WORK PLAN FOR COMPLETION OF SITE INVESTIGATION

Buffalo Terminal
Location No. 31-010
Buffalo, New York

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Prepared for:

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1.0 INTRODUCTION

Roux Associates, Inc. (Roux Associates) has prepared this work plan on behalf of ExxonMobil Oil Corporation (ExxonMobil) for completion of investigation activities in several areas of the Buffalo Terminal (Site) located at 625 Elk Street, Buffalo, New York (Figure 1). The Site has been divided into nine geographic areas, which have been defined for the purpose of assessing environmental conditions and reporting the results of area-specific activities (Figure 2). These areas were designated according to the primary operations that occurred in that portion of the Site and are the following:

- Eastern Tank Yard Area (Former Disposal Area [ETYA]);
- Northeast Process and Storage Area (NPSA);
- Northern Tank Yard Area (NTYA);
- Former Refinery Area (FRA);
- Central Rail and Process Area (CRPA);
- Southern Tank Yard Area (STYA);
- Babcock Street Properties Area (BSPA);
- Administrative Offices and Operations Area (AOOA); and
- Elk Street Properties Area (ESPA).

The areas addressed in this work plan include the ETYA, NPSA, NTYA, FRA, CRPA, STYA, and AOOA. These areas were selected since the investigation of environmental conditions is currently incomplete. The investigations of the BSPA and ESPA are being completed separately.

This Work Plan was developed based upon review of the existing data available for these areas of the Site. The objectives of the investigation in these areas are to develop the site specific data necessary to:

- Supplement previous investigations in order to complete the description of environmental conditions within these areas;
- Conduct an exposure assessment; and

- Evaluate remedial alternatives.

To achieve these objectives, the scope of work outlined in this Work Plan includes the following tasks:

- Measurement and sampling of solids in the three northernmost compartments of the former Main In-Ground Oil/Water Separator located in the FRA;
- A Geoprobe^{TM} soil and groundwater sampling program to complete the delineation of separate-phase product, soil and groundwater conditions throughout these areas;
- Installation of monitoring wells in locations where existing wells are not screened properly for monitoring separate-phase product and abandonment of the improperly screened wells;
- Abandonment of MW-19 in the STYA, which is not screened properly for monitoring separate phase product and is located in close proximity to two other wells (MW-14 and RW-2);
- Installation of a monitoring well to the east of MW-7 in the FRA to delineate the extent of separate phase product in this area;
- Installation of wells in additional locations selected based on the Geoprobe^{TM} sampling program;
- monitoring of water-level and separate-phase product (if present); and
- sampling of groundwater from selected wells.

The remainder of the Work Plan is organized as follows:

- Section 2.0 provides a summary of the history of the selected areas of the Site, including ownership, past and present operations (i.e., buildings, tanks, etc) and spills or releases;
- Section 3.0 provides a summary of environmental conditions based upon the results of previous investigations;
- Section 4.0 identifies data requirements for completion of the assessment of environmental conditions;
- Section 5.0 presents the scope of work to generate the necessary data;
- Section 6.0 presents sampling and sample custody procedures;
- Section 7.0 presents equipment calibration procedures and preventative maintenance;
- Section 8.0 discusses report preparation and project schedule; and
- Section 9.0 presents references.

Included with the Work Plan are the following appendices:

- Appendix A: Separate-Phase Product Analytical Results;
- Appendix B: Hydrographs;
- Appendix C: Roux Associates' Standard Operating Procedures;
- Appendix D: Procedures for Logging Geologic Borings and Preparation of Geologic and Well Construction Logs;
- Appendix E: Field Forms; and
- Appendix F: Lancaster Laboratories Sample Packaging and Shipping Requirements.

2.0 DESCRIPTION AND HISTORY OF SELECTED AREAS OF THE SITE

The historical information presented in this Section was obtained from the document entitled "History of Operations at Buffalo Terminal" (Roux Associates, 2000). Historically, the major Site refinery and terminal operations occurred south of Elk Street in an area of approximately 89 acres. The petroleum refining operations at the Site began during 1880. During the early period of refining, several petroleum companies occupied portions of the Site including Buffalo Pipeline Company, Solar Oil Company, Tidewater Pipe Line Company, Buffalo Lubricating Oil Company, and Atlas Refining Company. The majority of the Site was purchased by Standard Oil Company of New York (SOCONY), ExxonMobil's predecessor, in 1892. In May 1981, the Site terminated all refinery operations. The Site continued as a distribution terminal, receiving product via a pipeline and barge. Throughout the Site's history, the areal extent of property owned by ExxonMobil changed as portions of property were acquired or sold for various reasons. The area within the current ExxonMobil property boundary is 78.3 acres.

Formerly, the Buffalo River transected the southern portion of the Site. Between 1914 and 1917, the river was rerouted to the south to form a relatively straight channel. The rerouting of the Buffalo River was intended to facilitate the navigation of ships and in turn, benefit industries along the river. The rerouted river line became the Site's southern boundary. To the east of the D.L.&W.R.R tracks, the Buffalo River was filled in, relocated farther to the east, and rerouted to run generally in an west-southwesterly direction to the railroad bridge where the straightened navigable channel began. The parcel between the east side of the D.L. & W.R.R rail tracks and the new river channel is included in the ETYA.

Originally, until around 1917, the Site was utilized for the refining of crude petroleum for illuminating oil. The heavy residuum obtained from the distillation process was converted into paraffin oil and wax, which was refined on site. In the paraffin and wax refinery area, located within the NPSA, the oil was extracted from the wax and refined into lubricating oil. The wax was utilized on site for the manufacture of products such as candles. Additionally, the Site had extensive railcar shops where Union Tank Line railcars were manufactured and repaired. The car shops were capable of manufacturing six rail tank cars each day. The Site also had a cooper shop that manufactured approximately 1,600 storage barrels each day. The Site contained an acid treatment department in which sulfuric acid used in the refinery processes was treated and recycled. Additional departments included naphtha works and a compounding plant.

Between 1917 and 1924, the Site underwent a transformation in operations and structural layout. During this period, the emergence of motor vehicles began, thus leading to additional uses for refined petroleum. The Site terminated its tank car construction, repair operations and barrel manufacturing. The majority of the Site was cleared and reconstructed with new storage tanks and refining structures. The original structures remaining after the transformation were the paraffin and wax refining department and a few warehouses and boiler rooms.

Between 1939 and 1951, the Site continued to evolve through the addition of modernized refining units including the Houdry Unit, Thermofor Catalytic Cracking Unit (TCC Unit), and the Deflorez Cracking Unit. Between 1951 and 1955, the Site continued to be modernized and underwent another transformation including the addition of an Alkylation Unit, a Sovaformer Unit, a Treating, Blending, and Shipping Area, and Asphalt Refining and Distribution Units. These processes and structures remained at the Site until the refinery structures were demolished between 1988 and 1991, as discussed below. The primary products manufactured at the Site included gasoline, kerosene, home heating fuels, industrial fuels, diesel fuel, and asphalt.

In 1951, the ETYA, the parcel of land between the Erie Lackawanna Railroad and the Buffalo River, was purchased from the City of Buffalo, who had utilized the property from 1921 through 1951 for the disposal of municipal waste. This parcel originated from the filling of the original Buffalo River during the rerouting of the river, as discussed above. In 1953, the ETYA was developed with two 70,000-barrel storage tanks, four propane tanks, and a propane loading rack.

In September 1959, the paraffin and wax refining operations were terminated. Associated structures and 50 storage tanks with capacities ranging from 2,000 and 10,000 barrels were removed. In 1963, the terminal began receiving shipments of crude oil through a Canadian pipeline in addition to the crude oil delivered through the Buckeye Pipeline from Texas and occasionally by barge via the Buffalo River.

In May 1981, the Site terminated all refinery operations. The Site continued only as a distribution terminal, receiving product via a pipeline and barge. The terminal distributed No. 1 Fuel Oil, No. 2 Fuel Oil (diesel), leaded gasoline, two types of unleaded gasoline, and Jet A commercial fuel. Leaded gasoline storage was discontinued in 1989.

Demolition of the refinery occurred from 1988 through 1991. The demolition included the removal of buildings, structures, above ground tanks and piping. Upon completion of the demolition activities, the thirteen storage tanks remaining in the STYA and Tanks 175 and 176 in the ETYA were realigned. Subsequently, Tanks 96 and 198 were removed. In 1991, the current tank truck loading rack located in the CPRA was constructed to replace the former tank truck loading rack in the BSPA.

Currently, the Site operates as a distribution terminal within the limits of the property boundary shown on Plate 6. The northwestern portion of the FRA had been leased to Custom Topsoil through June 2001 for the storage and distribution of construction materials. The former Main Office on the northern Site boundary located in the NPSA has been leased to the City of Buffalo Police Department since 1991.

The Buffalo River is maintained as a federal navigation channel along the length of the Site's bulkhead to a location approximately 300 feet west of the former Erie Lackawanna Railroad Bridge. This federally maintained channel begins approximately 30 feet south of ExxonMobil's bulkhead and extends to within approximately 30 feet of the bulkhead on the southern bank of the river. ExxonMobil maintains the 30-foot portion of the Buffalo River between the bulkhead and the federal navigation channel for barge access. The federal navigation channel has been dredged by the United States Army Corps of Engineers (USACOE) every 2 to 5 years to remove sediment and maintain an adequate water depth for navigation. During the 1992 and 1997 dredging events, ExxonMobil participated by dredging the 30-foot wide portion of the river along the length of their bulkhead to maintain barge access to the Site.

Historical information related to the ETYA, NPSA, NTYA, FRA, CRPA, STYA, and AOOA, including tanks, disposal areas and documented product releases is provided below.

2.1 Eastern Tank Yard Area

The ETYA is located between the eastern side of the Erie Lackawanna Railroad Company (formerly D.L.&W.R.R.) rail tracks and the bank of the Buffalo River. Prior to the straightening of the Buffalo River between 1914 and 1917, the river's course ran in a generally north to south direction through the ETYA, parallel to the D.L.&W.R.R. tracks. The river was filled in, relocated to the east, and rerouted to continue in a west-southwesterly direction. A small parcel of land that existed prior to the rerouting between the D.L.&W.R.R. tracks and the original river was owned by SOCONY. This parcel of land was relinquished by SOCONY to the City of Buffalo on July 8, 1915. The City of Buffalo reportedly utilized the land between the D.L.&W.R.R. tracks and the rerouted river channel for disposal of municipal waste between the years 1921 and 1951. ExxonMobil purchased the parcel of land in 1951. The ETYA currently encompasses 15.3 acres.

2.1.1 Former and Current Structures

In 1953, two aboveground storage tanks (Tanks 175 and 176), each with 70,000-barrel capacities, were constructed in the ETYA. The details concerning these storage tanks are provided in Table 1. To the southwest of the storage tanks, four propane tanks and a propane loading rack were constructed between 1958 and 1966. According to discussions with former and/or current ExxonMobil employees, the propane loading rack was never utilized. The propane tanks and loading rack were removed in 1988.

Three product pipelines are present within the ETYA (Plate 1). Two of the pipelines are owned by ExxonMobil, one is abandoned in place and the other is currently active. ExxonMobil's pipeline enters the ETYA at the northeast boundary. The abandoned portion crosses through the length of the ETYA in a south/southwesterly direction and continues into the Southern Tank Yard Area (STYA) along the bulkhead immediately adjacent to the Buffalo River. According to a drawing of the pipeline, the depth of burial within the ETYA is approximately 4 ft. According to this drawing, the pipeline was purged of product and abandoned in place.

The active portion of the ExxonMobil pipeline follows the fence line in a northerly direction. The pipeline remains buried until it comes above grade along the northern border of the ETYA.

The aboveground portion of the pipeline continues to follow the fence line until it crosses underneath the former Erie-Lackawanna Railroad and into the STYA at the location of the access road between the ETYA and the STYA.

Lakehead Pipeline Company, Inc. (Lakehead) owns the third product pipeline. The approximate location of this pipeline is shown on Plate 1. This pipeline enters the ETYA at a location near the ExxonMobil pipeline, then it generally runs in a west/southwesterly direction south of the containment berm for Tanks 175 and 176 to a point approximately 200 ft beyond the tanks where it turns northwest and enters the STYA. Information provided to ExxonMobil by Lakehead indicates that the line was removed from active service in 1982 when the product was purged and the line was filled with nitrogen.

2.1.2 Waste Handling Areas

ExxonMobil also used the ETYA for disposal purposes. According to company records, the waste disposed in the ETYA included storage tank bottom material, spent cracking and reforming catalysts, oil/water separator material, slop oil solids, demolition debris, and asphalt-containing soil. ExxonMobil reportedly used this area for disposal between the years 1952 and 1974. Plate 1 shows disposal locations of wastes disposed in the ETYA as reported in the company records. In addition, a review of available aerial photographs indicates that the area southwest of the tanks was a possible disposal location. Following several subsurface investigations, the disposal area within the ETYA was re-classified in 1988 by the NYSDEC from a New York State Registry of Inactive Hazardous Waste Disposal Sites Class 2a site (indicating that additional information is needed to accurately categorize the site) to a Class 3 site. This Class 3 classification indicates that the area does not pose a significant threat to the public or environment.

2.1.3 Spills/Releases

Two spills were documented to have occurred in this area (Table 2). The following releases have supporting documentation in the form of ExxonMobil records and NYSDEC Spill Report Forms.

- On August 28, 1989, approximately 6,500 gallons of unleaded gasoline were released. This incident was reported to NYSDEC and assigned Spill No. 8905279. It was also reported to the City of Buffalo Fire Department. The incident occurred when Tank 176 was overfilled due to incorrect safe fill and high alarm settings being used. The area was barricaded and approximately 2,800 gallons of product were removed with a vacuum truck. In addition, the safe fill and high level alarm settings were corrected. Subsequently, monitoring wells were installed and monitored for the presence of product. The containment berm for this tank and Tank 175 were lined during the storage tank realignment project completed in 1991.

- On October 4, 2000, a sheen and seepage area was identified along the Buffalo River Bank adjacent to the ETYA during the installation of MW-28. The NYSDEC was notified on that date and assigned Spill No. 0075417. In response, ExxonMobil installed a sorbent boom around two areas where impacts were observed (total length of approximately 300 ft). The booms were inspected and maintained daily until December 18, 2000 to prevent any adverse impacts to the Buffalo River from this area. The booms were destroyed on December 18, 2000 due to significant ice accumulation and movement in the river. Through March 2001, it was not possible to install permanent booms due to ice conditions in the river. Sorbent booms were installed along the riverbank around the seepage areas on March 16, 2001 and have been maintained since. Permanent slick-bar booms were installed around the areas of seepage in May 2001 (see Plate 1 for locations). The seepage areas have been inspected regularly since October 2000. These inspections include a description of the area of seepage noting any differences in the appearance of the area (i.e., presence or absence of sheen and its location if present). The inspections also note the position of the boom and any adjustments required.

2.2 Northeast Process and Storage Area

The NPSA encompasses approximately 10.7 acres in the northeast section of the Site. The northwest portion of the NPSA, along the northern border of the Site, was purchased by Atlas Refining Company from Peter Schermerhorn on December 22, 1882. Atlas Refining Company purchased the eastern portion of the NPSA from National Transit Company on July 31, 1890. Two years later on June 16, 1892, SOCONY purchased both of these parcels from the Atlas Refining Company. The northeast portion of the NPSA, also along the northern border of the Site, was purchased by SOCONY from Mr. Edward Tanner in 1910.

2.2.1 Former and Current Structures

Plate 1 shows former structures that have existed on the NPSA, as well as structures that currently exist. The NPSA originally consisted primarily of structures and storage tanks associated with paraffin and wax refining/treatment and railcar construction and repair shops. The construction and repair of railcars terminated between 1917 and 1924. Through 1939, additional paraffin and wax refining structures and tanks replaced the railcar construction and repair shops. By 1951, roads were developed in the NPSA to provide access to the various portions of the area. A macadam roadway was constructed parallel to Elk Street, along the southern boundary of the NPSA. This roadway enabled better access to the paraffin and wax refining buildings in the northwest portion of the NPSA. A concrete roadway was constructed between the Wax Refinery and the Iroquois Gas Company Buildings. This roadway ran in a north to south direction and intersected with the macadam roadway. In 1959, many of the paraffin and wax refining structures and tanks were removed and replaced with larger storage tanks and the former Main Office building, currently leased to Police Community Services. From the 1960s through the 1980s, the northeast portion of the NPSA was used for the storage of debris. In 1989, this area was cleared of all debris piles and the Biotreatment Cell was constructed. In 1990, a gated entrance was installed on the above-mentioned concrete road, adjacent to the Main Office, providing additional security to the Site. Currently, the Police Community Services building (Former Main Office), the Biotreatment Cell liner/berm, and the gated entrance exist in the NPSA. All soil was removed from the Biotreatment Cell in February and March 2001 and disposed offsite.

Table 1 provides information on the storage tanks located within this area including their construction dates, capacities, demolition dates, and types of product stored. The following structures were located in the NPSA and are summarized in chronological order according to construction date.

Paraffin Boiler House. This structure, first appearing in 1917, was located along the northern border of the Site, adjacent to Elk Street. The Paraffin Boiler House was approximately 100 feet by 70 feet. Attached to the Paraffin Boiler House were a Fan House (approximately 35 feet by 40 feet) and a Wash Room (approximately 40 feet by 45 feet). The Fan House and Wash Room were demolished between 1917 and 1924. During the period of 1924 through 1939, the use of the Paraffin Boiler House was changed to serve as a garage, locker room, and lunchroom for personnel and was later demolished in 1989. Adjacent to the east of the Paraffin Boiler House was Transformer No. 98 in 1924. This transformer was removed between 1955 and 1977.

Paraffin Office. Located adjacent to the east of the Paraffin Boiler House, the Paraffin Office was approximately 17 feet by 32 feet. This structure first appeared on a 1917 map and was used to house office support to the paraffin and wax refinery. The Paraffin Office was demolished between 1917 and 1924.

Engine House and Press Rooms. The primary paraffin refining processes were conducted in the Engine House and Press Rooms structure. The structure was constructed prior to 1917 and was located adjacent to the east of the Paraffin Office. The Engine House measured approximately 80 feet by 65 feet. Attached to the Engine House were a Pump House (approximately 60 feet by 30 feet), a Chilling Room (approximately 22 feet by 36 feet) and five Press Rooms (each 62 feet by 15 feet) to support the paraffin refining processes. A Conveyor Room, approximately 78-feet by 15-feet in size, adjoined the Press Rooms on the eastern side of the building. The Engine House and Press Rooms structure was demolished between 1917 and 1924.

Sweater Structures. The Sweater structures, constructed prior to 1917, consisted of four adjoining structures along the northern boundary of the Site (each approximately 20 feet by 60 feet) and one single Sweater structure adjacent to the south (approximately 22-feet by 59-feet). Within the four adjoining Sweater structures was a pump house measuring approximately 11 feet by 60 feet. The Sweater structures were used for steam heating the wax to extract the oil from the wax. The wax was then used for the manufacture of products including candles. Three of the four adjoining Sweater structures were demolished between 1917 and 1924. The remaining Sweater structure and the single Sweater to the south were demolished between 1939 and 1955. Adjacent to the east were ten wax storage tanks with varying capacities. These tanks were constructed prior to 1917 and were dismantled between 1939 and 1951.

Pan House. The Pan House was used to house pans in which the wax for the paraffin and wax refining process was stored. The structure was constructed prior to 1917 and was approximately 42 feet by 32 feet. The Pan House was demolished some time between the years 1951 and 1955. According to a 1939 map, attached to the Pan House was a Switch House. The Switch House measured approximately 8 feet by 15 feet.

Wax House. The Wax House structure consisted of three adjoining structures, each 25-feet by 60-feet in size and was located adjacent to the east of the Pan House. The Wax House was an integral structure in the paraffin and wax refining processes. A 10-foot by 76-foot platform ran along the eastern side of the Wax House, used for loading and unloading of wax products from the adjacent railroad track. The Wax House was constructed prior to 1917 and demolished in between the years 1951 and 1955.

Iroquois Gas Company Buildings. The Iroquois Gas Company maintained 6 buildings in the NPSA. These buildings were constructed prior to 1917 and the exact uses are unknown. Two of the six Iroquois Gas Company structures were demolished between 1917 and 1924. Some time between 1917 and 1924, NY Transit began occupying one of the four remaining buildings. The three Iroquois Gas Company structures were demolished between 1924 and 1939. The NY Transit building was demolished between 1951 and 1955.

Hose House No. 87. Hose House No. 87 was located adjacent to the south of the Iroquois Gas Company Buildings. The hose house was constructed prior to 1917. The structure was 18 feet by 10 feet in size and was demolished between 1951 and 1955.

Car Shop. The Car Shop was used to construct and house railcars. The Car Shop was constructed prior to 1917 and was approximately 260 feet by 101 feet in size. Railroad tracks that ran in a general east to west direction along Prenatt Street branched to the northeast into the NPSA. The tracks branched again and one branch ran towards the wax and paraffin refining structures while the other ran towards the Car Shop and Car Repair Shop, where the tracks terminated. A 1939 map indicates that the Car Shop was modified into a wax and paraffin refining structure, including two rooms of presses. The size and construction of the structure remained the same. The wax and refining structure was later demolished between 1951 and 1955.

Car Repair Shop. The Car Repair Shop was constructed prior to 1917 and was 30 feet by 260 feet in size. This structure served as a repair shop for the railcars used on the Site. The Car Repair Shop and the tracks leading to the shop were removed between 1917 and 1924 and replaced with additional paraffin refining and treatment structures and tanks.

Scrap Shed. The Scrap Shed was constructed prior to 1917 and was located to the south of the Car Repair Shop. The shed was approximately 130 feet by 15 feet in size. The scrap stored in the Scrap Shed was associated with the surrounding railcar construction structures. The Scrap Shed was removed between 1917 and 1924.

Pump House and Sweater Structure. According to a 1924 map, additional pump house and sweater structures were constructed between 1917 and 1924, located south of the Wax House. The Pump House was an 18-foot by 44-foot brick structure. The Sweater Structure was also constructed of brick and measured approximately 23 feet by 44 feet in size. These two structures were used in association with the wax refining processes. The Pump House and Sweater Structure were demolished between the years 1951 and 1955.

Pump House No. 26. Pump House No. 26 was constructed between 1917 and 1924 in the former location of Car Repair Shop. The pump house was a brick structure and 70 feet by 30 feet in size. Pump House No. 26 was demolished between the years 1951 and 1955.

In-Ground Oil/Water Separator. An in-ground oil/water separator, approximately 10-feet by 30-feet, was located adjacent to Pump House No. 26 and was constructed between 1917 and 1924 near the former location of the Car Repair Shop. The trap was used for separation of petroleum from aqueous waste streams and storm water. The exact origin of the waste streams collected in the trap could not be determined from the available information. The trap does not appear on a 1955 map.

Engine House No. 40. Engine House No. 40 was constructed between 1917 and 1924 and was located adjacent to the Machine Shop in the AOOA. The Engine House, 14 feet by 20 feet in size, was demolished between the years 1951 and 1955.

Pressed Distillate Unit. Consisting of five structures, the Pressed Distillate Unit (P.D. Unit) first appears on a 1924 map. These structures were located along the eastern border of the Site. The P.D. Unit received the wax oil extracted from the Sweater units and distilled the oil, which was then sent to the lube plant. The P.D. Unit included a receiving house, condensers and a cooler. Also associated with the P.D. Unit was Stack No. 8, a brick stack measuring 5 feet in diameter and 100 feet in height. The P.D. Unit structures were demolished between the years 1958 and 1966 during which time; the wax refining operations were ceased.

Sweater Structure No. 7. This Sweater structure was constructed between the years 1924 and 1939. This structure, approximately 30 feet by 45 feet in size, was constructed in the location of the former Iroquois Gas Company buildings and adjacent to the former Car Shop. Similar to the Sweater structures discussed above, this structure was associated with the paraffin and wax refining and treatment process to extract the oil from the wax product. The Sweater structure was demolished between the years 1951 and 1955.

Building No. 38. This structure was constructed adjacent to Sweater Structure No. 7 between the years 1924 and 1939. The use of this structure could not be determined from the available information. This structure was removed between the years 1951 and 1955.

Locomotive House No. 19. The Locomotive House, approximately 8-feet by 15-feet, was located at the end of the tracks that ran toward the former Car Shop and Car Repair Shop. The structure first appears on a 1939 map, indicating that it was constructed between the years 1924 and 1939. Before the construction of the Locomotive House, the rail tracks continued towards the east and beyond the Site boundary. Therefore, at the time of construction, the tracks were removed and terminated at the location of the Locomotive House. The exact usage of the Locomotive House could not be determined from the available information. The Locomotive House was demolished between the years 1958 and 1966.

Rail Loading Racks. According to a 1939 map, a 93-foot by 5-foot loading rack was constructed near the former location of the Car Repair Shop, adjacent to the rail track that ran towards the northeast and terminated at the Locomotive House. Two additional loading racks were constructed south of the former Car Shop between 1939 and 1951. These two loading racks measured approximately 28 feet by 8 feet and 15 feet by 8 feet. The specific function of these loading racks could not be determined from the available information.

Main Office. The Main Office was constructed between the years 1951 and 1955. This building served as the main office structure for administrative operations at the terminal. The Main Office is a one-story building encompassing approximately 9,000 sf. The structure that currently exists at the Site has been leased to the City of Buffalo Police Community Services since 1991.

Biotreatment Cell. The Biotreatment Cell was constructed in 1989, was trapezoidal in shape, and measured approximately 570 feet from north to south and from east to west measured between 140 and 390 feet. The treatment cell had been used to biologically treat impacted soil from the terminal and other off-site ExxonMobil facilities. The Biotreatment Cell was lined with an impermeable plastic liner, was surrounded by a berm, and was capable of treating 6,000 cubic yards of soil. The Biotreatment Cell berm and liner currently exists at the Site. Approximately 7,227 tons of soil were removed from the Biotreatment Cell and disposed offsite in February and March 2001.

Gated Entrance. The gated entrance was constructed adjacent to the west of the Main Office, at the northern border of the Site. Associated with the construction of the new Truck Loading Rack in the CRPA in 1991, the gated entrance permitted entrance to authorized vehicles, thus adding additional security to the Site.

2.2.2 Waste Handling Areas

Two Waste Handling Areas (WHAs) were identified in the company records as being located in the NPSA. These two units include a steel storage tank used to store leaded tank bottom material and a debris disposal/storage area. Each of the units and their functions are described below.

Steel Storage Tank

The WHA was a 450-gallon steel storage tank located in the southern portion of the NPSA. The storage tank, designated WHA-1, was three feet in diameter and 8.5 feet in length. The tank was utilized from 1970 through 1981 for the storage of leaded tank bottoms, at an estimated rate of 10 pounds per year. The residence time of the waste was unknown.

Demolition Debris Storage Area

This demolition debris storage area was located in the northeast portion of the Site, in the current location of the Biotreatment Cell. This area, designated WHA-9 was used for the disposal of on-site construction and demolition debris including old pumps, wood, paper, scrap metal, insulation, transformer carcasses that may have contained PCBs during operation, and empty process tanks. A contractor retained by ExxonMobil periodically removed the debris. The area was cleared and contaminated soil was removed prior to the construction of the Biotreatment Cell in 1989.

2.2.3 Spills/Releases

No spills or releases were documented in this area.

2.3 Northern Tank Yard Area

The Atlas Refining Company had purchased the NTYA from Peter Schermerhorn on December 22, 1882. The NTYA was acquired by the SOCONY from the Atlas Refining Company on June 16, 1892. The NTYA encompasses approximately 9.2 acres in the northern section of the Site. The following sections discuss the former and current structures, and WHAs located in the NYTA, and spills or product releases that have occurred in this area.

2.3.1 Former and Current Structures

According to a 1917 map, the structures within this area were either associated with the paraffin and wax refinery operations in the NPSA or with the refining processes in the Former Refinery Area. From 1917 to 1995, this area was primarily maintained as a tank yard, consisting of various sizes of storage tanks. Table 1 provides information on the storage tanks located within this area including their construction dates, capacities, demolition dates, and types of product stored. The following structures were located in the NTYA and are itemized in chronological order according to its construction date.

> **Hose House.** The Hose House first appears on a 1917 map and was located near the northern border of the Site, adjacent to Elk Street. The structure was approximately 18 feet by 10 feet in size and was removed between the years 1924 and 1939.
>
> **Condensers/Receiving House.** This 47-foot by 18-foot structure, constructed prior to 1917, consisted of condensers and a Receiving House. The condenser structure measured approximately 30 feet by 18 feet. The Receiving House measured approximately 17 feet by 18 feet. Both the condensers and Receiving House were associated with the refining processes performed in the NTYA and FRA. This structure was demolished between 1917 and 1924.
>
> **Cooler.** This cooler was constructed prior to 1917 and located south of the Condenser/Receiving House. The cooler measured approximately 21 feet by 10 feet in size and acted as a heat exchanger to lower the temperature of the hot petroleum product refined in this area and the FRA. The cooler was removed between the years 1917 and 1924.
>
> **Blanket Room/Pipe Shop/Electrical Shop.** This structure, constructed prior to 1917 in the central portion of the NTYA, consisted of five adjoining structures including the Blanket Room, the Pipe Shop, the Electrical Shop, the Laboratory, and a cooler. The Blanket Room was "L-shaped" with major dimensions of 50 feet by 30 feet. The Pipe Shop was located south of the Blanket Room and Electrical Shop and measured approximately 42 feet by 36 feet. The Electrical Shop, located west of the Blanket Room, was approximately 26 feet by 14 feet. The Laboratory, in the northwest corner of the structure, measured approximately 15 feet by 14 feet. The cooler measured 20 feet by 10 feet in size. The structure was removed between the years 1917 and 1924. Approximately 5 feet to the west was a 22-feet by 12-feet hose house. This hose house was also removed between 1917 and 1924.
>
> **Bleachers Structure.** The Bleachers structure, measuring approximately 63 feet by 45 feet, housed two bleaching tanks (Tanks 76 and 77; Table 1). This structure first appears on a 1917 map. The structure and the tanks were removed between the years 1917 and 1924.
>
> **In-Ground Oil/Water Separator (Yard Trap).** This collection trap was located in the eastern portion of the NTYA and measured approximately 40 feet by 22 feet. The trap was constructed prior to 1917 and was used for the separation of petroleum from aqueous waste streams and storm water. Between 1924 and 1939, Tank Nos. 21 and 22 were constructed on

either side of the trap. According to a 1955 map, the pipelines leading to the collection trap are storm sewers indicating that the collection trap was used for the collection of storm water from the neighboring tank yards. The trap does not appear on a 1990 map. During implementation of a Site-wide sewer investigation, the corners of the concrete walls of this structure were located. No further investigation of this structure was performed.

Pulp Oil Building. The Pulp Oil Building was constructed prior to 1917. This structure measured approximately 118 feet by 78 feet and was located in the eastern portion of the NTYA. The Pulp Oil Building had two platforms, one along the northern wall (130 feet by 12 feet) and one along the eastern wall of the building (90 feet by 12 feet). The specific use of the Pulp Oil Building could not be determined from the available information. The Pulp Oil Building was demolished between the years 1917 and 1924.

Cripple Shed. The Cripple Shed was an ironclad structure measuring approximately 125 feet by 30 feet in size. The structure was constructed prior to 1917 and was located in the eastern portion of the NTYA, south of the Pulp Oil Building. Rail tracks, that ran generally from east to west along Prenatt Street, branched northeast into the NPSA and into the Cripple Shed. The Cripple Shed was removed between the years 1917 and 1924.

Union Tank Line Storehouse and Bull Room. The Union Tank Line (U.T.L) Storehouse and Bull Room was constructed prior to 1917 and measured approximately 115 feet by 45 feet. The structure was located in the eastern portion of the NTYA and south of the Pulp Oil Building. This structure was associated with the railcar construction and repair operations. The structure was demolished between the years 1917 and 1924.

Pump House No. 47. Pump House No. 47 was constructed between 1924 and 1939 and located adjacent to Tank 184 on the southern boundary of the NTYA. The structure measured 17 feet by 15 feet in size and was removed between 1951 and 1958.

Paint Shed. The Paint Shed was located adjacent and to the east of Tank 19 in the NTYA. The Paint Shed measured 21 feet by 15 feet and was constructed between 1939 and 1951. The structure was utilized for storing paint and was associated with the Wheel Shop/Blacksmith Shop/Machine Shop. The Paint Shed was removed between 1951 and 1955.

Sub-Station "C." This structure was "T-shaped" with major dimensions of 45 feet by 25 feet. Sub-Station "C" replaced the Watchman House between the years 1951 and 1955. Sub-Station "C" currently exists at the Site.

2.3.2 Waste Handling Areas

According to company records, any tank that was used to store leaded gasoline was cleaned out by spreading the tank bottoms in the tank yard. Consequently, the tank yards surrounding Tanks 21 and 187 were classified as WHAs and have been designated as WHA-4. Similar to the tank yards located in the STYA that formerly stored leaded gasoline, the tank yards were surrounded by dikes and drained to the Main In-Ground Oil/Water Separator. The storage of leaded gasoline at the site occurred between 1952 and 1989.

2.3.3 Spills/Releases

One significant spill was documented to have occurred in this area (Table 2). The documentation for this spill is in the form of information provided by current and/or former ExxonMobil employees, photographs taken at the time and a NYSDEC Spill Report Form for Spill No. 9314016 dated February 1, 1994.

- The NYSDEC Spill Report Form was filed after the incident occurred and refers to the incident as the “Old Spill at Elk Street.” The product release occurred on March 12, 1976. The roof of Tank 60 ruptured when hot cracking stock for the Thermofor Catalytic Cracking (TCC) unit entered the tank from the crude unit. The hot product contacted ice in the bottom of the tank, causing it to expand, increase the pressure within the tank and damage the roof. The cracking stock spilled onto Elk Street and Parcels No. 4 and No. 5 in the ESPA. At that time, Parcels No. 4 and No. 5 were vacant or occupied by residential and/or light commercial structures. The structures present were affected by the release. ExxonMobil cleaned up the cracking stock by vacuuming off excess product and then mixing the remaining material with sand, excavating the material and disposing it off-site. Subsequently, ExxonMobil purchased Parcels No. 4 and No. 5 of the ESPA and demolished the structures present. Property and structures located to the north of Parcel No. 5 were not believed to be impacted by the release and therefore were not purchased by ExxonMobil. Soil sampling was not conducted as part of the demolition effort.

2.4 Former Refinery Area

The FRA was owned by various entities in the late 1800's. The northern portion of the FRA was sold to Atlas Refining Company in 1888 by Buffalo Lubricating Oil Company, Ltd. The parcel of land to the east was sold to Atlas Refinery Company from Solar Oil Company in 1885. These parcels were purchased on June 16, 1892 by SOCONY from the Atlas Refining Company. The southern portion of the FRA, south of Prenatt Street, was purchased by SOCONY from Buffalo Hardwood Lumber Company, the City of Buffalo, and other unnamed entities on July 23, 1915. Prior to 1915, the Buffalo River transected the southern portion of the FRA. At that time, the Buffalo River was rerouted to the south to form a relatively straight channel, which then became the Site’s southern property boundary. The FRA currently encompasses 15.3 acres.

2.4.1 Former and Current Structures

Information regarding the storage tanks located within this area is provided on Table 1. Within the FRA was a brick roadway that ran in a north to south direction and bridged Elk Street and Prenatt Street. Additionally, three major railroad tracks originating from Prenatt Street branched towards the north. These tracks were utilized to deliver supplies to the structures within the FRA for refinery operations. Based on the available information, prior to 1917 and through 1981, the FRA had been the primary location for the petroleum refining processes at the Site. Between 1917 and 1924, many of the refinery associated structures on the east side of the brick roadway were removed and replaced with an electrical substation and storage tanks. The operations at the remaining portions of the FRA generally remained the same with some additions and modifications as refinery processes changed and evolved through the years. The refinery structures north of Prenatt Street were demolished between 1988 and 1991. The following former structures are summarized in chronological order according to their construction date in the FRA.

The Star Oil Barns and Office. The Star Oil structure was constructed prior to 1917 on the corner of Elk Street and Babcock Street. This structure measured approximately 110 feet by 60 feet and was used as a barn for the horse drawn bulk oil delivery wagons and an office for administrative purposes. The Star Oil structure was removed between the years 1924 and 1939.

Warehouses No. 1-3. According a 1917 map, three warehouses existed south of the Star Oil Barns and Office. Warehouse No. 1 was a four-story structure and approximately 205 feet by 60 feet in size. A rail platform, approximately 215 feet by 10 feet ran along the eastern wall of Warehouse No. 1. Rail tracks ran in a north to south direction adjacent to Warehouse No. 1 and terminated at the northeast corner of the warehouse. According to the 1939 map, Warehouse No. 1 was occupied by Star Oil Company and according to the 1955 map, the Lakes Division occupied Warehouse No. 1. Warehouse No. 1 was demolished in 1989. Warehouse No. 2 was adjoined to the south wall of Warehouse No. 1. This warehouse was approximately 102 feet by 42 feet in size. Warehouse No. 3, adjoined to the south wall of Warehouse No. 2, was approximately 95 feet by 42 feet. Associated with Warehouse No. 3 was a 70-feet by 8-feet rail platform, which was removed between 1917 and 1924. Within the warehouses, asphalt was packaged into two-pound containers. Warehouse Nos. 2 and 3 were removed between the years 1924 and 1939 and replaced with Tanks 81 and 82.

Watchman's House. This structure was constructed prior to 1917 and was used as a security watchman's station. The Watchman's House was approximately 10 feet by 5 feet in size and located along the northern border of the Site on Elk Street between the Star Oil Barns and Office and the Main Office of the Atlas Works. The structure was removed between the years 1917 and 1924.

Main Office of Atlas Works. The Main Office of Atlas Works was constructed prior to 1917 and was approximately 78 feet by 45 feet in size. The structure was located on Elk Street, along the northern border of the Site and was used for administrative operations for the Atlas Works Refinery. The Main Office was removed between the years 1958 and 1966.

Garages. According to a 1917 map, adjacent to the east side of the Main Office of Atlas Works was a structure consisting of two garages. The garages each measured approximately 19 feet by 17 feet in size and were removed between the years 1958 and 1966.

Barns. The barns were constructed prior to 1917 and were located south of the garages in the northern portion of the FRA. The barns were used to house the horse drawn bulk oil delivery wagons. The structure was approximately 42 feet by 42 feet and removed between the years 1917 and 1924.

Fan Houses. Three fan houses were located adjacent to the Tower Stills and Coal Sheds. The Fan House located in the northeast corner of the FRA was constructed prior to 1917 and measured approximately 20 feet by 20 feet. According to the 1939 map, the structure was used as a fire truck garage/hose house. The 1951 map indicates that the structure was used as a medical department. The fan house was demolished in between 1955 and 1966. Two additional fan houses, each measuring 25 feet by 20 feet, were located adjacent to the west of the Tower Stills and Coal Sheds. These fan houses were built prior to 1917 and demolished between 1924 and 1939.

Watchman's House at Gate No. 5. A watchman's house was constructed prior to 1917 on the northeast corner of the FRA at Gate No. 5. The structure measured approximately 10 feet by 5 feet and was used as a security station for the brick roadway that connected Elk Street to Prenatt Street. The Watchman's House was demolished between 1917 and 1924.

Sheds. According to a 1917 map, three sheds existed in the FRA. Shed No. 1 was located in the central portion of the FRA, adjacent to Tank No. 29. This shed measured approximately 50 feet by 20 feet in size. Shed No. 1 was removed between 1917 and 1924. Shed No. 2 was located between the Star Oil Barns and Office structure and the Main Office of the Atlas Works Refinery Company and measured approximately 63 feet by 22 feet. Shed No. 2 was demolished between 1924 and 1939 and replaced by loading racks. Shed No. 3, located approximately 50 feet south of Shed No. 2, measured approximately 57 feet by 48 feet and was removed between the years 1917 and 1924.

Pressure Stills/Coal Shed. Adjacent on the west side of the brick roadway within the FRA were 15 pressure stills. The pressure stills were constructed prior to 1917 on brick structures. They were aligned directly adjacent to each other and in total measured approximately 185 feet by 42 feet. Adjoined to the east side of the pressure stills was a 185 foot by 12 foot coal shed used to supply coal to the pressure stills. By 1924, nine of the fifteen pressure stills were removed. The six remaining pressure stills were removed between 1924 and 1939.

Condensers. A 1917 map indicates that approximately 15 condensers were located adjacent to the west of the Pressure Stills and Coal Shed. The condensers were utilized for the refining operations in the FRA as heat transfer units to condense vapor by removing heat from hot liquid product by utilizing a cooler medium. Two of these condensers were removed between 1917 and 1924. The remaining 13 condensers were removed between 1924 and 1939.

Tower Stills and Coal Sheds. South of the Pressure Stills and Coal Shed, a structure consisting of seven coal sheds and twelve tower stills was constructed prior to 1917. This structure measured approximately 380 feet by 50 feet. Each coal shed had a rail spur connecting it to the rail track that ran in a north to south direction adjacent to the brick roadway. The coal sheds stored coal to support the tower stills operations. Ten tower stills and all seven coal sheds were removed between the years 1924 and 1939 and were replaced by the Houdry Unit. The two remaining tower stills were removed between 1939 and 1951.

Receiving Houses. Based on the 1917 map, two receiving houses were located in the northern portion of the FRA, between the condensers and storage tanks. One of the receiving houses was located adjacent to the Star Oil Company filling tanks and measured approximately 80 feet by 12 feet. The second receiving house was located adjacent to the east of the Storage Tanks 173 and 175 and measured 63 feet by 20 feet. Both receiving houses were removed between 1924 and 1939.

Tar Cooler. The tar cooler was constructed prior to 1917 and was located between the storage tanks and receiving house in the northern portion of the FRA. The cooler measured 27 feet by 22 feet and was used as a heat exchanger through which hot liquid product was passed to lower its temperature. Between 1924 and 1939, the tar cooler was removed.

Watchman's House at Gate No. 7. Gate No. 7 was on Babcock Street, south of the former location of Warehouse No. 3. The Watchman's House, constructed prior to 1917, was approximately 14 feet by 12 feet in size and served as the security watchman's station. The Watchman's House was removed between 1917 and 1924.

Hose House. The Hose House was constructed prior to 1917 and was located approximately 110 feet north of Prenatt Street and adjacent to Tank No. 79. The Hose House was 22 feet by 8 feet in size and demolished between 1924 and 1939.

WC Structure. This structure, constructed prior to 1917, was located adjacent to the east of the Hose House. The WC Building was approximately 25 feet by 10 feet. The specific use of this building could not be determined from the available information. The WC Structure was removed between 1917 and 1924.

Pipe Shop/Experimental Stills. The Pipe Shop was located on the north side of Prenatt Street. The Pipe Shop was approximately 75 feet by 30 feet. Attached to the Pipe Shop were experimental stills, which were approximately 20 feet by 30 feet in size. According to the 1939 map, this structure was used as a wash room. The 1951 map indicates that the structure was used as a laboratory. The structure was later removed between 1958 and 1966. Adjacent to the east of the structure was Transformer No. 99. Located to the south of the Pipe Shop was a truck scale. The truck scale was constructed between 1939 and 1951 and was removed between 1977 and 1987.

Laboratory. Constructed prior to 1917, the laboratory was situated on the northwest corner of the brick roadway and Prenatt Street. The structure measured 40 feet by 32 feet. The laboratory was demolished between the years 1958 and 1966.

Watchman/Clock House. This 18-foot by 12-foot structure was constructed prior to 1917 and was located on the northeast corner of the FRA along Elk Street and a brick roadway connecting Elk Street to Prenatt Street. According to the 1924, 1939, and 1951 maps, this structure was used as a watchman or clock house. However, according to the 1940 Sanborn map, this structure was used as a hose house. The structure was replaced between 1940 and 1955 by Sub-Station "C". A 335-foot by 75-foot parking lot was constructed adjacent to the structure between 1924 and 1939.

Coal Shed and Reducing Stills. The Coal Shed was constructed prior to 1917 and was approximately 45 feet by 15 feet in size. The Coal Shed stored coal used to power the refining processes occurring in the FRA. Affixed to the Coal Shed were two Reducing Stills, each measuring 34 feet by 18 feet. The Coal Shed and Reducing Stills structure were removed between the years 1917 and 1924.

Coal Sheds and Tar Stills. A structure consisting of six tar stills and four coal sheds was located on the eastern side of the brick roadway. The structure was constructed prior to 1917. The structure was comprised of three sets of coal sheds adjoined by two tar stills. Each of the tar stills measured approximately 22 feet by 17 feet. The coal sheds varied in size and were used to store coal utilized to power the tar stills and other refinery operations. The coal sheds and tar stills were removed between 1917 and 1924.

Condensers/Receiving House. The Condensers/Receiving House structure was constructed prior to 1917 on the eastern side of the brick roadway in the FRA. The Receiving House was situated between the two condensers. The total structure measured 70 feet by 20 feet in size. Between 1917 and 1924, the Condensers/Receiving House structure was removed. Approximately 30 feet south of this structure was an additional condenser. This condenser measured approximately 30 feet by 20 feet and was constructed prior to 1917. The condenser was removed between 1917 and 1924.

Cooler. A cooler was formerly located adjacent to the east side of the Condensers/Receiving House. The cooler, approximately 22 feet by 8 feet, was situated at this location prior to 1917 and was later removed between the years 1917 and 1924.

Pump House. The Pump House was constructed prior to 1917 and located adjacent to the Condensers/Receiving House and storage tanks. The Pump House was removed between 1917 and 1924.

Coal Shed/Crude Oil Sheds/Condenser Structure. This structure, constructed prior to 1917, was comprised of multiple units including coal sheds, crude oil compartments, condensers, a fan house, W.C. house, coolers, receiving houses, an economizer, an engine house, and five stacks. The primary coal shed unit, measuring approximately 180 feet by 40 feet, was adjoined by nine crude oil compartments (each approximately 32 feet by 22 feet), a fan house (25 feet by 22 feet), a W.C. house (approximately 22 feet by 17 feet), a 600 foot stack, and a 60 foot stack. To the south was a 185-foot by 25-foot structure utilized for housing condensers. Adjoined to this condenser structure were two 40-foot stacks, an additional condenser (approximately 22 feet by 8 feet), and a structure (15 feet by 15 feet) whose use could not be determined from the available documentation. Adjacent to the east of the condenser unit was a cooler (25 feet by 10 feet) and a receiving house (approximately 46-feet by 22 feet). South of the condenser unit were 4 crude oil compartments (approximately 25 feet by 16 feet each) adjoined by a coal shed (64 feet by 26 feet). Adjacent to the east of this coal shed and crude oil compartments were an economizer (approximately 60 feet by 12 feet) and a water purifier (approximately 35 feet by 26 feet). South of the economizer was an engine house, measuring approximately 30 feet by 15 feet in size, and a 200-foot stack. The majority of these units were removed between 1917 and 1924. According to the 1924 map, the economizer, the 200-foot stack, and the 22-foot by 8-foot condenser were the only remaining units. These units were subsequently removed between 1924 and 1939.

Steam Still Condensers/Receiving House. Constructed prior to 1917, this structure was located on the north side of Prenatt Street in the central portion of the FRA. The Steam Still Condensers/Receiving House structure measured 185 feet by 25 feet and consisted of a receiving house centered between two steam still condenser units. Adjacent to the west were five steam stills, varying in size. One steam still condenser and the Receiving House were removed between 1917 and 1924. The remaining steam still condenser and five adjacent steam stills were removed between 1924 and 1939.

Refinery Office. The Refinery Office served as the main administrative office for the FRA. The office was located on the northeast corner of the brick roadway and Prenatt Street. The structure measured 34 feet by 30 feet and was adjoined by a 17-foot by 14-foot auxiliary structure. The office was constructed prior to 1917 and was demolished prior to 1924. The Refinery Office was replaced by Hose House No. 85.

Locomotive House. The Locomotive House was located in the center of Prenatt Street and was constructed some time prior to 1917. The Locomotive House was approximately 37 feet by 20 feet in size. The structure was removed between 1917 and 1924.

Refinery Boiler House/Pump House. The Refinery Boiler House/Pump House was constructed prior to 1917 on the south side of Prenatt Street. The Refinery Boiler House measured 144 feet by 67 feet. Adjoined to the east was the Pump House, which measured 59 feet by 53 feet. Both of these structures were associated with the refinery operations that occurred at the time in the southern portion of the FRA. Adjacent to the south was a 150-foot stack, also associated with the refinery operations. The Pump House structure was removed between the years 1924 and 1939. At that time, the Refinery Boiler House was changed to a storage house and the Pump House was relocated within this storage house. The former Refinery Boiler House was removed between 1958 and 1966 and replaced with the Asphalt Loading Area.

Icehouse. The Icehouse was constructed prior to 1917 on the south side of Prenatt Street. The Icehouse was an "L-shaped" structure with dimensions of 60 feet by 20 feet and 30 feet by 20 feet and was removed between 1917 and 1924.

Acid Shed. This structure measured approximately 27 feet by 16 feet and was constructed prior to 1917 near the southeast corner of the Refinery Boiler House/Pump House. The Acid Shed was removed between 1917 and 1924.

In-Ground Oil/Water Separator (Yard Trap). An in-ground oil/water separator was located to the south of the Refinery Boiler House/Pump House. The separator was constructed prior to 1917 and measured approximately 100 feet by 20 feet. The origin of the waste streams collected in the separator could not be determined from the available information. The orientation of the separator relative to the former Buffalo River channel indicates that this separator likely discharged to the Buffalo River prior to its realignment which occurred between 1914 and 1917. It is not clear where the separator discharged to after the realignment. The separator does not appear on the 1924 map.

Main In-Ground Oil/Water Separator. The Main In-Ground Oil/Water Separator was constructed between 1917 and 1924 in the southern portion of the FRA and is designated as WHA-2. The separator was used for the separation of petroleum from aqueous waste streams and storm water. The Main In-Ground Oil/Water Separator measured approximately 260 feet by 103 feet in size, was 16 feet deep and consisted of eight chambers with varying measurements. The trap collected waste streams from process areas, the Site's Well Point System and storm sewers across the entire Site. The Main In-Ground Oil/Water Separator currently exists at the Site. However, the five southernmost chambers were abandoned in 1993. The Main In-Ground Oil/Water Separator was used only temporary storage of storm water in excess of the capacity of the existing water treatment system prior to completion of treatment system upgrades in 2000. The Main In-Ground Oil/Water Separator has not been used since the treatment system upgrades were completed, however it is inspected periodically.

Building No. 85. This 18-foot by 10-foot brick structure was constructed between 1917 and 1924 and was located north of the Pipe Shop/Experimental Stills structure. The structure was demolished between 1924 and 1939. The use of this structure could not be determined from the available information.

Building No. 28. This corrugated iron structure was constructed between 1917 and 1924 and measured approximately 29 feet by 20 feet. The structure was located adjacent to the southwest corner of the Refinery Boiler House/Pump House. The specific function of this structure could not be determined from the available documentation. Between the years 1924 and 1939, the structure was removed.

Pump House No. 27. Pump House No. 27 was constructed between 1917 and 1924. This 15-foot by 13-foot brick structure was located approximately 95 feet south of the Refinery Boiler House/Pump House, adjacent to Tanks 291 and 292. The Pump House was removed in 1989.

Pump House No. 25. (Fire House/Current Remediation Building). This brick structure, constructed between 1917 and 1924, was located along the eastern boundary of the FRA and adjacent to the east of Pump House No. 27. Pump House No. 25 measured 40 feet by 68 and was demolished between 1951 and 1955. Between 1951 and 1955, the pump house was modified into a fire house. Also occurring at that time, the routing of the adjacent road was changed. The Fire House was constructed alongside this new macadam road. The Fire House structure currently exists at the Site, and was modified into the Remediation Building, which houses the Site's water treatment system.

Hose House No. 84. Hose House No. 84 was constructed between 1917 and 1924 just north of the settling tanks. The structure measured 18 feet by 10 feet and was demolished between 1951 and 1955.

Pipe Still/Condenser Unit. The Pipe Still/Condenser Unit replaced the Pressure Stills and Coal Shed between the years 1924 and 1939. This unit consisted of two pipe still units, two condensers and three stacks. Stack No. 5, a 150-foot stack, was constructed between 1917 and 1924. Between 1939 and 1951, a pump house was constructed adjacent to the Pipe Still/Condenser Unit. The pump house measured 23 feet by 23 feet and was demolished between 1951 and 1955. The Pipe Still/Condenser Unit was also demolished between 1951 and 1955.

Building No. 35. This structure, approximately 150 feet by 18 feet, was constructed between 1924 and 1939. The structure was located in the eastern portion of the FRA and adjacent to the south of the Watchman/Clock House. The specific use of this structure could not be determined from the available information. Building No. 35 was removed between 1951 and 1955.

Houdry Unit. The Houdry Unit was constructed in 1939 at the former location of the Tower Stills and the Coal Sheds. This unit consisted of two steel framed structures that housed suspended tanks, towers and exchangers, an evaporator heater, a tar cooler box, a pump house, a control house, a heater control house, and two furnaces. Catalytic cracking processes were performed in the Houdry Unit in which heavy hydrocarbon stock (crude oil) was converted into lighter products. This process not only increased the quantity of gasoline but also increased the quality and octane rating of the gasoline. By 1950, an additional furnace was installed and the tar cooler box was removed from the Houdry Unit. The remainder of the Houdry Unit was removed between 1990 and 1995.

Salt Heater/Electric Substation "B"/Vacuum Still. These three units replaced the Coal Shed/Crude Oil Sheds/Condenser Structure and steam stills between 1924 and 1939. The salt heater (approximately 151 feet by 7 feet), the Electric Substation "B" (approximately 53 feet by 13 feet), and the vacuum still (approximately 34 feet by 19 feet), were each associated with the refining processes performed in this area. The salt heater was removed in 1951. Substation "B" and the vacuum still were removed between 1951 and 1955.

Hose House No. 85. The Hose House was constructed between 1924 and 1939 at the former location of the Refinery Office. The Hose House measured approximately 19 feet by 15 feet in size and was removed in between 1951 and 1955.

Lab Sample Storage Structure. This structure, approximately 15 feet by 11 feet, was located north of Hose House No. 85 and adjacent to the east of the Laboratory. The Lab Sample Storage Structure was constructed between 1924 and 1939 and removed between 1977 and 1986.

Thermofor Catalytic Cracking (TCC) Area. The TCC Area was constructed between 1939 and 1951 in the former location of the Pressure Stills and Coal Shed, between the Pipe Still/Condenser Unit and the Houdry Unit. This area was used for conversion of heavier petroleum hydrocarbons into lighter products such as kerosene, gasoline, liquefied petroleum gasoline (LPG), and heating oil. Typical units that comprise a TCC Unit include a catalytic reactor bed, a fractionating tower, and a carbon-monoxide boiler. The TCC Area measured approximately 105 feet by 50 feet. According to a 1955 map, a TCC heater and a W.H. boiler had been installed to the north of the TCC Unit. The TCC Unit and associated structures were removed between 1989 and 1995.

Catalytic Polymerization Area. The Catalytic Polymerization Area was added to the FRA between 1939 and 1951. This area was located to the west of the Houdry Unit and housed processes in which light olefin gases were converted into higher-octane products to be used for gasoline blending. Typical units that comprise the polymerization process are a polymerization reactor, a stabilizer/fractionator system, and feed drums. The Catalytic Polymerization Area was removed between 1990 and 1995.

Compressor House. A compressor house was constructed adjacent to the west of the Houdry Unit and north of the Catalytic Polymerization Area between the years 1939 and 1951. This structure measured approximately 105 feet by 30 feet and was removed between 1990 and 1995.

Cooling Tower. A cooling tower was added to the FRA at the former location of the Coal Shed/Crude Oil Sheds/Condenser Structure between 1939 and 1951. The cooling tower was removed between 1951 and 1955.

Rail Loading Racks. Three loading racks were constructed between 1924 and 1939 at the former location of Shed No. 3. An additional loading rack was constructed at that time to the southeast of the three loading racks. Three 15 foot by 5 foot loading racks were located south of the tracks that led into the former Refinery Boiler House/Pump House. The three loading racks were removed between 1951 and 1977. Two loading racks (one measuring 15 feet by 5 feet and the other measuring 15 feet by 8 feet) were located on the north and south sides of a railroad track that ran in a southeast direction from Prenatt Street into the FRA and terminated north of the Main In-Ground Oil/Water Separator. These two loading racks were removed between 1951 and 1977. A rail loading rack was constructed between 1939 and 1951 on the eastern side of the brick roadway in the FRA. The loading rack was located along rail tracks that branched from Prenatt Street towards the north and parallel to the brick roadway. The loading rack measured approximately 12 feet by 8 feet and was removed between 1951 and 1977. Two additional rail loading racks were constructed between 1939 and 1951 adjacent to Building No. 35 (Item 76). Each loading rack measured approximately 12 feet by 8 feet and was removed between 1951 and 1977.

Control House. A control house was constructed to the northwest of the TCC Unit. The structure, approximately 60 feet by 45 feet, was constructed between 1951 and 1955. The control house was demolished between 1990 and 1995.

Gas Compressor/Exchanger Structure. This structure was located adjacent to the west side of the TCC unit. The structure measured approximately 70 feet by 45 feet and was constructed between the years 1951 and 1955. The exact use of the compressors and exchangers stored in this structure could not be determined. The structure was removed between 1977 and 1986.

Electric Substation "E". This electric substation replaced Electric Substation "B" when the Sovaformer Area was constructed in 1956. The substation measured approximately 84 feet by 24 feet and was used to supply the FRA and neighboring areas with electricity to support refinery operations. Electric Substation "E" was removed between 1977 and 1986.

Tar Box. A tar box, constructed between 1951 and 1955, was located north of Substation "E" and measured approximately 24 feet by 24 feet. The tar box was utilized to cool the rundown from the crude unit prior to storage in Tank 60. The structure was removed between 1977 and 1986.

Sovaformer Area. This area was located in the former location of the Steam Stills Condensers/Receiving House. The Sovaformer unit became operational in 1956 and consisted of a control building (45 feet by 30 feet), a heater building (58 feet by 55 feet), four towers (approximately 110 feet in height) and storage tanks. The Sovaformer unit utilized three reactors containing platinum catalysts to convert low-octane paraffin hydrocarbons into high-octane aromatic hydrocarbons. This process allowed for the production of 100-octane gasoline. The Sovaformer unit was removed between 1990 and 1995.

Asphalt Control House. The Asphalt Control House was constructed between 1951 and 1955. The structure measured approximately 65 feet by 20 feet and was located north of Tank No. 495. The structure was demolished in 1989.

Dissolved Air Flotation Unit. The dissolved air flotation unit was located north of the Main In-Ground Oil/Water Separator. The unit was installed in 1972 and operational by 1973. The dissolved air flotation unit was used in addition to the Main Separator for separation of waste streams and was removed between 1977 and 1986.

Asphalt Loading Area/Heater. The Asphalt Loading Area replaced the former Refinery Boiler House/Pump House structure between 1958 and 1966. The loading area was associated with the neighboring asphalt storage tanks, Asphalt Control House, Asphalt Heater, and Asphalt Pump House and was equipped with a truck loading rack. The Asphalt Loading Area was removed between 1982 and 1986. The asphalt heater was located to the southeast of the loading rack area. The heater was installed between 1951 and 1955 and was associated with the asphalt refining processes. The heater was removed between 1977 and 1986.

Fire Pump Houses. Two fire pump houses were constructed along the southern boundary of the Site, adjacent to the Buffalo River bulkhead. The pump houses were constructed between the years 1966 and 1974 and were used for fire suppression and protection purposes. These structures each measured 20 feet by 15 feet and were removed between 1977 and 1986.

2.4.2. Waste Handling Areas

Two WHAs located in the FRA were identified in company records. These WHAs are the Main In-Ground Oil/Water Separator and the Dissolved Air Flotation Unit.

Main In-Ground Oil/Water Separator

The Main In-Ground Oil/Water Separator was constructed between 1917 and 1924 in the southern portion of the FRA and is designated as WHA-2. The separator was used for the separation of petroleum from aqueous waste streams and storm water. The Main In-Ground Oil/Water Separator measured approximately 260 feet by 103 feet in size, was 16 feet deep and consisted of eight chambers with varying measurements. The trap collected waste streams from process areas, the Site's Well Point System and storm sewers across the entire Site. The Main In-Ground Oil/Water Separator currently exists at the Site. However, the five southernmost chambers were abandoned in 1993. The Main In-Ground Oil/Water Separator was used only temporary storage of storm water in excess of the capacity of the existing water treatment system prior to completion of treatment system upgrades in March 2000. The Main In-Ground Oil/Water Separator has not been used since the treatment system upgrades were completed, however it is inspected periodically.

Dissolved Air Flotation Unit

The Dissolved Air Flotation Unit was also a WHA (WHA-3). This unit was located to the north of the Main In-Ground Oil/Water Separator and was utilized as part of the wastewater treatment system. The unit measured approximately 16 feet by 64 feet and began operating in 1973. The dissolved air flotation unit was used in addition to the Main Separator for separation of waste streams and was removed between 1977 and 1986.

2.4.3. Spills/Releases

A list of spills/releases that occurred in the FRA are presented in Table 2. The significant spills are described below. Historical evidence supporting the occurrence of the significant releases in this area exists in two forms, those supported by documentation and those based on the knowledge of current and/or former ExxonMobil employees. The following release has supporting documentation in the form of ExxonMobil records and a NYSDEC Spill Report Form for Spill No. 9104672.

- On July 31, 1991, a release of 2,500 gallons of quench oil occurred. The release was believed to occur in the FRA based upon the description of events and the ongoing demolition of the former refinery. The release occurred when a 3,000 gallon aboveground storage tank was being emptied. The valve on the tank became stuck. In addition to the NYSDEC, the BSA was notified of the release. The product spilled onto a concrete pad and entered the Site's sewer system. The concrete pad was cleaned and a vacuum truck was used to remove product from the sewer. The recovered product was disposed off site.

The following spill description is based on knowledge of current and/or former ExxonMobil employees.

- Several releases of asphalt products occurred at the former asphalt loading rack. The quantities of product released and the timeframe during which these incidents occurred are not known.
- The seals on the pumps located south of Tank 82 would reportedly leak due to handling the heavy heated products. When the seals would leak, the heavy product would drain to the ground surface. The quantities of product released and the timeframe during which these incidents occurred are not known.

2.5 Central Rail and Process Area

The CRPA is located in the central portion of the Site and is transected by two roadways, Prenatt Street and an unpaved roadway, both running in a west to east direction. The CRPA encompasses approximately 8 acres.

The western portion of the CRPA was purchased by the Atlas Refining Company from Peter Schermerhorn on December 22, 1882. Atlas Refining Company purchased the eastern portion of the CRPA from the National Transit Company on July 31, 1890. These two parcels were purchased by SOCONY on June 16, 1915 from Buffalo Hardwood Lumber Company, the City of Buffalo and other unnamed entities.

2.5.1 Former and Current Structures

In 1917, the CRPA consisted primarily of railroad tracks on Prenatt Street and structures associated with the construction of barrels. Between 1924 and 1990, this area was generally used for housing refinery process related structures. Table 1 provides information regarding storage tanks that were previously located in this area. The following structures were previously located within the CRPA and are summarized in chronological order according to their construction date.

Hose House. This hose house was constructed prior to 1917 on the north side of Prenatt Street. The structure measured approximately 18 feet by 11 feet and was removed between 1917 and 1924.

Coal Shed. A coal shed was located adjacent to the Hose House on the north side of the railroad tracks that ran from east to west along Prenatt Street. The Coal Shed was constructed prior to 1917 and measured approximately 27 feet by 11 feet in size. The coal shed was demolished between 1917 and 1924.

Old Store House/Rivet Storage Room. This structure was comprised of 4 adjoining units, the Old Storage House (approximately 110 feet by 80 feet), the Rivet Storage Room (approximately 80 feet by 36 feet), the Carpenter Shed (60 feet by 25 feet), and the Lumber Shed (approximately 37 feet by 17 feet). This structure was constructed prior to 1917 and was located on the south side of Prenatt Street. Each of these units was associated with the construction of barrels. The structure was demolished between 1917 and 1924.

Stave Shed and Cooper Shop. These two structures were located to the southwest of the Old Store House/Rivet Storage Room and similarly were associated with the construction of barrels. The Stave Shed measured approximately 40 feet by 35 feet and was used to store the staves used in making barrels. The Cooper Shop, located south of the Stave Shed, measured approximately 42 feet by 20 feet and was where the assembly of barrels was performed. The two structures were removed between 1917 and 1924.

Paint Shed. The Paint Shed was constructed prior to 1917. The structure measured approximately 40 feet by 20 feet and was located north of the Old Storage House/Rivet Storage Room structure. The Paint Shed was demolished between 1917 and 1924.

Acid Oil Box. The Acid Oil Box, measuring approximately 20 feet by 8 feet, was located to the east of the Old Storage House/Rivet Storage Room structure. This structure was constructed prior to 1917 and was used for storage purposes. The Acid Oil Box was removed some time before 1924.

Pump House No. 95/Tool House No. 93 Structures. These structures were constructed between 1917 and 1924 and replaced the Old Storage House/Rivet Storage Room structure. Pump House No. 95 measured 43 feet by 15 feet. Tool House No. 93 measured approximately 15 feet by 10 feet. Associated structures located adjacent to these structures included a coal bunker, an ash hopper, a 150-foot stack, and a structure measuring approximately 225 feet by 67 feet containing twelve 25 foot by 15 foot compartments. The specific use or refinery process performed at these structures could not be determined from the available information. These structures, with the exception of the pump house and tool house, were removed between 1924 and 1939. The pump house and the tool house were removed between 1951 and 1955.

Rail Filling Racks. A rail filling rack was constructed in the central portion of the CRPA between two rail tracks for the transport of propane and No. 2 fuel oil. The filling rack was constructed prior to 1917 and measured approximately 300 feet by 5 feet. An additional filling rack was constructed prior to 1917 and was located adjacent to the west of the Barrel House. These filling racks were removed between 1924 and 1939. A filling rack was constructed between 1924 and 1939 in the same portion of the CRPA as the two former filling racks. The filling racks measured approximately 280 feet by 5 feet and was removed between 1951 and 1977 when the Treating, Blending, and Shipping Area was constructed. Between 1951 and 1955, a rail filling rack was constructed in the northeast and measured approximately 225 feet by 5 feet. The filling rack was removed between 1985 and 1990. Adjacent to the southeast was Transformer No. 97. This transformer was placed at this location between 1917 and 1924 and was removed between 1939 and 1951.

Tar Loading Rack. The tar loading rack was located on the north side of Prenatt Street. The loading rack was constructed between 1924 and 1939 and measured approximately 180 feet by 6 feet. The loading rack was removed between 1951 and 1955.

Ethyl Plant No. 16. The Ethyl Plant was constructed between 1924 and 1939 and was located south of Prenatt Street, adjacent to the west side of the railroad tracks. Within the Ethyl Plant, lead was injected into the gasoline. Between 1939 and 1951, Tank No. 49 was constructed adjacent and to the west of the Ethyl Plant. The Safety Building was constructed on the west side of Tank No. 49. The Ethyl Plant structure was removed between 1990 and 1995.

Dehydrator/Pipeline Pump House No. 38. A dehydrator and Pipeline Pump House No. 38 were constructed between 1924 and 1939 to the southeast of the Ethyl Plant. The dehydrator measured approximately 38 feet by 5 feet. The pump house measured approximately 53 feet by 30 feet. The dehydrator was removed between 1951 and 1955. The pump house structure was removed between 1977 and 1985.

Deflorez Cracking Unit/Cross-Cracking Unit. The Deflorez Cracking Unit was constructed in the former location of the Old Storage House/Rivet Storage Room. This unit was constructed between 1924 and 1939 and consisted of pump houses, a Deflorez furnace, a tar cooler, and towers. The Deflorez Unit converted stock and crude bottoms into No. 6 fuel oil and cracked naphtha, used for gasoline production. Adjacent to the west of the Deflorez Cracking Unit, were a control house and a Cross-Cracking Unit. The Cross-Cracking Unit was removed between 1939 and 1951. The Deflorez Cracking Unit was removed between 1951 and 1955.

Instrument Shop/Water Separator. The Instrument Shop and a water separator were constructed between the years 1939 and 1951 in the former location of the Cross-Cracking Unit. The Instrument Shop measured approximately 85 feet by 25 feet and was used for storage purposes. The water separator measured approximately 63 feet by 20 feet. Both structures were removed between 1951 and 1955.

Pipeline Storage House. The Pipeline Storage House was constructed adjacent to the west of the Pipeline Pump House No. 38 between 1951 and 1955. The storage house measured approximately 24 feet by 24 feet and was removed between 1985 and 1990.

Treating, Blending, and Shipping Area. This area was located between Prenatt Street and the unpaved roadway, after the removal of railroad tracks previously located in this area. The Treating, Blending, and Shipping Area was constructed between 1951 and 1955 and included a control house, a caustic storage area, stacks, and process tanks of various sizes. This area was used to remove non-hydrocarbons, impurities and other constituents that adversely affect the properties of finished products or intermediate hydrocarbon streams. The area was cleared between 1985 and 1990.

Alkylation Unit Area. The Alkylation Unit Area was located in the former location of the Deflorez Cracking Unit. The area was constructed between 1951 and 1955. Within the Alkylation Unit Area was a control house measuring approximately 36 feet by 24 feet. Additional roadways were constructed surrounding this area. Based on published descriptions of refinery processes, alkylation unit was used to produce high-octane aviation fuel and petrochemical feedstock for explosives and synthetic rubber. The Alkylation Area was demolished between 1990 and 1995.

Safety Building. The Safety Building was constructed between 1955 and 1977 and measured approximately 42 feet by 18 feet. The Safety Building was removed between 1990 and 1995.

Tank Truck Loading Rack. The Tank Truck Loading Rack was constructed in 1990. This construction included the additional removal of railroad tracks on Prenatt Street, the paving of roadways, and construction of truck parking facilities. The Truck Loading Rack has three loading bays and measured approximately 70 feet by 65 feet. The Truck Loading Rack currently exists at the Site.

2.5.2 Waste Handling Areas

Two WHAs were identified in the CRPA from company records. These WHAs include the Buried Acid Sludge Trench and three Hazardous Waste Dumpsters and are described below.

Buried Acid Sludge Trench

The Buried Acid Sludge Trench extended from the south side of the Alkylation Unit to the north side of the tank yard of Tank 99. The trench is designated as WHA-10 and is represented on Plate 1. The acid sludge originated from an acid treating process used in lube oil production and was disposed in a 60 foot by 40 foot by 8 foot clay lined construction pit. In October 1985, the material began to rise to the surface of the soil. Soil borings were performed to delineate the extent of the acid sludge. Subsequently, a total of 1,185 tons of material was excavated and disposed off site at CECOS in Niagara Falls.

Hazardous Waste Dumpsters

Three hazardous waste dumpsters were located north of the Alkylation Unit in the CRPA. The dumpsters were designated WHA-12 and are represented on Plate 1. The type of waste or duration of use could not be determined from the available information. In 1991, during the demolition of the refinery, the dumpsters were used to store and ship pipe that was scrapped.

2.5.3 Spill/Releases

A list of spills/releases that occurred in the CRPA are presented in Table 2. The most significant spill that documented in this area is described below. The following release has supporting documentation in the form of ExxonMobil records and a NYSDEC Spill Report Form.

- On October 25, 1988, approximately 34,062 gallons of No. 2 fuel oil was released in the CRPA. This release was reported to the NYSDEC and assigned Spill No. 8806247. The release was also reported to the BSA. The incident occurred while emptying Tank 22 in the NTYA for demolition. Product was pumped through a former diesel fuel line to Tank 221 in the BSPA. The former diesel line ruptured at a location between the Treatment, Blending and Shipping Pit Area and a location near the northwest corner of the containment berm for Tank 25. Product spilled into the contained concrete Treatment, Blending and Shipping Pit Area. The drains within the contained pit area connected to the Main In-Ground Oil/Water Separator located in the FRA. Approximately 33,984 gallons of the spilled product were recovered by vacuum trucks and pumped back to Tank 22 for storage. The remaining product released reportedly drained into the Site sewer system and to the Main In-Ground Oil/Water Separator.

2.6 Southern Tank Yard Area

The STYA encompasses approximately 15.5 acres and is located in the southern portion of the Site between Prenatt Street and the Buffalo River. Similar to the CRPA, the western portion of the STYA was purchased by the Atlas Refining Company from Peter Schermerhorn on December 22, 1882. Atlas Refining Company purchased the eastern portion of the STYA from the National Transit Company on July 31, 1890. The two parcels were purchased by SOCONY from Buffalo Hardwood Lumber Co., the City of Buffalo and other unnamed entities on July 23, 1915. As discussed previously, prior to 1915 the Buffalo River transected the southern portion of the Site through both the STYA and the Former Refinery Area. The Buffalo River was rerouted to the south to form a relatively straight channel. Due to the restructuring of the Buffalo River, SOCONY relinquished a parcel of property to the City of Buffalo in 1915 to allow for the altered course of the Buffalo River.

2.6.1 Former and Current Structures

Prior to 1917, the STYA housed refining related structures including treating process structures, structures associated with the barrel construction processes and storage tanks. Between 1917 to present, the STYA has primarily been maintained as a tank yard, housing storage tanks of various sizes. Table 1 provides information regarding the storage tanks located within this area. The following structures were located in the STYA and are listed chronologically by their construction date.

Acid Treating/Clay Contacting Area. This area was comprised of multiple units associated with acid treating and clay contacting of petroleum products. The structures were constructed prior to 1917 in the western portion of the STYA and included acid sheds, clay plants, a blow house, pump houses, alkali tanks, and lye storage tanks. The Acid Treating/Clay Contacting Area was removed between 1917 and 1924.

Barrel House. The Barrel House, approximately 200 feet by 75 feet, was constructed prior to 1917. This structure was associated with the barrel construction process structures described in Section 2.4. The Barrel House was bounded on the northwest and southeast sides of the structure by rail tracks. Along the northeast, northwest, and southwest walls was a platform for staging of barrels. The Barrel House was removed between 1917 and 1924.

Hose House. A hose house was located to the south of the southeast corner of the Barrel House. The hose house measured approximately 18 feet by 12 feet in size and was constructed prior to 1917. The structure was removed between 1917 and 1924.

Pan House/Boiler House Area. The Pan House and the Boiler House were two adjoining units constructed prior to 1917 in the southeast portion of the STYA. The Pan House measured approximately 45 feet by 40 feet. The Boiler House, located to the south of the Pan House measured approximately 35 feet by 40 feet. Adjoined to the Boiler House was an 18-foot by 10-foot shed. Adjacent to the north of the structure was a steam box unit measuring approximately 36 feet by 20 feet. To the east of the structure was a 50-foot stack and water tank. Adjacent to the southeast was a 14-foot by 5-foot hose house and a 60-foot stack. To the west of the structure was a rail track with a loading rack and several units whose specific purpose could not be determined from the available information. The Pan House/Boiler House Area was demolished between 1917 and 1924.

Bottle Houses and Pan House/Steam Boxes. Located to the south of the Pan House/Boiler House Area were two Bottle Houses and a Pan House/ Steam Box structure. Each of these structures was constructed prior to 1917. Located between the two Bottle Houses were two condensers, two 60-foot stacks, and storage tanks. It could not be determined what refining process was performed in these structures. The structures were removed between 1917 and 1924.

Atlas Works Office. The Atlas Works Office was constructed prior to 1917 adjacent to the Pan House and Steam Boxes Structure. The structure, measuring approximately 18 feet by 18 feet, served as the administrative office for the refining processes performed in this portion of the Site. The office structure was demolished between 1917 and 1924.

Hose House No. 88. Hose House No. 88 was constructed between 1917 and 1924 in the northern portion of the STYA. The structure was constructed of brick and measured 9 feet by 12 feet. Between 1951 and 1955, Hose House No. 88 was removed.

Pump Houses No. 44 and No. 24. These two pump houses, constructed between 1917 and 1924, were located on the southern boundary of the Site, adjacent to the bulkhead of the Buffalo River. Pump House No. 44 was constructed of brick and measured 21 feet by 32 feet. Attached to Pump House No. 44 was Structure 107, measuring 24-feet by 17-feet in size. Pump House No. 24 was located approximately 175 feet to the west of Pump House No. 44. This pump house was constructed of brick and concrete and measured 27 feet by 18 feet. Adjoined to Pump House No. 24 was Structure No. 106, which measured 17 feet by 20 feet in size. The two pump houses were removed between 1951 and 1955.

Building No. 79. This structure was located in the southeast corner of the STYA and constructed between 1917 and 1924. The structure measured 67 feet by 57 feet. Adjacent to the north and west were several storage tanks of varying capacities. Located to the south were two towers and a furnace. The specific refining process that was performed at this structure could not be determined. The structure and the associated storage tanks were removed prior to 1939.

Hose House No. 89. This hose house, measuring 9 feet by 12 feet, was located in the eastern portion of the STYA. The structure was constructed between 1917 and 1924 and was demolished between 1939 and 1951 and replaced by Tank No. 90.

Car Shop. This car shop was constructed between 1917 and 1924 and was used for the construction, maintenance and housing of railcars. The structure measured 220 feet by 30 feet, was located in the eastern portion of the STYA, and was removed between 1924 and 1939.

Stabilization Unit No. 35. This structure was associated with the Pump House No. 95/Tool House No. 93 structures. The stabilization unit measured 35 feet by 60 feet and was constructed between 1924 and 1939. The specific purpose of this structure could not be determined. The structure was demolished between 1951 and 1955.

Wash Room (Fire Truck House No. 31). According to the 1939 map, this structure served as a wash room. The structure was constructed some time between 1924 and 1939 in the eastern portion of the STYA and measured approximately 68 feet by 10 feet. According to a 1955 map, this structure served as a fire truck house. The structure was removed between 1951 and 1955 when the Alkylation Unit was constructed.

Storage Shed No. 54. This structure was constructed between 1924 and 1939 and located adjacent to Gate No. 23 on the eastern boundary of the Site. The storage shed measured approximately 55 feet by 30 feet and was removed between 1958 and 1977.

Hose House No. 131. Hose House No. 131 was constructed between 1939 and 1951 adjacent to Tank No. 90. The structure measured approximately 15 feet by 9 feet and was removed between 1951 and 1955 and replaced by Tank No. 75.

Shelter House No. 121. The Shelter House was located on the southern boundary of the Site and along the bulkhead of the Buffalo River. The structure was constructed between 1939 and 1951 and measured approximately 12 feet by 6 feet. Between 1951 and 1955, the Shelter House was removed.

Pump Pad. A pump pad was constructed between 1951 and 1955 at the former location of Tank No. 46, adjacent and to the west of Tank No. 40. The pump pad measured approximately 57 feet by 15 feet in size. Between 1977 and 1986, the pump pad was removed.

Crude Scale House. The Crude Scale House was located in the eastern portion of the STYA and constructed some time between 1951 and 1955. It was in this area of the Site that the crude oil supply pipeline entered the Site. The structure measured approximately 20 feet by 15 feet and was removed 1986 and 1990.

Cooling Tower. A cooling tower was constructed adjacent and to the west of Tank No. 90 between the years 1951 and 1955. The cooling tower was associated with the adjacent Alkylation Unit. The cooling tower structure measured approximately 56 feet by 36 feet and was removed between 1977 and 1986.

Pipe Rack and Pump Pad. An aboveground pipe rack was installed with the construction of the truck loading rack in the CRPA in 1990. The pipe rack originates at a pump pad located north of Tank No. 38 and No. 97 and runs north to the truck loading rack. The pump pad and pipe rack currently exists at the Site.

Vapor Recovery System. The Vapor Recovery System is located at the former location of the cooling tower, adjacent to Tank No. 90. The Vapor Recovery System recovers vapors at the truck loading rack and passes the vapors through carbon units. The Vapor Recovery Unit was constructed at the same time as the truck loading rack construction and currently exists at the Site.

2.6.2 Waste Handling Areas

Four WHAs were located in the STYA based on company records. These WHAs include the tank yards surrounding the former leaded gasoline storage tanks, wastewater treatment/storage tanks, slop oil tanks, and a hazardous waste storage area. Each of the WHAs and their functions are described below.

Tank Yards

The tank yard surrounding Tank 18 has been characterized as a WHA. Formerly, Tank 18 was used to store leaded gasoline. At that time, the tank yard was used as a disposal location, in which the leaded tank bottoms from Tank 18 were spread and allowed to weather. According to company records, any tank that was used to store leaded gasoline would have been cleaned out by spreading the tank bottoms in the tank yards. Therefore, tank yards surrounding Tanks 20, 21, 23, 25, 26, 38, 42, 75, 86, 96, 97, 98, 99, 100, 160, 171, 187, 197, and 198 would have been utilized similarly. Collectively, the tank yards have been designated as WHA-4 and are represented on Plate 1.

Drainage and containment was controlled by dikes surrounding the tank yards with drains that carried the material to the Main In-Ground Oil/Water Separator. The storage of leaded gasoline at the site occurred between 1952 and 1989.

Wastewater Storage/Treatment Tanks

Two storage tanks located within the containment wall of the hazardous drum storage area were WHAs (WHA-5). Both tanks were constructed of steel and had fixed roofs and utilized in association with the Dissolved Air Flotation Unit after its installation in 1972 and operation in 1973.

One of the tanks was identified as Tank 77. The other tank designation could not be determined from the available information. The location of these tanks could not be verified by the available information. Both tanks were used from 1940 to 1981. From 1973 through 1981 the tanks received a combined flow of oil and foam from the Dissolved Air Flotation Unit. The use of these tanks prior to 1973 could not be determined from available information. The tanks were surrounded by a concrete dike and drained to the Main In-Ground Oil/Water Separator.

Formerly, heat exchangers were used in conjunction with wastewater treatment. These exchangers contained chromium. During the closure of the refinery, the tanks were cleaned and removed and all material within the tanks was disposed.

Slop Oil Tanks

According to company records, Tanks 40 and 2 were utilized for storing slop and were characterized as WHAs. The tanks are designated as WHA-6 on Plate 1. The capacity of Tank 40 was approximately 840,000-gallons and was located in the northern portion of the STYA, north of Tank 18. The tank stored slop oil from the Main In-Ground Oil/Water Separator between 1940 and 1981. The tank was equipped with an automatic gauge and a high level alarm to notify personnel to stop inflow. From 1973 through 1981, when the dissolved air flotation unit was operating, the slop oil was received from the Dissolved Air Flotation Storage Tank 77 (WHA-5), separated, and was later reprocessed. The undesired separated material was disposed off site. Tank 40 was cleaned and removed between 1990 and 1994. Tank 2 was located north of the Alkylation Unit (in the CRPA) and stored caustic soda for the caustic treating area in the CRPA. Information regarding the dismantling of Tank 2 was not available.

Hazardous Drum Storage Area

According to company records, a hazardous drum storage area was located in the eastern portion of the STYA and north of Tanks 23 and 100. This storage area was identified as WHA-7 and is represented on Plate 1. The storage area measured approximately 200 feet by 140 feet and stored a maximum of 298,000 gallons of contained waste. Within the storage area, approximately 10 tons of corrosive solid waste was stored annually. Additionally, 1 ton of hazardous leaded tank bottom material was stored in this area annually. The area was surrounded by a 3-foot concrete wall and contained no means for drainage. The storage of waste in this area was discontinued in 1984. There were no reported releases in this storage area. A 35-foot by 35-foot area within this storage area was identified in the company records as storing material received from the Main In-Ground Oil/Water Separator beginning in 1980. Storage of waste was also discontinued in 1984.

2.6.3 Spills/Releases

A list of spills/releases that occurred in the CRPA is presented in Table 2. The significant spills that occurred in this area are described below. The following releases had supporting documentation in the form of ExxonMobil documentation and/or a NYSDEC Spill Report Form.

- On March 12, 1987 approximately 4,260 gallons of gasoline were released. This release was reported to the NYSDEC and assigned Spill No. 8607552. The BSA was also notified of the incident, which occurred when a flexible connector ruptured during a product transfer from Tank 18 to Tank 99. The location of the rupture is not mentioned in the report. NYSDEC spill report indicates that the spill was contained and cleaned up satisfactorily. A ExxonMobil document for this spill, reference in the NYSDEC spill report form, was not located during the research for this history document.

- In August 1993, approximately 42,600 gallons of super unleaded gasoline were released. This release was reported to the NYSDEC and assigned Spill No. 9305522. The incident occurred when a contractor left a valve at Tank 20 open while removing a common suction line (believed to be idled) from Tanks 20 and 96. When the valve on the active Tank 99 was opened to receive a delivery, product flowed by gravity through the open valve on the common suction line and to the ground on the west side of the Tank 20 containment. Approximately 500 gallons of product were removed from the ground surface using a vacuum truck. The remainder of the gasoline moved from the west side of the containment where the spill occurred, to the east side of the containment, where it entered the Site's sewer system through 3 catch basins on the east side of the Tank 20 containment berm. From there it went to the Main In-Ground Oil/Water Separator. The pipeline and approximately 20 yards of impacted soil were removed and placed in the Biotreatment Cell. Reportedly 9,500 gallons of product were recovered from the 3 catch basins and stored in tank trailers. Another 12,500 gallons were recovered from the Main In-Ground Oil/Water Separator. The remaining unrecovered product was not accounted for.

The following spill description is based on knowledge of current and/or former ExxonMobil employees.

- Several releases of crude oil occurred from the crude oil pumps located north of Tank 38. Reportedly, when the pumps malfunctioned, the crude oil would drain to the ground surface. The quantities of product released and the timeframe during which these incidents occurred are not known.

2.7 Administrative Offices and Operations Area

The AOOA is centered between the NPSA, the NTYA, the CRPA, and the STYA. This area encompasses approximately 3.7 acres.

Similar to the NPSA, the western portion of the AOOA was purchased by Atlas Refining Company from Peter Schermerhorn on December 22, 1882. Atlas Refining Company purchased the eastern portion of the AOOA from the National Transit Company on July 31, 1890. Subsequently, SOCONY purchased these two parcels from Atlas Refining Company on June 16, 1892.

2.7.1 Former and Current Structures

Historically, the AOOA has housed structures related to railcar construction and repair, mechanical shops, and a laboratory. Prior to 1917, the structures located in the AOOA consisted primarily of railcar construction and repair shops and storage houses. After 1951, these structures were converted for usage as mechanical shops, storage houses, and boiler rooms. These structures were replaced with a mechanical shop, a storage house and a laboratory between 1951 and 1955. These structures currently exist at the Site. Additionally, roadways were paved through the area. The following list of structures describes in further detail the types of structures located within the AOOA. The structures are listed in chronological order according to its construction date. Table 1 provides information regarding storage tanks that were located within the AOOA.

Coal Shed. The Coal Shed was located adjacent to the southwest of the Car Repair Shop. The 43-foot by 15-foot shed was constructed prior to 1917 and stored coal used to power various operations. The Coal Shed was demolished between 1917 and 1924.

Wheel Shop/Blacksmith Shop/Machine Shop. This structure was constructed prior to 1917 in the northern portion of the AOOA. The Wheel Shop measured approximately 48 feet by 55 feet. The Blacksmith Shop, adjoined to the east wall of the Wheel Shop, measured approximately 95 feet by 55 feet. The Machine Shop was adjoined to the east wall of the Blacksmith Shop and measured approximately 80 feet by 55 feet. Each of these units was associated with the railcar construction and repair processes that were performed in this area and the NPSA. After the railcar construction operations ceased at the Site between 1924 and 1939, the Wheel Shop became the Electrical Shop. This structure was removed between 1951 and 1955.

Iron Rack. An iron rack was located north of the Wheel Shop/Blacksmith Shop/Machine Shop structure. The rack, constructed prior to 1917, measured approximately 25 feet by 18 feet and was associated with the car construction and repair operations. The iron rack was removed between 1917 and 1924.

Car Shop. The Car Shop, constructed prior to 1917, was a brick 203 foot by 102 foot building located to the south of the Wheel Shop/Blacksmith Shop/Machine Shop structure. The Car Shop was the prime location of railcar construction operations. Following the termination of railcar construction at the Site, this structure became the Boiler/Mechanical Shop. This structure was removed between 1951 and 1955.

Furnace Room/Sub-Station A. The Furnace Room, constructed prior to 1917, was located adjacent to the west side of the Car Shop. This structure was a brick structure and measured 32 feet by 24 feet. During the period of time that the AOOA housed railcar construction and repair structures, the Furnace Room was used in conjunction with these processes. The structure was later changed to Electrical Sub-Station A. This structure currently exists at the Site.

Car Repair Shop/Steel Shed. The Car Repair Shop was constructed prior to 1917 and located in the southwest corner of the AOOA. A railroad track that ran along Prenatt Street terminated at the structure. Located on the northeast corner of the Car Repair Shed was the Steel Shed. This structure measured approximately 40 feet by 52 feet in size and was used for storage. These two structures were removed between 1917 and 1924.

Car Shop Storehouse and Offices. This structure was comprised of the Car Shop Storehouse (105 feet by 42 feet), an Engine Room and Boiler House (64 feet by 55 feet), and offices (approximately 42 feet by 42 feet). The structure was constructed prior to 1917 and was located south of the Car Shop. Adjacent and to the east of the Engine Room and Boiler House were a water heater and a 50-foot stack. Between 1917 and 1924, the Engine and Boiler Room, water heater and stack were removed from the structure and the remainder of the structure was utilized as a storehouse. The Car Shop Storehouse was demolished between 1951 and 1955.

Boiler House/Fire Foam House. The Boiler House/Fire Foam House structure was constructed between 1917 and 1924 at the former location of the Car Repair Shop/Steel Shed. The Boiler House was approximately 200 feet by 52 feet in size with an adjoining 20-foot by 26-foot brick structure on the western wall. The Fire Foam House was a 63-foot by 33-foot structure adjoined to the northern wall of the Boiler House. Adjacent to the north wall of the Boiler House were three storage tanks (Tanks 9, 352, and 353) and a 250-foot stack. The structure was demolished between 1951 and 1955.

Laboratory Building. The Laboratory building was constructed between 1951 and 1955 in the northern portion of the AOOA. The structure measures approximately 50 feet by 60 feet. The Laboratory building currently exists at the Site and is used for storage of records related to the Terminal operations.

Boiler House. This Boiler House was constructed between 1951 and 1955 at the former location of the Boiler House/Fire Foam House. The structure was approximately 120 feet by 60 feet in size and was demolished between 1986 and 1990.

Mechanical Shop. This structure was constructed between 1951 and 1955 at the former location of the Car Shop and the Wheel Shop/Blacksmith Shop/Machine Shop. The Mechanical Shop measured approximately 180 feet by 100 feet and contained a garage for repairs and offices (Plate 5). The Mechanical Shop currently exists at the Site and is used as the Main Office.

Store House. The Store House was constructed between 1951 and 1955 adjacent and to the east of the Mechanical Shop. The structure measures approximately 100 feet by 120 feet. The Store House currently exists at the Site and is used as a warehouse for storing miscellaneous equipment (i.e., snow plows). Located to the north were two storage sheds, one measuring approximately 30 feet by 65 feet, the other measuring approximately 35 feet by 40 feet. These storage sheds were removed between 1977 and 1986.

2.7.2 Waste Handling Areas

One storage tank was identified in the AOOA as a WHA from company records. The storage tank was designated as WHA-11 and is represented on Plate 1. This storage tank measured approximately 6 feet by 4 feet by 2 feet and was located adjacent to the Mechanical Shop. The tank was utilized to store waste oils and solvents generated from the maintenance and repair operations in the Mechanical Shop. A contractor was retained, as needed, for off-site reclamation of the waste. According to company records dated 1994, the tank was moved to a wash bay.

2.7.3 Spills/Releases

No significant spills have been documented to occur in this area. One spill, of less than 5 gallons, is described in Table 2.

3.0 SUMMARY OF ENVIRONMENTAL CONDITIONS

Data regarding environmental conditions at the Site, and particularly the ETYA, NPSA, NTYA, FRA, CRPA, STYA, and AOOA, were obtained from a review of the results of previous investigations and the ongoing monitoring program at the Site. The following sections include:

- a listing and brief description of previous investigations completed in the various areas of interest;
- a description of the topography of the Site;
- a description of the geology of the Site;
- a description of the hydrogeology of the Site; and
- a summary of the environmental quality in the various areas of interest based on previous investigations (soil quality, groundwater quality, separate-phase product occurrence, where applicable) and sediment quality (where applicable).

The summary of soil and groundwater quality include comparisons of the previous data collected to the NYSDEC soil and groundwater criteria, described below.

Soil Quality Criteria

Soil quality data from previous investigations has been compared to NYSDEC soil quality criteria. This type of comparison enables identification of areas that may pose a potential risk under a residential land use scenario, as well as those areas that may have potential to impact groundwater at concentrations exceeding drinking water standards. The soil quality data generated during previous investigations, described below, and the data to be generated during the investigation activities described in Section 5 of this work plan, will evaluated against the criteria presented in the following NYSDEC documents:

- NYSDEC Recommended Soil Cleanup Objectives (RSCOs) presented in the "Division of Hazardous Waste Remediation. Division Technical and Administrative Guidance Memorandum 4046: Determination of Soil Cleanup Objectives and Cleanup Levels" (NYSDEC 1994); Guidance Values, presented in "Spill Technology and Remediation Series (STARS) Memo # 1, Petroleum Contaminated Soil Guidance Policy" (NYSDEC 1992).
- NYSDEC memorandum regarding "Determination of Soil Cleanup Levels" dated December 20, 2000 (NYSDEC 2000); and

- NYSDEC memorandum regarding “Response to Comments Relative to 12/20/00 Soil Cleanup Consolidation Memo”, issued on April 10, 2001 (NYSDEC 2001).

Groundwater Criteria

In the discussions of previous investigations that follow, the groundwater data collected during these investigations is compared to the NYSDEC Ambient Water Quality Standards and Guidance (AWQSG), values for Class GA groundwater presented in the Division of Water Technical and Operational Guidance Series (1.1.1) “Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations” (NYSDEC, 1998) as amended in April 2000.

3.1 Previous Investigations

The Scope of Work described in this work plan is intended to supplement the results of previous investigations conducted in the NPSA, NTYA, FRA, CRPA, STYA, ETYA, and AOOA, which are the following:

- Phase I Investigation at the ETYA (former Disposal Area), conducted by Recra Research, Inc. in 1983 (URS, 1986);

- Phase II investigation at the ETYA (former Disposal Area), conducted by URS Company, Inc. in 1986 (URS, 1986) and follow-up sampling for the Phase II investigation in the ETYA conducted in the fall of 1986, spring of 1987 and March 1988;

- Installation of five monitoring wells (ESI-1 through ESI-5) in the STYA, and performance of water-level and product thickness measurements in these new wells, by Empire Soils Investigations, Inc. in March and April 1989 (ESI, 1989a);

- Installation of five monitoring wells (B-1MW, B-2MW and B-4MW through B-6MW) in various areas of the Site and performance of water-level and product thickness measurements in these new wells, by Empire Soils Investigations, Inc. in July 1989 (ESI, 1989b);

- Installation of two monitoring wells (W-1 and W-2) in the ETYA and performance of water-level and product thickness measurements in these new wells, by Empire Soils Investigations, Inc. in October 1989 (ESI, 1989c);

- Installation of 17 monitoring wells (MW-1 through MW-17) in various areas of the Site and performance of water-level and product thickness measurements in these new wells, by Empire Soils Investigations, Inc. in October and November 1989 (ESI, 1990a);

- Installation of 25 monitoring piezometers (P-1 through P-25) in the ETYA and performance of water-level and product thickness measurements in these new piezometers, by Empire Soils Investigations, Inc. in April 1990 (ESI, 1990b);
- Abandonment and replacement of well B-5MW with B-5MWR in the CRPA by Empire Soils Investigations, Inc. in May 1990 (ESI, 1990c);
- Abandonment and replacement of well B-5MWR with B-5MWRR in the CRPA by Empire Soils Investigations, Inc. in July 1990 (ESI, 1990d);
- Site Facility Investigation, conducted by Groundwater & Environmental Services, Inc. from June through August 1998 (Roux Associates, Inc., 1998);
- Site Facility Investigation completion, conducted by Groundwater & Environmental Services, Inc. and Roux Associates from July through October 1999 (Roux Associates, Inc., 1999); and
- Installation of MW-28 in the ETYA by Groundwater & Environmental Services, Inc. on October 4, 2000; and
- Field inspection of approximately 1,000 feet of shoreline along the Buffalo River by representatives of ExxonMobil, NYSDEC and Roux Associates on October 26, 2000.
- Installation of soil borings, collection of soil samples, installation of monitoring wells and collection of sediment samples conducted by GES and Roux Associates between December 2000 and April 2001 summarized in the Separate-Phase Product Investigation Report for the Eastern Tank Yard Area (Roux Associates 2001).

3.2 Topography

The topography of the NPSA, NTYA, FRA, CRPA, STYA, and AOOA is generally flat.

The topography in the ETYA is generally flat, with a steeply sloped embankment to the Buffalo River. The ground surface elevation drops by approximately 22 to 25 feet in a horizontal span of approximately 25 to 30 feet from the top of the embankment to the river level. The Buffalo River shoreline can usually be accessed by a narrow strip of level ground at the base of the embankment. At times, high water elevations in the Buffalo River prevent access to the shoreline.

3.3 Geology

The geology of the majority of the Site can be described in general terms. The geology of the ETYA has been influence by historical activities and differs slightly from the remainder of the

Site. A general description of the geology of the Site as a whole (excluding the ETYA) is presented below, along with a description specific to the ETYA. Figures 3 through 7 present seven generalized hydrogeologic cross sections through the Site in the following locations:

- Section A-A’ and Section B-B’ (Figures 3 and 4) run in an east to west direction;
- Section C-C’ and Section D-D’ (Figures 5 and 6) run in a north to south direction; and
- Section E-E’ runs parallel to the Buffalo River bank in the ETYA and Sections F-F’ and G-G’ run perpendicular to Section E-E’ in the ETYA (Figure 7).

General Description of Site Geology

The Buffalo Terminal is located within the Erie-Ontario Lowland physiographic region of the Interior Plains Division. In general, the region is underlain by Silurian and Devonian age interbedded shales, siltstones, sandstones, limestones and dolomites, dipping approximately 0.50 degrees to the south.

Three unconsolidated deposits exist at the Site. The first is a fill layer which consists of black cinders, silt, gravel, sand, slag, and trace amounts of concrete, brick, glass, and wood. The second unit, colored gray to brown, consists of alluvial deposits of silt (sandy silts to clayey silts), silts and clays, sands, and sands and gravel. Underlying the alluvial layer is a gray to brown glacio-lacustrine clay. Bedrock was not encountered in any of the wells installed to date.

The following generalization regarding Site geology can be made from available information.

- Fill thickness is generally greatest in the southern portion of the site.
- The thickness of the alluvial deposits is greatest in the southern portion of the Site, in proximity to the Buffalo River. This layer pinches out at the central portion of the Site and the depth to the top of the clay layer decreases northward.

Description of Geology in the ETYA

In general, the geology of the entire ETYA is influenced by the former disposal activities that were conducted in this area and re-routing of the Buffalo River. Four unconsolidated deposits exist in the area under consideration (two are subsets of the alluvial deposits described above). The first is a fill layer that consists of black cinders, concrete, brick, glass, wood, silt, gravel, sand and slag that is consistent with the historical disposal activities. This layer varies in thickness from 7 to 23 feet. The second unit consists of sands; silt (sandy silt to clayey silts); and silts and clays. The thickness of this layer is between 0 and 20 feet throughout the area of interest (a subset of the alluvial deposits described above). The third layer is predominantly comprised of sand and gravel and ranges in thickness from 4 to 11 feet (a subset of the alluvial deposits described above). Underlying the sand and gravel layer is a clay layer. Bedrock was not encountered in any of the wells installed in the ETYA.

3.4 Hydrogeology

The following is a general description of the hydrogeology of the Site as a whole, and is not specifically related to any geographic area of the site, except where noted. The description of groundwater flow direction presented below is based upon water-level and separate-phase product thickness data collected on April 19 and 20, 2001, which is generally consistent with data collected at the Site during previous investigations. Plate 2 presents water-level and separate-phase product thickness data for the Site from the April 2001 quarterly gauging round.

The groundwater flow direction in the area of the Site west of the former Erie-Lackawanna Railroad is generally southwest toward the Buffalo River. The influence of the western leg of the Well Point System (WPS) in drawing down the water table and affecting the direction of groundwater flow can be seen in monitoring wells in the southern portion of the FRA and BSPA. The drawdown caused by the western leg of the WPS was not as significant as during previous gauging rounds. Due to the discharge line from the pump being clogged, the western leg of the WPS had not operated efficiently since February/March 2001. This line was cleaned several days before the gauging round. The performance of the system has been observed to improve in data collected in May 2001. The influence of the eastern leg of the WPS can be seen in monitoring wells in the southern tank yard area (STYA) and the southwest portion of the ETYA.

The gauging data from the April 2001 quarterly round indicates that the Buffalo River level was higher than the water level observed in all wells located along the bulkhead, except monitoring well SB-39. Therefore, in general, the data demonstrates that pumping of the WPS depresses the water table sufficiently to induce recharge from the Buffalo River into the aquifer in the area between the WPS and the Buffalo River, except in the vicinity of SB-39.

In the area between the operating dual phase recovery wells and the WPS, a groundwater flow divide is created between the cones of influence of the two pumping systems.

Finally, a groundwater divide, caused by the operation of the eastern leg of the WPS, exists in the southwestern portion of the ETYA. The groundwater flow direction east of the divide is generally southeast toward the Buffalo River. The groundwater flow direction west of the divide, in the southwestern portion of the ETYA, is generally west toward the WPS.

3.5 Environmental Quality

The following sections present a brief summary of the data generated during prior investigations regarding the occurrence of separate-phase product, soil, sediment (where applicable) and groundwater quality and in the ETYA, NPSA, NTYA, FRA, CRPA, STYA, and AOOA.

3.5.1 Eastern Tank Yard Area (ETYA)

The following sections present a brief summary of the data generated during prior investigations regarding soil, sediment and groundwater quality and the occurrence of separate-phase product in the ETYA. Also included are field observations related to the sheen and seepage area along the Buffalo River adjacent to the ETYA.

3.5.1.1 Separate-Phase Product

The results of the current investigation and on-going water/product level gauging indicate that separate-phase product within monitoring wells (outside the limits of the active tank berms) is currently limited to the area shown on Plate 1 to the south of Tank 176 (i.e., separate-phase product is present in P-15, LF-1S, LF-3, LF-4, LF-6 and MW-28). Historically, MW-3URS also showed measurable separate-phase product, however none has been recorded since July 1998. In addition to existing wells that currently have measurable separate-phase product present, separate-phase product (light golden colored product that could be squeezed out of the recovered soil) was noted at or near the water table interface during the completion of borings/wells SB-82 and SB-84 during December 2000. However, none of the new wells installed in December 2000 have indicated the presence of measurable separate-phase product during ongoing water/product level gauging and/or groundwater sampling. In addition, no VOCs or SVOCs were detected in the groundwater samples collected from these wells in January 2001. Above the water table, black, heavier product (but capable of being squeezed from the recovered soil) was observed at SB-82 (7 to 9 ft bls) and SB-84 (5 to 9 ft bls). Finally, thick black tar-like material, that was relatively solid, was observed above the water table at SB-79 (5 to 7 ft bls), SB-80 (7 to 9 ft bls), SB-81 (17-17 ft bls), SB-82 (11 to 11.5, 15 to 17 and 18.5 to 19 ft bls) and SB-85 (5 to 7 ft bls).

Samples of separate-phase product were collected and analyzed from four wells in the ETYA (P-15, MW-3URS, LF-1S and MW-28). Appendix A presents the results of the laboratory analyses performed on these samples. The results of laboratory analyses performed on product samples from wells in the ETYA (MW-28, LF-1S, P-15 and MW-3URS) indicate that the product present is primarily comprised of diesel fuel and/or diesel range hydrocarbons. The results from MW-28 and LF-1S indicate that the separate-phase product at these locations is comprised entirely of severely biodegraded diesel fuels. The results from P-15 indicate that the product is comprised of 80 percent diesel range hydrocarbons and 20 percent gasoline range hydrocarbons. Finally, the results from MW-3URS, in which separate-phase product has not been observed since 1998, indicate that the product is comprised of 85 percent diesel range organics and 15 percent gasoline range organics.

Product recovery is ongoing at MW-28 using a solar powered product recovery pump. In addition, other wells in the ETYA are included in the Site's manual bailing and gauging program. To date (through May 2001), approximately 33 gallons of separate-phase product have been recovered from wells in the ETYA (23 gallons from manual bailing and 10 gallons from the solar powered product pump in MW-28).

3.5.1.2 Soil Quality

The samples collected during the SFI, SFI Completion and Investigation of Separate Phase Product indicate that several VOCs, SVOCs and metals exceeded NYSDEC RSCOs. In general, the results of previous investigations indicate that soil quality in the ETYA has been impacted by historical activities.

Soil samples were collected and sent for laboratory analysis from a total of 13 Geoprobe^{TM} soil boring locations along the portion of the ETYA adjacent to the Buffalo River during the Investigation of Separate-Phase Product (SB-74 through SB-86). In addition, two locations were sampled during the SFI (LF-1S and LF-2S), two locations were sampled during the SFI Completion (LF-5 and LF-7) and MW-28 was installed and sampled on October 4, 2000.

Impacts due to diesel range constituents (SVOCs and TPH-DRO) are more widespread with generally higher concentrations and concentrations of more compounds exceeding RSCOs than impacts due to gasoline constituents (VOCs and TPH-GRO). Limited impacts due to gasoline range constituents were observed within the product plume (at LF-1S) and in the west/southwest portion of the ETYA (LF-2S, SB-81 and SB-82)

Based on the results of the Site's ongoing water/product level gauging and groundwater sampling program, the extent of measurable separate-phase product is limited to the relatively small area of the ETYA south of Tank 176 shown on Plate 1. Separate-phase product has not been observed in wells to the west/southwest of MW-28.

Other potential sources of the impacts to soil to the west/southwest of the separate-phase product plume may be:

- the municipal waste disposal activities conducted by the City of Buffalo in the ETYA prior to 1951;
- the waste handling area to the west of Tank 176 (which was reportedly used for disposal of storage tank bottom material, spent cracking and reforming catalysts, oil/water separator material, slop oil solids, demolition debris, and asphalt-containing soil); and
- an area to the southwest of Tank 176 that was identified during preparation of the History Document (through aerial photo review) as a potential disposal area.

3.5.1.3 Sediment Quality

Sediment quality data collected from the area adjacent to the ETYA during previous investigations have indicated the presence of VOCs, SVOCs and metals.

The results of a Phase II investigation of the ETYA (formerly referred to as the Buffalo Terminal Disposal Site), conducted in 1985 (URS 1986), indicated that the sediment adjacent the ETYA was impacted by metals, VOCs and SVOCs. The locations of the two sediment samples collected during the Phase II investigation are shown on Plate 1. The investigation concluded that the impact to sediment could, at least in part, be attributed to non-ExxonMobil source(s). As a result of the Phase II investigation and additional sampling, the NYSDEC concluded that the Buffalo Terminal Disposal Site does not present a significant threat to human health and environment.

In addition, on a regional scale, historical sediment data was collected and evaluated by the United States Environmental Protection Agency (USEPA) during the period of 1981-1994 as part of several studies. This data indicates that the sediment both upstream and downstream from the Terminal is impacted by industrial activities. The impact upstream was demonstrated to be as great or greater than that found adjacent to the Terminal (USEPA 1984 and 1994).

The analytical results from sediment samples collected from the Buffalo River shoreline in April 2001 confirm field observations of petroleum-related impacts made during the October 2000 shoreline inspection and during the April 2001 sediment sampling program. Where odor, staining, sheen and/or separate-phase product were observed, the analytical results indicated the presence of petroleum-related constituents.

Laboratory results indicate that sediment quality in the 1,000-foot segment of Buffalo River shoreline inspected in October 2000 has been impacted by diesel range and gasoline range constituents. Impacts related to diesel fuel constituents (SVOCs and TPH-DRO) are more widespread with higher concentrations than impacts due to gasoline constituents (VOCs and TPH-GRO). This information is consistent with the analytical results of product samples collected from ETYA wells that indicate the product is primarily comprised of diesel fuel and diesel range hydrocarbons. The highest impacts from gasoline constituents were observed within the boomed areas at locations where product/iron staining and/or product seepage were observed during the October 2000 inspection of the shoreline and during the April 2001 sampling program.

The distribution of petroleum-related impacts along the shoreline is consistent with the possibility that impacts may be transported along the riverbank by the actions of currents and wind in either direction.

3.5.1.4 Groundwater Quality

Many wells in the ETYA have been sampled during the SFI, SFI completion and the quarterly groundwater sampling rounds conducted in January and April 2001. The results of the recent groundwater sampling conducted during January and April 2001 confirmed the conclusions drawn from previous investigations, that concentrations of VOCs and SVOCs in groundwater are generally low in the ETYA and that NYSDEC AWQSGs are exceeded only in localized areas (in the southwest portion of the ETYA and in the vicinity of the separate-phase product plume).

3.5.1.5 Field Observations Along the Buffalo River Bank Adjacent to the ETYA

On October 26, 2000, representatives from ExxonMobil, NYSDEC and Roux Associates inspected the Buffalo River shoreline for evidence of sheen and product seepage. Approximately 1,000 feet of shoreline was inspected, as indicated on Plate 1 (the width of the shoreline area inspected is exaggerated for clarity). Plate 1 shows the locations of sorbent booms that were installed on October 4, 2000 and are maintained daily by ExxonMobil. The following observations were made during the inspection. The locations of the items listed below shown on Plate 1.

- The area where product seepage and the greatest product/iron staining was observed along the river bank is shown within the limits of the northeastern boomed area. The product seepage was observed just above the river level on October 26, 2000 (570.76 feet msl) and the product/iron staining extended two to five feet into the river.

- Two areas where significant product/iron staining and sheen were observed and are shown within the southwestern boomed area. The product/iron staining extended several feet into the river.

- Two areas where product staining was observed within the embankment adjacent to the river are shown near the northeast boomed area. These areas were observed at an approximate elevation of 573 to 574 feet msl (approximately 2 to 3 feet above the river level on October 26, 2000).

- Three areas adjacent to the Buffalo River bank where an asphalt material was observed within the embankment are shown. The asphalt material was observed at an elevation of approximately 577 to 578 feet msl (approximately 6 to 7 feet above the river level on October 26, 2000).

- An area where an asphalt/tar-like material was observed on the ground surface is shown to the northeast of monitoring well MW-4URS.

- An area where drum remnants were observed within the embankment is shown. The drum remnants were observed at an approximate elevation of 581 to 586 feet msl (approximately 10 to 15 feet above the river level).

3.5.2 Northeast Process and Storage Area (NPSA)

The following sections present a brief summary of the data generated during prior investigations regarding soil and groundwater quality and the occurrence of separate-phase product in the NPSA.

3.5.2.1 Separate-Phase Product

Measurable separate-phase product was observed BTC-4 on July 24, 1998, but has not been observed since then. Separate-phase product has not been observed in the other two wells installed in this area (BTC-5 and BTC-6).

3.5.2.2 Soil Quality

In general, soil quality in the NPSA has been impacted by historical activities. During the SFI, six soil borings (BTC-1 thorough BTC-6) were installed around the perimeter of the former Biotreatment Cell. At each location, shallow soil (0 to 0.5 feet bls) was sampled for SVOCs, metals (including hexavalent chromium) and polychlorinated biphenyls (PCBs). One or more deeper intervals were sampled at each location for VOCs and SVOCs, metals PCBs, depending on the location).

The results of samples collected during the SFI indicated the presence of VOCs, SVOCs and metals. The samples collected during the SFI indicate that none of the RSCOs for VOCs were exceeded in the NPSA. Concentrations of several SVOCs and metals exceeded RSCOs in this area. PCBs were detected at all locations except BTC-3. Total PCBs in surface soil (0 to 0.5 feet bls) at BTC-5 exceeded the RSCO. Neither hexavalent chromium nor tetraethyl lead was detected in the NPSA.

3.5.2.3 Groundwater Quality

Three monitoring wells exist in the NPSA, in the vicinity of the former Biotreatment Cell (B-2MW, BTC-4 and BTC-5). These three wells were sampled for VOCs, SVOCs and metals (including hexavalent chromium and tetraethyl lead) during the SFI. The groundwater data collected during the SFI indicated that the concentrations of at least one metal exceeded the NYSDEC AWQSGs in each of the three monitoring wells. The data also indicated that relatively low levels of VOCs and SVOCs are present in the NPSA (i.e., concentrations for most compounds were non-detect or below AWQSGs). Hexavalent chromium, tetraethyl lead and PCBs were not detected in the NPSA.

Subsequent to the SFI, BTC-5 was sampled during quarterly sampling rounds conducted in January and April 2001 for VOCs and SVOCs. The results indicated the presence of several SVOCs exceeding NYSDEC AWQSGs and VOCs below AWQSGs.

3.5.3 Northern Tank Yard Area (NTYA)

The following sections present a brief summary of the data generated during prior investigations regarding soil and groundwater quality and the occurrence of separate-phase product in the NTYA.

3.5.3.1 Separate-Phase Product

Measurable separate-phase product has not been observed in the monitoring wells installed in the NTYA.

3.5.3.2 Soil Quality

In general, soil quality in the NTYA has been impacted by historical activities. Soil samples were collected from locations surrounding 13 former tanks (1, 19, 21, 22, 27, 31, 54, 60, 80, 89, 102, 187 and 198), all during the SFI. Samples were designated NTY-T1, NTY-T19, etc., according to the former tank number.

Composite samples from 0 to 0.5 feet bls were collected around all these tanks except Tanks 54 and Tanks 60 and analyzed for SVOCs and metals. Tetraethyl lead was analyzed in the composite samples collected at former Tanks 21 and 187. Grab samples were collected from these same locations at 1.5 to 2 feet bls and analyzed for VOCs. Finally, from these same locations, grab samples were collected from a deeper interval (varying depths) and analyzed for VOCs, SVOCs and metals. Around Tanks 54 and 60, samples were collected at two intervals (both deeper than 2 feet bls) and analyzed for VOCs, SVOCs and metals. Wherever soil was sampled for metals, analysis for hexavalent chromium was also conducted.

The SFI results indicate that several VOCs, SVOCs and metals exceeded RSCOs at various depths. Neither hexavalent chromium nor tetraethyl lead were detected in the NPSA.

3.5.3.3 Groundwater Quality

Two small diameter wells were installed during the SFI at NTY-T54 and NTY-T60. The groundwater data collected from these wells during the SFI indicated that the concentrations of at least one metal exceeded the NYSDEC AWQSGs in each of these monitoring wells. The data also indicated that relatively low levels of VOCs are present in the NTYA (i.e., concentrations for most compounds were non-detect or below AWQSGs). Several SVOCs exceeded AWQSGs at both locations. PCBs were analyzed for but not detected in the samples collected from the two wells. Several metals were detected, but none were detected at concentrations above NYSDEC AQWSGs.

3.5.4 Former Refinery Area (FRA)

The following sections present a brief summary of the data generated during prior investigations regarding soil and groundwater quality and the occurrence of separate-phase product in the FRA.

3.5.4.1 Separate-Phase Product

Separate-phase product has consistently been observed in monitoring and recovery wells located south of Prenatt Street and north of the Buffalo River (MW-4, MW-5, MW-7, MW-8, RW-4 and RW-5). The product at MW-7 has not been measured since it is too thick for the probe to pass through. MW-6 showed the presence of separate-phase product between the time of its installation in 1990 through October 1999, but not since that time. Product (0.04 feet) was also observed at SB-12 during two gauging rounds in February and March 2000, but not since that time.

Samples of separate-phase product were collected and analyzed from six wells in the FRA (MW-4, MW-5, MW-7, MW-8, RW-4 product tank, RW-5 product tank), one well in the CRPA

(MW-15). Appendix A presents the results of the laboratory analyses performed on these samples.

Product recovery is ongoing at RW-4 and RW-5 using dual-phase product recovery systems. In addition, a passive bailer was installed in MW-4 on March 30, 2001 and other wells in the FRA are included in the Site's manual bailing and gauging program. To date (through April 2001), approximately 4,517 gallons of separate-phase product have been recovered from wells in the FRA (96 gallons from manual bailing/passive bailer and 4,421 gallons from the automated product recovery systems).

3.5.4.2 Soil Quality

Soil samples were collected from locations surrounding former Tanks 23 and 100 during the SFI. One composite surface soil sample (GS-T23/100) was collected from 0 to 0.5 feet bls and analyzed for SVOCs and metals (including tetraethyl lead). Six grab samples designated GS-T23/100(1) through GS-T23/100(6) were also collected from 1.5 to 2 feet bls and analyzed for VOCs.

RSCOs for several SVOCs and metals were exceeded in the composite surface sample. In the deeper grab samples, RSCOs were exceeded for several VOCs. Tetraethyl lead was not detected.

3.5.4.3 Groundwater Quality

Groundwater samples were collected from B-1MW (near Elk Street) during the SFI and subsequent quarterly sampling rounds in January and April 2001 and analyzed for VOCs and SVOCs. Groundwater samples were collected from SB-12 (near the Buffalo River) during the SFI Completion and subsequent quarterly sampling rounds in January and April 2001 and analyzed for VOCs and SVOCs.

Several SVOCs were detected in both wells at concentrations exceeding NYSDEC AQWSGs. Several VOCs were detected at both locations, however benzene was the only VOC detected above the AWQSG at SB-12 during a sampling round conducted in August 1999.

3.5.5 Central Rail and Process Area (CRPA)

The following sections present a brief summary of the data generated during prior investigations regarding soil and groundwater quality and the occurrence of separate-phase product in the CRPA.

3.5.5.1 Separate-Phase Product

Measurable separate-phase product has been observed in MW-15 and MW-16 in the CRPA. Separate-phase product (0.01 feet) was observed in MW-16 for the first time in April 2001.

MW-15 is included in the Site's manual bailing and gauging program. To date (through April 2001), approximately 32 gallons of separate-phase product have been recovered from MW-15.

Samples of separate-phase product were collected and analyzed from MW-15. Appendix A presents the results of the laboratory analyses performed on these samples.

3.5.5.2 Soil Quality

In general, soil quality in the CRPA has been impacted by historical activities, including the burial of acid sludge north of Tank 99, as described in Section 2.4.2. Soil samples were collected at ten locations (ASA-B1 through ASA-B10) in the former Buried Acid Sludge Yard during the SFI. Samples from depths ranging from three to 16 feet bls were analyzed for SVOCs. Metals were only analyzed at ASA-B1.

The SFI results indicate that SVOC concentrations in this area ranged from very low (below RSCOs) to the highest concentrations observed during the SFI (exceeding RSCOs). Locations sampled within the CRPA north of Tank 99 near the CRPA/STYA border exhibited the highest total SVOC concentrations. Several metals were detected above RSCOs at ASA-B1.

3.5.5.3 Groundwater Quality

Groundwater samples were collected from four wells (MW-9, MW-13, MW-16 and MW-17) in the CRPA during the SFI and subsequent quarterly sampling rounds in January and April 2001 and analyzed for VOCs and SVOCs.

VOCs were detected at all locations during the three sampling rounds. Several VOCs exceeded AWQSGs at all locations except MW-17. SVOCs were detected at all locations except MW-13. Several SVOCs were detected at MW-9 and MW-16, but only naphthalene exceeded the AWQSG at MW-16. At MW-17 fluorine was the only SVOC detected (below the AWQSG).

3.5.6 Southern Tank Yard Area (STYA)

The following sections present a brief summary of the data generated during prior investigations regarding soil and groundwater quality and the occurrence of separate-phase product in the STYA.

3.5.6.1 Separate-Phase Product

- The majority of the STYA is underlain by separate phase product. Samples of separate-phase product were collected and analyzed from 13 wells in the STYA (ESI-1, ESI-2, ESI-5, MW-10, MW-11, MW-12, MW-14, MW-18, MW-19, MW-20, RW-3 product tank, RW-4 product tank and RW-5 product tank. Appendix A presents the results of the laboratory analyses performed on these samples.

Product recovery efforts in this area are ongoing and include:

- automated product recovery at RW-1, RW-2 and RW-3 using dual-phase recovery systems;
- manual bailing and gauging of selected wells; and
- recovery using passive bailers in MW-18 and MW-20.

To date (through April 2001), approximately 24,475 gallons of separate-phase product have been recovered from wells in the STYA (185 gallons from manual bailing/passive bailer and 27,290 gallons from the automated product recovery systems).

3.5.6.2 Soil Quality

In general, soil quality in the STYA has been impacted by historical activities. Soil samples were collected from locations surrounding 16 former tanks (18, 20, 25, 26, 38, 42, 75, 86, 88, 96, 97, 98, 99, 171, 197 and 198), all during the SFI. Samples were designated GS-T18, GS-T20, etc., according to the former tank number.

Depending upon the location, composite samples or grab samples were collected at the surface (0 to 0.5 feet bls) and analyzed for SVOCs, metals and tetraethyl lead. In addition, at one or more locations surrounding each tank, a grab sample was collected and analyzed for VOCs.

The SFI results indicate that concentrations at one or more locations exceeded the RSCO for all VOCs analyzed, with the exception of MTBE. SVOC concentrations exceeded RSCOs in many locations. SVOCs were detected throughout the STYA; however, samples collected adjacent to Tank 99, in close proximity to the buried acid sludge trench, exhibited the highest concentrations of individual SVOCs.

Metals concentrations detected in the STYA exceeded RSCOs for several analytes at one or more location.

3.5.6.3 Groundwater Quality

Groundwater samples were collected from three wells (ESI-3, ESI-4 and MW-21) in the CRPA during the SFI and analyzed for VOCs and SVOCs. During subsequent quarterly sampling rounds in January and April 2001 ESI-4 and MW-21 were sampled for VOCs and SVOCs. ESI-3 was sampled in January 2001 but not in April 2001 due to the presence of separate-phase product.

Several VOCs were detected at all three locations and AWQSGs were exceeded at ESI-3 and ESI-4 for several analytes. Several SVOCs exceeded AQWSGs at ESI-3 and ESI-4, however, SVOCs were not detected at MW-21.

3.5.7 Administrative Offices and Operations Area (AOOA)

The following sections present a brief summary of the data generated during prior investigations regarding soil and groundwater quality and the occurrence of separate-phase product in the AOOA.

3.5.7.1 Separate-Phase Product

Measurable separate-phase product has not been observed in the monitoring well (B-5MW(RR) installed in the AOOA.

3.5.7.2 Soil Quality

None of the investigations completed previously included soil sampling.

3.5.7.3 Groundwater Quality

Groundwater samples were collected from B-5MW(RR), the only well in the AOOA during the SFI and the quarterly sampling rounds in January and April 2001. The samples were analyzed for VOCs and SVOCs. SVOCs have not been detected in this well. Several VOCs have been detected above NYSDEC AWQSGs during all three sampling rounds.

4.0 DATA REQUIREMENTS FOR COMPLETION OF ASSESSMENT

This section identifies the data necessary to complete the characterization of environmental conditions in the ETYA, NPSA, NTYA, FRA, CRPA, STYA, and AOOA. The assessment items include areas of known and suspected environmental impact, areas associated with former refinery operations and/or terminal operations, buildings or structures and areas associated with former storage tank locations. The rationale for selecting portions of these areas to be included in this investigation include the lack of previous investigations and the need for additional data to complete the characterization of these areas of the Site. In many parts of the Site, several structures and/or tanks have occupied the same location (Plate 1). The rationale for sample location selection presented below list some of the structures that have potentially impacted environmental conditions in each area of the Site. Not every structure that may have existed in each geographic area of the Site is listed below.

4.1 Eastern Tank Yard Area (ETYA)

The following areas of the ETYA have not been previously investigated to characterize the soil and groundwater quality and separate-phase product (if present):

- Waste handling areas located in the southeast portion of the ETYA;
- Portions of the ETYA within and surrounding the lined containment areas for Tanks 175 and 176 that may have separate-phase product present and/or that were used by ExxonMobil (waste handling areas) and/or the City of Buffalo for disposal activities;
- Area of tar/asphalt-like material observed at the surface east of MW-4URS; and
- Area to the southwest of the tank containment areas that was identified through aerial photograph review as a potential disposal area.

4.2 Northeast Process and Storage Area (NPSA)

The following areas of the NPSA have not been previously investigated to characterize the soil and groundwater quality and separate-phase product (if present):

- Former paraffin and wax refining structures and tanks present in the northwest portion of the NPSA including the former Engine House/Press Rooms, Chilling Rooms, Sweaters Structures, Pan House and Wax House;
- The eastern perimeter of the Site;
- Former tanks located south of the Police Community Services building;

- The entire area shown on Plate 1 that was designated as a waste handling area, including beneath the former Biotreatment Cell;
- Former In-Ground Oil Water Separator located within the footprint of the former Biotreatment Cell;
- Former refinery structures located south of the former Biotreatment Cell, including former Pressed Distillate Units and associated structures; and
- Former tanks located in the northeast portion of the NPSA.

The perimeter of the former Biotreatment Cell was investigated previously, but area beneath the former structure requires additional soil/groundwater sampling work and separate-phase product delineation This area is now accessible since the Biotreatment Cell material was removed in February/March 2000.

4.3 Northern Tank Yard Area (NTYA)

The following areas of the NTYA have not been previously investigated to characterize the soil and groundwater quality and separate-phase product (if present):

- Former tanks located throughout the NPSA that were not investigated during the SFI or that require additional investigation (several of the tanks located in the NTYA were investigated during the SFI, however, the maps of the Site on which the SFI sample locations were based did not show many of the tanks that had been present throughout the Site's history);
- Former Pulp Oil Building located in the northeast portion of the NPSA and area where tar-like material was observed near former Tank 22; and
- Former Yard Trap (oil/water separator) located between former Tanks 21 and 22.

4.4 Former Refinery Area (FRA)

The majority of the FRA has not been investigated previously. Only the portion of the FRA surrounding the Main In-Ground Oil/Water Separator, where several recovery and monitoring wells exist, has been investigated. The areas of the FRA that require investigation to characterize the soil and groundwater quality and separate-phase product (if present) include tanks and former refinery structures. The following is a partial list of former refinery structures and tanks that may have impacted environmental conditions in the FRA:

- Former tanks are located throughout the FRA;

- Former loading racks located near the northwest portion of the FRA;
- Former loading rack located along the eastern portion of the FRA at the FRA/NTYA border;
- Former Pressure Stills and Coal Sheds, Cooler, Receiving House, Pipe Stills/Condensers located toward the northern portion of the FRA;
- The former Houdry Unit/Crude unit, condensers, Tower Stills and Coal Sheds, Vacuum Heater, Auxiliary Heater, Condensers and Receiving House and Tar Cooler located in the center of the portion of the FRA north of Prenatt Street;
- Former Coal Sheds, Tar Stills and Tar Box located south of Tank 60;
- Former Coal and Crude Oil Shed/Condenser Structure;
- Former Sovaformer Area and associated structures located just north of Prenatt Street;
- Former Catalytic Polymerization Area and associated structures/tanks located in the western portion of the FRA between Prenatt Street and Elk Street;
- Former Loading Racks located at the southwest corner of the Sovaformer Area;
- Former Tar Loading Rack that straddles between the FRA and CRPA just north of Prenatt Street and the former railroad tracks;
- Former laboratory located north of Prenatt Street;
- Several former Loading Racks located near the FRA/BSPA border south of Prenatt Street and the former railroad tracks;
- Former Rail Car Loading Rack that straddles between the FRA and BSPA south along the western border of the FRA;
- Former Asphalt Loading Area/Heater (where releases have been reported), Boiler House and Pump House located south of Prenatt Street;
- Former Acid Shed located northeast of the Remediation Building;
- Former In-Ground Oil/Water Separator located to the north of the Lift Station;
- Former Dissolved Air Flotation Unit (waste handling area) located north of the former Main In-Ground Oil/Water Separator;
- The compartments of the former Main In-Ground Oil/Water Separator (waste handling area) that were filled and abandoned in-place and three compartments that are currently filled with water/solids; and
- The area surrounding the Main In-Ground Oil/Water Separator.

4.5 Central Rail and Process Area (CRPA)

The majority of the CRPA has not been previously investigated, aside from the Acid Sludge Trench located north of Tank 99 that was investigated during the SFI. Several monitoring wells are also located throughout the area. The following areas of the CRPA have not been previously investigated to characterize the soil and groundwater quality and separate-phase product (if present):

- Former tanks located throughout the area;
- Former Tar Loading Rack that straddles between the CRPA and FRA north of Prenatt Street and former railroad tracks;
- Former Ethyl Plant located east of the former Safety Building;
- Former Treating, Blending and Shipping Area and associated structures located in the central portion of the CRPA south of Prenatt Street and the former railroad tracks;
- Former Filling Racks located in the area of the former Treating, Blending and Shipping Area;
- Former Filling Rack located south of Prenatt Street within the former railroad tracks and in the location of the existing parking/access area for the active Tank Truck Loading Rack;
- Active Tank Truck Loading Rack located in the northeast portion of the CRPA;
- Former Paint shed located within the former rail road tracks;
- Caustic Storage Area located to the east of the Treating, Blending and Shipping Area;
- Former acid sludge trench located north of Tank 99 which was not previously investigated for VOCs;
- Former Alkylation Area, associated structures and waste handling areas located in the southern portion of the CRPA; and
- Former Deflorez Cracking/Cross Cracking Unit and associated structures located east of the Alkylation Area.

4.6 Southern Tank Yard Area (STYA)

The majority of the STYA has been investigated previously, however several former tanks and structures have not been investigated. The following areas of the STYA have not been previously investigated to characterize the soil and groundwater quality and separate-phase product (if present):

- Former tanks and waste handling areas located along the western border of the STYA;
- Acid Treating/Clay Contacting Area, Pump Pad and former tanks located near the northwest CRPA/STYA border;
- Former Crude Scale House located east of Tank 97;
- Between Tanks 25 and 26;
- Beneath active tank lined containment areas for Tanks 99, 87, 104 and 75; and
- Former Tank 103 south of the former Car Shop that was not investigated during the SFI.

4.7 Administrative Offices and Operations Area (AOOA)

The majority of the AOOA is currently and has historically been occupied by offices, maintenance buildings, storehouses and a laboratory. The majority of this area has not been investigated (only one well exists in this area and no soil borings have been installed). The following areas of the AOOA have not been previously investigated to characterize the soil and groundwater quality and separate-phase product (if present):

- Former tanks in the northwest portion of the AOOA;
- Near existing wash bays on the east side of the Main Office Building;
- Southwest of the Storehouse; and
- The former tank that was located where the former laboratory building currently exists.

5.0 SCOPE OF WORK

The scope of work is designed to develop necessary information to complete the assessment of the soil and groundwater quality and the extent of separate-phase product in the ETYA, NPSA, NTYA, FRA, CRPA, STYA, and AOOA. In addition, the scope of work will develop additional data necessary to assist ExxonMobil in evaluating and implementing remedial action alternatives in these areas. The scope of work is divided into the following tasks:

- Task 1: Pre-surveying of Sample Locations and Field Locating of Former Underground Oil/Water Separator Structures;
- Task 2: Measurement and Sampling of Solids within Main In-Ground Oil/Water Separator;
- Task 3: Geoprobe^{TM} Soil and Groundwater Sampling program;
- Task 4: Monitoring Well Installation; and
- Task 5: Water-Level and Separate-phase Product Gauging and Groundwater Sampling.

The proposed scope of work is intended to be flexible and dynamic to respond to field conditions as they are encountered. For example, if additional delineation efforts are necessary based upon the field conditions encountered, the Work Plan will be amended accordingly, and additional field work will be performed immediately. This approach will streamline delineation efforts.

Any amendments to the Work Plan will be communicated to NYSDEC and recorded in a field change memorandum. All field change memorandums will be provided as an attachment to the investigation report.

The specific elements of each task are described below. The rationale for selecting the proposed sampling locations for each task is presented in Table 3.

The environmental media to be sampled during the implementation of the Work Plan are soil and groundwater. The projected number of field samples, the sample types and analytical parameters to be analyzed for each task are presented in Table 4. Soil and groundwater samples collected during the course of the field investigation outlined in this work plan will be analyzed in accordance with specified SW-846 methods for organic and inorganic parameters. Procedures for performance of field tasks and documenting field activities are included in Appendices C through F. All field tasks will be performed in accordance with the site-specific Health and Safety Plan (HASP).

5.1 Task 1: Pre-surveying of Sample Locations and Field Location of Former Oil/Water Separator Structures

The horizontal and vertical locations of sample points will be surveyed prior to installation where the placement of the location to be sampled is intended to be on or immediately adjacent to the location of former structures or tanks, or in open areas of the site where accurate placement would be difficult. Pre-surveying is important for locations in which the structures are no longer available to be used as a landmark. The horizontal coordinates of the selected sampling locations will be obtained from the surveyed base map of the Site (Plate 1) and provided in the New York State Plane Coordinate System by a surveyor licensed in the State of New York. Horizontal coordinates will be accurate to ±0.1 feet and vertical coordinates will be accurate to ±0.01 feet.

Samples are proposed to be collected within the Main In-Ground Oil/Water Separator and three other former oil/water separator structures (one in the NPSA, one in the NTYA and one in the FRA). The abandoned compartments of the Main In-Ground Oil/Water Separator are expected to be easily located, since three compartments of the structure are still visible and since engineering drawings for the separator are available.

However, the other three separators may not be as easy to locate. Therefore, it will be important to identify whether these structures are still in place to allow for accurate placement of the proposed borings. To accomplish this, the locations of the corners of the former structures will be surveyed using coordinates obtained from the surveyed base map of the Site. Once the locations are surveyed, the areas where the sidewalls of the structures are expected to be encountered will be excavated (this has already been completed for the separator in the NTYA). The final location of the soil borings will be selected following the field location activities. If the structures could not be located, the boring will be installed in the location shown on Plate 1.

5.2 Task 2: Measurement and Sampling of Solids in Main In-Ground Oil/Water Separator

The three northernmost compartments of the Main In-Ground Oil/Water Separator are currently filled with water. Inspections of the chambers indicate that product sheen is often observed on the water.

Measurement of Solids

The thickness of solids present at four locations within each of the three northernmost compartments will be measured. This will be used to estimate the quantity of solids requiring removal.

Sampling of Solids

One composite sample of the solids present will be collected from each of the three northernmost compartments of the separator. Samples will be designated "MAINOWS-1,2 and 3". The composite samples will be comprised of solids collected from four locations within each compartment. Each composite sample will be analyzed for the following for waste characterization purposes:

- VOCs and SVOCs according to USEPA methods SW846 8021 and 8270 for NYSDEC STARS list compounds, respectively;
- total petroleum hydrocarbons (TPH) for gasoline and diesel range organics (broken down into two ranges, C10 to C18 and above C18) by methods SW-846 8015B;
- reduced target analyte list (TAL) metals by method SW846 6010 (includes cadmium, chromium, lead, nickel, selenium, thallium and vanadium) and method SW-846 7470/7471 for mercury;
- the full suite of toxicity characteristics leaching procedure (TCLP) analyses;
- corrosivity;
- reactivity; and
- ignitability.

5.3 Task 3: Geoprobe^{TM} Soil and Groundwater Sampling program

A Geoprobe^{TM} soil and groundwater sampling program will be performed to expand upon the data collected during previous investigations in the ETYA, NPSA, NTYA, FRA, CRPA, STYA, and AOOA. A total of 106 soil borings (SB-87 through SB-192) are proposed in the locations presented on Plate 1. Groundwater will be sampled from 29 borings shown on Plate 1 using the Geoprobe^{TM}.

The objective of the Geoprobe^{TM} sampling program is to collect soil and groundwater samples (at selected locations) for analysis to delineate the nature and extent of petroleum-related impacts and identify the presence of separate-phase product. The results of the Geoprobe^{TM} sampling program will be used to select locations for the installation of groundwater monitoring wells, if necessary.

All soil samples will be collected using Geoprobe^{TM} sampling equipment. In accordance with ExxonMobil ground disturbance protocols, boring locations will be cleared from land surface to 5 feet bls using an ExxonMobil approved method (i.e., hand auger, air-knife, etc.). Soil samples will be collected continuously from 5 feet below ground surface to 5 feet below the water table or to a minimum of seven feet below grade if the water table is encountered less than two feet below ground surface. If significant impacts are observed at the completion depth, the borings should continue with samples collected at five foot intervals to define the vertical extent of impact.

The supervising technical staff will inspect all soil samples and record all applicable lithologic characteristics. In addition, all soil samples will be visually inspected for evidence of separate-phase product (i.e., separate-phase product sheen, odors, staining, etc.) and screened for organic vapors with a photoionization detector (PID).

Soil borings with Geoprobe^{TM} equipment will be conducted with van or truck mounted probing equipment, to the extent possible (i.e., in certain areas, hand-held Geoprobe^{TM} tools may need to be used due to access constraints). The vehicle will be positioned over the selected boring location and a 2 feet or 4 feet long drive point sampler containing an acetate liner will be attached to steel rods and driven to the desired sample depth. The drive point sampler remains closed while it is being driven to the sampling depth. The sampler is opened by releasing the stop pin from the surface, and the sampler is driven 2 feet into the material to be sampled.

Releasing the stop pin allows a piston to retract inside of the sampling tube while it is displaced by the soil core. The soil core is contained within the acetate liner in the sampler. The drive point sampler is removed from the ground by retracting the steel rods. The acetate liner, with the intact soil sample, is then removed from the drive point sampler. Management of any wastes generated during the implementation of this task is discussed in Section 6.

To collect groundwater samples using the Geoprobe™, a sampler with a screened head is advanced, and the sample is extracted through a sampling tube. At least three volumes of water will be drawn through the sampling tube prior to collecting the sample for laboratory analysis.

Any Geoprobe™ boring locations that were moved from their proposed locations will be surveyed for horizontal and vertical coordinates relative to the New York State Plane Coordinate System by a surveyor licensed in the State of New York after completion. Horizontal coordinates will be accurate to ±0.1 feet and vertical coordinates will be accurate to ±0.01 feet.

The number and type of samples to be collected and parameters to be analyzed for in each of the geographic areas of the Site are discussed in the following sections.

5.3.1 Eastern Tank Yard Area (ETYA)

A total of 12 soil borings (SB-87 through SB-98) are proposed in the locations presented on Plate 1 in the ETYA. Groundwater will be sampled from four borings (SB-90, 91, 96 and 98) shown on Plate 1 using the Geoprobe™. Two soil samples will be retained for laboratory analysis from each boring. One will be collected from the 0 to 0.5 feet interval and a second at the zone where the greatest PID reading and/or petroleum-related impacts (i.e., staining, sheen, odor) are observed. If no PID readings are observed, the second sample will be collected from the soil/water interface.

Soil samples retained for laboratory analysis from selected intervals and groundwater samples from selected Geoprobe™ locations will be analyzed for the following:

- VOCs and SVOCs according to USEPA methods SW846 8021 and 8270 for NYSDEC STARS list compounds, respectively; and

- reduced target analyte list (TAL) metals by method SW846 6010 (includes cadmium, chromium, lead, nickel, selenium, thallium and vanadium) and method SW-846 7470/7471 for mercury.

Soil samples will also be analyzed for:

- total petroleum hydrocarbons (TPH) for gasoline and diesel range organics (broken down into two ranges, C10 to C18 and above C18) by methods SW-846 8015B.

5.3.2 Northeast Process and Storage Area (NPSA)

A total of 15 soil borings (SB-99 through SB-113) are proposed in the locations presented on Plate 1 in the NPSA. Groundwater will be sampled from six borings (SB-99, 104, 105, 109, 110 and 113) shown on Plate 1 using the Geoprobe^{TM}. Within the former oil/water separator located within the footprint of the former Biotreatment Cell, borings will be completed to the bottom of the structure (if one still exists). Geoprobe^{TM} refusal will be used as the method to confirm the presence of the concrete bottom and verify the depth to the bottom.

Two soil samples will be retained for laboratory analysis from each boring. One will be collected from the 0 to 0.5 feet interval and a second at the zone where the greatest PID reading and/or petroleum-related impacts (i.e., staining, sheen, odor) are observed. If no PID readings are observed, the second sample will be collected from the soil/water interface.

Soil samples retained for laboratory analysis from selected intervals and groundwater samples from selected Geoprobe^{TM} locations will be analyzed for the following:

- VOCs and SVOCs according to USEPA methods SW846 8021 and 8270 for NYSDEC STARS list compounds, respectively; and
- reduced target analyte list (TAL) metals by method SW846 6010 (includes cadmium, chromium, lead, nickel, selenium, thallium and vanadium) and method SW-846 7470/7471 for mercury.

Soil samples will also be analyzed for:

- total petroleum hydrocarbons (TPH) for gasoline and diesel range organics (broken down into two ranges, C10 to C18 and above C18) by methods SW-846 8015B.

In addition, shallow soil samples and groundwater samples from the eight borings (SB-105 through 109 and SB-111 through 113) located within the waste handling area identified on

Plate 1, in which transformers were reportedly disposed, will also be sampled for PCBs by method SW-846-8081. Deep soil samples will not be analyzed for PCBs.

5.3.3 Northern Tank Yard Area (NTYA)

A total of 13 soil borings (SB-114 through SB-126) are proposed in the locations presented on Plate 1 in the NTYA. Groundwater will be sampled from three borings (SB-116, 119, and 125) shown on Plate 1 using the Geoprobe^{TM}. Within the former oil/water separator located between Tanks 21 and 22, borings will be completed to the bottom of the structure (if one still exists). Geoprobe^{TM} refusal will be used as the method to confirm the presence of the concrete bottom and verify the depth to the bottom.

Two soil samples will be retained for laboratory analysis from each boring. One will be collected from the 0 to 0.5 feet interval and a second at the zone where the greatest PID reading and/or petroleum-related impacts (i.e., staining, sheen, odor) are observed. If no PID readings are observed, the second sample will be collected from the soil/water interface.

Soil samples retained for laboratory analysis from selected intervals and groundwater samples from selected Geoprobe^{TM} locations will be analyzed for the following:

- VOCs and SVOCs according to USEPA methods SW846 8021 and 8270 for NYSDEC STARS list compounds, respectively; and
- reduced target analyte list (TAL) metals by method SW846 6010 (includes cadmium, chromium, lead, nickel, selenium, thallium and vanadium) and method SW-846 7470/7471 for mercury.

Soil samples were also analyzed for:

- total petroleum hydrocarbons (TPH) for gasoline and diesel range organics (broken down into two ranges, C10 to C18 and above C18) by methods SW-846 8015B.

5.3.4 Former Refinery Area (FRA)

A total of 29 soil borings (SB-127 through SB-155) are proposed in the locations presented on Plate 1 in the FRA. Groundwater will be sampled from nine borings (SB-127, 128, 131, 136, 138, 147, 148, 149 and 151) shown on Plate 1 using the Geoprobe^{TM}. Within three of the abandoned compartments (compartments 4, 6 and 8, from north to south) of the Main In-Ground

Oil/Water Separator and the former oil/water separator located to the north of the Lift Station, borings will be completed to the bottom of the structure (if one still exists). Geoprobe^{TM} refusal will be used as the method to confirm the presence of the concrete bottom and verify the depth to the bottom.

Two soil samples will be retained for laboratory analysis from each boring. One will be collected from the 0 to 0.5 feet interval and a second at the zone where the greatest PID reading and/or petroleum-related impacts (i.e., staining, sheen, odor) are observed. If no PID readings are observed, the second sample will be collected from the soil/water interface.

Soil samples retained for laboratory analysis from selected intervals and groundwater samples from selected Geoprobe^{TM} locations will be analyzed for the following:

- VOCs and SVOCs according to USEPA methods SW846 8021 and 8270 for NYSDEC STARS list compounds, respectively; and
- reduced target analyte list (TAL) metals by method SW846 6010 (includes cadmium, chromium, lead, nickel, selenium, thallium and vanadium) and method SW-846 7470/7471 for mercury.

Soil samples will also be analyzed for:

- total petroleum hydrocarbons (TPH) for gasoline and diesel range organics (broken down into two ranges, C10 to C18 and above C18) by methods SW-846 8015B.

5.3.5 Central Rail and Process Area (CRPA)

A total of 18 soil borings (SB-156 through SB-173) are proposed in the locations presented on Plate 1 in the CRPA. Groundwater will be sampled from three borings (SB-164, 166 and 172) shown on Plate 1 using the Geoprobe^{TM}.

Two soil samples will be retained for laboratory analysis from each boring. One will be collected from the 0 to 0.5 feet interval and a second at the zone where the greatest PID reading and/or petroleum-related impacts (i.e., staining, sheen, odor) are observed. If no PID readings are observed, the second sample will be collected from the soil/water interface.

Soil samples retained for laboratory analysis from selected intervals and groundwater samples from selected Geoprobe^{TM} locations will be analyzed for the following:

- VOCs and SVOCs according to USEPA methods SW846 8021 and 8270 for NYSDEC STARS list compounds, respectively;
- At SB-165 samples will only be analyzed for VOCs; and
- reduced target analyte list (TAL) metals by method SW846 6010 (includes cadmium, chromium, lead, nickel, selenium, thallium and vanadium) and method SW-846 7470/7471 for mercury.

Soil samples will also be analyzed for:

- total petroleum hydrocarbons (TPH) for gasoline and diesel range organics (broken down into two ranges, C10 to C18 and above C18) by methods SW-846 8015B.

5.3.6 Southern Tank Yard Area (STYA)

A total of 15 soil borings (SB-174 through SB-188) are proposed in the locations presented on Plate 1 in the STYA. Groundwater will be sampled from two borings (SB-175 and 181) shown on Plate 1 using the Geoprobe^{TM}.

Two soil samples will be retained for laboratory analysis from each boring. One will be collected from the 0 to 0.5 feet interval and a second at the zone where the greatest PID reading and/or petroleum-related impacts (i.e., staining, sheen, odor) are observed. If no PID readings are observed, the second sample will be collected from the soil/water interface.

Soil samples retained for laboratory analysis from selected intervals and groundwater samples from selected Geoprobe^{TM} locations will be analyzed for the following:

- VOCs and SVOCs according to USEPA methods SW846 8021 and 8270 for NYSDEC STARS list compounds, respectively; and
- reduced target analyte list (TAL) metals by method SW846 6010 (includes cadmium, chromium, lead, nickel, selenium, thallium and vanadium) and method SW-846 7470/7471 for mercury.

Soil samples will also be analyzed for:

- total petroleum hydrocarbons (TPH) for gasoline and diesel range organics (broken down into two ranges, C10 to C18 and above C18) by methods SW-846 8015B.

5.3.7 Administrative Offices and Operations Area (AOOA)

A total of four soil borings (SB-189 through 192) are proposed in the locations presented on Plate 1 in the AOOA. Groundwater will be sampled from two borings (SB-190 and 192) shown on Plate 1 using the Geoprobe^{TM}.

Two soil samples will be retained for laboratory analysis from each boring. One will be collected from the 0 to 0.5 feet interval and a second at the zone where the greatest PID reading and/or petroleum-related impacts (i.e., staining, sheen, odor) are observed. If no PID readings are observed, the second sample will be collected from the soil/water interface.

Soil samples retained for laboratory analysis from selected intervals and groundwater samples from selected Geoprobe^{TM} locations will be analyzed for the following:

- VOCs and SVOCs according to USEPA methods SW-846 8021 and 8270 for NYSDEC STARS list compounds, respectively; and
- reduced target analyte list (TAL) metals by method SW-846 6010 (includes cadmium, chromium, lead, nickel, selenium, thallium and vanadium) and method SW-846 7470/7471 for mercury.

Soil samples will also be analyzed for:

- total petroleum hydrocarbons (TPH) for gasoline and diesel range organics (broken down into two ranges, C10 to C18 and above C18) by methods SW-846 8015B.

5.4 Task 4: Monitoring Well Installation/Abandonment

The results of the Geoprobe^{TM} soil and groundwater sampling will be evaluated to determine if additional monitoring wells are needed to monitor for the presence of separate-phase product.

In addition, several existing wells in the FRA and STYA will be replaced and/or abandoned for the following reasons:

- MW-4 and MW-8 in the FRA and MW-11 and ESI-5 in the STYA will be replaced and the existing wells will be abandoned since the screened interval at each of these locations is inappropriate for monitoring for the presence of separate-phase product. The water/product table interface is often above the elevation of the top of the screen at these locations.
- MW-7 in the FRA will be replaced and the existing well abandoned in order to delineate the extent of separate phase product in this area. The thickness of product at MW-7 cannot be measured since it is too thick for the probe to pass through.
- MW-19 will be abandoned since the screened interval is inappropriate for monitoring separate-phase product, but will not be replaced since this well is in close proximity existing wells (MW-14 and RW-2) that will provide adequate coverage for monitoring this area.

Hydrographs presented in Appendix B show the screened interval relative to the product/water table elevation for these and other wells across the site.

ExxonMobil requests a variance to abandon existing wells MW-4 (FRA), MW-8 (FRA), MW-7 (FRA), MW-11 (STYA), MW-19 (STYA) and ESI-5 (SYTA) using the procedures outlined below in lieu of the procedures presented in the NYSDEC guidance document entitled "Groundwater Monitoring Well Decommissioning Procedures" dated October 1996. ExxonMobil proposes to use the following procedures to abandon these wells:

- Grouting the well casing to within two feet of the land surface;
- Cutting and removing the casing at two feet below land surface; and
- Restoring the borehole to the original land surface using material similar to the existing material surrounding the borehole.

Wells MW-4 and MW-8 will be replaced with new wells MW-29 and MW-30, respectively, in locations immediately adjacent to the existing wells (see Plate 1).

Well MW-7 will be replaced with well MW-31 to be located approximate 20 feet to the east of MW-7 in order to delineate the extent of the separate-phase product that has been observed at MW-7 and to monitor drawdown due to the eastern leg of the WPS.

Well MW-11 will be replaced with well MW-32, in a location approximately 50 feet north of MW-11. This new location is closer to the heart of the plume and therefore may be more appropriate for monitoring and recovering separate-phase product.

ESI-5 will be replaced by MW-33 in a location approximately 20 feet to the north of ESI-5. This new location is closer to the heart of the plume and therefore may be more appropriate for monitoring and recovering separate-phase product. The water table elevation monitored at ESI-5 has consistently been higher than expected given its location near the southern boundary of the Site and its proximity to the well point system. The installation of this new well will confirm whether there is an unexpectedly high water table in this area or if there was a problem with the well.

The pilot borehole for each well will be drilled with a hollow-stem auger rig using 6.25-inch diameter augers. Boreholes will be advanced to the depths outlined below. Soil samples will be collected continuously from 5 feet below grade to the bottom of the boring. In accordance with ExxonMobil ground disturbance protocols, the 0 to 5 foot interval will be cleared using an ExxonMobil approved sampling method (i.e., hand auger, air-knife, etc.). The supervising technical staff will inspect all soil samples and record all applicable lithologic characteristics. In addition, all soil samples will be visually inspected for evidence of separate-phase product (i.e., separate-phase product sheen, odors, staining, etc.) and screened for organic vapors with a PID. Soil samples will only be sent for laboratory analysis during the installation of wells MW-29 and MW-30.

Two soil samples will be retained for laboratory analysis from the pilot borings for MW-29 and MW-30. One will be collected from the 0 to 0.5 feet interval and a second at the zone where the greatest PID reading and/or petroleum-related impacts (i.e., staining, sheen, odor) are observed. If no PID readings are observed, the second sample will be collected from the soil/water interface.

Soil samples retained for laboratory analysis from selected intervals will be analyzed for the following:

- VOCs and SVOCs according to USEPA methods SW846 8021 and 8270 for NYSDEC STARS list compounds, respectively;
- total petroleum hydrocarbons (TPH) for gasoline and diesel range organics (broken down into two ranges, C10 to C18 and above C18) by methods SW-846 8015B; and
- reduced target analyte list (TAL) metals by method SW846 6010 (includes cadmium, chromium, lead, nickel, selenium, thallium and vanadium) and method SW-846 7470/7471 for mercury.

Each monitoring well will be constructed of 4-inch diameter, schedule 40, flush-joint internally-threaded, polyvinyl chloride (PVC) casing and the length of 20-slot PVC screen specified on Table 5. Glue will not be used to join the casing and screen lengths. The screen annulus of each monitoring well will be gravel packed to approximately 2 feet above the top of the screen at MW-31, and 1 foot above the screen at locations where field conditions necessitate a shorter gravel pack (i.e., at locations where the screen is set 2 feet below grade). The additional 1-2 feet of gravel pack is to account for any settlement that may occur during well development. A 2 foot thick bentonite pellet seal will be placed on top of the gravel pack at MW-31. A 6-inch thick bentonite pellet seal will be placed on top of the gravel pack at locations where the screen is set 2 feet below grade.

The remainder of the annulus will be grouted within 2 feet of land surface and finished with a concrete cap. The concrete cap will be sloped to divert precipitation away from the well. Each monitoring will well be finished either approximately 2 feet above grade and fitted with a 5 foot steel casing (except where field conditions necessitate the use of a shorter casing), or finished flush with ground surface and fitted with and 8-inch diameter steel curb box.

The wells should be installed to an approximate depths shown on Table 5, which are based upon previous water/product level data collected for the existing wells, and taking into account the influence of the well point system (WPS) and the dual-phase recovery wells on the water/product table elevation the portion of the Site south of Prenatt Street. The screened interval is intended to provide excess screen above the highest and below the lowest water/product table elevations observed, where possible. However, at several locations (MW-4, MW-8 and MW-11) product has been observed close to land surface. This will allow for natural and pumping-influenced fluctuations of the water table.

Following installation, each well will be developed to ensure hydraulic connection with the surrounding aquifer. The wells will be developed by pumping until each monitoring well produces sediment-clear water, to the extent possible, and a good hydraulic connection is established between the well screen and the aquifer. Management of any wastes generated during the implementation of this task is discussed in Section 6.

Each well will be surveyed for horizontal and vertical coordinates relative to the New York State Plane Coordinate System by a surveyor licensed in the State of New York after completion. Both ground surface and top of casing (i.e., measuring point) elevations will be determined for each well. Horizontal coordinates will be accurate to ±0.1 feet and vertical coordinates will be accurate to ±0.01 feet.

5.5 Task 5: Water-Level and Separate-phase Product Gauging and Groundwater Sampling

Once all proposed monitoring wells have been installed and developed, the water level and separate-phase product thickness (if present) will be gauged in each new and existing monitoring well on the Site during the scheduled quarterly comprehensive gauging round. Wells found to contain separate-phase product will be gauged and bailed more frequently and evaluated for inclusion in the Site-wide product removal program. An electronic product-water interface probe will be used to measure the water level, detect separate-phase product and to determine its thickness. Product-thickness measurements will be accurate to ±0.01 feet. Water-level elevations will be corrected for the presence of separate-phase product. These water-level data will be used to construct groundwater flow maps.

Groundwater samples will be collected during one of the Site's quarterly groundwater sampling rounds from all new wells that do not contain free product. The samples will be analyzed for VOCs and SVOCs according to USEPA methods SW846 8021 and 8270 for NYSDEC STARS list compounds, respectively.

6.0 FIELD ACTIVITIES, SAMPLING AND SAMPLE CUSTODY PROCEDURES

The following sections describe the standard protocols to be used by the field personnel during the course of sampling activities. Roux Associates' Standard Operating Procedures (SOPs) included in Appendix C, procedures for logging geologic borings and preparing geologic and well logs are presented in Appendix D, field forms are included in Appendix E and Lancaster Laboratories sample packaging and shipping requirements are included in Appendix F.

6.1 Field Management

The overall management structure for field activities and general discussions of the responsibilities of management and the field technical staff are provided.

Project Manager

The Project Manager (PM) bears the primary responsibility for the successful completion of the work assignment within the budget and schedule. The PM provides overall management for the execution of the investigation. The PM directs the activities of the technical staff and subcontractors such as drillers and surveyors; performs technical review of all field activities, data review and interpretation; and the preparation of all investigation reports. The PM works closely with the analytical laboratory, drillers, and surveyors during the execution of the field program. Activities of the Project Manager are supported by senior management and support staff.

Field Technical Staff

Field technical staff consists of hydrogeologists, engineers and technicians who will perform activities such as water-level measurements, soil and groundwater sampling, and preparation of any field documentation which may be necessary. The field technical staff report directly to the PM.

Site Health and Safety Officer

The Site Health and Safety Officer (SHSO) will be responsible for the implementation of the HASP. The SHSO will revise the HASP, if required based on the results of the investigation activities. Any necessary revision to the HASP will be submitted to the Office Health and Safety Manager for approval.

6.2 Control of the Investigation Area

Procedures for controlling the investigation area have been developed to minimize both the risk of exposure to contamination and the spread of contamination during field activities. In order to accomplish this objective, the following three considerations have been addressed:

- the establishment of discrete work zones in the investigative area;
- the decontamination of field equipment; and
- the security and access procedures for the investigation area.

All personnel who come onto the Site or the investigation area, including terminal employees, contractors, and observers, will be required to adhere strictly to the conditions imposed herein, and with the provisions of the HASP.

6.2.1 Field Work Zones

Field work zones will be limited to areas where intrusive activities, including soil sampling and drilling, are conducted. Access will be limited in accordance with the HASP. Control of work zone access will be the responsibility of the field technical staff.

6.2.2 Decontamination

The location of the decontamination area will be determined prior to the start of operations. The decontamination area will be constructed to ensure that all wash water generated during decontamination will be collected and containerized for proper disposal.

6.2.3 Security and Access

The majority of the areas to be investigated are within fenced areas of the Site, with the exception of several sample locations in the ETYA, which are outside the fence surrounding the ETYA. Security and access control protocols used by the terminal will be followed during implementation of these investigations. At the completion of each working day, all heavy equipment and all loose equipment (i.e., sampling equipment, water level measuring devices, coolers, etc.) will be secured within the fenced area of the Terminal.

6.3 Field Equipment

All measurement systems utilized in the field will be operated in accordance with the manufacturer’s instructions and the applicable SOPs in Appendix C. Methods of calibrating and maintaining the equipment are provided below.

6.3.1 Equipment Calibration

All measurement equipment will be calibrated according to the manufacturer’s recommendations, where applicable. Frequency of instrument calibration will be dictated by the type of measurement device. Table 6 lists the field measurement equipment that may be used and the calibration frequency for the instrument. Records of all calibrations (both frequency and results) will be kept in the field or instrument logbook.

6.3.2 Equipment Maintenance

All field equipment will be stored in a clean, controlled environment (as necessary) to prevent damage due to heat, cold, moisture, etc. prior to use. Reusable equipment will be decontaminated as soon as reasonably possible after use and stored as described above. Decontamination procedures are provided in Section 6.7 and in the SOPs (Appendix C). Maintenance for measurement and health and safety equipment will be in accordance with the schedule found in Table 6.

Equipment failing to meet manufacturer’s minimum specifications will be removed from service immediately and kept out of service until the problem is identified and/or resolved. Records of all routine maintenance and repair will be kept in the instrument or field logbook.

6.4 Field Documentation

The following sections provide guidance to field personnel in the areas of documentation and record keeping. The goal of field documentation is to provide a clear and complete record that can be used for reference and information retrieval at a later date. All field documentation will be recorded in bound logbooks or pre-generated activity-specific forms using indelible (waterproof) ink. Details of record keeping requirements are described in Appendix C. Procedures for logging geologic borings and preparing geologic and well logs are presented in

Appendix D. Samples of field forms are provided in Appendix E. Lancaster Laboratories' sample packaging and shipping procedures are presented in Appendix F.

6.4.1 Field Logbooks

Field logbooks will be used for all record keeping to provide a permanent, bound record of all field-related activities. Additional records may be kept on pre-generated forms for sample tracking and other purposes. The types of information and level of detail required for logbook recording are described in the Field Record Keeping and Quality Assurance/Quality Control SOP in Appendix C.

6.4.2 Field Documentation for Drilling and Well Installation

Daily field activities will be summarized in a field notebook to ensure that an accurate record of all field investigation tasks are maintained. Geologic logs will be prepared during the drilling of soil borings and the installation of monitoring wells. Procedures for logging geologic borings and preparing geologic and well construction logs are included in Appendix D. An example of a geologic log is provided in Appendix E. Well construction details for the monitoring wells will be recorded in the field notebook in accordance with the procedures provided in Appendix C. In addition, well construction logs (as-built diagrams) will be prepared for each well installed. Examples of well construction logs are provided in Appendix E.

6.4.3 Sampling Designation

Sample bottles (preserved, if necessary), labels, shipping containers, and field blank water will be provided by the laboratory.

During collection and containment of soil samples, groundwater samples, storm water samples and riverbank sediment samples, the sample containers will be labeled with the following information:

- a site identifier;
- date and time of sample collection;
- a sample identifier;

- analysis identifier, and
- type of preservative added (if applicable).

The sample identifier will follow the exact format described below.

Designation/Top-Bottom/QA Code/Filtered:

Designation: The sampling point designation (i.e., MW-29, SB-87).

Top: Where applicable, the top depth of the soil, test pit or sediment sample, or the top depth of the Geoprobe^{TM} groundwater sample. Depths must be in feet.

Bottom: Where applicable, the bottom depth of the soil or sediment sample, or the bottom depth of the Geoprobe^{TM} groundwater sample. Depths must be in feet.

QA Code: Where applicable, the QA code for the sample will be one of the following choices:

- D = field duplicate (replicate);
- TB = trip blank; and
- FB = field blank

Filtered: When a sample is field filtered, an "F" should be indicated after the last slash.

For example, a filtered groundwater sample collected from MW-29 would be labeled: MW-29/F. A field duplicate of a field filtered groundwater sample collected from MW-29 would be labeled MW-29/D/F. A soil sample collected from 8 to 10 feet bls in borehole SB-74 would be labeled SB-87/8-10. Sample bottle labels and "Field Sample ID" on the chain of custody forms must match exactly. Only standard letter or number characters should be used. The characters "/" and "-" should be used exactly as indicated in the example above. Other separators, such as "," should not be used within the sample identifier. In addition, the length of each label is restricted to 22 characters or less. The field technical staff will discuss any questions regarding sample designation with the project manager prior to delivery of samples to the laboratory.

6.4.4 Sampling Documentation

A complete record of how each sample was selected, aliquotted, packaged, and preserved for analysis will be maintained in field logbooks. Specific procedures regarding the level and type of sampling documentation can be found in the activity-specific Roux Associates' SOP in Appendix C. Questions regarding sampling methods and QA will be addressed by the Project Manager.

6.5 Field Custody Procedures and Documentation

The following sections describe the procedures necessary to document sample custody. The purpose of documenting sample custody is to ensure that the integrity and handling of the samples is not subject to question. Sample custody will be maintained from the point of sampling through the analysis (and return of unused sample portion, if applicable). Specific procedures regarding sample tracking from the field to the laboratory are described in (Appendix C). Examples of a chain of custody form and a custody seal can be found in Appendix E.

6.5.1 Field Custody

Each individual collecting samples is personally responsible for the care and custody of the samples. All sample labels should be pre-printed or filled out using waterproof ink. The technical staff will review all field activities with the Project Manager to determine whether proper custody procedures were followed during the field work and to decide if additional samples are required.

Samples must be accompanied by a properly completed chain of custody form (Appendix E). The sample numbers will be listed on the chain of custody form. When transferring the possession of samples, individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to/from a secure storage area, and to the laboratory.

Samples will be packaged for shipment and dispatched to the appropriate laboratory for analysis with a separate signed custody record enclosed in each sample box or cooler. Shipping containers will be locked and/or secured with strapping tape in at least two locations for shipment to the laboratory.

If split samples are requested, a separate chain of custody form is prepared for those samples and marked to indicate with whom the samples are being split. The person relinquishing the samples to the facility or agency will request the representative's signature on the chain of custody form, acknowledging sample receipt. If the representative is unavailable or refuses, this will be noted in the "Received By" space. Any questions regarding custody procedures or QA will be addressed by the Project Manager.

6.5.2 Laboratory Custody

The sample custodian at each laboratory will ensure that chain of custody records are completed upon receipt of the samples and will note questions or observations concerning sample integrity. The quality assurance officer will also ensure that sample tracking records are maintained. These records will follow each sample through all stages of laboratory processing. The sample tracking records must show the date of sample extraction or preparation and the date of instrument analysis. These records will be used, in part, to determine compliance with holding time requirements.

6.6 Sample Handling and Analysis

To assure quality data acquisition, and collection of representative samples, there are selective procedures to minimize sample degradation or contamination. These include procedures for preservation of the samples as well as sample packaging and shipping procedures.

6.6.1 Field Sample Handling and Shipment

All samples will be collected and handled according to the appropriate protocols for each matrix described in the Roux Associates SOPs (Appendix C). Sample packaging and shipment will be performed according to the procedures of Lancaster Laboratories (Lancaster) provided in Appendix F. The types of containers, volumes needed and preservation techniques for the aforementioned testing parameters are presented in Table 7.

Sample packaging and shipping procedures are based upon USEPA specifications, as well as U.S. Department of Transportation (DOT) regulations. The procedures vary according to potential sample analytes, concentration, and matrix, and are designed to provide optimum protection for the samples and the public.

Following the completion of all soil boring activities, the samples selected will be shipped to the laboratory for analysis. Samples to be sent from Monday through Friday will be delivered to the laboratory within 24 hours of collection. If Saturday delivery is not available, samples sent on Friday must be delivered by Monday morning.

6.6.2 Laboratory and Field Analysis Quality Control Checks

Field analyses for conductivity, temperature and pH in aqueous media will be conducted in accordance with the Roux Associates SOPs included in Appendix C.

Analytical methods for the chemical analysis of constituents of concern have been chosen to provide the highest level of data quality for purposes of performing an exposure assessment and evaluating remedial alternatives. Standard methodologies for laboratory analyses are summarized in Table 4.

Applicable QA/QC is described in Table 8 for laboratory QC and Table 4 for field QC .

6.7 Decontamination Procedures

The procedures for the decontamination of field equipment, personnel and sampling equipment are outlined in the following sections. Detailed procedures for the decontamination of field and sampling equipment are included in the SOPs provided in Appendix C.

In an attempt to avoid the spread of contamination, all equipment (i.e., drilling tools, sampling equipment, etc.) must be decontaminated as described in the following sections. The location of the decontamination area will be determined prior to the start of operations. All wash water generated during cleaning of drilling equipment will be collected, transported to the Site's water treatment system located at the Buffalo Terminal and offloaded for treatment.

6.7.1 Drilling Equipment

The rig and all associated equipment will be cleaned by the contractor before arriving at and exiting the site. The augers, drilling casings, rods, samplers, tools, and any piece of equipment that may come in contact (directly or indirectly) with the soil, will be steam cleaned prior to set up for drilling to ensure proper decontamination. The same steam cleaning procedures will be followed for augers and sampling tools used for each borehole.

All steam cleaning (decontamination) activities will be monitored and documented by the technical staff overseeing the field activities. Specific procedures for decontaminating drilling equipment are provided in the Roux Associates' SOP in Appendix C.

6.7.2 Personnel Protection

The field work will be performed in level D protection with continuous air monitoring provided to demonstrate the adequacy of this protection. Any decontamination of personnel required will be performed at a designated area of the site and appropriate decontamination materials (e.g., eye wash) will be maintained for use in this area. The required photoionization detector (PID) readings for changing protection levels and other specifics regarding personnel protection and decontamination are discussed in the HASP.

6.7.3 Sampling Equipment

All soil and groundwater sampling equipment will be decontaminated prior to sampling and between sampling locations according to the procedures outlined in the SOPs included in Appendix C.

6.8 Waste Handling and Disposal

Wastes generated during performance of field tasks (i.e., drill cuttings) will be containerized in labeled 55-gallon drums and stored within a designated area of the Site. Each drum will be labeled with the Site name, drum number, date, and nature of contents.

All development water and purge water will be containerized, transported to the Site's water treatment system located at the Buffalo Terminal and offloaded for treatment.

Drill cuttings may be removed from drums, stockpiled on polyethylene sheeting and covered with polyethylene sheeting prior to characterization for waste disposal purposes. Soil materials, liquid wastes and disposable personal protective equipment will be stored separately. The handling of all wastes will conform to all health and safety requirements of the HASP.

7.0 CALIBRATION PROCEDURES AND PREVENTIVE MAINTENANCE

This section describes procedures for maintaining the accuracy of all measurements and measuring equipment which are used for conducting field tests and laboratory analyses. All equipment must be calibrated prior to each use and on a periodic basis.

7.1 Field Instruments/Equipment

Field instruments and equipment used to gather, generate, or measure environmental data will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications.

Equipment to be used during field sampling will be examined to certify that it is in operating condition. This includes checking the manufacturer's operating manual to ensure that all maintenance requirements are being observed. Backup instrumentation will be sent into the field where possible. Preventive maintenance will be conducted for equipment and instruments to ensure the accuracy of measurement systems, and to verify the availability of spare parts and backup systems.

Calibration of field instruments is governed by the specific SOP for the applicable field analysis method, and such procedures take precedence over the following general discussion.

Calibration of field instruments will be performed at the intervals specified by the manufacturer or more frequently as conditions dictate. In the event that an internally calibrated field instrument fails to meet calibration/checkout procedures, it will be removed from service until the problem is resolved.

7.2 Laboratory Instruments

Calibration of laboratory equipment will be based on approved written procedures maintained by the laboratory. Records of calibration, repairs, or replacement will be filed and maintained by the designated laboratory personnel performing QC activities. These records will be filed at the location where the work is performed and will be subject to QA audits. For all instruments, the laboratory will retain a factory-trained repair staff with in-house spare parts or will maintain service contracts with vendors.

7.3 Standards/Calibration Solutions Preparation

The standards/calibration solutions preparation will be performed in accordance with the ASP/CLP SOWs, if applicable, and using good laboratory practice (GLP) in all cases.

8.0 REPORT PREPARATION AND PROJECT SCHEDULE

Following completion of the fieldwork outlined in this Work Plan, a report will be prepared summarizing the findings and conclusions of the investigation.

The fieldwork is tentatively scheduled to occur between August and October 2001. Report preparation will follow and is expected to be completed by February 2002. This schedule may require revisions if the field tasks are delayed by inclement weather or by the need for additional field data. In addition, if a task is completed ahead of schedule, subsequent tasks will be initiated ahead of schedule.

Respectfully submitted,

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Table 1. Tank Inventory for Areas of the Buffalo Terminal to be Investigated, ExxonMobil Oil Corporation, Buffalo, New York

	Size				Capacity (BBL)								
Tank No	Length	Width	Diameter (Feet)	Height (Feet)	Gross	Available	Year Built	Removed	Duplicate Tank Designation Notes	Location	Product Stored	Roof Type	Shell
Administrative Offices and Operations Area													
9			35	24	4,113		1924 map			AOOA			
222			75				1948	1955 map		AOOA			
348							1939 map	1951 map		AOOA			
349							1924 map	1977 map		AOOA			
351							1924 map	1977 map		AOOA			
352			10	20	280		1924 map	1977 map		AOOA			
353			10	20	280		1924 map	1977 map		AOOA			
412			12.67	10	224		1924 map	1939 map		AOOA (Inside Boiler House)			
413			12.67	10	224		1924 map	1939 map		AOOA (Inside Boiler House)			
414			10.5	8	123		1924 map	1939 map		AOOA (Inside Boiler House)			
415			10.5	8	123		1924 map	1939 map		AOOA (Inside Boiler House)			
416						180,600	1924 map	1939 map		AOOA (Inside Boiler House)			
417						35,700	1924 map	1939 map		AOOA (Inside Boiler House)			
Central Rail and Process Area													
50							1939 map	1951 map		CRPA			
265			20	111.92	6,262		1924 map	1939 map		CRPA			
354			25	17	1,486		1924 map	1939 map		CRPA			
355			25	17	1,486		1924 map	1939 map		CRPA			
356			25	17	1,486		1924 map	1939 map		CRPA			
357			25	17	1,486		1924 map	1939 map		CRPA			
Eastern Tank Yard Area													
175			130	32	68,548	63,366	1953	Existing		ETYA (Former Disposal Area)	TCC Charge/ No. 6 Fuel Oil and Cutter, No.2 Fuel Oil	Cone	Welded
176			130	30	68,548	63,366	1953	Existing		ETYA (Former Disposal Area)	TCC Charge/ No. 6 Fuel Oil and Cutter, Unleaded Gasoline	Cone	Welded
F213	46	10					1977 map	1987 map		ETYA (Former Disposal Area)	Liquified Petroleim Gas		
F214	46	10					1977 map	1987 map		ETYA (Former Disposal Area)	Liquified Petroleim Gas		
F215	46	10					1977 map	1987 map		ETYA (Former Disposal Area)	Liquified Petroleim Gas		
F216	46	10					1977 map	1987 map		ETYA (Former Disposal Area)	Liquified Petroleim Gas		

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Tank No	Size				Capacity (BBL)		Year Built	Removed	Duplicate Tank Designation Notes	Location	Product Stored	Roof Type	Shell
	Length	Width	Diameter (Feet)	Height (Feet)	Gross	Available							
Former Refinery Area													
4							1917	1939	Also called 29 and Duplicate tank name in NTYA	FRA			
29			54	30.167	12,305		1924 map	1990 photo	Same as Tank 4	FRA			
36			15	20	629		1924 map	1977 map		FRA			
37			15	20	629		1924 map	1977 map		FRA			
45			30	20	2,518		1917 map	1939 map	Not labeled until 1924 map	FRA	Hot Water Tank		
45			16				1917 map	1924 map		FRA			
47			30	25	3,147		1924 map	1977 map		FRA			
48			24				1939 map	1977 map		FRA			
51			15				1939 map			FRA			
81			48	40	1,210	11,941	1939	1989		FRA	Unblended No. 2/TCC Charge	Cone	Welded
82			48	40	12,100	10,826	1940	1988		FRA	Mobil Diesel #2 Fuel Oil (1986)	Cone	Riveted
85			10	10	140		1924 map	1939 map	Duplicate name in BSPA	FRA			
117			25	20	1,749		1924 map	1977 map		FRA	Diesel		
120			30	16.33	2,056		1924 map	1939 map		FRA			
157			23	14.33	1,060		1924 map	1977 map		FRA			
161	36	12					1951 map	1977 map		FRA			
165	36	12					1951 map	1977 map		FRA			
169			70	30	19,757	16,934	1924 map		Replaced	FRA			
169			70	30	19,757	16,934	1940	1988		FRA	Kerosene/Jet A #1 Fuel Oil	Cone	Riveted
173			30	12	1,511		1917 map	1939 map		FRA			
174			30	12	1,511		1917 map	1939 map		FRA			
175			30	12	1,511		1917 map	1939 map		FRA			
176			30	12	1,511		1917 map	1939 map		FRA			
177			30	12	1,511		1917 map	1939 map		FRA	Lube Oil		
178			30	12	1,511		1917 map	1951 map		FRA			
179			40	12	2,686		1917 map	1939 map		FRA			
180			40	12	2,686		1924 map	1977 map		FRA			
181			40	12	2,686		1917 map	1977 map		FRA			
185			30	40	4,645	4,277	1939	1995 map		FRA	No. 6 Fuel Oil	Cone	Welded
186			12	10	201		1924 map	1939 map		FRA			
186			30				1939 map	1995 map		FRA			
191			40	12	2,686		1924 map	1977 map		FRA			
192			40	12	2,686		1924 map	1977 map		FRA			
194			40	12	2,686		1924 map	1977 map		FRA			
195			40	12	2,686		1924 map	1977 map		FRA			
219			24				1951 map	1977 map		FRA			

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Tank No	Size				Capacity (BBL)		Year Built	Removed	Duplicate Tank Designation Notes	Location	Product Stored	Roof Type	Shell
	Length	Width	Diameter (Feet)	Height (Feet)	Gross	Available							
220			36				1951 map	1977 map		FRA			
291			18	14	635		1924 map	1951 map		FRA			
292			18	14	635		1924 map	1951 map		FRA			
301			15	10	315		1924 map	1977 map		FRA			
364			45	16	4,532	17,810	1917 map	1977 map		FRA	Gas Holder		
390	36	12					1951 map	1977 map		FRA			
392	36	12					1951 map	1977 map		FRA			
490			30	40	4,886	4,825	1942	1995 map		FRA	Asphalt	Cone	Welded
496							1939 map	1995 map		FRA			
497							1939 map	1995 map		FRA			
498			25	35	2,966	2,924	1942	1995 map		FRA	Asphalt	Cone	Welded
499			25	35	2,966	2,924	1942	1995 map		FRA	Asphalt Cutter (Kerosene Distillate)/Asphalt	Cone	Welded
525	36	12					1951 map	1977 map		FRA			
531			15				1951 map	1977 map		FRA			
534			30				1951 map	1977 map		FRA			
Northeast Process and Storage Area													
3			40	12	2,686		1924 map	1977 map		NPSA			
6			10	16	224		1924 map	1977 map		NPSA			
7			10	16	224		1924 map	1977 map		NPSA			
11			10	16	224		1924 map	1977 map		NPSA			
15			30	12	1,511		1924 map	1977 map		NPSA	Lube Oil		
17			10	16	224		1924 map	1977 map		NPSA			
30			40	11.875	2,658		1924 map	1977 map		NPSA	Lube Oil #2 Fuel Oil (1986)		
32			70	30	19,878	19,538	1923	1980		NPSA	Unleaded Gasoline	Cone	Riveted
34			30	10	1,259		1924 map	1977 map		NPSA			
38	48	18		NA			1939 map	1955 map		NPSA			
39			30	24	3,022		1924 map	1977 map		NPSA			
41			30	24	3,022		1924 map	1977 map		NPSA			
61			21.92	11.33	762		1924 map	1951 map		NPSA			
62			12	5.5	111		1924 map	1939 map		NPSA			
63			14	15	411		1924 map	1951 map		NPSA			
63			14				1951 map	1977 map	Different Location	NPSA			
64			14	15	411		1924 map	1951 map		NPSA			
64			14				1951 map	1977 map	Different Location	NPSA			
71			21				1939 map	1977 map		NPSA			
72			21				1939 map	1977 map		NPSA			
73			40	11.77	2,634		1924 map	1977 map		NPSA	Lube Oil		
74			24				1939 map	1977 map		NPSA			
108			16	18	645		1924 map	1977 map		NPSA			
114			20	15	839		1924 map	1977 map		NPSA			
124			2.92	12.25	15		1924 map	1939 map		NPSA (Pump House)			
135			18	20	906		1924 map	1977 map		NPSA			
135½			14	18.167	498		1924 map	1977 map		NPSA			

Table 1. Tank Inventory for Areas of the Buffalo Terminal to be Investigated, ExxonMobil Oil Corporation, Buffalo, New York

	Size				Capacity (BBL)								
Tank No	Length	Width	Diameter (Feet)	Height (Feet)	Gross	Available	Year Built	Removed	Duplicate Tank Designation Notes	Location	Product Stored	Roof Type	Shell
136			18	20	906		1924 map	1977 map		NPSA			
136½			14	18.167	498		1924 map	1977 map		NPSA			
141			14				1939 map	1977 map		NPSA			
142			14				1939 map	1977 map		NPSA			
143			14				1939 map	1977 map		NPSA			
144			14				1939 map	1977 map		NPSA			
155			35	6	1,028		1924 map	1977 map		NPSA			
156			35	6	1,028		1924 map	1977 map		NPSA	Lube Oil		
177			21				1939 map	1977 map		NPSA			
178			18				1939 map	1977 map		NPSA			
183			30	12	1,511		1924 map	1977 map		NPSA	Lube Oil		
201	18	8		4	103		1924 map	1939 map		NPSA	Water box		
215	40	21		9	1,346		1924 map	1977 map		NPSA			
216			12.75	5.33	121		1924 map	1977 map		NPSA			
218			70	30	19,878	19,500	1923	1990		NPSA	TCC Charge/ No. 6 Fuel Oil and Cutter	Cone	Riveted
223			15	18	567		1924 map	1951 map		NPSA			
223			18				1951 map	1977 map	Different Tank and Location	NPSA			
224	26	16		8	593		1917 map	1977 map		NPSA			
227			15	14.83	467		1924 map	1951 map		NPSA			
228					21		1939 map	1977 map		NPSA			
229					24		1939 map	1977 map		NPSA			
241	18.5	5.083		4.5	75		1924 map	1939 map		NPSA	Paraffin/Wax		
241½	18.5	5.167		4.417	75		1924 map	1939 map		NPSA	Paraffin/Wax		
242	18.458	4.67		4.333	67		1924 map	1939 map		NPSA	Paraffin/Wax		
242½	18.33	5.33		4.333	75		1924 map	1939 map		NPSA	Paraffin/Wax		
243	19.08	12		4.167	170		1924 map	1939 map		NPSA	Paraffin/Wax		
244	19.25	11.167		4.833	185		1924 map	1939 map		NPSA	Paraffin/Wax		
245			14	11.5	315		1924 map	1977 map		NPSA			
246			14	11.5	315		1924 map	1977 map		NPSA			
247			14	11.5	315		1924 map	1977 map		NPSA			
248			14	11.5	315		1924 map	1977 map		NPSA			
250			30	25.167	3,168		1924 map	1977 map		NPSA	Lube Oil		
251			50	30	9,828	9,650	1923	1990		NPSA	TCC Charge/ No. 6 Fuel Oil and Cutter	Cone	Riveted
252			50	30	9,791	9,616	1923	1990		NPSA	Unblended No. 2/TCC Charge	Cone	Riveted
254			25	18.833	1,647		1924 map	1977 map		NPSA			
255	21	14.75		5.667	313		1924 map	1939 map		NPSA	Paraffin/Wax		
256	21	14		5.417	284		1924 map	1939 map		NPSA	Paraffin/Wax		
257	21	14		5.417	284		1924 map	1939 map		NPSA	Paraffin/Wax		
258	21	14		5.333	279		1924 map	1939 map		NPSA	Paraffin/Wax		
259	12.083	6.167		5.83	77		1924 map	1977 map		NPSA			
260	12.083	6.167		5.83	77		1924 map	1977 map		NPSA			

Table 1. Tank Inventory for Areas of the Buffalo Terminal to be Investigated, ExxonMobil Oil Corporation, Buffalo, New York

Tank No	Size				Capacity (BBL)		Year Built	Removed	Duplicate Tank Designation Notes	Location	Product Stored	Roof Type	Shell
	Length	Width	Diameter (Feet)	Height (Feet)	Gross	Available							
264			12	5	101		1924 map	1951 map		NPSA			
266			20	24	1,343		1924 map	1977 map		NPSA			
267			20	24	1,343		1924 map	1977 map		NPSA			
274	18	12		5.5	212		1924 map	1939 map		NPSA (Pump House)			
279			27				1939 map	1977 map		NPSA			
280			27				1939 map	1977 map		NPSA			
281			24	25	2,014		1924 map	1977 map		NPSA	Lube Oil		
282	27	12					1939 map	1977 map		NPSA			
283			16	16	573		1924 map	1977 map		NPSA			
325	20	10		3	107		1924 map			NPSA			
326	5	10					1924 map			NPSA			
327	14	8		4	80		1924 map			NPSA			
330			12	4.5	97		1924 map			NPSA			
331			12.417	4.5	97		1924 map			NPSA			
335			40	26	5,819		1924 map			NPSA			
336			40	26	5,819		1924 map			NPSA			
337			40	26	5,819		1924 map			NPSA			
338			40	26	5,819		1924 map			NPSA			
339			40	26	5,819		1924 map			NPSA			
340			40	26	5,819		1924 map			NPSA			
341			40	26	5,819		1924 map			NPSA			
358			20	23.25	1,301		1924 map			NPSA			
359			20	23.08	1,291		1924 map	1939 map		NPSA			
360			20	23.08	1,291		1924 map	1939 map		NPSA			
361			20	23.375	1,308		1924 map	1939 map		NPSA			
373			45	30	8,498		1924 map	1939 map		NPSA			
379			45	30	8,498		1924 map	1939 map		NPSA			
249	8	6		5	43		1924 map	1939 map		NPSA (Pan House)			
249A	24	5		5	107		1924 map	1939 map		NPSA (Pan House)			
249B	24	5		5	107		1924 map	1939 map		NPSA (Pan House)			
295							1917 map	1977 map		NPSA			
296							1917 map	1977 map		NPSA			
298							1917 map	1977 map		NPSA			
319							1917 map	1977 map		NPSA			
328	4.67	12.083		5.0625	51		1924 map	1939 map		NPSA (Wax Refinery)			
329	4.583	12.083		5.083	50		1924 map	1939 map		NPSA (Wax Refinery)			
332			4	29.083	0		1924 map	1939 map		NPSA (Wax Refinery)			

Table 1. Tank Inventory for Areas of the Buffalo Terminal to be Investigated, ExxonMobil Oil Corporation, Buffalo, New York

	Size				Capacity (BBL)								
Tank No	Length	Width	Diameter (Feet)	Height (Feet)	Gross	Available	Year Built	Removed	Duplicate Tank Designation Notes	Location	Product Stored	Roof Type	Shell
418	42.25	12		3.5	316		1924 map	1939 map		NPSA (Former Car Shop)			
419	42.25	12		3.5	316		1924 map	1939 map		NPSA (Former Car Shop)			
225	29.5	8.5		5.417	242		1924 map	1939 map		NPSA (Sweater Structure)			
261	23.667	8.5		5.667	203		1924 map	1939 map		NPSA (Sweater Structure)			
268			4.5	6	17		1924 map	1939 map		NPSA (Sweater Structure)			
269			4.5	6	17		1924 map	1939 map		NPSA (Sweater Structure)			
270			4.5	6	17		1924 map	1939 map		NPSA (Sweater Structure)			
Northern Tank Yard Area													
1			70	30	19,194	17,479	1924	1989		NTYA	Jet A/Kerosene	Cone	Riveted
2			40	12	2,686		1924 map	1990 photo		NTYA			
4			48	40	12,892		1971	1990 photo		NTYA	Sour Water		
4			40	12	2,686		1924 map	1990 photo		NTYA			
10			40	12	2,686		1924 map	1990 photo		NTYA			
19			93	35	39,946	36,314	1927	1990 photo		NTYA	No.6 Fuel and Cutter Stock	Cone	Riveted
21			93	38	38,901	33,679	1940	1990 photo		NTYA	PTR Charge/Regular	Floater	Riveted
22			93	35	41,117	40,512	1931	1989		NTYA	TCC Charge/ No. 6 Fuel Oil Cutter	Cone	Riveted
24			45	30	8,498		1924 map	Existing		NTYA			
27			60	30		14,661	1920	1989		NTYA	PTR Special Pretreated Naphtha for Startup, Jet A (1986)	Cone	Riveted
28			35	20	3,263	3,202	1919	1995 map		NTYA	PTR Special Pretreated Naphtha for Startup	Cone	Riveted
31			70	30	19,573	17,513	1915	1990 photo		NTYA	No. 6 Fuel Oil	Cone	Riveted
33			60	30.08	15,148		1924 map	1990 photo		NTYA			
52	21						1939 map	1977 map		NTYA			
54	93						1939 map	1990 photo		NTYA			
55	93						1939 map	1990 photo		NTYA			
60			117	42	78,433	76,573	1945	1989		NTYA	TCC Charge, #2 Fuel Oil (1986)	Cone	Riveted
80			70	30	20,563		1924 map		Replaced	NTYA			
80			70	30	22,000	19,944	1934	1990 photo		NTYA	Out of Service/No. 6 Fuel Oil	Cone	Riveted
89			93	35	41,715	38,089	1920	1990 photo		NTYA	No. 6 Fuel Oil and Cutter Stock	Cone	Riveted
93			40	35	7,638	7,526	1944	1990 photo			Kerosene Distillate	Cone	Riveted
94			40	30	6,714		1924 map	1990 photo		NTYA			

Table 1. Tank Inventory for Areas of the Buffalo Terminal to be Investigated, ExxonMobil Oil Corporation, Buffalo, New York

	Size				Capacity (BBL)								
Tank No	Length	Width	Diameter (Feet)	Height (Feet)	Gross	Available	Year Built	Removed	Duplicate Tank Designation Notes	Location	Product Stored	Roof Type	Shell
95			40	30	6,270	6,178	1924	1995 map		NTYA	Kerosene Distillate	Cone	Riveted
101			40	11.79	2,639		1924 map	1990 photo		NTYA			
102			70	30	19,573	17,775	1924	1989		NTYA	Unblended No. 2/TCC Charge/ Jet A	Cone	Welded
141			15	19	598		1924 map	1939 map		NTYA			
142			15	19	598		1924 map	1939 map		NTYA			
143			15	19	598		1924 map	1939 map		NTYA			
144			15	19	598		1924 map	1939 map		NTYA			
184			23	14	1,036		1924 map	1939 map		NTYA			
187			93	34	41,135		1924 map	1989		NTYA	No. 2 Fuel Oil		
187			93	38	43,204	38,550	1940	1990 photo		NTYA	PTR Charge	Floater	Welded
189			70	30	19,573	19,230	1915	1989		NTYA	Jet A Unblended No. 2/TCC Charge	Cone	Welded
230							1939 map	1939 map		NTYA			
279			24	25	2,014		1924 map	1939 map		NTYA			
280			24	25	2,014		1924 map	1939 map		NTYA			
293			25	32	2,798		1924 map	1990 photo		NTYA			
350			40	12	2,686		1924 map	1990 photo		NTYA			
351			40	12	2,686		1924 map	1990 photo		NTYA			
Southern Tank Yard Area													
1			30	20	2,518		1924 map	1939 map		STYA			
2			25	25	2,186		1924 map	1977 map		STYA			
3			25	20	1,749		1924 map	1977 map		STYA	Lube Oil		
5			30	25	3,147		1924 map	1977 map		STYA			
12			50	10	3,497		1924 map	1977 map		STYA			
13			50	10	3,497		1924 map	1977 map		STYA			
14			50	10	3,497		1924 map	1977 map		STYA			
16			50	10	3,497		1924 map	1977 map		STYA			
18			93	37.25	40,636	35,575	1940	1989		STYA	Regular/Premium	Floater	Riveted
20			93	35	42,345		1924 map		Replaced	STYA			
20			93	37.25	40,382	37,082	1940	1992		STYA	Unleaded Gasoline	Floater	Riveted
23			45	36	9,634	9,210	1920	1990 photo		STYA	Out of Service/Gasoline/ Used for Phenolic Water Storage	Floater	Riveted
25							1939 map	Dec-1960	Replaced	STYA			
25			60	40	18,369	16,367	1960	Existing		STYA	Regular Gasoline	Floater	Welded
26							1939 map	Dec-1960	Replaced	STYA			
26			60	40	18,372	16,370	1960	Existing		STYA	Regular Gasoline	Floater	Welded
38			93	35	38,925	34,196	1990	Existing		STYA	Unleaded Gasoline	Floater	Riveted
40			60	40		19,735	1949	1989		STYA	Slop Oil	Cone	Riveted
42			93	37.25	41,266	36,136	1939	1990 photo		STYA	Regular/Premium	Floater	Riveted
43			8	6	54		1924 map	1939 map		STYA			
44			10	6.08	85		1924 map	1939 map		STYA			
46			30	25	3,147		1924 map	1977 map		STYA	Slop Oil		

Table 1. Tank Inventory for Areas of the Buffalo Terminal to be Investigated, ExxonMobil Oil Corporation, Buffalo, New York

	Size				Capacity (BBL)								
Tank No	Length	Width	Diameter (Feet)	Height (Feet)	Gross	Available	Year Built	Removed	Duplicate Tank Designation Notes	Location	Product Stored	Roof Type	Shell
49			25	30	2,600	2,480	1945	1990		STYA	Out of Service	Cone	Riveted
75			90	40	40,791	38,431	1956	Existing		STYA	Unleaded Gasoline	Internal Deck	Welded
86			87	40	39,794	35,446	1940	1988		STYA	#2 Fuel Oil (1986)	Floater	Welded
87			70	30	19,184	16,614	1940	Existing		STYA	Jet A No. 2 Fuel Oil/Kerosene	Cone	Riveted
88			102	40	52,340	49,311	1940	1990		STYA	Unleaded Gasoline	Internal Deck	Welded
90			65	35	20,689	18,917	1944	Replaced		STYA	No. 2 Fuel Oil	Cone	Riveted
90			80	33.5	29,991		1988	Existing		STYA	No. 2 Fuel Oil	Cone	Riveted
96			93	35	42,345		1924 map	1940		STYA	Unknown		
96			93	38	40,938	35,972	1940	1995 map		STYA	TCC, Gasoline/Regular Unleaded Gas	Floater	Riveted
97			93	35	42,345		1924 map		Replaced	STYA			
97			93	38	39,477	34,441	1940		Replaced	STYA	Out of Service/Crude Oil	Floater	Riveted
97			93	48	58,074		1990	Existing		STYA	Unleaded Gasoline		
98			93	38	39,465	34,335	1940	1989		STYA	Premium/Regular	Floater	Riveted
99			70	30	18,671	18,325	1913	1989		STYA	PTR Reformate/PTR Charge	Floater	Riveted
99			93	48	58,074		1990	Existing		STYA	Unleaded Gasoline		
100			70	30	18,557	15,765	1917	1924		STYA	Unleaded Gasoline	Floater	Riveted
103			80	40	32,211	31,785	1936	1988		STYA	PTR Charge/TCC Charge/No. 2 Fuel Oil	Cone	Riveted
104			75	40	30,665	27,910	1936	Existing		STYA	Jet A No. 2 Fuel Oil/Kerosene	Cone	Riveted
105			60	40	19,142	16,618	1936	Existing		STYA	Jet A/Kerosene	Cone	Riveted
125			8	30	269		1924 map			STYA			
126			8	30	269		1924 map			STYA			
127			8	30	269		1924 map			STYA			
128			8	30	269		1924 map			STYA			
129			8	30	269		1924 map			STYA			
130			8	30	269		1924 map			STYA			
131			8	30	269		1924 map			STYA			
132			8	30	269		1924 map			STYA			
133			8	30	269		1924 map			STYA			
134			8	30	269		1924 map			STYA			
140			10	5.083	71		1924 map	1939 map		STYA			
160			70	30	20,563		1924 map			STYA			
160			70	30	17,970	15,138	1939	1990 photo		STYA	PTR Reformate/PTR Charge	Floater	Riveted
171			90	30	40,633	36,039	1975	Existing		STYA	Unleaded Crude Oil	Internal Deck	Welded
197			93	35	42,345		1924 map			STYA	Crude Oil		
197			93	38	38,822	34,043	1939	1990 photo		STYA	Crude Oil	Floater	Riveted
198			93	35	42,345		1924 map	1990		STYA			
198			93	38	39,431	34,368	1939	1995 map		STYA	Regular/Premium	Floater	Riveted
199			5.5	20	85		1924 map			STYA			
299			32			3,056	1957			STYA	BB Mix	Spheroid	Welded

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	Size				Capacity (BBL)								
Tank No	Length	Width	Diameter (Feet)	Height (Feet)	Gross	Available	Year Built	Removed	Duplicate Tank Designation Notes	Location	Product Stored	Roof Type	Shell
300			32			3,056	1957			STYA	TCC Olefins	Spheroid	Welded
375			50	30	9,743	8,151	1924	1989		STYA	Jet A, Kerosene	Cone	Riveted
376			50	30	9,743	8,871	1924	1989		STYA	No. 1 Fuel Oil, Mobil Diesel, Kerosene	Cone	Riveted
377			45	30	7,483	6,349	1924	1989		STYA	Used for Phenolic Water Storage	Floater	Riveted
378			45	30	8,498		1923	1990		STYA			
381			12				1939 map	1977 map		STYA			
382			12				1939 map	1977 map		STYA			
389			18.4	17.08	809		1924 map	1939 map		STYA			
390			18.4	17.08	809		1924 map	1939 map		STYA			
391			18.4	17.08	809		1924 map	1939 map		STYA			
391			20	20	1,059	1,032	1960		Different Tank and Location	STYA	Asphalt	Cone	Welded
392			18.4	17.08	809		1924 map	1939 map		STYA			
392			20	20	1,059	1,032	1960		Different Tank and Location	STYA	Asphalt	Cone	Welded
393			18.4	17.08	809		1924 map	1939 map		STYA			
394			18.4	17.08	809		1924 map	1939 map		STYA			
395			14.625	14.833	444		1924 map	1939 map		STYA			
396			10	20	280		1924 map	1939 map		STYA			
397			10	20	280		1924 map	1939 map		STYA			
398			10	20	280		1924 map	1939 map		STYA			
399			10	20	280		1924 map	1939 map		STYA			
400			15	8.83	278		1924 map	1939 map		STYA			
401			15	8.83	278		1924 map	1939 map		STYA			
402			15	8.83	278		1924 map	1939 map		STYA			
403	5.125	9		2.5	21		1924 map	1939 map		STYA			
405			15	12.25	386		1924 map			STYA			
381	12	8		3			1924 map	1939 map		STYA (Bldg 79)			
382	12	8		3			1924 map	1939 map		STYA (Bldg 79)			
383	12	8		3			1924 map	1939 map		STYA (Bldg 79)			
384	12	8		3			1924 map	1939 map		STYA (Bldg 79)			
385	12	8		3			1924 map	1939 map		STYA (Bldg 79)			
386	12	8		3			1924 map	1939 map		STYA (Bldg 79)			
387	9	8		4			1924 map	1939 map		STYA (Bldg 79)			
388	9	8		4			1924 map	1939 map		STYA (Bldg 79)			

Table 1. Tank Inventory for Areas of the Buffalo Terminal to be Investigated, ExxonMobil Oil Corporation, Buffalo, New York

Tank No	Size				Capacity (BBL)		Year Built	Removed	Duplicate Tank Designation Notes	Location	Product Stored	Roof Type	Shell
	Length	Width	Diameter (Feet)	Height (Feet)	Gross	Available							
Underground Storage Tanks													
U-1			Unknown		2,000		1997			UST	Unleaded UST		FRP
U-2			Unknown		2,000		1986			UST	Fuel Oil		FRP
U-3			Unknown		4,000		1986			UST	Unleaded UST		FRP
U-4			Unknown		12,000		1992			CRPA	Stormwater Spills		FRP
					0	0							
A-1			Unknown		12,000		1992			CRPA	Gasoline Additive		
A-2			Unknown		8,000		88			CRPA	Unknown		

Notes:

1. Where blanks entries exist, information from the existing documentation was not available.
2. For Construction dates, an entry referencing a map or aerial photo indicates the map/aerial photo that the tank first appeared.
3. For Removal Dates, an entry referencing a map or aerial photo indicates the first map/aerial photo that the tank does not appear on.
4. Not all 1917 tanks are listed.

Table 2. Summary of Spills/Releases in Areas of the Buffalo Terminal to be Investigated, ExxonMobil Oil Corporation, Buffalo, New York

Date of Incident	Quantity	Product	Cause/Source of Spill	Geographic Area	Media Affected	Agency Notified	Action Taken/Comments	Source	Date Spill Closed by NYSDEC
FORMER REFINERY AREA (FRA)									
Various Dates	Unknown	Asphalt Products	Several releases of asphalt products occurred at the asphalt loading racks in the former refinery area throughout its years of operation.	FRA	Soil	None	Unknown	Current and/or Former ExxonMobil Employees	NA
3/15/1990	1 gallon	#6 Fuel Oil/Water	Abandoned overhead line in the former refinery area leaked after the pipeline was washed and drained. Oily water accumulated and leaked from a failed flange gasket. Stain was approximately 2 feet in diameter.	FRA	Soil/Stone	NYSDEC - #8911921	Gasket was replaced and area cleaned with absorbent pads; contaminated soil/stone was disposed.	Mobil Files/ NYSDEC Spills	3/16/1990
6/1/1991	100 gallons	Oil/Water	Contractor cut an abandoned pipe in overhead pipe rack during demolition and 100 gallons of light oil and water drained onto soil.	FRA	Soil	NYSDEC - #9102475	Free product picked up and put into container for disposal. Excavated impacted soil and placed on plastic prior to placement in biotreatment cell.	Mobil Files/ NYSDEC Spills	6/19/1991
8/27/1991	10-15 gallons	Hydraulic Oil	During demolition of the asphalt heater in the refinery, oil was left in the coils and leaked.	FRA	Soil	NYSDEC - #9105735 NRC - #85672	Absorbent pads used to clean free product. Soil was removed and placed in the biotreatment cell.	Mobil Files/ NYSDEC Spills	11/22/1991
7/31/1991	2500 gallons	Quench Oil	Aboveground tank holding approximately 3000 gallons was being emptied. The valve became stuck, product spilled onto a concrete pad and into the Terminal's sewer system.	FRA (assumed based on the description of the event)	Soil/concrete pad/sewer	NYSDEC - #9104672 NRC - #81721 Buffalo Sewer Authority	Cleaned pad and used vacuum truck to clean out sewer. No further action required on NYSDEC Spill Report Form. Recovered product was disposed offsite.	Mobil Files/ NYSDEC Spills	8/21/1991
CENTRAL RAIL AND PROCESS AREA (CRPA)									
10/25/1988	34,062 gallons	#2 Fuel Oil	While emptying Tank #22 for demolition, product was pumped through a former diesel pipeline to Tank #221. The former diesel line ruptured at a location between the treatment, blending and shipping (TBS) pit area and a location near the northwest corner o	CRPA	None	NYSDEC - #8806247 Albany & Buffalo Sewer Authority	33,894 gallons recaptured by vacuum trucks and pumped to storage in Tank # 22. Remaining 168 gallons reportedly drained into the Site sewer system to the Main in-ground Oil/Water Separator.	Mobil Files/ NYSDEC Spills	1/20/1989
4/1/1991	Unknown	PCB Oil	Exact date unknown. While removing the alkylation control room during the demolition project, an electrical cable was pulled from a transformer, releasing PCB oil to the concrete pad.	CRPA	Concrete pad	None	Remaining oil removed from the transformer and concrete pad cleaned. One week later during heavy rain, a sheen was observed in the vault that lead to the transformers. The sheen was cleaned up.	Mobil Files	NA
7/14/1995	75 gallons	Diesel Fuel	Goetz Trucking overfilled compartment during fueling at the loading rack	CRPA	Concrete	NYSDEC - #9504583	Spill was contained by concrete berms at the loading rack; product was squeegeed to catch basins which are connected to the loading rack's below grade product recovery tank.	NYSDEC Spills	7/14/1995
3/3/1998	40 gallons	Gasoline	Seal failed on product pump located at pump pad north of Tanks 38 and 97, product spilled into concrete dike area.	CRPA	Concrete	NYSDEC - #9713449	Product removed with vacuum truck and placed in Tank 75; drain valve was opened to allow the remaining product to drain to the Main in-ground Oil/Water Separator in the FRA, no further action required.	NYSDEC Spills	3/5/1998
6/19/1998	35 gallons	Gasoline	As driver was loading at the loading rack, a coupling handle was partially open, resulting in the release.	CRPA	Concrete	NYSDEC - #9804137	Spill was contained by concrete berms at the loading rack and was cleaned up.	Mobil Files/ NYSDEC Spills	7/24/1998
7/17/1998	71 gallons	Gasoline	Truck overfilled at the loading rack.	CRPA	Concrete	NYSDEC - #9804823	Spill was contained by concrete berms at the loading rack and was cleaned up.	Mobil Files/ NYSDEC Spills	7/24/1998

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Date of Incident	Quantity	Product	Cause/Source of Spill	Geographic Area	Media Affected	Agency Notified	Action Taken/Comments	Source	Date Spill Closed by NYSDEC
7/28/1998	170 gallons	HS #2 Fuel Oil	Truck overfilled at the loading rack.	CRPA	Concrete	NYSDEC - #9805267	Spill was contained by concrete berms at the loading rack and was cleaned up.	Mobil Files/ NYSDEC Spills	7/28/1998
7/31/1998	170 gallons	Gasoline	Truck overfilled at the loading rack.	CRPA	Concrete	NYSDEC - #9805432	Spill was contained by concrete berms at the loading rack and was cleaned up.	Mobil Files/ NYSDEC Spills	8/3/1998
1/12/1999	30 gallons	HS #2 Fuel Oil	Truck overfilled at the loading rack.	CRPA	Concrete	NYSDEC - #9812613	Spill was contained by concrete berms at the loading rack and was cleaned up.	Mobil Files/ NYSDEC Spills	1/13/1999
7/2/1999	20 gallons	#2 LSD	Truck overfilled at the loading rack.	CRPA	Concrete	NYSDEC - #9903796	Spill was contained by concrete berms at the loading rack and was cleaned up; debris drummed for disposal.	Mobil Files/ NYSDEC Spills	7/2/1999
8/4/1999	20 gallons	Super Unleaded Gasoline	Truck overfilled at the loading rack.	CRPA	Concrete	NYSDEC - #9905387	Spill was contained by concrete berms at the loading rack and was cleaned up.	Mobil Files/ NYSDEC Spills	8/4/1999
10/13/1999	25 gallons	HS #2 Fuel Oil	Truck overfilled at the loading rack.	CRPA	Concrete	NYSDEC - #9908513	Spill was contained by concrete berms at the loading rack and was cleaned up.	Mobil Files/ NYSDEC Spills	12/30/1999
1/17/2000	3-4 gallons	HS #2 Fuel Oil	Meter overfill onto top of truck as driver pulled out of rack, overfilled product spilled on ground	CRPA	Concrete	NYSDEC - #9911984	Spill was contained by concrete berms at the loading rack and was cleaned up.	Mobil Files/ NYSDEC Spills	1/18/2000
4/17/2000	Unknown	Unknown Petroleum Product	During repair catch basin invert found to be leaking at the tank truck loading rack. Grout concrete at pipe connection to catch basin had deteriorated.	CRPA	Soil	NYSDEC - #0075028	Repaired catch basin pipe connection, backfill excavation with clean soil, free product recovered with vacuum truck.	Mobil Files/ NYSDEC Spills	
Various Dates	Unknown	Crude Oil	Crude oil reportedly drained from the pumps located near tank 86 if they were malfunctioning.	CRPA	Soil	None	Unknown	Current and/or Former ExxonMobil Employees	NA
SOUTHERN TANK YARD AREA (STYA)									
3/12/1987	4,620 gallons	Gasoline	Ruptured flexible connector during transfer from Tank 18 to Tank 99	STYA	Soil	NYSDEC - #8607552 Buffalo Sewer Authority	Release was contained, some went to Main in-ground Oil/Water Separator. No further action required by NYSDEC.	NYSDEC Spills	3/20/1987
1988	Unknown	Distillate Storage	No specific spill mentioned, however, tank inspection indicated that there was a seam leak at the shell to floor joint in the northeast tank quadrant	STYA	Unknown	None	Repairs made	Mobil Tank Records	NA
12/10/1988	10-15 gallons	Jet A Fuel	Tank was out of service for rehabilitation, was tested and being refilled. While filling Tank 87, leak occurred at gate valve.	STYA	Soil (in a diked area)	NYSDEC - #8807485 Albany & Buffalo	Product cleaned from frozen ground; soil removed from area of spill. Approximately 185 lb. of contaminated debris disposed according to NYSDEC Spill Report Form.	Mobil Files/ NYSDEC Spills	2/1/1989
2/17/1989	Unknown	Naptha	Oil found in soil coring for new tank	STYA	Soil	NYSDEC - #8808982	Other spills number were later incorporated in to this one.	NYSDEC Spills	Spill not closed
12/8/1989	25-30 gallons	Diesel Fuel	The tank bottom valve to the fill hose on a contractors 300 gallon diesel tank used to fill diesel equipment was left open, the hose fell to the ground, diesel fuel spilled into Tank 97 yard.	STYA	Soil	NYSDEC - #8908893	Fill hose was secured so it could not vibrate from the diesel tank. Contractor cleaned up spill.	Mobil Files/ NYSDEC Spills	2/28/1990

Table 2. Summary of Spills/Releases in Areas of the Buffalo Terminal to be Investigated, ExxonMobil Oil Corporation, Buffalo, New York

Date of Incident	Quantity	Product	Cause/Source of Spill	Geographic Area	Media Affected	Agency Notified	Action Taken/Comments	Source	Date Spill Closed by NYSDEC
12/26/1989	< 1 gallon	Recovered product	Overfill protection system on the recovery tank for the product recovery system was defective and did not shut off when capacity reached, causing oily water to spurt from top of tank.	STYA assumed due to location of product plume	Tank Shell, Concrete Pad	NYSDEC - Buffalo notified on1/2/90 - no spill number	Pump setting was rechecked; other tanks checked also. Product on concrete pad and tank shell cleaned.	Mobil Files	NA
1990	Unknown	Regular Gasoline	No specific spill indicated, however, tank maintenance records indicate coating deterioration and an exterior tank shell and floor joint.	STYA	Unknown	None	Repairs made, epoxy coating applied to tank floor and double bottom installed.	Mobil Tank Records	NA
4/12/1991	10-15 gallons	Crude Oil	While shearing an old crude pipe at the former crude scales area, crude oil leaked out onto a stoned area.	STYA	Soil/Stone	NYSDEC - #9100500 Albany & Buffalo	Pipe put in small dumpster; stone excavated and disposed.	Mobil Files/ NYSDEC Spills	4/16/1991
6/9/1991	Unknown	Jet A Fuel	Leaking air eliminator.	STYA (assumed as Jet A tanks are located in this area)	Soil/Stone	NYSDEC - #9102759 Spill Emergency - #74936	Eliminator adjusted and repaired; NYSDEC Spill Report form noted the debris was cleaned up and placed in the biotreatment cell.	Mobil Files/ NYSDEC Spills	6/13/1991
1991	Unknown	Super Unleaded Gasoline	No specific spill mentioned, however, tank inspection records indicated that the tank should be retired due to unacceptable condition of vertical riveted shell seams caused by extreme corrosion activity on the interior.	STYA	Unknown	None	Tank was removed.	Mobil Tank Records	NA
1991	Unknown	Jet A Fuel	No specific spill mentioned, however, tank inspection records indicated that the tank was leaking around the bottom of tank	STYA	Unknown	None	Unknown	Mobil Tank Records	NA
3/29/1993	20 gallons	Gasoline	Product spill adjacent to Tank 75 occurred while transferring from the fix tank to a contractor's tanker truck.	STYA	Asphalt/Soil	NYSDEC - #9214525	Speedy-dri applied; all soil and debris collected and placed in the biotreatment cell.	NYSDEC Spills	5/28/1993
8/4/1993	42,600 gallons	Super Unleaded Gasoline	A contractor left a valve at Tank 20 open while removing a common suction line, believed to be idled, from Tanks 20 and 96. This line was connected to active tank 99. When the valve on Tank 99 was opened to receive a delivery, product	STYA	Soil	NYSDEC - #9305522	Approximately 500 gallons of product were removed from the ground surface using a vacuum truck. The remainder of the gasoline moved from the west side of the containment where the spill occurred, to the east side of the containment, where it	Mobil Files/ NYSDEC Spills	02/03/1994 (note, the NYSDEC spill report says 2/03/1993)
12/11/1998	Unknown	Unknown Petroleum Product	Product observed in monitoring well during MOSF monitoring	STYA	Groundwater	NYSDEC - #9811466	Unknown	NYSDEC Spills	12/17/1998
EASTERN TANK YARD AREA (ETYA - Former Disposal Area)									
8/28/1989	6500 gallons	Unleaded gasoline	Overfill from Mobil pipeline at Tank 176 due to incorrect safe fill and high alarm heights used.	ETYA	Soil	NYSDEC - #8905279 Albany & Buffalo Buffalo Fire Department	Area was barricaded; approximately 2800 gallons of product was removed with a vacuum truck; safe fill and alarm heights on tank were revised, monitoring wells installed. The containment berm for this tank and Tank 175 were lined during the	Mobil Files/ NYSDEC Spills	6/11/1991

Table 2. Summary of Spills/Releases in Areas of the Buffalo Terminal to be Investigated, ExxonMobil Oil Corporation, Buffalo, New York

Date of Incident	Quantity	Product	Cause/Source of Spill	Geographic Area	Media Affected	Agency Notified	Action Taken/Comments	Source	Date Spill Closed by NYSDEC
BUFFALO RIVER/BSPA									
8/29/1988	Sheen	Unknown Petroleum Product	Sheen identified on the Buffalo River coming from the BSA Outfall.	BSPA/RIVER	Buffalo River	NYSDEC - #8804710 Buffalo Sewer Authority	Unknown	NYSDEC Spills	9/12/1988
10/19/1989	Sheen	Unknown Petroleum Product	Sheen identified on the Buffalo River coming from the BSA Outfall.	BSPA/RIVER	Buffalo River	NYSDEC - #8907130	Unknown	NYSDEC Spills	11/2/1989
7/6/1990	Sheen	Unknown Petroleum Product	Sheen identified on the Buffalo River coming from the BSA Outfall.	BSPA/RIVER	Buffalo River	NYSDEC - #9003889 USCG, Buffalo Sewer Authority	NYSDEC Spill Report Form noted it was a one time incident and no further action was necessary.	NYSDEC Spills	7/9/1990
12/9/1991	Sheen	Unknown Petroleum Product	Oil substance discovered coming from BSA Outfall.	BSPA/RIVER	Buffalo River	NYSDEC - #9109562, Buffalo Sewer Authority, NRC - #98855, Buffalo Fire Department, USCG	Boom and absorbents deployed 12/9/91 and removed 12/11/91.	Mobil Files/ NYSDEC Spills	12/31/1991
4/11/1992	Sheen	Unknown Petroleum Product	Sheen identified on the Buffalo River.	BSPA/RIVER	Buffalo River	NYSDEC - #9200434	Unknown	NYSDEC Spills	4/13/1992
4/1/1995	Sheen	Unknown Petroleum Product	Received call from PVS Chemical notifying of sheen on Buffalo River coming from Mobil dock area. An oily sheen observed originating from Mobil bulkhead behind the former Barrel House.	BSPA/RIVER	Buffalo River	NRC - #285244 NYSDEC - #9500007	Installed absorbent pads and vacuum out free oil on the water. Two days later, still leaching product. Mobil continued to change absorbent pads. Well point system inspected for efficiency.	Mobil Files/ NYSDEC Spills	5/15/1995
4/5/1995	Sheen	Unknown Petroleum Product	Petroleum product was observed entering the Buffalo River from the same source as 4/1/95 release. The cause was believed to be a malfunction of the Well Point System.	BSPA/RIVER	Buffalo River	NYSDEC - #950223	Containment booms and absorbents still in place from 4/1/95, Well Point System checked for malfunctions and repairs made.	Mobil Files/ NYSDEC Spills	5/15/1995
10/19/1995	Sheen	Unknown Petroleum Product	Sheen observed on the Buffalo River near the BSA Outfall at the base of Mobil's dock	BSPA/RIVER	Buffalo River	NYSDEC - #9508906 Buffalo Sewer Authority, City of Buffalo, and Erie County	Boom and absorbents deployed.	NYSDEC Spills	11/28/1995
2/20/1998	Sheen	Unknown Petroleum Product	Sheen 5' x 30' along Mobil dock observed, sheen also identified at PVS property and behind Pinto building approximately 82' upstream of the BSA outfall.	BSPA/RIVER	Buffalo River	NRC - #425263 NYSDEC - #9712937	Mobil used vacuum truck to cleanup sheen and installed sorbent boom.	Mobil Files/ NYSDEC Spills	Spill not closed
10/4/1999	Sheen	Unknown Petroleum Product	Sheen observed on the Buffalo River near the BSA Outfall and to the west of Babcock Street approximately 100 ft.	BSPA/RIVER	Buffalo River	NRC - Unknown NYSDEC - #9908124	Installed slick bar boom and sorbent boom. Mobil has maintained boom since October 1999 and inspects the area daily.	Mobil Files/ NYSDEC Spills	Spill not closed
ADMINISTRATIVE OFFICES AND OPERATIONS AREA (AOOA)						US Coast Guard			
4/24/1991	<5 gallons	#6 Fuel Oil	An exchanger from the boiler area was laid down and leaked oil onto a small puddle from heavy rain.	AOOA (assumed since this is area contained boiler house)	Soil/storm water	NYSDEC - #9100966	Absorbents and vacuum truck used to clean area; ends removed from exchanger; exchanger drained.	Mobil Files/ NYSDEC Spills	4/29/1991

Table 2. Summary of Spills/Releases in Areas of the Buffalo Terminal to be Investigated, ExxonMobil Oil Corporation, Buffalo, New York

Date of Incident	Quantity	Product	Cause/Source of Spill	Geographic Area	Media Affected	Agency Notified	Action Taken/Comments	Source	Date Spill Closed by NYSDEC
SPILLS FOR WHICH THE AREA OF OCCURRENCE COULD NOT BE DETERMINED FROM AVAILABLE INFORMATION (UNKNOWN)									
7/17/1987	1 gallon	Gasoline	Gasoline found in trench excavation. (No other information)	Unknown	Unknown	NYSDEC - #8703102	Recovered one gallon.	NYSDEC Spills	8/4/1987
9/7/1989	Unknown	#2 Fuel Oil	Underground tanks failed tightness test.	Unknown	Unknown	NYSDEC - #8905567	Unknown	NYSDEC Spills	11/20/1989
2/2/1990	<1 gallon	Gasoline	Product pipeline test failure	Unknown	Unknown	NYSDEC - #8910543	Product was removed from the pipeline; location of the leak was to be located. Follow-up action by NYSDEC to be made under spill # 8808982.	NYSDEC Spills	12/7/1990
5/18/1991	15-20 gallons	Caustic	Contractor cut 3-inch pipe in pipe rack with a shear with (believed to be) caustic remaining in the pipeline	Unknown	Unknown	NYSDEC - #9101954	Drained the pipe and cleaned area; NYSDEC Spill Report Form noted no further action required.	Mobil Files/ NYSDEC Spills	5/20/1991
7/12/1990	50 gallons	Diesel Fuel	Equipment failure in the diked area (No additional information)	Unknown	Soil	NYSDEC - #9004061	NYSDEC Spill Report Form indicates spill was cleaned up by Mobil.	NYSDEC Spills	7/12/1990
3/24/1992	25 gallons	#6 Fuel Oil	Pipeline severed during construction	Unknown	Soil	NYSDEC - #9113037	Impacted soil removed and placed in the biotreatment cell, no further action required.	NYSDEC Spills	4/3/1992
3/27/1992	50 gallons	Unknown Petroleum Product	Contractor cutting up old piping released residual oil trapped in piping	Unknown	Soil	NYSDEC - #9113176	Spill cleaned up and debris placed in biotreatment cell.	NYSDEC Spills	3/31/1992
7/31/1992	15 gallons	Mixed Product	Oil/water separator overflowed due to rain	Unknown	Soil	NYSDEC - #9205006	Impacted soil removed and placed in the biotreatment cell.	NYSDEC Spills	8/3/1992
9/20/1992	10 gallons	Gasoline	Pressure valve malfunction	Unknown	Soil	NYSDEC - #9207108	Spill cleaned up, no further action required.	NYSDEC Spills	9/21/1992
10/22/1992	5 gallons	Jet Fuel	During demolition, jet fuel leaked from an out of service line	Unknown	Soil	NYSDEC - #9208484	Pipe was blanked; absorbent pads placed; impacted soil removed and placed in the biotreatment cell. No further action	NYSDEC Spills	10/23/1992
3/1/1993	Unknown	Petroleum Product	4,000 cubic yards of contaminated soil (Source not specified)	Unknown	Soil	NYSDEC - #9314328	NYSDEC Spill Report Form noted no further action required.	NYSDEC Spills	3/8/1994
6/23/1993	20 gallons	Unknown Petroleum Product	Unknown	Unknown	Soil/Stone	NYSDEC - #9303750	Soil and stone were excavated and placed in biotreatment cell, no further action required.	NYSDEC Spills	7/23/1993
7/5/1993	40 gallons	Gasoline	Equipment failure	Unknown	Soil/Stone	NYSDEC - #9304257	Impacted soil removed and replaced with new stone; repairs were made, no further action required.	NYSDEC Spills	7/23/1993
1/17/1995	10 gallons	Petroleum Product	Sewer backup due to storm water and runoff	Unknown	Sewer	NYSDEC - #9413823	One cubic yard of soil removed and placed in biotreatment cell; auto dialer installed in the event of high alarm at storm sewer lift	Mobil Files/ NYSDEC Spills	5/15/1995
5/18/1999	30	Diesel Fuel	Product Spill from a tractor trailer onto the road and in the parking lot.	Unknown	Sewer	NYSDEC - #9901860	Speedy-dri applied; contractor cleaned up debris; disposal records provided to NYSDEC; no further action required.	Mobil Files/ NYSDEC Spills	6/7/1999

Table 3. Rationale for Selection of Proposed Sampling and Monitoring Well Locations, Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

Geographic Area	Sample/Well Number	Media to be Sampled for Laboratory Analysis	Analytical Parameters [1, 2]	Approximate Location	Rationale for Selection	Northing	Easting
SOIL BORINGS							
ETYA	SB-87	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Southeast corner of the ETYA within former waste handling area	Characterize soil conditions and delineate separate-phase product (if present) within the former waste handling area	1042505.3	1081625.2
ETYA	SB-88	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Southeast corner of the ETYA within former waste handling area	Characterize soil conditions and delineate separate-phase product (if present) within the former waste handling area	1042552.9	1081684.8
ETYA	SB-89	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Southwest of containment berm for Tanks 175 and 176 between Lakehead pipeline and abandoned ExxonMobil Pipeline	Characterize soil conditions and delineate separate-phase product (if present) in the downgradient of the former waste handling area and the pipelines	1042592.3	1081957.7
ETYA	SB-90	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Within waste handling area in the location of former propane tanks	Characterize soil conditions and delineate separate-phase product (if present) within the former waste handling area	1042762.9	1082019.0
ETYA	SB-91	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	North side of Tank 176 within lined containment area	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of Tank 176	1042942.8	1082213.1
ETYA	SB-92	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	South of Tank 176 within lined containment area and within a former waste handling area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of Tank 176 and former waste handling area	1042764.5	1082282.5
ETYA	SB-93	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	East of Tank 176 within lined containment area and within a former waste handling area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of Tank 176 and former waste handling area	1042877.7	1082369.5
ETYA	SB-94	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	West of Tank 175 within lined containment area and within a former waste handling area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of Tank 175 and former waste handling area	1042909.5	1082451.0
ETYA	SB-95	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	North of Tank 175 within lined containment area and within a former waste handling area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of Tank 175 and former waste handling area	1043139.1	1082508.4
ETYA	SB-96	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Southwest of Tank 175 within lined containment area	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of Tank 175	1042852.0	1082528.1

Table 3. Rationale for Selection of Proposed Sampling and Monitoring Well Locations, Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New Yorl

Geographic Area	Sample/Well Number	Media to be Sampled for Laboratory Analysis	Analytical Parameters [1, 2]	Approximate Location	Rationale for Selection	Northing	Easting
ETYA	SB-97	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	East of Tank 175 within lined containment area and within a former waste handling area	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of Tank 175 and former waste handling area	1042996.4	1082714.0
ETYA	SB-98	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Northeast of MW-4URS within area where black tar/asphalt-like material was observed at the surface	Characterize soil conditions and delineate separate-phase product (if present)	1042883.8	1082745.7
NPSA	SB-99	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Northwest portion of NPSA in the vicinity of former engine house/press room and cilling room	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former structures	1044279.3	1081451.3
NPSA	SB-100	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former tanks and sweater structures	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks and structures	1044190.2	1081607.7
NPSA	SB-101	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former Tanks and pan house	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks and structures	1044209.9	1081742.2
NPSA	SB-102	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former Tanks	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1044089.0	1081736.2
NPSA	SB-103	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former Tanks	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1044014.1	1081971.9
NPSA	SB-104	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former Tanks	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1043909.1	1081936.4
NPSA	SB-105	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO, PCBs	Near northern boundary of the Site, in the location of former car shop, near former tanks and within former waste handling area	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former tanks, structures and waste handling area	1044102.7	1082259.0
NPSA	SB-106	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO, PCBs	Near northern boundary of the Site, near former tanks and within former waste handling area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks and waste handling area	1044081.3	1082401.2

Table 3. Rationale for Selection of Proposed Sampling and Monitoring Well Locations, Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

Geographic Area	Sample/Well Number	Media to be Sampled for Laboratory Analysis	Analytical Parameters $^{1, 2}$	Approximate Location	Rationale for Selection	Northing	Easting
NPSA	SB-107	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO, PCBs	Within waste handling area and inside footprint of former Biotreatment Cell	Characterize soil conditions and delineate separate-phase product (if present)	1043893.2	1082302.2
NPSA	SB-108	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO, PCBs	Near former tanks, within waste handling area and inside footprint of former Biotreatment Cell	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks, Biotreatment Cell and waste handling area	1043889.4	1082155.7
NPSA	SB-109	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO, PCBs	In the location of former inground oil/water separator within waste handling area and inside footprint of former Biotreatment Cell	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former inground oil/water separator and waste handling area/Biotreatment Cell	1043810.1	1082091.1
NPSA	SB-110	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near eastern boundary of the Site, east of the former Biotreatment Cell and waste handling area	Characterize soil/groundwater conditions and delineate separate-phase product (if present)	1043736.8	1082280.3
NPSA	SB-111	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO, PCBs	Near former tanks, within waste handling area and inside footprint of former Biotreatment Cell	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks, Biotreatment Cell and waste handling area	1043717.1	1082098.2
NPSA	SB-112	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO, PCBs	In the location of former Pressed Distillate Units within waste handling area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former structures and waste handling area	1043612.2	1082017.3
NPSA	SB-113	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO, PCBs	Southwest portion of waste handling area	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of waste handling area	1043471.6	1081953.9
NTYA	SB-114	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	South of former Tank 60	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1044219.7	1081019.3
NTYA	SB-115	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Within footprint of former Tank 55	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1044243.2	1081177.9
NTYA	SB-116	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Southwest of former Tanks 52, 93 and tank without desigantion and east of former tank 28	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1043978.0	1081124.3

Table 3. Rationale for Selection of Proposed Sampling and Monitoring Well Locations, Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New Yorl

Geographic Area	Sample/Well Number	Media to be Sampled for Laboratory Analysis	Analytical Parameters $^{1, 2}$	Approximate Location	Rationale for Selection	Northing	Easting
NTYA	SB-117	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	West of former Tank 95 and east of former Tank 94	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1043922.8	1081114.5
NTYA	SB-118	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	West of former Tank 101 and east of former Tank 10	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1043867.5	1081102.4
NTYA	SB-119	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	West of former Tank 351 and east of former Tank 4	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1043805.7	1081088.8
NTYA	SB-120	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	West of former Tank 350 and east of former Tank 2	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1043758.7	1081076.7
NTYA	SB-121	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Southwest of former Tank 33	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1043938.6	1081257.2
NTYA	SB-122	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	West of former Tank 189	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1044083.0	1081385.7
NTYA	SB-123	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	South of former Tank 24	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1043794.3	1081360.0
NTYA	SB-124	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	North of former Tank 21 within former waste handling area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks and waste handling area	1044083.0	1081601.7
NTYA	SB-125	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Within former yard trap/oil water separator between Tanks 21 and 22	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former tanks and former yard trap/oil water separator	1043997.1	1081646.0
NTYA	SB-126	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	East of former Tank 22 and in the location of former Pulp Oil Building and where asphalt/tar-like material was observed at the ground surface	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks and asphalt/tar-like material observed at the surface	1043961.0	1081758.1

Table 3. Rationale for Selection of Proposed Sampling and Monitoring Well Locations, Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

Geographic Area	Sample/Well Number	Media to be Sampled for Laboratory Analysis	Analytical Parameters [1, 2]	Approximate Location	Rationale for Selection	Northing	Easting
FRA	SB-127	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Northwest portion of the FRA south of former loading racks	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former structures	1044428.0	1080596.1
FRA	SB-128	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former Pipe Stills/Condenser Unit and other former refinery structures	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former structures	1044313.8	1080805.5
FRA	SB-129	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former Loading Racks and other former refinery structures	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former loading racks and former refinery structures	1044273.8	1080918.7
FRA	SB-130	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former Tanks	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1044279.8	1080643.6
FRA	SB-131	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former Tanks	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1044194.5	1080587.9
FRA	SB-132	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	In the location of former TCC unit and other former refinery structures	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former structures	1044186.9	1080776.0
FRA	SB-133	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	In the location of former tar box and near former coal sheds, tar stills and loading rack	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former structures	1044165.0	1080946.0
FRA	SB-134	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	East of former Tank 82	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1044097.7	1080455.5
FRA	SB-135	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	In the location of former Houdry Unit/Crude Unit and other former refinery structures	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former structures	1044117.4	1080649.1
FRA	SB-136	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	In the location of former Houdry Unit/Crude Unit, condensers and other former refinery structures	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former structures	1044024.5	1080716.9

Table 3. Rationale for Selection of Proposed Sampling and Monitoring Well Locations, Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

Geographic Area	Sample/Well Number	Media to be Sampled for Laboratory Analysis	Analytical Parameters [1, 2]	Approximate Location	Rationale for Selection	Northing	Easting
FRA	SB-137	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	In the location of former crude shed and near former coal shed	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former structures	1043973.1	1080904.5
FRA	SB-138	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	In the location of the former Sovaformer Area, south of former Crude Oil and Coal Shed and near former tanks	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former structures and tanks	1043852.2	1080893.0
FRA	SB-139	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	In the location of several former tanks	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1043988.4	1080570.9
FRA	SB-140	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	West of former Tank 169	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1043887.2	1080405.8
FRA	SB-141	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	In the location of former Houdry Unit/Crude Unit and other former refinery structures	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former structures	1043865.3	1080668.2
FRA	SB-142	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	In the location of the former Laboratory north of Prenatt Street	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former structures	1043740.7	1080739.3
FRA	SB-143	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former Loading Racks and other former refinery structures	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former loading racks and former refinery structures	1043747.8	1080831.2
FRA	SB-144	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	West side of former Tar Loading Rack north of Prenatt Street and near other former refinery structures	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former structures	1043695.3	1080914.9
FRA	SB-145	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former Loading Racks and former tanks south of Prenatt Street	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former loading racks and tanks	1043620.4	1080608.6
FRA	SB-146	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	In the vicinity of former Pump House and Asphalt Loading Area/Heater and former tanks	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former refinery structures and tanks	1043575.5	1080790.7
FRA	SB-147	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	West of the Safety Building, southeast of the Acid Shed and in the vicinity of former tanks	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former structures and tanks	1043507.2	1080881.0

Table 3. Rationale for Selection of Proposed Sampling and Monitoring Well Locations, Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New Yor

Geographic Area	Sample/Well Number	Media to be Sampled for Laboratory Analysis	Analytical Parameters [1, 2]	Approximate Location	Rationale for Selection	Northing	Easting
FRA	SB-148	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	In the vicinity of the former Acid Treatment/Clay Contacting Area and other former refinery structures	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former structures and tanks	1043426.2	1080888.6
FRA	SB-149	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former Rail Car Loading Rack, former Loading Racks and former tanks	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former structures and tanks	1043501.1	1080569.3
FRA	SB-150	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	In the location of the former Inground Oil/Water Separator located north of the Lift Station and near former tanks	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former Inground Oil/Water Separator and former tanks	1043436.1	1080675.4
FRA	SB-151	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	In the location of former Dissolved Air Flotation Unit (waste handling area)	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former Dissolved Air Flotation Unit/waste handling area	1043391.8	1080591.7
FRA	SB-152	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	North side of former Tank 117 on the west side of the former Main Inground Oil/Water Separator	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former structures and tanks	1043229.4	1080477.9
FRA	SB-153	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Within fourth compartment of Main Inground Oil/Water Separator that was abandoned in-place	Characterize soil conditions and delineate separate-phase product (if present) within the compartments of the Main Inground Oil/Water separator that were abandoned in-place	1043256.7	1080574.2
FRA	SB-154	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Within sixth compartment of Main Inground Oil/Water Separator that was abandoned in-place	Characterize soil conditions and delineate separate-phase product (if present) within the compartments of the Main Inground Oil/Water separator that were abandoned in-place	1043192.7	1080556.1
FRA	SB-155	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Within eighth compartment of Main Inground Oil/Water Separator that was abandoned in-place	Characterize soil conditions and delineate separate-phase product (if present) within the compartments of the Main Inground Oil/Water separator that were abandoned in-place	1043130.4	1080542.5
CRPA	SB-156	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	East side of former Tar Loading Rack north of Prenatt Street	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former Tar Loading Rack	1043669.0	1081050.5

Table 3. Rationale for Selection of Proposed Sampling and Monitoring Well Locations, Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New Yorl

Geographic Area	Sample/Well Number	Media to be Sampled for Laboratory Analysis	Analytical Parameters $^{1, 2}$	Approximate Location	Rationale for Selection	Northing	Easting
CRPA	SB-157	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former Tank 49 and former Ethyl Plant	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tank and Ethyl Plant	1043506.6	1080995.3
CRPA	SB-158	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Southwest side of former filling rack and near Treating, Blending and Shipping Area Structures	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former Filling Rack and other former refinery structures	1043368.3	1081128.1
CRPA	SB-159	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Intersection of two former filling racks, near Treating, Blending and Shipping Area Structures, former tanks and former railroad tracks	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former Filling Rack and other former refinery structures, railroad tracks and tanks	1043445.4	1081218.9
CRPA	SB-160	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	West side of former Filling Rack north of Prenatt Street within former railroad tracks	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former Filling Rack and railroad tracks	1043567.9	1081233.1
CRPA	SB-161	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	East side of former Filling Rack north of Prenatt Street within former railroad tracks	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former Filling Rack and railroad tracks	1043510.4	1081480.3
CRPA	SB-162	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	South of Prenatt Street within former railroad tracks and in location of former paint shed	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former railroad tracks and former paint shed	1043465.1	1081383.5
CRPA	SB-163	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	East side of former Filling Rack south of Prenatt Street within former railroad tracks	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former Filling Rack and railroad tracks	1043405.4	1081365.5
CRPA	SB-164	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	In former Treating, Blending and Shipping Area, near former tanks and south of former Caustic Storage Area	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former structures, tanks and former product release	1043336.5	1081343.6
CRPA	SB-165	Soil	VOCs	In location of the former acid sludge trench	Characterize soil conditions for VOCs since previous investigations did no include sampling for VOCs	1043102.5	1081274.7
CRPA	SB-166	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	West side of former Filling Rack near former Old Storehouse/Rivet Store Room	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former Filling Rack and former structures	1043439.3	1081494.0

Table 3. Rationale for Selection of Proposed Sampling and Monitoring Well Locations, Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

Geographic Area	Sample/Well Number	Media to be Sampled for Laboratory Analysis	Analytical Parameters [1, 2]	Approximate Location	Rationale for Selection	Northing	Easting
CRPA	SB-167	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Within former Alkylation Area and waste handling area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former structures and waste handling area	1043227.2	1081529.5
CRPA	SB-168	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Within former Alkylation Area and Tank 2/waste handling area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former structures and tank/waste handling area	1043199.8	1081454.6
CRPA	SB-169	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Northwest side of active Tank Truck Loading Rack	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity active Tank Truck Loading Rack	1043439.3	1081672.3
CRPA	SB-170	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Northeast side of active Tank Truck Loading Rack	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity active Tank Truck Loading Rack	1043419.7	1081751.5
CRPA	SB-171	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Southeast side of active Tank Truck Loading Rack	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity active Tank Truck Loading Rack	1043336.5	1081729.7
CRPA	SB-172	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Southwest side of active Tank Truck Loading Rack	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity active Tank Truck Loading Rack	1043356.2	1081654.8
CRPA	SB-173	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	In the location of the former Deflorez Cracking Unit/Cross Cracking Unit and other former refinery structures and near former tanks	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former structures and tanks	1043197.6	1081620.8
STYA	SB-174	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former tanks and within waste handling area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks and waste handling area	1043375.9	1080826.8
STYA	SB-175	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former tanks and within waste handling area	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former tanks and waste handling area	1043324.5	1080813.2
STYA	SB-176	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former tanks and within waste handling area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks and waste handling area	1043258.9	1080763.9

Table 3. Rationale for Selection of Proposed Sampling and Monitoring Well Locations, Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

Geographic Area	Sample/Well Number	Media to be Sampled for Laboratory Analysis	Analytical Parameters [1, 2]	Approximate Location	Rationale for Selection	Northing	Easting
STYA	SB-177	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former tanks and within waste handling area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks and waste handling area	1043245.2	1080832.8
STYA	SB-178	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former tanks and within waste handling area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks and waste handling area	1043187.8	1080745.9
STYA	SB-179	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former tanks and within waste handling area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks and waste handling area	1043175.8	1080817.0
STYA	SB-180	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former tanks, pump pad and other former refinery structures	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks and structures	1043340.4	1080959.7
STYA	SB-181	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former tanks and within waste handling area	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former tanks and waste handling area	1043306.5	1081030.8
STYA	SB-182	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Between Tanks 25 and 26 within waste handling area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks and waste handling area	1043245.2	1081163.7
STYA	SB-183	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	South of Tank 99 within lined containment area and former waste handling area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks and waste handling area	1042954.3	1081317.9
STYA	SB-184	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Northwest of Tank 87 within lined containment area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1042772.2	1081256.7
STYA	SB-185	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	East of Tank 104 within lined containment area and in the vicinity of former tanks	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1042673.2	1081440.9
STYA	SB-186	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	South of former Crude Scale House	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former structure	1042899.1	1081731.9

Table 3. Rationale for Selection of Proposed Sampling and Monitoring Well Locations, Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New Yorl

Geographic Area	Sample/Well Number	Media to be Sampled for Laboratory Analysis	Analytical Parameters [1, 2]	Approximate Location	Rationale for Selection	Northing	Easting
STYA	SB-187	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Southwest of Tank 75 within lined containment area and former waste handling area	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks and waste handling area	1043136.4	1081731.9
STYA	SB-188	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Southwest of former Tank 103	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tank	1043217.3	1081914.0
AOOA	SB-189	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near former tanks	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of former tanks	1043686.5	1081347.4
AOOA	SB-190	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Near Main Office wash bays	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of former wash bays	1043591.9	1081559.6
AOOA	SB-191	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Southwest corner of Store House	Characterize soil conditions and delineate separate-phase product (if present) in the vicinity of Store House	1043504.4	1081753.7

Table 3. Rationale for Selection of Proposed Sampling and Monitoring Well Locations, Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

Geographic Area	Sample/Well Number	Media to be Sampled for Laboratory Analysis	Analytical Parameters [1, 2]	Approximate Location	Rationale for Selection	Northing	Easting
AOOA	SB-192	Soil, Groundwater	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Southeast of former tank near former Laboratory Building that currently exists	Characterize soil/groundwater conditions and delineate separate-phase product (if present) in the vicinity of structure and former tank	1043722.6	1081840.7
COMPOSITE SAMPLES OF SOLIDS FROM FORMER MAIN INGROUND OIL/WATER SEPARATOR							
FRA	MAINOWS-1	SOLIDS	VOCS, SVOCS, Metals, TCLP (full suite), corrosivity, reactivity, ignitability	Composite sample of solids comprised of grab samples from four locations within the northernmost compartment of the former Main Inground Oil/Water	Characterize the solids present within the chambers of the former Main Inground Oil/Water that are filled with water	NA	NA
FRA	MAINOWS-2	SOLIDS	VOCS, SVOCS, Metals, TCLP (full suite), corrosivity, reactivity, ignitability	Composite sample of solids comprised of grab samples from four locations within the northernmost compartment of the former Main Inground Oil/Water	Characterize the solids present within the chambers of the former Main Inground Oil/Water that are filled with water	NA	NA
FRA	MAINOWS-3	SOLIDS	VOCS, SVOCS, Metals, TCLP (full suite), corrosivity, reactivity, ignitability	Composite sample of solids comprised of grab samples from four locations within the northernmost compartment of the	Characterize the solids present within the chambers of the former Main Inground Oil/Water that are filled with water	NA	NA
MONITORING WELLS[3]							
FRA	MW-29	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Immediately adjacent to MW-4	Replacement for MW-4 due to inappropriate screened interval for monitoring separate-phase product. MW-4 will be abandoned. Soil at this location will be sampled to characterize soil quality outside the Main Inground Oil/Water Separator.	1043432.2	1080523.5
FRA	MW-30	Soil	VOCs, SVOCs, Metals, TPH DRO, TPH GRO	Immediately adjacent to MW-8	Replacement for MW-8 due to inappropriate screened interval for monitoring separate-phase product. MW-8 will be abandoned. Soil at this location will be sampled to characterize soil quality outside the Main Inground Oil/Water Separator.	1043372.7	1080728.0
FRA	MW-31	NA	NA	Approximately 20 feet east of MW-7	Replacement for MW-7 to delineate extent of separate-phase product in the vicinity of MW-7 and monitor drawdown due to the well point system	1043100.4	1080642.6
STYA	MW-32	NA	NA	Approximately 50 feet north of MW-11	Replacement for MW-11 (moved further north into the product plume) due to inappropriate screened interval for monitoring separate-phase product. MW-11 will be abandoned.	1043081.3	1080996.6
STYA	MW-33	NA	NA	Approximately 20 feet north of ESI-5	Replacement for ESI-5 due to inappropriate screened interval for monitoring separate-phase product. ESI-5 will be abandoned.	1042846.3	1081187.3

1. Where shown, TPH DRO and GRO analyses will only be performed on soil samples, groundwater will not be analyzed for TPH DRO an GRO
2. Where shown, PCB analysis will only be performed on shallow soil samples and groundwater from selected boring locations, not deeper soil samples
3. Additional monitoring wells may be installed in locations selected based upon the results of the Geoprobe soil/groundwater sampling program

Table 4. Projected Number of Field Samples and Field QA/QC Samples[a], Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

Task	Environmental Media	Field Analysis	Parameters	Laboratry Method	Field Samples	Field Duplicates[b]	Trip Blanks[c]	Field Blanks[d]	Total Laboratory Samples
Task 1: Geoprobe Soil	Soil	PID Screening	VOCs	SW-846 8021	212	11	NA	NA	223
Boring/Groundwater			SVOCs	SW-846 8270	212	11	NA	NA	223
Sampling Program			TPH-DRO	SW-846 8015	212	11	NA	NA	223
			TPH-GRO	SW-846 8015	212	11	NA	NA	223
			TAL metals	SW-846 6010B, 7470/7471 for mercury	212	11	NA	NA	223
			PCBs	SW-846 8081	8	1	NA	NA	9
	Groundwater	NA	VOCs	SW-846 8021	29	2	15	NA	46
			SVOCs	SW-846 8270	29	2	15	NA	46
			TAL metals	SW-846 6010B, 7470/7471 for mercury	29	2	15	NA	46
			PCBs	SW-846 8081	3	1	2	NA	6

Notes:

a. These numbers are only estimates. Actual sample numbers are dependent upon field screening results and conditions encountered in the field.

b. Field duplicate frequency based on one duplicate per twenty samples.

c. Trip blanks are not applicable to soil/sediment samples. Trip blanks for groundwater samples are estimated at one per cooler.

d. Field blanks are not required for geoprobe soil/groundwater samples since disposable sampling equipment (i.e., acetate sample liner/diposable tubing) is used.

PID = Photoionization Detector
VOCs = NYSDEC STARS list Volatile Organic Compounds
SVOCs = NYSDEC STARS list Semi-Volatile Organic Compounds
TPH = Total Petroleum Hydrocarbons
DRO = Diesel Range Organics
GRO = Gasoline Range Organics
PCBs = Polychlorinated Biphenyls

Table 5. Existing and Proposed Monitoring Well Construction Details, Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

Existing Monitoring Wells								Proposed Monitoring Wells					
Existing Well Designation	Land Surface Elevation (ft msl)	Existing Well Screen Elevation		Corrected Water Table Elevation at Existing Well		Product Table Elevation at Existing Well		Proposed Well Designation	Proposed Screen Length (ft)	Proposed Screen Interval		Proposed Screen Elevation	
		Top (ft msl)	Bottom (ft msl)	Highest (ft msl)	Lowest (ft msl)	Highest (ft msl)	Lowest (ft msl)			(ft bls)	(ft bls)	Top (ft msl)	Bottom (ft msl)
MW-4	583.3	576.3	566.3	579.8	574.4	583.6	574.6	MW-29	20	2	22	581.3	561.3
MW-8	584.7	575.7	565.7	577.2	569.5	583.6	570.3	MW-30	20	2	22	581.3	561.3
MW-7	583.7	575.2	565.2	NA	NA	573.4	567.0	MW-31	20	5	25	579.7	559.7
MW-11	582.9	571.4	561.4	573.6	568.2	579.3	568.2	MW-32	20	2	22	581.7	561.7
ESI-5	582.3	570.3	560.3	577.5	562.6	578.1	564.4	MW-33	25	2	27	580.9	555.9

ft bls = feet below land surface
ft msl = feet above mean sea level
NA = Not applicable

Table 6. Field Equipment Calibration Requirements and Maintenance Schedule
Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

Equipment Type	Calibration Requirements	Maintenance Schedule
PID	Manufacturer's Directions/ Once per day minimum	Recharge or replace battery. Regularly clean lamp window. Regularly clean and maintain the instrument and accessories.
Personal Protective Equipment	Not Applicable	Integrity/function test prior to donning equipment. Visual inspection for defects/leakage for all reusable gear.
Magnetometer	Manufacturer's Directions	Replace batteries as necessary.
pH Meter	Manufacturer's Directions	Per manufacturer's specifications and as needed based on calibration checks.
Eh Meter	Manufacturer's Directions	Per manufacturer's specifications and as needed based on calibration checks.
Specific Conductance Meter	Manufacturer's Directions	Per manufacturer's specifications and as needed based on calibration checks.
Interface Probe/Water-Level Indicator	Manufacturer's Directions	Replace batteries as necessary.
Surveying Instruments	Appendix A	Regularly clean instruments
Thermometer	Manufacturer's Directions	Regularly check for breakage.

Table 7. Preservation, Holding Times and Sample Containers, Buffalo Terminal, ExxonMobil Oil Coproration, Buffalo, New York

Parameter	Preservation	Holding Time[a]	Sample Size/Container
Soil VOCs	4^{o}C until extraction and analysis (no headspace)	7 days	100 grams
Soil SVOCs	4^{o}C until extraction and	14 days until extraction 40 days until analysis	100 grams
Soil TAL Metals	4°C until extraction and analysis	180 days	200 grams
Soil TPH-DRO	4^{o}C until extraction and analysis (no headspace)	14 days	200 grams
Soil TPH-GRO	4^{o}C until extraction and analysis (no headspace)	14 days	100 grams
Soil PCBs	4°C until extraction and	14 days until extraction 40 days until analysis	100 grams
Aqueous VOCs	4^{o}C until extraction and analysis, HCL to PH<2 (no	7 days	3 x 40 ml
Aqueous SVOCs	4°C until extraction and analysis, $NA_2S_2O_3$	7 days until extraction 40 days until analysis	2 x 1,000 ml
Aqueous TAL Metals	HNO_3 to PH < 2, 4°C until extraction and analysis	180 days (13 days for mercury)	1 liter plastic
Aqueous PCBs	4°C until extraction and analysis, $NA_2S_2O_3$	7 days until extraction 40 days until analysis	2 x 1,000 ml

Notes:

a. From collection until analysis unless otherwise specified

VOCs = NYSDEC STARS list Volatile Organic Compounds
SVOCs = NYSDEC STARS list Semi-Volatile Organic Compounds
TPH = Total Petroleum Hydrocarbons
DRO = Diesel Range Organics
GRO = Gasoline Range Organics
Reduced list TAL Metals - Reduced Target Analyte List for metals includes cadmium, chromium, lead, mercury, lead, nickel, selenium, thallium, and vanadium
PCBs - Polychlorinated Biphenyls
ml = mililiters

Table 8. Laboratory Quality Control Sample Frequency, Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

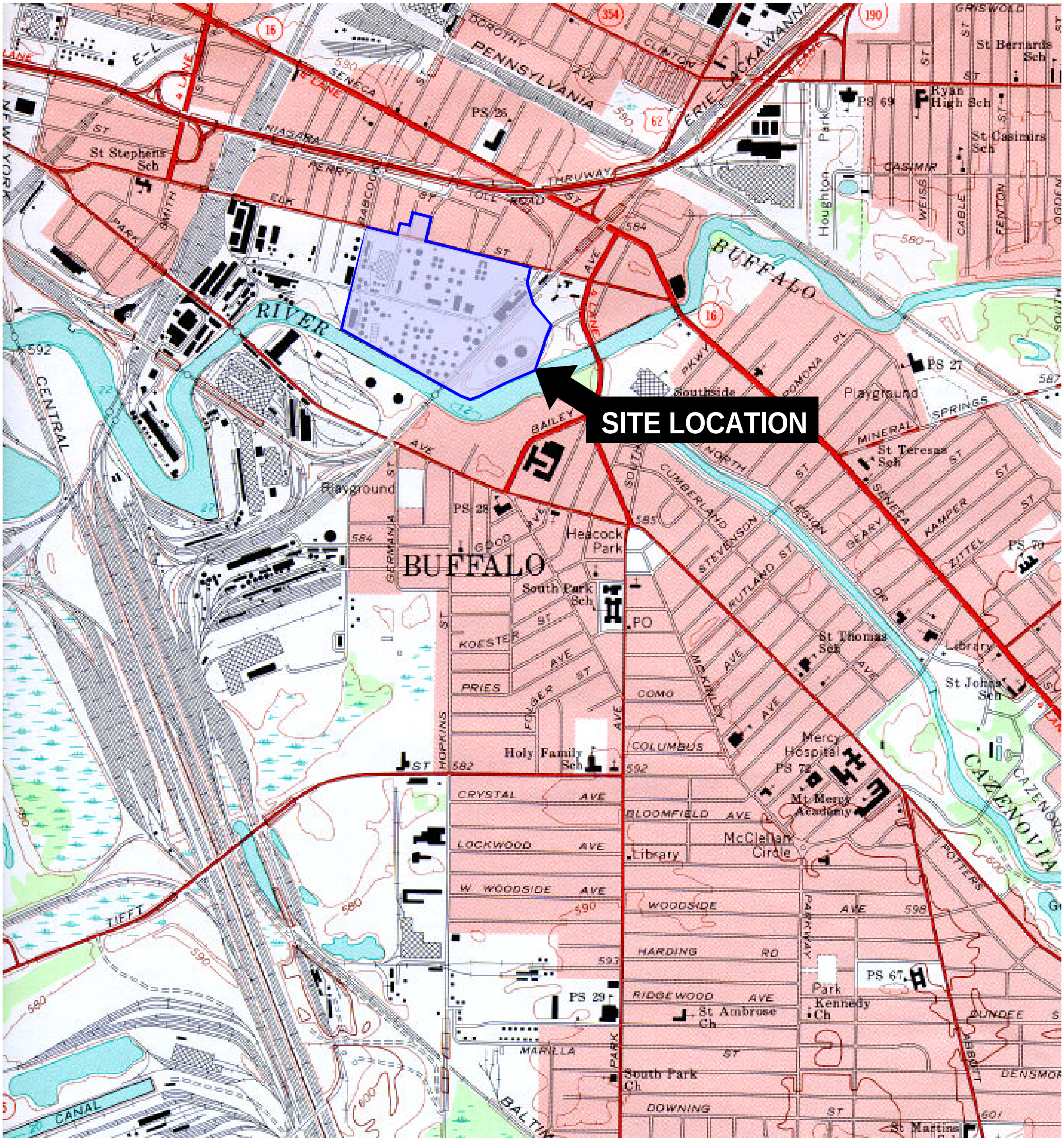
Parameter	Media	Method Blank[a]	MS/MSD[a]	Laboratory Replicate[a]	Analysis Method[b]
VOCs	Soil/Groundwater	1/20	1/20	1/20	8021
SVOCs	Soil/Groundwater	1/20	1/20	1/20	8270
TAL Metals	Soil/Groundwater	1/20	1/20	1/20	6010, 7470/7471 for mercury
PCBs	Soil/Groundwater	1/20	1/20	1/20	8081
TPH-DRO	Soil	1/20	1/20	1/20	8015
TPH-GRO	Soil	1/20	1/20	1/20	8015

NA - Not applicable

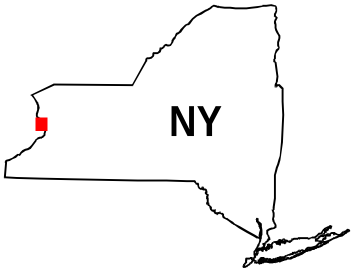
a. Where applicable, one per twenty or fewer field samples, or one per sample delivery group, whichever is more frequent

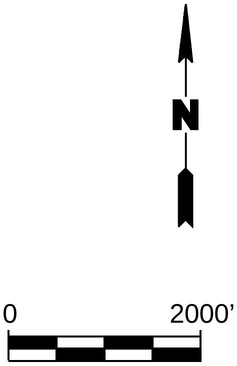
b. Test Methods for the Evaluation of Solid Wastes, SW-846, 3rd Addition

MS/MSD = Matrix Spike/Matrix Spike Duplicate
VOCs = NYSDEC STARS list Volatile Organic Compounds
SVOCs = NYSDEC STARS list Semi-Volatile Organic Compounds
TPH = Total Petroleum Hydrocarbons
DRO = Diesel Range Organics
GRO = Gasoline Range Organics
PCBs = Polychlorinated Biphenyls
Reduced list TAL Metals - Reduced Target Analyte List for metals includes cadmium, chromium, lead, mercury, lead, nickel, selenium, thallium, and vanadium



QUADRANGLE LOCATION





SOURCE:
USGS; 1965, Buffalo SE, New York
7.5 Minute Topographic Quadrangle

Title:

SITE LOCATION MAP

BUFFALO TERMINAL

Prepared for:

EXXONMOBIL OIL CORPORATION

ROUX
ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled by: N.C.	Date: 11JUL01	FIGURE
Prepared by: R.K.	Scale: AS SHOWN	1
Project Mgr.: N.C.	Office: NY	
File No.: MC5216207.CDR	Project No.: 17252Y03	

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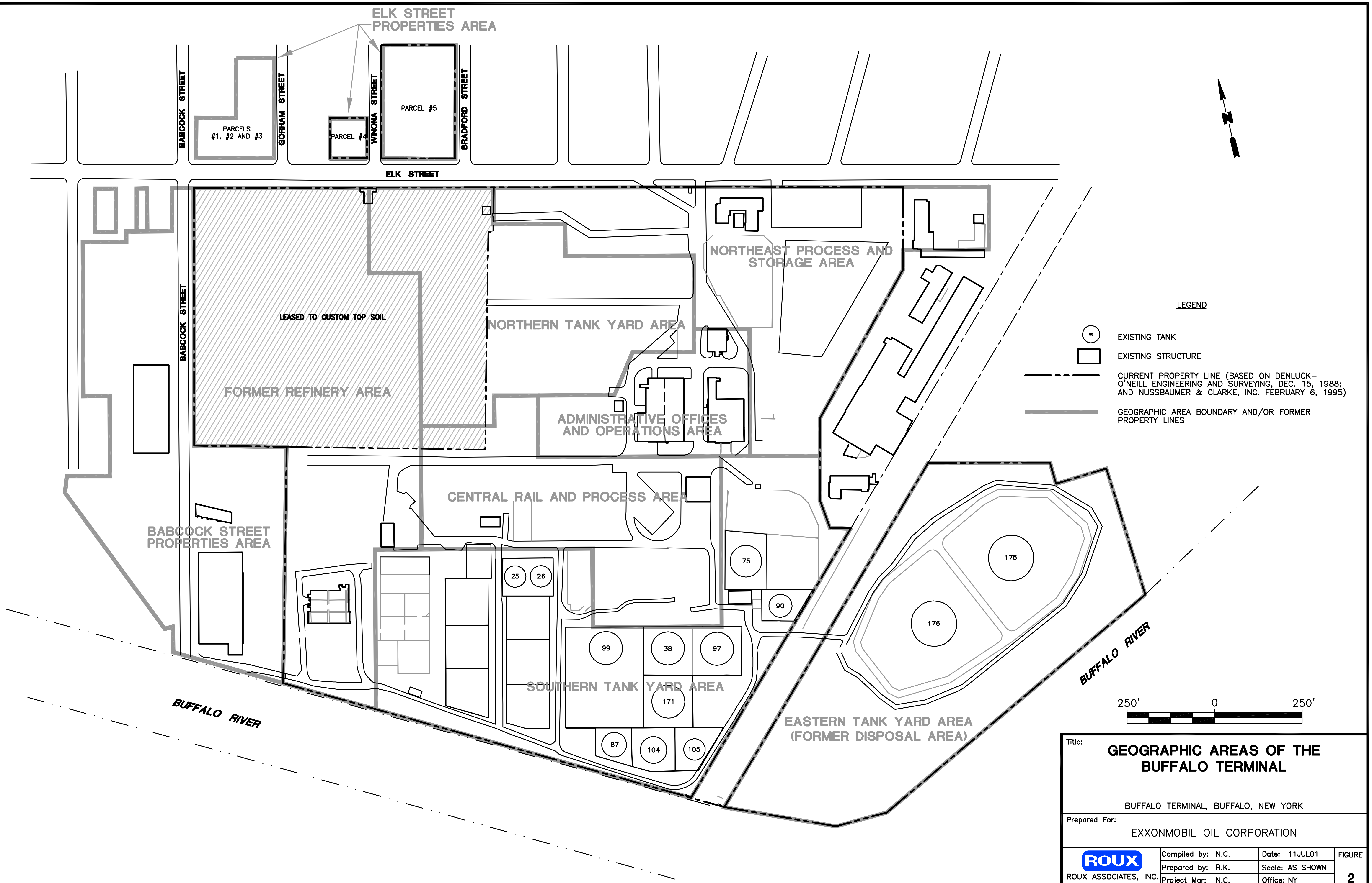

Title:

GEOGRAPHIC AREAS OF THE BUFFALO TERMINAL

BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For:

EXXONMOBIL OIL CORPORATION

ROUX
ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled by: N.C.	Date: 11JUL01	FIGURE
Prepared by: R.K.	Scale: AS SHOWN	2
Project Mgr: N.C.	Office: NY	
File No: MC5216206	Project: 17252Y03	

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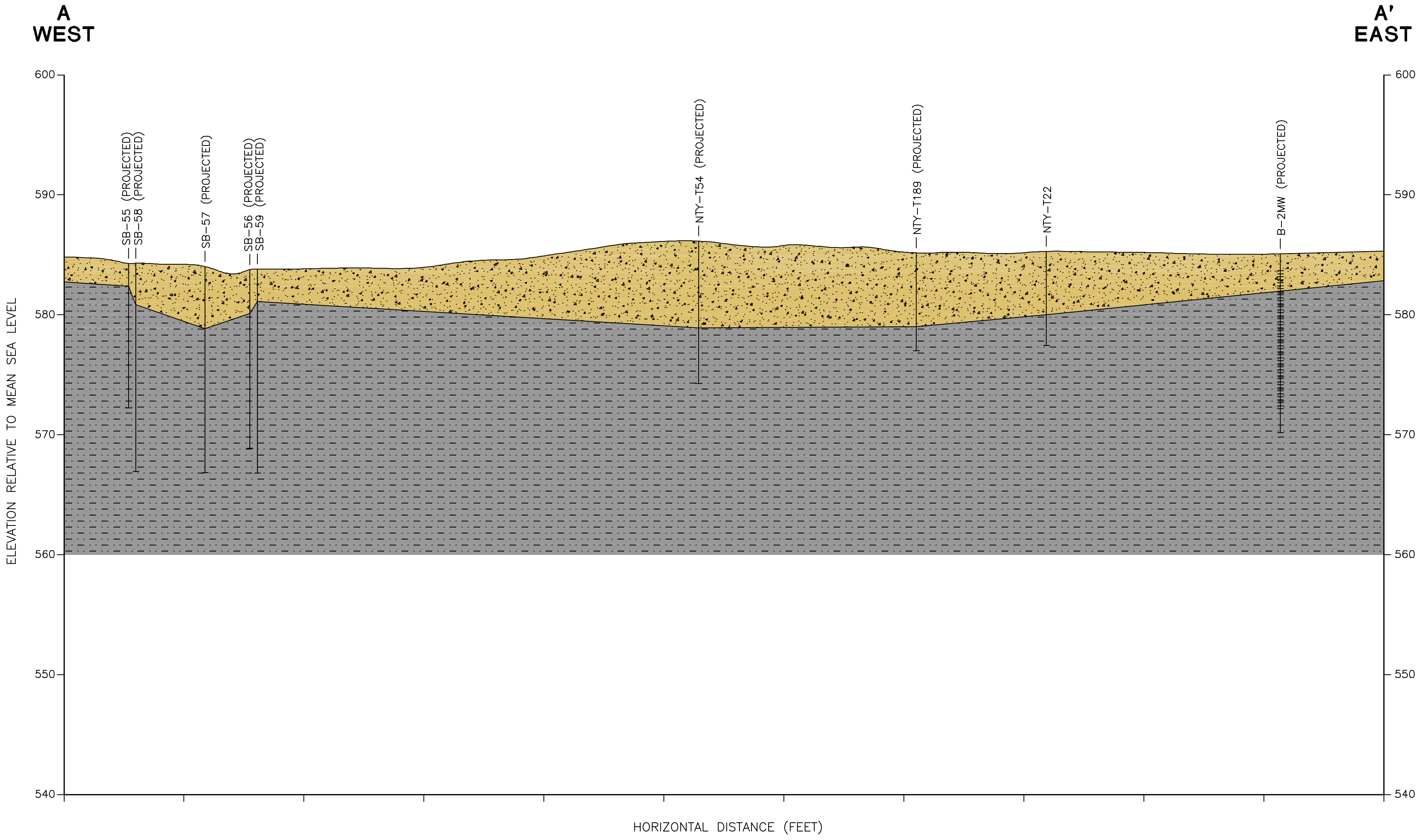


LEGEND

┿ INDICATES MONITORING WELL

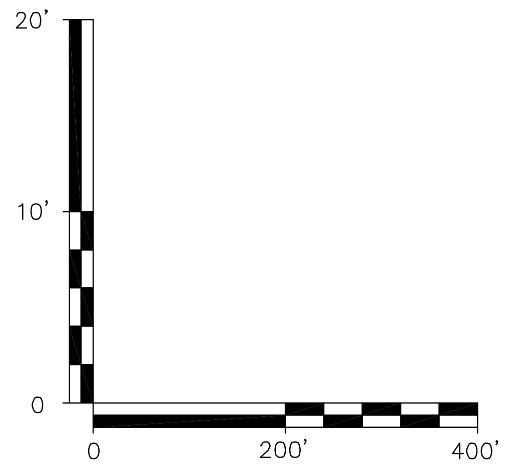
│ INDICATES SOIL BORING

▨ FILL MATERIAL CONSISTING OF BLACK CINDERS, CONCRETE, BRICK, GLASS, SLAG, WOOD, SILT, GRAVEL AND SAND

▤ CLAY (INCLUDES CLAY AND SAND AND CLAY)

NOTES:

1. FOR LOCATION OF SECTION LINES SEE PLATE 1.
2. LAND SURFACE SHOWN IS ALONG THE SECTION CUT LINE, NOT NECESSARILY AT THE WELL LOCATIONS IF WELL ISPROJECTED ONTO THE LINE.
3. DUE TO THE LIMITED NUMBER OF WELLS, THE WATER TABLE ELEVATION IS NOT SHOWN. WATER TABLE ELEVATION AT B-2MW ON APRIL 20, 2001 WAS 582.17 FT ABOVE MEAN SEA LEVEL.



Title:

GENERALIZED HYDROGEOLOGIC CROSS SECTION A-A'

BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For:

EXXONMOBIL OIL CORPORATION

ROUX
ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled by: N.C.	Date: 11JUL01	FIGURE
Prepared by: G.M.	Scale: AS SHOWN	3
Project Mgr: N.C.	Office: NY	
File No: MC5216201	Project: 17252Y03	

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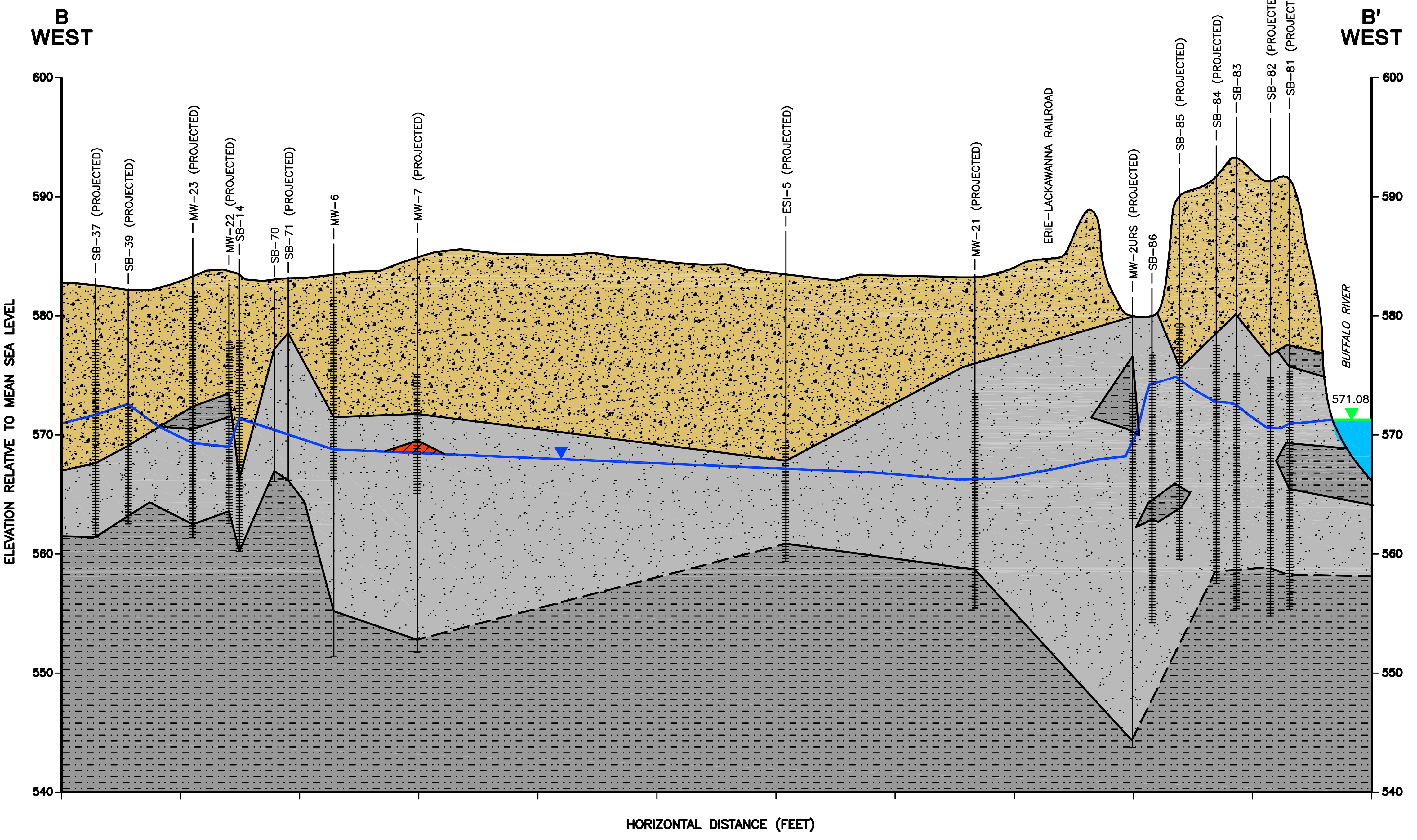

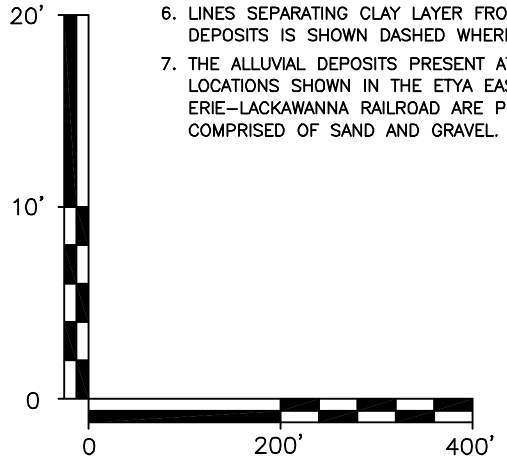

LEGEND

╪	INDICATES MONITORING WELL
│	INDICATES SOIL BORING
▼	GROUNDWATER TABLE ELEVATION IN FEET ABOVE MEAN SEA LEVEL (DASHED WHERE INFERRED)
▼	BUFFALO RIVER ELEVATION IN FEET ABOVE MEAN SEA LEVEL (DASHED WHERE INFERRED)
▨	FILL MATERIAL CONSISTING OF BLACK CINDERS, CONCRETE, BRICK, GLASS, SLAG, WOOD, SILT, GRAVEL AND SAND
▨	ALLUVIAL DEPOSITS (SAND, SAND AND SILT SAND AND GRAVEL, SILT AND SILTY SAND)
▨	CLAY (INCLUDES CLAY AND SAND AND CLAY)
▨	SEPARATE-PHASE PRODUCT

NOTES:

1. FOR LOCATION OF SECTION LINES SEE PLATE 1.
2. LAND SURFACE SHOWN IS ALONG THE SECTION CUT LINE, NOT NECESSARILY AT THE WELL LOCATIONS IF WELL IS PROJECTED ONTO THE LINE.
3. WATER/PRODUCT LEVEL DATA SHOWN WAS COLLECTED ON APRIL 19 AND 20, 2001.
4. WATER LEVEL AND SEPARATE PHASE PRODUCT THICKNESS SHOWN AT MW-7 WAS ESTIMATED BECAUSE PRODUCT WAS TOO THICK FOR PROBE TO PASS.
5. WATER PRODUCT DATA FROM ESI-5 IS NOT SHOWN AS IT IS ANOMOUSLY HIGH (574.74 FEET ABOVE MEAN SEA LEVEL).
6. LINES SEPARATING CLAY LAYER FROM ALLUVIAL DEPOSITS IS SHOWN DASHED WHERE INFERRED.
7. THE ALLUVIAL DEPOSITS PRESENT AT THE WELL LOCATIONS SHOWN IN THE ETYA EAST OF THE ERIE-LACKAWANNA RAILROAD ARE PRIMARILY COMPRISED OF SAND AND GRAVEL.

Title:

GENERALIZED HYDROGEOLOGIC CROSS SECTION B-B'

BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For:
EXXONMOBIL OIL CORPORATION

ROUX
ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled by: N.C.	Date: 12JUNE01	FIGURE
Prepared by: G.M.	Scale: AS SHOWN	4
Project Mgr: N.C.	Office: NY	
File No: MC5216202	Project: 17252Y03	

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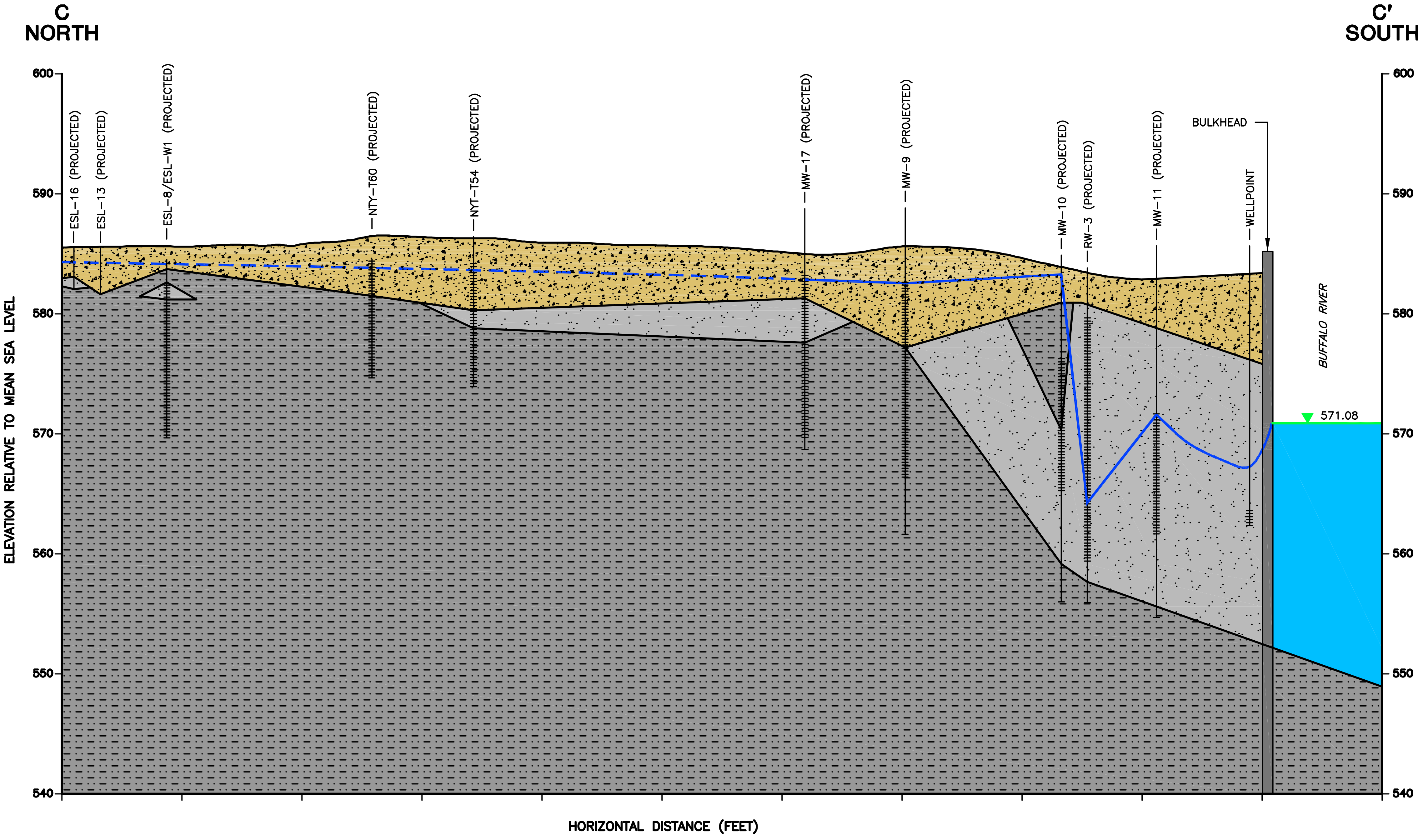
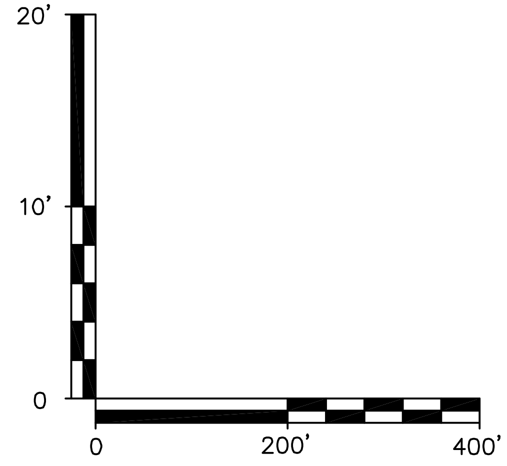


LEGEND

╪	INDICATES MONITORING WELL
│	INDICATES SOIL BORING
▼	WATER TABLE ELEVATION IN FEET ABOVE MEAN SEA LEVEL (DASHED WHERE INFERRED)
▼	BUFFALO RIVER ELEVATION IN FEET ABOVE MEAN SEA LEVEL
▨	FILL MATERIAL CONSISTING OF BLACK CINDERS, CONCRETE, BRICK, GLASS, SLAG, WOOD, SILT, GRAVEL AND SAND
▨	ALLUVIAL DEPOSITS (SAND, SAND AND SILT SAND AND GRAVEL, SILT AND SILTY SAND)
▨	CLAY (INCLUDES CLAY AND SAND AND CLAY)

NOTES:

1. FOR LOCATION OF SECTION LINES SEE PLATE 1.
2. LAND SURFACE SHOWN IS ALONG THE SECTION CUT LINE, NOT NECESSARILY AT THE WELL LOCATIONS IF WELL IS PROJECTED ONTO THE LINE.
3. WATER/PRODUCT LEVEL DATA SHOWN WAS COLLECTED ON APRIL 19 AND 20, 2001.



Title:

GENERALIZED HYDROGEOLOGIC CROSS SECTION C-C'

BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For:

EXXONMOBIL OIL CORPORATION

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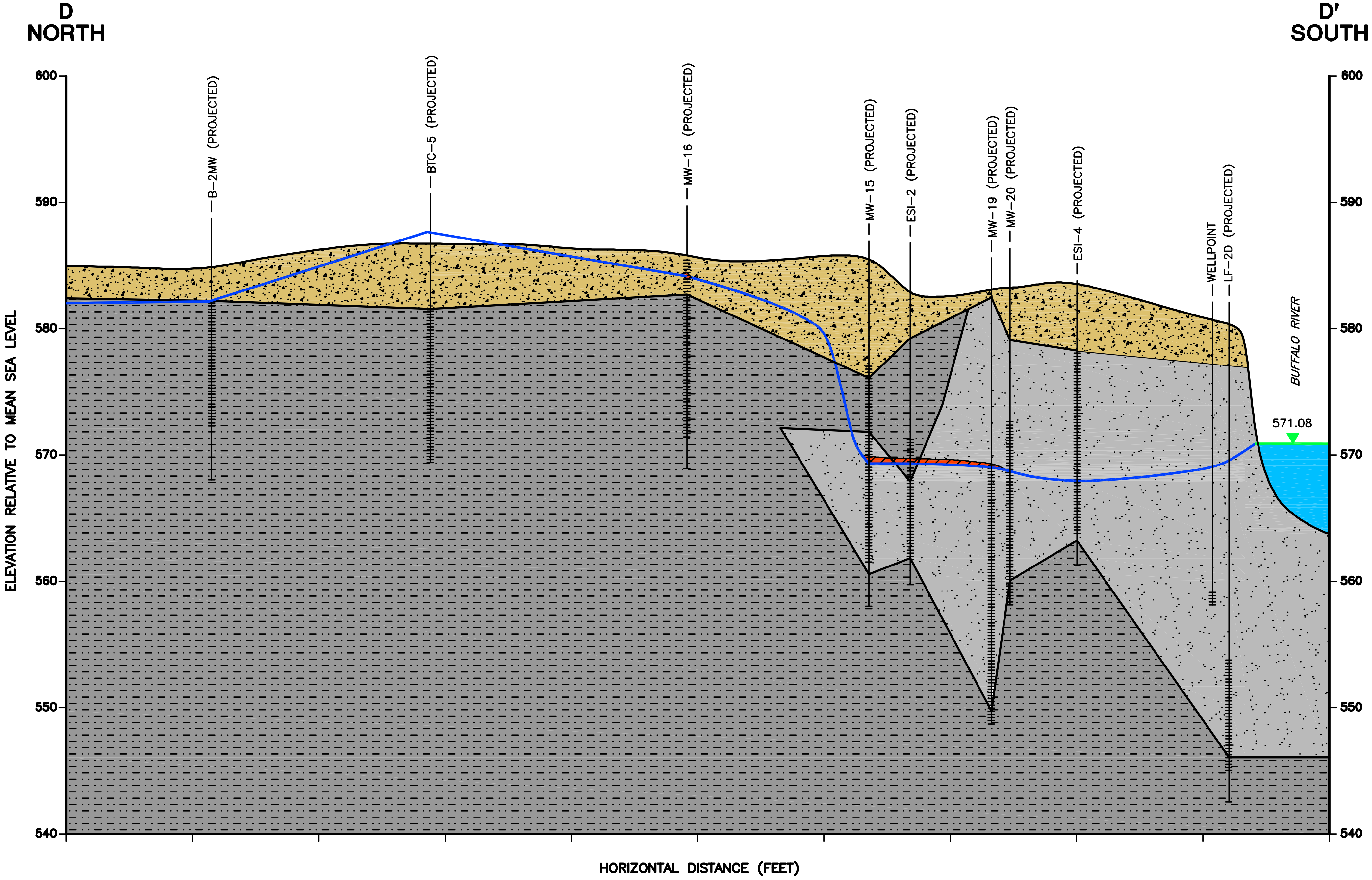
ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled by: N.C.	Date: 12JUNE01	FIGURE
Prepared by: G.M.	Scale: AS SHOWN	5
Project Mgr: N.C.	Office: NY	
File No: MC5216203	Project: 17252Y03	

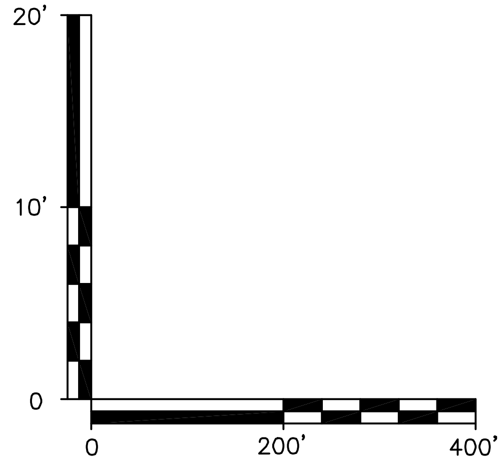


LEGEND

- ╪ INDICATES MONITORING WELL
- | INDICATES SOIL BORING
- ▼ WATER TABLE ELEVATION IN FEET ABOVE MEAN SEA LEVEL (DASHED WHERE INFERRED)
- ▼ BUFFALO RIVER ELEVATION IN FEET ABOVE MEAN SEA LEVEL
- ▨ FILL MATERIAL CONSISTING OF BLACK CINDERS, CONCRETE, BRICK, GLASS, SLAG, WOOD, SILT, GRAVEL AND SAND
- ▨ ALLUVIAL DEPOSITS (SAND, SAND AND SILT SAND AND GRAVEL, SILT AND SILTY SAND)
- ▨ CLAY (INCLUDES CLAY AND SAND AND CLAY)
- 🟥 SEPARATE-PHASE PRODUCT

NOTES:

1. FOR LOCATION OF SECTION LINES SEE PLATE 1.
2. LAND SURFACE SHOWN IS ALONG THE SECTION CUT LINE, NOT NECESSARILY AT THE WELL LOCATIONS IF WELL ISPROJECTED ONTO THE LINE.
3. WATER/PRODUCT LEVEL DATA SHOWN WAS COLLECTED ON APRIL 19 AND 20, 2001.
4. GROUNDWATER ELEVATION AT BTC-5 IS ABOVE GRADE ELEVATION.
5. 0.01 FT OF PRODUCT WAS OBSERVED AT MW-16.



Title:

GENERALIZED HYDROGEOLOGIC CROSS SECTION D-D'

BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For:

EXXONMOBIL OIL CORPORATION

ROUX
ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled by: N.C.	Date: 12JUNE01	FIGURE
Prepared by: G.M.	Scale: AS SHOWN	6
Project Mgr: N.C.	Office: NY	
File No: MC5216204	Project: 17252Y03	

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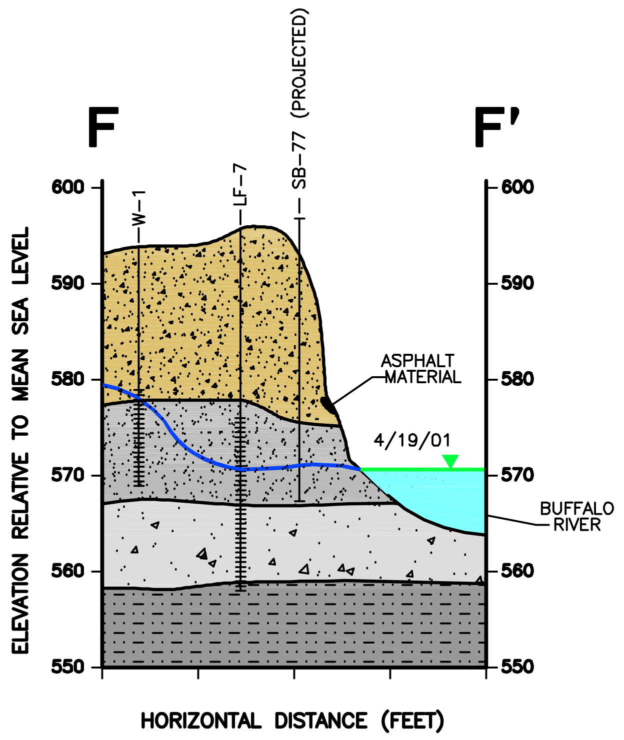
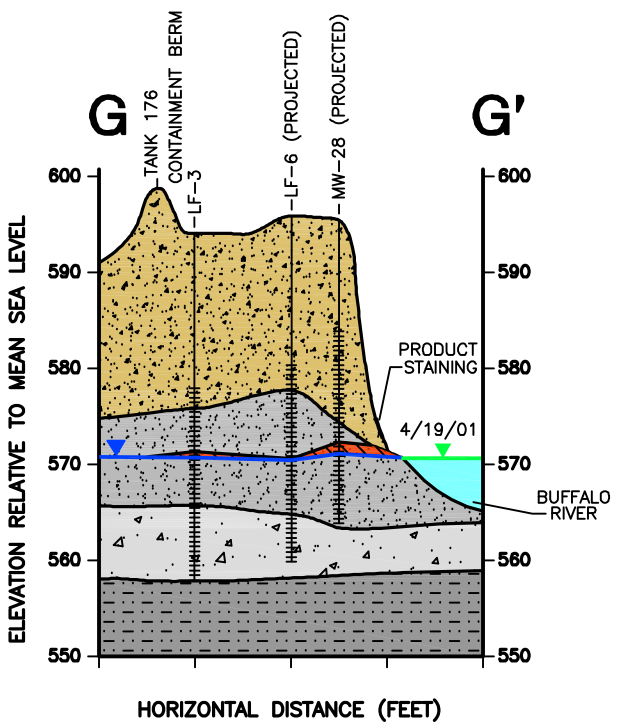
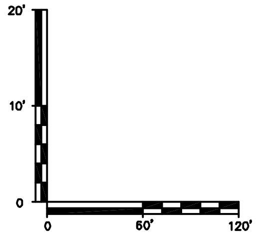
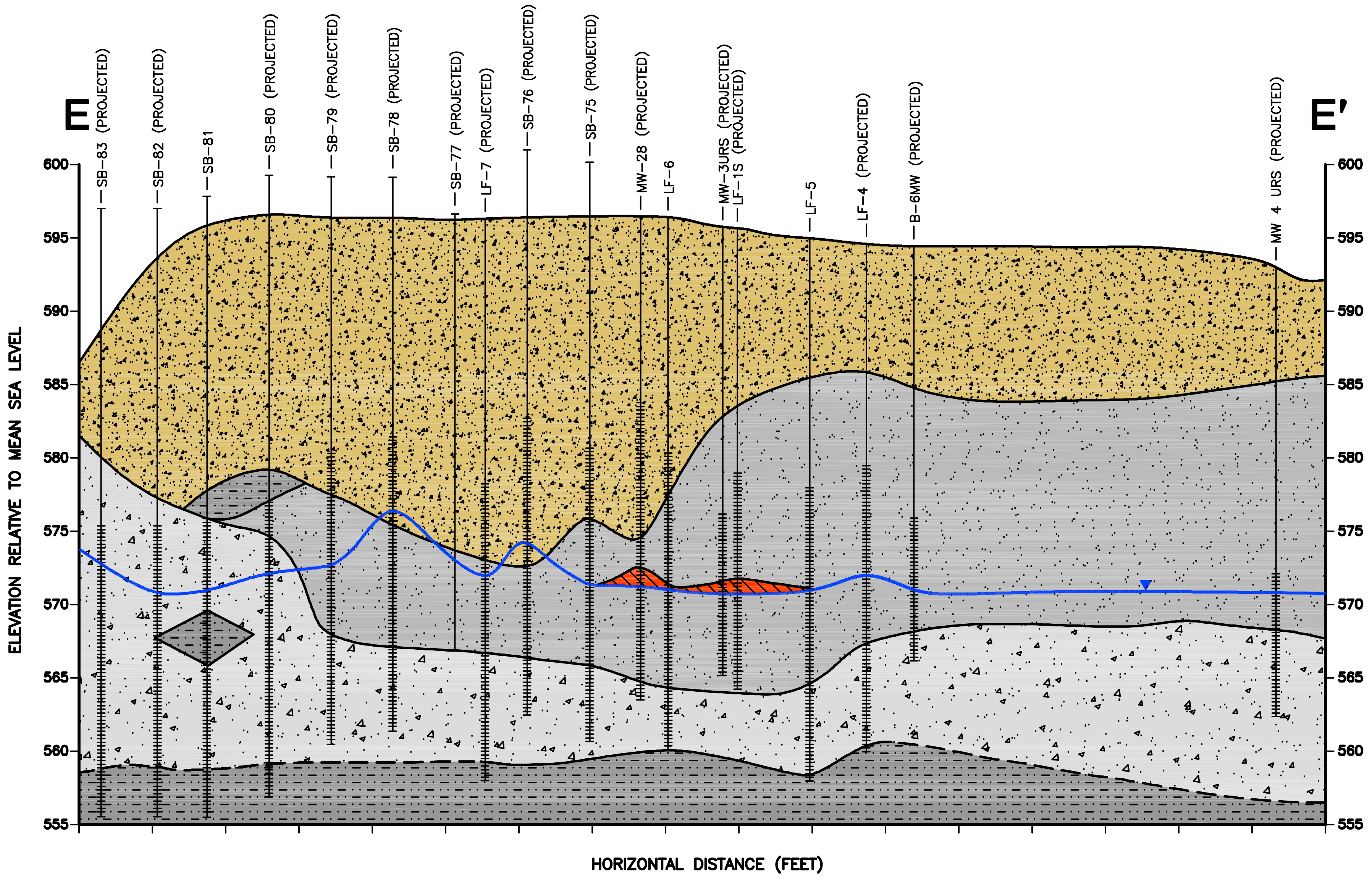


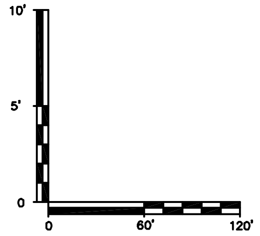




LEGEND

▼	BUFFALO RIVER ELEVATION IN FEET ABOVE MEAN SEA LEVEL
▼	WATER-TABLE ELEVATION IN FEET ABOVE MEAN SEA LEVEL
⫨	INDICATES MONITORING WELL SCREENED INTERVAL
|	INDICATES SOIL BORING
▨	FILL MATERIAL CONSISTING OF BLACK CINDERS, CONCRETE, BRICK, GLASS, SLAG, WOOD, SILT, GRAVEL AND SAND
▨	ALLUVIAL DEPOSITS (SAND, SAND AND SILT, SILTY SAND, SILT)
▨	ALLUVIAL DEPOSITS (SAND AND GRAVEL)
▨	CLAY
▨	SEPARATE-PHASE PRODUCT





NOTES:

1. FOR LOCATION OF SECTION LINES SEE PLATE 1.
2. LAND SURFACE SHOWN IS ALONG THE SECTION CUT LINE, NOT NECESSARILY AT THE WELL LOCATIONS IF WELL IS PROJECTED ONTO THE LINE.
3. MW-28 HAS A SOLAR POWERED PRODUCT RECOVERY PUMP INSTALLED SINCE APRIL 5, 2001.
4. LINES SEPARATING CLAY LAYER FROM SAND AND GRAVEL LAYER ARE SHOWN DASHED WHERE INFERRED.

Title:

GENERALIZED HYDROGEOLOGIC CROSS SECTIONS E-E' F-F' AND G-G'

BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For:

EXXONMOBIL OIL CORPORATION

ROUX
ROUX ASSOCIATES, INC.
Environmental Consulting & Management

Compiled by: N.C.	Date: 10JUL01	FIGURE
Prepared by: G.M.	Scale: AS SHOWN	7
Project Mgr: N.C.	Office: NY	
File No: MC5216205	Project: 17252Y03	

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APPENDIX A

Separate Phase Product
Analytical Results

TABLE 1

FREE PRODUCT CHARACTERIZATIONS
BUFFALO, NY TERMINAL
ENDORSEMENT NO. 98015-SP

SAMPLE INFORMATION

Sample Number:	98-33841-0	98-33842-0	98-33843-0	98-33845-0	98-33866-0	98-33867-0
Date of Sample:	6/15/98	6/15/98	6/15/98	6/15/98	6/16/98	6/16/98
Date Received:	6/22/98	6/22/98	6/22/98	6/22/98	6/22/98	6/22/98
Description on Label:	RW 4 Tank	RW 5 Tank	MW-4	MW-5	ESI 5	Catch Basin
Geographic Area	FRA	FRA	FRA	FRA	STYA	
ANALYTICAL DATA						
API Gravity @ 60° F (TSL LP 78)	36.3	34.4	34.9	27.1	33.8	35.2
Specific Gravity at 60 °F (from API gravity conversion chart)	0.8433	0.8529	0.8504	0.8922	0.8560	0.8488
Composition by High Temperature Simulated Distillation (Mobil Method 1567):						
% Gasoline Range Hydrocarbons	40	30	35	15	30	45
% Diesel Fuel Range Hydrocarbons	50	50	55	45	60	50
% Higher Boiling Hydrocarbons	10	20	10	40	10	5

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TABLE 2

FREE PRODUCT CHARACTERIZATIONS
BUFFALO, NY TERMINAL
ENDORSEMENT NO. 98015-SP

SAMPLE INFORMATION						
Sample Number:	98-33868-0	98-33869-0	98-33870-0	98-33871-0	98-33872-0	98-33873-0
Date of Sample:	6/15/98	6/15/98	6/15/98	6/15/98	6/16/98	6/16/98
Date Received:	6/22/98	6/22/98	6/22/98	6/22/98	6/22/98	6/22/98
Description on Label:	P-15	RW 1 Tank	RW 2 Tank	RW 3 Tank	MW 12	MW 14
Geographic Area	ETYA	STYA	STYA	STYA	STYA	STYA
ANALYTICAL DATA						
API Gravity @ 60° F (TSL LP 78)	29.3	41.8	36.7	33.2	29.1	42.6
Specific Gravity at 60 °F (from API gravity conversion chart)	0.8800	0.8165	0.8413	0.8591	0.8811	0.8128
Composition by High Temperature Simulated Distillation (Mobil Method 1567):						
% Gasoline Range Hydrocarbons	20	60	45	45	10	60
% Diesel Fuel Range Hydrocarbons	80	30	40	45	65	30
% Higher Boiling Hydrocarbons	0	10	15	10	25	10

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TABLE 3

FREE PRODUCT CHARACTERIZATIONS
BUFFALO, NY TERMINAL
ENDORSEMENT NO. 98015-SP

SAMPLE INFORMATION

Sample Number:	98-33874-0	98-33875-0	98-33878-0	98-33879-0	98-33880-0	98-33881-0
Date of Sample:	6/16/98	6/16/98	6/15/98	6/15/98	6/16/98	6/16/98
Date Received:	6/22/98	6/22/98	6/22/98	6/22/98	6/22/98	6/22/98
Description on Label:	MW 15	MW 18	MW 7	MW 8	MW 10	MW 11
Geographic Area	CRPA	STYA	FRA	FRA	STYA	STYA

ANALYTICAL DATA

API Gravity @ 60° F (method)	39.7 (TSL LP 78)	40.8 (TSL LP 78)	16.0 (D 4052)	45.0 (TSL LP 78)	45.9 (TSL LP 78)	39.4 (TSL LP 78)
Specific Gravity at 60 °F (from API gravity conversion chart)	0.8265	0.8212	0.9593	0.8017	0.7976	0.8280
Composition by High Temperature Simulated Distillation (Mobil Method 1567):						
% Gasoline Range Hydrocarbons	45	55	0	60	60	50
% Diesel Fuel Range Hydrocarbons	35	35	10	40	35	45
% Higher Boiling Hydrocarbons	20	10	90	0	15	5

Mobil Business Resources Corp., Laboratory Optimization Group, Paulsboro, NJ 08066
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TABLE 4

FREE PRODUCT CHARACTERIZATIONS
BUFFALO, NY TERMINAL
ENDORSEMENT NO. 98015-SP

SAMPLE INFORMATION

Sample Number:	98-33882-0	98-33883-0	98-33884-0	98-33885-0
Date of Sample:	6/16/98	6/16/98	6/16/98	6/16/98
Date Received:	6/22/98	6/22/98	6/22/98	6/22/98
Description on Label:	MW 19	MW 20	ESI-1	ESI-2
Geographic Area	STYA	STYA	STYA	STYA

ANALYTICAL DATA

API Gravity @ 60° F (TSL LP 78)	39.1	31.1	40.3	38.2
Specific Gravity at 60 °F (from API gravity conversion chart)	0.8294	0.8702	0.8236	0.8338
Composition by High Temperature Simulated Distillation (Mobil Method 1567):				
% Gasoline Range Hydrocarbons	45	10	50	45
% Diesel Fuel Range Hydrocarbons	40	70	35	40
% Higher Boiling Hydrocarbons	15	20	15	15

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TABLE 1

FREE PRODUCT INVESTIGATION
BUFFALO, NY
TERMINAL # 31-010

SAMPLE INFORMATION		
Sample Number:	00-6495	00-6497
Date of Sample:	11/3/00	11/3/00
Date Received:	11/6/00	11/6/00
Sample Description:	**MW-28**	**LF-1S**
Appearance:	Dark brown hydrocarbon in a pint bottle	Dark brown hydrocarbon in a pint bottle
Geographic Area	ETYA	ETYA
ANALYTICAL DATA		
API Gravity @ 60 °F (TSL LP 78)	28.8	28.6
Lead Content, g/gal (ESL LP)	0.00	0.00
High Temperature Simulated Distillation (Mobil Method 1567)		
Initial Boiling Point, °F	250	256
2 % recovered, °F	307	309
5 % recovered, °F	336	336
10 % recovered, °F	370	370
20 % recovered, °F	417	417
30 % recovered, °F	444	444
40 % recovered, °F	475	475
50 % recovered, °F	495	495
60 % recovered, °F	518	520
70 % recovered, °F	543	545
80 % recovered, °F	576	576
90 % recovered, °F	613	613
95 % recovered, °F	648	648
98 % recovered, °F	685	685
Final Boiling Point, °F	752	751
Comparative Hydrocarbon Distribution by Gas Chromatography, GC Fingerprint (ESL LP 26)	The fingerprints of MW-28 and LF-1S show severely biodegraded diesel fuels and are identical to each other.	
Composition by GC/FID, High Temperature Simulated Distillated Distillation and Fingerprint		
% Gasoline	0	0
% Distillate	100	100
% Higher Boiling Material	0	0

ExxonMobil Research & Engineering, Paulsboro Technical Center, Paulsboro, NJ
AJ Malanowicz/DH Richman
November 17, 2000

TABLE 5

FREE PRODUCT CHARACTERIZATIONS
BUFFALO, NY TERMINAL
ENDORSEMENT NO. 98015-SP

SAMPLE INFORMATION

Sample Number:	98-37050-0	98-37054-0	98-37060-0
Date of Sample:	6/24/98	6/26/98	7/1/98
Date Received:	7/8/98	7/8/98	7/8/98
Description on Label:	Storm Sewer	Sewer Drain 3 + 4	MW 3URS
Geographic Area			ETYA

ANALYTICAL DATA

API Gravity @ 60° F (TSL LP 78)	24.9	24.9	28.9
Specific Gravity at 60 °F (from API gravity conversion chart)	0.9047	0.9047	0.8822
Composition by High Temperature Simulated Distillation (Mobil Method 1567):			
% Gasoline Range Hydrocarbons	0	0	15
% Diesel Fuel Range Hydrocarbons	40	70	85
% Higher Boiling Hydrocarbons	60	30	0

Mobil Business Resources Corp., Laboratory Optimization Group, Paulsboro, NJ 08066
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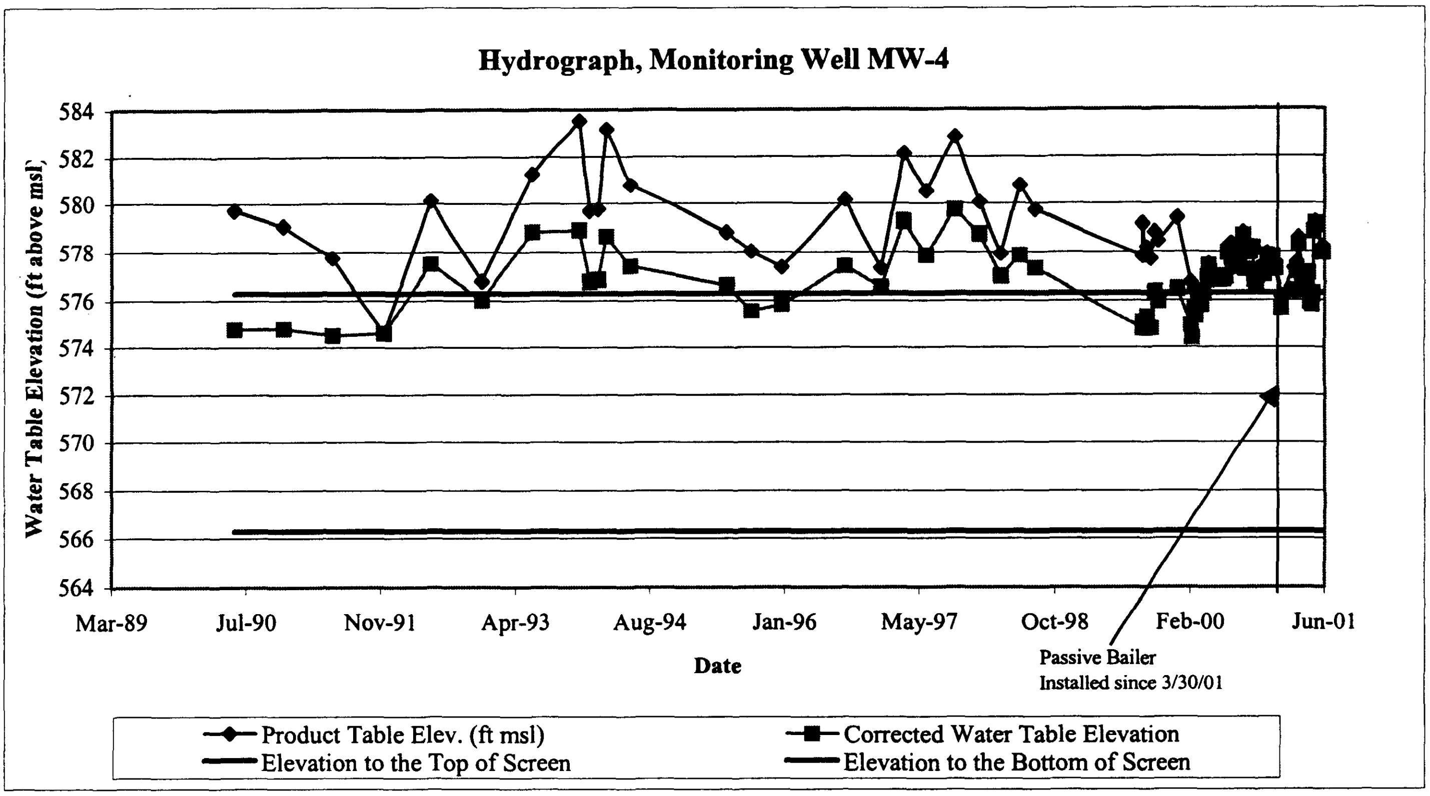
APPENDIX B

Hydrographs

Figure B-1. Hydrographs for MW-4 (FRA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



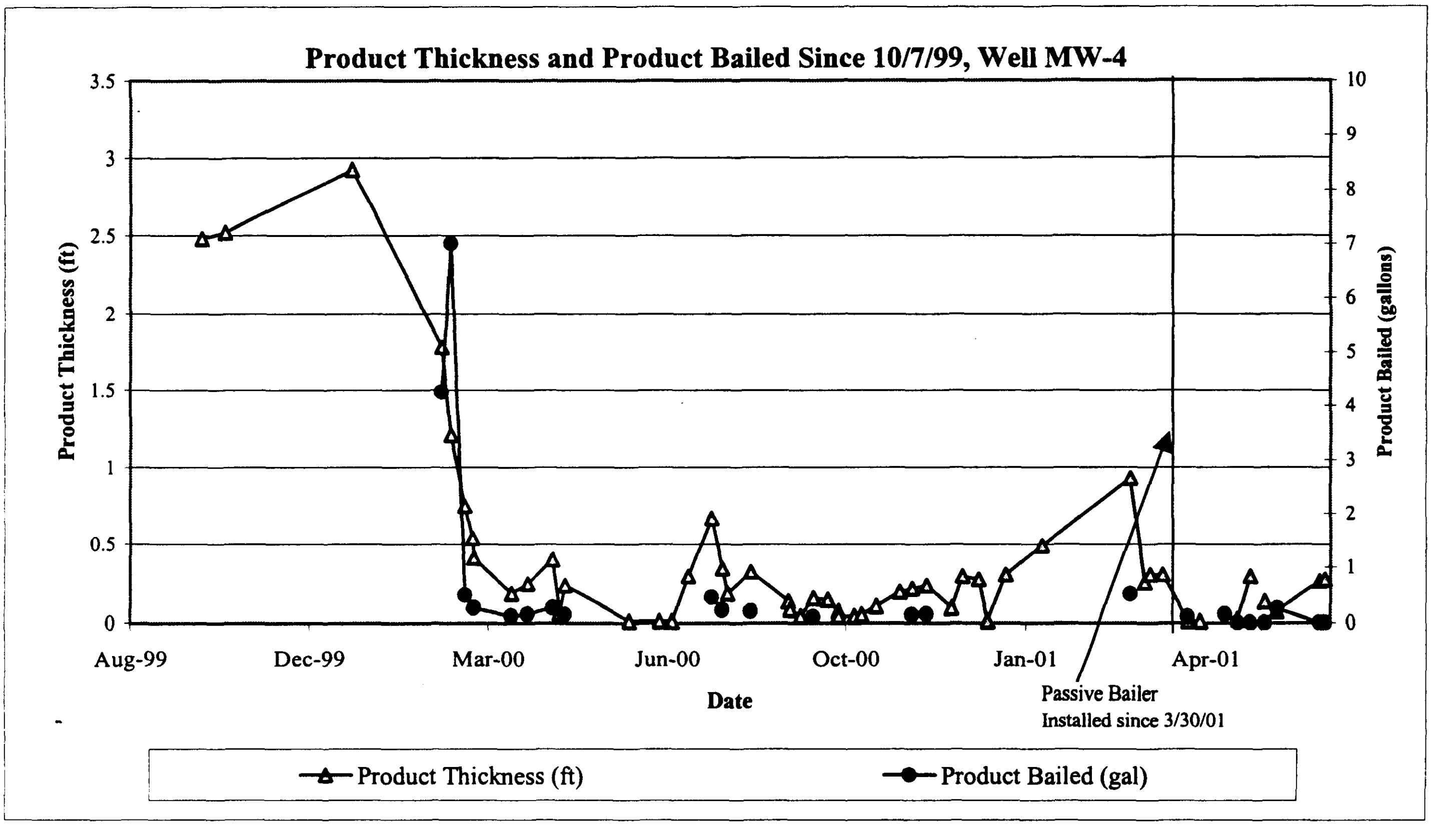
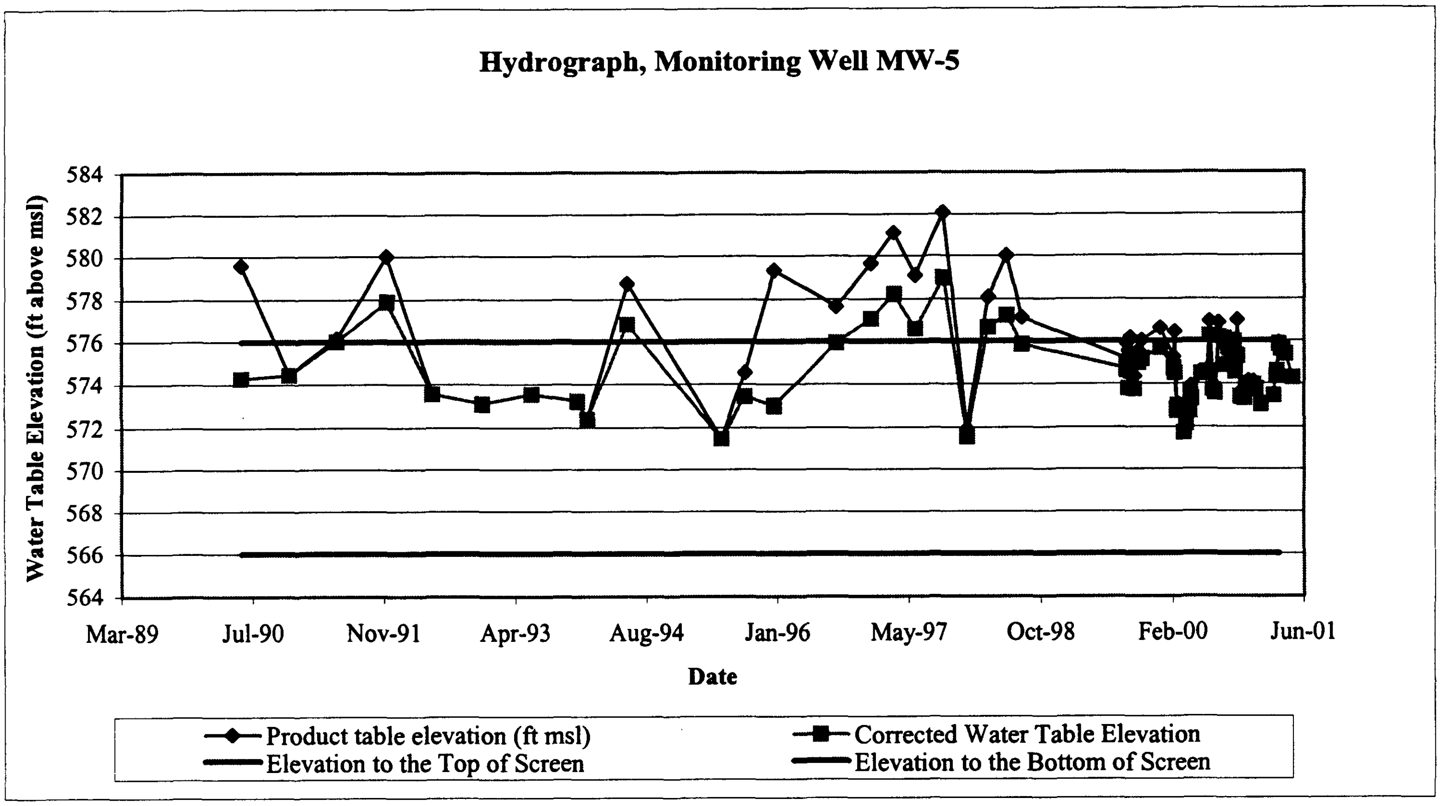


Figure B-2. Hydrographs for MW-5 (FRA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



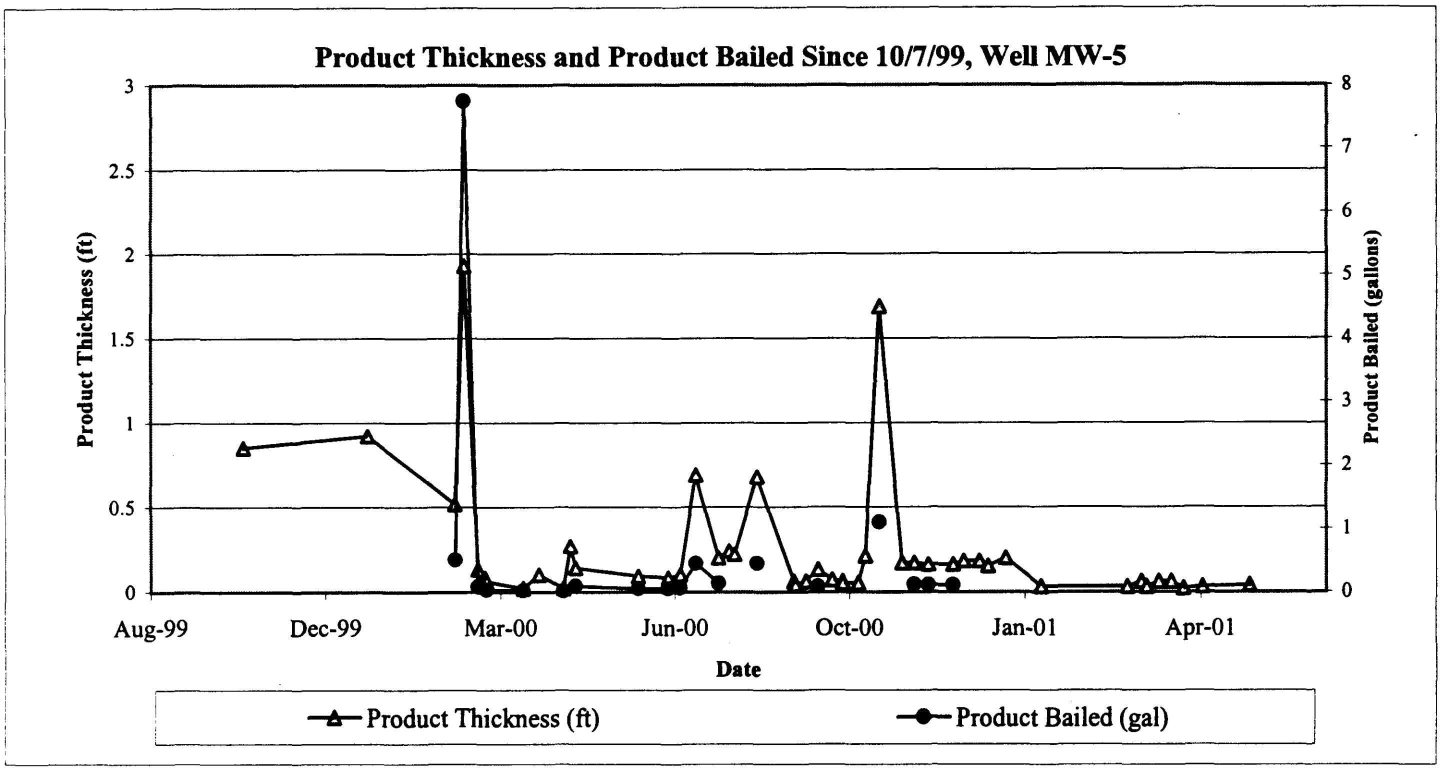
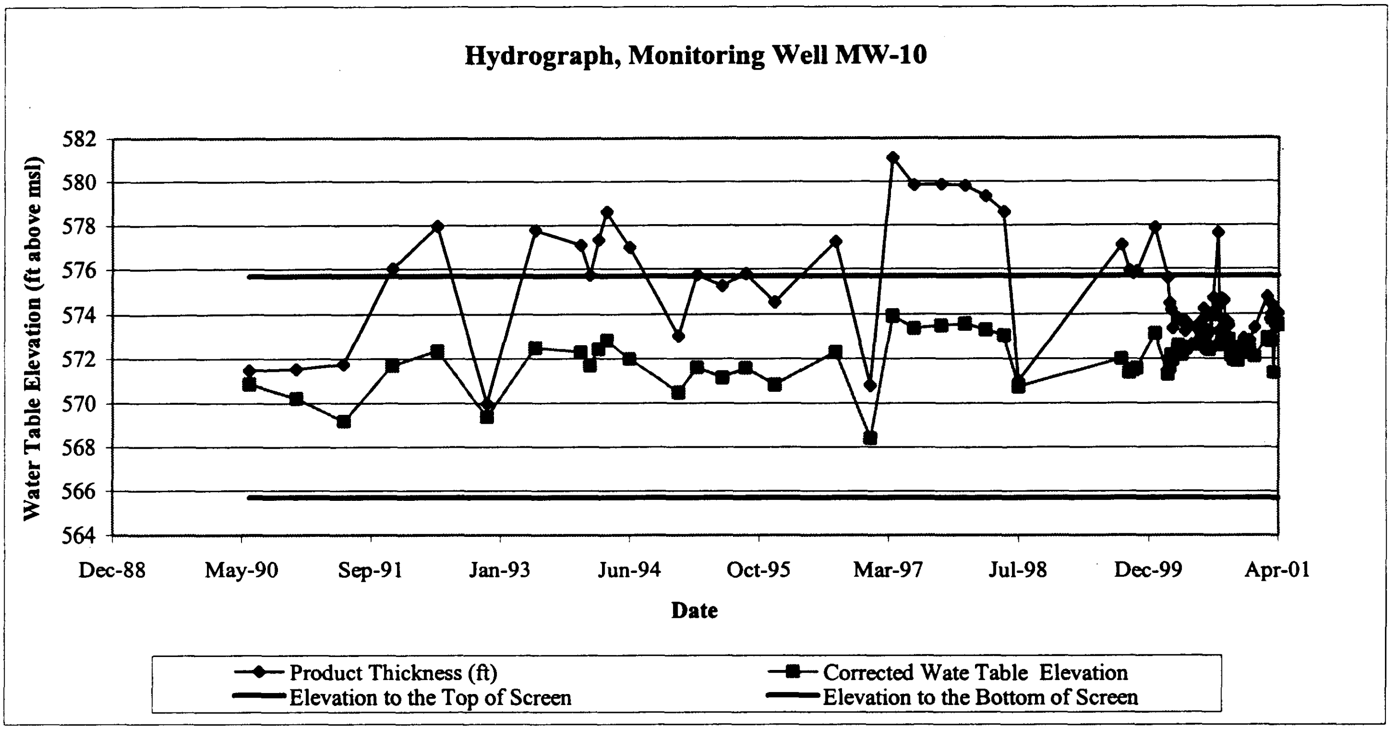


Figure B-3. Hydrographs for MW-10 (STYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



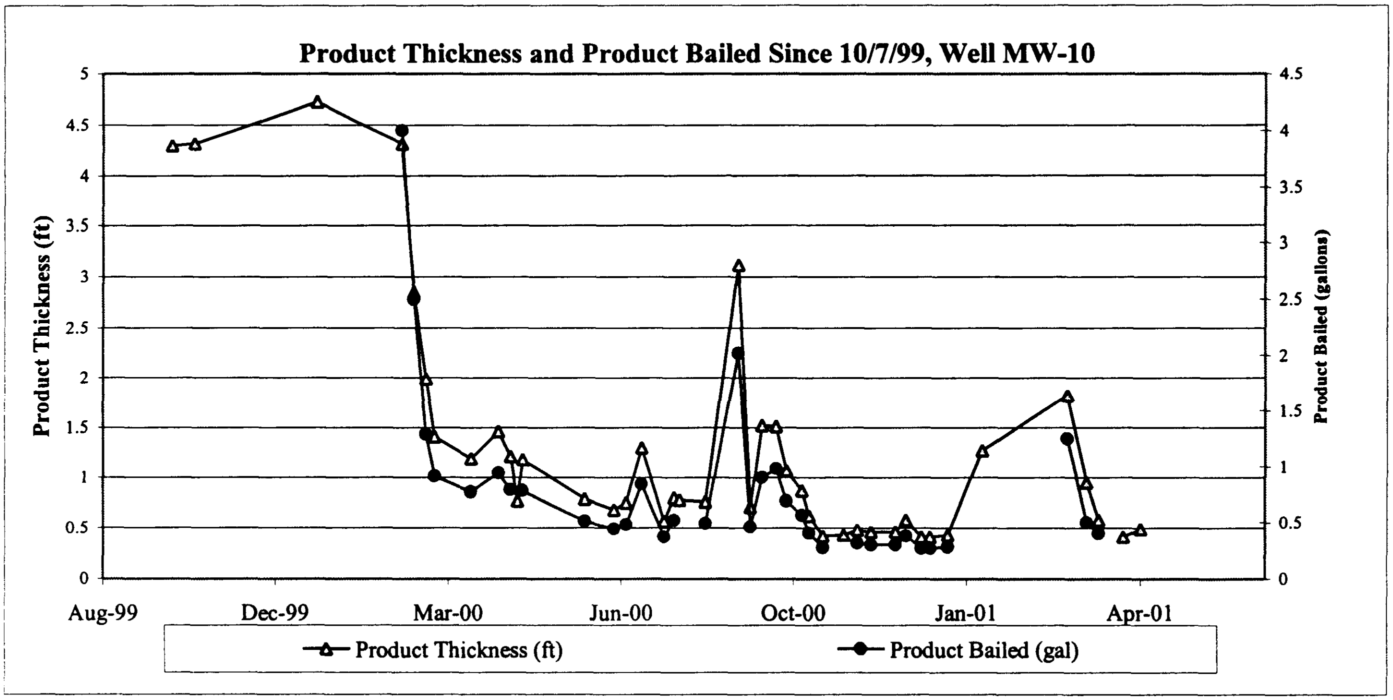
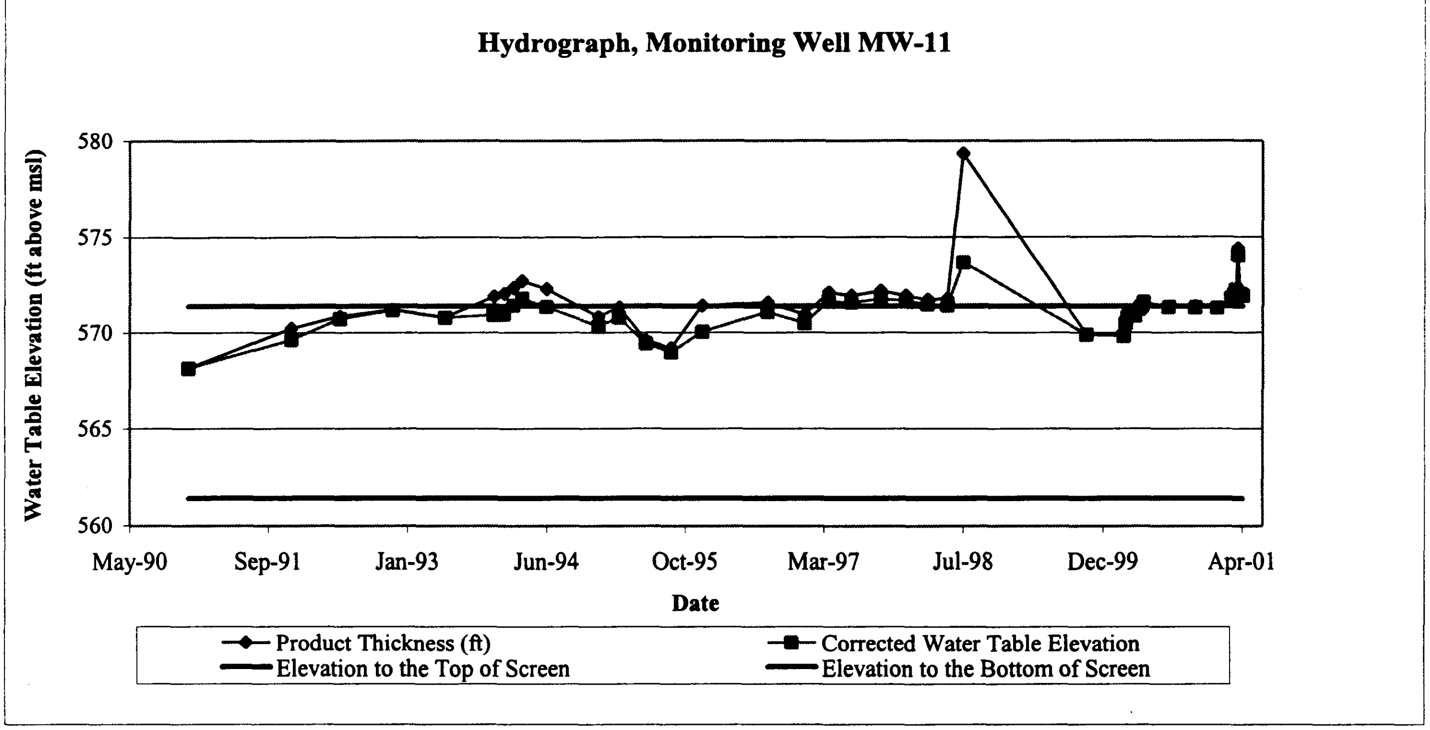


Figure B-4. Hydrographs for MW-11 (STYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



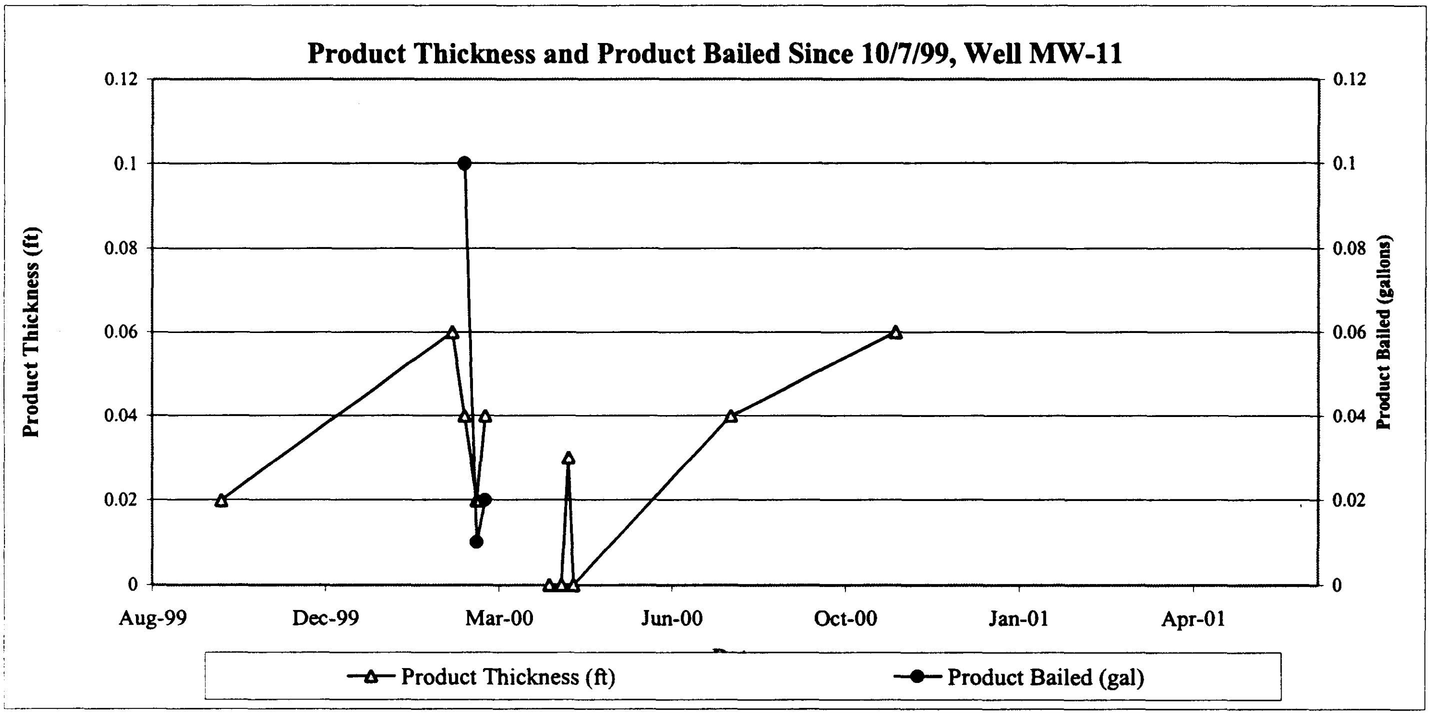
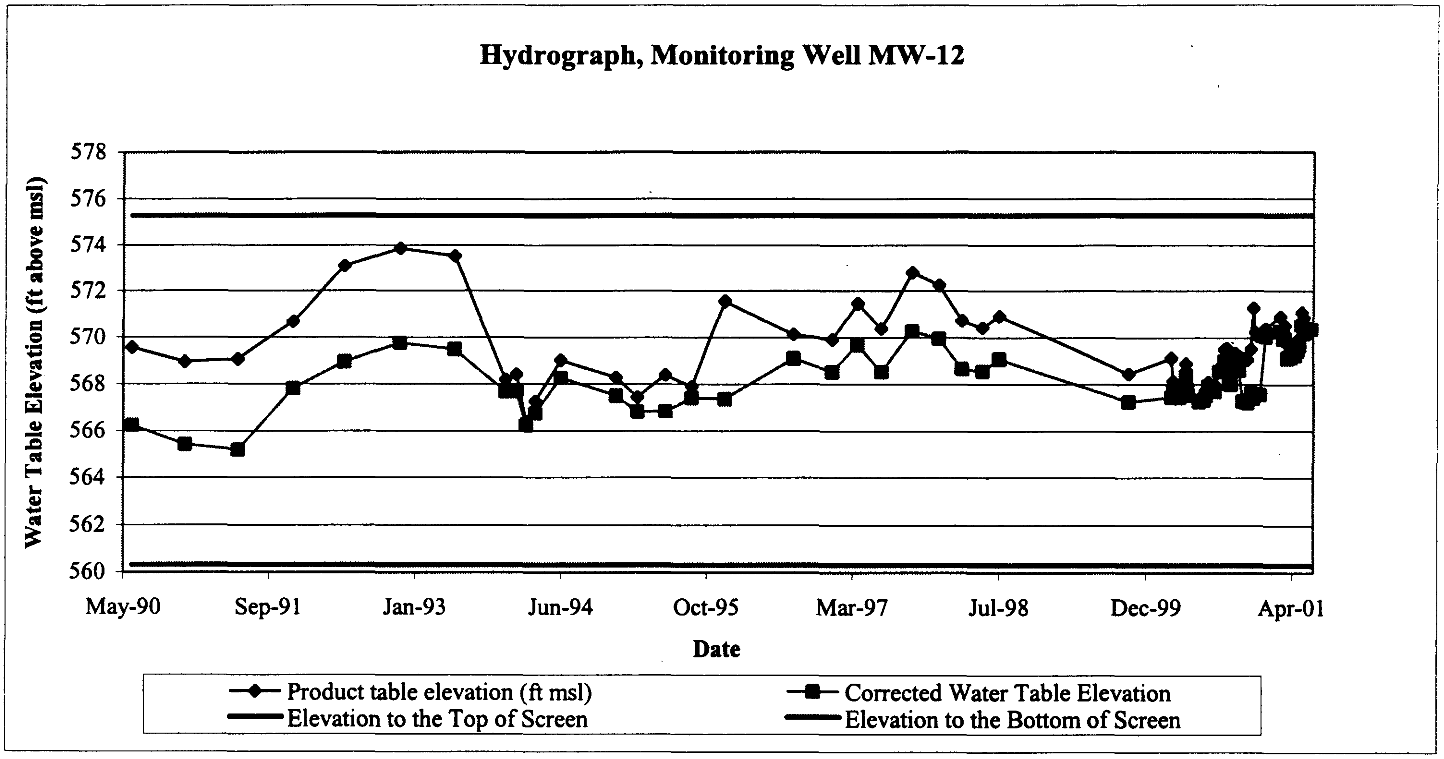


Figure B-5. Hydrographs for MW-12 (STYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



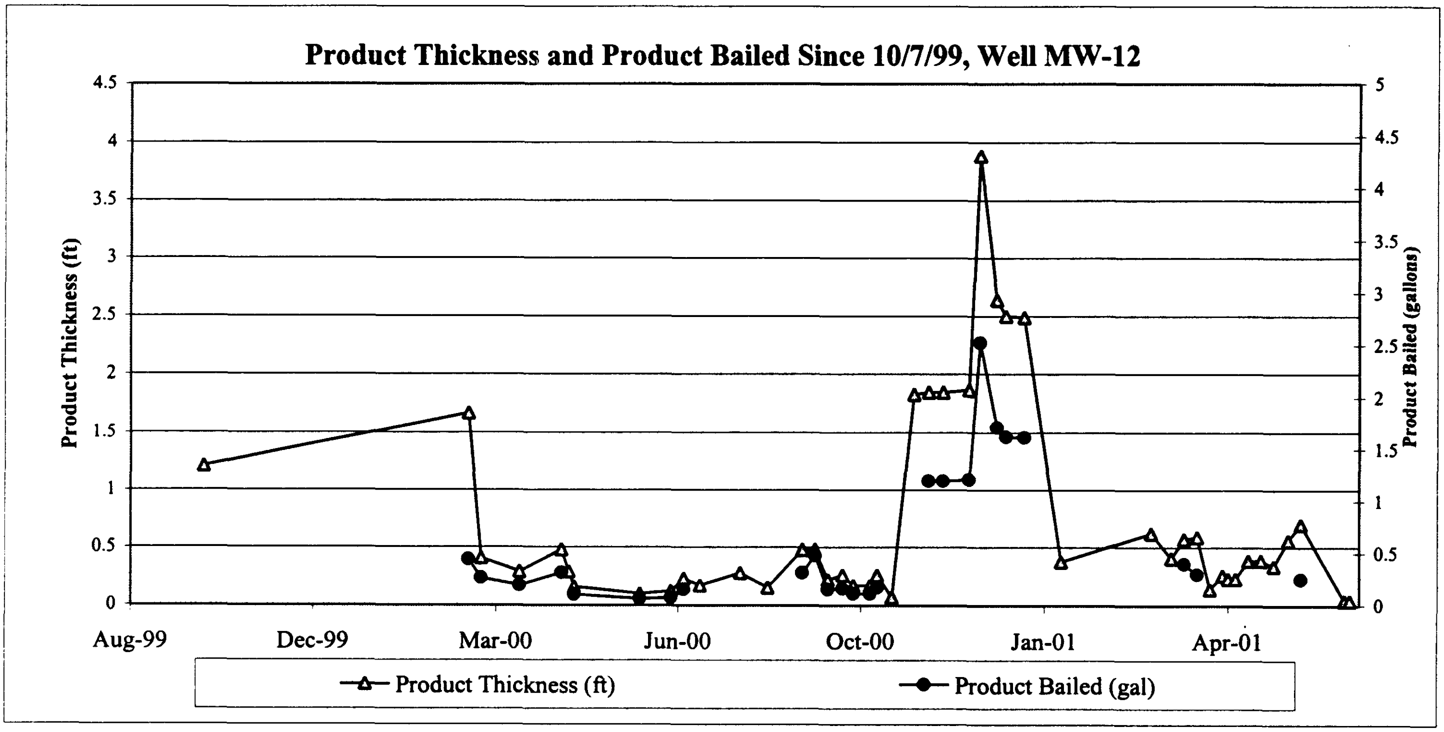
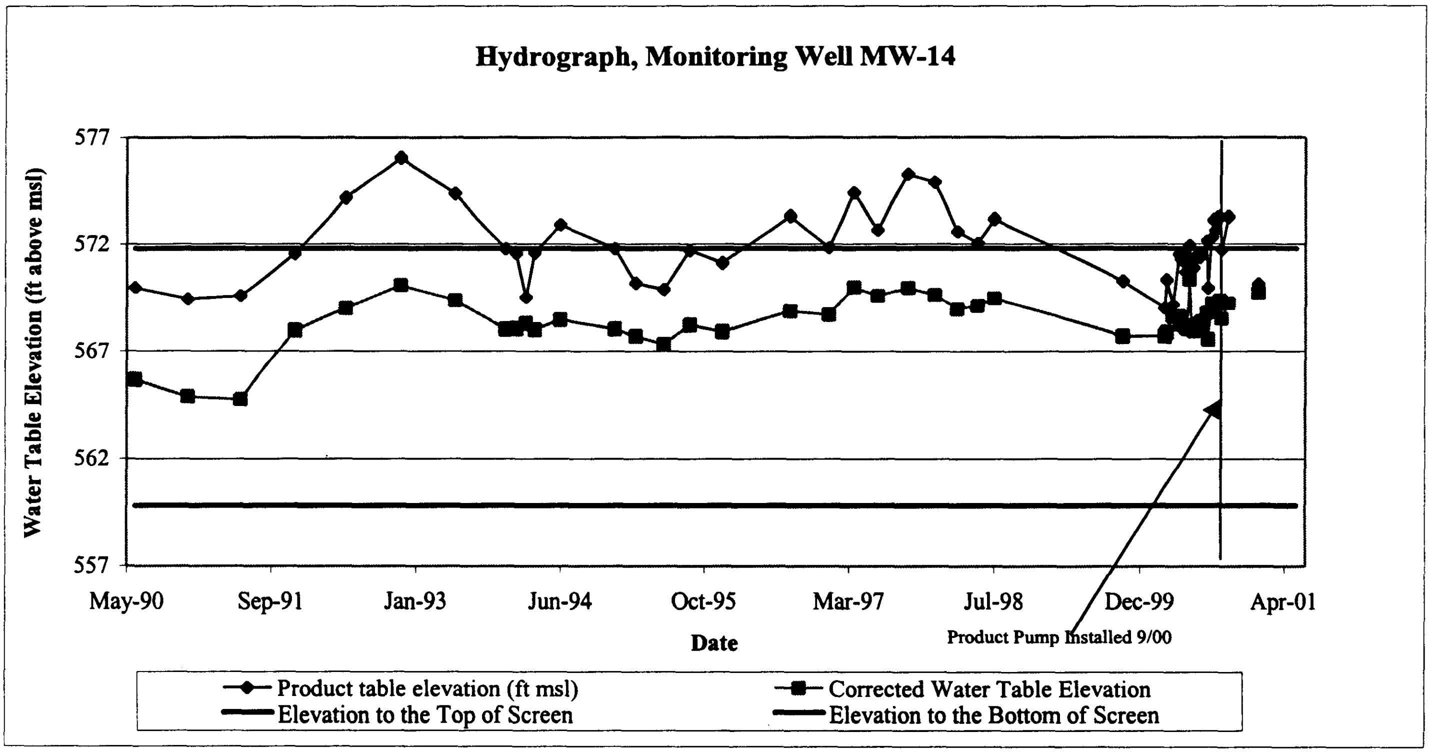


Figure B-6. Hydrographs for MW-14 (STYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



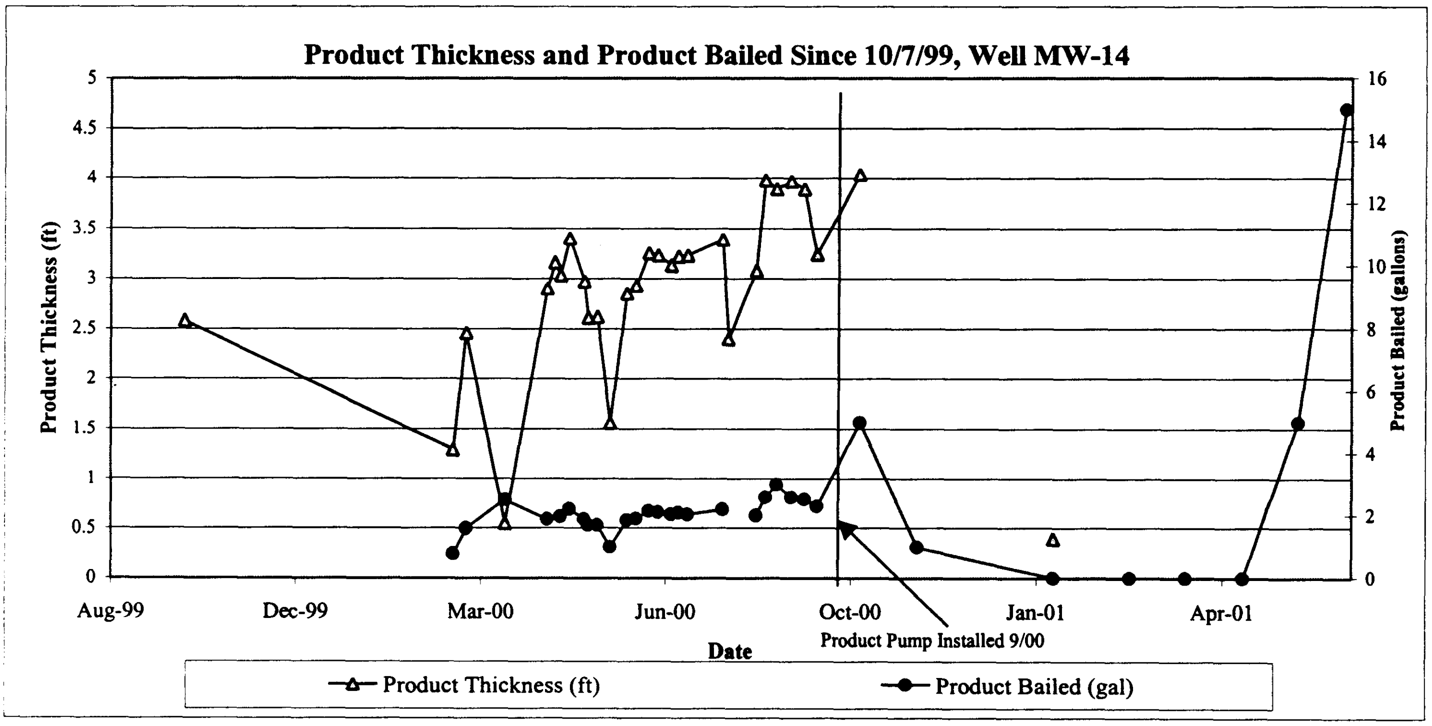
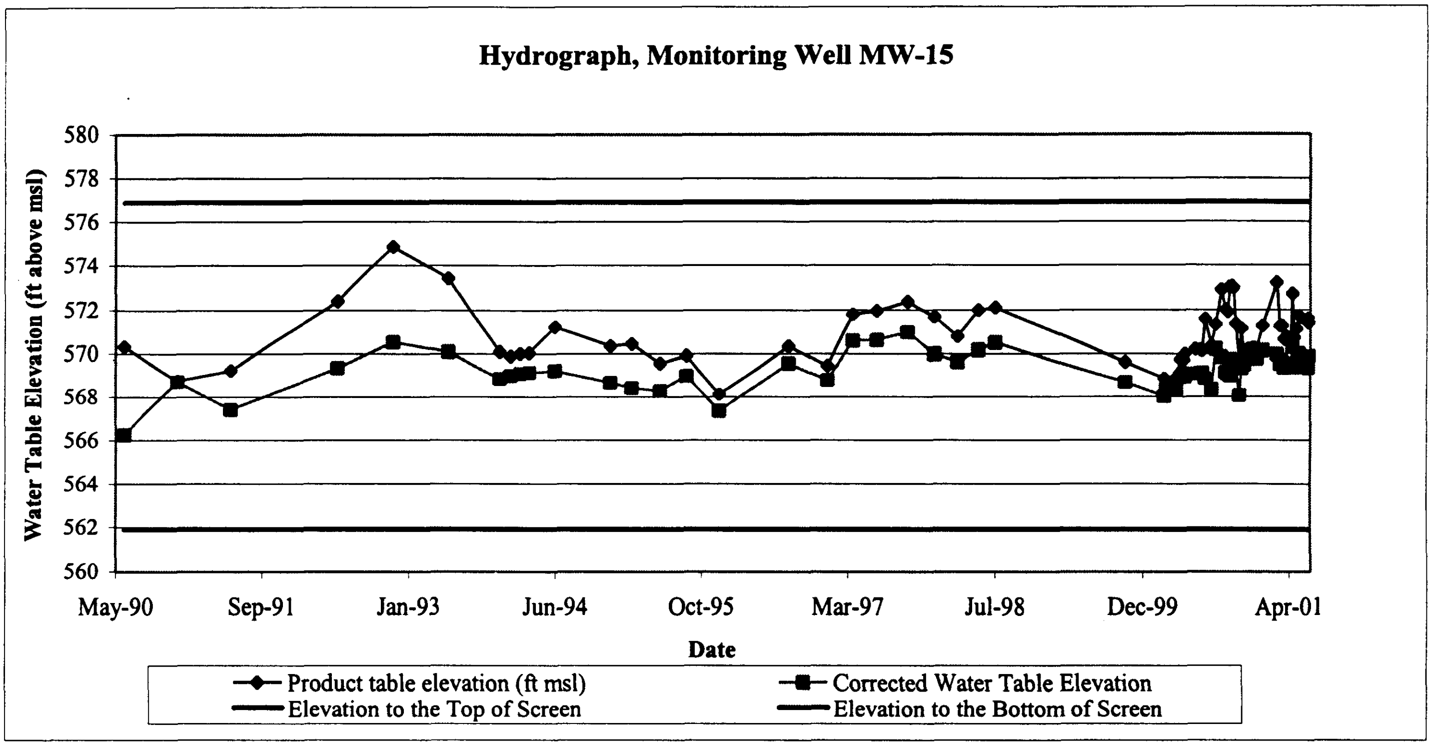


Figure B-7. Hydrographs for MW-15 (CRPA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



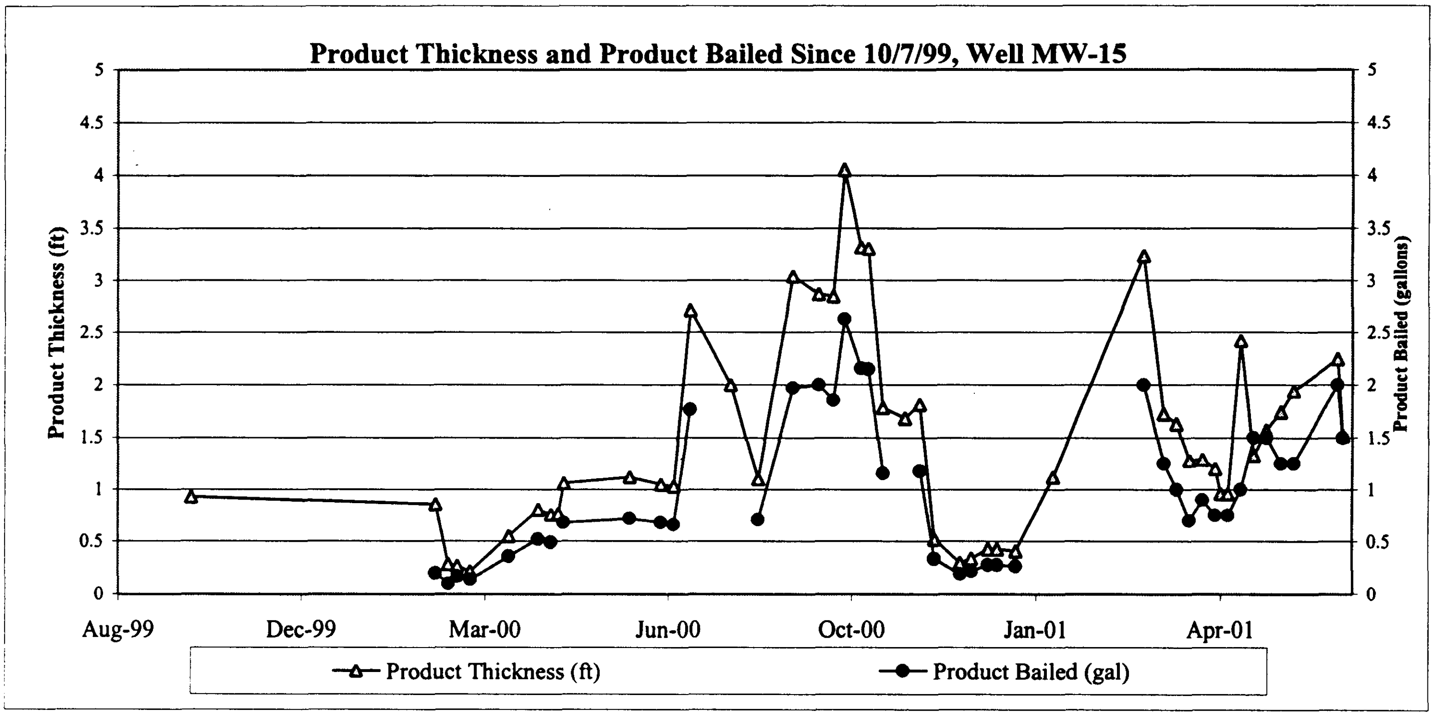
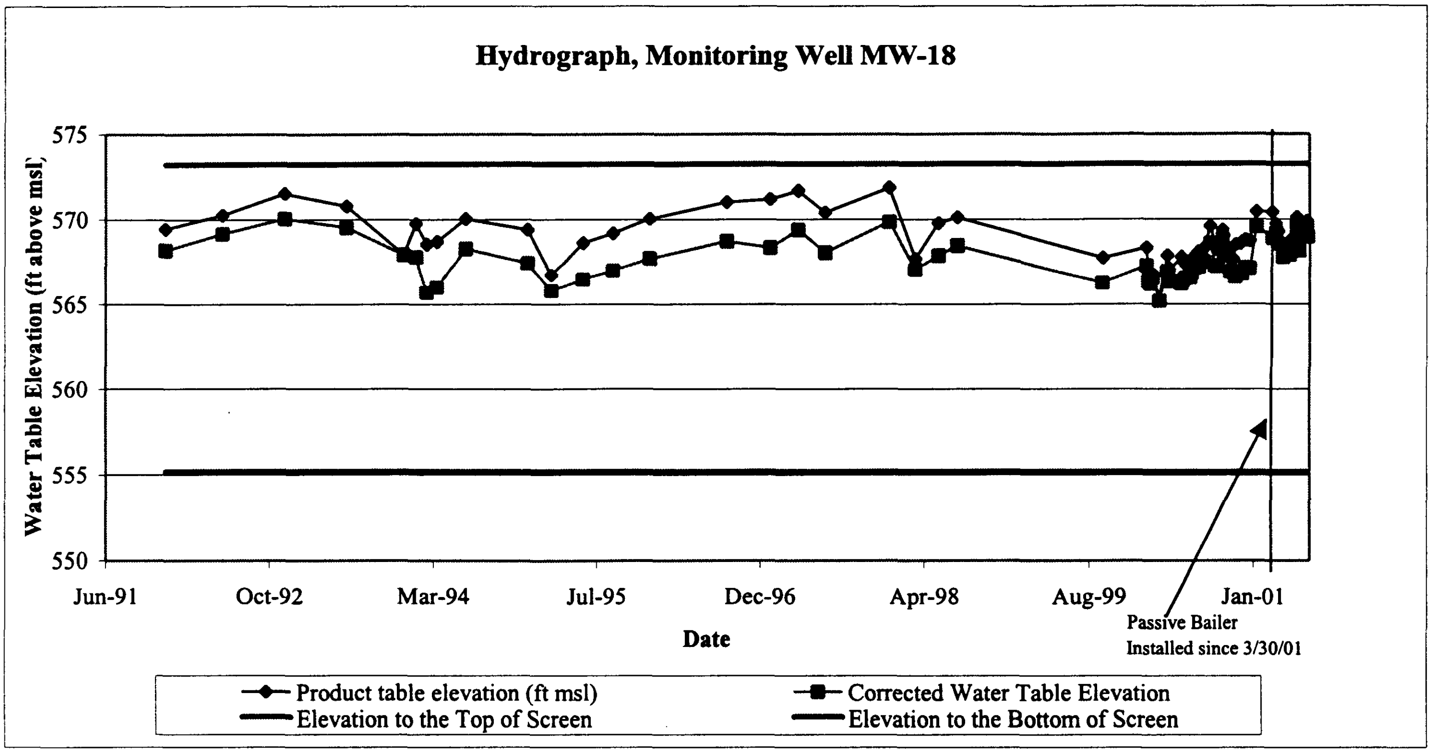


Figure B-8. Hydrographs for MW-18 (STYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



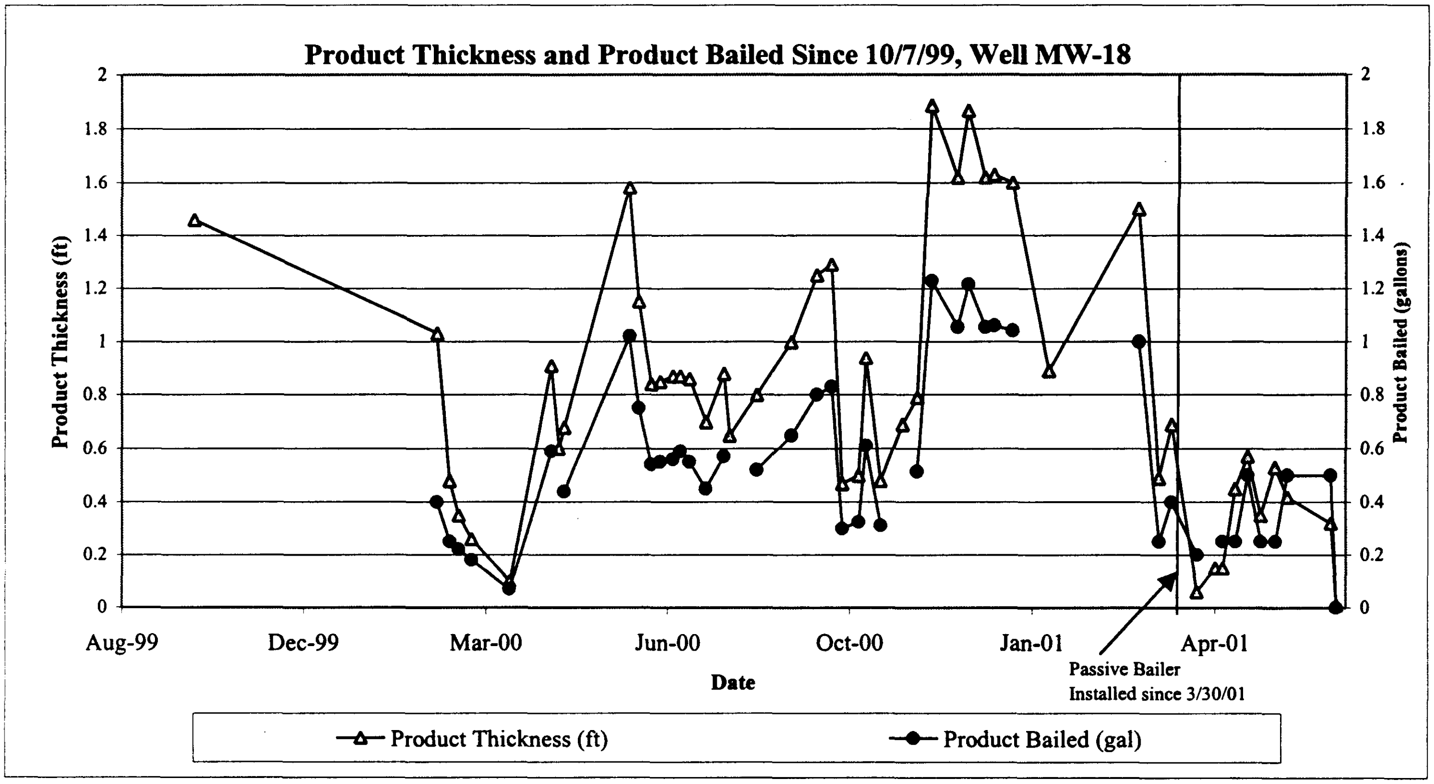
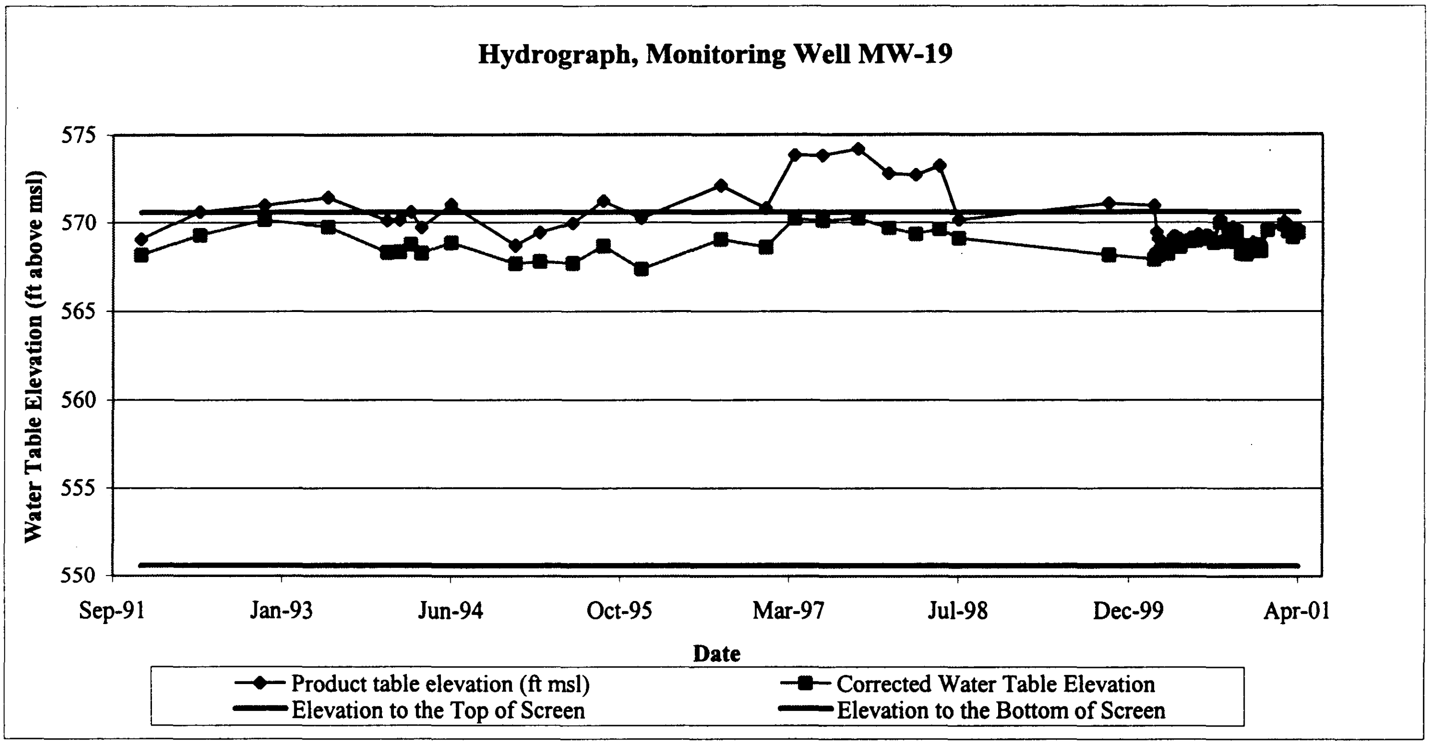


Figure B-9. Hydrographs for MW-19 (STYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



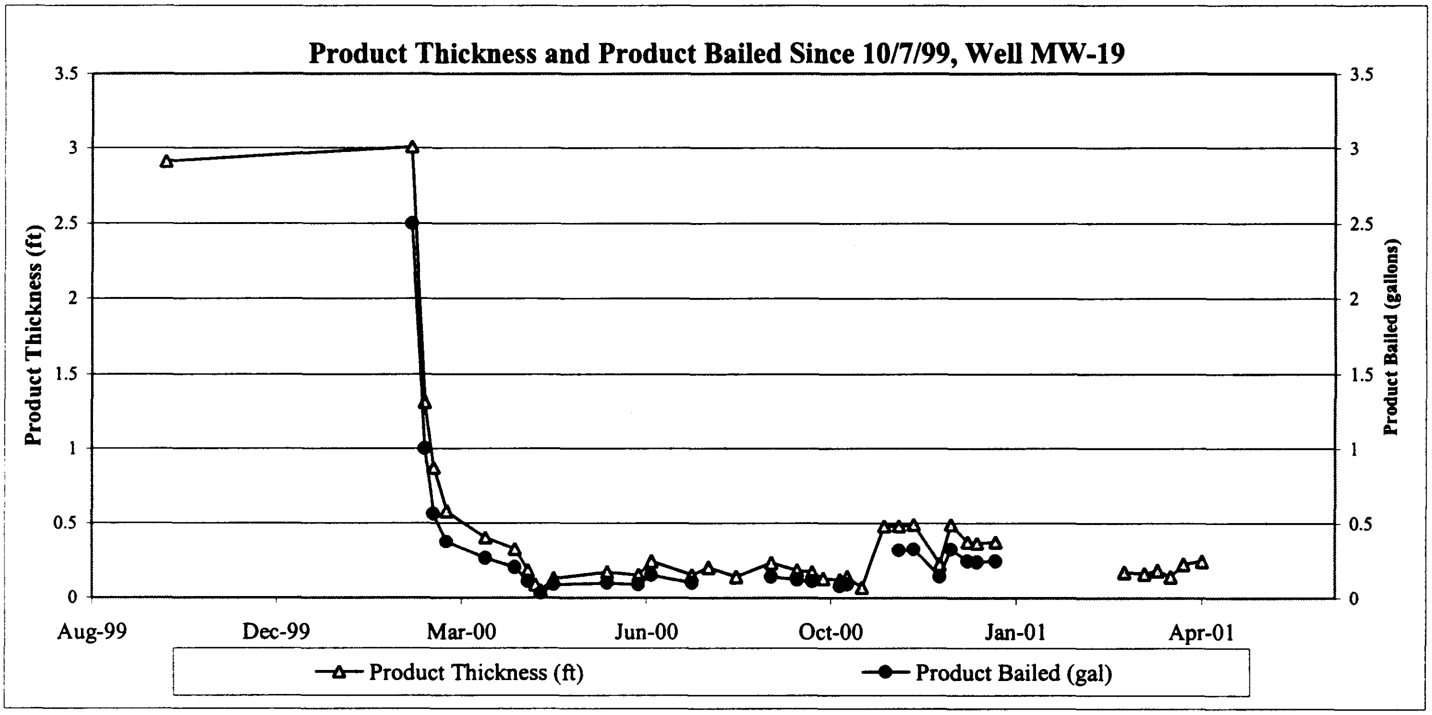
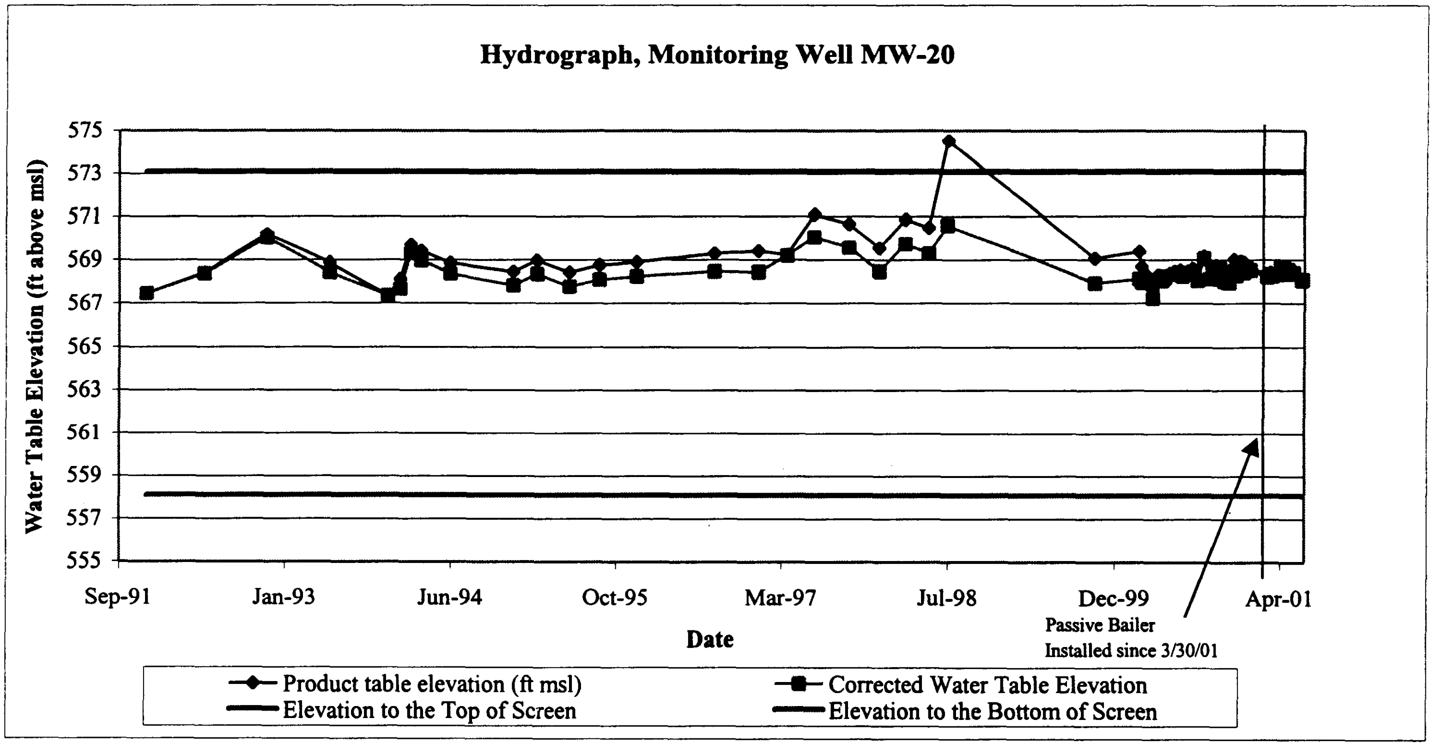


Figure B-10. Hydrographs for MW-20 (STYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



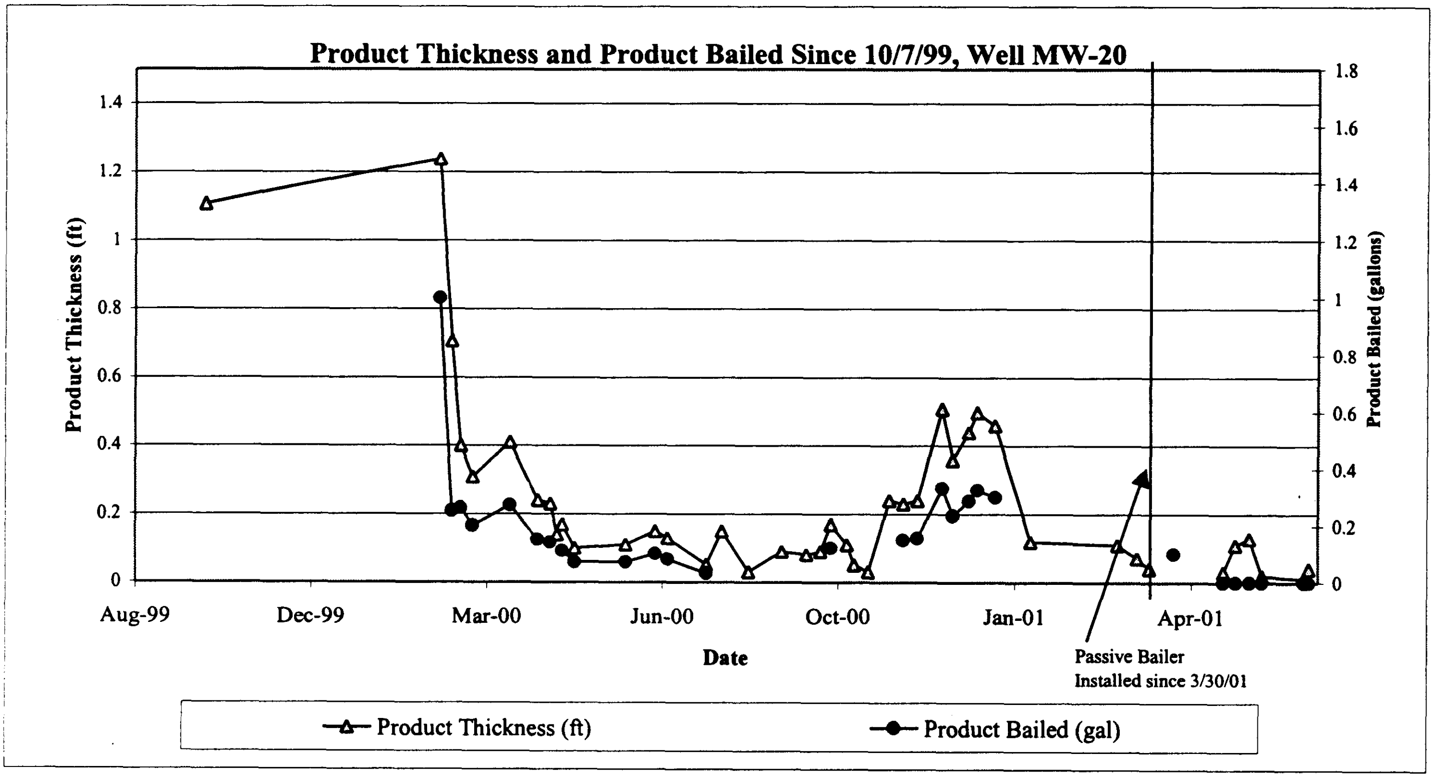
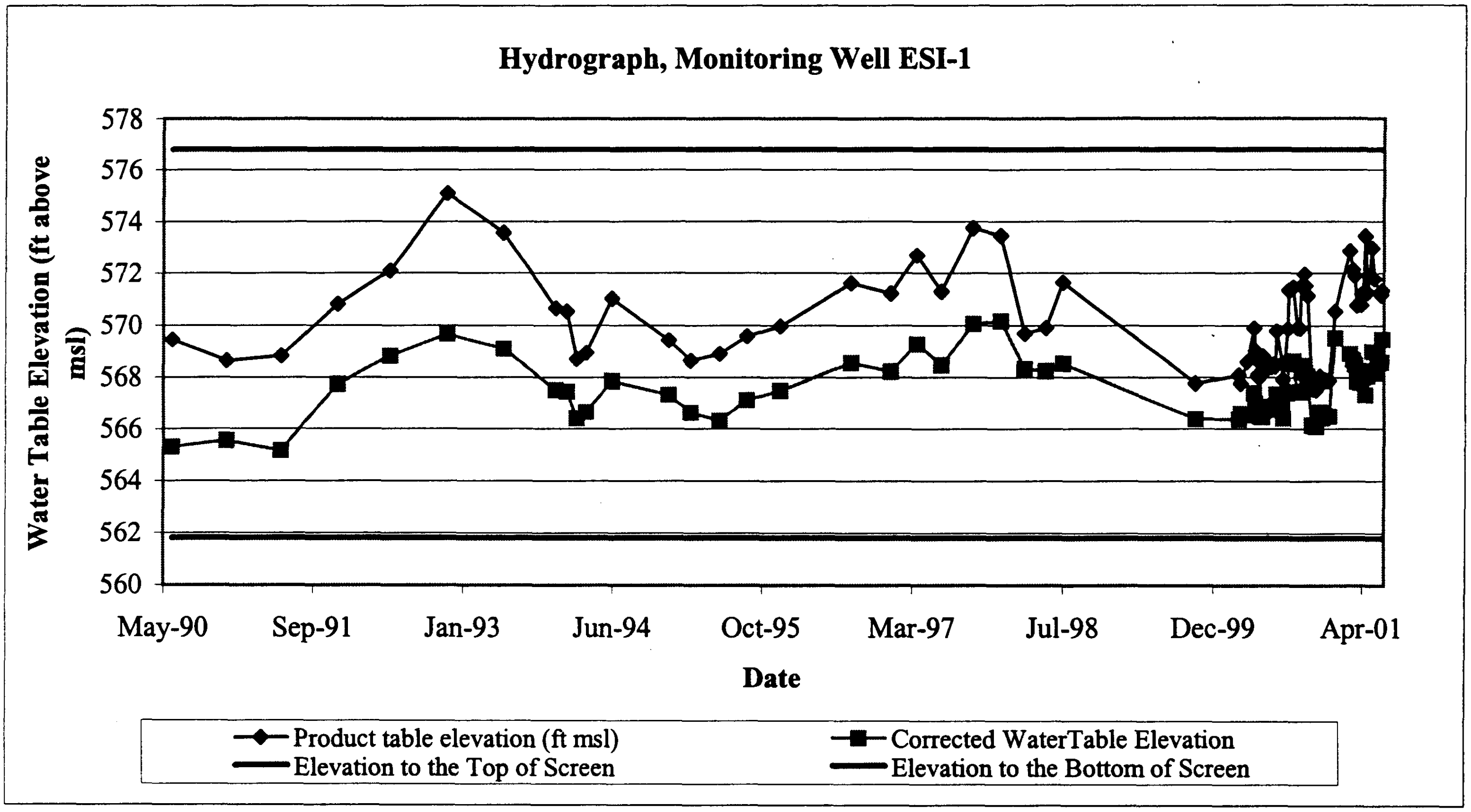


Figure B-11. Hydrographs for ESI-1 (STYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



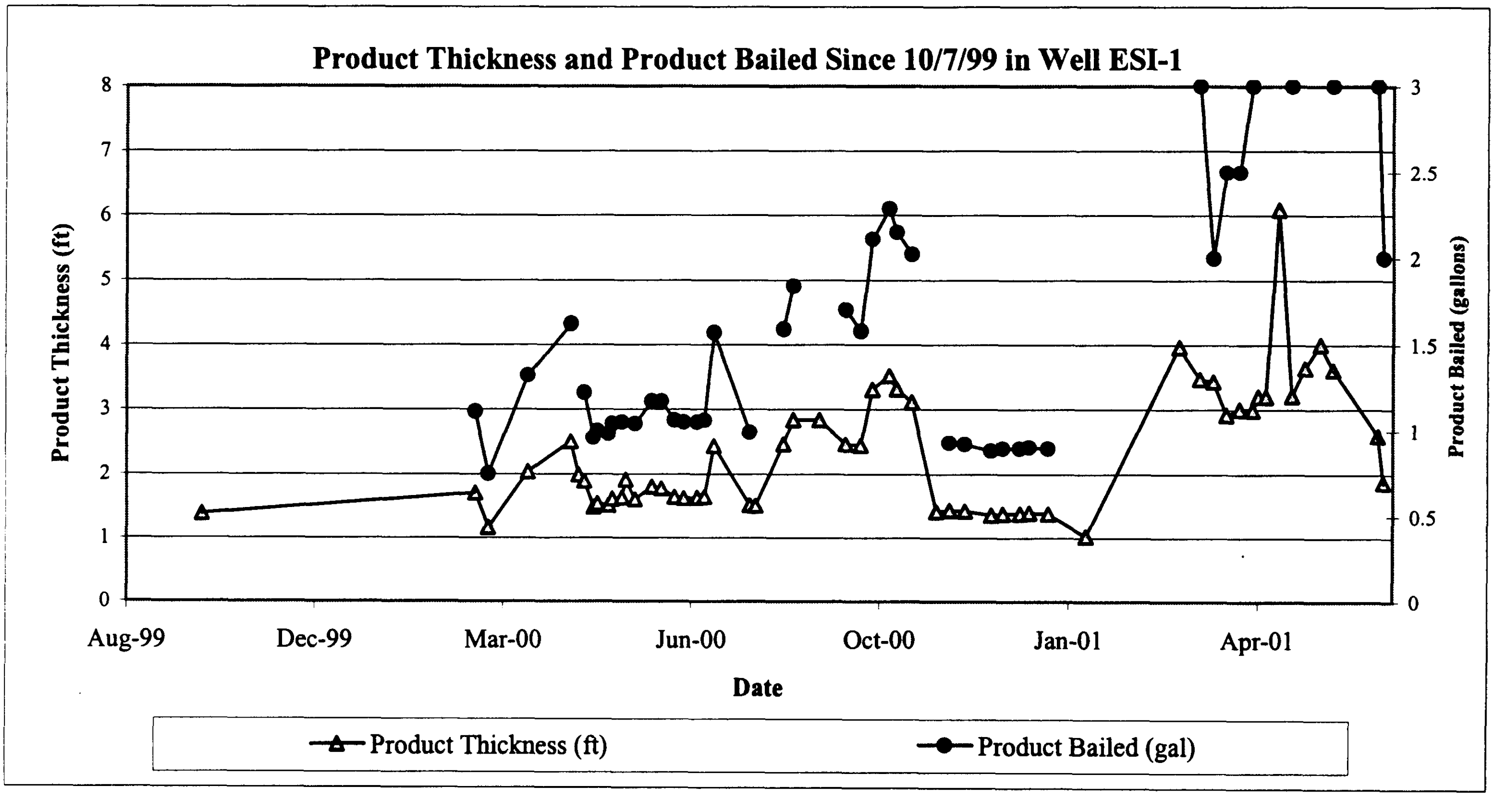
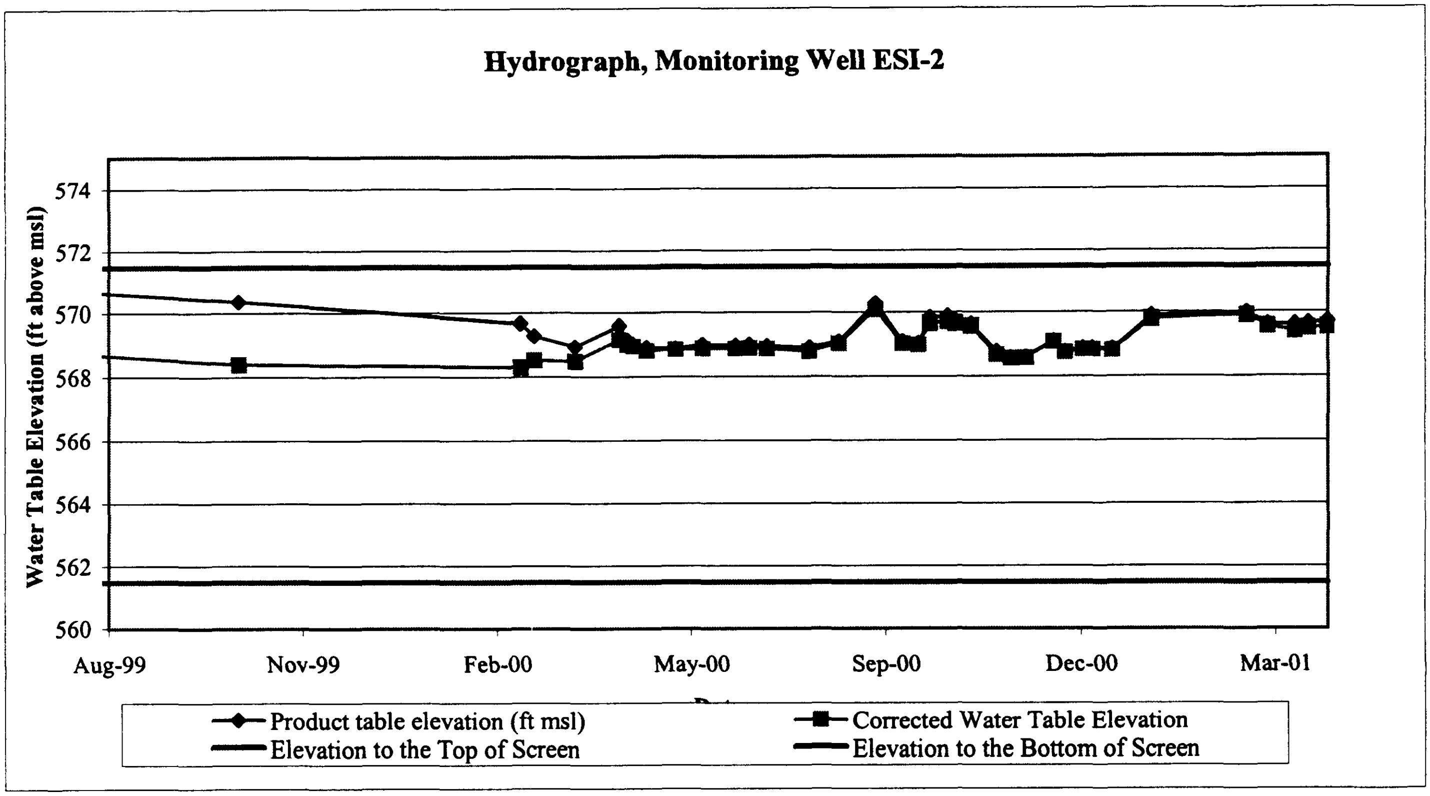


Figure B-12. Hydrographs for ESI-2 (STYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



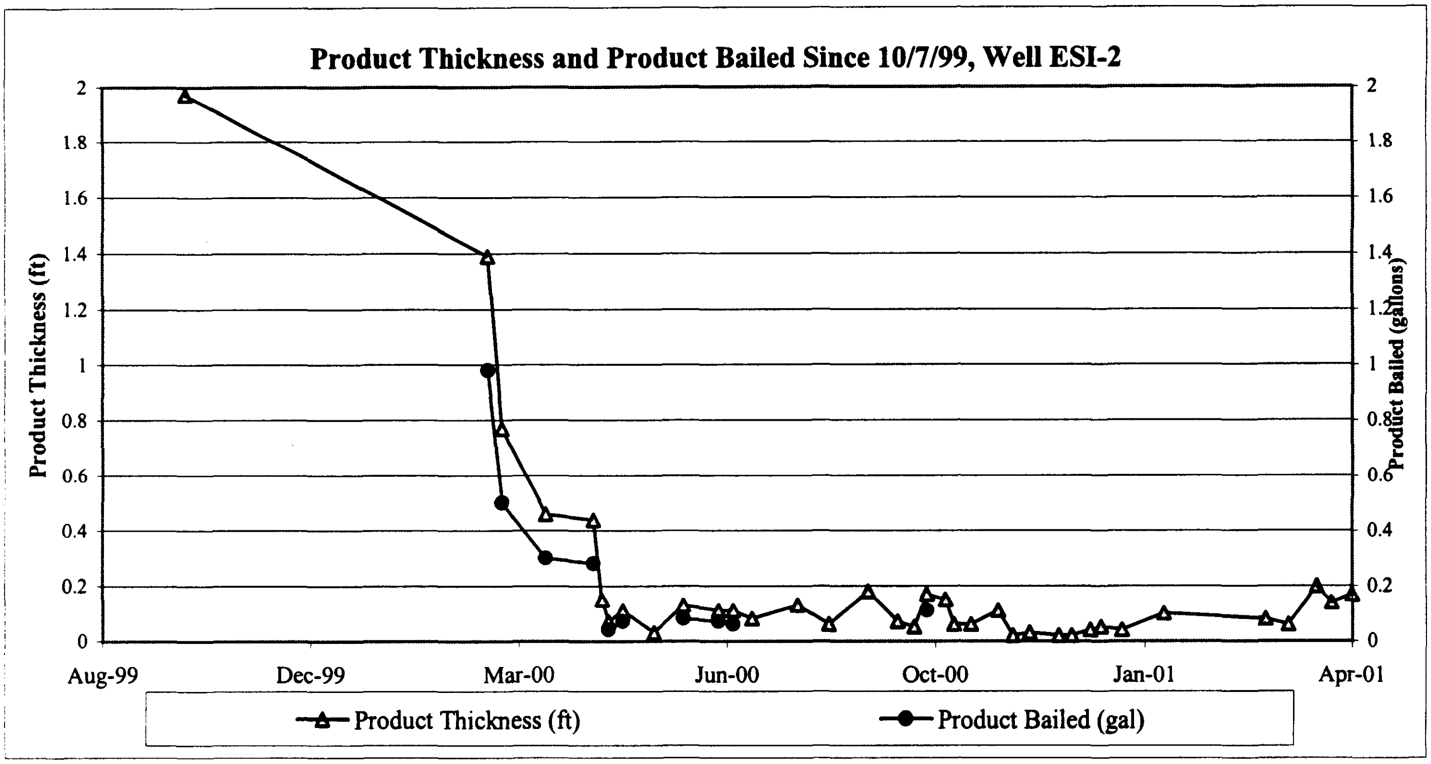


Figure B-13. Hydrograph for ESI-3 (STYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

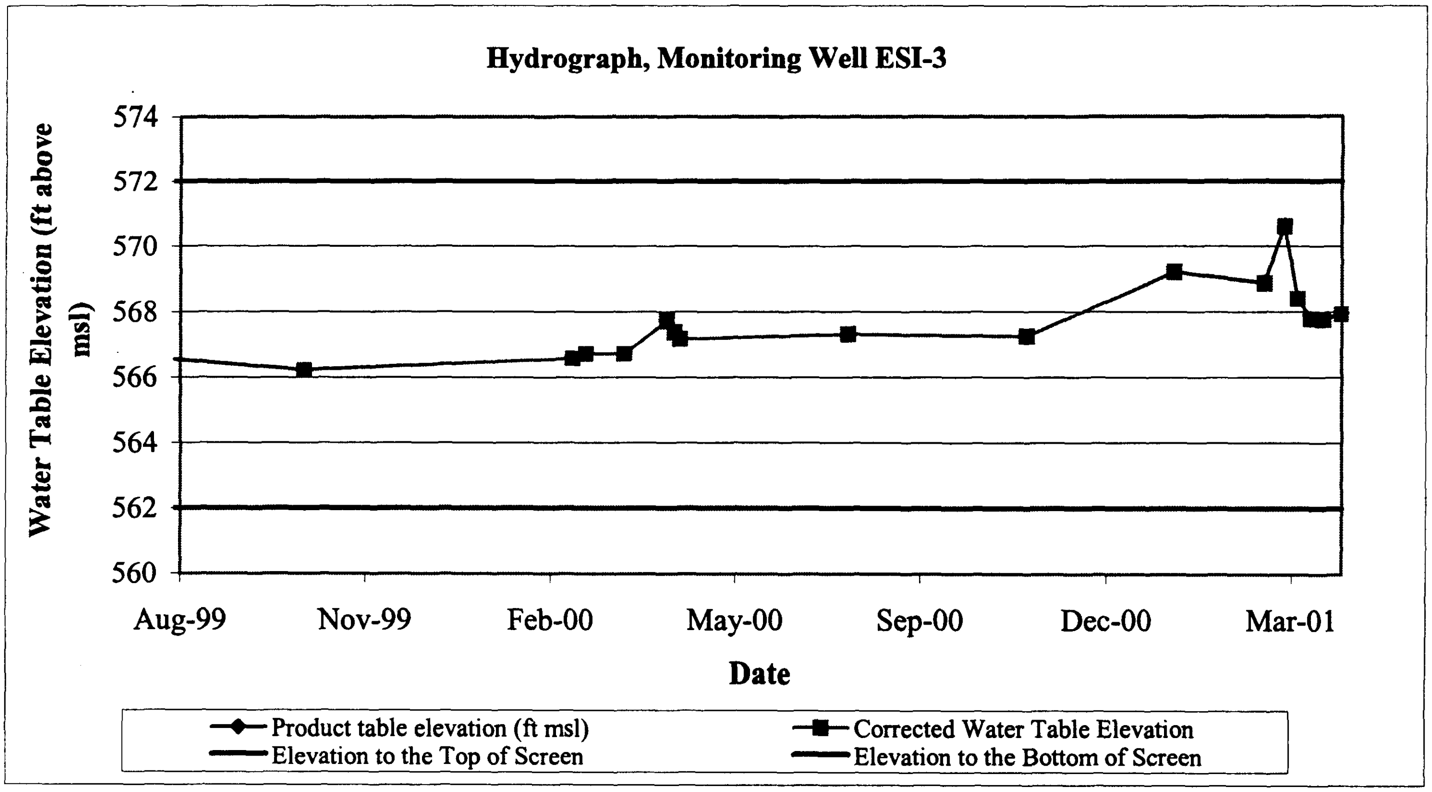


Figure B-14. Hydrograph for ESI-4 (STYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

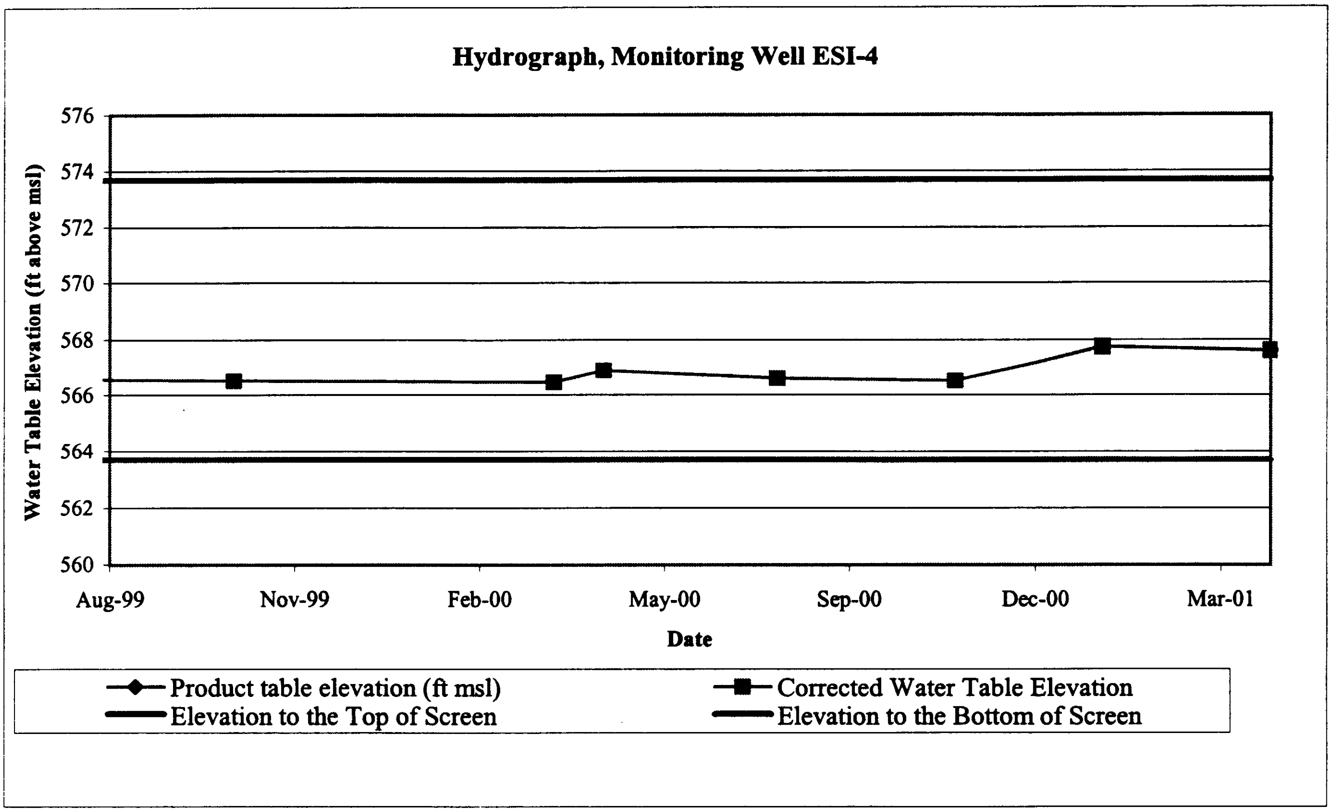
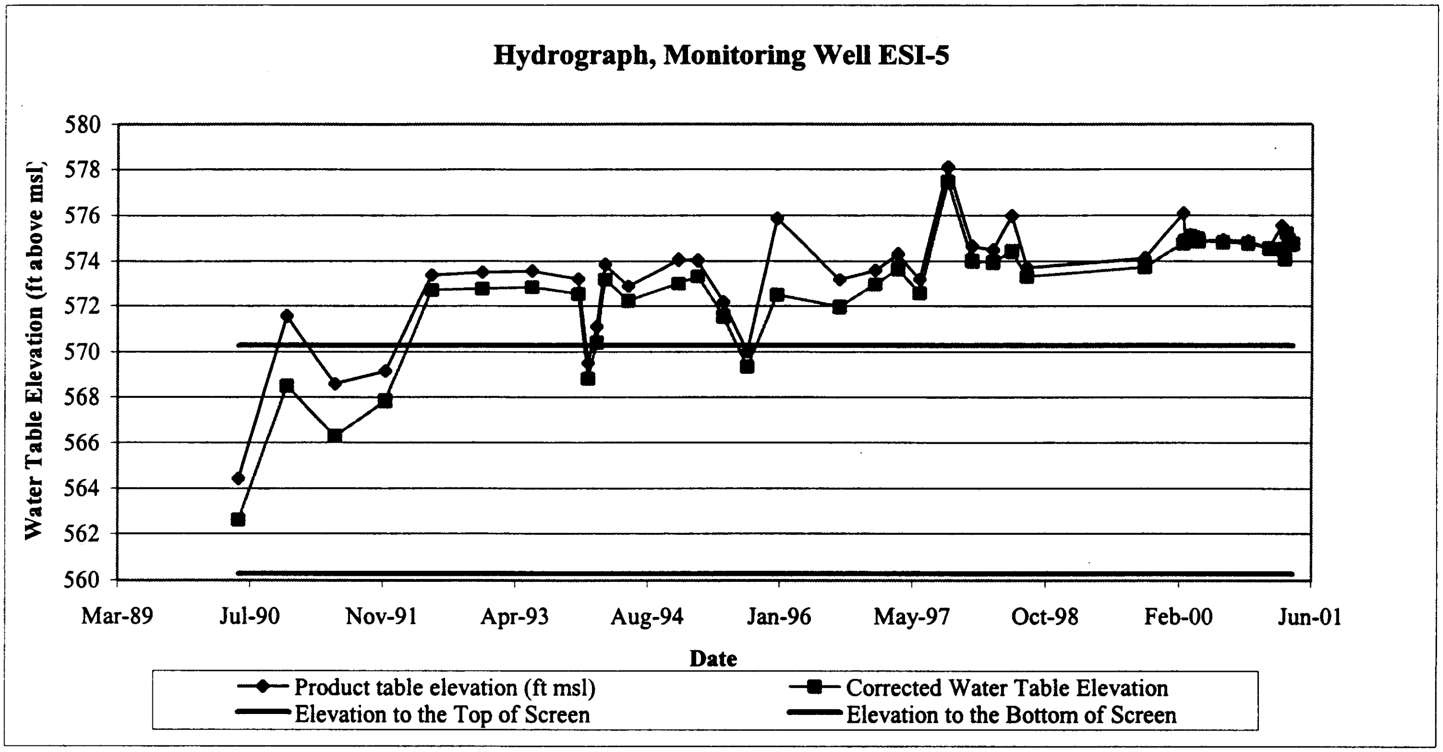


Figure B-15. HydrographS for ESI-5 (STYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



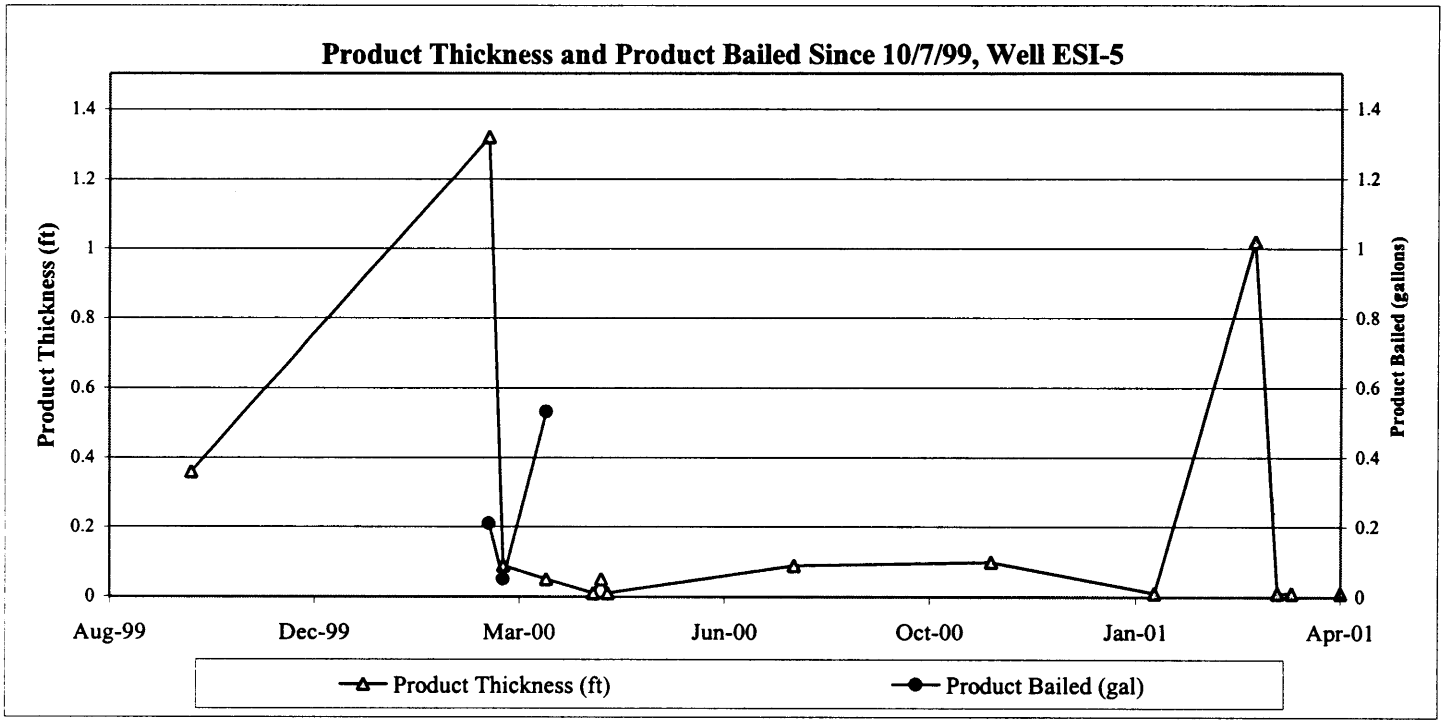
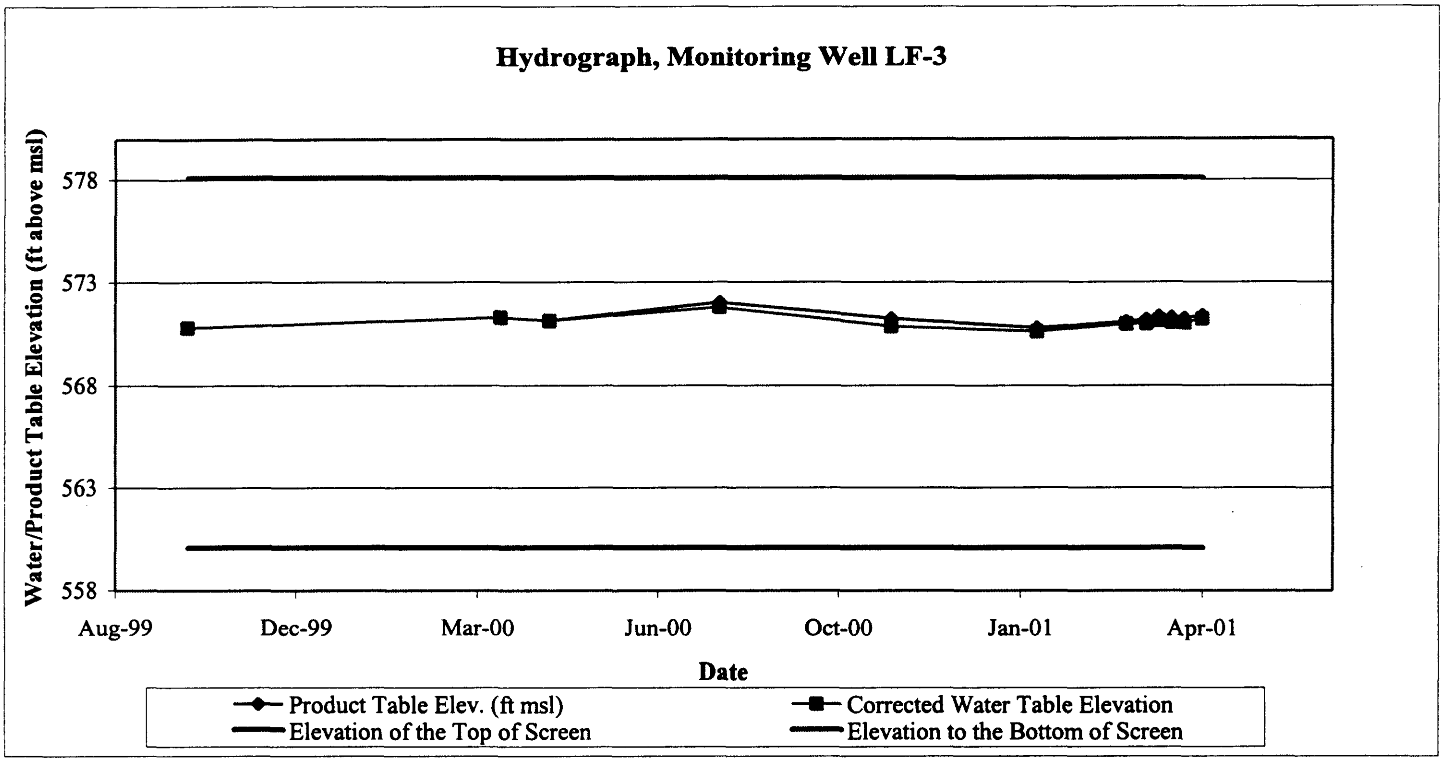


Figure B-16. Hydrographs for LF-3 (ETYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



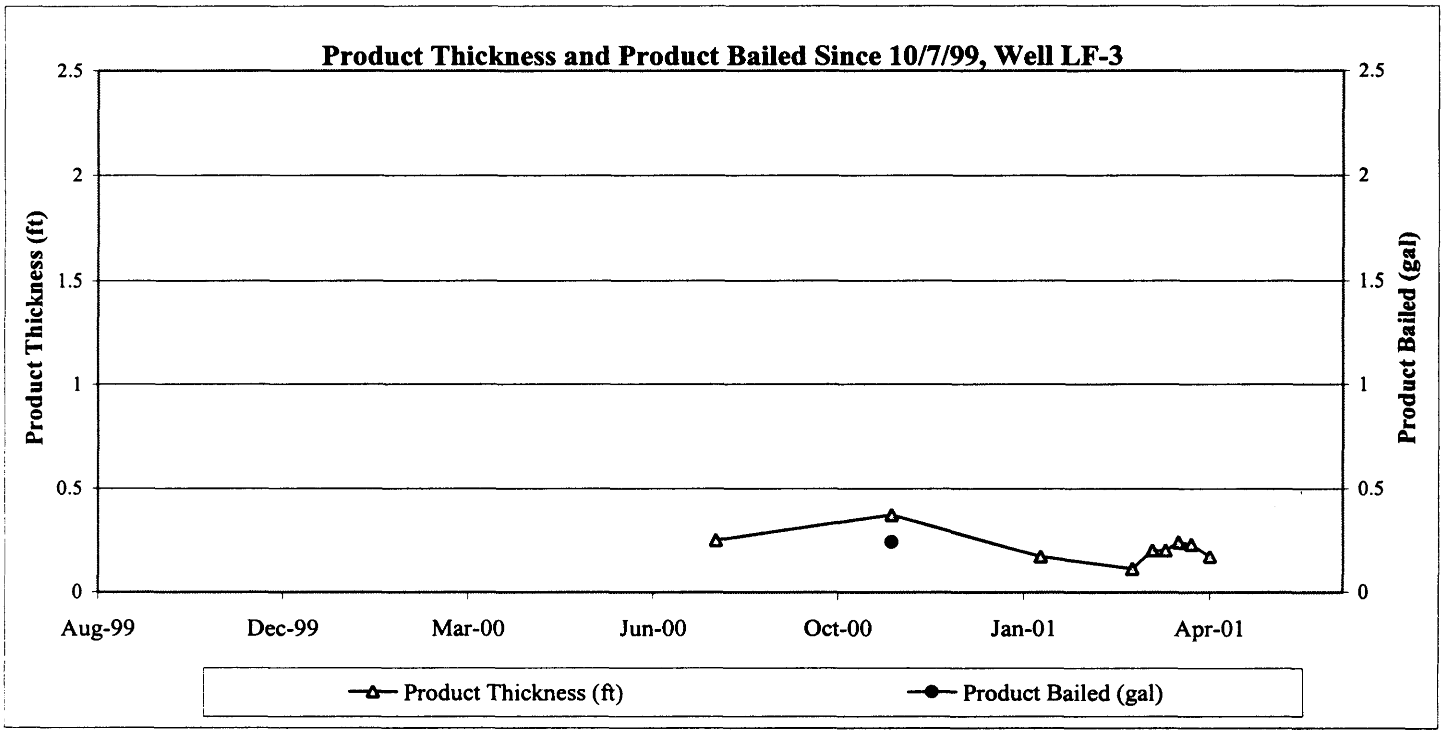
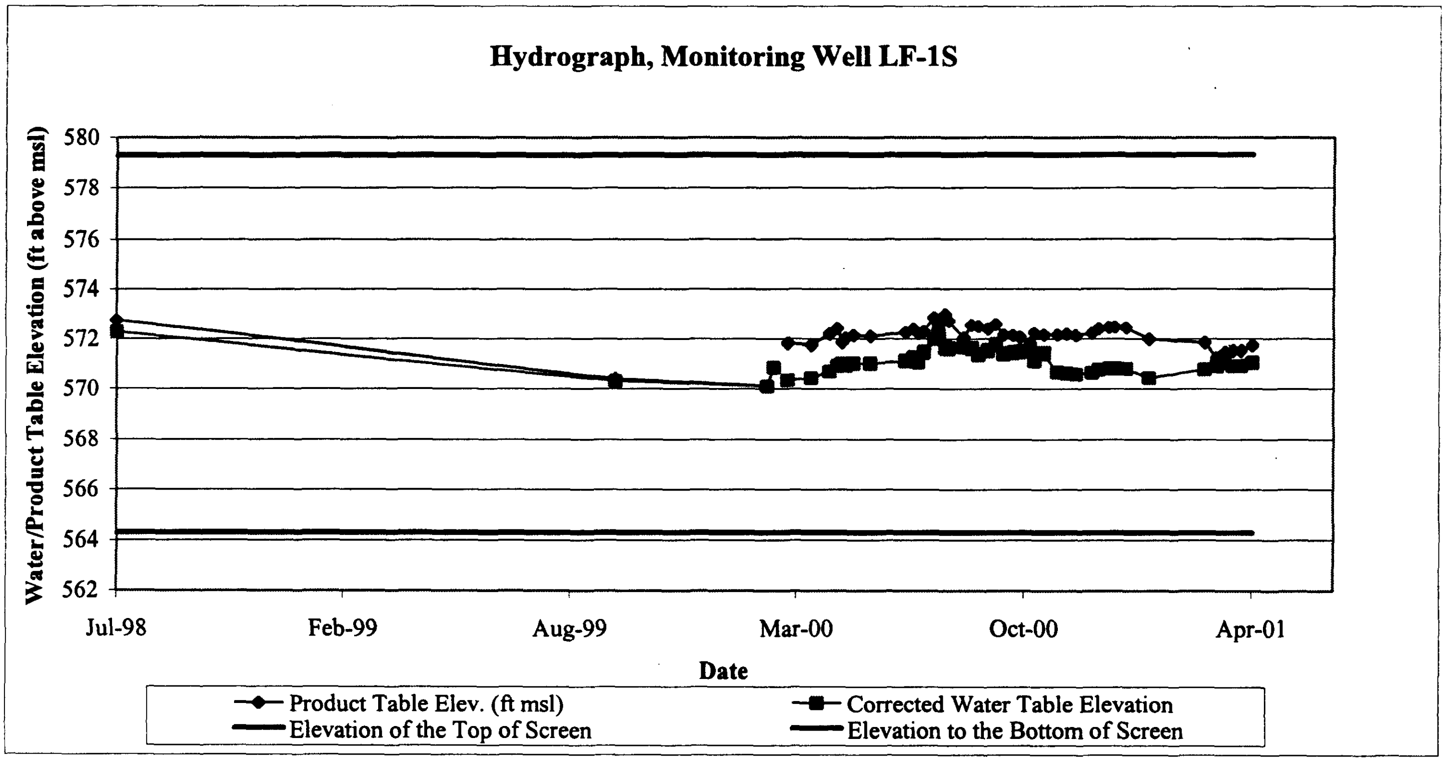


Figure B-17. Hydrographs for LF-1S (ETYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



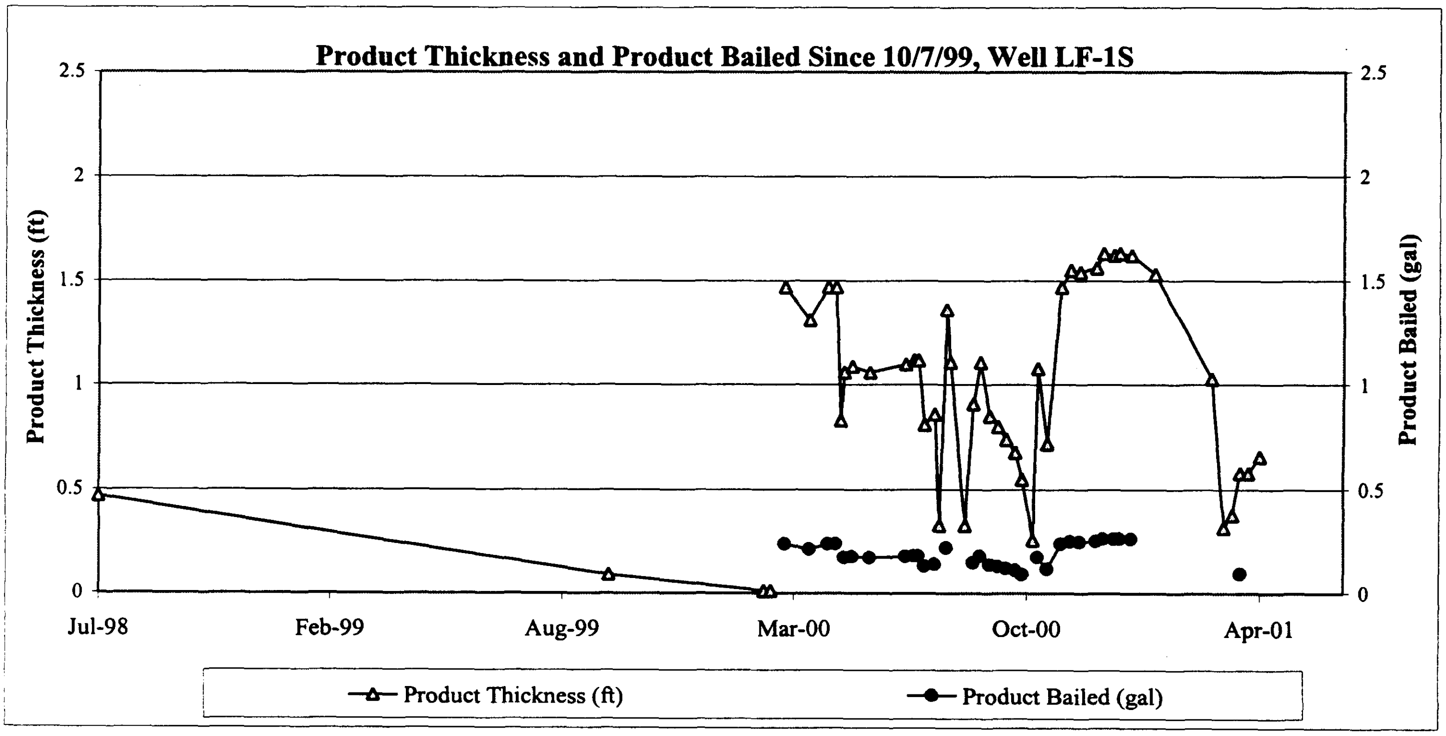
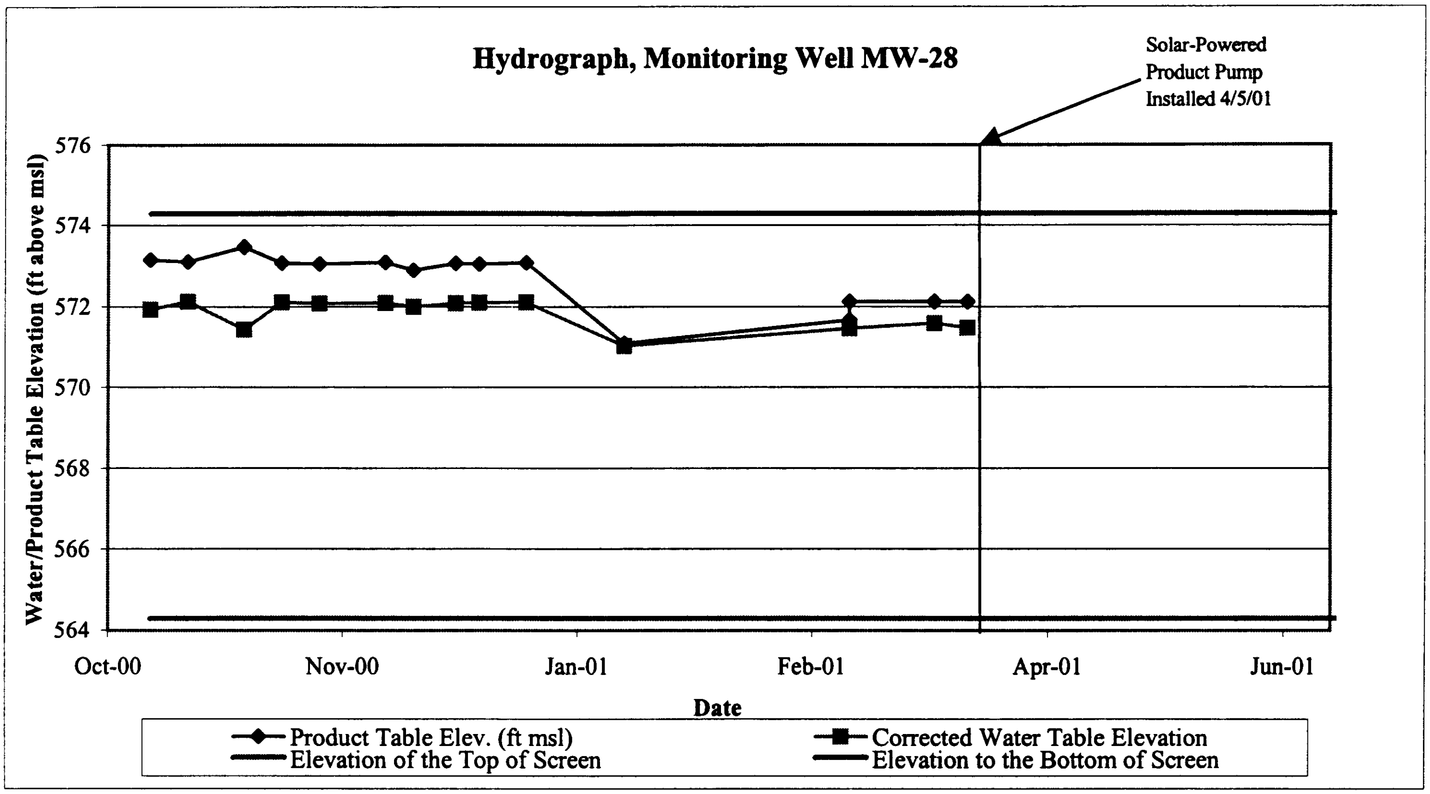


Figure B-18. Hydrographs for MW-28 (ETYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



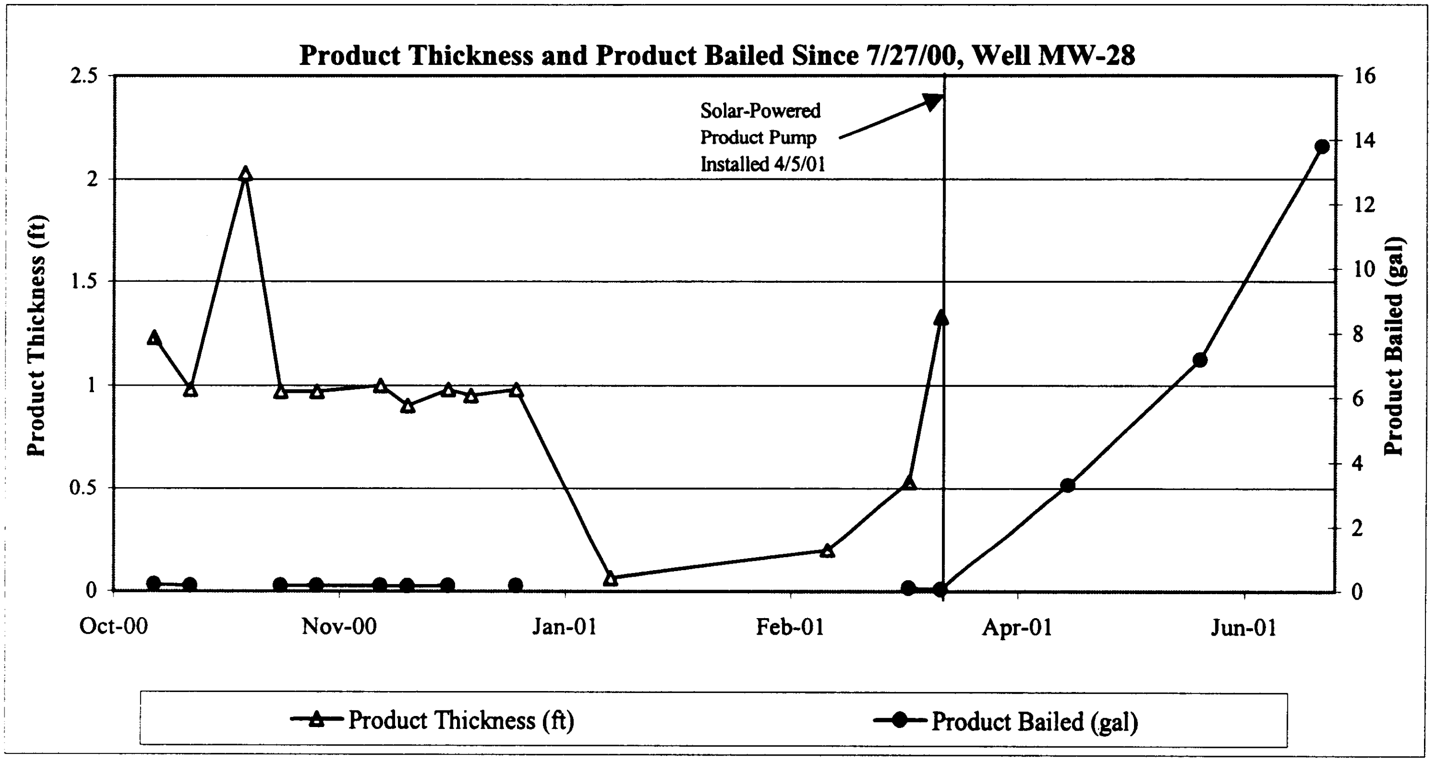
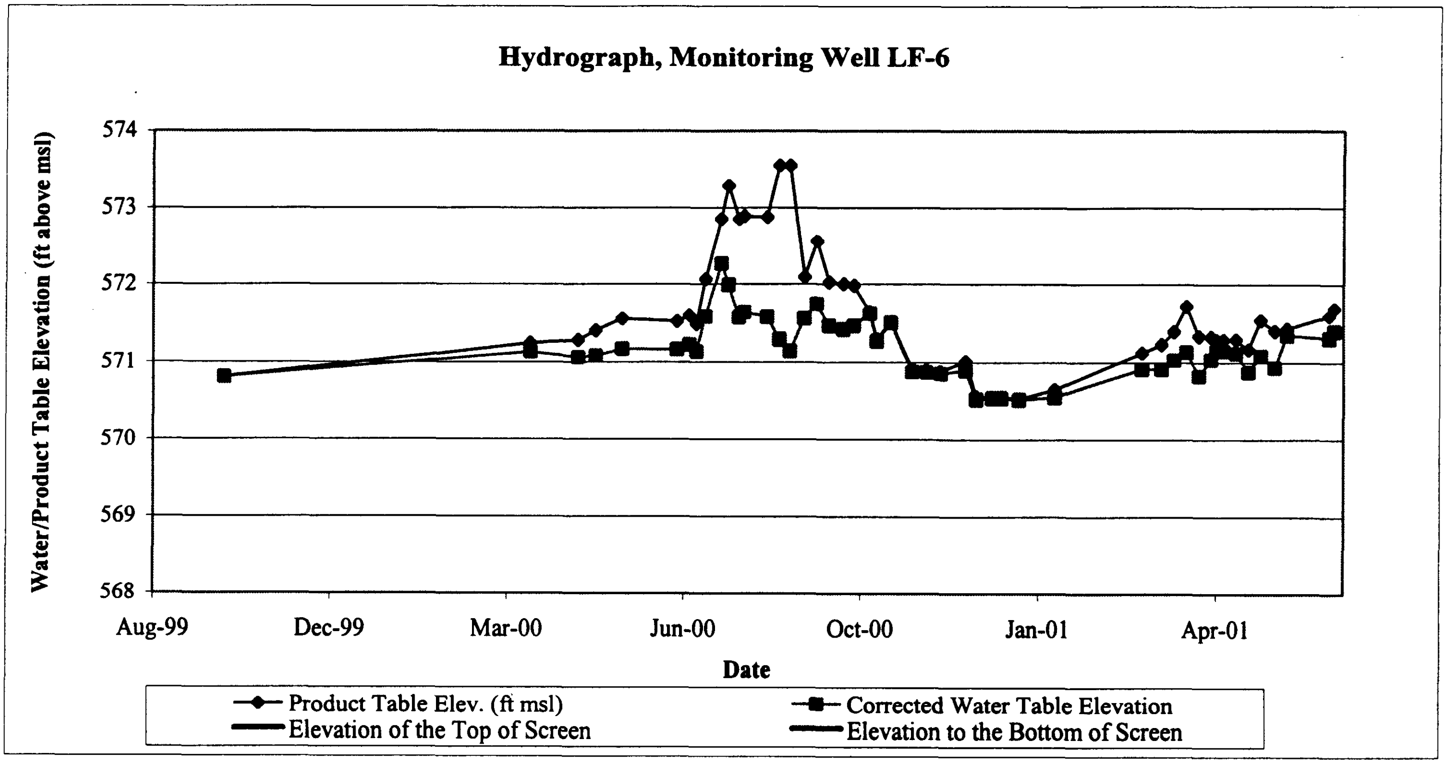


Figure B-19. Hydrographs for LF-6 (ETYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York


Hydrograph, Monitoring Well LF-6

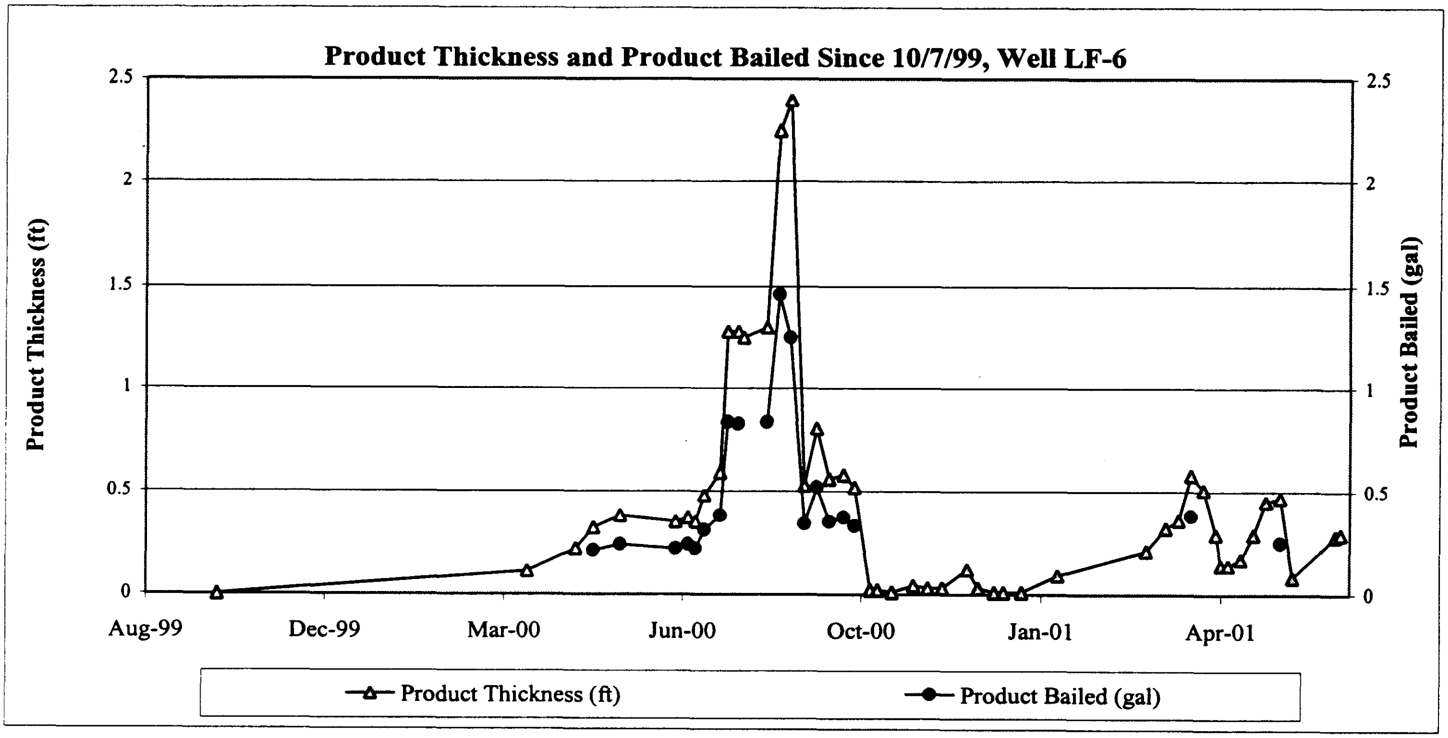
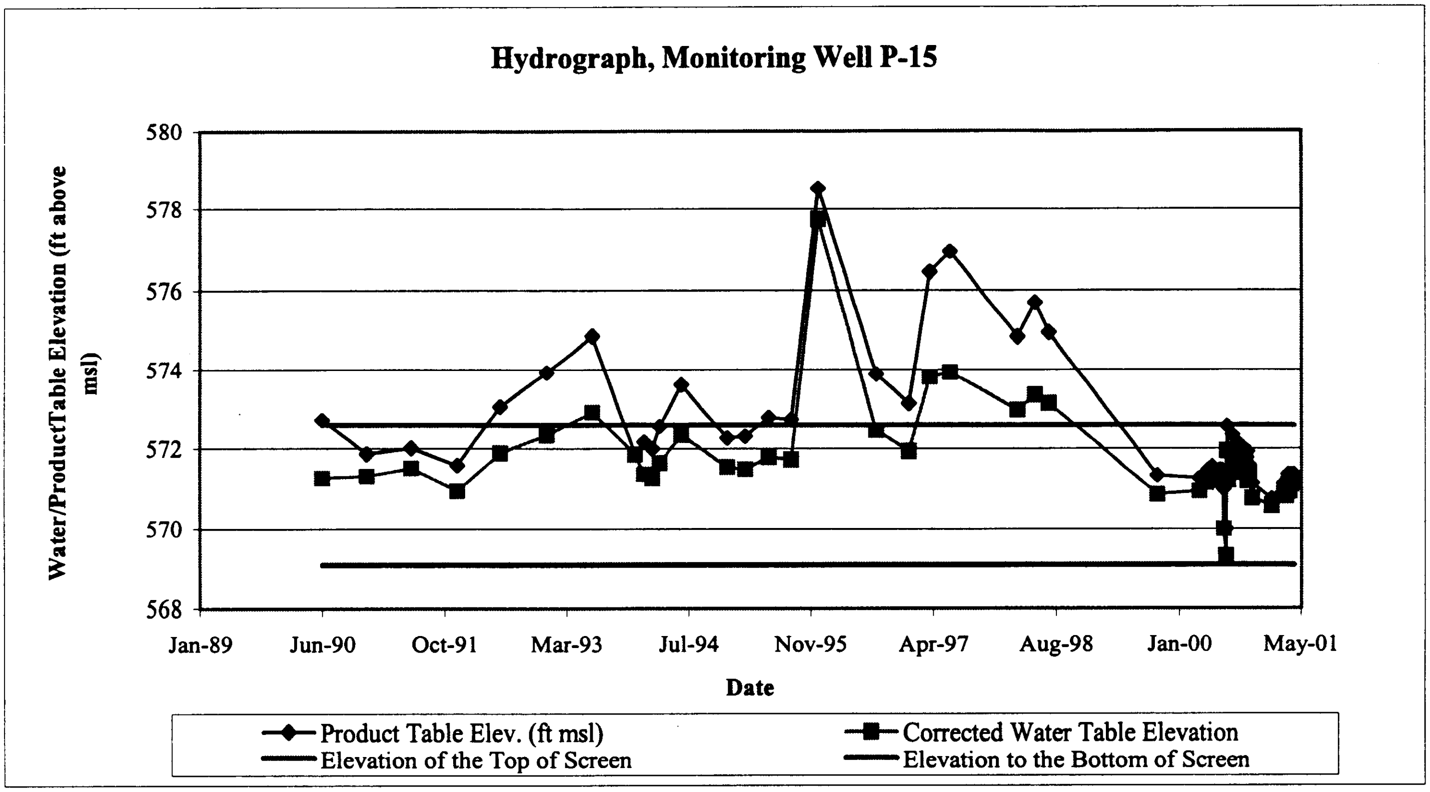

Product Thickness and Product Bailed Since 10/7/99, Well LF-6

Figure B-20. Hydrograph for P-15(ETYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



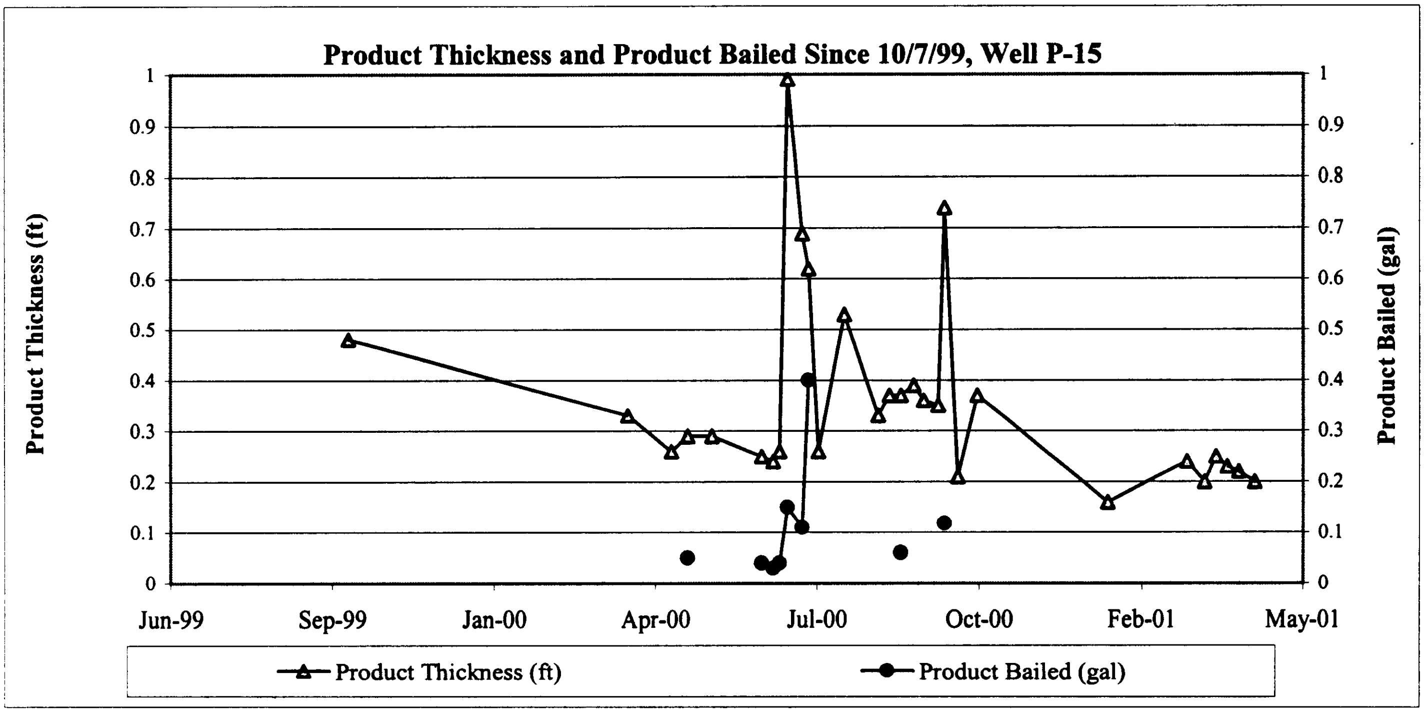


Figure B-21. Hydrograph for MW-6 (FRA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York

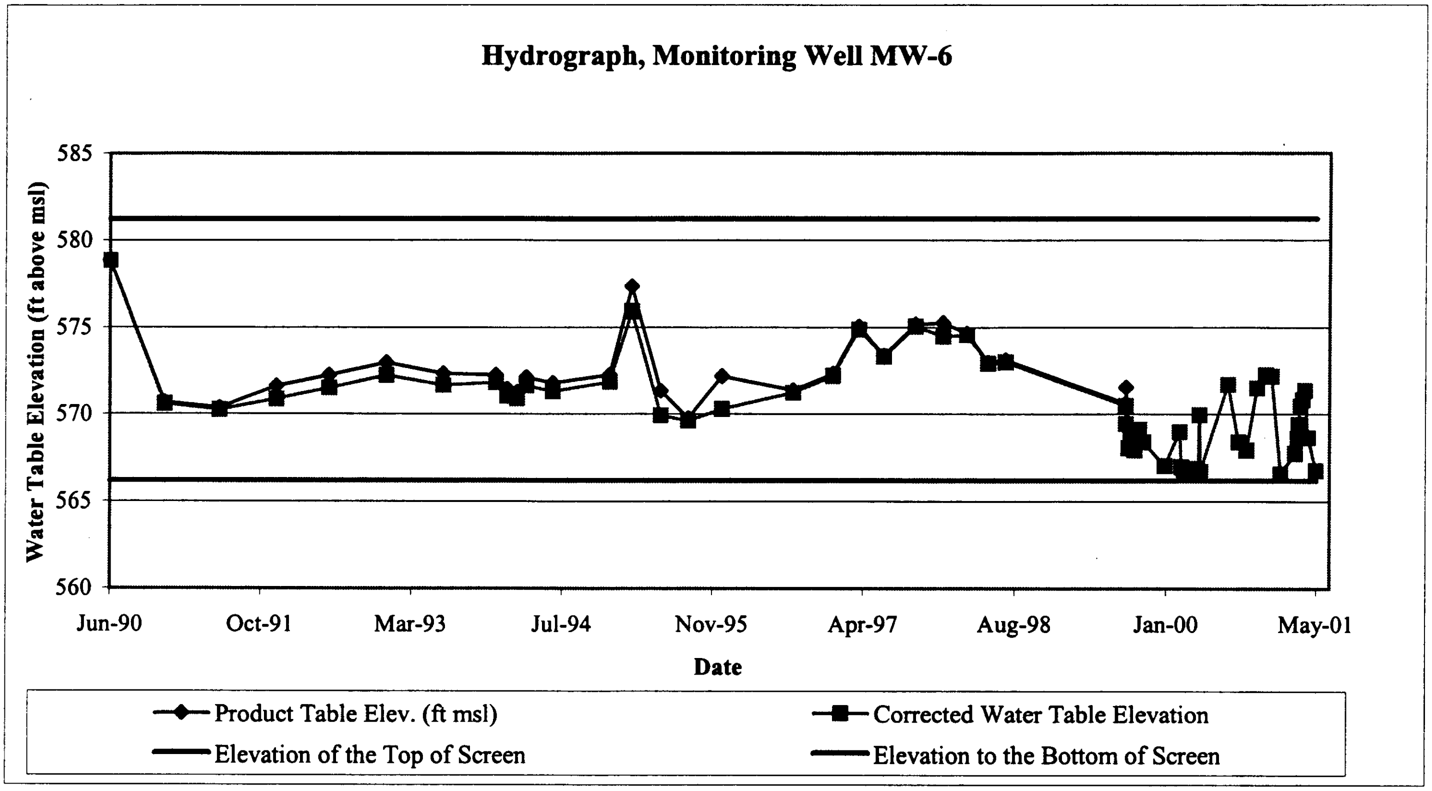
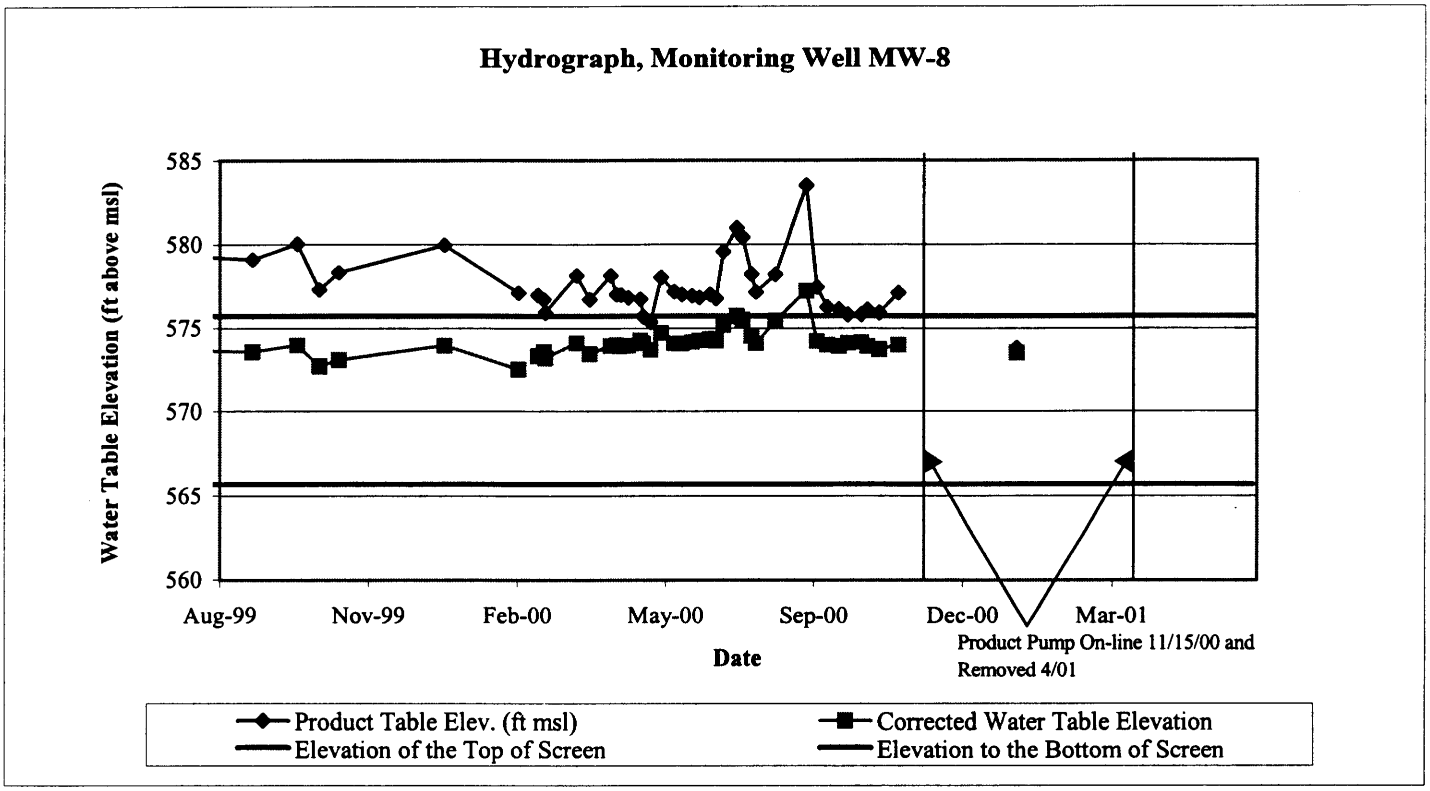


Figure B-22. Hydrograph for MW-8 (FRA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



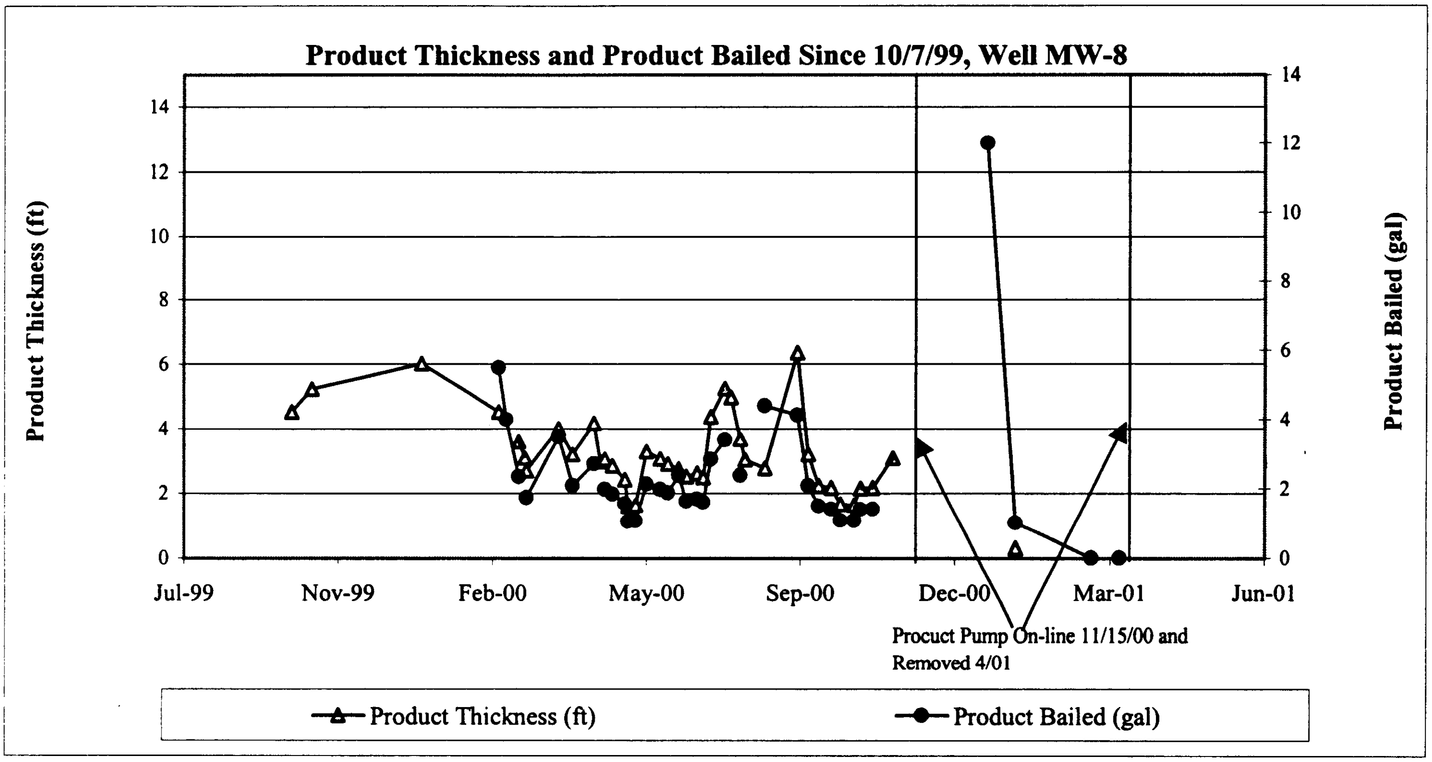
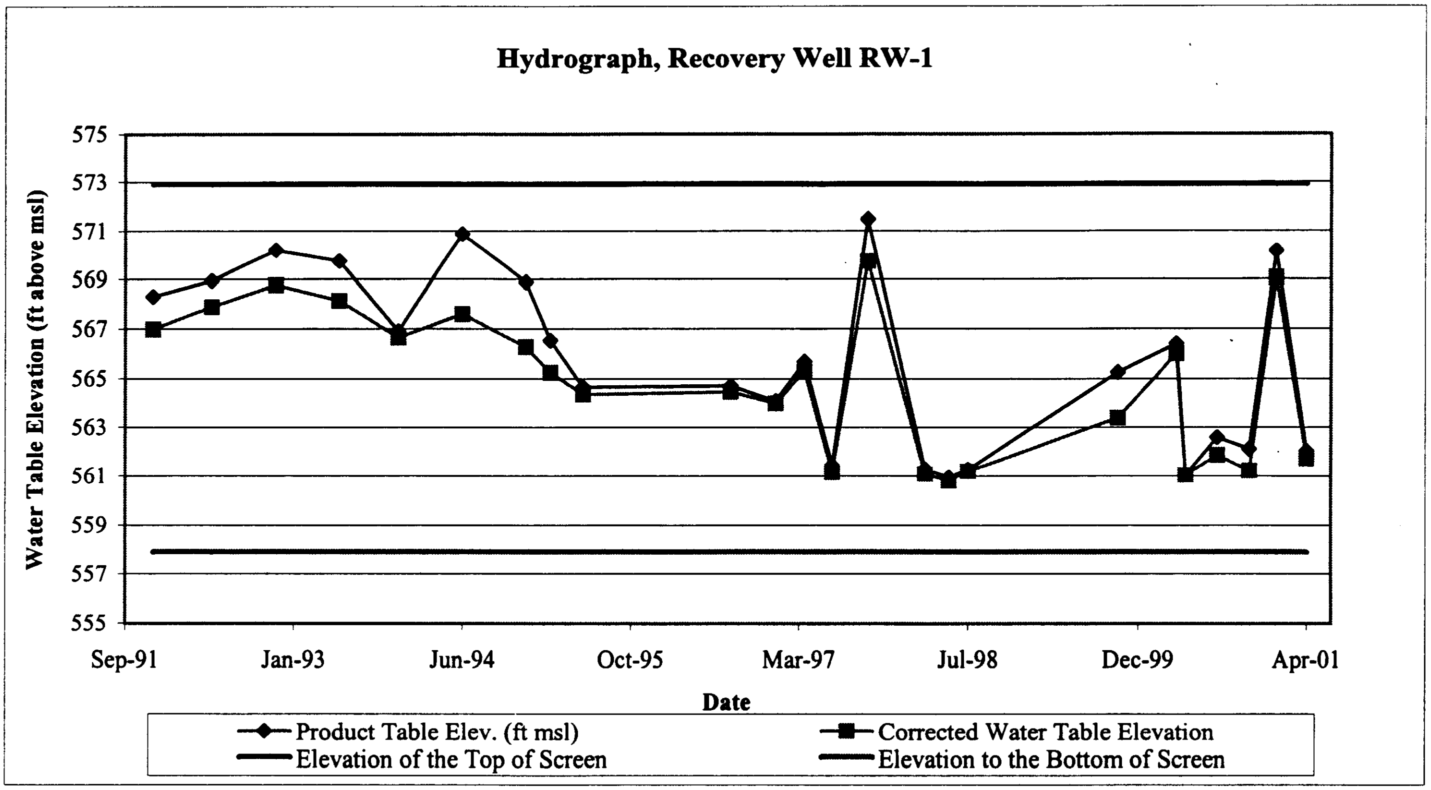


Figure B-23. Hydrograph for RW-1 (STYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



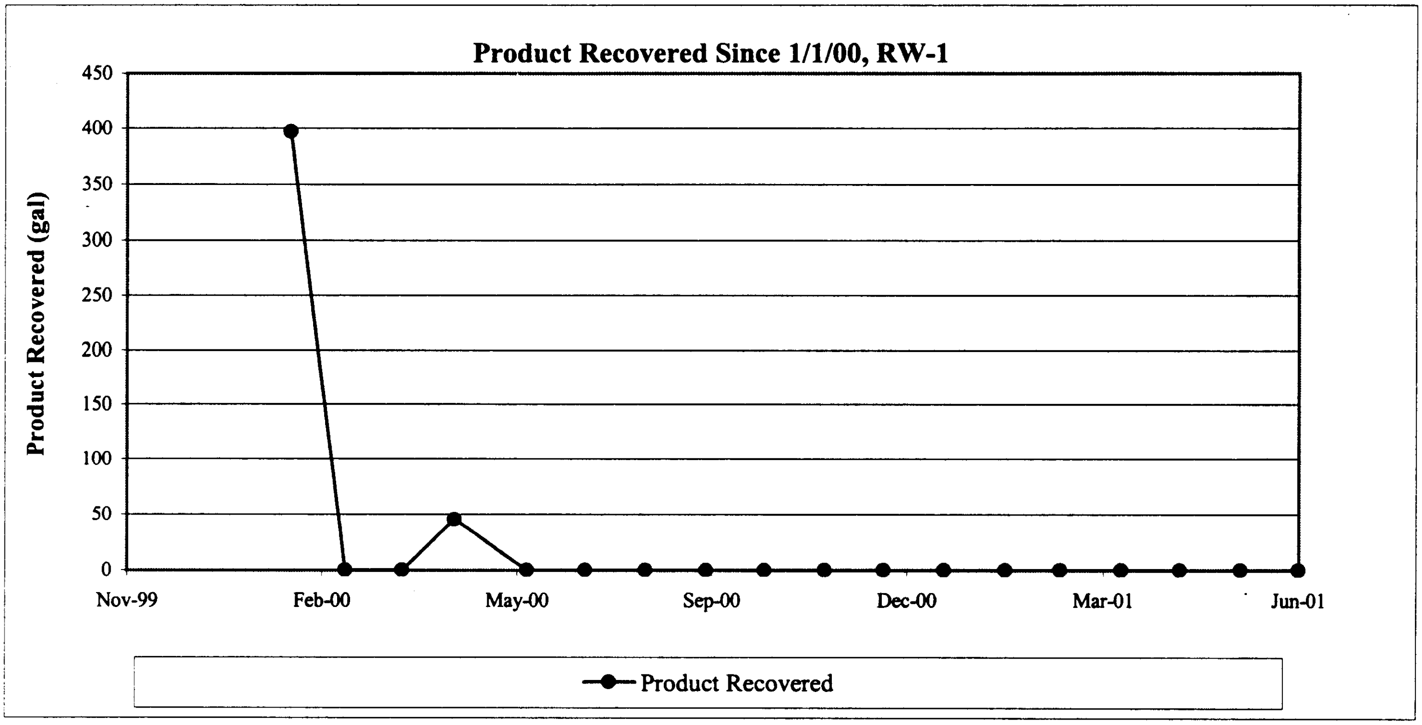
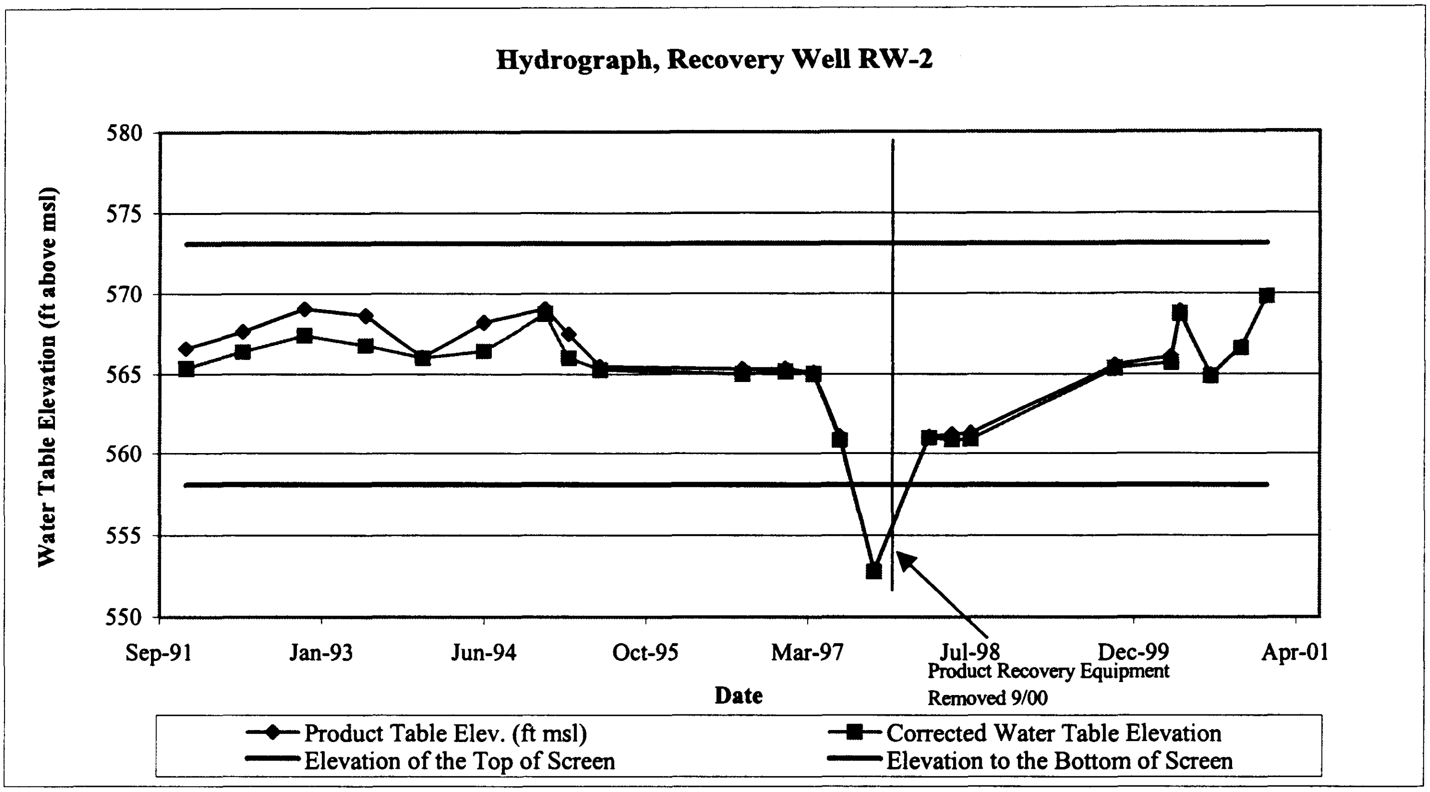


Figure B-24. Hydrograph for RW-2 (STYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



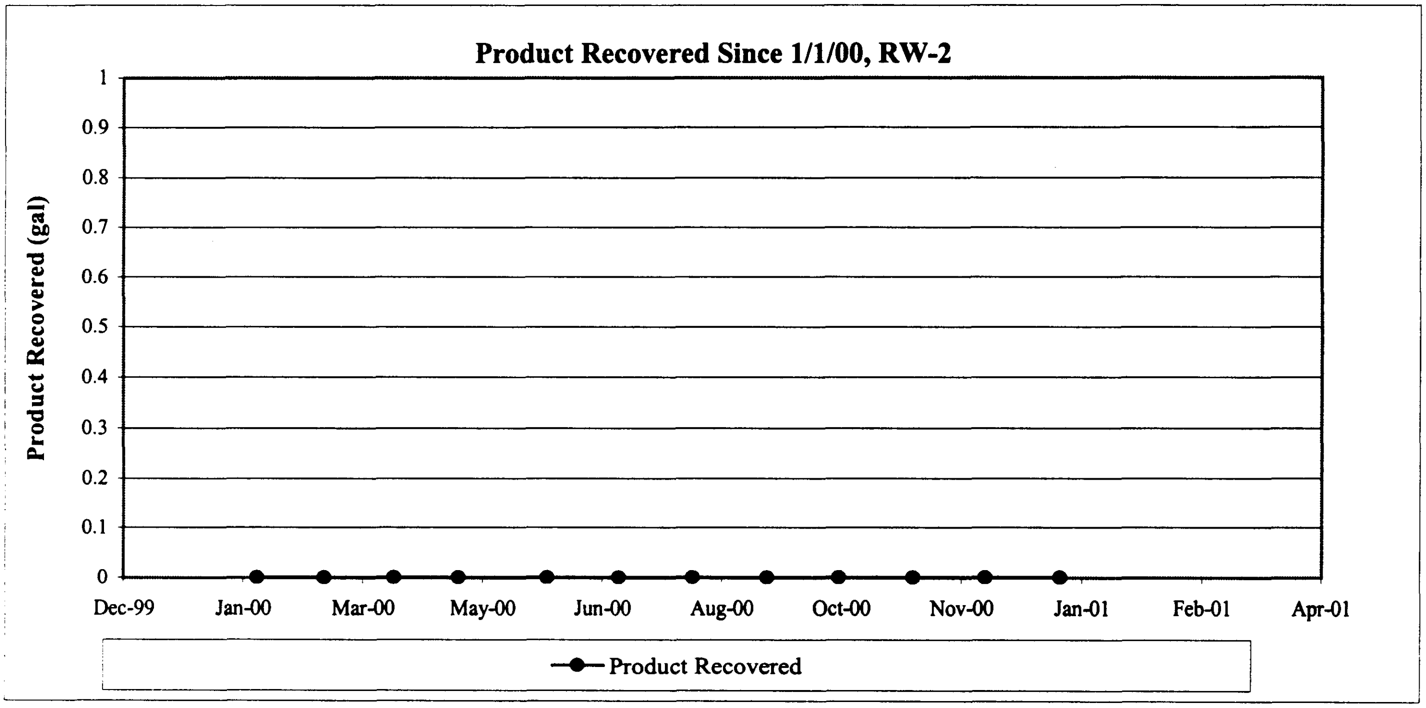
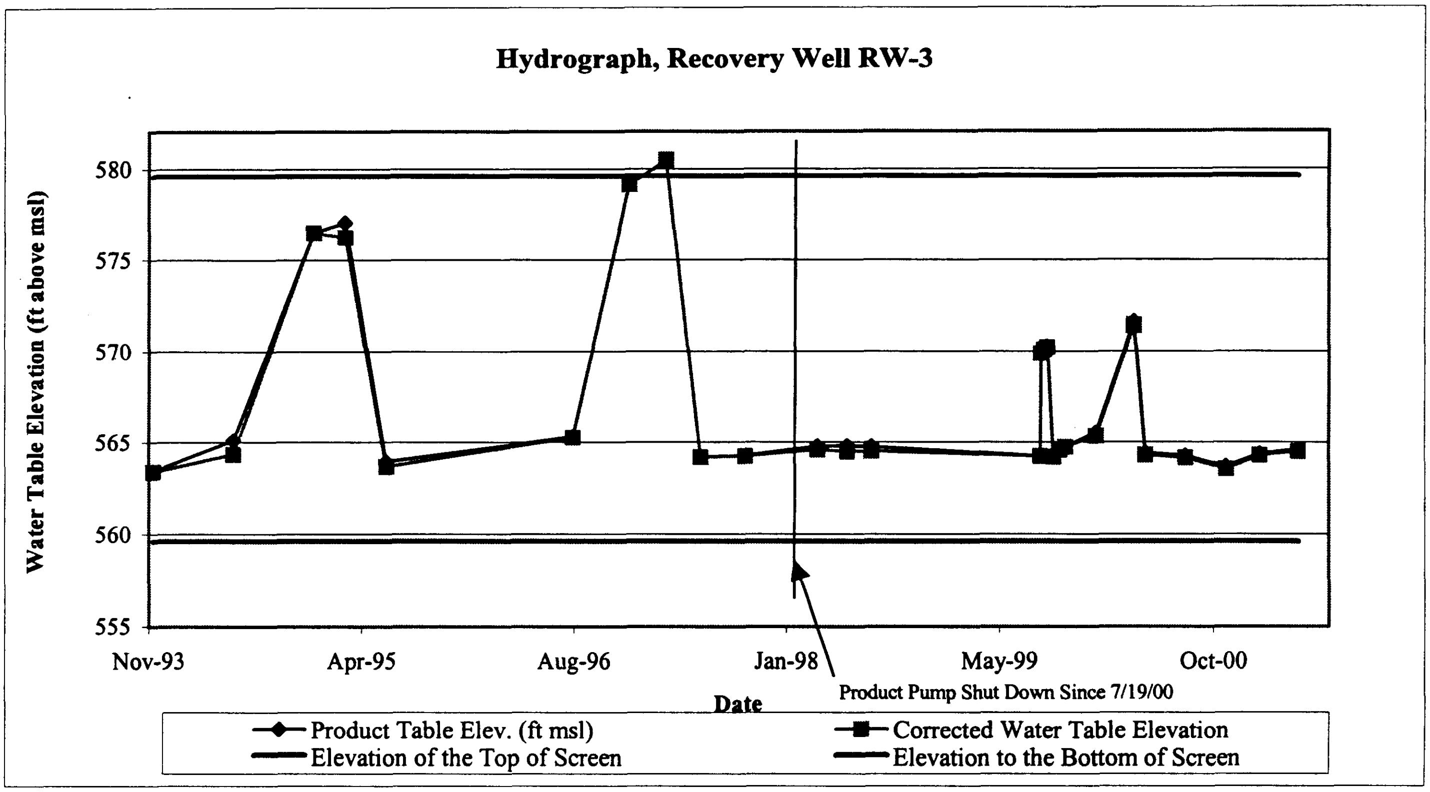


Figure B-25. Hydrograph for RW-3 (STYA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



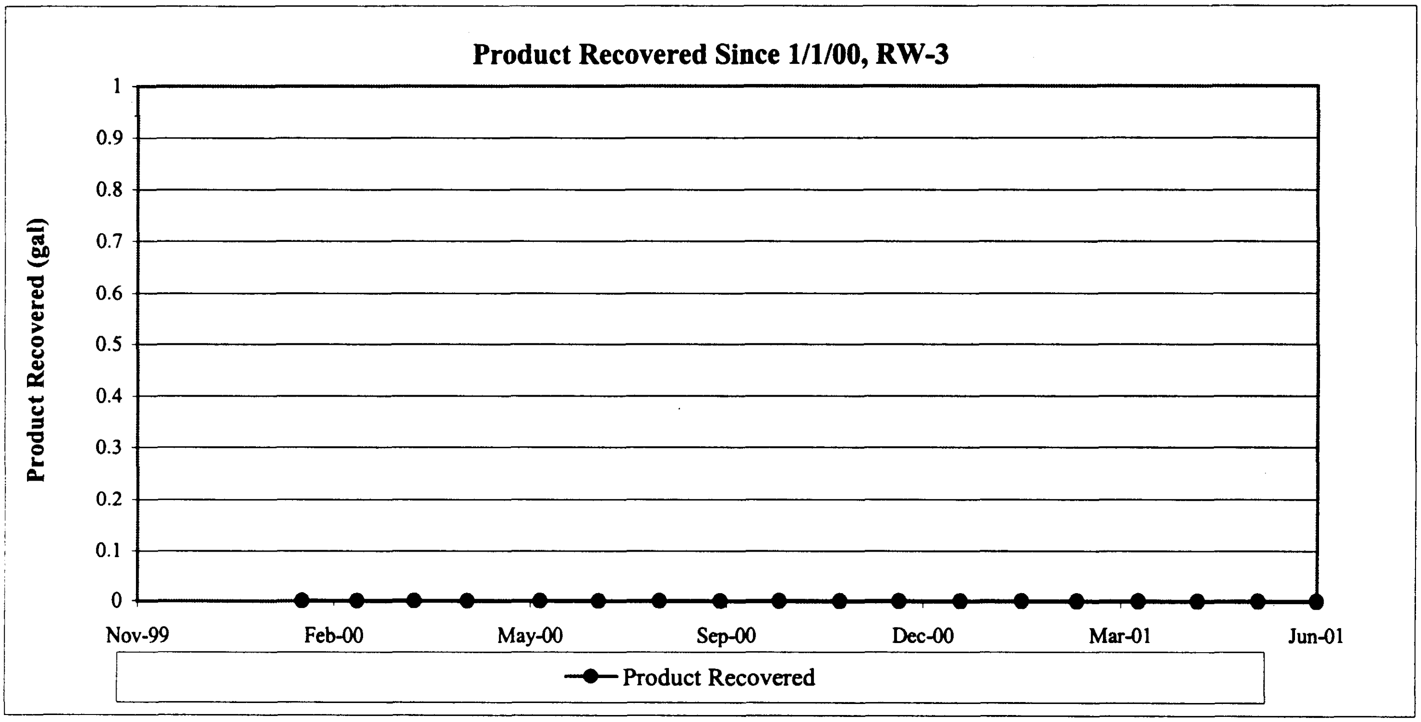
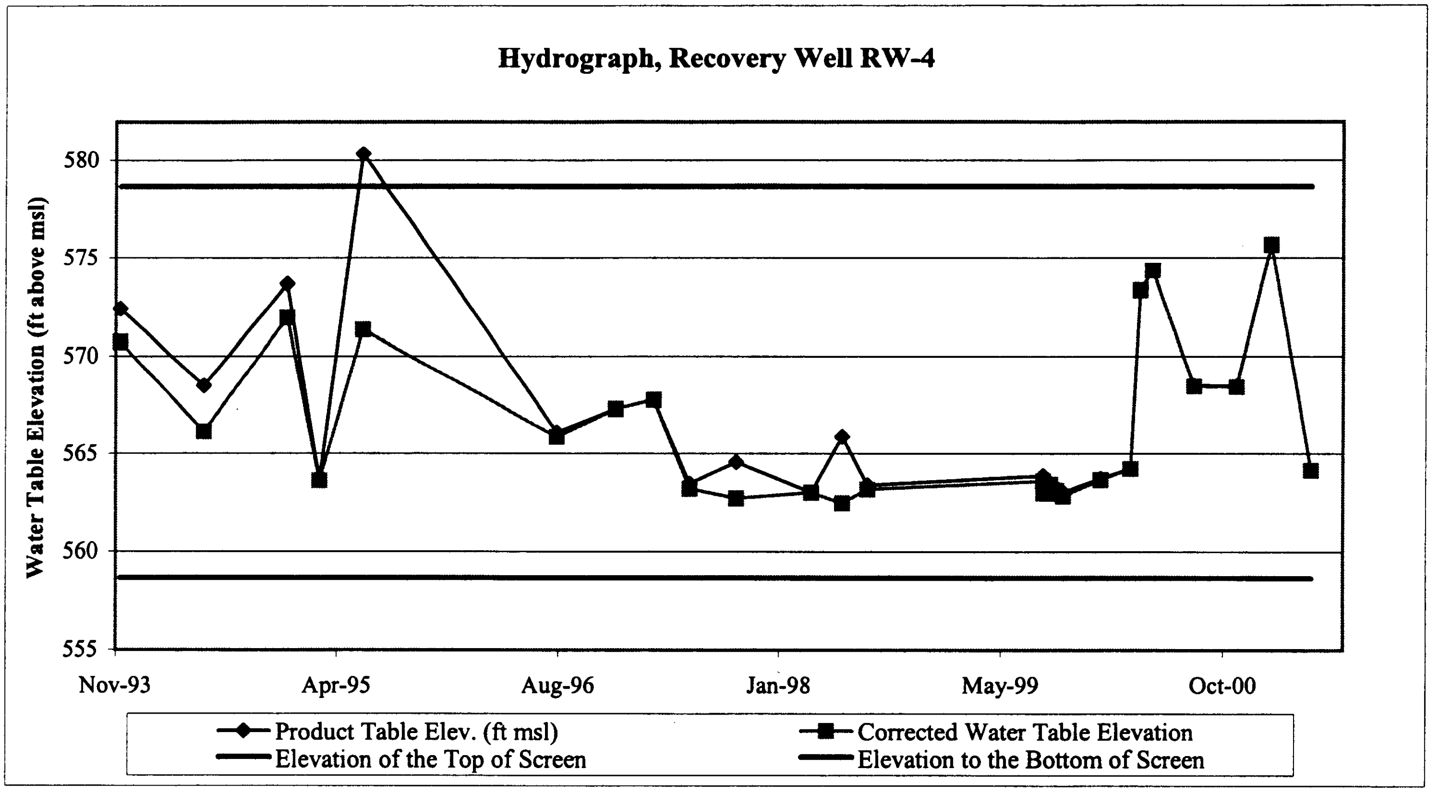


Figure B-26. Hydrograph for RW-4 (FRA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



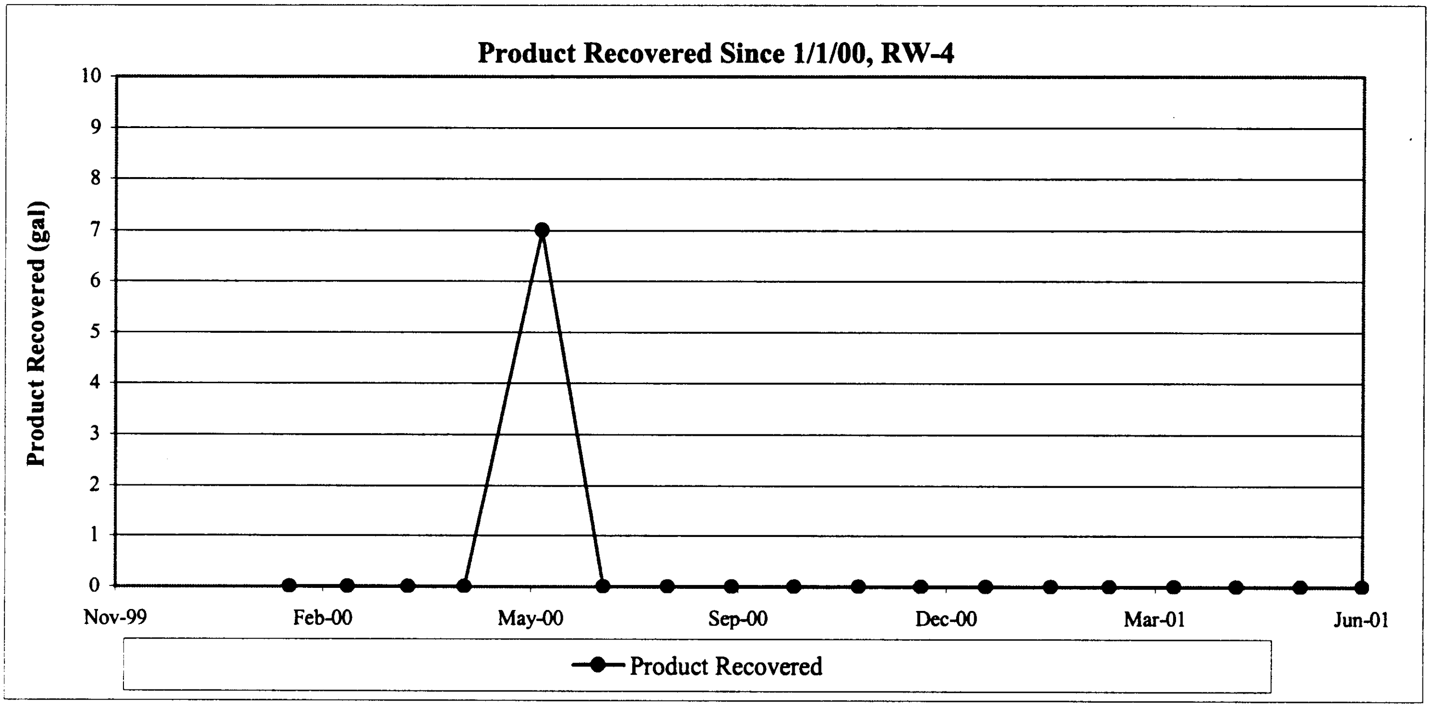
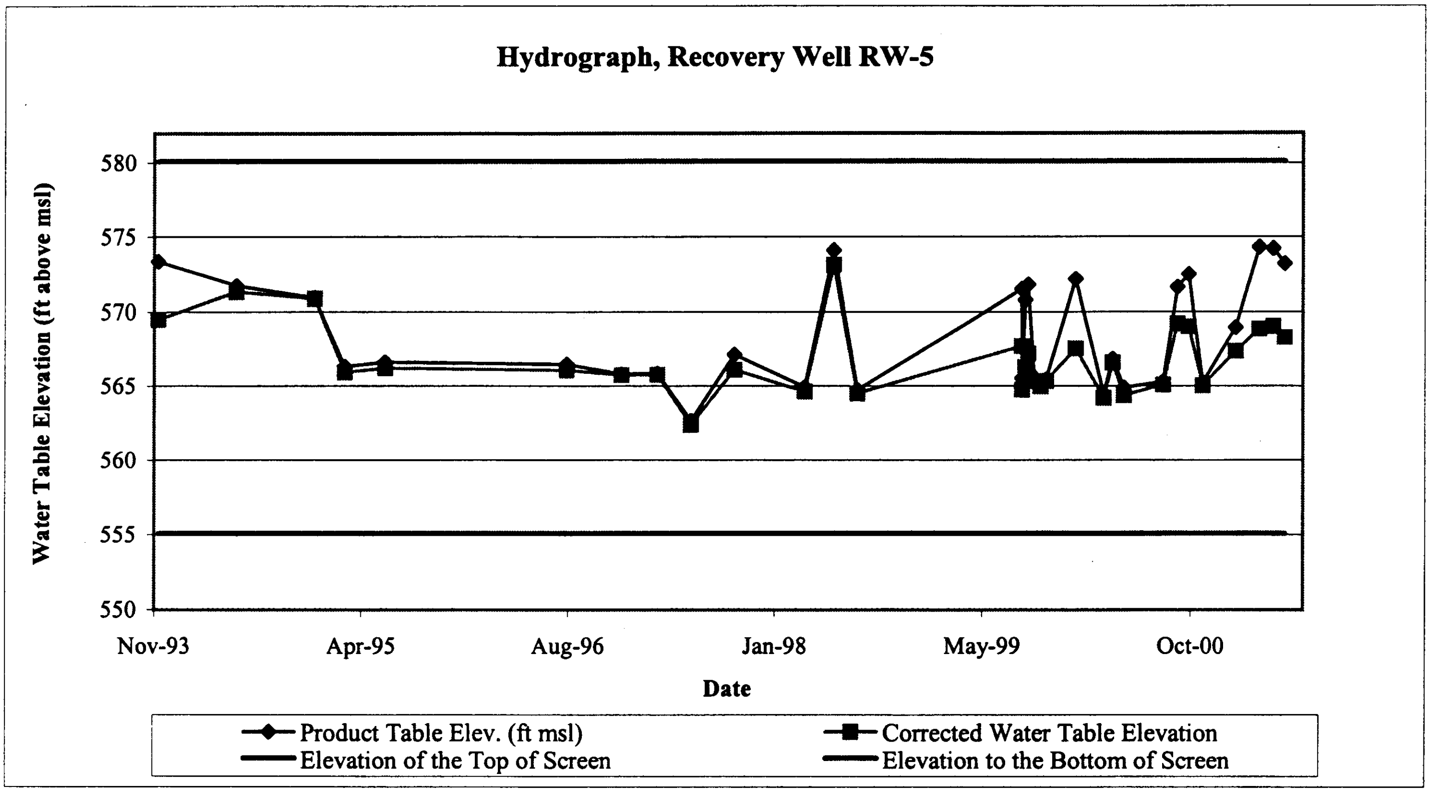


Figure B-27. Hydrograph for RW-5 (FRA), Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York



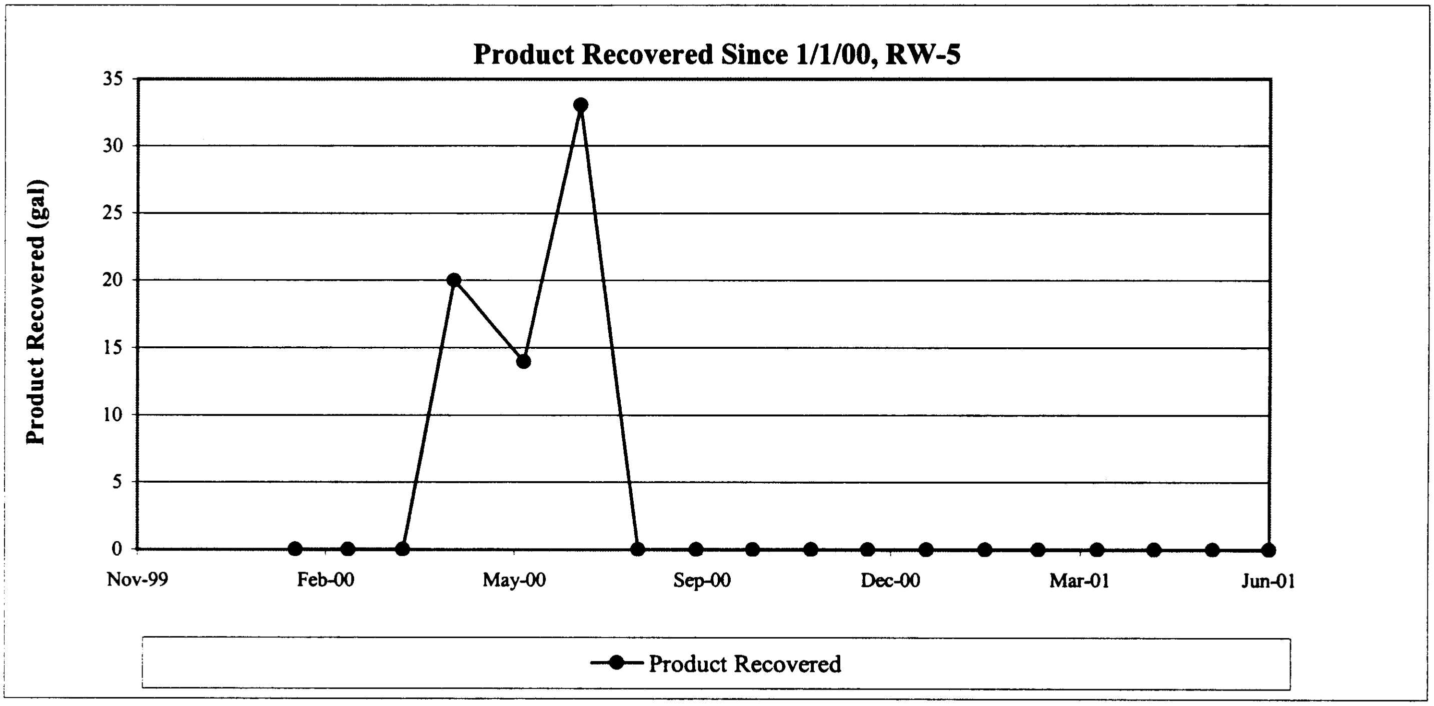
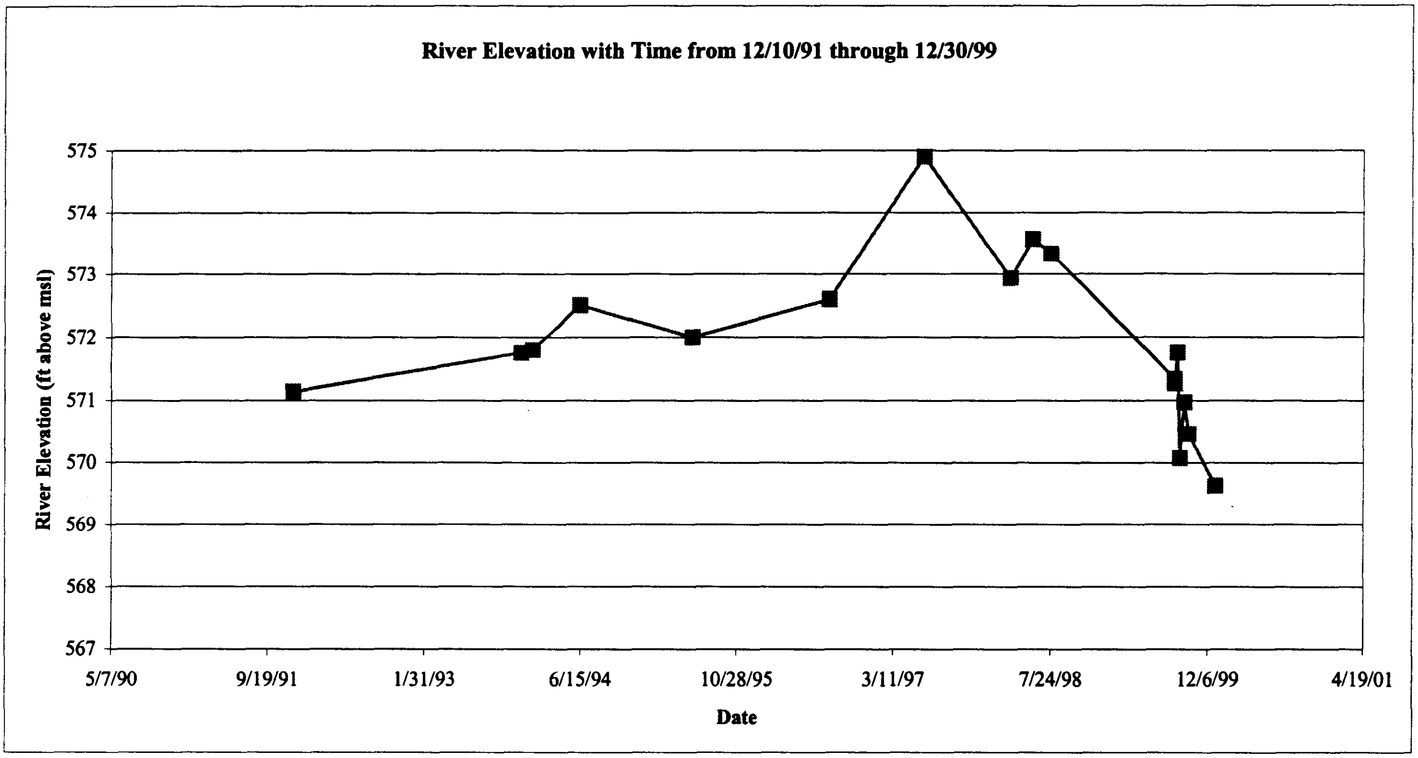
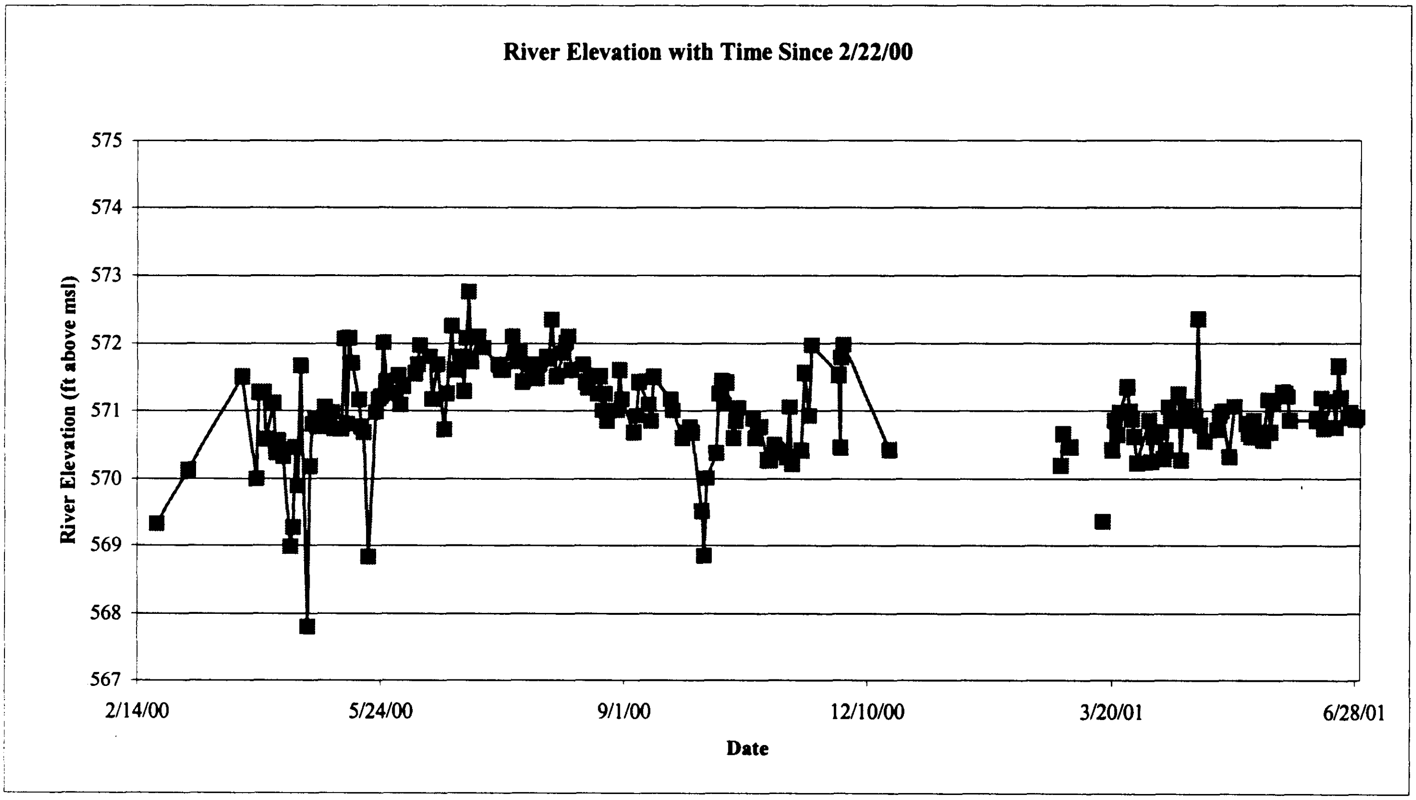


Figure B-28. River Elevation with Time, Buffalo Terminal, ExxonMobil Oil Corporation, Buffalo, New York





APPENDIX C

Standard Operating Procedures

TABLE OF CONTENTS
FOR STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE 3.1 FOR COLLECTION OF QUALITY CONTROL SAMPLES FOR WATER-QUALITY DATA

Date: May 5, 2000

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to explain the quality control (QC) measures taken to ensure the integrity of the samples collected and to establish the guidelines for the collection of QC samples. The objective of the QC program is to ensure that water-quality data of known and reliable quality are developed.

Because valid water-chemistry data are integral to a hydrogeologic investigation that characterizes water-quality conditions, the data will be confirmed by QC samples. Without checks on the sampling and analytical procedures, the potential exists for contradictory or incorrect results. The acceptance of water-quality data by regulatory agencies and in litigation-support investigations depends heavily on the proper QC program to justify the results presented. The QC sampling requirements must be determined by the project manager and be clearly defined in the work plan. If data validation (for in-house purposes or for compliance with the United States Environmental Protection Agency [USEPA] regulations) is stipulated as part of the hydrogeologic investigation, QC sampling must be conducted.

2.0 QUALITY CONTROL SAMPLES

2.1 Samples taken for analysis of compounds require the use of quality control samples to monitor sampling activities and laboratory performance. Types of quality control samples may include replicate and/or replicate split, trip blank, field equipment blank, matrix spike and matrix spike duplicate, and fortification. A discussion pertaining to each quality control sample follows:

a. Replicate and Replicate Split - Replicate sample analysis is done to check on the reproducibility of results either within a laboratory or between laboratories. A replicate sample is called a split sample when it is collected with or turned over to a second party (e.g., regulatory agency, consulting firm) for an independent analysis. Replicate samples are aliquots (equal portions) from a sample in a common container.

To collect a replicate sample, water from the bailer or pump will be distributed first to fill one container and then to fill the second container. Adequate water should be available to fill the bottles completely before they are capped. If the water is insufficient to fill all the bottles at once, then incrementally fill each bottle with water from two or more bailer volumes or pump cycles.

For some test substances, water may have to be accumulated in a common container and then decanted slowly into the sample bottles. The work plan should be checked for a description of how replicate samples are to be collected. Additionally, in the case of wells that recover slowly and produce insufficient water to fill all the replicate sample containers, the containers should be filled incrementally and kept on ice in the cooler in between filling periods.

b. Trip Blank - A trip blank sample is a sample bottle that is filled with "clean" (e.g., distilled/deionized) water in the laboratory, and travels unopened with the sample bottles. (The USEPA now uses the phrase "demonstrated analyte free water.") It is opened in the laboratory and analyzed along with the field samples for the constituent(s) of interest to detect if contamination has occurred during field handling, shipment, or in the laboratory. Trip blanks are primarily used to check for "artificial" contamination of the sample caused by airborne volatile organic compounds (VOCs) but may also be used to check for "artificial" contamination of the sample by a test substance or other analyte(s). One trip blank per cooler containing VOC samples, or test substance of other analyte(s) of interest would accompany each day's samples.

c. Field Equipment Blank - A field equipment blank (field blank) sample is collected to check on the sampling procedures implemented in the field. A field blank is made with "clean" (e.g., distilled/deionized/demonstrated analyte free) water by exposing it to sampling processes (i.e., the clean water must pass through the actual sampling equipment). For example, if samples are being collected with a bailer, the field blank would be made by pouring the clean water into a bailer which has been decontaminated and is ready for sampling, and then pouring from the bailer into the sample containers. If a metals equipment blank is to be made, and the water was filtered, then the sample must be filtered (i.e., exposed to the sampling process). One equipment blank would be incorporated into the sampling program for each day's collection of samples and analyzed for the identical suite of constituents as the sample. In some situations one equipment blank will be required for each type of sampling procedure (e.g., split-spoon, bailer, hand auger).

A special type of field blank may be needed where ambient air quality may be poor. This field blank sample would be taken to determine if airborne contaminants will interfere with constituent identification or quantification. This field blank sample is a sample bottle that is filled and sealed with "clean" (e.g., distilled/deionized/demonstrated analyte free) water in the analytical laboratory, and travels unopened with the sample bottles. It is opened in the field and exposed to the air at a location(s) to check for potential atmospheric interference(s). The field blank is resealed and shipped to the contract laboratory for analysis.

d. Matrix Spike and Matrix Spike Duplicate - Spikes of compounds (e.g., standard compound, test substance, etc.) may be added to samples in the laboratory to determine if the ground-water matrix is interfering with constituent identification or quantification, as well as a check for systematic errors and lack of sensitivity of analytical equipment. Samples for spikes are collected in the identical manner as for standard analysis, and shipped to the laboratory for spiking. Matrix spike duplicate sample collection, and laboratory spiking and analysis is done to check on the reproducibility of matrix spike results.

e. Fortification - A fortification, which is performed in the field, is used to check on the laboratory's ability to recover the test substance (analyte) added as well as its stability between fortification and analysis.

A field fortification (spike) is prepared by filling the container(s) with field or distilled/deionized/demonstrated analyte free water (as specified by the laboratory) to a predetermined volume (as specified by the laboratory) and adding the spike (supplied by the laboratory). The predetermined volume of water is measured with a clean (decontaminated) graduated cylinder. Field spikes will be prepared following the collection, labeling, and sealing of nonspiked samples in a separate cooler. The spike is kept at a safe distance from the sampling point (e.g., in the hotel room).

2.2 The work plan must be referred to for details regarding the type of QC samples to be collected and the QC sample collection method.

3.0 PROCEDURE

3.1 Implement QC sampling as outlined above, depending on the type of QC sample(s) specified in the work plan.

3.2 Ensure unbiased handling and analysis of replicate and blank QC samples by concealing their identity by means of coding so that the analytical laboratory cannot determine which samples are included for QC purposes. Attempt to use a code that will not cause confusion if additional samples are collected or additional monitoring wells are installed. For example, if there are three existing monitoring wells (MW-1, 2 and 3), do not label the QC blank MW-4. If an additional monitoring well were installed, confusion could result.

3.3 Label matrix spike and field fortification (spike) QC samples so that the analytical laboratory knows which samples are to be spiked in the laboratory and which samples were fortified (spiked) in the field, respectively. In certain situations, the field fortification will be "blind" or undisclosed to the laboratory to independently verify their analytical ability.

3.4 Verify that each sample is placed in an individual "zip-lock" bag, wrapped with "bubble wrap," and placed in its appropriate container (holder) in the cooler, and that the cooler has sufficient ice (wet ice or blue packs) to preserve the samples for transportation to the analytical laboratory. Consult the site work plan to determine if a particular ice is specified as the preservative for transportation (e.g., the USEPA prefers the use of wet ice because they claim that blue ice will not hold the samples at 4° Centigrade/Celsius).

3.5 Document the QC samples on the appropriate field form and in the field notebook. On the chain-of-custody form, replicate and blank QC samples will be labeled using the codes (Number 3.2, above), and matrix spike and field fortification QC samples will be identified as such (Number 3.3, above).

3.6 Follow standard shipping procedures for samples (i.e., retain one copy of the chain-of-custody form, secure the cooler with sufficient packing tape and a custody seal, forward the samples via overnight [express] mail or hand deliver to the designated analytical laboratory preferably within 24 hours but no later than 48 hours after sampling). However, check the site work plan for information on the analyte(s), as some have to be analyzed immediately (e.g., CN).

STANDARD OPERATING PROCEDURE 3.2
FOR FIELD RECORD KEEPING AND
QUALITY ASSURANCE/QUALITY CONTROL

Date: May 5, 2000

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide procedures and standards for record keeping and maintenance, for all field activities conducted by Roux Associates, Inc. (Roux Associates).

Strict quality assurance/quality control (QA/QC) is necessary to properly and accurately document and preserve all project-related information. Quality assurance is implemented to corroborate that quality control procedures are followed. Quality control provides a means to monitor investigation activities (e.g., sampling and laboratory performance) as a check on the quality of the data.

Valid data and information are integral to all aspects of Roux Associates' field activities. These aspects include, but are not necessarily limited to, activities that involve: drilling; sediment, sludge, and soil sampling (lithologic, and soil-quality and analysis); well construction and development; aquifer testing and analysis; water-quality sampling and analysis (surface water and ground water); free-product sampling and analysis; air-quality sampling and analysis; geophysical testing; demolition activities; waste removal operations; engineering installations; etc. The data will be confirmed by QA/QC methods established and set forth in the work plan/scope of work. Without checks on the field and analytical procedures, the potential exists for contradictory results, and associated incomplete or incorrect results from the interpretation of potentially questionable data.

Documentation will be entered in the field notebook and must be transcribed with extreme care, in a clear and concise manner, as the information recorded will become part of the permanent legal record. Because field notes are the legal record of site activities, they must be taken in a standard and consistent manner. If abbreviations are used, then they must first be spelled out for clarity (i.e., to avoid ambiguity and misunderstanding). All entries must be dated and initialed, and the time (military time) of the entry included. Field notebooks and forms must be assigned to an individual project and properly identified (i.e., client name, project number, location and name of site, individual recording information, dates, times, etc.). Change of possession of field notebooks or forms must be documented with the date and time, and initialed by both individuals. Following each day's entries, the field notebook or form must be photocopied in the event that the original documentation is lost or stolen. All field notebooks must have the company name and address legibly printed in indelible ink along with the message "If found, then please forward to Roux Associates, Inc. at the above address - REWARD OFFERED."

Information must be recorded while onsite because it may be difficult to recall details at a later date. Furthermore, information must be documented immediately as it provides unbiased information which will be used for writing the report when the field activities are completed. Project-related documentation is an irreplaceable, important record for other individuals who may become involved in the project, and provides the project manager with a complete history of project-related activities. Written information must be accompanied by maps, sketches, and photographs where appropriate, especially if these supplemental sources of information assist in the documentation process. A new page must be used in the field notebook for each new day's entries (i.e., unused portions of a previous page must have an "X" placed through it). The end of the day's records must be initialed and dated.

As part of record keeping and QA/QC activities, state and federal regulatory agencies should be contacted to check if special or different protocols are required and/or if particular or unconventional methods are required for the given field activity. Thus, the record keeping and QA/QC activities implemented by Roux Associates are based on technically sound standard practices and incorporate Roux Associates own, extensive experience in conducting hydrogeologic field activities.

2.0 MATERIALS

In order to track investigation activities, specific materials are required. These materials include the following:

a. A bound, waterproof field notebook.

b. Appropriate Roux Associates' forms (e.g., daily log, geologic log, monitoring well construction log, well sampling data form, location sketch, chain of custody, telephone conversation record, meeting notes, etc.).

c. Appropriate labels (e.g., sample, Roux Associates' Custody Seal, etc.)

d. Work plan/scope of work.

e. Health and safety plan (HASP).

f. Appropriate Roux Associates' SOPs.

g. Black pens, and indelible markers.

h. Camera and film.

3.0 DOCUMENTATION

3.1 Before the Roux Associates personnel leave the field, they must ensure that their field notes include comprehensive descriptions of the hydrogeologic conditions, and all investigation-related activities and results (onsite and offsite). This will safeguard against the inability to reconstruct and comprehend all aspects of the field investigation after its completion, and will serve to facilitate the writing of an accurate report. Properly documented information provides the QA/QC tracking (back-up) required for all Roux Associates' projects. General types of information that must be recorded (where pertinent to the investigation being conducted) include, but may not necessarily be limited to, the following:

a. List of Roux Associates personnel on site.

b. Name, date, and time of arrival on site by Roux Associates personnel, including temporary departures from, and returns to, the site during the work day.

c. Client and project number.

d. Name and location of study area.

e. Date and time of arrival on site by non-Roux Associates personnel (names and affiliation) and equipment (e.g., subcontractors and facility personnel, and drilling equipment, respectively, etc.), including temporary departures from, and returns to, the site during the work day, and departure at the end of the work day.

f. List of non-Roux Associates personnel on site.

g. Weather conditions at the beginning of the day as well as any changes in weather that occur during the working day.

h. Health and safety procedures including level of protection, monitoring of vital signs, frequency of air monitoring, and any change (i.e., downgrade or upgrade) in the level of protection for Roux Associates and other on-site personnel (e.g., subcontractors, facility personnel, etc.).

i. Health and safety procedures not in compliance with the HASP (for all on-site personnel).

j. Site reconnaissance information (e.g., topographic features, geologic features, surface-water bodies, seeps, areas of apparent contamination, facility/plant structures, etc.).

k. Air monitoring results (i.e., photoionization detector [PID], etc. measurements).

l. Task designation and work progress.

m. Work-related and site-related discussions with subcontractors, regulatory agency personnel, plant personnel, the general public, and Roux Associates personnel.

n. Delays, unusual situations, problems and accidents.

o. Field work not conducted in accordance with the work plan/scope of work, and rationale and justification for any change(s) in field procedures including discussions with personnel regarding the change(s) and who authorized the change(s).

p. QA/QC procedures not conducted in accordance with the QA/QC procedures established in the work plan/scope of work and rationale and justification for any change(s) in QA/QC procedures including discussions with personnel regarding the change(s) and who authorized the change(s).

q. Equipment and instrument problems.

r. Decontamination and calibration procedures.

s. Activities in and around the site and work area by any and all on-site personnel which may impact field activities.

t. Sketches, maps, and/or photographs (with dates and times) of the site, structures, equipment, etc. that would facilitate explanations of site conditions.

u. Contamination evidenced as a result of work-related activities (e.g., visible contaminants [sheen] in drilling fluids or on drilling equipment; sheen on, or staining of, sediments; color of, or separate [nonaqueous] phase on, water from borehole or well; vapors or odors emanating from a borehole or well; etc.); make all observations as objectively as possible (e.g., grey-blue, oil-like sheen; black and orange, rust-like stain; fuel-like odor; etc.) and avoid using nontechnical or negative-sounding terms (e.g., slimy, goopy, foul-smelling).

v. Date and time of final departure from the site of all personnel at the end of the work day.

3.2 In addition to the general types of information that must be recorded (as presented in Section 3.1), task-specific information must also be properly documented. Task-specific information which is required is provided in each respective task-oriented SOP, and the documentation procedures outlined in each SOP must be followed.

STANDARD OPERATING PROCEDURE 3.3 FOR SAMPLE HANDLING

Date: May 5, 2000

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish guidelines for sample handling which will allow consistent and accurate results. Valid chemistry data are integral to investigations that characterize media-quality conditions. Thus, this SOP is designed to ensure that once samples are collected, they are preserved, packed and delivered in a manner which will maintain sample integrity to as great an extent as possible. The procedures outlined are applicable to most sampling events and any required modifications must be clearly described in the work plan.

2.0 CONSIDERATIONS

Sample containers, sampling equipment decontamination, quality assurance/quality control (QA/QC), sample preservation, and sample handling are all components of this SOP.

2.1 Sample Containers

Prior to collection of a sample, considerations must be given to the type of container that will be used to store and transport the sample. The type and number of containers selected is usually based on factors such as sample matrix, potential contaminants to be encountered, analytical methods requested, and the laboratory's internal quality assurance requirements. In most cases, the overriding considerations will be the analytical methodology, or the state or federal regulatory requirements because these regulations generally encompass the other factors. The sample container selected is usually based on some combination of the following criteria:

a. Reactivity of Container Material with Sample

Choosing the proper composition of sample containers will help to ensure that the chemical and physical integrity of the sample is maintained. For sampling potentially hazardous material, glass is the recommended container type because it is chemically inert to most substances. Plastic containers are not recommended for most hazardous wastes because the potential exists for contaminants to adsorb to the surface of the plastic or for the plasticizer to leach into the sample.

In some instances, however, the sample characteristics or analytes of interest may dictate that plastic containers be used instead of glass. Because some metals species will adhere to the sides of the glass containers in an aqueous matrix, plastic bottles (e.g., nalgene) must be used for samples collected for metals analysis. A separate, plastic container should accompany glass containers if metals analysis is to be performed along with other analyses. Likewise, other sample characteristics may dictate that glass cannot be used. For example, in the case of a strong alkali waste or hydrofluoric solution, plastic containers may be more suitable because glass containers may be etched by these compounds and create adsorptive sites on the container's surface.

b. Volume of the Container

The volume of sample to be collected will be dictated by the analysis being performed and the sample matrix. The laboratory must supply bottles of sufficient volume to perform the required analysis. In most cases, the methodology dictates the volume of sample material required to complete the analysis. However, individual laboratories may provide larger volume containers for various analytes to ensure sufficient quantities for duplicates or other QC checks.

To facilitate transfer of the sample from the sampler into the container and to minimize spillage and sample disturbance, wide-mouth containers are recommended. Aqueous volatile organic samples must be placed into 40-milliliter (ml) glass vials with polytetrafluoroethylene (PTFE) (e.g., TeflonTM) septums. Non-aqueous volatile organic samples should be collected in the same type of vials or in 4-ounce (oz) wide-mouth jars provided by the laboratory. These jars should have PTFE-lined screw caps.

c. Color of Container

Whenever possible, amber glass containers should be used to prevent photodegradation of the sample, except when samples are being collected for metals analysis. If amber containers are not available, then containers holding samples should be protected from light (i.e., place in cooler with ice immediately after filling).

d. Container Closures

Container closures must screw on and off the containers and form a leak-proof seal. Container caps must not be removed until the container is ready to be filled with the sample, and the container cap must be replaced (securely) immediately after filling it. Closures should be constructed of a material which is inert with respect to the sampled material, such as PTFE (e.g., TeflonTM). Alternately, the closure may be separated from the sample by a closure liner that is inert to the sample material such as PTFE sheeting. If soil or sediment samples are being collected, the threads of the container must be wiped clean with a dedicated paper towel or cloth so the cap can be threaded properly.

e. Decontamination of Sample Containers

Sample containers must be laboratory cleaned by the laboratory performing the analysis. The cleaning procedure is dictated by the specific analysis to be performed on the sample. Sample containers must be carefully examined to ensure that all containers appear clean. Do not mistake the preservative as unwanted residue. The bottles should not be field cleaned. If there is any question regarding the integrity of the bottle, then the laboratory must be contacted immediately and the bottle(s) replaced.

f. Sample Bottle Storage and Transport

No matter where the sample bottles are, whether at the laboratory waiting to be packed for shipment or in the field waiting to be filled with sample, care must be taken to avoid contamination. Sample shuttles or coolers, and sample bottles must be stored and transported in clean environments. Sample bottles and clean sampling equipment must never be stored near solvents, gasoline, or other equipment that is a potential source of cross-contamination. When under chain of custody, sample bottles must be secured in locked vehicles, and custody sealed in shuttles or in the presence of authorized personnel. Information which documents that proper storage and transport procedures have been followed must be included in the field notebook and on appropriate field forms.

2.2 Decontamination of Sampling Equipment

Proper decontamination of all re-usable sampling equipment is critical for all sampling episodes. The SOP for Decontamination of Field Equipment and SOPs for method-specific or instrument-specific tasks must also be referred to for guidance for decontamination of various types of equipment.

2.3 Quality Assurance/Quality Control Samples

QA/QC samples are intended to provide control over the proper collection and tracking of environmental measurements, and subsequent review, interpretation and validation of generated analytical data. The SOPs for Collection of Quality Control Samples, for Evaluation and Validation of Data, and for Field Record Keeping and Quality Assurance/Quality Control must be referred to for detailed guidance regarding these respective procedures. SOPs for method-specific or instrument-specific tasks must also be referred to for guidance for QA/QC procedures.

2.4 Sample Preservation Requirements

Certain analytical methodologies for specific analytes require chemical additives in order to stabilize and maintain sample integrity. Generally, this is accomplished under the following two scenarios:

a. Sample bottles are preserved at the laboratory prior to shipment into the field.

b. Preservatives are added in the field immediately after the samples are collected.

Many laboratories provide pre-preserved bottles as a matter of convenience and to help ensure that samples will be preserved immediately upon collection. A problem associated with this method arises if not enough sample could be collected, resulting in too much preservative in the sample. More commonly encountered problems with this method include the possibility of insufficient preservative provided to achieve the desired pH level or the need for additional preservation due to chemical reactions caused by the addition of sample liquids to pre-preserved bottles. The use of pre-preserved bottles is acceptable; however, field sampling teams must always be prepared to add additional preservatives to samples if the aforementioned situations occur. Furthermore, care must be exercised not to overfill sample bottles containing preservatives to prevent the sample and preservative from spilling and therefore diluting the preservative (i.e., not having enough preservative for the volume of sample).

When samples are preserved after collection, special care must be taken. The transportation and handling of concentrated acids in the field requires additional preparation and adherence to appropriate preservation procedures. All preservation acids used in the field should be trace-metal or higher-grade.

2.5 Sample Handling

After the proper sample bottles have been received under chain-of-custody, properly decontaminated equipment has been used to collect the sample, and appropriate preservatives have been added to maintain sample integrity, the final step for the field personnel is checking the sample bottles prior to proper packing and delivery of the samples to the laboratory.

All samples should be organized and the labels checked for accuracy. The caps should be checked for tightness and any 40-ml volatile organic compound (VOC) bottles must be checked for bubbles. Each sample bottle must be placed in an individual "zip-lock" bag to protect the label, and placed on ice. The bottles must be carefully packed to prevent breakage during transport. When several bottles have been collected for an individual sample, they should not be placed adjacent to each other in the cooler to prevent possible breakage of all bottles for a given sample. If there are any samples which are known or suspected to be highly contaminated, these should be placed in an indivudual cooler under separate chain-of-custody to prevent possible cross contamination. Sufficient ice (wet or blue packs) should be placed in the cooler to maintain the temperature at 4 degrees Celsius (°C) until delivery at the laboratory. Consult the work plan to determine if a particular ice is specified as the preservation for transportation (e.g., the United States Environmental Protection Agency does not like the use of blue packs because they claim that the samples will not hold at 4°C). If additional coolers are required, then they should be purchased. The chain-of-custody form should be properly completed, placed in a "zip-lock" bag, and placed in the cooler. One copy must be maintained for the project files. The cooler should be sealed with packing tape and a custody seal. The custody seal number should be noted in the field book. Samples collected from Monday through Friday will be delivered to the laboratory within 24 hours of collection. If Saturday delivery is not available, samples collected on Friday must be delivered by Monday morning. Check the work plan to determine if certain analytes require a shorter delivery time. If overnight mail is utilized, then the shipping bill must be maintained for the files and the laboratory must be called the following day to confirm receipt.

3.0 EQUIPMENT AND MATERIALS

3.1 General equipment and materials may include, but not necessarily be limited to, the following:

- a. Sample bottles of proper size and type with labels.
- b. Cooler with ice (wet or blue pack).
- c. Field notebook, appropriate field form(s), chain-of-custody form(s), custody seals.
- d. Black pen and indelible marker.
- e. Packing tape, "bubble wrap", and "zip-lock" bags.
- f. Overnight (express) mail forms and laboratory address.
- g. Health and safety plan (HASP).
- h. Work plan/scope of work.
- i. Pertinent SOPs for specified tasks and their respective equipment and materials.

3.2 Preservatives for specific samples/analytes as specified by the laboratory. Preservatives must be stored in secure, spillproof glass containers with their content, concentration, and date of preparation and expiration clearly labeled.

3.3 Miscellaneous equipment and materials including, but not necessarily limited to, the following:

- a. Graduated pipettes.
- b. Pipette bulbs.
- c. Litmus paper.
- d. Glass stirring rods.
- e. Protective goggles.
- f. Disposable gloves.
- g. Lab apron.
- h. First aid kit.
- i. Portable eye wash station.
- j. Water supply for immediate flushing of spillage, if appropriate.
- k. Shovel and container for immediate containerization of spillage-impacted soils, if appropriate.

4.0 PROCEDURE

4.1 Examine all bottles and verify that they are clean and of the proper type, number, and volume for the sampling to be conducted.

4.2 Label bottles carefully and clearly with project name and number, site location, sample identification, date, time, and the sampler's initials using an indelible marker.

4.3 Collect samples in the proper manner (refer to specific sampling SOPs).

4.4 Conduct preservation activities as required after each sample has been collected. Field preservation must be done immediately and must not be done later than 30 minutes after sample collection.

4.5 Conduct QC sampling, as required.

4.6 Seal each container carefully and place in an individual "zip lock" bag.

4.7 Organize and carefully pack all samples in the cooler immediately after collection (e.g., bubble wrap). Insulate samples so that breakage will not occur.

4.8 Complete and place the chain-of-custody form in the cooler after all samples have been collected. Maintain one copy for the project file. If the cooler is to be transferred several times prior to shipment or delivery to the laboratory, it may be easier to tape the chain-of-custody to the exterior of the sealed cooler. When exceptionally hazardous samples are known or suspected to be present, this should be identified on the chain-of-custody as a courtesy to the laboratory personnel.

4.9 Add additional ice as necessary to ensure that it will last until receipt by the laboratory.

4.10 Seal the cooler with packing tape and a custody seal. Record the number of the custody seal in the field notebook and on the field form. If there are any exceptionally hazardous samples, then shipping regulations should be examined to ensure that the sample containers and coolers are in compliance and properly labeled.

4.11 Samples collected from Monday through Friday will be delivered to the laboratory within 24 hours of collection. If Saturday delivery is not available, samples collected on Friday must be delivered by Monday morning. Check the work plan to determine if certain analytes require a shorter delivery time.

4.12 Maintain the shipping bill for the project files if overnight mail is utilized and call the laboratory the following day to confirm receipt.

STANDARD OPERATING PROCEDURE 4.2
FOR MEASURING WATER LEVELS USING AN ELECTRONIC SOUNDING DEVICE (M-SCOPE)

Date: May 5, 2000

1.0 PURPOSE

The purpose for this standard operating procedure (SOP) is to establish the guidelines for using m-scopes. A m-scope is an electronic sounding device used to measure the depth to ground water below an established (surveyed) measuring point (MP). Measuring the depth to water (DTW) below the surveyed MP provides information for calculating ground-water elevations needed to construct ground-water elevation maps and determine the direction of ground-water flow.

M-scopes can be less accurate than a steel tape because the wire can kink, measurement increment marks can shift, and the tip may have been cut off and replaced without proper documentation. Thus, it is mandatory that a m-scope be calibrated before use.

2.0 DECONTAMINATION

The m-scope must be precleaned (decontaminated) using a non-phosphate, laboratory-grade solution and rinsed with copious amounts of distilled or deionized water. This process is repeated before each measurement and following the final measurement.

3.0 CALIBRATION

The m-scope must be calibrated before being used to measure water levels. Calibration is accomplished by measuring the water level with the m-scope followed by a measurement using a steel tape. This dual measurement procedure is continued until the individual is confident that measurements taken using both devices are similar and the m-scope is reliable. The calibration procedure is documented in the field notebook or on an appropriate field form, and initialed and dated.

4.0 PROCEDURE

4.1 If the well is not vented, then remove the cap and wait several minutes for the water level to equilibrate. Take several measurements to ensure that the water level measured is in equilibrium with the aquifer (i.e., not changing substantially).

4.2 The manufacturer's model must be noted because some have switches, lights, beepers, or a combination of the above.

4.3 The 1-foot or 5-foot marked intervals on the electrical line must be checked to ensure that they have not shifted, and the bottom of the probe has not been cut. Check on a periodic basis that the cord has not kinked.

4.4 The water-level measurement is taken by lowering the probe into the well until the instrument-specific detection method (e.g., light, beeper, or both) is activated by contacting the water.

4.5 The electrical line is held at the MP and, using a ruler (e.g., carpenter's folding ruler) or an engineer's scale, the distance from the "held" point to the nearest marked interval is measured. The distance measured is added to, or subtracted from, the marked interval reading. The result is the DTW.

4.6 Measurements will be taken accurately and to the nearest 0.01 foot.

4.7 After measuring all wells in an area, always re-measure at least one well, preferably the first well measured, to see if the static water level has changed (e.g., due to pumping in the area, tidal effects, etc.). If a significant change has occurred, it may be necessary to re-measure other wells.

4.8 If there are previous water-level measurements available for the wells, then have these data available to compare the measurements with those just taken. Use these data to see if water levels are similar or if they have changed. If water levels have changed, then check if the changes are consistent (i.e., all up or all down) and make sense.

4.9 Water-level elevations are calculated by subtracting the DTW from the MP and a water-elevation map is constructed (contoured) on a well location map. This also provides a check to evaluate if the water levels make sense (or anomalies are evidenced). Remeasure the well(s) where anomalies are found as a check on the initial measurement(s).

4.10 If anomalies persist or water-level trends are different from the historical database, then check to see if hydrogeologic conditions and/or stresses have changed (e.g., discharge areas, pumping and/or injection wells, etc.).

4.11 All pertinent data will be documented in the field notebook, and initialed and dated.

STANDARD OPERATING PROCEDURE 4.3
FOR PURGING A WELL

Date: May 5, 2000

1.0 PURPOSE

The purpose for this standard operating procedure (SOP) is to establish the guidelines for purging a well prior to the collection of a ground-water sample. Purging (evacuating) a well involves the removal of the standing column of water in the well to allow "fresh" (representative) formation water to enter the well. Two conventionally used methods for well purging include: 1) discharge of a specified number of casing volumes of water (which is more commonly used); and 2) pumping until specific indicator parameters (e.g., specific conductance, pH, temperature) stabilize. Wells must be purged prior to sampling to ensure the collection of representative formation ground water for water-quality analysis.

For accepted, existing sampling and analysis programs, the same purging method will be used each time to maintain consistency. For new sampling and analysis programs, the basis for the purging technique(s) will be site-specific field conditions, client input, the experience of Roux Associates, Inc. and regulatory agency(ies) guidelines (e.g., some states permit purging a low-yield well to dryness while others insist that some water remains in the well).

2.0 EQUIPMENT AND MATERIALS

2.1 The following equipment may be needed to purge a monitoring well before sampling:

a. Bailers.

b. Centrifugal pumps.

c. Electrical submersible pumps.

d. Peristaltic pumps.

e. Positive gas-displacement devices.

f. Bladder pumps.

g. Hand-operated diaphragm or bilge pump(s).

h. Teflon™ tape, electrical tape.

i. Tape measure (stainless steel, steel, fiberglass) with 0.01-foot measurement increments and chalk (e.g., blue carpenter's) or m-scope.

j. Appropriate discharge hose and valves.

k. Appropriate discharge tubing (e.g., polypropylene) if using a peristaltic pump.

l. Appropriate compressed gas if using bladder-type or gas-displacement device.

m. Extension cord(s) or portable generator (and fuel) if using an electric submersible pump.

n. Non-absorbent cord (e.g., polypropylene, etc.), cotton (absorbent) cord.

o. Tripod(s).

p. Water Well Handbook.

q. Explosimeter.

r. Flow meter.

2.2 Bailers or centrifugal pumps are recommended for shallow, small diameter monitoring wells. For deep wells, or large diameter wells, a submersible pump is recommended.

3.0 DECONTAMINATION

Each piece of equipment that is used to evacuate wells (e.g., bailers, pumps, hoses) will be decontaminated thoroughly prior to the introduction of the equipment into the well and prior to leaving the site. Additionally, disposable items (e.g., cord, tubing) will be changed between each well purged and discarded in an appropriate manner.

4.0 PROCEDURE

4.1 The depth to water (DTW) is measured and subtracted from the sounded (total) depth of the well to calculate the length of the column of standing water in the well (in feet).

4.2 The volume of the standing water in the well is calculated by multiplying the length of standing water by a coefficient which equates the diameter of the well to gallons per linear foot. (Refer to the attached table from the Water Well Handbook for the coefficient or use the following equation [V=(7.48 gal/ft3)(r2h), where V is volume of water in gallons, r is the radius of the well casing in feet, and h is the height of the water column in the well in feet].)

4.3 If purging is performed by evacuating a specified number of casing volumes, then three to five volumes are purged (typical regulatory agency requirement).

4.4 If wells are screened in low permeability formations, then the well may go dry prior to removing the specified volume of water. If the recovery rate is fairly rapid and time allows, then remove more than one casing volume; otherwise, the evacuation of one casing volume may suffice. (Refer to the site sampling and analysis plan [SAP] for details of purging a low-yield well.)

4.5 Evacuation will occur from the top of the water column in the well to ensure that "fresh" formation water enters the bottom of the well through the screen, moves up as standing water is removed from the top, and all standing water is removed (i.e., only representative formation water is in the well).

4.6 The volume of water purged from the well must be measured and can be calculated directly by discharging into containers of known volume or can be calculated by multiplying rate of flow by time.

4.7 If a submersible or centrifugal pump is used, then the intake is set just below the dynamic (pumping) water level in the well. The rate of flow in gallons per minute (gpm) can be measured using a calibrated bucket (e.g., 5-gallon) if the rate is relatively low, or a 55-gallon drum if the rate is relatively high, and a watch capable of measuring time in second intervals. A precalibrated flow meter may also be used if available.

4.8 After the specified number of casing volumes have been evacuated from the well, the pump intake is lifted slowly until it breaks suction to confirm that any standing water above the intake has been purged.

4.9 If a bailer is used, then the bailer is lowered only deep enough to remove water from the top of the water column and a 5-gallon bucket is used to measure the volume of water evacuated.

4.10 If purging is not executed by evacuating a specified number of well volumes, then purging is performed by pumping or bailing the well until specific indicator parameters (e.g., specific conductance, pH, temperature) stabilize. The volume of water removed is documented on an appropriate field form or in the field notebook.

4.11 Water purged from the well will be disposed of in accordance with the appropriate method outlined in the site SAP.

4.12 If historic site data indicate that explosive gases could be present and accumulate in the well, then an explosimeter will be used to check vapor concentrations in wells at the site prior to beginning the purging procedure. Vapor concentrations in a well that exceed the 25 percent lower explosive limit (LEL) will require specific precautionary measures to allow purging the well without danger of explosion or fire (e.g., use of cotton cord for bailers or lowering pumping devices, non-electric powered pumps). These conditions will be addressed in the site health and safety plan (HASP) and/or SAP.

STANDARD OPERATING PROCEDURE 4.4
FOR SAMPLING GROUND-WATER MONITORING WELLS FOR DISSOLVED CONSTITUENTS

Date: May 5, 2000

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish guidelines for the sampling of ground-water monitoring wells for dissolved constituents. As part of the SOP for the sampling of ground-water monitoring wells, sample collection equipment and devices must be considered, and equipment decontamination and pre-sampling procedures (e.g., measuring water levels, sounding wells, and purging wells) must be implemented. Sampling objectives must be firmly established in the work plan before considering the above.

Valid water-chemistry data are integral to a hydrogeologic investigation that characterizes ground-water quality conditions. Water-quality data are used to evaluate both current and historic aquifer chemistry conditions, as well as to estimate future conditions (e.g., trends, migration pathways). Water-quality data can be used to construct ground-water quality maps to illustrate chemical conditions within the flow system, to generate water-quality plots to depict conditions with time and trends, and to perform statistical analyses to quantify data variability, trends, and cleanup levels.

2.0 EQUIPMENT AND MATERIALS

2.1 In order to sample ground water from monitoring wells, specific equipment and materials are required. The equipment and materials list may include, but not necessarily be limited to, the following:

a. Bailers (Teflon™ or stainless steel).

b. Pumps (centrifugal, peristaltic, bladder, electric submersible, bilge, hand-operated diaphragm, etc.).

c. Gas-displacement device(s).

d. Air-lift device(s).

e. Teflon™ tape, electrical tape.

f. Appropriate discharge hose.

g. Appropriate discharge tubing (e.g., polypropylene, teflon, etc.) if using a peristaltic pump.

h. Appropriate compressed gas if using bladder-type or gas-displacement device.

i. Portable generator and gasoline or alternate power supply if using an electric submersible pump.

j. Non-absorbent cord (e.g., polypropylene, etc.).

k. Plastic sheeting.

l. Tape measure (stainless steel, steel, fiberglass) with 0.01-foot measurement increments and chalk (blue carpenter's).

m. Electronic water-level indicators (e.g., m-scope, etc.) or electric water-level/product level indicators.

n. Non-phosphate, laboratory-grade detergent.

o. Distilled/Deionized water.

p. Potable water.

q. Paper towels, clean rags.

r. Roux Associates' field forms (e.g., daily log, well inspection checklist, sampling, etc.) and field notebook.

s. Well location and site map.

t. Well keys.

u. Stop watch, digital watch with second increments, or watch with a second hand.

v. Water Well Handbook.

w. Calculator.

x. Black pen and water-proof marker.

y. Tools (e.g., pipe wrenches, screwdrivers, hammer, pliers, flashlight, pen knife, etc.).

z. Appropriate health and safety equipment, as specified in the site health and safety plan (HASP).

aa. pH meter(s) and buffers.

bb. Conductivity meter(s) and standards.

cc. Thermometer(s).

dd. Extra batteries (meters, thermometers, flashlight).

ee. Filtration apparatus, filters, pre-filters.

ff. Plasticware (e.g., premeasured buckets, beakers, flasks, funnels).

gg. Disposable gloves.

hh. Water jugs.

ii. Laboratory-supplied sample containers with labels.

jj. Cooler(s).

kk. Ice (wet, blue packs).

ll. Masking, duct, and packing tape.

mm. Chain-of-custody form(s) and custody seal(s).

nn. Site sampling and analysis plan (SAP).

oo. Site health and safety plan (HASP).

pp. Packing material (e.g., bubble wrap)

qq. "Zip-lock" plastic bags.

rr. Overnight (express) mail forms.

3.0 DECONTAMINATION

3.1 Make sure all equipment is decontaminated and cleaned before use (refer to the SOP for Decontamination of Field Equipment for detailed decontamination methods, summaries for bailers and pumps are provided below). Use new, clean materials when decontamination is not appropriate (e.g., non-absorbent cord, disposable gloves). Document, and initial and date the decontamination procedures on the appropriate field form and in the field notebook.

a. Decontaminate a bailer by: 1) wearing disposable gloves, 2) disassembling (if appropriate) and scrubbing in a non-phosphate, laboratory-grade detergent and distilled/deionized water solution, and 3) rinsing first with potable water and then distilled/deionized water.

b. Decontaminate a pump by: 1) wearing disposable gloves, 2) flushing the pump and discharge hose (if not disposable) first with a non-phosphate, laboratory-grade detergent and potable water solution in an appropriate container (clean bucket, garbage can, or 55-gallon drum) and then with distilled/deionized water or potable water, and 3) wiping pump-related equipment (e.g., electrical lines, cables, discharge hose) first with a clean cloth and detergent solution and then rinsing or wiping with a clean cloth and distilled/deionized water or potable water.

3.2 Note that the decontamination procedures for bailers and pumps are the minimum that must be performed. Check the work plan to determine if chemicals specified by individual state regulatory agencies must also be used for decontamination procedures (e.g., hexane, nitric acid, acetone, isopropanol, etc.).

4.0 CALIBRATION OF FIELD ANALYSIS EQUIPMENT

Calibrate field analysis equipment before use (e.g., thermometers, pH and conductivity meters, etc.). Refer to the specific SOP for field analysis for each respective piece of equipment. Document, and initial and date the calibration procedures on the appropriate field form, in the field notebook, and in the calibration log book.

5.0 PROCEDURE

5.1 Document, and initial and date well identification, pre-sampling information, and problems encountered on the appropriate field form and in the field notebook as needed.

5.2 Inspect the protective casing of the well and the well casing, and note any items of concern such as a missing lock, or bent or damaged casing(s).

5.3 Place plastic sheeting around the well to protect sampling equipment from potential cross contamination.

5.4 Remove the well cap or plug and, if necessary, clean the top of the well off with a clean rag. Place the cap or plug on the plastic sheeting. If the well is not vented, allow several minutes for the water level in the well to equilibrate. If fumes or gases are present, then diagnose these with the proper safety equipment. Never inhale the vapors.

5.5 Measure the depth to water (DTW) from the measuring point (MP) on the well using a steel tape and chalk or an electronic sounding device (m-scope). Refer to the specific SOPs for details regarding the use of a steel tape or a m-scope for measuring water levels. Calculate the water-level elevation. Document, and initial and date the information on the appropriate field form and in the field notebook.

5.6 Measuring the total depth of the well from the MP with a weighted steel tape. Calculate and record the volume of standing water in the well casing on the appropriate field form and in the field notebook.

5.7 Decontaminate the equipment used to measure the water level and sound the well with a non-phosphate, laboratory-grade detergent solution followed by a distilled/deionized water rinse.

5.8 Purge the well prior to sampling (refer to the SOP for Purging a Well). The well should be pumped or bailed to remove the volume of water specified in the work plan. Usually three to five casing volumes are removed if the recharge rate is adequate to accomplish this within a reasonable amount of time.

If the formation cannot produce enough water to sustain purging, then one of two options must be followed. These include: 1) pumping or bailing the well dry, or 2) pumping or bailing the well to "near-dry" conditions (i.e., leaving some water in the well). The option employed must be specified in the work plan and be in accordance with regulatory requirements.

If the well is purged dry, then all the standing water has been removed and upon recovery the well is ready for sampling. However, depending on the rate of recovery and the time needed to complete the sampling round, one of the following procedures may have to be implemented: 1) the well may have to be sampled over a period of more than one day; 2) the well may not yield enough water to collect a complete suite of samples and only select (most important) samples will be collected; or 3) the well may not recover which will preclude sampling. Regardless of the option that must be followed, the sampling procedure must be fully documented. When preparing to conduct a sampling round, review drilling, development and previous sampling information (if available) to identify low-yielding wells in order to purge them first, and potentially allow time for the well to recover for sampling.

5.9 Record the physical appearance of the water (i.e., color, turbidity, odor, etc.) on the appropriate field form and in the field notebook, as it is purged. Note any changes that occur during purging.

5.10 If a bailer is used to collect the sample, then:

a. Flush the decontaminated bailer three times with distilled/deionized water.

b. Tie the non-absorbent cord (polypropylene) to the bailer with a secure knot and then tie the free end of the bailer cord to the protective casing or, if possible, some nearby structure to prevent losing the bailer and cord down the well.

c. Lower the bailer slowly down the well and into the water column to minimize disturbance of the water surface. If a bottom-filling bailer is used, then do not submerge the top of the bailer; however, if a top-filling bailer is used, then submerge the bailer several feet below the water surface.

d. Remove and properly discard one bailer volume from the well to rinse the bailer with well water before sampling. Again, lower the bailer slowly down the well to the appropriate depth depending on the bailer type (as discussed above in 5.11 c). When removing the bailer from the well, do not allow the bailer cord to rest on the ground but coil it on the protective plastic sheeting placed around the well. Certain regulatory agencies require that the first bailer volume collected be utilized for the samples.

5.11 If a pump is used to collect the sample, then use the same pump used to purge the well and, if need be, reduce the discharge rate to facilitate filling sample containers and to avoid problems that can occur while filling sample containers (as listed in Number 5.14, below). Alternately, the purge pump may be removed and a thoroughly decontaminated bailer can be used to collect the sample.

5.12 Remove each appropriate container's cap only when ready to fill each with the water sample, and then replace and secure the cap immediately.

5.13 Fill each appropriate, pre-labeled sample container carefully and cautiously to prevent: 1) agitating or creating turbulence; 2) breaking the container; 3) entry of, or contact with, any other medium; and 4) spilling/splashing the sample and exposing the sampling team to contaminated water. Immediately place the filled sample container in a ice-filled (wet ice or blue pack) cooler for storage. If wet ice is used it is recommended that it be repackaged in zip-lock bags to help keep the cooler dry and the sample labels secure. Check the work plan as to whether wet ice or blue packs are specified for cooling the samples because certain regulatory agencies may specify the use of one and not the other.

5.14 "Top-off" containers for volatile organic compounds (VOCs) and tightly seal with Teflon™-lined septums held in place by open-top screw caps to prevent volatilization. Ensure that there are no bubbles by turning the container upside down and tapping it gently.

5.15 Filter water samples (Procedure 4.6) collected for dissolved metals analysis prior to preservation to remove the suspended sediment from the sample. If water samples are to be collected for total metals analysis, then collect a second set of samples without field filtering.

In the event that the regulatory agency(ies) want unfiltered samples for metals analysis, a second set of filtered samples should also be collected. Because unfiltered samples are indications of total metals (dissolved and suspended) they are not representative of aquifer conditions because ground water does not transport sediment (except in some rare cases). Thus, the results for dissolved metals in ground water should be based on filtered samples even if both filtered and unfiltered sets are presented in a report.

5.16 Add any necessary preservative(s) to the appropriate container(s) prior to, or after (preferred), the collection of the sample, unless the appropriate preservative(s) have already been added by the laboratory before shipment.

5.17 Collect quality control (QC) samples as required in the work plan to monitor sampling and laboratory performance. Refer to the SOP for Collection of Quality Control Samples.

5.18 Conduct field analyses after sample collection is complete by measuring and recording the temperature, conductivity, pH, etc. (as called for in the work plan). Note and record the "final" physical appearance of the water (after purging and sampling) on an appropriate field form and in the field notebook.

5.19 Wipe the well cap with a clean rag, replace the well cap and protective cover (if present). Lock the protective cover.

5.20 Verify that each sample is placed in an individual "zip-lock" bag, wrapped with "bubble wrap," placed in the cooler, and that the cooler has sufficient ice (wet ice or blue packs) to preserve the samples for transportation to the analytical laboratory.

5.21 Decontaminate bailers, hoses, and pumps as discussed in the decontamination SOP. Wrap decontaminated equipment with a suitable material (e.g., clean plastic bag or aluminum foil). Discard cords, rags, gloves, etc. in a manner consistent with site conditions.

5.22 Complete all necessary field forms, field notebook entries, and the chain-of-custody forms. Retain one copy of each chain-of-custody form. Secure the cooler with sufficient packing tape and a custody seal.

5.23 Samples collected from Monday through Friday will be delivered within 24 hours of collection. If Saturday delivery is not available, samples collected on Friday must be delivered by Monday morning. Consult the work plan to determine if any of the analytes require a shorter delivery time.

STANDARD OPERATING PROCEDURE 4.7
FOR MEASURING THE THICKNESS OF FLOATING SEPARATE-PHASE ORGANIC LIQUIDS

Date: May 5, 2000

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish guidelines for measuring the thickness of floating separate-phase organic liquids in a well, tank or drum. Measuring the thickness of floating, separate-phase organic liquids requires special health and safety considerations, equipment, and procedures.

Separate-phase layers can either be "floaters" or "sinkers". "Floaters" (non-aqueous phase liquids [NAPLs]) are separate-phase liquids that are less dense than water and float on the ground-water surface. "Sinkers" (dense non-aqueous phase liquids [DNAPLs]) are separate-phase liquids that are more dense than water and tend to migrate downward through aquifers due to gravitational forces until a low permeability layer is encountered (i.e., they accumulate at the bottom of the aquifer). For the purpose of this SOP, only measuring the thickness of floating separate-phase liquids will be addressed.

The objectives for measuring separate-phase organic liquids may include the following: 1) determination of the thickness of the free product in a well, tank or drum; 2) estimation of the volume of free product to be removed from a well before sampling, or from a tank or drum before removal; and 3) calculation of the "true" (non-free product depressed) elevation of the water table.

2.0 CONSIDERATIONS

The primary considerations when measuring the thickness of floating separate-phase liquids are health and safety, and proper equipment selection.

2.1 Health and Safety

All separate-phase products must be assumed to possess health and safety hazards equivalent to the most hazardous suspected on-site source. For example, if fuel oil is being measured in wells where polychlorinated biphenyls (PCBs) are known (or suspected) to be present, then the potential for PCBs to be present in the fuel oil must be considered. When measuring the thickness of flammable materials, it is imperative that all possible sources of ignition be eliminated. Minimum requirements include (NO EXCEPTIONS) no smoking or open flames, use of intrinsically safe downhole monitoring equipment, use of static free bailing cord (e.g., absorbent cord [cotton]), and use of properly vented and grounded product collection containers. When product collection containers will be stored onsite, the local fire code official must be consulted regarding product storage requirements (e.g. venting, grounding, labeling, permits, secondary containment, etc.). A detailed, comprehensive explanation of health and safety procedures must be outlined in the site health and safety plan (HASP).

2.2 Equipment Selection

There are several methods which may be employed to measure the thickness of separate-phase petroleum product in a monitoring well, tank or drum. The actual method to be utilized should be outlined in the work plan. Considerations in selecting a method shall include: the type and consistency of the product; the level of accuracy desired; the expected depth and thickness of the product; and the diameter of the well or port.

Measurements of floating separate-phase product thicknesses can be performed using 1) an electronic oil/water interface probe; 2) a graduated, clear acrylic bailer; or 3) a weighted steel measuring tape (or graduated "stick") in conjunction with oil and water paste.

An oil/water interface probe is capable of providing rapid and accurate (±0.01 foot) results under most field situations. However, viscous product or oil/water emulsions may interfere with performance by coating the probe and/or disguising the interface. In these situations, a clear, acrylic bailer may be used in wells, or oil and water paste in a tank or drum.

A clear, acrylic bailer may be used if simply the presence or absence of product or an approximate product thickness is desired. In certain situations (e.g., viscous product or product/water emulsions) a clear acrylic bailer may be the best available method. However, when product thicknesses are greater than approximately three feet, a bailer will be unable to provide approximate product thickness measurements. If the oil/water interface probe will not work, and the product thickness is too great to be measured by a bailer, then the best available technique may be oil and water paste.

A graduated "stick" or weighted steel tape in conjunction with oil and water paste may be appropriate for measuring residual water or product in a tank or drum. This method is not recommended for use in monitoring wells because of possible cross-contamination from the paste itself. In certain situations where no other method can provide the necessary data, oil and water paste may be used in monitoring wells containing product. This method is less accurate than an oil/water interface probe, but frequently more accurate than a clear, acrylic bailer.

It should be noted that erroneous data may be collected by all three methods when measurements are collected through the fill ports of tanks which are equipped with drop tubes. Whenever possible, product thickness measurements should be collected from ports with unobstructed access to the tank contents. When measurements must be collected from a fill port with a drop tube, it should be understood that there may be significant differences between the drop tube measurements and the actual thicknesses of the water and product in the tank.

3.0 CALIBRATION

3.1 Oil/Water Interface Probe

There is no specific calibration procedure for an oil/water interface probe. However, you should verify that the unit operates properly prior to taking it out in the field by testing it in a jar containing product and water. This jar should be stored in a flammable liquid cabinet and be dedicated to oil/water interface probe testing. Since most oil/water interface probes have a heavy probe assembly and a rigid graduated tape, kinking, stretching or twisting of the tape is not a significant concern. In order to ensure proper operation, the unit should be kept warm prior to use (e.g. hotel room or cab of truck).

3.2 Clear Acrylic Bailer

There is no specific calibration procedure for an acrylic bailer. However, since you only get one chance to measure the thickness correctly, you should verify that the check valve operates properly with distilled water. Based on previous data, if available, you should ensure that the length of the bailer is sufficient to measure the entire thickness of the product.

3.3 Oil/Water Paste

There is no specific calibration procedure for using oil and water paste. However, these pastes may not behave reliably if they are old or have been exposed to extreme temperatures. The pastes should be tested prior to taking them out in the field to confirm they work. The stick measure or weighted steel tape should be carefully examined to confirm that it is properly graduated and has not been damaged or modified.

4.0 DECONTAMINATION

4.1 Complete decontamination of a clear acrylic bailer which is dedicated to the measurement of separate-phase product thicknesses can be very difficult. Decontamination should involve removal of gross contamination before entering and exiting the site or moving to different areas of separate-phase product accumulation. Special care must be taken to make sure that a "product bailer" never enters a "clean" well which does not contain separate-phase product. This can be ensured by measuring separate-phase thickness in all wells before starting bailing operations. The oil/water interface probe must be thoroughly cleaned according to the field equipment decontamination SOP before entering each well. If historical data are available, then the order of measuring separate-phase thickness should be from the cleanest well to the dirtiest well to further reduce the potential for cross-contamination. If samples are also being collected for constituent or characterization analysis, then a disposable, dedicated bailer may be necessary for product collection.

5.0 EQUIPMENT AND MATERIALS

Depending on the method used to measure the thickness of separate-phase organic liquids, both method-specific and general equipment and materials are needed.

5.1 Regardless of the method used, general equipment and materials will include, but may not necessarily be limited to, the following:

a. Site Health and Safety Plan (HASP).

b. Appropriate health and safety equipment, as specified in the HASP.

c. Roux Associates' field forms and field notebook.

d. Non-phosphate, laboratory-grade detergent.

e. Distilled/deionized water.

f. Potable water.

g. Paper towels, clean rags.

h. Plastic sheeting.

i. Sorbent pads.

j. Well location and site map.

k. Well keys.

l. Disposable gloves.

m. Calculator.

n. Black pen and indelible marker.

o. Tools (e.g., pipe wrench, screw drivers, hammer, pliers, flashlight, pen knife, etc.).

p. Buckets for decontamination.

5.2 Clear Acrylic Bailer - the following will also be needed:

a. Clear acrylic bailer

b. Non-static cotton cord

c. Steel tape (10 foot)

5.3 Oil/Water Interface Probe - the following will also be needed:

a. Oil/water interface probe

5.4 Oil/Water Paste - the following will also be needed:

a. Oil paste

b. Water paste

c. Graduated stick or weighted steel tape

6.0 PROCEDURE

6.1 Oil/Water Interface Probe

6.1.1 Make sure the bottom five (5) feet of the probe and measuring tape have been decontaminated according to the field equipment decontamination SOP before entering each well.

6.1.2 Based on previous data, if any, ensure that non-product wells are measured prior to product wells to reduce the possibility of cross-contamination.

6.1.3 Remove the well cap or plug and clean the top of the well with a clean rag. Place the cap or plug on clean plastic on the ground to protect it from potential contamination.

6.1.4 Slowly lower the thoroughly decontaminated probe to the product surface. A distinct tone or beep will indicate the presence and level of product. The depth to product (DTP) from the measuring point will be recorded in the field notebook and on appropriate field forms. Continue lowering the probe until the tone or beep indicates the presence of water. The oil/water interface is best measured by lowering the probe about six inches into the water and then raising it to the interface. The depth to water (DTW) from the measuring point will be recorded in the field notebook and on appropriate field forms. The product thickness is the difference between the DTW and DTP.

6.1.5 Replace locking and/or protective caps on the well.

6.1.6 Thoroughly clean the probe and the portion of the tape which entered the product according to the field equipment decontamination SOP.

6.2 Clear Acrylic Bailer

6.2.1 Make sure all equipment is cleaned of gross contamination before entering and exiting the site or moving to different areas of product accumulation.

6.2.2 Remove the well cap or plug and clean the top of the well with a clean rag. Place the cap or plug on clean plastic on the ground to protect it from potential contamination.

6.2.3 Slowly lower a clear, decontaminated bottom-filling acrylic bailer into the well until the bottom of the bailer contacts the fluid surface.

6.2.4 Using a reference point on the bailer line, slowly lower the bailer into the fluid a distance less than the bailer length so that at its deepest point the top of the bailer remains above the air/fluid contact.

6.2.5 Slowly raise the bailer out of the well.

6.2.6 The thickness of the floating free product will be approximated by placing a tape measure along side the bailer. The data will be documented in the field notebook and on appropriate field forms.

6.2.7 Dispose of the product in an appropriate manner as specified in the work plan. This may include draining the product back into the well or tank, or containerization if the measurement is in conjunction with bailing for removal purposes.

6.2.8 Replace locking and/or protective caps on the well.

6.2.9 Thoroughly clean the bailer as described in Section 6.2.1. Discard the cotton cord in an appropriate manner. Wrap decontaminated bailer in a suitable material (e.g., clean plastic bag, aluminum foil).

6.2.10 If the free product is extensive or thicker than the height of the bailer, then an electronic interface probe should be used to measure product thickness.

6.3 Oil/Water Paste - (Generally not applicable for monitoring wells)

6.3.1 Make sure all equipment is decontaminated and cleaned before use according to the field equipment decontamination SOP.

6.3.2 Secure access to the tank or drum to be measured only after the contents are known and properly addressed in the HASP. Attempt to estimate the depth and thickness of product and the depth to water so the entire stick or weighted steel tape does not have to be coated with oil and water paste.

6.3.3 Coat one side of the stick or steel tape with oil paste and the other with water paste. Since these are typically different colors, confusion should not result. Depending upon information needs, lower the tape to just below the water interface or to the bottom of the tank or drum.

6.3.4 If only DTP and DTW data is required, then the top of the tape is held at an even-foot increment at the measuring point (MP). This is called the "held" value, and is recorded as such. If the depth to the bottom of the tank is also required, then the held value can't be specifically selected at an even-foot increment.

6.3.5 The steel tape or graduated stick is removed and the "water cut" and "product cut" levels are recorded. The difference between the "held" value and the "product cut" value is the DTP. The difference between the "held" value and the "water cut" is the DTW. The difference between the "product cut" and the "water cut" is the product thickness. If the diameter of a horizontal tank is desired, then the difference between the "held" value (to the bottom of the tank) and the depth of the fill pipe is required.

6.3.6 All pertinent data will be recorded in the field notebook and on appropriate field forms.

6.3.7 Make sure all equipment is decontaminated before use in the next tank or drum according to the field equipment decontamination SOP. All disposable materials must be discarded in a manner consistent with site conditions.

STANDARD OPERATING PROCEDURE 4.8
FOR HAND BAILING WELLS CONTAINING SEPARATE-PHASE ORGANIC LIQUIDS

Date: May 5, 2000

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish guidelines for hand bailing wells containing immiscible, separate-phase organic liquids. The hand bailing of immiscible, separate-phase organic liquids requires special health and safety considerations, equipment, and procedures.

Separate-phase layers can either be "floaters" or "sinkers." "Floaters" (non-aqueous phase liquids [NAPLs]) are separate-phase liquids that are less dense than water and float on the ground-water surface. "Sinkers" (dense non-aqueous phase liquids [DNAPLs]) are separate-phase liquids that are more dense than water and tend to migrate downward through aquifers due to gravitational forces until a low permeability layer is encountered (i.e., they accumulate at the bottom of the aquifer). For the purpose of this SOP, only the hand bailing of floating separate-phase liquids will be addressed.

The objectives for hand bailing wells containing floating separate-phase liquids (e.g., petroleum, petroleum products) may include the following: 1) removal of product before ground-water sampling; 2) remediation technique; 3) sampling product for constituent or characterization analysis; and 4) conducting product recharge tests to evaluate "true" versus "apparent" product thickness.

2.0 CONSIDERATIONS

The primary considerations when conducting hand bailing of wells are health and safety, and waste collection and disposal.

2.1 Health and Safety

All separate-phase products must be assumed to possess health and safety hazards equivalent to the most hazardous suspected on-site source. For example, if fuel oil is being removed from wells where polychlorinated biphenyls (PCBs) are known (or suspected) to be present, then the potential for PCBs to be present in the fuel oil must be considered. When bailing flammable materials, it is imperative that all possible sources of ignition be eliminated. Minimum requirements include (NO EXCEPTIONS) no smoking or open flames, use of intrinsically safe downhole monitoring equipment, use of static free bailing cord (e.g., absorbent cord [cotton]), and use of properly vented and grounded product collection containers. When product collection containers will be stored onsite, the local fire code official must be consulted regarding product storage requirements (e.g. venting, grounding, labeling, permits, secondary containment, etc.). A detailed, comprehensive explanation of health and safety procedures must be outlined in the site health and safety plan (HASP).

2.2 Waste Collection and Disposal

All product and product-contaminated waste materials must be properly stored, characterized, and disposed. A detailed, comprehensive explanation of waste (product) collection and disposal must be developed in accordance with regulatory agency requirements and must be outlined in the work plan/scope of work. Minimum requirements will include:

a. Collection of solid waste materials in a Department of Transportation (DOT) approved open-top drum (17C).

b. Collection of separate-phase product in a properly grounded and vented, DOT approved closed-top drum (17E).

c. Appropriate labeling of all drums with THIS SIDE UP, FLAMMABLE, and HAZARDOUS WASTE labels in accordance with Resource Conservation and Recovery Act (RCRA) and DOT requirements.

d. Collection and analysis of product sample for characterization prior to disposal, as required.

Any bailing operations which generate more than 100 kilograms per month (or approximately half of a 55 gallon drum) or that involve the storage of more than 1,000 kg of a RCRA hazardous waste must meet additional RCRA storage and disposal requirements (see 40CFR 261.5).

3.0 EQUIPMENT AND MATERIALS

The list of equipment and materials which may be needed for hand bailing floating separate-phase product from a well includes, but may not be limited to, the following:

a. Site HASP.

b. Appropriate health and safety equipment, as specified in the HASP.

c. A work plan which describes bailing requirements.

d. Oil/water interface probe.

e. Clear, acrylic product bailer (graduated).

f. Absorbent, nonstatic cord (e.g., cotton).

g. Sorbent pads.

h. Disposable PVC gloves.

i. Well construction log(s).

j. Two graduated buckets and funnels (dedicated to separate-phase product activities).

k. DOT approved product collection drum(s) (properly grounded).

l. DOT approved solid waste collection drum(s).

m. Roux Associates' field forms and field notebook.

n. Non-phosphate, laboratory-grade detergent.

o. Distilled/deionized water.

p. Potable water.

q. Paper towels, clean rags.

r. Calculator.

s. Black pen and indelible marker.

t. Well location and site map.

u. Tools (e.g., pipe wrench, screwdrivers, hammer, pliers, flashlight, pen knife, etc.)

v. Extra batteries (probe, flashlight).

w. Steel tape measure with 0.01-foot measurement increments, graduated measurement stick.

x. Plastic sheeting.

y. Specific gravity instruments.

4.0 DECONTAMINATION

4.1 Complete decontamination of a clear acrylic bailer which is dedicated to the removal of separate-phase product can be very difficult. When the primary task is the removal of product as a remedial technique, then decontamination should involve removal of gross contamination before entering and exiting the site or moving to different areas of separate-phase product accumulation. Special care must be taken to make sure that a "product bailer" never enters a "clean" well which does not contain separate-phase product. This can be ensured by measuring separate-phase thickness in all wells before starting bailing operations. The oil/water interface probe must be thoroughly cleaned according to the field equipment decontamination SOP before entering each well. Based on historical data, the order of measuring separate-phase thickness should be from the cleanest well to the dirtiest well to further reduce the potential for cross-contamination. If bailing is being conducted for product samples, it may be necessary to utilize a dedicated, disposable bailer as defined in the work plan.

5.0 PROCEDURE

5.1 Document, and initial and date the monitoring well identification and any problems encountered on the appropriate field form and in the field notebook.

5.2 Inspect the product collection drum or tank, and note any items of concern such as dents, holes, leaks, deformation, unauthorized access, etc. Document, and initial and date findings on an appropriate field form and in the field notebook.

5.3 Ensure that all equipment is properly decontaminated and cleaned.

5.4 Place plastic sheeting adjacent to the well to protect decontaminated equipment.

5.5 Remove the well cap and clean it off with a clean rag. Place the cap on the plastic sheeting. If fumes or gases are present, then diagnose these with the proper safety equipment. Never inhale the vapors.

Refer to Section 2.1 for the minimum health and safety considerations to prevent fire or explosion. Additional health and safety precautions based on site specific considerations must be outlined in the site HASP.

5.6 Place sorbent pads around the well to be bailed to prevent any loss of product in the event of spillage.

5.7 Determine the depth to product (DTP), depth to water (DTW), and product thickness within the well using an oil/water interface probe. Refer to the SOP for Measuring the Thickness of Floating Separate-phase Layers for the procedure to measure product thickness.

5.8 Lower the bailer into the product zone using absorbent, nonstatic cord (e.g., cotton). Refer to the work plan/scope of work to determine the method for draining off any excess water collected in the bailer (i.e., into the well or in a bucket). Drain off the water by slightly dislodging the capture ball (check valve) from the bailer seat with your finger; PVC gloves must be worn. Drain the product only into a separate, dedicated bucket.

5.9 Continue bailing until product thickness as observed in the bailer is reduced to less than ¼ inch (0.02 feet). If possible, then bail until no product is evidenced in the well (i.e., no more product is entering the well). Verify thickness measurements in the well using an oil/water interface probe. When bailing is completed, dispose of any excess water collected according to the specifications in the work plan/scope of work.

5.10 Wipe the well cap with a clean rag, replace the well cap and protective cover (if present). Lock the protective cover.

5.11 If required in the work plan, collect specific gravity measurements on representative samples of the product collected.

5.12 Transfer the product collected in the bucket to an on-site storage vessel. Record the volume of product collected and confirm by measuring the on-site storage vessel contents with an oil/water interface probe both before and after transferring the product from the bucket.

5.13 Place all contaminated sorbent pads, cord, and other solid waste materials into the open top drum and secure the lid.

5.14 Report any significant problems or deviations in product thickness measurements immediately (e.g., significant increase in product thickness or a substantial change in appearance).

5.15 Document all data (e.g., MP, DTP, DTW, product thickness, volume of product removed and disposed) on an appropriate field form and in the field notebook, and initial and date entries.

5.16 Secure storage containers and verify integrity.

5.17 Decontaminate all equipment as discussed in the decontamination section (4.0). Wrap decontaminated equipment with a suitable material (e.g., clean plastic bag or aluminum foil). Discard cords, rags, gloves, etc. in a manner consistent with accepted procedures.

STANDARD OPERATING PROCEDURE 5.1
FOR COLLECTION OF SOIL SAMPLES
FOR LABORATORY ANALYSIS

Date: May 5, 2000

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish guidelines for the collection of soil samples for laboratory analysis. This SOP is applicable to soil samples collected from split-spoon samplers during drilling, hand auger samples, grab samples from stockpiled soils, surface samples, test pit samples, etc.

2.0 CONSIDERATIONS

Soil samples may be collected in either a random or biased manner. Random samples can be based on a grid system or statistical methodology. Biased samples can be collected in areas of visible impact or suspected source areas. Soil samples can be collected at the surface, shallow subsurface, or at depth. When samples are collected at depth the water content should be noted, since generally "soil sampling" is restricted to the unsaturated zone. Equipment selection will be determined by the depth of the sample to be collected. A thorough description of the sampling locations and proposed methods of sample collection should be included in the work plan.

Commonly, surface sampling refers to the collection of samples at a 0 to 6 inch depth interval. Certain regulatory agencies may define the depth interval of a surface sample differently, and this must be defined in the work plan. Collection of surface soil samples is most efficiently accomplished with the use of a stainless steel trowel or scoop. For samples at greater depths a decontaminated bucket auger or power auger may be needed to advance the hole to the point of sample collection. Another clean bucket auger should then be used to collect the sample. To collect samples at depths of greater than approximately six feet the use of a drill rig and split spoon samples will usually be necessary. In some situations, sample locations are accessed with the use of a backhoe.

3.0 MATERIALS/EQUIPMENT

a. A work plan which outlines soil sampling requirements.

b. Field notebook, field form(s), maps, chain-of-custody forms, and custody seals.

c. Decontamination supplies (including: non-phosphate, laboratory grade detergent, buckets, brushes, potable water, distilled water, regulatory-required reagents, aluminum foil, plastic sheeting, etc.).

d. Sampling device (split-spoon sampler, stainless steel hand auger, stainless steel trowel, etc.).

e. Stainless steel spoons or spatulas.

f. Disposable sampling gloves.

g. Laboratory-supplied sample containers with labels.

h. Cooler with blue or wet ice.

i. Plastic sheeting.

j. Black pen and indelible marker.

k. Zip-lock bags and packing material.

l. Tape measure.

m. Paper towels or clean rags.

n. Masking and packing tape.

o. Overnight (express) mail forms.

4.0 DECONTAMINATION

All reusable sampling equipment will be thoroughly cleaned according to the decontamination SOP. Where possible, thoroughly pre-cleaned and wrapped sampling equipment should be used and dedicated to individual sampling locations. Disposable items such as sampling gloves, aluminum foil, and plastic sheeting will be changed after each use and discarded in an appropriate manner.

5.0 PROCEDURE

5.1 Prior to collecting soil samples, ensure that all sampling equipment has been thoroughly cleaned according to the decontamination SOP. If samples are to be collected at depth, then the boring must be advanced with thoroughly cleaned equipment to the desired sampling horizon and a different thoroughly cleaned sampler must be used to collect the sample.

5.2 Using disposable gloves and a pre-cleaned, stainless steel spatula or spoon, extract the soil sample from the sampler, measure the recovery, and separate the wash from the true sample. Where allowed by regulatory agency(ies), disposable plastic spoons may be used.

5.3 Place the sample in a laboratory-supplied, pre-cleaned sample container. This should be done as quickly as possible and this is especially important when sampling for volatile organic compounds (VOCs). Samples to be analyzed for VOCs must be collected prior to other constituents.

5.4 The sample container will be labeled with appropriate information such as, client name, site location, sample identification (location, depth, etc.), date and time of collection, and sampler's initials.

5.5 Using the remaining portion of soil from the sampler, log the sample in detail and record sediment characteristics (color, odor, moisture, texture, density, consistency, organic content, layering, grain size, etc.).

5.6 If soil samples are to be composited in the field, then equal portions from selected locations will be placed on a clean plastic sheet and homogenized. Alternately, several samples may be submitted to the laboratory for compositing by weight. The method used is dependent upon regulatory requirements. Specific compositing procedures shall be approved by the appropriate regulatory agency and described in the work plan. Samples to be analyzed for VOCs will not be composited unless required by a regulatory agency.

5.7 After the sample has been collected, labeled, and logged in detail, it is placed in a zip-lock bag and stored in a cooler at 4°C.

5.8 A chain-of-custody form is completed for all samples collected. One copy is retained and two are sent with the samples in a zip-lock bag to the laboratory. A custody seal is placed on the cooler prior to shipment.

5.9 Samples collected from Monday to Friday are to be delivered to the laboratory within 24 hours of collection. If Saturday delivery is unavailable, samples collected on Friday must be delivered by Monday morning. Check the work plan to determine if any analytes require a shorter delivery time.

5.10 The field notebook and appropriate forms should include, but not be limited to the following: client name, site location, sample location, sample depth, sample identification, date and time collected, sampler's name, method of sample collection, number and type of containers, geologic description of material, description of decontamination procedures, etc. A site map should be prepared with exact measurements to each sample location in case follow-up sampling is necessary.

5.11 All reusable sampling equipment must be thoroughly cleaned in accordance with the decontamination SOP. Following the final decontamination (after all samples are collected) the sampling equipment is wrapped in aluminum foil. Discard any gloves, foil, plastic, etc. in an appropriate manner that is consistent with site conditions.

STANDARD OPERATING PROCEDURE 5.2
FOR COLLECTING STREAM-BED, POND, AND LAGOON SEDIMENT SAMPLES

Date: May 5, 2000

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish guidelines for stream-bed, pond, and lagoon sediment samples. The specific procedure and equipment selection will be dependent upon the data objectives of the sampling program. The sampling procedure can range from one grab sample to many samples at different horizontal and vertical locations. The sampling requirements should be carefully designed and fully described in the work plan.

The objective of sediment sampling is to collect samples which are representative of the area of interest. Frequently this objective can be quite easy and routine such as one "grab" sample for a small stream with uniform stream-bed conditions. Other times, the nature of the site-specific conditions make collection of a representative sample more difficult. Consideration of such variables as stream flow velocity, pond depth, lagoon contents, turbulence, access, health and safety, water composition, tidal fluctuation, surface runoff, factory outfalls, tributaries, etc. is essential in the development of the work plan.

In collecting sediment samples, care must be taken to minimize disturbance and sample washing as it is retrieved through the liquid column above. Sediment fines may be carried out of the sample during collection if the liquid above is flowing or deep. This may result in collection of a nonrepresentative sample due to the loss of contaminants associated with these fines. While a sediment sample is usually expected to be a solid matrix, the sampler should avoid placing the sample in the bottle then decanting off the excess liquid. If the sample is collected properly, then any liquid that enters into the bottle is representative of sediment conditions.

As with liquid sampling, a determination of tidal influence on the location being sampled should be made and its effect on the sample collection should be detailed in the work plan. At a minimum, the stage of the tide at the time of sample collection must be recorded. Consideration should be given to sampling at varied tidal stages when appropriate.

2.0 CONSIDERATIONS

Collecting sediment samples from surface-water bodies and impoundments requires special considerations regarding general safety and sampling location.

2.1 Health and safety is a key aspect of all sampling procedures and therefore must be addressed when selecting a sampling location. In most instances sediment sampling will require entering the water. Therefore, the health and safety plan (HASP) must be referred to regarding the implementation of health and safety procedures (for compliance with the Occupational Safety and Health Administration [OSHA] and for general safety for sampling personnel). If entering the water body is necessary, then the water velocity, depth, sediment type and uniformity, tidal stage, and water chemistry must be evaluated. If any potential hazard is identified, then the sampler must use a safety harness and life jacket, and a buddy system must be employed. A raft or boat (vessel) may be necessary to collect samples. Depending upon the geographic location and season, considerations such as water temperature, snakes, rats, ticks, etc. may be important. Thus, the site-specific HASP must address all possible contingencies and allow flexibility for revision if unanticipated conditions arise.

2.2 The location of a sediment sampling point is the first consideration for a sediment sampling program. The general sampling location will be selected based on the requirements of the investigation. The specific sampling location should be selected where flow and turbulence are uniform, the sediment conditions seem representative, and access is favorable (i.e., shallow section with good footing).

The sampling location should avoid tributaries, parking lot runoff, factory outfalls, and obstructions unless these inputs are of specific interest. Sampling from the boundaries of the surface-water body should generally be avoided, except where these regions are of direct interest. For flowing surface-water bodies sampling should proceed from downstream locations to upstream locations so that disturbance related to sampling does not effect downstream sample quality. If liquid samples will be collected at the same locations as sediment samples, then the liquid samples must be collected first so that sediment sampling does not create turbulence that may alter water-quality conditions at the sampling location.

2.3 The factors that contribute to the selection of a sampling device include: 1) the width, depth, flow and the bed characteristics of the surface-water body to be sampled; 2) the required depth below the sediment surface; 3) whether the sample will be collected from the shore or a vessel; and 4) the objectives of the program. These factors must be addressed in the work plan.

The sampling of stream-bed sediments is generally accomplished through the use of one of the following samplers:

a. Scoop or trowel.

b. Bucket auger.

c. Soil coring device.

d. Veihmeyer sampler.

e. Waste pile sampler.

f. Split spoon sampler.

g. Ponar dredge.

h. Other commercially available sampler of proper construction material.

2.4 Sampling from on-shore or off-shore (wading or vessel) locations will be dependent on the site-specific sampling conditions as follows:

a. If liquid flow and depth is minimal and sediment is easy to reach, then a trowel or scoop may be used to collect the sediment sample. However, where the liquid above the sediment collection point is either flowing or greater than 4 inches in depth, a corer or other device that eliminates sample washing must be used to collect the sample in an attempt to minimize washing the sediment as it is retrieved. One of the coring devices listed above will allow the collection of an undisturbed core of sediment. It may be necessary to decant standing water from the top of the core. This should be done carefully and prior to transfer to the sample bottle. A decontaminated stainless-steel trowel, spoon, or spatula must be utilized to transfer the sample from the sampler directly into the bottle.

b. In some instances, the dimensions of the stream require that a vessel (e.g., a boat, raft, etc.) must be used. The device used for sample collection in this case will, again, depend upon the depth and flow of the liquid above the sample location and the stream-bed characteristics. Generally, trowels or scoops cannot be used in an off-shore situation. Instead, cores or dredges are more efficient means for sample collection. The vessel must be positioned just upstream of the desired sample location. As the corer or dredge is lowered it may be carried slightly downstream, depending upon the force of the flow. Upon retrieval, immediately transfer the contents of the corer or dredge directly into the sample bottle using a decontaminated stainless-steel trowel, spoon, or spatula.

3.0 EQUIPMENT AND MATERIALS

In order to sample stream-bed sediments, specific equipment and materials are required. The equipment and materials list may include, but necessarily be limited to, the following:

a. A work plan which defines sampling requirements.

b. A health and safety plan.

c. Decontamination supplies (including, as necessary: non-phosphate, laboratory-grade detergent; bucket; brushes; distilled/deionized water; potable water; regulatory-required reagents [e.g., acetone, nitric acid, etc.]; aluminum foil; etc.).

d. Field notebook and appropriate field form(s).

e. Maps (topographic and road/county).

f. Cooler and ice (wet or blue packs).

g. Sample bottles (including as necessary: appropriate field blanks, trip blanks, duplicates, extra bottles for breakage, proper size and type for analyte, labels, etc.).

h. Plastic sheeting.

i. Meters (pH, as modified for soil/sediment analysis), thermometer, and calculator.

j. Wading rod and current meter.

k. Calibration equipment/materials for all meters or devices.

l. Sampler (including as necessary: scoop, trowel, spatula, sampling trier, bucket auger, soil-coring device, Veihmeyer sampler, waste-pile sampler, split-spoon sampler, dredge sampler, and Ponar dredge).

m. Disposable sampling gloves.

n. Health and safety equipment (including as necessary: proper level of protection [OSHA], rubber boots, hip waders, chest waders, safety harness, rope, life jacket, life preserver, air horn, two-way communication, etc.).

o. Measuring tapes (100-foot, weighted and 10-foot, steel).

p. Camera and film.

q. Hand sledge hammer.

r. Pipe wrenches (14 inches long, 2 required).

s. Miscellaneous tools (e.g., screwdrivers, hammer, pliers, flashlight, pen knife, etc.).

t. Black pen and indelible marker.

u. Paper towels, clean rags.

v. Masking and packing tape.

w. Packing material (e.g., "bubble wrap") and "zip-lock" plastic bags.

x. Chain-of-custody form(s) and custody seals.

y. Overnight (express) mail forms.

4.0 DECONTAMINATION

When possible thoroughly pre-cleaned and wrapped sampling equipment should be used and dedicated to individual sampling locations. Disposable items such as cord, tubing, and gloves will be changed between each use and discarded in an appropriate manner. If a non-disposable item is to be reused during a sampling event, it will be thoroughly cleaned according to the field equipment decontamination SOP. Appropriate field, equipment and trip blanks will be collected as outlined in the work plan to demonstrate proper decontamination procedures.

5.0 CALIBRATION OF FIELD ANALYSIS EQUIPMENT

Calibrate field analysis equipment before use (e.g., thermometers and meters, etc.). Refer to the specific SOPs for field analysis for each respective piece of equipment. Equipment such as current meters must have the manufacturer's manual maintained with the instrument and must be referred to for use, repair, maintenance, trouble-shooting, or calibration, if required. Document, and initial and date the calibration procedures on the appropriate field form, in the field notebook, and in the calibration log book.

6.0 PROCEDURE

6.1 Identify each location to be sampled based upon requirements of the work plan. If any of the considerations outlined in Section 2.0 impact the proposed sampling method, then contact the Project Manager to get authorization to modify as necessary.

6.2 Record the site and sample location, weather conditions, date, and time of the selected sampling point in the field notebook and on any field forms being used, and initial the entry.

6.3 Describe the surface-water body or impoundment characteristics including: width (feet [ft]), depth (ft), flow (none, low, intermediate or flood; or measured velocity, if possible), turbidity (clear, turbid, very turbid), turbidity or flow variations, tributary locations and distances, surface runoff impacts, and adjacent land use. A photograph of each sampling location should be included as part of the documentation.

6.4 Evaluate health and safety concerns and take appropriate measures to eliminate potential hazards.

6.5 Prepare sample containers for collection by organizing, labeling, and verifying proper preservation methods.

6.6 Ensure all sampling equipment has been thoroughly decontaminated and is operational.

6.7 Place plastic sheeting on the ground or on the floor of the vessel to protect sampling materials from potential cross contamination.

6.8 Ensure all meters to be used are operational and have been calibrated.

6.9 Remove each appropriate container's cap only when ready to fill each with the water sample, and then replace and secure the cap immediately.

6.10 Collect the sample utilizing the selected sampling method and immediately place into pre-labeled, laboratory-supplied containers. Fill each appropriate, prelabeled sample container carefully and cautiously to prevent: 1) excessive agitating; 2) breaking the container; 3) entry of, or contact with, any other medium; and 4) spilling the sample and exposing the sampling team to contaminated sediment. Immediately place the filled sample container in a ice-filled (wet ice or blue pack) cooler for storage. Check the work plan as to whether wet ice or blue packs are specified for cooling the samples because certain regulatory agencies may specify the use of one and not the other.

6.11 Collect quality control (QC) samples to monitor sampling and laboratory performance as required in the work plan. Refer to the SOP for collection of QC samples for a detailed discussion of proper methods.

6.12 Analyze samples for field parameters (e.g., pH, etc.) immediately after collecting samples for laboratory analysis. Whenever possible, sufficient volume should be collected in the initial sample to complete all laboratory and field parameters.

6.13 Verify that each sample is placed in an individual "zip-lock" bag, wrapped with "bubble wrap," and placed in its appropriate container (holder) in the cooler, and that the cooler has sufficient ice (wet ice or blue packs) to preserve the samples for transportation to the analytical laboratory.

6.14 Thoroughly clean all reusable sampling equipment as discussed in the field equipment decontamination SOP. Wrap decontaminated equipment with a suitable material (e.g., clean plastic bag or aluminum foil). Discard cords, rags, gloves, etc. in a manner consistent with accepted procedures.

6.15 Complete field forms, field notebook entries, and the chain-of-custody forms. Retain one copy of each chain-of-custody form. Secure the cooler with sufficient packing tape and a custody seal.

6.16 Samples collected from Monday through Friday will be delivered to the laboratory within 24 hours of collection. If Saturday delivery is not available, samples collected on Friday must be delivered by Monday morning. Check the work plan to determine if certain analytes require a shorter delivery time.

STANDARD OPERATING PROCEDURE 5.4
FOR SCREENING SOIL SAMPLES FOR VOLATILE ORGANIC VAPORS USING A PORTABLE PHOTOIONIZATION DETECTOR

Date: May 5, 2000

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to establish guidelines for screening soil samples for volatile organic vapors using a portable photoionization detector (PID). This SOP is applicable to soil samples collected from split-spoon samplers during drilling, hand auger samples, and grab samples from stockpiled soils.

2.0 CONSIDERATIONS

The primary objective of photoionization screening of soil samples is to obtain a qualitative understanding of the distribution of volatile organic compounds (VOCs) in soil. The proper design of an organic vapor screening program requires an understanding of site hydrogeology, potential source areas, and potential constituents of concern. Sample locations and frequency must be fully defined in the work plan. The work plan should outline the type of lamp to be utilized in the PID based on the ionization potentials and response factors of the constituents of concern. The work plan must also clearly describe the heating or equilibration procedures to be employed if they differ from those described in this SOP. Regardless of the specific equilibration procedure employed, it is imperative that each sample be treated identically to allow the photoionization results from different locations to be compared. Observations such as water, clay, and organic content should be noted to facilitate interpretation of the data. Every effort should be made to collect a representative portion of soil from the sampling device.

3.0 MATERIALS/EQUIPMENT

a. A work plan which outlines photoionization screening requirements.

b. Decontamination supplies (including: non-phosphate, laboratory grade detergent, buckets, brushes, potable water, distilled water, regulatory-required reagents [e.g., acetone, nitric acid, hexane, etc.], aluminum foil, plastic sheeting, etc.).

c. Field notebook, field form(s), maps, chain-of-custody forms.

d. Sampling device (split-spoon sampler, stainless steel hand auger, stainless steel trowel, etc.).

e. Stainless steel spoons or spatulas.

f. Disposable plastic spoons.

g. Plastic sheeting.

h. Aluminum foil.

i. Mason jars or driller's jars.

j. Water bath (hot plate, extension cord, water tray, thermometer).

k. Photoionization detector with charging unit.

l. Calibration gases with regulator.

m. Indelible marker.

n. Masking tape.

o. Disposable sampling gloves.

4.0 DECONTAMINATION

Where possible, thoroughly pre-cleaned and wrapped sampling equipment must be used and dedicated to individual sampling locations. Disposable items such as sampling gloves, aluminum foil, and sample jars will be changed after each use and discarded in an appropriate manner. If only photoionization results are to be obtained, then split-spoon samples and hand augers may be cleaned with a soap and water wash and potable water rinse or steam cleaning, and a final distilled water rinse. However, if samples are to be collected concurrently for laboratory analytical results, then all reusable sampling equipment must be thoroughly decontaminated according to the SOP for decontamination of field equipment.

5.0 CALIBRATION

The PID must be calibrated according to the manufacturer's specifications at a minimum frequency of once per day prior to collecting photoionization readings. In addition, periodic checks (e.g., every 2 hours or every ten samples) with the standard gas will be conducted to confirm that the calibration has not drifted. The time, date, and calibration procedure must be clearly documented in the field notebook and the calibration log. If at any time the photoionization results appear erratic or inconsistent with field observations, then the unit must be recalibrated. If calibration is difficult to achieve, then the unit's lamp should be checked for dirt or moisture and cleaned, as necessary. During humid or wet conditions, the unit should be calibrated on a more frequent basis as determined by field personnel.

6.0 PROCEDURE

6.1 Extract the soil sample from the sampler, quickly measure the recovery, and separate the wash from the true sample by using a dedicated, stainless steel spatula. Where allowed by regulatory agency(ies), disposable plastic spoons may be used.

6.2 Place the sample in a pre-cleaned glass jar (as quickly as possible to avoid loss of VOCs) filling the jar half full. Place an aluminum foil seal between the glass and metal cap and screw tight.

6.3 Label jars with the boring number, depth of sample, date of collection and blow counts. In addition, the field personnel will ensure the following: samples are taken at appropriate depths; unrepresentative portions of the sample are discarded properly; that the sampler is decontaminated properly between use; and the driller uses proper methods during sample collection and does not use oil or grease on tools entering the borehole.

6.4 Log the sample in detail and record sediment characteristics (color, odor, moisture, texture, density, consistency, organic content, and layering).

6.5 After the sample has been collected, heat the sample under controlled conditions in a water bath for a 2 minute period.

6.6 Ensure that the PID has been calibrated and that the calibration information is documented in the field book. Pierce the aluminum foil seal with the probe from the PID and measure the relative concentration of VOCs in the headspace of the soil sample. The initial (peak) reading must be recorded.

6.7 Record the PID reading in the field notebook, on an appropriate field form, and on the base map, if appropriate.

6.8 Place any material not representative of the interval sampled in a pile with the other cuttings from the borehole.

6.9 If only photoionization results are to be obtained, then reusable sampling devices may be cleaned with a soap and water wash and a potable water rinse. The sampler will then be rinsed with distilled water, assembled and placed on plastic sheeting for reuse. A more rigorous decontamination procedure is required when samples are also being collected for laboratory analysis. Refer to the SOP for collection of soil samples for laboratory analysis for additional information.

STANDARD OPERATING PROCEDURE 6.1
FOR MEASURING pH OF WATER SAMPLES

Date: May 5, 2000

1.0 PURPOSE

The purpose for this standard operating procedure (SOP) is to establish the guidelines for measuring the pH of water in the field. The pH is measured in the field using a pH meter which should have the ability to compensate for temperature (automatically or manually). The pH will be measured in standard units (SU) and can be recorded with or without the SU designation. The conventional means of recording a pH value is without a unit designation (e.g., 7.0); however, the SU designation may be used provided the term is defined as standard units when first referenced. The manufacturer's instrument manual for each particular pH meter, which is maintained with the instrument, will be referred to for calibration, use, repair, maintenance, or trouble-shooting operations.

The pH is measured in the field to provide the pH of the water under ambient (in situ) conditions. The pH is a measure of acidic (<7.0) or basic (>7.0) nature of the water and is used to assist in evaluating the mobility of contaminants. In addition, pH measurements can be used during well purging to help determine when sufficient ground water has been purged (removed) from a well (i.e., the standing water in the well has been removed and replaced with "fresh" water from the aquifer). The determination is made when pH readings have achieved stabilization or near-stabilization.

2.0 CALIBRATION

2.1 Calibration of the pH meter is to be performed at the beginning and end of each day's use in accordance with the manufacturer's specific instructions. Usual procedures are given below.

2.2 Recalibration must occur if: 1) the pH of the samples being measured is outside the previous calibration range; 2) the procedure or use conditions warrant frequent calibrations; 3) four or more hours have elapsed; or 4) the instrument has been moved from one area to another (e.g., offsite or out of the study area).

2.3 Two buffer calibrations bracketing the expected pH range of samples are to be performed prior to its use in a study. Three pH buffers (4.0, 7.0, and 10.0) are read after standardization at pH of 7.0 to evaluate the linearity and electrodes.

2.4 The measurements of sample and buffers are made while stirring. The samples and buffers are measured at the same temperature; therefore, the pH meter must be temperature compensated. If not, then record the temperature.

2.5 The following information is documented in the calibration logbook at the time of calibration:

a. Date.
b. pH meter identification.
c. Calibration results using pH standards.
d. Initials of the individual performing calibration.

3.0 PROCEDURE

3.1 A warm-up period may or may not be necessary for the instrument, depending on instrument requirements. The manufacturer's instrument manual must be followed.

3.2 The pH electrodes must be kept in good working order as follows:

a. Proper levels of electrolyte solution are maintained. The electrolyte solution level should be at least 1 inch above the solution being measured.

b. The electrodes must be carefully rinsed with distilled or deionized water before each measurement.

3.3 The water sample (approximately 500 milliliters [ml]) is placed in a clean container and the temperature and pH are measured immediately.

3.4 The temperature of the sample is measured and the pH meter is compensated for the water temperature. If compensation is not possible, then record the temperature.

3.5 The electrodes are immersed in a water sample and stirred continuously until the pH reading equilibrates. The pH will be measured and recorded in increments of 0.1 or 0.1 SU.

3.6 Pertinent data are documented in the field notebook or appropriate field form, and initialed and dated.

3.7 The electrodes are rinsed with distilled or deionized water and the unit stored properly in accordance with the manufacturer's instructions (e.g., capping and storing in a buffer such as altex electrode storage solution). The electrodes are not to be stored in potable water, or distilled or deionized water.

STANDARD OPERATING PROCEDURE 6.2
FOR MEASURING THE CONDUCTIVITY OF WATER SAMPLES

Date: May 5, 2000

1.0 PURPOSE

The purpose for this standard operating procedure (SOP) is to establish the guidelines for measuring the electrical conductance (conductivity) of water in the field. The conductivity is measured in the field using a conductivity meter which compensates for temperature (automatically or manually). Some conductivity meters measure directly in micromhos/ centimeter (µmhos/cm) while others have to be converted to this unit. Conductivity will be recorded in µmhos/cm. The manufacturer's instrument manual of each particular conductivity meter, which is maintained with the instrument, will be referred to for calibration, use, repair, maintenance, or trouble-shooting operations.

The specific conductivity is measured in the field as a measure of the total dissolved solids (TDS) in the ground water or surface water. TDS data can then be used as a qualitative measure of contamination and to assist in evaluating electrical resistivity and borehole geophysical data. In addition, specific conductivity measurements can be used during well purging to help determine when sufficient ground water has been purged (removed) from a well (i.e., the standing water in the well has been removed and replaced with "fresh" water from the aquifer). The determination is made when conductivity readings have achieved stabilization or near-stabilization.

2.0 CALIBRATION

2.1 Calibration is in accordance with the manufacturer's specific directions.

2.2 Calibration of the conductivity meter is to be performed at the beginning and end of each day's use.

2.3 Recalibration must occur if: 1) the specific conductivity of samples being measured is outside the calibration standard solution range; or 2) the instrument has been moved from one area to another (e.g., offsite or out of the study area).

2.4 Choose a conductivity calibration solution that is near the conductivity of the water samples to be measured.

2.5 Select the appropriate conductivity calibration solution and adjust the span on the instrument to the conductivity calibration solution value.

2.6 Rinse the probe in distilled or deionized water and store the probe according to the manufacturer's specifications (e.g., distilled or deionized water, or a buffer solution).

2.7 The following information is documented in the calibration logbook:

   a. Date.

   b. Conductivity meter identification.

   c. Initials of individual performing calibration.

   d. Calibration results.

3.0 PROCEDURE

3.1 The conductivity electrodes must be kept in good working order as specified by the manufacturer.

3.2 The water sample is placed in a clean, appropriate container(s) and the temperature and conductivity are measured immediately.

3.3 The temperature of the sample is taken and the conductivity meter is compensated for the water temperature.

3.4 The probe is immersed in a water sample until the meter equilibrates.

3.5 In reading the conductivity meter scale, one or more of the following may have to be considered:

a. The reading may have to be multiplied appropriately (e.g., the reading is expressed in micromhos/centimeter).

b. If the conductivity meter is not capable of compensating for temperature differences, then note that the conductance measurements are not temperature compensated and document the temperatures.

c. If the conductivity meter can be compensated for temperature, then adjust the temperature control before reading the conductance measurement. (Some meters automatically compensate for temperature, and this should be documented.)

3.6 Conductivity measurements are recorded in the field notebook and on the appropriate field form, and initialed and dated. Units of µmhos/cm are used to represent conductivity.

3.7 The probe will be cleaned with distilled or deionized water after each use and will be stored according to the manufacturer's specifications (e.g., conductivity cells may have to be stored in distilled or deionized water, or a buffer solution).

STANDARD OPERATING PROCEDURE 6.3
FOR MEASURING WATER TEMPERATURE

Date: May 5, 2000

1.0 PURPOSE

The purpose for this standard operating procedure (SOP) is to establish the guidelines for measuring water temperature in the field. Temperature measuring devices may include thermometers, and pH and/or conductivity meters equipped with a temperature probe. The temperature measuring device must be rapidly equilibrating, precision-grade, and meet or exceed National Bureau of Standards (NBS) specifications for accuracy. Temperature will be measured and recorded in degrees Celsius/Centigrade (° C). If the temperature measuring device is a meter, then the manufacturer's instrument manual, which is maintained with the instrument, will be referred to for calibration, use, repair, maintenance, or trouble-shooting operations.

Temperature data is collected in the field to determine the temperature of the water sample under ambient (in situ) conditions. Temperature data can be used to evaluate the mobility of compounds in ground water and flow conditions. In addition, temperature measurements can be used during well purging to help determine when sufficient ground water has been purged (removed) from a well (i.e., the standing water in the well has been removed and replaced with "fresh" water from the aquifer). The determination is made when temperature readings have achieved stabilization or near-stabilization.

2.0 CALIBRATION

2.1 Calibration of thermometers and temperature measuring meters will be performed before entering the field and checked upon return to the office.

2.2 Temperature measuring devices will be calibrated against a NBS-traceable thermometer.

2.3 If a thermometer is used to measure temperature, then the thermometer must read within 1° C to 1.5° C of the NBS-traceable thermometer. If the thermometer does not read within this range and the thermometer cannot be calibrated, then it will not be used for temperature measurements and will be disposed of in an appropriate manner. If the thermometer does not read within this range and the thermometer can be calibrated, then the thermometer will be calibrated to the NBS-traceable thermometer.

2.4 If a temperature measuring meter is used to measure temperature, then the meter must read within 1° C to 1.5° C of the NBS-traceable thermometer. If the meter does not read within this range and the meter cannot be calibrated, then it will not be used for temperature measurements and will be sent to the manufacturer for service and repair. If the meter does not read within this range and the meter can be calibrated, then the meter will be calibrated to the NBS-traceable thermometer.

2.5 The following information is documented in the calibration logbook at the time of calibration:

a. Date.

b. Thermometer and/or Meter identification.

c. Calibration results relative to NBS-traceable thermometer.

d. Initials of individual performing calibration.

3.0 PROCEDURE

3.1 The water sample (approximately 500 milliliters [ml]) is placed in a clean container and the temperature is measured immediately.

3.2 If a thermometer is used, then the thermometer is first rinsed with distilled or deionized water and is then immersed in water until the temperature equilibrates. The temperature is read in °C. The thermometer is rinsed again after measuring the temperature.

3.3 If a temperature measuring meter is used, then the probe is first carefully rinsed with distilled or deionized water. The probe is then immersed in water according to the manufacturer's specifications (e.g., specified submergence, stirred) until the temperature equilibrates. The temperature is read in °C. The probe is rinsed again after measuring the temperature.

3.4 Temperature data are recorded in the field notebook or appropriate field form, and initialed and dated.

STANDARD OPERATING PROCEDURE 9.1
FOR DECONTAMINATION OF FIELD EQUIPMENT

Date: May 5, 2000

1.0 PURPOSE

The purpose for this standard operating procedure (SOP) is to establish the guidelines for decontamination of all field equipment potentially exposed to contamination during drilling, and soil and water sampling. The objective of decontamination is to ensure that all drilling, and soil-sampling and water-sampling equipment is decontaminated (free of potential contaminants): 1) prior to being brought onsite to avoid the introduction of potential contaminants to the site; 2) between drilling and sampling events/activities onsite to eliminate the potential for cross-contamination between boreholes and/or wells; and 3) prior to the removal of equipment from the site to prevent the transportation of potentially contaminated equipment offsite.

In considering decontamination procedures, state and federal regulatory agency requirements must be considered because of potential variability between state and federal requirements and because of variability in the requirements of individual states. Decontamination procedures must be in compliance with state and/or federal protocols in order that regulatory agency(ies) scrutiny of the procedures and data collected do not result in non acceptance (invalidation) of the work undertaken and data collected.

2.0 PROCEDURE FOR DRILLING EQUIPMENT

The following is a minimum decontamination procedure for drilling equipment. Drilling equipment decontamination procedures, especially any variation from the method itemized below, will be documented on an appropriate field form or in the field notebook.

2.1 The rig and all associated equipment should be properly decontaminated by the contractor before arriving at the test site.

2.2 The augers, drilling casings, rods, samplers, tools, rig, and any piece of equipment that can come in contact (directly or indirectly) with the soil, will be steam cleaned onsite prior to set up for drilling to ensure proper decontamination.

2.3 The same steam cleaning procedures will be followed between boreholes (at a fixed on-site location[s], if appropriate) and before leaving the site at the end of the study.

2.4 All on-site steam cleaning (decontamination) activities will be monitored and documented by a member(s) of the staff of Roux Associates, Inc.

2.5 If drilling activities are conducted in the presence of thick, sticky oils (e.g., PCBs) which coat drilling equipment, then special decontamination procedures may have to be utilized before steam cleaning (e.g., hexane scrub and wash).

2.6 Containment of decontamination fluids may be necessary (e.g., rinseate from steam cleaning) or will be required (e.g., hexane), and disposal must be in accordance with state and/or federal procedures.

3.0 PROCEDURE FOR SOIL-SAMPLING EQUIPMENT

The following is a minimum decontamination procedure for soil-sampling equipment (e.g., split spoons, stainless-steel spatulas). Soil-sampling equipment decontamination procedures, especially any variation from the method itemized below, will be documented on an appropriate field form or in the field notebook.

3.1 Wear disposable gloves while cleaning equipment to avoid cross-contamination and change gloves as needed.

3.2 Steam clean the sampler or rinse with potable water. If soil-sampling activities are conducted in the presence of thick, sticky oils (e.g., PCBs) which coat sampling equipment, then special decontamination procedures may have to be utilized before steam cleaning and washing in detergent solution (e.g., hexane scrub and wash).

3.3 Prepare a non-phosphate, laboratory-grade detergent solution and distilled or potable water in a clean bucket.

3.4 Disassemble the sampler, as necessary and immerse all parts and other sampling equipment in the solution.

3.5 Scrub all equipment in the bucket with a brush to remove any adhering particles.

3.6 Rinse all equipment with copious amounts of potable water followed by distilled or deionized water.

3.7 Place clean equipment on a clean plastic sheet (e.g., polyethylene)

3.8 Reassemble the cleaned sampler, as necessary.

3.9 Transfer the sampler to the driller (or helper) making sure that this individual is also wearing clean gloves, or wrap the equipment with a suitable material (e.g., plastic bag, aluminum foil.

As part of the decontamination procedure for soil-sampling equipment, state and/or federal protocols must be considered. These may require procedures above those specified as minimum for Roux Associates, Inc., such as the use of nitric acid, acetone, etc. Furthermore, the containment and proper disposal of decontamination fluids must be considered with respect to regulatory agency(ies) requirements.

4.0 PROCEDURE FOR WATER-SAMPLING EQUIPMENT

The following is a decontamination procedure for water-sampling equipment (e.g., bailers, pumps). Water-sampling equipment decontamination procedures, especially any variation from the method itemized below, will be documented on an appropriate field form or in the field notebook.

4.1 Decontamination procedures for bailers follow:

a. Wear disposable gloves while cleaning bailer to avoid cross-contamination and change gloves as needed.

b. Prepare a non-phosphate, laboratory-grade detergent solution and potable water in a bucket.

c. Disassemble bailer (if applicable) and discard cord in an appropriate manner, and scrub each part of the bailer with a brush and solution.

d. Rinse with potable water and reassemble bailer.

e. Rinse with copious amounts of distilled or deionized water.

f. Air dry.

g. Wrap equipment with a suitable material (e.g., clean plastic bag, aluminum foil).

h. Rinse bailer at least three times with distilled or deionized water before use.

4.2 Decontamination procedures for pumps follow:

a. Wear disposable gloves while cleaning pump to avoid cross-contamination and change gloves as needed.

b. Prepare a non-phosphate, laboratory-grade detergent solution and potable water in a clean bucket, clean garbage can, or clean 55-gallon drum.

c. Flush the pump and discharge hose (if not disposable) with the detergent solution, and discard disposable tubing and/or cord in an appropriate manner.

d. Flush the pump and discharge hose (if not disposable) with potable water.

e. Place the pump on clear plastic sheeting.

f. Wipe any pump-related equipment (e.g., electrical lines, cables, discharge hose) that entered the well with a clean cloth and detergent solution, and rinse or wipe with a clean cloth and potable water.

g. Air dry.

h. Wrap equipment with a suitable material (e.g., clean plastic bag).

As part of the decontamination procedure for water-sampling equipment, state and/or federal protocols must be considered. These may require procedures above those specified as minimum for Roux Associates, Inc., such as the use of nitric acid, acetone, etc. Furthermore, the containment and proper disposal of decontamination fluids must be considered with respect to regulatory agency(ies) requirements.

STANDARD OPERATING PROCEDURE 10.3 FOR SOIL BORING AND/OR MONITORING OR OBSERVATION WELL DRILLING, FORMATION SAMPLING AND BOREHOLE ABANDONMENT IN UNCONSOLIDATED FORMATIONS

Date: May 5, 2000

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the considerations and procedures, and to establish the guidelines for drilling (soil borings, wells, or piezometers) and formation sampling activities in unconsolidated formations. There are several drilling techniques available which include hollow-stem auger, cable tool, hydraulic rotary, cased-hole rotary, and air rotary. Formation (sediment/soil) sample collection include disturbed (drill cuttings), intact (split-spoon), and undisturbed (Shelby-tube or Denison-core). Borehole abandonment (closure) procedures will also be addressed in this SOP.

The objective of drilling is to collect accurate subsurface information and to prepare a borehole for potential completion as a well or piezometer. Consequently, the lithologic data is the all important, most essential information that can be collected. The lithologic data characterizes subsurface conditions, describes hydrogeologic coefficients qualitatively and/or quantitatively, and identifies optimum locations for screen zones if wells are constructed.

Data can be obtained through the physical examination and testing of formation samples, as well as knowledge regarding ground-water levels. Thus, drill fluid mix, fluid loss, rate of drilling, lengths of split-spoon and Shelby-tube/Denison-core recovery, etc. must be monitored by the on-site hydrogeologist or geologist.

2.0 DRILLING TECHNIQUE-SELECTION

Verify that the drilling technique is the one specified in the investigation work plan, and that the drilling equipment mobilized by the driller is in good condition and proper working order. Do not permit the driller to use a drilling rig that appears to be substandard, in disrepair, etc., and/or is questionable as to whether or not the rig has the capabilities to accomplish the goals of the drilling program. The drilling rig must be capable of:

a. Penetration of all anticipated subsurface materials and formations at a desired rate, and construction of a borehole of desired diameter (for the anticipated well, if applicable, including the placement of a gravel or sand pack through a tremie pipe and necessary formation sealing material such as bentonite or cement).

b. Identification of lithology for development of a geologic log of all unconsolidated formations and materials penetrated, including physical characteristics and visual description of color, grain sizes, sorting and mineralogy.

c. Collection of samples of aquifer fluids during the drilling process and prior to well construction, while at the same time minimizing potential for cross-contamination. The method used should prevent cross-contamination between surface soils and ground water or between different hydrogeologic units.

d. Collection of intact and/or undisturbed soil samples from the center line or sidewall of the borehole. This objective requires the drilling to be halted while soil samples are taken from the bottom or side of the incomplete borehole.

e. Completion of the borehole into a well (monitoring or observation) or piezometer during the initial construction process (i.e., constructing a well or piezometer as the borehole is drilled, or constructing a well or piezometer in the borehole immediately after the drilling tools are removed).

f. Implementation of borehole geophysical logging (when applicable and possible) to enable more accurate vertical and horizontal extrapolation of borehole data to the lithology of the hydrogeologic system.

g. Completion of a well or piezometer, if applicable, in the borehole following a time lapse for interpretation of geologic or geophysical data from the borehole.

3.0 DRILLING TECHNIQUE - DESCRIPTION

3.1 Hollow-Stem Auger - This drilling method is rapid and extremely effective in most cohesive sediments but less so in loose sandy material. Penetration may be up to 150 feet below land surface (bls) depending on the size of the rig, drilling conditions, and the diameter of the auger flight; however, depths up to 250 feet bls have been achieved under compatible conditions. A major advantage of this technique is that normally no fluids are introduced into the formation. If the auger flights can be removed and the integrity of the borehole maintained, then electrical and radiation (e.g., gamma, neutron, etc.) geophysical logs can be run. If the auger flights must remain in the borehole, then only radiation geophysical logs can be run. Casing, screen, and sampling devices can then be lowered through the hollow stem by removing the removable plug at the bottom of the auger flights, and gravel packing and cementing can be accomplished within the hollow stem. However, this can be difficult especially below the water table. Auger flight outside diameters (OD) range from 5 inches (in.) to 12 in. The diameter of a well that can be constructed inside the hollow stem is limited, however, to about 4 in.

3.2 Cable Tool (Percussion) - This drilling method is slow because the borehole is advanced by lifting and dropping a heavy string of drilling tools. Cuttings accumulate in the drill casing and are removed by a sand bailer. A steel casing is driven in as the hole is deepened. Cable-tool rigs can be used in unconsolidated sediment and bedrock to depths of hundreds or thousands of feet and often employ telescoping techniques for drilling deep boreholes. Electrical geophysical logs cannot be run through the steel cased borehole, but radiation logs (e.g., gamma, neutron, etc.) can be run. Well casing and screen can be installed within the cased hole after which the outer casing is pulled back (removed). Because the boring is cased as it is being drilled, cross-contamination between various depths is practically eliminated. The method provides an excellent means to collect good, representative formation samples.

3.3 Hydraulic Rotary - This drilling method uses a rotating bit to drill (advance) the borehole. Drill cuttings are removed using a recirculating drilling fluid (mud or water). Although setting up the drilling equipment is slow, the drilling process is reasonably fast. In the mud-rotary method, drilling mud forms a cake on the borehole wall which prevents excessive loss of fluid to the formation being drilled. The hydrostatic pressure combined with the weight and density of the mud slurry keeps the hole open. This allows the drill rods to be removed from the borehole and geophysical logs (electric and radiation) to be run in the open borehole.

In reverse hydraulic rotary drilling, the drilling fluid moves downward through annular space and then upward inside the drill pipe. If the drilling fluid does not contain mud, then sufficient water flow is required as make-up water because the borehole wall is not sealed; therefore, significant water loss can occur to the formation being drilled. The borehole is held open by hydrostatic pressure only. A serious obstacle to this drilling method occurs when the static water level is less than 15 feet below land surface because of insufficient hydrostatic head difference between the borehole and the water table. However, the problems of excessive water loss and shallow depths to water may be overcome by using mud as the drilling fluid.

In mud-rotary drilling, the drilling fluid (mud) moves downward through the drill pipe and then upward through the annular space. Therefore, the borehole is held open by hydrostatic pressure and the mud cake lining the wall of the borehole. The mud-rotary method can be used to construct moderate to deep wells in unconsolidated (and consolidated material), while the reverse rotary technique can be used to construct moderate to deep wells in unconsolidated materials. The principal disadvantage may be the difficulty in removing mud cake from the formation at the screened zone. Extensive well development may be required to remove the mud cake.

3.4 Cased-Hole Rotary - Several new rotary drilling techniques have been developed in which a steel casing is advanced with an air-rotary or mud-rotary drill. This technique is highly desirable for use in exploratory drilling at monitoring sites because water and soil samples may be collected under conditions which preclude contamination from shallower depths. Furthermore, this technique is extremely effective in boulder or cavernous zones which would inhibit or preclude drilling using other techniques. Drilling results are comparable to cable-tool drilling but with greatly enhanced speeds. In all the cased-hole techniques, the main benefit is that the only portion of the borehole which is open, is at the bottom of the drill casing; thus, no soil or water from shallower depths can move down and impact the depth drilled and/or sampled. Electrical geophysical logs cannot be run through the steel-cased borehole, however, radiation logs (e.g., gamma, neutron, etc.) can be run.

Presently, there are three cased-hole rotary techniques which include:

a. The drill-thru casing hammer technique in which the casing is advanced by percussion with a casing hammer or vibratory driver similar to the method used in a borehole drilled by the air-rotary method. The casing hammer can also pull out the casing (air drilling only).

b. The Odex™ Drilling System (European system) which "pulls" the casing using a fixture attached to an air-hammer type drill bit (air drilling only).

c. The Barber™ Drilling System in which drilling is done with a top-head drive and a rotary table that spins casing into the ground. Casing can be fitted with a carbide "shoe" to cut boulders and an air hammer can be used above the bit. Air or mud rotary can be used to lift cuttings.

Two potential problems may be encountered using the cased-hole rotary technique which include: 1) "sand heave" when drilling stops (which can be quickly drilled or bailed out) and 2) possible aeration of water in the cased borehole if volatiles are being tested (which can be overcome by pumping or bailing the standing water out before sampling). The minimum drill casing diameter is 6 inches and depth is limited to approximately 450 feet.

3.5 Air Rotary - This drilling method uses a rotating bit to drill, and high-velocity compressed air to remove cuttings from the borehole. A pneumatic down-hole hammer is often used to add percussion to the rotary drilling action. This drilling method is very fast and, although it is most suitable for penetrating hard bedrock, it can be used in unconsolidated formations. The borehole may be cased or uncased depending on geologic conditions. If an open borehole is drilled, then electrical and radiation (e.g., gamma, neutron, etc.) geophysical logs can be run. If a cased borehole is drilled, then only radiation geophysical logs can be run.

Four potential problems may be encountered when using the air-rotary technique:

a. When a prolific aquifer is tapped, the compressed air may not be able to lift the water to the surface.

b. Aeration of water in the borehole (and finished well) immediately prior to sampling can interfere with a number of inorganic and organic water-quality parameters.

c. Low yield water entry zones may not be identified because the air pressure prevents water from entering the borehole. Care should be taken to prevent overdrilling of the borehole.

d. Air rotary drilling can induce the migration of volatile organics to the surface or adjacent structures causing potential aesthetic or health and safety concerns.

If the air-rotary technique is used then the following special procedures will be implemented:

a. The type of air compressor and lubricating oil will be documented on an appropriate field form and in the field notebook and a 1-pint sample of the oil will be retained for characterization in the event organic compounds are detected in a well sample.

b. An air line oil filter will be required and changed per manufacturer's recommendations during operation with documentation of this maintenance on an appropriate field form and in the field notebook. More frequent oil filter changes will be made if oil is visibly detected in the filtered air.

c. The use of any additive will be prohibited, except approved water (e.g., potable water) for dust control and cuttings removal.

4.0 DECONTAMINATION

Drilling equipment decontamination procedures are outlined in the field equipment decontamination SOP. Proper decontamination in accordance with regulatory guidelines must be clearly documented in the field notebook.

5.0 PROCEDURE FOR DRILLING

5.1 Document all drilling-related activities (e.g., starting, stopping, footage, problems, decontamination, etc.) on the daily log form and in the field notebook. Record dates and times of activities, and names of Roux Associates personnel providing oversight.

5.2 Monitor and record drill fluid mix, speed of rotation, pressure on the drill fluid, rate of drilling, and length of drill rods or casing in the borehole.

5.3 Confirm that the drill rods and core barrel are straight, or discontinue drilling.

5.4 Pay particular attention to the advancement of the boring because differences in the rate of drilling may be indicative of differences in subsurface geologic conditions (e.g., sand and gravel versus clay).

5.5 Maintain a continuous dialogue with the driller to track and keep informed of all drilling activities (e.g., the speed of the drill and drilling pressure, difficult and easy drilling conditions, etc.).

5.6 Collect formation samples as described below in Section 6.0. Sample jars must be labeled appropriately (e.g., project number and name, site location, boring number, date, sample interval, blow counts, and initials of Roux Associates personnel collecting sample).

5.7 Record geologic information in the geologic log form and in the field notebook.

5.8 Handle and ship split-spoon sample jars carefully to avoid breakage and handle and ship tubes or cores carefully to prevent disturbance.

6.0 PROCEDURE FOR FORMATION SAMPLING

6.1 Intact formation sampling will be implemented using split-spoon samplers (which are driven), Shelby-tube samplers (which are pushed), or Denison-core samplers (which are rotated) depending on the drilling technique employed. Formation samples will be retained in suitable size (e.g., 1-pint or 0.5-pint) jars for physical descriptions and potential physical and chemical analysis. The appropriately labeled jars and tubes will be stored in a safe place to avoid breakage, agitation, and freezing. Intact formation samples will be collected as described in the work plan at specified intervals (e.g., at 5-foot increments below land surface) and at each major change in subsurface materials. Hydrogeologic information will be recorded on a geologic log form and in the field notebook. Detailed descriptions of the type(s) of intact sample(s) collected, sampling intervals and conditions, and objective(s) of the sample collection will be provided in the work plan.

6.2 Disturbed formation samples (drill cuttings) will be examined continuously throughout the entire depth of the borehole. If applicable to the study and/or stated in the work plan, borehole cuttings will be collected from the circulating auger flights which lift cuttings to land surface (hollow-stem auger technique), from the sand bailer (cable-tool technique), from the recirculating drilling fluid (mudflume) which transports cuttings to land surface (mud-rotary and related techniques), or from the compressed air used to carry cuttings to land surface (air-rotary and related techniques). Formation samples will be retained in appropriate size (e.g., 1-pint or 0.5-pint), properly labeled jars and stored in a safe place to avoid breakage, agitation, and freezing. Hydrogeologic data will be recorded on a geologic log form and in the field notebook.

6.3 The soil cores from the wells drilled at the site are used for lithologic identification. The first 18 inches of soil for each borehole will be collected intact using a split-spoon sample, Shelby-tube sampler, or Denison-core sampler. Split-spoon samples may be collected continuously from boreholes for cluster wells; single well and/or piezometer boreholes may be split-spooned throughout drilling or at specified intervals or changes in lithology. The conditions for sampling will be specified in the work plan.

6.4 Before collecting and retaining soil and/or sediments collected with the split-spoon sampler, the top several inches will be removed from the sampler and discarded to eliminate any sediment that may have caved into the bottom of the borehole.

6.5 Sediment sampling equipment such as split-spoon samplers, spatulas, etc. (but not including Shelby-tube or Denison-core samplers, which area not re-usable) will be decontaminated by steam cleaning and/or a non-phosphate, laboratory-grade and distilled/deionized wash followed by a distilled/deionized water rinse. (Refer to the SOP for Decontamination of Field Equipment for a detailed description of minimum and special decontamination procedures.) Decontamination of sediment sampling equipment will take place prior to the collection of the first sample and following the collection of each subsequent sample.

7.0 BOREHOLE ABANDONMENT OR CLOSURE

7.1 Upon the completion of the investigation, a determination will be made as whether to maintain the borehole (for a well or piezometer) or to close it (i.e., abandon and seal it). If the client and Roux Associates agree to abandon the borehole, then the state will be notified and a request will be presented for borehole abandonment. Upon state approval to seal the borehole, appropriate state

STANDARD OPERATING PROCEDURE 10.4 FOR CONSTRUCTION, DEVELOPMENT AND ABANDONMENT OF MONITORING OR OBSERVATION WELLS IN UNCONSOLIDATED FORMATIONS

Date: May 5, 2000

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to describe the considerations and procedures for constructing ground-water monitoring or observation wells in unconsolidated (e.g., gravel, sand, silt, and clay) formations. Well development and well abandonment (closure) procedures will also be addressed in this SOP. The United States Environmental Protection Agency (USEPA), the United States Geological Survey (USGS), and state regulatory agency procedures will be reviewed and considered in conjunction with the extensive experience of Roux Associates, Inc. (Roux Associates) to determine appropriate well construction and abandonment procedures. Discussions will be held with appropriate agencies to resolve conflicting procedures and finalize well construction or abandonment methods. The well construction plan and, if necessary, abandonment will be detailed in the work plan.

Monitoring wells will be completed in unconsolidated formations for the purposes of measuring ground-water levels and collecting ground-water samples. Ground-water level data will be used to calculate ground-water elevations which will be used, to construct water-level elevation and ground-water flow direction maps to illustrate head and flow relationships. Ground-water samples will be used to quantify water-quality conditions.

Observations wells will be completed in unconsolidated formations for the purpose of collecting water-level data from aquifer tests. Slug tests, step-drawdown tests, and constant-rate pumping tests (refer to the respective SOPs) may be conducted to qualitatively or quantitatively characterize flow system hydraulic parameters and/or intra-aquifer and inter-aquifer hydraulic connection.

2.0 PROCEDURE FOR WELL CONSTRUCTION

The installation of each unconsolidated well will begin immediately after borehole completion (and geophysical logging, if implemented). Once well installation has begun, no breaks in the process will be made until the well has been completed and secured against unauthorized access. In cases of unscheduled delays, such as personal injury, equipment breakdowns or sudden inclement weather, installation will be resumed as soon as practical.

2.1 The well will be constructed of appropriate type and diameter casing and screen (stainless steel and/or PVC) and will be at least 2 inches in diameter to accommodate most water-sampling and water-level measuring devices. However, if the well's purpose is multiple (pumping tests, remote sensing, water-level recorder station, etc.), a larger diameter monitoring well (4 inches, 6 inches, or greater) may be needed to accommodate pumps, floats, or sensors. The preferred minimum diameter for a well is 4 inches because larger diameter wells (greater than 2 inches) facilitate well purging and sampling procedures (e.g., they can accommodate pumps which 2-inch diameter wells may not).

2.2 Fittings (couplings) will not restrict the inside well diameter, as stainless steel casing will be welded and/or flush-joint threaded, and PVC joints will be internally threaded. Glues, solvents, or chemical cleaners will not be used in the construction of the wells. All casings, fittings, and screens will be new material. The well screens will be fabricated and have an inside diameter equal to the well casing. The lengths of casing and screen will be measured and recorded on an appropriate field form and in the field notebook by the field hydrogeologist prior to installation.

2.3 Wells in unconsolidated formations will be installed as described below unless depth to water or total depth require modifying the thickness of emplaced materials.

a. The screen and casing will be lowered into the borehole to the appropriate depth. Screen and casing materials may be either stainless steel or PVC. A bottom plug, well cap, and flush-joint sections will be used.

b. A gravel pack (quartz sand or pea gravel) will be filled in around the screen from a few feet below the bottom of the screen to several feet (approximately 5) above the screen to avoid applying the weight of the casing on the screen. The size of the uniformly graded gravel pack will be selected based on the grain size of the formation material in the screened interval. The placement of the gravel pack may require the use of a tremie pipe.

c. A 1-foot to 3-foot layer of clean, fine-grained silica sand may be placed above the selected gravel pack to isolate the coarse-grained gravel pack (below) from the fine-grained bentonite seal (above). Again, a tremie pipe may be used in the placement of the sand layer.

d. Several feet (approximately 1-3) of bentonite (powder or pellets) will be placed on top of the sand layer to seal the top of the gravel-packed screen zone.

e. The remainder of the annulus will be grouted to within a few feet of land surface. If PVC casing is used for the construction of deep wells, then extreme care must be taken in grouting the annular space in lifts (specified lengths) to avoid deformation of the PVC casing by the heat of curing and/or the weight of the grout. This is especially important if there are large voids which will serve as reservoirs for the grout.

f. A locking steel protective casing or curb box will be set over the well and cemented in place or welded to the steel casing to prevent water from ponding at the top of the well or directly entering the well, and safeguard the well from accidental damage or vandalism.

2.4 Each well will be properly identified with the appropriate information (e.g., local well number, state permit number [if applicable], etc.). The top of the well casing will serve as the measuring point (MP) for ground-water level measurements. The measuring point will be surveyed to the nearest 0.01 foot relative to a common datum (e.g., mean sea level) by trained Roux Associates personnel or a professional, state-licensed surveyor as defined in the work plan.

2.5 If required, well clusters will be constructed. A well cluster is defined as a group of two or more wells, located adjacent to or very near each other, which penetrate different depths of the aquifer or formation. Each well is screened at a different depth to obtain data defining the vertical distribution of water levels and quality in the aquifer or formation. In the event that a well cluster is drilled, then one large-diameter (e.g., 6-inch, 8-inch, 10-inch, etc.) borehole may be drilled and each well in the cluster will be individually cased within that one borehole; however, the preferred method is to drill individual boreholes for each well in the cluster.

2.6 Each well will have a location sketch, a well construction log, and a geologic log showing the casing placement and materials used to fill the annular space between the well casing and borehole. The appropriate log will show the depths of each casing material and discuss the geologic variability at the site. A description of the surface soils and unsaturated zone materials down to and including the water table is required.

The following information, if applicable, will be included on the well log:

a. Project number.

b. Date and initials of scientist documenting the well information.

c. Date and time of construction.

d. Well location.

e. Well and permit numbers.

f. Borehole diameter.

g. Well depth.

h. Casing material.

i. Screen material.

j. Screen slot size and length.

k. Gravel pack type and size (depths from _____ to _____).

l. Sand pack (depths from _____ to _____).

m. Bentonite pellets (depths from _____ to _____).

n. Bentonite grout (depths from _____ to _____).

o. Cement grout (depths from _____ to _____).

p. Ground-surface elevation.

q. Measuring point elevation.

r. Well height above or depth below land surface.

s. Depth where ground water was encountered.

3.0 DESCRIPTION OF WELL DEVELOPMENT

3.1 Before a newly constructed well can be used for water-quality sampling, measuring water levels, or aquifer testing, it must be developed. Well development refers to the procedure used to clear the well and formation around the screen of fine-grained materials (sands, silts, and clays) produced during drilling or naturally occurring in the formation. Well development continues until the well responds to water-level changes in the formation (i.e, a good hydraulic connection is established between the well and formation) and the well produces clear, sediment-free water to the extent practical.

3.2 Depending on the drilling technique used, composition of the formation screened, and well diameter and construction materials, well development may include one or more of the following techniques.

a. Bailing.

b. Pumping (centrifugal, submersible, or air).

c. Backwashing.

d. Surging (mechanical).

e. Jetting.

f. A combination of the above.

3.3 A 1-pint sample of the last water removed during development will be obtained and inspected by the field hydrogeologist for relative clarity to determine whether development is complete. A turbidimeter may be used to evaluate the clarity of the water removed from the well during development (and its use may also be stipulated by a regulatory agency). Well development procedures will be recorded on the well construction log form and in the field notebook.

3.4 Dispersing agents, acids, disinfectants, or other additives will not be used during development nor will they be introduced into the well at any other time unless specifically stipulated in the work plan. During development, water will be removed from the entire column of water standing in the well by periodically lowering and raising the pump intake. Well development will include the rinsing of the interior well casing above the water column in the well using only water from that well.

4.0 WELL ABANDONMENT OR CLOSURE

4.1 Upon the completion of the investigation, a determination will be made whether to maintain the well or to close it (i.e., abandon and seal it). If the client and Roux Associates agree to abandon the well, then the state will be notified and a request will be presented for well abandonment. Upon state approval to seal the well, appropriate state well abandonment forms will be completed. Following state approval, the abandonment of any well will be in accordance with local, state and/or Federal regulations.

4.2 For each abandoned well, the procedure will be documented on an appropriate field form and in the field notebook. Documentation may include, where appropriate, the following:

a. Well designation.

b. Location with respect to the replacement well, if replaced (e.g., 30 ft north and 40 ft west of Monitoring Well MW-1). A location sketch should be prepared.

c. Open depth prior to grouting and any other relevant circumstances (e.g., formation collapse).

d. Well casing left in the borehole by depth, size, and composition.

e. A copy of the geologic log.

f. A revised diagram of the abandoned well using the well construction log form.

g. Additional items left in hole by depth, description, and composition (e.g., lost tools, bailers, etc.).

h. A description and daily quantities of grout used to compensate for settlement.

i The date of grouting.

j. The level of water prior to grouting and the date and time measured.

k. The remaining casing, size, and composition above or below ground surface reported in depths or heights from ground surface.

l. **Any other state or local well abandonment reporting requirements.**

borehole abandonment forms will be completed, if required. Following state approval, the abandonment of any borehole (or boring) will be in accordance with local, state and/or Federal regulations.

7.2 For each abandoned borehole, the procedure will be documented on an appropriate field form or in the study notebook. Documentation may include, where appropriate, the following:

a. Borehole designation.

b. Location with respect to the replacement borehole, if replaced (e.g., 30 ft north and 40 ft west of Borehole B-1). A location sketch should be prepared.

c. Open depth prior to grouting and any other relevant circumstances (e.g., formation collapse).

d. Drill casing left in the borehole by depth, size, and composition.

e. A copy of the geologic log.

f. A revised diagram of the abandoned borehole using a supplemental geologic log form.

g. Additional items left in hole by depth, description, and composition (e.g., lost tools, bailers, etc.).

h. A description and daily quantities of grout used to compensate for settlement.

i. The date of grouting.

j. The level of water or mud prior to grouting and the date and time measured.

k. Any other state or local well abandonment reporting requirements.

STANDARD OPERATING PROCEDURE 11.1 FOR SURVEYING DISTANCES AND ELEVATIONS

Date: May 5, 2000

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish guidelines for surveying distances and elevations. This SOP applies to the following automatic level instruments: Wild-Heerbrugg models NA-1, NA-20, NA-24, and NA-28; and Lietz model C40.

2.0 CONSIDERATIONS

2.1 Personnel

Two people are required to conduct land surveying activities. The instrument person is responsible for collecting measurements with the automatic level. The leveling staff person is responsible for holding the leveling staff at given locations.

2.2 Equipment

The basic equipment required for surveying includes a tripod, an automatic level and a leveling staff (or rod). The leveling staffs and the tripods may vary slightly from office to office, but no discussion is warranted. The automatic levels are all quite similar in construction and operation. The primary differences are in the telescope, compensator setting, and leveling accuracy which are described in the technical data sections of the respective operator's manuals. Certain features such as the optical sight, pentaprism for viewing the circular bubble, and coarse/fine focusing vary between models, and in some cases these features are absent.

A composite description of automatic level features is provided in Exhibit A. The individual features are identified and briefly described. Those who are unfamiliar with the automatic level must seek instruction and practice with the instrument and the operator's manual prior to entering the field.

2.3 Equipment Assembly and Set Up

Tripod

The tripod is set up by fully extending each leg and locking the legs in place with the clamp screws. The legs are spread out until the tripod head is roughly at chin level and the leg tips form an equilateral triangle. While confirming that the tripod head is approximately level, push the legs into the ground by stepping on the tripod points. If the tripod is to be set up on smooth surfaces, then care must be taken to make sure the legs do not shift at all during measurements. In paved areas, putting the tripod points in cracks, grooves, or small holes helps to secure the legs. If the instrument is set up on asphalt in hot weather, then blocks or "shoes" must be placed under the tripod points to prevent it from sinking into the soft surface.

Automatic Level

Place the automatic level on the tripod head and anchor it using the centering screw. The base of the automatic level should be approximately centered within the tripod head. The instrument is leveled by adjustment of the three footscrews located between the instrument and the base plate. The adjustment is continued until the circular bubble is centered. Rotate the instrument 90° without disturbing the tripod, and ensure that the circular bubble is still centered. At this point, the instrument is set up to collect measurements.

Leveling Staff

The leveling staff is usually in three sections, each four or five feet in length. The leveling staff is extended to the desired length and carefully secured to prevent slipping of the sections. The leveling staffs which Roux Associates, Inc. (Roux Associates) uses are engineer's scale and graduated in 0.01 foot increments. The leveling staff is held at the desired location and a staff level (bubble) is used to confirm that the leveling staff is perfectly vertical. A turning plate should be used at turning point locations in grass, soft dirt, or bumpy areas. When on smooth hard surfaces, it is sometimes more suitable to use an "X" marked with chalk or crayon on a suitable location.

2.4 Elevations

When surveying to collect elevation data, a benchmark is required. The benchmark may be a known elevation (e.g., United States Geological Survey [USGS]) or an arbitrary elevation (e.g., assign 100.000 at a permanent location). Once the benchmark elevation has been established, the height of the properly leveled instrument is determined from a backsight. A backsight is taken from the instrument to the leveling staff at a point of known elevation (e.g., benchmark). The backsight reading added to the known elevation of the benchmark is the height of the instrument. When collecting elevation data, the leveling staff reading is always at the intersection of the vertical cross hair and the middle horizontal cross hair. The upper and lower horizontal cross hairs are for distance determination. Once the instrument height has been established, the leveling staff is moved to a location where the actual elevation will be determined. The automatic level is aligned with the new location, but is never releveled between a backsight and a foresight. A foresight is taken from the instrument to the leveling staff at a point where the elevation is to be determined (e.g., a monitoring well). The elevation of the new location (e.g., a monitoring well, turning point, etc.) is determined by subtracting the foresight reading from the height of the instrument. After collecting a foresight reading, the instrument person moves to a new location, levels the instrument, and collects a backsight reading. The leveling staff person remains at the location of known elevation. When the new backsight reading is collected, the height of the instrument is established and the leveling staff person moves to a new location. By repeating this procedure in a "leap-frog" manner, a "loop" is completed through all locations where elevations are desired and terminated with a foresight to the original benchmark for closure.

In order to determine the closure accuracy, the sum of all the backsights is subtracted from the sum of all the foresights. If the absolute difference is less than 0.02 foot, then the survey loop is considered accurate for determining the measuring points for monitoring wells. If the difference is greater than 0.10 foot and the calculations are correct, the survey loop must be repeated. If the difference is between 0.02 and 0.10 foot, then the project manager must determine if the accuracy is sufficient based on factors such as data needs, hydraulic gradient, topography, etc.

Items which can help ensure closure accuracy are discussed below. The length of any foresight or backsight must not exceed 100 feet. The length of the backsight and foresight for a given pair of readings must be approximately equal. By doing this, any minor internal adjustment problems are naturally eliminated. The instrument and the leveling staff must be carefully leveled and any instrument movement eliminated. If the leveling staff is not perfectly vertical, then a larger reading will result. On windy days, it is advisable to only extend the leveling staff as necessary. Both the instrument person and the leveling staff person must pay due attention to soft ground, grass, etc. and utilize "shoes" or turning plates where appropriate. Care must be taken during each reading to ensure that the middle horizontal cross hair is used. Errors from misreading the cross hairs are often made when the instrument is set too high or too low for the instrument person's natural line of sight. To eliminate reading errors, it is suggested that the reading be taken, written in the field notebook, and then confirmed with a second reading.

2.5 Distances

Horizontal distances can be easily measured with an automatic level. It is especially useful for measurements across busy roads, rivers, wetlands, hilly terrain, etc. However, if the distances are short and unobstructed it is often easier to use a 100-foot cloth tape measure.

The instrument person sets up and levels the instrument at point A. The leveling staff person places the leveling staff at point B. The top cross hair reading is subtracted from the bottom cross hair reading. The difference multiplied by 100 is the horizontal distance from point A to point B.

3.0 MATERIALS/EQUIPMENT

a. A work plan which outlines surveying requirements.

b. Field notebook, field surveying forms, maps, benchmark information.

c. Automatic level in carrying case.

d. Leveling staff.

e. Staff level (bubble).

f. Tripod.

g. Turning plate.

h. Lumber crayon or chalk.

i. Feet (or small pieces of wood to be placed beneath tripod legs when set up on asphalt in hot weather, etc.).

j. Flogging tape and spray paint.

k. Machete.

l. Pocket transit.

4.0 CALIBRATION

The automatic levels which Roux Associates owns are high quality instruments which hold their adjustment extremely well. Calibration, therefore, is not necessary for field personnel. It is advisable, however, to check the circular bubble and horizontal line-of-sight occasionally (i.e., quarterly). The procedures are easy and can be found in the operator's manual.

5.0 PROCEDURES

5.1. The instrument person sets up the tripod at the first station (ST-1). DO NOT set up the stations any further than 100 feet from the benchmark or turning points because, to do otherwise, would compromise the accuracy of the measurements. The instrument is now ready to be leveled.

5.2. The instrument is leveled by adjustment of the three footscrews between the instrument and the instrument base plate. The adjustment is continued until the level bubble is centered. Once this has been done, the instrument is not releveled until it is set up at a new station. An exception to this is if the tripod is moved (kicked, etc.) or for some other reason the instrument is no longer level (i.e., tripod legs sink in asphalt), in which case the instrument must be releveled. DO NOT relevel the instrument between backsights and foresights.

5.3. The instrument, once leveled, is turned by use of the horizontal drive screw to come into line to sight the leveling staff at the benchmark. The instrument is adjusted until the leveling staff numbering and points are in sharp focus. The cross hairs of the instrument are focused by use of the knob on the eyepiece (if present).

5.4. The button below the eyepiece (if present) is pushed as a final check to ensure that the automatic internal compensator has brought the line of sight to horizontal. Now record the number that is read at the intersection of the vertical and middle horizontal cross hairs that extend across the entire field of view. This number is recorded in the field notebook to the nearest 0.001 foot. This establishes the height of the instrument.

5.5. The leveling staff person picks up their equipment and moves past the instrument station to the next turning point. A turning plate should be used to turn in grass or dirt areas. When on pavement, it is sometimes more suitable to use an X marked on a suitable area of the pavement. The intersection of the two lines is used as the point and the lines are used to line up the staff or rod, placing the line in the middle of each face or edge of the rods.

5.6. The instrument is not moved other than to rotate the instrument by use of the horizontal drive screw to sight the new location of the leveling staff and focusing of the instrument. The instrument is NOT releveled by use of the foot screws between backsights and foresights. Once the instrument has been focused on the staff at the new location, the compensator button is pushed (if present) and the leveling staff reading is recorded. This reading is a foresight that establishes the elevation at the turning point and is recorded in the foresight column.

5.7. The instrument is moved past the turning point and the procedures are repeated until the final destination is reached.

5.8. After the final destination has been reached and the foresight establishing its elevation has been recorded, a loop should be closed to the original benchmark to confirm that no errors were made (Exhibit B). This can be done by going back through the same stations and turning points or returning by a separate route. If the same stations and turning points are used, then the leveling staff person should stay on the final destination. The instrument stays at the same general location but is moved enough to require releveling (i.e., move the legs outward or inward several inches). The instrument is then releveled. This will make another turning point in the loop and will ensure that if an error was made in the final foresight reading, the loop to the original benchmark will not close. After the instrument has been releveled, a backsight is recorded and procedures 5.1 to 5.6 are repeated until the leveling staff person reaches the original benchmark and the instrument person performs a foresight to the staff at this location.

5.9. The field notebook should have the same number of backsights and foresights if the leveling was conducted as described above and no side shots were made. (A side shot is a case where two or more foresights are made from the same station and same instrument height. However, because the side shots are not an integral part of the loop as are turning points, an error in the staff reading will not be caught, yet, the loop will still close.) It is therefore recommended that each elevation to be established be treated as a turning point and that side shots not be utilized.

5.10. To check the loop for closure, sum the column of foresights, then sum all the backsights. The difference between these two totals is the closure error. If the closure error is within the tolerance limits set by the project manager, then the leveling is completed and the equipment should be packed up and returned to the office. If the closure error exceeds the tolerance limits set by the project manager, then the loop needs to be redone.

APPENDIX D

Procedures for Logging Geologic Borings and Preparation of Geologic and Well Construction Logs

MEMORANDUM

TO: New York Technical Staff
FROM: Drew Baris
DATE: August 2, 2000
RE: Geologic Logging Procedures

Recently questions have arisen regarding geologic logging consistency and content for drilling in unconsolidated formations, which is the most typical drilling performed on NY Office projects. This work includes drilling of any type (e.g., Geoprobe™, hollow stem auger, rotary, etc.). The purpose of this memorandum is to summarize the pertinent information that should be documented in the field notebook during drilling activities and to provide guidance in the preparation of geologic logs. However, it should be noted that although intended to address data requirements relating specifically to drilling, many of the issues covered in this memo, especially lithologic descriptions, are applicable to any situation where soil is being described.

Any questions regarding any of the procedures or guidance outlined in this memo should be directed to Chris Clark, Mike Roux, or myself.

General Field Notes Relating to Drilling Activities

The following is a list of information in addition to that specifically discussed in Roux Associates' SOPs that should typically be documented at the start of each day, or if types of drilling equipment are changed during the course of the day.

- Drilling contractor performing the work (including name of the company personnel and times on or off site).
- Drilling equipment used (including rig manufacturer and model, and type and size of drilling tools).
- Type and size of sampling equipment (including method by which sampler is driven).
- Health and safety procedures followed (including such activities as utility markouts, pre-digging of drilling locations, traffic control, rig grounding, etc.).
- Land surface cover and thickness (i.e., asphalt, concrete, grass, etc.)
- Any pre-existing site damage in drilling locations that may later be attributed by the site owner to Roux Associates' activities (e.g., broken curbs or sidewalks, damage to landscaping, etc.).

This list is in no way meant to be a complete list. As with all field activities, any observations or conditions encountered in the field should be noted, and at a minimum, discussed with the Project Manager if the field staff is unsure of its relevancy. Field personnel should always adhere to the requirements and guidance specified in Roux Associates' Standard Operating Procedures (SOPs).

Sample Identification and Logging

In order to provide a clear and accurate record of where and how soil samples were collected during drilling, basic information must be documented. This proper documentation provides the back-up required for all projects for review of the data and quality assurance/quality control (QA/QC). The following is a list of general sample information that must be recorded (please note that not all the data below is applicable depending on the type of samples or method of collection being used).

- Sample location and depth.
- Method of collection (i.e., split spoon, Macrocore, etc.).
- Blow Counts: When standard penetration methods are utilized in the collection of soil samples (Attachment A), blow counts should be noted for each six-inch interval the sampler is driven.
- Notes regarding percentage or length of the sample recovered should be recorded (be consistent).
- Lithologic description (a more detailed discussion of lithologic description format is provided below).
- Photoionization Detector (PID) Readings: Headspace measurements collected in accordance with Roux Associates' SOPs should be noted.
- Soil sample intervals collected for laboratory analysis should be indicated including interval(s) sampled, sample ID, analyses requested, sample containers used, and rationale for sample collection.
- Well completion details should be documented per Roux Associates' SOP.

Lithologic Descriptions

For each sample collected, complete and accurate descriptions of the subsurface materials must be made. In order to establish a consistent method of logging soil samples, Roux Associates has, and will continue to utilize the following protocol, which is based upon the Burmeister System and the Unified Soil Classification System (USCS). The following descriptive order should be used when logging samples in the field.

1. Color: First letter of the first word should be capitalized.
2. Primary lithologic component (cobbles, gravel, sand, silt, or clay) and its range of grain-sizes using USCS-prescribed size limits (Attachment B): If the primary component comprises greater than 50 percent (by weight) of the sample, then that component should be written entirely in upper-case letters; if the primary component comprises less than 50 percent of the sample, then only the first letter should be capitalized; if the grain-size distribution of the primary component is skewed towards one end of its range, that end should be denoted with a "plus" sign in parentheses (+). Grain-size range should appear before the primary lithologic component (when the primary lithologic component is sand or gravel), and a comma should be placed after the primary component.
3. Minor constituents (if present), and an adjective indicating their approximate percentages: Minor components should appear in descending order (i.e., compounds present in greater percentages are listed first) and should be separated by commas; grain-size range (for sand and gravel only) should appear before the component, and only the first letter of each component should be capitalized; the adjectives used to indicate percentages of minor

components should appear in lower-case letters. The percentage ranges they represent are listed below:

- "and" -- 35 to 49 percent
- "some" -- 12 to 34 percent
- "little" -- 5 to 11 percent
- "trace" -- 0 to 4 percent

These ranges are based upon USCS criteria, and should be further modified by either a "plus" (+) or "minus" (-) sign to indicate the upper and lower ends, respectively, of each range. Fines passing a No. 200 sieve generally cannot be distinguished between silt and clay on a visual basis. Relative percentages of silt and clay should be approximated by use of either or both of two field techniques:

- "the roll test" - a small amount of the sample should be rolled between the fingers for some time; if it breaks apart easily, it likely contains very little clay; if it is quite compressible, then it likely contains substantial clay.
- "the knife test" - if the sample is cut with a knife, and the fresh cut is smooth and glossy, then the sample likely contains substantial clay.

In addition, the location and characteristics of any inclusions that are observed in the sample (see Attachment C) should be noted.

4. Evidence of organic soils or organic material in all stages of decomposition such as roots, wood, plant fragments, etc., should be noted.
5. Descriptions and percentage amounts of any debris encountered such as bricks, concrete, asphalt, metal, lumber (i.e., milled or treated wood), etc., should be noted.
6. If the sample falls into any generalized category, such as fill, till, peat or weathered bedrock, it should be noted at this point in parentheses.
7. The first major portion of the description (parts 1 through 6) should be followed by a semi-colon.
8. Any miscellaneous features observed, including stratification, relative density, plasticity (as observed through "the roll test" described above), and angularity/roundness of particles (especially gravel) should be described next, in any order, with each feature being followed by a semi-colon.
9. Moisture: The adjectives "dry" (absence of moisture, dusty, dry to the touch), "moist" (damp but no visible water), or "wet" (visible free water) should appear next in the description.
10. Other Observations: Other <u>objective</u> observations indicating the presence of potential contamination (e.g., odors, staining, sheen) should appear next in the description. These observations should be limited to <u>only</u> what is observed in the sample and not speculative as to the nature or source. Notation of sample saturation with a liquid other than water should only be made if there is <u>no question</u> that the sample will yield the liquid as a separate phase.

If "wash" or borehole "slough" is present in part of the sampler, it should be noted as such, and not included in lithologic descriptions, analytical sampling or grain size sampling.

Two example descriptions of soil samples are provided below:

SB-1/0-2' split spoon: blows 5,7,7,8; 75% rec.

> Reddish brown SILT, some fine to coarse(+) Sand, little brick and concrete fragments, fine sand parting at 6 inches from bottom of spoon, (fill); stiff; moist; PID 0 ppm

SB-1/20-22' split spoon: blows 35,50,65,60; 100% rec

> Top 0.5' - Wash
>
> Bottom 1.5' - Grey fine(+) to coarse SAND, some Silt, little fine Gravel, (till); very dense; angular gravel; moist; hydrocarbon odor; PID 100 ppm; sample collected (SB-1/20-22) based on PID for VOCs (Method 8021) and SVOCs (Method 8270); (2) two oz and (2) four oz jars collected

The above examples are only one way that the information can be documented in the field book. The field geologist/engineer should use a style that works best for him/her, provided that the lithologic description format is followed, all data objectives are met, and the notes are clear and legible.

Geologic Logs

Roux Associates utilizes a commercial logging program called "gEOTECHNICAL INTegrator™," or gINT™ (Geotechnical Computer Applications – Santa Rosa, California) to produce geologic logs. This program provides a way to compile site geologic data and to produce geologic logs for soil borings, monitoring wells and test pits, as well as fence diagrams. The "Users Guide for gINT" (available from Mike Roux) provides general instructions for data input and output and examples of logs. In addition to the instructions, for consistency, the following guidelines should be followed in preparation of the logs.

- When selecting symbols for lithologic type, USCS classifications should always be used. Combinations of classifications (e.g., SW-SM) may be used for borderline classifications.
- When differentiating between different lithologic types, a solid line should be used if the contact between the types is confirmed by visual observations of in situ soil samples (not cuttings) or rig response. If the contact is not observed, a dashed line should be used to represent an inferred lithologic boundary, with a margin of error limited by the length of space between sampling intervals.
- A description should be provided for each sample collected including relative moisture content. "Same as Above" or "Similar" should not be used.
- The "Visual Description" portion of the log should be limited to lithologic description only. Notes regarding evidence of contamination should be limited to the "Remarks" section of the log.

If there are project or client specific questions relating to logging or preparation of geologic logs, they should be directed to the project manager for the particular project.

ATTACHMENT A

ASTM Standard Method for
Penetrations Test and Split-Barrel
Sampling of Soils

Designation: D 1586 - 84

Standard Method for Penetration Test and Split-Barrel Sampling of Soils[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This method has been approved for use by agencies of the Department of Defense and for listing in the DOD Index of Specifications and Standards.

1. Scope

1.1 This method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For a specific precautionary statement, see 5.4.1.

1.3 The values stated in inch-pound units are to be regarded as the standard.

2. Referenced Documents

2.1 *ASTM Standards:*

D 2487 Test Method for Classification of Soils for Engineering Purposes[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 4220 Practices for Preserving and Transporting Soil Samples[2]

3. Descriptions of Terms Specific to This Standard

3.1 *anvil*—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.2 *cathead*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.3 *drill rods*—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.4 *drive-weight assembly*—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.

3.5 *hammer*—that portion of the drive-weight assembly consisting of the 140 ± 2 lb (63.5 ± 1 kg) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.6 *hammer drop system*—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.

3.7 *hammer fall guide*—that part of the drive-weight assembly used to guide the fall of the hammer.

3.8 *N-value*—the blowcount representation of the penetration resistance of the soil. The N-value, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.9 ΔN—the number of blows obtained from each of the 6-in. (150-mm) intervals of sampler penetration (see 7.3).

3.10 *number of rope turns*—the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.11 *sampling rods*—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.12 *SPT*—abbreviation for Standard Penetration Test, a term by which engineers commonly refer to this method.

4. Significance and Use

4.1 This method provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain disturbance in the sample.

4.2 This method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and widely published correlations which relate SPT blowcount, or N-value, and the engineering behavior of earthworks and foundations are available.

5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment that provides at the time of sampling a suitably clean open hole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to be suitable for advancing a borehole in some subsurface conditions.

5.1.1 *Drag, Chopping, and Fishtail Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjuction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.

5.1.2 *Roller-Cone Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in

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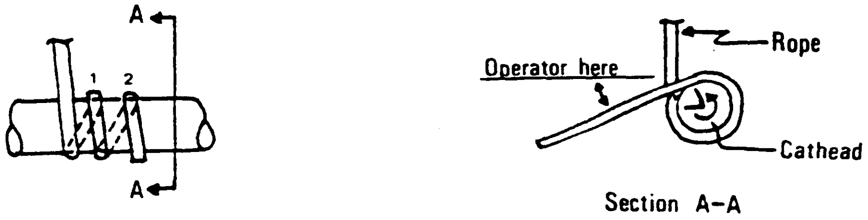
[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

Current edition approved Sept. 11, 1984. Published November 1984. Originally published as D 1586 – 58 T. Last previous edition D 1586 – 67 (1974).

[2] *Annual Book of ASTM Standards*, Vol 04.08.



(a) counterclockwise rotation approximately 1¾ turns

(b) clockwise rotation approximately 2¼ turns

FIG. 1 Definitions of the Number of Rope Turns and the Angle for (a) Counterclockwise Rotation and (b) Clockwise Rotation of the Cathead

conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 *Hollow-Stem Continuous Flight Augers*, with or without a center bit assembly, may be used to drill the boring. The inside diameter of the hollow-stem augers shall be less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm).

5.1.4 *Solid, Continuous Flight, Bucket and Hand Augers*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used if the soil on the side of the boring does not cave onto the sampler or sampling rods during sampling.

5.2 *Sampling Rods*—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod which has an outside diameter of 1⅝ in. (41.2 mm) and an inside diameter of 1⅛ in. (28.5 mm).

NOTE 1—Recent research and comparative testing indicates the type rod used, with stiffness ranging from "A" size rod to "N" size rod, will usually have a negligible effect on the N-values to depths of at least 100 ft (30 m).

5.3 *Split-Barrel Sampler*—The sampler shall be constructed with the dimensions indicated in Fig. 2. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The use of liners to produce a constant inside diameter of 1⅜ in. (35 mm) is permitted, but shall be noted on the penetration record if used. The use of a sample retainer basket is permitted, and should also be noted on the penetration record if used.

NOTE 2—Both theory and available test data suggest that N-values may increase between 10 to 30 % when liners are used.

5.4 *Drive-Weight Assembly:*

5.4.1 *Hammer and Anvil*—The hammer shall weigh 140 ± 2 lb (63.5 ± 1 kg) and shall be a solid rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting a free fall shall be used. Hammers used with the cathead and rope method shall have an unimpeded overlift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged.

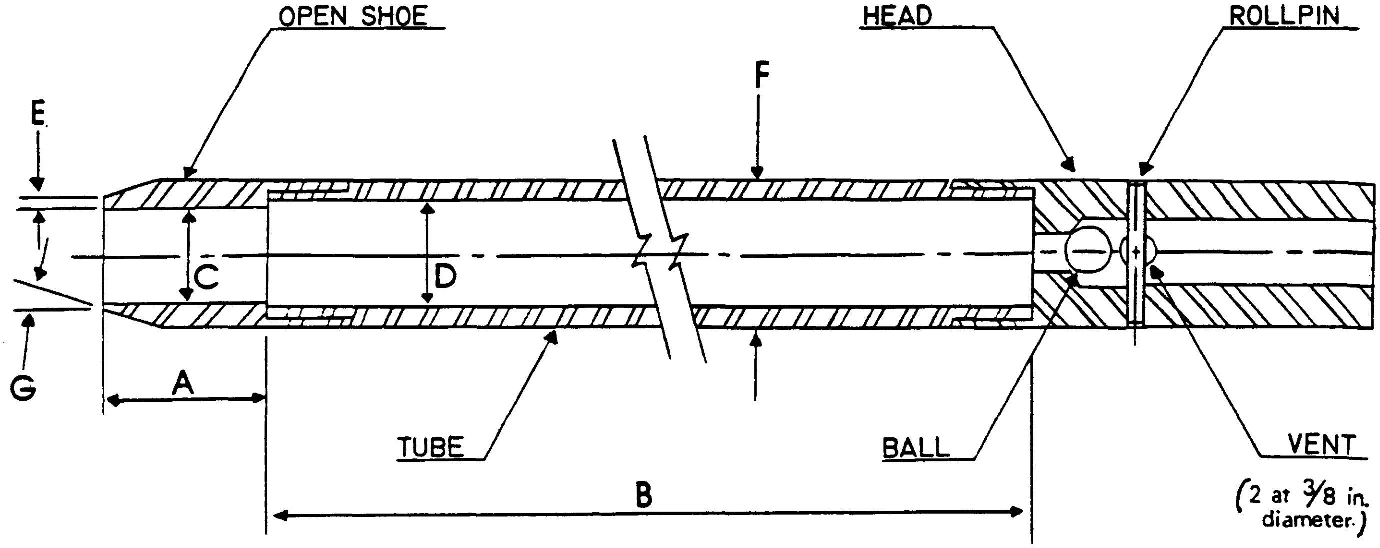
NOTE 3—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 *Hammer Drop System*—Rope-cathead, trip, semi-automatic, or automatic hammer drop systems may be used, providing the lifting apparatus will not cause penetration of the sampler while re-engaging and lifting the hammer.

5.5 *Accessory Equipment*—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. Drilling Procedure

6.1 The boring shall be advanced incrementally to permit



A = 1.0 to 2.0 in. (25 to 50 mm)
B = 18.0 to 30.0 in. (0.457 to 0.762 m)
C = 1.375 ± 0.005 in. (34.93 ± 0.13 mm)
D = 1.50 ± 0.05 − 0.00 in. (38.1 ± 1.3 − 0.0 mm)
E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
F = 2.00 ± 0.05 − 0.00 in. (50.8 ± 1.3 − 0.0 mm)
G = 16.0° to 23.0°

The 1½ in. (38 mm) inside diameter split barrel may be used with a 16-gage wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

FIG. 2 Split-Barrel Sampler

intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 mm) or less in homogeneous strata with test and sampling locations at every change of strata.

6.2 Any drilling procedure that provides a suitably clean and stable hole before insertion of the sampler and assures that the penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures have proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

6.2.1 Open-hole rotary drilling method.

6.2.2 Continuous flight hollow-stem auger method.

6.2.3 Wash boring method.

6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable borings. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. The continuous flight solid auger method shall not be used for advancing the boring below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a boring with bottom discharge bits is not permissible. It is not permissible to advance the boring for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the boring or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, prepare for the test with the following sequence of operations.

7.1.1 Attach the split-barrel sampler to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the boring, remove the sampler and sampling rods from the boring and remove the cuttings.

7.1.4 Mark the drill rods in three successive 6-in. (0.15-m) increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-in. (0.15-m) increment.

7.2 Drive the sampler with blows from the 140-lb (63.5-kg) hammer and count the number of blows applied in each 6-in. (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 6-in. (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 18 in. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.3 Record the number of blows required to effect each 6 in. (0.15 m) of penetration or fraction thereof. The first 6 in. is considered to be a seating drive. The sum of the number of blows required for the second and third 6 in. of penetration is ermed the "standard penetration resistance," or the "N-value." If the sampler is driven less than 18 in. (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 6-in. (0.15-m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 1 in. (25 mm), in addition to the number of blows. If the sampler advances below the bottom of the boring under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this nformation should be noted on the boring log.

7.4 The raising and dropping of the 140-lb (63.5-kg) hammer shall be accomplished using either of the following wo methods:

7.4.1 By using a trip, automatic, or semi-automatic hammer drop system which lifts the 140-lb (63.5-kg) hammer and allows it to drop 30 ± 1.0 in. (0.76 m ± 25 mm) nimpeded.

7.4.2 By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the ystem and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or rease and have a diameter in the range of 6 to 10 in. (150 to 50 mm).

7.4.2.2 The cathead should be operated at a minimum peed of rotation of 100 RPM, or the approximate speed of otation shall be reported on the boring log.

7.4.2.3 No more than 2¼ rope turns on the cathead may e used during the performance of the penetration test, as hown in Fig. 1.

NOTE 4—The operator should generally use either 1¾ or 2¼ rope urns, depending upon whether or not the rope comes off the top (1¾ urns) or the bottom (2¼ turns) of the cathead. It is generally known nd accepted that 2¾ or more rope turns considerably impedes the fall f the hammer and should not be used to perform the test. The cathead ope should be maintained in a relatively dry, clean, and unfrayed ondition.

7.4.2.4 For each hammer blow, a 30-in. (0.76-m) lift and rop shall be employed by the operator. The operation of ulling and throwing the rope shall be performed rhythmially without holding the rope at the top of the stroke.

7.5 Bring the sampler to the surface and open. Record the ercent recovery or the length of sample recovered. Describe he soil samples recovered as to composition, color, stratifiation, and condition, then place one or more representative ortions of the sample into sealable moisture-proof conainers (jars) without ramming or distorting any apparent ratification. Seal each container to prevent evaporation of oil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 6-in. (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel.

8. Report

8.1 Drilling information shall be recorded in the field and shall include the following:

8.1.1 Name and location of job,

8.1.2 Names of crew,

8.1.3 Type and make of drilling machine,

8.1.4 Weather conditions,

8.1.5 Date and time of start and finish of boring,

8.1.6 Boring number and location (station and coordinates, if available and applicable),

8.1.7 Surface elevation, if available,

8.1.8 Method of advancing and cleaning the boring,

8.1.9 Method of keeping boring open,

8.1.10 Depth of water surface and drilling depth at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,

8.1.11 Location of strata changes,

8.1.12 Size of casing, depth of cased portion of boring,

8.1.13 Equipment and method of driving sampler,

8.1.14 Type sampler and length and inside diameter of barrel (note use of liners),

8.1.15 Size, type, and section length of the sampling rods, and

8.1.16 Remarks.

8.2 Data obtained for each sample shall be recorded in the field and shall include the following:

8.2.1 Sample depth and, if utilized, the sample number,

8.2.2 Description of soil,

8.2.3 Strata changes within sample,

8.2.4 Sampler penetration and recovery lengths, and

8.2.5 Number of blows per 6-in. (0.15-m) or partial increment.

9. Precision and Bias

9.1 Variations in N-values of 100 % or more have been observed when using different standard penetration test apparatus and drillers for adjacent borings in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, N-values in the same soil can be reproduced with a coefficient of variation of about 10 %.

9.2 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in N-values obtained between operator-drill rig systems.

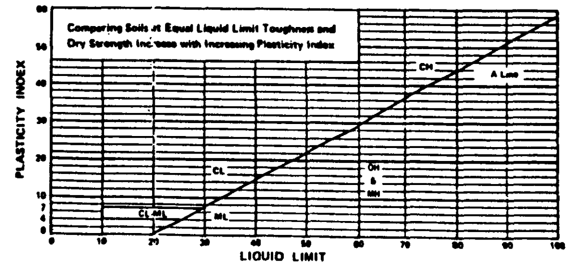
9.3 The variability in N-values produced by different drill rigs and operators may be reduced by measuring that part of the hammer energy delivered into the drill rods from the sampler and adjusting N on the basis of comparative energies. A method for energy measurement and N-value adjustment is currently under development.

ATTACHMENT B

Unified Soil Classification System

Unified Soil Classification (USCS) Grain Size Distribution

	Millimeters	Inches	Sieve Sizes
Boulders	>300	>11.8	–
Cobbles	75 – 300	2.9 – 11.8	–
Gravel:			
Coarse	75 – 19	2.9 – 0.75	–
Fine	19 – 4.8	0.75 – 0.19	¾" – No. 4
Sand:			
Coarse	4.8 – 2.0	0.19 – 0.08	No. 4 – No. 10
Medium	2.0 – 0.43	0.08 – 0.02	No. 10 – No. 40
Fine	0.43 – 0.08	0.02 – 0.003	No. 40 – No. 200
Fines:			
Silt	<0.08	<0.003	<No. 200
Clay	<0.08	<0.003	<No. 200

Major Divisions			Graphic Symbols		Typical Name	Field Identification Procedures (Excluding particles larger than 3 in. and basing fractions on estimated weights)			Information Required for Describing Soils	Laboratory Classification Criteria
1	2		3	3a	4	5			6	7
Coarse-Grained Soils More than half of material is larger than No. 200 sieve size. The No. 200 sieve size is about the smallest particle visible to the naked eye.	Gravels More than half of coarse fraction is larger than No. 4 sieve size. (For visual classification, the 1/4-in. size may be used as equivalent to the No. 4 sieve size)	Clean Gravels (Little or no fines)	GW	RED	Well-graded gravels, gravel-sand mixtures, little or no fines.	Wide range in grain size and substantial amounts of all intermediate particle sizes.			For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions, and drainage characteristics. Give typical name; indicate approximate percentages of sand and gravel, maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbol in parentheses. Example: Silty sand, gravelly; about 20% hard, angular gravel particles 1/2-in. maximum size; rounded and subangular sand grains, coarse to fine; about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM).	Use grain-size curve in identifying the fractions as given under field identification. Determine percentages of gravel and sand from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse-grained soils are classified as follows: Less than 5% = GW, GP, SW, SP More than 12% = GM, GC, SM, SC 5% to 12% = Borderline cases requiring use of dual symbols $C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			GP	RED	Poorly graded gravels or gravel-sand mixtures, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.				Not meeting all gradation requirements for GW
		Gravels with Fines (Appreciable amount of fines)	GM	YELLOW	Silty gravels, gravel-sand-silt mixture.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).				Atterberg limits below "A" line or PI less than 4 Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
			GC	YELLOW	Clayey gravels, gravel-sand-clay mixtures.	Plastic fines (for identification procedures see CL below).				Atterberg limits above "A" line with PI greater than 7
	Sands More than half of coarse fraction is smaller than No. 4 sieve size.	Clean Sands (Little or no fines)	SW	RED	Well-graded sands, gravelly sands, little or no fines.	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.				$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			SP	RED	Poorly graded sands or gravelly sands, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.				Not meeting all gradation requirements for SW
		Sands with Fines (Appreciable amount of fines)	SM	YELLOW	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).				Atterberg limits below "A" line or PI less than 4 Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
			SC	YELLOW	Clayey sands, sand-clay mixtures.	Plastic fines (for identification procedures see CL below).				Atterberg limits above "A" line with PI greater than 7
						Identification Procedures On Fraction Smaller than No. 40 Sieve Size				
						Dry Strength (Crushing Characteristics)	Dilatancy (Reaction to Shaking)	Toughness (Consistency near PL)		
Fine-Grained Soils More than half of material is smaller than No. 200 sieve size.	Silts and Clays	Liquid limit is less than 50	ML	GREEN	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	None to slight	Quick to slow	None	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions. Give typical name; indicate degree and character of plasticity; amount and maximum size of coarse grains; color in wet condition; odor, if any; local or geologic name and other pertinent descriptive information; and symbol in parentheses. Example: Clayey silt, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (ML).	 PLASTICITY CHART For laboratory classification of fine-grained soils
			CL	GREEN	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium to high	None to very slow	Medium		
			OL	GREEN	Organic silts and organic silty clays of low plasticity.	Slight to medium	Slow	Slight		
	Silts and Clays	Liquid limit is greater than 50	MH	BLUE	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Slight to medium	Slow to none	Slight to medium		
			CH	BLUE	Inorganic clays of high plasticity, fat clays.	High to very high	None	High		
			OH	BLUE	Organic clays of medium to high plasticity, organic silts.	Medium to high	None to very slow	Slight to medium		
Highly Organic Soils			Pt	ORANGE	Peat and other highly organic soils.	Readily identified by color, odor, spongy feel and frequently by fibrous texture.				

(1) Boundary classifications: Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW-GC, well-graded gravel-sand mixture with clay binder. (2) All sieve sizes on this chart are U.S. standard.

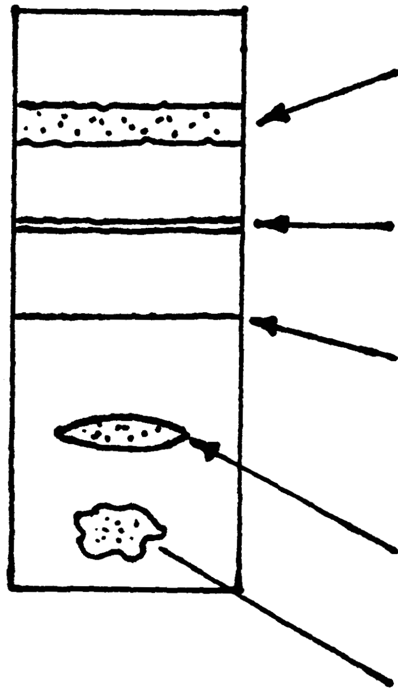
Unified Soil Classification System

ATTACHMENT C

Terminology to be Used
in Describing Sample Inclusions

ROUX

CLIENT/PROJECT ______ PAGE 1 OF 1
BY C.CLARK DATE 8/1/00 PROJECT NO. ______
CHECKED BY ______ DATE ______
DESCRIPTION TERMINOLOGY TO BE USED IN DESCRIBING SAMPLE INCLUSIONS



LAYER - AN INCLUSION, CONTINUOUS ACROSS SAMPLE, WITH THICKNESS OF 1/8 INCH OR MORE

SEAM - AN INCLUSION, CONTINUOUS ACROSS SAMPLE, WITH THICKNESS OF LESS THAN 1/8 INCH

PARTING - AN INCLUSION, CONTINUOUS ACROSS SAMPLE, WHICH IS VISIBLE BUT OF A THICKNESS WHICH IS TOO SMALL TO BE MEASURED OR DEFINED

LENSE - AN INCLUSION WHICH IS DISCONTINUOUS AND WHICH HAS CONVEX SURFACES

POCKET - AN INCLUSION WHICH IS DISCONTINUOUS AND WHICH HAS AN AMORPHOUS SHAPE

APPENDIX E

Field Forms

ROUX

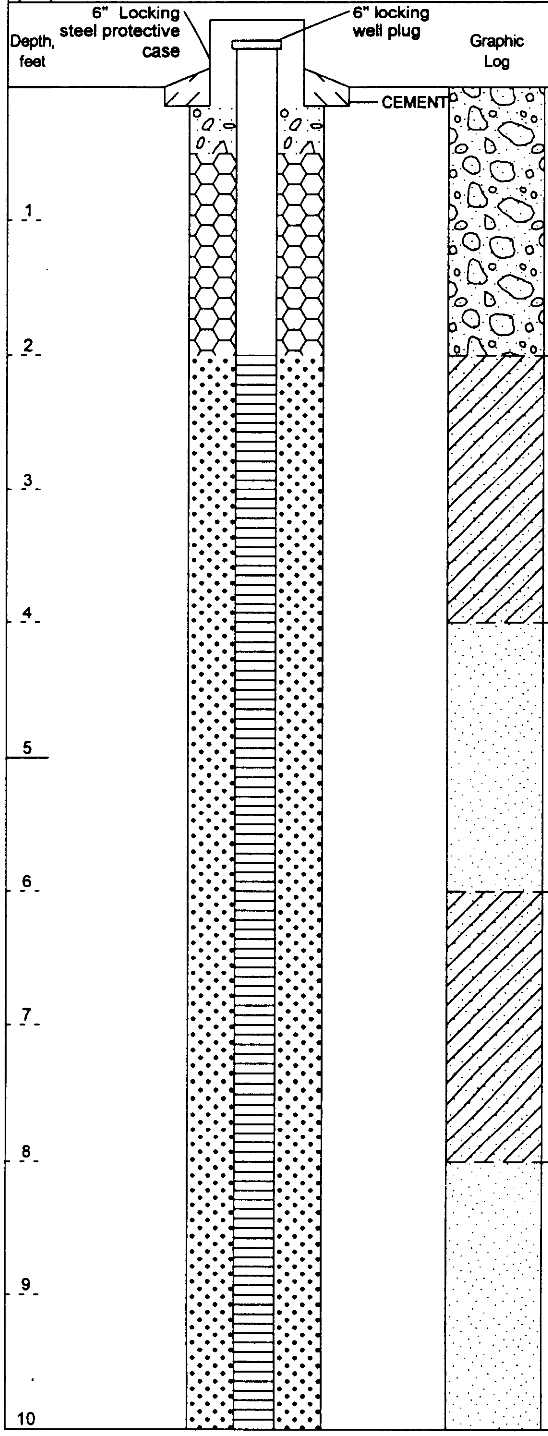
ROUX ASSOCIATES, INC.
Environmental Consulting
& Management

1377 Motor Parkway
Islandia, New York 11749
(631) 232-2600
(631) 232-9898

Page 1 of 1

WELL CONSTRUCTION LOG

WELL NO. **Test-1**	NORTHING	EASTING		
PROJECT NO./NAME **5551212 / Any Project USA**		LOCATION **555 Anystreet** **Anytown, Anycity**		
APPROVED BY **J. Doe**	LOGGED BY **J. Smith**			
DRILLING CONTRACTOR/DRILLER **Any Driller / R. Smith**		GEOGRAPHIC AREA **Northwest of area one, in former pool area**		
DRILL BIT DIAMETER/TYPE **6.25-inches / Auger**	BOREHOLE DIAMETER **2-inches**	DRILLING EQUIPMENT/METHOD **CME-550 / Geoprobe**	SAMPLING METHOD	START-FINISH DATE **5/24/00-5/24/00**
CASING MAT./DIA. **PVC / 4-inch**	SCREEN: TYPE **Slotted**	MAT. **PVC** TOTAL LENGTH **5.0**	DIA. **4-inch**	SLOT SIZE **10-Slot**
ELEVATION OF: (FT.)	GROUND SURFACE	TOP OF WELL CASING	TOP & BOTTOM SCREEN /	GW SURFACE
GRAVEL PACK **#0**				



Visual Description	Blow Counts per 6"	PID Values (ppm)	REMARKS
Brown fine to medium SANDY GRAVEL	2 4 6 8	14.7	
Brown to dark brown fine SANDY CLAY; Moist	6 9 3 2	13.2	
Brown fine SAND; Moist	2 5 6 4	15.9	
Brown fine SANDY CLAY; Moist	4 4 4 4	56.3	
Brown fine SAND; Wet	2 5 8 3	29.5	

ROUX

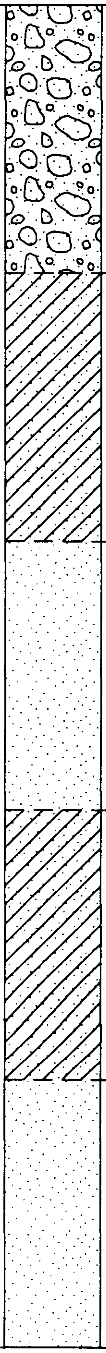
ROUX ASSOCIATES, INC.
Environmental Consulting
& Management

1377 Motor Parkway
Islandia, New York 11749
(631) 232-2600
(631) 232-9898

Page 1 of 1

SOIL BORING LOG

WELL NO. Test-2	NORTHING	EASTING	
PROJECT NO./NAME 5551212 / Any Project USA		LOCATION 555 Anystreet Anytown, Anycity	
APPROVED BY J. Doe	LOGGED BY J. Smith		
DRILLING CONTRACTOR/DRILLER Any Driller / R. Smith		GEOGRAPHIC AREA Northwest of area one, in former pool area	
DRILL BIT DIAMETER/TYPE 2-inches / Auger	BOREHOLE DIAMETER 2-inches	DRILLING EQUIPMENT/METHOD CME-550 / Geoprobe	SAMPLING METHOD	START-FINISH DATE 5/24/00-5/24/00
LAND SURFACE ELEVATION (FT.)	DEPTH TO WATER (Feet BLS)	BACKFILL Cuttings	



Depth, feet	Visual Description	Blow Counts per 6"	PID Values (ppm)	REMARKS
1 2	Brown fine to medium SANDY GRAVEL	2 4 6 8	14.7	
3 4	Brown to dark brown fine SANDY CLAY; Moist	6 9 3 2	13.2	
5 6	Brown fine SAND; Moist	2 5 6 4	15.9	
7 8	Brown fine SANDY CLAY; Moist	4 4 4 4	56.3	
9 10	Brown fine SAND; Wet	2 5 8 3	29.5	

Mobil Eastern Region Analysis Request/Chain of Custo

MAY 24 '00 15:38 TO

FROM

T-403 P.02

Lancaster Laboratories
Where quality is a science.

For Lancaster Laboratories use only

Acct. #: ____________ **Sample #:** ____________

SCR#: ____________

Please print.

Mobil Consultant: ____________
Consultant Project Manager: ____________
Consultant Phone #: ____________ Fax #: ____________
Location Code #: ____________ WBS #: ____________
Site Address: ____________ State: ____________
Sampler: ____________
Mobil Engineer: ____________

Analyses Requested List total number of containers in the box under each analysis.

Preservation Codes

Preservative Codes

H = HCl	T = Thiosulfate
N = HNO_3	B = NaOH
S = H_2SO_4	O = Other

Sample Identification	Date Collected	Time Collected	Grab	Composite	**Matrix** Soil	Water ☐ Potable ☐ NPDES	Oil ☐ Air ☐	BTEX 602 ☐ +MTBE ☐ +NAPH ☐ +TBA ☐	BTEX 8020 ☐ +MTBE ☐ +NAPH ☐ +TBA ☐	TPH API GRO ☐ DRO ☐	TPH Mobil DRO ☐ MRO ☐	TPH 418.1 ☐	BTEX 8021 ☐ MTBE ☐ NAPH ☐ STARS GAS ☐ STARS FUEL ☐	8270 BNA ☐ STARS PAH ☐	TPH MA VPH ☐	MA EPH ☐					**Remarks**

Turnaround Time Requested (TAT) (please circle):

MOBIL STD. TAT **72 hour** **48 hour**
24 hour **other** ____ **day** **Do not FAX**

Data Package Options (please circle if requested)

QC Summary GLP
Type I (Tier I) Other
Type II (Tier II) Disk
Type III (NJ Red. Del.)
Type IV (CLP)
Type VI (Raw Data)

SDG Complete?
Yes No

Site-specific QC required?
Yes No (If yes, indicate QC sample and submit triplicate volume.

Internal Chain of Custody required? Yes No

Relinquished by:	Date	Time	Received by:	Date	Time
Relinquished by:	Date	Time	Received by:	Date	Time
Relinquished by:	Date	Time	Received by:	Date	Time
Relinquished by:	Date	Time	Received by:	Date	Time

Relinquished by Commercial Carrier:
UPS FedEx Other ____________

Temperature Upon Receipt ____________ C°

Lancaster Laboratories is a Thermo Electron company.

2425 New Holland Pike, PO Box 12425, Lancaster, PA 17605-2425 (717) 656-2300

Copies: White and yellow should accompany samples to Lancaster Laboratories. The pink copy should be retained by the client

1764 Rev. 7/6/99

CUSTODY SEAL

DATE ____________________

SIGNATURE ____________________

ROUX

1377 Motor Parkway
Suite 403
Islandia, New York 11788
516-232-2600

FIELD CHANGE DOCUMENTATION

DATE: ____________________ FIELD CHANGE #: ____________

PERSON REQUESTING CHANGE: ______________________________

COMPANY/TITLE: ______________________________

FIELD CHANGE: ______________________________

____

____

____

REASON FOR FIELD CHANGE: ______________________________

____

____

____

____

ACKNOWLEDGEMENT: ______________________________

WORK PLAN ADDENDUM REQUIRED (Y/N): ______________________________

ADDENDUM SUBMITTED TO: ______________________________

ADDENDUM SUBMITTED TO: ______________________________

APPENDIX F

Lancaster Laboratories Sample Packing and Shipping Procedures

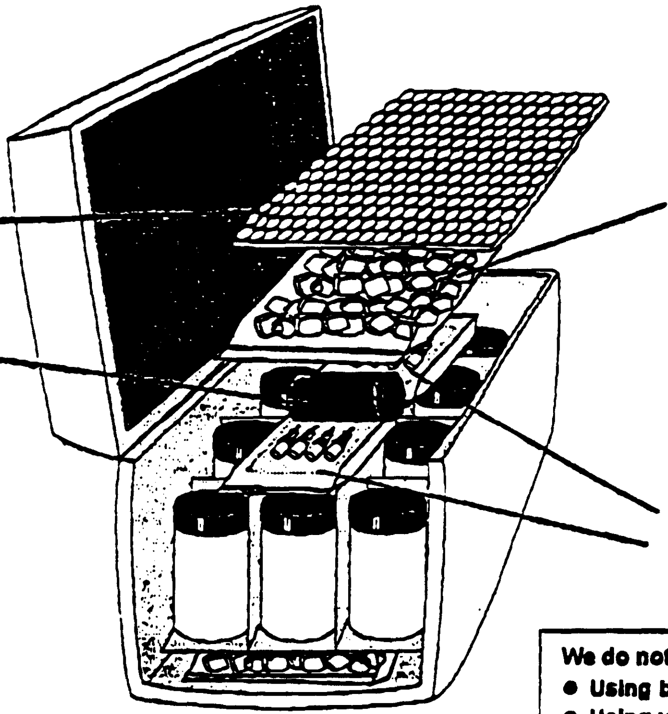
Lancaster Laboratories
A division of Thermo Analytical Inc.
Where quality is a science.

Keep It Cool

To protect samples, please package the kit in the same manner in which it was sent to you and follow the instructions below. Many analytical methods require the samples to be shipped at 4°C. **If your project requires that the samples be received at 4°C, <u>you must chill the bottles to at least 4°C (40°F) prior to shipment.</u>**

Suggestions for keeping samples cold during shipment:

- The kit/cooler must contain plenty of ice (roughly 20% of the volume of the cooler).
- You must use water ice (not dry ice or ice packs).
- Place ice above and below the samples. This will require removing the insert, adding bags of ice, and replacing insert.
- Pack any empty cells with bagged ice, preferrably the corner cells. (The inserts are designed to allow air to flow around the outside of the insert but you can fill the cells that do not have bottles.)
- Keep the corrugated or foam inserts and wrapping material intact.
- Tape around the seal of the cooler in addition to taping the cooler closed. Duct tape provides the best seal, but you may also use shipping tape. **Please place the custody seal vertically across the seam of the cooler lid to the body of the cooler.**
- Chill the samples to 4 degrees C, pack and ship them at the end of the day to minimize time in transit.



Bubble wrap should be placed on top of the ice pack.

Be sure the temperature bottle is in the kit. The bottle MUST be returned along with the kit.

If your project requires the samples to be received at 4°C, it is imperative that the temperature bottle be properly positioned under the top layer of ice.

For your convenience, sealable bags have been provided. Place bags of ice directly on top of and below the samples. It is your responsibility to provide this ice. The bottles must be chilled to at least 4°C prior to placement in the kit. You'll need to use wet ice.

NOTE: If ice is not placed in sealable bags and the kit leaks, commerical carriers may stop shipment of the item.

EnCore Samplers in foil packs, placed in sealable plastic bags.

We do not recommend:

- **Using bubble wrap around bottles**
- **Using vermiculite packing**
- **Using Blue Ice packs**

Sample Kit Return Policy

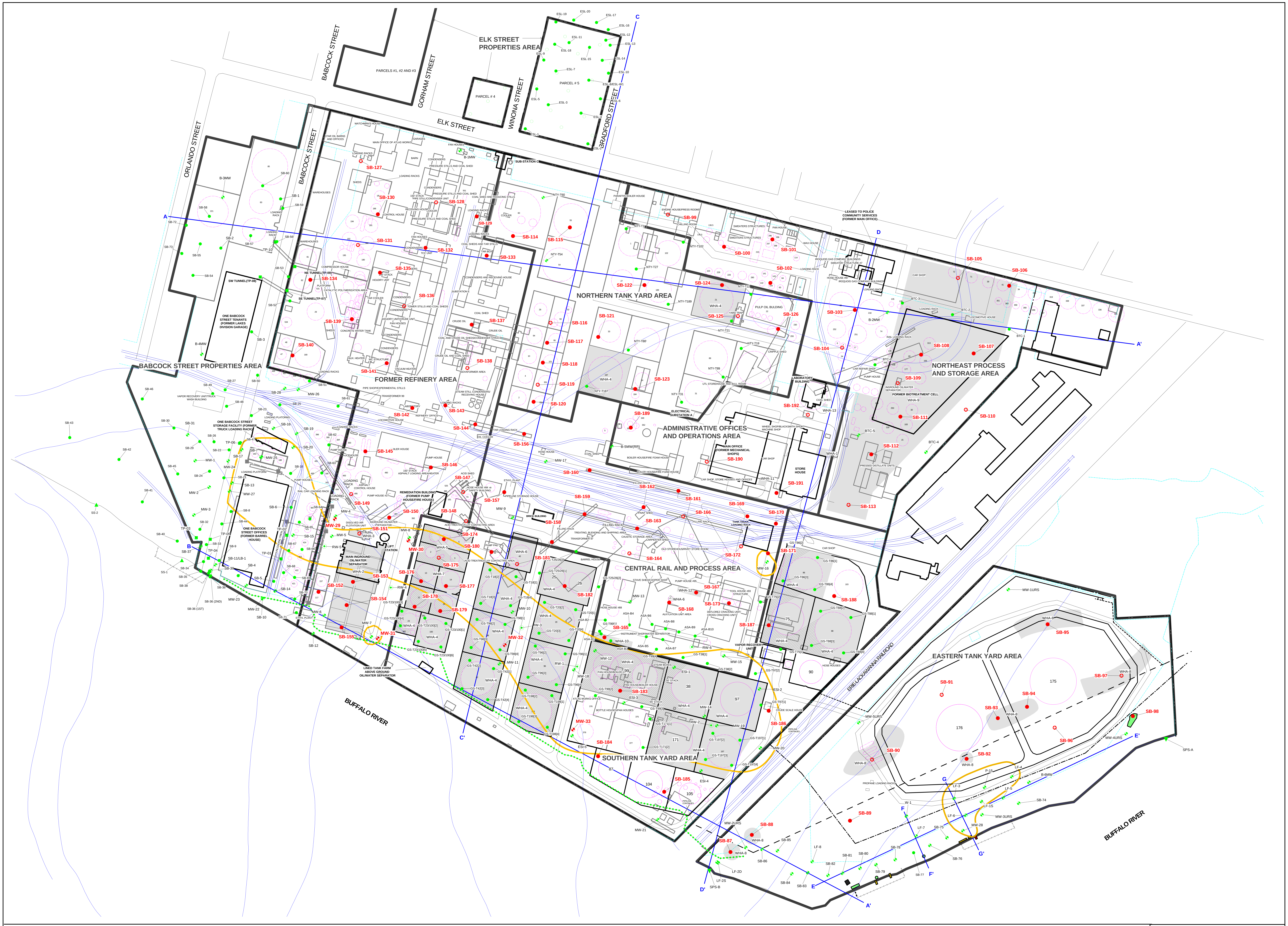
Please return this kit to us within 60 days. If your project is delayed or your schedule changes, notify your client service representative and provide us with the kit # and estimated date of return.

The sample kits, including inserts, bottles, pads, and packing materials are costly. **If the kit and its contents are not returned to us, we will bill your account $50 for the cost of the kit or for the missing parts.**

2117 Rev.4-21-98

Lancaster Laboratories • 2425 New Holland Pike, PO Box 12425, Lancaster, PA 17605-2425 • 717-656-2300 Fax: 717-656-2681

A subsidiary of Thermo TerraTech Inc., a Thermo Electron company



○ EXISTING STORAGE TANK

◌ FORMER STORAGE TANK

▭ EXISTING STRUCTURE

▭ FORMER STRUCTURE

— EXISTING ASPHALT/CONCRETE ROAD

● PROPOSED SOIL BORING

✪ PROPOSED SOIL BORING WITH GROUNDWATER SAMPLE

⊕ PROPOSED MONITORING WELL

◈ EXISTING RECOVERY WELL

⊕ EXISTING MONITORING WELL

● EXISTING SOIL BORING LOCATION

■ EXISTING TEST PIT LOCATION

○ EXISTING COMPOSITE SOIL BORING LOCATION IN THE ETYA

▲ SEPARATE-PHASE PRODUCT INVESTIGATION SEDIMENT SAMPLE LOCATION

▼ PHASE II INVESTIGATION SEDIMENT SAMPLE LOCATION

A——A' LOCATION OF HYDROGEOLOGIC CROSS SECTION

APPROXIMATE EXXON MOBIL CORP. PROPERTY LINE

GEOGRAPHIC AREA BOUNDARY

🟨 AREAS OF PRODUCT/IRON STAINING (proportions exaggerated for clarity)

🟥 AREA OF PRODUCT SEEPAGE OBSERVED ON OCTOBER 26, 2000 (proportions exaggerated for clarity)

▭ LIMITS OF CURRENT SEPARATE-PHASE PRODUCT OBSERVED IN MONITORING WELLS

LIMITS OF CONTAINMENT BOOMS

■ CATCH BASIN AND STORM SEWER PIPE

● HISTORICAL WASTE HANDLING AREAS

■ DRUM REMNANTS (proportions exaggerated for clarity)

🟩 ASPHALT MATERIAL (proportions exaggerated for clarity)

WELL POINT SYSTEM

APPROXIMATE LOCATION OF FORMER RIVER CHANNEL

PORTION OF EXXON MOBIL CORP.'S BURIED PRODUCT PIPELINE THAT IS ABANDONED (Line purged and abandoned in place)

PORTION OF EXXON MOBIL CORP.'S BURIED PRODUCT PIPELINE THAT IS ACTIVE

EXXON MOBIL CORP.'S ACTIVE ABOVEGROUND PRODUCT PIPELINE

LAKEHEAD PIPELINE CO.'S, BURIED PRODUCT PIPELINE (Line reportedly purged and filled with nitrogen in 1982)

FENCELINE

100' 0 100'

N

Title:

SITE LOCATION MAP WITH PROPOSED SAMPLING LOCATIONS

Prepared For:

EXXONMOBIL OIL CORPORATION

ROUX

ROUX ASSOCIATES INC
Environmental Consulting & Management

Compiled by: NC	Date: 7/30/01	PLATE
Prepared by: NC	Scale:AS SHOWN	1
Project Mgr: NC	Office: NY	
File No: MC5216201.WOR	Project: 17252Y03	

AREA	Structure Number	Current Structure Name (Original Structure Name)
Northeast Process and Storage Area	21	Leased to Police Community Services (Main Office)
	22	Former Biotreatment Cell
	23	Gated Entrance
Northern Tank Yard Area	35	Sub-Station C
Former Refinery Area	69	Main Inground Oil/Water Separator
	73	Remediation Building (Pump House #25, Fire House)
Central Rail and Process Area	105	Brick Building (Dehydrator/Pipe Line Pump House #38)
	112	Tank Truck Loading Rack
Southern Tank Yard Area	133	Vapor Recovery Unit
Babcock Street Properties Area	135	One Babcock Street Offices (Barrel House)
	140	Various Tenants of One Block of Babcock Street (Lakes Division Garage)
	141	One Babcock Street Storage Building (Truck Loading Rack)
Administrative Offices and Operations Area	146	Elelctrical Sub-Station A (Furnace Room)
	150	Laboratory Building
	152	Main Office/Mechanical Shops
	153	Store House
Elk Street Properties Area		Parcel #4
		Parcel #5

LEGEND

○	EXISTING TANK
153	EXISTING STRUCTURE
— — —	CURRENT PROPERTY LINE (BASED ON DENLUCK-O'NEILL ENGINEERING AND SURVEYING, DEC. 15, 1988; AND NUSSBAUMER & CLARKE, INC. FEBRUARY 6, 1995)
▬	GEOGRAPHIC AREA BOUNDARY AND/OR FORMER PROPERTY LINES
MW-4 ⊕	LOCATION AND DESIGNATION OF MONITORING WELL
RW-5 ◆	LOCATION AND DESIGNATION OF RECOVERY WELL
569.07	GROUNDWATER ELEVATION, MEASURED IN FEET ABOVE MEAN SEA LEVEL
5.20	FREE-PRODUCT THICKNESS IN FEET
NM	NOT MEASURED
ND	NOT DETECTED
— 584	LINE OF EQUAL GROUNDWATER ELEVATION, MEASURED IN FEET ABOVE MEAN SEA LEVEL (DASHED WHERE INFERRED)
←	APPROXIMATE GROUNDWATER FLOW DIRECTION
•—•—•	WELL POINT SYSTEM
•—•—•	SECTION OF WELL POINT SYSTEM NOT OPERATIONAL
MH ●	LOCATION AND DESIGNATION OF MANHOLE
🟧	SEPERATE-PHASE PRODUCT

WELL DESIGNATION	AVERAGE FLOW RATE FOR APRIL 2001 (GALLONS PER MINUTE)
RW-1 (6)	–
RW-2 (1)	–
RW-3	0.2
RW-4	1.4
RW-5	0.7
EASTERN WPS	97
WESTERN WPS (7)	–

NOTE:

1. THE RECOVERY WELL RW-2 DID NOT OPERATE DURING THE QUARTER.
2. LF-2D GROUNDWATER ELEVATION NOT USED; SCREENED AT DEEPER INTERVAL.
3. LF-2S AND ESI-5 GROUNDWATER ELEVATION NOT USED FOR CONTOURING DUE TO ANOMALOUSLY HIGH READING.
4. SB-28 WATER TABLE ELEVATION WAS NOT USED AS IT WAS REPLACED BY WELL MW-26.
5. SB-7, SB-13 AND SB-10 WERE NOT GAUGED AS THEY WERE REPLACED BY MW-25, MW-27 AND MW-22, RESPECTIVELY.
6. RECOVERY WELL RW-1 METER DID NOT OPERATE DURING APRIL 2001.
7. FLOW METER WAS NOT FUNCTIONING PROPERLY DURING APRIL 2001.

120' 0 120'

Title:

GROUNDWATER POTENTIOMETRIC MAP
APRIL 19 AND 20, 2001

BUFFALO TERMINAL, BUFFALO, NEW YORK

Prepared For:

EXXONMOBIL OIL CORPORATION

ROUX ROUX ASSOCIATES, INC. *Environmental Consulting & Management*	Compiled by: N.C.	Date: 03JUL01	PLATE
	Prepared by: R.K.	Scale: AS SHOWN	2
	Project Mgr: N.C.	Office: NY	
	File No: MC5216207	Project: 17252Y03	

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