SUNOCO PIPELINE
An ENERGY TRANSFER Company

535 Fritztown Road
Sinking Spring, PA 19608

June 10, 2019

Via Electronic Mail
Mr. Scott R. Williamson
Program Manager, Waterways & Wetlands Program
Pennsylvania Department of Environmental Protection
Southcentral Regional Office
909 Elmerton Avenue
Harrisburg, PA 17110-8200

Re: PADEP HDD Re-Evaluation Report- Request for additional information
Appalachian Drive 16" Horizontal Directional Drill Location (S2-0240-16)
Permit No. E21-449
Middlesex Township, Dauphin County

Dear Mr. Williamson:

In compliance with the Corrected Stipulated Order dated August 10, 2017, a Re-evaluation Report on the above-referenced horizontal directional drill (HDD) was submitted to the Pennsylvania Department of Environmental Protection (Department) on March 4, 2019. In a letter dated April 23, 2019, the Department requested further information. Please accept this letter as a response. Your requests are bolded below followed by Sunoco Pipeline, LP (SPLP) responses.

1. Relating to the overall Geologic and Hydrogeologic Summary and Report:

a. Provide further explanation about how the proposed guided bore, at a shallower profile depth will minimize the potential for inadvertent returns (IRs), sinkhole formation, and impacts to water supplies.

The Department should note that the 20-inch HDD had no issues in this section of the profile during completion of the HDD. The maximum depth of the guided bore has been designed to be 30 feet below ground surface with the entry and exit pits being excavated to a depth of 8- and 15-feet, respectively. This will put the exit pit in the zone of weathered bedrock encountered in soil boring SB-3, completed during the 2014 geotechnical investigation. Based on a review of the geotechnical investigation, the bedrock near the guided bore is described as very fine grained, thin to thick bedded, slightly weathered and hard limestone. The RQD values for bedrock within the upper 35 feet of the boring ranged from 32 (between 15 and 20 feet because of a 3.4-foot clay seam) to 100. Except for the 15 to 20-foot interval, all of the RQD values range between fair to excellent. Based on the high RQD values and the fact that the only low RQD value associated with a clay seam, this interval/depth of bedrock will be better suited for maintaining the integrity of the borehole. This will decrease the likelihood of the occurrence of IRs, sinkhole formation and impacts to residential water supply wells. Further, with the entry and exit pits being excavated below ground surface, this reduces the elevation between entry and exit, which reduces

drilling pressure requirements for maintaining returns, and will reduce the potential of a "punch-in/punch-out" release from occurring as the tooling is entering and exiting the borehole.

b. Describe the type of HDD equipment that will be utilized to drill the pilot hole for the proposed guided bore.

A midsize Uni 250 x 400 or DD-110 drill rig will be used to drill the pilot hole for the proposed guided bore. The drill rigs have a length of approximately 36-feet and a width of approximately 8-feet with a thrust/pullback capacity of up to 110,000 lbs. The tooling that will be used for the pilot hole will be an HDD 90, 9.25" air hammer or equivalent.

c. Will the equipment proposed for the guided bore be mud rotary or air rotary tooling?

The equipment proposed for the guided bore is an air hammer in the pilot phase followed by mud rotary in the reaming phase.

d. Please clarify the statement "The Pinesburg Station Formation is unimportant as a source of water." The report this statement was taken from makes the statement about finding large quantity, high yielding wells but there are still numerous wells drilled and completed in the Pinesburg Station Formation. Such information suggests, and the DEP reviewer agrees, that it is an important source of water for private water supply wells located in the areas underlain by the Pinesburg Station Formation.

There was no intention to imply that the Pinesburg Station Formation is not an important source of water for residential water wells. The statement about the formation being an unimportant source of water was referencing high-yielding wells, and if high yielding wells are encountered, they typically occur near valley bottoms. SPLP realizes and acknowledges that the formation is an important source for private water wells. With the redesign of the 16-inch profile to an open cut and guided bore, there is a decreased potential for loss of circulation, IR events, and impacts to groundwater resources.

2. Relating to the geophysical investigations:

a. During the installation of the 20-inch HDD, a geophysical survey with electrical resistivity, microgravity and ground penetrating radar (GPR) was completed for specific areas. However, these areas of geo-physical investigations were not shown on any plans or mapping or discussed within the re-evaluation report. Where were these areas? Was a geophysical survey completed on the area where the "guided bore" is being proposed? If not, we strongly recommend that a geophysical survey be completed for the "guided bore" (HDD pilot) portion of the 16-inch pipeline redesign or a provide adequate justification for why geophysical surveys will not be done at this portion of the Appalachian Drive site.

The geophysical survey was completed in the area of the subsidence features observed along Appalachian Drive at the north end of the 20-inch HDD. The survey was conducted to detect and delineate the subsurface voids or areas of low density bedrock beneath Appalachian Drive. A geophysical survey was not completed in the area of the proposed guided bore. Based on the results of the 2017 geotechnical investigation (which did not encounter any voids until a depth deeper than the guided bore designed profile depth and the presence of high RQD values) a geophysical survey along the guided bore would not produce any additional information that can be utilized to reduce the potential for a loss of circulation, IRs, sinkholes, or impacts to residential water wells.

b. The Geology Report states that Attachment 4 contains the geophysical survey. Attachment 4 was not included in the Geology Report submitted to the Department. Please provide Attachment 4.

The geophysics survey (Attachment 4 of the Geology Report) is attached.

3. Relating to the Analysis of Well Production Zones and use of information obtained during construction of the 20-inch pipeline;

The re-evaluation report fails to include an evaluation of the data and information collected for the private water supplies within 450 feet of the proposed guided bore or those water supplies that are in the vicinity of the proposed guided bore (such as the water supplies located along the proposed open-cut section of this site). It is also unclear whether any of the private water supplies identified within 450 feet are the same as any of the water supplies within 0.5 miles that were identified from the PaGWIS database.

In addition, Figure 3 of the Geology Report shows two wells in the vicinity of the 16-inch "guided bore" (PA Well ID 97976 and PA Well ID 98290). Attachment 3 of the Geology Report does not list or show these two wells. Please locate these two subject wells on Attachment 3 Supplemental Water Supply Information.

Any private or public water supply data obtained within 450 feet or otherwise obtained in the vicinity of the 20-inch or proposed 16-inch HDD should be used and discussed as part of this HDD reevaluation. This data should include but not be limited to any applicable water supply sampling data and any water supply complaints that SPLP may have obtained and received for water supplies within 450 feet of the HDD or within the general vicinity during construction of the 20-inch pipeline. The results of the SPLP's water supply sampling program, investigation, disposition of the complaint, and any correlation or non-correlation to SPLP's construction activities should be evaluated and discussed in the HDD re-evaluation report. Use the report to demonstrate how the proposed 16-inch HDD activity will minimize the potential for IR's and impacts to water supplies. Please revise the reevaluation report to include this information.

As part of the re-evaluation process and in accordance with the Corrected Stipulated Order, dated August 10, 2017, SPLP conducted a survey of water supplies located within 450 feet of the proposed guided bore. Additional surveys were also conducted for the portion of the originally permitted 16-inch HDD, which is now going to be completed by open cut installation techniques. The responses that SPLP received are represented graphically on the figure contained in Attachment 3 of the Hydrogeologic Report. As of March 1, 2019, SPLP has received a total of nine (9) responses to their survey requests with no information pertaining to the depth of the well, amount of surface casing or specific yield being provided. In addition to the survey, a search of the Pennsylvania Groundwater Information System (PaGWIS) was completed within a 0.5-mile radius of the Appalachian Drive location. A total of 24 water supply wells were identified within PaGWIS, with 17 of the wells being identified for domestic usage. None of the wells identified within the PaGWIS database search were identified within the 450-foot survey completed by SPLP. However, two wells were identified in the PaGWIS search that were not identified in the 450-foot survey and these wells have been added to the revised 450-foot well location map attached to this response.

As detailed below, one of the water supply wells (Wagner Residence) identified within the 450-feet of the Appalachian Drive HDD was impacted by drilling fluid during completion of the 20-inch HDD. For the remaining wells identified within the 450-foot radius survey, pre-construction and during construction water quality samples were collected. A review of the analytical results from the sampling events did not identify any changes other than changes associated with seasonal fluctuations. Further, drilling fluid in the form of residual bentonite was not detected in any of the water quality samples. As a result of these findings, only the water supply well at the Wagner Residence was impacted during the installation of the Appalachian Drive 20-inch HDD. Based on the redesign of the permitted 16-inch HDD to a guided bore, the potential for new or additional impacts to water supply wells has been reduced. The bore will be completed over a shorter distance, and as discussed in the response to Item 1 above, in more competent bedrock than the original planned 16-inch HDD.

To date, SPLP has received four (4) water well complaints that have been fully investigated. Two (2) of the four have been found to be unrelated to the installation of the 20-inch HDD and one (1) did not result from a complaint, but rather a precautionary installation of a water buffalo at a residence. Below is a summary of the complaints and the results of the investigations.

- Wagner Residence (141 Appalachian Drive, Carlisle, PA 17015): SPLP received a water well complaint on 09-14-2017, when the property owners observed an increase in cloudiness while doing laundry in the morning and then the presence of sediment in one of the bathroom toilets later in the day. Bottled water was provided upon receipt of the complaint and water buffalo service was setup. An investigation determined that the source of the cloudiness and sediment was likely drilling fluid migrating into their water supply well. As a result, a new water well was installed at the residence.

- Singer Residence (138 Appalachian Drive, Carlisle, PA 17015): No water well complaint was received from the Singer residence, however, as a precaution and at the owner's request, a water

buffalo was installed. SPLP, after confirmation sampling that no impact has occurred, is currently in the process of taking the residence off the water service and removing it from the location.

- Lepley Residence (140 Appalachian Drive, Carlisle, PA 17015): On March 29, 2018, a complaint was made regarding water well quality impacts resulting from pipeline activities at the Lepley residence. The complaint was based on sediment collecting in the screen of the aerator on the kitchen sink, which resulted in a reduction of flow. Mr. Lepley indicated that the collection of sediment and diminished flow had been occurring for approximately six months prior to the complaint. Water quality samples were collected prior to the start of construction (November 4, 2016 and February 26, 2017) and during construction (September 21, 2017 and April 3, 2018). A review of the analyzed parameters did not identify any significant changes other than those expected in groundwater chemistry in samples collected from different times of the year (i.e., seasonal fluctuations). No residual bentonite, in the form of sodium montmorillonite, was detected in the April 3, 2018 water quality sample. An evaluation conducted by a Pennsylvania Professional Geologist (PG) has concluded that the Lepley well was not impacted from the Appalachian Drive HDD activities. As discussed in the S2-0240 Appalachian Drive HDD Lepley Water Well Complaint Report (Report), that was prepared on May 24, 2018, the PG concluded that the reported sediment is possibly due to corrosion from the plumbing system or the precipitation of naturally occurring and pre-existing dissolved solids inside the plumbing system. The water treatment system includes a filter which removes sediment originating from the well. If the well had been impacted by the completion of the 20-inch HDD, other water quality parameters (i.e., turbidity, total suspended solids, iron and manganese) would show an increase between the pre- and during construction sampling events. The Department has completed a review of the Report and concurred with the conclusion that the construction activities associated with the installation of the 20-inch HDD were not responsible for the sediment within the kitchen sink aerator. The Lepley's made a second complaint for sediment build up in the aerator of their kitchen sink and diminished flow on February 7, 2019, while no activity was occurring at the Appalachian HDD. A second investigation determined that the source of the sediment build up was as result of their well becoming turbid during a maintenance event. A water well service company pulled their well pump, which stirred up sediment. A water buffalo was temporarily setup at the residence while the well was rehabilitated in an effort to reduce the turbidity levels. The well rehabilitation has been completed and the water buffalo is scheduled to be drained and removed from the property on April 30, 2019.

- Earley Residence (139 Appalachian Drive, Carlisle, PA 17015): On March 28, 2018, there was a noticed loss of water production from the water well supplying the residence of Mr. Robert Earley (There was no complaint made regarding an impact to water quality). Mr. Earley indicated that the water well pressure switch was shut off and after resetting the pressure switch, the well pump operated for approximately a week and shut off again. Negley's Clean Water Center (Negley) arrived at the residence on March 28, 2018, and after investigating, it was determined that the existing 17-year old submersible pump in the well was the source of the problem. Negley installed a new submersible pump and water production returned to normal levels. Based on the

source of the problem being a faulty submersible pump, it was concluded that the Appalachian HDD had not impacted this water well.

SPLP submits that we have been, and are, in complete compliance with the agreed terms and analysis requirements of the Order, as agreed to by the Department, and that no further analysis is required for the Department to consent to the start of this HDD. SPLP therefore requests that the Department approve of the Re-evaluation Report for the Appalachian Drive Crossing Horizontal Directional Drill (S2-0240) as soon as possible.

Sincerely,

Larry J. Gremminger, CWB
Vice-President – Environmental, Health & Safety
Energy Transfer Partners
Mariner East 2 Pipeline Project

Pertaining to the practice of geology and information conveyed.

6/10/2019

Douglas J. Hess, P.G. Date
License No. PG-000186-G
Skelly and Loy, Inc.
Director of Groundwater and Site Characterization
Geo-Environmental Services

Attachments as stated.

RETTEW ENVIROSCAN

3020 Columbia Avenue, Lancaster, PA 17603 ● Phone: (800) 738-8395
E-mail: rettew@rettew.com ● Website: rettew.com

May 18, 2018

Mr. Matthew L. Gordon
Sunoco Logistics, L.P.
535 Fritztown Road
Sinking Spring, PA 19608

RE: Sunoco Pipeline, L.P. Pipeline Project – Mariner East II
Appalachian Drive - Horizontal Directional Drill (S2-0240)
Void/Subsidence Detection/Delineation Report
Middlesex and Silver Spring Townships, Cumberland Township,
Cumberland County, Pennsylvania
RETTEW Project No. 096302009

Dear Mr. Gordon:

On May 9th and 10th, 2018, RETTEW Associates, Inc. completed a multi-technique geophysical survey within a client-designated area of Appalachian Drive and the Sunoco Pipeline, L.P. (SPLP) right-of-way (ROW). The purpose of the survey was to detect and delineate subsurface voids or low-density zones beneath Appalachian Drive and SPLP's ROW that have experienced recent subsidence. The following report, figures, and attachments describe the methods and results of the investigation.

EXECUTIVE SUMMARY

RETTEW Associates, Inc. completed a multi-technique geophysical survey to detect and delineate subsurface voids or low-density zones beneath a client-designated area of Appalachian Drive and the SPLP ROW that has experienced recent subsidence. Electrical Resistivity detected two distinct resistive zones that are consistent with possible air-filled solution cavities, as well as two electrically conductive anomalies that could represent water-or clay-filled solution cavities. Microgravity delineated several interconnected low-density zones throughout the survey area and around the recorded subsidence and inadvertent return locations. These zones could represent air, water, or clay-filled voids or locally deeper rock/thicker soils. GPR scanning depicted an anomalous area in the roadway coincident with the location of a recent inadvertent return, which could represent subsurface drilling fluid and/or air-filled voids. Results from the three techniques are consistent with each other and what is known about the site, indicating that the area is karstified. Locations where identified anomalies from the three surveys overlap warrant further investigation.

SITE DESCRIPTION

The Appalachian Drive horizontal direction drill (HDD) is located along the boundary of Middlesex and Silver Springs Townships, Cumberland County, Pennsylvania (see **Figure 1**). The location is HDD is located beneath and sub-parallel to, a section of Appalachian Drive and runs in a northwest to southeastern direction. A geophysical survey was conducted over the northern portion of the HDD alignment and encompassed an area roughly 40 feet wide by 280 feet in length (bounded by the western and eastern red dashed lines on **Figure 2**).

The Appalachian Drive HDD began on September 11, 2017. The bore is currently on the 30-inch ream pass which has been completed under Appalachian Drive. The approximate depth of the bore as it passes under the road surface ranges from 16 feet on the west side to 35 feet on the east side. The subsidence adjacent to the roadway was first observed on April 25, 2018. The bore is approximately 35 feet deep in this area. Inadvertent returns (IRs) occurred in two areas adjacent to the roadway on May 5, 2018. The IRs are to the west of the bore path which is approximately 36 to 38 feet deep in this area. At the time the IRs occurred, the reaming was being completing using air, and no drilling fluid had been circulated during the reaming phase.

The site bedrock geology consists of the Ordovician-aged St. Paul Group to the east and west of Appalachian Drive. A thin Jurassic-age diabase dike follows the extent of the roadway within the survey area. The St. Paul Group is characterized as mostly limestone at the top and base; fossiliferous limestone and black chert; and dolomite in the middle (Berg, T. M., Edmunds, W. E., Geyer, A. R., and others, compilers, 1980). The bedrock surface is characterized by pinnacles beneath a generally thin soil mantle (Ibid.). Common surface features in carbonate rock terranes are sinkholes and closed depressions. Both features form from the dissolution of carbonate bedrock (forming cavities and conduits) and the downward movement of surface material and groundwater into these voids. Note that the main difference between a sinkhole and a closed depression is that a sinkhole may appear suddenly as a break in the ground surface revealing a hole, whereas a closed depression typically subsides slowly with no break at the surface. The Pennsylvania Geologic Survey (PA DCNR Interactive Map, 2017) records two surface depressions within the limits of the survey area. Four sinkholes and 22 surface depressions are mapped within a half-mile of the site. These features were previously identified in the Pennsylvania Pipeline Project-Void Mitigation Plan for Karst Terrain and Underground Mining (November 18, 2016).

KARST TERRANE

Pinnacled bedrock, depressions, and sinkholes are among the geologic features characteristic of karst terranes — i.e. terranes underlain by soluble carbonate (limestone or dolomite) bedrock in wet climates. In karst terranes, infiltrating precipitation dissolves the carbonate bedrock surface, causing the top-of-rock to retreat downward leaving behind a soil mantle of the insoluble clay and/or silica particles formerly bonded in the rock. Within the bedrock, percolating water enlarges fractures, bedding planes, etc. to produce solution openings ranging in size from minor seams to scenic caverns.

Sinkholes form where particularly enhanced infiltration into a sufficiently wide solution opening (often called a throat or chimney) washes the soil mantle down into cavities in the underlying rock — a process commonly called soil piping. In areas where the residual soil mantle is clay-rich and cohesive, incipient sinkholes may not display any surficial topographic expression, and are present only as air-, water-, or mud-filled voids which may grow or “stope” upward. The overlying soil arch may collapse under its own weight, or under the weight of an overlying structure or passing vehicle. The resulting collapse sink, or “sinkhole,” is commonly filled with the remains of the soil arch and may display rock at its base. In some cases, surficial subsidence may keep pace with soil piping at depth such that a sinkhole forms by progressive deepening of a surficial depression (sometimes called a subsidence sink), rather than by catastrophic collapse of a stoping void.

ELECTRICAL RESISTIVITY SURVEY

Resistivity measurements involve driving an electrical current in the ground using two current electrodes at the ground surface. The apparent resistivity of the subsurface (the mathematical inverse of terrain conductivity) is determined by measuring the potential difference, or voltage, between two potential electrodes with a known separation and position/orientation relative to the current electrodes. The depth and volume of the subsurface zone, represented by the measured apparent resistivity, is a function of the geometry of the current and potential electrodes located at the surface.

Using an AGI Super Sting R8/IP resistivity meter, apparent resistivity readings were collected along three sub-parallel profiles spaced ~20 feet apart (red dashed lines in **Figure 2**). The profiles were centered along the recent road subsidence and IR locations. Along each profile, electrodes were spaced at the ground surface at 5-foot intervals. The locations of profile endpoints and topographic changes were surveyed using a Topcon Hyper-SR RTK DGPS with sub-cm accuracy.

The measured apparent resistivities (ρ_a) were plotted in the field as resistivity pseudosections depicting the apparent resistivity versus nominal survey depth for each profile, in order to confirm data quality. In post-field processing, the ρ_a pseudosections were mathematically inverted, using EarthImager2D Resistivity Software by Advanced Geosciences, Inc., to provide electrical images of true resistivity versus depth along each profile. The 2-D resistivity data are presented as a series of color contours of the true resistivity versus depth along each profile in **Figure 3**.

MICROGRAVITY SURVEY

Microgravity meters are capable of measuring the force of gravity with great precision. Worldwide, the acceleration of gravity has been adopted as 980 centimeters per second squared (cm/s^2). However, this is an average value, since the actual measured value of gravity at a given station is dependent upon many things, including:

- the elevation of the station reading (higher stations are farther from the center of mass of the earth);
- the latitude and longitude of the station (the earth is not truly spherical);
- the positions of the sun and the moon (which create not only the readily observed ocean tides, but small deformations of the entire earth called earth tides);
- minute changes in the calibration of the gravity meter (instrument drift);
- the attraction of massive landforms near or obliquely above the station (i.e. the mass of a nearby mountain produces a gravitational attraction which can have a significant effect on a precise gravity reading); and
- the density of materials immediately beneath a station.

The variations in gravity due to the first four factors above typically have magnitudes measured in milligals (where 1000 milligals equal one cm/s2). The fifth and sixth factors are typically measured in microgals (where 1000 microgals equal one milligal). Since the purpose of a microgravity survey is generally to determine factor six above (i.e. the density or mass distribution in the subsurface of a survey site), the raw gridded or profile gravity measurements that comprise a gravity survey must be corrected for factors one through five. This yields a set of numbers (which are generally several parts per billion of the earth's adopted average gravity) that can be interpreted to determine subsurface mass distribution (see e.g. Telford et al., 1990).

To arrive at a number representative of the subsurface mass distribution, raw gravity readings are subjected to the following corrections:

- *reference ellipsoid correction* — corrects for the non-spherical shape of the earth based on the latitude and longitude of a station;
- *earth tide correction* — corrects for deformation of the earth under the gravitational influence of the sun and moon;
- *drift correction* — corrects for slow changes in the calibration of a gravity meter based on repeated measurements at a fixed base station;
- *free air correction* — corrects for the elevation of a station above (or below) mean sea level based on a surveyed station elevation; and
- *Bouguer slab correction* — corrects for the density of the hypothetical slab of material between the station elevation and mean sea level based on an assumed average terrain density.

Processed microgravity data are called Bouguer gravity, and should retain only information on the mass or density distribution beneath a survey station. Bouguer gravity anomalies can be caused either by subsurface mass excesses (gravity highs) or deficiencies (gravity lows). Gravity highs commonly represent locally shallow bedrock pinnacles or float blocks in the soil profile, zones of particularly massive bedrock, etc. Gravity lows may represent locally deep bedrock cutters or clay seams where soil displaces bedrock; air-, water- or mud-filled voids within bedrock; stoping voids in the soil above bedrock; or zones where soils have been made less dense by removal of fines.

To complete the microgravity survey, Rettew completed the following specific tasks:

- Gravity readings were collected at 10-foot intervals along profiles spaced 10 feet apart (see gray circle [●] symbols on **Figure 4**), using a Scintrex CG-5 microgravity meter. At each station, the metered gravity (representing a 60-second average), meter height, reading date, and time were recorded in the logger.
- A fixed base station was re-occupied with the gravimeter approximately once every hour to provide drift control data.
- The location of each station was mapped, and several were surveyed using the Topcon GPS.
- The relative elevation of each station point was surveyed with a Topcon RTK-DGPS system and/or Ziplevel Pro.
- Initial data processing was automatically applied in the field by the instruments, which calculate the reference ellipsoid, earth tide, and coarse drift corrections. Free air, fine drift,

and Bouguer corrections were calculated in a spreadsheet using standard formulae (see e.g. Telford et al., 1990), and applied during post-processing.

- The best-fitting (in the least squares sense) simple planar surface was removed from the Bouguer data, to delete the effects of any deep geologic source or regional gravity trend.

The resulting residual microgravity data were contoured in SURFER by Golden Software, and are shown on **Figure 4**. Note that the values should depict the general plan-view shallow mass distribution beneath the survey area, with lower values (red) representing local mass deficiencies and higher values (blue) representing local mass excesses.

GROUND PENETRATING RADAR (GPR) SURVEY

A GPR survey was completed using a GSSI SIR-4000 digital GPR controller and a 400 megaHertz (mHz) scanning antenna. GPR systems produce cross-sectional images of subsurface features and layers by continuously emitting pulses of radar-frequency energy from a scanning antenna as it is towed along a survey profile. The radar pulses are reflected by interfaces between materials with differing dielectric properties. The reflections return to the antenna and are displayed on a video monitor as a continuous cross section in real time. Since the electrical properties of air and clay mud are distinctly different from undisturbed soils, such features produce characteristic reflections. In particular, air and mud typically produce very high-amplitude, characteristically reverberating reflections.

GPR scanning was conducted along the same orthogonal profiles used for the microgravity survey. The maximum depth of investigation was limited to roughly 5 feet below grade, due to suspected conductive soil conditions across the site. As the survey progressed, the radar profiles were examined in real time for high-amplitude reverberating anomalies of the type commonly associated with suspected air- or mud-filled voids. Anomalous features observed in the field were marked on the ground surface, and additional profiles were scanned in various directions to delineate the features.

RESULTS

The electrical resistivity data (**Figure 3**) show two distinct zones of elevated resistivity (orange) along Profiles 2 and 3 (and to a lesser degree on Profile 1). These anomalies are consistent with possible air-filled solution cavities. These same profiles also display more electrically conductive (low resistivity or blue), north-dipping anomalies at the 80-foot mark on Profiles 2 and 3 and the 160-foot mark on Profile 3 (south-dipping). These low-resistivity zones could also be solution cavities, but locally filled with water or clay and could provide pathways for drilling fluid to return to the surface. The surficial low-resistivity anomaly shown on Profile 2 is likely cultural interference caused by the existing UGI line running parallel to the profile and therefore should be ignored. Anomalies of this nature (both high and low resistivity) that lack electrical response at depth become suspect due to the presence of utilities and other sources of cultural interference.

The microgravity data are depicted on **Figure 4** as color contours representing the relative density of the subsurface, with blue for high-density, green for “site normal,” and red for locally low-density areas. The microgravity results delineated several interconnected low-mass (low-density) areas across the survey grid and around the recorded subsidence and inadvertent return locations. This is consistent with a

pinnacled rock surface and/or a system of solution cavities near the top-of-rock. Low density (red) represents "missing" rock (deep cutters between pinnacles or solution cavities beneath the top-of-rock), while blue represents intact pinnacles or large shallow float blocks ("goonies").

GPR profiles from the site are presented in **Figure 5**. The profiles show two areas of high-amplitude GPR reflectors typical of a distinct change in dielectric properties at an interface between overlying rock or soil and underlying clay or air. These are located at about 180 and 210 feet along microgravity Profile 5, starting at approximately 2 feet below the ground surface and reverberating down to approximately 4 feet in depth. The profiles appear to become less homogeneous and more disturbed in this area, which is coincident with the location of a recent inadvertent return location (see **Figure 2**). The spatial correlation with the inadvertent return suggests that these reflections may represent subsurface drilling fluid and/or air-filled voids beneath the roadway.

CONCLUSIONS

In general, the three techniques performed during the survey display anomalies coincident with each other and with the recent subsidence features and inadvertent returns observed at the site. All three methods also exhibit results characteristic of karst terrane and activity. The microgravity data show a significant mass deficiency in the southern portion of the site which encompasses all three features. This anomalous area is also coincident with high-amplitude GPR reflections that indicate possible voids (possibly drilling fluid or clay-filled) directly beneath the road. Additionally, electrical resistivity Profiles 2 and 3 display zones of high resistivity at depth which may indicate air-filled voids. Electrical resistivity Profiles 2 and 3 also depict two conductive anomalies which may indicate possible pathways for the drilling fluid to reach the surface. **Figure 6** summarizes the geophysical survey results by overlaying the various anomalous areas from each technique. Areas of overlapping features on the map are of the most imminent concern and warrant further investigation.

LIMITATIONS

The survey described above was completed using standard and/or routinely accepted practices of the geophysical industry, and the equipment employed represents, in RETTEW's professional opinion, the best available technology. RETTEW does not accept responsibility for survey limitations due to inherent technological limitations or unforeseen site-specific conditions. We will notify you of such limitations or conditions, when they are identifiable.

Please also note that the survey is based on observation of current subsurface conditions. Therefore, while the results of this survey can be used to guide further investigations, RETTEW cannot make any warranties concerning future sinkhole occurrence — particularly under the influence of altered surface and subsurface drainage patterns due to grading and construction activities.

We have enjoyed and appreciated the opportunity to have worked with you. If you have any questions, please do not hesitate to contact me.

Maxwell E. Griffiths
Geophysicist

Timothy D. Bechtel, PhD, PG
Sr. Project Manager

Enclosures
Figure 1: Site Location Map
Figure 2: Geophysical Survey Data Coverage Map and Historical Karst Features
Figure 3: Electrical Resistivity Profiles
Figure 4: Residual Microgravity Contour Map
Figure 5: Ground Penetrating Radar Profiles
Figure 6: Geophysical Survey Results Summary Map

Berg, T.M., Edmunds, W.E., Geyer, A.R., and others, 1980, Geologic Map of Pennsylvania, PA Geological Survey, 4th series.

PA Department of Conservation and Natural Resources Geology Interactive Map, (http://www.gis.dcnr.state.pa.us.html), 2017.

Telford, W.M., Geldart, L.P., and Sheriff, R.E. (1990), Applied Geophysics, Cambridge University Press.

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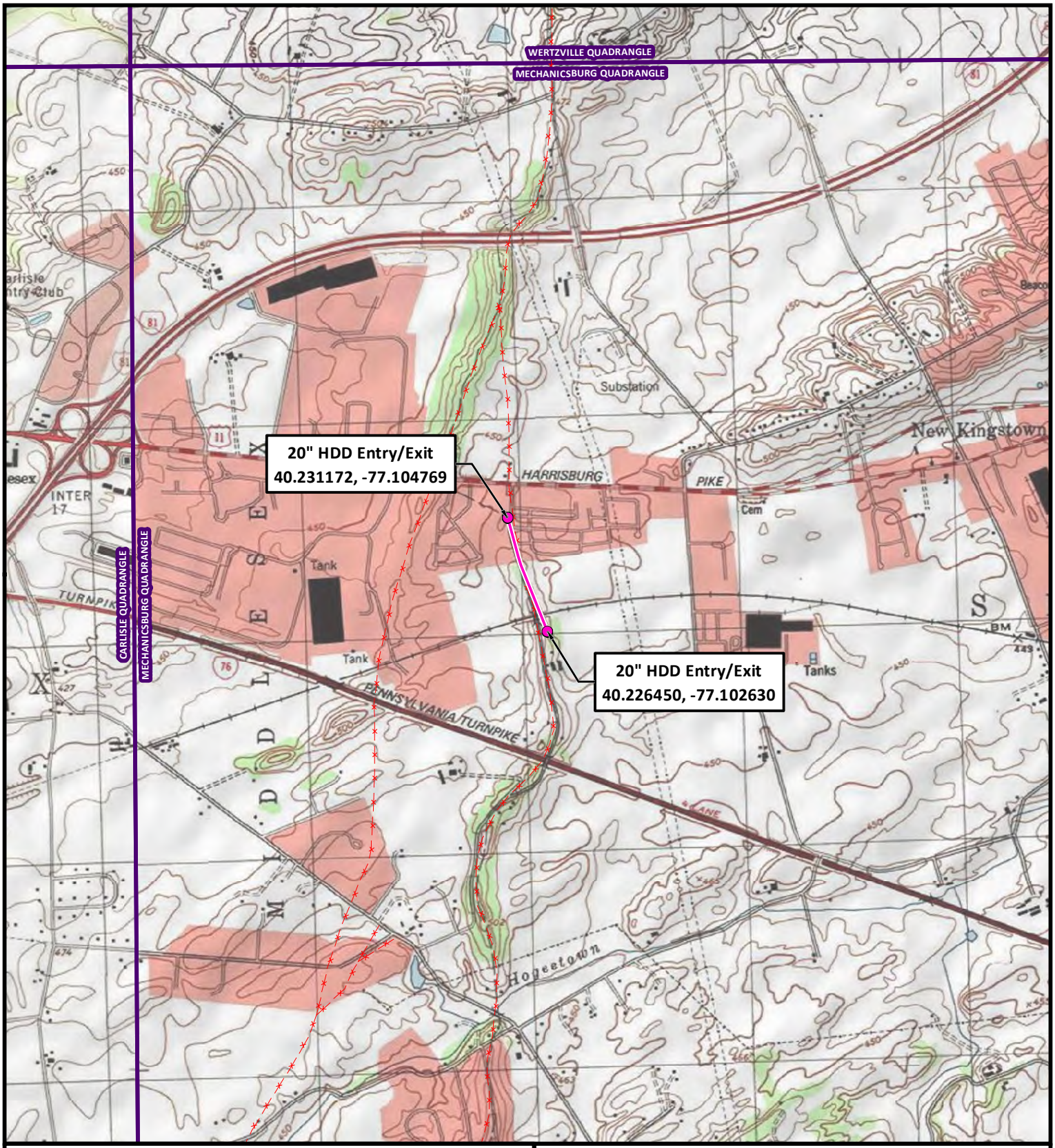
FIGURE 1
SITE LOCATION MAP



20" HDD Entry/Exit

20" HDD Bore

Diabase

Mechanicsburg, PA USGS 7.5' Topographic Quadrangle 5/17/2018

Figure 1

Appalachian Drive HDD Location

Site Location Map

Silver Spring Township, Cumberland County, PA

Project No. 096302011

N W E S

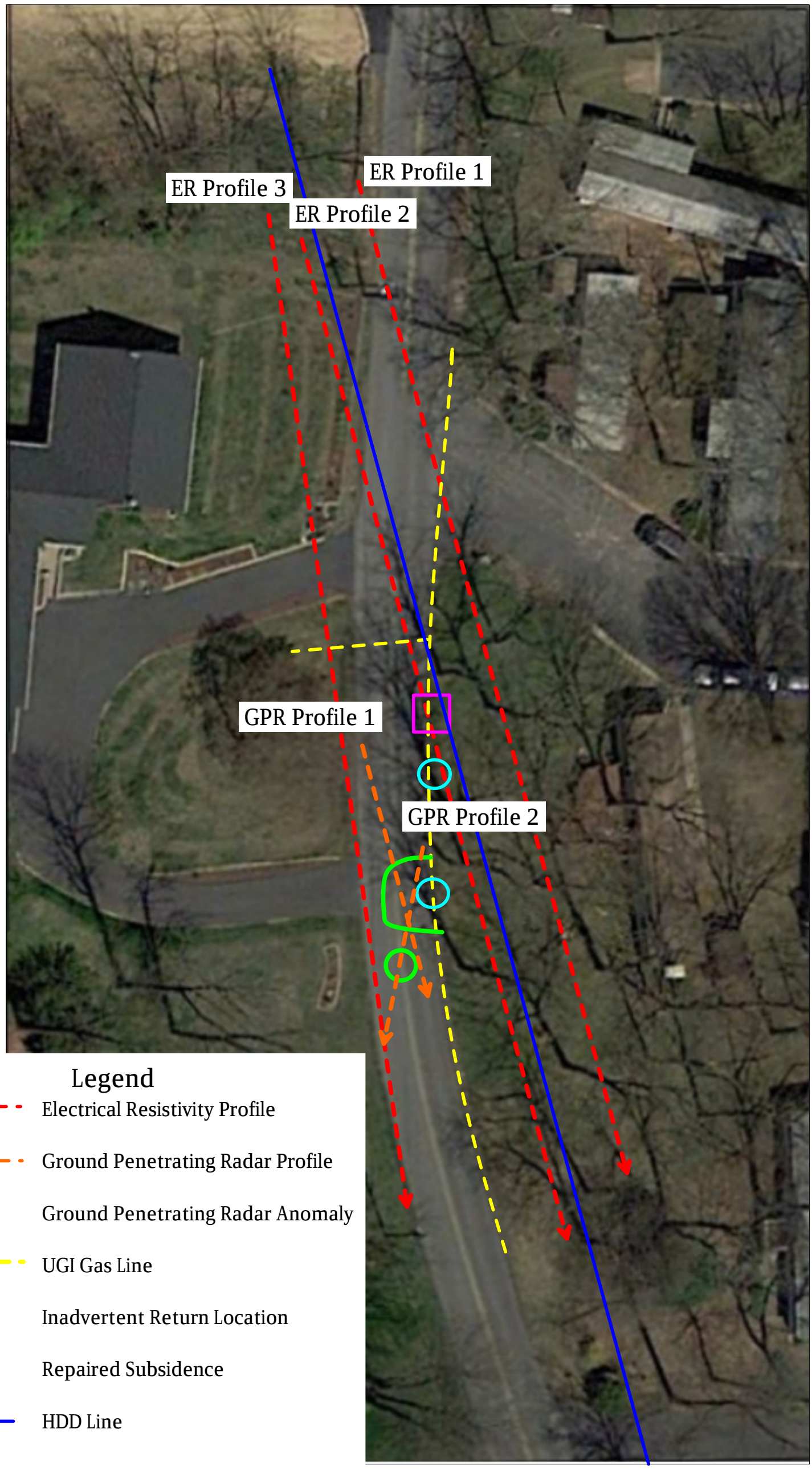
0 2,000 Feet

1 inch = 2,000 feet

Sunoco Logistics Partners L.P.

N:\Shared\Projects\09630\096302011\GIS\MapDocs\HDD Bores\Info Packets\Appalachian Drive\096302011_AppalachianDrive_HDDLocationMap_8x11.mxd

FIGURE 2
GEOPHYSICAL SURVEY DATA COVERAGE MAP
AND HISTORICAL KARST FEATURES



Legend

- Electrical Resistivity Profile
- Ground Penetrating Radar Profile
- Ground Penetrating Radar Anomaly
- UGI Gas Line
- Inadvertent Return Location
- Repaired Subsidence
- HDD Line

Notes:

Basemap from RETTEW personnel field sketches, Topcon GPS survey, and Google Earth Image.

Scale (ft)

0 15 30 45 60

Prepared by:

RETTEW SM | ENVIROSCAN

RETTEW Associates, Inc.
3020 Columbia Avenue, Lancaster, PA 17603
Phone (717) 394-3721 · Fax (717)394-1063

Title: Geophysical Survey Data Coverage

Project Location: Sunoco Spread #4 Appalachian Drive Middlesex, PA

Figure: 2

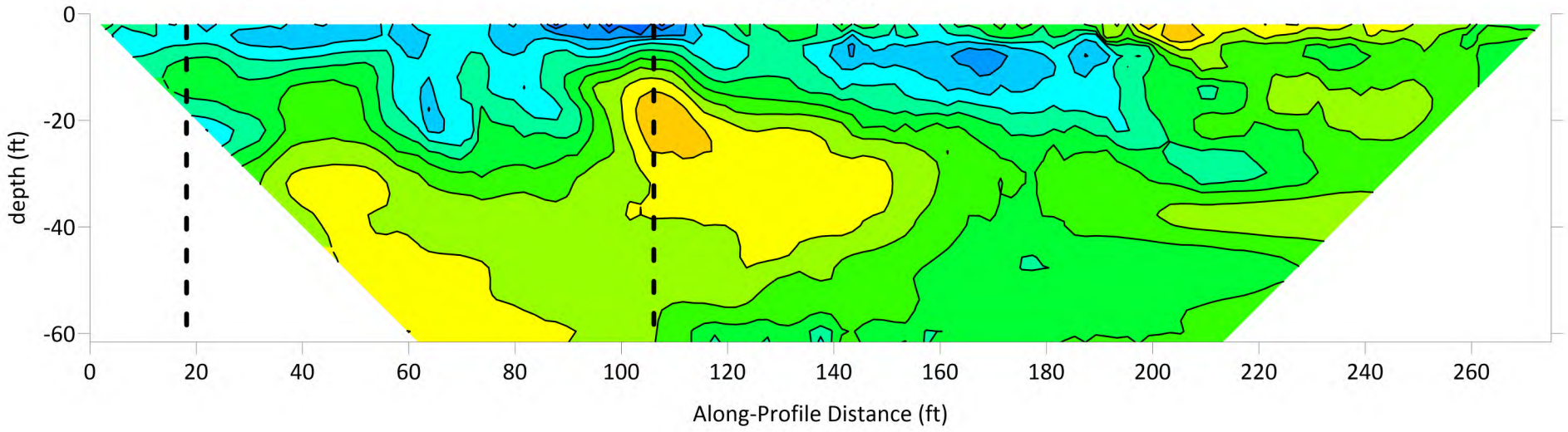
Project Number	Revision/Issue	Original Scale	Survey Ending Date	Drawn by:	Approved by:
096302009	5/17/2018	1" = 30'	5/09/18	MEG	FKB

RETTEW SM | ENVIROSCAN

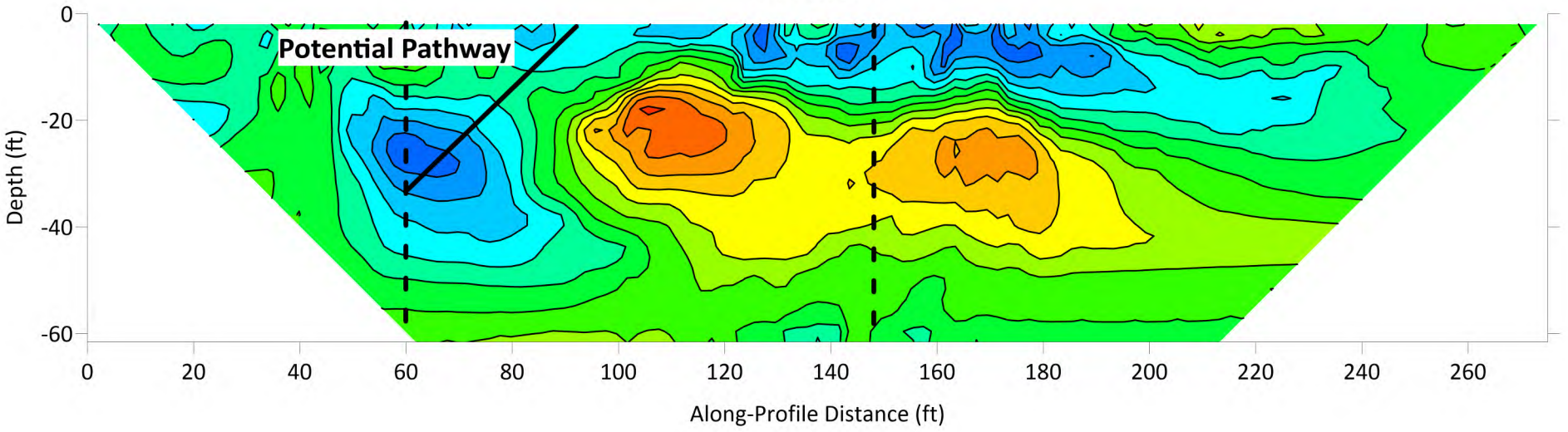
FIGURE 3
ELECTRICAL RESISTIVITY PROFILES

South →

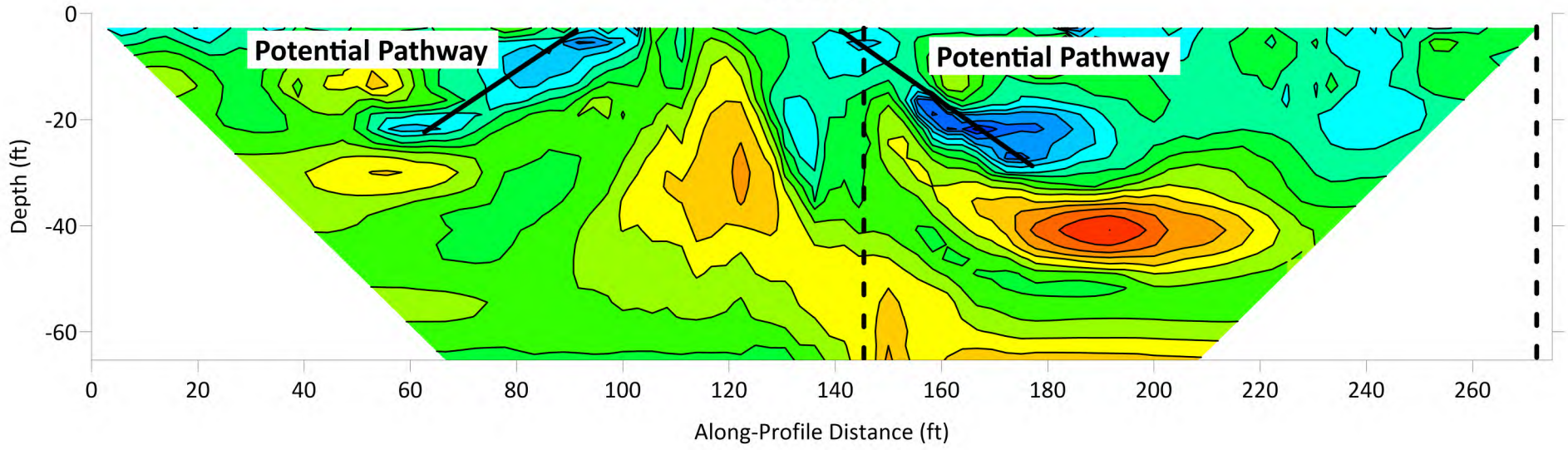
Profile 1



Profile 2



Profile 3



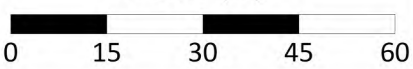
Resistivity (Ohm*m)

Notes:

Data from AGI Sting R-8, dipole-dipole expanded arrays.
Inversion of field data from AGI EarthImager2D.

- - - - - · Appalachian Drive

Scale (ft)



Prepared by:

RETTEW SM | ENVIROSCAN

RETTEW Associates, Inc.
3020 Columbia Avenue, Lancaster, PA 17603
Phone (717) 394-3721 • Fax (717)394-1063

Title:

Electrical Resistivity Profiles

Project Location:

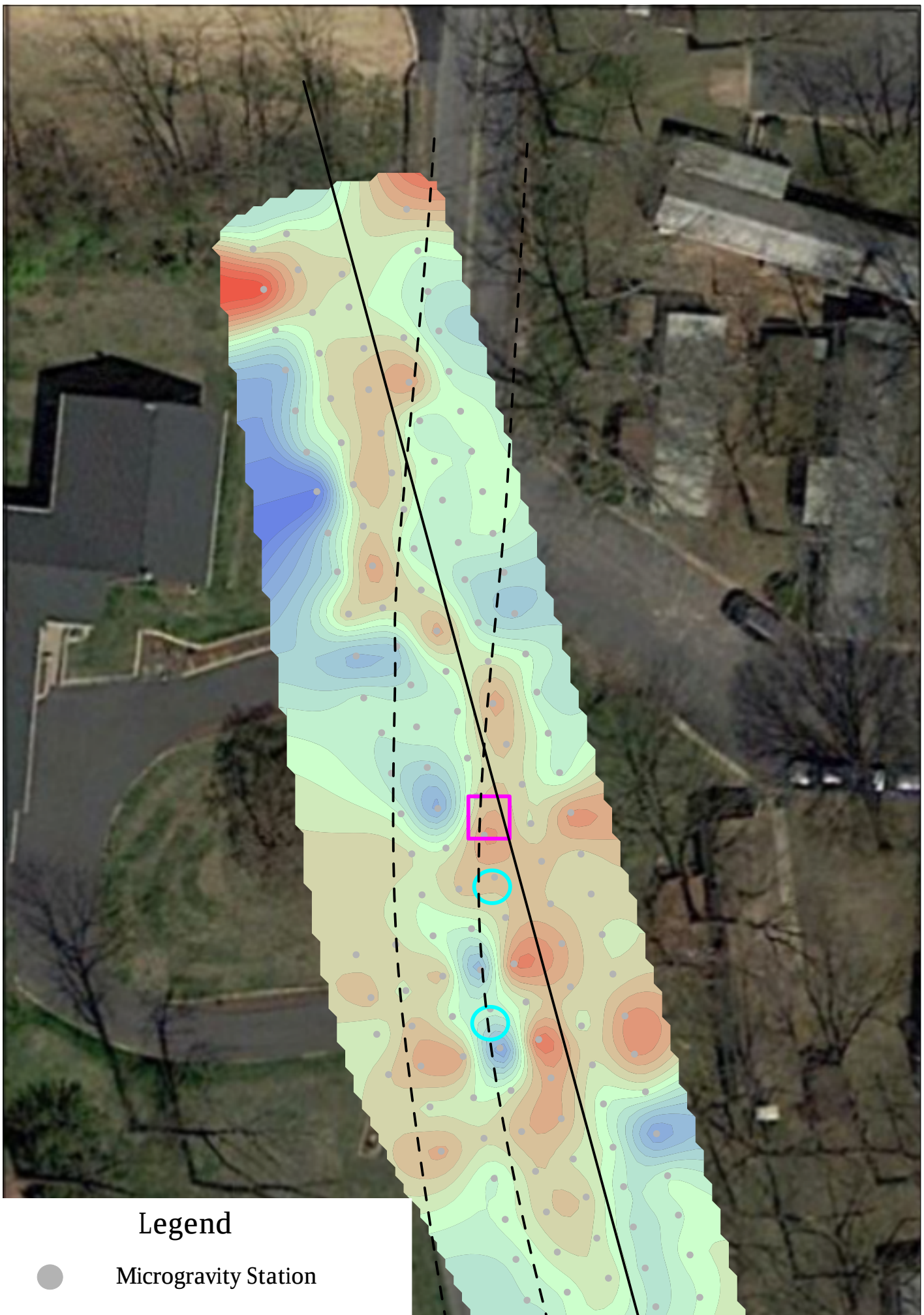
Sunoco Spread #4
Appalachian Drive
Middlesex, PA

Figure: 3

Project Number	Revision/Issue		
096302009	5/17/2018		
Original Scale	Survey Ending Date	Drawn by:	Approved by:
1" = 30'	5/09/18	MEG	FKB

RETTEW SM | ENVIROSCAN

FIGURE 4
RESIDUAL MICROGRAVITY CONTOUR MAP



Legend

- Microgravity Station
- Inadvertent Return Location
- Repaired Subsidence Feature
- HDD Line

Residual Microgravity (mgals)

-0.2 -0.1 -0.06 0 0.06 0.1 0.2

← Increasing Mass Deficiency | Increasing Mass Excess →

Notes:

Data from Scintrex CG-5 meter, with complete Bouguer correction and planar regional removal.

Scale (ft)

0 15 30 45 60

Prepared by:

RETTEW SM | ENVIROSCAN

RETTEW Associates, Inc.
3020 Columbia Avenue, Lancaster, PA 17603
Phone (717) 394-3721 · Fax (717)394-1063

Title: Residual Microgravity Contour Map

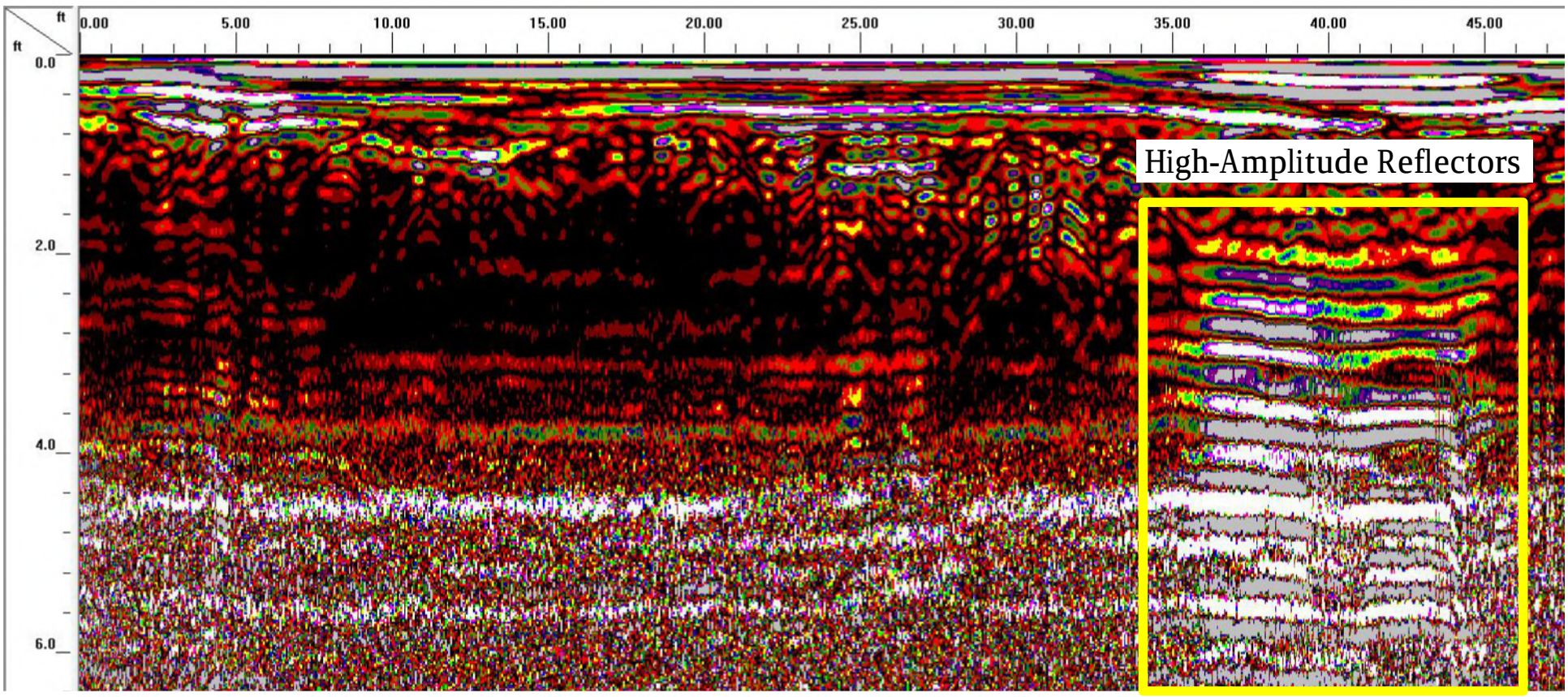
Project Location: Sunoco Spread #4 Appalachian Drive Middlesex, PA

Figure: 4

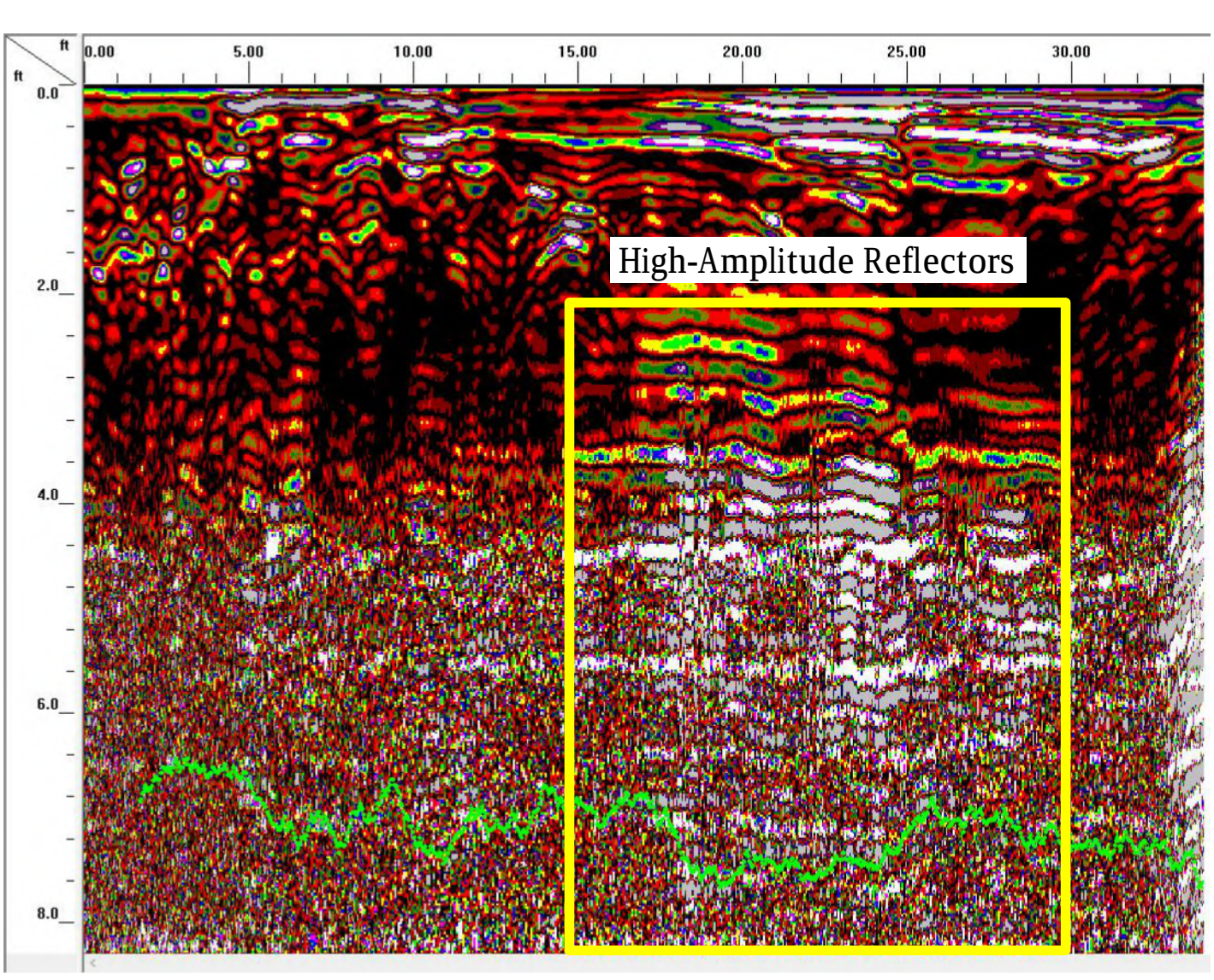
Project Number	Revision/Issue		
096302009	5/17/2018		
Original Scale	Survey Ending Date	Drawn by:	Approved by:
1" = 30'	5/09/18	MEG	FKB

FIGURE 5
GROUND PENETRATING RADAR PROFILES

Profile 1



Profile 2

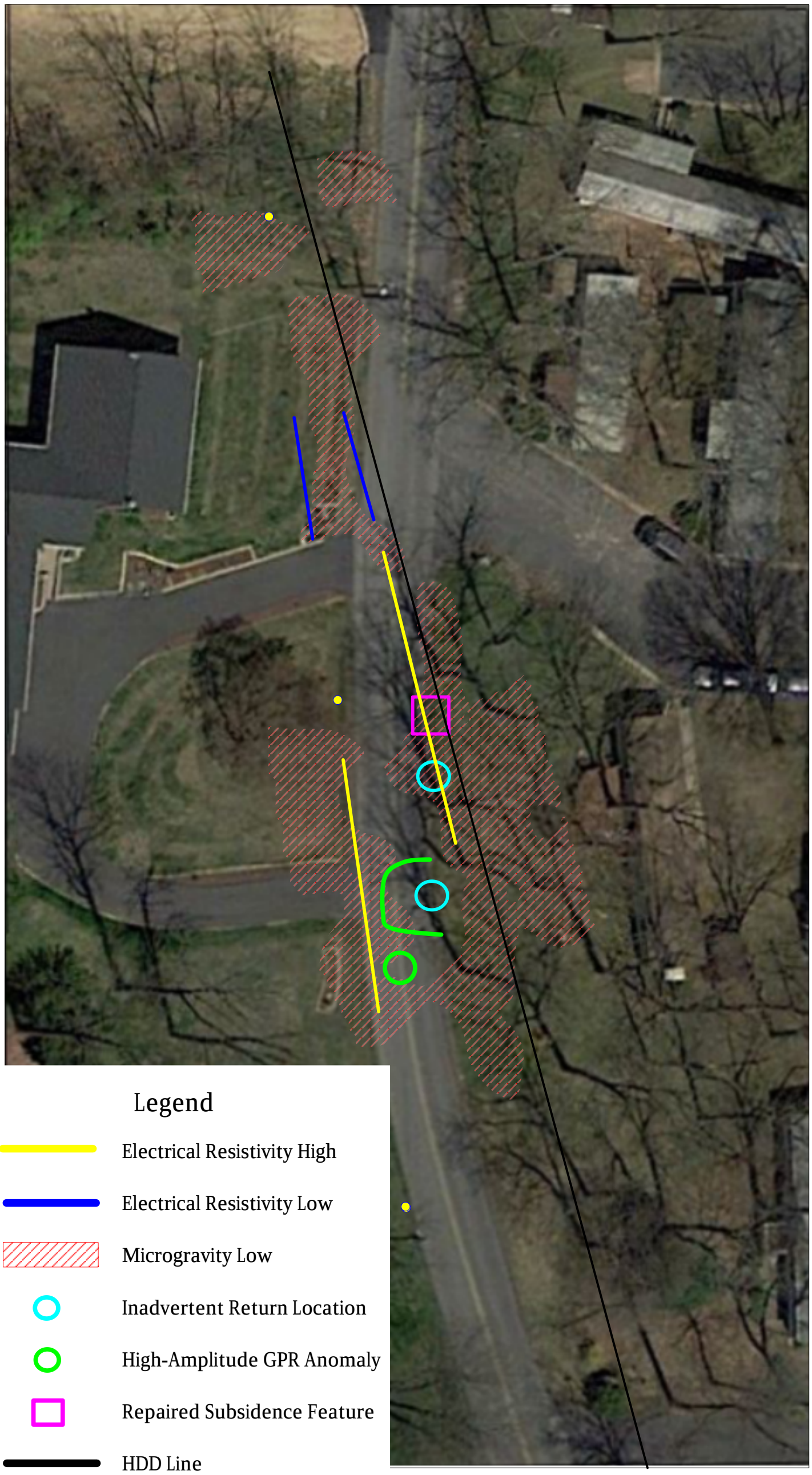


Notes:

Data from GSSI SIR-4000, 400 MHz transducer.

Prepared by: RETTEW SM | ENVIROSCAN RETTEW Associates, Inc. 3020 Columbia Avenue, Lancaster, PA 17603 Phone (717) 394-3721 · Fax (717)394-1063	Title: Ground Penetrating Radar Profiles	Project Location: Sunoco Spread #4 Appalachian Drive Middlesex, PA	Figure: 5
		Project Number: 096302009 / Revision/Issue: 5/17/2018	
		Original Scale: NTS / Survey Ending Date: 5/09/18	Drawn by: MEG / Approved by: FKB

FIGURE 6
GEOPHYSICAL SURVEY RESULTS SUMMARY MAP



Legend

- Electrical Resistivity High
- Electrical Resistivity Low
- Microgravity Low
- Inadvertent Return Location
- High-Amplitude GPR Anomaly
- Repaired Subsidence Feature
- HDD Line

Notes:

Basemap from RETTEW personnel field sketches, Topcon GPS survey, and Google Earth Image.

Scale (ft)

0 15 30 45 60

Prepared by:

RETTEW SM | ENVIROSCAN

RETTEW Associates, Inc.
3020 Columbia Avenue, Lancaster, PA 17603
Phone (717) 394-3721 · Fax (717)394-1063

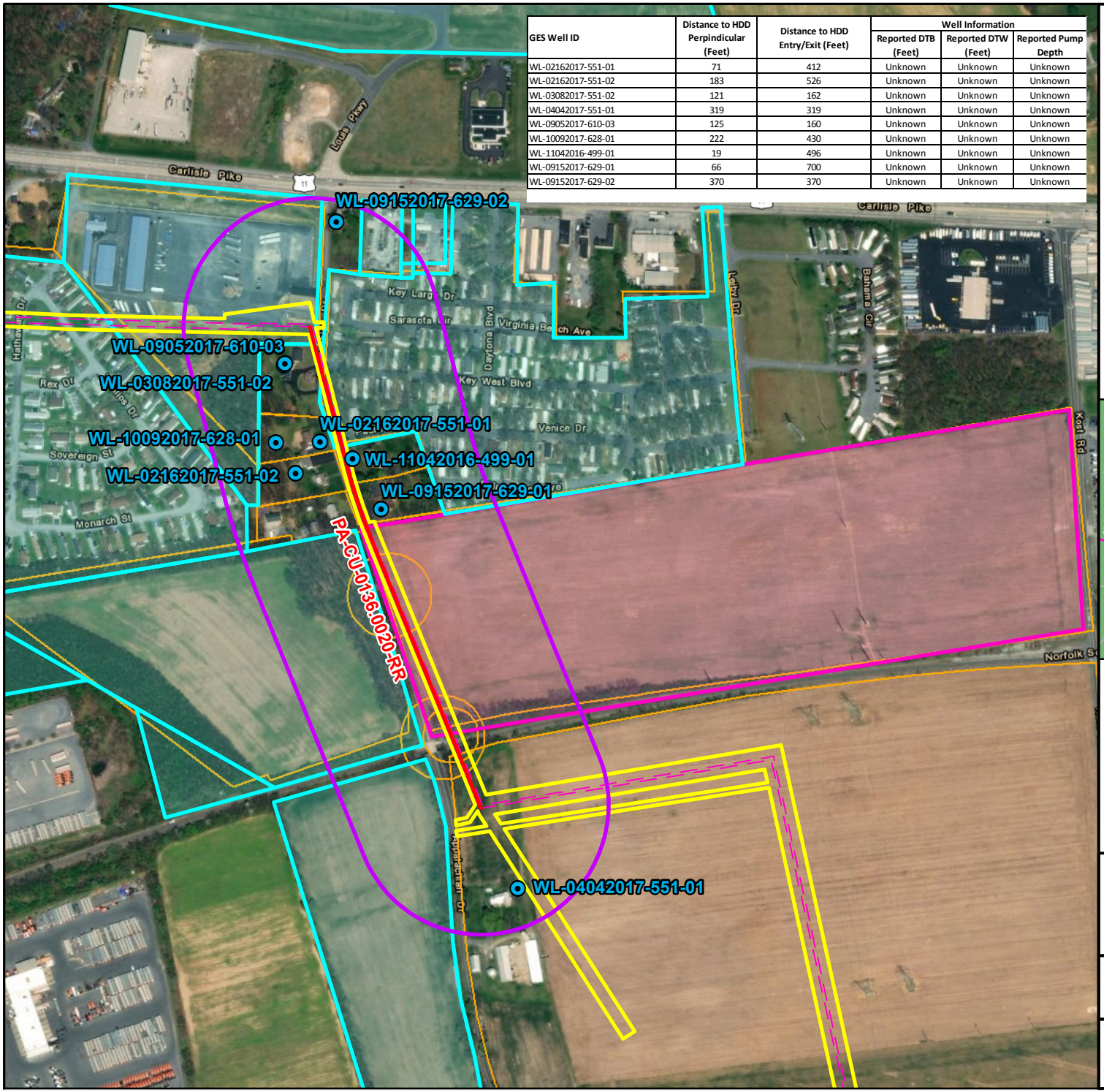
Title: Geophysical Survey Results Summary

Project Location: Sunoco Spread #4 Appalachian Drive Middlesex, PA

Figure: 6

Project Number	Revision/Issue	Drawn by:	Approved by:
096302009	5/17/2018	MEG	FKB

Original Scale	Survey Ending Date
NTS	5/09/18



GES Well ID	Distance to HDD Perpindicular (Feet)	Distance to HDD Entry/Exit (Feet)	Well Information		
			Reported DTB (Feet)	Reported DTW (Feet)	Reported Pump Depth
WL-02162017-551-01	71	412	Unknown	Unknown	Unknown
WL-02162017-551-02	183	526	Unknown	Unknown	Unknown
WL-03082017-551-02	121	162	Unknown	Unknown	Unknown
WL-04042017-551-01	319	319	Unknown	Unknown	Unknown
WL-09052017-610-03	125	160	Unknown	Unknown	Unknown
WL-10092017-628-01	222	430	Unknown	Unknown	Unknown
WL-11042016-499-01	19	496	Unknown	Unknown	Unknown
WL-09152017-629-01	66	700	Unknown	Unknown	Unknown
WL-09152017-629-02	370	370	Unknown	Unknown	Unknown

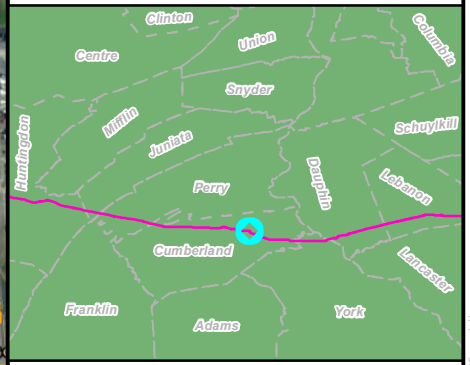
Legend

- LOD
- Parcel
- PPP Centerline
- HDD
- 450 foot buffer of HDD alignment
- Public Water Supply/Landowner Confirmed No Well
- Testing Refused

****Testing locations current as of 06/07/2018**

- GES Testing Location

Location



0 250 500 Feet

Well Location Map
HDD# PA-CU-0136.0020-RR
Cumberland County, PA.

Prepared By: TETRA TECH

Date: 6/7/2019

Base Map;
ESRI World Imagery, 09/24/2015

Coordinate System: NAD 83 Stateplane, PA South, Feet

P:\GIS\projects\112005938-PPP\MXD\WellLocations\PA_CU_0136_0020.mxd JL

Weiser Water Sample Analytical Results Summary

Parcel ID: 38-08-0571-001 (102 Appalachian Drive)
Well Location Map ID: WL-04042017-551-01

Parameter	Units	Sample Date: 4/4/2017 Sample I.D.: 04042017-551-01	Sample Date: 9/26/2017 Sample I.D.: 09262017-612-01	Sample Date: 4/27/2018 Sample I.D.: 04272018-639-03	PA DEP Drinking Water MCL/SMCL
Coliform, fecal	col/100ml	NA	<1	<1	-
E. Coli	MPN/100ml	NA	<1	<1	-
Coliform, total	MPN/100ml	NA	65.0	88.0	-
Dissolved Solids	mg/l	**525**	**543**	**536**	500
Suspended Solids	mg/l	3.16	ND	ND	-
Hardness (colorimetric) as CACO3	mg/l	434	457	464	-
Turbidity	NTU	0.854	ND	ND	-
Alkalinity	mg/l	328	355	308	-
pH	SU	7.44	7.13	7.08	-
Specific Conductance	umhos/cm	865	973	943	-
Bromide	mg/l	ND	ND	ND	-
Chloride	mg/l	36.1	66.6	75.9	250
Sulfate	mg/l	34.6	35.4	28.4	250
Barium	mg/l	0.0512	0.0562	0.0539	2
Calcium	mg/l	124	136	129	-
Iron	mg/l	**0.404**	ND	ND	0.3
Magnesium	mg/l	30.1	34.1	32.3	-
Manganese	mg/l	ND	ND	ND	0.05
Potassium	mg/l	2.74	2.31	2.27	-
Sodium	mg/l	16.2	19.6	19.8	-
Methane	mg/l	ND	ND	ND	-
Ethane	mg/l	ND	ND	ND	-
Ethene	mg/l	ND	ND	ND	-
Propane	mg/l	ND	ND	ND	-
Benzene	mg/l	ND	ND	ND	0.005
Toluene	mg/l	ND	ND	ND	1
Ethylbenzene	mg/l	ND	ND	ND	0.7
Total Xylenes	mg/l	ND	ND	ND	10
Residual Bentonite	-	NA	NA	NA	-

20-inch HDD construction dates: September 11, 2017 through June 7, 2018
16-inch HDD construction dates: Awaiting PA DEP authorization to start

Notes:
1. MCL - Maximum Primary Contaminant Level
2. SMCL - Maximum Secondary Contaminant Level
3. NA - Not Analyzed
4. ND - Not Detected
5. col/100ml - colonies per 100 milliliters
6. MPN/100ml - most probable number per 100 milliliters
7. mg/l - milligrams per liter
8. NTU - nephelometric turbidity units
9. SU - standard units
10. umhos/cm - micro ohms per centimeter

Concentrations that are bolded exceed or are equivalent to their respective PA DEP MCL/SMCL

Jernigan Water Sample Analytical Results Summary

Parcel ID: 38-19-1625-001 (145 Appalachian Drive)
Well Location Map ID: WL-03082017-551-02

Parameter	Units	Sample Date: 3/8/2017 Sample I.D.: 03082017-551-02	Sample Date: 9/5/2017 Sample I.D.: 09052017-610-03	Sample Date: 9/26/2017 Sample I.D.: 09262017-628-01	Sample Date: 3/12/2019 Sample I.D.: 03122019-604-03	PA DEP Drinking Water MCL/SMCL
Coliform, fecal	col/100ml	NA	5.00	19.0	3.1	-
E. Coli	MPN/100ml	NA	9.80	18.1	2.0	-
Coliform, total	MPN/100ml	NA	161	134	>2419.6	-
Dissolved Solids	mg/l	**659**	**586**	**562**	**647**	500
Suspended Solids	mg/l	ND	3.10	ND	5.10	-
Hardness (colorimetric) as CACO3	mg/l	422	336	351	398	-
Turbidity	NTU	0.510	0.265	ND	0.320	-
Alkalinity	mg/l	305	289	286	249	-
pH	SU	7.94	7.53	7.13	7.48	-
Specific Conductance	umhos/cm	1220	1010	1060	1230	-
Bromide	mg/l	ND	ND	ND	ND	-
Chloride	mg/l	174	137	128	203	250
Sulfate	mg/l	23.9	27.5	26.5	25.8	250
Barium	mg/l	0.0599	0.0481	0.0504	0.0586	2
Calcium	mg/l	133	114	120	127	-
Iron	mg/l	0.236	0.152	ND	ND	0.3
Magnesium	mg/l	21.9	17.4	18.5	19.6	-
Manganese	mg/l	ND	ND	ND	ND	0.05
Potassium	mg/l	1.74	1.52	1.82	1.24	-
Sodium	mg/l	92.9	68.7	75.6	91.3	-
Methane	mg/l	ND	ND	ND	ND	-
Ethane	mg/l	ND	ND	ND	ND	-
Ethene	mg/l	ND	ND	ND	ND	-
Propane	mg/l	ND	ND	ND	ND	-
Benzene	mg/l	ND	ND	ND	ND	0.005
Toluene	mg/l	ND	ND	ND	ND	1
Ethylbenzene	mg/l	ND	ND	ND	ND	0.7
Total Xylenes	mg/l	ND	ND	ND	ND	10
Residual Bentonite	-	NA	NA	NA	NA	-

20-inch HDD construction dates: September 11, 2017 through June 7, 2018
16-inch HDD construction dates: Awaiting PA DEP authorization to start

Notes:
1. MCL - Maximum Primary Contaminant Level
2. SMCL - Maximum Secondary Contaminant Level
3. NA - Not Analyzed
4. ND - Not Detected
5. col/100ml - colonies per 100 milliliters
6. MPN/100ml - most probable number per 100 milliliters
7. mg/l - milligrams per liter
8. NTU - nephelometric turbidity units
9. SU - standard units
10. umhos/cm - micro ohms per centimeter

Concentrations that are bolded exceed or are equivalent to their respective PA DEP MCL/SMCL

Wagner Water Sample Analytical Results Summary

Parcel ID: 38-19-1625-002 (141 Appalachian Drive)
Well Location Map ID: WL-02162017-551-01

Parameter	Units	Sample Date: 2/16/2017 Sample I.D.: 02162017-551-01	Sample Date: 9/15/2017 Sample I.D.: 09152017-629-01	Sample Date: 10/9/2017 Sample I.D.: 10092017-628-01	Sample Date: 11/15/2017 Sample I.D.: 11152017-630-01	Sample Date: 12/8/2017 Sample I.D.: 12082017-611-01	Sample Date: 2/2/2018 Pre-Treatment Sample I.D.: 02022018-630-01	Sample Date: 2/2/2018 Post-Treatment Sample I.D.: 02022018-630-02	Sample Date: 3/23/2018 Pre-Treatment Sample I.D.: 03232018-629-01	Sample Date: 3/23/2018 Post-Treatment Sample I.D.: 03232018-629-02	PA DEP Drinking Water MCL/SMCL
Coliform, fecal	col/100ml	NA	<1	1.00	<1	<2	2.00	<1	<1	<1	-
E. Coli	MPN/100ml	NA	<1	1.00	1.00	<1	7.40	<1	<1	<1	-
Coliform, total	MPN/100ml	NA	61.3	1120	8.60	<1	435	<1	<1	<1	-
Dissolved Solids	mg/l	50.0	463	**580**	**586**	**535**	**671**	**667**	**598**	**637**	500
Suspended Solids	mg/l	4.51	28.9	5.20	2.50	28.8	35.6	ND	128	ND	-
Hardness (colorimetric) as CACO3	mg/l	483	388	366	361	416	390	389	550	333	-
Turbidity	NTU	1.75	2.17	16.1	2.12	18.3	183	1.28	32.4	2.95	-
Alkalinity	mg/l	343	302	284	281	286	289	281	115	156	-
pH	SU	7.10	7.36	7.17	7.29	7.46	7.86	7.76	8.11	7.93	-
Specific Conductance	umhos/cm	1010	821	1200	1040	1040	1270	1280	1030	1080	-
Bromide	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
Chloride	mg/l	92.5	58.8	138	133	128	195	200	174	178	250
Sulfate	mg/l	18.8	19.3	29.2	25.7	26.5	27.8	27.8	74.0	67.7	250
Barium	mg/l	0.0410	0.0379	0.0571	0.0562	0.0550	0.0586	0.0516	0.0705	0.0412	2
Calcium	mg/l	153	124	122	115	112	128	126	181	101	-
Iron	mg/l	**1.62**	**5.03**	**1.55**	**0.457**	**2.44**	**17.6**	ND	**3.82**	0.124	0.3
Magnesium	mg/l	20.2	16.6	21.1	23.7	22.8	20.6	20.7	27.1	19.8	-
Manganese	mg/l	ND	0.0265	0.0243	0.0238	0.0371	**0.112**	**0.0965**	0.0301	0.0204	0.05
Potassium	mg/l	ND	1.08	2.84	1.56	1.31	2.00	2.05	7.50	6.48	-
Sodium	mg/l	36.4	26.1	78.6	69.2	65.1	101	104	90.6	89.2	-
Methane	mg/l	ND	ND	ND	0.0185	ND	ND	ND	ND	ND	-
Ethane	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
Ethene	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
Propane	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	-
Benzene	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.005
Toluene	mg/l	ND	ND	0.0106	0.0227	ND	0.00215	0.00147	0.00256	ND	1
Ethylbenzene	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.7
Total Xylenes	mg/l	ND	ND	ND	ND	ND	ND	ND	ND	ND	10
Residual Bentonite	-	NA	Trace	NA	NA	ND	NA	NA	NA	NA	-

20-inch HDD construction dates: September 11, 2017 through June 7, 2018
16-inch HDD construction dates: Awaiting PA DEP authorization to start

Notes:
1. MCL - Maximum Primary Contaminant Level
2. SMCL - Maximum Secondary Contaminant Level
3. NA - Not Analyzed
4. ND - Not Detected
5. col/100ml - colonies per 100 milliliters
6. MPN/100ml - most probable number per 100 milliliters
7. mg/l - milligrams per liter
8. NTU - nephelometric turbidity units
9. SU - standard units
10. umhos/cm - micro ohms per centimeter

Concentrations that are bolded exceed or are equivalent to their respective PA DEP MCL/SMCL

Earley Water Sample Analytical Results Summary

Parcel ID: 38-19-1625-003 (139 Appalachian Drive)
Well Location Map ID: WL-02162017-551-02

Parameter	Units	Sample Date: 2/16/2017 Sample I.D.: 02162017-551-02	Sample Date: 9/19/2017 Sample I.D.: 09192017-616-01	PA DEP Drinking Water MCL/SMCL
Coliform, fecal	col/100ml	NA	<1	-
E. Coli	MPN/100ml	NA	<1	-
Coliform, total	MPN/100ml	NA	35.0	-
Dissolved Solids	mg/l	60.0	497	500
Suspended Solids	mg/l	ND	ND	-
Hardness (colorimetric) as CACO3	mg/l	500	411	-
Turbidity	NTU	5.69	0.172	-
Alkalinity	mg/l	333	279	-
pH	SU	7.09	7.45	-
Specific Conductance	umhos/cm	1150	905	-
Bromide	mg/l	ND	ND	-
Chloride	mg/l	120	70.3	250
Sulfate	mg/l	23.2	20.8	250
Barium	mg/l	0.0486	0.0370	2
Calcium	mg/l	161	136	-
Iron	mg/l	**2.35**	ND	0.3
Magnesium	mg/l	21.5	16.9	-
Manganese	mg/l	0.0212	ND	0.05
Potassium	mg/l	1.10	ND	-
Sodium	mg/l	46.6	33.3	-
Methane	mg/l	ND	ND	-
Ethane	mg/l	ND	ND	-
Ethene	mg/l	ND	ND	-
Propane	mg/l	ND	ND	-
Benzene	mg/l	ND	ND	0.005
Toluene	mg/l	ND	ND	1
Ethylbenzene	mg/l	ND	ND	0.7
Total Xylenes	mg/l	ND	ND	10
Residual Bentonite	-	NA	NA	-

20-inch HDD construction dates: September 11, 2017 through June 7, 2018
16-inch HDD construction dates: Awaiting PA DEP authorization to start

Notes:
1. MCL - Maximum Primary Contaminant Level
2. SMCL - Maximum Secondary Contaminant Level
3. NA - Not Analyzed
4. ND - Not Detected
5. col/100ml - colonies per 100 milliliters
6. MPN/100ml - most probable number per 100 milliliters
7. mg/l - milligrams per liter
8. NTU - nephelometric turbidity units
9. SU - standard units
10. umhos/cm - micro ohms per centimeter

Concentrations that are bolded exceed or are equivalent to their respective PA DEP MCL/SMCL

Singer Water Sample Analytical Results Summary

Parcel ID: 38-19-1625-005 (138 Appaliachian Drive)
Well Location Map ID: WL-09152017-629-01

Parameter	Units	Sample Date: 9/15/2017 Sample I.D.: 09152017-629-01	Sample Date: 2/5/2018 Sample I.D.: 02052018-613-01	Sample Date: 3/26/2019 Pre-Treatment Sample I.D.: 03262019-611-01	Sample Date: 3/26/2019 Post-Treatment Sample I.D.: 03262019-611-02	PA DEP Drinking Water MCL/SMCL
Coliform, fecal	col/100ml	<1	<1	<1	<1	-
E. Coli	MPN/100ml	2.00	<1	<1	<1	-
Coliform, total	MPN/100ml	1300	69.1	1.0	<1	-
Dissolved Solids	mg/l	**616**	**647**	**507**	**523**	500
Suspended Solids	mg/l	ND	11.0	ND	ND	-
Hardness (colorimetric) as CACO3	mg/l	473	462	394	391	-
Turbidity	NTU	0.197	6.22	0.465	0.725	-
Alkalinity	mg/l	377	336	302	304	-
pH	SU	7.29	7.24	7.91	7.24	-
Specific Conductance	umhos/cm	1110	1160	941	848	-
Bromide	mg/l	ND	ND	ND	ND	-
Chloride	mg/l	106	129	65.4	67.1	250
Sulfate	mg/l	21.1	33.0	26.5	26.8	250
Barium	mg/l	0.0574	0.0449	0.0289	0.0369	2
Calcium	mg/l	147	153	136	124	-
Iron	mg/l	ND	**0.382**	ND	ND	0.3
Magnesium	mg/l	19.6	17.5	15.6	20.6	-
Manganese	mg/l	ND	0.0339	ND	ND	0.05
Potassium	mg/l	1.70	ND	ND	1.01	-
Sodium	mg/l	55.4	59.6	33.3	36.7	-
Methane	mg/l	ND	ND	ND	ND	-
Ethane	mg/l	ND	ND	ND	ND	-
Ethene	mg/l	ND	ND	ND	ND	-
Propane	mg/l	ND	ND	ND	ND	-
Benzene	mg/l	ND	ND	ND	ND	0.005
Toluene	mg/l	ND	ND	ND	ND	1
Ethylbenzene	mg/l	ND	ND	ND	ND	0.7
Total Xylenes	mg/l	ND	ND	ND	ND	10
Residual Bentonite	-	NA	Possible Trace	NA	NA	-

20-inch HDD construction dates: September 11, 2017 through June 7, 2018
16-inch HDD construction dates: Awaiting PA DEP authorization to start

Notes:
1. MCL - Maximum Primary Contaminant Level
2. SMCL - Maximum Secondary Contaminant Level
3. NA - Not Analyzed
4. ND - Not Detected
5. col/100ml - colonies per 100 milliliters
6. MPN/100ml - most probable number per 100 milliliters
7. mg/l - milligrams per liter
8. NTU - nephelometric turbidity units
9. SU - standard units
10. umhos/cm - micro ohms per centimeter

Concentrations that are bolded exceed or are equivalent to their respective PA DEP MCL/SMCL

Lepley Water Sample Analytical Results Summary

Parcel ID: 38-19-1625-006 (140 Appalachian Drive)
Well Location Map ID: WL-11042016-499-01

Parameter	Units	Sample Date: 11/04/2016	Sample Date: 02/16/2017	Sample Date: 09/21/2017	Sample Date: 4/3/2018	Sample Date: 5/17/2018	Sample Date: 3/26/2019 Pre-treatment	Sample Date: 3/26/2019 Post-Treatment	PA DEP Drinking Water MCL/SMCL
		Sample I.D.: 11042016-499-01	Sample I.D.: 02162017-551-03	Sample I.D.: 09212017-619-01	Sample I.D.: 04032018-630-01	Sample I.D.: 05172018-520-01	Sample I.D.: 03262019-611-03	Sample I.D.: 03262019-611-04	
Coliform, fecal	col/100ml	NA	NA	<1	<1	<1	<1	<1	
E. Coli	MPN/100ml	NA	NA	<1	<1	<1	<1	<1	
Coliform, total	MPN/100ml	NA	NA	2.00	<1	34.1	<1	<1	
Dissolved Solids	mg/l	491	512	472	418	475	463	**518**	500
Suspended Solids	mg/l	36.1	131	10.0	ND	6.84	12.4	ND	
Hardness (colorimetric) as CACO3	mg/l	410	428	375	372	363	342	ND	
Turbidity	NTU	5.40	16.5	4.87	1.93	4.26	6.47	0.87	
Alkalinity	mg/l	306	350	328	301	316	296	328	
pH	SU	8.17	7.75	7.36	7.73	7.48	7.28	7.37	
Specific Conductance	umhos/cm	841	912	836	796	821	777	860	
Bromide	mg/l	ND	ND	ND	ND	ND	ND	ND	
Chloride	mg/l	56.2	63.4	57.2	60.6	61.5	48.7	60.4	250
Sulfate	mg/l	31.3	28.2	33.4	35.0	35.3	21.5	31.2	250
Barium	mg/l	0.131	0.174	0.131	0.110	0.107	0.082	ND	2
Calcium	mg/l	105	132	96.0	93.2	97.5	120	7.13	
Iron	mg/l	ND	**8.24**	**4.93**	ND	0.222	**2.78**	ND	0.3
Magnesium	mg/l	30.9	25.1	35.7	37.3	34.5	17.4	1.02	
Manganese	mg/l	ND	**0.159**	**0.166**	ND	0.0101	**0.0523**	ND	0.05
Potassium	mg/l	2	1.45	1.76	2.04	1.97	1.04	1.27	
Sodium	mg/l	32.5	29.2	28.5	33.2	32.9	29	196	
Methane	mg/l	ND	ND	ND	0.0128	0.0105	ND	ND	
Ethane	mg/l	ND	ND	ND	ND	ND	ND	ND	
Ethene	mg/l	ND	ND	ND	ND	ND	ND	ND	
Propane	mg/l	ND	ND	ND	ND	ND	ND	ND	
Benzene	mg/l	ND	ND	ND	ND	ND	ND	ND	0.005
Toluene	mg/l	ND	ND	ND	ND	ND	ND	ND	1
Ethylbenzene	mg/l	ND	ND	ND	ND	ND	ND	ND	0.7
Total Xylenes	mg/l	ND	ND	ND	ND	ND	ND	ND	10
Residual Bentonite	-	NA	NA	NA	ND	NA	ND	ND	

20-inch HDD construction dates: September 11, 2017 through June 7, 2018
16-inch HDD construction dates: Awaiting PA DEP authorization to start

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