8976 Wellington Road
Manassas, VA 20109

March 11, 2010

Robert C. Knizek, P.E.
Director, Remedial Bureau E
Division of Environmental Remediation
New York State Department of Environmental Conservation
625 Broadway
Albany, NY 12233-7013

Re: Transmittal Supplemental Remedial Investigation Report
Operable Unit #5/Building 57 Area
Order on Consent Index # A7-0502-0104, Site # 704014, Endicott, New York

Dear Mr. Knizek:

The attached Supplemental Remedial Investigation Report for Operable Unit #5, the Building 57 Area, summarizes our findings of remedial investigation activities conducted at OU#5 from 2005 through 2009.

Should you have any questions, please contact me at 703-257-2587.

Sincerely,

M. E. Meyers

Mitchell E. Meyers
Program Manager

cc: K. Lynch, NYSDEC Region 7
D. Tuohy, NYSDEC – Albany
G. Litwin, NYSDOH – Troy
C. Edwards, Broome County Health Department
C. Pelto, EIT

Encl. Report

SANBORN, HEAD ENGINEERING, PC
20 Foundry Street ▪ Concord, NH 03301
P (603) 229-1900 ▪ F (603) 229-1919

March 11, 2010
File No. 2466.02

Mr. Mitchell Meyers
IBM Corporate Environmental Affairs
8976 Wellington Road
Manassas, VA 20110

Re: Supplemental Remedial Investigation Report
Operable Unit #5/Building 57 Area
Union and Endicott, New York
AOC Index # A7-0502-0104, Site # 704014, Endicott, New York

Dear Mr. Meyers:

Enclosed please find the report of findings of the Supplemental Remedial Investigation (SRI) for the Building 57 Area. This report summarizes findings from SRI explorations and assessments conducted between 2005 and 2009 at the subject site and neighboring properties, according to work plans submitted and approved over the course of the investigation. Findings have been periodically discussed with the New York State Departments of Environmental Conservation and Health. We understand that this report will be submitted to these agencies.

We greatly appreciate the opportunity to be of service to IBM on this project. Please contact us with any questions.

Very truly yours,
SANBORN, HEAD ENGINEERING, PC

Jonathan Ordway, P.E.
Senior Associate Principal
Sanborn, Head & Associates, Inc.

Daniel Carr, P.G., P.E.
Vice President and Principal
Sanborn, Head Engineering, P.C

LJJ/JO/DBC:ljj

Encl. Report

SANBORN, HEAD ENGINEERING, PC
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Report of Findings
Supplemental Remedial Investigation
Operable Unit #5/Building 57 Area
Union and Endicott, New York

Prepared for
IBM Corporation

Prepared by
Sanborn, Head Engineering, P.C.

File 2466.02
March 2010

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FIGURES

APPENDICES

LIST OF ABBREVIATIONS, ACRONYMS, AND SYMBOLS

Agencies	NYSDEC and NYSDOH together
AOC	Administrative Order of Consent Index #A7-0502-0104
ASTs	Above ground storage tanks
B57 Area	Building 57 Area Source Zone
B57A Area	Building 57A Area Source Zone
Building 57/57A property	Largest OU#5 property containing Buildings 57 and 57A (Tax parcels 141.82-1-15 and 141.82-1-16)
CFC-113	Freon®-113
CFC Area	Former CFC-113 AST Area Source Zone
CFCs	Chlorofluorocarbons including CFC9-113, CFC-123a
DCE(1,1)	1,1-dichloroethene
Ethanes	Chlorinated ethanes including: TCA(1,1,1-), DCA(1,1-), DCE (1,1)
Ethenes	Chlorinated ethenes including: PCE, TCE, cDCE(1,2-), VC
IBM	IBM Corporation
IRMs	Interim Remedial Measures
IRM Summary Report	Interim Remedial Measure Evaluation Summary Report
ISTD	In situ thermal desorption
Lot 26	Huron Lot No. 26 (Hayes Avenue Parking Area) Source Zone
Lower WBZ	Saturated zone between bedrock and bottom of site silt and clay aquitard
MNA	Monitored natural attenuation
NYSDEC	New York State, Department of Environmental Conservation
NYSDOH	New York State, Department of Health
Operable Unit #5	Area referred to by the AOC as the four Building 57 properties
OU#5	Operable Unit #5
Principal Site VOCs	Ethenes, ethanes, and CFCs
SAE	2005 Source Area Evaluation
SHA	Sanborn, Head & Associates, Inc.
SHPC	Sanborn Head Engineering, P.C.
SRI	Supplemental Remedial Investigation
SVE/DPE	Soil vapor and/or dual-phase extraction
SVOCs	Semivolatile organic compounds
TCA	Trichloroethane (1,1,1-)
TCA Area	Former TCA AST Area Source Zone
TCE	Trichloroethene
The site	Operable Unit #5
Upper WBZ	Saturated zone above site silt and clay aquitard
VOCs	Volatile organic compounds
Waste Solvent Area	Former Waste Solvent Area Source Zone
WBZ	Water-Bearing Zone

1.0 INTRODUCTION

This report presents the findings of the Supplemental Remedial Investigation (SRI) of the Operable Unit No. 5 (OU#5), also known as the Building 57 site. The Building 57 site was part of the former IBM Endicott facility. On behalf of the IBM Corporation (IBM), the investigation was conducted and completed by Sanborn, Head Engineering, P.C. (SHPC), with assistance from Sanborn, Head & Associates, Inc. (SHA). It was conducted and prepared pursuant to Administrative Order on Consent Index # A7-0502-0104 (AOC) between the New York State Department of Environmental Conservation (NYSDEC) and IBM, executed on August 4, 2004 and effective on August 14, 2004.

SRI activities and testing began following approval of the September 9, 2004 Work Plan[1]. Project work was conducted in accordance with the Work Plan and the AOC, with oversight by NYSDEC and the New York State Department of Health (NYSDOH; together, Agencies). The scope and focus of investigations have increased and evolved since the submittal and approval of the Work Plan, as discussed with the Agencies over the course of the SRI. Interim data and findings have been reported to the Agencies as detailed below. The purpose of this document is to summarize the scope and generalized findings of the SRI activities completed to date. This report is subject to the Limitations presented in Appendix A.

The SRI was conducted with the following objectives:

- To identify and characterize the nature and extent of potential on-site sources of volatile organic compounds (VOCs), in particular chlorinated volatile organic compounds (CVOCs), that appear to be responsible for the presence of CVOCs detected in groundwater and subsurface vapor in the vicinity, and downgradient of the site.

- To assess the hydrogeology of the OU#5 area relative to the potential transport and fate of VOCs, and

- To provide a preliminary screening of source mass removal technologies and strategies. Documentation of preliminary technology screening was provided in the October 2008 Initial Remedial Technology Screening Report[2] and is not included in this report.

Over the course of investigation, analytical data have been presented to the Agencies in the form of Analytical Summary Reports, according to the requirements of the AOC. Data and findings have also been presented in interim reports and during presentations. Interim and related reports have included:

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[1] Sanborn, Head Engineering, P.C., September 9, 2004, "Work Plan for Source Area Evaluation, Supplemental Remedial Investigation and Focused Feasibility Study, Operable Unit #5 – Building 57 Area, Union and Endicott, New York."

[2] Sanborn, Head Engineering P.C., October 24, 2008, "Interim Report of Findings, Initial Remedial Technology Screening, Supplemental Remedial Investigation, Operable Unit #5/Building 57 Area, Union and Endicott, New York."

- Source Area Evaluation (SAE) Report (September 9, 2005)[3];
- Groundwater Extraction and Treatment Test Report (June 16, 2006)[4];
- Interim Report of Findings, Initial Remedial Technology Screening Report (October 24, 2008);
- Dual-Phase and Soil Vapor Extraction Pilot Testing Summary Report (September 29, 2009)[5];
- Bioattenuation Study Report (February 9, 2010)[6]; and
- Interim Remedial Measure (IRM) Evaluation Summary Report (February 16, 2010)[7].

This report serves as a transmittal of data and interpretations that have been derived from SRI investigations and testing, much of which have been communicated to the Agencies in the documents outlined above. It is intended as a milestone marking a transition of the focus of work from investigations to remedial feasibility assessment and design. The focus of this report on source area characteristics reflects that a groundwater migration control measure is already in place, substantially limiting migration in groundwater; the future focus of work will be on source reduction. Due to private property access constraints, the recommended assessment of conditions to the east of the site has not been completed. If and when additional off-site assessment is performed, documentation will be provided as an addendum to this report.

2.0 BACKGROUND

OU#5 (shown on Figure 1) is located in the Town of Union in Broome County, New York, and is part of the former IBM campus. As shown on Figure 2, OU#5 comprises multiple parcels of land, including the approximate eight-acre property containing Buildings 57 and 57A, an approximate five-acre parking lot (Huron Lot No. 26), and two parcels located north of Building 57 (2107 and 2203 Wayne Street). The 2005 SAE and findings of initial SRI activities did not

[3] Sanborn, Head Engineering, P.C., September 9, 2005, "Source Area Evaluation, OU#5: Building 57 Area, Union and Endicott, New York, AOC Index # A7-0502-0104, Site # 704014, Endicott, New York."

[4] Sanborn, Head Engineering, P.C., June 16, 2006, "Report of Findings, Groundwater Extraction and Treatment Testing, Supplemental Remediation Investigations Operable Unit #5 (Building 57), Endicott and Union, New York."

[5] Sanborn, Head Engineering, P.C., September 29, 2009, "Dual-Phase and Soil Vapor Extraction Pilot Testing Summary Report, Supplemental Remedial Investigation, Operable Unit #5/Building 57 Area, Union and Endicott, New York."

[6] Sanborn, Head Engineering, P.C., February 9, 2010, "Bioattenuation Study Report, Supplemental Remedial Investigation, Operable Unit #5: Building 57 Area, Union and Endicott, New York."

[7] Sanborn, Head Engineering, P.C., February 16, 2010, "Interim Remedial Measure Evaluation Summary Report, Supplemental Remedial Investigation, Operable Unit #5/Building 57 Area, Union and Endicott, New York."

suggest the presence or potential presence of contamination on the 2107 and 2203 Wayne Street parcels. Subsequent SRI activities have therefore been focused on the Building 57/57A property and Huron Lot No. 26. The site properties were formerly owned by IBM, and are currently owned by Huron Real Estate Associates, LLC.

As shown on Figure 3, and outlined below, there are six separate source zones that have been identified and assessed at the OU#5 site.

- **Building 57A Area (B57A Area)**: Located beneath the central portion of Building 57A where sampling indicates the presence of VOCs and petroleum compounds, although no historical processes, uses, or releases have been identified to explain the observed conditions. We believe the identified contaminants were present in this area prior to construction of Building 57A in the mid-1980s.

- **Former Waste Solvent Area (Waste Solvent Area)**: Located east-southeast of Building 57A where a former approximately 500-gallon waste solvent tank and a former solvent incinerator were apparently situated (the identification of these features is based on review of historical mapping).

- **Former 1,1,1-Trichloroethane (TCA) Aboveground Storage Tank (AST) Area (TCA Area)**: Located south of Building 57A where it appears that two approximately 35,000-gallon TCA ASTs were located (according to historical mapping and aerial photographs).

- **Former Chlorofluorocarbon-113 (CFC-113) AST Area (CFC Area)**: Located to the south of the loading dock between Buildings 57 and 57A where a former CFC-113 AST was located (according to historical mapping). Despite several efforts, the zone of groundwater sourcing (i.e., evidence of residual separate phase mass in soil) has not been identified.

- **Building 57 Area (B57 Area)**: Located beneath Building 57 where historical mapping identifies a vapor degreasing and oil quenching operation, and soil vapor survey data suggested an area of subsurface VOC presence. The available data indicated this area to be a *de minimis* source.

- **Huron Lot No. 26, also referred to as Hayes Avenue Parking Area (Lot 26)**: Located on the south side of the Conrail railroad tracks, south of Building 57 and southwest of Building 57A. Based on regional groundwater flow directions, regional stratigraphy, and SRI groundwater data from Lot 26 and upgradient locations, the VOCs detected in this area do not appear to be related to VOC releases below and around Buildings 57 and 57A, but an areally definable source zone has not been found despite relatively extensive assessment.

2.1 Physical Setting

The site is located near the northern floodplain of the Susquehanna River, which is located approximately 2,500 feet to the south. The Building 57/57A property is bounded to the north and east by Brixius Creek, which flows east from the site then turns south to discharge approximately 0.7 miles southeast to the Susquehanna River. According to review of historical topographic maps and aerial photos, the course of Brixius Creek has been substantially altered over time to its current alignment. Also according to review of historical mapping (as well as anecdotal information from site personnel and neighbors), drainage features associated with Brixius Creek were present below portions of Building 57A. The current footprint of the buildings was filled to its current elevation when the parcels were developed.

As the ground surface elevation contours on Figure 2 indicate, topography of Buildings 57/57A property is relatively flat, at about 842 to 845 feet above mean sea level. The ground surface rises steeply to the north, and localized steep slopes border Brixius Creek. The ground surface rises to the south across Lot 26. Surface drainage from the Building 57/57A property is collected in a storm sewer system and discharged to Brixius Creek at the northeast corner of the property. As shown on Figure 2, water has been observed to collect and pond in the northeast corner of Lot 26, in an area with no defined outlet.

Buildings 57 and 57A are “high bay”-type warehouse structures connected by an enclosed loading dock. The remainder of the Building 57/57A property is mostly paved, with narrow areas of vegetation along the south, east, and north property boundaries. Lot 26 is mostly paved, with narrow grass areas bordering North Street and Hayes Avenue.

2.2 Site Use History

Building 57 was constructed in the early- to mid-1950s, and was used for manufacturing. Building 57A was constructed in the late 1970s or early 1980s for warehousing, before which time the building footprint and surroundings were paved parking areas. Both buildings are currently used for warehousing/storage, the northern portion of Building 57 is also used for light manufacturing. The SAE report documents our current understanding of the historic use and storage of various substances including VOCs on the Building 57/57A property. These uses included:

- Storage of 111-trichloroethane (TCA) and chlorofluorocarbons (CFCs), including Freon®-113 (CFC-113), in ASTs located near the current loading dock (CFC Area) and south of the current Building 57A (TCA Area);

- Storage and incineration of waste solvents adjacent to the southeast corner of Building 57A (Waste Solvent Area), which pre-dates the building construction; and

- A vapor degreasing operation in Building 57 (B57 Area).

The inferred locations of ASTs and other site features associated with chemical use and storage are shown on Figure 2. Additional detail, including sources of historic information, is provided in the SAE report.

2.3 Surrounding Land Use

There are known and/or potential chemical uses associated with several neighboring or adjacent properties, which are identified in the SAE report and shown on Figure 2. These include:

- Catalyst Manufacturing (north of Building 57A);
- Endicott Research Group (northeast of Building 57A);
- A former junk yard (south of Building 57A); and
- Former auto body and small engine repair shops (south of the loading dock, and adjacent to the eastern boundary of Lot 26).

2.4 Remediation History

Prior to initiating the SRI, groundwater was extracted from well EN-89R and treated on-site, in the temporary Hayes Avenue Groundwater Treatment Facility (GTF). An extraction and treatment system has been operating in this area since 1997 to address the identification of CFCs in groundwater. As described in our 2008 Initial Remedial Technology Screening Report (referenced above), initial SRI findings identified the presence of VOCs in the lower WBZ near the downgradient property boundaries.

As part of the SRI, extraction wells EN-623 and EN-624 were installed in 2005, and the Hayes Avenue Groundwater Treatment Facility was upgraded to accommodate water extracted from these new wells. Initial testing, conducted in 2006, indicated that the enhanced extraction and treatment system could achieve hydraulic containment of the primary source zones (documented in our 2006 Extraction and Treatment Testing Report, referenced above). We note that the total extraction rate from the three wells is less than 3 gallons per minute. Due to the relatively small saturated thickness and low permeability, we estimate that the combined extraction rate is greater than the flow of groundwater that would otherwise be migrating from the source zones.

As documented in annual and semi-annual reports by Groundwater Sciences Corporation, expansion of the groundwater extraction system resulted in significant mass removal. Since the beginning of 2006 (through December 2009), approximately 560 pounds of VOCs have been removed from the combined extraction wells, with more than 80% of this total from EN-624 in the Waste Solvent Area.

In addition to mass removal through groundwater extraction, in situ mass destruction is occurring through biochemical degradation. We have completed an assessment of ongoing biochemical attenuation (including methods for potential enhancement), which was reported to the Agencies on February 9, 2010 (referenced above). We estimate that VOC degradation across the site is occurring (without enhancements) at a rate on the order of 20 pounds per year.

3.0 SCOPE OF WORK

The scope of work described in the original Work Plan included two phases of investigation; subsequent investigation activities were communicated to, and approved by, the Agencies through a series of Work Plan Addenda and approval letters chronicled in Appendix B. Exploration activities included:

- Soil gas sampling with mobile and fixed laboratory VOC analysis;
- Sub-slab soil gas sampling and VOC analysis;
- Drilling, soil sampling and analysis, and monitoring well installation;
- Multiple rounds of groundwater sampling and analysis;
- Hydraulic testing of individual boreholes;
- Groundwater elevation and flow mapping; and
- Groundwater extraction and treatment testing.

Detailed documentation of the SRI activities is also provided in Appendix B. A brief chronological summary is provided in Exhibit 1.

Soil boring, monitoring well, extraction well, dual phase monitoring well, and stream gauge locations are shown on Figure 4. There were too many soil gas sampling locations to show on the exploration location plan; therefore, the locations are documented separately in Appendix B. Field investigations were generally conducted according to the 2004 Work Plan and subsequent work plan addenda.

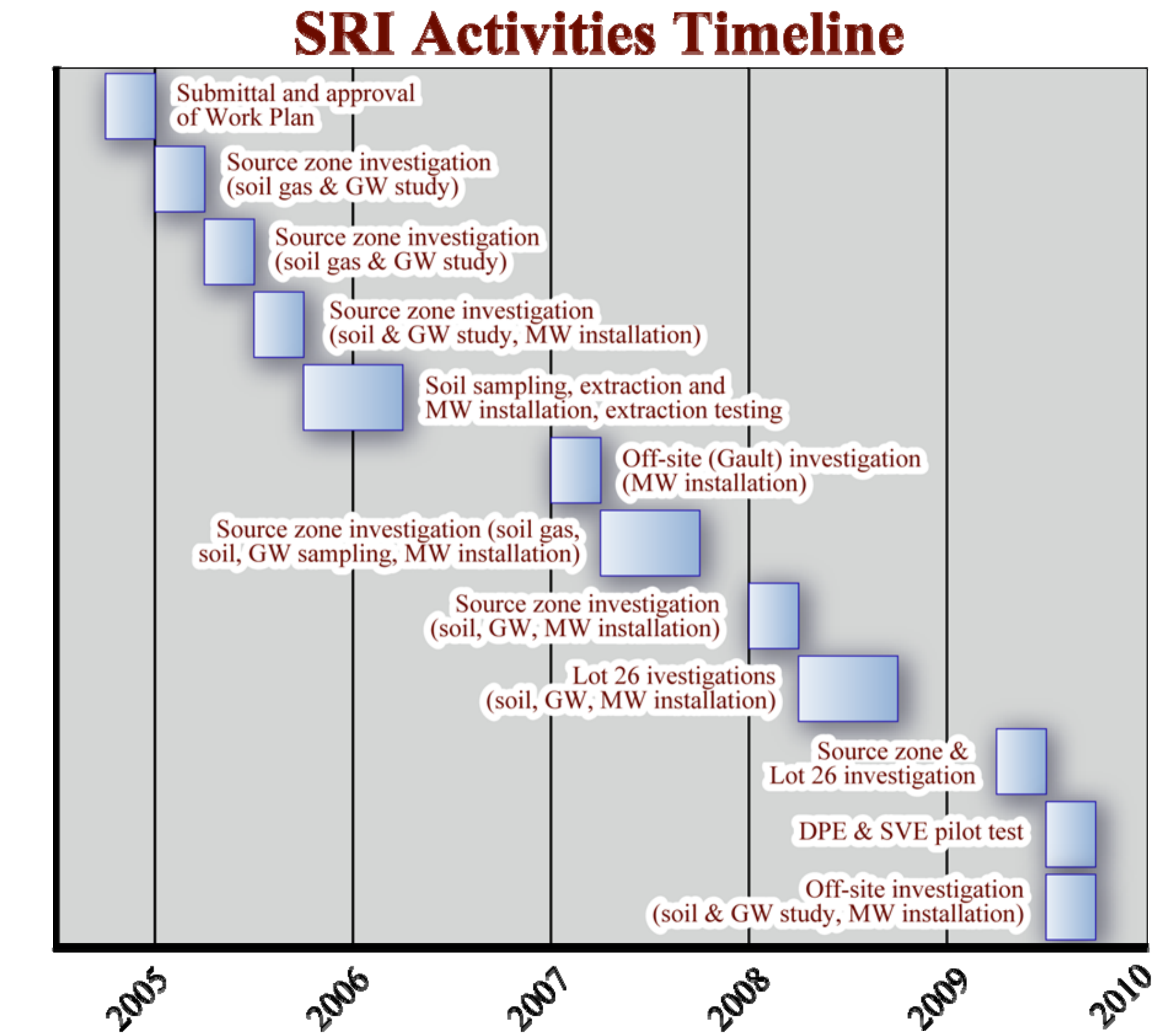

Exhibit 1. Chronological summary of SRI activities. More detail is provided in Appendix B.

All laboratory analytical data were validated and assessed for usability by New Environmental Horizons, Inc., prior to use for project decisions, with the exception of certain groundwater and soil gas grab samples that were used for screening purposes. Based on this assessment, we concluded that the data quality objectives outlined in the 2004 Work Plan were met. An overview of the usability of project analytical data is presented in Appendix C.

SHPC ENGINEERS

4.0 GEOLOGIC AND HYDROGEOLOGIC SETING

4.1 Regional Geology

The description of regional geology provided below is based on information presented in the Groundwater Assessment Report[8] and a United States Geological Survey publication by Holocek et al.[9] The Endicott area is located in the Susquehanna River Valley, which has been described hydrogeologically as a "two-aquifer system" within a glacial valley. The valley stratigraphy comprises glacial deposits, alluvial deposits and a regionally-present lacustrine silt and clay aquitard separating the "Upper Aquifer" and the "Lower Aquifer". Underlying bedrock is Devonian age Catskill Formation, comprising gray siltstone and shale, and occasionally limestone.

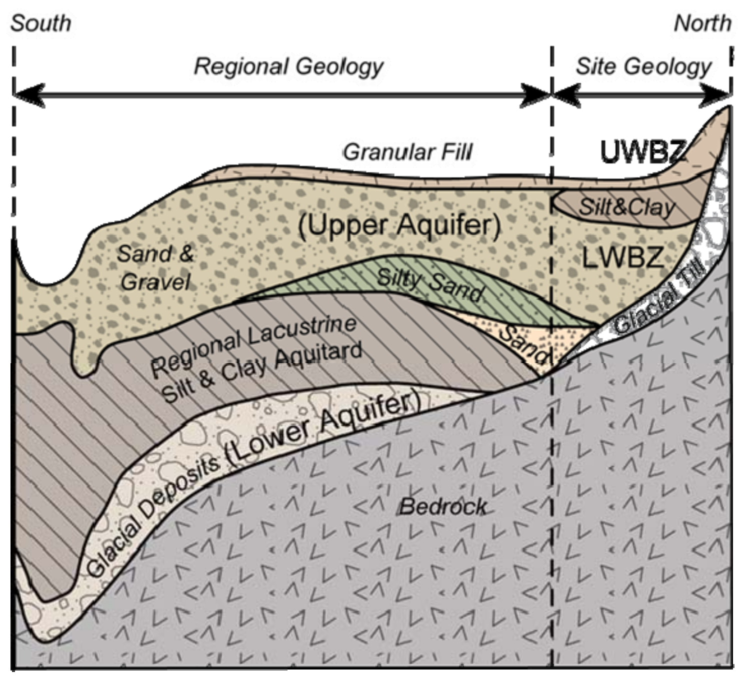

Exhibit 2. Generalized stratigraphy of Endicott area and OU#5.

In the Endicott area, the stratigraphic profile generally consists of bedrock overlain by glacial till, which is overlain by stratified, well-sorted, coarse-grained soil, overlain by a regional lacustrine silt and clay aquitard. This aquitard was not observed in some areas. "Outwash" sand and gravel overlies the regional lacustrine silt and clay aquitard.

4.2 Site Geology

As shown in Exhibit 2 the site is located near the northern boundary of the valley aquifer system. Although there are variations, as noted below, the generalized stratigraphy beneath the site consists of bedrock overlain by glacial till, overlain by alluvial deposits of silt, sand, and gravel, overlain by a local silt and clay aquitard, overlain by granular fill. The locations of geologic cross sections that represent the inferred stratigraphy of the site and surrounding areas are shown on Figure 5. Scaled geologic profiles are presented on Figures 6-A through 6-D.

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[8] Groundwater Sciences Corporation, May 2004, "Supplemental Groundwater Assessment Final Report, Village of Endicott/Town of Union, Broome County, New York."

[9] United States Geological Survey (USGS), T.J. Holocek, A.D. Randall, J.L Belli, and R.V. Allen, 1982, "Geohydrology of the Valley-Fill Aquifer in the Endicott-Johnson City Area, Broome County, New York." New York Geological Survey Open File No. 5K266, USGS Open-File Report 82-268.

The local silt and clay aquitard appears to be related to the alluvial history of Brixius Creek. Although the aquitard appears contiguous within the vicinity of the Building 57/57A property, it tapers out to the north and south as indicated in plan view on Figure 6 and in profile view on Figures 6-B through 6-D. As observed in borings within Lot 26 and on off-site properties to the south and southeast of Building 57A, the stratigraphy appears to transition toward the configuration described by others as the valley aquifer system.

The generalized stratigraphy, observed in soil borings across the site is represented in Exhibit 3. Exhibit 3A represents conditions typically observed north of the site. Exhibits 3B and C represent conditions typically observed in the central portions of the site and within the limits of the site silt and clay aquitard. Exhibit 3D represents the general conditions observed beneath Lot 26. The geologic cross sections illustrate the relatively high degree of stratigraphic variability in the vicinity of the site.

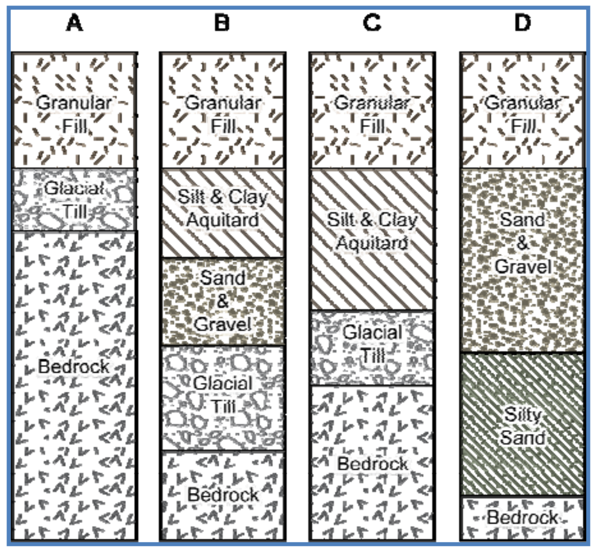

Exhibit 3. Generalized stratigraphy across the OU#5 site. See Figures 6-A through -D for more detailed cross sections.

A detailed assessment of physical properties of site soils, including grain size distribution, moisture content, organic carbon, and others, is described in Appendix D. These data were compiled and estimates were derived for physical properties to support data analysis over the course of the SRI, as well as development of the conceptual model of site conditions, summarized below.

4.3 Site Hydrogeology

The site silt and clay aquitard separates two water-bearing zones (WBZs), referred to hereinafter as the "upper WBZ" and the "lower WBZ." Where the site silt and clay aquitard is present, downward vertical gradients are consistently observed across the aquitard, suggesting that, in some areas, this unit limits the migration of VOCs between the upper and lower WBZs. Nevertheless, the detection of VOCs in the lower WBZ is evidence that there has been migration from the upper to the lower WBZ in some areas.

4.3.1 Silt and Clay Aquitard Surface and Upper WBZ Saturated Thickness

As shown on Figure 7, the surface of the site silt and clay aquitard generally slopes to the southeast, with local highs below the southern extent of Building 57 (in the area of well EN-602) and the southeastern corner of the Building 57/57A property (near wells EN-624 and EN-612).

Saturated thickness in the upper WBZ, above the aquitard surface, is inferred to range from 0 feet to 7 feet (as represented by shaded contours on Figure 7).

4.3.2 Upper WBZ Groundwater Elevations and Flow Directions

Groundwater elevation contours and inferred horizontal flow directions in the upper WBZ are shown on Figure 8. To assess the hydraulic communication between Brixius Creek and the upper WBZ, we installed data recording pressure transducers in two monitoring wells for a period of 30 days. We observed that upper WBZ water levels rise relatively quickly after it rains, which suggests that the upper WBZ is in hydraulic communication with Brixius Creek. The creek water surface has been observed to vary significantly during rain events such that during high flow periods, water is likely "recharged" into the upper WBZ; during low flow periods, groundwater is likely being discharged into the creek. The groundwater elevation contours shown on Figure 8 represent conditions when the creek level was low relative to the water table in the upper WBZ.

4.3.3 Storm Sewer Infiltration

VOCs were detected in samples from the outfall and manholes in a site storm drain that discharges into Brixius Creek. The VOC constituents were similar to those detected in groundwater, from which we inferred that VOC-containing groundwater was infiltrating the sewer. A remedial measure consisting of lining the storm sewer and manholes was completed by IBM in August 2009[10], and has appeared to limit further infiltration of groundwater into the storm sewer[11].

4.3.4 Glacial Till Surface and Lower WBZ Saturated Thickness

The surface of the glacial till is inferred to slope to the southeast, as shown on Figure 9. Although the till surface may influence groundwater flow directions to some degree, the till is relatively permeable in some areas and is considered to be part of the lower WBZ. Although there are areas where a poorly sorted sand and gravel is present below the silt and clay, there are also areas where the sand and gravel is relatively thin with clay "inclusions," or where the sand and gravel is not present. Within the Building 57/57A property, the effective thickness of the lower WBZ is generally limited to two to five feet, comprising varying proportions of silt, sand, and gravel, and (in some cases) the upper portion of the glacial till (see Figure 6-A).

[10] O'Brien & Gere, November 18, 2009, "Post Construction Documentation, Storm Drain Rehabilitation, Building 57A, IBM-Endicott, Endicott, New York."

[11] Sanborn, Head & Associates, Inc., February 9, 2010 letter to IBM, "Storm Sewer Confirmatory Sampling, Supplemental Remedial Investigation, OU#5/Building 57 Area, Union and Endicott, New York," submitted to the Agencies by IBM on February 9, 2010.

4.3.5 Hydraulic Properties of Upper and Lower WBZ

Both the upper and lower WBZs comprise relatively fine-grained, low-permeability soils. Estimates of hydraulic properties (provided in Appendix E) suggest low hydraulic conductivities in the upper WBZ, on the order of less than 0.1 to approximately 7 ft/day. Limited saturated thickness in the upper WBZ restricts the potential for lateral flow in these soil horizons. Given these observations, we infer that the overall lateral flow through the upper WBZ is relatively small.

Hydraulic conductivities of lower WBZ materials are generally higher than those in the upper WBZ, but still low in the context of groundwater flow through this area. As described in Appendix E, hydraulic conductivity values in lower WBZ soils are estimated to range from less than 0.1 ft/day (in the B57A Area) to approximately 11 ft/day (in the Waste Solvent Area). Hydraulic conductivities were observed to generally decrease from the Waste Solvent Area in a westerly direction, through the TCA and CFC Areas. This is consistent with higher extraction well yields from well EN-624, and lower yields from EN-623 and EN-89R.

Overall, groundwater flow through the lower WBZ is small, due to the combined effect of fine-grained, low-permeability material (low hydraulic conductivity) and limited saturated thickness. Although the rate of pumping from OU#5 extraction wells is relatively low (less than 3 gallons per minute combined), it is sufficient to capture most of the groundwater migrating through the identified source zones.

In areas south of the Building 57/57A property, both estimated hydraulic conductivities and saturated thickness increases (beyond the extent of the site silt and clay aquitard), as the stratigraphy transitions from site-specific geology to the regional “upper aquifer” noted above (see Figures 6-C and 6-D).

4.3.6 Lower WBZ Groundwater Elevations and Flow Directions

In response to the detection of VOCs in the lower WBZ groundwater near the downgradient property boundary, IBM expanded hydraulic containment at the site by adding extraction wells EN-623 and EN-624. These wells have been operating since January 2006 and influence groundwater elevations and flow directions in the lower WBZ. Documentation of the installation and startup of pumping from these wells is documented in the above-referenced Groundwater Extraction and Treatment Test Report (June 16, 2006).

Under ambient conditions (i.e., when the extraction wells are not being pumped), groundwater in the lower WBZ is inferred to flow generally south-southeast (as shown on Figure 10), and eventually toward the Susquehanna River. Extraction from wells EN-623 and EN-624 generates hydraulic gradients sufficient to “capture” lower WBZ groundwater that would otherwise migrate from the Waste Solvent, TCA, and B57A Areas. Inferred lower WBZ groundwater elevation contours under pumping conditions are shown on Figure 11, along with the inferred extent of hydraulic containment. An assessment of hydraulic capture is summarized in Appendix

F, with discussion of monitoring and hydraulic testing conducted during shut-down and start-up of pumping from OU#5-area extraction wells.

Review of groundwater elevations, monitoring the response to startup and shutdown of the pumps, and review of the extracted groundwater quality over time indicate that extraction at well EN-89R may not fully capture groundwater migrating from the CFC Area. The limited effectiveness of this extraction well is attributed to its low yield, which is likely a function of low hydraulic conductivity material and persistent biochemical fouling of the pump and well screen. Additional work is underway to add groundwater extraction capacity in the CFC area.

5.0 CONTAMINANT DISTRIBUTION

As we inferred from historical data and site use information, we have concluded through investigations and testing that CVOCs are the primary compounds of interest detected in site soil gas, soil, and groundwater. Analysis for potential non-VOC contaminants, including metals, petroleum hydrocarbons, and semi-volatile organic compounds (SVOCs) was conducted in a subset of soil and groundwater samples that were collected and analyzed for VOCs (refer to Appendix G for a summary of this effort). From review of investigation data and historical records, we concluded that no remedial measures are needed to address non-VOC contamination at this time.

CVOCs, including trichloroethene (TCE), TCA, and CFC-113 and their associated biochemical degradation products, are the principal VOCs of interest, based on the concentrations detected and the potential for migration. These compounds (chlorinated ethenes, chlorinated ethanes, and CFCs) are referred to hereinafter as “Principal Site VOCs.” The site-wide distributions of these VOCs in soil gas, soil, and groundwater are presented on figures and summarized below.

5.1 Distribution of VOCs in Soil Gas

The inferred distributions of Principal Site VOCs in soil gas are shown on Figures 12 through 14, respectively. The distributions of VOCs in soil gas were used to select exploration locations for the assessment of soil and groundwater, as well as to help approximate the limits of each source zone.

5.2 Distribution of VOCs in Soil

Locations for soil sampling and analysis were selected based on our understanding of historic site use, soil gas survey results, and observations made during drilling. Since there was limited evidence of VOCs found in soil gas samples that would help in identifying a particular source zone in Lot 26, soil sampling locations were selected based on detections of VOCs in groundwater and the inferred groundwater flow directions. Soil sampling locations (borings and monitoring wells) are shown on Figure 4.

As documented in Appendix H, and described in more depth in Section 6 for each source zone, the distributions of Principal Site VOCs in soil were generally consistent with the soil gas survey and groundwater data. Consistent with multiple sources and releases, we observed a relatively wide degree of variability (both in the constituents detected and their respective concentrations), even within the defined source zones.

Unlike the source zones defined on the Building 57/57A property, we were not able to define a contiguous area of concentrated VOCs in the soil samples collected from Lot 26. Efforts to identify and delineate a definable source zone included a relatively dense network of soil borings and a membrane interface probe (MIP) investigation. Rather than a discrete, concentrated release zone we infer that VOCs are present in groundwater due to residuals remaining from smaller spills or releases, or that the original mass released to the subsurface has diminished over time. As noted above, the SAE identified no definitive record of land use in the parking area that would explain why VOCs are intermittently present below Lot 26. A description of the MIP investigation and summary of findings is provided in Appendix I.

5.3 Distribution of VOCs in Groundwater

As noted above, there are two water bearing zones beneath the site, each with distinct geochemical conditions. General, site-wide conditions are described below and on Figures 15 through 22. More detailed descriptions of groundwater quality conditions in each source zone are provided in Section 6.

In general, observations of VOCs in groundwater are consistent with detections in soil gas and soil, and with our understanding of site use. VOC presence in upper and lower WBZ groundwater appears to relate primarily with sourcing from the site source zones described above. Principal Site VOCs have also been detected in groundwater from wells inferred to be upgradient of Building 57A[12], indicating some contribution of VOCs from off-site sources.

5.3.1 Upper Water Bearing Zone

The distribution of the Principal Site VOCs in upper WBZ groundwater, as summarized on Figure 15, is consistent with the distributions identified in soil and soil gas and available information on historic site use (i.e., AST locations). In general, concentrations of the Principal Site VOCs were found at lower concentrations than noted for the lower WBZ below. Based on the distribution of VOCs in the upper WBZ, limited saturated thickness, and the groundwater elevation data, we consider the primary dissolved phase migration pathway from the upper WBZ to be vertically downward, rather than horizontal.

VOC concentration data shown on Figure 15 to the south of the site silt and clay aquitard correspond to samples that were collected near the water table. Despite the absence of an aquitard, concentrations of VOCs are generally lower at the water table than they are at depth.

[12] *Chlorinated ethenes have been detected in upgradient wells EN-621, EN-642, and EN-411 (at concentrations up to approximately 20 ug/l). Chlorinated ethanes and CFCs have been detected in groundwater from wells EN-642 and EN-411, and CFCs have been detected in groundwater from EN-638, which is inferred to be upgradient and/or side-gradient of the site. Refer to Figures 15 and 16 and data provided in Appendix B for additional information.*

5.3.2 Lower Water-Bearing Zone

The distribution of the Principal Site VOCs in lower WBZ groundwater, as summarized on Figure 16, is generally consistent with the distributions identified in soil gas, soil, and upper WBZ groundwater, as well as our information on historic site use. The distribution of VOCs in lower WBZ groundwater is also presented using iso-concentration contour maps for total ethenes, total ethanes, and total CFCs (Figures 17, 18, and 19, respectively). Review of these figures shows that VOCs detected in the site groundwater are also detected in downgradient monitoring locations but at generally lower concentrations. These plots support the inference that, without the current containment system in place, groundwater migration from the CFC and TCA Areas was to the southeast.

VOC concentrations were detected at DEC-MW-34D (located east of and across Brixius Creek from the Waste Solvent Area) at concentrations and parent-to-daughter ratios consistent with detections in the Waste Solvent Area. This finding suggests an easterly migration from the Waste Solvent Area. Well DEC-MW-34D was installed and sampled under the direction of NYSDEC. Further downgradient exploration and testing have been recommended to further assess biochemical degradation patterns to the east of the Waste Solvent Area. Access restrictions have prevented further assessment of this area. Future assessment of this area will be documented in an addendum to this report.

5.4 Natural Attenuation Assessment

As indicated by the relative size of the pie chart sections on Figure 16, the concentrations of parent VOCs (TCE, TCA) are relatively low compared to the degradation byproducts in the area below and around Building 57A. Conversely, the distribution of parent to byproduct concentrations below the CFC Area indicates relatively limited degradation. These conditions are further evident through review of the relative concentrations of parent and byproduct VOCs for ethenes, ethanes, and CFCs, shown on Figures 20, 21, and 22, respectively.

A detailed assessment of biochemical degradation is provided in the above-referenced Bioattenuation Study Report. Figure 23 provides a summary of geochemical conditions in the eastern portion of the Building 57/57A property, where the more significant source zones are located and biochemical degradation appears to be relatively advanced.

As described in the Bioattenuation Study Report, assessment of geochemical conditions included groundwater sampling and analysis (laboratory and in-field), microcosm testing, and in-field testing of natural attenuation indicator parameters. These tests included “background” degradation rate assessments that helped support our current understanding of existing conditions. The tests also included an assessment of potential enhancements to biochemical degradation in four of the source zones. Further information regarding the potential application of enhanced bioremediation techniques is provided in the IRM Evaluation Summary Report.

6.0 CONCEPTUAL SOURCE ZONE MODELS

As indicated above, there are six separate areas within the OU#5 site limits where subsurface conditions reflect the historic releases of various contaminants, primarily VOCs. This section provides a description of our current conceptual site models (i.e., physical description, hydrogeology, and the distribution of contaminants) for each of these six areas. As presented in prior reports, and shown on Figure 24, we estimated the amount of source mass present in five of the six areas. Specific source mass estimates were not developed for Lot 26, because we found limited evidence of a definable source zone. Calculations supporting the VOC mass distribution estimates are provided in Appendix J.

6.1 Building 57A Area

Physical Description and Hydrogeology

As noted above, there is no historical record of industrial processes in this area and we have no information that explains how or when VOCs came to be present in the subsurface; however, based on the use of the building since construction for warehousing, we believe VOCs may have been present prior to the construction of B57A almost 30 years ago.

Granular soil fill beneath the building is distinguished by high density and poor sorting with variable fines content, and the presence of cinders, coal, and ash, which, along with the presence of petroleum hydrocarbons, explains the relatively high organic carbon recorded for samples of the fill. As shown on Exhibit 4, there is a relatively thin zone of clayey sand between the aquitard and the glacial till; therefore, the hydraulic characteristics of lower WBZ in this area are reflective of glacial till.

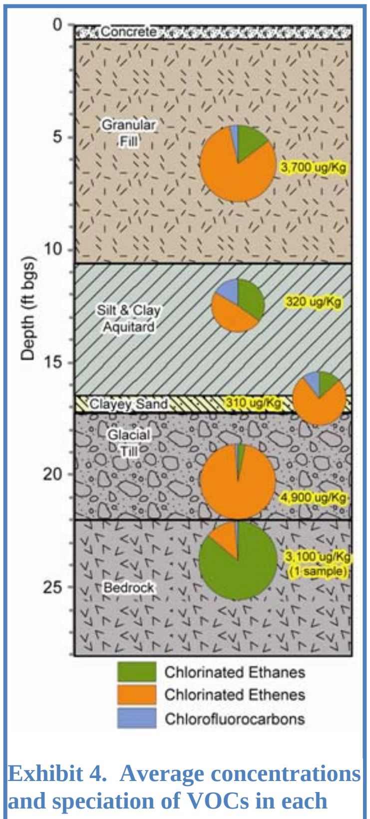

Exhibit 4. Average concentrations and speciation of VOCs in each soil horizon, B57A Area.

As indicated on the silt and clay aquitard surface contour map (Figure 7), there is a slight depression in the central portion of Building 57A. There is limited (usually less than one foot) saturated thickness above the aquitard consistent with limited potential for horizontal groundwater migration from this area. This area has relatively large vertical gradients between the upper and lower WBZs, indicative of downward flow between the two WBZs.

Consistent with the regional groundwater flow pattern, lower WBZ groundwater flows in a southeasterly direction from this area under ambient conditions (see Figure 10). The entire B57A Area source zone appears to be within the capture zone of the existing hydraulic containment system, as shown on Figure 11.

Contaminant Distribution

As shown on Figures 9 through 11, mixed VOCs were detected in soil gas samples including chlorinated ethenes, ethanes, and chlorofluorocarbons.

The speciation and relative concentration of Principal Site VOCs in soil for each stratigraphic unit is summarized on Exhibit 4. As shown on Figure 24, the majority of VOC mass is expected to be found in the soil fill above the aquitard. Based on the high organic carbon content in this soil fill, much of the VOC mass is likely sorbed to the soil solids. Note the distribution of VOCs across the source zone was not uniform and distributions are biased by the number of samples collected in each stratum. For example, the relatively high concentration of ethanes shown on the bedrock pie chart on Exhibit 4 reflects the results of a single sample collected in the eastern portion of the source zone. A more detailed graphical summary of the distribution of VOCs in soil is provided in the Appendix H.

As shown on the figures within Appendix H, at a given location (e.g., boring A+33,41+12) the concentrations of certain VOCs are two to five orders of magnitude lower in the site silt and clay aquitard than in the overlying fill., Nevertheless, there are areas in the lower WBZ soils where VOC concentrations are orders of magnitude higher than in the silt and clay.

As shown on Figures 15 and 16 chlorinated ethenes are the predominant VOCs found in groundwater. Chlorinated ethenes detected in the lower WBZ reflect a higher degree of biochemical degradation (i.e., lower parent to byproduct compound ratios) than ethenes detected in the upper WBZ. As described in more detail within the Bioattenuation Study Report, migration of VOCs in this zone appears to be limited by biochemical degradation processes.

6.2 Former Waste Solvent AST Area

Physical Description and Hydrogeology

Prior to construction of Building 57A, the area in the southeast corner of the property reportedly contained a waste solvent AST and an incinerator, as shown on Exhibit 5. Our understanding of prior use is based on historical site plans. We did not identify historical operation records or people with knowledge of the solvent tank or incinerator operation. The area is primarily asphalt-paved and flat, with a drop in elevation along the east and south property boundaries.

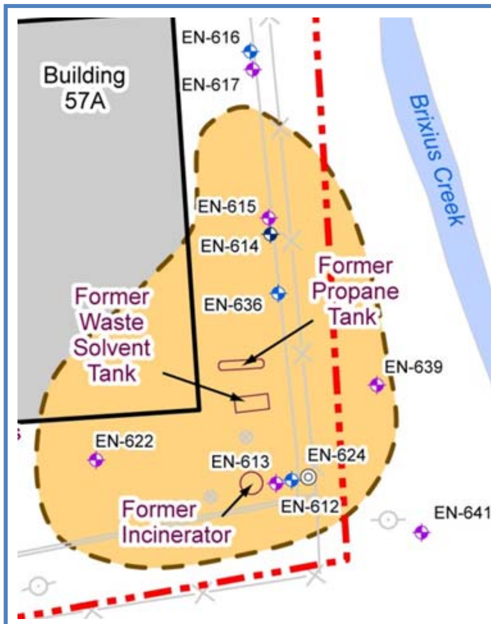

Exhibit 5. Waste Solvent Area and vicinity.

The generalized stratigraphy in this area is shown on Exhibit 6. Granular fill material in this area is composed primarily of sand and gravel, with varying amounts of silt and clay, and traces of cultural materials (e.g., brick, slag, cinders and wood fragments). Peat and other organic soils were observed near the top of the silt and clay aquitard, in locations in the western and southern areas of this source zone. Variable thickness of granular material was observed below the silt and clay, with an average thickness of approximately 5 ft and composed primarily of gravel, with variable amounts of sand, silt, and clay. Glacial till or weathered shale bedrock was encountered beneath the gravel.

As shown on Figure 7, there is limited saturated thickness in the upper WBZ, particularly in areas north and south of the defined source zone. The area around well EN-615 represents a consistent local groundwater high in the upper WBZ (as shown on Figure 8). The predominant direction of groundwater flow from this area is likely to the east due to the limited saturated thickness to the north and south, and the resulting limited horizontal gradient. Water levels in the upper WBZ do not appear to be affected by pumping from EN-624.

Groundwater in the lower WBZ is inferred to flow to the east-southeast under ambient conditions. The water level round used to generate the ambient groundwater elevation contours shown on Figure 10 did not include measurements from well DEC-MW-34D (access to this well for monitoring has been routinely denied by the property owner). Based on prior monitoring, and the distribution of VOCs in lower WBZ groundwater, we infer an easterly component of flow in the lower WBZ from this area, under ambient, non-pumping conditions. We infer from groundwater elevation data collected during pumping (Figure 11), that this source zone, and areas beyond, are currently within the capture zone for extraction well EN-624. Water is pumped from this well at an average of approximately 2.2 gallons per minute (a rate approximately 3 times that of the other two OU#5-area extraction wells combined), reflecting the greater transmissivity in this area.

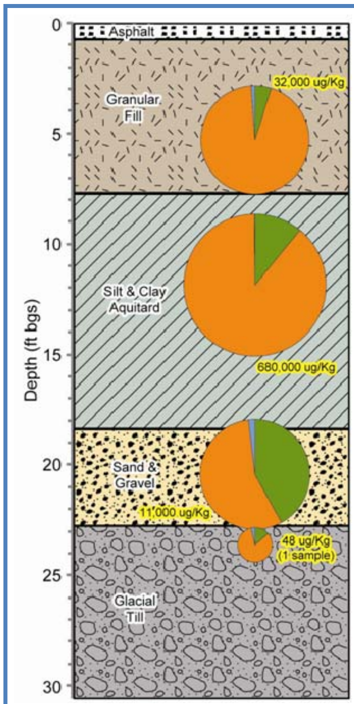

Exhibit 6. Average concentrations and speciation of VOCs in each soil horizon, Waste Solvent Area.

Contaminant Distribution

The average distribution of Principal Site VOCs in soil for each stratigraphic unit is summarized in Exhibit 6 (see legend in Exhibit 4). Similar to soil gas data, chlorinated ethenes were the predominant VOCs detected in soil. In one boring drilled near the former waste solvent AST, separate phase liquid was observed in a sample from near the top of the site silt and clay aquitard. TCE and gasoline-range petroleum hydrocarbons were the predominant VOCs detected in this sample. As shown on Figure 24, we estimate that approximately 62% of the total site VOC mass is present in the Waste Solvent Area, with greater than 75% of that total in the upper soil horizons (including the silt and clay). The high organic content of soils near the top of the site silt and clay aquitard may increase the potential for sorption of petroleum hydrocarbons and VOCs. A more detailed summary of the spatial distribution of VOCs in soil is provided in Appendix H.

Consistent with the soil and soil gas data, chlorinated ethenes were the predominant VOCs detected in groundwater. As described in more detail within the Bioattenuation Study Report, the speciation of CVOCs in the lower WBZ groundwater reflect a relatively high degree of biochemical degradation. Without the ongoing hydraulic containment or other measures, VOCs would migrate downgradient to the east and south.

6.3 TCA Area

Physical Description and Hydrogeology

The TCA Area is located south of the center of Building 57A, near the inferred location of two former 35,000-gallon TCA ASTs, as well as CFC ASTs (as shown in Exhibit 7). The ground surface is asphalt-paved and relatively flat.

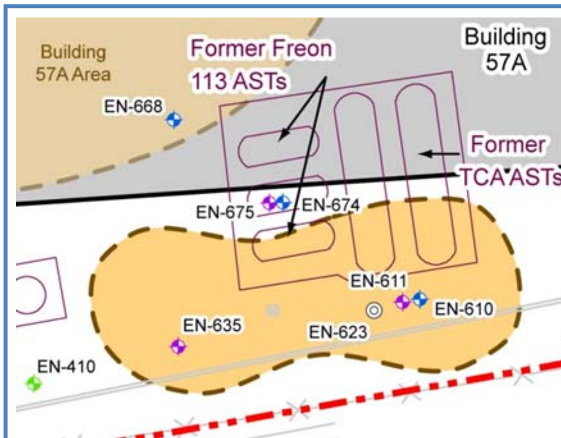

Exhibit 7. TCA Area and vicinity.

The shallow granular fill (upper 3 ft) in this area is primarily sand and gravel and transitions to silt and clay (from about 3 ft to the top of the site silt and clay aquitard). Native soils below the silt and clay were primarily gravel with variable amounts of sand and fines (generalized stratigraphy in this area is shown on Exhibit 8). The high fines content in the lower WBZ soils limits the groundwater migration through this area and the rate groundwater can be extracted.

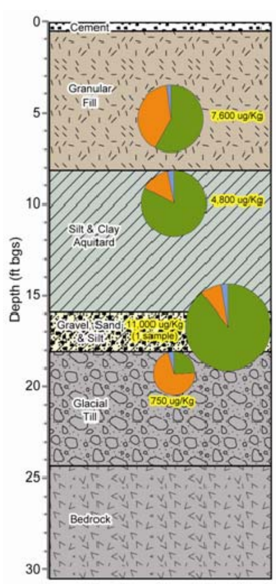

Exhibit 8. Average concentrations and speciation of VOCs in each soil horizon, TCA Area.

As shown on, Figure 7, there is limited saturated thickness observed in the upper WBZ, with limited potential for migration from this area. After a review of multiple groundwater extraction tests and routine monitoring data, we identified no evidence that groundwater flow in the upper WBZ is influenced by pumping from the lower WBZ. Under non-pumping conditions, lower WBZ groundwater flows southeast but appears to be contained by pumping from OU#5 extraction wells.

Contaminant Distribution

As shown by Exhibit 8, chlorinated ethanes were the predominant VOCs detected in soil. A greater proportion of chlorinated ethenes were found in the western portion of the source area. Petroleum hydrocarbons were detected in fill soils, particularly in the northern area of this source zone. As shown on Figure 24, we estimate that approximately 3% of the total site VOC mass is present in the TCA Area, with more than 75% of that total in the upper WBZ and silt and clay soils. In combination with organic-rich material observed in upper soil horizons, the high total organic carbon content in this area may increase the potential for sorption of VOCs to shallow soils. A more detailed summary of the spatial distribution of VOCs in soil is provided in Appendix H.

Consistent with soil analytical data, TCA and 1,1-dichloroethane are the predominant VOCs detected in upper and lower WBZ groundwater. Lesser concentrations of biochemical degradation products, as well as chlorinated ethenes and CFC-113, were also detected. Since the start of pumping from EN-623 in 2006, we have observed a reduction of chlorinated ethane concentrations by about two orders of magnitude. Time series plots of VOC concentrations in wells surrounding Building 57A, including several in the TCA Area, are shown in Appendix K.

6.4 CFC Area

Physical Description and Hydrogeology

According to historic site plans, CFC-113 was stored in an AST in this area prior to construction of the loading docks and staging areas between Buildings 57 and 57A (shown on Exhibit 9). CFC-113 and related biochemical degradation byproducts are the predominant VOCs detected in soil, soil gas, and groundwater samples.

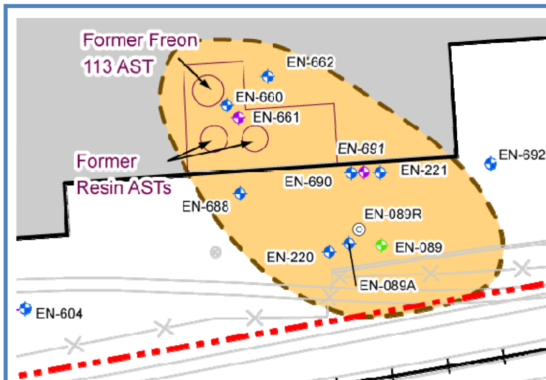

Exhibit 9. CFC Area and vicinity.

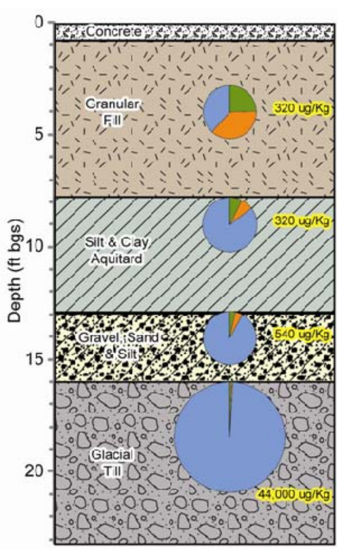

Exhibit 10. Average concentration and speciation of VOCs in each soil horizon, CFC Area.

The generalized stratigraphy in this area is shown on Exhibit 10. Granular fill beneath the building includes sand and gravel with varying amounts of silt, and concrete rubble. Organic soils were noted in samples from the silt and clay aquitard. Approximately one to two feet of sand and gravel were observed below the aquitard in a localized area near extraction well EN-89R.

Although there is limited saturated thickness in the upper WBZ above the aquitard and monitoring wells are frequently dry, the inferred groundwater flow direction is to the southeast. Under ambient conditions, lower WBZ groundwater would flow in a southeasterly direction. Extraction well EN-89R was installed to capture CFC-containing groundwater migrating from this area. The yield from well EN-89R is relatively limited, as is the associated hydraulic capture. Additional study is underway to assess options to increase groundwater withdrawals and hydraulic capture of this area.

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Contaminant Distribution

CFCs are the predominant VOCs detected in soil gas, soil, and groundwater. As indicated on Exhibit 10 and Figure 16, the highest concentrations of CFCs were detected in the lower WBZ soil and groundwater samples. Despite multiple borings we have not found similar conentrations of CFCs in soil within or above the aquitard. As shown on Figure 24, we estimate that approximately 24% of the total site VOC mass is present in the CFC Area, almost entirely in the lower WBZ soil and groundwater.

As indicated on Figure 23 and discussed in the Bioattenuation Study Report, geochemical conditions are more oxidized than other site areas indicating lower potential for natural attenuation of VOCs without enhancements. There is little evidence of natural degradation occurring in this area.

6.5 Building 57 Area

Physical Description and Hydrogeology

According to site plans and records, historical activities in this area included quenching, solvent storage, and vapor degreasing. Sub-slab soil gas sampling and analysis has indicated a potential area of mixed solvent presence (comprising primarily TCA) below a limited area central to the building as shown on Exhibit 11.

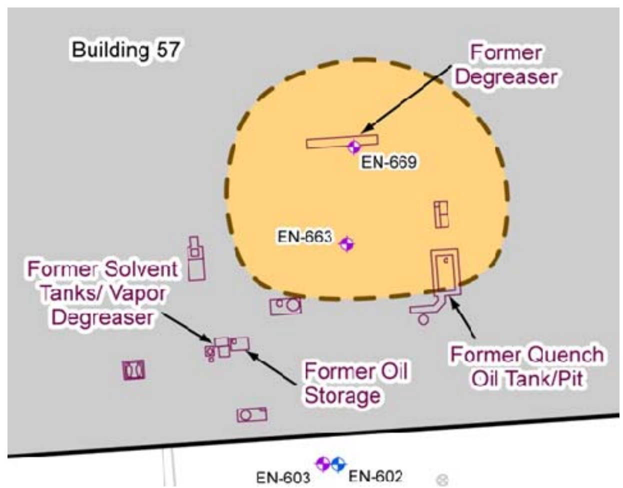


Exhibit 11. B57 Area and vicinity.

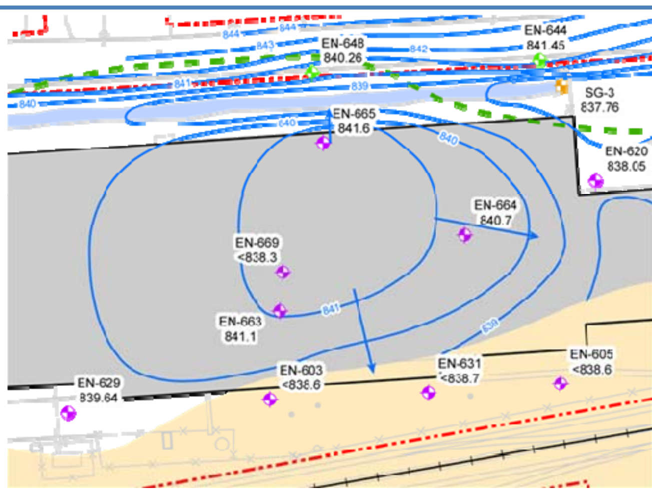


Exhibit 12. Upper WBZ groundwater elevation contours (excerpt from Figure 8).

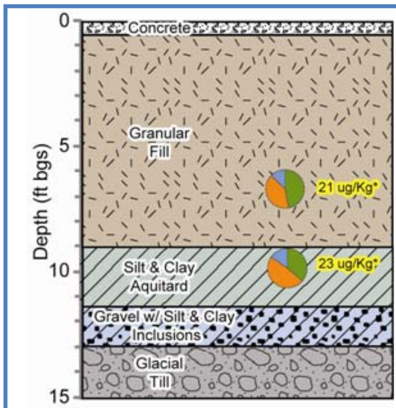
Granular soil fill beneath the building includes sand and gravel with an increasing proportion of fines with depth. The site silt and clay aquitard was observed at depths between 8.5 and 11.5 feet below the floor surface. Generalized stratigraphy observed beneath Building 57 is shown on Exhibit 12.

Groundwater elevation data indicate a local high below the central portion of Building 57, which suggests radial horizontal groundwater flow. The upper WBZ to the south of the building is seasonally dry.

In the lower WBZ, groundwater is inferred to flow in a southerly direction under ambient conditions. During pumping from well EN-89R, groundwater flow direction from this area is inferred to shift more to the south-southeast.

Contaminant Distribution

Chlorinated ethenes and ethanes were the predominant VOCs detected in soil gas and soil (Exhibit 13). Additional details regarding the observed presence of VOCs in soil beneath this area are presented in Figures H.13 through H.15 in Appendix H). Chlorinated ethanes were detected in shallow fill material from EN-669 at less than 50 µg/kg. All other VOCs were found at concentrations one to two orders of magnitude lower. No CFCs were detected above laboratory reporting limits in soil samples from this area (laboratory reporting limits are represented in Exhibit 13).



*Where no concentrations were detected above laboratory reporting limits (RLs), half of the RL was used as the assumed concentration. No CFCs were detected above RLs. In the silt & clay, no chlorinated ethanes were detected above RLs.

Exhibit 13. Average concentrations and speciation of VOCs in each soil horizon, B57 Area.

Low concentrations of chlorinated ethanes (up to 18 µg/L) have been detected in upper WBZ groundwater directly within in this source zone. Assuming equilibrium partitioning from groundwater, we would anticipate VOC concentrations one or two orders of magnitude lower than those observed directly beneath the floor slab. However, the soil gas concentrations are not suggestive of separate phase product residuals, and can be explained by dissolved concentrations in pore water. From this we infer the limited presence of a vadose zone source of VOC vapor, with limited impact to groundwater quality. Based on these findings and observations, we consider this area to represent a *de minimis* source for which no remedial measures are recommended.

6.6 Lot 26

Physical Description and Hydrogeology

As indicated in the SAE report, there have been limited historical uses of this area other than for parking. The ground surface in Lot 26 is asphalt-paved and slopes down to a low point in the northeast corner, where standing water collects after periods of rainfall.

The stratigraphy of this area is shown on Figures 25-A, 25-B and 25-C (refer to Figure 5 for a plan view showing the cross section locations). The site silt and clay aquitard extends as far south as the middle of Lot 26 before tapering out near the ground surface. Although we did not identify the regional silt and clay aquitard in this area, based on our observations, we believe that the area south and downgradient of Lot 26 transitions to the regional “two aquifer” system.

Contaminant Distribution

Characterization efforts in this area were focused on identification of VOC source mass in soils, and the potential for VOC migration from other OU#5 source zones. Except for a few locations, VOC concentrations in soil samples were near the laboratory detection limits or VOCs were not detected. As highlighted in Exhibit 14, higher concentrations of aromatic hydrocarbons and chlorinated ethenes were detected in a few shallow soil samples (EN-682, EN-683, EN-684, B57-217, and B57-225). Results of soil analytical and MIP sampling (in the blue-shaded area on Exhibit 14) suggested the diffuse presence of VOCs in shallow soils, rather than a well defined concentrated source zone.

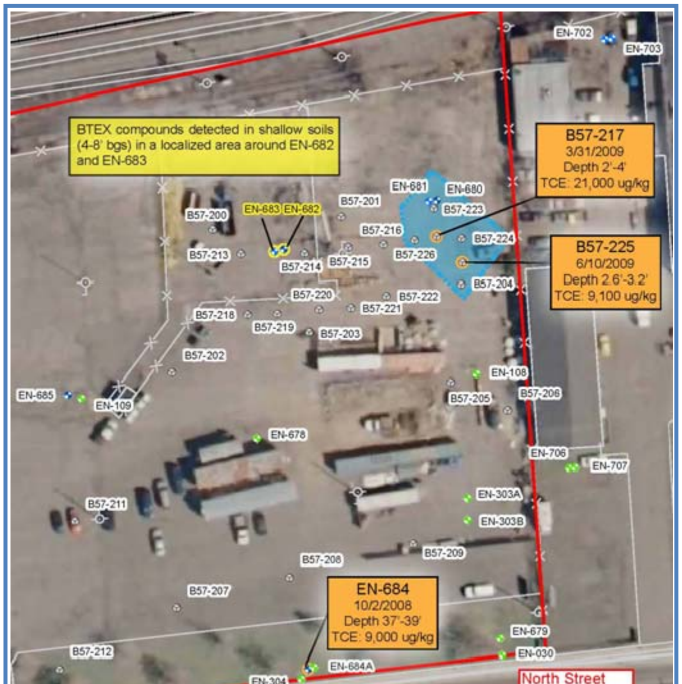


Exhibit 14. Summary of VOC concentrations detected in Lot 26 soil samples.

The distribution of Principal Site VOCs detected in groundwater are summarized on geologic cross sections (Figures 25-A, 25-B and 25-C). CFCs were detected in groundwater samples from wells located along the eastern boundary of Lot 26. There were no elevated CFC concentrations in soil samples from this area, which suggests that, if located in Lot 26, the source zone is relatively limited. Based on the data collected to date, migration of CFCs from the CFC Area on the Building 57/57A property is unlikely but cannot be ruled out.

Elevated concentrations of TCE were detected in groundwater near the water table in the central portion of Lot 26 (from soil boring B57-203, shown on Figure 25-A), and at depth near the southern and downgradient boundary. Given the detection of TCE in a few shallow soil samples in the northeastern portion of Lot 26, and the relatively low concentrations of TCE detected in shallow groundwater along the downgradient boundary, we believe observed concentrations reflect aged residuals of a limited release of TCE . The higher concentrations of TCE found in the deeper silty sand along the downgradient boundary are likely the result of mass that diffused into this lower-permeability material from historical transport.

We estimate that groundwater is flowing across the southern boundary of Lot 26 at a rate of approximately 1 gallon per minute, and that the VOC mass flux across this boundary is on the order of 2 pounds per year (refer to Appendix J for additional information). This mass flux is an order of magnitude lower than those estimated in on-site source zones (e.g., Waste Solvent and CFC Areas). These observations and the diffuse presence of VOCs in soils support a remedial strategy of containment, rather than a strategy of mass removal (which is more appropriate for selected on-site source zones).

7.0 REMEDIAL STRATEGIES UNDER CONSIDERATION

As migration in groundwater is largely controlled from the primary source zones, the objective of remedial measures under consideration for OU#5 is to reduce VOC mass in the source zones. As agreed with the Agencies, IBM will approach remediation of the source zones as a series of IRMs, rather than formulating a comprehensive remedial action plan for the entire site. The objective is to assess the effectiveness of various technologies through application. If the technology is successful, it may become part of the final remedial measure for the area in which it was employed. Given the complexity of the site conditions in terms of subsurface conditions and limitations imposed by buildings and other cultural features source reduction may require multiple technologies.

On IBM's behalf, SHA has prepared the Interim Remedial Measure Evaluation Summary Report (IRM Summary Report), approved by the Agencies in a letter dated March 9, 2010. The IRM Summary report outlines IBM's current approach for evaluating and applying IRMs; however, as data continue to be collected, the approach will likely be refined and adjusted in the future.

As described in the IRM Summary Report, the remedial technologies currently under consideration include:

- Hydraulic containment (ongoing) to limit VOC migration;
- Monitored natural attenuation;
- Enhanced in situ bioremediation (either biostimulation or bioaugmentation), for migration control and VOC source mass reduction;
- Soil vapor and/or dual-phase extraction (SVE/DPE) for VOC source mass reduction; and
- In situ thermal desorption (ISTD) for VOC source mass reduction.

Consistent with the 2004 Work Plan, SHA conducted a preliminary assessment of several remedial technologies that resulted in recommendations for additional testing. This assessment and subsequent recommendations were presented in our October 2008 Initial Remedial Technology Screening report. The recommendations from the initial screening report included pilot testing of SVE/DPE (completed in April 2009 and documented in our September 29, 2009 Report), and an assessment of biochemical degradation that included in situ and laboratory testing of background and enhanced biodegradation rates (completed in April 2009 and documented in our February 2010 Report).

Based on IBM's more recent experience with ISTD in Endicott, we have initiated bench scale testing to assess the viability of this technology for application in one or more of the source zones. This study includes laboratory treatability tests of soil from the Waste Solvent and the B57A Areas. Following completion of the ISTD treatability testing, a report will be prepared and presented to the Agencies that outlines the viability of the technology and IBM's intentions with regard to its possible application.

8.0 CONCLUSIONS

On behalf of IBM, SHPC has identified and characterized the nature and extent of on-site sources of chemical compounds, including VOCs that are responsible for the presence of VOCs in groundwater and subsurface vapor in the vicinity of the OU#5 site. Based on this characterization, we identified evidence of downgradient VOC migration in groundwater, which resulted in the implementation of an expanded hydraulic containment system to limit the potential for further migration. Preliminary findings also led to the screening and assessment of remedial technologies, which, as summarized herein and in the IRM Summary report, is ongoing.

Four definitive VOC source zones have been identified that contribute to VOC presence in groundwater. Relatively low permeability soils and small saturated thicknesses have limited the rate of VOC mass migration from the site, which is further limited by the operation a hydraulic containment system. As indicated in the IRM Summary Report, the remedial focus going forward will be toward partial mass removal (where practical) and enhanced hydraulic containment.

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FIGURES

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Note:

1. The basemap consists of a 24 tile mosaic of orthorectified (adjusted to scale) true color digital aerial photographs accessed by SHA in September, 2007 vis the New York State geographical information systems (NYGIS) website. The aerial photographs are dated April, 2006.

OU#5 Site Boundary

Town/Village Boundary

Drawn By: S. Warner
Designed By: L. Jacob
Reviewed By: J. Ordway
Date: March 2010

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Figure 1

Locus Plan

Supplemental Remedial Investigation Report
OU#5 / Building 57 Area

Union and Endicott, New York

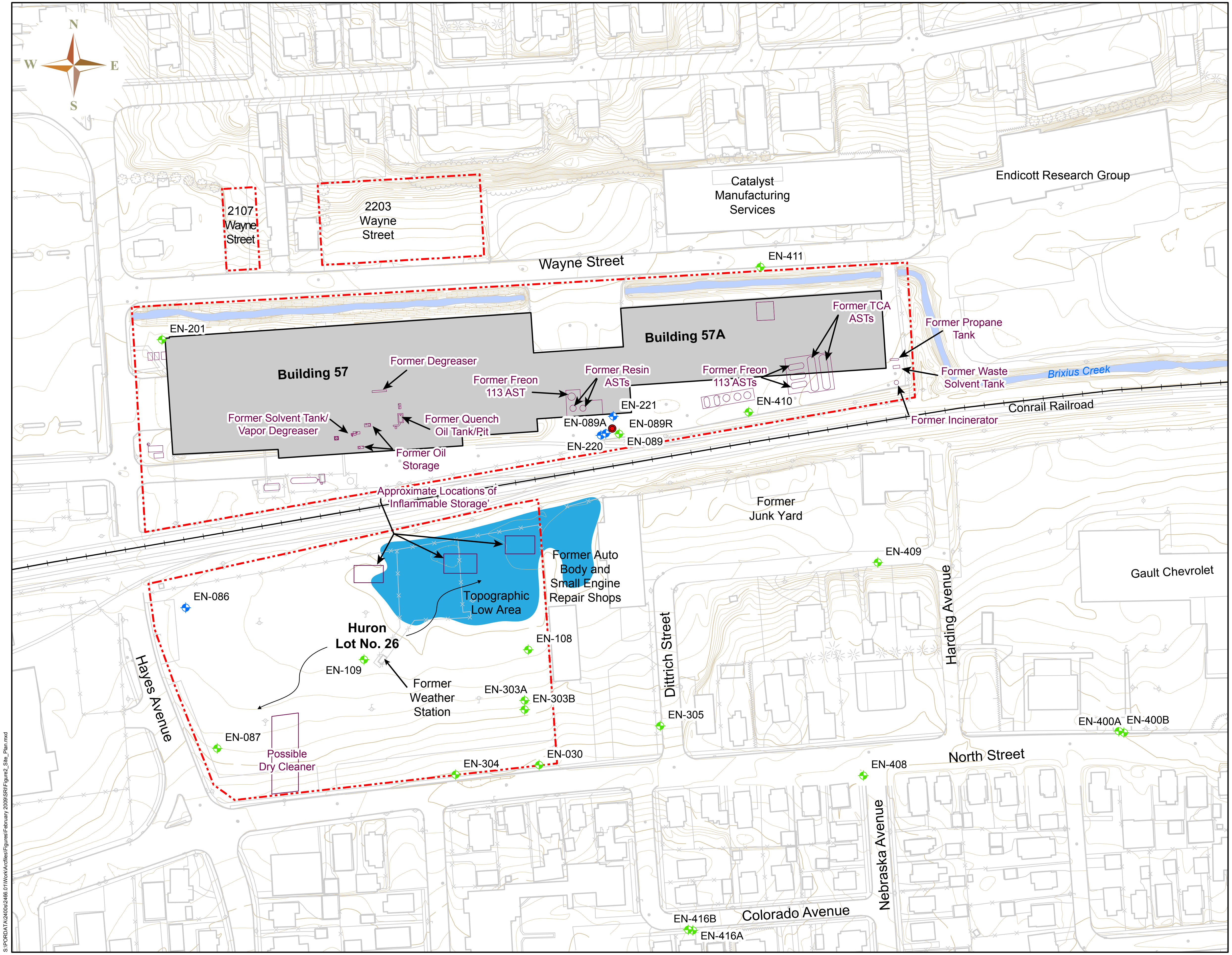

Figure 2

Site Plan

Supplemental Remedial Investigation Report OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: J. Prellwitz
Designed By: L. Jacob
Reviewed By: J. Ordway
Date: March 2010

Figure Narrative:

This figure shows site boundaries in the context of area topography (based on an autocad drawing provided by Groundwater Sciences Corporation [GSC] in September 2003), as well as the inferred locations of former site features. Refer to the Source Area Evaluation Report (SHPC, 2005) for further information about site features, as well as information sources.

Wells existing in and around the OU#5 property installed (by others) prior to the start of SRI investigations are shown. Locations for these wells were provided by Groundwater Sciences Corporation.

Legend

- Lower WBZ Monitoring Well (pre-2005)
- Monitoring Well (screened where site silt and clay not present, or through silt and clay layer; pre-2005)
- Groundwater Extraction Well
- Site Boundary
- Former Site Features Identified in Source Area Evaluation Report
- Topographic Contour Line (1 foot contour intervals)
- Topographic Low Area (Intermittently covered with standing water)

Feet: 70 35 0 70 140 210

SHPC ENGINEERS

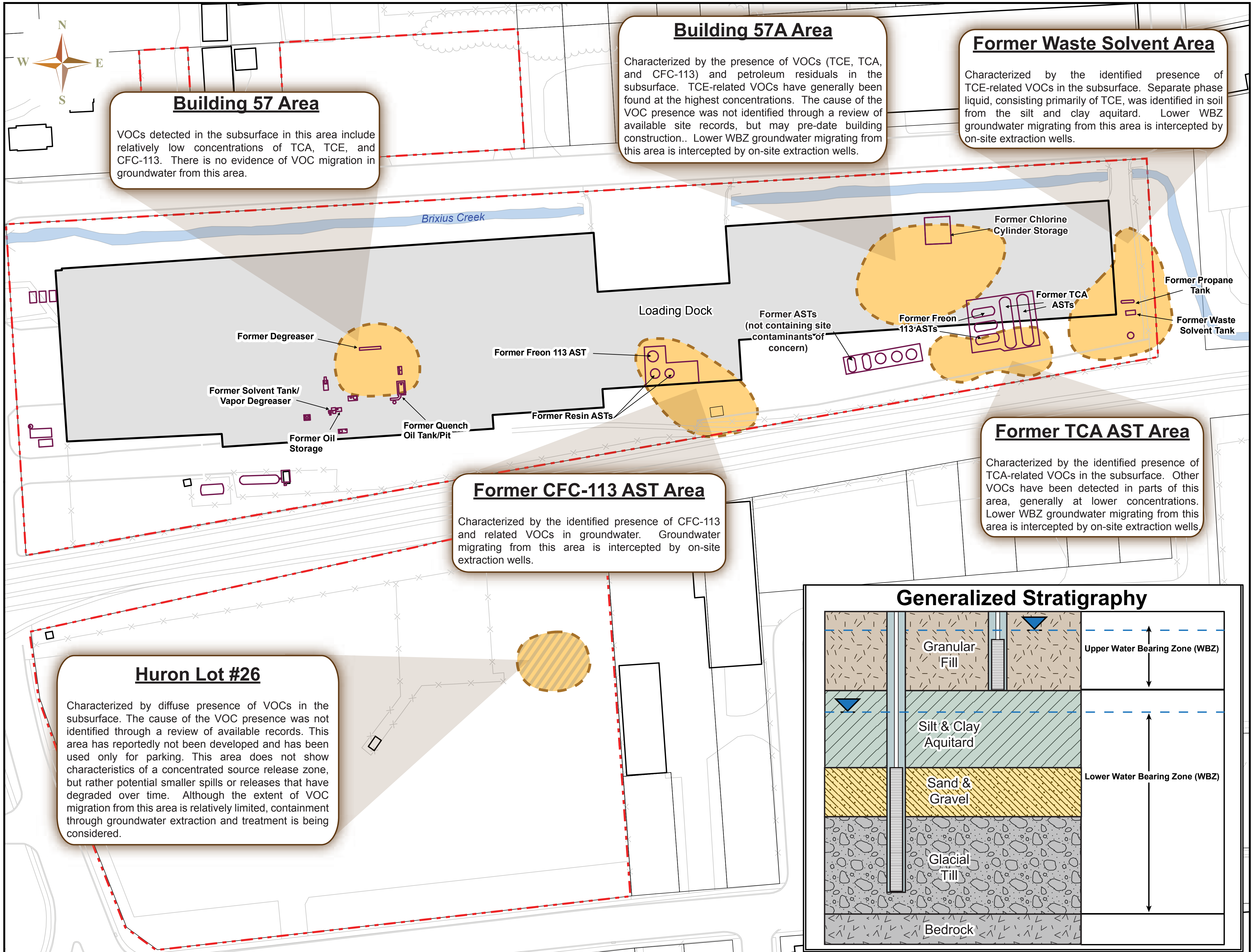

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Figure 3

Inferred Source Zone Summary

Supplemental Remedial Investigation Report
OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: S. Warner/J. Prellwitz/J. Pierce
Designed By: J. Ordway/L. Jacob
Reviewed By: J. Ordway
Date: March 2010

Figure Narrative

This map is intended to provide general information regarding inferred source zones at the Building 57 (OU#5) site. The source zones were identified through a review of historical documents (see September 2005 Source Area Evaluation report prepared by Sanborn, Head Engineering, P.C.), and multiple investigations of contaminant characterization and hydrogeologic conditions, performed between 2005 and 2009. Refer to the SRI report and appendices for further information.

Legend

Inferred Source Zone (showing characteristics of a concentrated source release zone)

Inferred Source Zone (showing characteristics of smaller, isolated spills or releases)

Feet
50 25 0 50 100 150

SHPC ENGINEERS

S:\PORDATA\2466.01\Figures\December 2009\20091223_Fig3_Source Zone Map.ai

Figure 4

Exploration Location Plan

Supplemental Remedial Investigation Report OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: S. Warner
Designed By: L. Jacob
Reviewed By: J. Ordway
Date: March 2010

Figure Narrative:

This figure shows the locations of soil and groundwater explorations conducted as part of the SRI, between 2005 and 2009. Refer to Appendix B for soil gas exploration locations. The locations of soil borings, monitoring wells, and extraction wells installed as part of the SRI were surveyed by Butler Land Surveying, LLC of Little Meadows, PA.

Locations of wells installed by others were provided separately by Groundwater Sciences Corporation, Inc.

Legend

Site Features

- Upper WBZ Monitoring Well (Screened Above Site Silt and Clay)
- Lower WBZ Monitoring Well (Screened Below Site Silt and Clay)
- Deep Monitoring Well (Screened in Till)
- Monitoring Well (Screened where Site Silt and Clay was not present)
- Groundwater Extraction Well
- Soil Vapor Extraction Well
- Soil Boring
- Dual Phase Extraction Pilot Test Monitoring Location
- Stream Gauge
- Manhole
- Catch Basin
- Stormwater Pipe
- Site Boundary

Feet
50 25 0 50 100 150

SHPC ENGINEERS

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S:\PORDATA\2400s\2466.01\Work\Arcfiles\Figures\December 2009\20091217_LocationPlan_SRI_Fig3.mxd

Figure 5

Geologic Profile Location Plan

Supplemental Remedial Investigation Report OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: J. Pierce
Designed By: J. Ordway
Reviewed By: J. Ordway
Date: March 2010

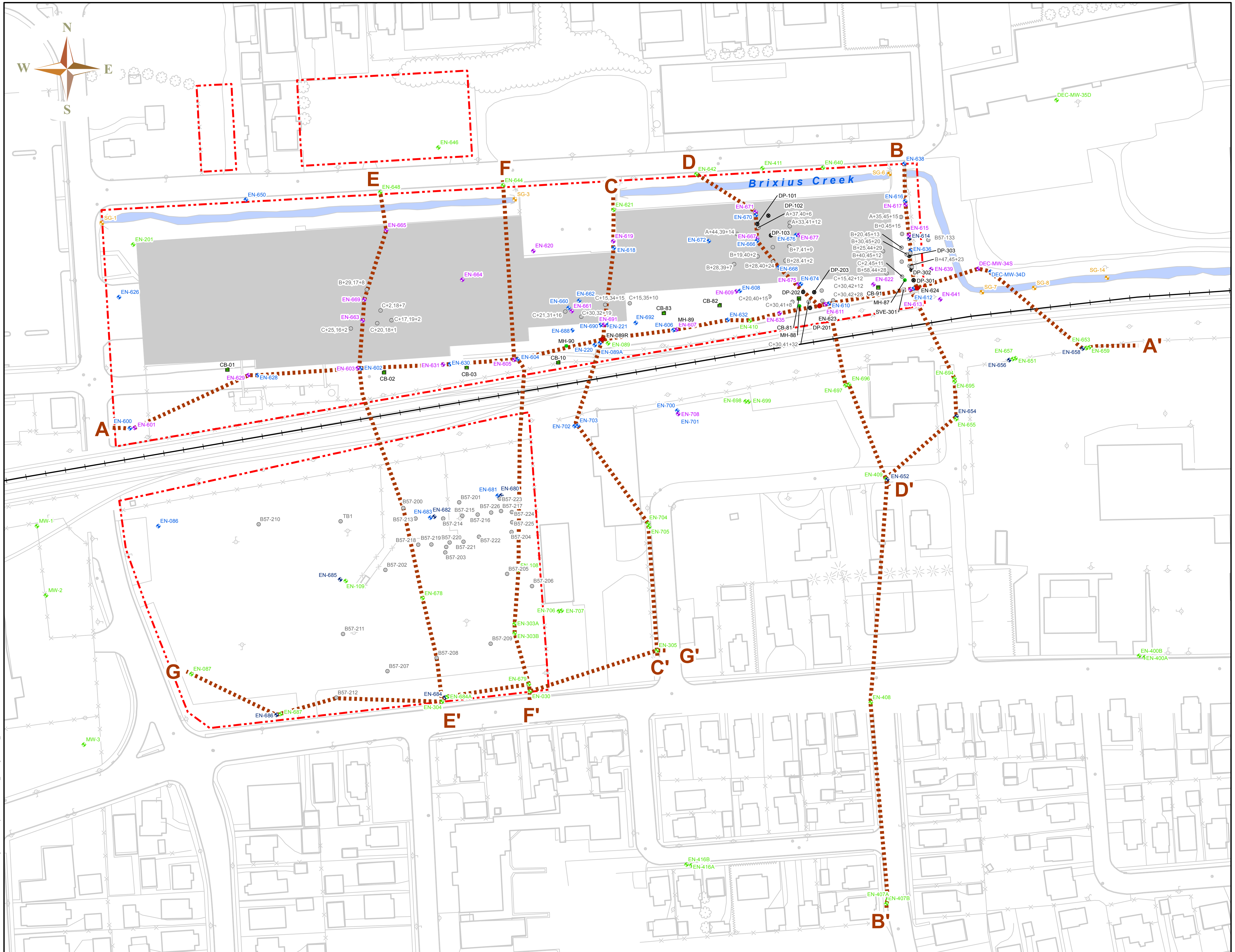

Figure Narrative:

This figure shows geologic profile lines A-A' through G-G'. Geologic profiles are provided on Figures 6-A through 6-D and Figures 25-A through 25-C. Refer to the SRI report text and Figure 4 for more information.

Legend

A - A' Geologic Profile Line
Upper WBZ Monitoring Well (Screened Above Site Silt and Clay)
Lower WBZ Monitoring Well (Screened Below Site Silt and Clay)
Deep Monitoring Well (Screened in Till)
Monitoring Well (Screened where Site Silt and Clay was not present)
Groundwater Extraction Well
Dual Phase Extraction Well
Soil Boring
Dual Phase Extraction Pilot Test Monitoring Location
Stream Gauge
Manhole
Catch Basin
Site Boundary

Feet: 70 35 0 70 140 210

SHPC ENGINEERS

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Figure 6-A

Geologic Profile A-A'

Supplemental Remedial Investigation Report

OU#5/Building 57 Area

Union and Endicott, New York

Drawn By: E. Wright
Designed By: P. Mouser
Reviewed By: L. Jacob
Date: March 2010

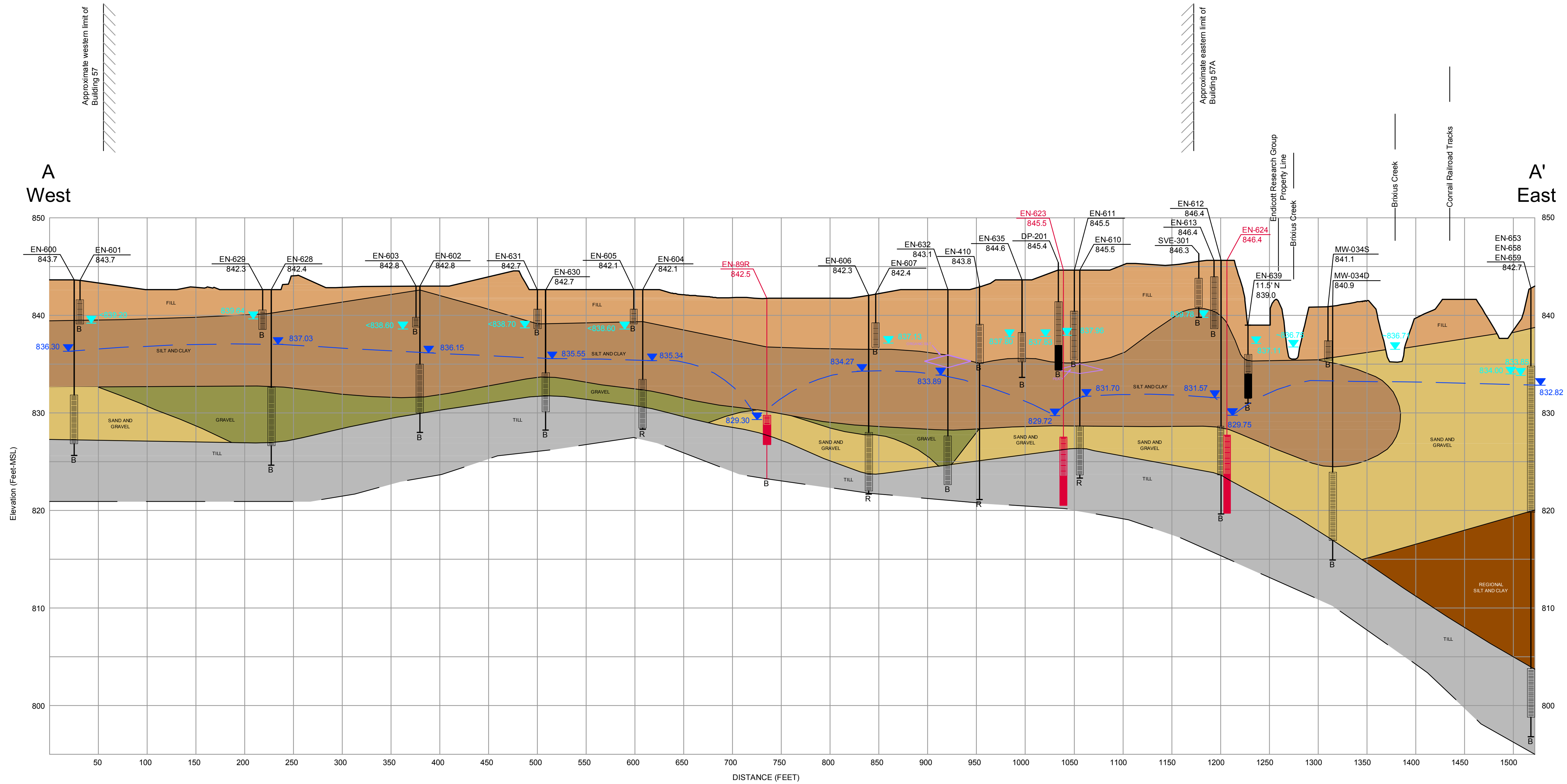


Figure Narrative

This figure shows a west to east geologic profile along the south side of Building 57. The inferred groundwater potentiometric surface for the lower water-bearing zone as measured in October 2009 is shown is blue. Monitoring well locations designated in red are currently operating as groundwater extraction wells.

Legend

- 839.78 — Groundwater elevation upper water-bearing zone measured in October 2009
- 834.27 — Groundwater elevation lower water-bearing zone measured in October 2009
- ~836.71 — Groundwater elevation is estimated based on historic measurements
- Inferred potentiometric surface lower water bearing zone
- EN-639 — Monitoring well/test boring designation
- 839.0 — Approximate ground surface elevation
- Approximate ground surface
- Inferred stratigraphic contact
- Well screen
- Sump
- B — Bottom of boring
- R — Refusal

Notes:

1. Lines representing strata have been interpolated from a limited number of widely spaced explorations. Actual conditions will vary from those shown.

Legend:

- **Fill** - typically loose/soft to dense/hard; color varies from light brown/brown to gray to black; varying mixtures of clay, silt, sand, and gravel; may contain minor amounts of organics, cinders, ash, brick fragments, wood, or glass.
- **Silt and Clay** - typically stiff; brown to olive gray; varying proportions of silt and clay with up to approximately 10 percent sand and 10 percent gravel; may contain organics; commonly shows orange mottling. Gravel fragments are typically rounded.
- **Regional Silt & Clay** - typically medium stiff; gray to olive-gray; Clayey SILT with varying proportions of silt and clay; 0 to 10 percent san or gravel, if present; commonly contains pinkish laminae and occasionaly pink to buff silt varves.
- **Sand and Gravel** - typically loose to dense; brown to gray; fine to coarse sand with up to approximately 50 percent gravel and 20 percent silt.
- **Silty Sand** - typically brown to brown-blue, clayey silt and fine sand, occasionally with varying amounts of gravel.
- **Gravel** - typically loose to very dense; gray; fine to coarse gravel with varying amounts of sand and/or silt/clay. Gravel fragments are typically rounded to subrounded.
- **Sand** - typically loose to very dense; brown; fine to coarse sand with varying amounts of silt/clay, and up to approximately 20 percent gravel.
- **Till** - typically dense to very dense; brown to olive gray; poorly sorted mixture of clay, silt, and gravel; also likely contains cobbles and boulders. Gravel fragments are typically angular and composed of fractured shale.

Summary of Subsurface Conditions

The stratigraphic units in this area are consistent with "Generalized Stratigraphy" described on the Source Zone Map. This area demonstrates the variable presence of the sand and gravel below the silt and clay. However, the inferred stratigraphy associated with boring EN-89R is based on historic well logs prepared by others, prior to development of the current conceptual model.

Water levels in the fill above the silt and clay likely vary temporally based on precipitation events and the water level in Brixius Creek. The variability of water levels across this section may be due to these temporal influences.

Vertical Exaggeration: 10x

SHPC ENGINEERS

File: V:\RANDOLPH\2466.02\dwg\Cross-Sections-2010\X-Sections.dwg Plot Date: 2-15-10

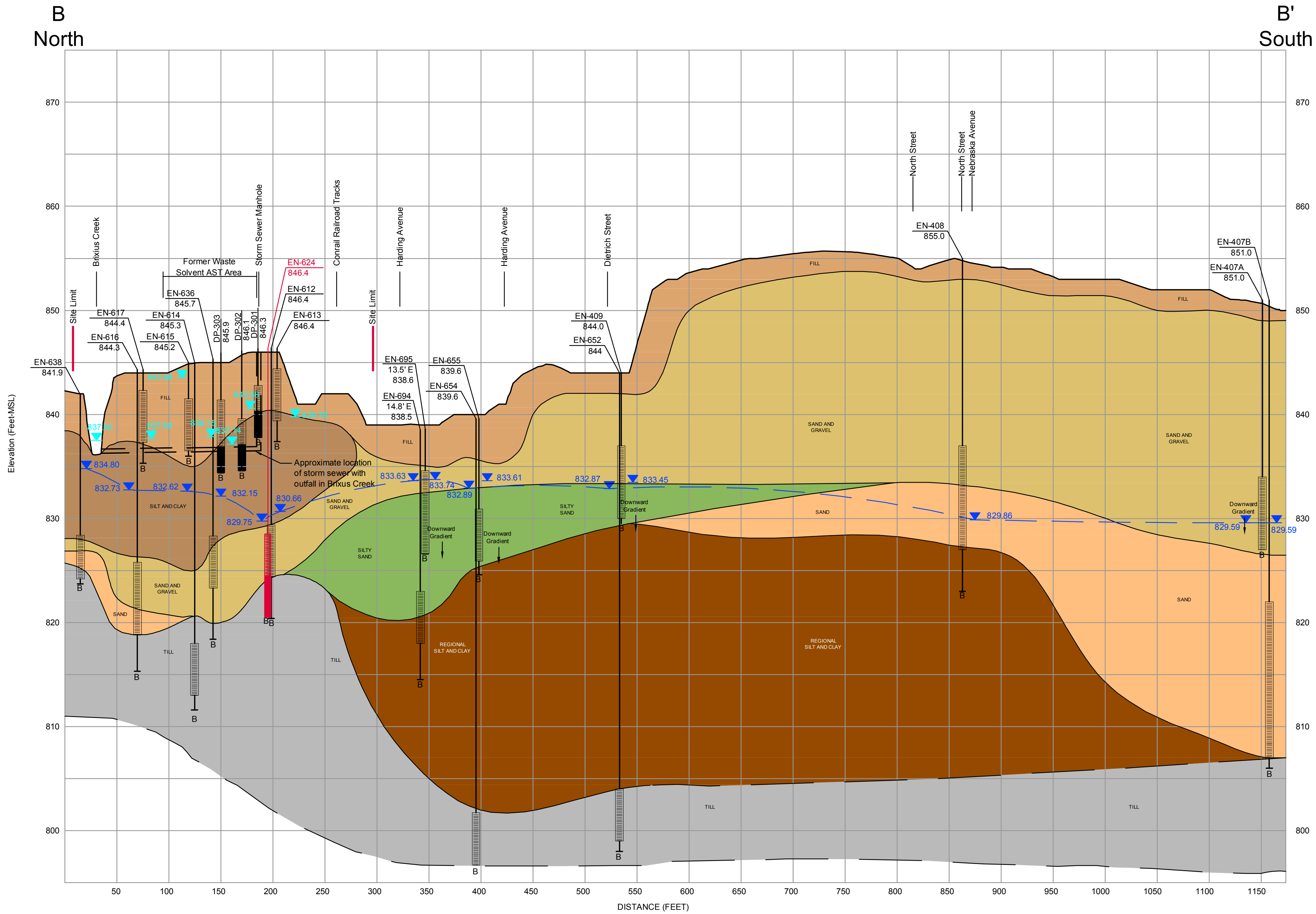


Figure 6-B

Geologic Profile B-B'

Supplemental Remedial Investigation Report

OU#5/Building 57 Area

Union and Endicott, New York

Drawn By: E. Wright
Designed By: P. Mouser
Reviewed By: L. Jacob
Date: March 2010

Figure Narrative

This figure shows an approximately north to south geologic profile for locations east of Building 57. The inferred groundwater potentiometric surface for the lower water-bearing zone as measured in October 2009 is shown is blue. Monitoring well EN-624 designated in red is currently operating as a groundwater extraction well.

Legend

- 838.15 — Groundwater elevation upper water-bearing zone measured in October 2009
- 829.86 — Groundwater elevation lower water-bearing zone measured in October 2009
- Inferred potentiometric surface lower water bearing zone
- EN-624 / 846.4 — Monitoring well/test boring designation / Approximate ground surface elevation
- Approximate ground surface
- Inferred stratigraphic contact
- Well screen
- Sump
- B Bottom of boring
- R Refusal

Notes:

1. Lines representing strata have been interpolated from a limited number of widely spaced explorations. Actual conditions will vary from those shown.

Legend:

Fill - typically loose/soft to dense/hard; color varies from light brown/brown to gray to black; varying mixtures of clay, silt, sand, and gravel; may contain minor amounts of organics, cinders, ash, brick fragments, wood, or glass.

Silt and Clay - typically stiff; brown to olive gray; varying proportions of silt and clay with up to approximately 10 percent sand and 10 percent gravel; may contain organics; commonly shows orange mottling. Gravel fragments are typically rounded.

Regional Silt & Clay - typically medium stiff; gray to olive-gray; Clayey SILT with varying proportions of silt and clay; 0 to 10 percent san or gravel, if present; commonly contains pinkish laminae and occasionaly pink to buff silt varves.

Sand and Gravel - typically loose to dense; brown to gray; fine to coarse sand with up to approximately 50 percent gravel and 20 percent silt.

Silty Sand - typically brown to brown-blue, clayey silt and fine sand, occasionally with varying amounts of gravel.

Gravel - typically loose to very dense; gray; fine to coarse gravel with varying amounts of sand and/or silt/clay. Gravel fragments are typically rounded to subrounded.

Sand - typically loose to very dense; brown; fine to coarse sand with varying amounts of silt/clay, and up to approximately 20 percent gravel.

Till - typically dense to very dense; brown to olive gray; poorly sorted mixture of clay, silt, and gravel; also likely contains cobbles and boulders. Gravel fragments are typically angular and composed of fractured shale.

Summary of Subsurface Conditions

The stratigraphic units in this area are consistent with the "Generalized Stratigraphy" described on the Source Zone Map. This area demonstrates the variable presence of the sand and gravel below the silt and clay. However, the inferred stratigraphy associated with borings EN-407A, EN-407B, EN-408 and EN-409 is based on historic well logs prepared by others, prior to development of the current conceptual model.

Water levels in the fill above the silt and clay likely vary temporally based on precipitation events and the water level in Brixius Creek. The variability of water levels across this section may be due to these temporal influences.

Vertical Exaggeration: 10x

SHPC ENGINEERS

File: V:\RANDOLPH\2466.02\dwg\Cross-Sections-2010\X-Sections.dwg Plot Date: 2-15-10

Figure 6-C

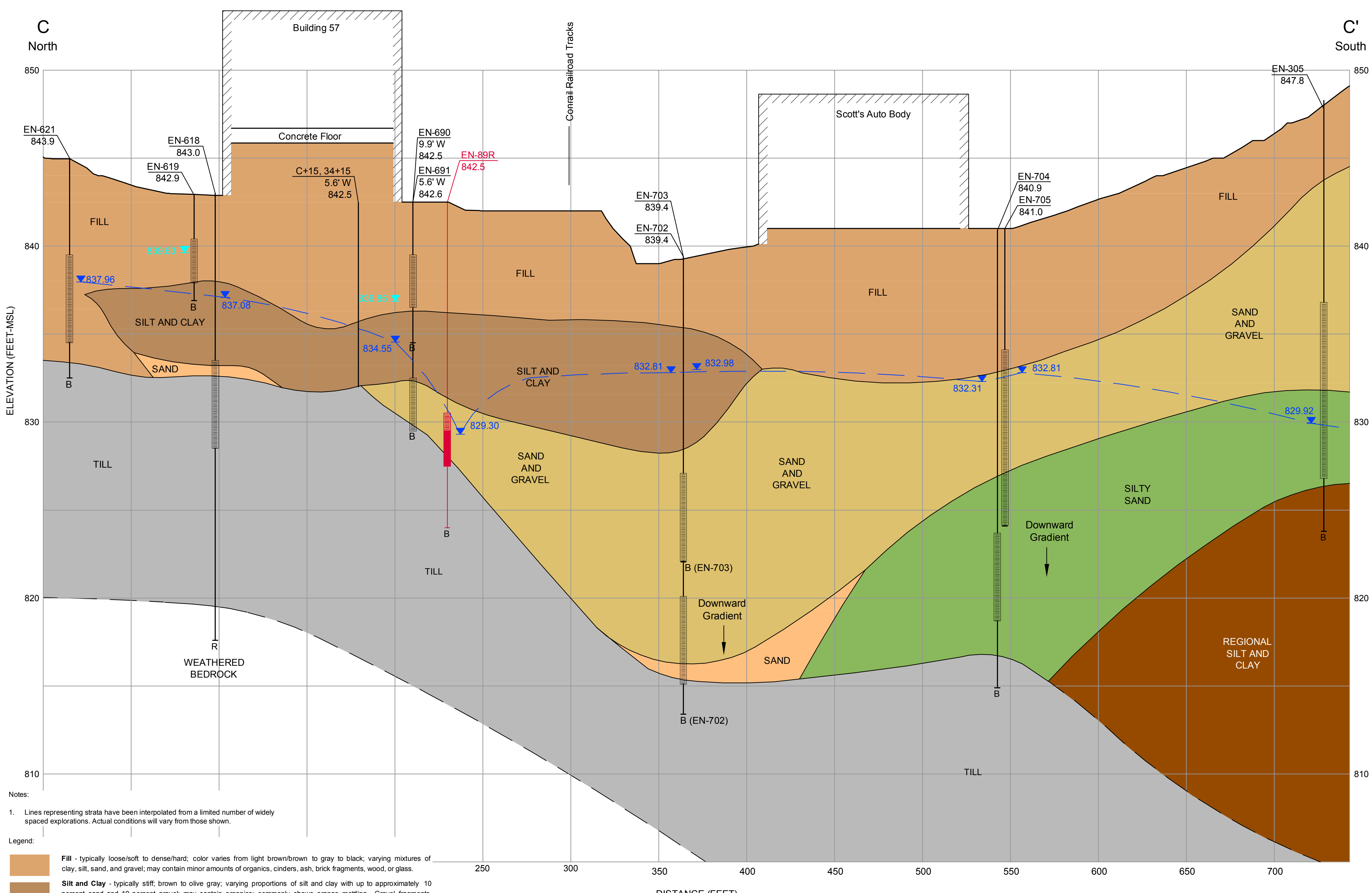
Geologic Profile C-C'

Supplemental Remedial Investigation Report

OU#5/Building 57 Area

Union and Endicott, New York

Drawn By: E. Wright
Designed By: P. Mouser
Reviewed By: L. Jacob
Date: March 2010



Notes:

1. Lines representing strata have been interpolated from a limited number of widely spaced explorations. Actual conditions will vary from those shown.

Legend:

- **Fill** - typically loose/soft to dense/hard; color varies from light brown/brown to gray to black; varying mixtures of clay, silt, sand, and gravel; may contain minor amounts of organics, cinders, ash, brick fragments, wood, or glass.
- **Silt and Clay** - typically stiff; brown to olive gray; varying proportions of silt and clay with up to approximately 10 percent sand and 10 percent gravel; may contain organics; commonly shows orange mottling. Gravel fragments are typically rounded.
- **Regional Silt & Clay** - typically medium stiff; gray to olive-gray; Clayey SILT with varying proportions of silt and clay; 0 to 10 percent san or gravel, if present; commonly contains pinkish laminae and occasionaly pink to buff silt varves.
- **Sand and Gravel** - typically loose to dense; brown to gray; fine to coarse sand with up to approximately 50 percent gravel and 20 percent silt.
- **Silty Sand** - typically brown to brown-blue, clayey silt and fine sand, occasionally with varying amounts of gravel.
- **Gravel** - typically loose to very dense; gray; fine to coarse gravel with varying amounts of sand and/or silt/clay. Gravel fragments are typically rounded to subrounded.
- **Sand** - typically loose to very dense; brown; fine to coarse sand with varying amounts of silt/clay, and up to approximately 20 percent gravel.
- **Till** - typically dense to very dense; brown to olive gray; poorly sorted mixture of clay, silt, and gravel; also likely contains cobbles and boulders. Gravel fragments are typically angular and composed of fractured shale.

Figure Narrative

This figure shows an approximately north-south geologic profile through Building 57 to locations to the south of OU#5. The silt and clay aquitard pinches south of EN-702/EN-703. The inferred groundwater potentiometric surface for the lower water-bearing zone beneath Building 57 as measured in October 2009 is shown in blue. Monitoring well designated EN-89R in red, is currently operating as an extraction well.

Legend

- 839.61 Groundwater elevation upper water-bearing zone measured in October 2009
- 830.31 Groundwater elevation lower water-bearing zone measured in October 2009
- Inferred potentiometric surface lower water bearing zone
- EN-704 Monitoring well/test boring designation; 840.9 Approximate ground surface elevation
- Approximate ground surface
- Inferred stratigraphic contact
- Well screen
- Sump
- B Bottom of boring
- R Refusal

__Summary of Subsurface Conditions__

The stratigraphic units in this area are consistent with the "Generalized Stratigraphy" described on the Source Zone Map. This area demonstrates the variable presence of the sand and gravel below the silt and clay. However, the inferred stratigraphy associated with borings EN-89R and EN-305 is based on historic well logs prepared by others, prior to development of the current conceptual model.

Water levels in the fill above the silt and clay likely vary temporally based on precipitation events and the water level in Brixius Creek.

Vertical Exaggeration: 10x

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Figure 6-D

Geologic Profile D-D'

Supplemental Remedial Investigation Report

OU#5/Building 57 Area

Union and Endicott, New York

Drawn By: E. Wright
Designed By: P. Mouser
Reviewed By: L. Jacob
Date: March 2010

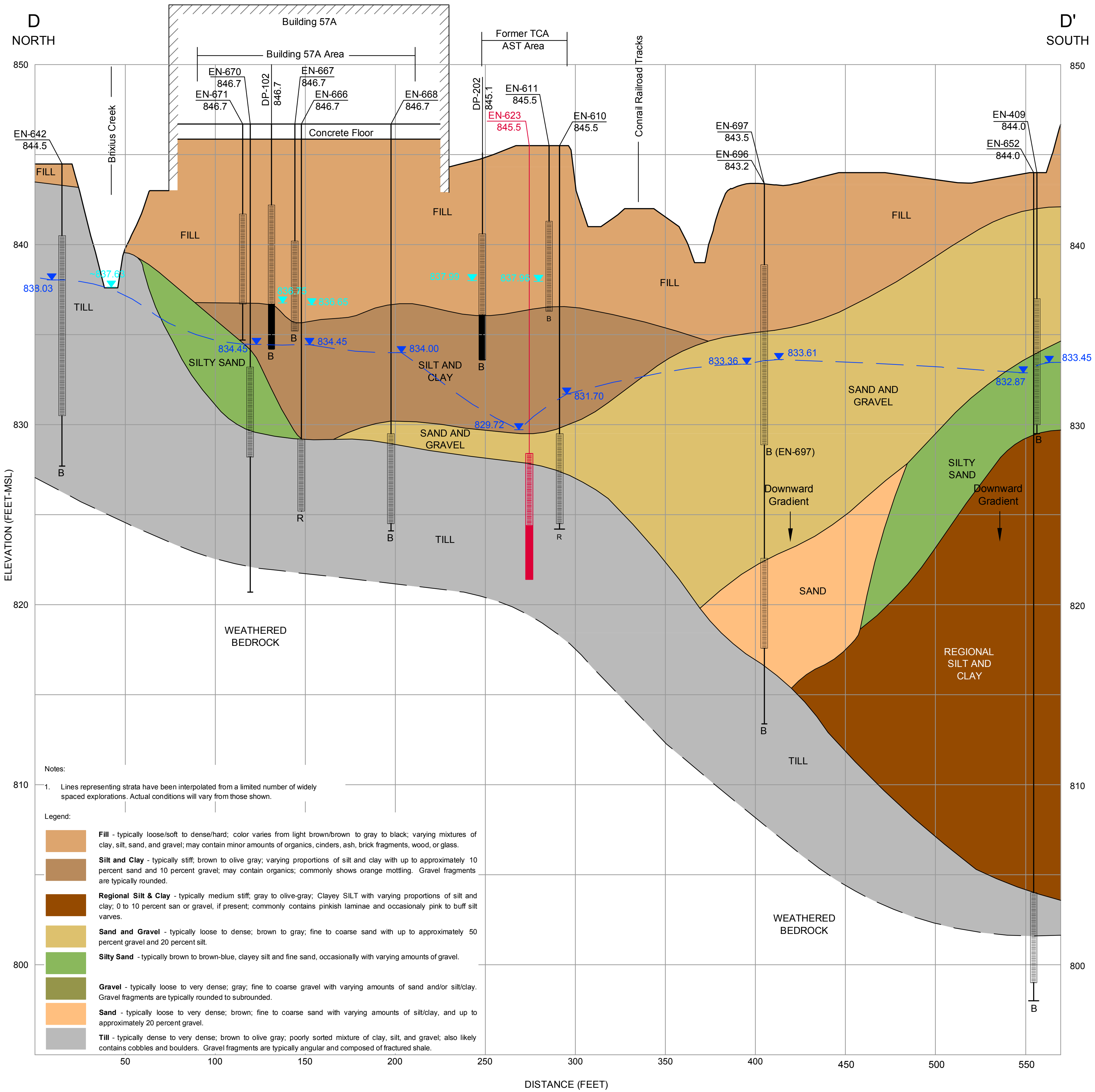

Figure Narrative

This figure shows an approximately north-south geologic profile through Building 57 to locations to the south of OU#5. The silt and clay aquitard pinches out near EN-696/EN-697. The inferred groundwater potentiometric surface for the lower water-bearing zone beneath Building 57 as measured in October 2009 is shown in blue. Monitoring well designated EN-623 in red, is currently operating as an extraction well.

Legend

- 833.96 — Groundwater elevation upper water-bearing zone measured in October 2009
- 833.85 — Groundwater elevation lower water-bearing zone measured in October 2009
- ~837.63 — Groundwater elevation is estimated based on upper water-bearing zone potentiometric surface
- Inferred potentiometric surface lower water bearing zone
- EN-623 845.5 — Monitoring well/test boring designation; Approximate ground surface elevation
- Approximate ground surface
- Inferred stratigraphic contact
- Well screen
- Sump
- B Bottom of boring
- R Refusal

Summary of Subsurface Conditions

The stratigraphic units in this area are consistent with the "Generalized Stratigraphy" described on the Source Zone Map. The inferred silt & clay aquitard surface slopes slightly upward to the South, while the inferred till surface slopes downward to the south.

Vertical Exaggeration: 10x

SHPC ENGINEERS

File: V:\RANDOLPH\2466.02\dwg\Cross-Sections-2010\X-Sections.dwg Plot Date: 2-15-10

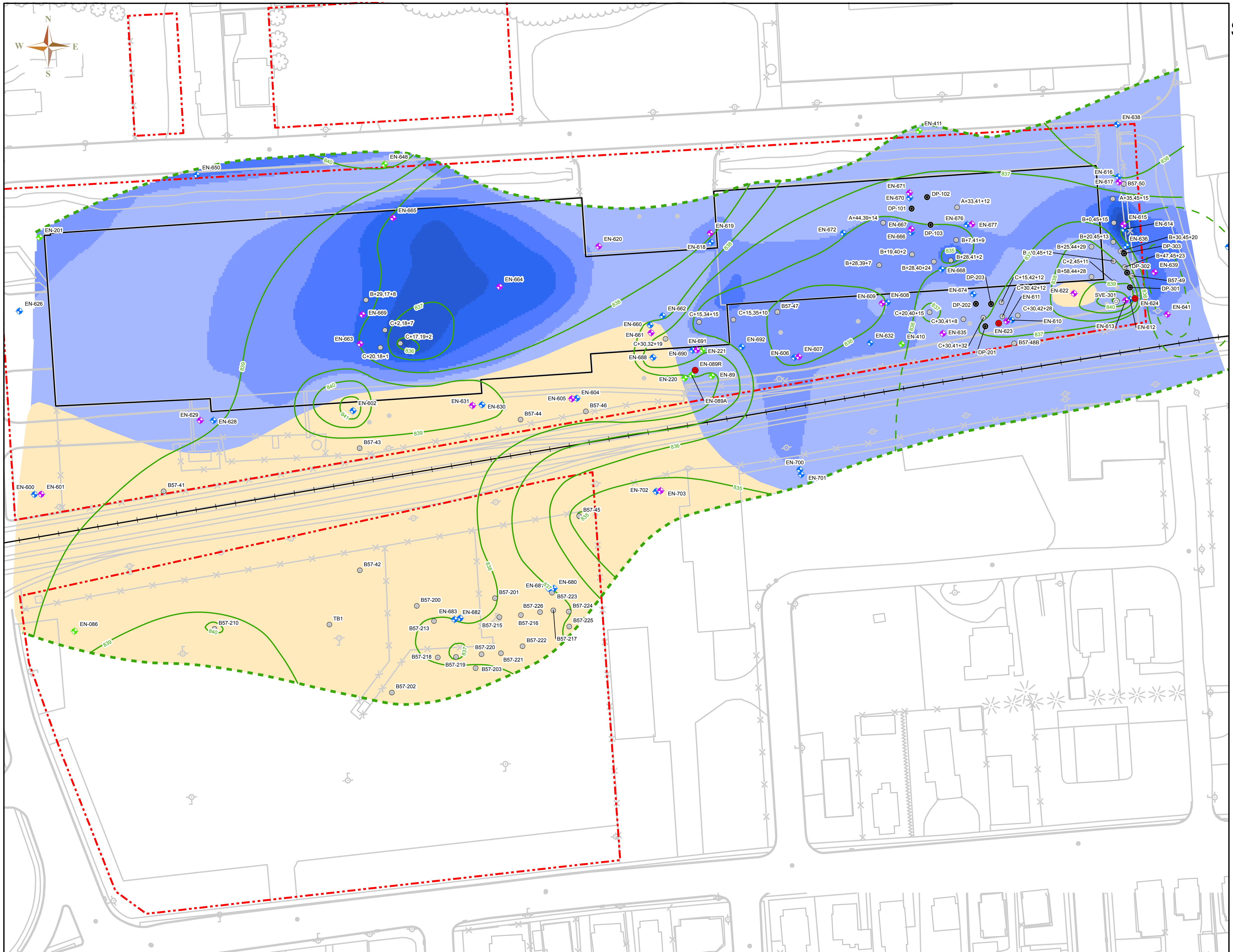

Figure 7

Site Silt and Clay Aquitard Surface Contours

Supplemental Remedial Investigation Report
OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: S. Warner/J. Pierce
Designed By: L. Jacob
Reviewed By: J. Ordway
Date: March 2010

Figure Narrative:

This figure is intended to show the inferred surface of the site silt and clay aquitard, as observed during drilling and sampling activities.

The inferred saturated thickness of the upper water-bearing zone (WBZ) is depicted with shaded contours, based on water level measurements in upper WBZ wells recorded on October 19 and 20, 2009.

Surface and groundwater elevation contours were developed using generally accepted hydrogeologic practices, involving interpolation between sampling locations. Other interpretations are possible.

Legend

834 — Site Silt and Clay Contour and Elevation (ft)

Extent of Site Silt and Clay Aquitard

Inferred Upper WBZ Saturated Thickness (ft)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- > 4

Inferred Seasonally/Intermittently Dry Area

Feet: 50 25 0 50 100 150

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Figure 8

Upper Water-Bearing Zone Groundwater Contours

Supplemental Remedial Investigation Report OU#5 / Building 57 Area

Endicott and Union, NY

Drawn By: S. Warner/J. Pierce
Designed By: S. Warner
Reviewed By: L. Jacob
Date: March 2010

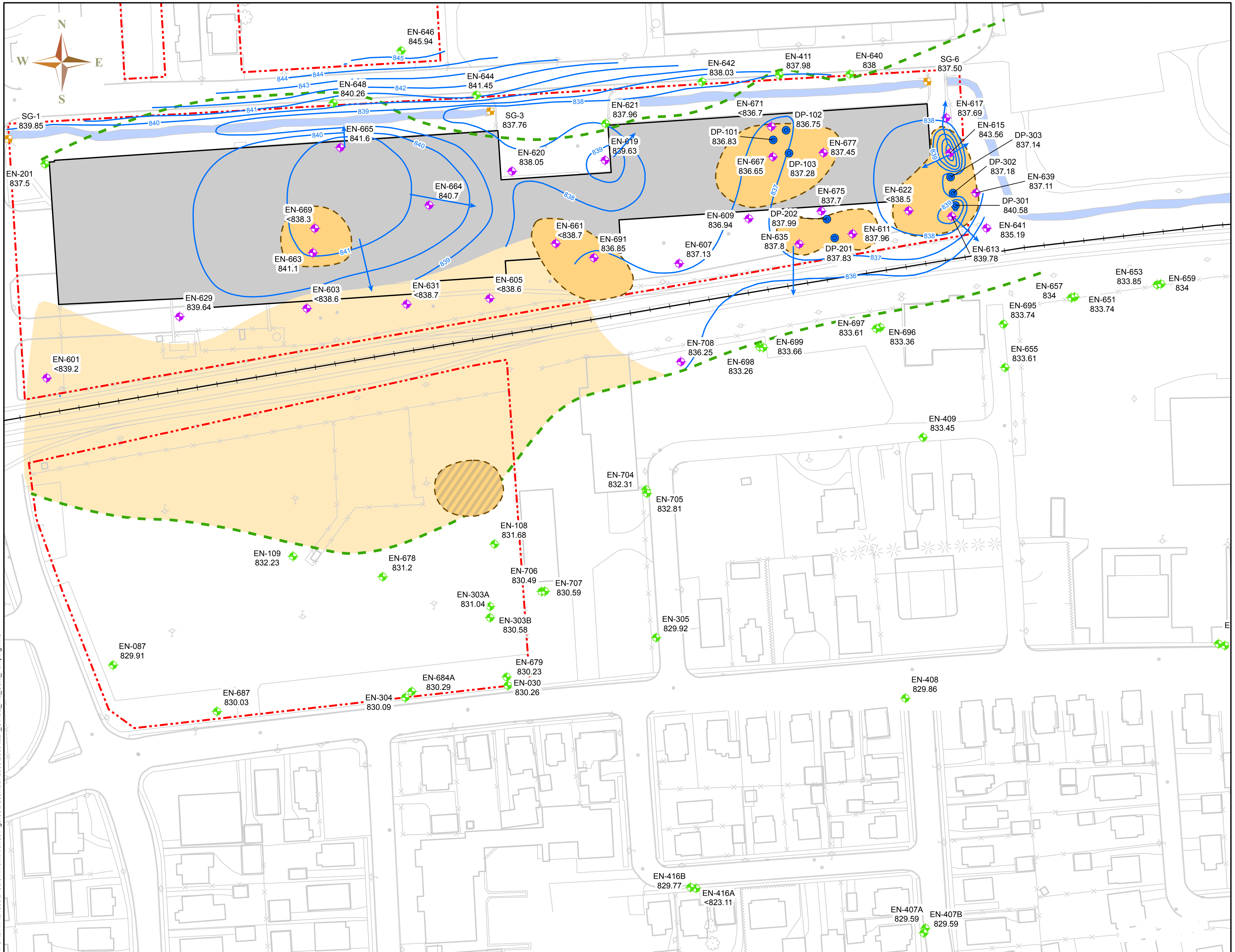

Figure Narrative:

This figure shows groundwater elevation contours inferred from water level measurements from selected upper water-bearing zone (WBZ) wells on October 19th & 20th, 2009. Groundwater levels were measured during pumping from OU#5 area extraction wells.

The contours were developed using generally accepted hydrogeologic practices, involving interpolation between monitoring wells. Fluctuations in water levels and groundwater flow directions are likely to occur due to seasonal trends and climatic events. Other interpretations are possible.

Legend

- Extent of Site Silt and Clay Aquitard
- 833 — Upper WBZ Water Table Surface Elevation based on Pumping Conditions from October 19 & 20, 2009 (ft amsl)
- Inferred Seasonally/Intermittently Dry Area
- Inferred Groundwater Flow Direction

Refer to Figure 3 for additional legend information.

60 30 0 60 120 180 Feet

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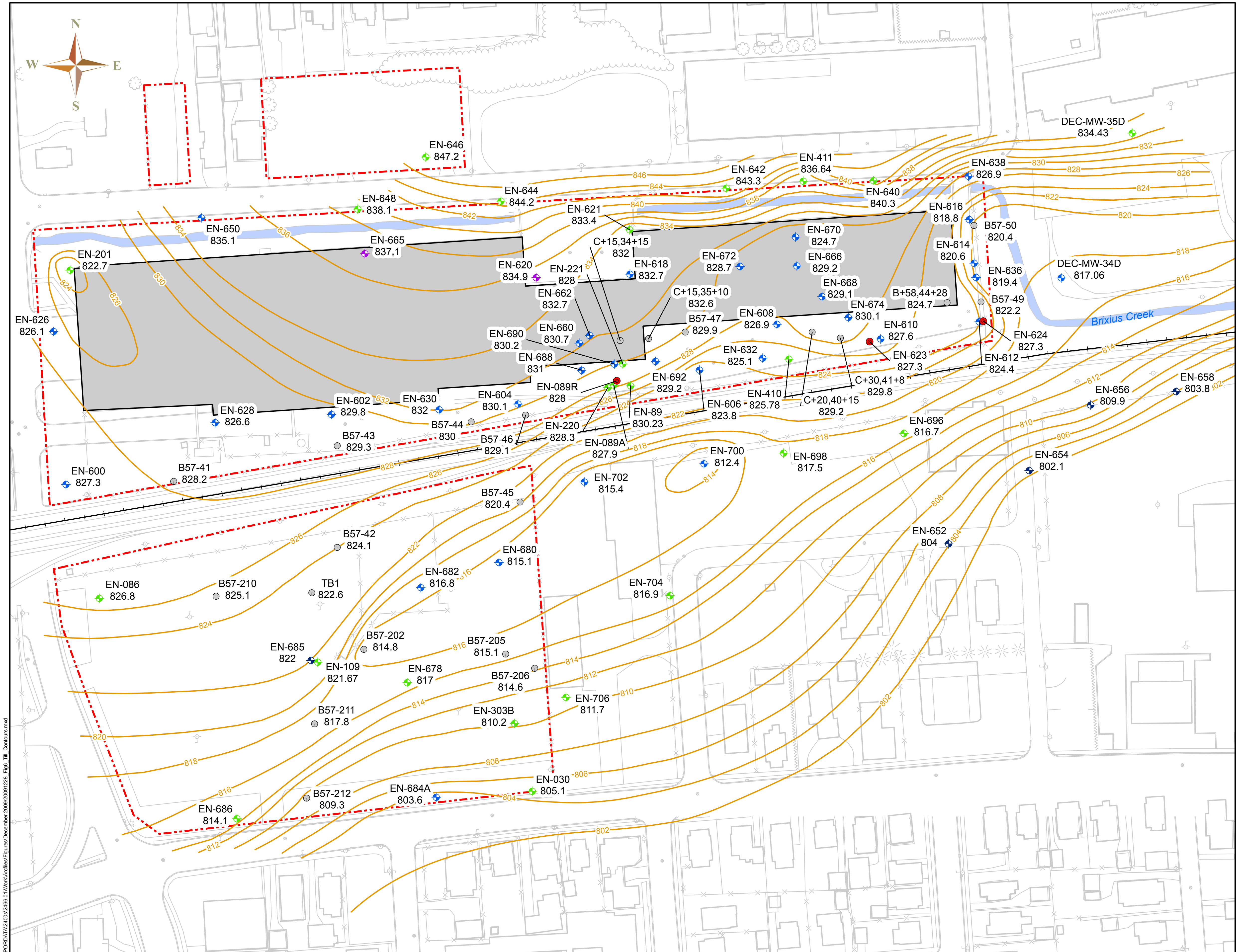

Figure 9

Glacial Till Surface

Supplemental Remedial Investigation Report
OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: J. Pierce
Designed By: L. Jacob
Reviewed By: J. Ordway
Date: March 2010

Figure Narrative:

This figure is intended to show the inferred surface of glacial till, as observed during drilling and sampling activities.

The surface contours were developed using generally accepted hydrogeologic practices, involving interpolation between sampling locations. Other interpretations are possible.

Legend

Glacial Till Contour and Elevation (ft)

SHPC ENGINEERS

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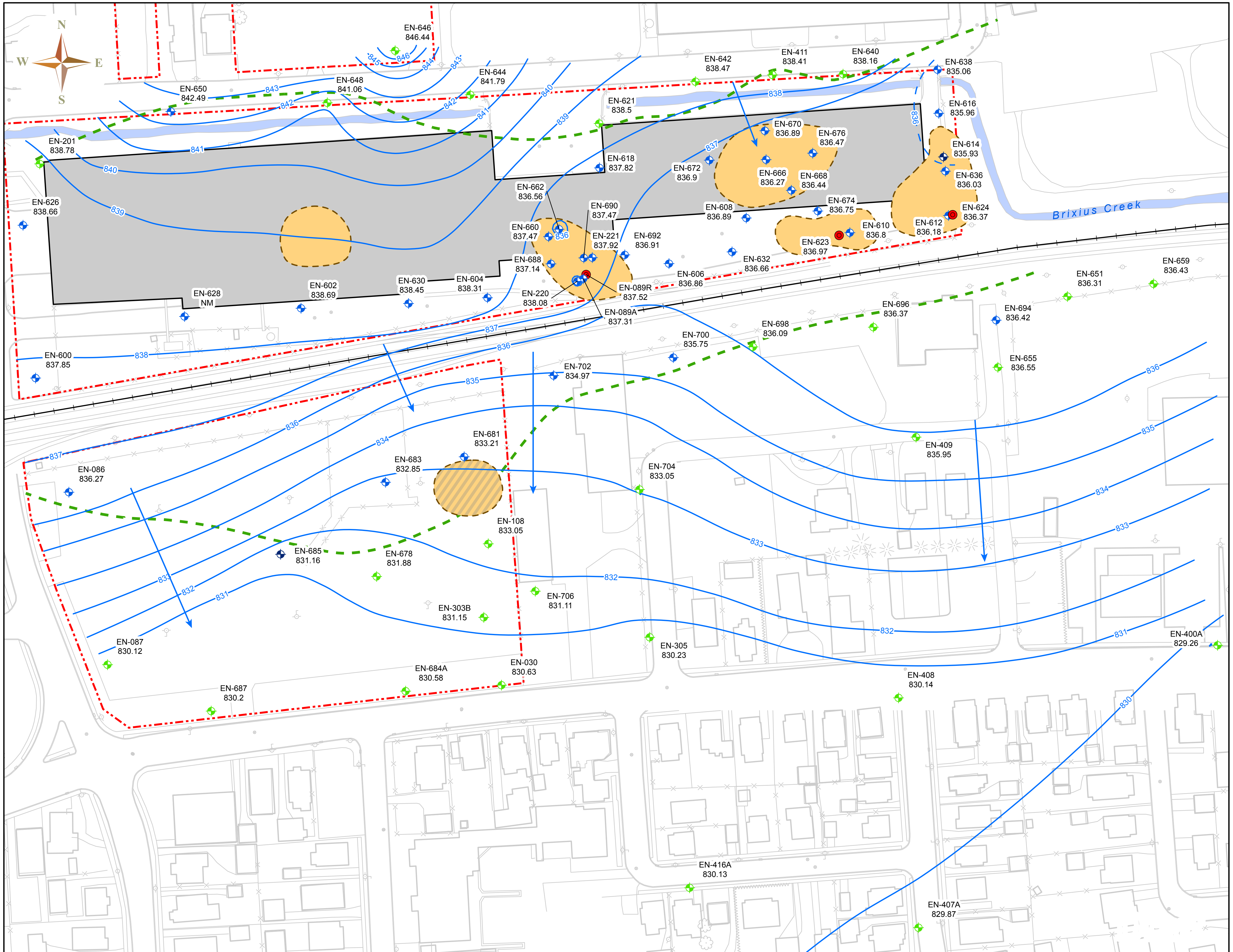

Figure 10

Lower Water-Bearing Zone Groundwater Contours, Ambient Conditions

Supplemental Remedial Investigation Report
OU#5 / Building 57 Area

Endicott and Union, NY

Drawn By:	J. Pierce
Designed By:	S. Warner
Reviewed By:	L. Jacob
Date:	March 2010

Figure Narrative:

This figure shows groundwater elevation contours inferred from water level measurements from selected lower water-bearing zone (WBZ) monitoring wells. Groundwater levels were measured under inferred ambient (e.g., non-pumping) conditions on October 29, 2009.

The contours were developed using generally accepted hydrogeologic practices, involving interpolation between monitoring wells. Fluctuations in water levels and groundwater flow directions are likely to occur due to seasonal trends and climatic events. Other interpretations are possible.

Legend

- Extent of Site Silt and Clay Aquitard
- 833 — Lower WBZ Potentiometric Surface Elevation based on Ambient Conditions from October 29, 2009 (ft amsl)
- Inferred Groundwater Flow Direction

60 30 0 60 120 180 Feet

SHPC ENGINEERS

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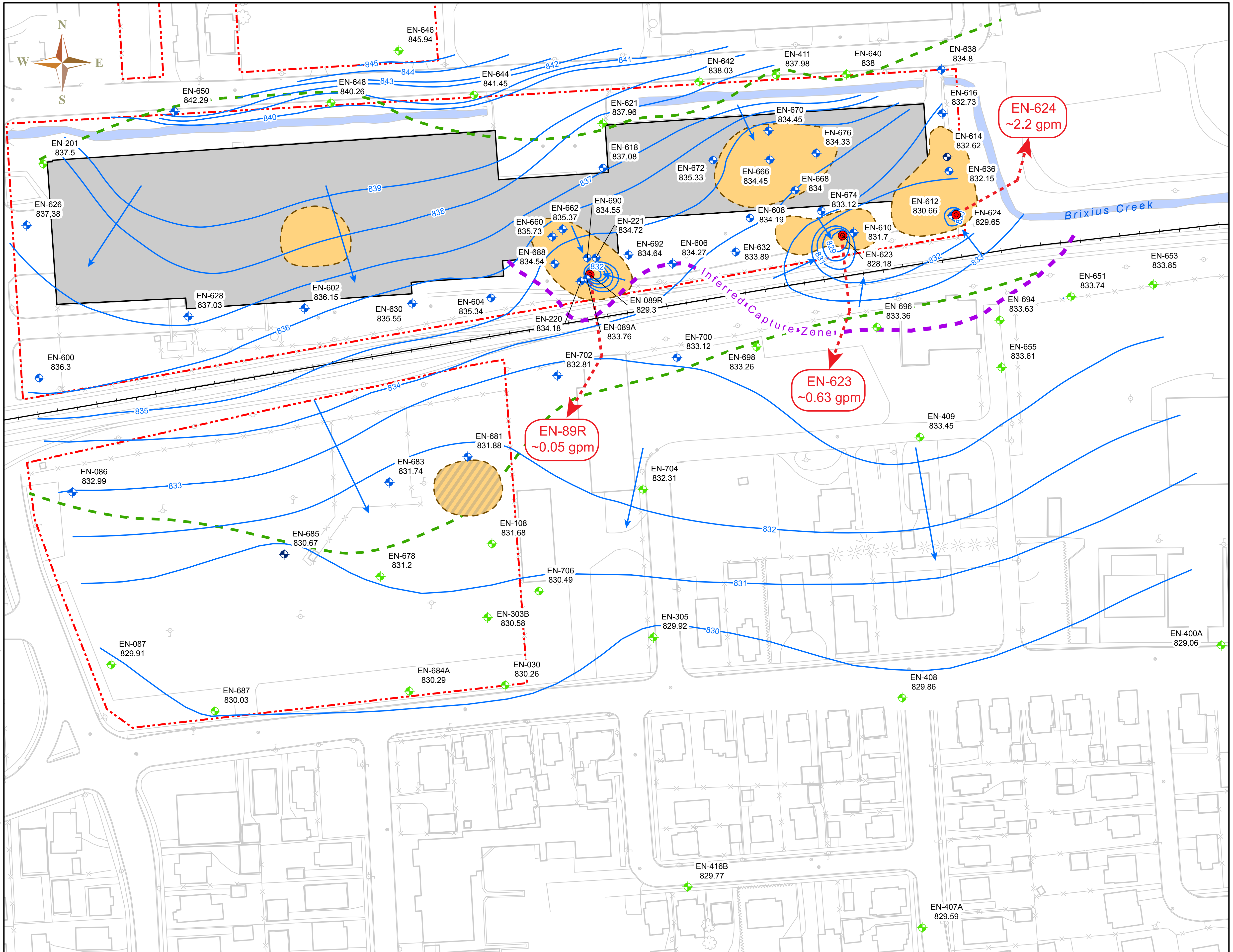

Figure 11

Lower Water-Bearing Zone Groundwater Contours, Pumping Conditions

Supplemental Remedial Investigation Report
OU#5 / Building 57 Area

Endicott and Union, NY

Drawn By: J. Pierce
Designed By: J. Pierce
Reviewed By: L. Jacob
Date: March 2010

Figure Narrative:

This figure shows groundwater elevation contours inferred from water level measurements from selected lower water-bearing zone (WBZ) monitoring wells. Groundwater levels were measured under pumping conditions in October 2009. Average groundwater extraction rates were determined from hourly flow rates from October 19, 2009, provided by GSC.

The extents of hydraulic containment were inferred using water level measurements and the results of monitoring during recent shut-down and re-starting of pumping from the OU#5-area extraction wells. Refer to the SRI report and appendices for further information.

The contours were developed using generally accepted hydrogeologic practices, involving interpolation between monitoring wells. Fluctuations in water levels and groundwater flow directions are likely to occur due to seasonal trends and climatic events. Other interpretations are possible.

Legend

EN-623 ~0.63 gpm — Average groundwater extraction rate in gallons per minute (gpm)

Extent of Site Silt and Clay Aquitard

833 — Lower WBZ Potentiometric Surface Elevation based on Pumping Conditions from October 19th & 20th, 2009 (ft amsl)

Inferred Groundwater Flow Direction

Inferred Capture Zone

60 30 0 60 120 180 Feet

SHPC ENGINEERS

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Figure 12

Chlorinated Ethene Concentrations in Soil Gas

Supplemental Remedial Investigation Report OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: S. Warner
Designed By: S. Warner
Reviewed By: L. Jacob
Date: March 2010

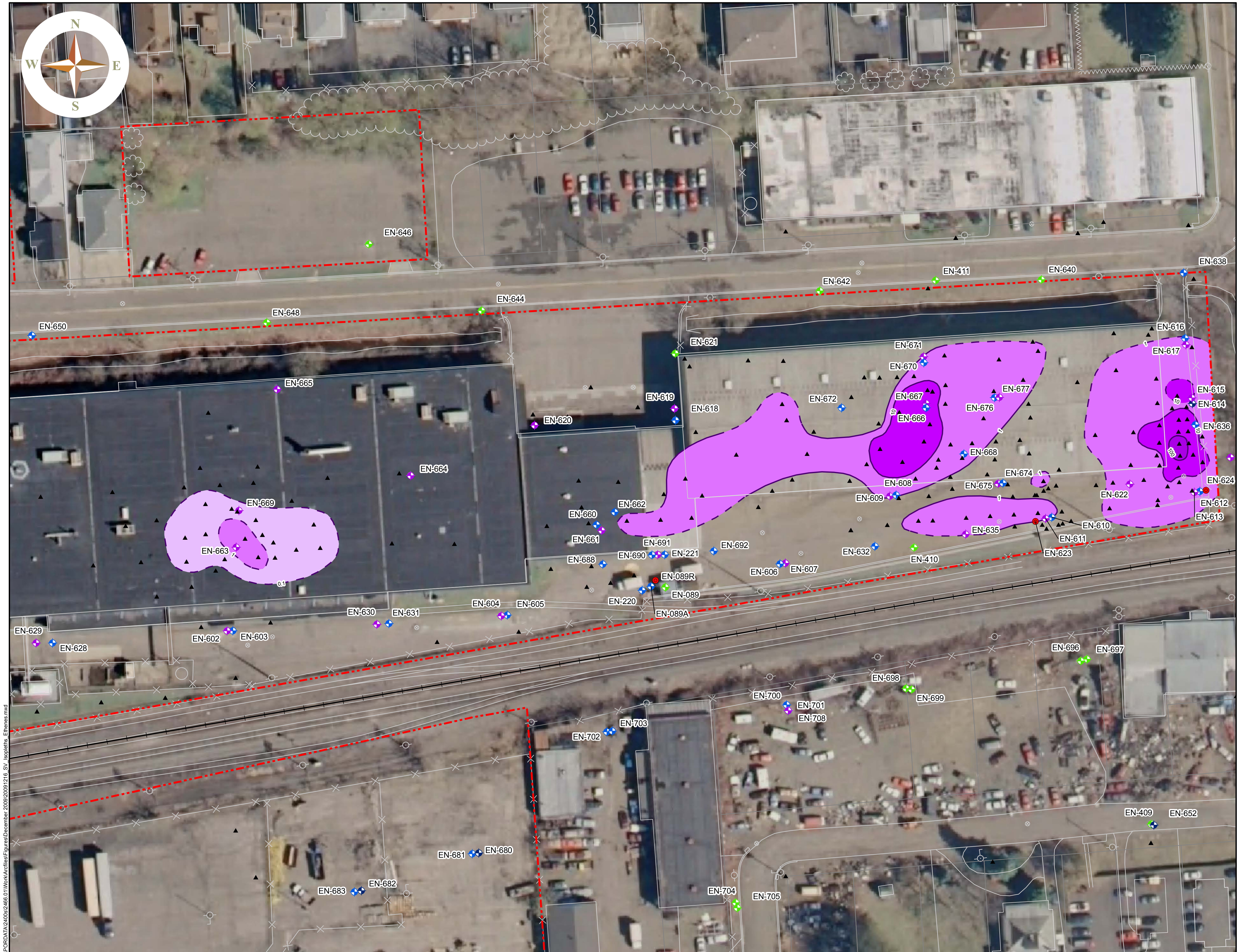

Figure Narrative:

This figure is intended to depict relative distribution of total chlorinated ethenes (i.e., PCE, TCE, cis-DCE, and vinyl chloride) in soil gas studies. Data are shown from samples collected by SHA in January and March 2005, March and April 2007, and April 2009. Fixed and mobile laboratory data are shown. Concentrations are presented in parts per million by volume (ppmv).

The isopleths were developed using generally accepted practices based on limited information and data from widely spaced monitoring points. The contours are intended to reflect the summed concentration of chorinated ethenes consistent with available data. The distribution of total chlorinated ethenes is likely more heterogeneous and actual isopleths may vary from those shown. Other interpretations are possible.

Legend

Groundwater Extraction Well

Soil Gas Sample Location

Total chlorinated ethene concentrations in soil gas. Dashed to reflect areas of greater uncertainty.

Concentration (ppmv) 0.1 1.0 10 100 1,000 >

40 20 0 40 80 120 Feet

SHPC ENGINEERS

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Figure 13

Chlorinated Ethane Concentrations in Soil Gas

Supplemental Remedial Investigation Report
OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: S. Warner
Designed By: S. Warner
Reviewed By: L. Jacob
Date: March 2010

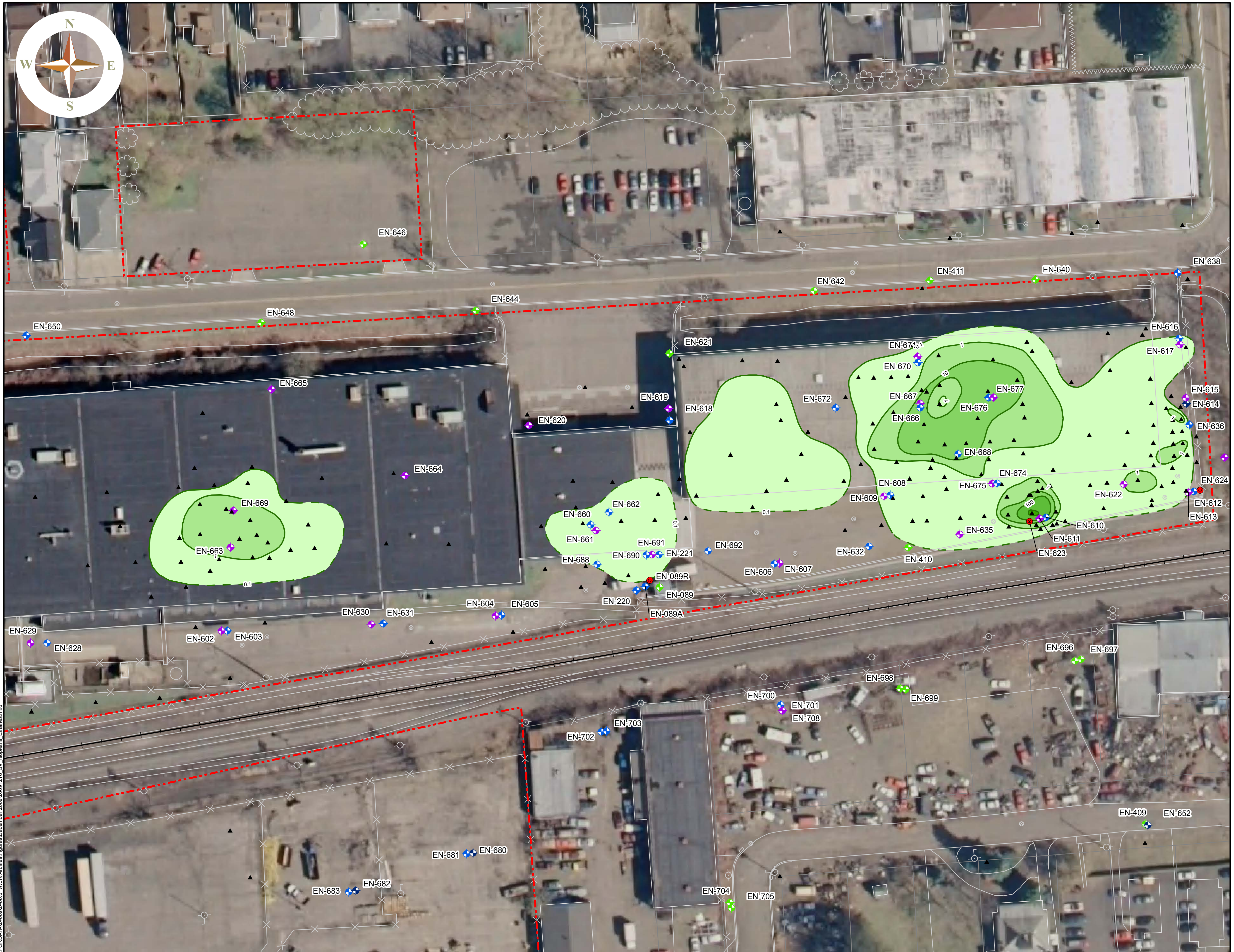

Figure Narrative:

This figure is intended to depict relative distribution of total chlorinated ethanes (e.g., 111TCA, 11DCA, and 11DCE) in soil gas studies. Data are shown from samples collected by SHA in January and March 2005, March and April 2007, and April 2009. Fixed and mobile laboratory data are shown. Concentrations are presented in parts per million by volume (ppmv).

The isopleths were developed using generally accepted practices based on limited information and data from widely spaced monitoring points. The contours are intended to reflect the summed concentration of chorinated ethanes consistent with available data. The distribution of total chlorinated ethanes is likely more heterogeneous and actual isopleths may vary from those shown. Other interpretations are possible.

Legend

Groundwater Extraction Well

Soil Gas Sample Location

Total chlorinated ethane concentrations in soil gas. Dashed to reflect areas of greater uncertainty

Concentration (ppmv) 0.1 1.0 10 100 1,000 >

Feet 40 20 0 40 80 120

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Figure 14

Chlorofluorocarbon Concentrations in Soil Gas

Supplemental Remedial Investigation Report
OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: S. Warner
Designed By: S. Warner
Reviewed By: L. Jacob
Date: March 2010

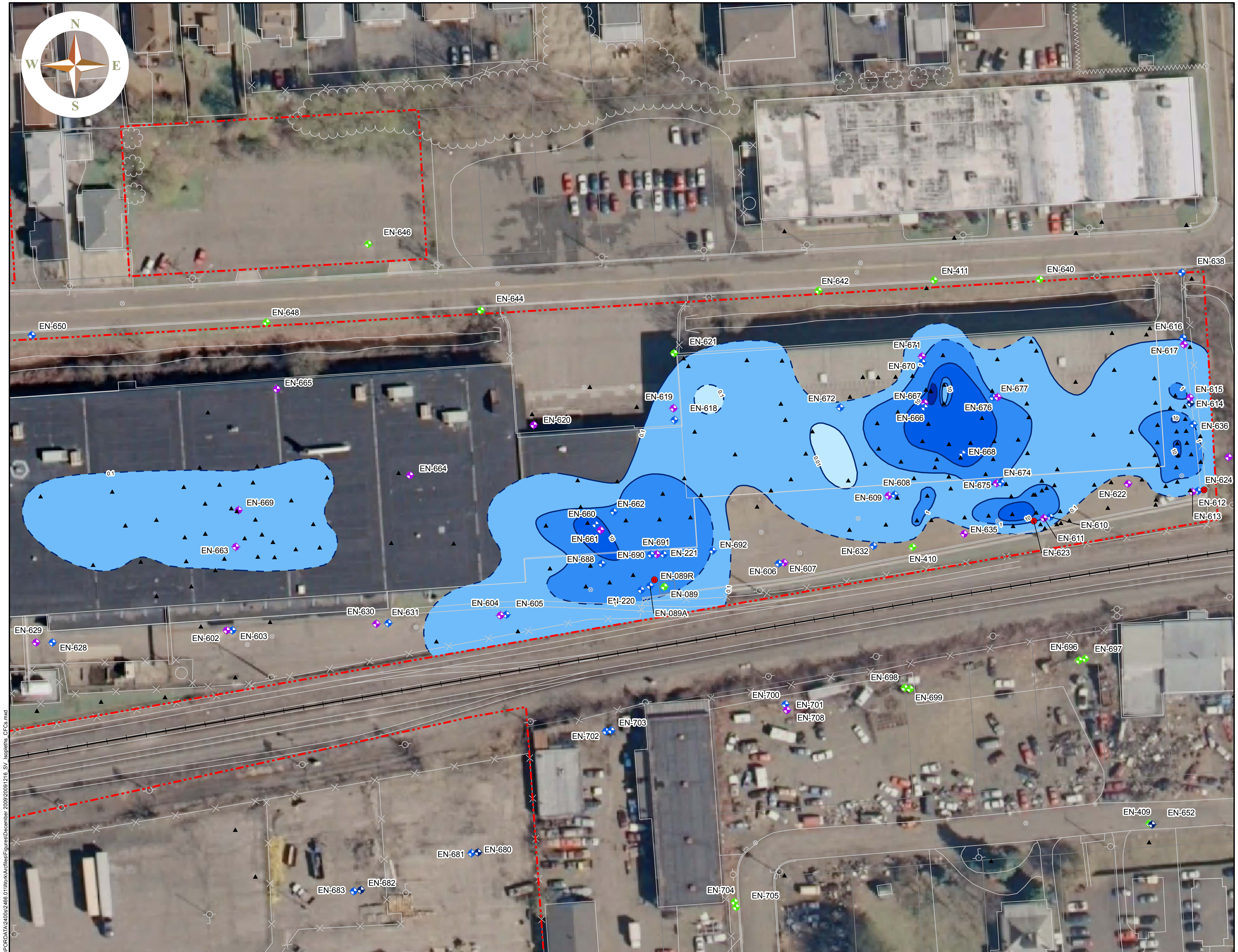

Figure Narrative:

This figure is intended to depict relative distribution of total chlorofluorocarbons (e.g., CFC-113 and CFC-123a) in soil gas studies. Data are shown from samples collected by SHA in January and March 2005, March and April 2007, and April 2009. Fixed and mobile laboratory data are shown. Concentrations are presented in parts per million by volume (ppmv).

The isopleths were developed using generally accepted practices based on limited information and data from widely spaced monitoring points. The contours are intended to reflect the summed concentration of chlorofluorocarbons consistent with available data. The distribution of total chlorofluorocarbons is likely more heterogeneous and actual isopleths may vary from those shown. Other interpretations are possible.

Legend

Groundwater Extraction Well

Soil Gas Sample Location

Total CFC concentrations in soil gas. Dashed to reflect areas of greater uncertainty

Concentration (ppmv) 0.01 0.1 1.0 10 100 >

Feet: 40 20 0 40 80 120

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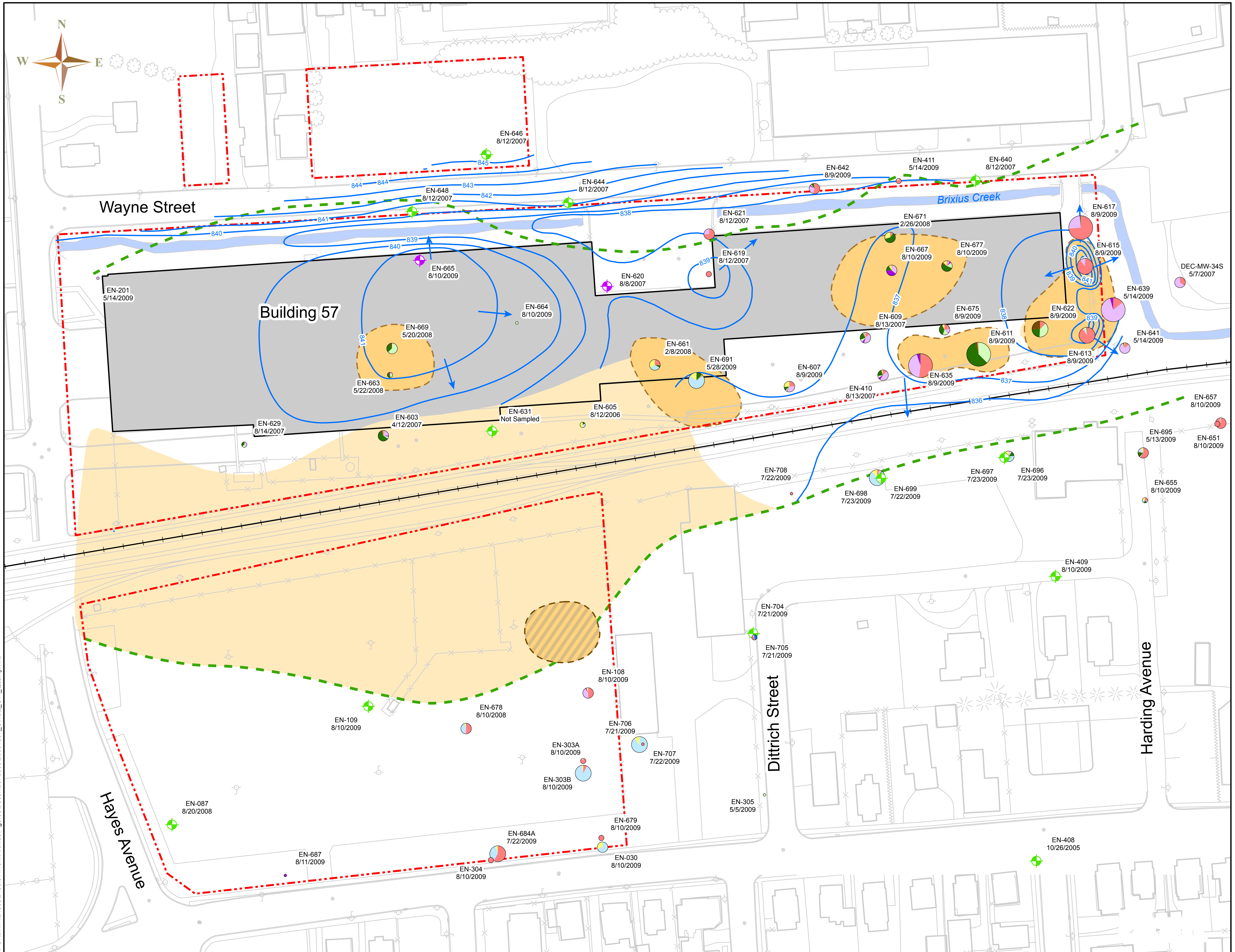

Figure 15

Summary of Groundwater Quality Upper Water-Bearing Zone

Supplemental Remedial Investigation Report OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: S. Warner
Designed By: L. Jacob/S. Warner
Reviewed By: J. Ordway
Date: March 2010

Figure Narrative:

This figure is intended to summarize the spatial distribution of key chlorinated VOCs detected in groundwater samples and the inferred upper WBZ groundwater potentiometric surface of the upper WBZ. Groundwater samples were collected from monitoring locations screened in the upper WBZ, or locations where the site silt and clay aquitard was not observed in the shallow subsurface. The VOC data used for this figure represent multiple monitoring rounds between October 2005 and August 2009. The most recently available data is shown for each monitoring point. Pie size represents the total mass of selected key VOCs (in ug/L) while pie slice represents the relative percent of individual parent and breakdown daughter products (in umoles/L). Upper WBZ groundwater elevation contours are based on measurements recorded in October 2009.

Legend

- Upper WBZ Groundwater Elevation Contours (ft amsl)
- Inferred Groundwater Flow Direction
- Inferred Seasonally/Intermittently Dry Area
- Extent of Site Silt and Clay Aquitard

Key Chlorinated VOCs Not Detected (ND)

- Upper WBZ Monitoring Well
- Monitoring Well

Total Key Chlorinated VOCs in Groundwater

- <1 ug/l
- 1 to <10 ug/l
- 10 to <100 ug/l
- 100 to <1,000 ug/l
- 1,000 to <10,000 ug/l
- 10,000 to <100,000 ug/l
- 100,000 to <1,000,000 ug/l

- PCE
- TCE
- cis 1,2-DCE
- Vinyl Chloride
- 1,1,1-TCA
- 1,1-DCE
- 1,1-DCA
- Chloroethane
- CFC-113
- CFC-123a

Feet: 60 30 0 60 120 180

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Figure 16

Summary of Groundwater Quality Lower Water-Bearing Zone

Supplemental Remedial Investigation Report
OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: S. Warner
Designed By: L. Jacob/S. Warner
Reviewed By: J. Orway
Date: March 2010

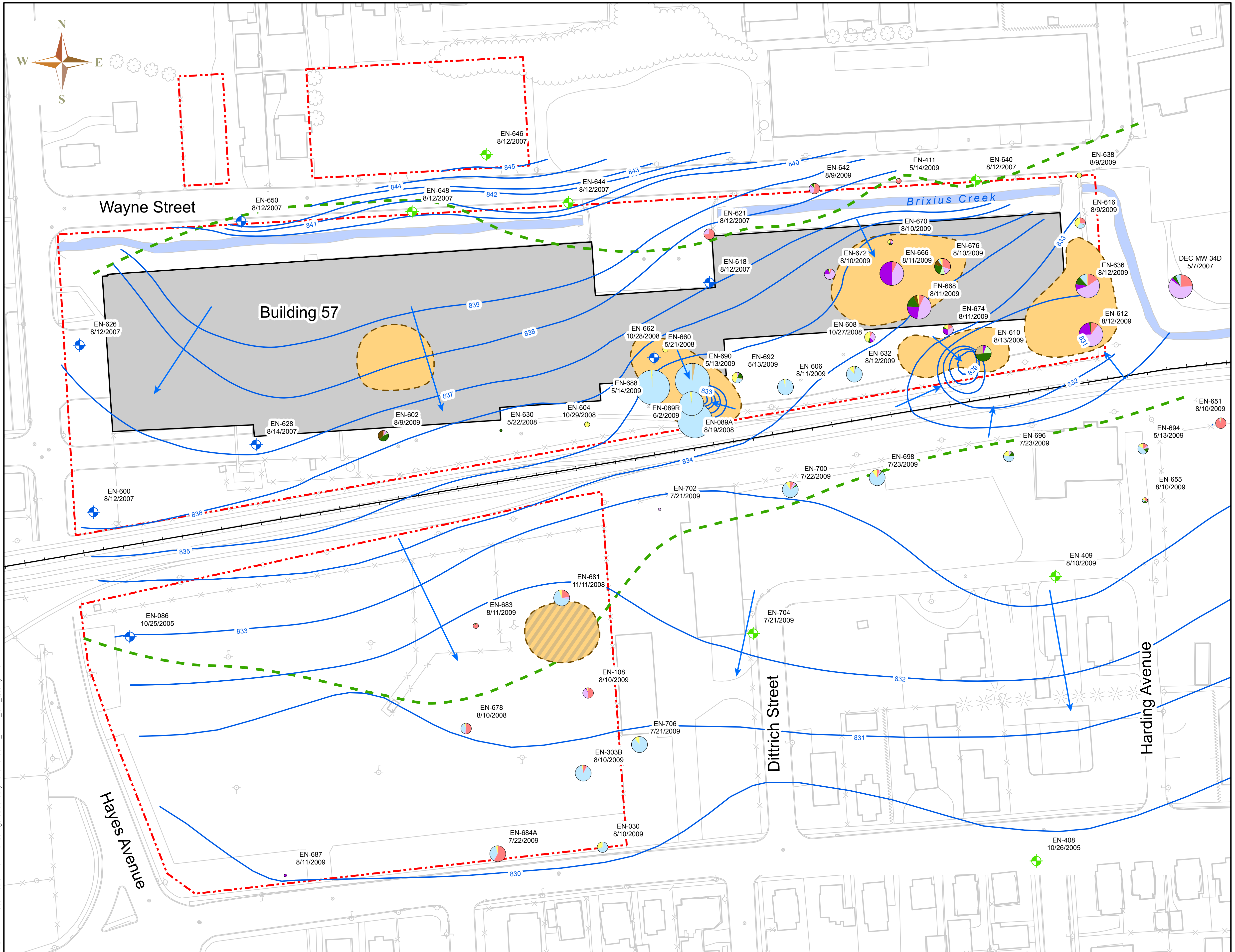

Figure Narrative:

This figure is intended to summarize the spatial distribution of key chlorinated VOCs detected in groundwater samples and the inferred groundwater potentiometric surface of the lower WBZ. Groundwater samples were collected from monitoring locations screened in the lower WBZ, or locations where the site silt and clay aquitard was not observed in the shallow subsurface. The VOC data used for this figure represent multiple monitoring rounds between October 2005 and August 2009. The most recently available data is shown for each monitoring point. Pie size represents the total mass of selected key VOCs (in ug/L) while pie slice represents the relative percent of individual parent and breakdown daughter products (in umoles/L). Lower WBZ groundwater elevation contours are based on measurements recorded in October 2009.

Legend

- Lower WBZ Groundwater Elevation Contours (ft amsl)
- Inferred Groundwater Flow Direction
- Extent of Site Silt and Clay Aquitard

Key Chlorinated VOCs Not Detected (ND)

- Lower WBZ Monitoring Well
- Monitoring Well

Total Key Chlorinated VOCs in Groundwater

- <1 ug/l
- 1 to <10 ug/l
- 10 to <100 ug/l
- 100 to <1,000 ug/l
- 1,000 to <10,000 ug/l
- 10,000 to <100,000 ug/l
- 100,000 to <1,000,000 ug/l

- PCE
- TCE
- cis 1,2-DCE
- Vinyl Chloride
- 1,1,1-TCA
- 1,1-DCE
- 1,1-DCA
- Chloroethane
- CFC-113
- CFC-123a

60 30 0 60 120 180 Feet

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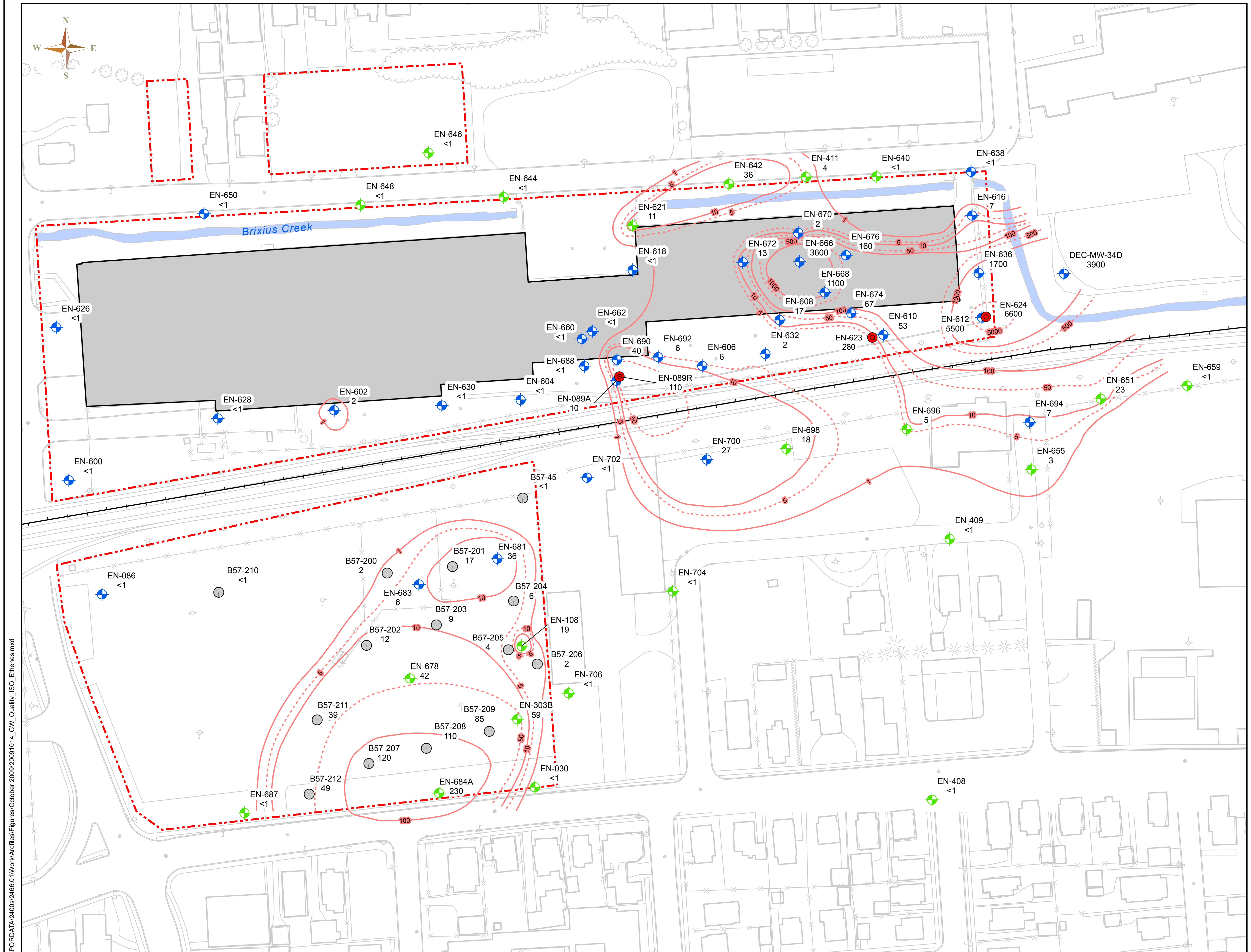

Figure 17

Isoconcentration Map Chlorinated Ethenes Lower WBZ Groundwater

Supplemental Remedial Investigation Report OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By:	J. Pierce
Designed By:	L. Jacob/P. Mouser
Reviewed By:	J. Ordway
Date:	March 2010

Figure Narrative

This figure shows concentration isopleths representing the total chlorinated ethenes detected in groundwater collected from the lower water-bearing zone (WBZ). Groundwater samples were collected from monitoring locations screened in the lower WBZ, or locations where the site silt and clay aquitard was not observed in the shallow subsurface. The VOC data used for this figure represent multiple monitoring rounds between October 2005 and August 2009. The most recently available data is shown for each monitoring point. Total chlorinated ethenes were calculated by summing detected concentrations of tetrachloroethene, trichloroethene, cis1,2-dichloroethene, and vinyl chloride.

The contours were developed using generally accepted hydrogeologic practices, involving interpolation between monitoring wells. Other interpretations are possible.

Legend

- Soil Boring
- Lower WBZ Monitoring Well
- Groundwater Extraction Well
- Monitoring Well
- Chlorinated Ethene Concentrations (ug/l)

Feet: 60 30 0 60 120 180

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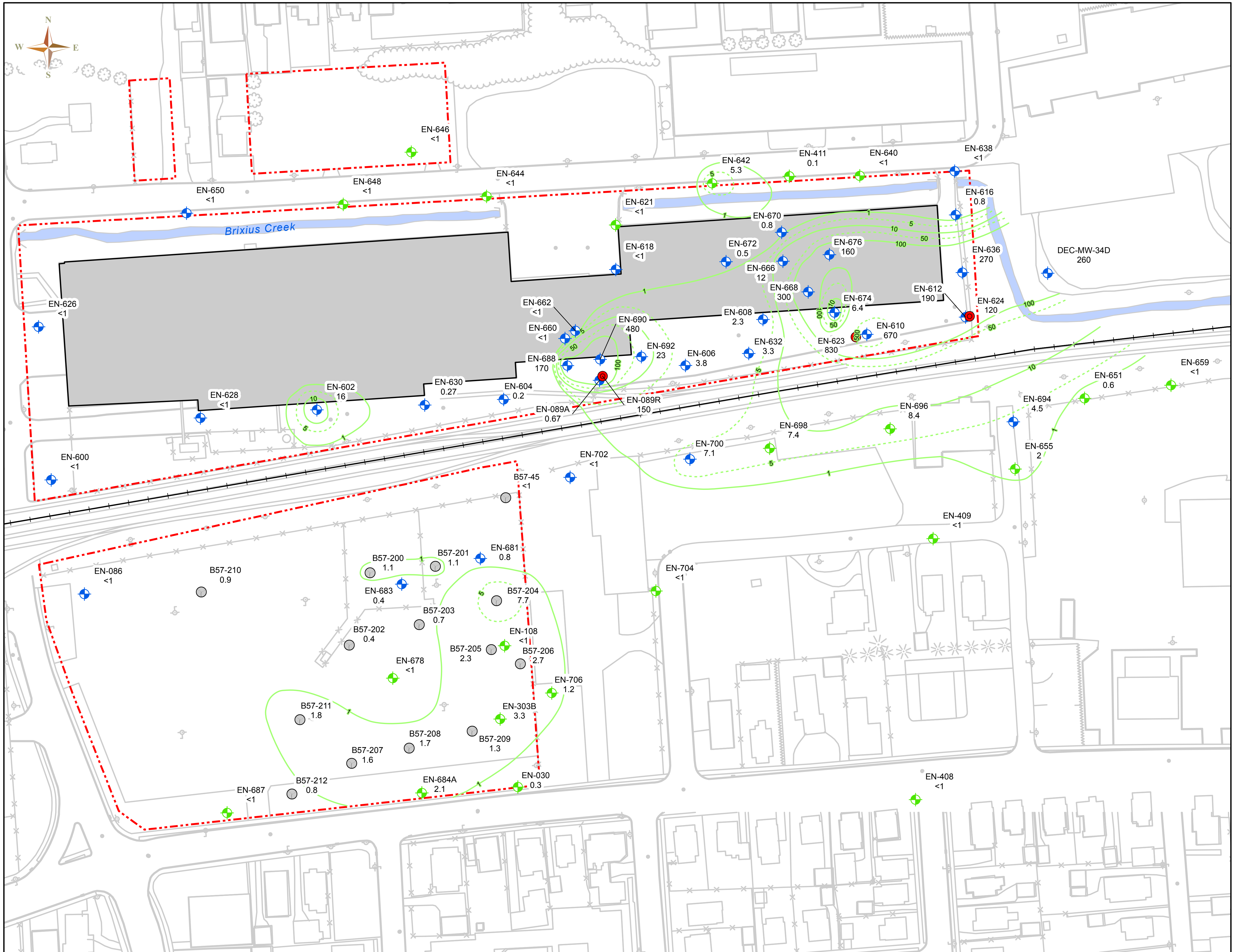

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Figure 18

Isoconcentration Map Chlorinated Ethanes Lower WBZ Groundwater

Supplemental Remedial Investigation Report OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: J. Pierce
Designed By: L. Jacob/P. Mouser
Reviewed By: J. Ordway
Date: March 2010

Figure Narrative

This figure shows concentration isopleths representing the total chlorinated ethanes detected in groundwater collected from the lower water-bearing zone (WBZ). Groundwater samples were collected from monitoring locations screened in the lower WBZ, or locations where the site silt and clay aquitard was not observed in the shallow subsurface. The VOC data used for this figure represent multiple monitoring rounds between October 2005 and August 2009. The most recently available data is shown for each monitoring point. Total chlorinated ethanes were calculated by summing detected concentrations of 1,1,1-trichloroethane, 1,1-dichloroethane, 1,1-dichloroethene, and chloroethane.

The contours were developed using generally accepted hydrogeologic practices, involving interpolation between monitoring wells. Other interpretations are possible.

Legend

- Soil Boring
- Lower WBZ Monitoring Well
- Groundwater Extraction Well
- Monitoring Well
- Chlorinated Ethane Concentrations (ug/l)

60 30 0 60 120 180 Feet

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Figure 19

Isoconcentration Map Chlorofluorocarbons Lower WBZ Groundwater

Supplemental Remedial Investigation Report OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: J. Pierce
Designed By: L. Jacob/P. Mouser
Reviewed By: J. Ordway
Date: March 2010

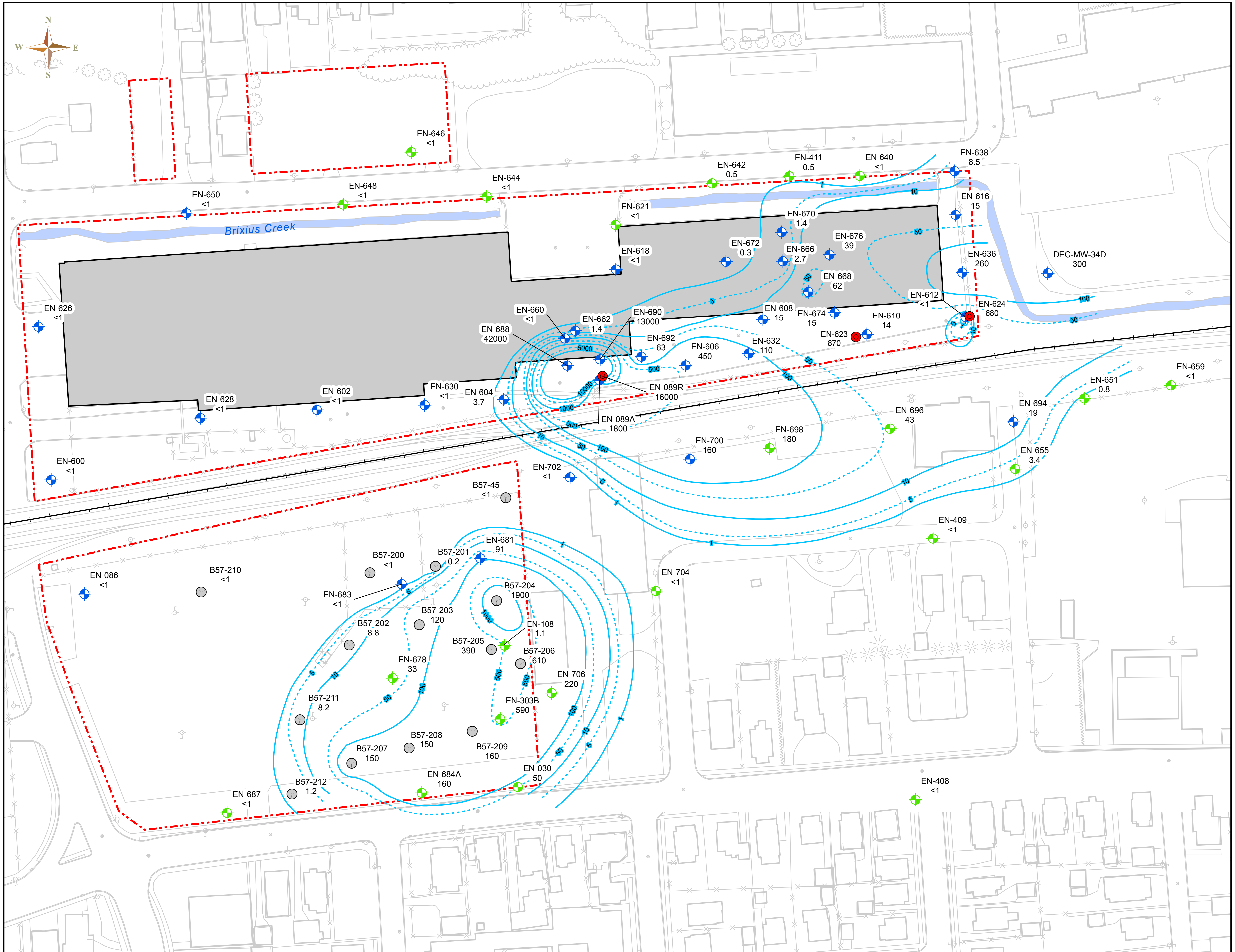

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Figure Narrative

This figure shows concentration isopleths representing the total chlorofluorocarbons detected in groundwater collected from the lower water-bearing zone (WBZ). Groundwater samples were collected from monitoring locations screened in the lower WBZ, or locations where the site silt and clay aquitard was not observed in the shallow subsurface. The VOC data used for this figure represent multiple monitoring rounds between October 2005 and August 2009. The most recently available data is shown for each monitoring point. Total chlorofluorocarbons were calculated by summing detected concentrations of CFC-113 and CFC-123a.

The contours were developed using generally accepted hydrogeologic practices, involving interpolation between monitoring wells. Other interpretations are possible.

Legend

- Soil Boring
- Lower WBZ Monitoring Well
- Groundwater Extraction Well
- Monitoring Well
- Chlorofluorocarbon Concentrations (ug/l)

Feet: 60 30 0 60 120 180

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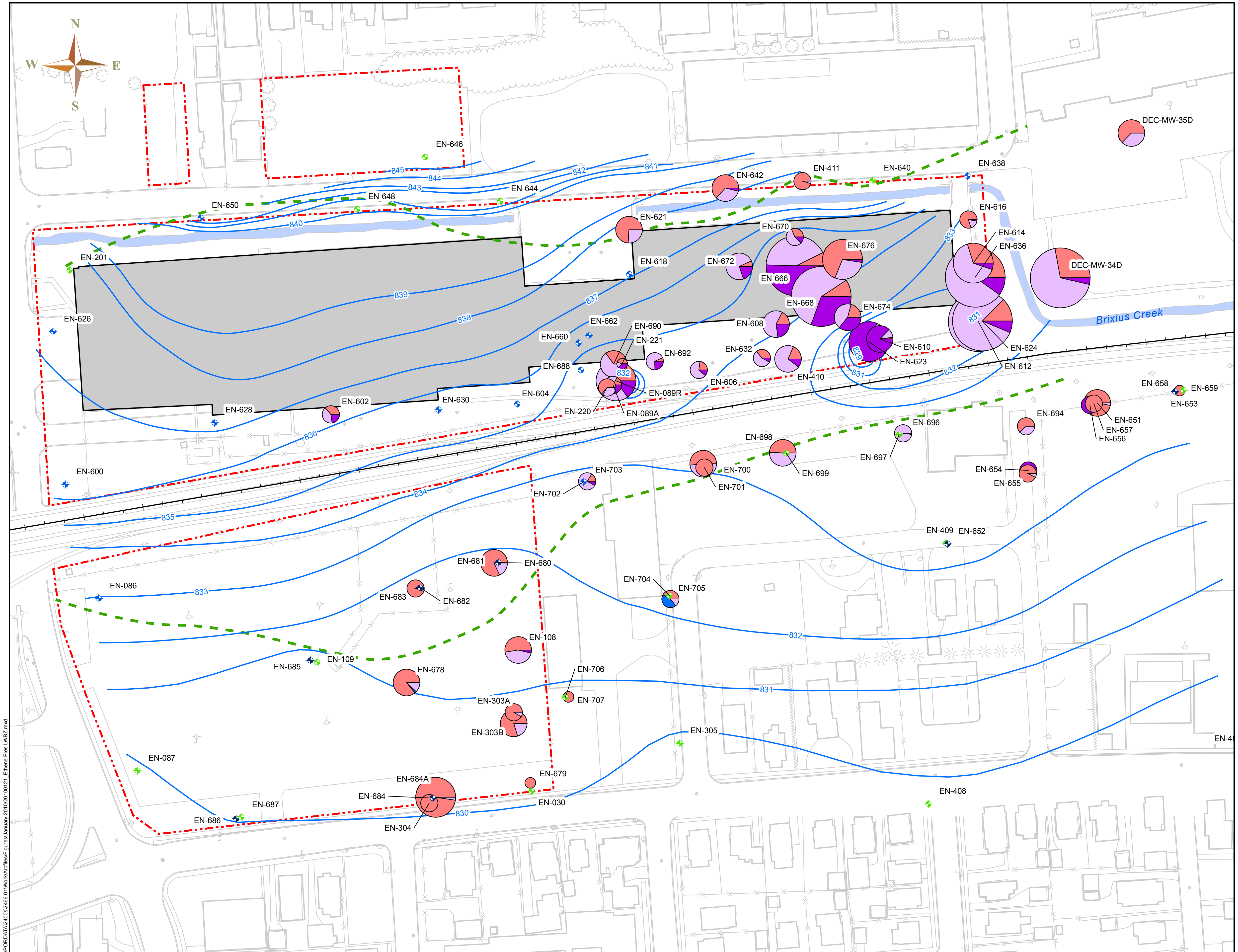

Figure 20

Summary of Chlorinated Ethene Speciation, Lower WBZ

Supplemental Remedial Investigation Report OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: J. Pierce
Designed By: P. Mouser
Reviewed By: J. Ordway
Date: March 2010

Figure Narrative:

This figure is intended to summarize the spatial distribution of chlorinated ethenes detected in groundwater samples and the groundwater potentiometric surface of the lower water-bearing zone (WBZ). Groundwater samples were collected from monitoring locations screened in the lower WBZ, or locations where the site silt and clay aquitard was not observed in the shallow subsurface. The VOC data used for this figure represent multiple monitoring rounds. The most recently available data is shown for each monitoring point, collected between January 2007 and August 2009. Pie size represents the total chlorinated ethene mass (in ug/L) while pie slice represents the relative percent of individual parent and breakdown daughter products (in umoles/L). Lower WBZ groundwater elevation contours are based on measurements recorded in October 2009. Further explanation is given on Figure 11, and in the SRI report and appendices.

Legend

Chlorinated Ethenes Not Detected (ND)

- Deep Monitoring Well
- Lower WBZ Monitoring Well
- Monitoring Well
- 832 Lower WBZ Groundwater Elevation Contours (ft amsl)
- Extent of Site Silt and Clay Aquitard

Total Chlorinated Ethenes in Groundwater

- PCE
- TCE
- cis-1,2-DCE
- Vinyl Chloride

- <1 ug/l
- 1 to <10 ug/l
- 10 to <100 ug/l
- 100 to <1,000 ug/l
- 1,000 to <10,000 ug/l

60 30 0 60 120 180 Feet

SHPC ENGINEERS

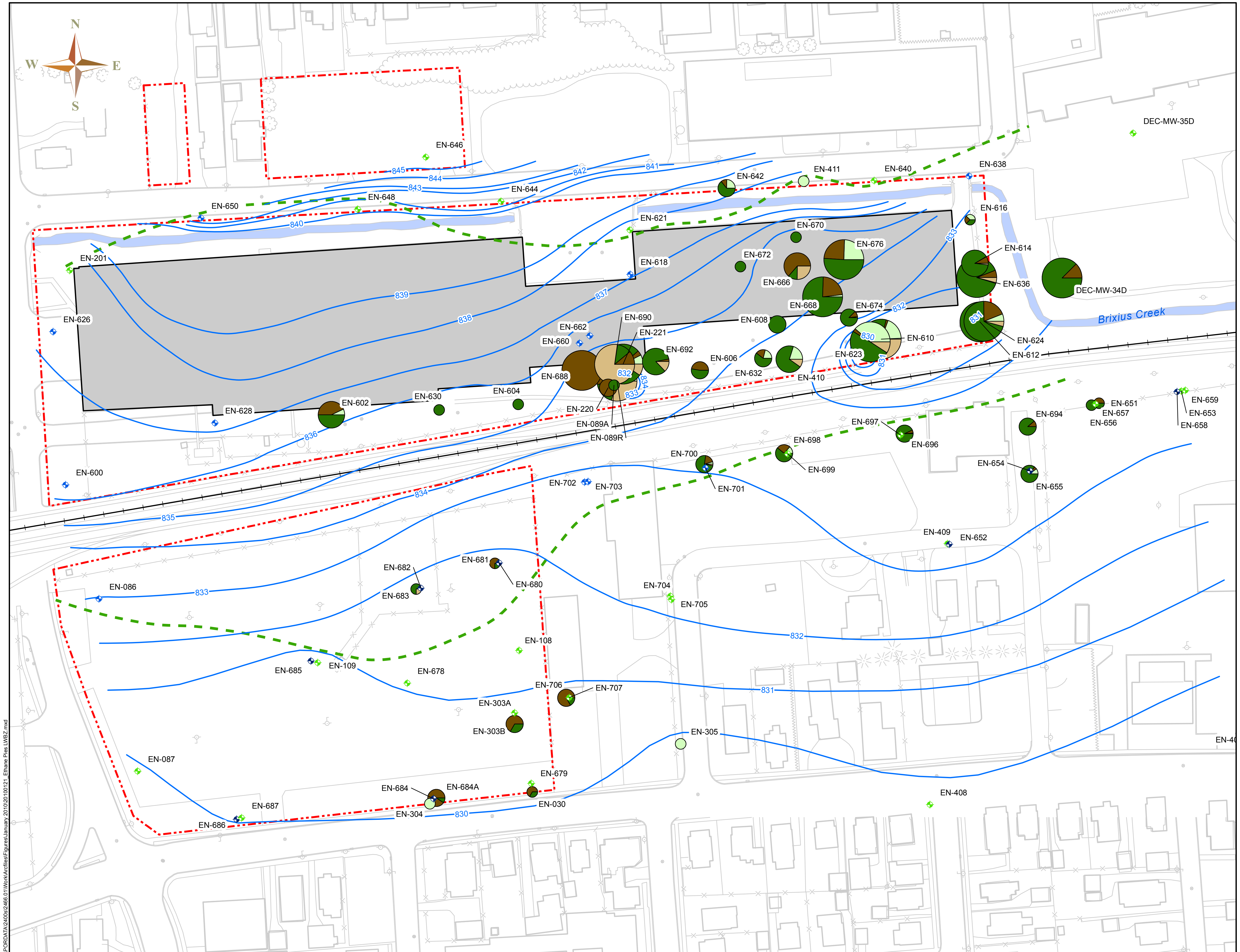

Figure 21

Summary of Chlorinated Ethane Speciation, Lower WBZ

Supplemental Remedial Investigation Report OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: J. Pierce
Designed By: P. Mouser
Reviewed By: J. Ordway
Date: March 2010

Figure Narrative:

This figure is intended to summarize the spatial distribution of chlorinated ethanes detected in groundwater samples and the groundwater potentiometric surface of the lower water-bearing zone (WBZ). Groundwater samples were collected from monitoring locations screened in the lower WBZ, or locations where the site silt and clay aquitard was not observed in the shallow subsurface. The VOC data used for this figure represent multiple monitoring rounds. The most recently available data is shown for each monitoring point, collected between January 2007 and August 2009. Pie size represents the total chlorinated ethane mass (in ug/L) while pie slice represents the relative percent of individual parent and breakdown daughter products (in umoles/L). Lower WBZ groundwater elevation contours are based on measurements recorded in October 2009. Further explanation is given on Figure 11, and in the SRI report and appendices.

Legend

Chlorinated Ethanes Not Detected (ND)

- Deep Monitoring Well
- Lower WBZ Monitoring Well
- Monitoring Well
- 832 Lower WBZ Groundwater Elevation Contours (ft amsl)
- Extent of Site Silt and Clay Aquitard

Total Chlorinated Ethanes in Groundwater

- 1,1,1-TCA
- 1,1-DCE
- 1,1-DCA
- Chloroethane

- <1 ug/l
- 1 to <10 ug/l
- 10 to <100 ug/l
- 100 to <1,000 ug/l

Feet
60 30 0 60 120 180

SHPC ENGINEERS

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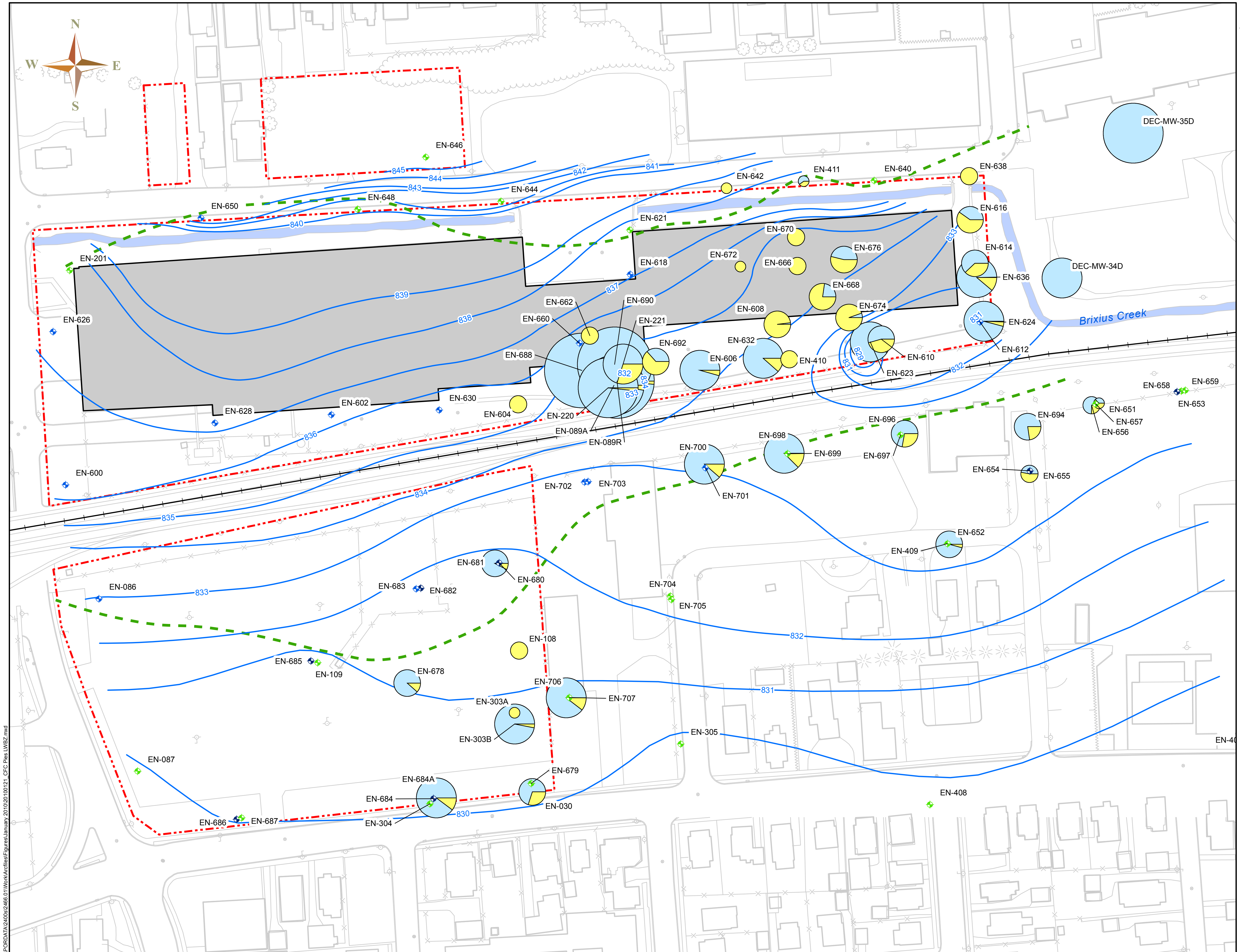

Figure 22

Summary of Chlorofluoro-carbon Speciation, Lower WBZ

Supplemental Remedial Investigation Report OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: J. Pierce
Designed By: P. Mouser
Reviewed By: J. Ordway
Date: March 2010

Figure Narrative:

This figure is intended to summarize the spatial distribution of chlorofluorocarbons detected in groundwater samples and the groundwater potentiometric surface of the lower water-bearing zone (WBZ). Groundwater samples were collected from monitoring locations screened in the lower WBZ, or locations where the site silt and clay aquitard was not observed in the shallow subsurface. The VOC data used for this figure represent multiple monitoring rounds. The most recently available data is shown for each monitoring point, collected between January 2007 and August 2009. Pie size represents the total chlorofluorocarbons mass (in ug/L) while pie slice represents the relative percent of individual parent and breakdown daughter products (in umoles/L). Lower WBZ groundwater elevation contours are based on measurements recorded in October 2009. Further explanation is given on Figure 11, and in the SRI report and appendices.

Legend

CFCs Not Detected (ND)

- Deep Monitoring Well
- Lower WBZ Monitoring Well
- Monitoring Well
- Lower WBZ Groundwater Elevation Contours (ft amsl)
- Extent of Site Silt and Clay Aquitard

Total CFCs in Groundwater

- CFC 113
- CFC 123a
- <1 ug/l
- 1 to <10 ug/l
- 10 to <100 ug/l
- 100 to <1,000 ug/l
- 1,000 to <10,000 ug/l
- >10,000 ug/l

60 30 0 60 120 180 Feet

SHPC ENGINEERS

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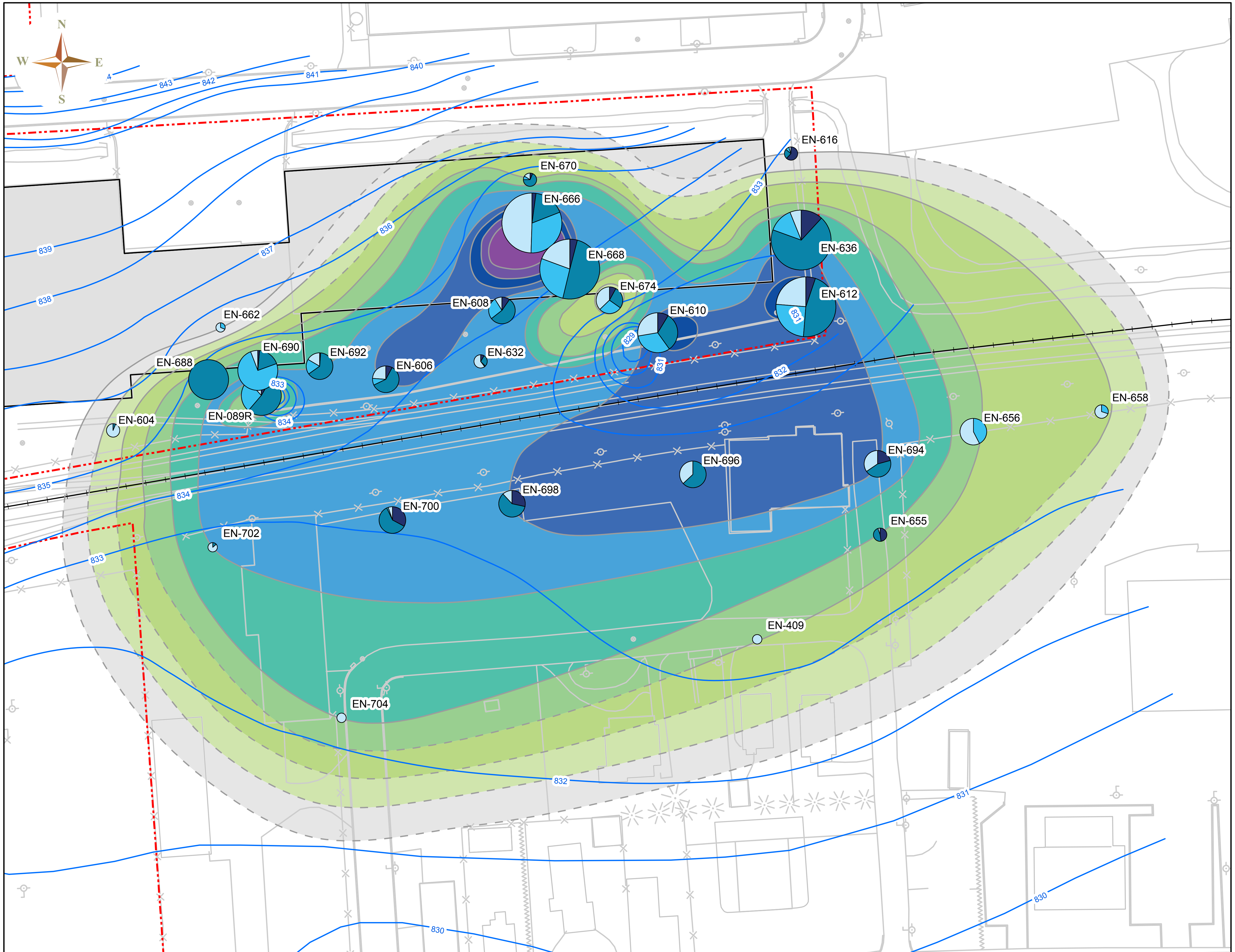

Figure 23

Summary of Geochemical Conditions in Lower WBZ

Supplemental Remedial Investigation Report OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: S. Warner
Designed By: P. Mouser
Reviewed By: J. Ordway
Date: March 2010

Figure Narrative:

This figure summarizes results of groundwater geochemical assessment during 2008 and 2009. The relative mass of parent and breakdown product VOCs (pie charts) are shown plotted with the primary terminal electron accepting processes (TEAPs, isopleths) for selected lower water bearing zone (WBZ) groundwater monitoring locations. TEAPs were inferred from geochemical information for the following oxidized and reduced chemical species: oxygen, nitrate, nitrite, Fe(III), Fe(II), sulfate, sulfide, and methane. The slice of the pie represents total cholorinated ethenes and ethanes (on a molar basis) while the size represents total mass on a µg/L basis. Please see the report text for further discussion.

Legend

Primary TEAP

Aerobic

Oxygenated (Type 1)
Nitrate Reducing (Type 2)
Iron Reducing (Type 2)
Sulfate Reducing (Type 3)
Methanogenesis (Type 3)

Anaerobic

838 Lower WBZ Potentiometric Surface Elevation Under Pumping Conditions (October 19, 2009)

Parent VOCs (TCE, PCE, 1,1,1-TCA)
Primary Breakdown Products (cis-1,2-DCE, 1,1-DCA, 1,1-DCE)
Secondary Breakdown Products (Vinyl Chloride, Chloroethane)
Terminal Breakdown Products (Ethane, Ethene)

Total Chlorinated Ethanes & Ethenes in Groundwater (µg/L)

0.1 to 1
1 to 10
10 to 100
100 to 1,000
> 1,000

40 20 0 40 80 120 Feet

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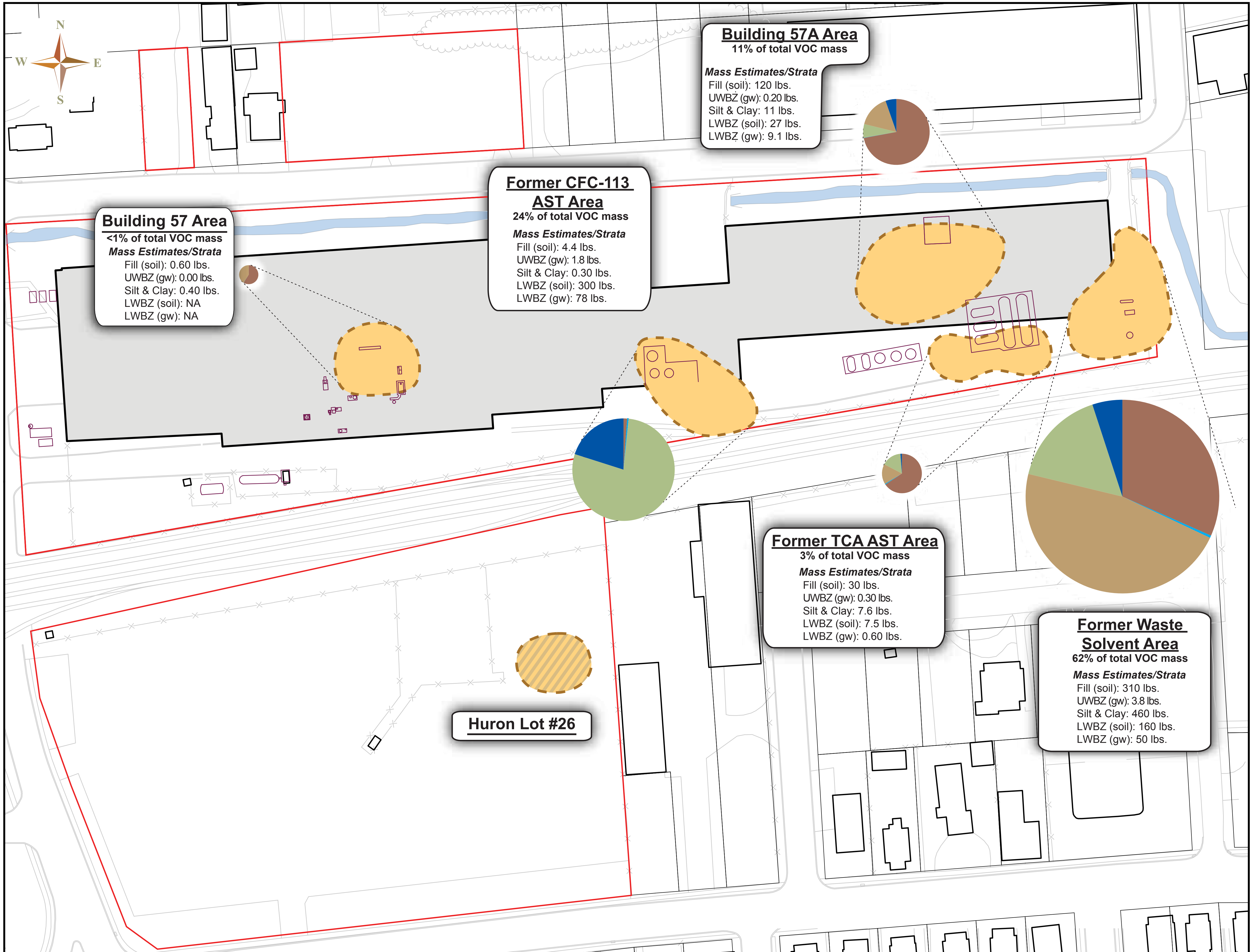

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S:\PORDATA\2400s\2466.01\Work\Source Area Mass Calculations\20090619 Source Mass Calculations (with actual gw results).xls

S:\PORDATA\2400s\2466.01\Figures\January 2010\20100121_VOC Mass Distribution.ai

Figure 24

VOC Mass Distribution Map

Supplemental Remedial Investigation Report
OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By: S. Warner/J. Prellwitz/J. Pierce
Designed By: P. Mouser
Reviewed By: J. Ordway/J. Sanborn
Date: March 2010

Figure Narrative

Pie diagrams are intended to communicate preliminary estimates of relative percentage of mass in each source area. Estimates were developed from site soil boring, soil vapor, and groundwater sampling completed during site investigation, routine monitoring, and dual-phase and soil vapor extraction pilot testing between 2005 and 2009.

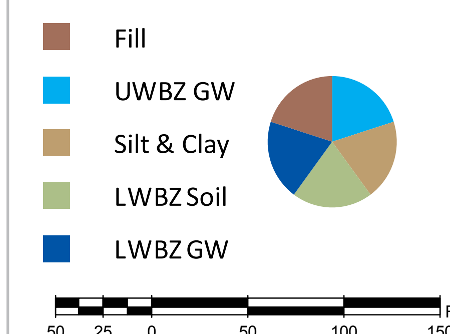
The slice of pie represents the relative percentage of mass associated with each stratigraphic or groundwater unit within each source zone.

The estimates of mass distribution are approximations based on the available data and inference supported by partitioning calculations. The actual amount of mass will vary, perhaps considerably, but are presented in the context of assessing remedial alternatives.

The total VOC mass at the site is estimated to be approximately 1,600 pounds.

The Parking Area was not included in the mass distribution analysis due to the diffuse, scattered nature of contaminant distribution. Unlike other source zones, this area does not show characteristics of a concentrated source release zone.

Legend



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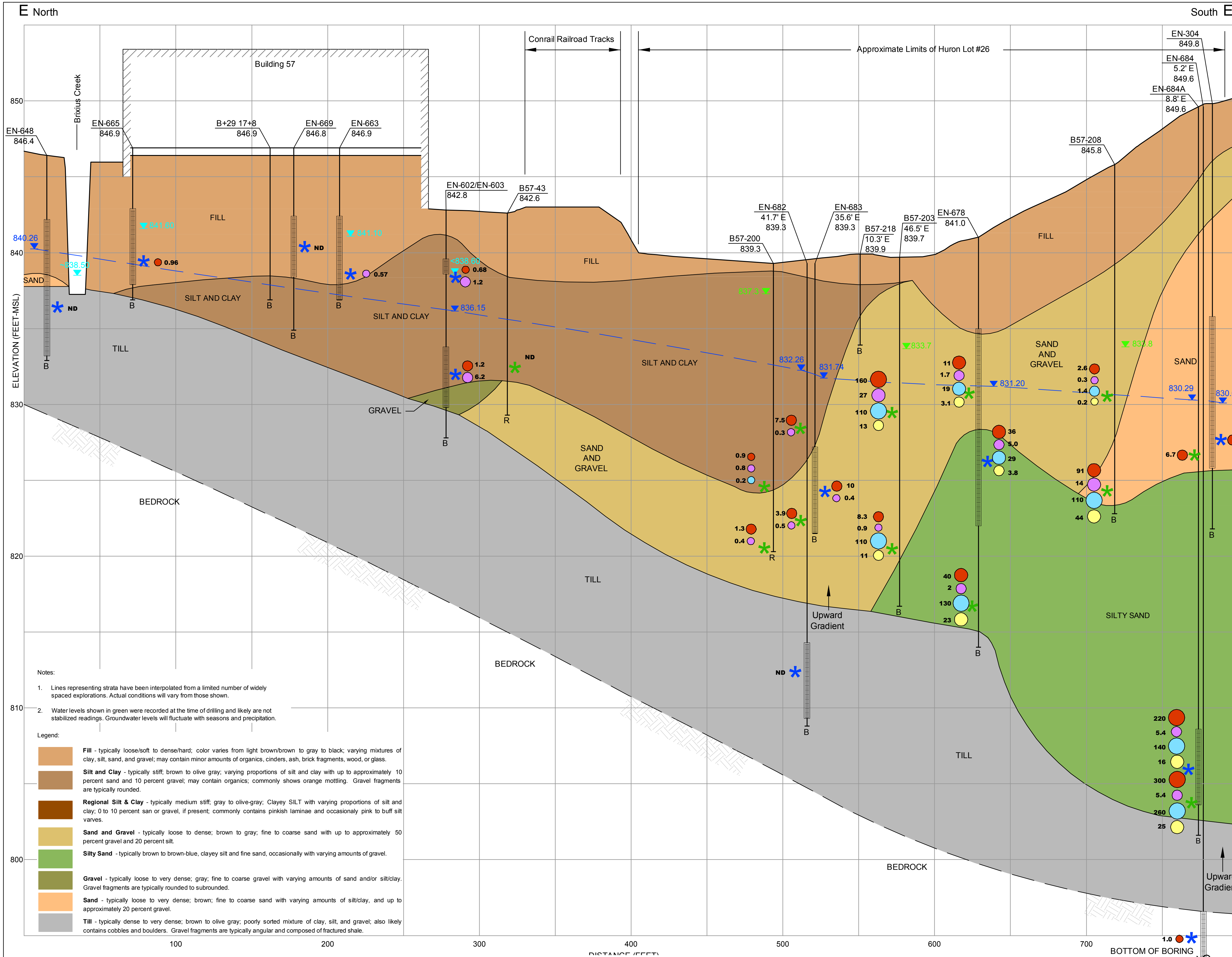


Figure 25-A

Geologic Profile E-E': Vertical Distribution of Select VOCs in Groundwater

Supplemental Remedial Investigation Report

OU#5/Building 57 Area

Union and Endicott, New York

Drawn By: E. Wright
Designed By: J. Sanborn
Reviewed By: L. Jacob
Date: March 2010

Figure Narrative

Geologic Profile E-E' is a north-south subsurface profile through Building 57 and Huron Lot #26 to the south. The profile shows that the site silt and clay aquitard pinches out near B57-203. Concentrations of TCE, cDCE, CFC-113, and CFC-123a in groundwater are shown at their approximate sampling depths. The circles near the concentrations represent the magnitude of the detected concentrations. Circles and concentrations are not shown for analytes that were not detected.

Legend

- 841.10 Groundwater elevation upper water-bearing zone measured in October 2009
- 830.29 Groundwater elevation lower water-bearing zone measured in October 2009
- 833.8 Approximate Water Level Observed During Drilling in April and September 2008
- ~838.50 Groundwater elevation is estimated based on upper water-bearing zone potentiometric surface
- Inferred potentiometric surface lower water bearing zone
- EN-678 Monitoring well/test boring designation
- 841.0 Approximate ground surface elevation
- Approximate ground surface
- Inferred stratigraphic contact
- Well screen
- Groundwater Grab Sample Location
- Groundwater Sampling Location from Monitoring Well (Data Collected from Most Recent Sampling Round at Each Well)
- B Bottom of boring
- R Refusal

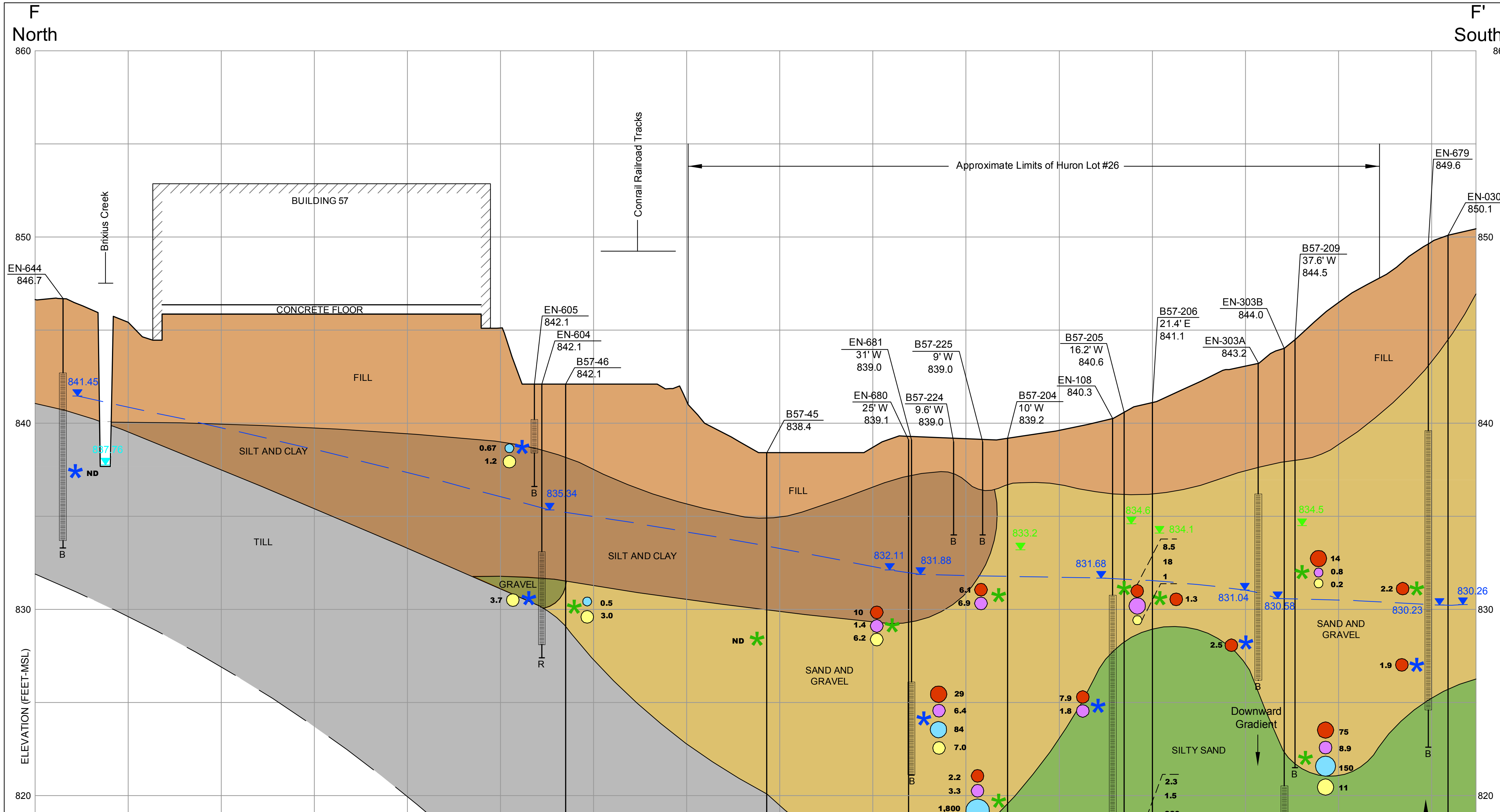
TCE
cis-1,2-DCE
Freon 113
Freon 123a

All data shown are in µg/l.

- 1,000.1-10,000 µg/l
- 100.1-1,000 µg/l
- 10.1-100 µg/l
- 1.1-10 µg/l
- 0-1 µg/l

Vertical Exaggeration: 10x

SHPC ENGINEERS



Notes:

1. Lines representing strata have been interpolated from a limited number of widely spaced explorations. Actual conditions will vary from those shown.
2. Water levels shown in green were recorded at the time of drilling and likely are not stabilized readings. Groundwater levels will fluctuate with seasons and precipitation.

Legend:

Fill - typically loose/soft to dense/hard; color varies from light brown/brown to gray to black; varying mixtures of clay, silt, sand, and gravel; may contain minor amounts of organics, cinders, ash, brick fragments, wood, or glass.

Silt and Clay - typically stiff; brown to olive gray; varying proportions of silt and clay with up to approximately 10 percent sand and 10 percent gravel; may contain organics; commonly shows orange mottling. Gravel fragments are typically rounded.

Regional Silt & Clay - typically medium stiff; gray to olive-gray; Clayey SILT with varying proportions of silt and clay; 0 to 10 percent san or gravel, if present; commonly contains pinkish laminae and occasionaly pink to buff silt varves.

Sand and Gravel - typically loose to dense; brown to gray; fine to coarse sand with up to approximately 50 percent gravel and 20 percent silt.

Silty Sand - typically brown to brown-blue, clayey silt and fine sand, occasionally with varying amounts of gravel.

Gravel - typically loose to very dense; gray; fine to coarse gravel with varying amounts of sand and/or silt/clay. Gravel fragments are typically rounded to subrounded.

Sand - typically loose to very dense; brown; fine to coarse sand with varying amounts of silt/clay, and up to approximately 20 percent gravel.

Till - typically dense to very dense; brown to olive gray; poorly sorted mixture of clay, silt, and gravel; also likely contains cobbles and boulders. Gravel fragments are typically angular and composed of fractured shale.

Figure 25-B

Geologic Profile F-F': Vertical Distribution of Select VOCs in Groundwater

Supplemental Remedial Investigation Report

OU#5/Building 57 Area

Union and Endicott, New York

Drawn By: E. Wright
Designed By: J. Sanborn
Reviewed By: L. Jacob
Date: March 2010

Figure Narrative

Geologic Profile F-F' is a north-south subsurface profile through Building 57 and Huron Lot #26 to the south. The profile shows that the site silt and clay aquitard pinches out just to the south of EN-680/EN-681. Concentrations of TCE, cDCE, CFC-113, and CFC-123a in groundwater are shown at their approximate sampling depths. The circles near the concentrations represent the magnitude of the detected concentrations. Circles and concentrations are not shown for analytes that were not detected.

Legend

<838.25 Groundwater elevation upper water-bearing zone measured in October 2009

830.64 Groundwater elevation lower water-bearing zone measured in October 2009

834.1 Approximate Water Level Observed During Drilling in April and September 2008

Inferred potentiometric surface lower water bearing zone

EN-679 Monitoring well/test boring designation
849.6 Approximate ground surface elevation

Approximate ground surface

Inferred stratigraphic contact

Well screen

Groundwater Grab Sample Location

Groundwater Sampling Location from Monitoring Well (Data Collected from Most Recent Sampling Round at Each Well)

B Bottom of boring

R Refusal

TCE
cis-1,2-DCE
Freon 113
Freon 123a

All data shown are in µg/l

1,000.1-10,000 µg/l
100.1-1,000 µg/l
10.1-100 µg/l
1.1-10 µg/l
0-1 µg/l

Vertical Exaggeration: 10x

SHPC ENGINEERS

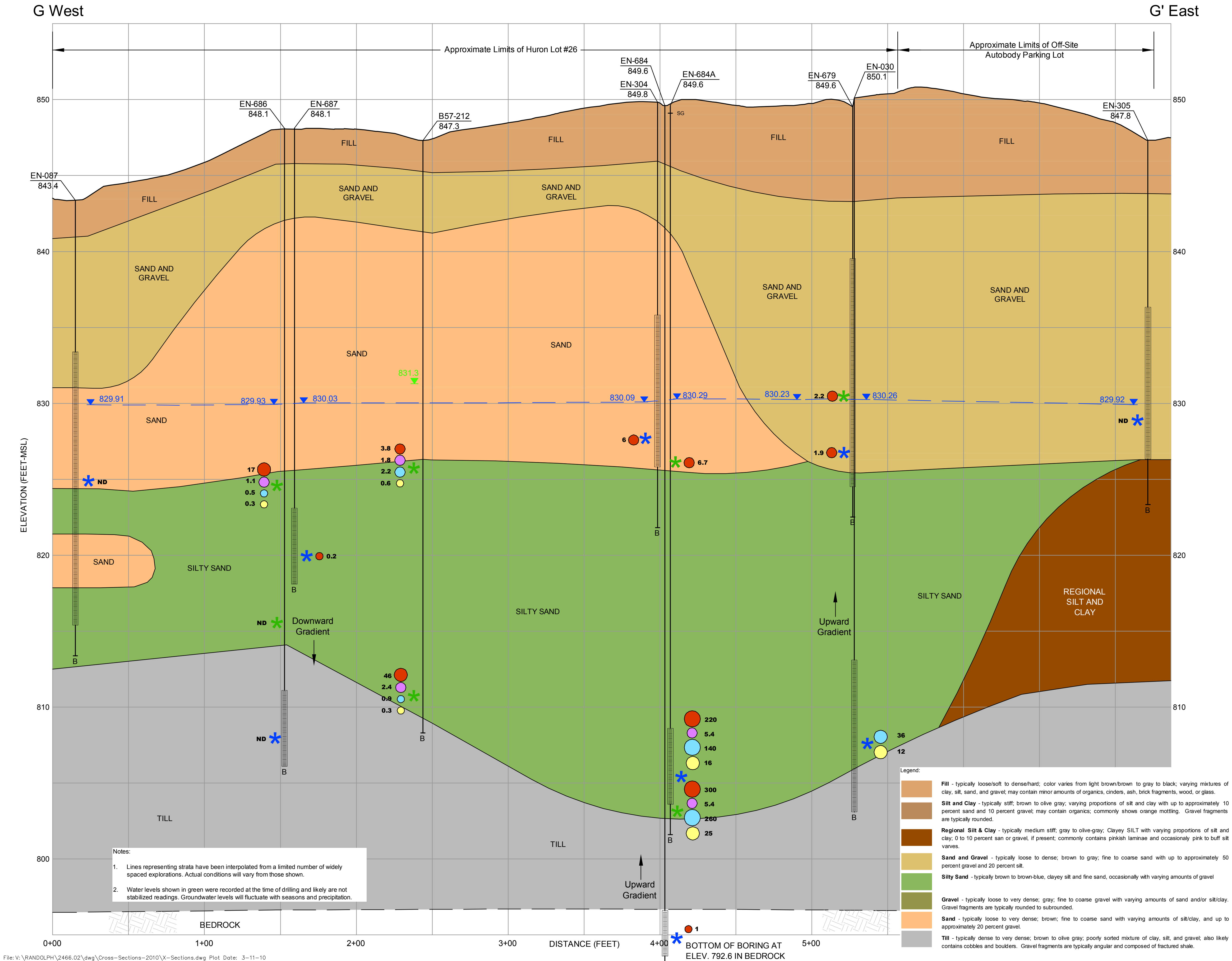


Figure 25-C

Geologic Profile G-G': Vertical Distribution of Select VOCs in Groundwater

Supplemental Remedial Investigation Report

OU#5/Building 57 Area

Union and Endicott, New York

Drawn By: E. Wright
Designed By: J. Sanborn
Reviewed By: L. Jacob
Date: March 2010

Figure Narrative

Geologic Profile G-G' is a west-east subsurface profile along the southern property line of Huron Lot #26 to the south of Building 57. Concentrations of TCE, cDCE, CFC-113, and CFC-123a in groundwater are shown at their approximate sampling depths. The circles near the concentrations represent the magnitude of the detected concentrations. Circles and concentrations are not shown for analytes that were not detected.

Legend

See Geologic Profile A-A' for strata descriptions

830.62 Groundwater elevation lower water-bearing zone measured in October 2009

831.3 Approximate water level observed during drilling in April and September 2008

Inferred potentiometric surface lower water bearing zone

EN-678 Monitoring well/test boring designation
841.0 Approximate ground surface elevation

Approximate ground surface

Inferred stratigraphic contact

Well screen

Groundwater Grab Sample Location

Groundwater Sampling Location from Monitoring Well (Data Collected from Most Recent Sampling Round at Each Well)

B Bottom of boring
R Refusal

TCE
cis-1,2-DCE
Freon 113
Freon 123a

All data shown are in µg/l

1,000.1-10,000 µg/l
100.1-1,000 µg/l
10.1-100 µg/l
1.1-10 µg/l
0-1 µg/l

Vertical Exaggeration: 10x

SHPC ENGINEERS

APPENDIX A

LIMITATIONS

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ENGINEERS

APPENDIX A
LIMITATIONS

1. The findings and conclusions described in this report are based in part on data obtained from a limited number of soil, groundwater, and soil gas samples collected from widely-spaced subsurface explorations, monitoring wells, and/or extraction wells. The nature and extent of variations between these explorations and wells may not become evident until further investigation, pilot testing, or remediation is initiated. If variations or other latent conditions then appear evident, it will be necessary to re-evaluate the conclusions and recommendations of this report.

2. The generalized soil profile described in the text and figures is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretations of widely-spaced explorations and samples; actual soil transitions are probably more gradual. For specific information, refer to the exploration logs.

3. Water level measurements have been made in the monitoring wells, extraction wells, and stream gauging locations at times and under conditions stated within the text and indicated on the figures of this report. Note that fluctuations in the level of the groundwater may occur due to variations in rainfall and other factors not evident at the time measurements were made.

4. Quantitative laboratory analyses were performed as part of the investigation as noted within the report. The analyses were performed for specific parameters that were selected during the course of this study. It must be noted that additional compounds not searched for during the current study may be present in soil gas, soil, and groundwater at the site. Moreover, it should be noted that variations in the types and concentrations of contaminants and variations in their distribution within the soil gas, soil, and groundwater may occur due to the passage of time, seasonal water table fluctuations, recharge events, and other factors.

5. The conclusions and recommendations contained in this report are based in part upon various types of chemical data as well as historical and hydrogeologic information developed by previous investigators. While SHPC has reviewed that data and information as stated in this report, any of SHPC's interpretations, conclusions, and recommendations that have relied on that information will be contingent on its validity. Should additional chemical data, historical information, or hydrogeologic information become available in the future, such information should be reviewed by SHPC and the interpretations, conclusions and recommendations presented herein should be modified accordingly.

6. This report has been prepared for, and is intended for the exclusive use of, the IBM Corporation for specific application to the Supplemental Remedial Investigation of Operable Unit #5/Building 57 Area, Union and Endicott, New York, in accordance with generally accepted professional practices. The contents of this report shall not be relied upon by any party other than IBM without the express written consent of IBM and SHPC. No other

warranty, express or implied, is made. We understand that this report will be submitted for regulatory review.

7. The analyses and recommendations contained in this report are based on the data obtained from the referenced subsurface explorations. The explorations indicate subsurface conditions only at the specific locations and times, and only to the depths penetrated. They do not necessarily reflect strata variations that may exist between such locations. The validity of the recommendations is based in part on assumptions SHPC has made about conditions at the site. Such assumptions may be confirmed only during remediation. If subsurface conditions different from those described become evident, the recommendations in this report must be re-evaluated.

8. SHPC is not responsible for any claims, damages, or liability associated with interpretation of subsurface data or re-use of the subsurface data or engineering analyses without the express written authorization of SHPC.

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APPENDIX B

SCOPE OF WORK AND FIELD METHODS SUMMARY

SHPC ENGINEERS

APPENDIX B
SCOPE OF WORK AND FIELD METHODS SUMMARY

B.1 INTRODUCTION

Sanborn, Head Engineering P.C. (SHPC) completed investigations and testing of soil, soil gas, and groundwater at the Building 57 Area (the site) of the former IBM Endicott facility, as part of the Supplemental Remedial Investigation (SRI). The SRI was performed under the Administrative Order on Consent[1] (AOC) between IBM Corporation (IBM) and the New York State Department of Environmental Conservation (NYSDEC) and the New York State Department of Health (NYSDOH; collectively, Agencies). Under the AOC, the Building 57 vicinity is referred to as Operational Unit #5, or OU#5. The work was conducted with the assistance of personnel from Sanborn, Head & Associates, Inc.

Investigation activities were conducted in multiple phases. Work was completed in accordance with SHPC's September 9, 2004 work plan[2], which identifies the technical approach for work conducted in most phases of the SRI and FFS. Additional procedures were noted in addenda to the 2004 Work Plan and submitted periodically, as described below, and work was conducted according to these Agency-approved plans.

Work Plan Addendum General Scope	Submitted by IBM	Approved by NYSDEC
Source Zone Investigation & Groundwater Extraction/Treatment Testing	October 14, 2005	October 27, 2006
Off-Site Investigation (Gault Chevrolet)	October 20, 2006	November 1, 2006
Source Zone Investigation	January 26, 2007	March 7, 2007
Lot 26 Investigation	February 25, 2008	March 5, 2008
Lot 26 Investigation	September 3, 2008	September 17, 2008
Source Zone & Lot 26 Investigation	March 6, 2009	March 19, 2009
Off-Site Investigation (Kopy Properties)	March 27, 2009	April 29, 2009

[1] Administrative Order on Consent Index number A7-0502-0104 between IBM Corporation (IBM) and the NYSDEC executed on August 4, 2004.

[2] Sanborn Head & Associates, Inc., September 9, 2004, "Work Plan for Source Area Evaluation, Supplemental Remedial Investigation and Focused Feasibility Study, Operable Unit #5 – Building 57 Area, Union and Endicott, New York", approved by the NYSDEC in a letter dated December 13, 2004.

B.2 SUMMARY OF FIELD INVESTIGATIONS AND TESTING

Explorations and analyses completed as part of the SRI are summarized in Table B.1, which provides an overview of the general scope, exploration locations, and analyses associated with each phase of investigations. Where applicable, the table also provides a reference to the document in which the corresponding data were reported to the Agencies.

Locations of soil borings and wells are provided on Figure 4 in the SRI report. Soil gas sampling locations are shown on Figure B.1.

B.3 FIELD METHODS

Field explorations, sampling, and analyses were conducted according to field methods described in the 2004 work plan and subsequent work plan addenda. Variations to the field procedures identified in work plan addenda and/or were described in the corresponding analytical summary reports (ASRs).

Other field methods, not previously documented in work plans or ASRs, are described in later appendices and include:

- Rising and falling head slug testing – Appendix E, Hydraulic Properties Assessment;
- Hydraulic testing in response to extraction well shut-down and start-up – Appendix F, Shut-Down Monitoring; and
- Membrane-interface probe investigation – Appendix I, Membrane Interface Probe Investigation and Findings Summary.

B.4 FIELD DOCUMENTATION

As noted above, most documentation (in the form of boring logs and sampling documentation was submitted with ASRs. An interactive location plan, with links to logs of soil borings, monitoring wells, and extraction wells installed during SRI activities, is included as Attachment B.1 (on disc).

B.5 ANALYTICAL METHODS

Fixed (as opposed to mobile) laboratory analyses were conducted by United States Environmental Protection Agency (USEPA) methods, as indicated in ASRs and interim reports of findings. Mobile laboratory analysis of soil gas samples was conducted according to the 2004 work plan.

In-field analyses for certain natural attenuation parameters were conducted during groundwater sampling in 2008. Sampling and analysis was conducted by SHA using a HACH DR 2800 Spectrophotometer and HACH standard colorimetric tests. Spectrophotometer performance was verified prior to use and at the end of each day to assess instrument drift using a three-point standard curve at four absorbance wavelengths. A three-point standard curve was also used to verify accuracy and reagent quality for one of four analytes (chloride, iron (total), nitrate, or ammonia) prior to use. HACH colorimetric tests for iron (total), nitrite, sulfate, and sulfide are USEPA-approved for reporting purposes in drinking water analysis. Analyses for chloride, dissolved oxygen, iron (ferrous), nitrate, and phosphorous were reported within the acceptable test range specified by HACH.

B.6 ANALYTICAL DATA DOCUMENTATION

All fixed laboratory analytical reports are on file in SHA's offices, and are available for review on request. Many have been submitted to the Agencies in ASRs.

Laboratory analytical results (from mobile and fixed laboratories) from samples collected as part of SRI activities are included in database format in Attachment B.2. Laboratory analytical results from samples collected by SHA and SHPC are included.

ATTACHMENTS

Table B.1	Summary of Investigations
Figure B.1	Soil Gas Sampling Exploration Location Plan
Attachment B.1	Interactive Location Plan (on disc)
Attachment B.2	Laboratory Analytical Data

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Table B.1
Summary of Investigations
Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

Date	Activity	Exploration Locations	Analyses: VOCs	PHCs	SVOCs	Metals	TOC	Grain Size	Specific Gravity	NA Parameters	Treatability Parameters	Report, Delivery Date
January 17-21, 2005	Soil Gas Sampling	B57-01 through B57-04, B57-09 through B57-40	X									Analytical Summary Report, June 14, 2005
	Grab Groundwater Sampling	B57-05 through B57-08	X									
March 14-18, 2005	Soil Gas Sampling	B57-41 through B57-44, B57-46 through B57-68	X									
	Grab Groundwater Sampling	B57-41 through B57-50	X									
	Soil Characterization	B57-41 through B57-50										
July 11 - August 1, 2005	Soil Characterization & Sampling	EN-600 through EN-622, P-1 through P-3, P-5 through P-7	X				X	X				Analytical Summary Report, January 23, 2006
	Monitoring Well Installation	EN-600 through EN-622										
July 27 - October 27, 2005	Groundwater Sampling	EN-600 through EN-622, other OU#5-area wells (EN-030 through EN-416B)	X							X		
	Surface Water Sampling	B57-128 through B57-132	X									
	Water Level Survey (August 22, 2005)											
November 28, 2005 - January 6, 2006	Soil Characterization & Sampling	EN-623 through EN-650	X				X					Analytical Summary Report, July 19, 2006
	Extraction Well Installation	EN-623, EN-624										
	Monitoring Well Installation	EN-626 through EN-650										
January 10 - April 19, 2006	Groundwater Sampling	EN-600 through EN-650	X							X		
January 11 - March 30, 2006	Groundwater Extraction & Treatment Testing	EN-89R, EN-623 and EN-624	X									Groundwater Extraction & Treatment Testing Report, June 16, 2006
August 10-12, 2006	Groundwater Sampling (*by others*)	EN-600 through EN-650	X									*Not applicable*
November 9, 2006	Groundwater Sampling (*by others*)	EN-600 through EN-650	X									*Not applicable*
February 12 - 22, 2007	Soil Characterization & Sampling	EN-651 through EN-659	X									Analytical Summary Report, July 2, 2007
	Monitoring Well Installation	EN-651 through EN-659										
March 1 - April 2, 2007	Groundwater Sampling	EN-651 through EN-659	X									
	Water Level Survey (March 20, 2007)											
March 26 - 31, 2007	Soil Gas Sampling	121 locations (sample names according to site grid coordinates)	X									Analytical Summary Report, September 21, 2007
April 11-13, 2007	Groundwater Sampling (*by others*)	EN-600 through EN-650	X									*Not applicable*
April 23 - May 11, 2007	Soil Characterization & Sampling	EN-662 through EN-668; 26 additional soil borings (named according to site grid)	X	X	X	X	X	X				Analytical Summary Report, September 21, 2007
	Monitoring Well Installation	EN-662 through EN-668										
	Water Level Survey (May 7, 2007)											
May 15 - June 28, 2007	Groundwater Sampling	EN-662 through EN-668	X									
	Water Level Survey (August 13, 2007)											
August 8-14, 2007	Groundwater Sampling (*by others*)	EN-600 through EN-650	X									*Not applicable*
November 14-15, 2007	Groundwater Sampling (*by others*)	EN-616, EN-617, EN-635, and EN-636	X									*Not applicable*
January 7 - 22, 2008	Soil Characterization & Sampling	EN-660, EN-661, EN-669 through EN-677; 4 additional soil borings (named according to site grid)	X					X	X			Analytical Summary Report, August 19, 2008
	Monitoring Well Installation	EN-660, EN-661, EN-669 through EN-677										
February 4-28, 2008	Groundwater Sampling	EN-660, EN-661, EN-669 through EN-677	X									
	Water Level Survey											
April 7-14, 2008	Soil Characterization & Sampling	B57-200 through B57-209, EN-678 and EN-679	X									Analytical Summary Report, September 9, 2008
	Grab Groundwater Sampling	B57-200 through B57-209, EN-678 and EN-679	X									
	Monitoring Well Installation	EN-678 and EN-679										
April 10 - May 2, 2008	Water Level Survey	OU#5 area wells measured under pumping and ambient conditions										*Not applicable*
May 2-22, 2008	Routine Groundwater Sampling (*by SHA and by others*)	EN-600 through EN-668 (selected wells)	X									*Not applicable*
May 3, 2008	Groundwater Sampling	EN-678, EN-679	X									Analytical Summary Report, September 9, 2008
May 20-22, 2008	Groundwater Sampling	EN-660, EN-661, EN-669 through EN-677	X									Analytical Summary Report, August 19, 2008
May 20-22, 2008	Groundwater Sampling	EN-678, EN-679	X									Analytical Summary Report, September 9, 2008
June 9-12, 2008	Non-Routine Groundwater Sampling	EN-89R through EN-674 (selected wells); installation of dedicated bladder pumps (selected wells)	X							X		BioattenuationStudy Report, February 9, 2010
June 9-12, 2008	Groundwater Sampling	EN-678, EN-679	X									Analytical Summary Report, September 9, 2008
August 5-29, 2008	Routine Groundwater Sampling (*by SHA and by others*)	EN-600 through EN-668 (selected wells)	X									*Not applicable*
August 18-21, 2008	Non-Routine Groundwater Sampling	EN-89R through EN-674 (selected wells)	X			X	X			X		BioattenuationStudy Report, February 9, 2010
September 22 through October 7, 2008	Soil Characterization & Sampling	B57-210, B57-211, B57-212, TB-1, and EN-680 through EN-687	X									Analytical Summary Report, January 29, 2009
	Grab Groundwater Sampling	B57-200 through B57-209, EN-678 and EN-679	X									
	Monitoring Well Installation	EN-680 through EN-687										
September 23, 2008 - April 7, 2009	Bioremediation Microcosm Study (*by SHA and others*)	Groundwater from EN-89R, EN-623, EN-624, and EN-666, and soil from TB-1										BioattenuationStudy Report, February 9, 2010
October 13-15, 2008	Groundwater Sampling	EN-680 through EN-687	X									Analytical Summary Report, January 29, 2009
October 27-31, 2008	Non-Routine Groundwater Sampling	EN-89R through EN-674 (selected wells)	X							X		BioattenuationStudy Report, February 9, 2010
October 27-29, 2008	Groundwater Sampling	EN-680 through EN-687	X			X	X			X	X	Analytical Summary Report, January 29, 2009
October 30, 2008 - February 3, 2009	*In Situ* Biotrap® Sampler Study	EN-610, EN-636, and EN-674										BioattenuationStudy Report, February 9, 2010
November 10-14, 2008	Groundwater Sampling	EN-680 through EN-687	X									Analytical Summary Report, January 29, 2009
February 3-4, 2009	Groundwater Sampling	EN-610, EN-636, and EN-674	X									Analytical Summary Report, May 4, 2009
	Storm Sewer Grab Water Sampling	MH-87 (reported as "MH-1"), Sewer outfall (reported as "SOF")	X									
March 23-April 10, 2009	Soil Characterization & Sampling	B57-213 through B57-222, and EN-684A	X									Analytical Summary Report, September 2, 2009
	Grab Groundwater Sampling	EN-684A	X									
	Monitoring Well Installation	EN-684A										
	Soil Characterization & Sampling	EN-639, EN-641, EN-688, EN-690, EN-691, EN-692, EN-694, EN-695, DP-101 through -103, DP-201 through -203, DP-301 through -303, and SVE-301	X									Analytical Summary Report, August 13, 2009
	Grab Groundwater Sampling	EN-688, EN-690, and EN-692	X									
	Monitoring Well Installation	EN-639, EN-641, EN-688, EN-690, EN-691, EN-692, EN-694, EN-695										
	Dual-Phase/Soil Vapor Extraction Well Installation	DP-101, DP-102, DP-103, DP-201, DP-202, DP-203, DP-301, DP-302, DP-303, and SVE-301										Analytical Summary Report, August 11, 2009
April 9-10, 2009	Groundwater Sampling	EN-639, EN-641, EN-688, EN-690, EN-691, EN-692, EN-694, and EN-695	X									Analytical Summary Report, August 13, 2009
April 13-May 1, 2009	Dual-Phase Extraction Testing Pilot Test	Daily groundwater composite sampling	X									Analytical Summary Report, August 11, 2009 and DPE/SVE Pilot Test Report, September 29, 2009
		Daily soil vapor composite sampling	X									
April 21-23, 2009	Groundwater Sampling	EN-639, EN-641, EN-688, EN-690, EN-691, EN-692, EN-694, and EN-695	X									Analytical Summary Report, August 13, 2009
May 12-15, 2009	Routine Groundwater Sampling (*by SHA and by others*)	Selected wells	X									
May 12-15, 2009	Groundwater Sampling	EN-639, EN-641, EN-688, EN-690, EN-691, EN-692, EN-694, and EN-695	X							X		
May 15, 2009	Soil Gas Sampling	SV-101 through SV-105, SV-201 through SV-205, SV-301 through SV-305, SS-102 through SS-104	X									Analytical Summary Report, August 11, 2009
May 16, 2009	Storm Sewer Grab Water Sampling *(by others)*	Catch basins, manholes, and "weep" drains south of Building 57A	X									Analytical Summary Report, July 8, 2009
June 7-19, 2009	Soil Characterization & Sampling	B57-300, EN-696 through EN-708	X									Analytical Summary Report, September 2, 2009
	Monitoring Well Installation	EN-696 through EN-708										
June 10, 2009	Soil Characterization & Sampling	B57-223 through B57-226	X									
June 22-23, 2009	Groundwater Sampling	EN-684A, EN-696 through EN-708	X									
July 7-10, 2009	Groundwater Sampling	EN-684A, EN-696 through EN-708	X									
July 20, 2009	Water Level Survey	OU#5 area wells measured under pumping conditions										*Not applicable*
July 21-23, 2009	Groundwater Sampling	EN-684A, EN-696 through EN-708	X							X		Analytical Summary Report, September 2, 2009
August 9-13, 2009	Routine Groundwater Sampling (*by SHA and by others*)	Selected wells	X									*Not applicable*
October 19 - November 3, 2009	Water Level Survey	OU#5 area wells measured under pumping and ambient conditions										*Not applicable*
October 24, 2009	Storm Sewer Grab Water Sampling *(by others)*	Confirmatory sample collected from MH-87	X									Storm Sewer Confirmatory Sampling letter report, February 9, 2010
November 30, 2009	Storm Sewer Grab Water Sampling	Confirmatory samples collected from catch basins and manholes south of Building 57A	X									

Figure B.1

Soil Gas Sampling Exploration Location Plan

Supplemental Remedial Investigation Report OU#5 Building 57 Area

Union and Endicott, New York

Drawn By: J. Prellwitz
Designed By: J. Prellwitz / L. Jacob
Reviewed By: J. Ordway
Date: March 2010

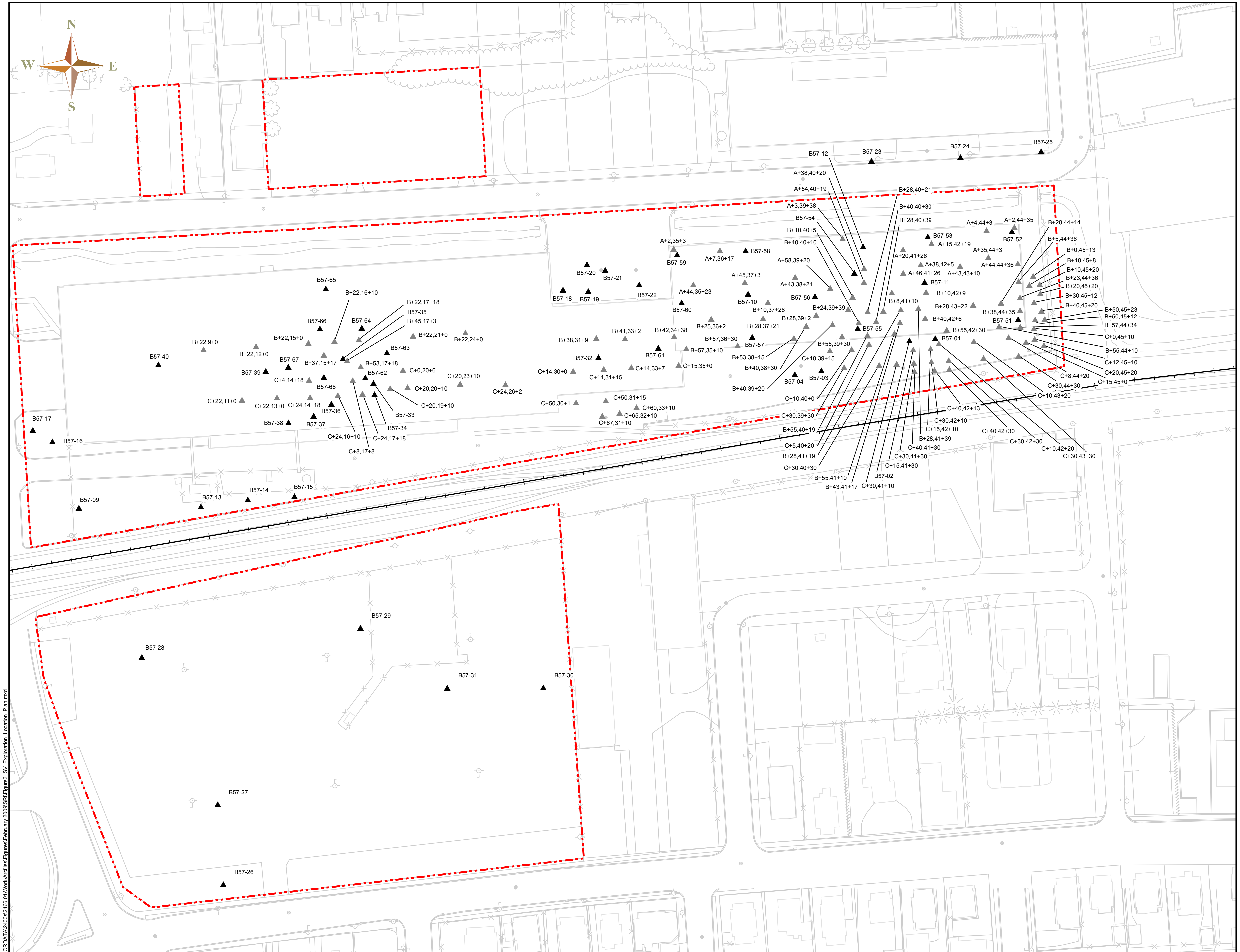

Figure Narrative:

This figure shows the locations and designations of soil gas explorations conducted as part of the SRI, between 2005 and 2007. The locations of soil and groundwater explorations are shown on Figure 4 in the SRI report.

"B-57"-series exploration locations were surveyed by Butler Land Surveying, LLC of Little Meadows, PA. Other soil gas monitoring points are named according to their position in the building column grid (as established in a CAD drawing provided by Huron Real Estate, Inc.). Locations were measured manually.

Legend

▲ Soil Gas Monitoring Point (2005)

▲ Soil Gas Probe Point (2007)

Site Boundary

60 30 0 60 120 180 Feet

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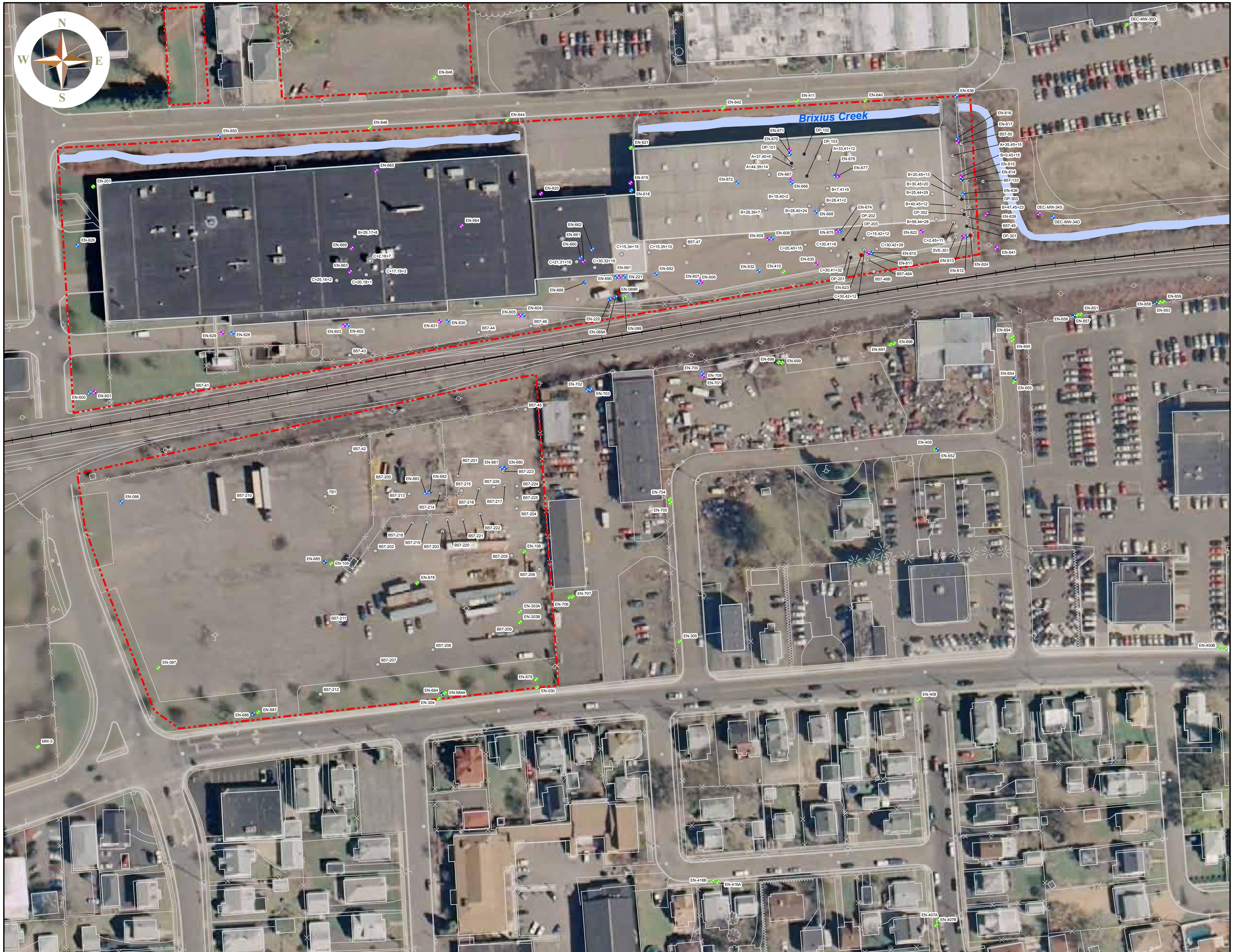

Attachment B.1

Interactive Location Plan

Supplemental Remedial Investigation Report
OU#5 / Building 57 Area

Union and Endicott, New York

Drawn By:	S. Warner/J. Pierce
Designed By:	S. Warner
Reviewed By:	J. Ordway
Date:	March 2010

Figure Narrative:

This interactive location plan is intended for on-screen viewing, and provides links to portable document format logs of soil borings, monitoring wells, and extraction wells installed during SRI activities. Individual logs are accessed by clicking on the boring or well label.

The locations of wells installed by others are shown for reference; however, logs for these wells are not provided here. SHA personnel observed and logged drilling and installation (conducted by others) of DEC-MW-34S, DEC-MW-34D, and DEC-MW-35D. Logs of these monitoring wells are included.

Legend

- Upper WBZ Monitoring Well (Screened Above Site Silt & Clay)
- Lower WBZ Monitoring Well (Screened Below Site Silt & Clay)
- Deep Monitoring Well (Screened in Till)
- Monitoring Well (Screened where Site Silt & Clay was not present)
- Groundwater Extraction Well
- Soil Vapor Extraction Well
- Soil Boring
- Dual Phase Extraction Pilot Test Monitoring Location
- Site Boundary

60 30 0 60 120 180 Feet

SHPC ENGINEERS

S:\PORDATA\2400s\2466.01\Work\Arcfiles\Figures\February 2010\20100226 Interactive Location Plan SRI AppB1.mxd

ATTACHMENT B.2
LABORATORY ANALYTICAL DATA

Laboratory analytical data from SRI explorations of soil gas, soil, surface water, and groundwater are provided in database format on the attached disc. This table is intended for on-screen viewing and querying only, to allow the user the opportunity to filter and sort the data as needed. Data have been reported in tabular format to the Agencies in ASRs.

The database fields and brief descriptions are provided below.

Field	Description
Object Name	Name of the exploration from which the sample was collected.
Object Type	Brief description of the primary classification of the exploration (i.e., Soil Boring, Extraction Well, etc.).
Sample Name	Unique name defined by SHA to track samples among field, laboratory, and database.
Collection Date	Date on which the sample was collected
Sample Matrix	Classification of the primary sample substance (i.e., Groundwater, Soil, etc.).
Lab Type	Indicates whether the sample was analyzed in the field (mobile) or sent to a (fixed) laboratory.
Lab Name	Name of laboratory where sample was analyzed.
Method	Analysis method used by laboratory.
Analyte	Name of analyte tested for (defined by SHA based on CAS number).
CAS	Chemical Abstracts Service (CAS) registry number; unique identifiers for chemical substances. Substances without a CAS number were assigned a unique identifier by SHA.
Analyte Class	Grouping of analytes based on chemical properties and analysis method.
Result	Numerical value of concentration of analyte per sample as reported by laboratory and (if appropriate) independent validator.
Unit	Unit of result.
Qualifier	Standard laboratory and validation qualifier as described in laboratory and data validation reports.
Validated Data	Indicates whether data was reviewed by an independent data validator, New Environmental Horizons, Inc.

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APPENDIX C

SUMMARY OF DATA VALIDATION AND USABILITY

APPENDIX C
SUMMARY OF DATA VALIDATION AND USABILITY

C.1 INTRODUCTION AND SUMMARY

This Appendix is intended to summarize how project-specific data quality objectives (DQOs) were met during investigation and analysis associated with the Supplemental Remedial Investigation (SRI) for the OU#5/Building 57 Area of the Former IBM Endicott Facility. DQOs were developed by Sanborn, Head and Associates, Inc. (SHA) on behalf of IBM Corporation (IBM), and were performed as outlined in the Quality Assurance/Quality Control (QA/QC) Plan in the SRI Work Plan[1] (Work Plan). The Work Plan DQOs and measurement performance criteria (MPC) were developed consistent with processes described by the USEPA[2] and Exhibit E of the New York State Analytical Services Protocol (NYSASP)[3]. Our work and this Appendix are subject to the Limitations outlined in the text to follow and summarized in Appendix A of the SRI report.

Review of the QA/QC data program for groundwater and soil sampling events conducted between January 2005 and August 2009 indicates that more than 99% of the analytical results for the 1,225 collected samples (including 879 primary field samples, 65 field duplicate samples, 70 matrix spike (MS) and matrix spike duplicate (MSD) samples, 95 trip blanks, 66 ambient air blanks, and 50 equipment rinseate blanks) are usable and valid for decision making purposes, subject to some data qualifiers/flags that are detailed below. In addition, the QA/QC review indicates that precision, accuracy, representativeness, comparability, sensitivity and completeness of the analytical results meet project data quality objectives (DQOs) for most samples collected. Based on the independent data validation assessment, only 29 of the total 57,059 analytical results, including 28 volatile organic compounds (VOCs) and one semi-volatile organic compound (SVOC), were unusable or rejected for risk-based decisions.

C.2 OBJECTIVE AND SCOPE

The QA/QC data collected during the Building 57 SRI were reviewed to assess whether performance criteria established for project-related DQOs were achieved. Groundwater and soil sampling events included in this assessment include the sampling events, laboratory QA/QC reports, and validation reports summarized in Table E.1.1. The project-specific DQOs for the Building 57 Area include:

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[1] Sanborn Head & Associates, Inc. "Work Plan for Source Area Evaluation, Supplemental Remedial Investigation and Focused Feasibility Study, Operable Unit #5 – Building 57 Area, Union and Endicott, New York" (Work Plan) dated September 9, 2004, and approved by the NYSDEC in a letter dated December 13, 2004.

[2] United States Environmental Protection Agency. Data Quality Objectives, Process for Hazardous Waste Site Investigations, Final, January 2000.

[3] New York State Department of Environmental Conservation. Analytical Services Protocol, Exhibit E-Quality Assurance Quality Control Requirements, June 2000.

- Identifying the presence and concentration, or absence, of target VOCs in soil vapor, soil, and groundwater in the Building 57 Area, relative to laboratory reporting limits (RLs);

- Providing data on the presence or absence of VOCs in samples of soil vapor, soil, and groundwater of sufficient precision, accuracy, bias, representativeness, completeness, sensitivity, and comparability to adequately assess the extent of VOCs, and support evaluation of potential remedial options, if necessary; and

- Developing hydrogeologic data (e.g. soil descriptions, groundwater and surface water elevations) of adequate quantity and quality to provide characterization of the hydrogeology sufficient to appropriately assess contaminant transport and fate in groundwater.

Three general types of laboratory data were generated during the SRI, including:

- Fixed laboratory analysis of samples of soil vapor, soil, and groundwater for organic and inorganic constituents. Data were used to quantify the extent and magnitude of site conditions and were used in support of a qualitative exposure assessment for risk-management decisions.

- Mobile laboratory analysis of samples of soil vapor and groundwater for organic and inorganic constituents. The mobile laboratory data were not used to quantify the extent and concentrations of site contamination, but rather to qualitatively assess for the presence or absence of contamination at certain locations and aid in the siting of borings and permanent monitoring wells; and

- Field screening of soil vapor, soil, and groundwater samples using hand-held instruments (e.g. PID and/or FID) to assist in selection of samples for mobile and fixed laboratory analysis and to provide ‘real-time’ data to assist in evaluating investigation locations during field programs. Field screening data were used only for qualitative purposes and not for risk-management decisions.

The QA/QC program included collection of field duplicates, trip blanks, atmospheric blanks, and equipment rinseate blanks when non-dedicated equipment was used. Analytical laboratories used during the SRI include Columbia Analytical Services (CAS) of Rochester, NY; IBM Hudson Valley Environmental Laboratory (IBM) of Hopewell Junction, NY; Severn Trent Laboratories (STL) of Newburgh, NY and Shelton, CT; and Lancaster Laboratories, Inc. (Lancaster) of Lancaster, PA. The laboratories used for analysis of groundwater samples included in this usability assessment were certified by the New York Department of Health (NYDOH) during their time of use, and included the analysis of method blanks, matrix spike and matrix spike duplicates (MS/MSDs – for organic analyses) or matrix duplicates (MDs – for inorganic analyses), laboratory control samples (LCSs), and surrogates.

New Environmental Horizons, Inc. (NEH) of Skillman, NJ performed data validation and usability assessment of the groundwater and soil analytical data collected throughout this SRI. NEH evaluated the data against project specific DQOs for usability, precision, accuracy/bias, representativeness, comparability, completeness, and sensitivity, and qualified or rejected data that did not meet relevant DQOs. Data validation reports have been included with interim Analytical Summary Reports (ASRs) throughout the SRI, and are available on file at the NYDEC.

C.3 SUMMARY OF QA/QC ELEMENTS

C.3.1 Precision

Precision is the degree of agreement among repeated measurements of the same characteristic (analyte, parameter, etc.) under the same or similar conditions. Precision data indicate how consistent and reproducible the field sampling or analytical procedures have been. "Overall project precision" was measured by collecting data from duplicate field samples (i.e. field duplicates [FDs]), while analytical laboratory precision as affected by the matrix was measured by analyzing matrix spike/matrix spike duplicate (MS/MSD) samples for water and soils. Our overall evaluation of precision is presented below.

Field Duplicate Precision

The relative percent difference (RPD) of the results from primary and field duplicate samples was used to evaluate laboratory precision. The target MPC for field duplicates was an RPD<30% in water samples and RPD<50% in soil samples. Overall, of the 3,053 paired results from the 65 duplicate soil and groundwater samples, only 27 paired results (<1%) did not meet the project DQOs for precision (RPDs outside MPCs). Of the 14 different VOCs and one metal that fell outside DQOs for one or more samples, acetone was the analyte most commonly flagged for field duplicate imprecision (see table below). Results not meeting DQOs were qualified as estimated with indeterminate bias, and found usable as qualified.

Analyte	Number of Groundwater Duplicate Pairs with RPD outside MPC	Number of Soil Duplicate Pairs with RPD Outside MPC
VOCs/SVOCs		
1,1,1-Trichloroethane	2	1
1,1-Dichloroethane	--	1
1,1-Dichloroethene	1	
2-Propanol	--	1
Acetone	3	4
Chloroethane	1	--
*cis*1,2-Dichloroethene	1	2
Freon 113	--	1
Freon 123a	--	1
m,p-Xylenes	1	--
Methylene Chloride	1	1
Tetrahydrafuran	1	--
Trichloroethene	1	1
Vinyl Chloride	1	--
Metals		
Aluminum	1	--
Total	**14**	**13**

Matrix Spike Duplicate Precision

The RPD of the results from matrix QC samples (MS/MSD samples) were a second measure of laboratory precision. The target MPCs for matrix spike/matrix spike duplicate sample RPDs are specified in the NYSASP[4]. Overall, 1,495 (93%) of the 1,614 paired results reported for the MS/MSD samples met project DQOs. Of the 119 (7%) paired groundwater or soil results that did not meet DQOs, 94 were flagged from two samples where all measured VOCs were outside the RPD range. Results not meeting DQOs were qualified as estimated with indeterminate bias, and found usable as qualified. Matrix spike and matrix spike duplicate samples were collected at a frequency of 4% throughout the SRI. This was slightly below the frequency specified in the QA/QC program of 5%; however, between 2008 and 2009, MS/MSD frequency increased to more than 7%, which is well above the frequency specified in the Work Plan.

Analyte	Number of Groundwater Duplicate Pairs with RPD outside MPC	Number of Soil Duplicate Pairs with RPD Outside MPC
VOCs/SVOCs		
1,2-Dichlorobenzene	1	--
1,3-Dichlorobenzene	1	--
1,4-Dichlorobenzene	1	--
2-Hexanone	1	--
2-Propanol	2	1
Bromomethane	1	--
Butyl Acetate	2	--
Chlorobenzene	1	--
Dichlorofluoromethane	1	--
Ethylbenzene	--	2
Freon 113	--	2
m,p-Xylenes	--	2
o-Xylene	--	2
Styrene	1	--
Toluene	1	--
Trichloroethene	--	2
Trichlorofluoromethane	1	--
All VOCs (2 samples)	94	--
Metals		
--	--	--
Total	**108**	**11**

[4] New York State Department of Environmental Conservation, June 2000. Analytical Services Protocol, Exhibit E – Quality Assurance Quality Control Requirements.

C.3.2 Accuracy/Bias

Accuracy is the extent of agreement between an observed value (sample result) and the accepted, or true, value of the measured parameter. Accuracy is frequently used synonymously with bias. Specifically, the term "bias" describes the systematic or persistent error associated with a measurement process. Sources of error in the field and the laboratory that may influence accuracy include laboratory measurement error, sampling inconsistency, field or laboratory contamination, preservation and handling issues, and matrix interferences. Accuracy and bias were evaluated using the following QC samples: laboratory control samples (LCS) and duplicates (LCSD), MS and MSD samples, surrogate spikes, and field and laboratory blank samples. In addition, method-required initial calibration and continuing calibration criteria were used to assess accuracy of analytical measurements. Acceptance control limits for QC samples were 70-130% recoveries.

Of the 57,059 total reported results, 52,779 (92%) were not flagged for possible bias while the remaining 4,280 (8%) were flagged with some form of bias. For VOC analytes, only 3,998 (7%) of the 54,856 results were flagged for possible bias; for SVOCs, Metals, and diesel- and gasoline-range organic (DRO/GRO) results, only 282 (13%) of the 2,203 results were flagged for possible bias, and the qualified data are considered usable for project decisions. Our assessment of the biased results is summarized below.

Assessment of Potential for Low Bias

Data validation conditions that imply a potential for a low bias in the sample result include:

- A recovery of a target compound in a Continuing Calibration Verification (CCV) sample was less than the acceptable range;
- A recovery of a target compound in an MS/MSD sample was less than the acceptable range;
- Analysis of the sample was conducted outside of project holding times;
- A sample was improperly preserved;
- Serial dilution was evidence of matrix suppression;
- Temperature upon receipt was outside acceptable criteria;
- A recovery of the low level check standard was less than the acceptable range for a specific compound; and
- A recovery of a surrogate compound was less than the acceptable range.

Overall, of the 57,059 reported target analytes, 1,248 (2%) were flagged as estimated with a potential low bias during data validation. These results were found usable for project objectives as qualified.

Assessment of Potential for High Bias

Data validation conditions that imply a potential for a high bias in the sample result include:

- A recovery for a target compound in a CCV sample was greater than the acceptable range;

- A high contract required quantitation limit (CRQL) standard recovery;
  A recovery for a target compound in a LCS/LCSD or MS/MSD greater than the acceptable range;
- A serial dilution RPD was greater than the acceptable range for a specific compound; and
- There was a possible co-eluting substance or interference present.

Overall, of the 56,332 reported target analytes, 48 (0.1%) were flagged as estimated with a potential high bias during data validation These results are usable for project objectives as qualified.

Assessment of Indeterminate Bias

Data validation conditions that imply an indeterminate bias in the sample result include:

- A RPD out of the acceptance range for a field duplicate pair, MS/MSD or sample/MD pair, or an initial and diluted result;
- A result reported as an estimated value below the Limit of Quantitation (LOQ);
- A result which is reported above or below the calibration range;
- A reporting limit for a non-detected result which is reported at the Method Detection Limit (MDL) to achieve the CRQL;
- A recovery of an internal standard less than the acceptable range for a specific compound;
- A tentatively identified compound (TIC); and
- Any combination of the above low, high, and indeterminate data validation conditions.

Of the 57,059 reported target analytes, 2,894 (5%) were flagged as estimated with indeterminate bias during data validation. These results are usable for project objectives as qualified.

C.3.3. Representativeness

Representativeness is a qualitative term that describes the extent to which a sampling design adequately reflects the environmental conditions of a site. It takes into consideration the magnitude of the site area represented by one sample and assesses the feasibility/reasonableness of that design rationale. Representativeness also reflects the ability of the sampling team to collect samples and laboratory personnel to analyze those samples in such a manner that the data generated accurately and precisely reflect the conditions at the Site.

As a quantitative measure of representativeness, field duplicate samples were collected and analyzed at a frequency of 7% throughout the SRI. This exceeded the minimum frequency established in the QA/QC program of 5%. Results where field duplicates did not meet project specific DQOs for precision are detailed in section E.3.1. In summary, only 27 paired results (<1%) were outside the DQOs (RPDs>30% for water samples and RPD>50% for soil samples).

C.3.4 Comparability

Comparability is a qualitative parameter that expresses the confidence with which data sets can be compared. Comparable data allows for combination of analytical results acquired from various sources during the period of the assessment. It relies on the acceptability of field sampling and analytical methods, precision, and accuracy within the individual data sets, and promotes confidence in the data sets. The consistent use of the sampling and analytical methods defined in the Work Plan yield comparable results within the distinct data sets of "definitive data" generated by the fixed laboratories, and the screening-level data generated by the mobile laboratories. In addition, comparability can be affected by QA/QC criteria such as sample preservation, holding times, blank contamination, quantitation limits, and matrix issues.

During data validation, NEH reviewed the data for laboratory compliance with analytical methods, correct calculation of sample results from the raw data by the laboratory, and validity of reporting limits for non-detects. Any results not meeting DQOs were qualified as estimated with possible bias, and found usable as qualified. No deviations or errors which would compromise the quality of the data were noted in the data validation package.

As an additional measure of comparability for analyses conducted at the IBM laboratory, split samples of soil and groundwater were collected and sent to STL. Comparability of results from this split laboratory data and the IBM laboratory data was assessed, and was considered acceptable if the RPD between split results was <30% in water samples and <50% in soil samples. Professional judgment was used if concentrations were near the reporting limit. This evaluation was made by SHPC after validation of analytical data provided by both laboratories.

In August, 2007, a data usability analysis was conducted on VOCs, SVOCs, metals, DRO, and GRO sample results from split soil samples analyzed at STL and CAS laboratories. All the sample results met comparability criteria (RPD≤50%) except eight analytes. Of the VOCs tested at both laboratories, only acetone was non-comparable for one split sample compared between the laboratories. DRO, GRO, and SVOCs 2-methylnaphthalene, benzo(a)anthracene, naphthalene, and phenanthrene were non-comparable for split samples compared between the laboratories. Of the metals analyzed, barium was outside criteria for one split sample in the comparison.

A second split sample comparison was conducted in September 2007 on groundwater samples sent to three laboratories: STL, CAS, and IBM HVEL for analysis of VOCs, SVOCs, metals, DRO, and GRO. Of the analytes detected, all the sample results met MPC (RPD<30%) except three analytes: xylenes (total), DRO, and GRO. SVOCs could not be compared because results were non-detect for all compounds.

C.3.5 Sensitivity

Sensitivity is the ability of the method or instrument to detect the target analytes at the concentration of interest. Several QC samples and procedures were used to assess the level of sensitivity, and its consistency with the project DQOs. These QC samples and procedures included collection and analysis of field blank samples (equipment rinseate blanks, trip blank samples, ambient air blank samples) and laboratory method and instrument blank samples, and instrument initial and continuing calibration criteria. Results for adherence to sensitivity are detailed below.

Review of Blank Contamination

Results of field blank samples and laboratory method blank samples were reviewed during data validation to evaluate potential contribution from field and laboratory activities.

During the data validation process, any analytes detected in a blank sample were reviewed in the associated field samples. If an analyte was detected in a field sample and also detected in an associated blank, NEH followed data validation protocol to determine if the values for the field samples should be qualified. If the value for the field sample was less than five times the value for the associated blank sample, the detection in the field sample was negated, and flagged as UJ. If the detected value in the field sample was greater than five times the detected value in the blank, no action was taken.

Atmospheric blanks were used to assess the presence of target compounds present in ambient field conditions and were collected at an overall rate of 7.5% throughout the SRI (66 atmospheric blanks/ 879 primary field samples). This exceeded the minimum frequency established in the QA/QC program of 5%.

Equipment rinseate blanks were used to assess the efficacy of equipment decontamination procedures. Equipment rinseate samples were collected at an overall rate of 6% throughout the SRI (50 equipment blanks/ 879 primary field samples). This exceeded the minimum frequency established in the QA/QC program of 5% for non-dedicated equipment.

Trip blanks were used to evaluate potential contamination associated with sample container preparation and transportation to and from the field. Trip blanks were submitted at a minimum of one per sampling event and more generally within each sample cooler at a rate of more than 10% throughout the SRI (95 trip blanks/ 879 primary field samples).

Of the total 9,842 individual blank results, five different analytes were negated in one or more blank samples. This occurred in 70 of the results, or less than 1%. As shown in the table below, analytes methylene chloride and acetone were the most commonly negated VOCs in blank sample results, and are typical laboratory contaminants.

Analyte	Number of Blank Results Negated (Changed to UJ)
VOCs	
2-Propanol	5
Acetone	14
Bromodichloromethane	4
Methylene Chloride	39
Tetrahydrofuran	8
Total	**70**

A total of eleven VOCs and one metal were detected in field samples at a level less than five times the detected value in associated blank samples. Negations occurred in 330 of the 40,842 primary field results, or less than 1%. As shown in the table below, the analytes acetone, 2-propanol, methylene chloride, and tetrahydrofuran were four of the most commonly negated VOCs in field samples. Negated VOCs represent commonly detected laboratory and field contaminants.

Analyte	# Sample Results Negated (Changed to UJ)
VOCs/SVOCs	
1,1,1-Trichloroethane	2
1,1-Dichloroethane	1
1,1-Dichloroethene	1
2-Butanone	21
2-Propanol	64
Acetone	79
Carbon Disulfide	6
Chloroform	2
Methylene Chloride	59
Tetrahydrofuran	56
Toluene	34
Metals	
Sodium	5
Total	**330**

Review of Instrument Initial and Continuing Calibration Criteria

Instrument initial and continuing calibration criteria were reviewed during data validation to assess the sensitivity of laboratory instrumentation. Of the 57,059 laboratory results, more than 99% met project DQOs for initial or continuing calibration. A total of 207 individual results

(<1%) were flagged as estimated during data validation due to calibrations above, below, or outside criteria. This included the 17 VOCs and 6 metals listed in the table below. These results are usable for project objectives as qualified.

Analyte	Number of Results Above Calibration Criteria	Number of Results Below Calibration Criteria	Number of Results Outside Initial Calibration Criteria
VOCs/SVOCs			
1,1,2,2-Tetrachloroethane		6	
1,1-Dichloroethane		4	
1,2,4-Trichlorobenzene			1
2-butanone		10	
2-hexanone		6	
2-Propanol		2	4
Acetone	16	6	2
Butyl acetate		27	
Carbon Tetrachloride		1	
Chloromethane			2
Dichlorofluoromethane	6	3	
Freon 113			1
Freon 123a		5	
Hexachlorocyclopentadiene		10	
Tetrahydrofuran			4
Vinyl Acetate		81	
Vinyl Chloride			2
Metals			
Aluminum		1	
Arsenic	1	1	
Cobalt		1	
Sodium		1	
Mercury		1	
Zinc	2		
Total	**25**	**166**	**16**

Review of CRQLs Against Achieved Reporting Limits

Analytical laboratory reporting limits for undiluted (i.e., dilution factor of 1) results were reviewed relative to expected reporting limits listed in the Work Plan to assess data sensitivity. Specifically, reporting limits achieved for each compound were compared with the expected CRQLs. A total of 11 VOCs and 7 metals were reported to have not met CRQLs during the SRI. The table below lists the analytes for which reporting limits did not meet Work Plan CRQLs and summarizes reasons given by the laboratories. These results are usable for project objectives as qualified.

Analyte	Reason CRQL not met
VOCs/SVOCs	
1,2,4-Trichlorobenzene	Sensitivity to CRQLs unacceptable
2-butanone	Instrument calibration characteristics
2-hexanone	Instrument calibration characteristics
2-propanol	Instrument calibration issues
4-methyl-2-pentanone	Instrument calibration characteristics
Bromomethane	Not part of instrument calibration
Chloroethane	Instrument calibration characteristics
Chloromethane	Instrument calibration issues
n-butyl acetate	Not part of instrument calibration
Tetrahydrofuran	Instrument calibration characteristics
Vinyl acetate	Instrument calibration issues
Metals	
Alumium	High CRDL standard recovery
Beryllium	ICP-AES limitations
Cadmium	ICP-AES limitations
Selenium	ICP-AES limitations
Silver	ICP-AES limitations
Thallium	ICP-AES limitations
Zinc	High CRDL standard recovery

For many samples collected during the SRI, the undiluted groundwater sample analysis and/or initial low-level soils analysis indicated that one or more analytes was out of instrument range. As a result, groundwater samples were diluted or medium-level soil aliquots were analyzed in order to quantify all analytes as required in the Work Plan. In these instances, detection limits (DLs) were above the reporting limits (RLs) as outlined in the Work Plan DQOs. Data usability reports specify that users should evaluate non-detected results in these instances for use in risk-based decisions. Examples include the following:

- In general, certain groundwater sample results were diluted if collected from monitoring locations from within “source areas” where concentrations of one or more key VOCs (including Freon 113, Freon 123a, Acetone, TCE, 1,1,1-TCA, cis1,2-DCE and others) were above the instrument range. For these samples, analysis of the diluted sample may have reduced the sensitivity to detect other VOCs that may be present at low concentrations, or at levels near instrument detection limits in these monitoring locations. Any VOCs that were not detected in diluted samples were reported with a detection limit that increased with the dilution factor.

- Similarly, when medium soil aliquots were analyzed as a result of a high detect of one or more analytes, analysis methodology may have reduced the sensitivity to detect other VOCs that may be present at low concentrations, or at levels near the instrument detection limits. DLs were generally above the limits specified in the Work Plan, Soil Cleanup Objectives (SCOs), or New York Technical and Administrative Guidance Memorandum (TAGM) 4046 Table 1, but below CRQL.

E.3.6 Completeness

Completeness is a measure of the amount of valid and usable data resulting from data collection and analysis activities. Completeness can be calculated as a percentage of the number of valid and usable results obtained compared to the total number of results (usable and rejected) obtained during the course of the investigation. Of the 57,059 results obtained in this SRI, only 29 (<1%) were rejected while more than 99% of the results met project DQOs. The remaining 57,030 results (99.9%) are usable as qualified. This exceeds the completeness objective of 90% set in the Work Plan. A summary of analytes and the reason the result was rejected is included in the table below.

Analyte	Media	Number of Results Rejected	Reason
VOCs/SVOCs			
1,1,2,2-Tetrachloroethane	Soil	7	<25% Internal Standard Recovery
1,2-Dichlorobenzene	Soil	7	
1,3-Dichlorobenzene	Soil	7	
1,4-Dichlorobenzene	Soil	7	
SVOCs			
3,3-Dichlorobenzidine	Groundwater	1	0% MS/MSD Recoverables
Total		**29**	

E.4. CONCLUSIONS

In summary, the results of the QA/QC program described in this Appendix indicate that more than 99% of the data reviewed by an independent contractor are usable for their intended purpose, subject to certain qualifiers detailed herein. These include the following QA/QC categories:

- Precision – More than 99% of field duplicate data and more than 93% of matrix spike (and duplicate) data fell within the project DQOs. Data for paired results that fell outside the target MPC for precision (RPD>30% for water samples and RPD>50% for soil samples) were flagged as estimated and found usable as qualified.

- Accuracy/Bias – DQOs set for accuracy and bias were met in more than 92% of the results. Data for 8% of the results were flagged as having low, high, or indeterminate bias and found usable as qualified.

- Representativeness – The rate at which field duplicates were collected (7%) exceeded the target frequency set in the Work Plan (5%). Based on a review of field duplicate RPDs, DQOs for representativeness were met in 99% of the results.

- Comparability –Validation of sample results collected throughout the SRI by an independent contractor found no deviations or errors which would compromise the quality of data. Split sample analysis indicated that comparability criteria were met for the majority of results.

- Sensitivity – A review of blank contamination found that negations occurred in less than 1% of sample results. The rate at which blank samples were collected (6-11%) exceeded the target frequencies set in the Work Plan (5%). Initial and continuing calibration criteria met project DQOs for more than 99% of results. Samples that required dilution or medium soil aliquot analysis were less sensitive to the CRQLs established in the Work Plan. Users should evaluate non-detected results from these samples for use in risk-based decisions.

- Completeness – More than 99% of results met the DQOs for completeness, with the remaining results found to be usable as qualified. This exceeds the minimum frequency of 90% set in the Work Plan.

The findings discussed in the data validation reports throughout the SRI are consistent with observations presented in this Appendix. In total, the OU#5 SRI includes results from 879 primary field samples, 65 field duplicate samples (7%), 36 matrix spike samples (4%), 34 matrix spike duplicate samples (4%), 95 trip blanks (11%), 66 ambient air blanks, and 50 equipment rinseate blanks.

ATTACHMENTS

Table C.1 Index of Sampling Events and Validated Data Results

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Table C.1
Index of Sampling Events and Validated Data Results
OU#5/Building 57 Area
Union and Endicott, New York

Laboratory	Sample Date Range	Lab Report Date	EDD Identifer/Laboratory ID	NEH Report Identifier
IBM	7/14 - 7/18/2005	8/8/2005	46903, 48283	0507608-0507617, 0508048-0508049
IBM	7/27 - 7/28/05	8/11/2005	48283	0508042-0508047, 0508050
IBM	8/2 - 8/4/2005	8/22/2005	51627	0508421-0508446
IBM	8/30 - 9/2/2005	9/22/2005	51628, 51631, 51632, 51633	0509669-0509679, 0509857 - 0509878
IBM	10/24/2005	11/9/2005	50881	0511913-0512163
IBM	10/25 - 10/26/2005	11/9/2005	50874, 50878, 50879	0511995-0512018
IBM	10/26 - 10/27/2005	11/11/2005	50884 50885 50886	0512139-0512163
STL	7/27/2005	11/28/2005	--	250497
STL	8/3/2005	11/28/2005	--	250821
STL	8/31 - 9/2/2005	11/28/2005	--	251774
STL	10/24/2005	12/1/2005	--	253221
Columbia	12/7 - 12/8/2005	1/27/2006	866448-866455	R2529203
IBM	1/10 - 1/14/2006	1/27/2006	51164, 51165	0600542-0600557
Columbia	12/14 - 12/15/2006	2/7/2006	868444-868454	R2529306
Columbia	1/10/2006	2/23/2006	874045-874049	R2629797
IBM	3/8/2006	4/20/2006	56243, 56450, 56452	0602729(4)-0602746
IBM	4/19/2006	5/8/2006	54709, 56720, 56237	0604184-0604211
Columbia	2/12/2007, 2/14/2007	3/9/2007	R273618R	R2736181
IBM	3/1/2007; 3/19/2007; 4/2 - 4/3/2007	3/13/2007; 4/10/2007; 4/24/2007	45879, 45881; 57314, 57316; 57317, 57342, 57345	0702444-0703775
Columbia	4/2/2007	4/20/2007	R2736978	R2736978
IBM	5/15/2007; 5/29/2007; 6/25 - 6/28/2007	5/31/2007; 6/15/2007; 7/13/2007	41114; May 61712-61714; Jun 62742, 62745	0705178-0706824
STL	5/1/2007	5/22/2007	--	220-1552
Columbia	4/23 - 4/24/2007	5/24/2007	R2737280	R2737280
Columbia	4/25 - 4/26/2007	5/30/2007	R2737369	R2737369
Columbia	5/2 - 5/4/2007	6/4/2007	R2737478	R2737478
Columbia	4/26 - 4/27/2007, 5/1 - 5/2/2007	6/5/2007	R2737393	R2737393
Columbia	5/8 - 5/9/2007	6/12/2007	R2737593	R2737593
STL	6/26/2007	7/11/2007	--	220-1961
Columbia	6/25 - 6/28/07	8/1/2007	R2738303	R2738303
Columbia	1/7 - 1/8/2008	1/25/2008	R2841672	R2841672
Columbia	1/8 - 1/9/2008	2/5/2008	R2841690	R2841690
Columbia	1/9 - 1/10/2008	2/7/2008	R2841708	R2841708
Columbia	1/10 - 1/11/2008	2/7/2008	R2841726	R2841726
Columbia	1/14/2008	2/11/2008	R2841764	R2841764
Columbia	1/14 - 1/15/2008	2/13/2008	R2841773	R2841773
Columbia	1/15 - 1/16/2008	2/14/2008	R2841802	R2841802
Columbia	1/17/2008	2/15/2008	R2841819	R2841819
Columbia	1/18/2008	2/15/2008	R2841841	R2841841
Lancaster	2/25 - 2/26/2008	3/18/2008	OUF01	OUF01
IBM	2/7 - 2/8/2008	3/19/2008	58831, 58835	0801375 - 0801395
Lancaster	4/10/2008	4/28/2008	OUF03	OUF03
Lancaster	4/7/2008	5/1/2008	OUF02	OUF02
Lancaster	5/3/2008	5/13/2008	OUF06	OUF06
Lancaster	5/20 - 5/22/2008	6/5/2008	OUF07	OUF07
Lancaster	5/20 - 5/21/2008	6/5/2008	OUF08	OUF08
Lancaster	6/10 - 6/12/2008	6/25/2008	OUF09	OUF09
Lancaster	8/20 - 8/21/2008	9/4/2008	OUF11	OUF11
Lancaster	8/18 - 8/19/2008	9/8/2008	OUF10	OUF10
Lancaster	9/22 - 9/25/2008	10/3/2008, 10/9/2008	OUF12	OUF12
Lancaster	10/2/2008	10/15/2008	OUF13	OUF13
Lancaster	10/13 - 10/15/2008	10/25/2008	OUF15	OUF15
Lancaster	10/27 - 10/29/2008	11/10/2008	OUF16	OUF16
Lancaster	10/27 - 10/28/2008	11/10/2008	OUF17	OUF17
Lancaster	10/29 - 10/30/2008	11/14/2008	OUF18	OUF18
Lancaster	11/11 - 11/13/2008	11/26/2008	OUF19	OUF19
Lancaster	3/23 - 3/25/2009, 3/30/2009, 3/31/2009	4/3/2009, 4/7/09, 4/8/2009, 4/10/2009	OUF22	OUF22
Lancaster	3/27/2009	4/8/2009	OUF23	OUF23
Lancaster	3/31 - 4/1/2009	4/21/2009	OUF24	OUF24
Lancaster	4/9 - 4/10/2009	4/23/2009	OUF25	OUF25
Lancaster	4/21 - 4/23/2009	5/12/2009	OUF28	OUF28
Lancaster	5/12 - 5/15/2009	5/29/2009	OUF30	OUF30
Lancaster	5/28/2009	6/5/2009	OUF32	OUF32
Lancaster	6/8 - 6/10/2009	6/23/2009	OUF33	OUF33
Lancaster	6/12/2009	6/25/2009	OUF35	OUF35
Lancaster	6/10/2009	6/30/2009	OUF34	OUF34
Lancaster	6/22 - 6/23/2009	7/7/2009	OUF36	OUF36
Lancaster	7/7 - 7/9/2009	7/21/2009	OUF37	OUF37
Lancaster	7/21 - 7/23/2009	8/4/2009	OUF39	OUF39
Lancaster	8/11 - 8/13/2009	8/25/2009	OUF40	OUF40

APPENDIX D

SOILS LABORATORY DATA AND INFERENCE

APPENDIX D
SOILS LABORATORY DATA AND INFERENCE

D.1 INTRODUCTION, DEFINITIONS AND SUMMARY

This Appendix summarizes soils laboratory data and inferences derived from field observations and laboratory testing of soil samples. Soil samples were collected by Sanborn, Head Engineering P.C., with assistance from Sanborn, Head and Associates, Inc. (SHA) during field exploration and testing events as part of the Supplemental Remedial Investigation (SRI), completed in general accordance with the approved SRI Work Plan[1]. Soil samples were submitted for laboratory testing to document texture and moisture conditions and to develop estimates of the in situ properties of the soils encountered at the site. Our work and this Appendix are subject to the Limitations outlined in the text to follow and summarized in Appendix A of the SRI report.

The soil physical properties discussed in this appendix include the soil particle or grain size, gravimetric and volumetric moisture contents, dry bulk density, and porosity. Moisture content is the quantity of water contained in a material (i.e., soil) and can be described either gravimetrically or volumetrically. Gravimetric moisture content (W_g %) can be defined as the mass of water per mass of dry solid soil material. Volumetric moisture content (θ_w) can be defined as the volume of water (V_w) per total volume (V_T), where V_T is equal to the total volume of soil, water, and void space. Volumetric moisture content was used to support estimates of dry bulk density, and will not be further discussed in this Appendix. Dry bulk density (ρ_b) is the mass per unit volume of dry soil (M/L^3) and is often expressed in units of pounds per cubic foot (lb/ft^3), or in grams per cubic centimeter (g/cm^3). Porosity (ϕ) is defined as the volume of void space that may be occupied by vapor or liquid relative to the total bulk volume, expressed as a unitless fraction. A summary of the laboratory analytical results and soil physical property estimates are included in the following sections.

D.2 OBJECTIVE AND SCOPE

The purpose of collection of soil samples and analysis of laboratory data was to derive estimates of the properties of the in situ soil to support development and refinement of the site conceptual model. Table D.1 below summarizes the scope of soil physical property sampling, including the analyses performed, and methods used. Sampling locations are shown on Figure D.1. Laboratory analytical reports are presented in Attachments D.1 through D.4. Field sampling was conducted according to the 2004 work plan and subsequent work plan addenda. Refer to Appendix B for further information about work completed and field methods.

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[1] Sanborn Head & Associates, Inc., September 9, 2004, "Work Plan for Source Area Evaluation, Supplemental Remedial Investigation and Focused Feasibility Study, Operable Unit #5 – Building 57 Area, Union and Endicott, New York."

Summary of soil samples collected for physical properties analysis.

Date(s)	No. of Samples	Analyses Completed	Method
March 2005	12	Particle Size Distribution	ASTM D 422
July - August 2005	12	Gravimetric Moisture Content	ASTM D 2216
April - May 2006	17	Particle Size Distribution	ASTM D 422
January 2008	14	Specific Gravity / Particle Size Distribution	ASTM D 854 / D 422

In order to summarize the findings of the afore-mentioned events, soil physical property results and estimates have been grouped by soil strata: upper water bearing zone (WBZ) soils (soil residing above the local aquitard; i.e., sub-slab and exterior fill), the site silt and clay aquitard, and lower WBZ soils (i.e., sand & gravel, sand, and till). Results and estimates are summarized both in Table D.1 and in the text below. All soil property data are included in Table D.2.

D.3 DATA AND FINDINGS

D.3.1 Soil Texture and Moisture

The average and range of grain sizes for each soil stratum are summarized in the table below.

		Mean Grain Size (Minimum-Maximum)			
Formation	**Soil Stratum**	**Gravel Fraction**	**Sand Fraction**	**Silt/Clay Fraction**	**d_{10}**
UWBZ	**Sub-slab Fill**	40.7 (28.4-70.9)	32.8 (9.30-47.3)	26.5 (4.80-36.1)	0.092 (0.0041-0.61)
	Exterior Fill	42.3 (19.8-64.5)	37.5 (20.5-60.2)	20.3 (4.70-48.6)	0.40 (0.00080-2.0)
Local Aquitard	**Silt & Clay**	0.5 (0-4.40)	7.8 (2.90-19.9)	91.7 (80.1-91.1)	0.00088 (0.00060-0.0013)
LWBZ	**Sand & Gravel**	49.6 (24.7-74.8)	37.4 (11.0-58.5)	13.0 (4.60-42.8)	0.31 (0.0041-2.0)
	Sand	3.20 (0-6.30)	75.4 (66.6-84.2)	21.5 (15.8-27.1)	0.033 (0.016-0.049)
	Till	46.6 (34.5-69.0)	29.6 (18.9-44.7)	23.8 (12.1-36.8)	0.010 (0.0026-0.030)

Gravimetric moisture content ranged from 6.8 to 15 percent in the upper WBZ soils, 18 to 33 percent in the local aquitard, and 5.0 to 25 percent in the lower WBZ soils.

D.3.2 Bulk Density and Porosity

Particle size distribution analysis typically included percent solids data. Through the relationships between the percentage of solid material in a soil sample (% solids), percent saturation, and specific gravity, estimates of both dry bulk density and porosity were derived. The geometric mean of dry bulk density and porosity estimates are shown in the table below.

Aquifer	Dry Bulk Density	Porosity *(unitless)*	Specific Gravity
UWBZ	121 lb/ft³	0.26	2.65
Site Silt and Clay Aquitard	112 lb/ft³	0.39	
LWBZ	129 lb/ft³	0.22	
LWBZ - Sand	103 lb/ft³	0.39	

Bulk density, as well as both air (ϕ) and water-filled porosity (ϕ_w), was calculated through relationships with the percentage of solid material in a soil sample, gravimetric water content (W_g), and specific gravity (G_s), via the following relationships:

$$W_g = \%\ \text{total volume} - \%\ \text{solids}$$

$$\phi_w = (\rho_b * (W_g / 100)) / \rho_w, \ (\text{where, } \rho_w = 62.4\ \text{lb./ft}^3)$$

$$\phi = 1 - (\rho_b / (\rho_w * G_s)$$

Laboratory analyses from soil samples submitted in 2007 reported % solids data, and SHA assumed a G_s of approximately 2.65 (typical for quartz sand). Soils collected in January 2008 were additionally tested for particle specific gravity and laboratory analytical results indicate a mean value of 2.64 (unitless), confirming the assumed value of 2.65 (unitless). In instances where % solids data were unavailable and the soil samples were observed to be fully saturated, bulk density was calculated by assuming that $\phi_w / \phi = 1$.

TABLES:

Table D.1 Summary of Soil Property Results and Estimates
Table D.2 Soil Properties

FIGURES:

ATTACHMENTS:

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TABLES

Table D.1 – Summary of Soil Property Results and Estimates

Table D.2 – Soil Properties

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Table D.1
Summary of Soil Property Results and Estimates
Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

Fill: Subslab	**Source Area**	**< #200 %**	**d_{10}**	**γ_{dry}**	**Wg**	**φ**	**θ_w**	**S_w %**	**TOC %**
B+28,41+2	B57A Area	36	0.0041	123	13	0.26	0.26	100%	-
B+29,17+8	B57 Area	27	0.0054	124	13	0.25	0.25	100%	0.63
C+2,18+7	B57 Area	29	0.0054	128	11	0.23	0.23	100%	0.20
C+30,32+19	CFC Area	24	0.0075	119	15	0.28	0.28	100%	7.0
EN-660	CFC Area	34	0.0048	119	11	0.24	0.21	88%	-
EN-666	B57A Area	4.8	0.61	123	13	0.25	0.25	100%	0.63
EN-669	B57 Area	32	0.0054	119	13	0.28	0.25	89%	0.26
Statistics									
Mean		27	0.092	122	13	0.25	0.25	97%	1.7
Maximum		36	0.61	128	15	0.28	0.28	100%	7.0
Minimum		4.8	0.0041	119	11	0.23	0.21	88%	0.20
Mode		N/A	0.0054	119	N/A	N/A	N/A	N/A	N/A
Median		29	0.0054	123	13	0.25	0.25	100%	0.63
Fill: Exterior	**Source Area**	**< #200 %**	**d_{10}**	**γ_{dry}**	**Wg**	**φ**	**θ_w**	**S_w %**	**TOC %**
B+30,45+20	Waste Solvent Area	49	0.00080	115	13	0.30	0.24	78%	-
B+40,45+12	Waste Solvent Area	4.7	0.35	123	6.8	0.25	0.13	53%	0.19
C+15,42+12	TCA Area	15	0.018	117	12	0.29	0.23	79%	1.5
C+30,41+8	TCA Area	24	0.0057	110	15	0.34	0.27	80%	-
B57-47		20	0.0035	123	13	0.25	0.25	100%	-
B57-49	Waste Solvent Area	9.2	2.0	128	7.8	0.23	0.16	70%	-
Statistics									
Mean		20	0.40	119	11	0.28	0.21	77%	0.85
Maximum		49	2.0	128	15	0.34	0.27	100%	1.5
Minimum		4.7	0.00080	110	6.8	0.23	0.13	53%	0.19
Mode		N/A	N/A	N/A	13	N/A	N/A	N/A	N/A
Median		18	0.012	120	13	0.27	0.23	78%	0.85
Local Aquitard Silt & Clay	**Source Area**	**< #200 %**	**d_{10}**	**γ_{dry}**	**Wg**	**φ**	**θ_w**	**S_w %**	**TOC %**
B+29,17+8	B57 Area	94	-	101	24	0.39	0.39	100%	0.72
B+40,45+12	Waste Solvent Area	92	0.0013	102	23	0.38	0.38	100%	2.0
C+30,41+32	TCA Area	95	0.00090	88.24	33	0.47	0.47	100%	2.5
EN-662	CFC Area	97	-	93.67	29	0.43	0.43	100%	1.2
EN-663	B57 Area	97	-	108	20	0.35	0.35	100%	0.51
EN-666	B57A Area	87	0.00070	108	20	0.35	0.35	100%	1.1
EN-668	B57A Area	92	0.00060	112	18	0.32	0.32	100%	0.093
B57-41		92	-	99.50	25	0.40	0.40	100%	-
B57-48	TCA Area	80	-	99.50	25	0.40	0.40	100%	-
Statistics									
Mean		92	0.00088	101	24	0.39	0.39	100%	1.2
Maximum		97	0.0013	112	33	0.47	0.47	100%	2.5
Minimum		80	0.00060	88.24	18	0.32	0.32	100%	0.093
Mode		N/A	N/A	99.50	25	0.40	0.40	100%	N/A
Median		92	0.00080	101	24	0.39	0.39	100%	1.1
Sand & Gravel	**Source Area**	**< #200 %**	**d_{10}**	**γ_{dry}**	**Wg**	**φ**	**θ_w**	**S_w %**	**TOC %**
EN-89A	CFC Area	21	-	128	7.8	0.23	0.16	70%	-
EN-612 (S-9A)	Waste Solvent Area	7.1	0.19	130	6.0	0.21	0.13	58%	-
EN-612 (S-10)	Waste Solvent Area	8.0	0.004	130	7.0	0.21	0.15	68%	-
EN-612 (S-11)	Waste Solvent Area	10	0.074	130	9.0	0.21	0.19	88%	-
EN-612 (S-12)	Waste Solvent Area	16	0.028	130	5.0	0.21	0.10	49%	0.48
EN-614 (S-10)	Waste Solvent Area	13	0.033	130	7.0	0.21	0.15	68%	-
EN-614 (S-11)	Waste Solvent Area	15	0.041	130	6.0	0.21	0.13	58%	-
EN-614 (S-12)	Waste Solvent Area	17	0.026	130	9.0	0.21	0.19	88%	-
EN-616 (S-9A)	Waste Solvent Area	43	-	126	12	0.24	0.24	100%	-
EN-616 (S-10)	Waste Solvent Area	19	0.013	128	8.0	0.23	0.16	73%	-
EN-616 (S-11)	Waste Solvent Area	20	0.012	128	11	0.23	0.23	100%	-
B57-42		5.4	0.85	128	7.8	0.23	0.16	70%	-
B57-43		10	0.075	128	7.8	0.23	0.16	70%	-
B57-44		11	0.050	128	7.8	0.23	0.16	70%	-
B57-45		9.00	0.15	128	7.8	0.23	0.16	70%	-
B57-46		9.00	1.2	128	7.8	0.23	0.16	70%	-
B57-49	Waste Solvent Area	4.60	2.0	128	7.8	0.23	0.16	70%	-
B57-50	Waste Solvent Area	5.00	0.30	128	7.8	0.23	0.16	70%	-
Statistics									
Mean		13	0.31	129	7.9	0.22	0.16	73%	N/A
Maximum		43	2.0	130	12	0.24	0.24	100%	N/A
Minimum		4.6	0.0041	126	5.0	0.21	0.10	49%	N/A
Mode		10	N/A	128	7.8	0.23	0.16	70%	N/A
Median		10	0.062	128	7.8	0.23	0.16	70%	N/A
Sand	**Source Area**	**< #200 %**	**d_{10}**	**γ_{dry}**	**Wg**	**φ**	**θ_w**	**S_w %**	**TOC %**
EN-616 (S-12)	Waste Solvent Area	16	0.049	99.5	25	0.40	0.40	100%	-
EN-616 (S-13)	Waste Solvent Area	27	0.016	106	21	0.36	0.36	100%	-
EN-670	B57A Area	33	0.0060	131	9.9	0.21	0.21	100%	-
Statistics									
Mean		21	0.033	103	23	0.38	0.38	100%	N/A
Maximum		27	0.049	106	25	0.40	0.40	100%	N/A
Minimum		16	0.016	99.5	21	0.36	0.36	100%	N/A
Mode		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Median		21	0.033	103	23	0.38	0.38	100%	N/A
Till	**Source Area**	**< #200 %**	**d_{10}**	**γ_{dry}**	**Wg**	**φ**	**θ_w**	**S_w %**	**TOC %**
EN-662	CFC Area	32	0.0030	123	13	0.25	0.25	100%	0.13
EN-668	B57A Area	25	0.0051	130	10	0.21	0.21	100%	0.14
EN-610 (S-10A)	TCA Area	37	0.0038	130	5.0	0.21	0.10	49%	-
EN-610 (S-11)	TCA Area	26	0.0050	130	5.0	0.21	0.10	49%	-
EN-614 (S-13)	Waste Solvent Area	15	0.022	130	5.0	0.21	0.10	49%	-
EN-614 (S-15)	Waste Solvent Area	12	0.030	130	5.0	0.21	0.10	49%	-
B57-47		20	0.0026	130	5.0	0.21	0.10	49%	-
Statistics									
Mean		24	0.010	129	6.9	0.22	0.14	63%	0.14
Maximum		37	0.030	130	13	0.25	0.25	100%	0.14
Minimum		12	0.0026	123	5.0	0.21	0.10	49%	0.13
Mode		N/A	N/A	130	5.0	0.21	0.10	49%	N/A
Median		25	0.0050	130	5.0	0.21	0.10	49%	0.14

Note: Empty Source Area cells indicate that the sampling location was not within a specific source area (See Figure L.1 for locations).

Table D.2
Soil Properties
Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

Source Area	B57 Area					CFC Area				
Sample Collection Year	2008	2007	2007	2007	2007	2008	2007	2007	<2005	<2005
Location I.D.	EN-669	B+29,17+8	C+2,18+7	B+29,17+8	EN-663	EN-660	C+30,32+19	EN-662	EN-89A	EN-89A
Sample I.D.	S-2	S-3A	S-3A	S-3B	S-3B	S-4A	S-4	S-5	6?	7?
Depth (Top/Bottom, ft bgs)	2 4	8 8.6	8 9.5	8.6 10	9 10	7 7.7	7.5 9.5	8 10	11.5 12	12 13
Soil Stratum Designation	FILL (subslab)	FILL (subslab)	FILL (subslab)	SILT & CLAY	SILT & CLAY	FILL (subslab)	FILL (subslab)	SILT & CLAY	SILT & CLAY	SAND & GRAVEL
Modified Burmister Classification	Hard, dark grayish brown, SAND, some Silt, some Gravel	Brown-gray, Sand, some Gravel, some Silt	Gray, GRAVEL, some Sand, some Silt	Gray, SILT & CLAY, trace Sand	Gray, SILT & CLAY, trace Sand	Loose, black, SAND, some Silt, some Gravel (sub-rounded to angular)	Medium dense, dark gray, GRAVEL, some Silt, little Sand	Stiff, gray, CLAY & SILT, trace Sand	Dense, gray, SILT, some Gravel, some Sand.	Loose, gray, GRAVEL, some Sand, some Silt.
Other Comments	trace Wood	-	-	-	-	trace Cinders	-	-	-	-
Upper/Lower Water Bearing Zone or Aquitard	UWBZ	UWBZ	UWBZ	Aquitard	Aquitard	UWBZ	UWBZ	Aquitard	Aquitard	LWBZ
Moisture Description	Moist	Wet	Wet	Moist	Wet	Moist	Wet	Moist	Wet	Wet
% Solids	87.1	87.5	88.8	76.1	80.1	89.1	85.3	71.1	92.25	92.25

Soil Physical Properties Laboratory Analytical Data

Fraction	Seive Size / Particle Size (mm)	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer
Gravel Fraction	2"/50.8		100		100		100		100		100		100		100		100		-		-
	1.5"/38.1		100		100		100		100		100		100		100		100		-		-
	1"/25.4		100		100		100		100		100		100		100		100		-		-
	3/4"/19.00		100		100		100		100		100		100		100		100		-		-
	1/2"/12.70	28.5	95	32.8	100	38.7	85	0.0	100	0.0	100	28.4	91	57.0	83	0.0	100	33.6	-	52.7	-
	3/8"/9.51		84		78		72		100		100		84		62		100		-		-
Sand Fraction	#4/4.75		72		67		61		100		100		72		43		100		66.4		47.3
	#10/2.00		56		51		50		100		100		62		37		100				
	#20/0.84	39.8	45	40.7	40	32.6	41	5.8	100	3.4	99	37.9	54	18.7	32	2.9	99	29.8	51.9	26.0	31
	#40/0.42		44		35		36		100		99		48		29		98				
	#60/0.25		36		32		33		100		98		43		28		98				
	#100/0.15		34		29		31		99		98		38		26		98		36.6		21.3
Silt/Clay Fraction	#200/0.074	31.7	32	26.5	27	28.7	29	94.2	94	96.6	97	33.7	34	24.3	24	97.1	97	36.6	33.8	21.3	19.4

D_{10} (mm)	0.0054	0.0054	0.0054	-	-	0.0048	0.0075	-	-	-
D_{50} (mm)	1.25	1.85	2.02	0.02	0.01	0.56	6.09	0.01	0.72	5.66
Wg (%)	12.9	12.5	11.2	23.9	19.9	10.9	14.7	28.9	7.75	7.75
Total Organic Carbon (TOC, mg/Kg)	2610	6,340	2,020	7,220	5,050	-	70,100	12,200	-	-
TOC %	0.26	0.63	0.20	0.72	0.51	-	7.01	1.22	-	-
Diesel-range Organics (DRO, µg/Kg)	-	-	< 49,000	-	< 50,000	< 47,000	< 47,000	-	-	-
Gasoline-range Organics (GRO, µg/Kg)	-	-	< 61	-	< 62	780	780	-	-	-

Assumed / Estimated Soil Properties

Bulk Density γ_{dry} (lb./ft³)	119.0	124.3	127.6	101.3	108.3	119.0	119.0	93.7	128.0	128.0
Specific Gravity G_s	**2.63**	2.65	2.65	2.65	2.65	**2.50**	2.65	2.65	2.65	2.65
Air-filled Porosity Φ (fraction)	0.28	0.25	0.23	0.39	0.35	0.24	0.28	0.43	0.23	0.23
Water-filled Porosity θ_w (fraction)	0.25	0.25	0.23	0.39	0.35	0.21	0.28	0.43	0.16	0.16
Saturation S_w (%)	89.4%	100%	100%	100%	100%	87.6%	100%	100%	70.2%	70.2%

Table D.2
Soil Properties
Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

Source Area		Freon Area		B57A Area												TCA Area					
Sample Collection Year		2007		2007		2007		2007		2007		2008		2007		2007		2008		2007	
Location I.D.		EN-662		B+28,41+2		EN-666		EN-666		EN-668		EN-670		EN-668		C+15,42+12		C+30,41+8		C+30,41+32	
Sample I.D.		S-8		S-5		S-4		S-7		S-6		S-11		S-10		S-3		S-3		S-4C	
Depth (Top/Bottom, ft bgs)		17	17.9	9	11	7	9	13.5	15.5	12.5	14.5	18	20	22	22.6	5		6	6.5	8.5	11
Soil Stratum Designation		TILL		FILL (subslab)		FILL (subslab)		SILT & CLAY		SILT & CLAY		Clayey SAND		TILL		FILL (Exterior)		FILL (Exterior)		SILT & CLAY	
Modified Burmister Classification		Very dense, gray, GRAVEL (fractured shale), some Silt, some Sand.		Very stiff, brown-gray, SILT & CLAY, some Gravel (shale frags), some Sand.		Medium dense, brown, GRAVEL, some Sand, trace Silt		Very stiff, gray, SILT & CLAY, little Sand		Stiff/very stiff, yellow, CLAY & SILT, trace Sand		Hard, olive, SAND, some Silt, some Gravel		Very dense, gray, GRAVEL (Shale fragments), some Sand, some Silt		Brown, GRAVEL, some Sand, little Silt.		Brown, GRAVEL and Sand, some Silt		Olive, CLAY & SILT, trace Sand	
Other Comments		-		Petroleum Odor		Petroleum odor in S-5 and S-6 (9-13ft)		Petroleum odor in S6 (11-13ft)		-				-		trace Wood		-		-	
Upper/Lower Water Bearing Zone or Aquitard		LWBZ		UWBZ		UWBZ		Aquitard		Aquitard		LWBZ		LWBZ		UWBZ		UWBZ		Aquitard	
Moisture Description		Wet		Wet		Wet		Wet		Wet		Moist		Wet		Moist		Moist		Moist	
% Solids		87.1		86.8		87.1		79.9		82		90.1		89.8		87.7		84.7		67	
Soil Physical Properties Laboratory Analytical Data																					
Seive Size / Particle Size (mm)		% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer
Gravel Fraction	2"/50.8		100		100		100		100		100		100		100		100		100		100
	1.5"/38.1		100		100		100		100		100		100		100		100		100		100
	1"/25.4		89		100		85		100		100		100		83		100		100		100
	3/4"/19.00		89		100		75		100		100		100		77		84		93		100
	1/2"/12.70	42.9	71	32.9	84	70.9	41	0.0	100	0.0	100	31.4	76	48.4	63	51.7	69	38.6	81	0.0	100
	3/8"/9.51		65		76		-		100		100		73		61		60		72		100
Sand Fraction	#4/4.75		57		67		29		100		100		69		52		48		61		100
	#10/2.00		49		58		15		100		100		57		41		43		55		100
	#20/0.84	25.0	42	31.0	52	24.3	11	13.2	100	8.4	100	35.2	47	26.6	33	33.1	39	37.6	51	4.9	99
	#40/0.42		38		48		9		100		100		41		29		31		44		98
	#60/0.25		36		45		7		99		99		38		27		23		33		98
	#100/0.15		34		41		6		96		99		36		26		18		27		97
Silt/Clay Fraction	#200/0.074	32.1	32	36.1	36	4.8	5	86.8	87	91.6	92	33.4	33	25.0	25	15.2	15	23.8	24	95.1	95
D_{10} (mm)		0.003		0.0041		0.6084		0.0007		0.0006		0.006		0.0051		0.0178		0.0057		0.0009	
D_{50} (mm)		2.24		0.63		14.10		0.02		0.02		1.12		4.14		5.24		0.77		0.01	
Wg (%)		12.9		13.2		12.9		20.1		18		9.9		10.2		12.3		15.3		33	
Total Organic Carbon (TOC, mg/Kg)		1,270		-		6,260		11,300		929		-		1,440		15,000		-		24,600	
TOC %		0.13		-		0.63		1.13		0.09		-		0.14		1.50		-		2.46	
Diesel-range Organics (DRO, µg/Kg)		<	46,000	-		<	1,800,000		8,900,000	<	49,000	-		-			160,000	-		-	
Gasoline-range Organics (GRO, µg/Kg)		<	57	-		<	51,000		140,000	<	61	-		-		<	57	-		-	
Assumed / Estimated Soil Properties																					
Bulk Density γ_{dry} (lb./ft³)		123.3		122.6		123.3		107.9		112.0		130.7		130.2		117.0		110.0		88.2	
Specific Gravity G_s		2.65		2.65		2.65		2.65		2.65		**2.64**		2.65		2.65		**2.65**		2.65	
Air-filled Porosity Φ (fraction)		0.25		0.26		0.25		0.35		0.32		0.21		0.21		0.29		0.34		0.47	
Water-filled Porosity θ_w (fraction)		0.25		0.26		0.25		0.35		0.32		0.21		0.21		0.23		0.27		0.47	
Saturation S_w (%)		100%		100%		100%		100%		100%		100%		100%		78.8%		80%		100%	

Table D.2
Soil Properties
Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

Source Area		TCA Area						Waste Solvent Area													
Sample Collection Year		2006		2006		2006		2007		2007		2005		2007		2006		2006		2006	
Location I.D.		EN-610		EN-610		EN-610		B+30,45+20		B+40,45+12		B57-49		B+40,45+12		EN-612		EN-612		EN-612	
Sample I.D.		B-106, S-9		B-106, S-10A		B-106,S-11		S-3		S-2		S-2B		S-3B		B107D,S-9A		B107D,S-10		B107D,S-11	
Depth (Top/Bottom, ft bgs)		16	18	18.2	19.4	20	21.3	4	5	4	-	7	8	9	11	17	18	18	20	20	22
Soil Stratum Designation		SAND & GRAVEL (gravel w/silt and clay intrusion)		TILL		TILL		FILL (Exterior)		FILL (Exterior)		FILL (Exterior)		SILT & CLAY		SAND & GRAVEL		SAND & GRAVEL		SAND & GRAVEL	
Modified Burmister Classification		Medium stiff/stiff, yellow brown, CLAY & SILT, and Gravel, little Sand		Hard, gray, Clayey SILT, some Sand, some Gravel (fractured shale)		Very dense, gray, GRAVEL (fractured shale), some Sand, some Silt		Brown, SILT & CLAY, some Gravel, little Sand		Brown, GRAVEL, some Sand, trace Silt		Dark brown, GRAVEL and f-c SAND, trace Silt.		Olive, CLAY & SILT, trace Gravel, trace Sand		Medium dense, brown, GRAVEL, some Sand, trace Silt		Loose, Olive, GRAVEL, little Sand, trace Silt		Medium dense, gray, GRAVEL, some Sand, little Silt	
Other Comments		-		-		-		-		-		-		-		-		-		-	
Upper/Lower Water Bearing Zone or Aquitard		LWBZ		LWBZ		LWBZ		UWBZ		UWBZ		UWBZ		Aquitard		LWBZ		LWBZ		LWBZ	
Moisture Description		Moist		Moist		Moist		Moist		Moist		Moist		Wet		Moist		Moist		Wet	
% Solids				95		95		87.1		93.2		87.1		76.6		94		93		91	
Soil Physical Properties Laboratory Analytical Data																					
Seive Size / Particle Size (mm)		% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer
Gravel Fraction	2"/50.8		100		100		100		100		100		100		100		100		100		100
	1.5"/38.1		100		100		100		97		92		100		100		100		100		100
	1"/25.4		100		100		59		91		76		100		100		43		44		100
	3/4"/19.00		80		73		59		85		64		82.9		100		43		44		100
	1/2"/12.70	38.5	72	34.5	73	48.8	59	30.9	80	64.5	51	48.2	74.3	4.4	100	58.3	43	74.8	34	59.5	71
	3/8"/9.51		68		71		59		75		42		66		100		43		29		58
Sand Fraction	#4/4.75		61		65		51		69		35		51.8		96		42		25		40
	#10/2.00		55		54		41		65		30		22.6		95		34		20		28
	#20/0.84	18.7	52	28.7	46	25.2	35	20.5	63	30.8	24	42.6	20.1	3.6	95	34.6	24	17.2	17	30.5	20
	#40/0.42		49		42		31		58		12		16.3		95		15		12		16
	#60/0.25		48		40		29		54		7		12.7		94		11		10		14
	#100/0.15		47		39		28		52		5		10.9		94		9		9		12
Silt/Clay Fraction	#200/0.074	42.8	43	36.8	37	26.0	26	48.6	49	4.7	5	9.2	9.2	92.0	92	7.1	7	8.0	8	10.0	10
D_{10} (mm)		0.0008		0.0038		0.005		0.0008		0.3456		0.1		0.0013		0.1897		0.0041		0.0744	
D_{50} (mm)		0.48		1.25		4.27		0.10		12.23		3.50		0.01		26.90		26.74		6.96	
Wg (%)				5		5		12.9		6.8		12.9		23.4		6		7		9	
Total Organic Carbon (TOC, mg/Kg)		-		-		-		-		1,900		-		19,700		-		-		-	
TOC %		-		-		-		-		0.19		-		1.97		-		-		-	
Diesel-range Organics (DRO, µg/Kg)		-		-		-		-		-		-		-		-		-		-	
Gasoline-range Organics (GRO, µg/Kg)		-		-		-		-		-		-		-		-		-		-	
Assumed / Estimated Soil Properties																					
Bulk Density γ_{dry} (lb./ft^3)		120.0		130.0		130.0		115.0		123.3		115.0		102.1		130.0		130.0		130.0	
Specific Gravity G_s		2.65		2.65		2.65		2.65		2.65		2.65		2.65		2.65		2.65		2.65	
Air-filled Porosity Φ (fraction)		0.27		0.21		0.21		0.30		0.25		0.30		0.38		0.21		0.21		0.21	
Water-filled Porosity θ_w (fraction)				0.10		0.10		0.24		0.13		0.24		0.38		0.13		0.15		0.19	
Saturation S_w (%)				48.6%		48.6%		78.0%		52.8%		78.0%		100%		58.4%		68.1%		87.5%	

Table D.2
Soil Properties
Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

	Source Area	Waste Solvent Area																			
	Sample Collection Year	2006		2006		2006		2006		2005		2005		2006		2005		2005		2006	
	Location I.D.	EN-612		EN-614		EN-614		EN-614		B57-49		B57-50		EN-616		EN-616		EN-616		EN-616	
	Sample I.D.	B107D,S-12		B108D,S-10		B108D,S-11		B108D,S-12		S-6		S-6A		B109D,S-9A		B109D,S-10		B109D,S-11		B109D,S-12	
	Depth (Top/Bottom, ft bgs)	22	24	20	22	22	24	24	24.7	20	24	20	23	18	19	19	21	21	23	23	25
	Soil Stratum Designation	SAND & GRAVEL		SAND & GRAVEL		SAND & GRAVEL		SAND & GRAVEL		SAND & GRAVEL		SAND & GRAVEL		SAND & GRAVEL (gravel w/silt and clay intrusion)		SAND & GRAVEL		SAND & GRAVEL		SAND	
	Modified Burmister Classification	Dense, gray, GRAVEL and Sand, little Silt		Medium dense, gray, GRAVEL, some Sand, little Silt		Dense, gray, SAND and Gravel, little Silt		Very dense, gray, SAND, some Gravel, little Silt		Brown, GRAVEL, some f-c Sand, trace Silt.		Gray, GRAVEL and f-c SAND, trace Silt.		Medium dense, gray, GRAVEL and Silt & Clay, little Sand.		Medium dense, gray, GRAVEL, some Sand, little Clayey Silt.		Loose, gray, SAND, some Gravel, little Silt & Clay.		Loose, red brown, f-m SAND, little Silt.	
	Other Comments	-		-		-		-		-		-		-		-		-		-	
	Upper/Lower Water Bearing Zone or Aquitard	LWBZ		LWBZ		LWBZ		LWBZ		LWBZ		LWBZ		LWBZ		LWBZ		LWBZ		LWBZ	
	Moisture Description	Moist		Moist		Moist		Moist		Wet		Wet		Wet		Wet		Wet		Wet	
	% Solids	95		93		94		91		92.25		92.25		88		92		89		75	
	Soil Physical Properties Laboratory Analytical Data																				
	Seive Size / Particle Size (mm)	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer
Gravel Fraction	2"/50.8		100		100		100		100		100		100		100		100		100		100
	1.5"/38.1		100		100		100		100		100		100		100		100		100		100
	1"/25.4		100		100		100		100		100		100		100		100		100		100
	3/4"/19.00		100		100		100		100		63.6		60.8		100		81		100		100
	1/2"/12.70	47.0	86	60.8	73	41.9	84	24.7	100	62.9	51.9	57.0	53	46.2	81	50.9	66	30.3	88	0.0	100
	3/8"/9.51		73		58		77		92		47				62		58		88		100
Sand Fraction	#4/4.75		53		39		58		75		37.1		43		54		49		70		100
	#10/2.00		40		29		43		52		10.4		14		50		38		52		98
	#20/0.84	37.5	33	26.0	23	43.3	34	58.5	40	32.5	8.9	38.0	11.8	11.0	49	29.8	32	49.4	41	84.2	83
	#40/0.42		29		20		29		35		7.5		11		48		28		34		66
	#60/0.25		25		18		25		29		6.2		9.2		48		25		28		54
	#100/0.15		19		16		19		21		5.3		6.5		46		22		24		35
Silt/Clay Fraction	#200/0.074	15.5	16	13.2	13	14.8	15	16.8	17	4.6	4.6	5.0	5	42.8	43	19.3	19	20.3	20	15.8	16
	D_{10} (mm)	0.0275		0.0334		0.0405		0.0263		2		0.3		-		0.0133		0.0115		0.0494	
	D_{50} (mm)	3.89		7.09		2.98		1.70		10.30		9.00		1.67		5.10		1.71		0.23	
	Wg (%)	5		7		6		9		7.75		7.75		12		8		11		25	
	Total Organic Carbon (TOC, mg/Kg)	4,820		-		-		-		-		-		-		-		-		-	
	TOC %	0.48		-		-		-		-		-		-		-		-		-	
	Diesel-range Organics (DRO, µg/Kg)	-		-		-		-		-		-		-		-		-		-	
	Gasoline-range Organics (GRO, µg/Kg)	-		-		-		-		-		-		-		-		-		-	
	Assumed / Estimated Soil Properties																				
	Bulk Density γ_{dry} (lb./ft³)	130.0		130.0		130.0		130.0		128.0		128.0		125.5		128.0		128.1		99.5	
	Specific Gravity G_s	2.65		2.65		2.65		2.65		2.65		2.65		2.65		2.65		2.65		2.65	
	Air-filled Porosity Φ (fraction)	0.21		0.21		0.21		0.21		0.23		0.23		0.24		0.23		0.23		0.40	
	Water-filled Porosity θ_w (fraction)	0.10		0.15		0.13		0.19		0.16		0.16		0.24		0.16		0.23		0.40	
	Saturation S_w (%)	48.6%		68.1%		58.4%		87.5%		70.2%		70.2%		100%		72.5%		100%		100%	

Table D.2
Soil Properties
Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

Source Area	Waste Solvent Area			Outside of Source Areas						
Sample Collection Year	2006	2006	2006	2005	2005	2005	2005	2005	2005	2005
Location I.D.	EN-616	EN-614	EN-614	B57-47	B57-41	B57-48	B57-42	B57-43	B57-44	B57-45
Sample I.D.	B109D,S-13	B108D,S-13	B108D,S-15	S-2A	S-2B	S-2B	S-4A	S-4	S-3C	S-4
Depth (Top/Bottom, ft bgs)	25 25.5	26 27.7	30 31.5	4 5.5	4 5.8	5 7	12 15.5	12 13.3	10.5 12	12 16
Soil Stratum Designation	SAND	TILL	TILL	FILL (Exterior)	SILT & CLAY	SILT & CLAY	SAND & GRAVEL	SAND & GRAVEL	SAND & GRAVEL (listed on log as TILL)	SAND & GRAVEL
Modified Burmister Classification	Dense, tan, SAND, some Silt, trace Gravel.	Very dense, gray, GRAVEL and Sand, little Silt.	Very dense, gray, GRAVEL (fractured shale), little Sand, little Silt.	Dark brown, f-c SAND, little Silt, little Gravel.	Brown, SILT & CLAY, trace m-f Sand. Orange mottling.	Dark brown, Clayey Silt, little f-c Sand.	Gray/brown, GRAVEL, some coarse Sand, trace Silt	Brown, coarse SAND, some Gravel, little Silt	Gray, coarse SAND, some Gravel, little Silt	Dark gray, f-c SAND, some Gravel, trace Silt
Other Comments	-	-	-	-	-	-	-	-	-	Petroleum odor in silt and clay
Upper/Lower Water Bearing Zone or Aquitard	LWBZ	LWBZ	LWBZ	UWBZ	Aquitard	Aquitard	LWBZ	LWBZ	LWBZ	LWBZ
Moisture Description	Wet	Moist	Moist	Wet	Moist	Wet	Wet	Wet	Wet	Wet
% Solids	79	95	95	87.1	75	75	92.25	92.25	92.25	92.25

Soil Physical Properties Laboratory Analytical Data

	Seive Size / Particle Size (mm)	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer	% Grain Size	% Finer
Gravel Fraction	2"/50.8		100		100		100		100		100		100		100		100		100		100
	1.5"/38.1		100		100		100		100		100		100		100		100		100		100
	1"/25.4		100		100		100		100		100		100		78		100		100		100
	3/4"/19.00		100		100		72		100		100		100		63.3		87		85.1		94.3
	1/2"/12.70	6.3	94	47.1	81	69.0	43	19.8	97.4	0.0	100	0.0	100	64.1	45.7	42.7	70.6	41.1	73.4	34.8	84.2
	3/8"/9.51		94		71		39		95.1		100		100		41.3		67.1		66.3		76.2
Sand Fraction	#4/4.75		94		53		31		80.2		100		100		35.9		57.3		56.9		65.2
	#10/2.00		92		34		23		53.1		99.9		97.8		11.1		24.7		25.9		37.2
	#20/0.84	66.6	90	38.1	24	18.9	18	60.2	46.7	8.3	99.7	19.9	94.1	30.5	9.9	47.3	18.5	48.2	19.9	56.2	31.8
	#40/0.42		89		20		15		37.8		99		90.5		8.3		13.2		14.1		22.8
	#60/0.25		88		18		14		29.2		98.1		86.3		6.4		11.5		12.3		14.6
	#100/0.15		75		16		13		24.2		96.6		83		5.9		10.8		11.6		10.7
Silt/Clay Fraction	#200/0.074	27.1	27	14.8	15	12.1	12	20.0	20	91.7	91.7	80.1	80.1	5.4	5.4	10.0	10	10.7	10.7	9.0	9

D_{10} (mm)	0.0162	0.0223	0.03	0.0035	-	-	0.85	0.075	0.05	0.15
D_{50} (mm)	0.10	4.18	14.00	1.60	0.03	0.02	10.50	4.00	6.00	3.00
Wg (%)	21	5	5	12.9	25	25	7.75	7.75	7.75	7.75
Total Organic Carbon (TOC, mg/Kg)	-	-	-	-	-	-	-	-	-	-
TOC %	-	-	-	-	-	-	-	-	-	-
Diesel-range Organics (DRO, µg/Kg)	-	-	-	-	-	-	-	-	-	-
Gasoline-range Organics (GRO, µg/Kg)	-	-	-	-	-	-	-	-	-	-
Assumed / Estimated Soil Properties										
Bulk Density γ_{dry} (lb./ft³)	106.3	130.0	130.0	123.3	99.5	99.5	128.0	128.0	128.0	128.0
Specific Gravity G_s	2.65	2.65	2.65	2.65	2.65	2.65	2.65	2.65	2.65	2.65
Air-filled Porosity Φ (fraction)	0.36	0.21	0.21	0.25	0.40	0.40	0.23	0.23	0.23	0.23
Water-filled Porosity θ_w (fraction)	0.36	0.10	0.10	0.25	0.40	0.40	0.16	0.16	0.16	0.16
Saturation S_w (%)	100%	48.6%	48.6%	100%	100%	100%	70.2%	70.2%	70.2%	70.2%

Table D.2
Soil Properties
Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

Source Area		Outside of Source Areas			
Sample Collection Year		2005		2005	
Location I.D.		B57-46		B57-47	
Sample I.D.		S-3 B		S-4	
Depth (Top/Bottom, ft bgs)		11	12	12	16
Soil Stratum Designation		SAND & GRAVEL		TILL	
Modified Burmister Classification		Olive, f-c SAND, some Gravel, trace Silt		Olive, f-c SAND, some Gravel, little Silts. Sporadic orange mottling.	
Other Comments		-		-	
Upper/Lower Water Bearing Zone or Aquitard		LWBZ		LWBZ	
Moisture Description		Wet		Wet-Moist	
% Solids		92.25		95	
Soil Physical Properties Laboratory Analytical Data					
Seive Size / Particle Size (mm)		% Grain Size	% Finer	% Grain Size	% Finer
Gravel Fraction	2"/50.8		100		100
	1.5"/38.1		100		100
	1"/25.4		100		100
	3/4"/19.00		95.9		100
	1/2"/12.70	46.0	77.5	35.3	82.3
	3/8"/9.51		69.6		77.5
Sand Fraction	#4/4.75		54		64.7
	#10/2.00		19.5		35.3
	#20/0.84	45.0	14.8	44.7	31.5
	#40/0.42		12.2		29.4
	#60/0.25		10.8		28.2
	#100/0.15		9.9		27.1
Silt/Clay Fraction	#200/0.074	9.0	9	20.0	26
D_{10} (mm)		1.15		0.0026	
D_{50} (mm)		3.50		3.10	
Wg (%)		7.75		5	
Total Organic Carbon (TOC, mg/Kg)		-		-	
TOC %		-		-	
Diesel-range Organics (DRO, µg/Kg)		-		-	
Gasoline-range Organics (GRO, µg/Kg)		-		-	
Assumed / Estimated Soil Properties					
Bulk Density γ_{dry} (lb./ft³)		128.0		130.0	
Specific Gravity G_s		2.65		2.65	
Air-filled Porosity Φ (fraction)		0.23		0.21	
Water-filled Porosity θ_w (fraction)		0.16		0.10	
Saturation S_w (%)		70.2%		48.6%	

Notes:

1) D_{10} refers to the soil particle diameter at which 10 percent of the soil sample is finer.

2) Wg (%) refers to gravimetric moisture content.

3) Where modified Burmister soil classification of Fill soil samples included the phrase "Wet," 100 percent saturation is assumed. Aquitard and Lower WBZ strata were assumed to be fully saturated regardless of moisture component of modified Burmister classification. Where this assumption led to unrealistically high calculated bulk density values, saturation values were adjusted to produce bulk density estimates no higher than 130 lb/ft³.

4) Yellow fill indicates estimated values.
- Mean specific gravity is estimated to be 2.65. This is supported by the 2.64 average of laboratory results from samples collected in January 2008 (shown in bold)
- Percent solids estimated from the average of laboratory results from soil samples from the same soil strata located below the UWBZ are outlined below:
  - -SILT & CLAY → 75% Solids
  - -SAND & GRAVEL (GRAVEL, some Sand, Trace Silt)→ 92.25% Solids
  - -TILL → 95% Solids (material is typically poorly sorted, with smaller grains filling in the void spaces between larger grains)

5) Bulk density values for fully-saturated media are calculated, based upon the percent solids data. Bulk density values for partially-saturated media (Fill) are estimated, in order to produce saturation percentages that fall near estimated representative values (~75-80%).

6) Blue fill indicates estimated values of TOC, DRO, GRO. These values are the mean results from neighboring samples within the same soil strata at each location.
- -Value listed for EN666/S-4 is actually value from EN666/S-5
- -Value listed for EN666/S/7 is actually value from EN666/S-6
- -Value listed for EN668/S-6 is actually value from EN668/S-7

7) Soil stratum designations were determined using the modified Burmister soil classification scheme and individual particle size analyses. Samples were further compared with boring logs for verification.

FIGURES

Figure D.1 – Exploration Location Plan

Figure D.2 – Soil Particle Gradation Plots

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Figure D.1

Exploration Location Plan
Appendix D: Soils Laboratory Data and Inference

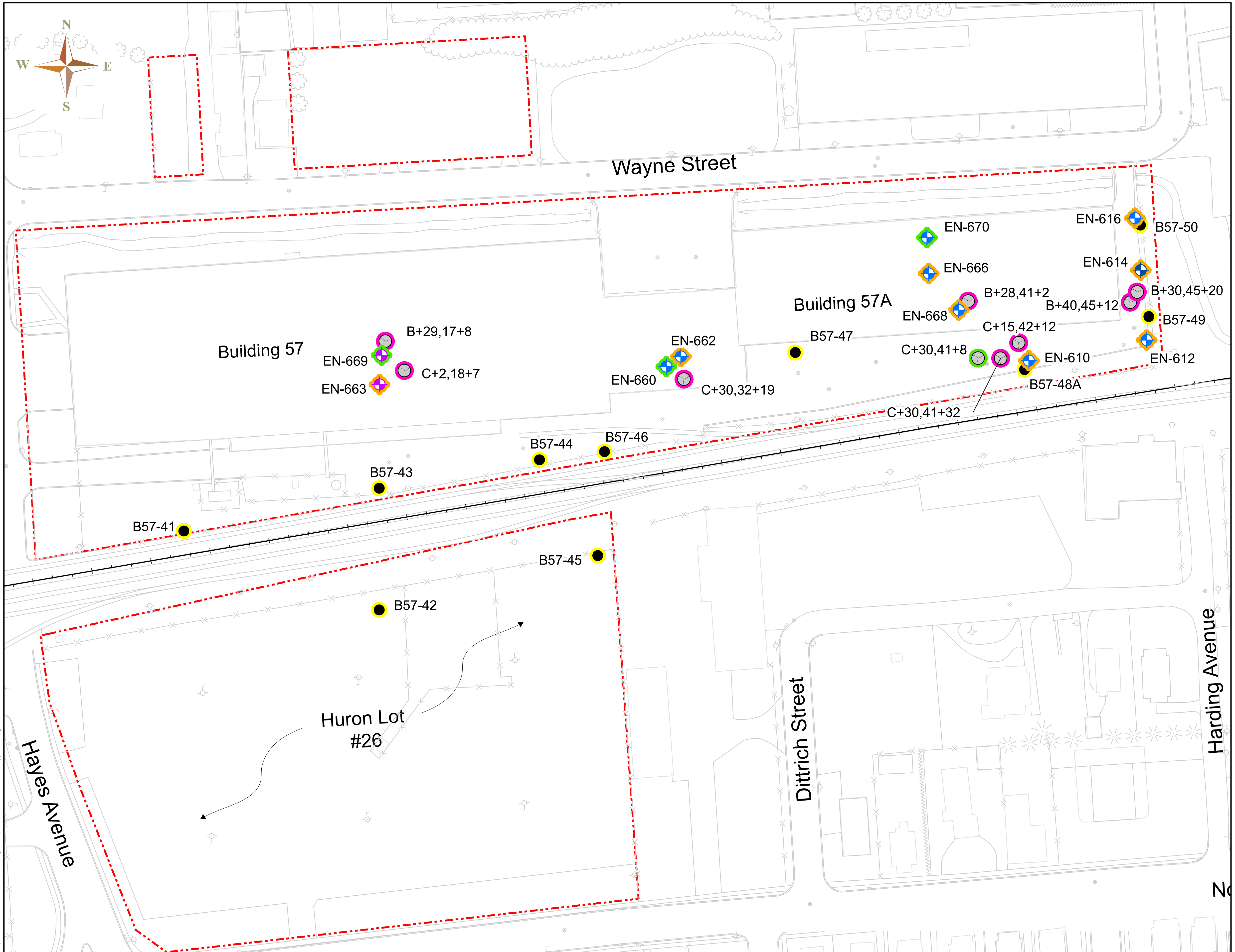
Supplemental Remedial Investigation Report
OU#5/Building 57 Area

Union and Endicott, New York

Drawn By: J. Prellwitz
Designed By: P. Mouser
Reviewed By: D. Carr
Date: March 2010

Figure Narrative:

This figure depicts the locations of explorations from which soil samples were collected and analyzed for soil physical properties.



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S:\PORDATA\2400s\2466.01\Figures\March 2010\SRI\20100311 SRI Appendix D Figure 1 Soil Properties Location Plan.ai

Figure D.2

Soil Particle Gradation Plots
Appendix D: Soils Laboratory Data and Inference

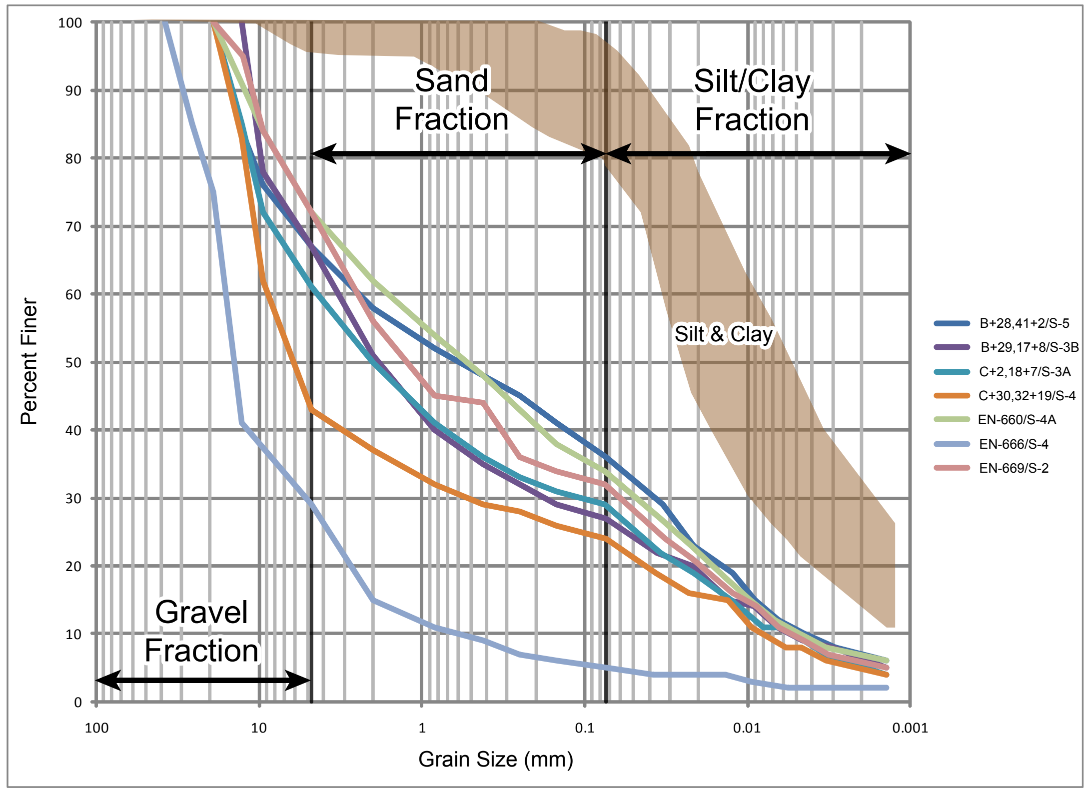
Supplemental Remedial Investigation Report
OU#5/Building 57 Area

Union and Endicott, New York

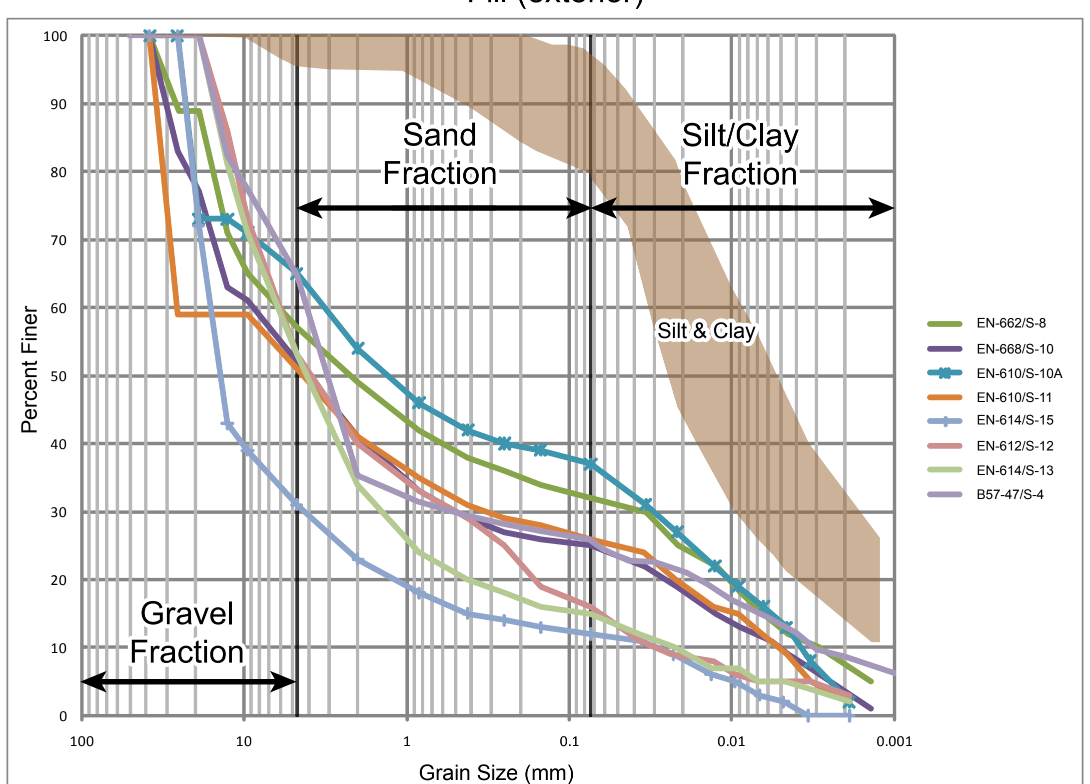
Drawn By: J. Prellwitz
Designed By: P. Mouser
Reviewed By: D. Carr
Date: March 2010

Upper Water Bearing Zone

Fill (beneath the building)

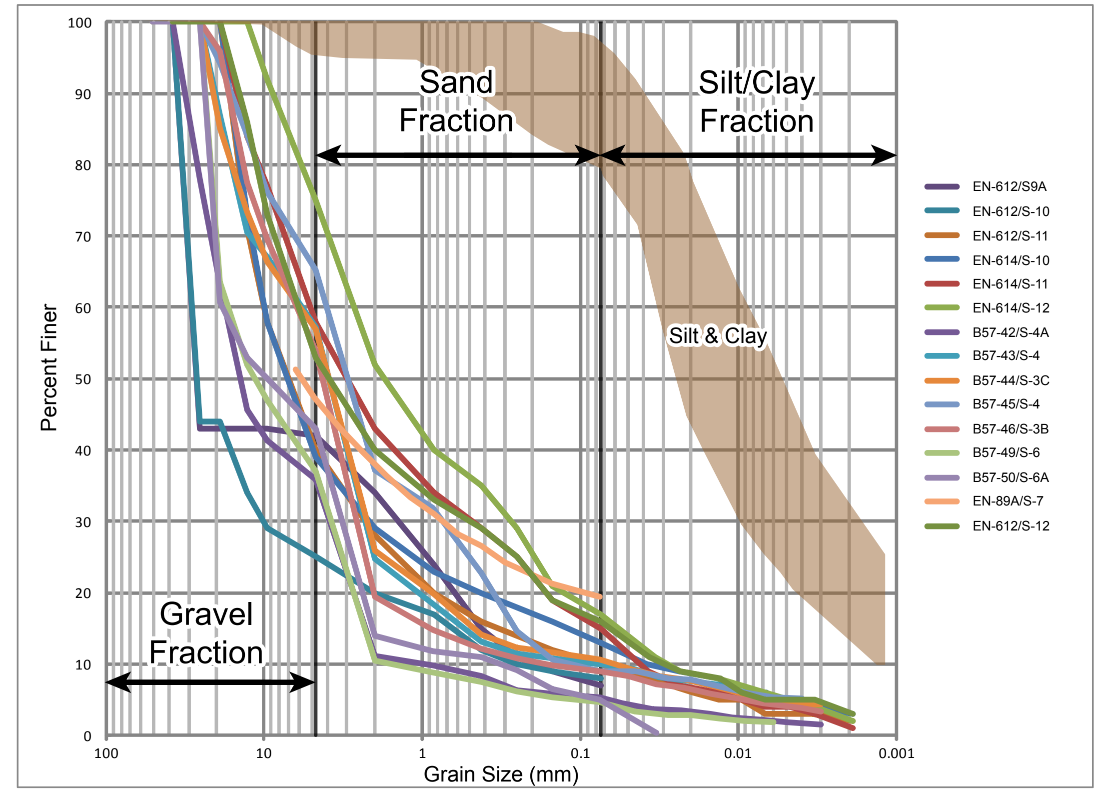


Fill (exterior)



Lower Water Bearing Zone

Sand and Gravel



Till

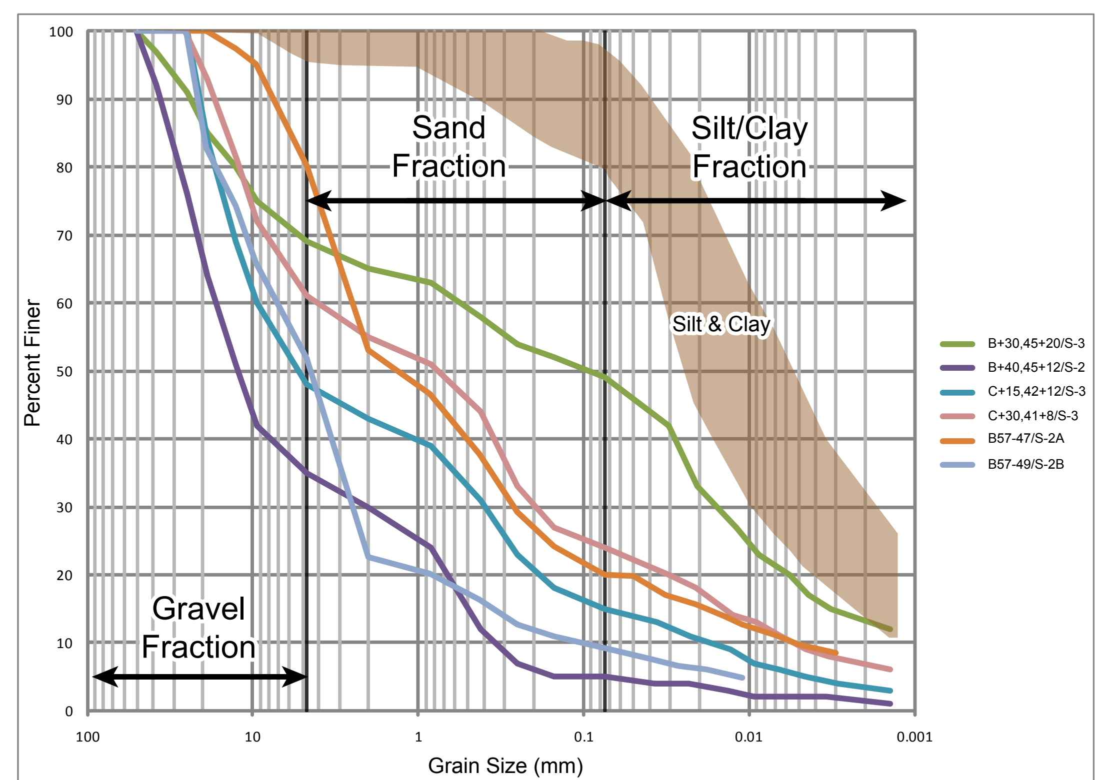


Figure Narrative:

These plots indicate the range of soil particle sizes within each stratum. The site silt and clay aquitard layer is shown in brown for comparison.

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ATTACHMENTS

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ATTACHMENT D.1

Soil Gradation Data
Investigations March 2005

SHPC ENGINEERS

LETTER OF TRANSMITTAL

JGI EASTERN, Inc.
77 Sundial Avenue, Suite 401W
Manchester, NH 03103
(603) 647-9700 (603) 647-4432 Fax
Internet Address: http://www.jgieastern.com

JGI EASTERN, Inc.

RECEIVED
JUN 1 0 2005
SHA

Date:	June 9, 2005
Project:	Sanborn Head & Assoc. Lab Services
	various locations/projects
Project No.:	05321C

Attention: Mr. Tren Hayden
Sent to: Project Geologist
Sanborn, Head & Assoc.
20 Foundry Street
Concord, NH 03301

WE ARE SENDING YOU:

Field work
__ Figures/Drawings
Other: ____

X Lab work
__ Report

Copies	Date	Description
1	5/5/05	Grain Size Distribution Test Reports
		(L233-05-L237-05, L250-05-L256-05)

THESE ARE TRANSMITTED as checked below:

__ For approval
X For your use
__ For review and comment

COPY TO:

Signed: pas

Remarks:

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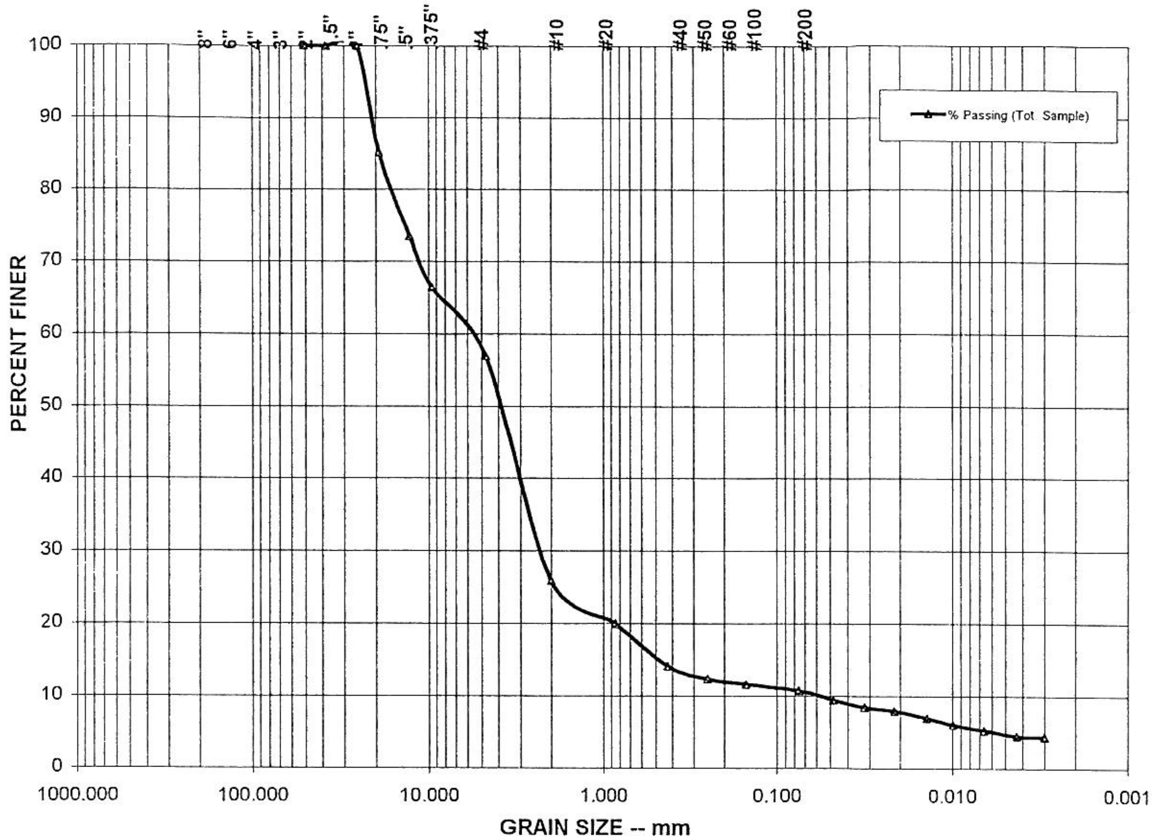
GRAIN SIZE DISTRIBUTION TEST REPORT

ASTM D-422



% Cobbles	% Gravel	Crs	Med	Fine	% Fines	
		67.2	25.6	7.2	Silt (>0.002)	Clay (<0.002)
	16.5	% Sand		46.2	10.7	

Classification: Olive brown coarse to fine SAND, little Gravel, little Silt.

Sieve Size (mm.)	Sieve Size (in./no.)	Cumulative Wt. Retnd	% Passing (Tot. Sample)	% Passing (Sand Port.)	Specification Minimum	Specification Maximum
50.800	2"	0.00	100.0			
38.100	1.5"	0.00	100.0			
25.400	1"	0.00	100.0			
19.050	3/4"	29.64	85.1			
12.700	1/2"	52.98	73.4			
9.525	3/8"	67.11	66.3			
4.750	#4	85.83	56.9			
2.000	#10	108.64	25.9			
0.850	#20	129.48	19.9			
0.425	#40	149.99	14.1			
0.300	#50	149.99				
0.250	#60	156.06	12.3			
0.150	#100	158.61	11.6			
0.075	#200	161.60	10.7			
0.048			9.4			
0.032			8.4			
0.022			7.9			
0.014			6.9			
0.010			6.0			
0.007			5.2			
0.004			4.4			
0.003			4.3			

Total Dry Wt. 199.19
Split Wt. 199.19

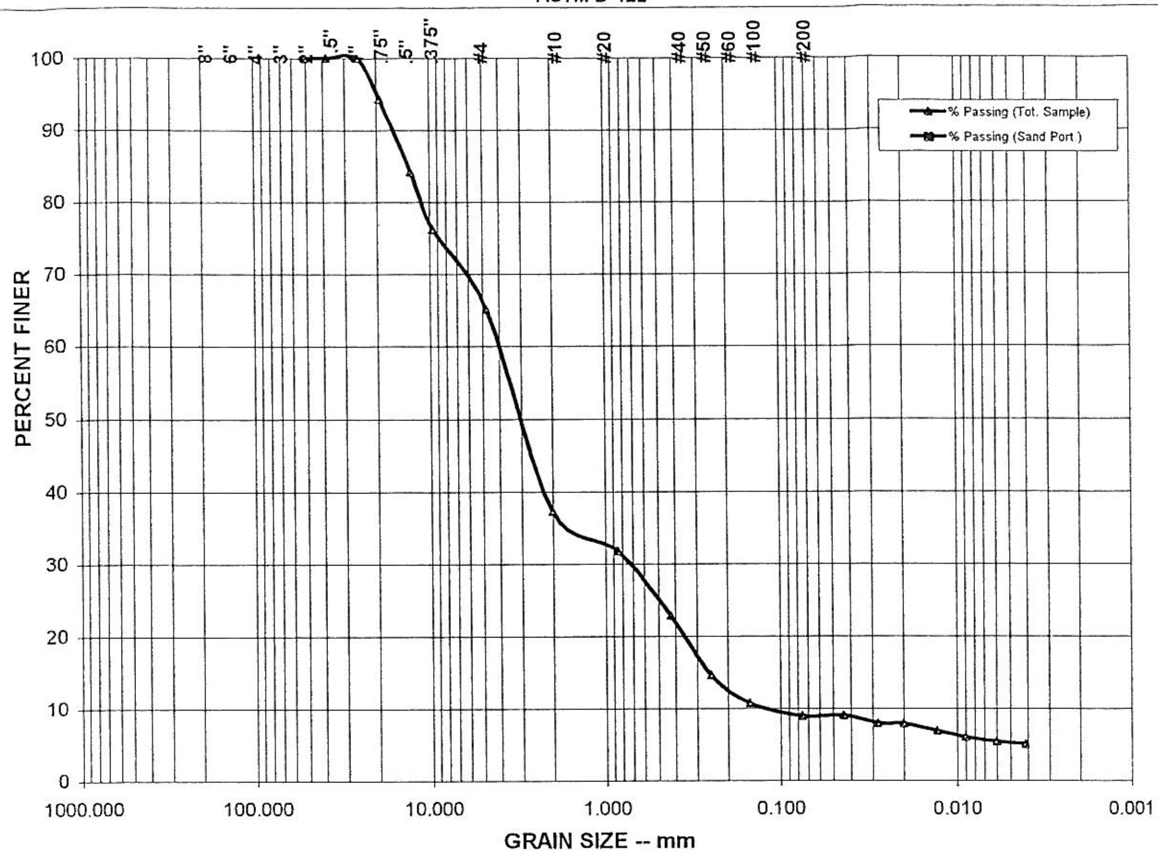
Project: Sanborn, Head,& Assoc. Lab Services	Project No.: **05321C**	Date: **5/5/05**	
	Specification: None Provided	Lab No: **L233-05**	
Source: B57-44/S-3C	Sampled from: Client Supplied		

JGI EASTERN Inc.
Manchester, New Hampshire

Remarks:
Tested By: EMM Reviewed By: wlo Date: 05.17.05

GRAIN SIZE DISTRIBUTION TEST REPORT

ASTM D-422



% Cobbles	% Gravel	Crs	Med	Fine	% Fines	
		49.7	25.6	24.7	Silt (>0.002)	Clay (<0.002)
	19.0		% Sand	56.2	9	

Classification Brown coarse to fine SAND, little Gravel, trace Silt.

Sieve Size (mm.)	Sieve Size (in./no.)	Cumulative Wt. Retnd	% Passing (Tot. Sample)	% Passing (Sand Port.)	Specification Minimum	Specification Maximum
50.800	2"	0.00	100.0			
38.100	1.5"	0.00	100.0			
25.400	1"	0.00	100.0			
19.050	3/4"	8.92	94.3			
12.700	1/2"	24.98	84.2			
9.525	3/8"	37.45	76.2			
4.750	#4	54.91	65.2			
2.000	#10	67.57	37.2			
0.850	#20	80.77	31.8			
0.425	#40	102.41	22.8			
0.300	#50	102.41				
0.250	#60	122.42	14.6			
0.150	#100	131.84	10.7			
0.075	#200	135.97	9.0			
0.044			9.0			
0.028			8.0			
0.020			7.9			
0.013			6.9			
0.009			6.0			
0.006			5.4			
0.004			5.1			

Total Dry Wt. 157.66
Split Wt. 157.66

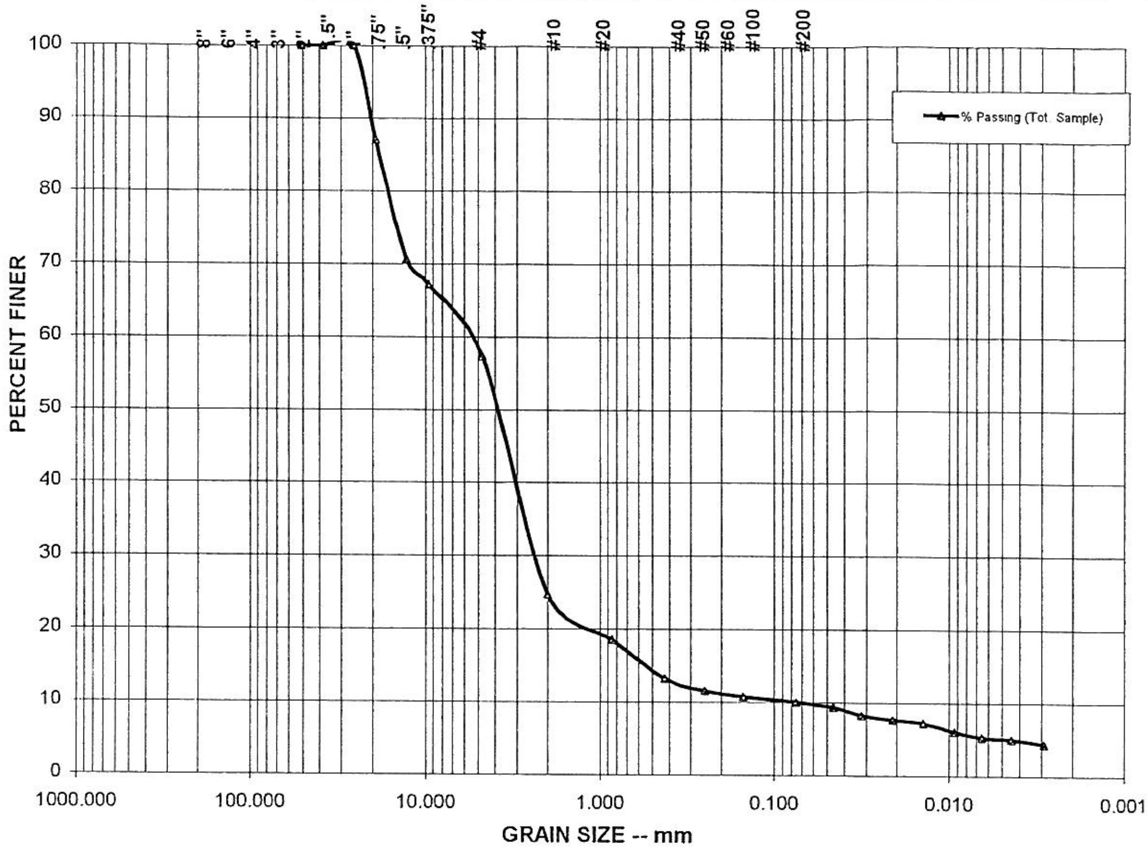
Project: Sanborn, Head,& Assoc. Lab Services	Project No.: **05321C**	Date:	**5/5/05**
	Specification: None Provided	Lab No:	**L234-05**
Source: B57-45/S-4	Sampled from: Client Supplied		

JGI EASTERN Inc.
Manchester, New Hampshire

Remarks:
Tested By: EMM Reviewed By: Nlo Date: 05.17.05

GRAIN SIZE DISTRIBUTION TEST REPORT

ASTM D-422



% Cobbles	% Gravel	Crs	Med	Fine	% Fines	
		68.9	24.4	6.7	Silt (>0.002)	Clay (<0.002)
	13.3	% Sand		47.3	10	

Classification Olive brown coarse to fine SAND, little Gravel, little Silt

Sieve Size (mm.)	Sieve Size (in./no.)	Cumulative Wt. Retnd	% Passing (Tot. Sample)	% Passing (Sand Port.)	Specification Minimum	Specification Maximum
50.800	2"	0.00	100.0			
38.100	1.5"	0.00	100.0			
25.400	1"	0.00	100.0			
19.050	3/4"	26.80	87.0			
12.700	1/2"	60.69	70.6			
9.525	3/8"	67.89	67.1			
4.750	#4	88.14	57.3			
2.000	#10	117.55	24.7			
0.850	#20	139.82	18.5			
0.425	#40	159.08	13.2			
0.300	#50	159.08				
0.250	#60	165.02	11.5			
0.150	#100	167.78	10.8			
0.075	#200	170.55	10.0	17.4		
0.046			9.3			
0.032			8.2			
0.021			7.6			
0.014			7.2			
0.009			6.0			
0.007			5.2			
0.004			5.0			
0.003			4.3			

Total Dry Wt. 206.55
Split Wt. 206.55

Project: Sanborn, Head,& Assoc. Lab Services	Project No.: **05321C**	Date: **5/5/05**	
	Specification: None Provided	Lab No: **L235-05**	
Source: B57-43/S-4	Sampled from: Client Supplied		

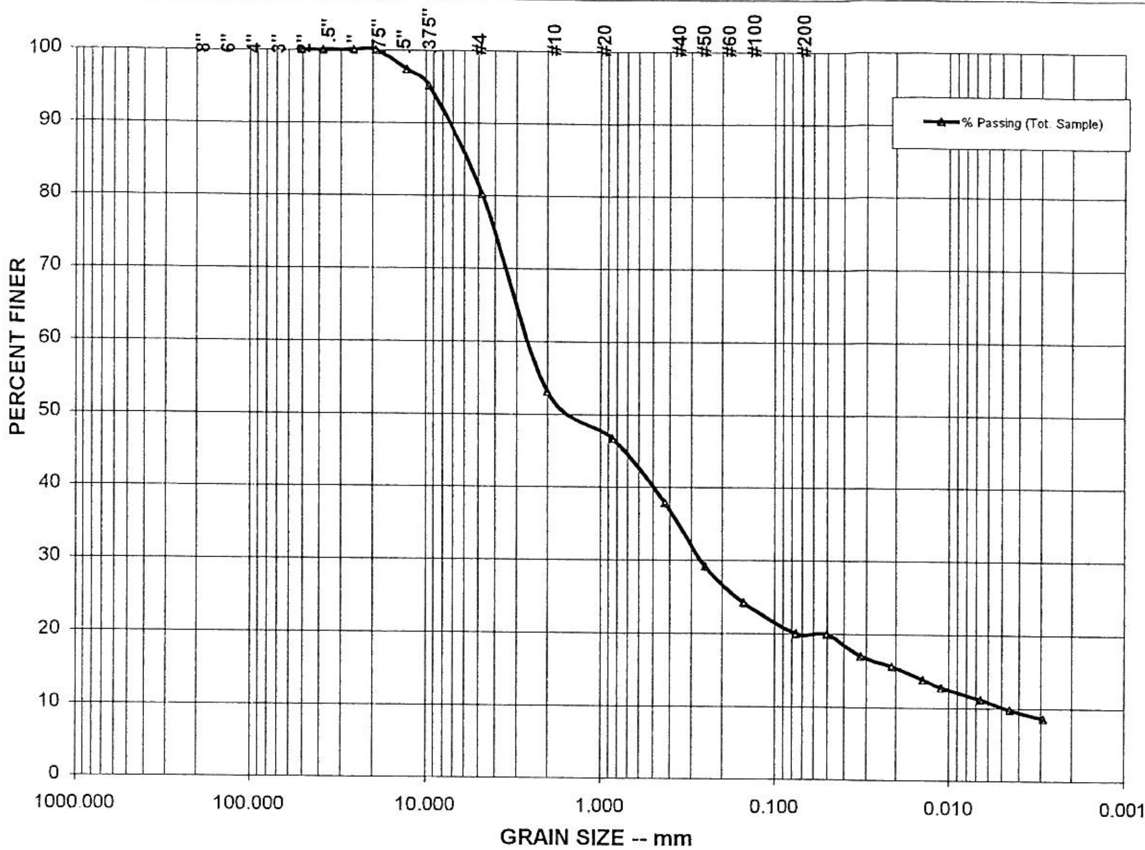
JGI EASTERN Inc.
Manchester, New Hampshire

Remarks:

Tested By: EMM Reviewed By: WHO Date: 05.19.05

GRAIN SIZE DISTRIBUTION TEST REPORT

ASTM D-422



% Cobbles	% Gravel	Crs	Med	Fine	% Fines Silt (>0.002)	Clay (<0.002)
		45.1	25.4	29.5		
	17.2	% Sand		60.1	20	

Classification Olive brown coarse to fine SAND, little Silt, little Gravel.

Sieve Size (mm.)	Sieve Size (in./no.)	Cumulative Wt. Retnd	% Passing (Tot. Sample)	% Passing (Sand Port.)	Specification Minimum	Maximum
50.800	2"	0.00	100.0			
38.100	1.5"	0.00	100.0			
25.400	1"	0.00	100.0			
19.050	3/4"	0.00	100.0			
12.700	1/2"	4.18	97.4			
9.525	3/8"	7.78	95.1			
4.750	#4	31.57	80.2			
2.000	#10	53.86	53.1			
0.850	#20	66.59	46.7			
0.425	#40	84.20	37.8			
0.300	#50	84.20				
0.250	#60	101.31	29.2			
0.150	#100	111.22	24.2			
0.075	#200	119.49	20.0			
0.050			19.9			
0.032			17.0			
0.021			15.6			
0.014			13.9			
0.011			12.7			
0.007			11.2			
0.005			9.7			
0.003			8.6			

Total Dry Wt 159.29
Split Wt. 159.29

Project: Sanborn, Head,& Assoc. Lab Services	Project No.: **05321C**	Date: **5/5/05**	
	Specification: None Provided	Lab No: **L236-05**	
Source: B57-47/S-2A	Sampled from: Client Supplied		

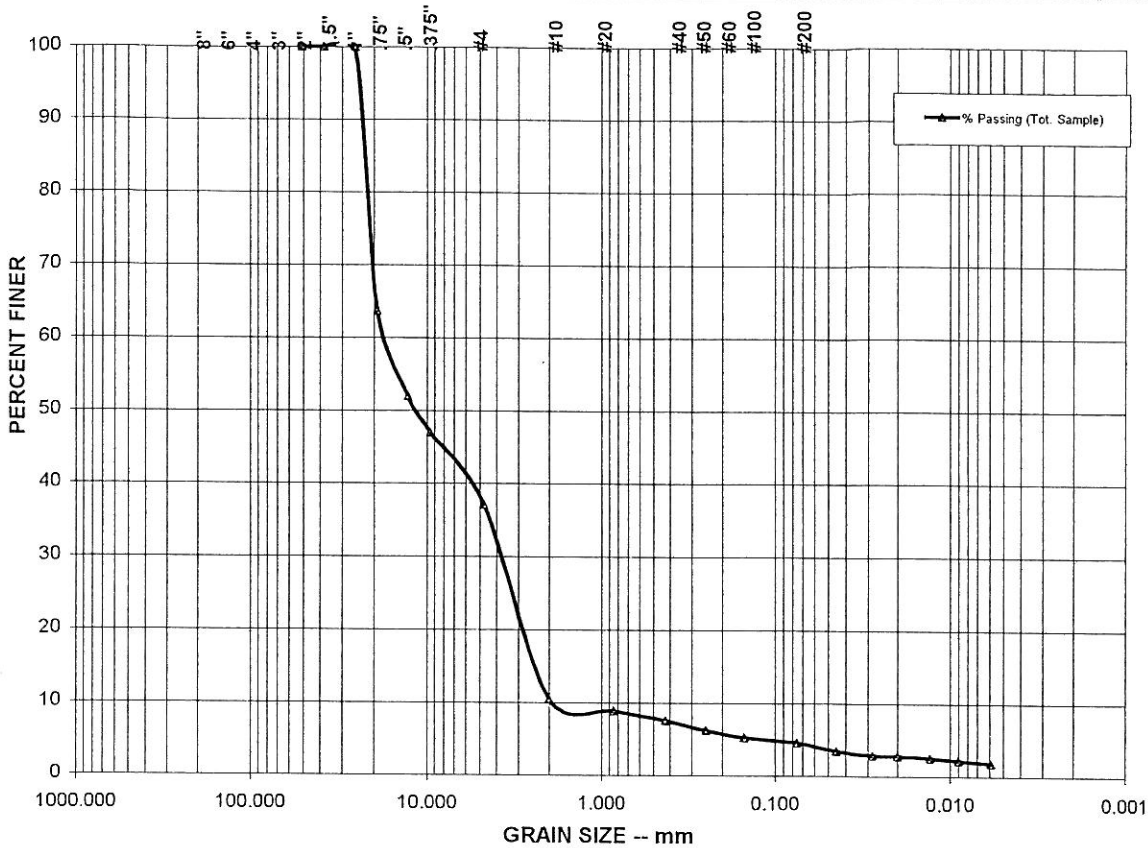
JGI EASTERN Inc.
Manchester, New Hampshire

Remarks:

Tested By: EMM Reviewed By: WLO Date: 05.17.05

GRAIN SIZE DISTRIBUTION TEST REPORT

ASTM D-422



% Cobbles	% Gravel	Crs	Med	Fine	% Fines	
		82.0	8.8	9.2	Silt (>0.002)	Clay (<0.002)
	14.8		% Sand	32.6	4.6	

Classification Dark brown coarse to fine SAND, little Gravel, trace Silt.

Sieve Size (mm.)	Sieve Size (in./no.)	Cumulative Wt. Retnd	% Passing (Tot. Sample)	% Passing (Sand Port.)	Specification Minimum	Maximum
50.800	2"	0.00	100.0			
38.100	1.5"	0.00	100.0			
25.400	1"	0.00	100.0			
19.050	3/4"	90.55	63.6			
12.700	1/2"	119.75	51.9			
9.525	3/8"	132.04	47.0			
4.750	#4	156.57	37.1			
2.000	#10	179.16	10.4			
0.850	#20	189.57	8.9			
0.425	#40	198.46	7.5			
0.300	#50	198.46				
0.250	#60	207.40	6.2			
0.150	#100	213.77	5.3			
0.075	#200	218.54	4.6	12.3		
0.045			3.4			
0.028			2.8			
0.020			2.8			
0.013			2.4			
0.009			2.1			
0.006			1.8			

Total Dry Wt. 249.07
Split Wt. 249.07

Project: Sanborn, Head,& Assoc. Lab Services	Project No.: 05321C	Date: 5/5/05	
	Specification: None Provided	Lab No: L237-05	
Source: B57-49/S-6	Sampled from: Client Supplied		

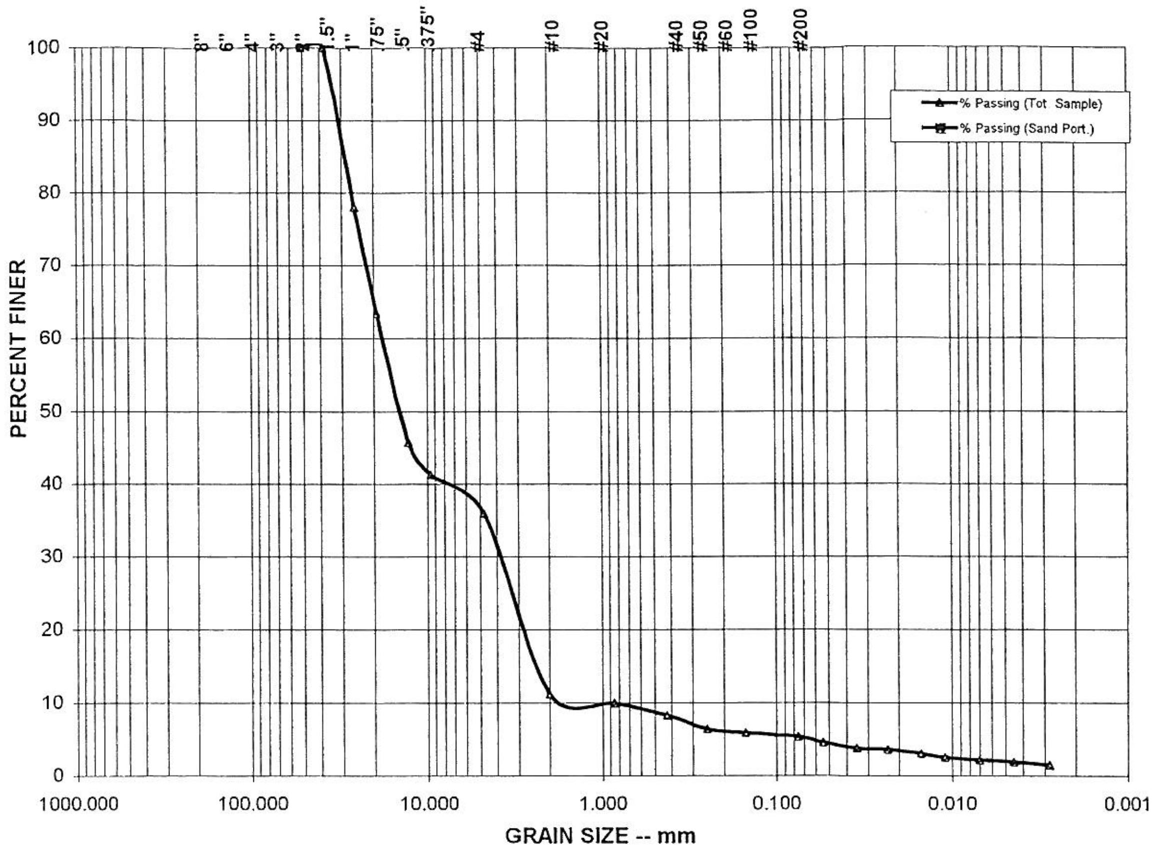
JGI EASTERN Inc.
Manchester, New Hampshire

Remarks:

Tested By: EMM Reviewed By: Wto Date: 05.19.05

GRAIN SIZE DISTRIBUTION TEST REPORT

ASTM D-422



% Cobbles	% Gravel	Crs	Med	Fine	% Fines	
		81.1	9.3	9.5	Silt (>0.002)	Clay (<0.002)
	9.7		% Sand	30.6	5.4	

Classification: Dark brown coarse to fine SAND, trace Gravel, trace Silt.

Sieve Size (mm.)	Sieve Size (in./no.)	Cumulative Wt. Retnd	% Passing (Tot. Sample)	% Passing (Sand Port.)	Specification Minimum	Specification Maximum
50.800	2"	0.00	100.0			
38.100	1.5"	0.00	100.0			
25.400	1"	60.55	78.0			
19.050	3/4"	100.96	63.3			
12.700	1/2"	149.41	45.7			
9.525	3/8"	161.45	41.3			
4.750	#4	176.19	35.9			
2.000	#10	189.96	11.1			
0.850	#20	199.09	9.9			
0.425	#40	211.78	8.3			
0.300	#50	211.78				
0.250	#60	226.11	6.4			
0.150	#100	230.08	5.9			
0.075	#200	234.12	5.4			
0.054			4.5			
0.035			3.7			
0.023			3.5			
0.015			3.0			
0.011			2.5			
0.007			2.2			
0.005			1.8			
0.003			1.5			

Total Dry Wt. 275.06
Split Wt. 275.06

Project: Sanborn, Head,& Assoc. Lab Services	Project No.: **05321C**	Date: **5/5/05**
	Specification: None Provided	Lab No: **L250-05**
Source: B57-42/S-4A	Sampled from: Client Supplied	

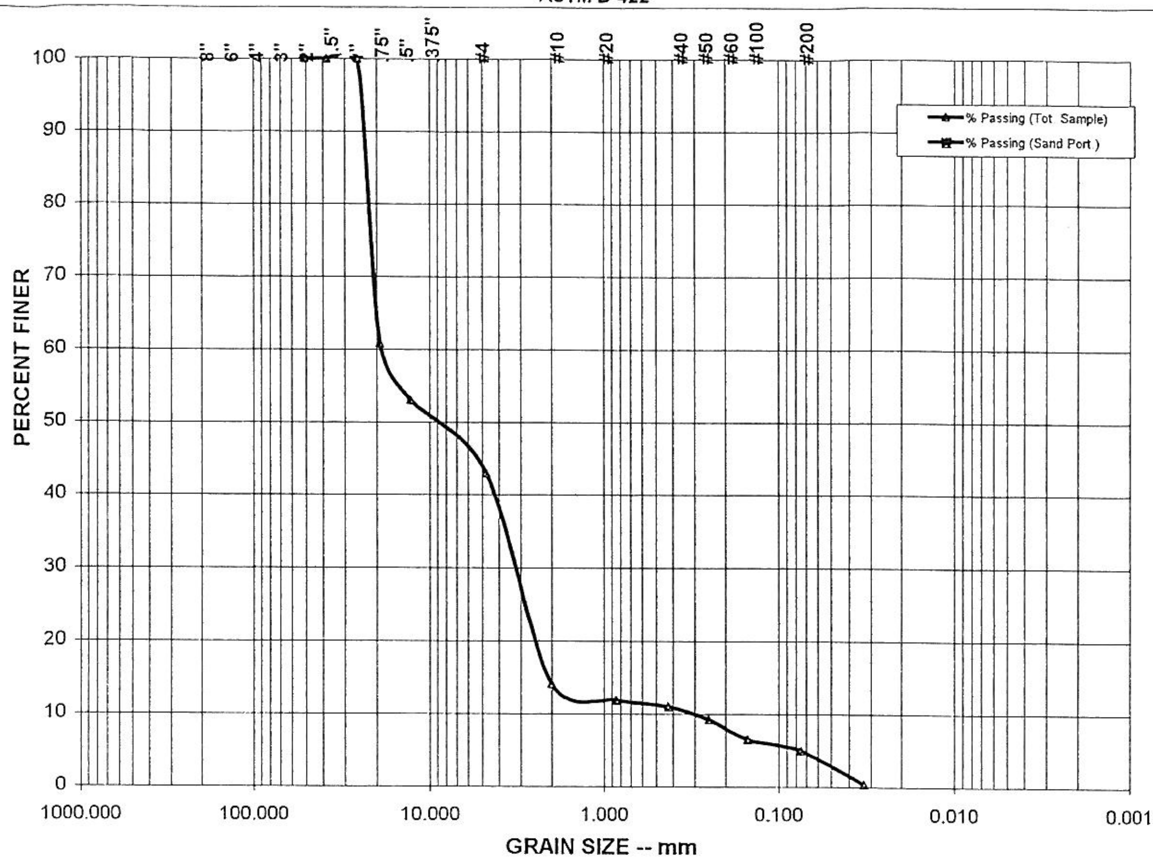
JGI EASTERN Inc.
Manchester, New Hampshire

Remarks:

Tested By: EMM Reviewed By: WJO Date: 05.23.05

GRAIN SIZE DISTRIBUTION TEST REPORT

ASTM D-422



% Cobbles	% Gravel	% Sand Crs	Med	Fine	% Fines Silt (>0.002)	Clay (<0.002)
		76.2	8.1	15.7		
	10.0	% Sand		38.0	5	

Classification Dark brown coarse to fine SAND, little Gravel, trace Silt.

Sieve Size (mm.)	Sieve Size (in./no.)	Cumulative Wt. Retnd	% Passing (Tot. Sample)	% Passing (Sand Port.)	Specification Minimum	Maximum
50.800	2"	0.00	100.0			
38.100	1.5"	0.00	100.0			
25.400	1"	0.00	100.0			
19.050	3/4"	49.95	60.8			
12.700	1/2"	59.87	53.0			
9.525	3/8"	59.87				
4.750	#4	72.63	43.0			
2.000	#10	85.72	14.0			
0.850	#20	92.27	11.8			
0.425	#40	94.87	11.0			
0.300	#50	94.87				
0.250	#60	100.16	9.2			
0.150	#100	108.09	6.5			
0.075	#200	112.52	5.0			
0.033			0.4			

Total Dry Wt. 127.35

Split Wt. 127.35

Project: Sanborn, Head,& Assoc. Lab Services	Project No.: 05321C	Date: 5/5/05
	Specification: None Provided	Lab No: L251-05
Source: B57-50/S-6A	Sampled from: Client Supplied	

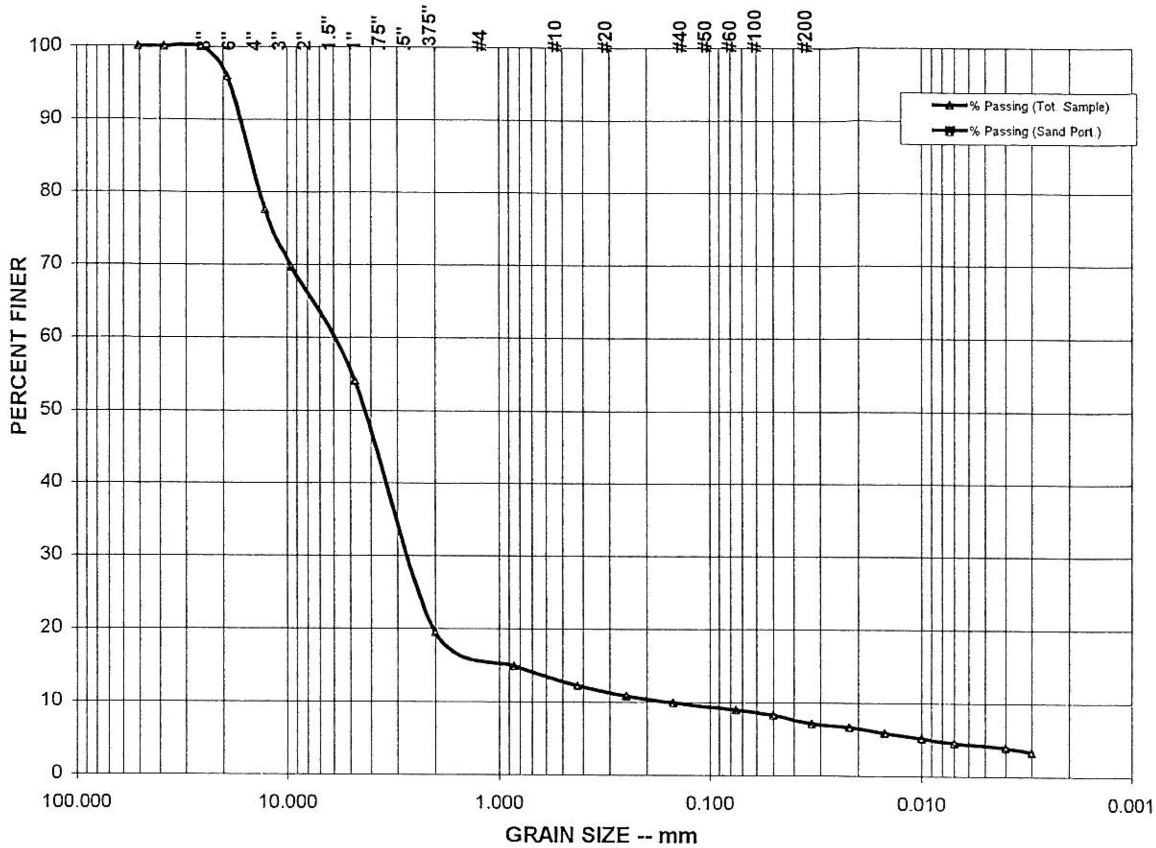
JGI EASTERN Inc.
Manchester, New Hampshire

Remarks:

Tested By: EMM Reviewed By: wdo Date: 05.23.05

GRAIN SIZE DISTRIBUTION TEST REPORT

ASTM D-422



% Cobbles	% Gravel	Crs	Med	Fine	% Fines	
		76.7	16.2	7.1	Silt (>0.002)	Clay (<0.002)
	23.5	% Sand		45.0	9	

Classification Brown coarse to fine SAND, some Gravel, trace Silt

Sieve Size (mm.)	Sieve Size (in./no.)	Cumulative Wt. Retnd	% Passing (Tot. Sample)	% Passing (Sand Port.)	Specification Minimum	Maximum
50.800	2"	0.00	100.0			
38.100	1.5"	0.00	100.0			
25.400	1"	0.00	100.0			
19.050	3/4"	10.13	95.9			
12.700	1/2"	55.79	77.5			
9.525	3/8"	75.20	69.6			
4.750	#4	113.85	54.0			
2.000	#10	158.30	19.5			
0.850	#20	179.46	14.8			
0.425	#40	191.67	12.2			
0.300	#50	191.67				
0.250	#60	197.82	10.8			
0.150	#100	202.02	9.9			
0.075	#200	206.42	9.0			
0.050			8.3			
0.033			7.1			
0.022			6.7			
0.015			5.8			
0.010			5.2			
0.007			4.5			
0.004			3.9			
0.003			3.3			

Total Dry Wt 247.50
Split Wt 247.50

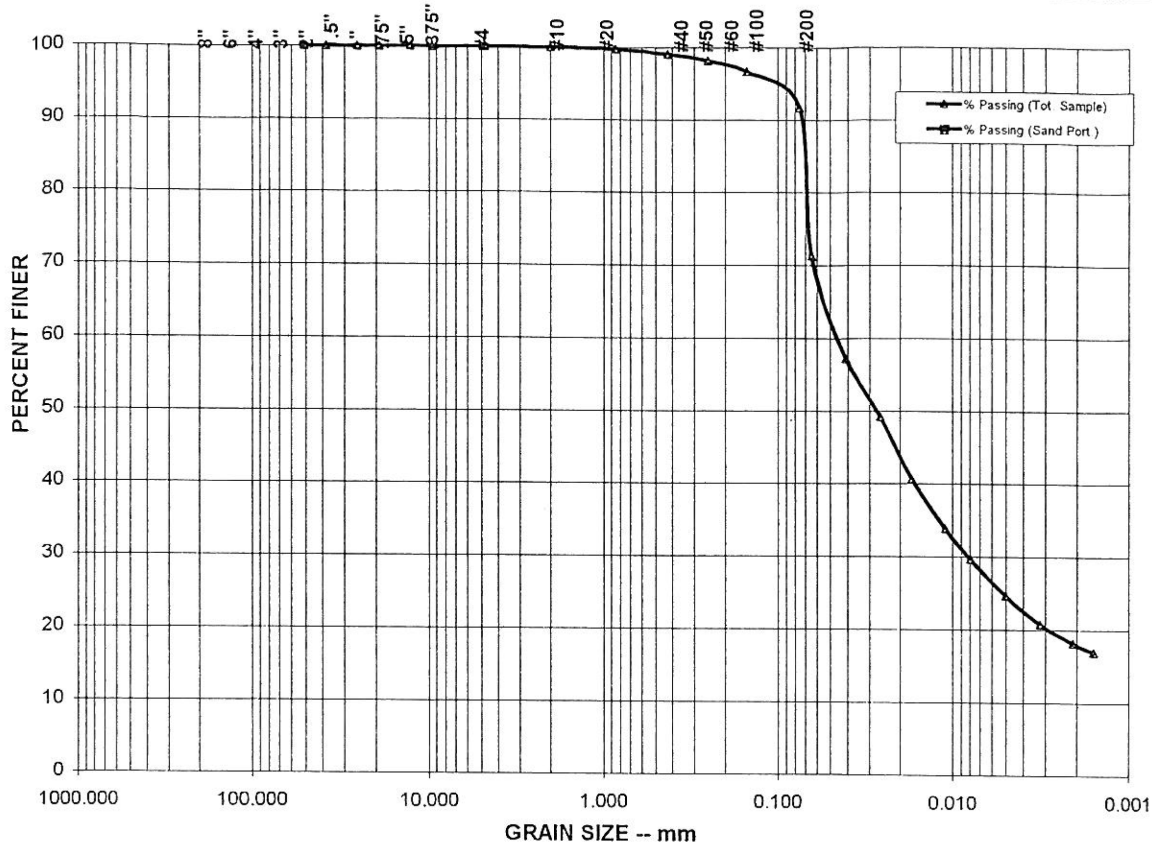
Project: **Sanborn, Head,& Assoc. Lab Services**	Project No.: **05321C**	Date: **5/5/05**
	Specification: None Provided	Lab No: **L252-05**
Source: B57-46/S-3B	Sampled from: Client Supplied	

JGI EASTERN Inc.
Manchester, New Hampshire

Remarks:
Tested By: EMM Reviewed By: MLO Date: 05.23.05

GRAIN SIZE DISTRIBUTION TEST REPORT

ASTM D-422



% Cobbles	% Gravel	Crs	Med	Fine	% Fines Silt (>0.002)	Clay (<0.002)
		0.8	11.0	88.1		
	0.0	% Sand		8.3	91.7	

Classification Tan SILT, and medium to fine Sand.

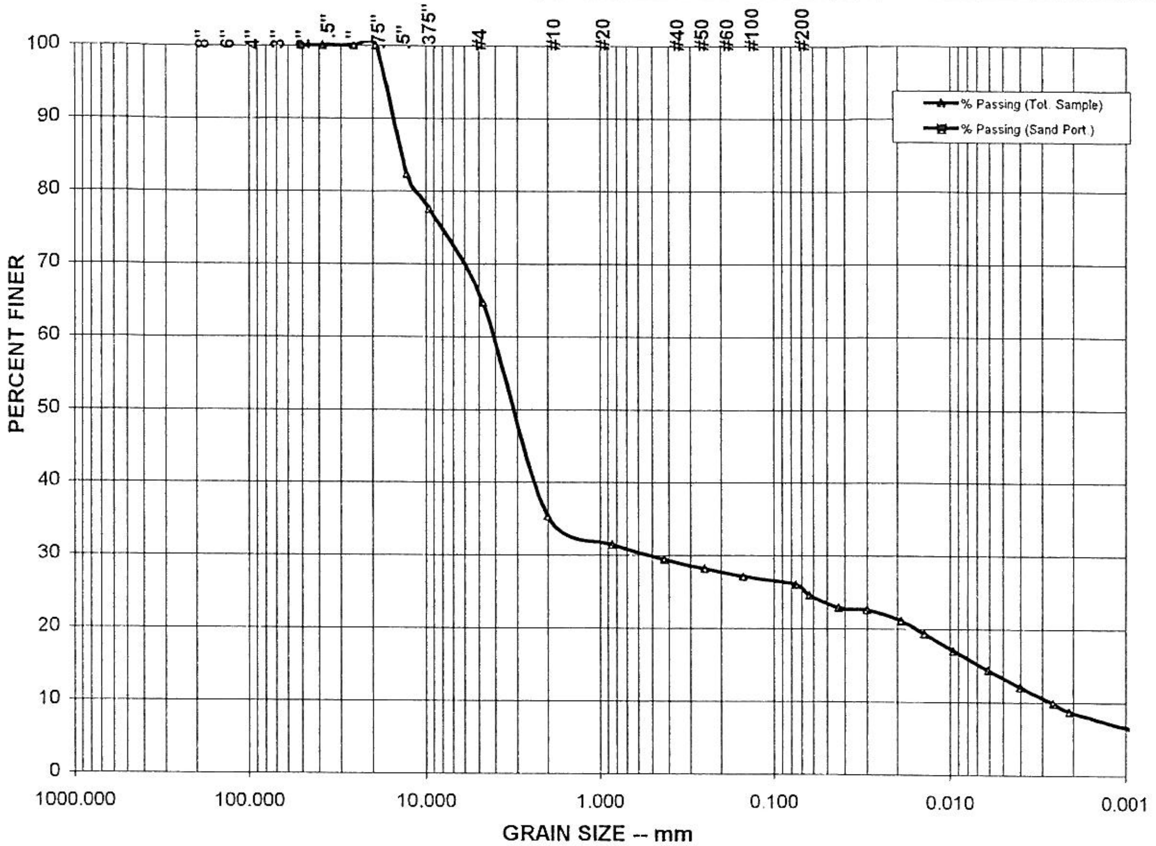
Sieve Size (mm.)	Sieve Size (in./no.)	Cumulative Wt. Retnd	% Passing (Tot. Sample)	% Passing (Sand Port.)	Specification Minimum	Maximum
50.800	2"	0.00	100.0			
38.100	1.5"	0.00	100.0			
25.400	1"	0.00	100.0			
19.050	3/4"	0.00	100.0			
12.700	1/2"	0.00	100.0			
9.525	3/8"	0.00	100.0			
4.750	#4	0.00	100.0			
2.000	#10	0.06	99.9			
0.850	#20	0.26	99.7			
0.425	#40	0.84	99.0			
0.300	#50	0.84				
0.250	#60	1.60	98.1			
0.150	#100	2.89	96.6			
0.075	#200	7.06	91.7			
0.064			71.2			
0.041			57.2			
0.026			49.2			
0.017			40.6			
0.011			33.8			
0.008			29.7			
0.005			24.6			
0.003			20.8			
0.002			18.2			
0.002			16.9			

Total Dry Wt. 84.83
Split Wt. 84.83

Project: **Sanborn, Head,& Assoc. Lab Services**	Project No.: **05321C**	Date: **5/5/05**
	Specification: None Provided	Lab No: **L253-05**
Source: B57-41/S-2B	Sampled from: Client Supplied	
JGI EASTERN Inc. Manchester, New Hampshire	Remarks: Tested By: EMM Reviewed By: WSo	Date: 5-23-05

GRAIN SIZE DISTRIBUTION TEST REPORT

ASTM D-422



% Cobbles	% Gravel	Crs	Med	Fine	% Fines	
		75.9	15.2	8.8	Silt (>0.002)	Clay (<0.002)
	17.6	% Sand		38.7	26	

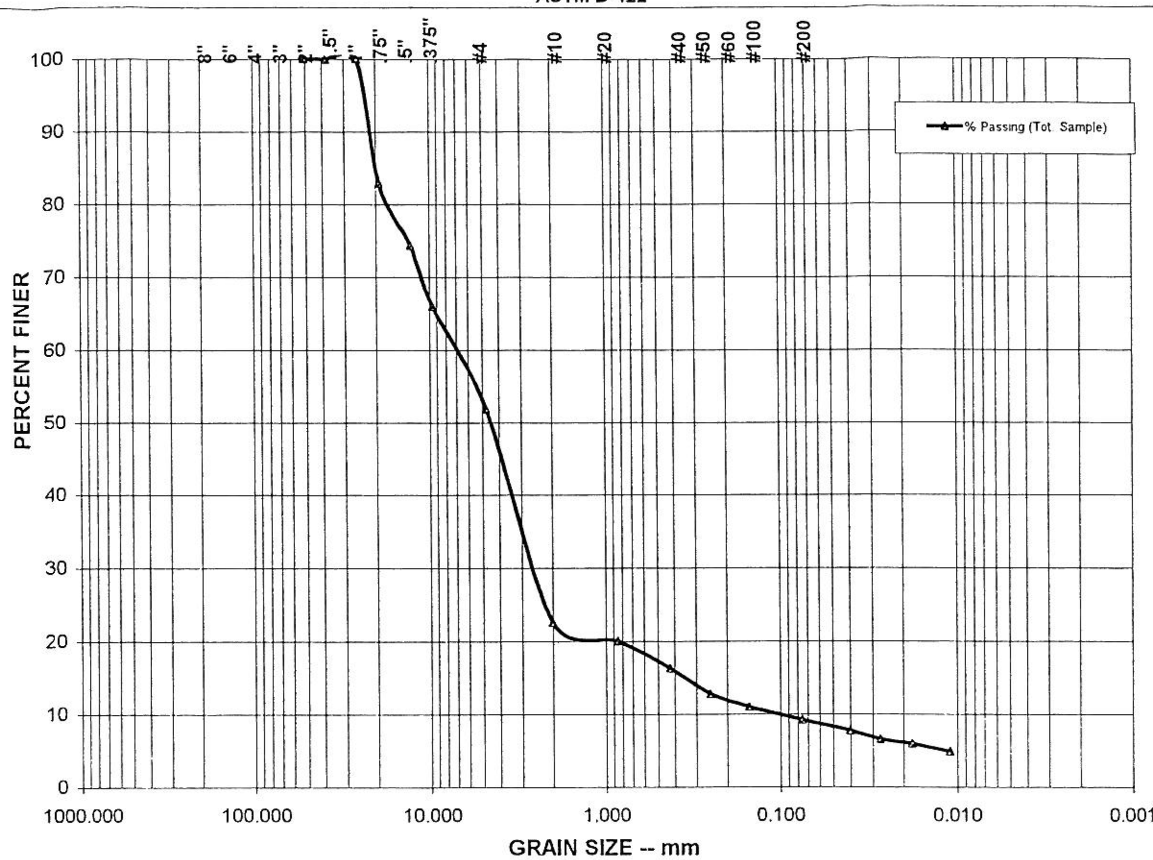
Classification Olive brown coarse to fine SAND, some Silt, little Gravel.

Sieve Size (mm.)	Sieve Size (in./no.)	Cumulative Wt. Retnd	% Passing (Tot. Sample)	% Passing (Sand Port.)	Specification Minimum	Specification Maximum
50.800	2"	0.00	100.0			
38.100	1.5"	0.00	100.0			
25.400	1"	0.00	100.0			
19.050	3/4"	0.00	100.0			
12.700	1/2"	17.13	82.3			
9.525	3/8"	21.79	77.5			
4.750	#4	34.13	64.7			
2.000	#10	43.89	35.3			
0.850	#20	49.67	31.5			
0.425	#40	52.70	29.4			
0.300	#50	52.70				
0.250	#60	54.55	28.2			
0.150	#100	56.15	27.1			
0.075	#200	57.81	26.0			
0.063			24.6			
0.043			22.8			
0.030			22.6			
0.019			21.1			
0.014			19.3			
0.010			17.0			
0.006			14.4			
0.004			12.1			
0.003			9.8			
0.002			8.7			
0.001			6.2			
	Total Dry Wt	96.67				
	Split Wt.	96.67				

Project: Sanborn, Head,& Assoc. Lab Services	Project No.: 05321C		Date: 5/5/05
	Specification: None Provided		Lab No: L254-05
Source: B57-47/S-4	Sampled from: Client Supplied		
JGI EASTERN Inc. Manchester, New Hampshire	Remarks: Tested By: EMM	Reviewed By: WLO	Date: 05.23.05

GRAIN SIZE DISTRIBUTION TEST REPORT

ASTM D-422



% Cobbles	% Gravel	Crs	Med	Fine	% Fines	
		68.6	14.8	16.6	Silt (>0.002)	Clay (<0.002)
	22.5		% Sand	42.7	9.2	

Classification: Brown coarse to fine SAND, some Gravel, trace Silt.

Sieve Size (mm.)	Sieve Size (in./no.)	Cumulative Wt. Retnd	% Passing (Tot. Sample)	% Passing (Sand Port.)	Specification Minimum	Specification Maximum
50.800	2"	0.00	100.0			
38.100	1.5"	0.00	100.0			
25.400	1"	0.00	100.0			
19.050	3/4"	16.78	82.9			
12.700	1/2"	25.26	74.3			
9.525	3/8"	33.43	66.0			
4.750	#4	47.35	51.8			
2.000	#10	55.50	22.6			
0.850	#20	60.26	20.1			
0.425	#40	67.44	16.3			
0.300	#50	67.44				
0.250	#60	74.13	12.7			
0.150	#100	77.54	10.9			
0.075	#200	80.89	9.2			
0.040			7.7			
0.027			6.6			
0.018			6.0			
0.011			4.9			

Total Dry Wt 98.29
Split Wt. 98.29

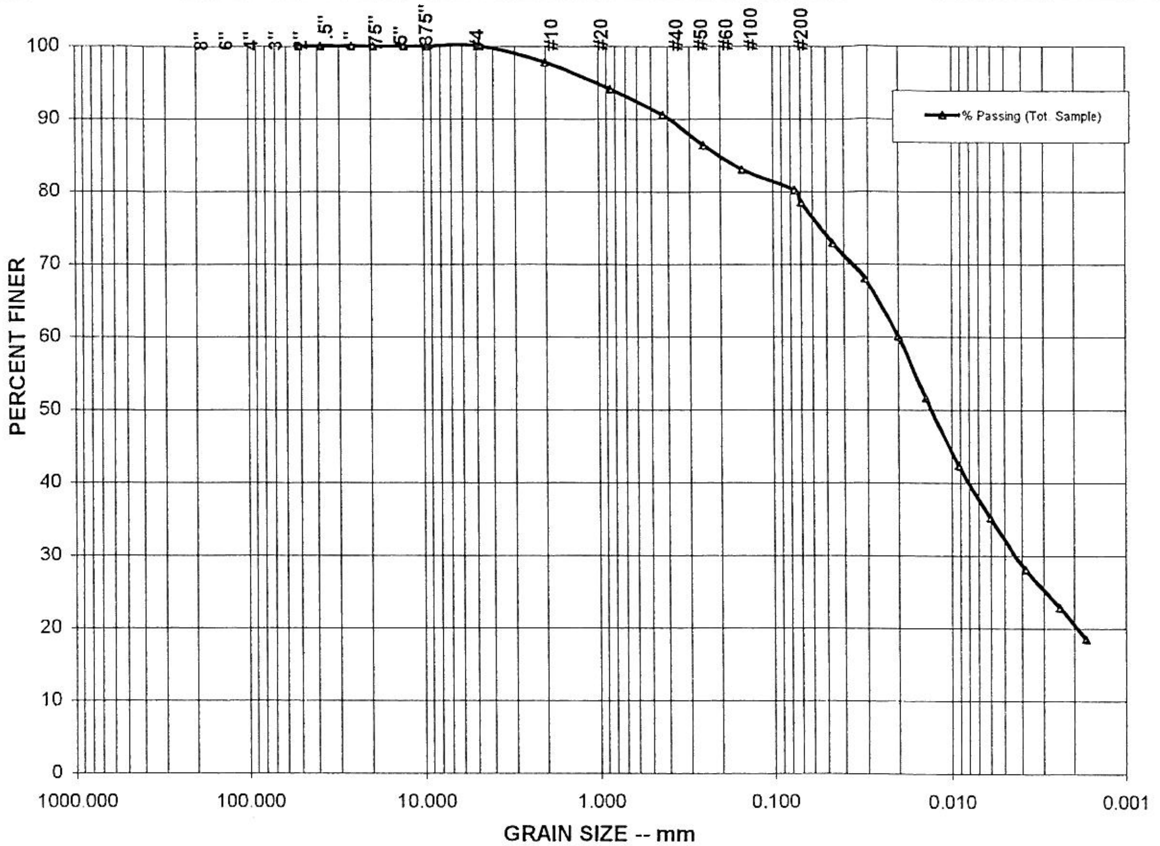
Project: Sanborn, Head,& Assoc. Lab Services	Project No.: 05321C	Date: 5/5/05
	Specification: None Provided	Lab No: L255-05
Source: B57-49/S-2B	Sampled from: Client Supplied	

JGI EASTERN Inc.
Manchester, New Hampshire

Remarks:
Tested By: EMM Reviewed By: WJO Date: 05.23.05

GRAIN SIZE DISTRIBUTION TEST REPORT

ASTM D-422



% Cobbles	% Gravel	Crs	Med	Fine	% Fines	
		11.2	36.6	52.2	Silt (>0.002)	Clay (<0.002)
	0.0		% Sand	19.9	80.1	

Classification Olive brown SILT, little coarse to fine Sand

Sieve Size (mm.)	Sieve Size (in./no.)	Cumulative Wt. Retnd	% Passing (Tot. Sample)	% Passing (Sand Port.)	Specification Minimum	Maximum
50.800	2"	0.00	100.0			
38.100	1.5"	0.00	100.0			
25.400	1"	0.00	100.0			
19.050	3/4"	0.00	100.0			
12.700	1/2"	0.00	100.0			
9.525	3/8"	0.00	100.0			
4.750	#4	0.00	100.0			
2.000	#10	1.28	97.8			
0.850	#20	3.42	94.1			
0.425	#40	5.46	90.5			
0.300	#50	5.46				
0.250	#60	7.87	86.3			
0.150	#100	9.78	83.0			
0.075	#200	11.42	80.1			
0.069			78.5			
0.046			72.9			
0.031			68.0			
0.020			59.9			
0.014			51.6			
0.009			42.3			
0.006			35.2			
0.004			28.1			
0.002			22.9			
0.002			18.5			

Total Dry Wt. 57.53
Split Wt. 57.53

Project: Sanborn, Head,& Assoc. Lab Services	Project No.: **05321C**	Date: **5/5/05**
	Specification: None Provided	Lab No: **L256-05**
Source: B57-48/S-2B	Sampled from: Client Supplied	

JGI EASTERN Inc.
Manchester, New Hampshire

Remarks:

Tested By: EMM Reviewed By: WJo Date: 05.23.05

ATTACHMENT D.2

Soil Gradation and Gravimetric Moisture Content Data
Investigations July and August 2005

SHPC
ENGINEERS

2466.01
"I"

GeoTesting
express

1145 Massachusetts Avenue
Boxborough, MA 01719
978 635 0424 Tel
978 635 0266 Fax

Transmittal

TO:

Mr. Tony Delano
Sanborn, Head & Associates
95 High Street
Portland, ME 04101

DATE: 8/2/2005	GTX NO: 6079
RE: Building 57 SRI Project	

COPIES	DATE	DESCRIPTION
1	8/2/2005	**August 2005 Laboratory Test Reports**
		2 Grain Size Analyses (ASTM D 422) - sieve only
		10 Grain Size Analyses (ASTM D 422) – with Hydrometer
		10 Moisture Contents (ASTM D 2216)

REMARKS:

CC:

SIGNED: [signature]
Joe Tomei – Laboratory Manager

APPROVED BY: [signature]
Gary Torosian – Director of Testing Services

GeoTesting
express

1145 Massachusetts Avenue
Boxborough, MA 01719
978 635 0424 Tel
978 635 0266 Fax

Geotechnical Test Report

August 2, 2005

Building 57
SRI
Project

Endicott, NY

Prepared for:

Sanborn, Head & Associates

GeoTesting express

Client:	Sanborn, Head & Associates				
Project:	Building 57 SRI				
Location:	Endicott, NY			Project No:	GTX-6079
Boring ID:	---	Sample Type:	---	Tested By:	pcs
Sample ID:	---	Test Date:	08/02/05	Checked By:	n/a
Depth :	---	Sample Id:	---		

Moisture Content of Soil - ASTM D 2216

Boring ID	Sample ID	Depth	Description	Moisture Content,%
S-11	B57-107	20-22	Wet, very dark gray gravel with silt and sand	9
S-12	B57-107D	23-24	Moist, dark grayish brown silty gravel with sand	5
S-9A	B57-107D	17-18	Moist, light olive brown gravel with silt and sand	6
S-10	B57-108D	20-22	Moist, dark gray silty gravel with sand	7
S-11	B57-108D	22-24	Moist, olive brown silty sand with gravel	6
S-12	B57-108D	24-24.7	Moist, dark grayish brown silty sand with gravel	9
S-13	B57-108D	26-27.7	Moist, olive gray silty gravel with sand	5

Notes: Temperature of Drying : 110° Celsius

GeoTesting
express

Client:	Sanborn, Head & Associates				
Project:	Building 57 SRI				
Location:	Endicott, NY			Project No:	GTX-6079
Boring ID:	---	Sample Type:	---	Tested By:	pcs
Sample ID:	---	Test Date:	08/02/05	Checked By:	n/a
Depth :	---	Sample Id:	---		

Moisture Content of Soil - ASTM D 2216

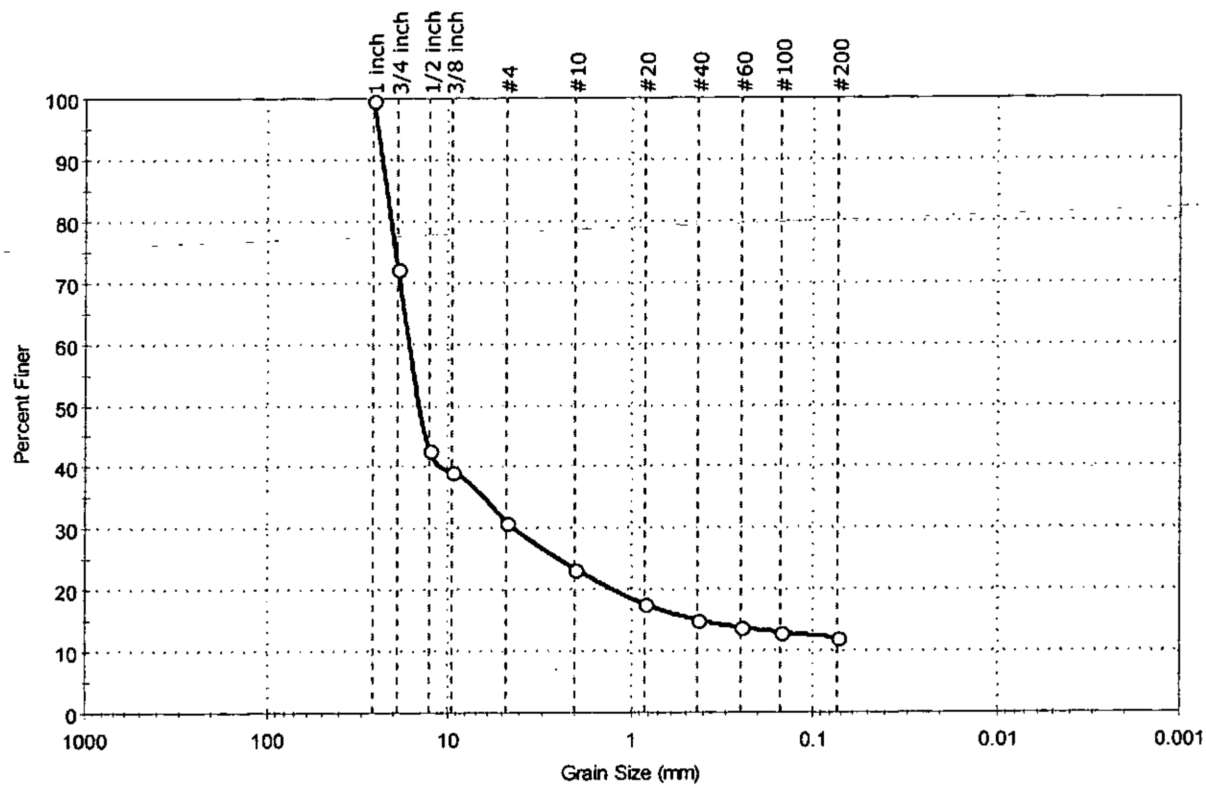
Boring ID	Sample ID	Depth	Description	Moisture Content,%
S-13	B57-109D	25-25.5	Moist, olive brown silty sand	21
S-9A	B57-109D	18-19	Moist, gray silty gravel	12
S-10	B57-109D	19-21	Moist, dark gray silty gravel with sand	8
S-11	B57-109D	21-23	Moist, dark gray silty sand with gravel	11
S-12	B57-109D	23-25	Wet, dark brown silty sand	25

Notes: Temperature of Drying : 110° Celsius

GeoTesting express

Client: Sanborn, Head & Associates			
Project: Building 57 SRI			
Location: Endicott, NY		Project No:	GTX-6079
Boring ID: B-108	Sample Type: jar	Tested By:	pcs
Sample ID:S-15	Test Date: 08/04/05	Checked By:	jdt
Depth : 30-31.5	Test Id: 74620		
Test Comment: ---			
Sample Description: Moist, gray silty gravel with sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	69.0	18.9	12.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 inch	25.70	100		
3/4 inch	19.00	72		
1/2 inch	12.70	43		
3/8 inch	9.51	39		
#4	4.75	31		
#10	2.00	23		
#20	0.84	18		
#40	0.42	15		
#60	0.25	14		
#100	0.15	13		
#200	0.074	12		
	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0000	0		

Coefficients

D_{85} =21.8522 mm D_{30} =4.2451 mm

D_{60} =16.0599 mm D_{15} =0.4180 mm

D_{50} =13.9978 mm D_{10} =0.1721 mm

C_u =93.317 C_c =6.520

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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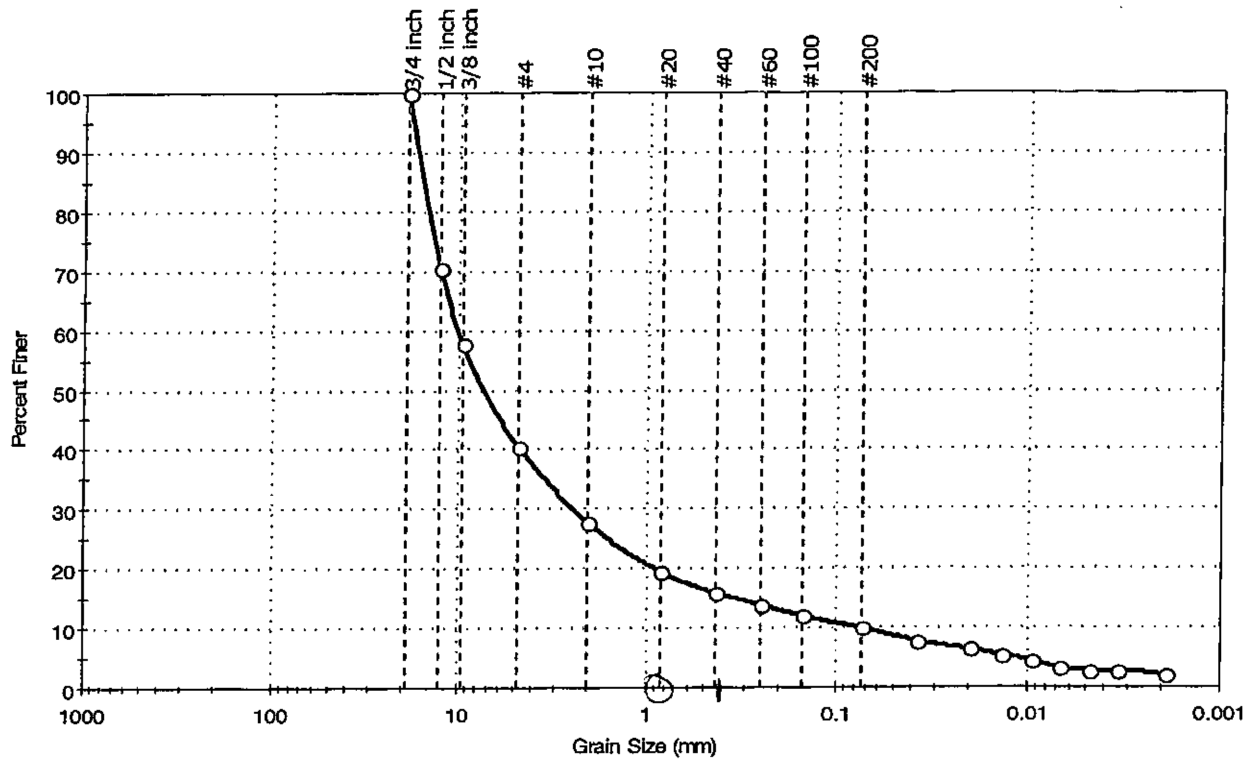
GeoTesting express

Client:	Sanborn, Head & Associates		
Project:	Building 57 SRI		
Location:	Endicott, NY	Project No:	GTX-6079
Boring ID: S-11	Sample Type: jar	Tested By:	pcs
Sample ID: B57-107	Test Date: 08/01/05	Checked By:	jdt
Depth : 20-22	Test Id: 73857		
Test Comment:	---		
Sample Description:	Wet, very dark gray gravel with silt and sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	59.5	30.5	10.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	71		
3/8 inch	9.51	58		
#4	4.75	40		
#10	2.00	28		
#20	0.84	20		
#40	0.42	16		
#60	0.25	14		
#100	0.15	12		
#200	0.074	10		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0374	8		
---	0.0195	6		
---	0.0133	5		
---	0.0095	5		
---	0.0068	3		
---	0.0048	3		
---	0.0034	3		
---	0.0019	2		

Coefficients

D_{85} = 15.4792 mm D_{30} = 2.3524 mm
D_{60} = 10.0044 mm D_{15} = 0.3331 mm
D_{50} = 6.9627 mm D_{10} = 0.0744 mm
C_u = 134.468 C_c = 7.435

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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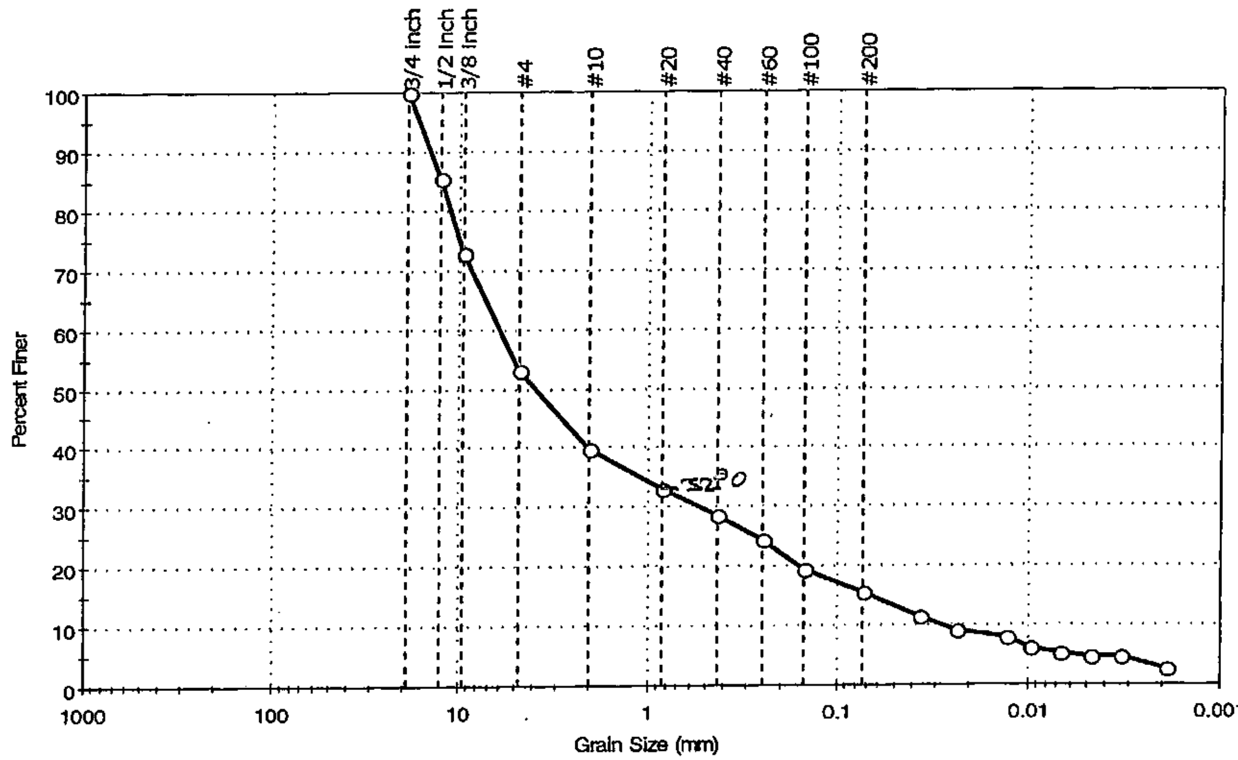
GeoTesting express

Client:	Sanborn, Head & Associates				
Project:	Building 57 SRI				
Location:	Endicott, NY			Project No:	GTX-6079
Boring ID:	S-12	Sample Type:	jar	Tested By:	pcs
Sample ID:	B57-107D	Test Date:	08/01/05	Checked By:	jdt
Depth :	23-24	Test Id:	73858		

Test Comment: ---
Sample Description: Moist, dark grayish brown silty gravel with sand
Sample Comment: ---

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	47.0	37.5	15.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	86		
3/8 inch	9.51	73		
#4	4.75	53		
#10	2.00	40		
#20	0.84	33		
#40	0.42	29		
#60	0.25	25		
#100	0.15	19		
#200	0.074	16		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0364	11		
---	0.0235	9		
---	0.0130	8		
---	0.0096	6		
---	0.0068	5		
---	0.0047	5		
---	0.0033	5		
---	0.0019	3		

Coefficients

D_{85} = 12.5481 mm — D_{30} = 0.5286 mm
D_{60} = 6.0522 mm — D_{15} = 0.0677 mm
D_{50} = 3.8927 mm — D_{10} = 0.0275 mm
C_u = 220.080 — C_c = 1.679

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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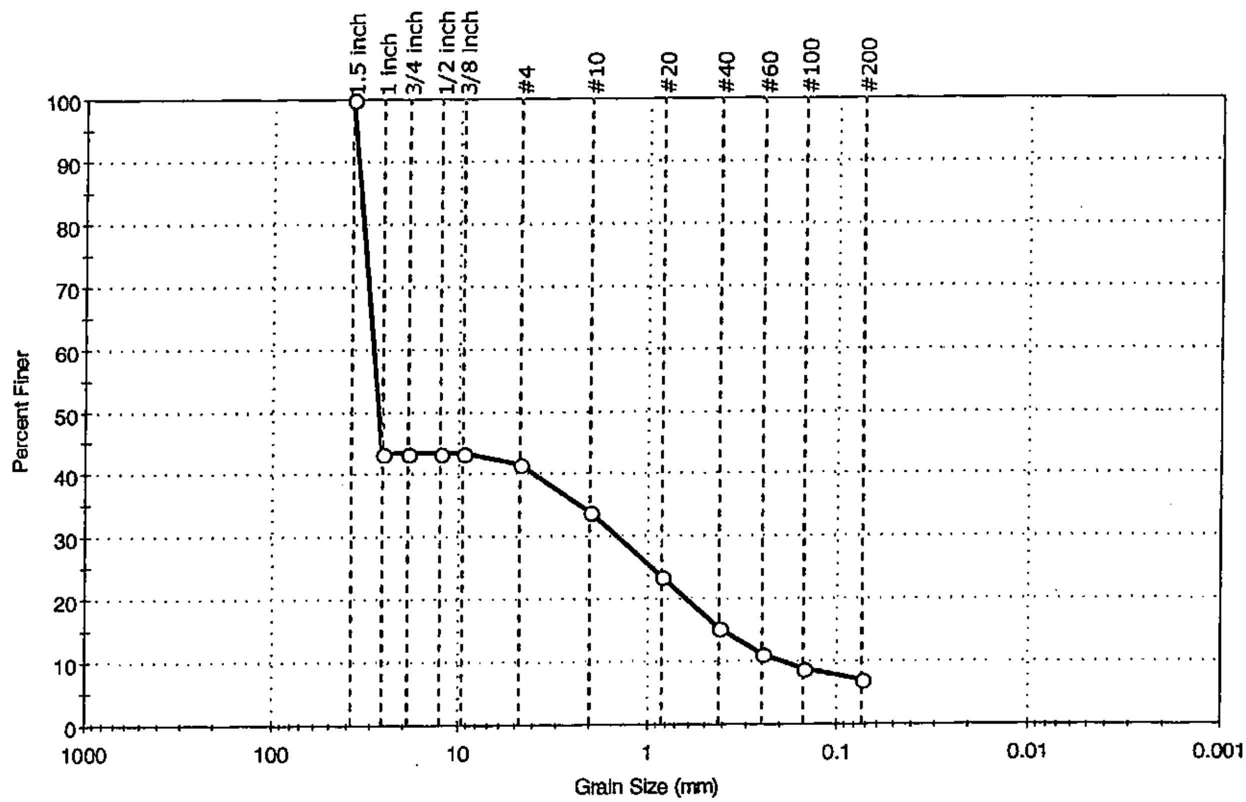
GeoTesting express

Client:	Sanborn, Head & Associates				
Project:	Building 57 SRI				
Location:	Endicott, NY			Project No:	GTX-6079
Boring ID:	S-9A	Sample Type:	jar	Tested By:	pcs
Sample ID:	B57-107D	Test Date:	07/29/05	Checked By:	jdt
Depth :	17-18	Test Id:	73856		
Test Comment:	Less than 10% fines, Hydrometer not required				
Sample Description:	Moist, light olive brown gravel with silt and sand				
Sample Comment:	The > one-inch portion of the sample consisted of only one stone.				

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	58.3	34.6	7.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 inch	38.10	100		
1 inch	25.70	43		
3/4 inch	19.00	43		
1/2 inch	12.70	43		
3/8 inch	9.51	43		
#4	4.75	42		
#10	2.00	34		
#20	0.84	24		
#40	0.42	15		
#60	0.25	11		
#100	0.15	9		
#200	0.074	7		

Coefficients

D_{85} =34.3224 mm D_{30} =1.4408 mm

D_{60} =28.8402 mm D_{15} =0.4034 mm

D_{50} =26.9009 mm D_{10} =0.1897 mm

C_u =152.031 C_c =0.379

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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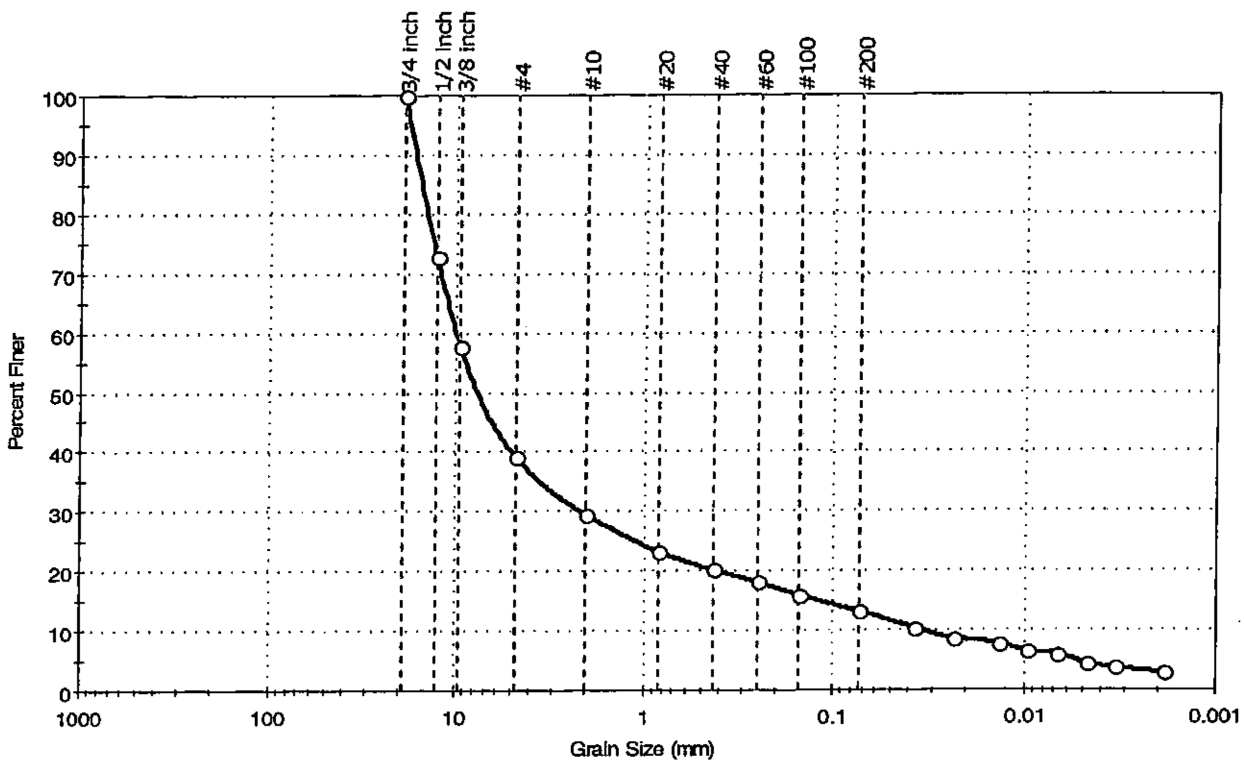
GeoTesting express

Client:	Sanborn, Head & Associates				
Project:	Building 57 SRI				
Location:	Endicott, NY			Project No:	GTX-6079
Boring ID:	S-10	Sample Type:	jar	Tested By:	pcs
Sample ID:	B57-108D	Test Date:	08/01/05	Checked By:	jdt
Depth :	20-22	Test Id:	73859		

Test Comment: ---
Sample Description: Moist, dark gray silty gravel with sand
Sample Comment: ---

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	60.8	26.0	13.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	73		
3/8 inch	9.51	58		
#4	4.75	39		
#10	2.00	29		
#20	0.84	23		
#40	0.42	20		
#60	0.25	18		
#100	0.15	16		
#200	0.074	13		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0378	10		
---	0.0236	9		
---	0.0135	8		
---	0.0095	6		
---	0.0067	6		
---	0.0048	4		
---	0.0033	4		
---	0.0019	3		

Coefficients

D_{85} =15.2199 mm D_{30} =2.1023 mm

D_{60} =9.8981 mm D_{15} =0.1161 mm

D_{50} =7.0854 mm D_{10} =0.0334 mm

C_u =296.350 C_c =13.369

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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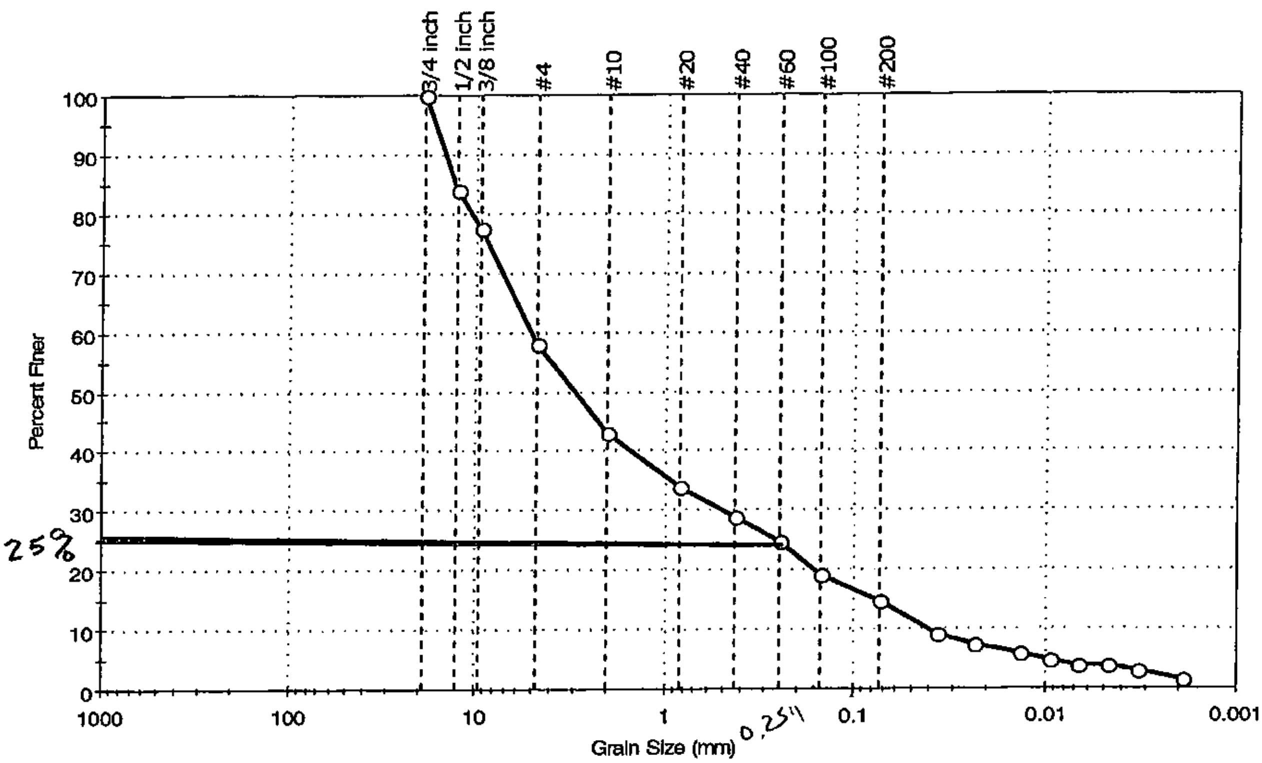
GeoTesting express

Client:	Sanborn, Head & Associates		
Project:	Building 57 SRI		
Location:	Endicott, NY	Project No:	GTX-6079
Boring ID: S-11	Sample Type: jar	Tested By:	pcs
Sample ID:B57-108D	Test Date: 08/01/05	Checked By:	jdt
Depth : (22-24')	Test Id: 73860		
Test Comment:	---		
Sample Description:	Moist, olive brown silty sand with gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	41.9	43.3	14.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	84		
3/8 inch	9.51	77		
#4	4.75	58		
#10	2.00	43		
#20	0.84	34		
#40	0.42	29		
#60	0.25	25		
#100	0.15	19		
#200	0.074	15		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0370	9		
---	0.0235	7		
---	0.0134	6		
---	0.0095	5		
---	0.0068	4		
---	0.0047	4		
---	0.0033	3		
---	0.0019	1		

Coefficients

D_{85} =12.9840 mm — D_{30} =0.4915 mm

D_{60} =5.0939 mm — D_{15} =0.0769 mm

D_{50} =2.9827 mm — D_{10} =0.0405 mm

C_u =125.775 — C_c =1.171

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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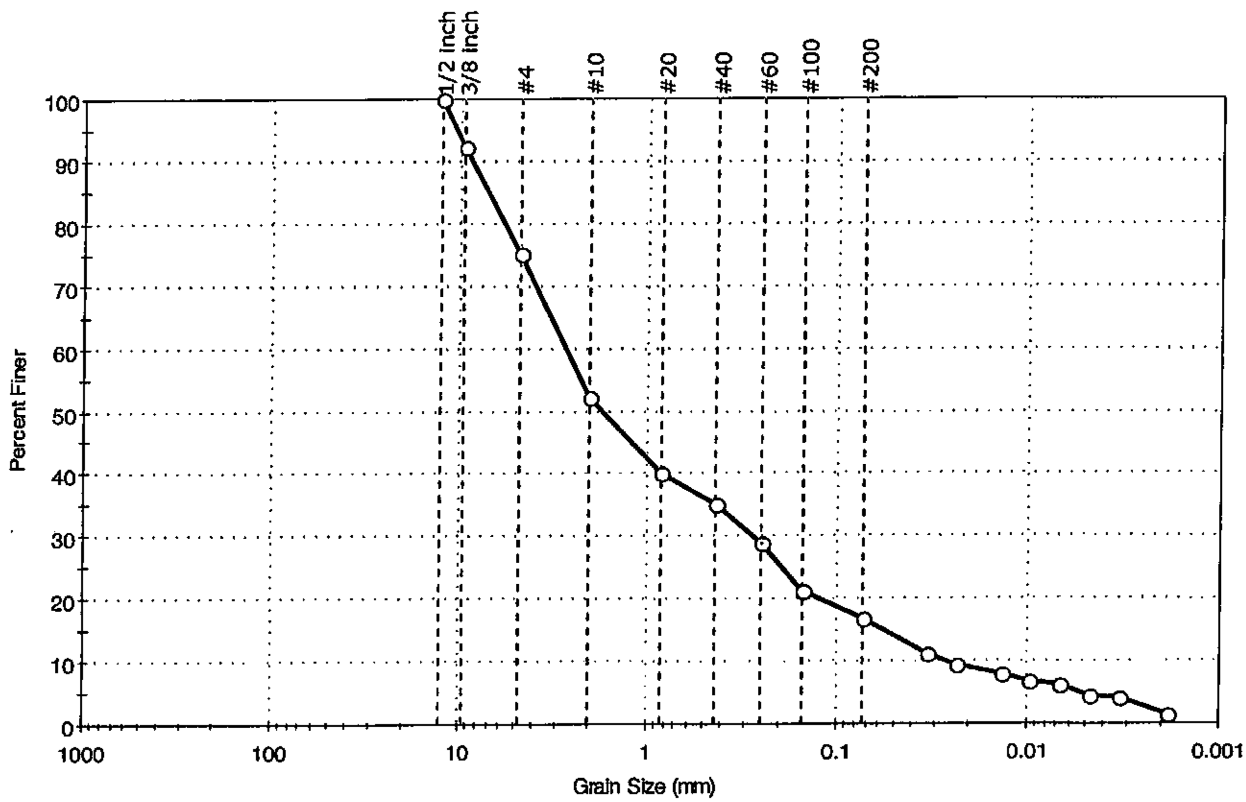
GeoTesting express

Client:	Sanborn, Head & Associates		
Project:	Building 57 SRI		
Location:	Endicott, NY	Project No:	GTX-6079
Boring ID: S-12	Sample Type: jar	Tested By:	pcs
Sample ID: B57-108D	Test Date: 08/01/05	Checked By:	jdt
Depth : (24-24.7)	Test Id: 73861		
Test Comment:	---		
Sample Description:	Moist, dark grayish brown silty sand with gravel		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422



%Cobble	%Gravel	%Sand	%Silt & Clay Size
—	24.7	58.5	16.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2 inch	12.70	100		
3/8 inch	9.51	92		
#4	4.75	75		
#10	2.00	52		
#20	0.84	40		
#40	0.42	35		
#60	0.25	29		
#100	0.15	21		
#200	0.074	17		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0337	11		
---	0.0235	9		
---	0.0134	8		
---	0.0096	7		
---	0.0068	6		
---	0.0048	5		
---	0.0033	4		
---	0.0019	2		

0.01 slot

Coefficients

D_{85} =7.0812 mm	D_{30} =0.2755 mm
D_{60} =2.6774 mm	D_{15} =0.0572 mm
D_{50} =1.7034 mm	D_{10} =0.0263 mm
C_u =101.802	C_c =1.078

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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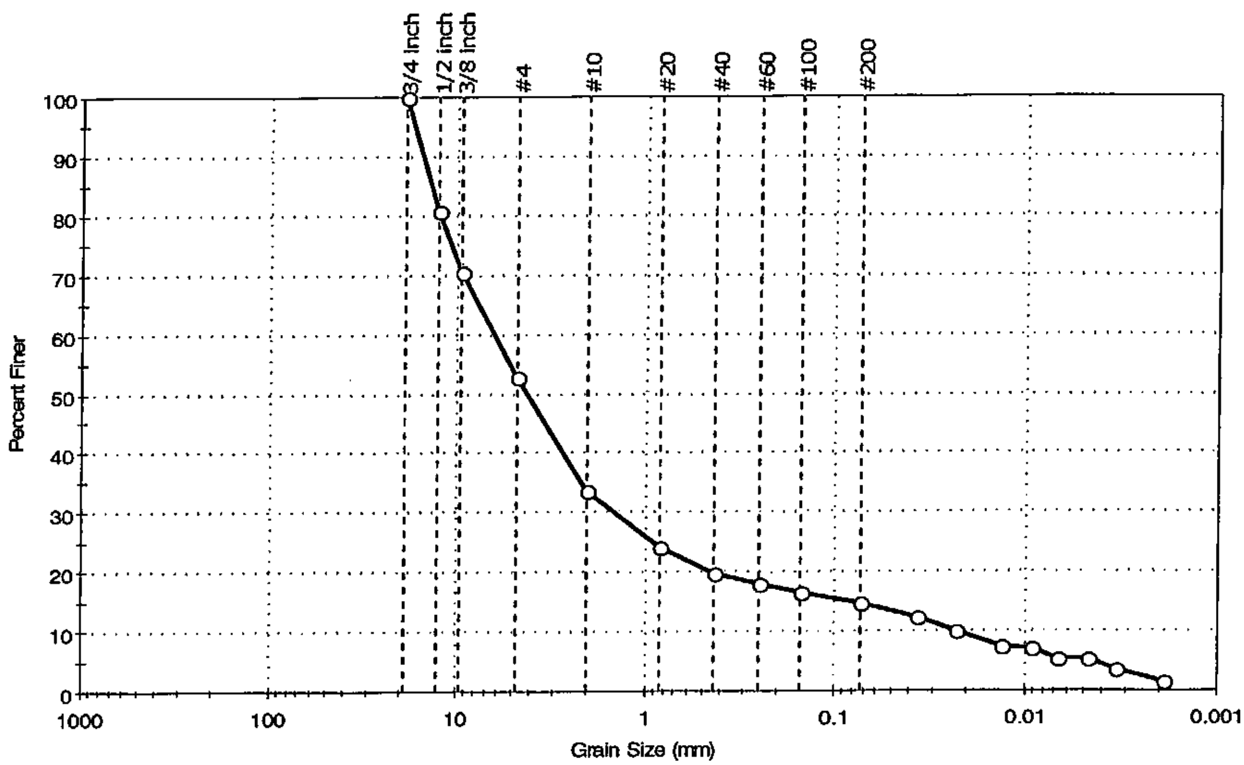
GeoTesting express

Client:	Sanborn, Head & Associates		
Project:	Building 57 SRI		
Location:	Endicott, NY	Project No:	GTX-6079
Boring ID: S-13	Sample Type: jar	Tested By:	pcs
Sample ID:B57-108D	Test Date: 08/01/05	Checked By:	jdt
Depth : (26-27.7')	Test Id: 73862		
Test Comment:	---		
Sample Description:	Moist, olive gray silty gravel with sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	47.1	38.1	14.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	81		
3/8 inch	9.51	71		
#4	4.75	53		
#10	2.00	34		
#20	0.84	24		
#40	0.42	20		
#60	0.25	18		
#100	0.15	16		
#200	0.074	15		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0371	12		
---	0.0225	10		
---	0.0132	7		
---	0.0091	7		
---	0.0068	5		
---	0.0047	5		
---	0.0034	4		
---	0.0019	2		

Coefficients

D_{85} =13.8543 mm D_{30} =1.4458 mm
D_{60} =6.2771 mm D_{15} =0.0799 mm
D_{50} =4.1771 mm D_{10} =0.0223 mm
C_u =281.484 C_c =14.933

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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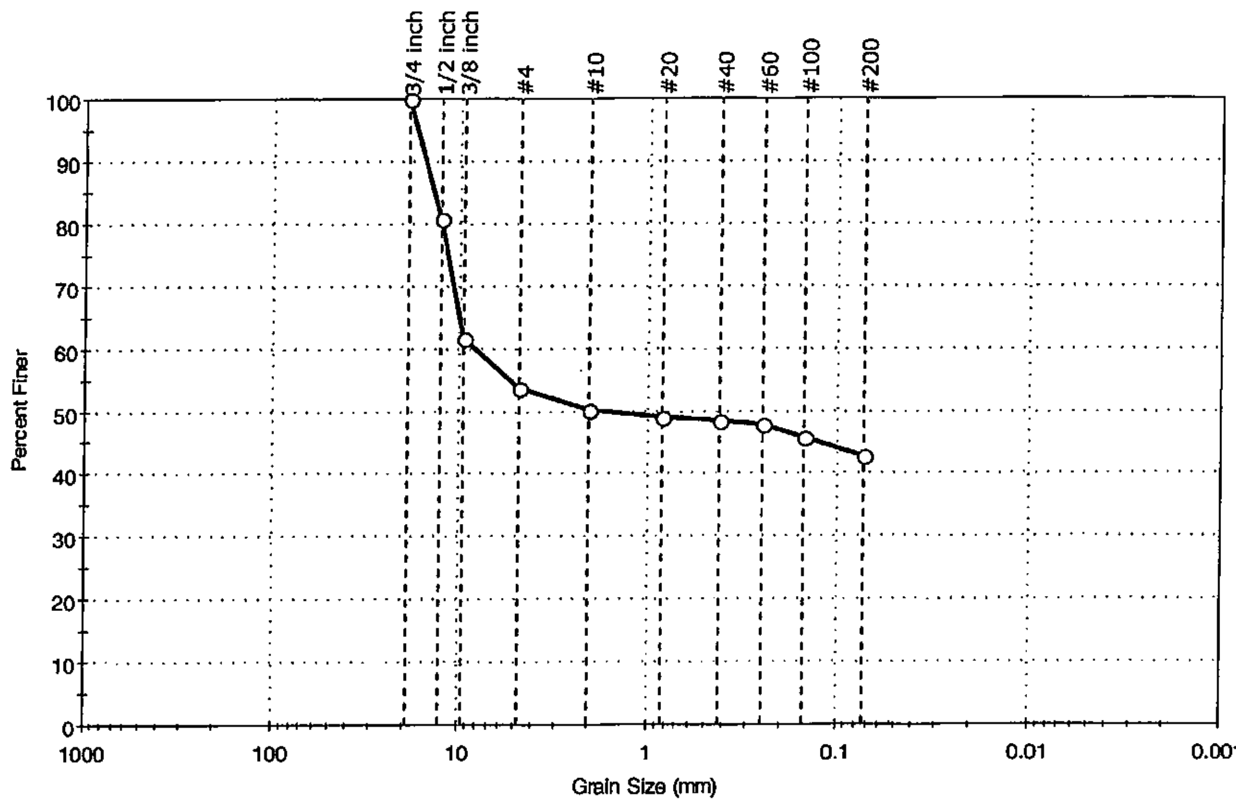
GeoTesting express

Client:	Sanborn, Head & Associates		
Project:	Building 57 SRI		
Location:	Endicott, NY	Project No:	GTX-6079
Boring ID: S-9A	Sample Type: jar	Tested By:	pcs
Sample ID:B57-109D	Test Date: 07/29/05	Checked By:	jdt
Depth : 18-19	Test Id: 73863		
Test Comment:	---		
Sample Description:	Moist, gray silty gravel		
Sample Comment:	less than 10% fines, Hydrometer not required		

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	46.2	11.0	42.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	81		
3/8 inch	9.51	62		
#4	4.75	54		
#10	2.00	50		
#20	0.84	49		
#40	0.42	48		
#60	0.25	48		
#100	0.15	46		
#200	0.074	43		

Coefficients

D_{85} = 13.8638 mm	D_{30} = N/A
D_{60} = 8.2401 mm	D_{15} = N/A
D_{50} = 1.6697 mm	D_{10} = N/A
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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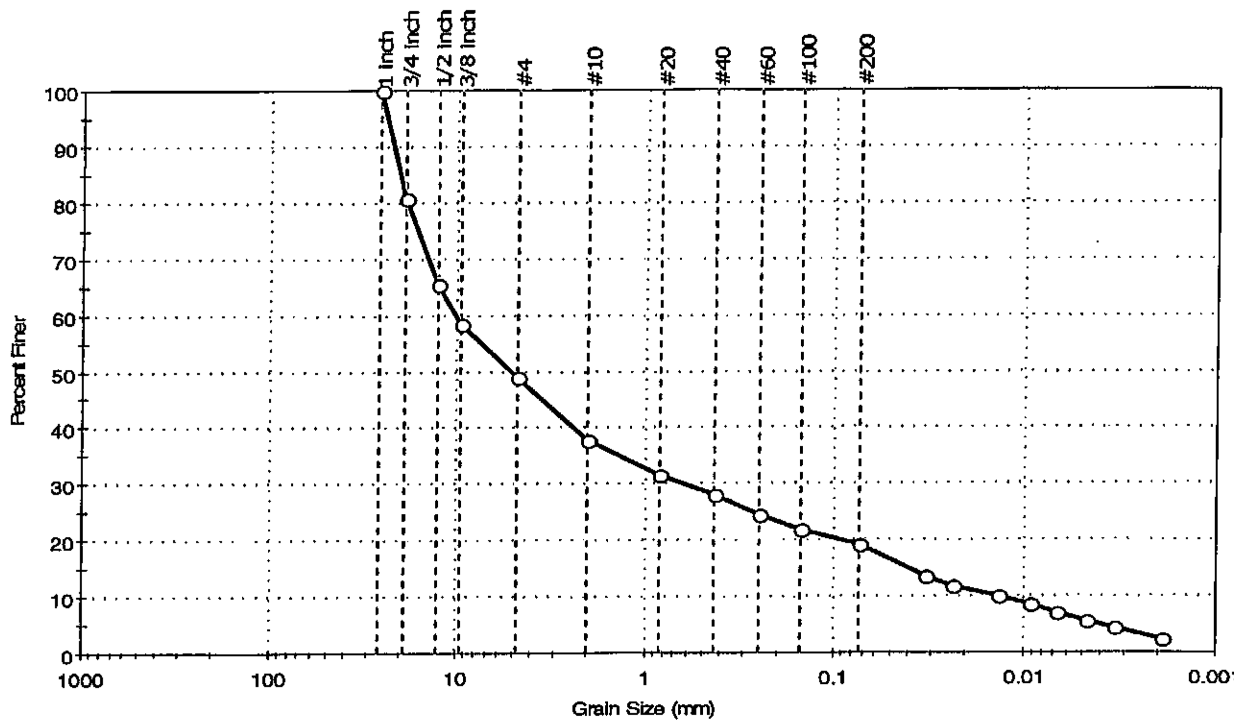
GeoTesting express

Client:	Sanborn, Head & Associates				
Project:	Building 57 SRI				
Location:	Endicott, NY			Project No:	GTX-6079
Boring ID:	S-10	Sample Type:	jar	Tested By:	pcs
Sample ID:	B57-109D	Test Date:	08/01/05	Checked By:	jdt
Depth :	19-21	Test Id:	73864		
Test Comment:	---				
Sample Description:	Moist, dark gray silty gravel with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	50.9	29.8	19.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 inch	25.70	100		
3/4 inch	19.00	81		
1/2 inch	12.70	66		
3/8 inch	9.51	58		
#4	4.75	49		
#10	2.00	38		
#20	0.84	32		
#40	0.42	28		
#60	0.25	25		
#100	0.15	22		
#200	0.074	19		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0328	14		
---	0.0232	12		
---	0.0134	10		
---	0.0093	9		
---	0.0068	7		
---	0.0047	6		
---	0.0034	4		
---	0.0019	2		

Coefficients

D_{85} =20.2995 mm
D_{30} =0.6083 mm
D_{60} =10.1721 mm
D_{15} =0.0403 mm
D_{50} =5.1048 mm
D_{10} =0.0133 mm
C_u =764.820
C_c =2.735

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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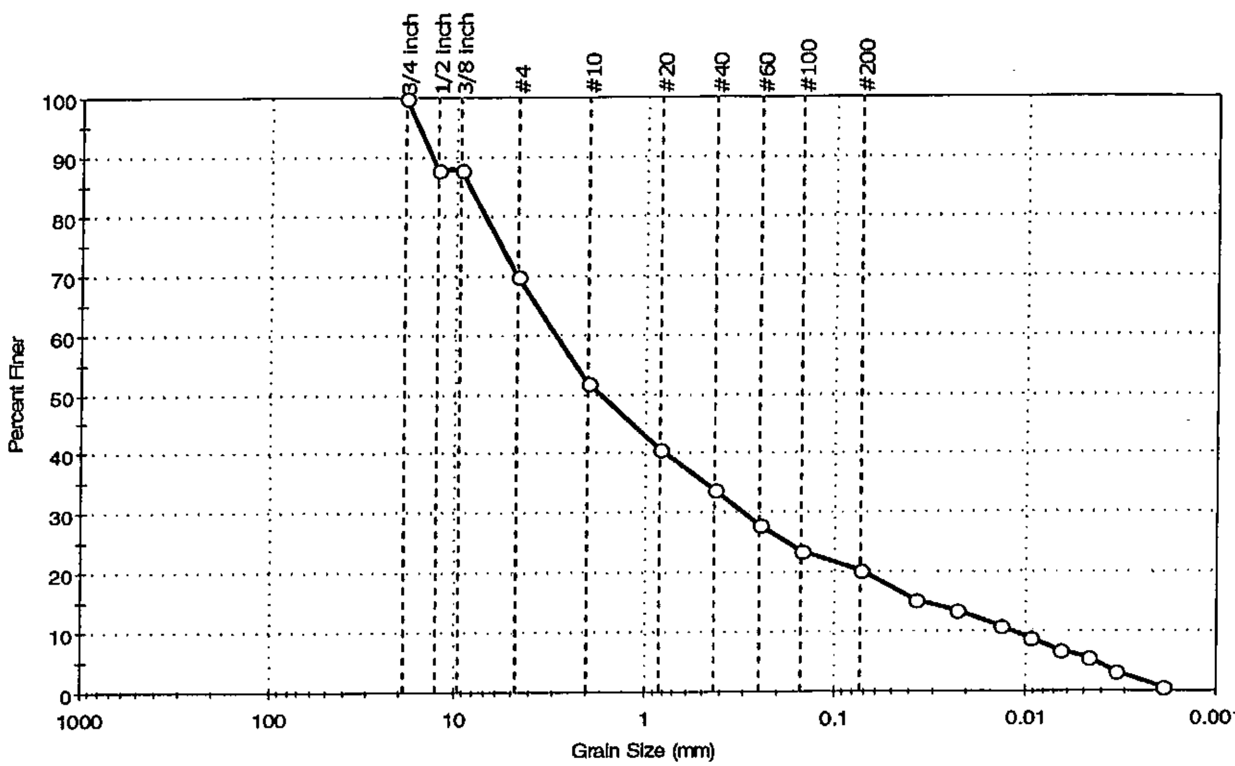
GeoTesting express

Client: Sanborn, Head & Associates			
Project: Building 57 SRI			
Location: Endicott, NY		Project No:	GTX-6079
Boring ID: S-11	Sample Type: jar	Tested By:	pcs
Sample ID:B57-109D	Test Date: 08/01/05	Checked By:	jdt
Depth : 21-23	Test Id: 73865		

Test Comment: ---
Sample Description: Moist, dark gray silty sand with gravel
Sample Comment: ---

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	30.3	49.4	20.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	88		
3/8 inch	9.51	88		
#4	4.75	70		
#10	2.00	52		
#20	0.84	41		
#40	0.42	34		
#60	0.25	28		
#100	0.15	24		
#200	0.074	20		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0372	15		
---	0.0226	14		
---	0.0134	11		
---	0.0095	9		
---	0.0067	7		
---	0.0047	6		
---	0.0034	3		
---	0.0019	1		

Coefficients

D_{85} =8.5071 mm D_{30} =0.2987 mm
D_{60} =2.9521 mm D_{15} =0.0334 mm
D_{50} =1.7148 mm D_{10} =0.0115 mm
C_u =256.704 C_c =2.628

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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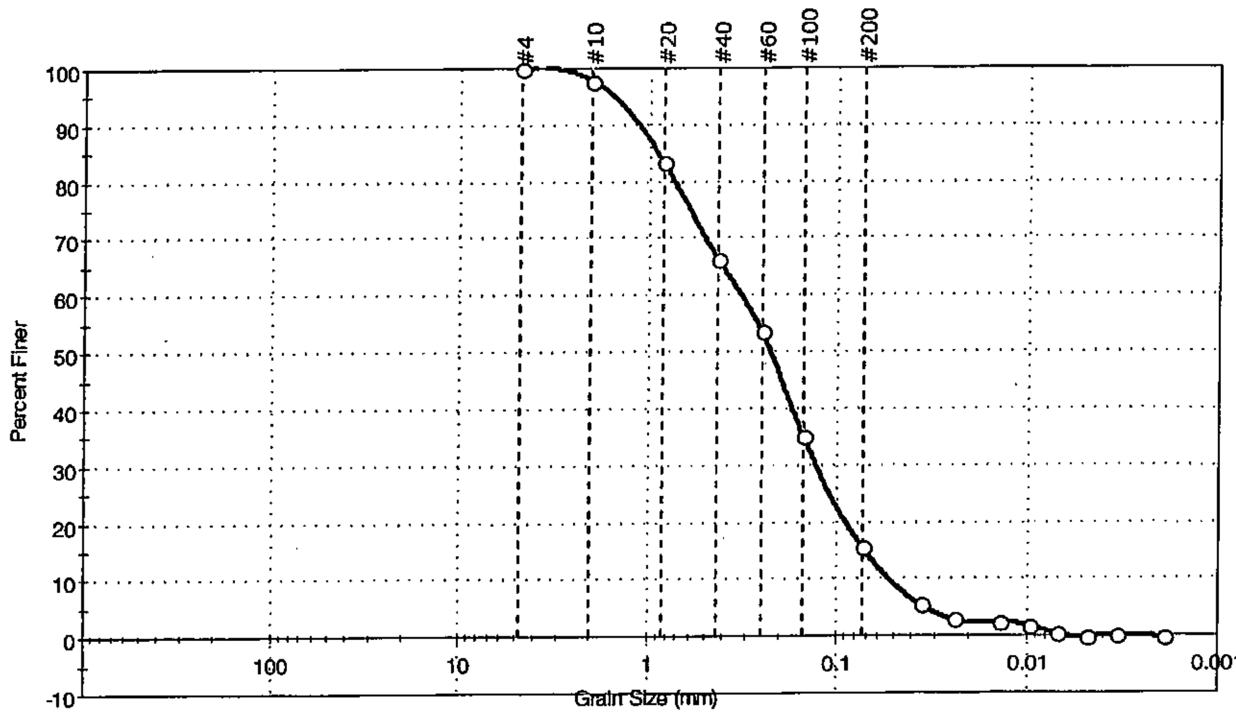
GeoTesting express

Client: Sanborn, Head & Associates			
Project: Building 57 SRI			
Location: Endicott, NY		Project No:	GTX-6079
Boring ID: S-12	Sample Type: jar	Tested By:	pcs
Sample ID: B57-109D	Test Date: 08/01/05	Checked By:	jdt
Depth : 23-25	Test Id: 73866		
Test Comment: ---			
Sample Description: Wet, dark brown silty sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	---	84.2	15.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	98		
#20	0.84	83		
#40	0.42	66		
#60	0.25	54		
#100	0.15	35		
#200	0.074	16		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0359	5		
---	0.0240	3		
---	0.0137	2		
---	0.0096	2		
---	0.0069	0		
---	0.0048	0		
---	0.0034	0		
---	0.0019	0		

Coefficients

D_{85} =0.9208 mm D_{30} =0.1249 mm

D_{60} =0.3272 mm D_{15} =0.0702 mm

D_{50} =0.2263 mm D_{10} =0.0494 mm

C_u =6.623 C_c =0.965

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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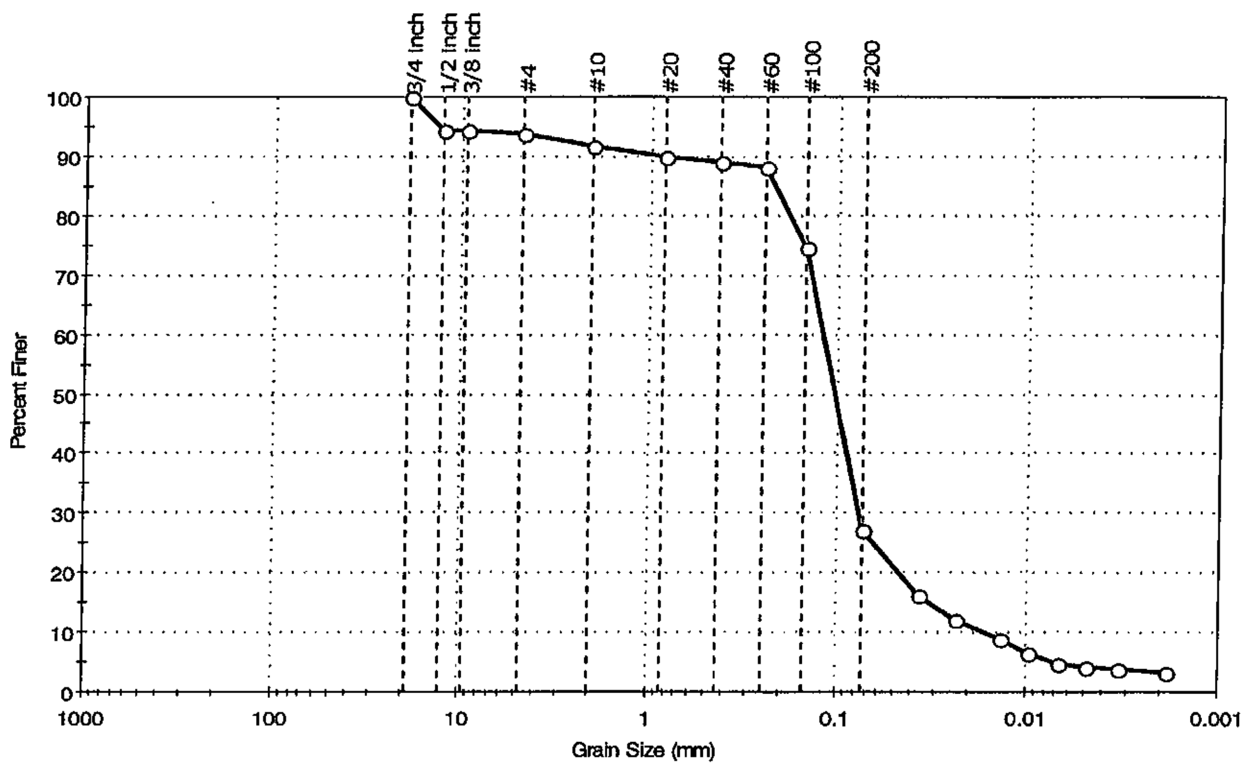
GeoTesting express

Client: Sanborn, Head & Associates			
Project: Building 57 SRI			
Location: Endicott, NY		Project No:	GTX-6079
Boring ID: S-13	Sample Type: jar	Tested By:	pcs
Sample ID: B57-109D	Test Date: 08/01/05	Checked By:	jdt
Depth : 25-25.5	Test Id: 73867		

Test Comment: ---
Sample Description: Moist, olive brown silty sand
Sample Comment: ---

Particle Size Analysis - ASTM D 422



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	6.3	66.6	27.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	94		
3/8 inch	9.51	94		
#4	4.75	94		
#10	2.00	92		
#20	0.84	90		
#40	0.42	89		
#60	0.25	88		
#100	0.15	75		
#200	0.074	27		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0364	16		
---	0.0232	12		
---	0.0135	9		
---	0.0096	6		
---	0.0067	5		
---	0.0048	4		
---	0.0033	4		
---	0.0019	3		

Coefficients

D_{85} =0.2207 mm
D_{30} =0.0772 mm
D_{60} =0.1206 mm
D_{15} =0.0322 mm
D_{50} =0.1039 mm
D_{10} =0.0162 mm
C_u =7.444
C_c =3.051

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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GeoTesting
express

WARRANTY and LIABILITY

GeoTesting Express (GTX) warrants that all tests it performs are run in general accordance with the specified test procedures and accepted industry practice. GTX will correct or repeat any test that does not comply with this warranty. GTX has no specific knowledge as to conditioning, origin, sampling procedure or intended use of the material.

GTX may report engineering parameters that require us to interpret the test data. Such parameters are determined using accepted engineering procedures. However, GTX does not warrant that these parameters accurately reflect the true engineering properties of the *in situ* material. Responsibility for interpretation and use of the test data and these parameters for engineering and/or construction purposes rests solely with the user and not with GTX or any of its employees.

GTX's liability will be limited to correcting or repeating a test which fails our warranty. GTX's liability for damages to the Purchaser of testing services for any cause whatsoever shall be limited to the amount GTX received for the testing services. GTX will not be liable for any damages, or for any lost benefits or other consequential damages resulting from the use of these test results, even if GTX has been advised of the possibility of such damages. GTX will not be responsible for any liability of the Purchaser to any third party.

Commonly Used Symbols

A	pore pressure parameter for $\Delta\sigma_1 - \Delta\sigma_3$
B	pore pressure parameter for $\Delta\sigma_3$
CIU	isotropically consolidated undrained triaxial shear test
CR	compression ratio for one dimensional consolidation
C_c	coefficient of curvature, $(D_{30})^2 / (D_{10} \times D_{60})$
C_u	coefficient of uniformity, D_{60}/D_{10}
C_c	compression index for one dimensional consolidation
C_α	coefficient of secondary compression
c_v	coefficient of consolidation
c	cohesion intercept for total stresses
c'	cohesion intercept for effective stresses
D	diameter of specimen
D_{10}	diameter at which 10% of soil is finer
D_{15}	diameter at which 15% of soil is finer
D_{30}	diameter at which 30% of soil is finer
D_{50}	diameter at which 50% of soil is finer
D_{60}	diameter at which 60% of soil is finer
D_{85}	diameter at which 85% of soil is finer
d_{50}	displacement for 50% consolidation
d_{90}	displacement for 90% consolidation
d_{100}	displacement for 100% consolidation
E	Young's modulus
e	void ratio
e_c	void ratio after consolidation
e_o	initial void ratio
G	shear modulus
G_s	specific gravity of soil particles
H	height of specimen
PI	plasticity index
i	gradient
K_o	lateral stress ratio for one dimensional strain
k	permeability
LI	Liquidity Index
m_v	coefficient of volume change
n	porosity
PI	plasticity index
P_c	preconsolidation pressure
p	$(\sigma_1 + \sigma_3) / 2$, $(\sigma_v + \sigma_h) / 2$
p'	$(\sigma'_1 + \sigma'_3) / 2$, $(\sigma'_v + \sigma'_h) / 2$
p'_c	p' at consolidation
Q	quantity of flow
q	$(\sigma_1 - \sigma_3) / 2$
q_f	q at failure
q_o, q_i	initial q
q_c	q at consolidation
S	degree of saturation
SL	shrinkage limit
s_u	undrained shear strength
T	time factor for consolidation

T	temperature
t	time
U, UC	unconfined compression test
UU, Q	unconsolidated undrained triaxial test
u_a	pore gas pressure
u_e	excess pore water pressure
u, u_w	pore water pressure
V	total volume
V_g	volume of gas
V_s	volume of solids
V_v	volume of voids
V_w	volume of water
V_o	initial volume
v	velocity
W	total weight
W_s	weight of solids
W_w	weight of water
w	water content
w_c	water content at consolidation
w_f	final water content
w_l	liquid limit
w_n	natural water content
w_p	plastic limit
w_s	shrinkage limit
w_o, w_i	initial water content
α	slope of q_f versus p_f
α'	slope of q_f versus p_f'
γ_t	total unit weight
γ_d	dry unit weight
γ_s	unit weight of solids
γ_w	unit weight of water
ε	strain
ε_{vol}	volume strain
ε_h, ε_v	horizontal strain, vertical strain
μ	Poisson's ratio, also viscosity
σ	normal stress
σ'	effective normal stress
σ_c, σ'_c	consolidation stress in isotropic stress system
σ_h, σ'_h	horizontal normal stress
σ_v, σ'_v	vertical normal stress
σ_1	major principal stress
σ_2	intermediate principal stress
σ_3	minor principal stress
τ	shear stress
φ	friction angle based on total stresses
φ'	friction angle based on effective stresses
φ'_r	residual friction angle
φ_{ult}	φ for ultimate strength

ATTACHMENT D.3

Soil Gradation and Specific Gravity Data
Investigations April and May 2007

SHPC
ENGINEERS

GeoTesting express
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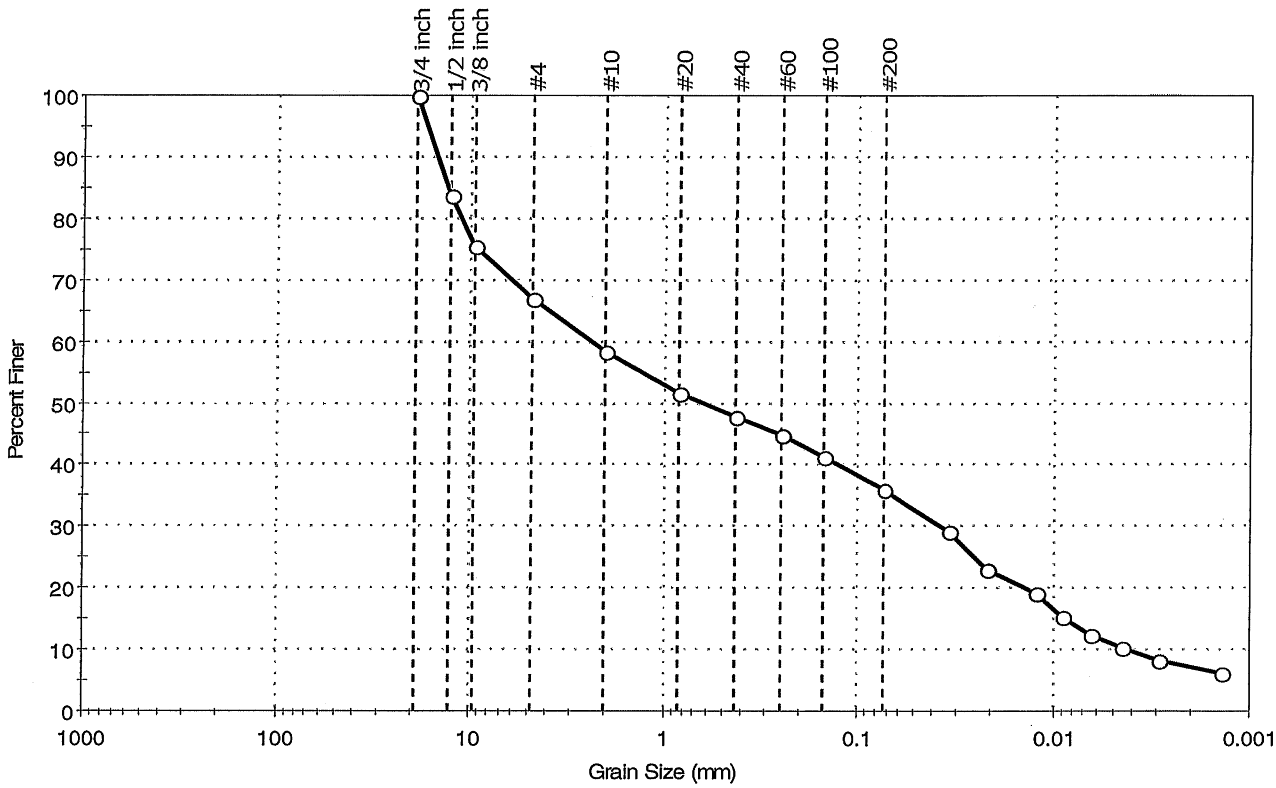
Client: Sanborn Head & Associates			
Project: Bldg 57 SRI			
Location: Endicott, NY		Project No:	GTX-7477
Boring ID: B+28, 41+2	Sample Type: bag	Tested By:	mll
Sample ID:S-5	Test Date: 05/21/07	Checked By:	jdt
Depth : 9-11 ft	Test Id: 111721		

Test Comment: ---
Sample Description: Moist, dark grayish brown clayey gravel with sand
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	32.9	31.0	36.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	84		
3/8 inch	9.51	76		
#4	4.75	67		
#10	2.00	58		
#20	0.84	52		
#40	0.42	48		
#60	0.25	45		
#100	0.15	41		
#200	0.074	36		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0332	29		
---	0.0213	23		
---	0.0124	19		
---	0.0090	15		
---	0.0064	12		
---	0.0045	10		
---	0.0029	8		
---	0.0014	6		

Coefficients

D_{85} =13.1003 mm — D_{30} =0.0369 mm
D_{60} =2.3621 mm — D_{15} =0.0087 mm
D_{50} =0.6297 mm — D_{10} =0.0041 mm
C_u =N/A — C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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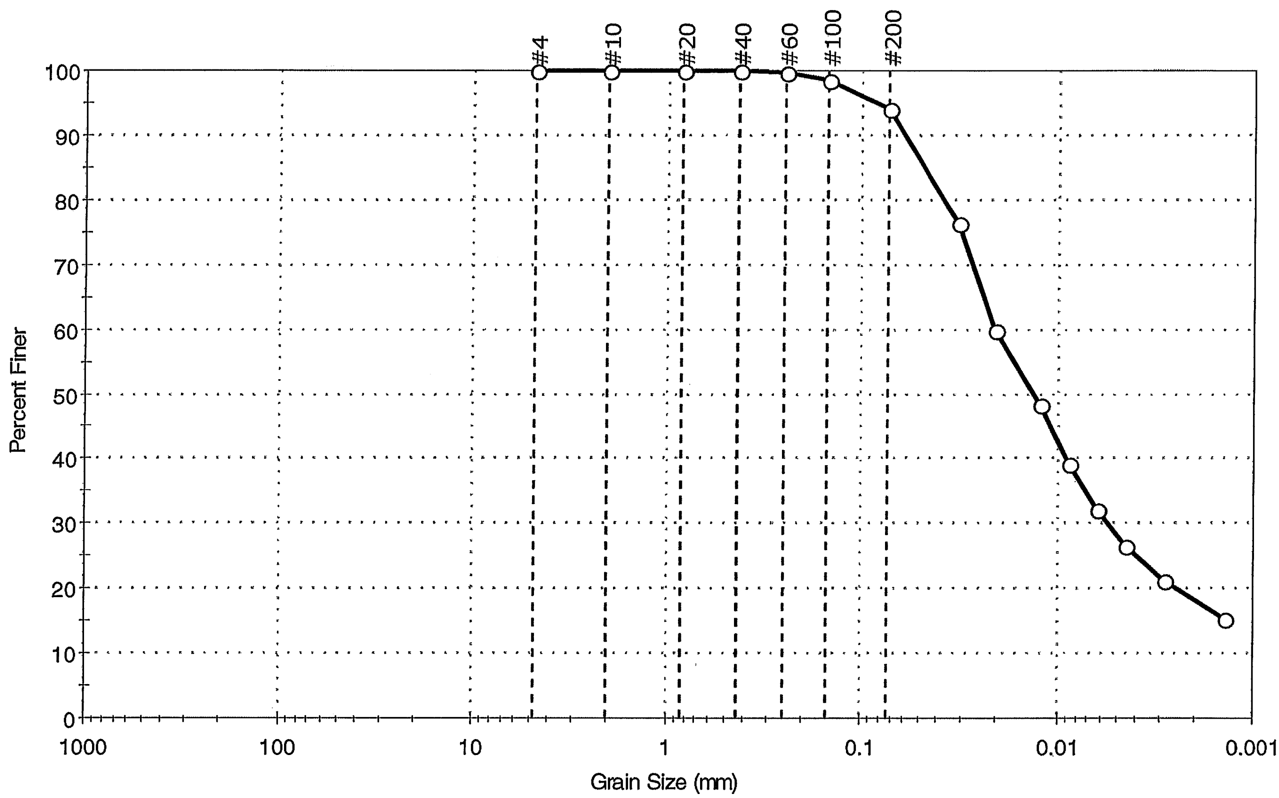
Client: Sanborn Head & Associates			
Project: Bldg 57 SRI			
Location: Endicott, NY		Project No:	GTX-7477
Boring ID: B+29, 17+8	Sample Type: bag	Tested By:	mll
Sample ID:S3B	Test Date: 05/24/07	Checked By:	jdt
Depth : 8.6-10 ft	Test Id: 111725		
Test Comment: ---			
Sample Description: Moist, olive gray clay			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	5.8	94.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.84	100		
#40	0.42	100		
#60	0.25	100		
#100	0.15	99		
#200	0.074	94		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0317	76		
---	0.0205	60		
---	0.0121	48		
---	0.0088	39		
---	0.0063	32		
---	0.0045	27		
---	0.0029	21		
---	0.0014	15		

Coefficients

D_{85} =0.0479 mm D_{30} =0.0055 mm
D_{60} =0.0205 mm D_{15} =N/A
D_{50} =0.0131 mm D_{10} =N/A
C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED
Sand/Gravel Hardness : HARD

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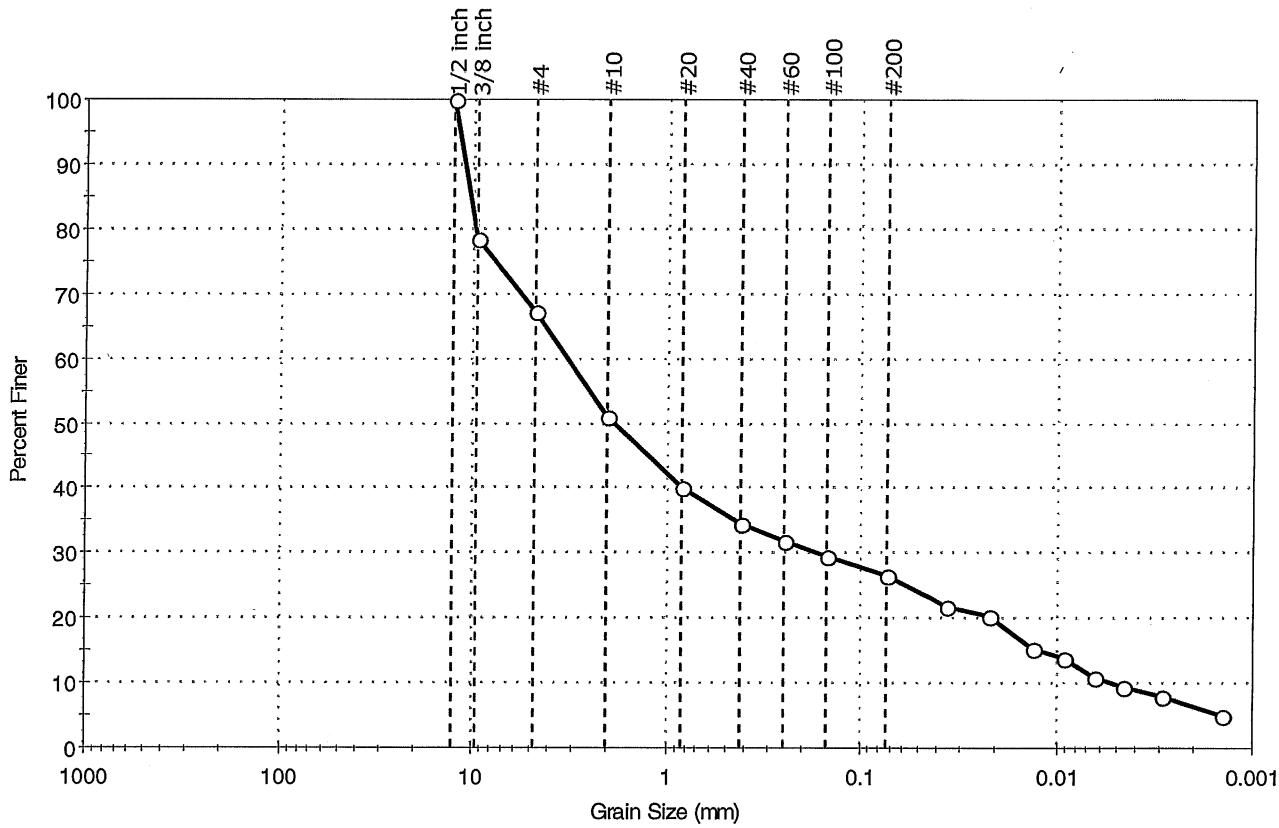
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	Sanborn Head & Associates				
Project:	Bldg 57 SRI				
Location:	Endicott, NY			Project No:	GTX-7477
Boring ID:	B+29, 17+8	Sample Type:	bag	Tested By:	mll
Sample ID:	S3A	Test Date:	05/24/07	Checked By:	jdt
Depth :	8-8.6 ft	Test Id:	111726		

Test Comment: ---
Sample Description: Moist, olive clayey sand with gravel
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	32.8	40.7	26.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1/2 inch	12.70	100		
3/8 inch	9.51	78		
#4	4.75	67		
#10	2.00	51		
#20	0.84	40		
#40	0.42	35		
#60	0.25	32		
#100	0.15	29		
#200	0.074	27		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0361	22		
---	0.0219	20		
---	0.0130	15		
---	0.0092	14		
---	0.0065	11		
---	0.0046	9		
---	0.0030	8		
---	0.0014	5		

Coefficients

D_{85} =10.3854 mm D_{30} =0.1699 mm
D_{60} =3.2383 mm D_{15} =0.0118 mm
D_{50} =1.8537 mm D_{10} =0.0054 mm
C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

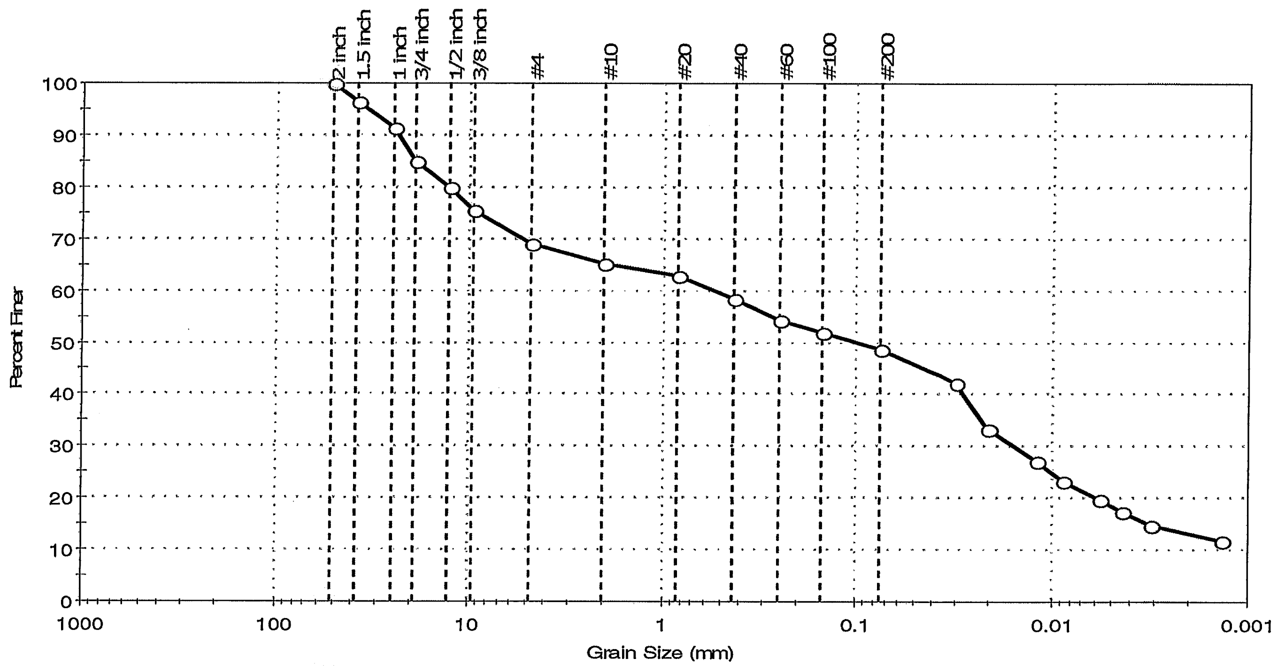
Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	Sanborn Head & Associates				
Project:	Bldg 57 SRI				
Location:	Endicott, NY			Project No:	GTX-7477
Boring ID:	B+30, 45+20	Sample Type:	bag	Tested By:	mll
Sample ID:	S-3	Test Date:	05/21/07	Checked By:	jdt
Depth :	4-5 ft	Test Id:	111719		
Test Comment:	---				
Sample Description:	Moist, light olive brown clayey gravel with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	30.9	20.5	48.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
2 inch	50.80	100		
1.5 inch	38.10	97		
1 inch	25.00	91		
3/4 inch	19.00	85		
1/2 inch	12.70	80		
3/8 inch	9.51	75		
#4	4.75	69		
#10	2.00	65		
#20	0.84	63		
#40	0.42	58		
#60	0.25	54		
#100	0.15	52		
#200	0.075	49		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0306	42		
---	0.0205	33		
---	0.0120	27		
---	0.0087	23		
---	0.0057	20		
---	0.0044	17		
---	0.0032	15		
---	0.0014	12		

Coefficients

D_{85} =19.1295 mm
D_{30} =0.0155 mm
D_{60} =0.5480 mm
D_{15} =0.0032 mm
D_{50} =0.1006 mm
D_{10} =0.0008 mm
C_u =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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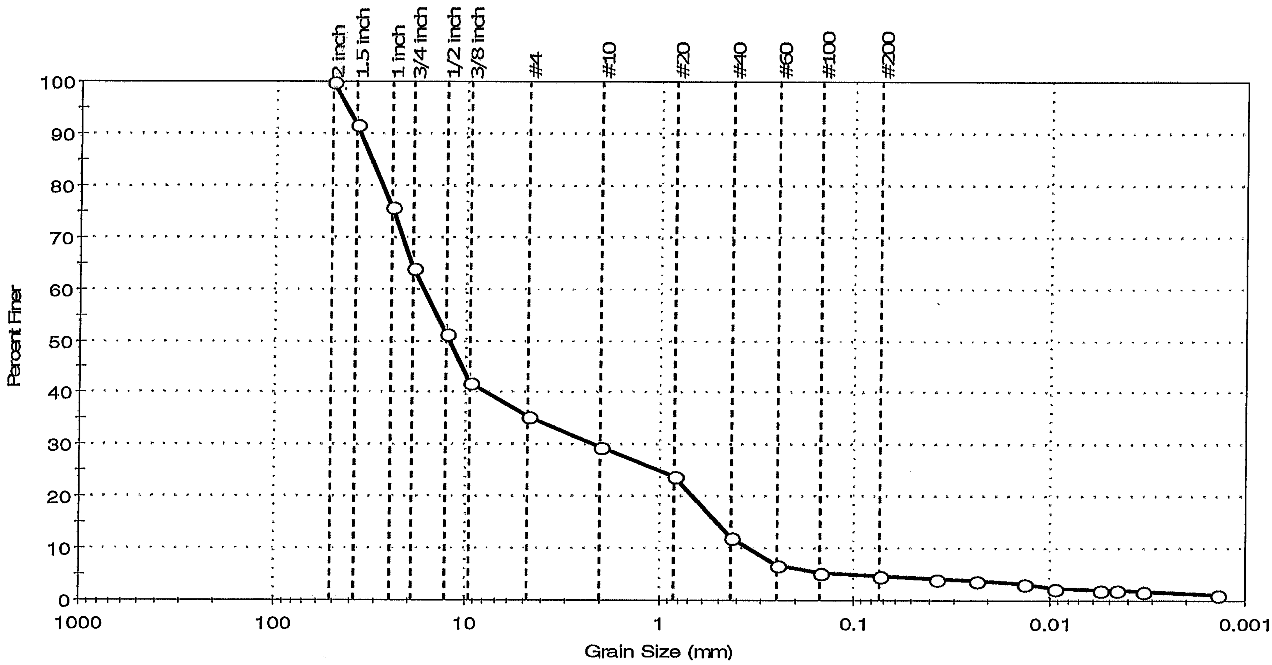
Client:	Sanborn Head & Associates				
Project:	Bldg 57 SRI				
Location:	Endicott, NY			Project No:	GTX-7477
Boring ID:	B+40, 45+12	Sample Type:	bag	Tested By:	mll
Sample ID:	S2	Test Date:	05/21/07	Checked By:	jdt
Depth :	4 ft	Test Id:	111720		
Test Comment:	---				
Sample Description:	Moist, light olive brown gravel with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	64.5	30.8	4.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
2 inch	50.80	100		
1.5 inch	38.10	92		
1 inch	25.00	76		
3/4 inch	19.00	64		
1/2 inch	12.70	51		
3/8 inch	9.51	42		
#4	4.75	35		
#10	2.00	30		
#20	0.84	24		
#40	0.42	12		
#60	0.25	7		
#100	0.15	5		
#200	0.074	5		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0373	4		
---	0.0233	4		
---	0.0134	3		
---	0.0094	2		
---	0.0056	2		
---	0.0046	2		
---	0.0034	2		
---	0.0014	1		

Coefficients

D_{85} =31.8167 mm	D_{30} =2.1333 mm
D_{60} =16.7418 mm	D_{15} =0.5029 mm
D_{50} =12.2286 mm	D_{10} =0.3456 mm
C_u =48.443	C_c =0.787

Classification

ASTM Poorly graded gravel with sand (GP)

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

printed 5/24/2007 11:27:09 AM

GeoTesting express
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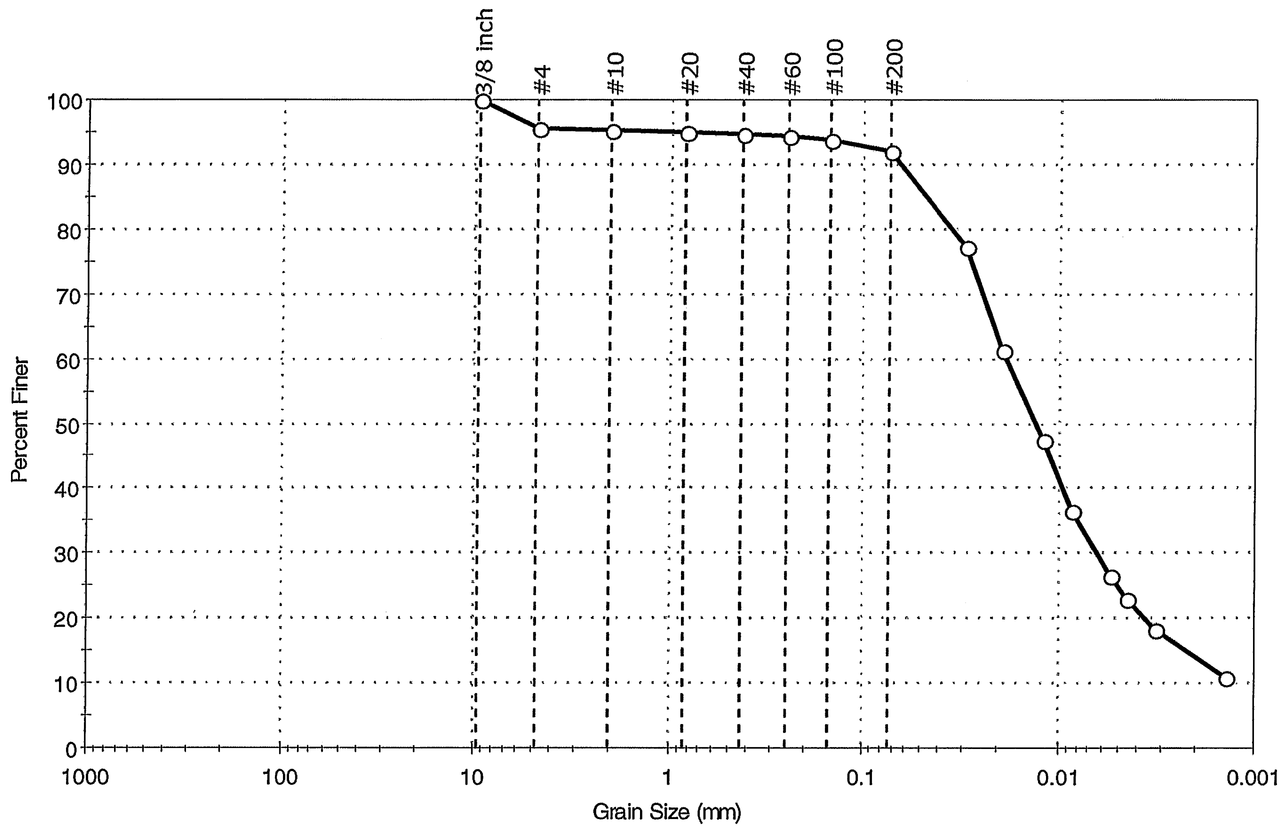
Client:	Sanborn Head & Associates				
Project:	Bldg 57 SRI				
Location:	Endicott, NY			Project No:	GTX-7477
Boring ID:	B+40, 45+12	Sample Type:	bag	Tested By:	mll
Sample ID:	S3B	Test Date:	05/22/07	Checked By:	jdt
Depth :	9-11 ft	Test Id:	111727		

Test Comment: ---
Sample Description: Moist, olive gray clay
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	4.4	3.6	92.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/8 inch	9.51	100		
#4	4.75	96		
#10	2.00	95		
#20	0.84	95		
#40	0.42	95		
#60	0.25	94		
#100	0.15	94		
#200	0.074	92		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0294	77		
---	0.0192	61		
---	0.0118	48		
---	0.0086	37		
---	0.0054	27		
---	0.0045	23		
---	0.0032	18		
---	0.0014	11		

Coefficients

D_{85} =0.0476 mm	D_{30} =0.0063 mm
D_{60} =0.0183 mm	D_{15} =0.0022 mm
D_{50} =0.0129 mm	D_{10} =0.0013 mm
C_u =N/A	C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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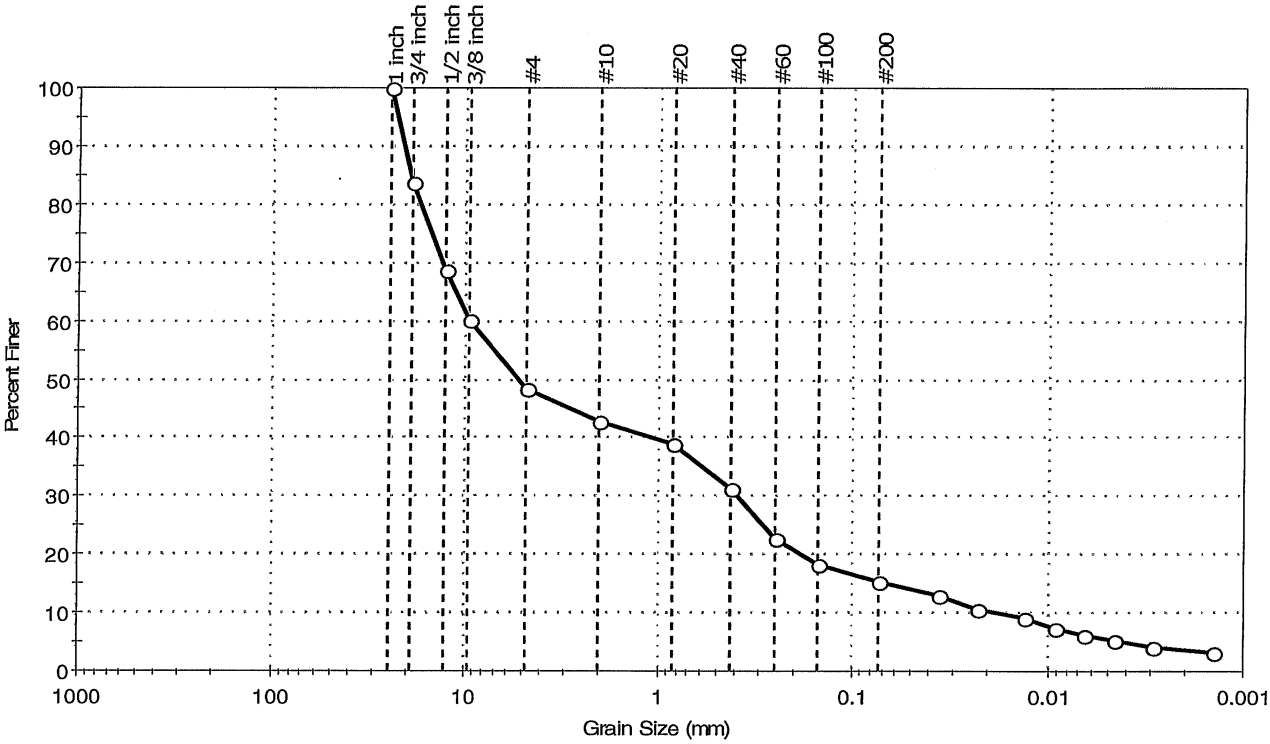
Client:	Sanborn Head & Associates				
Project:	Bldg 57 SRI				
Location:	Endicott, NY			Project No:	GTX-7477
Boring ID:	C+15, 42+12	Sample Type:	bag	Tested By:	mll
Sample ID:	S-3	Test Date:	05/21/07	Checked By:	jdt
Depth :	5 ft	Test Id:	111724		
Test Comment:	---				
Sample Description:	Moist, dark grayish brown silty gravel with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	51.7	33.1	15.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 inch	25.00	100		
3/4 inch	19.00	84		
1/2 inch	12.70	69		
3/8 inch	9.51	60		
#4	4.75	48		
#10	2.00	43		
#20	0.84	39		
#40	0.42	31		
#60	0.25	23		
#100	0.15	18		
#200	0.074	15		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0358	13		
---	0.0226	11		
---	0.0130	9		
---	0.0093	7		
---	0.0066	6		
---	0.0046	5		
---	0.0029	4		
---	0.0014	3		

Coefficients

D_{85} =19.3634 mm
D_{30} =0.3877 mm
D_{60} =9.4790 mm
D_{15} =0.0693 mm
D_{50} =5.2374 mm
D_{10} =0.0178 mm
C_u =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED
Sand/Gravel Hardness : HARD

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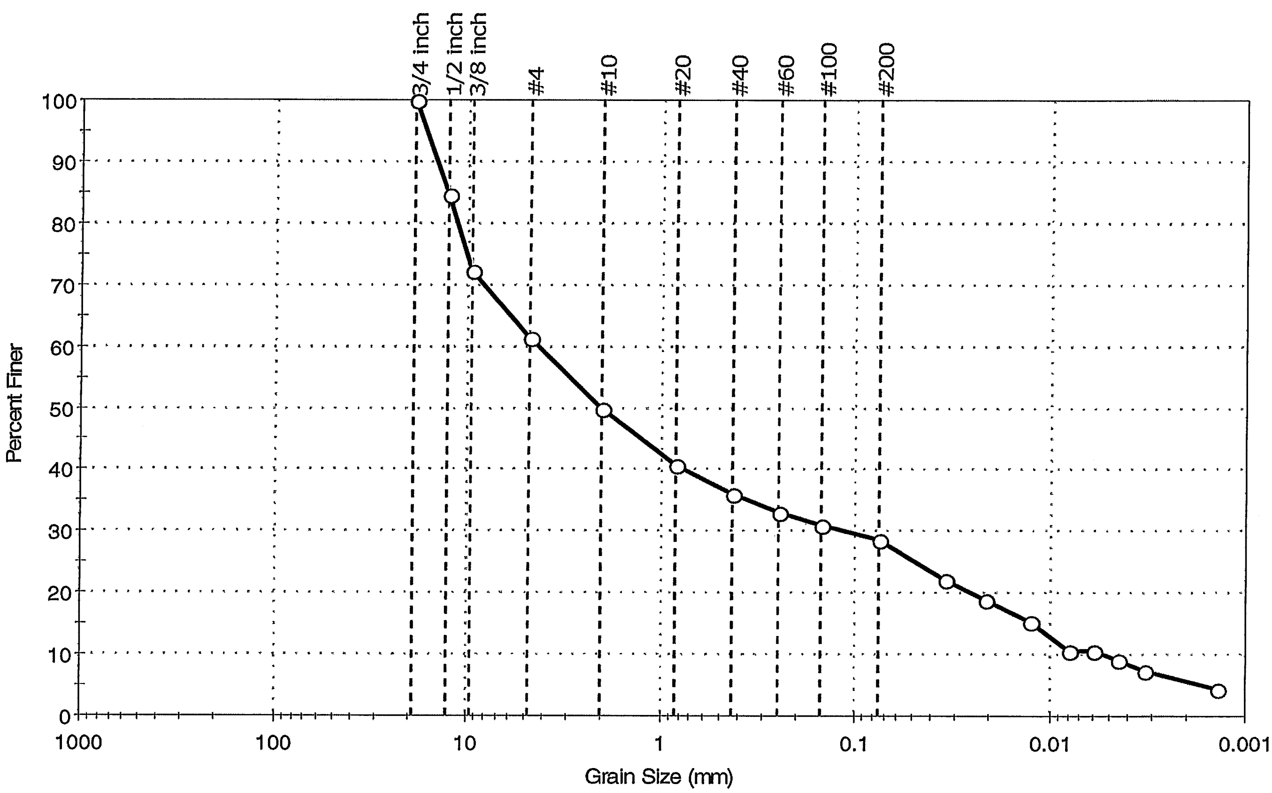
Client:	Sanborn Head & Associates				
Project:	Bldg 57 SRI				
Location:	Endicott, NY			Project No:	GTX-7477
Boring ID:	C+2, 18+7	Sample Type:	bag	Tested By:	mll
Sample ID:	S3A	Test Date:	05/21/07	Checked By:	jdt
Depth :	8-9.5 ft	Test Id:	111715		
Test Comment:	---				
Sample Description:	Moist, olive gray clayey gravel with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	38.7	32.6	28.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	85		
3/8 inch	9.51	72		
#4	4.75	61		
#10	2.00	50		
#20	0.84	41		
#40	0.42	36		
#60	0.25	33		
#100	0.15	31		
#200	0.075	29		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0341	22		
---	0.0213	19		
---	0.0126	15		
---	0.0080	11		
---	0.0060	11		
---	0.0045	9		
---	0.0033	7		
---	0.0014	4		

Coefficients

D_{85} = 12.8058 mm D_{30} = 0.1096 mm
D_{60} = 4.2878 mm D_{15} = 0.0122 mm
D_{50} = 2.0173 mm D_{10} = 0.0054 mm
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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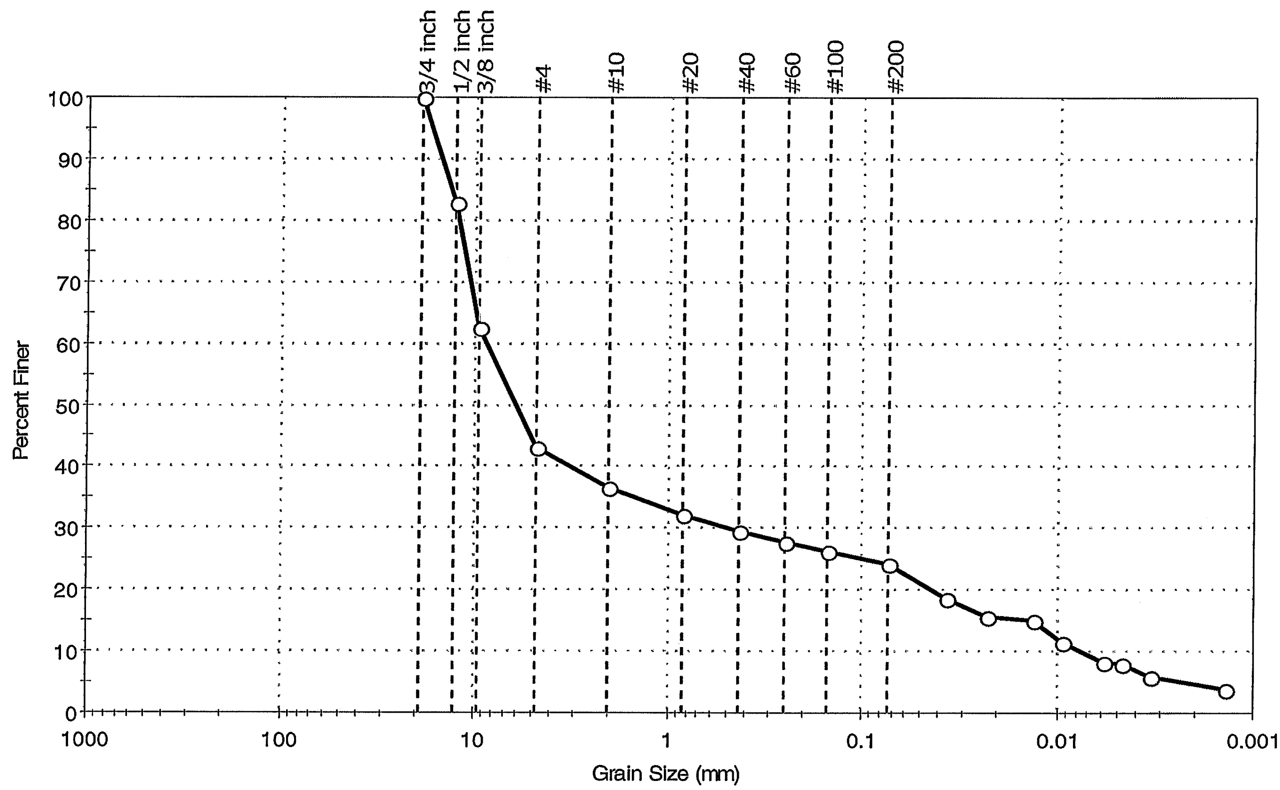
Client:	Sanborn Head & Associates				
Project:	Bldg 57 SRI				
Location:	Endicott, NY			Project No:	GTX-7477
Boring ID:	C+30, 32+19	Sample Type:	bag	Tested By:	mll
Sample ID:	S-4	Test Date:	05/17/07	Checked By:	jdt
Depth :	7.5-9.5 ft	Test Id:	111713		
Test Comment:	---				
Sample Description:	Moist, olive gray clayey gravel with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	57.0	18.7	24.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	83		
3/8 inch	9.51	62		
#4	4.75	43		
#10	2.00	37		
#20	0.84	32		
#40	0.42	29		
#60	0.25	28		
#100	0.15	26		
#200	0.074	24		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0367	19		
---	0.0230	16		
---	0.0132	15		
---	0.0094	11		
---	0.0058	8		
---	0.0047	8		
---	0.0033	6		
---	0.0014	4		

Coefficients

D_{85} =13.3293 mm — D_{30} =0.4929 mm

D_{60} =8.7118 mm — D_{15} =0.0142 mm

D_{50} =6.0932 mm — D_{10} =0.0075 mm

C_u =N/A — C_c =N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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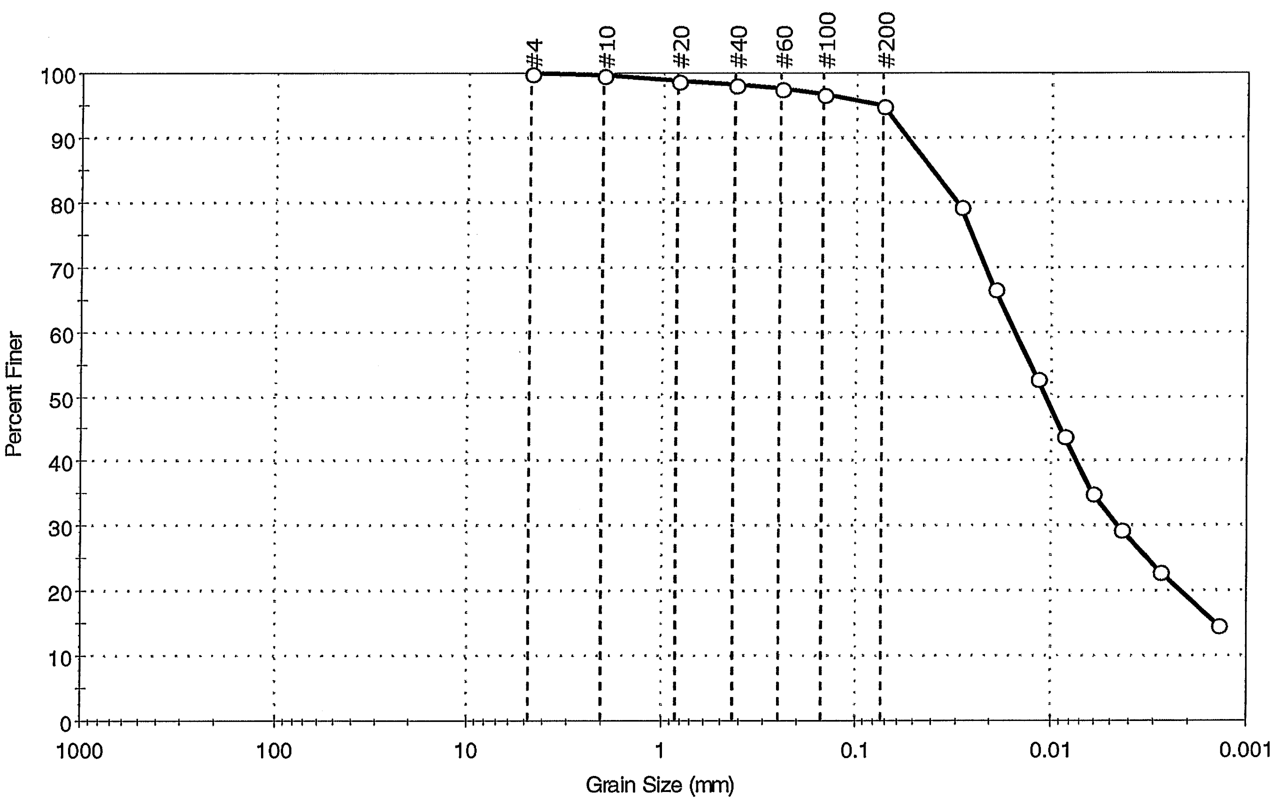
Client: Sanborn Head & Associates			
Project: Bldg 57 SRI			
Location: Endicott, NY		Project No:	GTX-7477
Boring ID: C+30, 41+32	Sample Type: bag	Tested By:	mll
Sample ID:S4C	Test Date: 05/24/07	Checked By:	jdt
Depth : 8.5-11 ft	Test Id: 111717		

Test Comment: ---
Sample Description: Moist, dark gray clay
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	4.9	95.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.84	99		
#40	0.42	98		
#60	0.25	98		
#100	0.15	97		
#200	0.074	95		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0289	79		
---	0.0194	67		
---	0.0117	53		
---	0.0085	44		
---	0.0062	35		
---	0.0044	29		
---	0.0028	23		
---	0.0014	15		

Coefficients

D_{85} =0.0404 mm
D_{30} =0.0045 mm
D_{60} =0.0153 mm
D_{15} =0.0014 mm
D_{50} =0.0106 mm
D_{10} =0.0009 mm
C_u =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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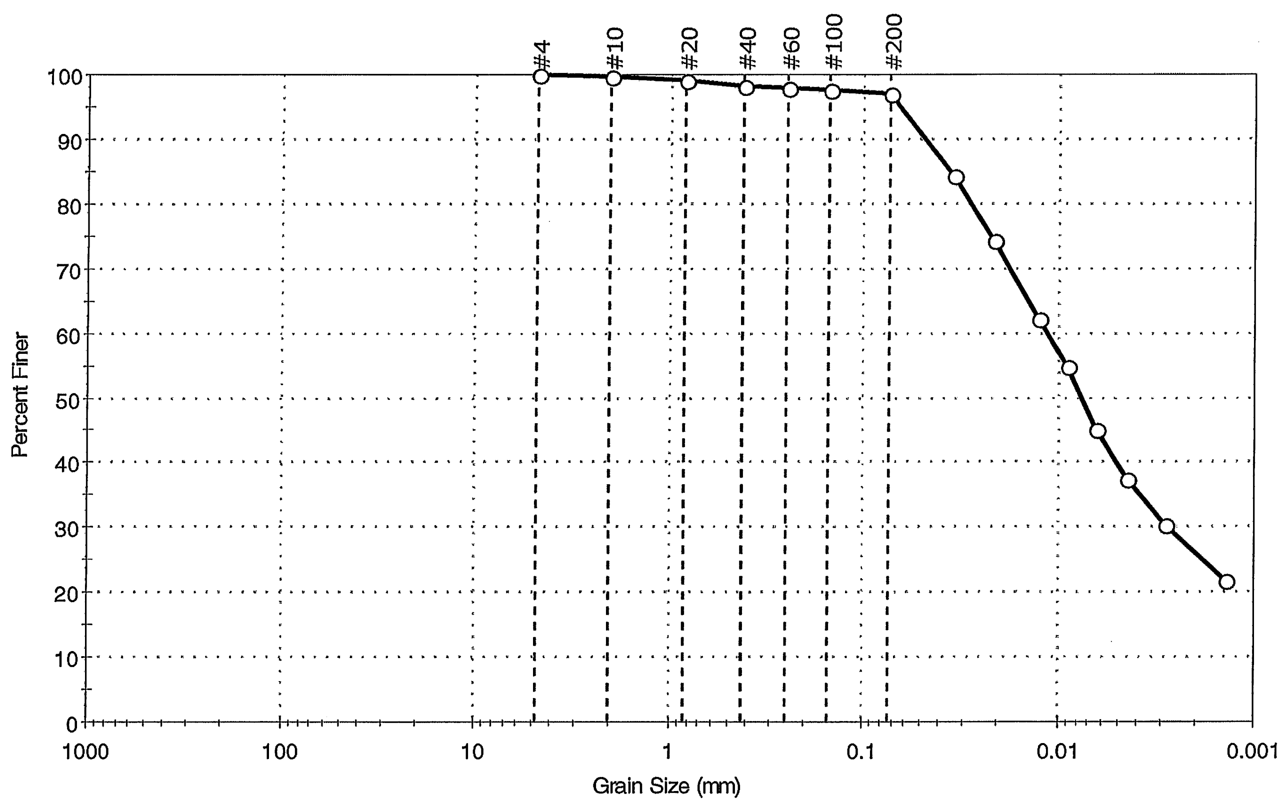
Client:	Sanborn Head & Associates				
Project:	Bldg 57 SRI				
Location:	Endicott, NY			Project No:	GTX-7477
Boring ID:	EN662	Sample Type:	bag	Tested By:	mll
Sample ID:	S5	Test Date:	05/24/07	Checked By:	jdt
Depth :	8-10 ft	Test Id:	111718		
Test Comment:	---				
Sample Description:	Moist, gray clay				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	2.9	97.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.84	99		
#40	0.42	98		
#60	0.25	98		
#100	0.15	98		
#200	0.074	97		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0340	84		
---	0.0212	74		
---	0.0126	62		
---	0.0090	55		
---	0.0064	45		
---	0.0045	38		
---	0.0029	30		
---	0.0014	22		

Coefficients

D_{85} =0.0353 mm D_{30} =0.0028 mm
D_{60} =0.0113 mm D_{15} =N/A
D_{50} =0.0076 mm D_{10} =N/A
C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ---

Sand/Gravel Hardness : ---

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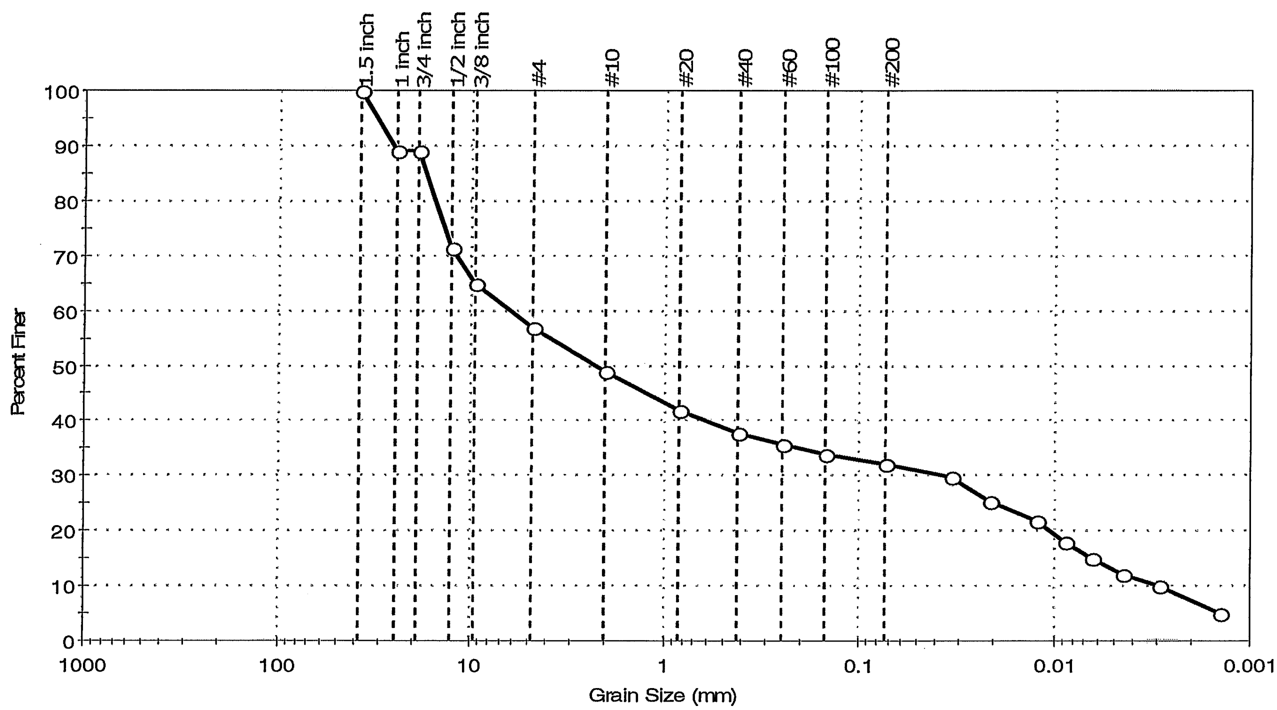
Client: Sanborn Head & Associates			
Project: Bldg 57 SRI			
Location: Endicott, NY		Project No:	GTX-7477
Boring ID: EN662	Sample Type: bag	Tested By:	mll
Sample ID:S-8	Test Date: 05/21/07	Checked By:	jdt
Depth : 17-17.9 ft	Test Id: 111723		
Test Comment: ---			
Sample Description: Moist, olive brown clayey gravel with sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	42.9	25.0	32.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 inch	38.10	100		
1 inch	25.00	89		
3/4 inch	19.00	89		
1/2 inch	12.70	71		
3/8 inch	9.51	65		
#4	4.75	57		
#10	2.00	49		
#20	0.84	42		
#40	0.42	38		
#60	0.25	36		
#100	0.15	34		
#200	0.074	32		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0335	30		
---	0.0213	25		
---	0.0124	22		
---	0.0088	18		
---	0.0064	15		
---	0.0045	12		
---	0.0029	10		
---	0.0014	5		

Coefficients

D_{85} =17.3255 mm　　D_{30} =0.0372 mm
D_{60} =6.1574 mm　　D_{15} =0.0063 mm
D_{50} =2.2405 mm　　D_{10} =0.0030 mm
C_u =N/A　　C_c =N/A

Classification

ASTM　N/A

AASHTO　Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED
Sand/Gravel Hardness : HARD

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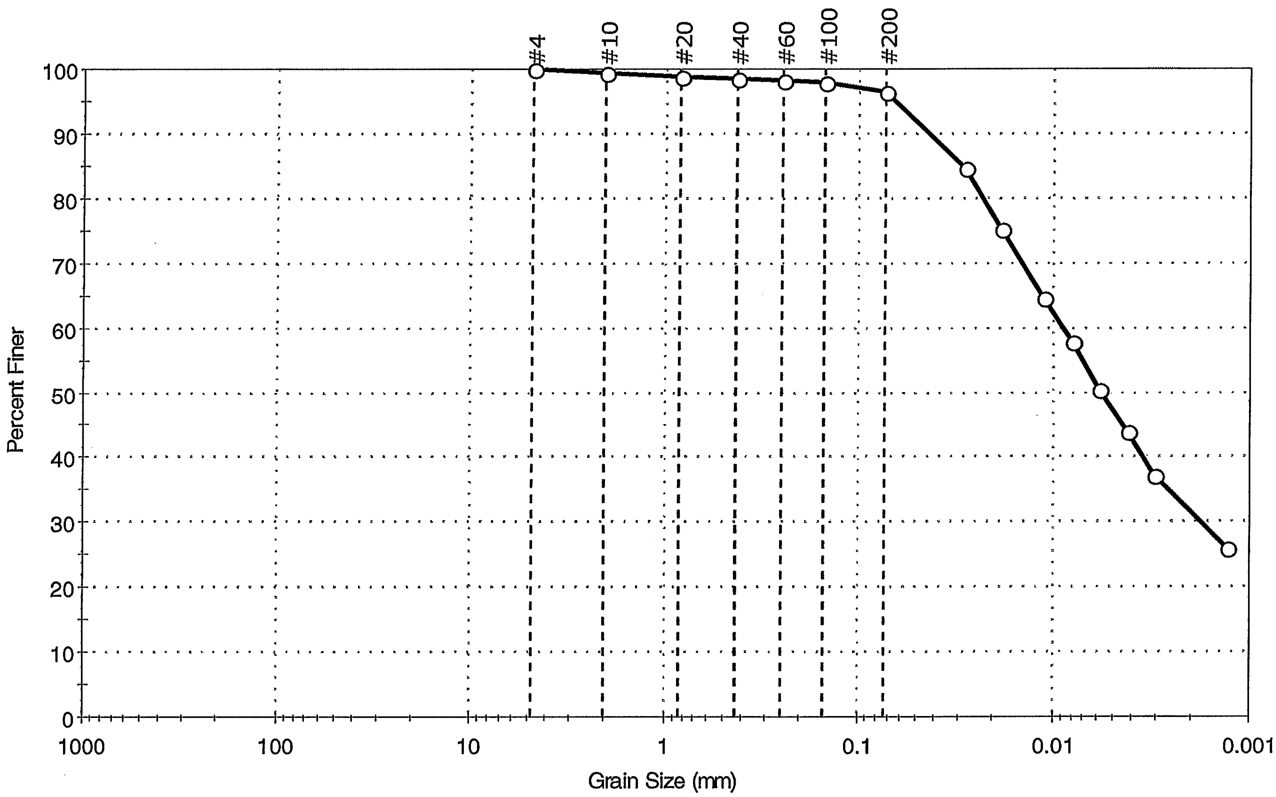
Client:	Sanborn Head & Associates				
Project:	Bldg 57 SRI				
Location:	Endicott, NY			Project No:	GTX-7477
Boring ID:	EN663	Sample Type:	bag	Tested By:	mll
Sample ID:	S3B	Test Date:	05/22/07	Checked By:	jdt
Depth :	9-10 ft	Test Id:	111714		
Test Comment:	---				
Sample Description:	Moist, very dark grayish brown clay				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	3.4	96.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.84	99		
#40	0.42	99		
#60	0.25	98		
#100	0.15	98		
#200	0.074	97		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0284	85		
---	0.0185	75		
---	0.0111	64		
---	0.0080	58		
---	0.0058	51		
---	0.0042	44		
---	0.0030	37		
---	0.0013	26		

Coefficients

D_{85} =0.0289 mm	D_{30} =0.0018 mm
D_{60} =0.0089 mm	D_{15} =N/A
D_{50} =0.0057 mm	D_{10} =N/A
C_u =N/A	C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
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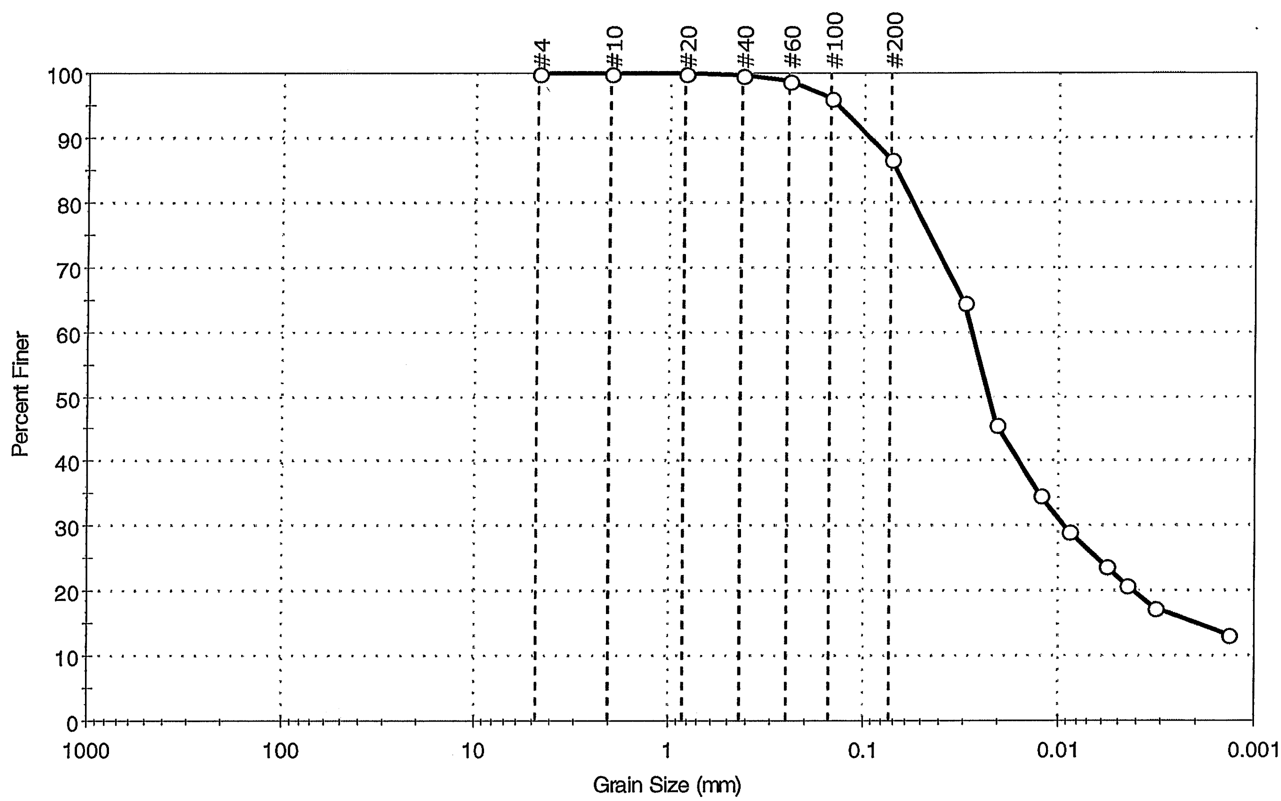
Client:	Sanborn Head & Associates				
Project:	Bldg 57 SRI				
Location:	Endicott, NY			Project No:	GTX-7477
Boring ID:	EN666	Sample Type:	bag	Tested By:	mll
Sample ID:	S7	Test Date:	05/22/07	Checked By:	jdt
Depth :	13.5-15.5 ft	Test Id:	111711		
Test Comment:	---				
Sample Description:	Moist, dark gray clay				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	13.2	86.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.84	100		
#40	0.42	100		
#60	0.25	99		
#100	0.15	96		
#200	0.074	87		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0307	64		
---	0.0208	46		
---	0.0124	35		
---	0.0089	29		
---	0.0057	24		
---	0.0045	21		
---	0.0032	18		
---	0.0014	13		

Coefficients

D_{85} =0.0690 mm — D_{30} =0.0093 mm

D_{60} =0.0280 mm — D_{15} =0.0020 mm

D_{50} =0.0228 mm — D_{10} =0.0007 mm

C_u =N/A — C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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GeoTesting express
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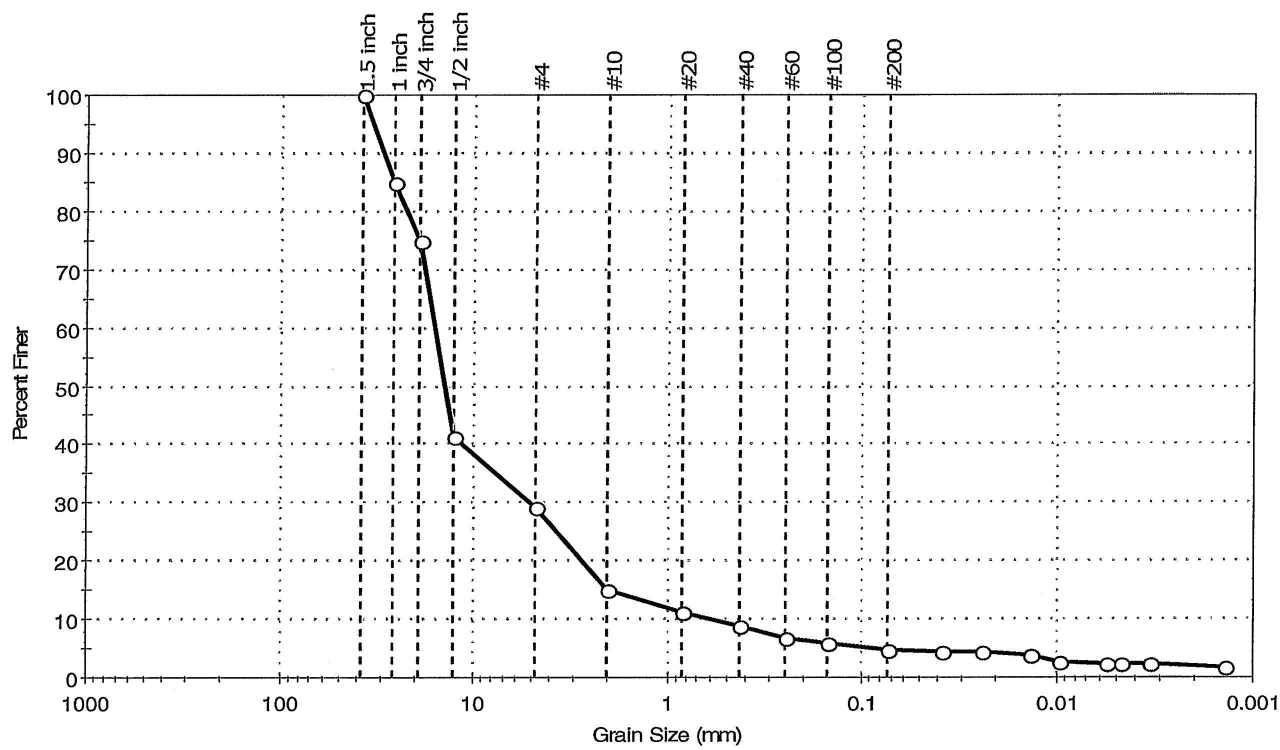
Client:	Sanborn Head & Associates		
Project:	Bldg 57 SRI		
Location:	Endicott, NY	Project No:	GTX-7477
Boring ID: EN666	Sample Type: bag	Tested By:	mll
Sample ID:S-4	Test Date: 05/17/07	Checked By:	jdt
Depth : 7-9 ft	Test Id: 111712		
Test Comment:	---		
Sample Description:	Moist, dark grayish brown gravel with sand		
Sample Comment:	---		

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	70.9	24.3	4.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 inch	38.10	100		
1 inch	25.70	85		
3/4 inch	19.00	75		
1/2 inch	12.70	41		
#4	4.75	29		
#10	2.00	15		
#20	0.84	11		
#40	0.42	9		
#60	0.25	7		
#100	0.15	6		
#200	0.074	5		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0381	4		
---	0.0237	4		
---	0.0136	4		
---	0.0095	3		
---	0.0056	2		
---	0.0048	2		
---	0.0034	2		
---	0.0014	2		

Coefficients

D_{85} =25.7466 mm D_{30} =5.1173 mm
D_{60} =15.8966 mm D_{15} =2.0085 mm
D_{50} =14.0967 mm D_{10} =0.6084 mm
C_u =26.129 C_c =2.708

Classification

ASTM   Well-graded gravel with sand (GW)

AASHTO   Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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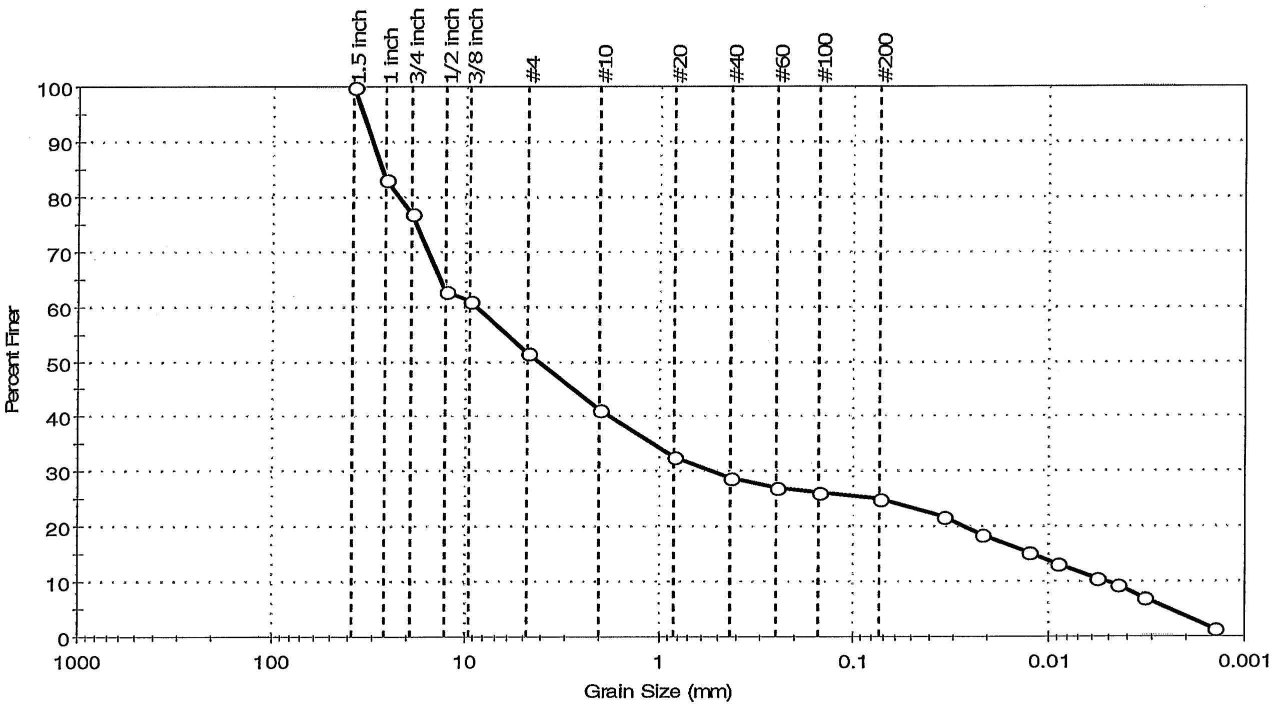
Client: Sanborn Head & Associates			
Project: Bldg 57 SRI			
Location: Endicott, NY		Project No:	GTX-7477
Boring ID: EN668	Sample Type: bag	Tested By:	mll
Sample ID: S-10	Test Date: 05/17/07	Checked By:	jdt
Depth : 22-22.6 ft	Test Id: 111716		
Test Comment: ---			
Sample Description: Moist, gray clayey gravel with sand			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	48.4	26.6	25.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1.5 inch	38.10	100		
1 inch	25.70	83		
3/4 inch	19.00	77		
1/2 inch	12.70	63		
3/8 inch	9.51	61		
#4	4.75	52		
#10	2.00	41		
#20	0.84	33		
#40	0.42	29		
#60	0.25	27		
#100	0.15	26		
#200	0.074	25		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0345	22		
---	0.0219	19		
---	0.0125	15		
---	0.0090	13		
---	0.0057	11		
---	0.0045	9		
---	0.0033	7		
---	0.0014	1		

Coefficients

D_{85} = 26.8651 mm D_{30} = 0.5133 mm
D_{60} = 8.7797 mm D_{15} = 0.0117 mm
D_{50} = 4.1394 mm D_{10} = 0.0051 mm
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

printed 5/24/2007 11:32:01 AM

GeoTesting express
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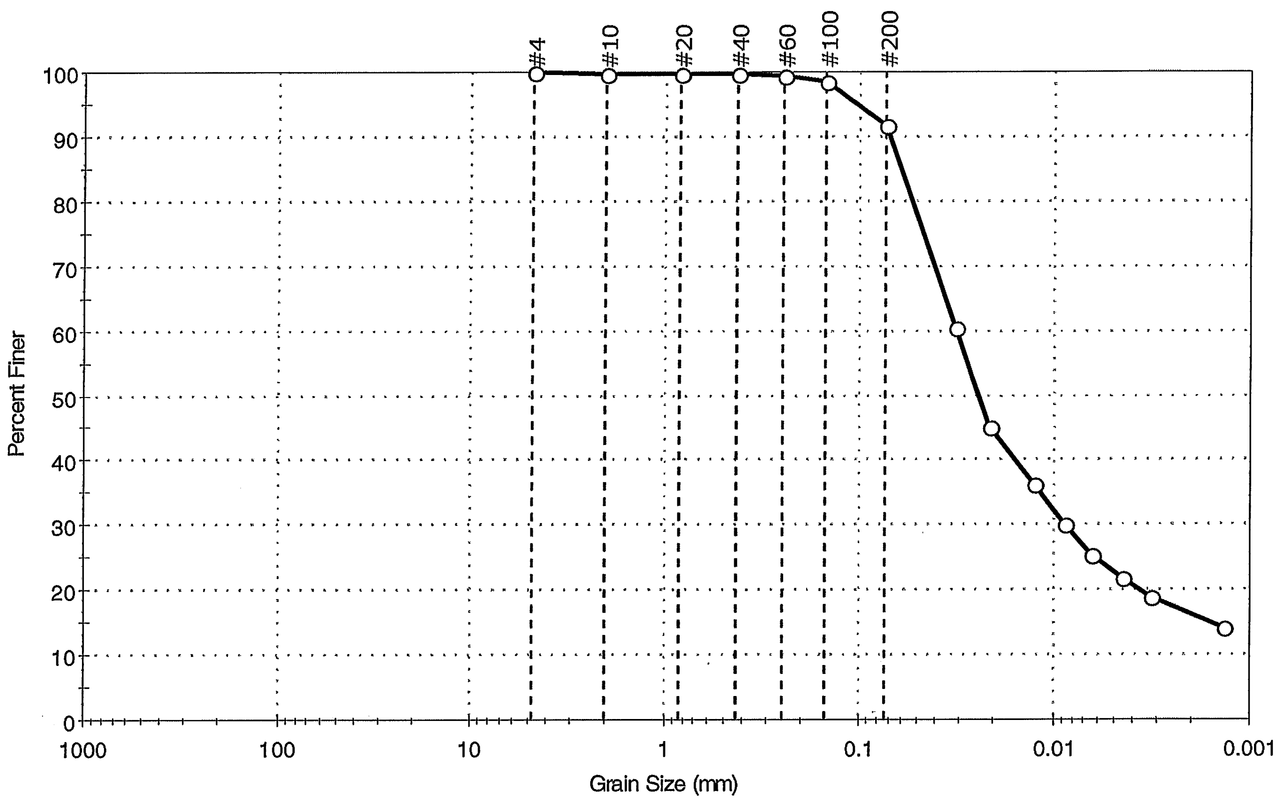
Client:	Sanborn Head & Associates				
Project:	Bldg 57 SRI				
Location:	Endicott, NY			Project No:	GTX-7477
Boring ID:	EN668	Sample Type:	bag	Tested By:	mll
Sample ID:	S-6	Test Date:	05/22/07	Checked By:	jdt
Depth :	12.5-14.5 ft	Test Id:	111722		

Test Comment: ---
Sample Description: Moist, olive clay
Sample Comment: ---

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	0.0	8.4	91.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#4	4.75	100		
#10	2.00	100		
#20	0.84	100		
#40	0.42	100		
#60	0.25	99		
#100	0.15	99		
#200	0.074	92		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0321	60		
---	0.0210	45		
---	0.0124	36		
---	0.0089	30		
---	0.0064	25		
---	0.0045	22		
---	0.0032	19		
---	0.0014	14		

Coefficients

D_{85} =0.0620 mm	D_{30} =0.0089 mm
D_{60} =0.0317 mm	D_{15} =0.0016 mm
D_{50} =0.0241 mm	D_{10} =0.0006 mm
C_u =N/A	C_c =N/A

Classification

ASTM N/A

AASHTO Silty Soils (A-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ROUNDED

Sand/Gravel Hardness : HARD

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ATTACHMENT D.4

Soil Gradation Data
Investigations January 2008

SHPC
ENGINEERS

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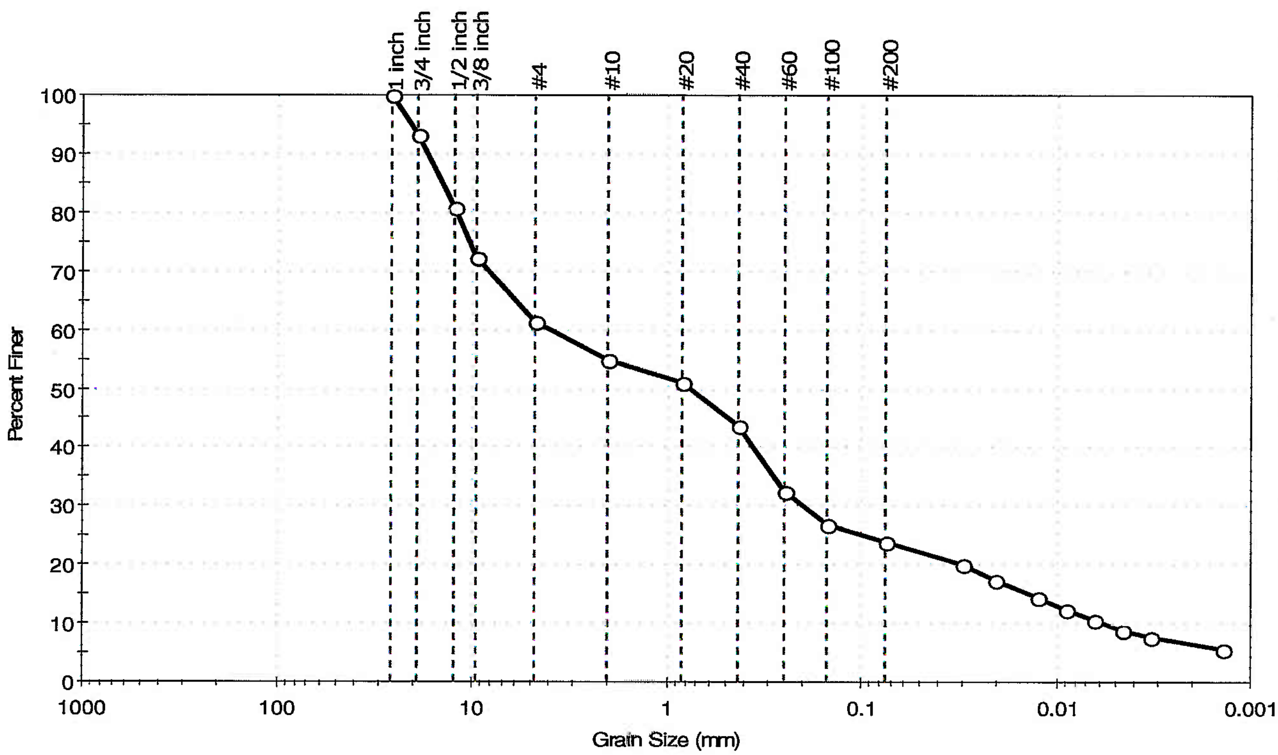
Client: Sanborn Head & Associates			
Project: Bldg 57 SRI			
Location: Endicott, NY		Project No:	GTX-7477
Boring ID: C+30, 41+8	Sample Type: jar	Tested By:	ap
Sample ID:S-3	Test Date: 01/28/08	Checked By:	jdt
Depth : 6-6.5 ft	Test Id: 125894		
Test Comment: ---			
Sample Description: Moist, dark brown silty sand with gravel			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	38.6	37.6	23.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
1 inch	25.70	100		
3/4 inch	19.00	93		
1/2 inch	12.50	81		
3/8 inch	9.51	72		
#4	4.75	61		
#10	2.00	55		
#20	0.84	51		
#40	0.42	44		
#60	0.25	33		
#100	0.15	27		
#200	0.075	24		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0304	20		
---	0.0209	18		
---	0.0125	14		
---	0.0090	13		
---	0.0064	11		
---	0.0046	9		
---	0.0033	8		
---	0.0014	6		

Coefficients

D_{85} =14.3293 mm D_{30} =0.1977 mm

D_{60} =3.9709 mm D_{15} =0.0137 mm

D_{50} =0.7707 mm D_{10} =0.0057 mm

C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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Client: Sanborn Head & Associates			
Project: Bldg 57 SRI			
Location: Endicott, NY		Project No:	GTX-7477
Boring ID: C+30, 41+8	Sample Type: jar	Tested By:	ap
Sample ID:S-3	Test Date: 01/29/08	Checked By:	njh
Depth : 6-6.5 ft	Test Id: 125887		
Test Comment: ---			
Sample Description: Moist, dark brown silty sand with gravel			
Sample Comment: ---			

Specific Gravity of Soils by ASTM D 854-06

Boring ID	Sample ID	Depth	Visual Description	Coarse %	Coarse SG	Fine %	Fine SG	Specific Gravity
C+30, 41+8	S-3	6-6.5 ft	Moist, dark brown silty sand with gravel	39	2.75	61	2.59	2.65

Notes: Specific Gravity performed by using method A (oven dried specimens) of ASTM D 854

Moisture Content determined by ASTM D 2216.

coarse fraction > #4 sieve

fine fraction < #4 sieve

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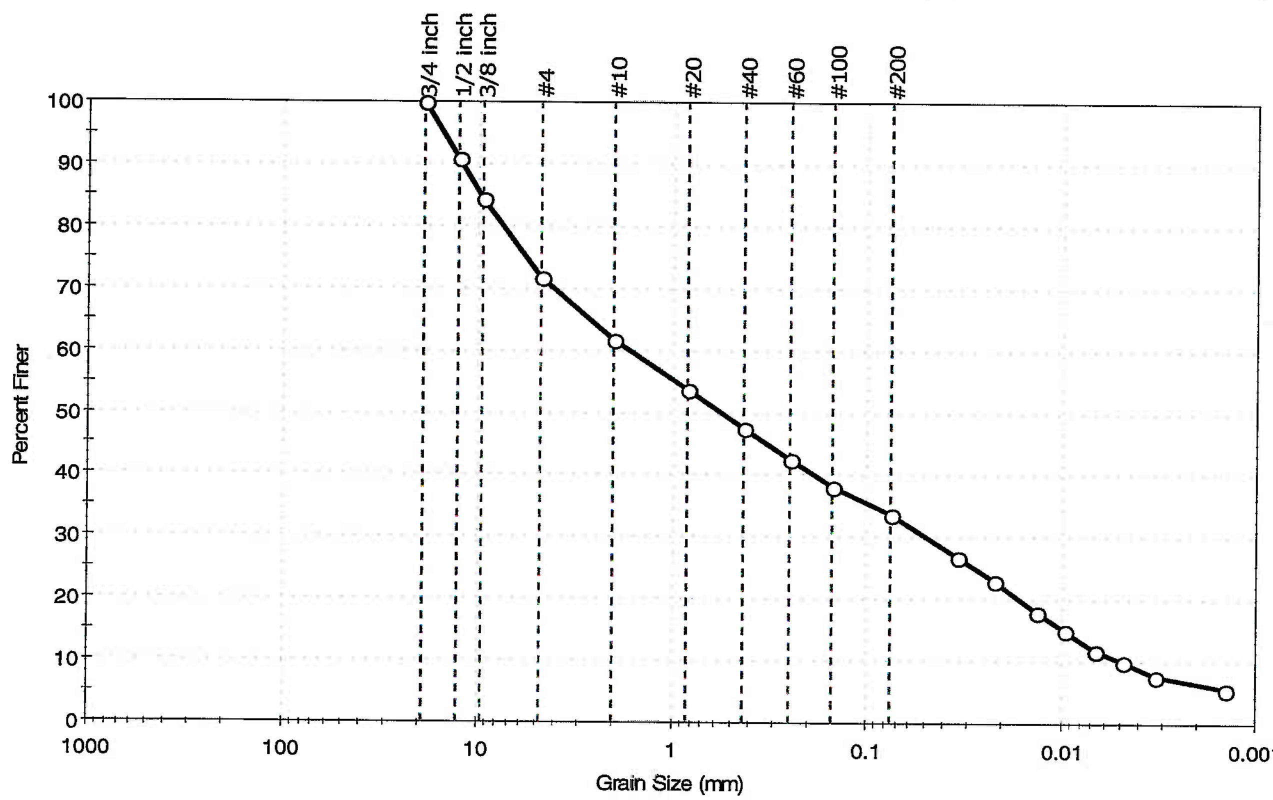
Client: Sanborn Head & Associates			
Project: Bldg 57 SRI			
Location: Endicott, NY		Project No:	GTX-7477
Boring ID: EN660	Sample Type: jar	Tested By:	ap
Sample ID:S-4A	Test Date: 01/29/08	Checked By:	jdt
Depth : 7-7.7 ft	Test Id: 125892		
Test Comment: ---			
Sample Description: Moist, black silty sand with gravel			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	28.4	37.9	33.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	91		
3/8 inch	9.51	84		
#4	4.75	72		
#10	2.00	62		
#20	0.84	54		
#40	0.42	48		
#60	0.25	43		
#100	0.15	38		
#200	0.075	34		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0344	27		
---	0.0222	23		
---	0.0134	18		
---	0.0096	15		
---	0.0067	12		
---	0.0048	10		
---	0.0033	8		
---	0.0014	6		

Coefficients

D_{85} =9.7602 mm D_{30} =0.0495 mm

D_{60} =1.6704 mm D_{15} =0.0095 mm

D_{50} =0.5555 mm D_{10} =0.0048 mm

C_u =N/A C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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GeoTesting express
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Client:	Sanborn Head & Associates		
Project:	Bldg 57 SRI		
Location:	Endicott, NY	Project No:	GTX-7477
Boring ID: EN660	Sample Type: jar	Tested By:	ap
Sample ID:S-4A	Test Date: 01/29/08	Checked By:	njh
Depth : 7-7.7 ft	Test Id: 125879		
Test Comment:	---		
Sample Description:	Moist, black silty sand with gravel		
Sample Comment:	---		

Specific Gravity of Soils by ASTM D 854-06

Boring ID	Sample ID	Depth	Visual Description	Coarse %	Coarse SG	Fine %	Fine SG	Specific Gravity
EN660	S-4A	7-7.7 ft	Moist, black silty sand with gravel	28	2.47	72	2.51	2.5

Notes: Specific Gravity performed by using method A (oven dried specimens) of ASTM D 854
Moisture Content determined by ASTM D 2216.

coarse fraction > #4 sieve
fine fraction < #4 sieve

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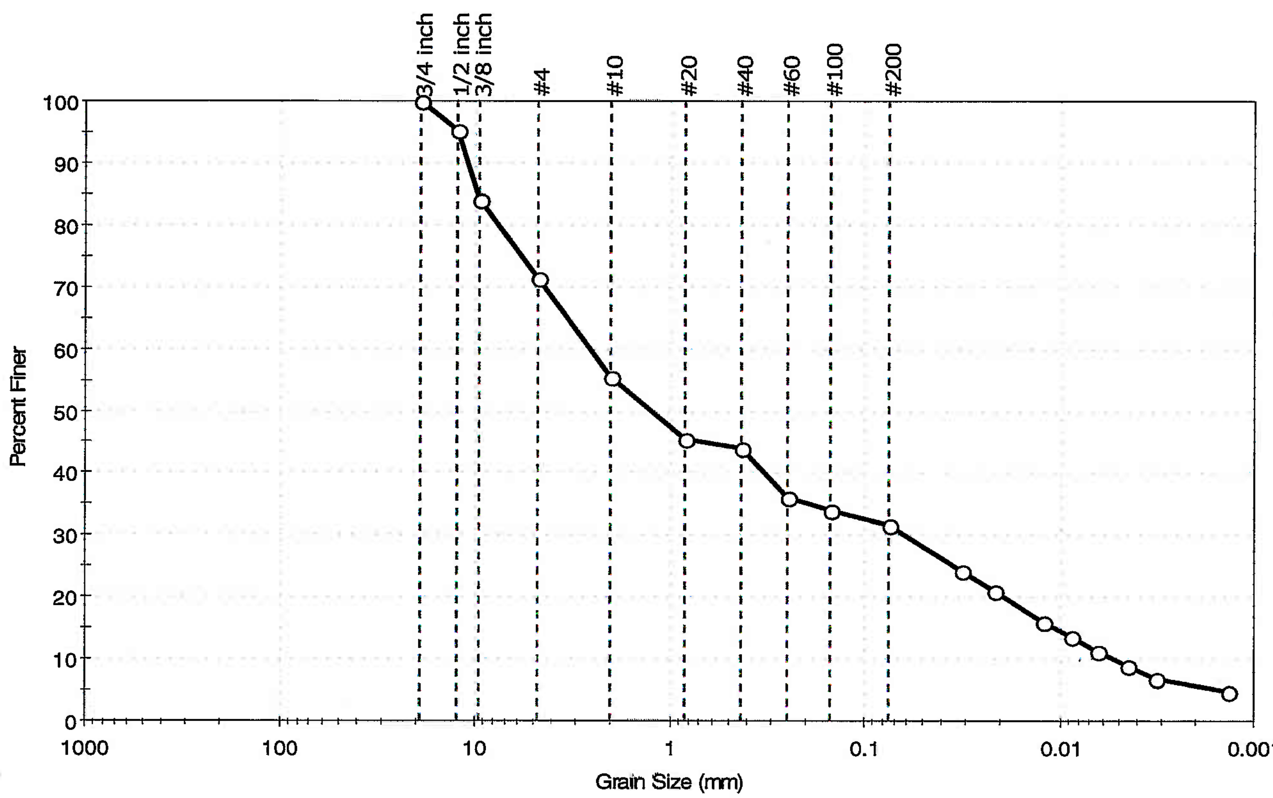
Client: Sanborn Head & Associates			
Project: Bldg 57 SRI			
Location: Endicott, NY		Project No:	GTX-7477
Boring ID: EN669	Sample Type: jar	Tested By:	ap
Sample ID: S-2	Test Date: 01/28/08	Checked By:	jdt
Depth : 2-4 ft	Test Id: 125891		
Test Comment: ---			
Sample Description: Moist, dark grayish brown silty sand with gravel			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	28.5	39.8	31.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.50	95		
3/8 inch	9.51	84		
#4	4.75	72		
#10	2.00	56		
#20	0.84	45		
#40	0.42	44		
#60	0.25	36		
#100	0.15	34		
#200	0.075	32		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0320	24		
---	0.0217	21		
---	0.0124	16		
---	0.0088	14		
---	0.0064	11		
---	0.0045	9		
---	0.0032	7		
---	0.0014	5		

Coefficients

D_{85} =9.7021 mm　D_{30} =0.0620 mm
D_{60} =2.5407 mm　D_{15} =0.0107 mm
D_{50} =1.2494 mm　D_{10} =0.0054 mm
C_u =N/A　C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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GeoTesting express
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Client: Sanborn Head & Associates			
Project: Bldg 57 SRI			
Location: Endicott, NY		Project No:	GTX-7477
Boring ID: EN669	Sample Type: jar	Tested By:	ap
Sample ID: S-2	Test Date: 01/29/08	Checked By:	njh
Depth : 2-4 ft	Test Id: 125877		
Test Comment: ---			
Sample Description: Moist, dark grayish brown silty sand with gravel			
Sample Comment: ---			

Specific Gravity of Soils by ASTM D 854-06

Boring ID	Sample ID	Depth	Visual Description	Coarse %	Coarse SG	Fine %	Fine SG	Specific Gravity
EN669	S-2	2-4 ft	Moist, dark grayish brown silty sand with gravel	28	2.52	72	2.68	2.63

Notes: Specific Gravity performed by using method A (oven dried specimens) of ASTM D 854

Moisture Content determined by ASTM D 2216.

coarse fraction > #4 sieve

fine fraction < #4 sieve

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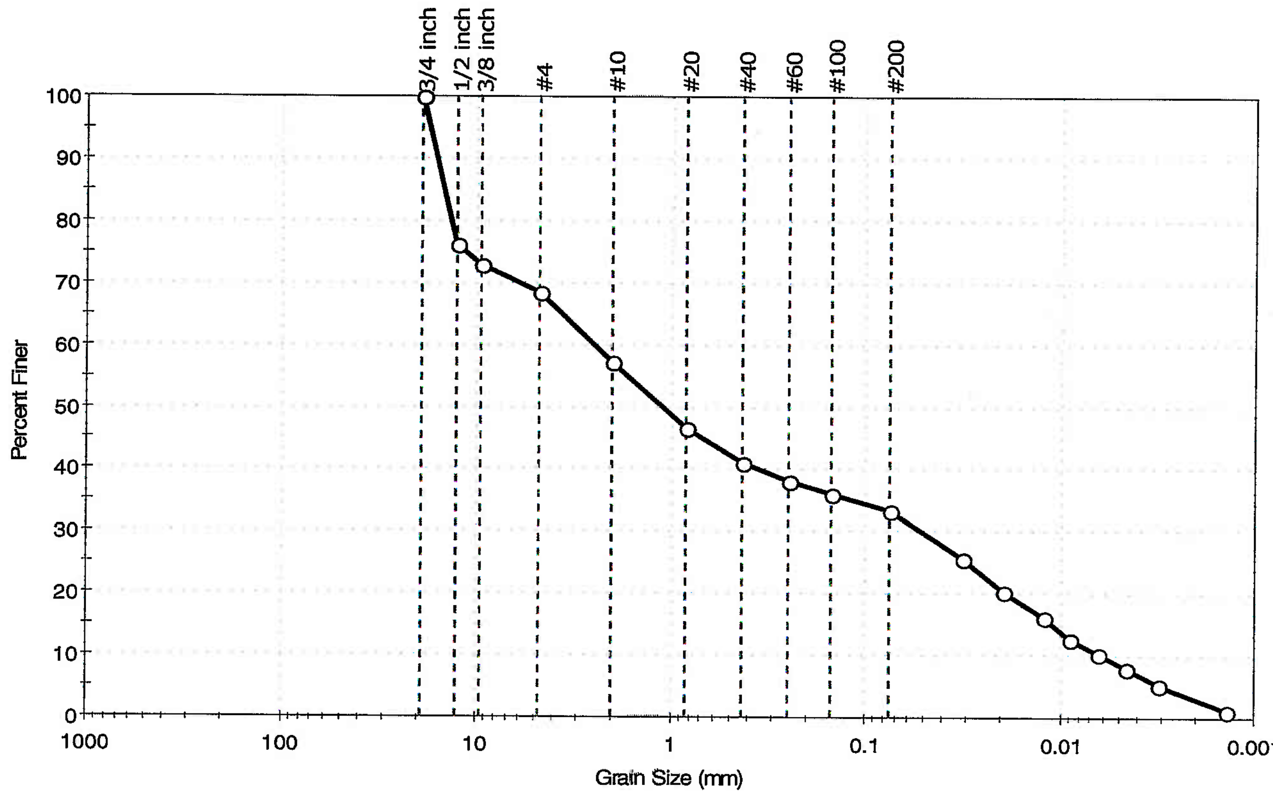
Client: Sanborn Head & Associates			
Project: Bldg 57 SRI			
Location: Endicott, NY		Project No:	GTX-7477
Boring ID: EN670	Sample Type: jar	Tested By:	ap
Sample ID:S-11	Test Date: 01/29/08	Checked By:	jdt
Depth : 18-20 ft	Test Id: 125893		
Test Comment: ---			
Sample Description: Moist, olive silty sand with gravel			
Sample Comment: ---			

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	31.4	35.2	33.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3/4 inch	19.00	100		
1/2 inch	12.70	76		
3/8 inch	9.51	73		
#4	4.75	69		
#10	2.00	57		
#20	0.84	47		
#40	0.42	41		
#60	0.25	38		
#100	0.15	36		
#200	0.075	33		
---	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0319	26		
---	0.0197	20		
---	0.0122	16		
---	0.0089	13		
---	0.0064	10		
---	0.0046	8		
---	0.0031	5		
---	0.0014	1		

Coefficients

D_{85} =14.7629 mm
D_{30} =0.0517 mm
D_{60} =2.4754 mm
D_{15} =0.0109 mm
D_{50} =1.1160 mm
D_{10} =0.0060 mm
C_u =N/A
C_c =N/A

Classification

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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GeoTesting express
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Client:	Sanborn Head & Associates		
Project:	Bldg 57 SRI		
Location:	Endicott, NY	Project No:	GTX-7477
Boring ID: EN670	Sample Type: jar	Tested By:	ap
Sample ID:S-11	Test Date: 01/29/08	Checked By:	njh
Depth : 18-20 ft	Test Id: 125883		
Test Comment:	---		
Sample Description:	Moist, olive silty sand with gravel		
Sample Comment:	---		

Specific Gravity of Soils by ASTM D 854-06

Boring ID	Sample ID	Depth	Visual Description	Coarse %	Coarse SG	Fine %	Fine SG	Specific Gravity
EN670	S-11	18-20 ft	Moist, olive silty sand with gravel	31	2.62	69	2.65	2.64

Notes: Specific Gravity performed by using method A (oven dried specimens) of ASTM D 854

Moisture Content determined by ASTM D 2216.

coarse fraction > #4 sieve

fine fraction < #4 sieve

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Client:	Sanborn Head & Associates		
Project:	Bldg 57 SRI		
Location:	Endicott, NY	Project No:	GTX-7477
Boring ID: B+58, 44+28	Sample Type: jar	Tested By:	ap
Sample ID:S-3	Test Date: 01/29/08	Checked By:	jdt
Depth : 4-6 ft	Test Id: 125888		
Test Comment:	---		
Sample Description:	Moist, brown silty sand with gravel		
Sample Comment:	---		

Specific Gravity of Soils by ASTM D 854-06

Boring ID	Sample ID	Depth	Visual Description	Coarse %	Coarse SG	Fine %	Fine SG	Specific Gravity
B+58, 44+28	S-3	4-6 ft	Moist, brown silty sand with gravel	31.8	2.55	68.2	2.7	2.65

Notes: Specific Gravity performed by using method A (oven dried specimens) of ASTM D 854

Moisture Content determined by ASTM D 2216.

coarse fraction > #4 sieve
fine fraction < #4 sieve

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Client: Sanborn Head & Associates			
Project: Bldg 57 SRI			
Location: Endicott, NY		Project No:	GTX-7477
Boring ID: B+58, 44+28	Sample Type: jar	Tested By:	ap
Sample ID: S-6	Test Date: 01/30/08	Checked By:	njh
Depth : 10-12 ft	Test Id: 125889		
Test Comment: ---			
Sample Description: Moist, gray silt			
Sample Comment: ---			

Specific Gravity of Soils by ASTM D 854-06

Boring ID	Sample ID	Depth	Visual Description	Specific Gravity
B+58, 44+28	S-6	10-12 ft	Moist, gray silt	2.64

Notes: Specific Gravity performed by using method A (oven dried specimens) of ASTM D 854
Moisture Content determined by ASTM D 2216.

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Client:	Sanborn Head & Associates				
Project:	Bldg 57 SRI				
Location:	Endicott, NY			Project No:	GTX-7477
Boring ID:	B+58, 44+28	Sample Type:	jar	Tested By:	ap
Sample ID:	S-11	Test Date:	01/29/08	Checked By:	jdt
Depth :	20-22 ft	Test Id:	125890		
Test Comment:	---				
Sample Description:	Moist, dark gray gravel with silt and sand				
Sample Comment:	---				

Specific Gravity of Soils by ASTM D 854-06

Boring ID	Sample ID	Depth	Visual Description	Coarse %	Coarse SG	Fine %	Fine SG	Specific Gravity
B+58, 44+28	S-11	20-22 ft	Moist, dark gray gravel with silt and sand	64.2	2.49	35.8	2.69	2.56

Notes: Specific Gravity performed by using method A (oven dried specimens) of ASTM D 854

Moisture Content determined by ASTM D 2216.

coarse fraction > #4 sieve
fine fraction < #4 sieve

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GeoTesting express
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Client:	Sanborn Head & Associates				
Project:	Bldg 57 SRI				
Location:	Endicott, NY			Project No:	GTX-7477
Boring ID:	EN660	Sample Type:	jar	Tested By:	ap
Sample ID:	S-11,S-12	Test Date:	01/29/08	Checked By:	njh
Depth :	20-22.9 ft	Test Id:	125880		
Test Comment:	---				
Sample Description:	Moist, dark gray gravel with sandy clay				
Sample Comment:	---				

Specific Gravity of Soils by ASTM D 854-06

Boring ID	Sample ID	Depth	Visual Description	Coarse %	Coarse SG	Fine %	Fine SG	Specific Gravity
EN660	S-11,S-12	20-22.9 ft	Moist, dark gray gravel with sandy clay	66.4	2.63	33.6	2.74	2.67

Notes: Specific Gravity performed by using method A (oven dried specimens) of ASTM D 854
Moisture Content determined by ASTM D 2216.

coarse fraction > #4 sieve
fine fraction < #4 sieve

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GeoTesting express
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Client:	Sanborn Head & Associates				
Project:	Bldg 57 SRI				
Location:	Endicott, NY			Project No:	GTX-7477
Boring ID:	EN669	Sample Type:	jar	Tested By:	ap
Sample ID:	S-5B	Test Date:	01/30/08	Checked By:	jdt
Depth :	8.5-10 ft	Test Id:	125878		
Test Comment:	---				
Sample Description:	Moist, dark olive brown clay				
Sample Comment:	---				

Specific Gravity of Soils by ASTM D 854-06

Boring ID	Sample ID	Depth	Visual Description	Specific Gravity
EN669	S-5B	8.5-10 ft	Moist, dark olive brown clay	2.67

Notes: Specific Gravity performed by using method A (oven dried specimens) of ASTM D 854
Moisture Content determined by ASTM D 2216.

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Client: Sanborn Head & Associates			
Project: Bldg 57 SRI			
Location: Endicott, NY		Project No:	GTX-7477
Boring ID: EN670	Sample Type: jar	Tested By:	ap
Sample ID:S-3	Test Date: 01/29/08	Checked By:	jdt
Depth : 4-6 ft	Test Id: 125881		
Test Comment: ---			
Sample Description: Moist, very dark brown sand with silt and gravel			
Sample Comment: ---			

Specific Gravity of Soils by ASTM D 854-06

Boring ID	Sample ID	Depth	Visual Description	Coarse %	Coarse SG	Fine %	Fine SG	Specific Gravity
EN670	S-3	4-6 ft	Moist, very dark brown sand with silt and gravel	28	2.4	72	2.59	2.53

Notes: Specific Gravity performed by using method A (oven dried specimens) of ASTM D 854
Moisture Content determined by ASTM D 2216.
coarse fraction > #4 sieve
fine fraction < #4 sieve

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GeoTesting express
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Client:	Sanborn Head & Associates				
Project:	Bldg 57 SRI				
Location:	Endicott, NY			Project No:	GTX-7477
Boring ID:	EN670	Sample Type:	jar	Tested By:	ap
Sample ID:	S-6A	Test Date:	01/29/08	Checked By:	njh
Depth :	10-12 ft	Test Id:	125882		
Test Comment:	---				
Sample Description:	Moist, dark gray silty sand				
Sample Comment:	---				

Specific Gravity of Soils by ASTM D 854-06

Boring ID	Sample ID	Depth	Visual Description	Specific Gravity
EN670	S-6A	10-12 ft	Moist, dark gray silty sand	2.63

Notes: Specific Gravity performed by using method A (oven dried specimens) of ASTM D 854
Moisture Content determined by ASTM D 2216.

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	Sanborn Head & Associates				
Project:	Bldg 57 SRI				
Location:	Endicott, NY			Project No:	GTX-7477
Boring ID:	EN670	Sample Type:	jar	Tested By:	ap
Sample ID:	S-14A	Test Date:	01/29/08	Checked By:	jdt
Depth :	24-24.6 ft	Test Id:	125884		
Test Comment:	---				
Sample Description:	Moist, gray silty sand with gravel				
Sample Comment:	---				

Specific Gravity of Soils by ASTM D 854-06

Boring ID	Sample ID	Depth	Visual Description	Coarse %	Coarse SG	Fine %	Fine SG	Specific Gravity
EN670	S-14A	24-24.6 ft	Moist, gray silty sand with gravel	34.7	2.65	65.3	2.74	2.71

Notes: Specific Gravity performed by using method A (oven dried specimens) of ASTM D 854
Moisture Content determined by ASTM D 2216.

coarse fraction > #4 sieve
fine fraction < #4 sieve

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GeoTesting express
a subsidiary of Geocomp Corporation

Client:	Sanborn Head & Associates				
Project:	Bldg 57 SRI				
Location:	Endicott, NY			Project No:	GTX-7477
Boring ID:	EN674	Sample Type:	jar	Tested By:	ap
Sample ID:	S-6	Test Date:	01/30/08	Checked By:	njh
Depth :	12-14 ft	Test Id:	125885		
Test Comment:	---				
Sample Description:	Moist, grayish brown clay				
Sample Comment:	---				

Specific Gravity of Soils by ASTM D 854-06

Boring ID	Sample ID	Depth	Visual Description	Specific Gravity
EN674	S-6	12-14 ft	Moist, grayish brown clay	2.71

Notes: Specific Gravity performed by using method A (oven dried specimens) of ASTM D 854
Moisture Content determined by ASTM D 2216.

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	Sanborn Head & Associates		
Project:	Bldg 57 SRI		
Location:	Endicott, NY	Project No:	GTX-7477
Boring ID: EN-674	Sample Type: jar	Tested By:	ap
Sample ID:S-8	Test Date: 01/29/08	Checked By:	jdt
Depth : 16-18 ft	Test Id: 125886		
Test Comment:	---		
Sample Description:	Moist, grayish brown silty sand with gravel		
Sample Comment:	---		

Specific Gravity of Soils by ASTM D 854-06

Boring ID	Sample ID	Depth	Visual Description	Coarse %	Coarse SG	Fine %	Fine SG	Specific Gravity
EN-674	S-8	16-18 ft	Moist, grayish brown silty sand with gravel	25.8	2.55	74.2	2.76	2.7

Notes: Specific Gravity performed by using method A (oven dried specimens) of ASTM D 854
Moisture Content determined by ASTM D 2216.
coarse fraction > #4 sieve
fine fraction < #4 sieve

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APPENDIX E

HYDRAULIC PROPERTIES ASSESSMENT

ENGINEERS

APPENDIX E
HYDRAULIC PROPERTIES ASSESSMENT

E.1 INTRODUCTION, DEFINITIONS AND SUMMARY

This appendix summarizes hydrogeologic parameter estimates derived from field observations of rising and falling head slug tests and pumping tests. As referenced in the Supplemental Remedial Investigation (SRI) report text, estimates derived from hydraulic testing were used to qualitatively and quantitatively assess groundwater hydrogeology, including estimates of advective seepage velocity, volumetric groundwater flux, and mass flux for certain areas of the site.

The work described in this appendix was performed or coordinated by Sanborn, Head and Associates, Inc. (SHA) as part of the SRI. The work was completed in general accordance with our approved Supplemental Remedial Investigation Work Plan[1]. Our work and this appendix are subject to the Limitations outlined in the text to follow and summarized in Appendix A of the report.

The hydrogeologic property values discussed in this appendix include the related parameters hydraulic conductivity (K), transmissivity (T), and storage coefficient or storativity (S). K is a proportionality constant that relates the hydraulic gradient to darcy velocity and is expressed in units of length over time. T represents the capacity of an aquifer to transmit water across its saturated thickness, and is expressed in units of l^2/t. S is a dimensionless coefficient representing the volume of water released by an aquifer per unit decline in hydraulic head per unit area. The methods used for determining hydrogeologic properties are provided below.

E.2 PURPOSE, OBJECTIVE AND SCOPE

The overall purpose of this work was to derive estimates of hydraulic properties of the soil strata beneath OU#5 to support further assessment of groundwater hydrogeology. Assessment of hydraulic properties supported development of site and source zone conceptual models, as well as assessment of biodegradation and mass removal (as documented in the Bioattenuation Study Report[2]). The scope of the work conducted to derive the estimates is described below.

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[1] Sanborn, Head & Associates, Inc., September 9, 2004, "Work Plan for Source Area Evaluation, Supplemental Remedial Investigation and Focused Feasibility Study, Operable Unit #5 – Building 57 Area, Union and Endicott, New York," approved by the NYSDEC in a letter dated December 13, 2004.

[2] Sanborn, Head Engineering P.C., February 9, 2010, "Bioattenuation Study Report, Supplemental Remedial Investigation, Operable Unit #5/Building 57 Area, Union and Endicott, New York."

E.2.1 Hydraulic Property Estimation Methods

Rising and Falling Head Tests

Between August 2005 and October 2009, rising and falling head (slug) tests were performed in 15 monitoring wells screened in the upper WBZ, 20 monitoring locations screened in the lower WBZ, and 9 locations screened in areas beyond the on-site, differentiated WBZs to estimate hydraulic conductivity values. Slug test data are summarized in Table E.1. Testing locations and dates are shown on Figure E.1. A description of slug test methods, response curves, and Aquifer Test reports are included as Attachments E.1 through E.3, respectively.

Pumping Tests

In January 2006, April 2008, and October 2009, the hydraulic response to groundwater pumping was monitored during three events of startup and shutdown of pumping from extraction wells EN-89R, EN-623 and/or EN-624. Testing locations for each event are shown on Figure E.1. Hydraulic properties estimated from pumping test data are summarized in Table E.2

Hydrogeologic testing in the Waste Solvent Area (refer to the SRI report text and Figure 3 for inferred source zone area references) was performed in January 2006 when the groundwater extraction and treatment system was expanded to include wells EN-623 and EN-624. Documentation of this testing was provided to the Agencies in the Groundwater Extraction and Treatment Test Report[3].

Additional pumping tests (startup and shutdown) were performed in April 2008 and October 2009 after the installation of monitoring wells on off-site properties located downgradient of the various extraction wells. The hydraulic response to the shut-down and start-up of pumping from extraction wells EN-89R, EN-623, and EN-624 in the CFC, TCA, and Waste Solvent Areas, respectively, was monitored using data-logging pressure transducers deployed in selected on- and off-site monitoring wells.

For wells where we observed a response to the pumping, estimates of K, T, and S, were derived using the Theis recovery method within Aquifer Test software version 4.2. The Theis method is based on certain assumptions (as outlined in Table E.2) which may not fully apply here. As such, the resulting estimates of hydraulic parameters may have an associated level of uncertainty. Rates of groundwater pumping were based on flow data provided by GSC during the monitoring programs. Further details on the field monitoring program and data analysis results can be found in Appendix F and Attachment E.4.

[3] Sanborn, Head Engineering, P.C., June 16, 2006, "Report of Findings, Groundwater Extraction and Treatment Testing, Supplemental Remedial Investigations, Operable Unit #5 (Building 57), Endicott and Union, New York."

TABLES

FIGURES

ATTACHMENTS

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TABLES

Table E.1 – Summary of Slug Test Hydrogeologic Estimates

Table E.2 – Summary of Pump Test Hydrogeologic Estimates

Table E.1

Summary of Slug Test Hydrogeologic Estimates

OU#5/Building 57 Area

Supplemental Remedial Investigation Report

Union and Endicott, New York

Test Area	Location	Water Bearing Zone	Slug Test Design	K (ft/day)	K (cm/s)
Building 57 Area	EN-664	Upper	Rising	2.9	1.0E-03
	EN-665	Upper	Rising	6.8	2.4E-03
Building 57A Interior	DP-101*	Upper	Falling	0.2	7.1E-05
	DP-102*	Upper	Falling	0.03	1.1E-05
	DP-103*	Upper	Falling	0.05	1.6E-05
	EN-666	Lower	Rising	0.2	7.1E-05
	EN-666	Lower	Falling	0.2	8.1E-05
	EN-667	Upper	Rising	2.0	7.2E-04
	EN-668	Lower	Falling	0.1	2.6E-05
	EN-668	Lower	Rising	0.1	2.9E-05
	EN-670	Lower	Rising	0.1	4.4E-05
	EN-670	Lower	Falling	0.1	4.4E-05
	EN-671*	Upper	Falling	0.2	6.4E-05
	EN-672	Lower	Falling	2.5	8.7E-04
	EN-672	Lower	Rising	2.7	9.7E-04
	EN-676	Lower	Falling	0.3	9.4E-05
	EN-676	Lower	Rising	0.3	1.0E-04
	EN-677*	Upper	Falling	0.5	1.8E-04
CFC AST Area	EN-660	Lower	Rising	0.6	2.3E-04
	EN-660	Lower	Falling	1.7	6.1E-04
	EN-661*	Upper	Falling	0.2	6.0E-05
	EN-662	Lower	Rising	0.2	5.3E-05
	EN-662	Lower	Falling	0.2	8.0E-05
	EN-662	Lower	Rising	0.1	4.6E-05
	EN-662	Lower	Falling	0.1	5.1E-05
	EN-688	Lower	Rising	0.6	2.1E-04
	EN-688	Lower	Falling	0.7	2.3E-04
	EN-690	Lower	Rising	0.8	2.7E-04
	EN-690	Lower	Falling	0.8	2.9E-04
	EN-691*	Upper	Falling	2.0	7.1E-04
TCA Area	EN-608	Lower	Falling	1.1	3.9E-04
	EN-608	Lower	Rising	1.2	4.1E-04
	EN-610	Lower	Falling	1.8	6.4E-04
	EN-610	Lower	Rising	3.0	1.1E-03
	EN-674	Lower	Falling	0.4	1.3E-04
	EN-674	Lower	Rising	0.8	2.8E-04
	EN-675	Upper	Rising	0.8	2.9E-04
Waste Solvent Area	DP-301*	Upper	Falling	0.05	1.6E-05
	DP-303*	Upper	Rising	0.1	3.5E-05
	EN-612	Lower	Falling	10.4	3.7E-03
	EN-612	Lower	Rising	11.6	4.1E-03
	EN-614	Lower	Falling	1.8	6.4E-04
	EN-614	Lower	Rising	10.9	3.9E-03
	EN-616	Lower	Falling	0.4	1.5E-04
	EN-616	Lower	Rising	2.0	7.0E-04
	EN-622	Upper	Rising	0.3	1.2E-04
	EN-622	Upper	Falling	0.5	1.7E-04
	EN-639	Upper	Rising	2.2	7.8E-04
	EN-639	Upper	Falling	3.7	1.3E-03
Other	EN-600	Lower	Falling	1.8	6.2E-04
	EN-600	Lower	Rising	1.9	6.5E-04
	EN-602	Lower	Falling	0.5	1.9E-04
	EN-602	Lower	Rising	0.8	2.9E-04
	EN-604	Lower	Falling	2.3	8.0E-04
	EN-604	Lower	Rising	2.9	1.0E-03
	EN-606	Lower	Falling	1.9	6.8E-04
	EN-606	Lower	Rising	2.0	7.1E-04
	EN-618	Lower	Falling	0.4	1.3E-04
	EN-618	Lower	Rising	0.4	1.3E-04
Lot 26	EN-303A	Sand & Gravel	Rising	45	1.6E-02
	EN-303B	Silty Sand	Falling	1.2	4.2E-04
	EN-303B	Silty Sand	Rising	1.3	4.6E-04
	EN-680	Till	Falling	0.5	1.9E-04
	EN-680	Till	Rising	0.6	2.0E-04
	EN-681	Water Table	Falling	3.9	1.4E-03
	EN-681	Water Table	Rising	2.3	8.1E-04
	EN-684A	Water Table	Falling	3.0	1.1E-03
	EN-684A	Water Table	Rising	2.2	7.8E-04
Off-Site	EN-694	Water Table	Falling	0.9	3.2E-04
	EN-694	Water Table	Rising	0.5	1.7E-04
	EN-695	Water Table	Falling	2.2	7.8E-04
	EN-695	Water Table	Rising	2.3	8.2E-04
	EN-698	Water Table	Falling	3.0	1.1E-03
	EN-698	Water Table	Rising	2.4	8.5E-04
	EN-699	Water Table	Falling	3.5	1.2E-03
	EN-699	Water Table	Rising	3.0	1.1E-03

Notes:
1. Hydrogeologic parameters were estimated using the Bouwer and Rice method in Aquifer Test software version 4.2. This method applies to homogeneous, isotropic, unconfined aquifers with fully- or partially-penetrating wells. The well radius was used as the casing radius (r); the boring radius was used as the borehole radius (B) and screen radius (R); the well screen length was used for (L). A porosity of 0.25 to 0.3 was used.

2. Hydraulic conductivities estimated for certain upper WBZ wells denoted with a "*" were conducted using a falling head test and the instantaneous injection of a water "slug," due to a limited saturated thickness in this geologic unit. Values are estimated to have a high bias.

3. Both rising and falling head tests were performed on wells screened below the groundwater table; rising head tests were performed on wells screened across the groundwater table; and falling head tests were performed on monitoring wells in the upper WBZ with less than 1.5' of saturated thickness.

Please see the report text for further details.

Table E.2
Summary of Pumping Test Hydrogeologic Estimates
OU#5/Building 57 Area
Supplemental Remedial Investigation Report
Union and Endicott, New York

Test Area	Location	Water Bearing Zone	Test Period	Radial Distance to Pumping Well (ft)	Storage coefficient S	Transmissivity T (ft^2/day)	Hydraulic Conductivity K (ft/day)	Hydraulic Conductivity K (cm/s)
Waste Solvent Area 2006	EN-610	Lower	Pump Test	131	1.31E-04	16	3.2	1.1E-03
	EN-612	Lower	Pump Test	5	8.97E-04	47	9.4	3.3E-03
	EN-616	Lower	Pump Test	128	5.88E-05	14	2.7	9.5E-04
	EN-636	Lower	Pump Test	56	1.42E-04	57	11	4.0E-03
Waste Solvent Area 2008	EN-612	Lower	Recovery	5	5.2E-04	53	11	3.7E-03
	EN-616	Lower	Recovery	128	5.5E-05	34	6.8	2.4E-03
	EN-624	Lower	Recovery	0	8.5E-02	44	8.7	3.1E-03
	DEC-MW-34D	Lower	Recovery	112	7.0E-05	75	15	5.3E-03
TCA Area	EN-610	Lower	Recovery	14	7.0E-04	10	2.0	7.1E-04
	EN-623	Lower	Recovery	0	1.5E-01	5	0.7	2.6E-04
	EN-632	Lower	Recovery	136	4.1E-04	79	16	5.6E-03
Building 57A Area	EN-666	Lower	Recovery	132	2.0E-04	26	5.2	1.8E-03
	EN-674	Lower	Recovery	40	3.8E-04	9	1.8	6.2E-04
CFC Area	EN-89R	Lower	Recovery	0	NA	0.3	0.1	1.9E-05
	EN-89A	Lower	Recovery	6	8.5E-03	2	0.4	1.4E-04
	EN-660	Lower	Recovery	67	1.2E-04	95	0.2	6.7E-05
	EN-688	Lower	Recovery	46	1.2E-04	25	5.0	1.8E-03
	EN-690	Lower	Recovery	21	1.0E-04	13	2.6	9.2E-04
Off-Site 2008	EN-651	Lower	Recovery	177	3.0E-04	> 100	> 100	>3.5E-02
	EN-654	Till	Recovery	196	1.5E-04	96	19	6.8E-03
	EN-655	Lower	Recovery	200	4.2E-03	> 100	> 100	> 3.5E-02
	EN-656	Till	Recovery	171	1.8E-04	>100	25	8.8E-03
Lot 26	EN-681	Lower	Recovery	275	9.9E-06	82	16	5.8E-03
Off-Site 2009	EN-695	Water Table	Recovery	No Observed Response				
	EN-697	Water Table	Recovery	No Observed Response				
	EN-699	Water Table	Recovery	175	1.2E-06	>100	70	2.5E-02
	EN-701	Lower	Recovery	155	5.3E-07	65	13	4.6E-03
	EN-703	Lower	Recovery	130	2.0E-05	54	11	3.9E-03

Hydrogeologic parameters were estimated using the Theis test method in Aquifer Test software version 4.2. This method applies to homogeneous, isotropic, confined aquifers, with fully penetrating wells and constant pumping rate. The well radius was used as the casing radius (r); the boring radius was used as the borehole radius (B) and screen radius (R); the well screen length was used for (L). A porosity of 0.3 was used for all wells. The distance from top of the aquifer to bottom of well screen (b) was determined between the top of the site silt and clay aquitard and the bottom of well screen except when this interval was not fully saturated. In that case, (b) was the saturated water column length. Monitoring wells were considered fully-penetrating except EN-651, EN-655, EN-681, EN-699, EN-701, EN-703 which were considered partially-penetrating. Please see the report text for further details. Estimates denoted with "*" are calculated using the ">" value in the calculation, and therefore have a low bias.

FIGURES

Figure E.1 – Hydraulic Testing Locations

Figure E.2 – Monitoring Locations During Extraction Well Shut-down and Start-up Event

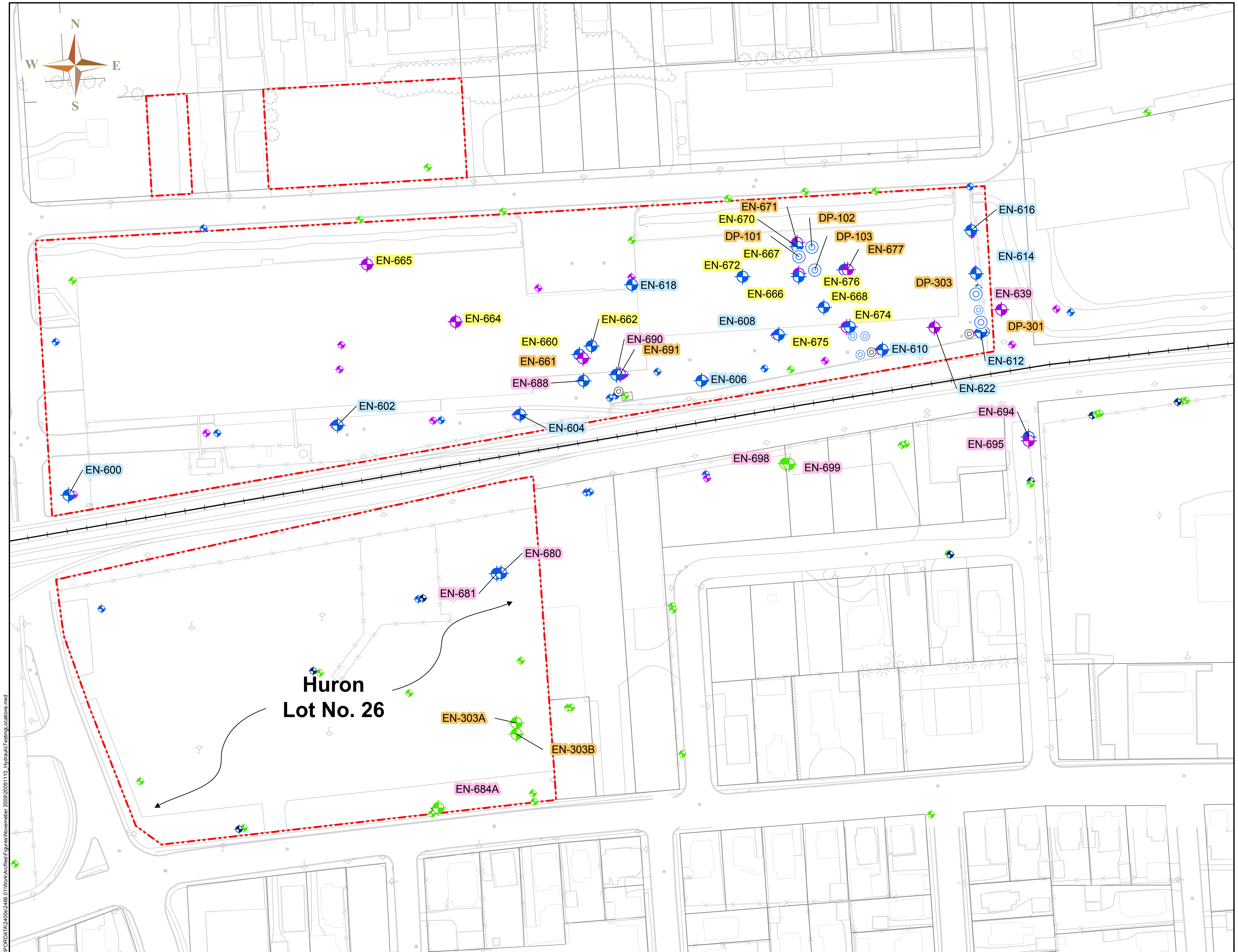

Figure E.1

Locations for Hydraulic Testing

Supplemental Remedial Investigation Report OU#5 Building 57 Area

Union and Endicott, New York

Drawn By: J. Pierce/J. Prellwitz
Designed By: P. Mouser
Reviewed By: J. Ordway
Date: March 2010

Figure Narrative:

This figure shows monitoring well locations and designations where hydraulic testing was conducted during site investigation activities between 2005 and 2009. Hydraulic testing was conducted using rising- and falling-head slug tests. The test design, analysis, and results are summarized in Appendix E of the SRI. Please see the report text for further details.

Legend

EN-602 Test Conducted in August 2005

EN-666 Test Conducted in February 2008

EN-680 Test Conducted in June 2009

EN-661 Test Conducted in October 2009

Upper WBZ Monitoring Well

Lower WBZ Monitoring Well

Deep Monitoring Well (screened in till or bedrock)

Other Monitoring Wells (screened in the water table)

Dual-Phase Extraction Well

Extraction Well

Site Boundary

60 30 0 60 120 180 Feet

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Figure E.2

Locations Monitored During Extraction Well Shut-down and Start-up Events

Supplemental Remedial Investigation Report
OU#5 Building 57 Area

Union and Endicott, New York

Drawn By: J. Prellwitz
Designed By: P. Mouser
Reviewed By: J. Ordway
Date: March 2010

Figure Narrative:

This figure shows monitoring well locations and designations where data loggers were deployed during the shut-down and start-up of extraction wells EN-89R, EN-623, and/or EN-624. Hydraulic response monitoring events were conducted in 2006, 2008, and 2009. The test design, analysis, and results are summarized in Appendix E of the SRI. Please see the report text for further details.

Legend

- EN-089A Monitoring Location Monitored During Multiple Events
- EN-636 January 2006 Monitoring Location
- EN-604 April 2008 Monitoring Location
- EN-688 October 2009 Monitoring Location
- Upper WBZ Monitoring Well
- Lower WBZ Monitoring Well
- Deep Monitoring Well (screened in till or bedrock)
- Other Monitoring Wells (screened in the water table)
- Dual-Phase Extraction Well
- Extraction Well
- Site Boundary

60 30 0 60 120 180 Feet

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ATTACHMENTS

E.1 **August 19, 2005 Slug Test Summary**

E.2 **Aquifer Test Results and February 27-28, 2008 Slug Test Summary**

E.3 **Aquifer Test Results for 2009 Slug Testing**

E.4 **Aquifer Test Results for 2008 and 2009 Shut-down Monitoring**

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ATTACHMENT E.1

August 19, 2005 Slug Test Summary

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2466.01 Building 57

Field Hydraulic Conductivity Testing

Slug Tests

Falling and rising head (slug) tests were performed by SHA in monitoring wells EN-610, EN-612, EN-614, EN-616 and EN-622 on August 9, 2005, and in monitoring wells EN-600, EN-602, EN-604, EN-606, EN-608, and EN-618 on August 10, 2005. The data collected were used to estimate the permeability (saturated hydraulic conductivity) of the materials in the vicinity of the monitoring wells tested.

The general procedure followed for hydraulic testing consisted of measuring the static water level in the test well with an electric water level meter, installing a Minitroll® downhole pressure transducer in the well below the anticipated displaced water level, then displacing water in the well by either adding or withdrawing a 3 foot, ¾" diameter sand-filled bailer to/from the standing water column, and recording the recovery of the water level using the downhole pressure transducer and a hand-held computer. Single-use disposable nylon rope suspended the sand-filled bailer in each well and the bailer and transducer were de-contaminated using Liquinox and water between each test. Changes in water level versus time were recorded using In-Situ® Minitroll series data logger/pressure transducers suspended at the bottom of the well.

Summary of August 2005 Slug Test Results
OU#5/Building 57
Union and Endicott, NY

Location	Water Bearing Zone	Screened Stratum Soil Description	Borehole radius, R (ft)	Well radius, r (ft)	Top of Screen (ft btoc)	Bottom of Screen (ft btoc)	Screen length, L (ft)	Initial Static WL (ft, btoc)	Height Water Column, b (ft)	Aquifer Saturated Thickness, D (ft)	Injection		Extraction	
											Hydraulic Conductivity, K (ft/day)	Hydraulic Conductivity, K (cm/s)	Hydraulic Conductivity, K (ft/day)	Hydraulic Conductivity, K (cm/s)
EN 600	Lower	SAND & GRAVEL	0.125	0.0625	11.8	16.8	5	7.24	9.56	5	1.8E+00	6.2E-04	1.9E+00	6.5E-04
EN 602	Lower	SILT & CLAY, Clayey GRAVEL	0.125	0.0625	8	13	5	4.98	8.02	5	5.4E-01	1.9E-04	8.2E-01	2.9E-04
EN 604	Lower	SILT & CLAY, Clayey GRAVEL, GLACIAL TILL	0.125	0.0625	9	14	5	3.64	10.36	5	2.3E+00	8.0E-04	2.9E+00	1.0E-03
EN 606	Lower	Silty GRAVEL, SAND & GRAVEL, GLACIAL TILL	0.125	0.0625	14.1	20.1	6	6.92	13.18	6	1.9E+00	6.8E-04	2.0E+00	7.1E-04
EN 608	Lower	SAND & GRAVEL, GLACIAL TILL	0.125	0.0625	15.5	20.5	5	8.59	11.91	5	1.1E+00	3.9E-04	1.2E+00	4.1E-04
EN 610	Lower	Clayey GRAVEL, SAND & GRAVEL, GLACIAL TILL	0.125	0.0625	16	21	5	11.86	9.14	5	1.8E+00	6.4E-04	3.0E+00	1.1E-03
EN 612	Lower	SAND & GRAVEL	0.125	0.0625	17	22	5	12.95	9.05	5	1.2E+01	3.7E-03	1.0E+01	4.1E-03
EN 614	Lower	TILL	0.125	0.0625	27	32	5	11.75	20.25	5	1.8E+00	6.4E-04	1.1E+01	3.9E-03
EN 616	Lower	SAND & GRAVEL, SAND	0.125	0.0625	18.5	25.5	7	10.56	14.94	7	4.1E-01	1.5E-04	2.0E+00	7.0E-04
EN 618	Lower	SILT & CLAY, SAND, GLACIAL TILL	0.125	0.0625	9.5	14.5	5	5.61	8.89	5	3.7E-01	1.3E-04	3.7E-01	1.3E-04
EN 621	no silt&clay layer	FILL	0.125	0.0625	5.5	11.5	6	DRY	n/a	n/a	-	-	-	-
EN 622	no silt&clay layer	FILL	0.125	0.0625	2.5	7.5	5	2.18	5.32	5	4.9E-01	1.7E-04	3.3E-01	1.2E-04
EN 601	Upper	FILL	0.375	0.0625	2	4.5	2.5	DRY	n/a	n/a	-	-	-	-
EN 603	Upper	SILT & CLAY	0.375	0.0625	3.2	4.2	1	DRY	n/a	n/a	-	-	-	-
EN 605	Upper	FILL, SILT & CLAY	0.375	0.0625	2	3.5	1.5	2.93	0.57	n/a	-	-	-	-
EN 607	Upper	FILL	0.375	0.0625	3	5.5	2.5	3.32	2.18	n/a	-	-	-	-
EN 609	Upper	FILL	0.375	0.0625	4.2	6.7	2.5	5.63	1.07	n/a	-	-	-	-
EN 611	Upper	FILL	0.375	0.0625	4	9	5	8.25	0.75	n/a	-	-	-	-
EN 613	Upper	FILL, SILT & CLAY	0.375	0.0625	2	7	5	DRY	n/a	n/a	-	-	-	-
EN 615	Upper	FILL, SILT & CLAY	0.375	0.0625	3.5	8.5	5	DRY	n/a	n/a	-	-	-	-
EN 617	Upper	FILL	0.375	0.0625	2	7	5	DRY	n/a	n/a	-	-	-	-
EN 619	Upper	FILL	0.375	0.0625	2.5	5	2.5	DRY	n/a	n/a	-	-	-	-
EN 620	Upper	FILL, SILT & CLAY	0.375	0.0625	3	8	5	4.34	3.66	n/a	-	-	-	-

Note:
1. Borehole radius, R, refers to the radius of the developed zone, including the gravel/sand pack. In the case of the well screens in the Lower Water Bearing Zone, the developed zone includes the borehole left by the 3" casing used to advance the hole. In the case of the Upper Water Bearing Zone, well screens are located in vacuum excavated holes with a developed zone diameter of roughly 9".
2. Well radius, r, refers to the inside radius of the piezometer/ well casing, in this case the nominal diameter of all Schedule 40 PVC well casing was 1.5".
3. Height Water Column, b, refers to the distance from the static piezometric surface to the bottom of the screen.
4. Aquifer Saturated Thickness, D, refers to the saturated thickness under static conditions.
5. Initial and final water levels (ft btoc) were recorded by installing a Minitroll® downhole pressure transducer in the well below the anticipated displaced water level.
5. Hydraulic Conductivity, K, values were calculated using the method developed by Bouwer and Rice (1976) via the software package Aquifer Test, version 4.0 developed and distributed by Waterloo Hydrogeologic, Inc.

ATTACHMENT E.2

Aquifer Test Results and February 27-28, 2008 Slug Test Summary

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MEMORANDUM

To: File

From: Joel S. Prellwitz

File: 2466.01

Date: April 1, 2008

Re: Slug Test Analysis Report, Building 57, February 27-28, 2008

cc: Lisa Jacob, P.M.

A series of falling and rising head slug tests were performed at the IBM Building 57 site from February 27 to 28, 2008, in monitoring wells EN-660 to EN-676. Both falling and rising head tests were performed in monitoring wells screened in the lower water bearing zone (LWBZ), including EN-660, EN-662, EN-666, EN-668, EN-670, EN-672, EN-674, and EN-676. A rising head test was performed in monitoring wells screened across the groundwater table in the upper water bearing zone (UWBZ), which included EN-663, EN-664, EN-665, and EN-667. No slug tests were performed in UWBZ monitoring wells EN-661, EN-669, or EN-671 as each well contained less than 1.5 feet of water.

The following steps were taken to collect slug test data:

- Depth to water table was measured;
- A Mini Troll Standard pressure transducer/data logger was lowered into a well and the water table was allowed time to return to static level;
- For "falling head" tests, a slug consisting of PVC filled with sand was rapidly lowered into the well, which raised the water level inside the well. The transducer/data logger recorded the re-equilibration of the water by making a measurement every 1 second;
- For "rising head" tests, the slug was initially below the well groundwater level under equilibrium conditions. The slug was rapidly pulled out of the well, which lowered the water level inside level. The transducer recorded the re-equilibration of the water by making a measurement every 1 second; and
- Between consecutive tests in a given well, the water table was allowed time to return to static level.

The test data were downloaded to a computer and exported to a Microsoft® Excel 2000 spreadsheet. The slug test field data were analyzed by the method of Bouwer and Rice (1976) using the software package Aquifer Test, version 4.0. Software input settings were adjusted according to the guidelines set forth in the August 23, 2007 SHA memo posted by A. O'Donnel, L. Levy, and B. Cole (Attachment 1). Porosity of the filter pack material surrounding the well screen was estimated to be ~0.3. Hydraulic conductivity data are summarized in Table 1 of this report. Aquifer Test plots and analyses are included as Attachment 2. Transducer/data logger measurements for monitoring well EN-663 were not suitable for estimation of hydraulic conductivity in Aquifer Test and have not been included in this report.

Encl. Table 1. Input & Results Summary
Attachment 1. Aquifer Test Pro 4.0, Slug Test Analysis by the Bouwer & Rice Method
Attachment 2. Slug Test Analysis Report

S:\PORDATA\2400s\2466.01\Work\Slug Tests\20080303 February Slug Test Data\20080401 Slug Test Analysis Report - Memo.doc

Table 1. Input Results Summary
Slug Test Analysis Report
Building 57, Endicott, New York

Location	Water Bearing Zone	Screened Stratum Soil Description	Data-logger/Serial number	Borehole radius, R (ft)	Well radius, r (ft)	Top of Screen (ft btoc)	Bottom of Screen (ft btoc)	Screen length, L (ft)	Initial Static WL (ft, btoc)	Height Water Column, b (ft)	Aquifer Saturated Thickness, D (ft)
EN 660	Lower	TILL	mini-Troll 3088	0.25	0.083333	17	23	6	9.58	13.42	6
EN 662, Test #1	Lower	TILL	mini-Troll 848	0.1875	0.041667	15	20	5	9.2	10.8	5
EN 662, Test #2	Lower	TILL	mini-Troll 3088	0.1875	0.041667	15	20	5	9.4	10.6	5
EN 663	Upper	FILL	mini-Troll 6515	0.1875	0.041667	4.5	10	5.5	5.26	4.74	n/a
EN 664	Upper	FILL and SILT & CLAY	mini-Troll 6257	0.1875	0.041667	4.4	10	5.6	5.54	4.46	n/a
EN 665	Upper	FILL	mini-Troll 3092	0.1875	0.041667	4	9	5	4.36	4.64	n/a
EN 666	Lower	TILL and BEDROCK	mini-Troll 3088	0.1875	0.041667	17.5	21.5	4	11.07	10.43	4
EN 667	Upper	FILL and SILT & CLAY	mini-Troll 6257	0.1875	0.041667	6.5	11.5	5	8.34	3.16	n/a
EN 668	Lower	Clayey SAND and TILL	mini-Troll 3092	0.1875	0.041667	17.2	22.2	5	11.31	10.89	5
EN 670, Test #4	Lower	Clayey SAND	mini-Troll 3088	0.25	0.083333	13.5	18.5	5	10.59	7.91	5
EN 672	Lower	TILL	mini-Troll 6257	0.25	0.083333	20	25	5	10.42	14.58	5
EN 674	Silt & Clay Aquitard	SILT & CLAY	mini-Troll 6515	0.25	0.083333	16.5	20	3.5	11.04	8.96	3.5
EN 675	Upper	FILL	mini-Troll 3092	0.25	0.083333	4	9	5	6.74	2.26	n/a
EN 676	Lower	BEDROCK	mini-Troll 6515	0.25	0.083333	19.5	22.5	3	11.28	11.22	3

Note:
1. Borehole radius, R, refers to the radius of the developed zone, including the gravel/sand pack.
2. Well radius, r, refers to the inside radius of the piezometer/ well casing.
3. Height Water Column, b, refers to the distance from the static piezometric surface to the bottom of the screen.
4. Aquifer Saturated Thickness, D, refers to the saturated thickness under static conditions.
5. Initial and final water levels (ft btoc) were recorded by installing a Minitroll® downhole pressure transducer in the well below the anticipated displaced water level.
5. Hydraulic Conductivity, K, values were calculated using the method developed by Bouwer and Rice (1976) via the software package Aquifer Test, version 4.0 developed and distributed by Waterloo Hydrogeologic, Inc.

Table 1. Input Results Summary
Slug Test Analysis Report
Building 57, Endicott, New York

	Injection					Extraction				
Location	**Initial WL btoc (ft)**	**Final WL btoc (ft)**	**Hydraulic Conductivity, K (ft/day)**	**Hydraulic Conductivity, K (cm/s)**	**Hydraulic Conductivity, K (m/s)**	**Initial WL btoc (ft)**	**Final WL btoc (ft)**	**Hydraulic Conductivity, K (ft/day)**	**Hydraulic Conductivity, K (cm/s)**	**Hydraulic Conductivity, K (m/s)**
EN 660	9.96	9.96	1.3E+00	4.7E-04	4.69E-06	9.54	9.57	6.2E-01	2.2E-04	2.17E-06
EN 662, Test #1	9.41	9.41	1.5E-01	5.1E-05	5.12E-07	9.41	9.44	1.3E-01	4.6E-05	4.59E-07
EN 662, Test #2	9.48	9.56	2.7E-01	9.4E-05	9.42E-07	9.50	9.51	2.0E-01	7.1E-05	7.06E-07
EN 663	-	-	-	-	-			-	-	-
EN 664	-	-	-	-	-	5.44	5.44	2.9E+00	1.0E-03	1.04E-05
EN 665	-	-	-	-	-	4.40	4.40	6.8E+00	2.4E-03	2.39E-05
EN 666	11.22	11.23	2.0E-01	7.1E-05	7.09E-07	11.24	11.24	1.6E-01	5.7E-05	5.68E-07
EN 667	-	-	-	-	-	8.19	8.25	2.0E+00	7.2E-04	7.20E-06
EN 668	11.35	11.32	6.6E-02	2.3E-05	2.31E-07	11.40	11.39	7.3E-02	2.6E-05	2.59E-07
EN 670, Test #4	10.53	10.54	1.2E-01	4.1E-05	4.06E-07	10.65	10.57	1.1E-01	3.9E-05	3.88E-07
EN 672	10.39	10.40	1.6E+00	5.8E-04	5.75E-06	10.46	10.44	3.0E+00	1.1E-03	1.07E-05
EN 674	10.79	10.83	3.5E-01	1.2E-04	1.22E-06	10.84	10.77	7.6E-01	2.7E-04	2.70E-06
EN 675	-	-	-	-	-	9.41	9.44	7.0E-01	2.5E-04	2.47E-06
EN 676	11.42	11.41	0.246	8.7E-05	8.68E-07	11.47	11.48	0.223	7.9E-05	7.87E-07

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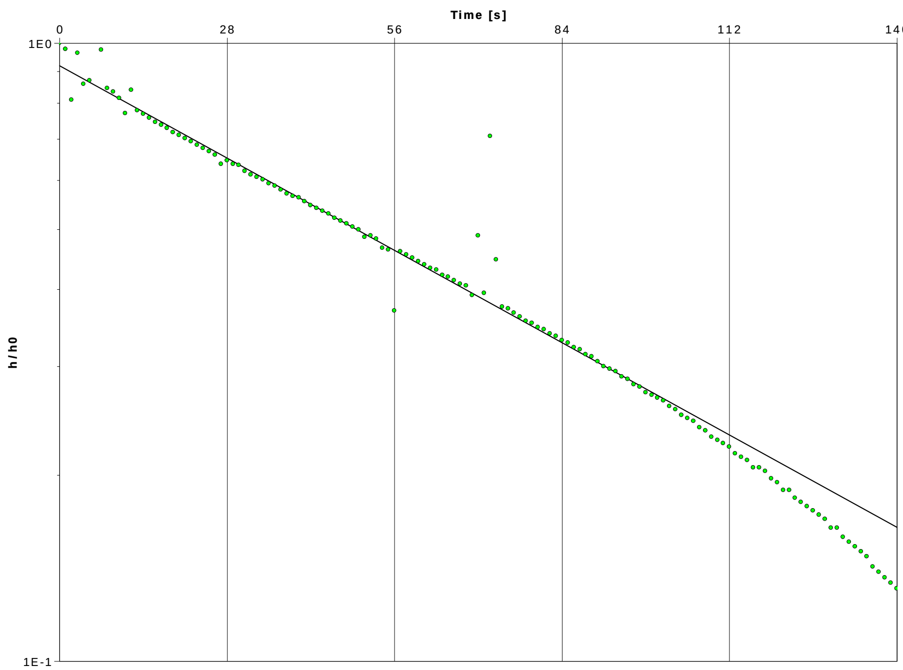
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM



Test name: EN-660 Test 1 Falling Head		
Aquifer Type: Confined		
Analysis Method: Bouwer & Rice		
Analysis Result:	Conductivity =	1.73 ft/day
Test Parameters:	Test well:	EN-660
	PVC well radius:	0.083 ft
	Saturated screen length:	6.00 ft
	Boring radius:	0.25 ft
	Aquifer thickness:	9.00 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	9.58 ft
	Depth to water (from tPVC) at t=0:	8.74 ft
	Depth to bottom of screen (from tPVC):	23.00 ft
Evaluated by:	J. Prellwitz, 03/28/08	
Comments: Test conducted by J. Prellwitz on February 28, 2008. A porosity of 0.3 was assumed for the well filter pack and surrounding material.		

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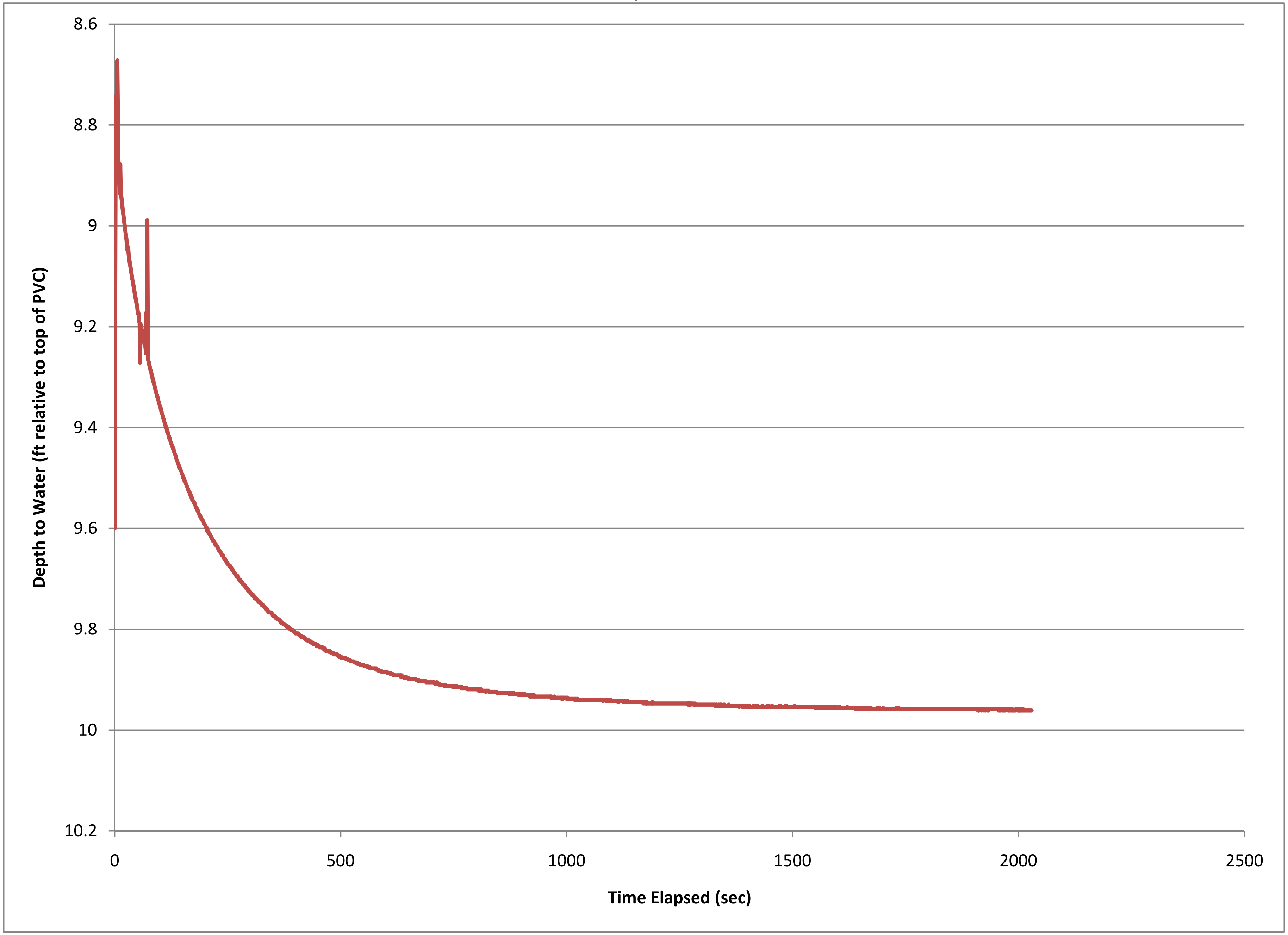
Encl. Monitoring Well EN-660 – Slug (Falling) Head Test 1 (February 28, 2008)

S:\PORDATA\2400s\2466.01\Work\Slug Tests\20080303 February Slug Test Data\EN-660\EN-660 Test 1 Falling Head.doc

Monitoring Well EN-660 - Slug (Falling) Test 1 (February 28, 2008)
Building 57 - IBM Facility
Endicott, New York



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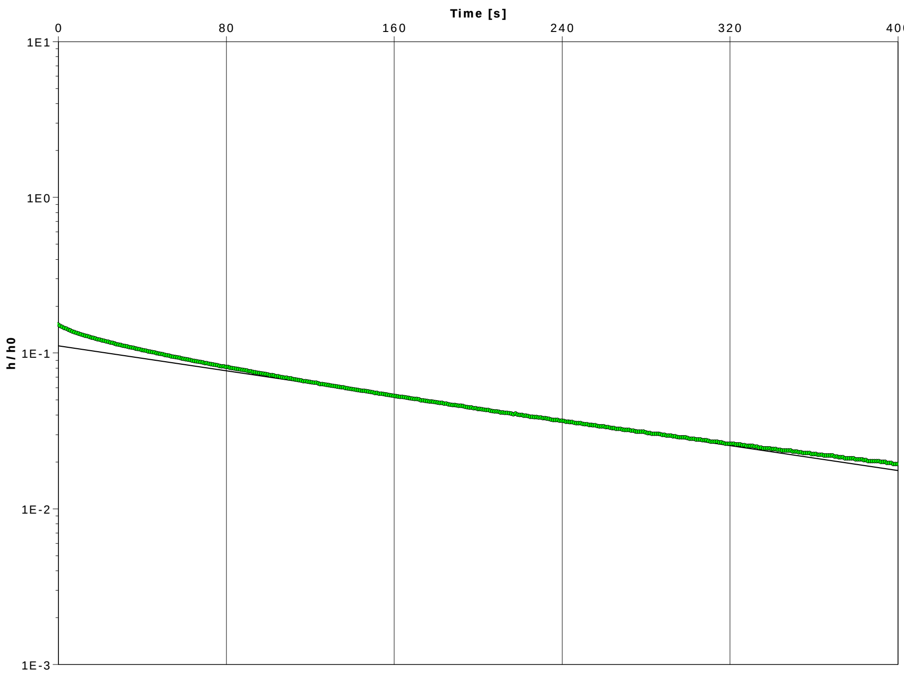
Project number: 2466.01
Client: IBM



Test Name: EN-660 Test 1 Rising Head		
Aquifer Type: Confined		
Analysis Method: Bouwer & Rice		
Analysis Result:	Conductivity =	6.49×10^{-1} ft/day
Test Parameters:	Test well:	EN-660
	PVC well radius:	0.083 ft
	Saturated screen length:	6.00 ft
	Boring radius:	0.25 ft
	Aquifer thickness:	9.00 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	9.54 ft
	Depth to water (from tPVC) at t=0:	10.79 ft
	Depth to bottom of screen (from tPVC):	23.00 ft
Evaluated by:	J. Prellwitz, 03/28/08	
Comments: Test conducted by J. Prellwitz on February 28, 2008. A porosity of 0.3 was assumed for the well filter pack and surrounding material.		

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Encl. Monitoring Well EN-660 – Slug (Rising) Head Test 1 (February 28, 2008)

Monitoring Well EN-660 - Slug (Rising) Test 1 (February 28, 2008)
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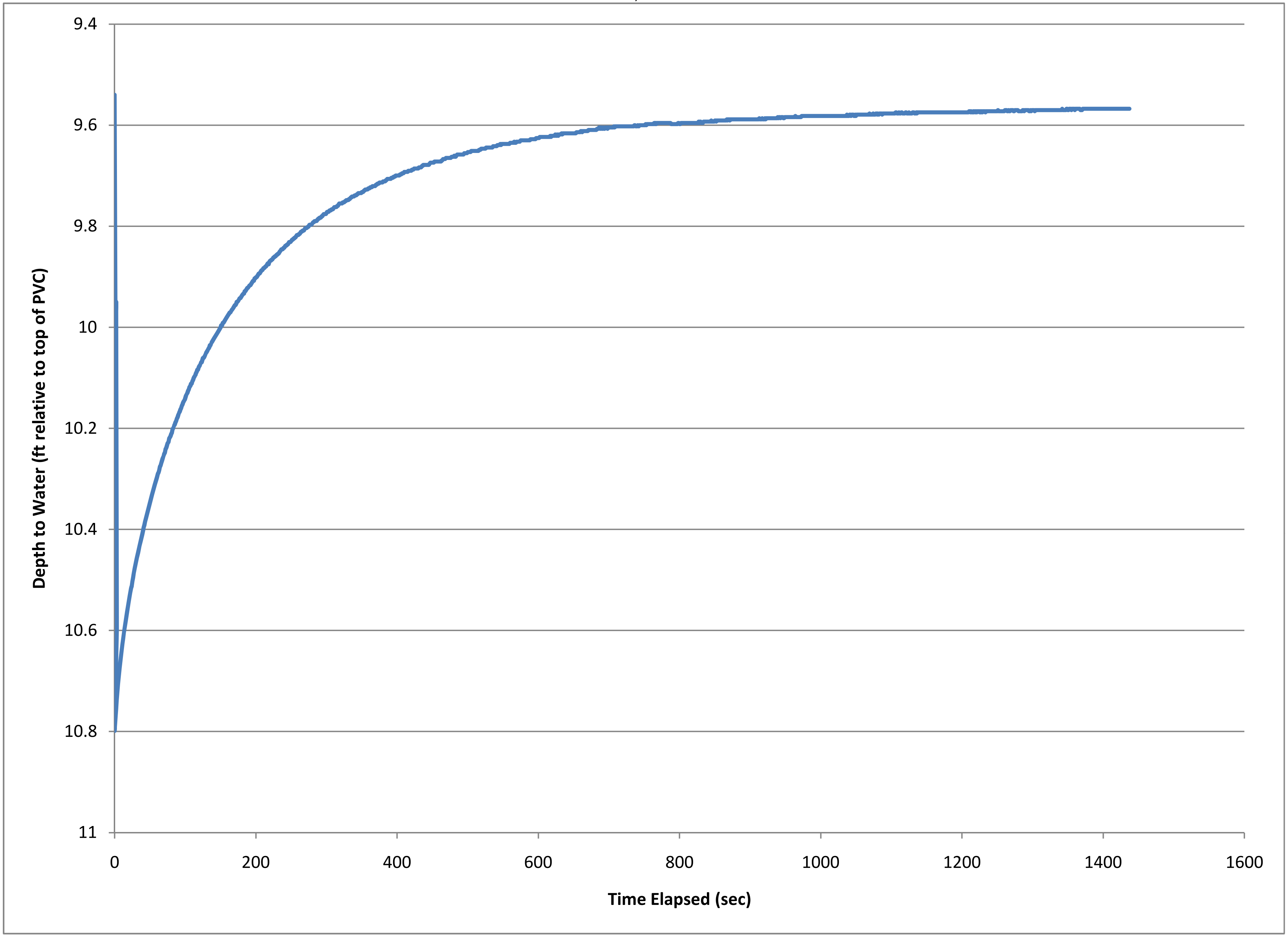

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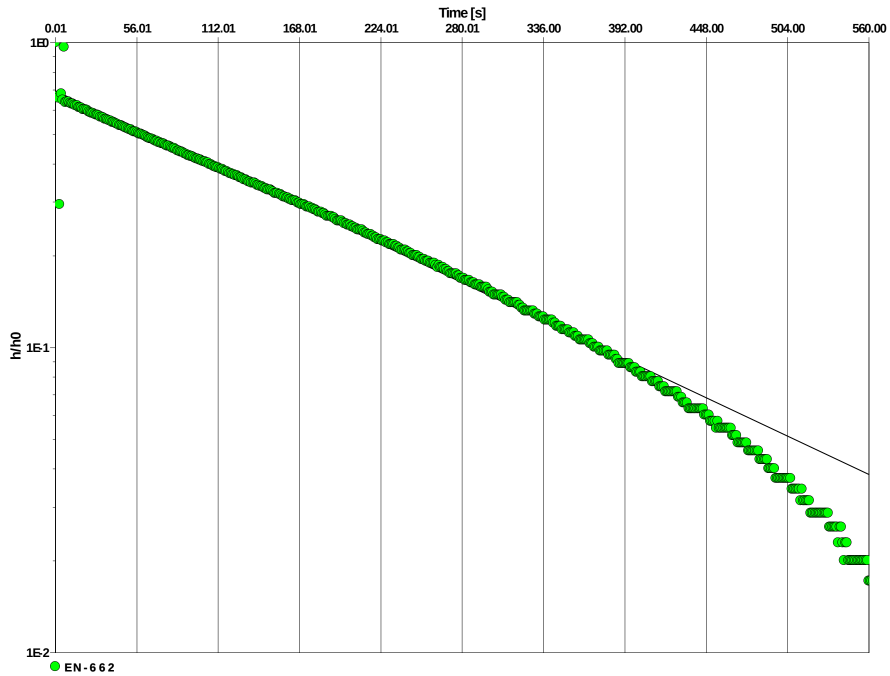
Client: IBM



Test name: EN-662 Test 2 Falling Head		
Aquifer Type: Confined		
Analysis Method: Bouwer & Rice		
Analysis Result:	Conductivity =	2.28×10^{-1} ft/day
Test Parameters:	Test well:	EN-662
	PVC well radius:	0.083 ft
	Saturated screen length:	5.00 ft
	Boring radius:	0.25 ft
	Aquifer thickness:	6.00 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	9.48 ft
	Depth to water (from tPVC) at t=0:	8.67 ft
	Depth to bottom of screen (from tPVC):	20.00 ft
Evaluated by:	J. Prellwitz, 03/21/08	
Comments: Test conducted by J. Prellwitz on February 27, 2008. A porosity of 0.3 was assumed for the well filter pack and surrounding material.		

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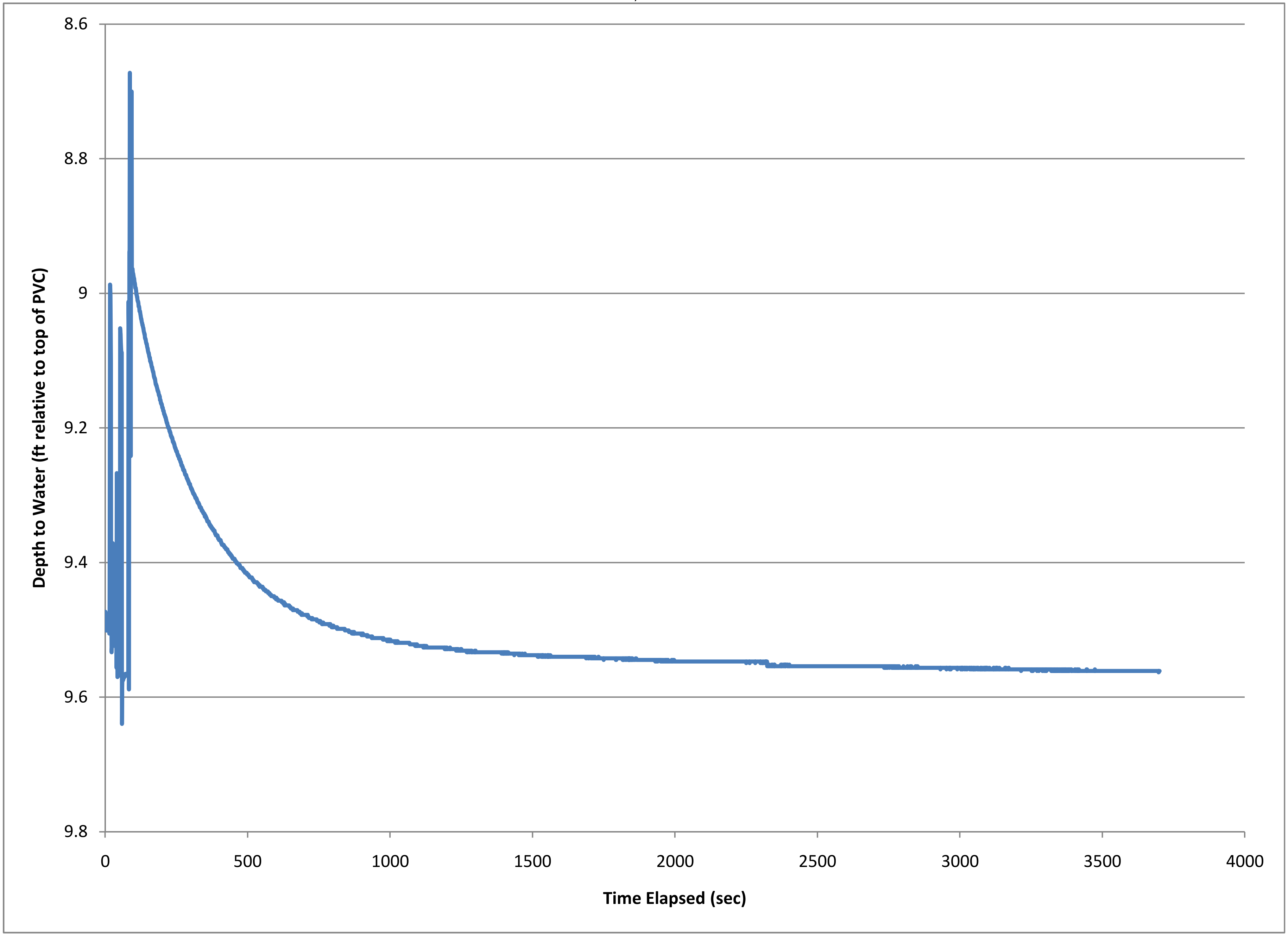
Encl. Monitoring Well EN-662 – Slug (Falling) Head Test 2 (February 27, 2008)

Monitoring Well EN-662 - Slug (Falling) Test 2 (February 27, 2008)
Building 57 - IBM Facility
Endicott, New York



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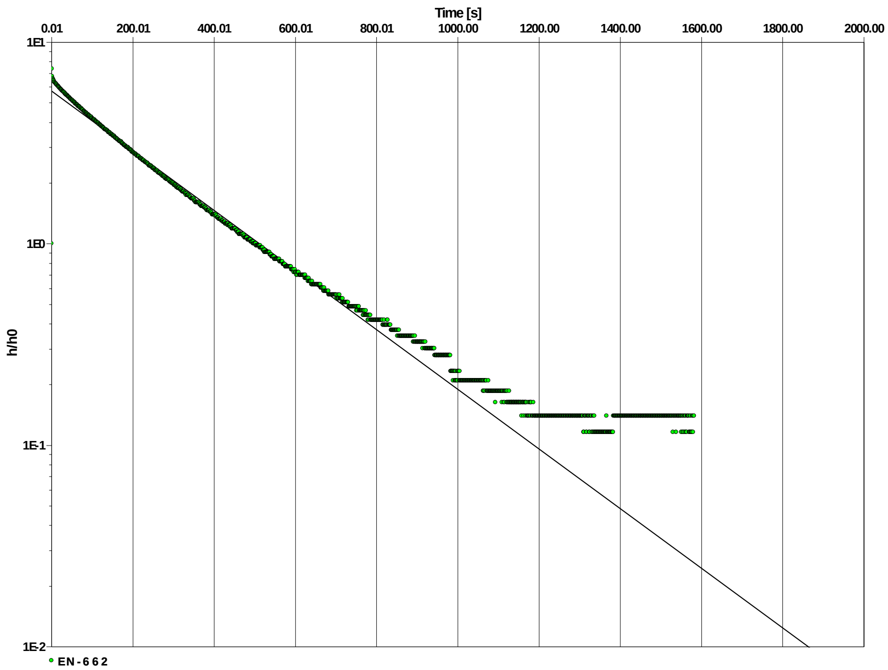
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM



Test name: EN-662 Test 2 Rising Head		
Aquifer Type: Confined		
Analysis Method: Bouwer & Rice		
Analysis Result:	Conductivity =	1.51×10^{-1} ft/day
Test Parameters:	Test well:	EN-662
	PVC well radius:	0.083 ft
	Saturated screen length:	5.00 ft
	Boring radius:	0.25 ft
	Aquifer thickness:	6.00 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	9.50 ft
	Depth to water (from tPVC) at t=0:	9.40 ft
	Depth to bottom of screen (from tPVC):	20.00 ft
Evaluated by:	J. Prellwitz, 03/21/08	
Comments: Test conducted by J. Prellwitz on February 27, 2008. A porosity of 0.3 was assumed for the well filter pack and surrounding material.		

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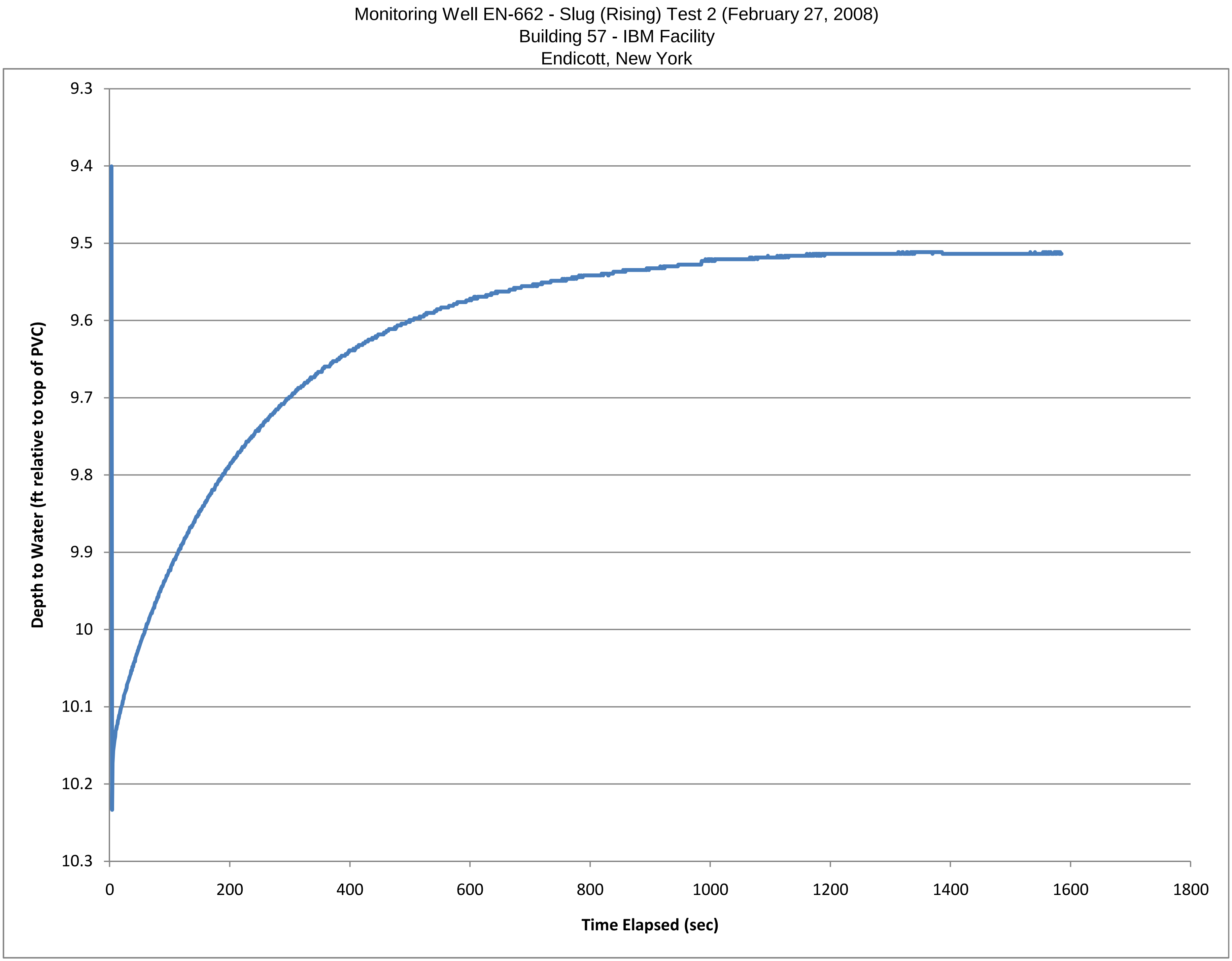
Encl. Monitoring Well EN-662 – Slug (Rising) Head Test 2 (February 27, 2008)


Monitoring Well EN-662 - Slug (Rising) Test 2 (February 27, 2008)
Building 57 - IBM Facility
Endicott, New York
Depth to Water (ft relative to top of PVC)
9.3
9.4
9.5
9.6
9.7
9.8
9.9
10
10.1
10.2
10.3
0
200
400
600
800
1000
1200
1400
1600
1800
Time Elapsed (sec)

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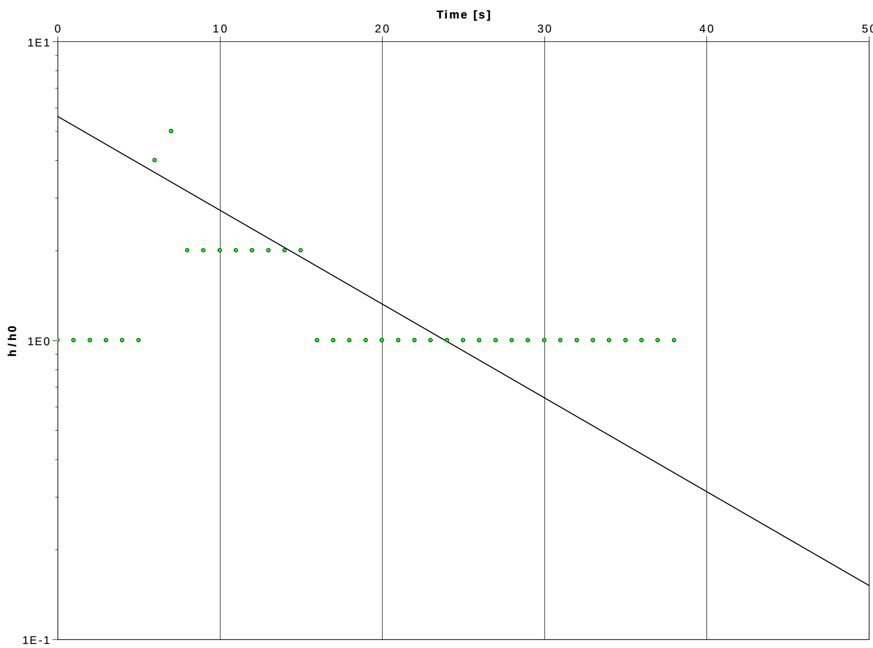
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM



Test Name: EN-664 Test 1 Rising Head
Aquifer Type: Unconfined
Analysis Method: Bouwer & Rice

Analysis Result:	Conductivity =	2.94 ft/day
Test Parameters:	Test well:	EN-664
	PVC well radius:	0.083 ft
	Saturated screen length:	4.57 ft
	Boring radius:	0.1875 ft
	Aquifer thickness:	8.85 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	5.43 ft
	Depth to water (from tPVC) at t=0:	5.44 ft
	Depth to bottom of screen (from tPVC):	10.00 ft
Evaluated by:	J. Prellwitz, 03/21/08	

Comments: Test conducted by J. Prellwitz on February 28, 2008.
A porosity of 0.3 was assumed for the well filter pack and surrounding material.

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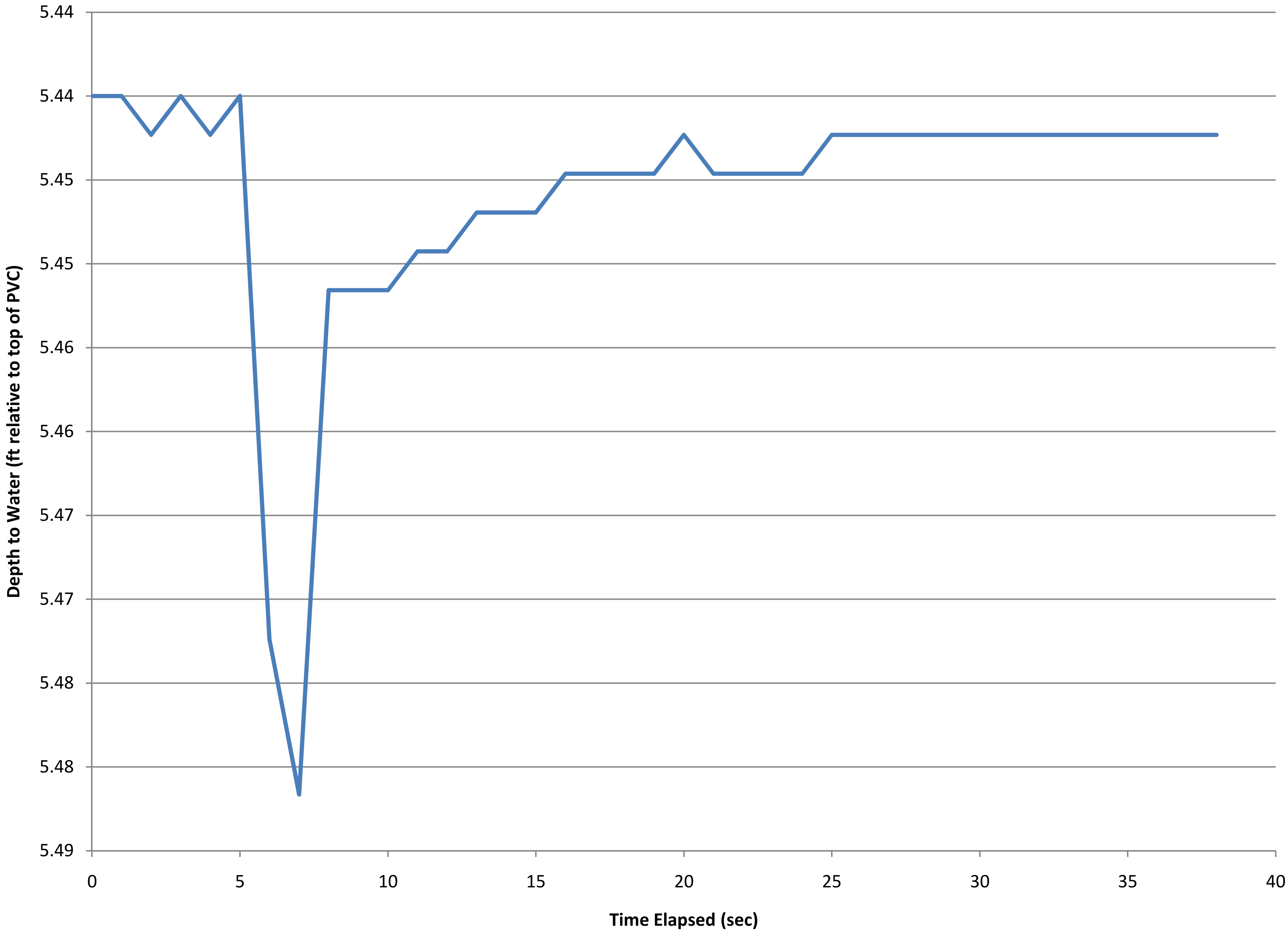
Encl. Monitoring Well EN-664 – Slug (Rising) Head Test 1 (February 28, 2008)

Monitoring Well EN-664 - Slug (Rising) Test 1 (February 28, 2008)
Building 57 - IBM Facility
Endicott, New York



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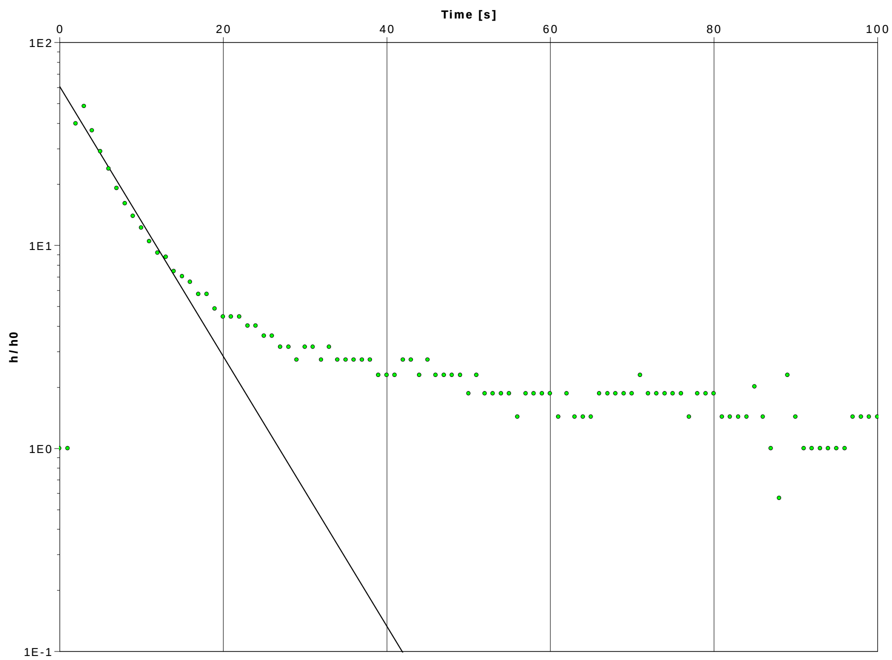
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM



Test Name: EN-665 Test 1 Rising Head
Aquifer Type: Unconfined
Analysis Method: Bouwer & Rice

Analysis Result:	Conductivity =	6.76 ft/day
Test Parameters:	Test well:	EN-665
	PVC well radius:	0.0416 ft
	Saturated screen length:	4.61 ft
	Boring radius:	0.1875 ft
	Aquifer thickness:	8.60 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	4.39 ft
	Depth to water (from tPVC) at t=0:	4.40 ft
	Depth to bottom of screen (from tPVC):	9.00 ft
Evaluated by:	J. Prellwitz, 03/21/08	

Comments: Test conducted by J. Prellwitz on February 28, 2008.
A porosity of 0.3 was assumed for the well filter pack and surrounding material.

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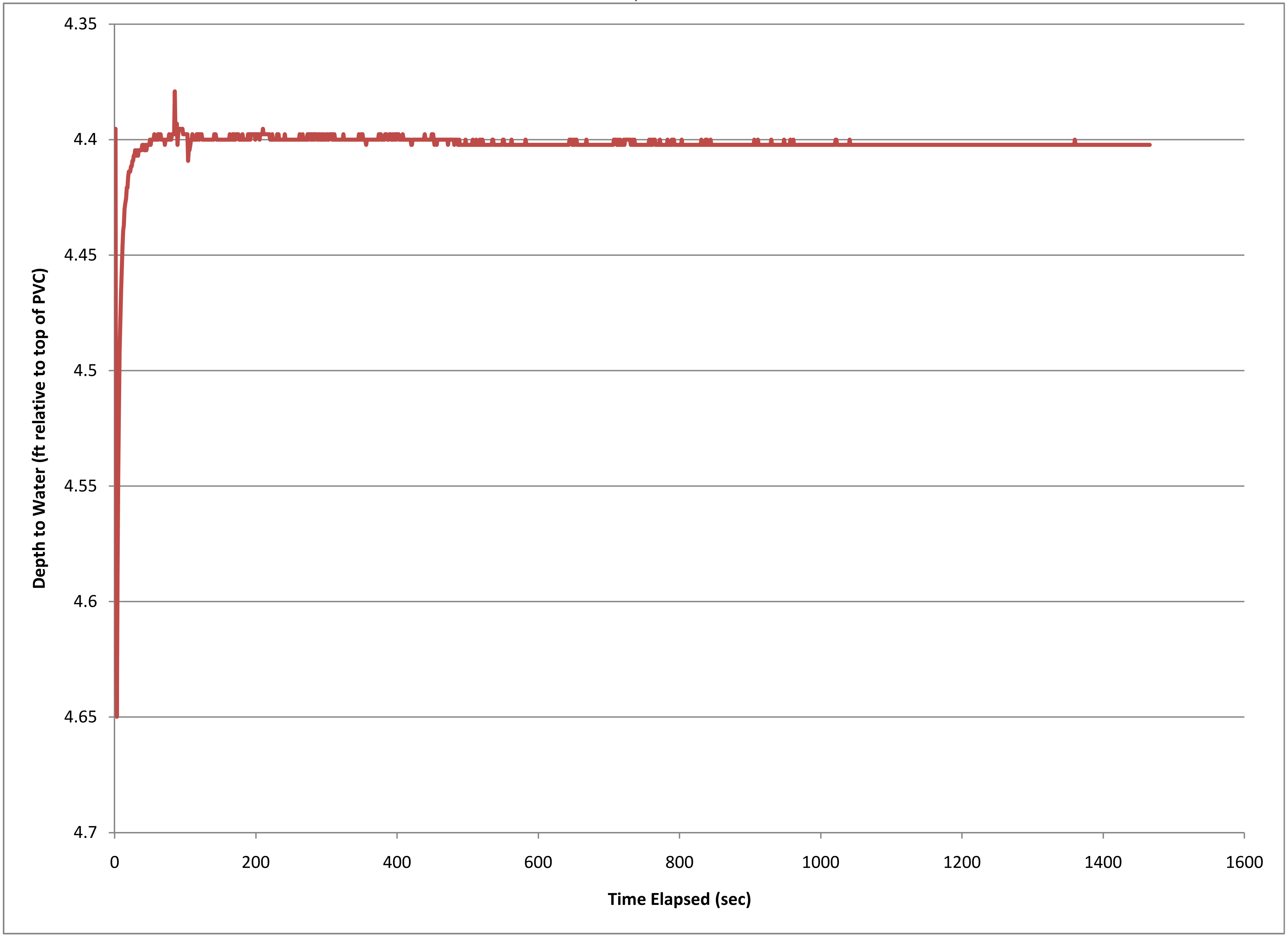
Encl. Monitoring Well EN-665 – Slug (Rising) Head Test 1 (February 28, 2008)

Monitoring Well EN-665 - Slug (Rising) Test 1 (February 28, 2008)
Building 57 - IBM Facility
Endicott, New York



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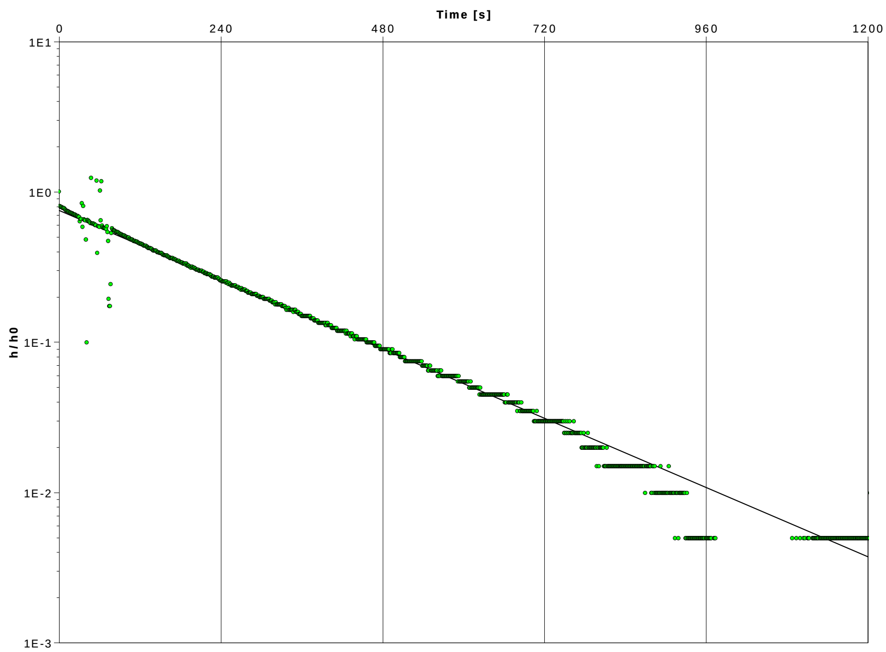
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM



Test Name: EN-666 Test 1 Falling Head
Aquifer Type: Confined
Analysis Method: Bouwer & Rice

Analysis Result: Conductivity = 2.29×10^{-1} ft/day

Test Parameters:

Test well:	EN-666
PVC well radius:	0.0416 ft
Saturated screen length:	4.00 ft
Boring radius:	0.1875 ft
Aquifer thickness:	3.50 ft
Pre-test depth to water (referenced to top of PVC (tPVC)):	11.22 ft
Depth to water (from tPVC) at t=0:	10.75 ft
Depth to bottom of screen (from tPVC):	21.50 ft

Evaluated by: J. Prellwitz, 03/21/08

Comments: Test conducted by J. Prellwitz and P. Malone on February 27, 2008.
A porosity of 0.3 was assumed for the well filter pack and surrounding material.

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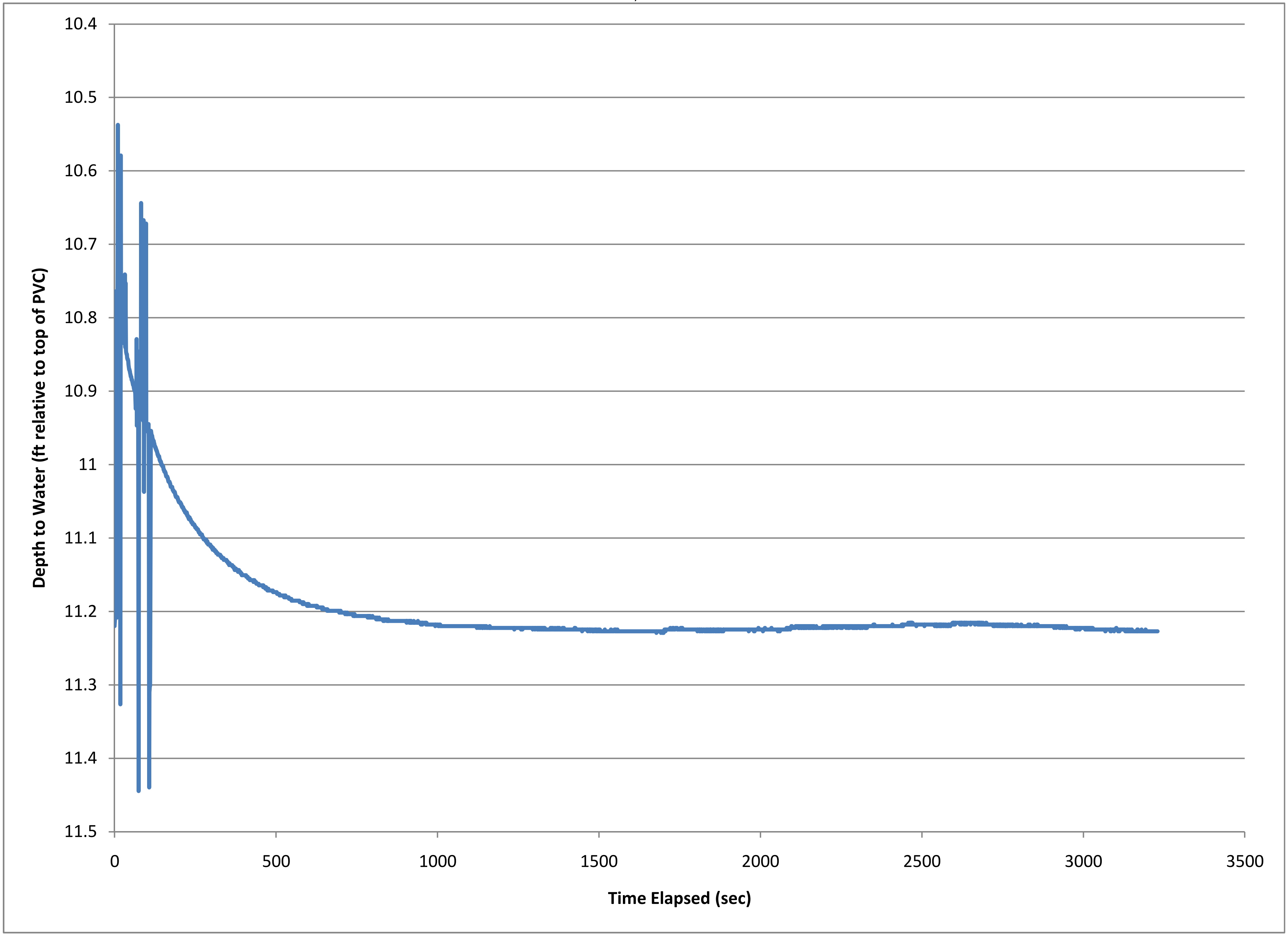
Encl. Monitoring Well EN-666 – Slug (Falling) Head Test 1 (February 27, 2008)

Monitoring Well EN-666 - Slug (Falling) Test 1 (February 27, 2008)
Building 57 - IBM Facility
Endicott, New York



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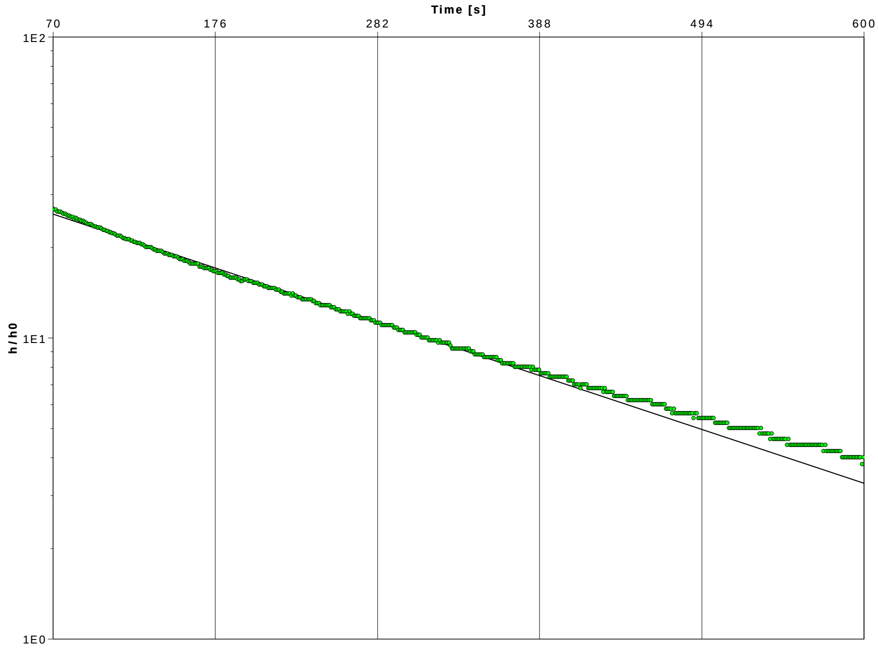
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM

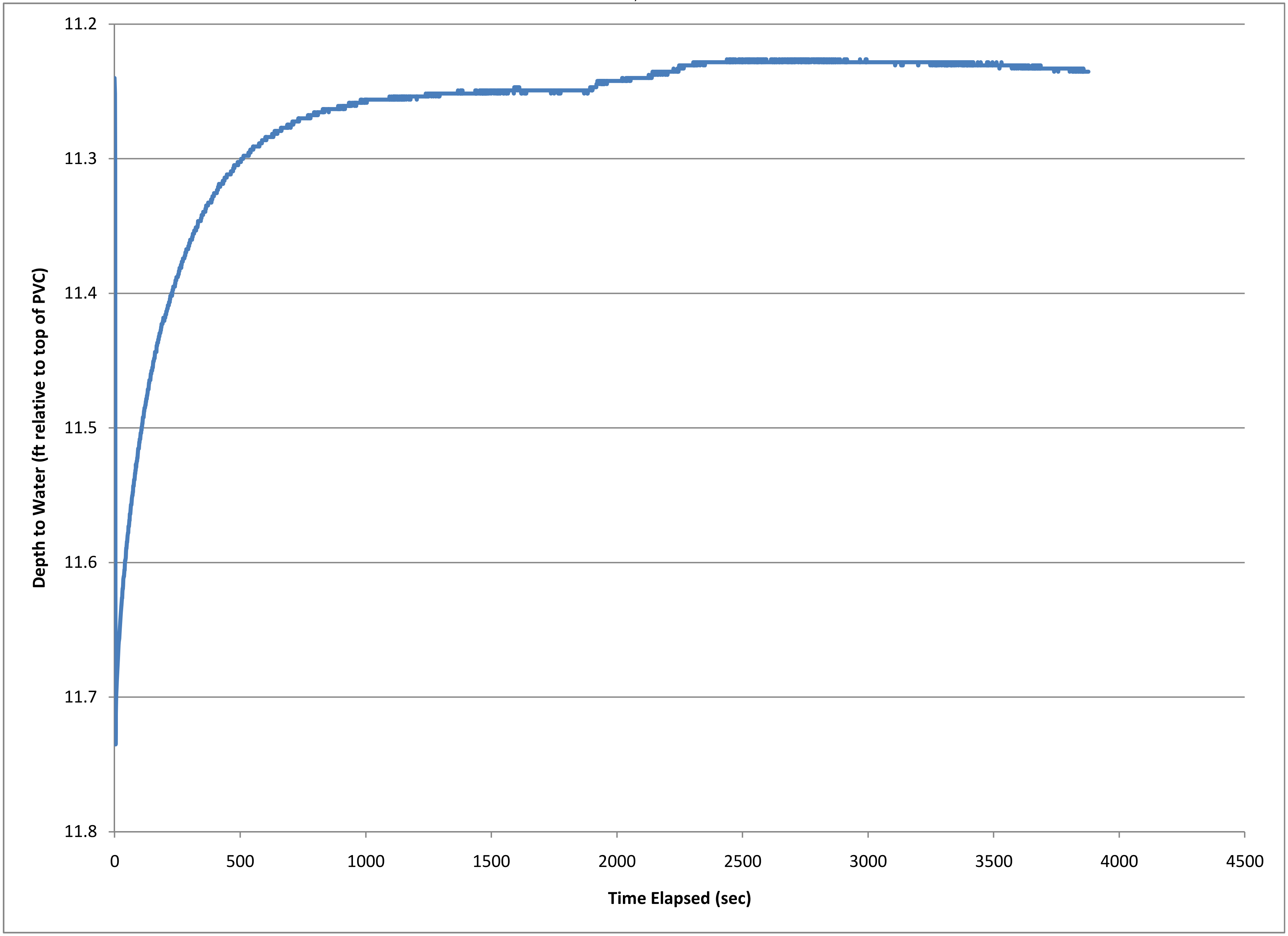


Test Name: EN-666 Test 1 Rising Head		
Aquifer Type: Confined		
Analysis Method: Bouwer & Rice		
Analysis Result:	Conductivity =	2.02×10^{-1} ft/day
Test Parameters:	Test well:	EN-666
	PVC well radius:	0.0416 ft
	Saturated screen length:	4.00 ft
	Boring radius:	0.1875 ft
	Aquifer thickness:	3.50 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	11.24 ft
	Depth to water (from tPVC) at t=0:	11.25 ft
	Depth to bottom of screen (from tPVC):	21.50 ft
Evaluated by:	J. Prellwitz, 03/21/08	
Comments: Test conducted by J. Prellwitz and P. Malone on February 27, 2008. A porosity of 0.3 was assumed for the well filter pack and surrounding material.		

JSP/LJJ:jsp

Encl. Monitoring Well EN-666 – Slug (Rising) Head Test 1 (February 27, 2008)

Monitoring Well EN-666 - Slug (Rising) Test 1 (February 27, 2008)
Building 57 - IBM Facility
Endicott, New York



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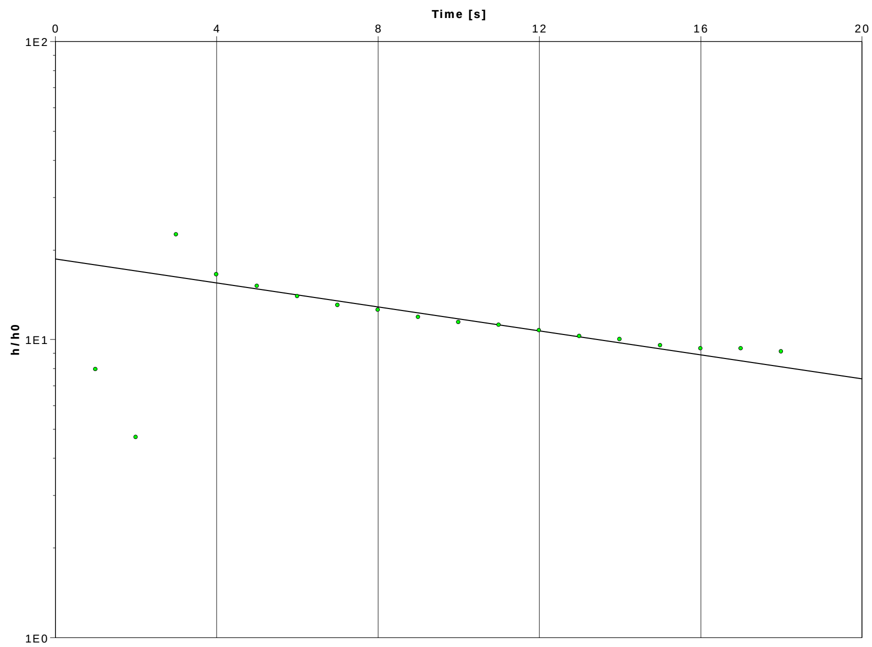
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM

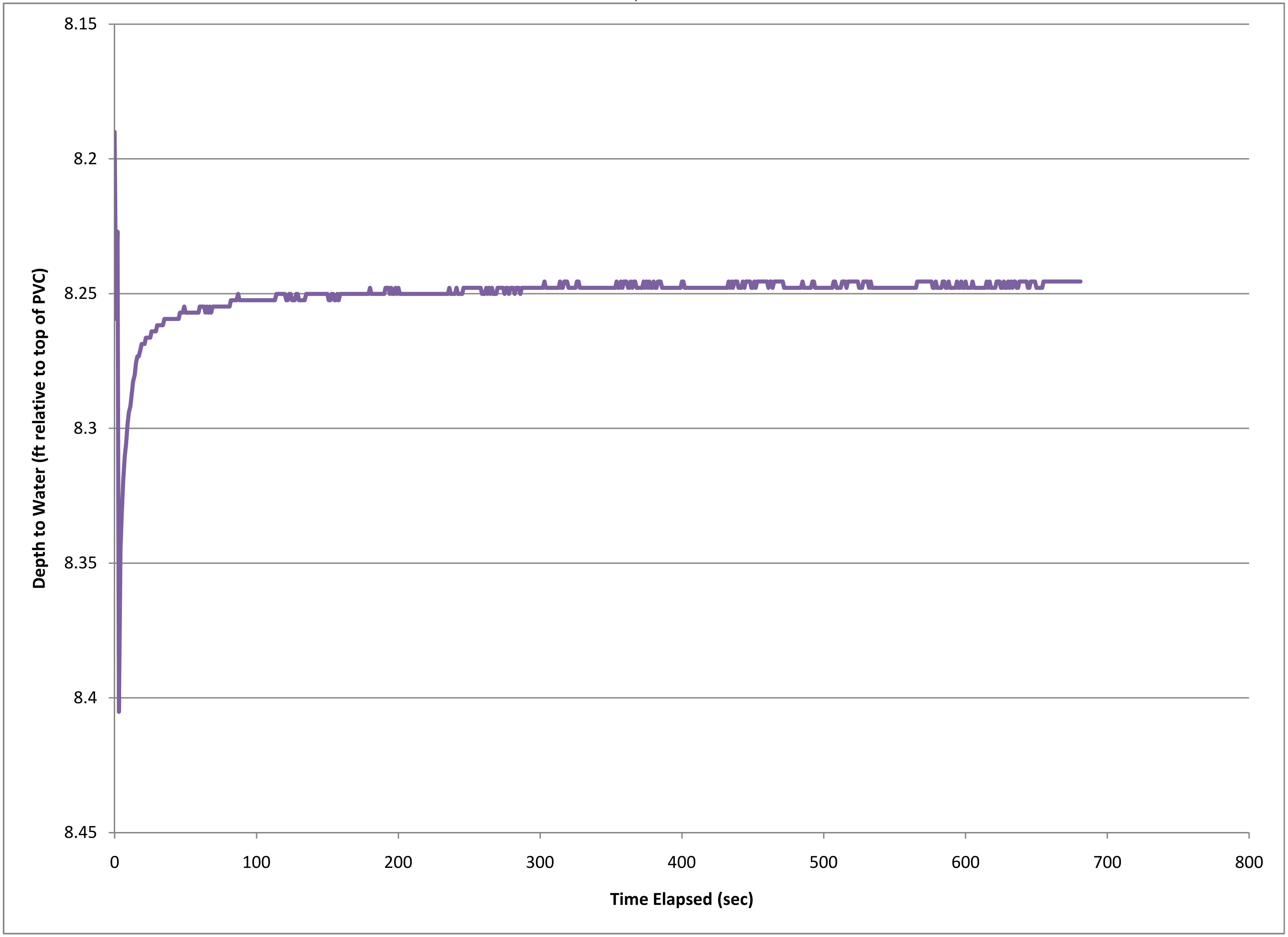


Test Name: EN-667 Test 1 Rising Head **Aquifer Type:** Unconfined **Analysis Method:** Bouwer & Rice		
Analysis Result:	Conductivity =	2.04 ft/day
Test Parameters:	Test well:	EN-667
	PVC well radius:	0.0416 ft
	Saturated screen length:	2.82 ft
	Boring radius:	0.1875 ft
	Aquifer thickness:	10.10 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	8.18 ft
	Depth to water (from tPVC) at t=0:	8.19 ft
	Depth to bottom of screen (from tPVC):	11.50 ft
Evaluated by:	J. Prellwitz, 03/21/08	
Comments: Test conducted by J. Prellwitz on February 28, 2008. A porosity of 0.3 was assumed for the well filter pack and surrounding material.		

JSP/LJJ:jsp

Encl. Monitoring Well EN-667 – Slug (Rising) Head Test 1 (February 28, 2008)

Monitoring Well EN-667 - Slug (Rising) Test 1 (February 28, 2008)
Building 57 - IBM Facility
Endicott, New York



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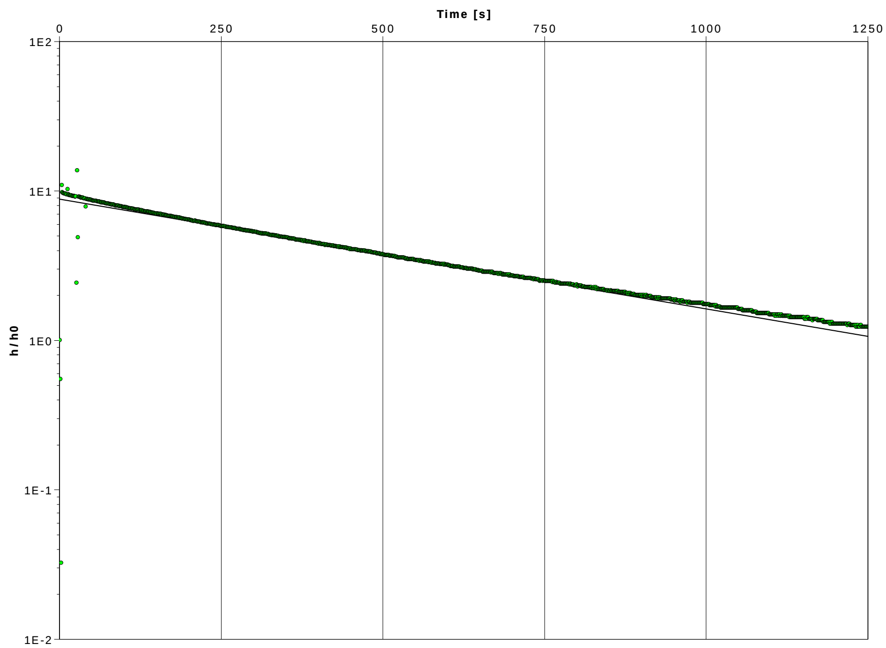
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM

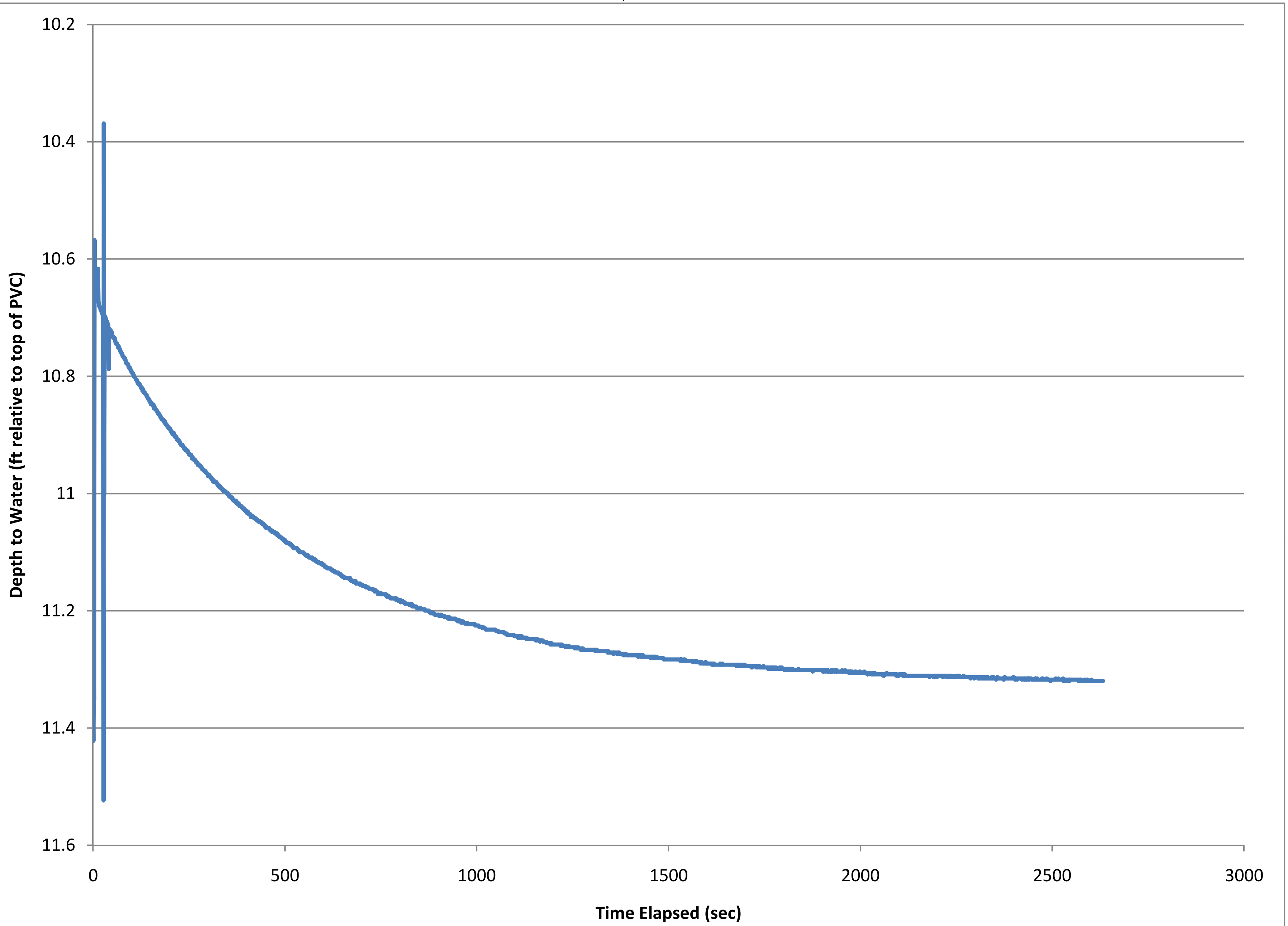


Test Name: EN-668 Test 1 Falling Head		
Aquifer Type: Confined		
Analysis Method: Bouwer & Rice		
Analysis Result:	Conductivity =	7.47×10^{-2} ft/day
Test Parameters:	Test well:	EN-668
	PVC well radius:	0.0416 ft
	Saturated screen length:	5.00 ft
	Boring radius:	0.1875 ft
	Aquifer thickness:	6.10 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	11.35 ft
	Depth to water (from tPVC) at t=0:	11.42 ft
	Depth to bottom of screen (from tPVC):	22.20 ft
Evaluated by:	J. Prellwitz, 03/21/08	
Comments: Test conducted by J. Prellwitz and P. Malone on February 27, 2008. A porosity of 0.3 was assumed for the well filter pack and surrounding material.		

JSP/LJJ:jsp

Encl. Monitoring Well EN-668 – Slug (Falling) Head Test 1 (February 27, 2008)

Monitoring Well EN-668 - Slug (Falling) Test 1 (February 27, 2008)
Building 57 - IBM Facility
Endicott, New York



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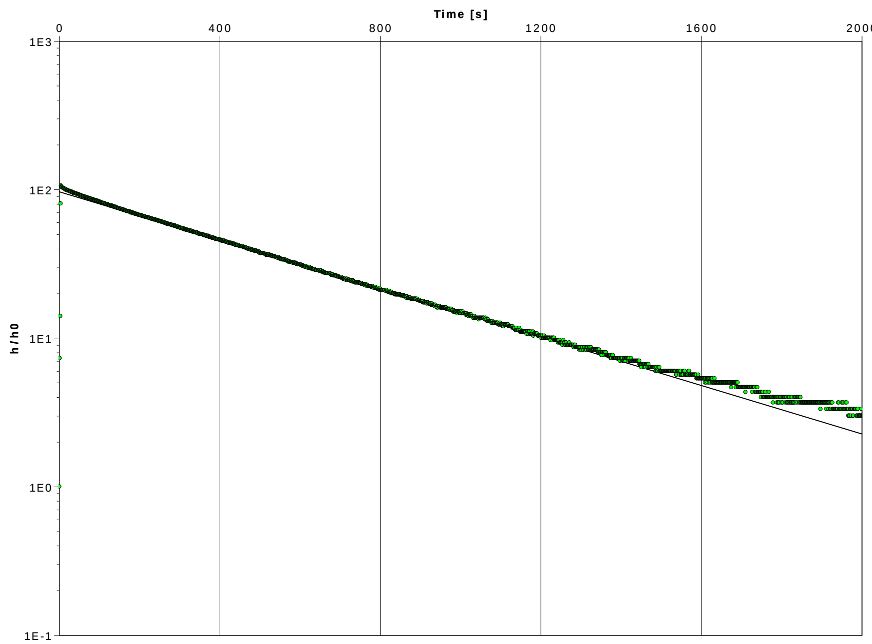
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM



Test Name: EN-668 Test 1 Rising Head
Aquifer Type: Confined
Analysis Method: Bouwer & Rice

Analysis Result: Conductivity = 8.30×10^{-2} ft/day

Test Parameters:		
	Test well:	EN-668
	PVC well radius:	0.0416 ft
	Saturated screen length:	5.00 ft
	Boring radius:	0.1875 ft
	Aquifer thickness:	6.10 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	11.40 ft
	Depth to water (from tPVC) at t=0:	11.41 ft
	Depth to bottom of screen (from tPVC):	22.20 ft

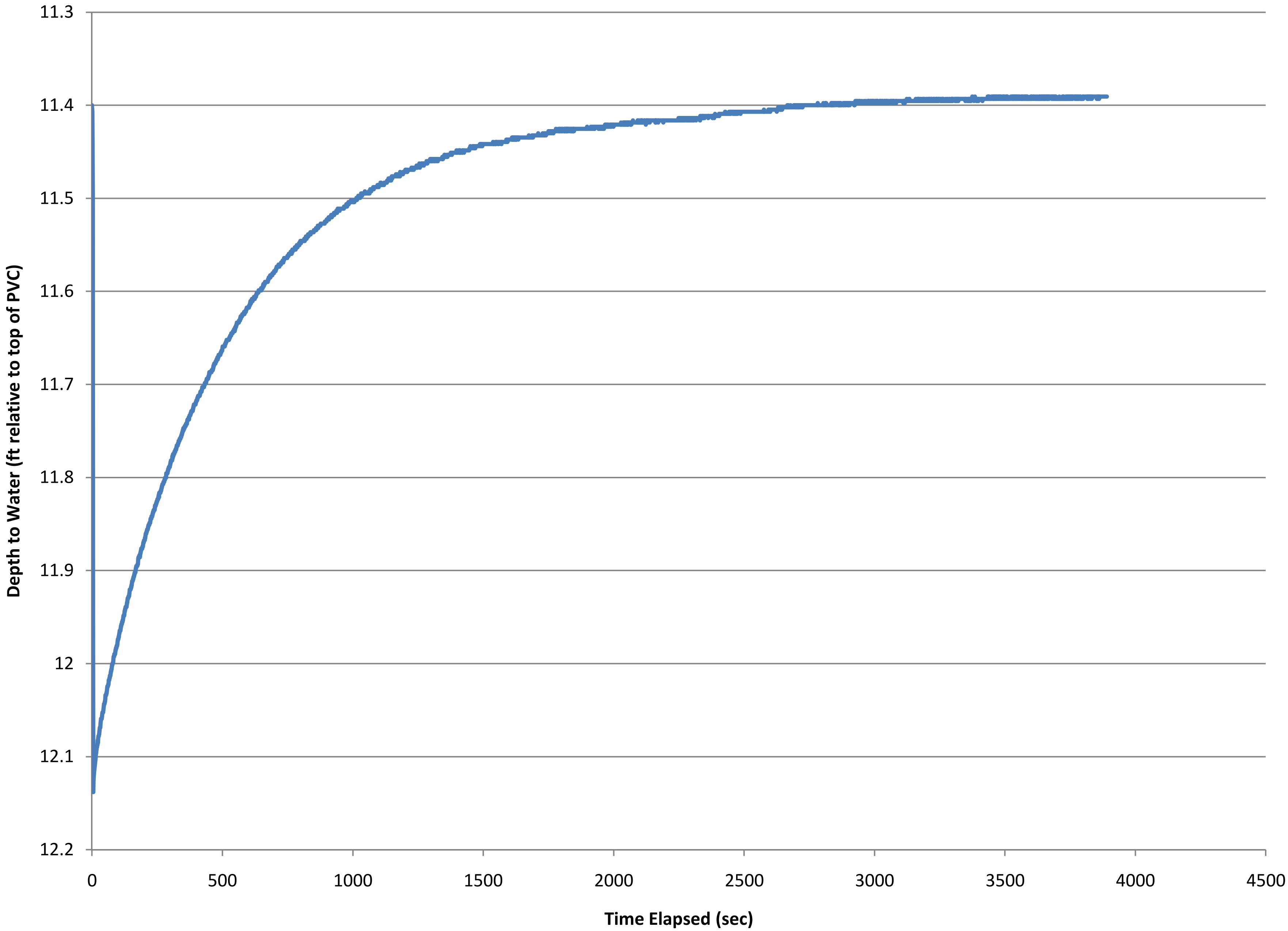
Evaluated by: J. Prellwitz, 03/21/08

Comments: Test conducted by J. Prellwitz and P. Malone on February 27, 2008.
A porosity of 0.3 was assumed for the well filter pack and surrounding material.

JSP/LJJ:jsp

Encl. Monitoring Well EN-668 – Slug (Rising) Head Test 1 (February 27, 2008)

Monitoring Well EN-668 - Slug (Rising) Test 1 (February 27, 2008)
Building 57 - IBM Facility
Endicott, New York



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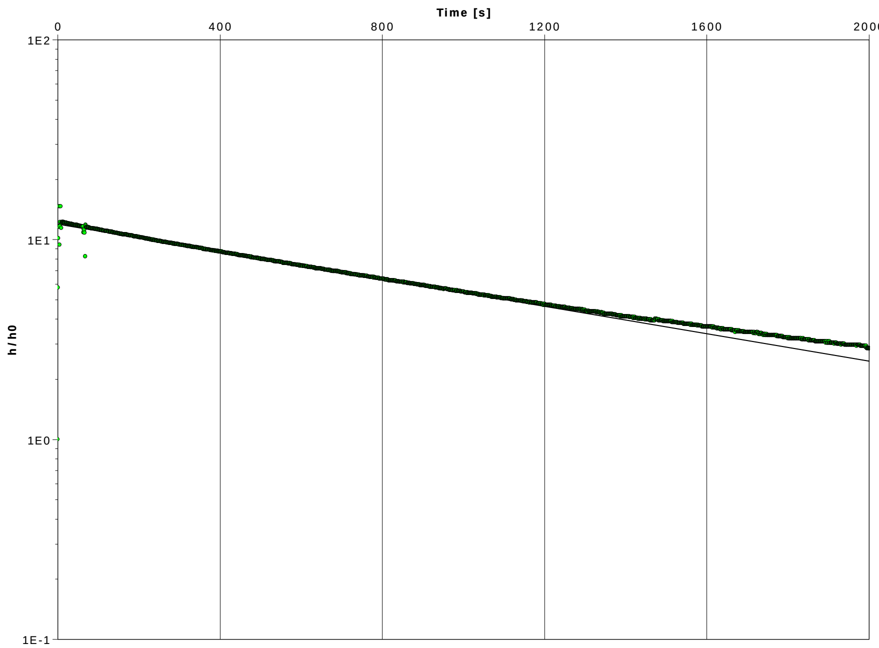
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM

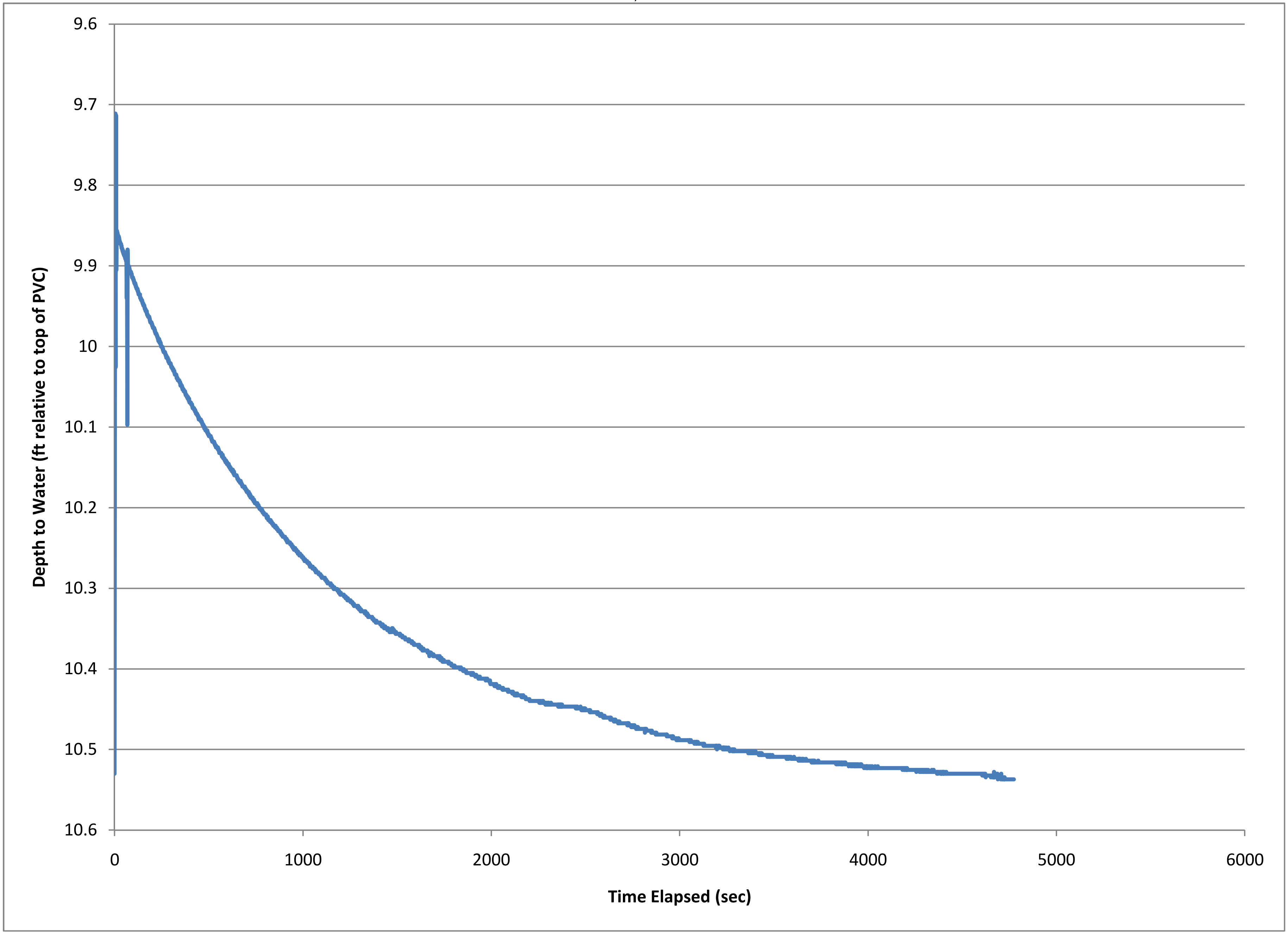


Test Name: EN-670 Test 1 Falling Head **Aquifer Type:** Confined **Analysis Method:** Bouwer & Rice		
Analysis Result:	Conductivity =	1.26×10^{-1} ft/day
Test Parameters:	Test well:	EN-670
	PVC well radius:	0.083 ft
	Saturated screen length:	5.00 ft
	Boring radius:	0.25 ft
	Aquifer thickness:	12.10 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	10.59 ft
	Depth to water (from tPVC) at t=0:	10.53 ft
	Depth to bottom of screen (from tPVC):	18.50 ft
Evaluated by:	J. Prellwitz, 03/21/08	
Comments: Test conducted by J. Prellwitz on February 28, 2008. A porosity of 0.3 was assumed for the well filter pack and surrounding material.		

JSP/LJJ:jsp

Encl. Monitoring Well EN-670 – Slug (Falling) Head Test 1 (February 28, 2008)

Monitoring Well EN-670 - Slug (Falling) Test 4 (February 28, 2008)
Building 57 - IBM Facility
Endicott, New York



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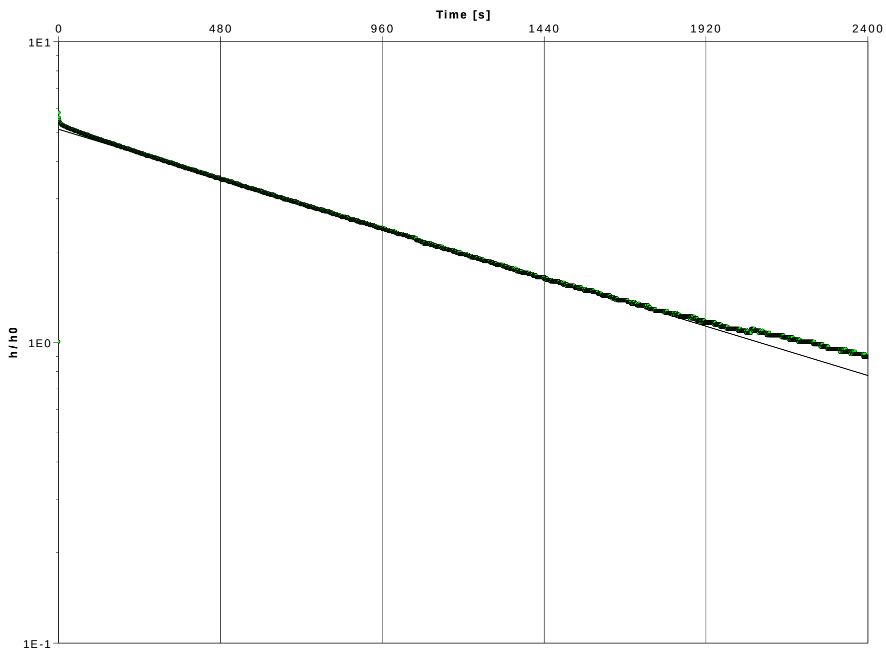
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM



Test Name: EN-670 Test 1 Rising Head		
Aquifer Type: Confined		
Analysis Method: Bouwer & Rice		
Analysis Result:	Conductivity =	1.25×10^{-1} ft/day
Test Parameters:	Test well:	EN-670
	PVC well radius:	0.083 ft
	Saturated screen length:	5.00 ft
	Boring radius:	0.25 ft
	Aquifer thickness:	12.10 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	10.52 ft
	Depth to water (from tPVC) at t=0:	10.65 ft
	Depth to bottom of screen (from tPVC):	18.50 ft
Evaluated by:	J. Prellwitz, 03/21/08	
Comments: Test conducted by J. Prellwitz on February 28, 2008. A porosity of 0.3 was assumed for the well filter pack and surrounding material.		

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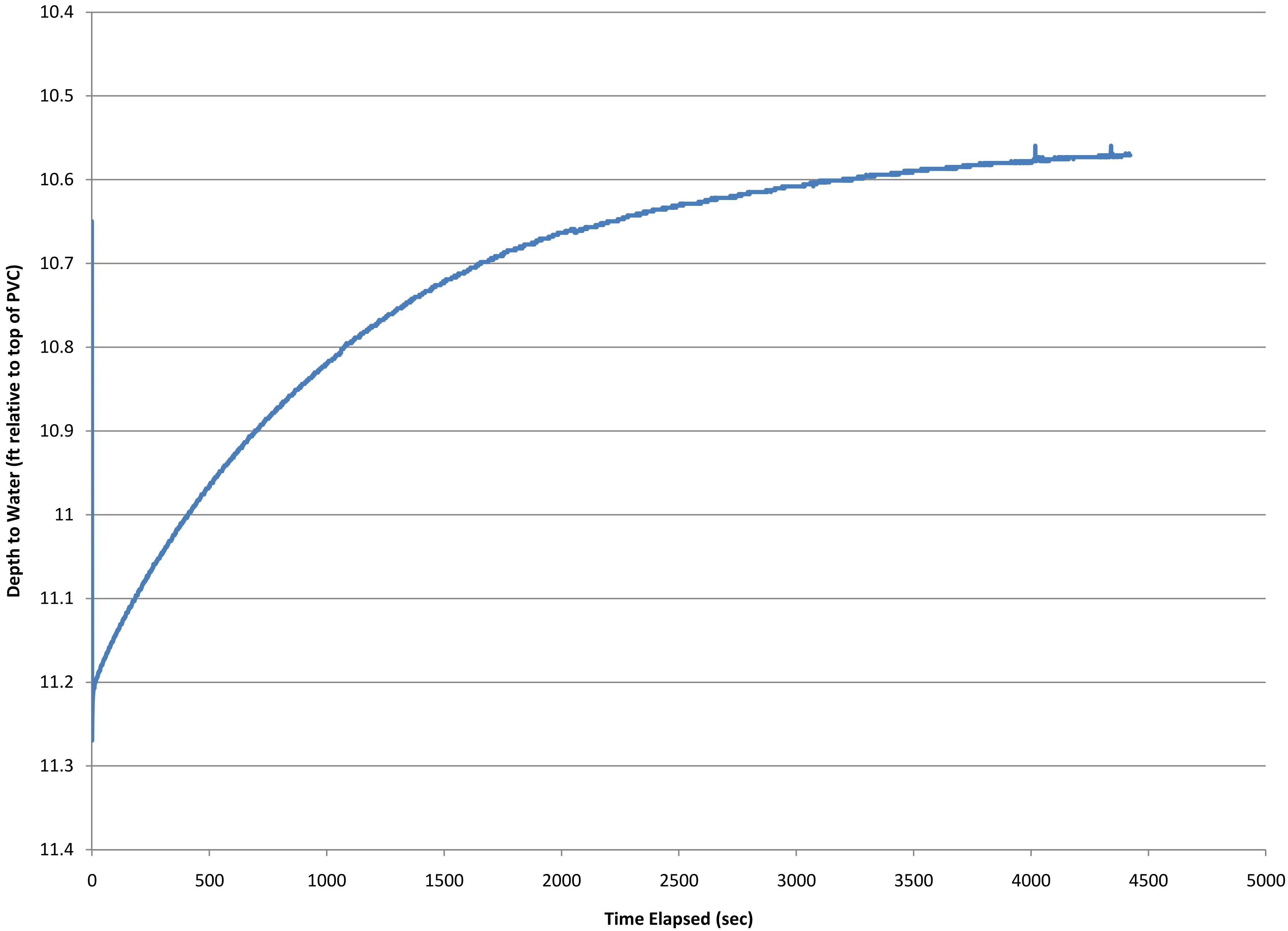
Encl. Monitoring Well EN-670 – Slug (Rising) Head Test 1 (February 28, 2008)

Monitoring Well EN-670 - Slug (Rising) Test 4 (February 28, 2008)
Building 57 - IBM Facility
Endicott, New York



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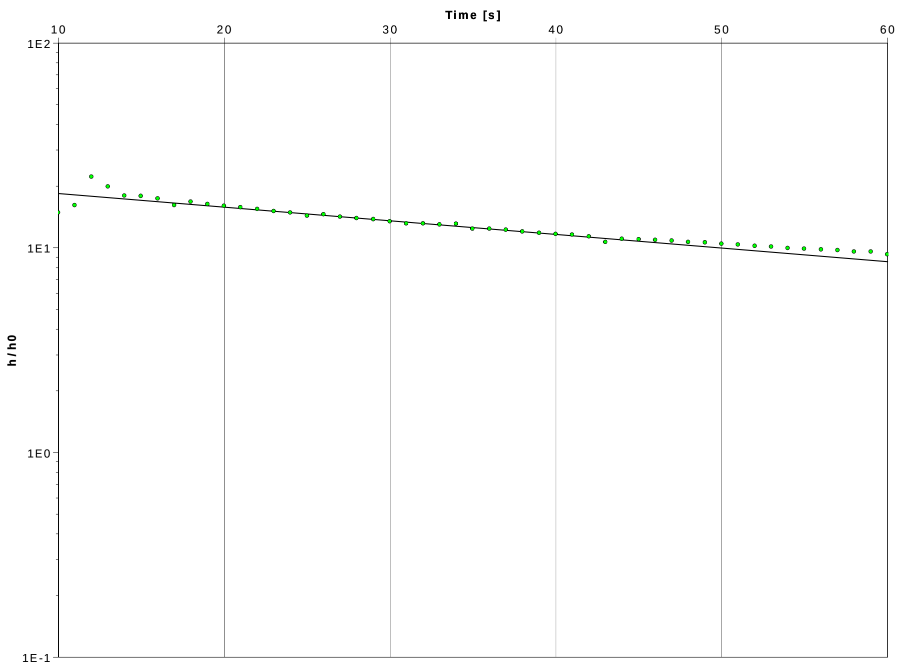
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM



Test name: EN-672 Test 1 Falling Head **Aquifer Type:** Confined **Analysis Method:** Bouwer & Rice		
Analysis Result:	Conductivity =	2.46 ft/day
Test Parameters:	Test well:	EN-672
	PVC well radius:	0.083 ft
	Saturated screen length:	5.00 ft
	Boring radius:	0.25 ft
	Aquifer thickness:	8.00 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	10.42 ft
	Depth to water (from tPVC) at t=0:	10.39 ft
	Depth to bottom of screen (from tPVC):	25.00 ft
Evaluated by:	J. Prellwitz, 03/31/08	
Comments: Test conducted by J. Prellwitz on February 27, 2008. A porosity of 0.3 was assumed for the well filter pack and surrounding material.		

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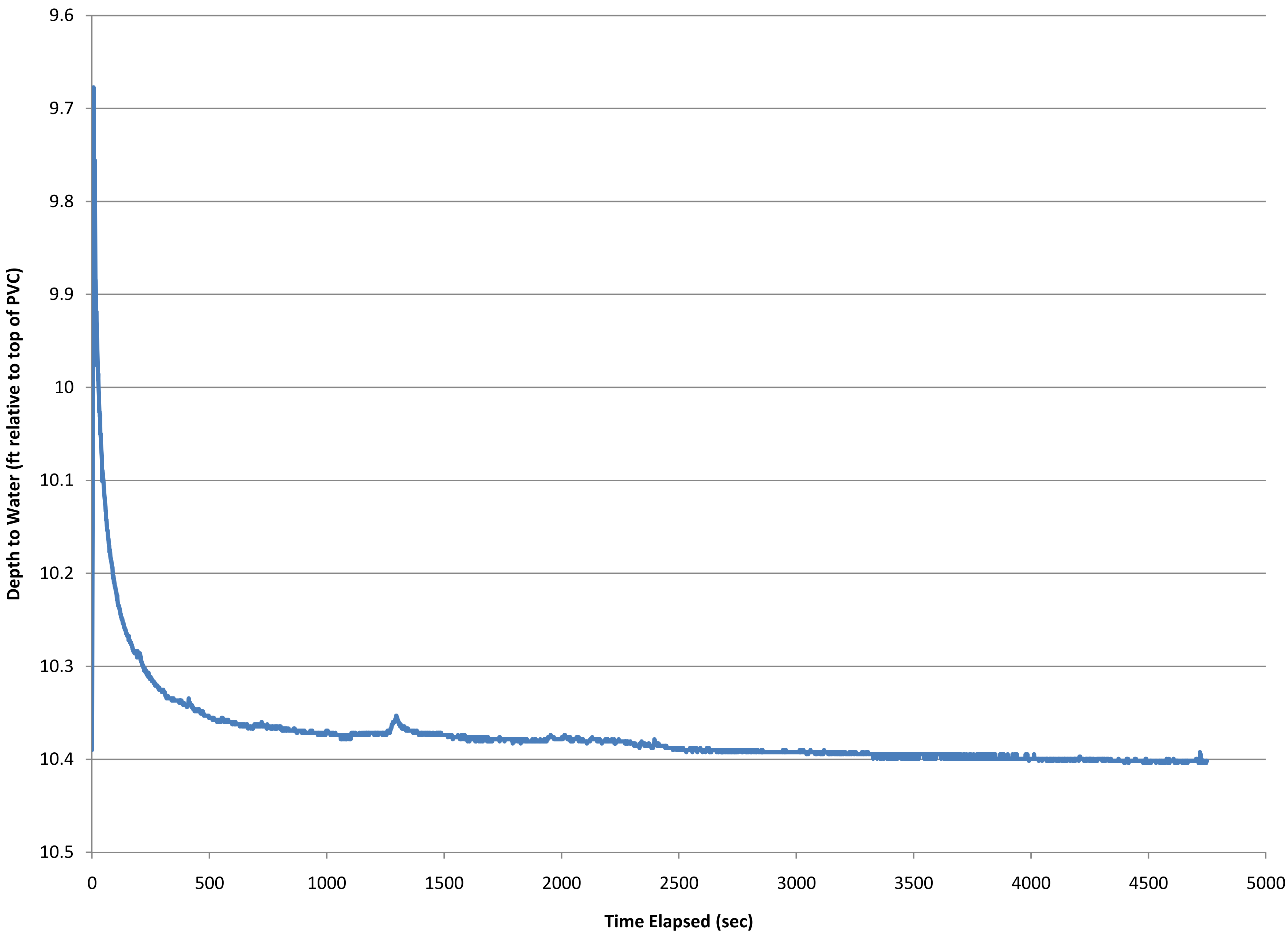
Encl. Monitoring Well EN-672 – Slug (Falling) Head Test 1 (February 27, 2008)

Monitoring Well EN-672 - Slug (Falling) Test 1 (February 27, 2008)
Building 57 - IBM Facility
Endicott, New York



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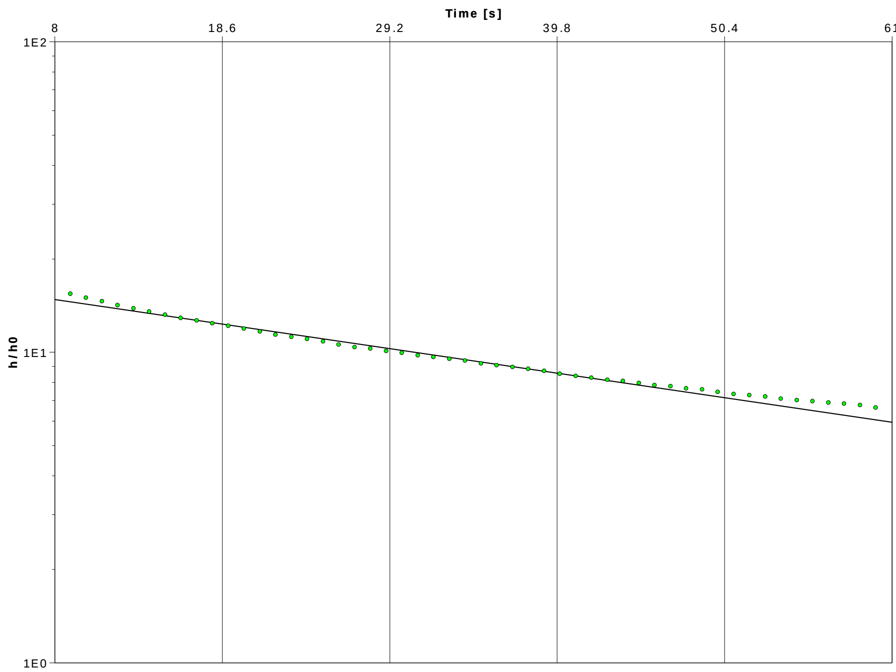
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM



<u>Test name:</u> EN-672 Test 1 Rising Head
<u>Aquifer Type:</u> Confined
<u>Analysis Method:</u> Bouwer & Rice

Analysis Result:	Conductivity =	2.74 ft/day
Test Parameters:	Test well:	EN-672
	PVC well radius:	0.083 ft
	Saturated screen length:	5.00 ft
	Boring radius:	0.25 ft
	Aquifer thickness:	8.00 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	10.42 ft
	Depth to water (from tPVC) at t=0:	10.46 ft
	Depth to bottom of screen (from tPVC):	25.00 ft
Evaluated by:	J. Prellwitz, 03/31/08	

<u>Comments:</u> Test conducted by J. Prellwitz on February 27, 2008.
A porosity of 0.3 was assumed for the well filter pack and surrounding material.

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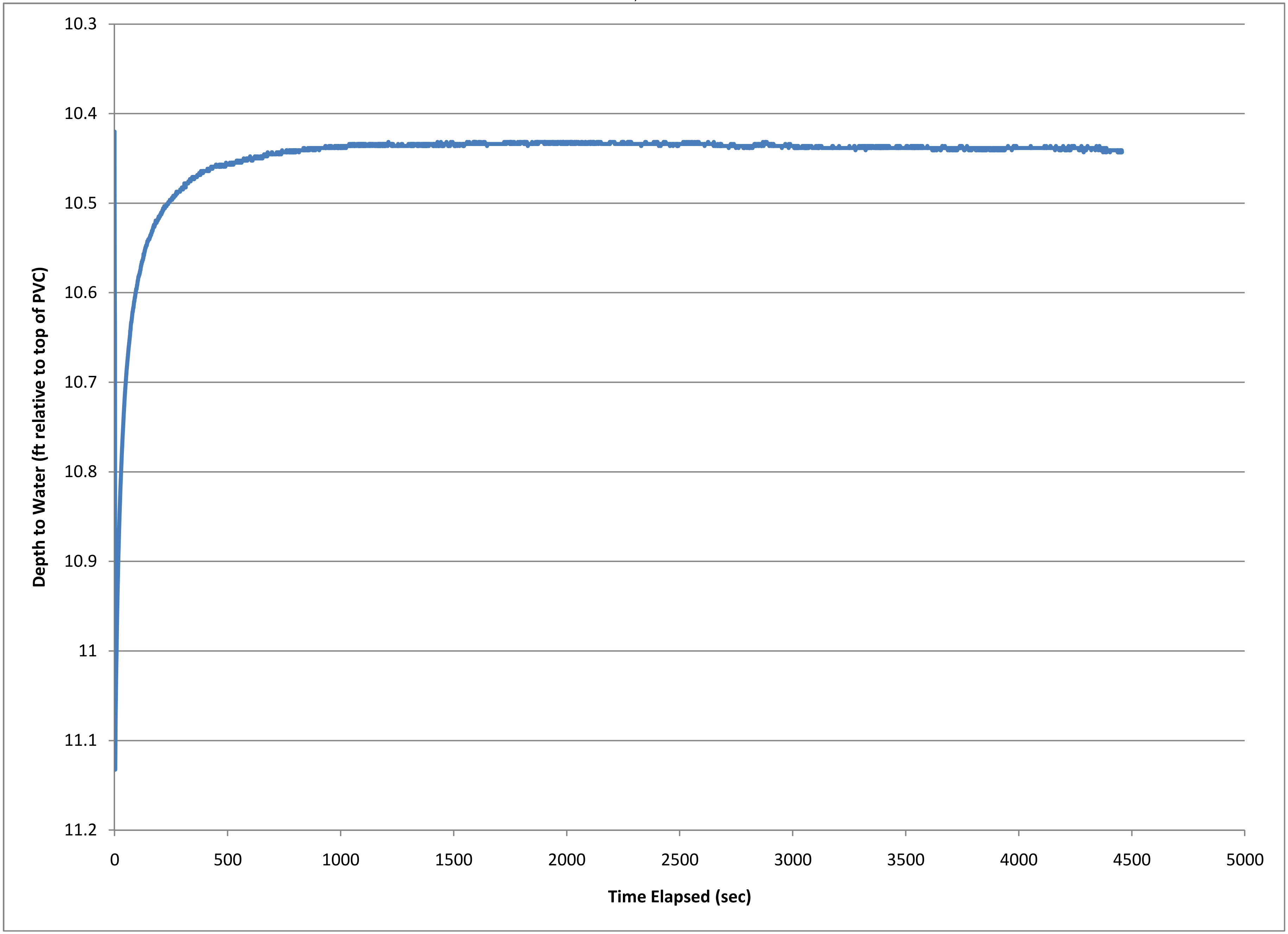
Encl. Monitoring Well EN-672 – Slug (Rising) Head Test 1 (February 27, 2008)

Monitoring Well EN-672 - Slug (Rising) Test 1 (February 27, 2008)
Building 57 - IBM Facility
Endicott, New York



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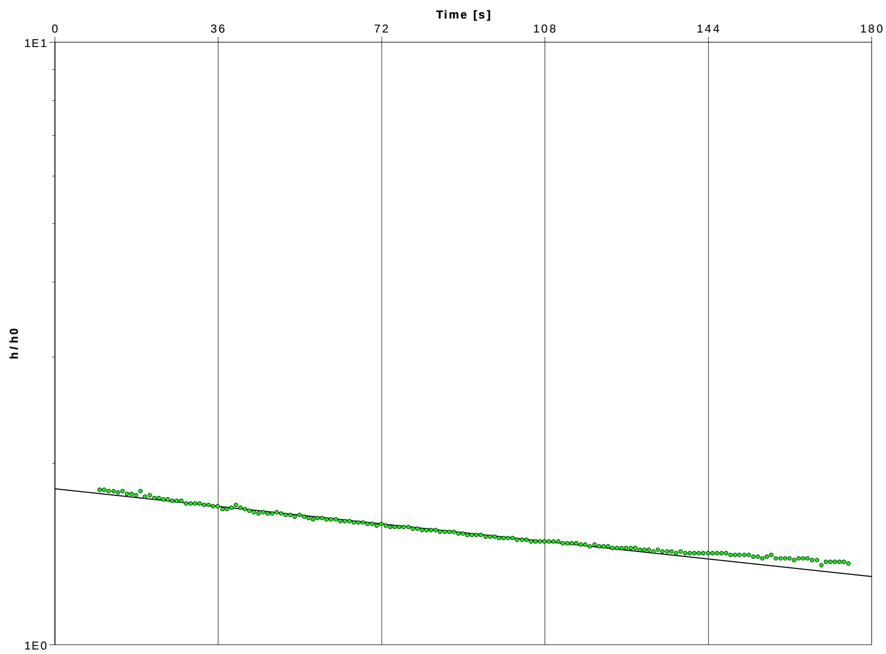
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM

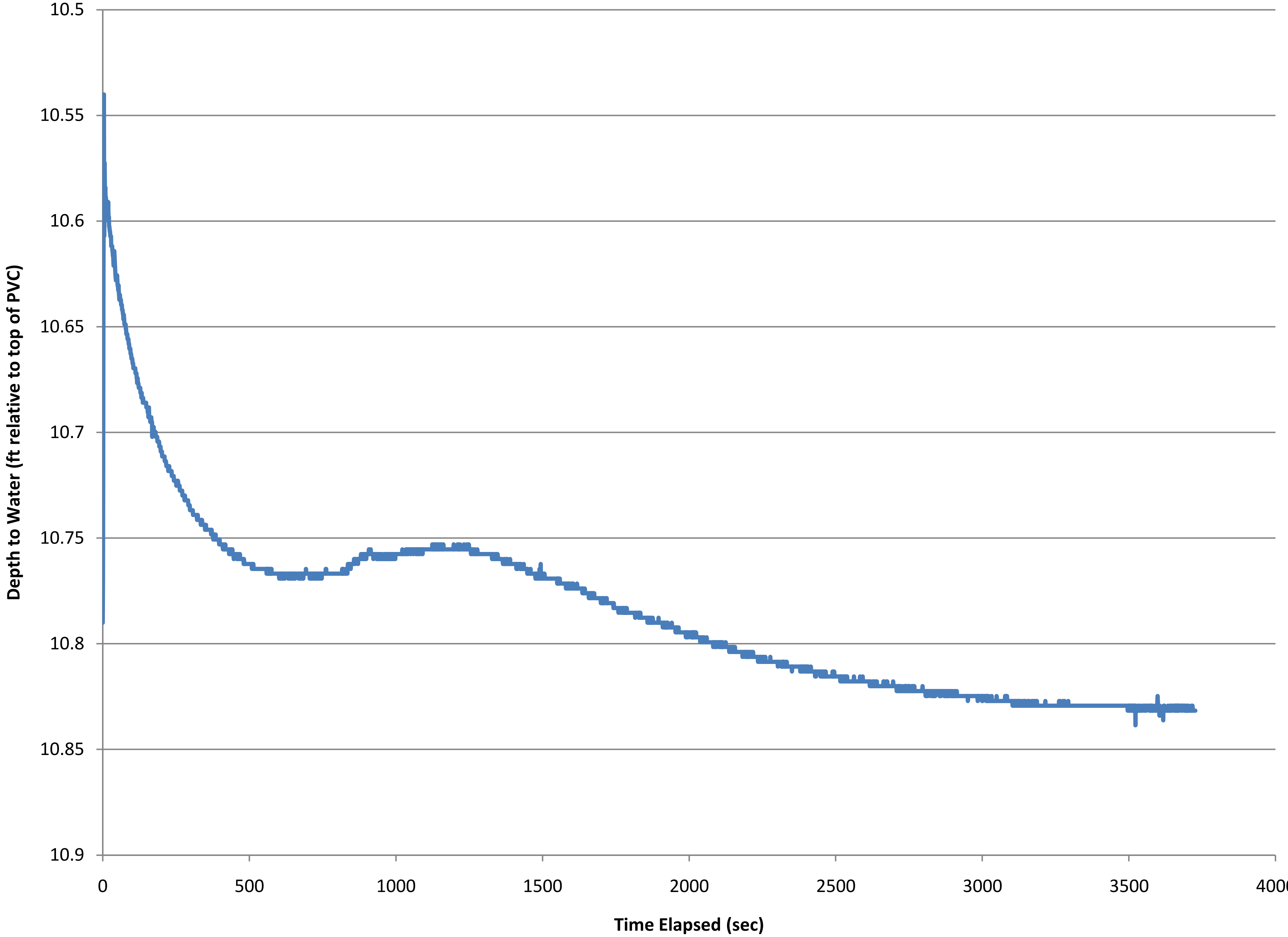


Test Name: EN-674 Test 1 Falling Head		
Aquifer Type: Confined		
Analysis Method: Bouwer & Rice		
Analysis Result:	Conductivity =	3.78×10^{-1} ft/day
Test Parameters:	Test well:	EN-674
	PVC well radius:	0.083 ft
	Saturated screen length:	3.50 ft
	Boring radius:	0.25 ft
	Aquifer thickness:	~4.00 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	11.04 ft
	Depth to water (from tPVC) at t=0:	10.79 ft
	Depth to bottom of screen (from tPVC):	20.00 ft
Evaluated by:	J. Prellwitz, 03/31/08	
Comments: Test conducted by J. Prellwitz on February 27, 2008. A porosity of 0.3 was assumed for the well filter pack and surrounding material.		

JSP/LJJ:jsp

Encl. Monitoring Well EN-674 – Slug (Falling) Head Test 1 (February 27, 2008)

Monitoring Well EN-674 - Slug (Falling) Test 1 (February 27, 2008)
Building 57 - IBM Facility
Endicott, New York



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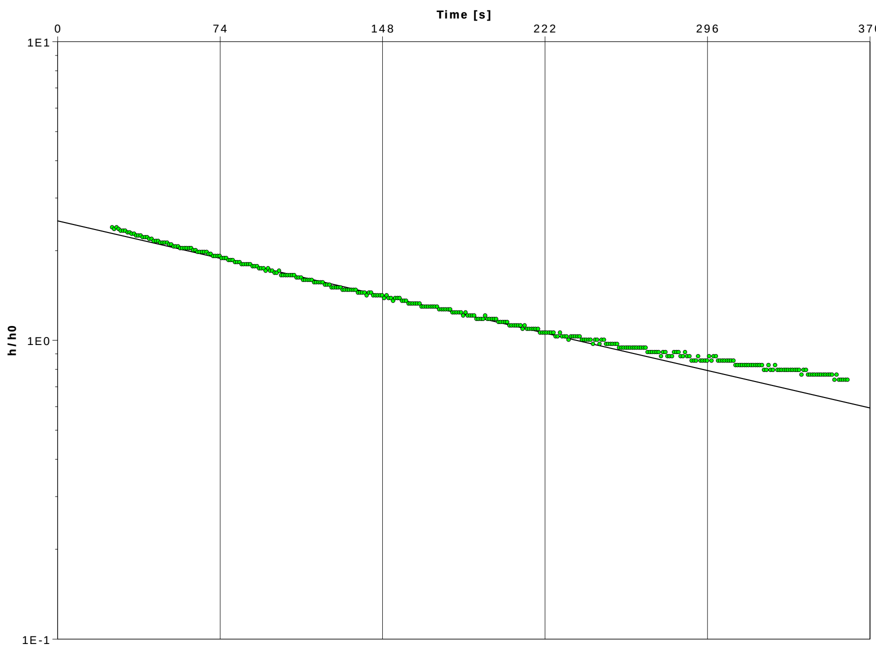
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM

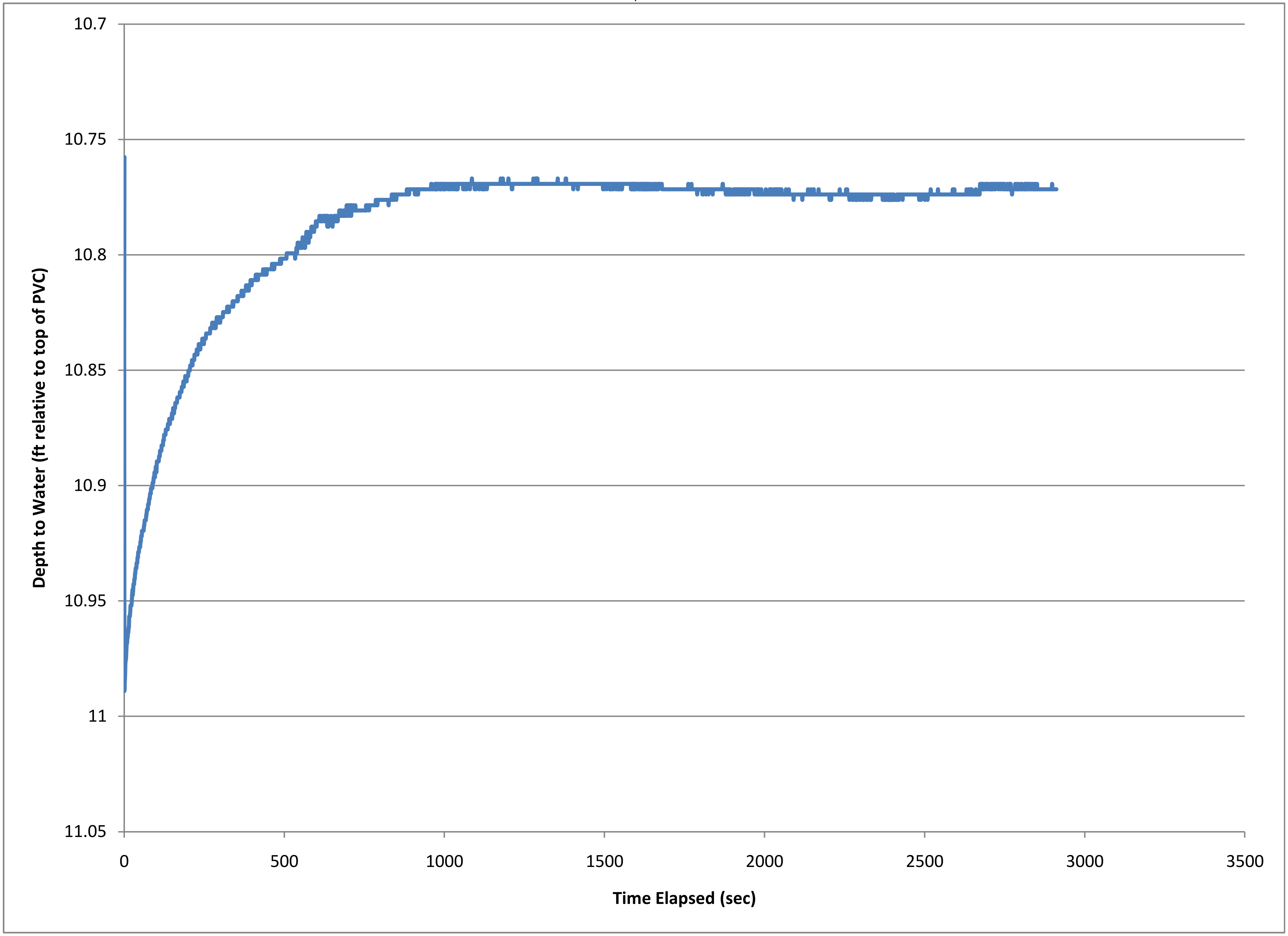


Test Name: EN-674 Test 1 Rising Head		
Aquifer Type: Confined		
Analysis Method: Bouwer & Rice		
Analysis Result:	Conductivity =	7.93×10^{-1} ft/day
Test Parameters:	Test well:	EN-674
	PVC well radius:	0.083 ft
	Saturated screen length:	3.50 ft
	Boring radius:	0.25 ft
	Aquifer thickness:	~4.00 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	10.76 ft
	Depth to water (from tPVC) at t=0:	10.84 ft
	Depth to bottom of screen (from tPVC):	20.00 ft
Evaluated by:	J. Prellwitz, 03/31/08	
Comments: Test conducted by J. Prellwitz on February 27, 2008. A porosity of 0.3 was assumed for the well filter pack and surrounding material.		

JSP/LJJ:jsp

Encl. Monitoring Well EN-674 – Slug (Rising) Head Test 1 (February 27, 2008)

Monitoring Well EN-674 - Slug (Rising) Test 1 (February 27, 2008)
Building 57 - IBM Facility
Endicott, New York



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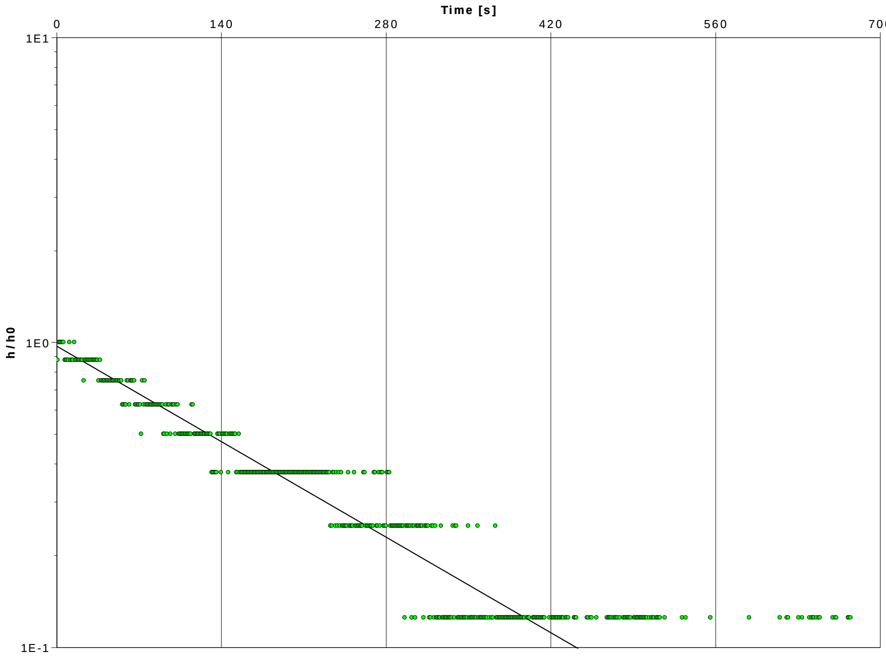
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM



Test Name: EN-675 Test 1 Rising Head		
Aquifer Type: Unconfined		
Analysis Method: Bouwer & Rice		
Analysis Result:	Conductivity =	8.23×10^{-1} ft/day
Test Parameters:	Test well:	EN-675
	PVC well radius:	0.083 ft
	Saturated screen length:	2.26 ft
	Boring radius:	0.25 ft
	Aquifer thickness:	8.56 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	6.74 ft
	Depth to water (from tPVC) at t=0:	6.76 ft
	Depth to bottom of screen (from tPVC):	9.00 ft
Evaluated by:	J. Prellwitz, 03/31/08	
Comments: Test conducted by J. Prellwitz on February 27, 2008. A porosity of 0.3 was assumed for the well filter pack and surrounding material.		

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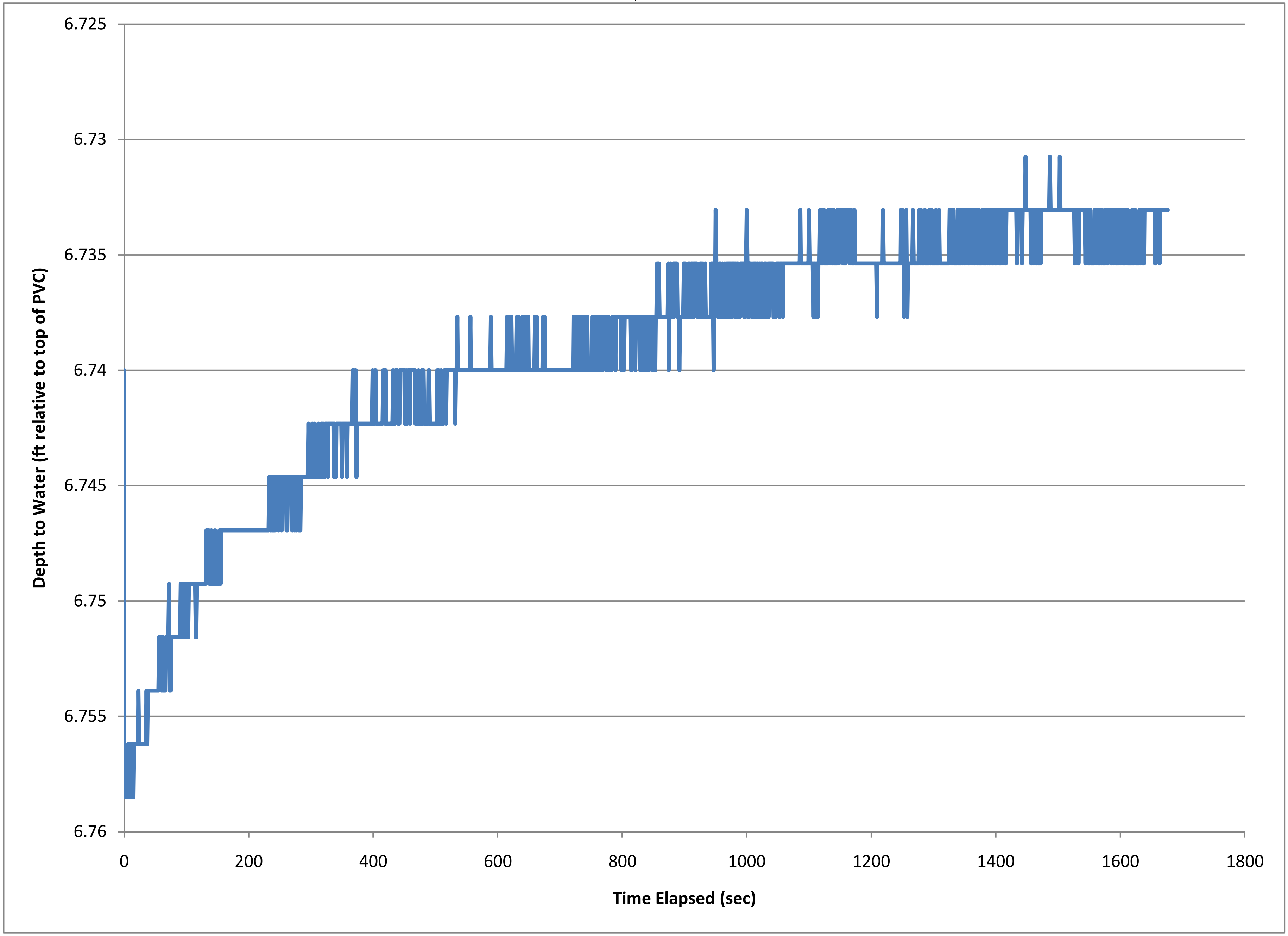
Encl. Monitoring Well EN-675 – Slug (Rising) Head Test 1 (February 27, 2008)

Monitoring Well EN-675 - Slug (Rising) Test 1 (February 27, 2008)
Building 57 - IBM Facility
Endicott, New York



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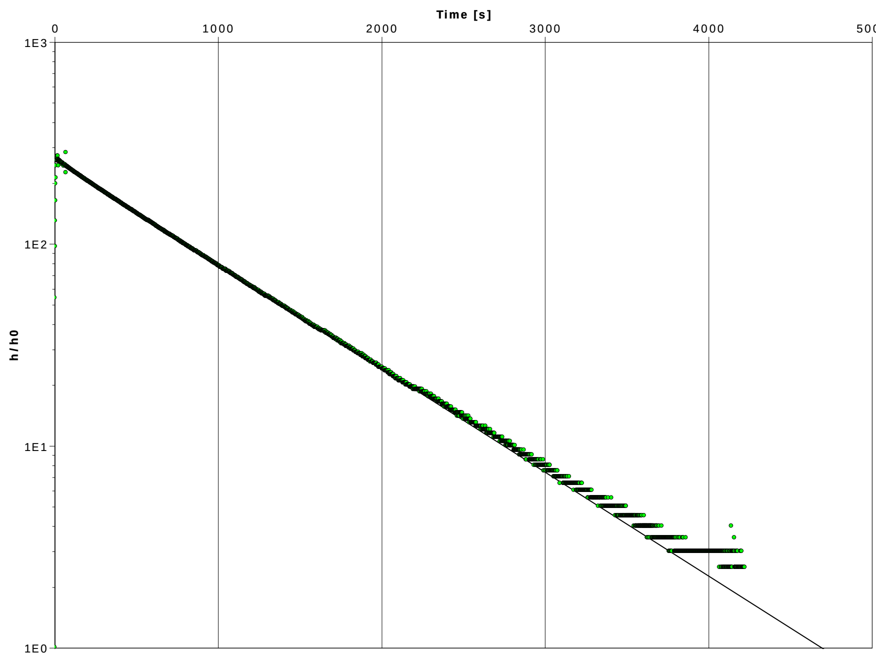
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM



Test Name: EN-676 Test 1 Falling Head		
Aquifer Type: Confined		
Analysis Method: Bouwer & Rice		
Analysis Result:	Conductivity =	2.66×10^{-1} ft/day
Test Parameters:	Test well:	EN-676
	PVC well radius:	0.083 ft
	Saturated screen length:	3.00 ft
	Boring radius:	0.25 ft
	Aquifer thickness:	~3.50 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	11.42 ft
	Depth to water (from tPVC) at t=0:	11.41 ft
	Depth to bottom of screen (from tPVC):	22.50 ft
Evaluated by:	J. Prellwitz, 03/31/08	
Comments: Test conducted by J. Prellwitz and P. Malone on February 27, 2008. A porosity of 0.3 was assumed for the well filter pack and surrounding material.		

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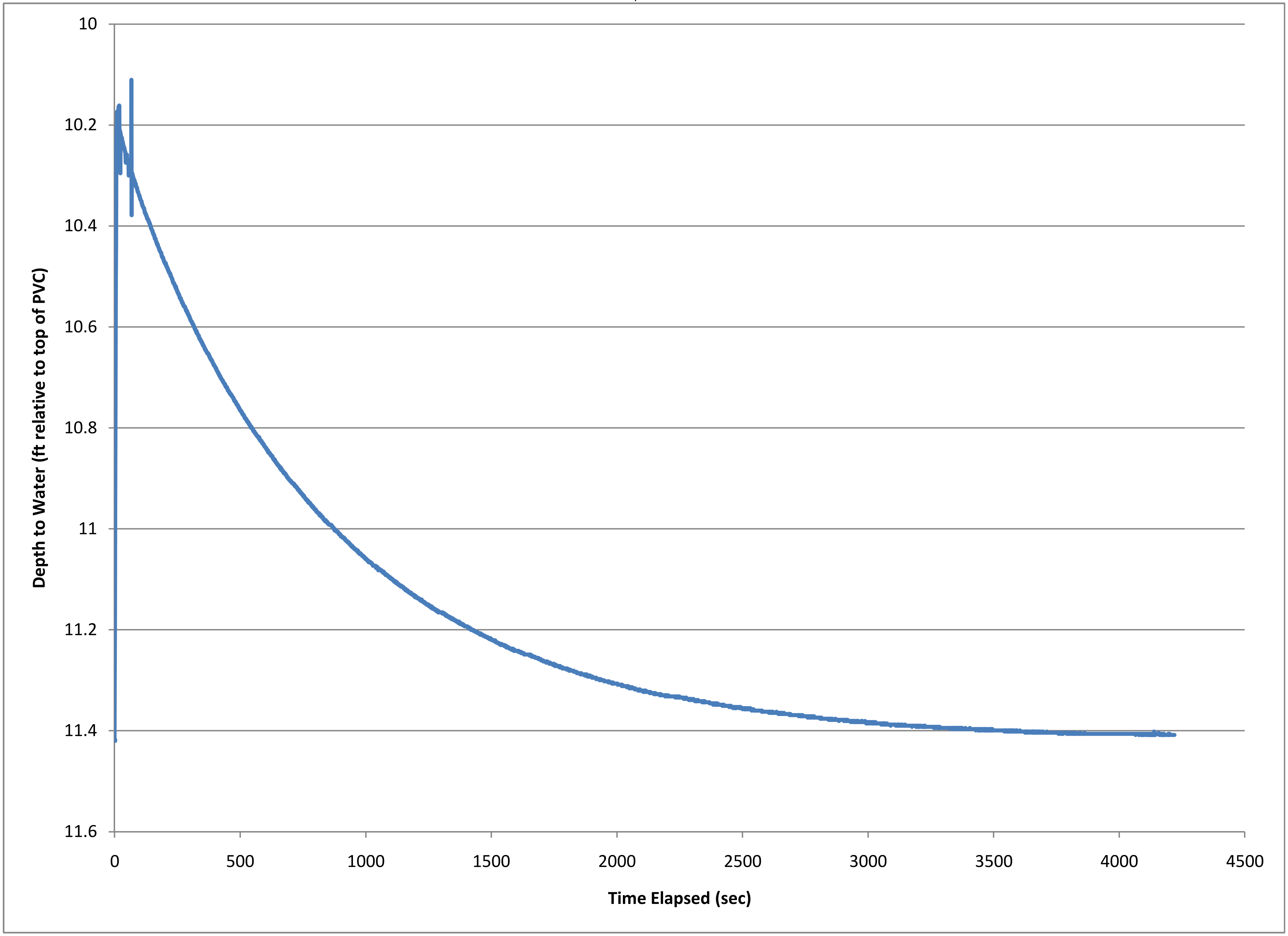
Encl. Monitoring Well EN-676 – Slug (Falling) Head Test 1 (February 27, 2008)

Monitoring Well EN-676 - Slug (Falling) Test 1 (February 27, 2008)
Building 57 - IBM Facility
Endicott, New York



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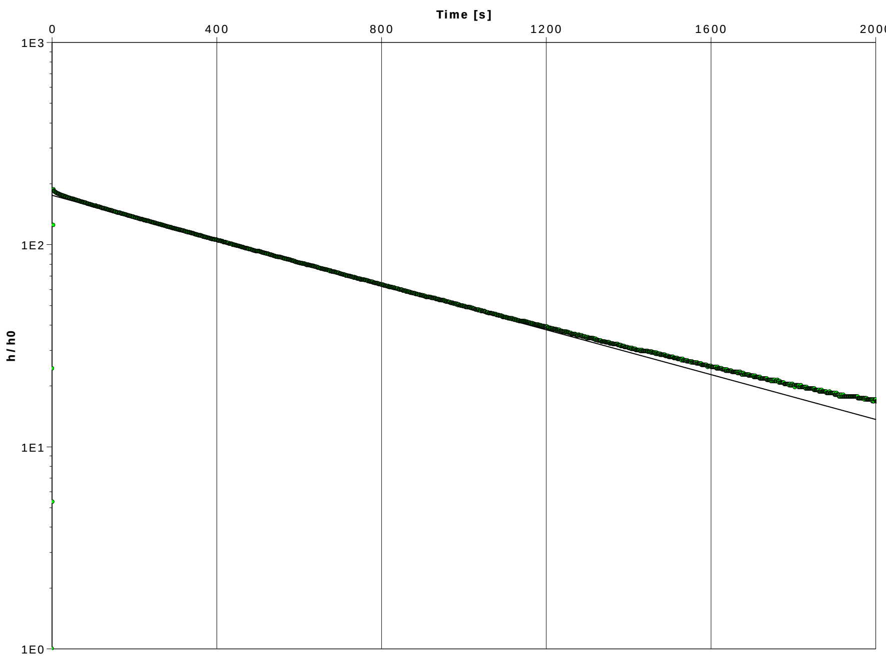
Slug Test Analysis Report
Project: Building 57, Endicott, New York
Project number: 2466.01
Client: IBM



Test Name: EN-676 Test 1 Rising Head		
Aquifer Type: Confined		
Analysis Method: Bouwer & Rice		
Analysis Result:	Conductivity =	2.87×10^{-1} ft/day
Test Parameters:	Test well:	EN-676
	PVC well radius:	0.083 ft
	Saturated screen length:	3.00 ft
	Boring radius:	0.25 ft
	Aquifer thickness:	~3.50 ft
	Pre-test depth to water (referenced to top of PVC (tPVC)):	11.46 ft
	Depth to water (from tPVC) at t=0:	11.47 ft
	Depth to bottom of screen (from tPVC):	22.50 ft
Evaluated by:	J. Prellwitz, 03/31/08	
Comments: Test conducted by J. Prellwitz and P. Malone on February 27, 2008. A porosity of 0.3 was assumed for the well filter pack and surrounding material.		

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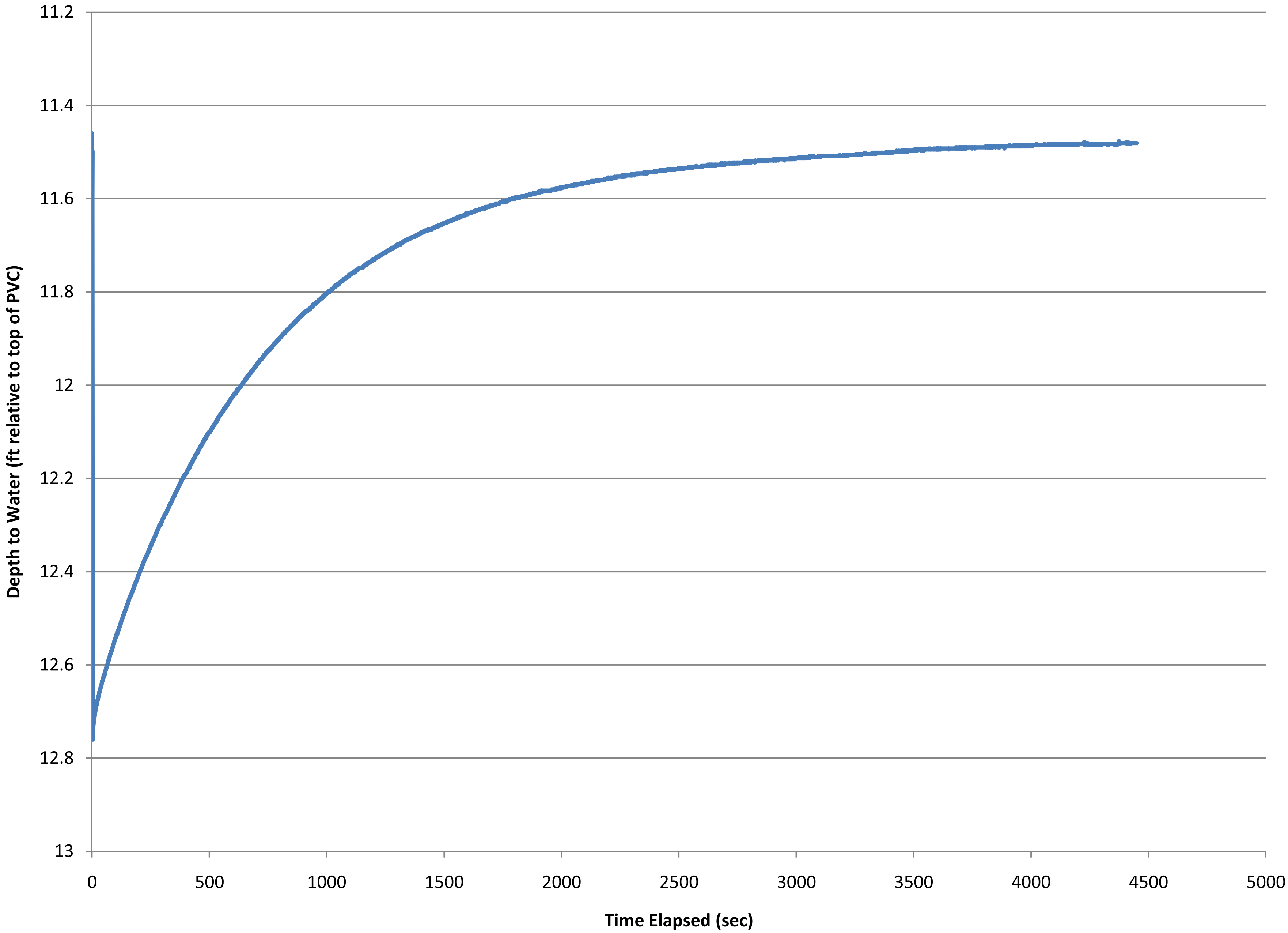
Encl. Monitoring Well EN-676 – Slug (Rising) Head Test 1 (February 27, 2008)

Monitoring Well EN-676 - Slug (Rising) Test 1 (February 27, 2008)
Building 57 - IBM Facility
Endicott, New York



ATTACHMENT E.3

Aquifer Test Results for 2009 Slug Testing

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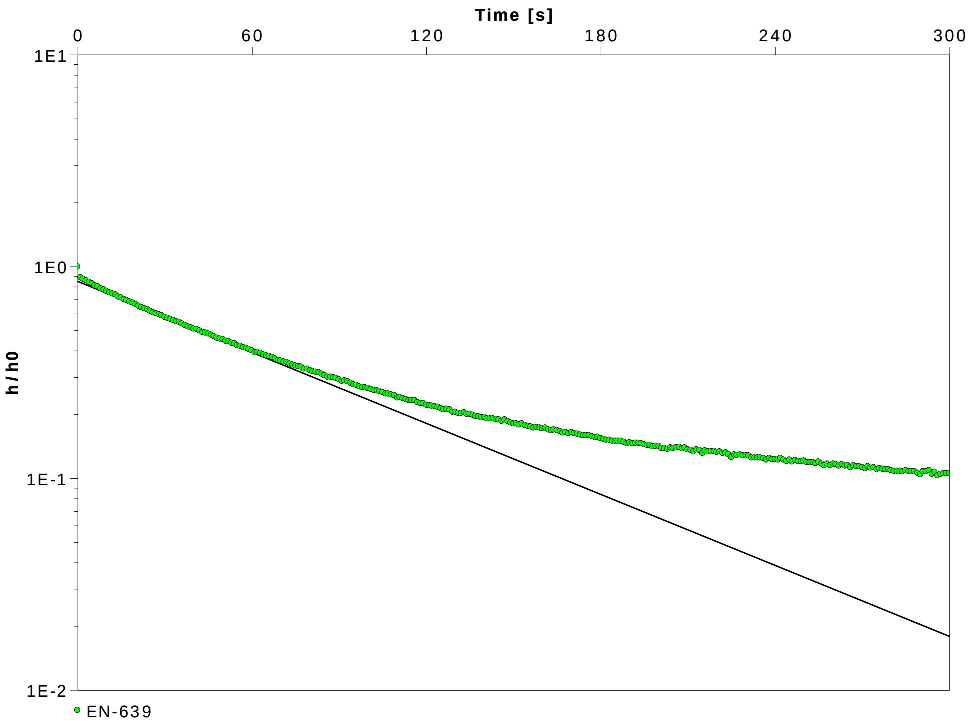
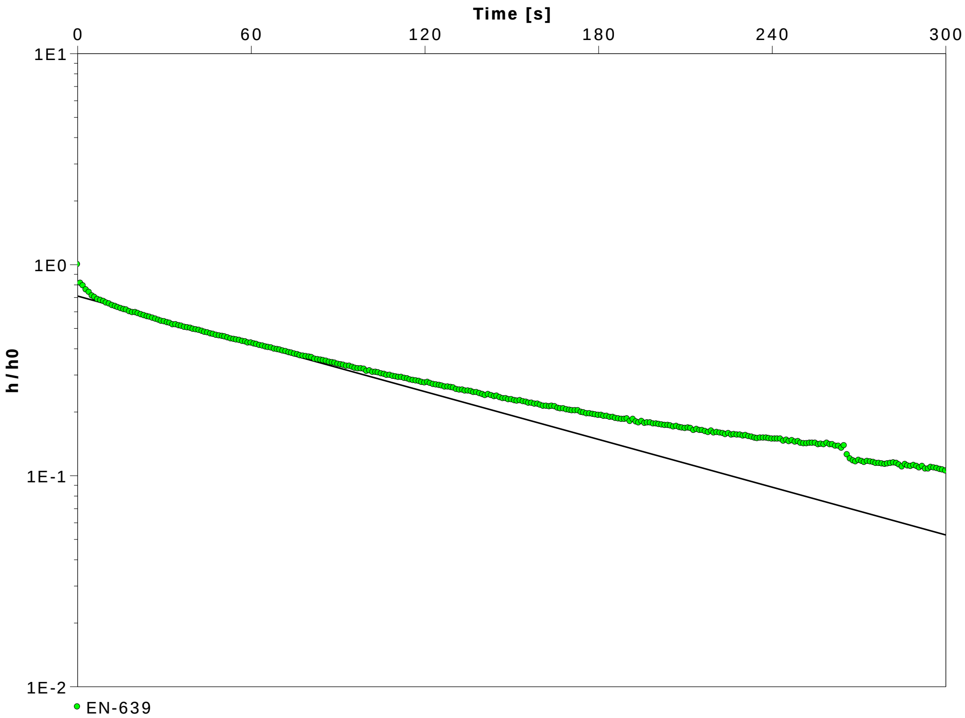
Slug Test Analysis Report – EN-639
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.01
Client: IBM

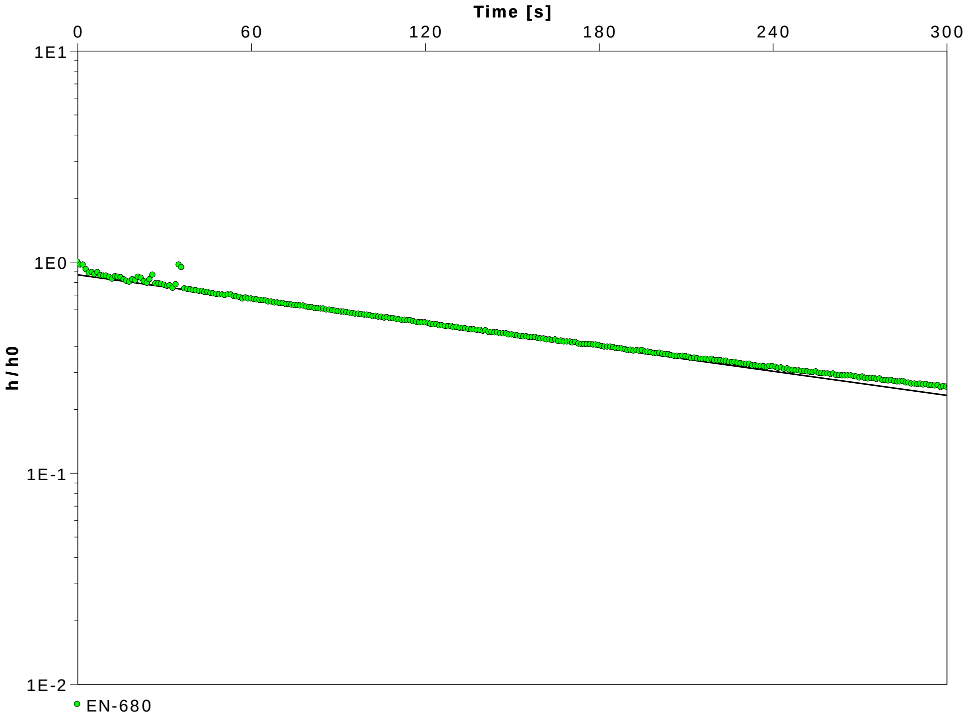


Test Name: EN-639 Falling **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 3.70 ft/d (1.31E-3 cm/s)	
Test Parameters Test Well: EN-639 PVC Well Radius (r): 1" (0.08 ft) Boring Radius (B): 1.5" (0.125 ft) Casing Radius (R): 1.5" (0.125 ft)* Boring Penetration: Partial Type Aquifer: Unconfined Screen Length (L): 2.0 ft Static water table level (b) (height of water column from transducer): 5.28 ft Aquifer Thickness: 2 ft Pre-Test height of water column (transducer reading): 5.28 ft Height of water column (from transducer) at t_0: 6.34 ft Depth to bottom of screen (from ground): 5 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 23, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O'Donnell (08/11/07)	

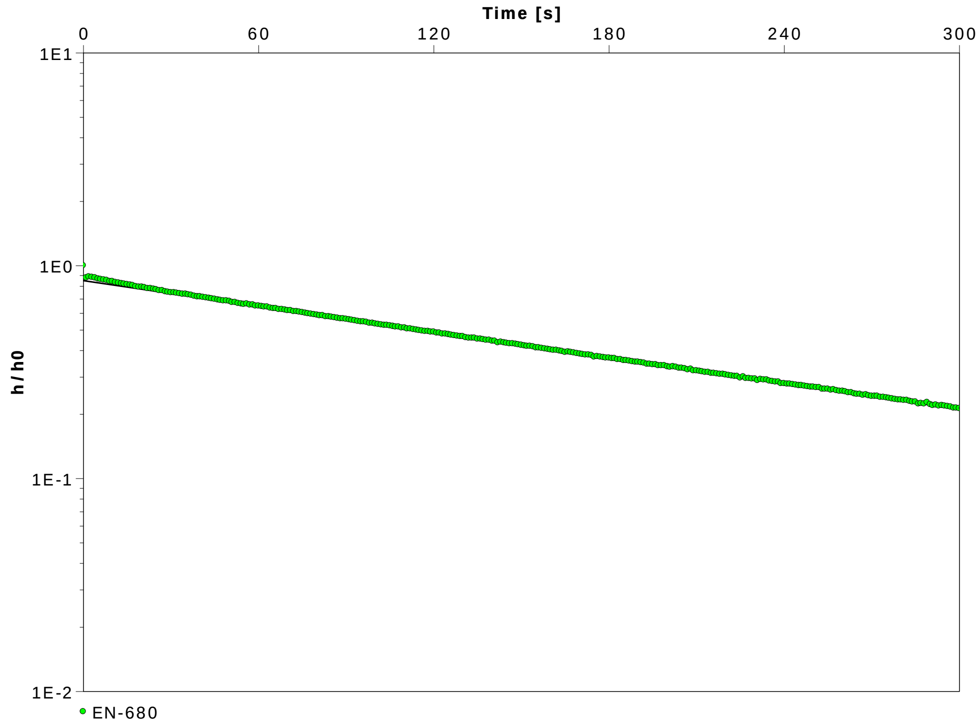


Test Name: EN-639 Rising **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 2.20 ft/d (7.77E-4cm/s)	
Test Parameters Test Well: EN-639 PVC Well Radius (r): 1” (0.08 ft) Boring Radius (B): 1.5” (0.125 ft) Casing Radius (R): 1.5” (0.125 ft)* Boring Penetration: Partial Type Aquifer: Unconfined Screen Length (L): 2.0 ft Static water table level (b) (height of water column from transducer): 5.28 ft Aquifer Thickness: 2 ft Pre-Test height of water column (transducer reading): 5.37 ft Height of water column (from transducer) at t_0: 3.66 ft Depth to bottom of screen (from ground): 5 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 23, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O’Donnell (08/11/07)	

Slug Test Analysis Report – EN-680
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.01
Client: IBM



Test Name: EN-680 Falling **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 5.26E-1 ft/d (1.86E-4 cm/s)	
Test Parameters Test Well: EN-680 PVC Well Radius (r): 1" (0.08 ft) Boring Radius (B): 2" (0.17 ft) Casing Radius (R): 2" (0.17 ft)* Boring Penetration: Partial Type Aquifer: Confined Screen Length (L): 5.0 ft Static water table level (b) (height of water column from transducer): 26.78 ft Aquifer Thickness: 20 ft Pre-Test height of water column (transducer reading): 26.78 ft Height of water column (from transducer) at t_0: 29.14 ft Depth to bottom of screen (from ground): 32 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 21, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O'Donnell (08/11/07)	



Test Name: EN-680 Rising
Analysis Method: Bouwer & Rice

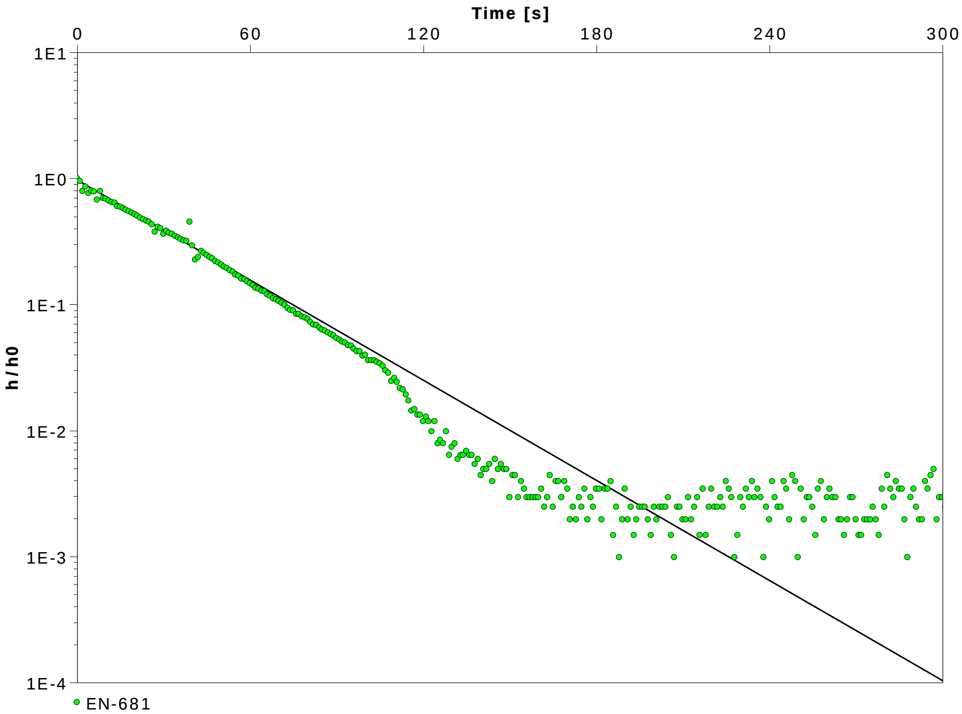
Analysis Result: Conductivity (K)= 5.57E-1 ft/d (1.97E-4cm/s)

Test Parameters
Test Well: EN-680
PVC Well Radius (r): 1" (0.08 ft)
Boring Radius (B): 2" (0.17 ft)
Casing Radius (R): 2" (0.17 ft)*
Boring Penetration: Partial
Type Aquifer: Confined
Screen Length (L): 5.0 ft
Static water table level (b) (height of water column from transducer): 26.78 ft
Aquifer Thickness: 20 ft
Pre-Test height of water column (transducer reading): 26.91 ft
Height of water column (from transducer) at t_0: 24.54 ft
Depth to bottom of screen (from ground): 32 ft

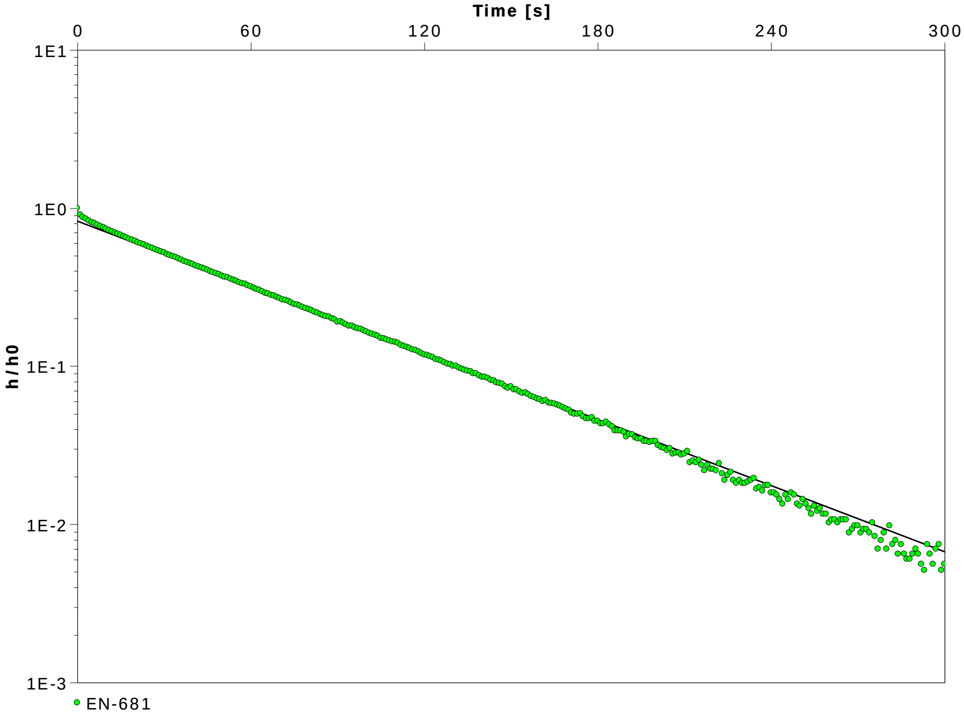
Comments: Test conducted by P. Mouser and R. Cook on June 21, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness.

*According to Aquifer Test Memo by O'Donnell (08/11/07)

Slug Test Analysis Report – EN-681
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.01
Client: IBM

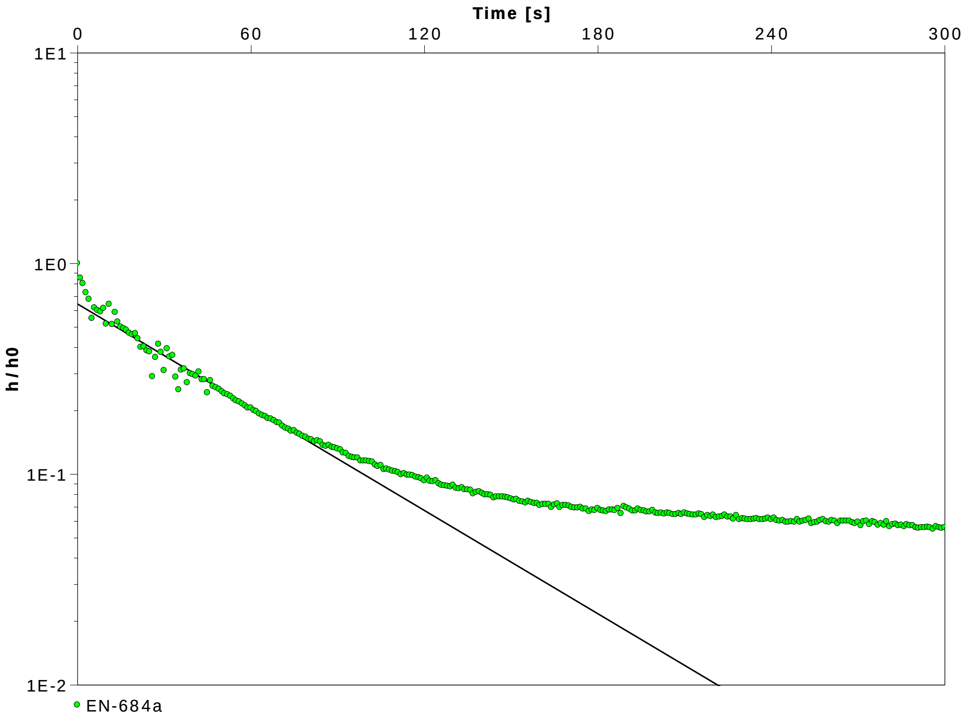


Test Name: EN-681 Falling **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 3.93 ft/d (1.39E-3 cm/s)	
Test Parameters Test Well: EN-681 PVC Well Radius (r): 1" (0.08 ft) Boring Radius (B): 2" (0.17 ft) Casing Radius (R): 2" (0.17 ft)* Boring Penetration: Partially Type Aquifer: Confined Screen Length (L): 5.0 ft Static water table level (b) (height of water column from transducer): 12.04 ft Aquifer Thickness: 5 ft Pre-Test height of water column (transducer reading): 12.04 ft Height of water column (from transducer) at t_0: 14.08 ft Depth to bottom of screen (from ground): 18 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 21, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O'Donnell (08/11/07)	

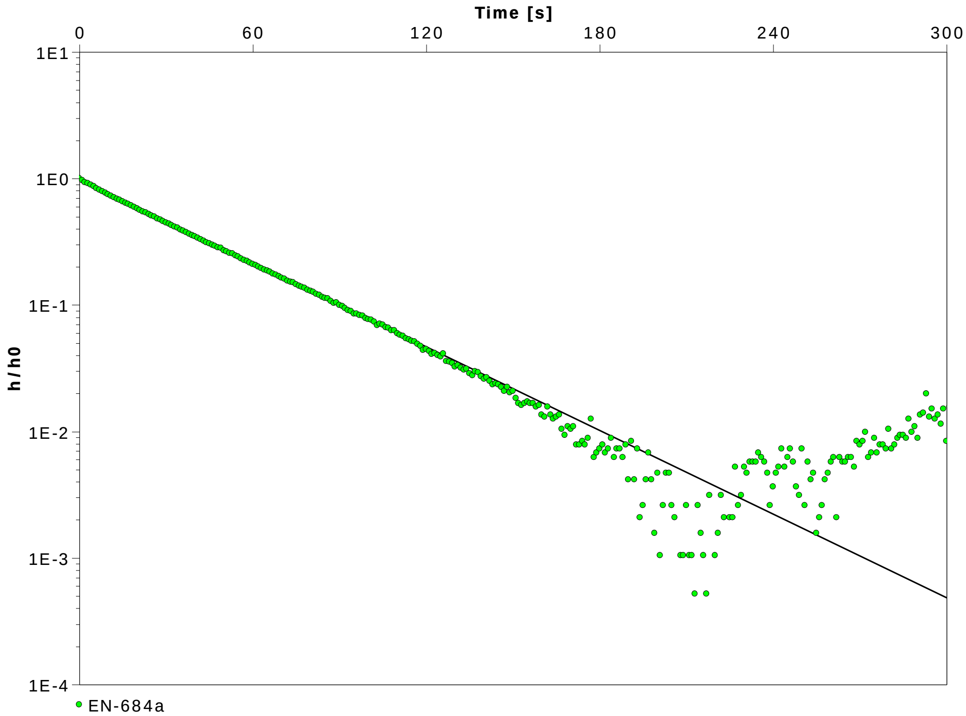


Test Name: EN-681 Rising **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 2.29 ft/d (8.08E-4cm/s)	
Test Parameters Test Well: EN-681 PVC Well Radius (r): 1" (0.08 ft) Boring Radius (B): 2" (0.17 ft) Casing Radius (R): 2" (0.17 ft)* Boring Penetration: Partially Type Aquifer: Confined Screen Length (L): 5.0 ft Static water table level (b) (height of water column from transducer): 12.04 ft Aquifer Thickness: 5 ft Pre-Test height of water column (transducer reading): 12.04 ft Height of water column (from transducer) at t_0: 9.89 ft Depth to bottom of screen (from ground): 18 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 21, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O'Donnell (08/11/07)	

Slug Test Analysis Report – EN-684A
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.01
Client: IBM

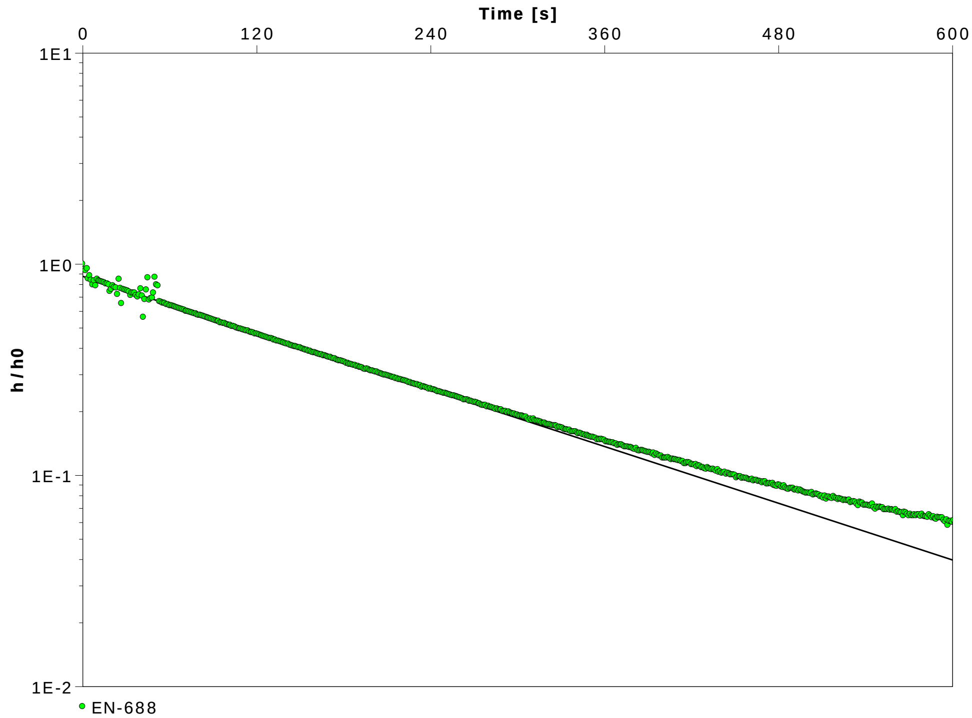


Test Name: EN-684A Falling **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 2.20 ft/d (7.77E-4 cm/s)	
Test Parameters Test Well: EN-684A PVC Well Radius (r): 1” (0.08 ft) Boring Radius (B): 2” (0.17 ft) Casing Radius (R): 2” (0.17 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Screen Length (L): 5.0 ft Static water table level (b) (height of water column from transducer): 22.86 ft Aquifer Thickness: 45 ft Pre-Test height of water column (transducer reading): 22.86 ft Height of water column (from transducer) at t_0: 25.43 ft Depth to bottom of screen (from ground): 46 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 23, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O’Donnell (08/11/07)	

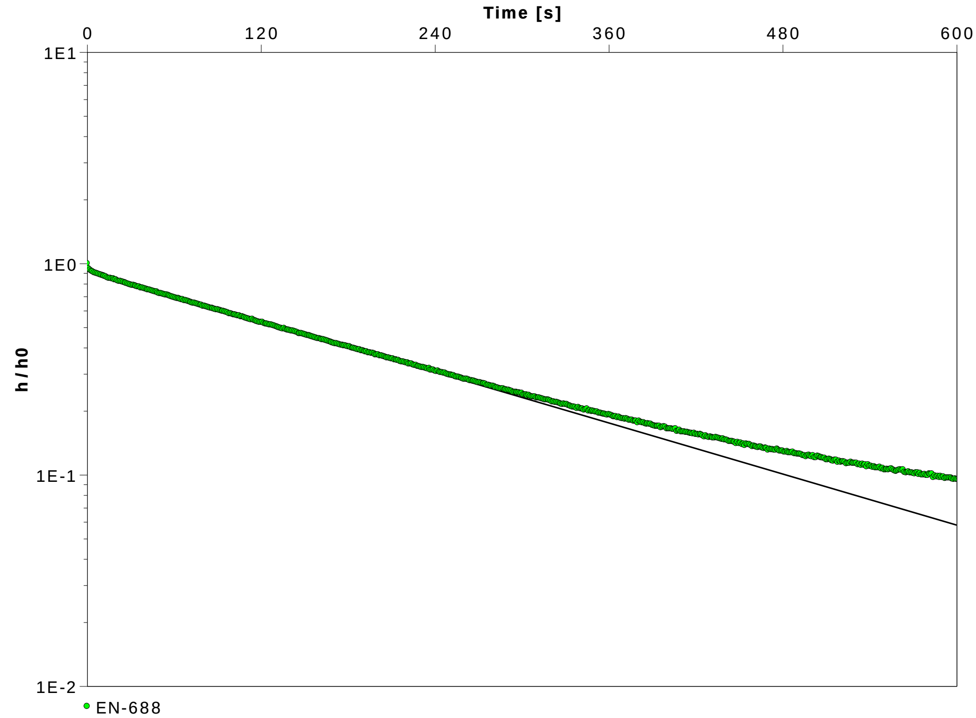


Test Name: EN-684A Rising **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 2.97 ft/d (1.05E-3cm/s)	
Test Parameters Test Well: EN-684A PVC Well Radius (r): 1" (0.08 ft) Boring Radius (B): 2" (0.17 ft) Casing Radius (R): 2" (0.17 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Screen Length (L): 5.0 ft Static water table level (b) (height of water column from transducer): 22.86 ft Aquifer Thickness: 45 ft Pre-Test height of water column (transducer reading): 23.0 ft Height of water column (from transducer) at t_0: 21.08 ft Depth to bottom of screen (from ground): 46 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 23, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O'Donnell (08/11/07)	

Slug Test Analysis Report – EN-688
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.01
Client: IBM

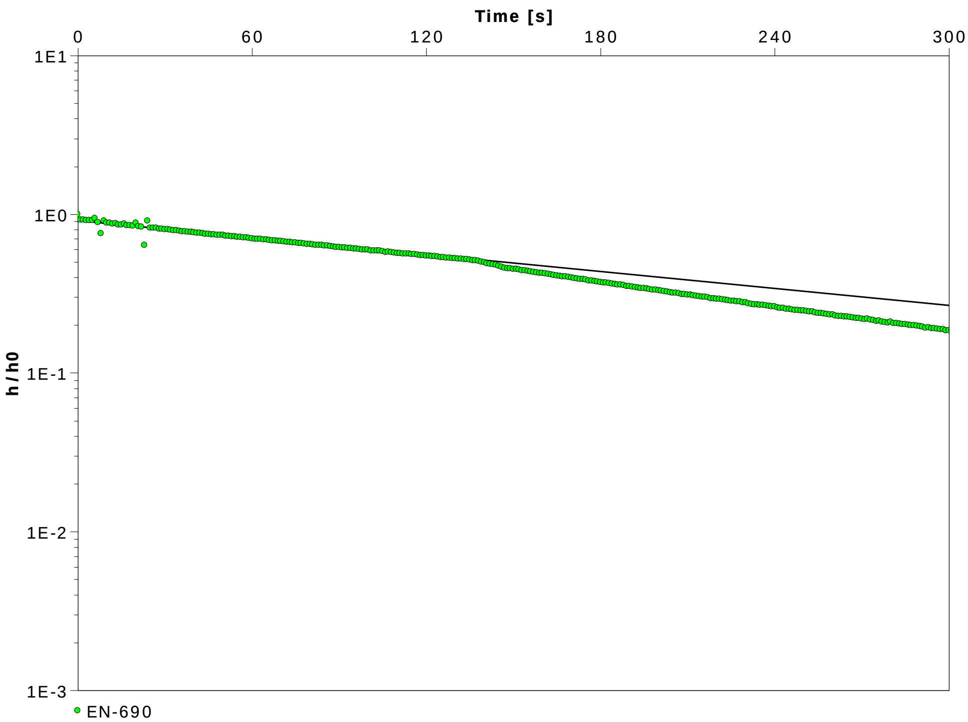


Test Name: EN-688 Falling **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 6.64E-1 ft/d (2.34E-4cm/s)	
Test Parameters Test Well: EN-688 PVC Well Radius (r): 1” (0.08 ft) Boring Radius (B): 2” (0.17 ft) Casing Radius (R): 2” (0.17 ft)* Boring Penetration: Partially Type Aquifer: Confined Screen Length (L): 5.0 ft Static water table level (b) (height of water column from transducer): 11.50 ft Aquifer Thickness: 6 ft Pre-Test height of water column (transducer reading): 11.50 ft Height of water column (from transducer) at t_0: 13.89 ft Depth to bottom of screen (from ground): 17.5 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 21, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O’Donnell (08/11/07)	

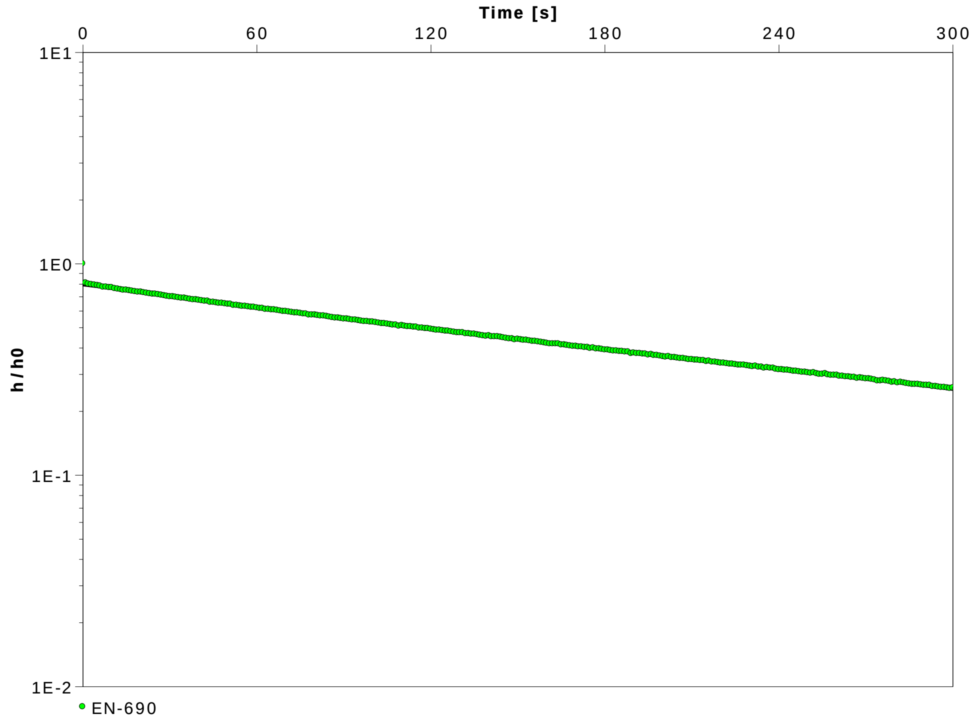


Test Name: EN-688 Rising **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 5.98E-1 ft/d (2.11E-4cm/s)	
Test Parameters Test Well: EN-688 PVC Well Radius (r): 1" (0.08 ft) Boring Radius (B): 2" (0.17 ft) Casing Radius (R): 2" (0.17 ft)* Boring Penetration: Partially Type Aquifer: Confined Screen Length (L): 5 ft Static water table level (b) (height of water column from transducer): 11.50 ft Aquifer Thickness: 6 ft Pre-Test height of water column (transducer reading): 11.53 ft Height of water column (from transducer) at t_0: 9.14 ft Depth to bottom of screen (from ground): 17.5 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 21, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O'Donnell (08/11/07)	

Slug Test Analysis Report – EN-690
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.01
Client: IBM



Test Name: EN-690 Falling **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 8.16E-1 ft/d (2.88E-4 cm/s)	
Test Parameters Test Well: EN-690 PVC Well Radius (r): 1” (0.08 ft) Boring Radius (B): 2” (0.17 ft) Casing Radius (R): 2” (0.17 ft)* Boring Penetration: Fully Type Aquifer: Confined Screen Length (L): 3.0 ft Static water table level (b) (height of water column from transducer): 6.81 ft Aquifer Thickness: 3 ft Pre-Test height of water column (transducer reading): 6.81 ft Height of water column (from transducer) at t_0: 9.05 ft Depth to bottom of screen (from ground): 13 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 21, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O’Donnell (08/11/07)	



Test Name: EN-690 Rising **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 7.58E-1 ft/d (2.67E-4cm/s)	
Test Parameters Test Well: EN-690 PVC Well Radius (r): 1" (0.08 ft) Boring Radius (B): 2" (0.17 ft) Casing Radius (R): 2" (0.17 ft)* Boring Penetration: Fully Type Aquifer: Confined Screen Length (L): 3.0 ft Static water table level (b) (height of water column from transducer): 6.81 ft Aquifer Thickness: 3 ft Pre-Test height of water column (transducer reading): 6.80 ft Height of water column (from transducer) at t_0: 4.78 ft Depth to bottom of screen (from ground): 13 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 21, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O'Donnell (08/11/07)	

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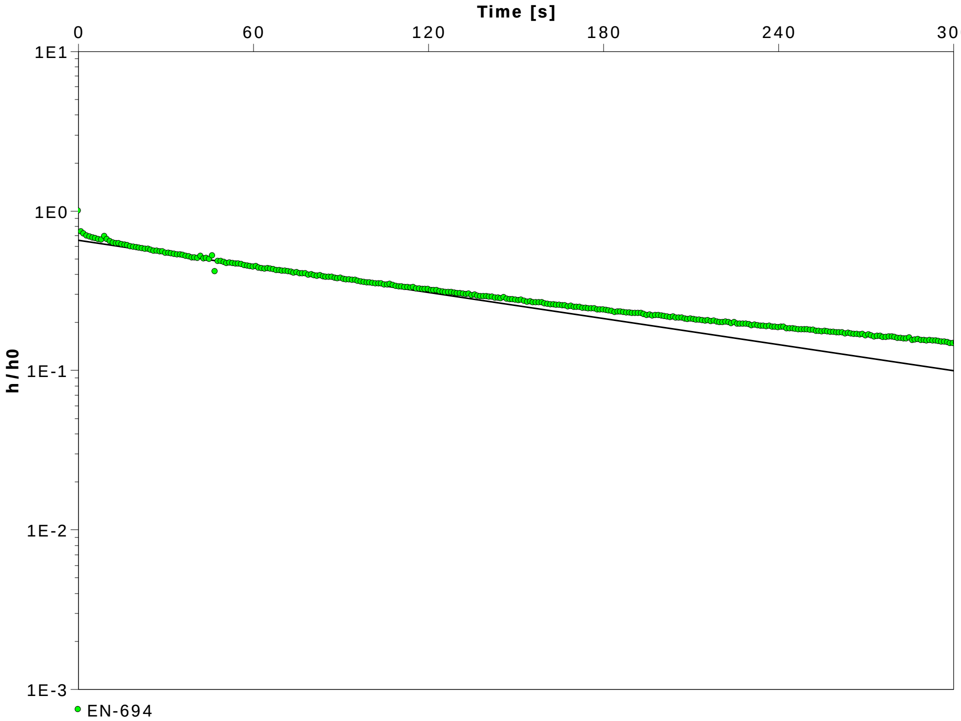
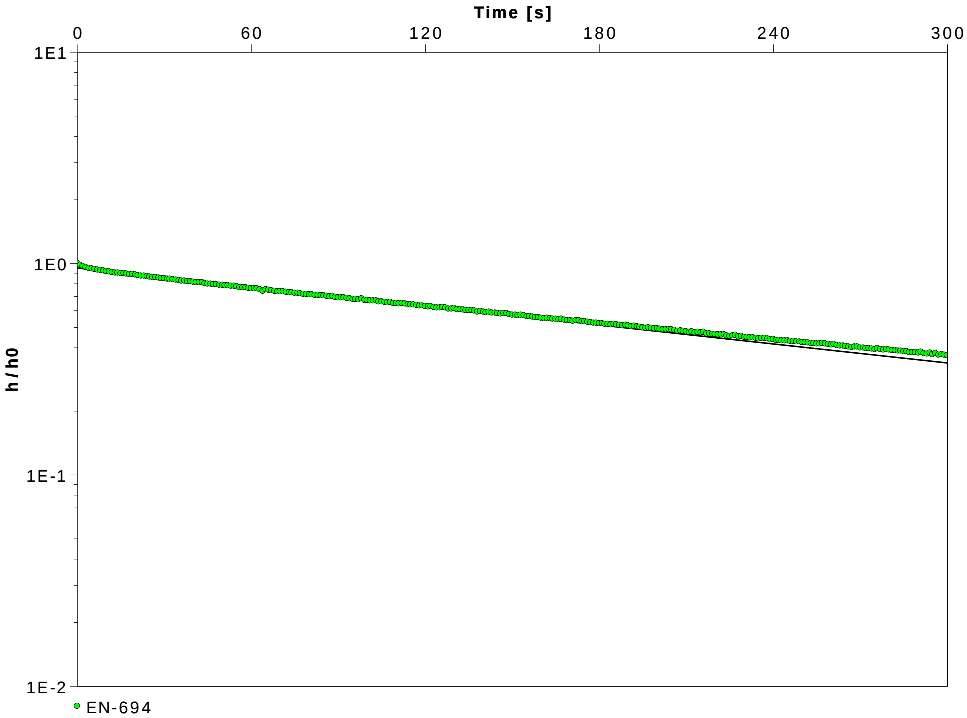
Slug Test Analysis Report – EN-694
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.01
Client: IBM

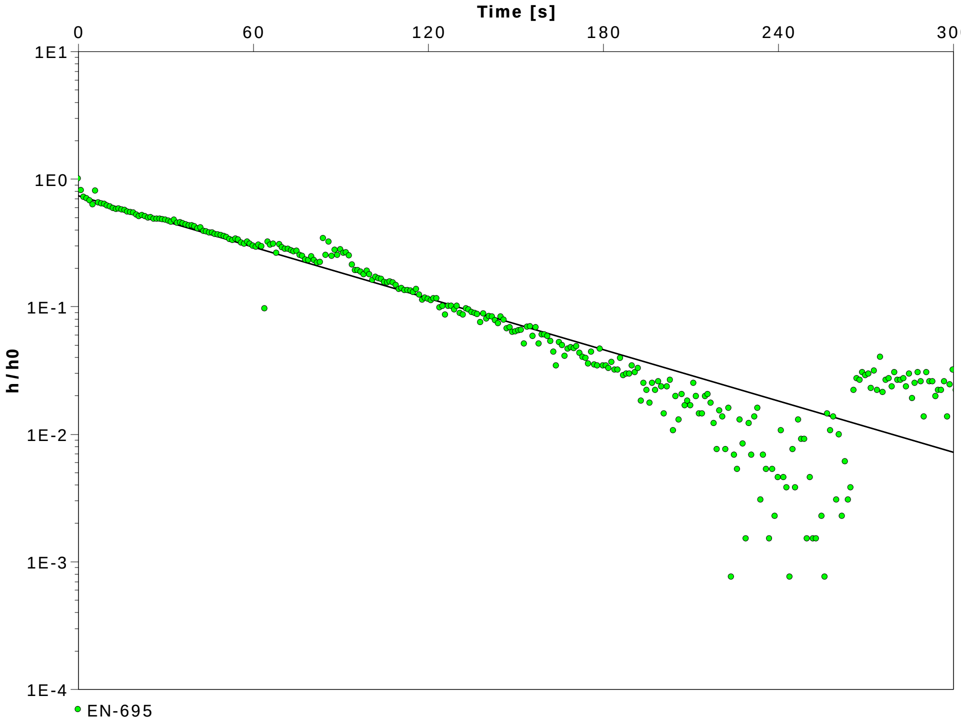


Test Name: EN-694 Falling **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 8.96E-1 ft/d (3.16E-4 cm/s)	
Test Parameters Test Well: EN-694 PVC Well Radius (r): 1” (0.08 ft) Boring Radius (B): 2” (0.17 ft) Casing Radius (R): 2” (0.17 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Screen Length (L): 5.0 ft Static water table level (b) (height of water column from transducer): 17.75 ft Aquifer Thickness: 20 ft Pre-Test height of water column (transducer reading): 17.75 ft Height of water column (from transducer) at t_0: 19.49 ft Depth to bottom of screen (from ground): 20.5 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 21, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O’Donnell (08/11/07)	

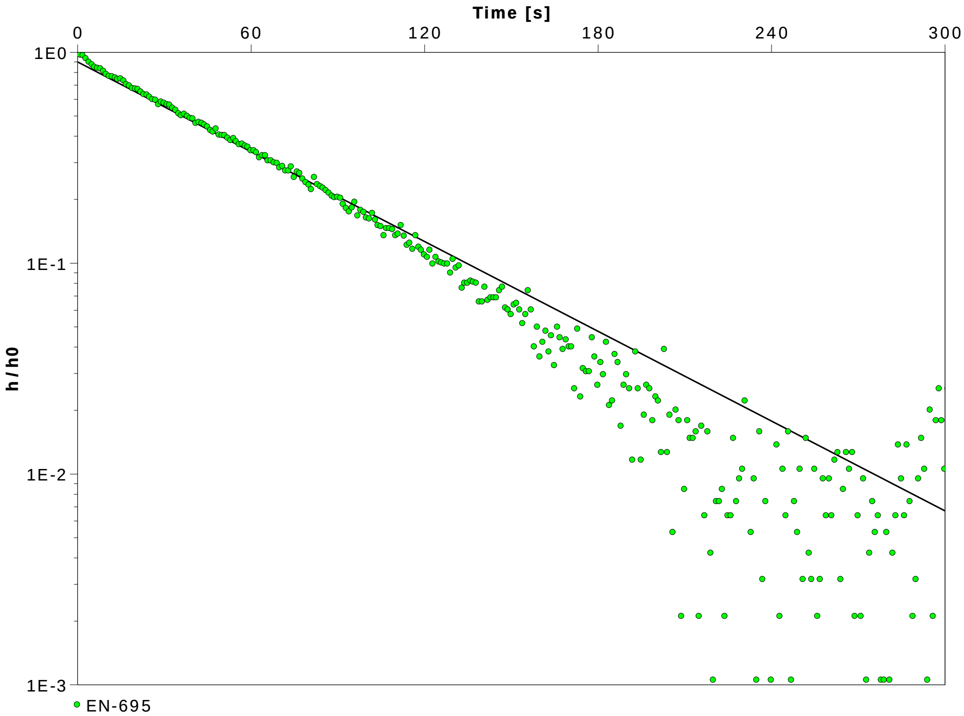


Test Name: EN-694 Rising **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 4.93E-1 ft/d (1.74E-4cm/s)	
Test Parameters Test Well: EN-694 PVC Well Radius (r): 1” (0.08 ft) Boring Radius (B): 2” (0.17 ft) Casing Radius (R): 2” (0.17 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Screen Length (L): 5 ft Static water table level (b) (height of water column from transducer): 17.75 ft Aquifer Thickness: 20 ft Pre-Test height of water column (transducer reading): 17.76 ft Height of water column (from transducer) at t_0: 16.36 ft Depth to bottom of screen (from ground): 20.5 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 21, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O’Donnell (08/11/07)	

Slug Test Analysis Report – EN-695
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.01
Client: IBM

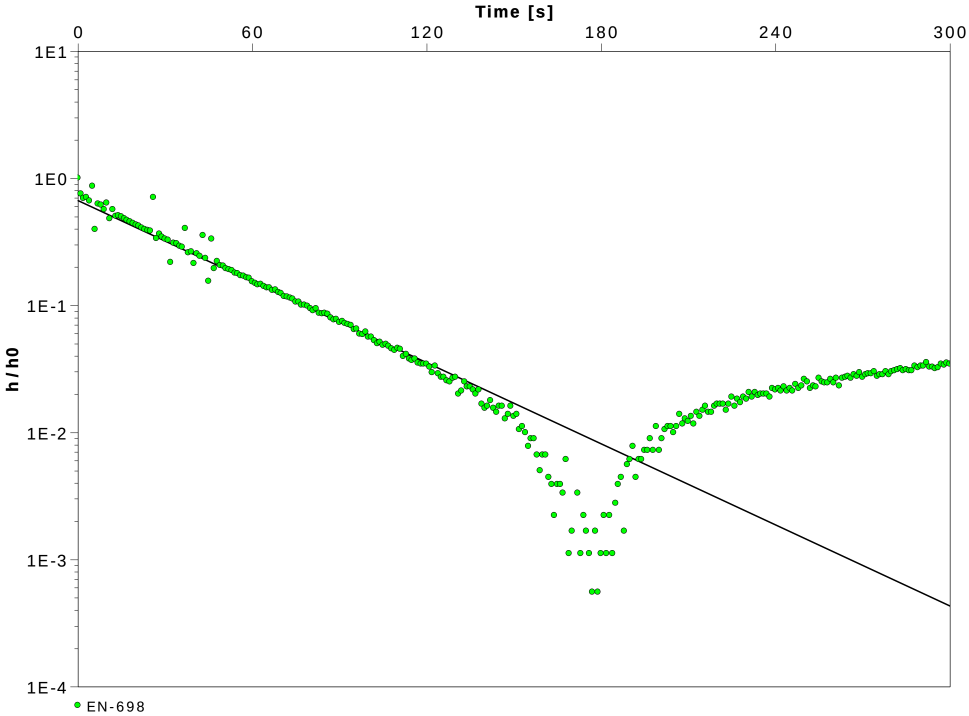


Test Name: EN-695 Falling **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 2.20 ft/d (7.77E-4 cm/s)	
Test Parameters Test Well: EN-695 PVC Well Radius (r): 1" (0.08 ft) Boring Radius (B): 2" (0.17 ft) Casing Radius (R): 2" (0.17 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Screen Length (L): 5.0 ft Static water table level (b) (height of water column from transducer): 8.87 ft Aquifer Thickness: 12 ft Pre-Test height of water column (transducer reading): 8.87 ft Height of water column (from transducer) at t_0: 10.19 ft Depth to bottom of screen (from ground): 12 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 21, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O'Donnell (08/11/07)	



Test Name: EN-695 Rising **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 2.33 ft/d (8.23E-4cm/s)	
Test Parameters Test Well: EN-695 PVC Well Radius (r): 1" (0.08 ft) Boring Radius (B): 2" (0.17 ft) Casing Radius (R): 2" (0.17 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Screen Length (L): 5 ft Static water table level (b) (height of water column from transducer): 8.87 ft Aquifer Thickness: 12 ft Pre-Test height of water column (transducer reading): 8.85 ft Height of water column (from transducer) at t_0: 7.90 ft Depth to bottom of screen (from ground): 12 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 21, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O'Donnell (08/11/07)	

Slug Test Analysis Report – EN-698
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.01
Client: IBM



Test Name: EN-698 Falling **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 2.97 ft/d (1.05E-3cm/s)	
Test Parameters Test Well: EN-698 PVC Well Radius (r): 1" (0.08 ft) Boring Radius (B): 2" (0.17 ft) Casing Radius (R): 2" (0.17 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Screen Length (L): 5.0 ft Static water table level (b) (height of water column from transducer): 17.55 ft Aquifer Thickness: 30 ft Pre-Test height of water column (transducer reading): 17.55 ft Height of water column (from transducer) at t_0: 19.35 ft Depth to bottom of screen (from ground): 29.5 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 22, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O'Donnell (08/11/07)	

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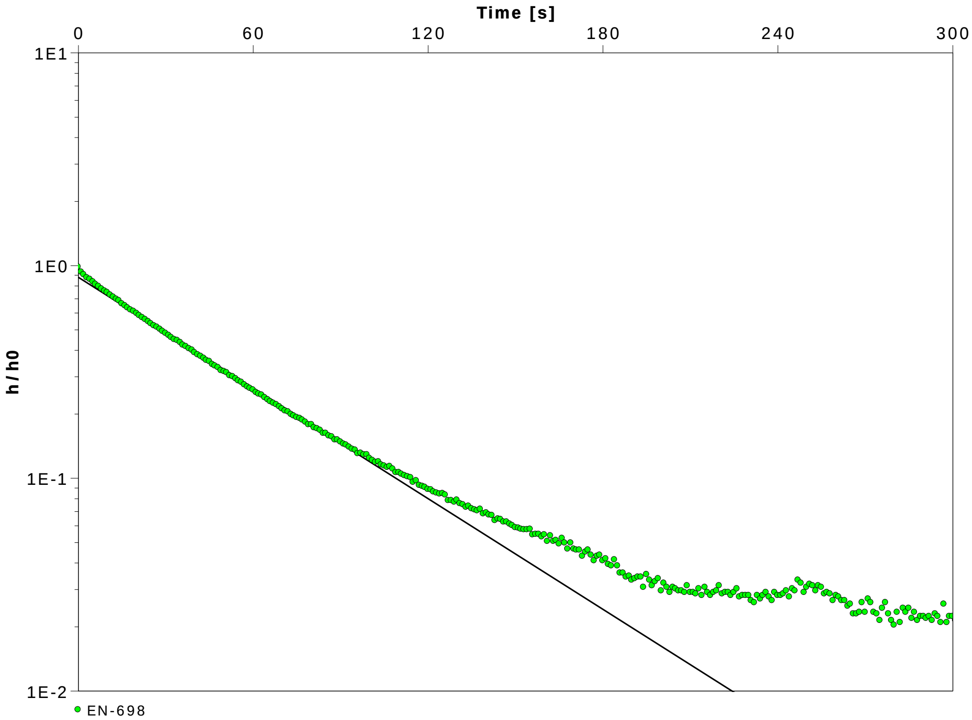

Test Name: EN-698 Rising **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 2.42 ft/d (8.53E-4cm/s)	
Test Parameters Test Well: EN-698 PVC Well Radius (r): 1" (0.08 ft) Boring Radius (B): 2" (0.17 ft) Casing Radius (R): 2" (0.17 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Screen Length (L): 5 ft Static water table level (b) (height of water column from transducer): 17.55 ft Aquifer Thickness: 30 ft Pre-Test height of water column (transducer reading): 17.48 ft Height of water column (from transducer) at t_0: 15.52 ft Depth to bottom of screen (from ground): 29.5 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 22, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O'Donnell (08/11/07)	

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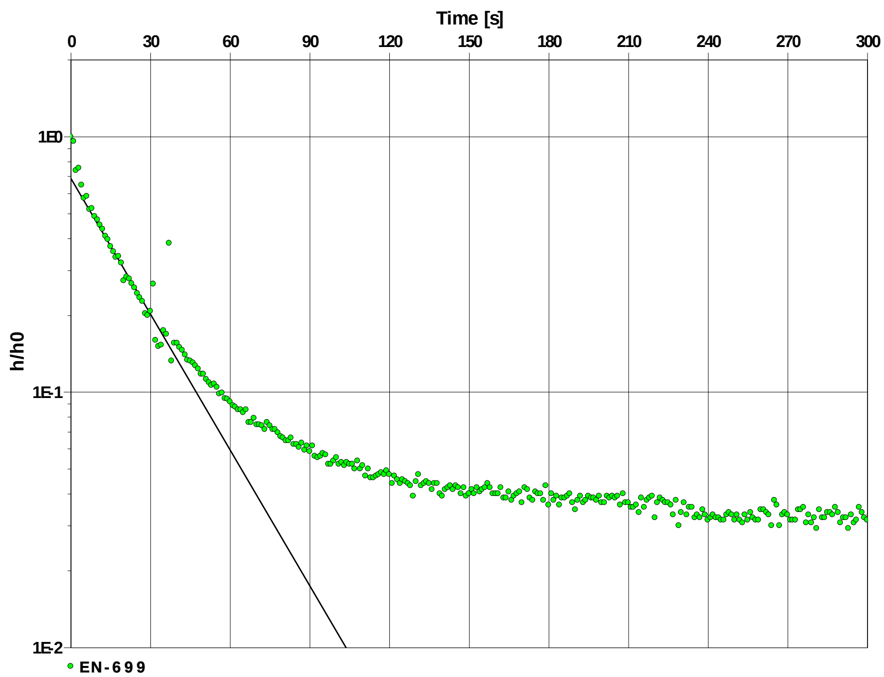
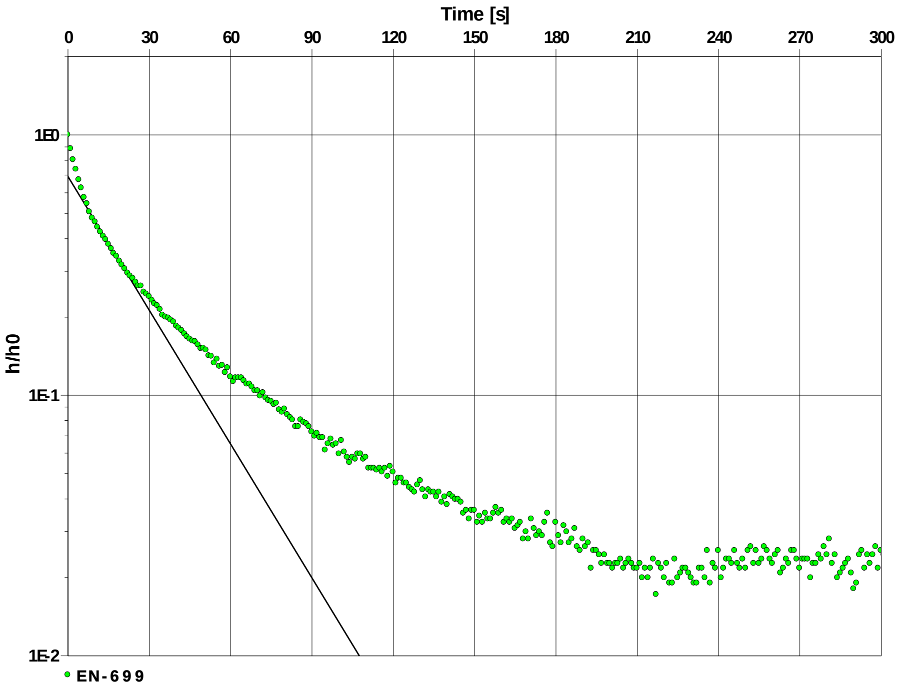
Slug Test Analysis Report – EN-699
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.01
Client: IBM

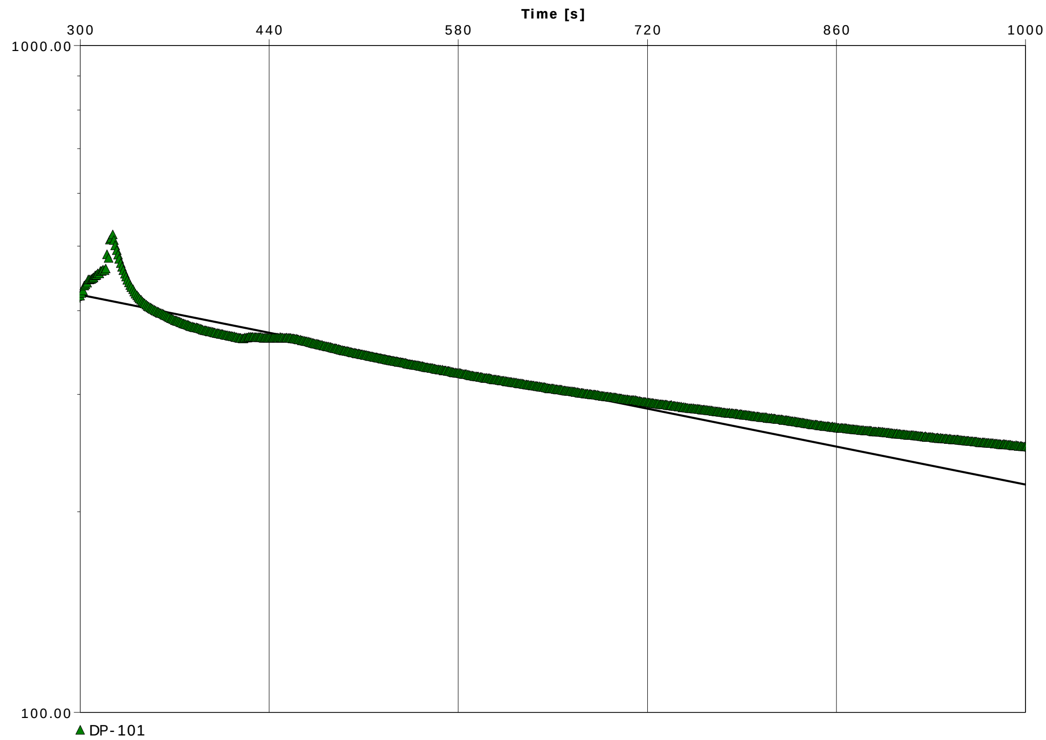


Test Name: EN-699 Falling **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 3.50 ft/d (1.23E-3cm/s)	
Test Parameters Test Well: EN-699 PVC Well Radius (r): 1" (0.08 ft) Boring Radius (B): 2" (0.17 ft) Casing Radius (R): 2" (0.17 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Screen Length (L): 10.0 ft Static water table level (b) (height of water column from transducer): 9.88 ft Aquifer Thickness: 30.0 ft Pre-Test height of water column (transducer reading): 9.88 ft Height of water column (from transducer) at t_0: 11.18 ft Depth to bottom of screen (from ground): 19.6 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 22, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. Note that final WTE was slightly higher than the WL before the start of the test. The initial WTE was used as the static WL for this analysis. *According to Aquifer Test Memo by O'Donnell (08/11/07)	



Test Name: EN-699 Rising **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K)= 2.97 ft/d (1.05E-3cm/s)	
Test Parameters Test Well: EN-699 PVC Well Radius (r): 1” (0.08 ft) Boring Radius (B): 2” (0.17 ft) Casing Radius (R): 2” (0.17 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Screen Length (L): 10.0 ft Static water table level (b) (height of water column from transducer): 9.88 ft Aquifer Thickness: 30.0 ft Pre-Test height of water column (transducer reading): 9.91 ft Height of water column (from transducer) at t_0: 8.80 ft Depth to bottom of screen (from ground): 19.6 ft	
Comments: Test conducted by P. Mouser and R. Cook on June 22, 2009. A porosity of 0.3 was assumed for the well filter pack. The length of the saturated screen was used as the aquifer thickness. *According to Aquifer Test Memo by O’Donnell (08/11/07)	

Slug Test Analysis Report – DP-101
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.02
Client: IBM



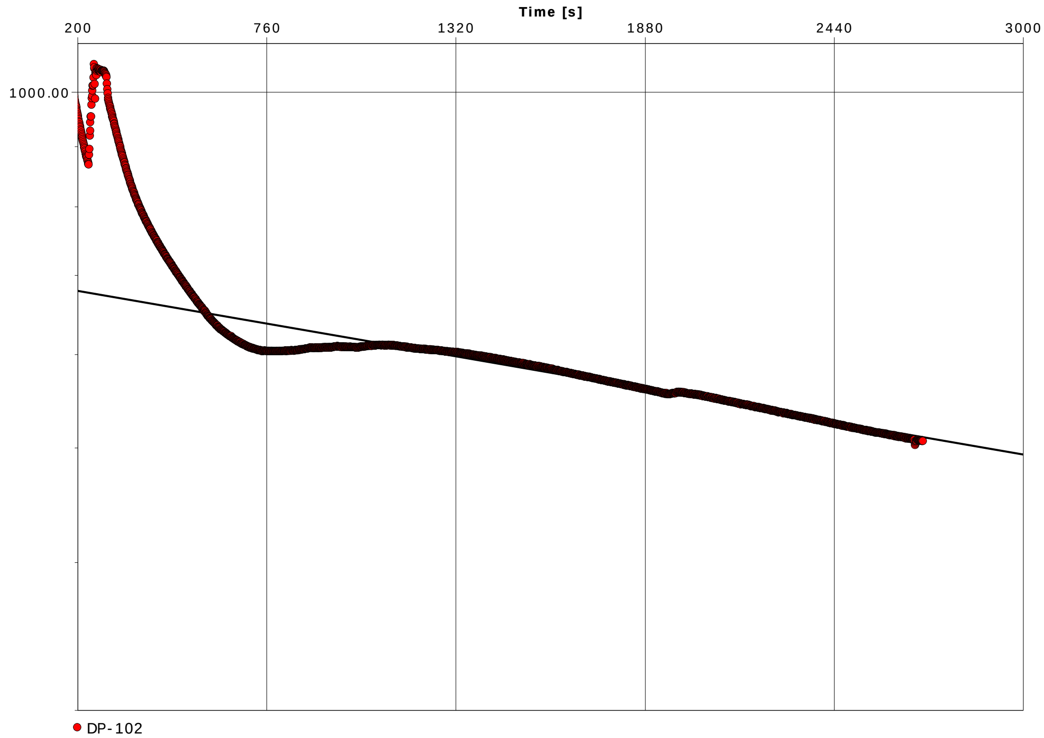
Test Name: DP-101 Falling Head
Analysis Method: Bouwer & Rice

Analysis Result: Conductivity (K) = 2E-1 ft/d (7.1E-5 cm/s)

Test Parameters
PVC Well Radius (r): 1" (0.083 ft) *
Boring Radius (B): 2.5" (0.208 ft)
Casing Radius (R): 2.5" (0.208 ft)*
Boring Penetration: Partially
Type Aquifer: Unconfined
Saturated Screen Length (L): 0.3 ft
Static water table level (b): 0.3 ft*
Aquifer Thickness: 10 ft
Pre-Test height of water column (transducer reading): 0.3 ft
Height of water column (from transducer) at t_0: 0.314 ft
Depth to bottom of screen (from ground): 10 ft

Comments: Test conducted by J. Prellwitz on October 22, 2009. A porosity of 0.3 was assumed for the well filter pack. Water was added to attempt to fill the screened interval and then a slug of water was then added. The initial recovery curve varies from that of the saturated filter pack. The K value of the line is representative of flow through the saturated media.
*For wells in which the screen interval straddles the water table, R=B, L=b.

Slug Test Analysis Report – DP-102
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.02
Client: IBM



Test Name: DP-102 Falling Head **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K) = 3E-2 ft/d (1.1E-5 cm/s)	
Test Parameters PVC Well Radius (r): 1" (0.083 ft) * Boring Radius (B): 2.5" (0.208 ft) Casing Radius (R): 2.5" (0.208 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Saturated Screen Length (L): 0.47 ft Static water table level (b): 0.47 ft* Aquifer Thickness: 10 ft Pre-Test height of water column (transducer reading): 0.47 ft Height of water column (from transducer) at t_0: 0.479 ft Depth to bottom of screen (from ground): 10 ft	
Comments: Test conducted by J. Prellwitz on October 22, 2009. A porosity of 0.3 was assumed for the well filter pack. Water was added to attempt to fill the screened interval and then a slug of water was then added. The initial recovery curve varies from that of the saturated filter pack. The K value of the line is representative of flow through the saturated media. *For wells in which the screen interval straddles the water table, R=B, L=b	

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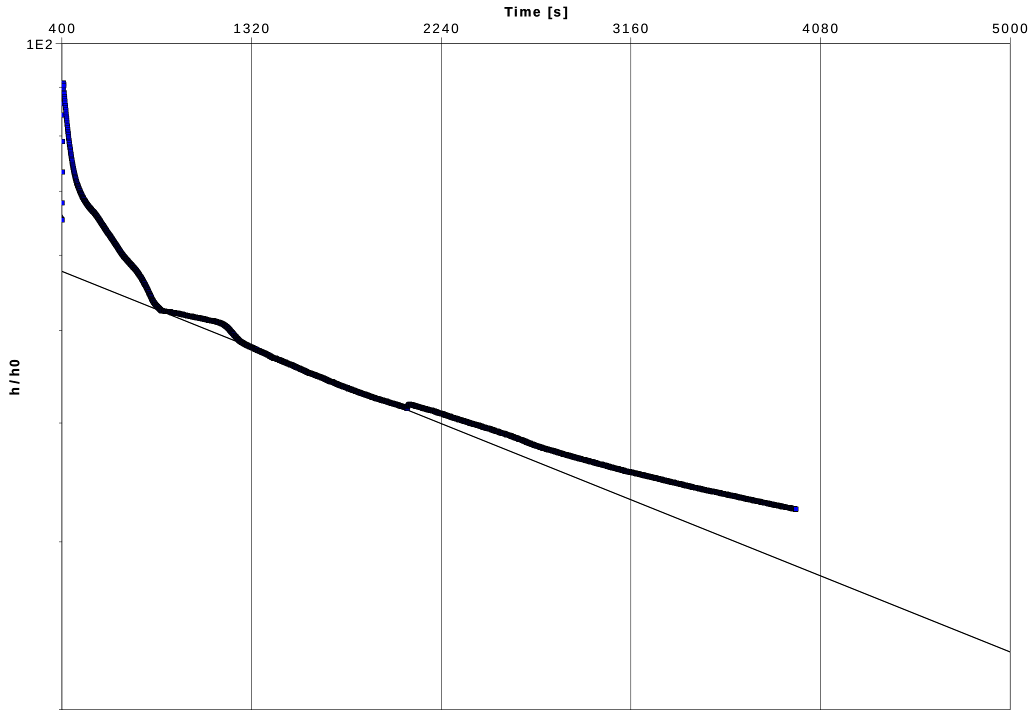
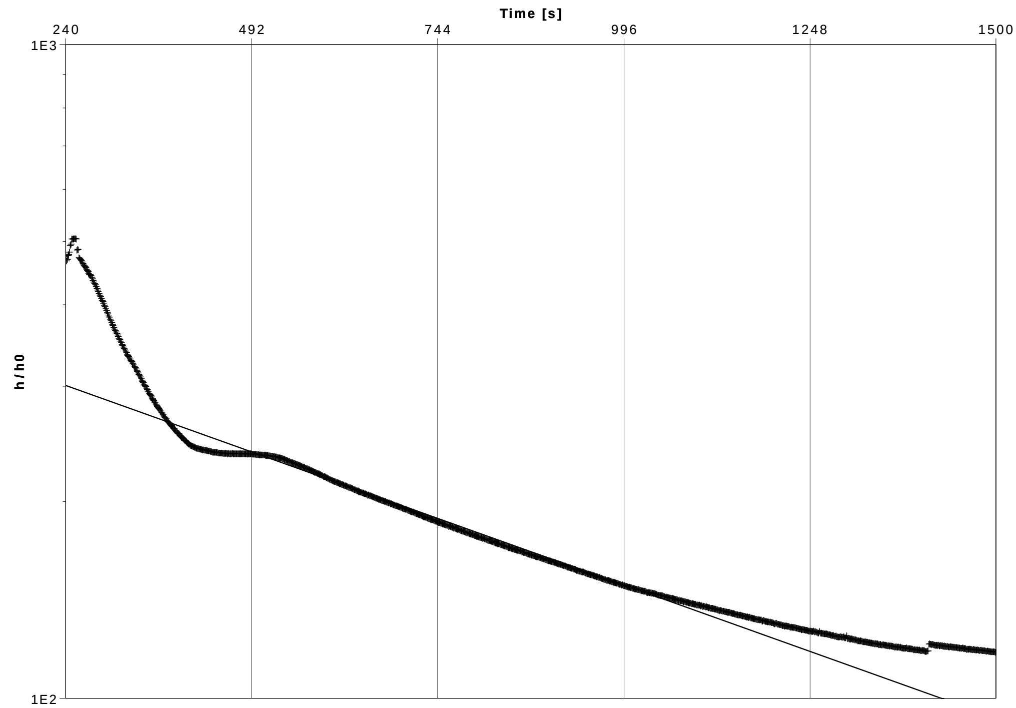
Slug Test Analysis Report – DP-103
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.02
Client: IBM



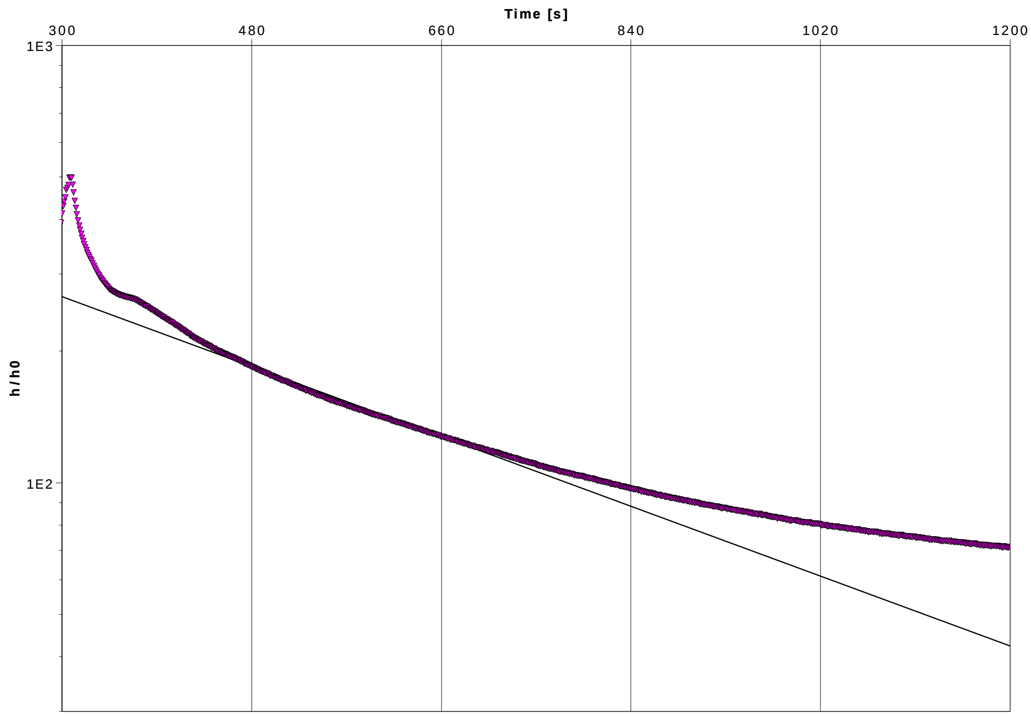
Test Name: DP-103 Falling Head **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K) = 4.5E-2 ft/d (1.6E-5 cm/s)	
Test Parameters PVC Well Radius (r): 1" (0.083 ft) * Boring Radius (B): 2.5" (0.208 ft) * Casing Radius (R): 2.5" (0.208 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Saturated Screen Length (L): 1.32 ft* Static water table level (b): 1.32 ft* Aquifer Thickness: 10.5 ft Pre-Test height of water column (transducer reading): 1.32 ft Height of water column (from transducer) at t_0: 1.22 ft Depth to bottom of screen (from ground): 10.5 ft	
Comments: Test conducted by J. Prellwitz on October 22, 2009. A porosity of 0.3 was assumed for the well filter pack. Water was added to attempt to fill the screened interval and then a slug of water was then added. The initial recovery curve varies from that of the saturated filter pack. The K value of the line is representative of flow through the saturated media. *For wells in which the screen interval straddles the water table, R=B, L=b	

Slug Test Analysis Report – EN-671
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.02
Client: IBM



Test Name: EN-671 Falling Head **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K) = 1.8E-1 ft/d (6.4E-5 cm/s)	
Test Parameters PVC Well Radius (r): 1” (0.083 ft) * Boring Radius (B): 2.5” (0.208 ft) * Casing Radius (R): 2.5” (0.208 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Saturated Screen Length (L): (Aquifer Dry) 2 ft* Static water table level (b): (Dry) 2 ft* Aquifer Thickness: 10ft Pre-Test height of water column (transducer reading): 0.0 ft Height of water column (from transducer) at t_0: 0.019 ft Depth to bottom of screen (from ground): 10 ft	
Comments: Test conducted by J. Prellwitz on October 22, 2009. A porosity of 0.3 was assumed for the well filter pack. Water was added to attempt to fill the screened interval and then a slug of water was then added. The initial recovery curve varies from that of the saturated filter pack. The K value of the line is representative of flow through the saturated media.*For wells in which the screen interval straddles the water table, R=B, L=b.	

Slug Test Analysis Report – EN-677
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.02
Client: IBM



Test Name: EN-677 Falling Head **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K) = 5E-1ft/d (1.8E-4 cm/s)	
Test Parameters PVC Well Radius (r): 1" (0.083 ft)* Boring Radius (B): 2.5" (0.208 ft)* Casing Radius (R): 2.5" (0.208 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Saturated Screen Length (L): 1.0 ft* Static water table level (b): 1.0 ft* Aquifer Thickness: 9.5 ft Pre-Test height of water column (transducer reading): 1.0 ft Height of water column (from transducer) at t_0: 1.013 ft Depth to bottom of screen (from ground): 9.5 ft	
Comments: Test conducted by J. Prellwitz on October 22, 2009. . A porosity of 0.3 was assumed for the well filter pack. Water was added to attempt to fill the screened interval and then a slug of water was then added. The initial recovery curve varies from that of the saturated filter pack. The K value of the line is representative of flow through the saturated media.*For wells in which the screen interval straddles the water table, R=B, L=b.	

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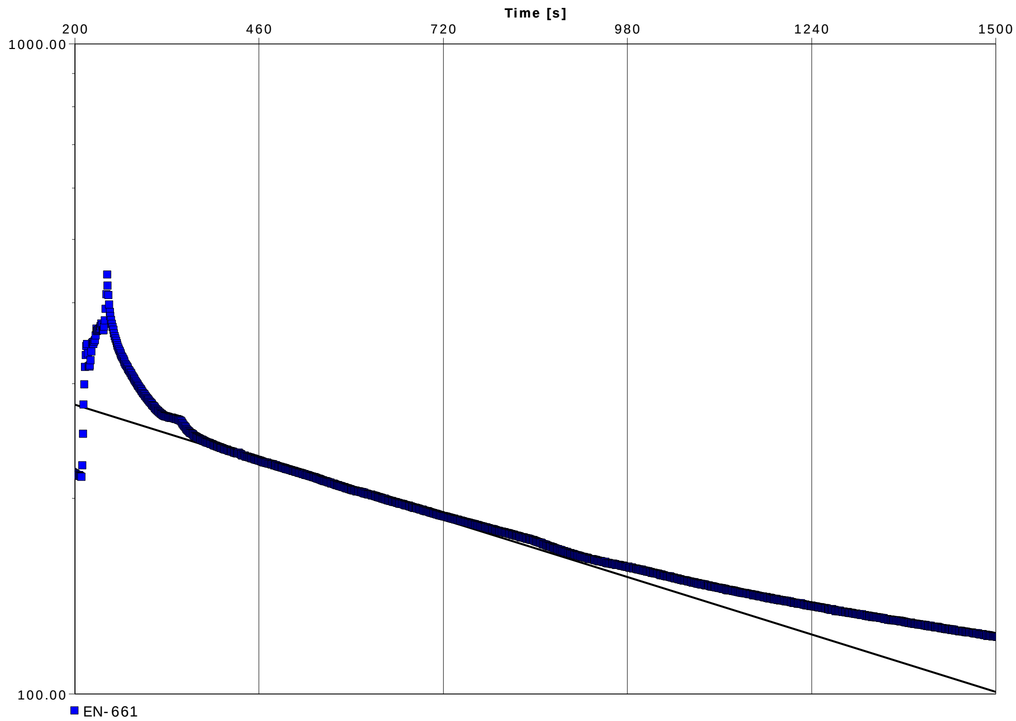
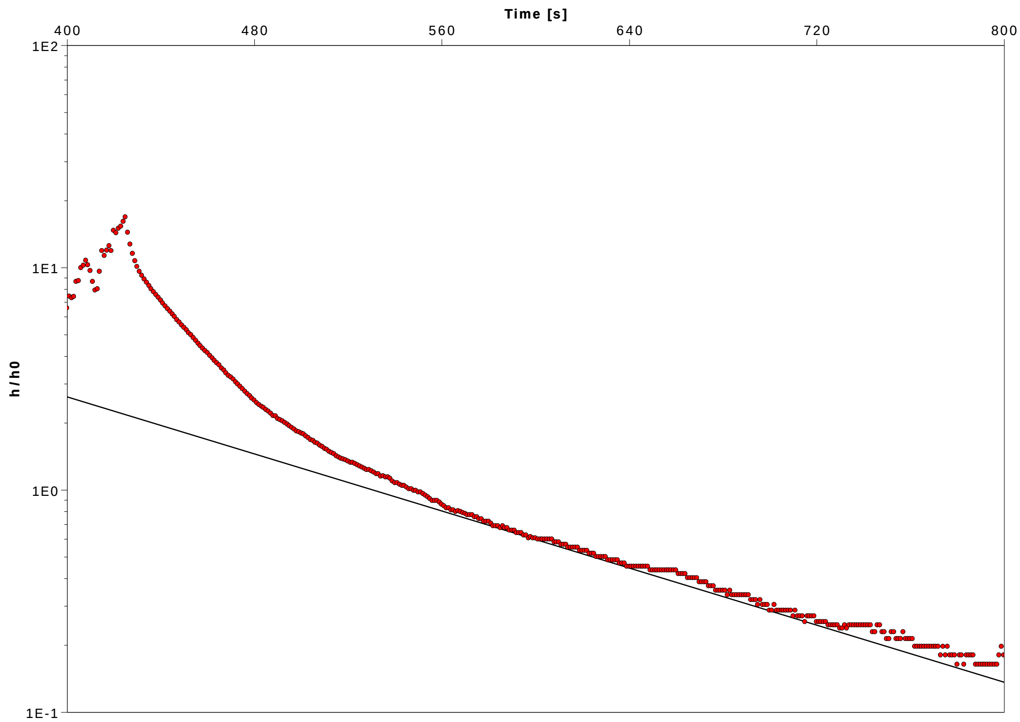
Slug Test Analysis Report – EN-661
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.02
Client: IBM



Test Name: EN-661 Falling Head **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K) = 1.7E-1 ft/d (6.0E-5 cm/s)	
Test Parameters PVC Well Radius (r): 1” (0.083 ft)* Boring Radius (B): 2.5” (0.208 ft)* Casing Radius (R): 2.5” (0.208 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Saturated Screen Length (L): 1.5 ft* Static water table level (b): 1.5 ft* Aquifer Thickness: 9 ft Pre-Test height of water column (transducer reading): 0.0 ft Height of water column (from transducer) at t_0: 0.017 ft Depth to bottom of screen (from ground): 9 ft	
Comments: Test conducted by J. Prellwitz on October 22, 2009. A porosity of 0.3 was assumed for the well filter pack. Water was added to attempt to fill the screened interval and then a slug of water was then added. The initial recovery curve varies from that of the saturated filter pack. The K value of the line is representative of flow through the saturated media. *For wells in which the screen interval straddles the water table, R=B, L=b.	

Slug Test Analysis Report – EN-691
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.02
Client: IBM



Test Name: EN-691 Falling Head **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K) = 2E0ft/d (7.1E-4 cm/s)	
Test Parameters PVC Well Radius (r): 1” (0.083 ft)* Boring Radius (B): 2.5” (0.208 ft)* Casing Radius (R): 2.5” (0.208 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Saturated Screen Length (L): 0.63 ft* Static water table level (b): 0.63 ft* Aquifer Thickness: 5.5 ft Pre-Test height of water column (transducer reading): 0.13 ft Height of water column (from transducer) at t_0: 0.008 ft Depth to bottom of screen (from ground): 5.5 ft	
Comments: Test conducted by J. Prellwitz on October 22, 2009. . A porosity of 0.3 was assumed for the well filter pack. Water was added to attempt to fill the screened interval and then a slug of water was then added. The initial recovery curve varies from that of the saturated filter pack. The K value of the line is representative of flow through the saturated media.*For wells in which the screen interval straddles the water table, R=B, L=b.	

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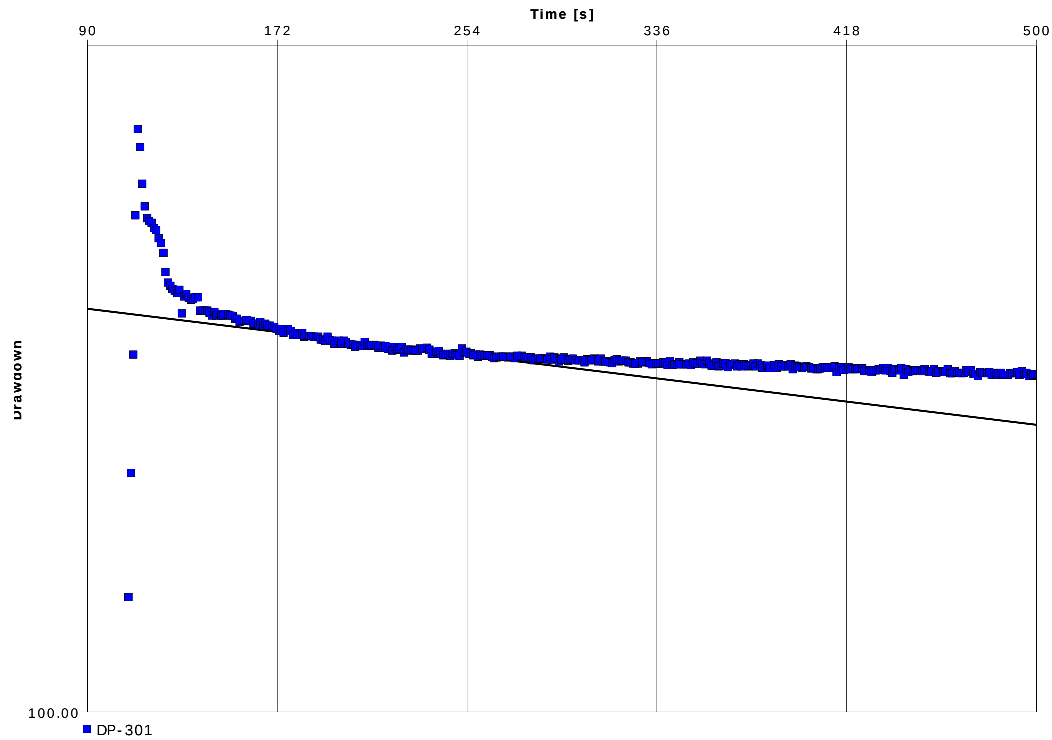
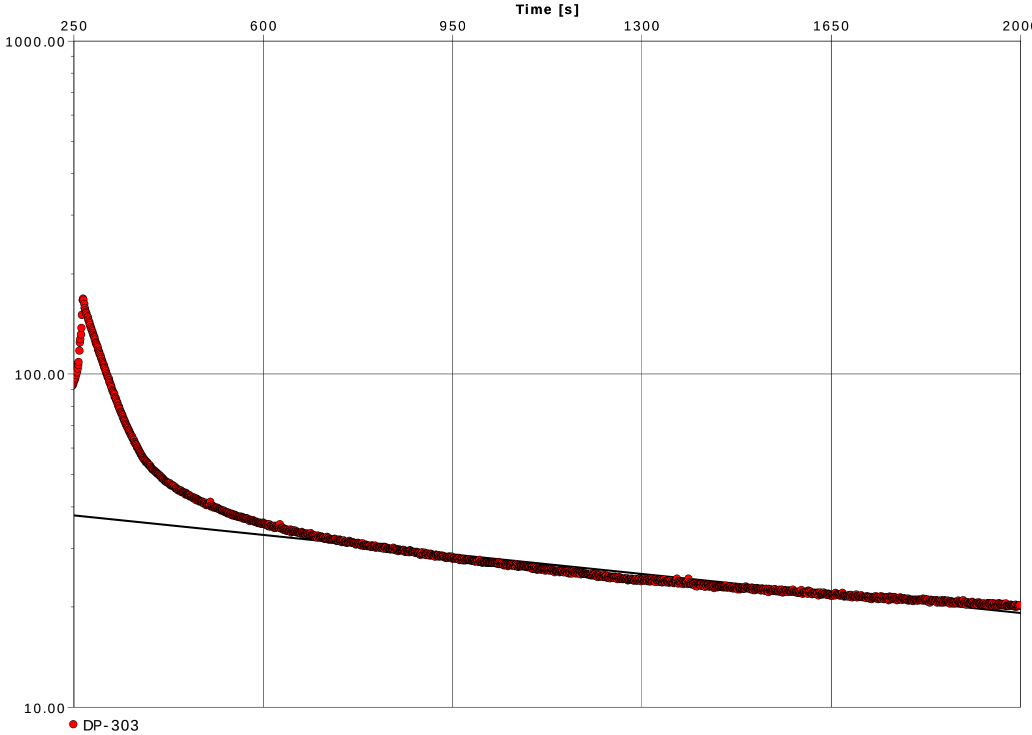
Slug Test Analysis Report – DP-301
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.02
Client: IBM



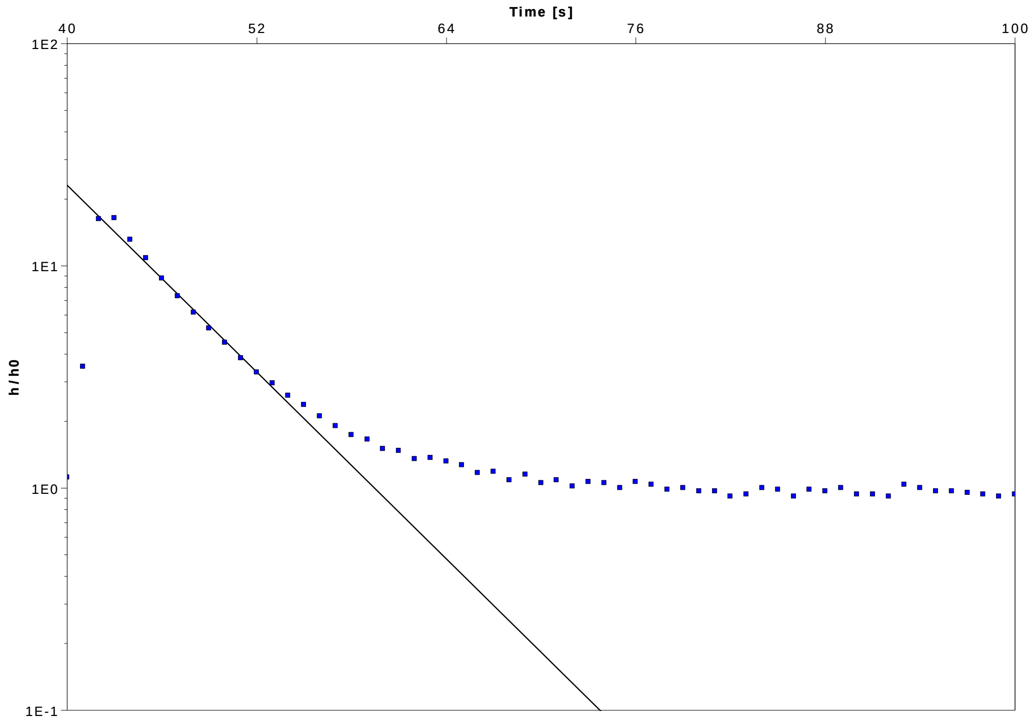
Test Name: DP-301 Falling Head **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K) = 4.5E-2 ft/d (1.6E-5 cm/s)	
Test Parameters PVC Well Radius (r): 1" (0.083 ft) * Boring Radius (B): 2.5" (0.208 ft) * Casing Radius (R): 2.5" (0.208 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Saturated Screen Length (L): 0.78 ft* Static water table level (b): 0.78 ft* Aquifer Thickness: 6.5 ft Pre-Test height of water column (transducer reading): 0.31 ft Height of water column (from transducer) at t_0: 0.29 ft Depth to bottom of screen (from ground): 6.0 ft	
Comments: Test conducted by J. Prellwitz on October 21, 2009. A porosity of 0.3 was assumed for the well filter pack. Water was added to attempt to fill the screened interval and then a slug of water was then added. The initial recovery curve varies from that of the saturated filter pack. The K value of the line is representative of flow through the saturated media. *For wells in which the screen interval straddles the water table, R=B, L=b.	

Slug Test Analysis Report – DP-303
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.02
Client: IBM



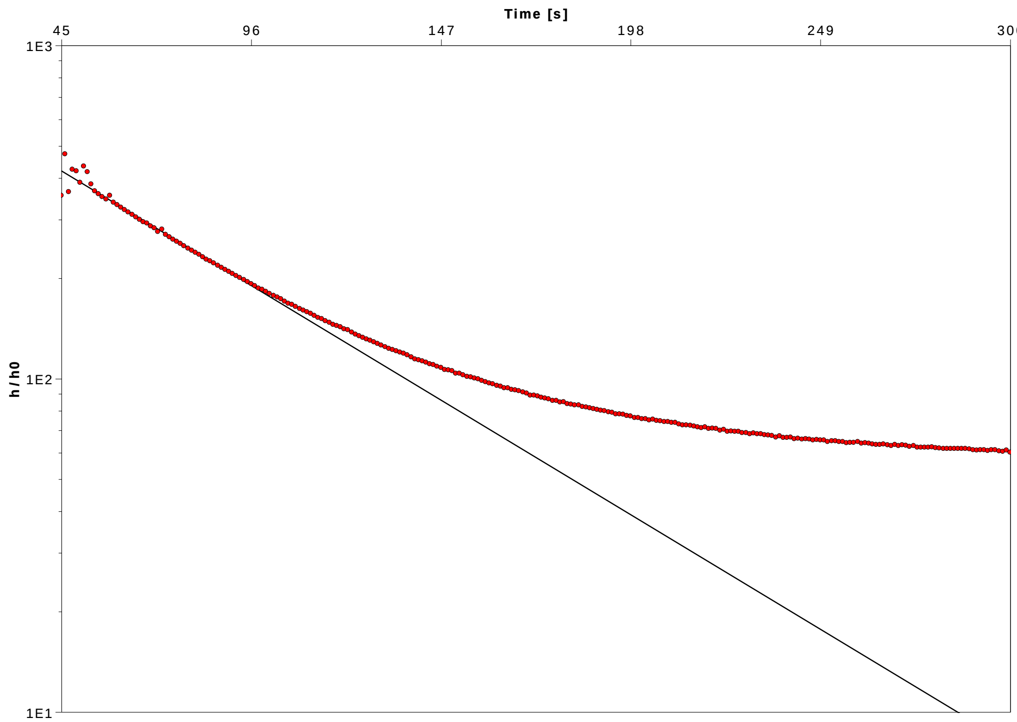
Test Name: DP-303 Falling Head (Water) **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K) = 1E-1ft/d (3.5E-5 cm/s)	
Test Parameters PVC Well Radius (r): 1" (0.083 ft) * Boring Radius (B): 2.5" (0.208 ft) * Casing Radius (R): 2.5" (0.208 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Saturated Screen Length (L): 0.73 ft* Static water table level (b): 0.73 ft* Aquifer Thickness: 9.3 ft Pre-Test height of water column (transducer reading): 0.73 ft Height of water column (from transducer) at t_0: 0.745 ft Depth to bottom of screen (from ground): 9.0 ft	
Comments: Test conducted by J. Prellwitz on October 22, 2009 A porosity of 0.3 was assumed for the well filter pack. Water was added to attempt to fill the screened interval and then a slug of water was then added. The initial recovery curve varies from that of the saturated filter pack. The K value of the line is representative of flow through the saturated media. *For wells in which the screen interval straddles the water table, R=B, L=b.	

Slug Test Analysis Report – EN-303A
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.02
Client: IBM



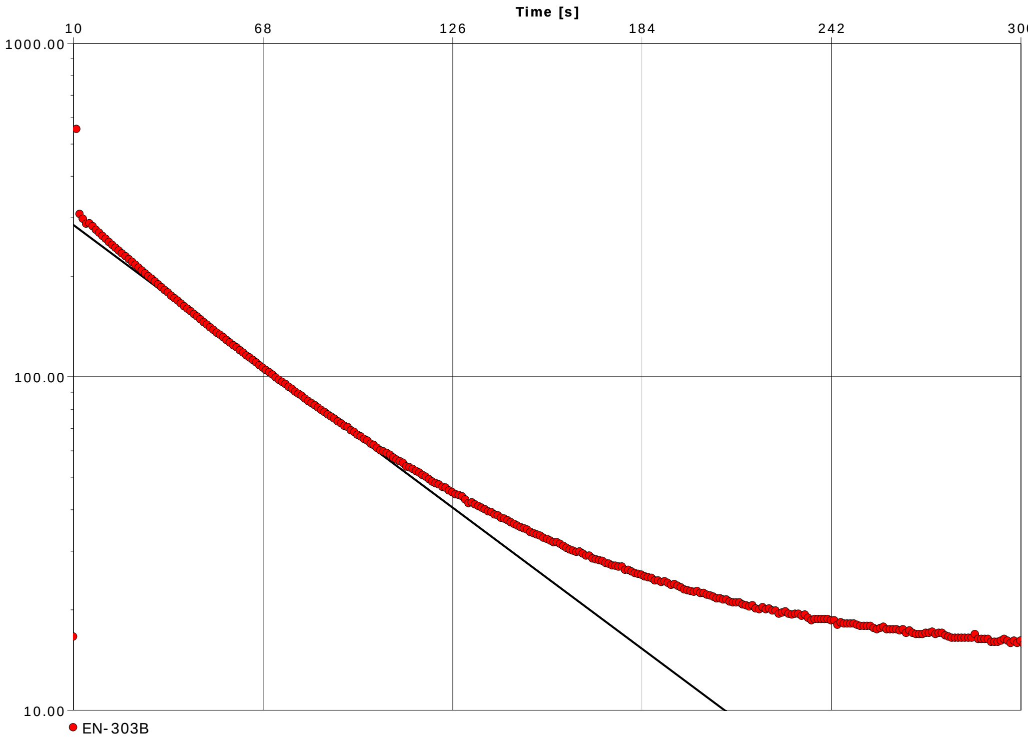
Test Name: EN-303A Rising Head **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K) = 4E1 ft/d (1.4E-2 cm/s)	
Test Parameters PVC Well Radius (r): 1.52” (0.126 ft) * Boring Radius (B): 2.5” (0.208 ft) * Casing Radius (R): 2.5” (0.208 ft)* Boring Penetration: Partially Type Aquifer: Unconfined Saturated Screen Length (L): 5 ft* Static water table level (b): 5 ft* Aquifer Thickness: 19.5 ft Pre-Test height of water column (transducer reading): 5.074 ft Height of water column (from transducer) at t_0: 5.014 ft Depth to bottom of screen (from ground): 17 ft	
Comments: Test conducted by J. Prellwitz on October 22, 2009. A sand-filled PVC slug (5’ by 1” diameter) was rapidly pulled from the well and the response was measured in 1 second intervals. A porosity of 0.25 was assumed for the well filter pack. *For wells in which the screen interval straddles the water table, R=B, L=b, and assuming a porosity (n) of 0.25, “r” is set to 1.52 in order for Aquifer Test 4.0 to calculate the correct K value. See Aquifer Test Memo by O’Donnell (08/11/07)	

Slug Test Analysis Report – EN-303B
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.02
Client: IBM



Test Name: EN-303B Falling Head **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K) = 1.2E0 ft/d (4.2E-4 cm/s)	
Test Parameters PVC Well Radius (r): 1" (0.083 ft)* Boring Radius (B): 4.0" (0.333 ft)* Casing Radius (R): 4.0" (0.333 ft)* Boring Penetration: Fully Type Aquifer: Confined Saturated Screen Length (L): 10 ft Static water table level (b): 13.5 ft Aquifer Thickness: 13.5 ft Pre-Test height of water column (transducer reading): 20.31 ft Height of water column (from transducer) at t_0: 20.315 ft Depth to bottom of screen (from ground): 33.5 ft	
Comments: Test conducted by J. Prellwitz on October 22, 2009. A sand-filled PVC slug (5' by 1" diameter) was rapidly lowered to a depth of 19.0' bTOIC, or at the top of the transducer and the response was measured in 1 second intervals. A porosity of 0.3 was assumed for the well filter pack. *R=B.	

Slug Test Analysis Report – EN-303B
Project: B-57, IBM Facility, Endicott, NY
Project number: 2466.02
Client: IBM



Test Name: EN-303B Rising Head **Analysis Method:** Bouwer & Rice	
Analysis Result: Conductivity (K) = 1.3E0 ft/d (4.6E-4 cm/s)	
Test Parameters PVC Well Radius (r): 1" (0.083 ft)* Boring Radius (B): 4.0" (0.333 ft)* Casing Radius (R): 4.0" (0.333 ft)* Boring Penetration: Fully Type Aquifer: Confined Saturated Screen Length (L): 10 ft Static water table level (b): 13.5 ft Aquifer Thickness: 13.5 ft Pre-Test height of water column (transducer reading): 20.31 ft Height of water column (from transducer) at t_0: 20.317 ft Depth to bottom of screen (from ground): 33.5 ft	
Comments: Test conducted by J. Prellwitz on October 22, 2009. A sand-filled PVC slug (5' by 1" diameter) was rapidly pulled from the well and the response was measured in 1 second intervals. A porosity of 0.3 was assumed for the well filter pack. *R=B.	

ATTACHMENT E.4

Aquifer Test Results for 2008 and 2009 Shut-down Monitoring

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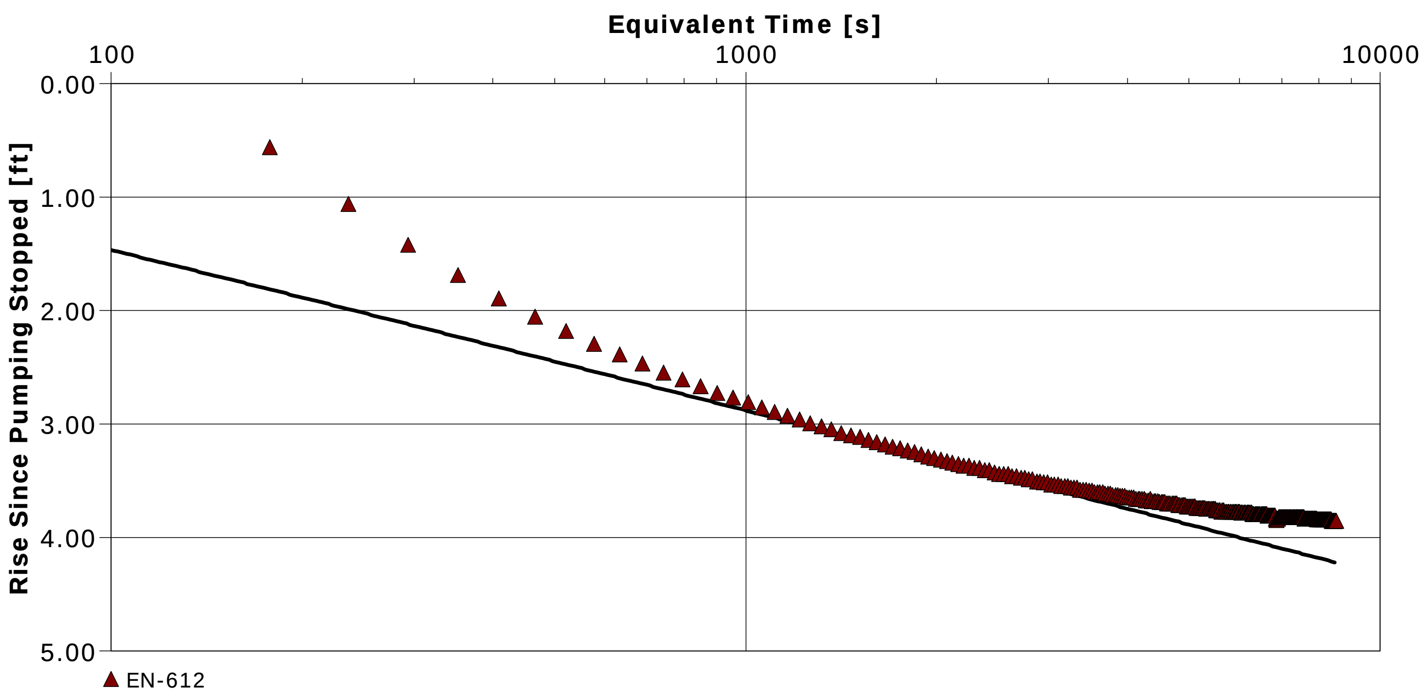
Company Name Contact Info Address City, State/Province	**Pumping Test Analysis Report** Project: Building 57 Number: 2466.02 Client: SHA

Location: Endicott, NY	Pumping Test: WSA Start Up Monitoring	Pumping Well: EN-624
Test Conducted by: J. Prellwitz		Test Date: 4/23/2008
Analysis Performed by: P. Mouser	Recovery	Analysis Date: 9/16/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.82237 [U.S. gal/min]	

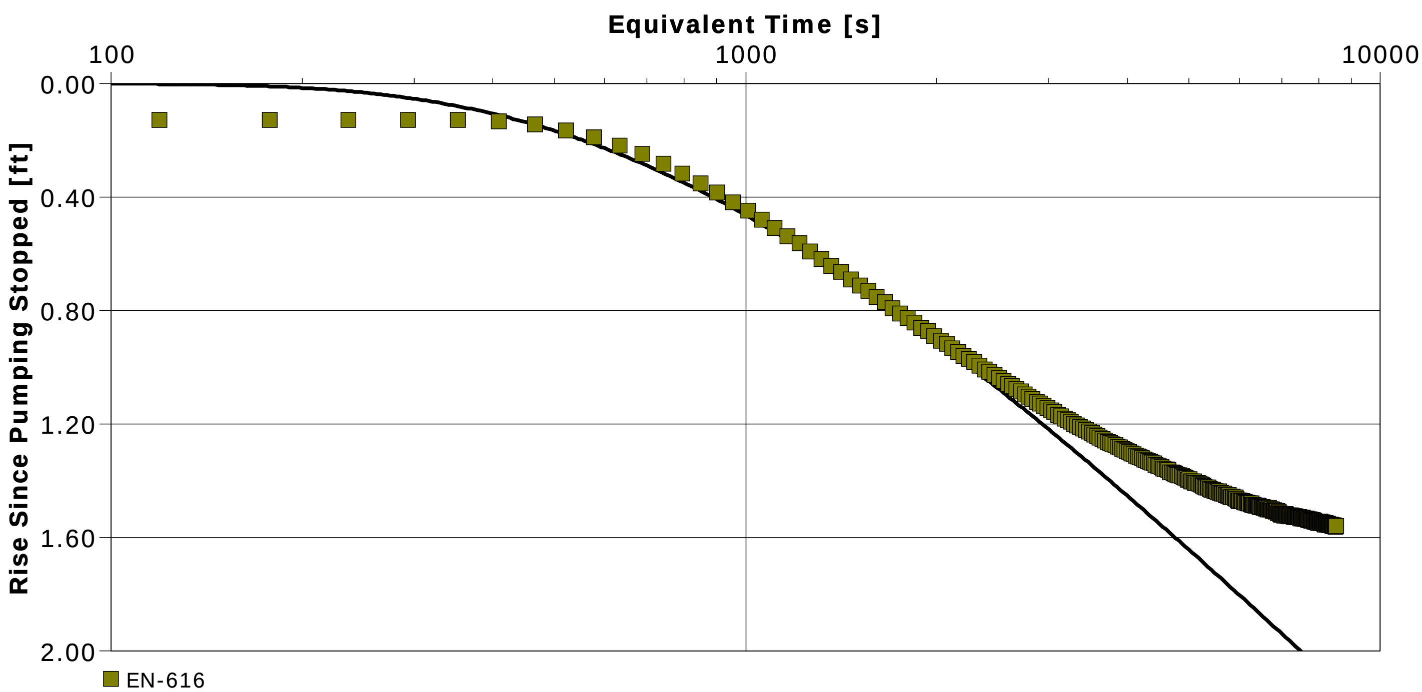


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-612	5.25×10^{1}	1.05×10^{1}	5.20×10^{-4}	5.18	

	Company Name Contact Info Address City, State/Province	**Pumping Test Analysis Report**
		Project: Building 57
		Number: 2466.02
		Client: SHA

Location: Endicott, NY	Pumping Test: WSA Start Up Monitoring	Pumping Well: EN-624
Test Conducted by: J. Prellwitz		Test Date: 4/23/2008
Analysis Performed by: P. Mouser	Recovery	Analysis Date: 9/16/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.82237 [U.S. gal/min]	

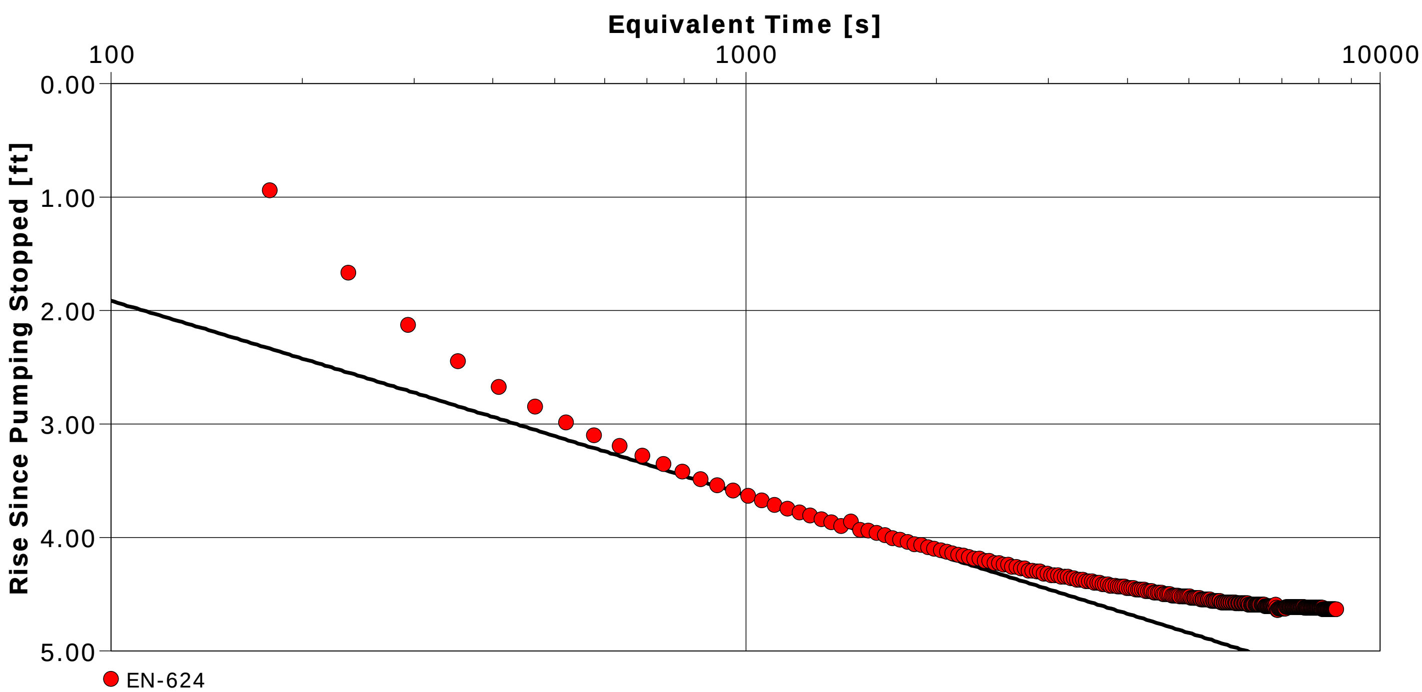


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-616	3.40×10^{1}	6.80×10^{0}	5.50×10^{-5}	128.31	

	Company Name Contact Info Address City, State/Province	Pumping Test Analysis Report Project: Building 57 Number: 2466.02 Client: SHA

Location: Endicott, NY	Pumping Test: WSA Start Up Monitoring	Pumping Well: EN-624
Test Conducted by: J. Prellwitz		Test Date: 4/23/2008
Analysis Performed by: P. Mouser	Recovery	Analysis Date: 9/16/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.82237 [U.S. gal/min]	



Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-624	4.35×10^{1}	8.70×10^{0}	8.50×10^{-2}	0.33	

Company Name **Contact Info** **Address** **City, State/Province**		**Pumping Test Analysis Report** Project: Building 57 Number: 2466.02 Client: SHA

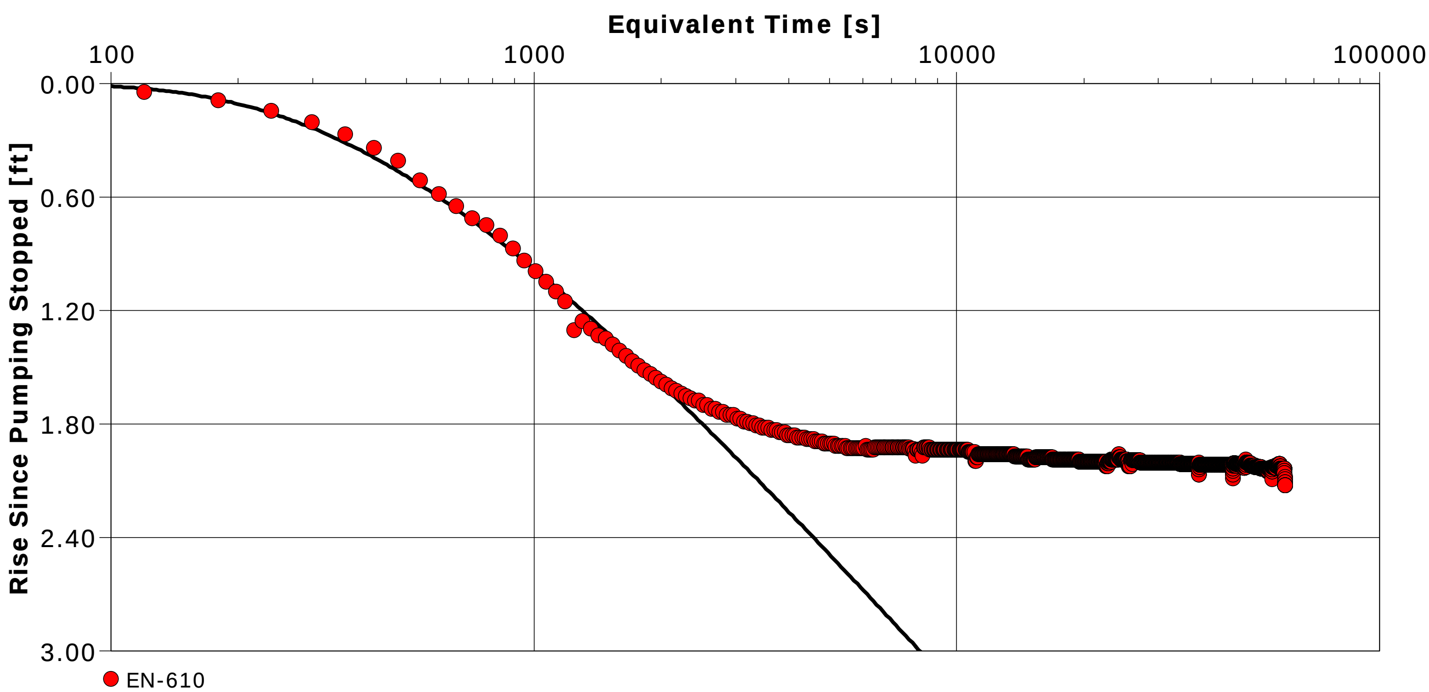
Location: Endicott, NY	Pumping Test: WSA Start Up Monitoring	Pumping Well: EN-624
Test Conducted by: J. Prellwitz		Test Date: 4/23/2008
Analysis Performed by: P. Mouser	Recovery	Analysis Date: 9/16/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.82237 [U.S. gal/min]	

Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
DEC-MW-34D	7.50×10^{1}	1.50×10^{1}	7.00×10^{-5}	111.68	

Company Name Contact Info Address City, State/Province	**Pumping Test Analysis Report**
	Project: Building 57
	Number: 2466.01
	Client: SHA

Location: Endicott, NY	Pumping Test: TCA Area Shut Down	Pumping Well: EN-623
Test Conducted by: PJM		Test Date: 4/23/2008
Analysis Performed by: PJM	Recovery	Analysis Date: 7/27/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.23667 [U.S. gal/min]	

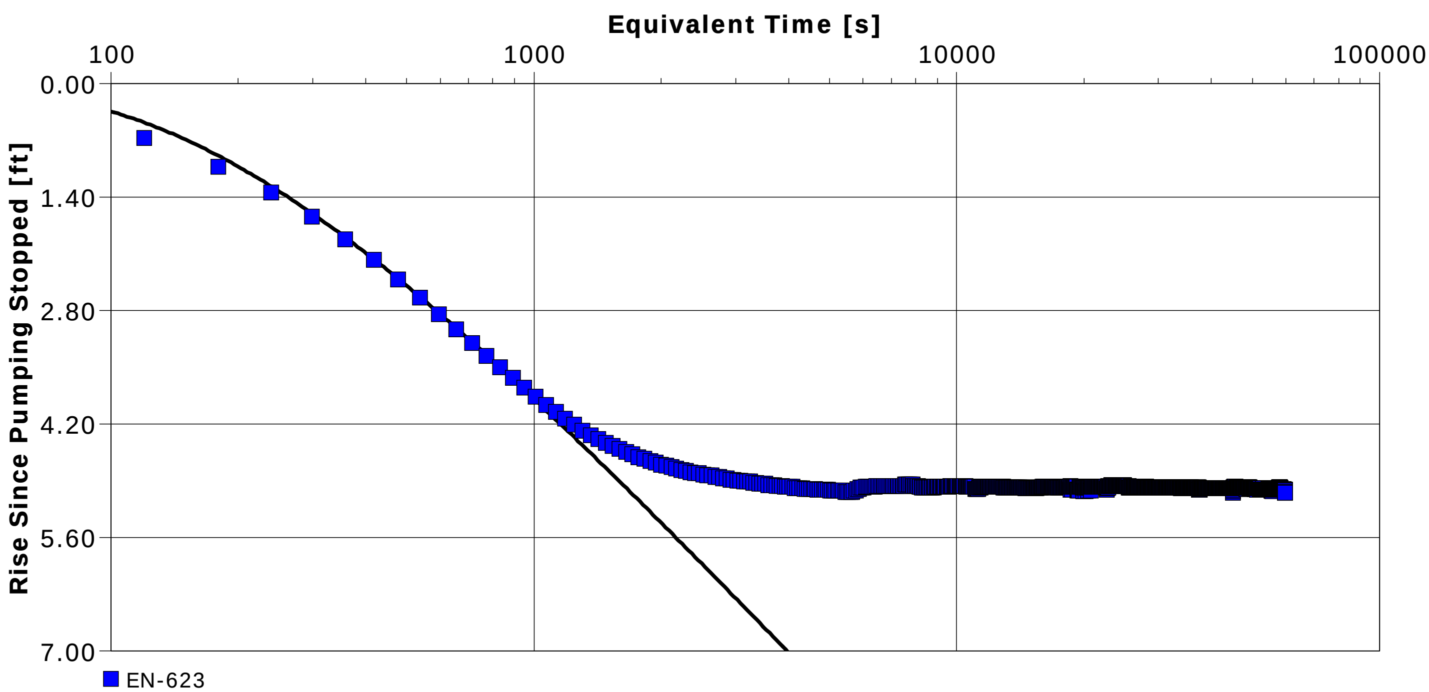


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-610	1.00×10^{1}	2.00×10^{0}	7.00×10^{-4}	14.13	

Company Name Contact Info Address City, State/Province	Pumping Test Analysis Report
	Project: Building 57
	Number: 2466.01
	Client: SHA

Location: Endicott, NY	Pumping Test: TCA Area Shut Down	Pumping Well: EN-623
Test Conducted by: PJM		Test Date: 4/23/2008
Analysis Performed by: PJM	Recovery	Analysis Date: 7/27/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.23667 [U.S. gal/min]	

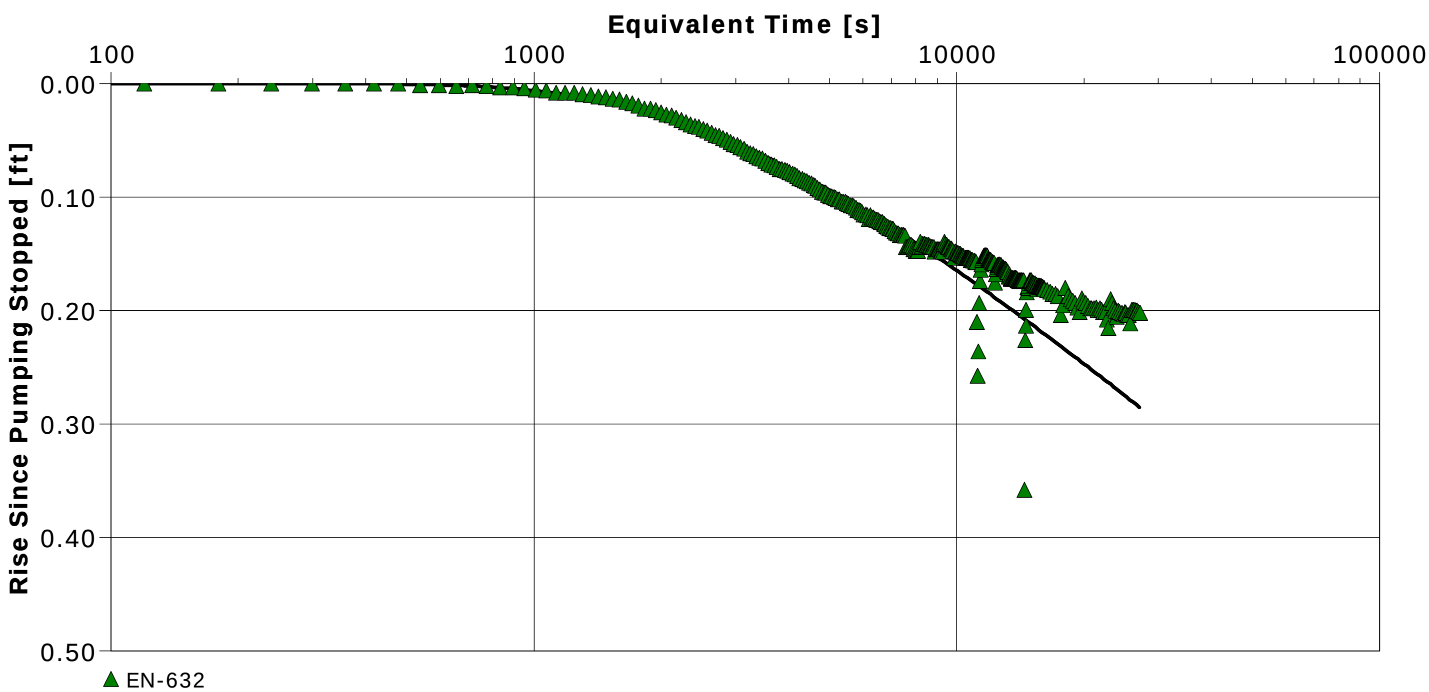


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-623	4.50×10^{0}	9.00×10^{-1}	1.50×10^{-1}	0.42	

Company Name Contact Info Address City, State/Province	**Pumping Test Analysis Report**	
	Project: Building 57	
	Number: 2466.01	
	Client: SHA	

Location: Endicott, NY	Pumping Test: TCA Area Shut Down	Pumping Well: EN-623
Test Conducted by: PJM		Test Date: 4/23/2008
Analysis Performed by: PJM	Recovery	Analysis Date: 7/27/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.23667 [U.S. gal/min]	

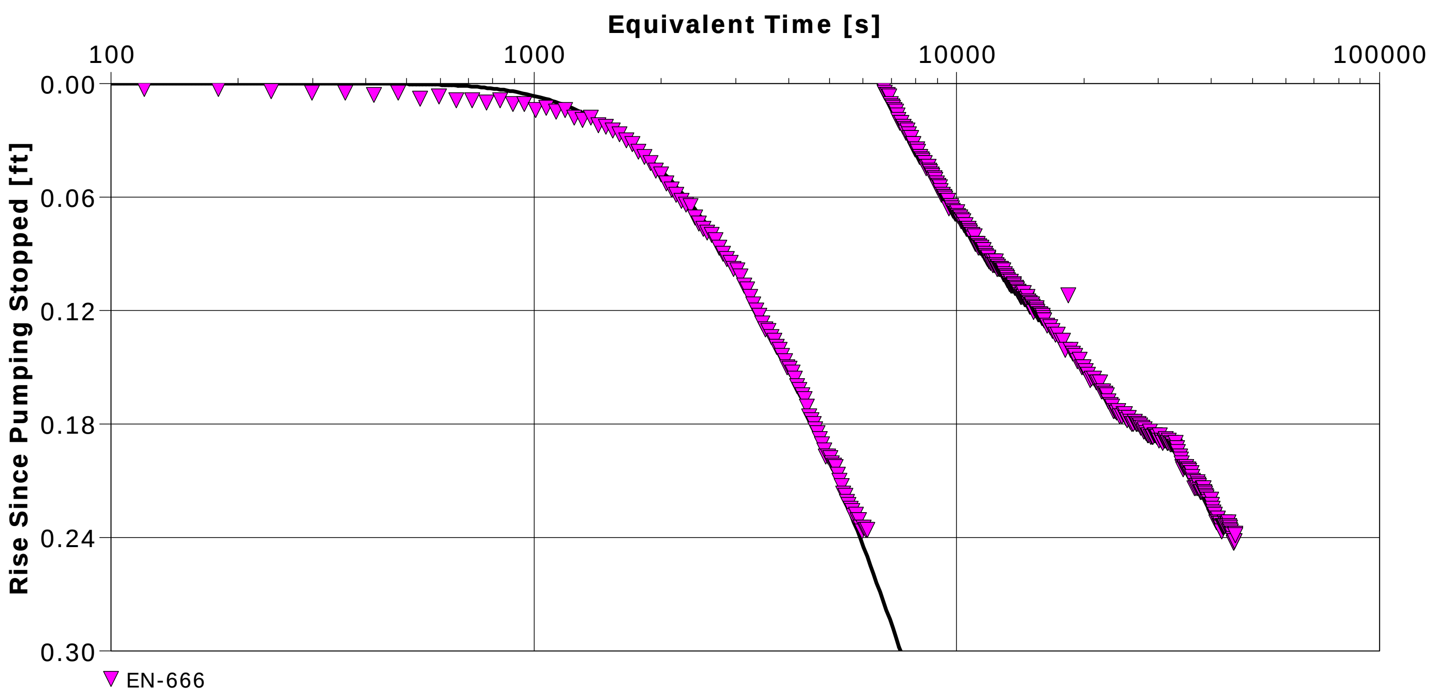


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-632	7.90×10^{1}	1.58×10^{1}	4.10×10^{-4}	135.67	

	Company Name Contact Info Address City, State/Province	**Pumping Test Analysis Report**
		Project: Building 57
		Number: 2466.01
		Client: SHA

Location: Endicott, NY	Pumping Test: TCA Area Shut Down	Pumping Well: EN-623
Test Conducted by: PJM		Test Date: 4/23/2008
Analysis Performed by: PJM	Recovery	Analysis Date: 7/27/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.23667 [U.S. gal/min]	

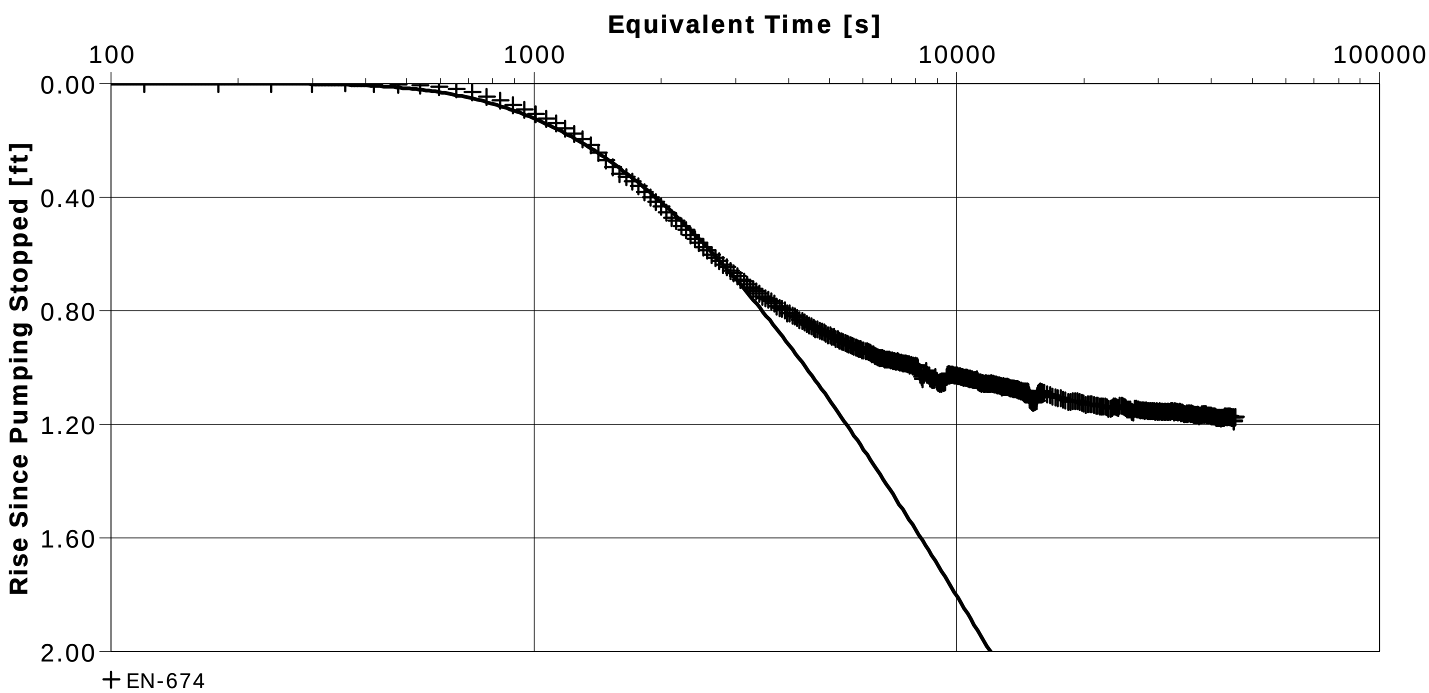


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-666	2.61×10^{1}	5.22×10^{0}	2.00×10^{-4}	131.76	

	Company Name Contact Info Address City, State/Province	**Pumping Test Analysis Report**
		Project: Building 57
		Number: 2466.01
		Client: SHA

Location: Endicott, NY	Pumping Test: TCA Area Shut Down	Pumping Well: EN-623
Test Conducted by: PJM		Test Date: 4/23/2008
Analysis Performed by: PJM	Recovery	Analysis Date: 7/27/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.23667 [U.S. gal/min]	

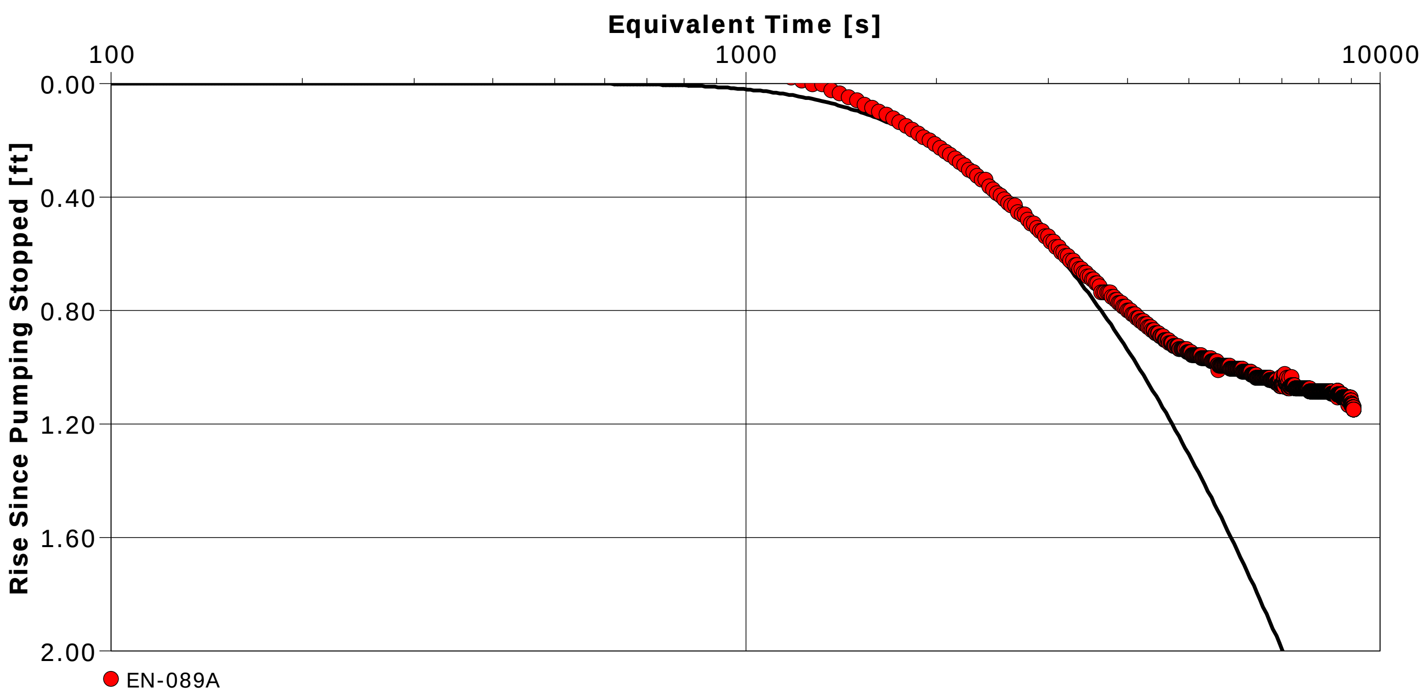


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-674	8.80×10^{0}	1.76×10^{0}	3.75×10^{-4}	40.47	

	Company Name Contact Info Address City, State/Province	**Pumping Test Analysis Report** Project: Building 57 Number: 2466.01 Client: SHA

Location: Endicott, NY	Pumping Test: CFC-113 Area Shut Down Monitoring	Pumping Well: EN-089R
Test Conducted by: PJM		Test Date: 4/23/2008
Analysis Performed by: PJM	Recovery	Analysis Date: 7/27/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.045455 [U.S. gal/min]	

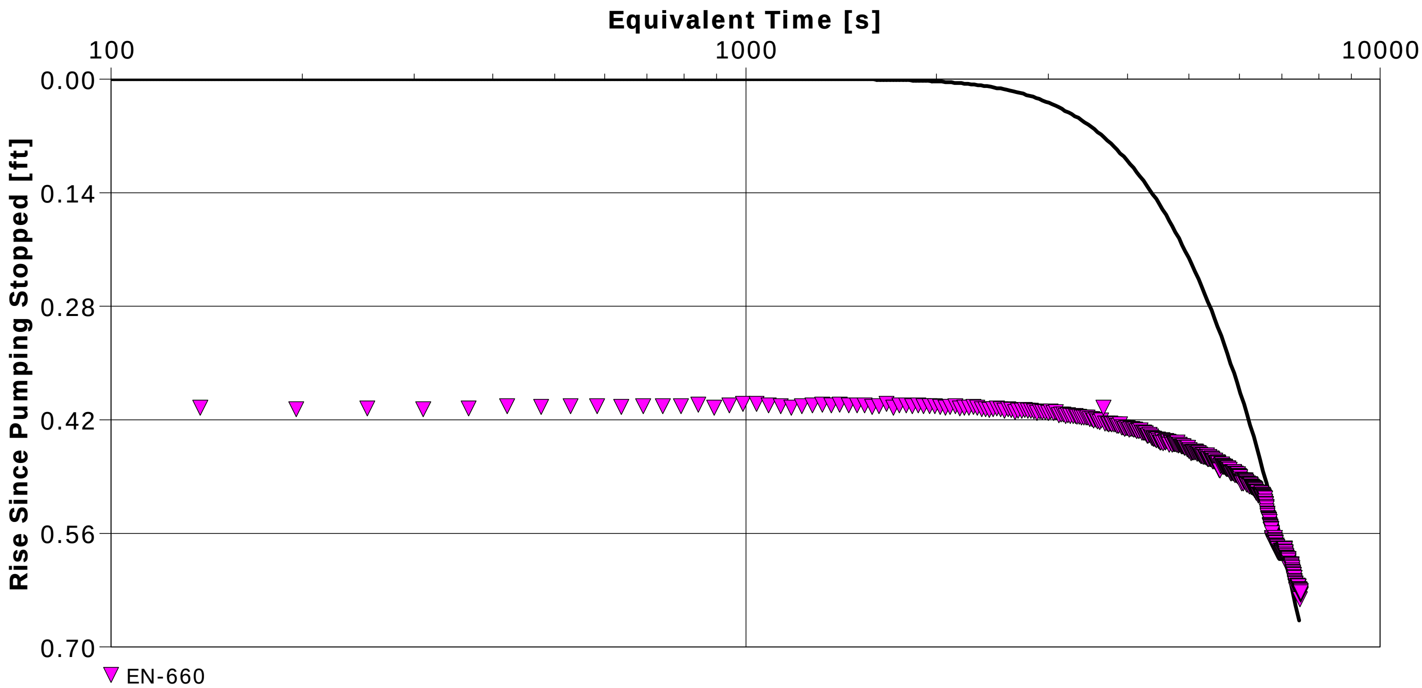


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-089A	2.00×10^{0}	4.00×10^{-1}	8.50×10^{-3}	6.38	

	Company Name Contact Info Address City, State/Province	**Pumping Test Analysis Report**
		Project: Building 57
		Number: 2466.01
		Client: SHA

Location: Endicott, NY	Pumping Test: CFC-113 Area Shut Down Monitoring	Pumping Well: EN-089R
Test Conducted by: PJM		Test Date: 4/23/2008
Analysis Performed by: PJM	Recovery	Analysis Date: 7/27/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.045455 [U.S. gal/min]	

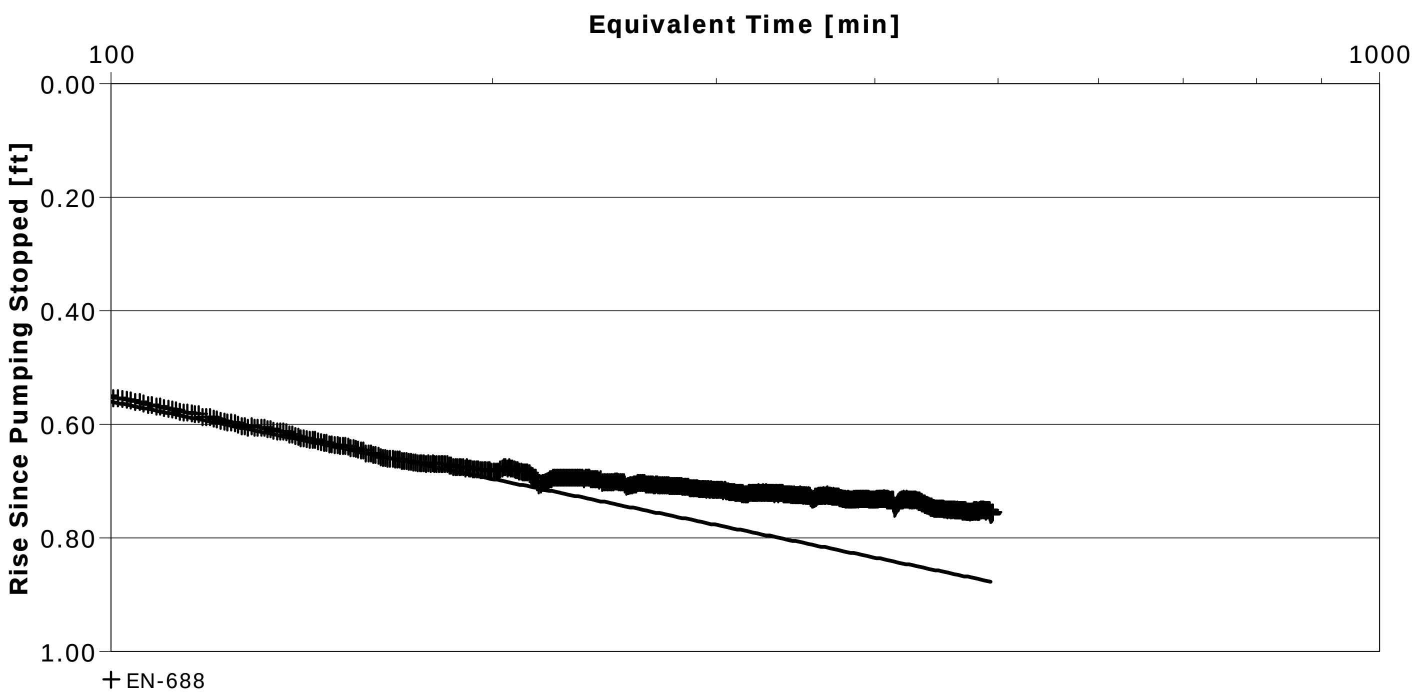


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-660	9.50×10^{-1}	1.90×10^{-1}	1.20×10^{-4}	66.68	

Company Name Contact Info Address City, State/Province	Pumping Test Analysis Report
	Project: Building 57
	Number: 2466.01
	Client: SHA

Location: Endicott, NY	Pumping Test: 10/2009 Shutdown Monitoring	Pumping Well: EN-089R
Test Conducted by: Joel Prellwitz		Test Date: 11/12/2009
Analysis Performed by: JSP	Recovery	Analysis Date: 11/16/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.17478 [U.S. gal/min]	

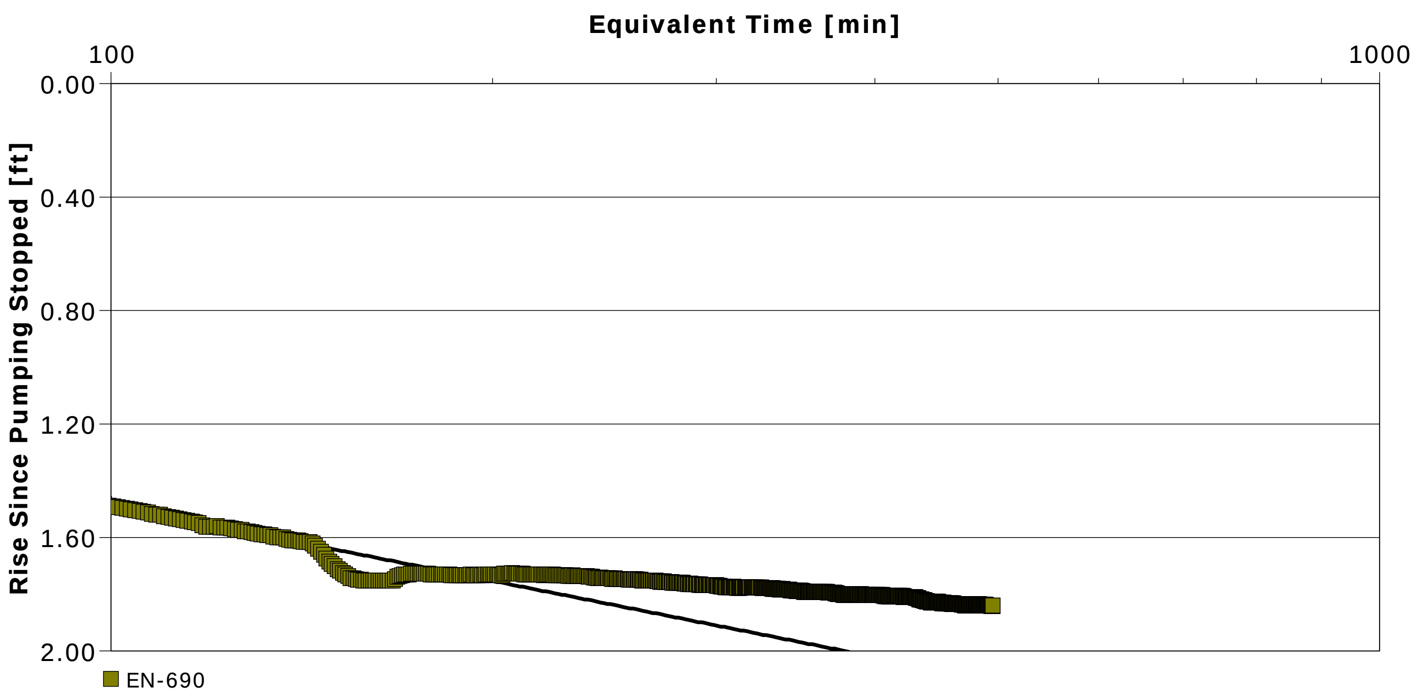


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-688	2.50×10^{1}	5.00×10^{0}	1.20×10^{-4}	45.97	

	Company Name Contact Info Address City, State/Province	Pumping Test Analysis Report
		Project: Building 57
		Number: 2466.01
		Client: SHA

Location: Endicott, NY	Pumping Test: 10/2009 Shutdown Monitoring	Pumping Well: EN-089R
Test Conducted by: Joel Prellwitz		Test Date: 11/12/2009
Analysis Performed by: JSP	Recovery	Analysis Date: 11/16/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.17478 [U.S. gal/min]	

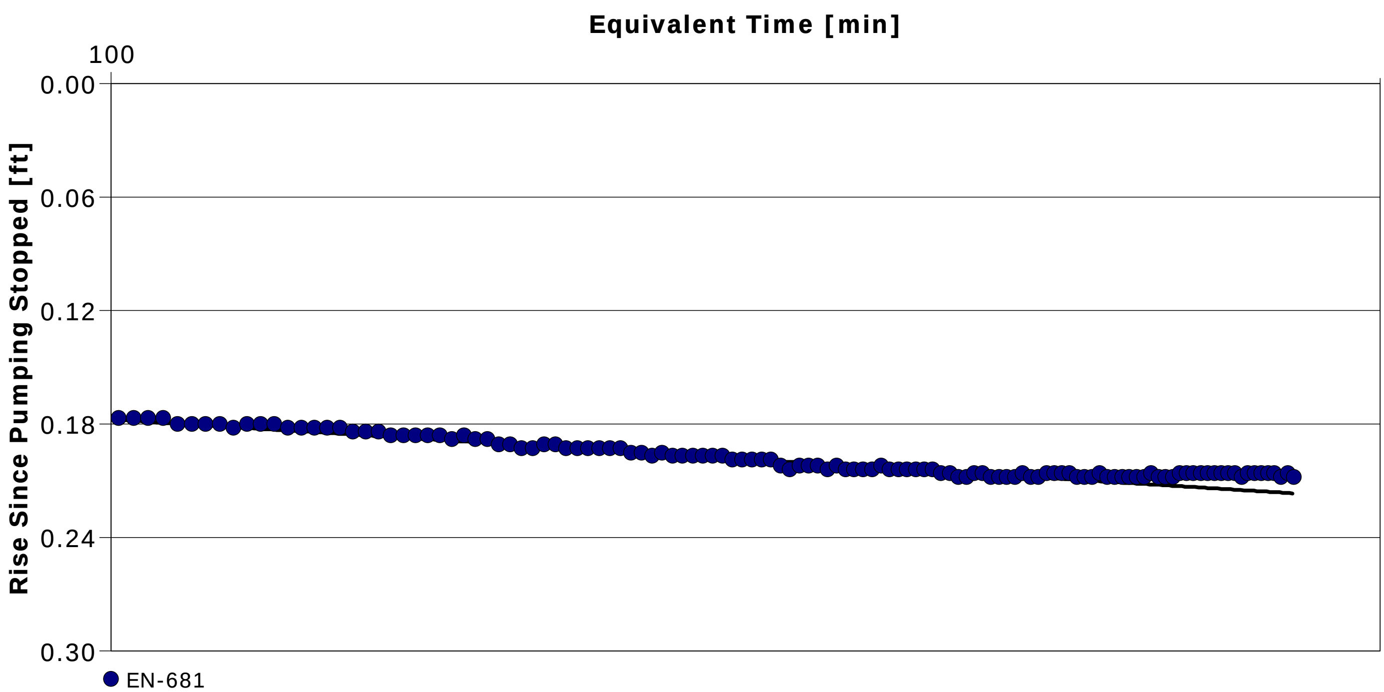


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-690	1.30×10^{1}	2.60×10^{0}	1.00×10^{-4}	21.2	

Company Name Contact Info Address City, State/Province	Pumping Test Analysis Report
	Project: Building 57
	Number: 2466.01
	Client: SHA

Location: Endicott, NY	Pumping Test: 10/2009 Shutdown Monitoring	Pumping Well: EN-089R
Test Conducted by: Joel Prellwitz		Test Date: 11/12/2009
Analysis Performed by: JSP	Recovery	Analysis Date: 11/16/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.17478 [U.S. gal/min]	

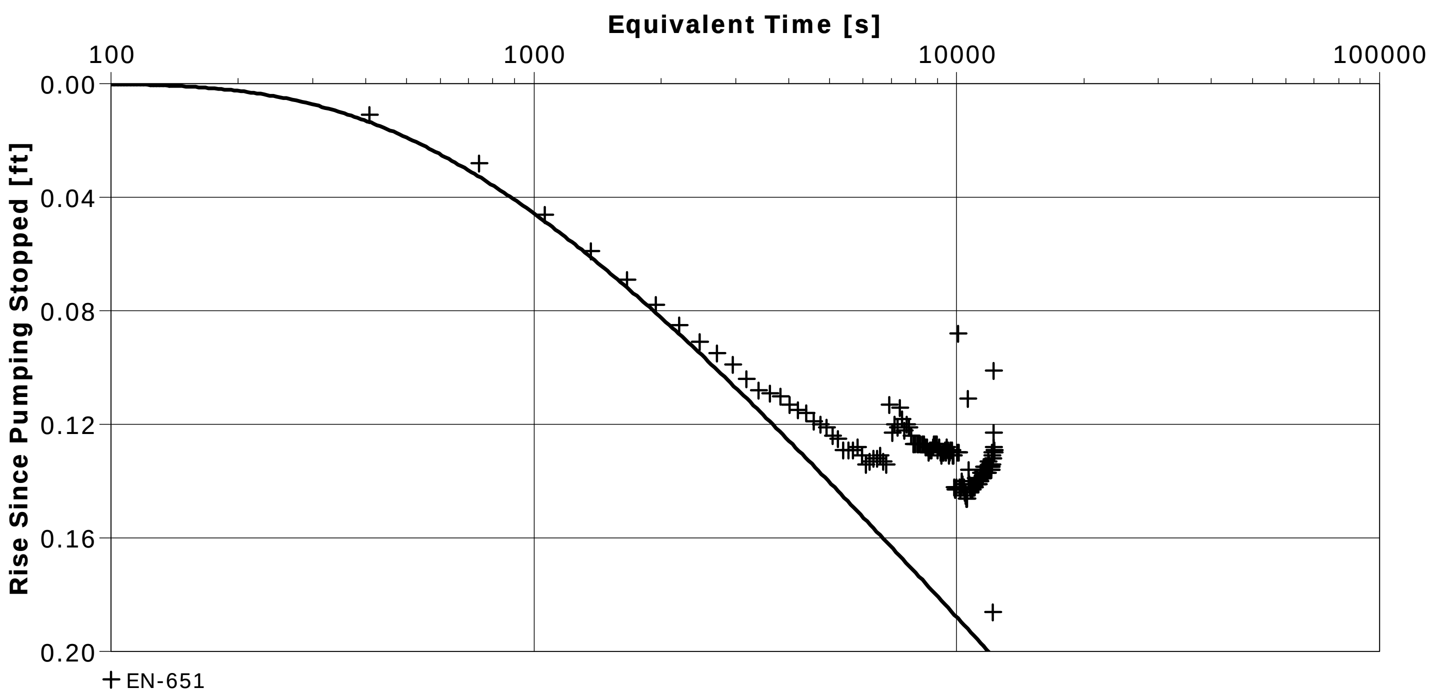


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-681	8.16×10^{1}	1.63×10^{1}	9.90×10^{-6}	274.85	

	Company Name Contact Info Address City, State/Province	**Pumping Test Analysis Report**
		Project: Building 57
		Number: 2466.02
		Client: SHA

Location: Endicott, NY	Pumping Test: WSA Start Up Monitoring	Pumping Well: EN-624
Test Conducted by: J. Prellwitz		Test Date: 4/23/2008
Analysis Performed by: P. Mouser	Recovery	Analysis Date: 9/16/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.82237 [U.S. gal/min]	

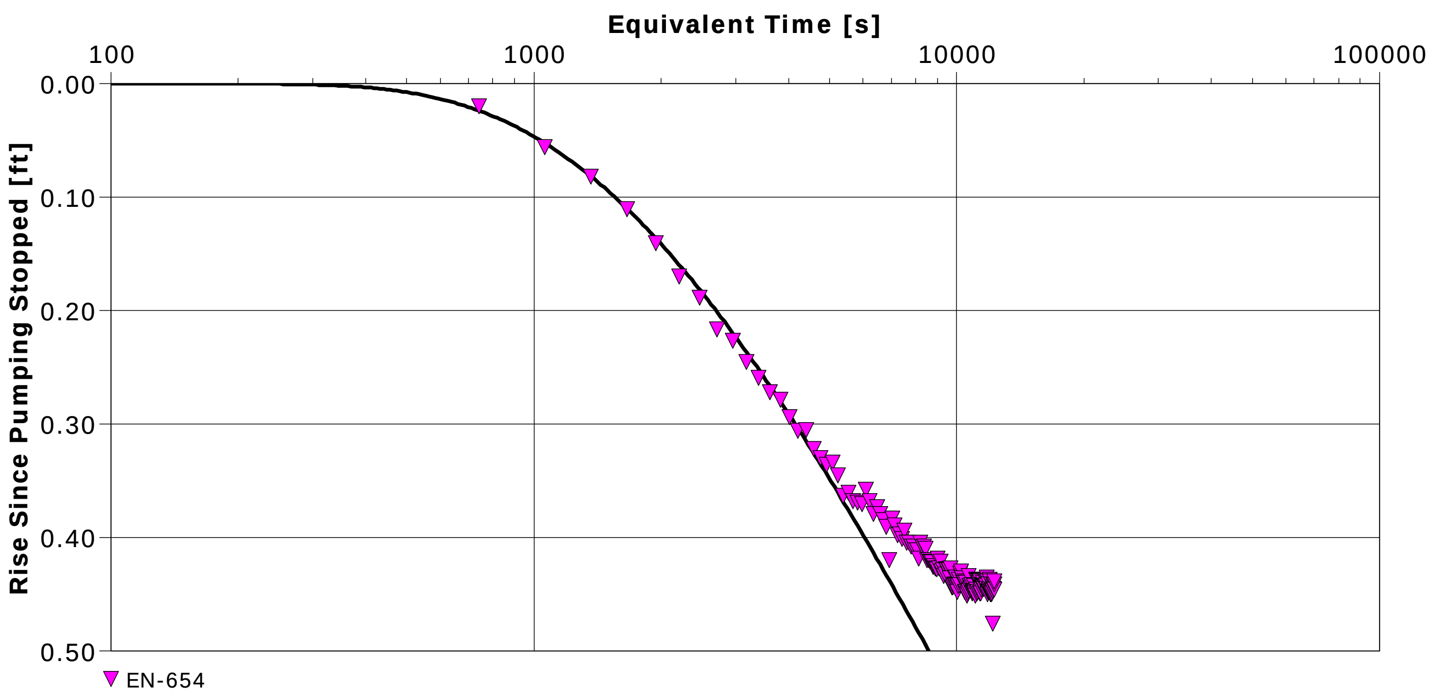


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-651	4.50×10^{2}	9.00×10^{1}	3.00×10^{-4}	176.87	

	Company Name Contact Info Address City, State/Province	**Pumping Test Analysis Report**
		Project: Building 57
		Number: 2466.02
		Client: SHA

Location: Endicott, NY	Pumping Test: WSA Start Up Monitoring	Pumping Well: EN-624
Test Conducted by: J. Prellwitz		Test Date: 4/23/2008
Analysis Performed by: P. Mouser	Recovery	Analysis Date: 9/16/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.82237 [U.S. gal/min]	

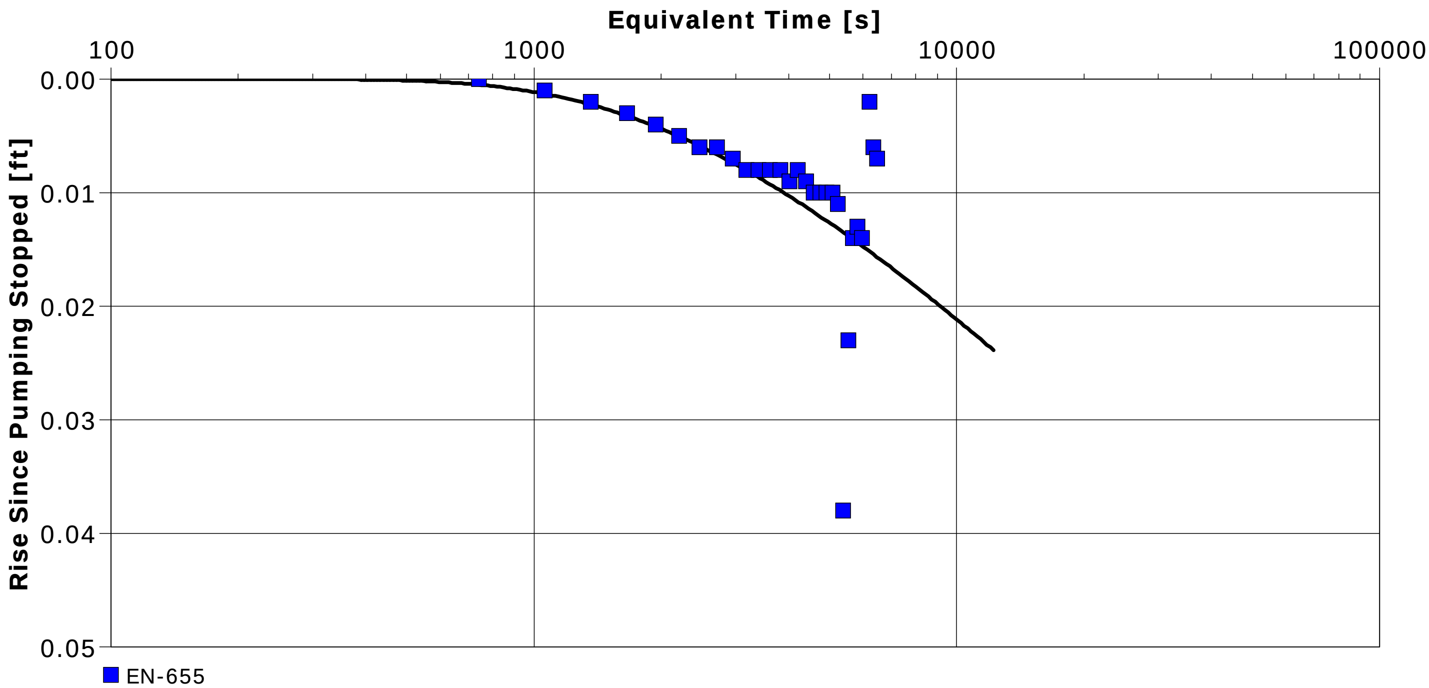


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-654	9.60×10^{1}	1.92×10^{1}	1.50×10^{-4}	196.12	

Company Name Contact Info Address City, State/Province		**Pumping Test Analysis Report**
		Project: Building 57
		Number: 2466.02
		Client: SHA

Location: Endicott, NY	Pumping Test: WSA Start Up Monitoring	Pumping Well: EN-624
Test Conducted by: J. Prellwitz		Test Date: 4/23/2008
Analysis Performed by: P. Mouser	Recovery	Analysis Date: 9/16/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.82237 [U.S. gal/min]	

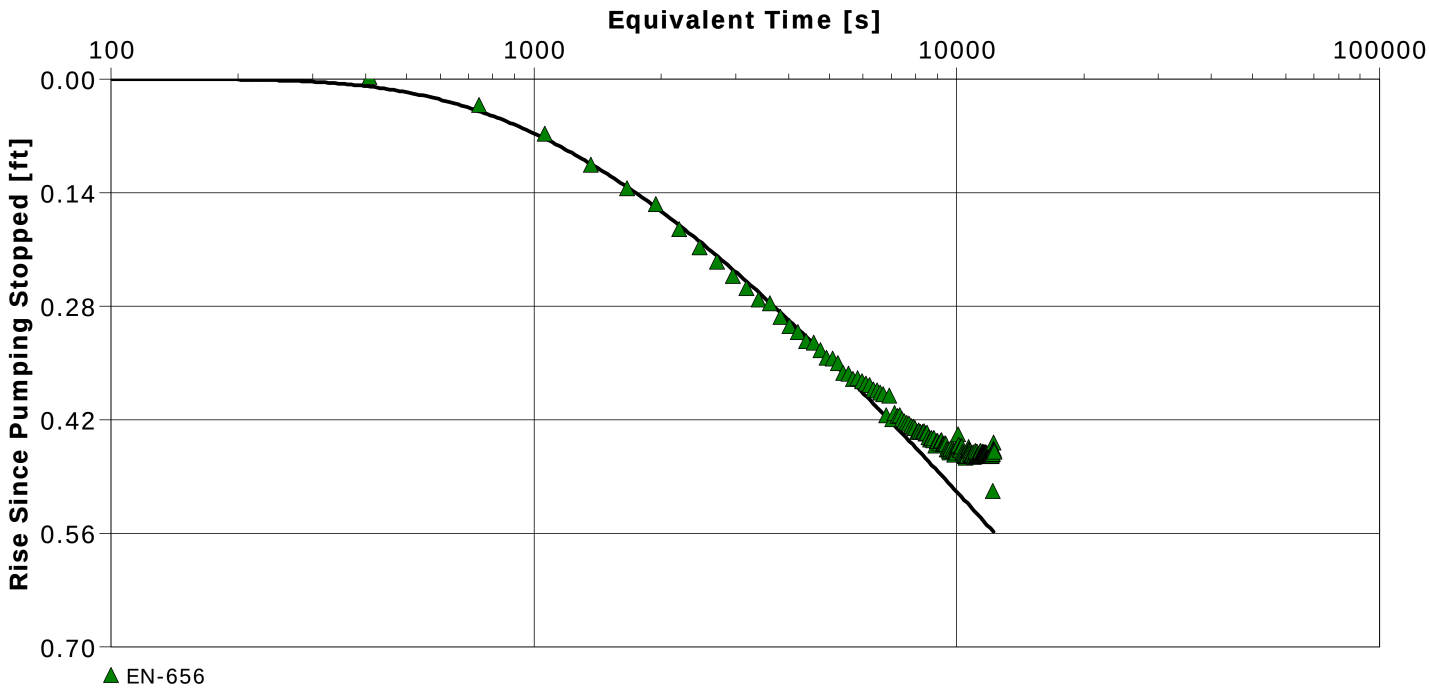


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-655	2.09×10^{3}	4.19×10^{2}	4.20×10^{-3}	199.58	

	Company Name Contact Info Address City, State/Province	Pumping Test Analysis Report Project: Building 57 Number: 2466.02 Client: SHA

Location: Endicott, NY	Pumping Test: WSA Start Up Monitoring	Pumping Well: EN-624
Test Conducted by: J. Prellwitz		Test Date: 4/23/2008
Analysis Performed by: P. Mouser	Recovery	Analysis Date: 9/16/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.82237 [U.S. gal/min]	

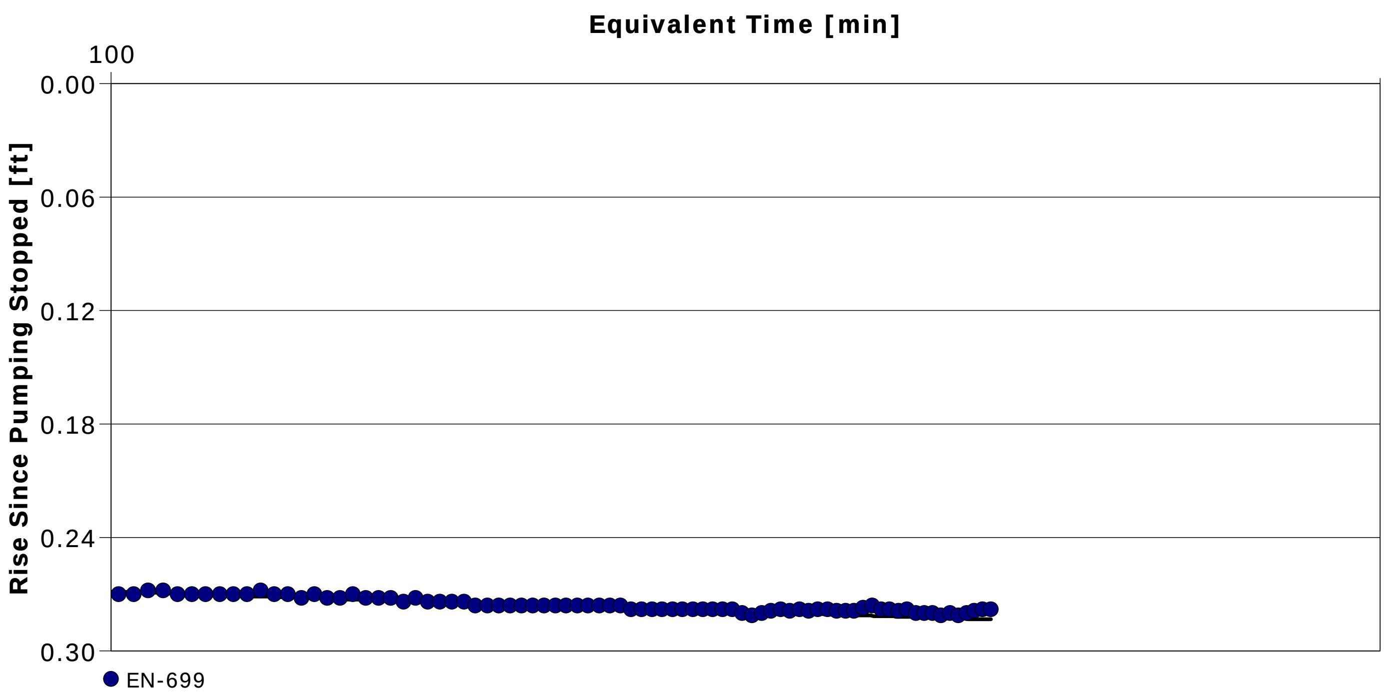


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-656	1.22×10^{2}	2.45×10^{1}	1.80×10^{-4}	170.91	

Company Name **Contact Info** **Address** **City, State/Province**		**Pumping Test Analysis Report** Project: Building 57 Number: 2466.01 Client: SHA

Location: Endicott, NY	Pumping Test: 10/2009 Shutdown Monitoring	Pumping Well: EN-623
Test Conducted by: Joel Prellwitz		Test Date: 11/16/2009
Analysis Performed by: JSP	Recovery	Analysis Date: 11/16/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.43961 [U.S. gal/min]	

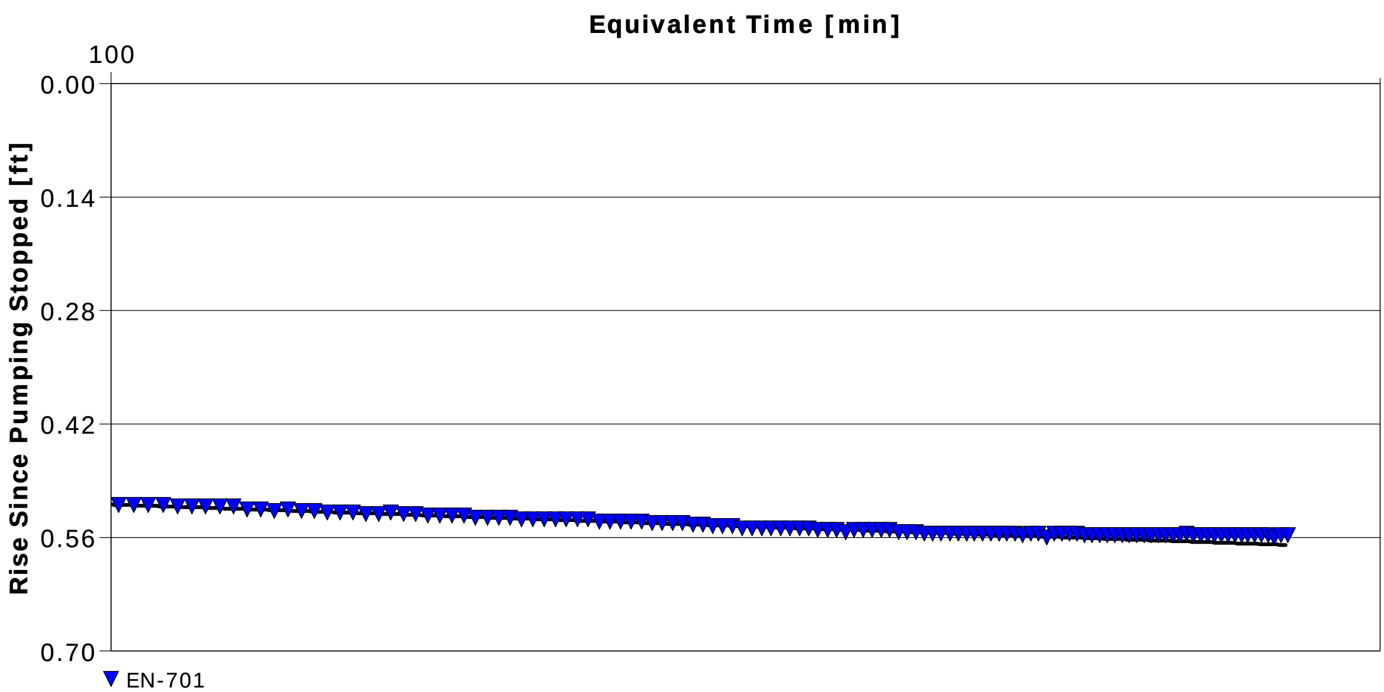


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-699	4.13×10^{2}	8.27×10^{1}	3.43×10^{-7}	174.21	

Company Name Contact Info Address City, State/Province	**Pumping Test Analysis Report**
	Project: Building 57
	Number: 2466.01
	Client: SHA

Location: Endicott, NY	Pumping Test: 10/2009 Shutdown Monitoring	Pumping Well: EN-089R
Test Conducted by: Joel Prellwitz		Test Date: 11/12/2009
Analysis Performed by: JSP	Recovery	Analysis Date: 11/16/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.17478 [U.S. gal/min]	

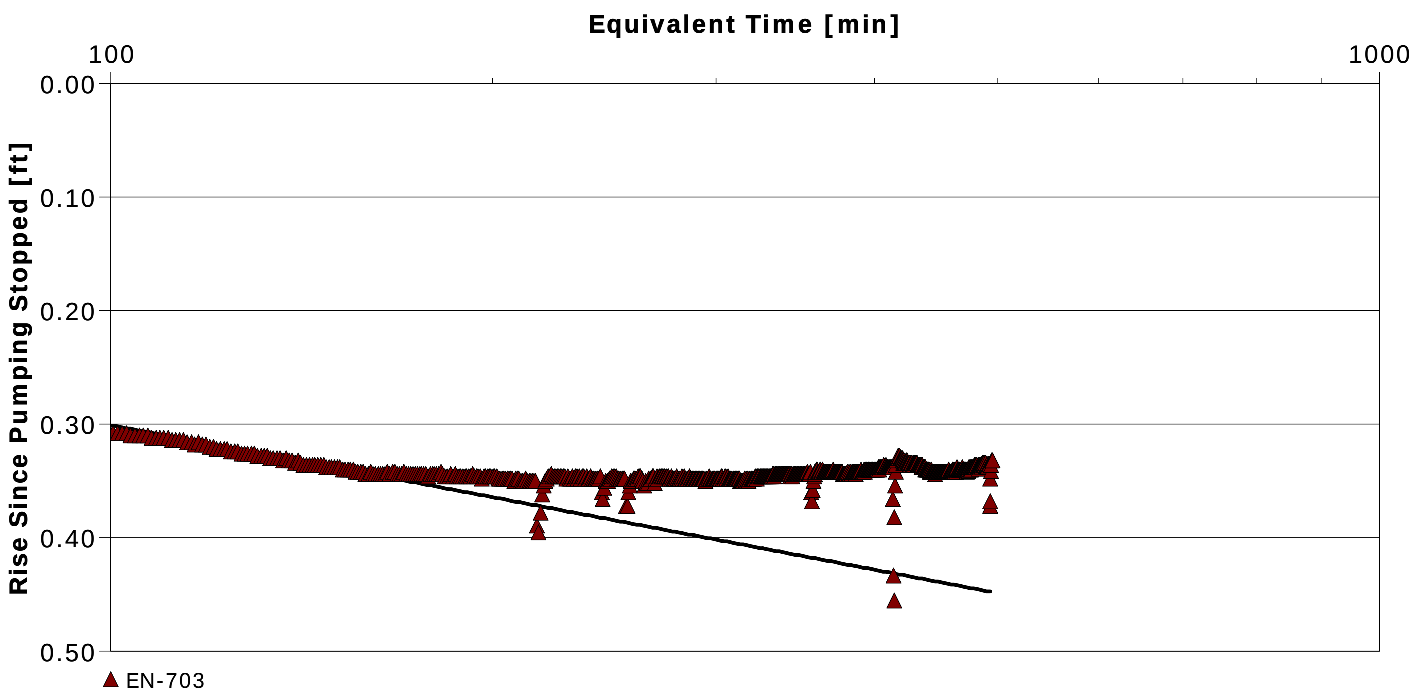


Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-701	6.50×10^{1}	1.30×10^{1}	5.30×10^{-7}	155.29	

Company Name Contact Info Address City, State/Province	**Pumping Test Analysis Report**
	Project: Building 57
	Number: 2466.01
	Client: SHA

Location: Endicott, NY	Pumping Test: 10/2009 Shutdown Monitoring	Pumping Well: EN-089R
Test Conducted by: Joel Prellwitz		Test Date: 11/12/2009
Analysis Performed by: JSP	Recovery	Analysis Date: 11/16/2009
Aquifer Thickness: 5.00 ft	Discharge: variable, average rate 0.17478 [U.S. gal/min]	



Calculation after AGARWAL + Theis

Observation Well	Transmissivity [ft²/d]	Hydraulic Conductivity [ft/d]	Storage coefficient	Radial Distance to PW [ft]	
EN-703	5.44×10^{1}	1.09×10^{1}	1.98×10^{-5}	131.07	

APPENDIX F

SHUT-DOWN MONITORING

SHPC

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APPENDIX F
SHUT-DOWN MONITORING

F.1 SUMMARY OF FIELD MONITORING PROGRAM

This appendix is intended to document groundwater monitoring that was performed in response to the shut-down and start-up of pumping from three extraction wells at the OU#5/Building 57 site. The monitoring was performed on two occasions (April 2008 and October 2009) to assess hydrogeologic conditions following the installation of new downgradient monitoring wells. The work was completed as part of the Supplemental Remedial Investigation (SRI). The work described in this appendix was performed or coordinated by Sanborn, Head & Associates, Inc. Our work and this appendix are subject to the Limitations outlined below, in the SRI report text, and in Appendix A.

The purpose of these field monitoring programs was to better assess hydrogeologic parameters in three source zones at the site, and to assess the influence of pumping on groundwater elevations in on- and off-site monitoring wells.

F.1.1 April 2008 Extraction Well Shut-down and Start-up

The April 2008 shut-down and start-up monitoring field events included the following:

1. Groundwater level monitoring by Groundwater Sciences Corporation (GSC) on April 7, 2008.

2. Groundwater level monitoring and pressure transducer deployment by SHA on April 9, 2008.

3. Shut-down of pumps in all three existing extraction wells at 06:40 a.m. on April 10, 2008.

4. Recording of groundwater levels and downloading of pressure transducer data on April 11, 2008.

5. Start-up of pumps in all three extraction wells at 09:45 a.m. on April 23, 2008.

6. Recording of groundwater levels and downloading of pressure transducer data, and removal of pressure transducers on April 25, 2008.

Eleven transducers were installed by SHA for the field program: six transducers in monitoring wells near one of three inferred source zones (Waste Solvent Area, TCA Area, and CFC Area; refer to SRI Figure 3 for source zone area references), and five transducers in off-site groundwater monitoring wells. These transducers were pre-programmed to record water level measurements every 60 seconds during the first 6 hours of the test, every 6 minutes for the next 18 hours of the test, and every 1 hour thereafter. In addition to these, pressure transducers maintained by GSC in six monitoring locations within or near the extraction wells recorded data at 60 second intervals during the shut-down and start-up pumping events. Table F.1 summarizes the water level measurements and the locations of pressure transducers deployed during the field program.

F.1.2 October 2009 Extraction Well Shut-down and Start-up

The October 2009 shut-down and start-up monitoring field events included the following:

1. Groundwater level monitoring by SHA on October 19, 2009.

2. Groundwater level monitoring and pressure transducer deployment by SHA on October 23, 2009.

3. Shut-down of pumps in all three groundwater extraction wells began at 11:25 a.m. on October 26, 2009.

4. Recording of groundwater levels by GSC on October 29, 2009.

5. Start-up of pumps in all three extraction wells at 11:27 a.m. on October 30, 2009.

6. Downloading and removal of pressure transducers on November 4, 2009.

Eight transducers were installed by SHA for the field program: two transducers in monitoring wells near EN-89R, and six in monitoring wells south of the site (off-site) or in Lot 26. Transducers were programmed to record water level measurements every 60 seconds throughout the field program. In addition to these, pressure transducers installed by GSC in six monitoring locations within or near the extraction wells recorded data on 60 second intervals during the pumping shut-down and start-up events. Table F.2 summarizes the water level measurements and the locations of pressure transducers deployed during the field program.

F.2 OBSERVED DRAWDOWN AND RECOVERY

Drawdown and recovery curves in response to the April 2008 and October 2009 pumping shut-down and start-up events are shown on Figures F.1 through F.4. No response to shut-down or start-up was observed in several wells (EN-604 and EN-622 in 2008; EN-695, -697, and -699 in 2009); therefore, data from these wells are not included in the drawdown and recovery curves. In several cases, background "noise" in the transducer data obscured clear results. Data from these tests (EN-610 and EN-612 in the 2008 drawdown curves; EN-089A, EN-610, and EN-612 in 2009) were not included. The inability to collect information from these monitoring points did not affect our conclusions or assessment related to hydraulic capture.

F.3 GROUNDWATER ELEVATIONS UNDER AMBIENT AND PUMPING CONDITIONS

Water level responses to shut-down and start-up of extraction from OU#5 wells are provided in Tables F.1 and F.2.

Groundwater elevation contours were developed to assess groundwater flow directions during ambient, non-pumping conditions (Figure F.5). These contours were used to assess potential groundwater migration pathways from identified source zones prior to implementing hydraulic containment, as discussed in the SRI text. The source zones are identified in the SRI text and on Figure 3. As indicated on Figure F.5, groundwater flow in the lower water bearing zone is toward the south to southwest from the CFC Area and south-southeast from the TCA and Waste Solvent Areas. Additional characterization to the east of the Waste Solvent Area is ongoing and future assessments of this area will be documented in a supplement to this report.

Under pumping conditions, groundwater contours indicate that the general direction of groundwater flow is toward the south-southeast below Building 57, and toward the south for locations south of Building 57. A cone of depression is apparent around each of the extraction wells (Figure F.6). From testing in 2009, including monitoring in newly-installed off-site wells, the inferred capture zone extends approximately 150 feet south of Building 57 near the TCA and Waste Solvent Areas, and approximately 50 feet south of the CFC Area (Figure F.6). As shown on Figures F.1 through F.4, effects of pumping have been observed beyond this inferred capture zone (i.e., in wells EN-651, -654 and -655, -681, -701, and -703), which was derived from inferred water level elevation contours.

TABLES

FIGURES

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TABLES

Table F.1 – Summary of Water Level Measurement Fluctuations, April 2008

Table F.2 – Summary of Water Level Measurement Fluctuations, October 2009

Table F.1
Summary of Water Level Measurements, April 2008
OU#5/Building 57 Area
Supplemental Remedial Investigation
Union and Endicott, New York

	Monitoring Well I.D.	Reference Elevation (ft amsl)	4/7/2008		4/11/2008		Rise in Water Level (ft)	4/25/2008		Rise in Water Level (ft)	Location
			Pre-Shutdown Depth to Water (ft)	Pre-Shutdown Groundwater Elevation (ft amsl)	Ambient Conditions Depth to Water (ft)	Ambient Conditions Groundwater Elevation (ft amsl)		Post Start-up Depth to Water (ft)	Post-Start-up Groundwater Elevation (ft amsl)		
Off-site	DEC-MW-034D	843.49	9.63	833.86	8.75	834.74	0.88	9.55	833.94	-0.80	E.R.G. property
	EN-651	845.27	10.56	834.71	10.61	834.66	-0.05	11.13	834.14	-0.52	Gault Chevrolet property
	EN-654	839.25	4.71	834.54	4.61	834.64	0.1	5.07	834.18	-0.46	Harding Avenue
	EN-655	839.28	4.29	834.99	4.54	834.74	-0.25	5.1	834.18	-0.56	Harding Avenue
	EN-656	844.9	10.64	834.26	10.33	834.57	0.31	11.25	833.65	-0.92	Gault Chevrolet property
On-site	EN-089A	841.91	5.86	836.05	4.92	836.99	0.94	7.08	834.83	-2.2	CFC-113 Area
	EN-089R	845.3	17.18	828.12	8.06	837.24	9.12	14.92	830.38	-6.9	CFC-113 Area
	EN-610	845.48	12.16	833.32	10.61	834.87	1.55	18.90	826.58	-8.3	TCA Area
	EN-612	846.15	15.51	830.64	11.46	834.69	4.05	15.36	830.79	-3.9	Waste Solvent Area
	EN-616	843.98	10.41	833.57	9.04	834.94	1.37	10.45	833.53	-1.4	North of EN-624
	EN-622	845.66	Dry	--	6.86	838.8	--	Dry	--	--	Waste Solvent Area
	EN-623	847.97	18.52	829.45	12.99	834.98	5.53	16.96	831.01	-4.0	TCA Area
	EN-624	849.01	20.09	828.92	14.34	834.67	5.75	18.80	830.21	-4.5	Waste Solvent Area
	EN-632	842.67	6.79	835.88	6.76	835.91	0.03	7.33	835.34	-0.57	West of EN-623
	EN-660	846.39	8.89	837.5	8.77	837.62	0.12	9.55	836.84	-0.78	CFC-113 Area
	EN-666	846.5	10.73	835.77	10.4	836.1	0.33	10.73	835.77	-0.33	Building 57A Area
	EN-674	844.69	10.64	834.05	9.11	835.58	1.53	11.16	833.53	-2.0	Northwest of EN-623

Notes:
- SHA deployed transducers in 11 monitoring wells (DEC-MW-34D, EN-616, EN-622, EN-632, EN-651, EN-654, EN-655, EN-656, EN-660, EN-666, and EN-674) on April 9, 2008.
- Groundwater Sciences Corporation (GSC) deployed transducers in 3 monitoring wells (EN-89A, EN-610, and EN-612) adjacent to the groundwater extraction wells (EN-89R, EN-623, and EN-624, respectively) prior to shutdown.
- Transducer measurements were adjusted to feet above mean sea level (ft AMSL) based on manual water level measurements and the measured deployment depth of the transducer within the well.
- Water level measurements on 4/7/2008 were performed by GSC.
- Water level measurements during ambient conditions and after extraction well start-up were performed by SHA on 4/11/2008 and 4/25/2008 by GSC on 4/15/2008 and 4/25/2008.

Table F.2
Summary of Water Level Measurements, October 2009
OU#5/Building 57 Area
Supplemental Remedial Investigation Report
Union and Endicott, New York

Monitoring Well I.D.		Reference Elevation (ft amsl)	10/26/2009		10/29/2009		Rise in Water Level (ft)	10/31/2009		Rise in Water Level (ft)	Location
			Pre-Shutdown Depth to Water (ft)	Pre-Shutdown Groundwater Elevation (ft amsl)	Ambient Conditions Depth to Water (ft)	Ambient Conditions Groundwater Elevation (ft amsl)		Post Start-up Depth to Water (ft)	Post Start-up Groundwater Elevation (ft amsl)		
Off-site	EN-681	841.22	9.43	831.79	4.97	836.25	4.46	8.88	832.34	-3.91	Hayes Avenue Parking Area/Southwest of EN-089R
	EN-695	838.14	2.18	835.96	1.62	836.52	0.56	2.03	836.11	-0.41	Southeast of EN-624
	EN-697	845.63	10.23	835.4	7.51	838.12	2.72	9.96	835.67	-2.45	South of EN-623
	EN-699	849.05	12.39	836.66	11.35	837.7	1.04	11.82	837.23	-0.47	Southeast of EN-089R/Southwest of EN-623
	EN-701	847.23	12.41	834.82	11.33	835.9	1.08	11.61	835.62	-0.28	Southeast of EN-089R
	EN-703	841.21	7.06	834.15	6.02	835.19	1.04	6.53	834.68	-0.51	South of EN-089R
On-site	EN-089A	841.91	6.69	835.22	4.6	837.31	2.09	6.50	835.41	-1.9	CFC-113 Area
	EN-089R	845.3	15.85	829.45	7.78	837.52	8.07	15.16	830.14	-7.38	CFC-113 Area
	EN-610	845.48	11.82	833.66	8.68	836.8	3.14	15.33	830.15	-6.65	TCA Area
	EN-612	846.15	16.25	829.9	9.97	836.18	6.28	15.28	830.87	-5.31	Waste Solvent Area
	EN-623	847.97	14.27	833.7	11	836.97	3.27	14.73	833.24	-3.73	TCA Area
	EN-624	849.01	19.53	829.48	12.64	836.37	6.89	19.49	829.52	-6.85	Waste Solvent Area
	EN-688	842.11	5.47	836.64	4.97	837.14	0.5	4.33	837.78	0.64	CFC-113 Area
	EN-690	842.1	6.16	835.94	4.63	837.47	1.53	5.17	836.93	-0.54	CFC-113 Area

Notes:
- SHA deployed transducers in 8 monitoring wells (EN-681, EN-688, EN-690, EN-695, EN-697, EN-699, EN-701, and EN-703) on October 23, 2009.
- Groundwater Sciences Corporation (GSC) deployed transducers in 3 monitoring wells (EN-89A, EN-610, and EN-612) adjacent to the groundwater extraction wells (EN-89R, EN-623, and EN-624, respectively) prior to shutdown.
- Transducer measurements were adjusted to feet above mean sea level (ft AMSL) based on manual water level measurements and the measured deployment depth of the transducer within the well.
- Water level measurements pre-shutdown are from transducer measurements at 00:00 10/26/2009.
- Water level measurements during ambient conditions were collected the morning of 10/29/2009.
- Water level measurements post-startup are from transducer measurements at 05:00 10/31/2009.
- EN-610 pre-shutdown reading taken at 8 am 10/26/2009.

FIGURES

Figure F.1
Observed Recovery - Response to Shut-down, April, 2008
OU#5, Union and Endicott, New York

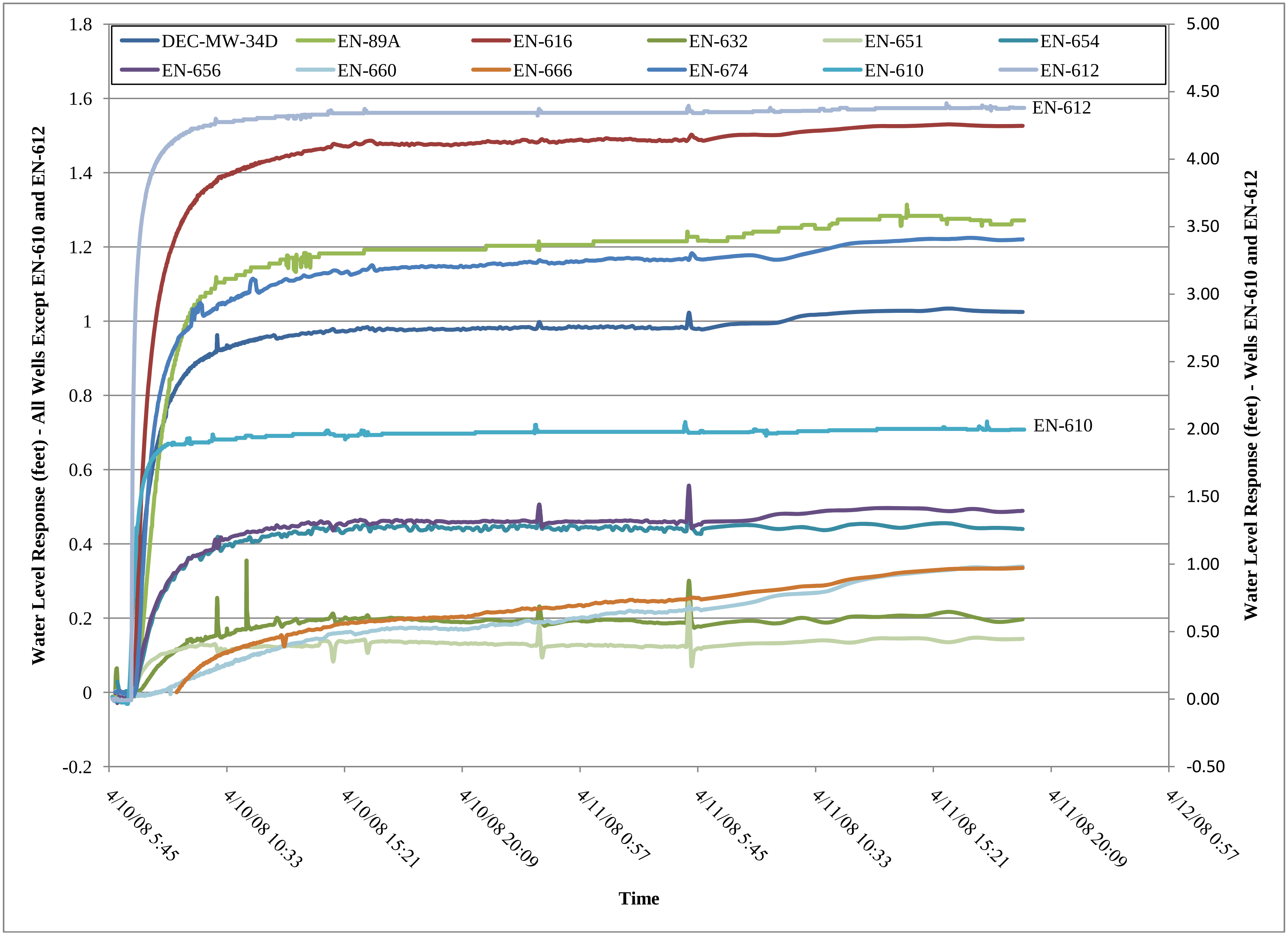


Figure F.2
Observed Drawdown - Response to Start-up, April, 2008
OU#5, Union and Endicott, New York

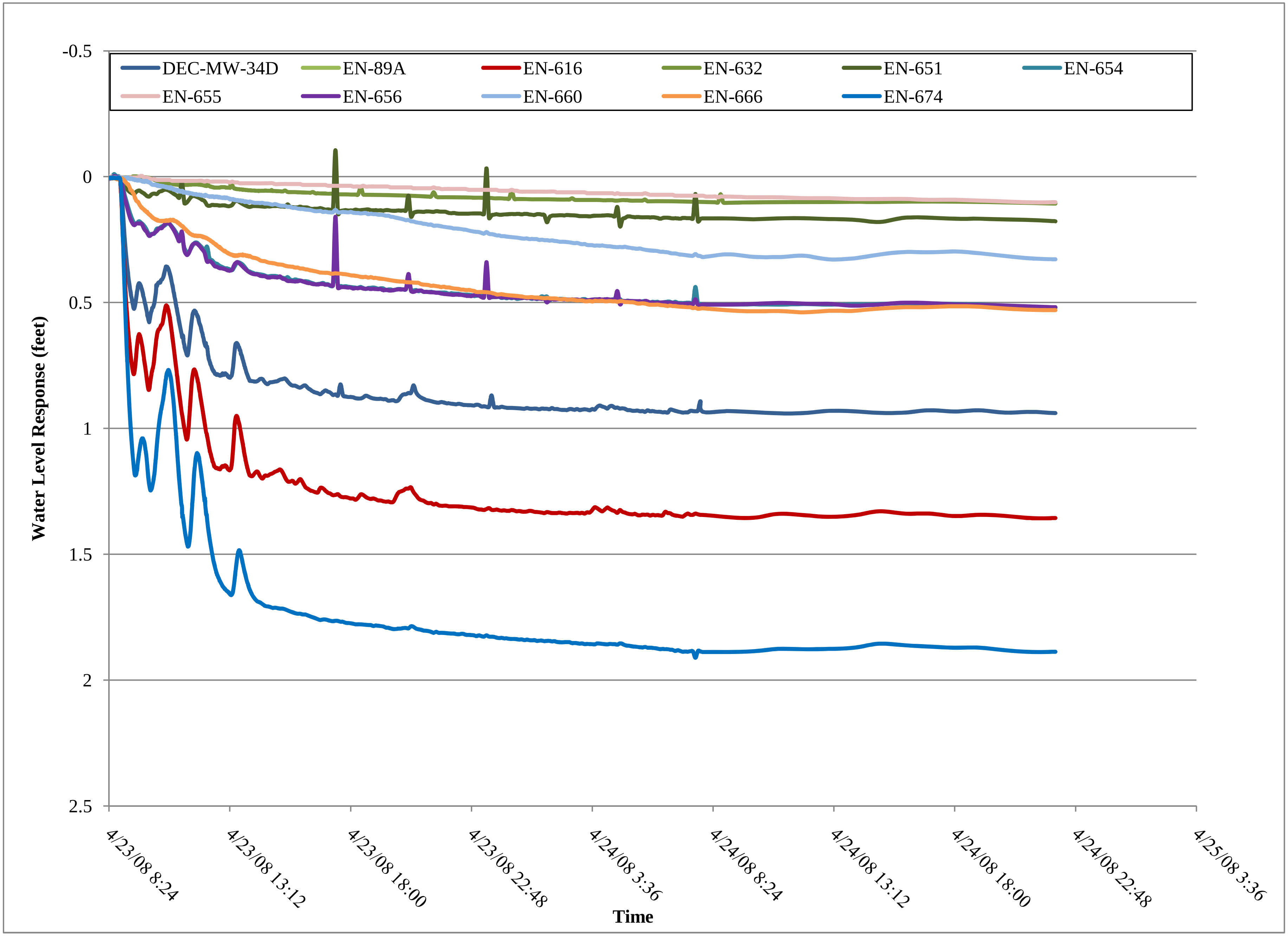


Figure F.3
Observed Recovery - Response to Stut-down, October, 2009
OU#5, Union and Endicott, New York

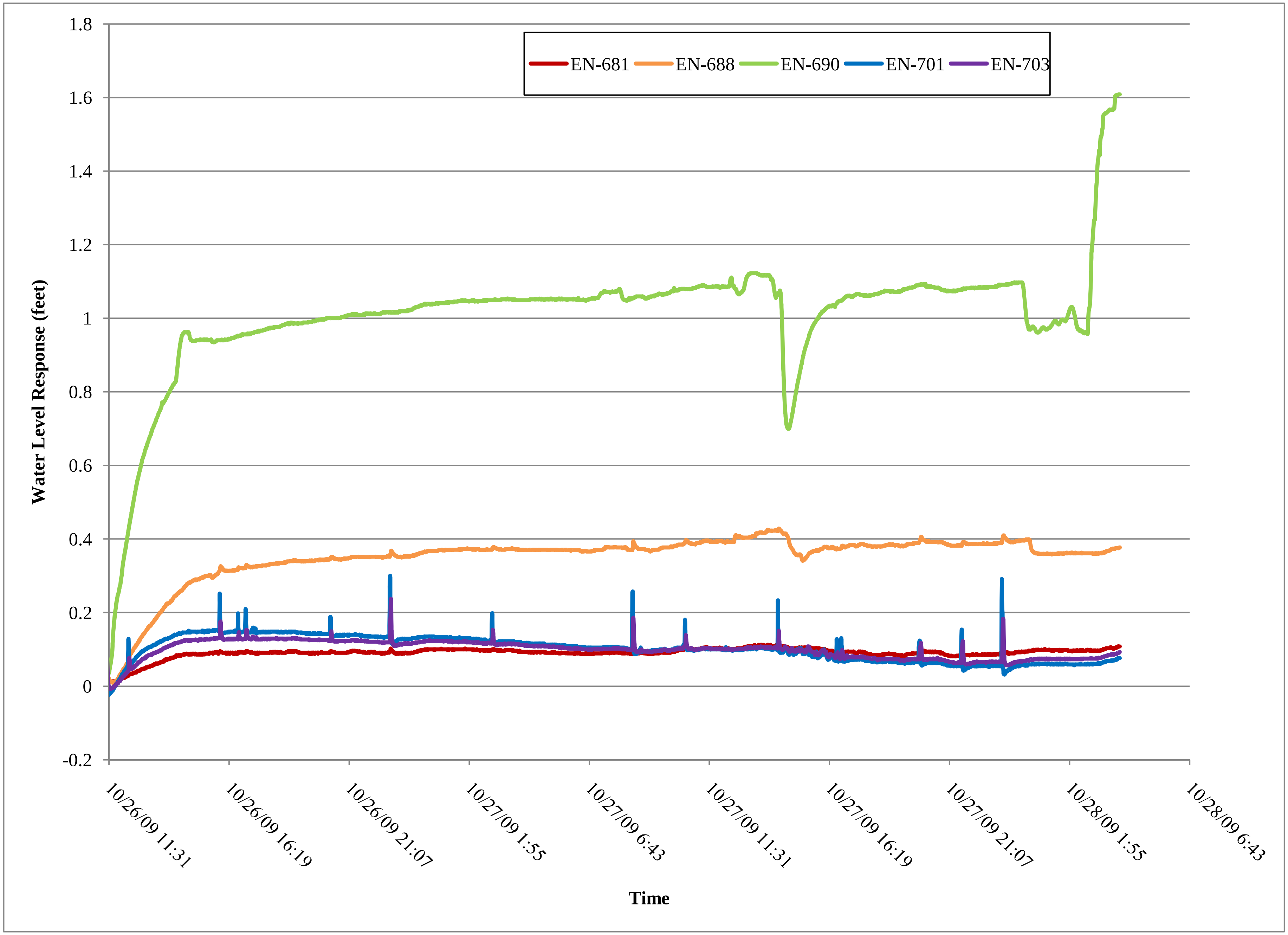
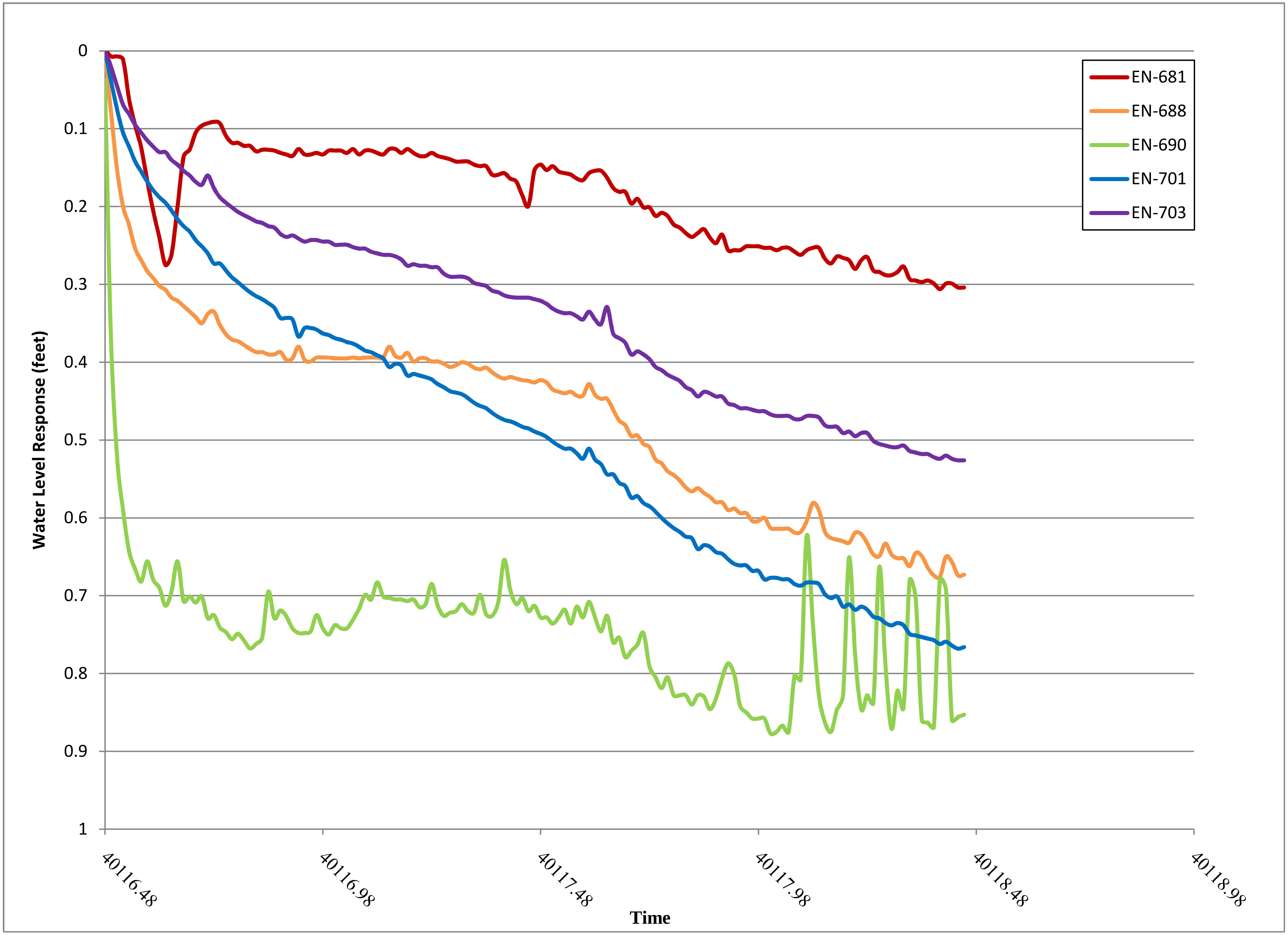


Figure F.4
Observed Drawdown - Response to Start-up, October, 2009
OU#5, Union and Endicott, New York



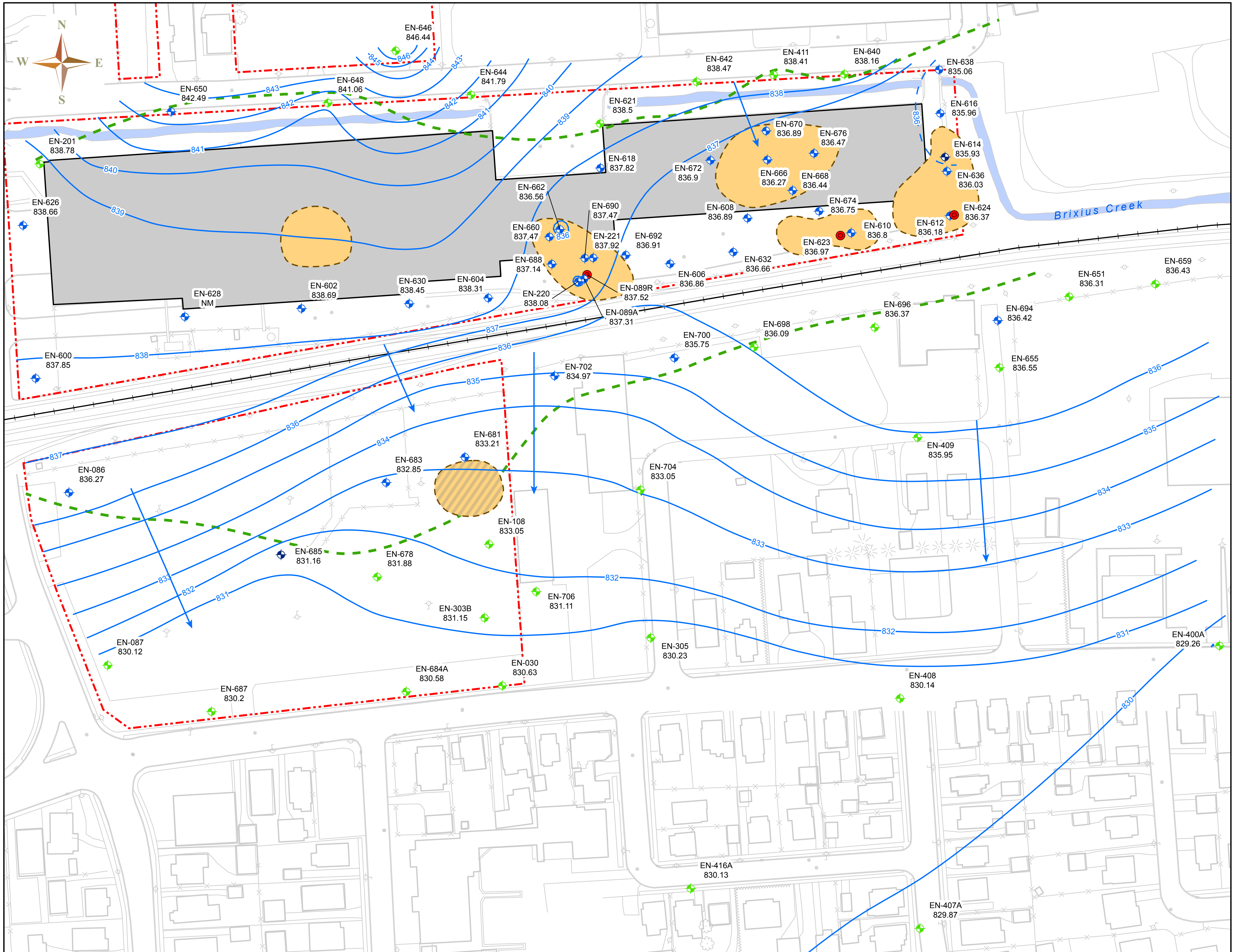


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Figure F.5

Lower Water-Bearing Zone Groundwater Contours, Ambient Conditions

Supplemental Remedial Investigation Report OU#5 / Building 57 Area

Endicott and Union, NY

Drawn By: J. Pierce
Designed By: S. Warner
Reviewed By: J. Ordway
Date: March 2010

Figure Narrative:

This figure shows groundwater elevation contours inferred from water level measurements from selected lower water-bearing zone (WBZ) monitoring wells. Groundwater levels were measured under inferred ambient (e.g., non-pumping) conditions on October 29, 2009.

The contours were developed using generally accepted hydrogeologic practices, involving interpolation between monitoring wells. Fluctuations in water levels and groundwater flow directions are likely to occur due to seasonal trends and climatic events. Other interpretations are possible.

Legend

- Lower WBZ Monitoring Well
- Groundwater Extraction Well
- Monitoring Well
- Deep Monitoring Well
- Extent of Site Silt and Clay Aquitard
- 833 — Lower WBZ Potentiometric Surface Elevation based on Ambient Conditions from October 29, 2009 (ft amsl)
- Inferred Groundwater Flow Direction
- Site Boundary

60 30 0 60 120 180 Feet

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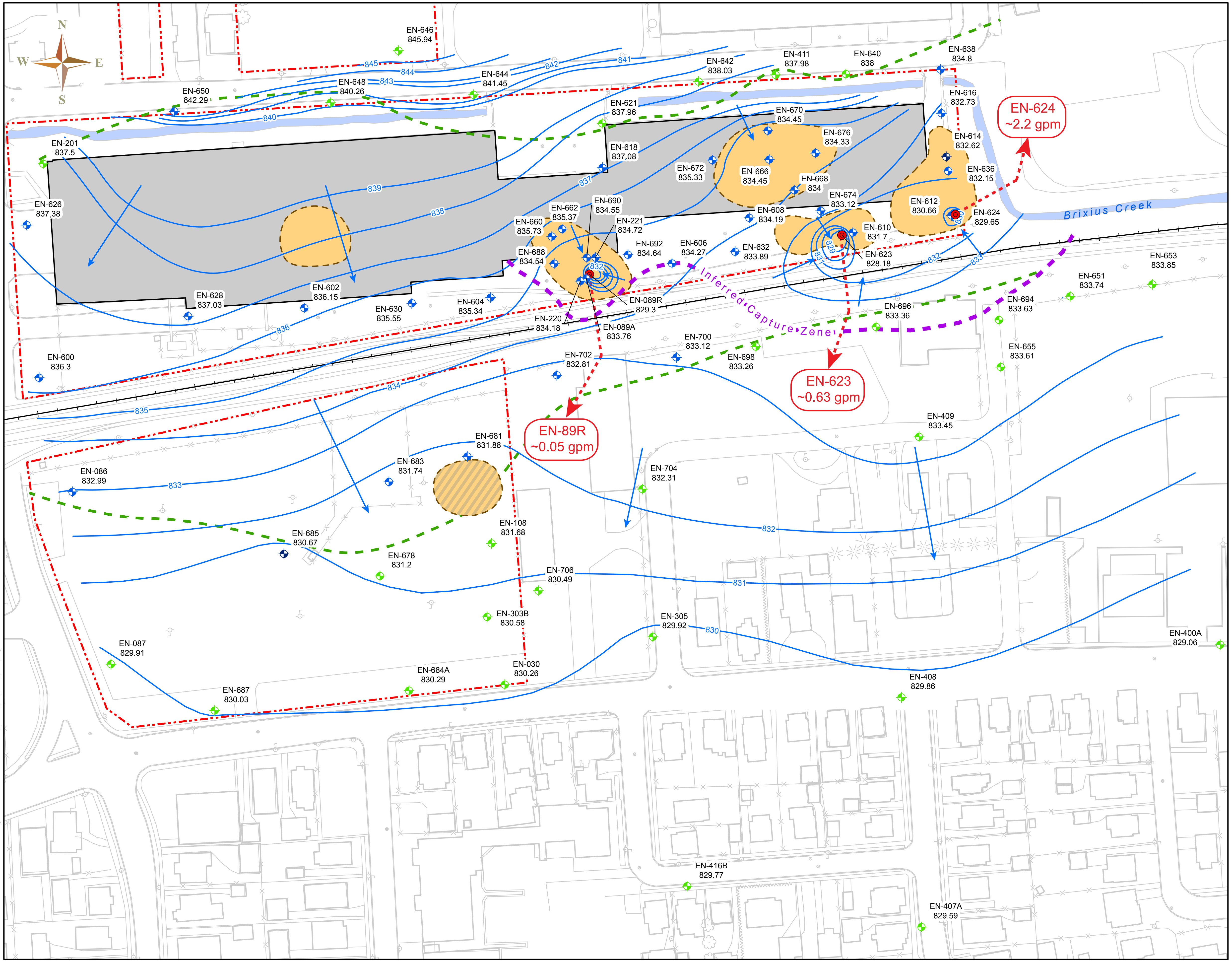

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Figure F.6

Lower Water-Bearing Zone Groundwater Contours, Pumping Conditions

Supplemental Remedial Investigation Report
OU#5 / Building 57 Area

Endicott and Union, NY

Drawn By: J. Pierce
Designed By: J. Pierce
Reviewed By: J. Ordway
Date: March 2010

Figure Narrative:

This figure shows groundwater elevation contours inferred from water level measurements from selected lower water-bearing zone (WBZ) monitoring wells. Groundwater levels were measured under pumping conditions in October 2009. Groundwater extraction rates were calculated by averaging hourly transducer readings on October 19.

The extents of hydraulic containment were inferred using water level measurements and the results of monitoring during recent shut-down and re-starting of pumping from the OU#5-area extraction wells. Refer to the SRI report and appendices for further information.

The contours were developed using generally accepted hydrogeologic practices, involving interpolation between monitoring wells. Fluctuations in water levels and groundwater flow directions are likely to occur due to seasonal trends and climatic events. Other interpretations are possible.

Legend

EN-623 ~0.63 gpm — Groundwater extraction rate in gallons per minute (gpm)

Extent of Site Silt and Clay Aquitard

833 — Lower WBZ Potentiometric Surface Elevation based on Pumping Conditions from October 19th & 20th, 2009 (ft amsl)

Inferred Groundwater Flow Direction

Inferred Capture Zone

Site Boundary

60 30 0 60 120 180 Feet

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APPENDIX G

SUMMARY OF NON-VOC ANALYSES

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APPENDIX G
SUMMARY OF NON-VOC ANALYSES

G.1 INTRODUCTION

Based on initial investigation findings, volatile organic compounds (VOCs) were the primary focus of the Supplemental Remedial Investigation (SRI). However, sampling and analysis of soil and groundwater samples was also performed for non-VOC contaminants in accordance with the standard of practice for remedial investigations. This Appendix includes a summary of sampling and analysis of semi-volatile organic compounds (SVOCs), total petroleum hydrocarbons (TPH), and metals in soil and groundwater across the site. The work described in this appendix, which was performed or coordinated by Sanborn, Head and Associates, Inc. (SHA), was completed in general accordance with our approved SRI Work Plan[1]. Our work and this appendix are subject to the limitations outlined in the text to follow and summarized in Appendix A of this report.

G.2 SAMPLING METHODS AND SCOPE

Soil samples were collected during soil boring investigations and installation of groundwater monitoring wells from the five different inferred source zones within the Building 57/57A property. The soil samples were generally collected from one or more soil strata (e.g., Fill, Silt & Clay Aquitard, etc.). Soil samples were selected for laboratory analysis based on observed conditions in the boring and geographic coverage. Groundwater samples were collected for laboratory analysis from primarily lower WBZ wells, selected based on representation across the site source zones and on results of soil laboratory analyses.

Samples collected for semi-volatile organic compounds were analyzed using EPA method 8270C, which tests for 64 semi-volatiles that belong to one of several classes of aromatic or poly aromatic hydrocarbons (PAH), solvents, or pesticide compounds. Analysis of samples for petroleum hydrocarbons included diesel range organics (DRO) and gasoline range organics (GRO) using EPA method 8015B. Detailed analysis of TPH by compound speciation for seven petroleum hydrocarbons was conducted using New York State Department of Health (NYSDOH) method 310-13. Metals analyses included the 23 EPA-identified target analyte list (TAL) compounds using method 8010B.

Soil

Table G.1 shows the number and location of soil samples collected for analysis for SVOCs, metals, and/or TPH. In summary, fifteen soil samples from 11 boring locations within the five inferred source zones were collected for SVOC analysis between February and May 2007.

[1] Sanborn Head & Associates, Inc., September 9, 2004, "Work Plan for Source Area Evaluation, Supplemental Remedial Investigation and Focused Feasibility Study, Operable Unit #5 – Building 57 Area, Union and Endicott, New York", and approved by the NYSDEC in a letter dated December 13, 2004.

Analysis of TAL metals was conducted for 15 samples from the different inferred source areas and soil strata. Soil samples from 16 locations across the site were analyzed for GRO and DRO.

Site investigation activities conducted during January 2008 included hydrocarbon speciation analysis for 109 soil samples from several soil strata and source areas. Chemical speciation analysis was conducted for seven common petroleum classes, as indicated in the laboratory reports, and reported in the analytical summary report.

Table G.1 Summary of soil samples collected for non-VOC analysis, including SVOCs, TPH, and TAL metals.

Source Zone	Soil Stratum	SVOCs	TPH	TPH Speciation	Metals
Building 57 Area	Fill	1	1	5	1
	Silt & Clay	1	1	2	1
Building 57A Area	Fill	1	1	15	1
	Silt & Clay	2	2	11	2
	Clayey Sand			7	
	Till			7	
	Bedrock			1	
CFC Area	Fill	1	1	4	1
	Silt & Clay	1	1	3	1
	Gravel w/Silt Clay Inclusion			1	
	Till	1	1	4	1
TCA Area	Fill	2	2	9	2
	Silt & Clay	1	1	11	1
	Till			7	
Waste Solvent Area	Fill	2	2	7	2
	Peat			1	
	Clay & Silt	2	2	5	2
	Silt & Clay			6	
	Gravel			2	
	Bedrock			1	
Lot 26	Sand & Gravel		1		
Total Number of Samples (excluding QA/QC samples)		**15**	**16**	**109**	**15**

Groundwater

A summary of groundwater samples collected and analyzed for SVOCs, TPH, and metals is provided in Table G.2.

Table G.2 Summary of groundwater samples collected for non-VOC analysis, including SVOCs, TPH, and trace and heavy metals.

Location ID	Source Zone	Water Bearing Zone	SVOCs	TPH	Metals
EN-663	Building 57 Area	Upper	X		X
EN-666	Building 57A Area	Lower	X	X	X
EN-668		Lower		X	X
EN-670		Lower		X	X
EN-604	CFC Area	Lower			X
EN-606		Lower			X
EN-662		Lower	X		X
EN-608	TCA Area	Lower			X
EN-610		Lower		X	X
EN-623		Lower		X	X
EN-674		Lower		X	X
EN-612	Waste Solvent Area	Lower		X	X
EN-616		Lower			X
EN-624		Lower		X	X
EN-636		Lower		X	X
EN-632	Other	Lower			X
Total Number of Locations			3	9	16

Analytical Data

Analytical data for non-VOC analytes described in this Appendix were submitted in Analytical Summary Reports (ASRs) throughout SRI activities. All SRI analytical data can be found in Appendix B. The locations of soil borings and groundwater sampling locations are shown on Figure 4 of the SRI. Please see the SRI text and appendices for further information and discussion.

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APPENDIX H

VOC CONTENT IN SOILS

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APPENDIX H
VOC CONTENT IN SOILS

Over the course of Supplemental Remedial Investigation (SRI) activities at OU#5, soil samples were collected from multiple locations typically targeting identified source zones and submitted for laboratory analysis of volatile organic compounds (VOCs). Within the five on-site source zones (refer to the SRI report text and Figure 3 for information and area references), SHPC created plots of detected VOC concentrations vs. depth to facilitate assessment of the subsurface distribution of VOCs (See Figures H.1 through H.15). Soil sampling was performed by Sanborn, Head and Associates, Inc. (SHA) in general accordance with our approved SRI Work Plan[1]. Our work and this appendix are subject to the Limitations outlined in the text to follow and summarized in Appendix A of the report. All analytical data have been reported to the Agencies in Analytical Summary Reports. Please reference the report text for more information.

The five source zones were determined based upon the highest soil analytical results, and source zone boundaries were inferred from soil and soil gas sample VOC concentrations. Samples were collected during multiple field mobilizations from 2005 to 2009. Refer to Appendix B of this report for a summary of the data collection activities.

FIGURES

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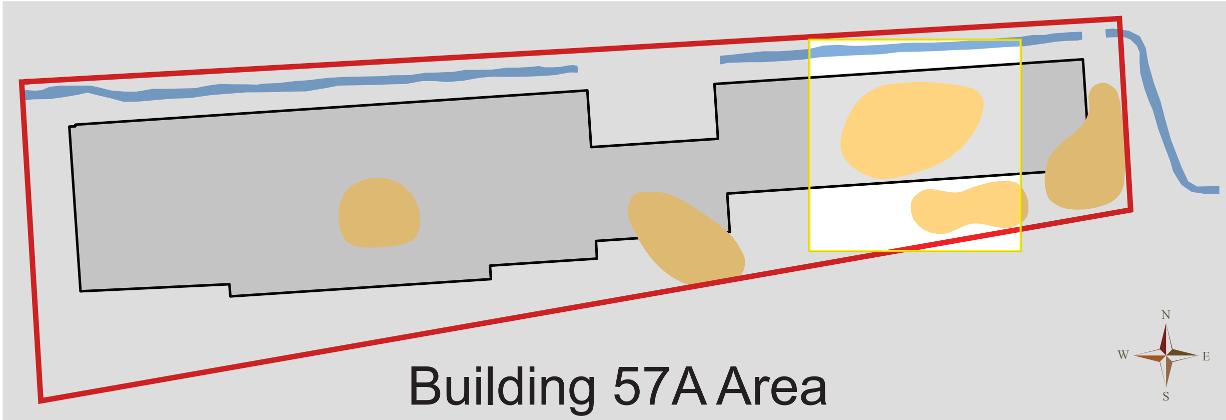
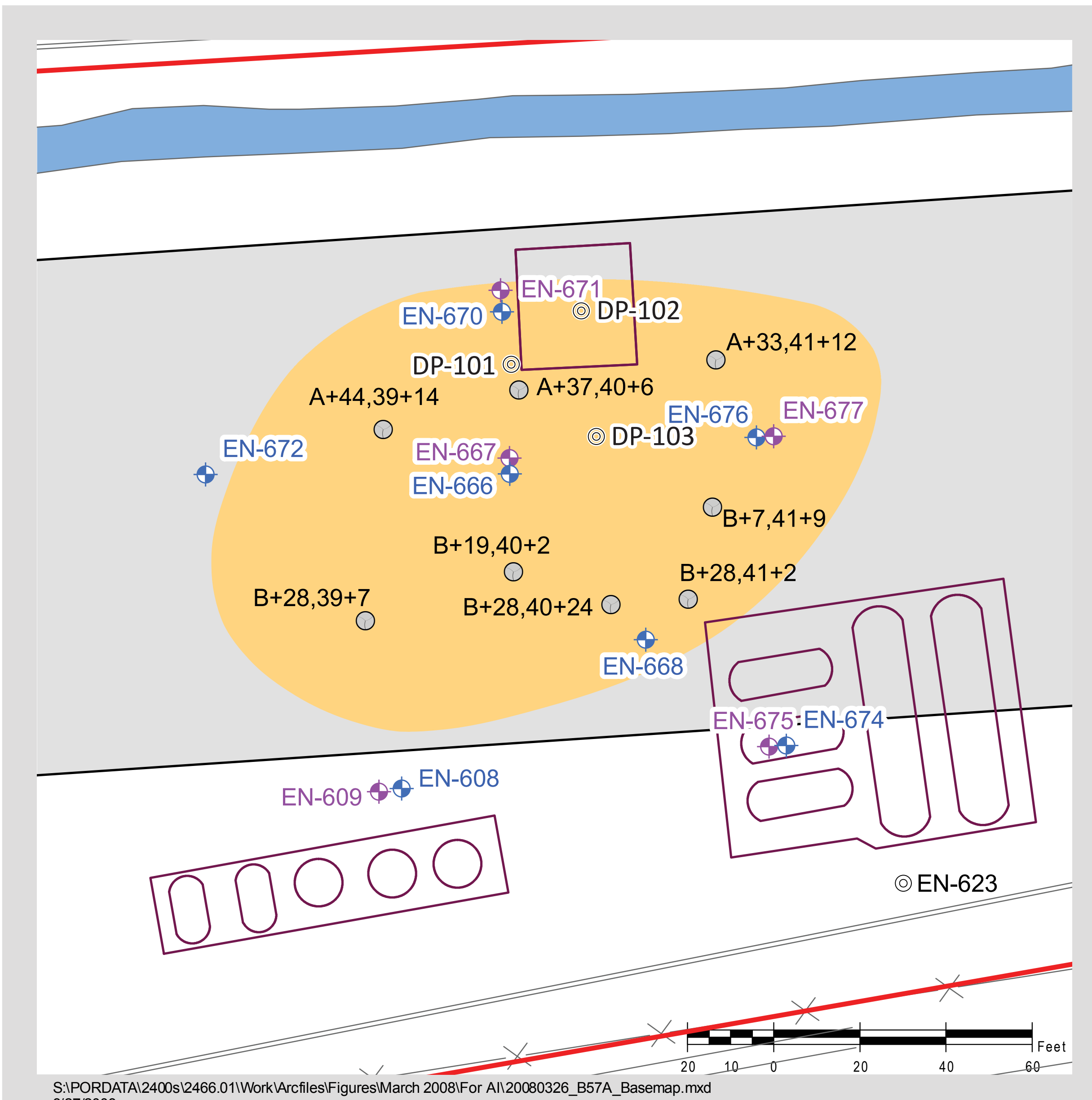
[1] Sanborn Head & Associates, Inc., September 9, 2004, "Work Plan for Source Area Evaluation, Supplemental Remedial Investigation and Focused Feasibility Study, Operable Unit #5 – Building 57 Area, Union and Endicott, New York," approved by the NYSDEC in a letter dated December 13, 2004.





This figure is a summary of soil sample analysis results generated as part of the Supplemental Remedial Investigation (SRI). It was prepared to complement a series of figures and text, and should be considered in that context. The concentrations shown represent the sum total of detected ethenes (tetra- and trichloroethene and degradation by-products cis-1,2-dichloroethene and vinyl chloride) for each sample identified. Analytical laboratory results are documented in the Analytical Summary Reports (ASRs) that have been prepared and submitted to the Agencies. The stratigraphic limits are intended to represent generalized conditions across the source zone; actual conditions vary among locations.

Figure H.1

Summary of Chlorinated Ethenes Detected in Soil: Building 57A Area

Appendix H - Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

Drawn By: J. Prellwitz/S. Warner
Designed By: L. Jacob
Reviewed By: J. Ordway
Date: March 2010

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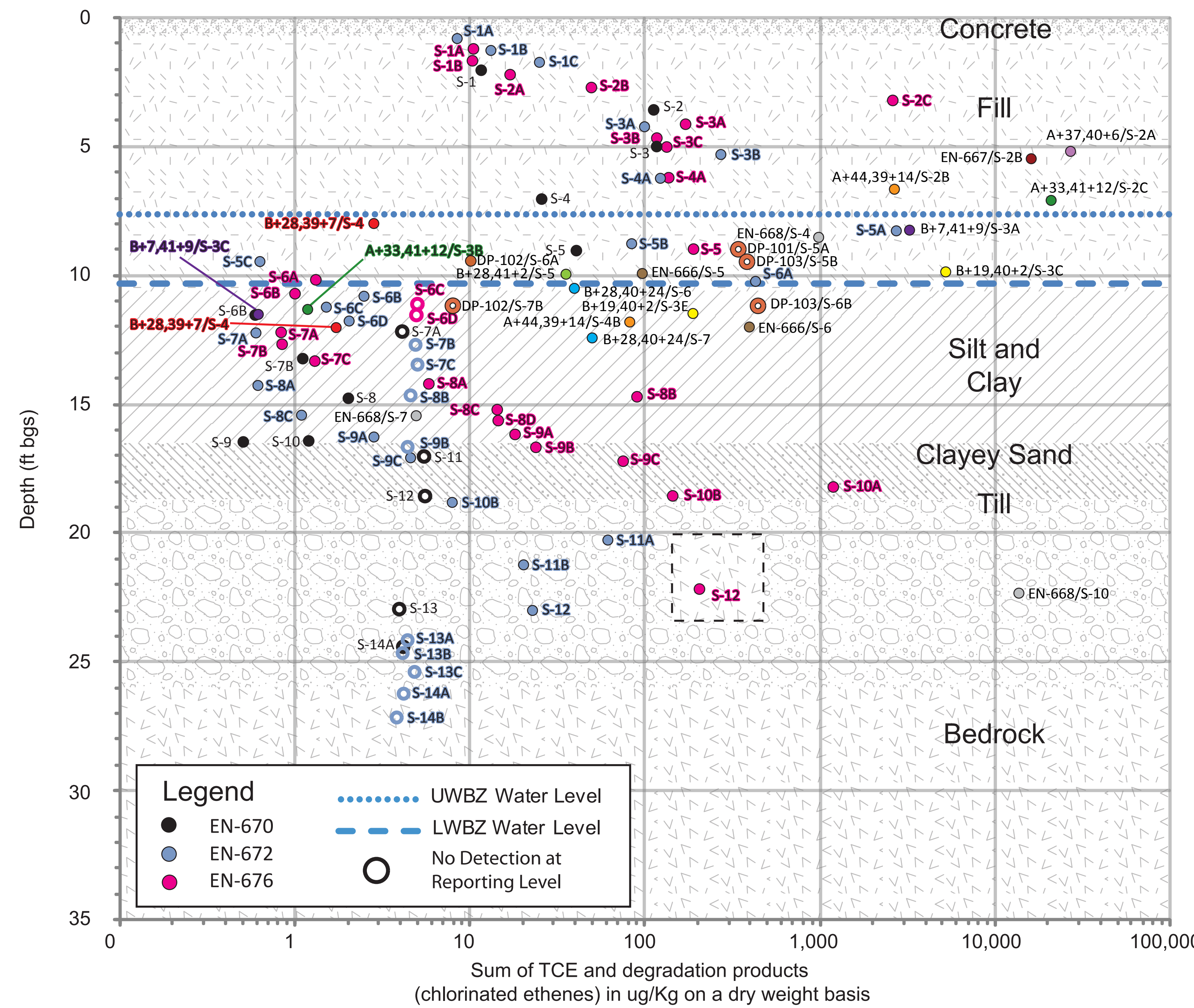

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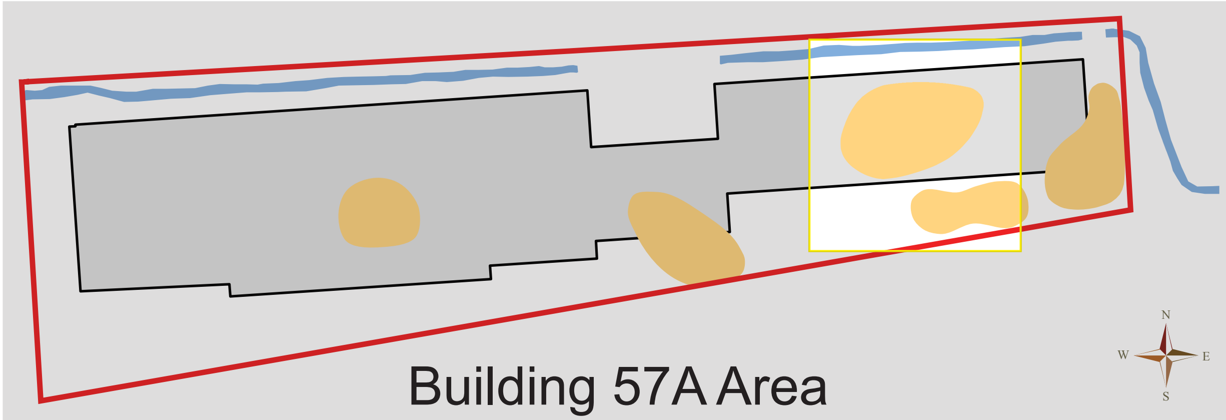

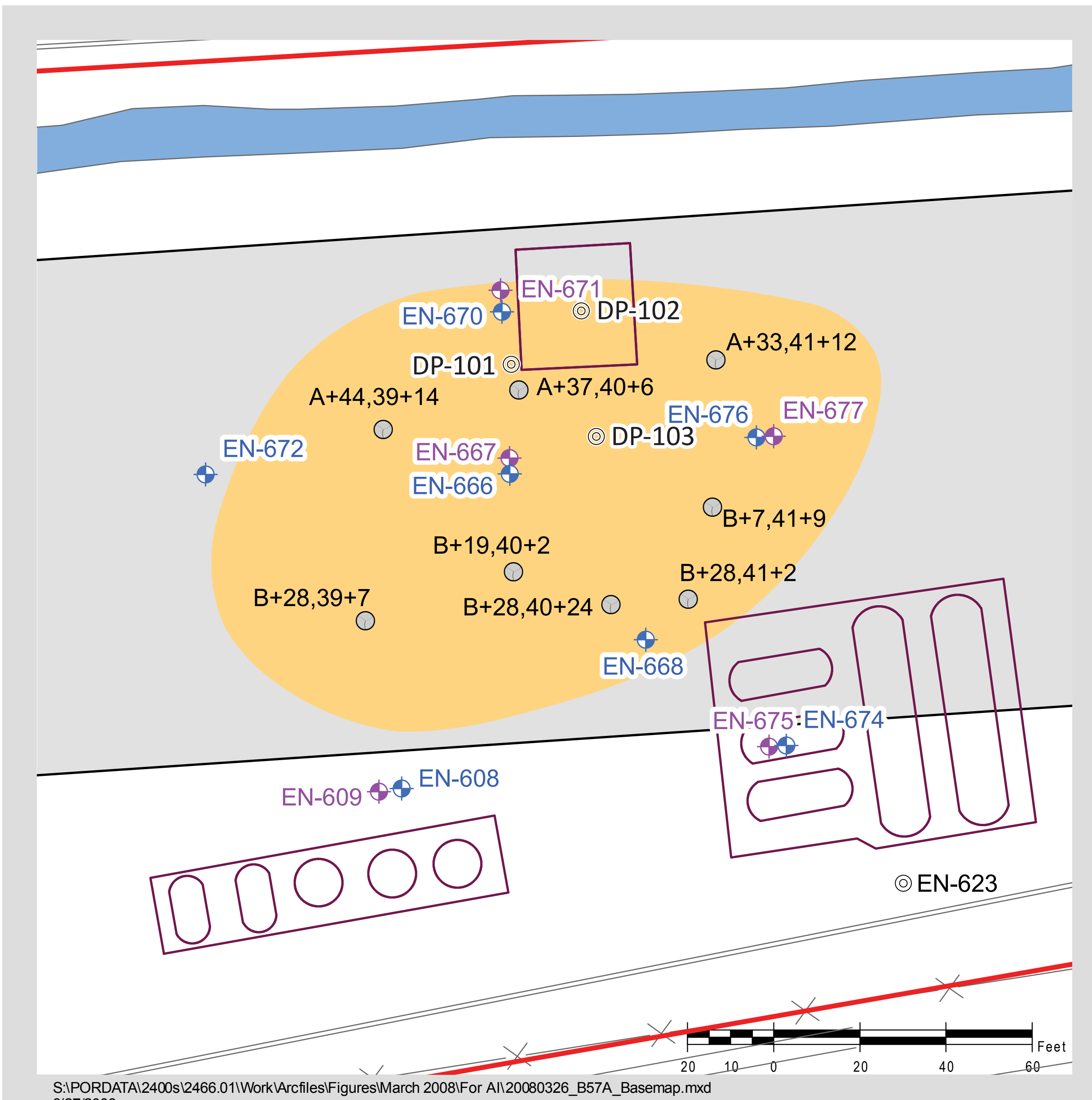

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Figure H.2

Summary of Chlorinated Ethanes Detected in Soil: Building 57A Area

Appendix H - Supplemental Remedial Investigation Report
OU#5/Building 57 Area
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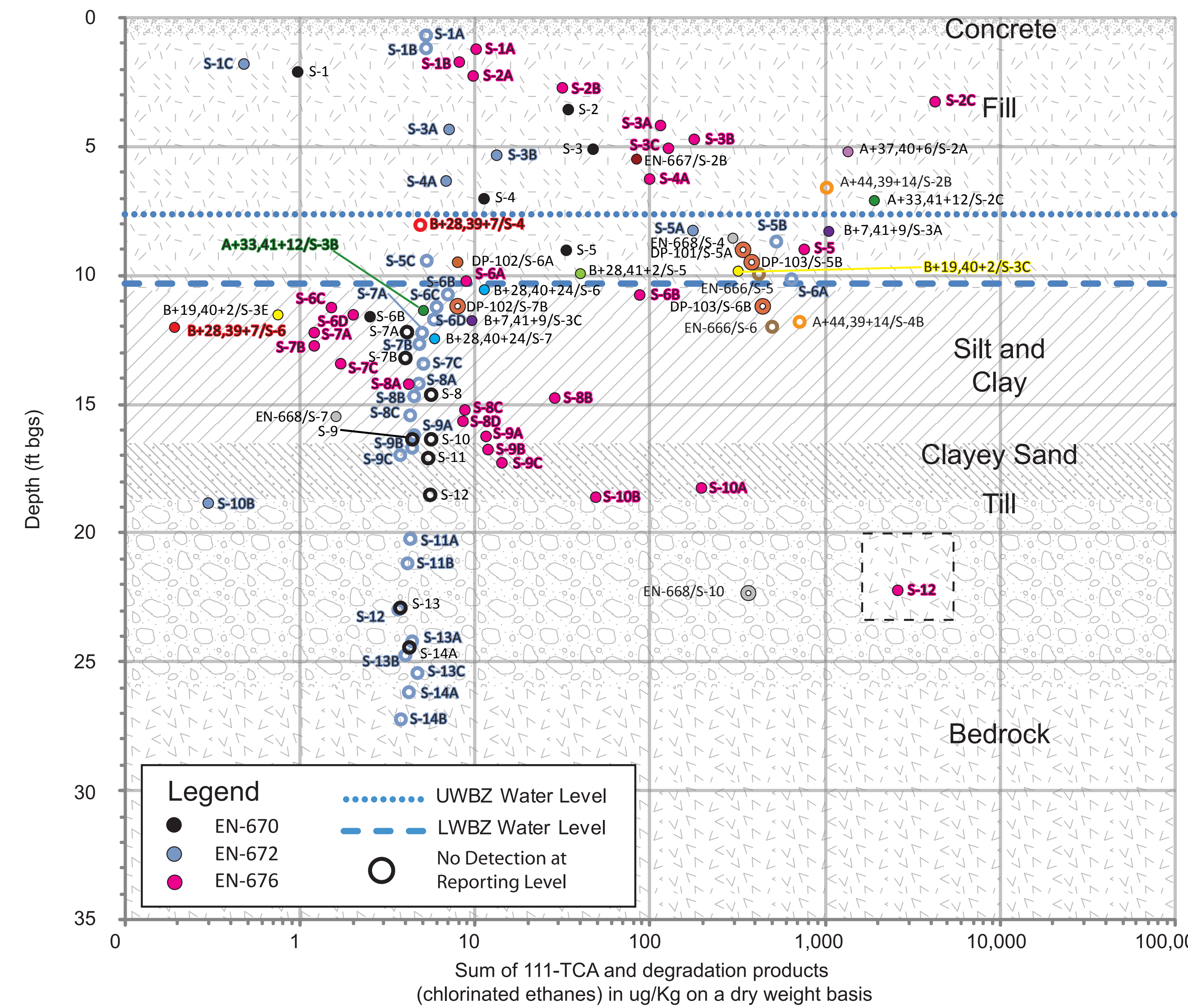

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Figure H.3

Summary of Chlorofluorocarbons Detected in Soil: Building 57A Area

Appendix H - Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

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Reviewed By: J. Ordway
Date: March 2010

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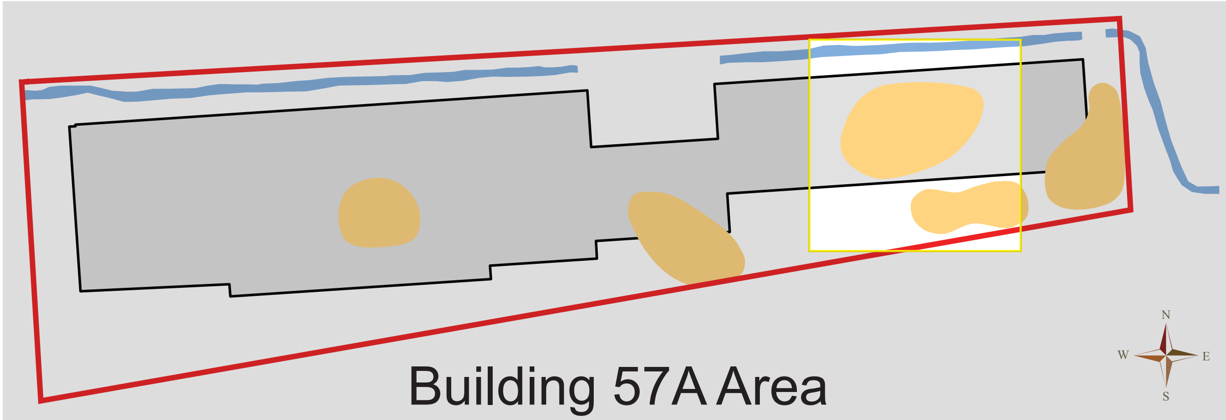

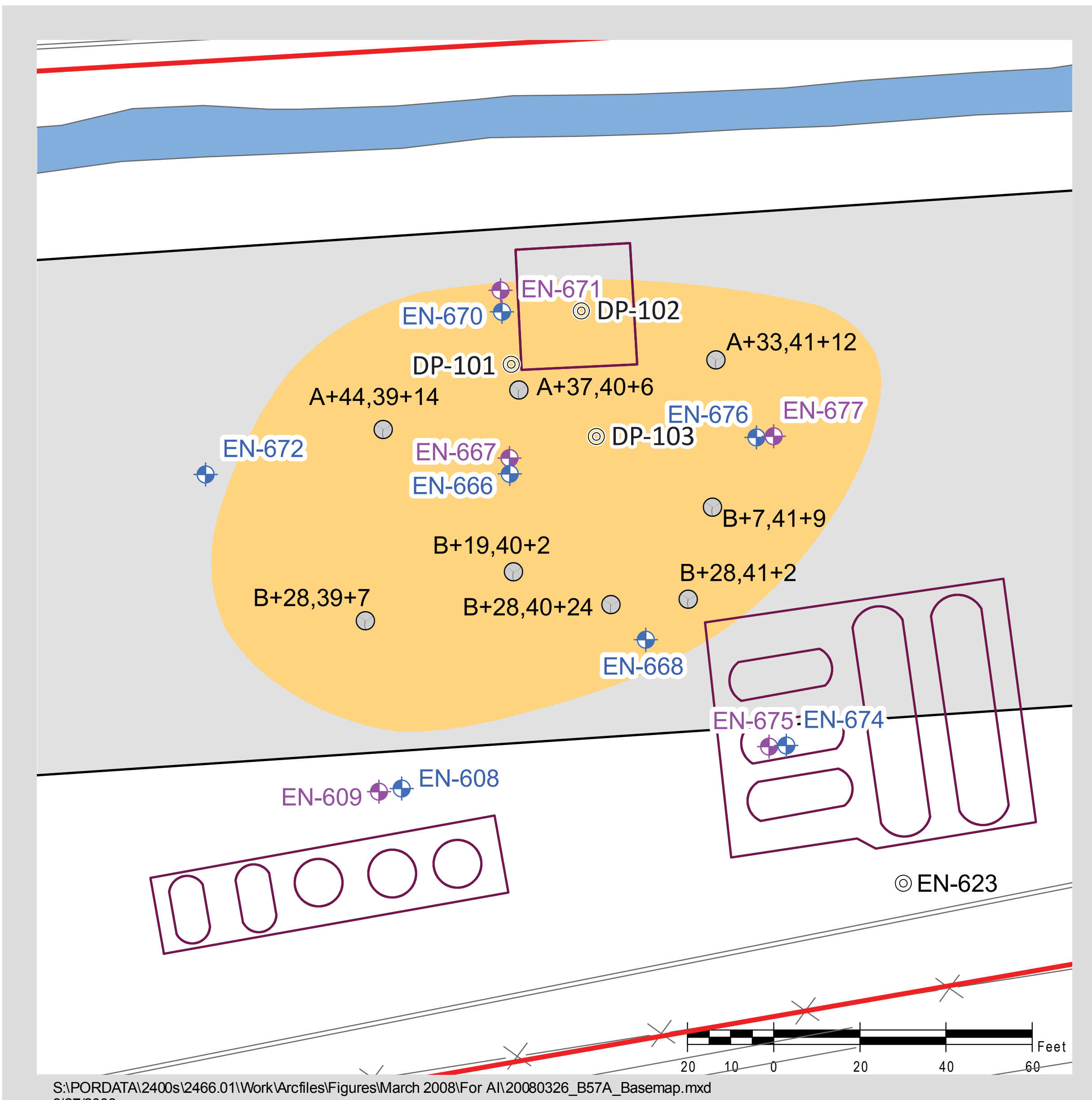

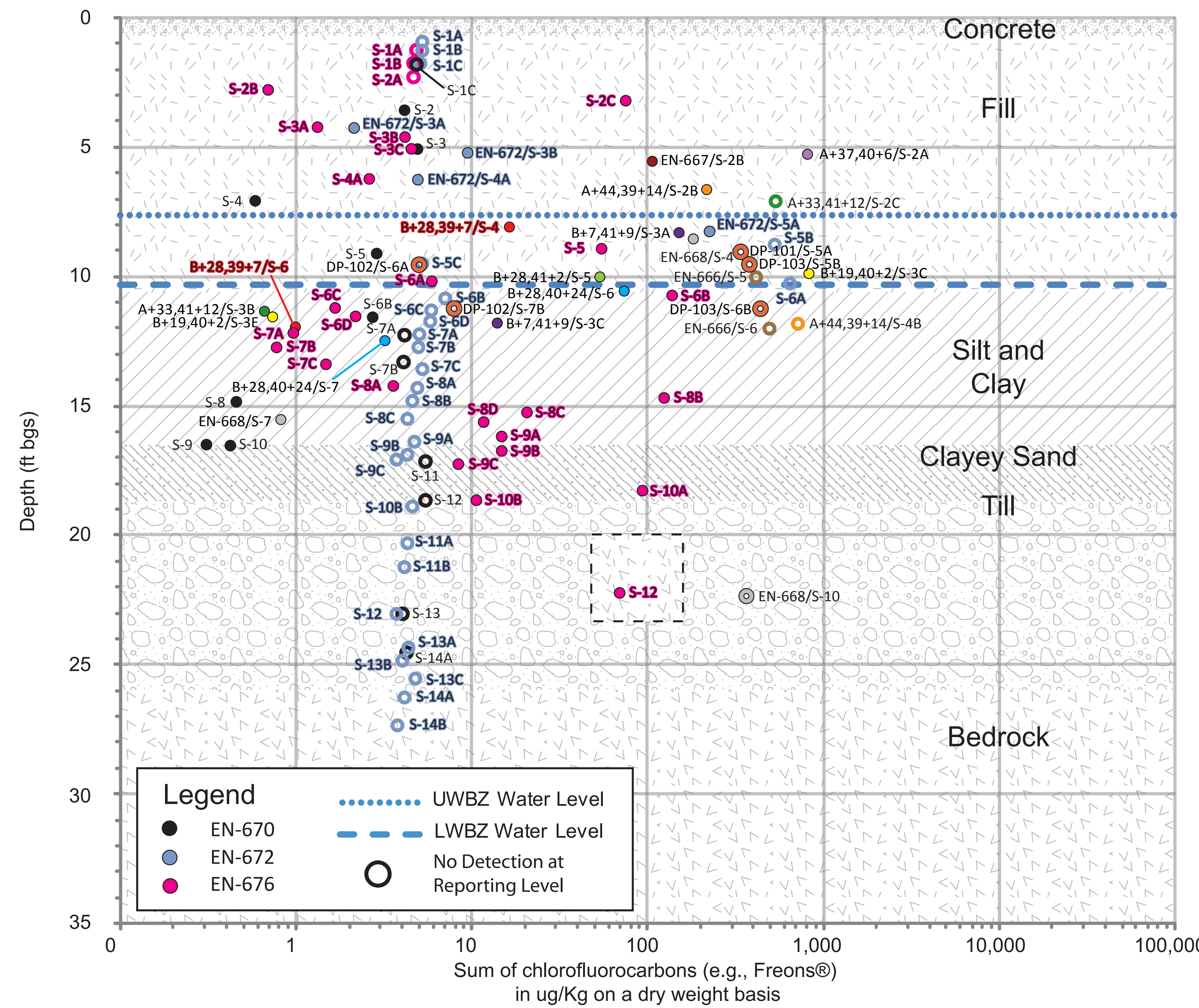

This figure is a summary of soil sample analysis results generated as part of the Supplemental Remedial Investigation (SRI). It was prepared to complement a series of figures and text, and should be considered in that context. The concentrations shown represent the sum total of detected chlorofluorocarbons (CFC-113 and CFC-123a) for each sample identified. Analytical laboratory results are documented in the Analytical Summary Reports (ASRs) that have been prepared and submitted to the Agencies. The strati-graphic limits are intended to represent generalized conditions across the source zone; actual conditions vary among locations.

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Figure H.4

Summary of Chlorinated Ethenes Detected in Soil: Waste Solvent Area

Appendix H - Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

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Designed By: L. Jacob
Reviewed By: J. Ordway
Date: March 2010

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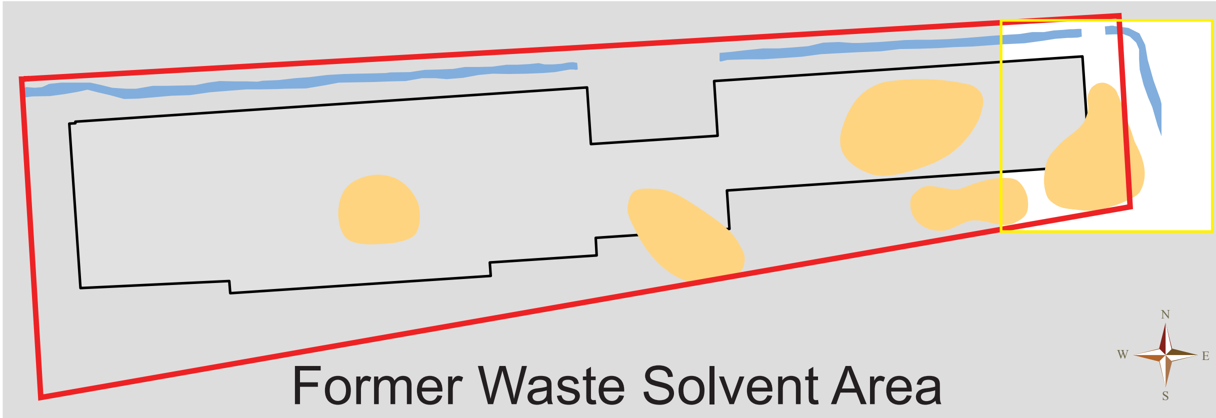

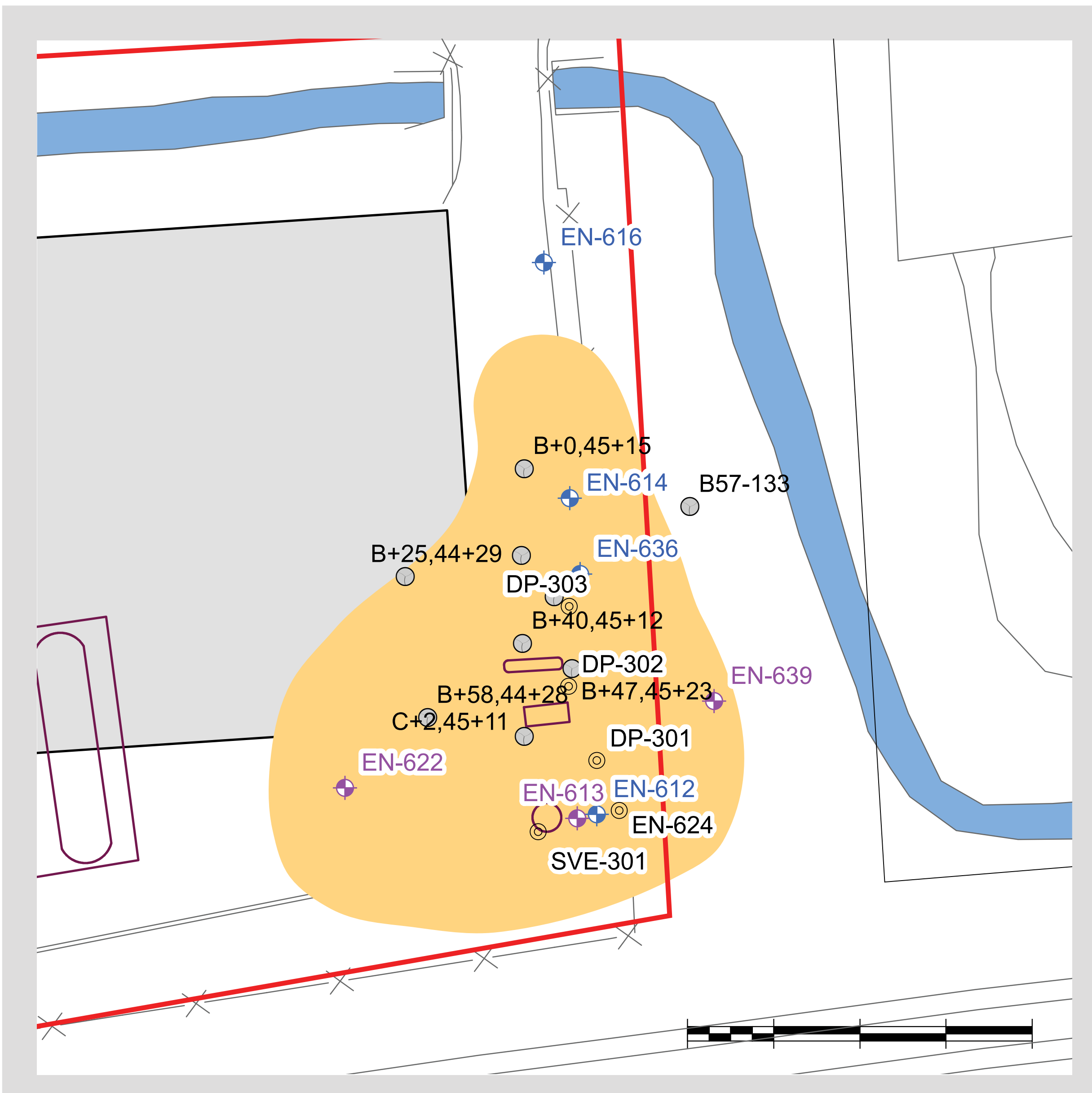

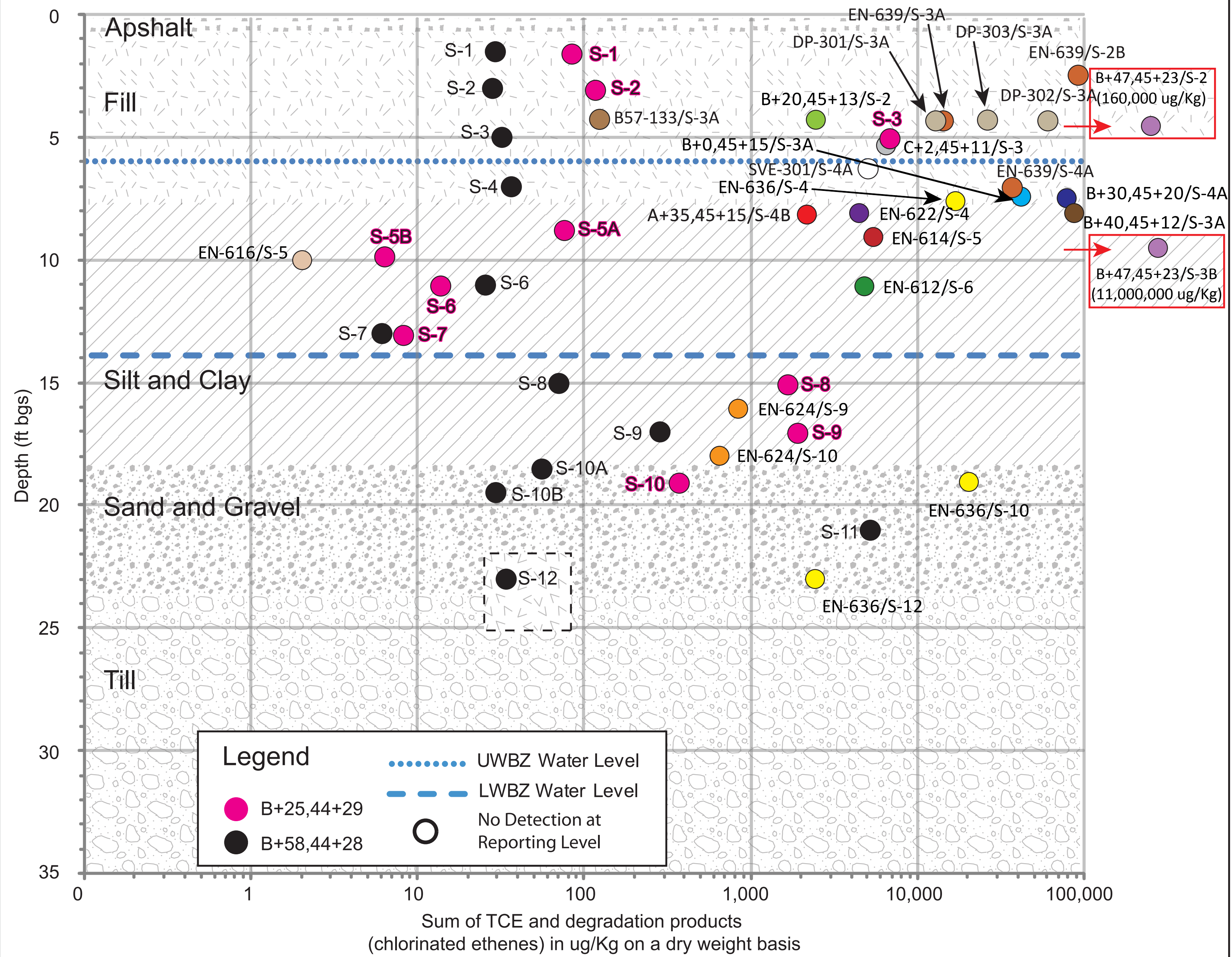

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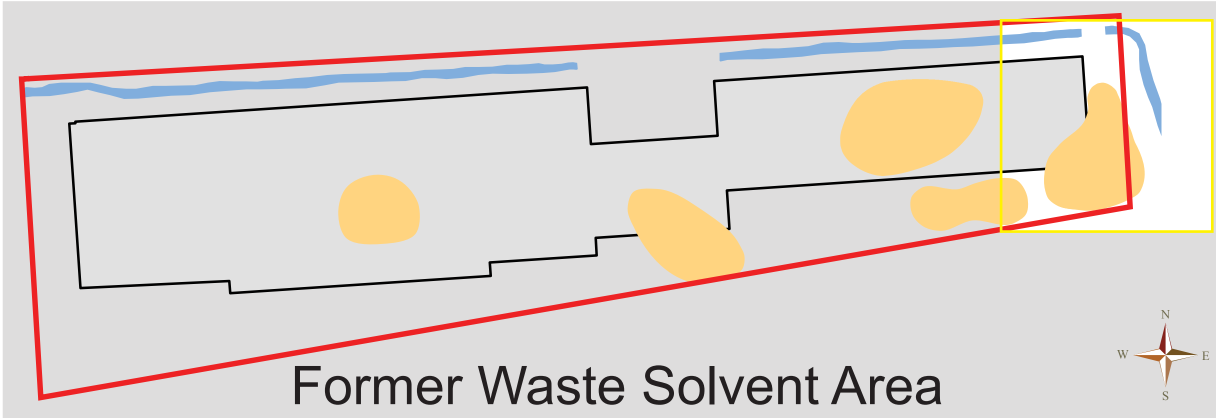

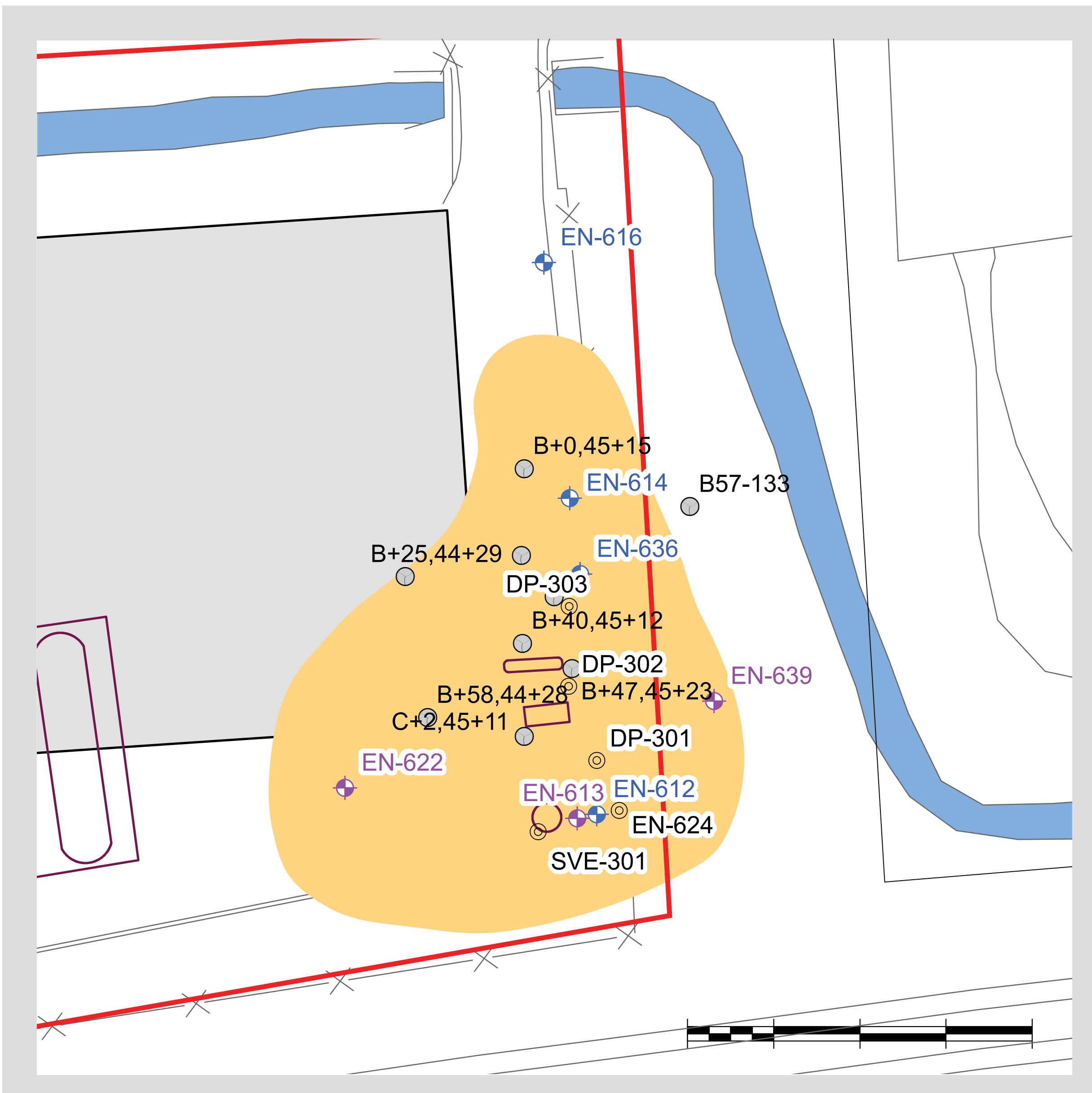

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Figure H.5

Summary of Chlorinated Ethanes Detected in Soil: Waste Solvent Area

Appendix H - Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

Drawn By: J. Prellwitz/S. Warner
Designed By: L. Jacob
Reviewed By: J. Ordway
Date: March 2010

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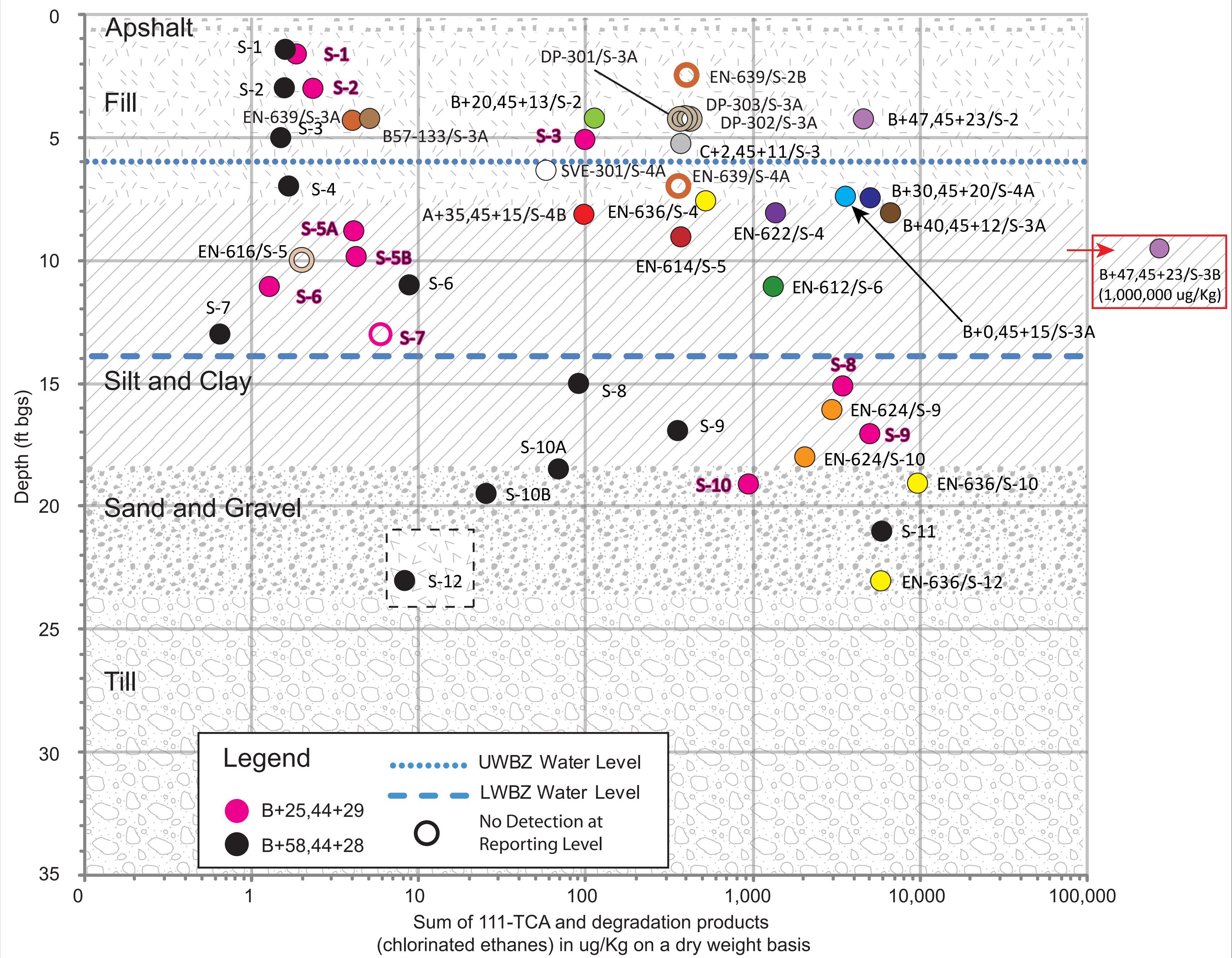

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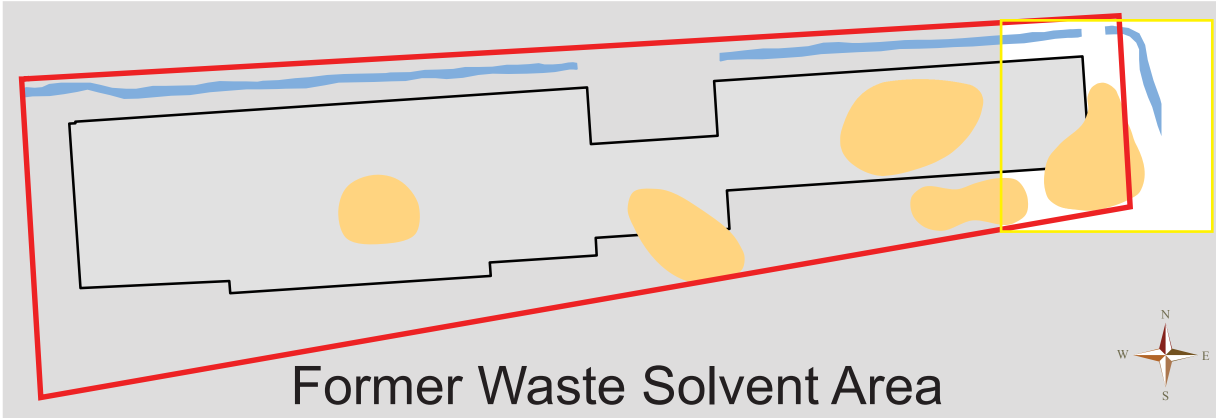

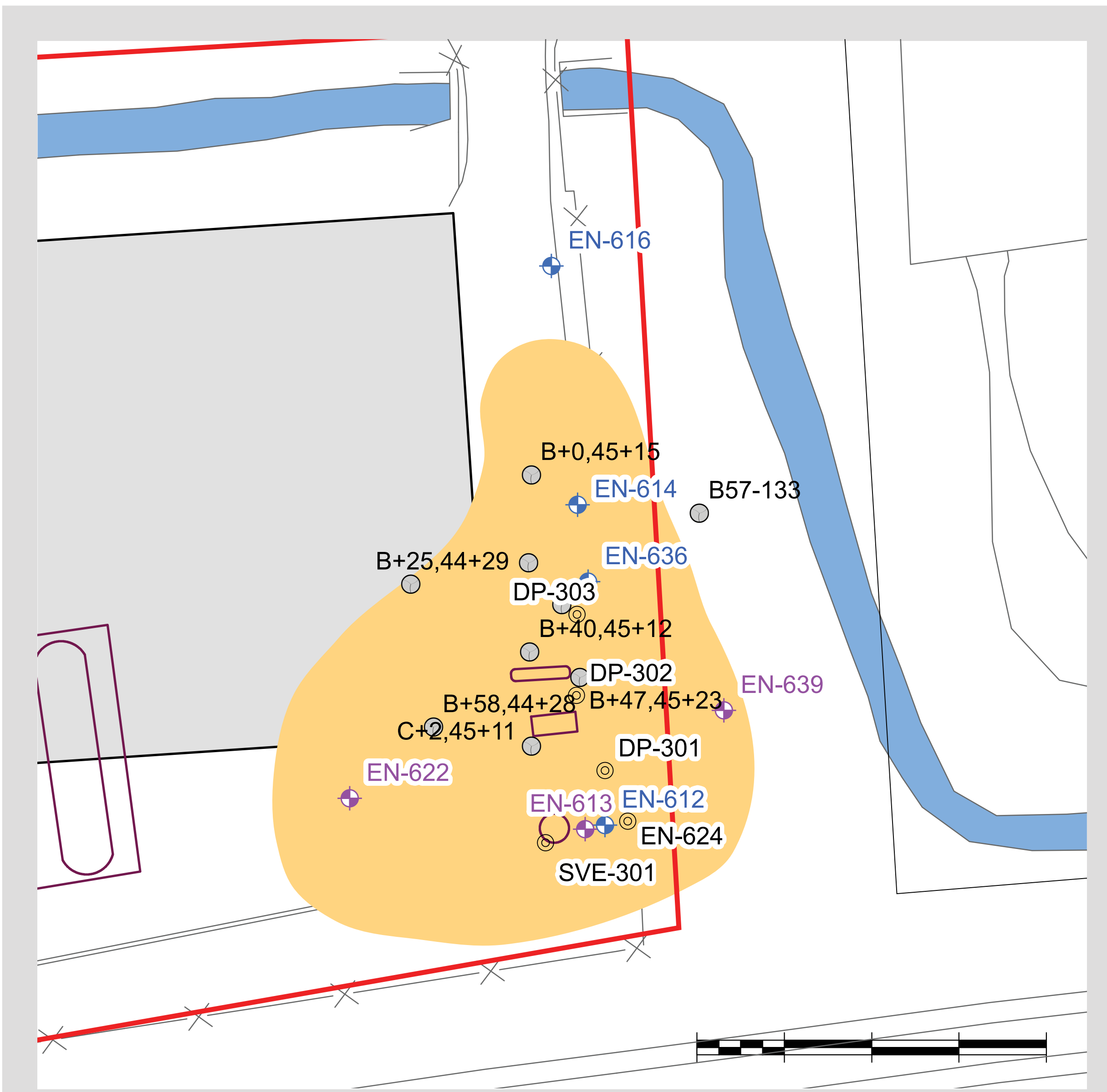

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This figure is a summary of soil sample analysis results generated as part of the Supplemental Remedial Investigation (SRI). It was prepared to complement a series of figures and text, and should be considered in that context. The concentrations shown represent the sum total of detected chlorofluorocarbons (CFC-113 and CFC-123a) for each sample identified. Analytical laboratory results are documented in the Analytical Summary Reports (ASRs) that have been prepared and submitted to the Agencies. The stratigraphic limits are intended to represent generalized conditions across the source zone; actual conditions vary among locations.

Figure H.6

Summary of Chlorofluorocarbons Detected in Soil: Waste Solvent Area

Appendix H - Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

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Designed By: L. Jacob
Reviewed By: J. Ordway

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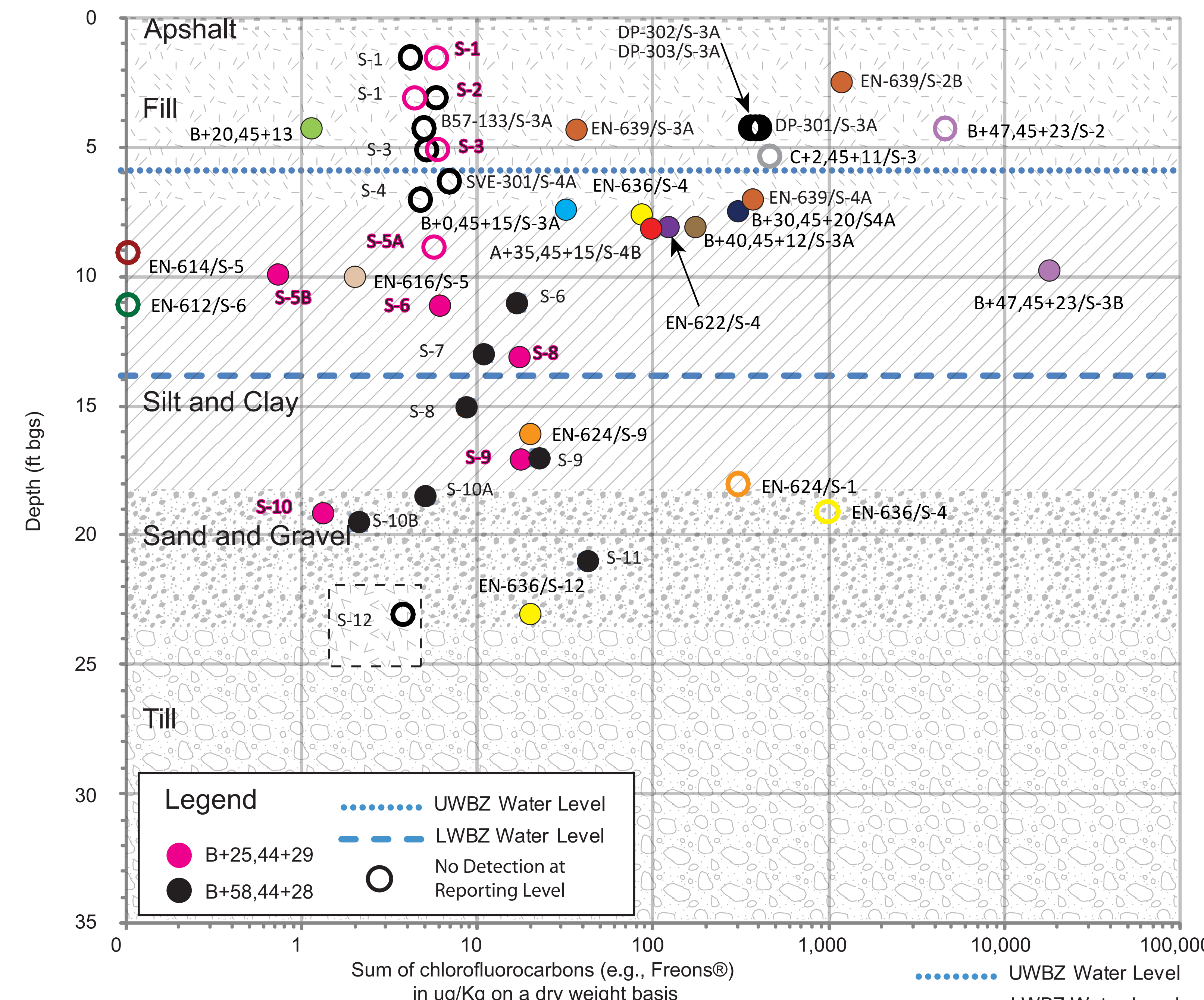

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UWBZ Water Level
LWBZ Water Level
B+25,44+29
B+58,44+28
No Detection at
Reporting Level

Figure H.7

Summary of Chlorinated Ethenes Detected in Soil: TCA Area

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OU#5/Building 57 Area
Union and Endicott, New York

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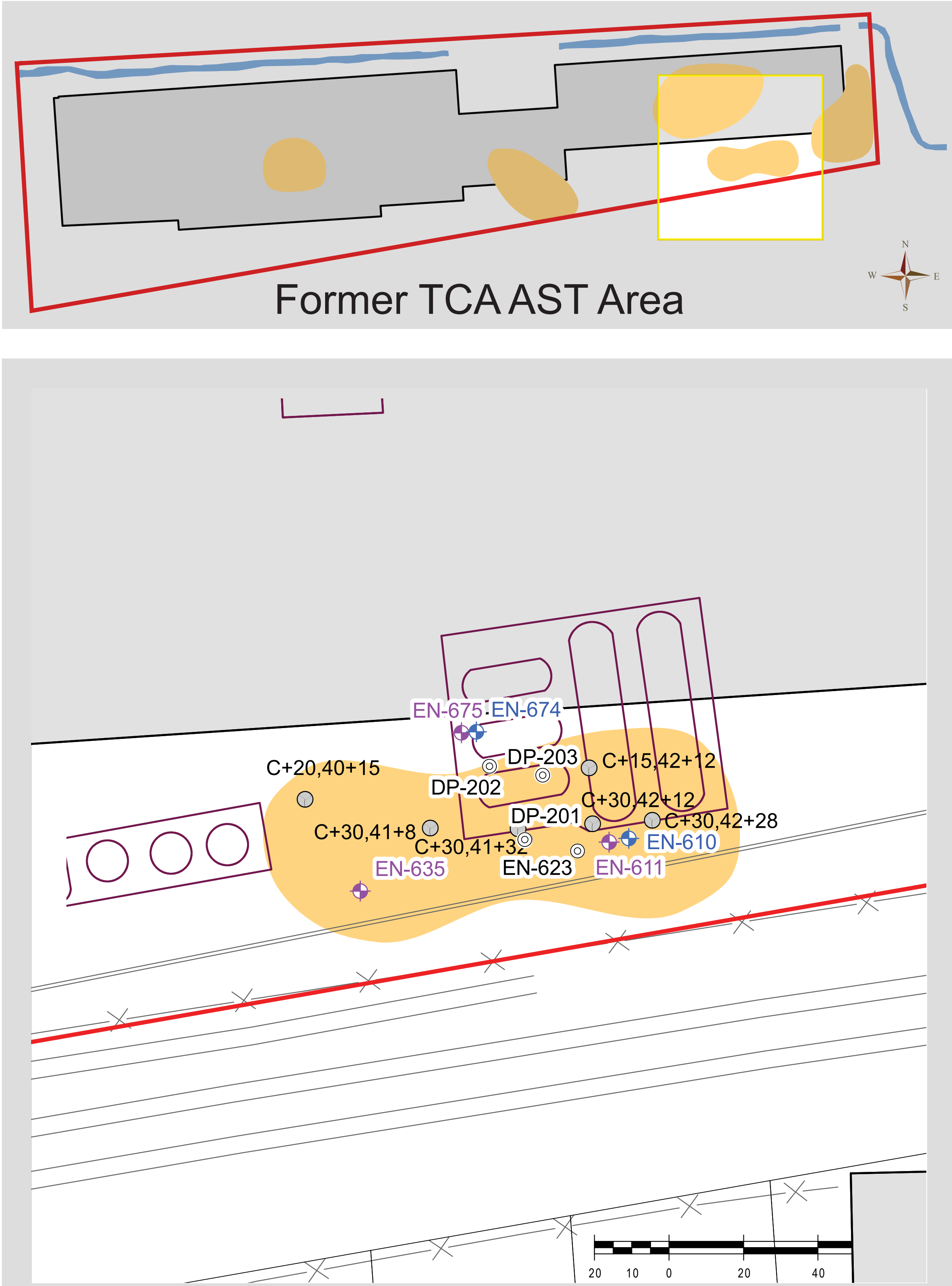
Reviewed By: J. Ordway
Date: March 2010



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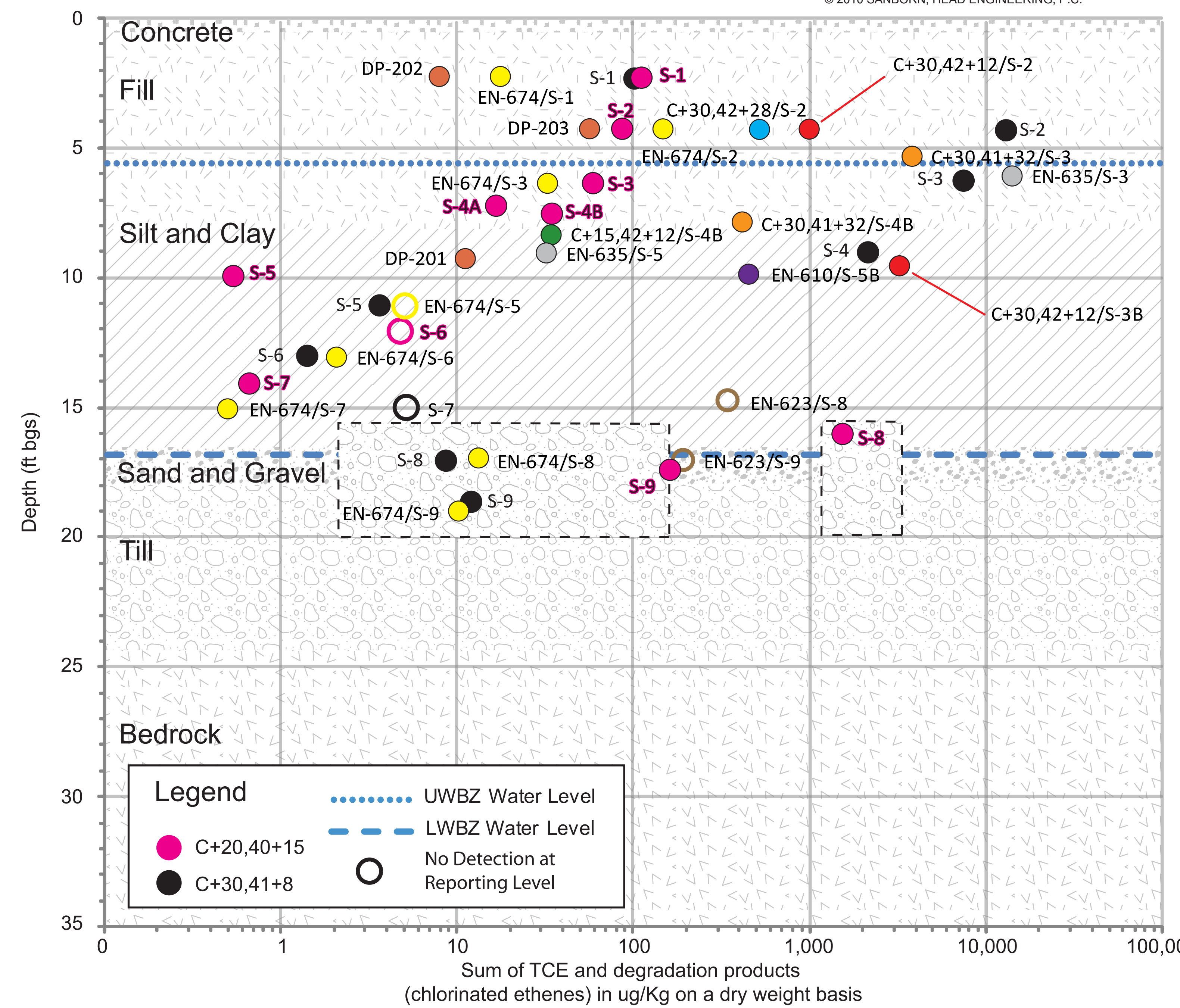

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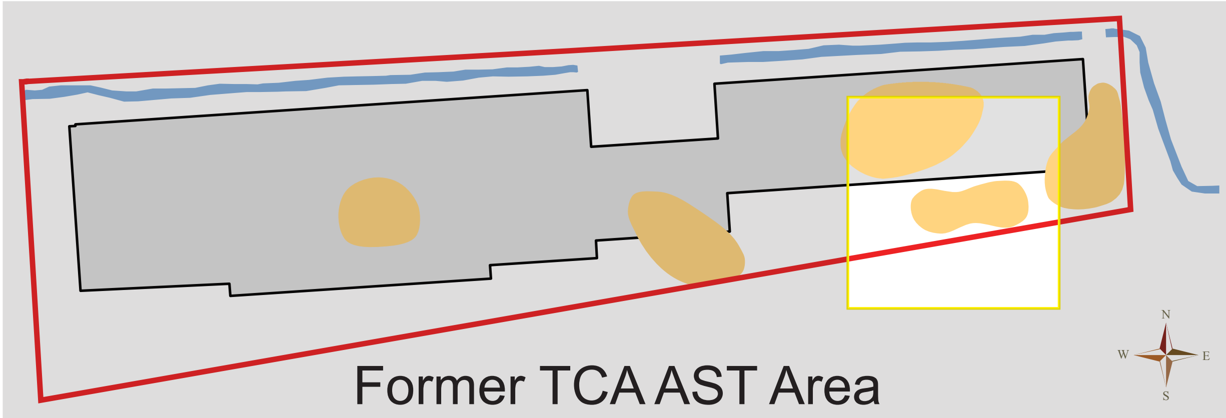

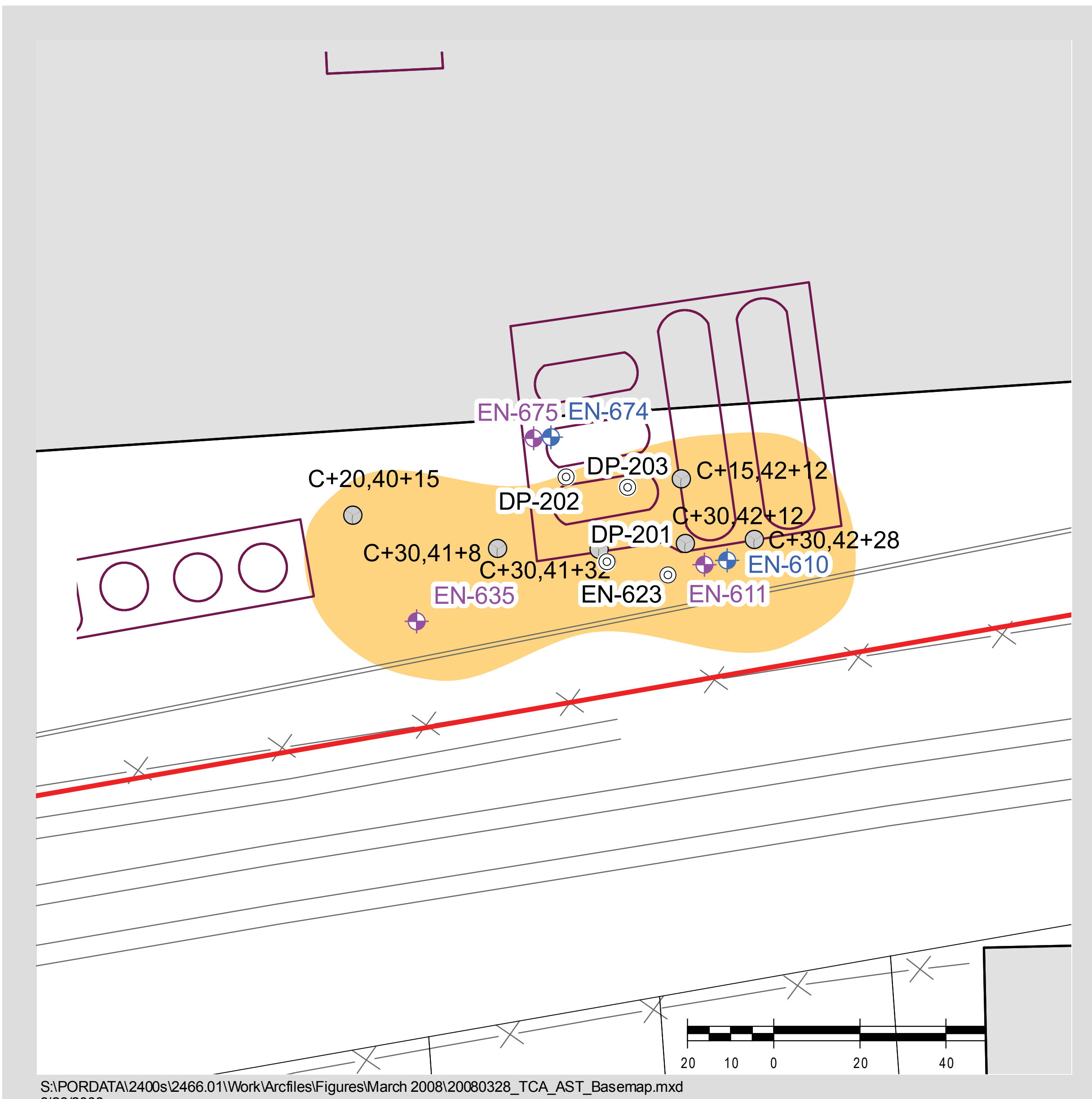

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Figure H.8

Summary of Chlorinated Ethanes Detected in Soil: TCA Area

Appendix H - Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

Drawn By: J. Prellwitz/S. Warner
Designed By: L. Jacob
Reviewed By: J. Ordway
Date: March 2010

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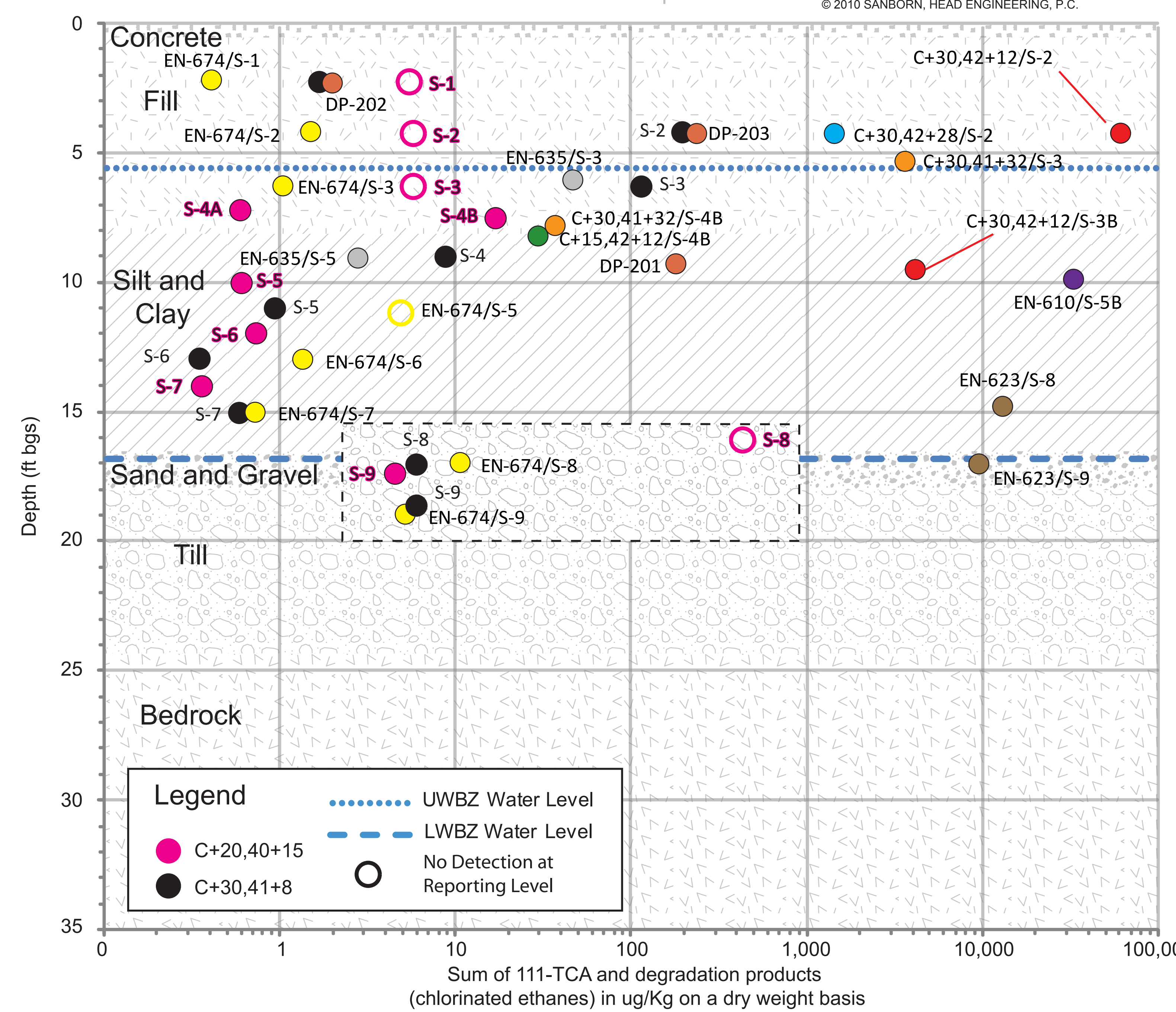

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Figure H.9

Summary of Chlorofluorocarbons Detected in Soil: TCA Area

Appendix H - Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

Drawn By: J. Prellwitz/S. Warner
Designed By: L. Jacob
Reviewed By: J. Ordway
Date: March 2010

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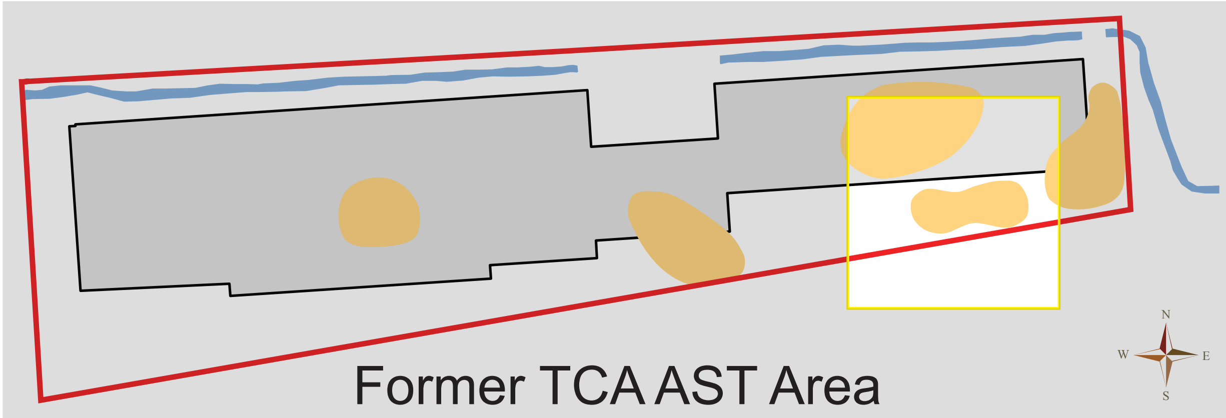

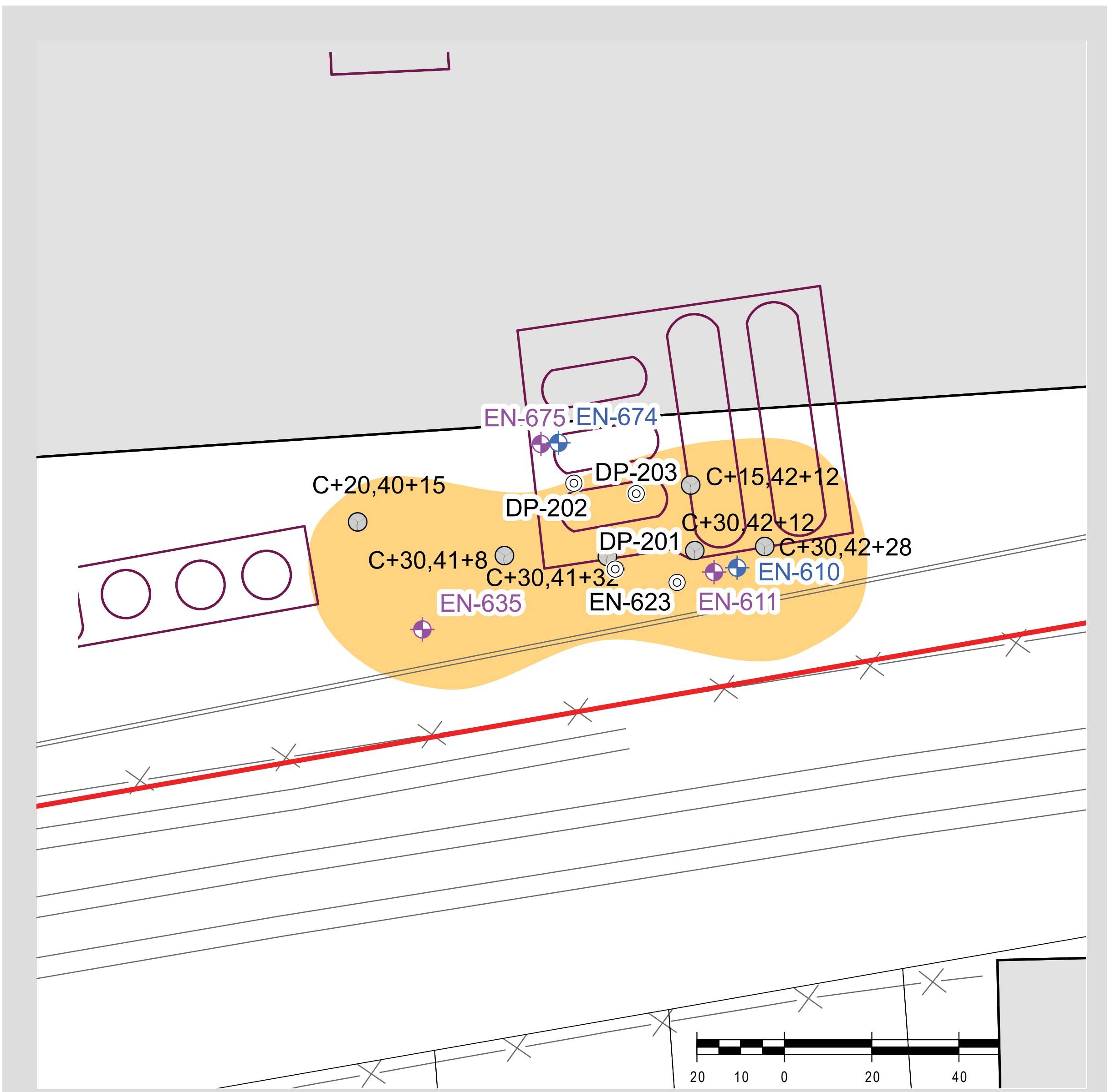

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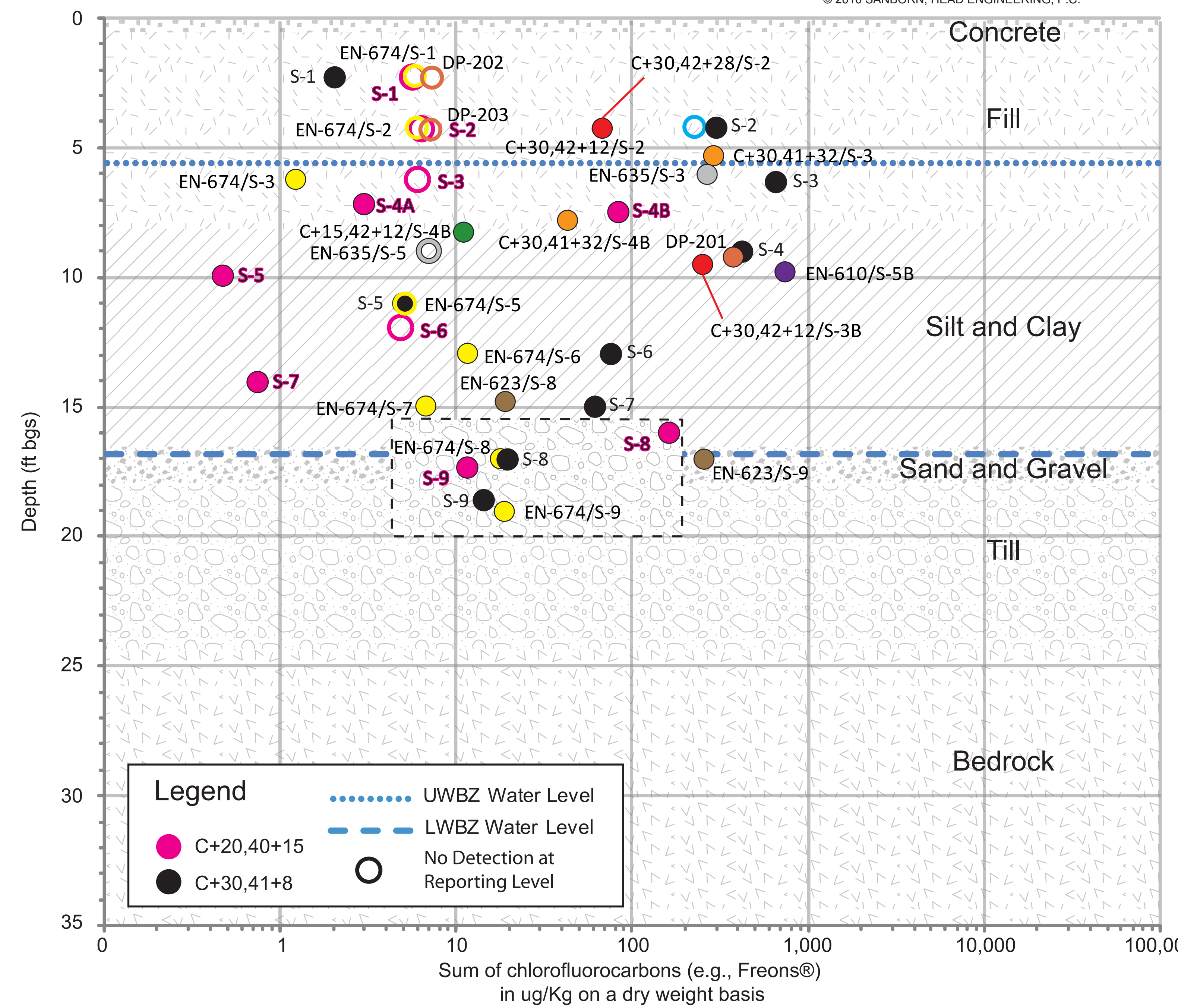

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Figure H.10

Summary of Chlorinated Ethenes Detected in Soil: CFC Area

Appendix H - Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

Drawn By: J. Prellwitz/S. Warner
Designed By: L. Jacob
Reviewed By: J. Ordway
Date: March 2010

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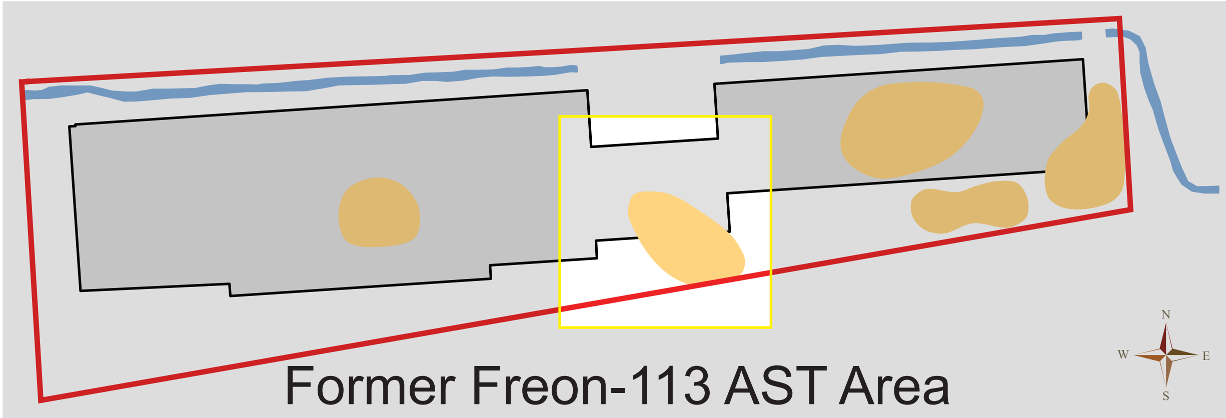

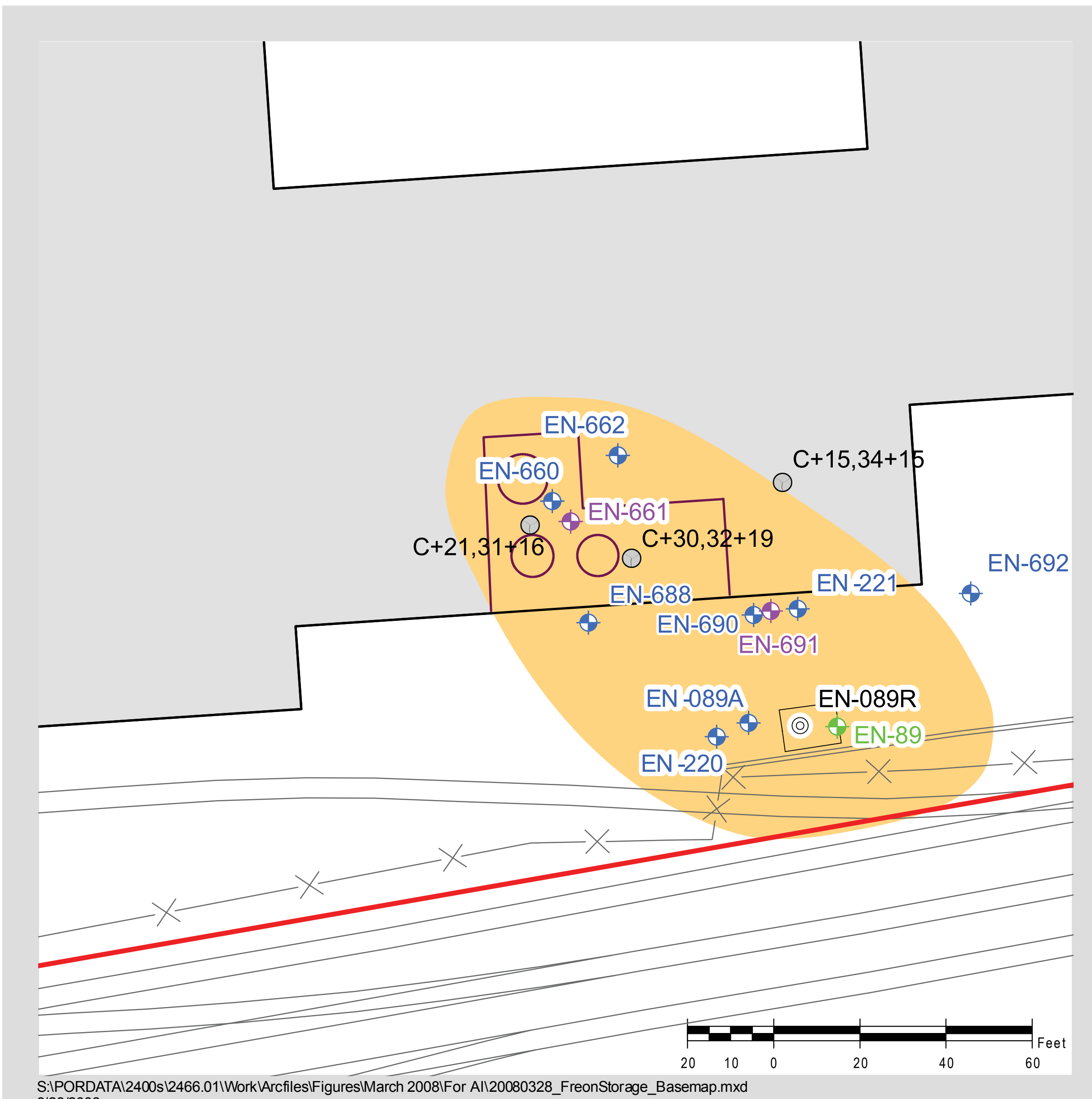

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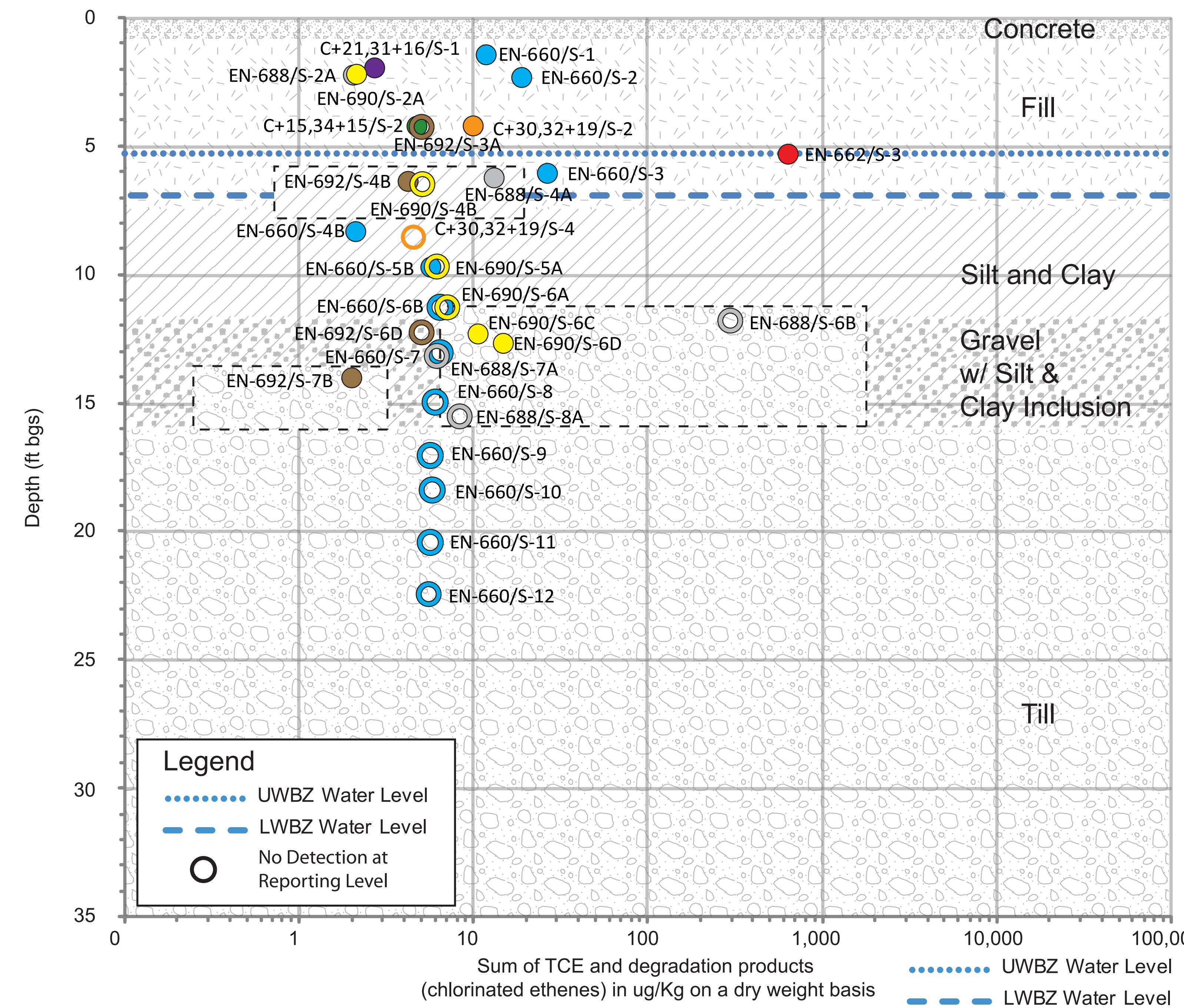

UWBZ Water Level
LWBZ Water Level
No Detection at Reporting Level

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Figure H.11

Summary of Chlorinated Ethanes Detected in Soil: CFC Area

Appendix H - Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

Drawn By: J. Prellwitz/S. Warner
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Reviewed By: J. Ordway
Date: March 2010

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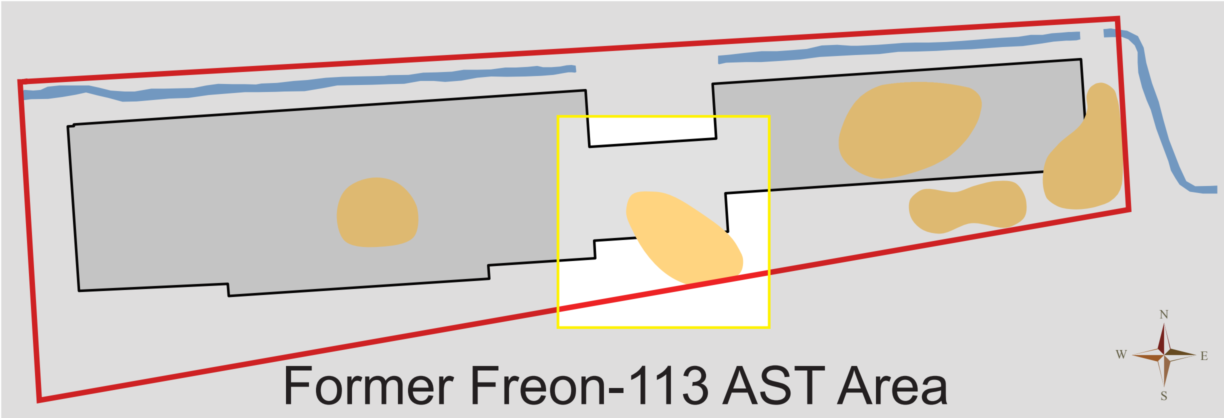

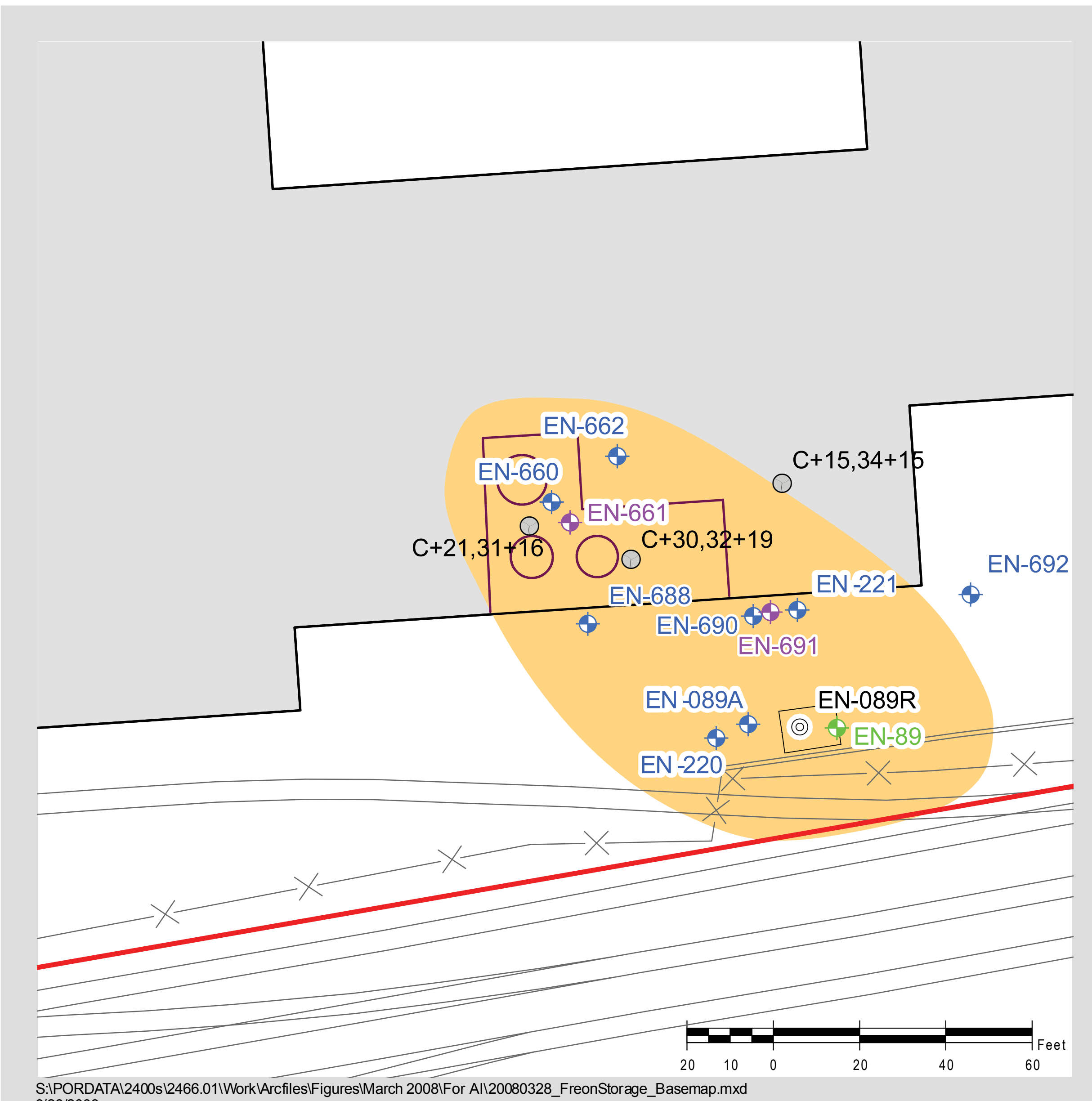

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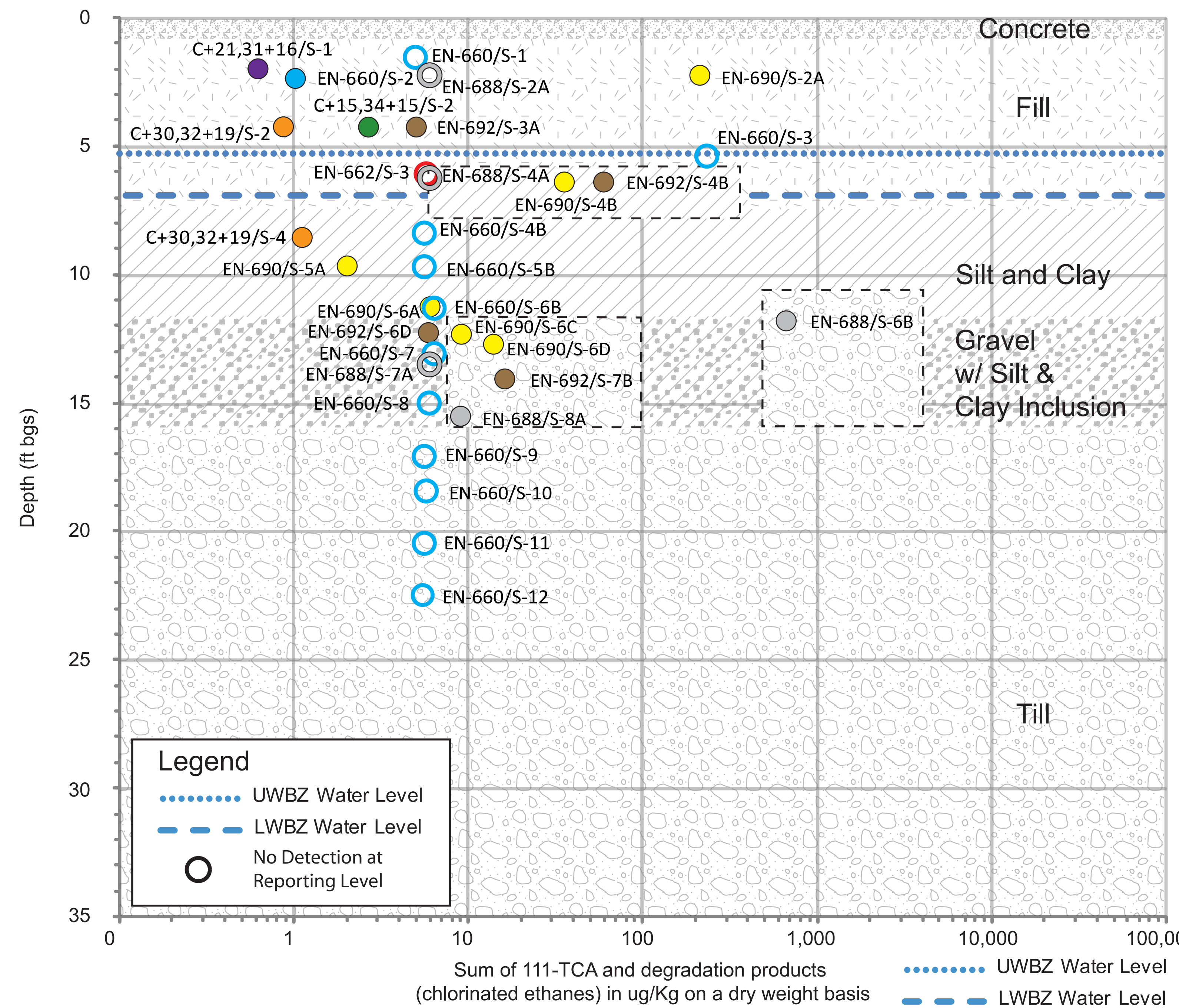

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Figure H.12

Summary of Chlorofluorocarbons Detected in Soil: CFC Area

Appendix H - Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

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Designed By: L. Jacob
Reviewed By: J. Ordway
Date: March 2010

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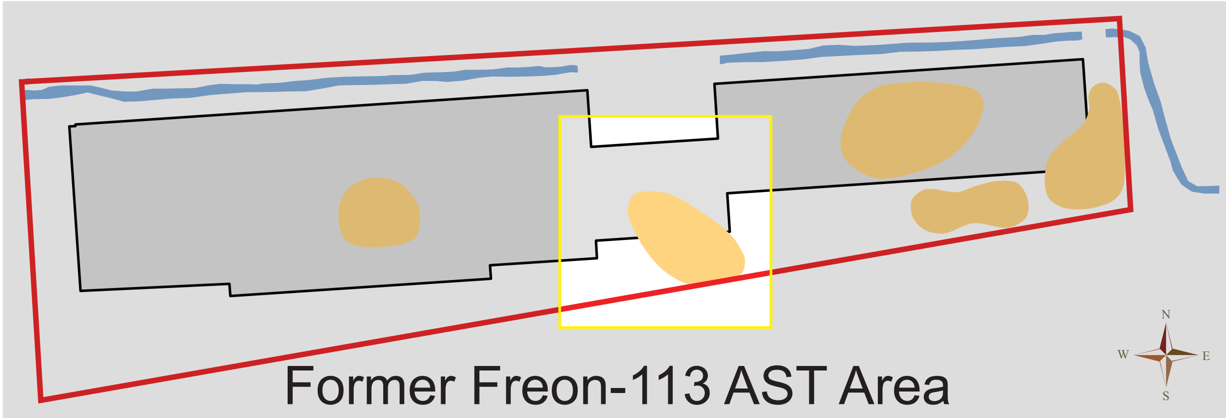

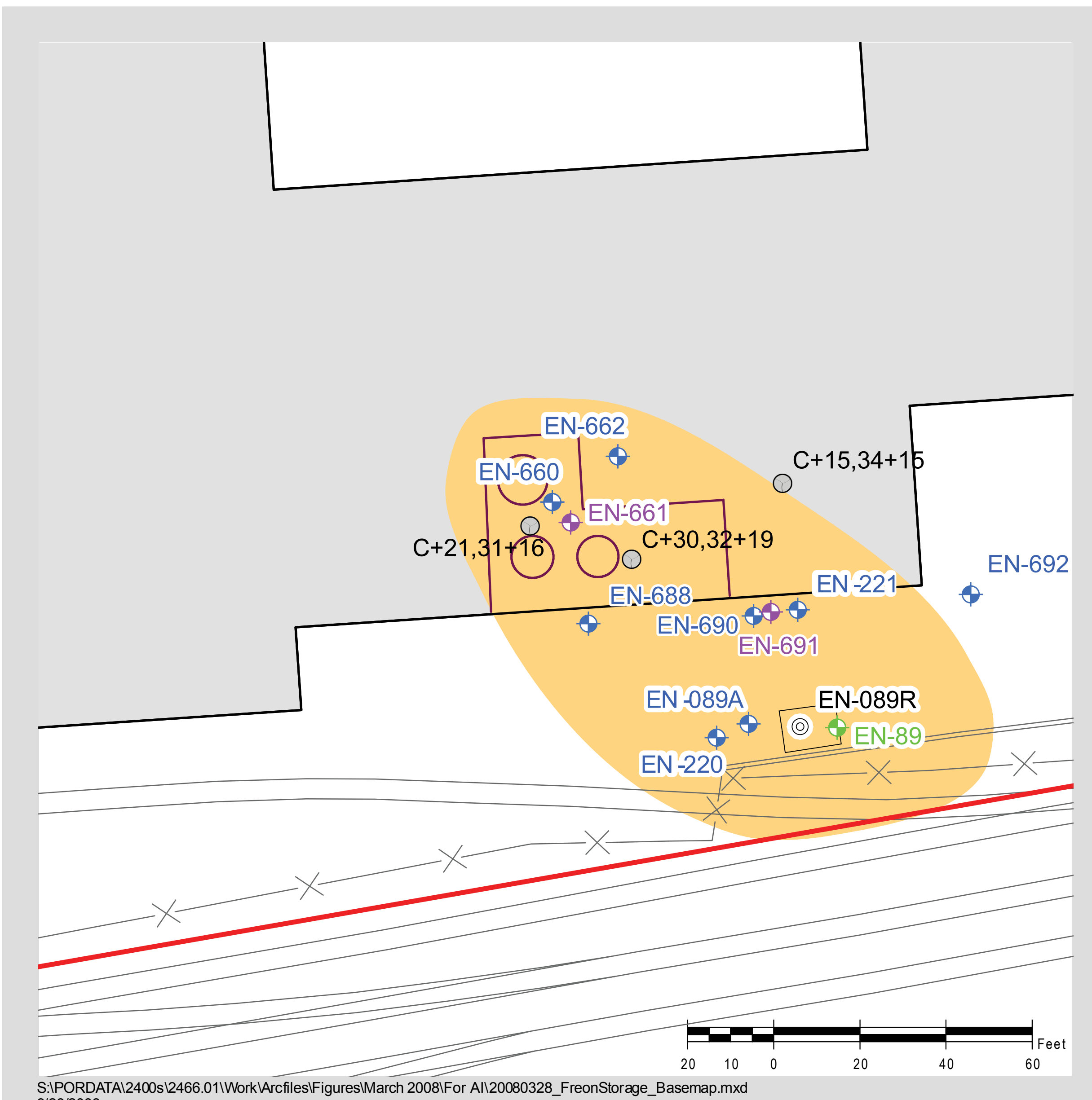

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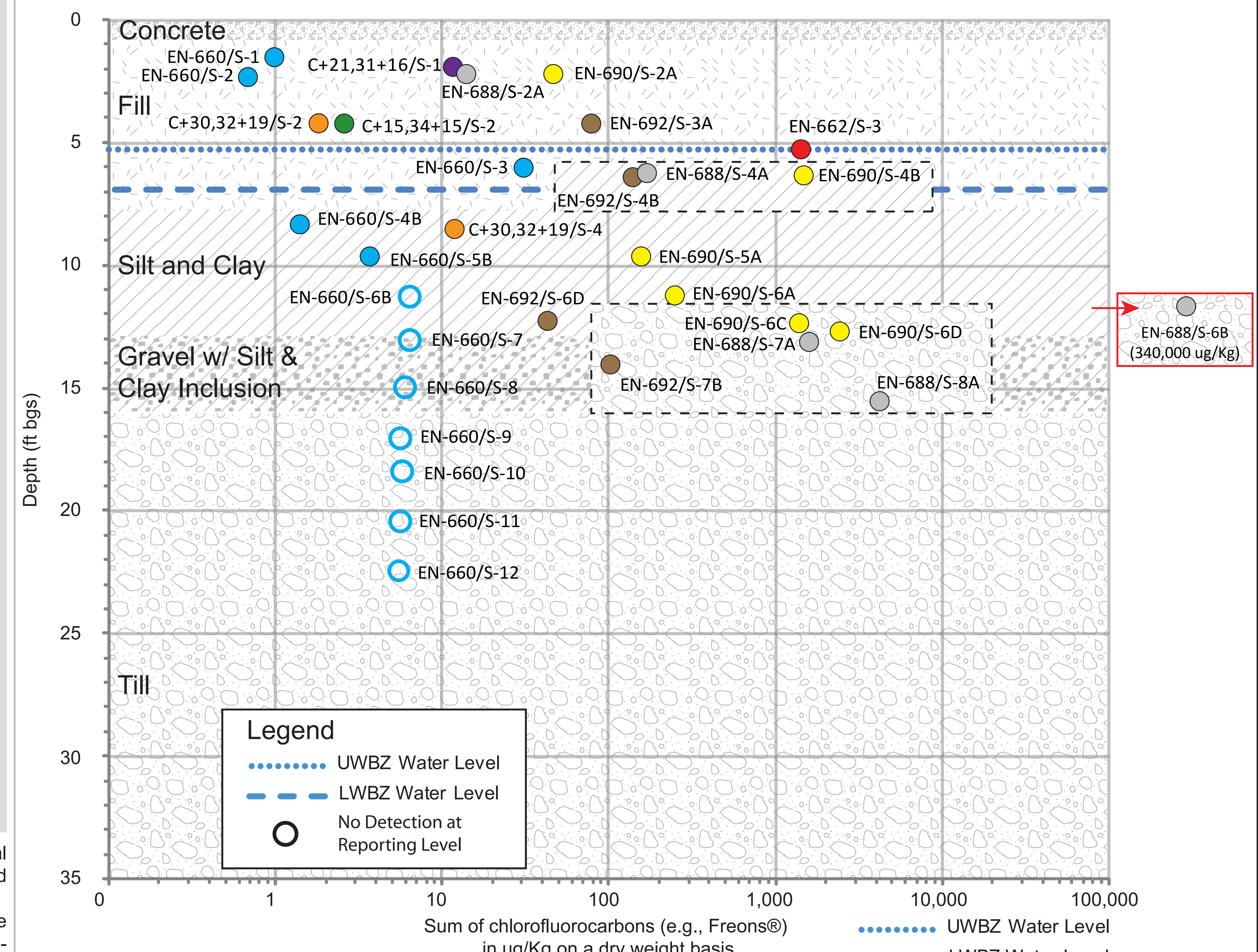

UWBZ Water Level
LWBZ Water Level
No Detection at Reporting Level

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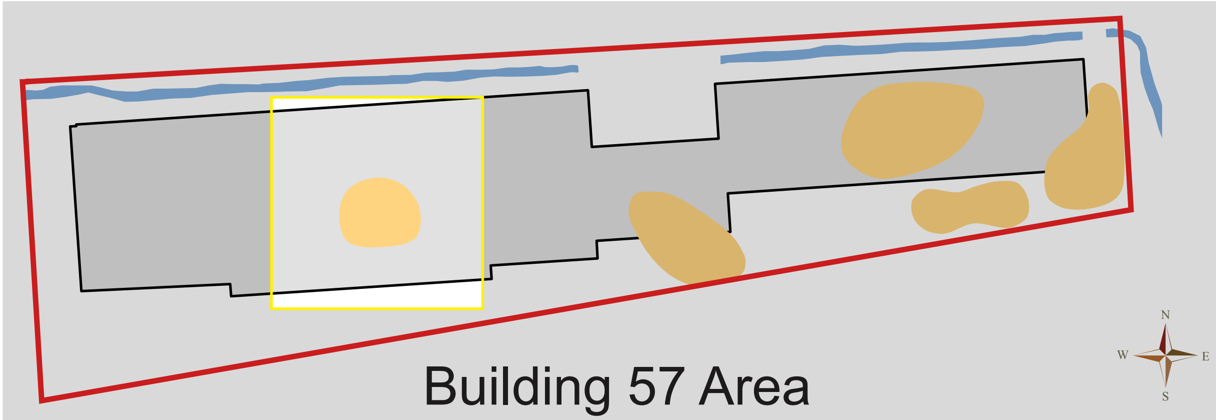

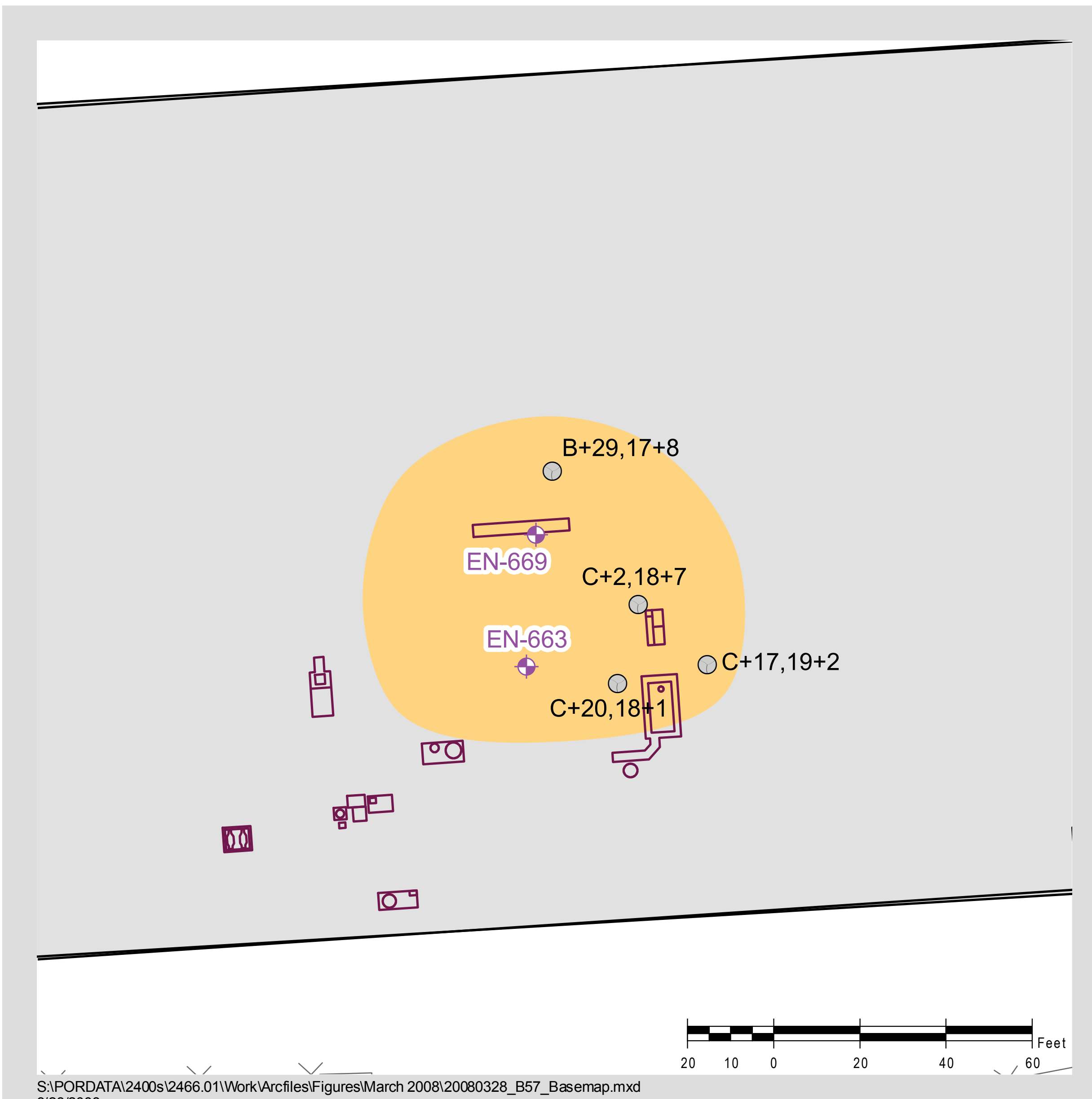

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Figure H.13

Summary of Chlorinated Ethenes Detected in Soil: Building 57 Area

Appendix H - Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

Drawn By: J. Prellwitz/S. Warner
Designed By: L. Jacob
Reviewed By: J. Ordway
Date: March 2010

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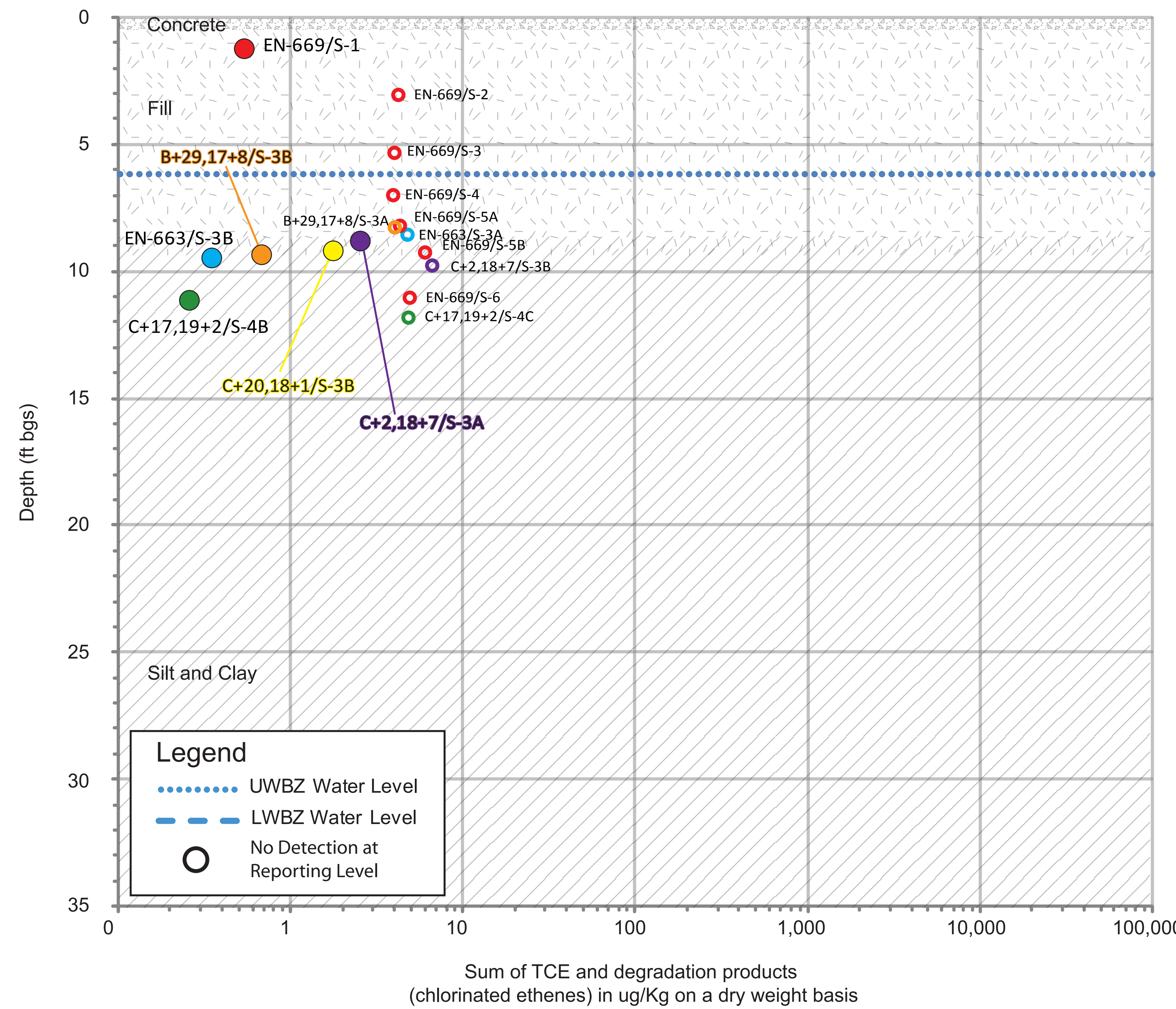

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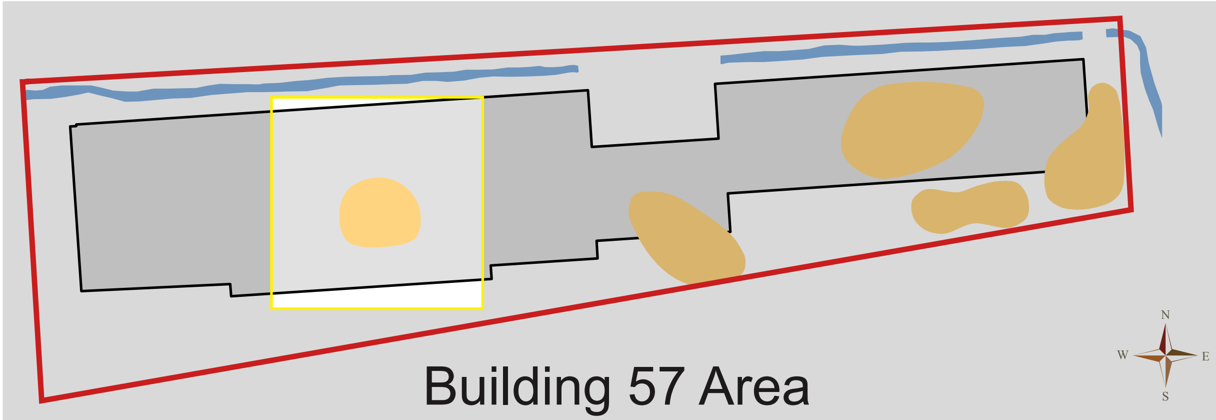

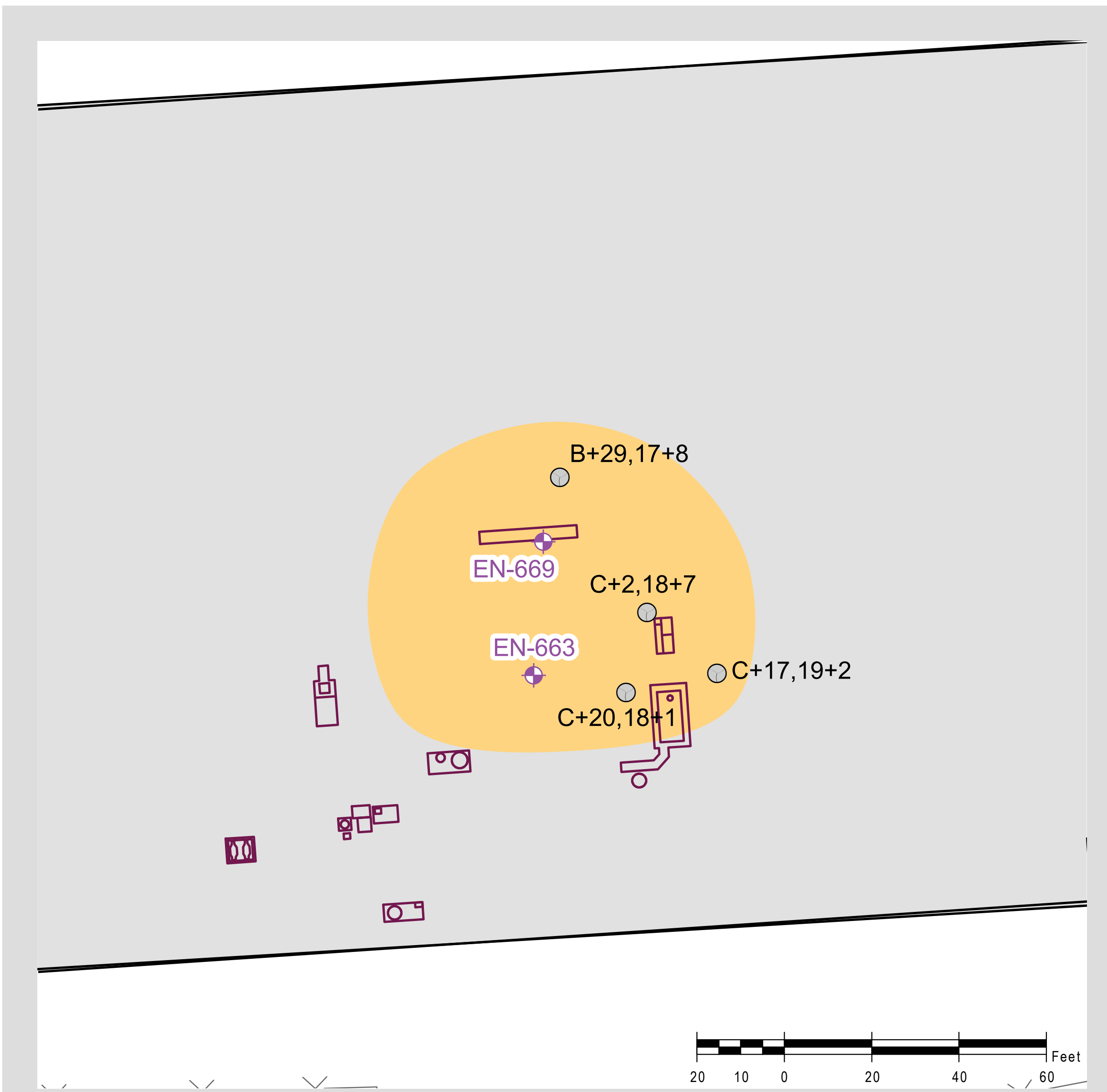

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This figure is a summary of soil sample analysis results generated as part of the Supplemental Remedial Investigation (SRI). It was prepared to complement a series of figures and text, and should be considered in that context. The concentrations shown represent the sum total of detected ethanes (1,1,1-trichloroethane and degradation by-products 1,1-dichloroethene and 1,1-dichloroethane) for each sample identified. Analytical laboratory results are documented in the Analytical Summary Reports (ASRs) that have been prepared and submitted to the Agencies. The stratigraphic limits are intended to represent generalized conditions across the source zone; actual conditions vary among locations.

Figure H.14

Summary of Chlorinated Ethanes Detected in Soil: Building 57 Area

Appendix H - Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

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Designed By: L. Jacob
Reviewed By: J. Ordway
Date: March 2010

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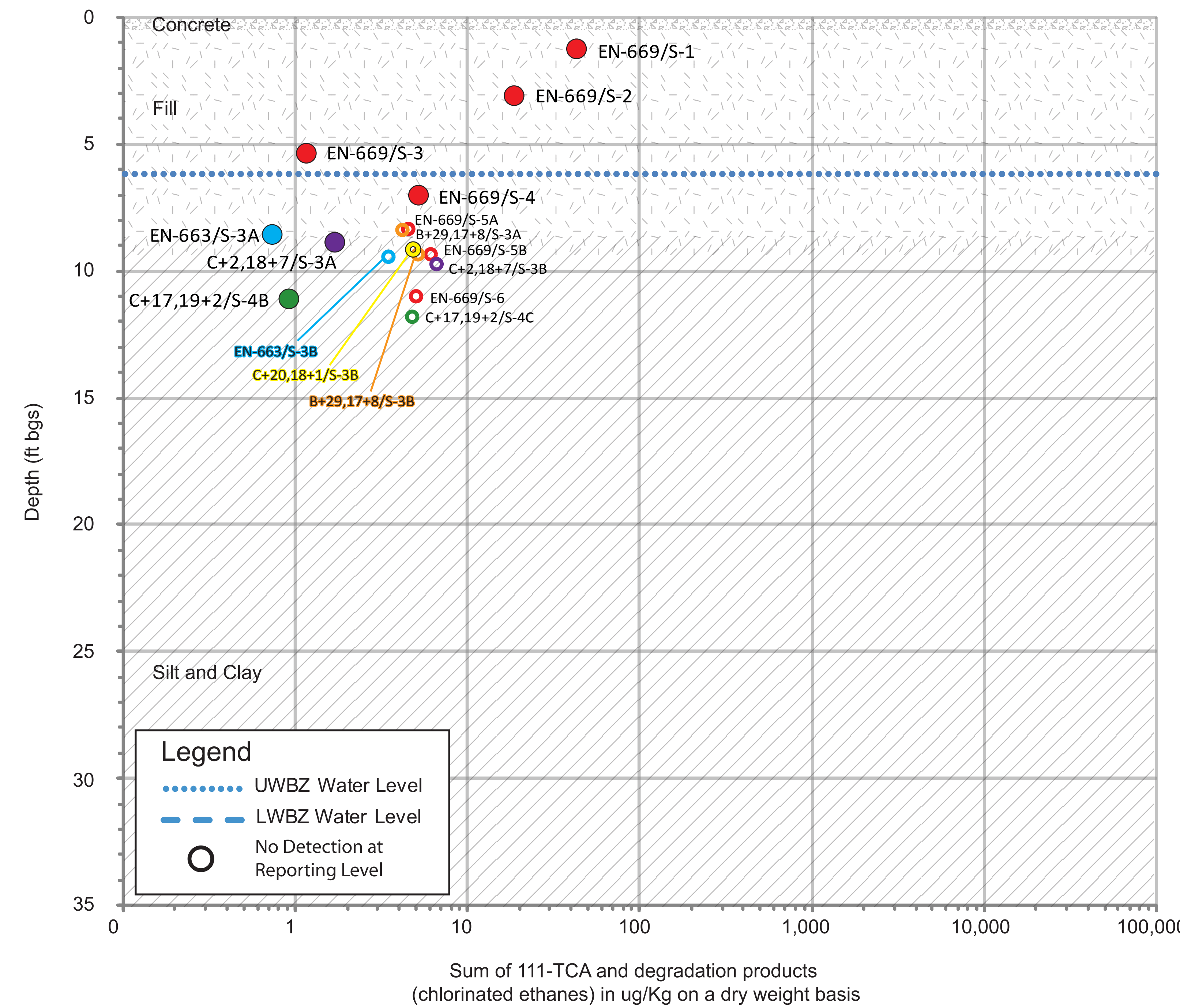

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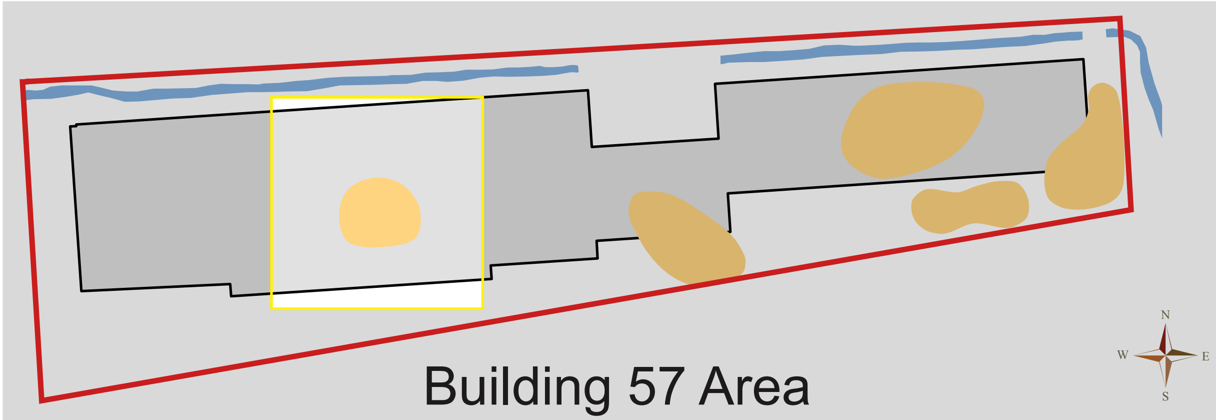

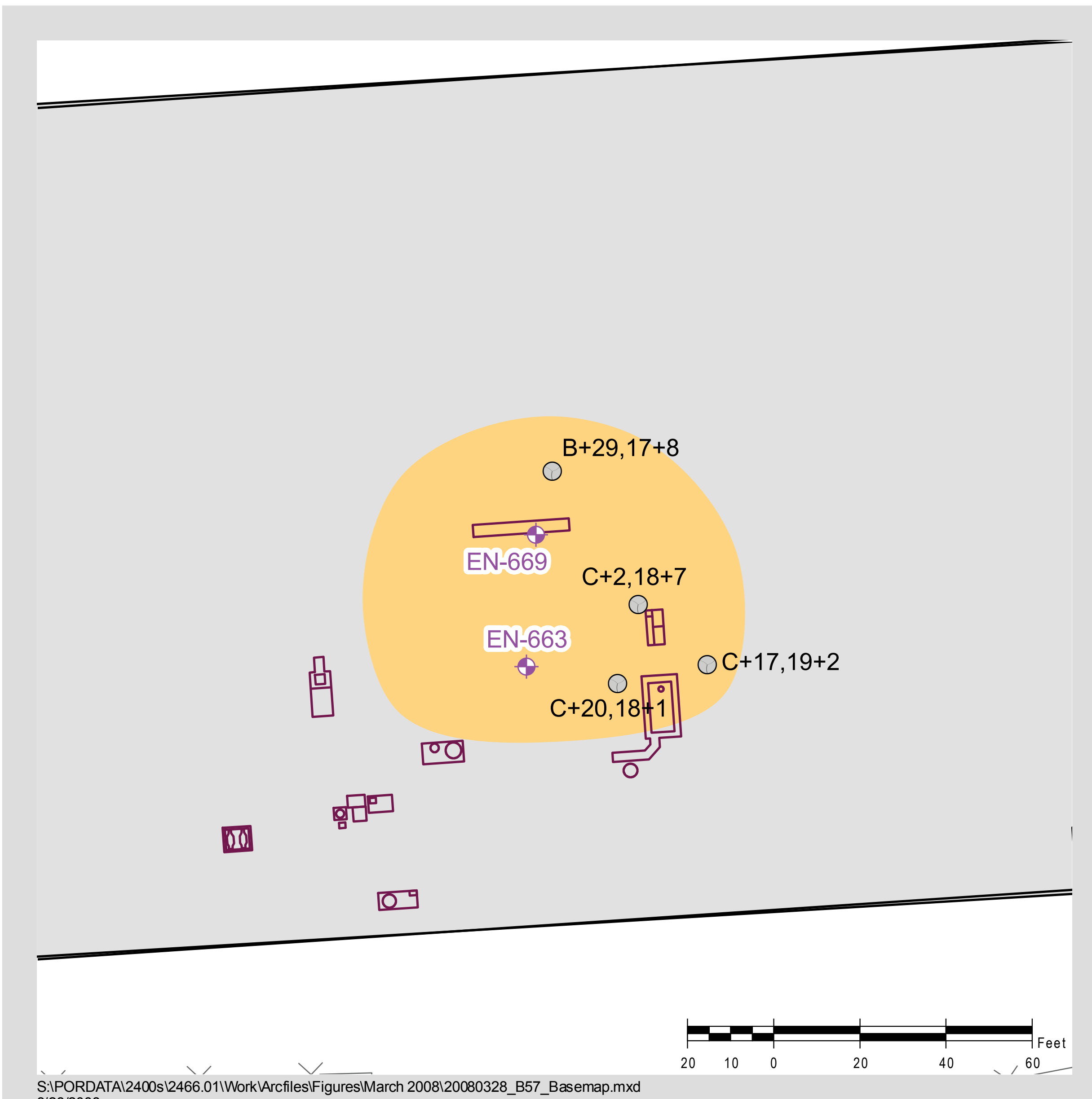

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Figure H.15

Summary of Chlorofluorocarbons Detected in Soil: Building 57 Area

Appendix H - Supplemental Remedial Investigation Report
OU#5/Building 57 Area
Union and Endicott, New York

Drawn By: J. Prellwitz/S. Warner
Designed By: L. Jacob
Reviewed By: J. Ordway
Date: March 2010

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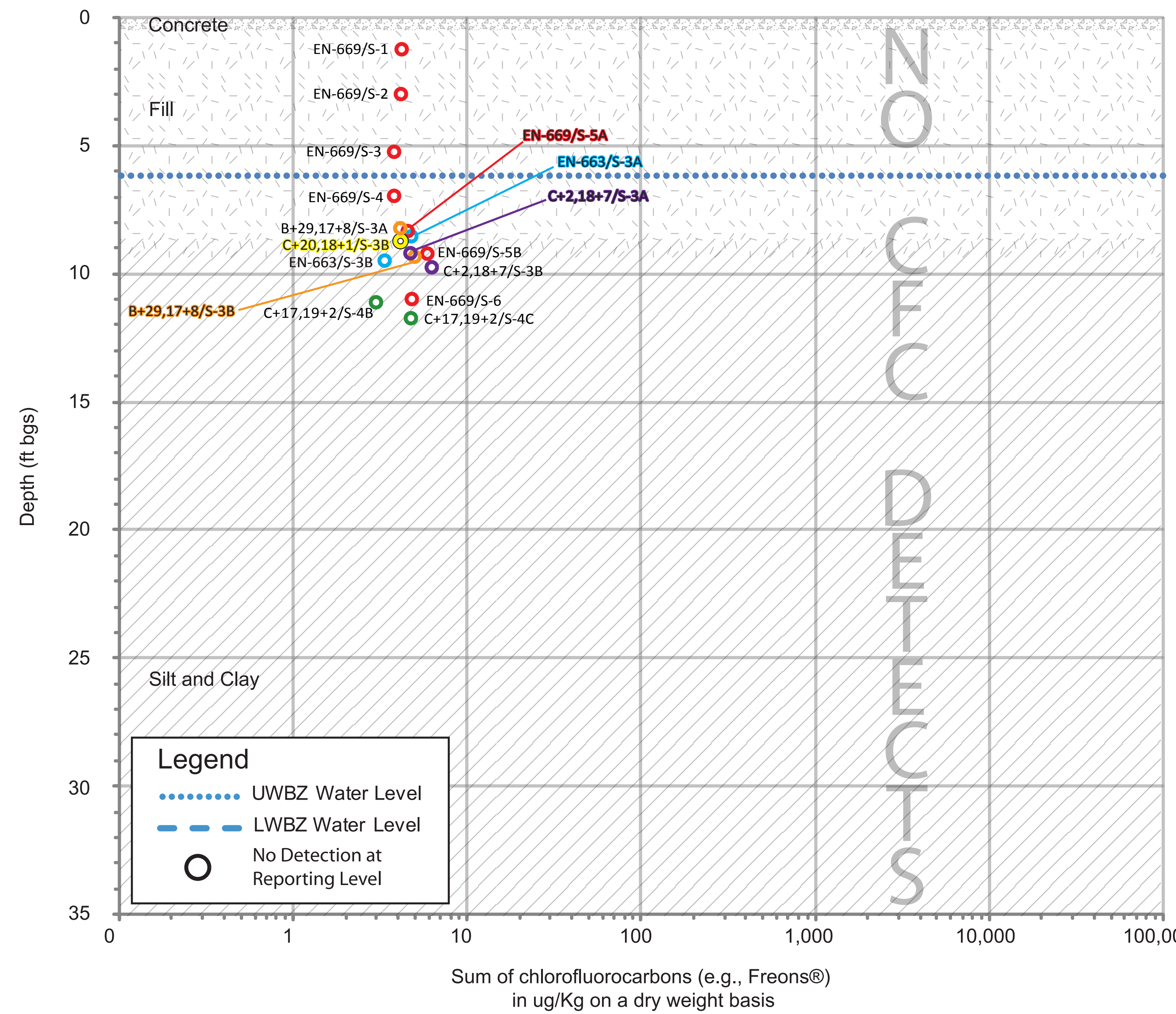

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APPENDIX I

MEMBRANE INTERFACE PROBE INVESTIGATION AND FINDINGS SUMMARY

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APPENDIX I
MEMBRANE INTERFACE PROBE INVESTIGATION AND FINDINGS SUMMARY

During the March 2009 Supplemental Remedial Investigation (SRI) field program, an elevated concentration of trichloroethene (TCE; 21,000 micrograms per kilogram [ug/kg]) was detected in shallow soil in the northeast corner of the Huron Lot #26 at soil boring B57-217. Sanborn, Head Engineering, P.C. (SHPC) retained Peak Investigations, LLC (PI) in June 2009 to conduct a Membrane Interface Probe (MIP) survey in the area of B57-217 to delineate the horizontal and vertical extent of elevated TCE concentrations in soil using real-time field data.

Refer to Section 3.0 of PI's June 15, 2009 "Membrane Interface Probe Investigation Report" (MIP Report; included As Attachment I.1) for a description of MIP technology. The following is a brief overview. The MIP is advanced into the subsurface using a direct push drilling rig. The probe heats the subsurface and uses a carrier gas to transport volatilized organic compounds to the surface. The gas is transported to a photoionization detector (PID) and electron capture detector (ECD) which are used to assess volatile organic compound (VOC) distribution with depth. A conductivity probe is also used to assess soil type with depth.

The MIP was advanced to about 5 to 6 feet into the silt and clay aquitard at 11 locations (refer to the SRI report text for discussion of stratigraphy). The survey was initiated in the area of B57-217, and MIP responses were used to select additional MIP exploration locations. For example, if the PID and ECD did not indicate the presence of VOCs at a particular location, it was assumed that the horizontal extent had been defined on that side of B57-217, and the next probe would be advanced on an alternate side of B57-217. Confirmatory soil samples were collected for laboratory analysis of VOCs from depths where PID and/or ECD responses indicated the potential presence of elevated concentrations of VOCs.

Refer to Section 4.0 of PI's MIP Report for a summary of results. MIP logs are included in Appendix A of the MIP Report. The results of MIP instrument responses and soil analytical data are presented on Figures I.1 and I.2, respectively. Soil analytical data were submitted in an analytical summary report during the SRI, and are included in Attachment B.2. Refer to the SRI report for further discussion.

FIGURES

Figure I.1 Lot 26 Membrane Interface Probe (MIP) Results
Figure I.2 Lot 26 Soil Results

ATTACHMENTS

Attachment I.1 Membrane Interface Probe Investigation Report, Peak Investigation, June 15, 2009

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FIGURES

Figure I.1 – Lot 26 Membrane Interface Probe (MIP) Results

Figure I.2 – Lot 26 Soil Results

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Figure I.1

Lot 26 Membrane Interface Probe (MIP) Results

Supplemental Remedial Investigation
OU#5 Building 57 Area

Union and Endicott, New York

Drawn By: J. Pierce
Designed By: J. Sanborn
Reviewed By: J. Ordway
Date: March 2010

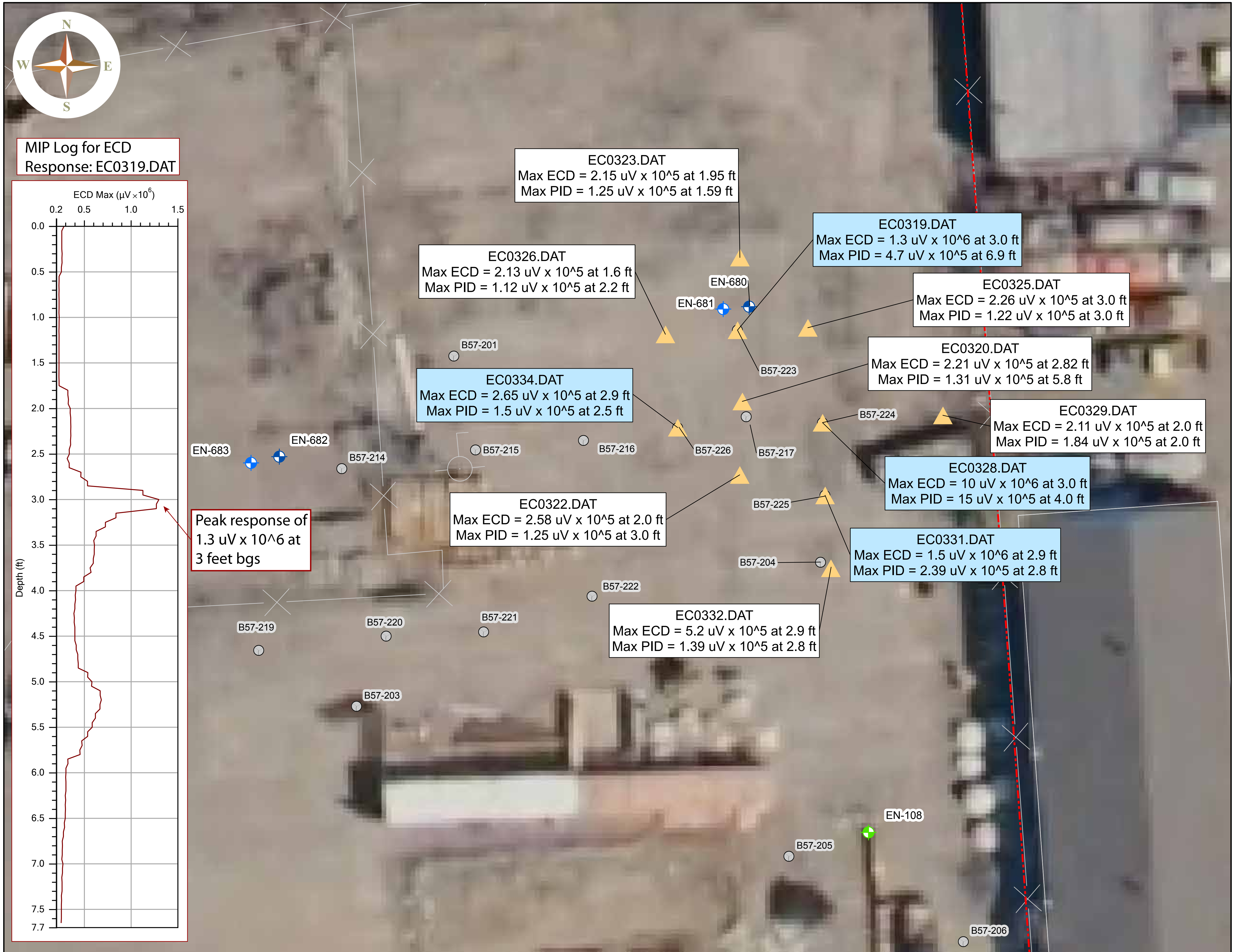

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Figure Narrative:

This figure shows the maximum photoionization detector (PID) and electron capture detector (ECD) responses (uV), and the associated depths where those responses were encountered, for each of the MIP locations.

Shaded boxes indicate that a soil sample was collected from a boring adjacent to the MIP location to speciate and quantitate VOCs at those locations/depths. These typically coincide with the maximum MIP responses detected during the program. In addition, one soil sample was collected from a location with low MIP responses (e.g, EC0334), to help establish background VOC concentrations.

Legend

- MIP Location
- Soil Boring
- Deep Monitoring Well
- Lower Water Bearing Zone Monitoring Well

10 5 0 10 20 30 Feet

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Figure I.2

Lot 26
Soil Results

Supplemental Remedial Investigation OU#5 Building 57 Area

Union and Endicott, New York

Drawn By: J. Pierce
Designed By: J. Sanborn
Reviewed By: J. Ordway
Date: March 2010

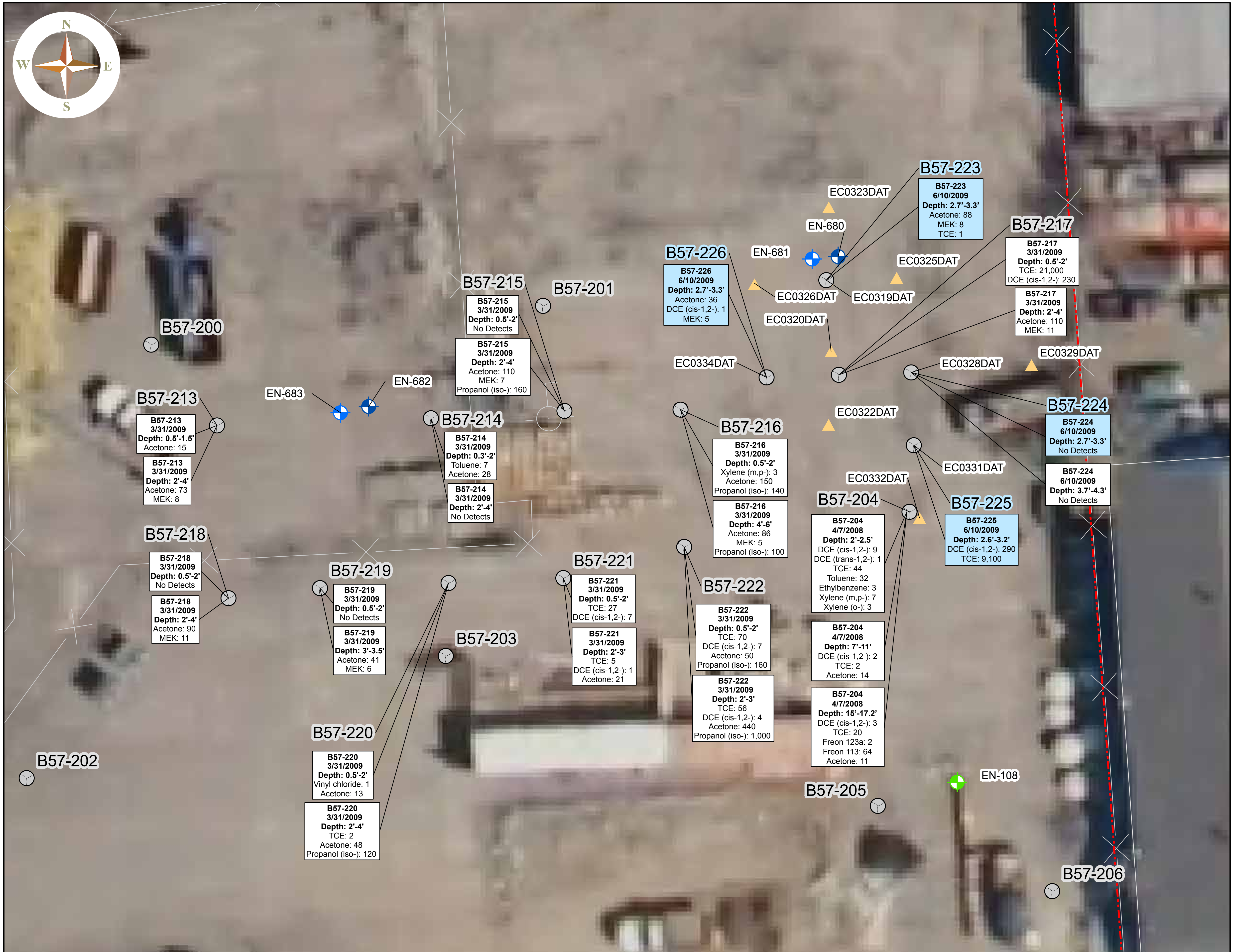

Figure Narrative:

This figure presents VOC detections in soil samples from borings conducted in March and June 2009. The borings shaded in blue were advanced adjacent to membrane interface probe (MIP) locations to speciate and quantitate MIP responses. The units for all concentrations are in ug/kg.

Legend

- Soil Boring
- Membrane Interface Probe (MIP) Location
- Deep Monitoring Well
- Lower Water Bearing Zone Monitoring Well

Feet: 10 5 0 10 20 30

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ATTACHMENT I.1

Membrane Interface Probe Investigation Report
Peak Investigation
June 15, 2009

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Membrane Interface Probe Investigation Report

OU 5
Endicott, New York

Prepared for:
Sanborn Head Associates, Inc.

Prepared By:

Peak Investigations, LLC.
163 Burns Way
Fanwood, New Jersey

June 15, 2009

Table of Contents

Jennifer Sanborn
Sanborn Head Associates, Inc.
June, 2009

1.0 Introduction

On June 10, 2009 Peak Investigations, LLC (PI) and Environmental Probing, Inc. completed eleven borings with the Membrane Interface Probe (MIP) at the property identified as Operating Unit #5 on North Avenue in Endicott, New York. The purpose of the MIP investigation was to determine the location and extent of volatile organic compounds (VOCs) and in the shallow (less than seven feet) subsurface.

2.0 Background

Based on information supplied to PI, prior investigations have indicated the presence of clVOCs at the subject property. The primary compound of concern is trichloroethylene, a commonly used industrial solvent. The Electron Capture Detector (ECD) employed by PI is sensitive to this compound with a lower detection limit of approximately 150 µg/kg. The Photo-ionization detector (PID), while less sensitive than the ECD, will also indicate the presence of the target chlorinated compounds and other volatile compounds. The shallow geology of the site was described as two feet of fill overlying a silty clay with some sand.

3.0 Technical Overview

The investigation was conducted utilizing a Membrane Interface Probe equipped with a Conductivity Probe. The MIP is a Geoprobe driven device that heats the subsurface media to volatilize organic compounds. The MIP collects gas samples from the subsurface through a hydrophobic membrane that is located within the heating element. The gas samples are transported via an inert carrier gas to a Photo-ionization detector (PID) and an Electron Capture Detector (ECD) mounted in a laboratory grade Hewlett Packard 5890 Gas Chromatograph (GC).

Contaminant distribution at this site is interpreted from the response of the PID and ECD. The PID uses ultraviolet light as a means of ionizing an analyte introduced into a chamber by the carrier gas. The ions produced by this process are collected by electrodes. A greater the number of ions on the electrodes allows a higher voltage. The voltage is a measure of the analyte concentration and is recorded by the GC and plotted against depth.

The ECD has a small radioactive source (Ni63) that emits beta particles into a chamber. The beta particles strike the Nitrogen molecules in the carrier gas and free electrons. These electrons are used to maintain a constant electrical current through the ECD chamber. As electro-negative chlorinated compounds are encountered in the subsurface and subsequently introduced into the chamber, they reduce the number of available electrons. To maintain a constant current with fewer available electrons, the ECD must increase voltage. The voltage fluctuations are recorded in microvolts by the GC and subsequently plotted against depth to portray the vertical distribution of chlorinated compounds

Jennifer Sanborn
Sanborn Head Associates, Inc.
June, 2009

The Conductivity Probe is used to give an indication of the nature of the subsurface materials. The probe emits a low voltage alternating current to measure the conductivity of the media in contact with the probe body. Voltage measurements are taken every 0.05 seconds and transitions between subsurface materials will be indicated by increases or decreases in conductivity. In general, clay is more conductive than sand. The conductivity is plotted against depth which allows correlation of sands and clays between borings.

During this investigation a highly conductive material was encountered in the fill material. This caused the conductivity probe to record an extremely high response masking the normal response. For the purposes of this investigation the extremely high data representing this conductive material has been removed so that lower responses associated with the native material are not discernable on the graphs.

The MIP also provides a constant measure of temperature at the probe heating element. These measurements are also collected every 0.05 seconds and are plotted against depth. As the probe enters the saturated zone some cooling of the probe occurs which gives an indication of the water table depth. The conductivity, temperature, and detector logs are included as Appendix A.

Over time the quality of the hydrophobic membrane used in the MIP probe will degrade. As a quality control measure, response tests are conducted periodically to provide validation of the ECD and PID data. The response test consists of submerging the MIP in water containing a known concentration of a target compound. The ECD and PID response are tested with 1 ppm, solution of trichloroethene. The results of the response tests are included as Appendix B. If the response test indicate a membrane is no longer viable (i.e. response < 50,000microvolts) it is replaced and the test is repeated.

During this investigation there were no issues with the response tests, however in boring MIP 332 the data recorder shutdown unexpectedly and the boring was terminated at 5.25 feet below ground surface (bgs).

4.0 Summary

Data from the MIP is recorded electronically in a spreadsheet format. The boring data (i.e. ECD, PID, etc) are plotted against depth. The response test data are plotted against time. Each boring and response test is recorded as a separate sequential file. The probe is advanced at a rate of one foot per minute and continuous responses of the ECD and PID are recorded. For the purposes of this report PID and ECD responses are described as follows:

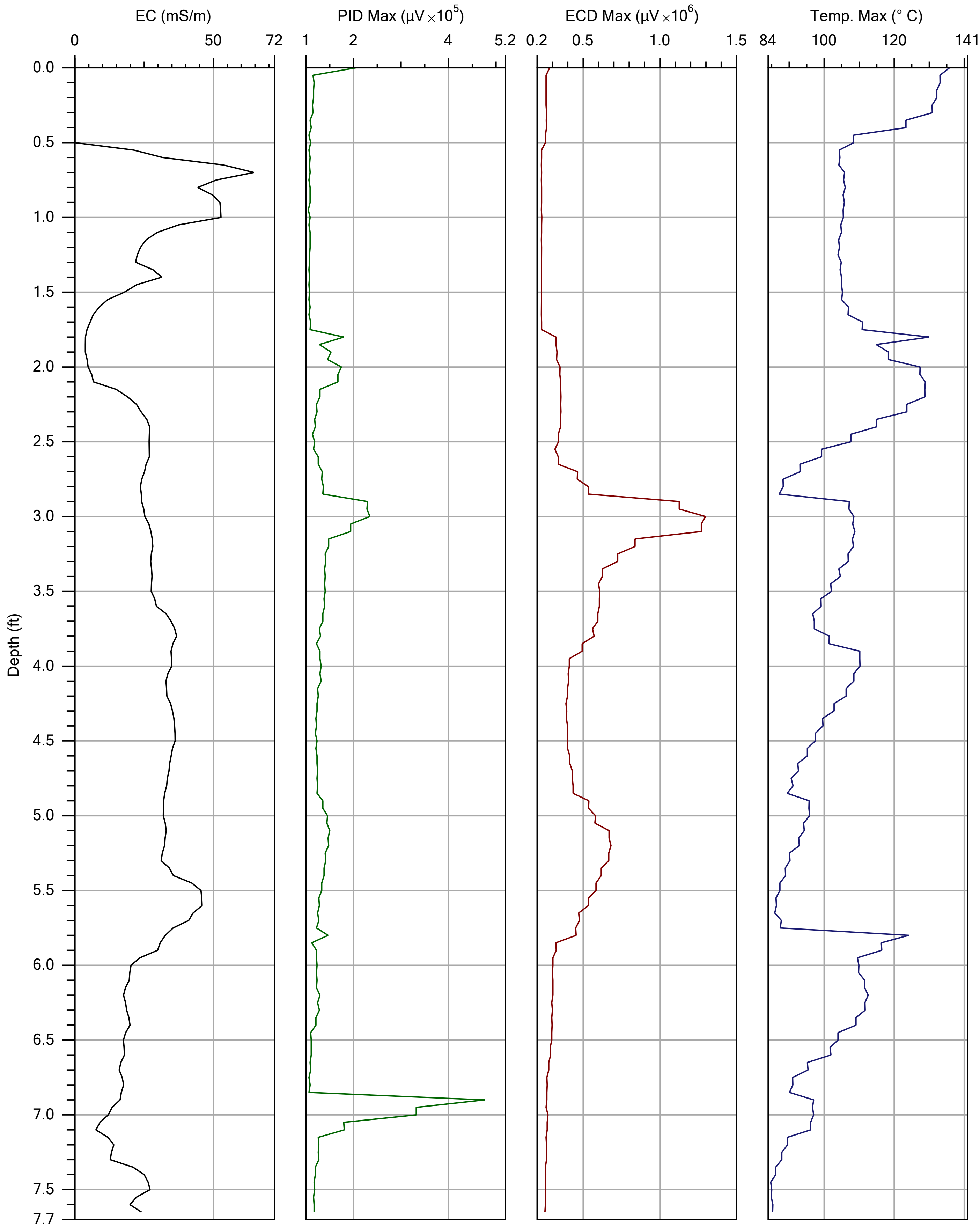
0 = No Response – no significant deviations from baseline (<10,000 microvolts);
1 = Minimal – a discernible response at or near the detector's lower detection limit (>10,000 microvolts < 100,000 microvolts);

2 = Moderate – (>100,000 microvolts <1,000,000 microvolts);

3 = Intermediate – (>1,000,000 microvolts <5,000,000 microvolts);
4 = Significant – a very strong response but the reading is not at maximum (>5,000,000 microvolts<14,000,000 microvolts); and,
5 = Maximum – the detectors have reached the maximum reading of 14,000,000 microvolts (ECD) or 25,000,000 microvolts (PID).

For this project the highest ECD response recorded was approximately 10 million microvolts from 2.9 feet bgs in boring MIP328. This boring also recorded the highest PID response of greater than 15 million microvolts from 4 to 4.3 feet bgs. Surrounding borings indicated lesser (one to two million microvolts on the ECD) to no response at these depth intervals indicating that MIP 328 is at or near the highest concentration of VOCs.

APPENDIX A



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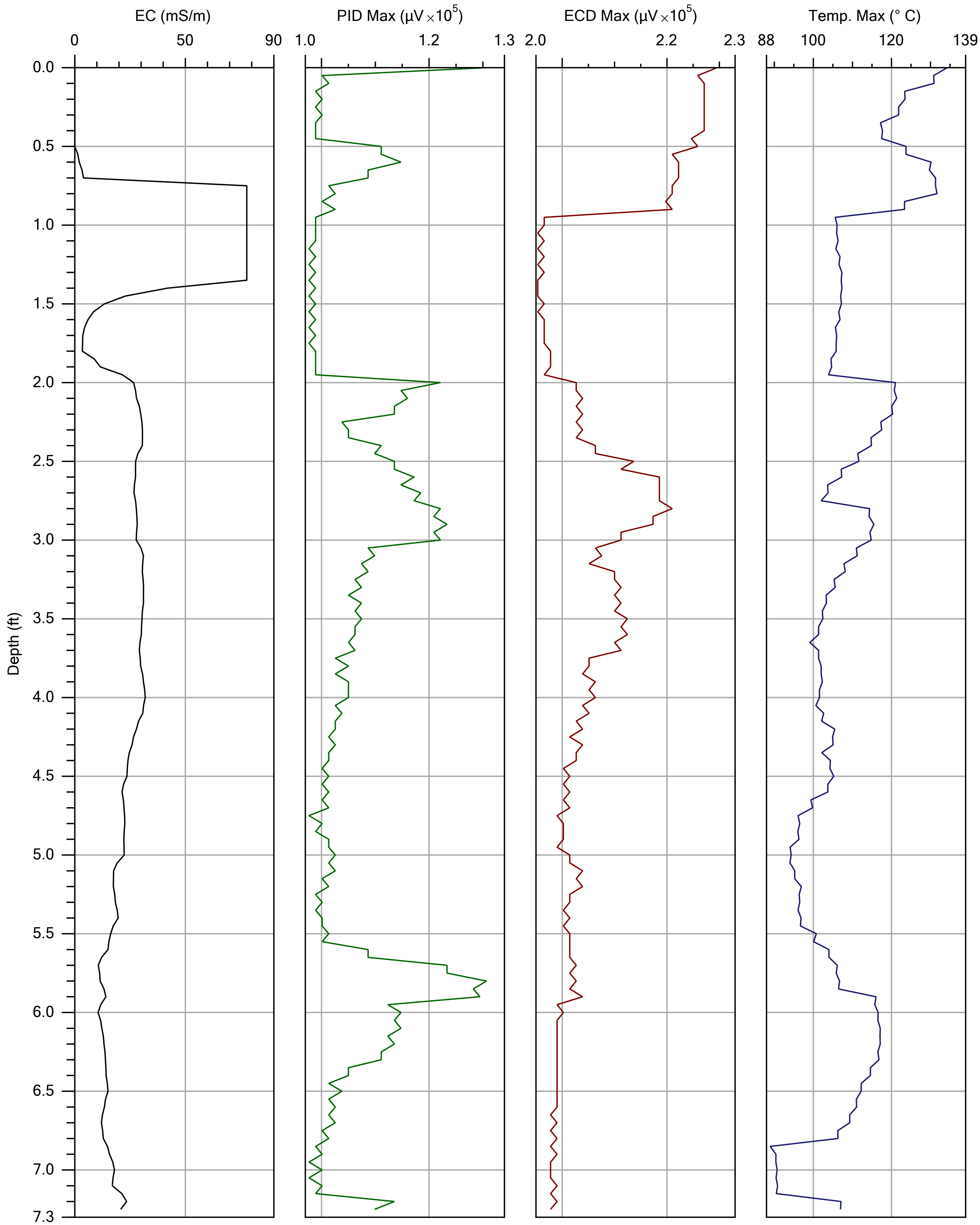

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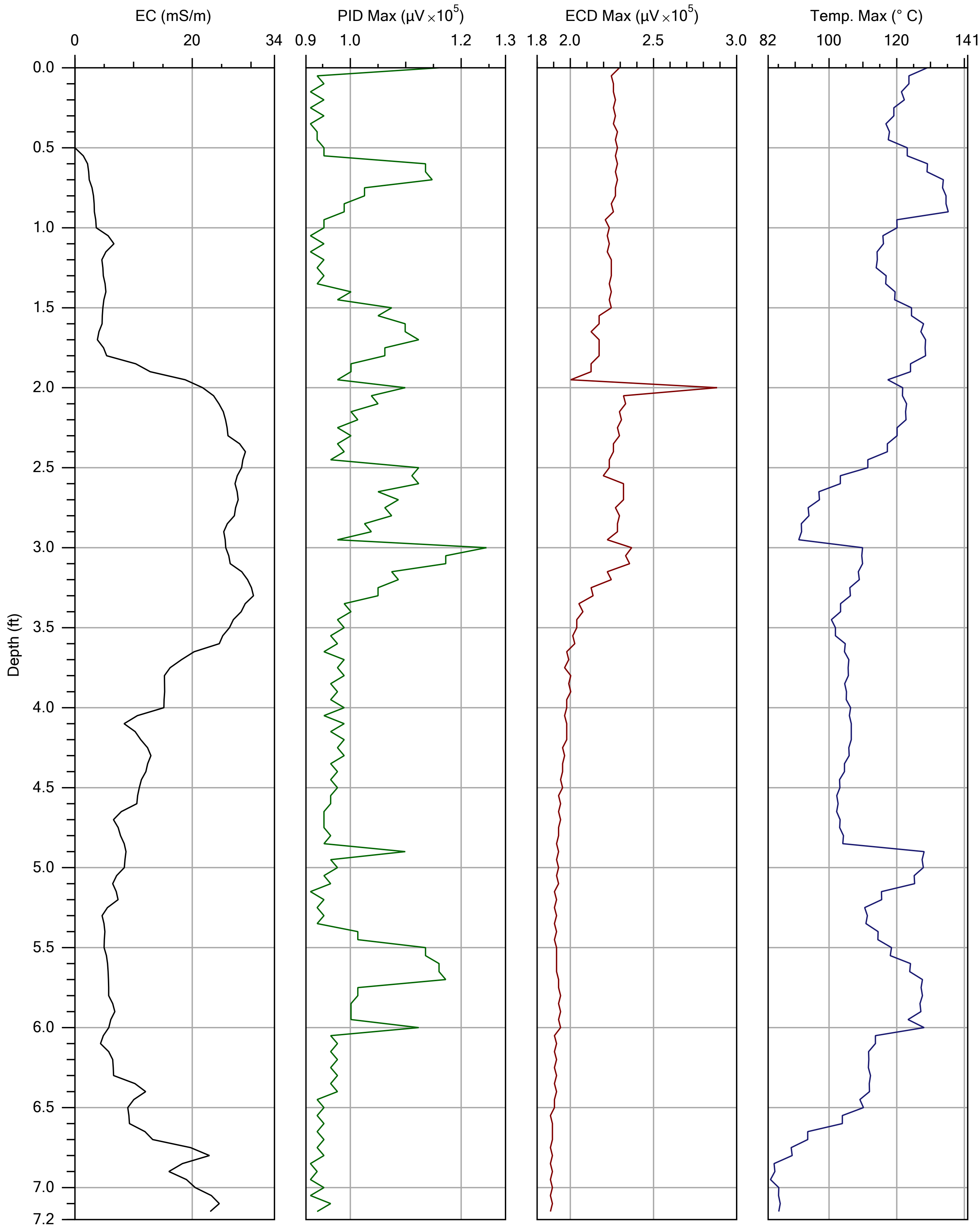

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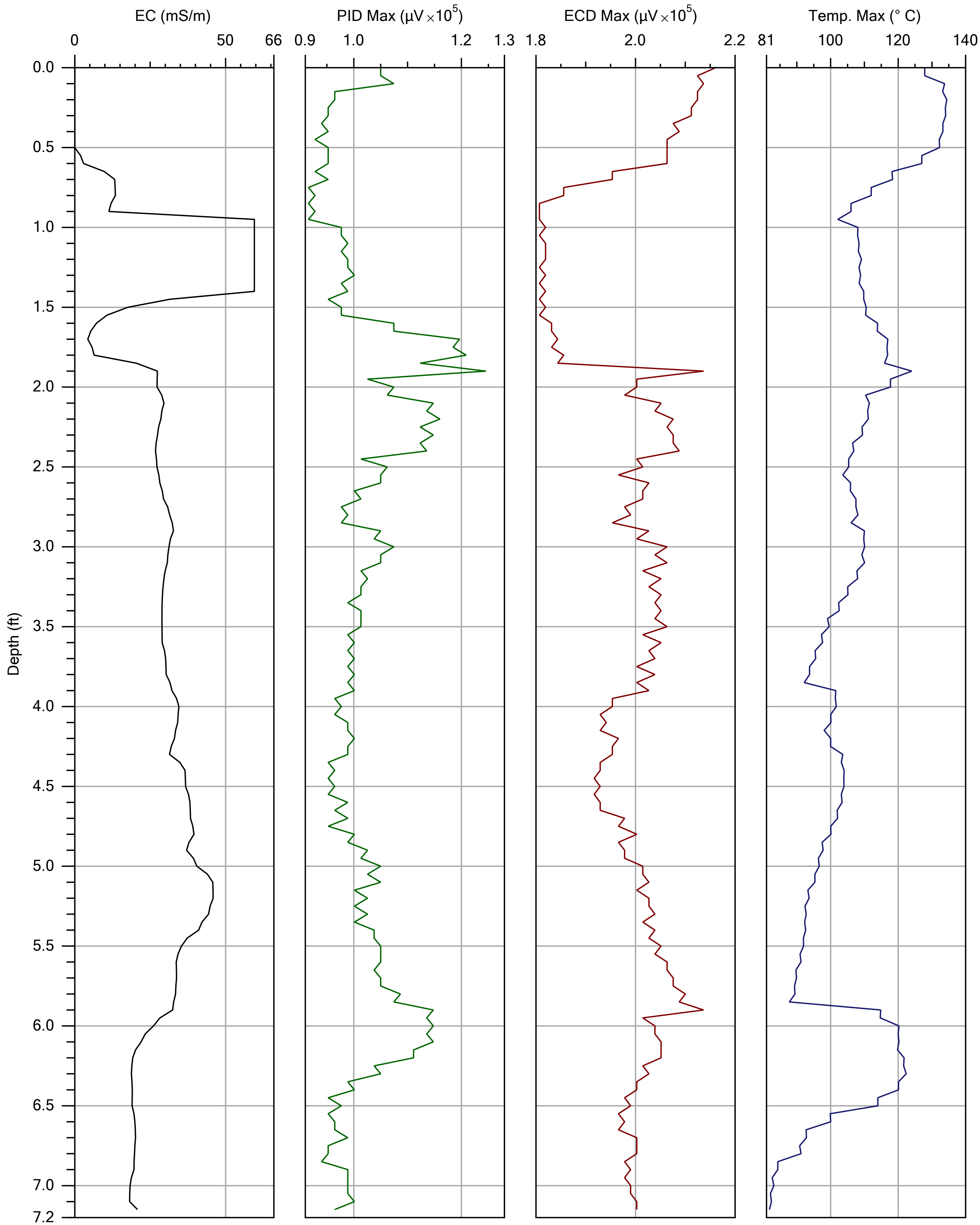

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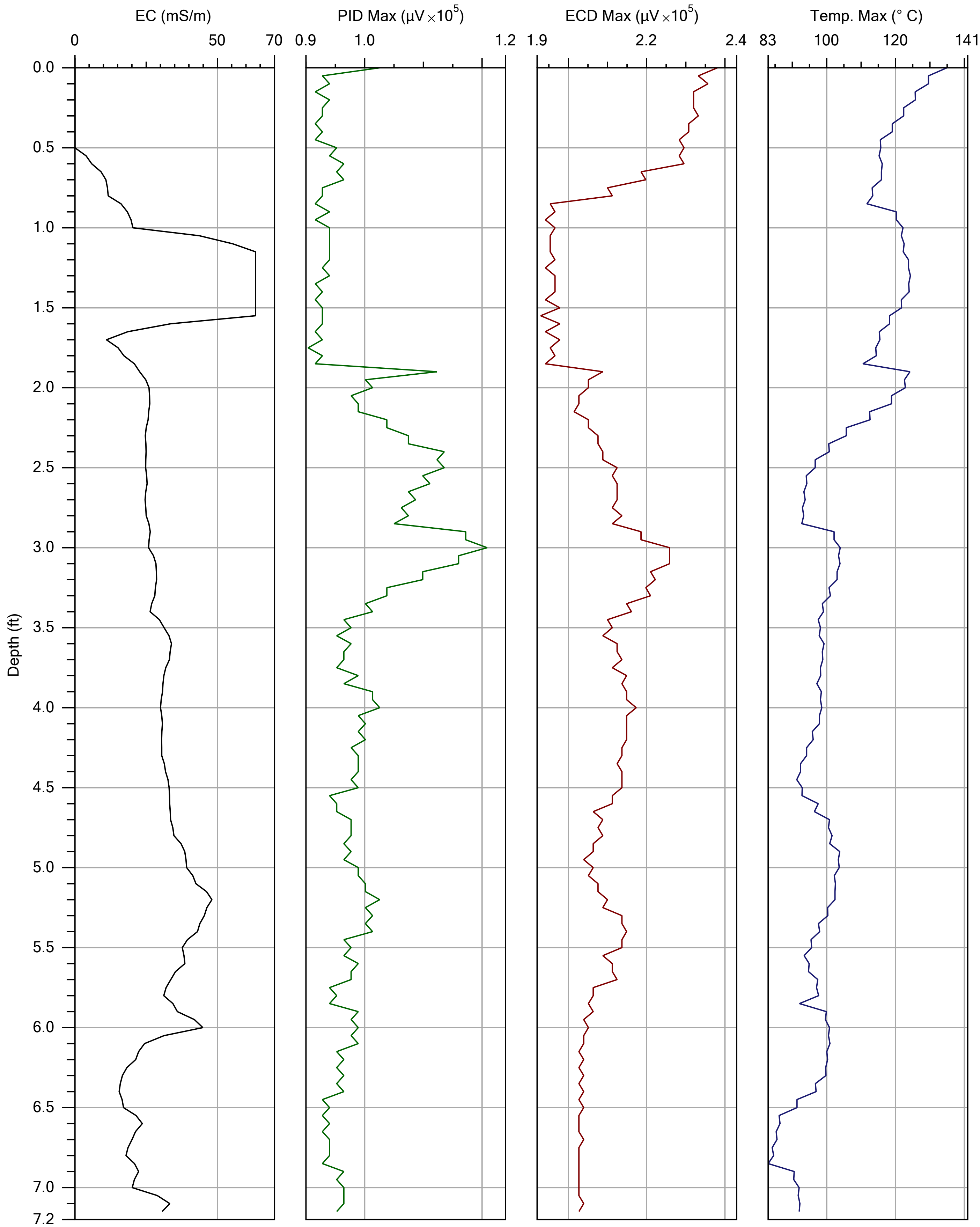

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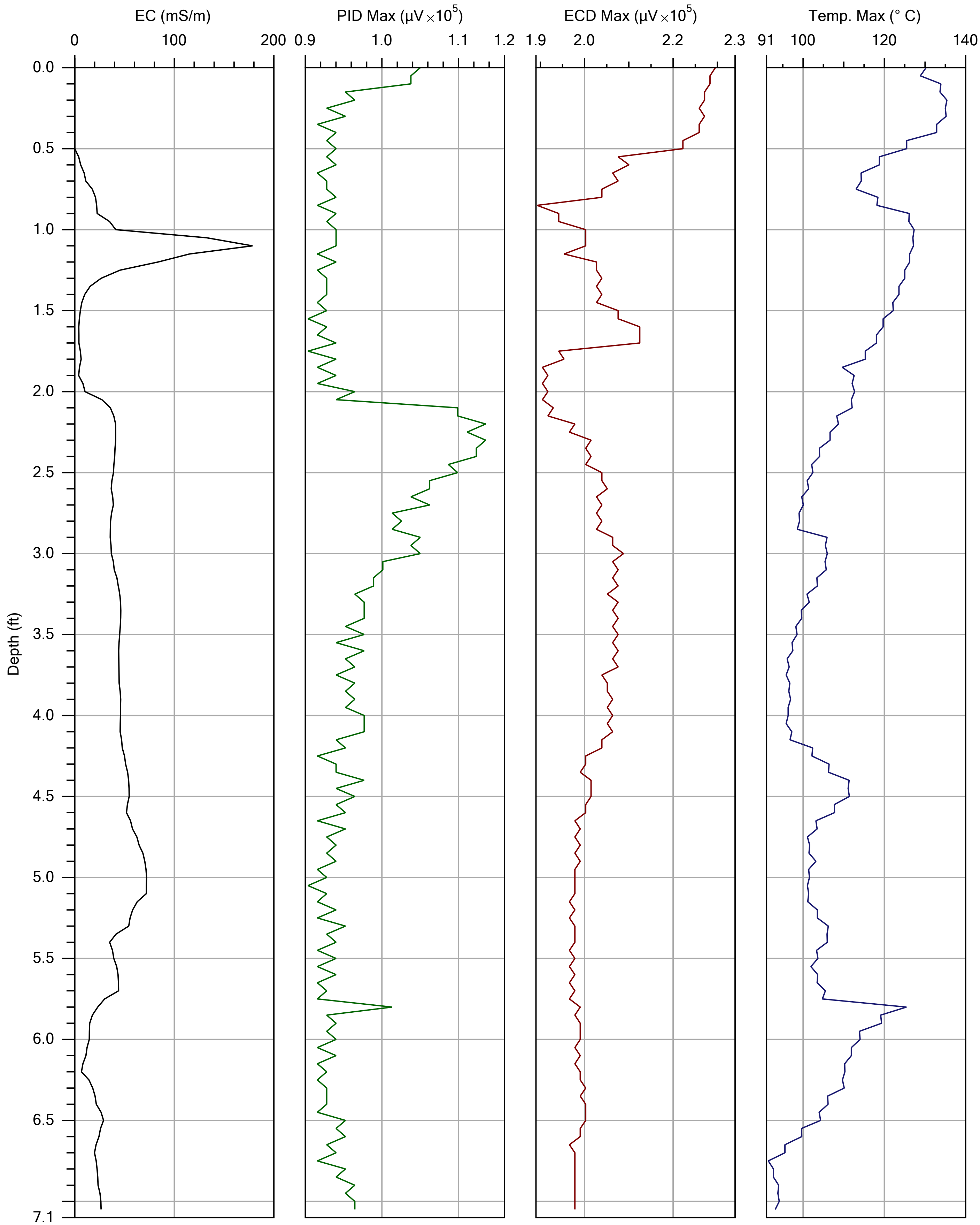

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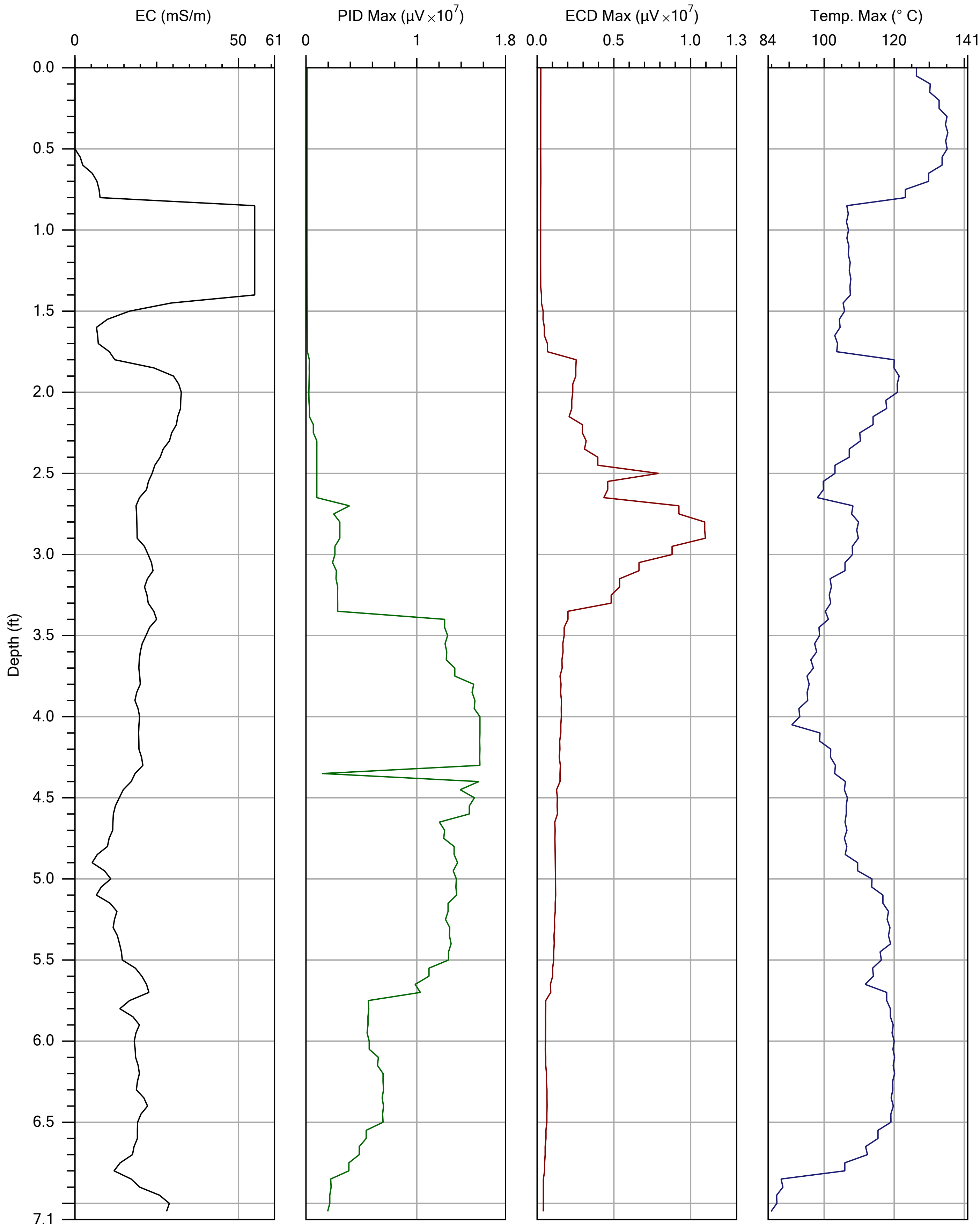

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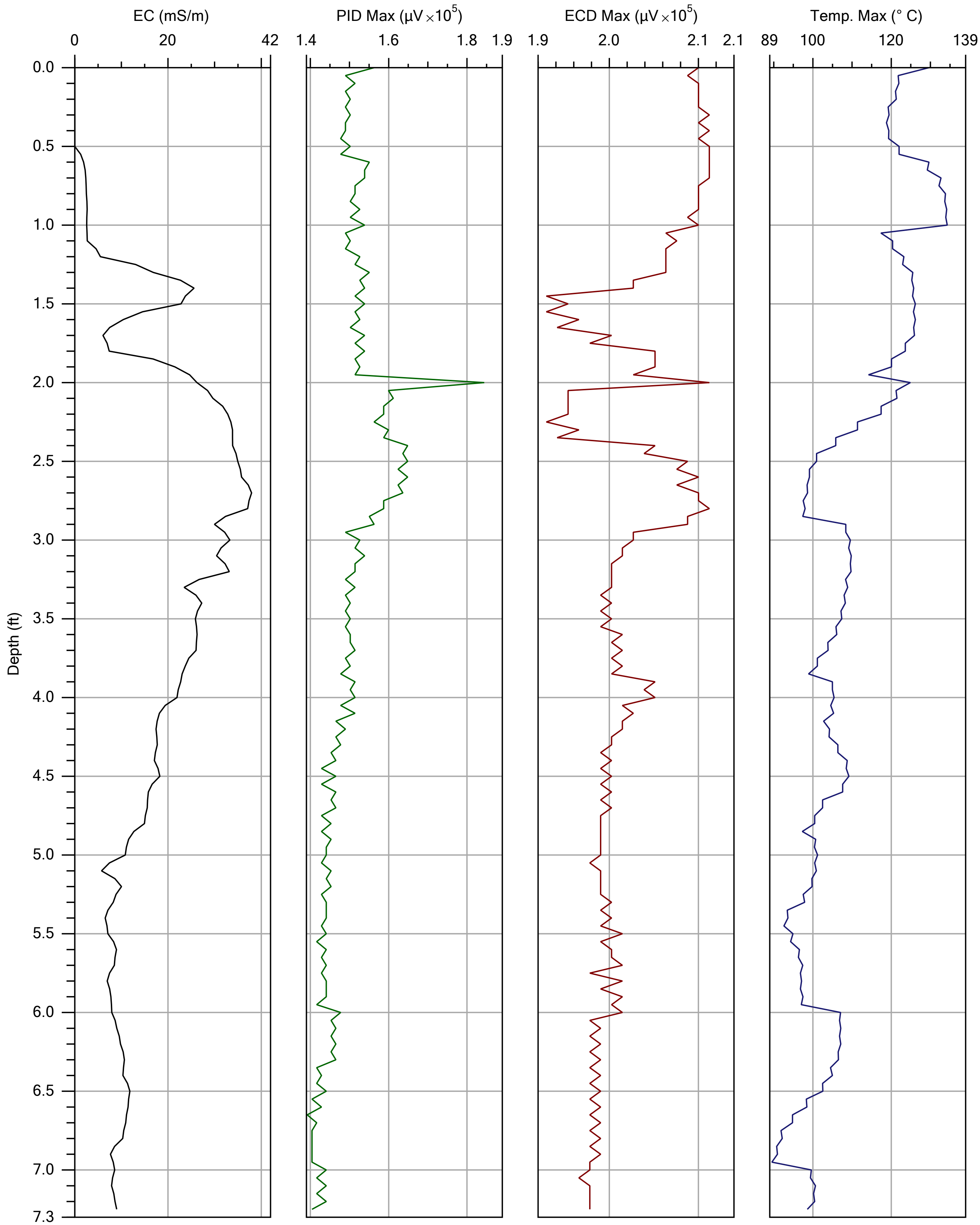

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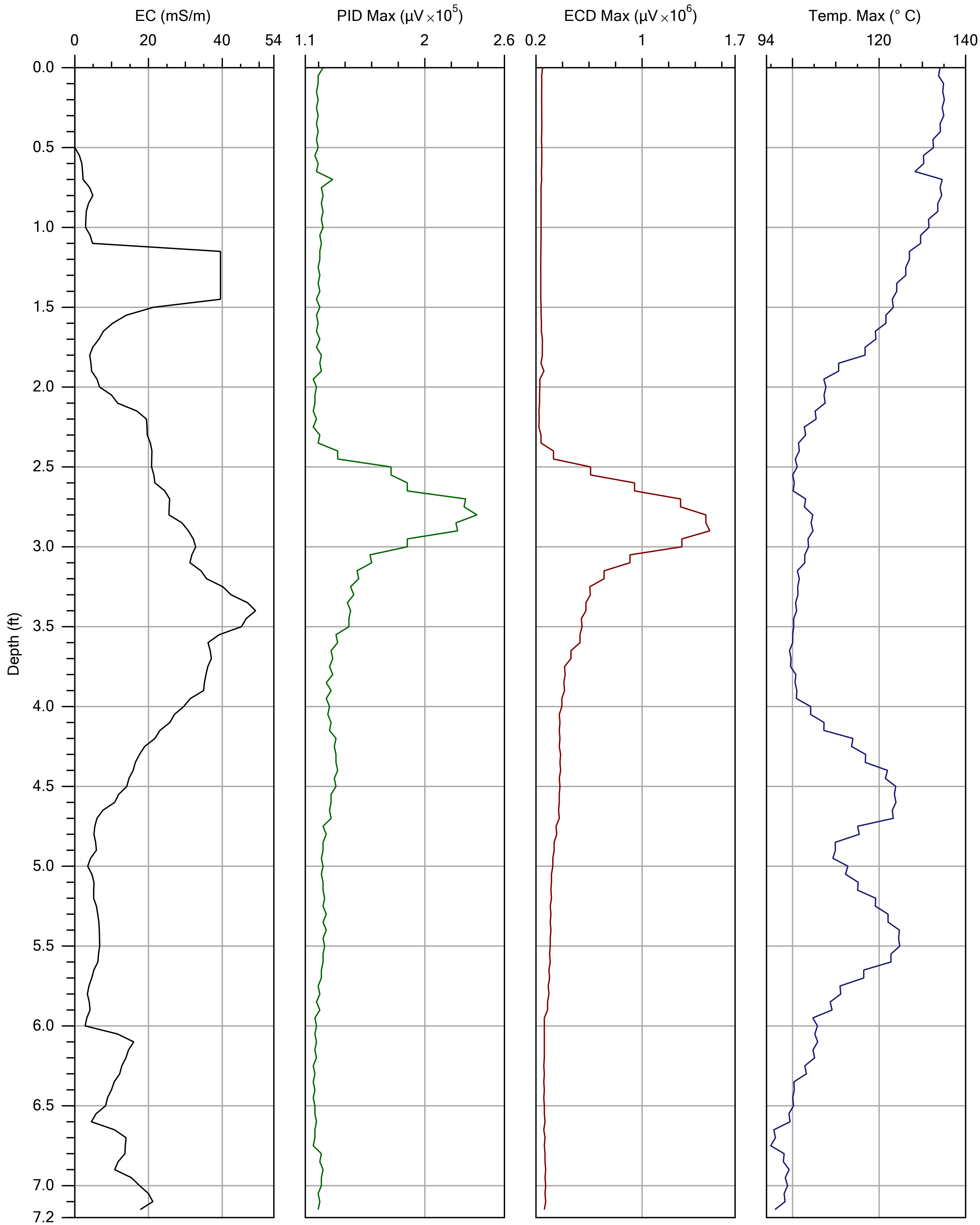

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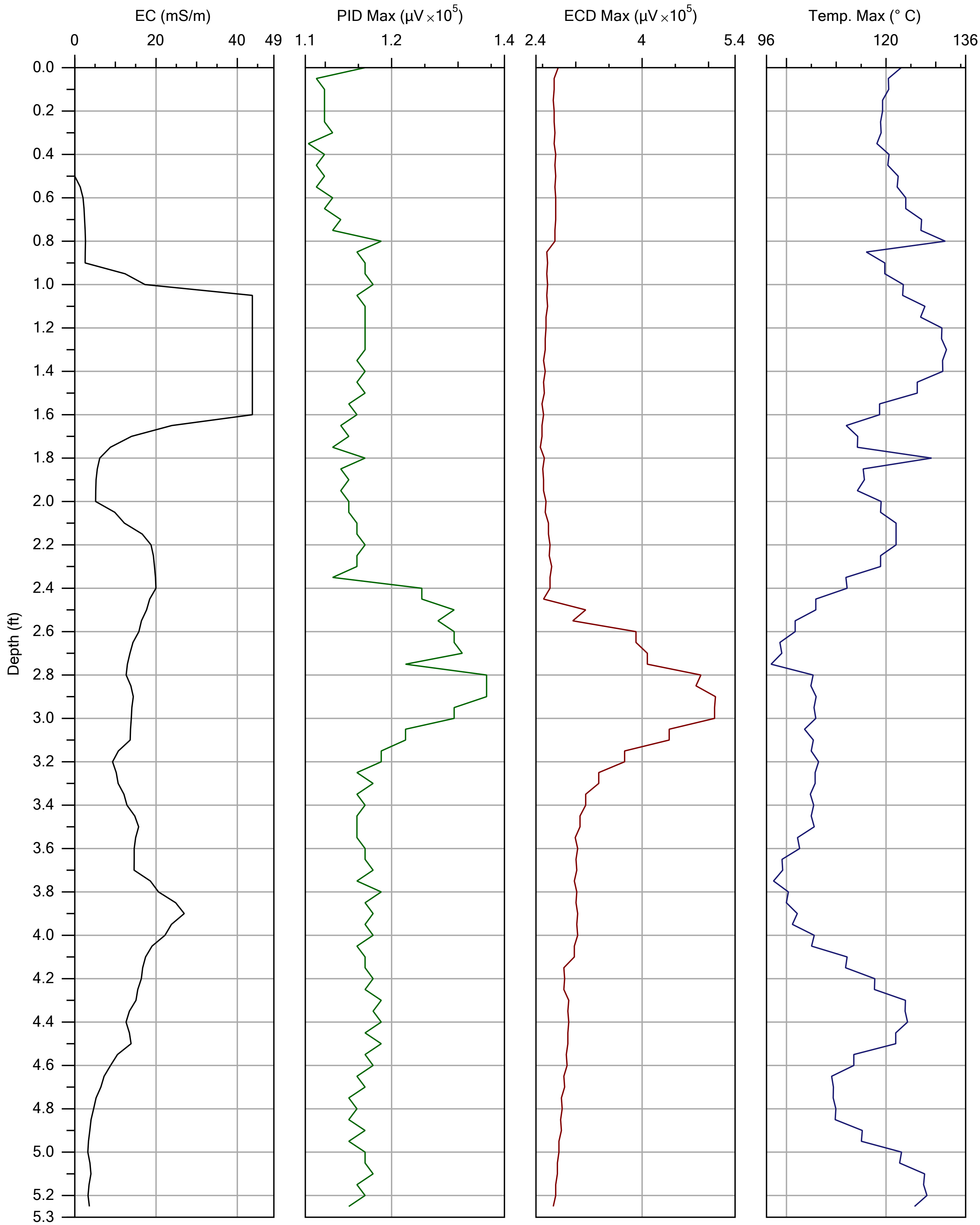

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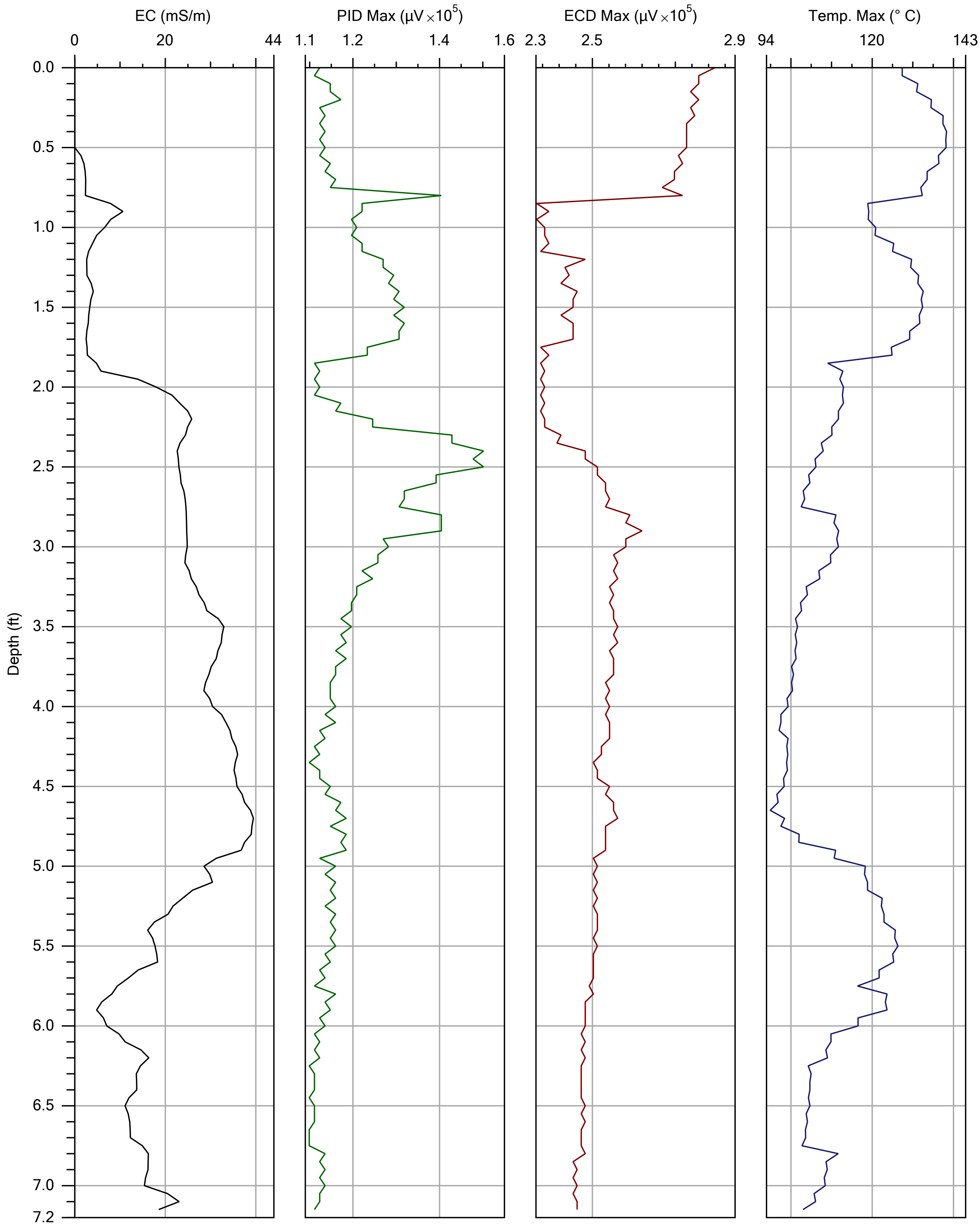

PEAK INVESTIGATIONS LLC

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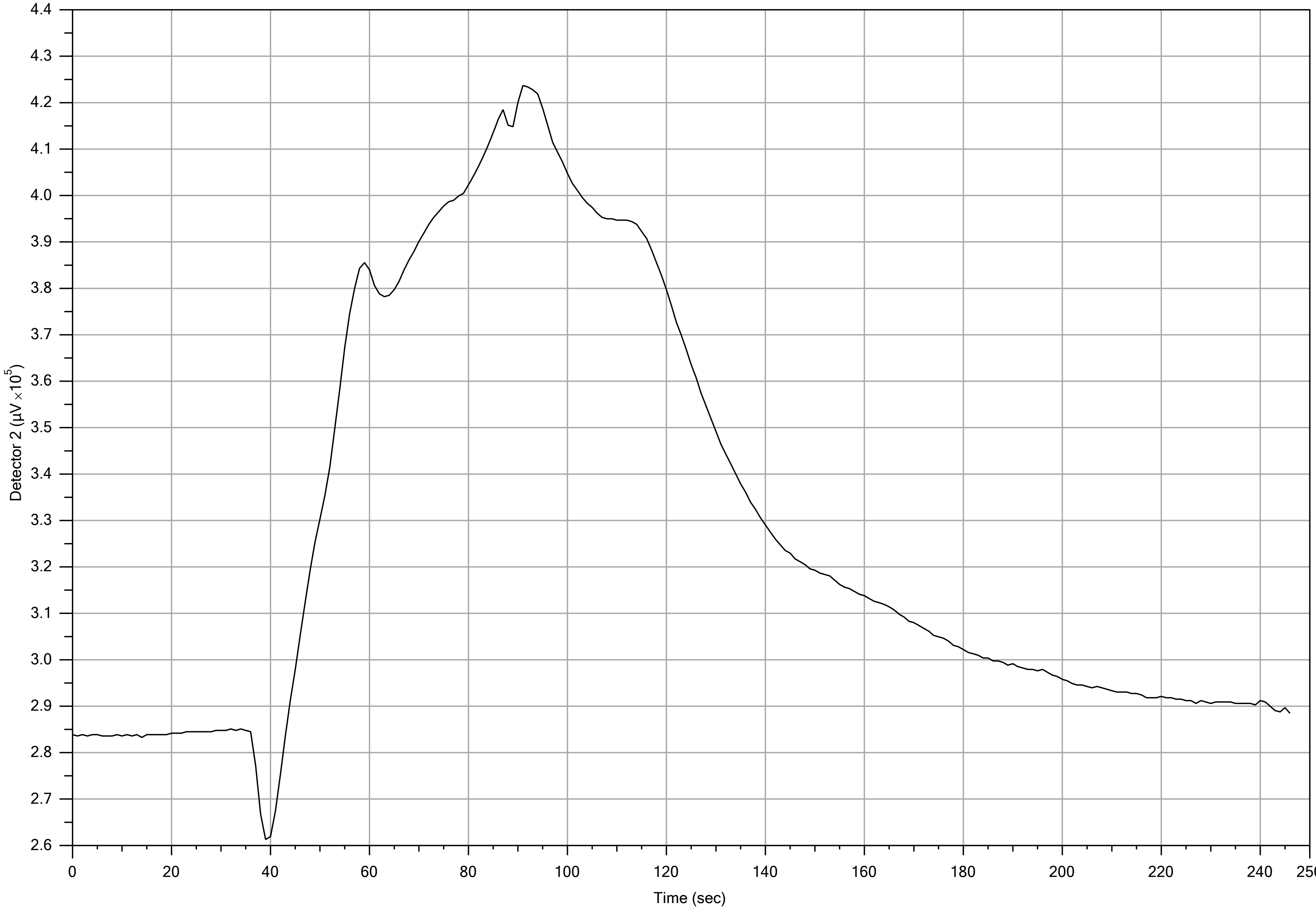
Project ID:	Client: Sanborn Head Assoc.	Location:

APPENDIX B



PEAK INVESTIGATIONS LLC

PRE-LOG RESPONSE

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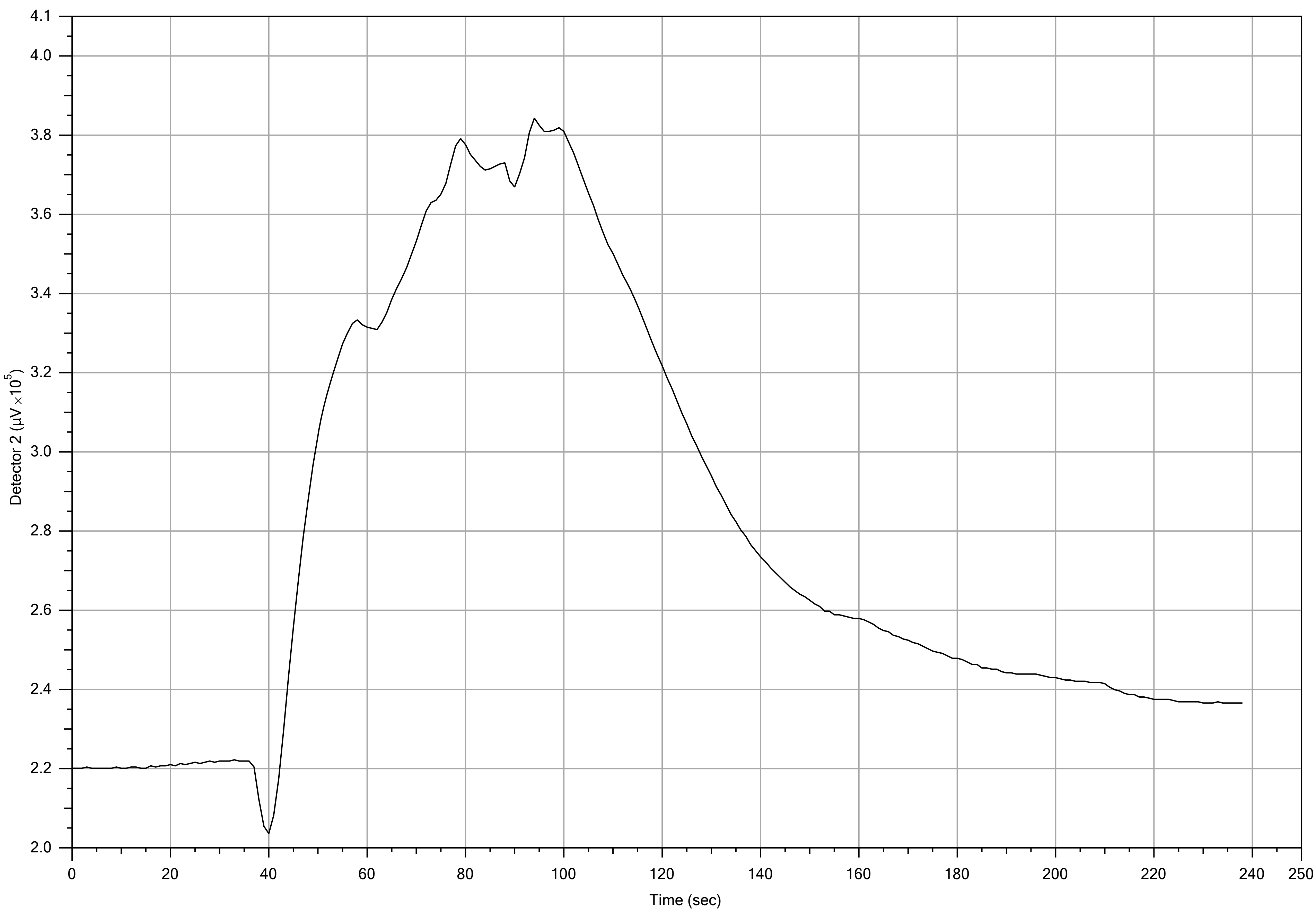
Project ID:	Client: Sanborn Head Assoc.	Compound: TCE	Peak Response: 423687.4 µV



POST-LOG RESPONSE

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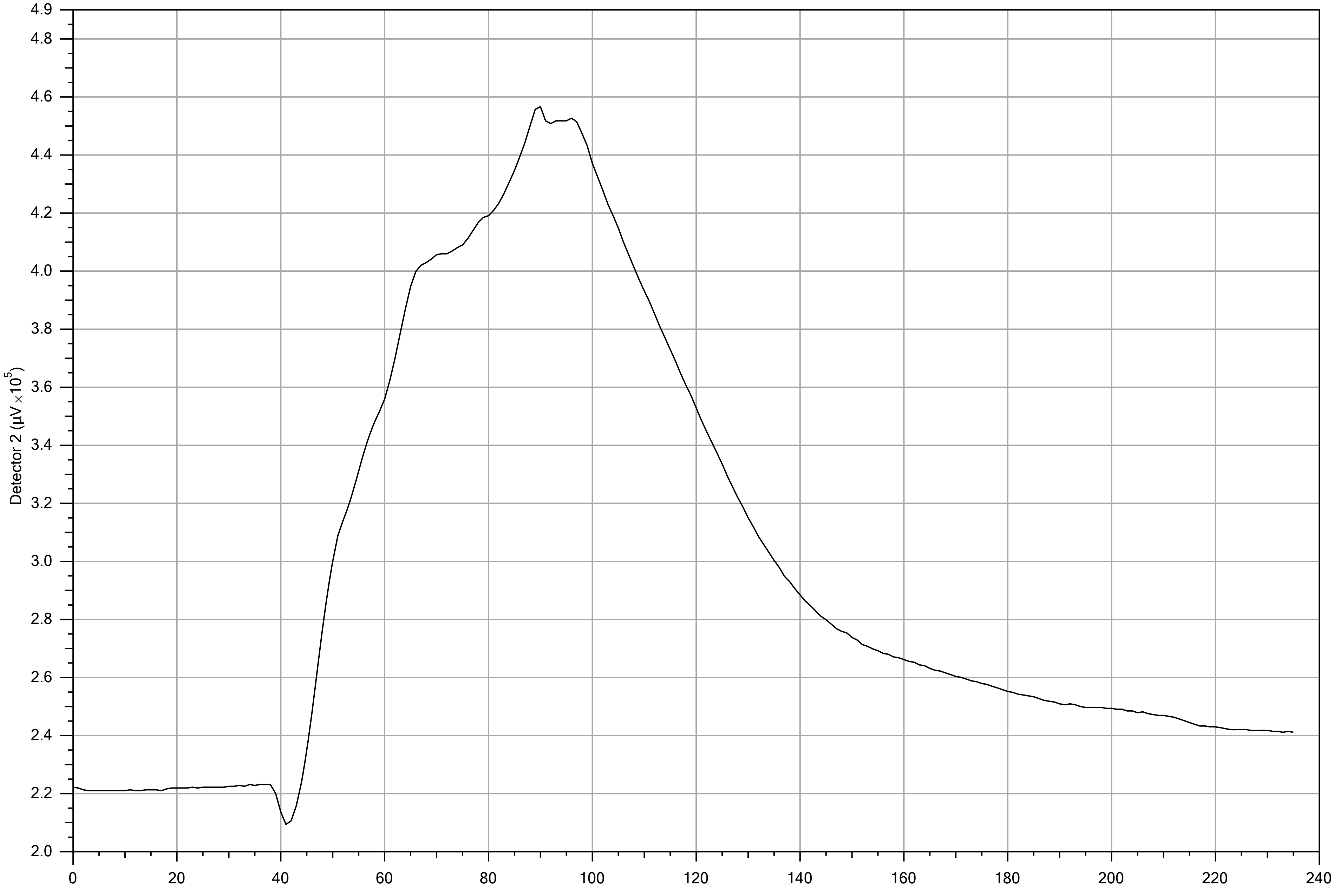
Project ID:	Client: Sanborn Head Assoc.	Compound:	Peak Response: 384310.1 μV



PRE-LOG RESPONSE

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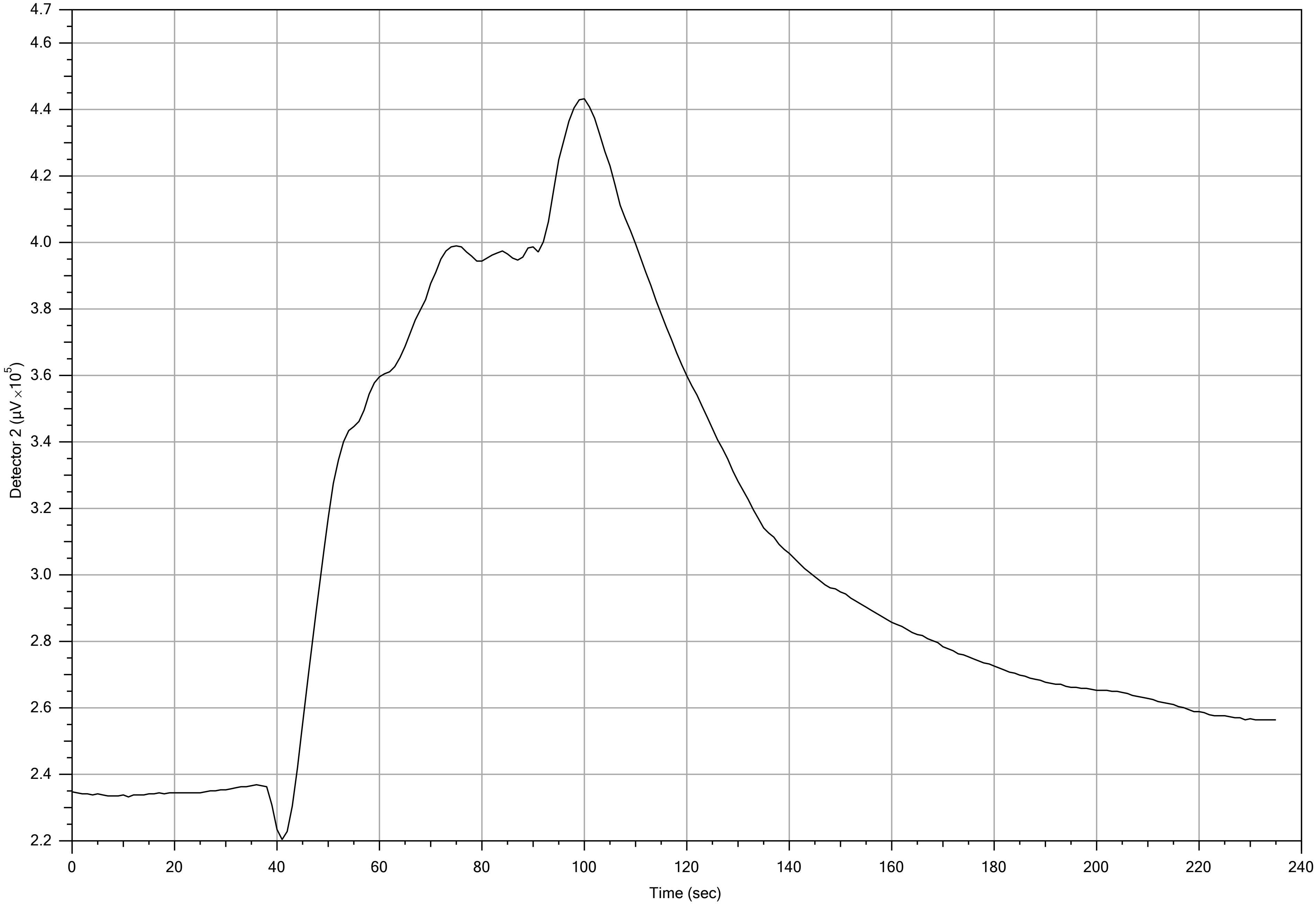
Company: Peak Investigations LLC	Operator: T Armstrong	Detector: ECD	Concentration: 1 ppm
Project ID:	Client: Sanborn Head Assoc.	Compound: TCE	Peak Response: 456654.4 μV



PEAK INVESTIGATIONS LLC

PRE-LOG RESPONSE

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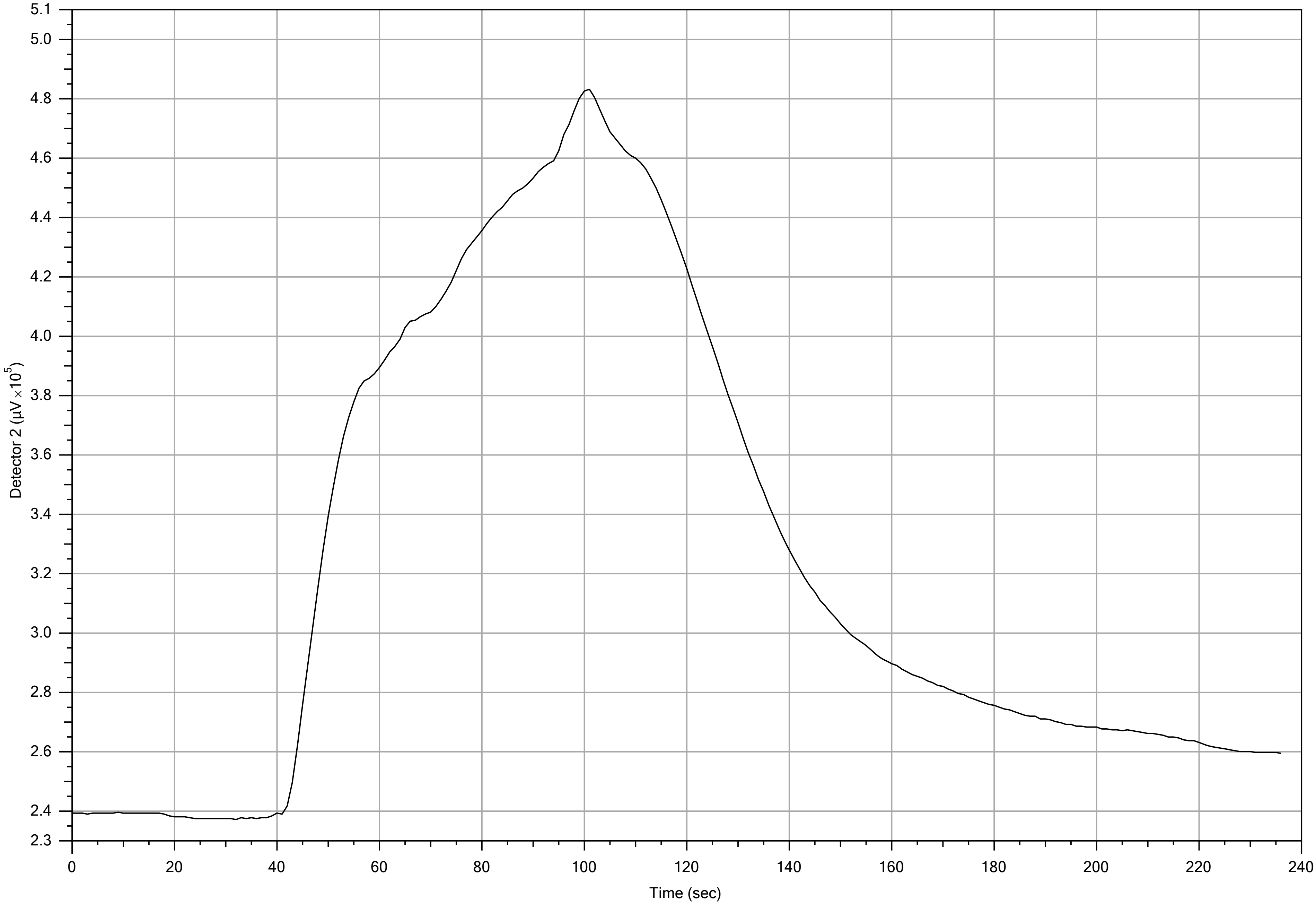
Project ID:	Client: Sanborn Head Assoc.	Compound: TCE	Peak Response: 443223.4 µV



PEAK INVESTIGATIONS LLC

PRE-LOG RESPONSE

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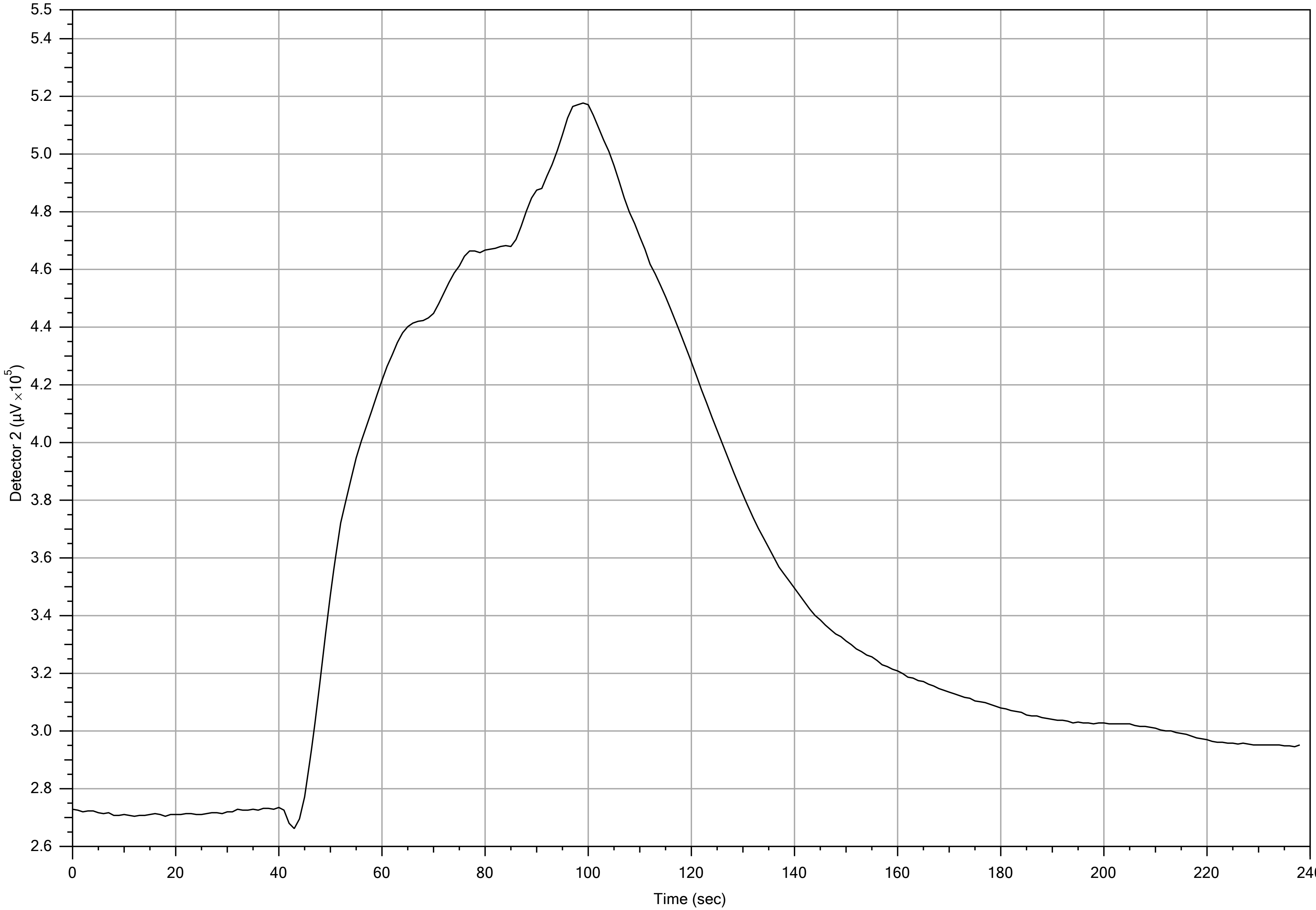
Project ID:	Client: Sanborn Head Assoc.	Compound: TCE	Peak Response: 483211.2 µV



POST-LOG RESPONSE

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Company: Peak Investigations LLC	Operator: T Armstrong	Detector: EC	Concentration: 1 ppm
Project ID:	Client: Sanborn Head Assoc.	Compound: TCE	Peak Response: 517704.5 µV

APPENDIX J

SUMMARY OF VOC MASS DISTRIBUTION, GROUNDWATER FLOW, AND MASS FLUX ESTIMATES

SHPC ENGINEERS

APPENDIX J
SUMMARY OF VOC MASS DISTRIBUTION, GROUNDWATER FLOW, AND MASS FLUX ESTIMATES

J.1 INTRODUCTION

This appendix summarizes quantitative mass estimates of chlorinated volatile organic compounds (VOCs) in the soils and groundwater at OU#5/Building 57 Area (the site), and estimates of groundwater flow conditions, including advective seepage velocities, travel times, volumetric groundwater flow and mass "flux". Assessment was conducted using commonly accepted hydrogeologic principles, hydraulic properties estimated from site investigation activities, and VOC concentrations data from routine sampling and monitoring. Mass estimates were approximated from concentrations of chlorinated VOCs detected in soil gas, soil, and groundwater samples collected during site investigation activities and subsequent groundwater monitoring events. Groundwater flow and mass flux conditions were derived using hydraulic properties estimated from soil samples and recovery curves recorded during slug and pumping tests in groundwater monitoring wells. The primary objective of this work was to: support further development of the site conceptual model; and support assessment of potential remedial goals and technology screening.

Estimates were derived for VOC mass present in the soil matrix in three different strata of interest: (1) granular fill materials, (2) the site silt and clay aquitard, and (3) the lower water bearing zone (WBZ) aquifer materials, including sand and gravel and glacial till soils. Mass estimates were also derived for total chlorinated VOCs that might be present in the dissolved phase in either the upper or lower WBZ groundwater. Mass estimates were developed for five inferred site source zones, including: (1) the Waste Solvent Area, (2) the TCA Area, (3) the Building 57A Area, (4) the CFC Area, and (5) the Building 57 Area as described in the SRI text (refer to SRI Figure 3 for source zone area references).

Estimates of lateral groundwater flow were calculated for the upper and lower WBZs, and estimates of vertical flow were calculated for groundwater flow across the aquitard from the upper to the lower WBZ. The calculations represent order of magnitude approximations derived using commonly accepted scientific principles and site-specific hydrogeologic properties and are intended to be used for framing discussion for source investigations and remedial technology screening. Based on the varied distribution of VOCs and non-uniform soil conditions, the estimates of mass present and migrating in the subsurface may vary significantly from actual conditions. Other limitations associated with these estimates are outlined in the text to follow and Appendix A of this SRI report.

J.2 METHODS

J.2.1 Estimates of VOC Mass Distribution

Several steps were followed to estimate the total chlorinated VOC mass at OU#5. First, an approximated source area was inferred for each source zone using soil gas concentration contours. Isopleths were created for total chlorinated ethenes (including TCE, cDCE(1,2-), tDCE(1,2), or VC), chlorinated ethanes (including TCA, DCA(1,1), DCA(1,2-), DCE(1,1-)), and chlorofluorocarbons (including CFC-113, CFC-123a) in four magnitude ranges: 0.01-0.1 ppmv, 0.1-1 ppmv, 1-10 ppmv, 10-100 ppmv, and concentrations greater than 100 ppmv.

Within each range of soil vapor VOC concentrations, chlorinated VOC mass was calculated for three phases in the subsurface: VOC mass associated with the vapor phase, VOC mass associated with soil samples, and dissolved VOC mass present in soil porewater (unsaturated zone) or groundwater (saturated soils).

Mass of VOCs in vapor form (m_{vapor}) was calculated using equation 1:

$$m_{vapor} = C_v * A * l * \phi_A \quad (1)$$

where C_v is the average concentration of VOCs in the vapor phase (in units of M/l^3), A is the area represented by each range of soil vapor VOC concentrations (l^2), l is the unsaturated soil thickness (l), and ϕ_A is the gas filled porosity (vol/vol).

The mass of VOCs in the pore water form (m_{pw}) was approximated using equation 2:

$$m_{pw} = C_{pw} * A * l * \phi_w \quad (2)$$

where C_{pw} represents the average concentration of VOCs in the unsaturated soil pore water (in units M/l)) and ϕ_W is the water filled porosity (vol/vol). Pore water concentrations were calculated from vapor concentrations using equation 3:

$$C_{pw} = C_v / H \quad (3)$$

where H (unitless) represents Henry's law constants found in the literature for individual VOCs at a given temperature.

Mass of VOCs in the soil (m_s) was calculated using equation 4:

$$m_s = C_s * A * l * \Upsilon_{dry} \quad (4)$$

where C_s is the average total concentration of VOCs in soil samples (units mass of VOCs/mass soil), and Υ_{dry} is the dry bulk density of the soil (in units M/l^3).

Mass in the groundwater phase (m_{pw}) was calculated using equation 5:

$$m_{gw} = C_{gw} * A * l * \phi \qquad (5)$$

where l is the saturated water column thickness (l), and ϕ is the total porosity (vol/vol). Derivation of the site-specific properties of soil bulk density and porosity used in these calculations are described in Appendix D. For the upper WBZ, an average saturated thickness of the fill unit was used for each source zone. In the lower water bearing zone, an average saturated thickness of both the site silt and clay aquitard and lower WBZ unit were used for each zone.

The overall estimate of total VOC mass was calculated as the sum of mass from all three phases (vapor, soil, pore water/groundwater).

J.2.2 Estimates of Groundwater Flow and Mass Flux

Estimates of groundwater flow, travel times, and mass flux were developed to assess the magnitude of groundwater and solute transport below the site and from each source zone. Mass migration rates are helpful both to provide perspective on potential downgradient conditions, but also to assess the potential effectiveness of proposed remedial technologies. These estimates were derived using commonly accepted scientific principles and site-specific estimates of hydrogeologic properties determined from field and laboratory testing that has been documented in the text, tables, figures, and appendices of the SRI report. Other limitations associated with these estimates are outlined in the text to follow.

Advective seepage velocities that are referenced in the text were calculated using Darcy flux equation 6, adjusted by the effective porosity:

$$v = -K\, i / \phi_e \qquad (6)$$

where K is hydraulic conductivity (L/t), i is the groundwater gradient (dh/dl in ft/ft), and ϕ_e is the effective porosity (vol/vol). The seepage velocity represents the average linear rate of advective transport for a particle of water moving through a porous medium through interconnected and saturated soil void spaces. We calculated average seepage velocities using average estimates of hydraulic conductivity, porosity, and hydraulic gradients.

Groundwater travel time estimates (T_t) were calculated using equation 7:

$$T_t = l/v \qquad (7)$$

where l is the travel distance and v is the seepage velocity calculated using equation 6. Although the rate of VOC mass migration in groundwater is related to the velocity of groundwater, solute (i.e., VOC) migration is influenced by other processes including diffusion, dispersion, sorption, and degradation, all of which would typically retard the advance of a solute in the direction of groundwater flow.

Estimates of bulk groundwater flow Q (l^3/t) were calculated using equation 8:

$$Q = KiA \qquad (8)$$

where K is the hydraulic conductivity, and *i* is the hydraulic gradient. Volumetric flux is calculated with the darcy flux (*q*) in units of volume per time per unit area (L/t) where *A* is the bulk cross sectional area of flow (L^2).

Mass transfer (*M*) estimates (M/t) were calculated as the groundwater flow (Q) multiplied by the inferred concentration along a specified cross section (equation 9). Mass flux (M_F), in units of mass per time per unit area, was calculated by dividing mass transfer estimate (M) by the bulk cross sectional area of flow (L^2).

$$M = C{*}Q \qquad (9)$$

In both equations 8 and 9, *A* is the width of the inferred flow field of interest multiplied by the saturated thickness of the water column (l^2). For vertical flow, volumetric and mass flux estimates were multiplied over a plan view area. The concentrations used in mass transfer calculations represent average concentrations observed in groundwater monitoring wells over the history of sampling. The mass transfer estimates represent order of magnitude approximations of the possible rate of VOC migration through the soil matrix. Based on the inherent variability of subsurface data, there is a relatively high degree of uncertainty associated with mass transfer estimates; nevertheless, these calculations provide an approximate order of magnitude scale of potential transport mechanisms.

Hydraulic gradients (*i*) for horizontal components of flow were calculated from groundwater elevation contour plans.

J.3 FINDINGS

J.3.1 Estimates of Mass Distribution

Table J.1 shows the estimated proportioning of subsurface chlorinated VOC mass[1] inferred for each source zone. Based on the assumptions and limitations noted above, we estimate the mass of chlorinated VOCs present may be on the order of 1,600 lbs. Further discussion of mass distribution within and among the source zones is provided in the SRI text and Figure 24.

J.3.2 Assessment of Seepage Velocities and Groundwater Travel Times

As indicated in the SRI Report text, the primary pathway for VOC migration in groundwater is within the lower water bearing zone. Estimated horizontal seepage velocities and groundwater

[1] *The estimates were derived considering only chlorinated ethenes, ethanes, and chloroflurocarbons. In certain areas, VOCs associated with petroleum products have been found and are not included in these estimates.*

travel times in five source areas (including Lot 26) are provided in Table J.2. Calculated seepage velocities during groundwater extraction were between 0.01 and 1 ft per day (ft/d) beneath the site, and approximately 3 ft/d beneath Lot 26. Under pumping conditions, these seepage velocities result in on-site horizontal travel time estimates of approximately one year for the distance across the Waste Solvent Area, several months across the TCA Area, several years across the CFC Area, and several decades across the Building 57A Area. In Lot 26, seepage velocity estimates suggest a travel time of more than 8 years (from the likely areas of release to the property boundary, approximately 270 feet). As noted above, the VOC migration rate/travel times are on average lower than the groundwater travel times due to "retardation" processes.

J.3.3 Assessment of Volumetric and Mass Flux

Volumetric groundwater flow and mass transfer estimates were calculated for lateral flow at five cross sectional areas in the lower WBZ, and five cross sectional areas in the upper WBZ corresponding to the various source zones. These estimates are shown in Exhibit 1 below, with calculation details provided in Table J.3.

Exhibit 1. Summary of groundwater flow and mass flux estimates in the upper and lower WBZs.

Water Bearing Zone (WBZ)	Source Zone	Groundwater Flow (gpm)	Mass Flux (lbs/yr)
Lower WBZ	Building 57A Area	0.02	0.1
	Waste Solvent Area	0.5	35
	TCA Area	1	5
	CFC Area	0.4	21
	Lot 26	1	2
Upper WBZ	Building 57A Area	0.003	0.002
	Waste Solvent Area	0.02	0.2
	TCA Area	0.01	0.3
	CFC Area	0.02	0.1
	Building 57 Area	0.03	0.002

In the upper WBZ, the total horizontal groundwater flow through all five source areas is estimated at less than 0.1 gpm. In total, we estimate that upper WBZ mass transfer amounts to less than one pound per year. These values support assertions made in the SRI report that downgradient VOC migration from the upper water bearing zone is not significant.

As shown in Table J.1, almost half of the total estimated mass at the site is thought to be present in the upper WBZ fill and silt and clay soils. To assess the potential contribution of upper WBZ groundwater flow and mass flux to the overall flux observed at the Waste Solvent Area extraction well, volumetric and mass flux were calculated between the upper and lower WBZs. Vertical volumetric flux estimates were derived at about 4 gal/yr-ft^2 from the upper to lower WBZ under ambient conditions, and 6 gal/yr-ft^2 under pumping conditions in the lower WBZ (see Table J.4). As a result, estimates of mass transfer from the upper to the lower WBZ were calculated to be less than 1 lb/year, or a mass flux of around 2 lb/yr-acre. This is less than 2% of the total mass removed on an annual basis from extraction well EN-624, reported to be approximately 60 lbs during 2008[2].

TABLES

S:\PORDATA\2400s\2466.01\Originals\SRI Appendices\J - Mass and Flux Estimates\20100311 Appendix J Volumetric Flow and Mass Flux.docx

[2] Groundwater Sciences Corporation, April, 2009. "Annual Groundwater Summary Report, Village of Endicott/Town of Union, New York".

Table J.1
Mass Distribution Estimates
OUI#5/Building 57 Area
Supplemental Remedial Investigation Report
Union and Endicott, New York

Building 57A Area	Ethenes (lb)	Ethanes (lb)	CFCs (lb)	Total (lb)		% Within Source Area	% Total
Fill (Soil)	108	9	6	123		72%	8%
UWBZ (Groundwater)	0	0.1	0	0		0%	0%
Silt & Clay	7	3	1	11		7%	1%
LWBZ (Soil)	21	4	2	27		16%	2%
LWBZ (Groundwater)	9	0	0.1	9		5%	1%
Sum				171		100%	**11%**

Waste Solvent Area	Ethenes (lb)	Ethanes (lb)	CFCs (lb)	Total (lb)	Lbs Extracted Jan 2006-Oct 2009, EN-624	% Within Source Area	% Total
Fill (Soil)	309	1	1.0	311		32%	20%
UWBZ (Groundwater)	4	0	0	4		0%	0.2%
Silt & Clay	204	101	156	461		47%	29%
LWBZ (Soil)	155	3	2	160		16%	10%
LWBZ (Groundwater)	49	0	0	49		5%	3%
Sum				986	454	100%	**62%**

TCA Area	Ethenes (lb)	Ethanes (lb)	CFCs (lb)	Total (lb)	Lbs Extracted Jan 2006-Oct 2009, EN-623	% Within Source Area	% Total
Fill (Soil)	12	18	0.5	30		66%	2%
UWBZ (Groundwater)	0.2	0.1	0.0	0		1%	0%
Silt & Clay	2	5	0.3	8		16%	0%
LWBZ (Soil)	2	5	0.3	7		16%	0%
LWBZ (Groundwater)	0	0.2	0.2	1		1%	0%
Sum				46	37	100%	**3%**

CFC Area	Ethenes (lb)	Ethanes (lb)	CFCs (lb)	Total (lb)	Lbs Extracted Jan 2006-Oct 2009, EN-89R	% Within Source Area	% Total
Fill (Soil)	NA	0.6	4	4.4		1%	0.3%
UWBZ (Groundwater)	0	0.01	2	1.8		0%	0.1%
Silt & Clay	NA	0.1	0.2	0.3		0%	0.02%
LWBZ (Soil)	NA	0.7	302	302		78%	19%
LWBZ (Groundwater)	NA	0.42	77	78		20%	5%
Sum				387	61	100%	**24%**

Building 57 Area	Ethenes (lb)	Ethanes (lb)	CFCs (lb)	Total (lb)		% Within Source Area	% Total
Fill (Soil)	0.3	0.1	0.2	0.6		59%	0.04%
UWBZ (Groundwater)	0.03	0	0	0.03		0%	0%
Silt & Clay	0.2	0.04	0.1	0.4		41%	0.02%
LWBZ (Soil)	NA	NA	NA	NA		NA	NA
LWBZ (Groundwater)	NA	NA	NA	NA		NA	NA
Sum				1.0		100%	**0.1%**

Totals per VOC and Unit

Totals Per Unit	Ethenes (lb)	Ethanes (lb)	CFCs (lb)	Total (lb)	% Total
Fill (Soil)	430	28	11	470	30%
UWBZ (Groundwater)	4	0	2	6	0%
Silt & Clay	213	109	158	481	30%
LWBZ (Soil)	178	12	306	496	31%
LWBZ (Groundwater)	58	1	78	137	9%
Sum	884	151	555	1590	100%

Percents by VOC and Unit

Totals Per Unit	Ethenes (lb.)	Ethanes (lb.)	CFCs (lb.)
Fill (Soil)	49%	19%	2%
UWBZ (Groundwater)	0%	0%	0%
Silt & Clay	24%	72%	28%
LWBZ (Soil)	20%	8%	55%
LWBZ (Groundwater)	7%	1%	14%
Sum	100%	100%	100%

Notes:
This table shows estimates of chlorinated VOC mass that may be present in the soil and groundwater beneath OU#5. Estimates were derived from soil properties and discrete soil, soil gas, and groundwater concentrations collected during site investigation activities, using generally accepted hydrogeologic principles. Please see the Appendix text for further explanation and disussion.

Table J.2
Summary of Seepage Velocity and Travel Time
OU#5/Building 57 Area
Supplemental Renedial Investigation Report
Union and Endicott, New York

Flow Transect	Segment	dh	dl	i	K_h	ϕ_e	V_s	T_{travel}	T_{travel}	Sum T_{travel}	
		ft	ft	ft/ft	ft/day	vol/vol	ft/day	days	years	days	years
Building 57A Area	EN-670 to EN-666	0.8	50	0.02	0.2	0.21	0.01	3,500	10		
	EN-666 to EN-668	0.3	50	0.01	0.2	0.21	0.01	8,203	22		
	EN-668 to EN-674	1.2	40	0.03	0.2	0.21	0.03	1,436	4	13,100	36
Waste Solvent Area	EN-616 to EN-636	0.4	50	0.01	6	0.21	0.20	250	0.7		
	EN-636 to EN-612	2.5	75	0.03	6	0.21	0.95	79	0.2	329	0.9
TCA Area	EN-674 to EN-610	4.9	50	0.10	1	0.21	0.47	106	0.3	106	0.3
CFC Area	EN-688 to EN-089R	5	50	0.10	0.6	0.21	0.30	167	0.5	167	0.5
Lot 26	EN-681 to EN-678	0.5	120	0.006	3	0.21	0.09	1,400	3.8		
	EN-678 to EN-684A	0.9	150	0.006	3	0.21	0.09	1,750	4.8	3,150	8.6

Notes:
This table presents average advective seepage velocity and travel time estimates for groundwater flow in the lower water bearing zone.
Please refer to the Appendix text for additonal details and limitations.

Table J.3
Summary of Volumetric and Mass Flux Assessment
OU#5/Building 57 Area
Supplemental Remedial Investigation Report
Union and Endicott, New York

Section	Segment	Length ft	Sat Thick ft	i ft/ft	K_h ft/day	Conc μg/l	Q ft^3/day	Q gals/day	Total Q gpm	M g/day	Total M lbs/yr
Lower Water Bearing Zone, Lateral Flow											
Building 57A Area	EN-608 to EN-668	66	7	0.02	0.2	1,400	2	15		0.1	
	EN-668 to EN-676	54	7	0.02	0.2	1,400	2	12	0.02	0.1	0.1
Waste Solvent Area	EN-612 to EN-636	50	10	0.02	6	10,000	60	450		17	
	EN-636 to EN-616	75	10	0.02	6	10,000	90	670		25	
	EN-612 to West	60	10	0.02	6	4,800	72	540	0.5	10	35
TCA Area	EN-606 to EN-632	40	8	0.1	1	50	32	240		0.0	
	EN-632 to EN-610	150	8	0.1	1	1,350	120	900		4.6	
	EN-610 to East	60	8	0.1	1	1,300	48	360	1.0	1.8	5
CFC Area	EN-604 to EN-089R	135	5	0.1	0.6	13,000	41	300		15	
	EN-089R to EN-606	100	5	0.1	0.6	13,000	30	220	0.4	11	21
Lot 26	EN-687 to EN-684A	250	30	0.006	3	430	135	1010		1.6	
	EN-684A to EN-030	125	30	0.006	3	430	68	500	1.0	0.8	2

Upper Water Bearing Zone, Lateral Flow											
Building 57A Area	EN-609 to EN-667	65	3	0.01	0.2	100	0.3	3		0.001	
	EN-667 to EN-677	55	3	0.01	0.2	125	0.3	2	0.003	0.001	0.002
Waste Solvent Area	EN-617 to EN-615	45	5	0.01	0.4	1,200	1	7		0.03	
	EN-615 to EN-613	80	5	0.01	0.4	5,000	2	12		0.23	
	EN-613 to West	60	5	0.01	0.4	1,000	1	9	0.02	0.03	0.2
TCA AST Area	EN-635 to EN-611	70	2	0.01	0.8	500	1	8		0.02	
	EN-611 to East	60	2	0.01	0.8	13,000	1	7	0.01	0.35	0.3
CFC Area	EN-605 to EN-691	125	1	0.01	2	700	3	19		0.05	
	EN-691 to EN-607	100	1	0.01	2	700	2	15	0.02	0.04	0.1
Building 57 Area	EN-603 to EN-663	70	1	0.01	5	15	4	26		0.001	
	EN-663 to EN-669	30	1	0.01	5	15	2	11	0.03	0.001	0.002

Notes:
This table presents a summary of groundwater flow and mass transfer estimates for lateral flux in the upper and lower water bearing zones. Please refer to the Appendix text for additonal details and limitations.

Table J.4
Summary of Volumetric and Mass Flux Assessment, Vertical Transport
OU#5/ Building 57 Area
Supplemental Remedial Investigation Report
Union and Endicott, New York

Upper to Lower Water Bearing Zone, Vertical Flow

	Comments	Area	i_v	K_v	Conc	Q		V_F	M		M_F
		ft^2	ft/ft	ft/day	μg/l	ft^3/day	gpm	gal/yr-ft^2	g/day	lb/yr	lb/yr-acre
Waste Solvent Area	Without Pumping	6,400	0.75	2.0E-03	1,000	10	0.05	4	0.3	0.2	1
	With Pumping	6,400	1.15	2.0E-03	1,000	15	0.08	6	0.4	0.3	2

Note: This table presents a summary of groundwater flow and mass transfer estimates vertical flow from the upper to lower water bearing zone. Please refer to the Appendix text for additonal details and limitations.

APPENDIX K

VOC TIME SERIES IN SELECT MONITORING LOCATIONS

APPENDIX K
VOC TIME SERIES IN SELECT MONITORING LOCATIONS

As part of the Supplemental Remedial Investigation (SRI) at OU#5, water level measurements and groundwater samples for analysis of volatile organic compounds (VOCs) were routinely collected from selected monitoring wells at the site. Groundwater sampling was performed by representatives of Sanborn, Head and Associates, Inc. and Groundwater Sciences Corporation, and was completed in general accordance with SHPC's approved SRI Work Plan[1].

Detected VOC concentrations and water level elevations over time were plotted on depth profiles for several monitoring wells or well pairs. The purpose of this exercise was to assess changes in detected concentrations of VOCs over time within both the upper and lower water-bearing zones (WBZs). Our work and this appendix are subject to the Limitations outlined in the text to follow and summarized in Appendix A of the report. All analytical data have been reported to the Agencies by SHPC or GSC. Please refer to the report text for more information.

Principal Site VOCs, as defined in the SRI report text, were plotted on separate profiles for each location, based upon type (e.g., chlorinated ethanes, chlorinated ethenes, and chlorofluorocarbons). Monitoring wells assessed in this exercise (shown on Figure K.1) are:

- EN-606 and EN-607,
- EN-610 and EN-611,
- EN-612,
- EN-615 and EN-636,
- EN-616 and EN-617,
- EN-632, and
- EN-635.

Wells were chosen based upon location along inferred groundwater flow paths in relation to on-site extraction wells EN-623 and EN-624, initial VOC concentration estimates, and screened intervals providing a representative coverage of both the upper and lower WBZs. Time series plots for these wells are provided in Attachment K.1.

Attachments:
Figure K.1 – VOC Time Series Monitoring Locations

Attachment K.1 – VOC Time Series Plots

S:\PORDATA\2400s\2466.01\Originals\SRI Appendices\K - VOC Time Series\20100311 Appendix K VOC Time Series.docx

[1] Sanborn Head & Associates, Inc., September 9, 2004, "Work Plan for Source Area Evaluation, Supplemental Remedial Investigation and Focused Feasibility Study, Operable Unit #5 – Building 57 Area, Union and Endicott, New York", approved by the NYSDEC in a letter dated December 13, 2004.

Figure K.1

VOC Time Series Monitoring Locations

Supplemental Remedial Investigation OU#5 Building 57 Area

Union and Endicott, New York

Drawn By: J. Prellwitz
Designed By: J. Prellwitz
Reviewed By: J. Ordway
Date: March 2010

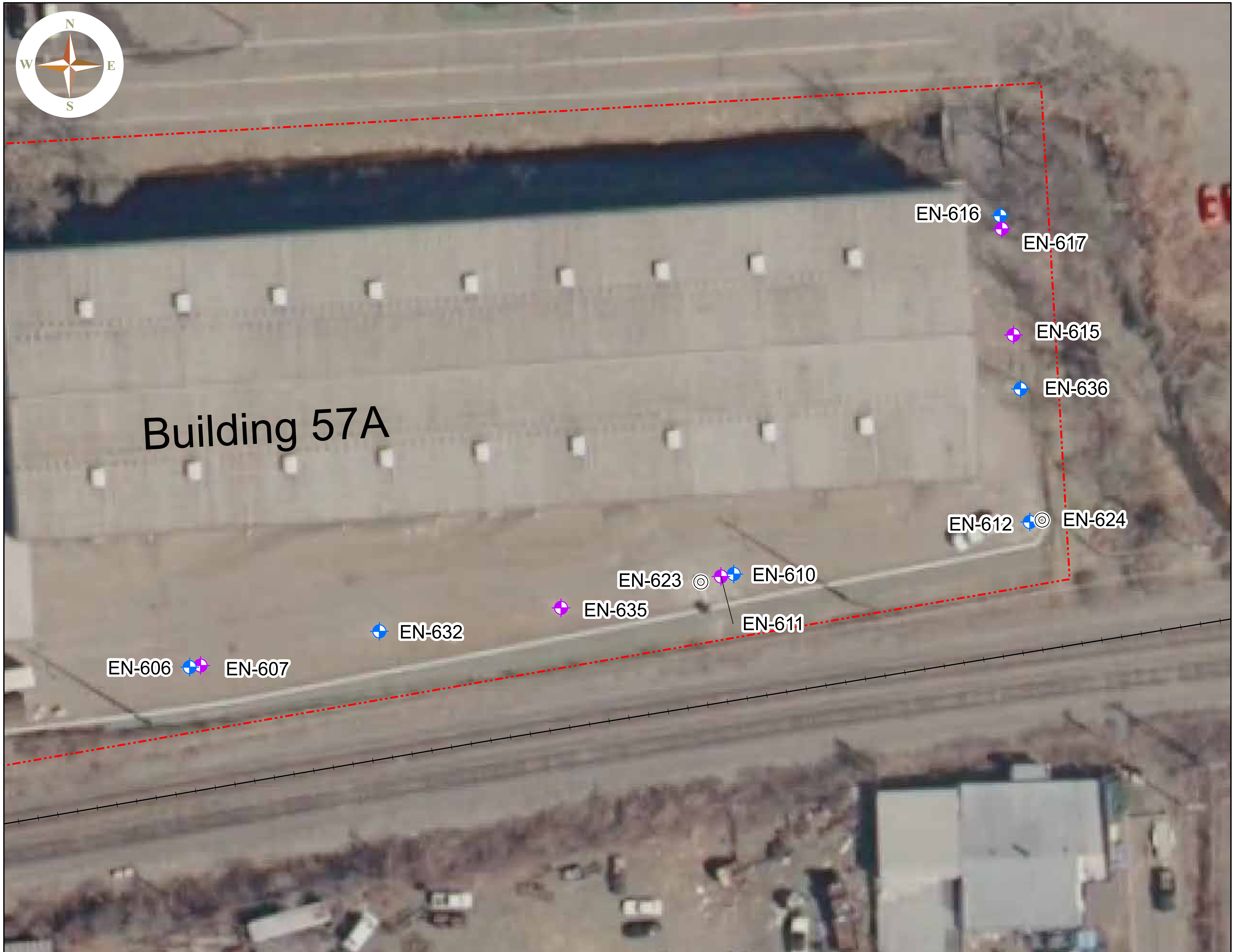


Figure Narrative:

This figure shows monitoring well locations and designations from which water level measurements and samples for analysis of VOCs were routinely collected, from 2005 through 2009. Detected VOC concentrations are shown as time series plots in Attachement K.1. This work is summarized in Appendix K of the SRI. Please see the report text for further details.

Legend

- Upper WBZ Monitoring Well
- Lower WBZ Monitoring Well
- Extraction Well
- Site Boundary

20 10 0 20 40 60 Feet

SHPC ENGINEERS

S:\PORDATA\2400s\2466.01\Work\Arcfiles\Figures\December 2009\20091231_VOC_Time_Series_Locations.mxd

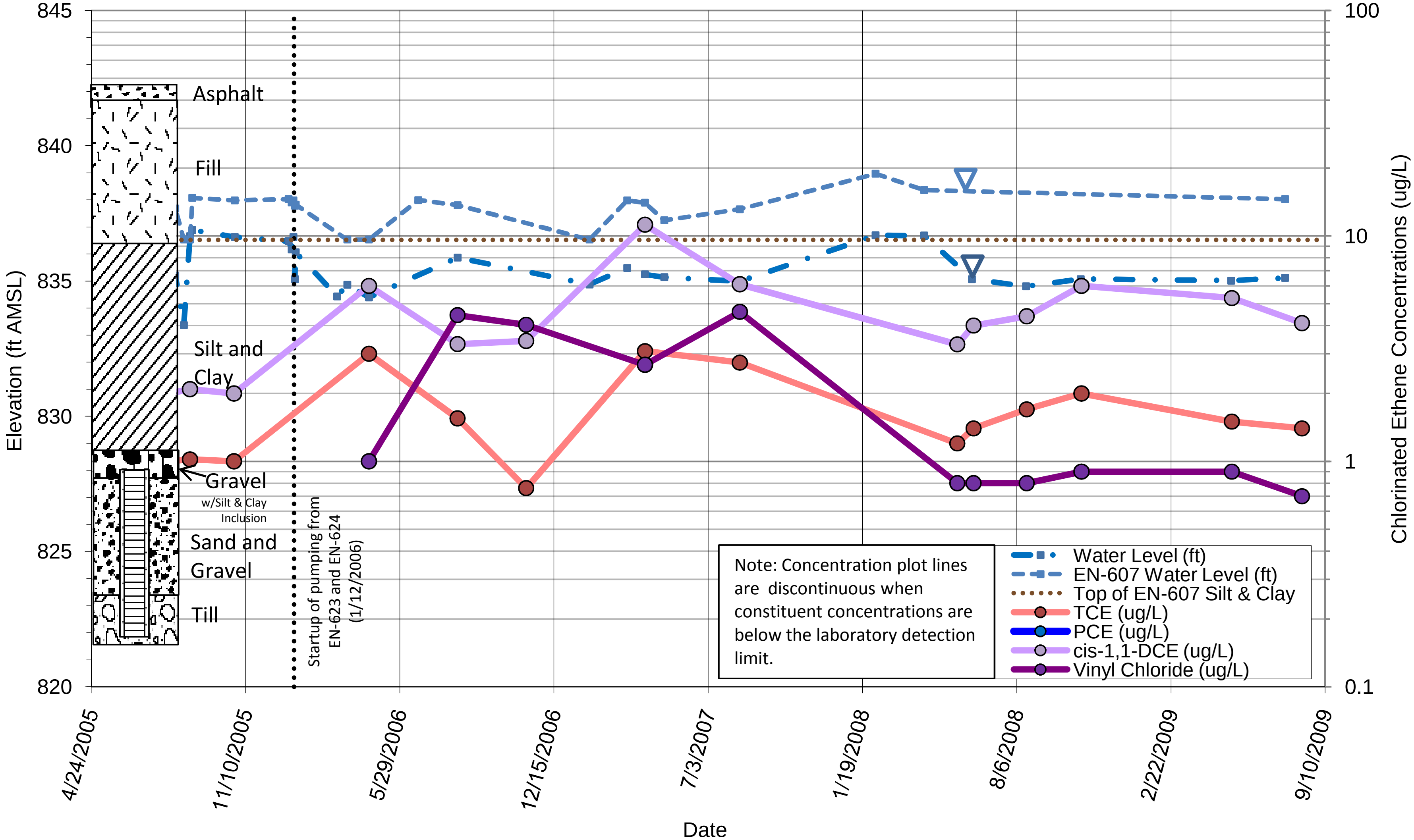
S:\PORDATA\2400s\2466.01\Figures\March 2010\SRI\20100311_VOC_Time_Series_Locations.pdf

Attachment K.1

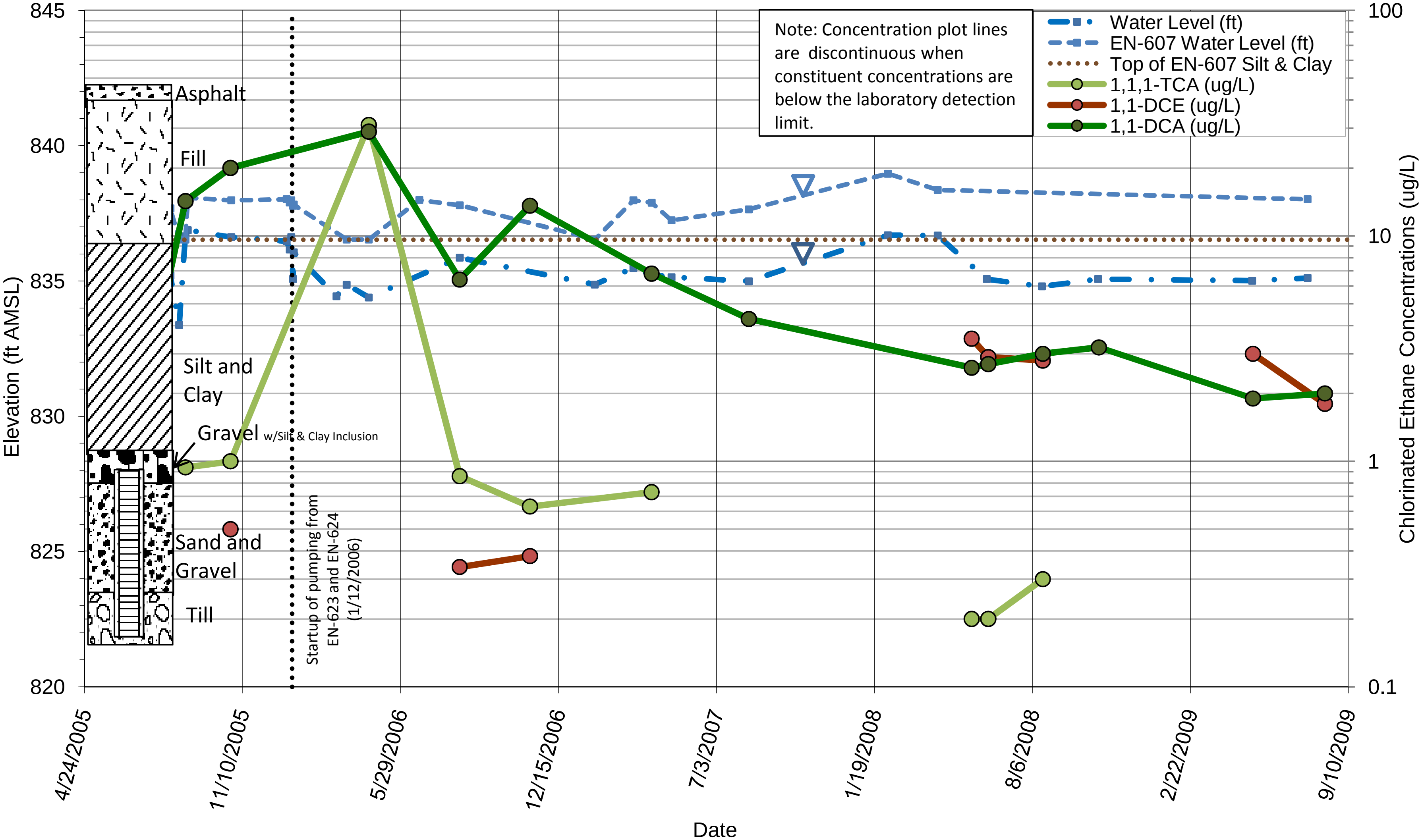
VOC Time Series Plots

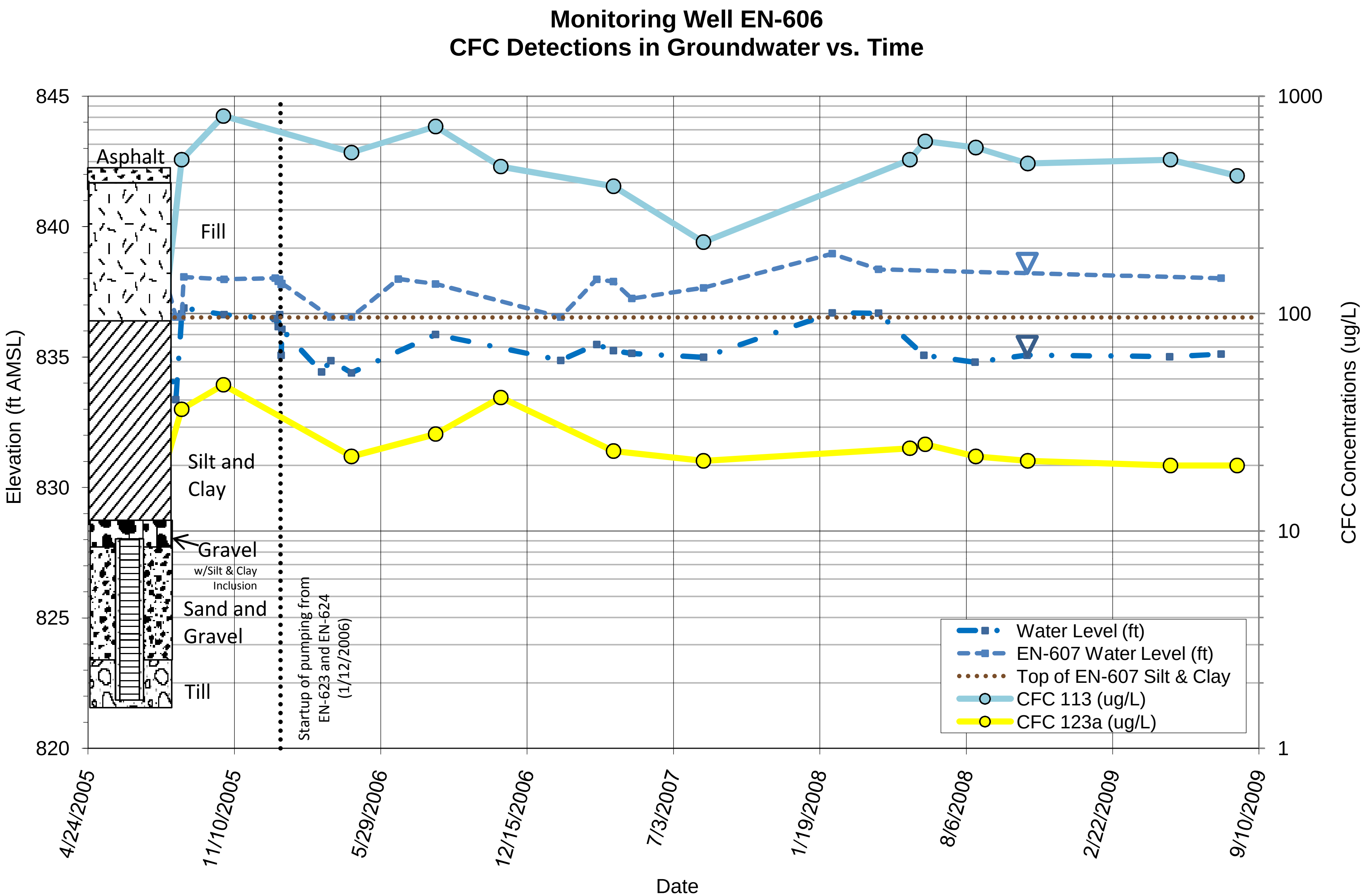
SHPC ENGINEERS

Monitoring Well EN-606
Chlorinated Ethene Detections in Groundwater vs. Time

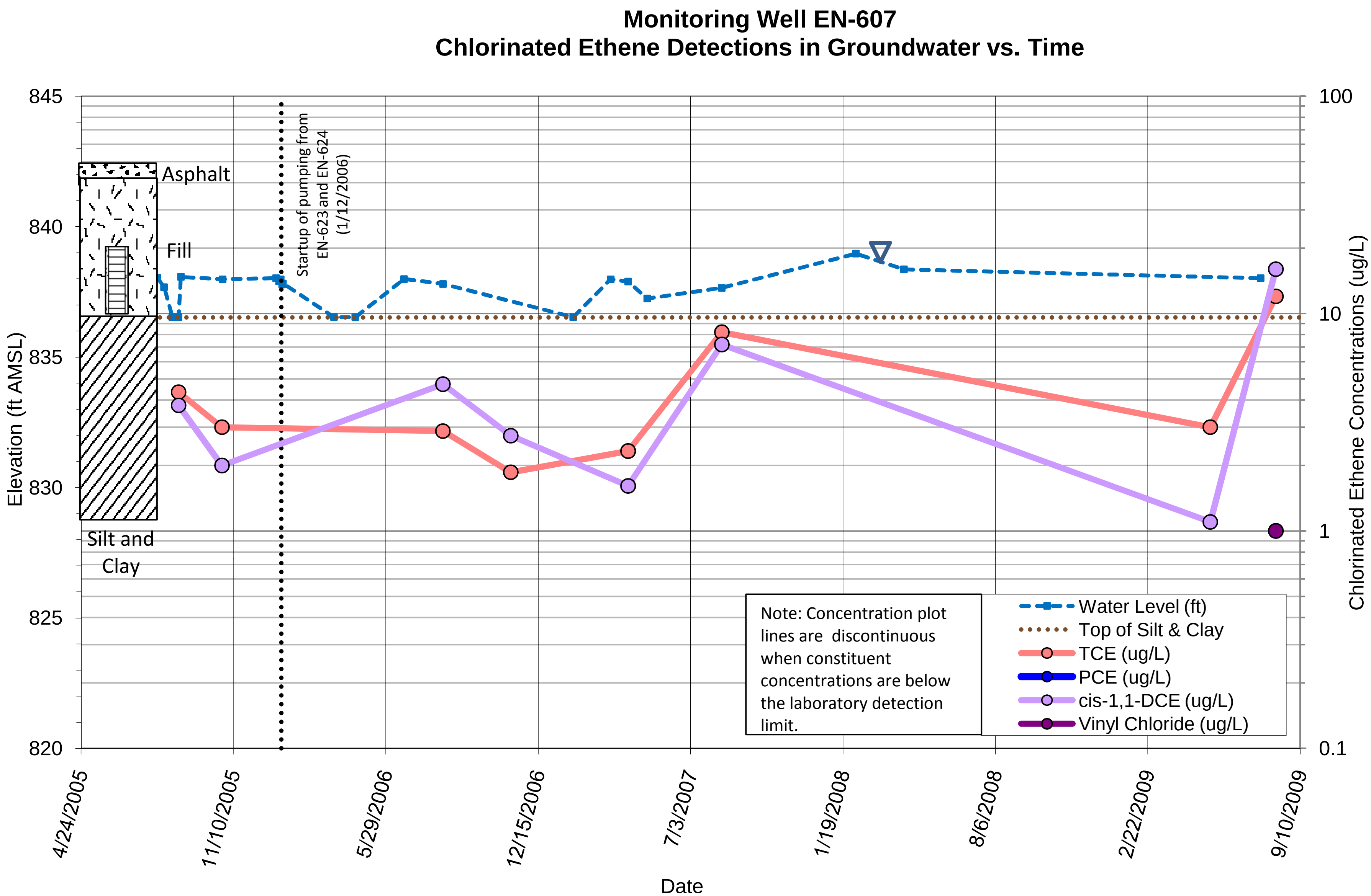


Monitoring Well EN-606
Chlorinated Ethane Detections in Groundwater vs. Time



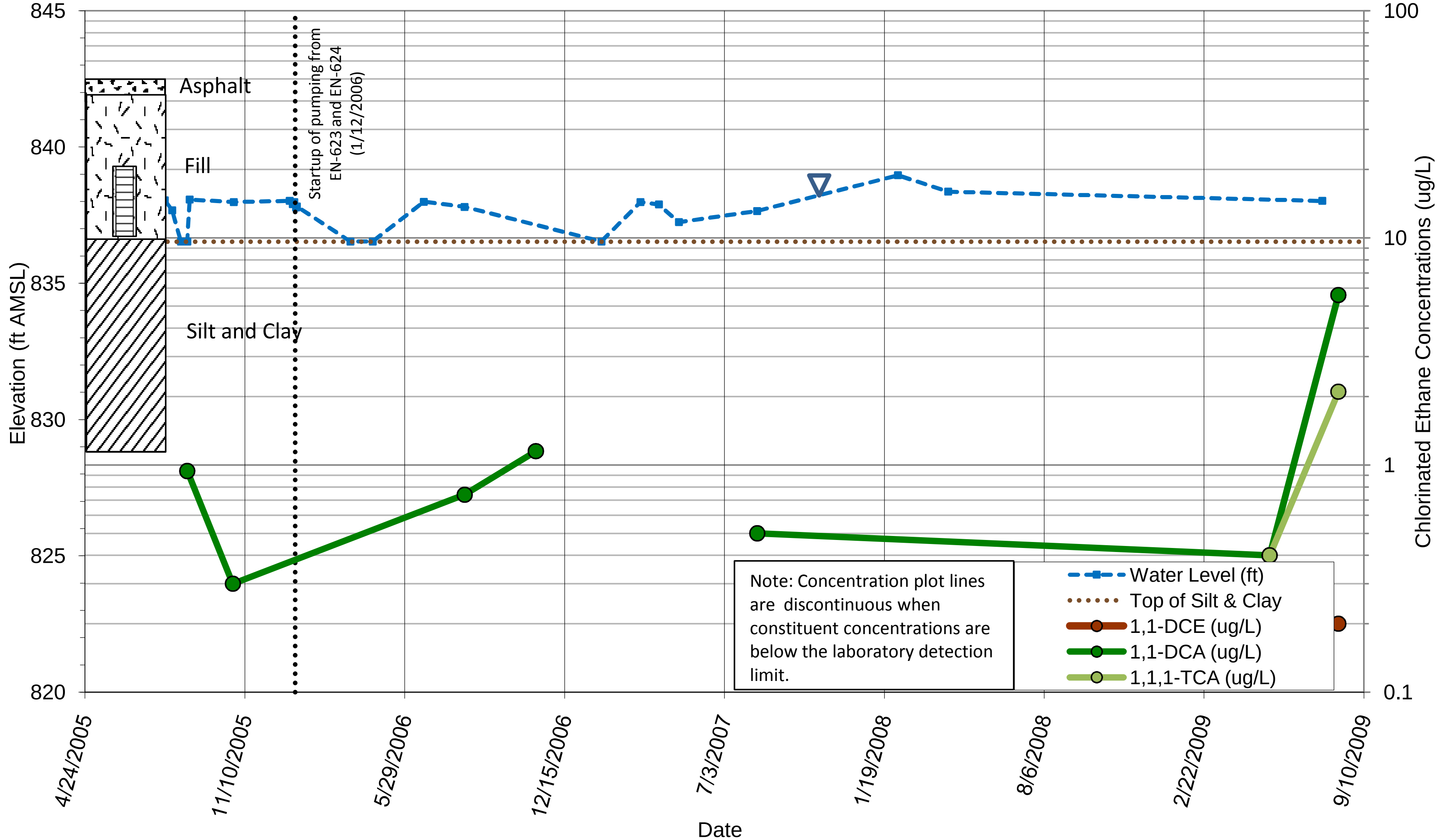


Monitoring Well EN-606
CFC Detections in Groundwater vs. Time
845
840
835
830
825
820
Elevation (ft AMSL)
1000
100
10
1
CFC Concentrations (ug/L)
Asphalt
Fill
Silt and Clay
Gravel
w/Silt & Clay Inclusion
Sand and Gravel
Till
Startup of pumping from EN-623 and EN-624 (1/12/2006)
4/24/2005
11/10/2005
5/29/2006
12/15/2006
7/3/2007
1/19/2008
8/6/2008
2/22/2009
9/10/2009
Date
Water Level (ft)
EN-607 Water Level (ft)
Top of EN-607 Silt & Clay
CFC 113 (ug/L)
CFC 123a (ug/L)

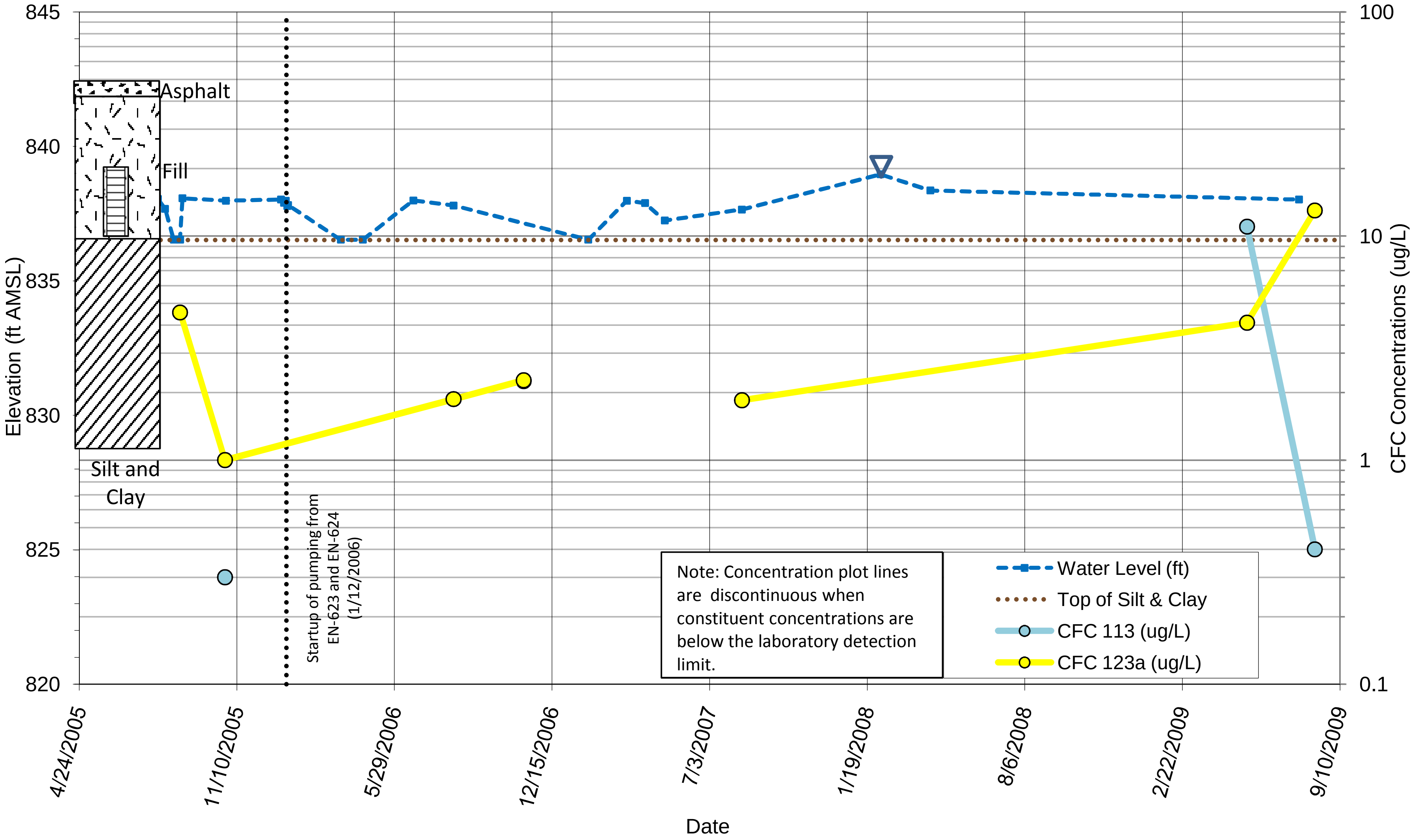


Monitoring Well EN-607
Chlorinated Ethene Detections in Groundwater vs. Time
Elevation (ft AMSL)
Chlorinated Ethene Concentrations (ug/L)
845
840
835
830
825
820
100
10
1
0.1
Asphalt
Fill
Silt and Clay
Startup of pumping from EN-623 and EN-624 (1/12/2006)
4/24/2005
11/10/2005
5/29/2006
12/15/2006
7/3/2007
1/19/2008
8/6/2008
2/22/2009
9/10/2009
Date
Note: Concentration plot lines are discontinuous when constituent concentrations are below the laboratory detection limit.
Water Level (ft)
Top of Silt & Clay
TCE (ug/L)
PCE (ug/L)
cis-1,1-DCE (ug/L)
Vinyl Chloride (ug/L)

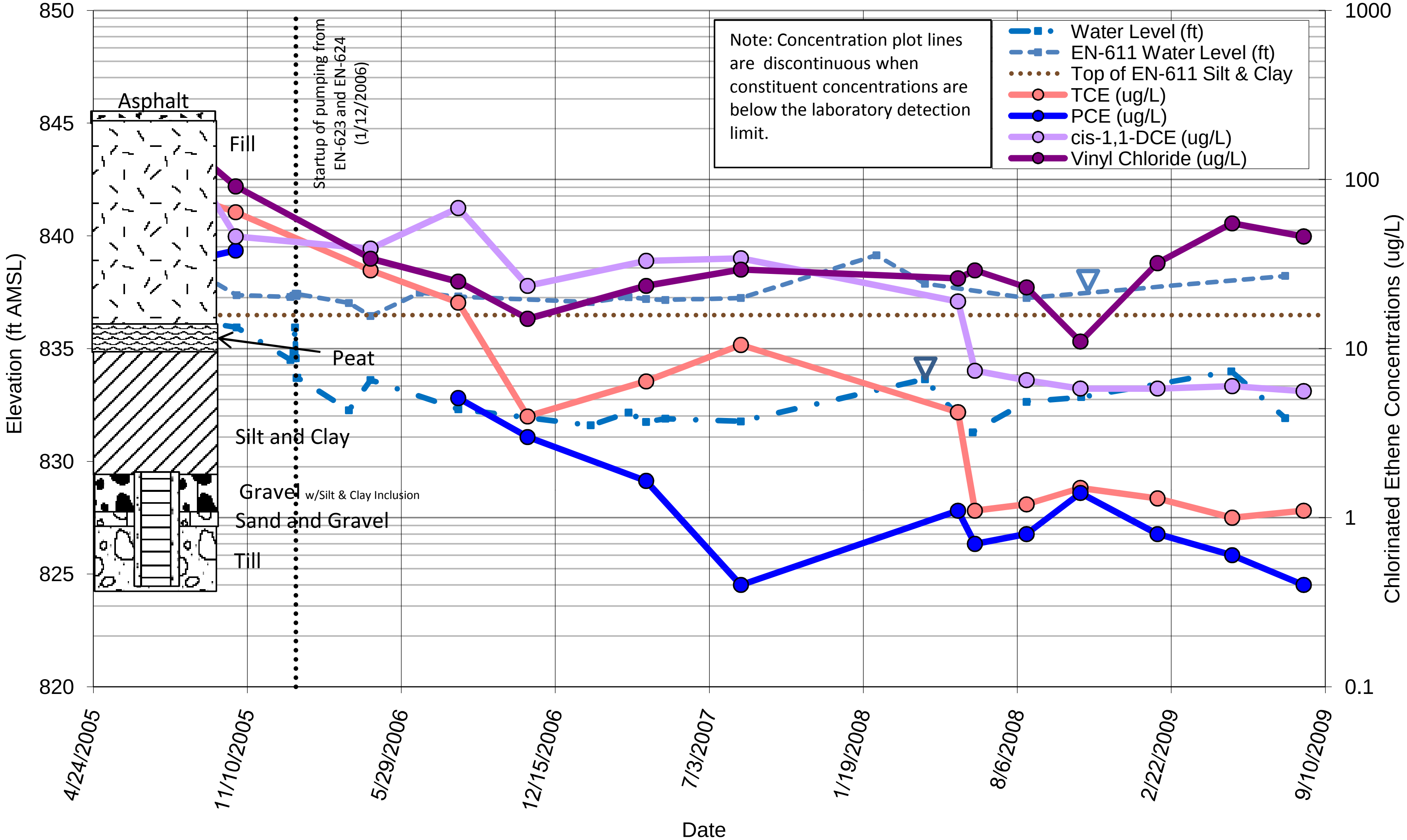
Monitoring Well EN-607
Chlorinated Ethane Detections in Groundwater vs. Time



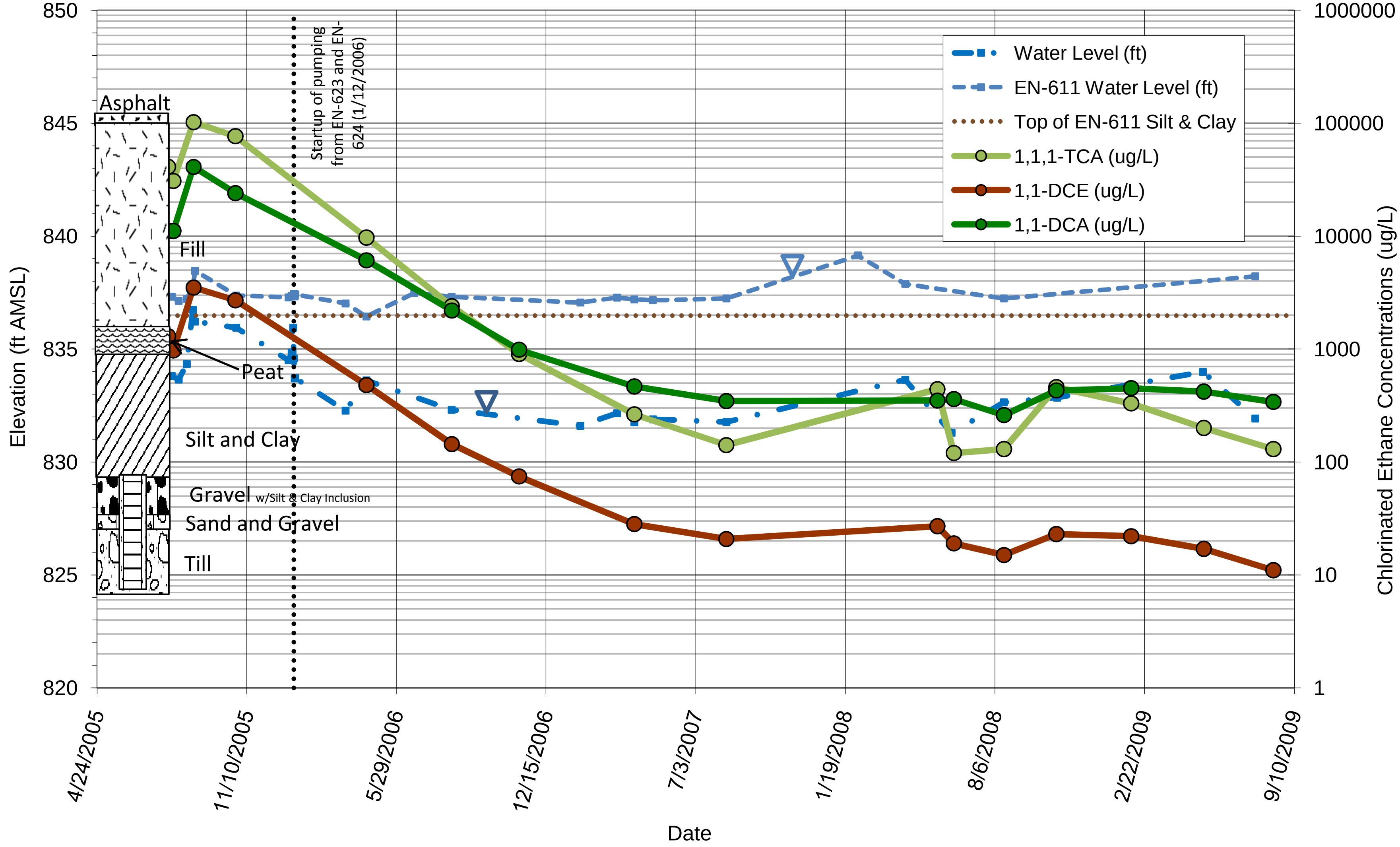
Monitoring Well EN-607
CFC Detections in Groundwater vs. Time



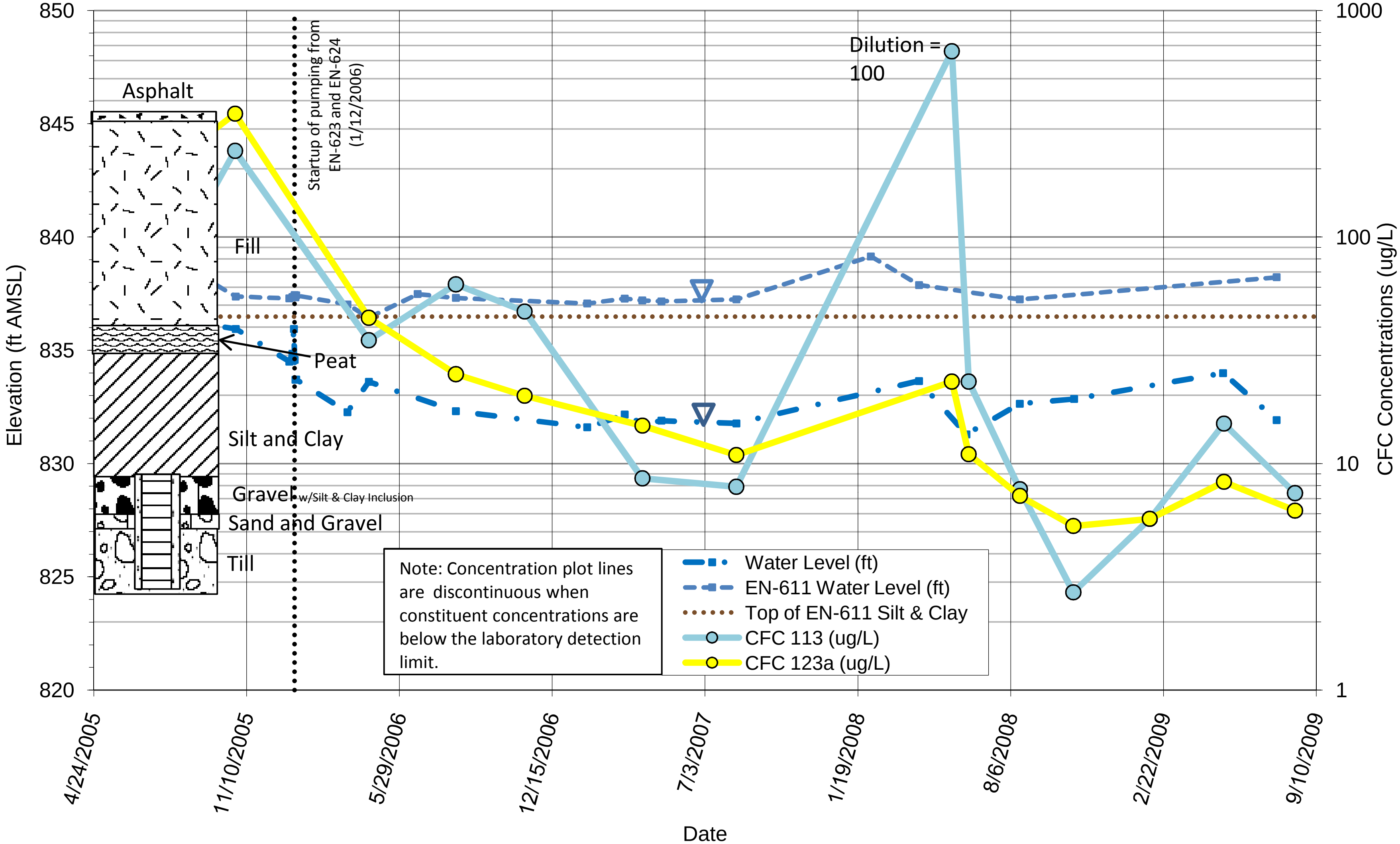
Monitoring Well EN-610
Chlorinated Ethene Detections in Groundwater vs. Time

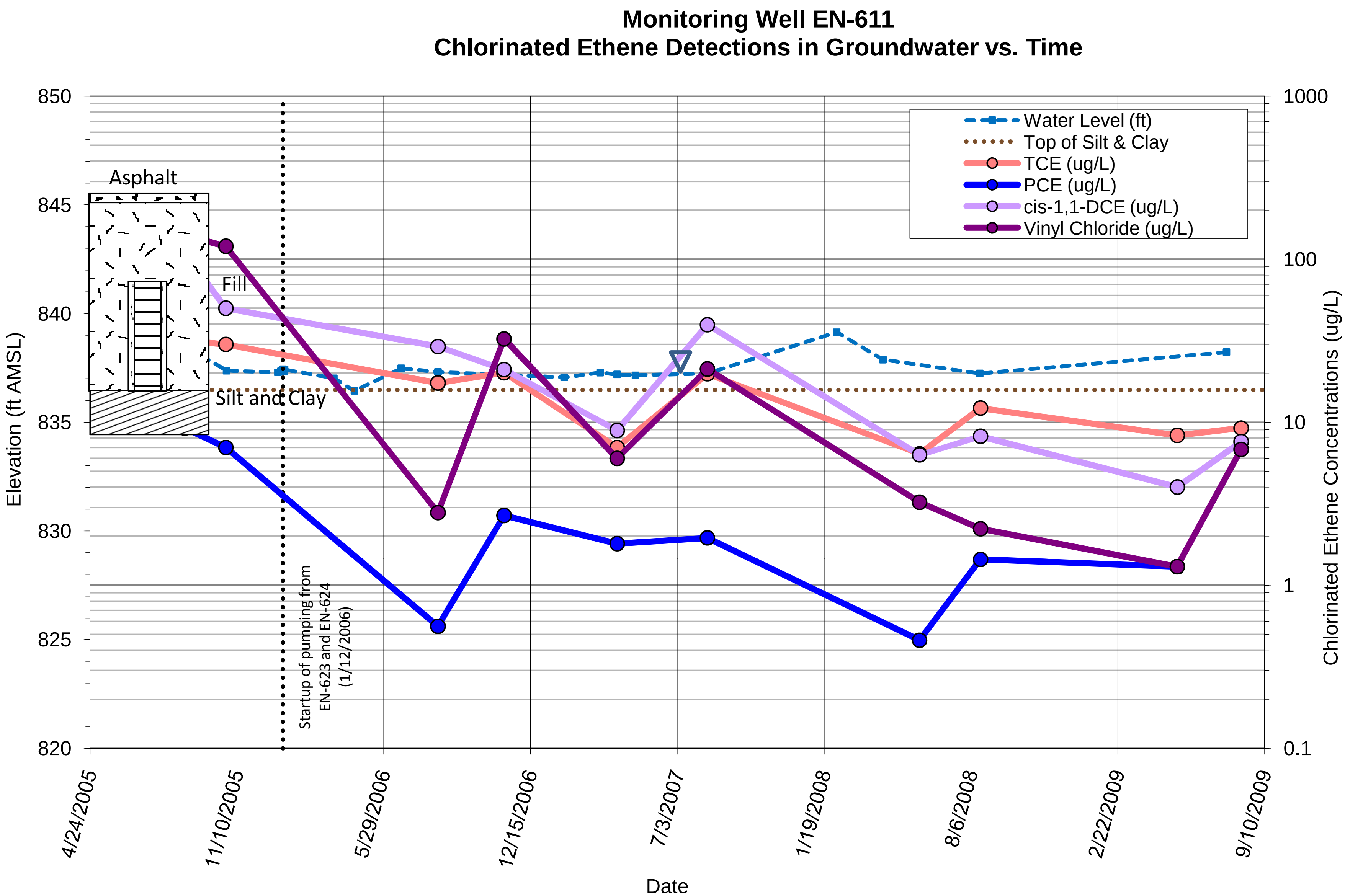


Monitoring Well EN-610
Chlorinated Ethane Detections in Groundwater vs. Time

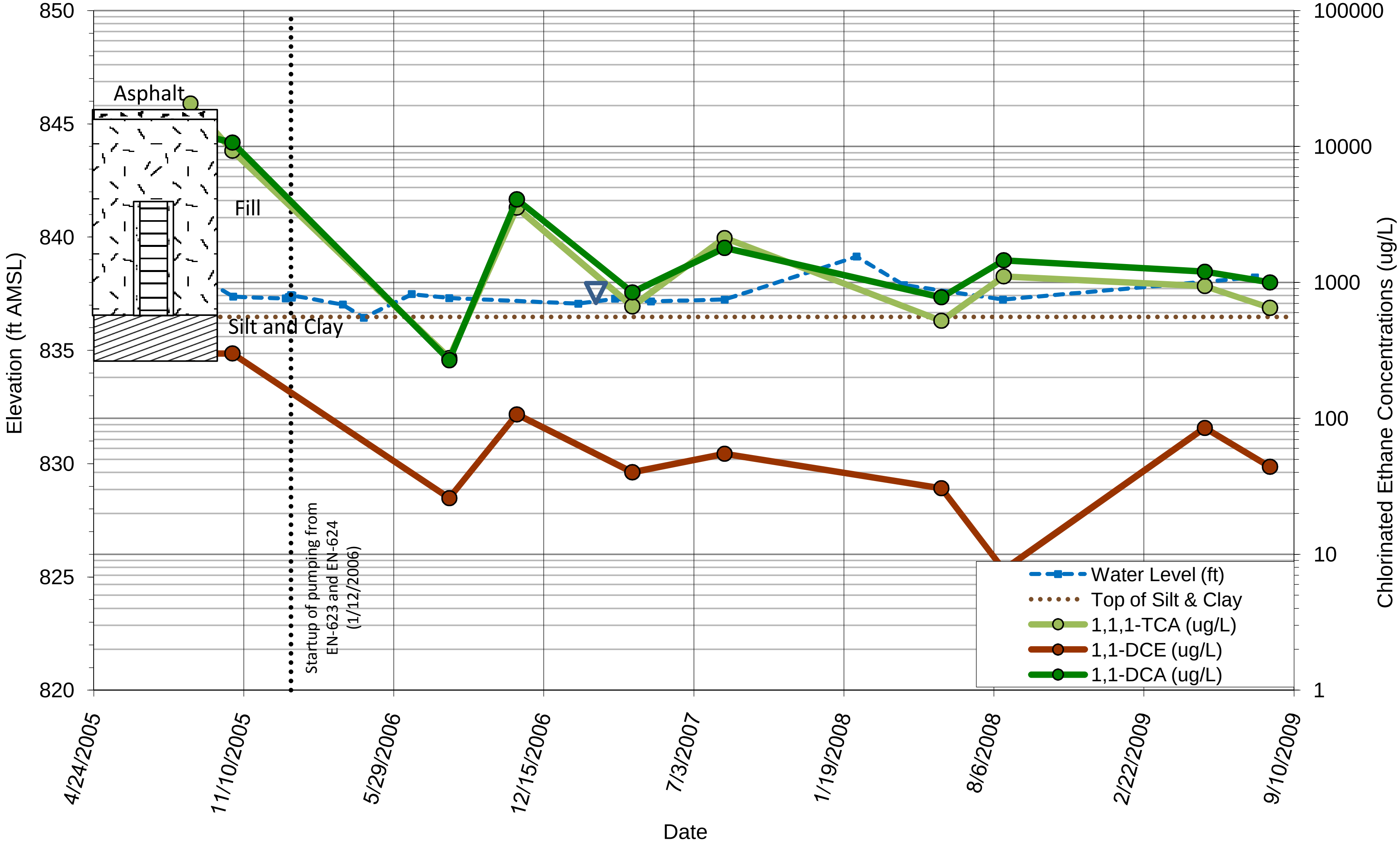


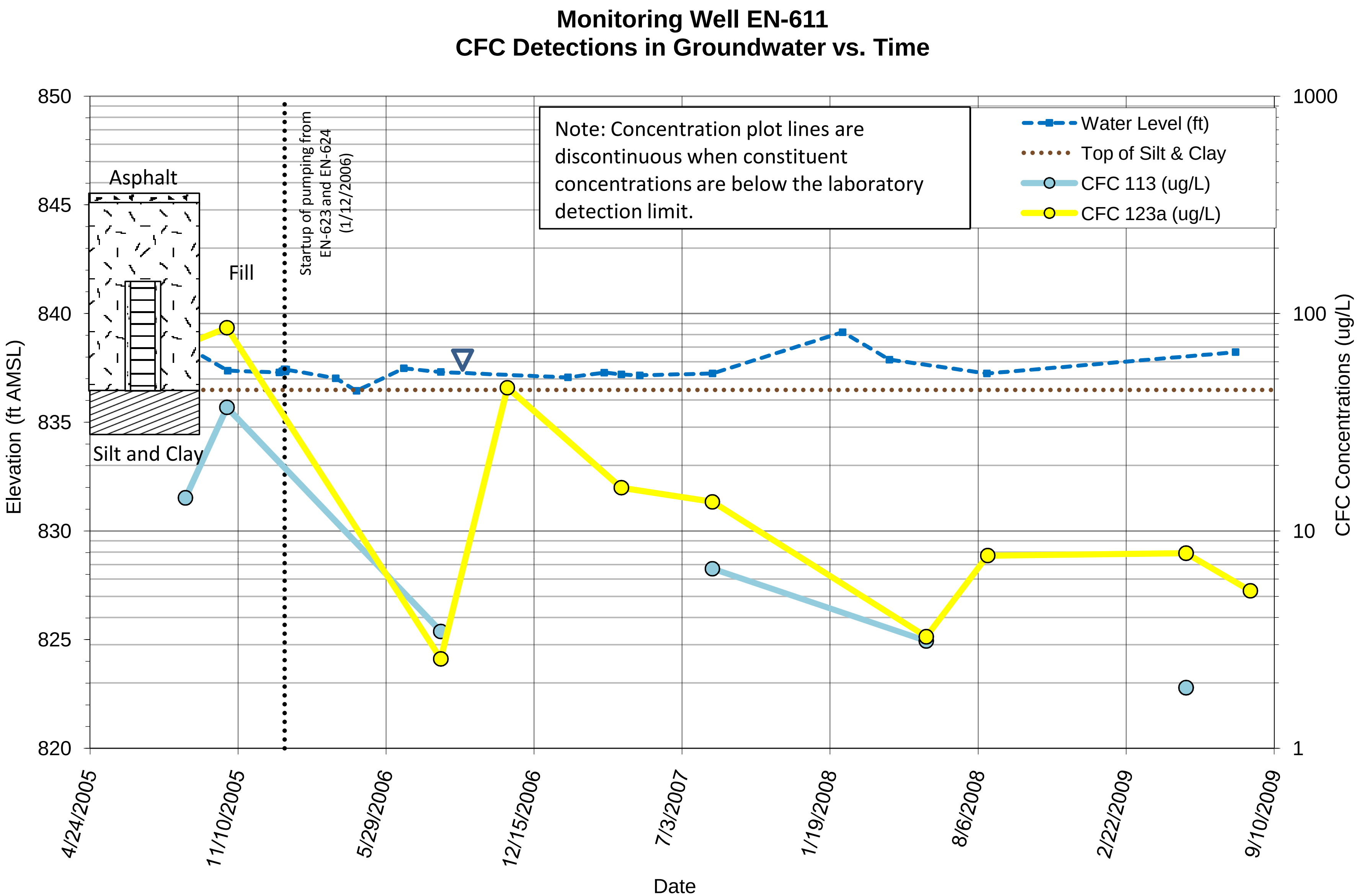
Monitoring Well EN-610
CFC Detections in Groundwater vs. Time




Monitoring Well EN-611
Chlorinated Ethene Detections in Groundwater vs. Time
850
845
840
835
830
825
820
Elevation (ft AMSL)
1000
100
10
1
0.1
Chlorinated Ethene Concentrations (ug/L)
Asphalt
Fill
Silt and Clay
Startup of pumping from EN-623 and EN-624 (1/12/2006)
Water Level (ft)
Top of Silt & Clay
TCE (ug/L)
PCE (ug/L)
cis-1,1-DCE (ug/L)
Vinyl Chloride (ug/L)
4/24/2005
11/10/2005
5/29/2006
12/15/2006
7/3/2007
1/19/2008
8/6/2008
2/22/2009
9/10/2009
Date

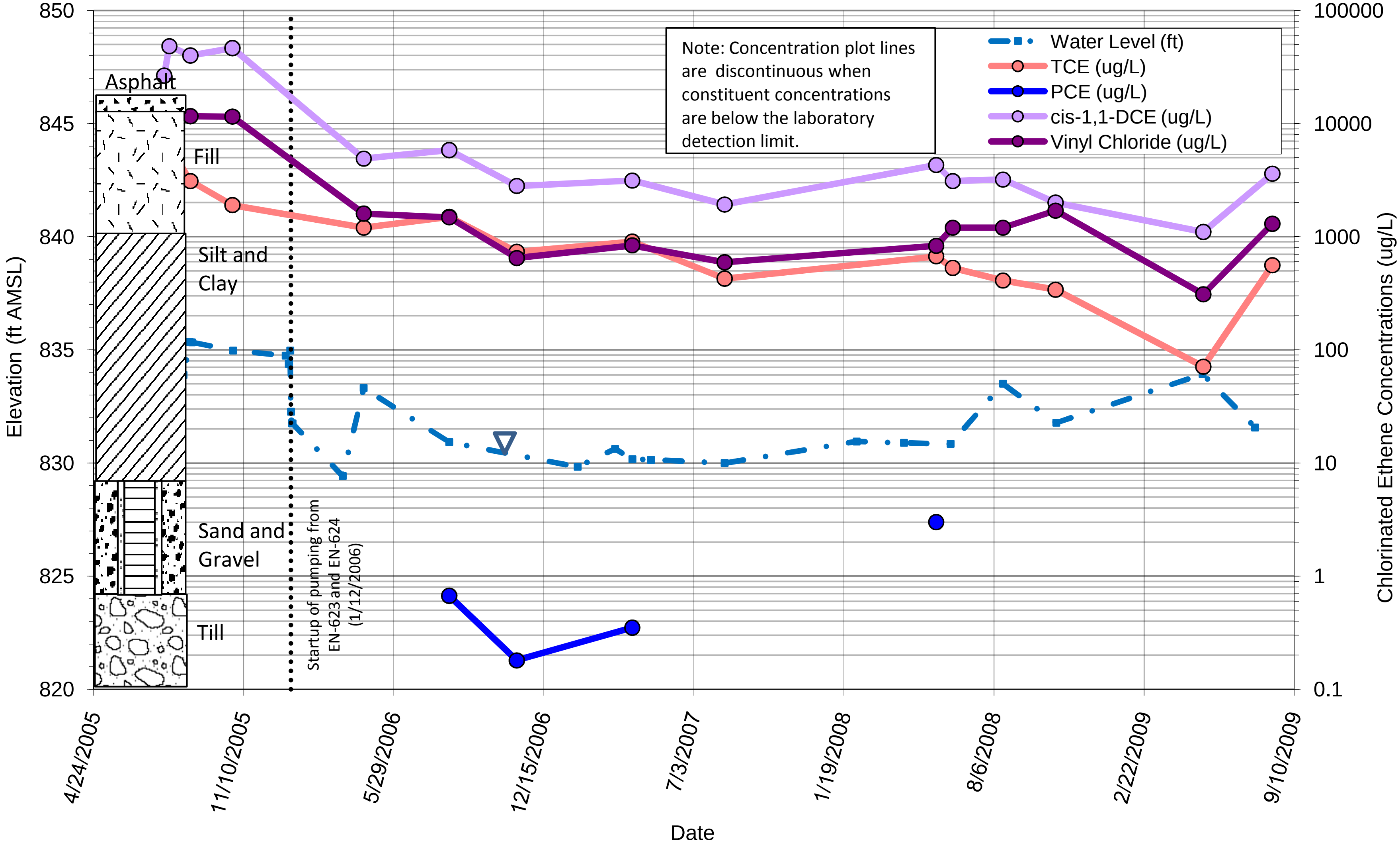
Monitoring Well EN-611
Chlorinated Ethane Detections in Groundwater vs. Time

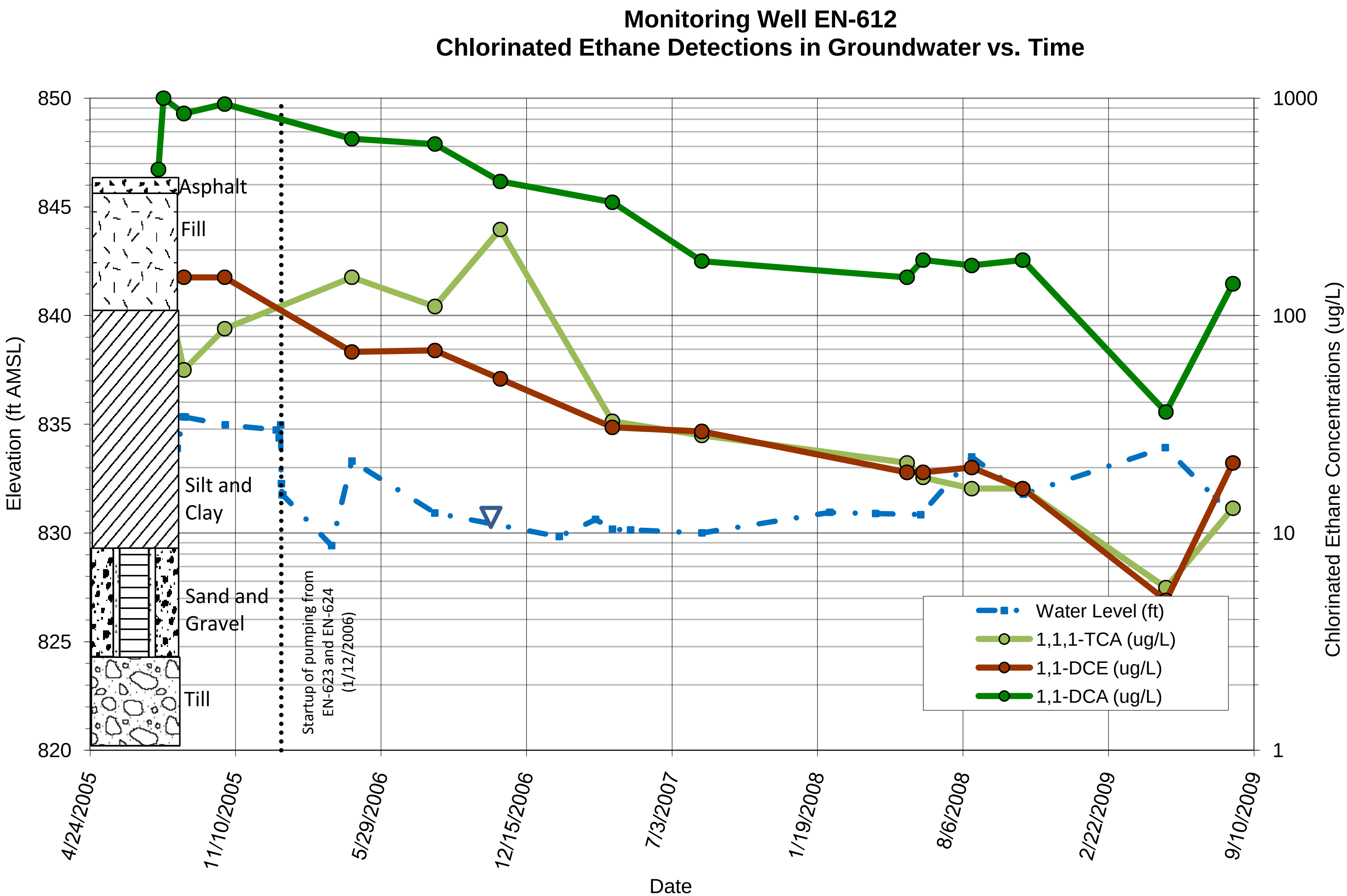




Monitoring Well EN-611
CFC Detections in Groundwater vs. Time
850
845
840
835
830
825
820
Elevation (ft AMSL)
1000
100
10
1
CFC Concentrations (ug/L)
Asphalt
Fill
Silt and Clay
Startup of pumping from EN-623 and EN-624 (1/12/2006)
Note: Concentration plot lines are discontinuous when constituent concentrations are below the laboratory detection limit.
Water Level (ft)
Top of Silt & Clay
CFC 113 (ug/L)
CFC 123a (ug/L)
4/24/2005
11/10/2005
5/29/2006
12/15/2006
7/3/2007
1/19/2008
8/6/2008
2/22/2009
9/10/2009
Date

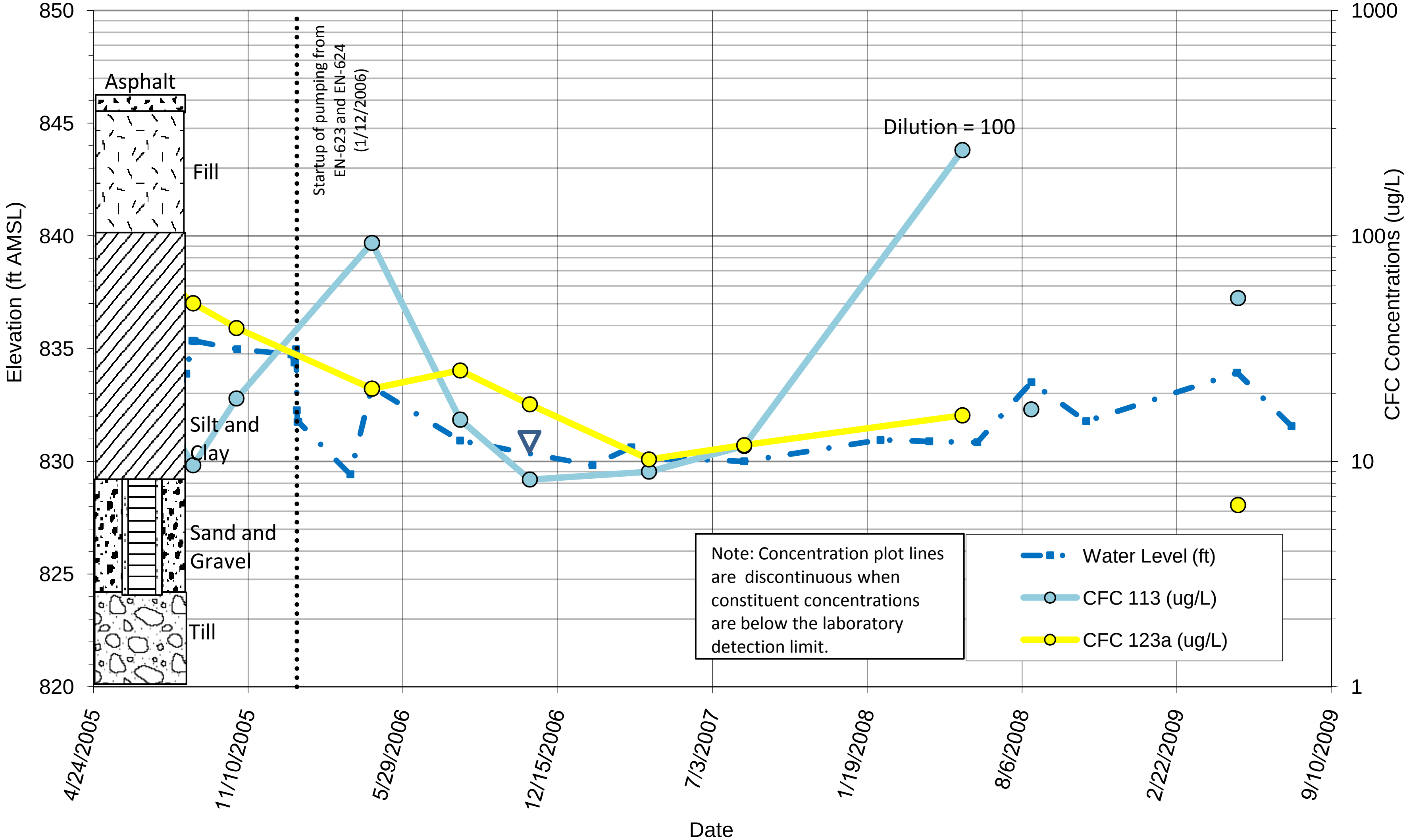
Monitoring Well EN-612
Chlorinated Ethene Detections in Groundwater vs. Time



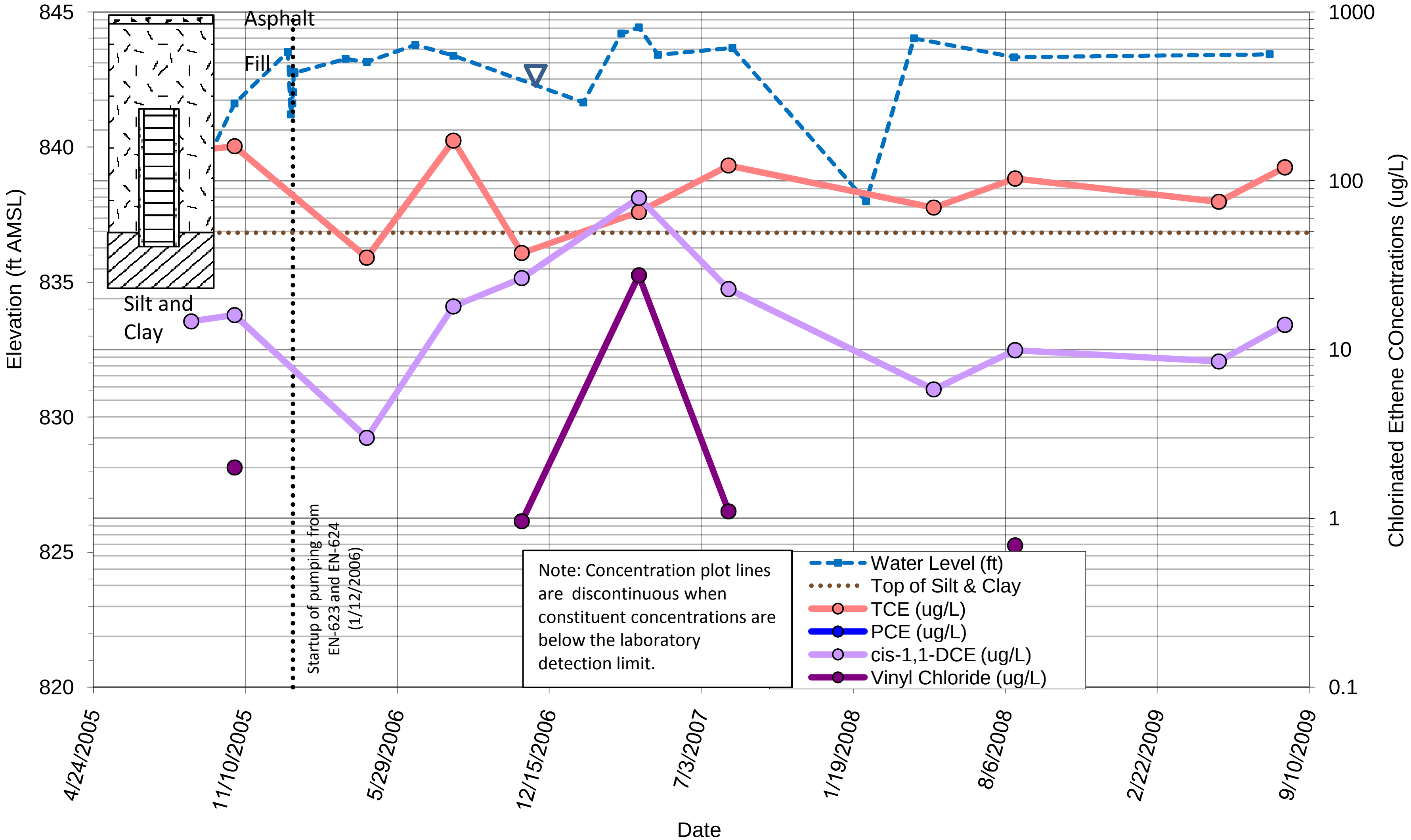


Monitoring Well EN-612
Chlorinated Ethane Detections in Groundwater vs. Time
Elevation (ft AMSL)
Chlorinated Ethane Concentrations (ug/L)
850
845
840
835
830
825
820
1000
100
10
1
Asphalt
Fill
Silt and Clay
Sand and Gravel
Till
Startup of pumping from EN-623 and EN-624 (1/12/2006)
Water Level (ft)
1,1,1-TCA (ug/L)
1,1-DCE (ug/L)
1,1-DCA (ug/L)
4/24/2005
11/10/2005
5/29/2006
12/15/2006
7/3/2007
1/19/2008
8/6/2008
2/22/2009
9/10/2009
Date

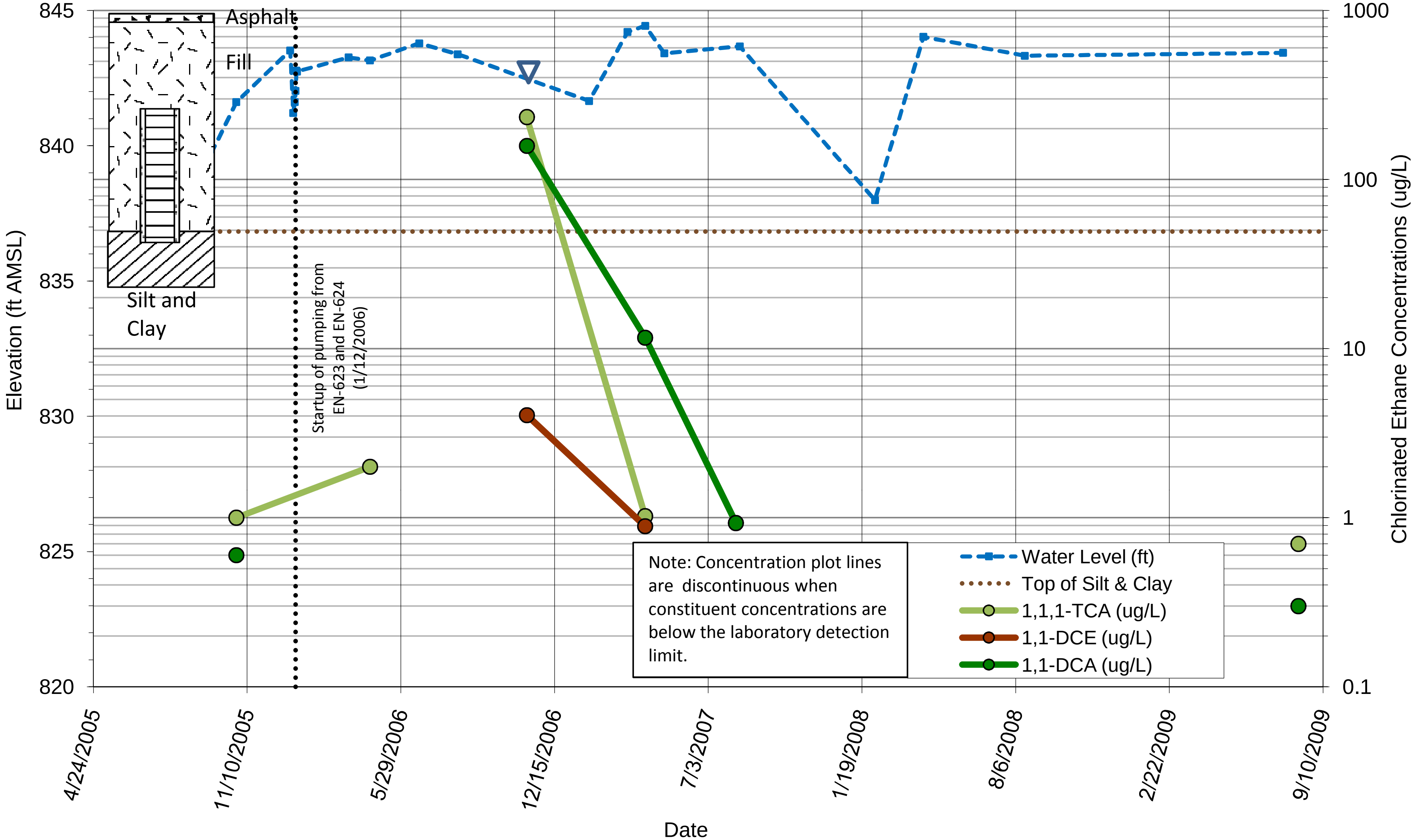
Monitoring Well EN-612
CFC Detections in Groundwater vs. Time



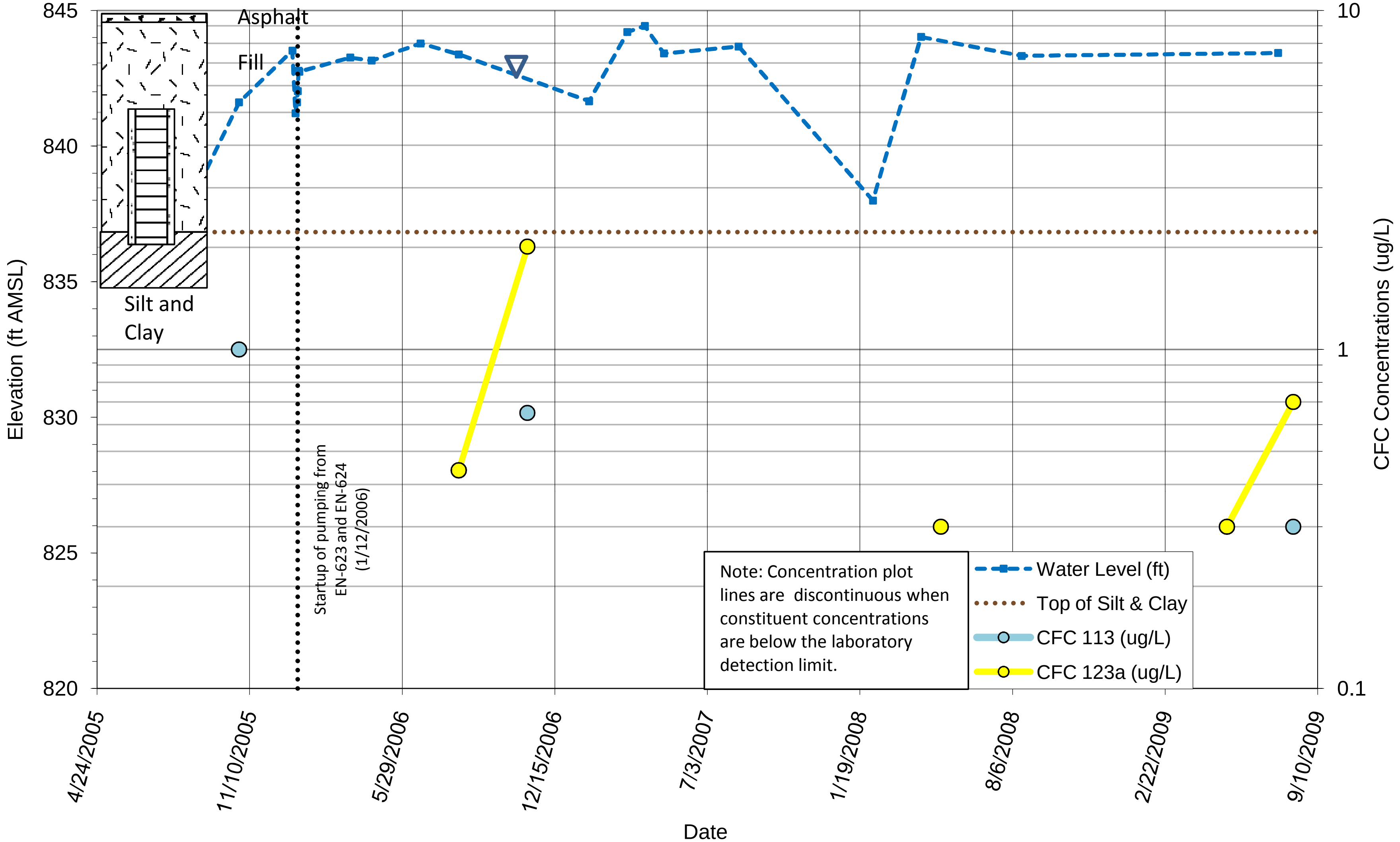
Monitoring Well EN-615
Chlorinated Ethene Detections in Groundwater vs. Time



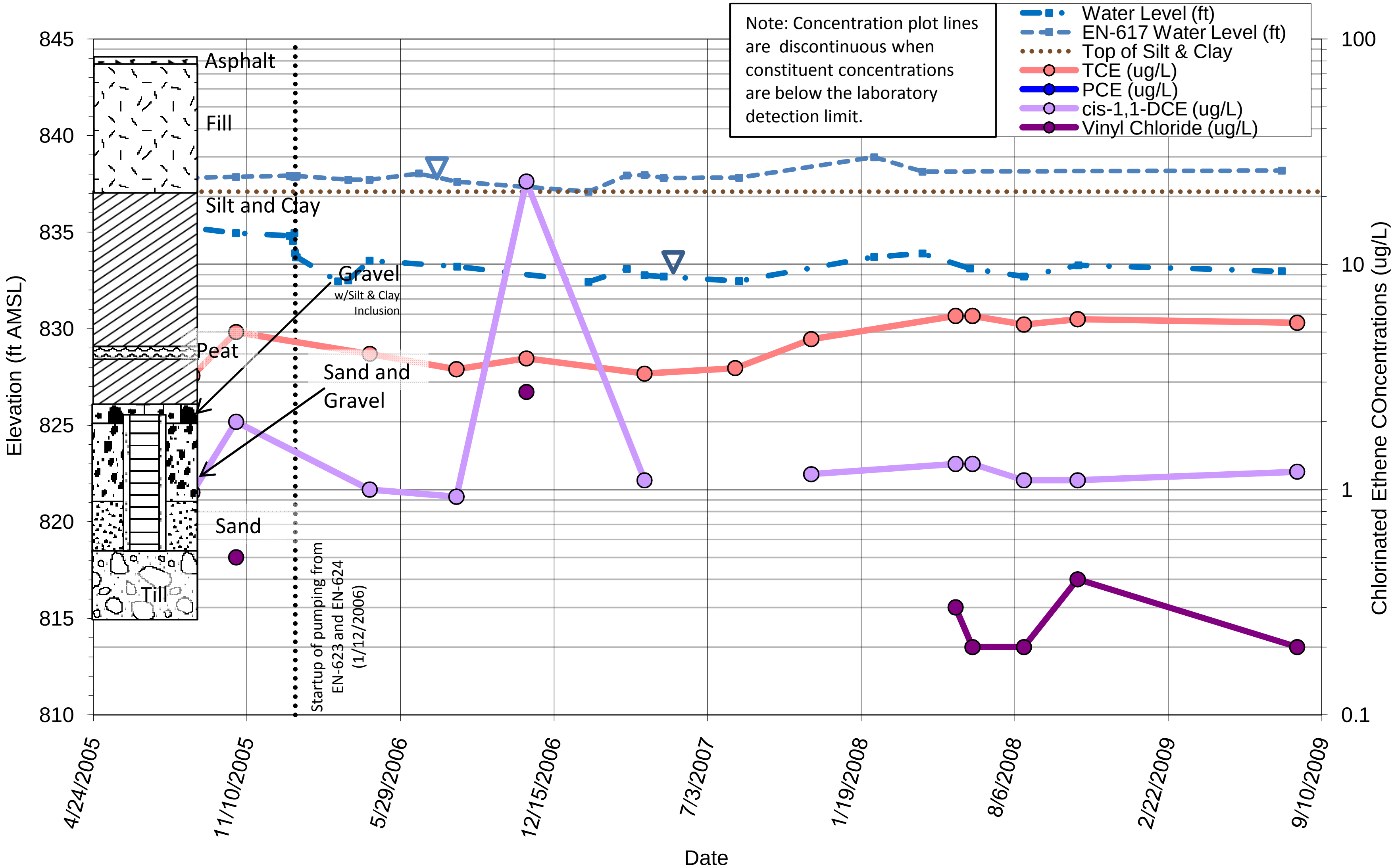
Monitoring Well EN-615
Chlorinated Ethane Detections in Groundwater vs. Time



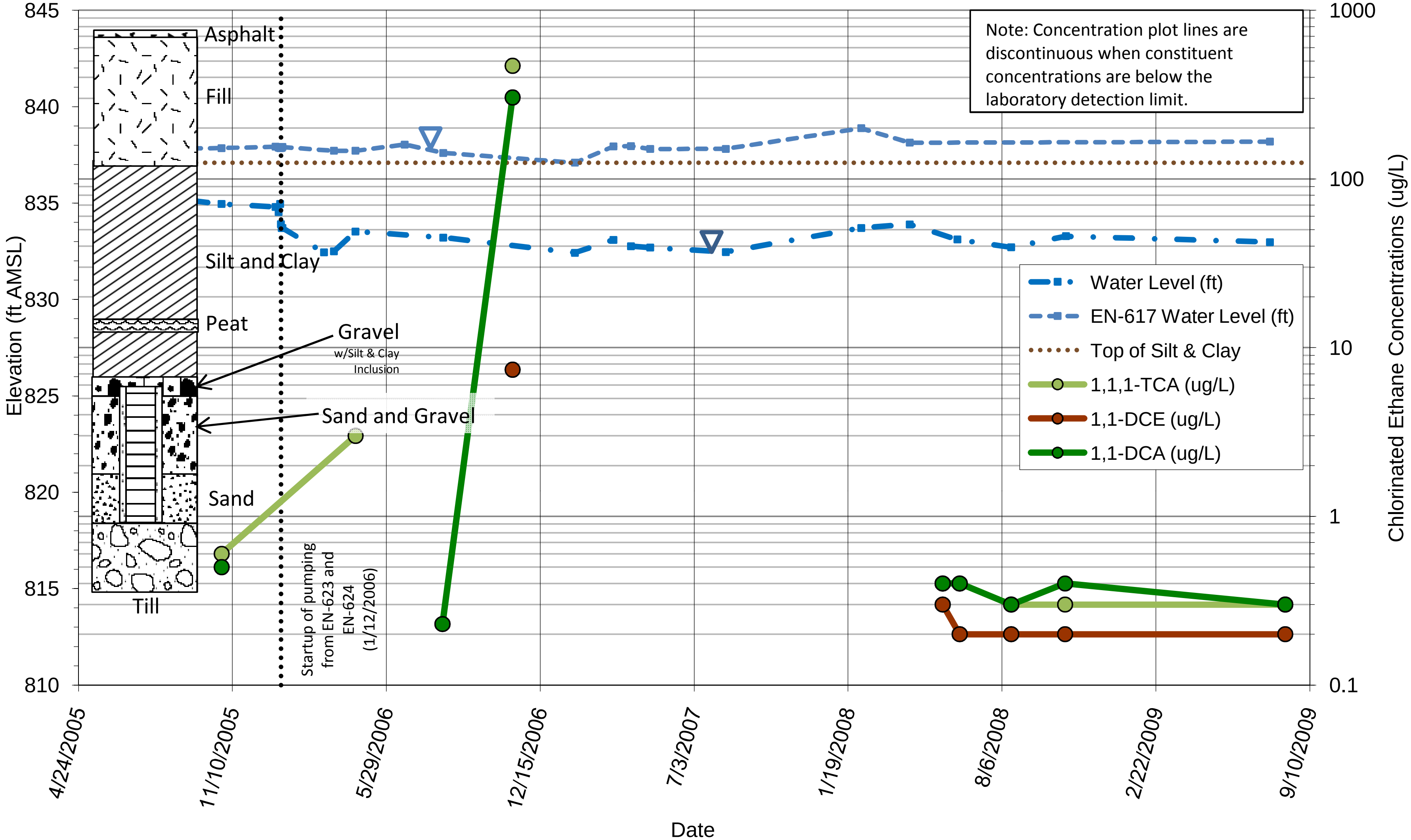
Monitoring Well EN-615
CFC Detections in Groundwater vs. Time



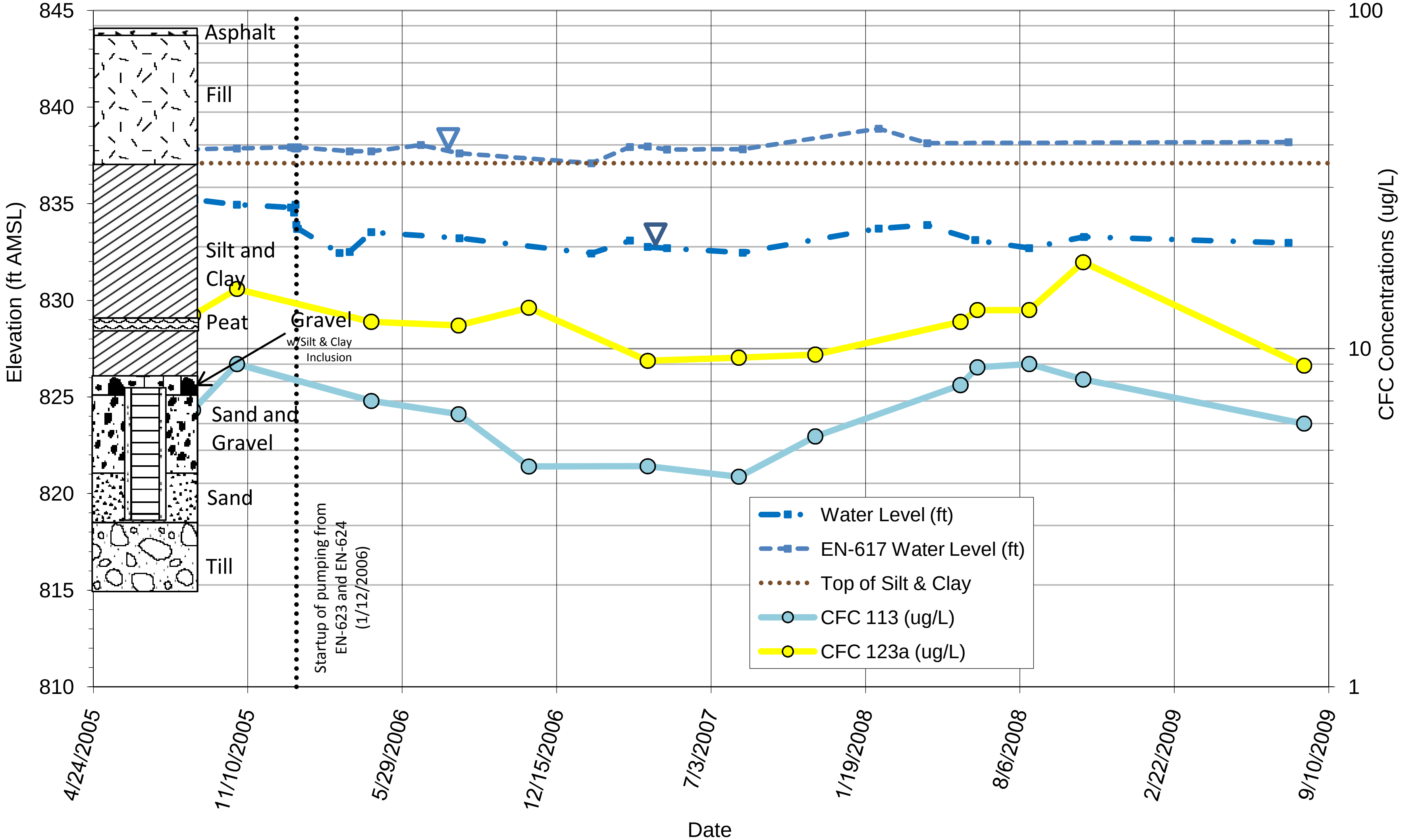
Monitoring Well EN-616
Chlorinated Ethene Detections in Groundwater vs. Time

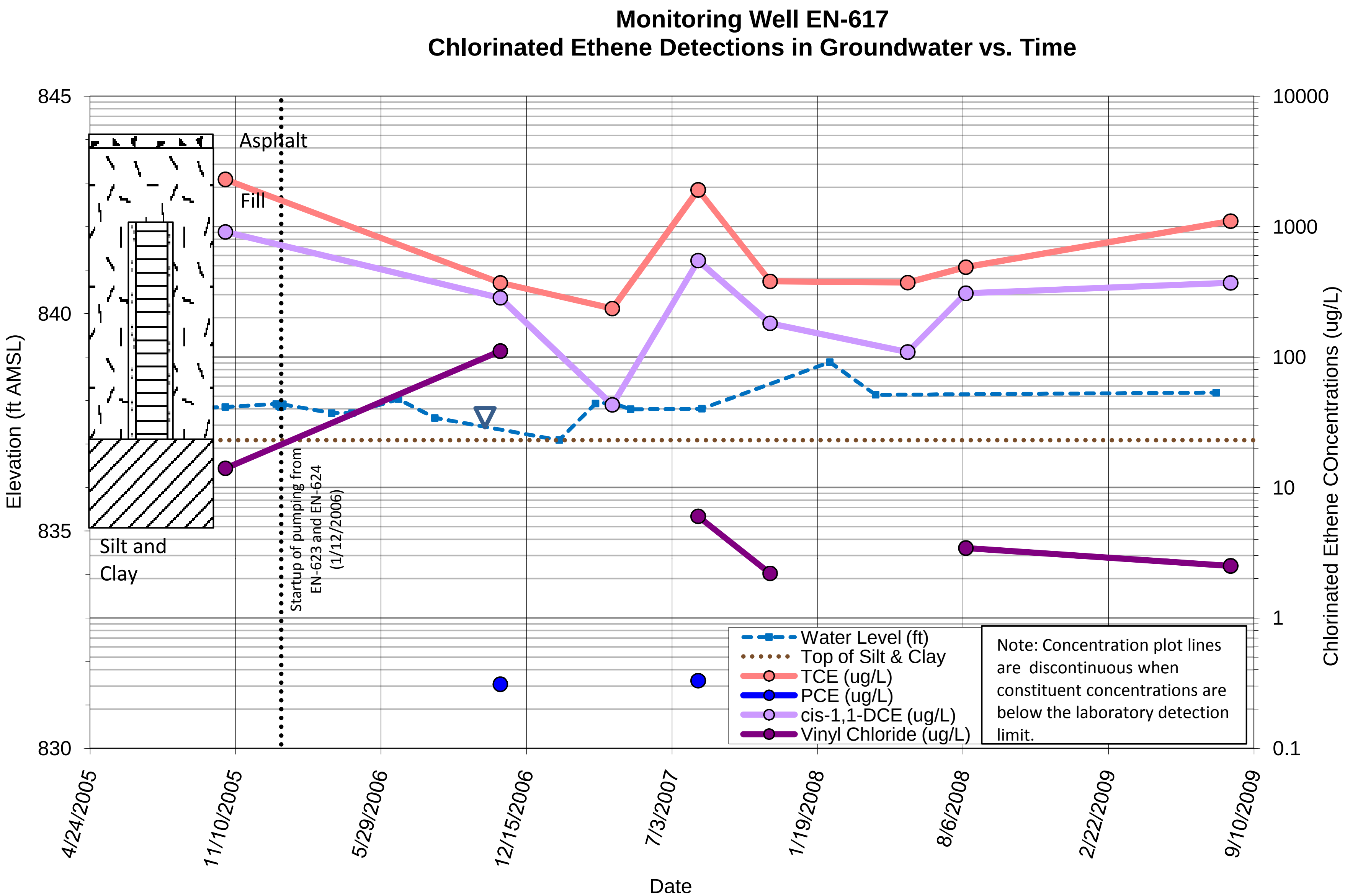


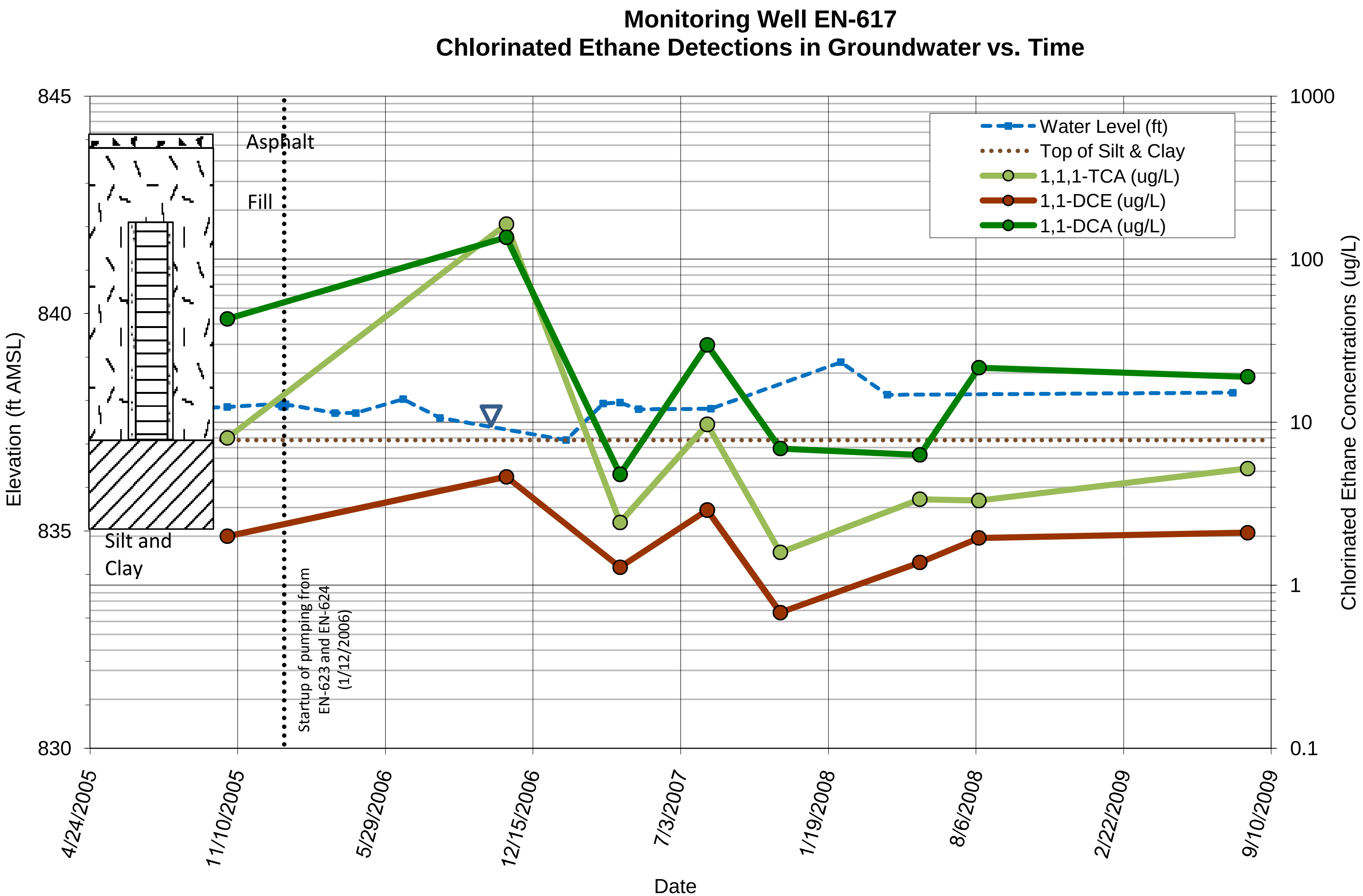
Monitoring Well EN-616
Chlorinated Ethane Detections in Groundwater vs. Time



Monitoring Well EN-616
CFC Detections in Groundwater vs. Time

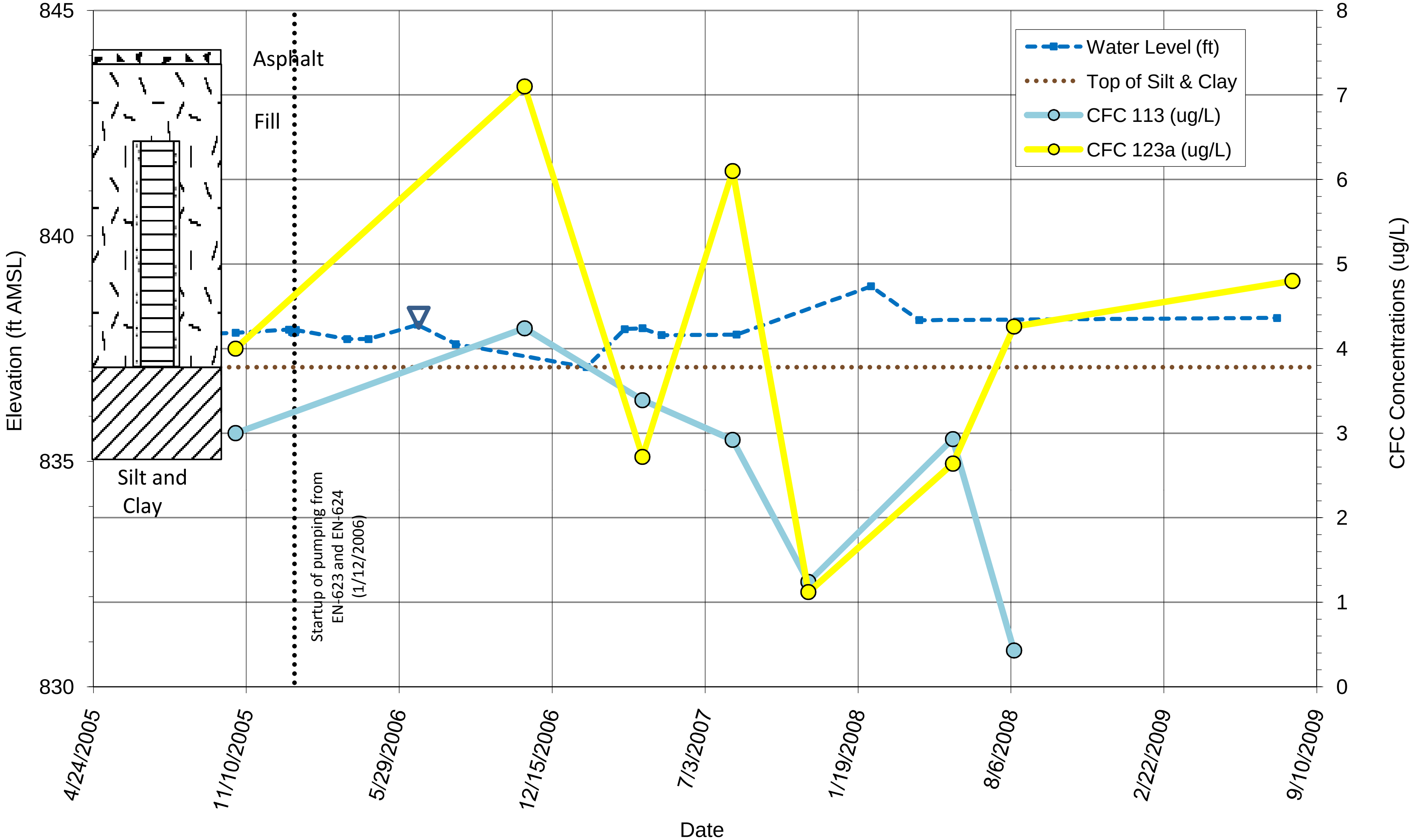


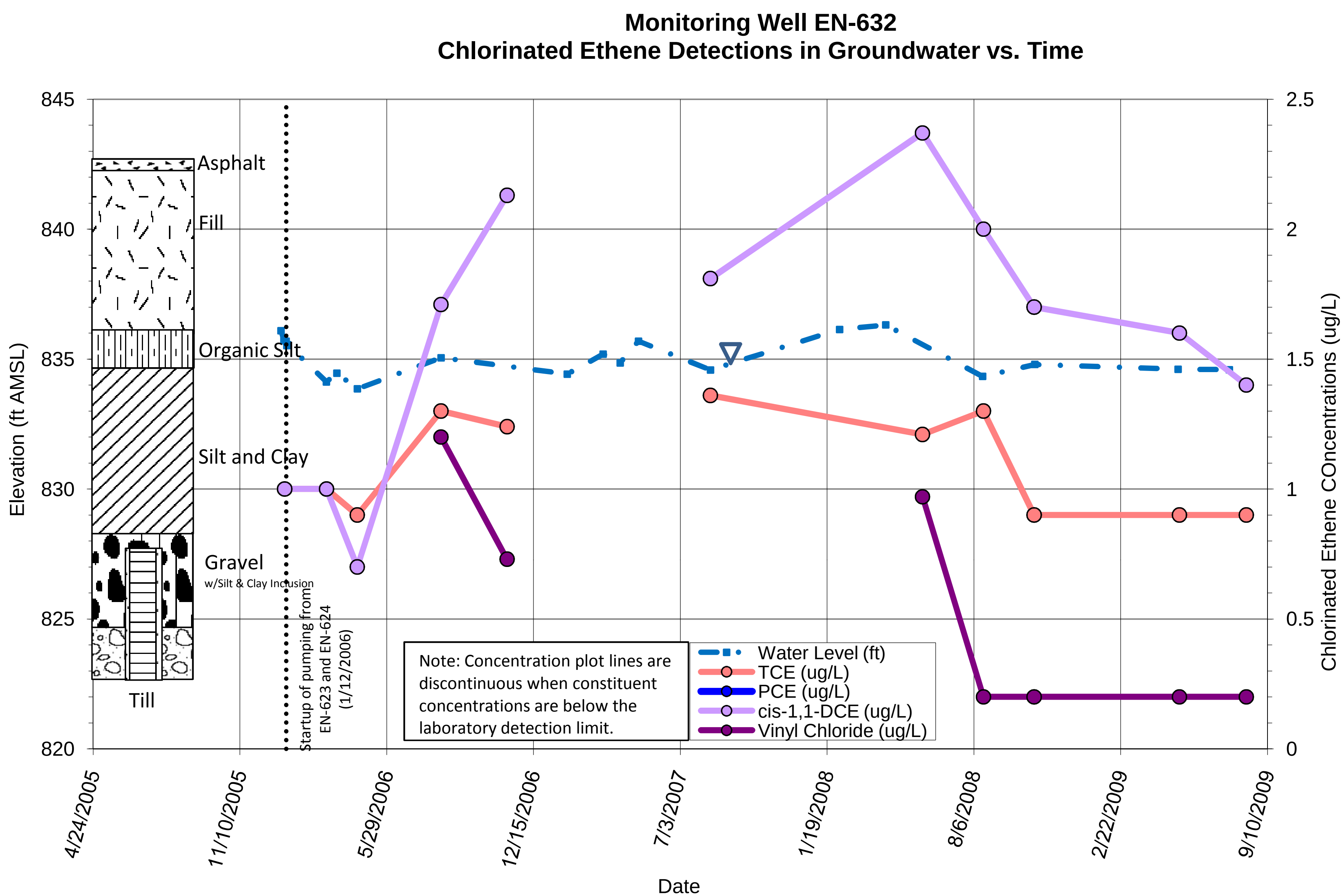

Monitoring Well EN-617
Chlorinated Ethene Detections in Groundwater vs. Time
845
840
835
830
10000
1000
100
10
1
0.1
Elevation (ft AMSL)
Chlorinated Ethene COncentrations (ug/L)
Asphalt
Fill
Silt and
Clay
Startup of pumping from
EN-623 and EN-624
(1/12/2006)
Water Level (ft)
Top of Silt & Clay
TCE (ug/L)
PCE (ug/L)
cis-1,1-DCE (ug/L)
Vinyl Chloride (ug/L)
Note: Concentration plot lines
are discontinuous when
constituent concentrations are
below the laboratory detection
limit.
4/24/2005
11/10/2005
5/29/2006
12/15/2006
7/3/2007
1/19/2008
8/6/2008
2/22/2009
9/10/2009
Date



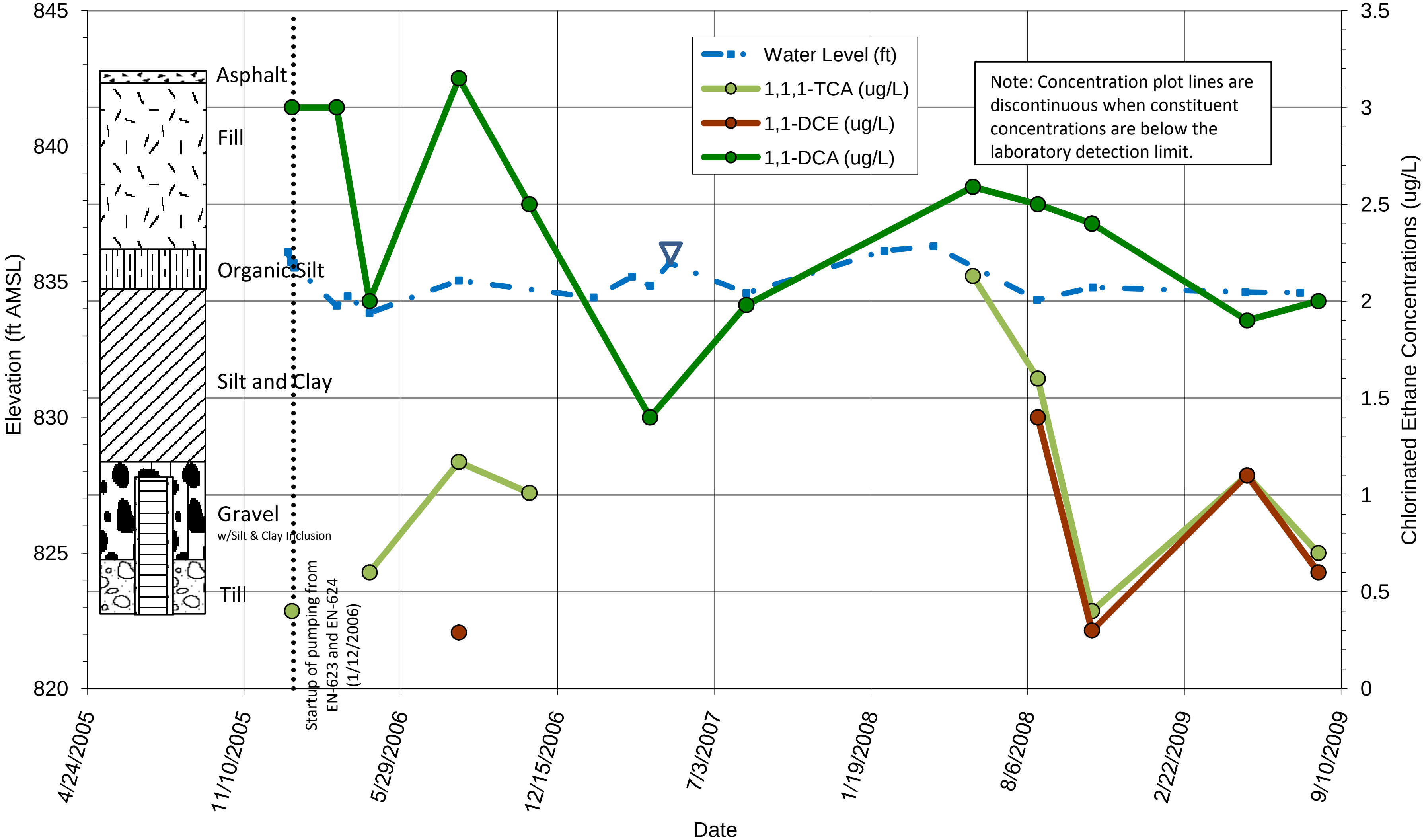
Monitoring Well EN-617
Chlorinated Ethane Detections in Groundwater vs. Time
845
840
835
830
Elevation (ft AMSL)
1000
100
10
1
0.1
Chlorinated Ethane Concentrations (ug/L)
Asphalt
Fill
Silt and Clay
Startup of pumping from EN-623 and EN-624 (1/12/2006)
Water Level (ft)
Top of Silt & Clay
1,1,1-TCA (ug/L)
1,1-DCE (ug/L)
1,1-DCA (ug/L)
4/24/2005
11/10/2005
5/29/2006
12/15/2006
7/3/2007
1/19/2008
8/6/2008
2/22/2009
9/10/2009
Date

Monitoring Well EN-617
CFC Detections in Groundwater vs. Time

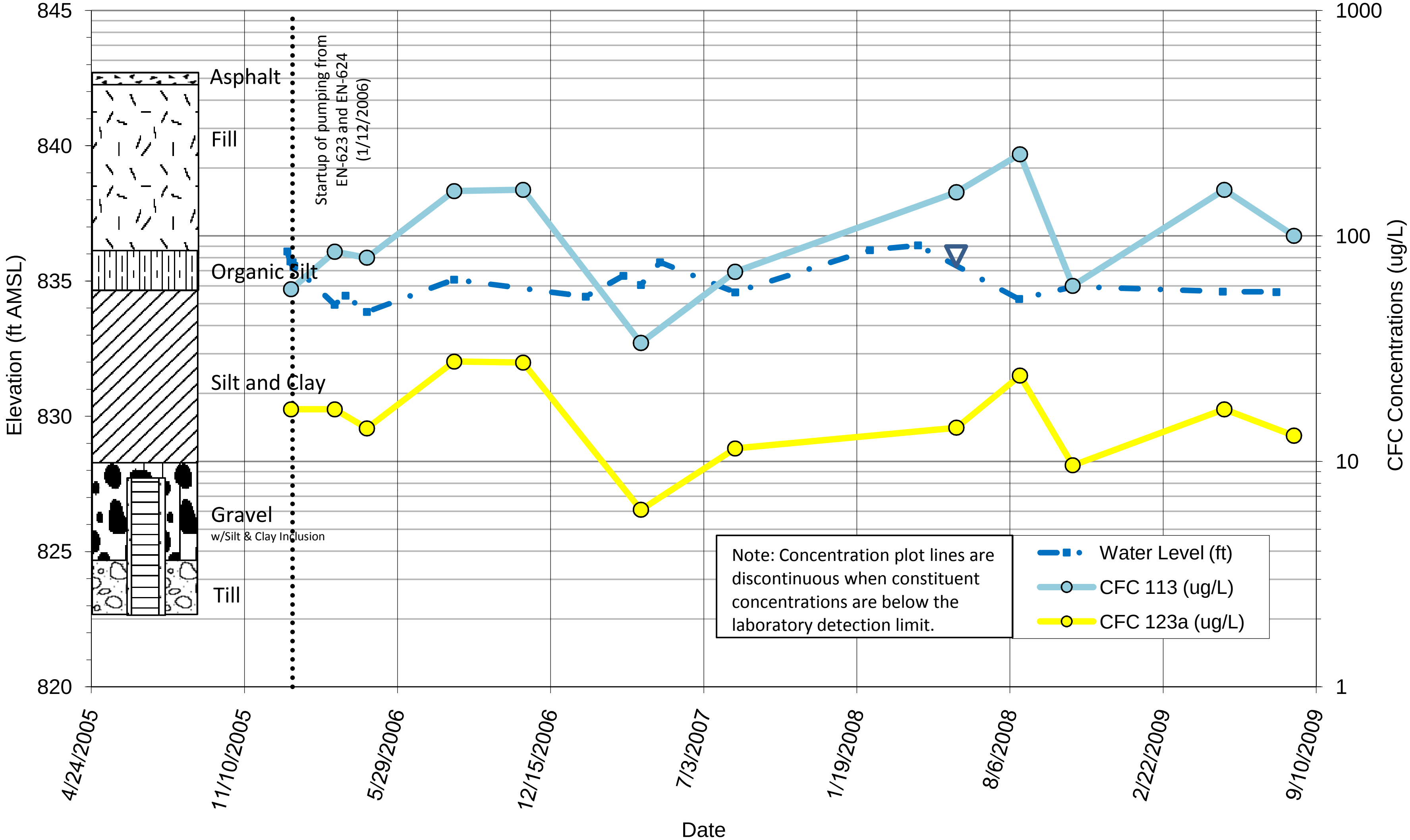



Monitoring Well EN-632
Chlorinated Ethene Detections in Groundwater vs. Time
845
840
835
830
825
820
Elevation (ft AMSL)
Asphalt
Fill
Organic Silt
Silt and Clay
Gravel
w/Silt & Clay Inclusion
Till
Startup of pumping from EN-623 and EN-624 (1/12/2006)
Note: Concentration plot lines are discontinuous when constituent concentrations are below the laboratory detection limit.
Water Level (ft)
TCE (ug/L)
PCE (ug/L)
cis-1,1-DCE (ug/L)
Vinyl Chloride (ug/L)
2.5
2
1.5
1
0.5
0
Chlorinated Ethene COncentrations (ug/L)
4/24/2005
11/10/2005
5/29/2006
12/15/2006
7/3/2007
1/19/2008
8/6/2008
2/22/2009
9/10/2009
Date

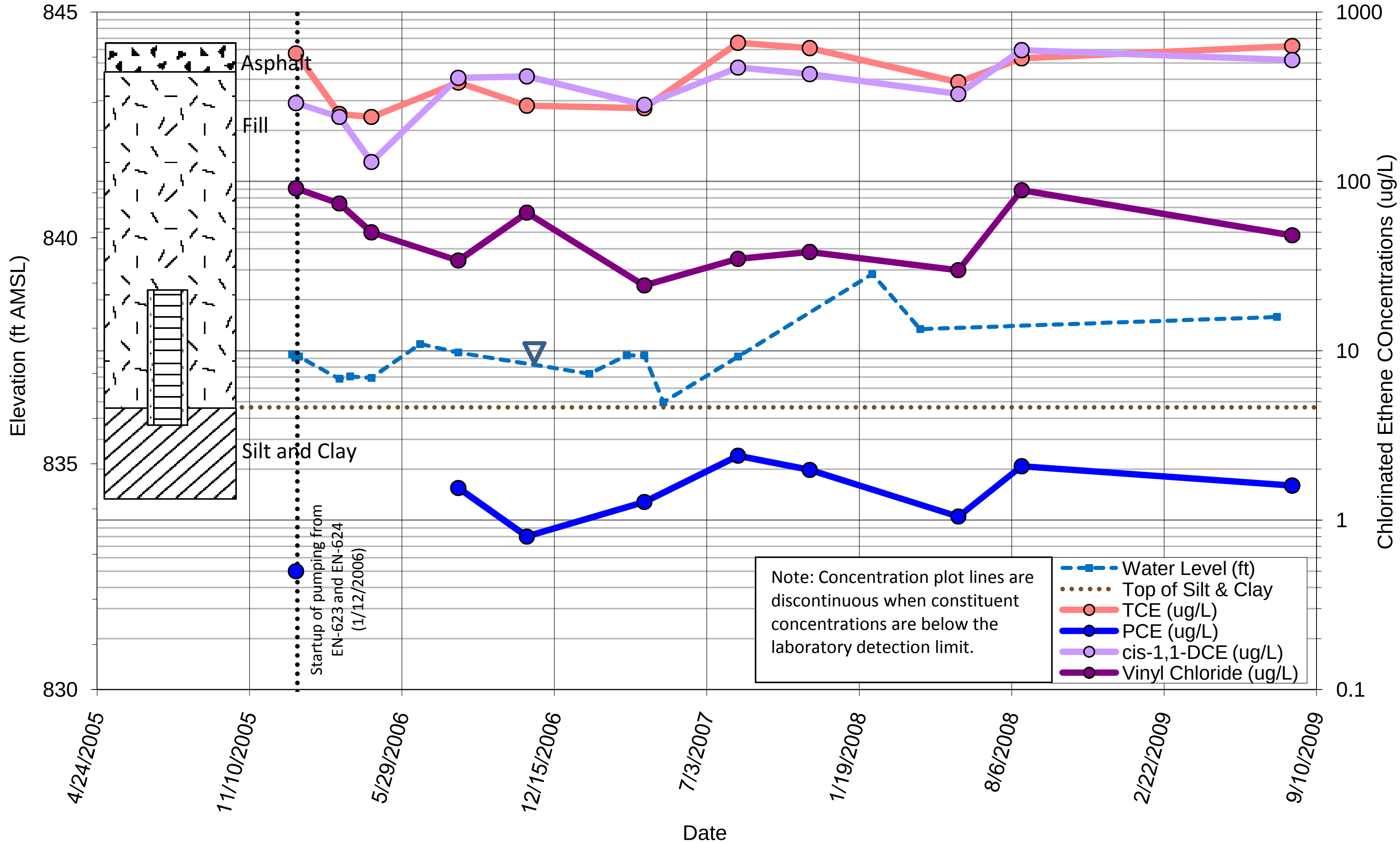
Monitoring Well EN-632
Chlorinated Ethane Detections in Groundwater vs. Time

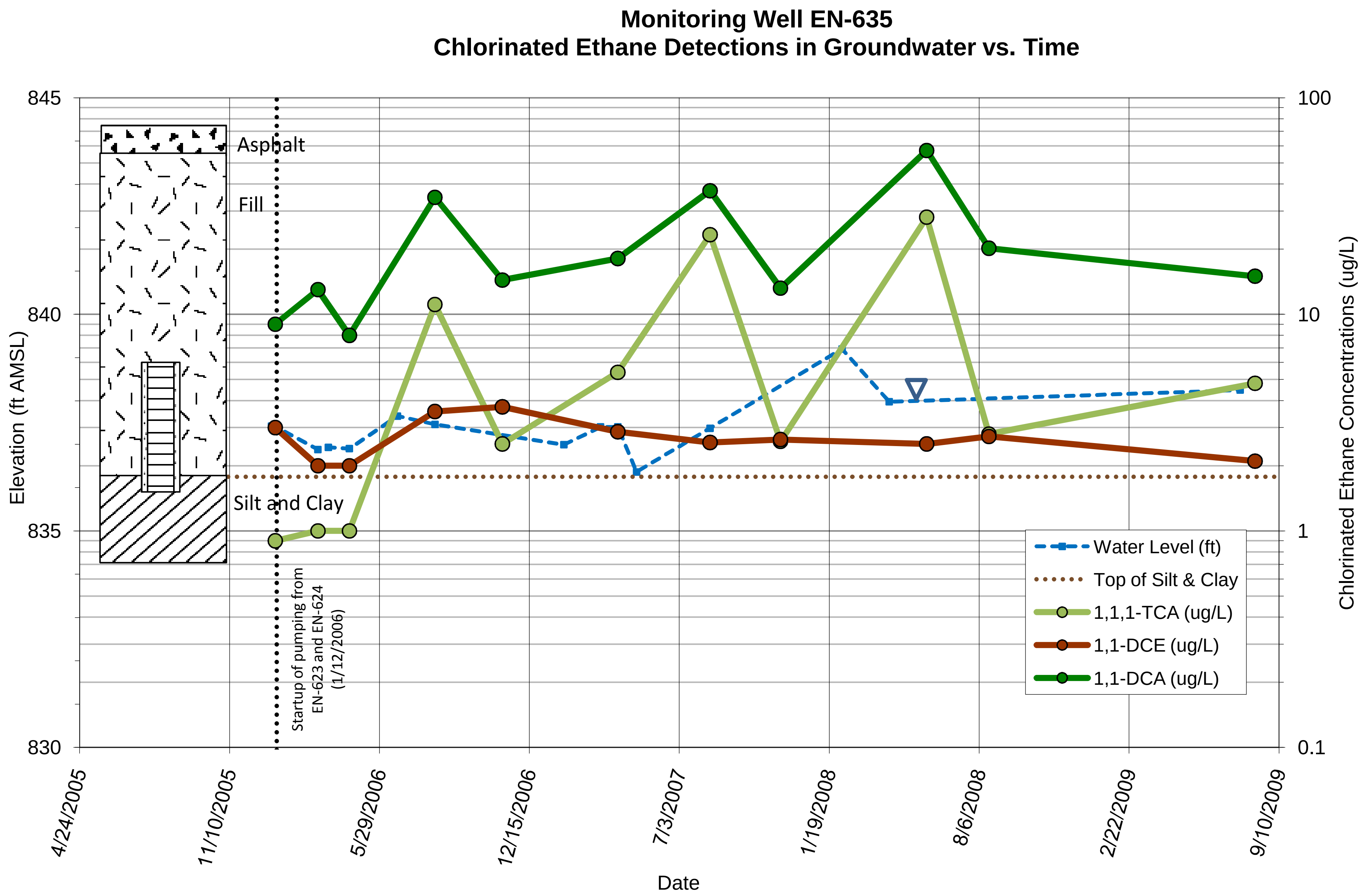


Monitoring Well EN-632
CFC Detections in Groundwater vs. Time



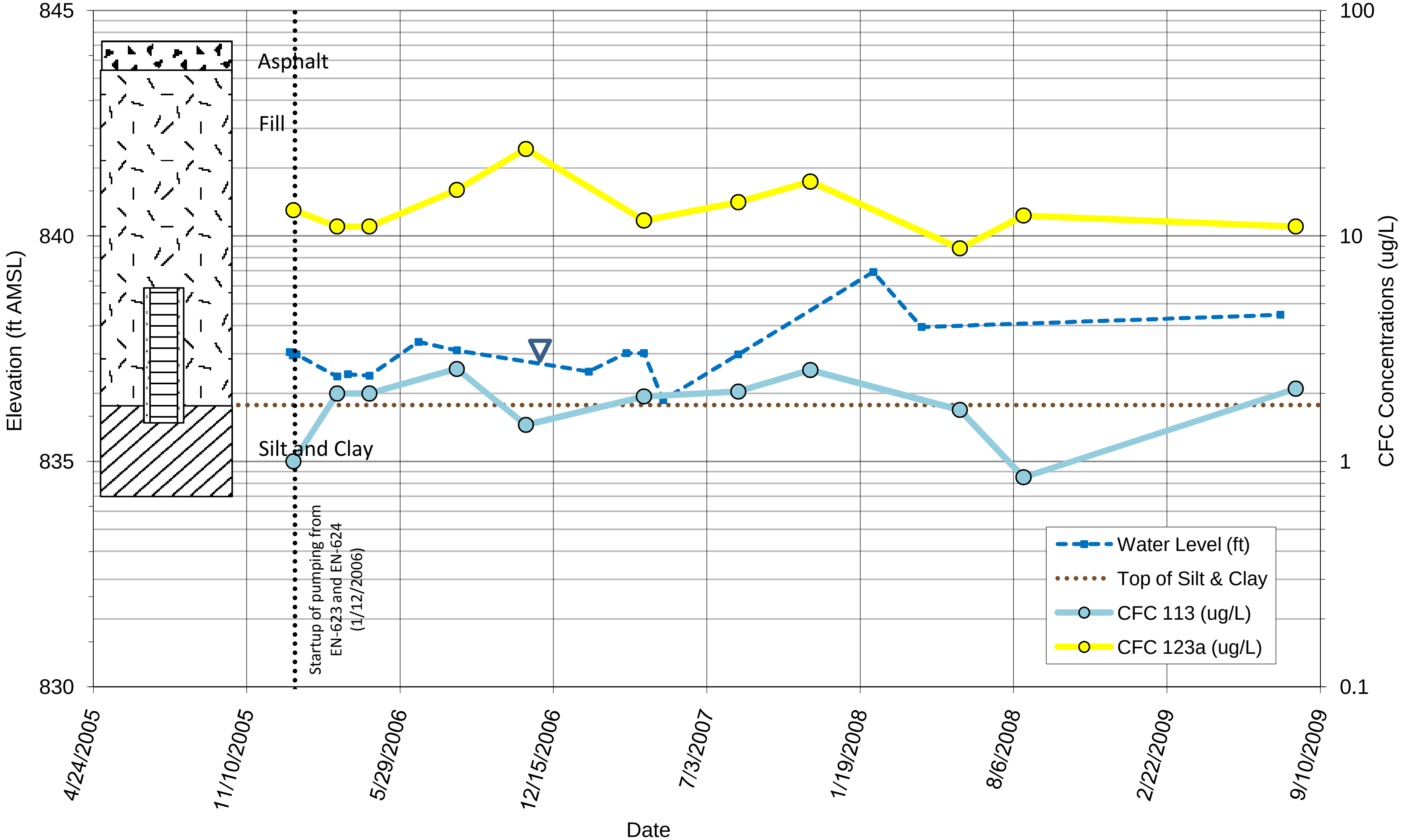
Monitoring Well EN-635
Chlorinated Ethene Detections in Groundwater vs. Time



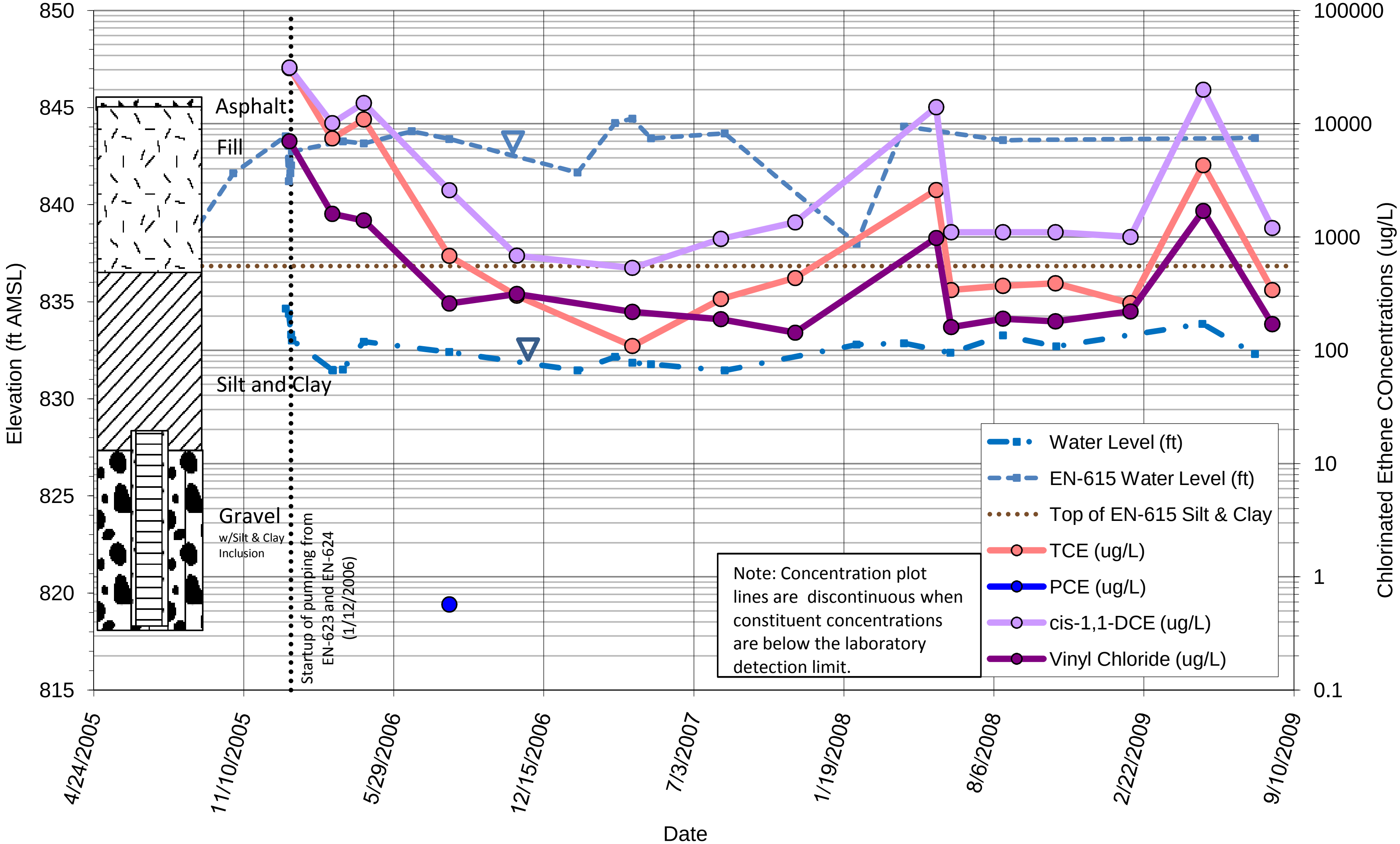


Monitoring Well EN-635
Chlorinated Ethane Detections in Groundwater vs. Time
845
840
835
830
100
10
1
0.1
Elevation (ft AMSL)
Chlorinated Ethane Concentrations (ug/L)
Asphalt
Fill
Silt and Clay
Startup of pumping from EN-623 and EN-624 (1/12/2006)
Water Level (ft)
Top of Silt & Clay
1,1,1-TCA (ug/L)
1,1-DCE (ug/L)
1,1-DCA (ug/L)
4/24/2005
11/10/2005
5/29/2006
12/15/2006
7/3/2007
1/19/2008
8/6/2008
2/22/2009
9/10/2009
Date

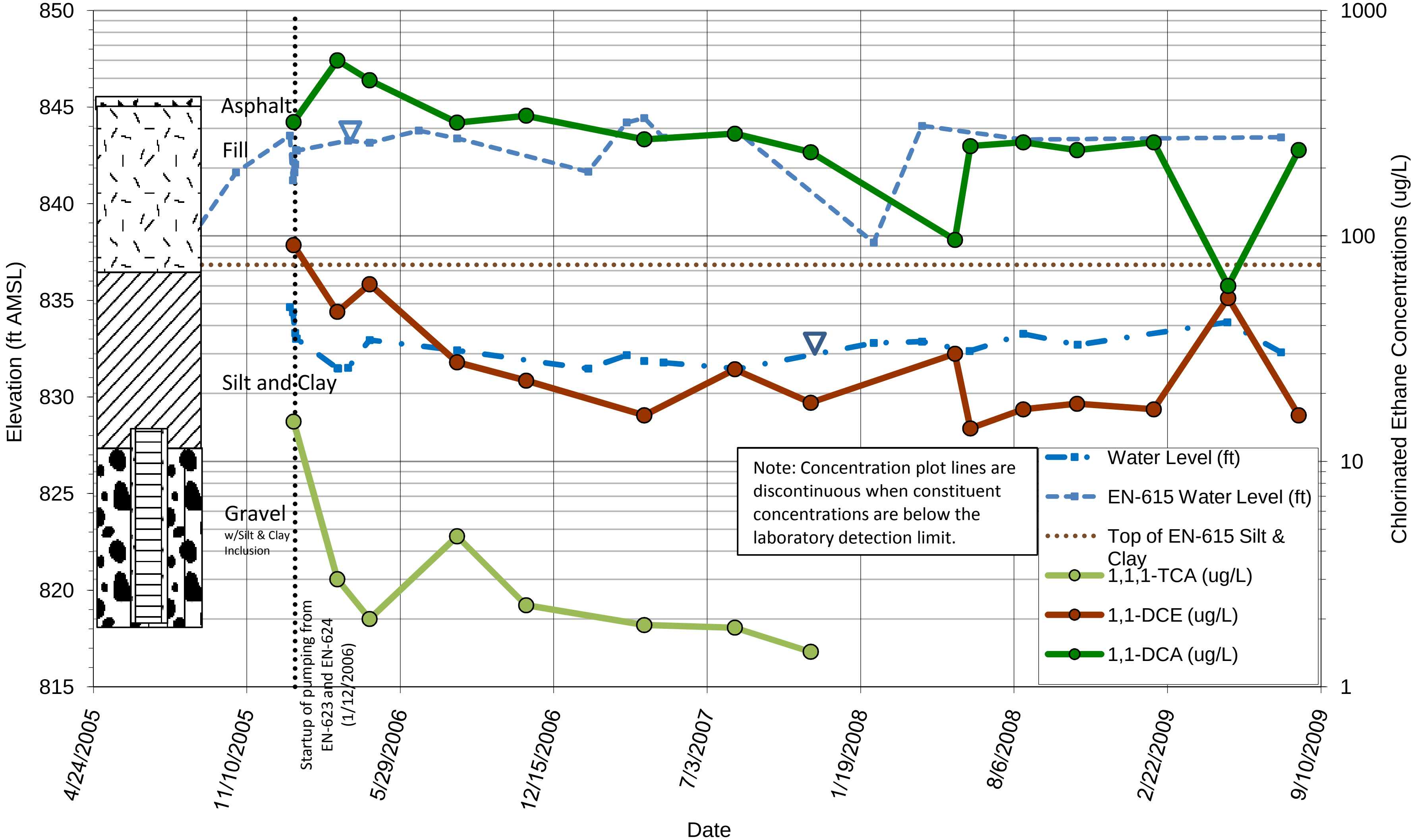
Monitoring Well EN-635
CFC Detections in Groundwater vs. Time

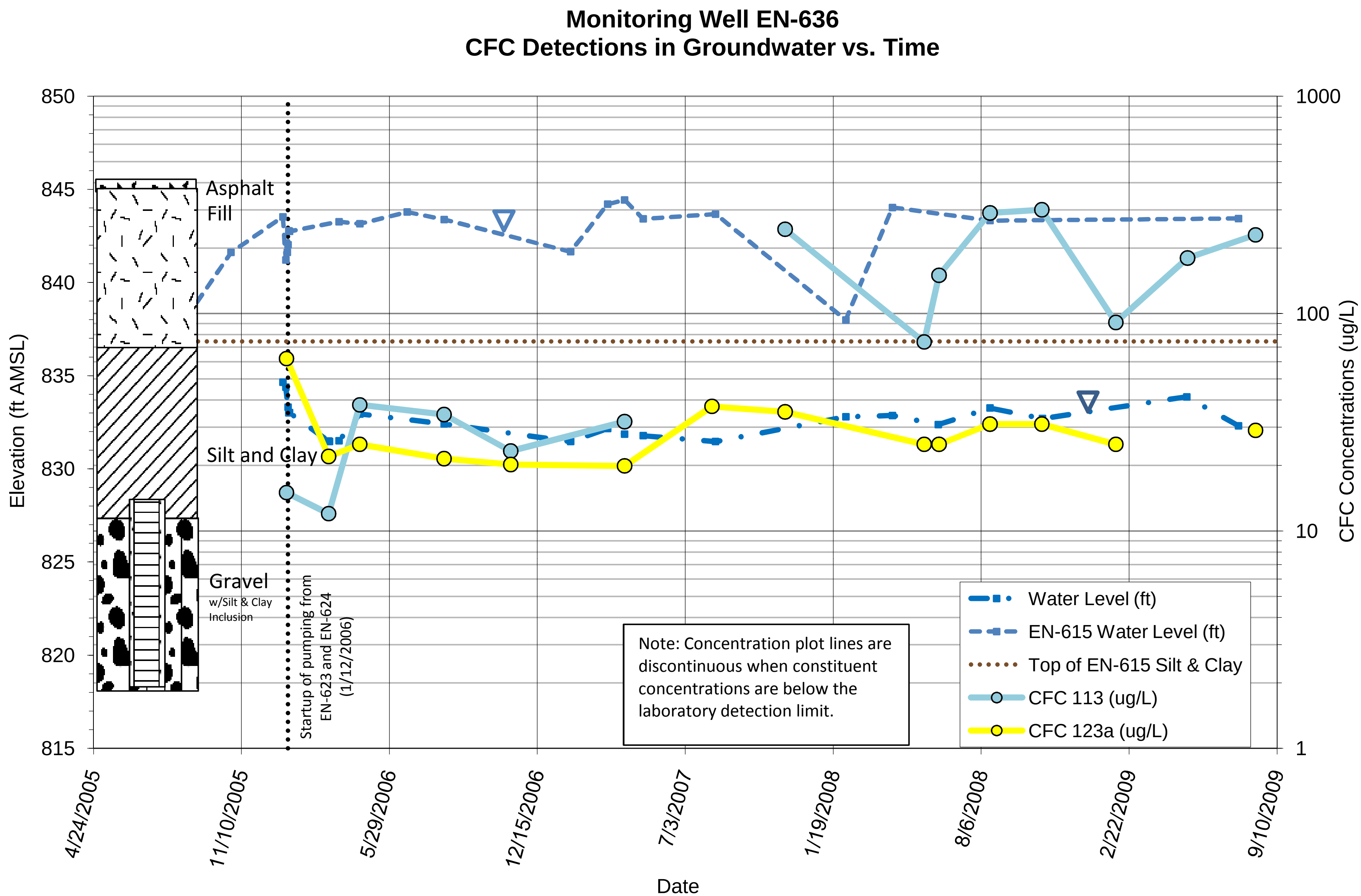


Monitoring Well EN-636
Chlorinated Ethene Detections in Groundwater vs. Time



Monitoring Well EN-636
Chlorinated Ethane Detections in Groundwater vs. Time




Monitoring Well EN-636
CFC Detections in Groundwater vs. Time
850
845
840
835
830
825
820
815
1000
100
10
1
Elevation (ft AMSL)
CFC Concentrations (ug/L)
Asphalt
Fill
Silt and Clay
Gravel
w/Silt & Clay
Inclusion
Startup of pumping from
EN-623 and EN-624
(1/12/2006)
Note: Concentration plot lines are discontinuous when constituent concentrations are below the laboratory detection limit.
Water Level (ft)
EN-615 Water Level (ft)
Top of EN-615 Silt & Clay
CFC 113 (ug/L)
CFC 123a (ug/L)
4/24/2005
11/10/2005
5/29/2006
12/15/2006
7/3/2007
1/19/2008
8/6/2008
2/22/2009
9/10/2009
Date