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December 1, 2012
Ref. No.: 12-207-1

Mr. Steve Snyder
Groundwater Sciences, Inc.
2601 Market Place Street, Suite 310-1
Harrisburg, Pennsylvania 17110

Subject: Geophysical Investigation Results
Harley Davidson Site
York, Pennsylvania

Dear Mr. Snyder:

Advanced Geological Services (AGS) presents this letter report to Groundwater Sciences, Inc. (GS), of Harrisburg, Pennsylvania detailing the methods and results of a geophysical investigation that was conducted at the Harley-Davidson Site in York, Pennsylvania. The survey was conducted along a 2,600-foot transect on the western side of Codorus Creek, next to an existing water treatment plant. The data was collected on the top of a large berm that was constructed by the Army Corps of Engineers in the southern section of the line, and in open grass areas in the northern section of the line. The field activities for this investigation were completed by AGS between October 16-18, 2012.

Objectives

The primary objectives of this geophysical survey were to locate possible bedrock fractures and karst features below the 2,600-foot transect that was defined above by Groundwater Sciences, Inc. Additional objectives included the characterization of overburden sediments, and the definition of bedrock topography below the geophysical profile. The geophysical data was analyzed closely for these targets and features, and the results are described below. To meet the objective of the investigation, AGS used the electrical resistivity imaging (ERI) method.

Often the subsurface fractures and karst features are not obvious at the ground surface and their effects on groundwater flow are difficult to quantify. However, significant advances have been made over the last few decades to remotely locate subsurface fractured bedrock aquifers using aerial photographs and satellite imagery, and through the use of various geophysical techniques such as electrical resistivity imaging (ERI). Water-bearing bedrock fracture zones may be identified in ERI profiles because of the sharp contrast in electrical properties between porous fractured rock saturated with water (low resistivity) and the surrounding dry unfractured rock (high resistivity).

Survey Grids

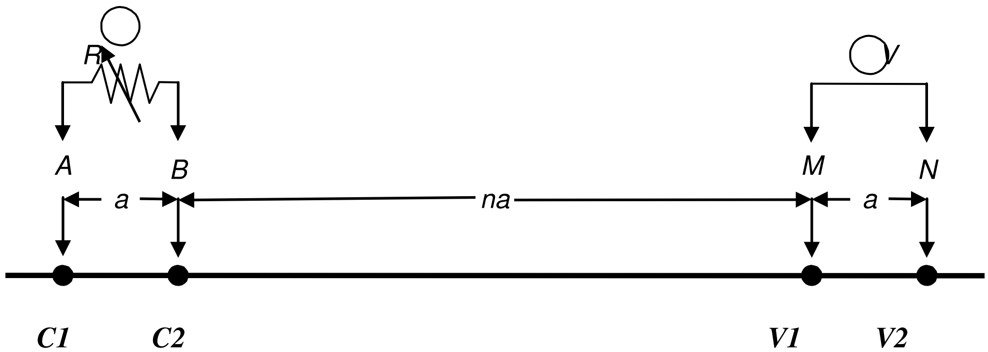
AGS collected two, in-line ERI profiles along the western side of Codorus Creek. Line 1 is located on the northern side of a large outfall that runs west-to-east into Codorus Creek, and Line 2 is located to the south of this same outfall. The electrode spacing for Lines 1 and 2 were 10 feet, which resulted in a total line lengths of 830 feet and 1810 feet, respectively. Line 1 exhibited a slight change in direction near AGS station 450 and the data was processed using a 3-dimensional algorithm, and presented in 2-dimensional format. Line 2 was processed and presented in 2-dimensional format.

AGS used a Trimble Pro XRS global positioning system (GPS) to measure the locations of the ERI lines, as well as important site features such as outfalls, a riprap location, and transformers. The high-resolution, geo-referenced orthophoto presented in Figure 1 shows the locations of the waste water treatment plant, Codorus Creek, and other buildings, bridges, and structures.

Electrical Resistivity Method

Electrical resistivity (ER) methods are used to measure the resistivity structure of subsurface materials using a direct current electrical source. For this survey, a linear series of 84 electrodes (metal stakes) were placed into the ground at a constant and known distance. Each resistivity measurement involves the activation of only four of the electrodes. A direct current signal is injected into the ground between two transmitting (current, C1 and C2) electrodes, and the resulting voltage drop is then measured between two receiving (potential, V1 and V2) electrodes. The measured voltage drop is converted into apparent resistivity using equations that take into account the geometry of the electrode array and the measured voltage and current at each station point. The automatic switching relay in the system moves to the next series of electrodes, and the process is repeated until a complete data set is acquired. Several thousand data points are typically acquired for each E/R line.

For this investigation, the dipole-dipole profiling-sounding electrode configuration was implemented. Among the various electrode arrays, this one is commonly used for detecting lateral variations in subsurface conditions, discrete anomalies, and detecting horizontal or sub-horizontal layers. The method typically provides greater lateral detail on the profiles. A schematic of the dipole-dipole electrode configuration is presented below.



The apparent resistivity equation for the dipole-dipole array is,

$$\boldsymbol{\rho_a = \pi a n(n+1)(n+2)(V/I)}, \text{ where}$$

$\boldsymbol{\rho_a}$ - apparent resistivity,
a - distance between A and B, and M and N,
n - whole number,
V - voltage, and
I - current

Apparent resistivity is a function of the porosity, permeability, water content, lithology, and ionic make up of the subsurface materials. Consequently, water-filled void spaces, fracture zones, saturated karst features, waste materials and leached fluids, or soils and rocks that contain a high percentage of clay minerals and a high water content generally have a low apparent resistivity. On the other hand, an air-filled void or fracture zone, unsaturated karst features, dry clean sand with few free ions, or a very dry clayey material will have a relatively high apparent resistivity. Due to the geologic nature of the site, AGS anticipated that the void spaces would contain leached fluids, and would therefore exhibit a very low resistivity.

Surface resistivity data was collected using a SuperSting R-8/IP resistivity meter and a Swift automatic multi-electrode system. The SuperSting R-8/IP resistivity meter is manufactured by Advanced Geosciences, Inc. of Austin Texas. The resistivity meter is self contained, battery operated, and is capable of monitoring data quality using predetermined statistical parameters, numerical stacking of measured data to increase the signal to noise ratio, and spontaneous potential cancellation. The data can be stored for downloading at the end of the day.

The Swift automatic multi-electrode system used in this investigation consisted of 84 electrodes. The Swift controller is connected directly to the Sting R-8/IP resistivity meter which was preprogrammed to collect data using the dipole-dipole configuration. Again, the electrodes were spaced 10 feet apart to provide an anticipated depth of investigation of approximately 180 feet below the ground surface. Upon completion of the electrode array set-up, electrode tests were conducted to ensure that all electrodes were correctly attached and that the resistance between the ground and the electrodes were within an acceptable range. Upon completion of the electrode test, the resistivity meter was set to automatically sample the dipole-dipole data. The resistivity data was processed and analyzed using the commercially available computer program, "Earth Imager" software package by Saga Geophysics. The resulting model presents resistivity as a function of depth. We have provided two ER profiles with this report.

Resolution of Subsurface Features

The ability to resolve a particular geologic interface or discrete geologic structure or body using the ERI method depends on several factors. It is important that a measurable electrical contrast exists between the surrounding materials and the target of interest. As the electrical contrast increases, the target will become more distinct and traceable on the modeled profiles.

Another important factor is the electrode configuration and the electrode spacing. The dipole-dipole configuration is typically used for delineating a target that possesses a discrete vertical and horizontal space, as well as large-scale geologic interfaces. The electrode spacing defines the depth of investigation and resolution of the interface. The closer the electrode separation, the greater the horizontal and vertical resolution, but the shallower the depth of investigation. It is important to define a balance between resolution and depth to the target interface, and project costs.

The horizontal resolution observed for the data set collected at the site was equal to the geophone/electrode spacing, which is 10 feet. Based on the manner in which ERI data is collected, the vertical resolution is highest near the ground surface, and decreases as the depth of investigation increases. In other words, the vertical distance between ER data points increases with depth. This translates to an approximate vertical resolution of 3 feet from 0 to 20 feet bgs, 5-6 feet from 30 to 60 feet bgs, and 10-12 feet from 80-180 feet bgs. Only those geologic features that are larger in size than the aforementioned horizontal and vertical resolution limitations can be observed on the resistivity cross sections.

Results

AGS has enclosed three figures with this report. Figure 1 that shows the locations of the geophysical profiles, various site features, and the locations of certain man-made structures. AGS has placed this information on a high-resolution orthophotograph so that direct referencing with our ERI line information can be accomplished. AGS collected global positioning system (GPS) data over our lines and certain site features to place on our maps.

We have also included with this report, Figures 2 and 3, which are annotated ERI profiles.

Line 1

Figure 2 shows the final computed depth model from Line 1, important resistivity interfaces, interpreted lithologies, and important features that were detected in the subsurface. The location of Line 1 is shown on the inset of this figure and the map in Figure 1.

The electrical resistivity data from Line 1 indicates the presence of a low resistivity zone (LRZ), that is less than 170 ohm-m, and a high resistivity zone (HRZ), that is greater than 170 ohm-m. AGS has placed a dashed line between these interfaces. In the northern part of the profile, the LRZ is approximately 35-50 feet thick. A strong metal anomaly was detected at AGS station 406 that probably represents a buried outfall that has metal associated with it. This anomaly creates noise in the data that is labeled on the profile. To the south of the metal anomaly, the LRZ/HRZ interface increases in depth through station 670, then abruptly dips vertically from a depth of 70 feet to 130 feet. The interface rises somewhat to 115 feet at the end of the profile. Extreme changes in bedrock elevation of this nature, in a limestone terrain, are somewhat common.

AGS detected three discrete anomalies, A1 through A3, that may represent karst features or possible fracture zones. A1 is located between stations 165-200, and within a depth range of 35-72 feet below ground surface (bgs). A1 exhibits lower resistivity values than the surrounding HRZ materials, and suggests a possible water-bearing karst feature. The deepest part of A1, at station 195, may be a good potential drilling location. A2 is located at station 572 and represents a smaller possible karst feature. It is located between stations 568-579, and is approximately 7 feet below the prevailing LRZ/HRZ interface. It does not appear to be as significant as A1. A3 is located at station 685 and it is located at the deepest point of the thick LRZ in the southern part of the profile. This resistivity configuration may be due to highly weathered limestone that possesses a higher water content than the surrounding materials. A3 may be a suitable drilling location, as well.

Line 2

Figure 3 shows the final computed depth model from Line 2, important resistivity interfaces, interpreted lithologies, and important features that were detected in the subsurface. The location of Line 2 is shown on the inset of this figure and the map in Figure 1.

The electrical resistivity data from Line 2 indicates the presence of a low resistivity zone (LRZ), that is less than 170 ohm-m, and a high resistivity zone (HRZ), that is greater than 170 ohm-m. AGS has placed a dashed line between these interfaces. There are two outfalls along Line 2 that create a substantial amount of noise along the line. They are located at stations 460 and

1415. The ERI data between stations 115-140 suggests there is evidence of possible limestone pinnacles at a depth of 5 feet bgs. The interface dips to the north and south from these interpreted pinnacles. It is important to note that there is a large difference in the position of the LRZ/HRZ interface between Line 1 and Line 2, and AGS believes the bedrock geometry below the southern part of Line 1 rises to meet the LRZ/HRZ interface at the northern end of Line 2. The outfall between the lines is approximately 150 feet wide. On Line 2, the depth to the HRZ is less than the corresponding depths on Line 1, except at the southernmost areas of Line 2, where depths to the HRZ are similar to those of Line 1. AGS detected two locations, A1 and A2, where the data indicate potential drilling locations. A1 is located near station 850, and is approximately 40 feet wide and 30 feet below the prevailing LRZ/HRZ interface. It exhibits lower relative resistivity values, which may indicate the presence of water or water-laden sediments. A1 is the most significant anomaly observed on the profile. A2 is located at station 1040, and is approximately 10 feet wide and 15 feet deep. It possesses lower resistivity values and water may be present here, as well.

Closing

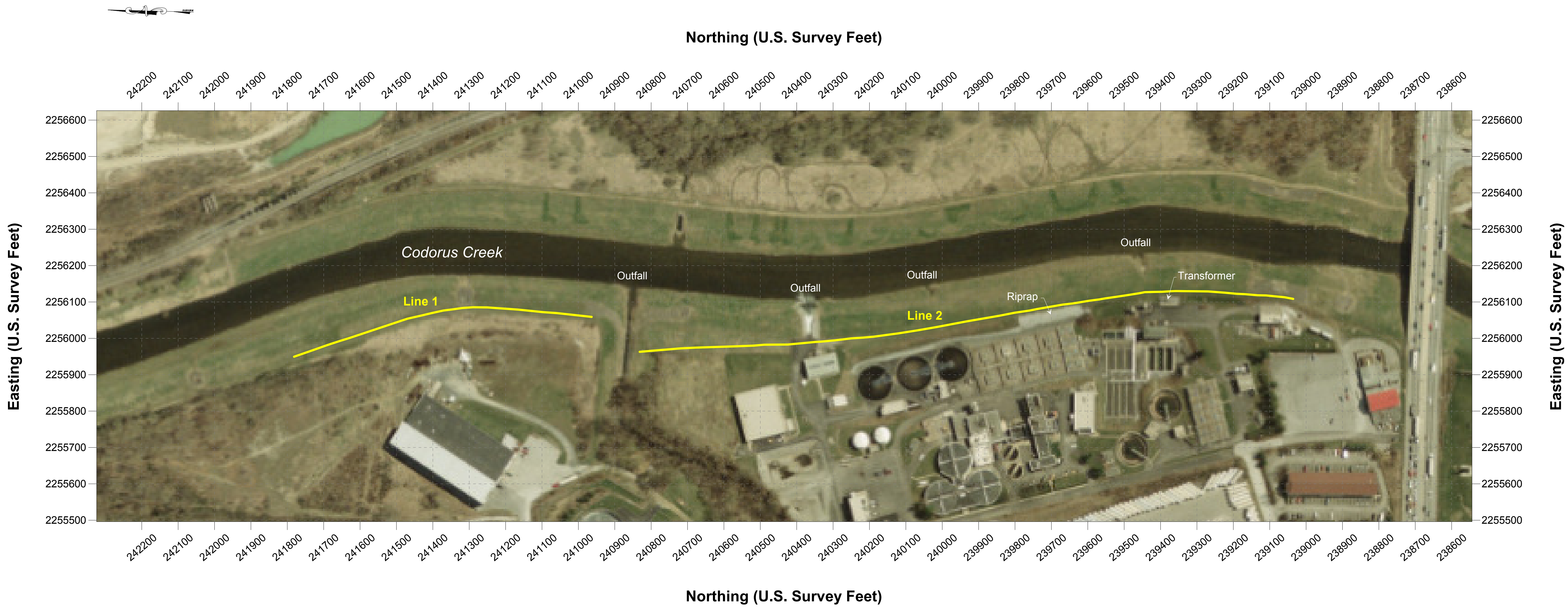
All geophysical data and field notes collected as a part of this investigation will be archived at the AGS office. The data collection and interpretation methods used in this investigation are consistent with standard practices applied to similar geophysical investigations. The correlation of geophysical responses with probable subsurface features is based on the past results of similar surveys although it is possible that some variation could exist at this site. Due to the nature of geophysical data, no guarantees can be made or implied regarding the targets identified or the presence or absence of additional objects or targets.

If you have any questions, please contact me 610-722-5500. It was a pleasure working with you on this project, and look forward to conducting geophysical investigations for you in the future.

Sincerely,

Peter T. Miller Ph.D., P.G.
Senior Geophysicist, AGS

encl.: Figure 1: High-Resolution Orthophotograph, Anomalies, and Geophysical Line Locations
Figure 2: Electrical Resistivity Line 1
Figure 3: Electrical Resistivity Line 2



Scale
(1 inch = 300 feet)

0 150 300 600

Notes

(1) An R8 Sting/Swift 84-electrode, electrical resistivity system by Advanced Geosciences, Inc. was used for this survey. Data from this instrument was used to locate potential fracture zones, karst features, and other soil or bedrock features that may indicate a possible pathway for the movement of fluids.
(2) The geo-referenced orthophotograph shows the locations of two ERI lines that were collected for this survey. Line 1 was 830 feet long and data was collec ted in the 3-D mode to accommodate the bend in the line. Line 2 was 1800 feet long and was collected in the 2-D mode because it was relatively straight. Important surface features that are shown on the photo include outfalls, buildings, aeration ponds, chain-link fencing (paralleling the lines), riprap, a transformer, and other man-made features. Line 2 was close to the waste water treatment plant structures, and was affected by their presence, and Line 1 was located away from structures, and was less affected by man-made objects.
(3) The depths of investigation for the ERI instrument was approximately 180 feet bgs.
(4) AGS used a global positioning system (GPS) to locate various site features and geophysical data points. However, the field positions were not surveyed by a licenced surveyor and should be considered approximate. AGS used the Pennsylvania State Plane coordinate system and U.S. Survey feet for the map.

Legend:

Electrical Resistivity Line Location and Line Number

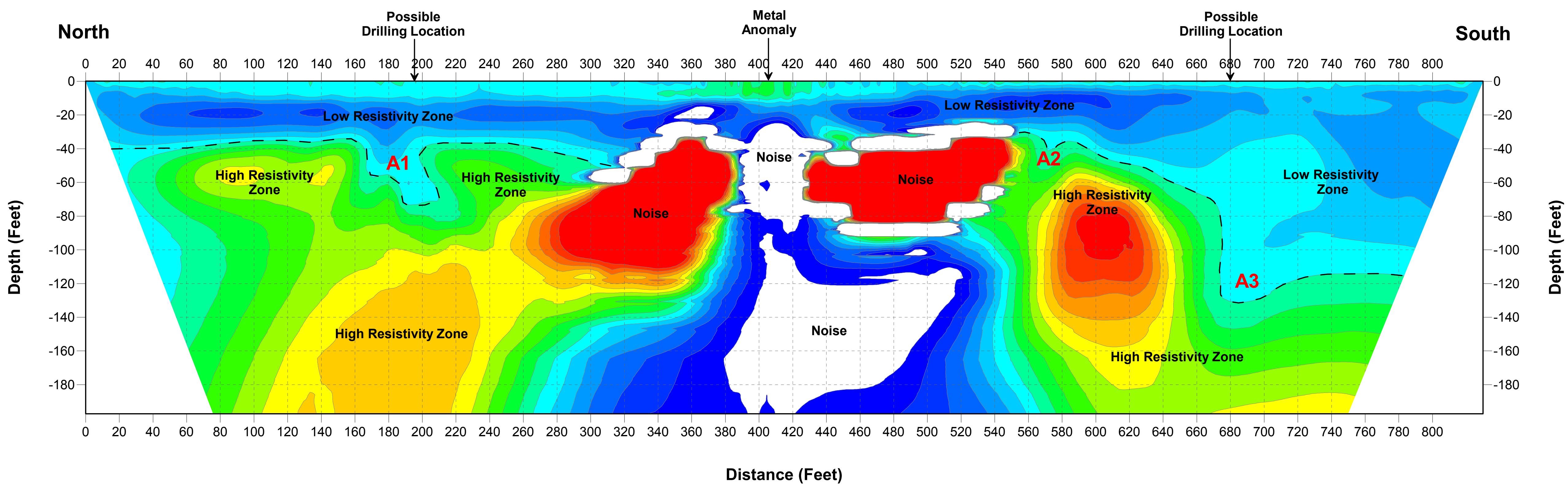
Figure 1
ERI Line Location Map and High-Resolution, Geo-Referenced Orthophotograph
Western Codorus Creek Area

Groundwater Sciences Corporation
Harley Davidson Site
1425 Eden Road
York, Pennsylvania

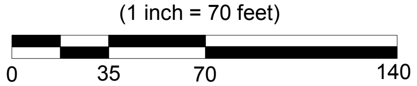
Date: October 24, 2012
AGS Reference: 12-207-1/pm

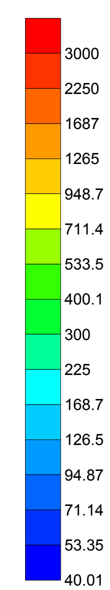
ADVANCED GEOLOGICAL SERVICES

Electrical Resistivity Line 1



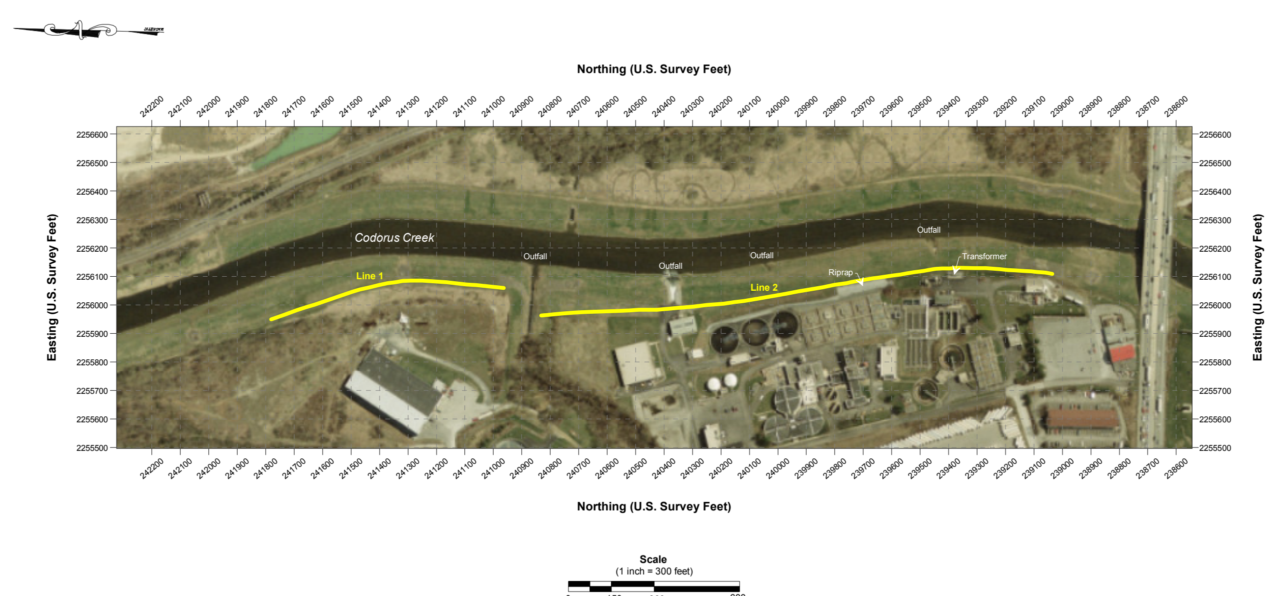
Scale
(1 inch = 70 feet)





Resistivity (Ohm-m)

Site Map



NOTES

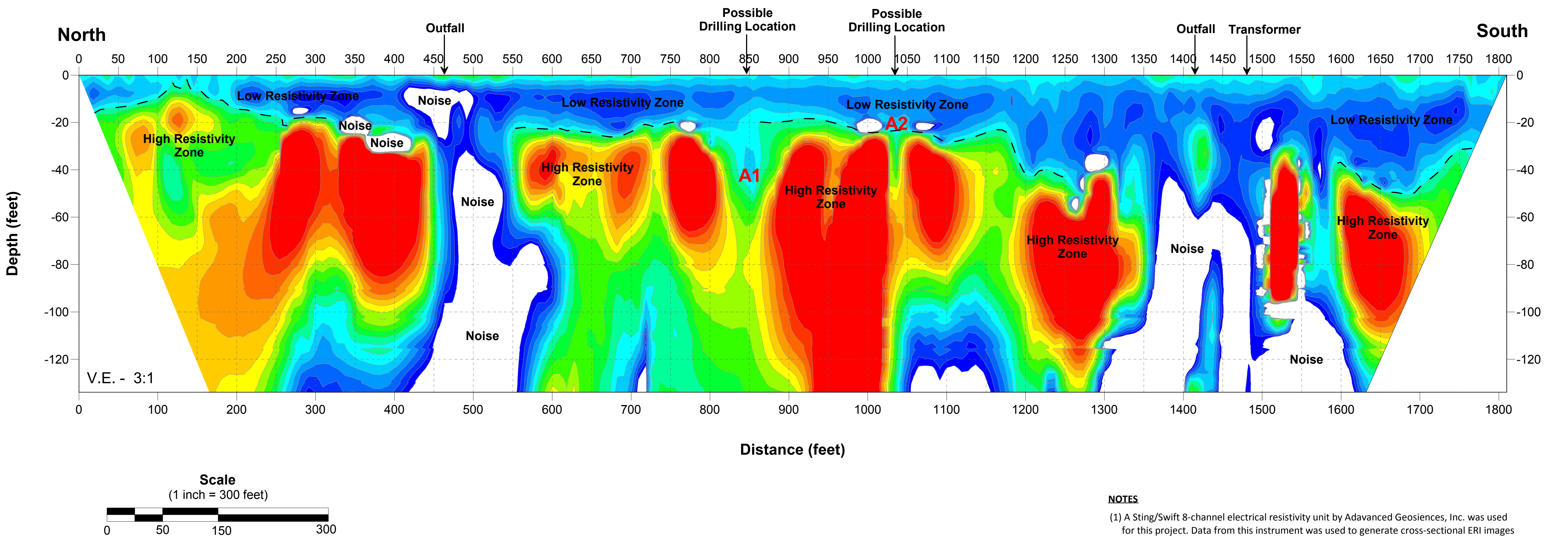
(1) A Sting/Swift 8-channel electrical resistivity unit by Adavanced Geosiences, Inc. was used for this project. Data from this instrument was used to generate cross-sectional ERI images of the subsurface.

(2) The figure shows the final computed depth model from Line 1, important resistivity interfaces, interpreted lithologies, and important features that were detected in the subsurface. The location of Line 1 is shown on the inset of this figure and the map in Figure 1.

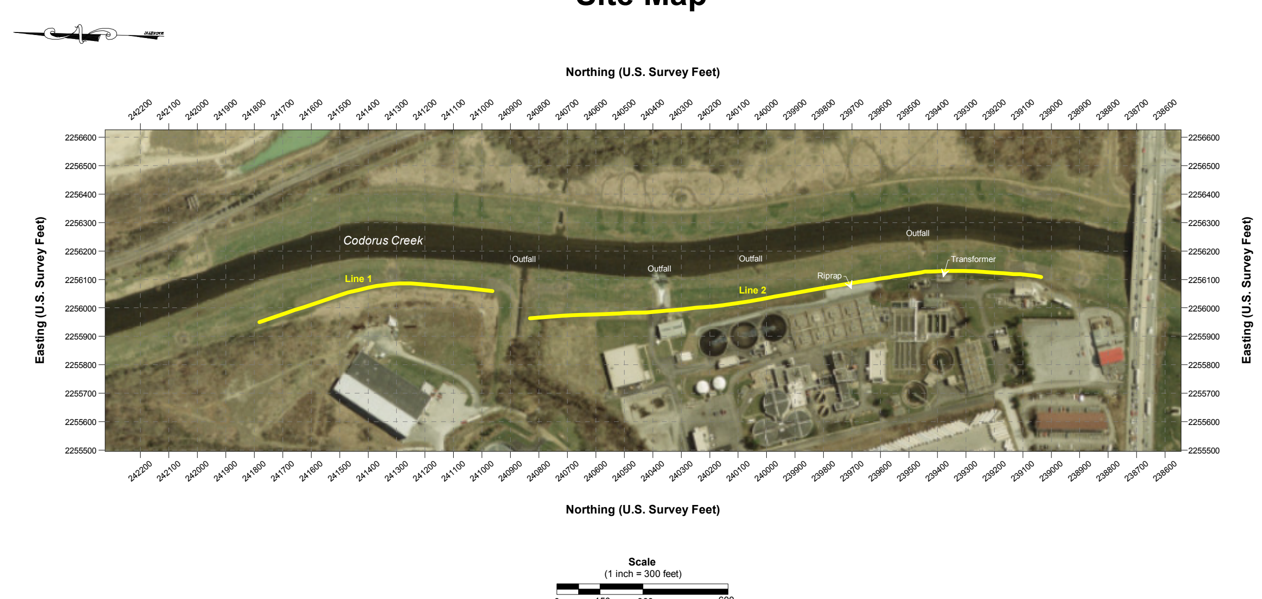
(3) The electrical resistivity data from Line 1 indicates the presence of a low resistivity zone (LRZ), that is less than 170 ohm-m, and a high resistivity zone (HRZ), that is greater than 170 ohm-m. AGS has placed a dashed line between these interfaces. In the northern part of the profile, the LRZ is approximately 35-50 feet thick. A strong metal anomaly was detected at AGS station 406 that probably represents a buried outfall that has metal associated with it. This anomaly creates noise in the data that is labelled on the profile. To the south of the metal anomaly, the LRZ/HRZ interface increases in depth through station 670, then abruptly dips vertically from a depth of 70 feet to 130 feet. The interface rises somewhat to 115 feet at the end of the profile. AGS detected three discrete amomalies, A1 through A3, that may represent karst features or possible fracture zones. A1 is located between stations 165-200, and within a depth range of 35-72 feet below ground surface (bgs). A1 exhibits lower resistivity values than the surrounding HRZ materials, and suggests a possible water-bearing karst feature. The deepest part of A1, at station 195, may be a good potential drilling location. A2 is located at station 572 and represents a smaller possible karst feature. It is located between stations 568-579, and is approximately 7 feet below the prevailing LRZ/HRZ interface. It does not appear to be as significant as A1. A3 is located at station 685 and it is located at the deepest point of the thick LRZ in the southern part of the profile. This resistivity configuration may be due to highly weathered limestone that possesses a higher water content than the surrounding materials. A3 may be a suitable drilling location, as well.

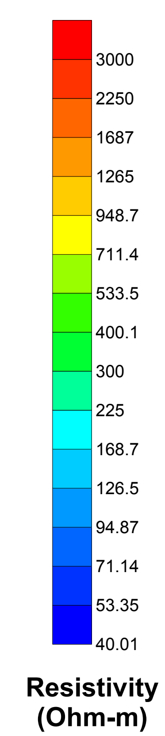
ADVANCED GEOLOGICAL SERVICES	ELECTRICAL RESISTIVITY LINE 1 AND SITE MAP HARLEY DAVIDSON SITE		
	LOCATION: YORK, PENNSYLVANIA		
	CLIENT: GROUNDWATER SCIENCES CORP.		FIGURE
PROJECT #: 12-207-1	ADVANCED GEOLOGICAL SERVICES, INC.		2
DATE: OCTOBER 24, 2012	DRAWN BY: P. MILLER	APPROVED BY: P. MILLER	

Electrical Resistivity Line 2



Site Map





NOTES

(1) A Sting/Swift 8-channel electrical resistivity unit by Adavanced Geosiences, Inc. was used for this project. Data from this instrument was used to generate cross-sectional ERI images of the subsurface.

(2) The figure shows the final computed depth model from Line 2, important resistivity interfaces, interpreted lithologies, and important features that were detected in the subsurface. The location of Line 2 is shown on the inset of this figure and the map in Figure 1.

(3) The electrical resistivity data from Line 2 indicates the presence of a low resistivity zone (LRZ), that is less than 170 ohm-m, and a high resistivity zone (HRZ), that is greater than 170 ohm-m. AGS has placed a dashed line between these interfaces. There are two outfalls along Line 2 that create a substantial amount of noise along the line. They are located at stations 460 and 1415. The ERI data between stations 115-140 suggests there is evidence of possible limestone pinnacles at a depth of 5 feet bgs. The interface dips to the north and south from these interpreted pinnacles. It is important to note that there is a large difference in the position of the LRZ/HRZ interface between Line 1 and Line 2, and AGS believes the bedrock geometry below the southern part of Line 1 rises to meet the LRZ/HRZ interface at the northern end of Line 2. The outfall between the lines is approximately 150 feet wide. On Line 2, the depth to the HRZ is less than the corresponding depths on Line 1, except at the southernmost areas of Line 2, where depths to the HRZ are similar to those of Line 1. AGS detected two locations, A1 and A2, where the data indicate potential drilling locations. A1 is located near station 850, and is approximately 40 feet wide and 30 feet below the prevailing LRZ/HRZ interface. It exhibits lower relative resistivity values, which may indicate the presence of water or water-laden sediments. A1 is the most significant anomaly observed on the profile. A2 is located at station 1040, and is approximately 10 feet wide and 15 feet deep. It possesses lower resistivity values and water may be present here, as well.

ADVANCED GEOLOGICAL SERVICES	ELECTRICAL RESISTIVITY LINE 2 AND SITE MAP HARLEY DAVIDSON SITE		
	LOCATION: YORK, PENNSYLVANIA		
	CLIENT: GROUNDWATER SCIENCES CORP.		FIGURE 3
PROJECT #: 12-207-1	ADVANCED GEOLOGICAL SERVICES, INC.		
DATE: OCTOBER 24, 2012	DRAWN BY: P. MILLER	APPROVED BY: P. MILLER	