Lake Ontario Mariner's Marina

JEFFERSON COUNTY, NEW YORK

Final Engineering Report

NYSDEC Site Number: V00585

Prepared for:

The Upstate National Bank
One West Main Street
Rochester, New York 14614

Prepared by:

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Rochester, New York 14614
585-454-6110

MARCH 2016

CERTIFICATIONS

I, Daniel Noll, am currently a registered professional engineer licensed by the State of New York, I had primary direct responsibility for implementation of the remedial program activities, and I certify that the Remedial Action Work Plan was implemented and that all construction activities were completed in substantial conformance with the Department-approved Remedial Action Work Plan.

I certify that the data submitted to the Department with this Final Engineering Report demonstrates that the remediation requirements set forth in the Remedial Action Work Plan and in all applicable statutes and regulations have been or will be achieved in accordance with the time frames, if any, established in for the remedy.

I certify that all use restrictions, Institutional Controls, Engineering Controls, and/or any operation and maintenance requirements applicable to the Site are contained in an environmental easement created and recorded pursuant ECL 71-3605 and that all affected local governments, as defined in ECL 71-3603, have been notified that such easement has been recorded.

I certify that a Site Management Plan has been submitted for the continual and proper operation, maintenance, and monitoring of all Engineering Controls employed at the Site, including the proper maintenance of all remaining monitoring wells, and that such plan has been approved by Department.

I certify that all documents generated in support of this report have been submitted in accordance with the DER's electronic submission protocols and have been accepted by the Department.

I certify that all data generated in support of this report have been submitted in accordance with the Department's electronic data deliverable and have been accepted by the Department.

I certify that all information and statements in this certification form are true. I understand that a false statement made herein is punishable as a Class "A" misdemeanor, pursuant to Section 210.45 of the Penal Law. I, Daniel Noll, of LaBella Associates, D.P.C., am certifying as Owner's Designated Site Representative for the site.

081996	3/14/16	[signature]
NYS Professional Engineer #	Date	Signature

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LIST OF ACRONYMS

Acronym	Definition
amsl	Above Mean Sea Level
AS	Air Sparge
bgs	Below Ground Surface
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
DO	Dissolved Oxygen
EC	Engineering Control
HASP	Health and Safety Plan
IRM	Interim Remedial Measure
NOAA	National Oceanic and Atmospheric Association
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ppb	Parts-per-billion
PDD	Proposed Decision Document
psi	Pounds per Square Inch
RAO	Remedial Action Objectives
RAWP	Remedial Action Work Plan
RIR	Remedial Investigation Report
SCO	Soil Cleanup Objective
SMP	Soil Management Plan
SSDS	Sub-slab Depressurization System
SVE	Soil Vapor Extraction
SWL	Standard Water Level
UST	Underground Storage Tank
VCA	Voluntary Cleanup Agreement
VOC	Volatile Organic Compound

FINAL ENGINEERING REPORT

1.0 BACKGROUND AND SITE DESCRIPTION

The Upstate National Bank entered into a Voluntary Cleanup Agreement (VCA) with the New York State Department of Environmental Conservation (NYSDEC) in August, 2002, to investigate and remediate petroleum discharge(s) on an 8.4-acre property located at 12548 Eastman Tract, Town of Henderson, Jefferson County, New York. Based on the findings of the investigations at the Site, the metes and bounds descriptions of the Project Site in the VCA was modified to encompass only a ±0.274 acre portion of the initial 8.4 acre Site in 2013 (refer to Figures 1 and 2). The property was remediated to conditions protective of the environment and public health for commercial/industrial use and, therefore can continue to be used as part of a marina.

The property that the Project Site is a part of is located in the County of Jefferson, New York and is identified as a portion of Block 0001 and Lot 014.22 on the Town of Henderson Tax Map #105. The site is situated on an approximately 0.274-acre area bounded by Henderson Harbor (i.e., Lake Ontario) to the north, east and west, and by the remainder of the 12548 Eastman Tract tax parcel to the south. The boundaries of the site are fully described in Appendix A: Survey Map, Metes and Bounds.

An electronic copy of this FER with all supporting documentation is included as Appendix B.

2.0 SUMMARY OF SITE REMEDY

2.1 REMEDIAL ACTION OBJECTIVES

Based on the results of the Remedial Investigation, the following Remedial Action Objectives (RAOs) were identified for this site.

2.1.1 Groundwater RAOs

RAOs for Public Health Protection

- Prevent ingestion of groundwater containing contaminant levels exceeding drinking water standards.
- Prevent contact with, or inhalation of, volatiles emanating from contaminated groundwater.

2.1.2 Soil RAOs

RAOs for Public Health Protection

- Prevent ingestion/direct contact with contaminated soil.
- Prevent inhalation of, or exposure to, contaminants volatilizing from contaminated soil.

2.2 DESCRIPTION OF SELECTED REMEDY

The site was remediated in accordance with the remedy selected by the NYSDEC in the Decision Document dated March 31, 2014.

The factors considered during the selection of the remedy are those listed in 6 NYCRR 375-1.8. The following are the components of the selected remedy:

1. Removal of five (5) orphan underground storage tanks (USTs) and approximately 436-tons of petroleum-impacted soil from the portion of the Site to the north of the Marina Building as an Interim Remedial Measure (IRM) in late 2009.

2. Installation of a sub-slab depressurization system (SSDS) in the Marina Building, located immediately south of the IRM excavation. This system was installed to mitigate the potential for soil vapor intrusion into the building due to the presence of residual soil and groundwater impacts left in place beneath the Marine Building footprint.

3. Installation and start-up of an air sparge (AS) system and a soil vapor extraction (SVE) system to address residually impacted groundwater within the former source area.

4. Execution and recording of a Deed Restriction to restrict land use and prevent future exposure to any residual contamination remaining at the site.

5. Development and implementation of a Site Management Plan (SMP) for long term management of remaining contamination which includes plans for: (1) Institutional and Engineering Controls, (2) monitoring, (3) operation and maintenance and (4) reporting;

6. Periodic certification of the institutional and engineering controls listed above.

3.0 INTERIM REMEDIAL MEASURES

The information and certifications made in the January 2011 Remedial Investigation Report (RIR) were relied upon to prepare this report and certify that the remediation requirements for the site have been met.

In accordance with the NYSDEC-approved IRM Work Plan, the IRM involved the removal and off-site disposal of 436.22 tons of petroleum impacted soil and five (5) orphan USTs that potentially could contribute contamination to the Site. This work was completed in November and December 2009. In addition to the source removal, vertical AS points and a passive SVE system were installed in the IRM excavation prior to backfill. However, the air sparging points were not activated immediately subsequent to the completion of the IRM. This infrastructure was installed in the event that the AS system was needed to address residual impacts.

The analytical results associated with the excavation closure soil samples ("confirmation samples") indicated that the source of contamination has been successfully removed from the Site. Of the nine (9) IRM confirmation soil samples, only three (3) confirmation soil samples (CS2-E-10, CS5-N-5, CS6-B-11) detected residual concentrations of volatile organic compounds (VOCs) above the Soil Cleanup Objectives (SCOs) for the Protection of Groundwater. Targeted compounds were not identified above SCOs for Commercial Uses. Based on these results, it appears that the previously identified source of petroleum contamination has been successfully removed from the Site. Confirmatory sample locations are depicted on Figure 3.

In addition, the analytical results associated with the Post-IRM Groundwater Assessment indicate that a significant reduction of VOCs in groundwater has taken place as a result of the completion of the IRM. Overall reductions of benzene, ethylbenzene, toluene and xylene (BTEX) from previously measured maximum concentrations to the most recently measured concentrations (i.e., December 2014) in groundwater samples collected from wells within or adjacent to the identified source area ranged from 44% to 99.6%. These reductions appear to indicate that the completion of the IRM has had a positive influence on the localized groundwater at the Site.

In summary, the completion of the IRM has successfully removed the mass of petroleum contaminants at the Site to the extent feasible, mitigated and/or remediated environmental damage at the Site, and minimized the potential for further migration of the contaminants at the Site. The IRM Report was submitted to the NYSDEC under separate cover. Additional remediation activities performed at the site are summarized in Section 4.0, below.

4.0 DESCRIPTION OF REMEDIAL ACTIONS PERFORMED

Remedial activities completed at the Site (in addition to the IRM discussed in Section 3.0) were conducted in accordance with the NYSDEC-approved Remedial Action Work Plan (RAWP) for the Lake Ontario Mariner's Marina site (May 2013). Any deviations from the RAWP are noted below.

4.1 GOVERNING DOCUMENTS

4.1.1 Site Specific Health & Safety Plan

All remedial work performed under this Remedial Action was in full compliance with governmental requirements, including Site and worker safety requirements mandated by Federal OSHA.

A Health and Safety Plan (HASP) was prepared and complied with for all remedial and invasive work performed at the Site by LaBella.

4.1.2 Community Participation Plan

Subsequent to the submission of the RAWP to the NYSDEC and New York State Department of Health (NYSDOH), the NYSDEC issued a Fact Sheet in February 2014 summarizing the proposed final remedy for the Site. A public comment period regarding the Proposed Decision Document (PDD) developed by the NYSDEC and NYSDOH was open from February 26, 2014 to March 28, 2014. No significant comments were received during the 30-day comment period and the Decision Document was executed by the NYSDEC on March 31, 2014.

4.2 REMEDIAL PROGRAM ELEMENTS

4.2.1 Contractors and Consultants

- LaBella Associates, D.P.C. ("LaBella") completed the design, oversight, sampling, documentation and reporting associated with the implementation of the IRM and RAWP, including the pilot test associated with the air sparging system (refer to Section 4.3.2.1). Daniel Noll, Environmental Engineer at LaBella, was the certifying Engineer of Record responsible for inspection of the work;

- LaBella Environmental, LLC ("LaBella Env.") completed the installation and startup of the AS/SVE system and the installation and of the SSDS.

4.2.2 Site Preparation

- A pre-construction meeting was held with NYSDEC and all contractors on May 8, 2014.
- LaBella and LaBella Env. mobilized to the Site on May 7, 2014 to install the SSDS in the Marina Building on the Site and complete venting of the SVE system. The majority of the SSDS was installed between May 7 and May 13, 2014, although electrical issues prevented startup of the SSDS at that time. Following modifications to the Site's electrical components, the SSDS achieved full startup the week of August 11, 2014.
- LaBella completed groundwater sampling the week of May 5, 2014 to establish accurate baseline data prior to the installations of the AS/SVE systems.
- LaBella and LaBella Env. completed a pilot test of the AS system to determine the most effective system design between May 13 and May 16, 2014.
- Subsequent to the analysis of the AS pilot test data, LaBella and LaBella Env. mobilized to the Site on August 14, 2014 to install the remaining components of the AS system. Specifically, the compressor, shed to house the compressor and piping to connect the compressor to the AS points were installed at that time. The AS/SVE systems achieved full startup the week of September 22, 2014.

Documentation of agency approvals required for the remediation work is included in Appendix C.

4.3 ENGINEERING CONTROLS

Since residual contaminants remain in the soil and groundwater beneath the Site, Engineering Controls (ECs) are required to protect human health and the environment. The Site has the following primary ECs, as described in the following subsections.

4.3.1 Sub-Slab Depressurization System

Procedures for monitoring, operating and maintaining the SSDS are provided in the Operation and Maintenance Plan in Section 4 of the SMP. The Site Monitoring Plan also addresses inspection procedures that must occur after any severe weather condition has taken place that may affect the SSDS. The general layout and system features of the SSDS are shown on as-built drawings included in Appendix D.

4.3.2 Air Sparging System

Air sparge points were installed in the IRM excavation prior to backfilling. The infrastructure consists of six (6) vertical, 1-in. diameter pipes connected via 1-in. diameter horizontal piping to the northern exterior of the Marina Building. The vertical sparge points are screened below the residually impacted soils and groundwater, which have been observed to be located at maximum depths of between 5-ft. and 11-ft. bgs. Components of the AS system are depicted on Figure 4.

In substantial accordance with the RAWP and Decision Document, the AS system was activated as part of the final remedy. Prior to the installation of the additional mechanical components needed to activate the AS system, LaBella performed pilot testing of the system in accordance with the RAWP. This work and the installation of the remainder of the system are described in the below sub-sections.

4.3.2.1 Pilot Testing

Methodology

As previously noted, six (6) AS points were installed at the Site in 2009 as part of the IRM. As described in the RAWP, the AS system was designed to cycle on and off between “banks” of two sparge points, for a total of three banks. Similar cycling has been found to increase mass contaminant removal by 20% to 30% as well as decrease the operating cost of the air compressor (Johnson et al., 2001; refer to Appendix E).

Pilot tests were planned to be performed on each of the three banks; however, heavy rain during the final testing day prohibited a test of the third bank. The tests were completed by pumping compressed air into one bank of points at 15 pounds per square inch (psi) for approximately 5 hours (test 1) and approximately 4 hours (test 2). Test 1 assessed sparge points 1 and 2 and was completed on May 14, 2014. Test 2 assessed sparge points 3 and 4 and was completed on May 15, 2014.

Static water levels (SWLs) and dissolved oxygen (DO) levels were collected from numerous wells prior to and periodically during and after each test to assess groundwater conditions. These parameters were measured approximately every 40-60 minutes during each test and for several hours after each test.

DO measurements were collected by bailing approximately 10-ounces of groundwater from each well into plastic cups and using a YSI Pro Plus Quatro meter to measure DO. The groundwater was then carefully poured back into its origin well. A YSI Pro 20 DO meter was initially used for DO measurements; however, this meter appeared to malfunction on the morning of the first pilot test (May 14, 2014) and the DO data collected for test 1 (sparge points 1 & 2) was unable to be used in this analysis. A YSI Pro Plus Quatro meter was utilized to measure DO concentrations during test 2 and appeared to be functioning properly during the test.

SWLs were measured manually using Heron Dipper T water level meters and electronically using Heron Dipperlog water level data loggers (i.e., pressure transducers). As part of the data analysis, SWLs were compensated for changes in Lake Ontario water levels. Lake level data was obtained from a weather station buoy offshore from Oswego, New York. This station is operated by the National Oceanic and Atmospheric Association (NOAA) and collects lake elevation levels every 60-min. This station is the closest located to Henderson Harbor. Because SWLs collected from Site monitoring wells were collected more frequently than every 60-min, modeled values were used to approximate lake levels between the 60-min collection periods. These values were calculated by graphing the lake levels obtained from NOAA and using the linear equation of each 60-min. segment to model the lake level at the particular time that SWLs were measured at the Site. The use of lake levels to compensate SWLs assumes a negligible lag time between changes in lake level and changes in groundwater. This assumption is supported by the fact that the majority of wells are in close proximity (i.e., as close as 4-ft.) to the harbor.

Results

Based on the latest groundwater data available at the start of the pilot testing (i.e., September 2013), wells with total VOC concentrations above 250 parts-per-billion (ppb) (i.e., the wells with the most residual contaminants) include MW-1, MW-4, MW-5, MW-12 and T-4. As such, the objective of the pilot test was to determine if the air sparge system would influence the areas surrounding these "target" wells. These five wells are located either under the northern portion of the marina building or in the areas of residual petroleum impacts along the northern and eastern perimeters of the IRM excavation. These well locations are depicted on Figure 3.

As previously noted, DO concentrations from Test 1 were unusable due to malfunctioning instrumentation. As shown in Table 3, DO concentrations generally increased from background (i.e., immediately before Test 2) during Test 2 active sparging, with the exception of wells MW-07 and MW-08. The data generally show influence from air sparging in the majority of wells; however, these results appear less reliable than the SWL results described below based on the time of collection of the background readings. The DO background readings were collected approximately 18 hours after Test 1, during which active sparging had occurred for approximately 5 hours. Although viable DO data are not available for Test 1 due to the malfunctioning instrumentation, the Test 1 sparging likely affected DO concentrations in groundwater in some way, potentially compromising the accuracy of the background DO readings collected immediately prior to Test 2. Without background DO data prior to any sparging at the Site (i.e. before Test 1), distinguishing the extent of natural changes in DO concentrations from those induced by air sparging is difficult. This does not appear to be in issue with the SWL data analysis as SWLs appear to have stabilized between the end of Test 1 and the beginning of Test 2. Specifically, Test 1 and Test 2 well-specific SWL background levels were within 10% of each other. In addition, research utilized to design the pilot test indicates SWLs typically stabilize within several hours subsequent to sparging in a relatively homogeneous subsurface such as that identified in this area of the Site. Background SWLs for Test 2 were measured approximately 18 hours subsequent to the ceasing of sparging during Test 1.

Based on research done to develop the RAWP (Johnson et al., 2001; refer to Appendix E), SWLs were anticipated to initially increase and then decrease at a slightly slower but similar rate (i.e., a bell curve) and finally stabilize (all while actively sparging). Subsequent to turning the sparging system off, SWLs were expected to immediately decrease below stable levels and then slowly stabilize; however, this research shows the decrease in SWLs to be about 60% of the magnitude of the initial increase when sparging began. In addition, this research shows that wells closest to the sparge points are expected to be affected as just described; however, wells further from the sparge points may experience the opposite effect. Essentially, water levels increase (or mound) closest to the sparge points and decrease further from the sparge points as water is “pulled away” from those outlaying areas.

Analysis of the test 1 (sparge points 1 and 2) SWL data indicates the “mounding” effect to be observed in wells MW-1, MW-7, MW-8, MW-11, MW-12 and T-4 (hereinafter known as the “T1 positive wells”) and the opposite effect (i.e., a sudden decrease in static water levels) was observed in wells MW-4, MW-5, MW-6, MW-9 and MW-13 (hereinafter known as the “T1 negative wells”). Charts showing changes in SWLs during test 1 are displayed as Tables 1A and 1B. Following the initial increase and decrease of SWLs in the T1 positive wells, unexpected increases and decreases in SWLs of similar magnitudes and durations were observed in these wells until sparging was ceased approximately 290-min. (4.8 hours) into the test. Following the termination of sparging, SWLs in the T1 positive wells generally stabilized. SWLs in the T1 negative wells had similar (but opposite) reactions initially with a sudden decrease and subsequent increase in SWLs. Unexpected decreases and increases in SWLs of similar magnitudes and durations were observed in the T1 negative wells. However, unlike the T1 positive wells, SWLs in the T1 negative wells did not stabilize immediately (i.e., within approximately 2.5 hours after ceasing sparging), although SWLs did not rise above background levels subsequent to ceasing sparging. Based on this analysis, the initial increase and decrease of SWLs in T1 positive wells was generally completed in the first 55-min. of the test. As such, a 55-min. pulsing duration was recommended for sparge points 1 and 2 for the full implementation of the AS system.

Analysis of test 2 (sparge points 3 and 4) SWL data identifies wells MW-01, MW-04, MW-05, MW-06, MW-11, MW-12, MW-13 and T-4 as “T2 positive wells” and MW-08 and MW-09 as “T2 negative wells”. Charts showing changes in SWLs during Test 2 are displayed as Tables 2A, 2B and 2C. Active sparging was completed for approximately 245-min. during Test 2. The T2 negative wells are the two wells included in this test located farthest from sparge points 3 and 4 (i.e., MW-08 and MW-09). Sparging to points 3 and 4 appears to have had the greatest positive effect on wells MW-01, MW-04, MW-05, MW-06 and MW-13. Unlike Test 1, SWLs appeared to stabilize in the positive wells following the initial increase and decrease in the T2 positive wells (which took approximately 80 min.) until sparging ceased approximately 245-min. into Test 2, at which point SWLs sharply increased in all T2 positive wells except MW-12. SWLs in the T2 negative wells behaved similarly (albeit oppositely) to those in the T2 positive wells; following the initial sudden decrease and increase in SWLs, the SWLs generally stabilized until sparging ceased approximately 245-min. into Test 2. However, at this point the T2 negative well SWLs increased (similar to the T2 positive wells at this same time). Based on this analysis, the initial increase and decrease of SWLs in T2 positive wells was generally completed in the first 80 minutes of the test. An 80-min. pulsing duration was recommended for sparge points 3 and 4 for the full implementation of the AS system.

Although a pilot test of points 5 & 6 was not completed due to time constraints and heavy rain throughout the day on May 16, 2014, based on the apparent positive impact to all targeted wells by sparging of points 1 & 2 and/or 3 & 4 within 80-min., an 80-min. pulsing duration was recommended for sparge points 5 and 6 for the full implementation of the AS system.

Figure 5 shows the interpreted areas of influence for Test 1 and Test 2 described above.

4.3.2.2 Installation and Activation

Based on data obtained from the pilot test, an Air Sparge Skid 2951 with a Becker DT4.10 – 4.40 Series compressor was selected to be installed at the Site for operation of the sparge system. General specifications of this system are included in the SMP. The compressor was customized to allow pulsing between the three sparge point banks.

The compressor was installed at the Site by LaBella Env. the week of August 11, 2014. Compressed air is conveyed from the compressor to the six sparge points via six ½", 300 psi air lines housed in 4" conduit. These lines connect to the 1-inch diameter horizontal PVC piping installed during the IRM. Each horizontal pipe connects to the corresponding vertical sparge point which consists of a 1-inch PVC riser connected to a 1-inch diameter, 0.010-inch slotted screen. Each vertical sparge point is screen below the water level depth intervals of approximately 5-ft. to 8-ft. below ground surface (bgs).

The compressor is housed in a shed located adjacent to the west of the Marina Building (refer to Figure 4). Following improvements to the Site's electrical system, the AS system achieved full operation the week of September 22, 2014. The compressor is designed to operate by pushing 5-psi of compressed air alternately into the three sparge point banks at intervals of 55-min. for points 1 and 2, and 80-min. each for points 3 and 4 and points 5 and 6.

Procedures for monitoring, operating and maintaining the AS system are provided in the Operation and Maintenance Plan in Section 4 of the SMP. The Monitoring Plan also addresses inspection procedures that must occur after any severe weather condition has taken place that may affect on-site ECs.

4.3.3 Soil Vapor Extraction System

The SVE system consists of two sets of 4-in. diameter perforated piping which were installed horizontally around the perimeter of the IRM excavation prior to backfill. The two sets of 4-in. diameter piping were installed at depths of approximately 2-ft. and 5-ft. below ground surface (bgs), respectively. These horizontal pipes extend around the excavation to the northern side of the building, where they are connected to vertical 4-in. PVC risers which terminate approximately 2-ft above the building's roofline. The risers are each capped with a 4-inch diameter passive turbine to enhance the SVE's effectiveness. This horizontal infrastructure creates a pathway for any vapors emitted from the residually impacted soil and/or groundwater and thus comprises a passive (SVE) system. Appendix D contains a schematic showing the features of the SVE system.

Procedures for monitoring, operating and maintaining the SVE system are provided in the Operation and Maintenance Plan in Section 4 of the SMP. The SMP also addresses inspection procedures that must occur after any severe weather condition has taken place that may affect on-site ECs.

4.4 INSTITUTIONAL CONTROLS

The site remedy requires that a deed restriction be placed on the property to (1) implement, maintain and monitor the Engineering Controls; (2) prevent future exposure to remaining residual contaminants by controlling disturbances and excavation of the subsurface contamination; and, (3) limit the use and development of the site to commercial and/or industrial uses only.

The Deed Restriction for the site will be executed by the Department and filed with the Jefferson County Clerk.

4.5 DEVIATIONS FROM THE REMEDIAL ACTION WORK PLAN

Significant deviations from the remedial action work plan were not made during the implementation of this plan.

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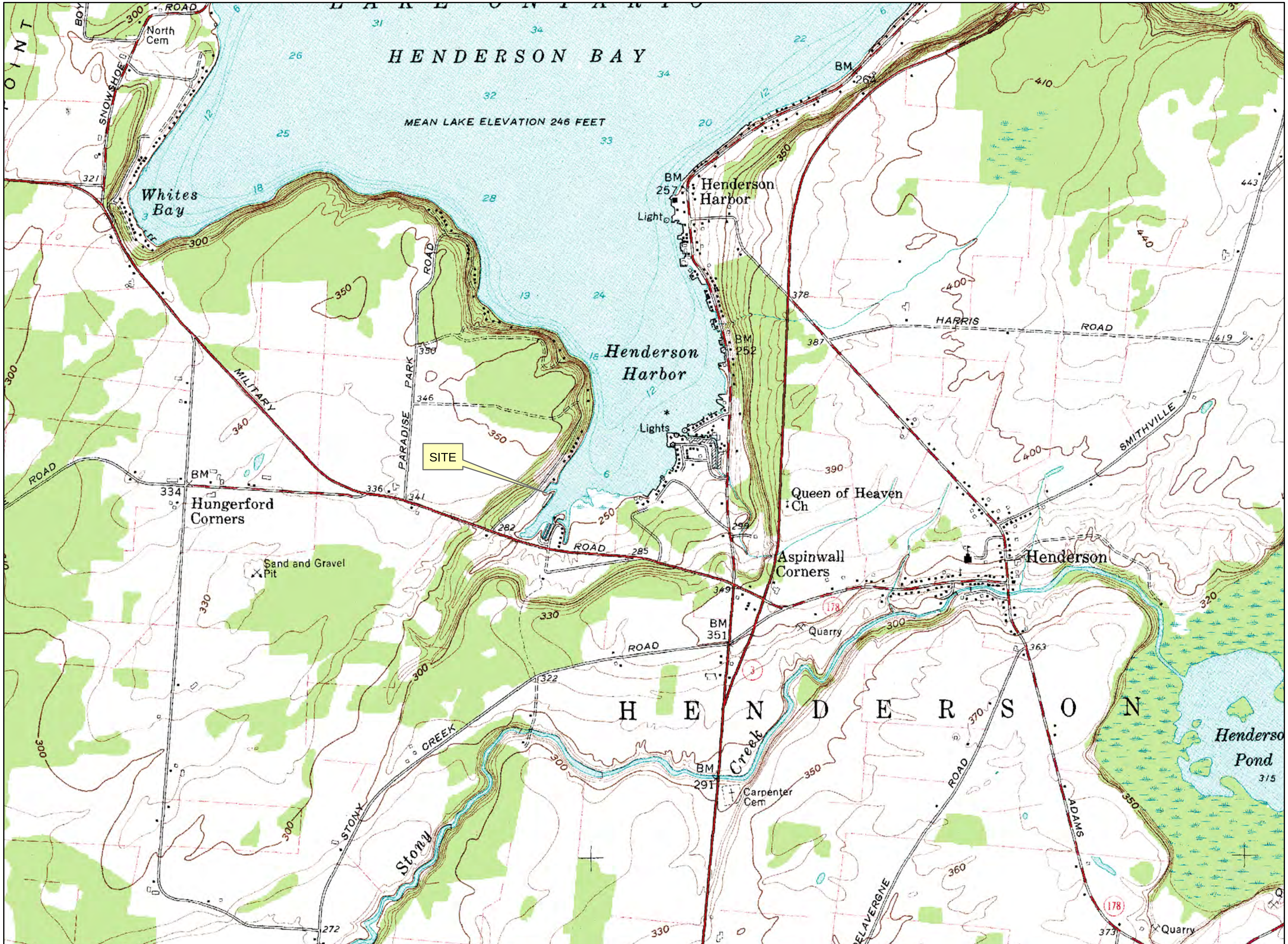
FIGURES



LABELLA
Associates, D.P.C.

Final Engineering Report

Project Location with USGS Topographic Quadrangle

12548 Eastman Tract
Henderson Harbor, NY

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500 0 1,000

1 inch = 1,500 feet
Intended to print as 11" x 17".

207820

FIGURE 1

Path: J:\Upstate National Bank\207820 Henderson Harbor\Drawings\FER\Figure 1 Site Location.mxd

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Final Engineering Report

Site Area Map

12548 Eastman Tract
Henderson Harbor, NY

N W E S

50 0 50

1 inch = 100 feet
Intended to print as 11" x 17".

207820

FIGURE 2

Path: J:\Upstate National Bank\207820 Henderson Harbor\Drawings\FER\Figure 2 Site boundary.mxd

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Final Engineering Report
NYSDEC VCA Index
No. A4-0463-0602
Lake Ontario Mariners Marina
12548 Eastman Tract
Henderson Harbor, New York

Client:
The Upstate National Bank

Site Features

N W E S

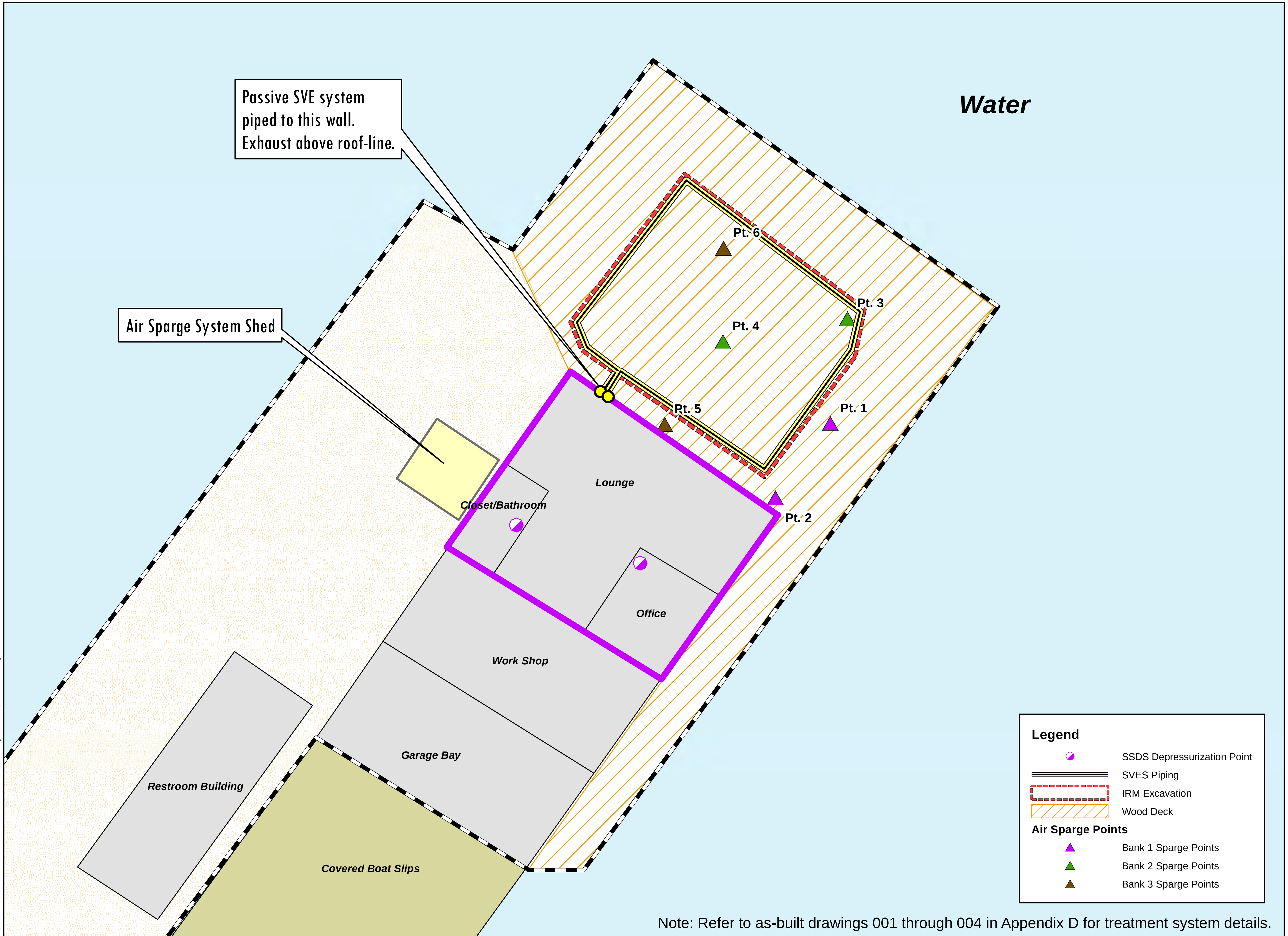
0 5 10 15 20 Feet

1 inch = 15 feet
Intended to print as 11" x 17".

207820

FIGURE 3

Path: J:\Upstate National Bank\207820 Henderson Harbor\Drawings\FER\Figure 3 Site Features.mxd



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LABELLA Associates, D.P.C.

Site Management Plan
NYSDEC VCA Index
No. A4-0463-0602
Lake Ontario Mariners Marina
12548 Eastman Tract
Henderson Harbor, New York

Client:
The Upstate National Bank

Treatment System Features

12548 Eastman Tract
Henderson Harbor, NY

N
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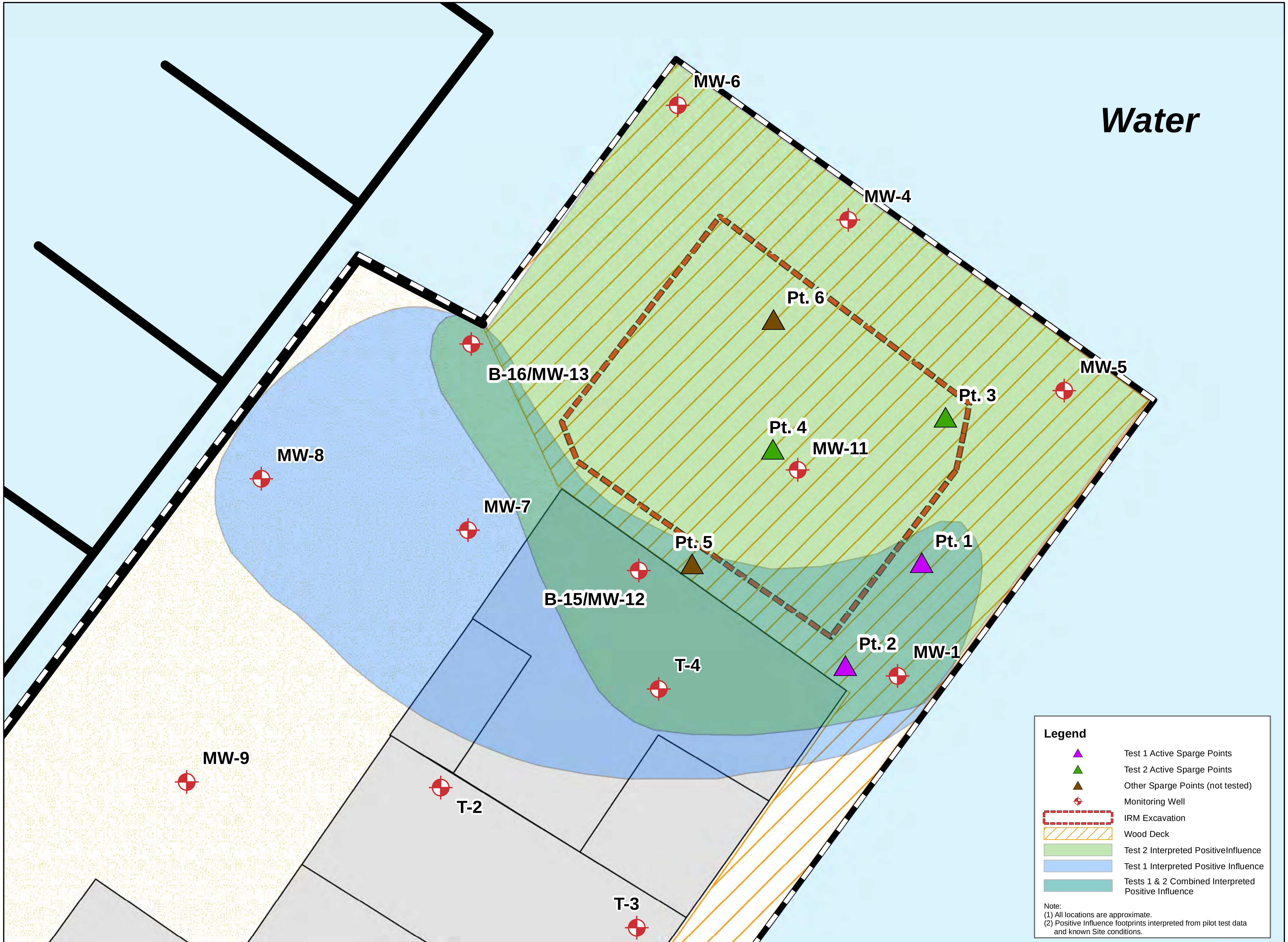
10 0 10
1 inch = 15 feet

207820

FIGURE 4



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Final Engineering Report

Air Sparging Pilot Test Summary of Results

12548 Eastman Tract
Henderson Harbor, NY

N W E S

0 10

1 inch = 10 feet
Intended to print as 11" x 17".

207820

FIGURE 5

Path: J:\Upstate National Bank\207820 Henderson Harbor\Drawings\FER\Figure 5 - AS Influence.mxd

TABLES

Table 1A

Test 1: Vertical red line shows time sparging ceased. Sparging lasted approximately 290-minutes.

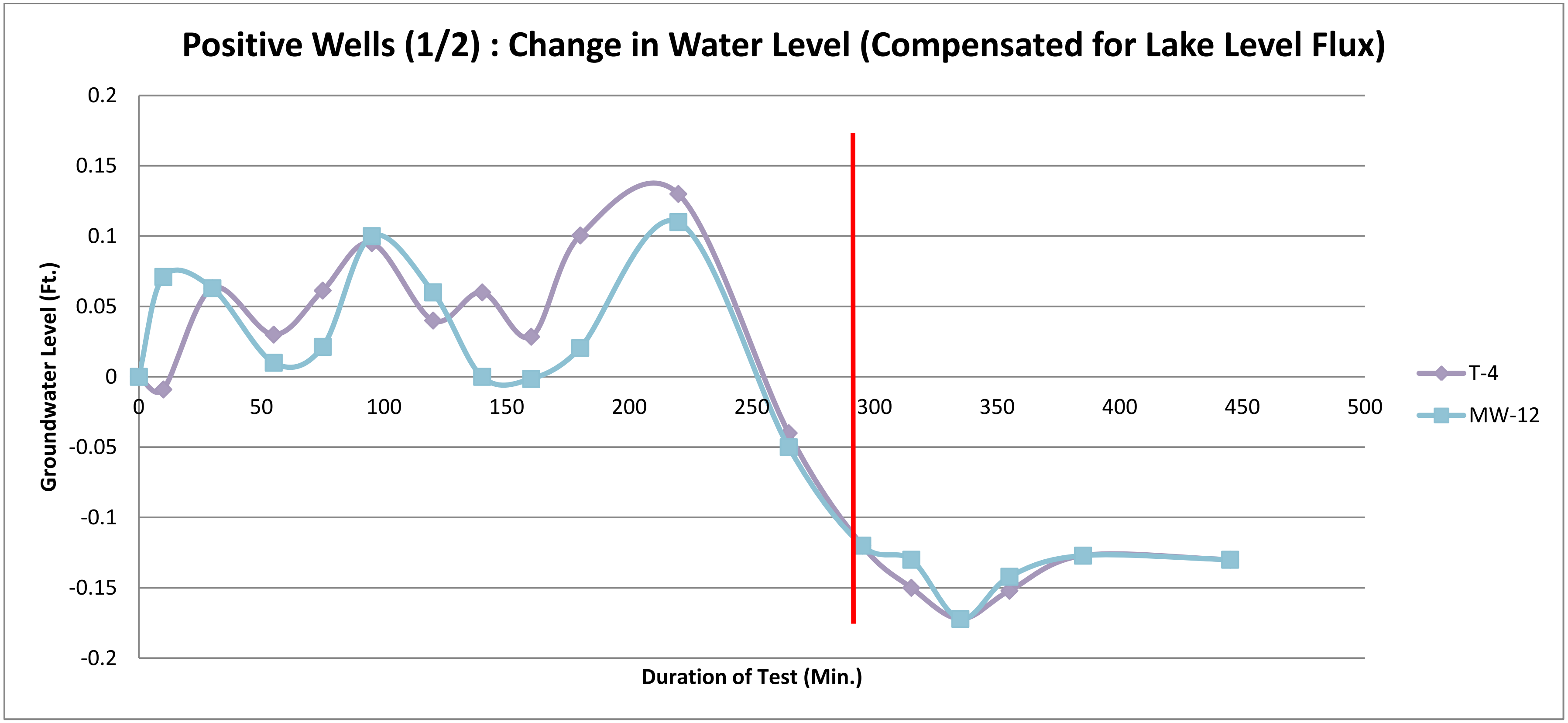

Table 1B

Test 1: Vertical red line shows time sparging ceased. Sparging lasted approximately 290-minutes.

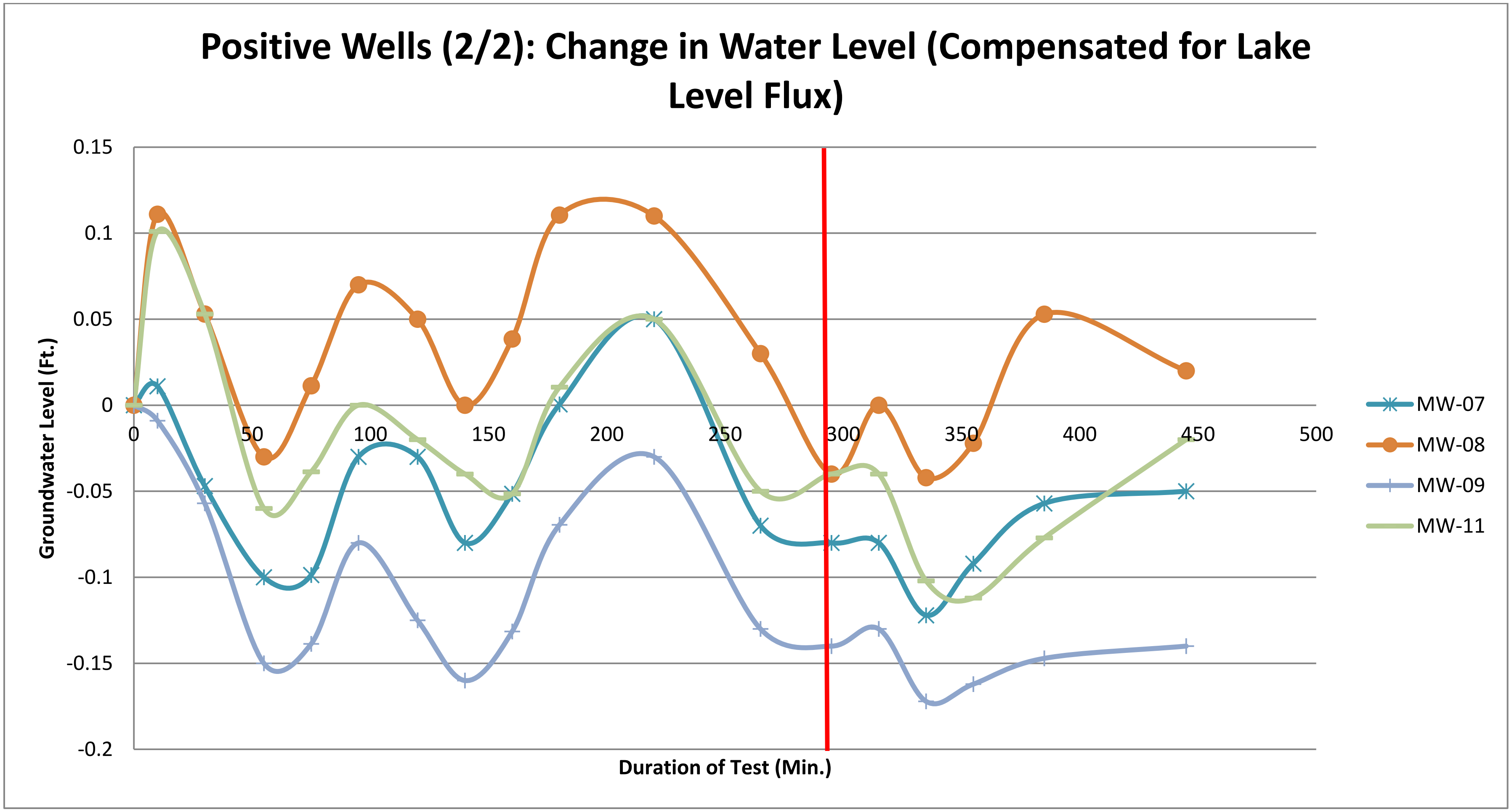

Table 1C

Test 1: Vertical red line shows time sparging ceased. Sparging lasted approximately 290-minutes.

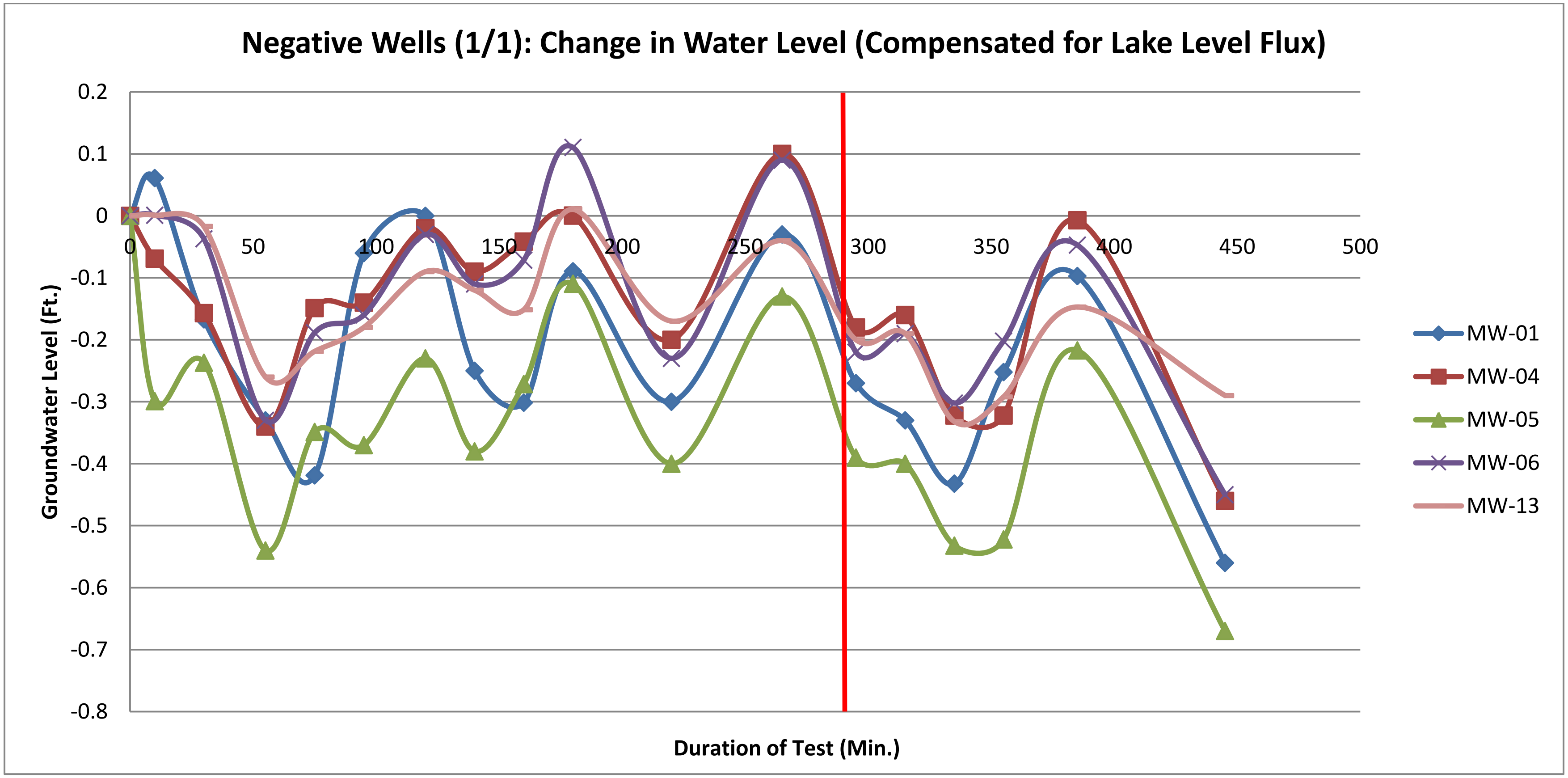

Table 2A

Test 2: Vertical red line shows time sparging ceased. Sparging lasted approximately 245-minutes.

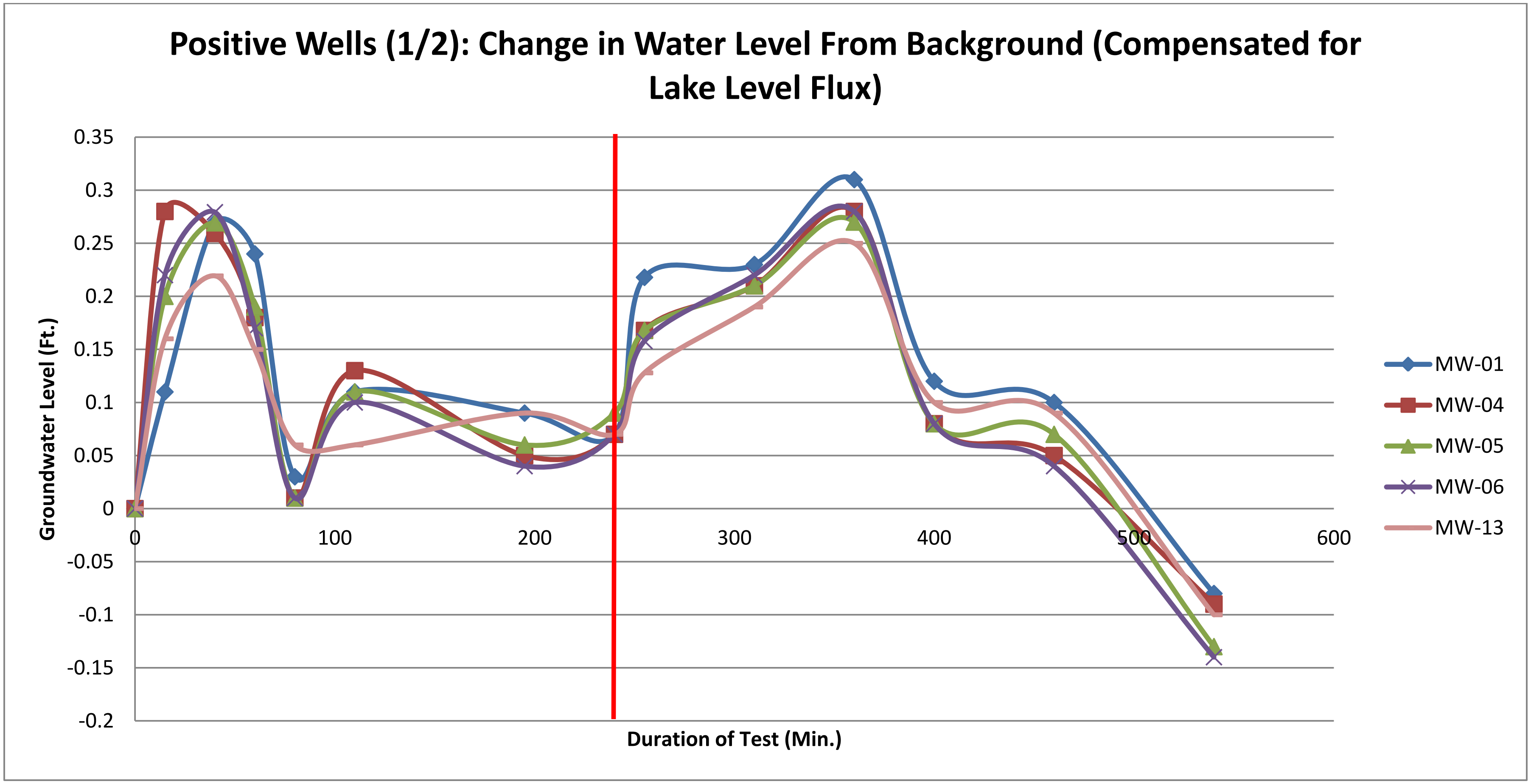

Table 2B

Test 2: Vertical red line shows time sparging ceased. Sparging lasted approximately 245-minutes.

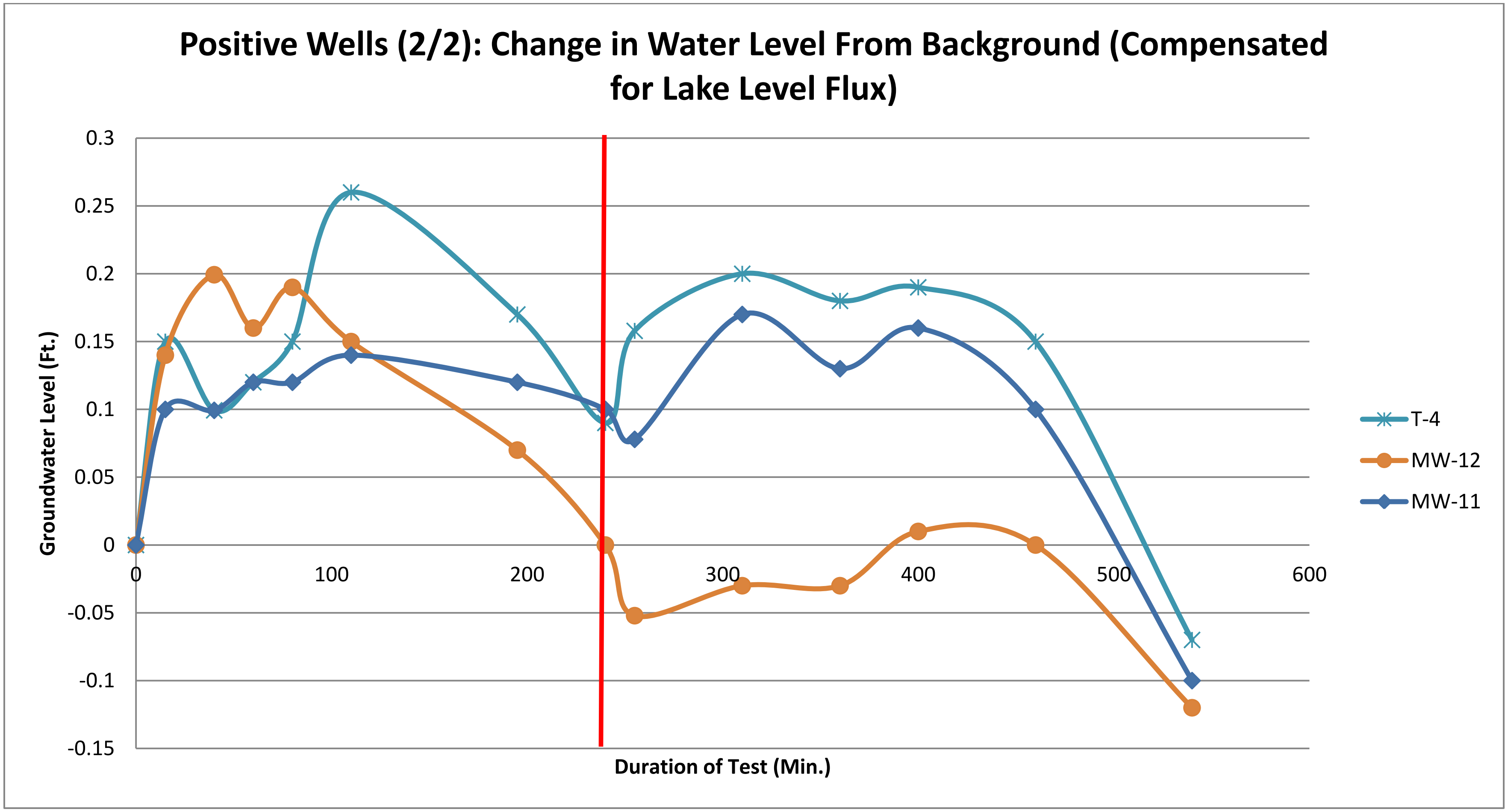

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Table 2C

Test 2: Vertical red line shows time sparging ceased. Sparging lasted approximately 245-minutes.

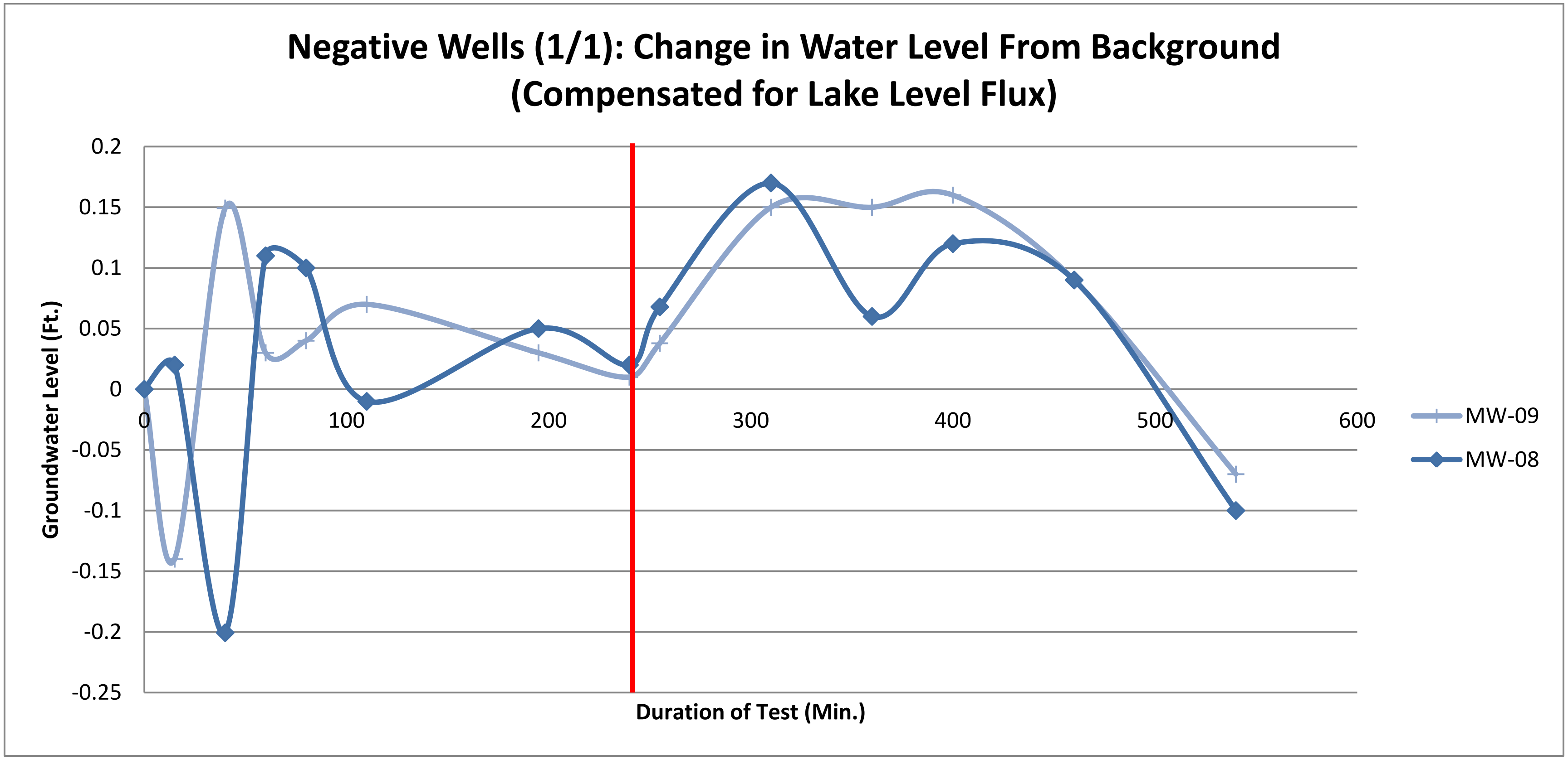
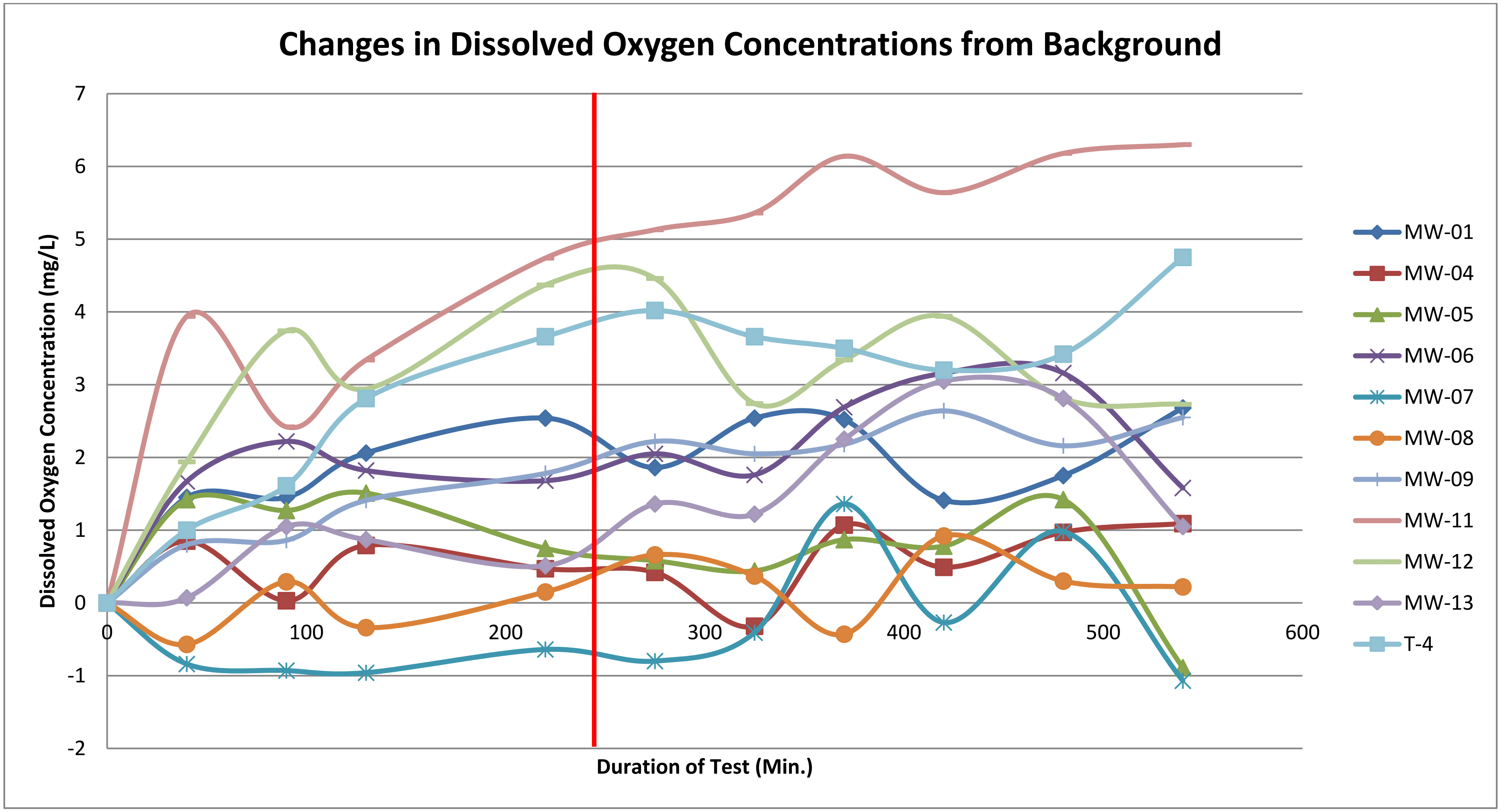


Table 3

Test 2: Vertical red line shows time sparging ceased. Sparging lasted approximately 245-minutes.



LABELLA Associates, D.P.C.

REFERENCE PAGE FOR SAMPLE RESULTS

Lake Ontario Mariners Marina, 12548 Eastman Tract, Henderson Harbor, New York
NYSDEC VCA Index #A4-0463-0602

Qualifiers
U - The compound was not detected at the indicated concentration.
J - This flag denotes the result was estimated as it was detected below the reporting limit

D - For Organics analysis, this flag indicates the compound concentration was obtained from a diluted analysis.
BTEX - Benzene, Toluene, Ethylbenzene and Xylenes
VOCs - Volatile Organic Compounds
NYSDEC - New York State Department of Environmental Conservation
TOGS 1.1.1 - NYSDEC Division of Water Technical and Operational Guidance Series (TOGS) No. 1.1.1 - *Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations*
ug/L - micrograms per Liter
NYS - New York State
NA - Not Applicable of Not Available
USEPA - denotes United States Environmental Protection Agency

Table 4 - Well MW-1
Groundwater Sample Results for Petroleum-Related Volatile Organic Compounds
Lake Ontario Mariners Marina, 12548 Eastman Tract, Henderson Harbor, New York
NYSDEC VCA Index #A4-0463-0602
Results Expressed in micrograms per Liter (ug/L)

WELL ID: MW-1

Sample Date	11/10/2009	1/22/2010	10/6/2010	6/28/2011	12/18/2012	9/20/2013	5/7/2014	12/17/2014	NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Groundwater Standard
Static Water Level (feet)	**4.68**	**NA**	**4.20**	**2.30**	**5.28**	**NA**	**3.11**	**5.02**	
Methyl tert-butyl ether	**5600 D**	**110**	**190 D**	**47**	**1900**	**150**	1.89	**46.5**	**10**
Benzene	**2000 D**	**120**	**95**	**23**	**910**	**88**	**11.2**	**37.3**	**1**
Toluene	**120**	**12**	**5.4**	0.99 J	**55**	3.1	1 U	1.61	**5**
Ethylbenzene	**270 D**	**33**	**20**	4.5 J	**280**	4.7	1.73	**8.93**	**5**
m,p-Xylene	**570 D**	**200**	**33**	**5.4**	**490**	ND	1.17	**13.4**	**5**
o-Xylene	**27**	11	4.9 J	5 U	**18**	ND	1 U	1.17	**5**
Xylene (total)	**597 D**	NL	**38**	**5.4**	**408**	**40**	1.17	**14.6**	**5**
Isopropylbenzene	**11**	**6.9**	3 J	5 U	**20**	4.6	1 U	1.40	**5**
n-Propylbenzene	**9.4**	**8.3**	3.5 J	5 U	**23**	**5.5**	1 U	NA	**5**
1,3,5-Trimethylbenzene	**24**	**22**	**6.6**	5 U	**28**	2.9	1 U	NA	**5**
tert-Butylbenzene	1.0 J	ND	5 U	5 U	5 U	<1.0	1	NA	**5**
1,2,4-Trimethylbenzene	**110**	**140**	**51**	**5.4**	**190**	**26**	1.53	NA	**5**
sec-Butylbenzene	5.0 U	ND	5 U	5 U	0.68 J	<1.0	1 U	NA	**5**
4-Isopropyltoluene	1.0 J	ND	5 U	5 U	5 U	ND	1 U	NA	**5**
n-Butylbenzene	5.0 U	3.6	2.9 J	5 U	5 U	1.7	1 U	NA	**5**
Naphthalene	**430 D**	5	**25**	3.6 **J**	**400**	5	1.56	NA	**10**
Total BTEX	2987	165	158.4	33.89	1653	135.8	14.1	62.44	**NA**
Total VOCs	9173 JD	674.5 J	464 J	95.29 J	4723 J	331.5	21.25	124.9	**NA**

Table 4 - Well MW-4
Groundwater Sample Results for Petroleum-Related Volatile Organic Compounds
Lake Ontario Mariners Marina, 12548 Eastman Tract, Henderson Harbor, New York
NYSDEC VCA Index #A4-0463-0602
Results Expressed in micrograms per Liter (ug/L)

WELL ID: MW-4

Sample Date	1/22/2010	10/6/2010	6/28/2011	12/18/2012	9/20/2013	5/7/2014	12/17/2014	NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Groundwater Standard
Static Water Level (feet)	**NA**	**4.50**	**2.47**	**4.50**	**NA**	**3.03**	**5.26**	
Methyl tert-butyl ether	**93**	**590 D**	**96**	**780**	7.5	**34.0**	**181**	**10**
Benzene	**58**	**240 D**	**48**	**430**	**87**	**17.5**	**97.8**	**1**
Toluene	2.4 J	**25**	4.2 J	**67**	<1.0	1.13	**10.2**	**5**
Ethylbenzene	**14**	**51**	**13**	**150**	**21**	3.60	**28.2**	**5**
m,p-Xylene	**17**	**130**	**28**	330	ND	4.75	**64.4**	**5**
o-Xylene	ND	**23**	2.6 J	38	ND	1 U	3.79	**5**
Xylene (total)	**17**	**150**	**31**	**370**	<1.0	4.75	**68.19**	**5**
Isopropylbenzene	ND	1.8 J	5 U	**5.9**	1.1	1 U	1.57	**5**
n-Propylbenzene	ND	2 J	5 U	**7.2**	<1.0	1 U	NA	**5**
1,3,5-Trimethylbenzene	ND	4.3 J	5 U	**11**	<1.0	1 U	NA	**5**
tert-Butylbenzene	ND	5 U	5 U	5 U	<1.0	1 U	NA	**5**
1,2,4-Trimethylbenzene	**7**	**24**	3.9 J	**78**	**7.8**	2.19	NA	**5**
sec-Butylbenzene	ND	5 U	5 U	5 U	<1.0	1 U	NA	**5**
4-Isopropyltoluene	ND	5 U	5 U	0.78 J	**97**	1 U	NA	**5**
n-Butylbenzene	ND	5 U	5 U	5 U	<1.0	1 U	NA	**5**
Naphthalene	**16**	**180**	**33**	**300**	**38** J	**12.2**	NA	**10**
Total BTEX	91.4	466	96.2	1017	108	26.98	204.39	**NA**
Total VOCs	207.4 J	1413	249	2267.88	259.4	46.12	386.96	**NA**

Table 4 - Well MW-5
Groundwater Sample Results for Petroleum-Related Volatile Organic Compounds
Lake Ontario Mariners Marina, 12548 Eastman Tract, Henderson Harbor, New York
NYSDEC VCA Index #A4-0463-0602
Results Expressed in micrograms per Liter (ug/L)

WELL ID: MW-5

Sample Date	1/22/2010	10/6/2010	6/28/2011	12/18/2012	9/20/2013	5/7/2014	12/17/2014	NYSDEC TOGS 1.1.1 Groundwater Standard
Static Water Level (feet)	**NA**	**4.50**	**2.45**	**5.40**	**NA**	**3.20**	**5.25**	
Methyl tert-butyl ether	**120**	**710 D**	**39**	**1100**	**270**	1 U	**92.9**	**10**
Benzene	**38**	**140**	**8.4**	**220**	**84**	**3.51**	**27.3**	**1**
Toluene	ND	3.5 J	5 U	**9.1**	1.6	1 U	1 U	**5**
Ethylbenzene	ND	5 U	5 U	0.97 J	ND<1.0	1 U	2.85	**5**
m,p-Xylene	ND	2.9 J	5 U	16	NA	1 U	**6.57**	**5**
o-Xylene	ND	5 U	5 U	1.1 J	NA	1 U	1 U	**5**
Xylene (total)	NL	2.9 J	5 U	**17**	2.0	1 U	**6.57**	**5**
Isopropylbenzene	ND	5 U	5 U	5 U	NA	1 U	1 U	**5**
n-Propylbenzene	ND	5 U	5 U	5 U	ND<1.0	1 U	NA	**5**
1,3,5-Trimethylbenzene	ND	5 U	5 U	5 U	ND<1.0	1 U	NA	**5**
tert-Butylbenzene	ND	5 U	5 U	5 U	ND<1.0	1 U	NA	**5**
1,2,4-Trimethylbenzene	ND	5 U	5 U	1.4 J	ND<1.0	1 U	NA	**5**
sec-Butylbenzene	ND	5 U	5 U	5 U	ND<1.0	1 U	NA	**5**
4-Isopropyltoluene	ND	5 U	5 U	5 U	ND<1.0	1 U	NA	**5**
n-Butylbenzene	ND	5 U	5 U	5 U	ND<1.0	1 U	NA	**5**
Naphthalene	ND	4.9 J	3.2 J	2.9 J	0.76 J	1 U	NA	**10**
Total BTEX	38	146.4	8.4	247.07	87.6	3.51	36.72	**NA**
Total VOCs	158	864.2	47.4	1368.47 J	358.36	3.51 U	136.19	**NA**

Table 4 - Well MW-6
Groundwater Sample Results for Petroleum-Related Volatile Organic Compounds
Lake Ontario Mariners Marina, 12548 Eastman Tract, Henderson Harbor, New York
NYSDEC VCA Index #A4-0463-0602
Results Expressed in micrograms per Liter (ug/L)

WELL ID: MW-6

Sample Date	1/22/2010	10/6/2010	6/28/2011	12/18/2012	9/20/2013	5/7/2014	12/17/2014	NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Groundwater Standard
Static Water Level (feet)	**NA**	**4.50**	**2.40**	**5.51**	**NA**	**3.29**	**5.31**	
Methyl tert-butyl ether	**37**	**18**	**11**	**25**	**36**	**26.3**	7.74	**10**
Benzene	ND	5 U	5 U	5 U	<1.0	**2.67**	1 U	**1**
Toluene	ND	5 U	5 U	0.88 J	<1.0	1 U	1 U	**5**
Ethylbenzene	ND	5 U	5 U	5 U	<1.0	1 U	1 U	**5**
m,p-Xylene	ND	5 U	5 U	5 U	ND	1 U	1 U	**5**
o-Xylene	ND	5 U	5 U	5 U	ND	1 U	1 U	**5**
Xylene (total)	NL	5 U	5 U	5 U	<2.0	1 U	1 U	**5**
Isopropylbenzene	ND	5 U	5 U	5 U	<1.0	1 U	1 U	**5**
n-Propylbenzene	ND	5 U	5 U	5 U	<1.0	1 U	NA	**5**
1,3,5-Trimethylbenzene	ND	5 U	5 U	5 U	<1.0	1 U	NA	**5**
tert-Butylbenzene	ND	5 U	5 U	5 U	<1.0	1 U	NA	**5**
1,2,4-Trimethylbenzene	ND	5 U	5 U	5 U	<1.0	1 U	NA	**5**
sec-Butylbenzene	ND	5 U	5 U	5 U	<1.0	1 U	NA	**5**
4-Isopropyltoluene	ND	5 U	5 U	5 U	**97**	1 U	NA	**5**
n-Butylbenzene	ND	5 U	5 U	5 U	<1.0	1 U	NA	**5**
Naphthalene	ND	5 U	5 U	5 U	<1.0	1 U	NA	**10**
Total BTEX	0	0	0	0.88	0	2.67	0	**NA**
Total VOCs	37	18	11	25.88 J	133	28.97 U	7.74	**NA**

Table 4 - Well MW-7
Groundwater Sample Results for Petroleum-Related Volatile Organic Compounds
Lake Ontario Mariners Marina, 12548 Eastman Tract, Henderson Harbor, New York
NYSDEC VCA Index #A4-0463-0602
Results Expressed in micrograms per Liter (ug/L)

WELL ID: MW-7

Sample Date	11/10/2009	10/6/2010	12/18/2012	9/19/2013	5/8/2014	12/17/2014	NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Groundwater Standard
Static Water Level (feet)	**3.88**	**3.60**	**3.62**	**NA**	**3.04**	**4.20**	
Methyl tert-butyl ether	**310 D**	**190 D**	4.4 J	**27**	1.34	**38.0**	**10**
Benzene	**180**	**96**	5 U	**3.2**	**1.92**	**2.73**	**1**
Toluene	**53**	**9.9**	5 U	<1.0	1 U	1 U	**5**
Ethylbenzene	**370 D**	**270 D**	5 U	1	**5.19**	2.41	**5**
m,p-Xylene	**620 D**	**140**	5 U	ND	1 U	1 U	**5**
o-Xylene	**28**	**7**	5 U	ND	1 U	1 U	**5**
Xylene (total)	**648 D**	**150**	5 U	<2.0	1 U	1 U	**5**
Isopropylbenzene	**46**	**32**	5 U	2.1	3.00	1.74	**5**
n-Propylbenzene	**60**	**42**	5 U	2.7	3.94	NA	**5**
1,3,5-Trimethylbenzene	**92**	4.5 J	5 U	<1.0	1 U	NA	**5**
tert-Butylbenzene	1.3 J	5 U	5 U	<1.0	1 U	NA	**5**
1,2,4-Trimethylbenzene	**470 D**	**190**	5 U	0.77 J	4.68	NA	**5**
sec-Butylbenzene	2.4 J	2.1 J	5 U	<1.0	1 U	NA	**5**
4-Isopropyltoluene	1.3 J	5 U	5 U	ND	1 U	NA	**5**
n-Butylbenzene	**6.2**	3.5 J	5 U	<1.0	1 U	NA	**5**
Naphthalene	**100**	**36**	5 U	<1.0	1 U	NA	**10**
Total BTEX	1251	525.9	0	4.2	7.11	5.14	**NA**
Total VOCs	2340.2	1173	4.4 J	36.77	20.07	44.9	**NA**

Table 4 - Well MW-8
Groundwater Sample Results for Petroleum-Related Volatile Organic Compounds
Lake Ontario Mariners Marina, 12548 Eastman Tract, Henderson Harbor, New York
NYSDEC VCA Index #A4-0463-0602
Results Expressed in micrograms per Liter (ug/L)

WELL ID: MW-8

Sample Date	10/6/2010		9/19/2013		NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Groundwater Standard
Static Water Level (feet)	**2.80**				
Methyl tert-butyl ether	**84**		**13**		**10**
Benzene	5	U	<1.0		**1**
Toluene	5	U	<1.0		**5**
Ethylbenzene	5	U	<1.0		**5**
m,p-Xylene	5	U	ND		**5**
o-Xylene	5	U	ND		**5**
Xylene (total)	5	U	<2.0		**5**
Isopropylbenzene	5	U	<1.0		**5**
n-Propylbenzene	5	U	<1.0		**5**
1,3,5-Trimethylbenzene	5	U	<1.0		**5**
tert-Butylbenzene	5	U	ND		**5**
1,2,4-Trimethylbenzene	5	U	<1.0		**5**
sec-Butylbenzene	5	U	ND		**5**
4-Isopropyltoluene	5	U	**99**		**5**
n-Butylbenzene	5	U	<1.0		**5**
Naphthalene	5	U	0.6	J	**10**
Total BTEX	0		0		**NA**
Total VOCs	84		112.6		**NA**

Table 4 - Well MW-9
Groundwater Sample Results for Petroleum-Related Volatile Organic Compounds
Lake Ontario Mariners Marina, 12548 Eastman Tract, Henderson Harbor, New York
NYSDEC VCA Index #A4-0463-0602
Results Expressed in micrograms per Liter (ug/L)

WELL ID: MW-9

Sample Date	11/10/2009	1/22/2010		10/6/2010		12/18/2012		9/19/2013	NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Groundwater Standard
Static Water Level (feet)	**4.40**	**NA**		**3.80**		**3.52**		**NA**	
Methyl tert-butyl ether	**110**	**55**	J	4.4	J	0.52	J	**40**	**10**
Benzene	ND	ND		5	U	5	U	<1.0	**1**
Toluene	ND	ND		5	U	5	U	<1.0	**5**
Ethylbenzene	ND	ND		5	U	5	U	<1.0	**5**
m,p-Xylene	ND	1.6	J	5	U	5	U	<1.0	**5**
o-Xylene	ND	ND		5	U	5	U	<1.0	**5**
Xylene (total)	ND	1.6		5	U	5	U	<1.0	**5**
Isopropylbenzene	ND	ND		5	U	5	U	<1.0	**5**
n-Propylbenzene	ND	ND		5	U	5	U	<1.0	**5**
1,3,5-Trimethylbenzene	ND	ND		5	U	5	U	<1.0	**5**
tert-Butylbenzene	ND	ND		5	U	5	U	<1.0	**5**
1,2,4-Trimethylbenzene	ND	1	J	5	U	5	U	<1.0	**5**
sec-Butylbenzene	ND	ND		5	U	5	U	<1.0	**5**
4-Isopropyltoluene	ND	ND		5	U	5	U	<1.0	**5**
n-Butylbenzene	ND	ND		5	U	5	U	<1.0	**5**
Naphthalene	ND	ND		5	U	5	U	<2.0	**10**
Total BTEX	0	1.6		0		0		0	**NA**
Total VOCs	110	57.6	J	4.4		0.52	J	40	**NA**

Table 4 - Well MW-10
Groundwater Sample Results for Petroleum-Related Volatile Organic Compounds
Lake Ontario Mariners Marina, 12548 Eastman Tract, Henderson Harbor, New York
NYSDEC VCA Index #A4-0463-0602
Results Expressed in micrograms per Liter (ug/L)

WELL ID: MW-10

Sample Date	11/10/2009	1/22/2010	10/6/2010	6/28/2011	12/18/2012	9/20/2013	NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Groundwater Standard
Static Water Level (feet)	**4.38**	**NA**	**3.80**	**2.57**	**4.30**	**NA**	
Methyl tert-butyl ether	5 U	ND	ND	5 U	5 U	<1.0	**10**
Benzene	5 U	ND	ND	5 U	5 U	**84**	**1**
Toluene	5 U	ND	ND	5 U	5 U	1.6	**5**
Ethylbenzene	5 U	ND	ND	5 U	5 U	<1.0	**5**
m,p-Xylene	5 U	ND	ND	5 U	5 U	ND	**5**
o-Xylene	5 U	ND	ND	5 U	5 U	ND	**5**
Xylene (total)	5 U	NL	ND	5 U	5 U	2	**5**
Isopropylbenzene	5 U	ND	ND	5 U	5 U	<1.0	**5**
n-Propylbenzene	5 U	ND	ND	5 U	5 U	<1.0	**5**
1,3,5-Trimethylbenzene	5 U	ND	ND	5 U	5 U	<1.0	**5**
tert-Butylbenzene	5 U	ND	ND	5 U	5 U	<1.0	**5**
1,2,4-Trimethylbenzene	5 U	ND	ND	5 U	5 U	<1.0	**5**
sec-Butylbenzene	5 U	ND	ND	5 U	5 U	<1.0	**5**
4-Isopropyltoluene	5 U	ND	ND	5 U	5 U	ND	**5**
n-Butylbenzene	5 U	ND	ND	5 U	5 U	ND	**5**
Naphthalene	5 U	ND	ND	5 U	5 U	0.76	**10**
Total BTEX	0	0	0	0	0	87.6	**NA**
Total VOCs	0	0	0	0	0	88.36	**NA**

Table 4 - Well MW-11
Groundwater Sample Results for Petroleum-Related Volatile Organic Compounds
Lake Ontario Mariners Marina, 12548 Eastman Tract, Henderson Harbor, New York
NYSDEC VCA Index #A4-0463-0602
Results Expressed in micrograms per Liter (ug/L)

WELL ID: MW-11

Sample Date	1/22/2010	10/6/2010	6/28/2011	12/18/2012	9/20/2013	5/7/2014	12/17/2014	NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Groundwater Standard
Static Water Level (feet)	**NA**	**3.00**	**2.20**	**5.28**	**NA**	**2.80**	**3.38**	
Methyl tert-butyl ether	**91**	**31**	9.8	4.5 J	3.3	4.0	1 U	**10**
Benzene	**19**	**7.9**	**3.8**	5 U	0.86	0.7 U	1 U	**1**
Toluene	**26**	1 J	5 U	5 U	<1.0	1 U	1 U	**5**
Ethylbenzene	**46**	**14**	**5.7**	5 U	**5.3**	1 U	1.56	**5**
m,p-Xylene	**270**	**23**	5 U	5 U	ND	1 U	3.17	**5**
o-Xylene	**150**	5 U	5 U	5 U	ND	1 U	1 U	**5**
Xylene (total)	420	**23**	5 U	5 U	1.7 J	1 U	3.17	**5**
Isopropylbenzene	**5.3**	2.2 J	5 U	5 U	<1.0	1 U	1 U	**5**
n-Propylbenzene	**8.9**	**5** J	5 U	5 U	<2.0	1 U	NA	**5**
1,3,5-Trimethylbenzene	**29**	2.9 J	5 U	5 U	<2.0	1 U	NA	**5**
tert-Butylbenzene	ND	5 U	5 U	5 U	<2.0	1 U	NA	**5**
1,2,4-Trimethylbenzene	**98**	**51**	1.5 J	5 U	<1.0	1 U	NA	**5**
sec-Butylbenzene	ND	1.1 J	5 U	5 U	<1.0	1 U	NA	**5**
4-Isopropyltoluene	ND	5 U	5 U	5 U	ND	1 U	NA	**5**
n-Butylbenzene	3.4 J	4.1 J	5 U	5 U	<1.0	1 U	NA	**5**
Naphthalene	**14**	**11**	5 U	5 U	<1.0	1 U	NA	**10**
Total BTEX	511	45.9	9.5	0	7.86	0	4.73	**NA**
Total VOCs	763.6 J	177.2	19.3	4.5 J	11.16	4.0	7.9	**NA**

Table 4 - Well MW-12
Groundwater Sample Results for Petroleum-Related Volatile Organic Compounds
Lake Ontario Mariners Marina, 12548 Eastman Tract, Henderson Harbor, New York
NYSDEC VCA Index #A4-0463-0602
Results Expressed in micrograms per Liter (ug/L)

WELL ID: MW-12

Sample Date	10/6/2010	6/28/2011	12/18/2012	9/19/2013	5/8/2014	12/17/2014	NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Groundwater Standard
Static Water Level (feet)	3.90	2.10	3.40	NA	2.79	3.63	
Methyl tert-butyl ether	39	43	73	51	10 U	20 U	10
Benzene	120	120	110	130	97.9	90.7	1
Toluene	130	80	55	51	38.4	37	5
Ethylbenzene	1500 D	1400 D	770	730	679	683	5
m,p-Xylene	8200 D	4900 D	2800	NA	1800	1380	5
o-Xylene	160	130	63	NA	126	83	5
Xylene (total)	8300 D	5000 D	2863	520	1926	1463	5
Isopropylbenzene	110	130	40	70	87.2	69.6	5
n-Propylbenzene	170	200	54	93	139	NA	5
1,3,5-Trimethylbenzene	660 D	660 D	380	240	318	NA	5
tert-Butylbenzene	5 U	5 U	5 U	<1.0	ND U	NA	5
1,2,4-Trimethylbenzene	2400 D	2500 D	2000	<1.0	1620	NA	5
sec-Butylbenzene	9.5	9.3	5 U	<1.0	11.4	NA	5
4-Isopropyltoluene	5 U	5 U	5 U	98	15.5	NA	5
n-Butylbenzene	39	49	27	16	10 U	NA	5
Naphthalene	360 D	380 D	380	390 B	317	NA	10
Total BTEX	10050	6600	3798	1431	2741.3	2273.7	NA
Total VOCs	22197.5	15601.3	6752	2389	7175.4	3733.70	NA

Table 4 - Well MW-13
Groundwater Sample Results for Petroleum-Related Volatile Organic Compounds
Lake Ontario Mariners Marina, 12548 Eastman Tract, Henderson Harbor, New York
NYSDEC VCA Index #A4-0463-0602
Results Expressed in micrograms per Liter (ug/L)

WELL ID: MW-13

Sample Date	**10/6/2010**		**6/28/2011**		**12/18/2012**		**9/20/2013**		**5/8/2014**		**12/16/2014**		**NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Groundwater Standard**
Static Water Level (feet)	**4.00**		**2.08**		**4.98**		**NA**		**2.72**		**4.74**		
Methyl tert-butyl ether	**84**		**71**		**140**		**41**		**31.2**		**36.9**		**10**
Benzene	1.8	J	5	U	5	U	<2.0		0.7	U	1	U	**1**
Toluene	1.1	J	5	U	5	U	<2.0		1	U	1	U	**5**
Ethylbenzene	5	U	5	U	5	U	<2.0		1	U	1	U	**5**
m,p-Xylene	4.5	J	2.1	J	5	U	ND		1	U	1	U	**5**
o-Xylene	2.2	J	5	U	5	U	ND		1	U	1.15		**5**
Xylene (total)	**6.7**		2.1	J	5	U	3.5	J	1	U	1.15		**5**
Isopropylbenzene	1.3	J	2.8	J	0.86	J	4.3		4.47		4.24		**5**
n-Propylbenzene	5	U	5	U	5	U	<2.0		1.14		NA		**5**
1,3,5-Trimethylbenzene	5	U	5	U	5	U	<2.0		1	U	NA		**5**
tert-Butylbenzene	5	U	5	U	5	U	<2.0		1	U	NA		**5**
1,2,4-Trimethylbenzene	1.9	J	5	U	5	U	<2.0		1	U	NA		**5**
sec-Butylbenzene	5	U	5	U	5	U	<2.0		1	U	NA		**5**
4-Isopropyltoluene	5	U	5	U	5	U	ND		1	U	NA		**5**
n-Butylbenzene	5	U	5	U	5	U	<2.0		1	U	NA		**5**
Naphthalene	5	U	5	U	5	U	<2.0		1	U	NA		**10**
Total BTEX	9.6		2.1		0		3.5		0.7		1.15		**NA**
Total VOCs	103.5		71		140.86	J	48.8		36.81		43.44		**NA**

Table 4 - Well T1
Groundwater Sample Results for Petroleum-Related Volatile Organic Compounds
Lake Ontario Mariners Marina, 12548 Eastman Tract, Henderson Harbor, New York
NYSDEC VCA Index #A4-0463-0602
Results Expressed in micrograms per Liter (ug/L)

WELL ID: T1

Sample Date	1/22/2010	10/6/2010	6/28/2011	12/18/2012	9/19/2013	5/8/2014	12/17/2014	NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Groundwater Standard
Static Water Level (feet)	**NA**	**3.90**	**2.15**	**4.18**	**NA**	**2.84**	**4.06**	
Methyl tert-butyl ether	**32**	**66**	8	**33**	**26**	1 U	**83.3**	**10**
Benzene	ND	5 U	5 U	5 U	<1.0 U	0.7 U	1 U	**1**
Toluene	ND	5 U	5 U	5 U	<1.0 U	1 U	1 U	**5**
Ethylbenzene	ND	5 U	5 U	5 U	<1.0 U	1 U	**10.2**	**5**
m,p-Xylene	ND	5 U	5 U	5 U	<1.0 U	1 U	**20.3**	**5**
o-Xylene	ND	5 U	5 U	5 U	<1.0 U	1 U	1.15	**5**
Xylene (total)	NL	5 U	5 U	5 U	<1.0 U	1 U	**21.4**	**5**
Isopropylbenzene	ND	5 U	5 U	5 U	<1.0 U	1 U	1.03	**5**
n-Propylbenzene	ND	5 U	5 U	5 U	<1.0 U	1 U	NA	**5**
1,3,5-Trimethylbenzene	ND	5 U	5 U	5 U	<1.0 U	1 U	NA	**5**
tert-Butylbenzene	ND	5 U	5 U	5 U	<1.0 U	1 U	NA	**5**
1,2,4-Trimethylbenzene	ND	5 U	5 U	5 U	<1.0 U	1 U	NA	**5**
sec-Butylbenzene	ND	5 U	5 U	5 U	<1.0 U	1 U	NA	**5**
4-Isopropyltoluene	ND	5 U	5 U	5 U	<1.0 U	1 U	NA	**5**
n-Butylbenzene	ND	5 U	5 U	5 U	<1.0 U	1 U	NA	**5**
Naphthalene	ND	5 U	5 U	5 U	<1.0 U	1 U	NA	**10**
Total BTEX	0	0	0	0	0	0	31.6	**NA**
Total VOCs	32	66	8	33	26	0	137.38	**NA**

Table 4 - Well T2
Groundwater Sample Results for Petroleum-Related Volatile Organic Compounds
Lake Ontario Mariners Marina, 12548 Eastman Tract, Henderson Harbor, New York
NYSDEC VCA Index #A4-0463-0602
Results Expressed in micrograms per Liter (ug/L)

WELL ID: T2

Sample Date	1/22/2010	10/6/2010		6/28/2011		12/18/2012		9/19/2013		NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Groundwater Standard
Static Water Level (feet)	**NA**	**3.80**		**2.30**		**3.99**		**NA**		
Methyl tert-butyl ether	**260**	**340**		**110**	**D**	**24**		**26**		**10**
Benzene	ND	5	U	0.86	J	0.50	J	<1.0	U	**1**
Toluene	ND	5	U	5	U	5	U	<1.0	U	**5**
Ethylbenzene	ND	5	U	5	U	5	U	<1.0	U	**5**
m,p-Xylene	ND	5	U	5	U	5	U	<1.0	U	**5**
o-Xylene	ND	5	U	5	U	5	U	<1.0	U	**5**
Xylene (total)	ND	5	U	5	U	5	U	<1.0	U	**5**
Isopropylbenzene	ND	5	U	5	U	5	U	<1.0	U	**5**
n-Propylbenzene	ND	5	U	5	U	5	U	<1.0	U	**5**
1,3,5-Trimethylbenzene	ND	5	U	5	U	5	U	<1.0	U	**5**
tert-Butylbenzene	ND	5	U	5	U	5	U	<1.0	U	**5**
1,2,4-Trimethylbenzene	ND	5	U	5	U	5	U	<1.0	U	**5**
sec-Butylbenzene	ND	5	U	5	U	5	U	<1.0	U	**5**
4-Isopropyltoluene	ND	5	U	5	U	5	U	<1.0	U	**5**
n-Butylbenzene	ND	5	U	5	U	5	U	<1.0	U	**5**
Naphthalene	ND	5	U	5	U	5	U	<1.0	U	**10**
Total BTEX	0	0		0.86		0.50		0		**NA**
Total VOCs	260	340		110		24.5	J	26		**NA**

Table 4 - Well T3
Groundwater Sample Results for Petroleum-Related Volatile Organic Compounds
Lake Ontario Mariners Marina, 12548 Eastman Tract, Henderson Harbor, New York
NYSDEC VCA Index #A4-0463-0602
Results Expressed in micrograms per Liter (ug/L)

WELL ID: T3

Sample Date	1/22/2010	10/6/2010		12/18/2012		9/19/201		NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Groundwater Standard
Static Water Level (feet)	**NA**	**3.70**		**4.05**		**NA**		
Methyl tert-butyl ether	**290**	**410**		**390**		**200**		**10**
Benzene	ND	5	U	5	U	<1.0	U	**1**
Toluene	ND	5	U	5	U	<1.0	U	**5**
Ethylbenzene	ND	5	U	5	U	<1.0	U	**5**
m,p-Xylene	ND	5	U	5	U	<1.0	U	**5**
o-Xylene	ND	5	U	5	U	<1.0	U	**5**
Xylene (total)	ND	5	U	5	U	<1.0	U	**5**
Isopropylbenzene	ND	5	U	5	U	<1.0	U	**5**
n-Propylbenzene	ND	5	U	5	U	<1.0	U	**5**
1,3,5-Trimethylbenzene	ND	5	U	5	U	<1.0	U	**5**
tert-Butylbenzene	ND	5	U	5	U	<1.0	U	**5**
1,2,4-Trimethylbenzene	ND	5	U	5	U	<1.0	U	**5**
sec-Butylbenzene	ND	5	U	5	U	<1.0	U	**5**
4-Isopropyltoluene	ND	5	U	5	U	<1.0	U	**5**
n-Butylbenzene	ND	5	U	5	U	<1.0	U	**5**
Naphthalene	ND	5	U	5	U	<1.0	U	**10**
Total BTEX	0	0		0		0		**NA**
Total VOCs	290	410		390		200		**NA**

Table 4 - Well T4
Groundwater Sample Results for Petroleum-Related Volatile Organic Compounds
Lake Ontario Mariners Marina, 12548 Eastman Tract, Henderson Harbor, New York
NYSDEC VCA Index #A4-0463-0602
Results Expressed in micrograms per Liter (ug/L)

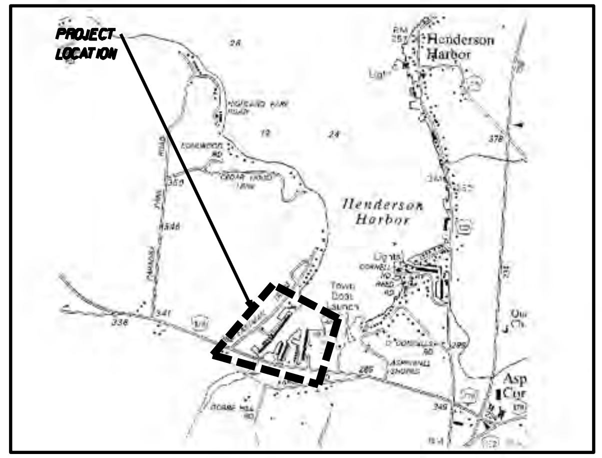
WELL ID: T4

Sample Date	1/22/2010	10/6/2010	6/28/2011	12/18/2012	9/19/2013	5/8/2014	12/17/2014	NYSDEC Technical and Operational Guidance Series (TOGS) 1.1.1 Groundwater Standard
Static Water Level (feet)	**NA**	**3.80**	**2.57**	**3.88**	**NA**	**2.89**	**3.98**	
Methyl tert-butyl ether	**610**	**1500** D	**670 D**	**540**	**270**	**37.2**	**358**	**10**
Benzene	**33**	**120**	**120**	**20**	**94**	**190**	**116**	**1**
Toluene	2 J	4.5 J	**9.6**	2 J	**6.4**	**11.8**	**7.81**	**5**
Ethylbenzene	**16**	**13**	**50**	**5.7**	**23**	**109**	**52.3**	**5**
m,p-Xylene	4.1 J	8	**12**	5.7	ND	**12.1**	5 U	**5**
o-Xylene	ND	1.7 J	2.3 J	1.2 J	**7.6**	10 U	5 U	**5**
Xylene (total)	NL	**9.7**	**15**	**6.8**	**7.6**	**12.1**	5 U	**5**
Isopropylbenzene	4.3 J	**8**	**11**	0.93 J	**9.6**	**16.8**	**6.07**	**5**
n-Propylbenzene	2.7 J	4.9 J	**5.5**	5 U	4.2	**11**	NA	**5**
1,3,5-Trimethylbenzene	ND	1.2 J	3 J	0.97 J	2.4	10 U	NA	**5**
tert-Butylbenzene	ND	5 U	5 U	5 U	<1.0	10 U	NA	**5**
1,2,4-Trimethylbenzene	ND	2.4 J	3.2 J	1.4 J	2.7	10 U	NA	**5**
sec-Butylbenzene	ND	2.2 J	0.87 J	5 U	<1.0	10 U	NA	**5**
4-Isopropyltoluene	ND	5 U	5 U	5 U	<1.0	10 U	NA	**5**
n-Butylbenzene	ND	5 U	5 U	5 U	<1.0	10 U	NA	**5**
Naphthalene	ND	1.7 J	1.7 J	6.3	1.6	10 U	NA	**10**
Total BTEX	51	147.2	194.6	34.5	131	322.9	181.11	**NA**
Total VOCs	672.1 J	1677.3	893.1	584.1 J	429.1	400	540.18	**NA**

APPENDIX A

Survey Map, Metes and Bounds

THE ENGINEERING AND INDUSTRIAL CONTROLS FOR THIS DECLARATION OF COVENANTS AND RESTRICTIONS ARE SET FORTH IN THE SITE MANAGEMENT PLAN (SMP). A COPY OF THE SMP MUST BE OBTAINED BY ANY PARTY WITH AN INTEREST IN THE PROPERTY. THE SMP CAN BE OBTAINED FROM THE NYS DEPARTMENT OF ENVIRONMENTAL CONSERVATION, DIVISION OF ENVIRONMENTAL REMEDIATION, SITE CONTROL SECTION, 625 BROADWAY, ALBANY, NY 12233, OR AT derweb@gw.dec.state.ny.us.



LOCATION MAP

CERTIFY TO: THE UPSTATE NATIONAL BANK, THE PEOPLE OF THE STATE OF NEW YORK ACTING THROUGH ITS COMMISSIONER OF THE DEPARTMENT OF ENVIRONMENTAL CONSERVATION THE TITLE COMPANY

WE, LABELLA ASSOCIATES PC, CERTIFY THAT THIS MAP WAS PREPARED USING REFERENCE MATERIAL AS LISTED HEREON AND FROM FIELD NOTES OF AN INSTRUMENT SURVEY COMPLETED FEBRUARY, 2012. THESE PARCELS ARE SUBJECT TO ANY EASEMENTS OR ENCUMBRANCES OF RECORD.

MICHAEL W. HALEY PLS
NYS PLS NO. 049788

SCALE BAR: 50 0 50 100 150 200'

REFERENCES

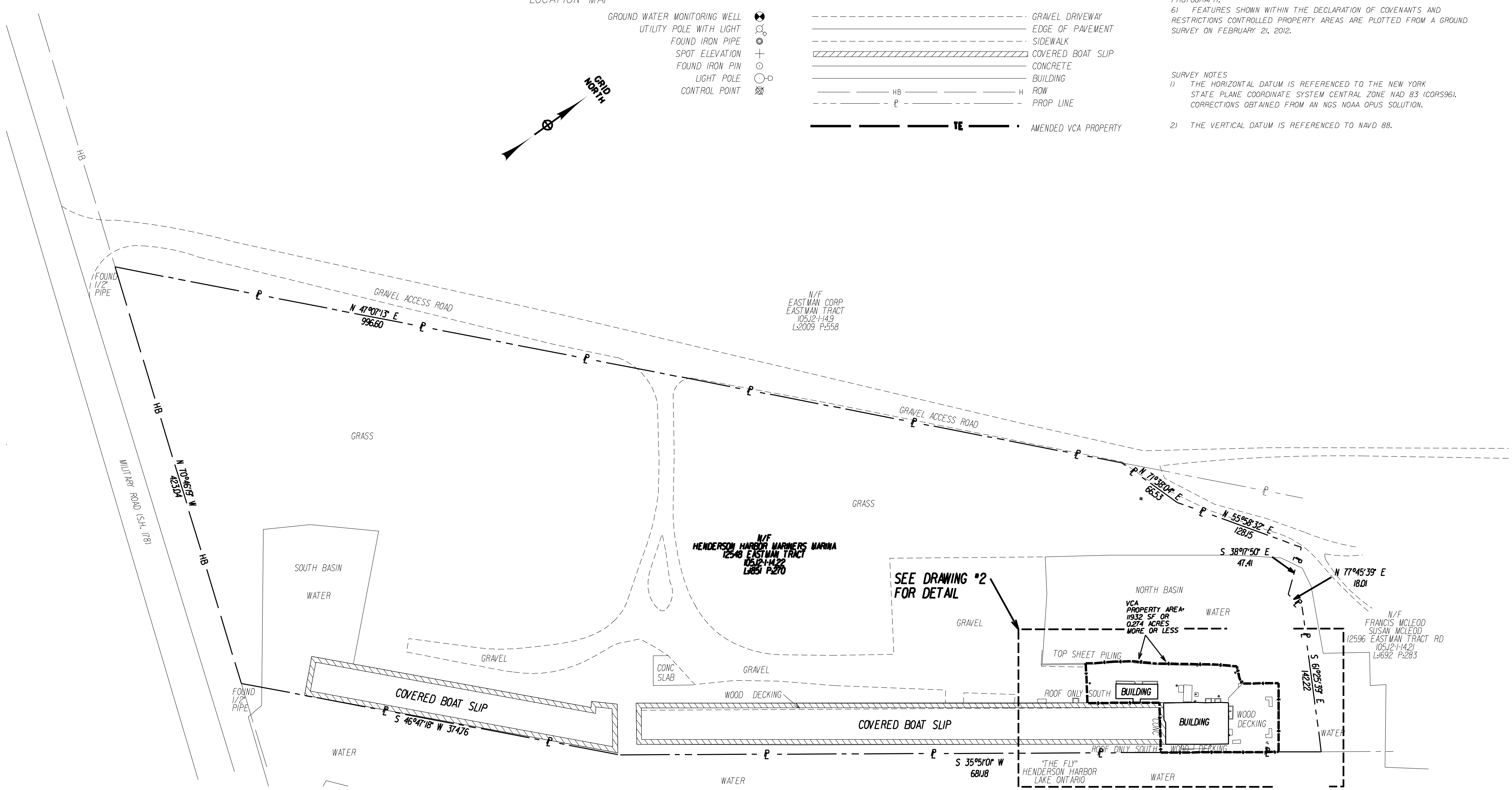
1) TOWN OF HENDERSON TAX MAP NO. 105J2
2) MAP OF "SURVEY OF LANDS, LAKE ONTARIO ASSOCIATES" BY ROBERT C. HUNTLEY - LAND SURVEYOR DATED MARCH 29, 1989
3) TITLES PREPARED BY FIDELITY NATIONAL TITLE INSURANCE COMPANY AS FOLLOWS:
A) TITLE NO. S-22188T, B) TITLE NO. S-16460T AND C) 97-21-HT10, 874-3186
4) DEEDS RECORDED IN THE JEFFERSON COUNTY CLERK'S OFFICE
LIBER 1851 PAGE 270 FILED APRIL 19, 2002
LIBER 1792 PAGE 72 FILED MAY 24, 2001
LIBER 1569 PAGE 103 FILED APRIL 18, 1997
5) FEATURES SHOWN OUTSIDE OF THE DECLARATION OF COVENANTS AND RESTRICTIONS CONTROLLED PROPERTY AREA ARE PLOTTED FROM AERIAL PHOTOGRAPH.
6) FEATURES SHOWN WITHIN THE DECLARATION OF COVENANTS AND RESTRICTIONS CONTROLLED PROPERTY AREAS ARE PLOTTED FROM A GROUND SURVEY ON FEBRUARY 21, 2012.

SURVEY NOTES
1) THE HORIZONTAL DATUM IS REFERENCED TO THE NEW YORK STATE PLANE COORDINATE SYSTEM CENTRAL ZONE NAD 83 (CORS96). CORRECTIONS OBTAINED FROM AN NGS NOAA OPUS SOLUTION.
2) THE VERTICAL DATUM IS REFERENCED TO NAVD 88.

LEGEND

GROUND WATER MONITORING WELL
UTILITY POLE WITH LIGHT
FOUND IRON PIPE
SPOT ELEVATION
FOUND IRON PIN
LIGHT POLE
CONTROL POINT

GRAVEL DRIVEWAY
EDGE OF PAVEMENT
SIDEWALK
COVERED BOAT SLIP
CONCRETE
BUILDING
ROW
PROP LINE
AMENDED VCA PROPERTY



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NYSDEC SITE NO. V00585
NYSDEC SPILL SITE NO. 0006174
HENDERSON HARBOR MARINER'S MARINA
12548 EASTMAN TRACT
HENDERSON, NY

THE UPSTATE NATIONAL BANK
1 WEST MAIN ST
ROCHESTER, NY 14614

AMENDED VOLUNTARY CLEANUP AGREEMENT (VCA) PROPERTY

DATE: SEPTEMBER 2012

PROJECT/DRAWING NUMBER: 207820

1 OF 2

2/8/2013 7:33:46 AM report inserts.dgn

ORIGINAL DESCRIPTION:
LANDS NOW OR FORMERLY OF HENDERSON HARBOR MARINERS' MARINA, INC. TA# 105J2-1-14.22 L. 1851 P. 270 AREA=365991 SF OR 8.402 ACRES TO ROW

SCHEDULE A - DESCRIPTION OF INSURED PREMISES

All that certain plot, piece or parcel of land, with the buildings and improvements thereon erected, situate, lying and being in the Town of Henderson, County of Jefferson, and State of New York and being part of Lot 29 in said town and bounded and described as follows:

BEGINNING at an existing iron pipe on the northerly highway boundary of New York State Highway Number 178 at the intersection of said boundary with the southeasterly side of a 50 foot wide right of way leading from said highway to the cottage lots on the westerly side of Henderson Bay on Lake Ontario in said Town, said iron pipe also being 50 plus or minus feet, northeasterly, measured at right angles from the center line of pavement of said Route 178 and said iron pipe also being at the southwesterly corner of a 9.1 acre parcel of land conveyed by John E. McKee to Henry J. and Lorraine E. Staniec, April 11, 1981 and recorded in the Jefferson County Clerk's Office the same day in Liber 914 of Deeds on Page 392 and of which the following described premises are a part of thereof;

THENCE along the southeasterly side of said 50 foot wide right of way, North 57 degrees 46 minutes 06 seconds East a distance of 996.60 feet to a point, said point being South 57 degrees 46 minutes 06 seconds West a distance of 314.14 feet from the most northerly corner of said Staniec Parcel;

THENCE through the lands of said Staniec, North 82 degrees 16 minutes 57 seconds East a distance of 66.33 feet to the center of a 40 inch Oak;

THENCE through the lands of said Staniec, North 66 degrees 37 minutes 25 seconds East a distance of 28.15 feet, said line being westerly of a 4 foot diameter concrete well cover to a point where an iron pipe is to be set;

THENCE South 27 degrees 38 minutes 57 seconds East, being northeasterly of said well cover, a distance of 47.41 feet to a point in the water of a small bay, southerly of the end of a wood slip;

THENCE continuing across the water, North 88 degrees 24 minutes 32 seconds East a distance of 18.01 feet to a point in the water, 16 plus or minus feet southwesterly of a wood dock;

THENCE parallel with said dock and 16 plus or minus feet therefrom and said line continued, South 50 degrees 46 minutes 46 seconds East a distance of 142.22 feet to a point in the water on the southeasterly line of said Staniec parcel first mentioned above;

THENCE along said southeasterly line of said Staniec, South 46 degrees 29 minutes 54 seconds West a distance of 40.79 feet the most easterly corner of a steel and concrete dock;

THENCE continuing on the same bearing along the face of said dock, 115 plus or minus feet and containing along a line 8 plus or minus feet from the face of a boat house a total distance of 640.39 feet to a point;

LIBER 1851 PAGE 273

THENCE along the face of another boat house, South 57 degrees 26 minutes 11 seconds West a distance of 374.76 feet to an existing iron pipe on the northeasterly highway boundary of N.Y.S. Route 178 first mentioned above, said iron pipe being 50 plus or minus feet from the center line of pavement of said highway and said iron pipe also being at the southeasterly corner of said Staniec Parcel;

THENCE along the northeasterly highway boundary of said Route 178, North 60 degrees 70 minutes 31 seconds West a distance of 423.06 feet to the point of beginning, being 8.402 acres of land, more or less.

It is intended to convey by the above survey description a portion of the land conveyed by McKee to Staniec previously mentioned above.

Also granting and conveying a right of ingress and egress along the 50 feet wide right of way previously mentioned above, said right of way being adjacent to and on the northwesterly side of said above described premises and running from N.Y.S. Route 178 a distance of 936.60 feet along the northwesterly side thereof;

ALSO granting and conveying all of the grantor's rights, title and interest, if any, in and to the premises lying westerly of a line running from the center of the northeasterly end of a concrete culvert headwall to the southeasterly corner of the last mentioned boat house, said culvert being located southeasterly 40.0 feet from the southeasterly corner of the above described premises.

THE ENGINEERING AND INDUSTRIAL CONTROLS FOR THIS DECLARATION OF COVENANTS AND RESTRICTIONS ARE SET FORTH IN THE SITE MANAGEMENT PLAN (SMP). A COPY OF THE SMP MUST BE OBTAINED BY ANY PARTY WITH AN INTEREST IN THE PROPERTY. THE SMP CAN BE OBTAINED FROM THE NYS DEPARTMENT OF ENVIRONMENTAL CONSERVATION, DIVISION OF ENVIRONMENTAL REMEDIATION, SITE CONTROL SECTION, 625 BROADWAY, ALBANY, NY 12233, OR AT derweb@gw.dec.state.ny.us.

METES AND BOUNDS DESCRIPTION
OF AMENDED VCA PROPERTY SITE No V00585

Beginning at a point in the easterly boundary of lands now or formerly of Henderson Harbor Mariners' Marina Inc., said point being S 35°51'01" W, as measured along said easterly boundary a distance of 41.36 feet from the southerly boundary of lands now or formerly of Francis McLeod and Susan McLeod, said point also being a corner of a sheet pile wall; thence

1) S 35°51'01" W along the face of said sheet pile wall a distance of 114.59 feet to an angle point in said wall; thence

2) N 55°17'42" W continuing along said sheet pile wall a distance of 48.41 feet to a point on the westerly face of an existing wood dock; thence

3) S 35°51'26" W along the westerly face of said wood dock a distance of 70.15 feet to a point; thence

4) N 56°04'41" W through the lands now or formerly of Henderson Harbor Mariners' Marina Inc. a distance of 38.75 feet to a point, said point being the corner of an existing sheet pile wall; thence

Along the face of said existing sheet pile wall the following courses and distances

5) N 37°33'42" E a distance of 6.53 feet to a point; thence

6)N 31°32'31" E a distance of 21.57 feet to a point; thence

7)N 35°02'10" E a distance of 18.23 feet to a point; thence

8)N 41°52'38" E a distance of 22.37 feet to a point; thence

9)N 37°00'58" E a distance of 58.87 feet to a point; thence

10)N 41°38'21" E a distance of 19.62 feet to a point; thence

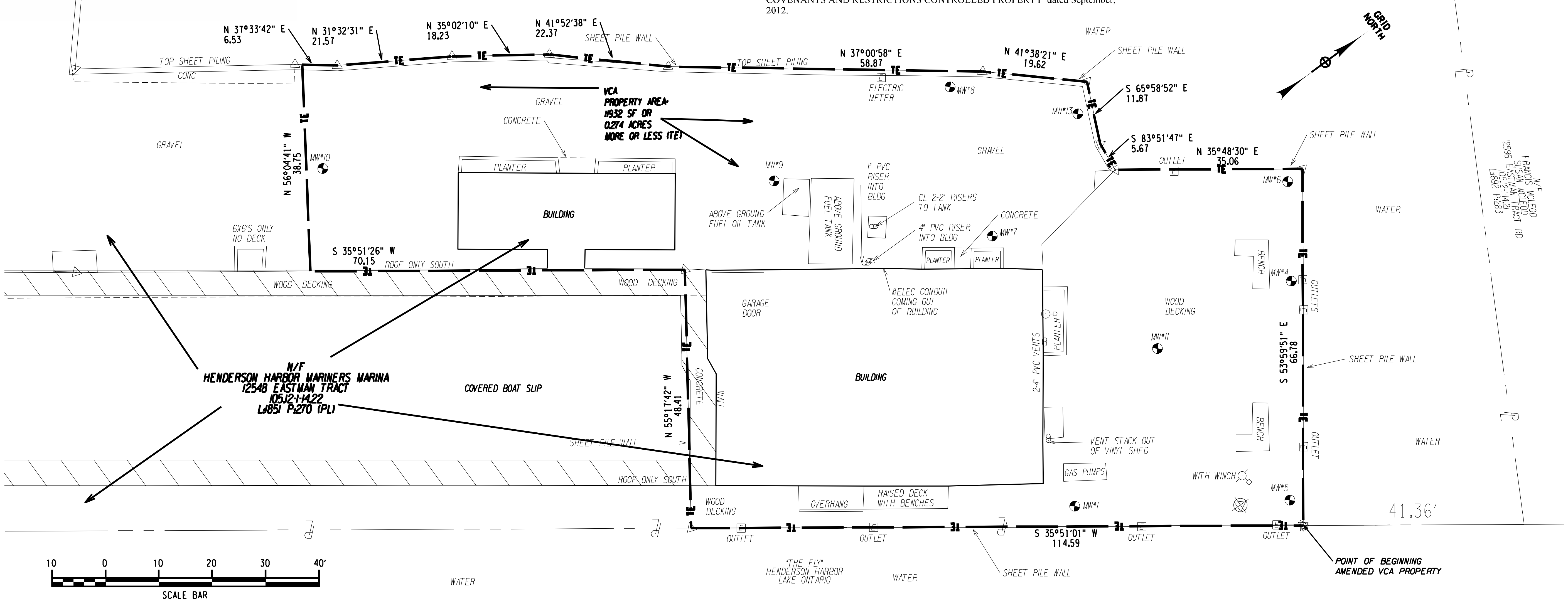
11)S 65°58'52" E a distance of 11.87 feet to a point; thence

12)S 83°51'47" E a distance of 5.67 feet to a point; thence

13)N 35°48'30" E a distance of 35.06 feet to a point; thence

14)S 53°59'51" E a distance of 66.78 feet to the POINT OF BEGINNING.

The above described parcel contains 0.274 acres (11932 sq. ft.) more or less.
All as shown on a plan by LaBella Associates PC titled "DECLARATION OF COVENANTS AND RESTRICTIONS CONTROLLED PROPERTY" dated September, 2012.



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NO.	REVISION	BY	DATE
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2			
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6			

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NYSDEC SITE NO. V00585
NYSDEC SPILL SITE NO. 0006174
HENDERSON HARBOR MARINER'S MARINA
12548 EASTMAN TRACT
HENDERSON, NY

THE UPSTATE NATIONAL BANK
1 WEST MAIN ST
ROCHESTER, NY 14614

AMENDED VOLUNTARY CLEANUP AGREEMENT (VCR) PROPERTY

DESIGNED BY: ECH
DRAWN BY: ECH
REVIEWED BY: MRH
DATE: SEPTEMBER 2012

207820

2 OF 2

APPENDIX B

Electronic Copy of Final Engineering Report

APPENDIX C

Agency Approvals

New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 6
Dulles State Office Building, 317 Washington Street, Watertown, New York 13601-3787
Phone: (315) 785-2513 • FAX: (315) 785-2422
Website: www.dec.ny.gov

Alexander B. Grannis
Commissioner

October 19, 2009

James L. Dudley, Vice President
The Upstate National Bank
One West Main Street
Rochester, NY 14614

RE: Lake Ontario Mariner's Marina, V00585
Voluntary Cleanup Agreement # A4-0463-0602
IRM Work Plan – Revised

Dear Mr. Dudley:

The Department received the above-referenced document from LaBella Associates, PC (LaBella) on September 28, 2009, and upon review has the following comments:

1. Section 5.4, pg. 6, paragraph 2, regarding excavated soils: Cleanup goals for this IRM will be pre-release conditions. If it is not feasible to obtain pre-release conditions, due to existing groundwater contamination, 6NYCRR Part 375-6 Protection of Ground Water Soil Clean-up Objectives (SCOs) should be used. As such, any material used as backfill into the IRM excavation must meet Protection of Groundwater SCOs (not STARS Memo #1 guidance values).

2. Section 5.6, pg. 9, regarding the quantitative risk assessment: Contamination underneath the building is highly likely and soil vapor intrusion sampling will be required. Modeling will not be accepted in lieu of direct sampling results.

Please be advised that the revised IRM Work Plan, dated September 2009, is approved contingent upon the above comments being met. LaBella should notify this office at least 48 hours prior to commencement of field work.

If you have any questions feel free to contact me at 315-785-2513.

Sincerely,

Philip G. Waite

Philip G. Waite, P.E.
Project Manager

PGW: aml

cc: Peter Taylor, RHWRE /File
Greg Rys, NYSDOH/Herkimer
Dennis Porter, LaBella Associates

DECISION DOCUMENT

Henderson Harbor Mariners' Marina
Voluntary Cleanup Program
Henderson, Jefferson County
Site No. V00585
March 2014

Prepared by
Division of Environmental Remediation
New York State Department of Environmental Conservation

DECLARATION STATEMENT - DECISION DOCUMENT

Henderson Harbor Mariners' Marina
Voluntary Cleanup Program
Henderson, Jefferson County
Site No. V00585
March 2014

Statement of Purpose and Basis

This document presents the remedy for the Henderson Harbor Mariners' Marina site, a voluntary cleanup site. The remedial program was chosen in accordance with the New York State Environmental Conservation Law and applicable guidance.

This decision is based on the Administrative Record of the New York State Department of Environmental Conservation (the Department) for the Henderson Harbor Mariners' Marina site and the public's input to the proposed remedy presented by the Department.

Description of Selected Remedy

The elements of the remedy are as follows:

1. Remedial Design

A remedial design work plan will be developed to provide the details necessary for the construction, operation, and maintenance and monitoring of the remedial action program. Green remediation principles and techniques will be implemented to the extent feasible in the implementation and site management of the remedy as per the Department guidance, DER-31. The major green remediation components are as follows:

- Considering the environmental impacts of treatment technologies and remedy stewardship over the long term;

- Reducing direct and indirect greenhouse gas and other emissions;

- Increasing energy efficiency and minimizing use of non-renewable energy;

- Conserving and efficiently managing resources and materials;

- Reducing waste, increasing recycling and increasing reuse of materials which will otherwise be considered a waste;

- Maximizing habitat value and creating habitat when possible;

- Fostering green and healthy communities and working landscapes which balance ecological, economic and social goals; and

- Integrating the remedy with the end use where possible and encouraging green and sustainable re-development.

2. Air Sparge/Soil Vapor Extraction System

Air sparging will be implemented to address the groundwater plume contaminated by volatile organic compounds (VOCs). VOCs will be physically removed from the groundwater and soil below the water table (saturated soil) by injecting air into the subsurface. As the injected air rises through the groundwater, the VOCs volatilize and transfer from the groundwater and/or soil into the injected air. The VOCs are carried with the injected air into the vadose zone (the area below the ground surface but above the water table) where a soil vapor extraction (SVE) system is used to remove the injected air. The SVE system applies a vacuum to wells that have been installed into the vadose zone to remove the VOCs along with the air introduced by the sparging process. The air extracted from the SVE wells is then treated as necessary prior to being discharged to the atmosphere.

At this site, air injection wells will be installed in the source removal area to a depth of approximately 5-8 feet below grade, which is approximately 3 feet below the average water table depth. The horizontal collectors installed during the IRM will be used to capture the volatilized contaminants. The air containing VOCs in the horizontal collectors will be tested to determine whether treatment is necessary. If necessary, the air will be treated using technology such as passing the air stream through activated carbon which removes the VOCs from the air prior to it being discharged to the atmosphere.

3. Site Cover

A site cover currently exists and will be maintained to allow for commercial use of the site. Any site redevelopment will maintain a site cover, which may consist either of the structures such as buildings, pavement and sidewalks comprising the site development or a soil cover in areas where the upper one foot of exposed surface soil will exceed the applicable soil cleanup objectives (SCOs). Where a soil cover is required it will be a minimum of one foot of soil, meeting the SCOs for cover material as set forth in 6 NYCRR Part 375-6.7(d) for commercial use. The soil cover will be placed over a demarcation layer, with the upper six inches of the soil of sufficient quality to maintain a vegetation layer. Any fill material brought to the site will meet the requirements for the identified site use as set forth in 6 NYCRR Part 375-6.7(d).

4. Institutional Control

Imposition of an institutional control in the form of a Deed Restriction for the controlled property that:

- requires the remedial party or site owner to complete and submit to the Department a periodic certification of institutional and engineering controls in accordance with Part 375-1.8(h)(3);

- allows the use and development of the controlled property for commercial and industrial use defined by Part 375-1.8(g), although land use is subject to local zoning laws.

- restricts the use of groundwater as a source of potable or process water, without necessary water quality treatment as determined by the New York State Department of Health(NYSDOH) or County DOH; and

- requires compliance with the Department approved Site Management Plan.

5. Site Management Plan

A Site Management Plan is required, which includes the following:

a. an Institutional and Engineering Control Plan that identifies all use restrictions and engineering controls for the site and details the steps and media-specific requirements necessary to ensure the following institutional and/or engineering controls remain in place and remain effective:

- Institutional Controls: The Deed Restriction discussed above;

- Engineering Controls: After it is modified; the active air sparge/soil vapor extraction system and the site cover;

- an Excavation Plan which details the provisions for management of future excavations in areas of remaining contamination.

- descriptions of the provisions of the Deed Restriction including any land use and groundwater use restrictions;

- a provision for evaluation of the potential for soil vapor intrusion for any buildings on the site or developed on the site in the future, including provision for implementing actions recommended to address exposures related to soil vapor intrusion;

- provisions for the management and inspection of the identified engineering controls;

- maintaining site access controls and Department notification; and

- the steps necessary for the periodic reviews and certification of the institutional and/or engineering controls.

b. a Monitoring Plan to assess the performance and effectiveness of the remedy. The plan includes, but is not necessarily limited to:

- monitoring of the air sparge/soil vapor extraction system;

- monitoring of groundwater to assess the performance and effectiveness of the remedy;

- a schedule of monitoring and frequency of submittals to the Department; and

- monitoring for vapor intrusion for any buildings on the site or developed on the site, as may be required by the Institutional and Engineering Control Plan discussed above.

c. an Operation and Maintenance (O&M) Plan to ensure continued operation, maintenance, monitoring, inspection, and reporting of any mechanical or physical components of the remedy. The plan includes, but is not limited to:

- compliance monitoring of treatment systems to ensure proper O&M as well as providing the data for any necessary permit or permit equivalent reporting;

- maintaining site access controls and Department notification; and

- providing the Department access to the site and O&M records.

Declaration

The remedy conforms with promulgated standards and criteria that are directly applicable, or that are relevant and appropriate and takes into consideration Department guidance, as appropriate. The remedy is protective of public health and the environment.

March 31, 2014

Date

George Heitzman, Director
Remedial Bureau C

DECISION DOCUMENT

Henderson Harbor Mariners' Marina
Henderson, Jefferson County
Site No. V00585
March 2014

SECTION 1: SUMMARY AND PURPOSE

The New York State Department of Environmental Conservation (the Department), in consultation with the New York State Department of Health (NYSDOH), has selected a remedy for the above referenced site. The disposal of contaminants at the site has resulted in threats to public health and the environment that would be addressed by the remedy. The disposal or release of contaminants at this site, as more fully described in this document, has contaminated various environmental media. Contaminants include hazardous waste and/or petroleum.

The Voluntary Cleanup Program (VCP) is a voluntary program. The goal of the VCP is to enhance private sector cleanup of brownfields by enabling parties to remediate sites using private rather than public funds and to reduce the development pressures on "greenfields." This document is a summary of the information that can be found in the site-related reports and documents.

SECTION 2: CITIZEN PARTICIPATION

The Department seeks input from the community on all remedies. A public comment period was held, during which the public was encouraged to submit comment on the proposed remedy. All comments on the remedy received during the comment period were considered by the Department in selecting a remedy for the site. Site-related reports and documents were made available for review by the public at the following document repository:

New York State Department of Environmental Conservation
Attn: Peter S. Ouderkirk
317 Washington Street
Watertown, NY 13601
Phone: 315-785-2614

Receive Site Citizen Participation Information By Email

Please note that the Department's Division of Environmental Remediation (DER) is "going paperless" relative to citizen participation information. The ultimate goal is to distribute citizen participation information about contaminated sites electronically by way of county email listservs. Information will be distributed for all sites that are being investigated and cleaned up in a particular county under the State Superfund Program, Environmental Restoration Program, Brownfield Cleanup Program, Voluntary Cleanup Program, and Resource Conservation and Recovery Act Program. We encourage the public to sign up for one or more county listservs at http://www.dec.ny.gov/chemical/61092.html

SECTION 3: SITE DESCRIPTION AND HISTORY

Location: The Henderson Harbor Mariners Marina is located in a rural setting on the eastern shore of Lake Ontario. The site is located northeast of the Military Road in the Hamlet of Henderson Harbor.

Site Features: The site encompasses 0.274 acres. The main site features include the Marina building, the former underground storage tank area, and adjacent boat docks.

Current Zoning and Land Use: The site is zoned as Harbor and its use is commercial. The surrounding parcels are zoned for a combination of residential and commercial use. The site includes the Marina office and customer service area for the Marina.

Past Use of the Site: Activities that led to contamination of the site include discharges from four underground petroleum storage tanks and ancillary equipment used to fill boats, use of an above-ground waste oil storage tank and a gasoline spill that occurred in August of 2000.

Several investigations were conducted prior to the site entering the Voluntary Cleanup Program. A Phase I Environmental Site Assessment was conducted in 2001 that identified four Underground Storage Tanks (USTs). A limited Phase II Environmental Site Assessment was conducted in 2002 that included the installation of eleven (11) soil borings. These borings were converted to temporary monitoring wells. Sampling confirmed the presence of petroleum contaminated soil and groundwater. Based on these investigations, the remedial party applied to the VCP in May 2002.

Site Geology and Hydrogeology: The majority of the site is comprised of up to nine feet of fill consisting of fine to coarse grained sand and gravel underlain by silt with little sand. Groundwater levels are essentially the same as the level of Lake Ontario. The base of the on-site building and surrounding grade ranges from 2.4 to 4.5 feet above the average lake level. Groundwater levels correspond and fluctuate with lake levels. Groundwater predominantly flows radially toward the Lake.

A site location map is attached as Figure 1.

SECTION 4: LAND USE AND PHYSICAL SETTING

The Department may consider the current, intended, and reasonably anticipated future land use of the site and its surroundings when evaluating a remedy for soil remediation. For this site, at a minimum, alternatives (or an alternative) that restrict(s) the use of the site to commercial use (which allows for industrial use) as described in DER-10, Technical Guidance for Site Investigation and Remediation were/was evaluated.

A comparison of the results of the Remedial Investigation (RI) to the appropriate standards, criteria and guidance values (SCGs) for the identified land use and the unrestricted use SCGs for the site contaminants is available in the RI Report.

SECTION 5: ENFORCEMENT STATUS

Upstate National Bank (Volunteer) entered into the Voluntary Cleanup Program on August 16, 2002. The Volunteer agreed to investigate and remediate the site in accordance with the executed Voluntary Cleanup Program Agreement (Index #A4-0463-0602).

SECTION 6: SITE CONTAMINATION

6.1: Summary of the Remedial Investigation

A remedial investigation (RI) serves as the mechanism for collecting data to:

- characterize site conditions;
- determine the nature of the contamination; and
- assess risk to human health and the environment.

The RI is intended to identify the nature (or type) of contamination which may be present at a site and the extent of that contamination in the environment on the site, or leaving the site. The RI reports on data gathered to determine if the soil, groundwater, soil vapor, indoor air, surface water or sediments may have been contaminated. Monitoring wells are installed to assess groundwater and soil borings or test pits are installed to sample soil and/or waste(s) identified. If other natural resources are present, such as surface water bodies or wetlands, the water and sediment may be sampled as well. Based on the presence of contaminants in soil and groundwater, soil vapor will also be sampled for the presence of contamination. Data collected in the RI influence the development of remedial alternatives. The RI report is available for review in the site document repository and the results are summarized in section 6.3.

The analytical data collected on this site includes data for:

- groundwater
- soil

6.1.1: Standards, Criteria, and Guidance (SCGs)

The remedy must conform to promulgated standards and criteria that are directly applicable or that are relevant and appropriate. The selection of a remedy must also take into consideration guidance, as appropriate. Standards, Criteria and Guidance are hereafter called SCGs.

To determine whether the contaminants identified in various media are present at levels of concern, the data from the RI were compared to media-specific SCGs. The Department has developed SCGs for groundwater, surface water, sediments, and soil. The NYSDOH has developed SCGs for drinking water and soil vapor intrusion. For a full listing of all SCGs see:

http://www.dec.ny.gov/regulations/61794.html

6.1.2: RI Results

The data have identified contaminants of concern. A "contaminant of concern" is a contaminant that is sufficiently present in frequency and concentration in the environment to require evaluation for remedial action. Not all contaminants identified on the property are contaminants of concern. The nature and extent of contamination and environmental media requiring action are summarized below. Additionally, the RI Report contains a full discussion of the data. The contaminant(s) of concern identified at this site is/are:

BENZENE	1,2,4-TRIMETHYLBENZENE
TOLUENE	1,3,5-Trimethylbenzene
ETHYLBENZENE	Sec-Butylbenzene
XYLENE (MIXED)	NAPHTHALENE
Isopropylbenzene	METHYL-TERT-BUTYL ETHER (MTBE)

The contaminant(s) of concern exceed the applicable SCGs for:

- groundwater
- soil

6.2: Interim Remedial Measures

An interim remedial measure (IRM) is conducted at a site when a source of contamination or exposure pathway can be effectively addressed before issuance of the Decision Document.

The following IRM(s) has/have been completed at this site based on conditions observed during the RI.

Tank and Source Removal with Passive Soil Vapor Extraction

The source removal IRM included the removal and off-site disposal of 436 tons of petroleum contaminated soil and five abandoned underground petroleum storage tanks. One above ground fuel tank used for waste oil was cleaned and remains on-site. Some of the contamination behind the sheet pile wall could not be removed during the IRM due to concerns regarding the stability of the wall. Therefore, once the excavation was terminated, soil samples were collected to evaluate the nature and extent of the remaining contamination. The results indicate that the source of contamination has successfully been removed and that only low levels of contamination remain. Prior to backfilling two sets of 4-inch diameter horizontal pipes were installed below grade to provide for interim, passive venting of remaining VOCs in the soil and groundwater and in anticipation of installing an active air sparge and soil vapor extraction system. The piping was connected to vertical 4-inch PVC risers above the building’s roof line. The excavation was backfilled with soil meeting the soil cleanup objectives for commercial use and the protection of groundwater. This IRM was completed between November and December of 2009.

6.3: Summary of Environmental Assessment

This section summarizes the assessment of existing and potential future environmental impacts presented by the site. Environmental impacts may include existing and potential future exposure pathways to fish and wildlife receptors, wetlands, groundwater resources, and surface water. The RI report presents a detailed discussion of any existing and potential impacts from the site to fish and wildlife receptors.

Based on the investigation and interim remedial measure conducted to date, the primary contaminants of concern are volatile organic compounds and semi-volatile organic compounds related to the release of petroleum contamination from five underground storage tanks and associated piping. An IRM was performed to remove the five USTs, contaminated soil, and contaminated groundwater from the source area.

Soil: The soil borings completed as part of this investigation also defined the extent of the remaining contamination which exists to the south and west of the source area. No contamination remains above the commercial use SCOs. Volatile organics were found above the protection of groundwater SCO and include ethylbenzene at 1.1 ppm (SCO 1 ppm), xylene from 3.8 ppm – 7.1 ppm (SCO 1.6 ppm), and 1, 2, 4-trimethylbenzene from 5.2 -6.6 ppm (SCO 3.5 ppm). The data indicates that the contamination related to the former USTs has not migrated significantly to the south or west, however, contamination remains beneath the on-site building.

Groundwater: Groundwater sampling conducted during the RI indicates that contaminant concentrations have decreased in six wells (MW-1, MW-9, MW-11, MW-12, T-2 and T-4) following the source removal IRM. Two wells (MW-4 and MW-5) located directly adjacent to the north side of the excavation showed a slight increase in contamination (methyl tertiary butyl ether (MTBE) from 120 ppb to 1100 ppb, benzene from 38 ppb to 430 ppb, toluene from 2.4 ppb to 67 ppb, ethylbenzene from 14 ppb to 150 ppb, total xylene from 17 ppb to 408 ppb, 1,2,4-trimethylbenzene from 7 ppb to 78 ppb and naphthalene from 16 ppb to 300 ppb). These increases are common in areas close to a source, especially when the excavation extends below the water table. Considering this, these wells will likely take longer to attenuate.

MTBE was the only contaminant detected in five of the monitoring wells MW-6, MW-9, T1, T2 and T3). Three of these wells (MW-6, MW-9 and T2) have shown a decrease in MTBE levels from 37 ppb to 25 ppb, 110 ppb to ND and 260 ppb to 24 ppb respectively. The contamination in well T3 increased from 290 ppb to 390 ppb and in well T1 from 32 ppb to 33 ppb.

6.4: Summary of Human Exposure Pathways

This human exposure assessment identifies ways in which people may be exposed to site-related contaminants. Chemicals can enter the body through three major pathways (breathing, touching or swallowing). This is referred to as *exposure*.

Since contaminated soil remains below the on-site building and at depth near the building, people will not come in contact with contaminated soil unless they dig below the building or ground surface. Contaminated groundwater at the site is not used for drinking or other purposes. Volatile organic compounds in the groundwater may move into the soil vapor (air spaces within the soil), which in turn may move into overlying buildings and affect the indoor air quality. This process, which is similar to the movement of radon gas from the subsurface into the indoor air of buildings, is referred to as soil vapor intrusion. Based on the presence of contaminated groundwater beneath the on-site building, the potential for soil vapor intrusion exists. Environmental sampling indicates soil vapor intrusion is not a concern for off-site properties.

6.5: <u>Summary of the Remediation Objectives</u>

The objectives for the remedial program have been established through the remedy selection process stated in 6 NYCRR Part 375. The goal for the remedial program is to restore the site to pre-disposal conditions to the extent feasible. At a minimum, the remedy shall eliminate or mitigate all significant threats to public health and the environment presented by the contamination identified at the site through the proper application of scientific and engineering principles.

The remedial action objectives for this site are:

<u>Groundwater</u>

RAOs for Public Health Protection

- Prevent ingestion of groundwater with contaminant levels exceeding drinking water standards.
- Prevent contact with, or inhalation of volatiles, from contaminated groundwater.

RAOs for Environmental Protection

- Restore ground water aquifer to pre-disposal/pre-release conditions, to the extent practicable.
- Prevent the discharge of contaminants to surface water.
- Remove the source of ground or surface water contamination.

<u>Soil</u>

RAOs for Public Health Protection

- Prevent ingestion/direct contact with contaminated soil.
- Prevent inhalation of or exposure from contaminants volatilizing from contaminants in soil.

RAOs for Environmental Protection

- Prevent migration of contaminants that would result in groundwater or surface water contamination.

<u>Soil Vapor</u>

RAOs for Public Health Protection

- Mitigate impacts to public health resulting from existing, or the potential for, soil vapor intrusion into buildings at a site.

SECTION 7: <u>ELEMENTS OF THE SELECTED REMEDY</u>

The alternatives developed for the site and the evaluation of the remedial criteria are presented in the Alternative Analysis. The remedy is selected pursuant to the remedy selection criteria set forth in DER-10, Technical Guidance for Site Investigation and Remediation.

The selected remedy is referred to as the Combined Air Sparge with SVE and a Site Cover with Institutional Controls remedy.

The elements of the selected remedy, as shown in Figure 2, are as follows:

1. Remedial Design

A remedial design work plan will be developed to provide the details necessary for the construction, operation, and maintenance and monitoring of the remedial action program. Green remediation principles and techniques will be implemented to the extent feasible in the implementation and site management of the remedy as per the Department guidance, DER-31. The major green remediation components are as follows:

- Considering the environmental impacts of treatment technologies and remedy stewardship over the long term;

- Reducing direct and indirect greenhouse gas and other emissions;

- Increasing energy efficiency and minimizing use of non-renewable energy;

- Conserving and efficiently managing resources and materials;

- Reducing waste, increasing recycling and increasing reuse of materials which will otherwise be considered a waste;

- Maximizing habitat value and creating habitat when possible;

- Fostering green and healthy communities and working landscapes which balance ecological, economic and social goals; and

- Integrating the remedy with the end use where possible and encouraging green and sustainable re-development.

2. Air Sparge/Soil Vapor Extraction System

Air sparging will be implemented to address the groundwater plume contaminated by volatile organic compounds (VOCs). VOCs will be physically removed from the groundwater and soil below the water table (saturated soil) by injecting air into the subsurface. As the injected air rises through the groundwater, the VOCs volatilize and transfer from the groundwater and/or soil into the injected air. The VOCs are carried with the injected air into the vadose zone (the area below the ground surface but above the water table) where a soil vapor extraction (SVE) system is used to remove the injected air. The SVE system applies a vacuum to wells that have been installed into the vadose zone to remove the VOCs along with the air introduced by the sparging process. The air extracted from the SVE wells is then treated as necessary prior to being discharged to the atmosphere.

At this site, air injection wells will be installed in the source removal area to a depth of approximately 5-8 feet below grade, which is approximately 3 feet below the average water table depth. The horizontal collectors installed during the IRM will be used to capture the volatilized contaminants. The air containing VOCs in the horizontal collectors will be tested to determine whether treatment is necessary. If necessary, the air will be treated using technology such as; passing the air stream through activated carbon which removes the VOCs from the air prior to it being discharged to the atmosphere.

3. Site Cover

A site cover currently exists and will be maintained to allow for commercial use of the site. Any site redevelopment will maintain a site cover, which may consist either of the structures such as buildings, pavement and sidewalks comprising the site development or a soil cover in areas where the upper one foot of exposed surface soil will exceed the applicable soil cleanup objectives (SCOs). Where a soil cover is required it will be a minimum of one foot of soil, meeting the SCOs for cover material as set forth in 6 NYCRR Part 375-6.7(d) for commercial use. The soil cover will be placed over a demarcation layer, with the upper six inches of the soil of sufficient quality to maintain a vegetation layer. Any fill material brought to the site will meet the requirements for the identified site use as set forth in 6 NYCRR Part 375-6.7(d).

4. Institutional Control

Imposition of an institutional control in the form of a Deed Restriction for the controlled property that:

- requires the remedial party or site owner to complete and submit to the Department a periodic certification of institutional and engineering controls in accordance with Part 375-1.8(h)(3);

- allows the use and development of the controlled property for commercial and industrial use defined by Part 375-1.8(g), although land use is subject to local zoning laws.

- restricts the use of groundwater as a source of potable or process water, without necessary water quality treatment as determined by the New York State Department of Health(NYSDOH) or County DOH; and

- requires compliance with the Department approved Site Management Plan.

5. Site Management Plan

A Site Management Plan is required, which includes the following:

a. an Institutional and Engineering Control Plan that identifies all use restrictions and engineering controls for the site and details the steps and media-specific requirements necessary to ensure the following institutional and/or engineering controls remain in place and remain effective:

- Institutional Controls: The Deed Restriction discussed above;

- Engineering Controls: After it is modified; the active air sparge/soil vapor extraction system and the site cover;

- an Excavation Plan which details the provisions for management of future excavations in areas of remaining contamination.

- descriptions of the provisions of the Deed Restriction including any land use and groundwater use restrictions;

- a provision for evaluation of the potential for soil vapor intrusion for any buildings on the site or developed on the site in the future, including provision for implementing actions recommended to address exposures related to soil vapor intrusion;

- provisions for the management and inspection of the identified engineering controls;

- maintaining site access controls and Department notification; and

- the steps necessary for the periodic reviews and certification of the institutional and/or engineering controls.

b. a Monitoring Plan to assess the performance and effectiveness of the remedy. The plan includes, but is not necessarily limited to:

- monitoring of the air sparge/soil vapor extraction system;

- monitoring of groundwater to assess the performance and effectiveness of the remedy;

- a schedule of monitoring and frequency of submittals to the Department; and

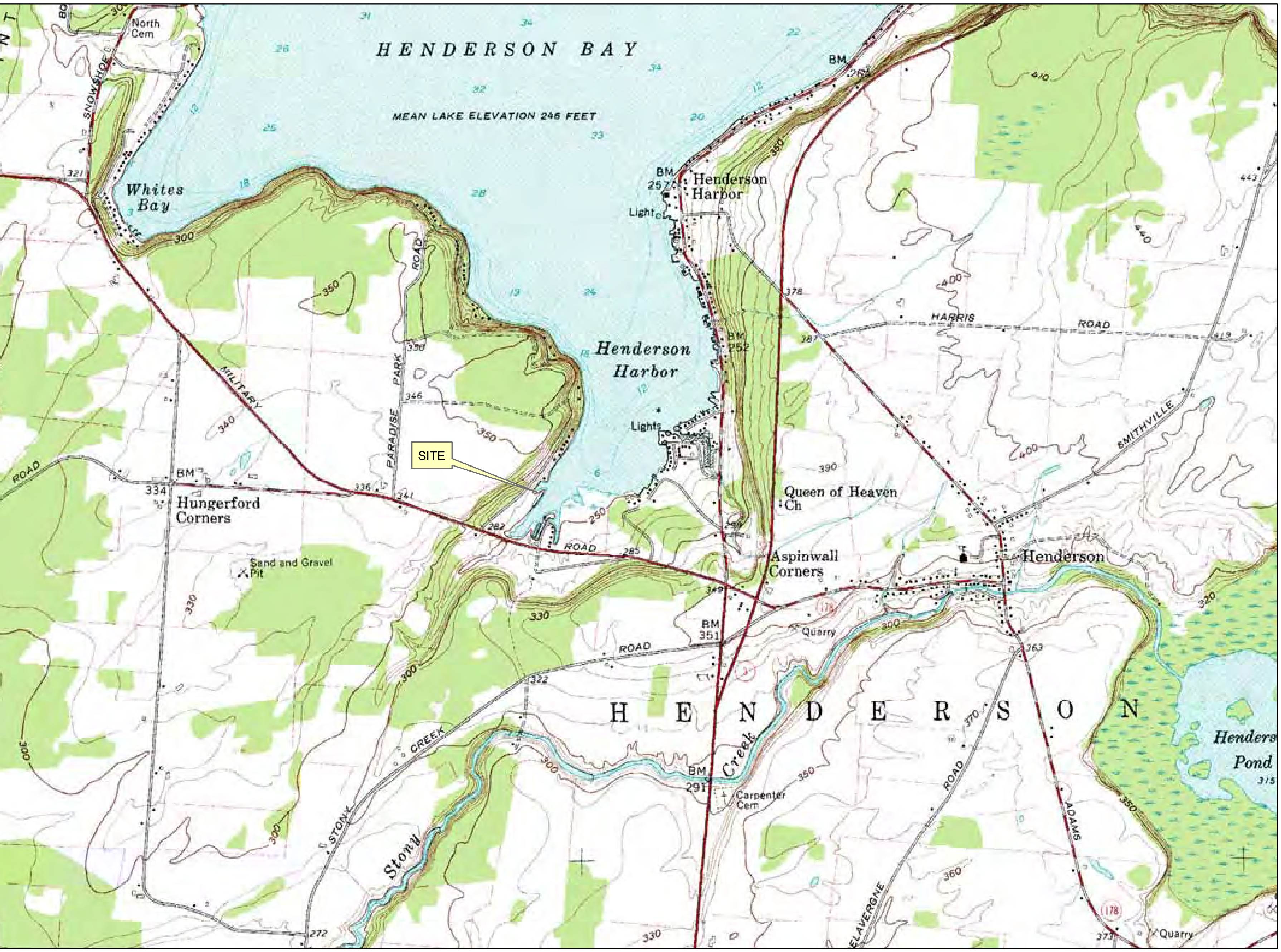
- monitoring for vapor intrusion for any buildings on the site or developed on the site, as may be required by the Institutional and Engineering Control Plan discussed above.

c. an Operation and Maintenance (O&M) Plan to ensure continued operation, maintenance, monitoring, inspection, and reporting of any mechanical or physical components of the remedy. The plan includes, but is not limited to:

- compliance monitoring of treatment systems to ensure proper O&M as well as providing the data for any necessary permit or permit equivalent reporting;

- maintaining site access controls and Department notification; and

- providing the Department access to the site and O&M records.



LABELLA Associates, P.C.

RAA/RAWP Report
NYSDEC VCA Index
No. A4-0463-0602
Lake Ontario Mariners Marina
12548 Eastman Tract
Henderson Harbor, New York

Client:
The Upstate National Bank

Project Location with USGS Topographic Quadrangle

N
W E
S

500 0 1,000
1 inch = 1,500 feet

207820

FIGURE 1

LABELLA Associates, P.C.

RAA/RAWP Report
NYSDEC VCA Index
No. A4-0463-0602
Lake Ontario Mariners Marina
12548 Eastman Tract
Henderson Harbor, New York

Client:
The Upstate National Bank

Site Area Map

N
W E
S

50 0 50
1 inch = 100 feet

207820

FIGURE 2

LABELLA Associates, P.C.

RAA/RAWP Report
NYSDEC VCA Index
No. A4-0463-0602
Lake Ontario Mariners Marina
12548 Eastman Tract
Henderson Harbor, New York

Client:
The Upstate National Bank

Area of Concern
and IRM Excavation
Locations

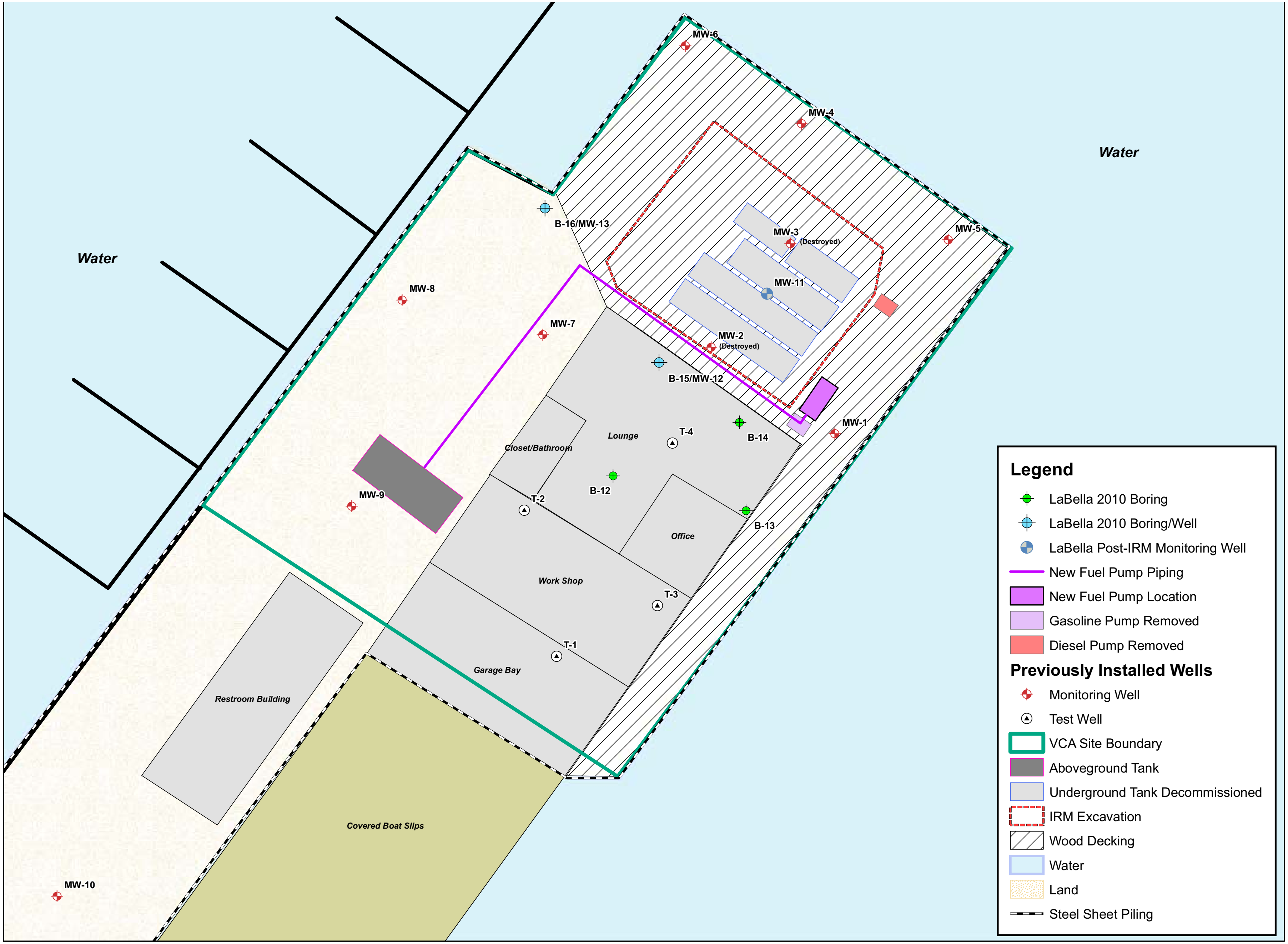
N
W E
S

0 5 10 15 20 Feet

1 inch = 15 feet

207820

FIGURE 3



LABELLA Associates, P.C.

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Client:
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Soil Boring and Monitoring Well Location Map

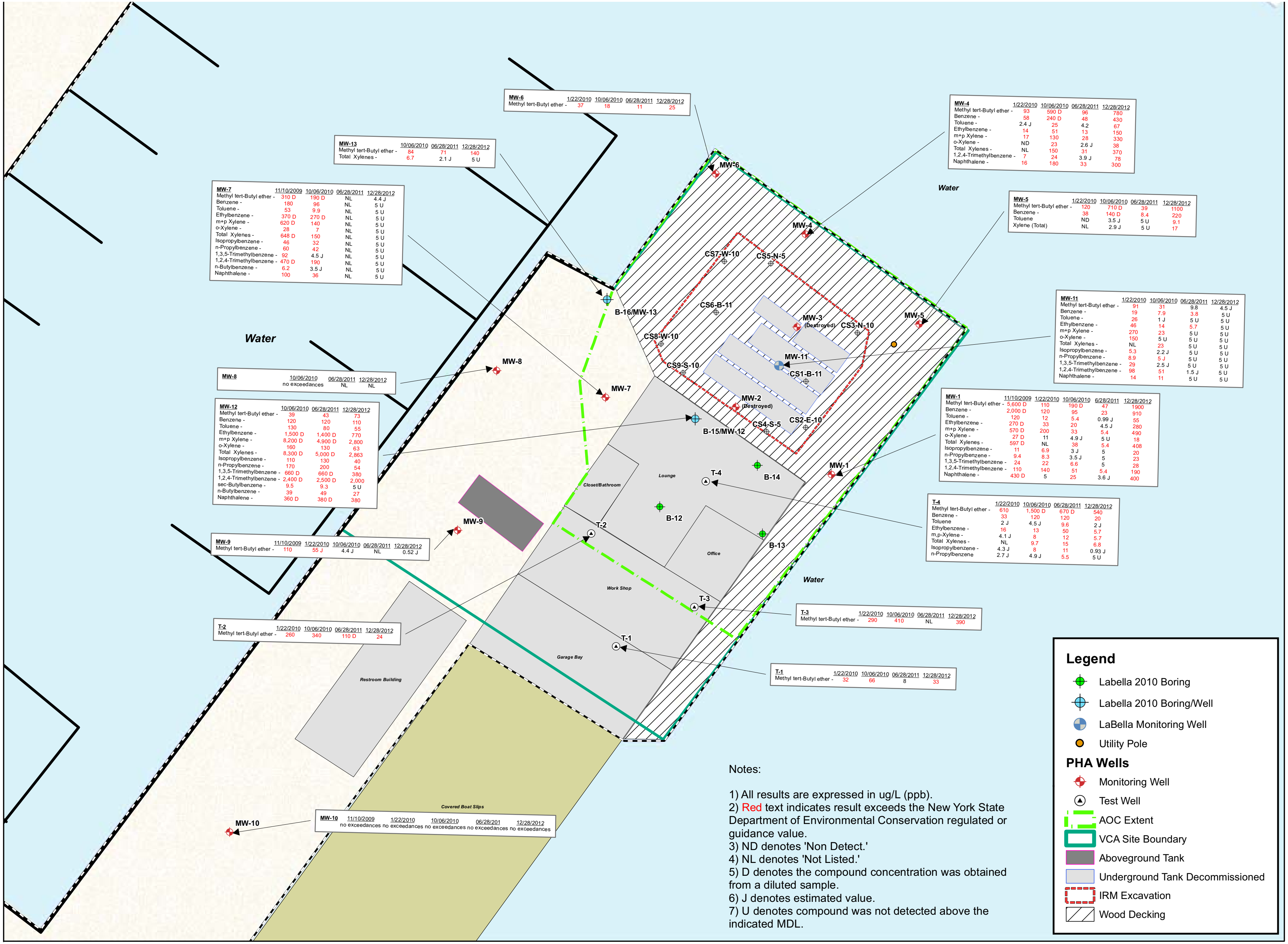
N
W E
S

0 5 10 15 20 Feet

1 inch = 15 feet

207820

FIGURE 4



MW-6

	1/22/2010	10/06/2010	06/28/2011	12/28/2012
Methyl tert-Butyl ether -	37	18	11	25

MW-13

	10/06/2010	06/28/2011	12/28/2012
Methyl tert-Butyl ether -	84	71	140
Total Xylenes -	6.7	2.1 J	5 U

MW-7

	11/10/2009	10/06/2010	06/28/2011	12/28/2012
Methyl tert-Butyl ether -	310 D	190 D	NL	4.4 J
Benzene -	180	96	NL	5 U
Toluene -	53	9.9	NL	5 U
Ethylbenzene -	370 D	270 D	NL	5 U
m+p Xylene -	620 D	140	NL	5 U
o-Xylene -	28	7	NL	5 U
Total Xylenes -	648 D	150	NL	5 U
Isopropylbenzene -	46	32	NL	5 U
n-Propylbenzene -	60	42	NL	5 U
1,3,5-Trimethylbenzene -	92	4.5 J	NL	5 U
1,2,4-Trimethylbenzene -	470 D	190	NL	5 U
n-Butylbenzene -	6.2	3.5 J	NL	5 U
Naphthalene -	100	36	NL	5 U

MW-8

	10/06/2010	06/28/2011	12/28/2012
	no exceedances	NL	NL

MW-12

	10/06/2010	06/28/2011	12/28/2012
Methyl tert-Butyl ether -	39	43	73
Benzene -	120	120	110
Toluene -	130	80	55
Ethylbenzene -	1,500 D	1,400 D	770
m+p Xylene -	8,200 D	4,900 D	2,800
o-Xylene -	160	130	63
Total Xylenes -	8,300 D	5,000 D	2,863
Isopropylbenzene -	110	130	40
n-Propylbenzene -	170	200	54
1,3,5-Trimethylbenzene -	660 D	660 D	380
1,2,4-Trimethylbenzene -	2,400 D	2,500 D	2,000
sec-Butylbenzene -	9.5	9.3	5 U
n-Butylbenzene -	39	49	27
Naphthalene -	360 D	380 D	380

MW-9

	11/10/2009	1/22/2010	10/06/2010	06/28/2011	12/28/2012
Methyl tert-Butyl ether -	110	55 J	4.4 J	NL	0.52 J

T-2

	1/22/2010	10/06/2010	06/28/2011	12/28/2012
Methyl tert-Butyl ether -	260	340	110 D	24

MW-10

	11/10/2009	1/22/2010	10/06/2010	06/28/201	12/28/2012
	no exceedances	no exceedances	no exceedances	no exceedances	no exceedances

MW-4

	1/22/2010	10/06/2010	06/28/2011	12/28/2012
Methyl tert-Butyl ether -	93	590 D	96	780
Benzene -	58	240 D	48	430
Toluene -	2.4 J	25	4.2	67
Ethylbenzene -	14	51	13	150
m+p Xylene -	17	130	28	330
o-Xylene -	ND	23	2.6 J	38
Total Xylenes -	NL	150	31	370
1,2,4-Trimethylbenzene -	7	24	3.9 J	78
Naphthalene -	16	180	33	300

MW-5

	1/22/2010	10/06/2010	06/28/2011	12/28/2012
Methyl tert-Butyl ether -	120	710 D	39	1100
Benzene -	38	140 D	8.4	220
Toluene	ND	3.5 J	5 U	9.1
Xylene (Total)	NL	2.9 J	5 U	17

MW-11

	1/22/2010	10/06/2010	06/28/2011	12/28/2012
Methyl tert-Butyl ether -	91	31	9.8	4.5 J
Benzene -	19	7.9	3.8	5 U
Toluene -	26	1 J	5 U	5 U
Ethylbenzene -	46	14	5.7	5 U
m+p Xylene -	270	23	5 U	5 U
o-Xylene -	150	5 U	5 U	5 U
Total Xylenes -	NL	23	5 U	5 U
Isopropylbenzene -	5.3	2.2 J	5 U	5 U
n-Propylbenzene -	8.9	5 J	5 U	5 U
1,3,5-Trimethylbenzene -	29	2.5 J	5 U	5 U
1,2,4-Trimethylbenzene -	98	51	1.5 J	5 U
Naphthalene -	14	11	5 U	5 U

MW-1

	11/10/2009	1/22/2010	10/06/2010	6/28/2011	12/28/2012
Methyl tert-Butyl ether -	5,600 D	110	190 D	47	1900
Benzene -	2,000 D	120	95	23	910
Toluene -	120	12	5.4	0.99 J	55
Ethylbenzene -	270 D	33	20	4.5 J	280
m+p Xylene -	570 D	200	33	5.4	490
o-Xylene -	27 D	11	4.9 J	5 U	18
Total Xylenes -	597 D	NL	38	5.4	408
Isopropylbenzene -	11	6.9	3 J	5	20
n-Propylbenzene -	9.4	8.3	3.5 J	5	23
1,3,5-Trimethylbenzene -	24	22	6.6	5	28
1,2,4-Trimethylbenzene -	110	140	51	5.4	190
Naphthalene -	430 D	5	25	3.6 J	400

T-4

	1/22/2010	10/06/2010	06/28/2011	12/28/2012
Methyl tert-Butyl ether -	610	1,500 D	670 D	540
Benzene -	33	120	120	20
Toluene	2 J	4.5 J	9.6	2 J
Ethylbenzene -	16	13	50	5.7
m,p-Xylene -	4.1 J	8	12	5.7
Total Xylenes -	NL	9.7	15	6.8
Isopropylbenzene -	4.3 J	8	11	0.93 J
n-Propylbenzene	2.7 J	4.9 J	5.5	5 U

T-3

	1/22/2010	10/06/2010	06/28/2011	12/28/2012
Methyl tert-Butyl ether -	290	410	NL	390

T-1

	1/22/2010	10/06/2010	06/28/2011	12/28/2012
Methyl tert-Butyl ether -	32	66	8	33

Notes:

1) All results are expressed in ug/L (ppb).
2) Red text indicates result exceeds the New York State Department of Environmental Conservation regulated or guidance value.
3) ND denotes 'Non Detect.'
4) NL denotes 'Not Listed.'
5) D denotes the compound concentration was obtained from a diluted sample.
6) J denotes estimated value.
7) U denotes compound was not detected above the indicated MDL.

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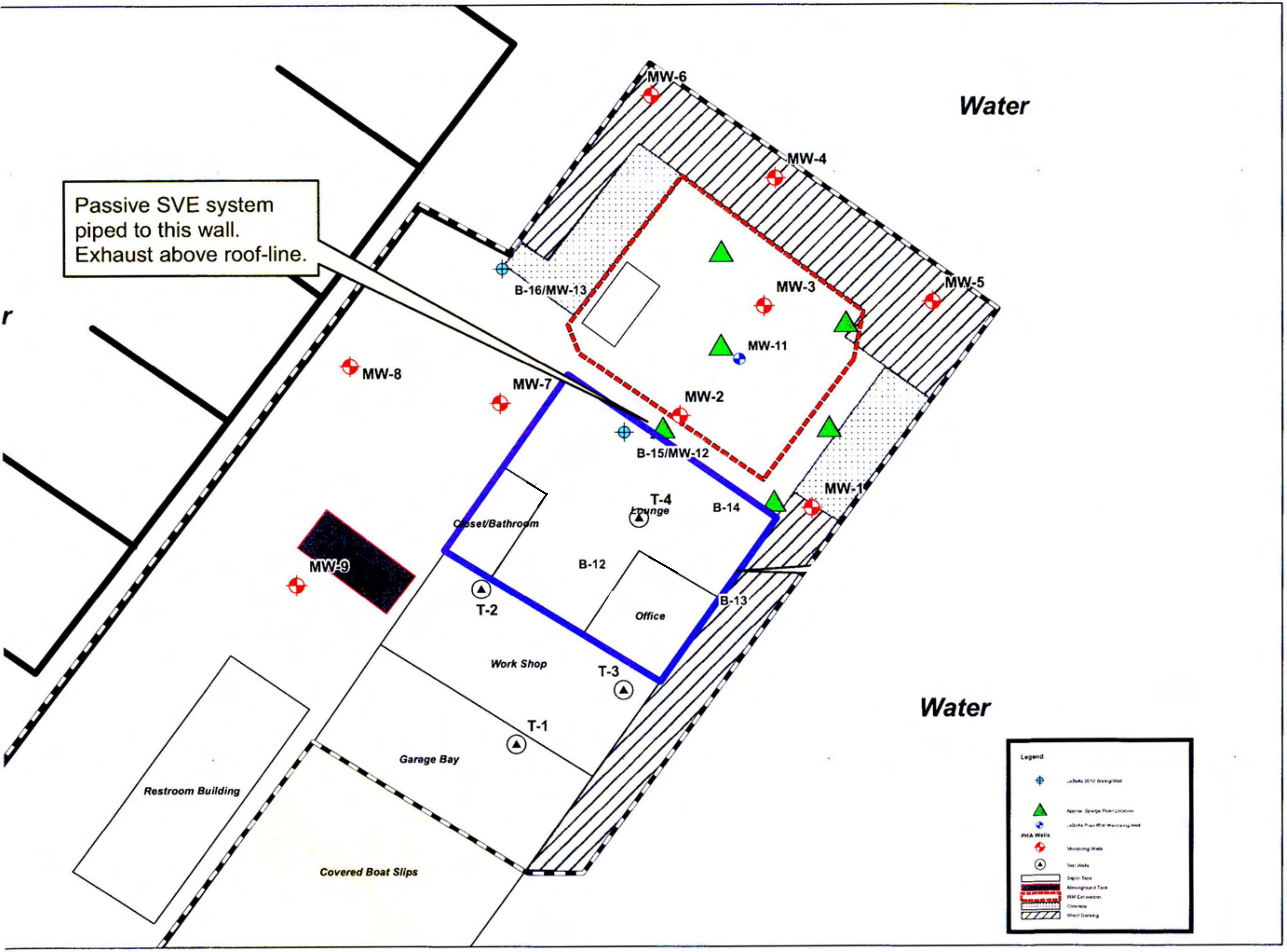
RAA/RAWP Report
NYSDEC VCA Index
No. A4-0463-0602
Lake Ontario Mariners Marina
12548 Eastman Tract
Henderson Harbor, New York

Client:
The Upstate National Bank

Soil Boring and Monitoring Well Location Map with Groundwater Sample Results

207820

FIGURE 5



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Air Sparging and
Sub-Slab Depressurization
System Designs

12548 Eastman Tract
Henderson Harbor, NY

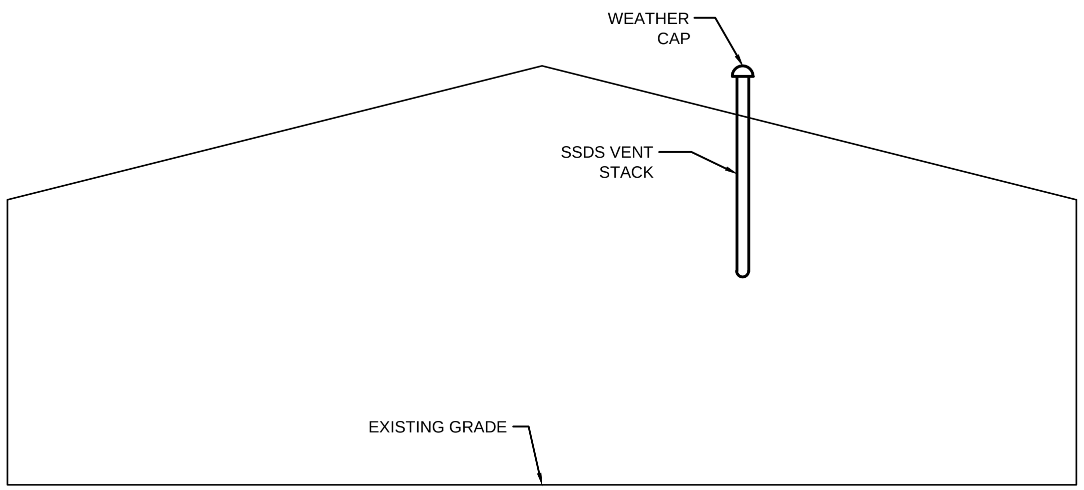
10 0 10
1 inch = 15 feet

207820

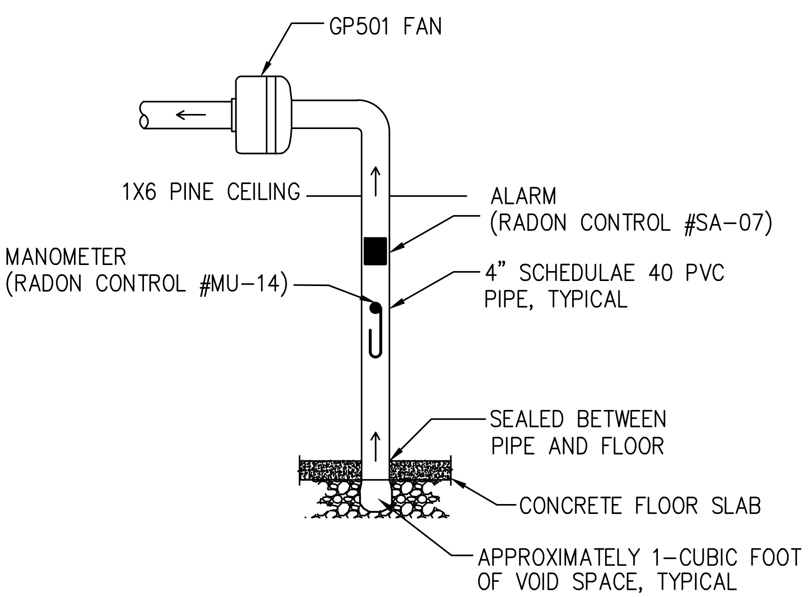
FIGURE 6

APPENDIX D

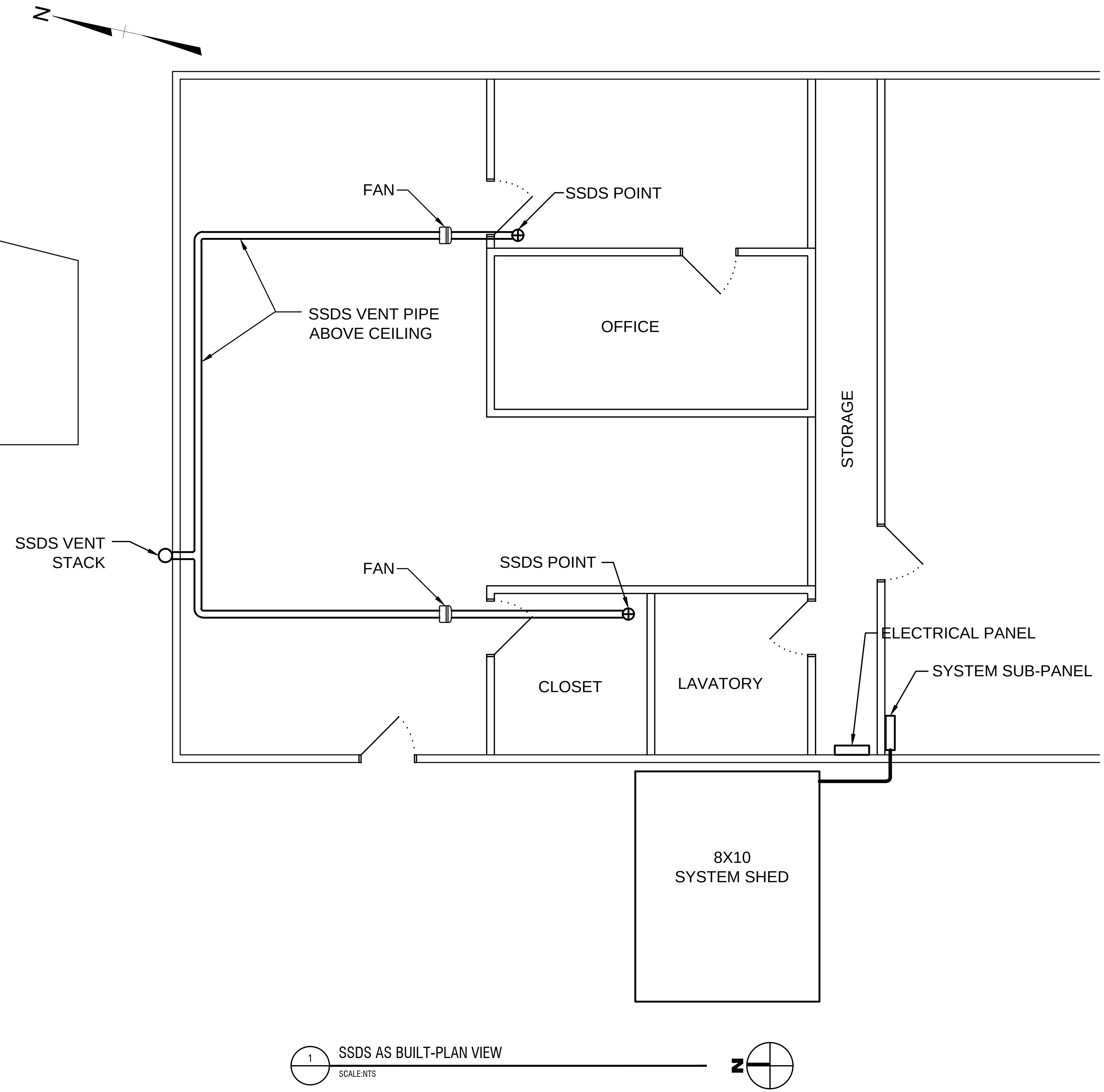
Treatment System As-Built Drawings



3 SSDS AS BUILT-NORTH BUILDING ELEVATION
SCALE:NTS



3 SSDS AS BUILT-VENT FAN DETAIL
SCALE:NTS



1 SSDS AS BUILT-PLAN VIEW
SCALE:NTS

NOTE:
DRAWING NOT TO SCALE.

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PROJECT NO: 207820

REVISION

NO.	DATE	DESCRIPTION
	--	--212000
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DRAWN BY: C. JOLLIFF

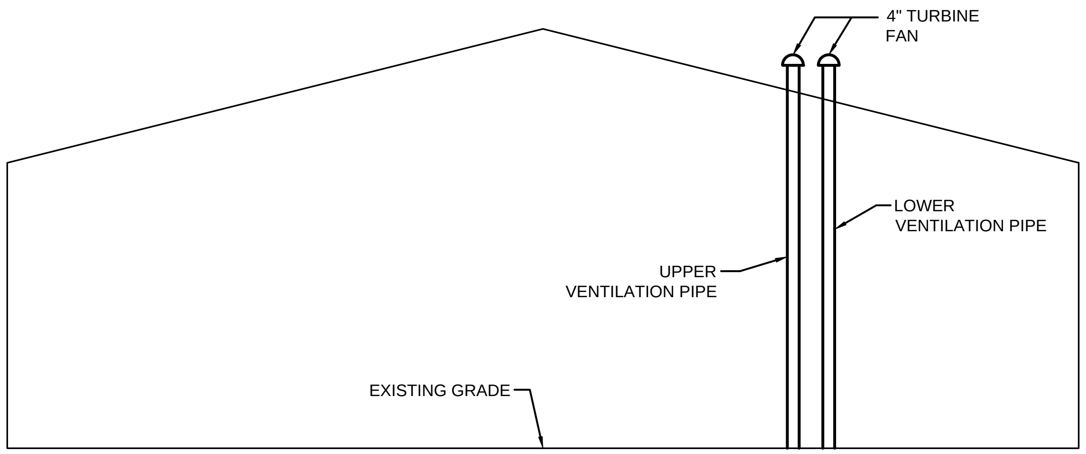
APPROVED BY: J. HEERKENS

ISSUED FOR: -

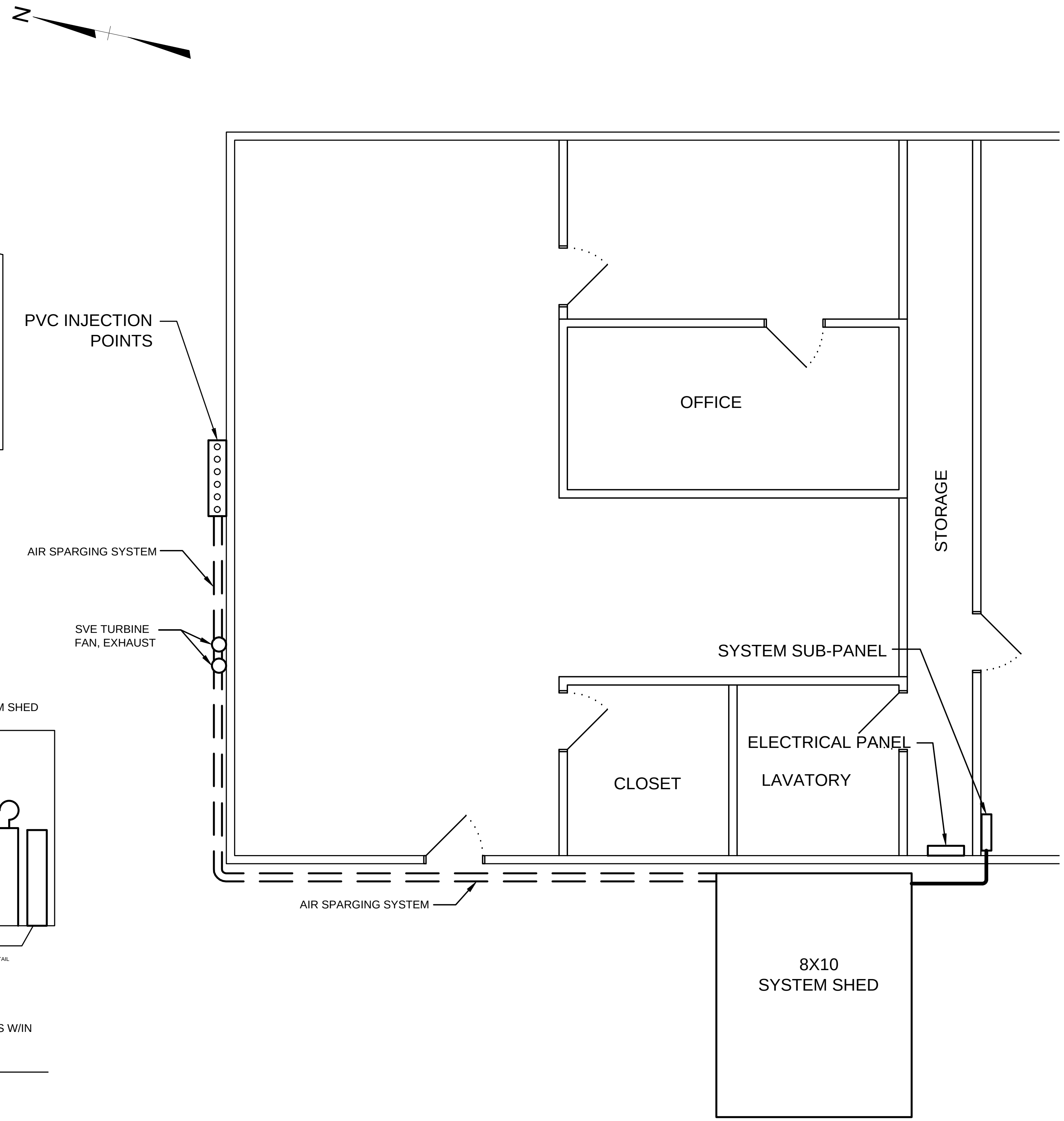
DATE: FEBRUARY 2015

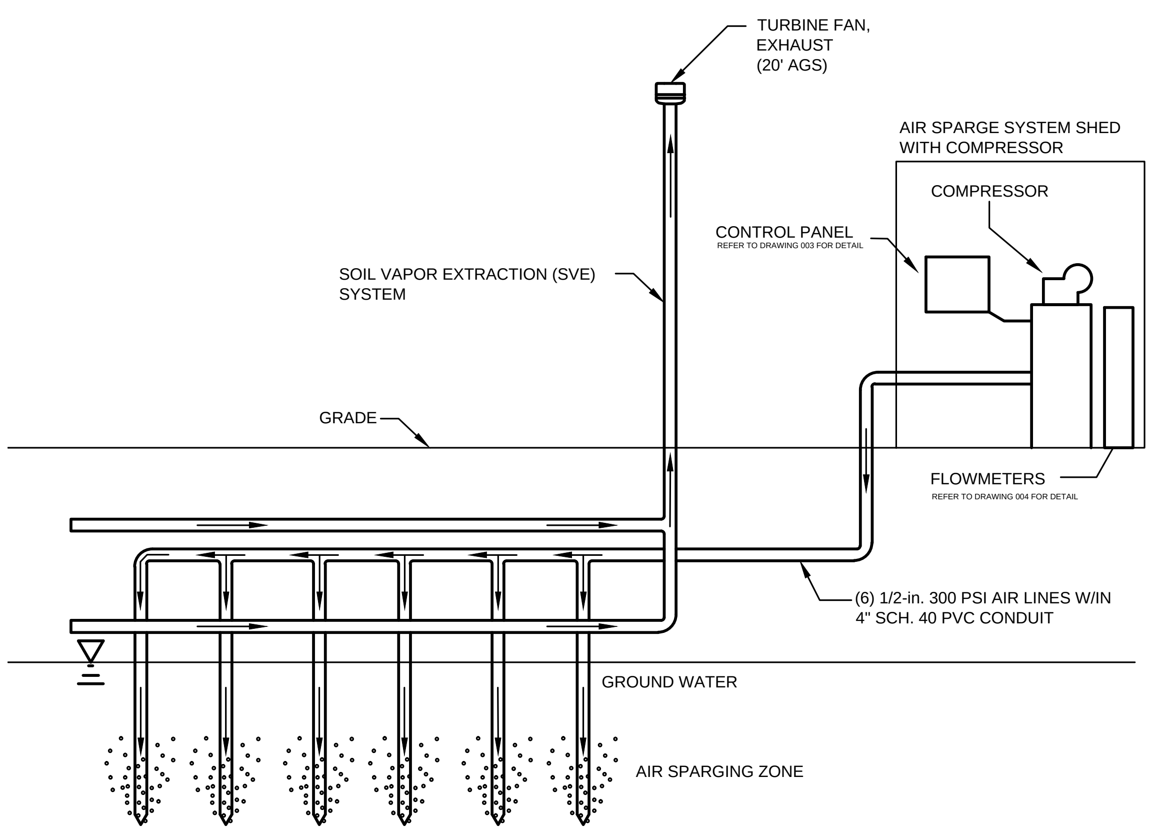
DRAWING NAME: HENDERSON HARBOR AS BUILT PLAN

FIGURE NO: 001



2 SPARGING SYSTEM-NORTH BUILDING ELEVATION
SCALE:NTS





3 SPARGING SYSTEM DETAIL
SCALE:NTS

1 SPARGING SYSTEM-NORTH BUILDING ELEVATION
SCALE:NTS

NOTE:
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REVISION

NO.	DATE	DESCRIPTION
	--	--212000
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DRAWN BY: C. JOLLIFF

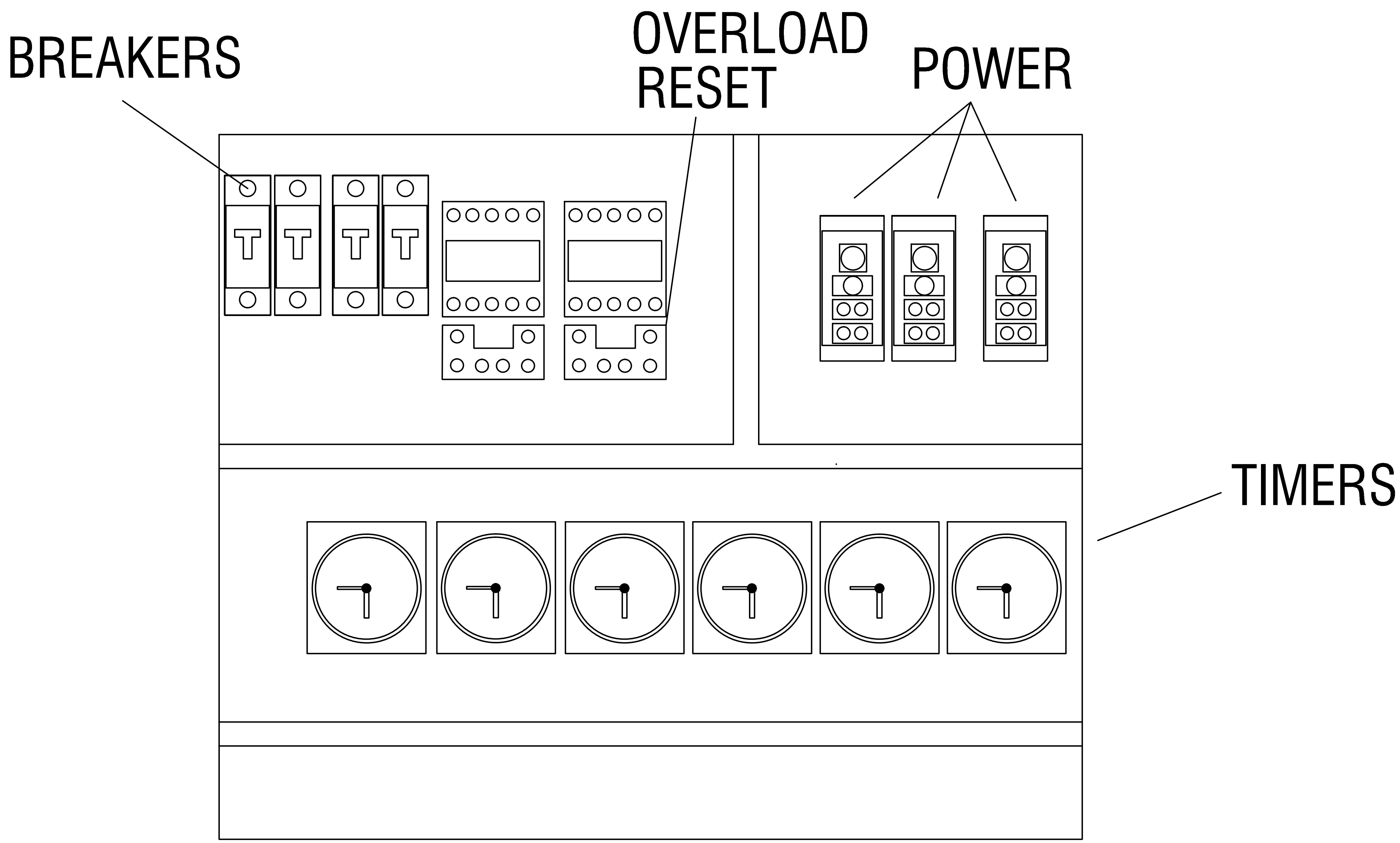
APPROVED BY: J. HEERKENS

ISSUED FOR: -

DATE: FEBRUARY 2015

DRAWING NAME: HENDERSON HARBOR AS BUILT PLAN

FIGURE NO: 002



CONTROL PANEL INTERIOR

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PROJECT/CLIENT
LAKE ONTARIO MARINER'S MARINA
NYSDEC SITE NO. V-00525-6
12548 EASTMAN TRACT
HENDERSON HARBOR, NEW YORK

DRAWING TITLE
AIR SPARGING SYSTEM
CONTROL PANEL

DESIGNED BY: ENVIRO-EQUIPMENT, INC.
DRAWN BY: JMG
REVIEWED BY: DPN
ISSUED FOR: FINAL
DATE: AUGUST 2014

PROJECT/DRAWING NUMBER
207820
003

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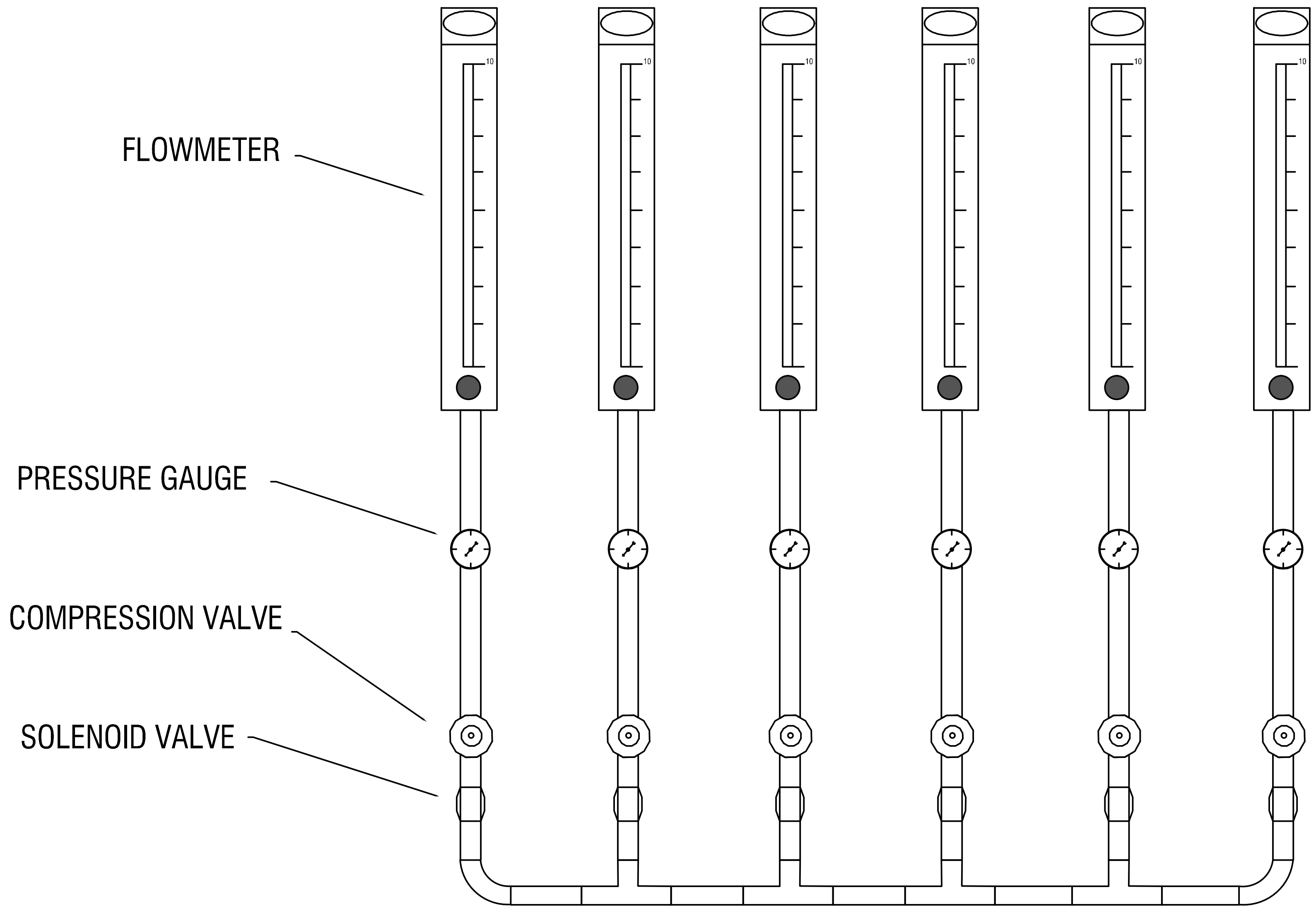

FLOWMETERS

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12548 EASTMAN TRACT
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DRAWING TITLE
AIR SPARGING SYSTEM
FLOWMETERS

ISSUED FOR: FINAL
DESIGNED BY: ENVIRO-EQUIPMENT, INC.
DRAWN BY: JMG
REVIEWED BY: DPN
DATE: AUGUST 2014

PROJECT/DRAWING NUMBER
207820
004

APPENDIX E

"Diagnosis of In Situ Air Sparging Performance Using Transient Groundwater Pressure Changes during Startup and Shutdown", Johnson et al., 2001

Diagnosis of In Situ Air Sparging Performance Using Transient Groundwater Pressure Changes during Startup and Shutdown

Richard L. Johnson,[1] Paul C. Johnson,[2] Tim L. Johnson,[1] Neil R. Thomson,[3] and Andrea Leeson[4**]*

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Abstract: Groundwater pressure measurements during startup and shutdown of in situ air sparging (IAS) systems are used to diagnose air flow behavior below the water table. The magnitude of the pressure response provides insight into the permeability of the zone into which the air is flowing. The duration of elevated pressures during startup and reduced pressures during shutdown indicate the extent to which air is being trapped below the water table by lower-permeability layers. The pressure measurements can be easily and quickly repeated and as a result are useful for both pilot tests and for optimizing operating conditions of existing IAS systems. Whether used alone or in conjunction with other diagnostic tools, pressure measurements are an important tool for assessing IAS performance.

Introduction

The air distribution achieved during in situ air sparging (IAS) is governed by complicated multi-phase flow processes that are very difficult to predict, even with extensive site characterization. As a consequence, a number of approaches for measuring air distribution during initial system operation have been proposed, the two most common being the use of dissolved oxygen measurements and transient pressure transducer responses measured in groundwater monitoring wells. It is the latter that is the focus of this manuscript.

In the last few years, it has become increasingly common to use pressure transducers (rather than water level tapes) to measure groundwater pressure changes during IAS operation. Water level pressure transducers are becoming a common piece of field equipment for many consulting firms, they are easy to employ in the field, and allow nearly continuous data collection. As a result, pressure data are more frequently being used to provide insight to air distributions achieved during IAS (Lundegard and LaBrecque, 1997). As discussed below, transient groundwater pressure changes during start-up and shutdown can be used to assess: (a) the time to reach near-steady air distributions, (b) the cumulative volume of air channels, and (c) qualitative features of the air distribution (e.g., significance of trapped air layers). Figure 1 presents a schematic diagram illustrating the use of pressure transducers to measure transient groundwater pressure changes during IAS startup.

Unfortunately, transient groundwater pressure data can also be misinterpreted. For example, it is common for practitioners to equate the lateral distance at which pressure changes are measured with the extent of the IAS treatment zone. This leads to over-estimation of the IAS treatment zone because: (a) although pressure attenuates with distance, it can theoretically propagate an infinite distance, while the air distribution is finite, and (b) water level pressure changes tend to propagate in a more radially symmetric manner than the air actually does. In addition, water level rises (and drops) in piezometers have often incorrectly been equated to formation water level changes, rather than simply being measurements of groundwater pressure change.

This manuscript focuses on the use of transient groundwater pressure measurements as a diagnostic tool for characterization of air distributions during IAS

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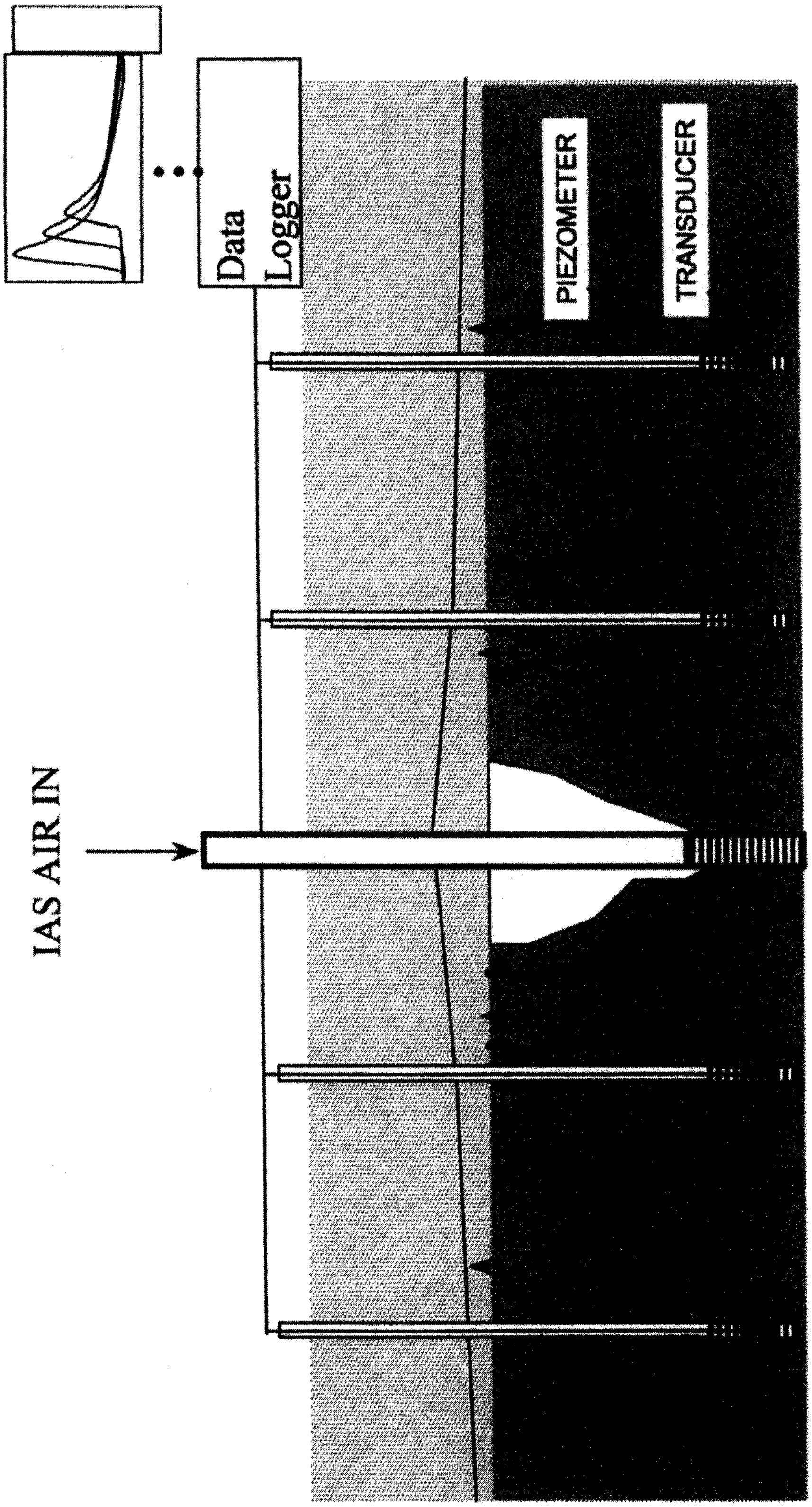

Figure 1. Schematic drawing of water pressure measurement during IAS startup.

operation. To help develop insight into the use and limitations of this tool, a simplistic conceptual model is first presented followed by examples of measurements collected during IAS start-up and shut-down at four field sites.

Current Conceptual Model of IAS Startup in a Near-Homogeneous Aquifer

During IAS start-up and shutdown, there are a number of operational parameters that can be controlled, including the injection well pressure and air flowrate. In the following discussion, it is assumed that the injection well pressure is being set at some predetermined value that is sufficient to achieve air flow into the aquifer.

A simple conceptual model for IAS start-up in homogeneous media is shown in Figure 2. As the air injection pressure is increased in the air injection well, groundwater is displaced from the well into the formation. Once the air injection pressure exceeds the hydrostatic head of groundwater above the top of the well screen, air flows out into the formation and continues to displace groundwater. Because groundwater is flowing away from the air injection well, a pressure gradient directed away from the air injection point is established; therefore increases in groundwater pressure are observed, with the pressure changes attenuating with distance away from the air injection well. The extent and rate of the groundwater pressure rise reflects the permeability of the aquifer and the air injection pressure (and air flowrate).

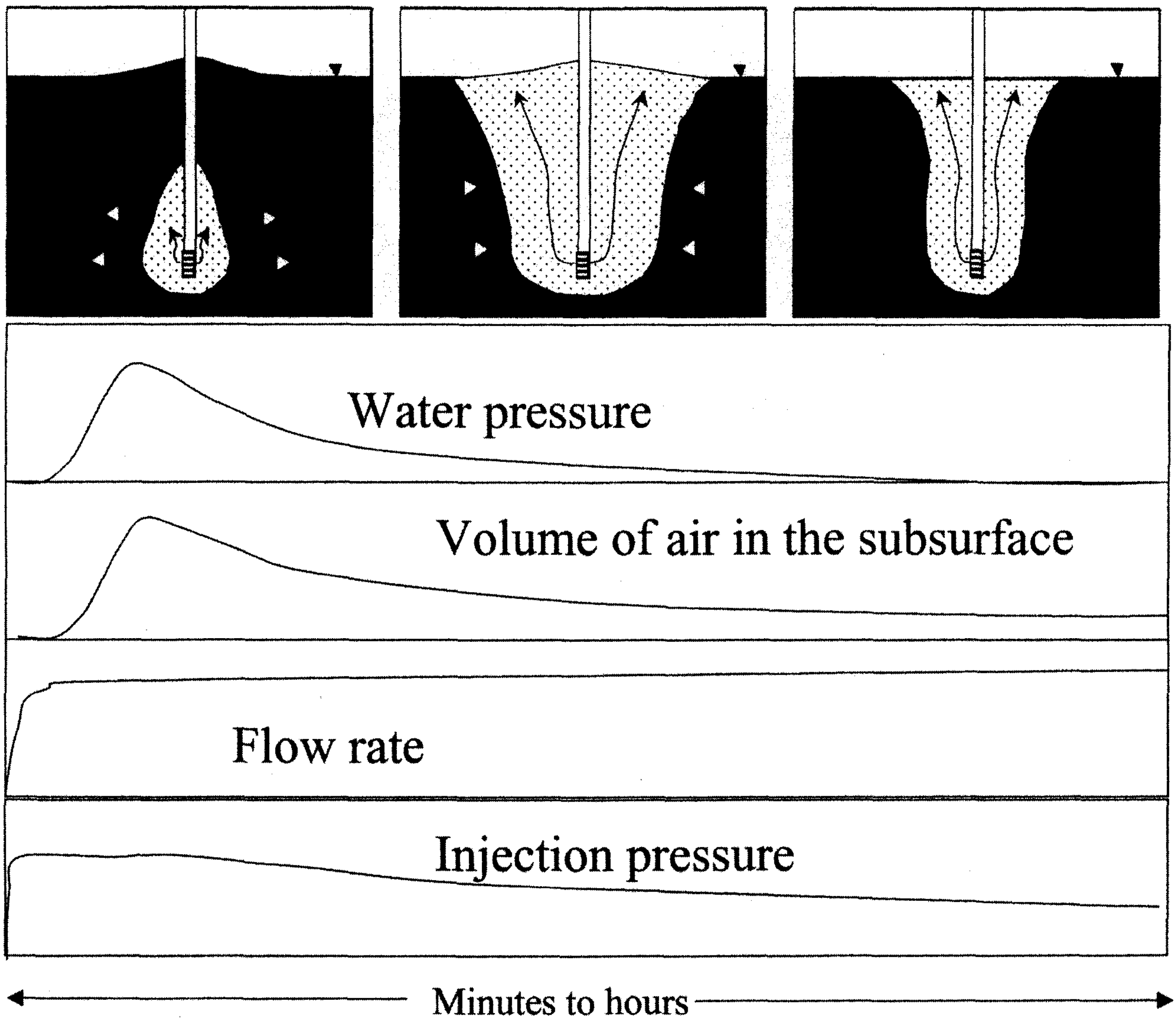

Figure 2. Simple conceptual model for IAS startup in homogeneous media.

After a very short period of more-or-less outward flow, buoyancy forces will cause the air to migrate upward (as well as possibly continuing to move outward). The volume of air found below the water table will continue to increase until the air reaches the water table and is "vented" to the vadose zone. At this point, the groundwater pressure passes through a maximum value and begins to drop back toward the pre-sparge hydrostatic level. In some cases, there is probably also a "deflating" of the air zone below the water table, as the injected air now only follows those paths that are continuous between the injection well and the vadose zone. After some period of time (e.g., probably minutes in a homogeneous isotropic aquifer), a balance is reached between the volume of air being injected and the flow to the vadose zone. At a macroscopic scale, this would correspond to steady-state air flow.

Conceptual Model of IAS Startup in a Stratified Aquifer

In stratified media, the upward movement of air to the water table is likely to be impeded or stopped by the presence of lower permeable layers (Figure 3). In these cases, there can be a significant accumulation of air below finer-grained strata; and this accumulation can be transient or permanent. As accumulation of air occurs the groundwater pressure continues to to be elevated. The extent to which this elevated pressure is measured depends on the locations of the measurement points relative to this injection well and the strata.

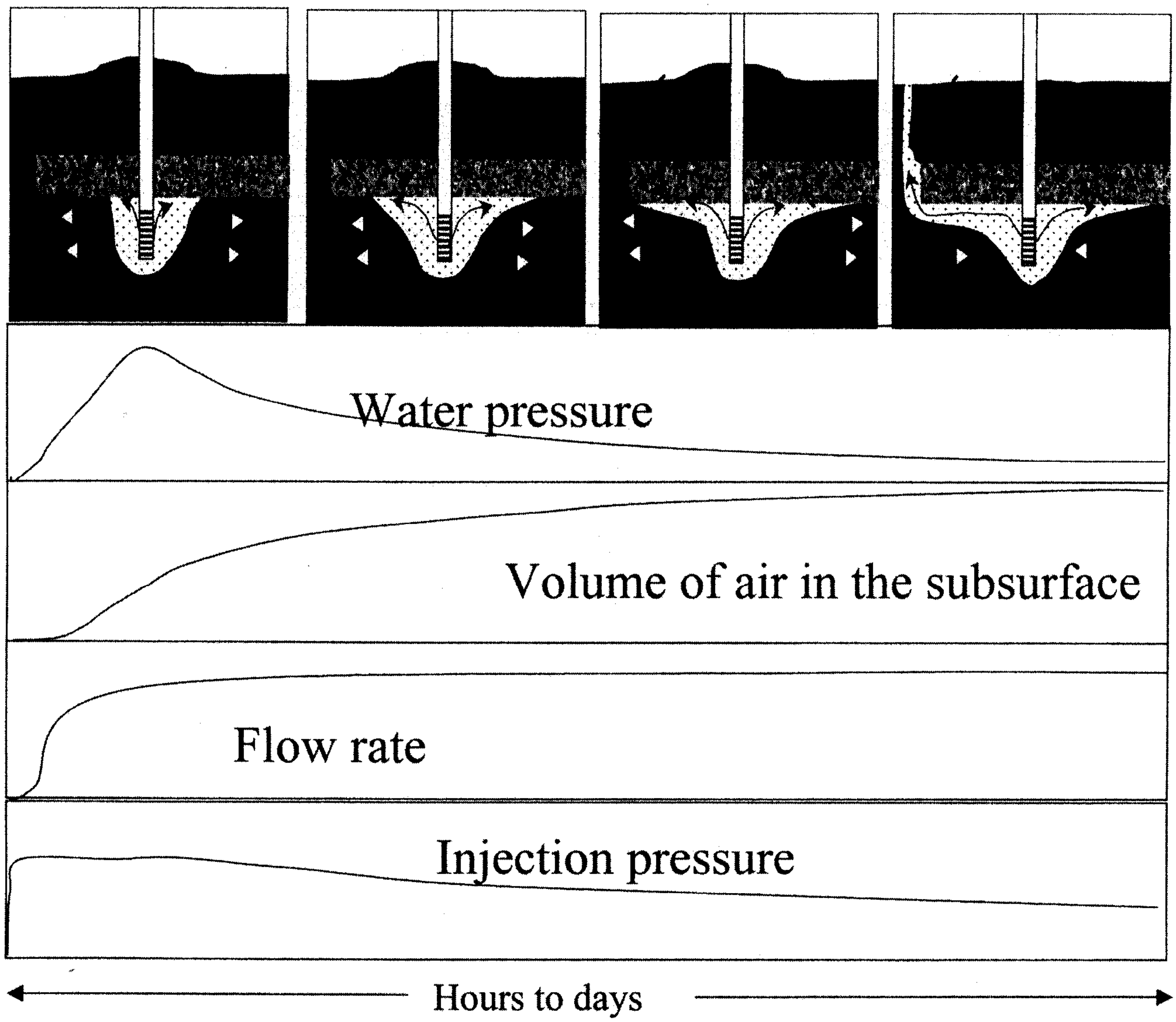

Figure 3. Simple conceptual model for IAS startup in a stratified aquifer.

At some point, the volume of air flowing through or going around those confining strata will become equal to the injection rate and the macroscopic air distribution will reach steady state. This decline to pre-start-up conditions generally occurs at a much slower rate than in near-homogeneous settings.

Conceptual Model of IAS Behavior During Shutdown

Whenever air injection is stopped, water will spontaneously begin to displace the air out of the groundwater zone (Figure 4). As groundwater is now flowing toward the air injection well and there must be a groundwater pressure gradient toward the well, the groundwater pressure decreases and remains below the initial hydrostatic pressure while the air volume is decreasing. As with system startup, the magnitude and rate of the hydrostatic pressure change in the formation is related to permeability (and the initial volume of displaced groundwater). For a near-homogeneous aquifer, this process is usually completed in minutes to a few hours. For a stratified aquifer, the process can go on for several hours or even days. At the conclusion of the process, there will be some residual air remaining in the formation as the result of entrapment by various mechanisms.

Transient Groundwater Pressure Measurements as a Diagnostic Tool for IAS Air Distributions

Because IAS involves complex, two-phase processes, and because there are a wide range of subsurface conditions found at contaminated sites, it is difficult to predict the subsurface air distribution, and the best approach is to use a suite of diagnostic tools. The transient pressure diagnostic tool described here compliments other field measurement techniques (e.g., helium tracer tests, dissolved oxygen measurements, or geophysical measurements) and can be used both as "red flag" indicators of IAS infeasibility during pilot tests and to assess changes in system operation.

The complexity of the processes governing air distributions and their sensitivity to subtle changes in subsurface conditions makes quantitative analysis of transient pressure transducer response data difficult at best. However, the experience at field sites discussed below leads us to conclude that this data can still be valuable, even if detailed quantitative analysis not possible at this time. For example:

1. The length of time over which the groundwater pressure remains above the pre-sparge hydrostatic value after IAS startup provides valuable insight to qualitative features of the air distribution. If the groundwater pressure remains above the pre-sparge hydrostatic value for many hours or days, this indicates that a significant volume of air is accumulating beneath lower-permeability strata and significant lateral air migration may be occurring. Conversely, a very short transient pressure response (e.g., minutes) may indicate that air flow is occurring within a fairly limited distance of the injection well, or even short-circuiting up the injection well annulus. As a result, in either case, air may not be reaching the desired treatment zone and/or lateral migration may carry contaminants to off-site receptors.
2. The duration of elevated groundwater pressure can also help to establish the time frame for pulsing of air in the IAS well. As part of the Design Paradigm described by P.C. Johnson et al. (2001), pulsed air flow is recommended for IAS operation. Pulsed air flow has been demonstrated to improve contaminant mass removal from groundwater via volatilization (P.C. Johnson et al., 2001). The pattern of pressure response immediately after IAS startup provides a good indication of the length of time required for a pulse of air to propagate through the treatment area, thereby providing the practitioner a starting point for determining a pulse cycle.
3. The magnitude of the groundwater pressure pulse can also be used to assess subsurface conditions. In general, small, short-duration increases in pressure during startup indicate that the permeability of the aquifer is high, while higher-pressure values generally suggest lower permeability. The magnitude and duration of pressure pulses can be used together to assess air distribution. For example, if both the magnitude and duration of pressure increases are small, this can indicate a limited radius of influence of the air around the well. Conversely, pressures approaching the overburden pressure and that are sustained for periods of hours are a clear indication that the air is stratigraphically trapped. In this case, the potential exists for extensive lateral migration of the air or even pneumatic fracturing. Most sites fall somewhere between these two examples, and the practitioner must evaluate the pressure data together with data from other air distribution indictors to determine whether IAS is feasible.

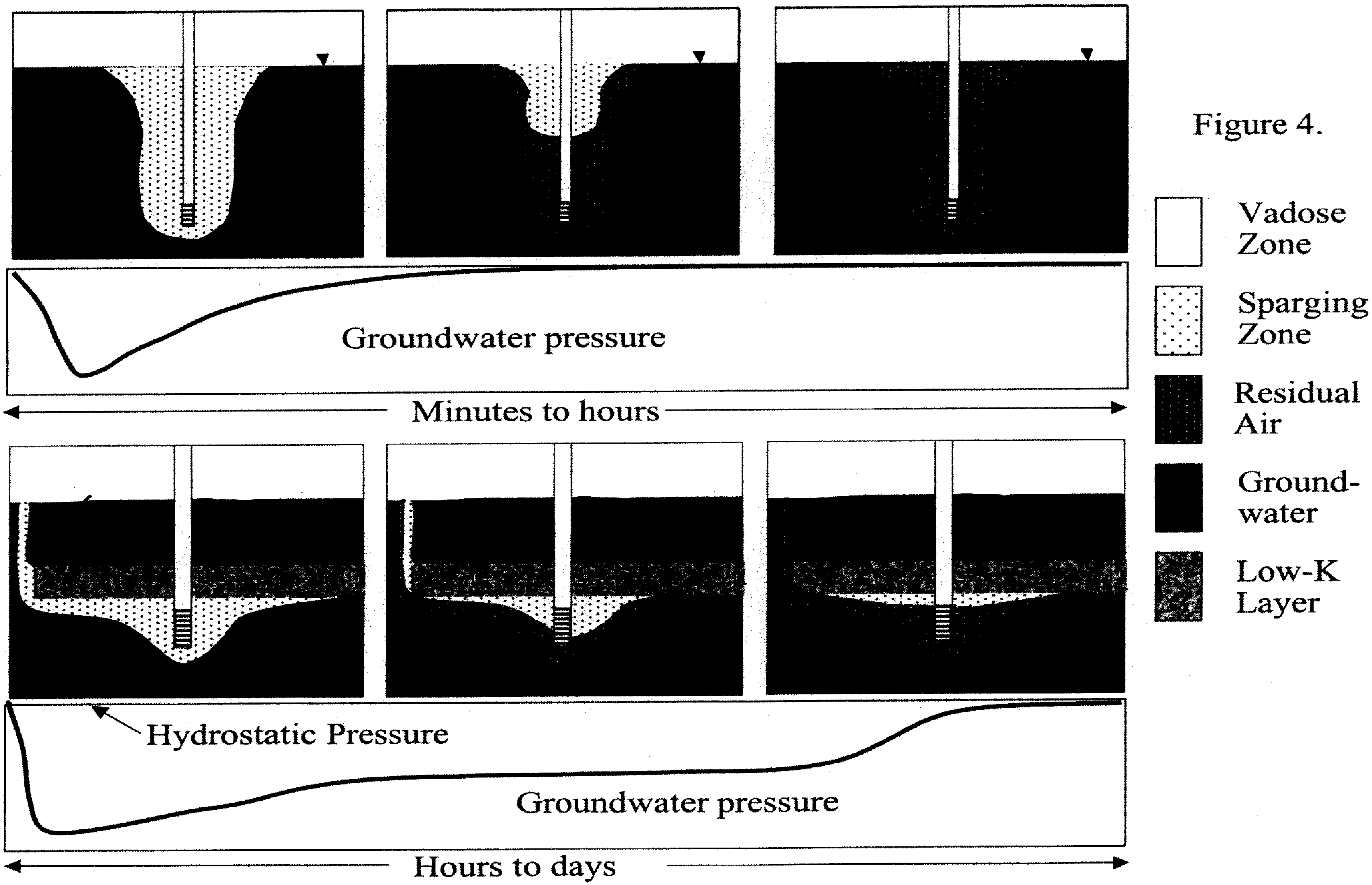

Figure 4. Conceptual model of IAS behavior during shutdown.

Results and Discussion

IAS startup and shutdown transient groundwater pressure data for four sites is examined here. The sites span a range of operating conditions (e.g., one to four IAS wells and injection rates from 5 to 20 standard cubic feet per minute [scfm]). Most sites are located in relatively permeable media that ranges from homogeneous sands and gravels to a site with extensive clay strata. The sites (in approximate order of increasing stratification) include: (1) Eielson Air Force Base (AFB), Alaska; (2) Port Hueneme, California; (3) Canadian Forces Base (CFB) Borden, Ontario, Canada; and (4) Hill AFB, Utah.

Example 1: Eielson AFB, Alaska

The lithology of the Eielson AFB site consists of a layer of sandy loam overlying a 200- to 300-ft-thick sequence of sand and gravel. In the vicinity of the IAS well, the thickness of the sandy loam is approximately 8 ft, which is also the depth to groundwater. IAS wells were installed at two depths at the site. The top of the well screen for the shallow well was approximately 4 ft below the water table, and for the deep well it was approximately 10 ft below the water table. Monitoring wells were installed at distances of 10, 20, and 30 ft from the well, and were screened from the water table to a depth of 10 ft. A schematic diagram of the Eielson AFB test plot is shown in Figure 5. Air was injected at

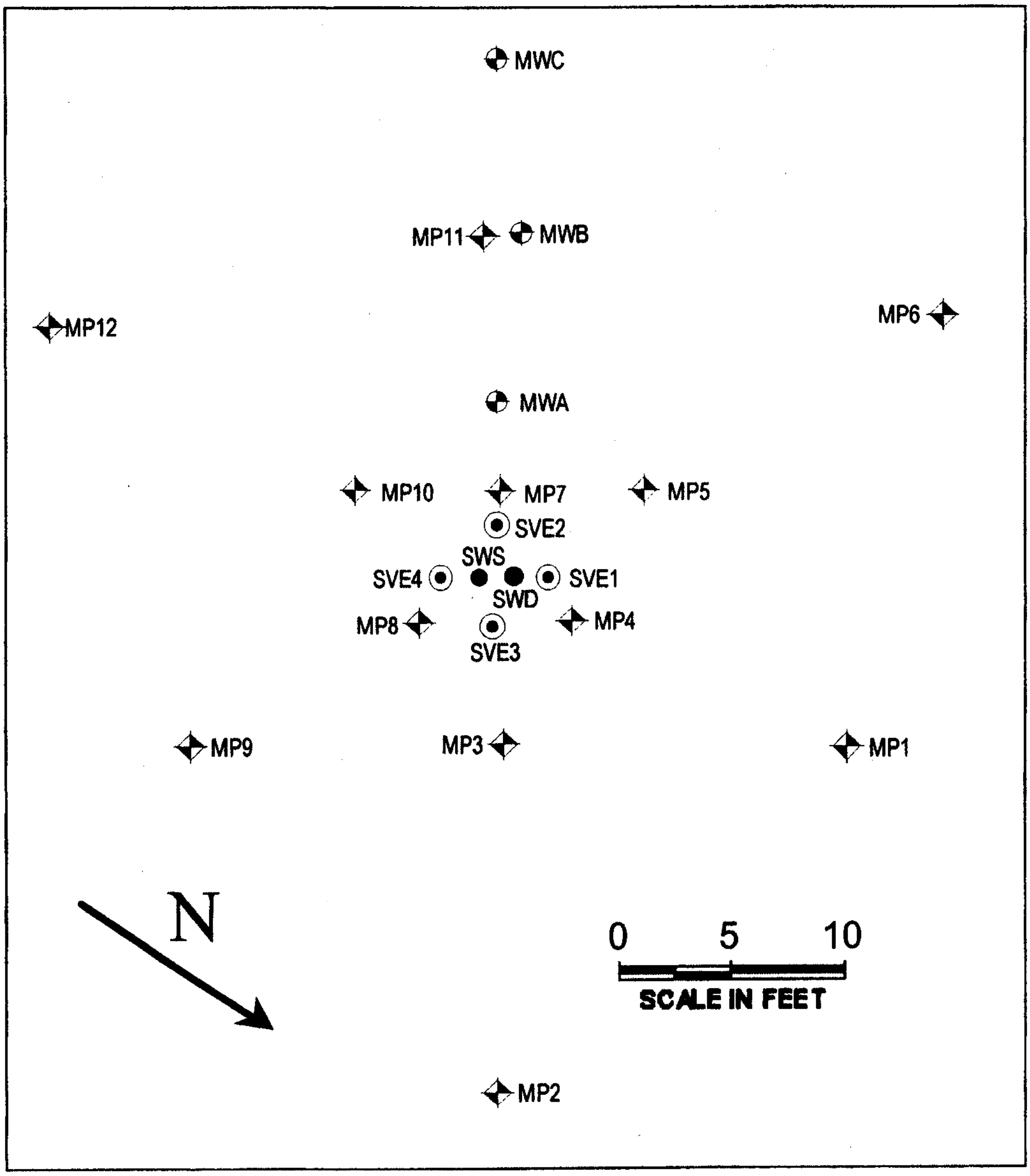

Figure 5. Schematic diagram of the test Plot, Eielson AFB, AK.

5 scfm in the shallow well and 10 scfm in the deeper well.

The groundwater pressure response to the injection of air into the shallow IAS well at a rate of 5 scfm is shown in Figure 6A. The pressure changes are very small (e.g., <1 cm water), indicating a very high permeability at that depth. Injection at 10 scfm into the deeper well (Figure 6B) shows an order of magnitude larger pressure increase than at the shallow depth; however, the absolute value is still relatively small (e.g., <10 cm of water), indicating that the aquifer is relatively permeable. Groundwater pressure curves for IAS shutdown at the two flowrates (Figures 6C and 6D) are similar in magnitude to the startup values. Also, the pressure data return to near-hydrostatic values within about an hour of startup and shutdown. This suggests that there was minimal stratification in the aquifer and that lateral migration of air will probably not be a problem at this site. However, pressure data alone cannot assess the lateral extent of the air distribution at this or most other sites. As a consequence, the pressure data are best used in conjunction with other diagnostic data.

Example 2: Port Hueneme, California

The pressure data reported here for Port Hueneme were collected at a site that is similar to and located approximately 100 m from the site described in Bruce (2001). The unconfined aquifer at the site consists of mildly stratified sands with hydraulic conductivities ranging from approximately 0.002 to 0.02 cm/s (Figure 7). The sparge well for these tests was screened from 4.8 to 5.1 m below ground surface (bgs). The water table at the site ranges from about 2.4 to 3 m bgs. Groundwater pressure data were collected from four 2-inch water table monitoring wells with screen intervals at approximately 1.5 to 6 m bgs and located at distances of 4.6 to 9.1 m (15 and 30 ft) from the sparge well (wells MW1, MW2, MW4, and MW5 in Figure 8). The air injection rate was approximately 0.27 m^3/min (10 scfm).

Pressure measurements following system startup and shutdown for two of the wells are shown in Figure 9. As can be seen, pressure fluctuations were on the order of tens of centimeters of water and the durations of the changes were on the order of 100 min, suggesting that steady flow had been established by that time. As a result, the IAS system at the site was operated in

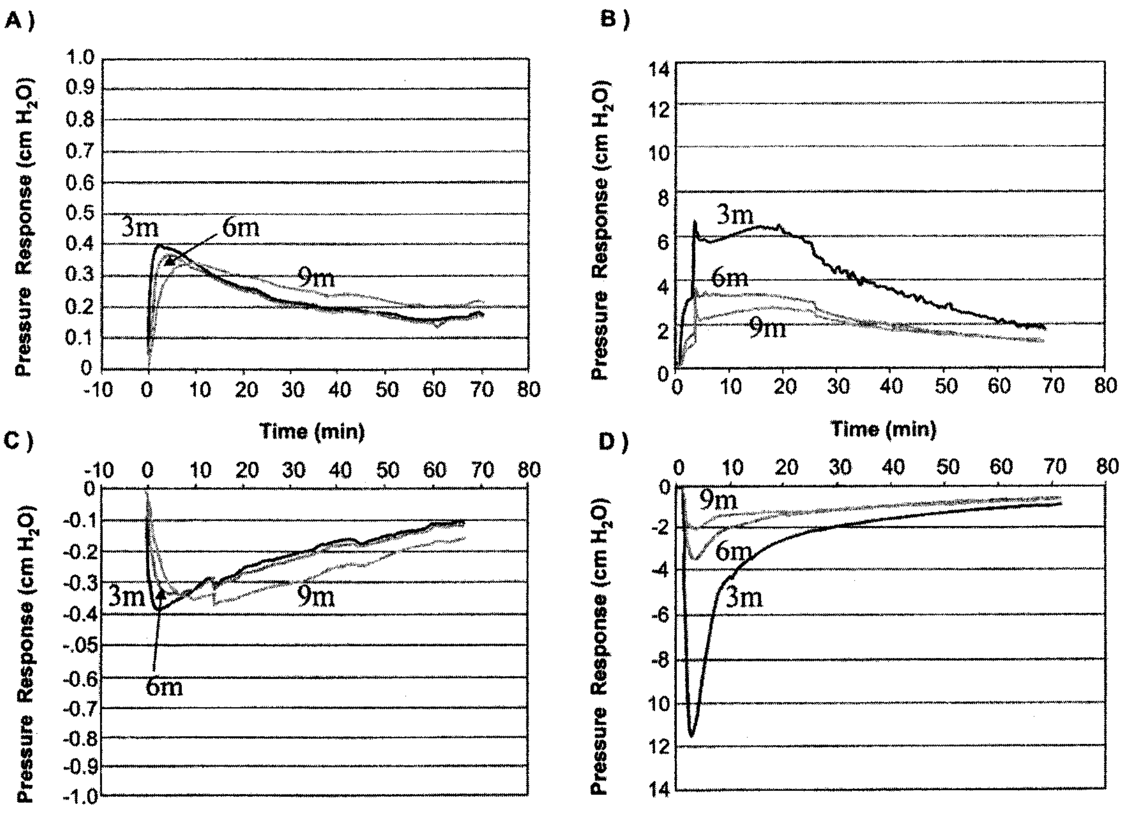

Figure 6. Pressure testing: (A) pressure response at initiation of air injection into the shallow well; (B) pressure response at Initiation of air injection into the deep well; (C) pressure response at discontinuation of air injection into the shallow well; (D) pressure response at discontinuation of air injection into the deep well; Eielson AFB, AK.

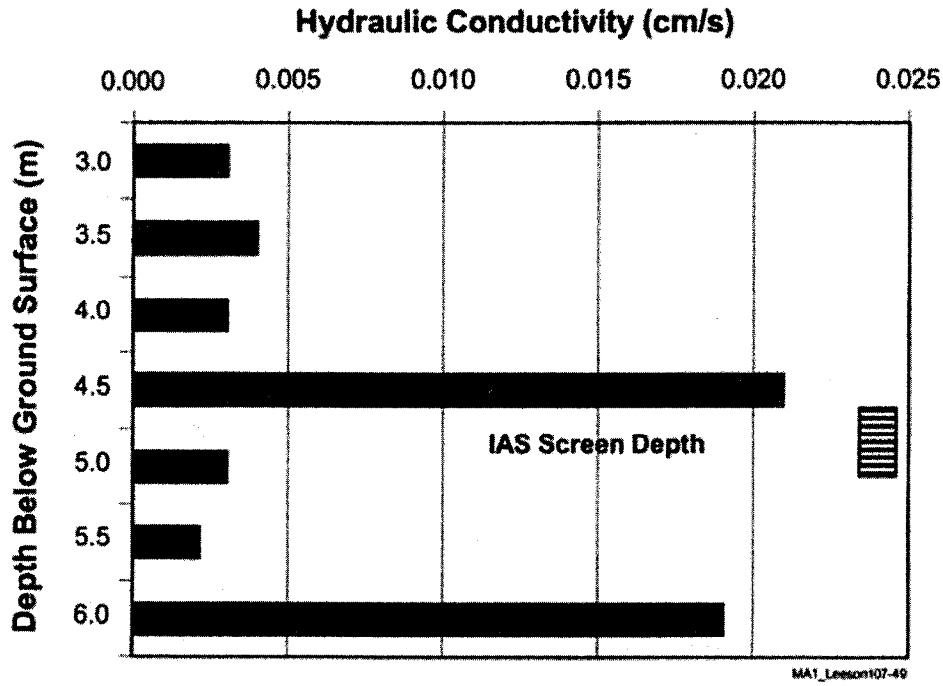

Figure 7. Hydraulic conductivity versus depth, Port Hueneme, CA.

a pulsed mode with a cycle of 3 h on and 3 h off. The pressure response in the four groundwater monitoring wells during pulsed operation is shown in Figure 10.[1] As shown, the pulse cycle of 3 h on, 3 h off allows for pressure measurements to return to near hydrostatic measurements before the initiation of the next pulse cycle.

Example 3: CFB Borden, Ontario

As described in Tomlinson et al. (2002), a range of IAS diagnostic tests was conducted at the CFB Borden site. The site consists of medium sand (average hydraulic conductivity of approximately 0.005 cm/s) and is composed of many small-scale beds or lenses with dimensions of a few centimeters in thickness and a few meters in areal extent. Unlike the other sites examined here, the vadose zone at the site had been removed so that the water table was just above ground surface. Air was injected into one of three IAS wells (Figure 11) and the pressure was monitored with pressure transducers in five piezometers.

The pressure data in Figure 12 were collected when air was injected into IAS2 at a rate of 5 scfm (0.135 m^3/min). As can be seen in the figure, the pressure quickly increased by up to 40 cm of water. The pressure remained significantly elevated for 6 hours until airflow was stopped. This indicated that during that period the volume of air was continuing to increase in the subsurface. Because the water table was above ground surface, the arrival of air at the water table could be observed as bubbles in the standing water. No significant air flow at the surface occurred for the first 30 min after sparging was initiated.

It is instructive to examine in detail the pressure changes during the first 30 min of sparging. Figure 13 shows that the pressure at all of the monitoring points began to rise in the first minute or two. For the point closest to the sparge well (p3-1), the pressure reached a maximum and began to fall after about 7 min (even though no air had reached the water table, which is in contrast to the conceptual model discussed above). The monitoring points that were 10 ft (3 m) away (p4-1 and p4-2) also reached a maximum in that same interval, but decreased at a slower rate. This was particularly true for the deeper point (p4-2), which had decreased only about 20% from the maximum value after 30 min. The two points at 20 ft (p5-1 and p5-2) did not go through a maximum during the first 30 min, but continued to rise over the whole interval. These data point out the complexities associated with interpreting pressure data in stratified media, particularly in the absence of other corroborating information. Never-

[1] It is useful here to comment on pressure responses in water table monitoring wells and piezometers. Piezometers reflect actual pressure changes in the groundwater at the depth of the well screen. Pressure responses in water table monitoring wells are more complicated in that water can move between the capillary zone and the well, thus pressure changes do not necessarily reflect groundwater pressure chances and can reflect actual transient changes in water table level in the immediate vicinity of the well.

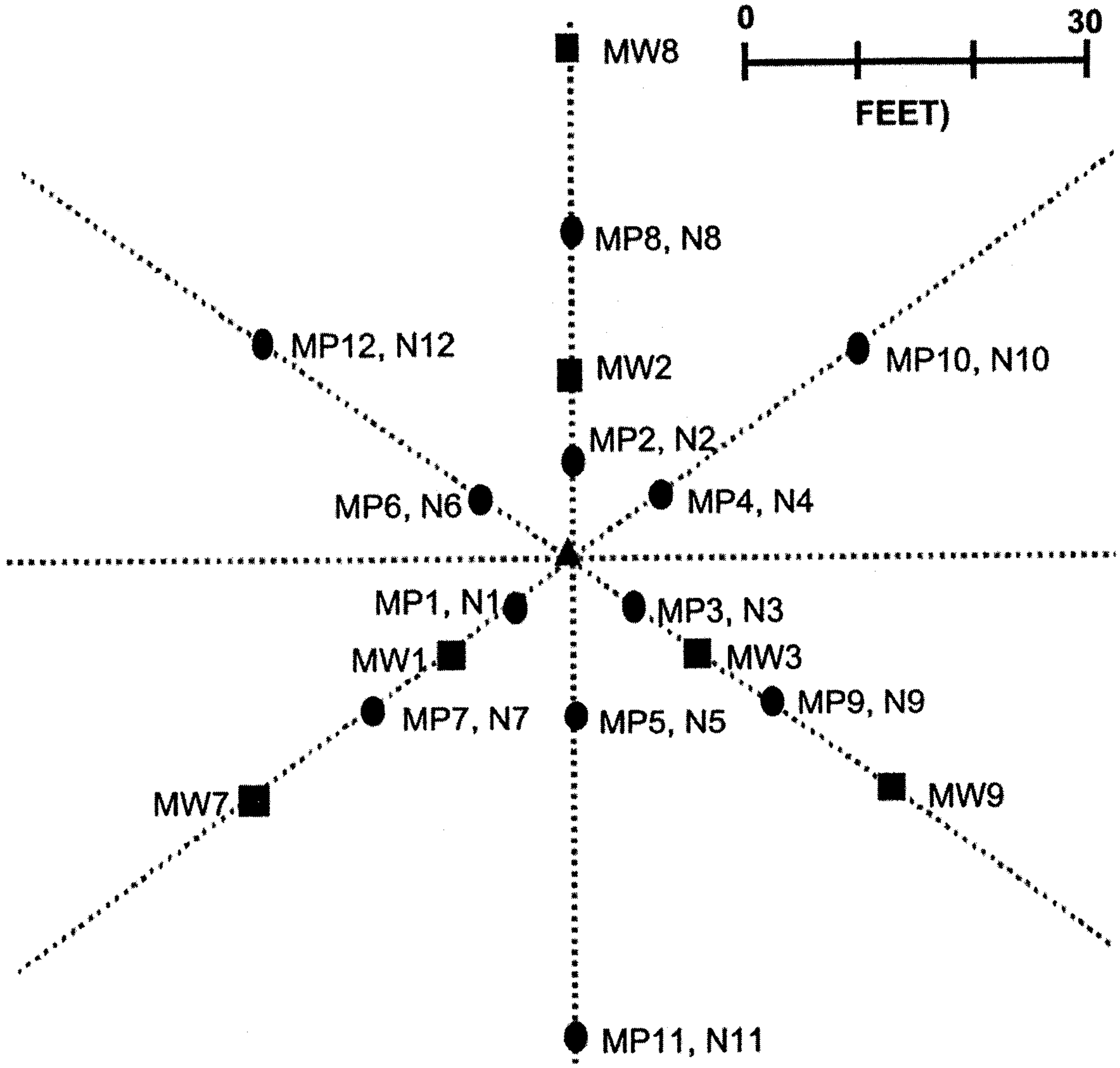

Figure 8. Site layout, Port Hueneme, CA.

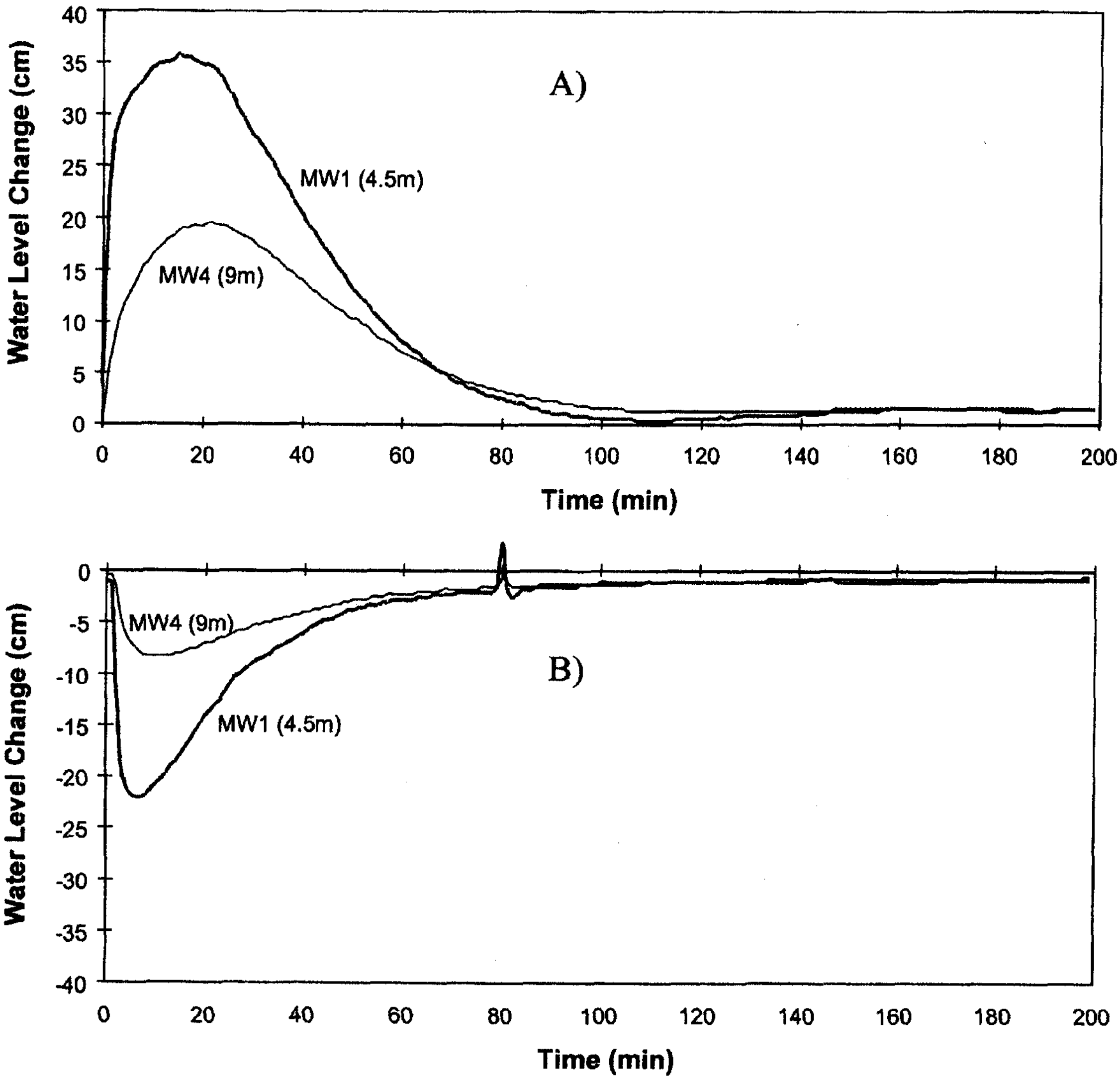

Figure 9. Pressure measurements following system (A) startup and (B) shutdown for monitoring wells MW1 and MW4, Port Hueneme, CA.

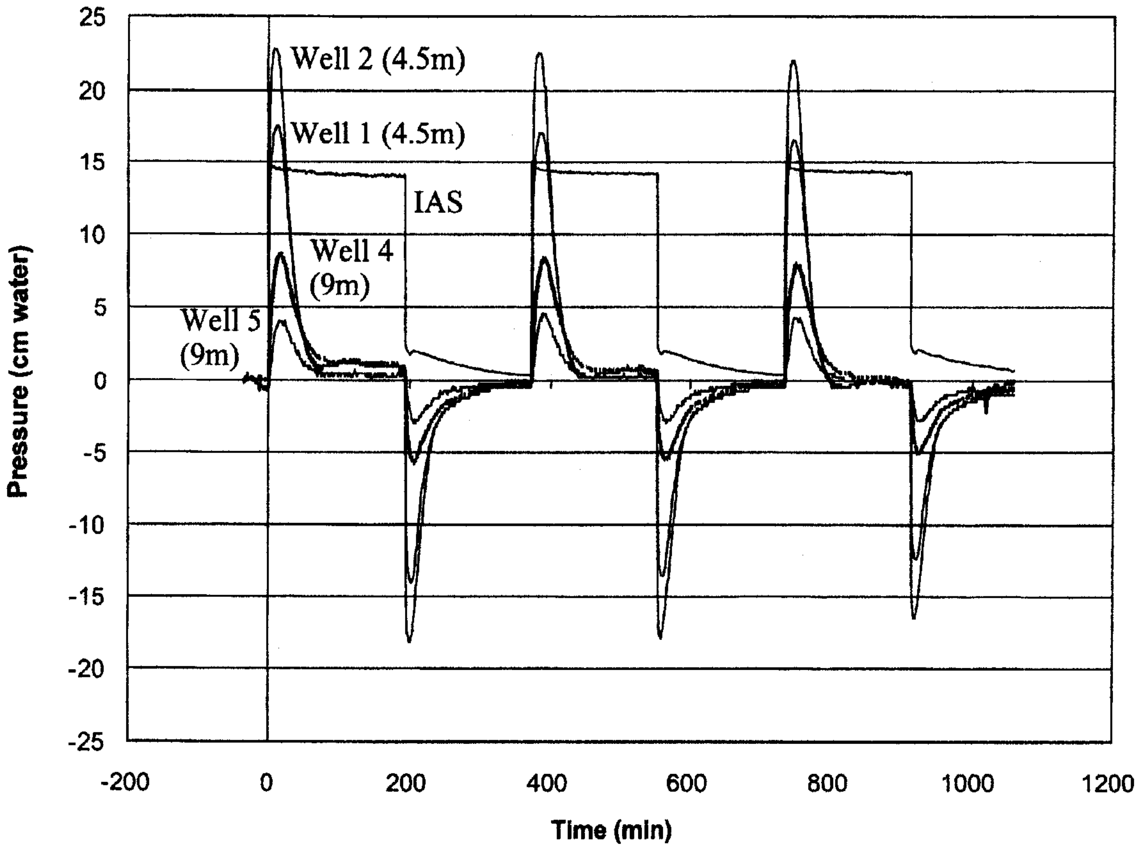

Figure 10. Pressure measurements during pulsed operation, Port Hueneme, CA.

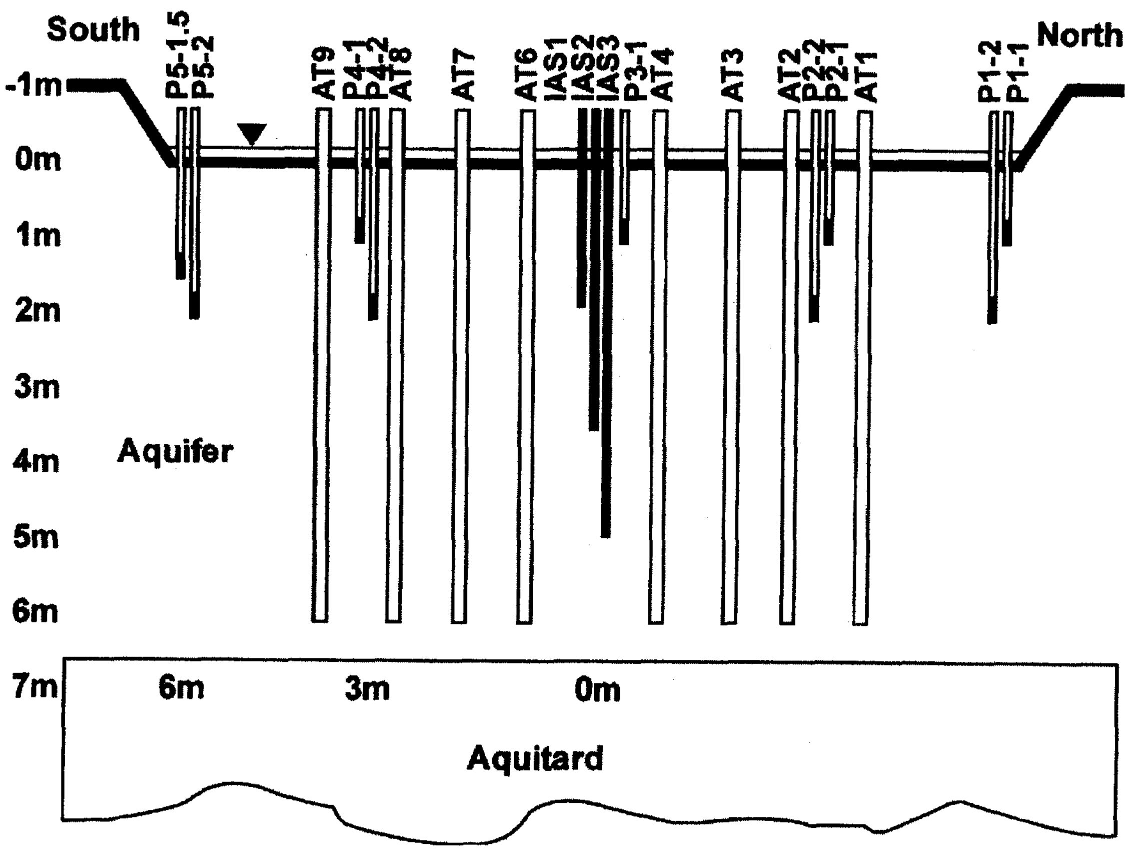

Figure 11. Site layout at CFB Borden, Ontario. (Adapted from Tomlinson et al., 2002.)

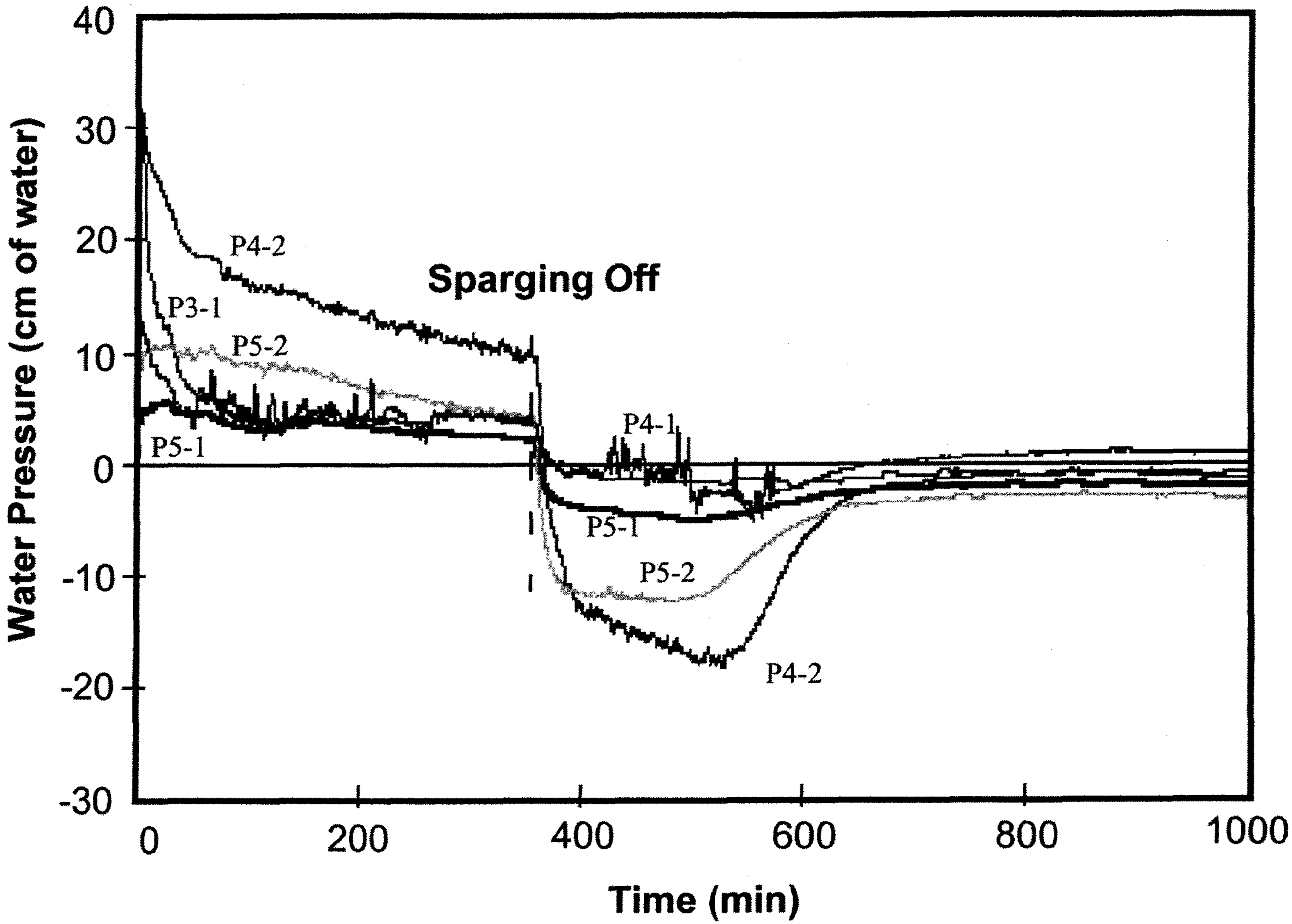

Figure 12. Pressure response versus time, CFB Borden, Ontario. (Adapted from Tomlinson et al., 2002.)

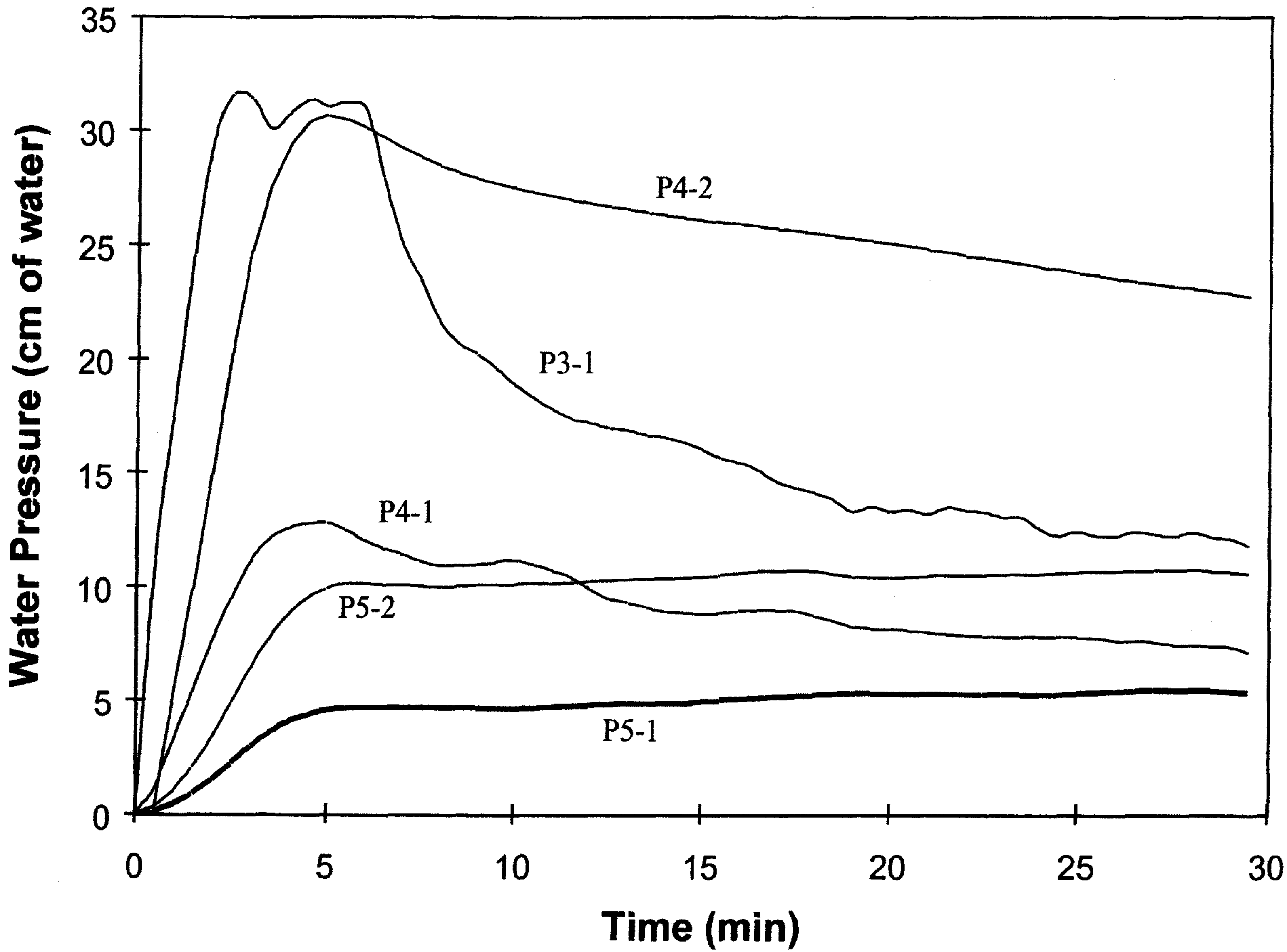

Figure 13. Pressure response versus time during the First 30 min after initiation of air injection, CFB Borden, Ontario.

theless, the period over which the pressure is elevated does clearly indicate that a substantial volume of air was accumulating below the water table.

Following cessation of air injection, the groundwater pressure dropped and remained below the hydrostatic value for approximately 4 h. During that period air continued to flow out of the saturated zone (as evidenced by bubble flow at the surface). Prior to cessation the air flow at the surface appeared quite steady, and when injection stopped the flow to the water table continued with little if any change. The air flowrate at the water table was estimated as a function of time following cessation and is shown in Figure 14. Based on that data, the volume of trapped air was estimated to be approximately 28 m^3, which corresponds to about 200 min of injection at 5 scfm. At this site, the entrapped air may have had a significant impact on hydraulic conductivity at the local scale (Tomlinson et al., 2002)

Example 4: Hill AFB, Utah

The water-bearing zone at Operable Unit (OU)-6, Hill AFB is composed primarily of sands and silty sands. It is overlain by silt with beds of sand and clay. The interface between these two is near the current water table at approximately 105 ft below ground surface (Figure 15). A line of four sparge wells with co-located soil vapor extraction (SVE) wells was placed across a portion of a dissolved trichloroethene (TCE) plume that was exiting the base boundary (Radian, 1995). In addition, nests of monitoring wells were distributed around the treatment zone. The locations of the wells are shown in Figure 16. The total injection rate was approximately 50 scfm for the four wells.

Groundwater pressure increases in excess of 300 cm were observed at the wells closest to the injection well. Pressure increases of nearly 200 cm were observed even at a distance of 130 ft (Figure 17). The pressures remained elevated for nearly 2 days, until the sparging system was turned off. This is indicative of an extensive layer that is effective at preventing upward migration of the air and is consistent with the helium tracer data for the site (R.L. Johnson et al., 2001). Vertical permeability was measured using intact soil cores from the site in a constant-head permeameter. The data are shown in Figure 18 and indicate that there is a very high conductivity layer at about 125 ft bgs and that the conductivity decreases by several orders of magnitude in the upper portions of the saturated zone. If the lower-permeability layer is extensive, then this permeability contrast would be sufficient to cause the stratigraphic entrapment of the air inferred from the pressure data.

At this site, the bulk of the contaminated groundwater lay below the confining layer so the sparge air was able to be reasonably effective at removing contaminants. However, the system was not capable of lowering concentrations to the drinking water limit (5 mg/L for TCE in this case). Furthermore, there is some concern that the large volume of air trapped below the water table may have had a significant impact on the water permeability of the aquifer (as was seen, for example, at the CFB Borden site) and could have caused part of the plume to be diverted around the treatment zone.

Conclusions

For many sites, groundwater pressure responses during startup and shutdown provide important insight into air movement below the water table. If lag times of hours to days are required for groundwater pressures to return to within a few cm of water of pre-sparge hydrostatic values, this indicates that there is significant stratigraphic trapping of air. Stratigraphic trapping can be either good or bad, depending where the confining layer is located relative to the zone to be treated and to risk pathways. For many sites, some degree of stratification is necessary to increase the width of the treatment zone to a scale that makes sparging practical. However, too much stratification can cause excessive lateral migration or it may prevent the sparge air from reaching the treatment zone.

In general terms, the magnitude of pressure responses during startup and shutdown can be viewed as proportional to air flowrate and inversely proportional to aquifer permeability. However, there is currently no overall modeling framework that allows the magnitude of the pressure responses to be directly related to unique characteristics of the aquifer and/or air distribution.

Because pressure measurements are easy and rapid to collect, they are a useful component of pilot tests, where they can act as a "red flag" for IAS infeasibility. They are also useful for evaluating system operating parameters (e.g., pulse cycle times, air flowrates) because the tests can be repeated quickly following changes in system parameters. In either case, the pressure data are best used in conjunction with other diagnostic tools, which collectively can present an overall picture of IAS performance.

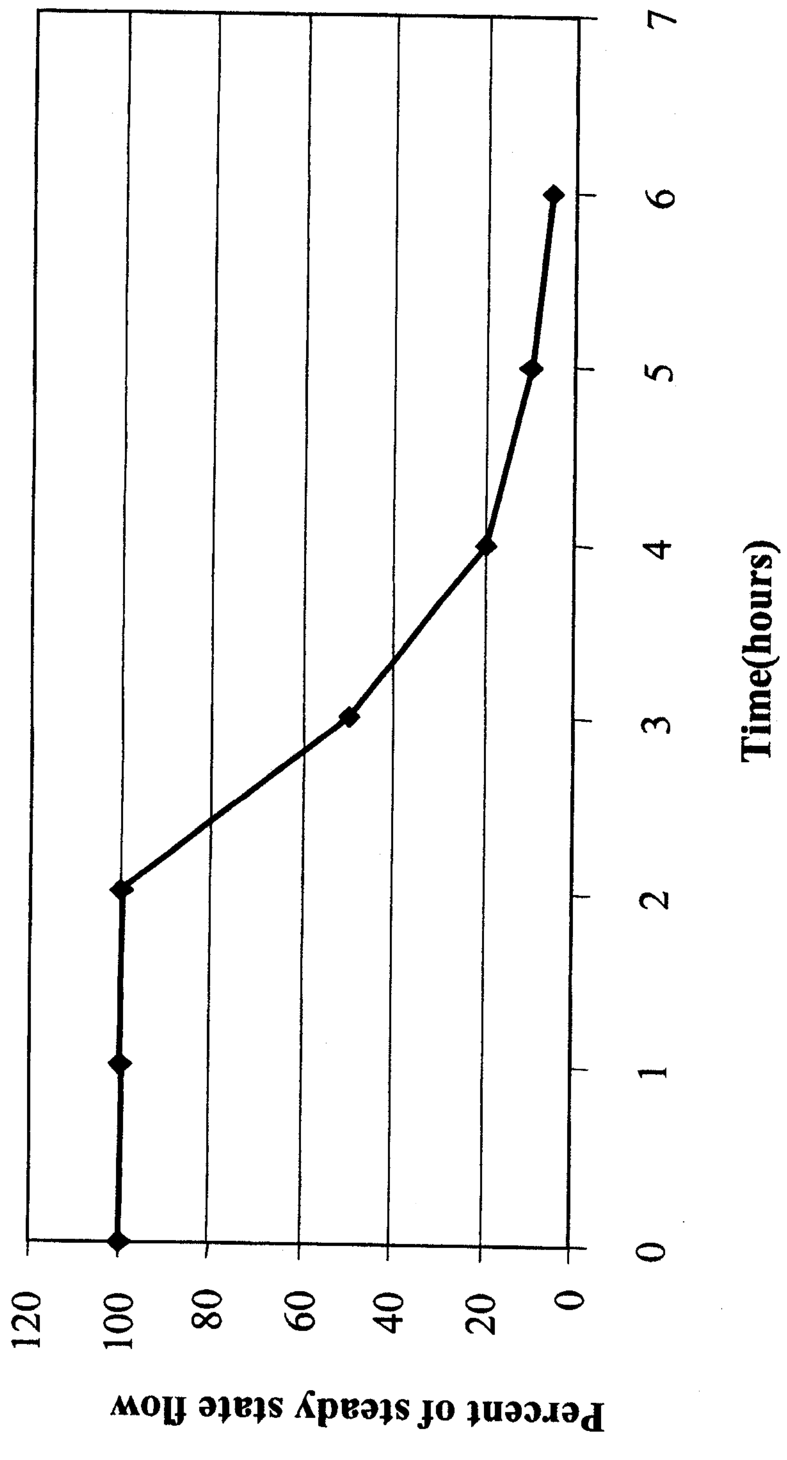

Figure 14. Air flowrate at water table versus time, CFB Borden, Ontario.

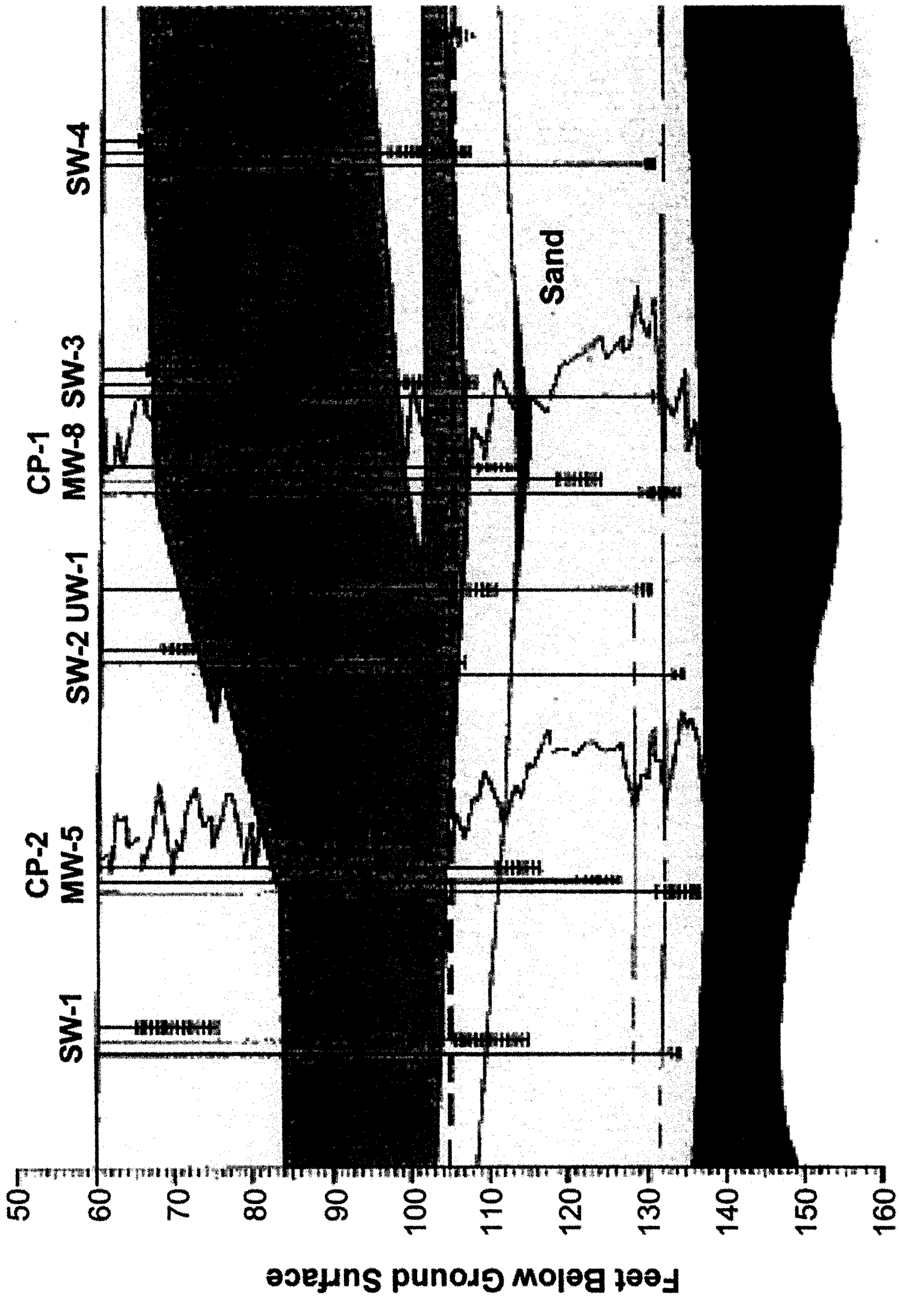

Figure 15. Site hydrogeology, Hill AFB, Utah.

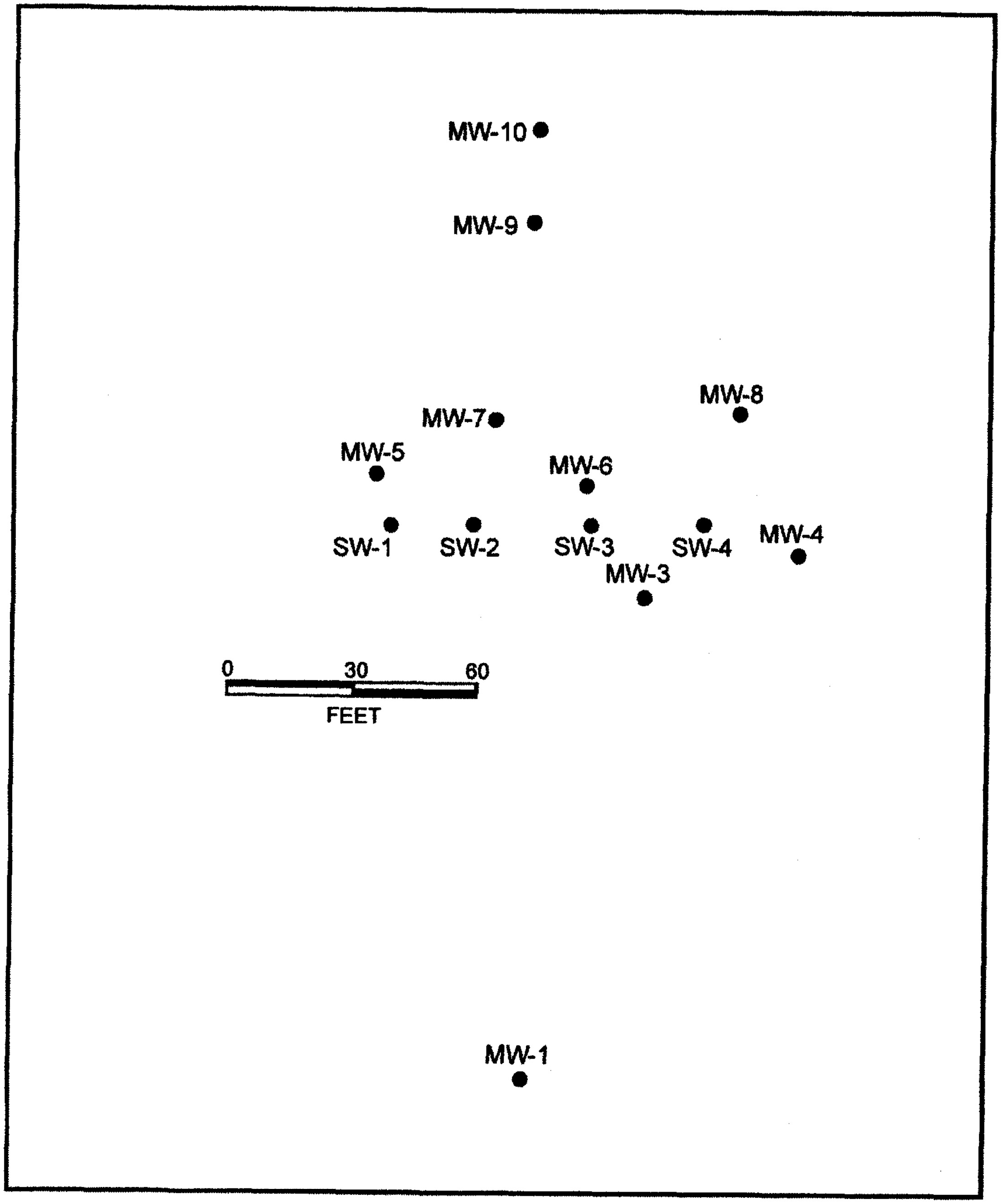

Figure 16. Site layout, OU-6, Hill AFB, Utah.

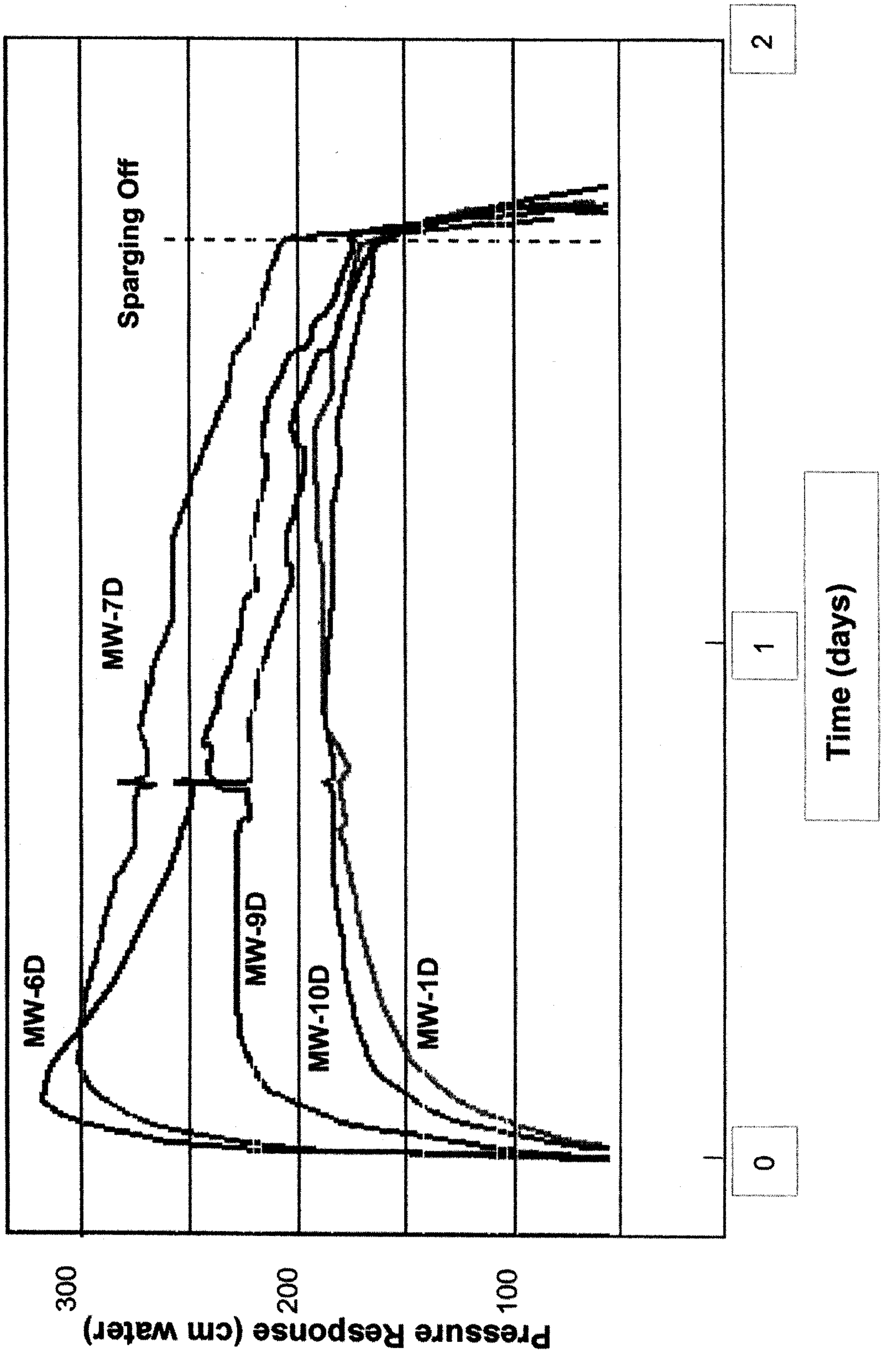

Figure 17. Pressure response versus time, Hill AFB, Utah.

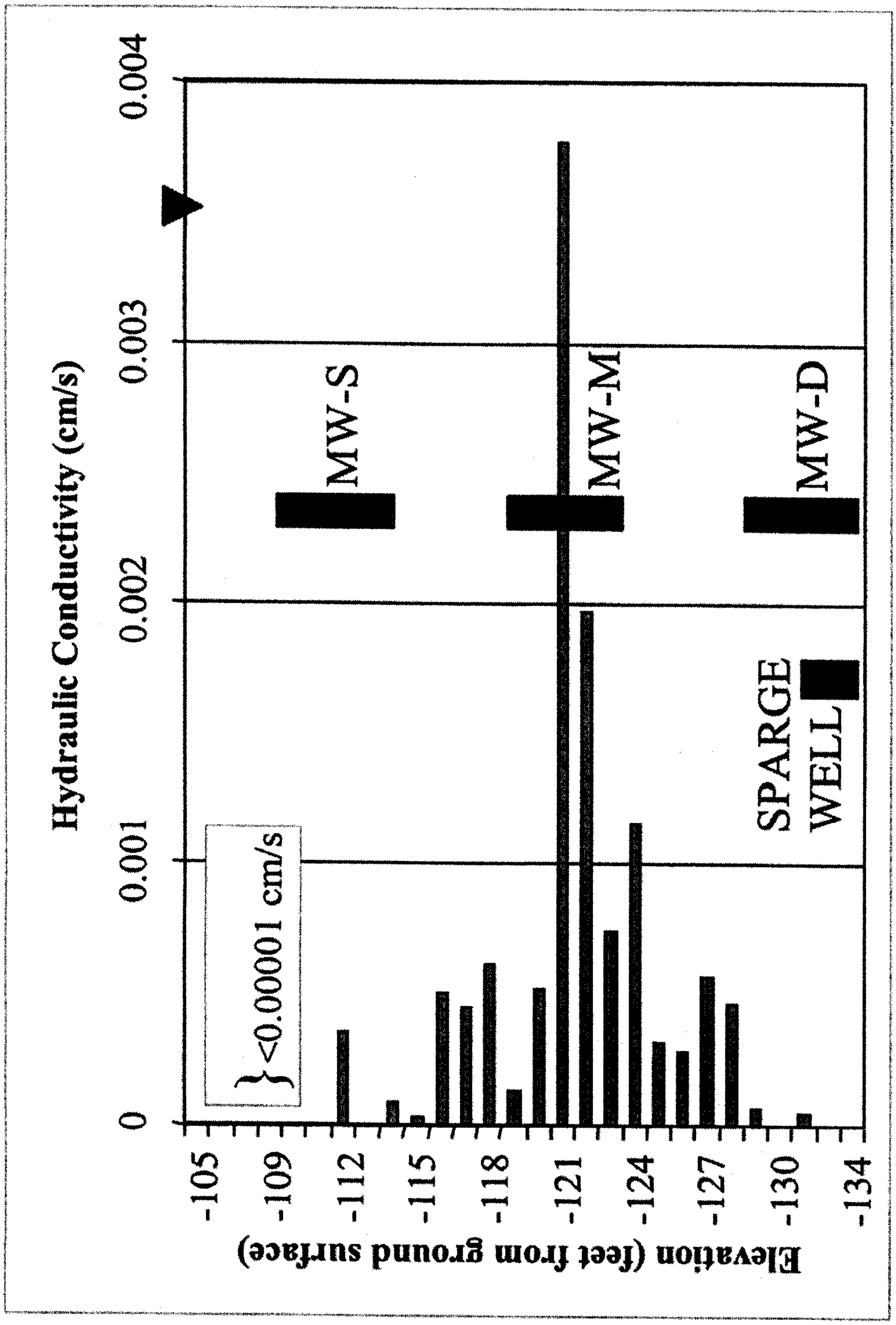

Figure 18. Hydraulic conductivity versus depth, Hill AFB, Utah.

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