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Framingham 3-[illegible]
133-135 Leland Street

GZA
GeoEnvironmental, Inc.

Engineers and
Scientists

December 14, 2001
File No. 15861.08-C, PC

Mr. Jeffrey Chormann
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Re: Supplemental Assessment Plan and Stabilization Measure Reports
General Chemical Corporation
Leland Street Site, Framingham, Massachusetts

Dear Mr. Chormann:

GZA GeoEnvironmental, Inc. (GZA) is submitting three copies of the attached Supplemental Assessment Plan and Stabilization Measure Reports for the above-referenced Site. These reports were prepared by GZA on behalf of our client, General Chemical Corporation (GCC). Both reports have been prepared in accordance with Massachusetts Department of Environmental Protection (DEP) Decisions with Modifications dated October 26, 1999 and November 2, 2000. Please do not hesitate to contact the undersigned at (781) 278-3700 if you have any additional questions or concerns.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

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APPENDICES

1.00 INTRODUCTION

On behalf of General Chemical Corporation (GCC), GZA GeoEnvironmental, Inc. (GZA) has prepared this Supplemental Assessment Plan (SAP) Report for the 133-135 Leland Street facility (the Facility) and the associated site (the Site) located in Framingham, Massachusetts. GZA has prepared this report in accordance with the Supplemental Investigation Scope (SIS) for the Site dated July 1999; GZA's Addendum to the SIS dated September 19, 1999; and Massachusetts Department of Environmental Protection (DEP) Decision with Modifications letters dated October 26, 1999 and November 2, 2000. This report is subject to the limitations set forth in Appendix A.

1.10 PURPOSE

The intent of this report is to present the findings of GZA's spring/summer 2001 Supplemental Investigation (SI) at the Site and incorporate those data into an upgraded Conceptual Site Model (CSM). The upgraded CSM provides support for the ability of the selected Site remedial alternative (pump and treat), to achieve remedial goals. Based upon that confirmation, the preliminary design and cost-benefit analyses for this alternative (referred to as the Stabilization Measure or SM) were completed.

In addition, this report also provides justification for streamlining the current Assessment and Monitoring Program (AMP) into a focused sampling program based upon the upgraded CSM and reductions in the numbers and types of environmental receptors at the Site. Finally, this report serves as a vehicle to submit a scope of work and schedule for submission of the final Comprehensive Assessment Report (CARP). The following scope of work was completed prior to preparing this SAP Report.

1.20 SCOPE OF WORK

The scope of work for the supplemental investigation and associated activities included the following:

1. Execution of a SI field program that consisted of:

    - advancement of soil borings with split spoon sampling,
    - laboratory analysis of soil samples,
    - installation of twelve overburden monitoring wells, one bedrock monitoring well, one extraction well and three overburden piezometers,
    - collection of groundwater samples from the above wells using low-flow sampling techniques,
    - long-term hydraulic testing,
    - geophysical investigation to supplement the subsurface investigation, and
    - fracture trace analysis.

2. Identification of areas where additional investigation and data collection are warranted;
3. Modification of the Assessment Monitoring Plan (AMP);
4. Updating the Conceptual Site Model by incorporating SI data, and
5. Preparation of a scope of work and schedule for submittal of the final Comprehensive Assessment Report (CARP II).

2.00 BACKGROUND

The following section presents a brief description of the Site, including current Site features and use, as well as a summary of the Facility historical uses and regulatory history. A more detailed Facility history provided by GCC is included as Appendix B to this report.

2.10 SITE LOCATION AND DESCRIPTION

As presented in Figure 1, the Site is located in Framingham, Massachusetts and occupies approximately 12 acres in an area containing residential, industrial, and undeveloped (e.g. wetlands) properties. It is located on the U.S. Geological Survey (U.S.G.S) Framingham, Massachusetts Quadrangle Map (1987) at U.T.M. coordinates 302,000 meters east, 4,682,400 meters north; and Latitude 42°16'23"N, Longitude 71°24'00"W.

The Site consists of the following, which are shown on Figure 2:

- The GCC facility (the Facility) located at 133-135 Leland Street;
- New York Central Lines, LLC (NYC) property;
- MWRA property on which the Sudbury Aqueduct is located;
- Residential properties located at 91 and 91A Leland Street;
- Wetlands located south of the Facility;
- An unnamed drainage ditch and Course Brook (also located south of the Facility)

2.10.1 General Chemical Corporation Facility Description – 133-135 Leland Street

The GCC portion of the Site (the Facility) is located to the south of Leland Street, at Map 1040, Block 214, Lot 40 and 3A (133-135 Leland Street). Town of Framingham tax assessors' maps encompassing the Facility and the Site are included as Appendix C to this report. The Facility is a permitted RCRA Treatment and Storage Facility (TSF). Waste management operations at the GCC Facility currently include (1) the storage and repackaging of bulk solvents, and (2) the storage and consolidation of waste solvents and other regulated hazardous and non-hazardous wastes. On-Facility storage of solvents includes five primary halogenated solvents: 1,1,1-trichloroethane (TCA); trichloroethylene (TCE); tetrachloroethylene (PCE); dichloromethane (also referred to as methylene chloride); and 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113).

Physical structures on the Facility include three buildings, seventeen aboveground storage tanks (ASTs), six settling vessels, associated piping, and concrete secondary containment for the tank farm. Refer to Figure 3 for a current layout of the Facility. Hazardous Waste Storage Buildings No. 1 and No. 2 (known as the "garage" and "dock," respectively) are used exclusively for the storage and transfer of regulated hazardous and non-hazardous waste. The Warehouse building is used for solvent recycling, empty drum storage, and the laboratory.

Of the 17 vertical cylindrical storage tanks located on the Facility, only five are used for the storage of regulated wastes. Ten of the remaining ASTs store virgin or reclaimed solvents, diesel fuel, and unregulated aqueous waste. In addition, one 48,000-gallon AST is used for storage of collected stormwater runoff and one 160,000-gallon AST is used to store a backup supply of fire-fighting water. Six settling or process vessels are also located on the Facility. Three process vessels are used to temporarily store waste solvents prior to distillation, while the remaining vessels temporarily hold reclaimed solvents prior to transfer into storage tanks or drums. Refer to Appendix B for sizing and storage information regarding the ASTs and process vessels.

There are currently no underground tanks (USTs) or associated piping on the Facility. The only subsurface structures on the Facility are associated with the system used for spill containment and stormwater collection and conveyance to the storage tank.

2.10.2 Other Site Properties

As shown on Figure 2, several properties are located on the Site south of the Facility. The NYC railroad property is located on the Site adjacent to the southern boundary of the Facility. The NYC property contains one active CSX Transportation railroad track. The MWRA-operated Sudbury Aqueduct crosses the NYC property, approximately 100 feet south of the Facility. The aqueduct serves as the backup water supply for the City of Boston and is currently not in use. If the aqueduct were to be brought on-line, it has a design flow rate of 90 million gallons per day (mgd). In addition, a chlorination house for the aqueduct is also located on the MWRA property within the Site.

Two residential properties are located directly south of the Sudbury Aqueduct property and approximately 250 feet south of the Facility: 91 and 91A Leland Street. The properties are approximately 0.9 and 0.2 acre in size, respectively. Each property contains a one-story residence, the former with a slightly below-grade crawl space and the later with a full basement.

A substantial portion of the Site is comprised of wetlands, with boundaries located at approximately 200 feet and 350 feet south of the Facility. A man-made, unnamed surface water drainage ditch is located southwest of the Facility. This ditch drains to the south, where it is intercepted by Course Brook.

2.20 FACILITY HISTORY

Samuel J. Beers and L. Alberta Beers owned the GCC Facility property until 1925, at which time the property deed was transferred to Gulf Refining Company. In 1936, Gulf Refining Company conveyed the property to Gulf Oil Corporation due to a name change. In 1967, Richard L. Gardner and Frederic J. Gardner, Trustees of the Rendrag Realty Trust, purchased the Facility from Gulf Oil Corporation, after leasing the Facility for seven years. GCC has operated on the Facility since 1960, when the company entered the business of storing and distributing halogenated solvents. In addition, Trinity Oil, Inc. (TOI) operated its business of home heating oil storage and distribution at the Facility from 1960 through 1978. In 1979, TOI operations were moved to 138 Leland Street. TOI operations ceased in May 1999.

According to GCC, there have been several Facility-documented releases at the Facility from 1983 to the present. The spills were generally the result of surface spills, overfilling of tanks and aboveground line ruptures. A more thorough Site history including release details are documented in Appendix B.

2.30 PREVIOUS STUDIES

Numerous studies have been performed at the Facility and Site since 1992. The following subsection presents a brief summary of these studies. The studies are described in further detail in the original CARP dated December 12, 1997, prepared by CDW Consultants, Inc. (CDW), as well as in the other subsurface investigation reports referenced in this section.

Environmental Resources Management, Inc. (ERM) performed initial site assessment activities at the Facility in late 1992. These activities included a limited subsurface investigation. In December 1995, ERM installed three additional monitoring wells on the Facility. The results of ERM's subsurface investigation activities indicated the presence of elevated levels of chlorinated solvents in soils and groundwater on the Facility.

In January 1996, CDW performed a comprehensive site assessment for both on-Facility and off-Facility areas. This study identified chlorinated solvent impacts to soil and groundwater on the Facility. In addition, analytical results for groundwater samples collected from the NYC (formerly Conrail) property indicated that Facility contamination was migrating off of the Facility in a southerly direction.

Between February and June 1997, CDW completed additional subsurface investigations at the Site. The data collected during this study identified chlorinated solvent impacts to soil and groundwater on the Facility and off the Facility. Groundwater elevation data indicated that groundwater was flowing in a southerly direction.

In September 1997, CDW continued Site and Facility investigations. Soil analytical data did not indicate the presence of significant levels of volatile organic compounds (VOCs) in off-Site soils. However, soil and groundwater analytical data indicated VOC impacts to Facility media. The southerly groundwater flow direction was again observed in this investigation. CDW presented the results of their investigations in their Comprehensive Assessment Report (CDW, 1997).

In June 1998, CDW collected six surface water and sediment samples from the wetland areas downgradient of the Facility. The surface water and sediment analytical results indicated the presence of eight VOCs in three surface water samples and one sediment sample.

An Assessment Monitoring Program (AMP) was initiated at the Site in June 1999. This program includes groundwater elevation measurement, quarterly and semi-annual groundwater and surface water sampling and analysis at select locations across the Site and indoor air monitoring at the 91 and 91A Leland Street residences. IT Group's Spring 1999 Sampling Round Report, and GZA's Quarterly Assessment Monitoring Reports (AMRs) document the results of the quarterly events between June 1999 and the publication of the Interim Comprehensive Assessment Report II (Interim CARP II) by GZA in May 2000.

The Interim CARP II documents the results of further Site investigations downgradient of the Facility, completed by GZA in February 2000. Activities included installation of wells and piezometers, a geophysical study and groundwater, air and surface water sampling. Based upon the data provided in the Interim CARP II, DEP recommended additional investigations at the Site as detailed in their November 2, 2000 Decision with Modifications (the Decision). This Decision provided GCC the opportunity to perform additional investigations at the Site, without an approved Scope of Work. Those additional investigations performed subsequent to the Decision are documented in this Supplemental Assessment Plan and the upgraded conceptual site model presented herein forms the basis for the preliminary design of the Site remedial system, which is provided in the Stabilization Plan (GZA, 2001).

In August 2001, GZA performed an ecological characterization of the wetlands on the Site and Course Brook in the immediate vicinity of the confluence of the surface water drainage ditch. This study was supplemental to GZA's February 2001 Imminent Hazard Evaluation (IHE). The conclusions of the August study, which were documented in a report to DEP on October 10, 2001, concur with those presented in February—No Imminent Hazard to ecological receptors in Site wetlands exists.

The potential for a Massachusetts Contingency Plan (MCP)-defined Critical Exposure Pathway (CEP) existed at 91 Leland Street as a result of the contaminant plume located proximate to the residence and the detection of VOCs in indoor air samples collected at the residence. An Immediate Response Action (IRA) Plan to modify the existing crawl space venting system at the residence was submitted by GZA on behalf of GCC in February 2000. This modification was designed to eliminate any potential pathway from groundwater to indoor air. Diversified Environmental Resources, Inc. (DER) had previously installed a crawl space venting system at the 91 Leland Street residence in December 1997. The system was operational for a short time, after which it was turned off at the request of the property owner. The modified system became operational in November 2000, and has been monitored by GZA on a monthly basis until September 2001. Monthly operational and air sampling data in the form of Implementation Status Reports are included in GZA's quarterly AMRs. GZA completed an evaluation of Critical Exposure Pathways which was submitted to DEP on November 2, 2001. GZA demonstrated, based on the results of ten air sampling events, that a CEP from groundwater to indoor air of the 91 Leland Street residence did not exist, and that the IRA was completed, pending submittal of an IRA completion report.

3.00 SUPPLEMENTAL INVESTIGATION

As discussed in the Interim CARP II (GZA, 2000), the goal of the SI was to obtain additional data and address data gaps prior to finalizing the remedial design for the Site. Specifically, it was necessary to obtain Site-specific geochemical and hydraulic conductivity data from areas downgradient of the Facility. The SI was initiated by GZA on behalf of GCC in spring 2001 to collect these data and additional data required by the DEP in their November 2000 Decision with Modifications. Each of the tasks performed during the SI is summarized in the sections that follow.

3.10 SUBSURFACE INVESTIGATION

Between March 20 and April 26, 2001, GZA directed D.L. Maher Drilling, Inc. of North Reading, Massachusetts, to advance 17 soil borings at various Site locations, as shown on Figure 2. Monitoring wells were installed in each of the soil borings except boring EW-1, in which a 6-inch-diameter extraction well was installed. Well locations were selected to provide specific Site information in advance of the final remedial design. Dependent upon the objective at each location and the contaminant distribution, various drilling techniques were employed.

At locations where sufficient contaminant concentrations were encountered or expected to be encountered, heavy weight drilling mud (weighted to the specific gravity of perchloroethylene) was used to limit the possibility of drilling-induced contaminant migration. At all locations, continuous split spoon sampling was performed, at a minimum, from ground surface to 5 feet below the water table. Where two or more monitoring wells were installed at the same location, soil samples were collected from the deepest boring in that cluster. Continuous split spoon sampling was performed while advancing the EW-1 pilot boring from ground surface to termination depth. Field headspace screening using a photoionization detector (PID) equipped with an 11.7-eV lamp was performed on all soil samples collected during boring advancement. PID readings are included in the soil boring logs in Appendix D. Based upon visual and headspace screening, select soil samples were preserved and submitted for laboratory analysis of VOCs via EPA Method 8260B. Total organic carbon (TOC) analysis via EPA Method 415.1 was also performed on samples collected from each stratigraphic unit (i.e., sand, silt and till) within several SI borings. Four soil samples from the extraction well pilot boring were additionally analyzed for extractable petroleum hydrocarbons/volatile petroleum hydrocarbons (EPH/VPH). The VOC, EPH/VPH and TOC data from these soil samples are reported in Tables 1, 2 and 3, respectively.

All monitoring wells were constructed of 2-inch-inner-diameter PVC continuous slot screens and threaded PVC riser. All well joints were connected without the use of adhesives, to avoid cross-contamination. Sand pack was placed in the annulus between the well and the borehole. Bentonite pellets were placed above the sand pack and then hydrated to form a surface seal. A locking steel protective casing (flush mount or 4-inch-diameter standpipe) was cemented in place using cement grout. Further details regarding well construction are summarized in Table 4. Boring logs are contained in Appendix D. All of the locations discussed in the following sections are shown on Figure 2. The monitoring wells were developed by D.L. Maher, Co. to remove fine particulates entrained in the wellscreens. Development employed surge block and overpumping methods, and were performed under direction from GZA. All water generated during development was stored on Site in a 21,000-gallon fractionation tank. This water was later treated and discharged to the surface water drainage ditch on Site during August/September 2001, under United States Environmental Protection Agency (USEPA) National Pollutant Discharge Elimination System (NPDES) exclusion permit No. 01-171. Following development, the new monitoring well elevations and coordinates were surveyed by GLM Engineering, relative to Massachusetts State Plane coordinates and imported into the Site base map.

3.20 MONITORING WELLS

Thirteen monitoring wells were installed as part of the SI. One well, GZ-13, was installed on the Facility property. The remaining twelve wells were installed off of the Facility property.

3.20.1 Northwest Facility Corner, GZ-13

GZ-13 is located near the northwest corner of the Facility property, inside of the Facility gates. The location of this well was selected to verify the presence of a groundwater divide, which is believed to be located in the vicinity of Leland Street. The well is screened across the water table, which was encountered at approximately 3 feet below ground surface (bgs).

The boring was advanced with hollow stem augers. Soil samples were collected continuously throughout the boring using a standard, 2-foot-long split spoon sampler, which was decontaminated between samples. Field headspace readings were taken throughout the boring advancement with a PID. Eight ¼-inch hollow stem augers were advanced to a total depth of 14 feet bgs. Upon completion of the boring, monitoring well GZ-13 was installed. The well consists of a 10-foot length of 2-inch PVC wellscreen and 1.5 feet of threaded PVC riser, with the well screened from 1.5 to 11.5 feet bgs. Filter sand was placed within the annular space surrounding the wellscreen. Bentonite pellets were placed above the filter sand and the remainder of the boring annulus was filled to ground surface with bentonite/cement grout. The monitoring well was completed with a cemented flush-mount road box and secured with a locking plug.

3.20.2 Electric Station Access Road, GZ-14M and GZ-14S

These overburden monitoring wells were installed along the east side of the access road, to assess potential impacts to soil and ground water south of the Facility. The shallow well, GZ-14S, was set at the bottom of the sand unit. The deep well, GZ-14M, was screened at the bottom of the silt unit and in the top of the glacial till unit. In this case, it appears that the top of the till unit had been eroded, leaving a sandy soil between the bottom of the silt unit and the top of the low permeability portion of the till.

GZ-14M

This pilot boring was advanced from ground surface to approximately 4 feet into glacial till, where equipment refusal was encountered at approximately 79 feet bgs. The water table was intersected at approximately 2.5 feet bgs. Soil samples were collected continuously 5 feet into the water table, then at 5-foot intervals throughout the remainder of the boring. Hollow stem augers were used to advance the boring until refusal was encountered at approximately 70 feet bgs. The drilling method was then switched to drive and wash with 4-inch-diameter flush-joint steel casing. After drilling through the obstruction with a rollerbit, the casing was advanced with a 300-pound hammer to approximately 75 feet bgs where low permeability till was encountered. The boring was advanced 4 feet into this deposit, and a final soil sample was collected at 78.5 to 79 feet bgs. At 79 feet bgs, the boring was terminated and the monitoring well was installed.

One foot of bentonite chips was added to the annulus and the bottom of the wellscreen was set at 77 feet bgs, with the top of the screen at 67 feet bgs. Filter sand was set within the annular space surrounding the wellscreen to 2 feet above the screen. Two feet of bentonite pellets were placed above the filter sand and the remainder of the borehole was grouted to ground surface with bentonite/cement grout. The monitoring well was completed with a locking steel standpipe.

GZ-14S

GZ-14S boring was advanced to approximately 25.3 feet bgs using hollow stem augers. There were no soil samples collected during boring advancement. The well is screened over the interval of 14.8 to 24.8 feet bgs. Filter sand was set within the annular space surrounding the wellscreen to 2 feet above the screen. Two feet of bentonite pellets were placed above the filter sand. The remainder of the boring was grouted to the ground surface with a bentonite/cement grout.

3.20.3 Century Estates Condominium Property, GZ-16M and GZ-16S

The locations of monitoring wells GZ-16S & M were selected to confirm the northwest extent of the identified plume.

GZ-16M

The GZ-16M pilot boring was advanced using hollow stem augers. Soil samples were collected continuously to 10 feet bgs, 5 feet below the water table, which was encountered at approximately 5 feet bgs. Thereafter, soil samples were collected over 5-foot intervals, until glacial till was encountered at approximately 48 feet bgs. Collection of two split spoon samples was attempted (one successfully), and equipment refusal was encountered at approximately 51.4 feet bgs. GZ-16M was installed in the borehole, with the 10-foot screen set between 40 and 50 feet bgs, which is approximately 2 feet into till. Filter sand was placed within the annular space surrounding the wellscreen to 2 feet above the screen. Two feet of bentonite pellets were placed above the filter sand and the remainder of the borehole (36 feet bgs to ground surface) was grouted with bentonite/cement grout and finished with a steel standpipe.

GZ-16S

The shallow monitoring well GZ-16S was installed immediately adjacent to GZ-16M. The pilot boring for this well was advanced to 12 feet bgs using hollow stem augers. There were no soil samples collected during boring advancement. The well was set with the screened interval between 2 and 12 feet bgs. Sandpack was placed around the screen and a bentonite seal was set over the sandpack, to ground surface. The monitoring well was completed with a cemented 4-inch steel locking casing and secured with a locking plug.

3.20.4 Southeast of Facility, GZ-17S and GZ-17M

The locations of monitoring wells GZ-17S and GZ-17M were selected to assess groundwater chemistry and hydraulics in a potential downgradient direction from the Facility. The primary objective of these borings was to verify that the contaminant plume was not migrating in this direction.

GZ-17M

Pilot boring GZ-17M was advanced using hollow stem augers. Soil samples were collected continuously to 10 feet bgs, then at 5-foot intervals to termination depth at 51 feet bgs (1 foot into till). The boring was advanced 1 foot into the till and a till sample was collected at 49 to 51 feet bgs. The well is installed across the clayey silt/till interface, with the screen set between 40 and 50 feet bgs. Filter sand was set within the annular space surrounding the well from the bottom of the screen to 2 feet above the screen. Two feet of bentonite pellets were placed above the sandpack and the remainder of the borehole (36 feet bgs to ground surface) was grouted with bentonite/cement grout and a locking steel standpipe was cemented in place to complete the well.

GZ-17S

The GZ-17S soil boring was advanced to 14 feet bgs using hollow stem augers. There were no soil samples collected during the boring advancement. During well installation, a 10-foot length of 2-inch PVC wellscreen and appropriate length of riser was placed in the borehole, with the screen seated between 4 and 14 feet bgs. Filter sand was set within the annular space surrounding the wellscreen to a point 2 feet above the screen. Two feet of bentonite pellets were placed above the filter sand. No grouting was required, and a locking steel standpipe was cemented in place over the well.

3.20.5 Southeast of Facility, GZ-18S and GZ-18M

As with the GZ-17 cluster, the locations of monitoring wells GZ-18S and GZ-18M were selected to assess groundwater chemistry and hydraulics in a potential downgradient direction from the Facility. The primary objective of these borings was to verify that the contaminant plume was not migrating in this direction.

GZ-18M

The GZ-18M pilot boring was advanced using hollow stem augers. Soil samples were collected continuously to 10 feet bgs, then at 5-foot intervals thereafter, until equipment refusal was encountered at an approximate depth of 46.4 feet bgs (approximately 2 feet into glacial till). The 10-foot screen was installed in this boring approximately 1 foot into the till unit, and extending upward into the clayey silt/silt and clay unit, between 35.5 and 45.5 feet bgs. Filter sand was set within the annular space surrounding the wellscreen between the bottom of the screen and 2 feet above the screen. Two feet of bentonite pellets were placed above the filter sand and the remainder of the borehole was grouted to ground surface with bentonite/cement grout. The monitoring well was completed with a cemented 4-inch steel locking casing.

GZ-18S

GZA installed a shallow monitoring well, GZ-18S adjacent to GZ-18M. The GZ-18S boring was advanced to 14 feet bgs using hollow stem augers. There were no soil samples collected during the boring advancement. The 10-foot wellscreen was installed within the completed boring, between 4 and 14 feet bgs. Filter sand was set within the annulus around the wellscreen to 2 feet bgs, followed by 2 feet of bentonite pellets. No grouting was required to backfill the annulus, and a locking steel standpipe was cemented in place to complete the well.

3.20.6 Electric Station Access Road, GZ-15S, GZ-15D and GZ-15R

The location of these wells was selected to assess groundwater quality and hydraulic gradients south of the Facility at the presumed terminus of the plume along the surface water drainage ditch. These wells were installed to confirm that the contaminant plume had completely discharged into the surface water drainage ditch prior to this location, provide information on the horizontal bedrock groundwater flow direction, determine the direction of the vertical groundwater flow between the overburden and bedrock and verify that the bedrock groundwater was clean in this originally presumed downgradient location. Heavy weight drilling fluid was used at this location to avoid cross-contamination of the bedrock.

GZ-15R

The boring was started using hollow stem augers and completed with drive and wash casing methods using a heavy weight drilling fluid. The drilling fluid was a mixture of Barite and SuperGel X, which was mixed together until the density of the fluid is 1.7 g/cm^3, greater than the density of perchloroethylene, the densest Dense Nonaqueous Phase Liquid (DNAPL) present at the Facility.

Initially, hollow stem augers were advanced to approximately 2.8 feet bgs at which point auger refusal was encountered (refer to boring log GZ-15RA, Appendix D). The augers were removed, the hole backfilled with bentonite, and the drill rig was moved approximately 3 feet south and a second boring (GZ-15RB) was advanced with hollow stem augers to a depth of 8.5 feet bgs. At this point, drilling was switched to a drive and wash technique. Six-inch-diameter steel casing was driven to a depth of 9 feet bgs; 4-inch steel casing was telescoped within the 6-inch casing and driven to 35.5 feet bgs. Continuous soil samples were collected to a depth of 10.5 feet bgs and on 5-foot intervals thereafter to 37.5 feet bgs (approximately 1.5 feet into till). At 38 feet bgs, the soil boring was terminated due to the rollerbit had sheared off of the drill rod and could not be retrieved. As with the other abandoned boring, soil boring GZ-15RB was backfilled to ground surface with bentonite chips.

The drill rig was moved 4 feet south of GZ-15RB and boring GZ-15R was advanced. Hollow stem augers were used to a depth of 35 feet bgs where the drilling method was switched to drive and wash (4-inch-diameter casing) using heavy weight drilling fluid. No soil samples were collected above 35 feet bgs as GZ-15RB had been sampled to that depth. The 4-inch casing was seated in the top of bedrock (encountered at approximately 42.65 feet bgs). Ten feet of bedrock was then cored using an HQ diamond bit wire line core barrel, to a total depth of 53 feet bgs. The rock cores were retained and logged by GZA's on-Site geologist. A 5-foot length of wellscreen was set within the core hole, between 48 and 53 feet bgs. Sand pack was placed in the borehole, from the bottom of the screen to approximately 2.5 feet above the screen. A 4.5 foot bentonite seal was set above the sand pack (which extends above the bedrock surface), and the remainder of the borehole was grouted to ground surface with bentonite/cement grout. The surface was finished with a cemented locking steel standpipe.

GZ-15D

GZA installed an intermediate monitoring well, GZ-15D, adjacent to GZ-15R. The GZ-15D soil boring was advanced to 34 feet bgs using hollow stem augers. There were no soil samples collected during this boring advancement. A 15-foot-long wellscreen was set within clay and silt in the completed borehole, at a depth of 19 to 34 feet bgs. Filter sand was placed in the borehole annulus, from 34 feet to 17 feet bgs, followed by 2 feet of bentonite. The remainder of the borehole was grouted with bentonite/cement grout and finished with a cemented locking steel standpipe.

GZ-15S

A shallow monitoring well, GZ-15S, was also installed adjacent to the bedrock and intermediate GZ-15 series wells. Again, as with GZ-15D, there were no soil samples collected during the completion of this boring. Ten feet of wellscreen were set in the borehole, spanning the 4 to 14 foot bgs interval. Sand pack was placed in the annulus around and extending 3 feet above the wellscreen. The boring was backfilled to ground surface with bentonite chips, and a locking steel standpipe was cemented in place.

3.20.7 91 Leland Street Property, GZ-19DD

Monitoring well GZ-19DD was installed to assess groundwater chemistry at deeper depths at this location and to complete the cluster of existing wells CDW-19S and CDW-19D (which are screened to a maximum depth of 20 feet bgs) with a deeper monitoring well in the silt unit below the shallow sand.

Due to elevated levels of VOCs present in groundwater in the vicinity of GZ-19DD, the boring was advanced from ground surface by drive and wash casing advancement with the use of heavyweight drilling fluid. Soil samples were collected continuously from ground surface to 6 feet bgs, then at 5-foot intervals to a depth of 38 feet bgs. At 38 feet bgs, soil headspace screening with a PID indicated elevated VOC concentrations were present in the soils. Therefore, soil samples were collected continuously from that depth until termination depth (4-inch-diameter casing refusal) at 54 feet bgs. Soil samples exhibiting elevated VOC levels during headspace screening were additionally screened in the field for the presence of DNAPL with Sudan IV dye. During the drilling operations, periodic PID headspace screenings were conducted on the heavy weight drilling fluid, which was replaced when elevated PID readings were noted. The depths at which the drilling fluid was changed are noted on the boring logs in Appendix D. Waste drilling fluid was containerized in 55-gallon drums and proper disposal was arranged for by GCC.

The casing was washed out with a rollerbit, and bumped back to allow the boring to be backfilled with bentonite chips to a depth of 50.5 feet bgs, followed by filter sand to a depth of 48 feet bgs. A wellscreen from 38 to 48 feet bgs was then installed in the borehole. Filter sand was set within the annular space surrounding the wellscreen to a point 2 feet above the screen. A total of 2.5 feet of bentonite pellets were placed above the filter sand and the remainder of the borehole was grouted to ground surface with a bentonite/cement grout. The monitoring well was completed with a cemented 4-inch steel locking casing.

3.20.8 Extraction Well (EW-1), Southwest of Facility between Railroad and Aqueduct

Extraction well (EW-1) is located hydraulically upgradient of the MWRA aqueduct property and downgradient of the Facility. The location of EW-1 was selected as it is within the core of the groundwater plume, and maintains the necessary clearance from the railroad easement, MWRA aqueduct and overhead power transmission lines.

Heavy weight drilling fluid coupled with drive and wash methods using 4-inch-diameter casing were utilized to advance the pilot boring. Soil samples were collected continuously over the length of the boring to a depth of 54 feet bgs. Headspace screening with a PID as well as DNAPL screening using Sudan IV dye was performed on soil samples collected from this boring. Casing was then driven to 57 feet bgs and a final split spoon sample (57 to 57.33 feet bgs) was collected at which point equipment refusal was encountered. During drilling operations, periodic PID headspace screening was performed on the drilling fluid. The drilling fluid was changed when elevated PID levels were recorded. Waste drilling fluid was containerized in 55-gallon drums and disposed of by GCC. The depths at which the drilling fluid was replaced can be found on the boring logs in Appendix D.

Following completion of the continuously sampled pilot boring, 1-foot-diameter steel casing was advanced around the pilot hole with a Barber dual rotary drilling rig. Cuttings and liquid from inside the casing were discharged directly from the rig cyclone to a 30-cubic-yard rolloff, for later disposition. Thirty-five feet of 6-inch stainless steel channel packed (prepacked, 0.008 slot) wellscreen with a 1.8-foot sump was installed within the pilot hole. The screen was set between 10 and 45 feet bgs. Fine filter sand was placed within the annular space surrounding the wellscreen to 5.13 feet above the screen. Two feet of bentonite pellets were placed above the filter sand to form a seal above the screened area. The extraction well was completed with a cemented 12-inch steel locking casing.

3.20.9 Extraction Well Piezometers, Southwest of Facility, EW-PZ-1, EW-PZ-2S and EW-PZ-2D

Three piezometers were installed in the vicinity of the extraction well to monitor groundwater elevations during the hydraulic testing of the extraction well (EW-1) in August/September 2001. These piezometers will eventually be used to demonstrate hydraulic containment by the proposed groundwater extraction and treatment system.

EW-PZ-1

EW-PZ-1 was installed approximately 3 feet from existing monitoring well CDW-6, and was designed to be the deep companion well to CDW-6. EW-PZ-1 was installed using the drive and wash casing method with water as the drilling fluid. No soil samples were collected during the installation given the proximity of EW-1. The piezometer is screened between 25 and 45 feet bgs. Filter sand was set within the annular space surrounding the wellscreen to a depth of 2 feet above the screen. Two feet of bentonite pellets were placed above the filter sand to form a seal above the screened area. The remainder of the borehole was completed via bentonite/cement grout. EW-PZ-1 was completed with a cemented 4-inch steel road box and secured with a locking plug.

EW-PZ-2S and EW-PZ-2D

A cluster of piezometers screened in the shallow sand layer (EW-PZ-2S) and in the underlying silt layer (EW-PZ-2D) were installed approximately 50 feet from the extraction well (EW-1). Both were installed with the drive and wash casing method, without the use of the heavy weight drilling fluid. EW-PZ-2D consists of a 15-foot length of 2-inch-diameter PVC wellscreen and appropriate length of riser set at 38 feet bgs. EW-PZ-2S is constructed of a 15-foot length of 2-inch-diameter PVC wellscreen and appropriate length of riser placed at 18 feet bgs. Both piezometers were completed using filter sand, bentonite seal and bentonite/cement grout to surface and finished with a locking protective casing.

3.30 GROUNDWATER SAMPLING OF SUPPLEMENTAL INVESTIGATION MONITORING WELLS

Between April 19 and May 4, 2001, following the installation and development of the SI wells, GZA personnel collected groundwater samples from the new monitoring wells. Prior to sampling, the wells were gauged to measure the groundwater elevation and to detect the presence, if any, of Light Nonaqueous Phase Liquid (LNAPL) or DNAPL. Low-flow sampling techniques were employed in accordance with EPA guidelines.[1] Physical parameters (i.e., pH, temperature, specific conductivity, dissolved oxygen, ORP, and turbidity) were recorded every three minutes using a YSI 600 XL multimeter and LaMotte 2020 turbidity meter. The YSI multimeter was calibrated on a daily basis prior to sampling by GZA field technicians. The calibration was verified at the end of each day. Groundwater samples were collected from each well upon parameter stabilization. Purge water was transferred to a 55-gallon drum and disposal services were arranged by GCC.

Groundwater samples were collected in hydrochloric acid-preserved 40-ml vials with Teflon™ septa. Samples were stored in an ice-packed cooler and transported to GZA's Environmental Chemistry Laboratory (ECL) in Hopkinton, Massachusetts following standard chain-of-custody protocol. Samples were analyzed for VOCs via EPA Method 8260, including 1,4-dioxane. The VOC results for these samples are summarized in Table 4. Copies of the laboratory data sheets for the groundwater samples are presented in Appendix G.

3.40 GEOPHYSICAL STUDY

Hager Geoscience, Inc. (HGI) of Waltham, Massachusetts performed geophysical surveys at the Site during April and May 2001. The program employed seismic refraction, seismic reflection and ground penetrating radar (GPR) methods. The objectives of the study were

[1] Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells (EPA, Region I, July 30, 1996).

to further resolve the stratigraphy across the Site and to map the top of bedrock. HGI's report, which incorporates the results of 1997 and 1999 HGI surveys at the Site, is included as Appendix H to this report.

3.50 FRACTURE TRACE ANALYSIS

A fracture trace analysis identifying regional bedrock controlled measurements was conducted by GZA using stereoscopic aerial photographs, published topographic, surficial/bedrock geologic maps, and joint/fracture field measurements.

Generally, many of the drumlins and hills in the region are bedrock controlled with the trend of the steepest slopes indicating dominant join/fracture orientation. Major linear trends between ½ and 2 miles to the north and southeast of the Site were identified and plotted on transparent acetate. Similarly, prominent linear features identified using a stereoscope and aerial photographs were plotted. These linear plots were superimposed on one another and organized into similar trending groups.

According to the Bedrock Geologic Map of the Framingham Quadrangle, Framingham and Worcester Counties, Massachusetts (1975), the Site is underlain by the Dedham Granodiorite. This bedrock unit is generally described as a light gray to pinkish-gray, fine- to coarse-grained granodiorite with local inclusions of gabbro, metasedimentory and metavolcanic rocks, and ranges from massive to faintly foliated. The map depicts a NNE (north-northeast) trending strike-slip fault proximate to the Site. However, no bedrock outcrops occur at the Site to verify that this fault actually exists, and it is only inferred on the map based on geologic evidence a few miles to the north and south of the site. The geologic map indicates features ½ to 1 mile southeast of the Site exhibit the major trending strike to be oriented NW-SE, with a secondary trend NNW-SSE.

Field reconnaissance was conducted southeast of the Site and confirms the major trends indicated on the geologic map. The rock core obtained from the Site generally indicates a hard, fresh granodiorite, moderately to highly fractured within the upper 7 feet, with iron-oxide stained to clay coated joints fractures, which is commonly observed in bedrock within the upper 10 to 15 feet. A schistose rock was observed at GZ-4R, and may be attributed to a mafic intrusive.

3.60 HYDRAULIC CONDUCTIVITY TESTING

Between August 27 and September 1, 2001, GZA conducted a pumping test at the Site using the new extraction well, EW-1, as the pumping well. The main objective of this pumping test was to estimate the hydraulic properties (i.e., hydraulic conductivity and transmissivity) of the aquifer impacted by the contaminant plume. These properties are utilized to develop the hydraulic containment system for the contaminant plume, estimate the number of extraction wells required and their combined flow rate to adequately contain the contaminant plume at the Site. In order to estimate the optimum flow rate for sustained yield of the extraction well, a step-drawdown test was performed in advance of the actual pumping test. The step-drawdown test results were used to estimate the appropriate pumping rate during the longer-term pumping test. The following sections describe the setup of the pumping test including pumping and monitoring equipment, procedures for the step-drawdown test and the pumping test, and data reduction methodologies. The aquifer parameters estimated from this test are discussed in Section 4.00 of this report. A conceptual remedial system design using the parameters discussed in that section can be found in GZA's December 14, 2001 Stabilization Measure Report.

GZA

3.70 PUMPING TEST SETUP

3.70.1 Pump and Temporary Treatment System

A 1.0-horsepower Grundfos-brand submersible centrifugal pump capable of pumping a maximum of 15 gallons per minute (gpm) was installed in extraction well EW-1 for the step-drawdown and pumping tests. EW-1 is 47 feet deep (see EW-1 boring log, Appendix D); the pump was installed with the intake at approximately 42 feet bgs. The pump discharge line (composed of HDPE tubing) was fed through a controlling valve and digital flow meter then to an on-Site fractionation tank, which was used as an equalization tank prior to treatment. Water was then pumped from the equalization tank to the treatment system, which consisted of a bag filter, and two 1,000-pound granulated activated carbon cells in series. Treated water was discharged through approximately 500 feet of roll-flat hose to the drainage ditch on Site. Discharge of treated water was allowed to flow over a 4'X 8' sheet of plywood to disperse the flow before entering the ditch, to avoid eroding the bank.

3.70.2 Pressure Transducers

Geokon brand vibrating wire pressure transducers were installed several days prior to the test, in the pumping well and selected observation wells to automatically record water levels. As discussed in Section 4.00, there are two different hydraulic units above the glacial till at the Site. These separate units will be referred to as the upper sand and lower silt zones. It is important to bear in mind that the upper sand zone has some silt fractions and the lower silt zone is significantly stratified with some sand and clayey silt layers. The pumping well, EW-1, is screened across both zones. In addition, the transition between units (which occurs about 20 feet bgs at EW-1) is gradational.

In addition to the pumping well, transducers were installed in the following wells:

Sand	**Silt**
CDW-6	EW-PZ-1
EW-PZ-2S	EW-PZ-2D
CDW-5	CDW-19D
CDW-1	GZA-19DD
CDW-3	
CDW-12	**Bedrock**
	GZ-4R
Till	GZ-7R
GZ-7	GZ-15R

Refer to Figure 2 for the location of wells instrumented with transducers. Because these transducers do not correct for atmospheric pressure, they record not only the pressure exerted by the column of water in the well above the instrument, but the air pressure as well. Therefore, one additional transducer was installed above the water column in well EW-1, to record changes in barometric pressure. These data were applied to the remaining transducer water level data to correct for barometric pressure changes.

When installed, transducers were placed approximately 1 foot above the bottom of the well. The initial water level reading for each transducer was set to zero after installation. This procedure allowed the transducers to measure absolute head changes within each well before, during and after the test. Transducer calibration was verified by elevating the transducer in each well a known distance and comparing that distance to the head change detected by the datalogger. The transducers initially placed at well GZ-14S and the adjacent surface water monitoring station could not be read due to unidentifiable electrical interference. Replacement units installed at these locations experienced similar interferences. Water levels at these locations were manually gauged with an electric water level indicator during and after the test.

Dataloggers were installed prior to pumping to record non-pumping background water levels. The dataloggers were programmed to collect water levels at 15-minute intervals. Upon start of the actual pumping test, the monitoring frequency changed to collect water levels every 10 seconds, increasing to 15-minute intervals after two hours of pumping. A rain gauge was also installed at the Site to monitor precipitation during the test.

3.80 NPDES EXCLUSION PERMIT

GCC applied for and was granted NPDES exclusion permit number 01-171 by the USEPA prior to the test. This permit exclusion granted GCC permission to discharge treated groundwater extracted during the pumping test to the drainage ditch on Site. At the termination of treatment on September 1, a total of 101,266 gallons of groundwater had been extracted, treated and discharged to the drainage ditch on Site.

3.80.1 Step-Drawdown Pumping Test

On Monday, August 27, 2001, a step drawdown test was performed at EW-1. A step-drawdown test is executed by pumping the well at a constant rate for a short period of time followed by successively higher pumping rates. At each rate, the drawdown in the well is observed and the specific yield (flow per unit drawdown) at each flow rate is estimated. This information is then used to estimate a satisfactory longer-term pump rate. The first step was conducted at 5.8 gallons per minute (gpm) for approximately 125 minutes, the second step at 10 gpm for approximately 50 minutes, and finally at 15 gpm for 45 minutes. The last step was conducted at the maximum pump rate (for the pump installed). With a starting non-pumping depth to water of approximately 6 feet, the observed drawdowns and corresponding specific yields were:

Pumping Rate, Q (gpm)	Drawdown, s (feet)	Specific Yield, Q/s (gpm/ft)	ΔQ at End of Step (ft/min.)
5.8	3.7	1.57	0.002
10	5.5	1.81	0.003
15	11.7	1.28	0.012

A plot of time versus drawdown measurements for the step-drawdown test is presented in Appendix I. These short-term results indicate that the depth to water during the final pumping rate was approximately 17.5 feet bgs, approximately 24.5 feet higher than the pump intake at 42 feet bgs. In keeping with the pumping test objective to have the greatest amount of sustained drawdown in an extraction well (to evaluate the largest area of influence for that well), preliminary results indicated that a pumping rate of greater than 15 gpm may be appropriate.

However, the change in water level at 15 gpm was 0.012 feet per minute (17 feet/day) which was a more rapid decline relative to that achieved with 5.8 and 10 gpm pumping rates achieved during the step test. Based upon the step-drawdown test, GZA determined that the longer-term test would be conducted at a pumping rate of approximately 14 gpm. This would allow for a decrease in drawdown as the aquifer approached steady state, and would allow for pumping rate adjustment on the 15-gpm pump installed in the well.

3.80.2 Longer-Term Pumping Tests

Following the step-drawdown test, two longer-term pumping tests were conducted. The tests were run with pumping rates of 14 and 18 gpm. The procedures for these tests are discussed in the sections that follow.

14-gpm Pumping Test

On August 28, 2001, before initiating the pumping test, manual water level measurements were taken at all wells in and around the Site. This included wells with electronic transducers. These non-pumping groundwater elevations are presented in Table I-1 and Figure I-1 in Appendix I. These non-pumping groundwater elevations were used in the water level contours shown on Figure I-1. Manual monitoring of additional wells without pressure transducers was continued throughout the entire pumping period.

Data collected by the datalogger over the previous days was downloaded onto a laptop computer. After data transfer was complete, the dataloggers were reprogrammed to collected data at short intervals at the start of pumping (every 15 seconds for 5 minutes) and at gradually lengthening intervals until readings were taken every 15 minutes after approximately 2.5 hours of pumping.

The pumping test was initiated at 12:30 on August 28, 2001. Pumping began at a rate of approximately 14 gpm and drawdown was manually measured in the extraction well using an electric water level indicator. The pump discharge pressure was altered manually using a ball valve to maintain the discharge flow rate at 14 gpm. Pumping was terminated at 09:30 on August 30, 2001, exactly 45 hours after start up. Prior to termination of pumping, one complete round of manual water level readings was made for all wells at the Site. This information was then used to construct a groundwater elevation contour plan representative of 14 gpm pumping conditions, as discussed in Section 4.

18-gpm Pumping Test

After termination of the 45-hour test at a rate of 14 gpm, a Gould-brand 25 gpm pump was installed in the well. Based on the high specific yield calculated using the results of the 14-gpm test, an attempt was made to pump the aquifer at a rate greater than 15 gpm. Pumping began at a rate of approximately 25 gpm at 11:10 on Thursday, August 30, 2001. Within five minutes, 28 feet of drawdown in the extraction well were observed and the pumping was stopped to avoid drawing the water level down below the pump intake. After allowing for substantial recovery, pumping resumed at approximately 18 gpm at 11:30 am on August 30, 2001 and maintained at a relatively steady rate until 12:10 pm on September 1, 2001, a total of approximately 48 hours of pumping.

Following termination of pumping, manual and automated water level readings were collected at least 48 hours after the end of the test. Extracted groundwater was discharged after being treated on Site. During extraction, three treatment system influent and effluent samples were collected and submitted to GZA's ECL for VOC analyses, with a 24-hour turnaround time. The results of these analyses are included in Appendix I.

4.00 SUPPLEMENTAL INVESTIGATION RESULTS

The results of the Supplemental Investigation (SI) generally concur with those of previous Site investigations. The bedrock lithology, general overburden stratigraphy and contaminant distribution were similar to that described in the Interim CARP II Report (GZA, 2000). With the installation of additional overburden and bedrock wells in the SI, groundwater flow patterns were found to be somewhat different than those shown in the quarterly Assessment Monitoring Reports. In addition, an industrial water supply well in the vicinity of the Site was discovered during this investigation, and its influence was clearly observed in the bedrock during water level gauging events. A thorough discussion of these new data is provided in Section 5.00, as they relate to the updating of the CSM. The following subsections summarize the results of the SI activities, which were described in Section 3.00.

4.10 GEOLOGIC SETTING

Based upon the U.S. Geological Survey Framingham, Massachusetts Quadrangle (1987) topographic map, the Site is located within a relatively flat area with a gentle slope toward low-lying wetlands south of the Facility. The wetlands are associated with Course Brook located approximately ½ mile southeast of the Site. Regional geology is characterized by granular fill, over sand, over a stratum of sand and silty sand, over glacial till (a dense, heterogeneous mixture of sand, silt, gravel and boulders), over bedrock.

Observed subsurface conditions consist of approximately 3 to 10 feet of granular fill material underlain by sand, silt and clay deposits. The fill material is comprised primarily of sand and gravel with trace amounts of silt. The underlying sand unit generally consists of 20 to 46 feet of fine to coarse sand with varying amounts of silt and gravel. This sand thins to the northwest and southeast of the Facility. Beneath the sand unit, a silt unit is encountered. This unit generally consists of greater than 40 feet of silt with trace amounts of sand and clay, and is interbedded or varved in some locations. Glacial till was encountered below the silt unit with a penetrated thickness from 2 to as much as 50 feet. Bedrock composed of competent to moderately fractured granodiorite was encountered at GZ-15R, at a depth of approximately 42 feet bgs. Boring logs for the Supplemental Investigation wells, which describe the lithology encountered, can be found in Appendix D.

4.20 GEOPHYSICAL STUDY

Data collected by HGI correlate well to the stratigraphy encountered in other subsurface investigations at the Site. The unconsolidated overburden as mapped by HGI's study consists of alluvium and silt outwash overlying a finer grained silt/clayey silt unit. Beneath the silt/clayey silt unit is a basal till of variable thickness overlying bedrock. The survey delineated a bedrock basin trending northwest-southeast in the vicinity of the Site. Based upon the survey results, the alluvium and silt outwash thins to the southwest of the Facility. The silt/clayey silt unit is thickest within the bedrock basin, and thins beneath the Facility and Century Estates Condominiums. Thickest beneath the GCC Facility, the glacial till unit thins to the bedrock high encountered to the southwest, and is thinnest along the axis of the bedrock basin. See Appendix H for more detail.

4.30 FRACTURE TRACE ANALYSIS

Based on the compilation of topographic and stereoscopic lineaments during the bedrock fracture trace analysis, the most dominant bedrock fracture trend is NW to SE, followed by NNW to SSE. This is coincident and consistent with published and field checked measurements within 2 miles of the site.

4.40 HYDRAULIC CONDUCTIVITY TESTING

4.40.1 Water Level Responses To Pumping

A water level drawdown of 14.2 feet was observed in the extraction well after pumping continuously for 45 hours at 14 gpm. Water level changes were observed in monitoring wells located in the upper sand and lower silt zones. Changes of greater magnitude were observed in the lower silt zone as compared to the upper sand zone. Two wells adjacent to EW-1 exhibited pumping-induced changes in water elevations of 4.4 feet at EW-PZ-1, located 13 feet from EW-1 and 2.5 feet at EW-PZ-2D located 50 feet from EW-1.

In the upper sand zone, there were many wells exhibiting drawdown. The maximum observed drawdown was 1.7 feet at CDW-6, (12 feet from EW-1), and the minimum observed drawdown was 0.3 feet at CDW-3 (127 feet from EW-1). Table I-2 illustrates all observed drawdowns for wells with transducers. Plots of drawdown versus time for wells with transducers are illustrated in Appendix I. Depth to water measurements from manually measured wells are contained in Table I-3, Appendix I.

Because the total amount of drawdown in the pumping well was 14.2 feet, the resulting pumping depth to water in EW-1 was 20 feet bgs. Although the water level in the well had not reached equilibrium 45 hours into the test, the rate of change had slowed sufficiently such that total drawdown in the well after 72 hours of pumping would not approach the pump intake. Because the pump in the well could yield a maximum of 15 gpm at this depth, the test was terminated at 45 hours, and a larger pump was installed in an attempt to stress the aquifer further.

Results of pumping at 18 gpm indicate significantly more drawdown than at 14 gpm. As illustrated on Table I-1, drawdown in the pumping well increased from 14.2 to 33.7 feet. At the end of the 18 gpm test, the water level in the pumping well was approximately 40 feet bgs. In the upper sand zone, drawdown increased by more than 50 percent in all wells to more than 200 percent in some wells. In the lower silty sand zone, drawdown increased by roughly 200 percent as compared to 14 gpm. These results indicate that although the flow rate was increased by 29 percent (14 to 18 gpm), resultant changes in water levels increased by a higher factor.

Most importantly, it must be noted that at the time the 18 gpm test was terminated, the water level in EW-1 was continuing to decline. In fact, near the end of pumping, it appeared that the level was still declining in a linear fashion, indicating that the pumping rate of 18 gpm could not be sustained.

4.40.2 Pumping Influence on Bedrock

Three bedrock wells were monitored during the pumping tests (GZ-7R, GZ-15R and GZ-4R). None of them showed a clear response to pumping of EW-1; however, all showed a very clear response to other pumping activities. Plots of time versus drawdown for bedrock wells are shown in Appendix I.

The well with the greatest response to outside pumping was GZ-7R. This well showed that out of the approximately 8.5 days the transducer was used to monitor the well, there were nine very clear drops in water level with many smaller magnitude drops. Some of these changes in water level were as much as 4.5 feet. A bedrock pumping well associated with the car wash directly across Leland Street is likely the cause of these cyclical changes. This conclusion is based on the data which show that monitoring well GZ-7R is closest to the bedrock well, it displays the greatest response in water levels and the periodic decline in water levels coincide with daylight hours when the car wash would be more heavily utilized.

The other two bedrock wells, GZ-4R and GZ-15R also display the cyclic effects of outside pumping on the bedrock aquifer. The magnitude of water level oscillation in these wells is far less at approximately 0.1 foot. This is as expected given that GZ-4R and GZ-15R are significantly further away from the car wash well (approximately 1,200 and 1,500 feet, respectively).

4.40.3 Pumping Influence on the Silty Sand Unit

The two wells on the Kinnarney property (GZ-19DD and CDW-19), which were monitored using transducers, also showed oscillating water level fluctuations due to the outside pumping well. The period of oscillation and magnitude (0.1 foot) is nearly identical to those discussed in the bedrock section above.

GZ-7, adjacent to GZ-7R is screened from 38 to 43 feet bgs in the glacial till. At this location, there appears to be a till hill which falls off sharply to the southeast toward EW-1. There was clearly a response to pumping of EW-1 in this well. The response appears to be delayed by approximately 40 minutes (that is, responses occur in this well 40 minutes later than the event in EW-1). In addition, there is also an affect on GZ-7 due to the car wash well. The observed drawdown in GZ-7 was approximately 0.2 to 0.3 feet during the 14 gpm test. Although there was a response at GZ-7 to pumping EW-1, it appears that either the car wash well has muted the response, or the slow drainage of groundwater from the till to the lower silt has muted the response.

4.40.4 Pumping Influence on the Sand Unit

The two wells monitored along the railroad tracks (CDW-3 and CDW-5) and CDW-1 on the GCC property adjacent to the railroad tracks also showed the oscillating water level fluctuations due to a pumping source other than EW-1. The responses in these wells were very slight but clearly evident. Most likely, these responses were masked in wells close to EW-1 due to greater drawdown from pumping of EW-1.

4.40.5 Aquifer Hydraulic Properties

Based on the above discussion, the long -term yield of the aquifer materials screened above the till at EW-1 ranges between 14 and 16 gpm. The upper sand unit and the lower silt unit have quite different hydraulic properties. During the pumping test, the lower unit responded more as a confined unit. This is evidenced by rapid pumping response in the lower zone and the low storativity values.

Time versus drawdown data from the 14 gpm test was used to estimate transmissivity values in each hydraulic zone. The 14 gpm data were used given that the proposed well pumping rate for the treatment system is closer to 14 gpm. Standard hydraulic curve matching techniques were applied using the computer program AquiferTest (Waterloo Hydrogeologic, v. 3.01). The Theis and Cooper-Jacob curve matching methods were employed in these analyses. Results are tabulated on Table I-3. Plots of Theis curve matching data and Cooper-Jacob straight line matches are shown in Appendix I.

When using a single well to pump from two hydraulic zones with different hydraulic conductivities (and therefore differing responses to pumping), the flow rate and saturated thickness used in the equations to estimate hydraulic properties must be adjusted proportionally. For this situation, the following apportionment was used:

	Saturated Thickness	Assumed Flow From Unit
Upper Sand Zone	12 feet	11 gpm
Lower Silty Sand Zone	30 feet	3 gpm

Results show an average transmissivity of 1,338 ft^2/day in the upper sand zone and 118 ft^2/day in the silt unit. Combined, the estimated bulk transmissivity of the two zones above the till at EW-1 is approximately 1,456 ft^2/day.

4.40.6 Capture Zone Analysis of EW-1

The transmissivity estimated in the previous hydraulic analysis can be used to estimate the likely capture zone for well EW-1 when it is pumped at its maximum sustained yield. Two steps were performed to predict the resulting capture zone for EW-1 while pumping at 14 gpm. First, the groundwater elevation contours (based on data collected at the very end of the 14 gpm pumping phase) are drawn. Second, the transmissivity estimate for the saturated zone above the till is applied to known capture zone equations to predict the size of the capture zone. Specifically, the equations are used to predict the lateral capture area (the distance crossgradient from the pumping well in which water is drawn to the well) and the stagnation distance (the distance downgradient of the pumping well that water will be drawn back to the well). The shape of the capture area is typically a parabola in a uniform flow field. Therefore, the maximum upgradient capture area is four times the lateral capture area described above. Knowing these points and applying them to the 14 gpm groundwater elevation contour plan allows the construction of the estimated capture area for EW-1 at 14 gpm.

The 14 gpm contour plans and capture zones for the sand and silt units are illustrated in Figures I-1 and I-2, respectively. The estimates of lateral capture and stagnation distance in the sand unit are about 50 feet and 30 feet, respectively (Table I-4). Lateral capture and stagnation distance estimates for the silt unit are about 100 feet and 60 feet respectively, and are also presented on Table I-5.

Capture zone estimates are directly proportional to the non-pumping hydraulic gradient. Because there is little hydraulic head data in the lower zone in the line of flow near EW-1 (the two wells in the lower silt are crossgradient of each other), an accurate gradient is difficult to ascertain. Therefore, the capture zone estimate is considered an approximation.

The upgradient maximum capture areas are also presented on Table I-4. These maximum upgradient zones typically vary from that computed due to variability in the actual flow conditions in the field. There is slight radial flow off of the GCC facility which reduces somewhat the width of upgradient capture from the predicted value which assumes uniform, linear flow. For this case, the actual maximum width of upgradient capture is best defined by the pumping groundwater elevation contours, as shown on Figures I-1 and I-2. This represents the best initial estimate as to the long-term capture area for EW-1 at 14 gpm. The actual capture zone under long-term conditions will change due to precipitation events and potential boundary conditions that may be encountered as the drawdown cone of depression extends outward as the well reaches steady-state conditions.

4.40.7 Capture Zones for the Hydraulic Containment System

The hydraulic containment system is based on capturing the full width of the contaminant plume as illustrated on Figures 8 and 13. The capture zone estimates encompass a wider zone in the silt unit due to the stratified, semi-confined nature of this deposit. For design purposes, however, the full-scale system should be designed based primarily on the smaller capture zone estimate. While the extent of the more expansive capture in the lower zone is an approximation, as discussed above, this drawdown will serve to drain the upper zone at steady state conditions, thus extending the overall capture zone.

Based on results of the 14 gpm pumping test, we have extrapolated the capture zones of well EW-1 to predict the number and spacing of additional wells required to capture the entire plume width. At the actual line of containment, the capture width of one well would be twice the lateral capture estimate of 50 feet (EW-1 pumping test) or 100 feet. The mapped crossgradient plume width at the location of EW-1 (Figure 12) is approximately 500 feet. At first glance, therefore, five to six wells would be required to contain the entire plume width. However, this calculation does not account for the added capture due to pumping from the lower unit. Therefore, the well spacing was set to be 20 percent greater than the estimated capture width for the upper unit only.[2] In addition, the optimal final spacing of wells should achieve full capture while limiting, to the extent possible, the quantity of groundwater extracted from outside the contaminant plume. This design constraint is significant on this Site given the proximity of the wetlands. This is accomplished by not placing the wells on the perimeter of the plume adjacent to the edge, but inward a distance of approximately one half of the expected capture zone width. Using this model, the total number of extraction wells required to provide full capture of the contaminant plume would be:

$$\text{Number of wells required to provide plume capture} = \frac{500\text{ feet}}{120\text{ feet (}120\%\text{ capture width)}} = 4\text{ wells}$$

Therefore, the final system should include four extraction wells screened across the sand and silt units, extending to the top of the glacial till, placed crossgradient to flow, at a spacing of about 120 feet. The total flow will be somewhat less than 56 gpm (14 gpm x 4 wells) due to superposition affects. However, 50 gallons should be the minimal design flow rate for a proposed remedial system. The remedial system design is provided in the Stabilization Measure Report, submitted concurrently with this report.

[2] Even in strictly unconfined aquifers, significant added overlap of individual well capture zones is achieved through superposition of the individual drawdown cones.

5.00 REVISED CONCEPTUAL SITE MODEL (CSM)

5.10 CONCEPTUAL SITE MODEL

The new data, as summarized in the above sections, has been used to update/upgrade our collective understanding of the Site. These new data, in general, have not required a substantial modification to the CSM. Rather, the data have been used to refine the Model. The only exception to this general statement is related to the groundwater flow direction in the bedrock. While all of the data still demonstrate that the bedrock is not contaminated,[3] the flow direction has changed from a presumed southeast direction (consistent with the overburden flow direction) to a northeast to southwest direction. As detailed more fully in subsequent sections, this change in flow direction, as well as the variability of the direction over time, is apparently due to a previously unreported[4] industrial bedrock pumping well.

The following sections present the CSM in outline form.[5] The outline is organized starting with a description of the nature and extent of the contaminant sources, followed by a description of the groundwater hydrology, and then concluding with a summary of contaminant fate and transport. Given that this is a supplemental assessment report, much of the detail covered in the May 2000 Interim CARP II will not be repeated herein; rather, the description of the CSM will build on the previous work and focus on the refinements to the Model.

5.20 CONTAMINANT SOURCE

The most logical starting point for development of the CSM is a description of the nature and extent of the source(s) of the contamination found on the Site. The Facility history, as summarized in Section 2.00, along with the magnitude and distribution of the contamination found on and off Facility, indicate that the primary sources of concern are chlorinated DNAPLs.

- Primary sources of the release are attributable to undocumented leaks and spills of separate phase chlorinated solvents. While the facility was originally a fuel oil storage

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[3] It is noted that monitoring well GZA-15R did show trace levels of two VOCs; chloroform, at 13 ppb, which is not a Site COC and is commonly found at these levels due to "contamination" of the groundwater by infiltration of chlorinated municipal drinking water, and toluene below drinking water standards at 10 ppb.

[4] The existence of municipal and/or industrial groundwater pumping wells in the vicinity of the site was previously researched. The Town of Framingham indicated that no pumping wells existed proximate to the Site. However, subsequent to the acquisition of unexplained transducer data during the pumping test, further research with the same Town departments found that an industrial pumping well did in fact exist across Leland Street from the GCC Facility. We have attempted to gain access to the drilling log for this well from both the Town and the well owner for over two months without success (the Town indicates that it has misplaced its record copy of the log and the well owner has not responded to requests for information). This effort will be continued in an attempt to close this data gap.

[5] An outline form was chosen for presentation of the CSM in the belief that this would better clarify which are the major findings as well as identify the supporting data for each major finding.

terminal prior to 1960, petroleum contamination is relatively minor and primarily confined to the Facility.[6]

- As evident from the groundwater VOC data presented in Figure 8, the primary contaminants are:

  - PCE (red) in the area of FW-14, FW-13 and ERM-4.
  - TCE (orange) upgradient of CDW-5 and CDW-7.
  - 1,1,1-TCA (green) in the area of FW-1, CDW-1, and FW-14.
  - Dichloromethane (blue, along w/ other compounds) upgradient of CDW-6 and CDW-12.

  While cis-1,2-DCE (yellow) is prevalent both on and off Facility, it is believed from the Facility history that this common breakdown product of both PCE and TCE evidences natural attenuation of these releases and is not due to a separate release of cis-1,2-DCE.[7]

- Figure 9 shows the locations where DNAPL has been identified based on groundwater concentrations greater than 10 percent of the solubility limit for the specific compound,[8] PID readings greater than 1,000 parts per million by volume (ppm-v/v) from soil samples and/or elevated soil sample laboratory analytical data. While the data show substantial overlap, "primary areas" have been delineated for individual DNAPLs where the existing data indicate prevalence of a specific compound. However, it is probable that other locations on the Facility also contain additional DNAPL deposits.

  - PCE is the only compound for which DNAPL has actually been quantitatively detected in a sample, as indicated by a groundwater sample from FW-14 which yielded a PCE concentration well over the solubility limit for this compound. Numerous soil samples from boring GZ-1, installed adjacent to FW-14, exhibited PID levels indicative of DNAPL from the surface to near the top of the till. Laboratory analysis of samples from this boring, as well as borings CDW-P16 through CDW-P20 and CDW-3, show that the primary constituent is PCE. This

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[6] As provided in further detail in the April 2001 AMR, the Decision mandated off-Facility EPH/VPH sampling data show: (1) No EPH detected, (2) only low levels of VPH detected, but consistent with interferences associated with the chlorinated VOCs, and (3) no significant levels of 8260 petroleum analytes detected.

[7] Records indicate that DCE was not stored at the Facility. It is further noted that DCE is manufactured as the trans-1,2 isomer. The data from the Site show a much higher prevalence of the cis-1,2 isomer which is consistent with environmental degradation of TCE. As such, we have a high degree of confidence that the DCE found on the Site is not attributable to a separate DCE release.

[8] It is noted that the standard test to indicate the presence of DNAPL is groundwater concentrations exceeding 1 percent of the solubility limit for the compound in question. However, given the ubiquity of high groundwater concentrations on the Facility, this more stringent test (>10 percent, as designated by red shading of the monitoring wellscreen) was used to help elucidate the primary source locations. For wells where the groundwater has yielded VOC concentrations greater than 1 percent but less than 10 percent, the wellscreen has been shaded orange.

conclusion is further supported by the historic groundwater concentrations of PCE in wells CDW-3, FW-13 and ERM-4. This primary PCE DNAPL area is consistent with the location of the former ASTs.

- TCE appears to exist as DNAPL on the Facility primarily in the CDW-5/CDW-7 area[9] given groundwater concentrations over 10 percent of the solubility limit for this compound in CDW-5. TCE also appears to be the primary DNAPL in this area based on the soil sample laboratory analytic data from CDW-5 and CDW-7. This primary area of TCE DNAPL is coincident with the location of the former rainwater/spill collection system.

- 1,1,1-TCA also appears to exist as DNAPL on the Facility, primarily in the area of FW-1, CDW-1 and FW-14, based on the high groundwater concentrations for this compound. This conclusion is further supported by the soil laboratory analytic data from borings CDW-P13, CDW--P14 and CDW-P15. As is the case for PCE, the primary 1,1,1-TCA DNAPL area appears to be coincident with the former AST area, but somewhat farther to the northeast of the PCE area.

- Dichloromethane exists at high concentrations primarily in monitoring wells CDW-6 and CDW-12. However, the concentrations do not exceed 1 percent of this compound's solubility limit. As such, it does not appear that dichloromethane exists on the Site as a DNAPL. This conclusion is further supported by the relative dearth of high concentrations in the laboratory soil analytical data.

- As discussed above, it is believed that cis-1,2-DCE is a breakdown product and not a separate release. This conclusion is supported by the relatively low groundwater concentrations, as compared to the solubility limit for this compound. The maximum concentrations currently measured in the monitoring wells generally do not exceed 1 percent of the solubility limit.[10] Therefore, it is not likely that this compound exists as DNAPL on the Site. This conclusion is further supported by the lack of high cis-1,2-DCE concentrations in the laboratory soil analytic data for on-Facility borings.

• As DNAPL, chlorinated solvents have the ability to penetrate the water table and move downward in the subsurface. This vertical migration is more heavily governed by gravity forces than by groundwater gradients. As such, DNAPLs tend to move down slope on the surface of lower permeability deposits such as the silt/silty clay and glacial till units.[11] The potential for off-Facility DNAPL migration was therefore investigated as follows:

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[9] A smaller, less significant TCE area also appears to exist in the vicinity of boring GZ-3.

[10] Cis-1,2-DCE has routinely been found at somewhat over 1 percent of its solubility limit in monitoring wells CDW-6 and CDW-12. However, these wells are immediately downgradient of well CDW-5, which has historically shown very high concentrations of TCE (over 30 percent of its solubility limit). It is also noted that the relative proportions of cis-1,2-DCE increase with downgradient groundwater flow from CDW-6 to CDW-12, while the TCE concentrations decrease.

[11] As discussed subsequently in the section describing the potential for DNAPL penetration of the glacial till layer, all of the data demonstrate that the DNAPL has not penetrated the glacial till and therefore has not

5.20.1 Silt/Silty Clay Deposit

Geophysical investigations were performed to map the top of the silt/silty clay, till and bedrock deposits.

- As shown on Plate 2 in Appendix H, the uppermost surface of the low permeability silt/silty clay deposit generally slopes both to the southwest toward the railroad tracks and to the southeast toward the school property. A relatively flat zone exists in the area of the former ASTs (PCE and 1,1,1-TCA DNAPL areas). The deeper silty clay portion of this deposit only slopes from the facility toward a "depression" to the southeast, in the vicinity of boring GZ-2 (see Plate 4 in Appendix H).

- Borings GZ-2 and GZ-3 were performed to investigate the slope to the southeast for potential DNAPL migration. GZ-3, located on the Facility property, encountered evidence of DNAPL in the soils at depths ranging from about 10 to 25 feet. The DNAPL appears to be located within both the sand and silt deposits. This boring showed no evidence of DNAPL at greater depths. Boring GZ-2, located farther down-slope near the center of the "depression," showed no evidence of DNAPL and only very limited evidence of contamination. These data indicate that the DNAPL has not migrated off Facility along the top of, or through the silt/silt clay deposit in the southeastern direction.

- Boring GZ-1 was performed in the most highly contaminated DNAPL area on the Facility in the down-slope direction to the southwest. This area contains primarily PCE DNAPL which is the heaviest DNAPL (PCE, specific gravity of 1.6) found on Site. Evidence of DNAPL was found throughout the sand and silt/silt clay deposits. Subsequently, boring EW-1 was performed further down-slope in the most contaminated portion of the off-Facility groundwater plume. Continuous sampling of the soil deposits was performed to investigate if the DNAPL found on the Facility had migrated off Facility to the southwest in the silt/silty clay deposit. Both the PID data and the laboratory analytic data for the soil samples indicated that DNAPL was not present in this off-Facility boring.[12]

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encountered the bedrock. Therefore, the bedrock surface topology, which generally mimics the till topology (see Plate 8 of Appendix H), has no significant impact on contaminant migration. It is the till surface that controls DNAPL migration direction.

[12] It is noted that EW-1 only verifies the absence of DNAPL off- Facility to the southwest at one location. Given the depth of DNAPL penetration along the southwestern trending slope (GZ-1), along with the trough in the surface of the glacial till deposit (see subsequent discussion), additional data need to be collected to further verify the absence of DNAPL off Facility. Specific additional areas of concern include: (1) to the northwest of EW-1, downgradient of the primary TCE DNAPL area (downgradient of CDW-5 and CDW-7), and (2) to the southeast of EW-1, directly downgradient of the primary PCE DNAPL area (GZ-1 area). These data gaps will be addressed during the installation of the additional extraction wells proposed as part of the stabilization measure. Continuous soil sampling will be included during the drilling of these wells.

5.20.2 Glacial Till Deposit

As shown on Figure 10, the top of the glacial till deposit slopes from the facility to the southwest. As discussed above for the silt/silty clay deposit, boring GZ-1 was performed in the most highly contaminated DNAPL area on the Facility. This boring is located on the slope and shows DNAPL has penetrated the sand and silt/silty clay deposits and reached the top of the till surface. Given that the till is believed to be generally more continuous and less permeable than the silt/silty clay deposit, the potential exists for DNAPL to migrate down-slope on the till surface.

- The geophysical mapping shows that the till surface forms a northwest to southeast trending trough. The general axis of the trough is penetrated by off-Facility borings EW-1, GZ-14 and GZ-17. The deepest portion of the trough is coincident with boring GZ-14.

- Boring EW-1 is located generally down-slope from boring GZ-1. This boring was specifically extended into the top of the till deposit to look for the presence of DNAPL. No evidence was found to indicate that the DNAPL had migrated off Facility to this point.

- Borings GZ-14 and GZ-17 were similarly extended into the top of the till. These borings also confirm that the DNAPL has not migrated off Facility to these locations. All three of these borings are located in the low spots in the till surface.

- As exemplified by boring GZ-1, the DNAPL has penetrated the silt/silty clay deposit on the Facility. This condition surely exists in numerous other locations on the Facility as indicated by the high groundwater concentrations at depth along the axis of the plume off Facility in the silt/silty clay deposit (e.g. GZ-19DD.) This conclusion is further supported by the increasing groundwater concentrations with depth as shown in several monitoring well clusters CDW-18, CDW-19/GZ-19DD and GZ-14. However, all of the data indicate that the DNAPL has not penetrated the till deposit, and therefore has also not entered the bedrock. These data are presented graphically on Figure 10.

  - GZ-1 was performed using double casing methods and drilling mud specifically to investigate if DNAPL had penetrated the till deposit.[13] The data show that while DNAPL exists proximate to/on top of the till surface, it has not penetrated a significant distance into the till deposit. This conclusion is supported by the PID soil data which show a PID reading of over 1,000 ppmv above the till surface and not detected (ND) at a depth of only 2 feet into the till deposit.

[13] The boring and well installation methods used for GZ-1are described in the Interim CARP II of May 2000.

- The PID readings from GZ-1 were then confirmed with laboratory Method 8260 soil analytical data, which yielded a total VOC value of ND.

- Finally, a groundwater monitoring well was installed in GZ-1 from 9 to 15 feet into the till. This well also yielded a total VOC value of ND.[14]

- Figure 10 also graphically summarizes all the glacial till PID data. These data show that PID readings decrease to less than 3 ppm-v/v at depths less than four feet, thus further confirming that DNAPL has not penetrated the till deposit.[15]

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5.30 GROUNDWATER HYDROLOGY

Overall, the Site hydrology can be characterized as governed by shallow upland flow from three directions (the southwest, northwest and northeast) towards a lowland containing wetlands and a surface water drainage ditch, which flows to the southeast and discharges into a northeast flowing stream. The stream, Course Brook, forms a divide between the Site and Sherborn to the southeast. This relatively simple flow pattern in the shallow overburden is somewhat confounded by groundwater extraction from what is believed to be an industrial bedrock pumping well proximate to the upgradient (northeastern) end of the Site. The pumping causes a reversal of the normal flow direction in the bedrock, which then reverses the vertical gradients over portions of the Site. The magnitude of the vertical gradient reversals on the northwestern portion of the Site is time dependent over a short time scale due to the cyclic nature of the pumping.

Further detail relative to groundwater flow is provided on the groundwater elevation contour figures, as described below. These figures include: contours of "wet season" (spring) piezometric heads for the upper, high permeability sand deposit (Figure 11A) and the deeper, low permeability silt/silty clay and till deposits (Figure 11B); contours of "dry season" (late summer/fall) piezometric heads for the upper, high permeability sand deposit (Figure 11C) and the deeper, low permeability silt/silty clay and till deposits (Figure 11D),[16] and bedrock flow direction for all monitoring rounds after the third bedrock well was installed (Figure 11E). The contour plans also include groundwater flow lines which are color-coded relative to the source area from which they originate; red for groundwater originating in the area where PCE is the primary source, orange for groundwater originating in the area where TCE is the primary source, and blue where the

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[14] It is noted that the last sampling round yielded a total VOC value of 238 ppb. It is believed that this discrepancy is due to cross-contaminated samples. This issue will be addressed as a data gap with resolution via additional sampling and analysis conducted during the next AMP sampling round.

[15] It is noted that additional borings will be required to further confirm this conclusion. This data gap will be addressed via the installation of additional borings associated with the stabilization measure. Specific additional areas of concern include: (1) to the northwest of EW-1, downgradient of the primary TCE DNAPL area (downgradient of CDW-5 and CDW-7), and 2) to the southeast of EW-1, directly downgradient of the primary PCE DNAPL area (GZ-1 area). Continuous soil sampling, along with Sudan IV dye testing, will be included during the drilling of these wells.

[16] It is noted that additional quarterly contour plans are provided in the AMP reports. However, it is noted that most of these data sets do not include the full complement of monitoring wells given the installation dates of some of the wells.