FINAL REPORT

SITE ASSESSMENT
at
AAFES STATION-BUILDING 200

(NYSDEC Spill # 9802727)

for

Environmental Division
Directorate of Pubic Works
U.S. Army Garrison Fort Hamilton
Brooklyn, NY 11252-6800

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EXECUTIVE SUMMARY

The purpose of this draft report, *Site Assessment at AAFES Station Building 200*, is to document the activities performed, discuss the results, and make recommendations for further action at Building 200, Fort Hamilton, Brooklyn, NY ("the site"). The overall objective of the Site Assessment is to define the vertical and horizontal extent of the petroleum contamination and provide recommendations for remedial action consisting of site closure in the most cost-effective and timely manner.

The site is located at 200 General Lee Avenue in Fort Hamilton, Brooklyn, New York and is currently utilized as a convenience store and gasoline station. The elevation of the site ranges from approximately 32 to 40 ft above MSL. The general slope of the ground surface is to the north-northeast. Based on an environmental records search there are three reported gasoline spill sites in the vicinity of the site. Based on distance from the site and hydraulic gradient, these sites do not appear to have impacted the Building 200 site. Historic USGS topographic maps for the years 1900, 1955, 1966, 1984 and 1998 were reviewed. The maps indicate that the site topography essentially remained unchanged. Historical aerial photographs from 1944, 1954, 1966, 1975, 1984 and 1994 were reviewed. No unusual features, such as pits, dumping areas or stressed vegetation are apparent on the aerial photographs around Building 200.

Available historical information and previous investigations established the contaminant source and nature. Data from this assessment was used in conjunction with data from the two previous investigations to gain a more complete understanding of the extent of contamination

Field activities were performed on October 21, December 12 to 23, 2002 and January 13 to 21, 2003. Nine direct-push and two monitoring wells were sampled and installed at the site. In the parking lot the site is underlain by road base, concrete and fill to approximately 5 ft bgs. Below this is a silty sand and clayey sand to 32 ft bgs. Gravel to boulder size slate and concrete fill is common. Inter-bedded in this silty sand and clayey sand lithofacies from 18 to 20 ft bgs is a cobble and boulder fill layer. Based on multiple water level measurements the groundwater flow direction is towards the north-northeast. The fine-grained silty sand and clayey sand facies that comprises the water table aquifer results a low groundwater yield.

Currently, free product is observed only in MW-01 and MW-05. Highest product thickness has always been observed in MW-05 and currently observed at 6.23 ft. Intermittent appearance/disappearance of product in MW-02, MW-03, and MW-04 can be attributed to the water table fluctuations.

Soil samples were analyzed for STARS 8021 VOCs. Several soil samples from direct-push borings (GB-1, GB-4 and GB-6) and previously installed soil borings/monitoring wells TRC-2, MW-01, MW-03, and MW-05 contained individual constituents exceeding the NYSDEC recommended cleanup objectives as per Technical and Administrative Guidance Memo (TAGM) 4046 related memo dated December 12, 2000. Horizontal extent of soil contamination is approximately 100 ft by 75 ft with the major axis of the plume in north-south direction. Benzene contamination is limited to the vicinity of MW-05 in the tank pit. Shallow contamination (10 to 15 ft bgs) appears to exist in the vicinity of the tank pit. Vertical extent of contamination in the rest of the area is between 15 and 30 ft bgs with majority of the hydrocarbons located near the water table. The spread of contamination can be attributed to smearing as a result of water table fluctuations.

Groundwater samples were analyzed for STARS 8021 VOCs. Several constituents, particularly BTEX compounds, MTBE and naphthalene, exceeded comparison criteria in all of the samples except at MW-6. Comparison criteria include Federal drinking water standards and NYSDEC water standards from the Division of Water Technical and Operations Guidance (TOGS 1.1.1). The highest concentrations of benzene (1,100 μg/l), total BTEX (10,060 μg/l), and MTBE (11,000 μg/l) occurred in the vicinity of the tank pit at MW-03, MW-04 and MW-03, respectively. Groundwater BTEX and benzene plumes are approximately 130 ft x 75 ft in size and are generally confined to the site boundaries. The major axis of the plume is in the approximate direction of groundwater flow.

An estimated 2,020 gallons of free product and 210 lbs of BTEX compounds, in adsorbed phase, are present at the site. The groundwater contamination appears to be the result of groundwater contact with free product and/or residual saturation. GP screened numerous available conventional and innovative technologies based on effectiveness, implementability and cost.

Based on the evaluation, our first preference would be free product recovery using mobile high vacuum extraction followed by implementation of MNA. Total cost of this alternative is estimated to be $130,000 to $155,000 for the first year and around $10,000 yearly thereafter for MNA.

As a second choice, GP recommends free product recovery using mobile high vacuum extraction in combination with ORC application. It is assumed that mobile high vacuum extraction would be implemented for approximately 1 year. ORC application is expected to start after 6-9 months of high vacuum extraction. This combination effectively addresses the site contamination, requires low/no O&M and is the most cost-effective. Furthermore, ORC treatment is effective in addressing any residuals released from underneath the southeast corner of the building due to the time-release characteristic of ORC. Cleanup cost using these technologies is estimated to be $230,000 to $270,000. Cleanup costs for the first and second years are estimated to be approximately $185,000 to $220,000 and $45,000 to $50,000. Other sampling, monitoring and reporting costs for second and third year would be around $20,000 to $25,000 per year.

Pending field testing, it is assumed that mobile high vacuum extraction would not be required beyond the first year. None of the above costs include Phase 2 costs and post-closure monitoring costs. These costs are based on several assumptions and developed for information purpose only. They are subject to change following completion of Phase 2.

The following Phase 2 activities are recommended to collect the required data for designing the remedy: (1) evaluate free product recoverability using a mobile vacuum extraction system; (2) collect soil samples and analyze for essential nutrients, microorganism populations, and geotechnical parameters; (3) perform a pumping test; and (4) establish cleanup levels and prepare a corrective action plan. Costs for Phase 2 are estimated to be around $30,000 to 35,000.

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List of Acronyms

ASTM	American Society for Testing and Materials
bgs	below ground surface
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
DPW	Directorate of Public Works
ft	Feet
HSA	Hollow Stem Auger
LNAPL	Light Non-Aqueous Phase Liquid
LTANKS	Leaking Storage Tank Incident Report
µg	Micrograms
mg	Milligrams
ml	Milliliters
µl	Microliters
MNA	Monitored Natural Attenuation
MSL	Mean Sea Level
MTBE	Methyl Tertiary Butyl Ether
NAPL	Non-Aqueous Phase Liquid
NYSDEC	New York State Department of Environmental Conservation
ORC	Oxygen Release Compound
Parsons	Parsons Engineering Science
PID	Photoionization Detector
ppm	Parts Per Million
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
SAR	Site Assessment Report
STARS	Spill Technology and Remediation Series
STATSGO	State Soil Geographical Database
SVE	Soil Vapor Extraction
TRC	TRC Environmental Corporation
UST	Underground Storage Tank
VOC	Volatile Organic Compounds

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this draft report, *Site Assessment at AAFES Station Building 200*, is to document the activities performed, discuss the results, and make recommendations for further action at Building 200, Fort Hamilton, Brooklyn, NY ("the site"). This work is performed under prime contact GS-10F-0167L and delivery order DADW39-02-F0039-P0001.

1.2 OBJECTIVE AND SCOPE

The overall objective of the Site Assessment is to define the vertical and horizontal extent of the petroleum contamination and provide recommendations for remedial action consisting of site closure in the most cost-effective and timely manner. This report has been prepared following the NYSDEC memorandum #14, *Spill Prevention Operations Technology Series (SPOTS), Site Assessments at Bulk Storage Facilities* (NYSDEC, 1994). The following activities were conducted to achieve the objective.

1) Attend a kick-off meeting and site walkthrough to review the objectives of the project, finalize the project schedule and agree on lines of communication and reporting.
2) Collect and review all available historical and environmental data to obtain a basic understanding of site conditions and past investigations.
3) Based on the background information, plan and perform a subsurface direct-push survey that includes geological and chemical characterization.
4) Collect soil and groundwater samples using a direct push rig. Screen soil samples onsite for the presence of petroleum hydrocarbons. Send select samples to a New York State Department of Environmental Conservation (NYSDEC) approved laboratory for Spill Technology and Remediation Series (STARS) analyses using method 8021.
5) Install monitoring wells based on the results of the direct-push sample data.
6) Collect groundwater samples from newly installed monitoring wells and appropriate existing wells. Send samples to a NYSDEC approved laboratory for STARS analyses using methods EPA 8021.
7) Prepare a Site Assessment Report (SAR) to document results, discuss the findings and recommend further action.

1.3 REPORT ORGANIZATION

The report is divided into six sections:

Section 1.0 Introduction
Section 2.0 Site Description and History
Section 3.0 Field Activities
Section 4.0 Results and Discussion
Section 5.0 Analysis of Further Action and Recommendations
Section 6.0 Conclusions
Section 7.0 References

All figures, tables, and appendices are incorporated in stand-alone sections following section 7.0.

2.0 SITE DESCRIPTION AND HISTORY

2.1 SITE LOCATION AND USE

The site is located at 200 General Lee Avenue in Fort Hamilton, Brooklyn, New York. The site is located near the intersection of Schum Avenue and General Lee Avenue (Figure 1). The majority of surrounding land use is residential, administrative and retail buildings. The site contains a single story building that is currently utilized as a convenience store and gasoline station. Building 200 was constructed in the 1960's that originally was utilized as a service station and contained two service bays. In the 1999-2000 time frame, the service station was converted into a convenience store. At that time, the retaining wall located on the southeast portion of the site was also upgraded (Connors, 2003 and Burgos, 2003).

2.2 SITE FEATURES

The elevation of the site ranges from approximately 32 to 40 ft above mean sea level (MSL). The general slope of the ground surface is to the north-northeast. A hill is located to the southeast of the UST field and is supported by a 5 to 7 foot high retaining wall. Building 202 was located on top of this hill but recently removed (Burgos, 2003). Underground utilities include electric, natural gas, telecommunication, fuel, water supply, storm and sanitary sewers. Fort Hamilton is bounded by two bodies of water, the Narrows to the East and Gravesend Bay to the south-southeast. Both of these estuarine water bodies are approximately 1500 to 1700 ft from site.

2.3 SITE HISTORY

2.3.1 Underground Storage Tank History and Removal

Three gasoline underground storage tanks (UST) and one waste oil UST existed at the site. The gasoline USTs, two 3000-gallon and one 4000-gallon were replaced in 1991. Soil staining from petroleum leaks was noted during excavation. All of the contaminated soil could not be removed and a decision was made to place new tanks in the existing excavation. Air monitoring indicated elevated petroleum hydrocarbons in the soils approximately 15 feet below the ground surface (bgs). The readings ranged from 70 to 380 parts per million (ppm) (TRC, 1997). Three new double-walled fiberglass tanks were installed. Based on the discovery of contaminated soil, two separate site investigations were completed (see section 2.3.2).

According to an interview with Mr. Luis Burgos, assistant store manager, the waste oil tank was removed when the building was converted into a convenience store (circa 1999-2000). Documentation for waste oil tank removal could not be located.

2.3.2 Previous Investigations

<u>TRC Environmental Corporation Investigation</u>

TRC Environmental Corporation (TRC) conducted a site investigation in June 1997. This invesitagtion included drilling and sampling of three soil borings (Figure 2, TRC 1, TRC-2 and TRC 3) using hollow stem auger (HSA) methods. Samples were screened onsite and select samples were sent to a laboratory. The results indicated elevated benzene, toluene, ethylbenzene and xylenes (BTEX) concentrations at approximately 19 to 31 ft bgs. Particularly boring TRC 2 (Figure 2) contained significant BTEX concentrations of 11.6 x 10^6 μg/Kg (or 11,160 ppm)

(Appendix A). No groundwater samples were collected during this investigation. TRC recommended that additional drilling and sampling be completed to include groundwater sampling down gradient of TRC-2 to determine contaminate migration.

Parsons Engineering Science Investigation

Parsons Engineering Science (Parsons) conducted a site investigation from March to May 2000. The Parsons investigation included installation and sampling of five monitoring wells (Figure 2, MW-01 to MW-05) using HSA methods. Ten soil samples were collected and analyzed for STARS volatile organic compounds (VOCs) and STARS base neutral compounds. None of the base neutral compounds were detected above method detection limits. Benzene soil sample results ranged from below method detection (BMD) limits to maximum of 12,237 μg/Kg at MW-05. BTEX concentrations ranged from 7.4 to a maximum of 69,669 μg/Kg at MW-05. Methyl tertiary butyl ether (MTBE) concentrations ranged from BMD limits to a maximum of 4,554 μg/Kg at MW-05. It should be noted that MW-05 is located adjacent to TRC-2 that exhibited the highest concentrations during the TRC investigation. A table of these results in provided in Appendix A.

The five monitoring wells were gauged for the presence of free product. Three of the five wells contained free product. The wells were monitored and bailed periodically from April 2000 to July 2000, May 2001 and July 2002. The July 2002 free product data indicated that monitoring wells contained free product ranging for 1.91 to 2.4 feet. Free product has increased in certain wells while decreasing in others. Further discussion of free product occurrences is presented in Section 4.0. Parsons recommended that additional subsurface characterization be conducted to define the extent of the contamination.

2.4 ENVIRONMENTAL RECORDS REVIEW

The following environmental databases were searched per the ASTM Standard 1527 using the required minimum search distance criteria:

Federal Databases:

- National Priority List (NPL) Sites, Proposed NPL Sites;
- The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) and CERCLIS No Further Remedial Action Planned (NFRAP) Sites
- Superfund Consent Decrees;
- Records of Decision;
- NPL deletions;
- Federal Superfund Liens;
- Comprehensive RCRA Corrective Actions (CORRACTS);
- The Resource Conservation and Recovery Information System (RCRIS) – Hazardous Waste Treatment, Storage, and Disposal (TSD) Sites;
- RCRA Large Quantity Generators (LQG) and Small Quantity Generators (SQG);
- Emergency Response Notification System of spills (ERNS);
- The Facility Index System (FINDS);
- The Toxic Substances Control Act (TSCA) Sites;

- Pesticide Enforcement Actions and Other Compliance Related to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), TSCA and Emergency Planning and Community Right-to-know (EPCRA) sites (FTTS);
- The Facility Index System (FINDS);
- Hazardous Materials Information Reporting System (HMIRS);
- Material Licensing Tracking System (MLTS);
- Mines Master Index File;
- PCB Activity Database System;
- RCRA Administrative Action Tracking System;
- Toxic Chemical Release Inventory System;
- Toxic Substance Control Act and
- Section 7 Tracking System.

State or Local Databases:

- Leaking Storage Tank Incident Reports;
- Inactive Hazardous Waste Disposal Sites in New York State;
- Facility Register;
- Petroleum Bulk Storage (PBS);
- Chemical Bulk Storage;
- Major Oil Facilities;
- Voluntary Cleanup Agreements;
- Registered Waste Tire Storage and Facility List;
- Registered Recycling Facility List;
- Hazardous Substance Waste Disposal Site Inventory;
- Petroleum Bulk Storage (AST);
- Chemical Bulk Storage (AST);
- Major Oil Facilities (AST);
- Spills Information Database;
- Former Manufactured Gas (Coal Gas) Sites;
- Leaking Underground Storage Tanks (LUST);
- Historical Leaking Underground Storage Tanks (HIST LUST);
- Aboveground Storage Tank (AST) Database;
- Historical UST Database and
- Federal USGS and State Well Databases.

The ASTM search included reviewing thirty-eight different environmental federal, state and local databases. The environmental database report is provided in Appendix B. The site does not appear in any federal, state or local databases perhaps because the site was recently (June 1998) assigned a spill number by NYSDEC. Only one database, Leaking Storage Tank Incident Reports, indicated environmental sites within one mile of the site. Twenty-two Leaking Storage Tank Incident Reports (LTANKS) were reported within 0.5 mile of the site. Thirteen of the 22 LTANK sites are located in Fort Hamilton. The majority of the incident reports were caused by a tank failure, tank test failure or overfill. Only three of the 22 sites reported involved gasoline spills. All of these gasoline spills involved tank test failures and are located at: Fort Hamilton 4th Ave and 100th Street, MTA-Verrazano Bridge, and 579 92 St-Sunoco station. Based on distance from Building 200 and hydraulic gradient, these sites do not appear to have impacted the Building 200 site. The remaining LTANK sites involved fuel oil, waste oil or unknown product. The mapped locations of all LTANKs sites are provided in the environmental database report

(Appendix B). Due to poor or inadequate address information in the database several sites were not mapped. These sites are listed in Appendix B.

The federal USGS and state well databases were searched to locate wells within one mile of the site. One public water supply well located at Longpoint State Park, Bemus Point, NY was reported. This well is located hydraulically cross-gradient from the site. No other wells were reported.

2.5 TOPOGRAPHIC MAP REVIEW

Historic USGS topographic maps for the years 1900, 1955, 1966, 1984 and 1998 were reviewed. Copies of these maps are included in Appendix C. The maps indicate that the site topography essentially remained unchanged. Building 200 does not appear on any of the topographic maps, however several nearby buildings and roads are apparent on the maps as early as 1955.

2.6 AERIAL PHOTOGRAPH REVIEW

Historical aerial photographs from 1944, 1954, 1966, 1975, 1984 and 1994 were reviewed. Copies of these aerial photographs are provided in Appendix C. Generally the shoreline along the Narrrows and Gravesend Bay has remained unchanged. Construction of the Verrazano Bridge can be seen between the 1954 and 1966 aerial photographs. The 1944 and 1954 photographs show open grassy areas surrounded by roads and sidewalks. The 1966 photograph shows a building on the site. In a telephone interview conducted by GP, Mr. Burgos, assistant store manager, stated that building 200 was constructed in the 1960's (Connors and Burgos, 2003). Therefore, the building on the 1966 photograph is most likely building 200. The 1975 and 1984 aerial photographs clearly show the building and surrounding structures. The 1994 photograph shows a disturbed area around the building in the parking lot. Perhaps this disturbance was related to building upgrade/conversion or other improvements. Other than this disturbance, no unusual features, such as pits, dumping areas or stressed vegetation are apparent on the aerial photographs around Building 200.

3.0 FIELD ACTIVITIES

The field activities performed as part of this site characterization included direct-push sampling, drilling, installation and development of two monitoring wells, surveying, monitoring well gauging and groundwater sampling. Field activities were performed on October 21, December 12 to 23, 2002 and January 13 to 21, 2003. A copy of the field logbook is included as Appendix D.

3.1 DIRECT-PUSH SURVEY

Eleven direct-push borings were attempted at the site. Only nine of the eleven borings were successfully completed due to fill and cobble material at various depths throughout the subsurface. Prior to drilling activities a Directorate of Public Works (DPW) excavation permit was obtained. GP coordinated the marking and location of all subsurface utilities by a licensed and insured locator. A copy of the utility map and approved excavation permit is provided in Appendix D.

All drilling was conducted by ADT, Inc. an experienced New York-licensed drilling firm. Drilling was performed under the direct supervision of a GP site geologist. Direct-push sampling was completed using a combination of drilling rigs. A Geoprobe™ 6610 track mounted direct-push rig was mobilized on October 21, 2002. This rig encountered refusal at four different locations. It was determined that the refusal encountered was due to a thick layer of concrete and fill material located from zero to four ft bgs. Fort Hamilton was notified of the issue and a modification was presented. This modification included mobilization of a conventional rig to drill through the concrete and fill. After Fort Hamilton approved this modification, a CME LC60 HSA rig and Geoprobe™ 6610 track mounted were mobilized to the site on December 18, 2002. The HSA rig used a 3.25-inch auger to open a borehole to 5 ft bgs. A temporary PVC casing was placed in the borehole to maintain stability. The Geoprobe™ rig then drilled and sampled through the pre-drilled borehole.

The direct-push rig uses a hydraulic impact/rotary hammer to push hollow 1.5-inch outer diameter carbon steel drill rods to a desired depth. The maximum depth of the direct-push borings was 30 feet below ground surface (bgs). Soil samples were collected in disposable core liners to analyze for the vertical extent of contamination. Refusal of the direct-push rig was encountered at GB-08 and GB-13 due to the presence of fill and cobble material. No soil samples were collected at GB-05 due to fill cave-in onto the drill rods. The pressure exuded on the drill rods from the fill cave-in prevented the core barrel from opening. Therefore only a groundwater sample was collected at GB-05. Direct-push locations GB-02 and GB-09 were planned and predrilled by the HSA rig, but were unused.

All soil samples were physically characterized by a GP site geologist. Samples were examined for the primary constituents of the unit, secondary constituents, color, sorting, plasticity, particle shape, moisture content, and sedimentary structure. The characterization was conducted in accordance with ASTM Standard D-2488-93, Standard Practice for the Description and Identification of Soils (Visual-Manual Procedure). Drill cuttings produced while drilling through the surficial concrete and fill (0 to 5 ft bgs) were placed back in the borehole. All other cuttings were placed in 55 gallon DOT 17H approved drums. Upon completion of drilling and sampling the direct-push boreholes were backfilled to using bentonite pellets.

Soil samples were analyzed for presence of petroleum contamination via visual, olfactory and PID methods. The soil sample from each direct-push borehole that exhibited the highest petroleum

contamination was selected for laboratory analysis. A total of eight samples, one duplicate and two trip blanks were sent to a NYSDEC approved laboratory for STARS 8021 VOC analysis.

Saturated soils were encountered from 18 to 24 ft bgs. However groundwater volume was not adequate to collect an immediate groundwater sample. Therefore, a temporary 1-inch polyvinyl chloride (PVC) well was driven manually after the completion of each borehole. These temporary wells were allowed to stabilize for 4 days before sampling on December 23, 2002. A total of eight groundwater samples, one duplicate and one trip blank were sent to a NYSDEC approved laboratory for STARS 8021 VOC analysis. The temporary well at GB-7 was clogged with sediment thus a groundwater sample could not be collected.

3.2 MONITORING WELL INSTALLATION

Two monitoring wells were installed using a CME 075 and Mobile 61 HSA rigs during January 13 to 16, 2003. A 6.25-inch HSA was used to advance a borehole to the desired depth. Starting at the designated depth samples were collected in five foot intervals using a 2-inch diameter split-spoon. Lithologic samples were physically characterized and screened in the same manner described in Section 3.1. Decontamination procedures consisted of a thorough high-pressure hot water and steam cleaning of all equipment which came in contact with the subsurface.

The wells were designed such that the screen was located 5 feet above static water level. After the desired depth was reached, a 15-foot long, 4-inch, schedule 40 PVC screen with a 0.010-inch slot size was screw threaded to successive lengths of 4-inch, schedule 40, PVC riser. No glues or solvents were used at any time during well installation. All PVC materials remained in the factory packaging until just prior to installation. The well materials were carefully placed to the desired depth through the augers. A #2 sand filter pack was then gravity fed through the annulus of the augers to the bottom of the hole and placed up to 2 ft above the screen by slowly pulling up the augers while continuously monitoring the sand level to avoid bridging and to maintain a positive head of sand in the augers. Bentonite pellets were gravity placed over the sand pack to install a 3-foot (dry measurement) thick seal and approximately ten gallons of water were added for pellet hydration. Seals were allowed to hydrate prior to grouting. The remaining annular space was grouted using cement:bentonite grout. All wells were completed with flush mount, steel manholes. The riser pipe was cut a few inches below the ground surface and a steel manhole was set in concrete over the riser.

Originally installation of three monitoring wells was planned. However, refusal of the HSA drill rig was repeatedly encountered along the hill southeast of the UST field allowing installation of two of the three monitoring wells. The refusal was due to the presence of large boulders (>10 ft) and/or bedrock located approximately 18 to 20 ft bgs. Several locations in the vicinity of the proposed third well were attempted without success. GP informed Fort Hamilton of this issue.

3.3 MONITORING WELL DEVELOPMENT

New wells were developed using over-pumping and surging techniques on January 15 and 16, 2003. Each well was initially surged with a surge block. Following surging a submersible pump was placed in the well and pumped at the maximum rate the well was capable of recharging. The well was surged and purged until clear water was observed and/or 3 casing volumes of water were

removed. Well development volumes ranged from 20 to 35 gallons. All water generated during development was placed in plastic 30-gallon drums provided by Fort Hamilton.

3.4 MONITORING WELL GAUGING

Depths to water were measured in all site monitoring wells on January 21, 2003. Depth measurements were obtained using an electronic interface/water level probe accurate to ± 0.01 ft. The probe was decontaminated between wells. The data was converted to water level elevations using surveyed elevations of the tops of well casing. New monitoring wells were surveyed with reference to existing well elevations provided in the Parsons report (Parsons, 2001). Groundwater isoelevation contours were prepared from the elevation data to determine the direction of groundwater flow. Results of monitoring well gauging are discussed in Section 4.0.

3.5 MONITORING WELL GROUNDWATER SAMPLING

Groundwater samples were collected from five of the seven site monitoring wells on January 21, 2003. Monitoring wells MW-01 and MW-05 contained free product and were not sampled. Monitoring wells were sampled using low flow purging techniques. These techniques include monitoring water quality parameters (e.g. dissolved oxygen, pH, temperature and oxidation-reduction potential) while purging to ensure that each sample represents the screened portion of the aquifer. Water quality parameters were monitored using a Horiba U-22 meter, equipped with a flow cell. Once water quality parameters were stabilized, the monitoring wells were sampled using teflon™ lined discharge tubing. The samples were analyzed for STARS 8021 VOCs. Quality assurance and quality control (QA/QC) samples included one trip blank and one duplicate sample. The pump and tubing were decontaminated by circulating with an Alconox®/water solution and thoroughly rinsing with deionized water. Samples were collected in appropriate containers, packed in ice and sent via courier to the laboratory. A completed chain of custody accompanied all samples.

3.6 WASTE DISPOSAL

All drill cuttings were placed in 55-gallon DOT 17H approved drums. Purge and development water was placed in plastic 30-gallon drums provided by Fort Hamilton. All drums were clearly labeled to identify contents, well number, point of contact and date. A total of 10 soil and 4 purge water drums were accumulated at the site during the investigation. Disposal characterization was taken from soil and groundwater samples. GP's licensed disposal contractor, Brookside Environmental, removed and disposed of the ten soil drums on January 21, 2003. Copies of the transportation manifest are provided in Appendix E. GP coordinated and cataloged drums containing purge water for handling and disposal by Fort Hamilton.

4.0 RESULTS AND DISCUSSION

The lithologic, hydrogeologic and chemical data collected during the field activities discussed in Section 3.0 were used to interpret subsurface features and determine extent and magnitude of contamination. A discussion of site soils, geology, hydrogeology and the extent and magnitude of contamination followed by a brief discussion on the fate and transport of contamination are presented in the following paragraphs.

4.1 SOILS

Soils information was obtained from the State Soil Geographical Database. The soil near the site is classified as urban land complex which consists of areas where more than 80% of the surface is covered by asphalt, concrete, building or other impervious surfaces.

4.2 GEOLOGY

4.2.1 Regional Geology

The regional geology of Brooklyn contains glacial tills and fluvial deposits (Cadwell, 1989 and Fisher et. al, 1970) The surficial deposits near the Fort Hamilton area consist of two differing deposits, till Moraine and fluvial sand and gravel (Cadwell, 1989). The till moraine is located the north-northwestern portion of Fort Hamilton and is variably sorted till with a thickness of 33 to 100 ft (10 to 30 meter). The fluvial sand and gravel is located on the south-southeastern portion of Fort Hamilton. The deposit consists of sand and gravel with occasional laterally continuous silt lens. A copy of the geologic information is provided in Appendix F.

4.2.2 Site Geology

Review of the drilling logs provides a fairly detailed understanding of the geology to approximately 32 ft bgs. Site geologic information below 32 ft bgs is not known. A cross section generated from the drilling logs is provided as Figure 3. The cross section transect is provided on Figure 2. All Drilling logs from this investigation and previous investigations are provided in Appendix G and Table 1.

Due to the elevation difference from the parking lot and hill, the upper lithofacies observed on the hill is absent in the site parking lot (Figure 3). The upper lithofacies underlying the site is characterized as a topsoil to approximately 3 ft bgs. In the parking lot the site is underlain by road base, concrete and fill to approximately 5 ft bgs. Below both of these lithofacies is a strong brown (7.5YR 4/6) and yellow brown (10YR 5/8) fine grained silty sand and clayey sand to 32 ft bgs. Gravel to boulder size slate and concrete fill is common throughout. Inter-bedded in this silty sand and clayey sand lithofacies from 18 to 20 ft bgs is a cobble and boulder fill layer.

4.3 HYDROGEOLOGY

Regional groundwater movement in the aquifers is generally to the southeast towards the Narrows and Gravesend Bay. Local perturbations, however, are very common especially in the water table aquifer. Based on multiple water level measurements the groundwater flow direction is towards the north-northeast (Figure 4).

The fine-grained silty sand and clayey sand lithofacies that comprises the water table aquifer results a low groundwater yield. This occurrence was seen during the installation of direct-push boreholes and monitoring wells. Although the static groundwater is approximately 18 to 22 ft bgs, saturated soils were rarely encountered during drilling activities. In fact direct-push temporary wells and monitoring well required several hours to several days for complete groundwater equilibrium. In addition, monitoring wells could only sustain a very low purge rate (100-150 ml/min) during development and sampling activities. The water table elevation has fluctuated approximately 3 to 4 ft since April 2000. These fluctuations are typical response to seasonal variations and/or drought conditions.

4.4 EXTENT AND MAGNITUDE OF CONTAMINATION

Available historical information and previous investigations established the contaminant source and nature. The focus of current assessment is on delineating the contaminant horizontal and vertical extent. Data from this assessment is used in conjunction with data from the two previous investigations (TRC and Parsons) to gain a more complete understanding of the extent of contamination. The following paragraphs discuss the extent of non-aqueous phase liquid (NAPL), adsorbed and dissolved contamination at the site.

4.4.1 Non-Aqueous Phase Liquid (NAPL)

Free product measurements obtained during this assessment are presented in Table 2 along with historical data. Free product has been consistently observed at MW-01 and MW-05, since free product monitoring began in April 2000. Currently, free product is observed only in MW-01 and MW-05. Highest product thickness has always been observed in MW-05. Free product thickness in MW-05 appears to be increasing with current observed thickness of 6.23 ft. Intermittent appearance/disappearance of product in MW-02, MW-03, and MW-04 can be attributed to water table fluctuations. Lower water table conditions (as in July 2002) generally increase apparent thickness of product in the monitoring wells.

NAPL volume present in the subsurface was estimated using the average product thickness and assuming that the NAPL has reached the water table. This is a reasonable assumption given that the spill is over 10 years old. The volume of NAPL in the subsurface is estimated to be approximately 2020 gallons. Supporting calculations are provided in Appendix I. Based on available data, it appears that the free product plume originated in the vicinity of the tank pit and probably migrated northward to MW-01.

4.4.2 Adsorbed Phase Contamination

Soil samples analyzed for STARS polynuclear aromatic hydrocarbons (PAHs, method 8270) during Parsons investigation indicated that the PAHs were not present in soil at levels above method detection limits. Therefore, soil and groundwater sample analysis during this assessment were limited to STARS 8021 VOCs.

Laboratory results for direct-push soil samples are summarized in Table 3. Complete analytical results are provided in Appendix H. Historical soil concentrations discussed here are provided in Appendix A. Constituent concentrations in soil are compared to Recommended Soil Cleanup Objectives for Gasoline Contaminated Soils published by the NYSDEC, Division of Environmental

Remediation (NYSDEC, 2000). Several of the constituents, primarily BTEX compounds, exceeded the recommended cleanup objectives in direct-push borings GB-1, GB-4 and GB-6 (Table 3). Previous soil samples collected from soil borings/monitoring wells TRC-2, MW-01, MW-03, and MW-05 contained individual constituents exceeding the recommended cleanup objectives. Several of these locations also exceeded the total VOC cleanup objective of 10,000 μg/Kg.

Benzene and total BTEX isoconcentration contours (Figures 5 and 6) were prepared using current and previous data. The highest concentrations of benzene (277,000 μg/Kg and 12,237 μg/Kg) and total BTEX (11,590,000 μg/Kg and 69,668 μg/Kg) were observed at TRC-2 and MW-05, respectively. The highest MTBE concentration of 4,555 μg/Kg was also observed at MW-05 (Appendix A). TRC-2 and MW-05 are located adjacent to each other (Figures 5 and 6). Concentrations observed at TRC-2 are several orders of magnitude higher than concentrations observed at MW-05 and would skew the contours if used in the interpolation. Therefore, highest concentrations observed at MW-05 were used for contouring. This will not have an effect on the shape or size of the plume.

Borings TRC-3, GB-7, GB-3, GB-12 and GB-10 approximately delineate the horizontal extent of contamination (Figures 5 and 6). Visual/olfactory observations and field monitoring at MW-07 indicate that the soil contamination is contained within the site boundaries. Horizontal extent of soil covers an area of approximately 100 ft by 75 ft with the major axis of the plume in north-south direction. Benzene contamination is limited to the vicinity of MW-05 in the tank pit.

Total BTEX concentration data is plotted on the hydrogeological cross section (Figure 3) to help visualize the vertical extent of contamination. Judging from these concentrations and field observations, shallow contamination (10 to 15 ft bgs) appears to exist in the vicinity of the tank pit. Vertical extent of contamination in the rest of the area is between 15 and 30 ft bgs with majority of the hydrocarbons located near the water table. The spread of contamination can be attributed to smearing as a result of water table fluctuations. Mass of BTEX present in the subsurface is estimated to be 210 lbs. Supporting calculations are provided in Appendix I.

4.4.3 Dissolved Phase Contamination

Groundwater samples were obtained from eight direct-push locations and five out of seven monitoring wells that did not contain free product. These samples were analyzed for STARS 8021 VOCs. No groundwater samples were collected during the TRC and Parsons investigations. Analytical results for direct-push and monitoring well samples are summarized in Tables 4 and 5, respectively. Analytical data is provided in Appendix H.

NYSDEC ambient water quality criteria for drinking water were used for comparison only. Several constituents, particularly BTEX compounds, MTBE and naphthalene, exceeded comparison criteria in all of the samples except MW-6 (Tables 4 and 5). Monitoring well samples together with direct-push samples were used to plot the isoconcentration contour maps for benzene, total BTEX and MTBE (Figures 7, 8, and 9). The highest concentrations of benzene (1,100 μg/l), total BTEX (10,060 μg/l), and MTBE (11,000 μg/l) occurred at MW-03, MW-04 and MW-03, respectively. It should be noted that highest groundwater concentrations are expected at MW-1 and MW-5; however, these wells could not be sampled due to presence of free product. Due to lack of data at these wells, contaminant plumes appear to be centered around MW-3 and/or MW-4 which

would otherwise be centered around MW-1 and MW-5. Presence of petroleum constituents in groundwater can be attributed to groundwater contact with free product and/or residual saturation.

MTBE is several hundred times more soluble than BTEX compounds. Due to its mobility, MTBE plumes are generally much larger than BTEX plumes. However, at Building 200 the MTBE plume appears to be smaller in extent than Benzene and total BTEX plumes probably due to conditions such as low permeability soils and/or small fraction of MTBE containing gasoline in the release. BTEX and benzene plumes are approximately 130 ft x 75 ft in size and are generally confined to the site boundaries. The major axis of the plume is in the approximate direction of groundwater flow.

4.5 FATE AND TRANSPORT

The petroleum compounds that are present at the site all have specific gravities of less than one and will therefore float on water. Such compounds are considered light non-aqueous phase liquids (LNAPLs). When an LNAPL enters a subsurface environment, it will migrate vertically through the vadose zone under the influence of gravity until it contacts the saturated zone (Domenico and Schwartz, 1990). In addition to gravity, the rate and path of migration are also effected by mass exchange processes such as aqueous and gaseous-phase molecular diffusion, partitioning between the aqueous, gas, and solid phases of the aquifer, and biodegradation. As the LNAPL migrates downward through the unsaturated zone, a portion of some of the compounds will adsorb to the subsurface matrix. A large portion of the LNAPL will be trapped in the pore spaces of the media by surface tension and will remain as residual saturation (Domenico and Schwartz, 1990). The amount of residual saturation will depend on the grain size and permeability of the porous medium. Once in contact with the saturated zone, a portion of some of the more soluble LNAPL compounds (e.g. benzene) will dissolve into the groundwater. The undissolved LNAPL will float on top of the water table and will tend to migrate in the direction of local groundwater flow (although, the LNAPL may advance in any direction if the flow velocity is sufficiently slow). In addition, the plume of contaminated groundwater will expand through the processes of advection and dispersion. The fate of the contaminant during its transport through groundwater primarily depends on physical/chemical processes such has adsorption, advection, dispersion, etc. and particularly biodegradation. When sufficient oxygen and nutrients are available for the indigenous aerobic bacteria, they will use petroleum hydrocarbons as a food source. More commonly natural attenuation of petroleum hydrocarbons is oxygen-limited and can be enhanced by supplying sufficient oxygen to the subsurface.

The known and documented source of the contamination is the former gasoline USTs. Based on the site conditions and field observations, the released product would have migrated vertically through the pea gravel fill in the tank pit down to the water table. A fill/gravel/cobble layer was generally observed just above the water table. This layer seems to dip toward north/northwest. This layer may have acted as a preferential pathway for free product migration to MW-1.

The field and laboratory data suggest that the plume has not migrated off-site. Since 1991, the date the older USTs were removed, the data suggest that in a maximum of 12 years, the plume has only migrated approximately 100 feet from the source in the direction of groundwater flow. This migration rate is representative of low permeable silty/clayey sands.

5.0 CONCLUSIONS

5.1 SITE DESCRIPTION AND HISTORY

1) The site is located at 200 General Lee Avenue in Fort Hamilton, Brooklyn, New York. The site contains a single story building that is currently utilized as a convenience store and gasoline station.
2) The elevation of the site ranges from approximately 32 to 40 ft above MSL. The general slope of the ground surface is to the north-northeast. A hill is located to the southeast of the UST field and is supported by a 5 to 7 foot high retaining wall.
3) Fort Hamilton is bounded by two bodies of water, the Narrows to the East and Gravesend Bay to the south-southeast. Both of these estuarine water bodies are approximately 1500 to 1700 ft from site.
4) An environmental search was conducted and included thirty-eight different environmental databases. Only one database, Leaking Storage Tank Incident Reports, indicated environmental sites near the Building 200 and includes 22 sites. Thirteen of the 22 sites are located in Fort Hamilton. Only three of the 22 sites reported involved gasoline spills and involved tank test failures. Based on distance from the site and hydraulic gradient, these sites do not appear to have impacted the Building 200 site.
5) Historic USGS topographic maps for the years 1900, 1955, 1966, 1984 and 1998 were reviewed. The maps indicate that the site topography essentially remained unchanged.
6) Historical aerial photographs from 1944, 1954, 1966, 1975, 1984 and 1994 were reviewed. No unusual features, such as pits, dumping areas or stressed vegetation are apparent on the aerial photographs around Building 200.

5.2 RESULTS AND FINDINGS

1) Field activities were performed on October 21, December 12 to 23, 2002 and January 13 to 21, 2003.
2) In the parking lot the site is underlain by road base, concrete and fill to approximately 5 ft bgs. Below this is a silty sand and clayey sand lithofacies to 32 ft bgs. Gravel to boulder size slate and concrete fill is common. Inter-bedded in this silty sand and clayey sand lithofacies from 18 to 20 ft bgs is a cobble and boulder fill layer.
3) Based on field observations, the fine-grained silty sand and clayey sand facies that comprises the water table aquifer results a low groundwater yield. Multiple water level measurements indicate the groundwater flow direction is towards the north-northeast.
4) Currently, free product is observed only in MW-01 and MW-05. Highest product thickness has always been observed in MW-05 and currently observed at 6.23 ft. Intermittent appearance/disappearance of product in MW-02, MW-03, and MW-04 can be attributed to the water table fluctuations.
5) Soil samples were analyzed for STARS 8021 VOCs. Several of the constituents exceeded the recommended cleanup objectives in borings GB-1, GB-4 and GB-6. Previous soil samples collected from soil borings/monitoring wells TRC-2, MW-01, MW-03, and MW-

05 contained individual constituents exceeding the recommended cleanup objectives. Several of these locations also exceeded the total VOC cleanup objective of 10,000 μg/Kg.

6) TRC-3, GB-7, MW-07, GB-3, GB-12 and GB-10 approximately delineate the horizontal extent of soil contamination. Horizontal extent of soil contamination is approximately 100 ft by 75 ft with the major axis of the plume in north-south direction. Benzene contamination is limited to the vicinity of MW-05 in the tank pit.

7) Shallow soil contamination (10 to 15 ft bgs) appears to exist in the vicinity of the tank pit. Vertical extent of contamination in the rest of the area is between 15 and 30 ft bgs with majority of the hydrocarbons located near the water table. The spread of contamination can be attributed to smearing as a result of water table fluctuations.

8) Groundwater samples were analyzed for STARS 8021 VOCs. Several constituents, particularly BTEX compounds, MTBE and naphthalene, exceeded comparison criteria in all of the samples except MW-6. The highest concentrations of benzene (1,100 μg/l), total BTEX (10,060 μg/l), and MTBE (11,000 μg/l) occurred at MW-03, MW-04 and MW-03, respectively.

9) Groundwater BTEX and benzene plumes are approximately 130 ft x 75 ft in size and are generally confined to the site boundaries. The major axis of the plume is in the approximate direction of groundwater flow.

10) The volume of NAPL in the subsurface is estimated to be approximately 2020 gallons. Mass of BTEX present in the subsurface is estimated to be 210 lbs.

11) A fill/gravel/cobble layer was generally observed just above the water table. This layer may have acted as a preferential pathway for free product migration to MW-1.

12) The data suggest that in a maximum of 12 years the plume has only migrated approximately 100 feet from the source in the direction of groundwater flow through low permeable silty/clayey sands. There are no water wells located within one mile of the facility. Therefore, the site contaminants are not likely to impact off-site water wells. It should be noted that EDR database erroneously reported a public water well within 1/8-1/4 mile of the site at Long Point State Park. Long Point State Park is located around Buffalo, NY.

6.0 ANALYSIS OF FURTHER ACTION

NYSDEC, Division of Environmental Remediation (Division) Technical and Administrative Guidance Memorandum (TAGM) #4046 provides guidance for in-situ management of contaminated material. The Division published Recommended Soil Cleanup Objectives for petroleum-contaminated soil in a related memorandum dated December 2000 (NYSDEC, 2000). As discussed in Section 4.0, several constituent concentrations exceeded the recommended cleanup objectives. Therefore, further action is required at the site.

An estimated 2,020 gallons of free product and 210 lbs of BTEX compounds, in adsorbed phase, are present at the site. The groundwater contamination appears to be the result of groundwater contact with free product and/or residual saturation. Therefore, free product recovery and treatment of adsorbed-phase contamination will minimize the groundwater contamination. It is not feasible to restore the site to pre-spill conditions due to site and technology limitations; however, the cleanup should focus on achieving reasonable cleanup levels acceptable to NYSDEC, with the ultimate goal of achieving the Division's recommended cleanup goals and water quality criteria. Upon completion of the cleanup, the Division will issue a "no further action" letter to Fort Hamilton. The following activities would be required to take the site to closure:

- Phase 1 - Site Assessment: This phase has been completed.
- Phase 2 - Development of a Cleanup Plan: This phase involves field testing of proposed technologies, collection of additional geologic, hydrogeologic, and chemical data, as required, to design the remedy, identification of permit requirements, development of cleanup levels and development of a cleanup/corrective action plan.
- Phase 3 - Cleanup Implementation: This phase involves installation and operation of the remedy, periodic monitoring and sampling to determine the achievement of established cleanup levels.

The site is an active gas station and the new tanks are in the ground. Therefore, the cleanup options for the site are rather limited. Excavation is the initial component in all ex-situ technologies. Excavation is neither practical nor cost-effective and has a high potential for worker exposure to contamination. This limits the available options to in- situ technologies. GP screened numerous available conventional and innovative technologies based on effectiveness, implementability and cost-effectiveness. Following is a summary of viable options for the site.

6.1 FREE PRODUCT RECOVERY

Due to the tight nature of the site soils, passive bailers or skimmer type product recovery systems would be less effective. Product recovery using high vacuum extraction techniques would be highly effective. This can be achieved using a fixed extraction system such as bioslurping or a commercial mobile high vacuum extraction system.

6.1.1 Bioslurping

This technology combines vacuum-enhanced LNAPL recovery with bioventing and soil vapor extraction (SVE) to simultaneously recover LNAPL and bioremediate the vadose zone. A bioslurper system withdraws free-phase LNAPL, relatively small amounts of groundwater, and

soil gas/vapor in the same process stream using the airlift created by a single aboveground vacuum pump. In addition, induced airflow in the subsurface promotes biodegradation of vadose zone hydrocarbons (bioventing). The vacuum pump is connected to several existing wells via underground piping. Due to the high vacuum, these systems tend to emulsify the product in groundwater. Therefore, collected liquid stream needs either off-site disposal or on-site treatment and disposal. Extracted vapors may require treatment before releasing to the atmosphere. The cleanup time depends on the recovery rates (to be determined through field testing) and may range from 12 to 18 months. The bioslurping system requires intensive operation and maintenance (O&M) and may require air and water discharge permits. This option has high capital and high O&M costs.

6.1.2 Mobile High Vacuum Extraction System

These services are offered by commercial vacuum trucks on a routine basis. The vacuum truck is brought on site periodically and product along with some groundwater and air is extracted from select wells containing free product. Discharge of extracted air from a mobile system may not require an air permit. Collected liquid is discharged at an off-site treatment and disposal facility. The advantages of this option over bioslurping are that it does not involve onsite operation and maintenance (O&M) and may not require any permits. Pending field testing it is assumed that high vacuum extraction events will take place at the rate of once every two weeks for the first 3 months, once a month for 6 months and once every other month thereafter. This option is more cost-effective and easily implementable compared to bioslurping.

6.2 TREATMENT OF ADSORBED/DISSOLVED CONTAMINATION

Adsorbed contamination is primarily located at or near the water table and in the smear zone. There are four viable options to address this. These include monitored natural attenuation (MNA), biosparging, ORC application and chemical oxidation. The three latter methods include subsurface pressurization to some extent and may cause dispersion of the free product. Therefore, they should be implemented only after significant amount of the free product is recovered.

6.2.1 Monitored Natural Attenuation

Petroleum hydrocarbons have been shown to undergo natural biodegradation and attenuate through other natural processes. U.S. Environmental Protection Agency policy allows consideration of MNA following source removal. Pending collection of supporting data, MNA may prove to be effective after free product removal because of the small quantity of adsorbed contamination and tight soil nature that prevents plume spreading. Implementation of MNA would involve extensive sampling, natural attenuation modeling with a risk analysis to demonstrate the natural attenuation process to the regulators, and a long term monitoring plan to ensure natural attenuation is occurring. The State of New York considers all of state's groundwater as drinking water resource and has stringent cleanup requirements. Under this strategy, it would take several years to obtain a "no further action" letter. MNA would be the most cost-effective of the four options discussed here.

6.2.2 Biosparging

Biosparging involves injecting atmospheric air (using a blower) into the saturated zone through an appropriate number of sparge wells to provide oxygen to native microorganisms, thereby stimulating aerobic biodegradation of petroleum contaminants. Lower flow rates can be applied to the sparge wells to implement biosparging, rather than in-situ air sparging as a remedy. The main objective of biosparging is to increase the oxygen concentration in the saturated zone to stimulate biodegradation of contaminants. Oxygen not utilized in the saturated zone migrates upward and promotes biodegradation of contaminants in the vadose zone. Biosparging flow rates can be designed to minimize volatilization, eliminating the need for SVE and aboveground vapor treatment. Due to the site conditions, one horizontal sparge well with approximately 100 ft of screen would be more cost-effective than installing a series of vertical sparge wells. Pending field testing, biosparging may take 12-18 months to remediate the site. This option requires intensive O&M and has high capital and high O&M costs.

6.2.3 ORC Application

ORC stands for oxygen release compound primarily containing a patented formulation of magnesium peroxide that slowly releases oxygen upon hydration. The released oxygen serves as an electron acceptor by the indigenous microorganisms in degrading petroleum hydrocarbons. ORC can be applied by suspending ORC-containing socks in existing monitoring wells and/or via direct injection into subsurface where there are no monitoring wells. Sometimes, a flow cell is created by downgradient groundwater extraction and upgradient re-injection of the extracted groundwater to improve oxygen distribution. This option may take 24-36 months for the site cleanup. ORC application has low/no O&M costs compared to other technologies. Overall cost of this technology is low to moderate compared to other technologies.

6.2.4 Chemical Oxidation

In-situ chemical oxidation achieves destruction of organic chemicals through the application or injection of strong oxidizing agents to the contaminated zone. The oxidizing compounds used in this process include hydrogen peroxide (H_2O_2), potassium permanganate ($KMnO_4$), Fenton's reagent (a combination of H_2O_2 and an iron catalyst), ozone, and dissolved oxygen. Various methods used for chemical delivery include: injection into a well, application using direct push systems, and mixing with an extract from the site followed by reinjection into a well. Chemical oxidation takes place at a much faster rate than biodegradation, and cleanup is often achieved in 2-3 months. An underground injection control (UIC) permit may be required for injection of the chemical oxidizers; which could impede the administrative feasibility of this technology. Field testing of this technology is required to determine the oxidant dosage and other field parameters. This technology does not require long-term O&M, but has a high upfront cost. Overall cost of this technology compared to other technologies is high.

6.3 RECOMMENDATION

Based on the above evaluation, our first preference would be free product recovery using mobile high vacuum extraction followed by implementation of MNA. Total cost of this alternative is estimated to be $130,000 to $155,000 for the first year and around $10,000 yearly thereafter for MNA.

As a second choice, GP recommends free product recovery using mobile high vacuum extraction in combination with ORC application. It is assumed that mobile high vacuum extraction would be implemented for approximately 1 year. ORC application is expected to start after 6-9 months of high vacuum extraction. This combination effectively addresses the site contamination, requires low/no O&M and is the most cost-effective. Furthermore, ORC treatment is effective in addressing any residuals released from underneath the southeast corner of the building due to the time-release characteristic of ORC. Cleanup costs using these technologies is estimated to be $230,000 to $270,000. Cleanup costs for the first and second years are estimated to be approximately $185,000 to $220,000 and $45,000 to $50,000. Other sampling, monitoring and reporting costs for second and third year would be around $20,000 to $25,000 per year.

Pending field testing, it is assumed that mobile high vacuum extraction would not be required beyond the first year. None of the above costs include Phase 2 costs and post-closure monitoring costs. These costs are based on several assumptions and developed for information purpose only. They are subject to change following completion of Phase 2.

The following Phase 2 activities are recommended to collect the required data for designing the remedy: (1) evaluate free product recoverability using a mobile vacuum extraction system; (2) collect soil samples and analyze for essential nutrients, microorganism populations, and geotechnical parameters; (3) perform a pumping test; and (4) establish cleanup levels and prepare a corrective action plan. Costs for Phase 2 are estimated to be around $30,000 to 35,000.

SECTION 7.0 - REFERENCES

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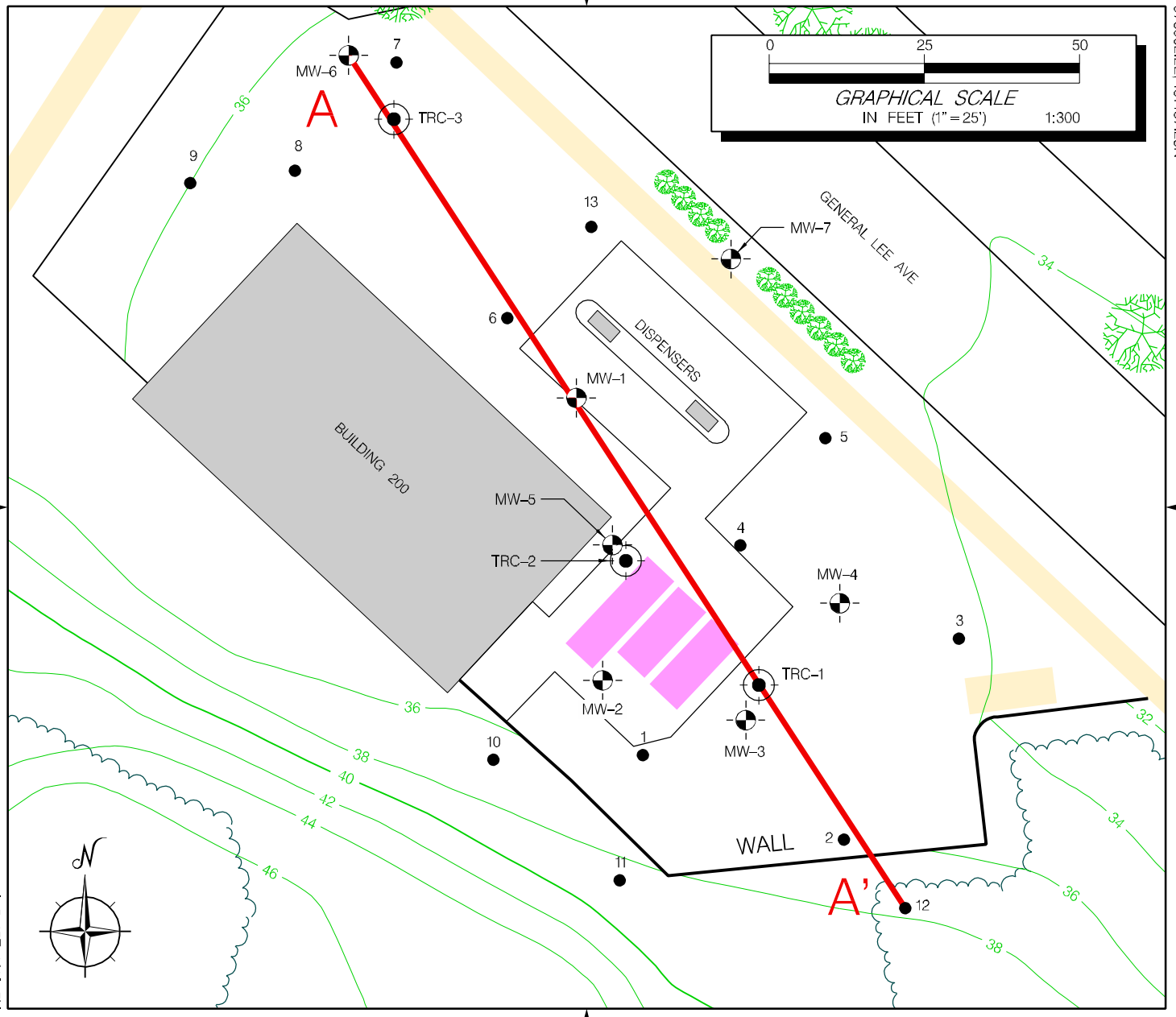
TITLE:

SITE LOCATION MAP

CARTOGRAPHER:	APPROVED BY:
B. JOYCE	R. DAMERA
DATE:	FIGURE:
02-06-03	1



L E G E N D

- Structure
- Paved Road
- Topography
- Treeline
- Tree / Shrub
- Concrete
- Monitoring Well
- Boring
- Direct Push Sample
- Geologic Traverse
- Refused / Unused Direct Push Sample
- Underground Storage Tank

NOTES:

Figure based on DGN master plan file provided by Fort Hamilton.

TRC-1, 2, 3 and MW-1, 2, 3, 4, and 5 from previous investigations.

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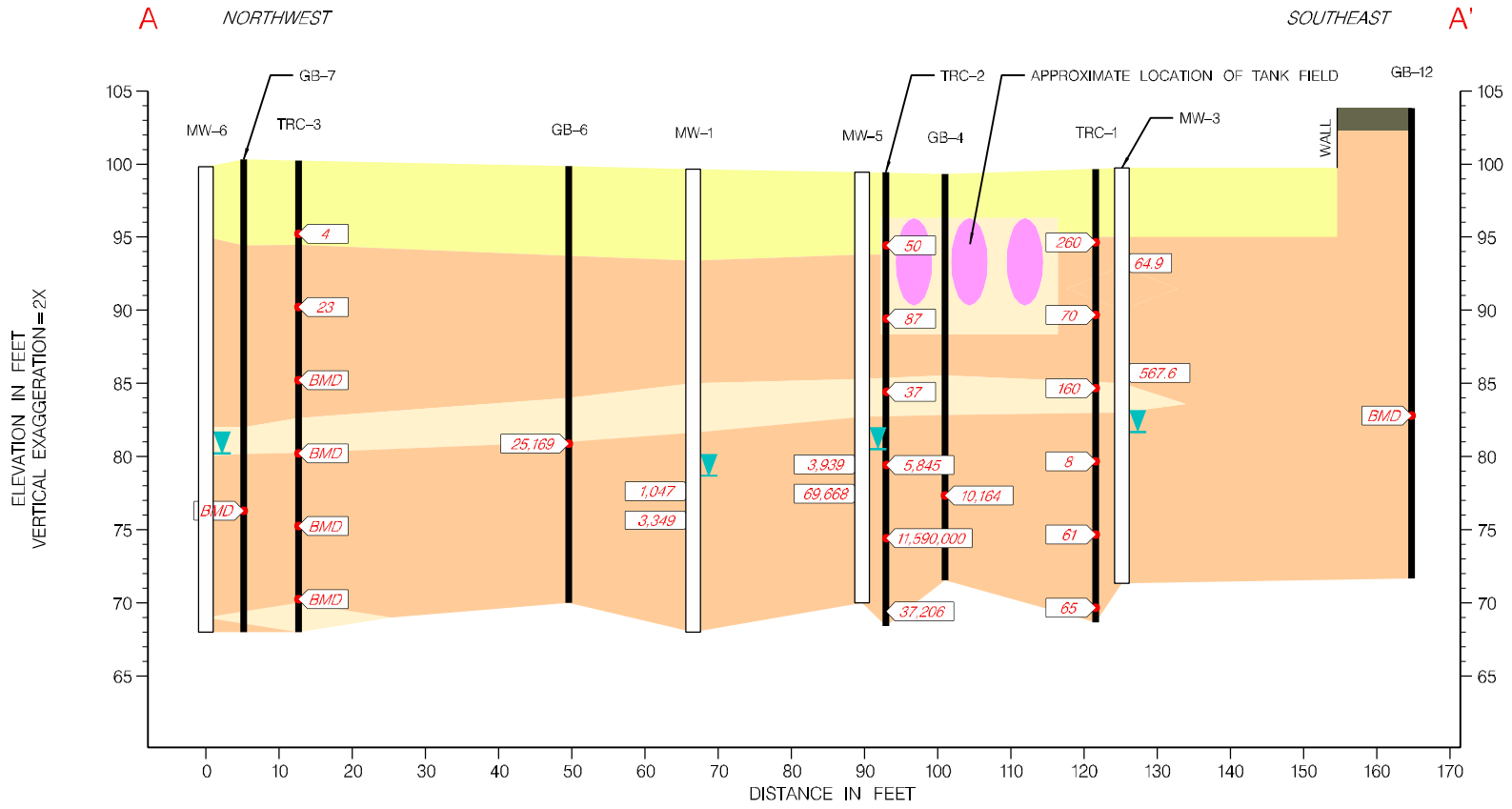
TITLE:

DETAILED SITE MAP

CARTOGRAPHER:	APPROVED BY:
B. JOYCE	T. ROSE
DATE:	FIGURE:
02-06-03	2

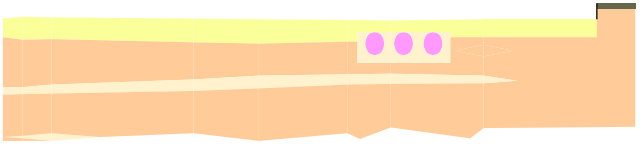
NOTE:
Elevations are relative to southern-most corner of Building 200.



K E Y

- Concrete and Fill
- Silty Sand and Clayey Sand
- Fill, Gravel, and Cobble
- Sand
- BMD — Below Method Detection
- Topsoil and Fill
- Pea Gravel
- Screened Interval
- Groundwater Elevation, January 2003 (ft)
- BTEX Soil Sample Location

UNEXAGGERATED PROFILE
SCALE: 1"=50'



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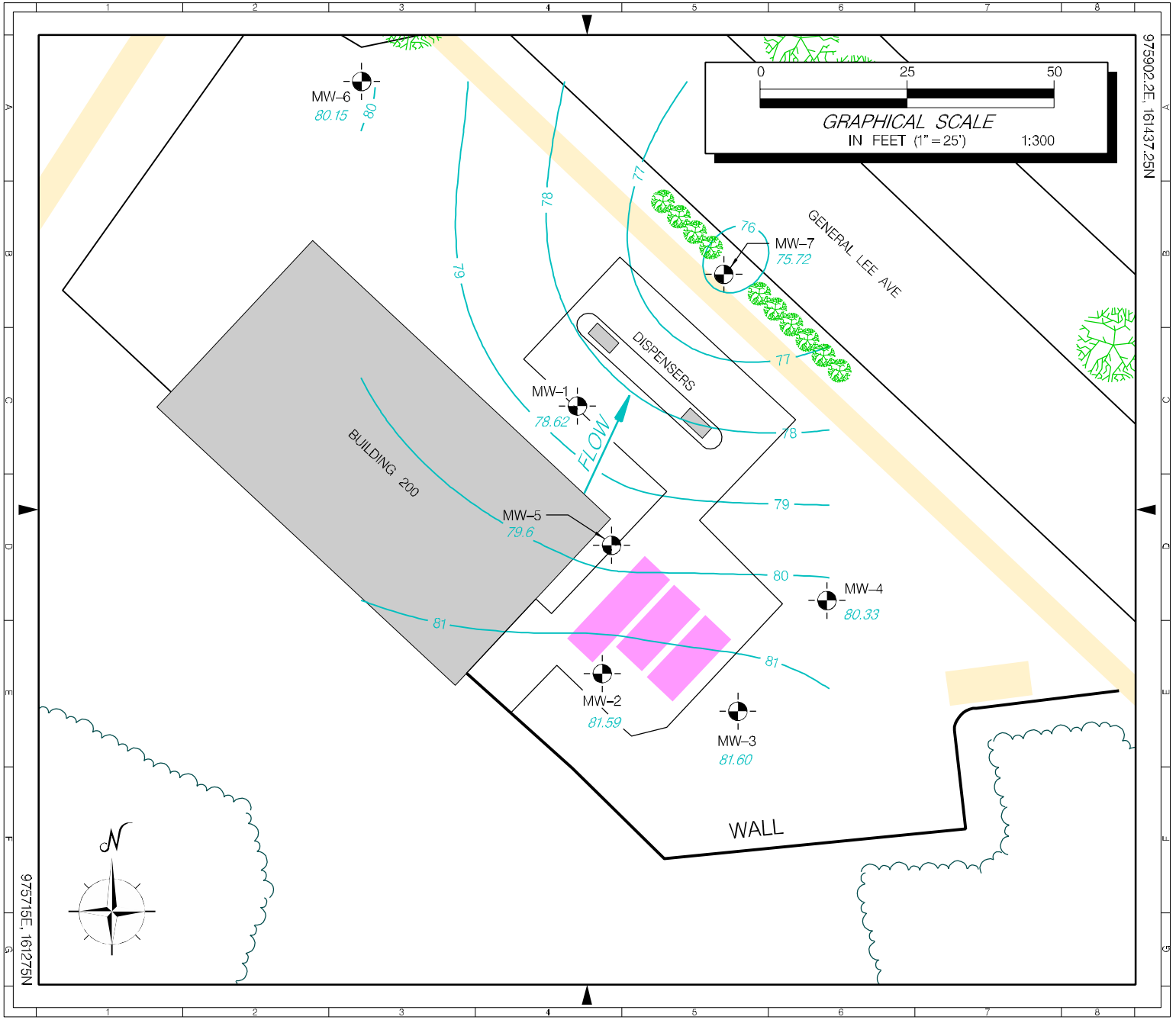
TITLE: CROSS SECTION A-A' WITH BTEX SOIL SAMPLE CONCENTRATIONS (μg / Kg)

DRAWN BY:	B. JOYCE	GEOLOGIST:	T. ROSE	DATE:	02-06-03	FIGURE:	3



L E G E N D

- Structure
- Paved Road
- Treeline
- Tree / Shrub
- Concrete
- Monitoring Well
- Underground Storage Tank
- Groundwater Isoelevation Contour (Ft)

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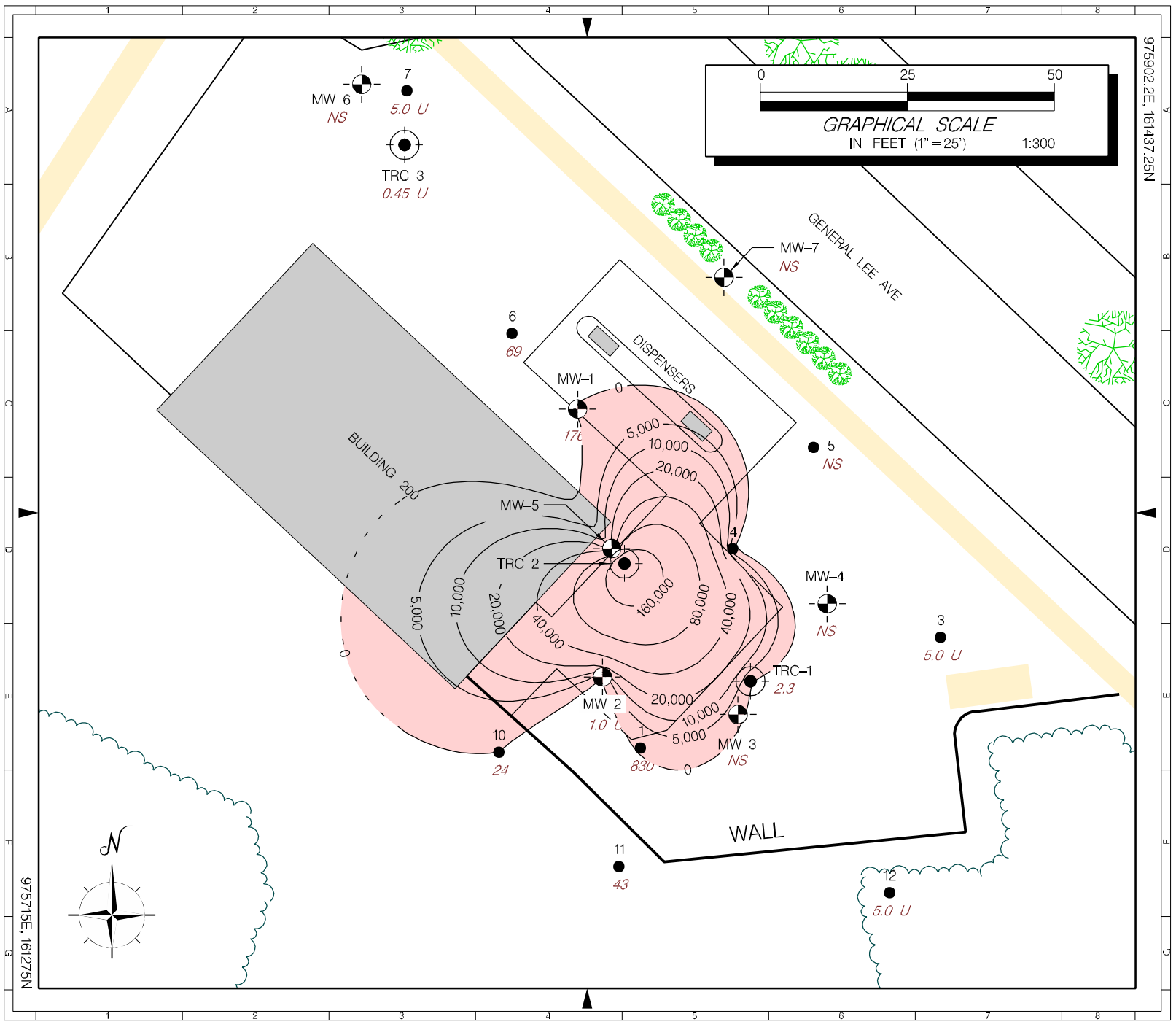
TITLE:

GROUNDWATER ISOELEVATION CONTOURS 01-21-03

CARTOGRAPHER:	APPROVED BY:
B. JOYCE	T. ROSE
DATE:	FIGURE:
02-13-03	4



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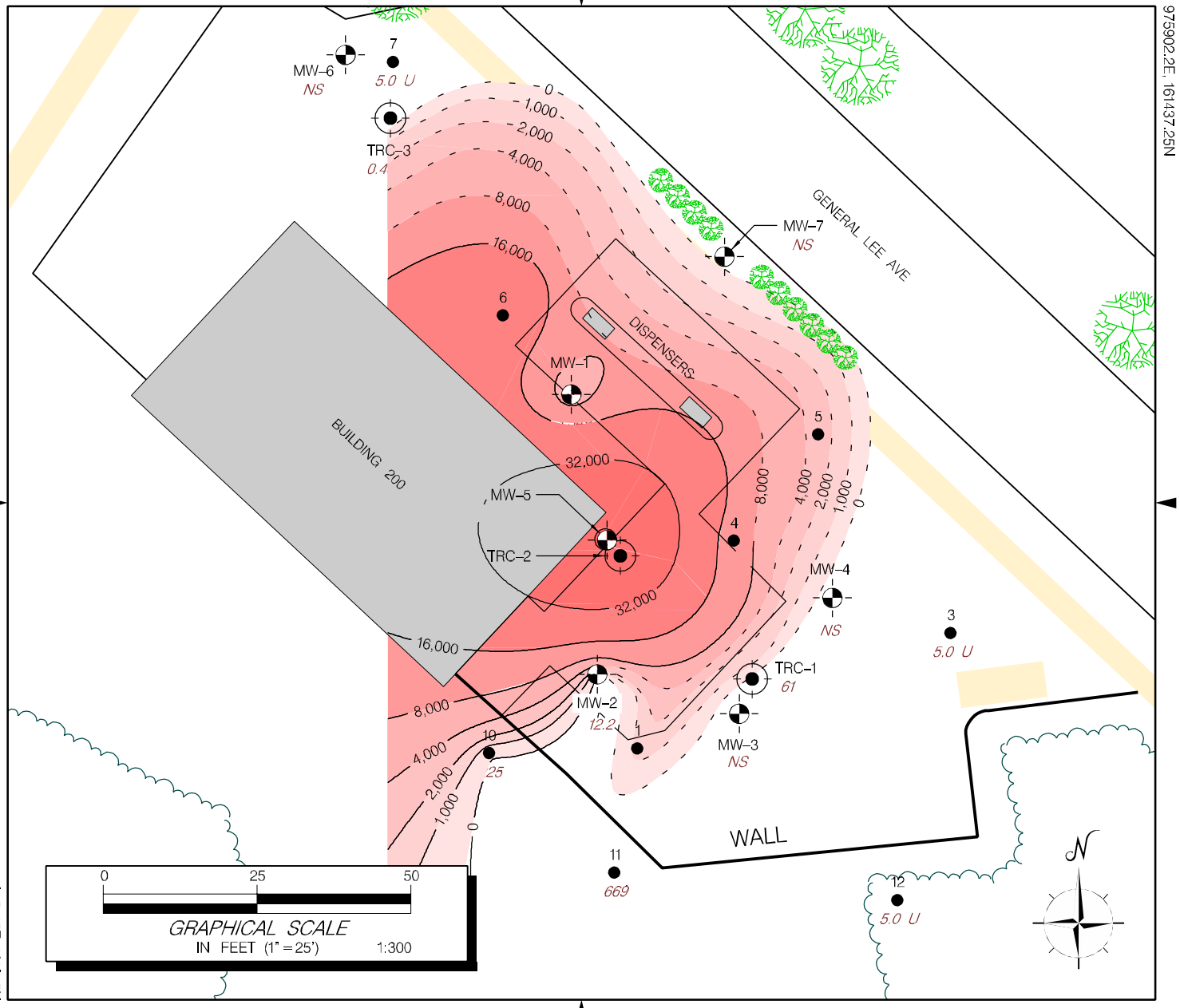
TITLE:

BENZENE SOIL

CARTOGRAPHER:	APPROVED BY:
B. JOYCE	T. ROSE
DATE:	FIGURE:
02-13-03	5



L E G E N D

- Structure
- Paved Road
- Treeline
- Tree / Shrub
- Concrete
- Monitoring Well
- Boring
- Direct Push Sample
- NS Not Sampled
- Underground Storage Tank

COLOR KEY

BTEX SOIL SAMPLE (µg / kg)

0
1,000
2,000
4,000
8,000
16,000
32,000
64,000

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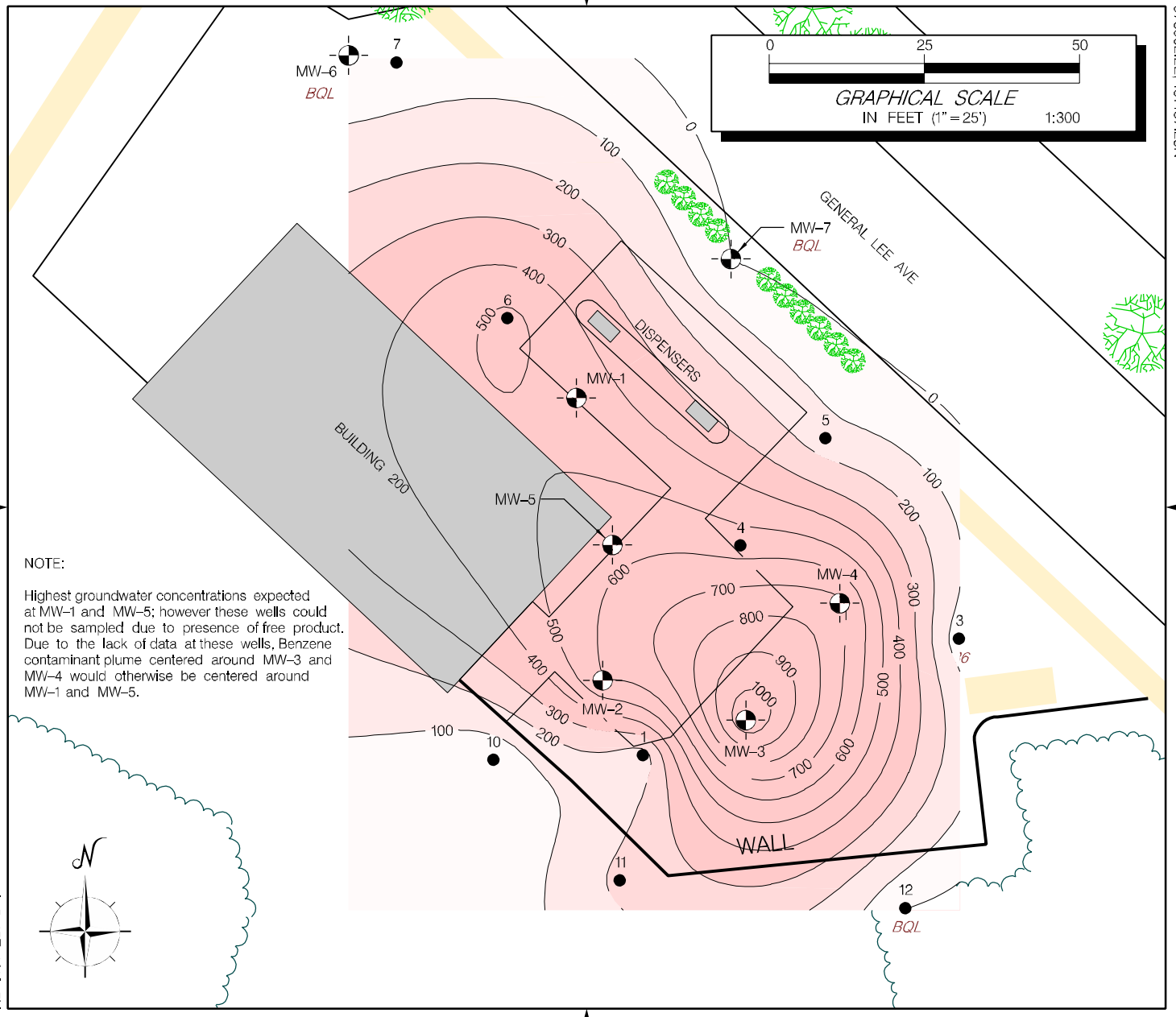
TITLE:

BTEX SOIL

CARTOGRAPHER:	APPROVED BY:
B. JOYCE	T. ROSE
DATE:	FIGURE:
02-13-03	6



L E G E N D

- Structure
- Paved Road
- Treeline
- Tree / Shrub
- Concrete
- Direct Push Sample
- Monitoring Well
- NS Not Sampled
- BQL Below Quantitation Limit of 1-5 μg / L.
- Underground Storage Tank

COLOR KEY

BENZENE GROUNDWATER SAMPLE (μg / L)

0, 100, 200, 300, 400, 500, 600, 700, 800, 900, 1,000

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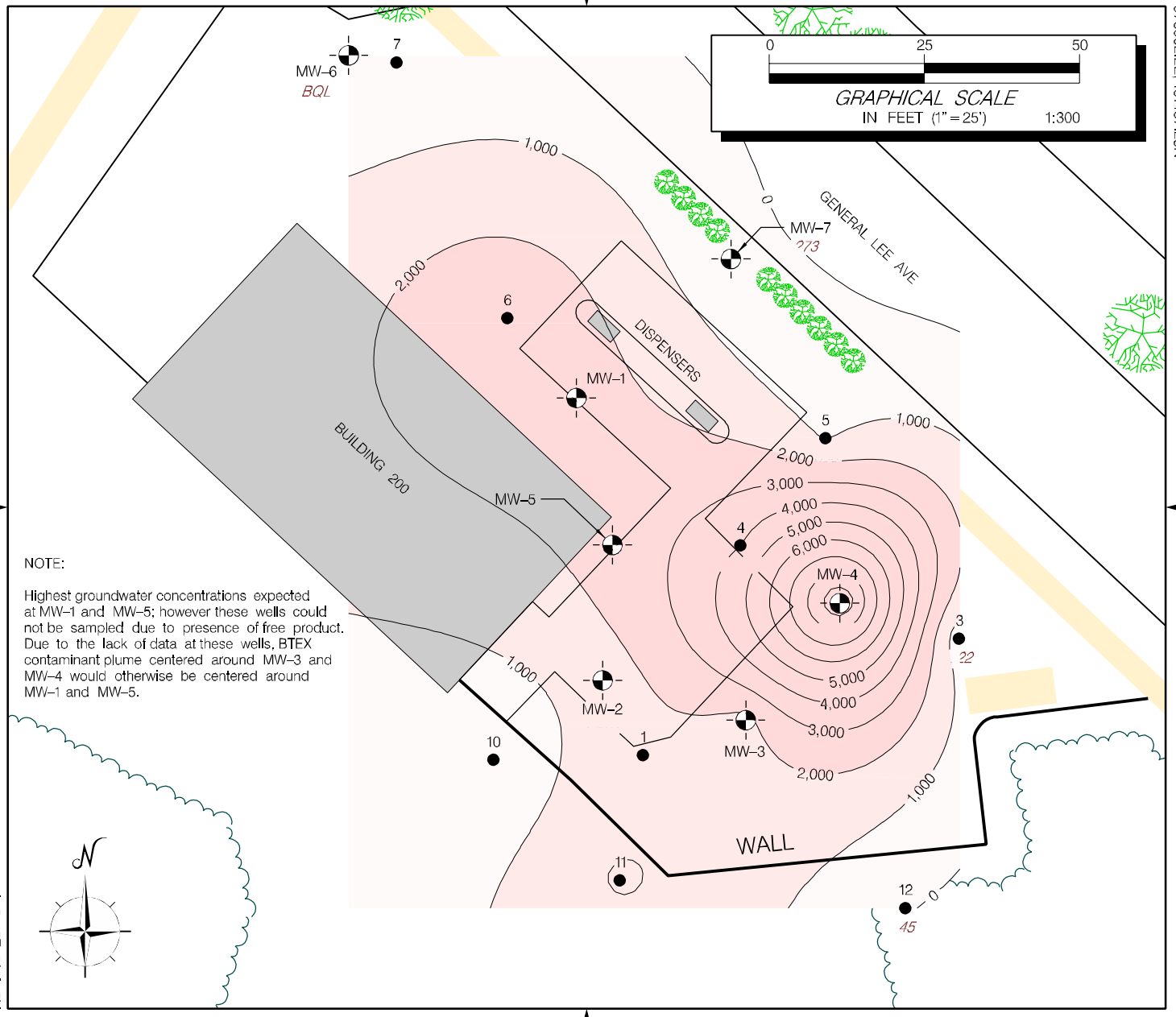
TITLE:

BENZENE WATER

CARTOGRAPHER:	APPROVED BY:
B. JOYCE	R. DAMERA
DATE: 06-13-03	FIGURE: 7



LEGEND

- Structure
- Paved Road
- Treeline
- Tree / Shrub
- Concrete
- Direct Push Sample
- Monitoring Well
- NS Not Sampled
- BQL Below Quantitation Limit of 1–5 μg / L.
- Underground Storage Tank

COLOR KEY

BTEX GROUNDWATER SAMPLE (μg / L)

0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000

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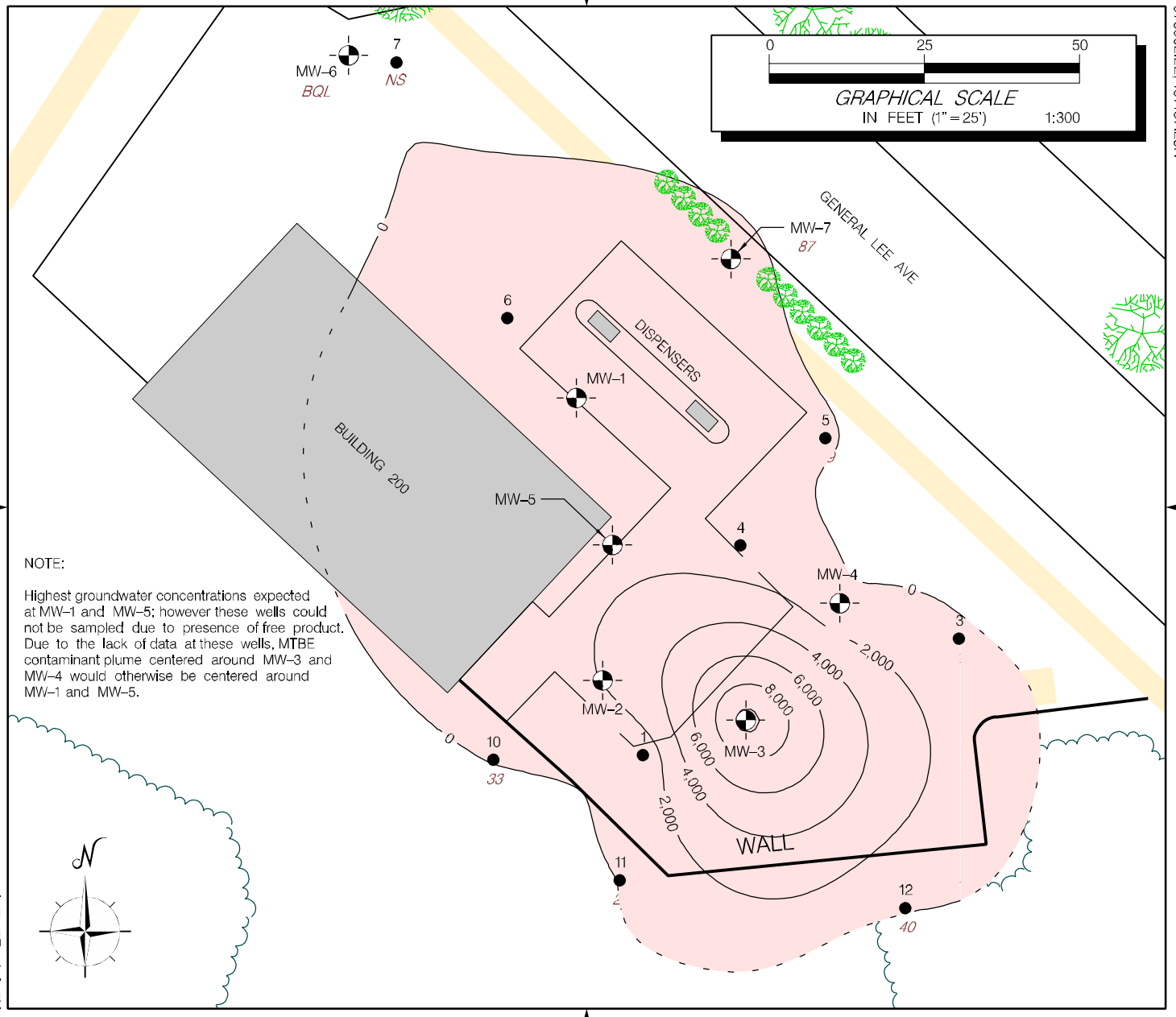
TITLE:

BTEX WATER

CARTOGRAPHER:	APPROVED BY:
B. JOYCE	R. DAMERA
DATE: 06–13–03	FIGURE: 8



L E G E N D

- Structure
- Paved Road
- Treeline
- Tree / Shrub
- Concrete
- Direct Push Sample
- Monitoring Well
- NS Not Sampled
- BQL Below Quantitation Limit of 1 μg / L.
- Underground Storage Tank

COLOR KEY

MTBE GROUNDWATER SAMPLE (μg / L)

0
2,000
4,000
6,000
8,000
10,000

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Leading the world to better performance

TITLE:

MTBE WATER

CARTOGRAPHER:	APPROVED BY:
B. JOYCE	R. DAMERA
DATE: 06-13-03	FIGURE: 9

Table 1
Building 200-Ft. Hamilton Site Assessment
Lithologic Descriptions

Location	Sample Interval (ft)	Description	Percent Sample Recovery
G-1	0-4	Not sampled; concrete and fill in cuttings.	NA
	4-14	Not sampled; fill and silty sand in cuttings.	NA
	14-18	**Silty Sand (SM)**, reddish brown (5YR 4/4), damp, homogenous, gravel fill present, **slight fuel odor**.	75
	18-22	Same **Silty Sand; strong fuel odor**.	NR
	22-26	Same **Silty Sand; sheen @ 24 to 24.5 ft; very strong fuel odor**.	NR
	26-29	Same **Silty Sand; wet with fuel**.	NR
G-3	0-22	Not sampled; fill and silty sand in cuttings.	NA
	22-26	**Silty Sand (SM),** strong brown (7.5YR 5/6), moist to saturated, homogenous, slate cuttings at 26 ft, no odor.	100
	26-30	Same **Silty Sand** as above.	100
G-4	0-5	Not sampled; concrete, fill and silty sand with clay in cuttings.	NA
	5-10	**Silty Sand (SM)** with clay, stained black (2.5Y 2.5/1) and grayish brown (2.5Y 5/2), damp to moist with fuel, **strong fuel odor**.	100
	10-15	**Silty Sand (SM),** strong brown (7.5YR 5/8), fine sand, damp, homogenous, gravel bearing, **fuel odor**.	100
	15-20	Same **Silty Sand, fuel odor**.	100
	20-24	**Silty Sand (SM)**, strong brown (7.5YR 5/8), homogenous, gravel common, damp to moist, **fuel odor**	NR
	24-28	**Silty Sand (SM)**, gravel, **strong fuel odor**	100
G-5	0-5	Not sampled; concrete and fill in cuttings.	NA
	5-22	Not sampled.	NA
	22	Encountered refusal, fill bent sample rods.	NA
G-6	0-5	Not sampled; concrete and fill in cuttings.	NA
	5-10	**Silty Sand (SM)**, strong brown (2.5YR 5/8), fine sand, damp, homogenous, gravel fill common.	100
	10-15	Same **Sand**, gravel fill common.	100
	15-20	Same **Silty Sand**, **strong fuel odor at 19 to 20 ft, sheen**.	100
	20-25	Same **Silty Sand**, **strong fuel odor**.	100
	25-29	Same **Silty Sand**, **strong fuel odor**. 5 foot sample broken, ran sample with 4 foot barrel.	100
G-7	0-5	Not sampled; concrete and fill in cuttings.	NA
	5-14	Not sampled.	NA
	14-18	**Silty Sand (SM)**, strong brown (7.5YR 5/6), gravel bearing, damp, homogenous.	75
	18-22	Same **Silty Sand,** no odor	100
	22-26	Same **Silty Sand,** no odor	100
	26-30	Sample fell out of core barrel	0
G-8	0-5	Not sampled; concrete and fill in cuttings.	NR
	5-7	Encountered refusal and 7 ft.	NR
G-10	0-5	Not sampled; concrete and fill in cuttings.	NA
	5-18	Not sampled.	NA
	18-22	**Silty sand (SM)**, reddish brown (5YR 4/4), damp, homogenous, gravel fill, no odor	100
	22-26	Same **Silty Sand**, **slight fuel odor at 23 ft**.	100
	26-30	Same **Silty Sand**, .	100
G-11	0-2	Topsoil and **Fill**.	75
	2-4	**Silty Sand** (7.5YR 4/3).	
	4-8	Same **Silty Sand**, wet-perched water, no odor.	100
	8-10	Same **Silty Sand**, wet-perched water, no odor.	100
	10-11	**Silty Clay (CL)**, black (2.5Y 2.5/1), homogenous, medium plastic, damp, soft.	
	11-12	**Silty Sand (SM)**, clay bearing, dark yellow brown (10YR 4/6), crumbly, damp to moist, homogenous.	
	12-16	Same **Silty Sand** as above, damp.	100
	18-22	Same **Silty Sand**	
	22-28	Not Sampled	NS
	28-32	Same **Silty Sand**, fuel odor at 28 to 28.5 ft	NR
G-12	0-3	Topsoil and Fill.	75
	3-4	**Clay Silt (ML)**, strong brown (7.5YR 4/6), micaceous, fine sand bearing, homogenous, damp, no odor	
	4-8	**Silty Sand (SM)**, yellow brown (10YR 5/8), sand is fine, subangular, damp to moist, homogenous, gravel size fill common, no odor	90
	8-12	Same **Silty Sand (SM)**, yellow brown (10YR 5/8) to very dark grayish brown (2.5Y 3/2), fill gravel and mica bearing, no odor	90
	12-16	**Silt** and **Sand** (SM), strong brown (7.5YR 5/6), damp, mottled, gravel and sand bearing, sand is yellow (2.5 7/6), gravel is fill material, no odor	100
	16-20	Same **Silty Sand (SM)**, damp, homogenous, silt stone gravel at 19.5 feet, no odor	100
	20-24	**Silty Sand** (SM), strong brown (7.5YR 4/6), clay bearing, homogenous, damp, fill gravel at 20.5 ft, organic odor at 21 ft.	100
	24-28	Same **Silty Sand** 27 ft, refusal at 28 ft.	75
G-13	0-5	Not sampled; concrete and fill in cuttings.	NR
	0-20	Encountered refusal and 20 ft.	NR

Table 2
Building 200-Ft. Hamilton Site Assessment
Historic and Currnet Free Product and Water

Well Number	Reference* Elevation (Ft-MSL)	April 11, 2000					May 5, 2000				
		Depth to Product (ft)	Depth to Water (ft)	Groundwater Elevation (ft)	Apparent Product Thickness** (ft)	Formation Product Thickness^ (ft)	Depth to Product (ft)	Depth to Water (ft)	Groundwater Elevation (ft)	Apparent Product Thickness (ft)	Formation Product Thickness (ft)
MW-1	98.93	22.55	22.57	76.37	0.02	0.01	21.57	21.78	77.30	0.21	0.06
MW-2	99.44	NP	22.39	77.05	NP	NA	NP	21.34	78.10	NP	NA
MW-3	99.00	NP	21.07	77.93	NP	NA	NP	19.94	79.06	NP	NA
MW-4	98.10	20.63	20.91	77.39	0.28	0.08	19.42	20.05	78.51	0.63	0.17
MW-5	98.74	20.78	23.34	77.27	2.56	0.69	19.22	23.87	78.26	4.65	1.26
MW-6	99.10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MW-7	99.47	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GB-1	99.53	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GB-3	98.19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GB-4	98.61	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GB-5	98.26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GB-6	99.15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GB-7	99.59	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GB-10	103.96	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GB-11	104.82	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
GB-12	103.08	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Well Number	Reference* Elevation (Ft-MSL)	July 9, 2002					December 23, 2002			January 21, 2003				
		Depth to Product (ft)	Depth to Water (ft)	Groundwater Elevation (ft)	Apparent Product Thickness (ft)	Formation Product Thickness (ft)	Depth to Product (ft)	Depth to Water (ft)	Groundwater Elevation (ft)	Depth to Product (ft)	Depth to Water (ft)	Groundwater Elevation (ft)	Apparent Product Thickness (ft)	Formation Product Thickness (ft)
MW-1	98.93	24.73	26.64	73.68	1.91	0.52	NA	NA	NA	20.3	20.35	78.6	0.05	0.01
MW-2	99.44	24.61	26.59	74.30	1.98	0.53	NA	NA	NA	NP	17.85	81.59	NP	NA
MW-3	99.00	25.19	25.22	73.80	0.03	0.01	NA	NA	NA	NP	17.4	81.6	NP	NA
MW-4	98.10	NP	24.24	NP	NP	NA	NA	NA	NA	NP	17.77	80.33	NP	NA
MW-5	98.74	22.30	24.70	75.79	2.40	0.65	NA	NA	NA	17.45	23.68	79.6	6.23	1.68
MW-6	99.10	NA	NA	NA	NP	NA	NA	NA	NA	NP	18.95	80.15	NP	NA
MW-7	99.47	NA	NA	NA	NP	NA	NA	NA	NA	NP	23.75	75.72	NP	NA
GB-1	99.53	NA	NA	NA	NA	NA	NP	19.2	80.33	NA	NA	NA	NA	NA
GB-3	98.19	NA	NA	NA	NA	NA	NP	17.6	80.59	NA	NA	NA	NA	NA
GB-4	98.61	NA	NA	NA	NA	NA	NP	18.1	80.51	NA	NA	NA	NA	NA
GB-5	98.26	NA	NA	NA	NA	NA	NP	18.72	79.54	NA	NA	NA	NA	NA
GB-6	99.15	NA	NA	NA	NA	NA	NP	NR	NR	NA	NA	NA	NA	NA
GB-7	99.59	NA	NA	NA	NA	NA	NP	NR	NR	NA	NA	NA	NA	NA
GB-10	103.96	NA	NA	NA	NA	NA	NP	22.97	80.99	NA	NA	NA	NA	NA
GB-11	104.82	NA	NA	NA	NA	NA	NP	23.95	80.87	NA	NA	NA	NA	NA
GB-12	103.08	NA	NA	NA	NA	NA	NP	22.6	80.48	NA	NA	NA	NA	NA

Note: Water level corrected for depression by free product where applicable
*corrected water level = groundwater elevation + (product thickness * product specific gravity), estimated @ 0.86*

NA - Not Applicable
NP - No Product
* - Elevations are taken from the Parsons 2001 report and are relative to the southeast corner of building 200.
** -Apparent Product thichness = Depth to Product-Depth to Grounwater
^ - Formation Product thickness = (Well Elevation-Depth to product)- Corrected water level

Table 3
Building 200-Ft. Hamilton Site Assessment
Direct-Push Soil Sample Results

Analyte (mg/kg)	Recommended Cleanup Objectives (µg/kg)*	Soil Analysis SW8021B STARS Method					
		GB-1	GB-3	GB-4	GB-14 (Dup. of G-4)	GB-6	GB-7
		29 ft	25 ft	22 ft	22 ft	19 ft	24 ft
1,2 4-Trimethylbenzene	10,000	5.0 U	5.0 U	6,100	1,400	**13,000**	5.0 U
1,3,5-Trimethylbenzene	3,300	5.0 U	5.0 U	**5,500**	960	**11,000**	5.0 U
4-Isopropyltoluene	NA	5.0 U	5.0 U	300 J	100	89	5.0 U
Benzene	60	**830**	5.0 U	**64**	9.9	**69**	5.0 U
Ethylbenzene	5,500	40	5.0 U	1,500	200 J	2,700	5.0 U
Isopropylbenzene	2,300	5.0 U	5.0 U	500 J	250	130	5.0 U
m-+p-Xylenes	1,200 (Total)	62	10 U	**6,500**	600 J	**14,000**	10.0 U
Methyl tert-Butyl Ether (MTBE)	120	5.0 U	5 J	5.0 U	**120**	5.0 U	5.0 U
Naphthalene	13,000	40	5.0 U	430	200	620 U	5.0 U
n-Butylbenzene	10,000	5.0 U	5.0 U	93	47	83	5.0 U
n-Propylbenzene	3,700	5.0 U	5.0 U	1,400	200 J	2,400	5.0 U
o-Xylene	1,200 (Total)	29	5.0 U	**1,800**	200 J	**5,200**	5.0 U
sec-Butylbenzene	10,000	5.0 U	5.0 U	5.0 U	120	130	5.0 U
tert-Butylbenzene	10,000	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
Toluene	1,500	96	5.0 U	300 J	220	**3,200**	5.0 U
Total BTEX	NA	1,057	5.0 U	10,164	1,230	25,169	5.0 U

Analyte (mg/kg)	Recommended Cleanup Objectives (µg/kg)*	Soil Analysis SW8021B STARS Method				
		GB-10	GB-11	GB-12	Trip Blank 1	Trip Blank 2
		23 ft	28 ft	21 ft		
1,2 4-Trimethylbenzene	10,000	5.0 U	5.0 U	5.6	1.0 U	1.0 U
1,3,5-Trimethylbenzene	3,300	5.0 U	5.0 U	3 J	1.0 U	1.0 U
4-Isopropyltoluene	NA	5.0 U	5.0 U	5.0 U	1.0 U	1.0 U
Benzene	60	24	43	5.0 U	1.0 U	1.0 U
Ethylbenzene	5,500	5.0 U	52	5.0 U	1.0 U	1.0 U
Isopropylbenzene	2,300	140	180	5.0 U	1.0 U	1.0 U
m-+p-Xylenes	1,200 (Total)	89	89	10.0 U	2.0 U	2.0 U
Methyl tert-Butyl Ether (MTBE)	120	5.0 U	5.0 U	5.0 U	1.0 U	1.0 U
Naphthalene	13,000	45	64	5.0 U	1.0 U	1.0 U
n-Butylbenzene	10,000	5.0 U	5.0 U	5.0 U	1.0 U	1.0 U
n-Propylbenzene	3,700	5.0 U	5.0 U	5.0 U	1.0 U	1.0 U
o-Xylene	1,200 (Total)	61	75	5.0 U	1.0 U	1.0 U
sec-Butylbenzene	10,000	5.0 U	5.0 U	5.0 U	1.0 U	1.0 U
tert-Butylbenzene	10,000	5.0 U	5.0 U	5.0 U	1.0 U	1.0 U
Toluene	1,500	51	410	5.0 U	1.0 U	1.0 U
Total BTEX	NA	225	669	5.0 U	1.0 U	1.0 U

Notes:
J - Analyte present but the reported value is estimated.
U - Compound(s) analyzed for but not detected
NA-Guidance Value not available
*-Recommended clean objectives are from table titled *Recommended Soil Cleanup Objectives for Gasoline Contaminated Soils* in memorandum *Determination of Soil Cleanup Levels* , NYSDEC, date December 20, 2000
Highlighted and Italics values exceed the Recommended Cleanup Objectives

Table 4
Building 200-Ft. Hamilton Site Assessment
Direct-Push Groundwater Sample Results

Analyte (µg/kg)	NYSDEC Ambient Water Quality Standard (µg/L)*	USEPA MCL (µg/L)^	Groundwater Analysis SW8021B STARS Method									
			GW-1	GW-14 (Dup of GW-1)	GW-3	GW-4	GW-5	GW-6	GW-10	GW-11	GW-12	Trip Blank 3
1,2 4-Trimethylbenzene	5	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
1,3,5-Trimethylbenzene	5	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
4-Isopropyltoluene	5	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Benzene	0.7	5	*140*	*140*	*36*	*550*	*140*	*530*	*20*	*230*	1.0 U	1.0 U
Ethylbenzene	5	700	*170*	*160*	*28*	*280*	*120*	*180*	*16*	*140*	*12*	1.0 U
Isopropylbenzene	5	NA	*87*	*81*	1.0 U	*130*	*35*	*67*	1.0 U	1.0 U	1.0 U	1.0 U
m-+p-Xylenes	5	10,000 (Total)	*490*	*450*	*64*	*630*	*190*	*470*	*31*	*470*	*11*	2.0 U
Methyl tert-Butyl Ether (MTBE)	10	20-40†	*210*	*450*	*220*	*620*	*89*	*69*	*33*	*28*	*40*	1.0 U
Naphthalene	10**	NA	*32*	*43*	*29*	*39*	*53*	*45*	*22*	1.0 U	1.0 U	1.0 U
n-Butylbenzene	5	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
n-Propylbenzene	5	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	*19*	1.0 U	1.0 U	1.0 U
o-Xylene	5	10,000 (Total)	*440*	*430*	*74*	*700*	*200*	*530*	*22*	*480*	2.3	1.0 U
sec-Butylbenzene	5	NA	*49*	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
tert-Butylbenzene	5	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Toluene	5	1000	*590*	*540*	*120*	*1,800*	*240*	*1,300*	*43*	*820*	*20*	1.0 U
Total BTEX	5	1000	*1,830*	*1,720*	*322*	*3,960*	*890*	*3,010*	*132*	*2,140*	*45*	1.0 U

Notes:

*- Standard for groundwater-drinking from NYSDEC-Division of Water Technical and Operational Guidance memorandum *titled Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations.*

^-United States Environmental Protection Agency (USEPA) Maximum Contaminant Level (MCL) drinking water standard

†-USEPA drinking water advisory

Highlighted and Italics values exceed the NYSDEC Standard.

Table 5
Building 200-Ft. Hamilton Site Assessment
Monitoring Well Groundwater Sample Results

Analyte (µg/kg)	NYSDEC Ambient Water Quality Standard (µg/L)*	USEPA MCL (µg/L)^	MW-2	MW-3	MW-4	MW-9 (Dup of MW-4)	MW-6	MW-7	Trip Blank
1,2 4-Trimethylbenzene	5	NA	*350*	*370*	*790*	*780*	1.0 U	*180*	1.0 U
1,3,5-Trimethylbenzene	5	NA	*490*	*420*	*1,000*	*1,000*	1.0 U	*190*	1.0 U
4-Isopropyltoluene	5	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Benzene	0.7	5	*600*	*1,100*	*700*	*730*	1.0 U	1.0 U	1.0 U
Ethylbenzene	5	700	*95*	*63*	*640*	*630*	1.0 U	*56*	1.0 U
Isopropylbenzene	5	NA	*41*	*80*	*220*	*280*	1.0 U	*62*	1.0 U
m-+p-Xylenes	5	10,000 (Total)	*380*	*230*	*2,600*	*2,600*	2.0 U	*87*	2.0 U
Methyl tert-Butyl Ether (MTBE)	10	20-40†	*2100*	*11,000*	*130*	*280*	1.0 U	*69*	1.0 U
Naphthalene	10**	NA	*240*	*110*	*130*	*130*	1.0 U	*17*	1.0 U
n-Butylbenzene	5	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
n-Propylbenzene	5	NA	*100*	*120*	*160*	*160*	1.0 U	1.0 U	1.0 U
o-Xylene	5	10,000 (Total)	*220*	*140*	*2,800*	*2,800*	1.0 U	*82*	1.0 U
sec-Butylbenzene	5	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
tert-Butylbenzene	5	NA	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Toluene	5	1000	*180*	*240*	*3,300*	*3,300*	1.0 U	*48*	1.0 U
Total BTEX	5	1000	*1,475*	*1,773*	*10,040*	*10,060*	1.0 U	273	1.0 U

Notes:

*- Standard for groundwater-drinking from NYSDEC-Division of Water Technical and Operational Guidance memorandum *titled Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations.*

^-United States Environmental Protection Agency (USEPA) Maximum Contaminant Level (MCL) drinking water standard

†-USEPA drinking water advisory

Highlighted and Italics values exceed the NYSDEC Standard.

Reference is MW-5; base on Parsons data
TOC=98.74 ft-msl

Location Set Up #1

Location	ROD Ground	ROD TOC	Difference	Elevation Ground	Elevation TOC	
Ref-MW-5	5.86	6.38	NA	99.26	98.74	
GB-1	5.59	NA	0.27	99.53	NA	
GB-3	6.93	NA	-1.07	98.19	NA	
GB-4	6.51	NA	-0.65	98.61	NA	
GB-5	6.86	NA	-1	98.26	NA	
GB-6	5.97	NA	-0.11	99.15	NA	
GB-7	5.53	NA	0.33	99.59	NA	
MW-6	5.4	6.02	0.36	99.62	99.1	0.52
MW-7	6.88	7.11	0.73	99.99	99.47	0.62

Location Setup #2

Location	ROD Ground	ROD TOC	Difference	Elevation Ground	Elevation TOC
Ref-MW-5	11.78	12.25	NA	99.26	NA
G-10	7.08	NA	4.7	103.96	NA
G-11	6.22	NA	5.56	104.82	NA
G-12	7.96	NA	3.82	103.08	NA