distribution of the soil borings surrounding SWMU Nos. 16 and 17, two soil borings at SWMU No. 16 (B16-3 and B16-4) and one soil boring at SWMU No. 17 (B17-4) are hydraulically downgradient from each SWMU. Boring logs are included in Appendix D. A summary of field observations recorded during subsurface soil sampling is presented in Table 4-5.

A discrete soil sample for laboratory analysis was collected from the 2-foot interval directly above the water table in each boring. The samples were analyzed for Skinner List constituents (Table 4-3). The laboratory results derived from analysis of subsurface soil samples are presented in Tables 4-11 through 4-13.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-14). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

VOCs were detected in the soil samples collected from the eight soil borings in SWMU Nos. 16 and 17. The detected compounds included benzene, 2-butanone, chloroform, cumene, 1,2-dichloropropane, methylene chloride, n-propylbenzene, toluene, and xylenes, with the highest concentrations occurring in the sample B016A3 collected from soil boring B16-3. Based on the preliminary risk evaluation, the VOC concentrations do not exceed action levels. Thus, a screening risk assessment was not performed for VOCs in subsurface soil in SWMU Nos. 16 and 17, and additional investigation is not warranted regarding VOCs in the subsurface soil within these SWMUs.

Semi-Volatile Organic Compounds

SVOCs were detected in the soil samples collected from the eight soil borings in SWMU Nos. 16 and 17. The detected compounds were primarily PAHs. The highest concentrations were detected in sample B016A3 collected from boring B16-3. Benzo(a)pyrene was detected in the subsurface soil samples at concentrations ranging from 110 ug/kg in boring B17-4 (B017A4) to 1,300 ug/kg in boring B16-3 (B016A3). The detected concentrations of benzo(a)pyrene exceed the preliminary risk evaluation action level for this compound. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

Inorganic Analytes

Skinner List metals, with the exception of cadmium, were detected in the eight subsurface soil samples collected from SWMU Nos. 16 and 17. Lead concentrations ranged from 57.2 mg/kg (B016A1) to 556 mg/kg (B017A2). These concentrations exceed the preliminary risk evaluation action level for lead. Beryllium was detected in samples B016A2 (0.78 mg/kg), B016A4 (1.2 mg/kg), B017A2 (0.73 mg/kg), and B017A4 (2.5 mg/kg). The detected beryllium concentrations in these samples exceed the preliminary risk evaluation action level for this analyte. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

4.7.4 Ground Water Investigation

SWMU Nos. 16 and 17 are oriented approximately along a ground water flow line and are very close to each other. As such, one monitoring well (A132) was installed to evaluate ground water quality immediately downgradient of both units. The location of this monitoring well is shown on Figure 4-5. The monitoring well construction diagram is included in Appendix E.

One ground water sample was collected from newly installed monitoring well A132. The ground water sample was collected using the procedures described in Appendix C and analyzed for the Skinner List constituents (Table 4-3). A summary of field observations recorded during ground water sampling is presented in Table 4-7. The laboratory results derived from analysis of ground water samples are presented in Tables 4-15 through 4-18.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-19). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

VOCs were not detected in the ground water sample (G017A1) collected from well A132. Thus, a screening risk assessment was not performed for VOCs in the ground water at SWMU Nos. 16 and 17, and further investigation regarding VOCs in ground water within these units is not warranted.

Semi-Volatile Organic Compounds

Two SVOCs, 1-methylnaphthalene (10 ug/l) and dimethyl phthalate (4 ug/l), were detected in ground water sample G017A1 at estimated concentrations below method detection limits. The detected SVOC concentrations do not exceed the preliminary risk evaluation action levels. Thus, a screening risk assessment was not performed for SVOCs in the ground water at SWMU Nos. 16 and 17, and further investigation regarding SVOCs in ground water within these units is not warranted.

Inorganic Analytes - Unfiltered

Several Skinner List metals, including arsenic, barium, beryllium, chromium, cobalt, lead, mercury, nickel, and vanadium, and cyanide were detected in the ground water sample G017A1. The detected concentrations of barium (2,010 ug/l), beryllium (6 ug/l), chromium (928 ug/l), lead (1,620 ug/l), mercury (3.4 ug/l), and vanadium (596 ug/l) exceed preliminary risk evaluation action levels for these analytes.

Inorganic Analytes - Filtered

Three Skinner List metals, arsenic (4.4 ug/l), barium (283 ug/l), and cobalt (42 ug/l), were detected in filtered ground water sample G017A2 collected from well A132. The detected concentrations of these analytes do not exceed preliminary risk evaluation action levels.

Unfiltered ground water samples were turbid with high sediment content. Filtered samples were generally clear in appearance with little to no color. The detected concentrations of inorganic analytes in the unfiltered ground water samples were generally greater than dissolved concentrations of these same analytes. This observation suggests that the concentration of inorganic analytes is directly related to the suspended sediment load in the ground water sample. Due to the low yield of the shallow aquifer, it is difficult to remove this sediment during well development. Additionally, the shallow, water table aquifer beneath the refinery consists primarily of silts and clays with small amounts of sand. In this fine-grained matrix, transport of suspended sediment would be minimal. Thus, the unfiltered ground water analytical data is not representative of ground water quality. The data derived from analysis of the filtered samples better represent the quality of the ground water beneath the site.

Because the unfiltered ground water analytical data is not representative of ground water quality, it was not used to evaluate risk. Based on the preliminary risk evaluation of the filtered ground water samples, concentrations of inorganic constituents in ground water do not exceed action levels.

## 4.8 TANK 200 PAST LAGOON (SWMU NO. 29)

### 4.8.1 Location and Background

SWMU No. 29 (Tank 200 Past Lagoon) is located primarily under Tank 200 (Separator No. T-844; SWMU No. 28) in the western section of the Refinery (Figure 4-6). The approximate dimensions of SWMU No. 29 were 100 feet by 100 feet based on a review of 1970

and 1975 aerial photographs. The depth of this unit below ground surface is not known. The unit possibly received sludges from Separators 2, 2A, and 2B (SWMU Nos. 25, 26, and 27) and tank bottoms. The waste was placed directly into the lagoon. The start up date of unit operation is not known. The end date is believed to be in 1974. Currently, the unit is inactive and underlies Separator No. T-844.

### 4.8.2 Soil Gas Survey

A soil gas survey was conducted in the area of SWMU No. 29, and consisted of five sampling points. As shown on Figure 4-6, the points were arranged in a circular arc spaced around the tanks. Perched ground water was encountered at depths ranging from 1.5 feet to 3 feet below ground surface (BGS) in each of the sampling locations except SG29-5.

The soil gas survey results for this SWMU area are summarized in Table 4-22. The maximum OVA concentrations exceeded 10,000 ppm at each sampling location. Xylenes were detected at each of the sampling locations and toluene was detected in SG29-1, SG29-3, and SG29-4. Benzene and ethylbenzene were not detected in any of the samples. Based on the GC analysis, total VOC concentrations ranged from 5.81 ppm in SG29-2 to 164 ppm in SG29-1.

A review of the GC chromatograms indicated that petroleum compounds were detected in each of the sampling locations at various concentrations. The petroleum compounds were primarily light hydrocarbons with boiling points lower than that of toluene.

As shown on Table 4-22, the detected concentrations of toluene and xylenes were converted from ppm to micrograms per cubic meter ($ug/m^3$). The detected concentrations of toluene in the soil gas samples do not the exceed action level for this compound. The concentrations of xylenes detected in the soil gas at locations SG29-1 (2,595 $ug/m^3$), SG29-3 (2,045 $ug/m^3$), and SG29-5 (1,251 $ug/m^3$) exceed preliminary risk evaluation action levels (Table 4-21). Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

### 4.8.3 Surface Soil Investigation

Surface soil samples were not collected within SWMU No. 29, as the area has been disturbed during the installation of Separator T-844. Thus, the current surface soil is not representative of the conditions that existed during operation of SWMU No. 29.

### 4.8.4 Subsurface Soil Investigation

Two soil borings (B29-1 and B29-2) were drilled in the area of SWMU No. 29. These borings are located along the southern edge of Separator T-844, where sections of the unit may exist in the subsurface (Figure 4-6). Boring logs are included in Appendix D. A summary of field observations recorded during subsurface soil sampling is presented in Table 4-5.

A discrete soil sample was collected from the 2-foot interval directly above the water table in each boring. The samples were analyzed for Skinner List Constituents (Table 4-3). The laboratory results derived from analysis of subsurface soil samples are presented in Tables 4-11 through 4-13.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-14). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

VOCs were detected in soil samples B029A1 and B029A2 collected from soil borings B29-1 and B29-2, respectively. The compounds 2-butanone, cumene, n-propylbenzene, and xylenes were detected in sample B029A1. Cumene and xylenes were detected in sample B029A2. Detected VOC concentrations in samples B029A1 and B029A2 do not exceed preliminary risk evaluation action levels. Thus, a screening risk assessment was not performed for VOCs in subsurface soil within SWMU 29, and additional investigation is not warranted regarding VOCs in the subsurface soil within this unit.

Semi-Volatile Organic Compounds

Several SVOCs were detected in the two soil samples collected from soil borings B29-1 and B29-2. The detected compounds were primarily PAHs and phthalates. The detected concentrations of benzo(a)anthracene (3,900 ug/kg) and benzo(a)pyrene (3,200 ug/kg) in sample B029A2 exceed preliminary risk evaluation action levels for these compounds. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

Inorganic Analytes

Skinner List metals, with the exception of cadmium, and cyanide were detected in soil samples B029A1 and B029A2. Sulfide and formaldehyde were not detected in either sample. Beryllium concentrations 0.99 mg/kg (B029A1) and 0.73 mg/kg (B029A2), and lead concentrations 295 mg/kg (B029A1) and 695 mg/kg (B029A2) detected in the samples exceed preliminary risk evaluation action levels for these analytes. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

### 4.8.5 Ground Water Investigation

One monitoring well (B130) was installed to evaluate ground water quality immediately downgradient of SWMU No. 29. The location of this monitoring well is shown on Figure 4-6. The monitoring well construction diagram is included in Appendix E.

One ground water sample was collected from newly installed monitoring well B130. The ground water sample was collected using the procedures described in Appendix C and analyzed for the Skinner List constituents (Table 4-3). A summary of field observations recorded during ground water sampling is presented in Table 4-7. The laboratory results derived from analysis of ground water samples are presented in Tables 4-15 through 4-18.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-19). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

VOCs, including benzene (5 ug/l), toluene (7 ug/l), and xylenes (24 ug/l), were detected in the ground water sample G029A1 collected from well B130. The detected concentration of benzene exceeds the preliminary risk evaluation action level for this compound.

Semi-Volatile Organic Compounds

Four SVOCs, 1-methylnaphthalene, bis(2-ethylhexyl)phthalate, diethyl phthalate, and dimethyl phthalate, were detected in ground water sample G029A1 at estimated concentrations below method detection limits. The detected concentration (5 ug/l) of bis(2-ethylhexyl) phthalate exceeds the preliminary risk evaluation action level for this compound.

Inorganic Analytes - Unfiltered

Six Skinner List metals, including arsenic, barium, chromium, lead, mercury, and vanadium, and cyanide were detected in the ground water sample G029A1 collected from well B130. The detected concentrations of arsenic (59.4 ug/l) and lead (171 ug/l) exceed preliminary risk evaluation action levels for these analytes.

Inorganic Analytes - Filtered

Two Skinner List metals, arsenic (49.4 ug/l) and barium (64 ug/l), were detected in filtered ground water sample G029A2 collected from well A130. The detected concentrations of these analytes do not exceed action levels.

Unfiltered ground water samples were brown in color and slightly turbid to turbid with high sediment content. Filtered samples were generally clear in appearance with little to no color. The detected concentrations of inorganic analytes in the unfiltered ground water samples were generally greater than dissolved concentrations of these same analytes. This observation suggests that the concentration of inorganic analytes is directly related to the suspended sediment load in the ground water sample. Due to the low yield of the shallow aquifer, it is difficult to remove this sediment during well development. Additionally, the shallow, water table aquifer beneath the refinery consists primarily of silts and clays with small amounts of sand. In this fine-grained matrix, transport of suspended sediment would be minimal. Thus, the unfiltered ground water analytical data is not representative of ground water quality. The data derived from analysis of the filtered samples better represent the quality of the ground water beneath the site.

Because the unfiltered ground water analytical data is not representative of ground water quality, it was not used to evaluate risk. Based on the preliminary risk evaluation of the filtered ground water samples, concentrations of inorganic constituents in ground water do not exceed action levels.

## 4.9 ADDITIVE PLANT DRUM STORAGE AREA (SWMU NO. 30)

### 4.9.1 Location and Background

SWMU No. 30 (Additive Plant Drum Storage Area) is located off Sixth Street and west of Tank 246, in the eastern part of the facility (Figure 4-7). The unit is currently covered with gravel. This unit is above ground. The approximate dimensions of this unit are 550 feet by 60 feet, based upon a review of aerial photographs. The start up date for this unit is unknown. However, the unit was in operation during 1965, while drum storage ceased in 1978. Prior to 1978, the storage area is believed to have received drums containing agents for use in the facility laboratory. The chemical composition of these agents is not known, but is believed to be both organic and inorganic in nature. Waste material is not believed to have been stored in this area.

### 4.9.2 Surface Soil Investigation

Three surface soil samples (S030A1, S030A2, and S030A3) were collected within SWMU No. 30. The sampling locations are shown on Figure 4-7. Sample S030A2 was located in the approximate center point of the area at location S30-2. The other two samples, S030A1 and S030A3, were collected 150 feet southeast and northwest of S30-2 at locations S30-1 and S30-3, respectively. A summary of field observations recorded during surface soil sampling is presented in Table 4-2.

Samples were analyzed for Skinner List constituents (Table 4-3), with the exception of VOCs. The laboratory results derived from analysis of surface soil samples are presented on Tables 4-8 and 4-9.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-10). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

#### Semi-Volatile Organic Compounds

Several SVOCs were detected in the three surface soil samples collected within SWMU No. 30. The concentrations of the detected compounds, primarily phthalates and PAHs, do not exceed the action levels based on the preliminary risk evaluation. Thus, a screening risk assessment was not performed for SVOCs in surface soil within SWMU No. 30, and further investigation is not warranted regarding SVOCs in surface soil within this SWMU.

Inorganic Analytes

Skinner List metals were detected in the three surface soil samples collected within SWMU No. 30. Lead was detected in samples S030A1 (347 mg/kg), S030A2 (2,270 mg/kg), and S030A3 (91.4 mg/kg). Cyanide and sulfide were detected, but not at concentrations that exceed preliminary risk evaluation action levels. The detected concentration of lead in each sample exceeds the preliminary risk evaluation action level. The detected concentrations of beryllium and chromium in samples S030A2 and S030A3 exceed preliminary risk evaluation action levels for these analytes. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

### 4.9.3 Subsurface Soil Investigation

Three soil borings were performed within SWMU No. 30. One boring was located at the approximate center of the unit (B30-2). Two other borings, one to the southeast (B30-3) and one to the northwest (B30-1), were both located approximately 150 feet from the center boring. These borings were paired with the surface soil samples. The boring locations are depicted on Figure 4-7. These boring locations were selected in order to develop a spatial distribution that will allow for an initial assessment of the entire unit to be made. Shallow ground water flow in this area is in a generally easterly direction as shown on Figure 3-16. Because the borings are situated within the SWMU itself, each boring was drilled downgradient from at least part of the SWMU. Boring logs are included in Appendix D. A summary of field observations recorded during surface soil sampling is presented in Table 4-5.

A discrete soil sample for laboratory analysis was collected from the 2-foot interval directly above the water table in each boring. The samples were analyzed for Skinner List constituents (Table 4-3). The laboratory results derived from analysis of subsurface soil samples are presented in Tables 4-11 through 4-13.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-14). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

VOCs were detected in each of the samples collected from soil borings B30-1, B30-2, and B30-3. Benzene, 2-butanone, methylene chloride, toluene, and xylenes were detected in sample B030A1 collected from boring B30-1. Cumene and n-propylbenzene were detected in samples B030A2 and B030A3 collected from borings B30-2 and B30-3, respectively. The detected VOC concentrations do not exceed preliminary risk evaluation action levels. Thus, a screening risk assessment was not performed for VOCs in subsurface soil within SWMU No. 30, and additional investigation is not warranted for VOCs in subsurface soil within this unit.

Semi-Volatile Organic Compounds

SVOCs, primarily phthalates and PAHs, were detected in samples collected from borings B30-1, B30-2, and B30-3. The detected SVOC concentrations were generally below preliminary risk evaluation action levels. However, benzo(a)pyrene (3,100 ug/kg) was detected in sample B030A1 (B30-1) at a concentration that exceeds the action level for this compound. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

Inorganic Analytes

Skinner List metals, with the exceptions of antimony and cadmium, and cyanide were detected in the soil samples B030A1, B030A2, and B030A3 collected from borings B30-1, B30-2, and B30-3, respectively. Beryllium was detected in samples B030A1 and B030A2 at concentrations of 0.57 mg/kg and 0.64 mg/kg, respectively. These concentrations exceed the preliminary risk evaluation action level for beryllium. Lead was detected in samples B030A1 and B030A3 at concentrations of 93.3 mg/kg and 471 mg/kg, respectively. The detected concentrations of lead in these samples exceed the preliminary risk evaluation action level for this analyte. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

### 4.9.4 Ground Water Investigation

One monitoring well (B129) was installed to evaluate ground water quality immediately downgradient of SWMU No. 30. The location of this monitoring well is shown on Figure 4-7. The monitoring well construction diagram is included in Appendix E.

A ground water sample was not collected from the newly installed well B129 because of the presence of free-phase hydrocarbon liquid within the well. A sample of the free-phase hydrocarbon (G030A1) was collected and analyzed using gas chromatograph (GC) techniques.

The results of the GC analysis on the hydrocarbon sample were compared to GC standards for kerosene, gasoline, and fuel oil. The GC results indicate that the free-phase liquid contained 950,000 milligrams per liter (mg/l) of total petroleum hydrocarbons (TPH). However, the laboratory was not able to evaluate whether the free-phase hydrocarbon was a degraded form of kerosene, gasoline, or fuel oil. Therefore, the reported concentration is an estimated value and represents a rough approximation of the TPH concentration.

Dames & Moore reviewed the GC chromatograms for hydrocarbon sample G030A1 collected from well B129. Based on this review, it appears that the hydrocarbon is not gasoline. The retention time of the baseline peak is similar to that of kerosene. However, it is lacking the second baseline peak evident on the kerosene standard. The baseline is steep with sharp peaks, and appears to be a more refined product than kerosene. It may be more similar to jet fuel, but no GC standard was available at the time of this analysis to make this evaluation.

The presence of free-phase hydrocarbon warrants further action regarding ground water within this SWMU. The extent and degree of free-phase hydrocarbon floating on the water table should be defined. In addition, potential hydrocarbon sources should be evaluated.

## 4.10 EMPTY DRUM STORAGE AREA (SWMU NO. 45)

### 4.10.1 Location and Background

SWMU No. 45 (Empty Drum Storage Area) is located north of the Penrose Avenue Bridge, off the western side of "H" Avenue (Figure 4-8). This unit is above ground. The unit was approximately 100 feet by 70 feet and contained empty 55-gallon steel drums. These drums contained water-treating chemicals, lube oils, and corrosion-inhibiting chemicals. The empty drums were placed on gravel. Drums were stored here before being sent for reclamation. The storage area began operation in 1978 and is currently inactive. The date operations ceased is unknown.

### 4.10.2 Surface Soil Investigation

Three surface samples (S045A1, S045A2, and S045A3, a replicate sample of S045A1) were collected at locations S45-1 and S45-2 within SWMU No. 45 (Figure 4-8). These samples were collected underneath gravel areas of visible surface discoloration. A summary of field observations recorded during subsurface soil sampling is presented in Table 4-2.

The samples were analyzed for Appendix IX constituents (Table 4-4), with the exception of VOCs. The laboratory results derived from analysis of surface soil samples are presented in Tables 4-23 and 4-24.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-10). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

#### Semi-Volatile Organic Compounds

Several SVOCs were detected in two of the surface soil samples (S045A1 and S045A2) collected within SWMU No. 45. The concentrations of the detected compounds, primarily phthalates and the PAH acenaphthene, do not exceed the action levels based on the preliminary risk evaluation. Thus, a screening risk assessment was not performed for SVOCs in surface soil within SWMU No. 45, and no further investigation is warranted for SVOCs in surface soil within this SWMU.

#### Inorganic Analytes

Appendix IX metals, with the exceptions of silver, thallium, and tin, were detected in the three surface soil samples (S045A1, S045A2, and S045A3). Sulfide was not detected in any of the samples. Cyanide was detected in S045A3 (replicate sample of S045A1). Detected concentrations of beryllium, chromium, and lead exceed preliminary risk evaluation action levels for these analytes in the samples. Therefore, a screening risk assessment was

performed for this SWMU. The results of this assessment are summarized in Chapter 5.0. The detected concentration of chromium in sample S045A2 does not exceed the action level for this analyte.

4.10.3 Subsurface Soil Investigation

Two soil borings (B45-1 and B45-2) were performed within SWMU No. 45. These borings were located in the central area of the unit (Figure 4-8). These boring locations were selected to develop a spatial distribution of the resulting data to allow for an initial assessment of the entire unit. Shallow ground water flow in the area of SWMU 45 is in a generally southeasterly direction as shown on Figure 3-16. Because the borings are situated within the SWMU itself, the borings are situated downgradient from at least part of the SWMU. Boring logs are included in Appendix D. A summary of field observations recorded during subsurface soil sampling is presented in Table 4-5.

A discrete soil sample for laboratory analysis was collected from the 2-foot interval directly above the water table in each boring. The samples were analyzed for Appendix IX constituents (Table 4-3). The laboratory results derived from analysis of subsurface soil samples are presented in Tables 4-25 through 4-27.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-14). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

Several VOCs were detected in the three subsurface soil samples B045A1, B045A2, and B045A3 (replicate of B045A1) collected within SWMU 45. The detected compounds include acetone, benzene, ethylbenzene, methylene chloride, toluene, and xylenes. The highest concentration of VOCs occurred in sample B045A2 collected from soil boring B45-2; however, VOC concentrations do not exceed the preliminary risk evaluation action levels. Thus, a screening risk assessment was not performed for VOCs in subsurface soil within SWMU 45, and additional investigation is not warranted regarding VOCs in subsurface soil within this unit.

Semi-Volatile Organic Compounds

Several SVOCs were detected in the samples collected from soil borings B45-1 and B45-2. The detected compounds include PAHs and phthalates. The greatest number and highest concentration of these compounds occurred in sample B045A2 collected from boring B45-2. The detected concentrations of benzo(a)pyrene (1,800 ug/kg) and dibenz(a,h)anthracene (570 ug/kg) in this sample exceed preliminary risk evaluation levels. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

Inorganic Analytes

Appendix IX metals, including arsenic, barium, chromium, cobalt, copper, lead, mercury, nickel, vanadium, and zinc, and cyanide were detected in soil samples B045A1, B045A2, and B045A3 (replicate of B045A1). The detected concentrations of lead exceed the preliminary risk evaluation action level for this analyte. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

4.10.4 Ground Water Investigation

One monitoring well (B131) was installed to evaluate ground water quality immediately downgradient of SWMU No. 45. The location of this monitoring well is shown on Figure 4-8. The monitoring well construction diagram is included in Appendix E.

Two ground water samples (G045A1 and G045A3, replicate of G045A1) were collected from well B131. A summary of field observations recorded during ground water sampling is presented in Table 4-7. The ground water samples were collected using the procedures described in Appendix C and analyzed for the Appendix IX constituents (Table 4-4). The laboratory results derived from analysis of ground water samples are presented in Tables 4-28 through 4-31.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-19). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

VOCs, including acetone, benzene, ethylbenzene, toluene, and xylenes, were detected in the ground water samples collected from well B131. Benzene was detected in samples G045A1 and G045A3 at concentrations of 520 ug/l and 510 ug/l, respectively. These concentrations exceed the preliminary risk evaluation action level for benzene.

Semi-Volatile Organic Compounds

SVOCs were detected in the ground water samples collected from well B131. Detected compounds include acenaphthene, diethyl phthalate, dimethyl phthalate, fluoranthene, and phenols. The detected concentrations do not exceed preliminary risk evaluation action levels for these compounds. Thus, a screening risk assessment for SVOCs was not performed for the ground water at SWMU No. 45, and additional investigation regarding SVOCs in ground water within SWMU No. 45 is not warranted.

Inorganic Analytes - Unfiltered

Appendix IX metals, including barium, lead, and zinc, and cyanide were detected in the ground water samples collected from well B131. Lead was detected at concentrations of 3.4 ug/l (G045A1) and 4.4 ug/l (G045A3). These concentrations exceed the preliminary risk evaluation action level for lead.

Inorganic Analytes - Filtered

Barium was detected at concentrations of 140 ug/l (G045A2) and 144 ug/l (G045A4) in the filtered samples collected from well B131. Zinc was detected at a concentration of 11 ug/l in G045A4. The detected concentrations of barium and zinc in the filtered ground water samples collected from well B131 do not exceed the preliminary risk evaluation action levels for these parameters.

Unfiltered ground water samples were brown in color and slightly turbid with high sediment content. Filtered samples were generally clear in appearance with little to no color. The detected concentrations of inorganic analytes in the unfiltered ground water samples were generally greater than dissolved concentrations of these same analytes. This observation suggests that the concentration of inorganic analytes is directly related to the suspended sediment load in the ground water sample. Due to the low yield of the shallow aquifer, it is difficult to remove this sediment during well development. Additionally, the shallow, water table aquifer beneath the refinery consists primarily of silts and clays with small amounts of sand. In this fine-grained matrix, transport of suspended sediment would be minimal. Thus, the unfiltered ground water analytical data is not representative of ground water quality. The data derived from analysis of the filtered samples better represent the quality of the ground water beneath the site.

Because the unfiltered ground water analytical data is not representative of ground water quality, it was not used to evaluate risk. Based on the preliminary risk evaluation of the filtered ground water samples, concentrations of inorganic constituents in ground water do not exceed action levels.

## 4.11 PAST LAGOON B (SWMU NO. 71)

### 4.11.1 Location and Background

SWMU No. 71 (Past Lagoon B) is located east of Third Street, partially under the present Bundle Cleaning Area (SWMU No. 72), in the northern section of the facility (Figure 4-9). The previous in-ground lagoon had approximate dimensions of 100 feet by 200 feet. The depth of this unit below ground surface is not known. The waste deposited in this unlined unit was reportedly removed in 1979. During this activity, four tank bottoms were discovered. The function of these former tanks is not known. The start up and shut down dates of SWMU No. 71 are unknown. Therefore, the dates of use are not known. However, the unit was operating in 1975 and operations were discontinued prior to waste removal in 1979. The unit is believed to have received separator sludges, cooling tower sludges, and coagulator alum sludge. No oily sludges were disposed in this unit. Currently, the area is covered with macadam, a concrete pad of the Bundle Cleaning Area, and gravel. It is not known if there were any release controls. No records regarding history of releases are available.

An additional lagoon was noted south of Separator No. 4, with approximate dimensions of 60 by 140 feet. This lagoon was noted on a 1975 aerial photograph; however, it was not present on the 1970 or 1980 aerial photographs. The precise start up and shut down dates are unknown. The lagoon may have received sludges similar to those in Past Lagoon B; however, the actual use of this lagoon is unknown. Currently, the area of this lagoon is overlain by gravel and Tank No. 1136. This lagoon is designated SWMU No. 71A (Figure 4-10).

### 4.11.2 Surface Soil Investigation

Surface soil samples were not collected with SWMU No. 71, because this area was regraded prior to placement of the overlying gravel, macadam, and concrete pad. Thus, the current surface soil is not representative of conditions at the time of the operation of SWMU No. 71.

### 4.11.3 Subsurface Soil Investigation

*Previous Investigation*

In December 1991, Dames & Moore conducted a soil quality investigation within SWMU No. 71 in the area of the Bundle Cleaning Area (BCA) expansion. This work was performed in accordance with, and in partial fulfillment of, the scope of work outlined in the VI Work Plan. This investigation was conducted in order to obtain soil samples from the area of the BCA expansion prior to its construction.

Four soil borings (SB-1, SB-2, SB-3, and SB-4) were drilled at the locations presented on Figure 4-9. The soil boring logs are presented in Appendix D. Observations recorded during the field activities are presented in Table 4-5.

A discrete soil sample for laboratory analysis was collected from the 3.0- to 3.5-foot interval from soil borings SB-1 and SB-2. Composite soil samples (0 to 4 feet) were collected from soil borings SB-3 and SB-4. The laboratory results derived from analysis of the subsurface soil samples collected from SWMU No. 71 during the December 1991 investigation are presented in Tables 4-32 through 4-34.

*Verification Investigation*

Six soil borings (B71-1 through B71-6) were drilled within SWMU No. 71. One boring was located in the center of each side of the unit as shown on Figure 4-9. Soil borings were drilled around the perimeter of the existing Bundle Cleaning Area. The shallow ground water flow direction in the area of this SWMU is generally northwesterly as shown on Figure 3-16. Because of the areal distribution of the borings around the perimeter of the SWMU, the soil borings were drilled downgradient from part of the SWMU. Boring logs are included in Appendix D. A summary of field observations recorded during subsurface soil sampling is presented in Table 4-5.

A discrete soil sample for laboratory analysis was collected from the 2-foot interval directly above the water table in each boring. The samples were analyzed for Skinner List constituents (Table 4-3). The laboratory results derived from analysis of subsurface soil samples are presented in Tables 4-11 through 4-13.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-14). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

VOCs, including dichloromethane (methylene chloride), benzene, toluene, xylenes, and cumene, were detected in soil borings SB-1, SB-2, SB-3, and SB-4, collected during the December 1991 investigation. The detected VOC concentrations do not exceed preliminary risk evaluation action levels for these compounds. Thus, a screening risk assessment was not performed for VOCs in subsurface soil within this SWMU, and additional investigation regarding subsurface soil within this unit is not warranted.

Several VOCs were detected in each of the subsurface soil samples (B071A1 through B071A7; B071A7 is a replicate sample of B071A6) collected from the six soil borings (B71-1 through B71-6) within SWMU No. 71. Detected compounds include benzene, 2-butanone, cumene, methylene chloride, n-propylbenzene, toluene, and xylenes. The detected VOC concentrations do not exceed preliminary risk evaluation action levels for these compounds. Thus, a screening risk assessment was not performed for VOCs in subsurface soil within this SWMU, and additional investigation regarding subsurface soil within this unit is not warranted.

Semi-Volatile Organic Compounds

Several SVOCs were detected in samples SB-1, SB-2, SB-3, and SB-4 collected during the December 1991 investigation. Detected concentrations of pyrene (11,000 ug/kg) and benzo(a)pyrene (5,100 ug/kg) exceed preliminary risk evaluation action levels. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

Several SVOCs were detected in the VI soil samples collected at SWMU No. 71. Detected SVOCs include anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b,j,k)fluoranthene, chrysene, p-cresol, di-n-butylphthalate, dimethylphthalate, bis(2-ethylhexyl)phthalate, fluoranthene, 1-methyl naphthalene, naphthalene, phenanthrene, and pyrene. Detected concentrations of benzo(a)pyrene in soil samples B071A2 (1,000 ug/kg), B071A3 (1,900 ug/kg), B071A7 (1,500 ug/kg) collected from soil borings B71-A2, B71-A3, and B71-A7, respectively, exceed the preliminary risk evaluation action level for this compound. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

Inorganic Analytes

Skinner List metals and cyanide were detected in each of the soil samples collected from borings SB-1, SB-2, SB-3, and SB-4. Lead concentrations detected in each of the four samples exceed the action level for this analyte. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

Skinner List metals, cyanide, formaldehyde, and sulfide were detected in the soil samples collected from the six SWMU No. 71 soil borings. Detected concentrations of beryllium and lead in each of the soil samples exceed preliminary risk evaluation action levels. The detected concentration of chromium in sample B071A2 collected from soil boring B71-2 exceeds the preliminary risk evaluation action level for this analyte. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

4.11.4 Ground Water Investigation

One monitoring well (C127) was installed to evaluate ground water quality immediately downgradient of SWMU No. 71. The location of the monitoring well is shown on Figure 4-9. The monitoring well construction diagram is included in Appendix E.

One ground water sample was collected from newly installed monitoring well C127. The ground water sample was collected using the procedures described in Appendix C and analyzed for the Skinner List constituents (Table 4-3). A summary of field observations recorded during ground water sampling is presented in Table 4-7. The laboratory results derived from analysis of ground water samples are presented in Tables 4-15 through 4-18.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-19). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

VOCs were not detected in the ground water sample (G071A1) collected from well C127. Thus, a screening risk assessment was not performed for VOCs in the ground water at SWMU No. 71, and additional investigation regarding VOCs in ground water within this unit is not warranted.

Semi-Volatile Organic Compounds

Four SVOCs, 1-methylnaphthalene (12 ug/l), fluoranthene (5 ug/l), phenanthrene (7 ug/l), and pyrene (4 ug/l), were detected in ground water sample G071A1 collected from well C127 at estimated concentrations below method detection limits. The detected concentration of pyrene in sample G071A1 exceeds the preliminary risk evaluation action level for this compound.

Inorganic Analytes - Unfiltered

Eight Skinner List metals, cyanide, and sulfide were detected in ground water sample G071A1 collected from well C127. The detected concentrations of arsenic (65 ug/l), chromium (281 ug/l), lead (1,440 ug/l), mercury (4.80 ug/l), and sulfide (2,200 ug/l) exceed preliminary risk evaluation action levels for these analytes.

Inorganic Analytes - Filtered

Three Skinner List metals, including arsenic (3 ug/l), barium (451 ug/l), and vanadium (14 ug/l), were detected in filtered ground water sample G071A2 collected from well C127. The detected concentrations of these analytes do not exceed preliminary risk evaluation action levels.

Unfiltered ground water samples were brown in color and slightly turbid with high sediment content. Filtered samples were generally clear in appearance with little to no color. The detected concentrations of inorganic analytes in the unfiltered ground water samples were generally greater than dissolved concentrations of these same analytes. This observation suggests that the concentration of inorganic analytes is directly related to the suspended sediment load in the ground water sample. Due to the low yield of the shallow aquifer, it is difficult to remove this sediment during well development. Additionally, the shallow, water table aquifer beneath the refinery consists primarily of silts and clays with small amounts of sand. In this fine-grained matrix, transport of suspended sediment would be minimal. Thus, the unfiltered ground water analytical data is not representative of ground water quality. The data derived from analysis of the filtered samples better represent the quality of the ground water beneath the site.

Because the unfiltered ground water analytical data is not representative of ground water quality, it was not used to evaluate risk. Based on the preliminary risk evaluation of the unfiltered ground water samples, concentrations of inorganic constituents in ground water do not exceed action levels.

## 4.12 PAST LAGOON B ADDITION (SWMU NO. 71A)

### 4.12.1 Location and Background

SWMU No. 71A (Past Lagoon B addition) is located directly southeast of SWMU No. 71 and south of separator No. 4 with approximate dimensions of 60 by 140 feet (Figure 4-10). The depth below land surface of this SWMU is not known. This lagoon was not present on the 1970 or 1980 aerial photographs. The precise start up and shut down dates and the dates of use are not known. The waste composition in the lagoon is unknown, but the lagoon may have received sludges similar to those in Past Lagoon B. Currently, the area of this lagoon is overlain by gravel and Tank No. 1136.

### 4.12.2 Soil Gas Survey

A soil gas survey consisting of three (3) sampling points was conducted within SWMU No. 71A. These sampling points were located as shown on Figure 4-10, one at each end of the SWMU and one in the center.

The soil gas survey results are summarized in Table 4-35. The OVA concentrations exceeded 10,000 ppm at each location. Toluene and xylenes were detected in all three samples. Benzene and ethylbenzene were not detected in any of the samples. Based on GC analysis, the total VOC concentrations were 26.7 ppm at SG71A-1 and 32.1 ppm at SG71A-2.

A review of the GC chromatograms indicated that petroleum compounds were detected in each of the sampling locations at various concentrations. The petroleum compounds were primarily light hydrocarbons with boiling points lower than that of toluene.

As shown in Table 4-35, the detected concentrations of toluene and xylenes were converted from ppm to micrograms per cubic meter ($ug/m^3$). The concentrations of toluene and xylenes in the soil gas samples do not exceed preliminary risk evaluation action levels (Table 4-21). Thus, a screening risk assessment was not performed for VOCs in soil gas in SWMU 71A, and additional investigation is not warranted regarding VOCs in the soil gas within this SWMU.

### 4.12.3 Surface Soil Investigation

Surface soil samples were not collected within SWMU No. 71A, because this area was regraded prior to placement of the overlying gravel and Tank No. 1136. Therefore, the current surface soil is not representative of conditions at the time of the operation of SWMU No. 71A.

### 4.12.4 Subsurface Soil Investigation

Two soil borings (B71A-1 and B71A-2) were drilled within SWMU No. 71A. These borings were located near each end of the unit as shown on Figure 4-10. These locations were selected in order to evaluate the presence of substances previously placed in this lagoon. As shown on Figure 3-16, the ground water flow in the vicinity of SWMU No. 71A is generally northwesterly in direction. Because the soil borings are situated within the interior of the SWMU, they are hydraulically downgradient from at least part of the SWMU. Boring logs are included in Appendix D. A summary of field observations recorded during subsurface soil sampling is presented in Table 4-5.

A discrete soil sample for laboratory analysis was collected from the 2-foot interval directly above the water table in each boring. The samples were analyzed for Skinner List constituents (Table 4-3). The laboratory results derived from analysis of subsurface soil samples are presented in Tables 4-11 through 4-13.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-14). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

Several VOCs were detected in soil samples collected from soil borings B71A-1 and B71A-2. The compounds 2-butanone, methylene chloride, and xylenes were detected in samples B071AA1 (B71A-1) and B071AA2 (B71A-2). Benzene, carbon disulfide, and toluene (B071AA2), and cumene and n-propylbenzene (both samples) were detected at concentrations below method detection limits. The detected VOC concentrations do not exceed preliminary risk evaluation action levels for these compounds. Thus, a screening risk assessment was not performed for VOCs in subsurface soil within SWMU No. 71A, and additional investigation regarding VOCs in subsurface soil within this unit is not warranted.

Semi-Volatile Organic Compounds

Several SVOCs were detected in the soil samples B071AA1 and B071AA2. The detected compounds were primarily PAHs and phthalates. Benzo(a)pyrene was detected in sample B071AA2 at a concentration (1,600 ug/kg) that exceeds the preliminary risk evaluation action level for this compound. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

Inorganic Analytes

Skinner List metals, including arsenic, barium, beryllium, chromium, cobalt, lead, mercury, nickel, selenium, and vanadium, and cyanide were detected in the soil samples B071AA1 and B071AA2. The detected concentrations of beryllium (2.2 mg/kg) in B071AA2 and lead in B071AA1 (227 mg/kg) and B071AA2 (360 mg/kg) exceed preliminary risk evaluation action levels. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

### 4.12.5 Ground Water Investigation

Due to extensive construction activity in the vicinity, a monitoring well could not be installed to evaluate SWMU No. 71A ground water quality, and a ground water sample was not collected from SWMU No. 71A. Several trench excavations prohibited drill rig or tripod access to the unit.

## 4.13 DRUM STORAGE AREA (SWMU NO. 79)

### 4.13.1 Location and Background

SWMU No. 79 (Drum Storage Area) is located east of Unit No. 1232 Precipitator, in the northern part of the facility (Figure 4-11). The unit was used for the temporary storage of 55-gallon drums on wooden pallets, and is underlain by gravel. These drums contained residue from the FCC unit, trash, and spent catalyst. The unit is above ground.

The approximate dimensions are 10 feet by 20 feet. The date of start up is unknown, and the site is currently inactive. The drums have been removed.

### 4.13.2 Surface Soil Investigation

One surface sample (S079A1) was collected from location S79-1 within SWMU No. 79 from underneath a gravel area with visible staining. The location of this surface soil sample is shown on Figure 4-11. A summary of field observations recorded during surface soil sampling is presented in Table 4-2.

The sample was analyzed for Appendix IX constituents (Table 4-4), with the exception of VOCs. The laboratory results derived from analysis of surface soil samples are presented on Tables 4-23 and 4-24.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-10). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

#### Semi-Volatile Organic Compounds

Two SVOCs, di-n-butyl phthalate and dimethyl phthalate, were detected in the surface soil sample (S079A1) collected within SWMU No. 79. The concentrations of these detected compounds do not exceed the action levels based on the preliminary risk evaluation. Thus, a screening risk assessment was not performed for SVOCs in surface soil within SWMU No. 79, and no further investigation is warranted regarding SVOCs in surface soil at this SWMU.

#### Inorganic Analytes

Appendix IX metals, with the exceptions of cadmium, selenium, silver, thallium, and tin, cyanide, and sulfide were detected in surface soil sample S079A1. The detected concentrations of beryllium (1.6 ug/kg), chromium (420 ug/kg), and lead (105 ug/kg) exceed preliminary risk evaluation action levels for these analytes. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

### 4.13.3 Subsurface Soil Investigation

Two soil borings (B79-1 and B79-2) were drilled within SWMU No. 79 at the locations shown on Figure 4-11. One of these borings (B79-1) was paired with the surface soil sample. The shallow ground water flow in the vicinity of this SWMU is in a generally northwesterly direction as shown on Figure 3-16. The distribution of the two borings within the interior of this SWMU assured that both borings are downgradient from at least part of the SWMU. Boring logs are included in Appendix D. A summary of field observations recorded during subsurface soil sampling is presented in Table 4-5.

A discrete soil sample for laboratory analysis was collected from the 2-foot interval directly above the water table in each boring. The samples were analyzed for Skinner List constituents (Table 4-3). The laboratory results derived from analysis of subsurface soil samples are presented in Tables 4-25 through 4-27.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-14). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

VOCs were detected in soil samples B079A1 and B079A2 collected from soil borings B79-1 and B79-2. Acetone, methylene chloride, and xylenes were detected in sample B079A1. Acetone was detected at a concentration below the method detection limit in soil sample B079A2. The detected concentrations do not exceed preliminary risk evaluation action levels for these compounds. Thus, a risk screening assessment was not performed for VOCs in subsurface soil within SWMU No. 79, and additional investigation regarding VOCs in subsurface soil within this unit is not warranted.

Semi-Volatile Organic Compounds

SVOCs, primarily PAHs and phthalates, were detected in the subsurface soil samples B079A1 and B079A2. The detected concentration of benzo(a)pyrene in sample B079A1 (2,000 ug/kg) and dibenz(a,h)anthracene in B079A2 (850 ug/kg) exceed preliminary risk evaluation action levels for these compounds. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

Inorganic Analytes

Appendix IX metals, including antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, thallium, vanadium, and zinc, cyanide and sulfide were detected in the two soil samples B079A1 and B079A2. The detected concentration of beryllium (1.6 mg/kg) in soil sample B079A1 exceeds the preliminary risk evaluation action level for this analyte. Therefore, a screening risk assessment was performed for this SWMU. The results of this assessment are summarized in Chapter 5.0.

### 4.13.4 Ground Water Investigation

One monitoring well (C128) was installed to evaluate ground water quality immediately downgradient of SWMU No. 79. The location of the monitoring well is shown on Figure 4-11. The monitoring well construction diagram is included in Appendix E.

One ground water sample was collected from newly installed monitoring well C128. The ground water sample was collected by the procedures described in Appendix C and analyzed for the Appendix IX constituents (Table 4-6). The laboratory results derived from analysis of ground water samples are presented in Tables 4-28 through 4-31.

The concentrations of detected constituents were compared to preliminary risk evaluation action levels (Table 4-19). The purpose of this comparison was to evaluate the need for further investigation within this SWMU.

Volatile Organic Compounds

Acetone (20 ug/l) was detected in the ground water sample (G079A1) collected from well C128. The detected concentration of acetone in this sample does not exceed the preliminary risk evaluation action level for this compound. Thus, a screening risk assessment was not performed for VOCs in the ground water at SWMU No. 79, and additional investigation regarding VOCs in ground water within this unit is not warranted.

Semi-Volatile Organic Compounds

Five SVOCs, including acenaphthene (18 ug/l), 2-methylnaphthalene (5 ug/l), dimethyl phthalate (4 ug/l), fluorene (8 ug/l), and phenanthrene (9 ug/l), were detected in ground water sample G079A1. With the exception of acenaphthene, the detections were estimated concentrations below method detection limits. The detected SVOC concentrations do not exceed preliminary risk evaluation action levels. Thus, a screening risk assessment for SVOCs was not performed for the ground water at SWMU No. 79, and additional investigation regarding SVOCs in ground water within this unit is not warranted.

Inorganic Analytes - Unfiltered

Ten Appendix IX metals and cyanide were detected in the ground water sample G079A1. The detected metals include arsenic (32.7 ug/l), barium (722 ug/l), chromium (312 ug/l), cobalt (32 ug/l), copper (215 ug/l), lead (400 ug/l), mercury (3.2 ug/l), nickel (61 ug/l), vanadium (66 ug/l), and zinc (876 ug/l). Cyanide was detected at 30.4 ug/l. The concentrations of chromium, lead, and mercury exceed preliminary risk evaluation action levels for these analytes.

Inorganic Analytes - Filtered

Arsenic (7.1 ug/l), barium (327 ug/l), and zinc (17 ug/l) were detected in filtered ground water sample G079A2 collected from well C128. The detected concentrations do not exceed preliminary risk evaluation action levels for these analytes.

Unfiltered ground water samples were brown to black in color and turbid with high sediment content. Filtered samples were generally clear in appearance with little to no color. The detected concentrations of inorganic analytes in the unfiltered ground water samples were generally greater than dissolved concentrations of these same analytes. This observation suggests that the concentration of inorganic analytes is directly related to the suspended sediment load in the ground water sample. Due to the low yield of the shallow aquifer, it is difficult to remove this sediment during well development. Additionally, the shallow, water table aquifer beneath the refinery consists primarily of silts and clays with small amounts of sand. In this fine-grained matrix, transport of suspended sediment would be minimal. Thus, the unfiltered ground water analytical data is not representative of ground water quality. The data derived from analysis of the filtered samples better represent the quality of the ground water beneath the site.

Because the unfiltered ground water analytical data is not representative of ground water quality, it was not used to evaluate risk. Based on the preliminary risk evaluation of the filtered ground water samples, concentrations of inorganic constituents in ground water do not exceed action levels.

## TABLE 4-1

## SUMMARY OF SPECIFIC TASKS COMPLETED AT EACH SWMU VERIFICATION INVESTIGATION

## CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

| SWMU NO. | PHYSICAL INTEGRITY EVALUATION | SOIL GAS SURVEY | SURFACE SOIL SAMPLING | SUBSURFACE SOIL SAMPLING | MONITORING WELL INSTALLATION | GROUND WATER SAMPLING |
|---|---|---|---|---|---|---|
| 1 | X | X | ✓ | ✓ | X[1] | ✓ |
| 2 | ✓ | X | ✓ | ✓ | ✓ | ✓ |
| 6 | X | X | ✓ | ✓ | ✓ | ✓ |
| 9 | ✓ | X | ✓ | ✓ | ✓ | ✓ |
| 11/12 | X | ✓ | X | ✓ | ✓ | ✓ |
| 13 | X | X | X | ✓ | ✓ | ✓ |
| 16/17 | X | X | ✓ | ✓ | ✓ | ✓ |
| 29 | X | ✓ | X | ✓ | ✓ | ✓ |
| 30 | X | X | ✓ | ✓ | ✓ | ✓ |
| 45 | X | X | ✓ | ✓ | ✓ | ✓ |
| 71 | X | X | X | ✓ | ✓ | ✓ |
| 71A | X | ✓ | X | ✓ | X[2] | X[2] |
| 79 | X | X | ✓ | ✓ | ✓ | ✓ |

Explanation:

SWMU - Solid Waste Management Unit
✓ - Task conducted at this SWMU as part of Verification Investigation
X - Task not conducted at this SWMU.

Notes:

1. A new monitoring well was not installed within SWMU No. 1 during the Verification Investigation because existing well A40 is situated to evaluate SWMU No. 1 ground water quality.

2. Due to extensive excavation and construction activities in the vicinity of SWMU No. 71A, Dames & Moore was not able to install a monitoring well to evaluate ground water quality downgradient of this unit.

# TABLE 4-2

## FIELD MEASUREMENT DATA/SOIL DESCRIPTIONS
## SURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU NOS. 1/2

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| SAMPLE LOCATION | SAMPLE DEPTH (INCHES) | HEADSPACE[1] | | SOIL DESCRIPTION | LABORATORY SAMPLE DESIGNATION |
|---|---|---|---|---|---|
| | | PID | OVA | | |
| S1-1 | 0-6 | ND | 2 | Fine to coarse sand with silt and gravel, brown, some staining, slight odor | S001A0 |
| S1-2 | 0-6 | ND | 1 | Fine to medium sand with trace fine gravel and silt, dark brown, no odor | S001A1 |
| S1-3 | 0-6 | 6 | 65 | Fine gravel with fine to medium sand, trace silt and coarse gravel, dark brown, no odor | S001A2 |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer
ND - Not Detected

Note:

1. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-2

## FIELD MEASUREMENT DATA/SOIL DESCRIPTIONS
## SURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU NO. 6

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| SAMPLE LOCATION | SAMPLE DEPTH (INCHES) | HEADSPACE[1] | | SOIL DESCRIPTION | LABORATORY SAMPLE DESIGNATION |
|---|---|---|---|---|---|
| | | PID | OVA | | |
| S6-1 | 0-6 | ND | ND | Silt with some fine to coarse sand, trace gravel, light to medium brown, no odor | S006A0 |
| S6-2 | 0-6 | ND | ND | Silt with fine to coarse sand little fine gravel, medium to dark brown, no odor | S006A1 |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer
ND - Not Detected

Note:

1. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-2

## FIELD MEASUREMENT DATA/SOIL DESCRIPTIONS
## SURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU NO. 9

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| SAMPLE LOCATION | SAMPLE DEPTH (INCHES) | HEADSPACE[1] | | SOIL DESCRIPTION | LABORATORY SAMPLE DESIGNATION |
|---|---|---|---|---|---|
| | | PID | OVA | | |
| S9-1 | 0-6 | 20.3 | 150 | Fine gravel, stained black with strong hydrocarbon odors, some silt and clay | S009A1/A2 |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer

Note:

1. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-2

## FIELD MEASUREMENT DATA/SOIL DESCRIPTIONS
## SURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU NOS. 16/17

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| SAMPLE LOCATION | SAMPLE DEPTH (INCHES) | HEADSPACE[1] | | SOIL DESCRIPTION | LABORATORY SAMPLE DESIGNATION |
|---|---|---|---|---|---|
| | | PID | OVA | | |
| S16-1 | 0-6 | 47 | 10 | Silt and fine to coarse sand trace gravel, dark brown, stained black, slight hydrocarbon odor | S016A1 |
| S16-2 | 0-6 | 0.4 | 12 | Silt and fine to coarse sand, dark brown, some crushed tan limestone gravel | S016A2 |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer

Note:

1. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-2

## FIELD MEASUREMENT DATA/SOIL DESCRIPTIONS
## SURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU NO. 30

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| SAMPLE LOCATION | SAMPLE DEPTH (INCHES) | HEADSPACE[1] | | SOIL DESCRIPTION | LABORATORY SAMPLE DESIGNATION |
|---|---|---|---|---|---|
| | | PID | OVA | | |
| S30-1 | 0-6 | ND | ND | Limestone ballast with some fine sand, silt and gravel, gray, no odor | S030A1 |
| S30-2 | 0-6 | ND | ND | Limestone ballast with some clay, silt and fine sand | S030A2 |
| S30-3 | 0-6 | ND | ND | Limestone ballast with some very fine to coarse sand and clay, trace gravel | S030A3 |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer
ND - Not Detected

Note:

1. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-2

## FIELD MEASUREMENT DATA/SOIL DESCRIPTIONS
## SURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU NO. 45

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| SAMPLE LOCATION | SAMPLE DEPTH (INCHES) | HEADSPACE[1] | | SOIL DESCRIPTION | LABORATORY SAMPLE DESIGNATION |
|---|---|---|---|---|---|
| | | PID | OVA | | |
| S45-1 | 0-6 | 25 | 170 | Medium sand, brown, limestone ballast, slight odor | S045A1/A3 |
| S45-2 | 0-6 | 150 | >10,000 | Very fine sand, trace coarse sand, stained black, hydrocarbon odor | S045A2 |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer

Note:

1. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-2

## FIELD MEASUREMENT DATA/SOIL DESCRIPTIONS
## SURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU NO. 79

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| SAMPLE LOCATION | SAMPLE DEPTH (INCHES) | HEADSPACE[1] | | SOIL DESCRIPTION | LABORATORY SAMPLE DESIGNATION |
|---|---|---|---|---|---|
| | | PID | OVA | | |
| S79-1 | 0-6 | ND | ND | Silt with very fine sand and limestone ballast | S079A1 |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer
ND - Not Detected

Note:

1. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-3

## SKINNER LIST CONSTITUENTS
## VERIFICATION INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| | |
|---|---|
| ** | Acetonitrile (Ethanenitrile) |
| ** | Acrolein (2-Propenal) |
| ** | Acrylonitrile (2-Propenenitrile) |
| | Aniline (Benzenamine) |
| | Antimony |
| | Arsenic |
| | Barium |
| | Benz(c)acridine (3,4-Benzacridine) |
| | Benz(a)anthracene (1,2-Benzanthracene) |
| ** | Benzene (Cyclohexatriene) |
| | Benzenethiol (Thiophenol) |
| | Benzidine (1,1-Biphenyl-4,4 diamine) |
| | Benzo(b)fluoranthene (2,3-Benzofluoranthene) |
| | Benzo(j)Fluoranthene (7,8-Benzofluoranthene) |
| | Benzo(a)pyrene (3,4-Benzopyrene) |
| ** | Benzyl chloride (Benzene, (Chloromethyl)-) |
| | Beryllium |
| | Bis (2-chloroethyl)ether (Ethane, 1,1-oxybis (2-chloro-)) |
| | Bis (2-chloroisopropyl)ether (Propane, 2,2-oxybis(2-chloro-)) |
| ** | Bis (chloromethyl)ether (Methane, oxybis(chloro)) |
| | Bis (2-ethylhexyl)phthalate (1,2-Benzenedicarboxylic acid, bis (2-ethylhexyl) ester) |
| | Butyl benzyl phthalate (1,2-Benzenedicarboxylic acid, butyl phenylmethyl ester) |
| | Cadmium |
| | Carbon disulfide (Carbon bisulfide) |
| | p-Chloro-m-cresol |
| ** | Chlorobenzene (Benzene, chloro-) |
| ** | Chloroform (Methane, trichloro-) |
| ** | Chloromethane (Methyl chloride) |
| | 2-Chloronapthalene (Naphthalene, beta-chloro-) |
| | 2-Chlorophenol (Phenol, o-chloro-) |
| | Chromium |
| | Chrysene (1,2-Benzphenanthrene) |
| | Cresols (Cresylic acid) (Phenol, methyl-) |
| ** | Crotonaldehyde (2-Butenal) |
| | Cumene (Isopropyl Benzene) |
| | Cyanide |
| | Dibenz(a,h)acridine (1,2,5,6-Dibenzacridine) |
| | Dibenz(a,j)acridine (1,2,7,8-Dibenzacridine) |
| | Dibenz(a,h)anthracene (1,2,5,6-Dibenzanthracene) |
| | 7H-Dibenzo(c,g)carbazole (3,4,5,6-Dibenzcarbazole) |
| | Dibenzo(a,e)pyrene (1,2,4,5-Dibenzpyrene) |

**SKINNER LIST CONSTITUENTS**
**VERIFICATION INVESTIGATION**

**CHEVRON REFINERY**
**PHILADELPHIA, PENNSYLVANIA**

| | |
|---|---|
| | Dibenzo(a,h)pyrene (1,2,5,6-Dibenzpyrene) |
| | Dibenzo(a,i)pyrene (1,2,7,8-Dibenzpyrene) |
| ** | 1,2-Dibromoethane (Ethylene dibromide) |
| | Di-n-butyl phthalate (1,2-Benzenedicarboxylic acid, dibutyl ester) |
| * | Dichlorobenzenes |
| ** | 1,2-Dichloroethane (Ethylene dichloride) |
| ** | trans-1,2-Dichloroethene (1,2-Dichloro-ethylene) |
| ** | 1,1-Dichloroethylene (Ethene, 1,1-dichloro-) |
| ** | Dichloromethane (Methylene chloride) |
| ** | Dichloropropane |
| | Dichloropropanol |
| | Diethyl phthalate (1,2-Benzenedicarboxylic acid, diethyl ester) |
| | 7,12-Dimethyl(benz(a)anthracene |
| | 2,4-Dimethylphenol (Phenol, 2,4-dimethyl-) |
| | Dimethyl phthalate (1,2-Benzenedicarboxylic acid, dimethyl ester) |
| | 4,6-Dinitro-o-cresol |
| | 2,4-Dinitrophenol (phenol, 2,4-nitro-) |
| | 2,4-Dinitrotoluene (Benzene, 1-methyl-2,4-dinitro-) |
| | Di-n-octyl phthalate (1,2-Benzenedicarboxylic acid, dioctyl ester) |
| ** | 1,4-Dioxane (1,4-Diethylene oxide) |
| | 1,2-Diphenylhydrazine (Hydrazine, 1,2-Diphenyl-) |
| ** | Ethyleneimine (Azridine) |
| ** | Ethylene oxide (Oxirane) |
| | Fluoranthene (Benzo(j,k)fluorene) |
| ** | Formaldehyde |
| | Hydrogen sulfide (Sulfur hydride) |
| | Indeno (1,2,3-cd)pyrene (1 10 (1,2-phenylene)pyrene) |
| | Lead |
| | Mercury |
| | Methanethiol (Thiomethanol) |
| | 3-Methylchlolanthrene (Benz(j)acean-thrylene, 1,2-dihydro-3-methyl-) |
| ** | Methyl ethyl ketone (MEK)(2-Butanone) |
| | Naphthalene |
| | Nickel |
| | p-Nitroaniline (Benzenamine, 4-nitro-) |
| | Nitrobenzene (Benzene, nitro-) |
| | 4-Nitrophenol (Phenol, pentachloro-) |
| | Pentachlorophenol (Phenol, pentachloro-) |
| | Phenol (Benzene, hydroxy-) |
| | Propyl benzene |
| | Pyridine |

**SKINNER LIST CONSTITUENTS**
**VERIFICATION INVESTIGATION**

**CHEVRON REFINERY**
**PHILADELPHIA, PENNSYLVANIA**

| | |
|---|---|
| | Selenium |
| ** | Tetrachloroethanes |
| ** | Tetrachloroethylene (Ethene, 1,1,2,2-tetra chloro-) |
| ** | Toluene (Benzene, methyl-) |
| * | Trichlorobenzenes |
| ** | Trichloroethanes |
| ** | Trichloroethene (Trichloroethylene) |
| * | Trichlorophenols |
| | Vanadium |
| | Xylene |

Non-Appendix VIII Constituents of Concern

Cobalt
1-Methylnapthalene
Styrene
Hydroquinone
Anthracene
Indene
5-nitro acenaphthene
Quinoline
Phenanthrene
Pyrene

Footnotes:

* If any of these groups of compounds are found, the specific isomers listed in Appendix VIII will be identified.

** Use Test Method 8240 for these volatile compounds.

Notes:

1) Use Test Method 3050 in SW-846 for all metals.

# TABLE 4-4

## APPENDIX IX CONSTITUENTS
## VOLATILE ORGANIC COMPOUNDS[1]
## VERIFICATION INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| COMPOUND |
|---|
| Acetone |
| Acetonitrile |
| Acrolein |
| Acrylonitrile |
| Allyl chloride |
| Benzene |
| Bromodichloromethane |
| Bromoform |
| Carbon disulfide |
| Carbon tetrachloride |
| Chlorobenzene |
| Chloroethane |
| Chloroform |
| Chloroprene |
| Dibromochloromethane |
| 1,2-dibromo-3-chloropropane |
| 1,2-dibromoethane |
| trans-1,4-dichloro-2-butene |
| Dichlorodifluoromethane |
| 1,1-dichloroethene |
| 1,2-dichloroethane |
| 1,1-dichloroethane |
| trans-1,2-dichloroethene |
| 1,2-dichloropropane |
| cis-1,3-dichloropropene |
| trans-1,3-dichloropropene |
| 1,4-dioxane |
| Ethylbenzene |
| Ethyl methacrylate |
| 2-hexanone |
| Isobutyl alcohol |
| Methacrylonitrile |
| Methyl bromide |
| Methyl chloride |
| Methylene bromide |
| Methylene chloride |
| Methyl ethyl ketone |
| Methyl iodide |
| Methyl methacrylate |
| 4-methyl-2-pentanone |
| Pentachloroethane |
| Propionitrile |
| Pyridine |
| Styrene |
| 1,1,1,2-tetrachloroethane |
| 1,1,2,2-tetrachloroethane |
| Tetrachloroethene |
| Toluene |
| 1,1,1-trichloroethane |
| 1,1,2-trichloroethane |
| Trichloroethene |
| Trichlorofluoromethane |
| 1,2,3-trichloropropane |
| Vinyl acetate |
| Vinyl chloride |
| Xylene |

Note:

1. Samples analyzed for volatile organic compounds by USEPA Method No. 624.

# TABLE 4-4

## APPENDIX IX CONSTITUENTS
## SEMIVOLATILE ORGANIC COMPOUNDS[1]
## VERIFICATION INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| COMPOUND |
|---|
| Acenaphthene |
| Acenaphthylene |
| Acetophenone |
| 2-acetylaminofluorene |
| 4-aminobiphenyl |
| Aniline |
| Anthracene |
| Aramite |
| Benzo[a]anthracene |
| Benzo[b]fluoranthene |
| Benzo[k]fluoranthene |
| Benzo[ghi]perylene |
| Benzo[a]pyrene |
| Benzyl alcohol |
| Bis(2-chloroethoxy)methane |
| Bis(2-chloroethyl)ether |
| Bis(2-chloro-1-methylethyl)ether |
| Bis(2-ethylhexyl)phthalate |
| 4-bromophenyl phenyl ether |
| Butyl benzyl phthalate |
| p-chloroaniline |
| Chlorobenzilate |
| p-chloro-m-cresol |
| 2-chloronaphthalene |
| 2-chlorophenol |
| 4-chlorophenyl phenyl ether |
| Chrysene |
| o-cresol |
| m-cresol |
| p-cresol |
| Diallate |
| Dibenzofuran |
| Di-n-butyl phthalate |
| Dibenz[a,h]anthracene |
| o-dichlorobenzene |
| m-dichlorobenzene |
| p-dichlorobenzene |
| 3,3'-dichlorobenzidine |
| 2,4-dichlorophenol |
| 2,6-dichlorophenol |
| Diethyl phthalate |
| 0,0-diethyl-0-2-pyrazinyl phosphorothioate |
| Dimethoate |
| p-(dimethylamino)azobenzene |
| 7,12-dimethylbenz[a]anthracene |
| 3,3'-dimethylbenzidine |
| alpha,alpha-dimethylphenethylamine |
| 2,4-dimethylphenol |
| Dimethyl phthalate |
| m-dinitrobenzene |
| 4,6-dinitro-o-cresol |
| 2,4-dinitrophenol |
| 2,4-dinitrotoluene |
| 2,6-dinitrotoluene |
| Di-n-octyl phthalate |
| Diphenylamine |
| Ethyl methanesulfonate |
| Fluoranthene |
| Fluorene |
| Hexachlorobenzene |
| Hexachlorobutadiene |
| Hexachlorocyclopentadiene |
| Hexachloroethane |
| Hexachlorophene |
| Hexachloropropene |
| Indeno(1,2,3-cd)pyrene |

## TABLE 4-4

## APPENDIX IX CONSTITUENTS
## SEMIVOLATILE ORGANIC COMPOUNDS[1]
## VERIFICATION INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| COMPOUND |
|---|
| Isodrin |
| Isophorone |
| Isosafrole |
| Methapyrilene |
| 3-Methylcholanthrene |
| Methyl methanesulfonate |
| 2-methylnaphthalene |
| Naphthalene |
| 1,4-naphthoquinone |
| 1-napthylamine |
| 2-napthylamine |
| o-nitroaniline |
| m-nitroaniline |
| p-nitroaniline |
| Nitrobenzene |
| o-nitrophenol |
| p-nitrophenol |
| 4-nitroquinoline 1-oxide |
| n-nitrosodi-n-butylamine |
| n-nitrosodiethylamine |
| n-nitrosodimethylamine |
| n-nitrosodiphenylamine |
| n-nitrosodipropylamine |
| n-nitrosomethylethylamine |
| n-nitrosomorpholine |
| n-nitrosopiperidine |
| n-nitrosopyrrolidine |
| 5-nitro-o-toluidine |
| Pentachlorobenzene |
| Pentachloronitrobenzene |
| Pentachlorophenol |
| Phenacetin |
| Phenanthrene |
| Phenol |
| p-phenylenediamine |
| 2-picoline |
| Pronamide |
| Pyrene |
| Safrole |
| 1,2,4,5-tetrachlorobenzene |
| 2,3,4,6-tetrachlorophenol |
| Tetraethyl dithiopyrophosphate |
| O-toluidine |
| 1,2,4-trichlorobenzene |
| 2,4,5-trichlorophenol |
| 2,4,6-trichlorophenol |
| 0,0,0-triethyl phosphorothioate |
| sym-trinitrobenzene |

Note:

1. Samples analyzed for semivolatile organic compounds by USEPA Method No. 627.

TABLE 4-4

## APPENDIX IX CONSTITUENTS
## INORGANIC PARAMETERS[1]
## VERIFICATION INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| COMPOUND |
|---|
| Antimony |
| Arsenic (EPA #7061) |
| Barium |
| Beryllium |
| Cadmium |
| Chromium |
| Cobalt |
| Copper |
| Lead (EPA #7421) |
| Nickel |
| Mercury (EPA #7470) |
| Selenium (EPA #7741) |
| Silver |
| Thallium (EPA #7841) |
| Tin |
| Vanadium |
| Zinc |
| Cyanide (EPA #9010) |
| Sulfide (EPA #9030) |

Note:

1. Samples analyzed for inorganic parameters by USEPA Method No. 6010, except where noted above.

# TABLE 4-5

## FIELD MEASUREMENT DATA
## SUBSURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU Nos. 1/2

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| BORING DESIGNATION | DEPTH INTERVAL (FEET) | BLOW COUNTS[1] | RECOVERY (INCHES) | HEADSPACE ANALYSIS[2] | | SAMPLE COLLECTED FOR LABORATORY ANALYSIS |
|---|---|---|---|---|---|---|
| | | | | PID | OVA | |
| B1-1 | 0-2 | 32,57,55,57 | 24 | 31.5 | 100 | - |
| | 2-4 | 28,18,9,13 | 24 | 16.5 | 100 | B001A0 |
| | 4-6 | 3,2,3,3 | 18 | 18.5 | 400 | - |
| B1-2 | 0-2 | 55,64,40,33 | 24 | 90 | 6.4 | - |
| | 2-4 | 14,12,13,13 | 24 | 350 | 7 | - |
| | 4-6 | 11,13,15,7 | 20 | 3,000 | 6 | B001A1 |
| | 6-8 | 2,3,3,3 | 4 | 300 | 5.4 | - |
| B1-3 | 0-2 | 29,34,85,50 | 12 | 27 | 100 | - |
| | 2-4 | 12,10,5,6 | 12 | 4.5 | 25 | - |
| | 4-6 | 2,3,3,3 | 6 | 0.9 | 50 | BA001A2 |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer

Notes:

1. A "blow count" refers to the number of blows required to drive a standard split-spoon sampler a distance of 6 inches using a 140-pound hammer falling 30 inches. Typically, as shown on the boring logs in Appendix E, the middle two numbers are added together resulting in the number of blows for 1 foot of undisturbed soil.

2. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-5

## FIELD MEASUREMENT DATA
## SUBSURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU No. 6

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| BORING DESIGNATION | DEPTH INTERVAL (FEET) | BLOW COUNTS[1] | RECOVERY (INCHES) | HEADSPACE ANALYSIS[2] | | SAMPLE COLLECTED FOR LABORATORY ANALYSIS |
|---|---|---|---|---|---|---|
| | | | | PID | OVA | |
| B6-1 | 0-2 | 10,13,8,5 | 24 | ND | ND | - |
| | 2-4 | 10,5,4,4 | 24 | ND | ND | B006A1 |
| | 4-6 | 2,5,1,3 | 2 | 40 | 80 | - |
| B6-2 | 0-2 | 5,6,11,21 | 15 | ND | ND | - |
| | 2-4 | 31,12,4,4 | 18 | 157 | 3,000 | B006A2 |
| | 4-6 | 7,2,1,1 | 6 | 247 | 3,000 | - |
| B6-3 | 0-2 | NA | NA | ND | ND | - |
| | 2-4 | NA | NA | ND | ND | B006A3 |
| B6-4 | 1-3 | 11,6,12,17 | 6 | 2 | 40 | - |
| | 3-5 | 13,12,11,10 | NR | 347 | 1500 | B006A4 |
| | 5-7 | 3,2,2,3 | NR | 381 | 200 | - |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer
ND - Not Detected
NA - Not Applicable. Boring advanced with a hand auger.
NR - Not Recorded

Notes:

1. A "blow count" refers to the number of blows required to drive a standard split-spoon sampler a distance of 6 inches using a 140-pound hammer falling 30 inches. Typically, as shown on the boring logs in Appendix E, the middle two numbers are added together resulting in the number of blows for 1 foot of undisturbed soil.

2. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-5

## FIELD MEASUREMENT DATA
## SUBSURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU No. 9

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| BORING DESIGNATION | DEPTH INTERVAL (FEET) | BLOW COUNTS[1] | RECOVERY (INCHES) | HEADSPACE ANALYSIS[2] | | SAMPLE COLLECTED FOR LABORATORY ANALYSIS |
|---|---|---|---|---|---|---|
| | | | | PID | OVA | |
| B9-1 | 0-2 | 18,42,26,18 | 18 | 347 | 450 | - |
| | 2-4 | 13,9,9,10 | 24 | 99 | 140 | B009A1 |
| | 4-6 | 3,2,1,1 | 6 | 247 | 300 | - |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer

Notes:

1. A "blow count" refers to the number of blows required to drive a standard split-spoon sampler a distance of 6 inches using a 140-pound hammer falling 30 inches. Typically, as shown on the boring logs in Appendix E, the middle two numbers are added together resulting in the number of blows for 1 foot of undisturbed soil.

2. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-5

## FIELD MEASUREMENT DATA
## SUBSURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU Nos. 11/12

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| BORING DESIGNATION | DEPTH INTERVAL (FEET) | BLOW COUNTS[1] | RECOVERY (INCHES) | HEADSPACE ANALYSIS[2] | | SAMPLE COLLECTED FOR LABORATORY ANALYSIS |
|---|---|---|---|---|---|---|
| | | | | PID | OVA | |
| B11-1 | 0-2 | 3,16,21,11 | 24 | 0.8 | ND | - |
| | 2-4 | 5,12,30,33 | 24 | 1.4 | ND | B011A1 |
| B11-2 | 0-2 | 6,14,16,12 | 24 | 0.2 | ND | - |
| | 2-4 | 11,7,7,4 | 20 | 1.4 | 5 | B011A2/A5 |
| B11-3 | 0-2 | 30,63,24,24 | 24 | 800 | 1,100 | - |
| | 2-4 | 15,12,13,12 | 20 | 970 | 5,000 | B011A3 |
| | 4-6 | 1,3,4,2 | 3 | 560 | 500 | - |
| B11-4 | 0-2 | 20,25,11,17 | 24 | 75 | 300 | - |
| | 2-4 | 7,10,6,8 | 20 | 23 | 100 | B011A4 |
| | 4-6 | NR | 1 | 500 | 3,000 | - |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer
ND - Not Detected
NR - Not Recorded

Notes:

1. A "blow count" refers to the number of blows required to drive a standard split-spoon sampler a distance of 6 inches using a 140-pound hammer falling 30 inches. Typically, as shown on the boring logs in Appendix E, the middle two numbers are added together resulting in the number of blows for 1 foot of undisturbed soil.

2. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-5

## FIELD MEASUREMENT DATA
## SUBSURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU No. 13

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| BORING DESIGNATION | DEPTH INTERVAL (FEET) | BLOW COUNTS[1] | RECOVERY (INCHES) | HEADSPACE ANALYSIS[2] | | SAMPLE COLLECTED FOR LABORATORY ANALYSIS |
|---|---|---|---|---|---|---|
| | | | | PID | OVA | |
| B13-1 | 0.5-2.5 | 13,17,11,5 | 24 | 240 | 3,000 | - |
| | 2.5-4.5 | 5,12,14,16 | 20 | 279 | 1,500 | B013A1 |
| | 4.5-6.5 | 7,10,5,5 | 0 | NA | NA | - |
| | 6.5-8.5 | 2,3,2,4 | 0 | NA | NA | - |
| B13-2 | 0.5-2.5 | 28,27,15,16 | 24 | 340 | 1,000 | - |
| | 2.5-4.5 | 30,11,11,10 | 20 | 345 | 2,500 | - |
| | 4.5-6.5 | 5,5,5,4 | 22 | 390 | 1,100 | B013A2 |
| | 6.5-8.5 | 6,2,1,4 | 3 | 330 | 900 | - |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer
NA - Not Applicable. Headspace analysis could not be conducted because no sample was recovered.

Notes:

1. A "blow count" refers to the number of blows required to drive a standard split-spoon sampler a distance of 6 inches using a 140-pound hammer falling 30 inches. Typically, as shown on the boring logs in Appendix E, the middle two numbers are added together resulting in the number of blows for 1 foot of undisturbed soil.

2. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-5

## FIELD MEASUREMENT DATA
## SUBSURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU No. 16

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| BORING DESIGNATION | DEPTH INTERVAL (FEET) | BLOW COUNTS[1] | RECOVERY (INCHES) | HEADSPACE ANALYSIS[2] | | SAMPLE COLLECTED FOR LABORATORY ANALYSIS |
|---|---|---|---|---|---|---|
| | | | | PID | OVA | |
| B16-1 | 0-2 | 16,21,16,12 | 24 | 50 | 300 | - |
| | 2-4 | 10,5,2,1 | 15 | 500 | 145 | B016A1 |
| | 4-6 | 2,1,1,1 | 3 | 300 | 130 | - |
| B16-2 | 0-2 | 8,8,7,9 | 24 | 160 | 500 | - |
| | 2-4 | 8,8,13,8 | 18 | 350 | 2,000 | B016A2 |
| | 4-6 | 2,1,1,1 | 3 | 750 | 1,500 | - |
| B16-3 | 0-2 | 6,7,8,9 | 24 | 99 | 2,500 | B016A3 |
| | 2-4 | 2,2,2,3 | 1 | NA | NA | - |
| B16-4 | 0-2 | 16,8,5,5 | 24 | 250 | 3,000 | - |
| | 2-4 | 5,3,2,3 | 24 | 740 | 3,000 | B016A4 |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer
NA - Not Applicable. Headspace analysis could not be conducted because no sample was recovered.

Notes:

1. A "blow count" refers to the number of blows required to drive a standard split-spoon sampler a distance of 6 inches using a 140-pound hammer falling 30 inches. Typically, as shown on the boring logs in Appendix E, the middle two numbers are added together resulting in the number of blows for 1 foot of undisturbed soil.

2. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-5

## FIELD MEASUREMENT DATA
## SUBSURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU No. 17

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| BORING DESIGNATION | DEPTH INTERVAL (FEET) | BLOW COUNTS[1] | RECOVERY (INCHES) | HEADSPACE ANALYSIS[2] | | SAMPLE COLLECTED FOR LABORATORY ANALYSIS |
|---|---|---|---|---|---|---|
| | | | | PID | OVA | |
| B17-1 | 0-2 | 10,9,12,17 | 20 | 290 | 400 | B017A1 |
| B17-2 | 0-2 | 1,3,6,7 | 20 | 88 | 150 | B017A2 |
| B17-3 | 0-2 | 5,10,8,13 | 24 | 200 | 400 | B017A3 |
| B17-4 | 0-2 | 16,27,30,20 | 22 | 120 | 30 | B017A4 |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer

Notes:

1. A "blow count" refers to the number of blows required to drive a standard split-spoon sampler a distance of 6 inches using a 140-pound hammer falling 30 inches. Typically, as shown on the boring logs in Appendix E, the middle two numbers are added together resulting in the number of blows for 1 foot of undisturbed soil.

2. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-5

## FIELD MEASUREMENT DATA
## SUBSURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU No. 29

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| BORING DESIGNATION | DEPTH INTERVAL (FEET) | BLOW COUNTS[1] | RECOVERY (INCHES) | HEADSPACE ANALYSIS[2] | | SAMPLE COLLECTED FOR LABORATORY ANALYSIS |
|---|---|---|---|---|---|---|
| | | | | PID | OVA | |
| B29-1 | 0-2 | 14,15,19,23 | 24 | 200 | 1,100 | - |
| | 2-4 | 25,14,14,17 | 24 | 340 | 3,000 | B029A1 |
| | 4-6 | 17,15,13,24 | 20 | 5,000 | 2,000 | - |
| B29-2 | 0-2 | 8,6,6,13 | 18 | ND | ND | - |
| | 2-4 | 17,17,19,18 | 22 | 130 | 200 | B029A2 |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer
ND - Not Detected

Notes:

1. A "blow count" refers to the number of blows required to drive a standard split-spoon sampler a distance of 6 inches using a 140-pound hammer falling 30 inches. Typically, as shown on the boring logs in Appendix E, the middle two numbers are added together resulting in the number of blows for 1 foot of undisturbed soil.

2. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-5

## FIELD MEASUREMENT DATA
## SUBSURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU No. 30

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| BORING DESIGNATION | DEPTH INTERVAL (FEET) | BLOW COUNTS[1] | RECOVERY (INCHES) | HEADSPACE ANALYSIS[2] | | SAMPLE COLLECTED FOR LABORATORY ANALYSIS |
|---|---|---|---|---|---|---|
| | | | | PID | OVA | |
| B30-1 | 0-2 | 17,27,89,85 | 20 | 160 | 120 | - |
| | 2-4 | 28,17,15,12 | 20 | 37 | 250 | B030A1 |
| | 4-6 | 2,1,1,1 | 2 | 51 | 100 | - |
| B30-2 | 0-2 | 9,18,14,68 | 20 | 1,200 | 400 | - |
| | 2-4 | 40,39,47,27 | 16 | 445 | 500 | B030A2 |
| B30-3 | 0-2 | 35,28,18,14 | 18 | 450 | 87 | - |
| | 2-4 | 13,8,10,13 | 20 | 250 | 29 | B030A3 |
| | 4-5 | 18,28 | 12 | 681 | 700 | - |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer

Notes:

1. A "blow count" refers to the number of blows required to drive a standard split-spoon sampler a distance of 6 inches using a 140-pound hammer falling 30 inches. Typically, as shown on the boring logs in Appendix E, the middle two numbers are added together resulting in the number of blows for 1 foot of undisturbed soil.

2. Headspace measurements in OVA/PID units of parts per million.

## TABLE 4-5

## FIELD MEASUREMENT DATA
## SUBSURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU No. 45

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| BORING DESIGNATION | DEPTH INTERVAL (FEET) | BLOW COUNTS[1] | RECOVERY (INCHES) | HEADSPACE ANALYSIS[2] | | SAMPLE COLLECTED FOR LABORATORY ANALYSIS |
|---|---|---|---|---|---|---|
| | | | | PID | OVA | |
| B45-1 | 0-1.5 | 20,150,161/6" | 18 | 177 | 90 | - |
| | 1.5-3.5 | 148,110,49,40 | 24 | 80 | 85 | B045A1/A3 |
| | 3.5-5.5 | 32,10,10,12 | 3 | 64 | 45 | - |
| B45-2 | 0-2 | 25,24,20,13 | 18 | 66 | 300 | - |
| | 2-4 | 13,6,6,6 | 18 | 247 | 10,000 | B045A2 |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer

Notes:

1. A "blow count" refers to the number of blows required to drive a standard split-spoon sampler a distance of 6 inches using a 140-pound hammer falling 30 inches. Typically, as shown on the boring logs in Appendix E, the middle two numbers are added together resulting in the number of blows for 1 foot of undisturbed soil.

2. Headspace measurements in OVA/PID units of parts per million.

## TABLE 4-5

## FIELD MEASUREMENT DATA
## SUBSURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU No. 71

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| BORING DESIGNATION | DEPTH INTERVAL (FEET) | BLOW COUNTS[1] | RECOVERY (INCHES) | HEADSPACE ANALYSIS[2] | | SAMPLE COLLECTED FOR LABORATORY ANALYSIS |
|---|---|---|---|---|---|---|
| | | | | PID | OVA | |
| B71-1 | 1-2 | 12,22 | 12 | 15 | 20 | B071A1 |
| B71-2 | 1-2 | 3,9 | 12 | 83 | 400 | - |
| | 2-4 | 15,18,40,183 | 20 | 500 | 500 | B071A2 |
| B71-3 | 1-3 | 5,22,12,5 | 24 | 121 | 100 | - |
| | 3-4.5 | 5,8 | 12 | 300 | 500 | B071A3 |
| B71-4 | 1-3 | 2,25,24,24 | 20 | 280 | 500 | - |
| | 3-5 | 12,75,60,15 | 16 | 60 | 300 | B071A4 |
| | 5-7 | 4,6,5,4 | 6 | 100 | 50 | - |
| B71-5 | 1-3 | 12,20,24,12 | 15 | 70 | 100 | B071A5 |
| | 3-5 | 5,8,10,2 | 20 | 42 | 150 | - |
| B71-6 | 0-1 | 20,26 | 12 | 15 | 5 | - |
| | 1-3 | 21,26,20,12 | 24 | 42 | 50 | B071A6/A7 |
| | 3-5 | 12,7,4,1 | 20 | 300 | 700 | - |
| SB-1 | 0-2 | 13,7,5,2 | 20 | 781 | NR | - |
| | 2-4 | 8,3,3,3 | 18 | 98.1 | NR | SB-1 (3.0-3.5') |
| | 4-6 | 2,1,1,2 | 20 | 259 | NR | - |
| SB-2 | 0-2 | 12,17,9,13 | 12 | 281 | NR | - |
| | 2-4 | 10,5,3,14 | 20 | 73.5 | NR | SB-1 (3.0-3.5') |
| SB-3 | 0-1 | NR | NR | NR | NR | SB-3 (composite) |
| | 1-3 | 25,17,19,23 | 12 | 154 | NR | |
| | 3-4 | 22,17 | 12 | 320 | NR | |
| SB-4 | 0-1 | NR | NR | NR | NR | SB-4 (composite) |
| | 1-3 | 16,12,15,10 | 12 | 9.8 | NR | |
| | 3-4 | 12,15 | 12 | 276 | NR | |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer
NR - Not Recorded

Notes:

1. A "blow count" refers to the number of blows required to drive a standard split-spoon sampler a distance of 6 inches using a 140-pound hammer falling 30 inches. Typically, as shown on the boring logs in Appendix D, the middle two numbers are added together resulting in the number of blows for 1 foot of undisturbed soil.

2. Headspace measurements in OVA/PID units of parts per million.

## TABLE 4-5

## FIELD MEASUREMENT DATA
## SUBSURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU No. 71A

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| BORING DESIGNATION | DEPTH INTERVAL (FEET) | BLOW COUNTS[1] | RECOVERY (INCHES) | HEADSPACE ANALYSIS[2] | | SAMPLE COLLECTED FOR LABORATORY ANALYSIS |
|---|---|---|---|---|---|---|
| | | | | PID | OVA | |
| B71A-1 | 0-2 | 8,18,37,16 | 18 | 11 | 50 | - |
| | 2-4 | 18,49,25,40 | 24 | 47 | 1,100 | B071AA1 |
| | 4-6 | 48,31,10,7 | 24 | 90 | 2,500 | - |
| B71A-2 | 0-2 | 11,16,17,12 | 16 | 17 | 10 | - |
| | 2-4 | 8,6,8,24 | 15 | 209 | 300 | - |
| | 4-6 | 80,20,14,6 | 18 | 12 | 500 | B071AA2 |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer

Notes:

1. A "blow count" refers to the number of blows required to drive a standard split-spoon sampler a distance of 6 inches using a 140-pound hammer falling 30 inches. Typically, as shown on the boring logs in Appendix E, the middle two numbers are added together resulting in the number of blows for 1 foot of undisturbed soil.

2. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-5

## FIELD MEASUREMENT DATA
## SUBSURFACE SOIL SAMPLING
## VERIFICATION INVESTIGATION - SWMU No. 79

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| BORING DESIGNATION | DEPTH INTERVAL (FEET) | BLOW COUNTS[1] | RECOVERY (INCHES) | HEADSPACE ANALYSIS[2] | | SAMPLE COLLECTED FOR LABORATORY ANALYSIS |
|---|---|---|---|---|---|---|
| | | | | PID | OVA | |
| B79-1 | 0-2 | 125,80,40,100 | 18 | 220 | 1,100 | - |
| | 2.5-4.5 | 21,14,15,5 | 18 | 16 | 300 | - |
| | 4.5-6.5 | 4,3,2,2 | 24 | 51 | 3,000 | B079A1 |
| | 6.5-8.5 | 4,3,2,3 | NR | NR | NR | - |
| B79-2 | 0-2 | 100,100,86,125 | 18 | 57 | 40 | B079A2 |
| | 2-2.5 | 100/6" | 1 | NA | NA | - |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer
NR - Not Recorded
NA - Not Applicable. Boring advanced with a hand auger.

Notes:

1. A "blow count" refers to the number of blows required to drive a standard split-spoon sampler a distance of 6 inches using a 140-pound hammer falling 30 inches. Typically, as shown on the boring logs in Appendix E, the middle two numbers are added together resulting in the number of blows for 1 foot of undisturbed soil.

2. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-6

## FIELD MEASUREMENT DATA
## MONITORING WELL INSTALLATION
## VERIFICATION INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| WELL DESIGNATION | SWMU NO. | DEPTH INTERVAL (FEET) | BLOW COUNTS[1] | RECOVERY (INCHES) | HEADSPACE ANALYSIS[2] | |
|---|---|---|---|---|---|---|
| | | | | | PID | OVA |
| A137 | 2 | 0-2 | 29,34,85,50 | 12 | 27 | 100 |
| | | 2-4 | 12,10,5,6 | 12 | 4.5 | 25 |
| | | 4-6 | 2,3,3,3 | 6 | 0.9 | 50 |
| | | 10-12 | 3,5,3,3 | 20 | 43 | 100 |
| | | 15-17 | 3,4,6,4 | 22 | ND | 1000 |
| A135 | 6 | 0-2 | 3,4,13,31 | 10 | 12 | 20 |
| | | 5-7 | 5,7,6,4 | 18 | 350 | >10,000 |
| | | 10-12 | 4,1,1,1 | 6 | 325 | 2,000 |
| | | 14.5-16.5 | 4,2,4,4 | 20 | 117 | 20 |
| A136 | 9 | 0-2 | 18,42,26,18 | 18 | 347 | 450 |
| | | 2-4 | 13,9,9,10 | 24 | 99 | 140 |
| | | 4-6 | 3,2,1,1 | 12 | 247 | 300 |
| | | 10-12 | 7,8,12,7 | 12 | 348 | 2,000 |
| | | 15-17 | 3,3,2,3 | 24 | 31 | 500 |
| A133 | 11/12 | 1-3 | 10,9,14,3 | 24 | NR | NR |
| | | 3-5 | 3,1,1,1 | 3 | 120 | 100 |
| A134 | 13 | 0-2 | 9,11,7,7 | 9 | 6 | 7 |
| | | 5-7 | 3,2,2,3 | 12 | 840 | 1,000 |
| | | 10-12 | 9,7,6,5 | 6 | 34 | 200 |
| | | 15-17 | 1,1,1,1 | 18 | 252 | 500 |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer
ND - Not Detected
NR - Not Recorded

Notes:

1. A "blow count" refers to the number of blows required to drive a standard split-spoon sampler a distance of 6 inches using a 140-pound hammer falling 30 inches. Typically, as shown on the boring logs in Appendix E, the middle two numbers are added together resulting in the number of blows for 1 foot of undisturbed soil.

2. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-6

## FIELD MEASUREMENT DATA
## MONITORING WELL INSTALLATION
## VERIFICATION INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| WELL DESIGNATION | SWMU NO. | DEPTH INTERVAL (FEET) | BLOW COUNTS[1] | RECOVERY (INCHES) | HEADSPACE ANALYSIS[2] | |
|---|---|---|---|---|---|---|
| | | | | | PID | OVA |
| A132 | 16/17 | 0-2 | 4,4,6,10 | 12 | 228 | 300 |
| | | 5-7 | 3,1,2,1 | 12 | 207 | 200 |
| | | 10-12 | 1,1,2,1 | 18 | 71 | 500 |
| | | 15-17 | 3,3,2,3, | 21 | 114 | 300 |
| B130 | 29 | 0-2 | 26,16,15,16 | 12 | 72 | 350 |
| | | 5-7 | 11,6,6,8 | 12 | 309 | 5,000 |
| | | 10-12 | 2,1,1,2 | 24 | 87 | 3,500 |
| | | 15-17 | 1,1,1,2 | 12 | 76 | 750 |
| B129 | 30 | 5-7 | 1,2,1,1 | 18 | 63 | 900 |
| | | 10-12 | 7,7,4,4 | 12 | 48 | 300 |
| | | 15-17 | 3,2,2,3 | 24 | 18 | 300 |
| B131 | 45 | 0-2 | 4,10,12,15 | 8 | 82 | >10,000 |
| | | 5-7 | 6,8,5,11 | 3 | 250 | >10,000 |
| | | 10-12 | 1,1,1,1 | 24 | 123 | 1,000 |
| C127 | 71 | 4-6 | 7,5,5,4 | 18 | 240 | 750 |
| | | 9-11 | 9,5,3,4 | 12 | 422 | 100 |
| | | 14-16 | 10,4,4,5 | 12 | 331 | 500 |
| C128 | 79 | 10-12 | 7,7,2,1 | 24 | 50 | 2,000 |
| | | 15-17 | 28,6,5,6 | 24 | 168 | 3,000 |

Explanation:

SWMU - Solid Waste Management Unit
PID - Photoionization Detector
OVA - Organic Vapor Analyzer

Notes:

1. A "blow count" refers to the number of blows required to drive a standard split-spoon sampler a distance of 6 inches using a 140-pound hammer falling 30 inches. Typically, as shown on the boring logs in Appendix E, the middle two numbers are added together resulting in the number of blows for 1 foot of undisturbed soil.

2. Headspace measurements in OVA/PID units of parts per million.

# TABLE 4-7

## SUMMARY OF FIELD MEASUREMENT DATA
## GROUND WATER SAMPLING
## VERIFICATION INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| Sample Identification | A40 | A137 | A135 | A136 | A133 | A134 |
|---|---|---|---|---|---|---|
| SWMU No. | 1 | 2 | 6 | 9 | 11/12 | 13 |
| Date Sampled | 9/2/92 | 9/2/92 | 9/2/92 | 9/3/92 | 9/9/92 | 9/3/92 |
| **Parameter (Units)** | | | | | | |
| Temperature (°C) | 22.0 | 21.5 | 23.7 | 22.3 | NA | 23.2 |
| pH (standard) | 6.59 | 6.75 | 7.12 | 7.10 | NA | 7.39 |
| Specific Conductance (micromhos) | 672 | 578 | 858 | 1,118 | NA | 630 |
| Field Observations Regarding Appearance of Ground Water or Free-Phase Hydrocarbon | Clear to slightly turbid with slight hydrocarbon odor | Slightly turbid, slight hydrocarbon odor | Clear, slight hydrocarbon odor & sheen | Turbid, dark brown sheen, hydrocarbon odor | Free-phase hydrocarbon; brown; viscosity and odor similar to that of fuel oil/gasoline | Slightly turbid, slight hydrocarbon odor & sheen |
| Sample Collected for Laboratory Analysis | G001A1/A2 | G002A1/A2<br>G002A3/A4 | G006A1/A2 | G009A1/A2 | G011A1 | G013A1/A2 |

# TABLE 4-7

## SUMMARY OF FIELD MEASUREMENT DATA
## GROUND WATER SAMPLING
## VERIFICATION INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| Sample Identification | A132 | B130 | B129 | B131 | C127 | C128 |
|---|---|---|---|---|---|---|
| SWMU No. | 16/17 | 29 | 30 | 45 | 71 | 79 |
| Date Sampled | 9/2/92 | 9/3/92 | 9/3/92 | 9/4/92 | 9/3/92 | 9/4/92 |
| **Parameter (Units)** | | | | | | |
| Temperature (°C) | 19.7 | 23.4 | NA | 22.8 | 22.4 | 21.2 |
| pH (standard) | 6.27 | 6.85 | NA | 7.30 | 6.80 | 6.55 |
| Specific Conductance (micromhos) | 794 | 1,041 | NA | 960 | 1,402 | 1,233 |
| Field Observations Regarding Appearance of Ground Water or Free-Phase Hydrocarbon | Turbid with hydrocarbon odor | Clear to turbid, brown, sheen, slight hydrocarbon odor | Free-phase hydrocarbon; brown to black; viscosity and odor similar to that of fuel oil/gasoline | Clear to slightly turbid, brown sheen, slight hydrocarbon odor | Slightly turbid, sheen, brown, slight hydrocarbon odor | Turbid, dark brown, slight hydrocarbon odor and sheen |
| Sample Collected for Laboratory Analysis | G017A1/A2 | G029A1/A2 | G030A1 | G045A1/A2<br>G045A3/A4 | G071A1/A2 | G079A1/A2 |

Explanation:

SWMU - Solid Waste Management Unit
NA - Not Applicable. Physicochemical measurements not recorded because the well contained free-phase hydrocarbon.

Table 4-8
Skinner List Semivolatile Organic Compound Analytical Data
Surface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 1 | | | SWMU 6 | | SWMU 9 | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | S001A0 | S001A1 | S001A2 | S006A0 | S006A1 | S009A1 | S009A1MS | S009A1MSD | S009A2 |
| Sample Location | S1-1 | S1-2 | S1-3 | S6-1 | S6-2 | S9-1 | S9-1 MS | S9-1 MSD | S9-1 Rep |
| Sample Depth | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in |
| Laboratory ID | P207734 | P207735 | P207736 | P207737 | P207738 | P207970 | P207971 | P207972 | P207974 |
| Sample Date | 08/04/92 | 08/04/92 | 08/04/92 | 08/04/92 | 08/04/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Semivolatile Organic Compounds | | | | | | | | | |
| Aniline | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| Anthracene | 340 U | 350 U | 340 U | **120 J** | 370 U | **1400 J** | **1300 J** | **1300 J** | 1200 U |
| Benz(c)acridine | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Benzenethiol | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| Benzidine | 1700 U | 1700 U | 1700 U | 1900 U | 1800 U | 7200 U | 7200 U | 7200 U | 6000 U |
| Benzo(a)anthracene | 340 U | 350 U | 340 U | **2000** | **120 J** | **1100 J** | **1000 J** | **1100 J** | **740 J** |
| Benzo(a)pyrene | 340 UJ | 350 U | 340 UJ | **2400** | **230 J** | **810 J** | **670 J** | **720 J** | 1200 U |
| Benzo(b,j,k)fluoranthene | 1300 U | 1300 U | 1300 U | **900 J** | 1400 U | 5400 U | 5400 U | 5400 U | 4500 U |
| Benzyl chloride | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| Butyl benzyl phthalate | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| p-Chloro-m-cresol | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| Bis(2-chloroethyl) ether | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| Bis(2-chloroisopropyl)ether | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| Bis(2-chloromethyl)ether | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 2-Chloronaphthalene | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| 2-Chlorophenol | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| Chrysene | 210 U | 210 U | 210 U | **3100** | **200 J** | **2600** | **2100** | **2500** | **1900** |
| o-Cresol | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| p-Cresol | 1000 U | 1100 U | 1000 U | 1200 U | 1100 U | 4500 U | 4500 U | 4500 U | 3700 U |
| Di-n-butylphthalate | 340 UJ | **370 B** | 340 UJ | **330 BJ** | **620 B** | **1100 BJ** | **1200 BJ** | **1100 BJ** | 1200 U |
| Di-n-octylphthalate | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| Dibenz(a,h)acridine | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| Dibenz(a,h)anthracene | 340 U | 350 U | 340 U | **640** | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| Dibenz(a,i)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |

Table 4-8
Skinner List Semivolatile Organic Compound Analytical Data
Surface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 1 | | | SWMU 6 | | SWMU 9 | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | S001A0 | S001A1 | S001A2 | S006A0 | S006A1 | S009A1 | S009A1MS | S009A1MSD | S009A2 |
| Sample Location | S1-1 | S1-2 | S1-3 | S6-1 | S6-2 | S9-1 | S9-1 MS | S9-1 MSD | S9-1 Rep |
| Sample Depth | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in |
| Laboratory ID | P207734 | P207735 | P207736 | P207737 | P207738 | P207970 | P207971 | P207972 | P207974 |
| Sample Date | 08/04/92 | 08/04/92 | 08/04/92 | 08/04/92 | 08/04/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Dibenz(a,j)acridine | 690 U | 700 U | 690 U | 770 U | 750 U | 3000 U | 3000 U | 3000 U | 2500 U |
| Dibenzo(a,e)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Dibenzo(a,h)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 7h-Dibenzo(c,g)carbazole | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 1,3-Dichloro-2-propanol | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| 1,2-Dichlorobenzene | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| 1,3-Dichlorobenzene | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| 1,4-Dichlorobenzene | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| Diethyl phthalate | 340 U | 350 U | 340 U | 380 U | **340 J** | 1500 U | 1500 U | 1500 U | 1200 U |
| Dimethyl phthalate | 340 U | 350 U | 340 U | **150 J** | **210 J** | **760 BJ** | **890 BJ** | **850 BJ** | 1200 U |
| 7,12-Dimethylbenz(a)anthracene | 310 U | 320 U | 310 U | 350 U | 340 U | 1300 U | 1300 U | 1300 U | 1100 U |
| 2,4-Dimethylphenol | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| 4,6-Dinitro-o-cresol | 1700 UJ | 1700 U | 1700 UJ | 1900 U | 1800 U | 7200 U | 7200 U | 7200 U | 6000 U |
| 2,4-Dinitrophenol | 1700 U | 1700 U | 1700 U | 1900 U | 1800 U | 7200 U | 7200 U | 7200 U | 6000 U |
| 2,4-Dinitrotoluene | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| 1,2-Diphenylhydrazine | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 UJ |
| Bis(2-ethylhexyl) phthalate | 340 U | **4700** | 340 U | 380 U | 370 U | **1000 J** | **860 J** | **970 J** | **750 J** |
| Fluoranthene | 340 U | 350 U | 340 U | **5000** | **220 J** | **1500** | **1200 J** | **1200 J** | **1000 J** |
| Hydroquinone | 1800 U | 1800 U | 1800 U | 2000 U | 1900 U | 7600 U | 7600 U | 7600 U | 6400 U |
| Indene | 700 U | 710 U | 700 U | 780 U | 760 U | 3000 U | 3000 U | 3000 U | 2500 U |
| Indeno(1,2,3-cd)pyrene | 340 U | 350 U | 340 U | **1400** | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| 3-Methylcholanthrene | 210 U | 210 U | 210 U | 230 U | 230 U | 900 U | 900 U | 900 U | 750 U |
| 1-Methylnaphthalene | 700 U | 710 U | **380 J** | 780 U | 760 U | **23000** | **20000** | **22000** | **16000** |
| Naphthalene | 340 U | 350 U | **110 J** | 380 U | 370 U | **2700** | **2200** | **2500** | 1200 U |
| 5-Nitroacenapthene | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |

Table 4-8
Skinner List Semivolatile Organic Compound Analytical Data
Surface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 1 | | | SWMU 6 | | SWMU 9 | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | S001A0 | S001A1 | S001A2 | S006A0 | S006A1 | S009A1 | S009A1MS | S009A1MSD | S009A2 |
| Sample Location | S1-1 | S1-2 | S1-3 | S6-1 | S6-2 | S9-1 | S9-1 MS | S9-1 MSD | S9-1 Rep |
| Sample Depth | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in |
| Laboratory ID | P207734 | P207735 | P207736 | P207737 | P207738 | P207970 | P207971 | P207972 | P207974 |
| Sample Date | 08/04/92 | 08/04/92 | 08/04/92 | 08/04/92 | 08/04/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| P-Nitroaniline | 1700 U | 1700 U | 1700 U | 1900 U | 1800 U | 7200 U | 7200 U | 7200 U | 6000 U |
| Nitrobenzene | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| P-Nitrophenol | 1700 U | 1700 U | 1700 U | 1900 U | 1800 U | 7200 U | 7200 U | 7200 U | 6000 U |
| N-Nitrosodimethylamine | 110 UJ | 120 U | 110 UJ | 130 U | 120 U | 490 U | 490 U | 490 U | 410 U |
| Pentachlorophenol | 1700 U | 1700 U | 1700 U | 1900 U | 1800 U | 7200 U | 7200 U | 7200 U | 6000 U |
| Phenanthrene | 340 U | 350 U | 340 U | **1300** | **130 J** | **16000** | **14000** | **16000** | **12000** |
| Phenol | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| Pyrene | 340 U | 350 U | 340 U | **3300** | **160 J** | **3800** | 1500 U | 1500 U | **2400** |
| Pyridine | 700 U | 710 U | 700 U | 780 U | 760 U | 3000 U | 3000 U | 3000 U | 2500 U |
| Quinoline | 700 U | 710 U | 700 U | 780 U | 760 U | 3000 U | 3000 U | 3000 U | 2500 U |
| 1,2,4-Trichlorobenzene | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| 2,4,5-Trichlorophenol | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |
| 2,4,6-Trichlorophenol | 340 U | 350 U | 340 U | 380 U | 370 U | 1500 U | 1500 U | 1500 U | 1200 U |

Table 4-8
Skinner List Semivolatile Organic Compound Analytical Data
Surface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 16 | | | SWMU 30 | | |
|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | S016A1 | S016A2 | S016A3 | S030A1 | S030A2 | S030A3 |
| Sample Location | S16-1 | S16-2 | Field Blank | S30-1 | S30-2 | S30-3 |
| Sample Depth | 0-6in | 0-6in | | 0-6in | 0-6in | 0-6in |
| Laboratory ID | P207875 | P207876 | P207877 | P208448 | P208449 | P208450 |
| Sample Date | 08/05/92 | 08/05/92 | 08/05/92 | 08/10/92 | 08/10/92 | 08/10/92 |
| Units | ug/kg | ug/kg | UG/L | ug/kg | ug/kg | ug/kg |
| Semivolatile Organic Compounds | | | | | | |
| Aniline | 3200 U | 370 U | 10 U | 370 U | 370 U | 350 U |
| Anthracene | **1800 J** | **170 J** | 10 U | **75 J** | 370 U | 350 U |
| Benz(c)acridine | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Benzenethiol | 3200 U | 370 U | 10 U | 370 U | 370 U | 350 U |
| Benzidine | 15000 U | 1800 U | 500 U | 1800 U | 1800 U | 1700 U |
| Benzo(a)anthracene | 3200 U | 370 UJ | 10 U | **290 J** | **120 J** | 350 U |
| Benzo(a)pyrene | **1400 J** | **380 J** | 10 UJ | **390** | **130 J** | 350 U |
| Benzo(b,j,k)fluoranthene | 12000 U | 1400 UJ | 40 U | **320 J** | 1400 U | 1300 U |
| Benzyl chloride | 3200 U | 370 U | 10 U | 370 U | 370 U | 350 U |
| Butyl benzyl phthalate | 3200 U | 370 UJ | 10 U | 370 U | 370 UJ | 350 U |
| p-Chloro-m-cresol | 3200 U | 370 U | 10 U | 370 U | 370 UJ | 350 U |
| Bis(2-chloroethyl) ether | 3200 U | 370 U | 10 U | 370 U | 370 UJ | 350 U |
| Bis(2-chloroisopropyl)ether | 3200 U | 370 U | 10 U | 370 U | 370 UJ | 350 U |
| Bis(2-chloromethyl)ether | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 2-Chloronaphthalene | 3200 U | 370 U | 10 U | 370 U | 370 U | 350 U |
| 2-Chlorophenol | 3200 U | 370 U | 10 U | 370 U | 370 UJ | 350 U |
| Chrysene | **7800** | **890 J** | 6 U | **340** | **160 J** | 210 U |
| o-Cresol | 3200 U | 370 U | 10 U | 370 U | 370 UJ | 350 U |
| p-Cresol | 9600 U | 1100 U | 30 U | 1100 U | 1100 UJ | 1100 U |
| Di-n-butylphthalate | 3200 U | **870 B** | 10 UJ | **830 B** | **860 B** | **860 B** |
| Di-n-octylphthalate | 3200 U | 370 UJ | 10 U | 370 U | 370 U | 350 U |
| Dibenz(a,h)acridine | 3200 U | 370 U | 10 U | 370 U | 370 U | 350 U |
| Dibenz(a,h)anthracene | 3200 U | 370 UJ | 10 U | 370 U | 370 U | 350 U |
| Dibenz(a,i)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |

Table 4-8
Skinner List Semivolatile Organic Compound Analytical Data
Surface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 16 | | | SWMU 30 | | |
|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | S016A1 | S016A2 | S016A3 | S030A1 | S030A2 | S030A3 |
| Sample Location | S16-1 | S16-2 | Field Blank | S30-1 | S30-2 | S30-3 |
| Sample Depth | 0-6in | 0-6in | | 0-6in | 0-6in | 0-6in |
| Laboratory ID | P207875 | P207876 | P207877 | P208448 | P208449 | P208450 |
| Sample Date | 08/05/92 | 08/05/92 | 08/05/92 | 08/10/92 | 08/10/92 | 08/10/92 |
| Units | ug/kg | ug/kg | UG/L | ug/kg | ug/kg | ug/kg |
| Dibenz(a,j)acridine | 6400 U | 750 U | 20 U | 730 U | 750 U | 700 U |
| Dibenzo(a,e)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Dibenzo(a,h)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 7h-Dibenzo(c,g)carbazole | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 1,3-Dichloro-2-propanol | 3200 U | 370 U | 10 U | 370 U | 370 U | 350 U |
| 1,2-Dichlorobenzene | 3200 U | 370 U | 10 U | 370 U | 370 UJ | 350 U |
| 1,3-Dichlorobenzene | 3200 U | 370 U | 10 U | 370 U | 370 UJ | 350 U |
| 1,4-Dichlorobenzene | 3200 U | 370 U | 10 U | 370 U | 370 UJ | 350 U |
| Diethyl phthalate | 3200 U | 370 U | 10 U | **120 J** | 370 U | 350 U |
| Dimethyl phthalate | **2700 BJ** | **220 BJ** | 10 U | **310 J** | **150 J** | 350 U |
| 7,12-Dimethylbenz(a)anthracene | 2900 U | 340 U | 9 U | 330 U | 340 U | 320 U |
| 2,4-Dimethylphenol | 3200 U | 370 U | 10 U | 370 U | 370 UJ | 350 U |
| 4,6-Dinitro-o-cresol | 15000 U | 1800 U | 50 UJ | 1800 U | 1800 U | 1700 U |
| 2,4-Dinitrophenol | 15000 U | 1800 U | 50 U | 1800 U | 1800 U | 1700 U |
| 2,4-Dinitrotoluene | 3200 U | 370 U | 10 U | 370 U | 370 U | 350 U |
| 1,2-Diphenylhydrazine | 3200 U | 370 U | 10 U | 370 U | 370 UJ | 350 UJ |
| Bis(2-ethylhexyl) phthalate | 3200 U | 370 UJ | 10 U | 370 U | 370 UJ | 350 U |
| Fluoranthene | **1700 J** | 370 U | 10 U | **520** | **180 J** | 350 U |
| Hydroquinone | 16000 U | 1900 U | 50 U | 1900 U | 1900 U | 1800 U |
| Indene | 6500 U | 760 U | 20 U | 740 U | 760 U | 710 U |
| Indeno(1,2,3-cd)pyrene | 3200 U | 370 UJ | 10 U | **200 J** | 370 U | 350 U |
| 3-Methylcholanthrene | 1900 U | 230 U | 6 U | 220 U | 230 U | 210 U |
| 1-Methylnapththalene | **36000** | 760 U | 20 U | 740 U | 760 U | 710 U |
| Naphthalene | **5100** | 370 U | 10 U | 370 U | 370 UJ | 350 U |
| 5-Nitroacenapthene | 3200 U | 370 U | 10 U | 370 U | 370 U | 350 U |

Table 4-8
Skinner List Semivolatile Organic Compound Analytical Data
Surface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 16 | | | SWMU 30 | | |
|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | S016A1 | S016A2 | S016A3 | S030A1 | S030A2 | S030A3 |
| Sample Location | S16-1 | S16-2 | Field Blank | S30-1 | S30-2 | S30-3 |
| Sample Depth | 0-6in | 0-6in | | 0-6in | 0-6in | 0-6in |
| Laboratory ID | P207875 | P207876 | P207877 | P208448 | P208449 | P208450 |
| Sample Date | 08/05/92 | 08/05/92 | 08/05/92 | 08/10/92 | 08/10/92 | 08/10/92 |
| Units | ug/kg | ug/kg | UG/L | ug/kg | ug/kg | ug/kg |
| P-Nitroaniline | 15000 U | 1800 U | 50 U | 1800 U | 1800 U | 1700 U |
| Nitrobenzene | 3200 U | 370 U | 10 U | 370 U | 370 UJ | 350 U |
| P-Nitrophenol | 15000 U | 1800 U | 50 U | 1800 U | 1800 U | 1700 U |
| N-Nitrosodimethylamine | 1100 U | 120 U | 5 UJ | 120 U | 120 U | 120 U |
| Pentachlorophenol | 15000 U | 1800 U | 50 U | 1800 U | 1800 U | 1700 U |
| Phenanthrene | **25000** | **130 J** | 10 U | **240 J** | **140 J** | 350 U |
| Phenol | 3200 U | 370 U | 10 U | 370 U | 370 UJ | 350 U |
| Pyrene | **6600** | **620 J** | 10 U | **510** | **210 J** | 350 U |
| Pyridine | 6500 U | 760 U | 20 U | 740 U | 760 U | 710 U |
| Quinoline | 6500 U | 760 U | 20 U | 740 U | 760 U | 710 U |
| 1,2,4-Trichlorobenzene | 3200 U | 370 U | 10 U | 370 U | 370 UJ | 350 U |
| 2,4,5-Trichlorophenol | 3200 U | 370 U | 10 U | 370 U | 370 U | 350 U |
| 2,4,6-Trichlorophenol | 3200 U | 370 U | 10 U | 370 U | 370 U | 350 U |

# TABLE 4-8

## Skinner List Semivolatile Organic Compound Analytical Data
## Surface Soil Investigation
## RCRA Verification Investigation
## Chevron Refinery
## Philadelphia, Pennsylvania

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| ug/kg | - | micrograms per kilogram. |
| MS | - | Matrix Spike quality assurance/quality control sample. |
| MSD | - | Matrix Spike Duplicate quality assurance/quality control sample. |
| Rep | - | Replicate Sample. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |
| UJ | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is estimated. |
| J | - | The associated numerical value is an estimated quantity. |
| B | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. |
| BJ | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. The associated numerical value is an estimated quantity. |

Table 4-9
Skinner List Inorganic Compound Analytical Data
Surface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 1 | | | SWMU 6 | | SWMU 9 | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | S001A0 | S001A1 | S001A2 | S006A0 | S006A1 | S009A1 | S009A2 |
| Sample Location | S1-1 | S1-2 | S1-3 | S6-1 | S6-2 | S9-1 | S9-1 Rep |
| Sample Depth | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in |
| Laboratory ID | P207734 | P207735 | P207736 | P207737 | P207738 | P207970 | P207974 |
| Sample Date | 08/04/92 | 08/04/92 | 08/04/92 | 08/04/92 | 08/04/92 | 08/06/92 | 08/06/92 |
| Units | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| Inorganic Compounds | | | | | | | |
| Antimony | 2.10 U | 1.80 | 3.00 | 2.80 | 4.80 | 2.20 | 4.00 |
| Arsenic | 7.50 L | 5.20 L | 2.20 L | 9.30 L | 24.90 L | 6.50 L | 2.40 L |
| Barium | 100.00 J | 175.00 J | 105.00 J | 752.00 J | 676.00 J | 28.60 J | 47.10 J |
| Beryllium | 0.73 | 1.10 | 0.94 | 2.10 | 1.60 | 0.56 U | 0.56 U |
| Cadmium | 5.20 UL | 0.53 UL | 5.20 UL | 3.80 L | 8.70 L | 0.56 UL | 2.80 UL |
| Chromium | 1140.00 K | 2420.00 K | 1170.00 K | 1730.00 K | 768.00 K | 25.60 K | 115.00 K |
| Cobalt | 9.20 J | 38.00 J | 8.70 J | 218.00 J | 126.00 J | 6.60 J | 8.70 J |
| Cyanide | 0.26 U | 0.39 | 0.26 U | 1.30 | 1.70 | 0.28 U | 0.01 U |
| Lead | 73.00 J | 72.70 J | 62.00 J | 1260.00 J | 839.00 J | 49.30 J | 72.90 J |
| Mercury | 0.17 L | 0.11 L | 0.08 UL | 5.20 L | 5.40 L | 0.61 L | 0.45 L |
| Nickel | 123.00 J | 179.00 J | 144.00 J | 156.00 J | 151.00 J | 8.40 J | 14.20 J |
| Selenium | 0.42 UL | 2.40 L | 0.42 UL | 0.73 L | 1.00 L | 0.45 UL | 0.45 UL |
| Sulfide | 3.10 UL | 17.60 L | 8.60 L | 3.50 UL | 38.50 L | 32.50 L | 3.40 UJ |
| Vanadium | 196.00 J | 333.00 J | 161.00 J | 330.00 J | 201.00 J | 19.10 J | 50.60 J |

Table 4-9
Skinner List Inorganic Compound Analytical Data
Surface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 16 | | | SWMU 30 | | |
|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | S016A1 | S016A2 | S016A3 | S030A1 | S030A2 | S030A3 |
| Sample Location | S16-1 | S16-2 | Field Blank | S30-1 | S30-2 | S30-3 |
| Sample Depth | 0-6in | 0-6in | | 0-6in | 0-6in | 0-6in |
| Laboratory ID | P207875 | P207876 | P207877 | P208448 | P208449 | P208450 |
| Sample Date | 08/05/92 | 08/05/92 | 08/05/92 | 08/10/92 | 08/10/92 | 08/10/92 |
| Units | mg/kg | mg/kg | UG/L | mg/kg | mg/kg | mg/kg |
| Inorganic Compounds | | | | | | |
| Antimony | **4.20** | **6.60** | 10.00 U | **1.20** | 1.10 U | **3.60** |
| Arsenic | **4.30 L** | **6.70 L** | 3.00 UR | **9.00 L** | **7.10 L** | **5.30 L** |
| Barium | **288.00 J** | **332.00 J** | 5.00 UJ | **152.00 J** | **117.00 J** | **162.00 J** |
| Beryllium | **2.30** | **1.00** | 5.00 U | 0.55 U | **0.68** | **1.30** |
| Cadmium | 0.60 UL | 2.80 UL | 5.00 UL | 0.55 UL | 0.57 UL | **4.00 L** |
| Chromium | **543.00 K** | **654.00 K** | 10.00 UJ | **36.70 K** | **1170.00 K** | **3450.00 K** |
| Cobalt | **122.00 J** | **93.30 J** | 10.00 UJ | **8.70 J** | **15.50 J** | **54.20 J** |
| Cyanide | **0.67** | **0.46** | 5.00 U | 0.27 U | **0.68** | 0.26 U |
| Lead | **539.00 J** | **237.00 J** | 50.00 UJ | **347.00 J** | **2270.00 J** | **91.40 J** |
| Mercury | **0.63 L** | **3.20 L** | 0.20 UL | **0.44 L** | **0.35 L** | 0.09 UL |
| Nickel | **83.40 J** | **83.90 J** | 20.00 UJ | **18.40 J** | **91.60 J** | **1540.00 J** |
| Selenium | 0.48 UL | 0.45 UL | 4.00 UL | 0.44 UL | 0.45 UL | **0.73 L** |
| Sulfide | 3.60 UK | **28.10 J** | 150.00 UK | 3.30 UJ | **9.30 J** | **8.70 J** |
| Vanadium | **333.00 J** | **136.00 J** | 10.00 UJ | **27.50 J** | **162.00 J** | **320.00 J** |

## TABLE 4-9

**Skinner List Inorganic Compound Analytical Data**
**Surface Soil Investigation**
**RCRA Verification Investigation**
**Chevron Refinery**
**Philadelphia, Pennsylvania**

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| mg/kg | - | milligrams per kilogram. |
| Rep | - | Replicate Sample. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |
| UK | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is biased high. |
| UL | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is biased low. |
| UR | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the data is unreliable. The compound may or may not be present. |
| J | - | The associated numerical value is an estimated quantity. |
| K | - | The associated numerical value is biased high. |
| L | - | The associated numerical value is biased low. |
| R | - | Due to discrepencies identified during the data validation process, the data is unreliable. The compound may or may not be present. |
| B | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. |
| BJ | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or UINBYa laboratory method blank sample at a similar concentration. The associated numerical value is an estimated quantity. |

AAW02E9B

# TABLE 4-10

## RISK-BASED EVALUATION ACTION LEVELS
## DETECTED SEMI-VOLATILE ORGANIC COMPOUNDS
## SURFACE SOIL INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| COMPOUND | ACTION LEVEL (ug/kg) | SOURCE |
|---|---|---|
| Acenaphthene | $6.1 \times 10^7$ | 1 |
| Anthracene | $3.1 \times 10^6$ | 1 |
| Benzo(a)anthracene | $3.4 \times 10^3$ | 1 |
| Benzo(a)pyrene | $4.9 \times 10^2$ | 1 |
| Benzo(b,j,k)fluoranthene | $3.5 \times 10^3$ | 1 |
| Chrysene | $1.1 \times 10^5$ | 1 |
| Di-n-butylphthalate | $8 \times 10^6$ | 2 |
| Dibenz(a,h)anthracene | $4.4 \times 10^2$ | 1 |
| Diethyl Phthalate | $6 \times 10^7$ | 2 |
| Dimethyl Phthalate | $1.0 \times 10^{10}$ | 1 |
| Bis(2-ethylhexyl)phthalate | $5 \times 10^4$ | 2 |
| Fluoranthene | $4.1 \times 10^7$ | 1 |
| Indeno(1,2,3-cd)pyrene | $2.1 \times 10^3$ | 1 |
| 1-Methylnaphthalene | NA | - |
| 2-Methylnaphthalene | NA | - |
| Naphthalene | $4.1 \times 10^7$ | 1 |
| Phenanthrene | $3.0 \times 10^7$ | 1 |
| Pyrene | $6.1 \times 10^3$ | 1 |

Explanation:

NA - No action level listed in either source
ug/kg - Micrograms per kilogram

Notes:

1. Roy L. Smith's April 14, 1992 USEPA Region III Memorandum.
2. Appendix A of July 27, 1990 Corrective Action Rule.

AAW02E6A

# TABLE 4-10

## RISK-BASED EVALUATION ACTION LEVELS
## DETECTED INORGANIC ANALYTES
## SURFACE SOIL INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| COMPOUND | ACTION LEVEL (mg/kg) | SOURCE |
|---|---|---|
| Antimony | $3 \times 10^{1}$ | 1 |
| Arsenic | $8 \times 10^{1}$ | 1 |
| Barium | $4 \times 10^{3}$ | 1 |
| Beryllium | $2 \times 10^{-1}$ | 1 |
| Cadmium | $4 \times 10^{1}$ | 1 |
| Chromium | $4 \times 10^{2}$ | 1 |
| Cobalt | NA | - |
| Copper | $3.8 \times 10^{4}$ | 2 |
| Lead | $1.13 \times 10^{2}$/$4.7 \times 10^{1}$ | 2 |
| Mercury | $2 \times 10^{1}$ | 1 |
| Nickel | $2 \times 10^{3}$ | 1 |
| Selenium | $5.1 \times 10^{3}$ | 2 |
| Vanadium | $7.2 \times 10^{3}$ | 2 |
| Zinc | $2 \times 10^{5}$ | 2 |
| Cyanide | $2 \times 10^{3}$ | 1 |
| Sulfide | $2 \times 10^{2}$ | 1 |

Explanation:

NA - No action level listed in either source
mg/kg - Milligrams per kilogram

Notes:

1. Appendix A of July 27, 1990 Corrective Action Rule.
2. Roy L. Smith's April 14, 1992 USEPA Region III Memorandum.
3. Lead action levels represent inorganic lead ($1.13 \times 10^{2}$ mg/kg) and carcinogenic lead ($4.7 \times 10^{1}$ mg/kg) values.

AAW02E6A

Table 4-11
Skinner List Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 1 | | | SWMU 6 | | | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B001A0 | B001A1 | B001A2 | B006A1 | B006A2 | B006A3 | B006A4 |
| Sample Location | B1-1 | B1-2 | B1-3 | B6-1 | B6-2 | B6-3 | B6-4 |
| Sample Depth | 2-4ft | 4-6ft | 4-6ft | 2-4ft | 2-4ft | 2-4ft | 3-5ft |
| Laboratory ID | P207731 | P207732 | P207733 | P207878 | P207739 | P207740 | P207879 |
| Sample Date | 08/04/92 | 08/04/92 | 08/04/92 | 08/05/92 | 08/04/92 | 08/04/92 | 08/05/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Volatile Organic Compounds | | | | | | | |
| Acetonitrile | 7600 UR | 61 U | 54 U | 62 U | 360 U | 58 U | 8700 UR |
| Acrolein | 15000 U | 120 U | 110 U | 120 U | 710 U | 120 U | 17000 U |
| Acrylonitrile | 15000 U | 120 U | 110 U | 120 U | 710 U | 120 U | 17000 U |
| Benzene | 760 U | 4 J | 5 U | 6 U | 36 U | 6 U | 870 U |
| 2-Butanone | 810 BJ | 21 | 11 U | 12 U | 71 U | 12 U | 930 BJ |
| Carbon disulfide | 760 U | 12 | 5 U | 6 U | 52 | 6 U | 870 U |
| Chlorobenzene | 760 U | 6 U | 5 U | 6 U | 36 U | 6 U | 870 U |
| Chloroform | 760 U | 6 U | 5 U | 6 U | 36 U | 6 U | 870 U |
| Chloromethane | 1500 U | 12 U | 11 U | 12 U | 71 U | 12 U | 1700 U |
| Crotonaldehyde (2-Butenal) | 7600 UR | 61 UR | 54 UR | 62 UR | 360 UR | 58 UR | 8700 UR |
| 1,2-Dibromoethane | 1500 U | 12 U | 11 U | 12 U | 71 U | 12 U | 1700 U |
| 1,2-Dichloroethane | 760 U | 6 U | 5 U | 6 U | 36 U | 6 U | 870 U |
| 1,1-Dichloroethene | 760 U | 6 U | 5 U | 6 U | 36 U | 6 U | 870 U |
| Trans-1,2-Dichloroethene | 760 U | 6 U | 5 U | 6 U | 36 U | 6 U | 870 U |
| 1,2-Dichloropropane | 1100 | 9 | 5 U | 6 U | 36 U | 6 U | 870 U |
| 1,4-Dioxane | 23000 UR | 180 UR | 160 UR | 190 UR | 1100 UR | 170 UR | 26000 UR |
| Ethylene oxide | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Ethyleneimine | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Isopropylbenzene (Cumene) | 1000 J | 6 J | 11 U | 12 U | 71 U | 12 U | 2100 |
| Methanethiol | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Methylene Chloride | 760 U | 6 BJ | 4 BJ | 4 BJ | 39 B | 5 BJ | 870 U |
| N-Propylbenzene | 2800 | 15 | 11 U | 12 U | 71 U | 12 U | 3100 |

Table 4-11
Skinner List Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 1 | | | SWMU 6 | | | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B001A0 | B001A1 | B001A2 | B006A1 | B006A2 | B006A3 | B006A4 |
| Sample Location | B1-1 | B1-2 | B1-3 | B6-1 | B6-2 | B6-3 | B6-4 |
| Sample Depth | 2-4ft | 4-6ft | 4-6ft | 2-4ft | 2-4ft | 2-4ft | 3-5ft |
| Laboratory ID | P207731 | P207732 | P207733 | P207878 | P207739 | P207740 | P207879 |
| Sample Date | 08/04/92 | 08/04/92 | 08/04/92 | 08/05/92 | 08/04/92 | 08/04/92 | 08/05/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Styrene | 760 U | 6 U | 5 U | 6 U | 36 U | 6 U | 870 U |
| 1,1,1,2-Tetrachloroethane | 1500 U | 12 U | 11 U | 12 U | 71 U | 12 U | 1700 U |
| 1,1,2,2-Tetrachloroethane | 760 U | 6 U | 5 U | 6 U | 36 U | 6 U | 870 U |
| Tetrachloroethene | 760 U | 6 U | 5 U | 6 U | 36 U | 6 U | 870 U |
| Toluene | 460 J | 7 | 6 | 6 U | 36 U | 6 U | 870 U |
| 1,1,1-Trichloroethane | 760 U | 6 U | 5 U | 6 U | 36 U | 6 U | 870 U |
| 1,1,2-Trichloroethane | 760 U | 6 U | 5 U | 6 U | 36 U | 6 U | 870 U |
| Trichloroethene | 760 U | 6 U | 5 U | 6 U | 36 U | 6 U | 870 U |
| Xylene (Total) | 19000 | 100 | 21 | 4 J | 41 | 6 | 870 U |
| Formaldehyde | 1000 U | 1000 U | 1000 U | 1000 U | 1000 U | 1000 U | 1000 U |

Table 4-11
Skinner List Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 9 | | SWMU 11 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B009A1 | B009A1RE | B011A1 | B011A1MS | B011A1MSD | B011A2 | B011A3 | B011A4 | B011A5 |
| Sample Location | B9-1 | B9-1 RE | B11-1 | B11-1 MS | B11-1 MSD | B11-2 | B11-3 | B11-4 | B11-2 Rep |
| Sample Depth | 2-4ft | 2-4ft | 1.5-3.5ft | 1.5-3.5ft | 1.5-3.5ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft |
| Laboratory ID | P207984 | P207984RE | P207975 | P207981 | P207982 | P207976 | P207977 | P207978 | P207979 |
| Sample Date | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Volatile Organic Compounds | | | | | | | | | |
| Acetonitrile | 64 U | 64 U | 59 U | 59 U | 59 U | 56 U | 7400 U | 62 U | 59 U |
| Acrolein | 130 U | 130 U | 120 U | 120 U | 120 U | 110 U | **15000** | 120 U | 120 U |
| Acrylonitrile | 130 U | 130 U | 120 U | 120 U | 120 U | 110 U | 15000 UJ | 120 U | 120 U |
| Benzene | **5 K** | 6 U | 6 U | 6 U | 6 U | 6 U | **1400** | 6 U | 6 U |
| 2-Butanone | **62 K** | **100 K** | 12 U | 12 U | 12 U | 11 U | **490 BJ** | **14** | 12 U |
| Carbon disulfide | **12 K** | **12 K** | 6 U | 6 U | 6 U | 6 U | 740 U | **21** | 6 U |
| Chlorobenzene | 6 U | 6 U | 6 U | 6 U | 6 U | 6 U | 740 U | 6 U | 6 U |
| Chloroform | 6 U | 6 U | 6 U | 6 U | 6 U | 6 U | 740 U | 6 U | 6 U |
| Chloromethane | 13 U | 13 U | 12 U | 12 U | 12 U | 11 U | 1500 U | 12 U | 12 U |
| Crotonaldehyde (2-Butenal) | 64 UR | 64 UR | 59 UR | 59 UR | 59 UR | 56 UR | 7400 UR | 62 UR | 59 UR |
| 1,2-Dibromoethane | 13 U | 13 U | 12 U | 12 U | 12 U | 11 U | 1500 U | 12 U | 12 U |
| 1,2-Dichloroethane | 6 U | 6 U | 6 U | 6 U | 6 U | 6 U | 740 U | 6 U | 6 U |
| 1,1-Dichloroethene | 6 U | 6 U | 6 U | 6 U | 6 U | 6 U | 740 U | 6 U | 6 U |
| Trans-1,2-Dichloroethene | 6 U | 6 U | 6 U | 6 U | 6 U | 6 U | 740 U | 6 U | 6 U |
| 1,2-Dichloropropane | 6 U | 6 U | 6 U | 6 U | 6 U | 6 U | 740 U | 6 U | 6 U |
| 1,4-Dioxane | 190 UR | 190 UR | 180 UR | 180 UR | 180 UR | 170 UR | 22000 UR | 190 UR | 180 UR |
| Ethylene oxide | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Ethyleneimine | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Isopropylbenzene (Cumene) | **33 K** | **49 K** | 12 U | 12 U | 12 U | 11 U | **1300 J** | **11 J** | 12 U |
| Methanethiol | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Methylene Chloride | **25 B** | **10 B** | **5 BJ** | **12 B** | **9 B** | **6 B** | **1100** | **23 B** | **6 B** |
| N-Propylbenzene | **11 K** | **18 K** | 12 U | 12 U | 12 U | 11 U | **1700** | 12 U | 12 U |

Table 4-11
Skinner List Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 9 | | SWMU 11 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B009A1 | B009A1RE | B011A1 | B011A1MS | B011A1MSD | B011A2 | B011A3 | B011A4 | B011A5 |
| Sample Location | B9-1 | B9-1 RE | B11-1 | B11-1 MS | B11-1 MSD | B11-2 | B11-3 | B11-4 | B11-2 Rep |
| Sample Depth | 2-4ft | 2-4ft | 1.5-3.5ft | 1.5-3.5ft | 1.5-3.5ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft |
| Laboratory ID | P207984 | P207984RE | P207975 | P207981 | P207982 | P207976 | P207977 | P207978 | P207979 |
| Sample Date | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Styrene | 6 U | 6 U | 6 U | 6 U | 6 U | 6 U | 740 U | 6 U | 6 U |
| 1,1,1,2-Tetrachloroethane | 13 U | 13 U | 12 U | 12 U | 12 U | 11 U | 1500 U | 12 U | 12 U |
| 1,1,2,2-Tetrachloroethane | 6 U | 6 U | 6 U | 6 U | 6 U | 6 U | 740 U | 6 U | 6 U |
| Tetrachloroethene | 6 U | 6 U | 6 U | 6 U | 6 U | 6 U | 740 U | 6 U | 6 U |
| Toluene | **11 K** | **13 K** | 6 U | 6 U | 6 U | 6 U | **1600** | 6 U | 6 U |
| 1,1,1-Trichloroethane | 6 U | 6 U | 6 U | 6 U | 6 U | 6 U | 740 U | 6 U | 6 U |
| 1,1,2-Trichloroethane | 6 U | 6 U | 6 U | 6 U | 6 U | 6 U | 740 U | 6 U | 6 U |
| Trichloroethene | 6 U | 6 U | 6 U | 6 U | 6 U | 6 U | 740 U | 6 U | 6 U |
| Xylene (Total) | **39 K** | **57 K** | **2 J** | 7 | **5 J** | **4 J** | **14000** | **19** | 6 U |
| Formaldehyde | 1200 UL | | 1000 U | | | 1000 U | 1000 U | 1200 UL | 1200 UL |

Table 4-11
Skinner List Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 13 | | SWMU 16 | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B013A1 | B013A2 | B016A1 | B016A2 | B016A3 | B016A4 | B016A5 | B016A6 |
| Sample Location | B13-1 | B13-2 | B16-1 | B16-2 | B16-3 | B16-4 | Field Blank | Trip Blank |
| Sample Depth | 2.5-4.5ft | 4.5-6.5ft | 2-4ft | 2-4ft | 0-2ft | 2-4ft | | |
| Laboratory ID | P207980 | P207880 | P207881 | P207882 | P207883 | P207884 | P207885 | P207886 |
| Sample Date | 08/06/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | UG/L | UG/L |
| Volatile Organic Compounds | | | | | | | | |
| Acetonitrile | 8900 UR | 8000 UR | 7400 UR | 8100 UR | 8100 UJ | 9600 UJ | 50 U | 50 U |
| Acrolein | 18000 U | 16000 U | 15000 U | 16000 U | 16000 U | 19000 U | 100 U | 100 U |
| Acrylonitrile | 18000 U | 16000 U | 15000 U | 16000 U | 16000 U | 19000 U | 100 U | 100 U |
| Benzene | 890 U | 800 U | 740 U | 810 U | 810 U | 960 U | 5 U | 5 U |
| 2-Butanone | **600 BJ** | 1600 U | 1500 U | **710 BJ** | 1600 U | **780 BJ** | 10 U | 10 U |
| Carbon disulfide | 890 U | 800 U | 740 U | 810 U | 810 U | 960 U | 5 U | 5 U |
| Chlorobenzene | 890 U | **730 J** | 740 U | 810 U | 810 U | 960 U | 5 U | 5 U |
| Chloroform | 890 U | 800 U | 740 U | 810 U | 810 U | **36 J** | 5 U | 5 U |
| Chloromethane | 1800 U | 1600 U | 1500 U | 1600 U | 1600 U | 1900 U | 10 U | 10 U |
| Crotonaldehyde (2-Butenal) | 8900 UR | 8000 UR | 7400 UR | 8100 UR | 8100 UR | 9600 UR | 50 UR | 50 UR |
| 1,2-Dibromoethane | 1800 U | 1600 U | 1500 U | 1600 U | 1600 U | 1900 U | 10 U | 10 U |
| 1,2-Dichloroethane | 890 U | 800 U | 740 U | 810 U | 810 U | 960 U | 5 U | 5 U |
| 1,1-Dichloroethene | 890 U | 800 U | 740 U | 810 U | 810 U | 960 U | 5 U | 5 U |
| Trans-1,2-Dichloroethene | 890 U | 800 U | 740 U | 810 U | 810 U | 960 U | 5 U | 5 U |
| 1,2-Dichloropropane | 890 U | 800 U | 740 U | 810 U | 810 U | **780 J** | 5 U | 5 U |
| 1,4-Dioxane | 27000 UR | 24000 UR | 22000 UR | 24000 UR | 24000 UR | 29000 UR | 150 UR | 150 UR |
| Ethylene oxide | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Ethyleneimine | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Isopropylbenzene (Cumene) | **1700 J** | **27000** | **2100** | **4100** | **31000** | **1100 J** | 10 U | 10 U |
| Methanethiol | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Methylene Chloride | 890 U | 800 U | 740 U | 810 U | 810 U | **280 J** | 5 U | 5 U |
| N-Propylbenzene | **1700 J** | **26000** | **3100** | **5000** | **1700** | **1400 J** | 10 U | 10 U |

Table 4-11
Skinner List Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 13 | | SWMU 16 | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B013A1 | B013A2 | B016A1 | B016A2 | B016A3 | B016A4 | B016A5 | B016A6 |
| Sample Location | B13-1 | B13-2 | B16-1 | B16-2 | B16-3 | B16-4 | Field Blank | Trip Blank |
| Sample Depth | 2.5-4.5ft | 4.5-6.5ft | 2-4ft | 2-4ft | 0-2ft | 2-4ft | | |
| Laboratory ID | P207980 | P207880 | P207881 | P207882 | P207883 | P207884 | P207885 | P207886 |
| Sample Date | 08/06/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | UG/L | UG/L |
| Styrene | 890 U | 800 U | 740 U | 810 U | 810 U | 960 U | 5 U | 5 U |
| 1,1,1,2-Tetrachloroethane | 1800 U | 1600 U | 1500 U | 1600 U | 1600 U | 1900 U | 10 U | 10 U |
| 1,1,2,2-Tetrachloroethane | 890 U | 800 U | 740 U | 810 U | 810 U | 960 U | 5 U | 5 U |
| Tetrachloroethene | 890 U | 800 U | 740 U | 810 U | 810 U | 960 U | 5 U | 5 U |
| Toluene | 890 U | 800 U | 740 U | 810 U | 810 U | **79 J** | 5 U | 5 U |
| 1,1,1-Trichloroethane | 890 U | 800 U | 740 U | 810 U | 810 U | 960 U | 5 U | 5 U |
| 1,1,2-Trichloroethane | 890 U | 800 U | 740 U | 810 U | 810 U | 960 U | 5 U | 5 U |
| Trichloroethene | 890 U | 800 U | 740 U | 810 U | 810 U | 960 U | 5 U | 5 U |
| Xylene (Total) | 890 U | 800 U | **940** | 810 U | **300 J** | 960 U | 5 U | 5 U |
| Formaldehyde | 1400 UL | 1000 U | 1000 U | 1000 U | 1000 U | 2000 U | 100 U | |

Table 4-11
Skinner List Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 17 | | | | | SWMU 29 | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B017A1 | B017A2 | B017A3 | B017A4 | B017A4RE | B029A1 | B029A2 |
| Sample Location | B17-1 | B17-2 | B17-3 | B17-4 | B17-4 RE | B29-1 | B29-2 |
| Sample Depth | 0-2ft | 0-2ft | 0-2ft | 0-2ft | 0-2ft | 2-4ft | 2-4ft |
| Laboratory ID | P207887 | P207888 | P207889 | P207890 | P207890RE | P208443 | P208444 |
| Sample Date | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/10/92 | 08/10/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Volatile Organic Compounds | | | | | | | |
| Acetonitrile | 7900 U | 61 U | 7400 U | 54 U | 54 U | 7700 UR | 7600 U |
| Acrolein | 16000 U | 120 U | 15000 U | 110 U | 110 U | 15000 U | 15000 U |
| Acrylonitrile | 16000 U | 120 U | 15000 U | 110 U | 110 U | 15000 U | 15000 U |
| Benzene | 790 U | 7 | 740 U | 7 K | 6 K | 770 U | 760 U |
| 2-Butanone | 1600 U | 44 | 1500 U | 11 U | 11 U | 1100 BJ | 1500 U |
| Carbon disulfide | 790 U | 6 U | 740 U | 5 U | 5 U | 770 U | 760 U |
| Chlorobenzene | 790 U | 6 U | 740 U | 5 U | 5 UJ | 770 U | 760 U |
| Chloroform | 790 U | 6 U | 740 U | 5 U | 5 U | 770 U | 760 U |
| Chloromethane | 1600 U | 12 U | 1500 U | 11 U | 11 U | 1500 U | 1500 U |
| Crotonaldehyde (2-Butenal) | 7900 UR | 61 UR | 7400 UR | 54 UR | 54 UR | 7700 UR | 7600 UR |
| 1,2-Dibromoethane | 1600 U | 12 U | 1500 U | 11 U | 11 U | 1500 U | 1500 U |
| 1,2-Dichloroethane | 790 U | 6 U | 740 U | 5 U | 5 U | 770 U | 760 U |
| 1,1-Dichloroethene | 790 U | 6 U | 740 U | 5 U | 5 U | 770 U | 760 U |
| Trans-1,2-Dichloroethene | 790 U | 6 U | 740 U | 5 U | 5 U | 770 U | 760 U |
| 1,2-Dichloropropane | 790 U | 6 U | 740 U | 5 U | 5 U | 770 U | 760 U |
| 1,4-Dioxane | 24000 UR | 180 UR | 22000 UR | 160 UR | 160 UR | 23000 UR | 23000 UR |
| Ethylene oxide | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Ethyleneimine | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Isopropylbenzene (Cumene) | 1100 J | 50 | 2800 | 11 U | 11 U | 1700 | 1400 J |
| Methanethiol | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Methylene Chloride | 790 U | 13 B | 740 U | 15 B | 7 B | 770 U | 760 U |
| N-Propylbenzene | 2200 | 20 | 4900 | 11 U | 11 U | 910 J | 2300 |

Table 4-11
Skinner List Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 17 | | | | | SWMU 29 | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B017A1 | B017A2 | B017A3 | B017A4 | B017A4RE | B029A1 | B029A2 |
| Sample Location | B17-1 | B17-2 | B17-3 | B17-4 | B17-4 RE | B29-1 | B29-2 |
| Sample Depth | 0-2ft | 0-2ft | 0-2ft | 0-2ft | 0-2ft | 2-4ft | 2-4ft |
| Laboratory ID | P207887 | P207888 | P207889 | P207890 | P207890RE | P208443 | P208444 |
| Sample Date | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/10/92 | 08/10/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Styrene | 790 U | 6 U | 740 U | 5 U | 5 UJ | 770 U | 760 U |
| 1,1,1,2-Tetrachloroethane | 1600 U | 12 U | 1500 U | 11 U | 11 U | 1500 U | 1500 U |
| 1,1,2,2-Tetrachloroethane | 790 U | 6 U | 740 U | 5 U | 5 UJ | 770 U | 760 U |
| Tetrachloroethene | 790 U | 6 U | 740 U | 5 U | 5 UJ | 770 U | 760 U |
| Toluene | 790 U | **15** | 740 U | **17 K** | **17 K** | 770 U | 760 U |
| 1,1,1-Trichloroethane | 790 U | 6 U | 740 U | 5 U | 5 U | 770 U | 760 U |
| 1,1,2-Trichloroethane | 790 U | 6 U | 740 U | 5 U | 5 U | 770 U | 760 U |
| Trichloroethene | 790 U | 6 U | 740 U | 5 U | 5 U | 770 U | 760 U |
| Xylene (Total) | **1300** | **140** | **360 J** | **78 K** | **84 K** | **1200** | **520 J** |
| Formaldehyde | 1000 U | 1000 U | 1000 U | 1000 U | | 1200 UL | 1100 UL |

Table 4-11
Skinner List Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 30 | | | SWMU 71 | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B030A1 | B030A2 | B030A3 | B071A1 | B071A2 | B071A2DL | B071A2MS | B071A2MSD | B071A3 |
| Sample Location | B30-1 | B30-2 | B30-3 | B71-1 | B71-2 | B71-2 DL | B71-2 MS | B71-2 MSD | B71-3 |
| Sample Depth | 2-4ft | 2-4ft | 2-4ft | 1-2ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 3-4.5ft |
| Laboratory ID | P208445 | P208446 | P208447 | P208497 | P208498 | P208498DL | P208499 | P208500 | P208502 |
| Sample Date | 08/10/92 | 08/10/92 | 08/10/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Volatile Organic Compounds | | | | | | | | | |
| Acetonitrile | 64 U | 7200 U | 7800 U | 56 U | 7400 UR | 74000 U | 7400 UR | 7400 UR | 7800 U |
| Acrolein | 130 U | 14000 U | 16000 U | 110 U | 15000 U | 150000 U | 15000 U | 15000 U | 16000 U |
| Acrylonitrile | 130 U | 14000 U | 16000 U | 110 U | 15000 U | 150000 U | 15000 U | 15000 U | 16000 U |
| Benzene | **5 J** | 720 U | 780 U | **7** | **1200** | 7400 U | 740 U | 740 U | 780 U |
| 2-Butanone | **29** | 1400 U | 1600 U | **15** | **990 BJ** | 15000 U | **630 J** | **980 J** | 1600 U |
| Carbon disulfide | 6 U | 720 U | 780 U | 6 U | 740 U | 7400 U | 740 U | 740 U | 780 U |
| Chlorobenzene | 6 U | 720 U | 780 U | 6 U | 740 U | 7400 U | 740 U | 740 U | 780 U |
| Chloroform | 6 U | 720 U | 780 U | 6 U | 740 U | 7400 U | 740 U | 740 U | 780 U |
| Chloromethane | 13 U | 1400 UJ | 1600 UJ | 11 U | 1500 U | 15000 U | 1500 U | 1500 U | 1600 UJ |
| Crotonaldehyde (2-Butenal) | 64 UR | 7200 UR | 7800 UR | 56 UR | 7400 UR | 74000 UR | 7400 UR | 7400 UR | 7800 UR |
| 1,2-Dibromoethane | 13 U | 1400 U | 1600 U | 11 U | 1500 U | 15000 U | 1500 U | 1500 U | 1600 U |
| 1,2-Dichloroethane | 6 U | 720 U | 780 U | 6 U | 740 U | 7400 U | 740 U | 740 U | 780 U |
| 1,1-Dichloroethene | 6 U | 720 U | 780 U | 6 U | 740 U | 7400 U | 740 U | 740 U | 780 U |
| Trans-1,2-Dichloroethene | 6 U | 720 U | 780 U | 6 U | 740 U | 7400 U | 740 U | 740 U | 780 U |
| 1,2-Dichloropropane | 6 U | 720 U | 780 U | 6 U | 740 U | 7400 U | 740 U | 740 U | 780 U |
| 1,4-Dioxane | 190 UR | 22000 UR | 24000 UR | 170 UR | 22000 UR | 220000 UR | 22000 UR | 22000 UR | 24000 UR |
| Ethylene oxide | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Ethyleneimine | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Isopropylbenzene (Cumene) | 13 U | **1100 J** | **570 J** | 11 U | **100000 J** | **270000** | **78000 J** | **140000 J** | **3900** |
| Methanethiol | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Methylene Chloride | **6 BJ** | 720 U | 780 U | **15 B** | **570 BJ** | 7400 U | 740 U | **460 BJ** | 780 U |
| N-Propylbenzene | 13 U | **2500** | **1500 J** | **4 J** | **8800** | **11000 J** | **5200** | **17000** | **990 J** |

Table 4-11
Skinner List Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 30 | | | SWMU 71 | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B030A1 | B030A2 | B030A3 | B071A1 | B071A2 | B071A2DL | B071A2MS | B071A2MSD | B071A3 |
| Sample Location | B30-1 | B30-2 | B30-3 | B71-1 | B71-2 | B71-2 DL | B71-2 MS | B71-2 MSD | B71-3 |
| Sample Depth | 2-4ft | 2-4ft | 2-4ft | 1-2ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 3-4.5ft |
| Laboratory ID | P208445 | P208446 | P208447 | P208497 | P208498 | P208498DL | P208499 | P208500 | P208502 |
| Sample Date | 08/10/92 | 08/10/92 | 08/10/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Styrene | 6 U | 720 U | 780 U | 6 U | 740 U | 7400 U | 740 U | 740 U | 780 U |
| 1,1,1,2-Tetrachloroethane | 13 U | 1400 U | 1600 U | 11 U | 1500 U | 15000 U | 1500 U | 1500 U | 1600 U |
| 1,1,2,2-Tetrachloroethane | 6 U | 720 U | 780 U | 6 U | 740 U | 7400 U | 740 U | 740 U | 780 U |
| Tetrachloroethene | 6 U | 720 U | 780 U | 6 U | 740 U | 7400 U | 740 U | 740 U | 780 U |
| Toluene | **6 J** | 720 U | 780 U | **8** | 740 U | 7400 U | 740 U | 740 U | 780 U |
| 1,1,1-Trichloroethane | 6 U | 720 U | 780 U | 6 U | 740 U | 7400 U | 740 U | 740 U | 780 U |
| 1,1,2-Trichloroethane | 6 U | 720 U | 780 U | 6 U | 740 U | 7400 U | 740 U | 740 U | 780 U |
| Trichloroethene | 6 U | 720 U | 780 U | 6 U | 740 U | 7400 U | 740 U | 740 U | 780 U |
| Xylene (Total) | **35** | 720 U | 780 U | **12** | 740 U | 7400 U | 740 U | 740 U | **480 J** |
| Formaldehyde | 1200 UL | 1100 UL | **6200 L** | 1100 UL | 1000 UL | | | | 1100 UL |

Table 4-11
Skinner List Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 71 (continued) | | | | | | SWMU 71A | | |
|---|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B071A4 | B071A5 | B071A6 | B071A7 | B071A8 | B071A9 | B071AA1 | B071AA2 | B071AA2RE |
| Sample Location | B71-4 | B71-5 | B71-6 | B71-6 Rep | Field Blank | Trip Blank | B71A-1 | B71A-2 | B71A-2 RE |
| Sample Depth | 2-4ft | 1-3ft | 1-3ft | 1-3ft | | | 2-4ft | 4-6ft | 4-6ft |
| Laboratory ID | P208503 | P208504 | P208505 | P208506 | P208507 | P208508 | P208614 | P208615 | P208615RE |
| Sample Date | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/12/92 | 08/12/92 | 08/12/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | UG/L | UG/L | ug/kg | ug/kg | ug/kg |
| Volatile Organic Compounds | | | | | | | | | |
| Acetonitrile | 6900 U | 65 U | 7200 UR | 7100 U | 50 U | 50 U | 62 U | 68 U | 68 UJ |
| Acrolein | 14000 U | 130 U | 14000 U | 14000 U | 100 U | 100 U | 120 U | 140 U | 140 UJ |
| Acrylonitrile | 14000 U | 130 U | 14000 U | 14000 U | 100 U | 100 U | 120 U | 140 U | 140 UJ |
| Benzene | 690 U | **8** | 720 U | 710 U | 5 U | 5 U | 6 U | **4 K** | **5 J** |
| 2-Butanone | 1400 U | **24** | **510 BJ** | 1400 U | 10 U | 10 U | **35** | **110 K** | **180 J** |
| Carbon disulfide | 690 U | 6 U | 720 U | 710 U | 5 U | 5 U | 6 U | **6 K** | **6 J** |
| Chlorobenzene | 690 U | 6 U | 720 U | 710 U | 5 U | 5 U | 6 U | 7 U | 7 UJ |
| Chloroform | 690 U | 6 U | 720 U | 710 U | 5 U | 5 U | 6 U | 7 U | 7 UJ |
| Chloromethane | 1400 U | 13 U | 1400 U | 1400 UJ | 10 U | 10 U | 12 U | 14 U | 14 UJ |
| Crotonaldehyde (2-Butenal) | 6900 UR | 65 UR | 7200 UR | 7100 UR | 50 UR | 50 UR | 62 UR | 68 UR | 68 UR |
| 1,2-Dibromoethane | 1400 U | 13 U | 1400 U | 1400 U | 10 U | 10 U | 12 U | 14 U | 14 UJ |
| 1,2-Dichloroethane | 690 U | 6 U | 720 U | 710 U | 5 U | 5 U | 6 U | 7 U | 7 UJ |
| 1,1-Dichloroethene | 690 U | 6 U | 720 U | 710 U | 5 U | 5 U | 6 U | 7 U | 7 UJ |
| Trans-1,2-Dichloroethene | 690 U | 6 U | 720 U | 710 U | 5 U | 5 U | 6 U | 7 U | 7 UJ |
| 1,2-Dichloropropane | 690 U | 6 U | 720 U | 710 U | 5 U | 5 U | 6 U | 7 U | 7 UJ |
| 1,4-Dioxane | 21000 UR | 190 UR | 22000 UR | 21000 UR | 150 UR | 150 UR | 190 UR | 200 UR | 200 UR |
| Ethylene oxide | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 UJ |
| Ethyleneimine | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 UJ |
| Isopropylbenzene (Cumene) | **11000** | **9 J** | **17000** | **13000** | 10 U | 10 U | **11 J** | **11 K** | **26 J** |
| Methanethiol | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 UJ |
| Methylene Chloride | 690 U | **11 B** | 720 U | 710 U | 5 U | 5 U | **10 B** | **14 B** | **13 BJ** |
| N-Propylbenzene | **3800** | **7 J** | **830 J** | **790 J** | 10 U | 10 U | **6 J** | **13 K** | **32 J** |

Table 4-11
Skinner List Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 71 (continued) | | | | | | SWMU 71A | | |
|---|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B071A4 | B071A5 | B071A6 | B071A7 | B071A8 | B071A9 | B071AA1 | B071AA2 | B071AA2RE |
| Sample Location | B71-4 | B71-5 | B71-6 | B71-6 Rep | Field Blank | Trip Blank | B71A-1 | B71A-2 | B71A-2 RE |
| Sample Depth | 2-4ft | 1-3ft | 1-3ft | 1-3ft | | | 2-4ft | 4-6ft | 4-6ft |
| Laboratory ID | P208503 | P208504 | P208505 | P208506 | P208507 | P208508 | P208614 | P208615 | P208615RE |
| Sample Date | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/12/92 | 08/12/92 | 08/12/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | UG/L | UG/L | ug/kg | ug/kg | ug/kg |
| Styrene | 690 U | 6 U | 720 U | 710 U | 5 U | 5 U | 6 U | 7 U | 7 UJ |
| 1,1,1,2-Tetrachloroethane | 1400 U | 13 U | 1400 U | 1400 U | 10 U | 10 U | 12 U | 14 U | 14 UJ |
| 1,1,2,2-Tetrachloroethane | 690 U | 6 U | 720 U | 710 U | 5 U | 5 U | 6 U | 7 U | 7 UJ |
| Tetrachloroethene | 690 U | 6 U | 720 U | 710 U | 5 U | 5 U | 6 U | 7 U | 7 UJ |
| Toluene | 690 U | 9 | 720 U | 710 U | 5 U | 5 U | 6 U | 6 K | 8 J |
| 1,1,1-Trichloroethane | 690 U | 6 U | 720 U | 710 U | 5 U | 5 U | 6 U | 7 U | 7 UJ |
| 1,1,2-Trichloroethane | 690 U | 6 U | 720 U | 710 U | 5 U | 5 U | 6 U | 7 U | 7 UJ |
| Trichloroethene | 690 U | 6 U | 720 U | 710 U | 5 U | 5 U | 6 U | 7 U | 7 UJ |
| Xylene (Total) | 530 J | 15 | 560 J | 810 | 5 U | 5 U | 21 | 30 K | 57 J |
| Formaldehyde | 35600 UL | 1200 UL | 1100 UL | 880 UL | 100.00 UL | | 1200 UL | 1300 UL | |

# TABLE 4-11

## Skinner List Volatile Compound Analytical Data
## Subsurface Soil Investigation
## RCRA Verification Investigation
## Chevron Refinery
## Philadelphia, Pennsylvania

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| ug/kg | - | micrograms per kilogram. |
| MS | - | Matrix Spike quality assurance/quality control sample. |
| MSD | - | Matrix Spike Duplicate quality assurance/quality control sample. |
| Rep | - | Replicate Sample. |
| DL | - | Sample Dilution. |
| RE | - | Repeat Analysis. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |
| UJ | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is estimated. |
| UL | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is biased low. |
| UR | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the data is unreliable. The compound may or may not be present. |
| J | - | The associated numerical value is an estimated quantity. |
| K | - | The associated numerical value is biased high. |
| B | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. |
| BJ | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. The associated numerical value is an estimated quantity. |

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Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 1 | | | SWMU 6 | | | | |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B001A0 | B001A1 | B001A2 | B006A1 | B006A2 | B006A3 | B006A3DL | B006A4 |
| Sample Location | B1-1 | B1-2 | B1-3 | B6-1 | B6-2 | B6-3 | B6-3 DL | B6-4 |
| Sample Depth | 2-4ft | 4-6ft | 4-6ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 3-5ft |
| Laboratory ID | P207731 | P207732 | P207733 | P207878 | P207739 | P207740 | P207740DL | P207879 |
| Sample Date | 08/04/92 | 08/04/92 | 08/04/92 | 08/05/92 | 08/04/92 | 08/04/92 | 08/04/92 | 08/05/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Semivolatile Organic Compounds | | | | | | | | |
| Aniline | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| Anthracene | 800 U | 260 J | 720 U | 410 U | 470 U | 650 | 660 J | 460 U |
| Benz(c)acridine | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Benzenethiol | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| Benzidine | 3900 U | 2000 U | 3500 U | 2000 U | 2300 U | 1900 U | 3700 U | 2200 U |
| Benzo(a)anthracene | 800 U | 760 | 720 U | 310 J | 210 J | 3600 | 3200 | 250 J |
| Benzo(a)pyrene | 800 U | 540 | 720 U | 650 | 220 J | 2800 | 2600 | 170 J |
| Benzo(b,j,k)fluoranthene | 2900 U | 940 J | 2600 U | 790 J | 1700 U | 1400 U | 3800 | 1700 U |
| Benzyl chloride | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| Butyl benzyl phthalate | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| p-Chloro-m-cresol | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| Bis(2-chloroethyl) ether | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| Bis(2-chloroisopropyl)ether | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| Bis(2-chloromethyl)ether | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 2-Chloronaphthalene | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| 2-Chlorophenol | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| Chrysene | 490 U | 590 | 430 U | 330 | 270 J | 3000 | 3000 | 220 J |
| o-Cresol | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| p-Cresol | 2400 U | 1200 U | 2200 U | 1200 U | 1400 U | 1200 U | 2300 U | 1400 U |
| Di-n-butylphthalate | 800 U | 470 B | 720 U | 740 B | 690 B | 400 B | 480 BJ | 850 B |
| Di-n-octylphthalate | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| Dibenz(a,h)acridine | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| Dibenz(a,h)anthracene | 800 U | 270 J | 720 U | 410 U | 470 U | 380 U | 700 J | 460 U |
| Dibenz(a,i)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 1 | | | SWMU 6 | | | | |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B001A0 | B001A1 | B001A2 | B006A1 | B006A2 | B006A3 | B006A3DL | B006A4 |
| Sample Location | B1-1 | B1-2 | B1-3 | B6-1 | B6-2 | B6-3 | B6-3 DL | B6-4 |
| Sample Depth | 2-4ft | 4-6ft | 4-6ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 3-5ft |
| Laboratory ID | P207731 | P207732 | P207733 | P207878 | P207739 | P207740 | P207740DL | P207879 |
| Sample Date | 08/04/92 | 08/04/92 | 08/04/92 | 08/05/92 | 08/04/92 | 08/04/92 | 08/04/92 | 08/05/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Dibenz(a,j)acridine | 1600 U | 810 U | 1400 U | 820 U | 940 U | 770 U | 1500 U | 920 U |
| Dibenzo(a,e)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Dibenzo(a,h)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 7h-Dibenzo(c,g)carbazole | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 1,3-Dichloro-2-propanol | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| 1,2-Dichlorobenzene | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| 1,3-Dichlorobenzene | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| 1,4-Dichlorobenzene | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| Diethyl phthalate | 800 U | 400 U | **230 J** | 410 U | 470 U | 380 U | 770 U | 460 U |
| Dimethyl phthalate | 800 U | 400 U | **590 BJ** | **180 BJ** | 470 U | 380 U | **430 J** | 460 U |
| 7,12-Dimethylbenz(a)anthracene | 730 U | 370 U | 650 U | 380 U | 430 U | 350 U | 700 U | 420 U |
| 2,4-Dimethylphenol | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| 4,6-Dinitro-o-cresol | 3900 U | 2000 U | 3500 U | 2000 U | 2300 U | 1900 U | 3700 U | 2200 U |
| 2,4-Dinitrophenol | 3900 U | 2000 U | 3500 U | 2000 U | 2300 U | 1900 U | 3700 U | 2200 U |
| 2,4-Dinitrotoluene | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| 1,2-Diphenylhydrazine | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| Bis(2-ethylhexyl) phthalate | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| Fluoranthene | **2000** | **1400** | 720 U | **260 J** | **320 J** | **7000 J** | **5900** | **430 J** |
| Hydroquinone | 4100 U | 2100 U | 3700 U | 2100 U | 2400 U | 2000 U | 4000 U | 2400 U |
| Indene | 1600 U | 820 U | 1500 U | 840 U | 960 U | 780 U | 1600 U | 930 U |
| Indeno(1,2,3-cd)pyrene | 800 U | **380 J** | 720 U | **570 J** | 470 U | **1200 J** | **1400 J** | 460 U |
| 3-Methylcholanthrene | 490 U | 240 U | 430 U | 250 U | 290 U | 230 U | 470 U | 280 U |
| 1-Methylnaphthalene | **16000 J** | 820 U | 1500 U | 840 U | 960 U | **200 J** | 1600 U | 930 U |
| Naphthalene | **7500** | 400 U | 720 U | **150 J** | 470 U | **140 J** | 770 U | 460 U |
| 5-Nitroacenapthene | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 1 | | | SWMU 6 | | | | |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B001A0 | B001A1 | B001A2 | B006A1 | B006A2 | B006A3 | B006A3DL | B006A4 |
| Sample Location | B1-1 | B1-2 | B1-3 | B6-1 | B6-2 | B6-3 | B6-3 DL | B6-4 |
| Sample Depth | 2-4ft | 4-6ft | 4-6ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 3-5ft |
| Laboratory ID | P207731 | P207732 | P207733 | P207878 | P207739 | P207740 | P207740DL | P207879 |
| Sample Date | 08/04/92 | 08/04/92 | 08/04/92 | 08/05/92 | 08/04/92 | 08/04/92 | 08/04/92 | 08/05/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| P-Nitroaniline | 3900 U | 2000 U | 3500 U | 2000 U | 2300 U | 1900 U | 3700 U | 2200 U |
| Nitrobenzene | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| P-Nitrophenol | 3900 U | 2000 U | 3500 U | 2000 U | 2300 U | 1900 U | 3700 U | 2200 U |
| Pentachlorophenol | 3900 U | 2000 U | 3500 U | 2000 U | 2300 U | 1900 U | 3700 U | 2200 U |
| Phenanthrene | **5200** | **920** | 720 U | **160 J** | 470 U | **2900** | **3400** | **390 J** |
| Phenol | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| Pyrene | **1800** | **970** | 720 U | **260 J** | **350 J** | **4300** | **4200** | **340 J** |
| Pyridine | 1600 U | 820 U | 1500 U | 840 U | 960 U | 780 U | 1600 U | 930 U |
| Quinoline | 1600 U | 820 U | 1500 U | 840 U | 960 U | 780 U | 1600 U | 930 U |
| 1,2,4-Trichlorobenzene | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| 2,4,5-Trichlorophenol | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |
| 2,4,6-Trichlorophenol | 800 U | 400 U | 720 U | 410 U | 470 U | 380 U | 770 U | 460 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 9 | SWMU 11 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B009A1 | B011A1 | B011A1MS | B011A1MSD | B011A2 | B011A3 | B011A4 | B011A4DL | B011A5 |
| Sample Location | B9-1 | B11-1 | B11-1 MS | B11-1 MSD | B11-2 | B11-3 | B11-4 | B11-4 DL | B11-2 Rep |
| Sample Depth | 2-4ft | 1.5-3.5ft | 1.5-3.5ft | 1.5-3.5ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft |
| Laboratory ID | P207984 | P207975 | P207981 | P207982 | P207976 | P207977 | P207978 | P207978DL | P207979 |
| Sample Date | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Semivolatile Organic Compounds | | | | | | | | | |
| Aniline | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| Anthracene | **550** | 390 U | 390 U | 390 U | 370 U | **400** | **11000 J** | **22000** | 390 U |
| Benz(c)acridine | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Benzenethiol | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| Benzidine | 2100 U | 1900 UJ | 1900 U | 1900 U | 1800 UJ | 1900 U | 2000 U | 40000 U | 1900 U |
| Benzo(a)anthracene | **2300** | **280 J** | **440** | **370 J** | **1000** | **920** | **30000 J** | **37000** | **940** |
| Benzo(a)pyrene | **2200 J** | **360 J** | **540** | **470** | 370 U | **670** | **25000 J** | **36000 J** | **480** |
| Benzo(b,j,k)fluoranthene | **1600 J** | **380 J** | **140 J** | 1400 U | 1300 U | **490 J** | **81000 J** | **25000 J** | **1100 J** |
| Benzyl chloride | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| Butyl benzyl phthalate | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| p-Chloro-m-cresol | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| Bis(2-chloroethyl) ether | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| Bis(2-chloroisopropyl)ether | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| Bis(2-chloromethyl)ether | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 2-Chloronaphthalene | 420 UJ | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| 2-Chlorophenol | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| Chrysene | **2200** | **460** | **690** | **650** | **1900** | **1400** | **18000 J** | **36000** | **1800** |
| o-Cresol | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| p-Cresol | 1300 U | 1200 U | 1200 U | 1200 U | 1100 U | 1200 U | 1200 U | 25000 U | 1200 U |
| Di-n-butylphthalate | **160 J** | **740** | **220 J** | **160 J** | **490** | 390 U | **440** | 8100 U | **280 J** |
| Di-n-octylphthalate | 420 UJ | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| Dibenz(a,h)acridine | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| Dibenz(a,h)anthracene | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | **360 J** | 8100 U | 390 U |
| Dibenz(a,i)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 9 | SWMU 11 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B009A1 | B011A1 | B011A1MS | B011A1MSD | B011A2 | B011A3 | B011A4 | B011A4DL | B011A5 |
| Sample Location | B9-1 | B11-1 | B11-1 MS | B11-1 MSD | B11-2 | B11-3 | B11-4 | B11-4 DL | B11-2 Rep |
| Sample Depth | 2-4ft | 1.5-3.5ft | 1.5-3.5ft | 1.5-3.5ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft |
| Laboratory ID | P207984 | P207975 | P207981 | P207982 | P207976 | P207977 | P207978 | P207978DL | P207979 |
| Sample Date | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Dibenz(a,j)acridine | 850 U | 780 U | 780 U | 780 U | 740 U | 780 U | 820 U | 16000 U | 780 U |
| Dibenzo(a,e)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Dibenzo(a,h)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 7h-Dibenzo(c,g)carbazole | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 1,3-Dichloro-2-propanol | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| 1,2-Dichlorobenzene | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| 1,3-Dichlorobenzene | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| 1,4-Dichlorobenzene | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| Diethyl phthalate | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| Dimethyl phthalate | 420 UJ | **170 J** | 390 U | **260 J** | **120 J** | 390 U | **320 J** | 8100 U | **130 J** |
| 7,12-Dimethylbenz(a)anthracene | 380 U | 350 U | 350 U | 350 U | 340 U | 350 U | 370 U | 7400 U | 350 U |
| 2,4-Dimethylphenol | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| 4,6-Dinitro-o-cresol | 2100 U | 1900 U | 1900 U | 1900 U | 1800 U | 1900 U | 2000 U | 40000 U | 1900 U |
| 2,4-Dinitrophenol | 2100 UJ | 1900 U | 1900 U | 1900 U | 1800 U | 1900 U | 2000 U | 40000 U | 1900 U |
| 2,4-Dinitrotoluene | 420 UJ | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| 1,2-Diphenylhydrazine | 420 U | 390 U | 390 U | 390 U | 370 U | 390 UJ | 410 U | 8100 U | 390 U |
| Bis(2-ethylhexyl) phthalate | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| Fluoranthene | **4200** | **320 J** | **430** | **460** | **480** | **1800** | **38000 J** | **89000** | **600** |
| Hydroquinone | 2200 U | 2000 U | 2000 U | 2000 U | 1900 U | 2000 U | 2100 U | 42000 U | 2000 U |
| Indene | 860 U | 790 U | 790 U | 790 U | 750 U | 790 U | 830 U | 17000 U | 790 U |
| Indeno(1,2,3-cd)pyrene | 420 UJ | **240 J** | **470** | 390 U | **250 J** | 390 U | **8400 J** | 8100 U | **240 J** |
| 3-Methylcholanthrene | 260 U | 240 U | 240 U | 240 U | 220 U | 240 U | 250 U | 4900 U | 240 U |
| 1-Methylnapththalene | 860 U | 790 U | 790 U | 790 U | 750 U | **3100** | **1800** | 17000 U | 790 U |
| Naphthalene | 420 U | 390 U | 390 U | 390 U | 370 U | **2000** | **6200** | **7300 J** | 390 U |
| 5-Nitroacenapthene | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 9 | SWMU 11 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B009A1 | B011A1 | B011A1MS | B011A1MSD | B011A2 | B011A3 | B011A4 | B011A4DL | B011A5 |
| Sample Location | B9-1 | B11-1 | B11-1 MS | B11-1 MSD | B11-2 | B11-3 | B11-4 | B11-4 DL | B11-2 Rep |
| Sample Depth | 2-4ft | 1.5-3.5ft | 1.5-3.5ft | 1.5-3.5ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft |
| Laboratory ID | P207984 | P207975 | P207981 | P207982 | P207976 | P207977 | P207978 | P207978DL | P207979 |
| Sample Date | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| P-Nitroaniline | 2100 U | 1900 U | 1900 U | 1900 U | 1800 U | 1900 U | 2000 U | 40000 U | 1900 U |
| Nitrobenzene | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| P-Nitrophenol | 2100 UJ | 1900 U | 1900 U | 1900 U | 1800 U | 1900 U | 2000 U | 40000 U | 1900 U |
| Pentachlorophenol | 2100 U | 1900 U | 1900 U | 1900 U | 1800 U | 1900 U | 2000 U | 40000 U | 1900 U |
| Phenanthrene | **1800** | **160 J** | **170 J** | **250 J** | 370 U | **2800** | **31000 J** | **70000** | **190 J** |
| Phenol | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| Pyrene | **4000** | **380 J** | 390 U | 390 U | **1800** | **1900** | **25000 J** | **90000** | **1800** |
| Pyridine | 860 U | 790 U | 790 U | 790 U | 750 U | 790 U | 830 U | 17000 U | 790 U |
| Quinoline | 860 U | 790 U | 790 U | 790 U | 750 U | 790 U | 830 U | 17000 U | 790 U |
| 1,2,4-Trichlorobenzene | 420 U | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| 2,4,5-Trichlorophenol | 420 UJ | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |
| 2,4,6-Trichlorophenol | 420 UJ | 390 U | 390 U | 390 U | 370 U | 390 U | 410 U | 8100 U | 390 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 13 | | |
|---|---|---|---|
| Dames & Moore Sample ID | B013A1 | B013A2 | B013A2DL |
| Sample Location | B13-1 | B13-2 | B13-2 DL |
| Sample Depth | 2.5-4.5ft | 4.5-6.5ft | 4.5-6.5ft |
| Laboratory ID | P207980 | P207880 | P207880DL |
| Sample Date | 08/06/92 | 08/05/92 | 08/05/92 |
| Units | ug/kg | ug/kg | ug/kg |
| Semivolatile Organic Compounds | | | |
| Aniline | 470 U | 420 U | 4200 U |
| Anthracene | **490** | 420 U | **1900 J** |
| Benz(c)acridine | 0 U | 0 U | 0 U |
| Benzenethiol | 470 U | 420 U | 4200 U |
| Benzidine | 2300 U | 2100 U | 21000 U |
| Benzo(a)anthracene | **1300** | 420 U | **2200 J** |
| Benzo(a)pyrene | **1400** | **910** | **1600 J** |
| Benzo(b,j,k)fluoranthene | **2000 J** | **1300 J** | 15000 U |
| Benzyl chloride | 470 U | 420 U | 4200 U |
| Butyl benzyl phthalate | 470 U | 420 U | 4200 U |
| p-Chloro-m-cresol | 470 U | 420 U | 4200 U |
| Bis(2-chloroethyl) ether | 470 U | 420 U | 4200 U |
| Bis(2-chloroisopropyl)ether | 470 U | 420 U | 4200 U |
| Bis(2-chloromethyl)ether | 0 U | 0 U | 0 U |
| 2-Chloronaphthalene | 470 U | 420 U | 4200 U |
| 2-Chlorophenol | 470 U | 420 U | 4200 U |
| Chrysene | **1400** | **6000** | **4000** |
| o-Cresol | 470 U | 420 U | 4200 U |
| p-Cresol | 1400 U | 1300 U | 13000 U |
| Di-n-butylphthalate | **240 J** | 420 U | **1600 BJ** |
| Di-n-octylphthalate | 470 U | 420 U | 4200 U |
| Dibenz(a,h)acridine | 470 U | 420 U | 4200 U |
| Dibenz(a,h)anthracene | 470 U | **150 J** | 4200 U |
| Dibenz(a,i)pyrene | 0 U | 0 U | 0 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 13 | | |
|---|---|---|---|
| Dames & Moore Sample ID | B013A1 | B013A2 | B013A2DL |
| Sample Location | B13-1 | B13-2 | B13-2 DL |
| Sample Depth | 2.5-4.5ft | 4.5-6.5ft | 4.5-6.5ft |
| Laboratory ID | P207980 | P207880 | P207880DL |
| Sample Date | 08/06/92 | 08/05/92 | 08/05/92 |
| Units | ug/kg | ug/kg | ug/kg |
| Dibenz(a,j)acridine | 940 U | 850 U | 8500 U |
| Dibenzo(a,e)pyrene | 0 U | 0 U | 0 U |
| Dibenzo(a,h)pyrene | 0 U | 0 U | 0 U |
| 7h-Dibenzo(c,g)carbazole | 0 U | 0 U | 0 U |
| 1,3-Dichloro-2-propanol | 470 U | **420** | 4200 U |
| 1,2-Dichlorobenzene | 470 U | 420 U | 4200 U |
| 1,3-Dichlorobenzene | 470 U | 420 U | 4200 U |
| 1,4-Dichlorobenzene | 470 U | 420 U | 4200 U |
| Diethyl phthalate | 470 U | 420 U | 4200 U |
| Dimethyl phthalate | 470 U | 420 U | 4200 U |
| 7,12-Dimethylbenz(a)anthracene | 430 U | 380 U | 3800 U |
| 2,4-Dimethylphenol | 470 U | 420 U | 4200 U |
| 4,6-Dinitro-o-cresol | 2300 U | 2100 U | 21000 U |
| 2,4-Dinitrophenol | 2300 U | 2100 U | 21000 U |
| 2,4-Dinitrotoluene | 470 U | 420 U | 4200 U |
| 1,2-Diphenylhydrazine | 470 U | 420 U | 4200 U |
| Bis(2-ethylhexyl) phthalate | 470 U | 420 U | 4200 U |
| Fluoranthene | **2200** | 420 U | **2500 J** |
| Hydroquinone | 2400 U | 2200 U | 22000 U |
| Indene | 960 U | 860 U | 8600 U |
| Indeno(1,2,3-cd)pyrene | **380 J** | 420 U | 4200 U |
| 3-Methylcholanthrene | 290 U | 260 U | 2600 U |
| 1-Methylnapththalene | **4400** | **27000 J** | **72000 J** |
| Naphthalene | **3100** | **21000 J** | **31000** |
| 5-Nitroacenapthene | 470 U | 420 U | 4200 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 13 | | |
|---|---|---|---|
| Dames & Moore Sample ID | B013A1 | B013A2 | B013A2DL |
| Sample Location | B13-1 | B13-2 | B13-2 DL |
| Sample Depth | 2.5-4.5ft | 4.5-6.5ft | 4.5-6.5ft |
| Laboratory ID | P207980 | P207880 | P207880DL |
| Sample Date | 08/06/92 | 08/05/92 | 08/05/92 |
| Units | ug/kg | ug/kg | ug/kg |
| P-Nitroaniline | 2300 U | 2100 U | 21000 U |
| Nitrobenzene | 470 U | 420 U | 4200 U |
| P-Nitrophenol | 2300 U | 2100 U | 21000 U |
| Pentachlorophenol | 2300 U | 2100 U | 21000 U |
| Phenanthrene | **2600** | **27000 J** | **33000** |
| Phenol | 470 U | 420 U | 4200 U |
| Pyrene | **1800** | **4600** | **4900** |
| Pyridine | 960 U | 860 U | 8600 U |
| Quinoline | 960 U | 860 U | 8600 U |
| 1,2,4-Trichlorobenzene | 470 U | 420 U | 4200 U |
| 2,4,5-Trichlorophenol | 470 U | 420 U | 4200 U |
| 2,4,6-Trichlorophenol | 470 U | 420 U | 4200 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 16 | | | | | | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B016A1 | B016A2 | B016A2DL | B016A3 | B016A3DL | B016A4 | B016A5 |
| Sample Location | B16-1 | B16-2 | B16-2 DL | B16-3 | B16-3 DL | B16-4 | Field Blank |
| Sample Depth | 2-4ft | 2-4ft | 2-4ft | 0-2ft | 0-2ft | 2-4ft | |
| Laboratory ID | P207881 | P207882 | P207882DL | P207883 | P207883DL | P207884 | P207885 |
| Sample Date | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | UG/L |
| Semivolatile Organic Compounds | | | | | | | |
| Aniline | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| Anthracene | 790 U | 330 J | 1700 U | 4300 U | 8600 U | 510 U | 10 UJ |
| Benz(c)acridine | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Benzenethiol | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| Benzidine | 3800 UJ | 2100 U | 8300 U | 21000 U | 42000 U | 2500 U | 500 U |
| Benzo(a)anthracene | 480 J | 920 | 990 J | 2100 K | 8600 U | 820 | 10 U |
| Benzo(a)pyrene | 280 J | 680 | 880 J | 1300 K | 8600 U | 610 | 10 UJ |
| Benzo(b,j,k)fluoranthene | 2900 U | 1000 J | 6200 U | 16000 U | 31000 U | 1000 J | 40 U |
| Benzyl chloride | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| Butyl benzyl phthalate | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| p-Chloro-m-cresol | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| Bis(2-chloroethyl) ether | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| Bis(2-chloroisopropyl)ether | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| Bis(2-chloromethyl)ether | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 2-Chloronaphthalene | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| 2-Chlorophenol | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| Chrysene | 780 | 1200 | 1500 | 3700 K | 3600 K | 840 | 6 U |
| o-Cresol | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| p-Cresol | 2400 U | 1300 U | 5200 U | 13000 U | 26000 U | 1500 U | 30 U |
| Di-n-butylphthalate | 370 BJ | 1000 B | 1300 BJ | 1400 BJ | 8600 U | 1500 B | 10 UJ |
| Di-n-octylphthalate | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| Dibenz(a,h)acridine | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| Dibenz(a,h)anthracene | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 250 J | 10 U |
| Dibenz(a,i)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 16 | | | | | | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B016A1 | B016A2 | B016A2DL | B016A3 | B016A3DL | B016A4 | B016A5 |
| Sample Location | B16-1 | B16-2 | B16-2 DL | B16-3 | B16-3 DL | B16-4 | Field Blank |
| Sample Depth | 2-4ft | 2-4ft | 2-4ft | 0-2ft | 0-2ft | 2-4ft | |
| Laboratory ID | P207881 | P207882 | P207882DL | P207883 | P207883DL | P207884 | P207885 |
| Sample Date | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | UG/L |
| Dibenz(a,j)acridine | 1600 U | 860 U | 3400 U | 8600 U | 17000 U | 1000 U | 20 U |
| Dibenzo(a,e)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Dibenzo(a,h)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 7h-Dibenzo(c,g)carbazole | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 1,3-Dichloro-2-propanol | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| 1,2-Dichlorobenzene | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| 1,3-Dichlorobenzene | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| 1,4-Dichlorobenzene | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| Diethyl phthalate | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| Dimethyl phthalate | 790 U | 430 U | 1700 U | **4600 B** | **4700 BJ** | **200 BJ** | 10 U |
| 7,12-Dimethylbenz(a)anthracene | 710 U | 390 U | 1600 U | 3900 U | 7800 U | 460 U | 9 U |
| 2,4-Dimethylphenol | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| 4,6-Dinitro-o-cresol | 3800 U | 2100 U | 8300 U | 21000 U | 42000 U | 2500 U | 50 UJ |
| 2,4-Dinitrophenol | 3800 U | 2100 U | 8300 U | 21000 U | 42000 U | 2500 U | 50 U |
| 2,4-Dinitrotoluene | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| 1,2-Diphenylhydrazine | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| Bis(2-ethylhexyl) phthalate | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| Fluoranthene | **970** | **1800** | **1700 J** | **2600 K** | 8600 U | **1100** | 10 UJ |
| Hydroquinone | 4000 U | 2200 U | 8800 U | 22000 U | 44000 U | 2600 U | 50 U |
| Indene | 1600 U | 870 U | 3500 U | 8700 U | 17000 U | 1000 U | 20 U |
| Indeno(1,2,3-cd)pyrene | 790 U | **300 J** | 1700 U | 4300 U | 8600 U | **390 J** | 10 U |
| 3-Methylcholanthrene | 480 U | 260 U | 1000 U | 2600 U | 5200 U | 310 U | 6 U |
| 1-Methylnaphthalene | **6500** | **20000 J** | **22000** | **74000 K** | **78000 K** | **840 J** | 20 U |
| Naphthalene | 790 U | **2000** | **1900** | 4300 U | 8600 U | 510 U | 10 U |
| 5-Nitroacenapthene | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 16 | | | | | | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B016A1 | B016A2 | B016A2DL | B016A3 | B016A3DL | B016A4 | B016A5 |
| Sample Location | B16-1 | B16-2 | B16-2 DL | B16-3 | B16-3 DL | B16-4 | Field Blank |
| Sample Depth | 2-4ft | 2-4ft | 2-4ft | 0-2ft | 0-2ft | 2-4ft | |
| Laboratory ID | P207881 | P207882 | P207882DL | P207883 | P207883DL | P207884 | P207885 |
| Sample Date | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | UG/L |
| P-Nitroaniline | 3800 U | 2100 U | 8300 U | 21000 U | 42000 U | 2500 U | 50 U |
| Nitrobenzene | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| P-Nitrophenol | 3800 U | 2100 U | 8300 U | 21000 U | 42000 U | 2500 U | 50 U |
| Pentachlorophenol | 3800 U | 2100 U | 8300 U | 21000 U | 42000 U | 2500 U | 50 UJ |
| Phenanthrene | 2700 | 6300 | 7000 | 19000 K | 19000 K | 560 | 10 UJ |
| Phenol | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| Pyrene | 1100 | 1800 | 1700 J | 4000 K | 4300 K | 1100 | 10 U |
| Pyridine | 1600 U | 870 U | 3500 U | 8700 U | 17000 U | 1000 U | 20 U |
| Quinoline | 1600 U | 870 U | 3500 U | 8700 U | 17000 U | 1000 U | 20 U |
| 1,2,4-Trichlorobenzene | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| 2,4,5-Trichlorophenol | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |
| 2,4,6-Trichlorophenol | 790 U | 430 U | 1700 U | 4300 U | 8600 U | 510 U | 10 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 17 | | | | | SWMU 29 | | |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B017A1 | B017A2 | B017A3 | B017A3DL | B017A4 | B029A1 | B029A2 | B029A2DL |
| Sample Location | B17-1 | B17-2 | B17-3 | B17-3 DL | B17-4 | B29-1 | B29-2 | B29-2 DL |
| Sample Depth | 0-2ft | 0-2ft | 0-2ft | 0-2ft | 0-2ft | 2-4ft | 2-4ft | 2-4ft |
| Laboratory ID | P207887 | P207888 | P207889 | P207889DL | P207890 | P208443 | P208444 | P208444DL |
| Sample Date | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/10/92 | 08/10/92 | 08/10/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Semivolatile Organic Compounds | | | | | | | | |
| Aniline | 420 U | 400 U | 390 U | 780 U | 360 U | 410 U | 1300 U | 4000 U |
| Anthracene | 420 UJ | 1300 | 300 J | 380 J | 360 U | 210 J | 2200 | 2300 J |
| Benz(c)acridine | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Benzenethiol | 420 U | 400 U | 390 U | 780 U | 360 U | 410 U | 1300 U | 4000 U |
| Benzidine | 2000 U | 2000 U | 1900 U | 3800 U | 1700 U | 2000 U | 6500 U | 20000 U |
| Benzo(a)anthracene | 420 U | 1200 | 1000 | 1100 | 260 J | 430 | 3900 | 3800 J |
| Benzo(a)pyrene | 200 J | 710 J | 1000 | 1100 | 110 J | 410 U | 3200 | 3700 J |
| Benzo(b,j,k)fluoranthene | 1500 U | 330 J | 1500 | 1500 J | 1300 U | 1100 J | 2000 J | 1900 J |
| Benzyl chloride | 420 U | 400 U | 390 U | 780 U | 360 U | 410 U | 1300 U | 4000 U |
| Butyl benzyl phthalate | 420 U | 400 U | 390 U | 780 U | 360 U | 410 UJ | 1300 U | 4000 U |
| p-Chloro-m-cresol | 420 U | 400 U | 390 U | 780 U | 360 U | 410 U | 1300 U | 4000 U |
| Bis(2-chloroethyl) ether | 420 U | 400 U | 390 U | 780 UJ | 360 U | 410 U | 1300 U | 4000 U |
| Bis(2-chloroisopropyl)ether | 420 U | 400 U | 390 U | 780 U | 360 U | 410 U | 1300 U | 4000 U |
| Bis(2-chloromethyl)ether | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 2-Chloronaphthalene | 420 UJ | 400 U | 390 U | 780 UJ | 360 U | 410 U | 1300 U | 4000 U |
| 2-Chlorophenol | 420 U | 400 U | 390 U | 780 UJ | 360 U | 410 U | 1300 U | 4000 U |
| Chrysene | 530 | 1700 | 1300 | 1200 | 410 | 520 | 5400 | 5400 |
| o-Cresol | 420 U | 400 U | 390 U | 780 UJ | 360 U | 410 U | 1300 U | 4000 U |
| p-Cresol | 1300 U | 1200 U | 1200 U | 2400 UJ | 1100 U | 1200 U | 4100 U | 12000 U |
| Di-n-butylphthalate | 420 UJ | 400 U | 910 B | 900 B | 580 B | 280 BJ | 1300 U | 4000 U |
| Di-n-octylphthalate | 420 U | 400 U | 390 U | 780 U | 360 U | 410 UJ | 1300 U | 4000 U |
| Dibenz(a,h)acridine | 420 U | 400 U | 390 U | 780 U | 360 U | 410 U | 1300 U | 4000 U |
| Dibenz(a,h)anthracene | 420 U | 400 UJ | 220 J | 780 U | 360 U | 410 U | 1300 U | 4000 U |
| Dibenz(a,i)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 17 | | | | | SWMU 29 | | |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B017A1 | B017A2 | B017A3 | B017A3DL | B017A4 | B029A1 | B029A2 | B029A2DL |
| Sample Location | B17-1 | B17-2 | B17-3 | B17-3 DL | B17-4 | B29-1 | B29-2 | B29-2 DL |
| Sample Depth | 0-2ft | 0-2ft | 0-2ft | 0-2ft | 0-2ft | 2-4ft | 2-4ft | 2-4ft |
| Laboratory ID | P207887 | P207888 | P207889 | P207889DL | P207890 | P208443 | P208444 | P208444DL |
| Sample Date | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/10/92 | 08/10/92 | 08/10/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Dibenz(a,j)acridine | 840 U | 810 U | 780 U | 1600 U | 720 U | 820 U | 2700 U | 8100 U |
| Dibenzo(a,e)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Dibenzo(a,h)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 7h-Dibenzo(c,g)carbazole | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 1,3-Dichloro-2-propanol | 420 U | 400 U | 390 U | 780 U | 360 U | 410 U | 1300 U | 4000 U |
| 1,2-Dichlorobenzene | 420 U | 400 U | 390 U | 780 UJ | 360 U | 410 U | 1300 U | 4000 U |
| 1,3-Dichlorobenzene | 420 U | 400 U | 390 U | 780 UJ | 360 U | 410 U | 1300 U | 4000 U |
| 1,4-Dichlorobenzene | 420 U | 400 U | 390 U | 780 UJ | 360 U | 410 U | 1300 U | 4000 U |
| Diethyl phthalate | 420 U | 400 U | 390 U | 780 U | 360 U | 410 U | 1300 U | 4000 U |
| Dimethyl phthalate | 420 UJ | **260 BJ** | 390 U | 780 UJ | 360 U | **150 J** | 1300 U | 4000 U |
| 7,12-Dimethylbenz(a)anthracene | 380 U | 370 U | 350 U | 710 U | 330 U | 370 U | 1200 U | 3700 U |
| 2,4-Dimethylphenol | 420 U | 400 U | 390 U | 780 U | 360 U | 410 U | 1300 U | 4000 U |
| 4,6-Dinitro-o-cresol | 2000 UJ | 2000 U | 1900 U | 3800 U | 1700 U | 2000 U | 6500 U | 20000 U |
| 2,4-Dinitrophenol | 2000 U | 2000 U | 1900 U | 3800 UJ | 1700 U | 2000 U | 6500 U | 20000 U |
| 2,4-Dinitrotoluene | 420 UJ | 400 U | 390 U | 780 UJ | 360 U | 410 U | 1300 U | 4000 U |
| 1,2-Diphenylhydrazine | 420 U | 400 U | 390 U | 780 U | 360 U | 410 U | 1300 U | 4000 U |
| Bis(2-ethylhexyl) phthalate | 420 U | 400 U | 390 U | 780 U | 360 U | 410 UJ | 1300 U | 4000 U |
| Fluoranthene | 420 UJ | 400 U | 390 U | **1400** | **430** | **440** | 1300 U | **6200** |
| Hydroquinone | 2200 U | 2100 U | 2000 U | 4000 U | 1800 U | 2100 U | 6900 U | 21000 U |
| Indene | 850 U | 820 U | 790 U | 1600 U | 730 U | 830 U | 2700 U | 8200 U |
| Indeno(1,2,3-cd)pyrene | 420 U | 400 UJ | **430 J** | **680 J** | 360 U | 410 U | 1300 U | 4000 U |
| 3-Methylcholanthrene | 250 U | 240 U | 240 U | 470 U | 220 U | 250 U | 810 U | 2400 U |
| 1-Methylnaphthalene | 850 U | 820 U | **9600 J** | **9700** | **770** | **370 J** | **28000 J** | **27000** |
| Naphthalene | 420 U | 400 U | 390 U | 780 U | 360 U | **390 J** | **2200** | **1900 J** |
| 5-Nitroacenapthene | 420 U | 400 U | 390 U | 780 U | 360 U | 410 U | 1300 U | 4000 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 17 | | | | | SWMU 29 | | |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B017A1 | B017A2 | B017A3 | B017A3DL | B017A4 | B029A1 | B029A2 | B029A2DL |
| Sample Location | B17-1 | B17-2 | B17-3 | B17-3 DL | B17-4 | B29-1 | B29-2 | B29-2 DL |
| Sample Depth | 0-2ft | 0-2ft | 0-2ft | 0-2ft | 0-2ft | 2-4ft | 2-4ft | 2-4ft |
| Laboratory ID | P207887 | P207888 | P207889 | P207889DL | P207890 | P208443 | P208444 | P208444DL |
| Sample Date | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/10/92 | 08/10/92 | 08/10/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| P-Nitroaniline | 2000 U | 2000 U | 1900 U | 3800 U | 1700 U | 2000 U | 6500 U | 20000 U |
| Nitrobenzene | 420 U | 400 U | 390 U | 780 U | 360 U | 410 U | 1300 U | 4000 U |
| P-Nitrophenol | 2000 UJ | 2000 U | 1900 U | 3800 UJ | 1700 U | 2000 U | 6500 U | 20000 U |
| Pentachlorophenol | 2000 UJ | 2000 U | 1900 U | 3800 U | 1700 U | 2000 U | 6500 U | 20000 U |
| Phenanthrene | 420 UJ | 400 U | **2500** | **2800** | **2500** | **530** | **17000** | **17000** |
| Phenol | 420 U | 400 U | 390 U | 780 UJ | 360 U | 410 U | 1300 U | 4000 U |
| Pyrene | 420 U | **470** | **1600** | **1500** | **670** | **450** | 1300 U | **6600** |
| Pyridine | 850 U | 820 U | 790 U | 1600 U | 730 U | 830 U | 2700 U | 8200 U |
| Quinoline | 850 U | 820 U | 790 U | 1600 U | 730 U | 830 U | 2700 U | 8200 U |
| 1,2,4-Trichlorobenzene | 420 U | 400 U | 390 U | 780 U | 360 U | 410 U | 1300 U | 4000 U |
| 2,4,5-Trichlorophenol | 420 UJ | 400 U | 390 U | 780 UJ | 360 U | 410 U | 1300 U | 4000 U |
| 2,4,6-Trichlorophenol | 420 UJ | 400 U | 390 U | 780 UJ | 360 U | 410 U | 1300 U | 4000 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 30 | | | | SWMU 71 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B030A1 | B030A2 | B030A2DL | B030A3 | B071A1 | B071A2 | B071A2MS | B071A2MSD | B071A3 |
| Sample Location | B30-1 | B30-2 | B30-2 DL | B30-3 | B71-1 | B71-2 | B71-2 MS | B71-2 MSD | B71-3 |
| Sample Depth | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 1-2ft | 2-4ft | 2-4ft | 2-4ft | 3-4.5ft |
| Laboratory ID | P208445 | P208446 | P208446DL | P208447 | P208497 | P208498 | P208499 | P208500 | P208502 |
| Sample Date | 08/10/92 | 08/10/92 | 08/10/92 | 08/10/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Semivolatile Organic Compounds | | | | | | | | | |
| Aniline | 420 U | 380 U | 1300 U | 410 U | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| Anthracene | **630 J** | **130 J** | 1300 U | 410 UJ | **110 J** | **1700 J** | **1700 J** | **1100 J** | **1100 J** |
| Benz(c)acridine | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Benzenethiol | 420 U | 380 U | 1300 U | 410 U | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| Benzidine | 2100 U | 1800 U | 6100 U | 2000 U | 1800 U | 9500 U | 9500 U | 9500 U | 6700 U |
| Benzo(a)anthracene | **2500** | 380 U | 1300 U | 410 U | **350 J** | 2000 U | **1300 J** | **960 J** | **2100** |
| Benzo(a)pyrene | **3100** | 380 U | 1300 U | 410 U | **320 J** | **1000 J** | **780 J** | **1000 J** | **1900 J** |
| Benzo(b,j,k)fluoranthene | **1800 J** | 1400 U | 4600 U | 1500 U | **360 J** | 7100 UJ | 7100 UJ | 7100 UJ | **1100 J** |
| Benzyl chloride | 420 U | 380 U | 1300 U | 410 U | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| Butyl benzyl phthalate | 420 U | 380 U | 1300 UJ | 410 U | 370 UJ | 2000 U | 2000 U | 2000 U | 1400 U |
| p-Chloro-m-cresol | 420 U | 380 U | 1300 U | 410 UJ | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| Bis(2-chloroethyl) ether | 420 UJ | 380 UJ | 1300 U | 410 UJ | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| Bis(2-chloroisopropyl)ether | 420 U | 380 U | 1300 U | 410 U | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| Bis(2-chloromethyl)ether | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 2-Chloronaphthalene | 420 U | 380 U | 1300 U | 410 UJ | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| 2-Chlorophenol | 420 UJ | 380 UJ | 1300 U | 410 UJ | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| Chrysene | **2700** | 230 U | 770 U | **170 J** | **480** | **3400** | **3300** | **2100** | **2600** |
| o-Cresol | 420 UJ | 380 UJ | 1300 U | 410 UJ | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| p-Cresol | 1300 UJ | 1100 UJ | 3800 U | 1200 UJ | 1100 U | 6000 U | 6000 U | 6000 U | 4200 U |
| Di-n-butylphthalate | **780 B** | **940 B** | **1100 B** | **1000 B** | **490 B** | 2000 U | **1800 J** | **1200 J** | **820 J** |
| Di-n-octylphthalate | 420 U | 380 U | 1300 UJ | 410 U | 370 U | 2000 UJ | 2000 UJ | 2000 UJ | 1400 UJ |
| Dibenz(a,h)acridine | 420 U | 380 U | 1300 U | 410 U | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| Dibenz(a,h)anthracene | 420 U | 380 U | 1300 U | 410 U | 370 U | 2000 UJ | 2000 U | 2000 U | 1400 UJ |
| Dibenz(a,i)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 30 | | | | SWMU 71 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B030A1 | B030A2 | B030A2DL | B030A3 | B071A1 | B071A2 | B071A2MS | B071A2MSD | B071A3 |
| Sample Location | B30-1 | B30-2 | B30-2 DL | B30-3 | B71-1 | B71-2 | B71-2 MS | B71-2 MSD | B71-3 |
| Sample Depth | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 1-2ft | 2-4ft | 2-4ft | 2-4ft | 3-4.5ft |
| Laboratory ID | P208445 | P208446 | P208446DL | P208447 | P208497 | P208498 | P208499 | P208500 | P208502 |
| Sample Date | 08/10/92 | 08/10/92 | 08/10/92 | 08/10/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Dibenz(a,j)acridine | 850 U | 760 U | 2500 U | 820 U | 740 U | 3900 U | 3900 U | 3900 U | 2700 U |
| Dibenzo(a,e)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Dibenzo(a,h)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 7h-Dibenzo(c,g)carbazole | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 1,3-Dichloro-2-propanol | 420 U | 380 U | 1300 U | 410 U | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| 1,2-Dichlorobenzene | 420 UJ | 380 UJ | 1300 U | 410 UJ | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| 1,3-Dichlorobenzene | 420 UJ | 380 UJ | 1300 U | 410 UJ | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| 1,4-Dichlorobenzene | 420 UJ | 380 UJ | 1300 U | 410 UJ | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| Diethyl phthalate | **180 J** | 380 U | 1300 U | 410 U | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| Dimethyl phthalate | **320 J** | 380 U | 1300 U | 410 UJ | **140 BJ** | 2000 U | 2000 U | 2000 U | 1400 U |
| 7,12-Dimethylbenz(a)anthracene | 380 U | 340 U | 1100 U | 380 U | 340 U | 1800 U | 1800 U | 1800 U | 1200 U |
| 2,4-Dimethylphenol | 420 U | 380 U | 1300 U | 410 UJ | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| 4,6-Dinitro-o-cresol | 2100 UJ | 1800 U | 6100 U | 2000 UJ | 1800 U | 9500 U | 9500 U | 9500 U | 6700 U |
| 2,4-Dinitrophenol | 2100 U | 1800 U | 6100 U | 2000 UJ | 1800 U | 9500 U | 9500 U | 9500 U | 6700 U |
| 2,4-Dinitrotoluene | 420 U | 380 U | 1300 U | 410 UJ | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| 1,2-Diphenylhydrazine | 420 U | 380 U | 1300 U | 410 U | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| Bis(2-ethylhexyl) phthalate | 420 U | 380 U | 1300 U | 410 U | 370 UJ | **1600 J** | 2000 U | 2000 U | 1400 U |
| Fluoranthene | **3300 J** | **180 J** | 1300 U | **280 J** | **620** | 2000 U | **2800** | **1800 J** | **4900** |
| Hydroquinone | 2200 U | 2000 U | 6500 U | 2100 U | 1900 U | 10000 U | 10000 U | 10000 U | 7100 U |
| Indene | 860 U | 770 U | 2600 U | 840 U | 750 U | 4000 U | 4000 U | 4000 U | 2800 U |
| Indeno(1,2,3-cd)pyrene | 420 U | 380 U | 1300 U | 410 U | 370 U | 2000 UJ | 2000 UJ | 2000 UJ | 1400 UJ |
| 3-Methylcholanthrene | 260 U | 230 U | 770 U | 250 U | 220 U | 1200 U | 1200 U | 1200 U | 830 U |
| 1-Methylnaphthalene | 860 U | **12000 J** | **10000 J** | **640 J** | 750 U | **32000** | **35000 E** | **23000** | **8300** |
| Naphthalene | **320 J** | 380 U | 1300 U | 410 UJ | 370 U | **13000** | **13000** | **9100** | **1400** |
| 5-Nitroacenapthene | 420 U | 380 U | 1300 U | 410 U | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 30 | | | | SWMU 71 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B030A1 | B030A2 | B030A2DL | B030A3 | B071A1 | B071A2 | B071A2MS | B071A2MSD | B071A3 |
| Sample Location | B30-1 | B30-2 | B30-2 DL | B30-3 | B71-1 | B71-2 | B71-2 MS | B71-2 MSD | B71-3 |
| Sample Depth | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 1-2ft | 2-4ft | 2-4ft | 2-4ft | 3-4.5ft |
| Laboratory ID | P208445 | P208446 | P208446DL | P208447 | P208497 | P208498 | P208499 | P208500 | P208502 |
| Sample Date | 08/10/92 | 08/10/92 | 08/10/92 | 08/10/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| P-Nitroaniline | 2100 U | 1800 U | 6100 U | 2000 U | 1800 U | 9500 U | 9500 U | 9500 U | 6700 U |
| Nitrobenzene | 420 U | 380 U | 1300 U | 410 UJ | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| P-Nitrophenol | 2100 U | 1800 U | 6100 U | 2000 UJ | 1800 U | 9500 U | 9500 U | 9500 U | 6700 U |
| Pentachlorophenol | 2100 UJ | 1800 U | 6100 U | 2000 UJ | 1800 U | 9500 U | 9500 U | 9500 U | 6700 U |
| Phenanthrene | **1600 J** | **1000** | **760 J** | **380 J** | **360 J** | **21000** | **22000** | **15000** | **9200** |
| Phenol | 420 UJ | 380 UJ | 1300 U | 410 UJ | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| Pyrene | **2600** | **130 J** | 1300 U | **190 J** | **570** | 2000 U | 2000 U | 2000 U | **3900** |
| Pyridine | 860 U | 770 U | 2600 U | 840 U | 750 U | 4000 U | 4000 U | 4000 U | 2800 U |
| Quinoline | 860 U | 770 U | 2600 U | 840 U | 750 U | 4000 U | 4000 U | 4000 U | 2800 U |
| 1,2,4-Trichlorobenzene | 420 U | 380 U | 1300 U | 410 UJ | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| 2,4,5-Trichlorophenol | 420 U | 380 U | 1300 U | 410 UJ | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |
| 2,4,6-Trichlorophenol | 420 U | 380 U | 1300 U | 410 UJ | 370 U | 2000 U | 2000 U | 2000 U | 1400 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 71 (continued) | | | | | SWMU 71A | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B071A4 | B071A5 | B071A6 | B071A7 | B071A8 | B071AA1 | B071AA2 |
| Sample Location | B71-4 | B71-5 | B71-6 | B71-6 Rep | Field Blank | B71A-1 | B71A-2 |
| Sample Depth | 2-4ft | 1-3ft | 1-3ft | 1-3ft | | 2-4ft | 4-6ft |
| Laboratory ID | P208503 | P208504 | P208505 | P208506 | P208507 | P208614 | P208615 |
| Sample Date | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/12/92 | 08/12/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | UG/L | ug/kg | ug/kg |
| Semivolatile Organic Compounds | | | | | | | |
| Aniline | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| Anthracene | **1200 J** | **320 J** | **320 J** | **580** | 10 U | 410 U | 2200 U |
| Benz(c)acridine | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Benzenethiol | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| Benzidine | 12000 U | 2100 U | 1800 U | 1800 U | 500 U | 2000 U | 11000 U |
| Benzo(a)anthracene | 2400 U | **750** | **940** | **1900** | 10 U | **240 J** | **910 J** |
| Benzo(a)pyrene | 2400 UJ | 430 UJ | 380 UJ | **1500** | 10 U | **180 J** | **1600 J** |
| Benzo(b,j,k)fluoranthene | 8900 UJ | **530 J** | **1600 J** | **1300 J** | 40 U | 1500 U | **1000 J** |
| Benzyl chloride | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| Butyl benzyl phthalate | 2400 U | 430 UJ | 380 UJ | 370 U | 10 U | 410 UJ | 2200 U |
| p-Chloro-m-cresol | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| Bis(2-chloroethyl) ether | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| Bis(2-chloroisopropyl)ether | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 UJ | 2200 U |
| Bis(2-chloromethyl)ether | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 2-Chloronaphthalene | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| 2-Chlorophenol | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| Chrysene | **1500** | **1100** | **1600** | **2500** | 6 U | **250** | **1200 J** |
| o-Cresol | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| p-Cresol | 7400 U | **740 J** | 1100 U | **790 J** | 30 U | 1200 U | 6800 U |
| Di-n-butylphthalate | **1100 J** | **740 B** | **630 B** | 370 U | 10 UJ | **790 B** | **980 J** |
| Di-n-octylphthalate | 2400 UJ | 430 UJ | 380 UJ | 370 U | 10 U | 410 UJ | 2200 U |
| Dibenz(a,h)acridine | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| Dibenz(a,h)anthracene | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| Dibenz(a,i)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 71 (continued) | | | | | SWMU 71A | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B071A4 | B071A5 | B071A6 | B071A7 | B071A8 | B071AA1 | B071AA2 |
| Sample Location | B71-4 | B71-5 | B71-6 | B71-6 Rep | Field Blank | B71A-1 | B71A-2 |
| Sample Depth | 2-4ft | 1-3ft | 1-3ft | 1-3ft | | 2-4ft | 4-6ft |
| Laboratory ID | P208503 | P208504 | P208505 | P208506 | P208507 | P208614 | P208615 |
| Sample Date | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/12/92 | 08/12/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | UG/L | ug/kg | ug/kg |
| Dibenz(a,j)acridine | 4900 U | 860 U | 760 U | 750 U | 20 U | 820 U | 4500 U |
| Dibenzo(a,e)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Dibenzo(a,h)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 7h-Dibenzo(c,g)carbazole | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 1,3-Dichloro-2-propanol | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| 1,2-Dichlorobenzene | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| 1,3-Dichlorobenzene | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| 1,4-Dichlorobenzene | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| Diethyl phthalate | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| Dimethyl phthalate | 2400 U | **170 BJ** | 380 U | 370 U | 10 U | **260 BJ** | 2200 U |
| 7,12-Dimethylbenz(a)anthracene | 2200 U | 390 U | 340 U | 340 U | 9 U | 380 U | 2000 U |
| 2,4-Dimethylphenol | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| 4,6-Dinitro-o-cresol | 12000 U | 2100 U | 1800 U | 1800 U | 50 UJ | 2000 U | 11000 U |
| 2,4-Dinitrophenol | 12000 U | 2100 U | 1800 U | 1800 U | 50 U | 2000 U | 11000 U |
| 2,4-Dinitrotoluene | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| 1,2-Diphenylhydrazine | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| Bis(2-ethylhexyl) phthalate | 2400 U | **150 J** | 380 UJ | 370 U | 10 U | 410 UJ | 2200 U |
| Fluoranthene | **860 J** | **1200** | **1100** | **4200** | 10 U | **350 J** | **1400 J** |
| Hydroquinone | 13000 U | 2200 U | 2000 U | 1900 U | 50 U | 2100 U | 11000 U |
| Indene | 5000 U | 870 U | 770 U | 760 U | 20 U | 840 U | 4500 U |
| Indeno(1,2,3-cd)pyrene | 2400 UJ | 430 UJ | 380 UJ | 370 U | 10 U | 410 U | 2200 U |
| 3-Methylcholanthrene | 1500 U | 260 U | 230 U | 230 U | 6 U | 250 U | 1400 U |
| 1-Methylnaphthalene | **29000** | **3100** | **3300** | **3100** | 20 U | **200 J** | **14000** |
| Naphthalene | **1700 J** | **990** | 380 U | **950** | 10 U | 410 U | 2200 U |
| 5-Nitroacenapthene | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |

Table 4-12
Skinner List Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 71 (continued) | | | | | SWMU 71A | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B071A4 | B071A5 | B071A6 | B071A7 | B071A8 | B071AA1 | B071AA2 |
| Sample Location | B71-4 | B71-5 | B71-6 | B71-6 Rep | Field Blank | B71A-1 | B71A-2 |
| Sample Depth | 2-4ft | 1-3ft | 1-3ft | 1-3ft | | 2-4ft | 4-6ft |
| Laboratory ID | P208503 | P208504 | P208505 | P208506 | P208507 | P208614 | P208615 |
| Sample Date | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/12/92 | 08/12/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | UG/L | ug/kg | ug/kg |
| P-Nitroaniline | 12000 U | 2100 U | 1800 U | 1800 U | 50 U | 2000 U | 11000 U |
| Nitrobenzene | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| P-Nitrophenol | 12000 U | 2100 U | 1800 U | 1800 U | 50 U | 2000 U | 11000 U |
| Pentachlorophenol | 12000 U | 2100 U | 1800 U | 1800 U | 50 U | 2000 U | 11000 U |
| Phenanthrene | 17000 | 3200 | 3200 | 4200 | 10 U | 410 J | 1500 J |
| Phenol | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| Pyrene | 2300 J | 1200 | 1800 | 3300 | 10 U | 290 J | 2400 |
| Pyridine | 5000 U | 870 U | 770 U | 760 U | 20 U | 840 U | 4500 U |
| Quinoline | 5000 U | 870 U | 770 U | 760 U | 20 U | 840 U | 4500 U |
| 1,2,4-Trichlorobenzene | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| 2,4,5-Trichlorophenol | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |
| 2,4,6-Trichlorophenol | 2400 U | 430 U | 380 U | 370 U | 10 U | 410 U | 2200 U |

# TABLE 4-12

## Skinner List Semivolatile Organic Compound Analytical Data
## Subsurface Soil Investigation
## RCRA Verification Investigation
## Chevron Refinery
## Philadelphia, Pennsylvania

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| ug/kg | - | micrograms per kilogram. |
| MS | - | Matrix Spike quality assurance/quality control sample. |
| MSD | - | Matrix Spike Duplicate quality assurance/quality control sample. |
| Rep | - | Replicate Sample. |
| DL | - | Sample Dilution. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |
| UJ | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is estimated. |
| J | - | The associated numerical value is an estimated quantity. |
| K | - | The associated numerical value is biased high. |
| B | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. |
| BJ | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. The associated numerical value is an estimated quantity. |

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Table 4-13
Skinner List Inorganic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 1 | | | SWMU 6 | | | | SWMU 9 |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B001A0 | B001A1 | B001A2 | B006A1 | B006A2 | B006A3 | B006A4 | B009A1 |
| Sample Location | B1-1 | B1-2 | B1-3 | B6-1 | B6-2 | B6-3 | B6-4 | B9-1 |
| Sample Depth | 2-4ft | 4-6ft | 4-6ft | 2-4ft | 2-4ft | 2-4ft | 3-5ft | 2-4ft |
| Laboratory ID | P207731 | P207732 | P207733 | P207878 | P207739 | P207740 | P207879 | P207984 |
| Sample Date | 08/04/92 | 08/04/92 | 08/04/92 | 08/05/92 | 08/04/92 | 08/04/92 | 08/05/92 | 08/06/92 |
| Units | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| Inorganic Compounds | | | | | | | | |
| Antimony | 24.00 K | 1.20 U | 2.20 K | 2.90 K | 2.00 K | 2.00 K | 3.00 K | 1.30 U |
| Arsenic | 14.40 K | 10.10 K | 5.00 K | 8.20 K | 3.50 K | 7.20 K | 6.80 K | 7.30 K |
| Barium | 1220.00 J | 280.00 J | 93.30 J | 520.00 J | 81.70 J | 233.00 J | 215.00 J | 97.70 L |
| Beryllium | 0.74 | 0.61 U | 0.65 | 0.87 | 0.71 U | 1.30 | 0.84 | 0.77 |
| Cadmium | 1.70 L | 1.20 UR | 2.70 UR | 0.03 UR | 3.60 UR | 0.58 UR | 0.03 UR | 0.64 UL |
| Chromium | 48.20 K | 12.20 K | 1140.00 K | 56.70 K | 45.30 K | 155.00 K | 47.60 K | 39.40 |
| Cobalt | 9.80 | 6.30 | 8.30 | 17.60 | 12.60 | 22.30 | 11.50 | 10.30 |
| Cyanide | 1.20 | 0.30 U | 0.52 | 3.90 | 0.36 U | 0.36 | 0.35 U | 0.29 U |
| Lead | 2260.00 L | 549.00 L | 98.70 L | 857.00 L | 223.00 L | 885.00 L | 3760.00 L | 106.00 |
| Mercury | 1.50 L | 0.41 L | 0.16 L | 4.70 L | 5.30 L | 0.69 L | 4.90 L | 0.48 K |
| Nickel | 33.90 | 14.20 | 116.00 | 26.10 | 15.00 | 46.10 | 38.80 | 17.70 L |
| Selenium | 1.30 L | 0.51 L | 0.47 L | 0.50 UL | 0.57 UL | 0.51 L | 1.30 L | 0.51 UL |
| Sulfide | 3.70 U | 51.30 | 18.00 | 25.90 | 17.80 | 4.70 | 57.80 | 3.80 UJ |
| Vanadium | 54.20 K | 23.30 K | 140.00 K | 45.30 K | 36.90 K | 403.00 K | 122.00 K | 43.10 L |

Table 4-13
Skinner List Inorganic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 11 | | | | | SWMU 13 | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B011A1 | B011A2 | B011A3 | B011A4 | B011A5 | B013A1 | B013A2 |
| Sample Location | B11-1 | B11-2 | B11-3 | B11-4 | B11-2 Rep | B13-1 | B13-2 |
| Sample Depth | 1.5-3.5ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 2.5-4.5ft | 4.5-6.5ft |
| Laboratory ID | P207975 | P207976 | P207977 | P207978 | P207979 | P207980 | P207880 |
| Sample Date | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/05/92 |
| Units | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| Inorganic Compounds | | | | | | | |
| Antimony | 9.10 K | 7.60 K | 2.10 K | 2.40 | 5.80 | 1.60 | 1.40 K |
| Arsenic | 7.10 K | 5.40 K | 3.60 K | 7.50 K | 6.80 K | 23.10 K | 6.90 K |
| Barium | 218.00 J | 134.00 J | 105.00 J | 124.00 L | 153.00 L | 300.00 L | 88.20 J |
| Beryllium | 2.60 | 1.50 | 0.59 | 0.99 | 1.80 | 1.40 | 0.90 |
| Cadmium | 5.90 UR | 0.56 UR | 5.90 UR | 3.10 UL | 1.50 L | 3.60 UL | 3.20 UR |
| Chromium | 648.00 K | 774.00 K | 160.00 K | 39.10 | 946.00 | 76.90 | 47.40 K |
| Cobalt | 72.40 | 65.20 | 14.70 | 18.20 | 72.10 | 27.10 | 14.50 |
| Cyanide | 5.50 | 7.50 | 0.70 | 0.48 K | 7.70 K | 0.74 K | 0.45 |
| Lead | 173.00 L | 140.00 L | 146.00 L | 507.00 | 234.00 | 229.00 | 580.00 L |
| Mercury | 1.80 L | 0.92 L | 0.95 L | 3.50 K | 0.76 K | 0.39 K | 1.00 L |
| Nickel | 203.00 | 115.00 | 38.90 | 52.70 L | 139.00 L | 38.00 L | 43.10 |
| Selenium | 0.47 UL | 0.45 UL | 0.47 UL | 0.50 UL | 0.47 UL | 1.00 L | 0.76 L |
| Sulfide | 3.50 UL | 3.40 UL | 3.50 UL | 30.70 J | 3.50 UJ | 4.30 UJ | 5.10 |
| Vanadium | 864.00 K | 455.00 K | 106.00 K | 182.00 L | 477.00 L | 40.20 L | 68.20 K |

Table 4-13
Skinner List Inorganic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 16 | | | | | SWMU 17 | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B016A1 | B016A2 | B016A3 | B016A4 | B016A5 | B017A1 | B017A2 | B017A3 | B017A4 |
| Sample Location | B16-1 | B16-2 | B16-3 | B16-4 | Field Blank | B17-1 | B17-2 | B17-3 | B17-4 |
| Sample Depth | 2-4ft | 2-4ft | 0-2ft | 2-4ft | | 0-2ft | 0-2ft | 0-2ft | 0-2ft |
| Laboratory ID | P207881 | P207882 | P207883 | P207884 | P207885 | P207887 | P207888 | P207889 | P207890 |
| Sample Date | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 |
| Units | mg/kg | mg/kg | mg/kg | mg/kg | UG/L | mg/kg | mg/kg | mg/kg | mg/kg |
| Inorganic Compounds | | | | | | | | | |
| Antimony | 2.00 K | 1.30 K | 1.40 K | 2.80 K | 10.00 U | 2.50 K | 1.20 U | 1.80 K | 1.10 U |
| Arsenic | 2.00 K | 9.30 K | 4.50 K | 10.80 K | 3.00 UJ | 6.30 K | 6.00 K | 2.90 K | 1.80 K |
| Barium | 28.90 J | 131.00 J | 175.00 J | 195.00 J | 5.00 UJ | 57.10 J | 122.00 J | 69.40 J | 148.00 J |
| Beryllium | 0.60 U | 0.78 | 0.65 U | 1.20 | 5.00 U | 0.63 U | 0.73 | 0.59 U | 2.50 |
| Cadmium | 3.00 UR | 3.20 UR | 0.65 UR | 0.04 UR | 5.00 UR | 3.10 UR | 3.00 UR | 2.90 UR | 5.40 UR |
| Chromium | 17.30 K | 48.60 K | 31.30 K | 234.00 K | 10.00 UJ | 28.30 K | 49.90 K | 23.30 K | 2220.00 K |
| Cobalt | 3.80 | 11.90 | 6.30 | 14.20 K | 10.00 U | 8.90 | 11.20 | 9.30 | 69.10 |
| Cyanide | 0.29 U | 0.32 U | 0.32 U | 0.39 U | 5.00 U | 0.46 | 0.54 | 0.29 U | 0.54 |
| Lead | 57.20 L | 191.00 L | 477.00 L | 149.00 L | 50.00 UL | 297.00 L | 556.00 L | 150.00 L | 49.60 L |
| Mercury | 0.53 L | 3.50 L | 1.50 L | 1.00 L | 0.20 UR | 1.70 L | 2.60 L | 0.40 L | 0.47 L |
| Nickel | 6.60 | 26.40 | 17.30 | 26.60 | 20.00 U | 19.30 | 57.70 | 16.00 | 31.00 |
| Selenium | 0.48 UL | 0.56 L | 0.52 UL | 0.62 UL | 4.00 UL | 0.50 UL | 0.49 UL | 0.47 UL | 0.43 UL |
| Sulfide | 9.90 | 5.20 | 10.70 | 51.30 | 200.00 UL | 5.20 | 15.10 | 3.50 U | 22.60 |
| Vanadium | 19.60 K | 39.50 K | 20.20 K | 77.90 K | 10.00 U | 60.30 K | 56.80 K | 34.00 K | 854.00 K |

Table 4-13
Skinner List Inorganic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 29 | | SWMU 30 | | |
|---|---|---|---|---|---|
| Dames & Moore Sample ID | B029A1 | B029A2 | B030A1 | B030A2 | B030A3 |
| Sample Location | B29-1 | B29-2 | B30-1 | B30-2 | B30-3 |
| Sample Depth | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft |
| Laboratory ID | P208443 | P208444 | P208445 | P208446 | P208447 |
| Sample Date | 08/10/92 | 08/10/92 | 08/10/92 | 08/10/92 | 08/10/92 |
| Units | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| Inorganic Compounds | | | | | |
| Antimony | 1.20 U | 11.80 | 1.30 U | 1.10 U | 5.70 |
| Arsenic | 10.70 K | 12.60 K | 11.60 K | 3.50 K | 17.40 K |
| Barium | 236.00 L | 202.00 L | 139.00 L | 72.10 L | 280.00 L |
| Beryllium | 0.99 | 0.73 | 0.64 | 0.57 | 0.62 U |
| Cadmium | 0.62 UL | 0.61 UL | 0.64 UL | 1.10 UL | 0.62 UL |
| Chromium | 308.00 | 137.00 | 38.80 | 19.20 | 21.80 |
| Cobalt | 32.00 | 12.00 | 13.20 | 8.40 | 4.60 |
| Cyanide | 0.69 K | 0.65 K | 0.36 K | 0.28 U | 0.80 K |
| Lead | 295.00 | 695.00 | 93.30 | 45.50 | 471.00 |
| Mercury | 7.40 K | 1.50 K | 0.69 K | 0.29 K | 0.60 K |
| Nickel | 55.90 L | 27.80 L | 19.90 L | 10.80 L | 10.10 L |
| Selenium | 0.94 L | 0.68 L | 0.64 L | 0.46 UL | 0.68 L |
| Sulfide | 3.70 UJ | 3.60 UJ | 3.90 UJ | 9.40 J | 15.30 J |
| Vanadium | 162.00 L | 75.10 L | 25.10 L | 22.40 L | 39.70 L |

Table 4-13
Skinner List Inorganic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 71 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B071A1 | B071A2 | B071A3 | B071A4 | B071A5 | B071A6 | B071A7 | B071A8 |
| Sample Location | B71-1 | B71-2 | B71-3 | B71-4 | B71-5 | B71-6 | B71-6 Rep | Field Blank |
| Sample Depth | 1-2ft | 2-4ft | 3-4.5ft | 2-4ft | 1-3ft | 1-3ft | 1-3ft | |
| Laboratory ID | P208497 | P208498 | P208502 | P208503 | P208504 | P208505 | P208506 | P208507 |
| Sample Date | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 |
| Units | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | UG/L |
| Inorganic Compounds | | | | | | | | |
| Antimony | 1.10 U | 1.20 U | 1.30 | 1.10 U | 2.10 | 1.30 | 1.10 U | 10.00 U |
| Arsenic | 5.10 K | 11.60 K | 9.10 K | 4.90 K | 8.90 K | 8.60 K | 7.60 K | 3.00 U |
| Barium | 102.00 L | 291.00 L | 229.00 L | 82.80 L | 302.00 L | 149.00 K | 159.00 L | 5.00 UL |
| Beryllium | 0.67 | 0.95 | 0.88 | 0.67 | 1.30 | 0.92 | 1.40 | 5.00 U |
| Cadmium | 0.56 UL | 0.83 L | 0.63 UL | 0.56 UL | 0.65 UL | 0.57 UL | 0.57 UL | 5.00 UL |
| Chromium | 230.00 | 753.00 | 131.00 | 234.00 | 199.00 | 251.00 | 185.00 | 10.00 U |
| Cobalt | 8.50 | 40.80 | 12.60 | 14.30 | 159.00 | 20.50 | 23.50 | 10.00 U |
| Cyanide | 0.28 U | 4.50 K | 0.31 U | 0.97 K | 0.64 K | 0.58 K | 3.00 K | 5.00 U |
| Lead | 166.00 | 358.00 | 373.00 | 149.00 | 324.00 | 322.00 | 336.00 | 50.00 U |
| Mercury | 3.30 K | 3.10 K | 1.30 K | 2.00 K | 2.80 K | 2.90 K | 2.40 K | 0.20 U |
| Nickel | 28.10 L | 61.30 L | 33.50 L | 37.30 L | 49.50 L | 49.80 L | 59.30 L | 20.00 UL |
| Selenium | 0.57 L | 0.01 L | 1.10 L | 0.53 L | 0.65 L | 0.56 L | 0.46 UL | 4.00 UL |
| Sulfide | 3.40 UJ | 14.70 J | 3.80 UJ | 3.30 UJ | 3.90 UJ | 9.40 J | 18.70 J | 200.00 UJ |
| Vanadium | 87.50 L | 145.00 L | 108.00 L | 100.00 L | 87.20 L | 117.00 L | 125.00 L | 10.00 UL |

Table 4-13
Skinner List Inorganic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 71A | |
|---|---|---|
| Dames & Moore Sample ID | B071AA1 | B071AA2 |
| Sample Location | B71A-1 | B71A-2 |
| Sample Depth | 2-4ft | 4-6ft |
| Laboratory ID | P208614 | P208615 |
| Sample Date | 08/12/92 | 08/12/92 |
| Units | mg/kg | mg/kg |
| Inorganic Compounds | | |
| Antimony | 1.30 U | 1.40 U |
| Arsenic | **9.80 K** | **14.60 K** |
| Barium | **128.00 L** | **294.00 L** |
| Beryllium | 0.63 U | **2.20** |
| Cadmium | 0.63 UL | 0.68 UL |
| Chromium | **244.00** | **81.10** |
| Cobalt | **12.80** | **7.60** |
| Cyanide | **1.40 K** | **2.30 K** |
| Lead | **227.00** | **360.00** |
| Mercury | **9.30 K** | **0.01 K** |
| Nickel | **70.70 L** | **69.30 L** |
| Selenium | **0.01 L** | **0.02 L** |
| Sulfide | 3.80 UJ | 4.10 UJ |
| Vanadium | **46.10 L** | **521.00 L** |

# TABLE 4-13

## Skinner List Inorganic Compound Analytical Data
## Subsurface Soil Investigation
## RCRA Verification Investigation
## Chevron Refinery
## Philadelphia, Pennsylvania

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| mg/kg | - | milligrams per kilogram. |
| Rep | - | Replicate Sample. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |
| UJ | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is estimated. |
| UL | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is biased low. |
| UR | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the data is unreliable. The compound may or may not be present. |
| J | - | The associated numerical value is an estimated quantity. |
| K | - | The associated numerical value is biased high. |
| L | - | The associated numerical value is biased low. |

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# TABLE 4-14

## RISK-BASED EVALUATION ACTION LEVELS
## DETECTED VOLATILE ORGANIC COMPOUNDS
## SUBSURFACE SOIL INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| COMPOUND | ACTION LEVEL (ug/kg) | SOURCE |
|---|---|---|
| Acetone | $8 \times 10^6$ | 1 |
| Benzene | $9.9 \times 10^4$ | 2 |
| 2-Butanone | $4 \times 10^6$ | 1 |
| Carbon Disulfide | $8 \times 10^6$ | 1 |
| Chlorobenzene | $2 \times 10^6$ | 1 |
| 1,2-Dichloropropane | $4.2 \times 10^4$ | 2 |
| Ethylbenzene | $8 \times 10^6$ | 1 |
| Isopropylbenzene (Cumene) | $4.1 \times 10^7$ | 2 |
| Methylene Chloride | $9 \times 10^4$ | 1 |
| N-Propylbenzene | NA | - |
| Toluene | $2 \times 10^7$ | 1 |
| Xylenes | $2 \times 10^8$ | 1 |

Explanation:

NA - No action level listed in either source
ug/kg - Micrograms per kilogram

Notes:

1. Appendix A of July 27, 1990 Corrective Action Rule.
2. Roy L. Smith's April 14, 1992 USEPA Region III Memorandum.

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# TABLE 4-14

## RISK-BASED EVALUATION ACTION LEVELS
## DETECTED SEMI-VOLATILE ORGANIC COMPOUNDS
## SUBSURFACE SOIL INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| COMPOUND | ACTION LEVEL (ug/kg) | SOURCE |
|---|---|---|
| Acenaphthene | $6.1 \times 10^{7}$ | 1 |
| Acenaphthalene | NA | - |
| Anthracene | $3.1 \times 10^{8}$ | 1 |
| Benzo(a)anthracene | $3.4 \times 10^{3}$ | 1 |
| Benzo(a)pyrene | $4.9 \times 10^{2}$ | 1 |
| Benzo(b,j,k)fluoranthene | $3.5 \times 10^{3}$ | 1 |
| Benzo(g,h,i)perylene | $2.2 \times 10^{1}$ | 1 |
| Chrysene | $1.1 \times 10^{5}$ | 1 |
| p-Cresol | $4 \times 10^{6}$ | 2 |
| Di-n-butylphthalate | $8 \times 10^{6}$ | 2 |
| Dibenz(a,h)anthracene | $4.4 \times 10^{2}$ | 1 |
| Dibenzofuran | NA | - |
| 1,3-Dichloro-2-propanol | NA | - |
| Diethyl Phthalate | $6 \times 10^{7}$ | 2 |
| Dimethyl Phthalate | $1.0 \times 10^{10}$ | 1 |
| Bis(2-ethylhexyl)phthalate | $5 \times 10^{4}$ | 2 |
| Fluoranthene | $4.1 \times 10^{7}$ | 1 |
| Fluorene | $4.1 \times 10^{7}$ | 1 |
| Indeno(1,2,3-cd)pyrene | $2.1 \times 10^{3}$ | 1 |
| 1-Methylnaphthalene | NA | - |
| 2-Methylnaphthalene | NA | - |
| Naphthalene | $4.1 \times 10^{7}$ | 1 |
| Phenanthrene | $3.0 \times 10^{7}$ | 1 |
| Pyrene | $6.1 \times 10^{3}$ | 1 |

Explanation:

NA - No action level listed in either source
ug/kg - Micrograms per kilogram

Notes:

1. Roy L. Smith's April 14, 1992 USEPA Region III Memorandum.
2. Appendix A of July 27, 1990 Corrective Action Rule.

# TABLE 4-14

## RISK-BASED EVALUATION ACTION LEVELS
## DETECTED INORGANIC ANALYTES
## SUBSURFACE SOIL INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| COMPOUND | ACTION LEVEL (mg/kg) | SOURCE |
|---|---|---|
| Antimony | $3 \times 10^{1}$ | 1 |
| Arsenic | $8 \times 10^{1}$ | 1 |
| Barium | $4 \times 10^{3}$ | 1 |
| Beryllium | $2 \times 10^{-1}$ | 1 |
| Cadmium | $4 \times 10^{1}$ | 1 |
| Chromium | $4 \times 10^{2}$ | 1 |
| Cobalt | NA | - |
| Copper | $3.8 \times 10^{4}$ | 2 |
| Lead[3] | $1.13 \times 10^{2}$/$4.7 \times 10^{1}$ | 2 |
| Mercury | $2 \times 10^{1}$ | 1 |
| Nickel | $2 \times 10^{3}$ | 1 |
| Selenium | $5.1 \times 10^{3}$ | 2 |
| Thallium | NA | - |
| Vanadium | $7.2 \times 10^{3}$ | 2 |
| Zinc | $2 \times 10^{5}$ | 2 |
| Cyanide | $2 \times 10^{3}$ | 1 |
| Sulfide | $2 \times 10^{2}$ | 1 |

Explanation:

NA - No action level listed in either source
mg/kg - Milligrams per kilogram

Notes:

1. Appendix A of July 27, 1990 Corrective Action Rule.
2. Roy L. Smith's April 14, 1992 USEPA Region III Memorandum.
3. Roy L. Smith's August 8, 1990 USEPA Region III Memorandum. Lead action levels represent inorganic lead ($1.13 \times 10^{2}$ mg/kg) and carcinogenic lead ($4.7 \times 10^{1}$ mg/kg) values.

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Table 4-15
Skinner List Volatile Organic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 1 | SWMU 2 | | | | SWMU 6 | | |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | G001A1 | G002A1 | G002A1MS | G002A1MSD | G002A3 | G006A1 | G006A3 | G006A5 |
| Sample Location | A40 | A137 | A137-MS | A137-MSD | A137 Rep | A135 | Field Blank | Trip Blank |
| Laboratory ID | P210683 | P210674 | P210685 | P210687 | P210676 | P210678 | P210680 | P210682 |
| Sample Date | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| Volatile Organic Compounds | | | | | | | | |
| Acetonitrile | 50 UJ | 50 UJ | 50 UJ | 50 UJ | 50 UJ | 50 UJ | 50 UJ | 50 UR |
| Acrolein | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U |
| Acrylonitrile | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U |
| Benzene | 5 U | 5 U | 5 U | 5 U | 5 U | **120** | 5 U | 5 U |
| 2-Butanone | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Carbon disulfide | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Chlorobenzene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Chloroform | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Chloromethane | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Crotonaldehyde (2-Butenal) | 50 UR | **9 R** | 50 UR | 50 UR | 50 UR | 50 UR | 50 UR | 50 UR |
| 1,2-Dibromoethane | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,2-Dichloroethane | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1-Dichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Trans-1,2-Dichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-Dichloropropane | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,4-Dioxane | 150 UR | 150 UR | 150 UR | 150 UR | 150 UR | 150 UR | 150 UR | 150 UR |
| Ethylene oxide | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Ethyleneimine | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Isopropylbenzene (Cumene) | 10 U | 10 U | 10 U | 10 U | 10 U | **86** | 10 U | 10 U |
| Methanethiol | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Methylene Chloride | 5 U | 5 U | **4 J** | **3 J** | 5 U | 5 U | 5 U | **2 J** |
| N-Propylbenzene | 10 U | 10 U | 10 U | 10 U | 10 U | **130** | 10 U | 10 U |
| Styrene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1,1,2-Tetrachloroethane | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,1,2,2-Tetrachloroethane | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

Table 4-15
Skinner List Volatile Organic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 1 | SWMU 2 | | | | SWMU 6 | | |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | G001A1 | G002A1 | G002A1MS | G002A1MSD | G002A3 | G006A1 | G006A3 | G006A5 |
| Sample Location | A40 | A137 | A137-MS | A137-MSD | A137 Rep | A135 | Field Blank | Trip Blank |
| Laboratory ID | P210683 | P210674 | P210685 | P210687 | P210676 | P210678 | P210680 | P210682 |
| Sample Date | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| Tetrachloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Toluene | 5 U | 5 U | 5 U | 5 U | 5 U | **32** | 5 U | 5 U |
| 1,1,1-Trichloroethane | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1,2-Trichloroethane | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Trichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Xylene (Total) | 5 U | 5 U | 5 U | 5 U | 5 U | **17** | 5 U | 5 U |
| Formaldehyde | 100.00 U | 100.00 U | | | 100.00 U | 100.00 U | 100.00 U | 100.00 U |

Table 4-15
Skinner List Volatile Organic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 9 | SWMU 13 | SWMU 16/17 | SWMU 29 | SWMU 71 | | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | G009A1 | G013A1 | G017A1 | G029A1 | G071A1 | G071A3 | G071A5 |
| Sample Location | A136 | A134 | A132 | B130 | C127 | Field Blank | Trip Blank |
| Laboratory ID | P210924 | P210918 | P210825 | P210920 | P210820 | P210822 | P210824 |
| Sample Date | 09/04/92 | 09/03/92 | 09/03/92 | 09/03/92 | 09/03/92 | 09/03/92 | 09/03/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| Volatile Organic Compounds | | | | | | | |
| Acetonitrile | 50 UR | 50 U | 50 U | 50 U | 50 UJ | 50 UJ | 50 U |
| Acrolein | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U |
| Acrylonitrile | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U |
| Benzene | 5 U | 23 | 5 U | 5 | 5 U | 5 U | 5 U |
| 2-Butanone | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Carbon disulfide | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Chlorobenzene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Chloroform | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Chloromethane | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Crotonaldehyde (2-Butenal) | 50 UR | 50 UR | 50 UR | 50 UR | 50 UR | 50 UR | 50 UR |
| 1,2-Dibromoethane | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,2-Dichloroethane | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1-Dichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Trans-1,2-Dichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-Dichloropropane | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,4-Dioxane | 150 UR | 150 UR | 150 UR | 150 UR | 150 UR | 150 UR | 150 UR |
| Ethylene oxide | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Ethyleneimine | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Isopropylbenzene (Cumene) | 10 U | 26 | 9 J | 30 | 4 J | 10 U | 10 U |
| Methanethiol | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Methylene Chloride | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| N-Propylbenzene | 10 U | 8 J | 10 U | 24 | 10 U | 10 U | 10 U |
| Styrene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1,1,2-Tetrachloroethane | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,1,2,2-Tetrachloroethane | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

Table 4-15
Skinner List Volatile Organic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 9 | SWMU 13 | SWMU 16/17 | SWMU 29 | SWMU 71 | | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | G009A1 | G013A1 | G017A1 | G029A1 | G071A1 | G071A3 | G071A5 |
| Sample Location | A136 | A134 | A132 | B130 | C127 | Field Blank | Trip Blank |
| Laboratory ID | P210924 | P210918 | P210825 | P210920 | P210820 | P210822 | P210824 |
| Sample Date | 09/04/92 | 09/03/92 | 09/03/92 | 09/03/92 | 09/03/92 | 09/03/92 | 09/03/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| Tetrachloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Toluene | 5 U | 9 | 5 U | 7 | 5 U | 5 U | 5 U |
| 1,1,1-Trichloroethane | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1,2-Trichloroethane | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Trichloroethene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Xylene (Total) | 5 U | 40 | 5 U | 24 | 5 U | 5 U | 5 U |
| Formaldehyde | 100.00 U | 100.00 U | 100.00 U | 100.00 U | 100.00 U | 100.00 U | 100.00 U |

## TABLE 4-15

**Skinner List Volatile Organic Compound Analytical Data**
**Groundwater Investigation**
**RCRA Verification Investigation**
**Chevron Refinery**
**Philadelphia, Pennsylvania**

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| ug/l | - | micrograms per liter. |
| MS | - | Matrix Spike quality assurance/quality control sample. |
| MSD | - | Matrix Spike Duplicate quality assurance/quality control sample. |
| Rep | - | Replicate Sample. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |
| UJ | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is estimated. |
| UR | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the data is unreliable. The compound may or may not be present. |
| J | - | The associated numerical value is an estimated quantity. |

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# Table 4-16
## Skinner List Semivolatile Organic Compound Analytical Data
## Groundwater Investigation
## RCRA Verification Investigation
## Chevron Refinery
## Philadelphia, Pennsylvania

| SWMU Designation | SWMU 1 | SWMU 2 | | | | SWMU 6 | | SWMU 9 |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | G001A1 | G002A1 | G002A1MS | G002A1MSD | G002A3 | G006A1 | G006A3 | G009A1 |
| Sample Location | A40 | A137 | A137-MS | A137-MSD | A137 Rep | A135 | Field Blank | A136 |
| Laboratroy ID | P210683 | P210674 | P210685 | P210687 | P210676 | P210678 | P210680 | P210924 |
| Sample Date | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/04/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| Semivolatile Organic Compounds | | | | | | | | |
| Aniline | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Anthracene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 3 J |
| Benz(c)acridine | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Benzenethiol | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Benzidine | 500 U | 500 U | 500 UJ | 500 UJ | 500 U | 500 UJ | 500 U | 500 UJ |
| Benzo(a)anthracene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Benzo(a)pyrene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Benzo(b,j,k)fluoranthene | 40 U | 40 U | 40 U | 40 U | 40 U | 40 U | 40 U | 40 U |
| Benzyl chloride | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Butyl benzyl phthalate | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| p-Chloro-m-cresol | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Bis(2-chloroethyl) ether | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Bis(2-chloroisopropyl)ether | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Bis(2-chloromethyl)ether | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 2-Chloronaphthalene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2-Chlorophenol | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Chrysene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| o-Cresol | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| p-Cresol | 30 U | 30 U | 30 U | 30 U | 30 U | 30 U | 30 U | 30 U |
| Di-n-butylphthalate | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Di-n-octylphthalate | 4 J | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Dibenz(a,h)acridine | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Dibenz(a,h)anthracene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Dibenz(a,i)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Dibenz(a,j)acridine | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |

Table 4-16
Skinner List Semivolatile Organic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 1 | SWMU 2 | | | | SWMU 6 | | SWMU 9 |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | G001A1 | G002A1 | G002A1MS | G002A1MSD | G002A3 | G006A1 | G006A3 | G009A1 |
| Sample Location | A40 | A137 | A137-MS | A137-MSD | A137 Rep | A135 | Field Blank | A136 |
| Laboratroy ID | P210683 | P210674 | P210685 | P210687 | P210676 | P210678 | P210680 | P210924 |
| Sample Date | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/04/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| Dibenzo(a,e)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| Dibenzo(a,h)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 7h-Dibenzo(c,g)carbazole | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U | 0 U |
| 1,3-Dichloro-2-propanol | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,2-Dichlorobenzene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,3-Dichlorobenzene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,4-Dichlorobenzene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Diethyl phthalate | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Dimethyl phthalate | **4 BJ** | **5 BJ** | **6 J** | 10 U | **5 BJ** | **4 J** | 10 U | 10 U |
| 7,12-Dimethylbenz(a)anthracene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2,4-Dimethylphenol | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 4,6-Dinitro-o-cresol | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U |
| 2,4-Dinitrophenol | 50 UJ | 50 UJ | 50 U | 50 U | 50 UJ | 50 U | 50 U | 50 U |
| 2,4-Dinitrotoluene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,2-Diphenylhydrazine | 10 U | 10 U | 10 UJ | 10 UJ | 10 U | 10 UJ | 10 U | 10 UJ |
| Bis(2-ethylhexyl) phthalate | **62** | **83** | **12** | **32** | **96** | **19** | 10 U | 10 U |
| Fluoranthene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Hydroquinone | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U |
| Indene | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U |
| Indeno(1,2,3-cd)pyrene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 3-Methylcholanthrene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1-Methylnaphthalene | 20 U | 20 U | 20 U | 20 U | 20 U | **38** | 20 U | **11 J** |
| Naphthalene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 5-Nitroacenapthene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| P-Nitroaniline | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U |
| Nitrobenzene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |

Table 4-16
Skinner List Semivolatile Organic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 1 | SWMU 2 | | | | SWMU 6 | | SWMU 9 |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | G001A1 | G002A1 | G002A1MS | G002A1MSD | G002A3 | G006A1 | G006A3 | G009A1 |
| Sample Location | A40 | A137 | A137-MS | A137-MSD | A137 Rep | A135 | Field Blank | A136 |
| Laboratroy ID | P210683 | P210674 | P210685 | P210687 | P210676 | P210678 | P210680 | P210924 |
| Sample Date | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/04/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| P-Nitrophenol | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U |
| Pentachlorophenol | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U |
| Phenanthrene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 9 J |
| Phenol | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Pyrene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Pyridine | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U |
| Quinoline | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U |
| 1,2,4-Trichlorobenzene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2,4,5-Trichlorophenol | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U |
| 2,4,6-Trichlorophenol | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |

Table 4-16
Skinner List Semivolatile Organic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 13 | SWMU 16/17 | SWMU 29 | SWMU 71 | |
|---|---|---|---|---|---|
| Dames & Moore Sample ID | G013A1 | G017A1 | G029A1 | G071A1 | G071A3 |
| Sample Location | A134 | A132 | B130 | C127 | Field Blank |
| Laboratroy ID | P210918 | P210825 | P210920 | P210820 | P210822 |
| Sample Date | 09/03/92 | 09/03/92 | 09/03/92 | 09/03/92 | 09/03/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L |
| Semivolatile Organic Compounds | | | | | |
| Aniline | 10 U | 10 U | 10 U | 10 U | 10 U |
| Anthracene | 10 U | 10 U | 10 U | 10 U | 10 U |
| Benz(c)acridine | 0 U | 0 U | 0 U | 0 U | 0 U |
| Benzenethiol | 10 U | 10 U | 10 U | 10 U | 10 U |
| Benzidine | 500 UJ | 500 U | 500 UJ | 500 UJ | 500 U |
| Benzo(a)anthracene | 10 U | 10 U | 10 U | 10 U | 10 U |
| Benzo(a)pyrene | 10 U | 10 U | 10 U | 10 U | 10 U |
| Benzo(b,j,k)fluoranthene | 40 U | 40 U | 40 U | 40 U | 40 U |
| Benzyl chloride | 10 U | 10 U | 10 U | 10 U | 10 U |
| Butyl benzyl phthalate | 10 U | 10 U | 10 U | 10 U | 10 U |
| p-Chloro-m-cresol | 10 U | 10 U | 10 U | 10 U | 10 U |
| Bis(2-chloroethyl) ether | 10 U | 10 U | 10 U | 10 U | 10 U |
| Bis(2-chloroisopropyl)ether | 10 U | 10 U | 10 U | 10 U | 10 U |
| Bis(2-chloromethyl)ether | 0 U | 0 U | 0 U | 0 U | 0 U |
| 2-Chloronaphthalene | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2-Chlorophenol | 10 U | 10 U | 10 U | 10 U | 10 U |
| Chrysene | 10 U | 10 U | 10 U | 10 U | 10 U |
| o-Cresol | 10 U | 10 U | 10 U | 10 U | 10 U |
| p-Cresol | 30 U | 30 U | 30 U | 30 U | 30 U |
| Di-n-butylphthalate | 10 U | 10 U | 10 U | 10 U | 10 U |
| Di-n-octylphthalate | 10 U | 10 U | 10 U | 10 U | 10 U |
| Dibenz(a,h)acridine | 10 U | 10 U | 10 U | 10 U | 10 U |
| Dibenz(a,h)anthracene | 10 U | 10 U | 10 U | 10 U | 10 U |
| Dibenz(a,i)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U |
| Dibenz(a,j)acridine | 10 U | 10 U | 10 UJ | 10 UJ | 10 U |

Table 4-16
Skinner List Semivolatile Organic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 13 | SWMU 16/17 | SWMU 29 | SWMU 71 | |
|---|---|---|---|---|---|
| Dames & Moore Sample ID | G013A1 | G017A1 | G029A1 | G071A1 | G071A3 |
| Sample Location | A134 | A132 | B130 | C127 | Field Blank |
| Laboratroy ID | P210918 | P210825 | P210920 | P210820 | P210822 |
| Sample Date | 09/03/92 | 09/03/92 | 09/03/92 | 09/03/92 | 09/03/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L |
| Dibenzo(a,e)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U |
| Dibenzo(a,h)pyrene | 0 U | 0 U | 0 U | 0 U | 0 U |
| 7h-Dibenzo(c,g)carbazole | 0 U | 0 U | 0 U | 0 U | 0 U |
| 1,3-Dichloro-2-propanol | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,2-Dichlorobenzene | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,3-Dichlorobenzene | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,4-Dichlorobenzene | 10 U | 10 U | 10 U | 10 U | 10 U |
| Diethyl phthalate | 10 U | 10 U | 3 J | 10 U | 10 U |
| Dimethyl phthalate | 10 U | 4 BJ | 10 B | 10 U | 4 BJ |
| 7,12-Dimethylbenz(a)anthracene | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2,4-Dimethylphenol | 10 U | 10 U | 10 U | 10 U | 10 U |
| 4,6-Dinitro-o-cresol | 50 U | 50 U | 50 U | 50 U | 50 U |
| 2,4-Dinitrophenol | 50 U | 50 UJ | 50 U | 50 U | 50 UJ |
| 2,4-Dinitrotoluene | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,2-Diphenylhydrazine | 10 UJ | 10 U | 10 UJ | 10 UJ | 10 U |
| Bis(2-ethylhexyl) phthalate | 10 U | 10 U | 5 J | 10 U | 10 U |
| Fluoranthene | 10 U | 10 U | 10 U | 5 J | 10 U |
| Hydroquinone | 50 U | 50 U | 50 U | 50 U | 50 U |
| Indene | 20 U | 20 U | 20 U | 20 U | 20 U |
| Indeno(1,2,3-cd)pyrene | 10 U | 10 U | 10 U | 10 U | 10 U |
| 3-Methylcholanthrene | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1-Methylnapthalene | 20 U | 10 J | 9 J | 12 J | 20 U |
| Naphthalene | 10 U | 10 U | 10 U | 10 U | 10 U |
| 5-Nitroacenapthene | 10 U | 10 U | 10 U | 10 U | 10 U |
| P-Nitroaniline | 50 U | 50 U | 50 U | 50 U | 50 U |
| Nitrobenzene | 10 U | 10 U | 10 U | 10 U | 10 U |

Table 4-16
Skinner List Semivolatile Organic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 13 | SWMU 16/17 | SWMU 29 | SWMU 71 | |
|---|---|---|---|---|---|
| Dames & Moore Sample ID | G013A1 | G017A1 | G029A1 | G071A1 | G071A3 |
| Sample Location | A134 | A132 | B130 | C127 | Field Blank |
| Laboratroy ID | P210918 | P210825 | P210920 | P210820 | P210822 |
| Sample Date | 09/03/92 | 09/03/92 | 09/03/92 | 09/03/92 | 09/03/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L |
| P-Nitrophenol | 50 U | 50 U | 50 U | 50 U | 50 U |
| Pentachlorophenol | 50 U | 50 U | 50 U | 50 U | 50 U |
| Phenanthrene | 10 U | 10 U | 10 U | 7 J | 10 U |
| Phenol | 10 U | 10 U | 10 U | 10 U | 10 U |
| Pyrene | 10 U | 10 U | 10 U | 4 J | 10 U |
| Pyridine | 20 U | 20 U | 20 U | 20 U | 20 U |
| Quinoline | 20 U | 20 U | 20 U | 20 U | 20 U |
| 1,2,4-Trichlorobenzene | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2,4,5-Trichlorophenol | 50 U | 50 U | 50 U | 50 U | 50 U |
| 2,4,6-Trichlorophenol | 10 U | 10 U | 10 U | 10 U | 10 U |

# TABLE 4-16

## Skinner List Semivolatile Organic Compound Analytical Data
## Groundwater Investigation
## RCRA Verification Investigation
## Chevron Refinery
## Philadelphia, Pennsylvania

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| ug/l | - | micrograms per liter. |
| MS | - | Matrix Spike quality assurance/quality control sample. |
| MSD | - | Matrix Spike Duplicate quality assurance/quality control sample. |
| Rep | - | Replicate Sample. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |
| UJ | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is estimated. |
| J | - | The associated numerical value is an estimated quantity. |
| B | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. |
| BJ | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. The associated numerical value is an estimated quantity. |

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Table 4-17
Skinner List Inorganic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 1 | SWMU 2 | | SWMU 6 | | SWMU 9 | SWMU 13 |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | G001A1 | G002A1 | G002A3 | G006A1 | G006A3 | G009A1 | G013A1 |
| Sample Location | A40 | A137 | A137 Rep | A135 | Field Blank | A136 | A134 |
| Laboratory ID | P210683 | P210674 | P210676 | P210678 | P210680 | P210924 | P210918 |
| Sample Date | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/04/92 | 09/03/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| Inorganic Compounds | | | | | | | |
| Antimony | 10.00 U | 10.00 U | 10.00 U | 10.00 U | 10.00 U | 10.00 U | 10.00 U |
| Arsenic | **7.10** | **6.80** | **7.50** | **13.30** | 3.00 U | **12.90** | **40.60** |
| Barium | **757.00** | **472.00** | **461.00** | **396.00** | 5.00 U | **377.00** | **256.00** |
| Beryllium | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U |
| Cadmium | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U |
| Chromium | **24.00** | **26.00** | **27.00** | **56.00** | 10.00 U | **68.00** | **71.00** |
| Cobalt | 10.00 U | 10.00 U | 10.00 U | **12.00** | 10.00 U | **24.00** | **13.00** |
| Cyanide | **9.20** | **8.50** | **8.00** | 5.00 U | 5.00 U | **9.60** | **11.00** |
| Lead | **747.00** | **413.00** | **411.00** | **318.00** | 50.00 U | **346.00** | **167.00** |
| Mercury | **0.83** | **0.29** | 0.20 U | 0.20 U | 0.20 U | **3.60** | **0.90** |
| Nickel | 20.00 U | 20.00 U | 20.00 U | **42.00** | 20.00 U | **59.00** | **20.00** |
| Selenium | 4.00 U | 4.00 U | 4.00 U | 4.00 U | 4.00 U | 4.00 U | 4.00 U |
| Sulfide | 200.00 UL | 200.00 UL | 200.00 UL | 200.00 UL | 200.00 UR | 200.00 UL | 200.00 U |
| Vanadium | 10.00 U | **24.00** | **22.00** | **51.00** | 10.00 U | **195.00** | **41.00** |

Table 4-17
Skinner List Inorganic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 16/17 | SWMU 29 | SWMU 71 | |
|---|---|---|---|---|
| Dames & Moore Sample ID | G017A1 | G029A1 | G071A1 | G071A3 |
| Sample Location | A132 | B130 | C127 | Field Blank |
| Laboratory ID | P210825 | P210920 | P210820 | P210822 |
| Sample Date | 09/03/92 | 09/03/92 | 09/03/92 | 09/03/92 |
| Units | UG/L | UG/L | UG/L | UG/L |
| Inorganic Compounds | | | | |
| Antimony | 10.00 U | 10.00 U | 10.00 U | 10.00 U |
| Arsenic | 28.50 | 59.40 | 65.00 | 3.00 U |
| Barium | 2910.00 | 234.00 | 1320.00 | 5.00 U |
| Beryllium | 6.00 | 5.00 U | 5.00 U | 5.00 U |
| Cadmium | 5.00 U | 5.00 U | 5.00 U | 5.00 U |
| Chromium | 928.00 | 17.00 | 281.00 | 10.00 U |
| Cobalt | 276.00 | 10.00 U | 76.00 | 10.00 U |
| Cyanide | 7.40 | 8.80 | 34.50 | 5.00 U |
| Lead | 1620.00 | 171.00 | 1440.00 | 50.00 U |
| Mercury | 3.40 | 0.44 | 4.80 | 0.20 U |
| Nickel | 238.00 | 20.00 U | 126.00 | 20.00 U |
| Selenium | 4.00 U | 4.00 U | 4.00 U | 4.00 U |
| Sulfide | 200.00 UL | 200.00 UL | 2200.00 L | 200.00 UL |
| Vanadium | 596.00 | 21.00 | 192.00 | 10.00 U |

# TABLE 4-17

## Skinner List Inorganic Compound Anaytical Data
## Groundwater Investigation
## RCRA Verification Investigation
## Chevron Refinery
## Philadelphia, Pennsylvania

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| ug/l | - | micrograms per liter. |
| Rep | - | Replicate Sample. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |
| UL | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is biased low. |
| UR | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the data is unreliable. The compound may or may not be present. |
| L | - | The associated numerical value is biased low. |

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Table 4-18
Skinner List Filtered Inorganic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 1 | SWMU 2 | | SWMU 6 | | SWMU 9 | SWMU 13 |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | G001A2 | G002A2 | G002A4 | G006A2 | G006A4 | G009A2 | G013A2 |
| Sample Location | A40 | A137 | A137 Rep | A135 | Field Blank | A136 | A134 |
| Laboratory ID | P210684 | P210675 | P210677 | P210679 | P210681 | P210925 | P210919 |
| Sample Date | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/02/92 | 09/04/92 | 09/03/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| Inorganic Compounds | | | | | | | |
| Antimony, Filtered | **19.50 B** | 10.00 U | 10.00 U | 10.00 U | **11.20** | 10.00 U | 10.00 U |
| Arsenic, Filtered | 3.00 U | 3.00 U | **6.10** | **7.20** | 3.00 U | 3.00 U | **24.40** |
| Barium, Filtered | 5.00 U | **292.00** | **292.00** | **169.00** | 5.00 U | **157.00** | **11.00** |
| Beryllium, Filtered | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U |
| Cadmium, Filtered | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U | 5.00 U |
| Chromium, Filtered | 10.00 U | 10.00 U | 10.00 U | 10.00 U | 10.00 U | 10.00 U | **11.00** |
| Cobalt, Filtered | 10.00 U | 10.00 U | 10.00 U | 10.00 U | 10.00 U | **11.00** | 10.00 U |
| Lead, Filtered | 50.00 U | 50.00 U | 50.00 U | 50.00 U | 50.00 U | 50.00 U | 50.00 U |
| Mercury, Filtered | **1.00** | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| Nickel, Filtered | 20.00 U | 20.00 U | 20.00 U | 20.00 U | 20.00 U | **29.00** | 20.00 U |
| Selenium, Filtered | 4.00 U | 4.00 U | 4.00 U | 4.00 U | 4.00 U | 4.00 U | 4.00 U |
| Vanadium, Filtered | 10.00 U | 10.00 U | 10.00 U | 10.00 U | 10.00 U | 10.00 U | 10.00 U |

Table 4-18
Skinner List Filtered Inorganic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 16/17 | SWMU 19 | SWMU 71 | |
|---|---|---|---|---|
| Dames & Moore Sample ID | G017A2 | G029A2 | G071A2 | G071A4 |
| Sample Location | A132 | B130 | C127 | Field Blank |
| Laboratory ID | P210826 | P210921 | P210821 | P210823 |
| Sample Date | 09/03/92 | 09/03/92 | 09/03/92 | 09/03/92 |
| Units | UG/L | UG/L | UG/L | UG/L |
| Inorganic Compounds | | | | |
| Antimony, Filtered | 10.00 U | 10.00 U | 10.00 U | **19.00** |
| Arsenic, Filtered | **4.40** | **49.40** | **3.00** | 3.00 U |
| Barium, Filtered | **283.00** | **64.00** | **451.00** | 5.00 U |
| Beryllium, Filtered | 5.00 U | 5.00 U | 5.00 U | 5.00 U |
| Cadmium, Filtered | 5.00 U | 5.00 U | 5.00 U | 5.00 U |
| Chromium, Filtered | 10.00 U | 10.00 U | 10.00 U | 10.00 U |
| Cobalt, Filtered | **42.00** | 10.00 U | 10.00 U | 10.00 U |
| Lead, Filtered | 50.00 U | 50.00 U | 50.00 U | 50.00 U |
| Mercury, Filtered | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| Nickel, Filtered | 20.00 U | 20.00 U | 20.00 U | 20.00 U |
| Selenium, Filtered | 4.00 U | 4.00 U | 4.00 U | 4.00 U |
| Vanadium, Filtered | 10.00 U | 10.00 U | **14.00** | 10.00 U |

# TABLE 4-18

## Skinner List Filtered Inorganic Compound Analytical Data
## Groundwater Investigation
## RCRA Verification Investigation
## Chevron Refinery
## Philadelphia, Pennsylvania

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| ug/l | - | micrograms per liter. |
| Rep | - | Replicate Sample. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |

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# TABLE 4-19

## RISK-BASED EVALUATION ACTION LEVELS
## DETECTED VOLATILE ORGANIC COMPOUNDS
## GROUND WATER INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| COMPOUND | ACTION LEVEL (ug/l) | SOURCE |
|---|---|---|
| Acetone | $4 \times 10^{3}$ | 1 |
| Benzene | $4.9 \times 10^{-1}$ | 2 |
| Methyl Ethyl Ketone | $2 \times 10^{3}$ | 1 |
| Methylene Chloride | 5 | 1 |
| Toluene | $1 \times 10^{4}$ | 1 |
| Trichlorofluoromethane | $1 \times 10^{4}$ | 1 |
| Vinyl Acetate | $3.7 \times 10^{4}$ | 2 |
| Xylenes | $7 \times 10^{4}$ | 1 |

Explanation:

ug/l - Micrograms per liter

Notes:

1. Appendix A of July 27, 1990 Corrective Action Rule.
2. Roy L. Smith's April 14, 1992 USEPA Region III Memorandum.

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# TABLE 4-19

## RISK-BASED EVALUATION ACTION LEVELS
## DETECTED SEMI-VOLATILE ORGANIC COMPOUNDS
## GROUND WATER INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| COMPOUND | ACTION LEVEL (ug/l) | SOURCE |
|---|---|---|
| Acenaphthene | $2.2 \times 10^3$ | 1 |
| Anthracene | $1.1 \times 10^4$ | 1 |
| Bis(2-ethylhexyl)phthalate | 3 | 2 |
| Diethyl Phthalate | $3 \times 10^4$ | 2 |
| Dimethyl Phthalate | $3.7 \times 10^5$ | 1 |
| Di-n-octyl Phthalate | $7.3 \times 10^2$ | 1 |
| Fluoranthene | $1.5 \times 10^3$ | 1 |
| Fluorene | $1.5 \times 10^3$ | 1 |
| 1-Methylnaphthalene | NA | - |
| 2-Methylnaphthalene | NA | - |
| Phenanthrene | $1.1 \times 10^3$ | 1 |
| Phenol | $2 \times 10^4$ | 2 |
| Pyrene | 0.18 | 1 |

Explanation:

NA - No action level listed in either source
ug/l - Micrograms per liter

Notes:

1. Roy L. Smith's April 14, 1992 USEPA Region III Memorandum.
2. Appendix A of July 27, 1990 Corrective Action Rule.

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# TABLE 4-19

## RISK-BASED EVALUATION ACTION LEVELS
## DETECTED INORGANIC ANALYTES
## GROUND WATER INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| COMPOUND | ACTION LEVEL (ug/l) | SOURCE |
|---|---|---|
| Antimony | 10 | 1 |
| Arsenic | 50 | 1 |
| Barium | 2,000 | 1 |
| Beryllium | 0.008 | 2 |
| Chromium | 100 | 1 |
| Cobalt | NA | - |
| Copper | 1,400 | 3 |
| Lead | 4.9/0.88 | 3 |
| Mercury | 2 | 1 |
| Nickel | 100 | 1 |
| Vanadium | 260 | 3 |
| Zinc | 7,300 | 3 |
| Cyanide | 700 | 2 |
| Sulfide | 100 | 2 |

Explanation:

NA - No action level listed in either source
ug/l - Micrograms per liter

Notes:

1. Appendix A of July 27, 1990 Corrective Action Rule, which referred to USEPA Maximum Contaminant Levels (MCLs).
2. Appendix A of July 27, 1990 Corrective Action Rule.
3. Roy L. Smith's April 14, 1992 USEPA Region III Memorandum.
4. Lead action levels represent inorganic lead (4.9 ug/l) and carcinogenic lead (0.88 ug/l) values.

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## TABLE 4-20

## SOIL GAS SURVEY RESULTS
## VERIFICATION INVESTIGATION - SWMU NOS. 11/12

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| SAMPLE NO. | SAMPLE DEPTH | SAMPLE DATE | SAMPLE TIME | MAXIMUM OVA CONCENTRATION (ppm) | CONSTANT OVA CONCENTRATION (ppm) | BACKGROUND OVA CONCENTRATION (ppm) | BENZENE (ppm) | TOLUENE (ppm) | TOLUENE[1] ($ug/m^3$) | ETHYL-BENZENE (ppm) | TOTAL XYLENES (ppm) | TOTAL XYLENES[1] ($ug/m^3$) | TOTAL VOCs (ppm) | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SG11-1 | 4' | 7-27-92 | 0905 | >10,000 | - | 6 | NA | NA | NA | BDL | 9.62 | 2,030 | 854 | Product on edge of rod |
| SG11-2 | 4' | 7-27-92 | 0941 | >10,000 | - | 6.5 | BDL | 8.86 | 2,154 | BDL | 5.62 | 1,186 | 80.9 | X |
| SG11-3 | 4' | 7-27-92 | 0956 | >10,000 | >10,000 | 6.2 | BDL | 0.952 | 231.4 | BDL | 0.291 | 61.4 | 8.15 | X |
| SG11-4 | 4' | 7-27-92 | 1013 | 50 | 20 | 6.2 | BDL | 0.339 | 82.4 | BDL | BDL | BDL | 0.697 | X |
| SG11-4 | 4' | 7-27-92 | 1013 | 50 | 20 | 6.2 | BDL | 0.558 | 135.6 | BDL | 0.305 | 64.4 | 1.88 | GC resample at increased sensitivity |
| SG11-4 | 6' | 7-27-92 | 1025 | 3000 | 500 | 6.1 | BDL | 0.433 | 105.3 | BDL | 0.361 | 76.2 | 2.67 | Refusal at 6' |
| SG11-5 | 4' | 7-27-92 | 1035 | >10,000 | - | 6.0 | BDL | 0.703 | 170.9 | BDL | 0.953 | 201.1 | 20.4 | X |
| SG11-5 | 6' | 7-27-92 | 1045 | >10,000 | - | 6.0 | BDL | 1.90 | 461.9 | BDL | 2.75 | 580.3 | 97.4 | Refusal at 6' |
| SG11-6 | 4' | 7-27-92 | 1055 | >10,000 | - | 6.2 | BDL | 0.689 | 167.5 | BDL | 0.382 | 80.6 | 11.4 | Refusal beyond 4' |
| SG11-7 | 3' | 7-27-92 | 1115 | >10,000 | 4,500 | 6.5 | BDL | 0.258 | 62.7 | BDL | BDL | BDL | 14.0 | Water at 3' |
| SG11-8 | 2.5' | 7-27-92 | 1140 | >10,000 | - | 9.0 | BDL | 2.26 | 549.4 | BDL | 2.85 | 601.4 | 171 | Water at 2.5' |
| SG11-9 | 3' | 7-27-92 | 1151 | 10,000 | - | 9.5 | BDL | 1.71 | 415.7 | BDL | 4.19 | 884.1 | 44.1 | Refusal at 3' |
| SG11-10 | 4' | 7-27-92 | 1202 | >10,000 | - | 9.0 | BDL | 0.907 | 220.5 | BDL | 10.8 | 2,279 | 72.7 | X |

Explanation:

ppm parts per million
$ug/m^3$ micrograms per cubic meter
OVA Organic vapor analyzer (flame ionization detector).
VOCs Volatile organic compounds. Total VOCs calculated relative to gas chromatograph (GC) sensitivity of benzene.
NA Not analyzed because of poor resolution due to off-scale peak response.
BDL Below detection limit

Note:

1. Detected concentrations of toluene and total xylenes converted from ppm to $ug/m^3$ by the equations:

   (concentration in ppm) x (.2431) = (concentration in ug/l) x (1,000 $l/m^3$) = concentration in $ug/m^3$ (Toluene)
   (concentration in ppm) x (.211) = (concentration in ug/l) x (1,000 $l/m^3$) = concentration in $ug/m^3$ (Total Xylenes)

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## TABLE 4-21

## RISK-BASED EVALUATION ACTION LEVELS
## DETECTED VOLATILE ORGANIC COMPOUNDS
## SOIL GAS SURVEYS

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| COMPOUND | ACTION LEVEL ($ug/m^3$) | SOURCE |
|---|---|---|
| Toluene | $7 \times 10^3$ | 1 |
| Xylenes | $1 \times 10^3$ | 1 |

Explanation:

$ug/m^3$ - Micrograms per cubic meter

Notes:

1. Appendix A of July 27, 1990 Corrective Action Rule.

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## TABLE 4-22

## SOIL GAS SURVEY RESULTS
## VERIFICATION INVESTIGATION - SWMU NO. 29

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| SAMPLE NO. | SAMPLE DEPTH | SAMPLE DATE | SAMPLE TIME | MAXIMUM OVA CONCENTRATION (ppm) | CONSTANT OVA CONCENTRATION (ppm) | BACKGROUND OVA CONCENTRATION (ppm) | BENZENE (ppm) | TOLUENE (ppm) | TOLUENE[1] ($ug/m^3$) | ETHYL BENZENE (ppm) | TOTAL XYLENES (ppm) | TOTAL XYLENES[1] ($ug/m^3$) | TOTAL VOCs (ppm) | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SG29-1 | 3' | 7-27-92 | 1431 | >10,000 | - | 5.2 | BDL | 1.03 | 250.4 | BDL | 12.3 | 2,595 | 164 | Water at 3'<br>Product on tip of rod at 4' |
| SG29-2 | 1.5' | 7-27-92 | 1510 | 11,000 | 11,000 | 10 | BDL | BDL | BDL | BDL | 1.49 | 314.4 | 5.81 | Water at 1.5'<br>Product on top of rod |
| SG29-3 | 2.5' | 7-27-92 | 1459 | >10,000 | - | 8.0 | BDL | 0.845 | 205.4 | BDL | 9.69 | 2,045 | 82.2 | Water at 2.5' |
| SG29-3 | 2.5' | 7-27-92 | 1459 | >10,000 | - | 8.0 | BDL | 0.799 | 194.2 | BDL | 9.43 | 1,990 | 78.4 | GC resample |
| SG29-4 | 3' | 7-27-92 | 1521 | 10,000 | 3,000 | 12.0 | BDL | 0.084 | 20.4 | BDL | 0.993 | 210 | 4.98 | Water at 3' |
| SG29-5 | 4' | 7-27-92 | 1414 | >10,000 | - | 6.0 | BDL | BDL | BDL | BDL | 5.93 | 1,251 | 62.6 | X |

Explanation:

- ppm parts per million
- $ug/m^3$ micrograms per cubic meter
- OVA Organic vapor analyzer (flame ionization detector).
- VOCs Volatile organic compounds. Total VOCs calculated relative to gas chromatograph (GC) sensitivity of benzene.
- NA Not analyzed because of poor resolution due to off-scale peak response.
- BDL Below detection limit

Note:

1. Detected concentrations of toluene and total xylenes converted from ppm to $ug/m^3$ by the equations:

   (concentration in ppm) x (.2431) = (concentration in ug/l) x (1,000 $l/m^3$) = concentration in $ug/m^3$ (Toluene)
   (concentration in ppm) x (.211) = (concentration in ug/l) x (1,000 $l/m^3$) = concentration in $ug/m^3$ (Total Xylenes)

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Table 4-23
Appendix IX Semivolatile Organic Compound Analytical Data
Surface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | | SWMU 79 |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | S045A1 | S045A1MS | S045A1MSD | S045A2 | S045A3 | S045A4 | S079A1 |
| Sample Location | S45-1 | S45-1 MS | S45-1 MSD | S45-2 | S45-1 Rep | Field Blank | S79-1 |
| Sample Depth | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | | 0-6in |
| Laboratory ID | P208094 | P208095 | P208096 | P208098 | P208099 | P208100 | P208611 |
| Sample Date | 08/07/92 | 08/07/92 | 08/07/92 | 08/07/92 | 08/07/92 | 08/07/92 | 08/12/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | UG/L | ug/kg |
| Semivolatile Organic Compounds | | | | | | | |
| Acenaphthene | 340 U | 340 U | 340 U | 4300 J | 350 UJ | 10 U | 340 U |
| Acenaphthylene | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Acetophenone | 390 U | 390 U | 390 U | 9600 U | 390 UJ | 11 U | 390 U |
| 2-Acetylaminofluorene | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| alpha-Naphthylamine | 210 U | 210 U | 210 U | 5200 U | 210 UJ | 6 U | 210 U |
| 4-Aminobiphenyl | 150 U | 150 U | 150 U | 3600 U | 150 UJ | 7 U | 150 U |
| Aniline | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Anthracene | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 UJ | 340 U |
| Aramite | 700 UR | 700 UR | 700 UR | 17000 UR | 710 UR | 20 UR | 700 UR |
| Benzamide,3,5-dichloro-N-(1,1-dimethyl-2-propyny | 210 U | 210 U | 210 U | 5200 U | 210 UJ | 6 U | 210 U |
| Benzeneethanamine, alpha,alpha-dimethyl- | 100 UJ | 100 UJ | 100 UJ | 2600 UJ | 110 UJ | 3 UJ | 100 UJ |
| Benzo(a)anthracene | 340 UJ | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Benzo(a)pyrene | 340 UJ | 340 U | 340 U | 8600 U | 350 UJ | 10 UJ | 340 U |
| Benzo(b,j,k)fluoranthene | 1300 UJ | 1300 U | 1300 U | 31000 U | 1300 UJ | 40 U | 1300 U |
| Benzo[ghi]perylene | 280 U | 280 U | 280 U | 7000 U | 280 UJ | 8 U | 280 U |
| Benzyl Alcohol | 340 UJ | 340 UJ | 340 UJ | 8600 U | 350 UJ | 10 U | 340 U |
| beta-Naphthylamine | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| 4-Bromophenyl phenyl ether | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 UJ | 340 U |
| Butyl benzyl phthalate | 340 UJ | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| p-Chloro-m-cresol | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| p-Chloroaniline | 1700 U | 1700 U | 1700 U | 42000 U | 1700 UJ | 50 U | 1700 U |
| Chlorobenzilate | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Bis(2-chloroethoxy) methane | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Bis(2-chloroethyl) ether | 340 UJ | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |

Table 4-23
Appendix IX Semivolatile Organic Compound Analytical Data
Surface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | | SWMU 79 |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | S045A1 | S045A1MS | S045A1MSD | S045A2 | S045A3 | S045A4 | S079A1 |
| Sample Location | S45-1 | S45-1 MS | S45-1 MSD | S45-2 | S45-1 Rep | Field Blank | S79-1 |
| Sample Depth | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | | 0-6in |
| Laboratory ID | P208094 | P208095 | P208096 | P208098 | P208099 | P208100 | P208611 |
| Sample Date | 08/07/92 | 08/07/92 | 08/07/92 | 08/07/92 | 08/07/92 | 08/07/92 | 08/12/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | UG/L | ug/kg |
| Bis(2-chloroisopropyl)ether | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 UJ |
| 2-Chloronaphthalene | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| 2-Chlorophenol | 340 UJ | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| 4-Chlorophenyl phenyl ether | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Chrysene | 210 UJ | 210 U | 210 U | 5200 U | 210 UJ | 6 U | 210 U |
| o-Cresol | 340 UJ | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| p-Cresol | 1000 UJ | 1000 U | 1000 U | 26000 U | 1100 UJ | 30 U | 1000 U |
| Di-n-butylphthalate | **120 J** | 340 U | 340 U | **3500 J** | 160 UJ | 10 UJ | **640 B** |
| Di-n-octylphthalate | 340 UJ | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Diallate | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Dibenz(a,h)anthracene | 340 UJ | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Dibenzofuran | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| 1,2-Dichlorobenzene | 340 UJ | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| 1,3-Dichlorobenzene | 340 UJ | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| 1,4-Dichlorobenzene | 340 UJ | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| 3,3'-Dichlorobenzidine | 690 UJ | 690 U | 690 U | 17000 U | 690 UJ | 20 U | 690 U |
| 2,4-Dichlorophenol | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| 2,6-Dichlorophenol | 150 U | 150 U | 150 U | 3600 U | 150 UJ | 4 U | 150 U |
| Diethyl phthalate | 340 U | 340 U | 340 U | 8600 U | 200 UJ | 10 U | 340 U |
| Dimethoate | 700 UJ | 700 UJ | 700 UJ | 17000 UJ | 710 UJ | 20 UJ | 700 UJ |
| Dimethyl phthalate | **160 J** | **550** | 340 U | 8600 U | 720 UJ | 10 U | **230 BJ** |
| 4-Dimethylaminoazobenzene | 250 U | 250 U | 250 U | 6200 U | 250 UJ | 7 U | 250 U |
| 7,12-Dimethylbenz(a)anthracene | 310 U | 310 U | 310 U | 7800 U | 320 UJ | 9 U | 310 U |
| 3,3'-Dimethylbenzidine | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| 2,4-Dimethylphenol | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |

Table 4-23
Appendix IX Semivolatile Organic Compound Analytical Data
Surface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | | SWMU 79 |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | S045A1 | S045A1MS | S045A1MSD | S045A2 | S045A3 | S045A4 | S079A1 |
| Sample Location | S45-1 | S45-1 MS | S45-1 MSD | S45-2 | S45-1 Rep | Field Blank | S79-1 |
| Sample Depth | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | | 0-6in |
| Laboratory ID | P208094 | P208095 | P208096 | P208098 | P208099 | P208100 | P208611 |
| Sample Date | 08/07/92 | 08/07/92 | 08/07/92 | 08/07/92 | 08/07/92 | 08/07/92 | 08/12/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | UG/L | ug/kg |
| 4,6-Dinitro-o-cresol | 1700 U | 1700 U | 1700 U | 42000 U | 1700 UJ | 50 UJ | 1700 U |
| m-Dinitrobenzene | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| 2,4-Dinitrophenol | 1700 U | 1700 U | 1700 U | 42000 U | 1700 UJ | 50 U | 1700 U |
| 2,4-Dinitrotoluene | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| 2,6-Dinitrotoluene | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Diphenylamine | 180 U | 180 U | 180 U | 4400 U | 180 UJ | 5 UJ | 180 U |
| Ethyl methanesulfonate | 100 U | 100 U | 100 U | 2600 U | 110 UJ | 3 U | 100 U |
| Bis(2-ethylhexyl) phthalate | 340 UJ | 340 U | 110 J | 8600 U | 350 UJ | 10 U | 340 U |
| Fluoranthene | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 UJ | 340 U |
| Fluorene | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Hexachloro-1,3-butadiene | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Hexachlorobenzene | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 UJ | 340 U |
| Hexachlorocyclopentadiene | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Hexachloroethane | 340 UJ | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Hexachlorophene | 34000 U | 34000 U | 34000 U | 860000 U | 35000 UJ | 10000 U | 34000 U |
| Hexachloropropene | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Indeno(1,2,3-cd)pyrene | 340 UJ | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Isodrin | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 UJ | 340 U |
| Isophorone | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Isosafrole | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Methanesulfonic Acid, Methyl | 350 U | 350 U | 350 U | 8900 U | 360 UJ | 10 U | 350 U |
| Methapyrilene | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 UJ | 340 U |
| 3-Methylcholanthrene | 210 U | 210 U | 210 U | 5200 U | 210 UJ | 6 U | 210 U |
| 2-Methylnaphthalene | 180 J | 210 J | 340 U | 110000 | 250 UJ | 10 U | 340 U |
| Naphthalene | 340 U | 340 U | 340 U | 13000 | 350 UJ | 10 U | 340 U |

Table 4-23
Appendix IX Semivolatile Organic Compound Analytical Data
Surface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | | SWMU 79 |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | S045A1 | S045A1MS | S045A1MSD | S045A2 | S045A3 | S045A4 | S079A1 |
| Sample Location | S45-1 | S45-1 MS | S45-1 MSD | S45-2 | S45-1 Rep | Field Blank | S79-1 |
| Sample Depth | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | | 0-6in |
| Laboratory ID | P208094 | P208095 | P208096 | P208098 | P208099 | P208100 | P208611 |
| Sample Date | 08/07/92 | 08/07/92 | 08/07/92 | 08/07/92 | 08/07/92 | 08/07/92 | 08/12/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | UG/L | ug/kg |
| 1,4-Naphthoquinone | 700 U | 700 U | 700 U | 17000 U | 710 UJ | 20 U | 700 U |
| 5-Nitro-o-toluidine | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| 2-Nitroaniline | 1700 UJ | 1700 UJ | 1700 UJ | 42000 U | 1700 UJ | 50 U | 1700 U |
| 3-Nitroaniline | 1700 U | 1700 U | 1700 U | 42000 U | 1700 UJ | 50 U | 1700 U |
| P-Nitroaniline | 1700 U | 1700 U | 1700 U | 42000 U | 1700 UJ | 50 U | 1700 U |
| Nitrobenzene | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| 2-Nitrophenol | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| P-Nitrophenol | 1700 U | 1700 U | 1700 U | 42000 U | 1700 UJ | 50 U | 1700 U |
| 4-Nitroquinoline-1-oxide | 340 UR | 340 UR | 340 UR | 8600 UJ | 350 UR | 10 U | 340 UR |
| N-Nitrosodi-n-butylamine | 150 U | 150 U | 150 U | 3600 U | 150 UJ | 4 U | 150 U |
| N-Nitrosodi-n-propylamine | 340 UJ | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| N-Nitrosodiethylamine | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 UJ | 340 U |
| N-Nitrosodimethylamine | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 UJ |
| N-Nitrosodiphenylamine | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 UJ | 340 U |
| N-Nitrosomethylethylamine | 340 UJ | 340 UJ | 340 UJ | 8600 U | 350 UJ | 10 U | 340 UJ |
| N-Nitrosomorpholine | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| N-Nitrosopiperidine | 350 U | 350 U | 350 U | 8900 U | 360 UJ | 10 U | 350 UJ |
| N-Nitrosopyrrolidine | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 UJ |
| Pentachlorobenzene | 180 U | 180 U | 180 U | 4400 U | 180 UJ | 5 U | 180 U |
| Pentachlorophenol | 1700 U | 1700 U | 1700 U | 42000 U | 1700 UJ | 50 UJ | 1700 U |
| Phenacetin | 180 U | 180 U | 180 U | 4400 U | 180 UJ | 5 U | 180 U |
| Phenanthrene | 340 U | 340 U | 340 U | 22000 | 350 UJ | 10 UJ | 340 U |
| Phenol | 340 UJ | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| p-Phenylenediamine | 1800 U | 1800 U | 1800 U | 44000 U | 1800 UJ | 50 UJ | 1800 U |
| 2-Picoline | 180 U | 180 U | 180 U | 4400 U | 180 UJ | 5 U | 180 U |

Table 4-23
Appendix IX Semivolatile Organic Compound Analytical Data
Surface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | | SWMU 79 |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | S045A1 | S045A1MS | S045A1MSD | S045A2 | S045A3 | S045A4 | S079A1 |
| Sample Location | S45-1 | S45-1 MS | S45-1 MSD | S45-2 | S45-1 Rep | Field Blank | S79-1 |
| Sample Depth | 0-6in | 0-6in | 0-6in | 0-6in | 0-6in | | 0-6in |
| Laboratory ID | P208094 | P208095 | P208096 | P208098 | P208099 | P208100 | P208611 |
| Sample Date | 08/07/92 | 08/07/92 | 08/07/92 | 08/07/92 | 08/07/92 | 08/07/92 | 08/12/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | UG/L | ug/kg |
| Pyrene | 120 J | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Pyridine | 700 U | 700 U | 700 U | 17000 U | 710 UJ | 20 U | 700 U |
| Quintozene | 340 UJ | 340 UJ | 340 UJ | 8600 U | 350 UJ | 10 U | 340 U |
| Safrole | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| Sulfotep | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 UJ | 340 U |
| 1,2,4,5-Tetrachlorobenzene | 100 U | 100 U | 100 U | 2600 U | 110 UJ | 3 U | 100 U |
| 2,3,4,6-Tetrachlorophenol | 180 U | 180 U | 180 U | 4400 U | 180 UJ | 5 U | 180 U |
| Thionazin | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| o-Toluidine | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| 1,2,4-Trichlorobenzene | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| 2,4,5-Trichlorophenol | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| 2,4,6-Trichlorophenol | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| o,o,o-Triethylphosphorothioate | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |
| 1,3,5-Trinitrobenzene | 340 U | 340 U | 340 U | 8600 U | 350 UJ | 10 U | 340 U |

## TABLE 4-23

## Appendix IX Semivolatile Organic Compound Analytical Data
## Surface Soil Investigation
## RCRA Verification Investigation
## Chevron Refinery
## Philadelphia, Pennsylvania

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| ug/kg | - | micrograms per kilogram. |
| MS | - | Matrix Spike quality assurance/quality control sample. |
| MSD | - | Matrix Spike Duplicate quality assurance/quality control sample. |
| Rep | - | Replicate Sample. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |
| UJ | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is estimated. |
| UR | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the data is unreliable. The compound may or may not be present. |
| J | - | The associated numerical value is an estimated quantity. |
| B | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. |
| BJ | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. The associated numerical value is an estimated quantity. |

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Table 4-24
Appendix IX Inorganic Compound Analytical Data
Surface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | SWMU 79 |
|---|---|---|---|---|---|
| Dames & Moore Sample ID | S045A1 | S045A2 | S045A3 | S045A4 | S079A1 |
| Sample Location | S45-1 | S45-2 | S45-1 Rep | Field Blank | S79-1 |
| Sample Depth | 0-6in | 0-6in | 0-6in | | 0-6in |
| Laboratory ID | P208094 | P208098 | P208099 | P208100 | P208611 |
| Sample Date | 08/07/92 | 08/07/92 | 08/07/92 | 08/07/92 | 08/12/92 |
| Units | mg/kg | mg/kg | mg/kg | UG/L | mg/kg |
| Inorganic Compounds | | | | | |
| Antimony | 1.60 | 1.00 U | 1.80 | 10.00 U | 26.20 |
| Arsenic | 7.00 K | 2.40 K | 5.80 K | 3.00 U | 3.20 K |
| Barium | 107.00 J | 41.50 J | 62.50 J | 5.00 UJ | 72.20 J |
| Beryllium | 0.84 | 0.84 | 1.00 | 5.00 U | 1.60 |
| Cadmium | 1.20 L | 0.52 UL | 1.20 L | 5.00 UL | 5.20 UL |
| Chromium | 1420.00 J | 79.20 J | 425.00 J | 10.00 UJ | 420.00 J |
| Cobalt | 10.40 J | 7.20 J | 12.30 J | 12.00 J | 14.00 J |
| Copper | 191.00 J | 78.70 J | 169.00 J | 10.00 UJ | 85.90 J |
| Cyanide | 0.26 U | 0.26 U | 0.27 | 5.00 U | 0.63 |
| Lead | 93.20 J | 134.00 J | 77.60 J | 2.00 UJ | 105.00 J |
| Mercury | 0.09 U | 0.56 | 0.09 U | 0.20 U | 0.14 |
| Nickel | 89.70 J | 22.40 J | 84.90 J | 20.00 UJ | 135.00 J |
| Selenium | 0.43 L | 0.42 UR | 0.42 UR | 4.00 UR | 0.42 UR |
| Silver | 1.00 UL | 1.00 UL | 1.00 UL | 10.00 UL | 1.00 UL |
| Sulfide | 3.10 UL | 3.10 UL | 3.10 U | 200.00 U | 17.20 L |
| Thallium | 0.10 U | 0.10 U | 0.10 U | 1.00 U | 0.10 U |
| Tin | 52.40 U | 104.00 U | 52.50 U | 100.00 U | 52.20 U |
| Vanadium | 191.00 | 35.50 | 90.70 | 10.00 U | 91.10 |
| Zinc | 253.00 J | 317.00 J | 218.00 J | 10.00 UJ | 842.00 J |

## TABLE 4-24

**Appendix IX Inorganic Compound Analytical Data**
**Surface Soil Investigation**
**RCRA Verification Investigation**
**Chevron Refinery**
**Philadelphia, Pennsylvania**

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| mg/kg | - | milligrams per kilogram. |
| Rep | - | Replicate Sample. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |
| UJ | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is estimated. |
| UL | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is biased low. |
| UR | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the data is unreliable. The compound may or may not be present. |
| J | - | The associated numerical value is an estimated quantity. |
| K | - | The associated numerical value is biased high. |
| L | - | The associated numerical value is biased low. |

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Table 4-25
Appendix IX Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B045A1 | B045A1DL | B045A2 | B045A2MS | B045A2MSD | B045A3 | B045A3DL |
| Sample Location | B45-1 | B45-1 DL | B45-2 | B45-2 MS | B45-2 MSD | B45-1 Rep | B45-1 DL |
| Sample Depth | 1.5-3.5ft | 1.5-3.5ft | 2-4ft | 2-4ft | 2-4ft | 1.5-3.5ft | 1.5-3.5ft |
| Laboratory ID | P208103 | P208103DL | P208439 | P208440 | P208441 | P208102 | P208102DL |
| Sample Date | 08/07/92 | 08/07/92 | 08/10/92 | 08/10/92 | 08/10/92 | 08/07/92 | 08/07/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Volatile Organic Compounds | | | | | | | |
| Acetone | **45 BJ** | **98 B** | 6000 U | **6100 J** | **7700 J** | **55 B** | **80 B** |
| Acetonitrile | 55 U | 270 UR | 30000 U | 30000 UR | 30000 UR | 59 U | 120 U |
| Acrolein | 110 U | 550 U | 60000 U | 60000 U | 60000 U | 120 U | 240 U |
| Acrylonitrile | 110 U | 550 U | 60000 U | 60000 U | 60000 U | 120 U | 240 U |
| Allyl chloride | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 UJ |
| Benzene | **34** | 27 U | **13000** | 3000 U | 3000 U | **20** | 12 U |
| Bromoform | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| Bromomethane | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| 2-Butanone | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| Carbon disulfide | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| Carbon tetrachloride | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| Chlorobenzene | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| Chlorodibromomethane | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| Chloroethane | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| Chloroform | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| Chloromethane | 11 U | 55 U | 6000 UJ | 6000 U | 6000 U | 12 U | 24 U |
| Chloroprene | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| 1,2-Dibromo-3-chloropropane | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| 1,2-Dibromoethane | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| Dichlorobromomethane | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| Trans-1,4-dichlorobutene | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| Dichlorodifluoromethane [CFC-12] | 16 U | 82 U | 8900 U | 8900 U | 8900 U | 18 U | 35 U |
| 1,1-Dichloroethane | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| 1,2-Dichloroethane | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |

Table 4-25
Appendix IX Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B045A1 | B045A1DL | B045A2 | B045A2MS | B045A2MSD | B045A3 | B045A3DL |
| Sample Location | B45-1 | B45-1 DL | B45-2 | B45-2 MS | B45-2 MSD | B45-1 Rep | B45-1 DL |
| Sample Depth | 1.5-3.5ft | 1.5-3.5ft | 2-4ft | 2-4ft | 2-4ft | 1.5-3.5ft | 1.5-3.5ft |
| Laboratory ID | P208103 | P208103DL | P208439 | P208440 | P208441 | P208102 | P208102DL |
| Sample Date | 08/07/92 | 08/07/92 | 08/10/92 | 08/10/92 | 08/10/92 | 08/07/92 | 08/07/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| 1,1-Dichloroethene | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| Trans-1,2-Dichloroethene | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| 1,2-Dichloropropane | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| cis-1,3-Dichloropropene | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| trans-1,3-Dichloropropene | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| 1,4-Dioxane | 160 UR | 820 UR | 90000 UR | 90000 UR | 90000 UR | 180 UR | 350 UR |
| Ethyl methacrylate | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| Ethylbenzene | **100** | **230** | **46000** | **41000** | **26000** | **62** | **21** |
| 2-Hexanone | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| Isobutyl alcohol | 110 U | 550 U | 60000 U | 60000 UJ | 60000 UJ | 120 U | 240 U |
| Methacrylonitrile | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| Methyl iodide | 22 U | 110 U | 12000 U | 12000 U | 12000 U | 24 U | 47 U |
| Methyl isobutyl ketone | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| Methyl methacrylate | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| Methylene bromide | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| Methylene Chloride | **5 BJ** | **72 B** | 3000 U | **2300 BJ** | **2400 BJ** | **26 B** | **14 B** |
| Pentachloroethane | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| Propionitrile | 27 U | 140 U | 15000 U | 15000 U | 15000 U | 29 U | 59 U |
| Styrene | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| 1,1,1,2-Tetrachloroethane | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| 1,1,2,2-Tetrachloroethane | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| Tetrachloroethene | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| Toluene | **190** | **200** | **2100 J** | 3000 U | 3000 U | **150** | **37** |
| 1,1,1-Trichloroethane | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| 1,1,2-Trichloroethane | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |

Table 4-25
Appendix IX Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B045A1 | B045A1DL | B045A2 | B045A2MS | B045A2MSD | B045A3 | B045A3DL |
| Sample Location | B45-1 | B45-1 DL | B45-2 | B45-2 MS | B45-2 MSD | B45-1 Rep | B45-1 DL |
| Sample Depth | 1.5-3.5ft | 1.5-3.5ft | 2-4ft | 2-4ft | 2-4ft | 1.5-3.5ft | 1.5-3.5ft |
| Laboratory ID | P208103 | P208103DL | P208439 | P208440 | P208441 | P208102 | P208102DL |
| Sample Date | 08/07/92 | 08/07/92 | 08/10/92 | 08/10/92 | 08/10/92 | 08/07/92 | 08/07/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg |
| Trichloroethene | 5 U | 27 U | 3000 U | 3000 U | 3000 U | 6 U | 12 U |
| Trichlorofluoromethane [CFC-11] | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| 1,2,3-Trichloropropane | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| Vinyl acetate | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| Vinyl chloride | 11 U | 55 U | 6000 U | 6000 U | 6000 U | 12 U | 24 U |
| Xylene (Total) | 1100 | 2600 | 100000 | 170000 | 59000 | 670 J | 290 |

Table 4-25
Appendix IX Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 (continued) | | SWMU 79 | |
|---|---|---|---|---|
| Dames & Moore Sample ID | B045A4 | B045A5 | B079A1 | B079A2 |
| Sample Location | Field Blank | Trip Blank | B79-1 | B79-2 |
| Sample Depth | | | 4.5-6.5ft | 0-2ft |
| Laboratory ID | P208101 | P208104 | P208612 | P208613 |
| Sample Date | 08/07/92 | 08/07/92 | 08/12/92 | 08/12/92 |
| Units | UG/L | UG/L | ug/kg | ug/kg |
| Volatile Organic Compounds | | | | |
| Acetone | 10 U | 10 U | **420 B** | **6 BJ** |
| Acetonitrile | 50 U | 50 U | 400 U | 51 U |
| Acrolein | 100 U | 100 U | 810 U | 100 U |
| Acrylonitrile | 100 U | 100 U | 810 U | 100 U |
| Allyl chloride | 10 U | 10 U | 81 UJ | 10 UJ |
| Benzene | 5 U | 5 U | 40 U | 5 U |
| Bromoform | 5 U | 5 U | 40 U | 5 U |
| Bromomethane | 10 U | 10 U | 81 U | 10 U |
| 2-Butanone | 10 U | 10 U | 81 U | 10 U |
| Carbon disulfide | 5 U | 5 U | 40 U | 5 U |
| Carbon tetrachloride | 5 U | 5 U | 40 U | 5 U |
| Chlorobenzene | 5 U | 5 U | 40 U | 5 U |
| Chlorodibromomethane | 5 U | 5 U | 40 U | 5 U |
| Chloroethane | 10 U | 10 U | 81 U | 10 U |
| Chloroform | 5 U | 5 U | 40 U | 5 U |
| Chloromethane | 10 U | 10 U | 81 U | 10 U |
| Chloroprene | 10 U | 10 U | 81 U | 10 U |
| 1,2-Dibromo-3-chloropropane | 10 U | 10 U | 81 U | 10 U |
| 1,2-Dibromoethane | 10 U | 10 U | 81 U | 10 U |
| Dichlorobromomethane | 5 U | 5 U | 40 U | 5 U |
| Trans-1,4-dichlorobutene | 10 U | 10 U | 81 U | 10 U |
| Dichlorodifluoromethane [CFC-12] | 15 U | 15 U | 120 U | 15 U |
| 1,1-Dichloroethane | 5 U | 5 U | 40 U | 5 U |
| 1,2-Dichloroethane | 5 U | 5 U | 40 U | 5 U |

Table 4-25
Appendix IX Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 (continued) | | SWMU 79 | |
|---|---|---|---|---|
| Dames & Moore Sample ID | B045A4 | B045A5 | B079A1 | B079A2 |
| Sample Location | Field Blank | Trip Blank | B79-1 | B79-2 |
| Sample Depth | | | 4.5-6.5ft | 0-2ft |
| Laboratory ID | P208101 | P208104 | P208612 | P208613 |
| Sample Date | 08/07/92 | 08/07/92 | 08/12/92 | 08/12/92 |
| Units | UG/L | UG/L | ug/kg | ug/kg |
| 1,1-Dichloroethene | 5 U | 5 U | 40 U | 5 U |
| Trans-1,2-Dichloroethene | 5 U | 5 U | 40 U | 5 U |
| 1,2-Dichloropropane | 5 U | 5 U | 40 U | 5 U |
| cis-1,3-Dichloropropene | 5 U | 5 U | 40 U | 5 U |
| trans-1,3-Dichloropropene | 5 U | 5 U | 40 U | 5 U |
| 1,4-Dioxane | 150 UR | 150 UR | 1200 UR | 150 UR |
| Ethyl methacrylate | 10 U | 10 U | 81 U | 10 U |
| Ethylbenzene | 5 U | 5 U | 40 U | 5 U |
| 2-Hexanone | 10 U | 10 U | 81 U | 10 U |
| Isobutyl alcohol | 100 U | 100 U | 810 U | 100 U |
| Methacrylonitrile | 10 U | 10 U | 81 U | 10 U |
| Methyl iodide | 20 U | 20 U | 160 U | 20 U |
| Methyl isobutyl ketone | 10 U | 10 U | 81 U | 10 U |
| Methyl methacrylate | 10 U | 10 U | 81 U | 10 U |
| Methylene bromide | 5 U | 5 U | 40 U | 5 U |
| Methylene Chloride | 5 U | 5 U | 60 B | 5 U |
| Pentachloroethane | 10 U | 10 U | 81 U | 10 U |
| Propionitrile | 25 U | 25 U | 200 U | 26 U |
| Styrene | 5 U | 5 U | 40 U | 5 U |
| 1,1,1,2-Tetrachloroethane | 10 U | 10 U | 81 U | 10 U |
| 1,1,2,2-Tetrachloroethane | 5 U | 5 U | 40 U | 5 U |
| Tetrachloroethene | 5 U | 5 U | 40 U | 5 U |
| Toluene | 5 U | 5 U | 40 U | 5 U |
| 1,1,1-Trichloroethane | 5 U | 5 U | 40 U | 5 U |
| 1,1,2-Trichloroethane | 5 U | 5 U | 40 U | 5 U |

Table 4-25
Appendix IX Volatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 (continued) | | SWMU 79 | |
|---|---|---|---|---|
| Dames & Moore Sample ID | B045A4 | B045A5 | B079A1 | B079A2 |
| Sample Location | Field Blank | Trip Blank | B79-1 | B79-2 |
| Sample Depth | | | 4.5-6.5ft | 0-2ft |
| Laboratory ID | P208101 | P208104 | P208612 | P208613 |
| Sample Date | 08/07/92 | 08/07/92 | 08/12/92 | 08/12/92 |
| Units | UG/L | UG/L | ug/kg | ug/kg |
| Trichloroethene | 5 U | 5 U | 40 U | 5 U |
| Trichlorofluoromethane [CFC-11] | 10 U | 10 U | 81 U | 10 U |
| 1,2,3-Trichloropropane | 10 U | 10 U | 81 U | 10 U |
| Vinyl acetate | 10 U | 10 U | 81 U | 10 U |
| Vinyl chloride | 10 U | 10 U | 81 U | 10 U |
| Xylene (Total) | 5 U | 5 U | 100 J | 5 U |

## TABLE 4-25

**Appendix IX Volatile Organic Compound Analytical Data**
**Subsurface Soil Investigation**
**RCRA Verification Investigation**
**Chevron Refinery**
**Philadelphia, Pennsylvania**

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| ug/kg | - | micrograms per kilogram. |
| MS | - | Matrix Spike quality assurance/quality control sample. |
| MSD | - | Matrix Spike Duplicate quality assurance/quality control sample. |
| Rep | - | Replicate Sample. |
| DL | - | Sample Dilution. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |
| UR | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the data is unreliable. The compound may or may not be present. |
| J | - | The associated numerical value is an estimated quantity. |
| B | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. |
| BJ | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. The associated numerical value is an estimated quantity. |

Table 4-26
Appendix IX Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B045A1 | B045A2 | B045A2DL | B045A2MS | B045A2MSD | B045A3 | B045A4 |
| Sample Location | B45-1 | B45-2 | B45-2 DL | B45-2 MS | B45-2 MSD | B45-1 Rep | Field Blank |
| Sample Depth | 1.5-3.5ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 1.5-3.5ft | |
| Laboratory ID | P208103 | P208439 | P208439DL | P208440 | P208441 | P208102 | P208101 |
| Sample Date | 08/07/92 | 08/10/92 | 08/10/92 | 08/10/92 | 08/10/92 | 08/07/92 | 08/07/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | UG/L |
| Semivolatile Organic Compounds | | | | | | | |
| Acenaphthene | 360 U | 1600 | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Acenaphthylene | 360 U | 310 J | 1300 U | 400 | 270 J | 390 U | 10 U |
| Acetophenone | 410 U | 440 U | 1500 U | 440 U | 440 U | 440 U | 11 U |
| 2-Acetylaminofluorene | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| alpha-Naphthylamine | 220 U | 240 U | 790 U | 240 U | 240 U | 240 U | 6 U |
| 4-Aminobiphenyl | 150 U | 170 U | 550 U | 170 U | 170 U | 160 U | 7 U |
| Aniline | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Anthracene | 360 U | 1900 | 1800 | 1100 | 1200 | 390 U | 10 U |
| Aramite | 740 UR | 800 UR | 2700 UR | 800 UR | 800 UR | 790 UR | 20 U |
| Benzamide,3,5-dichloro-N-(1,1-dimethyl-2-propyny | 220 U | 240 U | 790 U | 240 U | 240 U | 240 U | 6 U |
| Benzeneethanamine, alpha,alpha-dimethyl- | 110 UJ | 120 UJ | 400 UJ | 120 UJ | 120 UJ | 120 UJ | 3 UJ |
| Benzo(a)anthracene | 320 J | 2600 | 2500 | 1500 | 1900 | 180 J | 10 U |
| Benzo(a)pyrene | 360 UJ | 1800 | 1900 | 1100 | 1400 | 200 J | 10 UJ |
| Benzo(b,j,k)fluoranthene | 250 UJ | 1100 J | 1100 J | 720 J | 1100 J | 150 J | 40 U |
| Benzo[ghi]perylene | 300 U | 810 | 1100 | 360 | 550 | 320 U | 8 U |
| Benzyl Alcohol | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 UJ | 10 U |
| beta-Naphthylamine | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| 4-Bromophenyl phenyl ether | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Butyl benzyl phthalate | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| p-Chloro-m-cresol | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| p-Chloroaniline | 1800 U | 1900 U | 6300 U | 1900 U | 1900 U | 1900 U | 50 U |
| Chlorobenzilate | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Bis(2-chloroethoxy) methane | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Bis(2-chloroethyl) ether | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |

Table 4-26
Appendix IX Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B045A1 | B045A2 | B045A2DL | B045A2MS | B045A2MSD | B045A3 | B045A4 |
| Sample Location | B45-1 | B45-2 | B45-2 DL | B45-2 MS | B45-2 MSD | B45-1 Rep | Field Blank |
| Sample Depth | 1.5-3.5ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 1.5-3.5ft | |
| Laboratory ID | P208103 | P208439 | P208439DL | P208440 | P208441 | P208102 | P208101 |
| Sample Date | 08/07/92 | 08/10/92 | 08/10/92 | 08/10/92 | 08/10/92 | 08/07/92 | 08/07/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | UG/L |
| Bis(2-chloroisopropyl)ether | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| 2-Chloronaphthalene | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| 2-Chlorophenol | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| 4-Chlorophenyl phenyl ether | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Chrysene | **380** | **2800** | **2400** | **2100** | **2200** | **240** | 6 U |
| o-Cresol | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| p-Cresol | 1100 U | 1200 U | 4000 U | 1200 U | 1200 U | 1200 U | 30 U |
| Di-n-butylphthalate | 360 U | **140 BJ** | **590 BJ** | 390 U | **140 BJ** | **110 J** | 10 UJ |
| Di-n-octylphthalate | 360 UJ | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Diallate | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Dibenz(a,h)anthracene | 360 UJ | **360 J** | **570 J** | **150 J** | 390 U | 390 U | 10 U |
| Dibenzofuran | 360 U | **1200** | **1200 J** | **870** | **770** | 390 U | 10 U |
| 1,2-Dichlorobenzene | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| 1,3-Dichlorobenzene | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| 1,4-Dichlorobenzene | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| 3,3'-Dichlorobenzidine | 730 U | 790 U | 2600 U | 790 U | 790 U | 780 U | 20 U |
| 2,4-Dichlorophenol | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| 2,6-Dichlorophenol | 150 U | 170 U | 550 U | 170 U | 170 U | 160 U | 4 U |
| Diethyl phthalate | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Dimethoate | 740 U | 800 U | 2700 U | 800 U | 800 U | 790 U | 20 UJ |
| Dimethyl phthalate | **190 J** | 390 U | 1300 U | 390 U | 390 U | **210 J** | 10 U |
| 4-Dimethylaminoazobenzene | 260 U | 290 U | 950 U | 290 U | 290 U | 280 U | 7 U |
| 7,12-Dimethylbenz(a)anthracene | 330 U | 360 U | 1200 U | 360 U | 360 U | 350 U | 9 U |
| 3,3'-Dimethylbenzidine | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| 2,4-Dimethylphenol | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |

Table 4-26
Appendix IX Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B045A1 | B045A2 | B045A2DL | B045A2MS | B045A2MSD | B045A3 | B045A4 |
| Sample Location | B45-1 | B45-2 | B45-2 DL | B45-2 MS | B45-2 MSD | B45-1 Rep | Field Blank |
| Sample Depth | 1.5-3.5ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 1.5-3.5ft | |
| Laboratory ID | P208103 | P208439 | P208439DL | P208440 | P208441 | P208102 | P208101 |
| Sample Date | 08/07/92 | 08/10/92 | 08/10/92 | 08/10/92 | 08/10/92 | 08/07/92 | 08/07/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | UG/L |
| 4,6-Dinitro-o-cresol | 1800 U | 1900 U | 6300 U | 1900 U | 1900 U | 1900 U | 50 UJ |
| m-Dinitrobenzene | 360 UJ | 390 U | 1300 U | 390 U | 390 U | 390 UJ | 10 U |
| 2,4-Dinitrophenol | 1800 U | 1900 U | 6300 U | 1900 U | 1900 U | 1900 U | 50 U |
| 2,4-Dinitrotoluene | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| 2,6-Dinitrotoluene | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Diphenylamine | 190 U | 200 U | 670 U | 200 U | 200 U | 200 U | 5 UJ |
| Ethyl methanesulfonate | 110 U | 120 U | 400 U | 120 U | 120 U | 120 U | 3 U |
| Bis(2-ethylhexyl) phthalate | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Fluoranthene | **340 J** | **5000** | **4900** | **2900** | **3900** | **280 J** | 10 U |
| Fluorene | 360 U | **2000** | **2000** | **1800** | **1400** | 390 U | 10 U |
| Hexachloro-1,3-butadiene | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Hexachlorobenzene | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Hexachlorocyclopentadiene | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Hexachloroethane | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Hexachlorophene | 36000 U | 39000 U | 130000 U | 39000 U | 39000 U | 39000 U | 10000 U |
| Hexachloropropene | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Indeno(1,2,3-cd)pyrene | 360 UJ | **840** | **1200 J** | **350 J** | **540** | 390 UJ | 10 U |
| Isodrin | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 UJ |
| Isophorone | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Isosafrole | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Methanesulfonic Acid, Methyl | 370 U | 400 U | 1300 U | 400 U | 400 U | 400 U | 10 U |
| Methapyrilene | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 UJ |
| 3-Methylcholanthrene | 220 U | 240 U | 790 U | 240 U | 240 U | 240 U | 6 U |
| 2-Methylnaphthalene | **1900** | **12000 J** | **12000** | **13000 J** | **6700 J** | **250 J** | 10 U |
| Naphthalene | **730** | **8800 J** | **11000** | **4000** | **5200** | 390 U | 10 U |

Table 4-26
Appendix IX Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B045A1 | B045A2 | B045A2DL | B045A2MS | B045A2MSD | B045A3 | B045A4 |
| Sample Location | B45-1 | B45-2 | B45-2 DL | B45-2 MS | B45-2 MSD | B45-1 Rep | Field Blank |
| Sample Depth | 1.5-3.5ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 1.5-3.5ft | |
| Laboratory ID | P208103 | P208439 | P208439DL | P208440 | P208441 | P208102 | P208101 |
| Sample Date | 08/07/92 | 08/10/92 | 08/10/92 | 08/10/92 | 08/10/92 | 08/07/92 | 08/07/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | UG/L |
| 1,4-Naphthoquinone | 740 U | 800 U | 2700 U | 800 U | 800 U | 790 U | 20 U |
| 5-Nitro-o-toluidine | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| 2-Nitroaniline | 1800 U | 1900 U | 6300 U | 1900 U | 1900 U | 1900 U | 50 U |
| 3-Nitroaniline | 1800 U | 1900 U | 6300 U | 1900 U | 1900 U | 1900 U | 50 U |
| P-Nitroaniline | 1800 U | 1900 U | 6300 U | 1900 U | 1900 U | 1900 U | 50 U |
| Nitrobenzene | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| 2-Nitrophenol | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| P-Nitrophenol | 1800 U | 1900 U | 6300 U | 1900 U | 1900 U | 1900 U | 50 U |
| 4-Nitroquinoline-1-oxide | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| N-Nitrosodi-n-butylamine | 150 U | 170 U | 550 U | 170 U | 170 U | 160 U | 4 U |
| N-Nitrosodi-n-propylamine | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| N-Nitrosodiethylamine | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| N-Nitrosodimethylamine | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| N-Nitrosodiphenylamine | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 UJ |
| N-Nitrosomethylethylamine | 360 UJ | 390 U | 1300 U | 390 U | 390 U | 390 UJ | 10 U |
| N-Nitrosomorpholine | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| N-Nitrosopiperidine | 370 U | 400 U | 1300 U | 400 U | 400 U | 400 U | 10 U |
| N-Nitrosopyrrolidine | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Pentachlorobenzene | 190 UJ | 200 U | 670 U | 200 U | 200 U | 200 UJ | 5 U |
| Pentachlorophenol | 1800 U | 1900 U | 6300 U | 1900 U | 1900 U | 1900 U | 50 U |
| Phenacetin | 190 U | 200 U | 670 U | 200 U | 200 U | 200 U | 5 U |
| Phenanthrene | **310 J** | **6700 J** | **6800** | **5400** | **4500** | **200 J** | 10 U |
| Phenol | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| p-Phenylenediamine | 1900 U | 2000 U | 6700 U | 2000 U | 2000 U | 2000 U | 50 UJ |
| 2-Picoline | 190 U | 200 U | 670 U | 200 U | 200 U | 200 U | 5 U |

Table 4-26
Appendix IX Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | | |
|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B045A1 | B045A2 | B045A2DL | B045A2MS | B045A2MSD | B045A3 | B045A4 |
| Sample Location | B45-1 | B45-2 | B45-2 DL | B45-2 MS | B45-2 MSD | B45-1 Rep | Field Blank |
| Sample Depth | 1.5-3.5ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 1.5-3.5ft | |
| Laboratory ID | P208103 | P208439 | P208439DL | P208440 | P208441 | P208102 | P208101 |
| Sample Date | 08/07/92 | 08/10/92 | 08/10/92 | 08/10/92 | 08/10/92 | 08/07/92 | 08/07/92 |
| Units | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | ug/kg | UG/L |
| Pyrene | **490** | **4000** | **4200** | 390 U | 390 U | **240 J** | 10 U |
| Pyridine | 740 U | 800 U | 2700 U | 800 U | 800 U | 790 U | 20 U |
| Quintozene | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Safrole | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| Sulfotep | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| 1,2,4,5-Tetrachlorobenzene | 110 U | 120 U | 400 U | 120 U | 120 U | 120 U | 3 U |
| 2,3,4,6-Tetrachlorophenol | 190 U | 200 U | 670 U | 200 U | 200 U | 200 U | 5 U |
| Thionazin | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| o-Toluidine | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| 1,2,4-Trichlorobenzene | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| 2,4,5-Trichlorophenol | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| 2,4,6-Trichlorophenol | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| o,o,o-Triethylphosphorothioate | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 U |
| 1,3,5-Trinitrobenzene | 360 U | 390 U | 1300 U | 390 U | 390 U | 390 U | 10 UJ |

Table 4-26
Appendix IX Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 79 | | |
|---|---|---|---|
| Dames & Moore Sample ID | B079A1 | B079A1DL | B079A2 |
| Sample Location | B79-1 | B79-1 DL | B79-2 |
| Sample Depth | 4.5-6.5ft | 4.5-6.5ft | 0-2ft |
| Laboratory ID | P208612 | P208612DL | P208613 |
| Sample Date | 08/12/92 | 08/12/92 | 08/12/92 |
| Units | ug/kg | ug/kg | ug/kg |
| Semivolatile Organic Compounds | | | |
| Acenaphthene | **4800** | **6700 J** | 340 U |
| Acenaphthylene | **500 J** | **640 J** | 340 U |
| Acetophenone | 600 U | 1200 U | 380 U |
| 2-Acetylaminofluorene | 530 U | 1100 U | 340 U |
| alpha-Naphthylamine | 320 U | 650 U | 200 U |
| 4-Aminobiphenyl | 230 U | 450 U | 140 U |
| Aniline | 530 U | 1100 U | 340 U |
| Anthracene | **2000** | **2900 J** | 340 U |
| Aramite | 1100 UR | 2200 U | 680 UR |
| Benzamide,3,5-dichloro-N-(1,1-dimethyl-2-propyny | 320 U | 650 U | 200 U |
| Benzeneethanamine, alpha,alpha-dimethyl- | 160 U | 320 U | 100 U |
| Benzo(a)anthracene | **2600** | **4000 J** | 340 U |
| Benzo(a)pyrene | **2000** | **2900** | 340 U |
| Benzo(b,j,k)fluoranthene | **1300 J** | **1300 J** | 1200 U |
| Benzo[ghi]perylene | 440 U | **2000** | 280 U |
| Benzyl Alcohol | 530 U | 1100 U | 340 U |
| beta-Naphthylamine | 530 U | 1100 U | 340 U |
| 4-Bromophenyl phenyl ether | 530 U | 1100 UJ | 340 U |
| Butyl benzyl phthalate | 530 U | 1100 UJ | 340 U |
| p-Chloro-m-cresol | 530 U | 1100 U | 340 U |
| p-Chloroaniline | 2600 U | 5200 U | 1600 U |
| Chlorobenzilate | 530 U | 1100 U | 340 U |
| Bis(2-chloroethoxy) methane | 530 U | 1100 U | 340 U |
| Bis(2-chloroethyl) ether | 530 U | 1100 UJ | 340 U |

Table 4-26
Appendix IX Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 79 | | |
|---|---|---|---|
| Dames & Moore Sample ID | B079A1 | B079A1DL | B079A2 |
| Sample Location | B79-1 | B79-1 DL | B79-2 |
| Sample Depth | 4.5-6.5ft | 4.5-6.5ft | 0-2ft |
| Laboratory ID | P208612 | P208612DL | P208613 |
| Sample Date | 08/12/92 | 08/12/92 | 08/12/92 |
| Units | ug/kg | ug/kg | ug/kg |
| Bis(2-chloroisopropyl)ether | 530 U | 1100 U | 340 U |
| 2-Chloronaphthalene | 530 U | 1100 UJ | 340 U |
| 2-Chlorophenol | 530 U | 1100 UJ | 340 U |
| 4-Chlorophenyl phenyl ether | 530 U | 1100 UJ | 340 U |
| Chrysene | 3300 | 4700 J | 200 U |
| o-Cresol | 530 U | 1100 U | 340 U |
| p-Cresol | 1600 U | 3200 U | 1000 U |
| Di-n-butylphthalate | 630 BJ | 1100 UJ | 670 B |
| Di-n-octylphthalate | 530 U | 1100 U | 340 U |
| Diallate | 530 U | 1100 U | 340 U |
| Dibenz(a,h)anthracene | 530 U | 850 J | 340 U |
| Dibenzofuran | 290 J | 800 J | 340 U |
| 1,2-Dichlorobenzene | 530 U | 1100 UJ | 340 U |
| 1,3-Dichlorobenzene | 530 U | 1100 UJ | 340 U |
| 1,4-Dichlorobenzene | 530 U | 1100 UJ | 340 U |
| 3,3'-Dichlorobenzidine | 1100 U | 2100 UJ | 670 U |
| 2,4-Dichlorophenol | 530 U | 1100 U | 340 U |
| 2,6-Dichlorophenol | 230 U | 450 U | 140 U |
| Diethyl phthalate | 530 U | 1100 UJ | 150 J |
| Dimethoate | 1100 U | 2200 U | 680 U |
| Dimethyl phthalate | 530 U | 1100 UJ | 360 B |
| 4-Dimethylaminoazobenzene | 390 U | 770 U | 240 U |
| 7,12-Dimethylbenz(a)anthracene | 480 U | 970 U | 310 U |
| 3,3'-Dimethylbenzidine | 530 U | 1100 U | 340 U |
| 2,4-Dimethylphenol | 530 U | 1100 UJ | 340 U |

Table 4-26
Appendix IX Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 79 | | |
|---|---|---|---|
| Dames & Moore Sample ID | B079A1 | B079A1DL | B079A2 |
| Sample Location | B79-1 | B79-1 DL | B79-2 |
| Sample Depth | 4.5-6.5ft | 4.5-6.5ft | 0-2ft |
| Laboratory ID | P208612 | P208612DL | P208613 |
| Sample Date | 08/12/92 | 08/12/92 | 08/12/92 |
| Units | ug/kg | ug/kg | ug/kg |
| 4,6-Dinitro-o-cresol | 2600 U | 5200 U | 1600 U |
| m-Dinitrobenzene | 530 U | 1100 U | 340 U |
| 2,4-Dinitrophenol | 2600 U | 5200 UJ | 1600 U |
| 2,4-Dinitrotoluene | 530 U | 1100 UJ | 340 U |
| 2,6-Dinitrotoluene | 530 U | 1100 UJ | 340 U |
| Diphenylamine | 270 U | 550 U | 170 U |
| Ethyl methanesulfonate | 160 U | 320 U | 100 U |
| Bis(2-ethylhexyl) phthalate | 530 U | 1100 UJ | 340 U |
| Fluoranthene | **7100** | **9500 J** | 340 U |
| Fluorene | **2700** | **3700 J** | 340 U |
| Hexachloro-1,3-butadiene | 530 U | 1100 UJ | 340 U |
| Hexachlorobenzene | 530 U | 1100 UJ | 340 U |
| Hexachlorocyclopentadiene | 530 U | 1100 UJ | 340 U |
| Hexachloroethane | 530 U | 1100 UJ | 340 U |
| Hexachlorophene | 53000 U | 110000 U | 34000 U |
| Hexachloropropene | 530 U | 1100 U | 340 U |
| Indeno(1,2,3-cd)pyrene | **440 J** | **1700** | 340 U |
| Isodrin | 530 U | 1100 U | 340 U |
| Isophorone | 530 U | 1100 UJ | 340 U |
| Isosafrole | 530 U | 1100 U | 340 U |
| Methanesulfonic Acid, Methyl | 550 U | 1100 U | 350 U |
| Methapyrilene | 530 U | 1100 U | 340 U |
| 3-Methylcholanthrene | 320 U | 650 U | 200 U |
| 2-Methylnaphthalene | **760** | **860 J** | 340 U |
| Naphthalene | **890** | **1200 J** | 340 U |

Table 4-26
Appendix IX Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 79 | | |
|---|---|---|---|
| Dames & Moore Sample ID | B079A1 | B079A1DL | B079A2 |
| Sample Location | B79-1 | B79-1 DL | B79-2 |
| Sample Depth | 4.5-6.5ft | 4.5-6.5ft | 0-2ft |
| Laboratory ID | P208612 | P208612DL | P208613 |
| Sample Date | 08/12/92 | 08/12/92 | 08/12/92 |
| Units | ug/kg | ug/kg | ug/kg |
| 1,4-Naphthoquinone | 1100 U | 2200 U | 680 U |
| 5-Nitro-o-toluidine | 530 U | 1100 U | 340 U |
| 2-Nitroaniline | 2600 U | 5200 UJ | 1600 U |
| 3-Nitroaniline | 2600 U | 5200 UJ | 1600 U |
| P-Nitroaniline | 2600 U | 5200 U | 1600 U |
| Nitrobenzene | 530 U | 1100 UJ | 340 U |
| 2-Nitrophenol | 530 U | 1100 UJ | 340 U |
| P-Nitrophenol | 2600 U | 5200 U | 1600 U |
| 4-Nitroquinoline-1-oxide | 530 UR | 1100 UR | 340 UR |
| N-Nitrosodi-n-butylamine | 230 U | 450 U | 140 U |
| N-Nitrosodi-n-propylamine | 530 U | 1100 UJ | 340 U |
| N-Nitrosodiethylamine | 530 U | 1100 U | 340 U |
| N-Nitrosodimethylamine | 530 U | 1100 U | 340 U |
| N-Nitrosodiphenylamine | 530 U | 1100 U | 340 UJ |
| N-Nitrosomethylethylamine | 530 U | 1100 UJ | 340 U |
| N-Nitrosomorpholine | 530 U | 1100 U | 340 U |
| N-Nitrosopiperidine | 550 U | 1100 U | 350 UJ |
| N-Nitrosopyrrolidine | 530 U | 1100 U | 340 UJ |
| Pentachlorobenzene | 270 U | 550 U | 170 U |
| Pentachlorophenol | 2600 U | 5200 UJ | 1600 U |
| Phenacetin | 270 U | 550 U | 170 U |
| Phenanthrene | 9600 | 13000 J | 340 U |
| Phenol | 530 U | 1100 UJ | 340 U |
| p-Phenylenediamine | 2700 U | 5500 U | 1700 U |
| 2-Picoline | 270 U | 550 U | 170 U |

Table 4-26
Appendix IX Semivolatile Organic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 79 | | |
|---|---|---|---|
| Dames & Moore Sample ID | B079A1 | B079A1DL | B079A2 |
| Sample Location | B79-1 | B79-1 DL | B79-2 |
| Sample Depth | 4.5-6.5ft | 4.5-6.5ft | 0-2ft |
| Laboratory ID | P208612 | P208612DL | P208613 |
| Sample Date | 08/12/92 | 08/12/92 | 08/12/92 |
| Units | ug/kg | ug/kg | ug/kg |
| Pyrene | 5700 | 8700 J | 340 U |
| Pyridine | 1100 U | 2200 U | 680 U |
| Quintozene | 530 U | 1100 U | 340 U |
| Safrole | 530 U | 1100 U | 340 U |
| Sulfotep | 530 U | 1100 U | 340 U |
| 1,2,4,5-Tetrachlorobenzene | 160 U | 320 U | 100 U |
| 2,3,4,6-Tetrachlorophenol | 270 U | 550 U | 170 U |
| Thionazin | 530 U | 1100 U | 340 U |
| o-Toluidine | 530 U | 1100 U | 340 U |
| 1,2,4-Trichlorobenzene | 530 U | 1100 UJ | 340 U |
| 2,4,5-Trichlorophenol | 530 U | 1100 UJ | 340 U |
| 2,4,6-Trichlorophenol | 530 U | 1100 UJ | 340 U |
| o,o,o-Triethylphosphorothioate | 530 U | 1100 U | 340 U |
| 1,3,5-Trinitrobenzene | 530 UJ | 1100 UJ | 340 U |

# TABLE 4-26

## Appendix IX Semivolatile Organic Compound Analytical Data
## Subsurface Soil Investigation
## RCRA Verification Investigation
## Chevron Refinery
## Philadelphia, Pennsylvania

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| ug/kg | - | micrograms per kilogram. |
| MS | - | Matrix Spike quality assurance/quality control sample. |
| MSD | - | Matrix Spike Duplicate quality assurance/quality control sample. |
| Rep | - | Replicate Sample. |
| DL | - | Sample Dilution. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |
| UJ | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is estimated. |
| UR | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the data is unreliable. The compound may or may not be present. |
| J | - | The associated numerical value is an estimated quantity. |
| B | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. |
| BJ | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. The associated numerical value is an estimated quantity. |

Table 4-27
Appendix IX Inorganic Compound Analytical Data
Subsurface Soil Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | SWMU 79 | |
|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | B045A1 | B045A2 | B045A3 | B045A4 | B079A1 | B079A2 |
| Sample Location | B45-1 | B45-2 | B45-1 Rep | Field Blank | B79-1 | B79-2 |
| Sample Depth | 1.5-3.5ft | 2-4ft | 1.5-3.5ft | | 4.5-6.5ft | 0-2ft |
| Laboratory ID | P208103 | P208439 | P208102 | P208101 | P208612 | P208613 |
| Sample Date | 08/07/92 | 08/10/92 | 08/07/92 | 08/07/92 | 08/12/92 | 08/12/92 |
| Units | mg/kg | mg/kg | mg/kg | UG/L | mg/kg | mg/kg |
| Inorganic Compounds | | | | | | |
| Antimony | 1.10 U | 1.20 U | 1.20 U | 10.00 U | 1.60 U | 5.20 |
| Arsenic | 9.90 K | 4.90 K | 7.90 K | 3.00 U | 21.00 K | 1.40 K |
| Barium | 72.80 J | 87.00 J | 66.70 J | 5.00 UJ | 338.00 J | 80.00 J |
| Beryllium | 0.66 | 0.59 | 0.59 | 5.00 U | 1.60 | 0.61 |
| Cadmium | 0.55 U | 0.59 U | 0.59 U | 5.00 U | 1.80 | 0.51 U |
| Chromium | 376.00 K | 35.70 K | 28.10 K | 10.00 UJ | 57.40 K | 125.00 K |
| Cobalt | 13.50 J | 6.50 J | 7.40 J | 10.00 UJ | 26.70 J | 9.10 J |
| Copper | 299.00 K | 40.20 K | 55.20 K | 10.00 U | 147.00 K | 34.10 K |
| Cyanide | 1.40 | 0.39 B | 0.34 B | 7.00 | 10.00 | 0.42 |
| Lead | 173.00 J | 171.00 J | 101.00 J | 19.40 J | 468.00 J | 13.80 B |
| Mercury | 0.65 J | 0.59 J | 0.26 J | 0.20 UJ | 2.60 J | 0.24 J |
| Nickel | 43.70 J | 19.20 J | 16.20 J | 20.00 UJ | 45.20 J | 31.20 J |
| Selenium | 0.44 U | 0.47 U | 0.48 | 4.00 U | 2.40 | 0.41 U |
| Silver | 1.10 U | 1.20 U | 1.20 U | 10.00 U | 1.60 U | 1.00 U |
| Sulfide | 3.30 UL | 3.60 U | 3.50 UL | 200.00 U | 26.60 L | 16.80 L |
| Thallium | 0.12 | 0.12 U | 0.12 U | 1.00 U | 0.40 | 0.11 |
| Tin | 11.00 U | 11.80 U | 11.70 U | 100.00 U | 16.20 U | 50.90 U |
| Vanadium | 198.00 K | 118.00 K | 53.70 K | 10.00 UJ | 27.10 K | 37.10 K |
| Zinc | 300.00 K | 90.60 K | 81.60 K | 10.00 UJ | 733.00 K | 398.00 K |

# TABLE 4-27

## Appendix IX Inorganic Compound Analytical Data
## Subsurface Soil Investigation
## RCRA Verification Investigation
## Chevron Refinery
## Philadelphia, Pennsylvania

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| mg/kg | - | milligrams per kilogram. |
| Rep | - | Replicate Sample. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |
| UJ | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is estimated. |
| UL | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is biased low. |
| J | - | The associated numerical value is an estimated quantity. |
| K | - | The associated numerical value is biased high. |
| L | - | The associated numerical value is biased low. |
| B | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. |

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Table 4-28
Appendix IX Volatile Organic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | | | SWMU 79 |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | G045A1 | G045A1MS | G045A1MSD | G045A3 | G045A3DL | G045A5 | G045A7 | G079A1 |
| Sample Location | B131 | B131-MS | B131-MSD | B131-Rep | B131 DL | Field Blank | Trip Blank | C128 |
| Laboratory ID | P210928 | P210930 | P210932 | P210926 | P210926DL | P210935 | P210937 | P210938 |
| Sample Date | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| Volatile Organic Compounds | | | | | | | | |
| Acetone | 50 U | 50 U | 50 U | **24 J** | 50 U | 10 U | 10 U | **20 J** |
| Acetonitrile | 250 U | 250 U | 250 U | 50 U | 250 U | 50 U | 50 U | 50 U |
| Acrolein | 500 U | 500 U | 500 U | 100 U | 500 U | 100 U | 100 U | 100 U |
| Acrylonitrile | 500 U | 500 U | 500 U | 100 U | 500 U | 100 U | 100 U | 100 U |
| Allyl chloride | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| Benzene | **520** | 25 U | 25 U | **510 J** | **470** | 5 U | 5 U | 5 U |
| Bromoform | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| Bromomethane | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| 2-Butanone | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| Carbon disulfide | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| Carbon tetrachloride | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| Chlorobenzene | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| Chlorodibromomethane | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| Chloroethane | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| Chloroform | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| Chloromethane | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| Chloroprene | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| 1,2-Dibromo-3-chloropropane | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| 1,2-Dibromoethane | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| Dichlorobromomethane | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| Trans-1,4-dichlorobutene | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| Dichlorodifluoromethane [CFC-12] | 75 U | 75 U | 75 U | 15 U | 75 U | 15 U | 15 U | 15 U |
| 1,1-Dichloroethane | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| 1,2-Dichloroethane | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| 1,1-Dichloroethene | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |

Table 4-28
Appendix IX Volatile Organic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | | | SWMU 79 |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | G045A1 | G045A1MS | G045A1MSD | G045A3 | G045A3DL | G045A5 | G045A7 | G079A1 |
| Sample Location | B131 | B131-MS | B131-MSD | B131-Rep | B131 DL | Field Blank | Trip Blank | C128 |
| Laboratory ID | P210928 | P210930 | P210932 | P210926 | P210926DL | P210935 | P210937 | P210938 |
| Sample Date | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| Trans-1,2-Dichloroethene | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| 1,2-Dichloropropane | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| cis-1,3-Dichloropropene | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| trans-1,3-Dichloropropene | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| 1,4-Dioxane | 750 UR | 750 UR | 750 UR | 150 UR | 750 UR | 150 UR | 150 UR | 150 UR |
| Ethyl methacrylate | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| Ethylbenzene | 25 U | 25 U | 25 U | 8 | 25 U | 5 U | 5 U | 5 U |
| 2-Hexanone | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| Isobutyl alcohol | 500 U | 500 U | 500 U | 100 U | 500 U | 100 U | 100 U | 100 U |
| Methacrylonitrile | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| Methyl iodide | 100 U | 100 U | 100 U | 20 U | 100 U | 20 U | 20 U | 20 U |
| Methyl isobutyl ketone | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| Methyl methacrylate | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| Methylene bromide | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| Methylene Chloride | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| Pentachloroethane | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| Propionitrile | 120 U | 120 U | 120 U | 25 U | 120 U | 25 U | 25 U | 25 U |
| Styrene | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| 1,1,1,2-Tetrachloroethane | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| 1,1,2,2-Tetrachloroethane | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| Tetrachloroethene | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| Toluene | 25 U | 25 U | 25 U | 6 | 25 U | 5 U | 5 U | 5 U |
| 1,1,1-Trichloroethane | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| 1,1,2-Trichloroethane | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| Trichloroethene | 25 U | 25 U | 25 U | 5 U | 25 U | 5 U | 5 U | 5 U |
| Trichlorofluoromethane [CFC-11] | 50 U | 50 U | 50 U | 10 U | 50 U | 4 J | 10 U | 10 U |

Table 4-28
Appendix IX Volatile Organic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | | | SWMU 79 |
|---|---|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | G045A1 | G045A1MS | G045A1MSD | G045A3 | G045A3DL | G045A5 | G045A7 | G079A1 |
| Sample Location | B131 | B131-MS | B131-MSD | B131-Rep | B131 DL | Field Blank | Trip Blank | C128 |
| Laboratory ID | P210928 | P210930 | P210932 | P210926 | P210926DL | P210935 | P210937 | P210938 |
| Sample Date | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| 1,2,3-Trichloropropane | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| Vinyl acetate | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| Vinyl chloride | 50 U | 50 U | 50 U | 10 U | 50 U | 10 U | 10 U | 10 U |
| Xylene (Total) | 30 | 27 | 27 | 39 | 26 | 5 U | 5 U | 5 U |

## TABLE 4-28

**Appendix IX Volatile Organic Compound Analytical Data**
**Groundwater Investigation**
**RCRA Verification Investigation**
**Chevron Refinery**
**Philadelphia, Pennsylvania**

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| ug/l | - | micrograms per liter. |
| MS | - | Matrix Spike quality assurance/quality control sample. |
| MSD | - | Matrix Spike Duplicate quality assurance/quality control sample. |
| Rep | - | Replicate Sample. |
| DL | - | Sample Dilution. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |
| UR | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the data is unreliable. The compound may or may not be present. |
| J | - | The associated numerical value is an estimated quantity. |

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Table 4-29
Appendix IX Semivolatile Organic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | SWMU 79 |
|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | G045A1 | G045A1MS | G045A1MSD | G045A3 | G045A5 | G079A1 |
| Sample Location | B131 | B131-MS | B131-MSD | B131-Rep | Field Blank | C128 |
| Laboratory ID | P210928 | P210930 | P210932 | P210926 | P210935 | P210938 |
| Sample Date | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| Semivolatile Organic Compounds | | | | | | |
| Acenaphthene | 27 | 10 U | 10 U | 28 | 10 U | 18 |
| Acenaphthylene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Acetophenone | 11 U | 11 U | 11 U | 11 U | 11 U | 11 U |
| 2-Acetylaminofluorene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| alpha-Naphthylamine | 6 U | 6 U | 6 U | 6 U | 6 U | 6 U |
| 4-Aminobiphenyl | 7 U | 7 U | 7 U | 7 U | 7 U | 7 U |
| Aniline | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Anthracene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Aramite | 20 UR | 20 UR | 20 UR | 20 UR | 20 UR | 20 UR |
| Benzamide,3,5-dichloro-N-(1,1-dimethyl-2-propyny | 6 U | 6 U | 6 U | 6 U | 6 U | 6 U |
| Benzeneethanamine, alpha,alpha-dimethyl- | 3 U | 3 U | 3 U | 3 U | 3 U | 3 U |
| Benzo(a)anthracene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Benzo(a)pyrene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Benzo(b,j,k)fluoranthene | 40 U | 40 U | 40 U | 40 U | 40 U | 40 U |
| Benzo[ghi]perylene | 8 U | 8 U | 8 U | 8 U | 8 U | 8 U |
| Benzyl Alcohol | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| beta-Naphthylamine | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 4-Bromophenyl phenyl ether | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Butyl benzyl phthalate | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| p-Chloro-m-cresol | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| p-Chloroaniline | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U |
| Chlorobenzilate | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Bis(2-chloroethoxy) methane | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Bis(2-chloroethyl) ether | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Bis(2-chloroisopropyl)ether | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |

Table 4-29
Appendix IX Semivolatile Organic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | SWMU 79 |
|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | G045A1 | G045A1MS | G045A1MSD | G045A3 | G045A5 | G079A1 |
| Sample Location | B131 | B131-MS | B131-MSD | B131-Rep | Field Blank | C128 |
| Laboratory ID | P210928 | P210930 | P210932 | P210926 | P210935 | P210938 |
| Sample Date | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| 2-Chloronaphthalene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2-Chlorophenol | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 4-Chlorophenyl phenyl ether | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Chrysene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| o-Cresol | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| p-Cresol | 30 U | 30 U | 30 U | 30 U | 30 U | 30 U |
| Di-n-butylphthalate | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Di-n-octylphthalate | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Diallate | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Dibenz(a,h)anthracene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Dibenzofuran | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,2-Dichlorobenzene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,3-Dichlorobenzene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,4-Dichlorobenzene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 3,3'-Dichlorobenzidine | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U |
| 2,4-Dichlorophenol | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2,6-Dichlorophenol | 4 U | 4 U | 4 U | 4 U | 4 U | 4 U |
| Diethyl phthalate | 3 J | 10 U | 10 U | 4 J | 10 U | 10 U |
| Dimethoate | 20 UJ | 20 UJ | 20 UJ | 20 UJ | 20 UJ | 20 UJ |
| Dimethyl phthalate | 5 BJ | 5 BJ | 5 BJ | 6 BJ | 4 BJ | 4 BJ |
| 4-Dimethylaminoazobenzene | 7 U | 7 U | 7 U | 7 U | 7 U | 7 U |
| 7,12-Dimethylbenz(a)anthracene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 3,3'-Dimethylbenzidine | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2,4-Dimethylphenol | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 4,6-Dinitro-o-cresol | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U |
| m-Dinitrobenzene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |

Table 4-29
Appendix IX Semivolatile Organic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | SWMU 79 |
|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | G045A1 | G045A1MS | G045A1MSD | G045A3 | G045A5 | G079A1 |
| Sample Location | B131 | B131-MS | B131-MSD | B131-Rep | Field Blank | C128 |
| Laboratory ID | P210928 | P210930 | P210932 | P210926 | P210935 | P210938 |
| Sample Date | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| 2,4-Dinitrophenol | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U |
| 2,4-Dinitrotoluene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2,6-Dinitrotoluene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Diphenylamine | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Ethyl methanesulfonate | 3 U | 3 U | 3 U | 3 U | 3 U | 3 U |
| Bis(2-ethylhexyl) phthalate | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Fluoranthene | 4 J | 4 J | 5 J | 4 J | 10 U | 10 U |
| Fluorene | 10 U | 10 U | 3 J | 10 U | 10 U | 8 J |
| Hexachloro-1,3-butadiene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Hexachlorobenzene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Hexachlorocyclopentadiene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Hexachloroethane | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Hexachlorophene | 1000 U | 1000 U | 1000 U | 1000 U | 1000 U | 1000 U |
| Hexachloropropene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Indeno(1,2,3-cd)pyrene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Isodrin | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Isophorone | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Isosafrole | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Methanesulfonic Acid, Methyl | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Methapyrilene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 3-Methylcholanthrene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2-Methylnaphthalene | 10 U | 10 U | 10 U | 10 U | 10 U | 5 J |
| Naphthalene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,4-Naphthoquinone | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U |
| 5-Nitro-o-toluidine | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2-Nitroaniline | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U |

Table 4-29
Appendix IX Semivolatile Organic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | SWMU 79 |
|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | G045A1 | G045A1MS | G045A1MSD | G045A3 | G045A5 | G079A1 |
| Sample Location | B131 | B131-MS | B131-MSD | B131-Rep | Field Blank | C128 |
| Laboratory ID | P210928 | P210930 | P210932 | P210926 | P210935 | P210938 |
| Sample Date | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| 3-Nitroaniline | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U |
| P-Nitroaniline | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U |
| Nitrobenzene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2-Nitrophenol | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| P-Nitrophenol | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U |
| 4-Nitroquinoline-1-oxide | 10 UJ | 10 UJ | 10 UJ | 10 UJ | 10 UJ | 10 UJ |
| N-Nitrosodi-n-butylamine | 4 U | 4 U | 4 U | 4 U | 4 U | 4 U |
| N-Nitrosodi-n-propylamine | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| N-Nitrosodiethylamine | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| N-Nitrosodimethylamine | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| N-Nitrosodiphenylamine | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| N-Nitrosomethylethylamine | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| N-Nitrosomorpholine | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| N-Nitrosopiperidine | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| N-Nitrosopyrrolidine | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Pentachlorobenzene | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Pentachlorophenol | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U |
| Phenacetin | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Phenanthrene | 10 U | 10 U | 10 U | 10 U | 10 U | 9 J |
| Phenol | 25 | 10 U | 10 U | 23 | 10 U | 10 U |
| p-Phenylenediamine | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U |
| 2-Picoline | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Pyrene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Pyridine | 20 U | 20 U | 20 U | 20 U | 20 U | 20 U |
| Quintozene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| Safrole | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |

Table 4-29
Appendix IX Semivolatile Organic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | | | SWMU 79 |
|---|---|---|---|---|---|---|
| Dames & Moore Sample ID | G045A1 | G045A1MS | G045A1MSD | G045A3 | G045A5 | G079A1 |
| Sample Location | B131 | B131-MS | B131-MSD | B131-Rep | Field Blank | C128 |
| Laboratory ID | P210928 | P210930 | P210932 | P210926 | P210935 | P210938 |
| Sample Date | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 |
| Units | UG/L | UG/L | UG/L | UG/L | UG/L | UG/L |
| Sulfotep | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,2,4,5-Tetrachlorobenzene | 3 U | 3 U | 3 U | 3 U | 3 U | 3 U |
| 2,3,4,6-Tetrachlorophenol | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| Thionazin | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| o-Toluidine | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,2,4-Trichlorobenzene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 2,4,5-Trichlorophenol | 50 U | 50 U | 50 U | 50 U | 50 U | 50 U |
| 2,4,6-Trichlorophenol | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| o,o,o-Triethylphosphorothioate | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| 1,3,5-Trinitrobenzene | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |

# TABLE 4-29

## Appendix IX Semivolatile Organic Compound Analytical Data
## Groundwater Investigation
## RCRA Verification Investigation
## Chevron Refinery
## Philadelphia, Pennsylvania

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| ug/l | - | micrograms per liter. |
| MS | - | Matrix Spike quality assurance/quality control sample. |
| MSD | - | Matrix Spike Duplicate quality assurance/quality control sample. |
| Rep | - | Replicate Sample. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |
| UJ | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is estimated. |
| UR | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the data is unreliable. The compound may or may not be present. |
| J | - | The associated numerical value is an estimated quantity. |
| BJ | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. The associated numerical value is an estimated quantity. |

Table 4-30
Appendix IX Inorganic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | SWMU 79 |
|---|---|---|---|---|
| Dames & Moore Sample ID | G045A1 | G045A3 | G045A5 | G079A1 |
| Sample Location | B131 | B131-Rep | Field Blank | C128 |
| Laboratory ID | P210928 | P210926 | P210935 | P210938 |
| Sample Date | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 |
| Units | UG/L | UG/L | UG/L | UG/L |
| Inorganic Compounds | | | | |
| Antimony | 10.00 U | 10.00 U | 10.00 U | 10.00 U |
| Arsenic | 3.00 U | 3.00 U | 3.00 U | **32.70** |
| Barium | **163.00** | **165.00** | 5.00 U | **722.00** |
| Beryllium | 5.00 U | 5.00 U | 5.00 U | 5.00 U |
| Cadmium | 5.00 U | 5.00 U | 5.00 U | 5.00 U |
| Chromium | 10.00 U | 10.00 U | 10.00 U | **312.00** |
| Cobalt | 10.00 U | 10.00 U | 10.00 U | **32.00** |
| Copper | 10.00 U | 10.00 U | 10.00 U | **215.00** |
| Cyanide | **5.50** | **5.30** | 5.00 U | **30.40** |
| Lead | **3.40 L** | **4.40 L** | 2.00 UL | **400.00 L** |
| Mercury | 0.20 U | 0.20 U | 0.20 U | **3.20** |
| Nickel | 20.00 U | 20.00 U | 20.00 U | **61.00** |
| Selenium | 4.00 U | 4.00 U | 4.00 U | 4.00 U |
| Silver | 10.00 U | 10.00 U | 10.00 U | 10.00 U |
| Sulfide | 200.00 UL | 200.00 UL | 200.00 UL | 200.00 UL |
| Thallium | 1.00 U | 1.00 U | 1.00 U | 1.00 U |
| Tin | 100.00 U | 100.00 U | 100.00 U | 100.00 U |
| Vanadium | 10.00 U | 10.00 U | 10.00 U | **66.00** |
| Zinc | **21.00 B** | **25.00 B** | **12.00 B** | **876.00** |

# TABLE 4-30

## Appendix IX Inorganic Compound Analytical Data
## Groundwater Investigation
## RCRA Verification Investigation
## Chevron Refinery
## Philadelphia, Pennsylvania

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| ug/l | - | micrograms per liter. |
| Rep | - | Replicate Sample. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |
| UL | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is biased low. |
| L | - | The associated numerical value is biased low. |
| B | - | The result is qualitatively suspect because the compound was detected in a field blank, trip blank, and/or a laboratory method blank sample at a similar concentration. |

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Table 4-31
Appendix IX Filtered Inorganic Compound Analytical Data
Groundwater Investigation
RCRA Verification Investigation
Chevron Refinery
Philadelphia, Pennsylvania

| SWMU Designation | SWMU 45 | | | SWMU 79 |
|---|---|---|---|---|
| Dames & Moore Sample ID | G045A2 | G045A4 | G045A6 | G079A2 |
| Sample Location | B131 | B131 Rep | Field Blank | C128 |
| Laboratory ID | P210929 | P210927 | P210936 | P210939 |
| Sample Date | 09/04/92 | 09/04/92 | 09/04/92 | 09/04/92 |
| Units | UG/L | UG/L | UG/L | UG/L |
| Inorganic Compounds | | | | |
| Antimony, Filtered | 10.00 U | 10.00 U | **16.10 B** | 10.00 U |
| Arsenic, Filtered | 3.00 U | 3.00 U | 3.00 U | **7.10** |
| Barium, Filtered | **140.00** | **144.00** | 5.00 U | **327.00** |
| Beryllium, Filtered | 5.00 U | 5.00 U | 5.00 U | 5.00 U |
| Cadmium, Filtered | 5.00 U | 5.00 U | 5.00 U | 5.00 U |
| Chromium, Filtered | 10.00 U | 10.00 U | 10.00 U | 10.00 U |
| Cobalt, Filtered | 10.00 U | 10.00 U | 10.00 U | 10.00 U |
| Copper, Filtered | 10.00 U | 10.00 U | 10.00 U | 10.00 U |
| Lead, Filtered | 2.00 UL | 2.00 UL | 2.00 UL | 2.00 UL |
| Mercury, Filtered | 0.20 U | 0.20 U | 0.20 U | 0.20 U |
| Nickel, Filtered | 20.00 U | 20.00 U | 20.00 U | 20.00 U |
| Selenium, Filtered | 4.00 U | 4.00 U | 4.00 U | 4.00 U |
| Silver, Filtered | 10.00 U | 10.00 U | 10.00 U | 10.00 U |
| Thallium, Filtered | 1.00 UL | 1.00 UL | 1.00 UL | 1.00 UL |
| Tin, Filtered | 100.00 U | 100.00 U | 100.00 U | 100.00 U |
| Vanadium, Filtered | 10.00 U | 10.00 U | 10.00 U | 10.00 U |
| Zinc, Filtered | 10.00 U | **11.00 B** | **12.00 B** | **17.00 B** |

## TABLE 4-31

## Appendix IX Filtered Inorganic Compound Analytical Data
## Groundwater Investigation
## RCRA Verification Investigation
## Chevron Refinery
## Philadelphia, Pennsylvania

Explanation:

| | | |
|---|---|---|
| RCRA | - | Resource Conservation and Recovery Act. |
| SWMU | - | Solid Waste Management Unit. |
| ug/l | - | micrograms per liter. |
| Rep | - | Replicate Sample. |
| U | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. |
| UL | - | Laboratory analysis was conducted for the corresponding compound, but the compound was not detected. Numerical value is the sample detection limit. However, due to discrepencies identified during the data validation process, the detection limit is biased low. |

# TABLE 4-32A

## SKINNER LIST VOLATILE ORGANIC COMPOUND ANALYTICAL DATA
## SOIL SAMPLES - SWMU 71 (DECEMBER 1991 INVESTIGATION)

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| Dames & Moore Sample No.<br>Laboratory Sample No. | SB-1 (3.0-3.5')<br>P184061 | SB-2 (3.0-3.5')<br>P184062 | SB-3 (COMPOSITE)<br>P184063 | SB-4 (COMPOSITE)<br>P184066 |
|---|---|---|---|---|
| **PARAMETER/UNITS** | **ug/kg** | **ug/kg** | **ug/kg** | **ug/kg** |
| Chloromethane | 25 U | 34 U | 62 U | 9200 U |
| Dichloromethane | 12 U | 17 U | 31 U | 6600 |
| Carbon disulfide | 12 U | 17 U | 31 U | 4800 UR |
| 1,1-Dichloroethene | 12 U | 17 U | 31 U | 4800 U |
| trans-1,2-Dichloroethene | 12 U | 17 U | 31 U | 4800 U |
| Chloroform | 12 U | 17 U | 31 U | 4800 UR |
| 1,2-Dichloroethane | 12 U | 17 U | 31 U | 4800 UR |
| Methyl ethyl ketone | 25 U | 34 U | 62 U | 9200 UR |
| 1,1,1-Trichloroethane | 12 U | 17 U | 31 U | 4800 U |
| 1,1,2-Trichloroethane | 12 U | 17 U | 31 U | 4800 U |
| 1,2-Dichloropropane | 12 U | 17 U | 31 U | 4800 U |
| Trichloroethene | 12 U | 17 U | 31 U | 4800 U |
| Benzene | 12 U | 17 U | 27000D | 5700 R |
| Tetrachloroethene | 12 U | 17 U | 31 U | 4800 U |
| 1,1,1,2-Tetrachloroethane | 25 U | 34 U | 62 U | 9200 U |
| 1,1,2,2-Tetrachloroethane | 12 U | 17 U | 31 U | 4800 U |
| Toluene | 8 J | 17 U | 25 J | 4800 UR |
| Chlorobenzene | 12 U | 17 U | 31 U | 4800 UR |
| Styrene | 12 U | 17 U | 31 U | 4800 UR |
| Xylene | 66 | 120 | 94 | 14000 DJ |
| Acrolein | 250 U | 340 U | 620 U | 92000 U |
| Acrylonitrile | 250 U | 340 U | 620 U | 9200 U |
| 1,4-Dioxane | NA | NA | NA | NA |
| Acetonitrile | 250 U | 340 U | 620 U | 92000 U |

## TABLE 4-32A

## SKINNER LIST VOLATILE ORGANIC COMPOUND ANALYTICAL DATA
## SOIL SAMPLES - SWMU 71 (DECEMBER 1991 INVESTIGATION)

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| Dames & Moore Sample No.<br>Laboratory Sample No. | SB-1 (3.0-3.5')<br>P184061 | SB-2 (3.0-3.5')<br>P184062 | SB-3 (COMPOSITE)<br>P184063 | SB-4 (COMPOSITE)<br>P184066 |
|---|---|---|---|---|
| **PARAMETER/UNITS** | **ug/kg** | **ug/kg** | **ug/kg** | **ug/kg** |
| Formaldehyde | 0 U | 0 U | 0 U | 0 U |
| 1,2-Dibromoethane | 12 U | 17 U | 31 U | 4800 U |
| Cumene | 180 | 500D | 450000 D | 660000 D |
| Crotonaldehyde (LS) | ND | ND | ND | ND |
| Ethyleneimine (LS) | ND | ND | ND | ND |
| Ethylene oxide (LS) | ND | ND | ND | ND |
| Methanethiol (LS) | ND | ND | ND | ND |
| Propyl benzene (LS) | 7400 J | ND | ND | ND |

Explanation:

| | |
|---|---|
| SWMU | Solid Waste Management Unit. |
| ND | Not Detected. |
| NA | Not Analyzed. |
| LS | Compound analyzed through library search |
| U | Laboratory analysis conducted for this compound, but the compound was not detected. Numerical value is the sample detection limit. |
| J | The associated numerical value is an estimated quantity. |
| D | The sample was diluted in order to bring the compound into the linear calibration range. |
| R | The data is unreliable. The compound may or may not be present. |

TABLE 4-32B

# SKINNER LIST VOLATILE ORGANIC COMPOUND ANALYTICAL DATA QUALITY ASSURANCE SAMPLES - SWMU 71 (DECEMBER 1991 INVESTIGATION)

## CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

| Dames & Moore Sample No. / Laboratory Sample No. | FIELD BLANK P184069 | TRIP BLANK P184070 |
|---|---|---|
| **PARAMETER/UNITS** | **ug/l** | **ug/l** |
| Chloromethane | 10 U | 10 U |
| Dichloromethane | 5 U | 5 U |
| Carbon disulfide | 5 U | 5 U |
| 1,1-Dichloroethene | 5 U | 5 U |
| trans-1,2-Dichloroethene | 5 U | 5 U |
| Chloroform | 5 U | 5 U |
| 1,2-Dichloroethane | 5 U | 5 U |
| Methyl ethyl ketone | 10 U | 10 U |
| 1,1,1-Trichloroethane | 5 U | 5 U |
| 1,1,2-Trichloroethane | 5 U | 5 U |
| 1,2-Dichloropropane | 5 U | 5 U |
| Trichloroethene | 5 U | 5 U |
| Benzene | 5 U | 5 U |
| Tetrachloroethene | 5 U | 5 U |
| 1,1,1,2-Tetrachloroethane | 10 U | 10 U |
| 1,1,2,2-Tetrachloroethane | 5 U | 5 U |
| Toluene | 5 U | 5 U |
| Chlorobenzene | 5 U | 5 U |
| Styrene | 5 U | 5 U |
| Xylene | 5 U | 5 U |
| Acrolein | 100 U | 100 U |
| Acrylonitrile | 100 U | 100 U |
| 1,4-Dioxane | NA | NA |
| Acetonitrile | 100 U | 100 U |

# SKINNER LIST VOLATILE ORGANIC COMPOUND ANALYTICAL DATA QUALITY ASSURANCE SAMPLES - SWMU 71 (DECEMBER 1991 INVESTIGATION)

## CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

| Dames & Moore Sample No. / Laboratory Sample No. | FIELD BLANK P184069 | TRIP BLANK P184070 |
|---|---|---|
| **PARAMETER/UNITS** | **ug/l** | **ug/l** |
| Formaldehyde | 0 U | 0 U |
| 1,2-Dibromoethane | 5 U | 5 U |
| Cumene | 0 U | 0 U |
| Crotonaldehyde (LS) | ND | ND |
| Ethyleneimine (LS) | ND | ND |
| Ethylene oxide (LS) | ND | ND |
| Methanethiol (LS) | ND | ND |
| Propyl benzene (LS) | ND | ND |

Explanation:

| | |
|---|---|
| SWMU | Solid Waste Management Unit. |
| ND | Not Detected. |
| NA | Not Analyzed. |
| LS | Compound analyzed through library search |
| U | Laboratory analysis conducted for this compound, but the compound was not detected. Numerical value is the sample detection limit. |

## TABLE 4-33A

## SKINNER LIST SEMI-VOLATILE ORGANIC COMPOUND ANALYTICAL DATA
## SOIL SAMPLES - SWMU 71 (DECEMBER 1991 INVESTIGATION)

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| Dames & Moore Sample No.<br>Laboratory Sample No. | SB-1 (3.0-3.5')<br>P184061 | SB-2 (3.0-3.5')<br>P184062 | SB-3 (COMPOSITE)<br>P184063 | SB-4 (COMPOSITE)<br>P184066 |
|---|---|---|---|---|
| **PARAMETER/UNITS** | **ug/kg** | **ug/kg** | **ug/kg** | **ug/kg** |
| 2,4,6-Trichlorophenol | 550 U | 460 U | 390 U | 380 U |
| 2,4,5-Trichlorophenol | 2700 U | 2300 U | 1900 U | 1800 U |
| 2-Chloronapthalene | 550 U | 460 U | 390 U | 380 U |
| 2-Nitroaniline | 2700 U | 2300 U | 1900 U | 1800 U |
| 3-Nitroaniline | 2700 U | 2300 U | 1900 U | 1800 U |
| 4-Nitroaniline | 2700 U | 2300 U | 1900 U | 1800 U |
| Dimethyl phthalate | 550 U | 460 U | 390 U | 380 U |
| 4,6-Dinitro-o-cresol (4,6-Dinitro-2-methylphenol) | 2700 U | 2300 U | 1900 U | 1800 U |
| 2,4-Dinitrophenol | 2700 U | 2300 U | 1900 U | 1800 U |
| 4-Nitrophenol | 2700 U | 2300 U | 1900 U | 1800 U |
| 2,4-Dinitrotoluene | 550 U | 460 U | 390 U | 380 U |
| Diethyl phthalate | 550 U | 460 U | 390 U | 380 U |
| 1,2-Diphenylhydrazine | 550 U | 460 U | 390 U | 380 U |
| Pentachlorophenol | 2700 U | 2300 U | 1900 U | 1800 U |
| Phenanthrene | 29000 D | 4400 | 19000 D | 6400 D |
| Anthracene | 6300 D | 710 | 1900 DJ | 670 DJ |
| Di-n-butyl phthalate | 550 U | 400 BJ | 390 U | 550 BJ |
| Fluoranthene | 17000 D | 3900 | 4300 D | 1800 D |
| Benzidine | 2700 U | 2300 U | 1900 U | 1800 U |
| Pyrene | 11000 D | 2700 | 4100 D | 1500 D |
| Butyl benzyl phthalate | 550 U | 460 U | 390 U | 380 U |
| Chrysene | 9300 D | 2200 | 8900 D | 1500 D |
| Bis(2-ethylhexyl)phthalate | 550 U | 180 J | 390 U | 380 U |
| Di-n-octyl phthalate | 550 U | 460 U | 390 U | 380 U |

## TABLE 4-33A

## SKINNER LIST SEMI-VOLATILE ORGANIC COMPOUND ANALYTICAL DATA
## SOIL SAMPLES - SWMU 71 (DECEMBER 1991 INVESTIGATION)

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| Dames & Moore Sample No.<br>Laboratory Sample No. | SB-1 (3.0-3.5')<br>P184061 | SB-2 (3.0-3.5')<br>P184062 | SB-3 (COMPOSITE)<br>P184063 | SB-4 (COMPOSITE)<br>P184066 |
|---|---|---|---|---|
| **PARAMETER/UNITS** | **ug/kg** | **ug/kg** | **ug/kg** | **ug/kg** |
| Benzo(b)Fluoranthene | 9500 D | 2500 | 3200 D | 1400 D |
| Benzo(a)pyrene | 5100 D | 1500 | 2600 D | 780 D |
| Indeno(1,2,3-cd)pyrene | 1000 | 580 | 800 | 430 |
| Dibenz(a,h)anthracene | 550 U | 460 U | 390 U | 380 U |
| Pyridine | 550 U | 460 U | 390 U | 380 U |
| 7,12-Dimethylbenz(a)anthracene | 550 U | 460 U | 390 U | 380 U |
| 3-Methylchlolanthrene | 550 U | 460 U | 390 U | 380 U |
| Dibenz(a,j)acridine | 550 U | 460 U | 390 U | 380 U |
| Phenol | 550 U | 560 | 390 U | 380 U |
| Aniline | 550 U | 460 U | 390 U | 380 U |
| Bis(2-chloroethyl)ether | 550 U | 460 U | 390 U | 380 U |
| 2-Chlorophenol | 550 U | 460 U | 390 U | 380 U |
| 1,2-Dichlorobenzene | 550 U | 460 U | 390 U | 380 U |
| 1,3-Dichlorobenzene | 550 U | 460 U | 390 U | 380 U |
| 1,4-Dichlorobenzene | 550 U | 460 U | 390 U | 380 U |
| 2-Methylphenol (o-cresol) | 550 U | 460 U | 390 U | 380 U |
| 3-Methylphenol (m-cresol) | 550 U | 460 U | 390 U | 380 U |
| 4-Methylphenol (p-cresol) | 550 U | 460 U | 390 U | 380 U |
| Nitrobenzene | 550 U | 460 U | 390 U | 380 U |
| 2,4-Dimethylphenol | 550 U | 460 U | 390 U | 380 U |
| 1,2,4-Trichlorobenzene | 550 U | 460 U | 390 U | 380 U |
| Naphthalene | 2000 DJ | 1800 | 5000 D | 1900 D |
| p-Chloro-m-cresol | 550 U | 460 U | 390 U | 380 U |
| Indene | 550 U | 460 U | 390 U | 380 U |

## TABLE 4-33A

## SKINNER LIST SEMI-VOLATILE ORGANIC COMPOUND ANALYTICAL DATA
## SOIL SAMPLES - SWMU 71 (DECEMBER 1991 INVESTIGATION)

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| Dames & Moore Sample No.<br>Laboratory Sample No. | SB-1 (3.0-3.5')<br>P184061 | SB-2 (3.0-3.5')<br>P184062 | SB-3 (COMPOSITE)<br>P184063 | SB-4 (COMPOSITE)<br>P184066 |
|---|---|---|---|---|
| **PARAMETER/UNITS** | **ug/kg** | **ug/kg** | **ug/kg** | **ug/kg** |
| Benzyl chloride | 550 U | 460 U | 390 U | 380 U |
| Hydroquinone | 550 U | 460 U | 390 U | 380 U |
| Quinoline | 550 U | 460 U | 390 U | 380 U |
| 1-Methylnapthalene (LS) | 4400 J | 7000 J | 20000 J | 11000 J |
| Benzo(j)Fluoranthene (LS) | 670 J | 380 J | ND | ND |
| Benz(c)acridine (LS) | ND | ND | ND | ND |
| Benzenethiol (LS) | NA | NA | NA | NA |
| Bis(2-chloroisopropyl)ether (LS) | ND | ND | ND | ND |
| Bis(chloromethyl)ether (LS) | ND | ND | ND | ND |
| Dibenz(a,h)acridine (LS) | NA | NA | NA | NA |
| 7H-Dibenzo(c,g)carbazole (LS) | ND | ND | ND | ND |
| Dibenzo(a,e)pyrene (LS) | ND | ND | ND | ND |
| Dibenzo(a,h)pyrene (LS) | ND | ND | ND | ND |
| Dibenzo(a,i)pyrene (LS) | ND | ND | ND | ND |
| 5-Nitro acenaphthene (LS) | ND | ND | ND | ND |

Explanation:

| | |
|---|---|
| SWMU | Solid Waste Management Unit. |
| ND | Not Detected. |
| NA | Not Analyzed. |
| LS | Compound analyzed through library search |
| U | Laboratory analysis conducted for this compound, but the compound was not detected. Numerical value is the sample detection limit. |
| J | The associated numerical value is an estimated quantity. |
| B | This result is qualitatively suspect since this compound was detected in a field and/or laboratory blank at a similar concentration. |
| D | The sample was diluted in order to bring the compound into the linear calibration range. |

# TABLE 4-33B

## SKINNER LIST SEMI-VOLATILE ORGANIC COMPOUND ANALYTICAL DATA QUALITY ASSURANCE SAMPLES - SWMU 71 (DECEMBER 1991 INVESTIGATION)

## CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

| Dames & Moore Sample No. Laboratory Sample No. | FIELD BLANK P184069 |
|---|---|
| **PARAMETER/UNITS** | **ug/l** |
| 2,4,6-Trichlorophenol | 10 U |
| 2,4,5-Trichlorophenol | 50 U |
| 2-Chloronapthalene | 10 U |
| 2-Nitroaniline | 50 U |
| 3-Nitroaniline | 50 U |
| 4-Nitroaniline | 50 U |
| Dimethyl phthalate | 10 U |
| 4,6-Dinitro-o-cresol (4,6-Dinitro2-methylphenol) | 50 U |
| 2,4-Dinitrophenol | 50 U |
| 4-Nitrophenol | 50 U |
| 2,4-Dinitrotoluene | 10 U |
| Diethyl phthalate | 10 U |
| 1,2-Diphenylhydrazine | 10 U |
| Pentachlorophenol | 50 U |
| Phenanthrene | 10 U |
| Anthracene | 10 U |
| Di-n-butyl phthalate | 10 U |
| Fluoranthene | 10 U |
| Benzidine | 50 U |
| Pyrene | 10 U |
| Butyl benzyl phthalate | 10 U |
| Chrysene | 10 U |
| Bis(2-ethylhexyl)phthalate | 10 U |
| Di-n-octyl phthalate | 10 U |

## SKINNER LIST SEMI-VOLATILE ORGANIC COMPOUND ANALYTICAL DATA QUALITY ASSURANCE SAMPLES - SWMU 71 (DECEMBER 1991 INVESTIGATION)

## CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

| Dames & Moore Sample No. Laboratory Sample No. | FIELD BLANK P184069 |
|---|---|
| **PARAMETER/UNITS** | **ug/l** |
| Benzo(b)Fluoranthene | 10 U |
| Benzo(a)pyrene | 10 U |
| Indeno(1,2,3-cd)pyrene | 10 U |
| Dibenz(a,h)anthracene | 10 U |
| Pyridine | 20 U |
| 7,12-Dimethylbenz(a)anthracene | 10 U |
| 3-Methylchlolanthrene | 10 U |
| Dibenz(a,j)acridine | 10 U |
| Phenol | 10 U |
| Aniline | 10 U |
| Bis(2-chloroethyl)ether | 10 U |
| 2-Chlorophenol | 10 U |
| 1,2-Dichlorobenzene | 10 U |
| 1,3-Dichlorobenzene | 10 U |
| 1,4-Dichlorobenzene | 10 U |
| 2-Methylphenol (o-cresol) | 10 U |
| 3-Methylphenol (m-cresol) | 10 U |
| 4-Methylphenol (p-cresol) | 10 U |
| Nitrobenzene | 10 U |
| 2,4-Dimethylphenol | 10 U |
| 1,2,4-Trichlorobenzene | 10 U |
| Naphthalene | 10 U |
| p-Chloro-m-cresol | 10 U |
| Indene | 10 U |

# SKINNER LIST SEMI-VOLATILE ORGANIC COMPOUND ANALYTICAL DATA QUALITY ASSURANCE SAMPLES - SWMU 71 (DECEMBER 1991 INVESTIGATION)

## CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

| Dames & Moore Sample No. / Laboratory Sample No. | FIELD BLANK P184069 |
|---|---|
| **PARAMETER/UNITS** | **ug/l** |
| Benzyl chloride | 10 U |
| Hydroquinone | 10 U |
| Quinoline | 10 U |
| 1-Methylnapthalene (LS) | ND |
| Benzo(j)Fluoranthene (LS) | ND |
| Benz(c)acridine (LS) | ND |
| Benzenethiol (LS) | NA |
| Bis(2-chloroisopropyl)ether (LS) | ND |
| Bis(chloromethyl)ether (LS) | ND |
| Dibenz(a,h)acridine (LS) | NA |
| 7H-Dibenzo(c,g)carbazole (LS) | ND |
| Dibenzo(a,e)pyrene (LS) | ND |
| Dibenzo(a,h)pyrene (LS) | ND |
| Dibenzo(a,i)pyrene (LS) | ND |
| 5-Nitro acenaphthene (LS) | ND |

Explanation:

| | |
|---|---|
| SWMU | Solid Waste Management Unit. |
| ND | Not Detected. |
| NA | Not Analyzed. |
| LS | Compound analyzed through library search |
| U | Laboratory analysis conducted for this compound, but the compound was not detected. Numerical value is the sample detection limit. |

# TABLE 4-34A

## SKINNER LIST INORGANIC ANALYTES ANALYTICAL DATA
## SOIL SAMPLES - SWMU 71 (DECEMBER 1991 INVESTIGATION)

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| Dames & Moore Sample No. / Laboratory Sample No. | SB-1 (3.0-3.5') P184061 | SB-2 (3.0-3.5') P184062 | SB-3 (COMPOSITE) P184063 | SB-4 (COMPOSITE) P184066 |
|---|---|---|---|---|
| **PARAMETER/UNITS** | **mg/kg** | **mg/kg** | **mg/kg** | **mg/kg** |
| Antimony | 0.65 | 0.42 | 0.45 | 0.92 |
| Arsenic | 25.0 | 6.4 | 7.4 | 6.6 |
| Barium | 413 | 92.8 | 158 | 168 |
| Beryllium | 1.8 | 0.70 | 4.4 | 1.5 |
| Cadmium | 4.2 | 0.70 U | 2.1 | 2.4 |
| Chromium | 76.6 K | 15.1 K | 720 K | 461 K |
| Cobalt | 30.9 | 16.1 | 29.7 | 23.0 |
| Lead | 422 | 106 | 407 | 179 |
| Mercury | 3.0 | 0.9 | 4.2 | 3.3 |
| Nickel | 51.8 | 24.4 | 66.6 | 114 |
| Selenium | 3.3 L | 1.4 L | 1.0 L | 0.48 L |
| Vanadium | 37.2 | 15.8 | 242 | 509 |
| Cyanide | 11.9 | 3.5 | 3.4 | 0.90 |

Explanation:

SWMU Solid Waste Management Unit.
U Laboratory analysis conducted for this compound, but the compound was not detected. Numerical value is the sample detection limit.
K The associated numerical value is biased high.
L The associated numerical value is biased low.

# SKINNER LIST INORGANIC ANALYTES ANALYTICAL DATA
# QUALITY ASSURANCE SAMPLES - SWMU 71
# (DECEMBER 1991 INVESTIGATION)

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| Dames & Moore Sample No.<br>Laboratory Sample No. | FIELD BLANK<br>P184069 |
|---|---|
| **PARAMETER/UNITS** | **ug/l** |
| Antimony | 3.0 U |
| Arsenic | 3.0 U |
| Barium | 5.0 U |
| Beryllium | 5.0 U |
| Cadmium | 5.0 U |
| Chromium | 10.0 U |
| Cobalt | 10.0 U |
| Lead | 50.0 U |
| Mercury | 0.2 U |
| Nickel | 30.0 U |
| Selenium | 4.0 UL |
| Vanadium | 10.0 U |
| Cyanide | 5.0 U |

Explanation:

SWMU Solid Waste Management Unit.
U Laboratory analysis conducted for this compound, but the compound was not detected. Numerical value is the sample detection limit.
L The associated numerical value is biased low.

## TABLE 4-35

## SOIL GAS SURVEY RESULTS
## VERIFICATION INVESTIGATION - SWMU NO. 71A

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| SAMPLE NO. | SAMPLE DEPTH | SAMPLE DATE | SAMPLE TIME | MAXIMUM OVA CONCENTRATION (ppm) | CONSTANT OVA CONCENTRATION (ppm) | BACKGROUND OVA CONCENTRATION (ppm) | BENZENE (ppm) | TOLUENE (ppm) | TOLUENE[1] ($ug/m^3$) | ETHYL-BENZENE (ppm) | TOTAL XYLENES (ppm) | TOTAL XYLENES[1] ($ug/m^3$) | TOTAL VOCs (ppm) | COMMENTS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SG71A-1 | 3' | 7-28-92 | 1451 | >10,000 | - | 7.2 | BDL | 0.063 | 15.3 | BDL | 1.67 | 352.4 | 26.7 | Refusal at 3' |
| SG71A-2 | 4' | 7-28-92 | 1439 | >10,000 | - | 9.5 | BDL | 4.70 | 1,143 | BDL | 1.69 | 356.6 | 32.1 | X |
| SG71A-3 | 4' | 7-28-92 | 1432 | >10,000 | - | 5.0 | BDL | 1.69 | 410.8 | BDL | 1.96 | 413.6 | 26.9 | X |

Explanation:

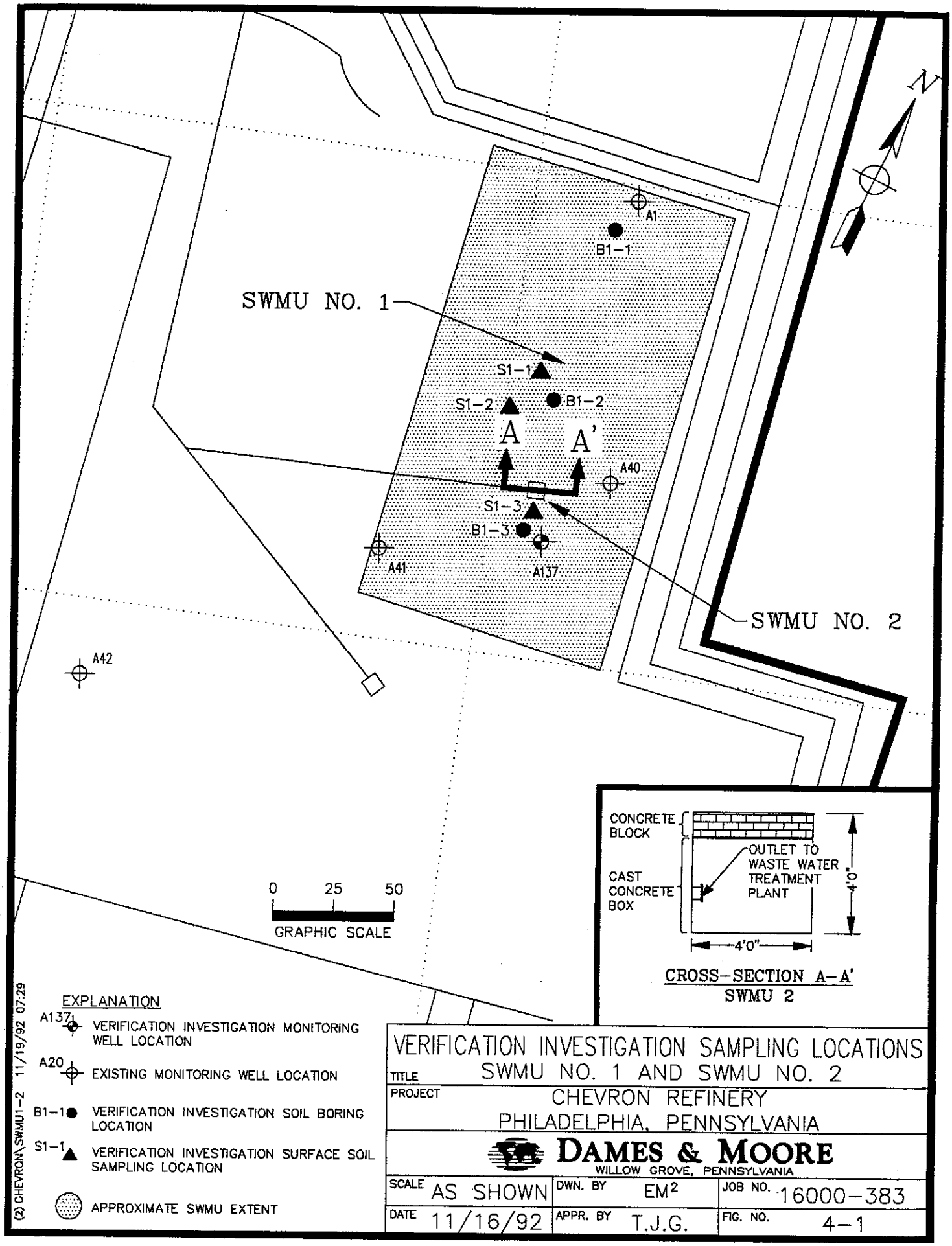
ppm parts per million
$ug/m^3$ micrograms per cubic meter
OVA Organic vapor analyzer (flame ionization detector).
VOCs Volatile organic compounds. Total VOCs calculated relative to gas chromatograph (GC) sensitivity of benzene.
NA Not analyzed because of poor resolution due to off-scale peak response.
BDL Below detection limit

Note:

1. Detected concentrations of toluene and total xylenes converted from ppm to $ug/m^3$ by the equations:

   (concentration in ppm) x (.2431) = (concentration in ug/l) x (1,000 $l/m^3$) = concentration in $ug/m^3$ (Toluene)
   (concentration in ppm) x (.211) = (concentration in ug/l) x (1,000 $l/m^3$) = concentration in $ug/m^3$ (Total Xylenes)

AAW02E6F




(2) CHEVRON\SWMU1-2 11/19/92 07:29

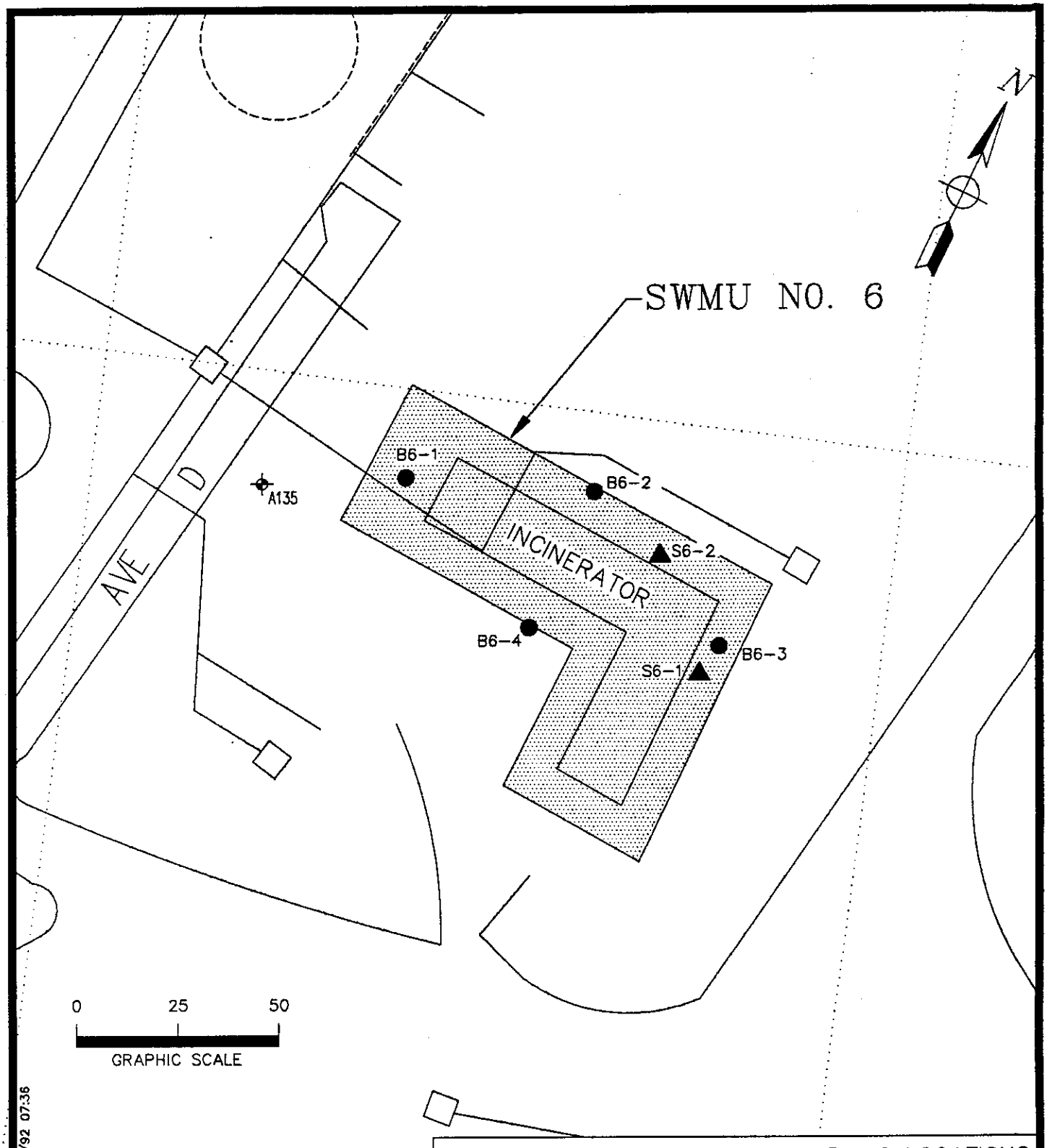
VERIFICATION INVESTIGATION SAMPLING LOCATIONS
SWMU NO. 1 AND SWMU NO. 2

TITLE

PROJECT CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE
WILLOW GROVE, PENNSYLVANIA

| | | | | | |
|---|---|---|---|---|---|
| SCALE | AS SHOWN | DWN. BY | EM² | JOB NO. | 16000-383 |
| DATE | 11/16/92 | APPR. BY | T.J.G. | FIG. NO. | 4-1 |




(2) CHEVRON\MM-SWMU6 11/19/92 07:36

EXPLANATION

A135 — VERIFICATION INVESTIGATION MONITORING WELL LOCATION

B6-1 — VERIFICATION INVESTIGATION SOIL BORING LOCATION

S6-1 — VERIFICATION INVESTIGATION SURFACE SOIL SAMPLING LOCATION

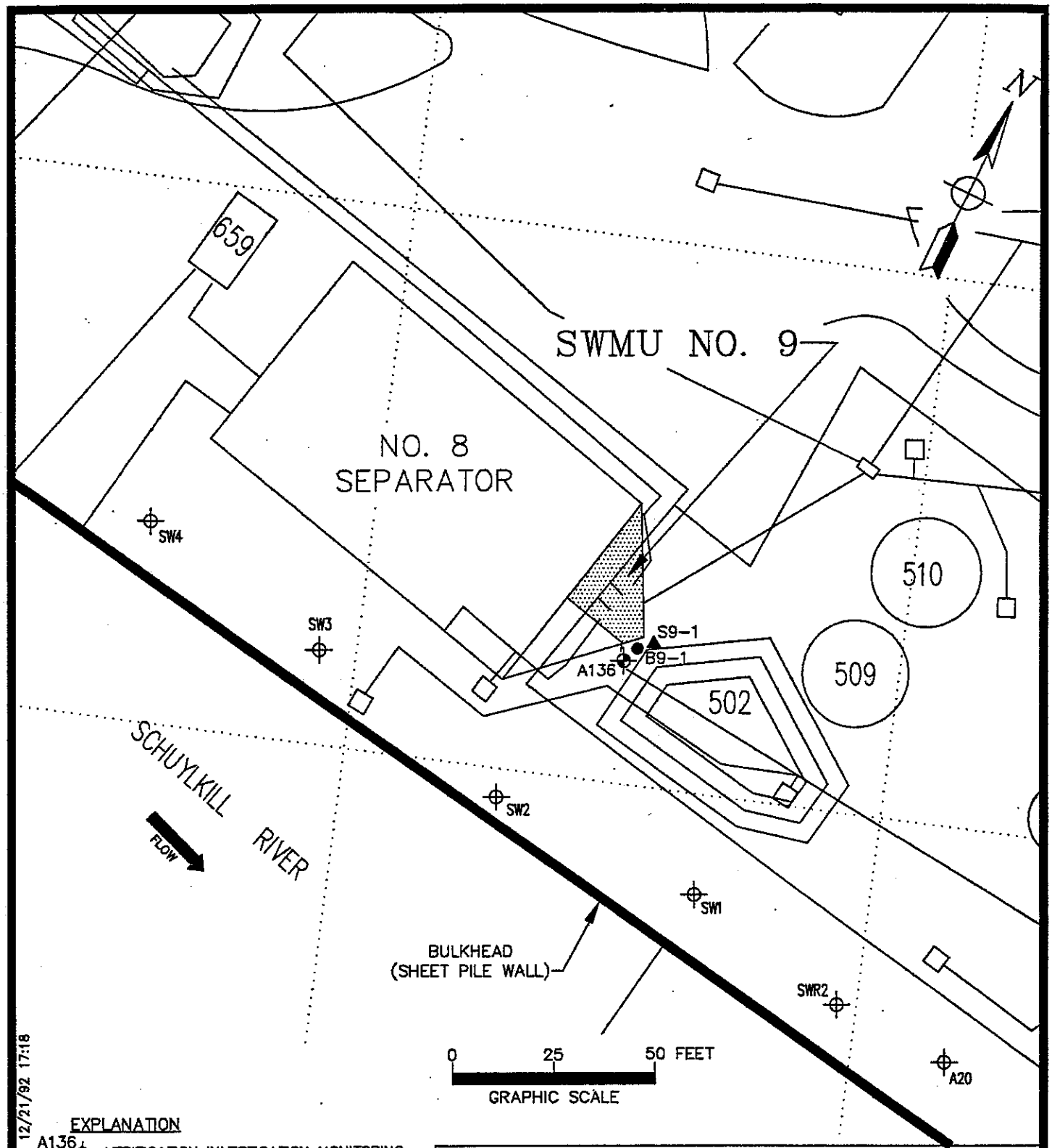
APPROXIMATE SWMU EXTENT

# VERIFICATION INVESTIGATION SAMPLING LOCATIONS

| | |
|---|---|
| TITLE | SWMU NO. 6 |
| PROJECT | CHEVRON REFINERY<br>PHILADELPHIA, PENNSYLVANIA |

DAMES & MOORE
WILLOW GROVE, PENNSYLVANIA

| | | | | | |
|---|---|---|---|---|---|
| SCALE | AS SHOWN | DWN. BY | EM² | JOB NO. | 16000-383 |
| DATE | 11/16/92 | APPR. BY | T.J.G. | FIG. NO. | 4-2 |




EXPLANATION

- A136 ⊕ VERIFICATION INVESTIGATION MONITORING WELL LOCATION
- A20 ⊕ EXISTING MONITORING WELL LOCATION
- B9-1 ● VERIFICATION INVESTIGATION SOIL BORING LOCATION
- S9-1 ▲ VERIFICATION INVESTIGATION SURFACE SOIL SAMPLING LOCATION
- APPROXIMATE SWMU EXTENT

(6) C:\ACAD\CHEVRON\MM-SWMU9 12/21/92 17:18

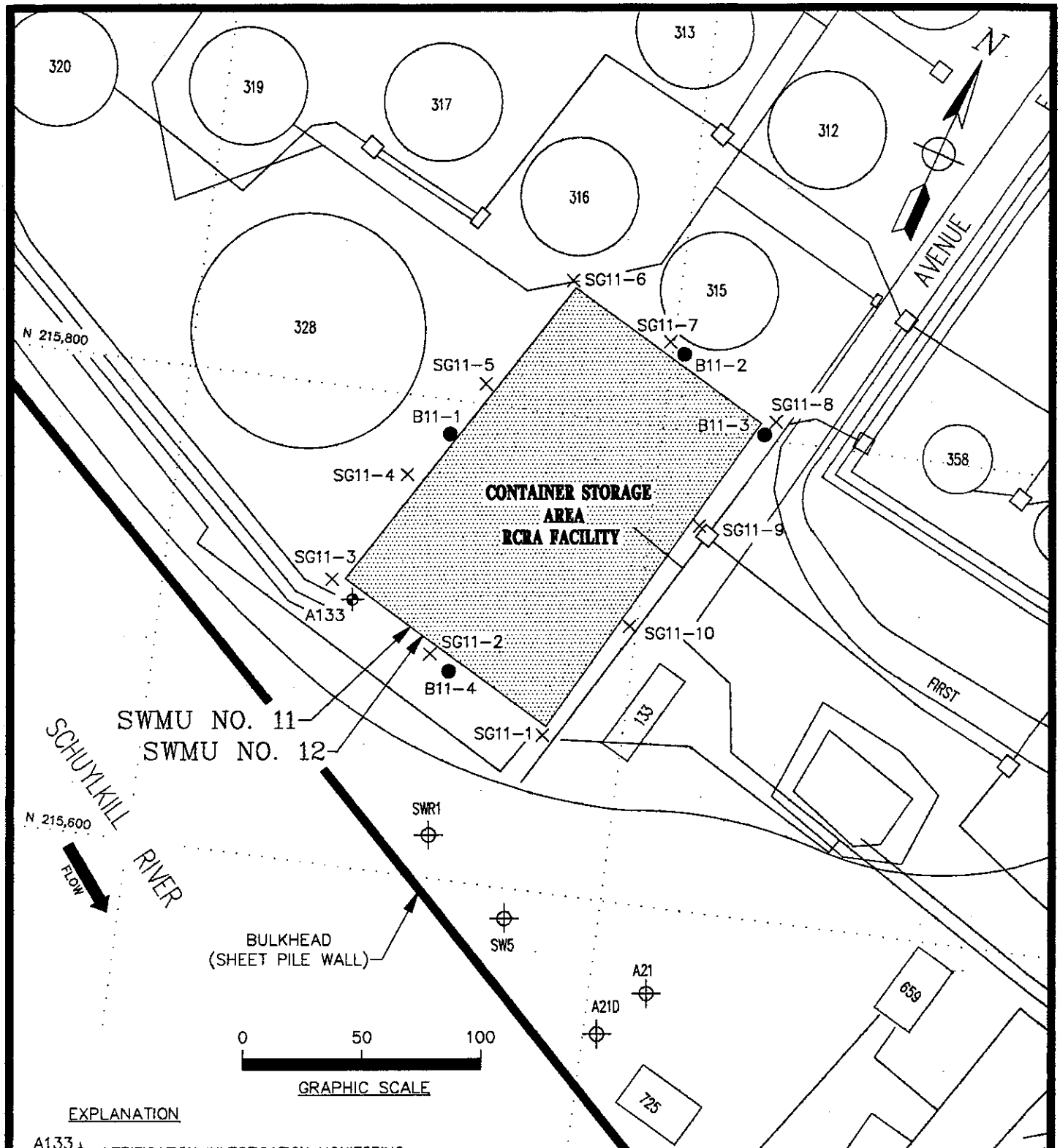
# VERIFICATION INVESTIGATION SAMPLING LOCATIONS

TITLE: SWMU NO. 9

PROJECT: CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE
WILLOW GROVE, PENNSYLVANIA

| SCALE | DWN. BY | JOB NO. |
|---|---|---|
| AS SHOWN | EM2 | 16000-383 |
| DATE | APPR. BY | FIG. NO. |
| 12-21-92 | T.J.G. | 4-3 |

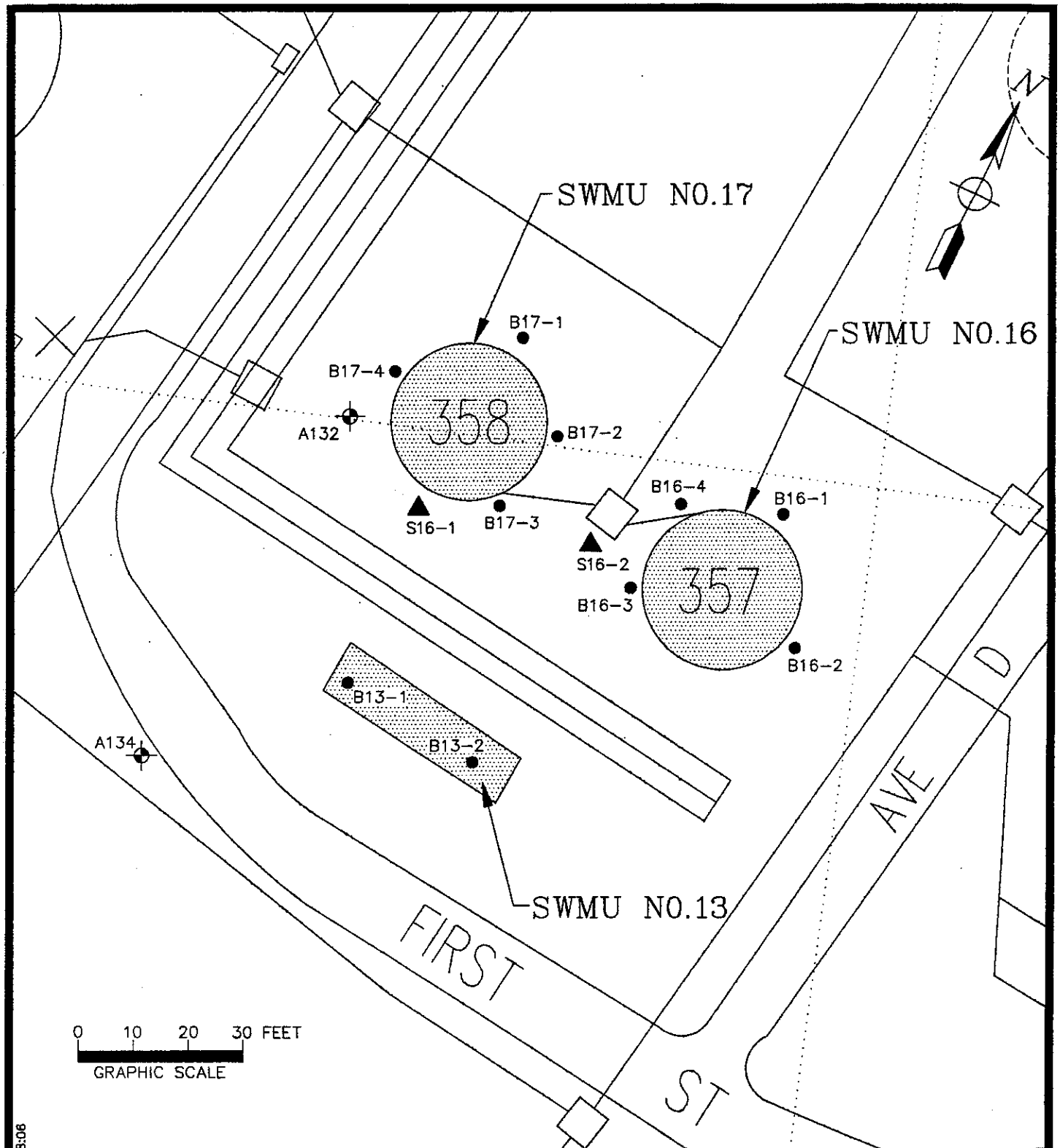



(3) CHEVRON\MM-1A 11/19/92 07:59

# VERIFICATION INVESTIGATION SAMPLING LOCATIONS SWMU NO. 11 AND SWMU NO. 12

| | |
|---|---|
| PROJECT | CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA |
| | Dames & Moore WILLOW GROVE, PENNSYLVANIA |

| | | | |
|---|---|---|---|
| SCALE AS SHOWN | DWN. BY EM² | JOB NO. 16000-383 |
| DATE 11/16/92 | APPR. BY M.M. | FIG. NO. 4-4 |




(4) CHEVRON\MM-17 11/19/92 08:06

EXPLANATION

A132 — VERIFICATION INVESTIGATION MONITORING WELL LOCATION

B16-1 — VERIFICATION INVESTIGATION SOIL BORING LOCATION

S16-1 — VERIFICATION INVESTIGATION SURFACE SOIL SAMPLING LOCATION

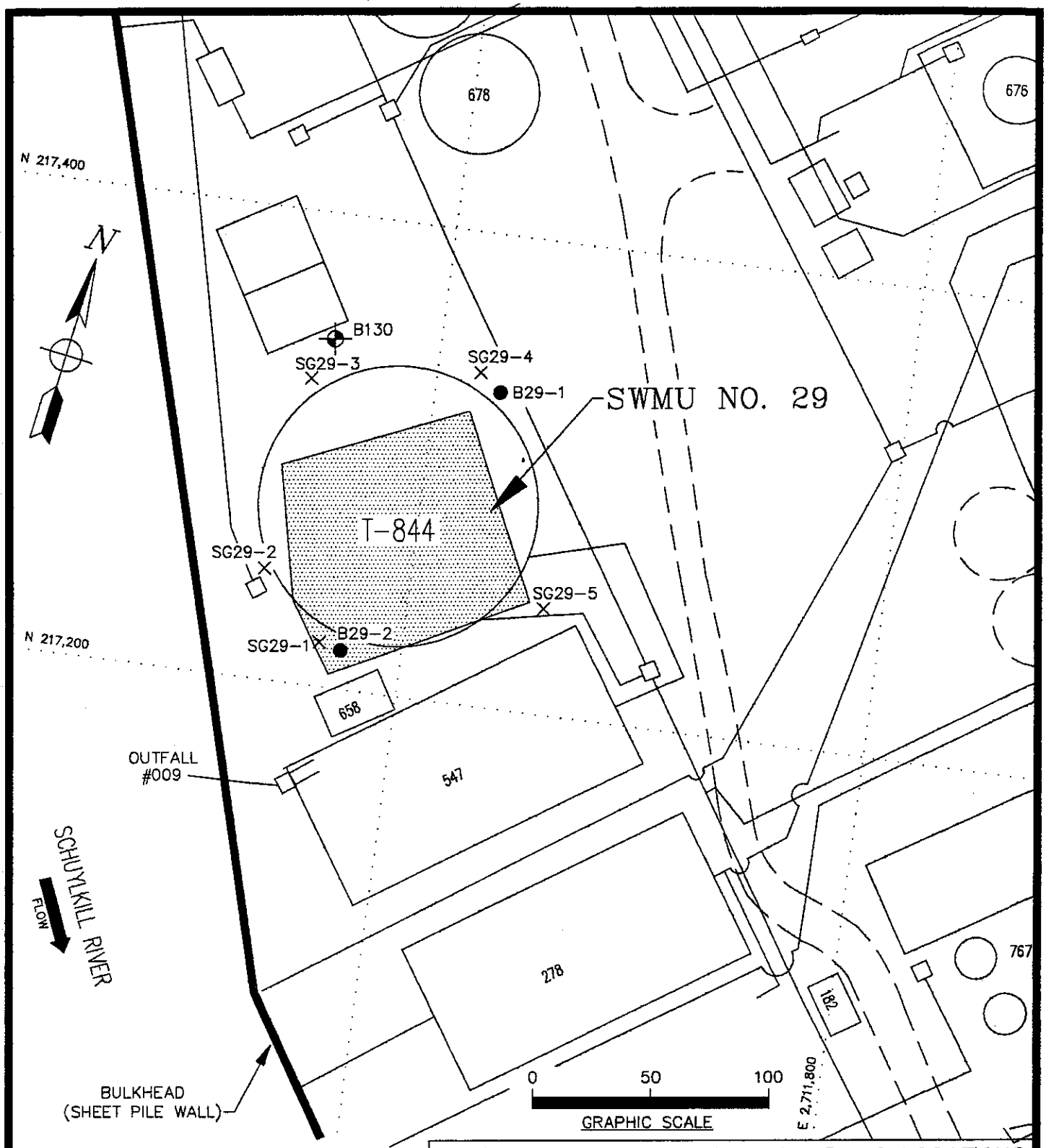
APPROXIMATE SWMU EXTENT

# VERIFICATION INVESTIGATION SAMPLING LOCATIONS
## SWMU NO. 13, SWMU NO. 16, SWMU NO. 17

PROJECT: CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE
WILLOW GROVE, PENNSYLVANIA

| | | | | | |
|---|---|---|---|---|---|
| SCALE | AS SHOWN | DWN. BY | EM² | JOB NO. | 16000-383 |
| DATE | 11/16/92 | APPR. BY | T.J.G. | FIG. NO. | 4-5 |




EXPLANATION

- B130 — VERIFICATION INVESTIGATION MONITORING WELL LOCATION
- SG29-1 — VERIFICATION INVESTIGATION SOIL GAS SAMPLING LOCATION
- SG29-1 — VERIFICATION INVESTIGATION SOIL BORING LOCATION
- APPROXIMATE SWMU EXTENT

(3) CHEVRON\MM-3A 11/19/92 08:08

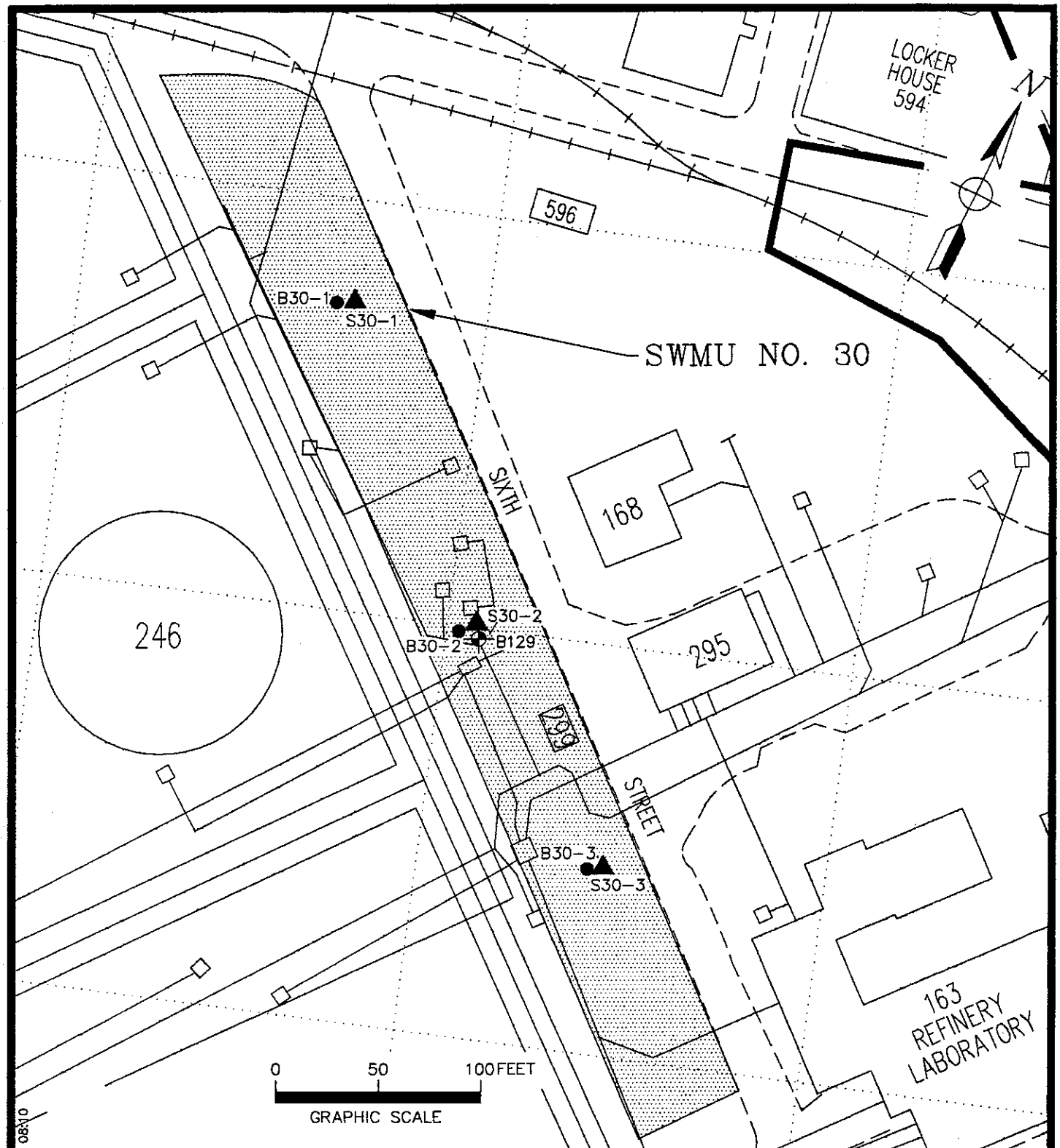
# VERIFICATION INVESTIGATION SAMPLING LOCATIONS

TITLE: SWMU NO. 29

PROJECT: CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

Dames & Moore
WILLOW GROVE, PENNSYLVANIA

| SCALE | DWN. BY | JOB NO. |
|---|---|---|
| AS SHOWN | EM² | 16000-383 |
| DATE | APPR. BY | FIG. NO. |
| 11/16/92 | T.G. | 4-6 |




EXPLANATION

B129 ⊕ VERIFICATION INVESTIGATION MONITORING WELL LOCATION

B30-1 ● VERIFICATION INVESTIGATION SOIL BORING LOCATION

S30-1 ▲ VERIFICATION INVESTIGATION SURFACE SOIL SAMPLING LOCATION

APPROXIMATE SWMU EXTENT

(3) CHEVRON\SWMU-30 11/19/92 08:10

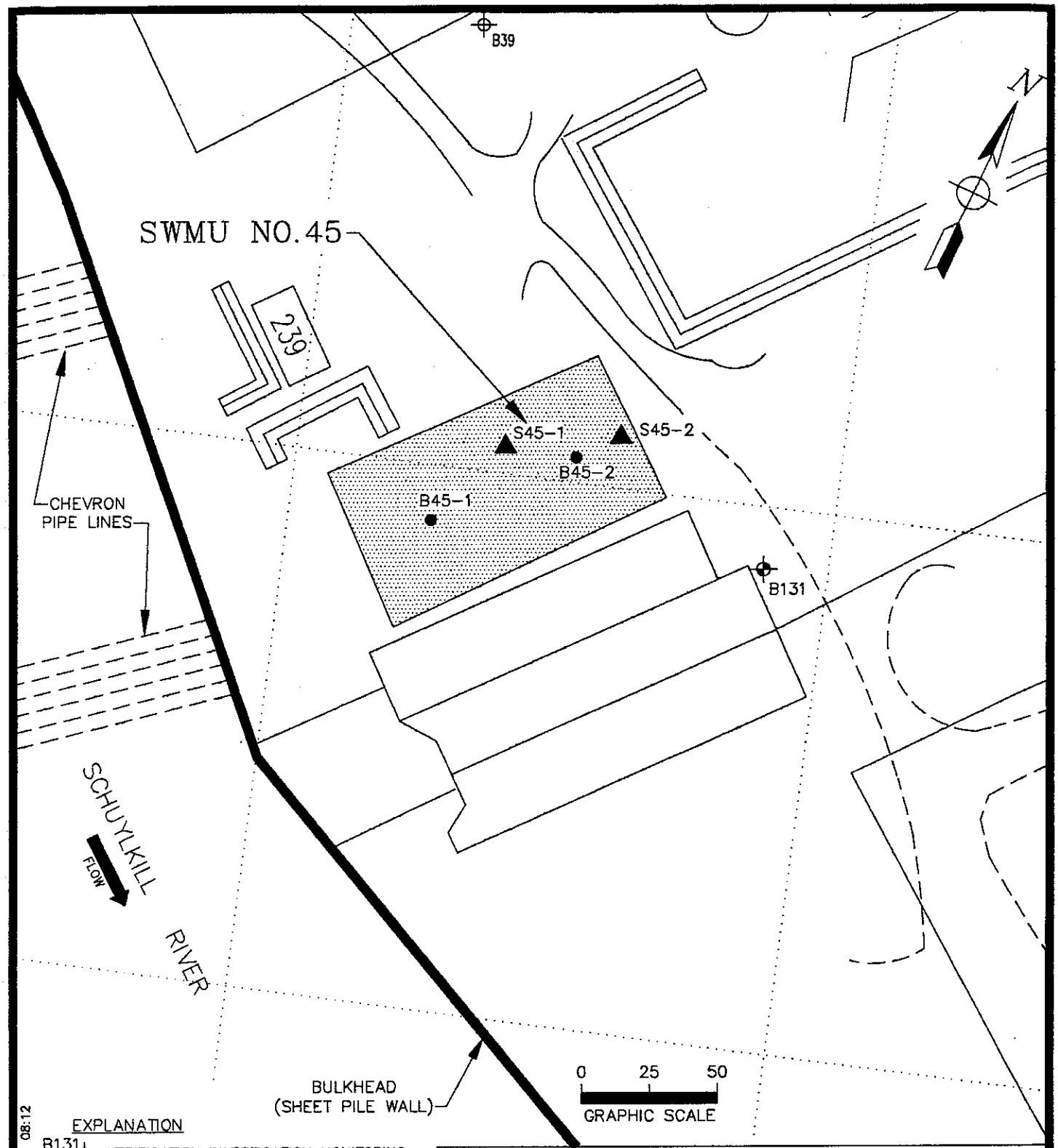
# VERIFICATION INVESTIGATION SAMPLING LOCATIONS SWMU NO. 30

TITLE

PROJECT CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE
WILLOW GROVE, PENNSYLVANIA

| | | | |
|---|---|---|---|
| SCALE AS SHOWN | DWN. BY EM² | JOB NO. 16000-383 | |
| DATE 11/16/92 | APPR. BY T.J.G. | FIG. NO. 4-7 | |




EXPLANATION

- B131 — VERIFICATION INVESTIGATION MONITORING WELL LOCATION
- B39 — EXISTING MONITORING WELL LOCATION
- B45-1 — VERIFICATION INVESTIGATION SOIL BORING LOCATION
- S45-1 — VERIFICATION INVESTIGATION SURFACE SOIL SAMPLING LOCATION
- APPROXIMATE SWMU EXTENT

(4) CHEVRON\SWMU-45 11/19/92 08:12

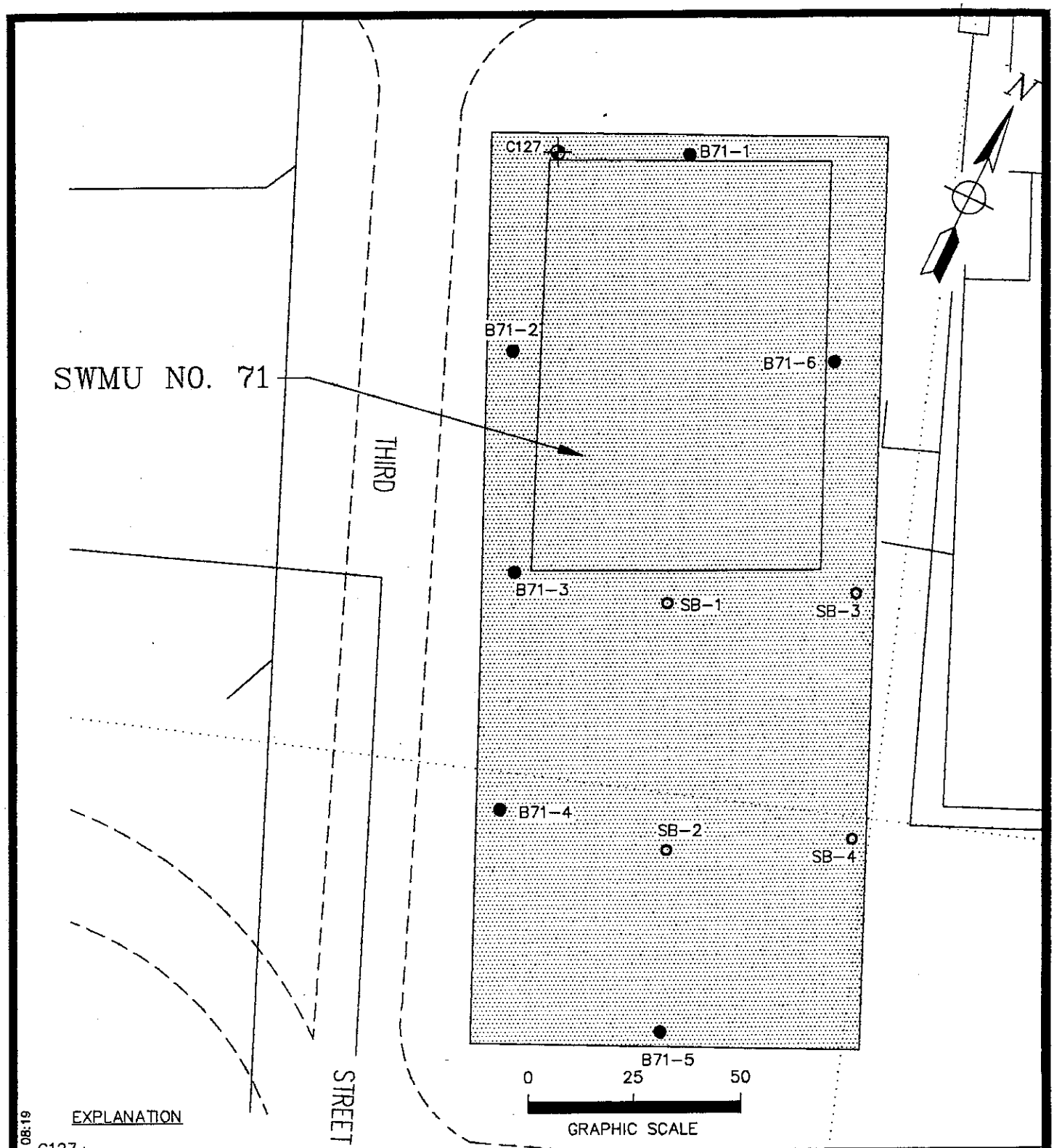
# VERIFICATION INVESTIGATION SAMPLING LOCATIONS SWMU NO.45

TITLE

PROJECT CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE
WILLOW GROVE, PENNSYLVANIA

| | | |
|---|---|---|
| SCALE AS SHOWN | DWN. BY EM2 | JOB NO. 16000-383 |
| DATE 11/16/92 | APPR. BY T.J.G. | FIG. NO. 4-8 |




EXPLANATION

C127 — VERIFICATION INVESTIGATION MONITORING WELL LOCATION

SB-1 — SOIL BORING LOCATION (PRELIMINARY VERIFICATION INVESTIGATION)

B71-1 — VERIFICATION INVESTIGATION SOIL BORING LOCATION

APPROXIMATE SWMU EXTENT

(2) CHEVRON\SWMU-71 11/19/92 08:19

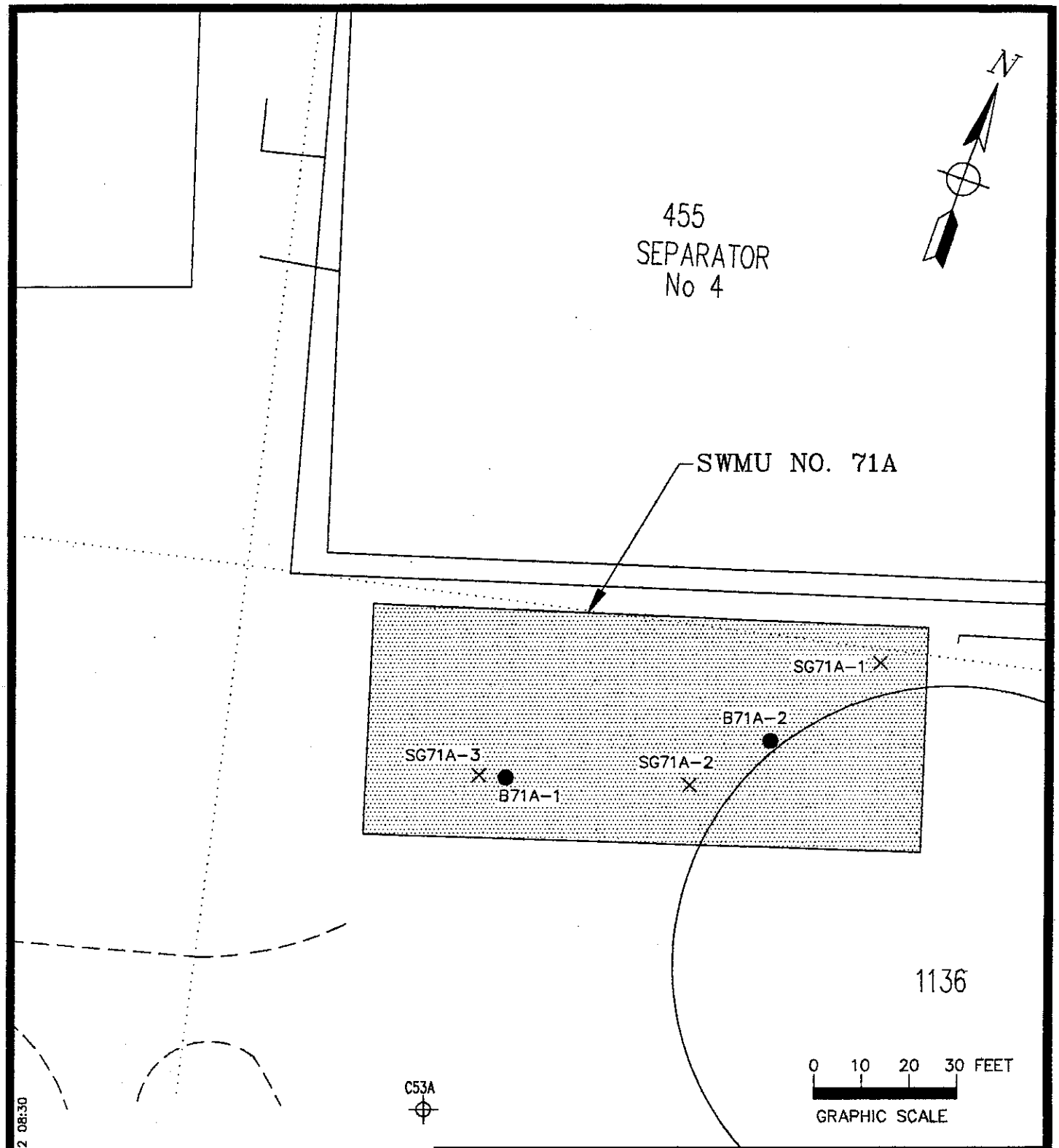
# VERIFICATION INVESTIGATION SAMPLING LOCATIONS

TITLE: SWMU NO. 71

PROJECT: CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE
WILLOW GROVE, PENNSYLVANIA

| | | | |
|---|---|---|---|
| SCALE AS SHOWN | DWN. BY EM2 | JOB NO. 16000-383 |
| DATE 11/16/92 | APPR. BY T.J.G. | FIG. NO. 4-9 |




(3) CHEVRON\SWMU-71A 11/19/92 08:30

EXPLANATION

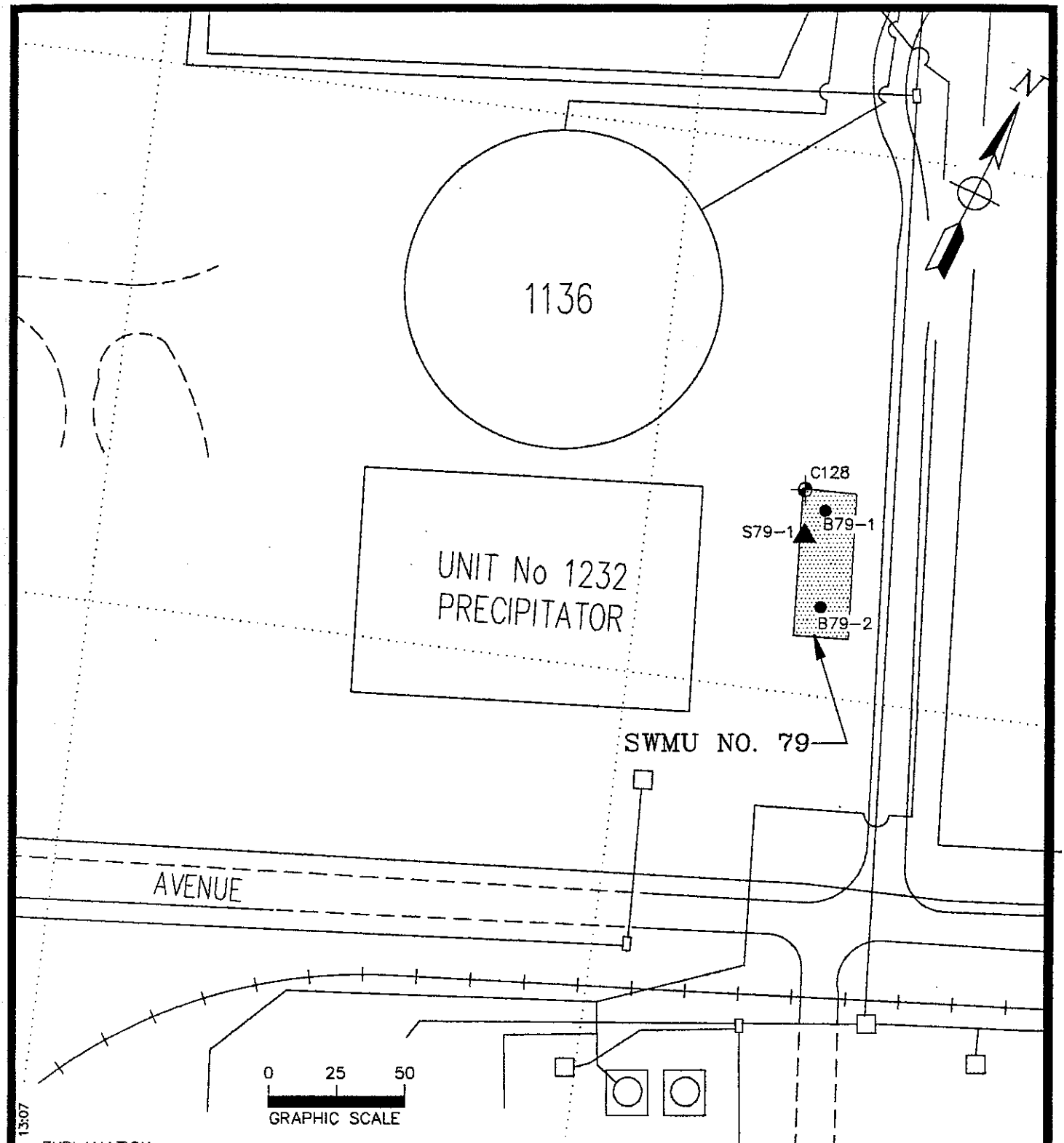
- C53A — EXISTING MONITORING WELL LOCATION
- B71A-2 — VERIFICATION INVESTIGATION SOIL BORING LOCATION
- SG71A-1 — VERIFICATION INVESTIGATION SOIL GAS SAMPLING LOCATION
- APPROXIMATE SWMU EXTENT

# VERIFICATION INVESTIGATION SAMPLING LOCATIONS

| | |
|---|---|
| TITLE | SWMU NO. 71A |
| PROJECT | CHEVRON REFINERY<br>PHILADELPHIA, PENNSYLVANIA |

**DAMES & MOORE**
WILLOW GROVE, PENNSYLVANIA

| | | |
|---|---|---|
| SCALE AS SHOWN | DWN. BY EM² | JOB NO. 16000-383 |
| DATE 11/16/92 | APPR. BY T.J.G. | FIG. NO. 4-10 |




EXPLANATION

C128 — VERIFICATION INVESTIGATION MONITORING WELL LOCATION

B79-1 — VERIFICATION INVESTIGATION SOIL BORING LOCATION

S79-1 — VERIFICATION INVESTIGATION SURFACE SOIL SAMPLING LOCATION

APPROXIMATE SWMU EXTENT

(2) CHEVRON\SWMU-79 11/19/92 13:07

TITLE: VERIFICATION INVESTIGATION SAMPLING LOCATIONS
SWMU NO. 79

PROJECT: CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE
WILLOW GROVE, PENNSYLVANIA

| SCALE | AS SHOWN | DWN. BY | EM² | JOB NO. | 16000-383 |
|---|---|---|---|---|---|
| DATE | 11/16/92 | APPR. BY | T.J.G. | FIG. NO. | 4-11 |

# 5.0 RESULTS OF SCREENING RISK ASSESSMENT

## 5.1 PROCEDURES AND METHODOLOGY

A screening risk assessment was performed for each of the SWMUs identified in the VI Work Plan (Dames & Moore, July 2, 1991) for the Chevron Refinery in Philadelphia, Pennsylvania. The risk assessment was conducted as the second phase of a two-phase approach to evaluate the need for additional investigation at each of the VI SWMUs. The overall approach to this screening risk assessment was based on the USEPA proposed RCRA Corrective Action Rule for SWMUs (Federal Register, July 27, 1990) and the Risk Assessment Guidance for Superfund (RAGS, USEPA, 1989).

The intent of the screening risk assessment is to provide a simple methodology for evaluating health risks potentially associated with chemicals detected in soils at the SWMUs, and to evaluate the need for additional investigation at a given SWMU. This methodology is conservatively health-protective in that it uses exposure parameters that tend to overestimate health risks (i.e., site-specific exposure parameters are not used). The screening risk assessment assumes future land usage will remain unchanged from present, and that access to the SWMUs at the Refinery is controlled so that the only potentially exposed individuals are workers. It also assumes that worker exposure is limited to the ingestion of, and dermal contact with, soil, and the inhalation of vapors.

According to the proposed Corrective Action Rule (USEPA, 1990a), further action may not be warranted at a given SWMU (a determination of "no further action") if:

- Constituent concentrations are below USEPA-designated action levels
- Health risks fall below acceptable levels (if exposure is feasible)

Each SWMU was evaluated on an individual basis to determine whether further investigation is warranted. These evaluations were conducted by a phased approach using the data derived from the VI conducted at each SWMU. The phased approach consisted of a preliminary risk evaluation and a screening risk assessment. The first phase, the preliminary risk evaluation, consisted of comparing the analytical data to risk-based action levels. The second phase, the screening risk assessment, consisted of calculating carcinogenic and non-carcinogenic risks associated with the detected concentrations of hazardous constituents. The criteria for evaluating the data support the objective of the investigation by determining whether hazardous waste constituents detected in each unit pose a risk to human health. This phased data evaluation, conducted to determine whether additional investigation is warranted at a SWMU, involved:

- Concentrations of parameters detected in soil were compared to the preliminary risk evaluation action levels specified in the RCRA 3004(u) draft Corrective Action Rule, published in the Federal Register on July 27, 1990, (55 CFR 30798). If the concentrations of detected constituents in all samples were below the respective action levels in the July 27, 1990, Corrective Action Rule, no further action is warranted at that SWMU. These action levels are risk-based, using highly conservative exposure assumptions.

- If analytes detected in a specific media at the Refinery were not listed in the July 27, 1990, Corrective Action Rule, detected concentrations of these constituents were compared to the risk-based concentrations listed in the April 14, 1992, USEPA Region III memorandum prepared by Roy L. Smith (Senior Toxicologist). Dr. Smith's risk-based concentrations are also considered preliminary risk evaluation action levels. If the concentrations of detected constituents in all samples were below the respective action levels in the April 14, 1992, memorandum, no further action is warranted at that SWMU.

- If concentrations of constituents in any sample from a SWMU were above the risk-based action level in the RCRA Corrective Action Rule or USEPA's previously referenced memorandum, a screening risk assessment was performed based on the highest concentration detected at the SWMU. If the highest concentration of a constituent detected within a SWMU results in a risk that is below the acceptable risk levels specified in the screening risk assessment methods, no further action is warranted at that SWMU. If the highest concentration detected at a SWMU results in an estimated risk that is above the acceptable risk level, an RFI is recommended for that SWMU.

Chapter 4.0 presented the risk-based criteria (preliminary risk evaluation action levels) and the results of the preliminary risk evaluation that compares the analytical data obtained during the VI to the risk-based action levels. The results of the screening risk assessment are summarized in the remainder of this chapter. The procedures and results of the screening risk assessment are detailed in Appendix A.

The results of this assessment are not intended to determine whether corrective measures are required at a given SWMU. Rather, the purpose of the screening risk assessment was to establish whether further investigation is warranted at a specific SWMU. Risk estimates generated by the screening risk assessment should not be construed as the expected rate of adverse effects in the exposed populations, but are merely estimates of risk based on current knowledge and a large number of assumptions. As such, the risk levels generated in the screening risk assessment are useful to compare one SWMU to another and set priorities for further investigations.

## 5.2 OBJECTIVE

The objective of the risk assessment was to assess health risks, associated with chemicals detected in soil at concentrations that exceed action levels, using USEPA-recommended default exposure parameters. This objective served to evaluate the need for further investigation based on constituent concentrations detected in soil at a particular SWMU. Acceptable concentrations are those associated with:

- Carcinogenic risks between or below the one-per-one-million ($10^{-6}$) and one-per-ten-thousand range ($10^{-4}$)
- Non-carcinogenic risks below regulatory criteria (a hazard ratio of unity)

These guidelines are general because action may or may not be triggered by the estimation of risk depending on other factors pertinent to the site (i.e., background concentrations, plausibility of exposure, etc.). As the assessment provided a more refined analysis of risk than the comparison performed in the first phase (the preliminary risk evaluation), chemical concentrations may be deemed acceptable although they were detected at concentrations that exceed action levels.

## 5.3 LIMITATIONS AND DATA GAPS

The following factors are presented as an overview of the limitations and data gaps that could influence the estimation of risk at a particular SWMU.

- Risk estimates are likely to decrease if site-specific information is used to estimate worker exposure.

- The carcinogenic potency of several PAHs and the non-carcinogenic effects of several chemicals were derived using surrogate values (if available), which may tend to over- or underestimate health risks.

- Health risks from cobalt and 1,3-dichloro-2-propanol were not estimated because action levels, health criteria, and surrogate values were not available.

## 5.4 IDENTIFICATION OF EXPOSURE SCENARIOS

Exposure scenarios were generated based on the following assumptions:

- Access to the SWMUs at the Refinery was controlled
- Future land usage would not vary from current conditions
- Potentially exposed individuals was limited to on-site workers
- Current and future exposure scenarios were equivalent

The exposure pathways evaluated in the assessment were dermal contact and ingestion of soil, and inhalation of vapors.

## 5.5 CONSTITUENTS DETECTED ABOVE ACTION LEVELS

Chemicals detected at concentrations that exceed action levels in soil within each SWMU were considered in this assessment. Chemicals without action levels were also considered. The data derived from the soil gas surveys and laboratory analysis of the VI soil samples (surface and subsurface) indicate that the following constituents were detected at concentrations above the risk-based evaluation action levels:

Polycyclic Aromatic Hydrocarbons (PAHs)

- Benzo(a)Anthracene
- Benzo(a)Pyrene
- Benzo(b,j,k)Fluoranthene
- Dibenzo(a,h)Anthracene
- Indeno(1,2,3-cd)Pyrene
- Pyrene
- Xylenes (Total)

Inorganic Analytes

- Beryllium
- Chromium
- Lead

With the exception of xylene, the only constituent detected above action levels in the soil gas surveys, all of these chemicals were detected as soil-bound constituents. Volatile organic compounds (VOCs) were not detected in the soil samples above the preliminary risk evaluation action levels. Therefore, these compounds were not included in the screening risk assessment performed for the VI SWMUs.

Action levels do not exist for the following eight non-carcinogenic constituents detected in site soils:

Polycyclic Aromatic Hydrocarbons (PAHs)

- 1,3-Dichloro-2-propanol
- N-Propylbenzene
- Acenaphthene
- Dibenzofuran
- 1-Methylnapthalene
- 2-Mehtylnaphthalene

Inorganic Analytes

- Cobalt
- Thallium

The non-carcinogenic risks associated with these chemicals were evaluated for those chemicals with USEPA-developed health criteria (these criteria included all the chemicals above except cobalt and 1,3-dichloro-2-propanol).

Ingestion of lead from soils was also evaluated. As set forth by OSWER directive 9355.4-02, the USEPA recommended an interim soil cleanup level of 500 to 1,000 mg/kg total lead for CERCLA sites characterized as residential (USEPA, August 29, 1991). The IU/BK model developed by the USEPA to assess blood lead levels from exposure to lead in various

media including soil is limited to children under 7 years of age. The USEPA has not approved additional methodologies for computing blood lead levels in adults. Therefore, for the purpose of this assessment, it is assumed that soil lead levels up to 1,000 mg/kg would be protective of worker health, because worker exposures are expected to be less extensive than residential exposures, and because adults are less vulnerable to the toxic effects of lead than are children. Furthermore, SWMUs containing lead concentrations in soil above 1,000 mg/kg were identified as possibly requiring further investigation.

Ground water sampling was also performed as part of the VI conducted at the Refinery. Because the screening risk assessment considered each SWMU separately, evaluating the need for further action regarding ground water contamination was beyond the scope of the assessment, since chemical concentrations in ground water cannot be attributed to specific SWMUs. Therefore, risks from exposure to ground water were not evaluated in the risk assessment.

## 5.6 RESULTS OF THE RISK ASSESSMENT

### 5.6.1 Carcinogenic and Non-Carcinogenic Risks

Carcinogenic and non-carcinogenic risks were calculated using the data derived from analysis of VI soil samples. The risks were estimated using the highest detected concentrations of hazardous constituents that exceed the preliminary risk evaluation action levels. The primary constituents evaluated in relation to carcinogenic and non-carcinogenic risks were polycyclic aromatic hydrocarbons (PAHs) and the metals beryllium and chromium. The carcinogenic and non-carcinogenic risks associated with each SWMU are presented in Table 5-1 and are summarized below:

*Carcinogenic Risks*

- The cumulative risks from carcinogens in soil at all SWMUs range between 3 x $10^{-6}$ and 1 x $10^{-4}$. Risks from hazardous constituents at a SWMU falling within this range do not warrant further investigation.

*Non-carcinogenic Risks*

- For non-carcinogenic health risks, the Hazard Index (HI) was less than one for all SWMUs, indicating that adverse health effects are unlikely to occur.

- The HI for all chemicals without action levels was less than one, indicating that adverse health effects are unlikely to occur.

### 5.6.2 Risks from Lead

Lead was detected in the soil within SWMU Nos. 1, 6, and 30 at concentrations that exceed the 1,000-mg/kg USEPA cleanup level. The detected concentrations of lead in SWMU Nos. 1, 6, and 30 were 2,260 mg/kg, 3,760 mg/kg, and 2,270 mg/kg, respectively.

### 5.6.3 Overall Assessment of Risk

Based on the worker exposure scenario, the results of the screening risk assessment indicate that additional investigation is not warranted at the VI SWMUs based on risks posed by carcinogens and non-carcinogens in soil. The lead concentrations detected in soil within SWMU Nos. 1, 6, and 30 indicate that further investigation regarding lead in soil is warranted within these SWMUs.

## TABLE 5-1

## SUMMARY OF TOTAL INTAKES AND RISKS
## SCREENING RISK ASSESSMENT
## VERIFICATION INVESTIGATION

## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

| EXPOSURE SITE | PATHWAY | HAZARD INDEX | CARCINOGENIC RISK |
|---|---|---|---|
| SWMU No. 1 | Dermal Contact | 0.001 | 1 E-06 |
| | Soil Ingestion | 0.001 | 1 E-06 |
| | Total: | 0.003 | 3 E-06 |
| SWMU No. 6 | Dermal Contact | 0.001 | 7 E-06 |
| | Soil Ingestion | 0.001 | 7 E-06 |
| | Total: | 0.002 | 1 E-05 |
| SWMU No. 9 | Dermal Contact | 0.00007 | 3 E-06 |
| | Soil Ingestion | 0.00007 | 3 E-06 |
| | Total: | <0.001 | 7 E-06 |
| SWMU Nos. 11/12 | Dermal Contact | 0.002 | 6 E-05 |
| | Soil Ingestion | 0.002 | 6 E-05 |
| | Vapor Inhalation | 0.000005 | NA |
| | Total: | 4 E-03 | 1 E-04 |
| SWMU No. 13 | Dermal Contact | 0.0001 | 3 E-06 |
| | Soil Ingestion | 0.0001 | 3 E-06 |
| | Total: | <0.001 | 6 E-06 |
| SWMU No. 16 | Dermal Contact | 0.0006 | 3 E-06 |
| | Soil Ingestion | 0.0006 | 3 E-06 |
| | Total: | 1 E-03 | 7 E-06 |
| SWMU No. 17 | Dermal Contact | 0.001 | 3 E-06 |
| | Soil Ingestion | 0.001 | 3 E-06 |
| | Total: | 3 E-03 | 6 E-06 |
| SWMU No. 29 | Dermal Contact | 0.001 | 1 E-06 |
| | Soil Ingestion | 0.001 | 1 E-06 |
| | Vapor Inhalation | 0.000005 | NA |
| | Total: | 3 E-03 | 3 E-06 |
| SWMU No. 30 | Dermal Contact | 0.002 | 5 E-06 |
| | Soil Ingestion | 0.002 | 5 E-06 |
| | Total: | 4 E-03 | 1 E-05 |
| SWMU No. 45 | Dermal Contact | 0.0008 | 4 E-06 |
| | Soil Ingestion | 0.0008 | 4 E-06 |
| | Total: | 2 E-03 | 8 E-06 |

**TABLE 5-1**
**(Continued)**

**SUMMARY OF TOTAL INTAKES AND RISKS**
**SCREENING RISK ASSESSMENT**
**VERIFICATION INVESTIGATION**

**CHEVRON REFINERY**
**PHILADELPHIA, PENNSYLVANIA**

| EXPOSURE SITE | PATHWAY | HAZARD INDEX | CARCINOGENIC RISK |
|---|---|---|---|
| SWMU No. 71 | Dermal Contact | 0.0005 | 3 E-06 |
| | Soil Ingestion | 0.0005 | 3 E-06 |
| | Total: | <0.0001 | 7 E-06 |
| SWMU No. 71A | Dermal Contact | 0.0002 | 4 E-06 |
| | Soil Ingestion | 0.0002 | 4 E-06 |
| | Total: | <0.001 | 7 E-06 |
| SWMU No. 79 | Dermal Contact | 0.0005 | 6 E-06 |
| | Soil Ingestion | 0.0005 | 6 E-06 |
| | Total: | <0.001 | 1 E-05 |

Explanation:

NA - Not Applicable

# 6.0 CONCLUSIONS AND RECOMMENDATIONS

## 6.1 CONCLUSIONS

This section presents a summary of conclusions regarding the presence of hazardous constituents at each of the VI SWMUs. These conclusions are based on the analytical results derived from physical integrity evaluations, soil gas surveys, and laboratory analysis of surface soil, subsurface soil, ground water, comparison of these data to risk-based evaluation action levels, and the screening risk assessment performed for each SWMU. The conclusions pertaining to the VI conducted at each SWMU are presented for each SWMU individually.

### 6.1.1 Empty Lube Storage Area (SWMU No. 1) and Empty Lube Area Sump (SWMU No. 2)

*Surface soil*

Semi-volatile organic compounds (SVOCs) were not detected in surface soil at concentrations that exceed preliminary risk-evaluation action levels. Beryllium, chromium, and lead were detected in surface soil at concentrations that exceed action levels.

*Subsurface Soil*

Volatile organic compounds (VOCs) were not detected in subsurface soil at concentrations that exceed preliminary risk-evaluation action levels. The SVOC benzo(a)pyrene and the metals beryllium, chromium, and lead were detected at concentrations that exceed action levels.

*Ground Water*

VOCs were not detected in ground water at concentrations that exceed preliminary risk-evaluation action levels. The SVOC bis(2-ethylhexyl)phthalate and lead were detected at concentrations that exceed action levels in the unfiltered ground water samples. Based on the information obtained during this investigation, the unfiltered ground water data for inorganic constituents is not considered to be representative of ground water quality due to the high turbidity of the samples. Antimony was detected above action levels in the filtered samples, but was not detected in the unfiltered samples. However, antimony was detected in the field blank sample. Therefore, antimony is not considered to be present in the filtered samples.

### 6.1.2 Trash Incinerator (SWMU No. 6)

*Surface soil*

SVOCs were not detected in surface soil at concentrations that exceed preliminary risk-evaluation action levels. Beryllium, chromium, and lead were detected in surface soil at concentrations that exceed action levels.

*Subsurface Soil*

VOCs were not detected in subsurface soil at concentrations that exceed preliminary risk-evaluation action levels. The SVOCs benzo(a)pyrene, benzo(a)anthracene, and dibenzo(a,h)anthracene, and the metals beryllium and lead, were detected at concentrations that exceed action levels.

*Ground Water*

The VOC benzene, the SVOC bis (2-ethylhexyl)phthalate, and lead were detected in the unfiltered ground water sample at concentrations that exceed preliminary risk-evaluation action levels. Based on the information obtained during this investigation, the unfiltered ground water data for inorganic constituents is not considered to be representative of ground water quality due to the high turbidity of samples. The detected concentrations of inorganic analytes in the filtered ground water sample do not exceed action levels.

6.1.3 Product Storage Sump (SWMU No. 9)

*Surface soil*

The SVOC benzo(a)anthracene and lead were detected in surface soil at concentrations that exceed preliminary risk-evaluation action levels.

*Subsurface Soil*

VOCs were not detected in subsurface soil at concentrations that exceed preliminary risk-evaluation action levels. The SVOC benzo(a)pyrene and the metals beryllium and lead were detected at concentrations that exceed action levels.

*Ground Water*

VOCs and SVOCs were not detected in the unfiltered ground water sample at concentrations that exceed preliminary risk-evaluation action levels. The detected concentrations of lead and mercury were above action levels in the unfiltered ground water sample. Based on the information obtained during this investigation, the unfiltered ground water data for inorganic constituents is not considered to be representative of ground water quality due to the high turbidity of the sample. The detected concentrations of inorganic analytes in the filtered ground water sample do not exceed action levels.

6.1.4 Past Lagoon A (SWMU No. 11) and Previous Crude Oil Topping Unit (SWMU No. 12)

*Soil Gas*

Benzene and ethylbenzene were not detected in the samples collected during the soil gas survey. The detected concentrations of toluene in the soil gas samples do not exceed preliminary risk-evaluation action levels. Total xylenes were detected at 3 of the 10 soil gas sampling locations at concentrations that exceed action levels.

*Subsurface Soil*

VOCs were not detected in subsurface soil at concentrations that exceed preliminary risk-evaluation action levels. The SVOCs benzo(a)anthracene, benzo(a)pyrene, benzo(b,j,k) fluoranthene, indeno(1,2,3-cd)pyrene, and pyrene were detected at concentrations that exceed action levels. Beryllium, chromium, and lead were detected at concentrations that exceed action levels.

*Ground Water*

Free-phase hydrocarbon was present on the water table downgradient of these units. The hydrocarbon is possibly a less refined product similar to, or a degraded combination of, No. 2 fuel oil or diesel fuel.

6.1.5 Tank 355 (SWMU No. 13)

*Subsurface Soil*

VOCs were not detected in subsurface soil at concentrations that exceed preliminary risk-evaluation action levels. The SVOC benzo(a)pyrene, and the metals beryllium and lead were detected at concentrations that exceed action levels.

*Ground Water*

The VOC benzene and lead were detected in the unfiltered ground water sample at concentrations that exceed preliminary risk-evaluation action levels. SVOCs were not detected above action levels in the unfiltered ground water sample. Based on the information obtained during this investigation, the unfiltered ground water data for inorganic constituents is not considered to be representative of ground water quality due to the high turbidity of the sample. The detected concentrations of inorganic analytes in the filtered ground water sample do not exceed action levels.

6.1.6 Tank 357 (SWMU No. 16) and Tank 358 (SWMU No. 17)

*Surface soil*

The SVOC benzo(a)pyrene, and the metals beryllium, chromium, and lead were detected in surface soil at concentrations that exceed preliminary risk-evaluation action levels.

*Subsurface Soil*

VOCs were not detected in subsurface soil at concentrations that exceed preliminary risk-evaluation action levels. The SVOC benzo(a)pyrene and the metals beryllium and lead were detected at concentrations that exceed action levels.

*Ground Water*

VOCs and SVOCs were not detected in the unfiltered ground water sample at concentrations that exceed preliminary risk-evaluation action levels. The detected concentrations of barium, beryllium, chromium, lead, mercury, and vanadium in the unfiltered ground water sample exceed action levels. Based on the information obtained during this investigation, the unfiltered ground water data for inorganic constituents is not considered to be representative of ground water quality due to the high turbidity of the sample. The detected concentrations of inorganic analytes in the filtered ground water sample do not exceed action levels.

6.1.7 Tank 200 Past Lagoon (SWMU No. 29)

*Soil Gas*

Benzene and ethylbenzene were not detected in the samples collected during the soil gas survey. The detected concentrations of toluene in the soil gas samples do not exceed preliminary risk-evaluation action levels. Total xylenes were detected at three of the five soil gas sampling locations at concentrations that exceed action levels.

*Subsurface Soil*

VOCs were not detected in subsurface soil at concentrations that exceed preliminary risk-evaluation action levels. The SVOCs benzo(a)pyrene, benzo(a)anthracene, and the metals beryllium and lead were detected at concentrations that exceed action levels.

*Ground Water*

The VOC benzene, the SVOC bis(2-ethylhexyl)phthalate, and the metals arsenic and lead were detected in the unfiltered ground water sample at concentrations that exceed preliminary risk-evaluation action levels. Based on the information obtained during this investigation, the unfiltered ground water data for inorganic constituents is not considered to be representative of ground water quality due to the high turbidity of the sample. The detected concentrations of inorganic analytes in the filtered ground water sample do not exceed action levels.

6.1.8 Additive Plant Drum Storage Area (SWMU No. 30)

*Surface soil*

SVOCs were not detected in surface soil at concentrations that exceed preliminary risk-evaluation action levels. Beryllium, chromium, and lead were detected in surface soil at concentrations that exceed action levels.

*Subsurface Soil*

VOCs were not detected in subsurface soil at concentrations that exceed preliminary risk-evaluation action levels. The SVOC benzo(a)pyrene, and the metals beryllium and lead were detected at concentrations that exceed action levels.

*Ground Water*

Free-phase hydrocarbon was present on the water table downgradient of this unit. The hydrocarbon is possibly similar to kerosene or jet fuel.

6.1.9 Empty Drum Storage Area (SWMU No. 45)

*Surface soil*

SVOCs were not detected in surface soil at concentrations that exceed preliminary risk-evaluation action levels. Beryllium, chromium, and lead were detected in surface soil at concentrations that exceed action levels.

*Subsurface Soil*

VOCs were not detected in subsurface soil at concentrations that exceed preliminary risk-evaluation action levels. The SVOCs benzo(a)pyrene and dibenzo(a,h)anthracene and lead were detected at concentrations that exceed action levels.

*Ground Water*

The VOC benzene and lead were detected in the unfiltered ground water sample at concentrations that exceed preliminary risk-evaluation action levels. SVOCs were not detected above action levels. Based on the information obtained during this investigation, the unfiltered ground water data for inorganic constituents is not considered to be representative of ground water quality due to the high turbidity of the sample. The detected concentrations of inorganic analytes in the filtered ground water sample do not exceed action levels.

6.1.10 Past Lagoon B (SWMU No. 71)

*Subsurface Soil*

VOCs were not detected in the subsurface soil samples at concentrations that exceed preliminary risk-evaluation levels. The SVOCs benzo(a)pyrene and pyrene, and the metals beryllium, chromium, and lead, were detected at concentrations that exceed action levels.

*Ground Water*

VOCs were not detected in the unfiltered ground water sample at concentrations that exceed preliminary risk-evaluation action levels. The SVOC pyrene and the metals arsenic, chromium, lead, and mercury, and sulfide were detected in the unfiltered ground water sample

at concentrations that exceed action levels. Based on the information obtained during this investigation, the unfiltered ground water data for inorganic constituents is not considered to be representative of ground water quality due to the high turbidity of the sample. The detected concentrations of inorganic analytes in the filtered ground water sample do not exceed action levels.

### 6.1.11 Past Lagoon B Addition (SWMU No. 71A)

*Soil Gas*

Benzene and ethylbenzene were not detected in samples collected during the soil gas survey. The detected concentrations of toluene and total xylenes do not exceed preliminary risk-evaluation action levels.

*Subsurface Soil*

VOCs were not detected in subsurface soil at concentrations that exceed preliminary risk-evaluation action levels. The SVOC benzo(a)pyrene and the metals beryllium and lead were detected in subsurface soil at concentrations that exceed action levels.

### 6.1.12 Drum Storage Area (SWMU No. 79)

*Surface soil*

SVOCs were not detected in surface soil at concentrations that exceed preliminary risk-evaluation action levels. Beryllium, chromium, and lead were detected at concentrations that exceed action levels.

*Subsurface Soil*

VOCs were not detected in subsurface soil at concentrations that exceed preliminary risk-evaluation action levels. The SVOCs benzo(a)pyrene and dibenzo(a,h)anthracene, and the metals arsenic and beryllium were detected in subsurface soil at concentrations that exceed action levels.

*Ground Water*

VOCs and SVOCs were not detected in the unfiltered ground water sample at concentrations that exceed preliminary risk-evaluation action levels. Chromium, lead, and mercury were detected in the unfiltered ground water sample at concentrations that exceed action levels. Based on the information obtained during this investigation, the unfiltered ground water data for inorganic constituents is not considered to be representative of ground water quality due to the high turbidity of the sample. The detected concentrations of inorganic analytes in the filtered ground water sample do not exceed action levels.

### 6.1.13 Screening Risk Assessment

The screening risk assessment performed for each VI SWMU indicated that cumulative risks from carcinogens in soil at all SWMUs range between $3 \times 10^{-6}$ and $1 \times 10^{-4}$. Risks from hazardous constituents at a SWMU falling within this range do not warrant further investigation. For non-carcinogenic health risks, the Hazard Index was less than 1.0 for all VI SWMUs, indicating that adverse health effects from detected non-carcinogens are unlikely to occur.

Lead was detected in the soil within SWMU Nos. 1/2, 6, and 30 at concentrations that exceed the 1,000-mg/kg USEPA cleanup level. The detected concentrations of lead in SWMU Nos. 1/2, 6, and 30 were 2,260 mg/kg, 3,760 mg/kg, and 2,270 mg/kg, respectively. These concentrations indicate that additional investigation is warranted for lead in soil within these SWMUs.

## 6.2 RECOMMENDATIONS

This section presents recommendations regarding additional investigation at several of the RCRA SWMUs. These recommendations are based on the results of the VI conducted at each SWMU, and the screening risk assessment. Dames & Moore's recommendations are:

- Additional investigation of soil within the VI SWMUs is not warranted based on risk posed by carcinogens and non-carcinogens in soil.
- Additional investigation of soil within SWMU Nos. 1/2, 6, and 30 should be conducted regarding lead in soil based on detected soil-lead concentrations.
- Additional investigation should be conducted within SWMU Nos. 11 and 30 to evaluate the extent of free-phase hydrocarbon floating on the water table beneath these units.
- Additional investigation of dissolved constituents in ground water at the VI SWMUs should be addressed as part of the RFI.

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# APPENDIX A

## SCREENING RISK ASSESSMENT
## VERIFICATION INVESTIGATION
## CHEVRON REFINERY
## PHILADELPHIA, PENNSYLVANIA

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## EXECUTIVE SUMMARY

A screening level risk assessment was performed as part of the Verification Investigation for the Solid Waste Management Units (identified in Chapter 4.0 of the VI report) at the Chevron Refinery in Philadelphia, Pennsylvania. The risk assessment characterizes the potential effects of chemicals in each Solid Waste Management Unit (SWMU), based on the Risk Assessment Guidance for Superfund (RAGS, USEPA, 1989) and the USEPA proposed RCRA Corrective Action Rule for Solid Waste Management Units (USEPA, 1990a). The objective of the risk assessment was to assess health risks associated with worker exposure to chemicals detected in soil that exceed action levels (or that did not have action levels) using USEPA-recommended default exposure parameters. This objective served to evaluate the need for further investigation based on constituents concentrations detected in soil at a particular SWMU. According to the proposed Corrective Action Rule (USEPA, 1990a), further action may not be warranted at a given SWMU (a determination of "no further action") for chemical concentrations exceeding the action levels, if:

- carcinogenic risks are between or below the one in a million and one in ten-thousand range

- non-carcinogenic risks are below regulatory criteria for allowable exposures (a hazard quotient of unity)

Based on worker exposure to all hazardous constituents except lead, the results of the screening level risk assessment indicated that further action is not warranted with regard to soil at any SWMU evaluated during the VI at the Refinery. The detected concentrations of lead in soil within three of the VI SWMUs warrant further investigation.

# 1.0 INTRODUCTION

This portion of the Verification Investigation (VI) report presents the methodology and results of the screening risk assessment performed for the Solid Waste Management Units (SWMUs), identified in Chapter 4.0 of the VI report, at the Chevron Refinery in Philadelphia, Pennsylvania. This risk assessment corresponds to the second phase of a two-phase approach to evaluate the need for further investigation at each of the VI SWMUs under the Resource Conservation and Recovery Act (RCRA). According to the proposed Corrective Action Rule (USEPA, 1990), further action may not be warranted at a given SWMU (a determination of "no further action") if:

- Chemical concentrations are below Agency-designated action levels
- Health risks fall below acceptable levels (if exposure is possible)

The concentrations of hazardous constituents at the site were compared to action levels (RCRA corrective action rule or USEPA Region III screening criteria) in the first phase (discussed in Chapter 4.0 of the VI report). If the detected concentrations of specific chemicals exceeded action levels (or if detected chemicals did not have action levels), they were further evaluated in the second phase to assess whether the health risks associated with chemical exposure fall below levels deemed to be acceptable by the USEPA.

The results of this assessment are not intended to determine if corrective measures are required at a given SWMU. Rather, the purpose of the screening risk assessment was to establish whether further investigation is required at a specific SWMU. Risk estimates generated by the screening risk assessment should not be construed as the expected rate of adverse effects in the exposed populations, but are merely estimates of risk based on current knowledge and a large number of assumptions. As such, the risk levels generated in the screening risk assessment are useful to compare one SWMU with another and set priorities for further investigations.

This risk assessment characterizes the potential effects of chemicals detected at each SWMU, based on the Risk Assessment Guidance for Superfund (RAGS, USEPA, 1989) and the USEPA proposed RCRA Corrective Action Rule for Solid Waste Management Units (USEPA, 1990). The objectives of this risk assessment are to:

- Identify chemicals that exceed (or do not have) action levels (preliminary risk evaluation)
- Estimate worker exposure to these chemicals in selected SWMUs, using default exposure parameters
- Identify applicable health-based criteria to assess the toxicity associated with the chemicals of concern
- Quantify the non-carcinogenic and carcinogenic health effects associated with potential human contact under the identified exposure scenarios

These objectives served to evaluate the need for further action based on concentrations detected in soil at a particular SWMU. Acceptable concentrations of hazardous constituents are those that are associated with:

- carcinogenic risks between or below the one in a million and one in ten-thousand range

- non-carcinogenic risks below regulatory criteria (a hazard ratio of unity)

These are general guidelines because action may or may not be triggered by the estimation of risk depending on other factors pertinent to the site (i.e. background concentrations, plausibility of exposure, *etc.*). As this assessment provides a more refined analysis of risk than the comparison performed in the first phase (preliminary risk evaluation), chemical concentrations may be deemed acceptable even though they were detected at concentrations that exceed action levels.

# 2.0 BACKGROUND

This section provides a brief description of each of the VI SWMUs and the chemicals evaluated in this assessment. This section is not intended as a comprehensive review of site data. Each of the SWMUs evaluated in this document have previously been described in Chapter 4.0 of the VI report.

## 2.1 SWMU DESCRIPTIONS

Thirteen SWMUs, (identified as SWMUs 1, 6, 9, 11, 13, 16, 17, 29, 30, 45, 71, 71A, and 79), contained chemical concentrations that exceed action levels (Chapter 4.0 of the VI report). Table 2-1 provides a summary of the SWMUs evaluated.

## 2.2 SUMMARY OF CHEMICALS EVALUATED

This section summarizes the chemicals of concern (COC) evaluated during this assessment. Chemicals detected in each SWMU were considered in this assessment if they exceed action levels. Chemicals without action levels were also considered.

*Soil Data*

Chemicals detected in soil above the action levels include:

Polycyclic Aromatic Hydrocarbons (PAHs)

- Benzo[a]Anthracene
- Benzo[a]Pyrene
- Benzo[b,j,k]Fluoranthene
- Dibenz[a,h]Anthracene
- Indeno[1,2,3-cd]Pyrene
- Pyrene

Inorganic Analytes

- Beryllium
- Chromium
- Lead

Chemicals detected above action levels are presented in Table 2-2 for surface soils and Tables 2-3 through 2-8 for subsurface soil. Note that samples from a SWMU may be identified on these tables through the location code (*i.e.*, S1-1 corresponds to SWMU 1).

*Soil Gas Data*

The results of soil gas surveys (conducted at SWMUs 11/12, 29, and 71A) indicate that xylene was the only constituent detected above action levels. Xylene concentrations for each SWMU are summarized in Table 2-9.

*Ground Water Data*

Ground water sampling was also performed as part of the VI conducted at the Refinery (described in Chapter 4.0 of the VI report). Because this risk assessment considers each SWMU separately, it was beyond the scope of the assessment to determine further action for ground water contamination since chemical concentrations in ground water cannot be attributed to specific SWMUs. Therefore, risks from exposure to ground water were not evaluated in this assessment.

*Chemicals Without Action Levels*

Eight non-carcinogenic chemicals detected in site soils did not have action levels:

Polycyclic Aromatic Hydrocarbons (PAHs)

- Acenaphthalene
- Dibenzofuran
- 1-Methylnaphthalene
- 1,3-Dichloro-2-propanol
- 2-Methylnaphthalene
- N-Propylbenzene

Inorganic Analytes

- Cobalt
- Thallium

The non-carcinogenic risks associated with these chemicals were evaluated for those chemicals with USEPA-developed health criteria (these included all the chemicals above except cobalt, and 1,3-dichloro-2-propanol). The results of the analysis are presented in Section 5.0 of this assessment.

## TABLE 2-1

## SUMMARIZED DESCRIPTION OF THE SWMUS EVALUATED IN THE RISK ASSESSMENT FOR THE CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA

| SOLID WASTE MANAGEMENT NO. | USE/TITLE | GROUND COVER | CHEMICALS USED | SURFACE AREA (M) (DEPTH IF KNOWN) |
|---|---|---|---|---|
| 01 | Empty Lube Oil Storage Area | Gravel | Lube Oil | 30.5 x 61.0 |
| 06 | Trash Incinerator | Concrete and asphalt pad; exposed soil less than 10% of area[1] | Miscellaneous | 18.3 x 9.1 |
| 09 | Product Storage Sump | Asphalt; exposed soil less than 10% of area[1] | Miscellaneous chemicals, heating oil, and jet fuel | 3.5 x 3.5 (9.1 bgs) |
| 11 | Past Lagoon A | Gravel and concrete | Oil | 61.0 x 30.5 |
| 13 | Tank 355 (Sunken Storage Basin) | Concrete | Oil, waste oil | 6.4 x 10.1 (3.5 bgs) |
| 16 & 17 | Above Ground Steel Storage Tanks | Concrete, gravel base | Slop oil | |
| 29 | Tank 200/Past Lagoon | Gravel | Separated sludges | 30.5 x 30.5 |
| 30 | Additive Plant Drum Storage Area | Gravel | Inorganic and organic chemicals | 16.7 x 18.3 |
| 45 | Empty Drum Storage Area | Gravel. Bare soils comprise approximately 5% of total surface area[1] | Lube oil, corrosion inhibiters | 30.5 x 21.3 |
| 71 | Past Lagoon B | New soil, gravel | Separator sludges, cooling tower sludges, coagulate alum sludges | 30.5 x 61.0 |
| 71A | Past Lagoon B Addition | Gravel, Tank # 1136 | Unknown | 18.3 x 42.7 |
| 79 | Drum Storage Area | Gravel | FCC residue (define), ash, and spent catalyst | 3.5 x 6.1 |

Note:

1. This information obtained during November 17, 1992 telephone conversation with Thomas J. Glancey (Dames & Moore, Philadelphia Geosciences).

**Table 2-2**
**Summary of Chemical Concentrations Detected above Action Levels in Surface Soils from Various SWMUs at the Chevron Refinery, Philadelphia, Pennsylvania**

| D & M Sample ID | S001A0 | S001A1 | S001A2 | S006A0 | S006A1 | S009A1 | S009A2 | S016A1 | S016A2 |
|---|---|---|---|---|---|---|---|---|---|
| Location | S1-1 | S1-2 | S1-3 | S6-1 | S6-2 | S9-1 | S009A1-Rep | S16-1 | S16-2 |
| Laboratory ID | P207734 | P207735 | P207736 | P207737 | P207738 | P207970 | P207974 | P207875 | P207876 |
| Sample Date | 08/04/92 | 08/04/92 | 08/04/92 | 08/04/92 | 08/04/92 | 08/06/92 | 09/06/92 | 08/05/92 | 08/05/92 |
| Units | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| **Metals** | | | | | | | | | |
| Beryllium | 0.73 | 1.1 | 0.94 | 2.1 | 1.6 | - | - | 2.3 | 1 |
| Chromium | 1140 K | 2420 K | 1170 K | 1730 K | 768 K | - | - | 543 K | 654 K |
| Lead | 73 J | 72.7 J | 62 J | 1260 J | 839 J | 49.3 J | 72.9 J | 539 J | 237 J |
| **PAHs** | | | | | | | | | |
| Benzo(a)Pyrene | - | - | - | 2.4 | - | 0.81 | - | 1.4 J | - |
| Pyrene | - | - | - | - | - | - | - | 6.6 | - |

Table 2-2 (continued)

| D & M Sample ID | S030A1 | S030A2 | S030A3 | S045A1 | S045A2 | S045A3 | S079A1 |
|---|---|---|---|---|---|---|---|
| Location | S30-1 | S30-2 | S30-3 | S45-1 | S45-2 | S045A1-Rep | S79-1 |
| Laboratory ID | P208448 | P208449 | P208450 | P208094 | P208098 | P208099 | P208611 |
| Sample Date | 08/10/92 | 08/10/92 | 08/10/92 | 08/07/92 | 08/07/92 | 08/07/92 | 08/12/92 |
| Units | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| **Metals** | | | | | | | |
| Beryllium | - | 0.68 | 1.3 | 0.84 | 0.84 | 1 | 1.6 |
| Chromium | - | 1170 K | 3450 K | 1420 J | - | 425 J | 420 J |
| Lead | 347 J | 2270 J | 91.4 J | 93.2 J | 134 J | 77.6 J | 105 J |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | - | - | - | - | - | - | - |
| Pyrene | - | - | - | - | - | - | - |

- Not detected above Action Levels

**Table 2-3**
**Summary of Chemical Concentrations Detected above Action Levels in Subsurface Soils from SWMUs 1 and 6 at the Chevron Refinery, Philadelphia, Pennsylvania**

| D & M Sample ID | B001A0 | B001A1 | B001A2 | B006A1 | B006A2 | B006A3 | B006A3DL | B006A4 |
|---|---|---|---|---|---|---|---|---|
| Sample Location | B1-1 | B1-2 | B1-3 | B6-1 | B6-2 | B6-3 | B6-3 DL | B6-4 |
| Sample Depth | 2-4ft | 2-4ft | 4-6ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft |
| Laboratory ID | P207731 | P207732 | P207733 | P207878 | P207739 | P207740 | P207740DL | P207879 |
| Sample Date | 08/04/92 | 08/04/92 | 08/04/92 | 08/05/92 | 08/04/92 | 08/04/92 | 08/04/92 | 08/05/92 |
| Units | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| **Metals** | | | | | | | | |
| Beryllium | 0.74 | - | 0.65 | 0.87 | - | 1.3 | - | 0.84 |
| Chromium | - | - | 1140 K | - | - | - | - | - |
| Lead | 2260 L | 549 L | 98.7 L | 857 L | 223 L | 885 L | - | 3760 L |
| **PAHs** | | | | | | | | |
| Benzo(a)Anthracene | - | - | - | - | - | 3.6 | - | - |
| Benzo(a)Pyrene | - | 0.54 | - | 0.65 | - | 2.8 | 2.6 | - |
| Benzo(b,j,k)Fluoranthene | - | - | - | - | - | - | 3.8 | - |
| Dibenz(a,h)Anthracene | - | - | - | - | - | - | 0.7 J | - |

- Not detected above Action Levels

**Table 2-4**
**Summary of Chemical Concentrations Detected above Action Levels in Subsurface Soils from SWMUs 9 and 11 at the Chevron Refinery, Philadelphia, Pennsylvania**

| D & M Sample ID | B009A1 | B011A1 | B011A2 | B011A3 | B011A4 | B011A4DL | B011A5 |
|---|---|---|---|---|---|---|---|
| Sample Location | B9-1 | B11-1 | B11-2 | B11-3 | B11-4 | B11-4 DL | B11-2 Rep |
| Sample Depth | 2-4ft | 1.5-3.5ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft | 2-4ft |
| Laboratory ID | P207984 | P207975 | P207976 | P207977 | P207978 | P207978DL | P207979 |
| Sample Date | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 | 08/06/92 |
| Units | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| **Metals** | | | | | | | |
| Beryllium | 0.77 | 2.6 | 1.5 | 0.59 | 0.99 | - | 1.8 |
| Chromium | - | 648 K | 774 K | - | - | - | 946 |
| Lead | 106 | 173 L | 140 L | 146 L | 507 | - | 234 |
| **PAHs** | | | | | | | |
| Benzo(a)Anthracene | - | - | - | - | 30 | 37 | - |
| Benzo(a)Pyrene | 2.2 J | - | - | 0.67 | 25 | 36 J | - |
| Benzo(b,j,k)Fluoranthene | - | - | - | - | 81J | 25 J | - |
| Indeno(1,2,3-cd)Pyrene | - | - | - | - | 8.4 J | - | - |
| Pyrene | - | - | - | - | 25 | 90 | - |

- Not detected above Action Levels

**Table 2-5**
**Summary of Chemical Concentrations Detected above Action Levels in Subsurface Soils from SWMUs 13 and 16 at the Chevron Refinery, Philadelphia, Pennsylvania**

| D & M Sample ID | B013A1 | B013A2 | B013A2DL | B016A1 | B016A2 | B016A2DL | B016A3 | B016A4 |
|---|---|---|---|---|---|---|---|---|
| Sample Location | B13-1 | B13-2 | B13-2 DL | B16-1 | B16-2 | B16-2 DL | B16-3 | B16-4 |
| Sample Depth | 2.5-4.5ft | 4.5-6.5ft | 4.5-6.5ft | 2-4ft | 2-4ft | 2-4ft | 0-2ft | 2-4ft |
| Laboratory ID | P207980 | P207880 | P207880DL | P207881 | P207882 | P207882DL | P207883 | P207884 |
| Sample Date | 08/06/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 |
| Units | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| **Metals** | | | | | | | | |
| Beryllium | 1.4 | 0.9 | - | - | 0.78 | - | - | 1.2 |
| Lead | 229 | 580 L | - | 57.2 L | 191 L | - | 477 L | 149 L |
| **PAHs** | | | | | | | | |
| Benzo(a)Pyrene | 1.4 | 0.91 | 1.6 J | - | 0.68 | 0.88 J | 1.3 K | 0.61 |

- Not detected above Action Levels

Table 2-6
Summary of Chemical Concentrations Detected above Action Levels in Subsurface Soils
from SWMUs 17 and 29 at the Chevron Refinery, Philadelphia, Pennsylvania

| D & M Sample ID | B017A1 | B017A2 | B017A3 | B017A3DL | B017A4 | B029A1 | B029A2 | B029A2DL |
|---|---|---|---|---|---|---|---|---|
| Sample Location | B17-1 | B17-2 | B17-3 | B17-3 DL | B17-4 | B29-1 | B29-2 | B29-2 DL |
| Sample Depth | 0-2ft | 0-2ft | 0-2ft | 0-2ft | 0-2ft | 2-4ft | 2-4ft | 2-4ft |
| Laboratory ID | P207887 | P207888 | P207889 | P207889DL | P207890 | P208443 | P208444 | P208444DL |
| Sample Date | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/05/92 | 08/10/92 | 08/10/92 | 08/10/92 |
| Units | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| **Metals** | | | | | | | | |
| Beryllium | - | 0.73 | - | - | 2.5 | 0.99 | 0.73 | - |
| Chromium | - | - | - | - | 2220 K | - | - | - |
| Lead | 297 L | 556 L | 150 L | - | 49.5 L | 295 | 695 | - |
| **PAHs** | | | | | | | | |
| Benzo(a)Anthracene | - | - | - | - | - | - | - | 3.8 J |
| Benzo(a)Pyrene | - | 0.71 J | 1 | 1.1 | - | - | 3.2 | 3.7 J |
| Pyrene | - | - | - | - | - | - | - | 6.6 |

- Not detected above Action Levels

**Table 2-7**
**Summary of Chemical Concentrations Detected above Action Levels in Subsurface Soils from SWMUs 30 and 45 at the Chevron Refinery, Philadelphia, Pennsylvania**

| D & M Sample ID | B030A1 | B030A2 | B030A3 | B045A1 | B045A2 | B045A2DL | B045A3 |
|---|---|---|---|---|---|---|---|
| Sample Location | B30-1 | B30-2 | B30-3 | B45-1 | B45-2 | B45-2 DL | B45-1 |
| Sample Depth | 2-4ft | 2-4ft | 2-4ft | 1.5-3.5 ft | 2-4 ft | 2-4ft | 1.5-3.5 ft |
| Laboratory ID | P208445 | P208446 | P208447 | P208103 | P208439 | P208439DL | P208102 |
| Sample Date | 08/10/92 | 08/10/92 | 08/10/92 | 08/7/92 | 08/10/92 | 08/10/92 | 08/7/92 |
| Units | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| **Metals** | | | | | | | |
| Beryllium | 0.64 | 0.57 | - | 0.66 | 0.59 | - | 0.59 |
| Chromium | - | - | - | 376 K | - | - | - |
| Lead | 93.3 | - | 471 | 173 J | 171 J | - | 101 J |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 3.1 | - | - | - | 1.8 | 1.9 | - |
| Dibenz(a,h)Anthracene | - | - | - | - | - | 0.57 J | - |

- Not detected above Action Levels

Table 2-8
**Summary of Chemical Concentrations Detected above Action Levels in Subsurface Soils from SWMUs 71, 71A and 79 at the Chevron Refinery, Philadelphia, Pennsylvania**

| D & M Sample ID | B071A1 | B071A2 | B071A3 | B071A4 | B071A5 | B071A6 | B071A7 |
|---|---|---|---|---|---|---|---|
| Sample Location | B71-1 | B71-2 | B71-3 | B71-4 | B71-5 | B71-6 | B71-6 Rep |
| Sample Depth | 1-2ft | 2-4ft | 3-4.5ft | 2-4ft | 1-3ft | 1-3ft | 1-3ft |
| Laboratory ID | P208497 | P208498 | P208502 | P208503 | P208504 | P208505 | P208506 |
| Sample Date | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 | 08/11/92 |
| Units | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| **Metals** | | | | | | | |
| Beryllium | 0.67 | 0.95 | 0.88 | 0.67 | 1.3 | 0.92 | 1.4 |
| Chromium | - | 753 | - | - | - | - | - |
| Lead | 166 | 358 | 373 | 149 | 324 | 322 | 336 |
| **PAHs** | | | | | | | |
| Benzo(a)Anthracene | - | - | - | - | - | - | - |
| Benzo(a)Pyrene | - | 1.0 J | 1.9 J | - | - | - | 1.5 |
| Dibenz(a,h)Anthracene | - | - | - | - | - | - | - |
| Pyrene | - | - | - | - | - | - | - |

Table 2-8 (continued)

| D & M Sample ID | B071AA1 | B071AA2 | B079A1 | B079A1DL | B079A2 |
|---|---|---|---|---|---|
| Sample Location | B71A-1 | B71A-2 | B79-1 | B79-1 DL | B79-2 |
| Sample Depth | 2-4ft | 4-6ft | 4.5-6.5 ft | 4.5-6.5ft | 0-2 ft |
| Laboratory ID | P208614 | P208615 | P208612 | P208612D | P208613 |
| Sample Date | 08/12/92 | 08/12/92 | 08/12/92 | 08/12/92 | 08/12/92 |
| Units | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| **Metals** | | | | | |
| Beryllium | - | 2.2 | 1.6 | - | 0.61 |
| Chromium | - | - | - | - | - |
| Lead | 227 | 360 | 468 J | - | - |
| **PAHs** | | | | | |
| Benzo(a)Anthracene | - | - | - | 4.0 J | - |
| Benzo(a)Pyrene | - | 1.6 J | 2 | 2.9 | - |
| Dibenz(a,h)Anthracene | - | - | - | 0.85 J | - |
| Pyrene | - | - | - | 8.7 | - |

- Not detected above Action Levels

Table 2-9
**Summary of Xylene Concentrations (as Soil Gas) Detected above Action Levels from SWMUs 11 and 29 at the Chevron Refinery, Philadelphia, Pennsylvania**

| Sample No. | SG11-1 | SG11-2 | SG11-1 | SG29-1 | SG29-3 | SG29-3 | SG29-5 |
|---|---|---|---|---|---|---|---|
| Sample Depth (ft) | 4 | 4 | 4 | 3 | 2.5 | 2.5 | 4 |
| Sample Date | 07/27/92 | 07/27/92 | 07/27/92 | 07/27/92 | 07/27/92 | 07/27/92 | 07/27/92 |
| Units | mg/m^3 | mg/m^3 | mg/m^3 | mg/m^3 | mg/m^3 | mg/m^3 | mg/m^3 |
| Xylenes (total) | 2.03 | 1.19 | 2.28 | 2.60 | 2.04 | 1.99 | 1.25 |

# 3.0 EXPOSURE ASSESSMENT

Exposure assessment consists of the estimation of the magnitude, frequency, duration, and routes of exposure (or contact) of a chemical to a receptor. Human exposure to chemicals is typically evaluated by estimating the amount of chemical intake upon chemical contact with the lungs, gastrointestinal tract, or skin during a specified period of time. Chemical intakes and associated risks were quantified for all exposure pathways considered to be complete. The exposure assessment involves the following steps:

- Identification of potentially exposed populations and exposure scenarios
- Identification of potential exposure pathways
- Evaluation of the environmental fate and transport of chemicals in soil
- Estimation of exposure point concentrations used to quantify chemical intakes
- Quantification of chemical intakes for each exposure pathway

Default values were used in the exposure equations to yield estimates of risk. Given the relatively small areas of the SWMUs, it is unlikely that workers would be exposed to chemicals in each area at the intensity assumed in this assessment. However, in the absence of more detailed, site-specific information, health-protective assumptions were made.

## 3.1 IDENTIFICATION OF EXPOSURE SCENARIOS

The screening risk assessment is based on the assumption that access to each SWMU at the Refinery is controlled and that future land usage will not vary from current conditions. Thus, the only potentially exposed individuals are on-site workers. It was also assumed that current and future exposure scenarios were equivalent.

## 3.2 IDENTIFICATION OF EXPOSURE PATHWAYS

An exposure pathway traces the mechanism through which a chemical comes into contact with a receptor. The exposure pathways evaluated in this assessment are:

- Dermal contact with soil
- Soil ingestion
- Vapor inhalation

A summary of the pathways examined for each SWMU is presented in Table 3-1. On-site workers may be directly exposed to surface or subsurface soils via soil ingestion or dermal contact with exposed soils. Note that it was assumed that workers could be exposed (via ingestion or dermal contact) to subsurface soils in the event that periodic maintenance or other activities would result in the mixing of surface and subsurface soils. Inhalation of xylene vapors was examined for the exposures associated with SWMUs 11 and 29.

## 3.3 ENVIRONMENTAL FATE AND TRANSPORT VOLATILE ORGANIC COMPOUNDS TO AIR

Chemical diffusion through soil and volatilization to air is the principal pathway for the loss of volatile organic compounds (VOCs) from soil, and is a complex process controlled by soil, chemical, and atmospheric processes. VOCs can also be emitted to the air from ground water. In general, chemicals with high Henry's Law constants are more volatile, diffuse more readily through soil, and tend to move relatively independently of atmospheric conditions.[1] Factors that limit diffusion, such as increased adsorption to soil and increased soil moisture content, can decrease the amount of volatilization that occurs. Factors that increase volatilization include increased soil temperature and increased chemical concentrations in soil (Jury and Valentine, 1986).

Concentrations of chemicals in air resulting from emissions from underground sources were estimated using relatively simple models. Using the results of the VI soil gas samples these models provide conservative estimates of concentrations in air (*i.e.*, estimates that are higher than would be measured under field conditions). The steps used to estimate chemical concentrations in air are:

1) Compile the results of the soil gas samples from the 1992 VI data

2) Estimate soil gas concentrations for volatile organic compounds (VOCs) detected in soil (this step only performed for chemicals without Action Levels)

3) Estimate steady-state emission rates (using the Farmer *et al.*, (1980) emission model)

4) Calculate chemical concentrations in outdoor air (based on the emission rates) using the "box model"

These steps are described in detail in the following subsections. The calculations performed for the estimation of air concentrations are shown in Attachment A.

*Step 1:* *Compile appropriate sample concentrations from data*

As noted in Table 2-9, only SWMUs 11 and 29 contained xylene concentrations in soil gas above action levels. The maximum soil gas concentration for each of these SWMUs is presented in Table 3-2.

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[1]Henry's Law constant, the ratio of vapor concentration to the aqueous concentration, is an index of the partitioning of a chemical between dissolved and gaseous phases. The larger the value of Henry's constant, the more likely the chemical is to move by vapor diffusion as opposed to liquid diffusion.

*Step 2: Estimate Soil Gas Concentrations for VOCs Detected In Soil*

Because this step was used for VOCs without action levels, only the SWMU which would produce the greatest air emissions (*i.e.*, high soil concentration, large surface area, and shallow sample depth) was chosen. Of the chemicals without action levels, only N-propylbenzene and 1,3-dichloro-2-propanol are VOCs. Health criteria were not available for either of these VOCs and surrogate values were only available for N-propylbenzene. Therefore, soil gas concentrations were estimated only for N-propylbenzene using the physical and chemical properties of ethylbenzene as a surrogates. The parameters and equations used in estimating N-propylbenzene air concentrations are shown in Attachment A. The methodology for estimating soil gas concentrations for this chemical is presented below.

If chemical concentrations in soil and interstitial vapors are assumed to approach equilibrium, they are related by the following equation (EPA, 1988):

$$C_v = C_s \times \left( \frac{H}{K_d \times RT} \right) \times CF \qquad (1)$$

where,

$C_v$ = Concentration of chemical in vapor phase in soil pores ($mg/m^3$)
$C_s$ = Concentration of chemical in soil (mg/kg)
H = Henry's Law constant (atm $m^3$/mol)
R = Universal gas law (atm $m^3$/mol K)
T = Temperature (283 K)
$K_d$ = Soil/water partition coefficient (ml/g)
CF = Conversion factor ($10^{-3}$ kg/g)($10^6$ $ml/m^3$)

The $C_s$, H and $K_d$ parameters are all chemical-specific; the other factors will remain unchanged.

*Chemical Concentration*

The chemical concentration in soil ($C_s$) is 17 mg/kg which is the maximum concentration detected in soils from SWMU 17.

*Henry's Law Constant*

The Henry's Law constant used in Equation 1 is 6.43 x $10^{-3}$ which was obtained from the Superfund Public Health Evaluation Manual (SPHEM) (EPA, 1986a).

*Soil/Water Partition Coefficient*

The soil/water partition coefficient ($K_d$) is an important factor affecting the migration of chemicals. Since $K_d$ values (also referred to as the soil distribution factor) are not available for all chemicals, they must often be estimated. EPA (1988) suggests that $K_d$ values can be estimated by multiplying the Organic Carbon Partition Coefficient ($K_{oc}$) by the fraction of organic carbon in soil ($f_{oc}$):

$$K_d = K_{oc} \times f_{oc} \qquad (2)$$

where,

$K_d$ = Soil/water partition coefficient (ml/g)
$K_{oc}$ = Organic carbon partition coefficient (ml/g)
$f_{oc}$ = Fraction of organic carbon in soil

*Organic Carbon Partition Coefficient*

The organic partition coefficient used Equation 2 is 1100 ml/g, which was obtained from the Superfund Public Health Evaluation Manual (SPHEM) (EPA, 1986a).

*Fraction of Organic Carbon*

Since the amount of organic carbon in soil can vary between soil types, as well as individual samples of like soils, $f_{oc}$ was assumed to be 0.0158. This represents the median value of the range of $f_{oc}$ values (0.0011 to 0.0304) reported by Karickhoff (1984).

*Step 3: Estimate Emission Rates*

Xylene emissions were estimated using the covered-landfill emission model developed by Farmer *et al.*, (1980). This steady state model is also cited in the Superfund Exposure Assessment Manual (EPA, 1988). The model is used to predict emissions from a covered landfill based on Fick's First Law of diffusion and accounts for many of the factors that influence chemical migration such as soil temperature, chemical concentrations, Henry's Law constants, soil moisture content, and chemical adsorption to soil. Diffusion of chemicals to the soil surface is described by the relationships developed by Millington and Quirk (1961). The emission rate for xylene was calculated as follows:

$$Q = D \times \left( \frac{P_A^{10/3}}{P_T^2} \right) \left( \frac{C_v}{L} \right) \times CF \qquad (3)$$

where,

Q = Emission rate ($mg/m^2/s$)
D = Diffusion coefficient of the chemical in air ($cm^2/s$)
$P_A$ = Air-filled soil porosity (dimensionless)
$P_T$ = Total soil porosity (dimensionless)
$C_v$ = Concentration of the chemical as soil gas at depth L ($mg/m^3$)
L = Depth of soil cover (m)
CF = Conversion factor ($10^{-4}$ $m^2/cm^2$)

The chemical concentration in soil gas was determined in Step 1, all other parameters used in Equation 3 are discussed below.

*Diffusion coefficient*

The diffusion coefficient (D) in air for xylene is 0.06742 $cm^2/S$ (EPA, 1988).

*Total soil porosity*

Total soil porosity ($P_T$) is the space in soil not occupied by soil particles. These spaces are occupied by either vapor or water and allow for the travel of chemical substances. Based on guidance provided in the Verification Investigation work plan (Dames & Moore, July 2, 1991), the total porosity for site soils was assumed to be 0.430.

*Air-filled soil porosity*

The air-filled soil porosity ($P_A$) is the portion of total soil porosity not occupied by water. Water in soil pores impedes the travel of volatile compounds to the surface. $P_A$ accounts for the effect of soil moisture on chemical vapor migration, and can be calculated as follows:

$$P_A = P_T - W \qquad (4)$$

where,

$P_A$ = Air-filled soil porosity (unitless)
W = Volumetric water content of soil (vol/vol)
$P_T$ = Total soil porosity (unitless)

Based on guidance provided in the VI workplan (Dames & Moore, July 2, 1991), the volumetric water content (W) of soils was assumed to be 0.25 (or 25%). From Equation 4 then, $P_A$ is the difference of $P_T$ and W, or .018.

*Depth of soil cover*

The depth of soil cover (L) for SWMUs 11 and 29 are presented in Table 3-2.

*Summary*

Soil parameters $P_A$, $P_T$, and W were assumed to be similar for all soil at both SWMUs 11 and 29. This assumption introduces some uncertainty, as soil conditions are likely to change with depth and location. These and all other parameters used to the estimate emission rate (Q) of xylene are summarized in Table 3-2.

From the parameters and equations shown above, emission rate (Q) was calculated for chemicals detected as soil gas. The emission rate was then used in Step 4 to calculate chemical concentration in air.

*Step 4: Calculate Chemical Concentrations in Outdoor Air*

Chemical concentrations in air from emissions from an area source are expected to be highest at the source, and decrease with distance from the source. A screening-level approach for evaluating concentrations in air from VOC emissions involves calculating concentrations in air over the source area (air dispersion models (such as ISCST) are not designed to calculate concentrations in air over an area source). However, EPA has recommended use of a "box model" (EPA, 1986a) for calculating concentrations in on-site air:

$$C_a = \frac{Q \times A}{L \times V \times H} \qquad (5)$$

where,

$C_a$ = Concentration in air ($mg/m^3$)
Q = Emission rate ($mg/m^2/s$)
A = Surface area of the source area ($m^2$)
L = Width of the surface area perpendicular to the wind direction (m).
V = Average windspeed within the mixing zone, assumed to be 0.5 the windspeed at the mixing height (m/s)
H = Mixing height (m)

The values selected for this model were as follows:

- The values of Q for the chemicals of concern were calculated in the last step
- The areas of emission (A) were assumed to be 1858 and 929 $m^2$ for SWMUs 11 and 29 respectively
- The value of H represents the breathing zone of an individual (2 m)
- The value of V was 2.13 m/s which is based on the annual average windspeed of 4.25 m/s measured at the Philadelphia International Airport (personal communication, National Weather Service (NWS, 1992)
- The value of L was 43.10 and 30.48 m, the square root of the surface area for SWMUs 11 and 29, respectively

## 3.4 SELECTION OF EXPOSURE POINT CONCENTRATIONS

This section discusses the selection of exposure concentrations. Exposure concentrations are concentrations in environmental media (*e.g.*, soil) used to calculate chemical intakes in humans. Exposure concentrations were selected based on the site-specific scenarios described previously, and site analytical data or modeling results. The sections below describe the selection of exposure point concentrations.

### 3.4.1 Exposure Point Concentrations In Soil

The maximum concentration detected in either surface or sub-surface soil for each SWMU were selected as the actual exposure point concentrations used for the screening risk assessment. Table 3-3 summarizes these exposure point concentrations for each SWMU evaluated.

### 3.4.2 Exposure Point concentrations In Air

Xylene concentrations in outdoor air were estimated using the emissions models described in Section 3.3. These air concentrations were, in turn, derived using the maximum soil gas concentrations detected from a particular SWMU. The actual exposure point concentrations used in the screening level risk assessment were:

- $2.27 \times 10^{-6}$ $mg/m^3$ for SWMU 11
- $2.44 \times 10^{-6}$ $mg/m_3$ for SWMU 29

## 3.5 QUANTIFICATION OF INTAKE RATES

This section describes the methods used for calculating potential chemical intakes for the population and exposure pathways selected.

Intake is calculated as either the Average Daily Dose (ADD) or the Lifetime Average Daily Dose (LADD). The ADD is used in the evaluation of non-carcinogenic health effects, while the LADD is used to evaluate carcinogenic effects (the evaluation of these intakes is discussed further in Section 4.0). These two intake rates differ in the averaging time (AT) variable. When evaluating non-carcinogenic effects, intakes (ADD) are calculated by averaging intake over the period of exposure (exposure duration, or ED). For carcinogens, intakes (LADDs) are calculated by prorating the average daily dose over a lifetime. The input parameters and assumptions used to estimate worker exposures are presented in Table 3-4.

### 3.5.1 Soil: Ingestion

The equation to calculate intake from the ingestion of soil can be expressed as:

$$Intake = \frac{(C_s)\ (F)\ (Is)\ (EF)\ (ED)\ (10^{-6})}{(BW)\ (AT)\ (365)} \qquad (6)$$

where,

| | | |
|---|---|---|
| Intake | = | ADD or LADD (mg/kg/day) |
| $C_S$ | = | Soil concentration of chemical (mg/kg) |
| F | = | Fraction from chemical-containing soil (unitless) |
| Is | = | Soil ingestion rate (mg/day) |
| EF | = | Exposure frequency (days/year) |
| ED | = | Exposure duration (years) |
| BW | = | Body weight (kg) |
| AT | = | Averaging time (years) |
| $10^{-6}$ | = | Conversion factor (kg/mg) |
| 365 | = | Conversion factor (days/year) |

### 3.5.2 Soil: Dermal Contact

EPA guidelines on assessing dermal absorption of chemicals from soil are still evolving. A recent guideline on assessing dermal absorption recommends quantitative assessments only for selected compounds (chlorinated dioxins and furans, PCBs, DDT and its related compounds and cadmium). For all other chemicals, the following quantitative approaches are recommended (EPA, 1991a):

- Volatile organic compounds - assume that dermal contact with these compounds in soil will not significantly increase risk over risks caused by other pathways of exposure to soil

- Other organic compounds and inorganic analytes - assume that dermal contact with these compounds in soil may result in risks comparable to those from direct ingestion of soil

It was assumed for this risk assessment that intake from dermal contact with chemicals in soil is equivalent to the intake from soil ingestion.

### 3.5.3 Air: Vapor Inhalation

The following equation was used to calculate the intake associated with the inhalation of chemicals in air:

$$Intake = \frac{(C_A)\ (Br)\ (ET)\ (EF)\ (ED)}{(BW)\ (AT)\ (365)} \qquad (7)$$

where,

| | | |
|---|---|---|
| Intake | = | ADD or LADD (mg/kg/day) |
| $C_A$ | = | Air concentration of contaminant (mg/m$^3$) |
| Br | = | Breathing rate (m$^3$/hour) |
| ET | = | Exposure time (hours/day) |
| EF | = | Exposure frequency (days/year) |
| ED | = | Exposure duration (years) |
| BW | = | Body weight (kg) |
| AT | = | Averaging time (years) |
| 365 | = | Conversion factor (days/year) |

The concentrations of contaminants in air were estimated using the models described in Section 3.3.

## TABLE 3-1

## SUMMARY OF THE EXPOSURE PATHWAYS FOR WORKERS ASSOCIATED WITH EACH SWMU AT THE CHEVRON REFINERY

| SOLID WASTE MANAGEMENT UNIT | EXPOSURE PATHWAYS | | |
|---|---|---|---|
| | DERMAL CONTACT | SOIL INGESTION | VAPOR INHALATION |
| 01 | + | + | - |
| 03 | + | + | - |
| 09 | + | + | - |
| 11 | + | + | + |
| 13 | + | + | - |
| 16 | + | + | - |
| 17 | + | + | - |
| 29 | + | + | + |
| 30 | + | + | - |
| 47 | + | + | - |
| 71 | + | + | - |
| 71A | + | + | - |
| 79 | + | + | - |

+ Pathway evaluated
- Pathway not evaluated

## TABLE 3-2

## SUMMARY OF PARAMETERS USED TO ESTIMATE THE EMISSION RATE (Q) OF XYLENE

| PARAMETER | SWMU NO. | | SOURCE |
|---|---|---|---|
| | 11 | 29 | |
| Maximum Concentration ($C_V$) ($mg/m^3$) | 2.28 | 2.60 | Table 4-20 and 4-22 of this report. |
| Diffusion Coefficient (D) | 0.06742 | 0.06742 | EPA, 1988 |
| Sample Depth (L) (meters) | 1.22 | 0.914 | Table 4-20 and 4-22 of this report. |
| Total Porosity ($P_T$) | 0.43 | 0.43 | Assumed Value. See VI Workplan (D&M 1991). |
| Volumetric Water Content of Soil (W) | 0.25 | 0.25 | Assumed Value. See VI Workplan (D&M 1991). |
| Air-filled Porosity ($P_A$) | 0.18 | 0.18 | Calculated (Equation 4) |

**Table 3-3**
**Summary of Maximum Chemical Concentrations Detected Above Action Levels in Soils From Each SWMU Evaluated at the Chevron Refinery, Philadelphia, Pennsylvania**

| Chemical | Maximum Concentration (mg/kg) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | SWMU 1 | SWMU 6 | SWMU 9 | SWMU 11 | SWMU 13 | SWMU 16 | SWMU 17 | SWMU 29 |
| **Metals** | | | | | | | | |
| Beryllium | 1.1 | 2.1 | 0.77 | 2.6 | 1.4 | 2.3 | 2.5 | 0.99 |
| Chromium | 2420 | 1730 | - | 946 | - | 654 | 2220 | - |
| Lead | 2260 | 3760 | 106 | 507 | 580 | 539 | 556 | 695 |
| **PAHs** | | | | | | | | |
| Benzo(a)Anthracene | - | 3.6 | - | 37 | - | - | - | 3.8 |
| Benzo(a)Pyrene | 0.54 | 2.8 | 2.2 | 36 | 1.6 | 1.4 | 1.1 | 3.7 |
| Benzo(b,j,k)Fluoranthene | - | 3.8 | - | 81 | - | - | - | - |
| Dibenz(a,h)Anthracene | - | 0.7 | - | - | - | - | - | - |
| Indeno(1,2,3-cd)Pyrene | - | - | - | 8.4 | - | - | - | - |
| Pyrene | - | - | - | 90 | - | 6.6 | - | 6.6 |

- Not detected above Action Levels

Table 3-3 (continued)

| Chemical | Maximum Concentration (mg/kg) | | | | |
|---|---|---|---|---|---|
| | SWMU 30 | SWMU 45 | SWMU 71 | SWMU 71A | SWMU 79 |
| **Metals** | | | | | |
| Beryllium | 1.3 | 1 | 1.4 | 2.2 | 1.6 |
| Chromium | 3450 | 1420 | 753 | - | 420 |
| Lead | 2270 | 173 | 373 | 360 | 468 |
| **PAHs** | | | | | |
| Benzo(a)Anthracene | - | - | - | - | 0 |
| Benzo(a)Pyrene | 3.1 | 1.9 | 1.9 | 1.6 | 2.9 |
| Benzo(b,j,k)Fluoranthene | - | - | - | - | - |
| Dibenz(a,h)Anthracene | - | 0.57 | - | - | 0.85 |
| Indeno(1,2,3-cd)Pyrene | - | - | - | - | - |
| Pyrene | - | - | - | - | 8.7 |

- Not detected above Action Levels

## TABLE 3-4

## SUMMARY OF EXPOSURE PARAMETERS USED TO CALCULATE CARCINOGENIC AND NON-CARCINOGENIC HEALTH RISKS FOR THE CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA

| PARAMETER | VALUE | RATIONALE/SOURCE |
|---|---|---|
| **GENERAL PARAMETERS** | | |
| Lifetime Average Daily Dose (LADD) or Average Daily Dose (ADD) | mg/kg/day | Calculated |
| Soil Concentrations ($C_S$)<br>Particulate Concentrations ($C_p$) | mg/kg<br>$mg/m^3$ | Equivalent to ADD or LADD<br>Equivalent to ADD or LADD |
| Fraction from Chemical-containing Soil (F) | 1 | Maximum |
| Exposure Frequency (EF) | 245 days/year | Number of workdays per year |
| Exposure Duration (ED) | 25 years | Default, EPA (1991c) |
| Body Weight (BW) | 70 kg | Default, EPA (1989) |
| Averaging Time (AT)<br>Carcinogens<br>Non-carcinogens | <br>70 years<br>Variable | <br>Lifetime (EPA, 1991c)<br>Corresponds to exposure duration |
| Conversion Factor | 365<br>$10^{-6}$ | Days per year<br>Kg per mg |
| **PATHWAY - SPECIFIC PARAMETERS** | | |
| Soil Ingestion | | |
| Soil Ingestion Rate (Is) | 50 mg/day | Default, EPA (1991c) |
| Vapor Inhalation | | |
| Breathing Rate (Br) | 2.5 $m^3$/hour | Default value based on a breathing rate of 20 $m^3$/8 hour workday (EPA, 1991c) |

## 4.0 TOXICITY ASSESSMENT

For this assessment the potential for chemicals to elicit adverse effects were interpreted through the use of USEPA-derived toxicity criteria. This section presents the source of the toxicity criteria and the use of surrogate values.

The chemicals of concern have been classified into two broad categories: non-carcinogens and carcinogens. This classification has been selected because health risks are quantified quite differently for carcinogenic and non-carcinogenic effects. Toxicity studies with laboratory animals or epidemiological studies of human populations provide the data used to develop these toxicity values. The toxicity values are then combined with the exposure estimates (developed in Section 3.0) in the risk characterization process (Section 5.0) to estimate potential adverse effects of the chemicals of concern.

Toxicity values used in this risk assessment were obtained from these sources:

- The Integrated Risk Information System (IRIS), a database available through the EPA Environmental Criteria and Assessments Office (ECAO) in Cincinnati, Ohio. IRIS, prepared and maintained by EPA, is an electronic database containing health risk and EPA regulatory information on specific chemicals (EPA, 1992a)

- The Health Effects Assessment Summary Tables (HEAST), provided by the EPA Office of Solid Waste and Emergency Response (OSWER) (EPA, 1991b; 1992b). HEAST is a compilation of toxicity values published in health effects documents issued by EPA. HEAST is for use in Superfund and RCRA programs

Criteria obtained from IRIS are given priority over those from HEAST. If criteria are not available from either source, then one of the following procedures was used:

- Oral values were used to represent criteria for the inhalation pathway

- Surrogate values were substituted for similar chemicals (*i.e.*, isomers)

- Specific agency guidance was consulted

For some chemicals without criteria (and without guidance from the Environmental Criteria and Assessment Office), it may not be appropriate to use surrogate values. In such cases, RAGS (1989) recommends that the chemical be qualitatively evaluated. The implications of the absence of chemicals from the quantitative risk estimate are addressed in the uncertainty section.

## 4.1 NON-CARCINOGENIC EFFECTS

Non-carcinogenic effects were evaluated using *reference doses* (RfDs) developed by EPA. The RfD is determined based on the assumption that thresholds exist for certain toxic effects (such as liver or kidney damage). In general, the RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) via the oral route of exposure that is likely to be without an appreciable risk of deleterious effects during a lifetime of exposure (EPA, 1989a). A corresponding value known as a *reference concentration* (RfC) is used to evaluate adverse effects from inhalation exposure (previously, the EPA presented these criteria as inhalation RfDs). RfDs and RfCs were obtained either from IRIS or HEAST. The RfDs (and RfCs converted to RfDs) for the chemicals of concern at the SWMU are presented in Table 4-1. RfCs were converted from concentrations ($mg/m^3$) to intake rates (mg/kg/day) by assuming an inhalation rate of 20 $m^3$/day and a body weight of 70 kg.

## 4.2 CARCINOGENIC EFFECTS

Evidence of the carcinogenicity of a chemical comes from lifetime studies with laboratory animals and/or human epidemiologic studies. Because of the difficulties in quantifying risks at low levels of exposure in either animal or epidemiological studies, mathematical models are used to extrapolate from high measured intakes in sensitive animals to low estimated intakes in humans. The true risk is not likely to be higher than the estimate and is most likely lower (and could even be zero).

Numerical estimates of cancer potency are presented as *slope factors* (SFs). The slope factor defines the cancer risk due to continuous lifetime exposure to one unit of carcinogen (in units of risk per mg/kg/day). Individual cancer risk is calculated as the product of exposure to a chemical (in mg/kg/day) and the slope factor for that chemical (in $(mg/kg/day)^{-1}$). Cancer risks from exposure to multiple carcinogens and multiple pathways are assumed to be additive, based on the EPA carcinogen risk assessment guidelines (EPA, 1986b). Slope factors were obtained either from IRIS or HEAST.

Each slope factor is accompanied by a weight-of-evidence classification. The weight-of-evidence classification indicates the likelihood that the chemical is a potential human carcinogen, and is based on the available data for a chemical. The evidence is characterized separately for studies in humans and studies in laboratory animals according to the groups listed below:

| WEIGHT OF EVIDENCE GROUP | DESCRIPTION |
|---|---|
| A | Human carcinogen |
| B1 | Probable human carcinogen based on limited human data |
| B2 | Probable human carcinogen based on sufficient evidence for carcinogenicity in animals and inadequate or no evidence of carcinogenicity in humans |
| C | Possible human carcinogen based on limited data for carcinogenicity in animals |
| D | Not classifiable as to human carcinogenicity |
| E | Evidence of non-carcinogenicity in humans |

Source: EPA(1986b)

The slope factors and accompanying weight-of-evidence classification for ingestion and inhalation exposures are presented in Table 4-1.

## 4.3 CHEMICALS WITHOUT EXISTING TOXICITY VALUES

*Chemicals without RfDs or RfCs*

Oral toxicity values are not available for some of the chemicals of concern at the Site, therefore, surrogate values using similar compounds were used for selected chemicals. For example, the oral RfDs for the non-carcinogenic PAHs evaluated were assumed to be equivalent to the oral RfD listed for naphthalene. Please see Table 4-1 for additional details.

*Chemicals without Slope Factors*

Inadequate ingestion and/or inhalation bioassay data exist for all Polycyclic Aromatic Hydrocarbons (PAHs) detected at the Chevron facilities except benzo[a]pyrene. Since benzo[a]pyrene has consistently been demonstrated to be one of the most potent carcinogenic PAHs, estimating cancer risks using a benzo[a]pyrene equivalency approach will greatly overestimate the carcinogenic potency of the other PAHs less potent than benzo[a]pyrene. However, USEPA Region IV has developed Toxicity Equivalence Factors (TEFs) that rank the carcinogenic potency of other PAHs relative to benzo[a]pyrene (EPA, 1992c). By multiplying the TEF of a particular PAH and the Slope Factor of benzo[a]pyrene, a Slope Factor for that PAH is obtained. The resultant product (a TEF-adjusted Slope Factor) is then used directly in the equations to estimate cancer risks. Table 4-2 presents the resultant TEF-based Slope Factors for each carcinogenic PAH.

## 4.4 LEAD TOXICITY

Lead has a wide variety of potential toxic effects which are both dose- and age-dependent (*i.e.*, children are substantially more susceptible to low-level exposures than are adults, and also absorb lead more readily from ingestion than adults). As set forth by OSWER directive 9355.4-02, EPA recommended an interim soil cleanup level of 500 to 1000 ppm total lead for CERCLA sites characterized as residential (EPA, August 29, 1991). The IU/BK model developed by the EPA to assess blood lead levels from exposure to lead in various media including soil is limited to children under seven years of age. Furthermore, there is no other EPA-approved methodology for computing blood lead levels in adults as is the case at the Chevron refinery. Therefore, it was assumed that soil lead levels up to 1,000 ppm would be protective of worker health, because worker exposures are expected to be less intensive than residential exposures, and adults are much less vulnerable to the toxic effects of lead than are children. SWMUs having soil lead concentrations above 1000 ppm were therefore identified as possibly requiring further action.

## 4.5 UNCERTAINTIES RELATED TO TOXICITY INFORMATION

Some of the uncertainties related to the risk assessment include:

- Assumption that cancer risks are linearly related to exposure (*i.e.*, that carcinogenic effects have no thresholds).

- Assumption that exposure variables, and toxicity constants formulated for lifetime cancer risks are applicable for less than lifetime (subchronic) exposures.

- Although EPA recommends the use of TEFs to rank the carcinogenic potency of PAHs relative to benzo(a)pyrene, it is not known if this rationale will tend to overestimate or underestimate risks. Additionally, PAHs may be contact carcinogens via the dermal route, however, no criteria or methodology is widely accepted by regulatory agencies to address this issue. It, therefore, is a source of uncertainty that may underestimate risk.

- Assumption that all chromium detected is Chromium III. This assumption was made since anthropogenic sources of soil-bound chromium are expected to be Cr III due to bioconversion, and when soil pH is greater than six (ATSDR, 1989). Therefore, it is not likely that chromium VI will contribute significantly to total soil chromium.

- A surrogate value was used for thallium. Most toxicity values are available only for water soluble thallium containing compounds. Of these, the most health-protective value (that of thallium sulfate) was selected.

- Health risks from cobalt and 1,2-dichloro-2-propanol were not estimated because action levels, health criteria, and surrogate values were not available.

**Table 4-1**
**Toxicity Criteria Used to Evaluate Chemicals in Soil at the Chevron Refinery, Philadelphia, Pennsylvania**

| Chemical | Non-carcinogenic Effects Chronic Reference Dose (RfD) | | Carcinogenic Effects Slope Factor (SF) | | | |
|---|---|---|---|---|---|---|
| | Oral (mg/kg/day) | Inhalation (mg/kg/day) | Oral (mg/kg/day)^-1 | Group* | Inhalation (mg/kg/day)^-1 | Group* |
| **Metals** | | | | | | |
| Beryllium | 0.005 | NA | 4.3 | B2 | NA | B2 |
| Chromium III | 1 | NA | -- | -- | NA | -- |
| Lead | (a) | NA | -- | B2 | NA | B2 |
| Thallium (b) | 0.00008 | NA | -- | -- | NA | -- |
| **PAHs** | | | | | | |
| 1-Methylnaphthalene (c) | 0.04 | NA | -- | D | NA | D |
| 2-Methylnaphthalene (c) | 0.04 | NA | -- | D | NA | D |
| Acenaphthalene (d) | 0.04 | NA | -- | D | NA | D |
| Benzo(a)Anthracene (e) | -- | NA | -- | B2 | NA | B2 |
| Benzo(a)Pyrene | -- | NA | 7.3 | B2 | NA | B2 |
| Benzo(b,j,k)Fluoranthene (e) | -- | NA | -- | B2 | NA | B2 |
| Dibenzo(a,h)Anthracene (e) | -- | NA | -- | B2 | NA | B2 |
| Dibenzofuran | 0.01 (f) | NA | -- | D | NA | D |
| Indeno(1,2,3-cd)Pyrene (e) | -- | NA | -- | B2 | NA | B2 |
| Pyrene | 0.03 | NA | -- | D | NA | D |
| **VOCs** | | | | | | |
| N-Propylbenzene (g) | 0.1 | 0.29 (h) | ND | D | ND | D |
| Xylenes (total) | 2 | 0.086 (i) | ND | D | ND | D |

**All data obtained from IRIS (November, 1992) unless otherwise noted.**

## Table 4-1 (continued)

* EPA rates chemical carcinogenicity on a weight-of-evidence classification system where:
Group B2 - Probable human carcinogen (based on sufficient evidence in animals)
Group D - Not classifiable as to human carcinogenicity

-- Data not available ND - Not Determined NA - Not Applicable

(a) EPA's RfD work group determined that it is inappropriate to develop a RfD for lead.
(b) Value listed is for Thallium Sulfate, obtained from HEAST (EPA, 1991b).
(c) Health criteria for Naphthalene (from HEAST, EPA, 1991b) were used as surrogates since data for this chemical were not available from IRIS or HEAST.
(d) Data inadequate for quantitative assessment of risk. Used health criteria for Naphthalene (from HEAST, EPA, 1991b) as surrogate.
(e) Carcinogenic health criteria for this chemical were not available from IRIS or HEAST. See Table 4-2 for surrogate values.
(f) Value obtained from HEAST (EPA, 1991b).
(g) Health criteria for Ethyl Benzene were used as surrogates since data for this chemical were not available from IRIS or HEAST.
(h) Value calculated from a reference concentration of 1.0 mg/m^3.
(i) Value calculated from a reference concentration of 0.3 mg/m^3 from HEAST (EPA, 1991b).

**Table 4-2**
**Toxicity Criteria Used to Evaluate Carcinogenic PAHs - based on Toxicity Equivalency Factors* (TEFs) - at the Chevron Refinery, Philadelphia, Pennsylvania**

| Carcinogenic PAH | TEF | Oral Slope Factor (SF) Benzo(a)Pyrene (mg/kg/day)^-1 | TEF-Based Oral Slope Factor (SF) (mg/kg/day)^-1 |
|---|---|---|---|
| Benzo(a)Anthracene | 0.1 | 7.3 | 0.73 |
| Benzo(b,j,k)Fluoranthene | 0.1 | 7.3 | 0.73 |
| Dibenzo(a,h)Anthracene | 1.0 | 7.3 | 7.3 |
| Indeno(1,2,3-cd)Pyrene | 0.1 | 7.3 | 0.73 |

* Rationale describing the TEF approach is listed in Section 4.3 of this assessment.

# 5.0 RISK CHARACTERIZATION

## 5.1 QUANTIFICATION OF HEALTH RISKS

This section describes the general procedures for applying the toxicity criteria presented in Section 4.0 to the intakes calculated using the methods presented in Section 3.0.

*Non-carcinogenic Risks*

The potential for chronic non-carcinogenic health effects for each chemical and pathway can be evaluated as the ratio of the ADD and the RfD; this ratio is referred to as the *Hazard Quotient*. The hazard quotient is calculated as:

$$Hazard\ Quotient = \frac{ADD}{RfD}$$

Hazard quotients less than one indicate that the predicted exposures are acceptable by the EPA.

*Carcinogenic Risks*

Carcinogenic risks are defined as the probability of an individual developing cancer as the result of a specific exposure to a given chemical. The cancer risk associated with a given chemical and pathway may be calculated as:

$$Risk = LADD \times SF$$

The carcinogenic risks evaluated in this document are reported as cumulative cancer risks. Cumulative cancer risks are the sum of the cancer risks associated with all chemicals and pathways at a particular SWMU.

## 5.2 RESULTS OF RISK CALCULATIONS

According to the Proposed Corrective Action Rule, if a hazardous constituent does not pass the initial screening procedure (in this report comparison with Action Levels), a site-specific assessment may verify the absence of risk. The results of the risk assessment indicate that:

- The cumulative cancer risk at all SWMUs ranges between $3 \times 10^{-6}$ and $1 \times 10^{-4}$. As mentioned previously, risks from hazardous constituents at a SWMU falling within this range may not require corrective action.

- For non-cancer health risks, the Hazard Index was less than one (indicating that adverse health effects are unlikely to occur) for all SWMUs evaluated.

- The chemical specific intakes and risks associated with dermal contact, soil ingestion, and vapor inhalation for each SWMU are presented in Tables 5-1, 5-2, and 5-3, respectively. The data presented in these tables were further summarized in Table 5-4 which lists the total intake and risks associated with each SWMU.

- Lead was detected in soils above the 1,000 ppm cleanup level at SWMUs 1, 6, and 30. These detected concentrations were 2260, 3760, and 2270 mg/kg (ppm) for SWMUs 1, 6, and 30, respectively.

- The hazard index for all chemicals without Action Levels was less than one (indicating that adverse health effects are unlikely to occur). The hazard quotient associated with dermal contact, soil ingestion, and vapor inhalation for each chemical is presented in Tables B-1, B-2, and B-3 (Attachment B), respectively. These data were further summarized in Table B-4 which presents the hazard index for each chemical.

Based on worker exposure to all hazardous constituents except lead, the results of this screening risk assessment indicate that further action with regard to soil may not be required at any SWMU evaluated at the Refinery as part of the Verification Investigation.

Table 5-1
TOTAL INTAKE AND RISKS FROM DERMAL CONTACT WITH SOIL FROM SELECTED SWMUs.
ON-SITE WORKER SCENARIO - CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA

| CHEMICAL | CONCENTRATION (mg/kg) | ADD (mg/kg/day) | RfD (mg/kg/day) | HAZARD QUOTIENT | LADD (mg/kg/day) | SF* (mg/kg/day)^-1 | CARCINOGENIC RISK |
|---|---|---|---|---|---|---|---|
| **Dermal Contact** | | | | | | | |
| **SWMU 01** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 1.1 | 5.27E-07 | 0.005 | 1.05E-04 | 1.88E-07 | 4.3 | 8.10E-07 |
| Chromium III | 2420 | 1.16E-03 | 1 | 1.16E-03 | 4.14E-04 | NA | NA |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 0.54 | 2.59E-07 | NA | NA | 9.25E-08 | 7.3 | 6.75E-07 |
| | | | **Hazard Index:** | **1 E-03** | | **Total Risk:** | **1 E-06** |
| **SWMU 06** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 2.1 | 1.01E-06 | 0.005 | 2.01E-04 | 3.60E-07 | 4.3 | 1.55E-06 |
| Chromium III | 1730 | 8.29E-04 | 1 | 8.29E-04 | 2.96E-04 | NA | NA |
| **PAHs** | | | | | | | |
| Benzo(a)Anthracene | 3.6 | 1.73E-06 | NA | NA | 6.16E-07 | 0.73 | 4.50E-07 |
| Benzo(a)Pyrene | 2.8 | 1.34E-06 | NA | NA | 4.79E-07 | 7.3 | 3.50E-06 |
| Benzo(b,j,k)Fluoranthene | 3.8 | 1.82E-06 | NA | NA | 6.51E-07 | 0.73 | 4.75E-07 |
| Dibenz(a,h)Anthracene | 0.7 | 3.36E-07 | NA | NA | 1.20E-07 | 7.3 | 8.75E-07 |
| | | | **Hazard Index:** | **1 E-03** | | **Total Risk:** | **7 E-06** |
| **SWMU 09** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 0.77 | 3.69E-07 | 0.005 | 7.38E-05 | 1.32E-07 | 4.3 | 5.67E-07 |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 2.2 | 1.05E-06 | NA | NA | 3.77E-07 | 7.3 | 2.75E-06 |
| | | | **Hazard Index:** | **<0.001** | | **Total Risk:** | **3 E-06** |

Table 5-1
TOTAL INTAKE AND RISKS FROM DERMAL CONTACT WITH SOIL FROM SELECTED SWMUs.
ON-SITE WORKER SCENARIO - CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA

| CHEMICAL | CONCENTRATION (mg/kg) | ADD (mg/kg/day) | RfD (mg/kg/day) | HAZARD QUOTIENT | LADD (mg/kg/day) | SF* (mg/kg/day)^-1 | CARCINOGENIC RISK |
|---|---|---|---|---|---|---|---|
| **Dermal Contact** | | | | | | | |
| **SWMU 11** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 2.6 | 1.25E-06 | 0.005 | 2.49E-04 | 4.45E-07 | 4.3 | 1.91E-06 |
| Chromium III | 946 | 4.54E-04 | 1 | 4.54E-04 | 1.62E-04 | NA | NA |
| **PAHs** | | | | | | | |
| Benzo(a)Anthracene | 37 | 1.77E-05 | NA | NA | 6.34E-06 | 0.73 | 4.63E-06 |
| Benzo(a)Pyrene | 36 | 1.73E-05 | NA | NA | 6.16E-06 | 7.3 | 4.50E-05 |
| Benzo(b,j,k)Fluoranthene | 81 | 3.88E-05 | NA | NA | 1.39E-05 | 0.73 | 1.01E-05 |
| Indeno(1,2,3-cd)Pyrene | 8.4 | 4.03E-06 | NA | NA | 1.44E-06 | 0.73 | 1.05E-06 |
| Pyrene | 90 | 4.32E-05 | 0.03 | 1.44E-03 | 1.54E-05 | NA | NA |
| | | | **Hazard Index:** | **2 E-03** | | **Total Risk:** | **6 E-05** |
| **SWMU 13** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 1.4 | 6.71E-07 | 0.005 | 1.34E-04 | 2.40E-07 | 4.3 | 1.03E-06 |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 1.6 | 7.67E-07 | NA | NA | 2.74E-07 | 7.3 | 2.00E-06 |
| | | | **Hazard Index:** | **<0.001** | | **Total Risk:** | **3 E-06** |

**Table 5-1**
**TOTAL INTAKE AND RISKS FROM DERMAL CONTACT WITH SOIL FROM SELECTED SWMUs.**
**ON-SITE WORKER SCENARIO - CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA**

| CHEMICAL | CONCENTRATION (mg/kg) | ADD (mg/kg/day) | RfD (mg/kg/day) | HAZARD QUOTIENT | LADD (mg/kg/day) | SF* (mg/kg/day)^-1 | CARCINOGENIC RISK |
|---|---|---|---|---|---|---|---|
| **Dermal Contact** | | | | | | | |
| **SWMU 16** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 2.3 | 1.10E-06 | 0.005 | 2.21E-04 | 3.94E-07 | 4.3 | 1.69E-06 |
| Chromium III | 654 | 3.14E-04 | 1 | 3.14E-04 | 1.12E-04 | NA | NA |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 1.4 | 6.71E-07 | NA | NA | 2.40E-07 | 7.3 | 1.75E-06 |
| Pyrene | 6.6 | 3.16E-06 | 0.03 | 1.05E-04 | 1.13E-06 | NA | NA |
| | | | **Hazard Index:** | **<0.001** | | **Total Risk:** | **3 E-06** |
| **SWMU17** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 2.5 | 1.20E-06 | 0.005 | 2.40E-04 | 4.28E-07 | 4.3 | 1.84E-06 |
| Chromium III | 2220 | 1.06E-03 | 1 | 1.06E-03 | 3.80E-04 | | |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 1.1 | 5.27E-07 | | | 1.88E-07 | 7.3 | 1.38E-06 |
| | | | **Hazard Index:** | **1 E-03** | | **Total Risk:** | **3 E-06** |
| **SWMU 29** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 1.1 | 5.27E-07 | 0.005 | 1.05E-04 | 1.88E-07 | 4.3 | 8.10E-07 |
| Chromium III | 2420 | 1.16E-03 | 1 | 1.16E-03 | 4.14E-04 | NA | NA |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 0.54 | 2.59E-07 | NA | NA | 9.25E-08 | 7.3 | 6.75E-07 |
| | | | **Hazard Index:** | **1 E-03** | | **Total Risk:** | **1 E-06** |

Table 5-1
TOTAL INTAKE AND RISKS FROM DERMAL CONTACT WITH SOIL FROM SELECTED SWMUs.
ON-SITE WORKER SCENARIO - CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA

| CHEMICAL | CONCENTRATION (mg/kg) | ADD (mg/kg/day) | RfD (mg/kg/day) | HAZARD QUOTIENT | LADD (mg/kg/day) | SF* (mg/kg/day)^-1 | CARCINOGENIC RISK |
|---|---|---|---|---|---|---|---|
| **Dermal Contact** | | | | | | | |
| **SWMU 30** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 1.3 | 6.23E-07 | 0.005 | 1.25E-04 | 2.23E-07 | 4.3 | 9.57E-07 |
| Chromium III | 3450 | 1.65E-03 | 1 | 1.65E-03 | 5.91E-04 | NA | NA |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 3.1 | 1.49E-06 | NA | NA | 5.31E-07 | 7.3 | 3.88E-06 |
| | | | **Hazard Index:** | **2 E-03** | | **Total Risk:** | **5 E-06** |
| **SWMU 45** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 1 | 4.79E-07 | 0.005 | 9.59E-05 | 1.71E-07 | 4.3 | 7.36E-07 |
| Chromium III | 1420 | 6.81E-04 | 1 | 6.81E-04 | 2.43E-04 | | |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 1.9 | 9.11E-07 | | | 3.25E-07 | 7.3 | 2.38E-06 |
| Dibenz(a,h)Anthracene | 0.57 | 2.73E-07 | | | 9.76E-08 | 7.3 | 7.13E-07 |
| | | | **Hazard Index:** | **<0.001** | | **Total Risk:** | **4 E-06** |
| **SWMU 71** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 1.4 | 6.71E-07 | 0.005 | 1.34E-04 | 2.40E-07 | 4.3 | 1.03E-06 |
| Chromium III | 753 | 3.61E-04 | 1 | 3.61E-04 | 1.29E-04 | NA | NA |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 1.9 | 9.11E-07 | NA | NA | 3.25E-07 | 7.3 | 2.38E-06 |
| | | | **Hazard Index:** | **<0.001** | | **Total Risk:** | **3 E-06** |

**Table 5-1**
**TOTAL INTAKE AND RISKS FROM DERMAL CONTACT WITH SOIL FROM SELECTED SWMUs.**
**ON-SITE WORKER SCENARIO - CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA**

| CHEMICAL | CONCENTRATION (mg/kg) | ADD (mg/kg/day) | RfD (mg/kg/day) | HAZARD QUOTIENT | LADD (mg/kg/day) | SF* (mg/kg/day)^-1 | CARCINOGENIC RISK |
|---|---|---|---|---|---|---|---|
| **Dermal Contact** | | | | | | | |
| **SWMU 71A** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 2.2 | 1.05E-06 | 0.005 | 2.11E-04 | 3.77E-07 | 4.3 | 1.62E-06 |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 1.6 | 7.67E-07 | NA | NA | 2.74E-07 | 7.3 | 2.00E-06 |
| | | | **Hazard Index:** | **<0.001** | | **Total Risk:** | **4 E-06** |
| **SWMU 79** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 1.6 | 7.67E-07 | 0.005 | 1.53E-04 | 2.74E-07 | 4.3 | 1.18E-06 |
| Chromium III | 420 | 2.01E-04 | 1 | 2.01E-04 | 7.19E-05 | NA | NA |
| **PAHs** | | | | | | | |
| Benzo(a)Anthracene | 4 | 1.92E-06 | NA | NA | 6.85E-07 | 0.73 | 5.00E-07 |
| Benzo(a)Pyrene | 2.9 | 1.39E-06 | NA | NA | 4.97E-07 | 7.3 | 3.63E-06 |
| Dibenz(a,h)Anthracene | 0.85 | 4.08E-07 | NA | NA | 1.46E-07 | 7.3 | 1.06E-06 |
| Pyrene | 8.7 | 4.17E-06 | 0.03 | 1.39E-04 | 1.49E-06 | NA | NA |
| | | | **Hazard Index:** | **<0.001** | | **Total Risk:** | **6 E-06** |

ADD = Average Daily Dose
RfD = Reference Dose
Hazard Quotient = ADD / RfD

LADD = Lifetime Average Daily Dose
SF = Carcinogenic Slope Factor
RISK = LADD x SF

1E-6 = 1/1,000,000

* SF for a particular PAHs is the product of the actual SF for B[a]P and the TEF corresponding to that PAH

Table 5-2
TOTAL INTAKE AND RISKS FROM INGESTION OF SOIL FROM SELECTED SWMUs.
ON-SITE WORKER SCENARIO - CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA

| CHEMICAL | CONCENTRATION (mg/kg) | ADD (mg/kg/day) | RfD (mg/kg/day) | HAZARD QUOTIENT | LADD (mg/kg/day) | SF* (mg/kg/day)^-1 | CARCINOGENIC RISK |
|---|---|---|---|---|---|---|---|
| **Soil Ingestion** | | | | | | | |
| **SWMU 01** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 1.1 | 5.27E-07 | 0.005 | 1.05E-04 | 1.88E-07 | 4.3 | 8.10E-07 |
| Chromium III | 2420 | 1.16E-03 | 1 | 1.16E-03 | 4.14E-04 | NA | NA |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 0.54 | 2.59E-07 | NA | NA | 9.25E-08 | 7.3 | 6.75E-07 |
| | | | **Hazard Index:** | **1 E-03** | | **Total Risk:** | **1 E-06** |
| **SWMU 06** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 2.1 | 1.01E-06 | 0.005 | 2.01E-04 | 3.60E-07 | 4.3 | 1.55E-06 |
| Chromium III | 1730 | 8.29E-04 | 1 | 8.29E-04 | 2.96E-04 | NA | NA |
| **PAHs** | | | | | | | |
| Benzo(a)Anthracene | 3.6 | 1.73E-06 | NA | NA | 6.16E-07 | 0.73 | 4.50E-07 |
| Benzo(a)Pyrene | 2.8 | 1.34E-06 | NA | NA | 4.79E-07 | 7.3 | 3.50E-06 |
| Benzo(b,j,k)Fluoranthene | 3.8 | 1.82E-06 | NA | NA | 6.51E-07 | 0.73 | 4.75E-07 |
| Dibenz(a,h)Anthracene | 0.7 | 3.36E-07 | NA | NA | 1.20E-07 | 7.3 | 8.75E-07 |
| | | | **Hazard Index:** | **1 E-03** | | **Total Risk:** | **7 E-06** |
| **SWMU 09** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 0.77 | 3.69E-07 | 0.005 | 7.38E-05 | 1.32E-07 | 4.3 | 5.67E-07 |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 2.2 | 1.05E-06 | NA | NA | 3.77E-07 | 7.3 | 2.75E-06 |
| | | | **Hazard Index:** | **<0.001** | | **Total Risk:** | **3 E-06** |

Table 5-2
TOTAL INTAKE AND RISKS FROM INGESTION OF SOIL FROM SELECTED SWMUs.
ON-SITE WORKER SCENARIO - CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA

| CHEMICAL | CONCENTRATION (mg/kg) | ADD (mg/kg/day) | RfD (mg/kg/day) | HAZARD QUOTIENT | LADD (mg/kg/day) | SF* (mg/kg/day)$^{-1}$ | CARCINOGENIC RISK |
|---|---|---|---|---|---|---|---|
| **Soil Ingestion** | | | | | | | |
| **SWMU 11** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 2.6 | 1.25E-06 | 0.005 | 2.49E-04 | 4.45E-07 | 4.3 | 1.91E-06 |
| Chromium III | 946 | 4.54E-04 | 1 | 4.54E-04 | 1.62E-04 | NA | NA |
| **PAHs** | | | | | | | |
| Benzo(a)Anthracene | 37 | 1.77E-05 | NA | NA | 6.34E-06 | 0.73 | 4.63E-06 |
| Benzo(a)Pyrene | 36 | 1.73E-05 | NA | NA | 6.16E-06 | 7.3 | 4.50E-05 |
| Benzo(b,j,k)Fluoranthene | 81 | 3.88E-05 | NA | NA | 1.39E-05 | 0.73 | 1.01E-05 |
| Indeno(1,2,3-cd)Pyrene | 8.4 | 4.03E-06 | NA | NA | 1.44E-06 | 0.73 | 1.05E-06 |
| Pyrene | 90 | 4.32E-05 | 0.03 | 1.44E-03 | 1.54E-05 | NA | NA |
| | | | **Hazard Index:** | **2 E-03** | | **Total Risk:** | **6 E-05** |
| **SWMU 13** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 1.4 | 6.71E-07 | 0.005 | 1.34E-04 | 2.40E-07 | 4.3 | 1.03E-06 |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 1.6 | 7.67E-07 | NA | NA | 2.74E-07 | 7.3 | 2.00E-06 |
| | | | **Hazard Index:** | **<0.001** | | **Total Risk:** | **3 E-06** |

Table 5-2
TOTAL INTAKE AND RISKS FROM INGESTION OF SOIL FROM SELECTED SWMUs.
ON-SITE WORKER SCENARIO - CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA

| CHEMICAL | CONCENTRATION (mg/kg) | ADD (mg/kg/day) | RfD (mg/kg/day) | HAZARD QUOTIENT | LADD (mg/kg/day) | SF* (mg/kg/day)^-1 | CARCINOGENIC RISK |
|---|---|---|---|---|---|---|---|
| **Soil Ingestion** | | | | | | | |
| **SWMU 16** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 2.3 | 1.10E-06 | 0.005 | 2.21E-04 | 3.94E-07 | 4.3 | 1.69E-06 |
| Chromium III | 654 | 3.14E-04 | 1 | 3.14E-04 | 1.12E-04 | NA | NA |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 1.4 | 6.71E-07 | NA | NA | 2.40E-07 | 7.3 | 1.75E-06 |
| Pyrene | 6.6 | 3.16E-06 | 0.03 | 1.05E-04 | 1.13E-06 | NA | NA |
| | | | **Hazard Index:** | **<0.001** | | **Total Risk:** | **3 E-06** |
| **SWMU17** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 2.5 | 1.20E-06 | 0.005 | 2.40E-04 | 4.28E-07 | 4.3 | 1.84E-06 |
| Chromium III | 2220 | 1.06E-03 | 1 | 1.06E-03 | 3.80E-04 | | |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 1.1 | 5.27E-07 | | | 1.88E-07 | 7.3 | 1.38E-06 |
| | | | **Hazard Index:** | **1 E-03** | | **Total Risk:** | **3 E-06** |
| **SWMU 29** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 1.1 | 5.27E-07 | 0.005 | 1.05E-04 | 1.88E-07 | 4.3 | 8.10E-07 |
| Chromium III | 2420 | 1.16E-03 | 1 | 1.16E-03 | 4.14E-04 | NA | NA |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 0.54 | 2.59E-07 | NA | NA | 9.25E-08 | 7.3 | 6.75E-07 |
| | | | **Hazard Index:** | **1 E-03** | | **Total Risk:** | **1 E-06** |

Table 5-2
TOTAL INTAKE AND RISKS FROM INGESTION OF SOIL FROM SELECTED SWMUs.
ON-SITE WORKER SCENARIO - CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA

| CHEMICAL | CONCENTRATION (mg/kg) | ADD (mg/kg/day) | RfD (mg/kg/day) | HAZARD QUOTIENT | LADD (mg/kg/day) | SF* (mg/kg/day)^-1 | CARCINOGENIC RISK |
|---|---|---|---|---|---|---|---|
| **Soil Ingestion** | | | | | | | |
| **SWMU 30** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 1.3 | 6.23E-07 | 0.005 | 1.25E-04 | 2.23E-07 | 4.3 | 9.57E-07 |
| Chromium III | 3450 | 1.65E-03 | 1 | 1.65E-03 | 5.91E-04 | NA | NA |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 3.1 | 1.49E-06 | NA | NA | 5.31E-07 | 7.3 | 3.88E-06 |
| | | | **Hazard Index:** | **2 E-03** | | **Total Risk:** | **5 E-06** |
| **SWMU 45** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 1 | 4.79E-07 | 0.005 | 9.59E-05 | 1.71E-07 | 4.3 | 7.36E-07 |
| Chromium III | 1420 | 6.81E-04 | 1 | 6.81E-04 | 2.43E-04 | | |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 1.9 | 9.11E-07 | | | 3.25E-07 | 7.3 | 2.38E-06 |
| Dibenz(a,h)Anthracene | 0.57 | 2.73E-07 | | | 9.76E-08 | 7.3 | 7.13E-07 |
| | | | | 0.000776712 | | | |
| | | | **Hazard Index:** | **<0.001** | | **Total Risk:** | **4 E-06** |
| **SWMU 71** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 1.4 | 6.71E-07 | 0.005 | 1.34E-04 | 2.40E-07 | 4.3 | 1.03E-06 |
| Chromium III | 753 | 3.61E-04 | 1 | 3.61E-04 | 1.29E-04 | NA | NA |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 1.9 | 9.11E-07 | NA | NA | 3.25E-07 | 7.3 | 2.38E-06 |
| | | | **Hazard Index:** | **<0.001** | | **Total Risk:** | **3 E-06** |

Table 5-2
**TOTAL INTAKE AND RISKS FROM INGESTION OF SOIL FROM SELECTED SWMUs.**
**ON-SITE WORKER SCENARIO - CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA**

| CHEMICAL | CONCENTRATION (mg/kg) | ADD (mg/kg/day) | RfD (mg/kg/day) | HAZARD QUOTIENT | LADD (mg/kg/day) | SF* (mg/kg/day)^-1 | CARCINOGENIC RISK |
|---|---|---|---|---|---|---|---|
| **Soil Ingestion** | | | | | | | |
| **SWMU 71A** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 2.2 | 1.05E-06 | 0.005 | 2.11E-04 | 3.77E-07 | 4.3 | 1.62E-06 |
| **PAHs** | | | | | | | |
| Benzo(a)Pyrene | 1.6 | 7.67E-07 | NA | NA | 2.74E-07 | 7.3 | 2.00E-06 |
| | | | **Hazard Index:** | **<0.001** | | **Total Risk:** | **4 E-06** |
| **SWMU 79** | | | | | | | |
| **METALS** | | | | | | | |
| Beryllium | 1.6 | 7.67E-07 | 0.005 | 1.53E-04 | 2.74E-07 | 4.3 | 1.18E-06 |
| Chromium III | 420 | 2.01E-04 | 1 | 2.01E-04 | 7.19E-05 | NA | NA |
| **PAHs** | | | | | | | |
| Benzo(a)Anthracene | 4 | 1.92E-06 | NA | NA | 6.85E-07 | 0.73 | 5.00E-07 |
| Benzo(a)Pyrene | 2.9 | 1.39E-06 | NA | NA | 4.97E-07 | 7.3 | 3.63E-06 |
| Dibenz(a,h)Anthracene | 0.85 | 4.08E-07 | NA | NA | 1.46E-07 | 7.3 | 1.06E-06 |
| Pyrene | 8.7 | 4.17E-06 | 0.03 | 1.39E-04 | 1.49E-06 | NA | NA |
| | | | | 0.000493836 | | | |
| | | | **Hazard Index:** | **<0.001** | | **Total Risk:** | **6 E-06** |

ADD = Average Daily Dose
RfD = Reference Dose
Hazard Quotient = ADD / RfD

LADD = Lifetime Average Daily Dose
SF = Carcinogenic Slope Factor
RISK = LADD x SF

1E-6 = 1/1,000,000

* SF for a particular PAH is the product of the actual SF for B[a]P and the TEF corresponding to that PAH

**Table 5-3**
**TOTAL INTAKE AND RISKS FROM VAPOR INHALATION (OUTDOOR) IN THE ON-SITE WORKER SCENARIO - CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA**

| CHEMICAL | CONCENTRATION (mg/m^3) | ADD (mg/kg/day) | RfD (mg/kg/day) | HAZARD QUOTIENT | LADD (mg/kg/day) | SF (mg/kg/day)^-1 | CARCINOGENIC RISK |
|---|---|---|---|---|---|---|---|
| **Vapor Inhalation (Outdoor)** | | | | | | | |
| **SMWU 11** | | | | | | | |
| Xylenes (total) | 2.27E-06 | 4.35E-07 | 0.086 | 5.06E-06 | 1.56E-07 | NA | NA |
| | | | **Hazard Index:** | **<0.001** | | **Total Risk:** | **NA** |
| **SWMU 29** | | | | | | | |
| Xylenes (total) | 2.44E-06 | 4.69E-07 | 0.086 | 5.45E-06 | 1.67E-07 | NA | NA |
| | | | **Hazard Index:** | **<0.001** | | **Total Risk:** | **NA** |

ADD = Average Daily Dose
RfD = Reference Dose
Hazard Quotient = ADD / RfD

LADD = Lifetime Average Daily Dose
SF = Carcinogenic Slope Factor
RISK = LADD x SF

NA = Not Applicable, no criteria.
1E-6 = 1/1,000,000

**Table 5-4**
**Summary of Total Intakes and Risks for All SWMUs Evaluated at the Chevron Refinery, Philadelphia, Pennsylvania**

| EXPOSURE SITE | PATHWAY | HAZARD INDEX | CARCINOGENIC RISK |
|---|---|---|---|
| **SWMU 01** | Dermal Contact | 0.001 | 1 E-06 |
| | Soil Ingestion | 0.001 | 1 E-06 |
| | **Total:** | **0.003** | **3 E-06** |
| **SWMU 06** | Dermal Contact | 0.001 | 7 E-06 |
| | Soil Ingestion | 0.001 | 7 E-06 |
| | **Total:** | **0.002** | **1 E-05** |
| **SWMU 09** | Dermal Contact | 0.00007 | 3 E-06 |
| | Soil Ingestion | 0.00007 | 3 E-06 |
| | **Total:** | **<0.001** | **7 E-06** |
| **SWMU 11** | Dermal Contact | 0.002 | 6 E-05 |
| | Soil Ingestion | 0.002 | 6 E-05 |
| | Vapor Inhalation | 0.000005 | NA |
| | **Total:** | **4 E-03** | **1 E-04** |
| **SWMU 13** | Dermal Contact | 0.0001 | 3 E-06 |
| | Soil Ingestion | 0.0001 | 3 E-06 |
| | **Total:** | **<0.001** | **6 E-06** |
| **SWMU 16** | Dermal Contact | 0.0006 | 3 E-06 |
| | Soil Ingestion | 0.0006 | 3 E-06 |
| | **Total:** | **1 E-03** | **7 E-06** |
| **SWMU17** | Dermal Contact | 0.001 | 3 E-06 |
| | Soil Ingestion | 0.001 | 3 E-06 |
| | **Total:** | **3 E-03** | **6 E-06** |

**Table 5-4**
**Summary of Total Intakes and Risks for All SWMUs Evaluated at the Chevron Refinery, Philadelphia, Pennsylvania**

| EXPOSURE SITE | PATHWAY | HAZARD INDEX | CARCINOGENIC RISK |
|---|---|---|---|
| **SWMU 29** | Dermal Contact | 0.001 | 1 E-06 |
| | Soil Ingestion | 0.001 | 1 E-06 |
| | Vapor Inhalation | 0.000005 | NA |
| | **Total:** | **3 E-03** | **3 E-06** |
| **SWMU 30** | Dermal Contact | 0.002 | 5 E-06 |
| | Soil Ingestion | 0.002 | 5 E-06 |
| | **Total:** | **4 E-03** | **1 E-05** |
| **SWMU 45** | Dermal Contact | 0.0008 | 4 E-06 |
| | Soil Ingestion | 0.0008 | 4 E-06 |
| | **Total:** | **2 E-03** | **8 E-06** |
| **SWMU 71** | Dermal Contact | 0.0005 | 3 E-06 |
| | Soil Ingestion | 0.0005 | 3 E-06 |
| | **Total:** | **<0.001** | **7 E-06** |
| **SWMU 71A** | Dermal Contact | 0.0002 | 4 E-06 |
| | Soil Ingestion | 0.0002 | 4 E-06 |
| | **Total:** | **<0.001** | **7 E-06** |
| **SWMU 79** | Dermal Contact | 0.0005 | 6 E-06 |
| | Soil Ingestion | 0.0005 | 6 E-06 |
| | **Total:** | **<0.001** | **1 E-05** |

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AAW02F8A

# ATTACHMENT A

# AIR MODELING CALCULATION SPREADSHEETS

***VOC EMISSIONS MODEL USING SOIL, SOIL GAS, & GROUNDWATER SAMPLES. MODEL ESTIMATES CHEMICAL CONCENTRATIONS IN AIR USING BOTH THE "BOX MODEL" & INDOOR AIR APPROACH.***

**PREPARED BY:** *DAMES & MOORE*
*TOXICOLOGY AND RISK ASSESSMENT GROUP*
*SACRAMENTO, CALIFORNIA*

**VERSION NO.:** VEM_01.XLS **LAST REVISED:** 6-Oct-92

This multi-media model for estimating VOC emissions is based on Farmer's covered landfill emissions model presented in "Land Disposal of Hexachlorobenzene Wastes: Controlling Vapor Movement in Soil." EPA 600/2-80/119 (1980). The "box model" is based on the model presented in "Development of Advisory Levels for Polychlorinated Biphenyls (PCBs) Cleanup" EPA/600/6-86/002 (1986).

## PROJECT INFORMATION

| | |
|---|---|
| ***PROJECT:*** | Screening Risk Assessment for the Chevron Refinery, Philadelphia, Pennsylvania |
| ***PROJECT FILENAME:*** | CHEV_V11.XLS |
| ***SITE/STUDY AREA:*** | SWMU 11 |
| ***SCENARIO:*** | Calculation of Xylene emissions from SWMU 11 |

***NOTES:***

## MODEL PARAMETERS

| Description | Parameter | Value | Units | Notes/Source |
|---|---|---|---|---|
| ***Emissions model parameters*** | | | | |
| Soil moisture | W | 0.25 | unitless | |
| Bulk density | p | 0 | g/cm^3 | |
| Particle density | d | 0 | g/cm^3 | |
| Fraction of soil organic matter | foc | 0 | unitless | |
| Total soil porosity | PT | 0.43 | unitless | Can be calculated from 1-(p/d) |
| Air-filled porosity | PA | 0.18 | unitless | Can be calculated from PT-W |
| ***Box model parameters*** | | | | |
| Surface area | A | 1858 | m^2 | |
| Box height | Hb | 2 | m | |
| Windspeed within mixing zone | V | 2.13 | m/s | |
| Width of area | L | 43.10 | m | |
| ***Indoor air model parameters*** | | | | |
| Building ventilation rate | Vn | 0.000 | m^3/s | ASHRAE std. for general living areas |
| Surface area of building | | 0 | m^2 | |
| Leakage area of building | | 0 | m^2/m^2 | Ranges from 1-10cm2/m2 (Grimsrud et al, 1983) |
| Emission area of building | Ab | 0 | m^2 | Based on product of the two previous entries. |
| ***Miscellaneous parameters*** | | | | |
| Ideal gas constant | R | 8.21E-05 | atm m^3/mol K | Universal constant. |
| Temperature | T | 283 | K | Site specific assumption. |

**CHEMDATA**

| Chemical | Diffusion Coefficient D (cm^2/s) | Molecular Weight MW (g/mol) | Koc (mL/g) | Kd (m^3/kg) | Henry's Law Constant H (atm m^3/mol) |
|---|---|---|---|---|---|
| Xylenes (total) | 0.06742 | 106 | 0 | 0 | 0.00709 |

**Kd was calculated as follows: Kd = Koc x foc x (10^-6 m^3/mL) x (10^3 g/kg)**

## CHEMICAL CONCENTRATIONS

| Chemical | Soil Concentration Cs (mg/kg) | Sample Depth La (m) | Groundwater Concentration Cw (mg/L) | Sample Depth Lw (m) | Soil Gas Concentration Cr (ug/L) | Sample Depth Lr (m) |
|---|---|---|---|---|---|---|
| Xylenes (total) | -- | -- | -- | -- | 2.28 | 1.22 |

-- Not applicable

## SOIL VAPOR CALCULATIONS

| Chemical | Soil Vapor Concentration (Cv) Estimated From | | |
|---|---|---|---|
| | Soil Samples Cv (mg/m^3) | Groundwater Samples Cv (mg/m^3) | Soil Gas Cv (mg/m^3) |
| Xylenes (total) | -- | -- | 2.28 |

-- Not Applicable

**Cv calculated from the following equations:**

SOIL: Cv = Cs x H/(Kd x R x T)

GROUNDWATER: P = Cw x H/MW x (10^-3 g/mg) x (10^3 L/m^3) ; and Cv = P x MW/(R x T) x (10^3 mg/g)

SOIL VAPOR: Cv x (10^3 L/m^3 ) x (10^-3 mg/ug)

**EMISSION RATE**

| Chemical | Emission Rate (Q) | | | Selected (a) Emissions Rate Q (mg/m^2/s) |
|---|---|---|---|---|
| | Soil Q (mg/m^2/s) | Groundwater Q (mg/m^2/s) | Soil Gas Q (mg/m^2/s) | |
| Xylenes (total) | -- | -- | 2.24E-07 | 2.24E-07 |

-- Not applicable if soil vapor samples available

(a) Emission rates based on soil gas samples were used in preference to soil or groundwater samples. If soil gas estimates were not available, the sum of soil and groundwater emission rates were used.

Q was calculated from the following equation:

Q = D x (Pa^(10/3)/Pt^2) (Cv/L) x (10^-4 m^2/cm^2)

## ESTIMATED CONCENTRATIONS IN OUTDOOR AIR (THE "BOX MODEL")

| Chemical | Emission Rate Q (mg/m^2/s) | Concentrations in Air (Ca) | |
|---|---|---|---|
| | | Box Model Ca (mg/m^3) | Indoor Air Model Ca (mg/m^3) |
| Xylenes (total) | 2.24E-07 | 2.27E-06 | NA |

NA = Not applicable

Ca calculated from the following equation:

(Box Model) $Ca = Q \times A/(L \times V \times H)$

(Indoor Air) $Ca = Q \times Ab/Vn$

***VOC EMISSIONS MODEL USING SOIL, SOIL GAS, & GROUNDWATER SAMPLES. MODEL ESTIMATES CHEMICAL CONCENTRATIONS IN AIR USING BOTH THE "BOX MODEL" & INDOOR AIR APPROACH.***

**PREPARED BY:** *DAMES & MOORE*
*TOXICOLOGY AND RISK ASSESSMENT GROUP*
*SACRAMENTO, CALIFORNIA*

**VERSION NO.:** VEM_01.XLS **LAST REVISED:** 6-Oct-92

This multi-media model for estimating VOC emissions is based on Farmer's covered landfill emissions model presented in "Land Disposal of Hexachlorobenzene Wastes: Controlling Vapor Movement in Soil." EPA 600/2-80/119 (1980). The "box model" is based on the model presented in "Development of Advisory Levels for Polychlorinated Biphenyls (PCBs) Cleanup" EPA/600/6-86/002 (1986).

## PROJECT INFORMATION

| | |
|---|---|
| ***PROJECT:*** | Screening Risk Assessment for the Chevron Refinery, Philadelphia, Pennsylvania |
| ***PROJECT FILENAME:*** | CHEV_V29.XLS |
| ***SITE/STUDY AREA:*** | SWMU 29 |
| ***SCENARIO:*** | Calculation of Xylene emissions from SWMU 29 |

***NOTES:***

## MODEL PARAMETERS

| Description | Parameter | Value | Units | Notes/Source |
|---|---|---|---|---|
| ***Emissions model parameters*** | | | | |
| Soil moisture | W | 0.25 | unitless | |
| Bulk density | p | 0 | g/cm^3 | |
| Particle density | d | 0 | g/cm^3 | |
| Fraction of soil organic matter | foc | 0 | unitless | |
| Total soil porosity | PT | 0.43 | unitless | Can be calculated from 1-(p/d) |
| Air-filled porosity | PA | 0.18 | unitless | Can be calculated from PT-W |
| ***Box model parameters*** | | | | |
| Surface area | A | 929 | m^2 | |
| Box height | Hb | 2 | m | |
| Windspeed within mixing zone | V | 2.13 | m/s | |
| Width of area | L | 30.48 | m | |
| ***Indoor air model parameters*** | | | | |
| Building ventilation rate | Vn | 0.000 | m^3/s | ASHRAE std. for general living areas |
| Surface area of building | | 0 | m^2 | |
| Leakage area of building | | 0.0001 | m^2/m^2 | Ranges from 1-10cm2/m2 (Grimsrud et al, 1983) |
| Emission area of building | Ab | 0 | m^2 | Based on product of the two previous entries. |
| ***Miscellaneous parameters*** | | | | |
| Ideal gas constant | R | 8.21E-05 | atm m^3/mol K | Universal constant. |
| Temperature | T | 283 | K | Site specific assumption. |

**CHEMDATA**

| Chemical | Diffusion Coefficient D (cm^2/s) | Molecular Weight MW (g/mol) | Koc (mL/g) | Kd (m^3/kg) | Henry's Law Constant H (atm m^3/mol) |
|---|---|---|---|---|---|
| Xylenes (total) | 0.06742 | 106 | 0 | 0 | 0.00709 |

**Kd was calculated as follows: Kd = Koc x foc x (10^-6 m^3/mL) x (10^3 g/kg)**

## CHEMICAL CONCENTRATIONS

| Chemical | Soil Concentration Cs (mg/kg) | Sample Depth Ls (m) | Groundwater Concentration Cw (mg/L) | Sample Depth Lw (m) | Soil Gas Concentration Cv (ug/L) | Sample Depth Lv (m) |
|---|---|---|---|---|---|---|
| Xylenes (total) | -- | -- | -- | -- | 2.6 | 0.914 |

-- Not applicable

## SOIL VAPOR CALCULATIONS

| Chemical | Soil Vapor Concentration (Cv) Estimated From | | |
|---|---|---|---|
| | Soil Samples Cv (mg/m^3) | Groundwater Samples Cv (mg/m^3) | Soil Gas Cv (mg/m^3) |
| Xylenes (total) | -- | -- | 2.60 |

-- Not Applicable

**Cv calculated from the following equations:**

SOIL: Cv = Cs x H/(Kd x R x T)

GROUNDWATER: P = Cw x H/MW x (10^-3 g/mg) x (10^3 L/m^3) ; and Cv = P x MW/(R x T) x (10^3 mg/g)

SOIL VAPOR: Cv x (10^3 L/m^3 ) x (10^-3 mg/ug)

**EMISSION RATE**

| Chemical | Emission Rate (Q) | | | Selected (a) Emissions Rate |
|---|---|---|---|---|
| | Soil Q (ug/m^2/s) | Groundwater Q (mg/m^2/s) | Soil Gas Q (mg/m^2/s) | Q (mg/m^2/s) |
| Xylenes (total) | -- | -- | 3.42E-07 | 3.42E-07 |

-- Not applicable if soil vapor samples available

(a) Emission rates based on soil gas samples were used in preference to soil or groundwater samples. If soil gas estimates were not available, the sum of soil and groundwater emission rates were used.

Q was calculated from the following equation:

Q = D x (Pa^(10/3)/Pt^2) (Cv/L) x (10^-4 m^2/cm^2)

## ESTIMATED CONCENTRATIONS IN OUTDOOR AIR (THE "BOX MODEL")

| Chemical | Emission Rate Q (mg/m^2/s) | Concentrations in Air (Ca) | |
|---|---|---|---|
| | | Box Model Ca (mg/m^3) | Indoor Air Model Ca (mg/m^3) |
| Xylenes (total) | 3.42E-07 | 2.44E-06 | NA |

**NA = Not applicable**

**Ca calculated from the following equation:**

**(Box Model)** $Ca = Q \times A/(L \times V \times H)$

**(Indoor Air)** $Ca = Q \times Ab/Vn$

***VOC EMISSIONS MODEL USING SOIL, SOIL GAS, & GROUNDWATER SAMPLES. MODEL ESTIMATES CHEMICAL CONCENTRATIONS IN AIR USING BOTH THE "BOX MODEL" & INDOOR AIR APPROACH.***

**PREPARED BY:** *DAMES & MOORE*
*TOXICOLOGY AND RISK ASSESSMENT GROUP*
*SACRAMENTO, CALIFORNIA*

**VERSION NO.:** VEM_01.XLS **LAST REVISED:** 6-Oct-92

This multi-media model for estimating VOC emissions is based on Farmer's covered landfill emissions model presented in "Land Disposal of Hexachlorobenzene Wastes: Controlling Vapor Movement in Soil." EPA 600/2-80/119 (1980). The "box model" is based on the model presented in "Development of Advisory Levels for Polychlorinated Biphenyls (PCBs) Cleanup" EPA/600/6-86/002 (1986).

## PROJECT INFORMATION

| | |
|---|---|
| ***PROJECT:*** | Screening Risk Assessment for the Chevron Refinery, Philadelphia, Pennsylvania |
| ***PROJECT FILENAME:*** | V_SCREEN.XLS |
| ***SITE/STUDY AREA:*** | SWMU 71 |
| ***SCENARIO:*** | Calculation of N-Propylbenzene emissions from SWMU 71. This SWMU represents the greatest air concentration possible from all SWMUs (i.e., it has high Cs, large Area, and shallow depth L) having |
| ***NOTES:*** | detected concentrations of N-propylbenzene. |

## MODEL PARAMETERS

| Description | Parameter | Value | Units | Notes/Source |
|---|---|---|---|---|
| ***Emissions model parameters*** | | | | |
| Soil moisture | W | 0.25 | unitless | |
| Bulk density | p | 0 | g/cm^3 | |
| Particle density | d | 0 | g/cm^3 | |
| Fraction of soil organic matter | foc | 0.0158 | unitless | |
| Total soil porosity | PT | 0.43 | unitless | Can be calculated from 1-(p/d) |
| Air-filled porosity | PA | 0.18 | unitless | Can be calculated from PT-W |
| ***Box model parameters*** | | | | |
| Surface area | A | 1585 | m^2 | |
| Box height | Hb | 2 | m | |
| Windspeed within mixing zone | V | 2.13 | m/s | |
| Width of area | L | 39.81 | m | |
| ***Indoor air model parameters*** | | | | |
| Building ventilation rate | Vn | 0.000 | m^3/s | ASHRAE std. for general living areas |
| Surface area of building | | 0 | m^2 | |
| Leakage area of building | | 0 | m^2/m^2 | Ranges from 1-10cm2/m2 (Grimsrud et al, 1983) |
| Emission area of building | Ab | 0 | m^2 | Based on product of the two previous entries. |
| ***Miscellaneous parameters*** | | | | |
| Ideal gas constant | R | 8.21E-05 | atm m^3/mol K | Universal constant. |
| Temperature | T | 283 | K | Site specific assumption. |

**CHEMDATA**

| Chemical | Diffusion Coefficient D (cm^2/s) | Molecular Weight MW (g/mol) | Koc (mL/g) | Kd (m^3/kg) | Henry's Law Constant H (atm m^3/mol) |
|---|---|---|---|---|---|
| N-Propylbenzene | 0.06274 | 106 | 1100 | 0.01738 | 6.43E-03 |

**Kd was calculated as follows: Kd = Koc x foc x (10^-6 m^3/mL) x (10^3 g/kg)**

## CHEMICAL CONCENTRATIONS

| Chemical | Soil Concentration $C_S$ (mg/kg) | Sample Depth $L_S$ (m) | Groundwater Concentration $C_W$ (mg/L) | Sample Depth $L_W$ (m) | Soil Gas Concentration $C_V$ (ug/L) | Sample Depth $L_V$ (m) |
|---|---|---|---|---|---|---|
| N-Propylbenzene | 17 | 0.6089 | -- | -- | -- | -- |

-- Not applicable

## SOIL VAPOR CALCULATIONS

| Chemical | Soil Vapor Concentration (Cv) Estimated From | | |
|---|---|---|---|
| | Soil Samples Cv (mg/m^3) | Groundwater Samples Cv (mg/m^3) | Soil Gas Cv (mg/m^3) |
| N-Propylbenzene | 2.71E+02 | -- | -- |

-- Not Applicable

**Cv calculated from the following equations:**

SOIL: Cv = Cs x H/(Kd x R x T)

GROUNDWATER: P = Cw x H/MW x (10^-3 g/mg) x (10^3 L/m^3) ; and Cv = P x MW/(R x T) x (10^3 mg/g)

SOIL VAPOR: Cv x (10^3 L/m^3 ) x (10^-3 mg/ug)

**EMISSION RATE**

| Chemical | Emission Rate (Q) | | | Selected (a) Emissions Rate Q (mg/m^2/s) |
|---|---|---|---|---|
| | Soil Q (mg/m^2/s) | Groundwater Q (mg/m^2/s) | Soil Gas Q (mg/m^2/s) | |
| N-Propylbenzene | 4.97E-05 | -- | -- | 4.97E-05 |

-- Not applicable if soil vapor samples available

(a) Emission rates based on soil gas samples were used in preference to soil or groundwater samples. If soil gas estimates were not available, the sum of soil and groundwater emission rates were used.

Q was calculated from the following equation:

Q = D x (Pa^(10/3)/Pt^2) (Cv/L) x (10^-4 m^2/cm^2)

## ESTIMATED CONCENTRATION IN OUTDOOR AIR (THE "BOX MODEL")

| Chemical | Emission Rate Q (mg/m^2/s) | Concentrations in Air (Ca) | |
|---|---|---|---|
| | | Box Model Ca (mg/m^3) | Indoor Air Model Ca (mg/m^3) |
| N-Propylbenzene | 4.97E-05 | 4.64E-04 | NA |

**NA = Not applicable**

**Ca calculated from the following equation:**

**(Box Model)**

$$Ca = Q \times A/(L \times V \times H)$$

**(Indoor Air)**

$$Ca = Q \times Ab/Vn$$

# ATTACHMENT B

## SUMMARY OF NON-CANCER HEALTH RISKS FOR CHEMICALS WITHOUT ACTION LEVELS

**Table B-1**

**TOTAL INTAKE AND RISKS FROM DERMAL CONTACT WITH SOIL FOR CHEMICALS WITHOUT ACTION LEVELS IN THE ON-SITE WORKER SCENARIO - CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA**

| CHEMICAL | CONCENTRATION (mg/kg) | ADD (mg/kg/day) | RfD (mg/kg/day) | HAZARD QUOTIENT | LADD (mg/kg/day) | SF* (mg/kg/day)$^{-1}$ | CARCINOGENIC RISK |
|---|---|---|---|---|---|---|---|
| **Dermal Contact** | | | | | | | |
| **Metals** | | | | | | | |
| Thallium | 0.4 | 1.92E-07 | 0.00008 | 2.40E-03 | 6.85E-08 | NA | NA |
| **PAHs** | | | | | | | |
| 1-Methylnaphthalene | 78 | 3.74E-05 | 0.04 | 9.35E-04 | 1.34E-05 | NA | NA |
| 2-Methylnaphthalene | 110 | 5.27E-05 | 0.04 | 1.32E-03 | 1.88E-05 | NA | NA |
| Acenaphthalene | 0.64 | 3.07E-07 | 0.04 | 7.67E-06 | 1.10E-07 | NA | NA |
| Dibenzofuran | 1.2 | 5.75E-07 | 0.01 | 5.75E-05 | 2.05E-07 | NA | NA |
| N-Propylbenzene | 26 | 1.25E-05 | 0.1 | 1.25E-04 | 4.45E-06 | NA | NA |
| | | | **Hazard Index:** | **5 E-03** | | **Total Risk:** | **NA** |

ADD = Average Daily Dose
RfD = Reference Dose
Hazard Quotient = ADD / RfD

LADD = Lifetime Average Daily Dose
SF = Carcinogenic Slope Factor
RISK = LADD x SF

1E-6 = 1/1,000,000

* SF for PAHs is the product of the actual SF and the corresponding TEF

**Table B-2**

**TOTAL INTAKE AND RISKS FROM THE INGESTION OF SOIL FOR CHEMICALS WITHOUT ACTION LEVELS IN THE ON-SITE WORKER SCENARIO - CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA**

| CHEMICAL | CONCENTRATION (mg/kg) | ADD (mg/kg/day) | RfD (mg/kg/day) | HAZARD QUOTIENT | LADD (mg/kg/day) | SF* (mg/kg/day)^-1 | CARCINOGENIC RISK |
|---|---|---|---|---|---|---|---|
| **Soil Ingestion** | | | | | | | |
| **Metals** | | | | | | | |
| Thallium | 0.4 | 1.92E-07 | 0.00008 | 2.40E-03 | 6.85E-08 | NA | NA |
| **PAHs** | | | | | | | |
| 1-Methylnaphthalene | 78 | 3.74E-05 | 0.04 | 9.35E-04 | 1.34E-05 | NA | NA |
| 2-Methylnaphthalene | 110 | 5.27E-05 | 0.04 | 1.32E-03 | 1.88E-05 | NA | NA |
| Acenaphthalene | 0.64 | 3.07E-07 | 0.04 | 7.67E-06 | 1.10E-07 | NA | NA |
| Dibenzofuran | 1.2 | 5.75E-07 | 0.01 | 5.75E-05 | 2.05E-07 | NA | NA |
| N-Propylbenzene | 26 | 1.25E-05 | 0.1 | 1.25E-04 | 4.45E-06 | NA | NA |
| | | | **Hazard Index:** | **5 E-03** | | **Total Risk:** | **NA** |

ADD = Average Daily Dose
RfD = Reference Dose
Hazard Quotient = ADD / RfD

LADD = Lifetime Average Daily Dose
SF = Carcinogenic Slope Factor
RISK = LADD x SF

1E-6 = 1/1,000,000

* SF for PAHs is the product of the actual SF and the corresponding TEF

**Table B-1**
**TOTAL INTAKE AND RISKS FROM DERMAL CONTACT WITH SOIL FOR CHEMICALS WITHOUT ACTION LEVELS IN THE ON-SITE WORKER SCENARIO - CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA**

| CHEMICAL | CONCENTRATION (mg/kg) | ADD (mg/kg/day) | RfD (mg/kg/day) | HAZARD QUOTIENT | LADD (mg/kg/day) | SF* (mg/kg/day) -1 | CARCINOGENIC RISK |
|---|---|---|---|---|---|---|---|
| **Dermal Contact** | | | | | | | |
| **Metals** | | | | | | | |
| Thallium | 0.4 | 1.92E-07 | 0.00008 | 2.40E-03 | 6.85E-08 | NA | NA |
| **PAHs** | | | | | | | |
| 1-Methylnaphthalene | 78 | 3.74E-05 | 0.04 | 9.35E-04 | 1.34E-05 | NA | NA |
| 2-Methylnaphthalene | 110 | 5.27E-05 | 0.04 | 1.32E-03 | 1.88E-05 | NA | NA |
| Acenaphthalene | 0.64 | 3.07E-07 | 0.04 | 7.67E-06 | 1.10E-07 | NA | NA |
| Dibenzofuran | 1.2 | 5.75E-07 | 0.01 | 5.75E-05 | 2.05E-07 | NA | NA |
| N-Propylbenzene | 26 | 1.25E-05 | 0.1 | 1.25E-04 | 4.45E-06 | NA | NA |
| | | | **Hazard Index:** | **5 E-03** | | **Total Risk:** | **NA** |

ADD = Average Daily Dose
RfD = Reference Dose
Hazard Quotient = ADD / RfD

LADD = Lifetime Average Daily Dose
SF = Carcinogenic Slope Factor
RISK = LADD x SF

1E-6 = 1/1,000,000

* SF for PAHs is the product of the actual SF and the corresponding TEF

**Table B-2**
**TOTAL INTAKE AND RISKS FROM THE INGESTION OF SOIL FOR CHEMICALS WITHOUT ACTION LEVELS IN THE ON-SITE WORKER SCENARIO - CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA**

| CHEMICAL | CONCENTRATION (mg/kg) | ADD (mg/kg/day) | RfD (mg/kg/day) | HAZARD QUOTIENT | LADD (mg/kg/day) | SF* (mg/kg/day)^-1 | CARCINOGENIC RISK |
|---|---|---|---|---|---|---|---|
| **Soil Ingestion** | | | | | | | |
| **Metals** | | | | | | | |
| Thallium | 0.4 | 1.92E-07 | 0.00008 | 2.40E-03 | 6.85E-08 | NA | NA |
| **PAHs** | | | | | | | |
| 1-Methylnaphthalene | 78 | 3.74E-05 | 0.04 | 9.35E-04 | 1.34E-05 | NA | NA |
| 2-Methylnaphthalene | 110 | 5.27E-05 | 0.04 | 1.32E-03 | 1.88E-05 | NA | NA |
| Acenaphthalene | 0.64 | 3.07E-07 | 0.04 | 7.67E-06 | 1.10E-07 | NA | NA |
| Dibenzofuran | 1.2 | 5.75E-07 | 0.01 | 5.75E-05 | 2.05E-07 | NA | NA |
| N-Propylbenzene | 26 | 1.25E-05 | 0.1 | 1.25E-04 | 4.45E-06 | NA | NA |
| | | | **Hazard Index:** | **5 E-03** | | **Total Risk:** | **NA** |

ADD = Average Daily Dose
RfD = Reference Dose
Hazard Quotient = ADD / RfD

LADD = Lifetime Average Daily Dose
SF = Carcinogenic Slope Factor
RISK = LADD x SF

1E-6 = 1/1,000,000

* SF for PAHs is the product of the actual SF and the corresponding TEF

## Table B-3

**TOTAL INTAKE AND RISKS FROM THE INHALATION OF N-PROPYLBENZENE VAPORS IN OUTDOOR AIR FOR THE ON-SITE WORKER SCENARIO - CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA**

| CHEMICAL | CONCENTRATION (mg/m^3) | ADD (mg/kg/day) | RfD (mg/kg/day) | HAZARD QUOTIENT | LADD (mg/kg/day) | SF (mg/kg/day)^-1 | CARCINOGENIC RISK |
|---|---|---|---|---|---|---|---|
| Vapor Inhalation (Outdoor) | | | | | | | |
| N-Propyl Benzene | 4.64E-04 | 8.90E-05 | 0.29 | 3.07E-04 | 3.18E-05 | NA | NA |
| | | | Hazard Index: | <0.001 | | Total Risk: | NA |

ADD = Average Daily Dose
RfD = Reference Dose
Hazard Quotient = ADD / RfD

LADD = Lifetime Average Daily Dose
SF = Carcinogenic Slope Factor
RISK = LADD x SF

NA = Not Applicable, no criteria.
1E-6 = 1/1,000,000

Table B-4
**SUMMARY OF THE NON-CARCINOGENIC HEALTH RISKS FOR THE CHEMICALS WITHOUT ACTION LEVELS AT THE CHEVRON REFINERY, PHILADELPHIA, PENNSYLVANIA**

| CHEMICAL | HAZARD QUOTIENT BY PATHWAY | | | CHEMICAL SPECIFIC HAZARD INDEX |
|---|---|---|---|---|
| | Dermal Contact | Soil Ingestion | Vapor Inhalation | |
| **Metals** | | | | |
| Thallium | 0.0024 | 0.0024 | NA | **0.005** |
| **PAHs** | | | | |
| 1-Methylnaphthalene | 0.00093 | 0.00093 | NA | **0.002** |
| 2-Methylnaphthalene | 0.0013 | 0.0013 | NA | **0.003** |
| Acenaphthalene | 0.0000077 | 0.0000077 | NA | **<0.001** |
| Dibenzofuran | 0.000058 | 0.000058 | NA | **<0.001** |
| N-Propylbenzene | 0.00012 | 0.00012 | 0.00031 | **<0.001** |

# APPENDIX B

## MONITORING WELL CONSTRUCTION LOGS, PREVIOUS INVESTIGATIONS

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

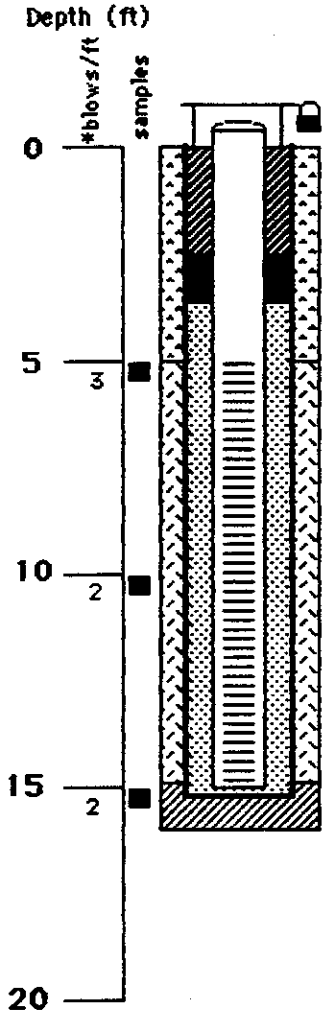
Project : Chevron/Philadelphia Refinery

Boring/Well No. - A1

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Andreu Ivansiu




| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |
| **CONSTRUCTION DATA** | |
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 5' - 15' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |
| **MEASUREMENTS (NGVD)** | |
| Top of Casing Elevation - | 8.63' |
| Static Water Level Elevation - | 3.08' |
| Date Measured - | 1/9/87 |
| Surface Elevation - | 8.63' |
| **TEST DATA** | |
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/27/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. -A2

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/27/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

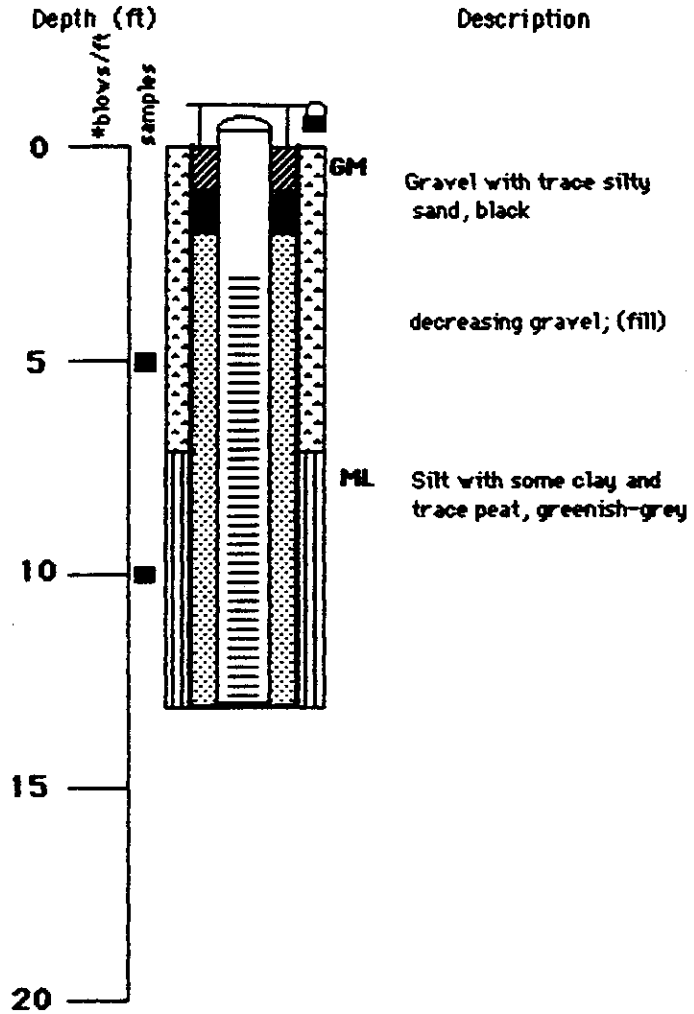
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 13' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 7.84' |
| Static Water Level Elevation - | 6.12' |
| Date Measured - | 1/9/87 |
| Surface Elevation - | 7.84' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

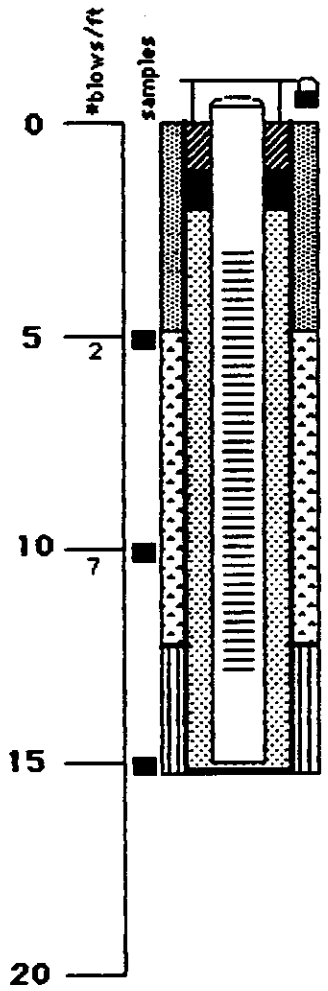
Project : Chevron/Philadelphia Refinery

Boring/Well No. - A3

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Mark Robertson




| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

**MEASUREMENTS (NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 9.37' |
| Static Water Level Elevation - | 5.26' |
| Date Measured - | 1/9/87 |
| Surface Elevation - | 9.32' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

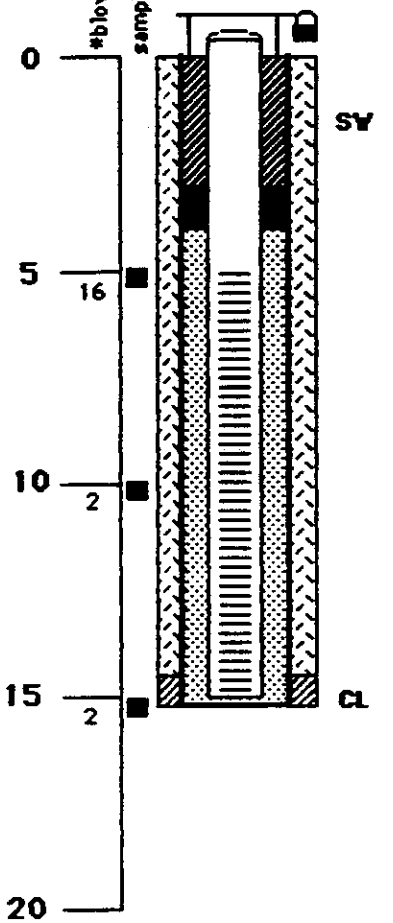
Project : Chevron/Philadelphia Refinery

Boring/Well No. - A4

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Andrew Ivansiu




Description

Fine to coarse sand with some fine gravel, petroleum odor

trace clay, wet

Silty clay, dark gray, moist

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |
| **CONSTRUCTION DATA** | |
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 5' - 15' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |
| **MEASUREMENTS (NGVD)** | |
| Top of Casing Elevation - | 7.06' |
| Static Water Level Elevation - | 1.58' |
| Date Measured - | 1/9/87 |
| Surface Elevation - | 6.90' |
| **TEST DATA** | |
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

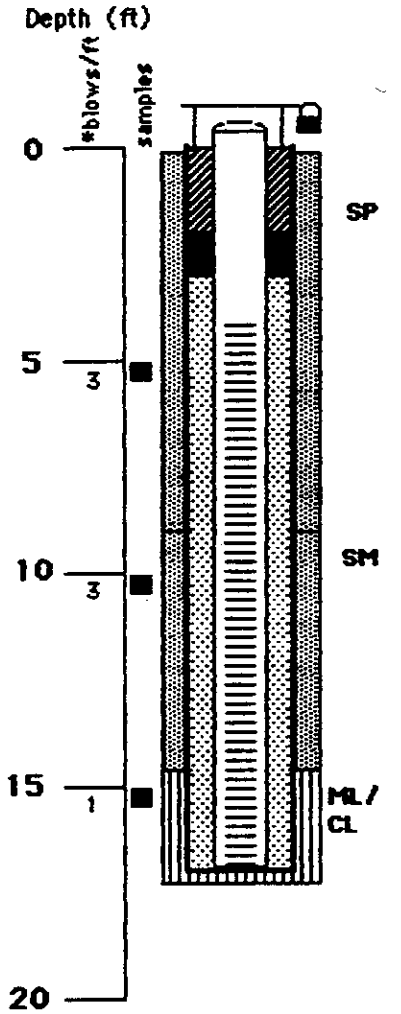
Project : Chevron/Philadelphia Refinery

Boring/Well No. - A5

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Andrei Ivansiu




Description

Sandy gravel, dark grey, moist

Silty sand, dark grey, moist, soft

Silty clay, soft, moist, dark gray

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/25/86 |
| Type of Rig - | Hollow Stem Auger |
| **CONSTRUCTION DATA** | |
| Borehole Diam. - | 10" |
| Borehole Depth - | 18' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 17' |
| Screen Setting - | 4' - 17' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |
| **MEASUREMENTS (NGVD)** | |
| Top of Casing Elevation - | 6.93' |
| Static Water Level Elevation - | Not Available |
| Date Measured - | 1/9/87 |
| Surface Elevation - | 6.77' |
| **TEST DATA** | |
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Andreu Ivansiu

Boring/Well No. - A6

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

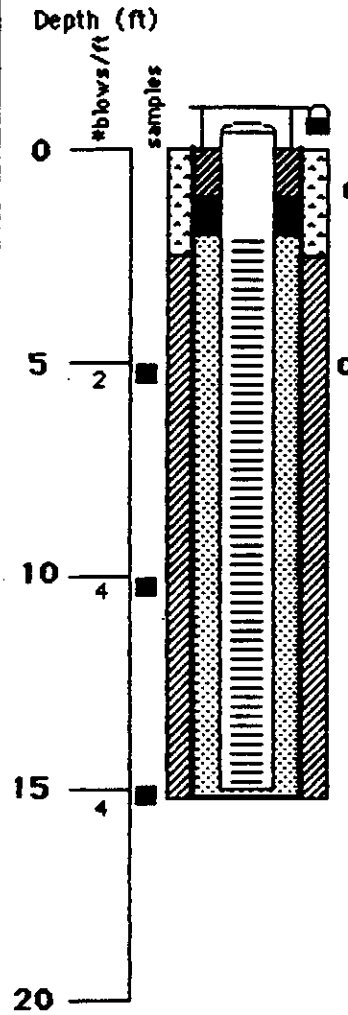
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 3' - 15' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

**MEASUREMENTS (NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 7.96' |
| Static Water Level Elevation - | 3.25' |
| Date Measured - | 1/9/87 |
| Surface Elevation - | 7.88' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - A7

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

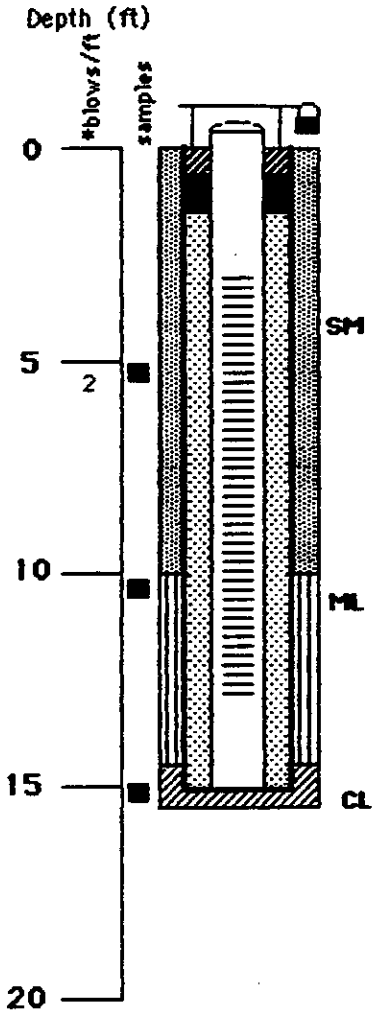
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 8.02' |
| Static Water Level Elevation - | 4.95' |
| Date Measured - | 1/9/87 |
| Surface Elevation - | 8.02' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

SM — Silty sand with gravel, dark grey-brown

ML — Silty sand with trace gravel, gray, soft

CL — Silty clay to clayey silt, gray

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

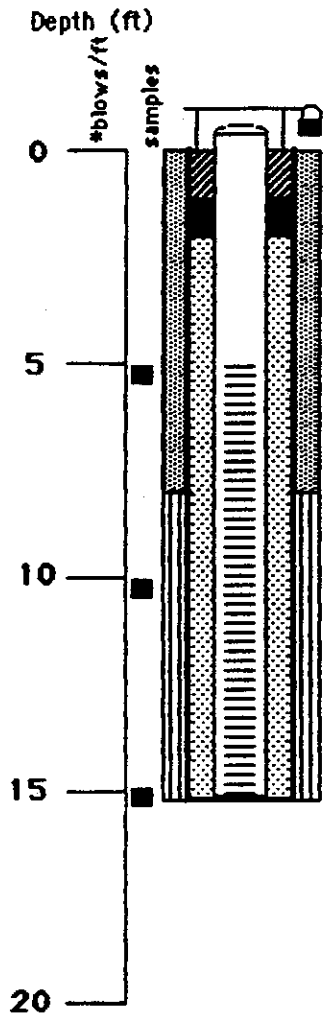
Project : Chevron/Philadelphia Refinery

Boring/Well No. - A8

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Mark Robertson




Description

Silty to clayey sand with trace gravel, brown

grades to dark gray-brown

Grades to clayey silt, greenish-brown, soft

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |
| **CONSTRUCTION DATA** | |
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 5' - 15' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |
| **MEASUREMENTS (NGVD)** | |
| Top of Casing Elevation - | 6.29' |
| Static Water Level Elevation - | 1.04' |
| Date Measured - | 1/9/87 |
| Surface Elevation - | 6.13' |
| **TEST DATA** | |
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - A9

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

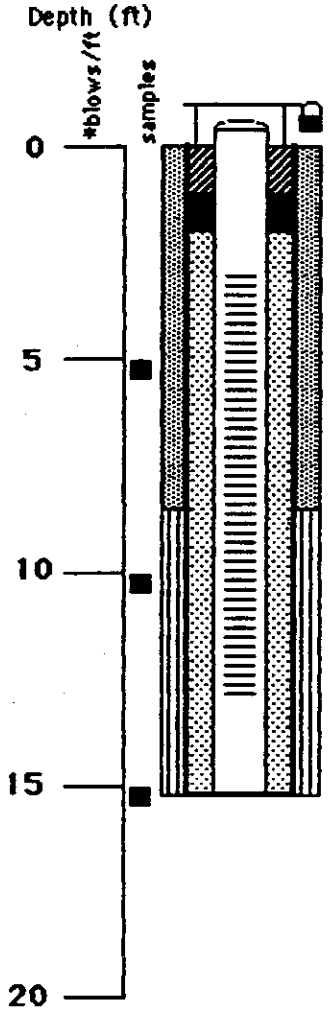
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 3' -13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

**MEASUREMENTS (NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 7.17' |
| Static Water Level Elevation - | 3.23' |
| Date Measured - | 1/9/87 |
| Surface Elevation - | 7.17' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

SM — Silty sand with some gravel, dark grey-brown

ML — Changes to clayey silt with trace sand and gravel, greenish-brown, soft

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - A10

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/25/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

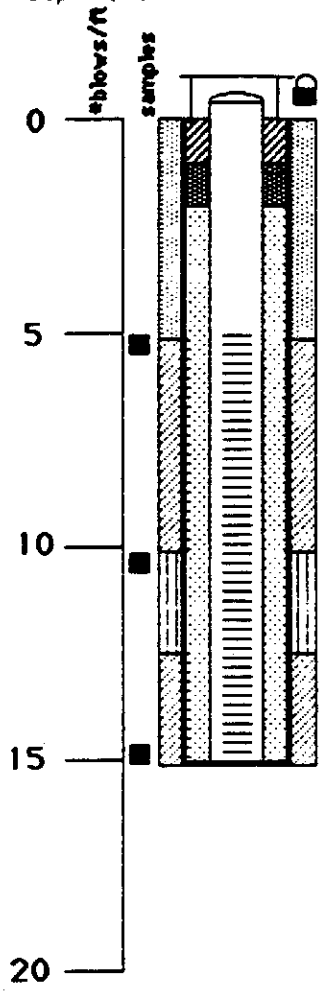
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 5' - 15' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 9.48' |
| Static Water Level Elevation - | 6.04' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 9.40' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Andrei Ivansiu

Boring/Well No. - A11

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/25/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

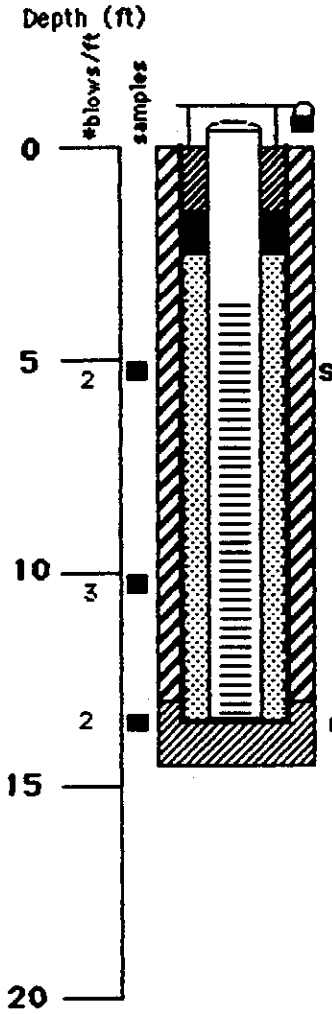
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 14' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' 6" |
| Screen Setting - | 3' 6" - 13' 6" |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 5.89' |
| Static Water Level Elevation - | 4.04' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 5.57' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Silty sand with trace gravel, black; (fill)

Clayey sand with some pebbles, black, soft, loose

Silty clay, black, fine

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Andrei Ivansiu

Boring/Well No. - A12

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

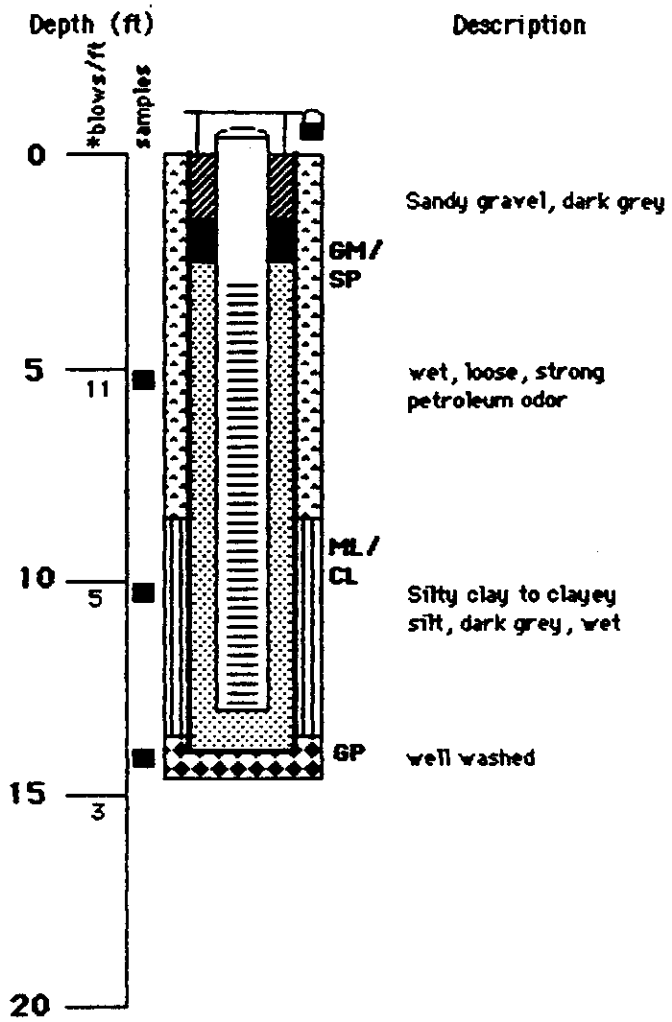
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 14' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

**MEASUREMENTS (NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 6.14' |
| Static Water Level Elevation - | 3.53' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 5.90' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

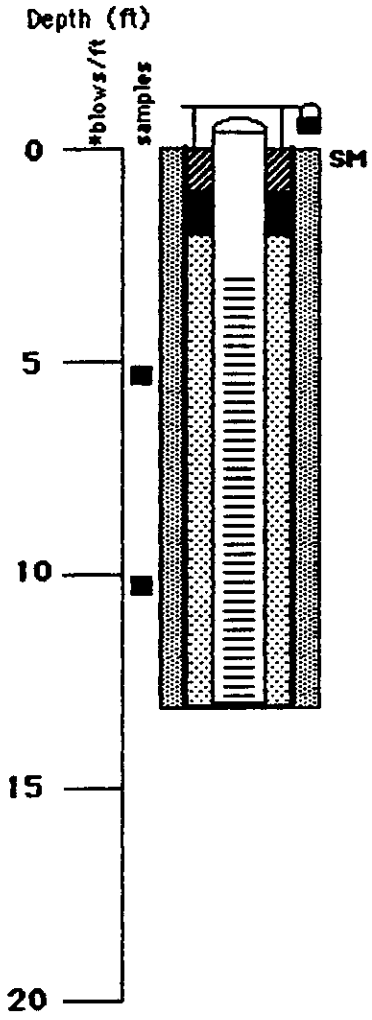
Project : Chevron/Philadelphia Refinery

Boring/Well No. -A13

Project No. 113-909-032

Date M.W. completed 2/27/86

Supervising D & M Engineer/Geologist Mark Robertson




Description

Silty sand with trace gravel, gray-brown

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/27/86 |
| Type of Rig - | Hollow Stem Auger |
| **CONSTRUCTION DATA** | |
| Borehole Diam. - | 10" |
| Borehole Depth - | 13' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |
| **MEASUREMENTS (NGVD)** | |
| Top of Casing Elevation - | 7.91' |
| Static Water Level Elevation - | 4.52' |
| Date Measured - | 1/9/87 |
| Surface Elevation - | 7.83' |
| **TEST DATA** | |
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

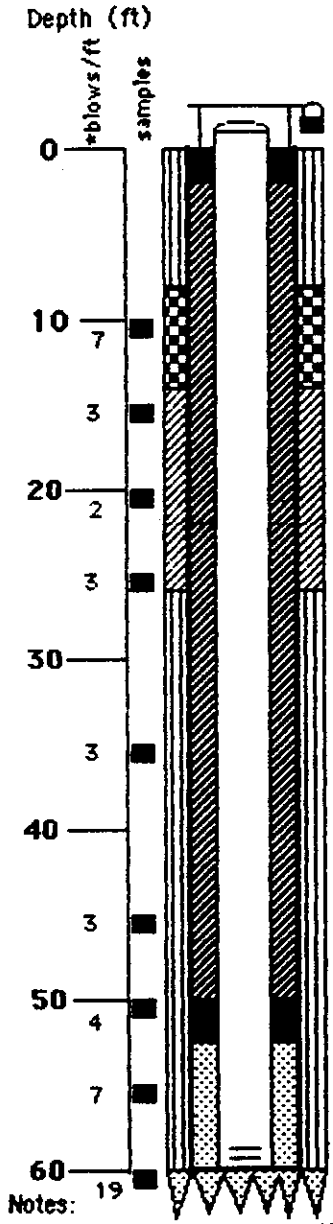
Project : Chevron/Philadelphia Refinery

Boring/Well No. - A13D

Project No. 113-950-032

Date M.W. completed 11/13/86

Supervising D & M Geologist David Wagner




| | Description |
|---|---|
| ML | Silt with some fine to coarse sand, trace fine gravel, black, saturated; petroleum odor; petroleum residues present |
| GW | Fine gravel with some silt, little fine to coarse sand, black, loose, saturated; strong petroleum odor |
| CL | Clay with little to some silt, dark gray, very soft, saturated; trace organics |
| | Grading to dark brown |
| ML | Increasing silt; silt with some clay |
| | Grading to medium brown |
| | Grading to brownish-gray |
| | Trace mica |
| | Silt with little to some clay, trace fine to medium sand, gray, medium stiff, saturated; trace organics; very micaceous |

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.
** All soils classified by visual inspection.

DAMES & MOORE

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Lambert, Inc. |
| Drilling Completed - | 11/13/86 |
| Type of Rig - | Hollow Stem Auger |
| **CONSTRUCTION DATA** | |
| Borehole Diam. - | 10" |
| Borehole Depth - | 70' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 69' |
| Screen Setting - | 59' - 69' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Bentonite |
| **MEASUREMENTS(NGVD)** | |
| Top of Casing Elevation - | 7.99' |
| Static Water Level Elevation - | -1.95' |
| Date Measured - | 12/22/86 |
| Surface Elevation - | 8.10' |
| **TEST DATA** | |
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

**WELL CONSTRUCTION KEY**

- FILTER PACK
- BENTONITE SEAL
- BENTONITE GROUT
- CAVE IN MATERIAL
- CONCRETE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - A13D (Cont.)

Project No. 113-950-032

Date M.W. completed 11/13/86

Supervising D & M Geologist David Wagner

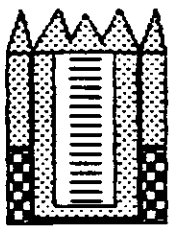
Location - Chevron Refinery

Driller - Lambert, Inc.

Drilling Completed - 11/13/86

Type of Rig - Hollow Stem Auger

| Depth (ft) | #blows/ft | samples | Description |
|---|---|---|---|
| 60 | 19 | | SP Fine sand with little to some medium sand, trace silt, reddish-brown, medium dense, saturated |
| | 117 | | GW Fine to coarse gravel with some fine to coarse sand, reddish-brown, very dense, saturated |
| 70 | 50/1" | | |
| 80 | | | |
| 90 | | | |



WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- BENTONITE GROUT
- CAVE IN MATERIAL
- CONCRETE

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/26/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. -A14

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/26/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 13' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

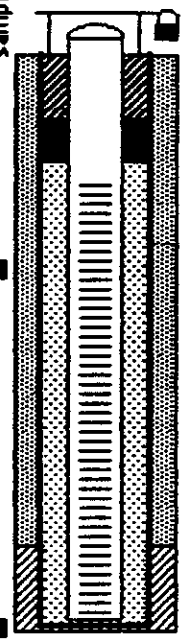
MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 8.55' |
| Static Water Level Elevation - | 4.95' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 8.55' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

| Depth (ft) | *blows/ft | samples | Description |
|---|---|---|---|
| 0 | | | SM/GM Silty sand and gravel, brown |
| 5 | | | grades dark grey |
| 10 | | | gravel decreasing |
| 15 | | | very loose |
| 20 | | | CL Silty clay with trace sand, light gray, wet |



Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

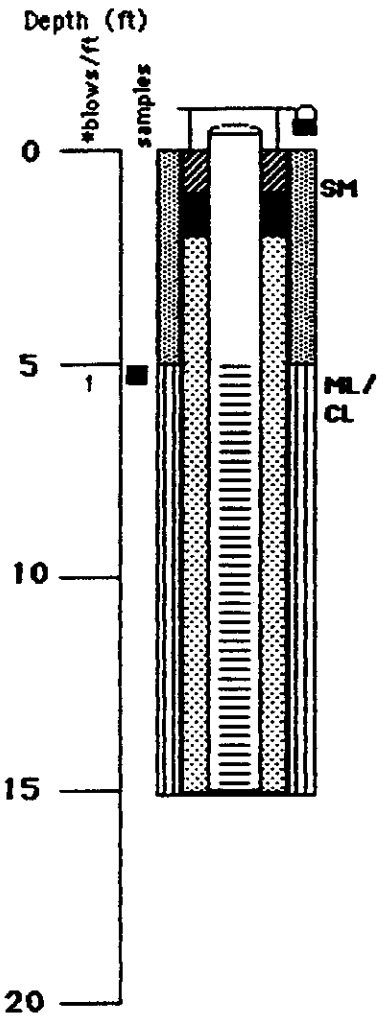
Project : Chevron/Philadelphia Refinery

Boring/Well No. - A15

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Mark Robertson




| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/25/86 |
| Type of Rig - | Hollow Stem Auger |
| **CONSTRUCTION DATA** | |
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 5' - 15' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |
| **MEASUREMENTS (NGVD)** | |
| Top of Casing Elevation - | 6.90' |
| Static Water Level Elevation - | 6.48' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 6.84' |
| **TEST DATA** | |
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

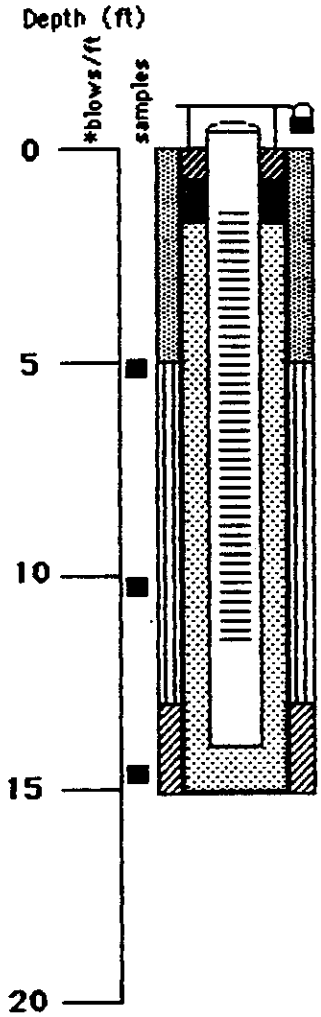
Project : Chevron/Philadelphia Refinery

Boring/Well No. - A16

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Mark Robertson




Description

Silty sand with some gravel and cobbles, dark-grey

decreasing cobbles and gravel

Clayey silt, green

grades to greenish-brown

grades to silty clay and peat

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/25/86 |
| Type of Rig - | Hollow Stem Auger |
| **CONSTRUCTION DATA** | |
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 14' |
| Screen Setting - | 1'6" - 11'6" |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |
| **MEASUREMENTS (NGVD)** | |
| Top of Casing Elevation - | 8.47' |
| Static Water Level Elevation - | 6.33' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 7.81' |
| **TEST DATA** | |
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/27/86

Supervising D & M Engineer/Geologist Ralph T. Golia

Boring/Well No. -A17

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/27/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

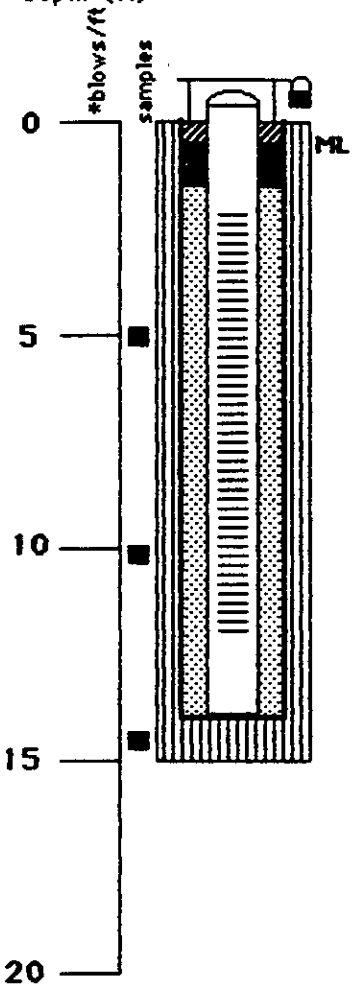
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 14' |
| Screen Setting - | 2' - 12' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 9.42' |
| Static Water Level Elevation - | 6.02' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 9.34' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Clayey silt with some fine gravel and sand, blackish-brown, moist, soft; petroleum odor

very moist, some wood debris, petroleum odor

increased moisture

saturated

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/27/86

Supervising D & M Engineer/Geologist Ralph T. Golia

Boring/Well No. -A18

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/27/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

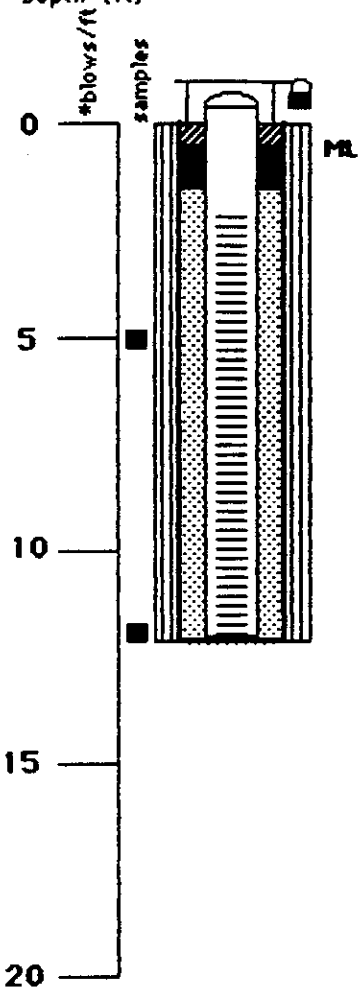
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 12' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 12' |
| Screen Setting - | 2' - 12' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 9.52' |
| Static Water Level Elevation - | 7.27' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 9.35' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Clayey silt with some fine gravel and sand, blackish-brown, moist, soft; petroleum odor

very moist to wet, some wood debris, petroleum odor

increased moisture; wet to saturated

sample not collected

resistance; wood at 10'

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/27/86

Supervising D & M Engineer/Geologist Ralph T. Golia

Boring/Well No. -A19

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/27/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

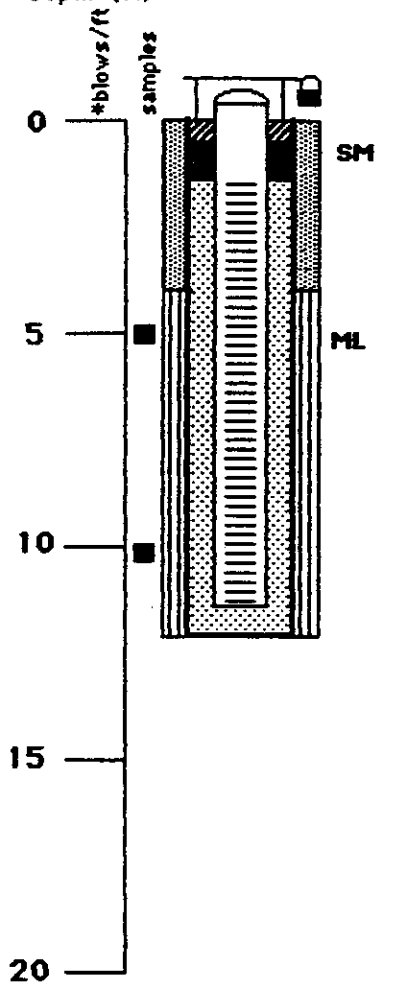
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 12' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 11'6" |
| Screen Setting - | 1'6" - 11'6" |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 9.52' |
| Static Water Level Elevation - | 5.77' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 9.28' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Asphalt

Silty sand with some gravel and trace clay, medium brown, damp, medium dense;(fill)

change to blackish-brown, slight petroleum odor

Clayey silt with trace sand, blackish-brown, wet to saturated, soft; petroleum oder

wood debris; resistance

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

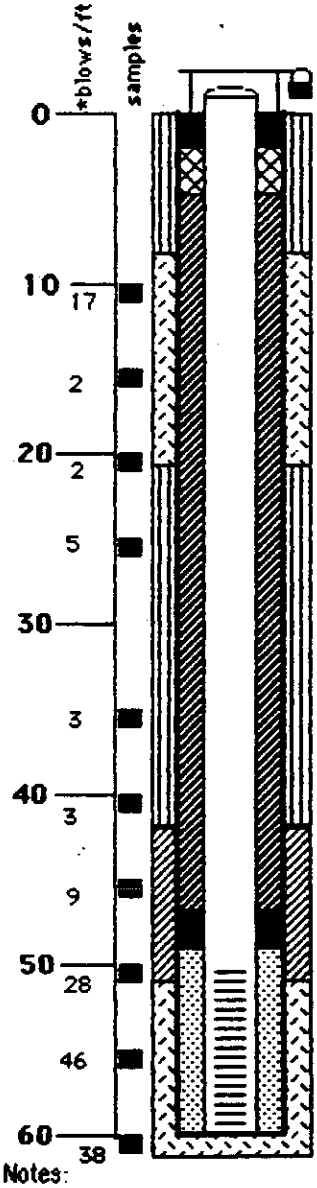
Project : Chevron/Philadelphia Refinery

Boring/Well No. - A19D

Project No. 113-950-032

Date M.W. completed 10/30/86

Supervising D & M Geologist David Wagner




| Description |
|---|
| ML Silt with some fine to coarse sand, trace clay, brown, soft, moist; petroleum odor Grading to very dark gray, saturated |
| SW Fine to coarse sand with some fine gravel, little silt, blackish-gray, medium dense, saturated; resistance encountered - wood |
| ML Silt with some clay, dark gray, soft, moist; organics; micaceous; weak petroleum odor |
| SHELBY TUBE taken from 30' to 31.5' |
| Increasing clay; silt and clay |
| CL Clay with some silt and little fine sand, reddish-brown, soft, saturated, micaceous |
| SW Fine to coarse sand with some fine gravel, reddish-brown, medium dense, saturated Grading to brownish-gray Increasing density : dense Increasing gravel: fine gravel and sand |

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Lambert, Inc. |
| Drilling Completed - | 10/30/86 |
| Type of Rig - | Hollow Stem Auger |
| **CONSTRUCTION DATA** | |
| Borehole Diam. - | 10" |
| Borehole Depth - | 60' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 60' |
| Screen Setting - | 50' - 60' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Bentonite |
| **MEASUREMENTS(NGVD)** | |
| Top of Casing Elevation - | 11.69' |
| Static Water Level Elevation - | -1.71' |
| Date Measured - | 12/22/86 |
| Surface Elevation - | 8.69' |
| **TEST DATA** | |
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

**WELL CONSTRUCTION KEY**

- FILTER PACK
- BENTONITE SEAL
- BENTONITE GROUT
- CAVE IN MATERIAL
- CONCRETE

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project :Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Andreu Ivansiu

Boring/Well No. - A20

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/25/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

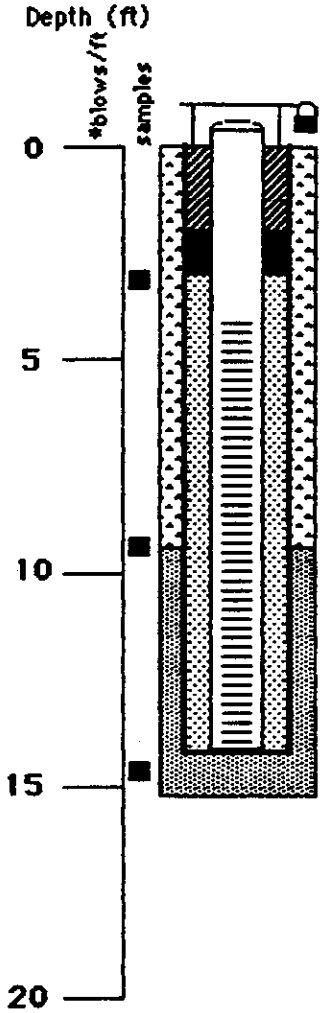
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 14' |
| Screen Setting - | 4'-14' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 8.81' |
| Static Water Level Elevation - | 4.08' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 8.73' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

GM Silty to clayey fine sand, black, moist,soft, petroleum odor

SP Sand with some pebbles, black, wet, petroleum oder

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - A21

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/25/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

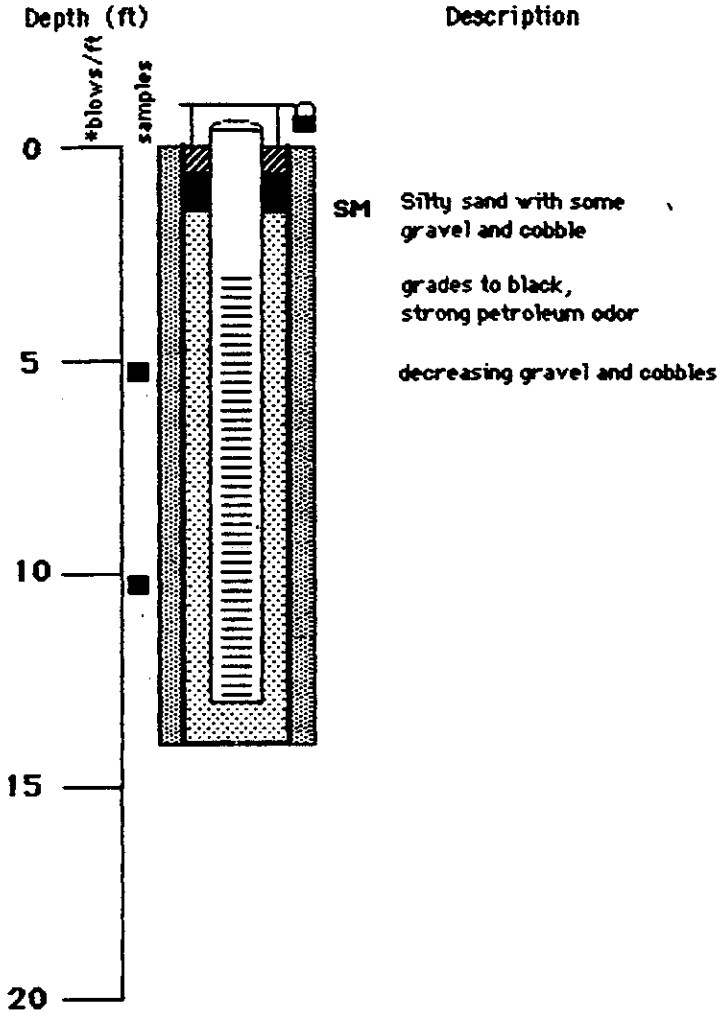
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 13' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 9.84' |
| Static Water Level Elevation - | Not Available |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 9.02' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - A21D

Project No. 113-950-032

Date M.W. completed 10/28/86

Supervising D & M Geologist David Wagner

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Lambert, Inc. |
| Drilling Completed - | 10/28/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

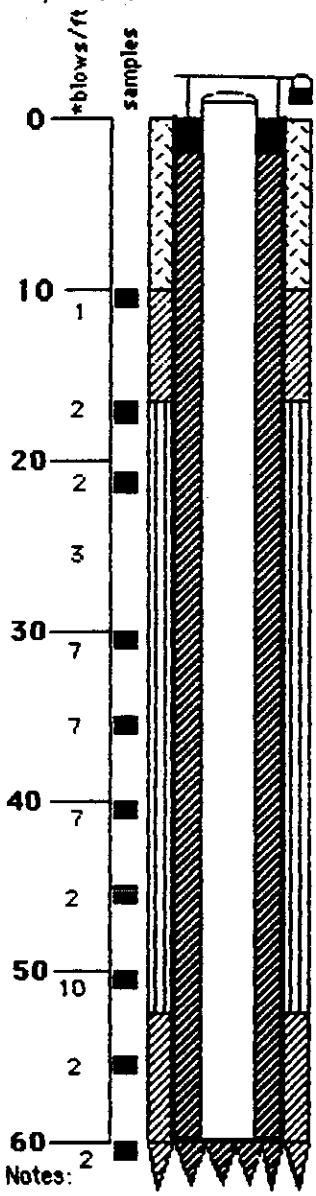
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 85' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 85' |
| Screen Setting - | 75' - 85' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

**MEASUREMENTS(NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 12.18' |
| Static Water Level Elevation - | -4.13' |
| Date Measured - | 12/22/86 |
| Surface Elevation - | 8.48' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




| | Description |
|---|---|
| SW | Fine to coarse sand with some silt, little fine gravel, very dark brown, soft, very moist; wood debris, brick, wire, etc.; petroleum odor; oily |
| CL | Clay with little silt, trace fine sand, very dark brown, soft, saturated; very strong petroleum odor; oily |
| ML | Silt with some clay, trace fine sand, medium gray, soft, saturated; trace mica; trace organics; petroleum odor |
| | Decreasing clay; little clay, weak petroleum odor |
| | SHELBY TUBE taken from 19' to 21' |
| | Decreasing clay and increasing fine sand; trace to little clay, little fine sand |
| | 2" sand lense at 36'; fine to medium sand with little clay, medium gray, trace mica |
| | Silt with little to some clay, little fine sand, dark gray, soft, saturated; wood debris |
| | Increasing clay and decreasing fine sand; some clay, trace fine sand |
| | Decreasing clay : little clay |
| CL | No petroleum odor |
| | Clay with little silt, dark gray, soft, saturated; trace mica |

**WELL CONSTRUCTION KEY**

- FILTER PACK
- BENTONITE SEAL
- BENTONITE/CEMENT
- CAVE IN MATERIAL
- CONCRETE

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - A21D (Cont.)

Project No. 113-950-032

Date M.W. completed 10/28/86

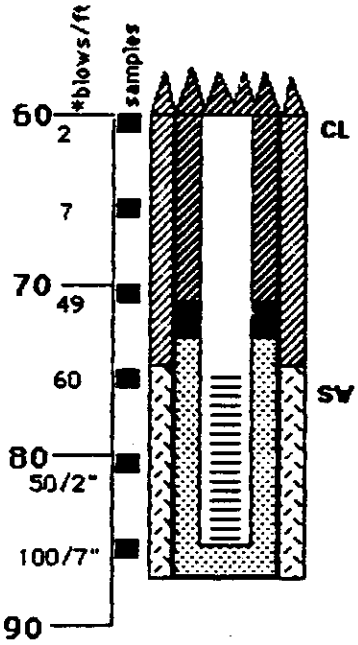
Supervising D & M Geologist David Wagner

Location - Chevron Refinery

Driller - Lambert, Inc.

Drilling Completed - 10/28/86

Type of Rig - Hollow Stem Auger




Description

Increasing silt : some silt

6" lense of fine to medium sand with little coarse sand at 66', grayish-brown, saturated

Clay with some silt, trace to little fine sand, dark-gray, soft, saturated

Little to some fine gravel and little fine to coarse sand

Fine to coarse sand with some fine gravel, brownish-gray, very dense, saturated

Fine to coarse sand with some fine gravel, trace clay(white), very light gray, very dense, saturated

Weathered bedrock : Wissahickon Schist

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- BENTONITE/CEMENT
- CAVE IN MATERIAL
- CONCRETE

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

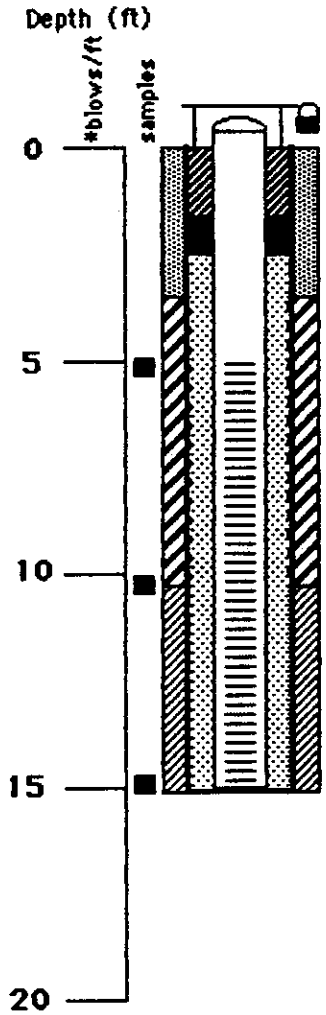
Project : Chevron/Philadelphia Refinery

Boring/Well No. -A22

Project No. 113-909-032

Date M.W. completed 2/26/86

Supervising D & M Engineer/Geologist Mark Robertson




Description

SM — Silty sand with trace gravel, discolored, strong petroleum odor

SC — Silty to clayey fine to coarse sand with trace fine gravel, petroleum odor

CL — Silty clay, gray, petroleum odor

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/26/86 |
| Type of Rig - | Hollow Stem Auger |
| **CONSTRUCTION DATA** | |
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 5' - 15' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |
| **MEASUREMENTS (NGVD)** | |
| Top of Casing Elevation - | 9.02' |
| Static Water Level Elevation - | 1.71' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 8.78' |
| **TEST DATA** | |
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/27/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. -A23

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/27/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

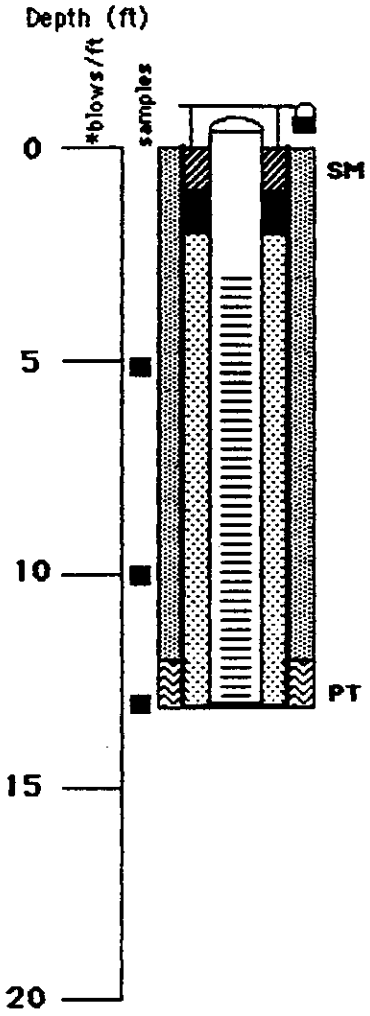
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 13' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

**MEASUREMENTS (NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 4.71' |
| Static Water Level Elevation - | 4.31' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 4.71' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

SM — Silty sand with some gravel and mica flakes, light brown

grades to dark brown with trace gravel, very soft

grades to grey-brown

PT — Fibrous peat

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project :Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - A24

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

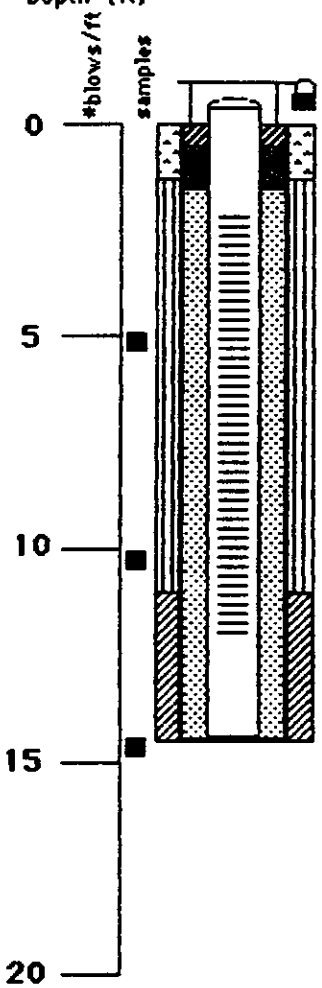
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 14' 6" |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 14' 6" |
| Screen Setting - | 2' - 12' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

**MEASUREMENTS (NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 6.54' |
| Static Water Level Elevation | 3.78' |
| Date Measured - | 1/9/87 |
| Surface Elevation - | 6.46' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




| | |
|---|---|
| GM | Silty sand with gravel, brown |
| ML | Silt with some sand, black, discolored, strong odor |
| CL/ ML | Silty clay with trace sand, green, medium stiff |
| | grades to brown with some peat fibers |

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

**WELL CONSTRUCTION KEY**

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOO

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/27/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. -A25

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/27/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

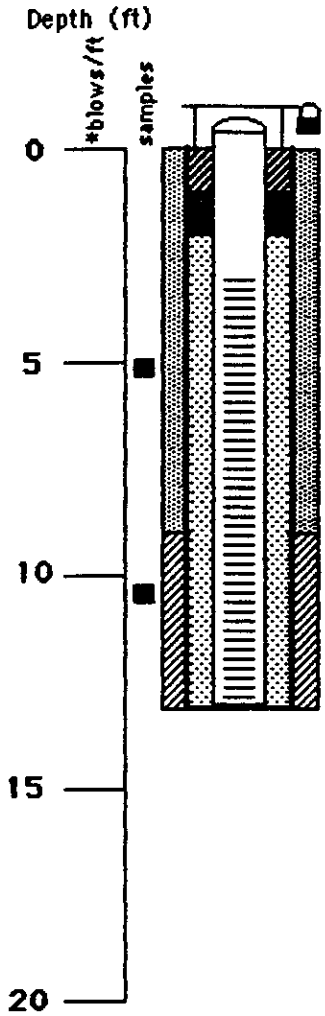
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 13' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

**MEASUREMENTS (NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 10.46' |
| Static Water Level Elevation - | 5.16' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 10.38' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

SM — Silty sand with trace gravel, brown

decreasing sand and gravel

very moist

CL — Silty clay, grey

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/27/86

Supervising D & M Engineer/Geologist Ralph T. Golia

Boring/Well No. -A26

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/27/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

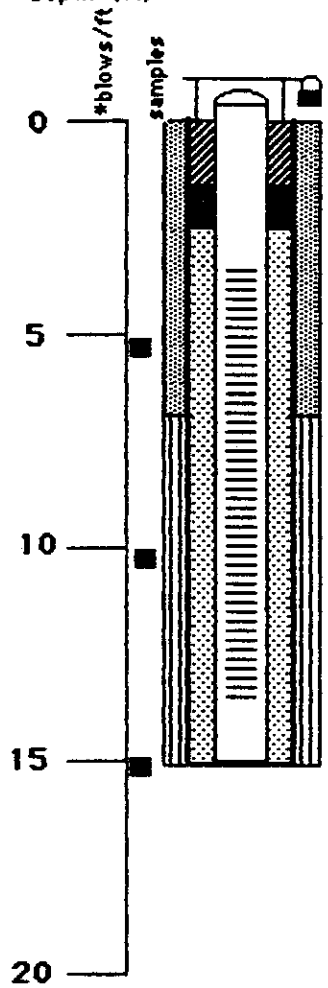
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 3'6" - 13'6" |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 11.38' |
| Static Water Level Elevation - | 4.23' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 11.24' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Asphalt

SP Gravelly sand with trace silt and clay, reddish-brown, damp, medium dense; fill

change to dark brown

moist to very moist

ML/CL Clayey silt to silty clay, blackish-brown, wet to saturated, soft; slight petroleum oder

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/27/86

Supervising D & M Engineer /Geologist Ralph T. Golia

Boring/Well No. -A27

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/27/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

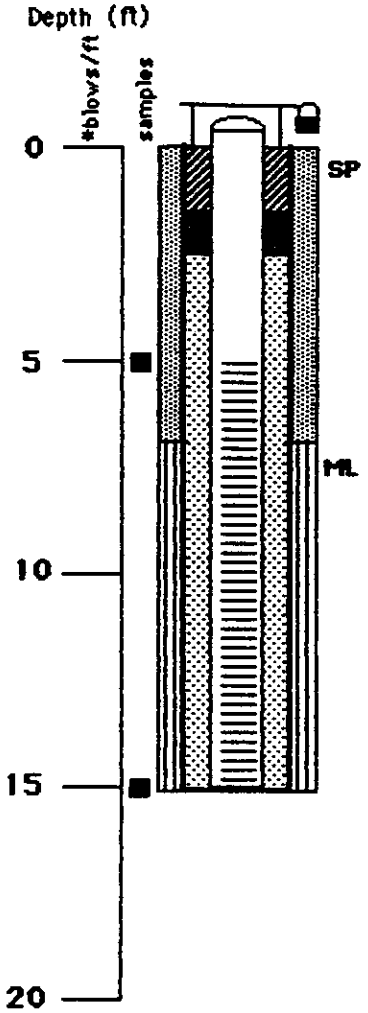
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 5' -15' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 12.08' |
| Static Water Level Elevation - | 3.84' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 11.58' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Gravelly sand with trace silt and clay, reddish-brown, damp, medium dense

change to dark brown

moist to very moist

Clayey silt to silty clay with trace wood, blackish-brown, wet to saturated, soft; slight petroleum odor, wood

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# GROUNDWATER TECHNOLOGY, INC.

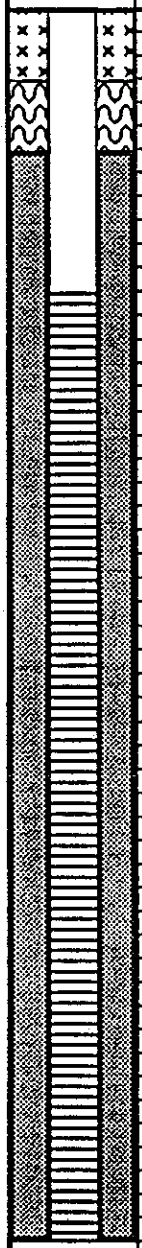
CLIENT: CHEVRON USA, INC.
PROJECT NAME: CHEVRON REFINERY
PROJECT NUMBER: 300-175-3482
LOCATION: PHILADELPHIA, PA

DATE 30 AUGUST 1988 WELL NUMBER A-39

DRILLER: GT DRILLING

CASED FROM 0 TO 3' WITH THREADED PVC
SCREENED FROM 3' TO 13' WITH 0.010" SLOT
WELL DEPTH 13' WELL DIAMETER 4"
ELEVATION 8.93 (PVC)
ANNULUS COMPLETION 2" ANNULUS PACKED WITH #1 MORIE SAND, BENTONITE SEALED, CONCRETE GROUTED.
OTHER 24" PVC STICKUP, 30" PROTECTIVE STEEL CASING

DRILL RIG MOBILE DRILL® B-57
DRILL METHOD HOLLOW STEM AUGER
DATE(S) DRILLED 18 JULY 1988
LOGGED BY C. CARLSON



| DEPTH | LITHOLOGICAL DESCRIPTION | SAMPLE | COMMENTS |
|---|---|---|---|
| | | | |
| | | 4-6-4-4 | (0 - 2.0') |
| 1 | Stone, silt, and brick fill | | |
| | | | |
| 2 | | | |
| | | 11-10-4-10 | (2 - 4') |
| 3 | Poorly sorted sand, some silt | | PID = ND |
| | Clean, fine sand (lens) | | EX = 0% |
| 4 | Micaceous clayey silt, moist at 5'. Wet on spoon at 6' | | |
| | | | |
| 5 | | | |
| | | 3-2-3-1 | (5 - 7') |
| 6 | | | PID = 5ppm |
| | | | EX = 30% |
| 7 | Clayey silt, slightly plastic, moist | | |
| | | | |
| 8 | | | PID = 4.5ppm |
| | | | EX = 5% |
| 9 | | | |
| | | | |
| 10 | Fine gravel, some coarse sand.HC staining and odors | | |
| | | 11-11-6-3 | (10 - 12') |
| 11 | Very plastic clay, trace silt, HC staining | | |
| | | | |
| 12 | Coarse angular gravel, some sand, HC staining and odor | | |
| | | | PID = Photoionization Device |
| 13 | | | EX = Explosimeter |
| | | | HC = Hydrocarbon |

# GROUNDWATER TECHNOLOGY, INC.

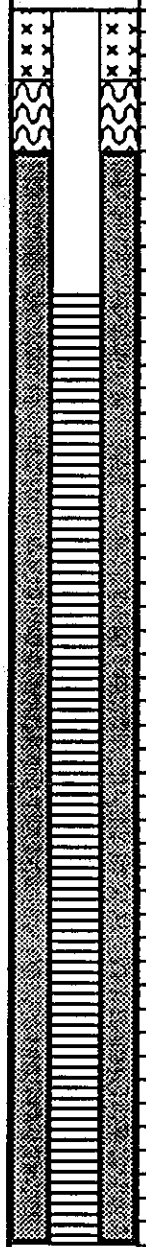
CLIENT: CHEVRON USA, INC.
PROJECT NAME: CHEVRON REFINERY
PROJECT NUMBER: 300-175-3482
LOCATION: PHILADELPHIA, PA

DATE 30 AUGUST 1988 WELL NUMBER A-40

DRILLER: GT DRILLING

CASED FROM 0 TO 3' WITH THREADED PVC
SCREENED FROM 3' TO 13' WITH 0.010" SLOT
WELL DEPTH 13' WELL DIAMETER 4"
ELEVATION 10.06' (PVC)
ANNULUS COMPLETION 2" ANNULUS PACKED WITH #1 MORIE SAND, BENTONITE SEALED, CONCRETE GROUTED.
OTHER 39" PVC STICKUP, PROTECTIVE STEEL CASING

DRILL RIG MOBILE DRILL® B-57
DRILL METHOD HOLLOW STEM AUGER
DATE(S) DRILLED 18 JULY 1988
LOGGED BY C. CARLSON



| DEPTH | LITHOLOGICAL DESCRIPTION | SAMPLE | COMMENTS |
|---|---|---|---|
| 1 | | | |
| | | 4-2-1-1 | (0 - 2) |
| | | | PID = 12.5ppm |
| 2 | Silt, stone, and brick fill, HC stained | | |
| | | | |
| 3 | | | |
| | | | |
| 4 | | 14-17-19-8 | (3 - 5) |
| | | | PID = 4ppm |
| 5 | Fine, well-sorted sand (fill) | | EX = 0% |
| | | | |
| 6 | | | |
| | | | |
| 7 | | 10-3-2-5 | (5 - 7) |
| | Fill with brick, some silty sand. Wet on spoon at 5.5' | | |
| 8 | | | |
| | | | |
| 9 | | | |
| | | | |
| 10 | | | |
| | | | |
| 11 | Black, HC stained medium sand, some medium gravel | | |
| | | 3-2-2-4 | (10 - 12) |
| 12 | Slightly plastic clay, HC stained, fill | | |
| | | | |
| 13 | Fill | | PID = Photoionization Device |
| | | | EX = Explosimeter |
| | | | HC = Hydrocarbon |

# GROUNDWATER TECHNOLOGY, INC.

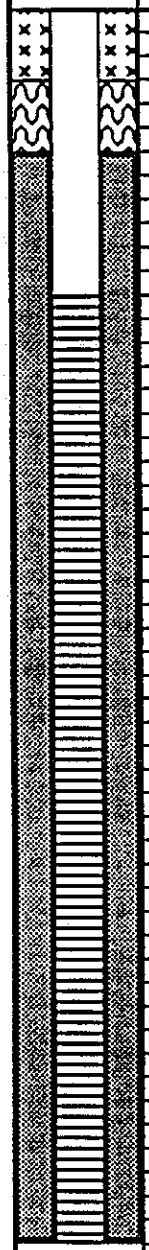
CLIENT: CHEVRON USA, INC.
PROJECT NAME: CHEVRON REFINERY
PROJECT NUMBER: 300-175-3482
LOCATION: PHILADELPHIA, PA

DATE 30 AUGUST 1988 WELL NUMBER A-41

DRILLER: GT DRILLING

CASED FROM 0 TO 3' WITH THREADED PVC
SCREENED FROM 3' TO 13' WITH 0.010" SLOT
WELL DEPTH 13' WELL DIAMETER 4"
ELEVATION 9.94' (PVC)
ANNULUS COMPLETION 2" ANNULUS PACKED WITH #1 MORIE SAND, BENTONITE SEALED, CONCRETE GROUTED.
OTHER 39" PVC STICKUP, 42" PROTECTIVE STEEL CASING

DRILL RIG MOBILE DRILL® B-57
DRILL METHOD HOLLOW STEM AUGER
DATE(S) DRILLED 18 JULY 1988
LOGGED BY C. CARLSON



| DEPTH | LITHOLOGICAL DESCRIPTION | SAMPLE | COMMENTS |
|---|---|---|---|
| 1 | | 4-1-1-2 | (0 - 2) |
| 2 | Stone and brick fill | | |
| 3 | | 6-7-6-2 | (2.5 - 4.5) |
| 4 | | | |
| 5 | Silty sand, trace of medium gravel. HC stained. Wet on spoon at 5.5' | | |
| 6 | | 11-12-6-4 | (5 -7) |
| 7 | | | |
| 8 | Clayey silt, some medium sand and gravel | | |
| 9 | | | |
| 10 | Tight plastic clay, HC stained, some fill | 15-11-10-9 | (10 - 12) |
| 11 | | | |
| 12 | Clayey silt. | | |
| 13 | | | PID = Photoionization Device |
| | | | EX = Explosimeter |
| | | | HC = Hydrocarbon |

# GROUNDWATER TECHNOLOGY, INC.

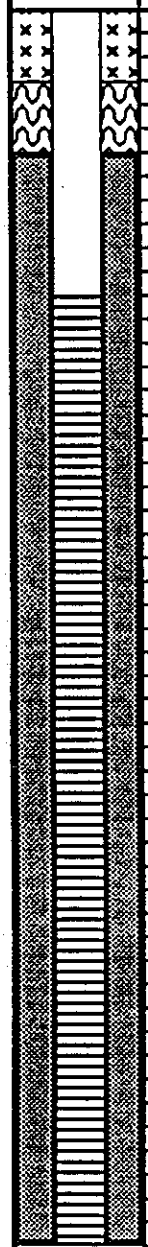
CLIENT: CHEVRON USA, INC.
PROJECT NAME: CHEVRON REFINERY
PROJECT NUMBER: 300-175-3482
LOCATION: PHILADELPHIA, PA

DATE 30 AUGUST 1988 WELL NUMBER A-42

DRILLER: GT DRILLING

CASED FROM 0 TO 3' WITH THREADED PVC
SCREENED FROM 3' TO 13' WITH 0.010" SLOT
WELL DEPTH 13' WELL DIAMETER 4"
ELEVATION 8.58' (PVC)
ANNULUS COMPLETION 2" ANNULUS PACKED WITH #1 MORIE SAND, BENTONITE SEALED, CONCRETE GROUTED.
OTHER 24" PVC STICKUP, 30" PROTECTIVE STEEL CASING

DRILL RIG MOBILE DRILL® B-57
DRILL METHOD HOLLOW STEM AUGER
DATE(S) DRILLED 19 JULY 1988
LOGGED BY C. CARLSON



| DEPTH | LITHOLOGICAL DESCRIPTION | SAMPLE | COMMENTS |
|---|---|---|---|
| | | | |
| | | 4-4-3-5 | (0 - 2) |
| 1 | | | |
| | Gravel and silt fill, slight HC odor at 3.5' | | |
| 2 | | 4-5-5-6 | (2.5 - 4.5) |
| | | | PID = 25ppm |
| 3 | | | EX = 5% |
| | | | |
| 4 | | | |
| | | | |
| 5 | | | |
| | | 2-2-1-1 | (5 - 7) |
| 6 | | | PID = 4ppm |
| | | | EX = 45% |
| 7 | Wet clayey silt, some coarse gravel (fill). Wet on spoon at 6'. | | |
| | Strong HC odors and staining | | |
| 8 | | | |
| | | | |
| 9 | | | |
| | | | |
| 10 | Coarse gravel and silt fill | | |
| | | 6-1-4-3 | (10 - 12) |
| 11 | | | |
| | | | |
| 12 | Slightly plastic clay, some silt | | |
| | | | PID = Photoionization Device |
| 13 | | | EX = Explosimeter |
| | | | HC = Hydrocarbon |

# GROUNDWATER TECHNOLOGY, INC.

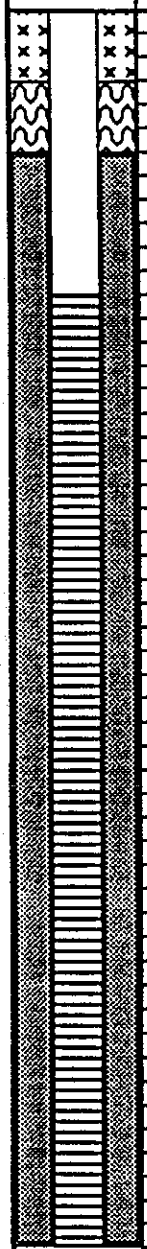
CLIENT: CHEVRON USA, INC.
PROJECT NAME: CHEVRON REFINERY
PROJECT NUMBER: 300-175-3482
LOCATION: PHILADELPHIA, PA

DATE 30 AUGUST 1988 WELL NUMBER A-43

DRILLER: GT DRILLING

CASED FROM 0 TO 3' WITH THREADED PVC
SCREENED FROM 3' TO 13' WITH 0.010" SLOT
WELL DEPTH 13' WELL DIAMETER 4"
ELEVATION 11.0' (PVC)
ANNULUS COMPLETION 2" ANNULUS PACKED WITH #1 MORIE SAND, BENTONITE SEALED, CONCRETE GROUTED.
OTHER 24" PVC STICKUP, 30" PROTECTIVE STEEL CASING

DRILL RIG MOBILE DRILL® B-57
DRILL METHOD HOLLOW STEM AUGER
DATE(S) DRILLED 19 JULY 1988
LOGGED BY C. CARLSON



| DEPTH | LITHOLOGICAL DESCRIPTION | SAMPLE | COMMENTS |
|---|---|---|---|
| 1 | | | |
| | | | |
| | | | |
| 2 | Silt fill, some gravel. Black, heavily stained, with strong | | (2.5 - 4.5) |
| | HC odor | | PID = 45ppm |
| 3 | | | EX = 0% |
| | | | |
| 4 | | | |
| | | | |
| | | | |
| 5 | Same, but increase in clayey silt and moisture. Wet on | 4-3-4-4 | (5 - 7) |
| | spoon at 6'. Heavy HC residue on soil. | | PID = 10ppm |
| 6 | | | Ex = 0% |
| | | | |
| 7 | | | |
| | | | |
| 8 | | | |
| | | | |
| 9 | | | |
| | | | |
| 10 | Clayey sand, wet, slight odor | | |
| | | 6-4-4-5 | (10 - 12) |
| 11 | | | |
| | | | |
| 12 | | | |
| | | | PID = Photoionization Device |
| 13 | | | EX = Explosimeter |
| | | | HC = Hydrocarbon |

# GROUNDWATER TECHNOLOGY, INC.

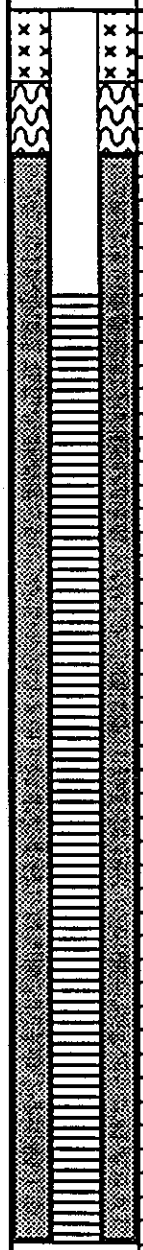
CLIENT: CHEVRON USA, INC.
PROJECT NAME: CHEVRON REFINERY
PROJECT NUMBER: 300-175-3482
LOCATION: PHILADELPHIA, PA

DATE 30 AUGUST 1988 WELL NUMBER A-44

DRILLER: GT DRILLING

CASED FROM 0 TO 3' WITH THREADED PVC
SCREENED FROM 3' TO 13' WITH 0.010" SLOT
WELL DEPTH 13' WELL DIAMETER 4"
ELEVATION 11.20' (PVC)
ANNULUS COMPLETION 2" ANNULUS PACKED WITH #1 MORIE SAND, BENTONITE SEALED, CONCRETE GROUTED.
OTHER 24" PVC STICKUP, 30" PROTECTIVE STEEL CASING

DRILL RIG MOBILE DRILL® B-57
DRILL METHOD HOLLOW STEM AUGER
DATE(S) DRILLED 19 JULY 1988
LOGGED BY C. CARLSON



| DEPTH | LITHOLOGICAL DESCRIPTION | SAMPLE | COMMENTS |
|---|---|---|---|
| | | | |
| 1 | Asphalt, cobble and gravel fill | | |
| | | | |
| 2 | | | |
| | | | |
| 3 | | | |
| | Medium, well sorted sand with some silt, cinders. wet on | | (2.5 - 4.5) |
| 4 | spoon at 6', strong HC odors | | PID = 15ppm |
| | | | EX = 0% |
| 5 | | | |
| | | | |
| 6 | | | |
| | | | |
| 7 | | | |
| | | | |
| 8 | Silty sand, strong HC odor. Visible residue on particles | | PID = 10ppm |
| | | | |
| 9 | | | |
| | | | |
| 10 | | | |
| | | | |
| 11 | | | |
| | Fine to medium gravel and sand, some wood. | 2-1-1-1 | (10 - 12) |
| 12 | | | |
| | | | PID = Photoionization Device |
| 13 | | | EX = Explosimeter |
| | | | HC = Hydrocarbon |

# GROUNDWATER TECHNOLOGY, INC.

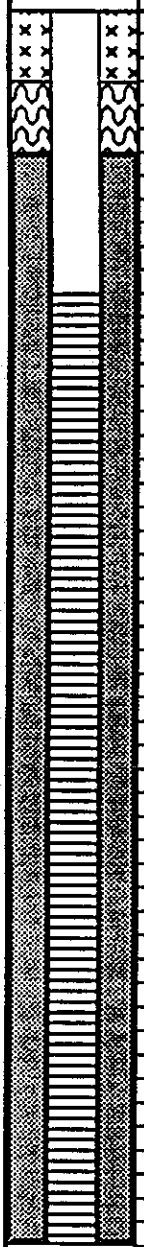
CLIENT: CHEVRON USA, INC.
PROJECT NAME: CHEVRON REFINERY
PROJECT NUMBER: 300-175-3482
LOCATION: PHILADELPHIA, PA

DATE 30 AUGUST 1988 WELL NUMBER A-45

DRILLER: GT DRILLING

CASED FROM 0 TO 3' WITH THREADED PVC
SCREENED FROM 3' TO 13' WITH 0.010" SLOT
WELL DEPTH 13' WELL DIAMETER 4"
ELEVATION 6.02' (PVC)
ANNULUS COMPLETION 2" ANNULUS PACKED WITH #1 MORIE SAND, BENTONITE SEALED, CONCRETE GROUTED.
OTHER 12" MANHOLE, FLUSH WITH GRADE, LOCKING STEP-ON CAP

DRILL RIG MOBILE DRILL® B-57
DRILL METHOD HOLLOW STEM AUGER
DATE(S) DRILLED 19 JULY 1988
LOGGED BY C. CARLSON



| DEPTH | LITHOLOGICAL DESCRIPTION | SAMPLE | COMMENTS |
|---|---|---|---|
| | Asphalt | | Offset 2X - Encountered concrete |
| | | | |
| 1 | Fill, silt ,trace of gravel | | |
| | | | |
| 2 | | | |
| | | 3-3-2-3 | (2.5 - 4.5) |
| 3 | Silty, medium, poorly sorted sand, strong HC odor and staining | | PID = 7ppm |
| | | | EX = 0% |
| 4 | | | |
| | | | |
| 5 | Silty clay, slighty plastic. Wet on spoon at 6' | | |
| | | 7-2-5-4 | (5 - 7) |
| 6 | Silty sand, HC stain and odor | | |
| | | | |
| 7 | | | |
| | | | |
| 8 | Wet, sandy clay, very plastic | | PID = 3ppm |
| | | | EX = 0% |
| 9 | | | |
| | | | |
| 10 | | | |
| | Silty clay, very plastic, grading to slightly sandy, silty clay | | |
| 11 | with depth. | | |
| | | | |
| 12 | Slightly running sand at 13' | | |
| | | | PID = Photoionization Device |
| 13 | | | EX = Explosimeter |
| | | | HC = Hydrocarbon |

# GROUNDWATER TECHNOLOGY, INC.

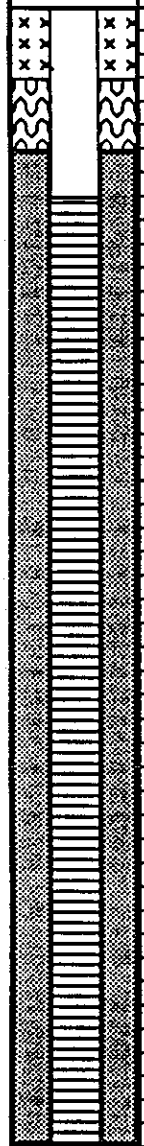
CLIENT: CHEVRON USA, INC.
PROJECT NAME: CHEVRON REFINERY
PROJECT NUMBER: 300-175-3482
LOCATION: PHILADELPHIA, PA

DATE 30 AUGUST 1988 WELL NUMBER A-46

DRILLER: GT DRILLING

CASED FROM 0 TO 2' WITH THREADED PVC
SCREENED FROM 2' TO 12' WITH 0.010" SLOT
WELL DEPTH 12' WELL DIAMETER 4"
ELEVATION 12.01' (PVC)
ANNULUS COMPLETION 2" ANNULUS PACKED WITH #1 MORIE SAND, BENTONITE SEALED, CONCRETE GROUTED.
OTHER 24" PVC STICKUP, 30" PROTECTIVE STEEL CASING

DRILL RIG MOBILE DRILL® B-57
DRILL METHOD HOLLOW STEM AUGER
DATE(S) DRILLED 19 JULY 1988
LOGGED BY C. CARLSON



| DEPTH | LITHOLOGICAL DESCRIPTION | SAMPLE | COMMENTS |
|---|---|---|---|
| | | | |
| | | | |
| 1 | Cobble and gravel fill | | |
| | | | |
| 2 | | | |
| | | 5-6-7-7 | (2.5 - 4.5) |
| 3 | | | |
| | | | |
| 4 | Brick and cobble fill | | |
| | | | |
| 5 | | | |
| | | | |
| 6 | Same, but with clayey silt and minor brick | | |
| | | | |
| 7 | Clayey medium sand, HC odor and stain | 5-6-4-4 | (5 - 7) |
| | | | PID = 4ppm |
| 8 | | | EX = 0% |
| | Silt and gravel .brick fill | | |
| 9 | | | |
| | | | |
| 10 | | | |
| | Clayey medium sand, Slight HC staining and odor | 10-7-8-5 | (10 - 12) |
| 11 | | | |
| | | | |
| 12 | | | |
| | | | PID = Photoionization Device |
| 13 | | | EX = Explosimeter |
| | | | HC = Hydrocarbon |

# GROUNDWATER TECHNOLOGY, INC.

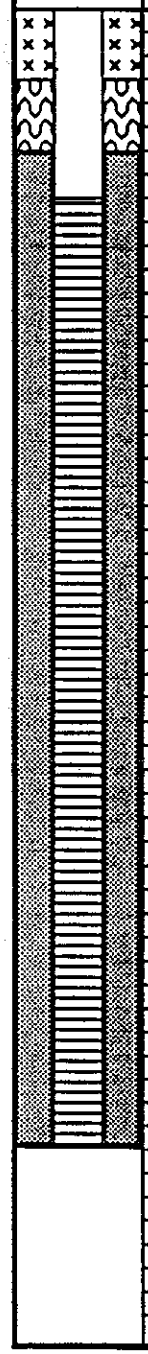
CLIENT: CHEVRON USA, INC.
PROJECT NAME: CHEVRON REFINERY
PROJECT NUMBER: 300-175-3482
LOCATION: PHILADELPHIA, PA

DATE 30 AUGUST 1988 WELL NUMBER A-47

DRILLER: GT DRILLING

CASED FROM 0 TO 2' WITH THREADED PVC
SCREENED FROM 2' TO 12' WITH 0.010" SLOT
WELL DEPTH 12' WELL DIAMETER 4"
ELEVATION 8.58' (PVC)
ANNULUS COMPLETION 2" ANNULUS PACKED WITH #1 MORIE SAND, BENTONITE SEALED, CONCRETE GROUTED.
OTHER 24" PVC STICKUP, 30" PROTECTIVE STEEL CASING

DRILL RIG MOBILE DRILL® B-57
DRILL METHOD HOLLOW STEM AUGER
DATE(S) DRILLED 19 JULY 1988
LOGGED BY C. CARLSON



| DEPTH | LITHOLOGICAL DESCRIPTION | SAMPLE | COMMENTS |
|---|---|---|---|
| | | | |
| | | | |
| 1 | | 3-2-2-4 | (2.5 - 4.5) |
| | | | |
| 2 | Gravel and micaceous silt fill, some medium sand, some | | |
| | HC odor | | |
| 3 | | | |
| | | | |
| 4 | | | |
| | | | |
| 5 | | | |
| | Medium sand and silt. Wet on spoon at 5' | | |
| 6 | | 1-1-1-1 | (5 - 7) |
| | | | |
| 7 | | | |
| | | | |
| 8 | Slightly clayey silt, minor plasticity | | |
| | | | |
| 9 | | | |
| | | | |
| 10 | | | |
| | Slightly silty clay, very plastic. HC staining and odors | 1-3-2-2 | (10 - 12) |
| 11 | | | |
| | | | |
| 12 | | | |
| | | | PID = Photoionization Device |
| 13 | | | EX = Explosimeter |
| | | | HC = Hydrocarbon |

# GROUNDWATER TECHNOLOGY, INC.

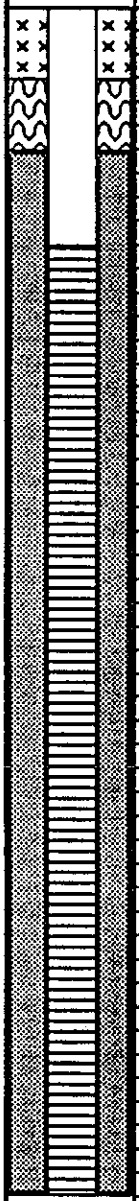
CLIENT: CHEVRON USA, INC.
PROJECT NAME: CHEVRON REFINERY
PROJECT NUMBER: 300-175-3482
LOCATION: PHILADELPHIA, PA

DATE 30 AUGUST 1988 WELL NUMBER A-48

DRILLER: GT DRILLING

CASED FROM 0 TO 2.5' WITH THREADED PVC
SCREENED FROM 2.5' TO 12.5' WITH 0.010" SLOT
WELL DEPTH 12.5' WELL DIAMETER 4"
ELEVATION 7.70' (PVC)
ANNULUS COMPLETION 2" ANNULUS PACKED WITH #1 MORIE SAND, BENTONITE SEALED, CONCRETE GROUTED.
OTHER 30" PVC STICKUP, 30" PROTECTIVE STEEL CASING

DRILL RIG MOBILE DRILL® B-57
DRILL METHOD HOLLOW STEM AUGER
DATE(S) DRILLED 20 JULY 1988
LOGGED BY C. CARLSON



| DEPTH | LITHOLOGICAL DESCRIPTION | SAMPLE | COMMENTS |
|---|---|---|---|
| | Silt and gravel fill | | |
| | | | |
| 1 | Heavily oil-stained silt and medium gravel fill | | |
| | | 3-2-2-1 | (2.5 - 4.5) |
| 2 | | | |
| | | | |
| 3 | | | |
| | | | |
| 4 | | | |
| | | | |
| 5 | | | |
| | Same, free oil in split spoon | | |
| | | 2-2-2--1 | (5 - 7) |
| 6 | | | |
| | | | |
| 7 | | | |
| | | | |
| 8 | | | |
| | | | |
| 9 | | | |
| | | | |
| 10 | | | |
| | | | |
| 11 | | 2-1-3-1 | (10 - 12) |
| | Slightly silty clay, slightly plastic. HC stained. | | |
| 12 | | | |
| | | | PID = Photoionization Device |
| 13 | | | EX = Explosimeter |
| | | | HC = Hydrocarbon |

# GROUNDWATER TECHNOLOGY, INC.

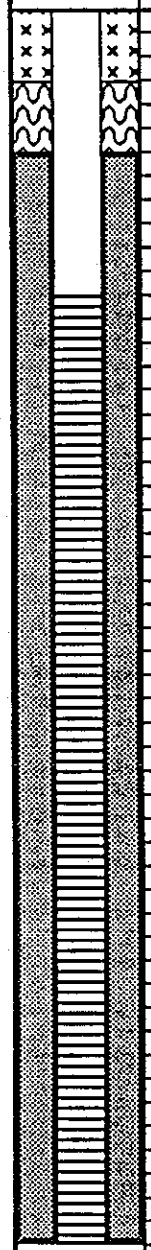
CLIENT: CHEVRON USA, INC.
PROJECT NAME: CHEVRON REFINERY
PROJECT NUMBER: 300-175-3482
LOCATION: PHILADELPHIA, PA

DATE 30 AUGUST 1988 WELL NUMBER A-49

DRILLER: GT DRILLING

CASED FROM 0 TO 3' WITH THREADED PVC
SCREENED FROM 3' TO 13' WITH 0.010" SLOT
WELL DEPTH 13' WELL DIAMETER 4"
ELEVATION 8.44' (PVC)
ANNULUS COMPLETION 2" ANNULUS PACKED WITH #1 MORIE SAND, BENTONITE SEALED, CONCRETE GROUTED.
OTHER 30" PVC STICKUP, 30" PROTECTIVE STEEL CASING

DRILL RIG MOBILE DRILL® B-57
DRILL METHOD HOLLOW STEM AUGER
DATE(S) DRILLED 20 JULY 1988
LOGGED BY C. CARLSON



| DEPTH | LITHOLOGICAL DESCRIPTION | SAMPLE | COMMENTS |
|---|---|---|---|
| | | | |
| 1 | Gravel and silt fill | | |
| | | 2-2-1-1 | (2.5 - 4.5) |
| 2 | | | |
| | | | |
| 3 | Very clayey silt, HC odors, oil soaked to 4.5' | | |
| 4 | | | |
| | | | |
| 5 | Wet at 5' | 1-1-2-1 | (5 - 7) |
| | | | |
| 6 | | | |
| | | | |
| 7 | | | |
| | | | |
| 8 | Clayey silt, some minor amounts of medium sand present in | | |
| 9 | sparse lenses. | | |
| | | | |
| 10 | | 2-3-4-4 | (10 -12) |
| | | | |
| 11 | | | |
| | | | |
| 12 | | | |
| | | | |
| 13 | | | PID = Photoionization Device |
| | | | EX = Explosimeter |
| | | | HC = Hydrocarbon |

# GROUNDWATER TECHNOLOGY, INC.

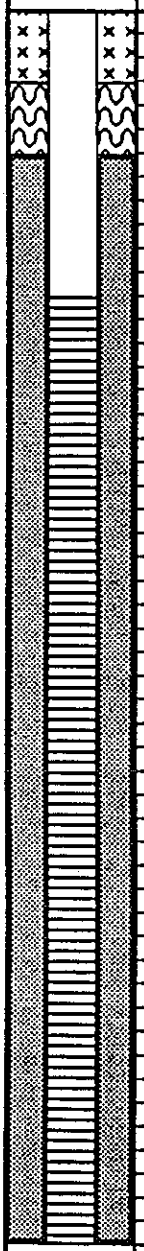
CLIENT: CHEVRON USA, INC.
PROJECT NAME: CHEVRON REFINERY
PROJECT NUMBER: 300-175-3482
LOCATION: PHILADELPHIA, PA

DATE 30 AUGUST 1988 WELL NUMBER A-50

DRILLER: GT DRILLING

CASED FROM 0 TO 3' WITH THREADED PVC
SCREENED FROM 3' TO 13' WITH 0.010" SLOT
WELL DEPTH 13' WELL DIAMETER 4"
ELEVATION 9.72' (PVC)
ANNULUS COMPLETION 2" ANNULUS PACKED WITH #1 MORIE SAND, BENTONITE SEALED, CONCRETE GROUTED.
OTHER 30" PVC STICKUP, 30" PROTECTIVE STEEL CASING

DRILL RIG MOBILE DRILL® B-57
DRILL METHOD HOLLOW STEM AUGER
DATE(S) DRILLED 20 JULY 1988
LOGGED BY C. CARLSON



| DEPTH | LITHOLOGICAL DESCRIPTION | SAMPLE | COMMENTS |
|---|---|---|---|
| 1 | Gravel and silt fill | | |
| 2 | | | |
| 3 | | | |
| 4 | Slightly clayey silt | 4-2-3-7 | (2.5 - 4.5) |
| 5 | Water at 5' | | |
| 6 | | 6-4-3-2 | (5 - 7) |
| 7 | Medium-coarse gravel and sand | | |
| 8 | | | |
| 9 | Medium-fine sand, some silt and clay | | |
| 10 | | | |
| 11 | | | |
| 12 | Silty clay, slightly plastic | | |
| 13 | | | PID = Photoionization Device |
| | | | EX = Explosimeter |
| | | | HC = Hydrocarbon |

# GROUNDWATER TECHNOLOGY, INC.

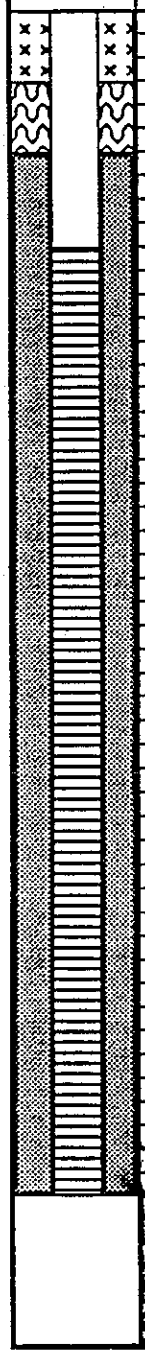
CLIENT: CHEVRON USA, INC.
PROJECT NAME: CHEVRON REFINERY
PROJECT NUMBER: 300-175-3482
LOCATION: PHILADELPHIA, PA

DATE 30 AUGUST 1988 WELL NUMBER A-51

DRILLER: GT DRILLING

CASED FROM 0 TO 2.5' WITH THREADED PVC
SCREENED FROM 2.5' TO 12.5' WITH 0.010" SLOT
WELL DEPTH 12.5' WELL DIAMETER 4"
ELEVATION 11.24' (PVC)
ANNULUS COMPLETION 2" ANNULUS PACKED WITH #1 MORIE SAND, BENTONITE SEALED, CONCRETE GROUTED.
OTHER 24" PVC STICKUP, 30" PROTECTIVE STEEL CASING

DRILL RIG MOBILE DRILL® B-57
DRILL METHOD HOLLOW STEM AUGER
DATE(S) DRILLED 20 JULY 1988
LOGGED BY C. CARLSON



| DEPTH | LITHOLOGICAL DESCRIPTION | SAMPLE | COMMENTS |
|---|---|---|---|
| | Gravel fill | | |
| 1 | | | |
| | | | |
| 2 | | | |
| | | 7-4-3-4 | (2.5 - 4.5) |
| 3 | | | |
| | | | |
| 4 | Slighty clayey silt, HC stained, Trace of gravel | | |
| | | | |
| 5 | | | |
| | | | |
| 6 | Wet at 6' | | |
| | | 10-3-2-1 | (5 -7) |
| 7 | | | |
| | | | |
| 8 | | | |
| | | | |
| 9 | | | |
| | | | |
| 10 | | | |
| | | | |
| 11 | | 10-7-6-1 | (10-0-12-0) |
| | | | |
| 12 | | | |
| | | | PID = Photoionization Device |
| 13 | | | EX = Explosimeter |
| | | | HC = Hydrocarbon |

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

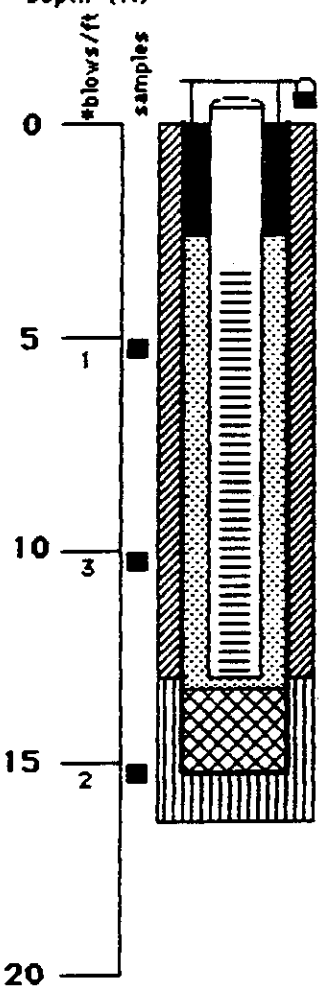
Project : Chevron/Philadelphia Refinery

Boring/Well No. - A91

Project No. 113-950-032

Date M.W. completed 10/21/86

Supervising D & M Geologist David Wagner




Description

CL — Clay with some silt, blackish-brown, very soft, saturated; organics; petroleum odor

Decreased clay; silt and clay

ML — Inceased silt; silt with some clay; weak petroleum odor

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Lambert, Inc. |
| Drilling Completed - | 10/21/86 |
| Type of Rig - | Hollow Stem Auger |
| **CONSTRUCTION DATA** | |
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3'-13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | |
| **MEASUREMENTS(NGVD)** | |
| Top of Casing Elevation - | 10.85' |
| Static Water Level Elevation - | 5.93' |
| Date Measured - | 1/14/87 |
| Surface Elevation - | 7.85' |
| **TEST DATA** | |
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

**WELL CONSTRUCTION KEY**

- FILTER PACK
- BENTONITE SEAL
- CONCRETE
- CAVE IN MATERIAL

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

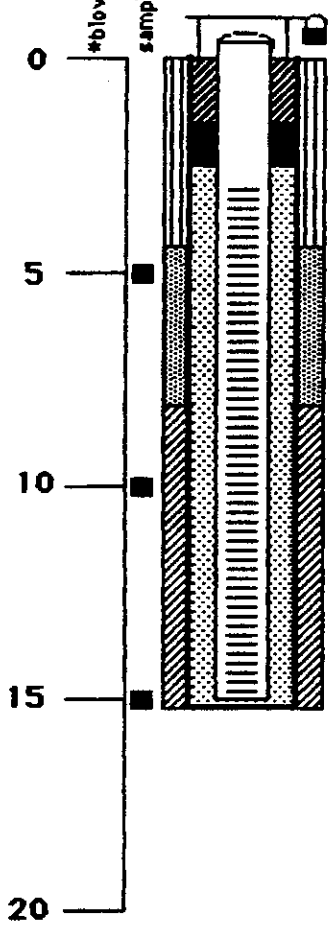
Project : Chevron/Philadelphia Refinery

Boring/Well No. - B39

Project No. 113-909-032

Date M.W. completed 2/19/86

Supervising D & M Engineer/Geologist David Wagner




Description

Sandy silt with trace clay, black-brown-grey, very moist, loose

Silty sand with some gravel

visible product, black-brown, oily

Silty clay with clay lenses, black-brown, organic content increasing toward bottom; wood fragments

increasing silt

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/19/86 |
| Type of Rig - | Hollow Stem Auger |
| **CONSTRUCTION DATA** | |
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 3'-15' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |
| **MEASUREMENTS (NGVD)** | |
| Top of Casing Elevation - | 8.73' |
| Static Water Level Elevation - | 6.68' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 8.33' |
| **TEST DATA** | |
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

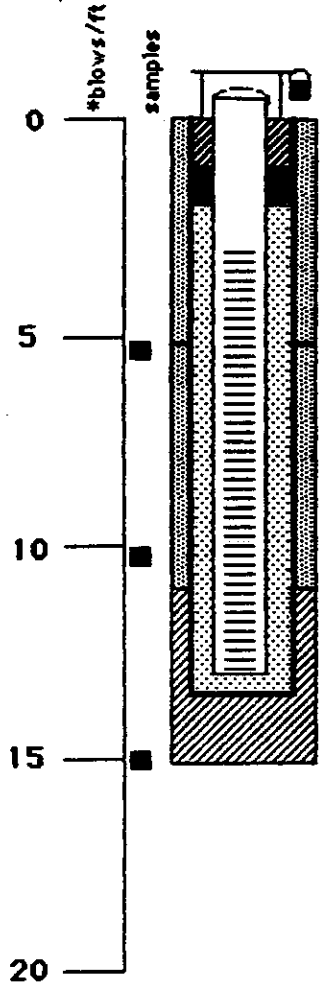
Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/18/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - B40




| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/18/86 |
| Type of Rig - | Hollow Stem Auger |
| **CONSTRUCTION DATA** | |
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |
| **MEASUREMENTS (NGVD)** | |
| Top of Casing Elevation - | 7.17' |
| Static Water Level Elevation - | 5.56' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 7.17' |
| **TEST DATA** | |
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project :Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/21/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - B41

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/21/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

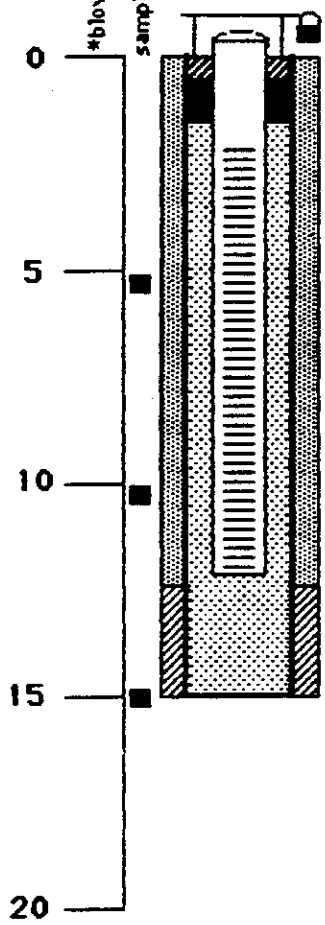
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 12' |
| Screen Setting - | 2' - 12' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 8.85' |
| Static Water Level Elevation- | 6.77' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 8.78' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project :Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/19/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - B42

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/19/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

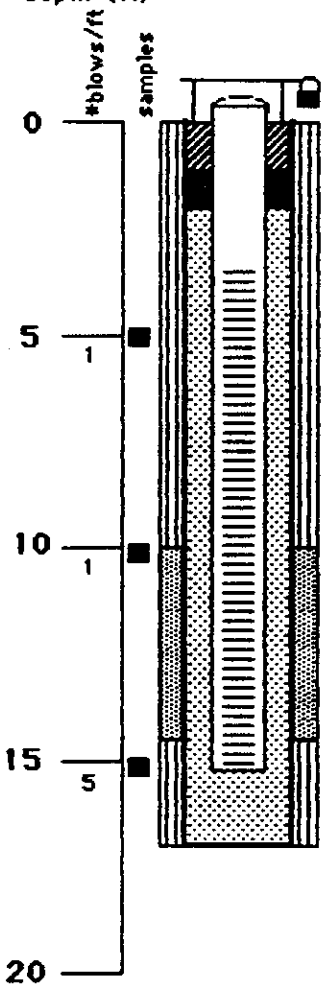
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 17' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 2.5' - 15' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

**MEASUREMENTS (NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 8.04' |
| Static Water Level Elevation- | 7.11' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 8.04' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Silt with some sand and cobbles, dark grey, very soft; petroleum odor

Clayey silt with trace sand and wood, greenish -grey, very soft

Grades to silty sand with trace gravel, dark grey-brown

Silt, laminated, greenish brown, medium stiff

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/19/85

Supervising D & M Engineer/Geologist David Wagner

Boring/Well No. - B43

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/19/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

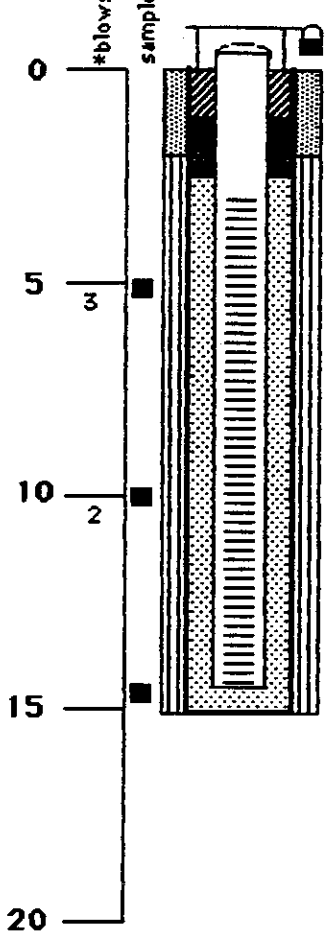
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 14.5' |
| Screen Setting - | 3' - 14.5' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 9.36' |
| Static Water Level Elevation - | 4.30' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 9.28' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

SM — Silty sand with some pebbles and cobbles, black-brown, moist; (fill)

ML — Silty clay, with coarse sand, black-brown, fairly moist; brick fragments, (fill)

very moist

Silty to sandy clay, black-brown; (fill)

mica flakes

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION DETAILS

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/20/86

Supervising D & M Engineer/Geologist Blake Moyer, Jr.

Boring/Well No. - B44

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/20/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

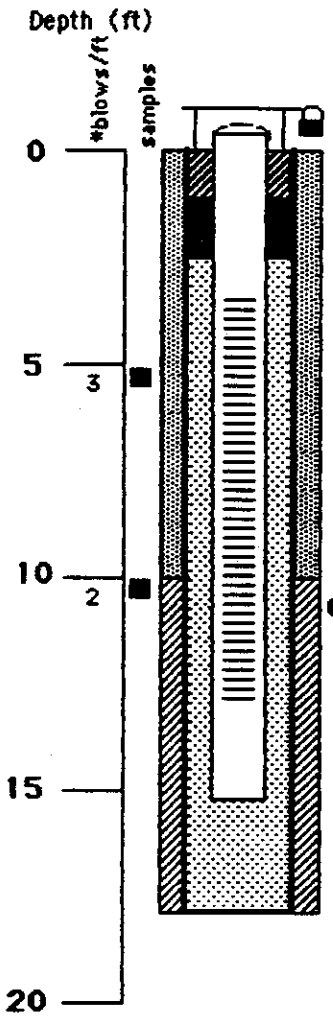
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 17' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 8.21' |
| Static Water Level Elevation - | 6.16' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 7.97' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

SP/SM: Medium to coarse silty sand with trace gravel, brownish-black, slightly moist, soft; gasoline odor; (fill)

CL: Silty clay with trace organic matter, greyish -brown, very moist, very soft

brownish-black

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/20/86

Supervising D & M Engineer/Geologist Blake Moyer, Jr.

Boring/Well No. - B45

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/20/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

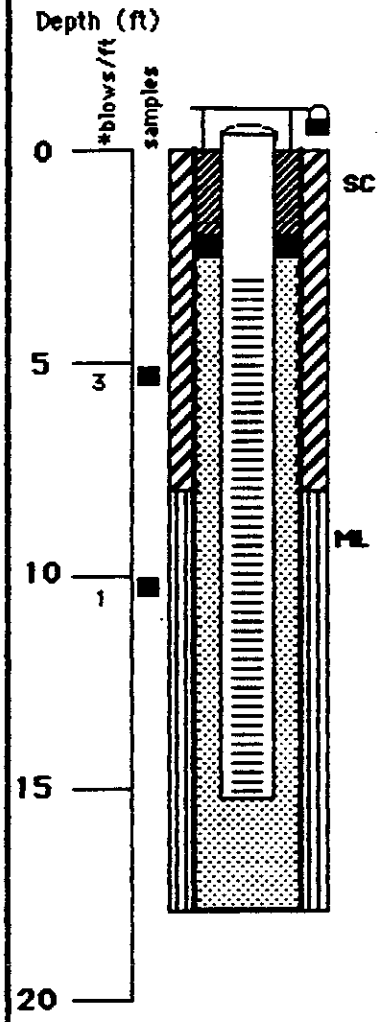
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 17' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 3' - 15' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 7.30' |
| Static Water Level Elevation - | 5.70' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 6.98' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Sandy clay with fine to medium, silt and gravel, black, very moist to wet, soft; (fill)

Silty clay to clayey silt with trace fine sand, brownish-black, very moist to wet, very soft;

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/21/86

Supervising D & M Engineer/Geologist David Wagner

Boring/Well No. - B46

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/21/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

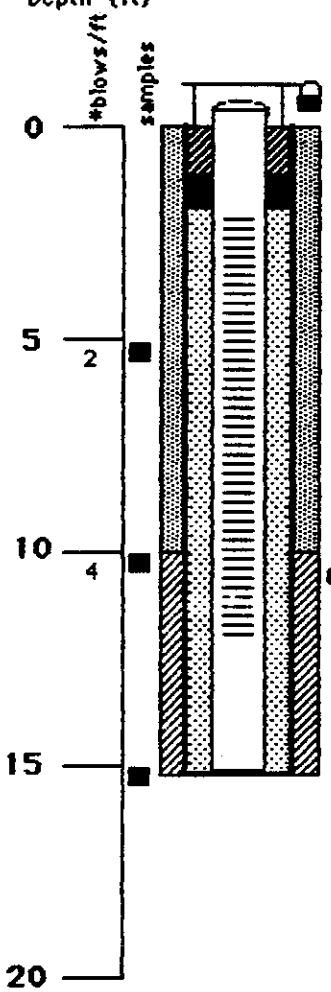
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 2' - 12' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 10.56' |
| Static Water Level Elevation - | 9.03' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 10.47' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Silty sand to sandy silt, with trace gravel, brownish-grey, wet to saturated

Grading to silty sand with gravel, brownish-grey, saturated

Silty clay, grey-brown, saturated

trace organics

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/21/86

Supervising D & M Engineer/Geologist David Wagner

Boring/Well No. - B47

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/21/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

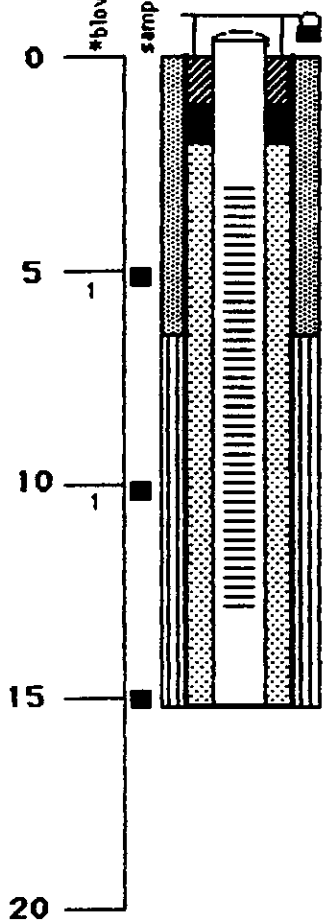
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 10.56' |
| Static Water Level Elevation - | 7.28' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 10.32' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

SM — Silty sand with trace gravel, brown, moist, loose

changes to grey-brown, very moist

trace mica flakes

ML — Sandy silt with sand lense and trace clay, very moist

wet to saturated

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/21/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - B48

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/21/86 |
| Type of Rig | Hollow Stem Auger |

CONSTRUCTION DATA

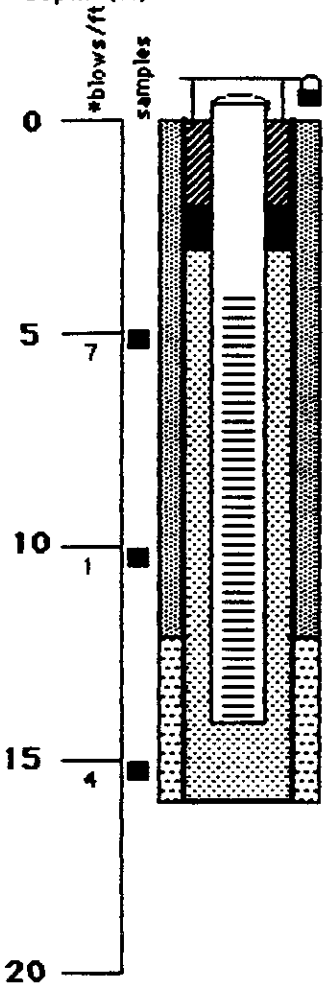
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 16' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 14' |
| Screen Setting - | 4' - 14' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 8.90' |
| Static Water Level Elevation - | 8.35' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 8.90' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - B48D

Project No. 113-950-032

Date M.W. completed 11/6/86

Supervising D & M Geologist David Wagner

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Lambert, Inc. |
| Drilling Completed - | 11/6/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

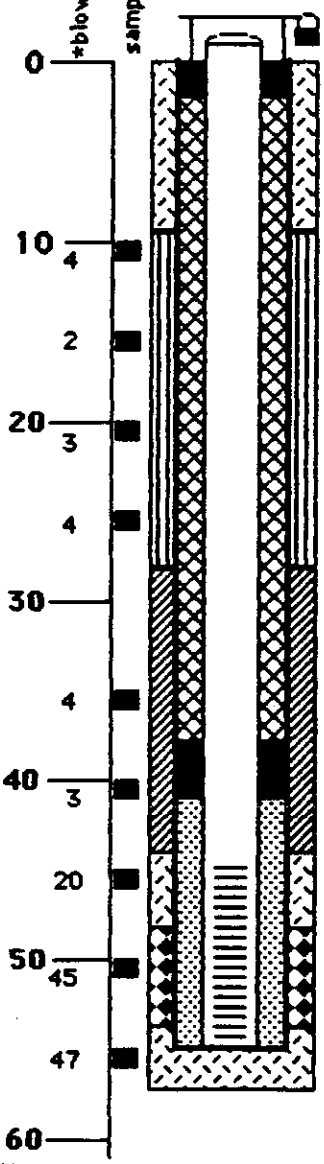
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 55' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 55' |
| Screen Setting - | 45' - 55' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | |

**MEASUREMENTS(NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 9.82' |
| Static Water Level Elevation - | -2.17' |
| Date Measured - | 12/22/86 |
| Surface Elevation - | 8.90' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




| | |
|---|---|
| SW | Fine to coarse sand with little to some fine gravel, little clay and silt, very dark brown, soft, saturated; strong petroleum odor |
| ML | Silt with little clay, very dark brown, soft, very moist; micaceous; strong petroleum odor |
| | Increasing clay; some clay with abundant organics |
| | Increasing clay; silt and clay |
| | Decreasing clay; some clay and trace fine sand; organics; weak petroleum odor |
| CL | Clay with some silt, dark gray, soft, very moist; organics; very weak petroleum odor SHELBY TUBE taken from 30' to 31.5' |
| SW | Fine to coarse sand with some fine gravel, trace silt, reddish-brown, medium dense, saturated |
| GP | Fine gravel with little to some fine to coarse sand, trace silt and clay, dark reddish-brown, dense, saturated; micaceous |
| SW | Fine to coarse sand with some fine gravel, light reddish-brown to light reddish-gray, dense, saturated |

**WELL CONSTRUCTION KEY**

- FILTER PACK
- BENTONITE SEAL
- BENTONITE GROUT
- CAVE IN MATERIAL
- CONCRETE

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

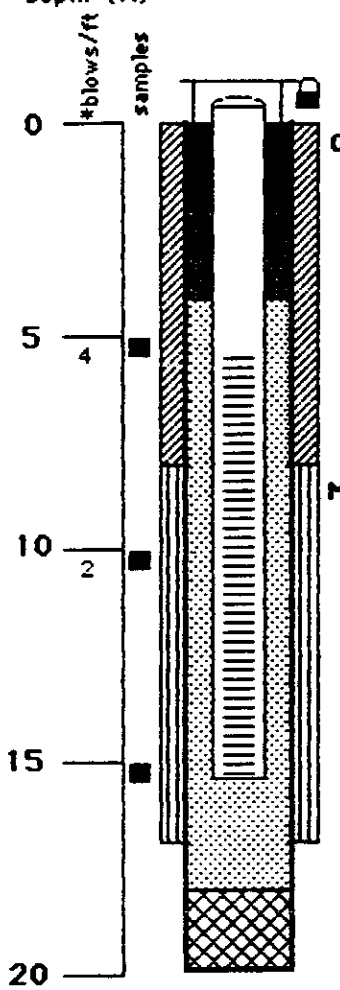
Project : Chevron/Philadelphia Refinery

Boring/Well No. - B92

Project No. 113-950-032

Date M.W. completed 10/21/86

Supervising D & M Geologist David Wagner




Description

CL — Clay with little silt, trace fine sand, blackish - brown, very soft, saturated; organics; petroleum odor

ML — Increased silt; silt with some clay

Decreased clay; little to some clay

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Lambert, Inc. |
| Drilling Completed - | 10/21/86 |
| Type of Rig - | Hollow Stem Auger |
| **CONSTRUCTION DATA** | |
| Borehole Diam. - | 10" |
| Borehole Depth - | 20' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15.5' |
| Screen Setting - | 5.5' - 15.5' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | |
| **MEASUREMENTS(NGVD)** | |
| Top of Casing Elevation - | 12.33' |
| Static Water Level Elevation - | 7.19' |
| Date Measured - | 1/14/87 |
| Surface Elevation - | 9.33' |
| **TEST DATA** | |
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

**WELL CONSTRUCTION KEY**

- FILTER PACK
- BENTONITE SEAL
- CONCRETE
- CAVE IN MATERIAL

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

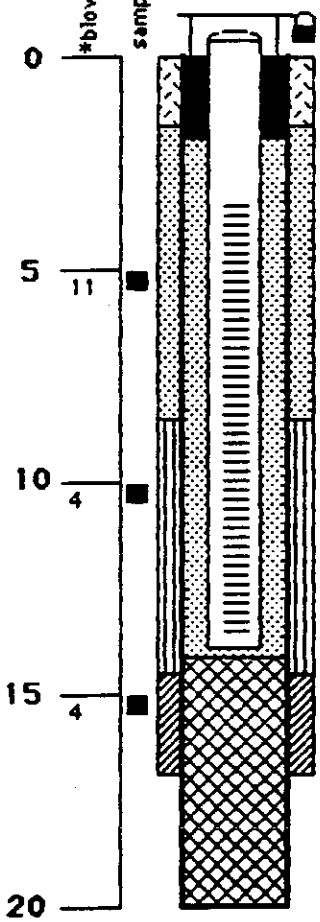
Project : Chevron/Philadelphia Refinery

Boring/Well No. - B93

Project No. 113-950-032

Date M.W. completed 10/22/86

Supervising D & M Geologist David Wagner




| | Description |
|---|---|
| SW | Fine to coarse sand with little silt and little to some fine gravel, very dark brown, loose, slightly moist |
| SP | Fine to medium sand with little coarse sand and little silt, blackish - brown, medium dense, saturated; micaceous; petroleum odor; sheen on water |
| ML | Silt with little to some clay, dark - brownish - gray, soft, saturated; micaceous; weak petroleum odor |
| CL | Increased clay; clay with little to some silt |

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Lambert, Inc. |
| Drilling Completed - | 10/22/86 |
| Type of Rig - | Hollow Stem Auger |
| **CONSTRUCTION DATA** | |
| Borehole Diam. - | 10" |
| Borehole Depth - | 20' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13.5' |
| Screen Setting - | 3.5' - 13.5' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | |
| **MEASUREMENTS (NGVD)** | |
| Top of Casing Elevation - | 12.83' |
| Static Water Level Elevation - | 7.79' |
| Date Measured - | 1/14/87 |
| Surface Elevation - | 9.83' |
| **TEST DATA** | |
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

**WELL CONSTRUCTION KEY**

FILTER PACK
BENTONITE SEAL
CONCRETE
CAVE IN MATERIAL

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - B94

Project No. 113-950-032

Date M.W. completed 10/22/86

Supervising D & M Geologist David Wagner

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Lambert, Inc. |
| Drilling Completed - | 10/22/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

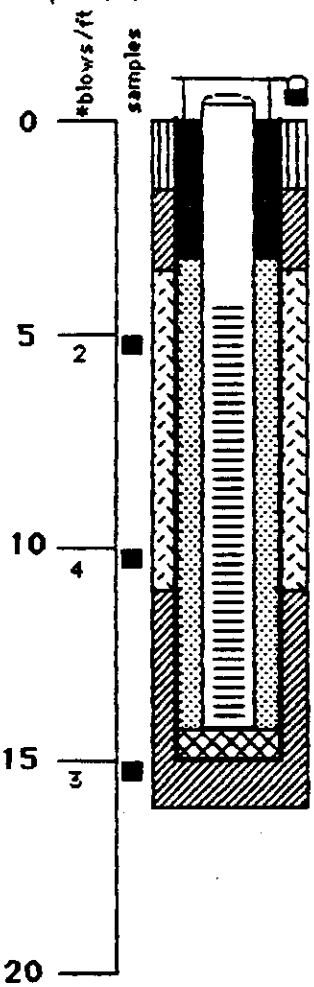
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 14' |
| Screen Setting - | 4' - 14' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | |

**MEASUREMENTS (NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 11.21' |
| Static Water Level Elevation - | 5.11' |
| Date Measured - | 1/14/87 |
| Surface Elevation - | 8.03' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




| | Description |
|---|---|
| ML | Silt and fine to coarse sand and fine gravel, dark gray, loose, moist |
| CL | Clay with little to some silt, trace fine to medium sand, dark gray, soft, moist; micaceous |
| SW | Fine to coarse sand with fine gravel, little silt, trace clay, dark brown, loose, saturated; weak petroleum odor; sheen on water |
| CL | Clay with some silt, dark gray, soft, saturated; micaceous |

**WELL CONSTRUCTION KEY**

- FILTER PACK
- BENTONITE SEAL
- CONCRETE
- CAVE IN MATERIAL

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project :Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/22/86

Supervising D & M Engineer/Geologist T. Helgason

Boring/Well No. - C49

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Drill Consult |
| Drilling Completed - | 2/22/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

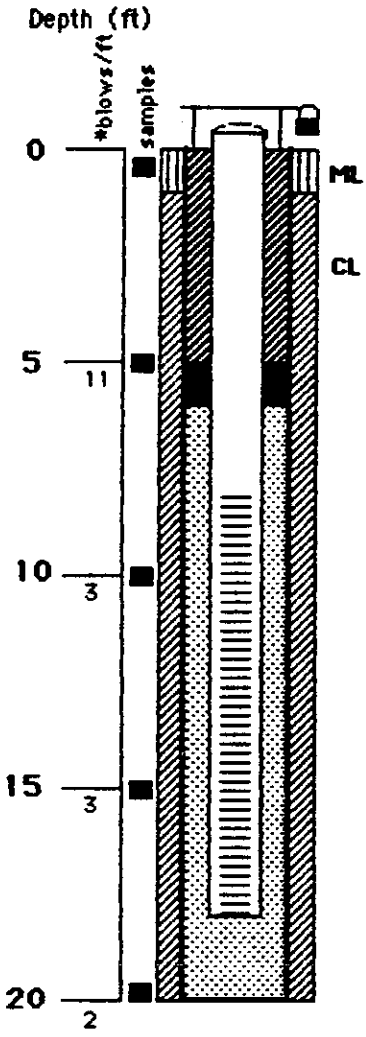
| | |
|---|---|
| Borehole Diam. - | 7" |
| Borehole Depth - | 20' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 18' |
| Screen Setting - | 8' - 18' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 12.16' |
| Static Water Level Elevation - | 5.94' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 10.92' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Gravelly silt with trace brick fragments, brown

Silty clay with some fine sand, greyish-brown, slightly moist

petroleum odor, decomposed material

trace coarse sand, wet

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project :Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/22/86

Supervising D & M Engineer/Geologist E.J. Fillo

Boring/Well No. - C50

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Drill Consult |
| Drilling Completed - | 2/22/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

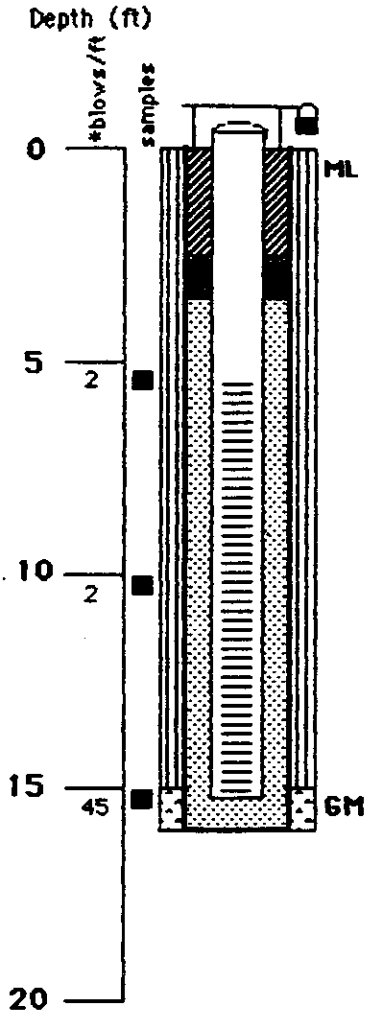
| | |
|---|---|
| Borehole Diam. - | 7" |
| Borehole Depth - | 16' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' 6" |
| Screen Setting - | 5' 6" - 15' 6" |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 15.35' |
| Static Water Level Elevation- | 4.71' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 11.14' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - C50D

Project No. 113-950-032

Date M.W. completed 11/4/86

Supervising D & M Geologist David Wagner

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Lambert, Inc. |
| Drilling Completed - | 11/4/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

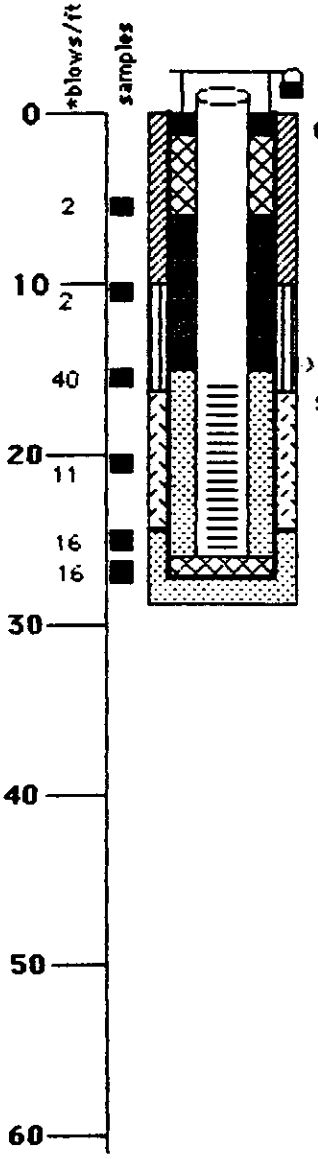
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 27' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 26' |
| Screen Setting - | 16' - 26' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | |

MEASUREMENTS(NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 13.76' |
| Static Water Level Elevation - | 1.43' |
| Date Measured - | 12/22/86 |
| Surface Elevation - | 10.97' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

CL — Clay with some silt, blackish-gray, very soft, saturated; micaceous; organics; petroleum odor
SHELBY TUBE taken from 7' to 9'

ML — Increased silt; silt with some clay; strong petroleum odor

Little to some fine sand

SW — Fine to coarse sand with some fine gravel, medium brown, dense, saturated
Increasing gravel; sand and gravel, trace silt and clay

SP — Decreased fine gravel; fine to medium sand with trace to little gravel; petroleum odor

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- BENTONITE GROUT
- CAVE IN MATERIAL
- CONCRETE

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Blake Moyer, Jr.

Boring/Well No. - C51

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Drill Consult |
| Drilling Completed - | 2/25/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

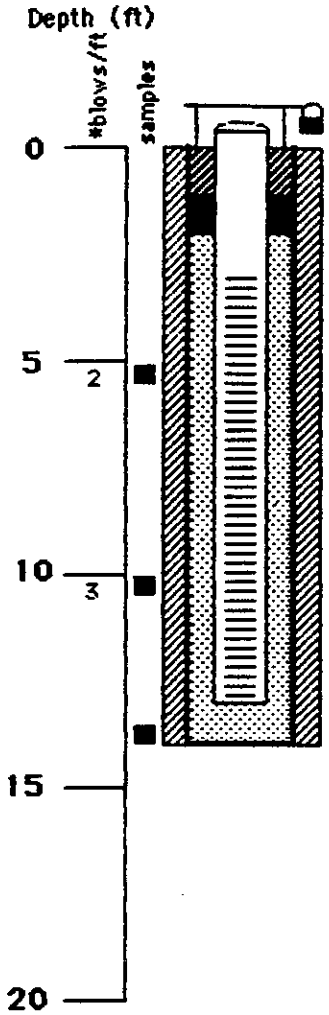
| | |
|---|---|
| Borehole Diam. - | 7" |
| Borehole Depth - | 14' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 10.71' |
| Static Water Level Elevation - | 7.86' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 9.06' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Blake Moyer, Jr.

Boring/Well No. - C52

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Drill Consult |
| Drilling Completed - | 2/25/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

| | |
|---|---|
| Borehole Diam. - | 7" |
| Borehole Depth - | 14' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

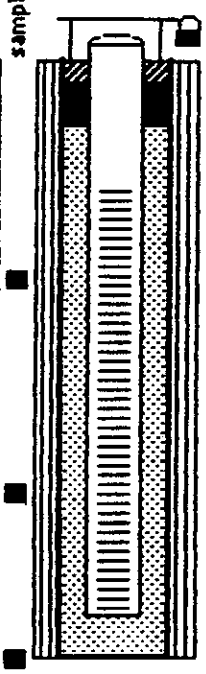
MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 10.14' |
| Static Water Level Elevation - | 2.91' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 9.07' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

| Depth (ft) | *blows/ft | samples | Description |
|---|---|---|---|
| 0 | | | |
| 5 | 2 | | CL Silty clay with trace organics, reddish-brown, moist, very soft |
| 10 | 2 | | trace sand, soft |
| 15 | | | greyish-black, moist to wet, petroleum odor |
| 20 | | | |



Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist T. Helgason

Boring/Well No. - C53

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Drill Consult |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

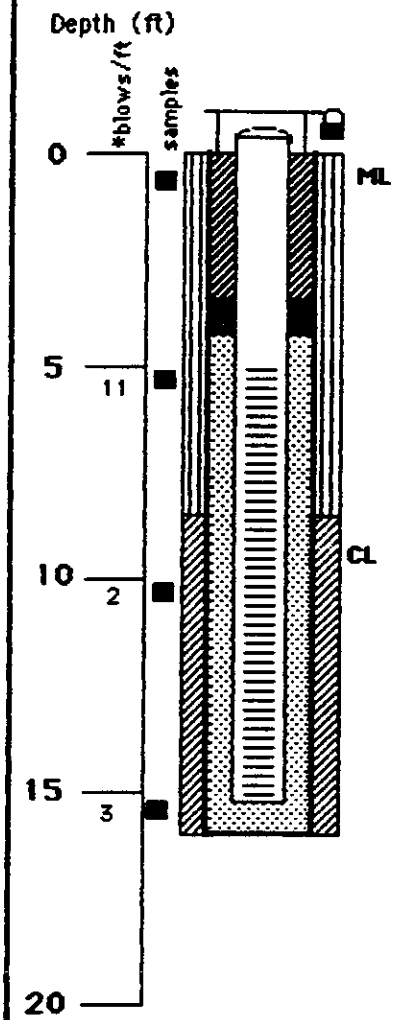
| | |
|---|---|
| Borehole Diam. - | 7" |
| Borehole Depth - | 16' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 5' - 15' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

**MEASUREMENTS (NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 11.93' |
| Static Water Level Elevation - | 6.78' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 10.13' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

ML — Clayey silt to silty sand with some fine sand, trace brick fragments and gravel, black; (fill)

Sandy silt, fine

CL — Silty clay with trace fine sand, black

grading to gray, less fine sand

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist T. Helgason

Boring/Well No. - C54

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Drill Consult |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

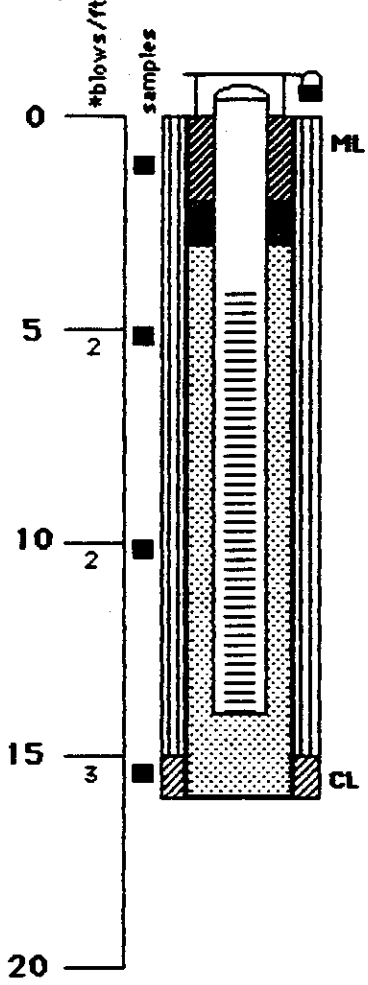
| | |
|---|---|
| Borehole Diam. - | 7" |
| Borehole Depth - | 16' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 14' |
| Screen Setting - | 4' - 14' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

**MEASUREMENTS (NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 9.58' |
| Static Water Level Elevation - | 8.44' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 8.26' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Clayey silt with some fine sand and trace cobbles, black

Sandy silt with trace brick fragments, black; (fill)

trace fine to coarse sand

Silty clay with trace wood blackish-grey,

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOOI

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist David Wagner

Boring/Well No. - C55

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Warren George |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

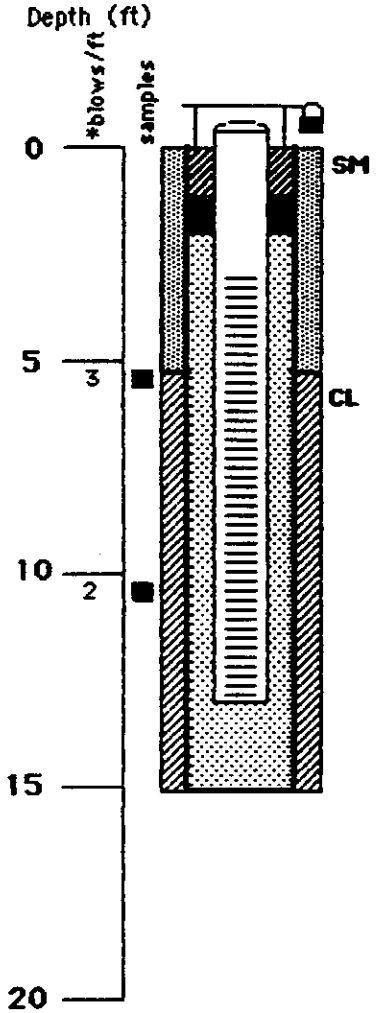
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 5' - 15' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 12.21' |
| Static Water Level Elevation - | 6.73' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 8.31' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Silty sand with some gravel and trace brick, brown-grey, moist, loose

Silty clay with some sand and gravel, brown-grey, moist, loose

wet

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist T. Helgason

Boring/Well No. - C56

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Drill Consult |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

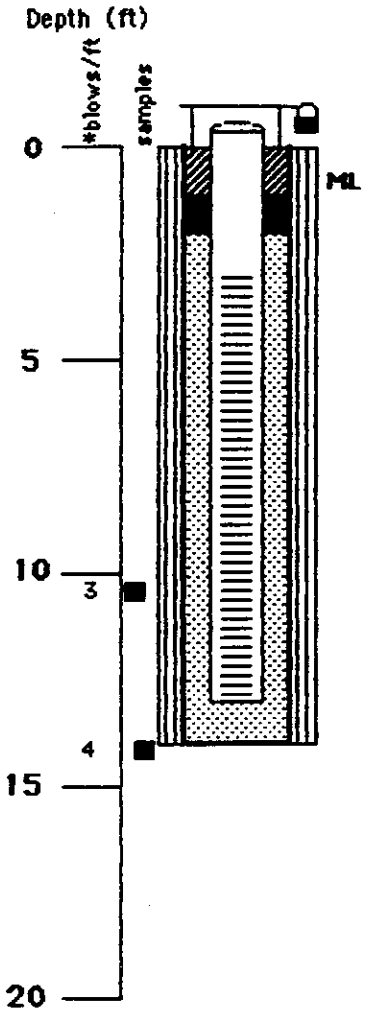
| | |
|---|---|
| Borehole Diam. - | 7" |
| Borehole Depth - | 14' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 11.77' |
| Static Water Level Elevation - | 9.39' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 10.04' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Clayey silt with some fine to coarse sand, trace cobbles and trace brick fragments, blackish-grey

trace fine sand

trace wood

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist T. Helgason

Boring/Well No. - C57

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Drill Consult |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

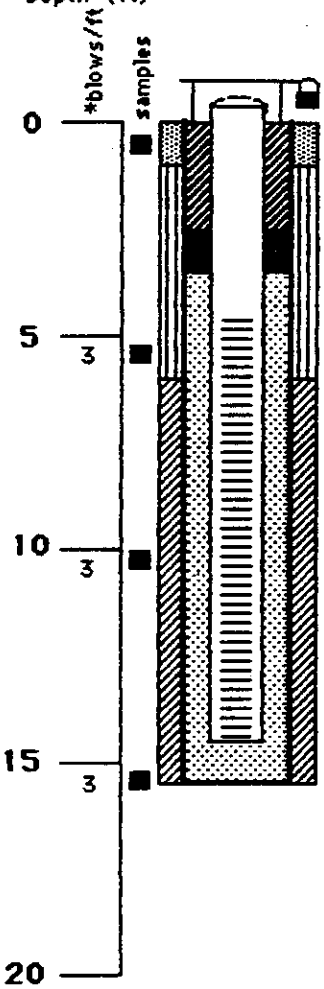
| | |
|---|---|
| Borehole Diam. - | 7" |
| Borehole Depth - | 15' 6" |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 14' 6" |
| Screen Setting - | 4' 6" - 14' 6" |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

**MEASUREMENTS (NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 10.77' |
| Static Water Level Elevation - | 7.67' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 10.61' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

**SM** Silty sand, fine, brown

**ML** Clayey silt with some fine sand, black

**CL** Silty clay to clayey silt with some fine sand, black; wood fragments

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/29/86

Supervising D & M Engineer/Geologist Dave Wagner

Boring/Well No. - C58

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Drill Consult |
| Drilling Completed - | 2/29/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

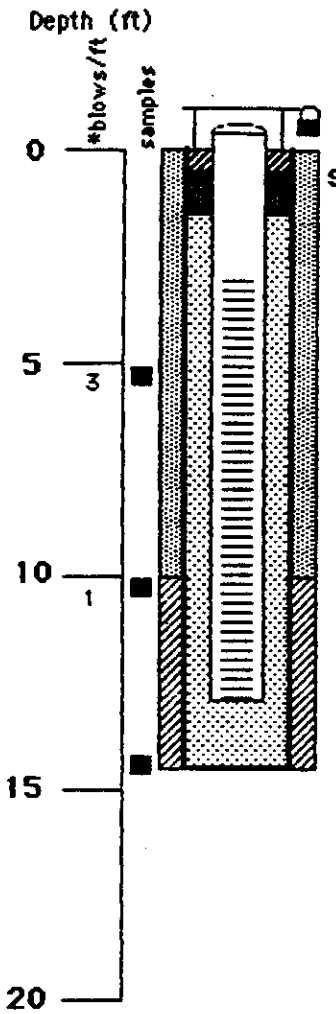
| | |
|---|---|
| Borehole Diam. - | 7" |
| Borehole Depth - | 14' 6" |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

**MEASUREMENTS (NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 9.75' |
| Static Water Level Elevation - | 8.57' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 9.58' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

SM — Silty sand with trace clay and gravel, black, wet, loose

CL — Silty clay with trace organics, black-brown, wet, loose

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery.

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist David Wagner

Boring/Well No. - C59

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Drill Consult |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

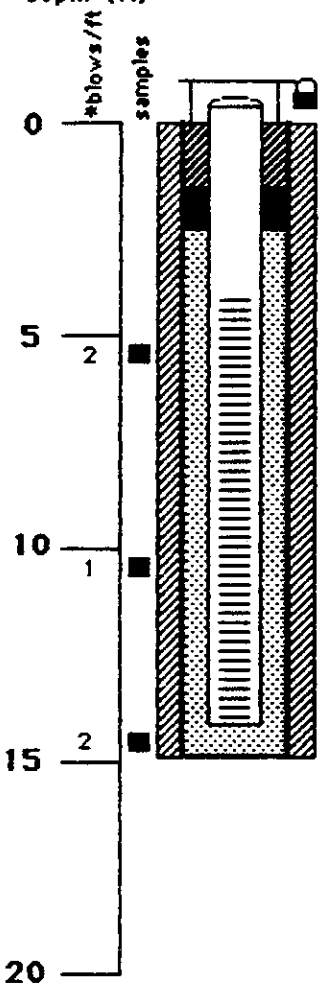
| | |
|---|---|
| Borehole Diam. - | 7" |
| Borehole Depth - | 15' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 14' |
| Screen Setting - | 4' - 14' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 9.75' |
| Static Water Level Elevation - | 8.73' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 9.67' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Silty clay with some gravel, black, moist, loose

black-brown

wet to saturated

trace sand, very moist

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Dave Wagner

Boring/Well No. - C60

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Drill Consult |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

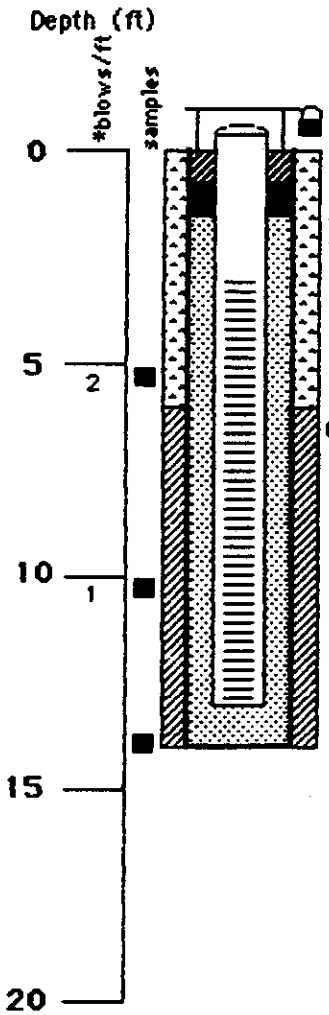
| | |
|---|---|
| Borehole Diam. - | 7" |
| Borehole Depth - | 14' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 9.85' |
| Static Water Level Elevation - | 6.05' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 8.61' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Blake Moyer, Jr.

Boring/Well No. - C61

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Drill Consult |
| Drilling Completed - | 2/25/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

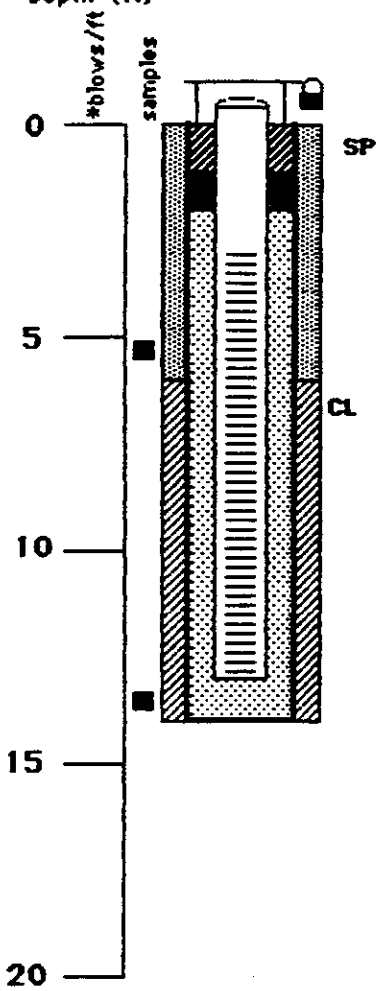
| | |
|---|---|
| Borehole Diam. - | 7" |
| Borehole Depth - | 14' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 11.27' |
| Static Water Level Elevation - | 7.72' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 9.87' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Sand with trace gravel

Silty clay with trace sand, brownish-black, slightly moist, very soft

very moist, soft

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project :Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Blake Moyer, Jr.

Boring/Well No. - C62

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Drill Consult |
| Drilling Completed - | 2/25/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

| | |
|---|---|
| Borehole Diam. - | 7" |
| Borehole Depth - | 14' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

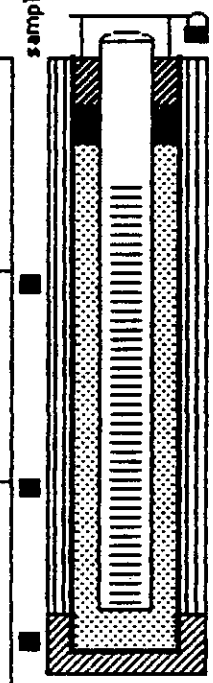
**MEASUREMENTS (NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 13.90' |
| Static Water Level Elevation - | 9.96' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 10.35' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

| Depth (ft) | *blows/ft | samples | Description |
|---|---|---|---|
| 0 | | | |
| 5 | 4 | | ML Silty clay with trace sand, reddish-brown, moist, soft |
| 10 | 2 | | trace organics, greyish-black, very moist |
| | | | moist to wet |
| 15 | | | CL Silty clay to clayey silt with trace very fine sand, very soft |
| 20 | | | |



Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist T. Helgason

Boring/Well No. - C63

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Drill Consult |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

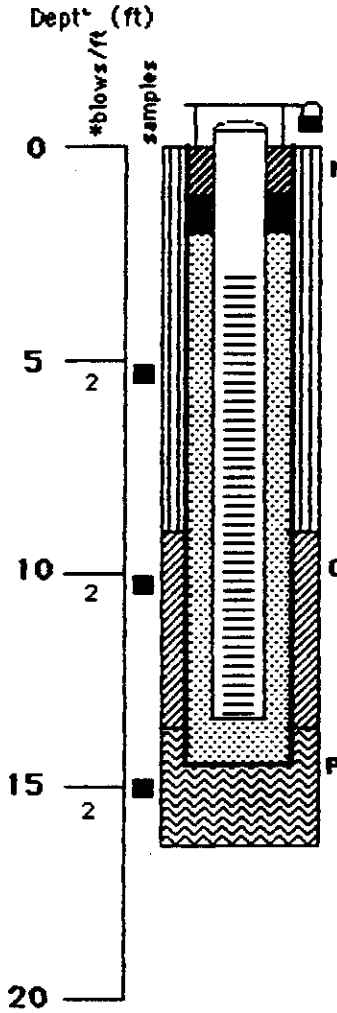
| | |
|---|---|
| Borehole Diam. - | 7" |
| Borehole Depth - | 17' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

**MEASUREMENTS (NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 9.22' |
| Static Water Level Elevation - | 4.02' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 7.82' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

ML — Sandy silt, fine, black

Clayey silt with some fine to coarse sand, blackish-grey

CL — Silty clay with trace wood, blackish grey

PT — Clayey peat with some wood

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Dave Wagner

Boring/Well No. - C64

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Drill Consult |
| Drilling Completed - | 2/24/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

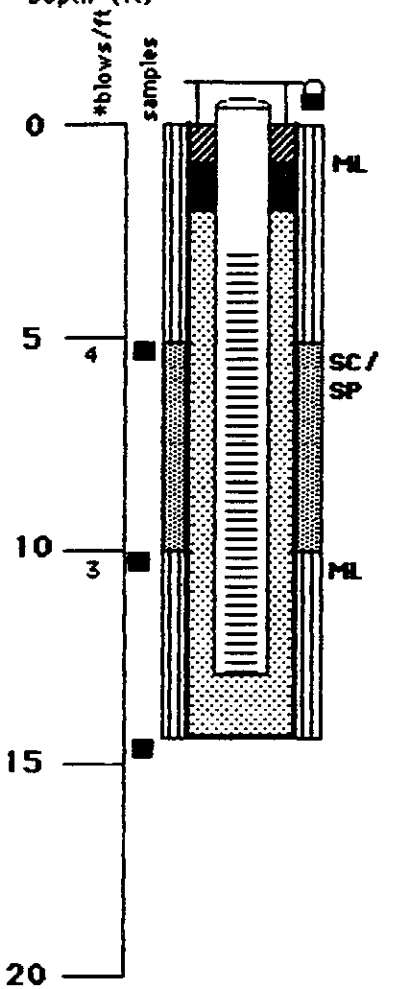
| | |
|---|---|
| Borehole Diam. - | 7" |
| Borehole Depth - | 14' 6" |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 10.21' |
| Static Water Level Elevtation - | 3.72' |
| Date Measured - | 1/13/87 |
| Surface Elevation - | 8.40' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Silty clay with gravel and brick, black-brown, moist; (fill)

Sandy clay with trace silt, gravel and brick, black-brown, very moist

Silty clay with trace organics, moist

wet

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Blake Moyer, Jr.

Boring/Well No. - C65

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Drill Consult |
| Drilling Completed - | 2/25/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

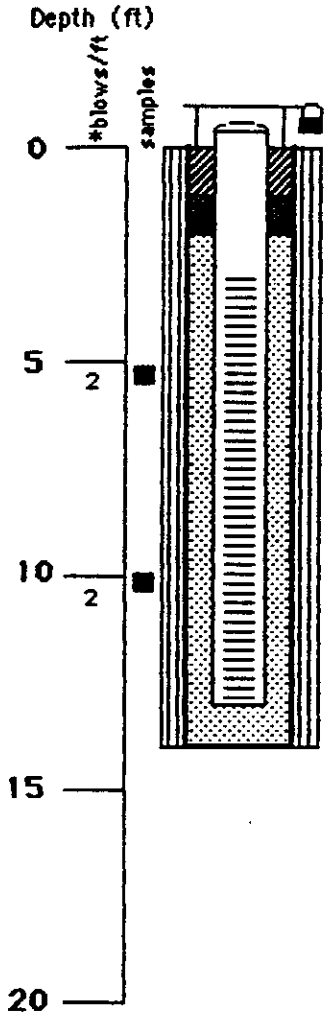
| | |
|---|---|
| Borehole Diam. - | 7" |
| Borehole Depth - | 14' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 13' |
| Screen Setting - | 3' - 13' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Cement/Bentonite |

MEASUREMENTS (NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 13.33' |
| Static Water Level Elevation - | Not Available |
| Date Measured - | 1/15/87 |
| Surface Elevation - | 9.70' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - C65D

Project No. 113-950-032

Date M.W. completed 11/11/86

Supervising D & M Geologist David Wagner

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Lambert, Inc. |
| Drilling Completed - | 11/11/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

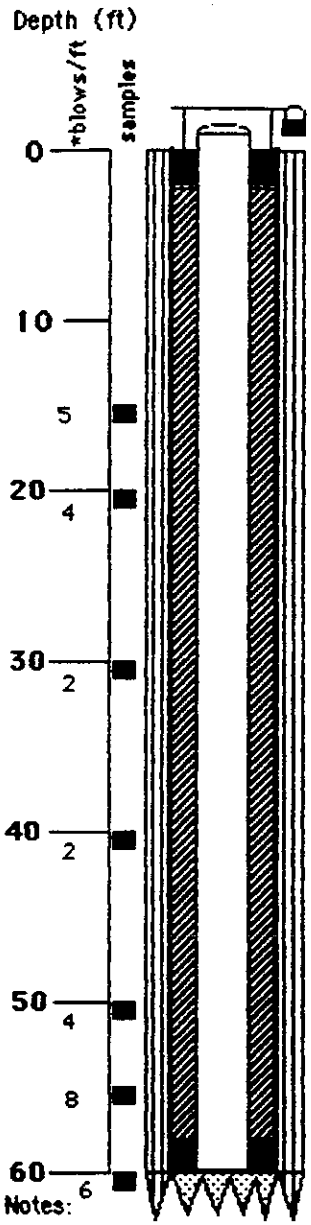
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 75' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 75' |
| Screen Setting - | 65' - 75' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | Bentonite |

**MEASUREMENTS(NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 11.96' |
| Static Water Level Elevation - | -2.16' |
| Date Measured - | 12/22/86 |
| Surface Elevation - | 9.94' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

ML Silt with trace to little fine to coarse sand, trace fine gravel, black, moist; strong petroleum odor; brick fragments

Silt with little clay, medium gray, soft, moist; organics

SHELBY TUBE taken from 25' to 27'
Trace mica

Decreasing density; very soft

Increasing density; soft
Decreasing clay; trace clay and trace fine sand

Increasing sand; little fine sand, stratified

**WELL CONSTRUCTION KEY**

- FILTER PACK
- BENTONITE SEAL
- BENTONITE GROUT
- CAVE IN MATERIAL
- CONCRETE

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.
** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - C65D **(Cont.)**

Project No. 113-950-032

Date M.W. completed 11/12/86

Supervising D & M Geologist David Wagner

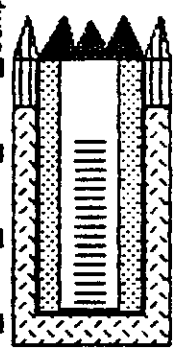
Location - Chevron Refinery

Driller - Lambert, Inc.

Drilling Completed - 11/12/86

Type of Rig - Hollow Stem Auger

| Depth (ft) | *blows/ft | samples | Description |
|---|---|---|---|
| 60 | 6 | | ML 1" interbeds of fine to coarse sand from 60' to 62' |
| | 94 | | SW Fine to coarse sand with little fine gravel, trace to little clay, trace silt, brownish-gray, medium dense, saturated |
| 70 | 25 | | |
| | 32,75/3" | | Decreasing clay; no clay |
| 80 | | | |
| 90 | | | |



**WELL CONSTRUCTION KEY**

- FILTER PACK
- BENTONITE SEAL
- BENTONITE GROUT
- CAVE IN MATERIAL
- CONCRETE

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

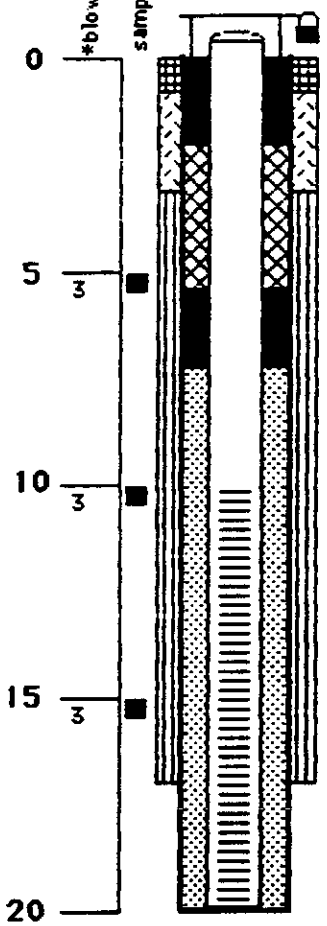
Project : Chevron/Philadelphia Refinery

Boring/Well No. - C95

Project No. 113-950-032

Date M.W. completed 10/22/86

Supervising D & M Geologist David Wagner




| | Description |
|---|---|
| | Macadam underlain by gravel |
| SW | Fine to coarse sand with some fine gravel, little silt, black, dry; brick fragments |
| ML | Silt with little to some clay, dark - gray, soft, moist; organics; micaceous; weak petroleum odor |
| | Increasing moisture; saturated |

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Lambert, Inc. |
| Drilling Completed - | 10/22/86 |
| Type of Rig - | Hollow Stem Auger |
| **CONSTRUCTION DATA** | |
| Borehole Diam. - | 10" |
| Borehole Depth - | 20' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 20' |
| Screen Setting - | 10' - 20' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | |
| **MEASUREMENTS(NGVD)** | |
| Top of Casing Elevation - | 14.84' |
| Static Water Level Elevation - | 8.71' |
| Date Measured - | 1/14/87 |
| Surface Elevation - | 12.38' |
| **TEST DATA** | |
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

**WELL CONSTRUCTION KEY**

- FILTER PACK
- BENTONITE SEAL
- CONCRETE
- CAVE IN MATERIAL

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-950-032

Date M.W. completed 10/23/86

Supervising D & M Geologist David Wagner

Boring/Well No. - C96

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Lambert, Inc. |
| Drilling Completed - | 10/23/86 |
| Type of Rig - | Hollow Stem Auger |

**CONSTRUCTION DATA**

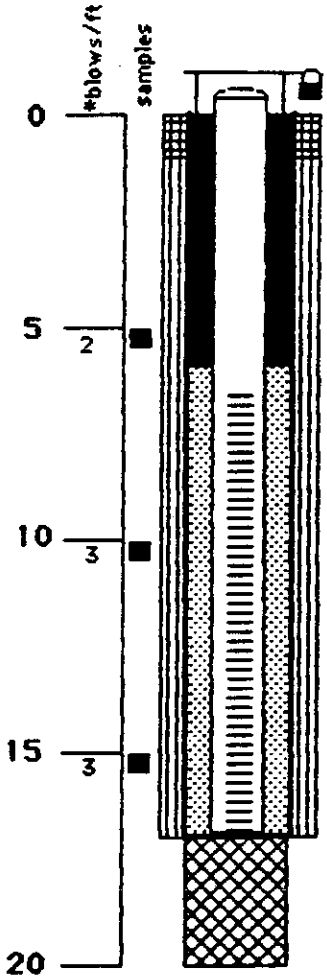
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 20' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 17' |
| Screen Setting - | 7' - 17' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | |

**MEASUREMENTS(NGVD)**

| | |
|---|---|
| Top of Casing Elevation - | 14.61' |
| Static Water Level Elevation - | 9.96' |
| Date Measured - | 1/14/87 |
| Surface Elevation - | 11.51' |

**TEST DATA**

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

Slag, silt and sand

ML Silt with little to some clay and trace fine sand, dark - gray, soft, slightly moist, organics; micaceous; petroleum odor

Increased moisture; moist

Increased moisture; saturated

Increased organics

**WELL CONSTRUCTION KEY**

FILTER PACK
BENTONITE SEAL
CONCRETE
CAVE IN MATERIAL

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - C97

Project No. 113-950-032

Date M.W. completed 10/23/86

Supervising D & M Geologist David Wagner

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Lambert, Inc. |
| Drilling Completed - | 10/23/86 |
| Type of Rig - | Hollow Stem Auger |

CONSTRUCTION DATA

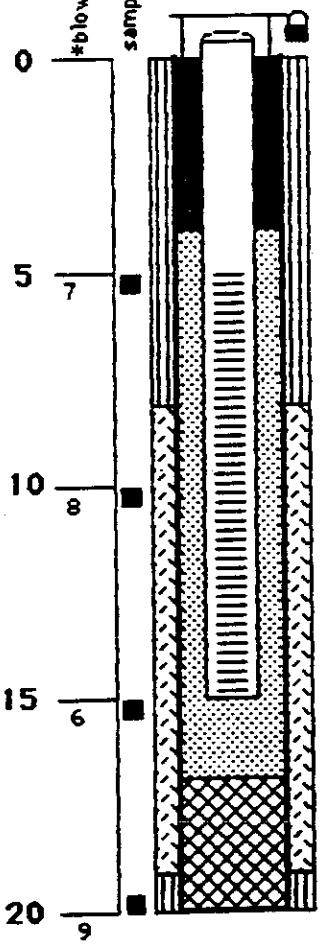
| | |
|---|---|
| Borehole Diam. - | 10" |
| Borehole Depth - | 20' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 15' |
| Screen Setting - | 5' - 15' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | |

MEASUREMENTS(NGVD)

| | |
|---|---|
| Top of Casing Elevation - | 13.07' |
| Static Water Level Elevation - | 3.17' |
| Date Measured - | 1/14/87 |
| Surface Elevation - | 9.68' |

TEST DATA

| | |
|---|---|
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |




Description

ML Silt with little to some clay, little fine gravel, trace fine to coarse sand, blackish - brown, soft, slightly moist to moist; brick fragments; petroleum odor

SW Fine to coarse sand with some fine gravel, little silt, little clay, blackish - gray and brown, loose, saturated; brick fragments; strong petroleum odor; sheen on water

ML Silt with some clay, blackish-gray, soft, very moist; organics; petroleum odor

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- CONCRETE
- CAVE IN MATERIAL

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

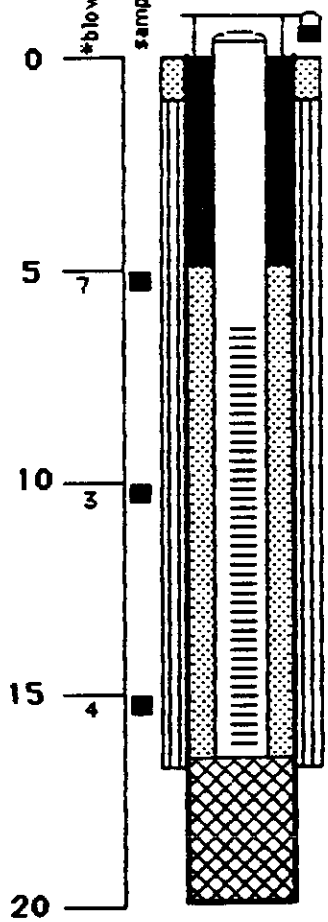
Project : Chevron/Philadelphia Refinery

Boring/Well No. - C98

Project No. 113-950-032

Date M.W. completed 10/23/86

Supervising D & M Geologist David Wagner




Description

SP Fine to medium sand and gravel

ML Silt with little clay, little to fine to medium sand, little to some fine gravel, grayish - black, medium stiff, moist; micaceous; glass and brick fragments; strong petroleum odor

Silt with some clay, grayish - brown, soft, moist, weak petroleum odor

Increasing moisture; saturated

| | |
|---|---|
| Location - | Chevron Refinery |
| Driller - | Lambert, Inc. |
| Drilling Completed - | 10/23/86 |
| Type of Rig - | Hollow Stem Auger |
| **CONSTRUCTION DATA** | |
| Borehole Diam. - | 10" |
| Borehole Depth - | 20' |
| Casing/Screen Type - | PVC |
| Casing Diam. - | 4" |
| Casing Depth - | 16.5' |
| Screen Setting - | 6.5' - 16.5' |
| Slot Width - | 0.02" |
| Type of Seal - | Bentonite |
| Type of Filterpack - | #2 Sand |
| Type of Grout - | |
| **MEASUREMENTS(NGVD)** | |
| Top of Casing Elevation - | 12.90' |
| Static Water Level Elevation - | 5.98' |
| Date Measured - | 1/14/87 |
| Surface Elevation - | 9.47' |
| **TEST DATA** | |
| Pump Type - | |
| Depth to Intake (ft) - | |
| Satic Water Level (ft) - | |
| Pumping Water Level (ft) - | |
| Drawdown (ft) - | |
| Length of Test (Hrs) - | |

**WELL CONSTRUCTION KEY**

FILTER PACK

BENTONITE SEAL

CONCRETE

CAVE IN MATERIAL

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

# APPENDIX C

# FIELD PROCEDURES

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# 1.0 SOIL GAS SURVEYS PROCEDURES

The purpose of soil gas surveys was to evaluate the extent and degree of volatile organic compounds in the subsurface soil gas. The following section describes the appropriate procedures for the soil gas surveys including sample collection and analysis, and calibration of the portable gas chromatograph (GC). The sampling plan was prepared in consideration of site plans showing underground piping, utilities, and aboveground structures that could potentially interfere with the sampling activities. In the event that unknown factors interfered with the sampling at the planned locations, the sampling point was shifted to an alternate nearby location.

Soil gas surveys were performed at SWMU Nos. 11/12, 29, and 71A to evaluate the extent and degree of volatile organic compounds (VOCs) in the subsurface soil gas. The soil gas surveys were performed at these SWMUs between July 27, 1992 and July 28, 1992. The data derived from these surveys was used to evaluate the potential for hazardous waste releases from the SWMUs and aid in the placement of soil borings.

## 1.1 SAMPLE COLLECTION

A borehole was advanced with a 7/8-inch-diameter stainless steel rod to a depth of 4 or 6 feet below ground surface (BGS). At some locations, where ground water or obstructions precluded the collection of soil gas samples at these depths, samples were collected from shallower depths ranging from 1.5 to 3 feet BGS.

When the desired depth was reached, the stainless steel rod was removed and a 3/16-inch-diameter steel tube was lowered into the hole to approximately 6 inches above the bottom of the borehole. The annular space between the borehole wall and the steel tube was plugged at the ground surface to prevent the influx of atmospheric air that could alter the analytical results of the sample.

## 1.2 SAMPLE ANALYSIS

Soil gas vapors were extracted from the borehole using a peristaltic pump, connected to the steel tube by teflon tubing. The discharge vapors were monitored using an organic vapor analyzer (OVA) equipped with a flame ionization detector (FID). The maximum, constant, and background OVA concentrations were recorded. When the OVA measurement reached its maximum concentration, soil gas vapors were collected in a 1-liter Tedlar bag. An aliquot of the soil gas sample was extracted from the Tedlar bag using a 500-microliter (ul) syringe. The sample was then injected into a Photovac 10S50 gas chromatograph (GC) equipped with a photoionization detector (PID). After collecting each soil gas sample, the sampling apparatus was purged with atmospheric air until OVA measurements reached background concentrations. Each Tedlar bag was purged a minimum of three times with ultra zero air (less than 0.1 parts per million (ppm) total hydrocarbons).

Several apparatus blanks were collected by drawing atmospheric air through the sampling apparatus. These blanks were analyzed by the GC as previously described.

## 1.3 CALIBRATION OF GAS CHROMATOGRAPH

Calibrations of the GC were performed at the beginning and end of each day and after every 2 hours of GC operation. Calibrations were performed by injecting 200 ul of certified laboratory standards of benzene, toluene, ethylbenzene, and o-xylene (2.6 ppm each) into the GC. The concentrations of unidentified compounds were calculated relative to the sensitivity of benzene and included in the calculation of total VOCs. The GC is far less sensitive to the unidentified compounds than to benzene; thus, the estimated total VOC concentrations derived from GC analysis are most likely one to two orders of magnitude lower than their actual concentrations in the soil gas.

# 2.0 SURFACE SOIL SAMPLING

The purpose of the surface soil sampling was to characterize surface soil quality from 0 to 6 inches below ground surface. The following sections detail the appropriate sampling, decontamination, custody, and sample blank procedures for surface soil sampling. The sampling plan was prepared in consideration of site plans showing underground piping, utilities, and aboveground structures that could potentially interfere with the sampling activities. In the event that unknown factors interfered with the sampling at the planned locations, the sampling point was shifted to an alternate nearby location.

## 2.1 SOIL SAMPLING PROCEDURES

Soil sampling procedures were as follows:

1. The laboratory "shuttle" was opened and the sample bottles were inspected to ensure that all of the required bottles were present and properly labeled.

2. Soil sampling locations were designated in accordance with the Work Plan. (Samples were not collected during periods of rainfall).

3. The sampling area was cleaned of gravel and/or twigs. Collection of soil samples was performed using a clean stainless steel trowel. Each trowel was cleaned using the procedures outlined in Section 2.2. At each sample location, the soil was placed into the sample jars using the trowel.

4. Samples were field-screened using a photoionization (PID) detector and an organic vapor analyzer (OVA) for the presence of VOCs in accordance with the procedures described in Chapter 5.0 of this Appendix.

5. Each sample was collected with a new pair of disposable plastic surgical gloves.

6. Upon the completion of sampling at each location, the stainless steel trowel was decontaminated in accordance with the procedures described in Section 2.2.

7. Each bottle was labeled with the following information:

   a. Job number
   b. Owner/client
   c. Location
   d. Sample code
   e. Date
   f. Time
   g. Type of laboratory analysis (i.e., metals, pH, etc.)
   h. Name of person collecting the sample
   i. Laboratory ID number

8. Sample bottles were wrapped in bubble-wrap and packaged in the shuttle to prevent bottle damage, then packed with ice or chemical ice packs to maintain the temperature at 4°C.

9. The Chain-of-Custody and Field Parameter Forms from the analytical laboratory were completed and signed. The Sampling Record, kept in a designated field notebook, documented the sample ID, SWMU location, and analysis.

10. The shuttle was sealed and stored.

11. Field blanks were collected in accordance with procedures described in Section 1.4.

12. The shuttles were picked up at the Refinery by the laboratory each day. The laboratory was notified by the project manager in a timely manner of the impending arrival of the samples. The laboratory received the samples and performed preliminary extractions or analyses within the recommended holding times.

## 2.2 SAMPLING EQUIPMENT DECONTAMINATION PROCEDURES

All sampling equipment was constructed of inert materials and decontaminated in the field prior to use. Sampling equipment was cleaned and prepared for field use according to the following procedures:

1. Non-phosphate detergent and tap water wash
2. Tap water rinse
3. Distilled/deionized water rinse
4. 10% nitric acid rinse
5. Distilled/deionized water rinse
6. Methanol (reagent grade) rinse*
7. Total air dry or nitrogen blow out*
8. Distilled/deionized water rinse

Note:* Methanol is an acceptable cleaning solvent provided that it is allowed to totally evaporate via air drying or a nitrogen blowout and if it is followed by a distilled/deionized rinse.

## 2.3 SAMPLE CUSTODY PROCEDURES

Sample chain of custody was initiated by the laboratory with the selection and preparation of the sample containers. To reduce the chance for error, the number of personnel that assumed custody of the samples was held to a minimum.

In-situ or on-site monitoring and sampling data was controlled and entered into the designated field notebooks. Trained personnel maintained the chain of custody and transfer of samples and supervised packing each shuttle.

### 2.3.1 Field Sample Custody

Dames & Moore personnel receiving the sample containers checked each cooler for the integrity of the seals. Sample containers were shipped in boxes and coolers. No custody seals were violated during transport from the laboratory. The receiving Dames & Moore personnel broke the seal, inspected the contents for breakage, and documented receipt of the sample containers.

A Chain-of-Custody Form accompanied the samples from initial sample container selection and preparation at the laboratory to the field for sample containment and preservation, through its return to the laboratory. Sample coolers and bottles were never left unattended in the field and were stored in a locked and secured field trailer.

The project manager notified the laboratory of upcoming field sampling activities and the subsequent transfer of samples to the laboratory. This notification included information concerning the number and type of samples shipped and the samples' anticipated date of arrival. Insulated sample shipping containers (coolers) were provided by the laboratory. Sample bottles within each shipping container were individually labeled.

After the sample containers were filled, they were placed in the cooler with sealed bags of ice or chemical ice to maintain the samples at 4°C. Field personnel indicated the sample designation/location number in the space provided on the appropriate Chain-of-Custody Form for each soil or water sample. The Chain-of-Custody Forms were signed and placed in the cooler. The completed shipping container was closed and a seal was affixed to the latch or lid. This seal would break if the cooler was opened to indicate tampering before receipt at the laboratory. The samples were picked up by the laboratory daily.

Samples requiring a 24-hour holding time were shipped in a separate cooler using a separate Chain-of-Custody. The original Chain-of-Custody Form accompanied the samples to the primary laboratory. The "remarks" column of the Chain-of-Custody Form was used to record specific considerations associated with the samples, such as sample type, container type, sample preservation methods, and analyses to be performed. The laboratory maintained the completed original forms on file. Copies will be submitted as part of the final analytical report.

### 2.3.2 Laboratory Sample Custody

Receipt, storage, and tracking of samples was conducted according to strict protocol in order to prevent sample contamination or loss, and to avoid the production of invalid laboratory data as a result of sample deterioration or tampering.

## 2.4 SAMPLE BLANKS

For quality assurance, blanks were prepared or collected and analyzed in order to:

1. Provide a check on sample bottle preparation

2. Evaluate the effectiveness of the field cleaning procedures

Field blanks were collected at a rate of one per twenty samples of a media (soil or water) by the sampling team during the course of the project. The field blanks were analyzed as another sample for the same test parameters as the soil samples where the blank was collected. The field blanks consisted of water.

A field blank consisted of two sets of laboratory-cleaned sample containers. One set of containers was empty and served as the sample control containers for the media that was analyzed. The second set of containers was filled at the laboratory with laboratory-demonstrated analyte-free water. At the field location, this analyte-free water was passed through the sampling device, after the device had been decontaminated, and was placed in the empty set of sample containers for analysis. This sample was labeled as a unique individual sample and packaged with the other samples for analysis. Field blanks evaluate the effectiveness of the field decontamination procedures for sampling equipment.

Trip blanks were submitted periodically for laboratory analysis of volatile organic compounds (VOCs) in accordance with the Data Collection Quality Assurance Plan (Appendix C of the VI Work Plan).

# 3.0 SOIL BORING PROCEDURES

The soil boring program was conducted in order to provide data to:

- Evaluate the degree and extent of soil contamination

- Evaluate contamination source areas

Specifications for materials and procedures for soil borings are described in this Appendix. Section 3.1 describes preparatory activities; Section 3.2 lists field equipment; Section 3.3 presents the site management responsibilities; and Section 3.4 the soil boring procedures. The sampling plan was prepared in consideration of site plans showing underground piping, utilities, and aboveground structures that could potentially interfere with the sampling activities.

In the event that unknown factors interfered with the sampling at the planned locations, the sampling point was shifted to an alternate nearby location.

## 3.1 PREPARATORY ACTIVITIES

The field geologist located and staked all soil boring locations, at the area of the facility under investigation, prior to the commencement of field activities. The borings were situated at the locations presented in the VI Work Plan, where possible. Furthermore, borings were not drilled during period of rainfall.

## 3.2 FIELD EQUIPMENT

Field equipment used for this task included:

- Organic vapor analyzer (OVA)
- Photoionization detector (PID)
- Stainless steel trowel, spatula, or spoon
- Boring logs and sampling records
- Decontamination detergents and methanol
- Tap water
- Distilled water
- Sample bottles
- Cleaning brushes
- Stakes, marking flags, and paint
- Depth-sounding tape
- Required health and safety clothing and equipment

## 3.3 PROCEDURES AND SITE MANAGEMENT

The field geologist supervised the drilling of soil borings, as discussed in Section 3.4. The field geologist also maintained field notes, obtained soil samples, and ensured that both decontamination and health and safety procedures were observed in the field.

## 3.4 SOIL BORING PROCEDURES

Soil borings were conducted in accordance with the specifications presented below.

### 3.4.1 Cleaning

The drilling contractor shall steam-clean, and the project manager/geologist shall confirm by visual observation, that the tools, and any downhole components or materials have been steam-cleaned immediately before work begins. The on-site controlled decontamination area for equipment cleaning will be the existing bundle cleaning area (SWMU 71). This area is fully contained in that its base is constructed of asphalt with concrete berms (approximately 1 foot high) surrounding the asphalt pad. The perimeter of the bundle cleaning area is surrounded with an approximately 8-foot-high fence. Rinse water from cleaning will be released

to the asphalt pad within the bundle cleaning area. The asphalt pad is pitched so that rinse water will migrate to a trench drain that is piped directly to an oil/water separator that discharges directly into the on-site wastewater treatment plant (WWTP), where the water is treated to meet the standards of the Chevron discharge permit. This enclosed system will prevent discharges to the environment. The RCRA permit by rule for the WWTP and Chevron's NPDES permit allow for management of all wastes generated on-site. Hazardous constituents in the decon area rinse water will be similar to those generated through site processes, and, therefore, will not violate any pretreatment agreements or permits.

1. All equipment introduced into a borehole was decontaminated by steam cleaning followed by a spray rinse with deionized water.

2. Split-spoon samplers and related sampling equipment were decontaminated by washing with alconox and tap water, rinsing them with the tap water, followed by a rinse with deionized water, a 10% nitric acid rinse, a deionized water rinse, a methanol rinse, a complete air-dry, and a final rinse with deionized water. The sampling equipment was allowed to totally air-dry after the methanol rinse.

3. The split-spoon samplers were decontaminated in accordance with the procedures stated in step 2 after collection of each soil sample.

4. All augers, split-spoon samplers, and equipment used in drilling were stored on clean plastic until required for use.

5. The boring and sampling equipment were decontaminated as described in steps 1 through 4, prior to augering at each successive borehole.

6. Clean latex gloves were used to handle augers, split-spoon samplers, and other sampling equipment. Gloves were collected in garbage bags and disposed of at the conclusion each day.

These cleaning and decontamination procedures were used for all drilling activities to minimize the potential for possible cross-contamination between borings.

3.4.2 Boring Operations

Borings were advanced to a maximum depth of between 2 and 8.5 feet using a 3-inch stainless steel split spoon driven with a 140-pound hammer. The hammer was mounted on the drill rig or a portable tripod rig. One borehole was completed using a stainless steel hand auger. Soil sampling procedures are detailed in Section 2.1 of this Sampling Plan.

Split-spoon samples were collected and described every 2 feet, if possible, to the final depth of the boring. The samples were described and logged by a qualified geologist. Additionally, OVA and PID readings were made of the sample immediately after collection. Further, OVA readings were collected in the completed borehole.

Once the sample was collected, blow counts recorded, the sample described, and OVA and PID readings measured and recorded, a grab/discrete sample was obtained for laboratory analysis from a designated section. The sample(s) were immediately placed in jar(s) supplied by the laboratory using a decontaminated stainless steel trowel, spatula, or spoon. After each use, split-spoon samplers and sampling spoons/trowels, etc. were cleaned as per subsection 3.4.1. At the conclusion of each boring, the borehole was grouted from the bottom to the ground surface with portland cement.

## 4.0 SUBSURFACE SOIL SAMPLING

The purpose of subsurface soil sampling was to characterize the soil quality with depth. The following sections detail the appropriate sampling, decontamination, custody, and sample blank procedures. Calibration procedures for the OVA, PID, and gas chromatograph are provided on pages 6 and 7 of the Data Quality Assurance Plan (Appendix C of this VI Work Plan).

The sampling plan was prepared in consideration of site plans showing underground piping, utilities, and aboveground structures that could potentially interfere with the sampling activities. In the event that unknown factors interfered with the sampling at the planned locations, the sampling point was shifted to an alternate nearby location.

### 4.1 SOIL SAMPLING PROCEDURES

The subsurface soils were retrieved from below ground surface in accordance with the procedures outlined in this appendix, Chapter 2. The soil samples were collected and containerized for laboratory analysis as per the procedures of Section 2.1 in this appendix, except for step 3. The subsurface soils were collected from a split spoon sample using decontaminated stainless-steel trowels.

### 4.2 SAMPLING EQUIPMENT DECONTAMINATION PROCEDURES

Subsurface equipment was decontaminated in accordance with this Appendix, subsection 3.4.1.

### 4.3 CUSTODY PROCEDURES

Applicable custody procedures are included as Section 2.3 of this Appendix.

### 4.4 SAMPLE BLANKS

The procedures included as Section 2.4 of this Appendix are also appropriate for subsurface soil sampling.

## 4.5 FIELD MEASUREMENTS

A statistically sufficient number of field measurements was provided in the following manner:

- At every SWMU, all retrieved soil boring samples were scanned with an OVA and PID. The OVA and PID were also used to scan every borehole following completion.

- Soil gas surveys were conducted at SWMUs 11/12, 29, and 79. In each case, sampling points were arranged in a grid pattern with a 50-foot spacing between points (where possible), assuring optimal coverage of these areas.

# 5.0 SAMPLE FIELD SCREENING

The following describes the procedures used for field screening of soils with a portable organic vapor analyzer (OVA) and photoionization detector (PID);

Two clean eight-ounce (approximately 250 ml) glass jars were half-filled with representative portions of the sample. Each jar was quickly covered with one sheet of clean aluminum foil. Screw caps were subsequently applied to tightly seal the jars.

Headspace development was allowed in each jar for at least 10 minutes. Each jar was vigorously shaken for 15 seconds both at the beginning and end of the headspace development period. After headspace development, the screw caps were removed from both jars. The foil seal was quickly punctured with the PID or OVA instrument sampling probe to a point about one-half of the headspace depth. Care was taken to avoid uptake of water droplets and soil particles.

Following probe insertion through the foil seal, the highest meter response was recorded in each as the field screening headspace concentration. The headspace screening data from both jar samples were recorded in the field logbooks.

Field instruments were calibrated no less than once every 10 analyses. Operation, maintenance, and calibration were performed in accordance with the manufacturer's specifications.

# 6.0 MONITORING WELL INSTALLATION PROCEDURES

The purpose of installing monitoring wells was to:

- Provide more complete information of the hydrogeologic regime under the Chevron Refinery facility for the RFI.
- Evaluate ground water quality at each VI SWMU.

Specifications for materials and procedures used during monitoring well installation and development are described in this chapter. It describes preparatory activities, discusses field equipment, and presents site management responsibilities, field procedures for monitoring well construction, decontamination procedures, and materials specifications. Chapter 7.0 describes monitoring well development techniques, and Chapter 8.0 addresses monitoring well surveying.

## 6.1 PREPARATORY ACTIVITIES

The drilling contractor, Marcor Drilling of Exton, Pennsylvania, was contacted prior to initiation of site work to review the scope of work. The scope was based on existing knowledge of site hydrogeology. All required permits, licenses, approvals, certificates, and authorizations were obtained prior to initiation of field activities. The field geologist located and staked all well locations prior to the commencement of drilling activities. These locations were consistent with locations presented in the VI Work Plan. Site conditions precluded the placement of a well within SWMU 71A due to several trench excavations in the SWMU.

Field equipment used for this task included:

- Organic vapor analyzer (OVA)
- Boring logs and sampling records
- Decontamination detergents, nitric acid, and methanol
- Distilled water
- Sample bottles
- Stakes and marking flags
- Depth-sounding tape
- Required health and safety clothing and equipment

The field geologist supervised the installation of monitoring wells, as discussed in Chapter 3.0. The field geologist was also responsible for maintaining field notes, logging boreholes, and ensuring that decontamination and health and safety procedures were observed in the field.

Monitoring wells were installed in accordance with the specifications expressed below.

## 6.2 CLEANING

The drilling contractor shall steam-clean, and the project manager/geologist shall confirm by visual observation, that the tools, and any downhole components or materials have been steam-cleaned immediately before work begins. The on-site controlled decontamination area for equipment cleaning will be the existing bundle cleaning area (SWMU 71). This area is fully contained in that its base is constructed of asphalt with concrete berms (approximately 1 foot high) surrounding the asphalt pad. The perimeter of the bundle cleaning area is surrounded with an approximately 8-foot-high fence. Rinse water from cleaning will be released to the asphalt pad within the bundle cleaning area. The asphalt pad is pitched so that rinse water will migrate to a trench drain that is piped directly to an oil/water separator that discharges directly into the on-site wastewater treatment plant (WWTP), where the water is treated to meet the standards of the Chevron discharge permit. This enclosed system will prevent discharges to the environment. The RCRA permit by rule for the WWTP and Chevron's NPDES permit allow for management of all wastes generated on-site. Hazardous constituents in the decon area rinse water will be similar to those generated through site processes, and, therefore, will not violate any pretreatment agreements or permits.

1. Steam-cleaning all equipment introduced into the boreholes.

2. Storing equipment used in drilling on clean plastic until it was required for use.

3. Using dedicated, disposable Latex plastic gloves when handling drilling equipment and downhole tools. Gloves were collected in garbage bags and disposed of upon completion of each borehole. Dedicated gloves and other handling materials were used at each subsequent borehole location.

These cleaning and decontamination procedures were followed for all drilling activities in potentially contaminated environments. Their purpose was to minimize the potential for possible cross-contamination from one borehole to another.

## 6.3 DRILLING OPERATIONS

All boreholes for monitoring wells were sampled at 5 foot intervals to the final depth of the borehole. These samples were described and logged by a qualified geologist. Additionally, lithological changes and significant water entry zones were noted for all well types.

## 6.4 MONITORING WELL CONSTRUCTION MATERIALS

Four-inch diameter schedule 40 flush-threaded PVC riser pipe and screen was placed in the 8-inch diameter borehole. The borehole was drilled from the ground surface to an approximate depth of 10 to 15 feet. The appropriate sandpack, No. 1 grade quartz sand, was poured into the annular space between the borehole wall and the outside of the PVC casing to 1 foot above the screen. On top of the sand, a 2-foot-thick bentonite pellet seal was set. Grout, which is portland cement with 3 to 5 percent bentonite, was placed on top of the seal to approximately 3 feet from ground surface. The PVC casing was capped with a water-tight lid. To secure the PVC casing, a lockable 6-inch-diameter protective steel casing with a steel lid was

cemented in place to a depth of 3 feet. The protective steel casing stood approximately 2 feet above the ground surface.

## 7.0 MONITORING WELL DEVELOPMENT

After the installation of the monitoring wells, each well was developed to ensure that a representative ground water sample of the aquifer could be obtained.

Development of the wells consisted of pumping and backwashing with a centrifugal pump. The pump was positioned opposite the water-bearing fracture zone or 5 feet below the top of the screen. The pump was started at a reduced capacity, and gradually increased to capacity. The pump was stopped after 15 minutes to allow a column of water to flow into the well. The procedure was repeated at the discretion of the supervising geologist.

The discharge rate during development was estimated by timing the pump discharge fill rate of a 5-gallon bucket or other suitable container.

Equipment used to develop the wells was thoroughly cleaned as specified before each well development program was begun.

## 8.0 MONITORING WELL SURVEYING

All newly installed monitoring wells were surveyed to determine their geographic locations. With accurate locations, the configurations of contaminant plumes potentially present may be estimated by correlation of the water quality data and the well locations. Survey data were also essential for construction of maps showing lines of equipotential, from which ground water gradients were determined.

The elevation of the inner well casing on all monitoring wells and well points was surveyed to the nearest 0.01 foot. In addition, the ground elevation at the base of the protective outer well casing was surveyed to an accuracy of 0.01 foot. The geographic location or horizontal survey measurement accuracy is within 1 foot.

A mark was incised in the top of each inner well casing at the time of construction. The elevation of the inner well casing was surveyed at the mark, and all future water level recordings were made with respect to this surveyed casing reference point.

## 9.0 GROUND WATER SAMPLING PROCEDURES

### 9.1 INTRODUCTION

The following procedures for the collection, preservation, field analysis, shipment, and chain of custody of ground water samples were used to collect representative ground water samples in a credible, uniform, and well-documented manner.

Ground water sampling was conducted by personnel knowledgeable and trained in procedures necessary for the proper collection of ground water samples and the proper operation of field sampling equipment. All personnel used for ground water sampling activities completed the OSHA 40-hour 29 CFR 1910.20 Health and Safety Training course.

Materials used for ground water sampling included pumps and associated supplies, ground water sample collection devices and associated supplies, sample bottles and preservatives, and sample shuttles. The materials associated with the various elements of ground water sampling are listed in their respective sections below.

Ground water collection procedures include depth to ground water measurements, well evacuation, sample withdrawal, and sample placement into jars. Ground water collection proceeded from the upgradient wells to the downgradient wells or from the well of least suspected contamination to the well of greatest suspected contamination. The elements of ground water sampling are discussed in Sections 9.2, 9.3, and 9.4, respectively. All observations collected during ground water sampling were recorded in dedicated field notebooks.

Please note that if floating petroleum hydrocarbon was encountered, a water sample was not collected for analysis. However, a sample of the hydrocarbon was collected for GC analysis.

### 9.2 DEPTH TO GROUND WATER MEASUREMENTS

Objective

The objective of this task was to provide data on water level elevations so that ground water gradients could be evaluated.

Materials

1. Electric ground water measuring device, or steel tape
2. Cleaning materials, including tap water, paper towels, and detergent
3. Spray bottle of deionized water

Activity

1. Before static water levels were measured, the steel tape or electric water level depth recorder, including any part of the device that entered the well or was

positioned over it, was cleaned using a detergent wash. Cleaning was followed by a spray wash of deionized water.

2. Water levels were measured and recorded to the nearest 0.01 foot relative to a datum marked on the inner PVC well casing.

3. The total depth of the well was measured and recorded from the datum.

4. If floating petroleum hydrocarbon was encountered, an Oil Recovery Systems interface probe was used to measure product thickness and depth.

## 9.3 WELL EVACUATION

Objective

Following the ground water level measurement at each location, the wells were evacuated. Evacuation was performed to remove standing water in the well and in the filter pack to enhance the likelihood that the ground water sampled was representative of the water within the screened formation.

Materials

1. Submersible pump and generator or centrifugal pump
2. PVC pipe to fit pump
3. Decontamination materials, including non-phosphate detergent, tap water, deionized water, methanol, paper towels, and scrub brushes
4. 5-gallon buckets
5. Polypropylene or nylon rope, knife, and stopwatch
6. Latex gloves
7. pH meter, specific conductance meter, and temperature meter

Activity

1. Prior to evacuation, a dedicated length of polypipe was sprayed with deionized water and wiped dry with clean paper towels.

2. For a 2-inch-diameter monitoring well, the minimum volume of water evacuated was calculated by the formula:

   3 volumes = 0.57 x length of water column (well depth from top of casing in feet - depth to ground water from top of casing in feet) = volume in gallons

   For a 4-inch diameter monitoring well, the minimum volume of water to be evacuated was calculated by the formula:

   3 volumes = 1.96 x (well depth from top of PVC casing in feet - depth to ground water from top of PVC casing in feet) = volume in gallons

3. The check valve associated with the centrifugal pump was lowered into the well by the dedicated polypipe until it was several feet below the water surface.

4. The pump was operated until a minimum of three volumes of well water was removed or until the well and filter pack ran dry.

5. The discharge rate of well water was measured using a stopwatch. Discharged water was containerized and released at specified wastewater treatment sumps.

6. After the water was evacuated, the temperature, pH, and specific conductance of the water were measured.

Dedicated latex gloves were worn at all times when personnel handled sampling equipment. Before evacuation equipment was reused, it was decontaminated in accordance with the specifications of Step 1 above.

## 9.4 SAMPLE RECOVERY

Objective

Immediately following well evacuation, ground water samples were collected for laboratory analysis. The goal of the procedures described below was to minimize the potential for altering the sample during the sample recovery process.

Materials

1. Decontaminated teflon or stainless steel bailers
2. Polypropylene or nylon rope
3. Clean plastic sheeting
4. Sample bottles and preservatives
5. Latex gloves
6. Paper towels
7. Decontaminating materials
8. Sample labels

Activity

1. Prior to sampling, bailers were decontaminated in laboratory space designated for ground water sampling equipment decontamination or in the field. Decontamination included:

    - Wash with a alconox detergent and tap water
    - Rinse with deionized water
    - Rinse with 10% nitric acid
    - Rinse with deionized water
    - Rinse with methanol
    - Complete air dry

- Rinse with deionized water

The bailers were allowed to air dry after the methanol rinse. Following decontamination, the bailers were wrapped in aluminum foil (shiny side out).

2. Field notes were recorded and sample labels were completed.

3. Each bailer was unwrapped at the sampling location and tied to dedicated plastic or nylon rope. The bailers were slowly lowered into the wells to minimize agitation of the ground water.

4. Samples were collected in the bailer. Where appropriate, containers were filled to overfilling, so that no head space remained. Containers with preservatives were not filled to overflow. Care was taken to fill the sample bottles in a manner that did not aerate or agitate the sample.

Because the samples were analyzed for volatile organic compounds, care was taken so that sampling did not degas the samples. The sample containers were filled by allowing the sample to flow gently down the inside surface of the container, so that no bubbles were formed and the sample was not degassed by agitation. Each container was filled so that a meniscus formed over the container mouth. The container cap was inverted and filled with sample. Then the container cap was turned over onto the bottle mouth and tightened in such a manner that no air was trapped inside the container. The sealed container was sealed and shaken vigorously to verify that no air was trapped in the container. If visual inspection indicated that air was present, the container was unsealed and emptied, and the collection process was repeated.

Note that dedicated sampling materials, including bailers and rope, were stored on dedicated clean plastic sheeting, to ensure that contaminants were not introduced into the well or the sample. All sampling equipment was handled with dedicated, disposable latex gloves. New plastic sheeting and gloves were used for each well sampled.

Samples were maintained at 4°C from the time they were collected until receipt at the laboratory.

9.4.1 Trip Blanks and Equipment Blanks

Trip and equipment blanks were prepared for each day of ground water sample collection.

Trip Blanks

Objective

Trip blanks served as quality control to identify sample contamination resulting from interaction between the sample and the container, or laboratory handling procedures that alter the chemical nature of the samples.

Activity

The laboratory provided trip blanks in sealed 40-milliliter vials, and in sealed bottles identical to those used for collection of the ground water samples to be analyzed for volatile organic compounds.

Equipment Blanks

Objective

Equipment, or field, blanks were used to verify the effectiveness of sample handling procedures, and to establish the effectiveness of equipment decontamination procedures. Equipment blanks were prepared for each set of parameters to be analyzed.

Activity

1. The laboratory provided ultrapurified water for the preparation of equipment blanks.

2. The equipment blank was prepared after evacuating and sampling a portion of the wells designated for daily sampling.

3. Ultrapurified water provided by the laboratory was poured into a decontaminated bailer, and then into the designated sample bottles.

9.4.2 Field Logbook

Field personnel involved in ground water sampling maintained field notes. The field notes included:

1. Well identification

2. Weather conditions

3. Static water level and depth of the well

4. Rate of well evacuation and volume of water purged

5. Notes on the physical appearance of the ground water, including unique or unexpected colors or odors

6. Ground water sampling equipment

7. Date and time of sample collection

8. Name of sample collector

9. Specific conductance, pH, and temperature of the ground water after evacuation

10. Notes on unexpected or unique conditions or events related to evacuation of ground water or sample collection

## 10.0 SAMPLE SHIPMENT PROCEDURES

Sample shipment procedures include chain-of-custody protocols and procedures for storing and shipping collected samples. These procedures are discussed in Sections 10.1 and 10.2, respectively.

### 10.1 SAMPLE CHAIN-OF-CUSTODY PROCEDURES

Objective

Sample chain-of-custody was initiated by the analytical laboratory, with the selection and preparation of the sample containers. The goal of chain-of-custody procedures is to document possession and handling of the sample jars from the time of laboratory preparation through sample collection and laboratory analysis.

Materials

1. Sample labels
2. Chain-of-custody records
3. Coolers/ice

Activities

1. Using indelible ink, labels on the sample bottles were marked with information that will include:

    a. Site name
    b. A unique identification number
    c. Name of the collector
    d. Date and time of collection
    e. Place of collection
    f. Parameters for laboratory analysis
    g. Type of sample
    h. Volume of sample
    i. Preservative (when applicable)

2. A chain-of-custody record was completed and included:

    a. A unique identification number
    b. Signature and name of the collector
    c. Date and time of collection

d. Place of collection
e. Parameters for laboratory analysis
f. Sample type
g. Identification of the well
h. Dates of possession

A Chain-of-Custody Form (supplied by the analytical laboratory) accompanied the sample from initial sample container selection and preparation at the laboratory, to the field for sample containment and preservation, through its return to the laboratory. The Chain-of-Custody Form traced the path of each individual sample container by means of a unique identification number.

The project manager notified the laboratory of upcoming field sampling activities and the subsequent transfer of samples to the laboratory. This notification included information concerning the number and type of samples shipped.

## 10.2 STORAGE AND SHIPMENT OF COLLECTED SAMPLES

Objective

The goal of procedures described in this section is to ensure that ground water samples were not altered by handling or storage procedures after collection, and to provide documentation to trace potential sample alteration.

Materials

1. Chain-of-custody record
2. Sample seals
3. Refrigerated or insulated shipping containers
4. Frozen "blue ice" packs or ice
5. Packing materials

Activities

1. The full labeled sample bottles were packed in the shipping containers with frozen "blue ice" packs or ice. The bottles were arranged and packed with suitable materials to minimize the potential for breakage.

2. The shipping container was secured with "sample seals" in cases where the sample container left the immediate possession of the contractors.

3. The chain-of-custody record accompanied the shipping container at all times. Transfer of possession of the shipping container(s) was accompanied by signatures of release and receipt on the Chain-of-Custody Form. Notes pertaining to the condition of the sample container were made on the chain-of-custody record at the time of transfer.

## 11.0 CALIBRATION PROCEDURES AND FREQUENCY

All instruments used in the field to gather information or to perform analytical tests were calibrated prior to use in accordance with the manufacturer's instructions and recommended frequency.

The following steps were observed by personnel engaged in ground water sampling for pH and specific conductance:

- The pH meter was calibrated with a fresh standard buffer solution (pH 7) prior to each field test.
- The operation of the instrument was checked with fresh standard buffer solutions (pH 4 and pH 10) prior to each day's sampling.
- The specific conductance meter was calibrated prior to each sampling event using a standard solution of known specific conductance.

More frequent calibrations were performed as necessary to maintain analytical integrity. Calibration records for each field instrument used on the project were maintained in designated field notebooks.

## 12.0 WASTE DISPOSAL

All wastes such as drill cuttings and purge water were disposed of as directed by Chevron. Soil cuttings were stored in a roll-off bin; purged ground water and decontamination water was discharged to the facility's wastewater treatment system.

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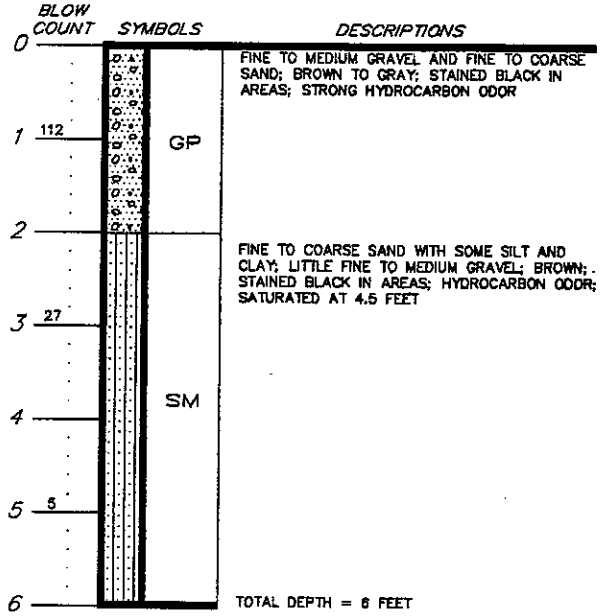
# APPENDIX D

SOIL BORING LOGS

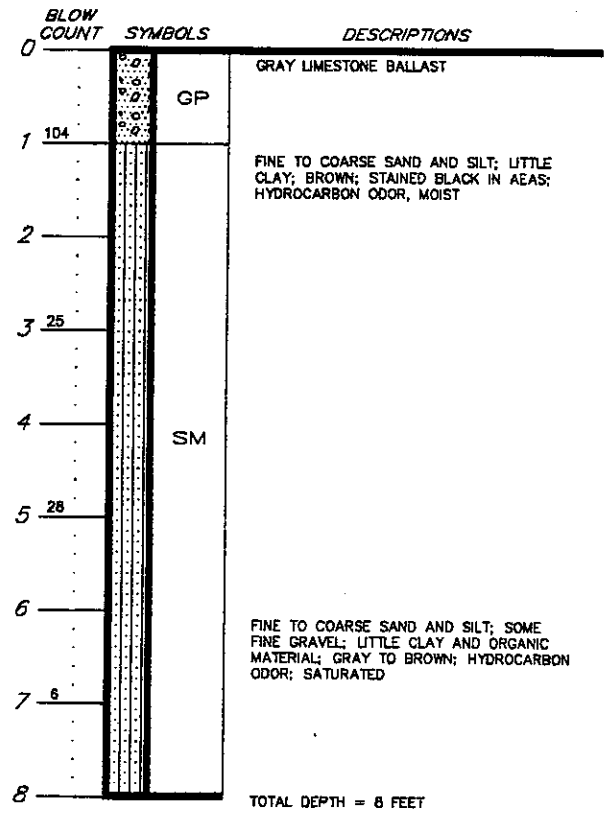
## BORING B1—1

SURFACE ELEVATION = NOT SURVEYED




## BORING B1—2

SURFACE ELEVATION = NOT SURVEYED




### NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/4/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 6.0 FEET ON 8/4/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/4/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

### NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/4/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 8.0 FEET ON 8/4/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/4/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 4 TO 6 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

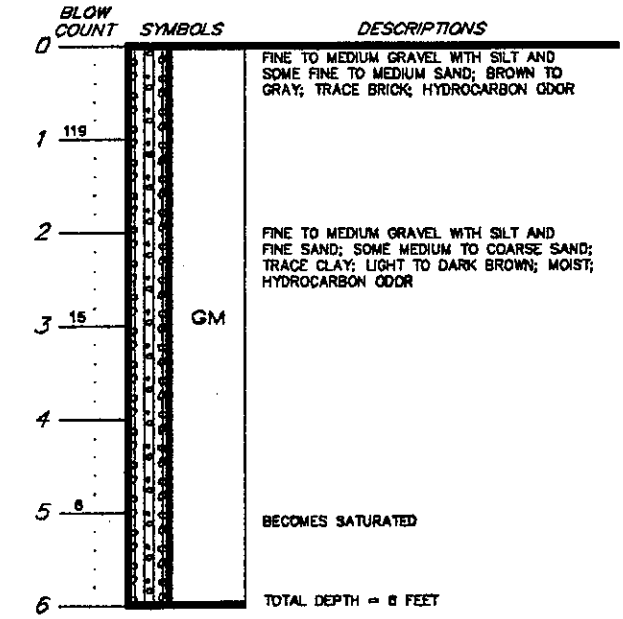
# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(2) CHEV92\B1-1 11/16/92 07:08

BORING B1-3

SURFACE ELEVATION = NOT SURVEYED




NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/4/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 6.0 FEET ON 8/4/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/4/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 4 TO 6 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

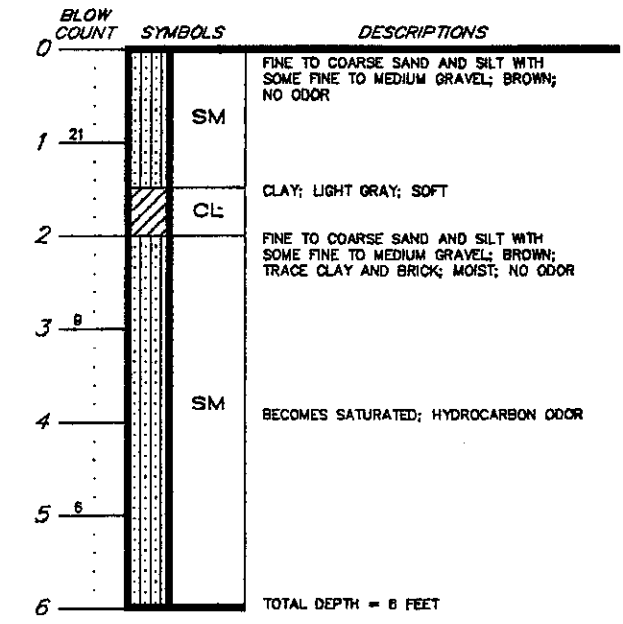
# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(3) CHEV92\81-3 11/19/92 14:33

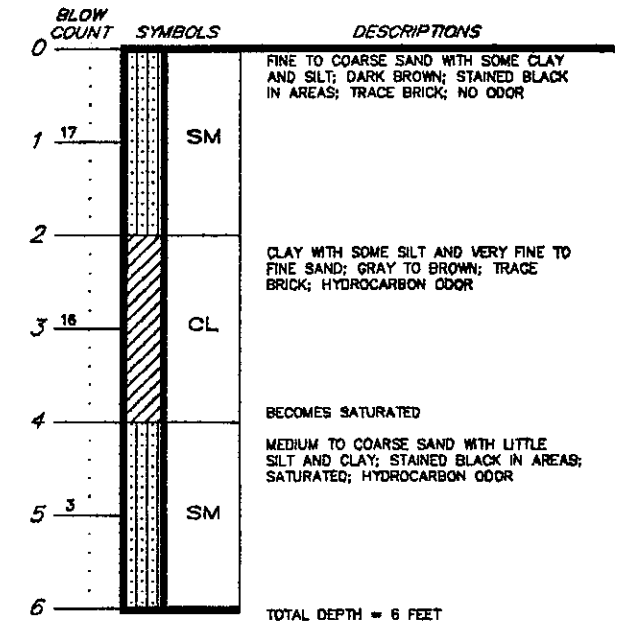
## BORING B6–1

SURFACE ELEVATION = NOT SURVEYED




## BORING B6–2

SURFACE ELEVATION = NOT SURVEYED




### NOTES:

1. BORING ADVANCED WITH A TRIPOD RIG AND SPLIT–SPOON SAMPLER ON 8/5/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 6.0 FEET ON 8/5/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/5/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3–INCH STAINLESS STEEL SPLIT–SPOON SAMPLER.
5. A "BLOW–COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT–SPOON SAMPLER A DISTANCE OF ONE–FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

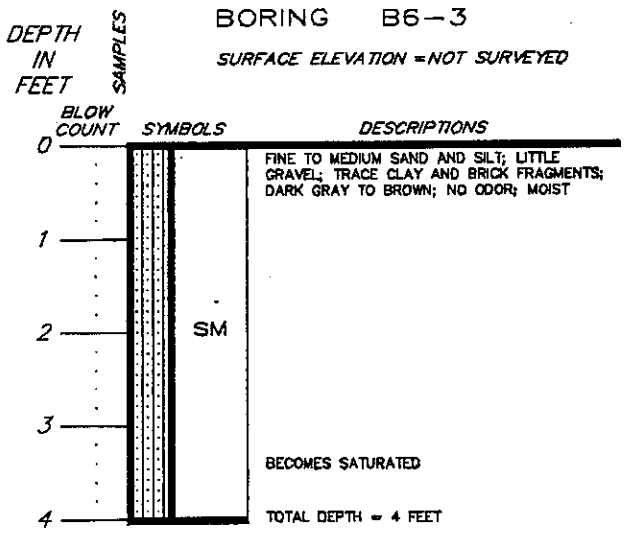
### NOTES:

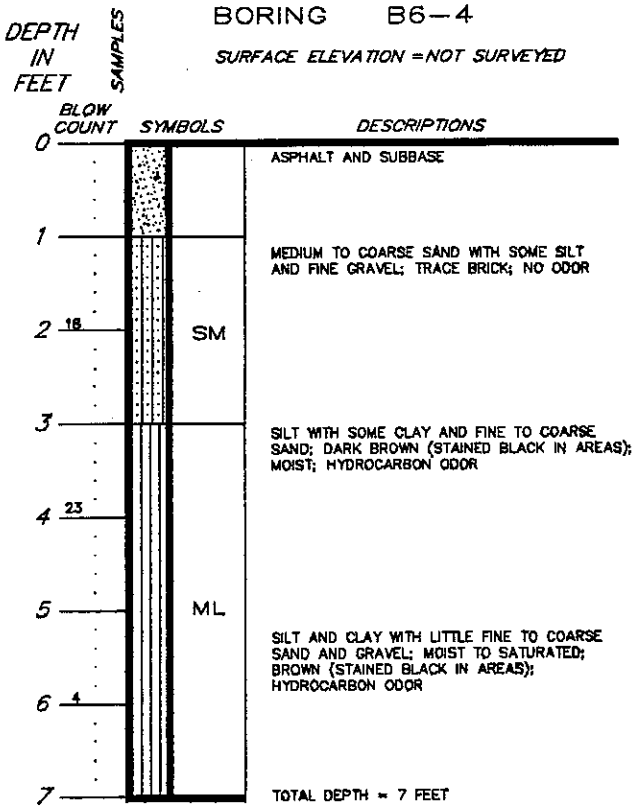
1. BORING ADVANCED WITH A DRILL RIG AND SPLIT–SPOON SAMPLER ON 8/4/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 6.0 FEET ON 8/4/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/4/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3–INCH STAINLESS STEEL SPLIT–SPOON SAMPLER.
5. A "BLOW–COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT–SPOON SAMPLER A DISTANCE OF ONE–FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(3) CHEV92\B6-1 11/16/92 07:11




## NOTES:

1. BORING ADVANCED WITH A HAND AUGER SAMPLER ON 8/4/92 BY DAMES & MOORE PERSONNEL.
2. BORING TERMINATED AT 4.0 FEET ON 8/4/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/4/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. NO BLOW COUNTS RECORDED AT THIS BORING LOCATION BECAUSE BORING WAS ADVANCED WITH A HAND AUGER.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

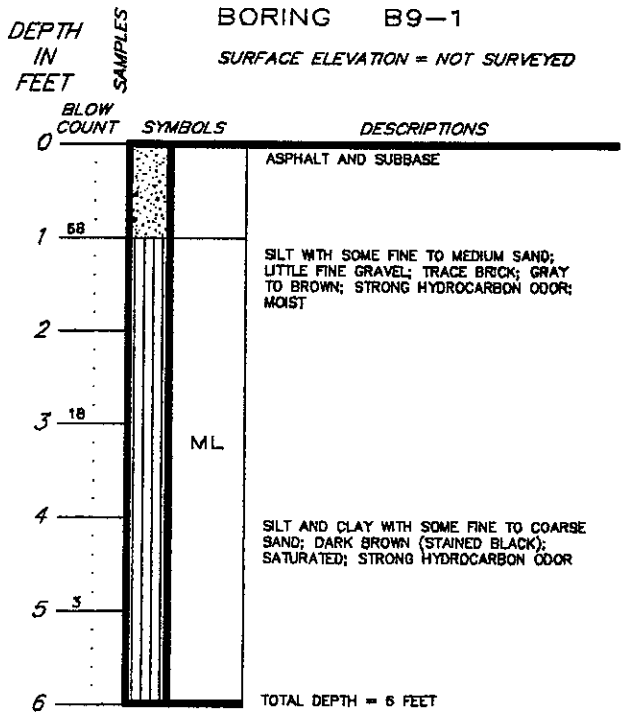
## NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/5/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 7.0 FEET ON 8/5/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/5/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 3 TO 5 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(3) CHEV92\B6-3 11/19/92 14:39



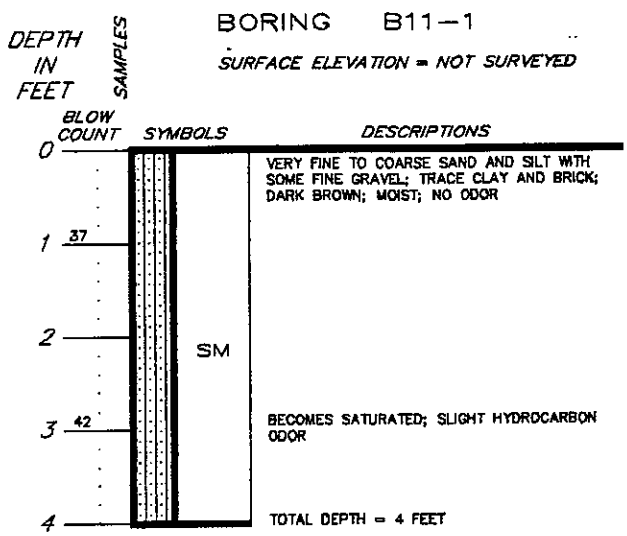

NOTES:

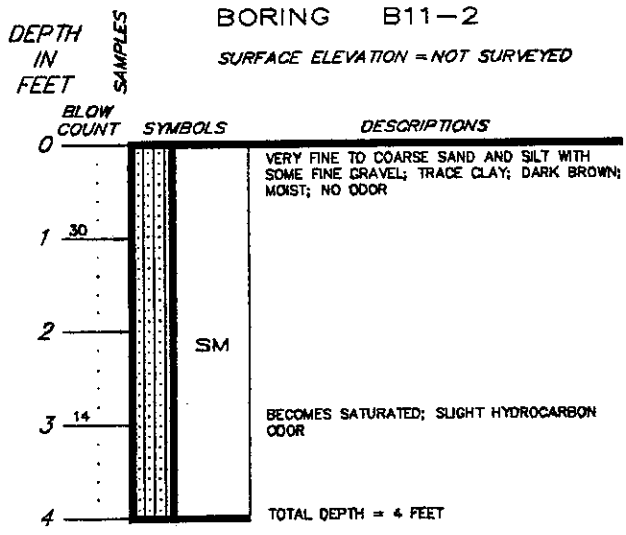
1. BORING ADVANCED WITH A TRIPOD RIG AND SPLIT-SPOON SAMPLER ON 8/7/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 6.0 FEET ON 8/7/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/7/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(3) CHEV92\B9-1 11/19/92 14:41




NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/6/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 4.0 FEET ON 8/6/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/6/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 1.5 TO 3.5 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

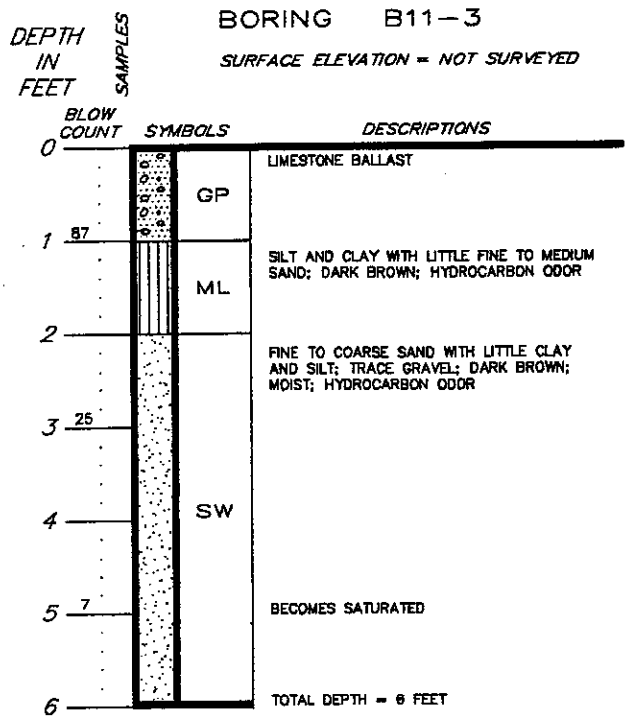
NOTES:

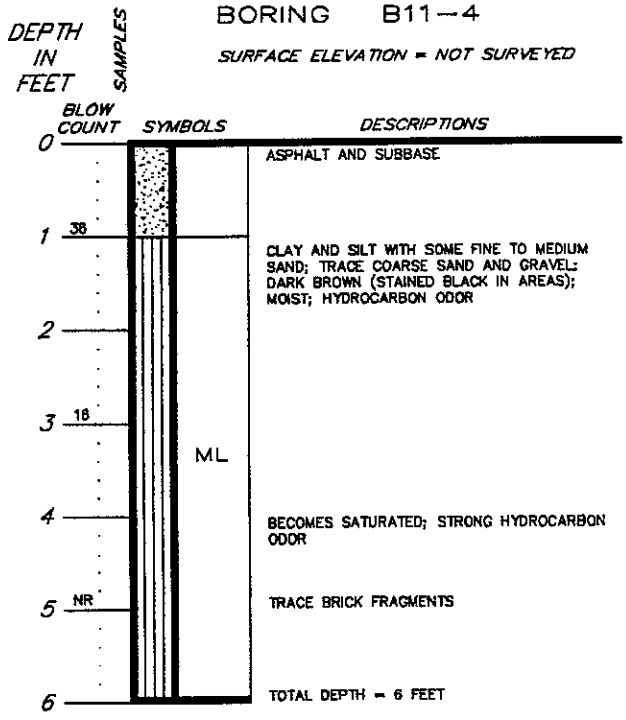
1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/6/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 4.0 FEET ON 8/6/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/6/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(3) CHEV92\B11-1 11/19/92 14:42




## NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/6/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 6.0 FEET ON 8/6/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/6/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

## NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/6/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 6.0 FEET ON 8/6/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/6/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

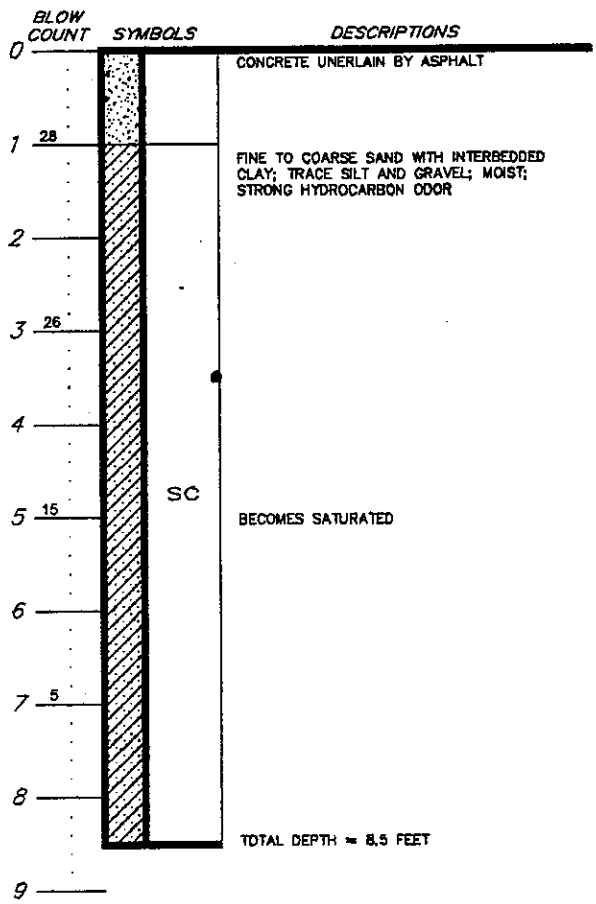
# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(2) CHEV92\B11-3 11/16/92 07:20

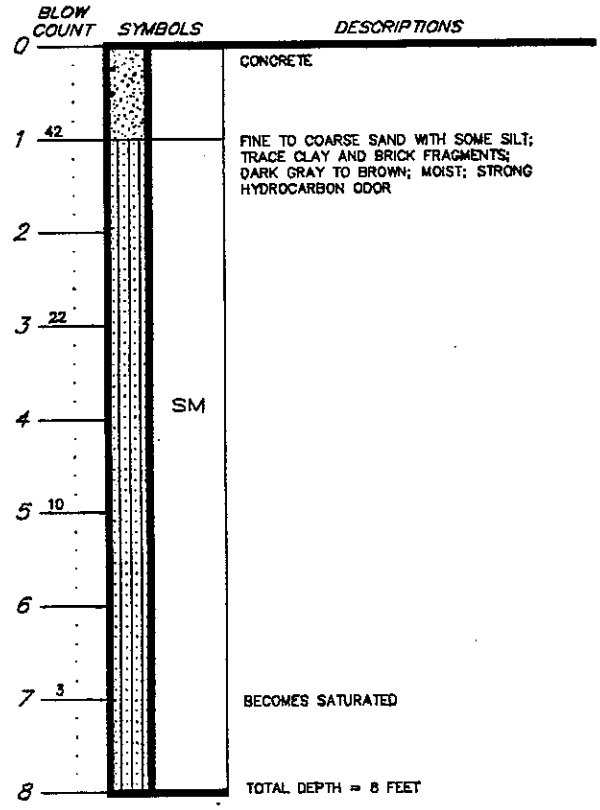
## BORING B13-1

SURFACE ELEVATION = NOT SURVEYED




## BORING B13-2

SURFACE ELEVATION = NOT SURVEYED




### NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/6/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 8.5 FEET ON 8/6/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/6/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2.5 TO 4.5 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

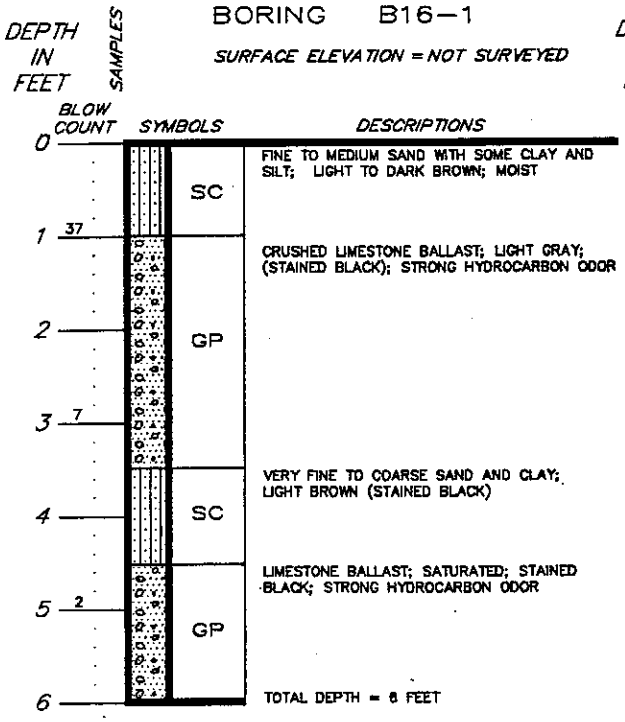
### NOTES:

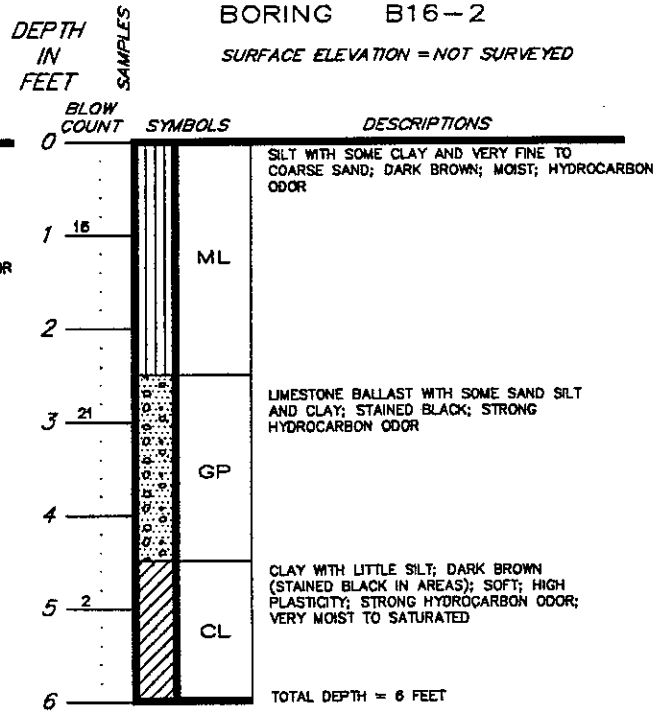
1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/5/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 8.0 FEET ON 8/5/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/5/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 4.5 TO 6.5 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(3) CHEV92\B13-1 11/19/92 14:43




## NOTES:

1. BORING ADVANCED WITH A TRIPOD RIG AND SPLIT-SPOON SAMPLER ON 8/5/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 6.0 FEET ON 8/5/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/5/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

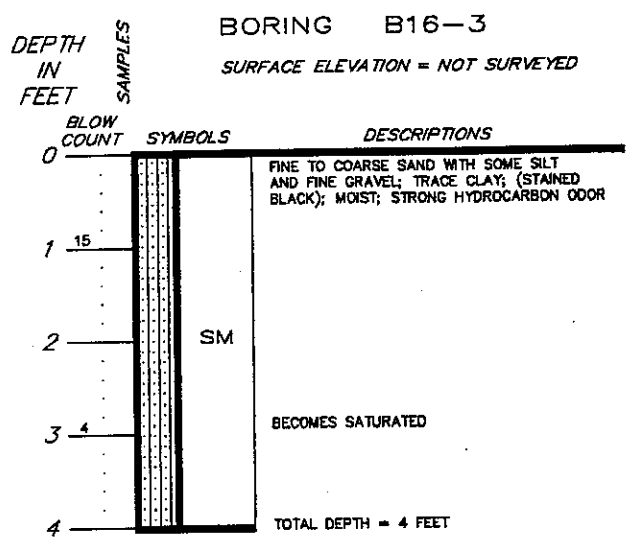
## NOTES:

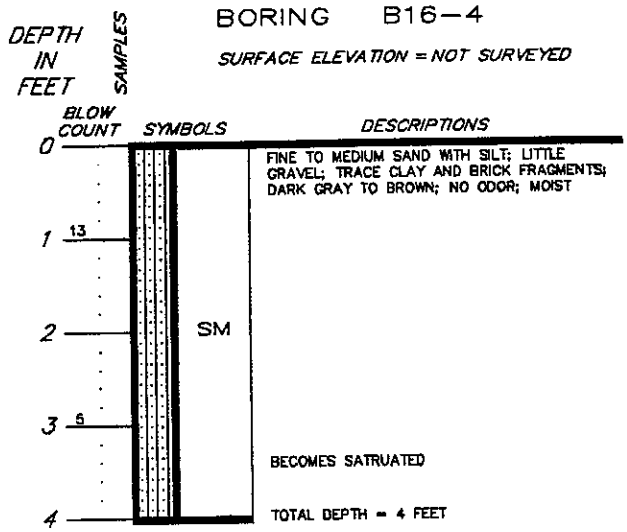
1. BORING ADVANCED WITH A TRIPOD RIG AND SPLIT-SPOON SAMPLER ON 8/5/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 6.0 FEET ON 8/5/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/5/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(2) CHEV92\B16-1 11/16/92 07:24




## NOTES:

1. BORING ADVANCED WITH A TRIPOD RIG AND SPLIT-SPOON SAMPLER ON 8/5/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 4.0 FEET ON 8/5/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/5/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOW REQUIRED TO DRIVE A STANDARD SPLIT-SPPON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 0 TO 2 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

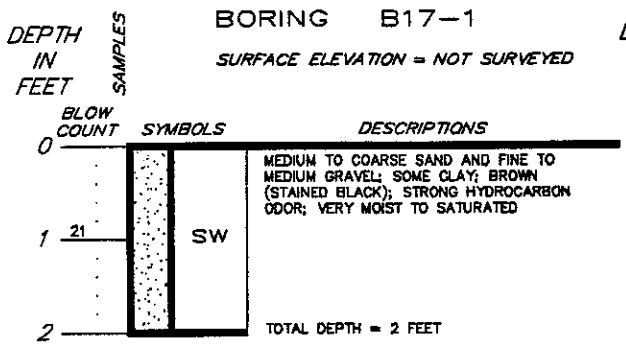
## NOTES:

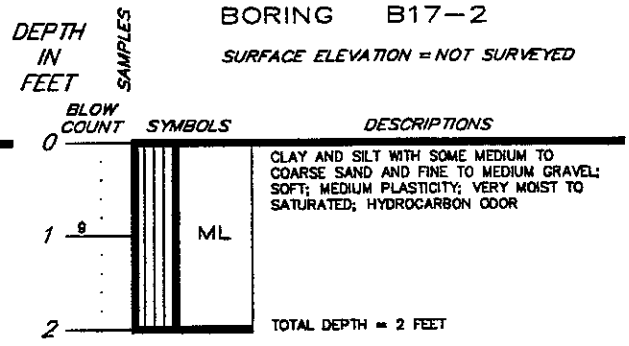
1. BORING ADVANCED WITH A TRIPOD RIG AND SPLIT-SPOON SAMPLER ON 8/5/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 4.0 FEET ON 8/5/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/5/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOW REQUIRED TO DRIVE A STANDARD SPLIT-SPPON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(2) CHEV92\B16-3 11/16/92 07:47




NOTES:

1. BORING ADVANCED WITH A TRIPOD RIG AND SPLIT-SPOON SAMPLER ON 8/5/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 2.0 FEET ON 8/5/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/5/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 0 TO 2 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

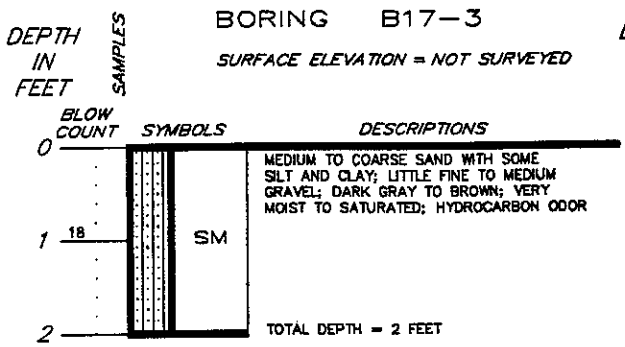
NOTES:

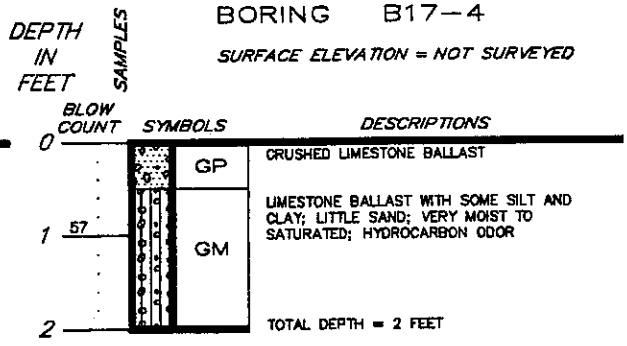
1. BORING ADVANCED WITH A TRIPOD RIG AND SPLIT-SPOON SAMPLER ON 8/5/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 2.0 FEET ON 8/5/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/5/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 0 TO 2 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(2) CHEV92\B17-1 11/16/92 07:49




## NOTES:

1. BORING ADVANCED WITH A TRIPOD RIG AND SPLIT-SPOON SAMPLER ON 8/5/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 2.0 FEET ON 8/5/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/5/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 0 TO 2 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

## NOTES:

1. BORING ADVANCED WITH A TRIPOD RIG AND SPLIT-SPOON SAMPLER ON 8/5/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 2.0 FEET ON 8/5/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/5/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 0 TO 2 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

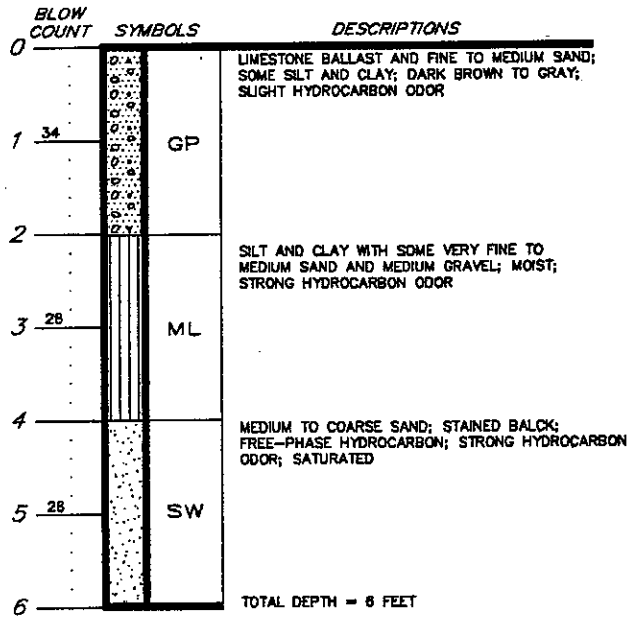
# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(2) CHEV92\B17-3 11/16/92 07:51

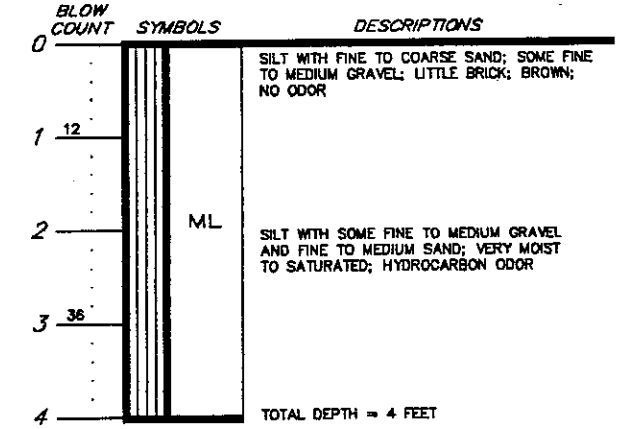
## BORING B29-1

SURFACE ELEVATION = NOT SURVEYED




## BORING B29-2

SURFACE ELEVATION = NOT SURVEYED




### NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/10/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 6.0 FEET ON 8/10/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/10/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

### NOTES:

1. BORING ADVANCED WITH A TRIPOD RIG AND SPLIT-SPOON SAMPLER ON 8/10/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 4.0 FEET ON 8/10/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/10/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

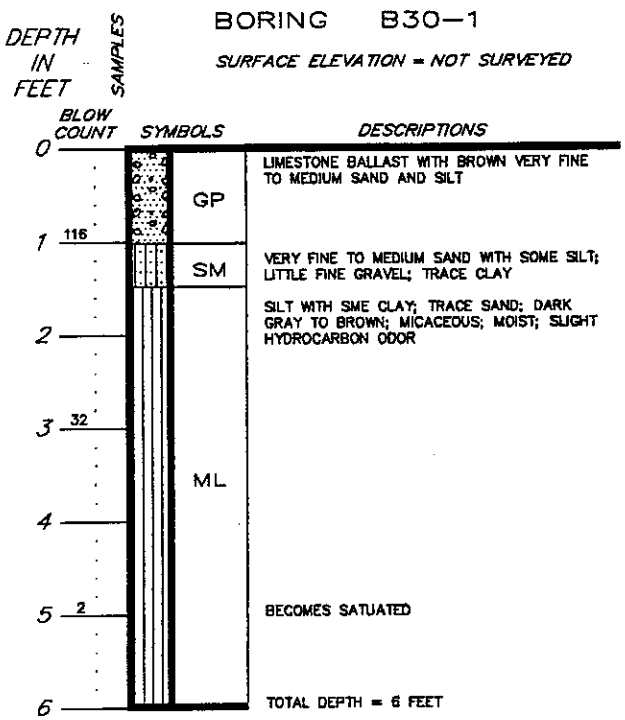
# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(2) CHEV92\B29-1 11/18/92 07:52

## BORING B30–1

SURFACE ELEVATION = NOT SURVEYED

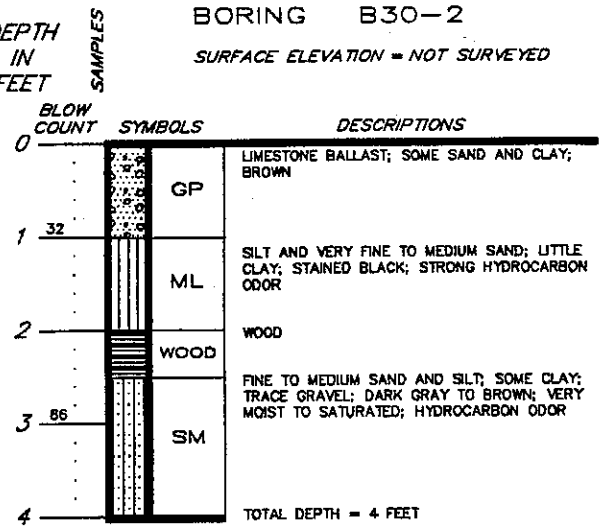



### NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT–SPOON SAMPLER ON 8/10/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 6.0 FEET ON 8/10/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/10/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3–INCH STAINLESS STEEL SPLIT–SPOON SAMPLER.
5. A "BLOW–COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT–SPOON SAMPLER A DISTANCE OF ONE–FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

## BORING B30–2

SURFACE ELEVATION = NOT SURVEYED



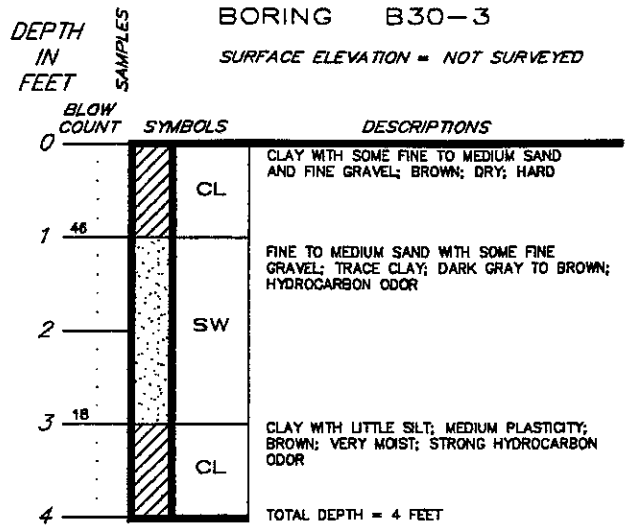

### NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT–SPOON SAMPLER ON 8/10/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 4.0 FEET ON 8/10/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/10/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3–INCH STAINLESS STEEL SPLIT–SPOON SAMPLER.
5. A "BLOW–COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT–SPOON SAMPLER A DISTANCE OF ONE–FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(2) CHEV92\B30–1 11/16/92 07:54



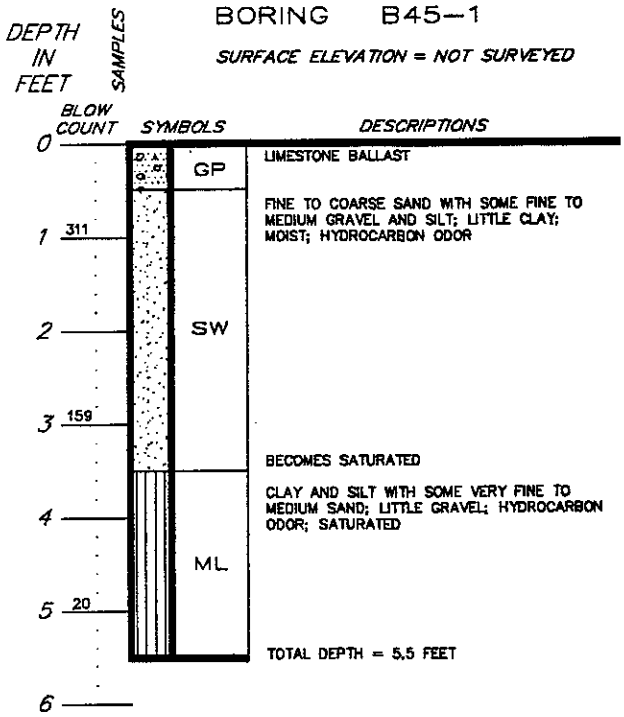

## NOTES:

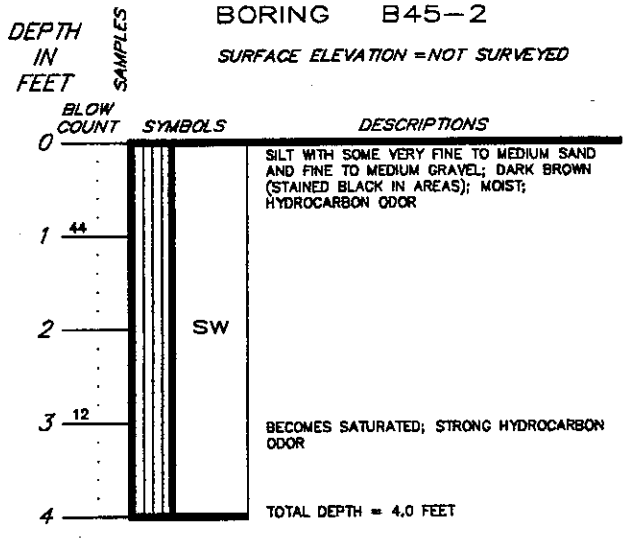
1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/10/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 4.0 FEET ON 8/10/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/10/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

(2) CHEV92\B30-3 11/16/92 07:58

DAMES & MOORE




## NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/7/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 5.5 FEET ON 8/7/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/7/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 1.5 TO 3.5 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

## NOTES:

1. BORING ADVANCED WITH A TRIPOD RIG AND SPLIT-SPOON SAMPLER ON 8/10/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 4.0 FEET ON 8/10/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/10/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

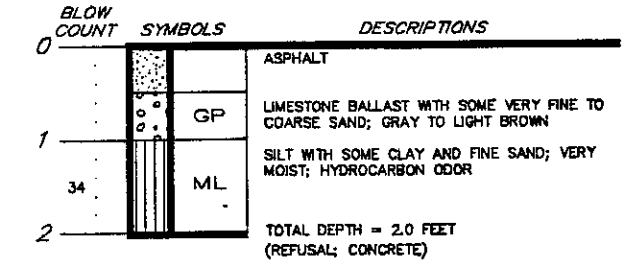
# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(2) CHEV92\B45-1 11/16/92 08:00

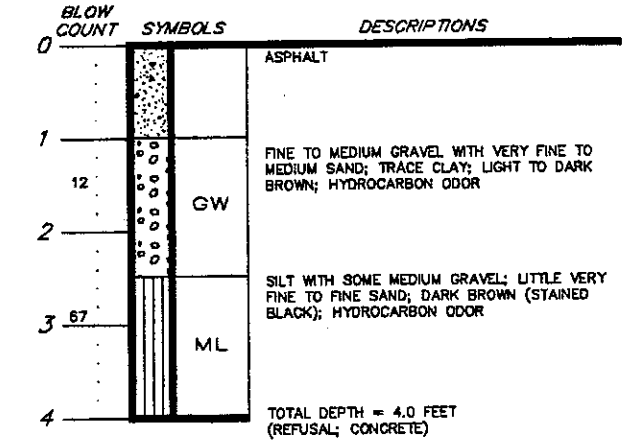
BORING B71–1

SURFACE ELEVATION = NOT SURVEYED




BORING B71–2

SURFACE ELEVATION = NOT SURVEYED




NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT–SPOON SAMPLER ON 8/11/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 2.0 FEET ON 8/11/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/11/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3–INCH STAINLESS STEEL SPLIT–SPOON SAMPLER.
5. A "BLOW–COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT–SPOON SAMPLER A DISTANCE OF ONE–FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 1 TO 2 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT–SPOON SAMPLER ON 8/11/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 4.0 FEET ON 8/11/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/11/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3–INCH STAINLESS STEEL SPLIT–SPOON SAMPLER.
5. A "BLOW–COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT–SPOON SAMPLER A DISTANCE OF ONE–FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

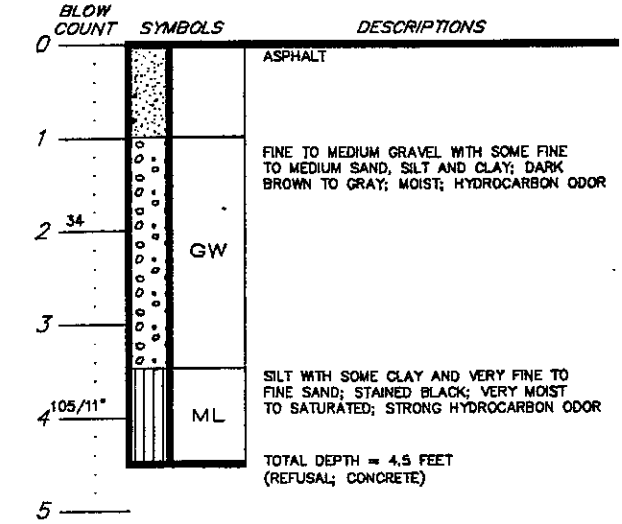
# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(3) CHEV92\B71–1 11/19/92 14:44

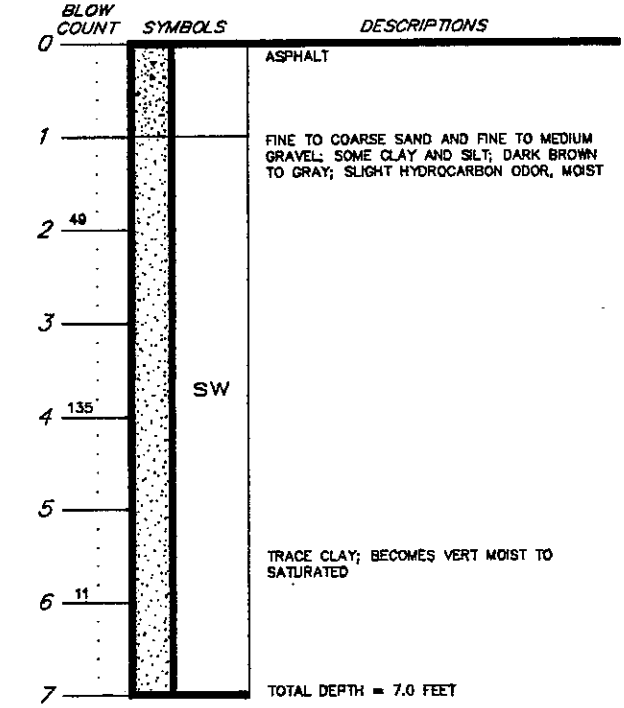
## BORING B71–3

SURFACE ELEVATION = NOT SURVEYED




## BORING B71–4

SURFACE ELEVATION = NOT SURVEYED




### NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT–SPOON SAMPLER ON 8/11/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 4.5 FEET ON 8/11/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/11/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3–INCH STAINLESS STEEL SPLIT–SPOON SAMPLER.
5. A "BLOW–COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT–SPOON SAMPLER A DISTANCE OF ONE–FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 3 TO 4.5 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

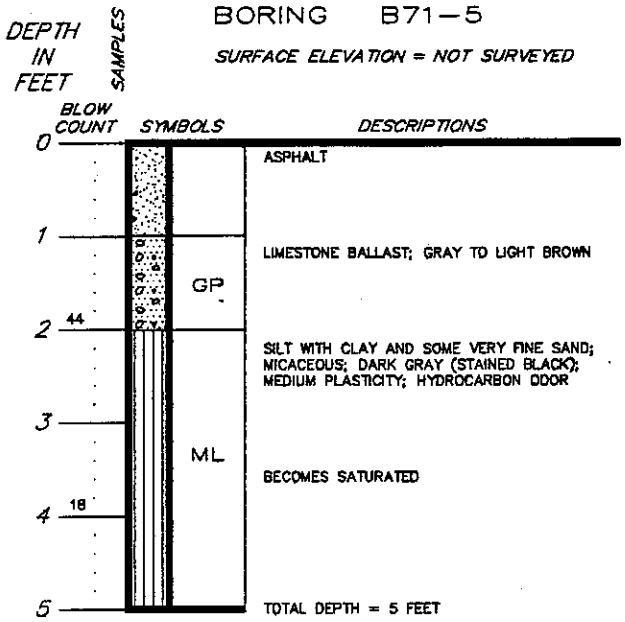
### NOTES:

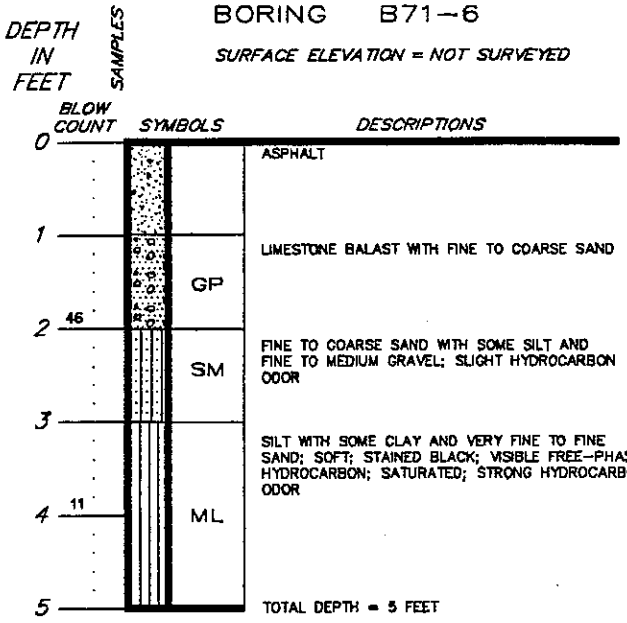
1. BORING ADVANCED WITH A DRILL RIG AND SPLIT–SPOON SAMPLER ON 8/11/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 7.0 FEET ON 8/11/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/11/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3–INCH STAINLESS STEEL SPLIT–SPOON SAMPLER.
5. A "BLOW–COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT–SPOON SAMPLER A DISTANCE OF ONE–FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 3 TO 5 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(3) CHEV92\B71-3 11/19/92 14:45




## NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/11/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 5.0 FEET ON 8/11/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/11/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 1 TO 3 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

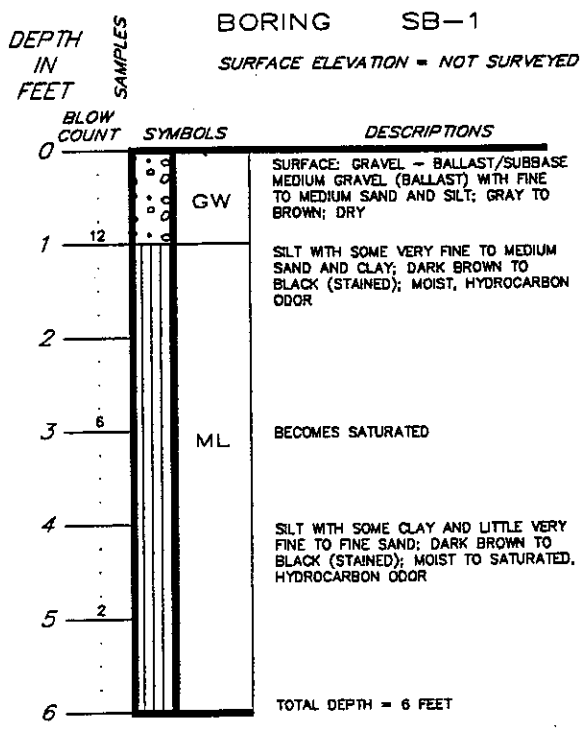
## NOTES;

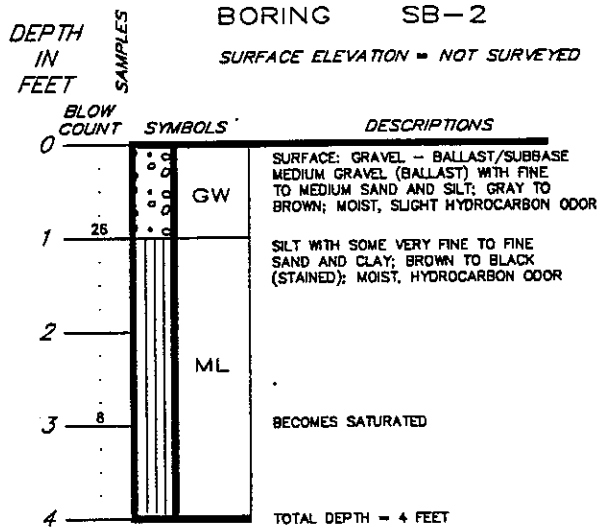
1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/11/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 5.0 FEET ON 8/11/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/11/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 1 TO 3 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(3) CHEV92\B71-5 11/19/92 14:47




## NOTES:

1. BORING ADVANCED WITH DRILL RIG AND SPLIT-SPOON SAMPLER ON 12/19/91 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 6 FEET (WATER TABLE) ON 12/19/91.
3. BORING GROUTED WITH BENTONITE/CEMENT SLURRY ON 12/19/91.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 2-INCH STAINLESS STEEL SPLIT SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 3 TO 3.5 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

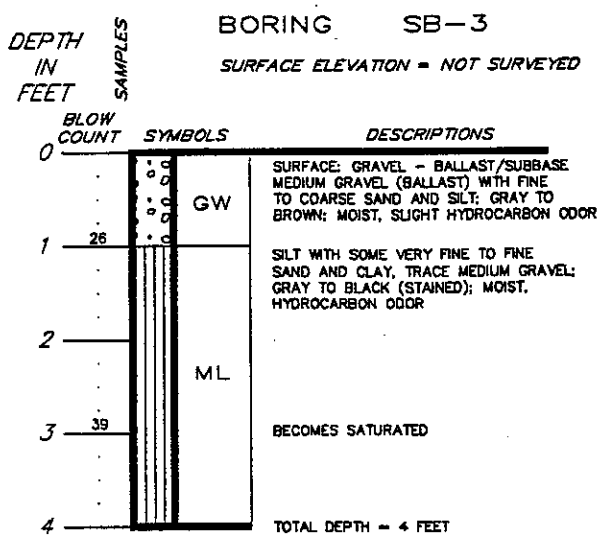
## NOTES:

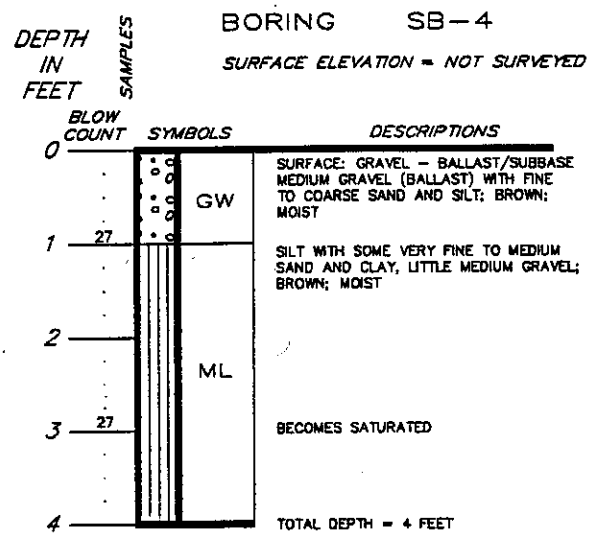
1. BORING ADVANCED WITH DRILL RIG AND SPLIT-SPOON SAMPLER ON 12/19/91 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 4 FEET (WATER TABLE) ON 12/19/91.
3. BORING GROUTED WITH BENTONITE/CEMENT SLURRY ON 12/19/91.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 2-INCH STAINLESS STEEL SPLIT SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 3 TO 3.5 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

TG-SB1 (2)

DAMES & MOORE




NOTES:

1. BORING ADVANCED WITH DRILL RIG AND SPLIT-SPOON SAMPLER ON 12/19/91 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 4 FEET (WATER TABLE) ON 12/19/91.
3. BORING GROUTED WITH BENTONITE/CEMENT SLURRY ON 12/19/91.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 2-INCH STAINLESS STEEL SPLIT SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A COMPOSITE SOIL SAMPLE (0 TO 4 FEET) WAS COLLECTED FROM THIS BORING FOR LABORATORY ANALYSIS.

NOTES:

1. BORING ADVANCED WITH DRILL RIG AND SPLIT-SPOON SAMPLER ON 12/19/91 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 4 FEET (WATER TABLE) ON 12/19/91.
3. BORING GROUTED WITH BENTONITE/CEMENT SLURRY ON 12/19/91.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 2-INCH STAINLESS STEEL SPLIT SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A COMPOSITE SOIL SAMPLE (0 TO 4 FEET) WAS COLLECTED FROM THIS BORING FOR LABORATORY ANALYSIS.

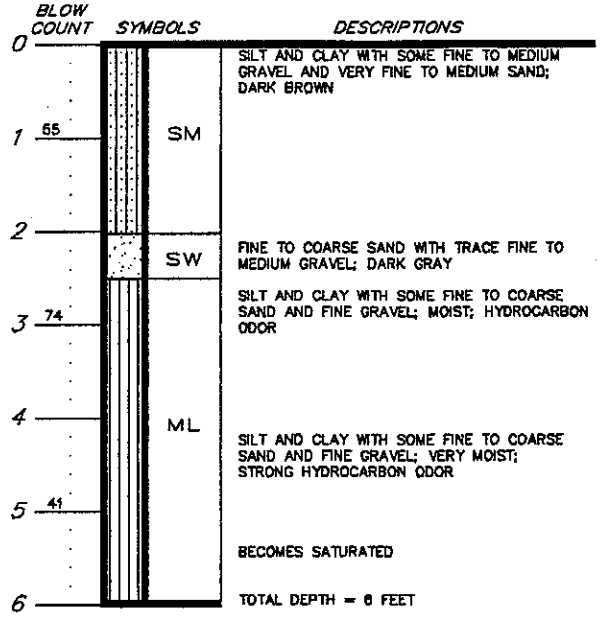
# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

TC-SB3 (2)

DAMES & MOORE

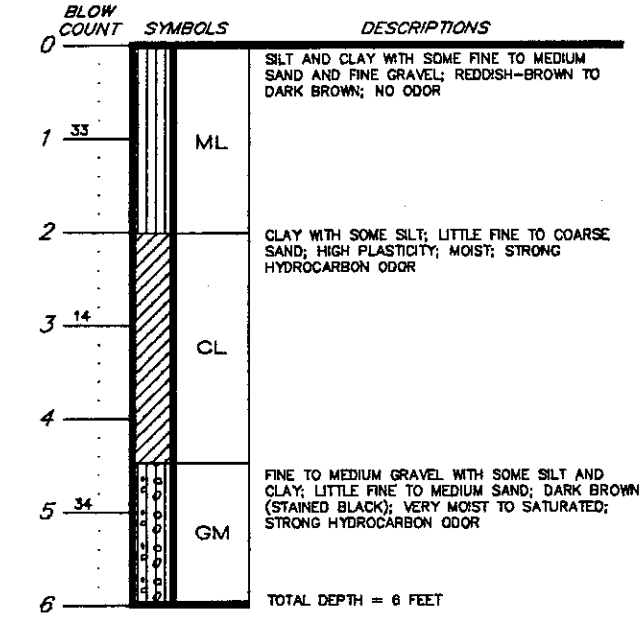
## BORING B71A–1

SURFACE ELEVATION = NOT SURVEYED




## BORING B71A–2

SURFACE ELEVATION = NOT SURVEYED




### NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT–SPOON SAMPLER ON 8/12/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 6.0 FEET ON 8/12/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/12/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3–INCH STAINLESS STEEL SPLIT–SPOON SAMPLER.
5. A "BLOW–COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT–SPOON SAMPLER A DISTANCE OF ONE–FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 2 TO 4 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

### NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT–SPOON SAMPLER ON 8/12/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 6.0 FEET ON 8/12/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/12/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3–INCH STAINLESS STEEL SPLIT–SPOON SAMPLER.
5. A "BLOW–COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT–SPOON SAMPLER A DISTANCE OF ONE–FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 4 TO 6 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

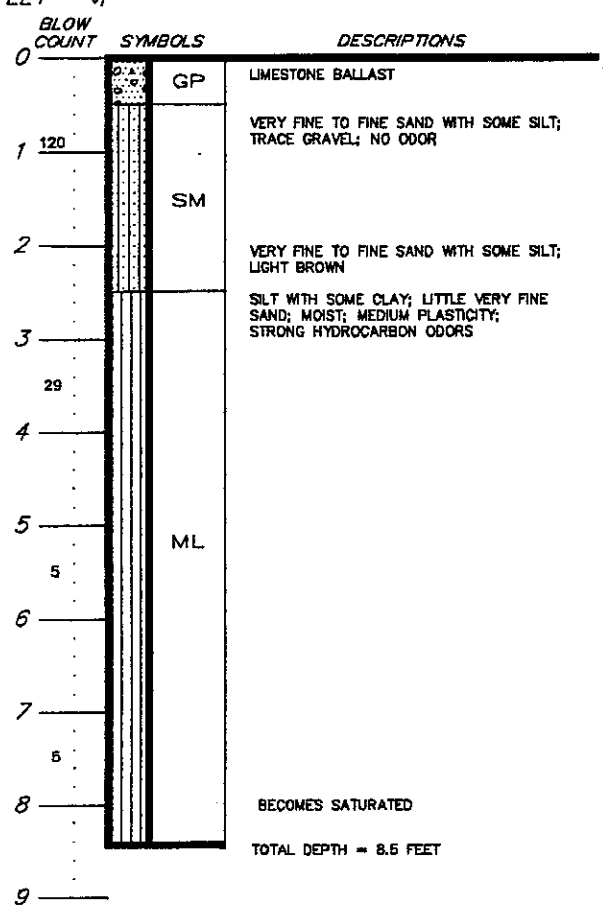
# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(2) CHEV92\B71A–1 11/16/92 08:12

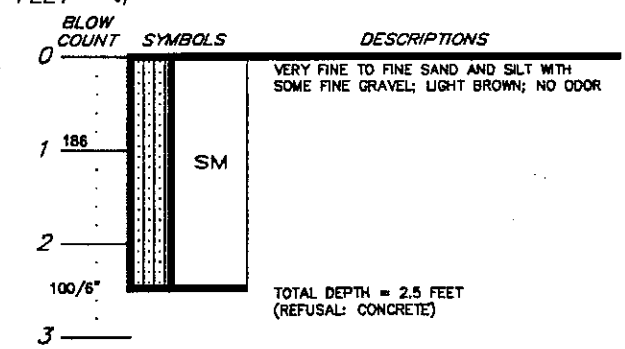
## BORING B79-1

SURFACE ELEVATION = NOT SURVEYED




## BORING B79-2

SURFACE ELEVATION = NOT SURVEYED




### NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/12/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 8.5 FEET ON 8/12/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/12/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 4.5 TO 6.5 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

### NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/12/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 2.5 FEET ON 8/12/92.
3. BORING GROUTED TO THE GROUND SURFACE WITH PORTLAND CEMENT ON 8/12/92.
4. SAMPLES WERE CONTINUOUSLY COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
5. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE-FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
6. A SOIL SAMPLE FROM THE 0 TO 2 FOOT INTERVAL WAS COLLECTED FOR LABORATORY ANALYSIS.

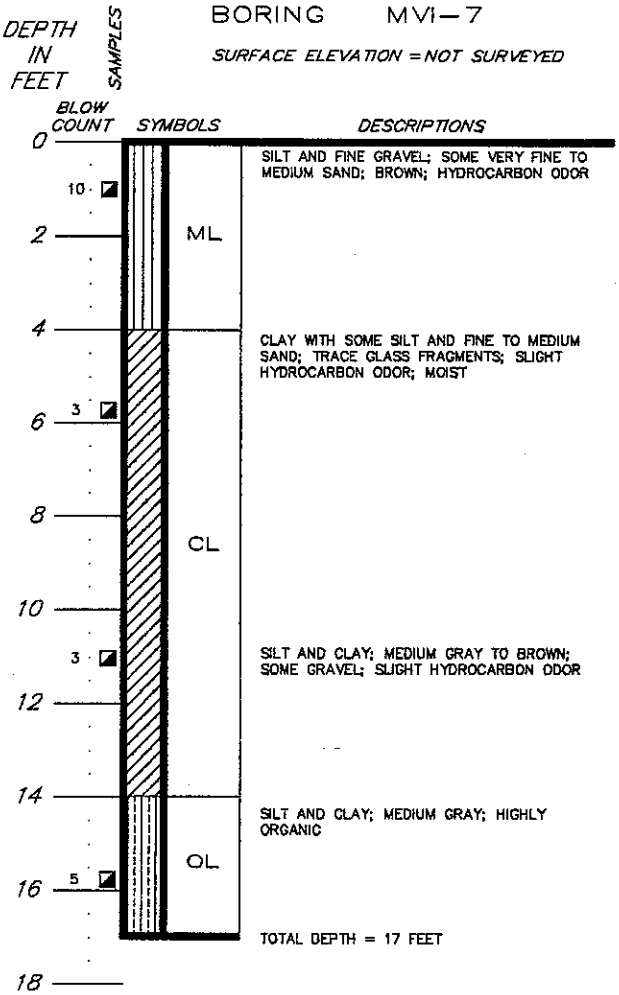
# LOG OF SOIL BORING
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

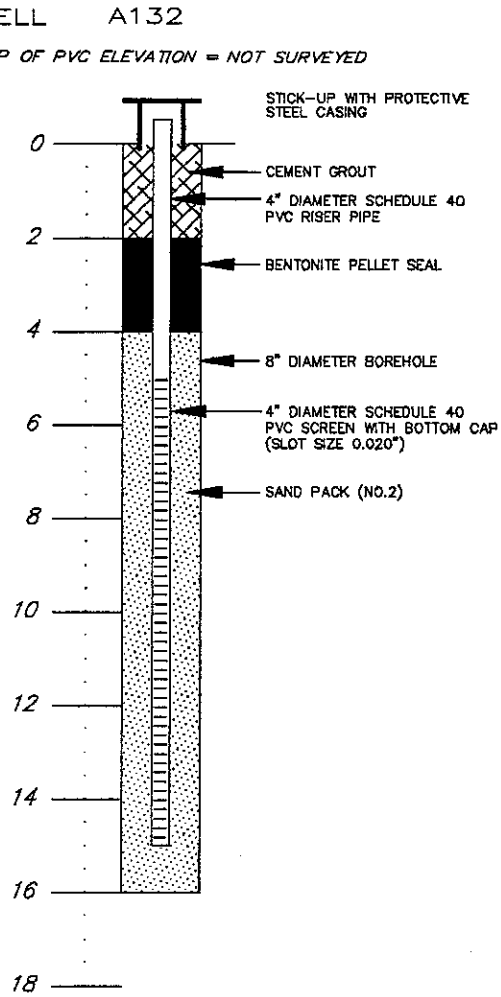
DAMES & MOORE

(2) CHEV92\B79-1 11/16/92 08:14

# APPENDIX E

## MONITORING WELL CONSTRUCTION DIAGRAMS




## EXPLANATION:

◪ 2-FOOT SPLIT-SPOON SAMPLE COLLECTED FROM THIS INTERVAL

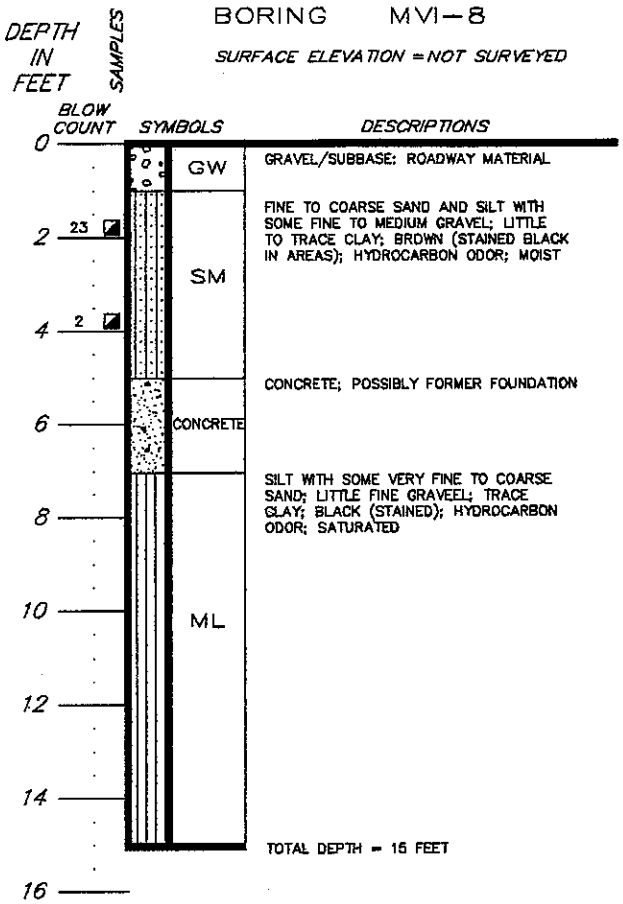
## NOTES:

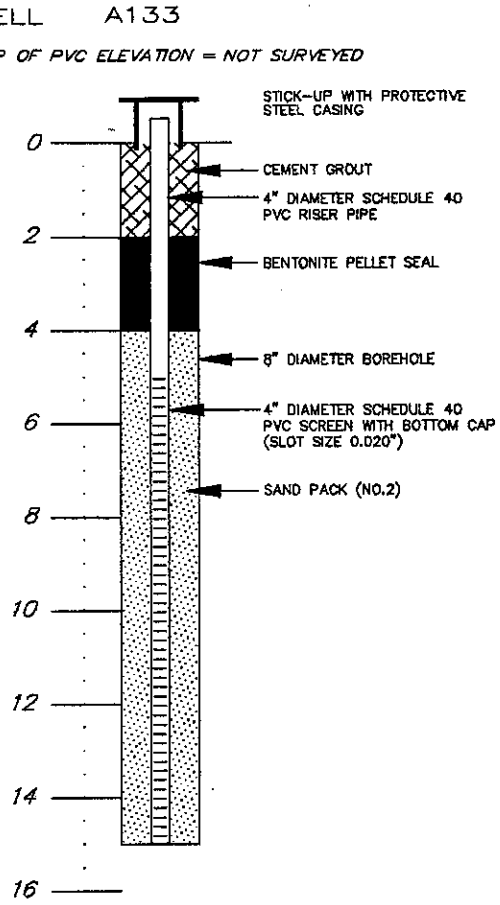
1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/5/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 17 FEET ON 8/5/92.
3. MONITORING WELL A132 INSTALLED ON 8/5/92.
4. MONITORING WELL A132 DEVELOPED ON 8/19/92.
5. SAMPLES WERE COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
6. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
7. DEPTH TO WATER MEASURED TO BE 3.61 FEET ON 9/2/92.

# LOG OF SOIL BORING AND MONITORING WELL DETAIL CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(3) CHEV92\TG-MVI7 10/26/92 08:07




## EXPLANATION:

■ 2-FOOT SPLIT-SPOON SAMPLE COLLECTED FROM THIS INTERVAL

## NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/4/92 & 8/6/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 15 FEET ON 8/6/92.
3. MONITORING WELL A133 INSTALLED ON 8/6/92.
4. MONITORING WELL A133 DEVELOPED ON 8/19/92.
5. SAMPLES WERE COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
6. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
7. DEPTH TO WATER MEASURED TO BE 10.19 FEET ON 9/2/92.
8. DEPTH TO FREE-PHASE HYDROCARBON MEASURED TO BE 9.96 FEET ON 9/2/92.
9. IN ORDER TO DRILL THROUGH THE CONCRETE AT 6 TO 7 FEET BELOW GROUND SURFACE (BGS) THE BOTTOM OF THE LEAD AUGER WAS "PLUGGED" WITH WOOD. THIS WOOD PLUG COULD NOT BE REMOVED, AND, THUS THIS BOREHOLE WAS LOGGED FROM DRILL CUTTINGS FROM 7 FEET TO 15 FEET BGS.

# LOG OF SOIL BORING AND MONITORING WELL DETAIL CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

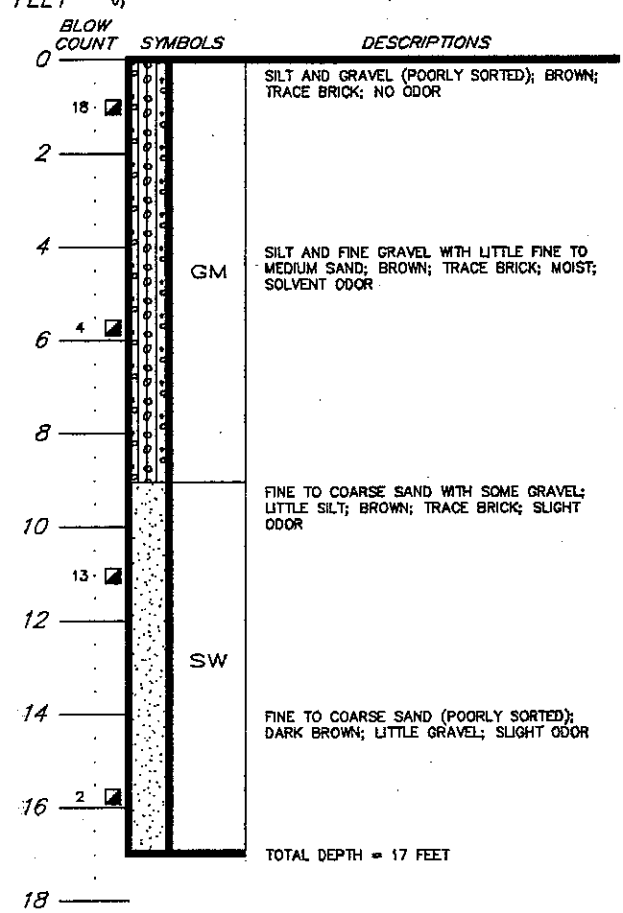
(2) CHEVRON\TG-MWB 10/05/92 09:09

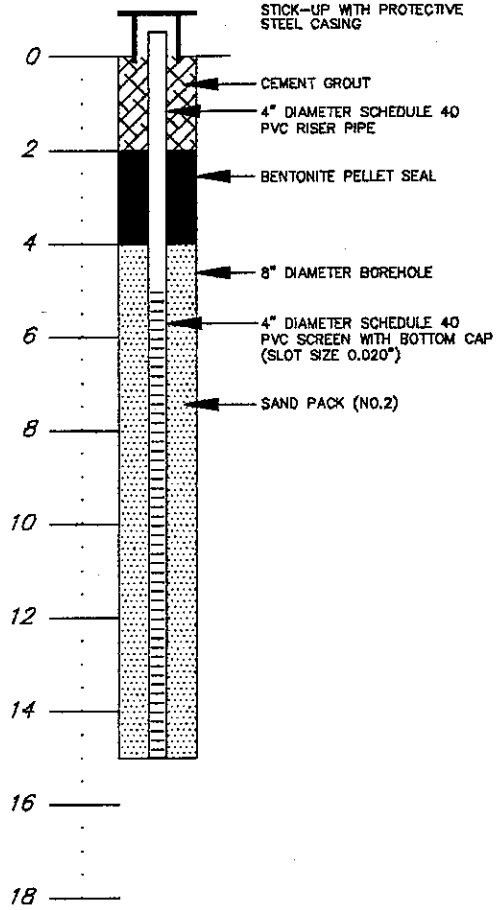
BORING MVI-9

SURFACE ELEVATION = NOT SURVEYED

WELL A134

TOP OF PVC ELEVATION = NOT SURVEYED




## EXPLANATION:

◪ 2-FOOT SPLIT-SPOON SAMPLE COLLECTED FROM THIS INTERVAL

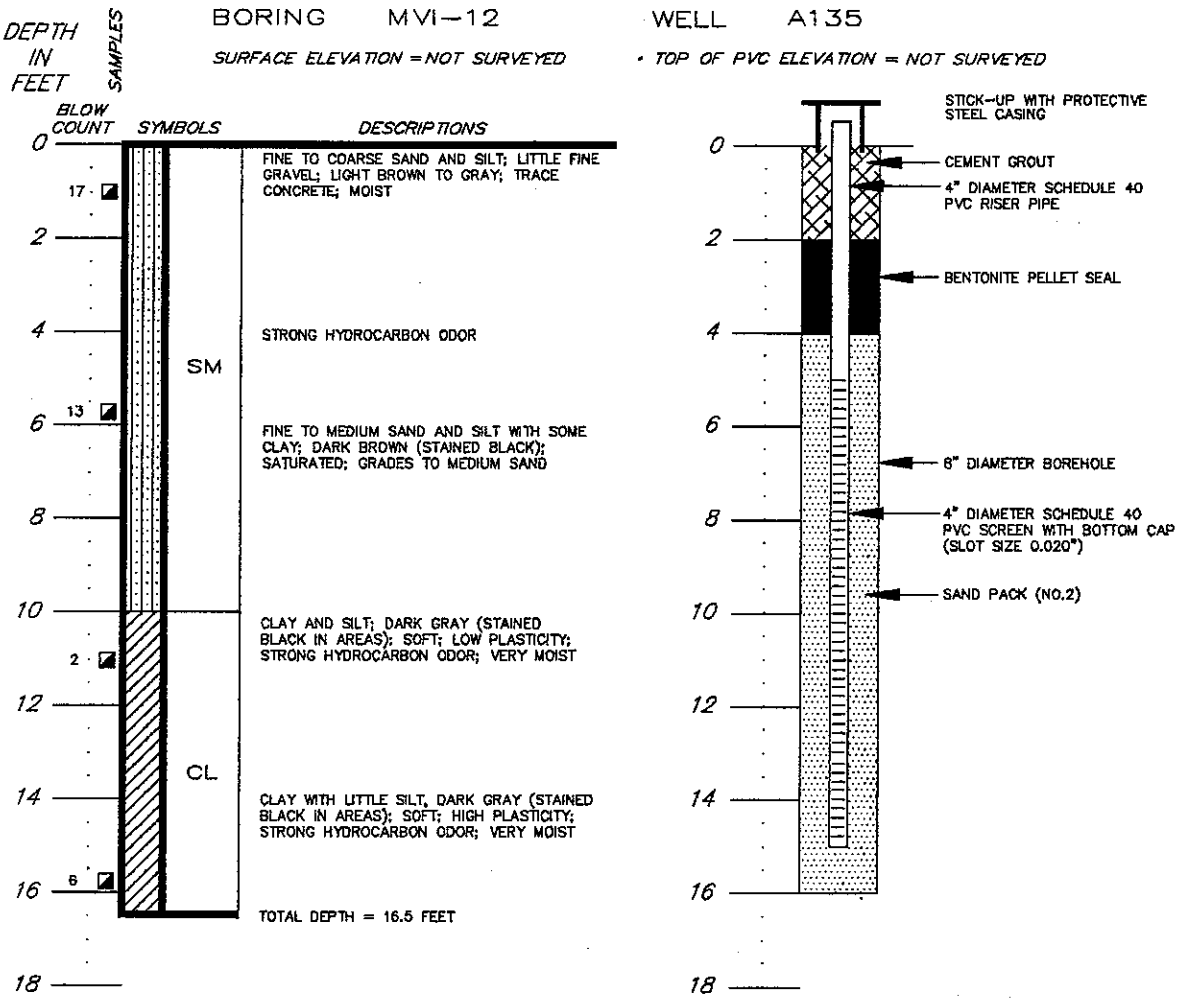
## NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/6/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 17 FEET ON 8/6/92.
3. MONITORING WELL A134 INSTALLED ON 8/6/92.
4. MONITORING WELL A134 DEVELOPED ON 8/19/92.
5. SAMPLES WERE COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
6. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
7. DEPTH TO WATER MEASURED TO BE 7.78 FEET ON 9/3/92.

# LOG OF SOIL BORING AND MONITORING WELL DETAIL CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(2) CHEVRON\TG-MW9 10/05/92 09:12




## EXPLANATION:

■ 2-FOOT SPLIT-SPOON SAMPLE COLLECTED FROM THIS INTERVAL.

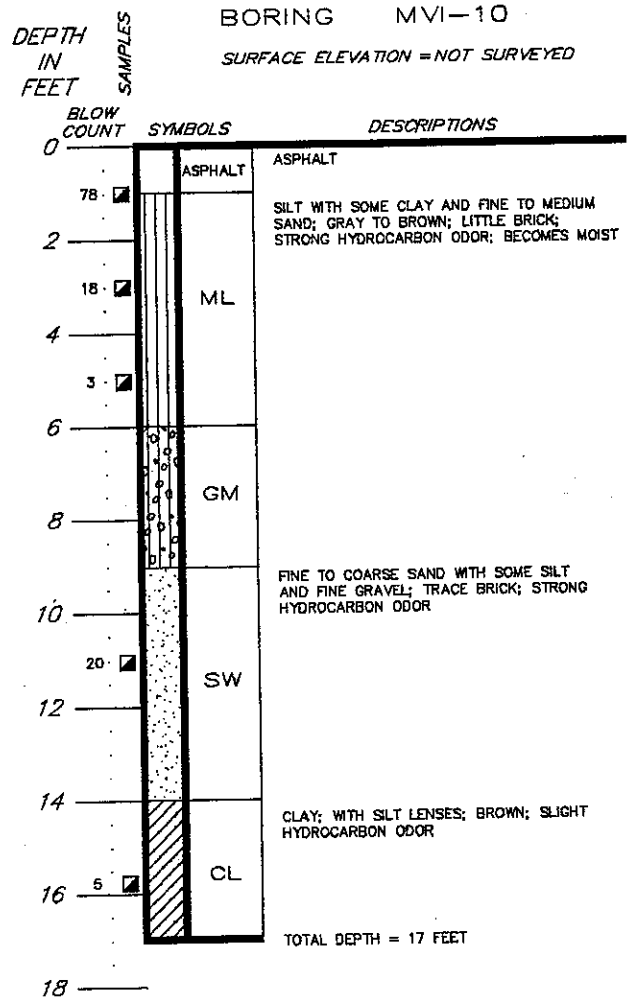
## NOTES:

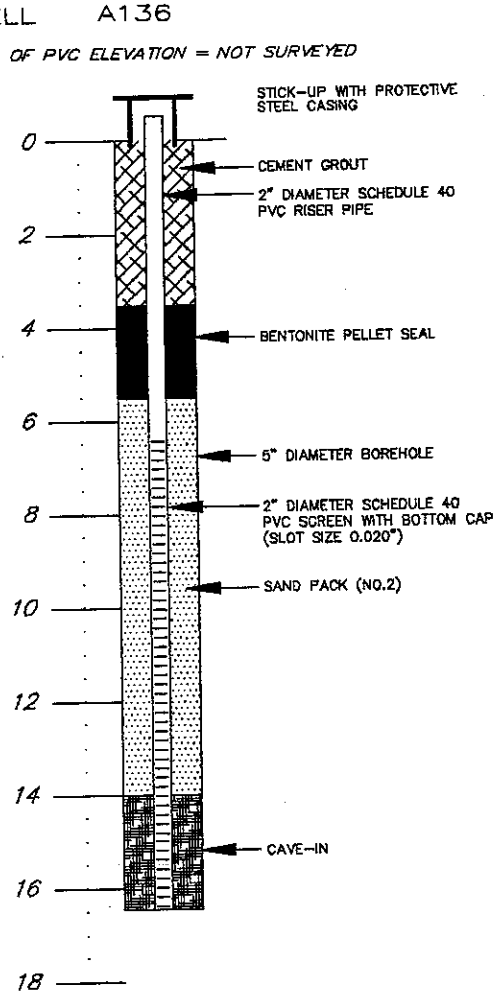
1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/20/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 16.5 FEET ON 8/20/92.
3. MONITORING WELL A135 INSTALLED ON 8/20/92.
4. MONITORING WELL A135 DEVELOPED ON 8/21/92.
5. SAMPLES WERE COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
6. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
7. DEPTH TO WATER MEASURED TO BE 7.43 FEET ON 9/2/92.

# LOG OF SOIL BORING AND MONITORING WELL DETAIL
# CHEVRON REFINERY
# PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(2) CHEVRON\TG-MW12 10/05/92 09:38




## EXPLANATION:

■ 2-FOOT SPLIT-SPOON SAMPLE COLLECTED FROM THIS INTERVAL

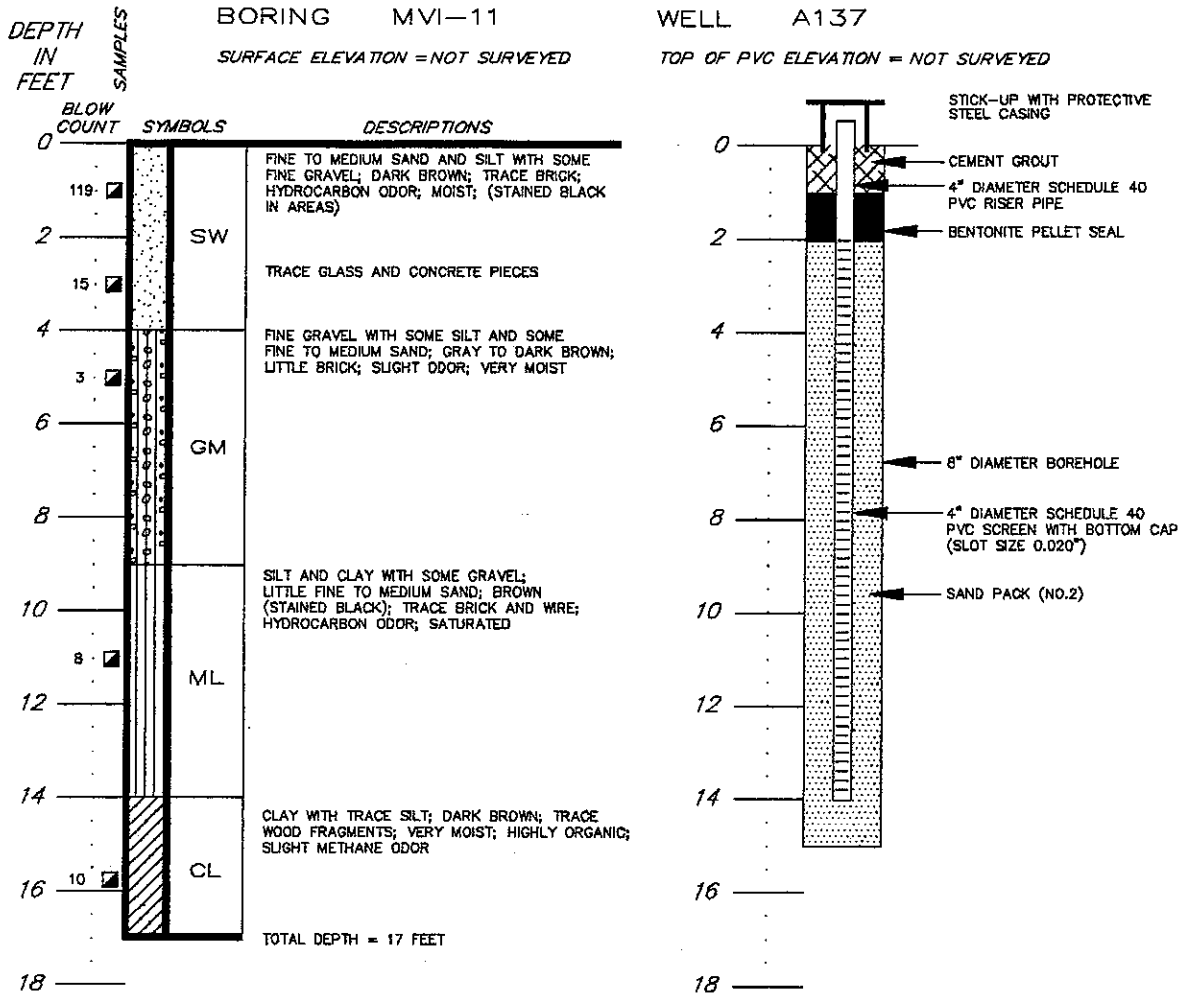
## NOTES:

1. BORING ADVANCED WITH A TRIPOD RIG AND SPLIT-SPOON SAMPLER ON 8/6/92 & 8/8/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 17 FEET ON 8/7/92.
3. MONITORING WELL A136 INSTALLED ON 8/10/92.
4. MONITORING WELL A136 DEVELOPED ON 8/20/92.
5. SAMPLES WERE COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
6. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
7. DEPTH TO WATER MEASURED TO BE 6.91 FEET ON 9/3/92.

# LOG OF SOIL BORING AND MONITORING WELL DETAIL CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(2) CHEVRON\TG-MW10 10/05/92 08:32




## EXPLANATION:

■ 2–FOOT SPLIT–SPOON SAMPLE COLLECTED FROM THIS INTERVAL

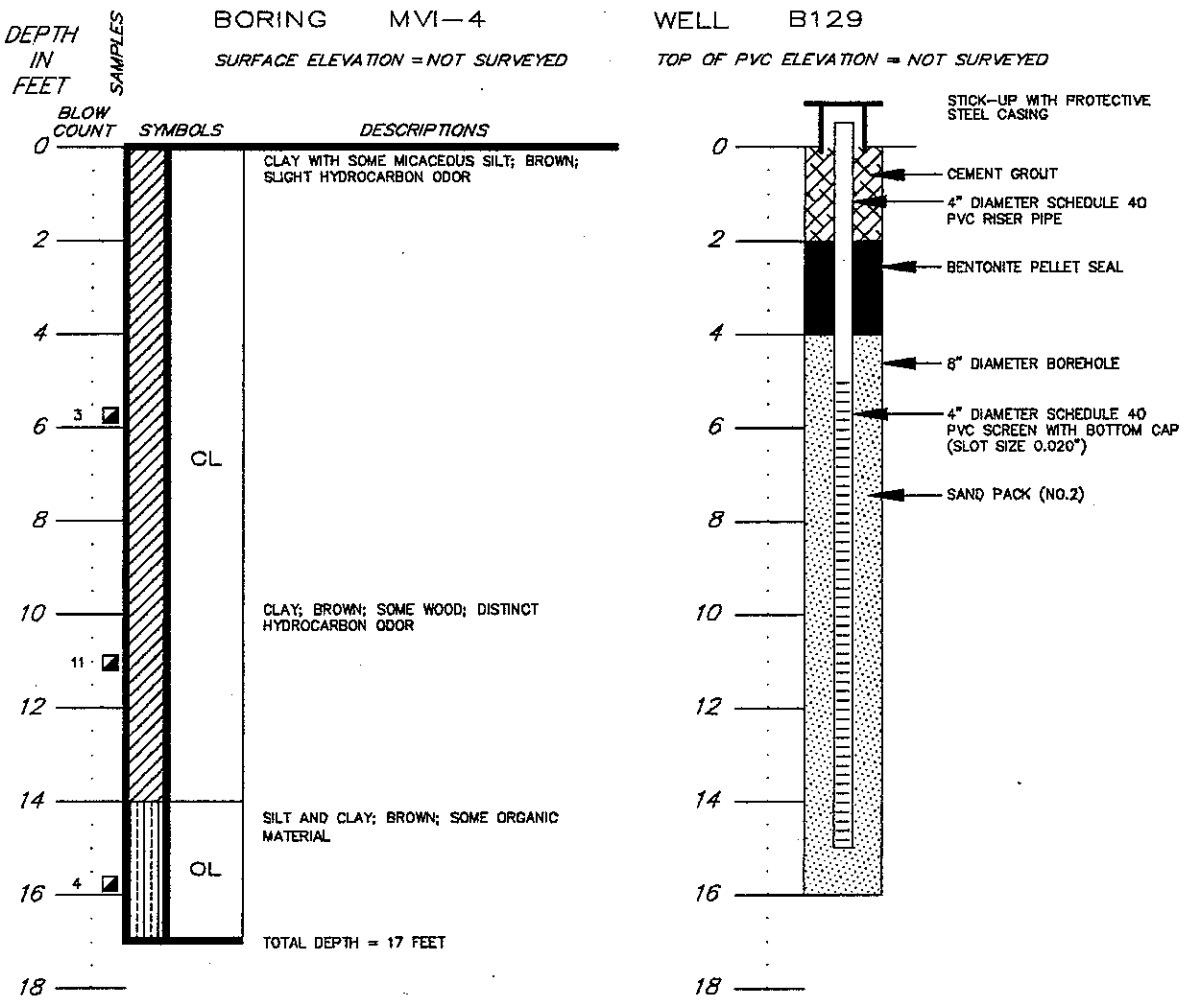
## NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT–SPOON SAMPLER ON 8/4/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 17 FEET ON 8/4/92.
3. MONITORING WELL A137 INSTALLED ON 8/4/92.
4. MONITORING WELL A137 DEVELOPED ON 8/19/92.
5. SAMPLES WERE COLLECTED AT THIS SOIL BORING LOCATION WITH A 3–INCH STAINLESS STEEL SPLIT–SPOON SAMPLER.
6. A "BLOW–COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT–SPOON SAMPLER A DISTANCE OF ONE FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
7. DEPTH TO WATER MEASURED TO BE 7.91 FEET ON 9/2/92.

# LOG OF SOIL BORING AND MONITORING WELL DETAIL CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(2) CHEVRON\TG-MVI11 10/05/92 09:31




## EXPLANATION:

■ 2-FOOT SPLIT-SPOON SAMPLE COLLECTED FROM THIS INTERVAL

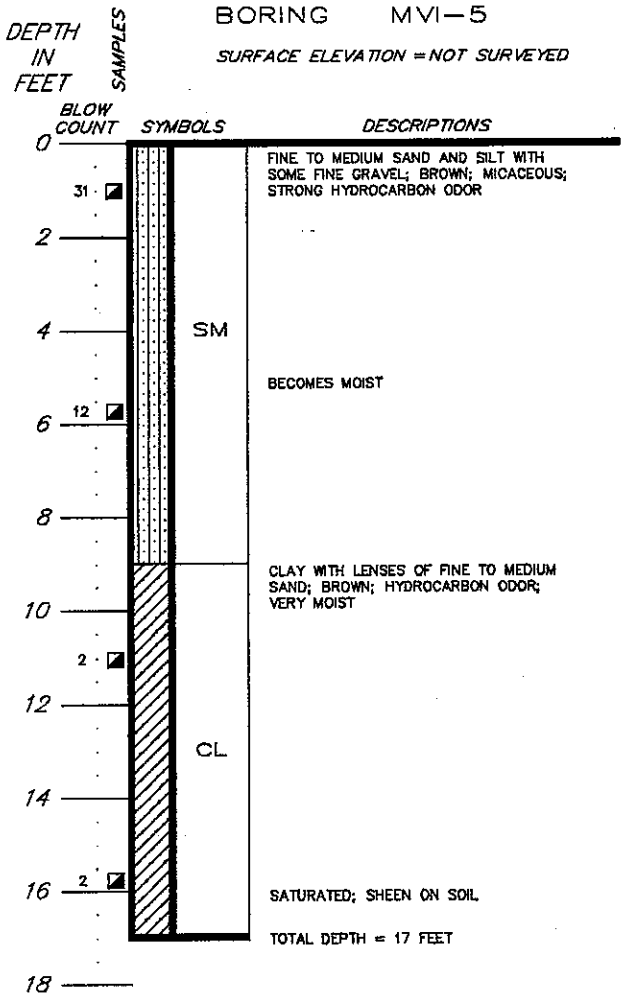
## NOTES:

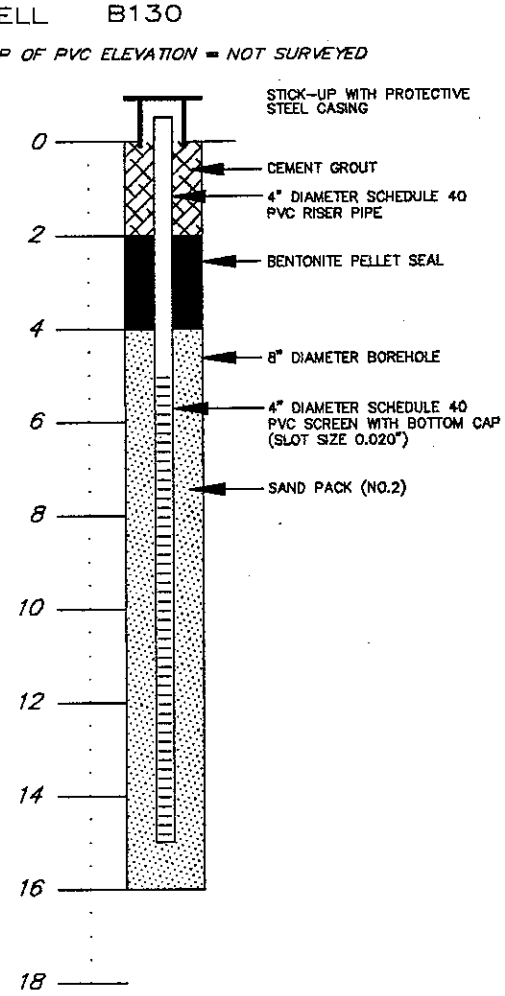
1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/11/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 17 FEET ON 8/11/92.
3. MONITORING WELL B129 INSTALLED ON 8/11/92.
4. MONITORING WELL B129 DEVELOPED ON 8/20/92.
5. SAMPLES WERE COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
6. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
7. DEPTH TO WATER MEASURED TO BE 8.26 FEET ON 9/3/92.
8. DEPTH TO FREE-PHASE HYDROCARBON MEASURED TO BE 6.40 FEET ON 9/3/92.

# LOG OF SOIL BORING AND MONITORING WELL DETAIL CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(2) CHEVRON\TG-MW14 10/05/92 08:46




## EXPLANATION:

■ 2-FOOT SPLIT-SPOON SAMPLE COLLECTED FROM THIS INTERVAL

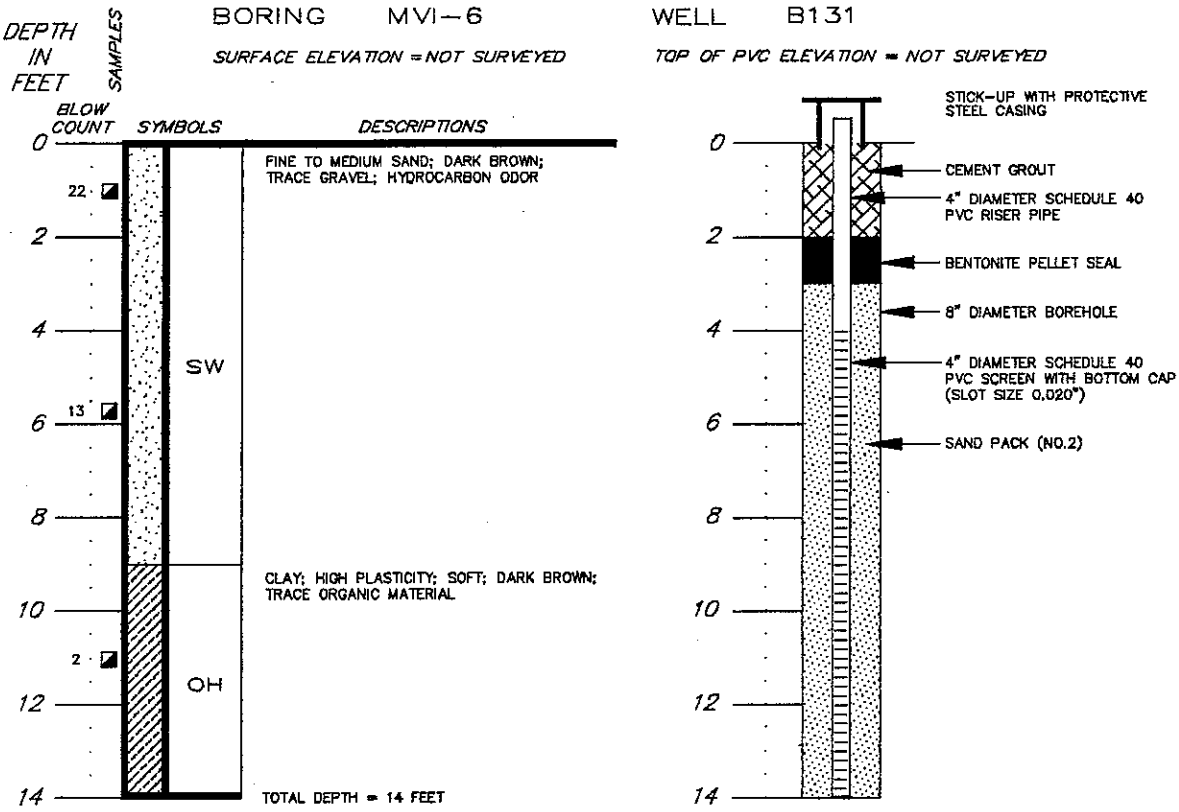
## NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/10/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 17 FEET ON 8/10/92.
3. MONITORING WELL B130 INSTALLED ON 8/11/92.
4. MONITORING WELL B130 DEVELOPED ON 8/20/92.
5. SAMPLES WERE COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
6. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
7. DEPTH TO WATER MEASURED TO BE 5.44 FEET ON 9/3/92.

# LOG OF SOIL BORING AND MONITORING WELL DETAIL CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(2) CHEVRON\TG-MW5 10/05/92 08:53




## EXPLANATION:

◪ 2-FOOT SPLIT-SPOON SAMPLE COLLECTED FROM THIS INTERVAL

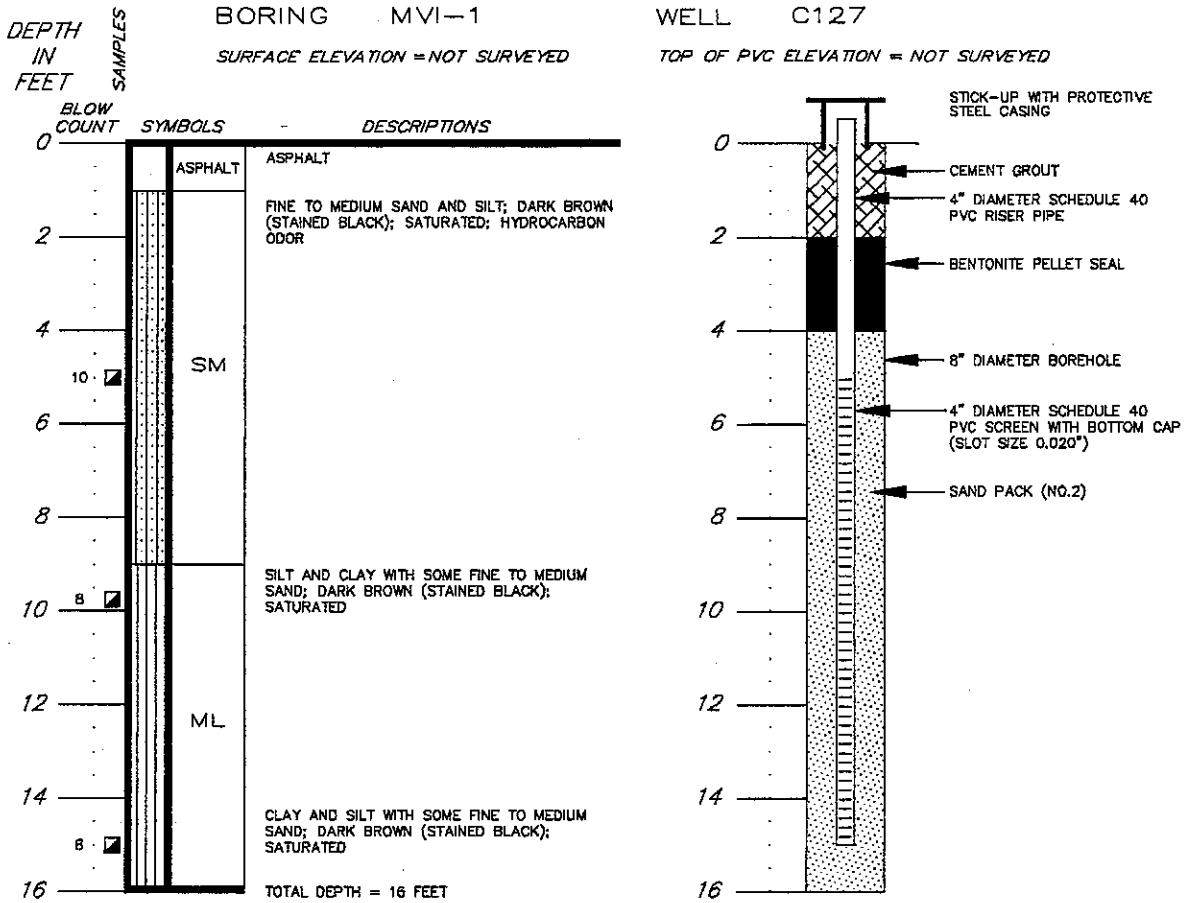
## NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/7/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 14 FEET ON 8/7/92.
3. MONITORING WELL B131 INSTALLED ON 8/7/92.
4. MONITORING WELL B131 DEVELOPED ON 8/20/92.
5. SAMPLES WERE COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
6. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
7. DEPTH TO WATER MEASURED TO BE 4.84 FEET ON 9/4/92.

# LOG OF SOIL BORING AND MONITORING WELL DETAIL CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(2) CHEVRON\TG-MW6 10/05/92 08:59




## EXPLANATION:

◪ 2-FOOT SPLIT-SPOON SAMPLE COLLECTED FROM THIS INTERVAL

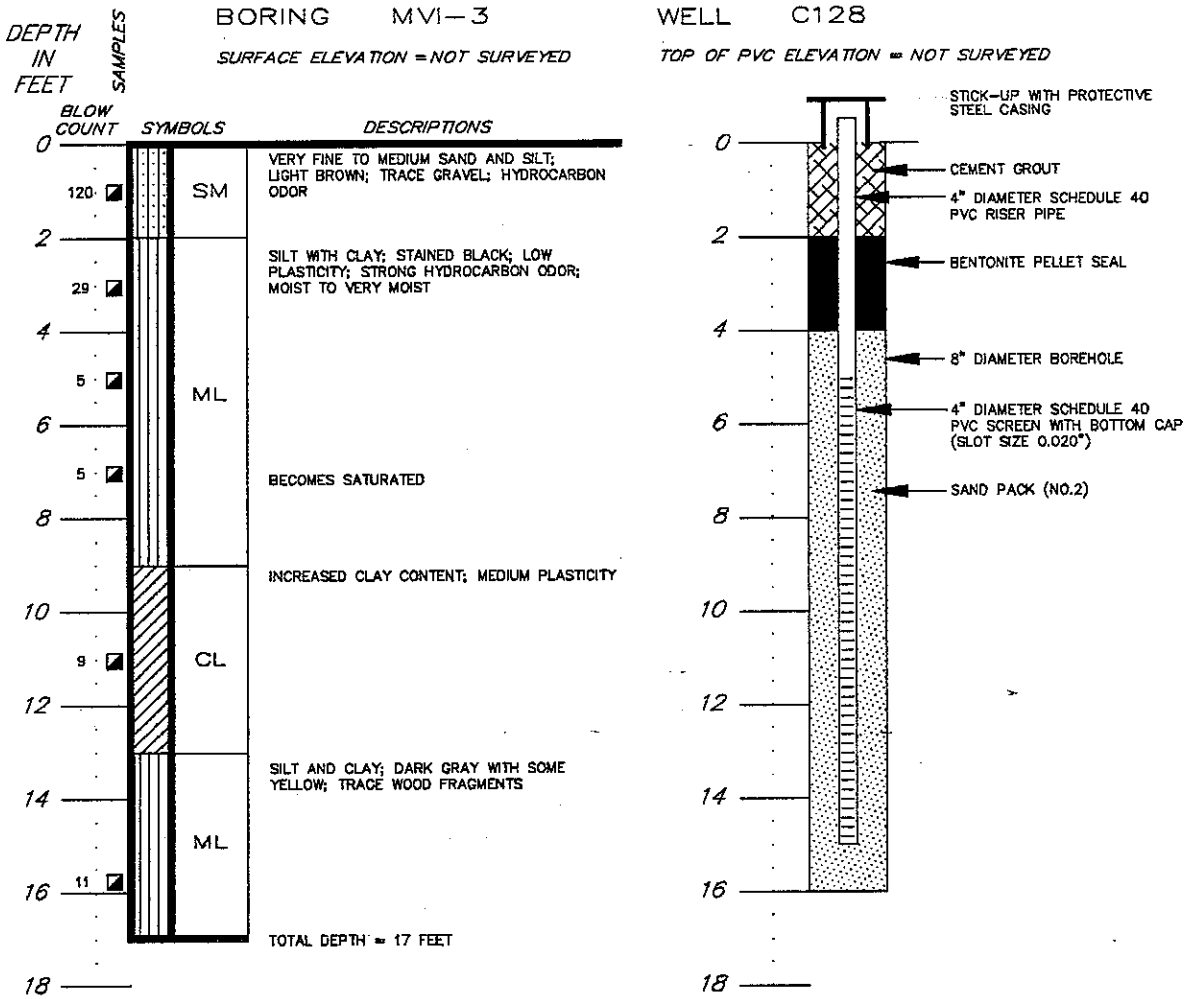
## NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/14/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 16 FEET ON 8/14/92.
3. MONITORING WELL C127 INSTALLED ON 8/14/92.
4. MONITORING WELL C127 DEVELOPED ON 8/20/92.
5. SAMPLES WERE COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
6. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
7. DEPTH TO WATER MEASURED TO BE 8.24 FEET ON 9/3/92.

# LOG OF SOIL BORING AND MONITORING WELL DETAIL CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(3) CHEV92\TG-MW1 10/26/92 08:04




## EXPLANATION:

■ 2-FOOT SPLIT-SPOON SAMPLE COLLECTED FROM THIS INTERVAL

## NOTES:

1. BORING ADVANCED WITH A DRILL RIG AND SPLIT-SPOON SAMPLER ON 8/12/92 BY MARCOR DRILLING OF EXTON, PENNSYLVANIA.
2. BORING TERMINATED AT 17 FEET ON 8/12/92.
3. MONITORING WELL C128 INSTALLED ON 8/12/92.
4. MONITORING WELL C128 DEVELOPED ON 8/12/92.
5. SAMPLES WERE COLLECTED AT THIS SOIL BORING LOCATION WITH A 3-INCH STAINLESS STEEL SPLIT-SPOON SAMPLER.
6. A "BLOW-COUNT" REFERS TO THE NUMBER OF BLOWS REQUIRED TO DRIVE A STANDARD SPLIT-SPOON SAMPLER A DISTANCE OF ONE FOOT (UNLESS OTHERWISE NOTED) USING A 140 lb. HAMMER FALLING 30 INCHES.
7. DEPTH TO WATER MEASURED TO BE 5.40 FEET ON 9/4/92.

# LOG OF SOIL BORING AND MONITORING WELL DETAIL CHEVRON REFINERY PHILADELPHIA, PENNSYLVANIA

DAMES & MOORE

(3) CHEV92\TG-MV3 10/26/92 08:06