Addendum #4 to
Field Sample Plan for Part 2 of the Supplemental Groundwater Remedial Investigation
Former York Naval Ordnance Plant
1425 Eden Road, Springettsbury Township
York, Pennsylvania

Prepared for Harley-Davidson Motor Company Operations, Inc.
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Suspected Source Areas MIP Sampling Investigation

Section 4.2.1.1 of the Field Sampling Plan (FSP) for Part 2 of the Supplemental Groundwater Remedial Investigation (GSC, April 2012) specifies that Membrane Interface Probe (MIP) sampling will be conducted at the West Building 2 Corridor (WBldg2 Corr) and former Building 58 (Bldg58) to identify volatile organic compound (VOC) source areas in the shallow subsurface. MIP is a semi-quantitative field screening device that can detect volatile organic compounds in unsaturated or saturated soil and sediment and provide vertical profiling information of total chlorinated volatile organic compounds. Up to 80 MIP sampling borings will be installed at the WBldg2 Corr and up to 60 MIP sampling borings will be installed at the Bldg58 area. The purpose of this addendum is to record and present new data that was collected as part of the ongoing field work, select locations for MIP sampling, and a path forward for the investigation of source areas.

Both areas are underlain by groundwater with high concentrations of VOCs, primarily tetrachloroethene (PCE), trichloroethene (TCE) and trichloroethene (TCA) and their degradation products (see section 4.1.5 of the FSP). These compounds were used by fYNOP and AMF on Site for metal processing (degreasing) prior to plating or painting, and may have been used for other purposes. Other locations on Site where high concentrations of these compounds are found in the groundwater are related to known industrial operations or disposal activities, and surface soils containing these compounds have been found, and in some cases remediated. However, there are no known industrial activities, nor has surface soil containing these compounds been found in the WBldg2 Corr and Bldg58 areas.

Most areas on Site that have been found to contain high concentrations of VOCs in soil have been a result of first finding high concentrations of VOCs in the groundwater. Soil sampling or soil gas sampling on a grid has had limited success at discovering sources of contaminants at this Site (although soil sampling has been very successful at delineating known sources). For those reasons shallow groundwater wells were installed surrounding both areas, and groundwater samples were collected from these newly installed wells. Field logs from the attending geologist are included as **Attachment 1**. These wells were surveyed by NuTec during the last week of June. Water levels and groundwater samples were collected from the new wells at WBldg2 Corr on July 2, 2012 and from the new wells at Bldg58 on July 5, 2012. Water level elevations are included as **Table 1**. Analytical results are summarized in **Table 2.**

In addition, as laid out in Section 4.1.5 of the FSP, GSC reviewed historical building drawings and plans in the areas shown on **Figure 1**. A ground penetrating radar (GPR) investigation of the Bldg58 area was conducted to locate former press pits, which were described by a former employee as a potential source of leakage/spillage. Subsection 4.2.4.11 of the FSP provides background on the GPR procedures. Methodology used in the field followed the FSP. **Figures 2, 3**, and **4** show examples of the output from the GPR. Anomalies were outlined and found to correlate with seams or stains in the concrete slab at four locations.

Data Analysis and Proposed Boring Locations

Bedrock elevation contours were updated, using data from the ten (10) additional wells. Also, a groundwater contour map was constructed using water levels from the added wells plus surrounding wells. **Table 1** summarizes the water level measurements and elevations from the new and adjacent wells. The locations of the new wells were added to the existing wells, and shown on **Figure 5**. In addition, GPR anomalies were added to **Figure 5**.

The most significant compounds of interest with respect to locating the sources are PCE and TCE, and their degradation products. Groundwater chemistry results for PCE and TCE from the most recent sampling are posted beside the new wells. PCE and TCE groundwater chemistry from 2007 through 2009 are posted next to previously installed wells in the same format as used on plates in the Supplemental Remedial Investigation Groundwater Report (Part 1) (GSC, September 2011) (SRI GWR Part1).

On **Figures 6** and **7** pie diagrams showing the ratios of prominent VOCs were added, following Figure 4.1.2 of the SRI GWR Part1. The pie diagrams were examined to look for similarities of ratios of the VOCs and the degree of degradation that may be useful in sorting out multiple sources.

Building 58 MIP Boring Placement

Five (5) initial MIP borings will be placed near the anomalies from the GPR survey at Building 58. These locations are shown on **Figure 5** as yellow diamond (◊). They are located immediately northwest of the GPR anomalies, which is down gradient with respect to the groundwater table contours. These boring locations were selected prior to the availability of the groundwater chemistry data in order to have time to pre-clear the locations for utilities.

Depth to bedrock between Building 58 and Building 59 to the north, is known to be very deep based on existing wells MW-113 and MW-87. The addition of MW-126, -127, -128, and -129 surrounding the existing wells indicate higher bedrock surface elevations to the north and south, and consistently low bedrock surface elevations east and west, suggesting an east-west trending valley in the bedrock surface. Groundwater elevation contours show an even more distinct east-west trending valley in this area. Both of these configurations are shown on **Figure 5**. These configurations suggests a permeable zone in the aquifer most likely related to karst solutioning in the bedrock.

Groundwater chemistry in this area is primarily TCE in the 1 part per million (ppm) concentration range and cis 1,2 dichloroethene (cis1,2DCE) in existing wells MW-87 and MW-113. To the north (MW-126) and west (MW-129, CW-18) TCE concentrations are significantly lower. To the east (MW-128) and south (MW-127), TCE and cis1,2DCE concentrations are elevated (in the range of 0.5 to 1 parts per million (ppm). **Figure 6** shows that ratios of chlorinated compounds in MW-80, -87 and -113 are similar to MW-128 and MW-127, suggesting a common source. Please note that the sampling indicating soil to groundwater exceedances shown on the map near CW-18 are for chromium, not VOCs.

Based on these observations a series of MIP borings will be located to the south and east, extending out from the borings that will have been placed near the GPR anomalies. Nine locations are shown as green diamonds (◊) in this general vicinity, as shown on Figure 5. One boring is located near MW-126 to the north for “background” purposes. The results of these borings will be used to focus subsequent borings.

West Bldg 2 Corridor MIP Boring Placement

Seven initial borings will be placed around MW-132, where high photoionization detector (PID) readings were encountered during drilling, and between known soil VOC contamination 300 feet to the southeast (near MW-94) in the WBldg2 Corr. These boring locations were selected prior to the availability of the groundwater chemistry data in order to have time to pre-clear the locations for utilities. These locations are shown as yellow diamonds (◊).

The six (6) wells added surrounding the WBldg2 Corr provided considerable additional detail to the bedrock surface contours, indicating top of bedrock is lower under Bldg2 at MW-132 and MW-131. The groundwater level contours are also heavily influenced by the addition of these wells, resulting in a large low gradient area between the northwest corner of former Building 4 to the middle of the north end on Bldg2 (compare with Figure 3.4-1 from the SRI GWR Part1).

Figure 5 posts TCE values in MW-132 (the well that had high PID readings during drilling) that are similar to concentrations in MW-81S. Ratios of chlorinated solvents shown on the pie diagrams on **Figure 7** do not show a clear pattern, with the exception that MW-134 to the west of MW-81S&D have similar signatures. Lower concentrations in MW-134 relative to MW-81S&D, along with the groundwater gradient to the west, suggest MW-134 may have been sourced from the southeast. The higher concentrations and ratios of PCE in MW-27, -114, and -135 compared to MW-81S&D and wells to the east indicate at least two separate source locations.

The results of the groundwater analyses and comparison of ratios was less definitive in this area compared to the Bldg58 Area. For that reason, in addition to the previously selected MIP locations, MIP borings will be placed in close proximity to most wells in order to calibrate MIP results with groundwater quality. Those borings will be followed by borings spaced generally between and up gradient of wells showing high concentrations of VOCs. Sixteen (16) borings are positioned in this manner. The proposed locations are shown on **Figure 5** as green diamonds (◊).

Data collected from these MIP locations at each area will be used to guide the placement of later MIP sampling locations.

Field Procedures

Areas to be sampled using MIP technology will be marked on the ground surface and a utility clearance will be conducted. Concrete overlying the MIP locations will be cut and then the top approximately four feet will be advanced with vacuum excavation/air knifing to avoid contacting and damaging any subsurface utilities. MIP sampling will be conducted by Vironex, Inc. and supervised by Groundwater Sciences Corporation personnel. A Geoprobe will be used to push the MIP sampling device into the subsurface at a rate of approximately one foot per minute. MIP sampling will be performed to the depth of Geoprobe refusal for most exploratory holes. Once some definition of the vertical distribution of VOCs is established in an area, the depth may be limited to the vertical extent of the VOCs.

The ASTM International Standard Practice for Direct Push Technology for Volatile Contaminant Logging with the Membrane Interface Probe (Designation: D7352 – 07) is included as **Attachment 2**. The document identifies the apparatus, reagents, materials, and procedure for MIP sampling. The main output will be graphs of five parameters as shown on **Figure 8.** Combined, the sensors indicate stratigraphic changes and the occurrence of organic compounds, and whether those organic compounds are chlorinated.

MIP technology is considered a screening tool. Therefore, after MIP sampling is complete, soil or water from 10 to 15 percent of the MIP locations may be sampled. A Geoprobe with direct push technology will be used to collect the confirmatory soil samples or water samples. MIP probe locations will be selected for confirmatory sampling will be distributed over various conditions encountered and biased toward confirmation of suspected source areas. A boring will be located immediately adjacent (within 2 to 5 feet) of the MIP boring, depending on access and underground utilities. Collection of soil samples will be accomplished using macrocore sampling sleeve or dual wall sampling sleeve system if sloughing of the soil material occurs during sampling. Water samples will be obtained using a peristaltic pump, small diameter bailer or GeoProbe's SP-16 sampling system (see **Attachment 3**).

The samples will be put into laboratory-supplied containers and shipped to TestAmerica Laboratories for confirmatory analyses of VOCs via Method 8260B. Parameters to be tested are listed in Table A-6 of the Quality Assurance Project Plan (GSC, June 2012).

Sampling methodologies are further specified in Section 4.2.4.5 of the FSP and Section B.1.1, B.1.2, B.1.4 and Table B-1 of the QAAP.

Upon completion of the testing, the borehole will be filled with bentonite, and the top of the hole will be patched with materials to match the ground surface (concrete, bituminous patch, or top soil).

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TABLE 1

Groundwater Elevation Data

FORMER YORK NAVAL ORDNANCE PLANT

1425 Eden Road, York PA 17402

Monitoring Location	Date	Reference Elevation (ft. AMSL)	Depth to Groundwater	Water Level (ft. AMSL)
CW-15	7/2/2012	361.48	18.22	343.26
CW-15A	7/2/2012	361.4	25.49	335.91
MW-27	6/28/2012	361.29	17.48	343.81
MW-27	7/2/2012	361.29	17.5	343.79
MW-35D	7/2/2012	360.6	18.49	342.11
MW-35S	7/2/2012	360.49	18.07	342.42
MW-45	7/2/2012	359.91	17.49	342.42
MW-46	7/2/2012	359.19	17.33	341.86
MW-47	7/2/2012	360.57	19.09	341.48
MW-49D	7/2/2012	361.44	17.76	343.68
MW-49S	7/2/2012	361.45	17.84	343.61
MW-54	7/2/2012	365.26	23.16	342.10
MW-55	7/2/2012	365.22	23.03	342.19
MW-80	7/6/2012	370.29	25.6	344.69
MW-81D	6/28/2012	359.89	16.71	343.18
MW-81D	7/2/2012	359.89	16.73	343.16
MW-81S	6/28/2012	360.12	17.61	342.51
MW-81S	7/2/2012	360.12	17.44	342.68
MW-83	6/28/2012	363.69	25.32AN	338.37AN
MW-83	7/2/2012	363.69	9.15	354.54
MW-87	6/28/2012	370.64	25.87	344.77
MW-87	7/6/2012	370.64	25.86	344.78
MW-94	7/2/2012	365.03	9.77	355.26
MW-113	6/28/2012	371.02	26.11	344.91
MW-113	7/6/2012	371.02	25.9	345.12
MW-114	6/28/2012	360.71	17.4	343.31
MW-114	7/2/2012	360.71	17.52	343.19
MW-126	6/28/2012	371.4202	25.71	345.71
MW-126	7/6/2012	371.4202	27.14	344.28
MW-127	6/28/2012	371.549	26.33	345.22
MW-127	7/6/2012	371.549	26.85	344.70
MW-128	6/28/2012	370.5761	25.54	345.04
MW-128	7/6/2012	370.5761	25.88	344.70
MW-129	6/28/2012	365.4081	19.89	345.52
MW-129	7/6/2012	365.4081	20.87	344.54
MW-130	6/28/2012	362.1467	19.61	342.54
MW-130	7/2/2012	362.1467	19.52	342.63
MW-131	6/28/2012	365.3489	21.61	343.74
MW-131	7/2/2012	365.3489	21.56	343.79
MW-132	6/28/2012	365.3011	21.29	344.01
MW-132	7/2/2012	365.3011	21.26	344.04
MW-133	6/28/2012	365.3126	21.23	344.08
MW-133	7/2/2012	365.3126	21.22	344.09
MW-134	6/28/2012	361.2118	17.6	343.61
MW-134	7/2/2012	361.2118	17.59	343.62
MW-135	6/28/2012	361.5747	17.93	343.64
MW-135	7/2/2012	361.5747	17.97	343.60

Note:

A= Location was artesian.

D= Location was dry.

AN= Anomalous Reading

DDC= Gauged on different date due to inaccessibility.

OG= Water was over the gauge.

fYNOP FSP Addendum 4 Table2

Preliminary Groundwater Data Summary - MW-126 Through MW-135 Initial Sampling

			PA MSC Used Aquifer R	180-12206-1	180-12206-2	180-12206-3	180-12206-4	180-12124-1	180-12163-1	180-12163-2	180-12163-3	180-12163-4	180-12124-2
				HD-MW-126-0/1-0	HD-MW-127-0/1-0	HD-MW-128-0/1-0	HD-MW-129-0/1-0	HD-MW-130-0/1-0	HD-MW-131-0/1-0	HD-MW-132-0/1-0	HD-MW-133-0/1-0	HD-MW-134-0/1-0	HD-MW-135-0/1-0
Analyte	CAS Number	Units	(ug/L)	7/6/2012 12:25	7/6/2012 11:25	7/6/2012 12:30	7/6/2012 10:00	7/2/2012 15:35	7/5/2012 11:25	7/5/2012 14:30	7/5/2012 14:35	7/5/2012 10:25	7/2/2012 12:15
VOC- 8260 ug/L													
1,1,1,2-Tetrachloroethane	630-20-6	ug/L	70	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
1,1,1-Trichloroethane	71-55-6	ug/L	200	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
1,1,2,2-Tetrachloroethane	79-34-5	ug/L	0.84	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
1,1,2-Trichloroethane	79-00-5	ug/L	5	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
1,1-Dichloroethane	75-34-3	ug/L	31	1 U	50 U	25 U	10 U	100 U	250 U	***92 J***	***0.27 J***	25 U	***9.4 J***
1,1-Dichloroethene	75-35-4	ug/L	7	1 U	***30 J***	***14 J***	***5.7 J***	***41 J***	250 U	***160 J***	***1.2***	***9 J***	***17 J***
1,2-Dibromoethane (EDB)	106-93-4	ug/L	0.05	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
1,2-Dichloroethane	107-06-2	ug/L	5	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
1,2-Dichloropropane	78-87-5	ug/L	5	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
1,4-Dioxane	123-91-1	ug/L	6.4	200 U	10000 U	5000 U	2000 U	20000 U	50000 U	50000 U	200 U	5000 U	8000 U
2-Butanone (MEK)	78-93-3	ug/L	4000	5 U	250 U	130 U	50 U	500 U	1300 U	1300 U	5 U	130 U	200 U
2-Hexanone	591-78-6	ug/L	11	5 U	250 U	130 U	50 U	500 U	1300 U	1300 U	5 U	130 U	200 U
4-Methyl-2-pentanone (MIBK)	108-10-1	ug/L	2900	5 U	250 U	130 U	50 U	500 U	1300 U	1300 U	5 U	130 U	200 U
Acetone	67-64-1	ug/L	33000	5 U	250 U	130 U	50 U	500 U	1300 U	1300 U	5 U	130 U	200 U
Acrylonitrile	107-13-1	ug/L	0.72	20 U	1000 U	500 U	200 U	2000 U	5000 U	5000 U	20 U	500 U	800 U
Benzene	71-43-2	ug/L	5	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
Bromochloromethane	74-97-5	ug/L	90	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
Bromodichloromethane	75-27-4	ug/L	80	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
Bromoform	75-25-2	ug/L	80	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
Bromomethane	74-83-9	ug/L	10	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
Carbon disulfide	75-15-0	ug/L	1500	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
Carbon tetrachloride	56-23-5	ug/L	5	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
Chlorobenzene	108-90-7	ug/L	100	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
Chloroethane	75-00-3	ug/L	230	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
Chloroform	67-66-3	ug/L	80	1 U	50 U	25 U	10 U	100 U	250 U	250 U	***0.2 J***	25 U	40 U
Chloromethane	74-87-3	ug/L	30	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
cis-1,2-Dichloroethene	156-59-2	ug/L	70	***2.6***	***590***	***210***	***200***	***690***	***1100***	***3600***	11	***270***	***730***
cis-1,3-Dichloropropene	10061-01-5	ug/L		1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
Dibromochloromethane	124-48-1	ug/L	80	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
Ethylbenzene	100-41-4	ug/L	700	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
Methyl tert-butyl ether	1634-04-4	ug/L	20	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
Methylene Chloride	75-09-2	ug/L	5	1 U	***17 J B***	***14 J B***	***5.1 J B***	***64 J B***	***100 J B***	***160 J B***	1 U	***16 J B***	***27 J B***
Styrene	100-42-5	ug/L	100	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
Tetrachloroethene	127-18-4	ug/L	5	***0.2 J***	***33 J***	***11 J***	10 U	***25 J***	250 U	250 U	***0.15 J***	***41***	***420***
Toluene	108-88-3	ug/L	1000	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
trans-1,2-Dichloroethene	156-60-5	ug/L	100	1 U	50 U	25 U	**19**	100 U	250 U	250 U	1 U	25 U	40 U
trans-1,3-Dichloropropene	10061-02-6	ug/L		1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
Trichloroethene	79-01-6	ug/L	5	***4.5***	***1200***	***420***	***67***	***1300***	***4000***	***3800***	***27***	***620***	***410***
Vinyl chloride	75-01-4	ug/L	2	1 U	50 U	25 U	10 U	100 U	250 U	250 U	1 U	25 U	40 U
Xylenes, Total	1330-20-7	ug/L	10000	3 U	150 U	75 U	30 U	300 U	750 U	750 U	3 U	75 U	120 U

All Data is to be considered preliminary.
PA MSC standards are from TestAmerica's TotalAccess system and have not been proofed for accuracy.

DNA-Labratory has not made data available at time of report.
NA- Not analyzed for.

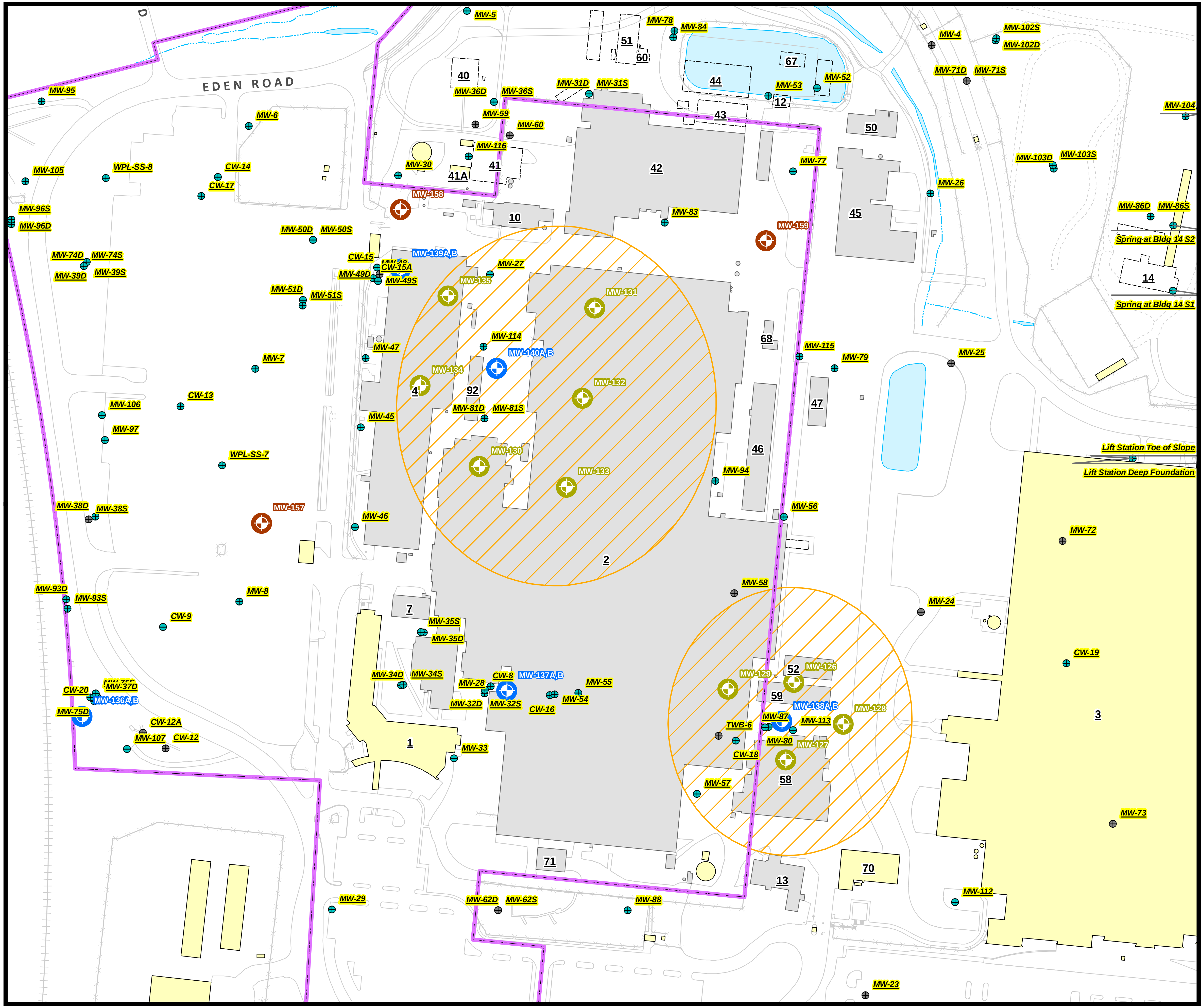
			PA MSC Used	180-12206-1	180-12206-2	180-12206-3	180-12206-4	180-12124-1	180-12163-1	180-12163-2	180-12163-3	180-12163-4	180-12124-2
			Aquifer R	HD-MW-126-0/1-0	HD-MW-127-0/1-0	HD-MW-128-0/1-0	HD-MW-129-0/1-0	HD-MW-130-0/1-0	HD-MW-131-0/1-0	HD-MW-132-0/1-0	HD-MW-133-0/1-0	HD-MW-134-0/1-0	HD-MW-135-0/1-0
Analyte	CAS Number	Units	(ug/L)	7/6/2012 12:25	7/6/2012 11:25	7/6/2012 12:30	7/6/2012 10:00	7/2/2012 15:35	7/5/2012 11:25	7/5/2012 14:30	7/5/2012 14:35	7/5/2012 10:25	7/2/2012 12:15
SVOC- 8270C ug/L													
1,2,4-Trichlorobenzene	120-82-1	ug/L	70	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
1,2-Dichlorobenzene	95-50-1	ug/L	600	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
1,3-Dichlorobenzene	541-73-1	ug/L	600	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
1,4-Dichlorobenzene	106-46-7	ug/L	75	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
2,4,5-Trichlorophenol	95-95-4	ug/L	3700	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
2,4,6-Trichlorophenol	88-06-2	ug/L	37	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
2,4-Dichlorophenol	120-83-2	ug/L	20	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
2,4-Dimethylphenol	105-67-9	ug/L	730	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
2,4-Dinitrophenol	51-28-5	ug/L	73	48 U	48 U	48 U	48 U	49 U	48 U	48 U	49 U	48 U	48 U
2,4-Dinitrotoluene	121-14-2	ug/L	2.1	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
2,6-Dinitrotoluene	606-20-2	ug/L	37	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
2-Chloronaphthalene	91-58-7	ug/L	2900	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
2-Chlorophenol	95-57-8	ug/L	40	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
2-Methylnaphthalene	91-57-6	ug/L	150	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
2-Methylphenol	95-48-7	ug/L	1800	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
2-Nitroaniline	88-74-4	ug/L	110	48 U	48 U	48 U	48 U	49 U	48 U	48 U	49 U	48 U	48 U
2-Nitrophenol	88-75-5	ug/L	290	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
3,3'-Dichlorobenzidine	91-94-1	ug/L	1.5	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
3-Nitroaniline	99-09-2	ug/L	11	48 U	48 U	48 U	48 U	49 U	48 U	48 U	49 U	48 U	48 U
4,6-Dinitro-2-methylphenol	534-52-1	ug/L	3.7	48 U	48 U	48 U	48 U	49 U	48 U	48 U	49 U	48 U	48 U
4-Bromophenyl phenyl ether	101-55-3	ug/L		9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
4-Chloro-3-methylphenol	59-50-7	ug/L	180	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
4-Chloroaniline	106-47-8	ug/L	3.3	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
4-Chlorophenyl phenyl ether	7005-72-3	ug/L		9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
4-Nitroaniline	100-01-6	ug/L	33	48 U	48 U	48 U	48 U	49 U	48 U	48 U	49 U	48 U	48 U
4-Nitrophenol	100-02-7	ug/L	60	48 U	48 U	48 U	48 U	49 U	48 U	48 U	49 U	48 U	48 U
Acenaphthene	83-32-9	ug/L	2200	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Acenaphthylene	208-96-8	ug/L	2200	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Anthracene	120-12-7	ug/L	66	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Benzo[a]anthracene	56-55-3	ug/L	0.29	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Benzo[a]pyrene	50-32-8	ug/L	0.2	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Benzo[b]fluoranthene	205-99-2	ug/L	0.29	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Benzo[g,h,i]perylene	191-24-2	ug/L	0.26	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Benzo[k]fluoranthene	207-08-9	ug/L	0.55	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
bis (2-chloroisopropyl) ether	108-60-1	ug/L	300	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Bis(2-chloroethoxy)methane	111-91-1	ug/L	110	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
Bis(2-chloroethyl)ether	111-44-4	ug/L	0.15	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Bis(2-ethylhexyl) phthalate	117-81-7	ug/L	6	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U
Butyl benzyl phthalate	85-68-7	ug/L	350	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
Carbazole	86-74-8	ug/L	33	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Chrysene	218-01-9	ug/L	1.9	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Dibenz(a,h)anthracene	53-70-3	ug/L	0.029	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Dibenzofuran	132-64-9	ug/L	37	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
Diethyl phthalate	84-66-2	ug/L	29000	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
Dimethyl phthalate	131-11-3	ug/L		9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
Di-n-butyl phthalate	84-74-2	ug/L	3700	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
Di-n-octyl phthalate	117-84-0	ug/L	1500	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
Fluoranthene	206-44-0	ug/L	260	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Fluorene	86-73-7	ug/L	1500	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Hexachlorobenzene	118-74-1	ug/L	1	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Hexachlorobutadiene	87-68-3	ug/L	8.5	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Hexachlorocyclopentadiene	77-47-4	ug/L	50	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
Hexachloroethane	67-72-1	ug/L	1	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
Indeno[1,2,3-cd]pyrene	193-39-5	ug/L	0.29	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Isophorone	78-59-1	ug/L	100	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
Methylphenol, 3 & 4	106-44-5	ug/L	180	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
Naphthalene	91-20-3	ug/L	100	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Nitrobenzene	98-95-3	ug/L	73	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U	19 U
N-Nitrosodi-n-propylamine	621-64-7	ug/L	0.094	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
N-Nitrosodiphenylamine	86-30-6	ug/L	130	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
Pentachlorophenol	87-86-5	ug/L	1	9.6 U	9.6 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U	9.7 U	9.6 U	9.6 U
Phenanthrene	85-01-8	ug/L	1100	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Phenol	108-95-2	ug/L	2000	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U
Pyrene	129-00-0	ug/L	130	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U	1.9 U

fYNOP FSP Addendum 4 Table2
Preliminary Groundwater Data Summary - MW-126 Through MW-135 Initial Sampling

Analyte	CAS Number	Units	PA MSC Used Aquifer R (ug/L)	180-12206-1	180-12206-2	180-12206-3	180-12206-4	180-12124-1	180-12163-1	180-12163-2	180-12163-3	180-12163-4	180-12124-2
				HD-MW-126-0/1-0	HD-MW-127-0/1-0	HD-MW-128-0/1-0	HD-MW-129-0/1-0	HD-MW-130-0/1-0	HD-MW-131-0/1-0	HD-MW-132-0/1-0	HD-MW-133-0/1-0	HD-MW-134-0/1-0	HD-MW-135-0/1-0
				7/6/2012 12:25	7/6/2012 11:25	7/6/2012 12:30	7/6/2012 10:00	7/2/2012 15:35	7/5/2012 11:25	7/5/2012 14:30	7/5/2012 14:35	7/5/2012 10:25	7/2/2012 12:15
SVOC- 8270C LL ug/L													
1,4-Dioxane	123-91-1	ug/L	6.4	1.9 U	***24***	***8.8***	5.3	***13***	***14***	***60***	0.95 J	***57***	***10***
Dissolved Metals 6020 ug/L													
Antimony	7440-36-0	ug/L	6	**0.58 J B**	**0.23 J B**	**0.14 J B**	**0.14 J B**	2 U	**0.38 J B**	**0.38 J B**	**0.19 J B**	**0.15 J B**	2 U
Arsenic	7440-38-2	ug/L	10	**0.62 J B**	**0.55 J B**	**0.51 J B**	1.7 B	1 U	1 U	1 U	1 U	1 U	1 U
Barium	7440-39-3	ug/L	2000	***41***	***13***	***19***	***65***	***82***	***49***	***28***	***51***	***55***	***71***
Beryllium	7440-41-7	ug/L	4	**0.039 J**	1 U	**0.041 J**	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Cadmium	7440-43-9	ug/L	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chromium	7440-47-3	ug/L	100	***1 J***	***1.2 J***	***1.4 J***	***0.89 J***	***1.9 J***	***1.5 J***	***1.4 J***	***2***	***2.2***	***2***
Copper	7440-50-8	ug/L	1000	***1.1 J***	***0.77 J***	***0.86 J***	***0.69 J***	***2.1 B***	***1.9 J***	***1.3 J***	***1.5 J***	***1.5 J***	***2.5 B***
Lead	7439-92-1	ug/L	5	***0.12 J***	***0.025 J***	***0.047 J***	***0.021 J***	***0.019 J B***	***0.16 J B***	***0.083 J B***	***0.097 J B***	***0.047 J B***	***0.034 J B***
Nickel	7440-02-0	ug/L	100	**0.59 J**	1 U	1 U	**0.87 J**	**0.46 J**	1.7	**0.75 J**	**0.81 J**	**0.92 J**	8
Selenium	7782-49-2	ug/L	50	**3.2 J B**	**2.9 J B**	5 U	**0.65 J B**	5 U	5 U	5 U	5 U	5 U	5 U
Silver	7440-22-4	ug/L	100	1 U	1 U	1 U	1 U	1 U	**0.038 J**	1 U	1 U	1 U	**0.054 J**
Thallium	7440-28-0	ug/L	2	**0.5 J**	**0.082 J**	**0.067 J**	**0.06 J**	**0.029 J**	**0.35 J**	**0.31 J**	**0.12 J**	**0.088 J**	**0.037 J**
Vanadium	7440-62-2	ug/L	260	**0.35 J**	1 U	1 U	1 U	1 U	1 U	**0.41 J**	**0.59 J**	**0.45 J**	1 U
Zinc	7440-66-6	ug/L	2000	**3.1 J**	**4.9 J**	**3.5 J**	5.2	**3.8 J B**	**3.7 J**	**4.6 J**	5.6	**4 J**	6.2 B
Dissolved Mercury 7470A ug/L													
Mercury	7439-97-6	ug/L	2	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Total Metals 6020 ug/L													
Antimony	7440-36-0	ug/L	6	**0.45 J**	**0.16 J**	**0.072 J**	**0.14 J**	**0.12 J B**	**0.38 J B**	**0.44 J B**	**0.24 J B**	**0.24 J B**	**0.063 J B**
Arsenic	7440-38-2	ug/L	10	**0.39 J**	**0.72 J**	**0.43 J**	2.4	1 U	1.0 U	1.0 U	1.0 U	1.0 U	**0.52 J B**
Barium	7440-39-3	ug/L	2000	40	14	20	68	**80**	**53**	**31**	**55**	**56**	66
Beryllium	7440-41-7	ug/L	4	**0.045 J**	**0.048 J**	1 U	**0.071 J**	1 U	**0.058 J**	0.050 J	1.0 U	1.0 U	1 U
Cadmium	7440-43-9	ug/L	5	1 U	1 U	1 U	1 U	1 U	1.0 U	1.0 U	1.0 U	1.0 U	1 U
Chromium	7440-47-3	ug/L	100	**1.1 J**	**1.5 J**	**1.2 J**	2	**6.8**	**1.9 J**	**1.6 J**	2.4	**1.5 J**	6.5
Copper	7440-50-8	ug/L	1000	**1.2 J**	**1.1 J**	**0.92 J**	**1.3 J**	**0.98 J**	**1.9 J**	**1.4 J**	**1.5 J**	**1.2 J**	**1.2 J**
Lead	7439-92-1	ug/L	5	**0.054 J**	**0.1 J**	**0.1 J**	**0.69 J**	**0.13 J B**	**0.30 J**	**0.055 J**	**0.13 J**	**0.064 J**	**0.041 J B**
Nickel	7440-02-0	ug/L	100	**0.54 J**	**0.33 J**	1 U	1.6	**0.53 J**	2.3	**0.71 J**	**0.86 J**	**1**	6.6
Selenium	7782-49-2	ug/L	50	**1.1 J B**	**1.5 J B**	**1.5 J B**	**2.2 J B**	5 U	5.0 U	5.0 U	5.0 U	5.0 U	5 U
Silver	7440-22-4	ug/L	100	1 U	1 U	1 U	1 U	1 U	**0.048 J**	**0.037 J**	1.0 U	1.0 U	**0.04 J**
Thallium	7440-28-0	ug/L	2	**0.39 J**	**0.075 J**	**0.068 J**	**0.067 J**	**0.053 J B**	**0.32 J B**	**0.33 J B**	**0.12 J B**	**0.11 J B**	**0.04 J B**
Vanadium	7440-62-2	ug/L	260	**0.12 J**	1 U	1 U	**0.4 J**	**9.1 B**	1.0 U	1.0 U	**0.27 J**	1.0 U	9 B
Zinc	7440-66-6	ug/L	2000	**5.3**	**4.7 J**	**5.8**	**5.3**	**1.6 J**	**3.7 J B**	**5.8 B**	**5.4 B**	**2.5 J B**	**1.6 J**
Total Mercury 7470A ug/L													
Mercury	7439-97-6	ug/L	2	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Miscelanous													
Available cyanide	N/A	mg/L		0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Cyanide, Total	57-12-5	mg/L		**0.0016 J**	0.01 U	0.01 U	0.01 U	**0.0019 J**	**0.0018 J**	0.01 U	0.01 U	0.01	0.01 U
Hexavalent chromium	18540-29-9	mg/L		0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	**0.0033 J**	0.01 U	0.01 U	**0.0058 J**	0.01 U
Hexavalent chromium	18540-29-9	mg/L		**0.0046 J**	**0.0033 J**	0.01 U	**0.0046 J**	**0.0033 J**	0.01 U	**0.0058 J**	**0.0039 J**	**0.0052 J**	0.012

All Data is to be considered preliminary.
PA MSC standards are from TestAmerica's TotalAccess system and have not been proofed for accuracy.

DNA-Labratory has not made data available at time of report.
NA- Not analyzed for.



LEGEND

- Proposed Vertical Extent Wells
- Proposed Shallow Air Rotary
- Proposed Stratigraphic Boring
- Abandoned Wells
- Active Wells
- West Campus Property Line
- MIP Sampling Area
- Existing Building to Remain
- Demolished
- Demolished/Slab Removed
- Railroad
- Road (Paved)
- Road Curb
- Road (Unpaved)
- Walkway
- Fenceline

Scale (feet)
0 50 100 200

Figure 1

Former York Naval Ordnance Plant

1425 Eden Road, York, PA 17402

West Building 2 and Building 58
Source Area Investigations

DRAWN BY: JPB	CHECKED AND APPROVED BY: SMS	DATE: 4/13/2012

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GROUNDWATER SCIENCES CORPORATION

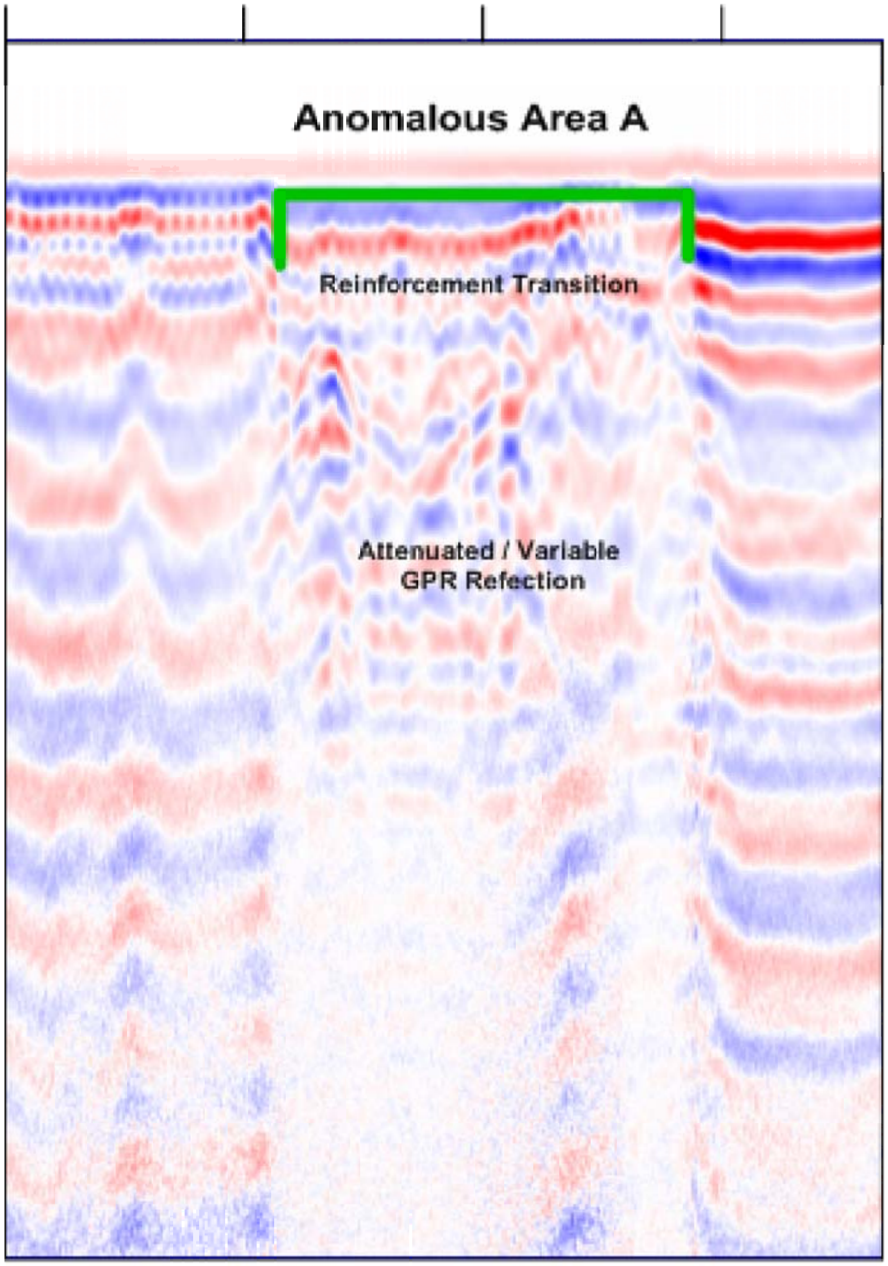

Figure 2

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

Building 58 GPR Anomalous Area A

DRAWN BY: AGM	DATE: 7/23/2012	DRAWN NO: Anom_A_20120723
CHECKED & APPROVED BY: SMS		

GROUNDWATER SCIENCES CORPORATION

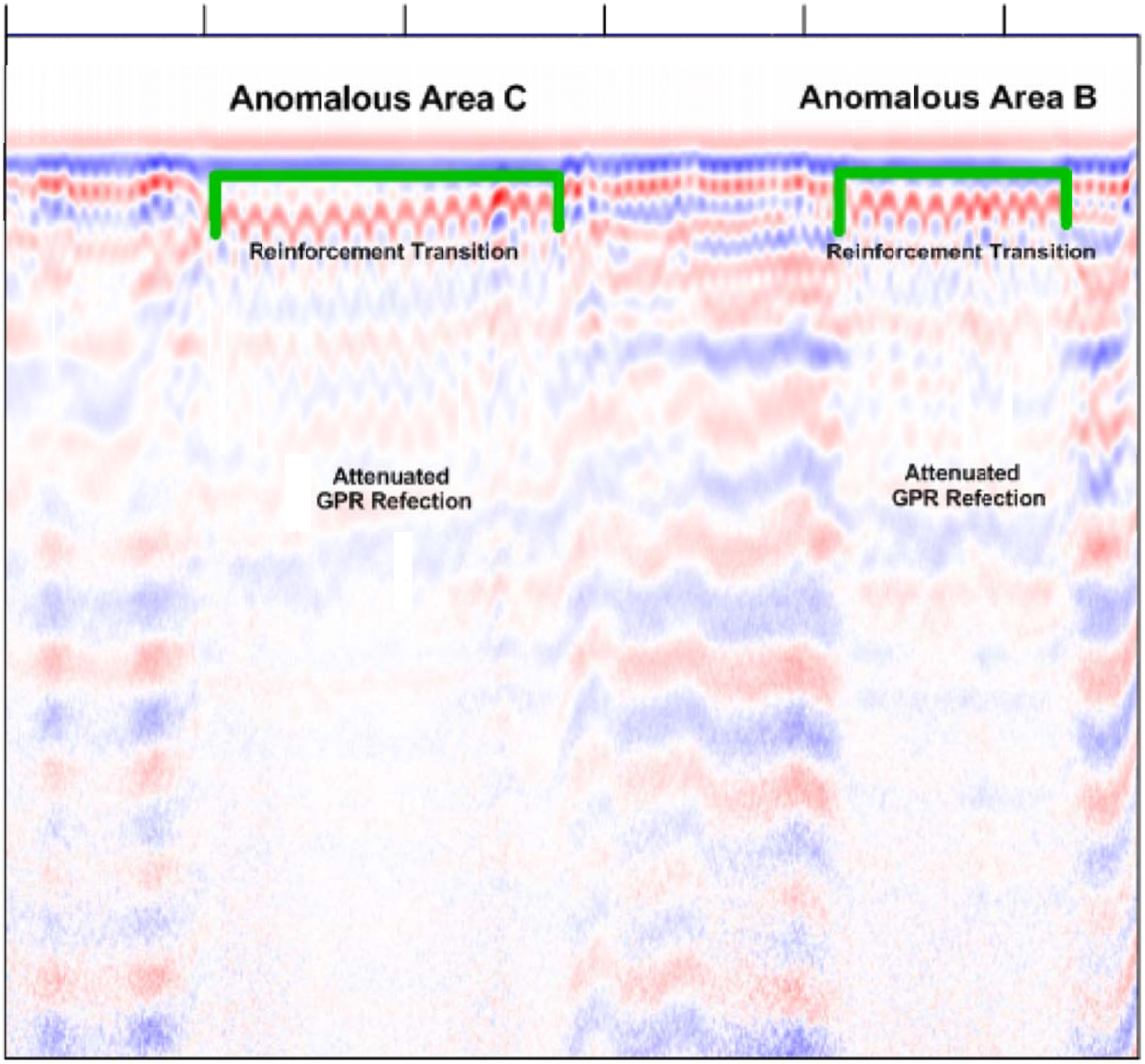

Figure 3

Former York Naval Ordnance Plant

1425 Eden Road, York, PA 17402

Building 58 GPR Anomalous Area B and C

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CHECKED & APPROVED BY: SMS		

GROUNDWATER SCIENCES CORPORATION

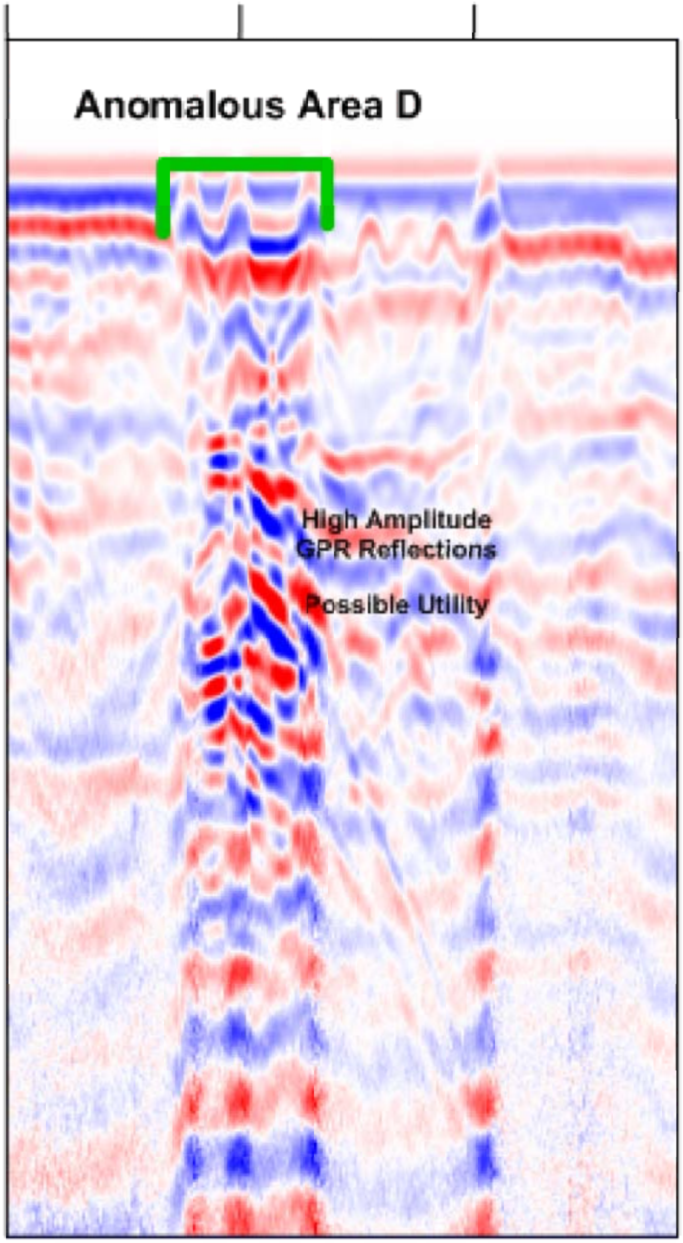

Figure 4

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

Building 58 GPR Anomalous Area D

DRAWN BY: AGM	DATE: 7/23/2012	DRAWN NO: Anom_D_20120723
CHECKED & APPROVED BY: SMS		

GROUNDWATER SCIENCES CORPORATION

For New Wells MW-126thru 135
Location ID
Trichloroethene and Tetrachloroethylene
June-July 2012

For all Wells with #s < MW-126
Location ID
Top of Open Interval FtBGS - Bottom of Open Interval FtBGS (Open Interval Thickness)
Trichloroethene and Tetrachloroethylene
1. 2007 Key Well (May-June 2007)
2. 2008 Sup RI Rnd 1 (April-May 2008)
3. 2008 Sup RI Rnd 2 (September-October 2008)
4. 2009 Key Well (June-July 2009)

Legend

- Pre-Located MIP Boring
- Proposed MIP Boring
- Building 58 Anomalous Areas
- Monitoring Well
- Active Collection Well
- Residential Well
- Lift Station
- Spring
- Gauged Wells
- Soil Samples Collected Prior to 1/1/2007
- Soil Samples Collected After 1/1/2007 (Current Investigation)
- Exceeds Direct Contact and Soil to Groundwater MSC
- Results > or = Direct Contact MSC (0-2' and 2'-15')
- Results > or = Soil to Groundwater MSC
- Soil to Groundwater or Direct Contact MSC Exceedance that has been excavated

June/July 2012 Groundwater Contour

- Groundwater Contour (FAMSL)
- Inferred Groundwater Contour (FAMSL)
- Major Bedrock Contour Closed Depression
- Major Bedrock Contour
- Minor Bedrock Contour
- Fracture Trace
- Bedrock Surface Depression Following Bedrock Contact
- Bedrock Surface Depression - 330 Contours
- West Campus Property Line
- Existing Building to Remain
- Demolished
- Demolished/Slab Removed

- Road (Paved)
- Road Curb
- Road (Unpaved)
- Walkway
- Fenceline

Scale (feet)
0 25 50 100

Figure 5

Former York Naval Ordnance Plant
Location

MIP Placement Map

DRAWN BY: AGM	DATE: 7/18/2012	DRAWING NO.
CHECKED & APPROVED BY: SMS		

GROUNDWATER SCIENCES CORPORATION

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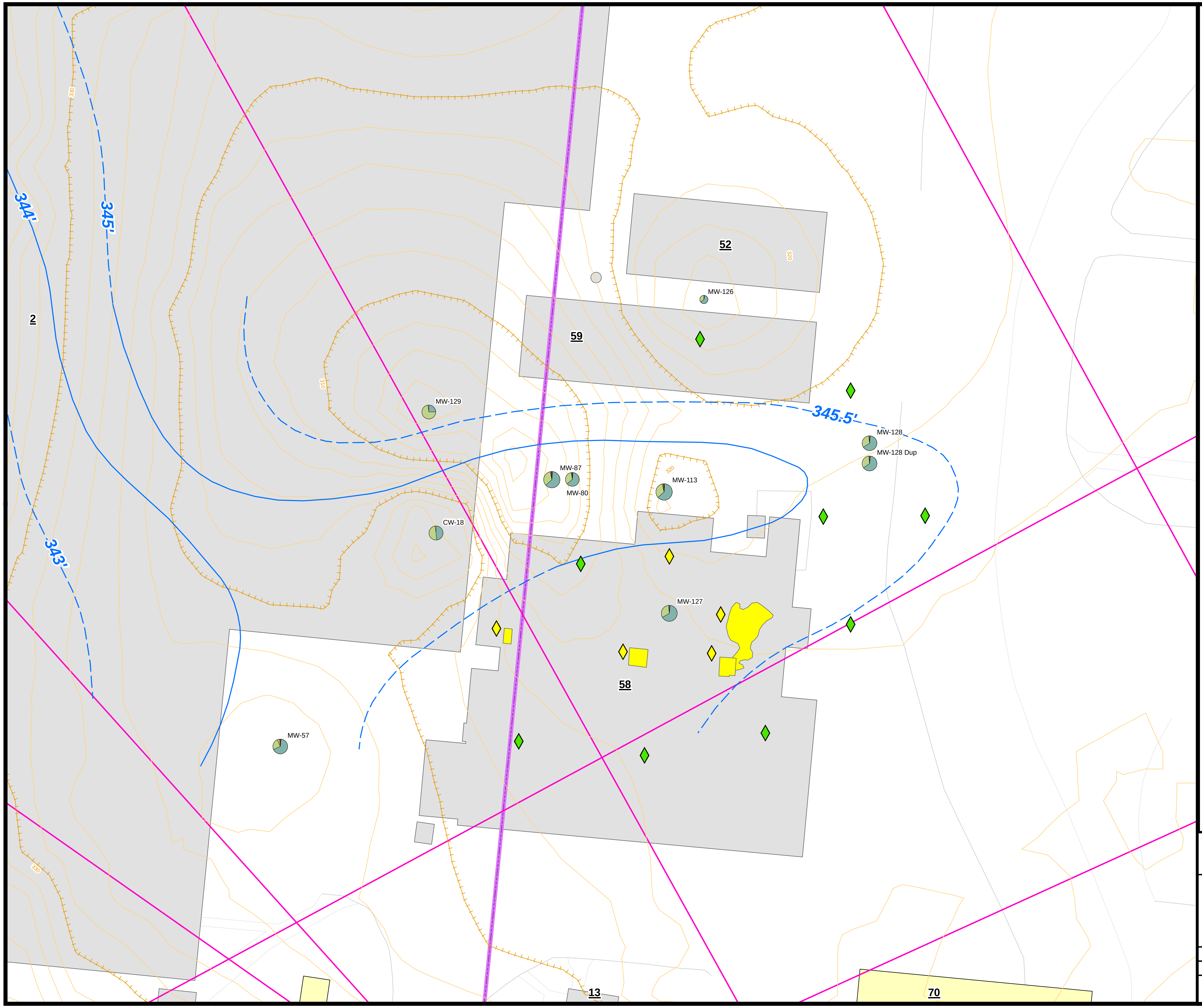

N
W E
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LEGEND

10ppb 100ppb 1000ppb 10000ppb

- 🟦 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)
- Groundwater Contour (FAMSL) (June/July 2012)
- Inferred Groundwater Contour (FAMSL) (June/July 2012)
- Oct. 2008 Groundwater Divide
- Major Bedrock Contour Closed Depression
- Major Bedrock Contour
- Minor Bedrock Contour
- Fracture Trace
- Cv Vintage Formation
- West Campus Property Line
- Building to Remain
- Building Demolished
- Roads and Curb Boundary (2006)
- ◆ Pre-Located MIP Boring
- ◆ Proposed MIP Boring
- 🟨 Building 58 Anomalous Areas

NOTE: Pie diagrams are based on 1st Round Supplemental RI sampling, April/May 2008. MW-126 through MW-129 Pie diagrams are from July 2012.

Scale (feet)
0 25 50 100

Figure 6

Former York Naval Ordnance Plant

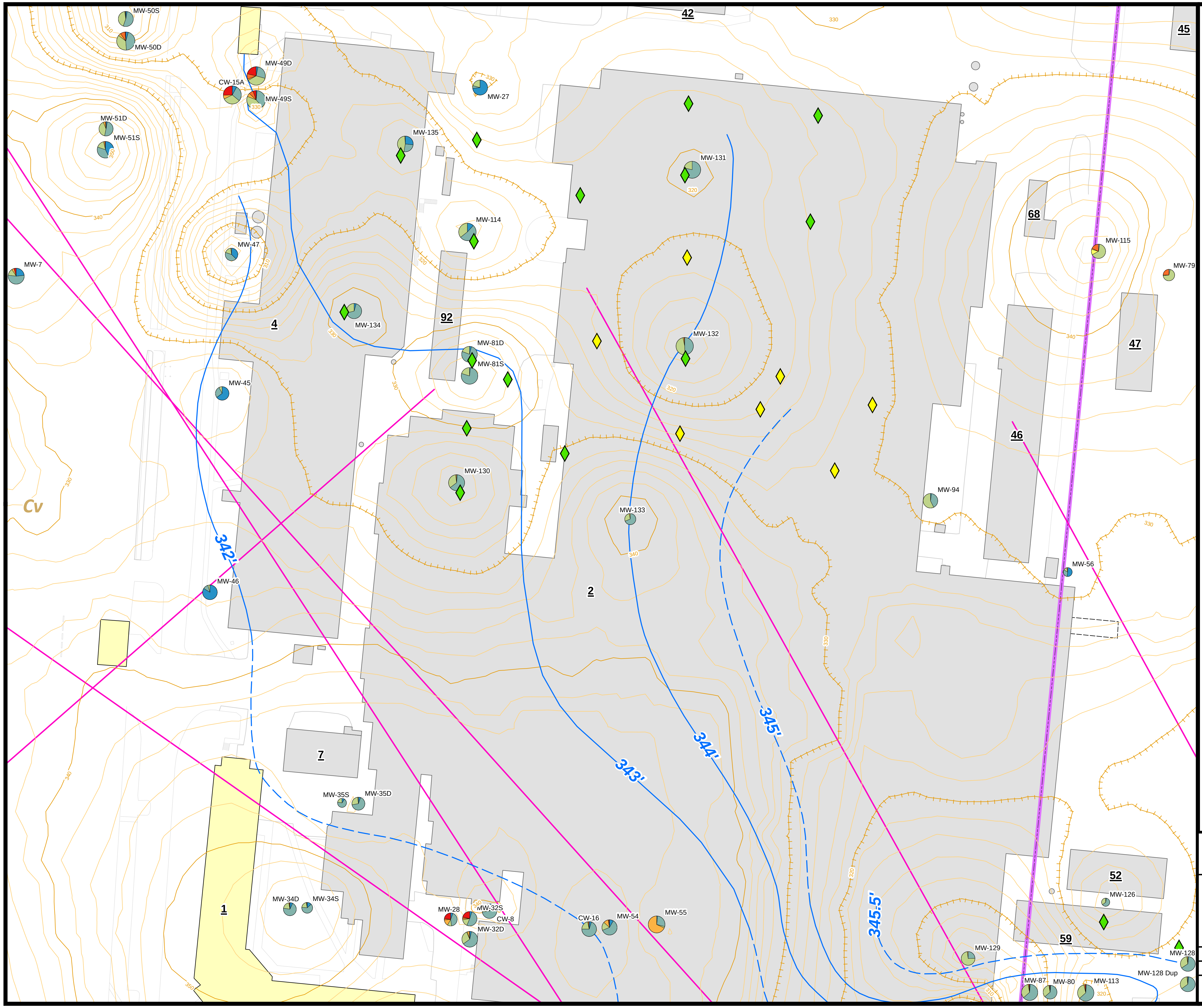
1425 Eden Road, York, PA 17402

Former Buidling 58 Area
Graduated Pie Diagrams of
Prominent CVOCs in Groundwater

DRAWN BY: JPB	CHECKED AND APPROVED BY: SMS	DATE: 8/9/2011

K:\10000\10012\Projects\2012 Field Sampling Plan\Aden_4\Building_58_CVOC_20120720.mxd

GROUNDWATER SCIENCES CORPORATION



N
E
S
W

LEGEND

10ppb 100ppb 1000ppb 10000ppb

- 🟦 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)
- — Groundwater Contour (FAMSL) (June/July 2012)
- – – Inferred Groundwater Contour (FAMSL) (June/July 2012)
- –·– Oct. 2008 Groundwater Divide
- ┴┴┴ Major Bedrock Contour Closed Depression
- — Major Bedrock Contour
- — Minor Bedrock Contour
- — Fracture Trace
- Cv Vintage Formation
- ▭ West Campus Property Line
- 🟨 Building to Remain
- ⬜ Building Demolished
- — Roads and Curb Boundary (2006)
- ◆ Pre-Located MIP Boring
- ◆ Proposed MIP Boring

NOTE: Pie diagrams are based on 1st Round Supplemental RI sampling, April/May 2008. MW-130 through MW-135 Pie diagrams are from July 2012.

Scale (feet)
0 50 100 200

Figure 7

Former York Naval Ordnance Plant

1425 Eden Road, York, PA 17402

Former Buidling 2 Corridor Area
Graduated Pie Diagrams of
Prominent CVOCs in Groundwater

DRAWN BY: JPB	**CHECKED AND APPROVED BY:** SMS	**DATE:** 8/9/2011

Q:\10000\10012\Projects\2012 Field Sampling Plan\Aden_4\Bld2 Corridor_CVOC_20120720.mxd

GROUNDWATER SCIENCES CORPORATION

4961 Telsa Drive
Suite E
Bowie, MD 20715
P:301-352-6642
F:301-352-6643
www.vironex.com

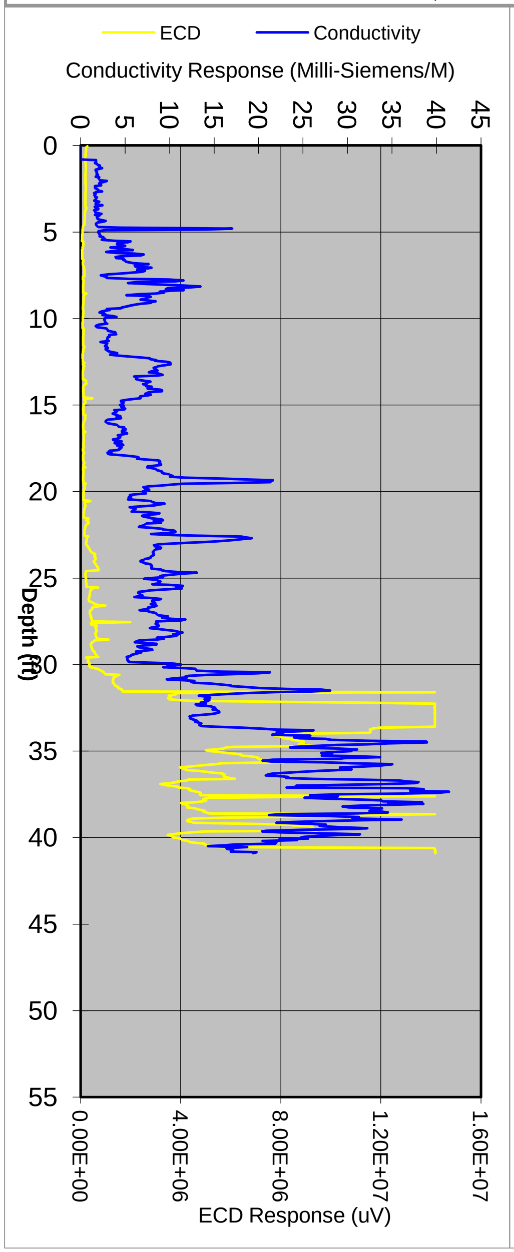
Boring Name: **WB2COR-MP-004** **Total Depth (ft):** **40.90**

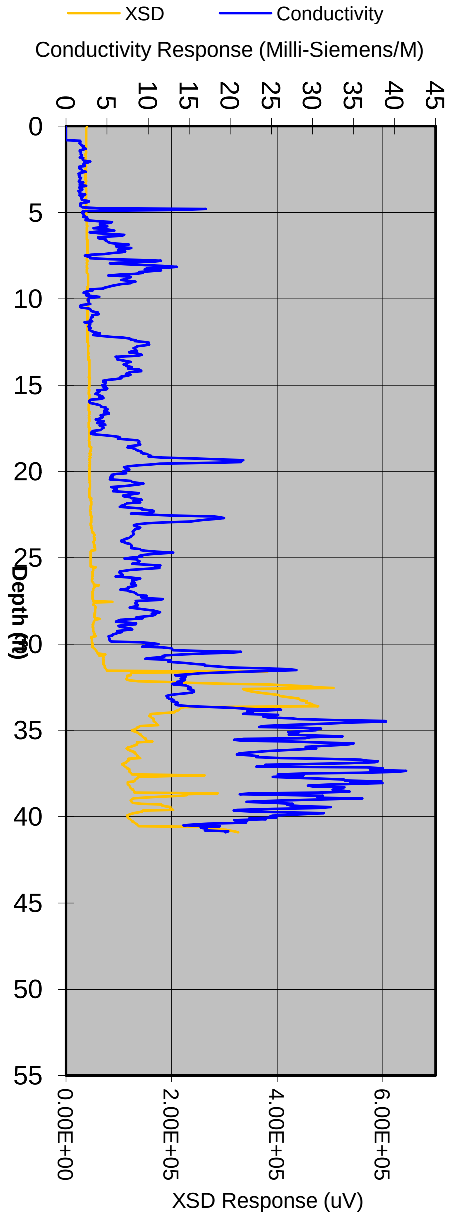
Notes:
Concrete and soil cleared by airknife to 5 feet bgs. Refusal at 40.90 feet bgs.

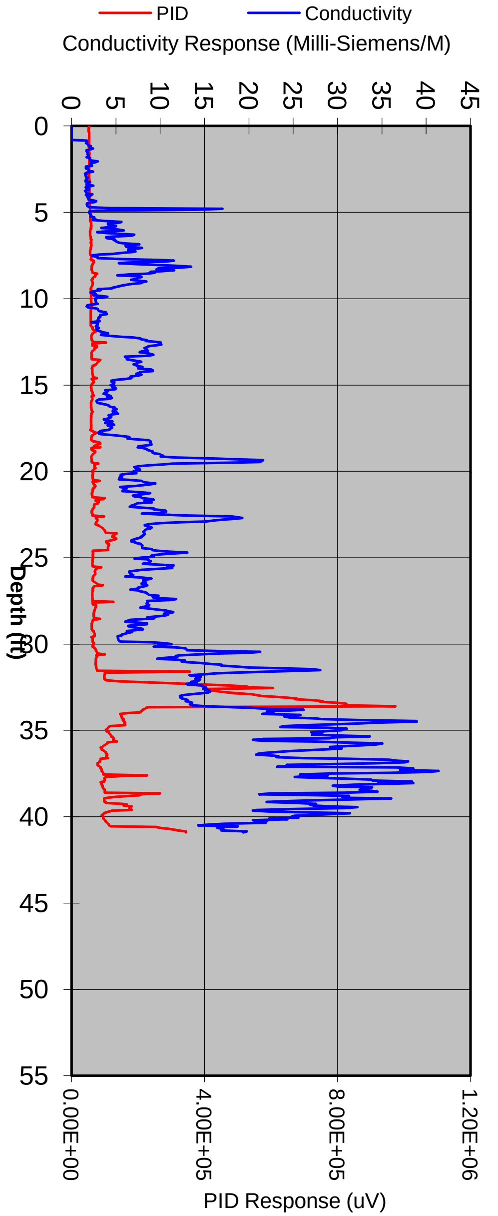
GW Depth (ft): 19
Depth of GW Provided by Client

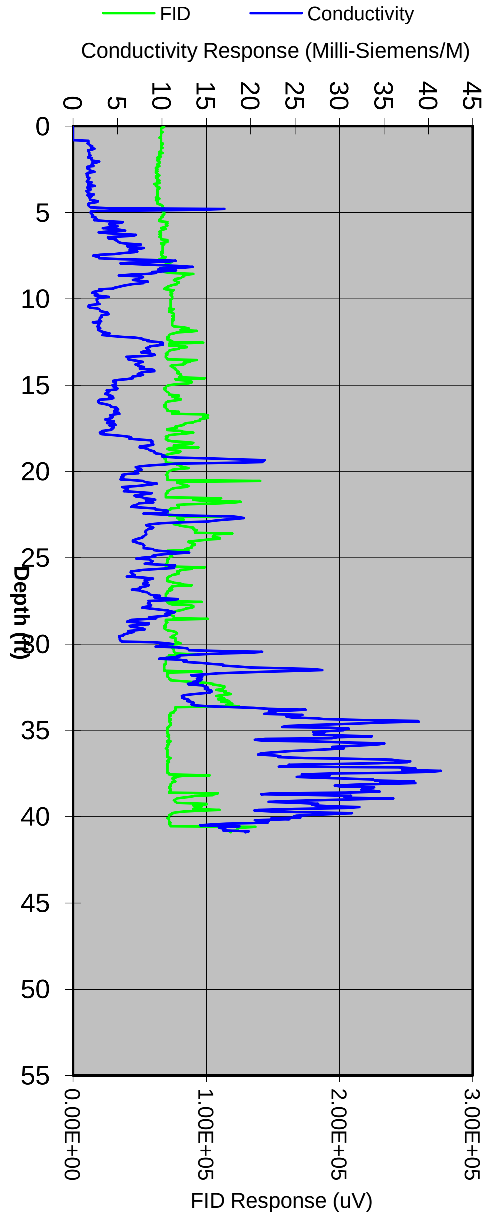
Job Information	
Client Company:	GSC
Project Name:	H-D / fYNOP
Site Address:	1425 Eden Rd. York, PA

MIP Sampling Information			
Trunkline Length:	150	Start Boring Time:	Wed Jul 25 2012 16:55:12
Probe Type:	6520	End Boring Time:	Wed Jul 25 2012 17:49:17
Rig Type:	Geoprobe 6600	MIP Specialist:	Chuck Terry









Attachment 1

To

Addendum 4
Field Sampling Plan For Part 2 of the Supplemental Groundwater Investigation
Former York Naval Ordnance Plant
1425 Eden Road, Springettsbury Township
York, PA

Field Boring Logs for Wells

MW-126
MW-127
MW-128
MW-129
MW-130
MW-131
MW-132
MW-133
MW-134
MW-135

Groundwater Sciences Corporation

Rock Classification Sheet

Project Harley Davidson Job. No. 10012.07
Site Area Bldg 58
Contractor Eichelberger Driller Chris Classified By VKF Date 6/15/12

Sheet 1 of
Drill Hole No. MW 26
Coordinates N/S
E/W

	Drilling History					Geologic Characteristics	Engineering Characteristics		Groundwater
Depth	Run No.	Core Rec.	Remarks	Well Constr	Graphic Log	Description	Description	Discont.	Static Water Level Time & Date
0			5'- 0.0ppm 10'- 0.0ppm			0'-2' concrete and fill, blacktop 0'-5' moderate to light brown F-C sand and silt trace clay, trace quartz pebbles, dry	Background = 0.0ppm BS@ 1010 = 0.0ppm for setup		
5			15'-0.0ppm 20'-0.5ppm			5'-10' Same as above	1051 BS = 0.0ppm		
10			23' = 0.0ppm						
1			25'- 0.5ppm			10'-15' F-M sand and silt, mod. brown, trace clay, dry			
15									
20			@23' Rounded to subrounded quartz pebble to cobble size + clay alluvial?			15'-20' light brown silt, some clay, dry			
25						20'-25' same as above trace gravel size quartz moist	1st water @23' <2gpm @30' >15gpm		
30						25'-30' same as above, wet	@35' >25gpm		

Groundwater Sciences Corporation

Rock Classification Sheet

Project Harley Davidson Job. No. 10012.07

Site Area Bldg 58

Contractor Eichelberger Driller Chris Classified By KBF Date 6/15/12

Sheet 2 of

Drill Hole No. mw12f

Coordinates N/S

E/W

	Drilling History					Geologic Characteristics	Engineering Characteristics		Groundwater
Depth	Run No.	Core Rec.	Remarks	Well Constr	Graphic Log	Description	Description	Discont.	Static Water Level Time & Date
30			35' = 0.0 ppm			30'-35' limestone, blue gray, pebble to gravel size, and quartz, rounded pebble size	water @ 40' 0.0 ppm		
35			44' = 0.0 ppm						
			50' = 0.0 ppm			35'-40' same as above			
40						42' weathered limestone	Bedrock 44'		
						40-45' limestone, bluish grey pebble gravel size some quartz, angular to rounded			
45						45'-50' same as above			
50						50'-61' void limestone and gravel fill some clay			
			62' = 0.0 ppm			62' competent rock again			
55									
60									

Groundwater Sciences Corporation

Rock Classification Sheet

Project Bldg 58
Site Area J Harley Davidson
Contractor Eichelbergers
Job. No. 1042.07
Driller Chris
Classified By WBF
Date 6/12/17
Sheet 1 of 2
Drill Hole No. MW127
Coordinates N/S
E/W

Depth	Drilling History: Run No.	Drilling History: Core Rec.	Drilling History: Remarks	Well Constr	Graphic Log	Geologic Characteristics: Description	Engineering Characteristics: Description	Engineering Characteristics: Discont.	Groundwater: Static Water Level Time & Date
0			PID			0'-2' concrete and fill, trace quartz	PID Background =0.0 ppm		
			5'=0.0 ppm				BS@ 930=0.0ppm		
5			10'=0.6ppm			2'-5' pale grey silty sand, trace clay, trace angular gravel size quartz, dry			
10			15'=0.0ppm			5'-10' moderate to light brown F-C sand and silt, little quartz gravel, angular, dry			
			16'=0.0 ppm						
15			20'=0.0ppm			10'-15' F-C sand and quartz gravel quartz gravel to pebble size, subrounded to angular			
			25'=0.0ppm						
20			30'=0.0ppm			16'-18' pale yellowish orange fine med sand and quartz gravel	BS@1030=0.0ppm		
25						18'-20' moderate brown to light brown silty clay and fine gravel, trace angular quartz, chalky zone 22'-24'			
30									

25' same as above and weathered blue/grey [illegible]

30' silty clay and weathering limestone)

Groundwater Sciences Corporation

Rock Classification Sheet

Project: Bailey
Site Area: Bldg 58 Pad
Contractor: Feldbergers
Job. No.: 10012.07
Driller: Chris
Classified By: RBF
Date: 6/12/12
Sheet 2 of 2
Drill Hole No.: MW127
Coordinates N/S
E/W

Depth	Drilling History					Geologic Characteristics	Engineering Characteristics		Groundwater
Depth	Run No.	Core Rec.	Remarks	Well Constr	Graphic Log	Description	Description	Discont.	Static Water Level Time & Date
30			40' 0.0 ppm			wet @ 36' - mud 30'-35' same as above - mud and little broken limestone			
35			50' 0.0 ppm			35'-40' clay and weathered shale and limestone			
40			55' = 0.0 ppm 60' = 0.0 ppm			40-45' same as above 45'-50' same as above	40-55 very muddy 34'-49' mud/clay seam		
45			75' = 0.4 ppm			50-55' same as above 75'-80' mud and clay water > 30 gpm broken gravel boulder @ 80	49' - 5[illegible]' boulder		
50			water @ 80' = 1.2 ppm				51'-55' clay seam 55'-75' mud and clay seam broken limestone		
55			well cleared out to 82' gpack 82'-61' sand to			Build well @ 80 20' [illegible] screen			
60									

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Rock Classification Sheet

Project Harley Davidson Job. No. 10012.07
Site Area Bldg 58
Contractor Eichelbergers Driller Chris Classified By KBF Date 6/18/12

Sheet 1 of
Drill Hole No. MW128
Coordinates N/S
E/W

	Drilling History					Geologic Characteristics	Engineering Characteristics		Groundwater
Depth	Run No.	Core Rec.	Remarks	Well Constr	Graphic Log	Description	Description	Discont.	Static Water Level Time & Date
0			PID Samples Background = 0.0ppm			0'-2' concrete and fill 2'-5' silty sand and clay, trace gravel, pale brown, dry			
5			5' = 5.0 ppm 10' = 0.3 ppm 12' = 0.1 ppm			5'-10' silty sand, moderate brown, some quartz gravel trace gravel, Dry 12' limestone gravel and silty sand, Dry			
10			BS: 0.0ppm @ 25'						
15			15' = 3.4ppm 20' = 0.0ppm 25' = 0.0ppm 30' = 3.6ppm 35' = 1.5ppm			12'-15' silty sand and quartz gravel, trace clay trace limestone, Dry 15'-20' moderate brown silt and clay some quartz gravel, trace limestone and coarse sand, moist			
20						20'-25' same as above			
25						25'-30' same as above	water @ 31'		
30									

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Rock Classification Sheet

Project Harley Davidson Job. No. 10012.07
Site Area Bldg 58
Contractor Eichelbergers Driller chris Classified By WBF Date 6/18/12

Sheet 2 of
Drill Hole No. MW128
Coordinates N/S
E/W

	Drilling History					Geologic Characteristics	Engineering Characteristics		Groundwater
Depth	Run No.	Core Rec.	Remarks	Well Constr	Graphic Log	Description	Description	Discont.	Static Water Level Time & Date
30			40 = 0 ppm			30'-35' silty clay and limestone / gravel	Clayseam 34'-41'		
35			50 = 0.2 ppm 60 = 0 ppm			35'-40' ~~[illegible]~~ same as above weathered limestone w/ and some silty clay ~41			
40			65 = 0 ppm 72 = 0 ppm			40'-45' same as above 45'-50 same as above	weathered rock @ 41'		
45						50'-55 same as above trace quartz 60' Bedrock			
50						65' same as above Broken limestone, gravel, weathered [illegible]			
55									
60									

Groundwater Sciences Corporation

Rock Classification Sheet

Project Harley davidson
Site Area Bldg 5 corridor
Contractor Eichelbergers
Driller Chris
Job. No. 18012.07
Classified By KBK
Date 6/7/12 / 6/8/12
Sheet 1 of 2
Drill Hole No. mw29
Coordinates
N/S
E/W

Depth	Drilling History: Run No.	Drilling History: Core Rec.	Drilling History: Remarks	Drilling History: Well Constr	Graphic Log	Geologic Characteristics: Description	Engineering Characteristics: Description	Engineering Characteristics: Discont.	Groundwater: Static Water Level Time & Date
0						0'-2' concrete fill 0'-5' silt and coarse sand, tight brown, dry	BS @ 1450 = 0 ppm		
5						5'-10' same as above w/ trace broken quartz			
10						10'-15' same as above w/ ~~fraittle~~ little brown quartz and little gravel-pebble size limestone			
15						15'-20' same as 10'-15' chattey,	little water @ 25'		
20						20'-25' same as above			
25						25' pale brown silt and clay little ~~fd~~ sand wet	6/8/12 BS 0850 = 0.0ppm		
30									

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Rock Classification Sheet

Project Harley Davidson Job. No. 1002.07 Sheet 2 of 2
Site Area Bldg 2 Drill Hole No. MW129
Contractor Eichelbergers Driller Chris Classified By KBF Date 6/8/12 Coordinates N/S
E/W

	Drilling History					Geologic Characteristics	Engineering Characteristics		Groundwater
Depth	Run No.	Core Rec.	Remarks	Well Constr	Graphic Log	Description	Description	Discont.	Static Water Level Time & Date
30			All PID samples 5', 10', 15' 20', 25', 30' 35', 50', 60' Rad 0.0ppm			25'-30' clay and cobble size sandstone Brown, wet trace silty limestone light greenish grey	PID samples 35' to 48' = 0.0ppm		
35						30'-35' same as above mostly mud red brn	weathered BR @ 38'		
40			competent Rock @ 63' attempt to drill w/o casing failed & set temp casing to 64'9"			35'-40' mud and weathered limestone			
45			upack 64'9" - 43'9"			40'-50' mud and weathered LS weathered LS and quartz pebble size			
50			sand to 39' pellets to 36' plug to 31'			slightly more competent rock @ 43 40'-43' same as above	@ 43' still no water 7.5gpm		
55			Benseal grout to 21' Hole plug to 15' when grout failed grout 15' to surface			43'-46' same as above mud filled void/or mud seem 48'-61' ~~[illegible]~~ no loss of circulation			
60									

2

Groundwater Sciences Corporation

Rock Classification Sheet

Project Harley Davidson Job. No. 10012.07
Site Area Bldg 2 Corridor
Contractor Eicklbergers Driller Keith Classified By KBF Date 5/30/12

Sheet 1 of
Drill Hole No. ML-130
Coordinates N/S
E/W

	Drilling History					Geologic Characteristics	Engineering Characteristics		Groundwater
Depth	Run No.	Core Rec.	Remarks	Well Constr	Graphic Log	Description	Description	Discont.	Static Water Level Time & Date
0			Background PID =0.1ppm			5' medium Brown sandy silt, Some fragments of quartz and dolostone dry	1043 Breathing space =0.1ppm 1056 BS = 0.1ppm		
5						10' same as above			
						15' Same as above Small angular quartz crystals	150 rotational Pressure		
10						20' same as above dry	~24' lots of chatter advancing		
						25' Same as above but w/ little clay dry	1109 BS = 0.3ppm		
15						30' same as above moist			
20						35' ~~[illegible]~~ Brown silty clay, moist Soft zone 38-41	water @ 35-36' PID = 2.1ppm @ water		
25						40' silty clay mixed w/ dolostone (grey) and quartzite (rounded) grains (1.4ppm)	1125 BS = 0.6ppm waterflow out of hole = 1.2ppm		
30									

Groundwater Sciences Corporation

Rock Classification Sheet

Project Harley Davidson
Site Area Bldg 2 corridor
Contractor Eichelberger
Job. No. 10012.07
Driller Keith/Chris
Classified By UGF
Date 5/30/12
Sheet 2 of 2
Drill Hole No. MW130
Coordinates
N/S
E/W

	Drilling History					Geologic Characteristics	Engineering Characteristics		Groundwater
Depth	Run No.	Core Rec.	Remarks	Well Constr	Graphic Log	Description	Description	Discont.	Static Water Level Time & Date
40						~41' ~15gpm large angular pieces of dolostone and large rounded quartzite wet	@ 41' water ~15 gpm or >		
50						43' dolostone and quartz mixed with silty sand wet 1.5 ppm	water @ 43 = 3.5 1141 BS = 1.2		
60						46' angular and rounded quartzite grains, angular dolostone, silty sand Brown 1.4 ppm	42'-45' competent limestone/dolostone 45'-46' weathered limestone/dolostone		
65							1147 stopped to pump out water		
70									
75									

Groundwater Sciences Corporation

Rock Classification Sheet

Project Harley davidson
Site Area Bldg 2 condr
Contractor Eichelberger
Job. No. 10012-07
Driller Chris
Classified By LKF
Date 6/1/12
Sheet 1 of 2
Drill Hole No. MW131
Coordinates N/S
E/W

	Drilling History					Geologic Characteristics	Engineering Characteristics		Groundwater
Depth	Run No.	Core Rec.	Remarks	Well Constr	Graphic Log	Description	Description	Discont.	Static Water Level Time & Date
0						5' ~~yell~~ orang Brown ~~[illegible]~~ silty sand pieces (pebble size) fill quartz rounded grains Dry	Breathing space = 0.0 ppm 5' sample = 2.2 ppm 10' sample = 8.9 ppm 15' Sample = 16.4 ppm 20' " = 2.5 ppm 25' " = 2.8 ppm 30' " = 0.4 ppm		
5									
10						10' same as above w/ large angular quartzite pebbles			
15						15' same as above angular pebble/gravel/cobble size quartz some Rounded some angular little clay moist	20' Breathing space: 0.0 ppm		
20						20' orange Brown some clay sandy silty trace quartz pebbles moist	water 1st @ 25'-27' water ~ 5 gpm @ 31'		
25						25' same as above Broken Rock maybe some water moist			
30						30' muddy orange Brown silt and clay little quartz and Dolostone pebbles			

Groundwater Sciences Corporation

Rock Classification Sheet

Project Harley Davidson
Site Area Bldg 2 corridor
Contractor Eichelbergers
Job. No. 10012.07
Driller Chris
Classified By KBK
Date 6/1/12
Sheet 2 of 2
Drill Hole No. MW 131
Coordinates N/S
E/W

Depth	Drilling History					Geologic Characteristics	Engineering Characteristics		Groundwater
Depth	Run No.	Core Rec.	Remarks	Well Constr	Graphic Log	Description	Description	Discont.	Static Water Level Time & Date
30							Breathing Space @ 31' = 08ppm		
35						35' mud change in color mod olive Brown then Orange Brown orange brown to Olive Brown, almost looks like oil sheen? Black patterns in mud	35' BS = 0.3 ppm Sample @ 30' = 05ppm Sample @ 35' = 1.7ppm		
40									
45						40' large pieces of angular cobblestone cobble to pebble size cobble to pebble size orange/quartzite sub rounded very muddy intermixed with angular dark grey shale	45' near water = 161 ppm BS = 1.9 ppm		
50							37' to 45' weathered Rock possible void @ 43'45'		
55						45' mud only Return	Back into competent Rock @ 45		
60						46' competent Bedrock again return same as above			

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Rock Classification Sheet

Project [illegible] Harley Davidson Job. No. 10012.07
Site Area Bldg 2 Condor
Contractor Eichelbergers Driller Chris Classified By KBF Date 6/5/12

Sheet 1 of
Drill Hole No. MW32
Coordinates N/S
E/W

	Drilling History					Geologic Characteristics	Engineering Characteristics		Groundwater
Depth	Run No.	Core Rec.	Remarks	Well Constr	Graphic Log	Description	Description	Discont.	Static Water Level Time & Date
0						0-5' silty sand Light to moderate Brown ~~&~~ Dry gravel fill, some rounded quartz grains	Background PID = 0.0 ppm Breathing space = 0.0 ppm 5' sample = 0.2 ppm		
5						5-10' same as above W/ ~~trace~~ little clay	10' sample = 0.1 ppm		
10						color change @ 15' to light to pale brown angular an rounded pebble to gravel size grains	BS @ 0930 = 0.0 ppm soft spot 22'-24' little water @ 33'		
15						10'-20' same as 5'-10'	15' sample = 0.0 ppm		
20						20'-25' silty clay trace sand, light brown moist	20' sample = 0.2 ppm		
25						30' silty sand and gravel quartz grained rounded to subangular (alluvium?)	25' sample = 0.2 ppm 30' sample = 0.1 ppm		
30									

Groundwater Sciences Corporation

Rock Classification Sheet

Project Harley davidson Job. No. 10012.07

Site Area Bldg 2 center

Contractor Eickelbergers Driller Chris Classified By [illegible] Date 6/5/12

Sheet ______ of ______ MW132

Drill Hole No. [illegible]

Coordinates N/S ______ E/W ______

Depth	Drilling History: Run No.	Drilling History: Core Rec.	Drilling History: Remarks	Drilling History: Well Constr	Graphic Log	Geologic Characteristics: Description	Engineering Characteristics: Description	Engineering Characteristics: Discont.	Groundwater: Static Water Level Time & Date
30			alluvial 30'- Bottom. old stream channel?			35' silt and Light gravel quartz Brown Rounded to subangular (alluvium) mottled wet	35' sample - 0.6ppm 45' sample = 6.3ppm 53' sample =		
35						40' no return	40' Roller jumping		
40			water > 5gpm @ 41' ~50 gal pm			45 intermixed little shale (micaceous minerals) quartz (rounded to subangular) and Brown limestone quartz is pebble to cobble in size (alluvial)	45'- 51'.9" possible void no loss of circulation but still lots coming out of hole Driller not sure if void		
45									
50			water @ 53' = 177.3ppm			53' same as above smaller quartz grains	BS = 3.5 water coming out = 75ppm		
55						trace shale (alluvial	52' water out of hole is 123ppm		
60									

Groundwater Sciences Corporation

Rock Classification Sheet

Project Harley Davidson Job. No. 10012.07

Site Area Bldg 2 corner

Contractor Eichelberger Driller Chris Classified By KB+ Date 6/7/2

Sheet 1 of 2

Drill Hole No. MW-133

Coordinates N/S

E/W

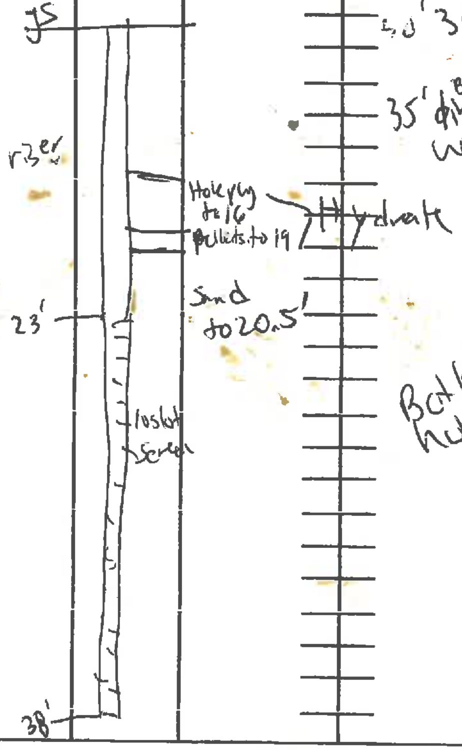
Depth	Drilling History: Run No.	Drilling History: Core Rec.	Drilling History: Remarks	Well Constr	Graphic Log	Geologic Characteristics: Description	Engineering Characteristics: Description	Engineering Characteristics: Discont.	Groundwater: Static Water Level Time & Date
0						0'-2' concrete, fill, dry	Background 0.0ppm BS = 0822 = 0.0ppm		
						0'-5' siltysand, light brown, trace clay, trace gravel, Dry			
5							5' sample = 1.0 ppm		
						5'-10' moderate brown, silty sand, trace clay, trace pebble size angular quartz, Dry	10' sample = 0.6 ppm 15' sample = 1.0 ppm 20' sample = 0.4 ppm 25' sample = 0.9 ppm		
10						10'-15' same as above	BS = 0858 = 0.0ppm		
15						15-20' siltyclay, pale-moderate brown trace F-C sand, moist, tr gravel size quartz	20'-25' same as above		
20						color change @ 23' to grayish Brown Brown blue limestone			
25			24' top of Bedrock - 30'			23'-25' pale to grayish Brown siltand Black/Blue limestone	water @ 25' >5gpm @ 26'-27'		
						25'-27' limestone	26'-27' 50 RP <1 ft per 3mins		
30									

27'-29' Broken black/blue limestone

Groundwater Sciences Corporation

Rock Classification Sheet

Project Harley Davidson
Site Area Bldg 2 Kondor
Contractor Eichelbergers
Job. No. 10012.07
Driller Chris
Classified By KWBF
Date 6/7/12
Sheet 2 of 2
Drill Hole No. 133
Coordinates N/S ____
E/W ____

	Drilling History					Geologic Characteristics	Engineering Characteristics		Groundwater
Depth	Run No.	Core Rec.	Remarks	Well Constr	Graphic Log	Description	Description	Discont.	Static Water Level Time & Date
						cobble to apple size quartz @ 29.5" 30' weathered siltstone and quartz pebble to gravel size trace silt wet 30'-35' weathered same as above wet 35' Black Bluegray siltstone, some quartz rounded to subrounded/ orang mottely wet Bottom of hole 38'	0927 BS=0.0ppm 24'-30' Bedrock 30'-37' weathered zone 37'- Back into competent Shale water @ 37' 0.2ppm 30' sample = 0.6ppm 35' sample = 0.4ppm		

☆ All PIDs were re-scanned w/ mini Rae 3000 and read 0.0 ppm

Groundwater Sciences Corporation

Rock Classification Sheet

Project Harley
Site Area Bldg 2 corridor
Contractor Eichelbergers
Job. No. 10012-06
Driller Keith Lenker / Kevin Huffman
Classified By KBF
Date 5/22/12 / 5/25/12
Sheet 1 of 2
Drill Hole No. MW134
Coordinates N/S
E/W

	Drilling History					Geologic Characteristics	Engineering Characteristics		Groundwater
Depth	Run No.	Core Rec.	Remarks	Well Constr	Graphic Log	Hardness; weathering, color shape Description ~~texture~~ Rocktype, structures	Fractures Description ~~RQD~~	Discont.	Static Water Level Time & Date
0			Background PID☆ = 0.0 - 3.2 ~5'-6' PID = 2.3			0-6 concrete, metal matting, backfill 5-6 Brown to grey clayey silt, little sand/fill Dry	12" Roller Bit Background PID = 0-2.2 ppm		
5			~7' PID = 4.1☆			7' silty clay, little sand Brown to orange Brown Dry			
10						10' silt and sand, some clay, light Brown - Brown moist ~11' slight color change, light Brown Dry			
15			~15' PID = 4.2☆			15' same as above Dry	@17' - 1.5 min/ft		
20			~20' PID = 1.2☆ Resume drilling @ 1422 start @ 20ft			20' Brown, ~~grey~~ silty clay, little fg sand, moist trace of rounded quartz pebbles	~~[illegible]~~ 14:13 1st Rod down		
25			~25 PID = 4.2☆ ~26.5 PID = 5.0☆			25' Brown to dark Brown silty clay, little sand, moist trace rounded dark color pebbles	26.5' top of Bedrock water added is stable top of Bedrock		
30									

~26' Same as above w/ Broken pieces of Dolostone or limestone fizzes w/ acid

* All PID scans were Re-scanned w/ mini Rae 3000 and Read 0.0ppm

Groundwater Sciences Corporation

Rock Classification Sheet

Project: Harley
Site Area: Bldg 4
Contractor: Eichelbergers
Job. No.: 100106
Driller: Keith Jenkins
Classified By: VNSF
Date: ~~5/22/12~~ 5/23/12
Sheet 2 of 2
Drill Hole No.: MW134
Coordinates N/S:
E/W:

	Drilling History					Geologic Characteristics	Engineering Characteristics		Groundwater
Depth	Run No.	Core Rec.	Remarks	Well Constr	Graphic Log	Description	Description	Discont.	Static Water Level Time & Date
30			~30' PID = 3.1 Background PID 0.0ppm			29.5' silty clay seam Brown-dark Brown ~30 Dolostone ~~[illegible]~~ Dark gray bluish intermixes w/ silty clay formation	@30' 1.5min/ft ~32'. setting casing 5' below top of Bedrock		
35						35' 5Y2/1 olive Black, slightly weathered Dolostone, fizzes wet medium hard ~~[illegible]~~ FG			
40			Drilled to 65' void ~46-~64			40' No Return	46 — ~53' Void 6ft in 20 seconds 46-53		
45			Instructed drillers to put 20' screen 44-64' Build in steal casing for sand			45' same as above 50' No Return void			
50						55' No Return void 60' No Return void 65' intermixed dolostone and Rounded quartzite grains dolostone is olive black and quartz is Dark yellowish orange wet dolostone is not rounded Slightly weathered DS is medium	water @ ~53' ~7 gallons a minute		
55			well collapsed to 55' will set casing and try to blow out, push through				65' PID = 0.0		
60									

Groundwater Sciences Corporation

Rock Classification Sheet

Project Harley Davidson Job. No. 10012.07

Site Area Bldg 2 corridor /4 pad/ MW135

Contractor Eichelbergers Driller Kevin Hoffman Classified By KBF/RSU Date 5/24/12

Sheet 1 of 2

Drill Hole No. MW135

Coordinates N/S

E/W

	Drilling History					Geologic Characteristics	Engineering Characteristics		Groundwater
Depth	Run No.	Core Rec.	Remarks	Well Constr.	Graphic Log	Description	Description	Discont.	Static Water Level Time & Date
0			Background PID=0.0ppm			0-3' Fill, concrete			
			5' PID=0.0ppm 10' PID=0.0ppm 15' PID=0.0ppm			5' clayey silt, trace Sand, Brownish orange, dry	Rotational pressure 7-9' 100/1500		
5						10' sandy silt, orangeish Brown, Dry trace clay	Same rotational pressure zero pulldown pressure so far		
10						15' same as above except w/ some semi-rounded quartz pebbles	1659 Breathing space =0.0ppm		
15						~17' same as above w/ gravel size quartzite			
20			20' PID=0.0ppm			←	20' reddish yellow, Clayey SILT, little fine to medium Sand. moist.		
25									
30									

Groundwater Sciences Corporation

Rock Classification Sheet

Project Harley Davidson Job. No. 10012.07 Sheet 2 of 2
Site Area Bldg 2 corridor / 4 pad / MW-135 Drill Hole No. MW-135
Contractor Eichelbergers Driller Kevin Hoffman Classified By RSU Date 5/25/12 Coordinates N/S ___ E/W ___

Depth	Drilling History: Run No.	Drilling History: Core Rec.	Drilling History: Remarks	Drilling History: Well Constr	Graphic Log	Geologic Characteristics: Description	Engineering Characteristics: Description	Engineering Characteristics: Discont.	Groundwater: Static Water Level Time & Date
30			30' reddish yellow, Clayey SILT, little f-c Sand, tr. f. Gravel. moist.			30' headspace PID=0.4 ppm 30' breathing space PID=0.0ppm			
35			35' reddish yellow, clayey SILT, little f-c Sand, little f. Gravel. moist.			35' headspace PID=0.3ppm Water at 38'			
40			40' yellowish brown, f. Gravel (well-rounded quartzite), little f-c Sand, little Clayey Silt. wet.			40' breathing space PID=0.0ppm	Rod marked incorrectly. Add 3' to all depths below this line (competent rock is at 48', not 45'; bottom of boring is at 54', not 51')		
45			44' yellowish brown, f-c SAND (SR-SA), little Clayey Silt, little f. Gravel. wet 45' dk gray [redacted] aphanitic, mod. hard, mod. weathered carbonate bedrock. Perhaps dolostone?	Confirmed dolostone		44' headspace PID=0.0ppm competent rock at 45'			
50			Void ~ 49'-50' 51' bottom of boring			50' - 6.0 ppm PID breathing space			

Attachment 2

To

Addendum 4
Field Sampling Plan For Part 2 of the
Supplemental Groundwater Investigation
Former York Naval Ordnance Plant
1425 Eden Road, Springettsbury Township
York, PA

ASTM Standard Practice for Direct Push Technology for Volatile Contaminant Logging with the Membrane Interface Probe

ASTM Designation D 7352-07

Designation: D 7352 – 07

Standard Practice for Direct Push Technology for Volatile Contaminant Logging with the Membrane Interface Probe (MIP)[1, 2]

This standard is issued under the fixed designation D 7352; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This standard practice describes a method for rapid delineation of volatile organic contaminants (VOC) in the subsurface using a membrane interface probe. Logging with the membrane interface probe is usually performed with direct push equipment.

1.2 This standard practice describes how to obtain a real time vertical log of volatile organic contaminants with depth. The data obtained is indicative of the total volatile organic contaminant concentration in the subsurface at depth.

1.3 Other sensors, such as electrical conductivity, fluorescence detectors, and cone penetration tools may be included to provide additional information. The use of a lithologic logging tool is highly recommended to define hydrostratigraphic conditions, such as migration pathways, and to guide confirmation sampling.

1.4 *Limitations*—The MIP system does not provide specificity of analytes. This tool is to be used as a total volatile organic contaminant-screening tool. Soil and/or water sampling (Guides D 6001, D 6282, D 6724, and Practice D 6725) must be performed to identify specific analytes and exact concentrations. Only VOCs are detected by the MIP system in the subsurface. Detection limits are subject to the selectivity of the gas phase detector applied and characteristics of the formation being penetrated (for example, clay and organic carbon content).

1.5 *This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without the consideration of a project's many unique aspects. The word "standard" in the title means that the document has been approved through the ASTM consensus process.*

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [3]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids

D 5299 Guide for Decommissioning of Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities

D 6001 Guide for Direct-Push Ground Water Sampling for Environmental Site Characterization

D 6282 Guide for Direct Push Soil Sampling for Environmental Site Characterizations

D 6724 Guide for Installation of Direct Push Ground Water Monitoring Wells

D 6725 Practice for Direct Push Installation of Prepacked Screen Monitoring Wells in Unconsolidated Aquifers

E 355 Practice for Gas Chromatography Terms and Relationships

3. Terminology

3.1 Terminology used within this practice is in accordance with Terminology D 653 with the addition of the following:

3.2 *Definitions:*

3.2.1 *carry over*—retention of contaminant in the membrane and trunkline which may result in false positive results or an increased detector baseline at subsequent depth intervals.

3.2.2 *closed couple flow*—gas flow in the MIP system when a probe is detached and the gas lines are coupled together. The flow is then measured with a gas flow meter on the return tubing before entering the gas phase detectors. Used to verify continuity of gas flow in the MIP system.

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[1] This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Ground Water and Vadose Zone Investigations.

Current edition approved May 15, 2007. Published July 2007.

[2] The Membrane Interface Probe is covered by a patent. Interested parties are invited to submit information regarding the identification of an alternative(s) to this patented item to the ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.2.3 *gas dryer*—a selectively permeable membrane tubing (Nafion®) is used to continuously dry the MIP carrier gas stream by removing only water vapor.

3.2.4 *gas phase detectors*—heated laboratory grade detectors used for gas chromatography (Practice E 355). Gas effluent from the MIP flows through these detectors for the analysis of VOC compounds. Detectors most often used with the MIP include photoionization detector (PID), flameionization detector (FID), and an electron capture detector (ECD).

3.2.5 *membrane interface probe (MIP)*—a subsurface logging tool for detection of volatile organic compounds (VOCs).

3.2.6 *response test*—a test of the working MIP system performed by placing the MIP probe in an aqueous phase solution with a known contaminant of known concentration. Performed before each MIP log is conducted and one at the end of the working day to validate the MIP system performance. Also used to compare data from individual locations.

3.2.7 *trigger*—mechanical interface between the operator and instrumentation to initiate or terminate data collection.

3.2.8 *trip time*—the time required for a contaminant to penetrate the semi-permeable membrane and travel to the gas phase detectors at the surface through a fixed length of tubing.

3.2.9 *trunkline*—plastic or metal jacketed cord containing electrical wires for the heaters in the probe block, electrical wires for other sensors, and tubing for the transport of carrier gas and the contaminant to the surface and detectors.

3.2.10 *working standard*—a chemical standard used in response testing the MIP system. This standard is a diluted concentration of an analyte stock standard, used for one application and then properly disposed.

4. Summary of Practice

4.1 This practice describes the field method for delineation of volatile organic contaminants with depth via the Membrane Interface Probe (MIP). The MIP is a continuously sampling tool advanced through the soil using a direct push machine for the purpose of logging contaminant and lithologic data in real time (**1**, **2**).[4]

4.2 A semipermeable membrane on the probe is heated to a temperature of 100 to 120°C. Clean carrier gas is circulated across the internal surface of the membrane carrying volatile organic contaminants, which have diffused (**3**) through the membrane, to the surface for analysis by gas phase detectors.

5. Significance and Use

5.1 The MIP system provides a timely and cost effective way (**4**) for delineation of volatile organic contaminants (for example, benzene, toluene, solvents, trichloroethylene, tetrachloroethylene) with depth (**5**, **6**). Recent investigation (**2**) has found the MIP can be effective in locating zones where dense nonaqueous phase liquids (DNAPL) may be present. MIP provides real-time measurement for optimizing selection of sample locations when using a dynamic work plan. By identifying the depth at which a contaminant is located, a more representative sample of soil or water can be collected.

5.2 Correlation of a series of MIP logs across a site can provide 2-D and 3-D definition of the contaminant plume. When lithologic logs are obtained (EC, CPT, etc.) with the MIP data, contaminant migration pathways may be defined.

5.3 The MIP logs provide a detailed record of contaminant distribution in the saturated and unsaturated formations. A proportion of the chlorinated and non-chlorinated volatile organic contaminants in the sorbed, aqueous, or gaseous phases partition through the membrane for detection up hole.

5.4 The data obtained from application of this practice may be used to guide soil (Guide D 6282) and groundwater sampling (Guide D 6001) or placement of long-term monitoring wells (Guide D 6724).

5.5 MIP data can be used to optimize site remediation by knowing the depth distribution of volatile organic contaminants. For example, materials injected for remediation are placed at correct depths in the formation.

5.6 This practice also may be used as a means of evaluating remediation performance. MIP can provide a cost-effective way to monitor the progress of remediation. When properly performed at suitable sites, logging locations can be compared from the initial investigation to the monitoring of the contaminant under remediation conditions.

NOTE 1—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Practitioners that meet the criteria of Practice D 3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D 3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D 3740 provides a means of evaluating some of those factors. Practice D 3740 was developed for agencies engaged in the testing and/or inspection of soils and rock. As such, it is not totally applicable to agencies performing this practice. However, users of this practice should recognize that the framework of Practice D 3740 is appropriate for evaluating the quality of an agency performing this practice. Currently there is no known qualifying national authority that inspects agencies that perform this practice.

6. Apparatus

6.1 *General*—The following discussion provides descriptions and details for the Membrane Interface Probe and system components (Fig. 1). Additional details on the MIP system are available in the Geoprobe MIP SOP (**1**).

6.1.1 *The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

6.2 *Membrane Interface Probe*—The MIP is the interface between the bulk formation and the gas phase detectors up hole. Volatile compounds outside the probe diffuse across the membrane and are swept up hole via an inert carrier gas (Fig. 2).

6.2.1 The membrane is set in a removable insert. It is constructed of a polymer coating impregnated into stainless steel wire mesh.

6.2.2 The membrane is inserted into a heater block. The elevated temperature of the heater block is used to speed the diffusion of contaminants out of the bulk formation and

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[4] The boldface numbers in parentheses refer to the list of references at the end of this standard.

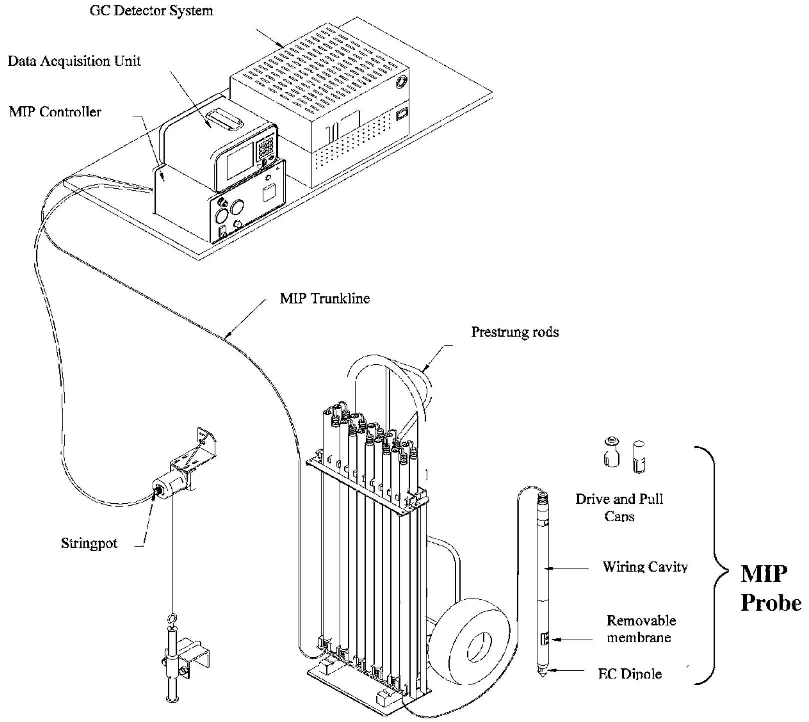


FIG. 1 The Primary Components of the Membrane Interface System

through the membrane. This heater block has a regulated temperature typically set at 100 to 120°C.

6.2.3 Tubing is used to supply carrier gas to the membrane. Two tubes are used: a supply tube running from the carrier gas source to the membrane and a return tube running from the membrane to the gas phase detectors at ground surface.

6.2.4 The MIP system may be configured with a soil electrical conductivity dipole for simultaneous collection of general lithologic data.

6.2.5 The MIP probe may be coupled to a CPT probe at its lower end for simultaneous collection of CPT data (Fig. 3).

6.3 *MIP Trunkline*—This cable consists of electrical wires for heating the MIP heater block and supplying voltage to additional sensors. The trunkline also contains gas lines for the transport of VOCs from the probe to detectors up-hole. This trunkline is packaged in a durable, protective jacketing to be prestrung through steel drive rods prior to logging (Fig. 2).

6.4 *MIP Controller*—The MIP controller is used to control the flow delivered to the membrane and the voltage delivered to the heater block and electrical conductivity dipole electrode. The primary features of the MIP controller include:

6.4.1 Primary pressure regulator to control the pressure of carrier gas to the flow regulation circuit of the MIP controller.

6.4.2 A mass flow controller is used to regulate the flow of carrier gas through the MIP system. Typical flow rates of 20 to 60 mL/min are used in the operation of the membrane interface probe.

6.4.3 Temperature controller regulates the voltage supplied to the heater block to maintain an elevated temperature in the subsurface. The temperature controller has two outputs on an LCD. The top output is the temperature of the membrane in the heater block. The bottom output is the set temperature of the controller; the manufacturer sets this temperature at 121°C.

6.4.4 Analog signal input from the detector system. The analog outputs from the gas phase detectors are connected to the controller to be transferred to the data acquisition system.

6.5 *Data Acquisition System*—The primary purpose of this system is to save and graph data collected from the MIP probe and detector system in real time. The data saved by the acquisition system are: depth; soil electrical conductivity; rate of probe penetration into the subsurface; temperature of the probe; pressure of the carrier gas supply at the flow controller; and four possible gas phase detector inputs. The primary components of the data acquisition system include:

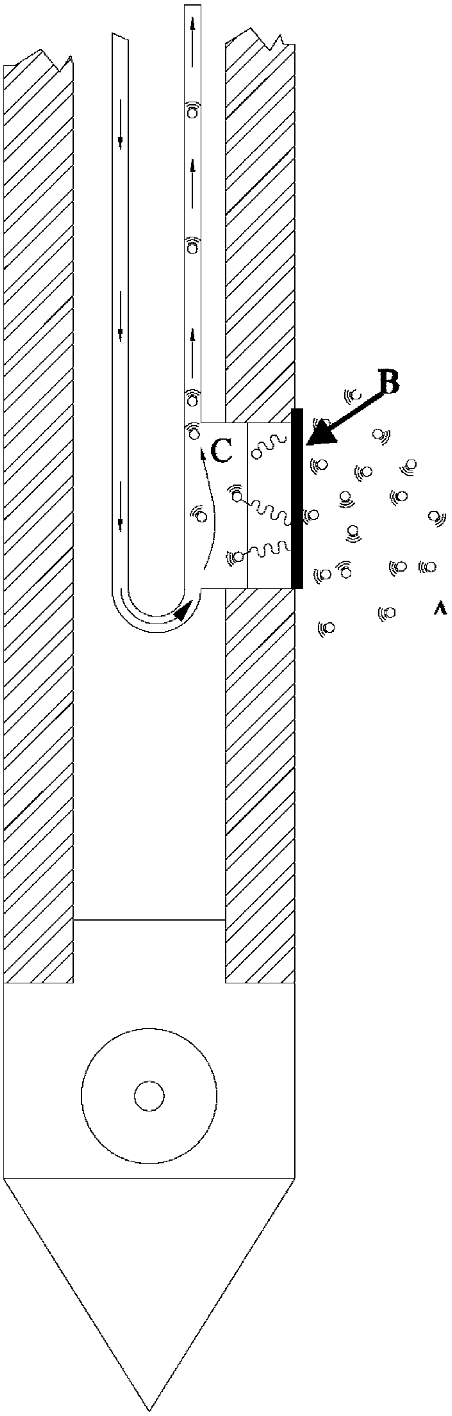
6.5.1 Alpha/numeric keypad for entry of site location information,

6.5.2 Internal and/or external data storage device for transfer of data from acquisition system to desktop or laptop computers, and

6.5.3 Global positioning system connections for acquiring latitude and longitude locations of logging location and storage of this data directly to the log file.

6.6 *Detector System*—Laboratory grade, gas phase detectors are needed for the detection of volatile organic contaminants in the carrier gas stream. Detectors may be in a gas chromatograph or in a stand-alone chassis. Different detectors are used for identification of species groups of volatile compounds, not individual volatile compounds. Certain detectors may be operated in series for the detection of different contaminant types. A brief discussion of commonly used detectors with the MIP system is provided.

6.6.1 *Photoionization Detector (PID)*—The PID uses an intense beam of ultraviolet radiation to ionize molecules in the effluent of the MIP carrier gas stream for analyte detection. The PID is a non-destructive detector and can therefore be used in series with other detector types. A gas dryer must be used on



NOTE—The schematic of the membrane interface probe depicts the movement of VOCs in the bulk formation (A) diffusing through the membrane (B) into the carrier gas (C) to be swept to the surface detectors.

FIG. 2 Schematic Diagram of the Membrane Interface Probe

the carrier gas before entering the PID. The PID in the MIP system is generally used for detection of aromatic hydrocarbons such as benzene and toluene.

6.6.2 *Flameionization Detector (FID)*—The FID uses a hydrogen/air flame to produce ions and electrons that can conduct electricity through the flame. A potential is applied across the burner tip and the collector electrode. The resulting current is then amplified and recorded. The FID is best used with a high carbon content contaminant (that is, propane, octane, heptane, and volatile aliphatic hydrocarbons).

6.6.3 *Electron Capture Detector (ECD)*—The ECD operates by passing the effluent of the MIP carrier gas over a beta-emitter, such as nickel-63, causing ionization of the carrier gas and the production of electrons. In the presence of

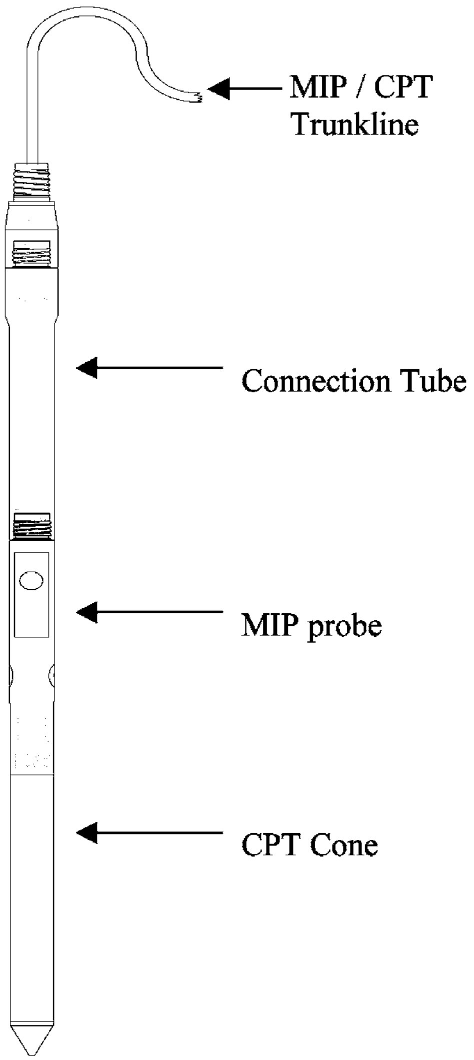


FIG. 3 Diagram of a MIP Connected in Series with the CPT Cone

molecules that tend to capture electrons the current will decrease. This decrease in current is then measured and recorded. The ECD is highly sensitive toward electronegative functional groups such as halogens, peroxides, quinines, and nitro groups. The MIP system primarily uses the ECD for the detection of chlorinated VOCs.

6.6.4 *Dry Electrolytic Conductivity Detector (DELCD)*—The DELCD uses pyrolysis and oxygen to react with the effluent of the sample stream. This device uses the elevated temperature to separate the chlorinated molecule from the compound forming chlorine dioxide. The chlorine dioxide reacts with an electrode measuring the conductivity of the gases in the cell which generates a current that is amplified and recorded. The DELCD is a destructive detector typically used for the selective determination of chlorinated species.

6.7 *Stringpot*—A depth measuring potentiometer mounted to the direct push machine, transfers a voltage to the data acquisition system for accurate depth measurement below ground surface.

6.8 *Drive Rods*—Steel rods having adequate strength to sustain the force required to advance the membrane interface probe into the subsurface. The rods must be secured together to form a rigid column of drive rods.

6.9 *Direct Push Machine*—A machine with hydraulic rams supplemented with vehicle weight or a high frequency hammer to advance drive rods into unconsolidated formations.

7. Reagents and Materials

7.1 *Carrier Gas*—A non-reactive (inert) gas is used for the transportation of the contaminant from the membrane to the up hole detector system. Examples of gases used for MIP logging include: UHP grade Nitrogen, UHP grade Helium, or a filtered AIR supply. Nitrogen is mainly used for the carrier gas because it is readily available, is a stable gas, and is inert to hydrocarbons.

NOTE 2—Electron capture detectors require the use of a Nitrogen carrier gas or a 5 % Argon/Methane mix auxiliary gas.

7.2 *Methanol*—CH_3OH, for use in the dilution of stock standards.

7.3 *Neat Volatile Organic Standards*—Pure product standards are used for the preparation of stock standards. The neat product chosen should correlate to the contaminant of concern at the investigation site. If specific contaminants are known (for example, TCE, benzene), standards of those compounds may be used.

8. Preparation/Conditioning

8.1 *General*—Response testing is an integral part of ensuring the quality of data from the MIP system. A response test must be conducted before deploying the system in the field. To conduct a response test, a stock standard is prepared. The stock standard is determined by the contaminants of concern. Preparation of the stock standard is critical to the final outcome of the concentration to be used in the response test.

8.2 *Preparation of Stock Standards*—A 50 mg/mL stock standard is sufficient for a stock standard concentration. At this concentration, only a small amount (25 mL) in a 40 mL vial is needed in the field. Stock standards have a shelf life of 30 days when appropriately handled and stored.

8.2.1 *Mass of Solute, M_s*—This parameter is the mass, in milligrams, of solute needed to prepare the stock standard and is defined as:

$$M_s = V_m \times C_{final} \tag{1}$$

where:

V_m = volume of solvent (methanol) in milliliters, and
C_{final} = final concentration of stock standard in milligrams per milliliter.

8.2.2 *Volume of Solute in Microliters, V_s*—This parameter is the volume of solute needed for the stock standard prepared to equal a concentration of 50 mg/mL. By using the density of the compound and the result in 8.2.1, a volume of the solute is obtained.

$$V_s = \frac{M_s}{d_s} \tag{2}$$

where:

M_s = definition in 8.2.1, and
d_s = density, in milligrams per micro liter, of the solute.

8.3 Label the vial with the date the standard was prepared, initials of the one who prepared the standard, the concentration and the contaminant contained within the standard.

8.4 Handle and store standards appropriately. VOC standards should be handled with appropriate gloves in a well-ventilated area. Some standards are considered to be carcinogens and a material safety data sheet (MSDS) should be consulted before handling. Some VOCs (for example, benzene) will degrade in sunlight and standards should be stored in a cool and dark container. When storing, replace damaged septa or lids on vials.

9. Procedure

9.1 *General Requirements*:

9.1.1 Prior to driving the membrane interface probe into the subsurface, ensure that the proper clearance for direct push equipment has been provided to avoid any hazards from underground and overhead utilities.

9.2 *MIP System Start Up*:

9.2.1 Turn on carrier gases. Typically compressed cylinders are equipped with a 2-stage gas regulator that is typically set at 40 psi for MIP operation.

9.2.2 Power on the detector system, data acquisition system and MIP controller box. The data acquisition system and controller box require a 10-minute warm up time. The detector systems may require up to 60 minutes of warm up time depending upon the detector being used.

9.3 *Response Testing*—Response testing must be conducted before and after each log (Fig. 4). This will ensure the validity of the data and the integrity of the system. Response testing also provides for comparison of data for later MIP logs at the same site. Results of the response test may change due to membrane wear from soil contact and abrasion.

9.3.1 Power on the MIP heater and submerge the probe into a container of clean water to obtain a stable baseline on all detectors. Typically 5 minutes of temperature cycling in the clean water will result in a stable baseline.

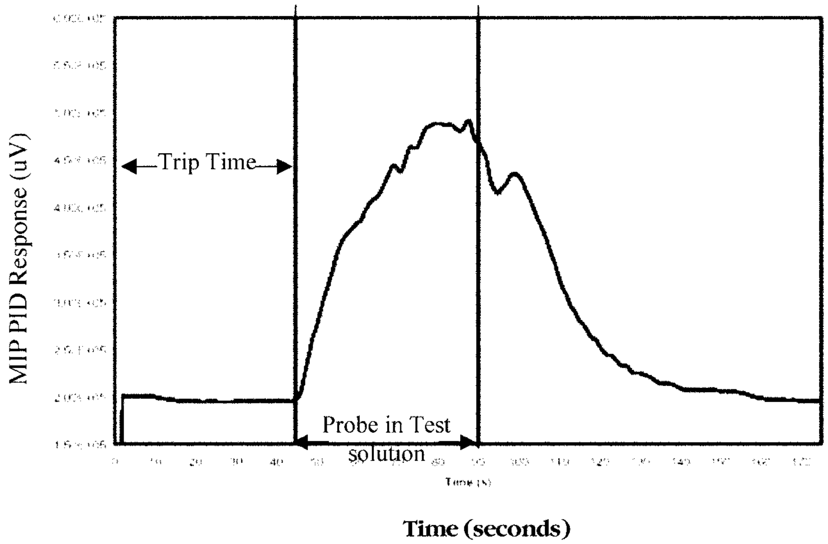


FIG. 4 Response Test Graph of a 10 mg/L Benzene Solution Analyzed with MIP System Coupled to a PID Detector

9.3.2 Prepare Response test standard solution by adding the appropriate volume of the stock standard solution to 0.5 liters of clean water in a suitable measuring container (beaker or graduated cylinder). Example: 10 µL of a 50 mg/mL concentration stock standard into 0.5 liters of water yields a 1 mg/L working standard.

9.3.3 Pour the working standard into a nominal 2-in. diameter by 30-in. long PVC pipe that is plugged or capped at one end. Immediately insert the stabilized MIP into the solution. Leave the MIP in the test solution for 45 seconds. At the end of 45 seconds, place the probe back in the clean water. This standard cannot be reused throughout the day, it must be made fresh each time a response test is conducted.

9.3.4 Record the baseline, in micro-Volts, of each detector, the maximum peak height obtained during the test, and the trip time observed on the data acquisition unit (Fig. 4). The trip time is measured by timing the response of the detectors, starting when the probe is placed into the response test solution and ending when the response is first recorded on the acquisition unit. The peak height and base line data should be recorded digitally on the internal and/or external storage devices. The trip time is entered manually into the data acquisition system each time to account for change in flow or length of trunkline.

9.4 *Probe Advancement*—After a successful response test, position the direct push machine over the cleared location and anchor or level the machine as appropriate for the direct push machine being used for the logging operation. Place a split drive cap on the top of the rods to ensure the safety of the trunkline ascending out of the drive rods.

9.5 Attach the stringpot and all necessary cables to the direct push machine and the data acquisition system.

9.6 Zero the depth of the MIP by driving the tip into the subsurface aligning the membrane with the ground surface.

9.7 Turn the trigger, located on the data acquisition unit, to the ON position. The data acquisition system is now ready to obtain data. Any downward movement will now be recorded.

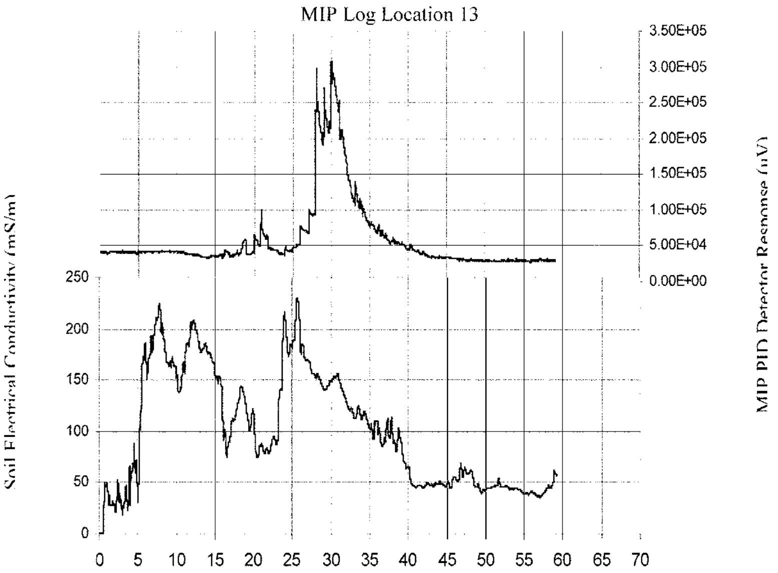
9.8 The MIP tool string is driven into the subsurface at a rate in which the temperature of the probe can stay constant. Typically the probe is driven into the subsurface at 1 foot per minute. Example: If 20 seconds is needed to advance the MIP 1 foot, then a 40 second wait time should be used before the MIP is advanced to the next interval. Advance the probe to the predetermined depth or until refusal. The rate of advancement is important for the consistent diffusion of contaminants through the membrane. Consistency of this diffusion enables comparison of depth intervals.

9.9 MIP logs are displayed on screen as the probe is advanced to depth. MIP data is stored and saved within the acquisition unit every 0.05 feet. Data points saved on the acquisition unit are all in reference to depth from surface. Detector data and lithologic data may be printed in the field for on-site decision making (Fig. 5). Other data graphed versus depth include rate of advancement, temperature of the probe, and carrier gas pressure of the system (Fig. 6).

9.9.1 Record in the field notes any observations of bore hole irregularities, pressure differences of the carrier gas, temperature fluctuations and any detector anomalies.

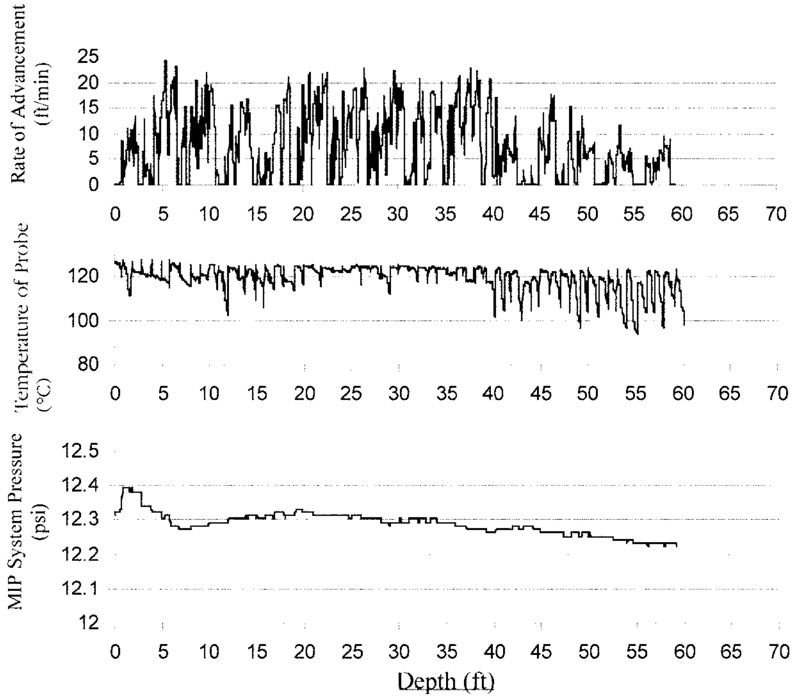
9.9.2 The MIP should be advanced at a consistent rate. Any extended periods at a depth interval can change the relative response and should be recorded in the field notes.

9.10 *Removal from the Subsurface*:



NOTE—An MIP PID log obtained at a petroleum-contaminated site is graphed in the upper half of this diagram. Detector response in microvolts (µV) is on the right (y) axis and EC on the left with probing depth on the bottom (x) axis. An increment of one foot per minute was used in the advancement of the MIP probe with no contaminant encountered until the 17 ft depth interval. Significant PID response was observed at the 26–35 ft interval. Detector response returned to baseline below the 45 ft interval. An electrical log obtained during MIP probe advancement is shown graphed below the MIP-PID detector results. Lower conductivity readings (20–23 ft depth interval and 39–59 ft depth interval) indicate coarse grain units (for example, sand) and possible higher permeability zones. The elevated conductivity readings (5–16 ft depth interval and 23–31 ft depth intervals) indicate fine-grain units (for example, clay) and lower permeability zones.

FIG. 5 MIP Log



NOTE—Rate of Advancement, Temperature, and Pressure are other parameters logged with the PID and EC results of Fig. 5. The rate of advancement (top diagram) gives indication of the density of a material. The slower the rate (for example, 42–45 ft depth increment) indicates a dense zone of material. The temperature graph (middle diagram) is used to monitor the temperature of the membrane. The temperature graph is needed to ensure the membrane temperature stays consistent throughout the MIP push. MIP system pressure is graphed (lower diagram) to monitor carrier gas fluctuations. Fluctuations in pressure can change the trip time. This change could cause the contaminant to be graphed at the wrong depth.

FIG. 6 MIP Log

9.10.1 Before removing the MIP from the subsurface, pause at the terminal depth for a period equal to three times the measured trip time. This allows data from the final probe position to be recorded to the appropriate depth in the data acquisition system.

9.10.2 Set the trigger to the OFF position and use the direct push machine to remove the MIP from the subsurface. It may be necessary to turn the heater off for removal if an elevated amount of contaminant was encountered at the location. Turning off of the heater allows for cooling of the membrane and minimizes diffusion of the contaminant into the system during removal.

9.10.3 Upon complete removal of the probe, clean the membrane with water and a wire brush, turn on the heater, and place the probe back into the clean water in preparation for response testing with a newly prepared working standard.

9.10.4 Record baseline readings and complete another response test as outlined in Section 8. Compare the results of the response tests, noting any major differences in trip time or peak response.

9.10.5 Properly abandon open borehole by grouting as per Guide D 5299.

10. Report

10.1 The following information should be included in the field report. Refer to the form in Appendix X1.

10.1.1 Facility name, location and site contacts,

10.1.2 Date and Time the log is obtained,

10.1.3 MIP Contractor, MIP field technician and assistants,

10.1.4 File name of the MIP logging location and depth of final penetration,

10.1.5 File name of the pre-log response test along with test compound used and concentration,

10.1.6 File name of the post-log response test along with test compound used and concentration,

10.1.7 Equipment used in the investigation (gas phase detectors, flow rate and type of carrier gas, probe serial number, data acquisition unit, MIP controller, etc.), and

10.1.8 Site and location specific information relevant to the project. (for example, Petroleum UST, dry cleaning shop, dense till with cobbles, etc.).

11. Precision and Bias

11.1 *Precision*—Test data on precision is not presented due to the nature of this test method. It is either not feasible or too costly at this time to have 10 or more agencies participate in an in situ testing program at a given site.

11.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

12. Keywords

12.1 CPT; direct push; electrical conductivity; membrane interface probe; MIP; soil investigations; VOC; volatile organic contaminants

ANNEX

(Mandatory Information)

A1. REMOVAL AND REPLACEMENT REQUIREMENTS FOR MIP MEMBRANES

A1.1 Introduction

A1.1.1 This annex describes procedures and requirements for removing and replacing the MIP membrane.

A1.1.2 A membrane is operational if the response test signal (μV) of a compound is twice that of the baseline noise and if the flow of the system has not changed more than 3 mL/min from the closed couple flow of the system.

A1.2 Removal of a Membrane

A1.2.1 Turn off the heater power switch and allow the block to cool to 50°C or less.

A1.2.2 Clean the heater block and probe to remove any debris that may interfere with removal of the membrane or clog small gas ports in the block.

A1.2.3 Remove the membrane with the membrane wrench from the MIP service kit (Fig. A1.1). Keep the wrench parallel to the probe while removing the membrane to ensure proper engagement with socket head cap screw.

NOTE A1.1—Do not leave the membrane cavity open for extended periods of time. Debris can become lodged in the gas openings and affect the flow of the system.

A1.2.4 Remove and discard the copper washer. The copper washer conforms to a membrane and may not seal with a new membrane inserted.

A1.2.5 Inspect the open cavity for any foreign particles. Remove if necessary.

A1.3 Installation of Membranes

A1.3.1 Insert the new copper washer into the cavity. Ensure that the washer is setting flat on the base of the cavity.

A1.3.2 Install the new membrane by threading it into the socket. Use the membrane wrench to tighten the membrane to a snug fit.

A1.3.3 As the membrane is being inserted into the socket, a flow meter must be attached to the up-hole tubing to measure the flow of the MIP system. A minimum flow of 3 mL/min difference from the closed couple measurement is required to ensure a proper seal. If a minimum flow of 3 mL/min is not achieved, then more torque is applied to the membrane to further seal the membrane.

A1.3.4 Run a response test as per Section 8.

FIG. A1.1 Membrane Wrench Shown with Membrane Removed Exposing the Sub-Membrane Fittings

APPENDIX

(Nonmandatory Information)

X1. MIP FIELD INFORMATION FORM

SITE INFORMATION

Site Name: ____________________

Location Name: ____________________

Date: ____________________ Time: ____________________

MIP Operator: ____________________

MIP Contractor: ____________________

INSTRUMENT INFORMATION

Detectors Used: ____________________

Probe Type: MP4510 MP6510

Probe S/N: ____________________

LOGGING INFORMATION

MIP File Name: ____________________

Pre-Log Response Test File Name: ____________________

Response Test Compound: ____________________ Concentration: ____________________

Trip Time (seconds): ____________________

Final Depth of Penetration: ____________________

Post Log Response Test File Name: ____________________

Response Test Compound: ____________________ Concentration: ____________________

Trip Time (seconds): ____________________

OBSERVATIONS

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(**1**) Kejr Inc., “A Percussion Probing Tool for the Direct Sensing of Soil Conductivity,” *Technical Bulletin No. 94-100*, Geoprobe® Systems, 1995.

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(**7**) Costanza, J., and Davis W. M., “Rapid Detection of Volatile Organic Compounds in the Subsurface by Membrane Introduction into a Direct Sampling Ion Trap Mass Spectrometer,” *Field Analytical Chemistry and Technology*, Vol 4, Issue 5, October 2000, pp. 246-254.

(**8**) Nielsen, D. M., *Environmental Site Characterization and Ground-Water Monitoring*, CRC Press Taylor and Francis Group, LLC, Boca Raton, FL, September 2005, pp. 345-472.

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Attachment 3

To

Addendum 4
Field Sampling Plan For Part 2 of the
Supplemental Groundwater Investigation
Former York Naval Ordnance Plant
1425 Eden Road, Springettsbury Township
York, PA

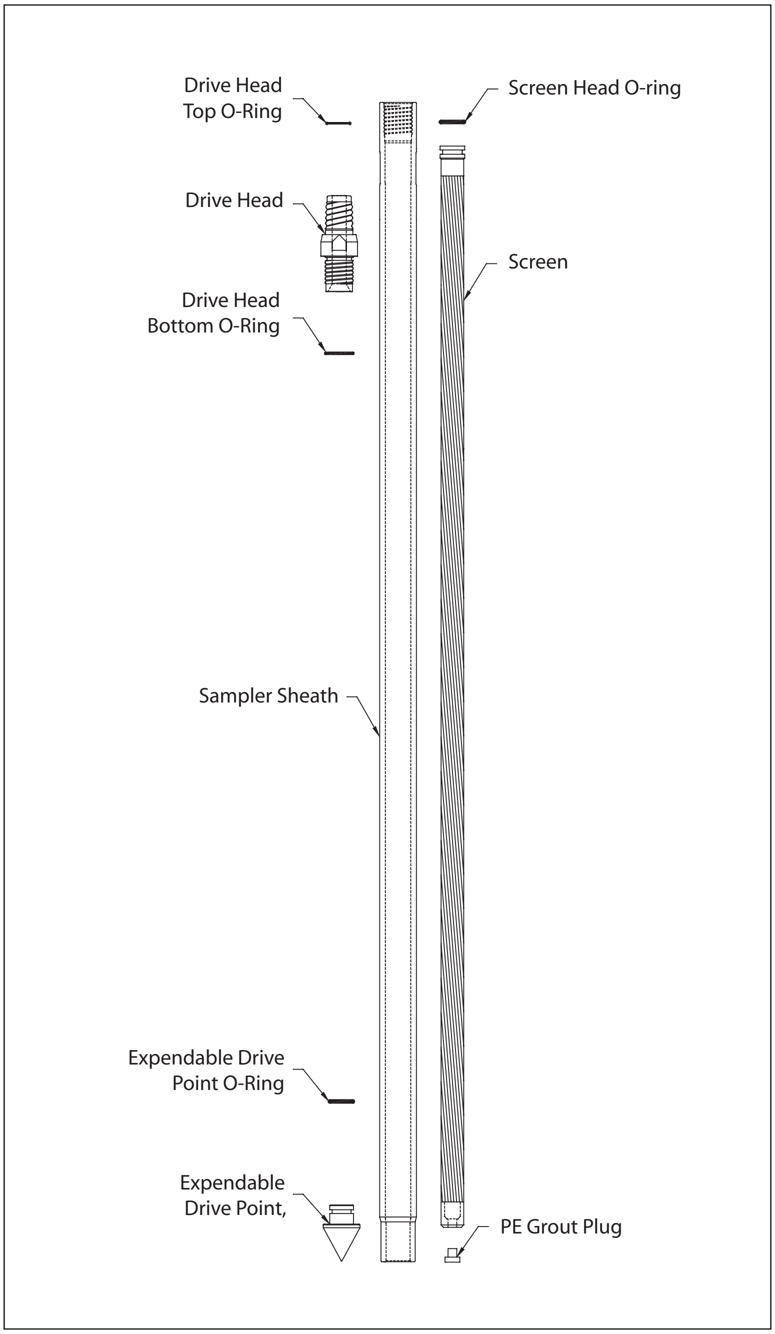
Geoprobe® Screen Point 16 Groundwater Sampler

GEOPROBE® SCREEN POINT 16 GROUNDWATER SAMPLER

STANDARD OPERATING PROCEDURE

Technical Bulletin No. MK3142

PREPARED: November, 2006



GEOPROBE® SCREEN POINT 16 GROUNDWATER SAMPLER PARTS

Geoprobe® and Geoprobe Systems®, Macro-Core® and Direct Image® are Registered Trademarks of Kejr, Inc., Salina, Kansas

Screen Point 16 Groundwater Sampler is manufactured under U.S. Patent 5,612,498

1.0 OBJECTIVE

The objective of this procedure is to drive a sealed stainless steel or PVC screen to depth, deploy the screen, obtain a representative water sample from the screen interval, and grout the probe hole during abandonment. The Screen Point 16 Groundwater Sampler enables the operator to conduct abandonment grouting that meets American Society for Testing and Materials (ASTM) Method D 5299 requirements for decommissioning wells and borings for environmental activities (ASTM 1993).

2.0 BACKGROUND

2.1 Definitions

Geoprobe®: A brand name of high quality, hydraulically powered machines that utilize both static force and percussion to advance sampling and logging tools into the subsurface. The Geoprobe® brand name refers to both machines and tools manufactured by Geoprobe Systems®, Salina, Kansas. Geoprobe® tools are used to perform soil core and soil gas sampling, groundwater sampling and monitoring, soil conductivity and contaminant logging, grouting, and materials injection.

Screen Point 16 (SP16) Groundwater Sampler: A direct push device consisting of a PVC or stainless steel screen that is driven to depth within a sealed, steel sheath and then deployed for the collection of representative groundwater samples. The assembled SP16 Sampler is approximately 51.5 inches (1308 mm) long with an OD of 1.625 inches (41 mm). Upon deployment, up to 41 inches (1041 mm) of screen can be exposed to the formation. The Screen Point 16 Groundwater Sampler is designed for use with 1.5-inch probe rods and machines equipped with the more powerful GH60 Hydraulic Hammer. Operators with GH40 Series hammers may chose to use this sampler in soils where driving is difficult.

Rod Grip Pull System: An attachment mounted on the hydraulic hammer of a direct push machine which makes it possible to retract the tool string with extension rods or flexible tubing protruding from the top of the probe rods. The Rod Grip Pull System includes a pull block with rod grip jaws that are bolted directly to the machine. A removable handle assembly straddles the tool string while hooking onto the pull block to effectively grip the probe rods as the hammer is raised. A separate handle assembly is required for each probe rod diameter.

2.2 Discussion

In this procedure, the assembled Screen Point 16 Groundwater Sampler (Fig. 2.1A) is threaded onto the leading end of a Geoprobe® probe rod and advanced into the subsurface with a Geoprobe® direct push machine. Additional probe rods are added incrementally and advanced until the desired sampling interval is reached. While the sampler is advanced to depth, O-ring seals at each rod joint, the drive head, and the expendable drive point provide a watertight system. This system eliminates the threat of formation fluids entering the screen before deployment and assures sample integrity.

Once at the desired sampling interval, extension rods are sent downhole until the leading rod contacts the bottom of the sampler screen. The tool string is then retracted approximately 44 inches (1118 mm) while the screen is held in place with the extension rods (Fig. 2.1B). As the tool string is retracted, the expendable point is released from the sampler sheath. The tool string and sheath may be retracted the full length of the screen or as little as a few inches if a small sampling interval is desired.

There are three types of screens that can be used in the Screen Point 16 Groundwater Sampler. Two of the these, a stainless steel screen with a standard slot size of 0.004 inches (0.10 mm) and a PVC screen with a standard slot size of 0.010 inches (0.25 mm), are recovered with the tool string after sampling. The third screen is also manufactured from PVC with a standard slot size of 0.010 inches (0.25 mm), but is designed to be left downhole when sampling is complete. This disposable screen has an exposed screen length of approximately 43 inches (1092 mm). The two screens that are recovered with the sampler both have an exposed screen length of approximately 41 inches (1041 mm).

(continued on following page)

An O-ring on the head of the stainless steel screens maintains a seal at the top of the screen. As a result, any liquid entering the sampler during screen deployment must first pass through the screen. PVC screens do not require an O-ring because the tolerance between the screen head and sampler sheath is near that of the screen slot size.

The screens are constructed such that flexible tubing, a mini-bailer, or a small-diameter bladder pump can be inserted into the screen cavity. This makes direct sampling possible from anywhere within the saturated zone. A removable plug in the lower end of the screens allows the user to grout as the sampler is extracted for further use.

Groundwater samples can be obtained in a number of ways. A common method utilizes polyethylene (TB25L) or Teflon® (TB25T) tubing and a Check Valve Assembly (GW4210). The check valve (with check ball) is attached to one end of the tubing and inserted down the casing until it is immersed in groundwater. Water is pumped through the tubing and to the ground surface by oscillating the tubing up and down.

An alternative means of collecting groundwater samples is to attach a peristaltic or vacuum pump to the tubing. This method is limited in that water can be pumped to the surface from a maximum depth of approximately 26 feet (8 m). Another technique for groundwater sampling is to use a stainless steel Mini-Bailer Assembly (GW41). The mini-bailer is lowered down the inside of the casing below the water level where it fills with water and is then retrieved from the casing.

The latest option for collecting groundwater from the SP16 sampler is to utilize a Geoprobe® MB470 Series Mechanical Bladder Pump (MBP)*. The MBP may be used to meet requirements of the low-flow sampling protocol (Puls and Barcelona 1996, ASTM 2003). Through participation in a U.S. EPA Environmental Technology Verification study, it was confirmed that the MB470 can provide representative samples (EPA 2003).

**The Mechanical Bladder Pump is manufactured under U.S. Patent No. 6,877,965 issued April 12, 2005.*

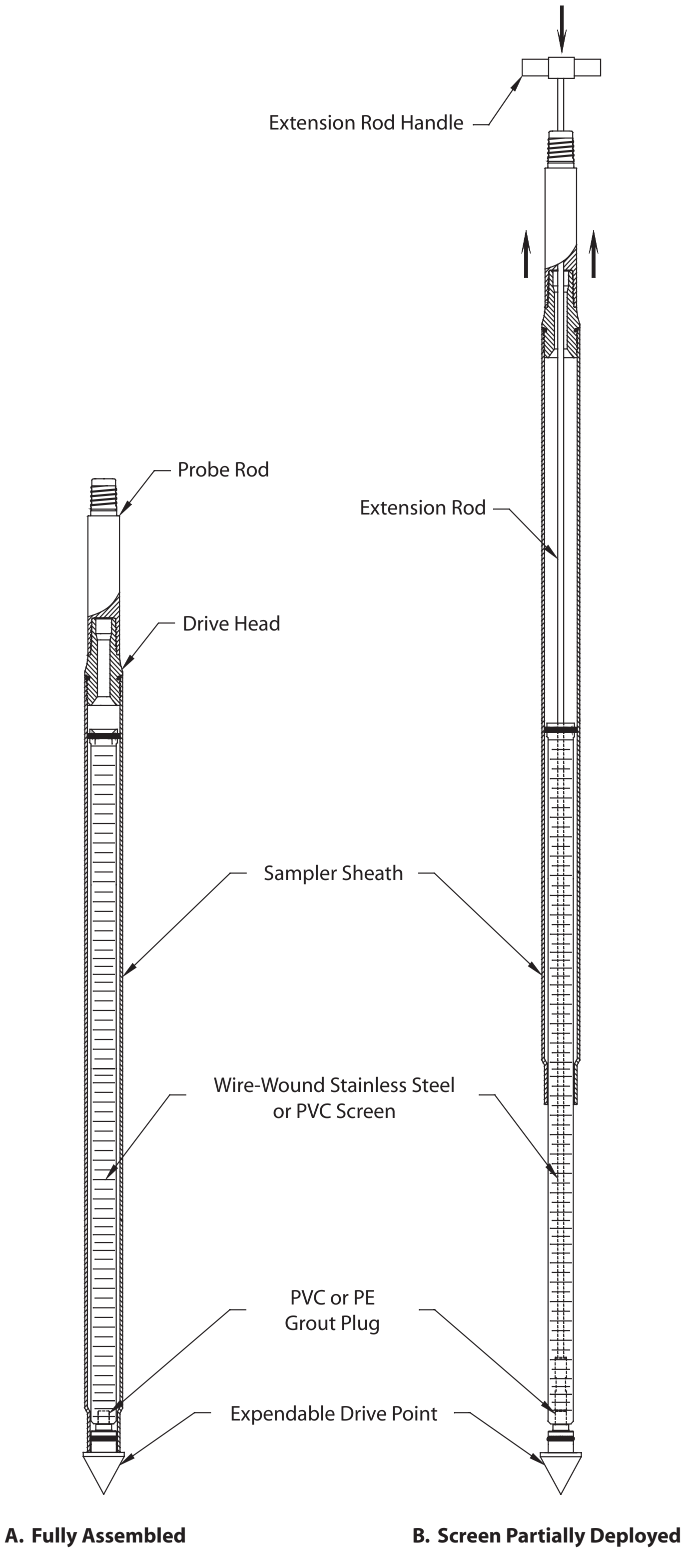


FIGURE 2.1

Screen Point 16 Groundwater Sampler

3.0 TOOLS AND EQUIPMENT

The following tools and equipment can be used to successfully recover representative groundwater samples with the Geoprobe® Screen Point 16 Groundwater Sampler. Refer to Figures 3.1 and 3.2 for identification of the specified parts. Tools are listed below for the most common SP16 / 1.5-inch probe rod configurations. Additional parts for optional rod sizes and accessories are listed in Appendix A.

SP16 Sampler Parts	**Part Number**
SP16 Sampler Sheath	15187
SP16 Drive Head, 0.5-inch bore, 1.5-inch rods*	18307
SP16 O-ring Service Kit, 1.5-inch rods *(includes 4 each of the O-ring packets below)*	15844
O-rings for Top of SP16 Drive Head, 1.5-inch rods only (Pkt. of 25)	*15389*
O-rings for Bottom of SP16 Drive Head (Pkt. of 25)	*13196*
O-rings for GW1520 Screen Head (Pkt. of 25)	*GW1520R*
O-rings for SP16 Expendable Drive Point (Pkt. of 25)	*GW1555R*
Screen, Wire-Wound Stainless Steel, 4-Slot*	GW1520
Grout Plugs, PE (Pkg. of 25)	GW1552K
Expendable Drive Points, steel, 1.625-inch OD (Pkg. of 25)*	GW1555K
Screen Point 16 Groundwater Sampler Kit, 1.5-inch Probe Rods *(includes 1 each of: 15187, 18307, 15844, GW1520, GW1535, GW1540, GW1555K, and GW1552K)*	15770

Probe Rods and Probe Rod Accessories	**Part Number**
Drive Cap, 1.5-inch probe rods, threadless, (for GH60 Hammer)	12787
Pull Cap, 1.5-inch probe rods	15090
Probe Rod, 1.5-inch x 60-inch*	11121

Extension Rods and Extension Rod Accessories	**Part Number**
Screen Push Adapter	GW1535
Grout Plug Push Adapter	GW1540
Extension Rod, 60-inch*	10073
Extension Rod Coupler	AT68
Extension Rod Handle	AT69
Extension Rod Jig	AT690
Extension Rod Quick Link Coupler, pin	AT695
Extension Rod Quick Link Coupler, box	AT696

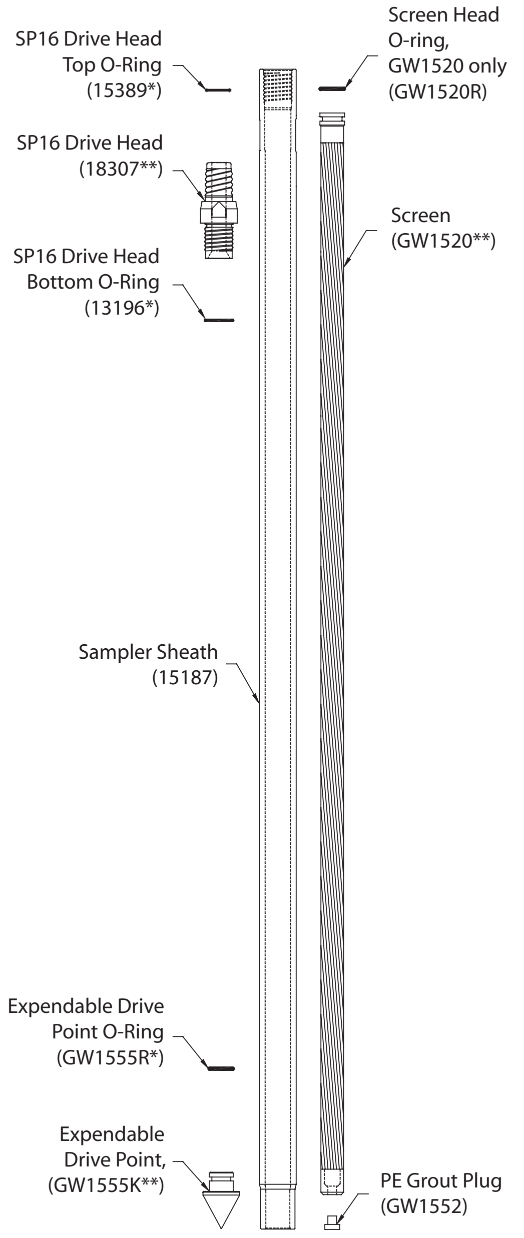
Grout Accessories	**Part Number**
Grout Nozzle, for 0.375-inch OD tubing	GW1545
High-Pressure Nylon Tubing, 0.375-inch OD / 0.25-inch ID, 100-ft. (30 m)	11633
Grout Machine, self-contained*	GS1000
Grout System Accessories Package, 1.5-inch rods	GS1015

Groundwater Purging and Sampling Accessories	**Part Number**
Polyethylene Tubing, 0.375-inch OD, 500 ft.*	TB25L
Check Valve Assembly, 0.375-inch OD Tubing*	GW4210
Water Level Meter, 0.438-inch OD Probe, 100 ft. cable*	GW2000
Mechanical Bladder Pump**	MB470
Mini Bailer Assembly, stainless steel	GW41

Additional Tools	**Part Number**
Adjustable Wrench, 6.0-inch	FA200
Adjustable Wrench, 10.0-inch	FA201
Pipe Wrenches	NA

* See Appendix A for additional tooling options.

** Refer to the Standard Operating Procedure (SOP) for the Mechanical Bladder Pump (Technical Bulletin No. MK3013) for additional tooling needs.



* Included in the SP16 O-ring Service Kit (15844)

** Part numbers show most common tool configuration. See Appendix A for alternative parts.

FIGURE 3.1
SP16 Sampler Parts

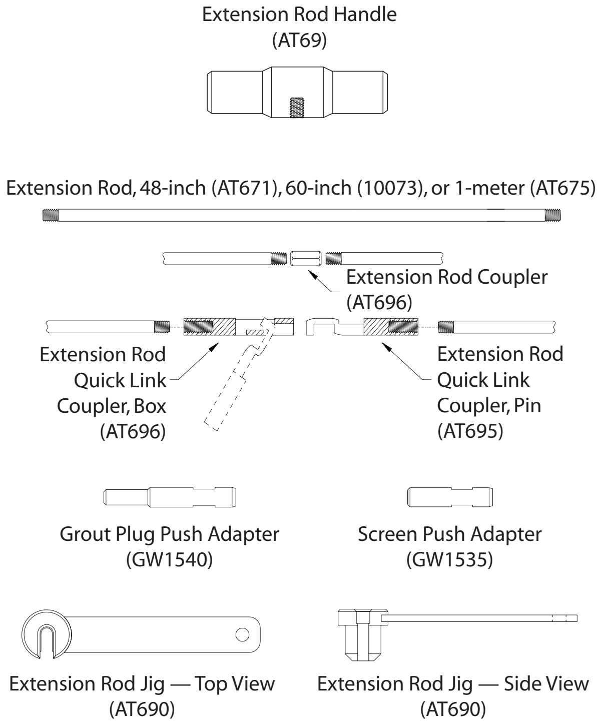


FIGURE 3.2
Geoprobe® Extension Rods and Accessories

4.0 OPERATION

4.1 Basic Operation

The SP16 sampler utilize a stainless steel or PVC screen which is encased in an alloy steel sampler sheath. An expendable drive point is placed in the lower end of the sheath while a drive head is attached to the top. O-rings on the drive head and expendable point provide a watertight sheath which keeps contaminants out of the system as the sampler is driven to depth.

Once the sampling interval is reached, extension rods equipped with a screen push adapter are inserted down the ID of the probe rods. The tool string is then retracted up to 44 inches (1118 mm) while the screen is held in place with the extension rods. The system is now ready for groundwater sampling. When sampling is complete, a removable plug in the bottom of the screen allows for grouting below the sampler as the tool string is retrieved.

4.2 Sampler Options

The Screen Point 15 and Screen Point 16 Groundwater Samplers are nearly identical. Subtle differences in the design of the SP16 sampler make it more durable than the earlier SP15 system. Operators of GH60-equipped machines should always utilize SP16 tooling. Operators of machines equipped with GH40 Series hammers may also choose SP16 tooling when sampling in difficult probing conditions.

A 1.75-inch OD Expendable Drive Point (17066K) and Disposable PVC Screen (16089) provide two useful options for the SP16 sampler. The 1.75-inch drive point may be used when soil conditions make it difficult to remove the sampler after driving to depth. The disposable PVC screen may be left downhole after sampling (when regulations permit) to eliminate the time required for screen decontamination.

4.3 Decontamination

In order to collect representative groundwater samples, all sampler parts must be thoroughly cleaned before and after each use. Scrub all metal parts using a stiff brush and a nonphosphate soap solution. Steam cleaning may be substituted for hand-washing if available. Rinse with distilled water and allow to air-dry before assembly.

4.4 SP16 Sampler Assembly (Figure 4.1)

Part numbers are listed for a standard SP16 sampler using 1.5-inch probe rods. Refer to Page 6 for screen and drive head alternatives.

1. Place an O-ring on a steel expendable drive point (GW1555K). Firmly seat the expendable point in the necked end of a sampler sheath (15187).

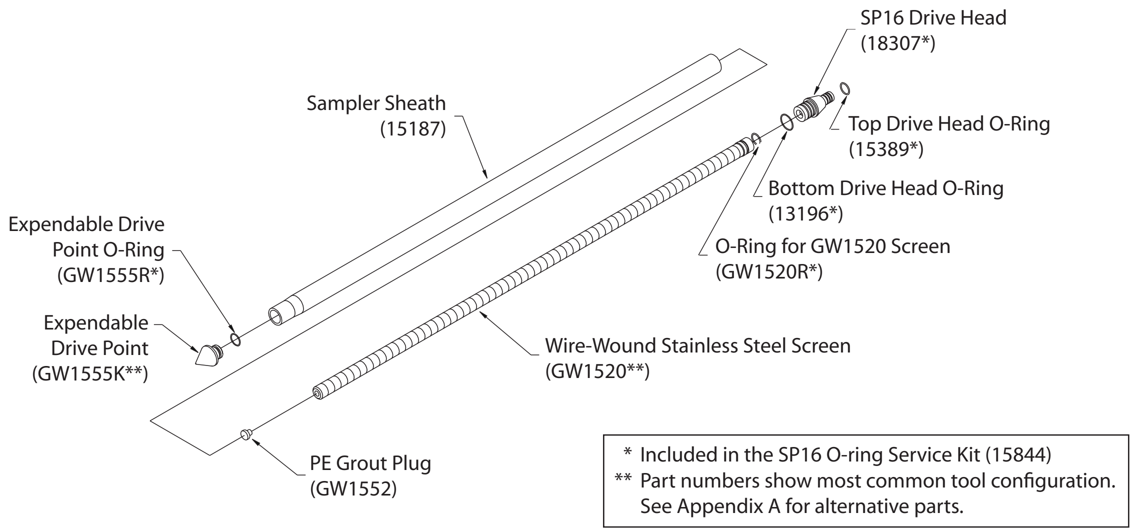
2. Install a PE Grout Plug (GW1552) in the bottom end of a Wire-wound Stainless Steel Screen (GW1520). Place a GW1520R O-ring in the groove on the top end of the screen.

3. Slide the screen inside of the sampler sheath with the grout plug toward the bottom of the sampler. Ensure that the expendable point was not displaced by the screen.

4. Install a bottom O-ring (13196) on a Drive Head (18307 or 15188). Thread the drive head into the sampler sheath using an adjustable wrench if necessary to ensure complete engagement of the threads. Attach a Drive Cap (12787 or 15590) to the top of the drive head.

   NOTE: The 18307 drive head should be used whenever possible as the smaller 0.5-inch ID provides a greater material cross-section for increased durability.

Sampler assembly is complete.



* Included in the SP16 O-ring Service Kit (15844)
** Part numbers show most common tool configuration.
See Appendix A for alternative parts.

FIGURE 4.1
Screen Point 16 Groundwater Sampler Assembly

4.5 Advancing the SP16 Sampler

To provide adequate room for screen deployment with the Rod Grip Pull System, the probe derrick should be extended a little over halfway out of the carrier vehicle when positioning for operation.

1. Begin by placing the assembled sampler (Fig. 2.1.A) in the driving position beneath the hydraulic hammer of the direct push machine as shown in Figure 4.2.

2. Advance the sampler with the throttle control at slow speed for the first few feet to ensure that the sampler is aligned properly. Switch to fast speed for the remainder of the probe stroke.

3. Completely raise the hammer assembly. Remove the drive cap and place an O-ring in the top groove of the drive head. Distilled water may be used to lubricate the O-ring if needed.

   Add a probe rod (length to be determined by operator) and reattach the drive cap to the rod string. Drive the sampler the entire length of the new rod with the throttle control at fast speed.

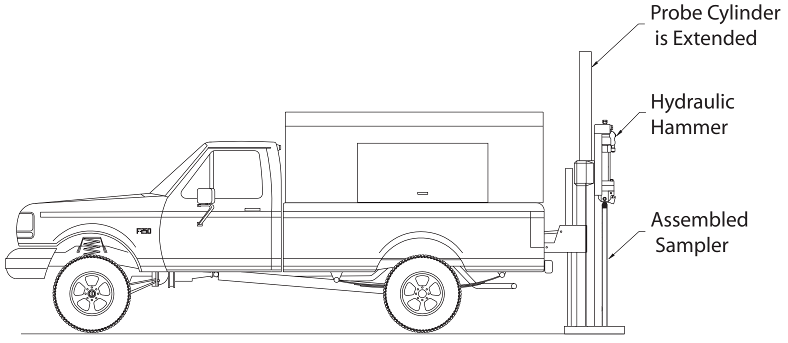


FIGURE 4.2
Screen Point 16 Groundwater Sampler in Driving Position

4. Repeat Step 3 until the desired sampling interval is reached. Approximately 12 inches (305 mm) of the last probe rod must extend above the ground surface to allow attachment of the puller assembly. A 12-inch (305 mm) rod may be added if the tool string is over-driven.

5. Remove the drive cap and retract the probe derrick away from the tool string.

4.6 Screen Deployment

1. Thread a screen push adapter (GW1535) on an extension rod of suitable length (AT671, 10073, or AT675). Attach a threaded coupler (AT68) to the other end of the extension rod. Lower the extension rod inside of the probe rod taking care not to drop it down the tool string. An extension rod jig (AT690) may be used to hold the rods.

2. Add extension rods until the adapter contacts the bottom of the screen. To speed up this step, it is recommended that Extension Rod Quick Links (AT695 and AT696) are used at every other rod joint.

3. Ensure that at least 48 inches (1219 mm) of extension rod protrudes from the probe rod. Thread an extension rod handle (AT69) on the top extension rod.

4. Maneuver the probe assembly into position for pulling.

5. Raise (pull) the tool string while physically holding the screen in place with the extension rods (Fig. 4.3.B). A slight knock with the extension rod string will help to dislodge the expendable point and start the screen moving inside the sheath.

   Raise the hammer and tool string about 44 inches (1118 cm) if using a GW1520 or GW1530 screen. At this point the screen head will contact the necked portion of the sampler sheath (Fig. 4.3.C.) and the extension rods will rise with the probe rods. Use care when deploying a PVC screen so as not to break the screen when it contacts the bottom of the sampler sheath.

   The Disposable Screen (16089) will extend completely out of the sheath if the tool string is raised more than 45 inches (1143 mm). Measure and mark this distance on the top extension rod to avoid losing the screen during deployment.

6. Remove the rod grip handle, lower the hammer assembly, and retract the probe derrick. Remove the top extension rod (with handle) and top probe rod. Finally, extract all extension rods.

7. Groundwater samples can now be collected with a mini-bailer, peristaltic or vacuum pump, tubing bottom check valve assembly, bladder pump, or other acceptable small diameter sampling device.

   When inserting tubing or a bladder pump down the rod string, ensure that it enters the screen interval. The leading end of the tubing or bladder pump will sometimes catch at the screen head giving the illusion that the bottom of the screen has been reached. An up-and-down motion combined with rotation helps move the tubing or bladder pump past the lip and into the screen.

4.7 Abandonment Grouting for GW1520 and GW1530 Screens

The SP16 Sampler can meet ASTM D 5299 requirements for abandoning environmental wells or borings when grouting is conducted properly. A removable grout plug makes it possible to deploy tubing through the bottom of GW1520 and GW1530 screens. A GS500 or GS1000 Grout Machine is then used to pump grout into the open probe hole as the sampler is withdrawn. The following procedure is presented as an example only and should be modified to satisfy local abandonment grouting regulations.

1. Maneuver the probe assembly into position for pulling. Attach the rod grip puller to the top probe rod. Raise the tool string approximately 4 to 6 inches (102 to 152 cm) to allow removal of the grout plug.

2. Thread the Grout Plug Push Adapter (GW1540) onto an extension rod. Insert the adapter and extension rod inside the probe rod string. Add extension rods until the adapter contacts the grout plug at the bottom of the screen. Attach the handle to the top extension rod. When the extension rods are slightly raised and lowered, a relatively soft rebound should be felt as the adapter contacts the grout plug. This is especially true when using a PVC screen.

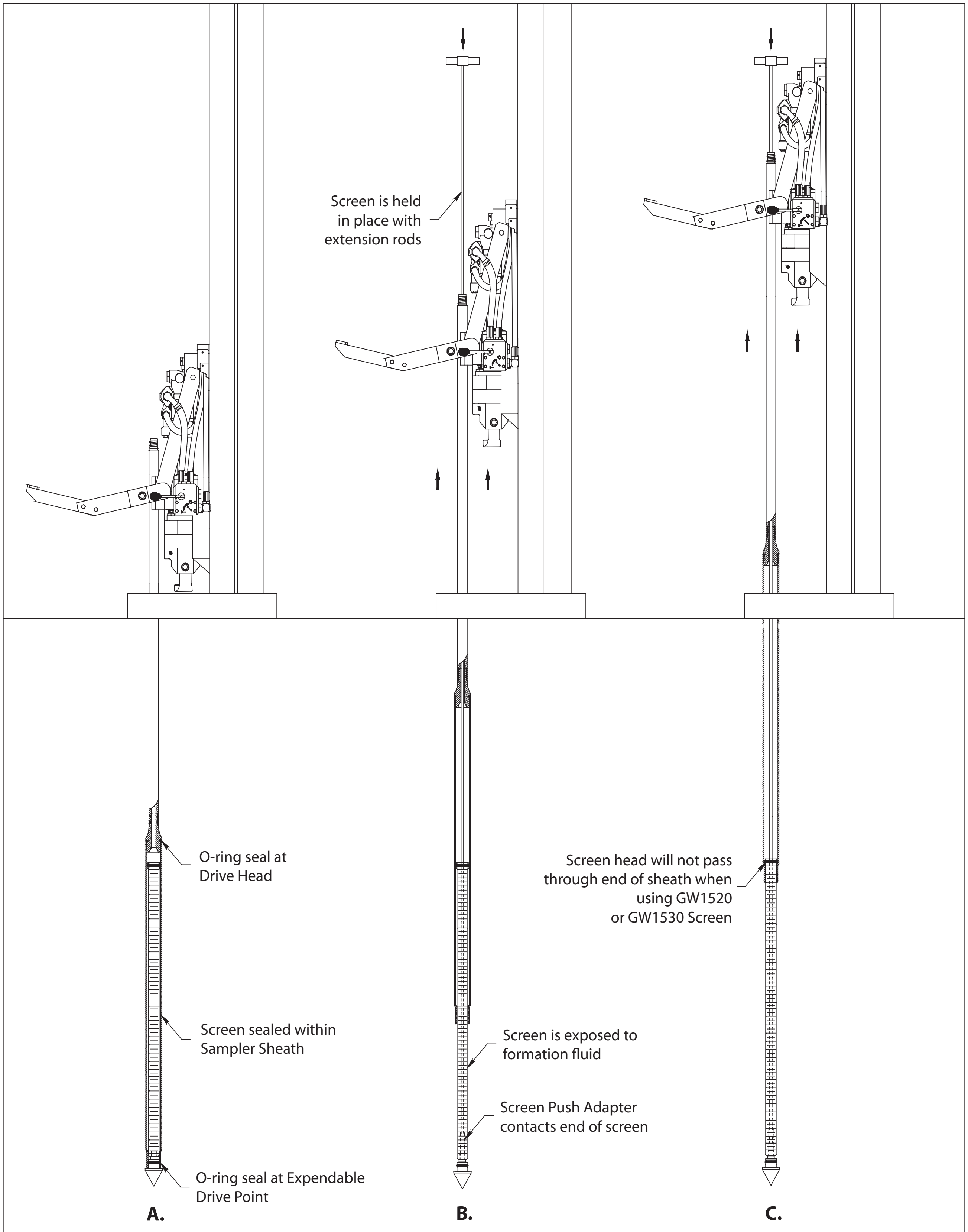
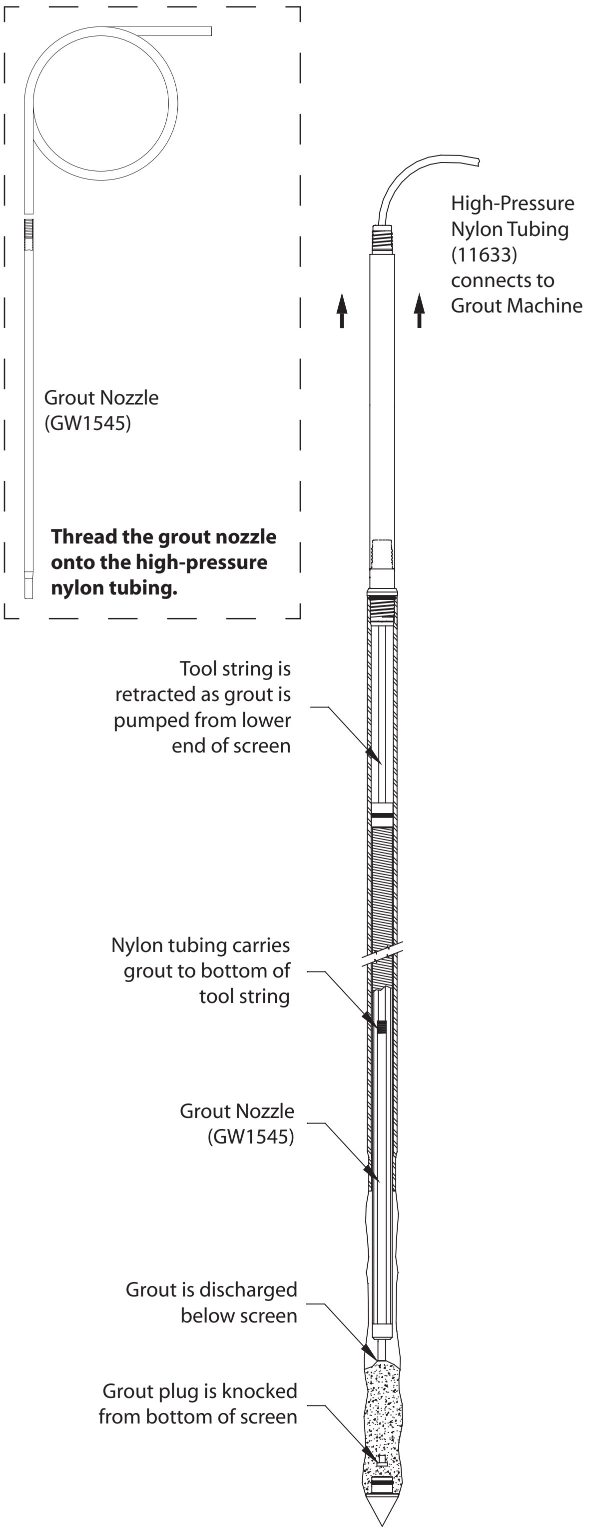


FIGURE 4.3

Screen Deployment for SP16 Sampler



Thread the grout nozzle onto the high-pressure nylon tubing.

FIGURE 4.4

Grouting the SP16 Sampler With a GW1520 or GW1530 Screen

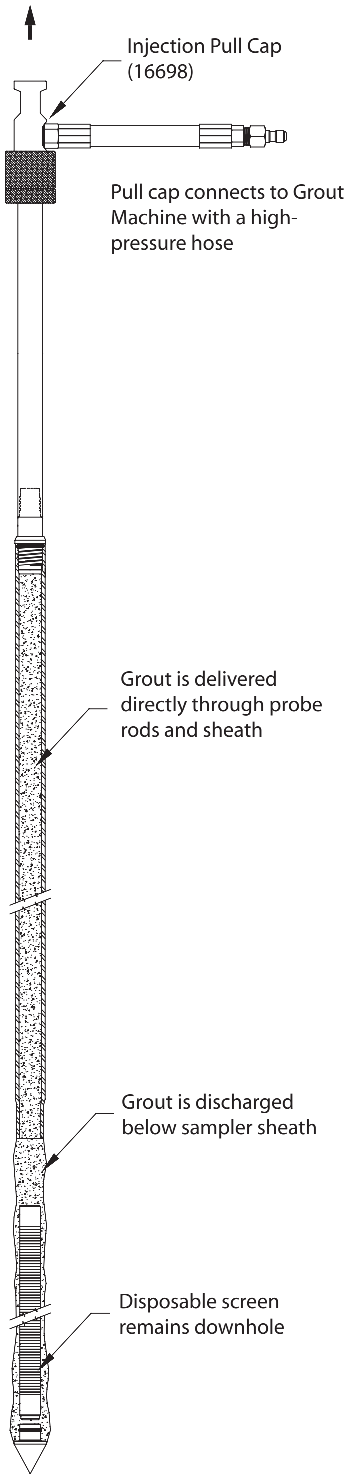


FIGURE 4.5

Grouting the SP16 Sampler With a 16089 Disposable Screen

3. Place a mark on the extension rod even with the top of the probe rod. Apply downward pressure on the extension rods and push the grout plug out of the screen. The mark placed on the extension rod should now be below the top of the probe rod. Remove all extension rods.

   Note: When working with a stainless steel screen, it may be necessary to raise and quickly lower the extension rods to jar the grout plug free. When the plug is successfully removed, a metal-on-metal sensation may be noted as the extension rods are gently "bounced" within the probe rods.

4. A Grout Nozzle (GW1545) is now connected to High-Pressure Nylon Tubing (11633) and inserted down through the probe rods to the bottom of the screen (Fig. 4.4). It may be necessary to pump a small amount of clean water through the tubing during deployment to jet out sediments that settled in the bottom of the screen. Resistance will sometimes be felt as the grout nozzle passes through the drive head. Rotate the tubing while moving it up-and-down to ensure that the nozzle has reached the bottom of the screen and is not hung up on the drive head.

   Note: *All probe rods remain strung on the tubing as the tool string is pulled. Provide extra tubing length to allow sufficient room to lay the rods on the ground as they are removed. An additional 20 feet is generally enough.*

5. Operate the grout pump while pulling the first rod with the rod grip pull system. Coordinate pumping and pulling rates so that grout fills the void left by the sampler. After pulling the first rod, release the rod grip handle, fully lower the hammer, and regrip the tool string. Unthread the top probe and slide it over the tubing placing it on the ground near the end of the tubing.

6. Repeat Step 5 until the sampler is retrieved. Do not bend or kink the tubing when pulling and laying out the probe rods. Sharp bends create weak spots in the tubing which may burst when pumping grout. Remember to operate the grout pump only when pulling the rod string. The probe hole is thus filled with grout from the bottom up as the rods are extracted.

7. Promptly clean all probe rods and sampler parts before the grout sets up and clogs the equipment.

4.8 Abandonment Grouting for the 16089 Disposable Screen

ASTM D 5299 requirements can also be met for the SP16 samplers when using the 16089 disposable screen. Because the screen remains downhole after sampling, the operator may choose either to deliver grout to the bottom of the tool string with nylon tubing or pump grout directly through the probe rods using an Injection Pull Cap (16698). A GS500 or GS1000 Grout Machine is needed to pump grout into the open probe hole as the sampler is withdrawn. The following procedure is presented as an example only and should be modified to satisfy local abandonment grouting regulations.

1. Maneuver the probe assembly into position for pulling with the rod grip puller.

2. Thread the screen push adapter onto an extension rod. Insert the adapter and extension rod inside the probe rod string. Add extension rods until the adapter contacts the bottom of the screen. Attach the handle to the top extension rod.

3. The disposable screen must be extended at least 46 inches (1168 mm) to clear the bottom of the sampler sheath. Considering the length of screen deployed in Section 4.7, determine the remaining distance required to fully extend the screen from the sheath. Mark this distance on the top extension rod.

4. Pull the tool string up to the mark on the top extension rod while holding the disposable screen in place.

   The screen is now fully deployed and the sampler is ready for abandonment grouting. Apply grout to the bottom of the tool string during retrieval using either flexible tubing (as described in Section 4.7) or an injection pull cap (Fig. 4.5). This section continues with a description of grouting with a pull cap.

5. Remove the rod grip handle and maneuver the probe assembly directly over the tool string. Thread an Injection Pull Cap (16698) onto the top probe rod and close the hammer pull latch over the top of the pull cap.

6. Connect the pull cap to a Geoprobe® grout machine using a high-pressure grout hose.

7. Operate the pump to fill the entire tool string with grout. When a sufficient volume has been pumped to fill the tool string, begin pulling the rods and sampler while continuing to operate the grout pump. Considering the known pump volume and sampler cross-section, time tooling withdrawal to slightly "overpump" grout into the subsurface. This will ensure that all voids are filled during sampler retrieval.

   The grouting process can lubricate the probe hole sufficiently to cause the tool string to slide back downhole when disconnected from the pull cap. Prevent this by withdrawing the tool string with the rod grip puller while maintaining a connection to the grout machine with the pull cap.

4.9 Retrieving the Screen Point 16 Sampler

If grouting is not required, the Screen Point 16 Sampler can be retrieved by pulling the probe rods as with most other Geoprobe® applications. The Rod Grip Pull System should be used for this process as it allows the operator to remove rods without completely releasing the tool string. This avoids having the probe rods fall back downhole when released during the pulling procedure. A standard Pull Cap (15164) may still be used if preferred. Refer to the Owner's Manual for your Geoprobe® direct push machine for specific instructions on pulling the tool string.

5.0 REFERENCES

American Society of Testing and Materials (ASTM), 2003. D6771-02 Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations. ASTM, West Conshocken, PA. (www.astm.org)

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Puls, Robert W., and Michael J. Barcelona, 1996. Ground Water Issue: Low-Flow (Minimal Drawdown) Ground Water Sampling Procedures. EPA/540/S-95/504. April.

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Appendix A
ALTERNATIVE PARTS

The following parts are available to meet unique soil conditions. See section 3.0 for a complete listing of the common tool configurations for the Geoprobe® Screen Point 16 Groundwater Sampler.

SP16 Sampler Parts and Accessories	**Part Number**
SP16 Drive Head, 0.625-inch bore, 1.5-inch rods	15188
Expendable Drive Points, aluminum, 1.625-inch OD (Pkg. of 25)	GW1555ALK
Expendable Drive Points, steel, 1.75-inch OD (Pkg. of 25)	17066K
Screen, PVC, 10-Slot	GW1530
Screen, Disposable, PVC, 10-Slot	16089

Groundwater Purging and Sampling Accessories	**Part Number**
Polyethylene Tubing, 0.25-inch OD, 500 ft.	TB17L
Polyethylene Tubing, 0.5-inch OD, 500 ft.	TB37L
Polyethylene Tubing, 0.625-inch OD, 50 ft.	TB50L
Check Valve Assembly, 0.25-inch OD Tubing	GW4240
Check Valve Assembly, 0.5-inch OD Tubing	GW4220
Check Valve Assembly, 0.625-inch OD Tubing	GW4230
Water Level Meter, 0.375-inch OD Probe, 100-ft. cable	GW2001
Water Level Meter, 0.438-inch OD Probe, 200-ft. cable	GW2002
Water Level Meter, 0.375-inch OD Probe, 200-ft. cable	GW2003
Water Level Meter, 0.438-inch OD Probe, 30-m cable	GW2005
Water Level Meter, 0.438-inch OD Probe, 60-m cable	GW2007
Water Level Meter, 0.375-inch OD Probe, 60-m cable	GE2008

Grouting Accessories	**Part Number**
Grout Machine, auxiliary-powered	GS500

Probe Rods, Extension Rods, and Accessories	**Part Number**
Probe Rod, 1.5-inch x 1-meter	17899
Probe Rod, 1.5-inch x 48-inch	13359
Drive Cap, 1.5-inch rods (for GH40 Series Hammer)	15590
Rod Grip Pull Handle, 1.5-inch Probe Rods (for GH40 Series Hammer)	GH1555
Extension Rod, 48-inch	AT671
Extension Rod, 1-meter	AT675

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