GROUNDWATER SCIENCES CORPORATION

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July 11, 2017

Mr. Griff Miller, CHMM, CPH
U.S. Environmental Protection Agency Region 3 (3LC30)
1650 Arch Street
Philadelphia, PA 19103-2029

Ms. Pamela S. Trowbridge, P.G.
Pennsylvania Department of Environmental Protection
Southcentral Regional Office
909 Elmerton Avenue
Harrisburg, PA 17110

Re: Response to HHRA and Proposal

Dear Mr. Miller and Ms. Trowbridge:

On behalf of former York Naval Ordnance Plant (fYNOP) remediation team, Groundwater Sciences Corporation (GSC) is submitting this letter outlining plans for groundwater investigation and interim remedial action in the Southern Property Boundary Area (SPBA), and further groundwater investigation along the eastern perimeter road in the area of monitoring well MW-15. **Figure 1** illustrates the locations of these two areas at the Site. The fYNOP remediation team seeks the concurrence of the plans outlined herein from the United States Environmental Protection Agency (EPA) and the Pennsylvania Department of Environmental Protection (PADEP).

SOUTHERN PROPERTY BOUNDARY AREA

Background

The EPA raised an issue regarding off-Site migration of constituents of concern (COCs) from the SPBA in groundwater. In particular, EPA has noted that groundwater samples from a few of the shallow wells on the fYNOP Site contain concentrations of chlorinated volatile organic compounds (VOCs) consisting of tetrachloroethene (PCE) and trichloroethene (TCE) that exceed EPA's vapor intrusion (VI) screening criteria (https://www.epa.gov/vaporintrusion/vapor-intrusion-screening-levels-visls). In a letter dated May 30, 2017, EPA provided comments on the Human Health Risk Assessment (HHRA) for groundwater dated November 21, 2016. EPA comment number 2 in the letter stated:

> *"Section 4.1, Off-site residents: As noted above, contaminated groundwater off the site should also be evaluated as a potential potable source. Monitoring wells at the eastern*

and southern boundaries of the site reveal VOC contamination exceeding VISL screening concentrations, and in accordance with EPA VI guidance, residences within 100 ft of these wells should be evaluated for potential VI exposure."

These shallow wells consist of MW-64S, MW-161, MW-162 and MW-163 (**Figure 2**).

The vadose zone underlying the SPBA is composed of predominately fine-grained residual soil. The depth to groundwater in the shallow wells ranges from approximately 40 to 60 feet below ground surface (bgs). Cross section A-A' from the SPBA VI Investigation (GSC, July 2015) that extends east-west across the SPBA is provided as **Figure 3**. This figure shows shallow groundwater within residuum along the central and eastern portions of the SBPA (e.g., MW-64S when it is not dry and MW-162) and within limestone bedrock along the western portion of the SPBA where the residuum is thinner (e.g., MW-163). Due to the extremely complex hydrogeology across the area, a robust plan is proposed consisting of three arrays of extraction test wells.

The lateral groundwater gradient in the residual soil slopes generally southward from the SPBA off-Site towards the Canterbury Lane residential area (**Figure 2**). Cross sections A-A' and B-B' (**Figure 3**) illustrate the strong downward vertical gradient from the saturated zone in the residual soil to the underlying limestone bedrock along the fYNOP property boundary. This condition essentially creates an underdrain system below the residuum, causing the downward vertical gradient to exceed the horizontal gradient, resulting in limited lateral groundwater flow southward in the residuum (GSC, July 2015).

In March 2017, a supplemental soil quality investigation was completed in the SPBA in response to EPA's comment number 16 on the Supplemental Groundwater RI Report to further assess potential soil contamination as an ongoing source of the VOCs in groundwater (GSC, July 2017 in process). No VOC concentrations were detected in soil samples that exceeded PADEP direct contact and soil to groundwater medium specific concentrations (MSCs) (**Figure 4**) that could serve as a continuing source of the VOCs in groundwater.

Objectives

The EPA VI policy allows for engineering controls and mitigation of the vapor intrusion potential as a means of addressing a potential VI pathway. EPA indicated during preliminary discussions with the fYNOP remediation team that a groundwater extraction system in the SPBA can be an acceptable engineering control to address the potential for VI. This letter outlines plans to test, design and construct an interim groundwater extraction system in the SPBA to address EPAs concern regarding the potential VI pathway risk from COCs in shallow groundwater in the area of the south side of the SPBA. The main objective for the groundwater extraction system is to capture and control shallow groundwater containing COCs from the fine-grained residual soil and shallow bedrock along the fYNOP property boundary where groundwater concentrations exceed VI screening criteria using groundwater extraction coupled with vacuum-enhancement, if necessary.

Operation of the extraction well network along the SPBA will be designed to achieve hydraulic control and capture of the shallow groundwater plume in the near term (i.e., within months of

startup). Confirmation of hydraulic capture will be accomplished via aquifer testing, comparing estimated groundwater flow from water budget calculations versus total groundwater extraction system flow, and periodic water level elevation monitoring during the operation of the groundwater extraction system. These data will be used to prepare groundwater contours in plan and cross section view.

We expect pumping of the carbonate aquifer to draw down the shallow groundwater table in the residuum and shallow bedrock, and potentially dewater the shallow monitoring wells on the fYNOP Site. Aquifer testing will be performed to evaluate if pumping of the carbonate aquifer will effectively drain portions of the residuum. Vacuum-enhanced extraction of shallow groundwater from the residuum using a high vacuum pump will also be tested, as necessary, to evaluate its effectiveness at dewatering the shallow portion of the aquifer. Controlling groundwater at the site boundary will result in reduced off site concentrations south of the site.

Outline of Proposed Plan

Implementation of the SPBA plan is outlined below in Tasks 1 through 4.

Task 1 – Background Water Levels and Groundwater Chemistry

Groundwater samples will be collected for VOC analysis from 24 wells in the SPBA area, the area upgradient of the SPBA, and the Canterbury Road neighborhood as shown on **Figure 5**. Water level recorders will be set up in approximately 6 wells, and a round of water levels from approximately 35 wells will be collected. This information will be compared to historical data, and used to establish the baseline conditions in the area prior to the installation and operation of the proposed extraction wells.

Task 2 – Well Installations

Three new multi-level monitoring well clusters, 6 shallow monitoring wells, 3 test groundwater extraction wells and 3 shallow test multi-phase (groundwater and soil vapor) extraction wells will be constructed, developed, and surveyed at the approximate locations shown on **Figure 6**. The well installations will be completed during one mobilization to the Site to minimize impact to the off-Site properties and enable collection of more data on the shallow aquifer during aquifer testing (Task 3A). Groundwater elevation and chemistry data from the new and existing monitoring wells will be evaluated to monitor conditions and demonstrate attainment of the project objectives (e.g., capture and control shallow groundwater containing COCs from the fine-grained residual soil and shallow bedrock).

The extraction and monitoring wells will be installed in the karst/fractured limestone bedrock aquifer and in the overlying residual soil aquifer. The geologic contact between the limestone and the quartzite is approximately 80 feet to the north of the Harley-Davidson property boundary (**Figure 6**). The use of geophysics and or fracture trace data to help with the placement of the wells was considered. However, the investigation area is relatively small, the subsurface karst conditions are unpredictable (fracturing, connectivity, yield, etc.) and the mapped geologic contact between carbonate and quarzitic sandstone bedrock is nearby, which make it difficult to

accurately interpret information from these methods and supports the need for testing the three locations in the SPBA.

The following provides a description of the extraction and monitoring wells:

- **Test Groundwater Extraction Wells** – These wells will be located along the north side of the southern perimeter road approximately 20 feet to the north of the monitoring well clusters, and will be drilled to depths of approximately 100 feet bgs. The success and effectiveness of the extraction system at capturing and controlling the off-Site migration of shallow contaminated groundwater depends on the extraction wells intersecting well-connected fractures and solution-enhanced zones in the carbonate aquifer below the residuum. If a test extraction well does not intersect those features, consideration will be given to immediately redrilling a new well within approximately 10 feet of the original well location or performing hydraulic fracturing on the well.

- **Multi-level Monitoring Well Clusters** – The well clusters will be located as far to the south (downgradient) along the fYNOP property as practical, and screened at target depths in the carbonate aquifer of approximately 65-75 feet bgs and 90-100 feet bgs.

- **Test Multi-Phase (Groundwater and Soil Vapor) Extraction Wells** – These shallow wells will be located as close to the fYNOP property boundary as practical and screened at target depths of 40-60 feet bgs in the residuum aquifer. The wells will be constructed to enable vacuum-enhanced groundwater extraction to dewater the saturated residual soil and extract soil vapor containing VOCs from the vadose zone to address the potential for lateral off-site migration of VOC vapors.

- **Shallow Monitoring Wells** – These wells will be co-located with the multi-phase extraction wells to monitor the effects of vacuum-enhanced shallow groundwater (e.g., drawdown and vacuum effects). Two monitoring wells will be located at distances of approximately 7-10 feet and 15-20 feet away from each of the extraction wells, and will be screened at depths generally consistent with the extraction wells.

Existing overhead electrical lines along the Harley-Davidson property line will be in close proximity to the drilling rig mast during the installation of the wells. This condition will be addressed by shielding (booting) of the electrical lines during drilling, if allowed by Harley-Davidson Safety and the electrical company, or by increasing the setback distance of the rig from the lines (moving the monitoring wells to the north).

The geographic coordinates and elevations of the new monitoring wells and test extraction wells will be surveyed following their development. In addition, groundwater samples will be collected for VOCs analyses from the new wells approximately one week following the completion of the well development activities.

Task 3A – Aquifer Testing

Step drawdown tests will be conducted on the 3 test groundwater extraction wells to determine well efficiency and sustainable yield, followed by a 48 to 72 hour constant rate pumping test on

each extraction well. The lateral and vertical extent of hydraulic influence (connection) between the carbonate aquifer and the overlying residual soil, along with other physical parameters, will be determined by the hydraulic testing for use in the design of the groundwater extraction system. Groundwater samples will be collected from the test extraction wells during the testing to evaluate VOC concentrations and assess various groundwater-quality treatment system design parameters.

Task 3B – Vacuum Enhanced Extraction Testing

Vacuum enhanced extraction testing on the 3 test multi-phase extraction wells will be performed following the completion of the aquifer testing (Task 3A) and stabilization of the aquifer to non-pumping conditions. The tests will be performed for a time period of 4-10 hours.

The objectives of the vacuum enhanced extraction testing are to evaluate the following:

- Effectiveness at dewatering the shallow portion of the aquifer, and the total number of shallow multi-phase extraction wells required based on radius of influence (ROI).

- Ability to limit the potential lateral off-site migration of VOC vapors in the vadose zone.

- Remedial design parameters consisting of:
    - Vacuum system type and sizing.
    - Estimated air flow, vacuum and vapor treatment requirements.
    - Groundwater yield.
    - Vacuum-enhanced extraction method including determination and feasibility of the extraction method using either a single vacuum source for removal of both vapors and groundwater from the well, which may be limited due to groundwater being deep, or a dual-phase source using separate systems for pumping groundwater and extracting vapors.
    - Electrical/power requirements.

If additional multi-phase extraction wells are warranted based on the vacuum enhanced extraction testing results, they will be installed within a short timeframe following the completion of the tests.

Task 4 – Design Groundwater Extraction System

The test results will form the basis of the remedial system design to meet the objectives of controlling shallow groundwater at the SPBA. The extraction system will consist of groundwater pumping wells, submersible pumps, conveyance and power lines, and water level and flow monitoring as conceptually shown on **Figure 5**. If vacuum enhanced extraction of shallow groundwater is warranted, the system would include multi-phase extraction wells, a high vacuum pump, supplemental groundwater pumps, provisions to address noise and vapor discharge treatment. Groundwater and vapors will be piped to a local control building, which will be established onsite to northwest of the extraction wells. Groundwater will be conveyed to the groundwater treatment plant for treatment, and vapors will be treated at a temporary local control building.

A monitoring program will be designed to establish the functionality of the extraction system in meeting the project objectives.

Schedule

Planning for and implementation of the background water level collection and sampling of wells in the SPBA (Task 1) will begin immediately after agreement of this plan by EPA and PADEP. The overall schedule goal is to have the extraction system operational by the end of 2017.

EASTERN PERIMETER ROAD (MW-15 AREA)

Introduction

In a letter dated May 30, 2017, EPA provided comments on the HHRA for groundwater dated November 21, 2016. EPA comment number 5 in the letter stated:

> *"Section 4.4, Residential VI exposure risks in LUA # 4 should not be eliminated from evaluation because residential properties are located within 100 ft of groundwater contamination exceeding VISL screening concentrations."*

During a meeting with EPA on April 27, 2017, EPA suggested the need for additional information in the HHRA to support eliminating potential residential VI exposure risk for an occupied building potentially located within a distance of 100 feet of the PCE plume to the southwest (downgradient) of monitoring well MW-15 along the eastern perimeter road.

Purpose

The building in question is shown on **Figure 1**. The building is approximately 150 feet to the southeast of MW-15, roughly side gradient with respect to groundwater flow downgradient of MW-15, and approximately 25 feet away from the interpreted eastern edge of the 5 micrograms per liter (µg/L) PCE plume. The most recent concentrations of PCE and TCE at MW-15 in September 2015 were 210 µg/L and 5.7 µg/L, respectively. The building appears to be located within a lateral distance of 100 feet from the interpreted PCE plume at a concentration that exceeds the VISL screening concentrations for PCE and TCE of 32 µg/l and 2.4 µg/l, respectively, but is not within 100 feet of MW-15. The EPA VI policy recommends additional investigation to determine if a completed pathway exists for vapor migration into the building, including determining whether groundwater containing COC concentrations that exceed the VISL screening concentration in fact extends to within 100 feet of the occupied building.

With the exception of the MW-15 area described above, no other occupied buildings are currently located within 100 feet of known contaminated groundwater in LUA#4. This includes the North Property Boundary Area (NPBA).

Groundwater Quality Investigations

Monitoring well MW-15 is constructed with steel casing grouted in place to a depth of 40 feet bgs, and an open rock borehole that extends vertically downward into quarzitic sandstone bedrock from a depth of 40 to 120 feet bgs. The overburden at MW-15 is described on the log as silty sand with weathered rock fragments and is relatively thick to a depth of approximately 30 feet. The thickness of the overburden above the quartzite bedrock to the southwest of MW-15 at MW-2, MW-91 and MW-92 is much thinner (13 feet or less).

The average depth to groundwater at MW-15 is relatively deep (approximately 60 feet bgs). As shown on **Figure 1**, the interpreted lateral groundwater gradient from MW-15 appears to be towards the south-southwest, indicating the occupied building is side gradient with respect to groundwater flow downgradient of MW-15.

In 1987, 2005, 2008 (twice) and 2015, groundwater samples were collected for laboratory analysis from MW-15. PCE concentrations in the samples ranged from 201 µg/L to 460 µg/L. TCE concentrations dropped over an order of magnitude since the first sampling round in 1987 (325 µg/L), and showed a steady decline to 5.7 µg/L during last sampling round in 2015 (see attached time versus concentration graph). Lower concentrations of PCE were detected to the southwest (downgradient) of MW-15 at monitoring wells MW-2, MW-91 and MW-92 (**Figure 1**).

The interpreted lateral extent of the PCE plume is shown on **Figure 1**. The PCE plume is oriented northeast to southwest, consistent with the interpreted groundwater gradient. The eastern edge of the plume is interpreted to extend off-Site in the area of MW-15. To the southwest of MW-15, the connection of the plume with downgradient wells MW-2, MW-91 and MW-92 is the most likely interpretation.

Investigation Plan

This plan was developed based on the results of the previous investigations with the objective to address the potential VI pathway as outlined below in Tasks 1 and 2.

Task 1 – Monitoring Well Installation and Sampling

Drill, install, develop and survey one shallow groundwater monitoring well along the eastern perimeter road to the southeast (side to downgradient) of MW-15. The well would be screened across the top of the water table (estimated to be 60 to 70 feet bgs) to determine COC concentrations along the interpreted eastern edge of the PCE plume in relative close proximity to the occupied building (**Figure 1**). COC concentrations from this well will be compared to the VISL screening concentrations to help evaluate whether further action is warranted to address the potential VI pathway for the off-site occupied building.

Groundwater at the new well will be analyzed for VOCs. In addition, groundwater at MW-15 and the wells downgradient of MW-15 with historic PCE concentrations (MW-2, MW-91 and MW-92) will be sampled for VOCs to obtain updated groundwater chemistry.

Task 2 – Data Evaluation

The results of the investigation will be evaluated to determine if further action is warranted to address the potential VI pathway for the occupied building. No further action will be recommended if the residential building is not located within a lateral distance of 100 feet from groundwater containing COC concentrations that exceed the VISL screening concentration. If the VISL screening concentration is exceeded and/or other multiple lines of evidence are not available to address the potential VI pathway (e.g., groundwater is deep, there are no preferential pathways, soil is tight, the building is not downgradient with respect to the PCE plume, etc.), further evaluation will be recommended.

Schedule

The fieldwork associated with the installation of the new monitoring well will begin after receiving agreement on this plan from EPA and PADEP, and will be performed concurrent with the SPBA well installations, to the extent possible. The monitoring well installation, sampling and data evaluation tasks are anticipated to take two to three months to complete.

We look forward to your expedited review of this plan.

Sincerely,
GROUNDWATER SCIENCES CORPORATION

Stephen M. Snyder, P.G.
Senior Associate & Hydrogeologist

CDO/jms

Attachments

cc: Sharon R Fisher (Harley-Davidson)
Ralph T. Golia (AMOED)
Hamid Rafiee (USACE)

REFERENCES

GSC, 2015. Southern Property Boundary Area Vapor Intrusion Investigation. July 2015.

GSC, 2017. Southern Property Boundary Area Supplemental Soil Quality Investigation. July 2017 (in process).

FIGURES

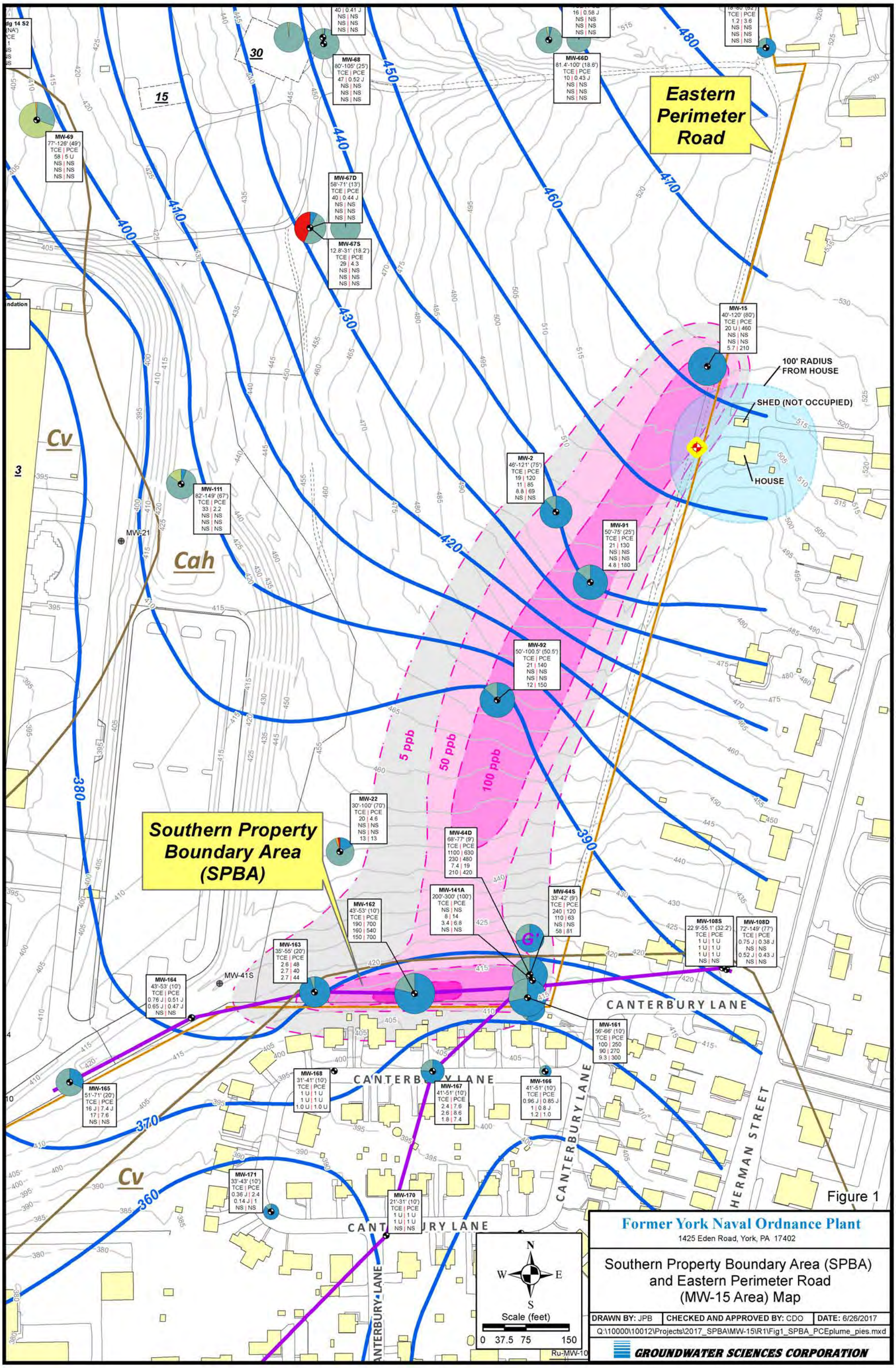

Figure 1

Former York Naval Ordnance Plant
1425 Eden Road, York, PA 17402

Southern Property Boundary Area (SPBA) and Eastern Perimeter Road (MW-15 Area) Map

DRAWN BY: JPB	CHECKED AND APPROVED BY: CDO	DATE: 6/26/2017

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LEGEND

- Proposed Shallow Monitoring Well
- Monitoring Well
- Tetrachloroethene (PCE)
- Trichloroethene (TCE)
- cis-1,2-Dichloroethene (cis-12DCE)
- Vinyl Chloride (VC)
- 1,1-Dichloroethene (11DCE)
- 1,1-Dichloroethane (11DCA)
- 1,1,1-Trichloroethane (TCA)
- Cv — Vintage Formation
- Cah — Antietam & Harpers Formation, undiv.
- SPBA Cross Section Transect
- Contact
- YCIDA Property Boundary
- Harley-Davidson Property Boundary
- Groundwater Contour (feet amsl)
- Inferred Groundwater Contour (feet amsl)
- Existing Building to Remain
- Demolished
- Demolished/Slab Removed
- 100' Radius From House
- Topographical Contour (5' Interval)
- PCE Concentration 5 ppb
- PCE Concentration 50 ppb
- PCE Concentration 100 ppb
- PCE Concentration 500 ppb

Note:
1) Well pie diagram data source:
2014 Comprehensive Event; if the location was not sampled in 2014 it is the 2013 Comprehensive Event; if the location was not sampled in 2013 it is the 2008 RI Round 1 Event.
2) Surface water pie diagram data source:
2014 Comprehensive Event; if the location was not sampled in 2014 it is the 2013 Comprehensive Event; if the location was not sampled in 2013 it is the 2013 Codorus Creek Groundwater Discharges Event 2.
3) Rutters well chemistry from 11/9/12 sampling event.
4) SPBA well chemistry (MW-161 through MW-175) are from March and April 2015.
5) SPBA PIE diagrams (MW-161 through MW-175) are from April 2015.
6) * Groundwater contours in the Canterbury Lane Residential Area is composited with April 2015 Contours shown on Figure 2.3-13.
7) Concentration contour data source from "2014 Comprehensive Sampling Event"

(Surface Water)
Location ID
Top of Open Interval FtBGS - Bottom of Open Interval FtBGS (Open Interval Thickness)
Trichloroethene and Tetrachloroethylene
2013 Codorus Creek Groundwater Discharges Event 2
2014 Restart Test Event 5
2014 Comprehensive Sampling Event
2015 Comprehensive Sampling Event

(Well)
Location ID
Top of Open Interval FtBGS - Bottom of Open Interval FtBGS (Open Interval Thickness)
Trichloroethene and Tetrachloroethylene
2008 RI Round 1 Event
2013 Comprehensive Sampling Event
2014 Comprehensive Sampling Event
2015 Comprehensive Sampling Event

Figure 1 Legend

N W E S

Scale (feet)
0 37.5 75 150

Former York Naval Ordnance Plant
1425 Eden Road, York, PA 17402

Southern Property Boundary Area (SPBA) and Eastern Perimeter Road (MW-15 Area) Map

DRAWN BY: JPB	CHECKED AND APPROVED BY: CDO	DATE: 6/26/2017

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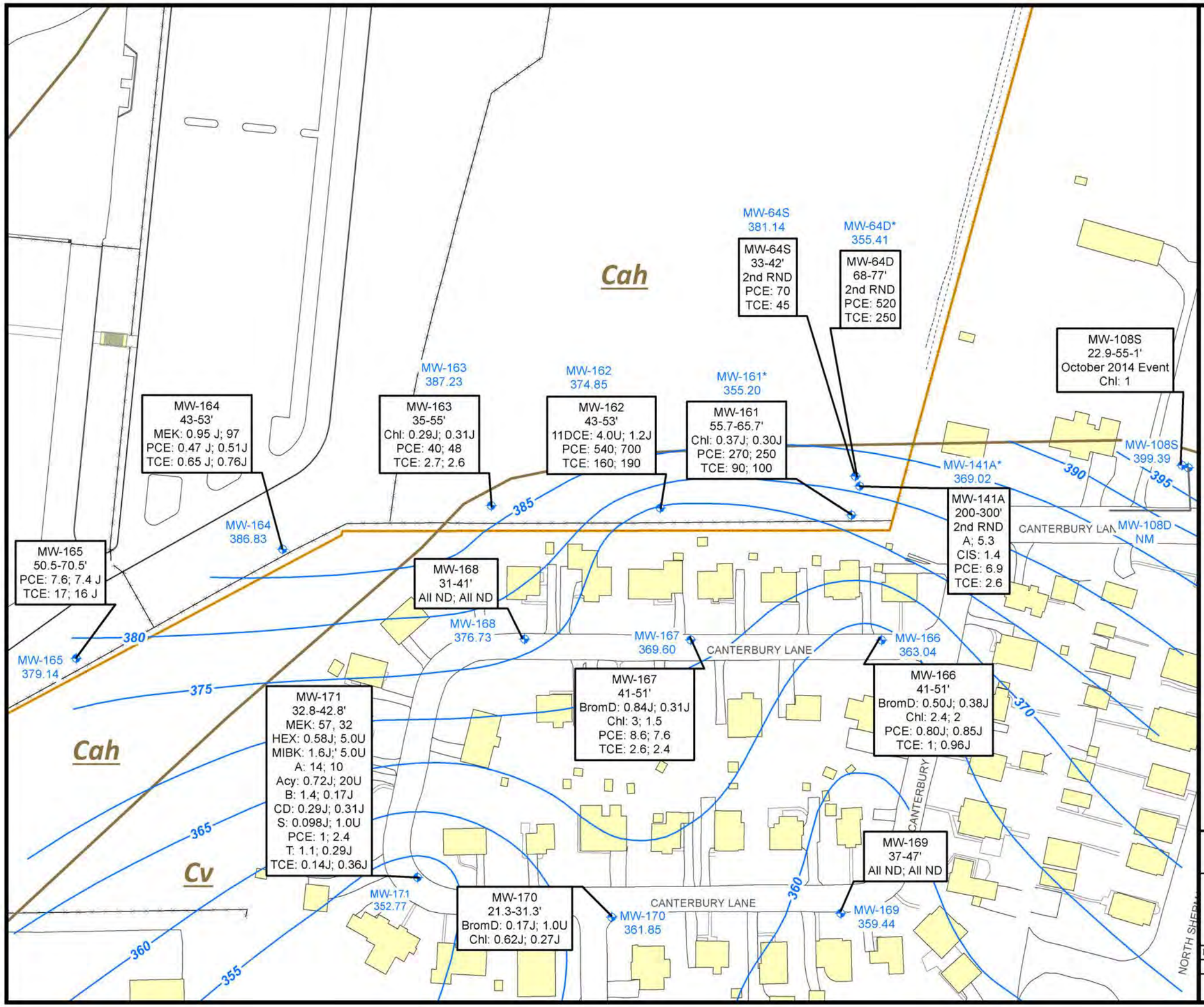
Cah
Cv
MW-64S
381.14
MW-64S
33-42'
2nd RND
PCE: 70
TCE: 45
MW-64D*
355.41
MW-64D
68-77'
2nd RND
PCE: 520
TCE: 250
MW-108S
22.9-55-1'
October 2014 Event
Chl: 1
MW-163
387.23
MW-163
35-55'
Chl: 0.29J; 0.31J
PCE: 40; 48
TCE: 2.7; 2.6
MW-162
374.85
MW-162
43-53'
11DCE: 4.0U; 1.2J
PCE: 540; 700
TCE: 160; 190
MW-161*
355.20
MW-161
55.7-65.7'
Chl: 0.37J; 0.30J
PCE: 270; 250
TCE: 90; 100
MW-164
43-53'
MEK: 0.95 J; 97
PCE: 0.47 J; 0.51J
TCE: 0.65 J; 0.76J
MW-141A*
369.02
MW-141A
200-300'
2nd RND
A; 5.3
CIS: 1.4
PCE: 6.9
TCE: 2.6
MW-108S
399.39
MW-108D
NM
CANTERBURY LAN
MW-164
386.83
MW-165
50.5-70.5'
PCE: 7.6; 7.4 J
TCE: 17; 16 J
MW-165
379.14
MW-168
31-41'
All ND; All ND
MW-168
376.73
MW-167
369.60
CANTERBURY LANE
MW-166
363.04
MW-167
41-51'
BromD: 0.84J; 0.31J
Chl: 3; 1.5
PCE: 8.6; 7.6
TCE: 2.6; 2.4
MW-166
41-51'
BromD: 0.50J; 0.38J
Chl: 2.4; 2
PCE: 0.80J; 0.85J
TCE: 1; 0.96J
MW-171
32.8-42.8'
MEK: 57, 32
HEX: 0.58J; 5.0U
MIBK: 1.6J;' 5.0U
A: 14; 10
Acy: 0.72J; 20U
B: 1.4; 0.17J
CD: 0.29J; 0.31J
S: 0.098J; 1.0U
PCE: 1; 2.4
T: 1.1; 0.29J
TCE: 0.14J; 0.36J
MW-171
352.77
MW-170
21.3-31.3'
BromD: 0.17J; 1.0U
Chl: 0.62J; 0.27J
MW-170
361.85
CANTERBURY LANE
MW-169
37-47'
All ND; All ND
MW-169
359.44
CANTERBURY
NORTH SHER
385
390
395
380
375
370
365
360
355
N
W
E
S
LEGEND
Monitoring Well
Groundwater Contour
Groundwater Contour (Inferred)
Cah Antietam & Harpers Formation, undiv.
Cv Vintage Formation
Harley-Davidson Property Boundary
Road (Paved)
Road Curb
Road (Unpaved)
Walkway
Fenceline
Existing Building
Well ID
Top of Open Interval FBGS and Bottom of Open Interval FBGS
1st Result Rnd 1 (March and April 2015): 2nd Result Rnd 2 (October 2015)
11DCE; 1,1-Dichloroethene
MEK: 2-Butanone
HEX: 2-Hexanone
MIBK: 4-Methyl-2-pentanone
MTBE: Methyl tert-butyl ether
A: Acetone
Acy: Acrylonitrile
B: Benzene
Bromch: Bromochloromethane
BromD: Bromodichloromethane
CD: Carbon disulfide
Chl: Chloroform
CIS: cis-1,2-Dichloroethene
Dibro: Dibromochloromethane
S: Styrene
PCE: Tetrachloroethene
T: Toluene
TCE: Trichloroethene
NOTES:
FBGS = Feet Below Ground Surface
Chemistry results in µg/L.
NM = Not measured.
ND = Not detected.
J = Estimated concentration.
U = Not detected above reported value.
Water levels measured 4/14/2015.
Contours are in Feet Above Mean Sea Level.
Water levels for deeper wells marked with * not used in contouring.
Scale (feet)
0 25 50 100
Figure 2
Former York Naval Ordnance Plant
1425 Eden Road, York, PA 17402
Water Table Contour Map and Groundwater Quality Results
DRAWN BY: JPB
CHECKED AND APPROVED BY: CDO
DATE: 6/26/2017
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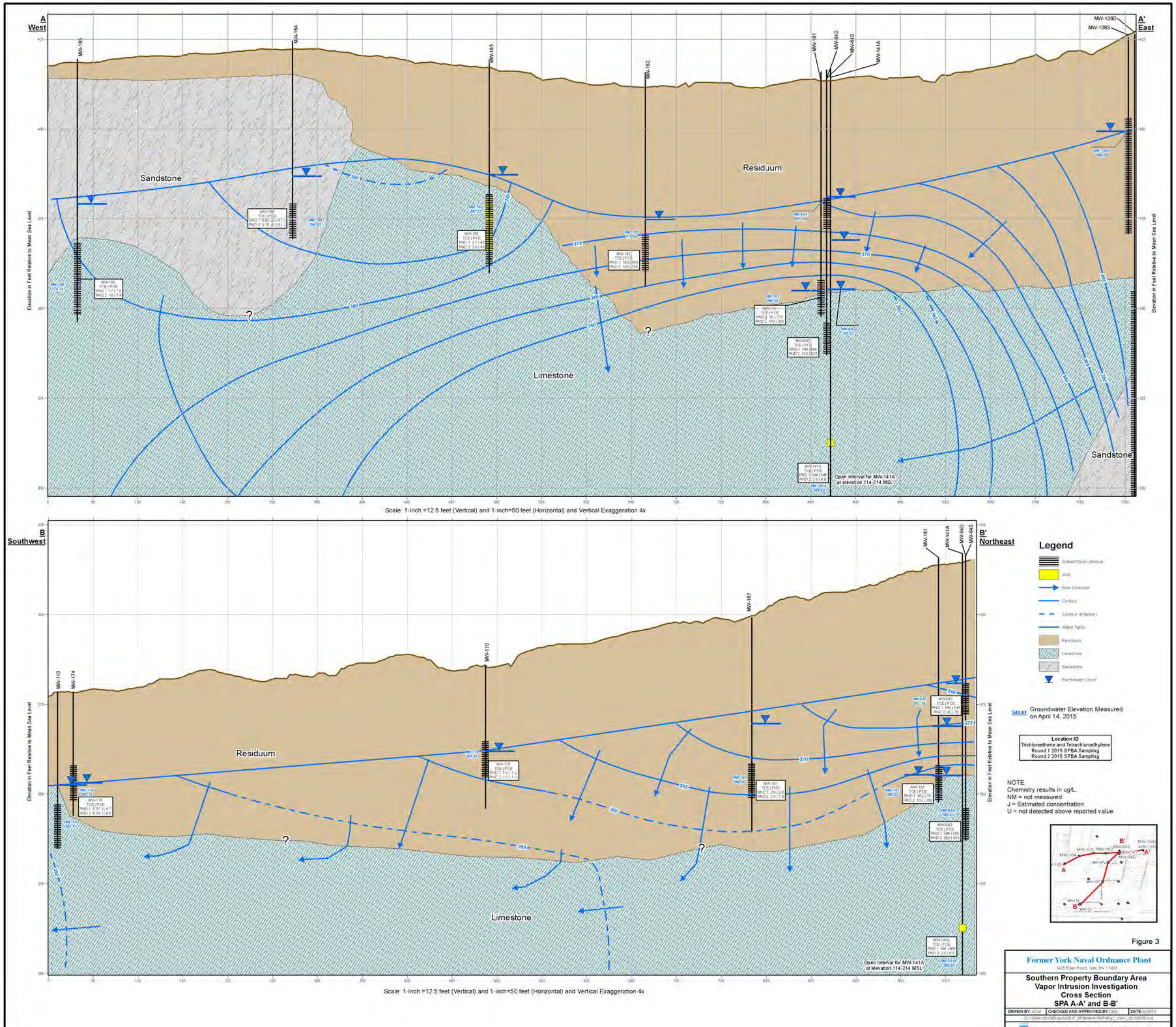
A
West
A'
East
Sandstone
Residuum
Limestone
Sandstone
Scale: 1-Inch =12.5 feet (Vertical) and 1-inch=50 feet (Horizontal) and Vertical Exaggeration 4x
Elevation in Feet Relative to Mean Sea Level
Open Interval for MW-141A at elevation 114-214 MSL
B
Southwest
B'
Northeast
Residuum
Limestone
Scale: 1-Inch =12.5 feet (Vertical) and 1-inch=50 feet (Horizontal) and Vertical Exaggeration 4x
Legend
Screen/Open Interval
Void
Flow Direction
Contour
Contour (Inferred)
Water Table
Residuum
Limestone
Sandstone
Piezometric Level
Groundwater Elevation Measured on April 14, 2015
Location ID
Trichloroethene and Tetrachloroethylene
Round 1 2015 SPBA Sampling
Round 2 2015 SPBA Sampling
NOTE:
Chemistry results in ug/L.
NM = not measured.
J = Estimated concentration.
U = not detected above reported value.
Figure 3
Former York Naval Ordnance Plant
Southern Property Boundary Area
Vapor Intrusion Investigation
Cross Section
SPA A-A' and B-B'
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SPBA-SB-006	3/27/2017	
Depth (feet)	*PCE*	*TCE*
0 - 1	0.0058 U	0.0058 U
5 - 5.5	0.0052 U	0.0052 U
10 - 10.5	0.0046 U	0.0046 U
15 - 15.5	0.0041 U	0.0041 U
20 - 20.5	**0.0012 J**	0.0049 U
25 - 25.5	0.0045 U	0.0045 U
30 - 30.5	**0.0011 J**	0.0036 U
35 - 35.5	**0.0014 J**	0.0039 U
40 - 40.5	0.0043 U	0.0043 U

SPBA-SB-009	3/29/2017	
Depth (feet)	*PCE*	*TCE*
0.5 - 1	0.0051 U	0.0051 U
5 - 5.5	0.005 U	0.005 U
10 - 10.5	0.0049 U	0.0049 U
15 - 15.5	0.0041 U	0.0041 U
20 - 20.5	0.0043 U	0.0043 U
25 - 25.5	0.0045 U	0.0045 U
30 - 30.5	0.0051 U	0.0051 U
35 - 35.5	0.0046 U	0.0046 U
40 - 40.5	0.0046 U	0.0046 U
45 - 45.5	0.0051 U	0.0051 U
53.5 - 54	**0.006**	**0.24**
58.5 - 59	**0.0025 J**	**0.072**
61 - 61.5	**0.0056**	**0.15**
65 - 68	0.0045 U	0.0045 U

SPBA-SB-010	3/30/2017	
Depth (feet)	*PCE*	*TCE*
0.5 - 1	0.0052 U	0.0052 U
5 - 5.5	0.0051 U	0.0051 U
10 - 10.5	0.005 U	0.005 U
15 - 15.5	0.0046 U	0.0046 U
20 - 20.5	0.0045 U	0.0045 U
25 - 25.5	0.005 U	0.005 U
31.6 - 32.2	0.0044 U	0.0044 U
35 - 35.5	0.0045 U	0.0045 U
40 - 40.5	**0.011**	0.0043 U
45 - 45.5	**0.071**	**0.0046**
50 - 50.5	**0.039**	**0.0021 J**

SPBA-SB-008	3/29/2017	
Depth (feet)	*PCE*	*TCE*
0.5 - 1	0.0047 U	0.0047 U
5 - 5.5	0.0043 U	0.0043 U
10 - 10.5	0.0044 U	0.0044 U
15 - 15.5	0.0052 U	0.0052 U
20 - 20.5	0.004 U	0.004 U
25 - 25.5	0.0053 U	0.0053 U
30 - 30.5	0.0042 U	**0.0013 J**
35 - 35.5	**0.0013 J**	**0.0023 J**
40 - 40.5	**0.0035 J**	**0.0074**
45 - 45.5	**0.013**	**0.04**

SPBA-SB-007	3/28/2017	
Depth (feet)	*PCE*	*TCE*
0.5 - 1	0.0051 U	0.0051 U
5 - 5.5	0.0047 U	0.0047 U
10 - 10.5	0.0048 U	0.0048 U
15 - 15.5	0.0041 U	0.0041 U
20 - 20.5	0.0044 U	0.0044 U
25 - 25.5	0.0045 U	0.0045 U
30 - 30.5	0.0041 U	0.0041 U
35 - 35.5	0.0051 U	0.0051 U
45 - 50	0.0049 U	0.0049 U
50 - 55	0.0043 U	0.0043 U

MW-92
MW-22
MW-41S
MW-41D
MW-163
MW-162
MW-161
MW-164
MW-165
MW-168
MW-167
MW-166
MW-171
MW-170
MW-169
MW-64S
MW-64D
MW-141A
MW-108S
MW-108D
SPBA-SB-006
SPBA-SB-007
SPBA-SB-008
SPBA-SB-009
SPBA-SB-010
CANTERBURY LANE
CANTERBURY LANE
CANTERBURY LANE
NORTH SHERMAN STREET
Cah
Cah
Cv

N
W E
S

LEGEND

- 2017 Soil Boring Location
- Abandoned Well
- Monitoring Well
- Cah — Antietam & Harpers Formation, undiv.
- Cv — Vintage Formation
- Harley-Davidson Property Boundary
- Road (Paved)
- Road Curb
- Road (Unpaved)
- Walkway
- Fenceline
- Existing Building

NOTES:
Analytical results in milligrams per kilogram (mg/kg).
U = Not detected above reported value
J = Estimated concentration
Bold font indicates analyte was detected.
PCE = Tetrachloroethene
TCE = Trichloroethene
Depth = Sample depth in feet below ground surface
The PADEP non-residential soil to groundwater medium specific concentration (MSC) for PCE and TCE is 0.500 mg/kg.

Scale (feet)
0 25 50 100

Figure 4

Former York Naval Ordnance Plant
1425 Eden Road, York, PA 17402

PCE and TCE Soil Quality Results (2017)

DRAWN BY: JPB | **CHECKED AND APPROVED BY:** CDO | **DATE:** 6/26/2017

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GROUNDWATER SCIENCES CORPORATION

MW-91
MW-15
(±425' NE from MW-91)
MW-92
Cah
PROPOSED
CONTROL
BUILDING
MW-22
MW-41D
MW-41S
MW-163
MW-162
MW-64S
MW-64D
MW-141A
MW-161
MW-108S
MW-108D
MW-164
MW-165
MW-168
MW-167
MW-166
CANTERBURY LANE
Cv
MW-171
MW-170
MW-169
NORTH SHERMAN STREET
Ru-MW-4
Ru-MW-102
Ru-MW-3
Ru-MW-4R
Ru-MW-10
Ru-MW-103
Ru-MW-2
Ru-MW-1
Ru-MW-101
MW-109D
MW-109S
MW-175
OLD ARSENAL ROAD
MW-174
MW-110
MW-173
Ru-MW-8
MW-172
Ru-MW-7
Ru-MW-9
U.S. ROUTE 30 / ARSENAL ROAD

LEGEND

- Proposed Multi-Level Monitoring Well Cluster
- Proposed Test Groundwater Extraction Well
- Proposed Test Multi-Phase Extraction Well and Two Shallow Monitoring Wells
- Proposed Control Building
- Proposed Extraction Well Piping to Treatment System
- Abandoned Well
- Monitoring Well
- Cah — Antietam & Harpers Formation, undiv.
- Cv — Vintage Formation
- Harley-Davidson Property Boundary
- Road (Paved)
- Road Curb
- Road (Unpaved)
- Walkway
- Fenceline
- Existing Building
- Surface Contours (2' Intervals)

N W E S

NOTES:
1) All proposed locations are approximate.
2) Background groundwater samples will be collected from wells that are indicated by well designations shaded in blue.

Scale (feet)
0 30 60 120

Figure 5

Former York Naval Ordnance Plant
1425 Eden Road, York, PA 17402

Background Groundwater Monitoring Locations

DRAWN BY: JPB	CHECKED AND APPROVED BY: CDO	DATE: 7/10/2017

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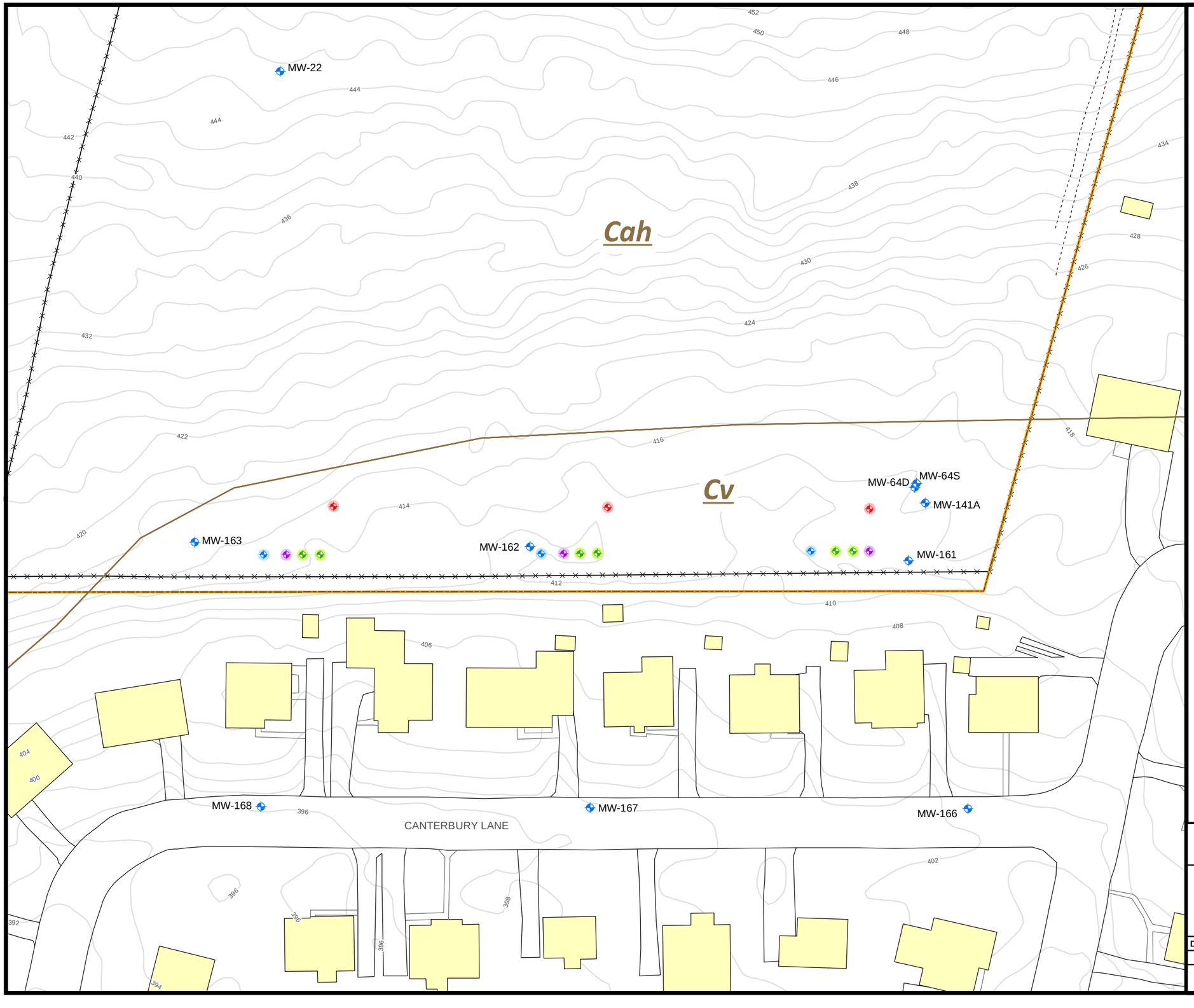
GROUNDWATER SCIENCES CORPORATION



N
W E
S

LEGEND

- Proposed Multi-Level Monitoring Well Clusters
- Proposed Test Groundwater Extraction Wells
- Proposed Test Multi-Phase Extraction Wells
- Proposed Shallow Monitoring Wells
- Monitoring Well
- Cah — Antietam & Harpers Formation, undiv.
- Cv — Vintage Formation
- Harley-Davidson Property Boundary
- Road (Paved)
- Road Curb
- Road (Unpaved)
- Walkway
- Fenceline
- Existing Building
- Surface Contour (2' Intervals)

Scale (feet)
0 12.5 25 50

Figure 6

Former York Naval Ordnance Plant
1425 Eden Road, York, PA 17402

Conceptual SPBA
Monitoring/Extraction Well Layout

DRAWN BY: JPB	CHECKED AND APPROVED BY: CDO	DATE: 7/10/2017

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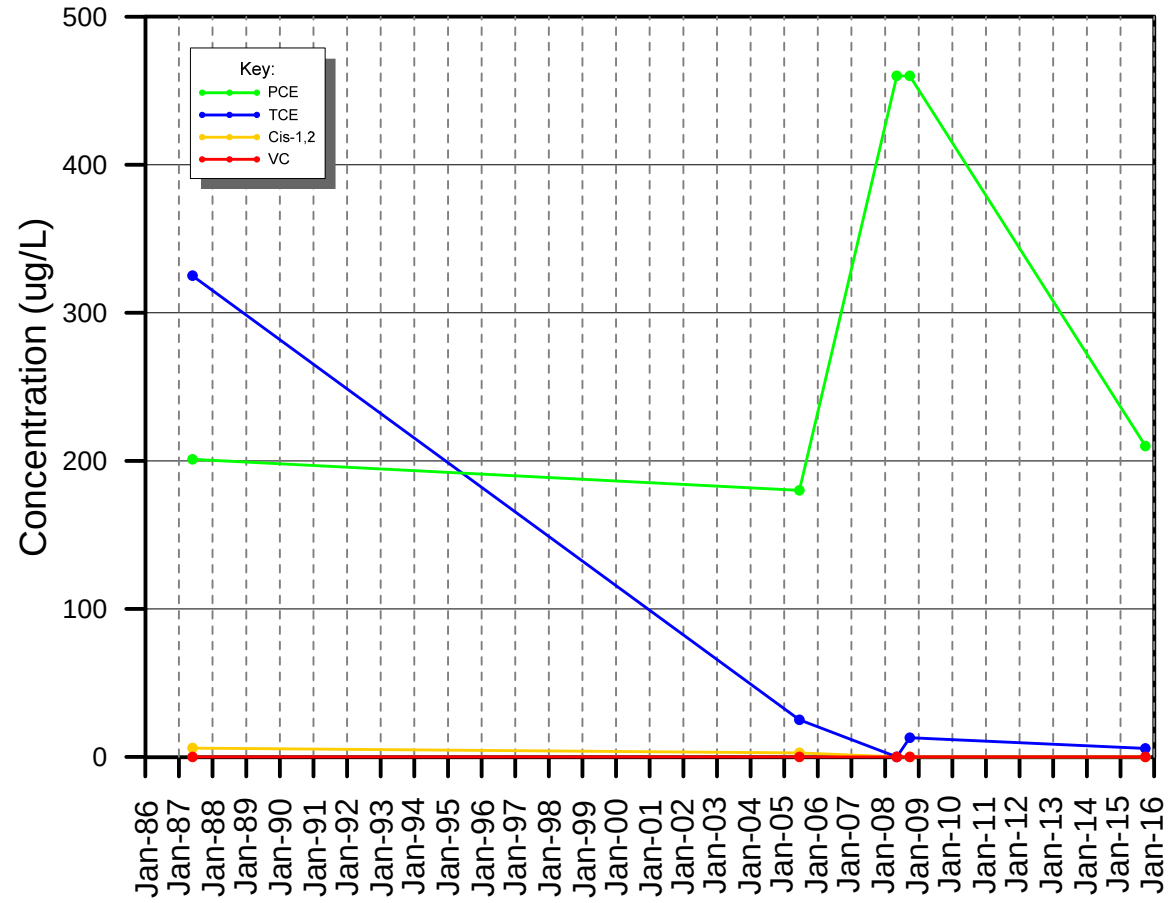
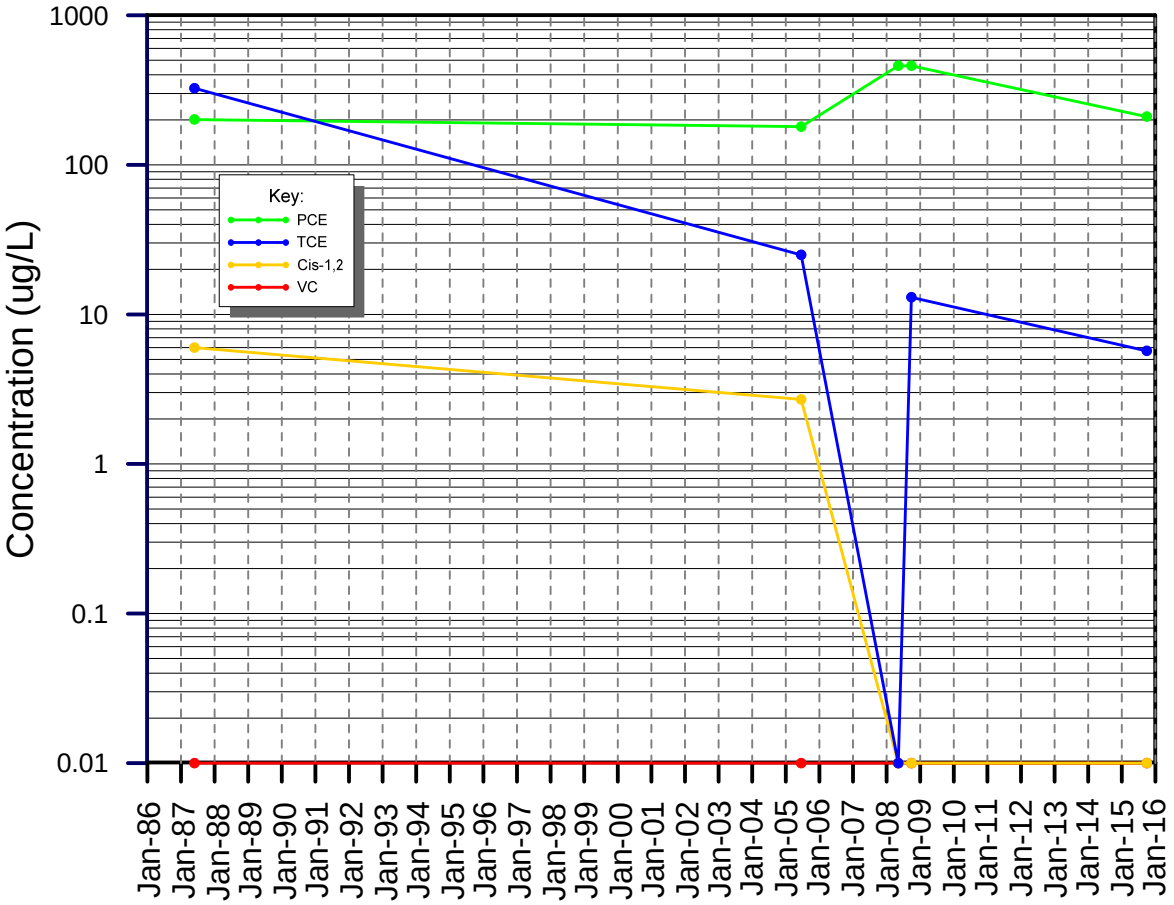
GROUNDWATER SCIENCES CORPORATION

MW-15 Time Versus Concentration Graphs

Undetected laboratory results are represented on the graphs as a concentration of 0.01 micrograms per liter (µg/l), regardless of method detection limit or laboratory reporting limit. "J" qualified (estimated) results are plotted on the graphs as actual values.

MW-15


Key:
PCE
TCE
Cis-1,2
VC
Concentration (ug/L)
500
400
300
200
100
0
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16


Key:
PCE
TCE
Cis-1,2
VC
Concentration (ug/L)
1000
100
10
1
0.1
0.01
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10
Jan-11
Jan-12
Jan-13
Jan-14
Jan-15
Jan-16