SUNOCO PIPELINE
An ENERGY TRANSFER Company

535 Fritztown Road
Sinking Spring, PA 19608

March 8, 2018

<u>Via Electronic and First Class Mail</u>
Ed J. Muzic, P.E.
Civil Engineer Manager; Dam Safety, Waterways and Wetlands Section
Department of Environmental Protection
South-central Regional Office
909 Elmerton Avenue
Harrisburg, PA 17110

**Re: Hydrogeological Re-evaluation Report**
**Piney Creek Crossing Horizontal Directional Drill Location (S2-0142)**
**Permit No. E07-459**
**Woodbury Township, Blair County; Pennsylvania**

Dear Mr. Muzic:

In compliance with the Corrected Stipulated Order dated August 10, 2017 (Order) a Reevaluation Report on the above-referenced horizontal directional drill ("HDD") was submitted to the Department on December 28, 2017. Sunoco Pipeline, L.P. (SPLP) has received your letter of February 1, 2018 requesting additional information and corrections to the Reevaluation Report. Please accept this letter and attached revised Reevaluation Report as a response to this request.

1. **Sunoco's report states that the HDD "could affect individual well use during active drilling." In order to resolve this issue, Sunoco needs to enter into written agreements with all private water supply owners whose water supplies may be impacted by this drill as part of this reevaluation and in advance of commencing the HDD. Under the agreements, Sunoco must provide temporary and if necessary, permanent, replacement potable water supplies adequate in quantity and quality for the purposes served, to the satisfaction of all potentially affected water supply owners. Sunoco shall provide proof of these agreements to the DEP with a response to this letter. The agreements should provide for Sunoco to conduct water quality and quantity testing of each potentially affected water supply prior to, during, and after the HDD activities.**

   On February 23, 2018, SPLP received a letter from Domenic Rocco at the Department, which clarified the requests included in Comment 1 of your February 1, 2018 letter. Specifically, Mr. Rocco's letter allowed SPLP to respond to these requests by providing a discussion of actions that SPLP will take to avoid impacts to water supplies, other than entering into agreements with landowners for alternative potable water supplies. In accordance with that clarification, SPLP provides the following response.

SPLP provided notice and offered temporary water supplies to all water supply owners within 450 feet of HDD profiles. Significantly, the facts regarding water supply wells within 450 feet of the HDD profile are:

(i) There are 14 parcels with water supply wells within 450 feet of this HDD profile. All have received written notification that they are entitled to temporary water supplies at this time.

(ii) Eight of the 14 landowners have identified the locations for 10 water wells; of these, 7 landowners have water wells within 450 ft of the HDD profile.

(iii) One of the 7 landowners has accepted temporary water replacement. The remaining landowners have stated a preference to monitor their own wells and take action, if necessary, upon observing any adverse changes in water quality or quantity.

(iv) Six parcels are vacant, *i.e.,* there are no structures on these parcels that would reasonably be expected to be associated with human habitation or occupation.

SPLP's goal, as noted above, is to minimize any potential impacts to water supply wells. To that end, SPLP will take the following additional action:

During the progression of the pilot hole phase on this HDD, SPLP will add DrilPlex to its drilling mud for the entire length of pilot hole progress. DrilPlex is an ANSI/NSF-60 approved drinking water certified additive that allows the drilling mud to gel in the formation thereby minimizing the risk of impact to any of the nearby wells in question. SPLP will add DrilPlex in a 1:10 ratio to the raw bentonite during mixing of the drilling fluid, in accordance with the manufacturer's recommendations. In addition, SPLP intends to follow all conditions included as part of DrilPlex's ANSI/NSF-60 certification. An application guide and Safety Data Sheet for DrilPlex is provided as Attachment 1 for the Department's reference.

2. **Additionally, DEP requests the following information related to the project's potential effect on well production zones and water supplies:**

- **An analysis of private water supply well production zones and how the proposed HDD activities will interact with them (listing the depths of wells and pumps is insufficient).**

As stated in paragraph 2 on page 3 in Reevaluation report for this HDD, *"The production zone for water wells is from the well bottom to highest point of water inflow from the water* *bearing seams, joints, and fractures in the rock formation"*. Water wells in bedrock can only pump water from inside the surface casing and open rock interval within the bore annulus, and water volume from the top water elevation down to the pump intake.

SPLP believes the intended subject matter of the question listed in Item 2. bullet 1, is the "recharge" of these wells from the surrounding geologic formation.

As stated in the Reevaluation Report in the Hydrogeology section, *"Groundwater at the site occurs in a fractured carbonate and clastic sedimentary bedrock aquifer system"*. To explain further, this means that available groundwater is stored within, and moves through, fissures and bedding plane partings in the bedrock. A water well in a bedrock formation is a simple vertical hole in the bedrock that intercepts water bearing fissures and bedding plane partings and provides an open vertical annulus for the water within the bedrock to flow into and fill (recharge)with a volume of water rising towards the land's surface until equilibrium with the piezometric surface in bedrock formation is achieved.

Any technically defensible analysis of this subject in this unique geology is dependent upon information on the orientation of the fissures and bedding plane partings; their width; do they dip or incline; and to what extent hydrostatic forces or the effects of gravity influence the movement of water in these bedrock features. This information, however, cannot be determined for a given well location in this geology even with extensive geologic coring and water investigation because the bedrock characteristics for these features and behavior can vary significantly in each core. Furthermore, the private water supply yields are governed by well construction and resulting well efficiency and its relation to the available water bearing fissures and bedding plane parting horizons they intercept and does not reflect a homogenous consistency as seen in layered unconsolidated aquifers.

In addition, the effect of the HDD on a given water supply well will depend upon the level of use and resultant groundwater draw at a specific time. According to water use data published by Pennsylvania State University (https://extension.psu.edu/water-system-planning-estimating-water-needs), in general, a household will use 50 to 100 gallons per person per day (200 to 400 gallons per day for a family of four). For a drilled well, the borehole provides a significant amount of water storage. A typical 6-inch-diameter well will store about 1.5 gallons of water for every foot of standing water in the borehole and a 10-inch well stores about 4 gallons of water per foot. Therefore, a 6-inch-diameter well with about 100 feet of standing water in the borehole would contain about 150 gallons of stored water.

Use of this water and the resulting draw upon adjacent groundwater within the fractured bedrock is cyclic throughout the day, with the greatest demand occurring during morning and evening hours and on weekend days and holidays when residents are generally home.

In sum, the well yield and production can and often varies greatly over relatively short distances and time periods in these complex rock formations. The well production can be influenced by seasonal variability in precipitation, well construction, well consumption rates, recharge rates, infiltration rates, radius of influence (ROI) of other well systems, multiple production zones, and known and unknown geologic structural features (i.e., fissures, bedding planes and rock type). For these reasons discussed above, and consistent with the permit and incorporated plans, as amended, SPLP will offer baseline, active drilling, and post drilling monitoring of all wells in the 450 feet buffer zone. This data will be used to evaluate the water chemistry and other physical characteristics of the water quality at the specific well location before, during and after construction, and if an impact occurs, the permit requires replacement of the water supply to the satisfaction of the well owner.

- **A map showing all the private water supplies in the correct, surveyed locations.**

  The revised Hydrogeologic Report contains an updated Water Supply Illustration. The well or spring locations were recorded by Global Positioning System equipment and are accurate.

- **A description of the following: if there is short tripping of the tooling during the HDD, what are the chances of a plunger-effect occurring during either the drilling or reaming phases or during pipe pullback, and could this affect private water supplies?**

  The "plunger effect" is only a concern during the complete removal of stem and tooling during the pilot phase of a HDD, since there is only one exit annulus for any pressures created while returning the tool and drive stem to the bedrock face for continued progress. If the drilling operator rushes the return, this could have a plunger effect, and could potentially push drilling fluids into the surrounding bedrock fissures and open bedding planes, and result in migration of diluted fluids towards a well.

  By contrast, during a routine "short-tripping" of the drilling stem and tooling, the length of tripping is typically 2-5 joints of drilling stem, 60-150 foot (ft) of length, as needed to ensure that the annulus surrounding the drill stem is not blocked and the full circulation of returns is being maintained. As a result, the return trip or "re-insertion" is so minor in extent that it does not create a "plunger effect" since the drilling fluids and cuttings have no settling time for phase separation to occur. The potential to affect water supplies by normal short-tripping is nearly zero.

  Similarly, there is typically no plunger effect during the reaming or pipe pullback phases of an HDD since an open pathway exists between the entry and exit for pressure relief and movement of materials within the reamed borehole.

- **Water quality sample results of the private water supplies that may be affected.**

The results of water quality testing for the sampled wells is provided as Attachment 2.

- **Water quantity test results (pump yield tests) of the private water supplies that may be affected.**

  SPLP has notified each water supply well owner within 450 feet of the HDD profile that they have the option to have water quantity tests of their well. To date, water supply well owners have not asked SPLP to perform any water quantity tests at any well location.

3. **Given the concerns related to the HDD's potential impact on water supplies, provide a more detailed discussion regarding the feasibility of conducting this crossing by open cut methodology.**

   An open cut or trenched crossing method would result in direct but temporary impacts to two high-quality trout waters; and a designated exceptional value wetland. Direct affects to Chapter 105 resources from open-cut construction include temporary impacts to 0.8 acres of stream bed and 0.10 acres of wetlands, an increase that the Department considers "major" for permitting purposes.

   Converting this HDD to an open-cut construction area also results in the following direct and indirect effects to residences that are located near the pipeline easement.

   - The residence at Station 3+50 has secondary buildings encroaching within the permanent easement, and these would have to be removed for the construction corridor.

   - From the east side of Creek Road at Station 6+44 to the east side of Piney Creek floodplain at Station 9+00, SPLP would require expanded temporary workspace (TWS) on both sides of the creek crossing for use in spoil storage during excavation of the creek crossing and for completing a horizontal bore of Creek Rd. Since the existing active SPLP 8-inch pipeline occurs to the north side of the permanent easement, for safety reasons the TWS is needed on the south side of the easement which places this disturbance in the front yard of the residence occurring at Station 8+50. This home is located 57 ft south of 20-inch centerline.

   - A residence and associated driveway is located at Station 13+00. To not impede access to the home, SPLP will have to perform a 175 ft horizontal bore, with the bore receiving pit adjacent to the home site. SPLP will require overlying the residence driveway with mats to allow for access of equipment and construction materials to the construction corridor. The disturbance to this residence for the entire construction period will be unavoidable.

- Lastly, clearing of the standard 75 ft wide construction corridor would require clearing of 1.9 acres of lands that is currently forested. This 1.9 acres of clearing will remove a significant amount of the forested buffer adjacent to and between all the home sites abutting the construction corridor. This will permanently alter the aesthetic values at each residence when compared to current conditions.

As demonstrated above, while the conversion of this HDD to a combination of conventional open-trench construction and horizontal bores is possible, SPLP believes it is unlikely that the affected landowners would be supportive of the construction plan, in light of the level of disruption the landowners would experience during construction. Since SPLP would require the approval of these affected, and likely unwilling, landowners to implement this construction plan if insisted upon by the Department, legal action probably would be required to acquire the needed workspace.

4. **More information is needed to provide an adequate site-specific re-examination of the bedrock geology in addition to the information provided from county geologic reports and from a core boring at either end of a drill path that arcs through highly dissolution-prone dipping bedrock**.

   As noted in the response to Comment #2 of your February 1, 2018 letter, additional specific information about bedrock geology cannot be determined at a given location in this geology even with extensive geologic coring because the bedrock characteristics for these features and behavior can vary significantly in each core.

5. **Additional evaluation of the overburden strength needs to be provided, including grain size analysis, a narrative discussion of all data related to the overburden, and how this data was used in the overall reevaluation. Provide a detailed description of the processes and procedures that will be implemented if void spaces are encountered during drilling activity**.

   Overburden characteristics have little to no value to an HDD analysis or design other than establishing where initial bedrock occurs below ground. Based on the geotechnical core data, overburden depth at this HDD location varies from 10 ft of depth at the west end of these HDD to 1.5 ft of depth at the east end of these HDD. During the pilot hole phase, each HDD will enter initial bedrock within 30 ft of the entry point along the profile path.

   During these HDDs, if relatively large open fractures or voids in the bedrock are encountered, these geologic features would be identified during the pilot phase by Loss of Circulation (LOC) of drilling fluids and cuttings to the HDD entry point, and possibly loss of pressure on the pilot tool face while advancing.

Minor LOC events, indicative of fractures in the bedrock, can be effectively treated using a combination of NFS 60 certified polymer and fiber additives such as “Fuse It” and “Magma Fiber”. Set time requirements are relatively low before re-advancement of the tool can commence.

Significant fractures or voids will require multiple grout injections before a plug could be set, and advance of the drill could recommence. Where fractures and voids are sufficiently large, the typical grout injection only fills the bottom of the opening because of gravity and size of the opening.

The recommended treatment procedure for large fractures and voids during the Piney Creek HDDs will be the use of a low mobility grout based on bentonite types of products including “Hole Plug” and “Bore Grout”. Grout placement would utilize standard mixing and pumping techniques. The objective of the grouting program is to get as much of the bentonite chips into the fracture as possible but limiting the individual placement volumes to between 3 and 5 times the theoretical hole volume using a ‘packer’ system to prevent grouting areas that are not in the immediate vicinity of the fracture or void. Filling of the voids by the use of multiple limited volume injections will allow the grout to layer up in the crack or void and eventually fill the opening sufficiently for a seal to develop. Sealing of the opening will be identified when the pump pressure increases during the next grout placement. When backpressure is identified on the last grout injection, the hole has been sealed and drilling may resume after allowing for set time.

6. **Provide an evaluation of the geologic strength at profile depth (beyond the boring descriptions, rock quality descriptions (RQDs), and unconfined compressive strength test results) and how the data collected was used to arrive at the revised drill paths.**

   As noted in the Reevaluation Report, the data from two new geotechnical borings indicate that overall rock quality parameters generally improve as depth below ground increases. Accordingly, SPLP has chosen to modify the original profile design and to pursue a deeper and longer HDD profile. The new profile passes through rock with higher rock quality designations that the original, shallower profile and allows for deeper crossings beneath the wetland and the stream. The deeper profile will assist in the suppression of IRs.

7. **Please provide the annular pressure and formation pressure capacity curves, along with a narrative discussion of how the geotechnical information was used to produce those curves and arrive at the revised drill paths. Please also address the role of groundwater occurrence in the derivation of these curves.**

   The Annular Pressure and Formation Pressure Capacity analysis is provided as Attachment 3. Groundwater levels are accounted for by assuming a saturated formation which has an effect in the Formation Strength calculations.

8. **Provide an analysis of the pipe stress angle and how that information was used to arrive at the revised drill paths.**

   In pipeline engineering, there is no factor of "pipe stress angle" as referred to by the Department. SPLP believes the Department could be referring to pipe's "free stress radius". If so, then the "free stress radius" is a calculated circle, based on the steel qualities, diameter of the pipe, and thickness of the pipe. The curvature of this circle creates a diameter, and has a radius. The free stress radius is the maximum allowable "bend" in a length of pipe from end to end which can occur without kinking or damaging the pipe.

   The free stress radius of the pipe, in combination with segment length, ground elevations and changes in ground elevation adjacent to, before, after, and at the beginning and ending of an HDD, in part set the framework by which an HDD profile is engineered.

9. **The initial 8-page narrative of this HDD analysis makes interpretations which are not included in any of the attached professional geologist-signed/sealed reports. This section of the report must be signed and sealed by the PA-licensed professional geologist who wrote it and made these interpretations. The following items are in the 8-page narrative but are not included in any of the attached professional geologist-signed/sealed reports:**

Contrary to this comment, each of the statements in the Reevaluation Report identified by the Department either references and restates information from the Hydrogeological Reevaluation Report signed by Pennsylvania licensed professional geologists from Rettew, or is based upon widely known industry standards. Additional information is provided below in response to each of the Department's specific comments on this point.

- **A discussion of indications of a high degree of fracturing in the near subsurface geology from immediately west of Piney Creek to within 200 of the west end of the HDD in the Hydrogeology Report.**

  The preface to this statement within the 8-page narrative directly references the Hydrogeological Report and Geophysics Assessment Report.

- **The discussion of the results of the any geotechnical drilling.**

  The discussion on the data provided within the geotechnical drilling report is a simple recitation of the data presented in the logs and discussed in Section 5.0 of the attached Hydrogeological Report as referenced in the upfront narrative.

- **The interpretations of the rock quality parameters gleaned from the core borings.**

  The discussion on the rock quality parameters simply follows geotechnical and geologic industry standards that are widely publicized; can be found in numerous publications by a simple internet search, and do not represent anything that requires certification solely by a Pennsylvania licensed professional geologist since they are widely utilized within multiple professional disciplines.

- **The determination of the distance of the wells that could be affected.**

  See SPLP's discussion on this subject in the response to Comment 2 of your February 1, 2018 letter.

  Finally, SPLP notes that similar statements to the four items noted above have appeared in HDD Reevaluation Reports that have been approved by the Department for other locations. SPLP sees no reason for the Department to depart from past practice and now require the overall Reevaluation Report for an HDD site to include a signature and seal of a Pennsylvania licensed professional geologist.

10. **The Inadvertent Return (IR) event at this site was attributed to the shallow depth of the original design profile. Why is the same entry angle being used? How is this going to prevent another IR?**

    The angle of entry for an HDD is associated with the physical and mechanical ability to elevate the drive end of an HDD rig to an elevation above ground and resulting angle to the land surface. Currently, the mechanical lift of an HDD unit on a trailer-mounted frame limits the elevation at a 17 degree angle to the land surface or below. The entry angle limitations relationship to the IR event is that it sets the angle of drilling tool entry. There is no other relationship to referenced IR event.

    As detailed in the Reevaluation Report, these HDDs were lengthened by approximately 237 ft resulting in a change of depth below ground of an additional 30 ft below the wetlands overlying the HDD profile and a 25 ft increase in depth below Piney Creek. The increase in depth into the bedrock formation is by itself a measure to prevent an IR.

11. **The plan/profile maps should be revised as follows:**

- **All geotechnical borings should be shown on these drawings, as well as their depth of penetration on the profiles**.

This revision request has been incorporated into the data provided in the revised Hydrogeological Report.

- **The private water supplies should be shown on these maps, as well as their depth of penetration on the profiles.**

  This revision request has been incorporated into the data provided in the revised Hydrogeological Report.

- **Top-of-bedrock should be shown on the profiles.**

  This revision request has been incorporated into the data provided in the revised Hydrogeological Report.

- **The plan and profile are not at the same scale. The revised plan and profile maps have profiles that do not directly match-up with the adjacent plan view. The original drawings were OK in this respect but the revised plan/profile maps should be fixed.**

  This revision request has been incorporated into the data provided in the revised Hydrogeological Report and presented HDD profiles.

- **The seismic and electrical resistivity profiles should be shown on a separate profile along with the drill path, surface features, homes and wells/springs, including the depth of private water supply wells.**

  This revision request has been incorporated into the data provided in the revised Hydrogeological Report.

12. **The appendix that Terracon refers to as an explanation of the various water level observations on its two core boring logs symbols and abbreviations is not attached to the report. The water level data from the two core borings are not referenced anywhere in the reevaluation except the boring description. Are the water level data considered in revising the dill paths?**

    The water level data recorded during the geotechnical coring is not normally considered in the design of the HDD profile. The water levels do provide information to be considered by the driller. The presence of saturated materials, water height and related hydrostatic pressure is valuable information to possess in advance of an HDD.

**13. The table labeled "Regional Geology Summary" lists all three soil boring locations (the SB borings) as occurring in the Coburn Formation. Elsewhere in the reevaluation, SB-03 is shown to occur in the Bellefonte/Axemann Formations. Please clarify.**

For clarification, Borings SB-01 and SB-02 are located in the Coburn Formation and Boring SB-03 is located in the Bellefonte/Axemann Formation as shown on Figure 2 of RETTEW's Hydrogeological Re-Evaluation Report.

**14. The table labeled "Rock Core Description Summary" mentions dip angles of fractures. Provide the direction in which these dip angles are oriented.**

These geotechnical cores are not oriented, therefore the dip direction cannot be accurately determined from the core data.

**15. Rettew states that Lower Piney Creek discharges to the Juniata River, which forms a structurally controlled regional groundwater discharge boundary in Blair and Mifflin Counties. This HDD location is nowhere near Mifflin County. Please revise or clarify this statement.**

This statement has been modified in the revised Hydrogeologic Report.

**16. Rettew states that a "non-evasive" geophysical survey was performed. What is a "non-evasive" geophysical survey? Please explain.**

". For clarification, this term has been revised to non-intrusive in the text of the revised Hydrogeologic Report.

**17. The legend of Rettew's Figure 2 lists the geologic formations in alphabetical order. Standard practice is to list them in descending stratigraphic order. Please revise.**

Figure 2 has been revised and is included in RETTEW's revised Hydrogeologic Report.

SPLP submits that we have been, and are, in complete compliance with the agreed terms and requirements of analysis 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. We therefore request that the Department approve the Reevaluation Report for the Piney Creek Horizontal Directional Drills (S2-0142) as soon as possible.

Sincerely,

Matthew Gordon
Project Director

Attachments:
1-DrilPlex Information
2-Water Testing Results
3- Annual and Formation Capacity Analysis

Attachment 1

DrilPlex; Additive Use, and Safety Data Sheet

# DRILPLEX

## DRILPLEX* Mixed Metal Oxide (MMO) is a bentonite extender and secondary shale stabilizer designed to give improved carrying capacity and suspending ability in water-base drilling fluids.

It has particular application in drilling of high-angle and horizontal wells, lost circulation zones, production reservoirs as a reservoir drill-in fluids (RDF) and for casing milling operations. It is effective over a broad range of temperatures.

### Typical Physical Properties

| | |
|---|---|
| Physical appearance | Granular, free flowing, off-white powder |
| Odor | Odorless |
| Specific gravity | 2.6 – 2.9 |
| pH | 9.5 – 10.0 (1% slurry in water) |
| Solubility (in water) | Slight |
| Bulk density | 40.51 lb/ft$^3$ (648 kg/m$^3$) |

### Applications

DRILPLEX mixed metal oxide extends the rheology of bentonite slurries by adsorbing onto the clay platelets to form a strong, stable complex that is sensitive to anionic products and some salts. It provides improvements in shale stabilization and solids tolerance.

The addition of this product structures the bentonite to produce a very flat, shear-thinning rheological profile with low plastic viscosity, high yield point and flat gel strengths.

The high viscosities achieved at lower shear rates (3 and 6 rpm) allow excellent hole cleaning capabilities and suspension properties and reduced flow through fractures. Flow at the wellbore face is low-to-zero, so mechanical washout is minimized.

The DRILPLEX bentonite complex is an excellent bridging agent and acts to prevent solids invasion when drilling into many reservoirs. The filtercake is external and easily removed.

DRILPLEX extender is not compatible with anionic materials. The use of dispersants and anionic polymers (such as CMC and PAC) will destroy the rheological advantages.

A 1:10 ratio of DRILPLEX extender to bentonite specially designed for this application is normally recommended although salinity and density affect the ratio. Typical concentrations are 0.8 to 1.2 lb/bbl (2.3 to 3.4 kg/m) of DRILPLEX extender and 8 to 12 lb/bbl (23 to 34 kg/m) of bentonite.

Higher concentrations may be needed for casing milling applications. The ratio of DRILPLEX extender to bentonite should be increased to 1:8 for reservoir drilling to ensure that an excess of polymer is present.

### Advantages

- Excellent milling fluid
- Protects reservoir from solids invasion
- Minimizes mechanical washout
- Superior hole cleaning and suspension
- Controls losses

**Limitations**

- Sensitive to dispersants and anionic polymers

**Toxicity and Handling**

Bioassay information is available upon request.

Handle as an industrial chemical, wearing protective equipment and observing the precautions as described in the Material Safety Data Sheet (MSDS).

**Packaging and Storage**

DRILPLEX extender is packaged in 25-lb (11.35-kg) multi-wall, polyester bags, impregnated with a 1.0-mm aluminum liner.

Store in a dry location away from sources of heat or ignition, and minimize dust.


MS-10413 6/04

A Schlumberger Company

P.O. Box 42842
Houston, Texas 77242-2842
www.miswaco.com
E-mail: questions@miswaco.com

SAFETY DATA SHEET
DRILPLEX*

## SECTION 1: IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY/UNDERTAKING

### 1.1. Product identifier

Product name DRILPLEX*

### 1.2. Relevant identified uses of the substance or mixture and uses advised against

Identified uses Rheology modifier

### 1.3. Details of the supplier of the safety data sheet

Supplier
M-I Australia Pty Ltd
Level 11
251 Adelaide Terrace
Perth
WA 6000
T = 08 9440 2900

Manufacturer
M-I SWACO
A Schlumberger Company
Endeavour Drive
Arnhall Business Park, Westhill
Aberdeen AB32 6UF
Scotland UK
T = +44 (0)1224-742200
F = +44 (0)1224-742288
E-mail = MBXMSDS-EH@miswaco.slb.com

### 1.4. Emergency telephone number

(24 Hour) Australia +61 2801 44558, Asia Pacific +65 3158 1074, China +86 10 5100 3039, Europe +44 (0) 1235 239 670, Middle East and Africa +44 (0) 1235 239 671, New Zealand +64 9929 1483, USA 001 281 561 1600.

## SECTION 2: HAZARDS IDENTIFICATION

### 2.1. Classification of the substance or mixture

Classification (1999/45/EEC) Not classified.

### 2.2. Label elements

Risk Phrases

NC Not classified.

Safety Phrases

NC Not classified.

### 2.3. Other hazards

Not Classified as PBT/vPvB by current EU criteria.

## SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

### 3.2. Mixtures

| ALUMINIUM OXIDE/HYDROXIDE | 30-60% |
|---|---|
| Classification (EC 1272/2008)<br>Not classified. | Classification (67/548/EEC)<br>Not classified. |

| UREA | | 10-30% |
|---|---|---|
| CAS-No.: 57-13-6 | EC No.: 200-315-5 | |
| Classification (EC 1272/2008)<br>Not classified. | Classification (67/548/EEC)<br>Not classified. | |

| MAGNESIUM OXIDE | | 10-30% |
|---|---|---|
| Classification (EC 1272/2008)<br>Not classified. | Classification (67/548/EEC)<br>Not classified. | |

| SODIUM CARBONATE | | 1-5% |
|---|---|---|
| CAS-No.: 497-19-8 | EC No.: 207-838-8 | |
| Classification (EC 1272/2008)<br>Eye Irrit. 2 - H319 | Classification (67/548/EEC)<br>Xi;R36 | |

The Full Text for all R-Phrases and Hazard Statements are Displayed in Section 16.

Composition Comments

The data shown is in accordance with the latest EC Directives.

## SECTION 4: FIRST AID MEASURES

### 4.1. Description of first aid measures

Inhalation

Move the exposed person to fresh air at once. If respiratory problems, artificial respiration/oxygen. Get medical attention if any discomfort continues.

Ingestion

Do not induce vomiting. Immediately give a couple of glasses of water or milk, provided the victim is fully conscious. Get medical attention if any discomfort continues.

Skin contact

Remove contaminated clothing immediately and wash skin with soap and water. Get medical attention promptly if symptoms occur after washing.

Eye contact

Make sure to remove any contact lenses from the eyes before rinsing. Promptly wash eyes with plenty of water while lifting the eye lids. Continue to rinse for at least 15 minutes and get medical attention.

### 4.2. Most important symptoms and effects, both acute and delayed

Inhalation.

Irritation of nose, throat and airway.

Ingestion

Nausea, vomiting.

Skin contact

Prolonged skin contact may cause redness and irritation.

Eye contact

Irritating and may cause redness and pain.

### 4.3. Indication of any immediate medical attention and special treatment needed

Get medical attention if any discomfort continues.

## SECTION 5: FIREFIGHTING MEASURES

### 5.1. Extinguishing media

Extinguishing media

Use fire-extinguishing media appropriate for surrounding materials.

5.2. Special hazards arising from the substance or mixture

Hazardous combustion products

When heated, vapours/gases hazardous to health may be formed.

Unusual Fire & Explosion Hazards

High concentrations of dust may form explosive mixture with air.

5.3. Advice for firefighters

Special Fire Fighting Procedures

Containers close to fire should be removed immediately or cooled with water.

Protective equipment for fire-fighters

Self contained breathing apparatus and full protective clothing must be worn in case of fire.

## SECTION 6: ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions, protective equipment and emergency procedures

Wear protective clothing as described in Section 8 of this safety data sheet.

6.2. Environmental precautions

Do not allow to enter drains, sewers or watercourses.

6.3. Methods and material for containment and cleaning up

Avoid generation and spreading of dust. Shovel into dry containers. Cover and move the containers. Flush the area with water. Product becomes slippery when wet.

6.4. Reference to other sections

Wear protective clothing as described in Section 8 of this safety data sheet.

## SECTION 7: HANDLING AND STORAGE

7.1. Precautions for safe handling

Avoid inhalation of dust and contact with skin and eyes. Avoid handling which leads to dust formation.

7.2. Conditions for safe storage, including any incompatibilities

Store in tightly closed original container in a dry, cool and well-ventilated place.

7.3. Specific end use(s)

The identified uses for this product are detailed in Section 1.2.

## SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control parameters

| Name | STD | TWA - 8 Hrs | | STEL - 15 Min | | Notes |
|---|---|---|---|---|---|---|
| ALUMINIUM OXIDE/HYDROXIDE | WEL | | 10 mg/m3 | | | |
| MAGNESIUM OXIDE | WEL | | 10 mg/m3 | | | as Mg |

WEL = Workplace Exposure Limit.

SODIUM CARBONATE (CAS: 497-19-8)

DNEL

| | | | |
|---|---|---|---|
| Inhalation. | Long Term | Local Effects | 10 mg/m³ |
| Inhalation. | Short Term | Local Effects | 10 mg/m³ |

UREA (CAS: 57-13-6)

DNEL

| | | | |
|---|---|---|---|
| Dermal | Short Term | Systemic Effects | 580 mg/kg |
| Inhalation. | Short Term | Systemic Effects | 292 mg/m³ |
| Dermal | Long Term | Systemic Effects | 580 mg/kg |
| Inhalation. | Long Term | Systemic Effects | 292 mg/m³ |

PNEC

Freshwater 0.047 mg/L

8.2. Exposure controls

Protective equipment

**Process conditions**

All chemical Personal Protective Equipment (PPE) should be selected based on an assessment of both the chemical hazard present and the risk of exposure to those hazards. The PPE recommendations below are based on an assessment of the chemical hazards associated with this product. Where this product is used in a mixture with other products or fluids, additional hazards may be created and as such further assessment of risk may be required. The risk of exposure and need of respiratory protection will vary from workplace to workplace and should be assessed by the user in each situation.

**Engineering measures**

Provide adequate general and local exhaust ventilation.

**Respiratory equipment**

No specific recommendation made, but respiratory protection may still be required under exceptional circumstances when excessive air contamination exists. Wear mask supplied with: Dust filter P2 (for fine dust).

**Hand protection**

Use protective gloves made of: Neoprene. or Nitrile.

**Eye protection**

Wear approved chemical safety goggles where eye exposure is reasonably probable.

**Other Protection**

Wear appropriate clothing to prevent any possibility of skin contact. Provide eyewash station.

## SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

### 9.1. Information on basic physical and chemical properties

| | |
|---|---|
| Appearance | Powder, dust |
| Colour | Off-white |
| Odour | Odourless. |
| Solubility | Slightly soluble in water. |
| Relative density | 2.6 - 2.9 sg @20°C |
| Bulk Density | 650 - 800 kg/m3 |
| pH-Value, Diluted Solution | 9.0 - 10.5 @ 1% |

### 9.2. Other information

Not relevant

## SECTION 10: STABILITY AND REACTIVITY

### 10.1. Reactivity

There are no known reactivity hazards associated with this product.

### 10.2. Chemical stability

Stable under normal temperature conditions and recommended use.

### 10.3. Possibility of hazardous reactions

Not known.

### 10.4. Conditions to avoid

Avoid wet and humid conditions.

### 10.5. Incompatible materials

**Materials To Avoid**

Not known.

### 10.6. Hazardous decomposition products

When heated, vapours/gases hazardous to health may be formed.

## SECTION 11: TOXICOLOGICAL INFORMATION

### 11.1. Information on toxicological effects

**Aspiration hazard:**

Not anticipated to present an aspiration hazard based on chemical structure.

Inhalation

Dust may irritate respiratory system or lungs.

Ingestion

May cause gastric distress, nausea and vomiting if ingested.

Skin contact

Prolonged and frequent contact may cause redness and irritation.

Eye contact

Particles in the eyes may cause irritation and smarting.

Route of entry

No route of entry noted.

Target Organs

No specific target organs noted

## SECTION 12: ECOLOGICAL INFORMATION

Ecotoxicity

Contact M-I SWACO's QHSE Department for ecological information at env@miswaco.slb.com.

### 12.1. Toxicity

Acute Fish Toxicity

Not considered toxic to fish.

### 12.2. Persistence and degradability

Degradability

There are no data on the degradability of this product.

### 12.3. Bioaccumulative potential

Bioaccumulative potential

No data available on bioaccumulation.

### 12.4. Mobility in soil

Mobility:

Slightly soluble in water.

### 12.5. Results of PBT and vPvB assessment

Not Classified as PBT/vPvB by current EU criteria.

### 12.6. Other adverse effects

None known.

## SECTION 13: DISPOSAL CONSIDERATIONS

### 13.1. Waste treatment methods

Recover and reclaim or recycle, if practical. Dispose of waste and residues in accordance with local authority requirements.

## SECTION 14: TRANSPORT INFORMATION

General — The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).

### 14.1. UN number

Not applicable.

### 14.2. UN proper shipping name

Not applicable.

### 14.3. Transport hazard class(es)

Not applicable.

### 14.4. Packing group

Not applicable.

### 14.5. Environmental hazards

Environmentally Hazardous Substance/Marine Pollutant

No.

### 14.6. Special precautions for user

Not applicable.

### 14.7. Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code

Not applicable.

## SECTION 15: REGULATORY INFORMATION

### 15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

Uk Regulatory References

Chemicals (Hazard Information & Packaging) Regulations. Control of Substances Hazardous to Health Regulations 2002 (as amended) Workplace Exposure Limits EH40.

EU Legislation

Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC, including amendments.

Water hazard classification

WGK 1

New Zealand Hazard Classification

Not Classified.

HSNO Approval No.

Not required.

### 15.2. Chemical Safety Assessment

International Chemical Inventories

Contact REACH@miswaco.slb.com for REACH information. Complies with the following national/regional chemical inventory requirements: Canada (DSL / NDSL), China (IECSC), Europe (EINECS / ELINCS), Japan (METI / ENCS), New Zealand (NZIoC), Phillipines (PICCS),

## SECTION 16: OTHER INFORMATION

Abbreviations and acronyms used in the safety data sheet

*a mark of M-I L.L.C.

General information

HMIS Health - 2 HMIS Flammability - 1 HMIS Physical Hazard - 0 E - Safety glasses, Gloves, Dust Respirator

Information Sources

Product information provided by the commercial vendor(s). Material Safety Data Sheet, Misc. manufacturers. LOLI. European Chemicals Bureau - ESIS (European Chemical Substances Information).

Revision Comments

General revision. Compiled or revised by Sandra McWilliam

| | |
|---|---|
| Issued By | Bill Cameron |
| Revision Date | 17-Apr-12 |
| Revision | 4 |
| Supersedes date | 05-May-09 |
| SDS No. | 12564 |

Risk Phrases In Full

| | |
|---|---|
| R36 | Irritating to eyes. |
| NC | Not classified. |

<u>Hazard Statements In Full</u>

| | |
|---|---|
| H319 | Causes serious eye irritation. |

Disclaimer

MSDS furnished independent of product sale. While every effort has been made to accurately describe this product, some of the data are obtained from sources beyond our direct supervision. We cannot make any assertions as to its reliability or completeness; therefore, user may rely only at user's risk. We have made no effort to censor or conceal deleterious aspects of this product. Since we cannot anticipate or control the conditions under which this information and product may be used, we make no guarantee that the precautions we have suggested will be adequate for all individuals and/or situations. It is the obligation of each user of this product to comply with the requirements of all applicable laws regarding use and disposal of this product. Additional information will be furnished upon request to assist the user; however, no warranty, either expressed or implied, nor liability of any nature with respect to this product or to the data herein is made or incurred hereunder.

# Attachment 2

# Water Quality Test Results

ESC LAB SCIENCES
YOUR LAB OF CHOICE

# ANALYTICAL REPORT

April 20, 2017

myESC
REAL TIME DATA ACCESS

## GES, Inc - Sunoco

| | |
|---|---|
| Sample Delivery Group: | L901992 |
| Samples Received: | 04/12/2017 |
| Project Number: | 0204728-06-160-XX |
| Description: | Pre-Construction Sampling |
| Site: | ME2 |
| Report To: | Holly Smoker<br>440 Creamery Way, Ste 500<br>Exton, PA  19341 |

Entire Report Reviewed By:

Mark W. Beasley
Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

# TABLE OF CONTENTS




| | |
|---|---|
| 1Cp: Cover Page | 1 |
| 2Tc: Table of Contents | 2 |
| 3Ss: Sample Summary | 3 |
| 4Cn: Case Narrative | 4 |
| 5Sr: Sample Results | 5 |
| 04112017-520-04 L901992-01 | 5 |
| 6Qc: Quality Control Summary | 7 |
| Gravimetric Analysis by Method 2540 C-2011 | 7 |
| Gravimetric Analysis by Method 2540 D-2011 | 8 |
| Wet Chemistry by Method 2130 B-2011 | 9 |
| Wet Chemistry by Method 2320 B-2011 | 10 |
| Wet Chemistry by Method 9040C | 11 |
| Wet Chemistry by Method 9050A | 12 |
| Wet Chemistry by Method 9056A | 13 |
| Metals (ICP) by Method 6010B | 15 |
| Volatile Organic Compounds (GC) by Method RSK175 | 16 |
| Volatile Organic Compounds (GC/MS) by Method 8260B | 17 |
| 7Gl: Glossary of Terms | 18 |
| 8Al: Accreditations & Locations | 19 |
| 9Sc: Chain of Custody | 20 |

| | Collected by | Collected date/time | Received date/time |
|---|---|---|---|
| 04112017-520-04 L901992-01 GW | Ryan M. Bidelspach | 04/11/17 12:20 | 04/12/17 08:45 |

| Method | Batch | Dilution | Preparation date/time | Analysis date/time | Analyst |
|---|---|---|---|---|---|
| Calculated Results | WG969965 | 1 | 04/13/17 07:47 | 04/13/17 12:16 | LTB |
| Gravimetric Analysis by Method 2540 C-2011 | WG970396 | 1 | 04/14/17 17:25 | 04/14/17 18:29 | AS |
| Gravimetric Analysis by Method 2540 D-2011 | WG970715 | 1 | 04/15/17 12:50 | 04/15/17 15:20 | AS |
| Wet Chemistry by Method 2130 B-2011 | WG969736 | 1 | 04/12/17 13:29 | 04/12/17 13:29 | MA |
| Wet Chemistry by Method 2320 B-2011 | WG969891 | 1 | 04/13/17 09:34 | 04/13/17 09:34 | AMC |
| Wet Chemistry by Method 9040C | WG969809 | 1 | 04/14/17 09:06 | 04/14/17 09:06 | MA |
| Wet Chemistry by Method 9050A | WG970006 | 1 | 04/13/17 01:29 | 04/13/17 01:29 | MZ |
| Wet Chemistry by Method 9056A | WG969853 | 1 | 04/13/17 15:18 | 04/13/17 15:18 | SAM |
| Metals (ICP) by Method 6010B | WG969965 | 1 | 04/13/17 07:47 | 04/13/17 12:16 | LTB |
| Volatile Organic Compounds (GC) by Method RSK175 | WG969641 | 1 | 04/13/17 02:44 | 04/13/17 02:44 | MJ |
| Volatile Organic Compounds (GC/MS) by Method 8260B | WG970426 | 1 | 04/14/17 02:41 | 04/14/17 02:41 | BMB |

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times. All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Mark W. Beasley
Technical Service Representative

## Calculated Results

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Hardness | 490 | | 6.62 | 1 | 04/13/2017 12:16 | WG969965 |

## Gravimetric Analysis by Method 2540 C-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Dissolved Solids | 543 | | 10.0 | 1 | 04/14/2017 18:29 | WG970396 |

## Gravimetric Analysis by Method 2540 D-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Suspended Solids | ND | | 2.50 | 1 | 04/15/2017 15:20 | WG970715 |

## Wet Chemistry by Method 2130 B-2011

| Analyte | Result NTU | Qualifier | RDL NTU | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Turbidity | 0.561 | | 0.100 | 1 | 04/12/2017 13:29 | WG969736 |

## Wet Chemistry by Method 2320 B-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Alkalinity | 347 | | 20.0 | 1 | 04/13/2017 09:34 | WG969891 |

## Wet Chemistry by Method 9040C

| Analyte | Result su | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| pH | 7.51 | T8 | 1 | 04/14/2017 09:06 | WG969809 |

**Sample Narrative:**

9040C L901992-01 WG969809: 7.51 at 19.9c

## Wet Chemistry by Method 9050A

| Analyte | Result umhos/cm | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| Specific Conductance | 966 | | 1 | 04/13/2017 01:29 | WG970006 |

## Wet Chemistry by Method 9056A

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Bromide | ND | | 1.00 | 1 | 04/13/2017 15:18 | WG969853 |
| Chloride | 73.8 | | 1.00 | 1 | 04/13/2017 15:18 | WG969853 |
| Sulfate | 33.0 | | 5.00 | 1 | 04/13/2017 15:18 | WG969853 |

## Metals (ICP) by Method 6010B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Barium | 0.0582 | | 0.00500 | 1 | 04/13/2017 12:16 | WG969965 |
| Calcium | 105 | | 1.00 | 1 | 04/13/2017 12:16 | WG969965 |
| Iron | ND | | 0.100 | 1 | 04/13/2017 12:16 | WG969965 |
| Magnesium | 55.3 | | 1.00 | 1 | 04/13/2017 12:16 | WG969965 |
| Manganese | ND | | 0.0100 | 1 | 04/13/2017 12:16 | WG969965 |
| Potassium | 3.56 | | 1.00 | 1 | 04/13/2017 12:16 | WG969965 |
| Sodium | 26.0 | | 1.00 | 1 | 04/13/2017 12:16 | WG969965 |

## Volatile Organic Compounds (GC) by Method RSK175

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Methane | ND | | 0.0100 | 1 | 04/13/2017 02:44 | WG969641 |
| Ethane | ND | | 0.0130 | 1 | 04/13/2017 02:44 | WG969641 |
| Ethene | ND | | 0.0130 | 1 | 04/13/2017 02:44 | WG969641 |
| Propane | ND | | 0.0190 | 1 | 04/13/2017 02:44 | WG969641 |

## Volatile Organic Compounds (GC/MS) by Method 8260B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Benzene | ND | | 0.00100 | 1 | 04/14/2017 02:41 | WG970426 |
| Toluene | ND | | 0.00100 | 1 | 04/14/2017 02:41 | WG970426 |
| Ethylbenzene | ND | | 0.00100 | 1 | 04/14/2017 02:41 | WG970426 |
| Total Xylenes | ND | | 0.00300 | 1 | 04/14/2017 02:41 | WG970426 |
| *(S) Toluene-d8* | *102* | | *80.0-120* | | *04/14/2017 02:41* | WG970426 |
| *(S) Dibromofluoromethane* | *97.9* | | *76.0-123* | | *04/14/2017 02:41* | WG970426 |
| *(S) a,a,a-Trifluorotoluene* | *98.6* | | *80.0-120* | | *04/14/2017 02:41* | WG970426 |
| *(S) 4-Bromofluorobenzene* | *101* | | *80.0-120* | | *04/14/2017 02:41* | WG970426 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3211292-1 04/14/17 18:29

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Dissolved Solids | U | | 2.82 | 10.0 |

## L901777-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901777-01 04/14/17 18:29 • (DUP) R3211292-4 04/14/17 18:29

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Dissolved Solids | 1100 | 1100 | 1 | 0.364 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3211292-2 04/14/17 18:29 • (LCSD) R3211292-3 04/14/17 18:29

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Dissolved Solids | 8800 | 8520 | 8520 | 96.8 | 96.8 | 85.0-115 | | | 0.000 | 5 |

## Method Blank (MB)

(MB) R3211542-1 04/15/17 15:20

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Suspended Solids | U | | 0.350 | 2.50 |

## L901975-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901975-01 04/15/17 15:20 • (DUP) R3211542-4 04/15/17 15:20

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 1030 | 1020 | 1 | 1.30 | | 5 |

## L901987-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901987-01 04/15/17 15:20 • (DUP) R3211542-5 04/15/17 15:20

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 113 | 114 | 1 | 0.885 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3211542-2 04/15/17 15:20 • (LCSD) R3211542-3 04/15/17 15:20

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Suspended Solids | 773 | 892 | 876 | 115 | 113 | 85.0-115 | | | 1.81 | 5 |

## Method Blank (MB)

(MB) WG969736-1 04/12/17 13:29

| | MB Result | MB Qualifier | MB MDL | MB RDL |
|---|---|---|---|---|
| Analyte | NTU | | NTU | NTU |
| Turbidity | 0.0890 | J | 0.0310 | 0.100 |

## L901961-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901961-01 04/12/17 13:29 • (DUP) WG969736-4 04/12/17 13:29

| | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| Analyte | NTU | NTU | | % | | % |
| Turbidity | 1.66 | 1.67 | 1 | 0.601 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG969736-2 04/12/17 13:29 • (LCSD) WG969736-3 04/12/17 13:29

| | Spike Amount | LCS Result | LCSD Result | LCS Rec. | LCSD Rec. | Rec. Limits | LCS Qualifier | LCSD Qualifier | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | NTU | NTU | NTU | % | % | % | | | % | % |
| Turbidity | 40.0 | 40.0 | 40.0 | 100 | 100 | 90.0-110 | | | 0.000 | 20 |

## Method Blank (MB)

(MB) R3210498-1 04/13/17 07:55

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Alkalinity | 2.71 | J | 2.71 | 20.0 |

## L901987-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901987-01 04/13/17 08:07 • (DUP) R3210498-3 04/13/17 08:15

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Alkalinity | 196 | 202 | 1 | 3.00 | | 20 |

## L902263-01 Original Sample (OS) • Duplicate (DUP)

(OS) L902263-01 04/13/17 10:26 • (DUP) R3210498-5 04/13/17 10:33

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Alkalinity | 254 | 258 | 1 | 2.00 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3210498-4 04/13/17 08:59 • (LCSD) R3210498-6 04/13/17 10:39

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity | 100 | 98.9 | 102 | 99.0 | 102 | 85.0-115 | | | 3.00 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Cp Tc Ss Cn Sr Qc Gl Al Sc

## L901700-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901700-01 04/14/17 09:06 • (DUP) WG969809-3 04/14/17 09:06

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 7.73 | 7.74 | 1 | 0.129 | T8 | 1 |

## L901993-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901993-01 04/14/17 09:06 • (DUP) WG969809-4 04/14/17 09:06

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 7.75 | 7.73 | 1 | 0.258 | T8 | 1 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG969809-1 04/14/17 09:06 • (LCSD) WG969809-2 04/14/17 09:06

| Analyte | Spike Amount su | LCS Result su | LCSD Result su | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | 7.50 | 7.45 | 7.48 | 99.3 | 99.7 | 98.7-101 | | | 0.402 | 1 |

## Method Blank (MB)

(MB) WG970006-1 04/13/17 01:29

| Analyte | MB Result umhos/cm | MB Qualifier | MB MDL umhos/cm | MB RDL umhos/cm |
|---|---|---|---|---|
| Specific Conductance | 1.59 | J | | |

## L901992-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901992-01 04/13/17 01:29 • (DUP) WG970006-4 04/13/17 01:29

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 966 | 966 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG970006-2 04/13/17 01:29 • (LCSD) WG970006-3 04/13/17 01:29

| Analyte | Spike Amount umhos/cm | LCS Result umhos/cm | LCSD Result umhos/cm | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Specific Conductance | 169 | 165 | 165 | 97.6 | 97.6 | 90.0-110 | | | 0.000 | 20 |

Cp Tc Ss Cn Sr Qc Gl Al Sc

## Method Blank (MB)

(MB) R3210785-2 04/13/17 09:34

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Bromide | U | | 0.079 | 1.00 |
| Chloride | 0.264 | J | 0.0519 | 1.00 |
| Sulfate | U | | 0.0774 | 5.00 |

## L901882-05 Original Sample (OS) • Duplicate (DUP)

(OS) L901882-05 04/13/17 13:57 • (DUP) R3210785-7 04/13/17 14:07

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | ND | 0.000 | 1 | 0 | | 15 |
| Chloride | 6.37 | 6.58 | 1 | 3 | | 15 |
| Sulfate | ND | 3.64 | 1 | 23 | J P1 | 15 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3210785-3 04/13/17 09:44 • (LCSD) R3210785-4 04/13/17 09:54

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 40.0 | 41.2 | 41.2 | 103 | 103 | 80-120 | | | 0 | 15 |
| Chloride | 40.0 | 39.9 | 40.0 | 100 | 100 | 80-120 | | | 0 | 15 |
| Sulfate | 40.0 | 40.8 | 40.9 | 102 | 102 | 80-120 | | | 0 | 15 |

## L901882-01 Original Sample (OS) • Matrix Spike (MS)

(OS) L901882-01 04/13/17 13:06 • (MS) R3210785-6 04/13/17 13:16

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MS Rec. % | Dilution | Rec. Limits % | MS Qualifier |
|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | ND | 47.7 | 95 | 1 | 80-120 | |
| Chloride | 50.0 | 10.4 | 62.9 | 105 | 1 | 80-120 | |
| Sulfate | 50.0 | ND | 52.2 | 102 | 1 | 80-120 | |

## L902037-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L902037-01 04/13/17 15:49 • (MS) R3210785-8 04/13/17 15:59 • (MSD) R3210785-9 04/13/17 16:29

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | ND | 52.4 | 48.9 | 105 | 98 | 1 | 80-120 | | | 7 | 15 |
| Chloride | 50.0 | 5.09 | 54.7 | 54.3 | 99 | 99 | 1 | 80-120 | | | 1 | 15 |

## L902037-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L902037-01 04/13/17 15:49 • (MS) R3210785-8 04/13/17 15:59 • (MSD) R3210785-9 04/13/17 16:29

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sulfate | 50.0 | ND | 55.7 | 55.6 | 104 | 104 | 1 | 80-120 | | | 0 | 15 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3210553-1 04/13/17 11:42

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Barium | U | | 0.0017 | 0.00500 |
| Calcium | U | | 0.0463 | 1.00 |
| Iron | U | | 0.0141 | 0.100 |
| Magnesium | U | | 0.0111 | 1.00 |
| Manganese | U | | 0.0012 | 0.0100 |
| Potassium | U | | 0.102 | 1.00 |
| Sodium | U | | 0.0985 | 1.00 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3210553-2 04/13/17 11:44 • (LCSD) R3210553-3 04/13/17 11:47

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 1.06 | 1.05 | 106 | 105 | 80-120 | | | 1 | 20 |
| Calcium | 10.0 | 9.88 | 9.74 | 99 | 97 | 80-120 | | | 1 | 20 |
| Iron | 10.0 | 10.1 | 10.0 | 101 | 100 | 80-120 | | | 1 | 20 |
| Magnesium | 10.0 | 10.0 | 9.88 | 100 | 99 | 80-120 | | | 1 | 20 |
| Manganese | 1.00 | 1.02 | 1.01 | 102 | 101 | 80-120 | | | 1 | 20 |
| Potassium | 10.0 | 9.81 | 9.73 | 98 | 97 | 80-120 | | | 1 | 20 |
| Sodium | 10.0 | 10.1 | 10.0 | 101 | 100 | 80-120 | | | 1 | 20 |

## L902038-02 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L902038-02 04/13/17 11:50 • (MS) R3210553-5 04/13/17 11:55 • (MSD) R3210553-6 04/13/17 11:57

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 0.0700 | 1.12 | 1.12 | 105 | 105 | 1 | 75-125 | | | 0 | 20 |
| Calcium | 10.0 | 92.1 | 101 | 101 | 90 | 88 | 1 | 75-125 | | | 0 | 20 |
| Iron | 10.0 | 1.01 | 11.1 | 11.1 | 101 | 101 | 1 | 75-125 | | | 0 | 20 |
| Magnesium | 10.0 | 17.6 | 27.3 | 27.2 | 98 | 96 | 1 | 75-125 | | | 0 | 20 |
| Manganese | 1.00 | 2.35 | 3.28 | 3.26 | 93 | 91 | 1 | 75-125 | | | 1 | 20 |
| Potassium | 10.0 | 3.55 | 13.5 | 13.5 | 99 | 100 | 1 | 75-125 | | | 0 | 20 |
| Sodium | 10.0 | 56.5 | 65.5 | 65.6 | 90 | 91 | 1 | 75-125 | | | 0 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3210496-1 04/12/17 23:07

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Methane | U | | 0.00291 | 0.0100 |
| Ethane | U | | 0.00407 | 0.0130 |
| Ethene | U | | 0.00426 | 0.0130 |
| Propane | U | | 0.00548 | 0.0190 |

## L901416-03 Original Sample (OS) • Duplicate (DUP)

(OS) L901416-03 04/12/17 23:24 • (DUP) R3210496-2 04/13/17 02:27

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | 2.46 | 2.50 | 10 | 1.67 | | 20 |
| Ethane | U | 0.000 | 10 | 0.000 | | 20 |
| Ethene | U | 0.000 | 10 | 0.000 | | 20 |
| Propane | U | 0.000 | 10 | 0.000 | | 20 |

## L901992-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901992-01 04/13/17 02:44 • (DUP) R3210496-3 04/13/17 05:31

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3210496-4 04/13/17 05:48 • (LCSD) R3210496-5 04/13/17 06:04

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Methane | 0.0678 | 0.0635 | 0.0640 | 93.6 | 94.5 | 85.0-115 | | | 0.870 | 20 |
| Ethane | 0.129 | 0.111 | 0.113 | 86.0 | 87.2 | 85.0-115 | | | 1.41 | 20 |
| Ethene | 0.127 | 0.109 | 0.110 | 86.1 | 86.8 | 85.0-115 | | | 0.840 | 20 |
| Propane | 0.186 | 0.158 | 0.160 | 85.0 | 86.2 | 85.0-115 | | | 1.39 | 20 |

## Method Blank (MB)

(MB) R3211952-3 04/13/17 21:25

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Benzene | U | | 0.000331 | 0.00100 |
| Ethylbenzene | U | | 0.000384 | 0.00100 |
| Toluene | U | | 0.000412 | 0.00100 |
| Xylenes, Total | U | | 0.00106 | 0.00300 |
| *(S) Toluene-d8* | *102* | | | *80.0-120* |
| *(S) Dibromofluoromethane* | *99.3* | | | *76.0-123* |
| *(S) a,a,a-Trifluorotoluene* | *99.8* | | | *80.0-120* |
| *(S) 4-Bromofluorobenzene* | *101* | | | *80.0-120* |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3211952-1 04/13/17 20:06 • (LCSD) R3211952-2 04/13/17 20:22

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Benzene | 0.0250 | 0.0247 | 0.0230 | 98.8 | 92.1 | 69.0-123 | | | 6.99 | 20 |
| Ethylbenzene | 0.0250 | 0.0255 | 0.0240 | 102 | 95.9 | 77.0-120 | | | 6.03 | 20 |
| Toluene | 0.0250 | 0.0248 | 0.0232 | 99.3 | 92.6 | 77.0-120 | | | 6.94 | 20 |
| Xylenes, Total | 0.0750 | 0.0781 | 0.0742 | 104 | 98.9 | 77.0-120 | | | 5.12 | 20 |
| *(S) Toluene-d8* | | | | *102* | *102* | *80.0-120* | | | | |
| *(S) Dibromofluoromethane* | | | | *97.5* | *97.4* | *76.0-123* | | | | |
| *(S) a,a,a-Trifluorotoluene* | | | | *99.6* | *99.8* | *80.0-120* | | | | |
| *(S) 4-Bromofluorobenzene* | | | | *102* | *103* | *80.0-120* | | | | |

## Abbreviations and Definitions

| | |
|---|---|
| SDG | Sample Delivery Group. |
| MDL | Method Detection Limit. |
| RDL | Reported Detection Limit. |
| ND | Not detected at the Reporting Limit (or MDL where applicable). |
| U | Not detected at the Reporting Limit (or MDL where applicable). |
| RPD | Relative Percent Difference. |
| Original Sample | The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG. |
| (S) | Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media. |
| Rec. | Recovery. |

| Qualifier | Description |
|---|---|
| J | The identification of the analyte is acceptable; the reported value is an estimate. |
| P1 | RPD value not applicable for sample concentrations less than 5 times the reporting limit. |
| T8 | Sample(s) received past/too close to holding time expiration. |

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE.**
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

## State Accreditations

| | | | |
|---|---|---|---|
| Alabama | 40660 | Nevada | TN-03-2002-34 |
| Alaska | UST-080 | New Hampshire | 2975 |
| Arizona | AZ0612 | New Jersey–NELAP | TN002 |
| Arkansas | 88-0469 | New Mexico | TN00003 |
| California | 01157CA | New York | 11742 |
| Colorado | TN00003 | North Carolina | Env375 |
| Conneticut | PH-0197 | North Carolina [1] | DW21704 |
| Florida | E87487 | North Carolina [2] | 41 |
| Georgia | NELAP | North Dakota | R-140 |
| Georgia [1] | 923 | Ohio–VAP | CL0069 |
| Idaho | TN00003 | Oklahoma | 9915 |
| Illinois | 200008 | Oregon | TN200002 |
| Indiana | C-TN-01 | Pennsylvania | 68-02979 |
| Iowa | 364 | Rhode Island | 221 |
| Kansas | E-10277 | South Carolina | 84004 |
| Kentucky [1] | 90010 | South Dakota | n/a |
| Kentucky [2] | 16 | Tennessee [1,4] | 2006 |
| Louisiana | AI30792 | Texas | T 104704245-07-TX |
| Maine | TN0002 | Texas [5] | LAB0152 |
| Maryland | 324 | Utah | 6157585858 |
| Massachusetts | M-TN003 | Vermont | VT2006 |
| Michigan | 9958 | Virginia | 109 |
| Minnesota | 047-999-395 | Washington | C1915 |
| Mississippi | TN00003 | West Virginia | 233 |
| Missouri | 340 | Wisconsin | 9980939910 |
| Montana | CERT0086 | Wyoming | A2LA |
| Nebraska | NE-OS-15-05 | | |

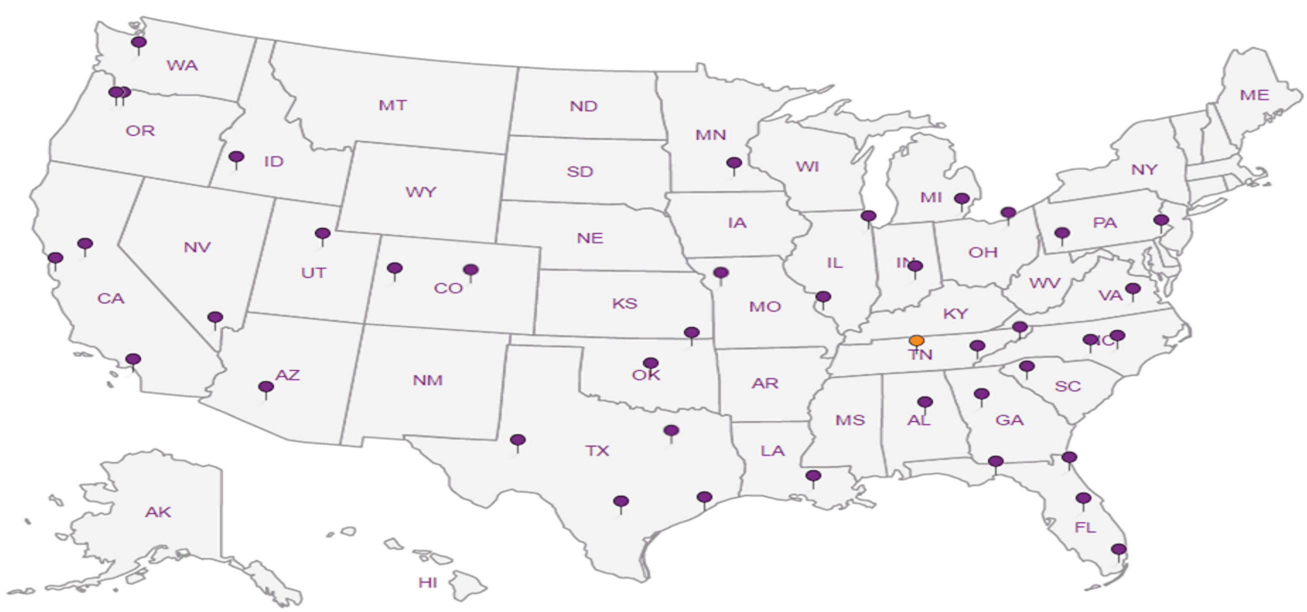
## Third Party & Federal Accreditations

| | | | |
|---|---|---|---|
| A2LA – ISO 17025 | 1461.01 | AIHA-LAP,LLC | 100789 |
| A2LA – ISO 17025 [5] | 1461.02 | DOD | 1461.01 |
| Canada | 1461.01 | USDA | S-67674 |
| EPA–Crypto | TN00003 | | |

1. Drinking Water 2. Underground Storage Tanks 3. Aquatic Toxicity 4. Chemical/Microbiological 5. Mold n/a Accreditation not applicable

## Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**



| Company Name/Address: | Billing Information: |
|---|---|
| GES, Inc - Sunoco<br>440 Creamery Way, Suite 500<br>Exton, PA 19341 | Accounts Payable<br>440 Creamery Way, Suite 500<br>Exton, PA 19341 |
| Report to: Holly Smoker | Email To: hsmoker@gesonline.com |

Analysis / Container / Preservative

Chain of Custody Page 1 of 1

ESC LAB SCIENCES

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L# 190996

J060

Acctnum: SUNGES
Template: T114657
Prelogin: P564159
TSR: Mark Beasley
Cooler:
Shipped Via: Fed Ex

Project Description: Pre-Construction Sampling

City/State Collected: Williamsburg, PA

Phone: 610-458-1077
Fax: NA

Client Project #: NA

Lab Project #: SUNGES-GRILLO

Collected by (print): Ryan M. Biddle[illegible]

Site/Facility ID #: ME2

P.O. #: NA

Collected by (signature):

Immediately Packed on Ice N ___ Y ✓

Rush? (Lab MUST Be Notified)
___ Same Day .......... 200%
___ Next Day .......... 100%
___ Two Day .......... 50%
___ Three Day .......... 25%

Date Results Needed: Standard

Email? ___ No ✓ Yes
FAX? ___ No ___ Yes

| Sample ID | Comp/Grab | Matrix * | Depth | Date | Time | No. of Cntrs | **pH,SPCON,TDS,TURB* 250mlHDPE-NoPres | ALK, Br, Cl, SO4 250mlHDPE-NoPres | Total Metals, Hardness 250mlHDPE-HNO3 <2 | RSK175 + Propane 40mlAmb-HCl | TSS 1L-HDPE NoPres | V8260BTEX 40mlAmb-HCl | | | | Rem./Contaminant | Sample # (lab only) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 04112017-520-04 | Grab | DW | – | 4/11/17 | 1220 | 8 | X | X | X | X | X | X | | | | | -01 |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |

* Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other ________

pH ________ Temp ________

Flow ________ Other ________

Remarks: Metals = Ba,Ca,Fe,K,Mg,Mn,Na. Project #: 0204728 -06-160-xx Org 1402

Hold #

| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Samples returned via: ☐ UPS ☑ FedEx ☐ Courier ☐ ____ | Condition: (lab use only) |
|---|---|---|---|---|---|
| [signature] | 4/11/17 | 1600 | Fed Ex 4/11/17 1600 | | ok TD TO11 |
| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Temp: N7 °C 2.3 Bottles Received: 8 | COC Seal Intact: ✓ Y ___ N ___ NA |
| Relinquished by: (Signature) | Date: | Time: | Received for lab by: (Signature) [signature] | Date: 4-12-17 Time: 845 | pH Checked: <2 NCF: |

# ESC LAB SCIENCES
## Cooler Receipt Form

| | | | |
|---|---|---|---|
| Client: SUNGES | | SDG# | L901992 |
| Cooler Received/Opened On: 4/ 12 /17 | | Temperature: | 2.3 |
| Received By: Rickey Mosley | | | |
| Signature: | | | |

| Receipt Check List | NP | Yes | No |
|---|---|---|---|
| COC Seal Present / Intact? | | ✓ | |
| COC Signed / Accurate? | | ✓ | |
| Bottles arrive intact? | | ✓ | |
| Correct bottles used? | | ✓ | |
| Sufficient volume sent? | | ✓ | |
| If Applicable | | | |
| VOA Zero headspace? | | ✓ | |
| Preservation Correct / Checked? | | ✓ | |

# ANALYTICAL REPORT

July 27, 2017

## GES, Inc - Sunoco

| | |
|---|---|
| Sample Delivery Group: | L924733 |
| Samples Received: | 07/26/2017 |
| Project Number: | 0204728-06-160-XX |
| Description: | Pre-Construction Sampling |
| Site: | ME2 |
| Report To: | Holly Smoker<br>440 Creamery Way, Ste 500<br>Exton, PA 19341 |

Entire Report Reviewed By:

Mark W. Beasley
Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

# TABLE OF CONTENTS

| | |
|---|---|
| Cp: Cover Page | 1 |
| Tc: Table of Contents | 2 |
| Ss: Sample Summary | 3 |
| Cn: Case Narrative | 4 |
| Sr: Sample Results | 5 |
| 07252017-604-02 L924733-01 | 5 |
| Qc: Quality Control Summary | 7 |
| Gravimetric Analysis by Method 2540 C-2011 | 7 |
| Gravimetric Analysis by Method 2540 D-2011 | 8 |
| Wet Chemistry by Method 130.1 | 9 |
| Wet Chemistry by Method 2130 B-2011 | 10 |
| Wet Chemistry by Method 2320 B-2011 | 11 |
| Wet Chemistry by Method 9040C | 12 |
| Wet Chemistry by Method 9050A | 13 |
| Wet Chemistry by Method 9056A | 14 |
| Metals (ICP) by Method 6010B | 16 |
| Volatile Organic Compounds (GC) by Method RSK175 | 18 |
| Volatile Organic Compounds (GC/MS) by Method 8260B | 19 |
| Gl: Glossary of Terms | 20 |
| Al: Accreditations & Locations | 21 |
| Sc: Chain of Custody | 22 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## 07252017-604-02 L924733-01 GW

| Collected by | Collected date/time | Received date/time |
|---|---|---|
| Jacob Gonzalez | 07/25/17 10:15 | 07/26/17 08:45 |

| Method | Batch | Dilution | Preparation date/time | Analysis date/time | Analyst |
|---|---|---|---|---|---|
| Gravimetric Analysis by Method 2540 C-2011 | WG1002916 | 1 | 07/26/17 17:23 | 07/26/17 17:33 | EG |
| Gravimetric Analysis by Method 2540 D-2011 | WG1002914 | 1 | 07/26/17 17:46 | 07/26/17 17:58 | EG |
| Wet Chemistry by Method 130.1 | WG1003102 | 5 | 07/27/17 01:24 | 07/27/17 01:24 | ASK |
| Wet Chemistry by Method 2130 B-2011 | WG1002804 | 1 | 07/26/17 15:07 | 07/26/17 15:07 | GB |
| Wet Chemistry by Method 2320 B-2011 | WG1003123 | 1 | 07/27/17 08:10 | 07/27/17 08:10 | MCG |
| Wet Chemistry by Method 9040C | WG1002801 | 1 | 07/26/17 12:51 | 07/26/17 12:51 | TH |
| Wet Chemistry by Method 9050A | WG1002791 | 1 | 07/26/17 15:20 | 07/26/17 15:20 | MAJ |
| Wet Chemistry by Method 9056A | WG1002604 | 1 | 07/26/17 18:07 | 07/26/17 18:07 | SAM |
| Metals (ICP) by Method 6010B | WG1002920 | 1 | 07/26/17 17:45 | 07/27/17 12:07 | CCE |
| Metals (ICP) by Method 6010B | WG1002920 | 1 | 07/26/17 17:45 | 07/27/17 16:45 | CCE |
| Volatile Organic Compounds (GC) by Method RSK175 | WG1002460 | 1 | 07/26/17 13:23 | 07/26/17 13:23 | AMC |
| Volatile Organic Compounds (GC/MS) by Method 8260B | WG1002773 | 1 | 07/26/17 13:34 | 07/26/17 13:34 | BMB |

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times. All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Mark W. Beasley
Technical Service Representative

## Gravimetric Analysis by Method 2540 C-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Dissolved Solids | 478 | | 10.0 | 1 | 07/26/2017 17:33 | WG1002916 |

## Gravimetric Analysis by Method 2540 D-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Suspended Solids | 7.90 | | 2.50 | 1 | 07/26/2017 17:58 | WG1002914 |

## Wet Chemistry by Method 130.1

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 468 | | 150 | 5 | 07/27/2017 01:24 | WG1003102 |

## Wet Chemistry by Method 2130 B-2011

| Analyte | Result NTU | Qualifier | RDL NTU | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Turbidity | 1.26 | | 0.100 | 1 | 07/26/2017 15:07 | WG1002804 |

## Wet Chemistry by Method 2320 B-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Alkalinity | 381 | | 20.0 | 1 | 07/27/2017 08:10 | WG1003123 |

## Wet Chemistry by Method 9040C

| Analyte | Result su | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| pH | 7.02 | T8 | 1 | 07/26/2017 12:51 | WG1002801 |

**Sample Narrative:**

L924733-01 WG1002801: 7.02 at 15.2c

## Wet Chemistry by Method 9050A

| Analyte | Result umhos/cm | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| Specific Conductance | 863 | | 1 | 07/26/2017 15:20 | WG1002791 |

## Wet Chemistry by Method 9056A

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Bromide | ND | | 1.00 | 1 | 07/26/2017 18:07 | WG1002604 |
| Chloride | 28.8 | | 1.00 | 1 | 07/26/2017 18:07 | WG1002604 |
| Sulfate | 26.5 | | 5.00 | 1 | 07/26/2017 18:07 | WG1002604 |

## Metals (ICP) by Method 6010B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Barium | 0.0375 | | 0.00500 | 1 | 07/27/2017 12:07 | WG1002920 |
| Calcium | 89.4 | | 1.00 | 1 | 07/27/2017 12:07 | WG1002920 |
| Iron | 0.233 | | 0.100 | 1 | 07/27/2017 12:07 | WG1002920 |
| Magnesium | 50.5 | | 1.00 | 1 | 07/27/2017 12:07 | WG1002920 |
| Manganese | ND | | 0.0100 | 1 | 07/27/2017 12:07 | WG1002920 |
| Potassium | 3.09 | | 1.00 | 1 | 07/27/2017 16:45 | WG1002920 |
| Sodium | 14.7 | | 1.00 | 1 | 07/27/2017 16:45 | WG1002920 |

## Volatile Organic Compounds (GC) by Method RSK175

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Methane | ND | | 0.0100 | 1 | 07/26/2017 13:23 | WG1002460 |
| Ethane | ND | | 0.0130 | 1 | 07/26/2017 13:23 | WG1002460 |
| Ethene | ND | | 0.0130 | 1 | 07/26/2017 13:23 | WG1002460 |
| Propane | ND | | 0.0190 | 1 | 07/26/2017 13:23 | WG1002460 |

## Volatile Organic Compounds (GC/MS) by Method 8260B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Benzene | ND | | 0.00100 | 1 | 07/26/2017 13:34 | WG1002773 |
| Toluene | ND | | 0.00100 | 1 | 07/26/2017 13:34 | WG1002773 |
| Ethylbenzene | ND | | 0.00100 | 1 | 07/26/2017 13:34 | WG1002773 |
| Total Xylenes | ND | | 0.00300 | 1 | 07/26/2017 13:34 | WG1002773 |
| *(S) Toluene-d8* | *101* | | *80.0-120* | | *07/26/2017 13:34* | WG1002773 |
| *(S) Dibromofluoromethane* | *79.9* | | *76.0-123* | | *07/26/2017 13:34* | WG1002773 |
| *(S) a,a,a-Trifluorotoluene* | *103* | | *80.0-120* | | *07/26/2017 13:34* | WG1002773 |
| *(S) 4-Bromofluorobenzene* | *87.1* | | *80.0-120* | | *07/26/2017 13:34* | WG1002773 |

## Method Blank (MB)

(MB) R3236737-1 07/26/17 17:33

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Dissolved Solids | U | | 2.82 | 10.0 |

## L924733-01 Original Sample (OS) • Duplicate (DUP)

(OS) L924733-01 07/26/17 17:33 • (DUP) R3236737-4 07/26/17 17:33

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Dissolved Solids | 478 | 478 | 1 | 0.000 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3236737-2 07/26/17 17:33 • (LCSD) R3236737-3 07/26/17 17:33

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Dissolved Solids | 8800 | 8560 | 8680 | 97.3 | 98.6 | 85.0-115 | | | 1.39 | 5 |

## Method Blank (MB)

(MB) R3236591-1 07/26/17 17:58

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Suspended Solids | U | | 0.350 | 2.50 |

## L924799-01 Original Sample (OS) • Duplicate (DUP)

(OS) L924799-01 07/26/17 17:58 • (DUP) R3236591-4 07/26/17 17:58

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 8300 | 8500 | 1 | 2.38 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3236591-2 07/26/17 17:58 • (LCSD) R3236591-3 07/26/17 17:58

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Suspended Solids | 773 | 800 | 788 | 103 | 102 | 85.0-115 | | | 1.51 | 5 |

## Method Blank (MB)

(MB) R3236507-1 07/27/17 00:44

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 4.83 | J | 1.43 | 30.0 |

## L924183-01 Original Sample (OS) • Duplicate (DUP)

(OS) L924183-01 07/27/17 01:08 • (DUP) R3236507-7 07/27/17 01:09

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 56.5 | 53.4 | 1 | 6 | | 20 |

## L922983-03 Original Sample (OS) • Duplicate (DUP)

(OS) L922983-03 07/27/17 00:49 • (DUP) R3236507-4 07/27/17 00:50

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 34.0 | 29.3 | 1 | 15 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3236507-2 07/27/17 00:45 • (LCSD) R3236507-3 07/27/17 00:46

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 153 | 153 | 102 | 102 | 85-115 | | | 0 | 20 |

## L922986-03 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L922986-03 07/27/17 00:50 • (MS) R3236507-5 07/27/17 00:51 • (MSD) R3236507-6 07/27/17 00:52

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 35.3 | 180 | 179 | 96 | 96 | 1 | 80-120 | | | 1 | 20 |

## Method Blank (MB)

(MB) WG1002804-1 07/26/17 15:07

| Analyte | MB Result NTU | MB Qualifier | MB MDL NTU | MB RDL NTU |
|---|---|---|---|---|
| Turbidity | 0.0900 | J | 0.0310 | 0.100 |

## L924827-03 Original Sample (OS) • Duplicate (DUP)

(OS) L924827-03 07/26/17 15:07 • (DUP) WG1002804-4 07/26/17 15:07

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 0.165 | 0.166 | 1 | 0.604 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG1002804-2 07/26/17 15:07 • (LCSD) WG1002804-3 07/26/17 15:07

| Analyte | Spike Amount NTU | LCS Result NTU | LCSD Result NTU | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Turbidity | 40.0 | 39.8 | 39.8 | 99.5 | 99.5 | 90.0-110 | | | 0.000 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3236617-1 07/27/17 08:01

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Alkalinity | 3.08 | J | 2.71 | 20.0 |

## L924034-09 Original Sample (OS) • Duplicate (DUP)

(OS) L924034-09 07/27/17 11:13 • (DUP) R3236617-5 07/27/17 11:21

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Alkalinity | 170 | 170 | 1 | 0.000 | | 20 |

## L923870-03 Original Sample (OS) • Duplicate (DUP)

(OS) L923870-03 07/27/17 08:32 • (DUP) R3236617-2 07/27/17 08:40

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Alkalinity | 4.92 | 0.000 | 1 | 200 | P1 | 20 |

**Sample Narrative:**

OS: ending pH = 4.5

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3236617-3 07/27/17 09:20 • (LCSD) R3236617-4 07/27/17 10:53

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity | 100 | 99.7 | 109 | 100 | 109 | 85.0-115 | | | 9.00 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## L919296-02 Original Sample (OS) • Duplicate (DUP)

(OS) L919296-02 07/26/17 12:51 • (DUP) WG1002801-3 07/26/17 12:51

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 6.56 | 6.58 | 1 | 0.304 | T8 | 1 |

Sample Narrative:

OS: 6.56 at 21.4c

DUP: 6.58 at 21.4c

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG1002801-1 07/26/17 12:51 • (LCSD) WG1002801-2 07/26/17 12:51

| Analyte | Spike Amount su | LCS Result su | LCSD Result su | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | 6.38 | 6.38 | 6.37 | 100 | 99.8 | 98.4-102 | | | 0.157 | 1 |

Sample Narrative:

LCS: 6.38 at 20.1c

LCSD: 6.37 at 20.1c

## Method Blank (MB)

(MB) WG1002791-10 07/26/17 15:20

| Analyte | MB Result umhos/cm | MB Qualifier | MB MDL umhos/cm | MB RDL umhos/cm |
|---|---|---|---|---|
| Specific Conductance | 1.69 | | | |

## L924572-01 Original Sample (OS) • Duplicate (DUP)

(OS) L924572-01 07/26/17 15:20 • (DUP) WG1002791-6 07/26/17 15:20

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 2730 | 2730 | 1 | 0.367 | | 20 |

## L924904-01 Original Sample (OS) • Duplicate (DUP)

(OS) L924904-01 07/26/17 15:20 • (DUP) WG1002791-9 07/26/17 15:20

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 59.9 | 59.5 | 1 | 0.670 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG1002791-7 07/26/17 15:20 • (LCSD) WG1002791-8 07/26/17 15:20

| Analyte | Spike Amount umhos/cm | LCS Result umhos/cm | LCSD Result umhos/cm | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Specific Conductance | 1070 | 1070 | 1070 | 99.1 | 100 | 90.0-110 | | | 0.939 | 20 |

## Method Blank (MB)

(MB) R3236559-1 07/26/17 04:29

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Bromide | U | | 0.079 | 1.00 |
| Chloride | U | | 0.0519 | 1.00 |
| Sulfate | U | | 0.0774 | 5.00 |

## L924672-05 Original Sample (OS) • Duplicate (DUP)

(OS) L924672-05 07/26/17 17:07 • (DUP) R3236559-4 07/26/17 17:22

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | ND | 0.000 | 1 | 0 | | 15 |
| Chloride | 5.75 | 5.75 | 1 | 0 | | 15 |
| Sulfate | 18.8 | 18.9 | 1 | 1 | | 15 |

## L924770-05 Original Sample (OS) • Duplicate (DUP)

(OS) L924770-05 07/26/17 19:21 • (DUP) R3236559-6 07/26/17 19:36

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | ND | 0.000 | 1 | 0 | | 15 |
| Chloride | 2.09 | 2.09 | 1 | 0 | | 15 |
| Sulfate | 15.7 | 15.6 | 1 | 0 | | 15 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3236559-2 07/26/17 04:44 • (LCSD) R3236559-3 07/26/17 04:59

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 40.0 | 40.0 | 40.0 | 100 | 100 | 80-120 | | | 0 | 15 |
| Chloride | 40.0 | 40.0 | 39.9 | 100 | 100 | 80-120 | | | 0 | 15 |
| Sulfate | 40.0 | 40.0 | 40.0 | 100 | 100 | 80-120 | | | 0 | 15 |

## L924770-04 Original Sample (OS) • Matrix Spike (MS)

(OS) L924770-04 07/26/17 18:21 • (MS) R3236559-5 07/26/17 19:06

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MS Rec. % | Dilution | Rec. Limits % | MS Qualifier |
|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | ND | 50.0 | 100 | 1 | 80-120 | |
| Chloride | 50.0 | 1.66 | 53.2 | 103 | 1 | 80-120 | |

## L924770-04 Original Sample (OS) • Matrix Spike (MS)

(OS) L924770-04 07/26/17 18:21 • (MS) R3236559-5 07/26/17 19:06

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MS Rec. % | Dilution | Rec. Limits % | MS Qualifier |
|---|---|---|---|---|---|---|---|
| Sulfate | 50.0 | ND | 55.0 | 103 | 1 | 80-120 | |

## L924775-06 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L924775-06 07/26/17 22:50 • (MS) R3236559-7 07/26/17 23:20 • (MSD) R3236559-8 07/26/17 23:35

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | 1.20 | 49.1 | 49.4 | 96 | 96 | 1 | 80-120 | | | 1 | 15 |
| Sulfate | 50.0 | 43.2 | 91.5 | 91.5 | 97 | 97 | 1 | 80-120 | | | 0 | 15 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3236717-1 07/27/17 11:03

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Barium | U | | 0.0017 | 0.00500 |
| Calcium | U | | 0.0463 | 1.00 |
| Iron | U | | 0.0141 | 0.100 |
| Magnesium | 0.031 | J | 0.0111 | 1.00 |
| Manganese | U | | 0.0012 | 0.0100 |

## Method Blank (MB)

(MB) R3236717-7 07/27/17 16:23

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Potassium | 0.302 | J | 0.102 | 1.00 |
| Sodium | 0.474 | J | 0.0985 | 1.00 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3236717-2 07/27/17 11:06 • (LCSD) R3236717-3 07/27/17 11:10

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 1.00 | 0.989 | 100 | 99 | 80-120 | | | 1 | 20 |
| Calcium | 10.0 | 9.53 | 9.47 | 95 | 95 | 80-120 | | | 1 | 20 |
| Iron | 10.0 | 9.62 | 9.55 | 96 | 95 | 80-120 | | | 1 | 20 |
| Magnesium | 10.0 | 9.65 | 9.62 | 97 | 96 | 80-120 | | | 0 | 20 |
| Manganese | 1.00 | 0.968 | 0.952 | 97 | 95 | 80-120 | | | 2 | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3236717-8 07/27/17 16:26 • (LCSD) R3236717-9 07/27/17 16:29

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Potassium | 10.0 | 9.83 | 9.85 | 98 | 98 | 80-120 | | | 0 | 20 |
| Sodium | 10.0 | 10.5 | 10.4 | 105 | 104 | 80-120 | | | 1 | 20 |

## L924926-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L924926-01 07/27/17 11:13 • (MS) R3236717-5 07/27/17 11:19 • (MSD) R3236717-6 07/27/17 11:22

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 0.709 | 1.68 | 1.68 | 97 | 97 | 1 | 75-125 | | | 0 | 20 |
| Calcium | 10.0 | 116 | 124 | 124 | 80 | 78 | 1 | 75-125 | | | 0 | 20 |
| Iron | 10.0 | 21.4 | 33.4 | 33.0 | 119 | 115 | 1 | 75-125 | | | 1 | 20 |
| Magnesium | 10.0 | 30.4 | 39.0 | 39.4 | 87 | 90 | 1 | 75-125 | | | 1 | 20 |
| Manganese | 1.00 | 0.868 | 1.80 | 1.81 | 93 | 94 | 1 | 75-125 | | | 1 | 20 |

## L924926-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L924926-01 07/27/17 16:33 • (MS) R3236717-11 07/27/17 16:39 • (MSD) R3236717-12 07/27/17 16:42

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Potassium | 10.0 | 2.06 | 11.8 | 11.9 | 97 | 98 | 1 | 75-125 | | | 1 | 20 |
| Sodium | 10.0 | 22.1 | 31.7 | 31.7 | 95 | 96 | 1 | 75-125 | | | 0 | 20 |

## Method Blank (MB)

(MB) R3236330-1 07/26/17 12:33

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Methane | U | | 0.00291 | 0.0100 |
| Ethane | U | | 0.00407 | 0.0130 |
| Ethene | U | | 0.00426 | 0.0130 |
| Propane | U | | 0.00548 | 0.0190 |

## L924733-01 Original Sample (OS) • Duplicate (DUP)

(OS) L924733-01 07/26/17 13:23 • (DUP) R3236330-2 07/26/17 13:37

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3236330-3 07/26/17 13:44 • (LCSD) R3236330-4 07/26/17 13:47

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Methane | 0.0678 | 0.0710 | 0.0689 | 105 | 102 | 85.0-115 | | | 3.04 | 20 |
| Ethane | 0.129 | 0.125 | 0.123 | 96.9 | 95.5 | 85.0-115 | | | 1.53 | 20 |
| Ethene | 0.127 | 0.119 | 0.118 | 93.8 | 92.9 | 85.0-115 | | | 0.920 | 20 |
| Propane | 0.186 | 0.183 | 0.181 | 98.4 | 97.5 | 85.0-115 | | | 0.930 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3236501-3 07/26/17 09:55

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Benzene | U | | 0.000331 | 0.00100 |
| Ethylbenzene | U | | 0.000384 | 0.00100 |
| Toluene | U | | 0.000412 | 0.00100 |
| Xylenes, Total | U | | 0.00106 | 0.00300 |
| *(S) Toluene-d8* | *101* | | | *80.0-120* |
| *(S) Dibromofluoromethane* | *82.1* | | | *76.0-123* |
| *(S) a,a,a-Trifluorotoluene* | *105* | | | *80.0-120* |
| *(S) 4-Bromofluorobenzene* | *91.5* | | | *80.0-120* |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3236501-1 07/26/17 08:47 • (LCSD) R3236501-2 07/26/17 09:04

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Benzene | 0.0250 | 0.0241 | 0.0237 | 96.5 | 94.6 | 69.0-123 | | | 1.93 | 20 |
| Ethylbenzene | 0.0250 | 0.0244 | 0.0243 | 97.8 | 97.4 | 77.0-120 | | | 0.400 | 20 |
| Toluene | 0.0250 | 0.0235 | 0.0236 | 94.1 | 94.4 | 77.0-120 | | | 0.270 | 20 |
| Xylenes, Total | 0.0750 | 0.0718 | 0.0720 | 95.7 | 96.0 | 77.0-120 | | | 0.280 | 20 |
| *(S) Toluene-d8* | | | | *102* | *101* | *80.0-120* | | | | |
| *(S) Dibromofluoromethane* | | | | *85.1* | *84.0* | *76.0-123* | | | | |
| *(S) a,a,a-Trifluorotoluene* | | | | *105* | *105* | *80.0-120* | | | | |
| *(S) 4-Bromofluorobenzene* | | | | *91.6* | *90.7* | *80.0-120* | | | | |

## Abbreviations and Definitions

| | |
|---|---|
| SDG | Sample Delivery Group. |
| MDL | Method Detection Limit. |
| RDL | Reported Detection Limit. |
| ND | Not detected at the Reporting Limit (or MDL where applicable). |
| U | Not detected at the Reporting Limit (or MDL where applicable). |
| RPD | Relative Percent Difference. |
| Original Sample | The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG. |
| (S) | Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media. |
| Rec. | Recovery. |

| Qualifier | Description |
|---|---|
| J | The identification of the analyte is acceptable; the reported value is an estimate. |
| P1 | RPD value not applicable for sample concentrations less than 5 times the reporting limit. |
| T8 | Sample(s) received past/too close to holding time expiration. |

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE.**
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

## State Accreditations

| | |
|---|---|
| Alabama | 40660 |
| Alaska | UST-080 |
| Arizona | AZ0612 |
| Arkansas | 88-0469 |
| California | 01157CA |
| Colorado | TN00003 |
| Conneticut | PH-0197 |
| Florida | E87487 |
| Georgia | NELAP |
| Georgia [1] | 923 |
| Idaho | TN00003 |
| Illinois | 200008 |
| Indiana | C-TN-01 |
| Iowa | 364 |
| Kansas | E-10277 |
| Kentucky [1] | 90010 |
| Kentucky [2] | 16 |
| Louisiana | AI30792 |
| Maine | TN0002 |
| Maryland | 324 |
| Massachusetts | M-TN003 |
| Michigan | 9958 |
| Minnesota | 047-999-395 |
| Mississippi | TN00003 |
| Missouri | 340 |
| Montana | CERT0086 |
| Nebraska | NE-OS-15-05 |
| Nevada | TN-03-2002-34 |
| New Hampshire | 2975 |
| New Jersey–NELAP | TN002 |
| New Mexico | TN00003 |
| New York | 11742 |
| North Carolina | Env375 |
| North Carolina [1] | DW21704 |
| North Carolina [2] | 41 |
| North Dakota | R-140 |
| Ohio–VAP | CL0069 |
| Oklahoma | 9915 |
| Oregon | TN200002 |
| Pennsylvania | 68-02979 |
| Rhode Island | 221 |
| South Carolina | 84004 |
| South Dakota | n/a |
| Tennessee [1 4] | 2006 |
| Texas | T 104704245-07-TX |
| Texas [5] | LAB0152 |
| Utah | 6157585858 |
| Vermont | VT2006 |
| Virginia | 109 |
| Washington | C1915 |
| West Virginia | 233 |
| Wisconsin | 9980939910 |
| Wyoming | A2LA |

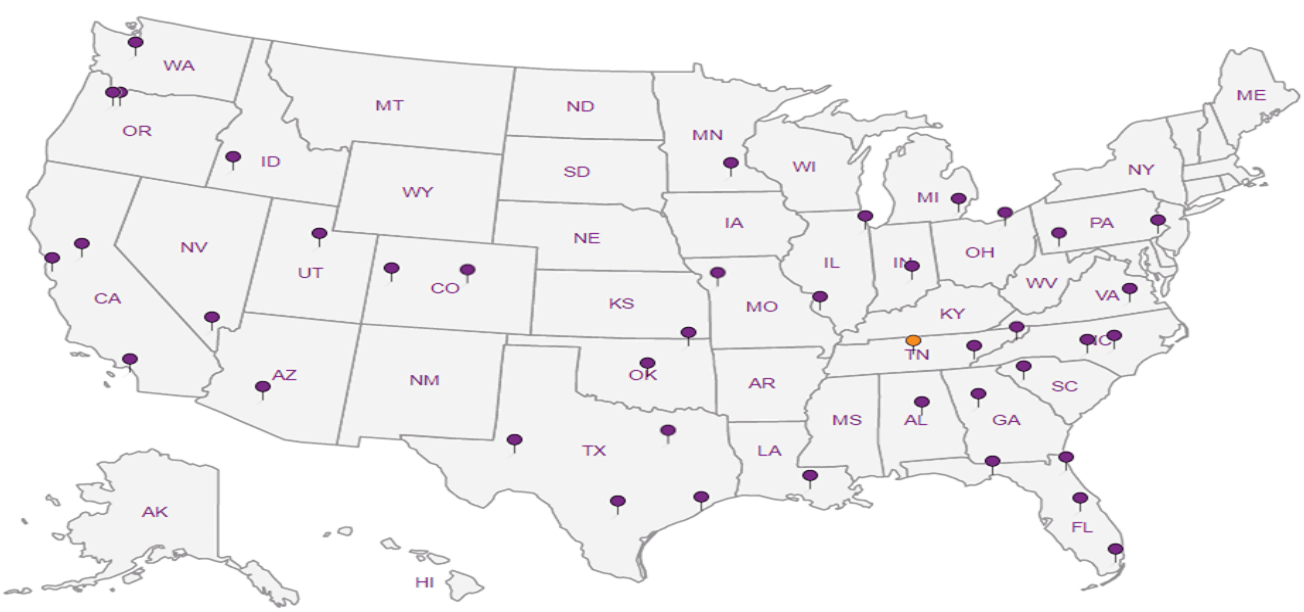
## Third Party & Federal Accreditations

| | |
|---|---|
| A2LA – ISO 17025 | 1461.01 |
| A2LA – ISO 17025 [5] | 1461.02 |
| Canada | 1461.01 |
| EPA–Crypto | TN00003 |
| AIHA-LAP,LLC | 100789 |
| DOD | 1461.01 |
| USDA | S-67674 |

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [n/a] Accreditation not applicable

## Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**



| Company Name/Address: | Billing Information: |
|---|---|
| **GES, Inc - Sunoco**<br>440 Creamery Way, Suite 500<br>Exton, PA 19341 | Accounts Payable<br>440 Creamery Way, Suite 500<br>Exton, PA 19341 |

Report to: Holly Smoker

Email To: hsmoker@gesonline.com

Project Description: Pre-Construction Sampling

City/State Collected: Williamsburg, PA

Phone: 610-458-1077

Fax: NA

Client Project #: NA

Lab Project #: SUNGES-GRILLO

Collected by (print): Jacob Gonzalez

Site/Facility ID #: ME2

P.O. #: NA

Collected by (signature):

Immediately Packed on Ice N ___ Y ✓

Rush? (Lab MUST Be Notified)
- ___ Same Day .......... 200%
- ___ Next Day .......... 100%
- ___ Two Day .......... 50%
- ___ Three Day .......... 25%

Date Results Needed: Standard

Email? ___No ✓Yes

FAX? ___No ___Yes

Analysis / Container / Preservative

Chain of Custody Page 1 of 1

ESC LAB SCIENCES

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L# 1241733

H093

Acctnum: SUNGES

Template: T114657

Prelogin: P564159

TSR: Mark Beasley

Cooler:

Shipped Via: Fed Ex

| Sample ID | Comp/Grab | Matrix * | Depth | Date | Time | No. of Cntrs | **pH,SPCON,TDS,TURB* 250mlHDPE-NoPres | ALK, Br, Cl, SO4 250mlHDPE-NoPres | Total Metals, Hardness 250mlHDPE-HNO3 | RSK175 + Propane 40mlAmb-HCl | TSS 1L-HDPE NoPres | V8260BTEX 40mlAmb-HCl | | | | Rem./Contaminant | Sample # (lab only) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 07252017-604-02 | Grab | DW | — | 7/25/17 | 1015 | 8 | X | X | X | X | X | X | | | | | 01 |

* Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other ________

pH ______ Temp ______

Flow ______ Other ______

Remarks: Metals = Ba,Ca,Fe,K,Mg,Mn,Na. Project #: 0204728 -06-160-xx Org 1402

Hold #

| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Samples returned via: ☐ UPS ☑ FedEx ☐ Courier ☐ ____ | Condition: (lab use only) |
|---|---|---|---|---|---|
| | 7/25/17 | 1200 | FedEx 7/25/17 1200 | | OK Y011 |
| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Temp: °C Bottles Received: | COC Seal Intact: ✓Y ___N ___NA |
| | | | 7215 4518 9828 | 1.1° 8 | |
| Relinquished by: (Signature) | Date: | Time: | Received for lab by: (Signature) | Date: 7/25/17 Time: 0845 | pH Checked: NCF: |

ESC LAB SCIENCES

Cooler Receipt Form

| | | | |
|---|---|---|---|
| Client: Surbes | SDG# | 924??? | |
| Cooler Received/Opened On: 7/ 26 /2017 | Temperature: | 1.7 | |
| Received By: David Riggin | | | |
| Signature: David Riggin | | | |

| Receipt Check List | NP | Yes | No |
|---|---|---|---|
| COC Seal Present / Intact? | | ✓ | |
| COC Signed / Accurate? | | ✓ | |
| Bottles arrive intact? | | ✓ | |
| Correct bottles used? | | ✓ | |
| Sufficient volume sent? | | ✓ | |
| If Applicable | | | |
| VOA Zero headspace? | | ✓ | |
| Preservation Correct / Checked? | | ✓ | |

# ANALYTICAL REPORT

November 17, 2017

## GES, Inc - Sunoco

| | |
|---|---|
| Sample Delivery Group: | L949455 |
| Samples Received: | 11/09/2017 |
| Project Number: | 0204728-06-160-XX |
| Description: | Pre-Construction Sampling |
| | |
| Report To: | Holly Smoker<br>440 Creamery Way, Ste 500<br>Exton, PA 19341 |

Entire Report Reviewed By:

Mark W. Beasley
Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

# TABLE OF CONTENTS


| | |
|---|---|
| Cp: Cover Page | 1 |
| Tc: Table of Contents | 2 |
| Ss: Sample Summary | 3 |
| Cn: Case Narrative | 4 |
| Sr: Sample Results | 5 |
| 11082017-614-02 L949455-01 | 5 |
| Qc: Quality Control Summary | 7 |
| Gravimetric Analysis by Method 2540 C-2011 | 7 |
| Gravimetric Analysis by Method 2540 D-2011 | 8 |
| Wet Chemistry by Method 130.1 | 9 |
| Wet Chemistry by Method 2130 B-2011 | 10 |
| Wet Chemistry by Method 2320 B-2011 | 11 |
| Wet Chemistry by Method 9040C | 12 |
| Wet Chemistry by Method 9050A | 13 |
| Wet Chemistry by Method 9056A | 14 |
| Metals (ICP) by Method 6010B | 16 |
| Volatile Organic Compounds (GC) by Method RSK175 | 17 |
| Volatile Organic Compounds (GC/MS) by Method 8260B | 18 |
| Gl: Glossary of Terms | 19 |
| Al: Accreditations & Locations | 20 |
| Sc: Sample Chain of Custody | 21 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

| | Collected by | Collected date/time | Received date/time |
|---|---|---|---|
| 11082017-614-02 L949455-01 GW | Jaclyn Burke | 11/08/17 13:55 | 11/09/17 08:45 |

| Method | Batch | Dilution | Preparation date/time | Analysis date/time | Analyst |
|---|---|---|---|---|---|
| Microbiology by Method 9223 B-1997 | WG1042444 | 1 | 11/09/17 14:40 | 11/09/17 14:40 | SWS |
| Gravimetric Analysis by Method 2540 C-2011 | WG1041481 | 1 | 11/11/17 12:22 | 11/11/17 12:55 | BS |
| Gravimetric Analysis by Method 2540 D-2011 | WG1041040 | 1 | 11/10/17 12:41 | 11/10/17 13:43 | MMF |
| Wet Chemistry by Method 130.1 | WG1042449 | 10 | 11/14/17 11:40 | 11/14/17 11:40 | KK |
| Wet Chemistry by Method 2130 B-2011 | WG1040859 | 1 | 11/09/17 17:16 | 11/09/17 17:16 | ER |
| Wet Chemistry by Method 2320 B-2011 | WG1041418 | 1 | 11/13/17 12:07 | 11/13/17 12:07 | MCG |
| Wet Chemistry by Method 9040C | WG1041404 | 1 | 11/11/17 13:28 | 11/11/17 13:28 | GB |
| Wet Chemistry by Method 9050A | WG1041021 | 1 | 11/10/17 01:22 | 11/10/17 01:22 | MZ |
| Wet Chemistry by Method 9056A | WG1040890 | 1 | 11/09/17 18:57 | 11/09/17 18:57 | DR |
| Wet Chemistry by Method 9056A | WG1040890 | 5 | 11/09/17 19:12 | 11/09/17 19:12 | DR |
| Metals (ICP) by Method 6010B | WG1041010 | 1 | 11/11/17 15:40 | 11/12/17 22:45 | ST |
| Volatile Organic Compounds (GC) by Method RSK175 | WG1041282 | 1 | 11/10/17 10:08 | 11/10/17 10:08 | BG |
| Volatile Organic Compounds (GC/MS) by Method 8260B | WG1040955 | 1 | 11/09/17 19:55 | 11/09/17 19:55 | BMB |

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Mark W. Beasley
Technical Service Representative

## Project Narrative

Not enough volume received to run fecal coliform. E.Coli results are included in the COLILERT analysis.

## Microbiology by Method 9223 B-1997

| Analyte | Result MPN/100ml | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| E.Coli | 1.00 | P1 | 1 | 11/09/2017 14:40 | WG1042444 |
| Coliform,Total | 179 | | 1 | 11/09/2017 14:40 | WG1042444 |

## Gravimetric Analysis by Method 2540 C-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Dissolved Solids | 533 | | 10.0 | 1 | 11/11/2017 12:55 | WG1041481 |

## Gravimetric Analysis by Method 2540 D-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Suspended Solids | 8.95 | | 2.50 | 1 | 11/10/2017 13:43 | WG1041040 |

## Wet Chemistry by Method 130.1

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 411 | B | 300 | 10 | 11/14/2017 11:40 | WG1042449 |

## Wet Chemistry by Method 2130 B-2011

| Analyte | Result NTU | Qualifier | RDL NTU | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Turbidity | ND | | 0.300 | 1 | 11/09/2017 17:16 | WG1040859 |

## Wet Chemistry by Method 2320 B-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Alkalinity | 363 | | 20.0 | 1 | 11/13/2017 12:07 | WG1041418 |

**Sample Narrative:**

L949455-01 WG1041418: Endpoint pH 4.5

## Wet Chemistry by Method 9040C

| Analyte | Result su | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| pH | 7.47 | T8 | 1 | 11/11/2017 13:28 | WG1041404 |

**Sample Narrative:**

L949455-01 WG1041404: 7.47 at 18.5C

## Wet Chemistry by Method 9050A

| Analyte | Result umhos/cm | Qualifier | RDL umhos/cm | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Specific Conductance | 1300 | | 10.0 | 1 | 11/10/2017 01:22 | WG1041021 |

## Wet Chemistry by Method 9056A

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Bromide | ND | | 1.00 | 1 | 11/09/2017 18:57 | WG1040890 |
| Chloride | 168 | | 5.00 | 5 | 11/09/2017 19:12 | WG1040890 |
| Sulfate | 31.0 | | 5.00 | 1 | 11/09/2017 18:57 | WG1040890 |

## Metals (ICP) by Method 6010B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Barium | 0.0775 | | 0.00500 | 1 | 11/12/2017 22:45 | WG1041010 |
| Calcium | 105 | | 1.00 | 1 | 11/12/2017 22:45 | WG1041010 |
| Iron | ND | | 0.100 | 1 | 11/12/2017 22:45 | WG1041010 |
| Magnesium | 52.3 | | 1.00 | 1 | 11/12/2017 22:45 | WG1041010 |
| Manganese | ND | | 0.0100 | 1 | 11/12/2017 22:45 | WG1041010 |
| Potassium | 3.28 | | 1.00 | 1 | 11/12/2017 22:45 | WG1041010 |
| Sodium | 89.7 | | 1.00 | 1 | 11/12/2017 22:45 | WG1041010 |

## Volatile Organic Compounds (GC) by Method RSK175

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Methane | ND | J3 J4 | 0.0100 | 1 | 11/10/2017 10:08 | WG1041282 |
| Ethane | ND | | 0.0130 | 1 | 11/10/2017 10:08 | WG1041282 |
| Ethene | ND | | 0.0130 | 1 | 11/10/2017 10:08 | WG1041282 |
| Propane | ND | | 0.0190 | 1 | 11/10/2017 10:08 | WG1041282 |

## Volatile Organic Compounds (GC/MS) by Method 8260B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Benzene | ND | | 0.00100 | 1 | 11/09/2017 19:55 | WG1040955 |
| Toluene | ND | | 0.00100 | 1 | 11/09/2017 19:55 | WG1040955 |
| Ethylbenzene | ND | | 0.00100 | 1 | 11/09/2017 19:55 | WG1040955 |
| Total Xylenes | ND | | 0.00300 | 1 | 11/09/2017 19:55 | WG1040955 |
| *(S) Toluene-d8* | *107* | | *80.0-120* | | *11/09/2017 19:55* | WG1040955 |
| *(S) Dibromofluoromethane* | *103* | | *76.0-123* | | *11/09/2017 19:55* | WG1040955 |
| *(S) a,a,a-Trifluorotoluene* | *114* | | *80.0-120* | | *11/09/2017 19:55* | WG1040955 |
| *(S) 4-Bromofluorobenzene* | *89.9* | | *80.0-120* | | *11/09/2017 19:55* | WG1040955 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

Cp Tc Ss Cn Sr Qc Gl Al Sc

## Method Blank (MB)

(MB) R3265821-1 11/11/17 12:55

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Dissolved Solids | U | | 2.82 | 10.0 |

## L949499-03 Original Sample (OS) • Duplicate (DUP)

(OS) L949499-03 11/11/17 12:55 • (DUP) R3265821-4 11/11/17 12:55

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Dissolved Solids | 23800 | 24300 | 1 | 2.16 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3265821-2 11/11/17 12:55 • (LCSD) R3265821-3 11/11/17 12:55

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Dissolved Solids | 8800 | 8390 | 8520 | 95.3 | 96.8 | 85.0-115 | | | 1.54 | 5 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3264847-1 11/10/17 13:43

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Suspended Solids | U | | 0.350 | 2.50 |

## L949423-02 Original Sample (OS) • Duplicate (DUP)

(OS) L949423-02 11/10/17 13:43 • (DUP) R3264847-4 11/10/17 13:43

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 1180 | 1120 | 1 | 5.20 | J3 | 5 |

## L949456-01 Original Sample (OS) • Duplicate (DUP)

(OS) L949456-01 11/10/17 13:43 • (DUP) R3264847-5 11/10/17 13:43

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 82.9 | 85.7 | 1 | 3.39 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3264847-2 11/10/17 13:43 • (LCSD) R3264847-3 11/10/17 13:43

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Suspended Solids | 773 | 776 | 764 | 100 | 98.8 | 85.0-115 | | | 1.56 | 5 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3265400-1 11/14/17 11:05

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 4.25 | J | 1.43 | 30.0 |

## L949416-01 Original Sample (OS) • Duplicate (DUP)

(OS) L949416-01 11/14/17 11:11 • (DUP) R3265400-4 11/14/17 11:11

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 123 | 119 | 1 | 3 | | 20 |

## L949577-02 Original Sample (OS) • Duplicate (DUP)

(OS) L949577-02 11/14/17 11:30 • (DUP) R3265400-7 11/14/17 11:31

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 59.7 | 58.4 | 1 | 2 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3265400-2 11/14/17 11:05 • (LCSD) R3265400-3 11/14/17 11:06

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 139 | 137 | 93 | 91 | 85-115 | | | 1 | 20 |

## L949577-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L949577-01 11/14/17 11:28 • (MS) R3265400-5 11/14/17 11:29 • (MSD) R3265400-6 11/14/17 11:29

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 58.8 | 173 | 177 | 76 | 79 | 1 | 80-120 | J6 | J6 | 2 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3264490-1 11/09/17 17:16

| Analyte | MB Result NTU | MB Qualifier | MB MDL NTU | MB RDL NTU |
|---|---|---|---|---|
| Turbidity | 0.0520 | J | 0.0310 | 0.300 |

## L949360-01 Original Sample (OS) • Duplicate (DUP)

(OS) L949360-01 11/09/17 17:16 • (DUP) R3264490-4 11/09/17 17:16

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 18.0 | 18.4 | 1 | 2.00 | | 20 |

## L949499-03 Original Sample (OS) • Duplicate (DUP)

(OS) L949499-03 11/09/17 17:16 • (DUP) R3264490-5 11/09/17 17:16

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 63.8 | 63.4 | 1 | 1.00 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3264490-2 11/09/17 17:16 • (LCSD) R3264490-3 11/09/17 17:16

| Analyte | Spike Amount NTU | LCS Result NTU | LCSD Result NTU | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Turbidity | 40.0 | 41.7 | 41.7 | 104 | 104 | 90.0-110 | | | 0.000 | 20 |

## L949413-01 Original Sample (OS) • Duplicate (DUP)

(OS) L949413-01 11/13/17 11:24 • (DUP) R3265310-1 11/13/17 11:33

| Analyte | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| | mg/l | mg/l | | % | | % |
| Alkalinity | 235 | 239 | 1 | 2.00 | | 20 |

Sample Narrative:

OS: Endpoint pH 4.5

DUP: Endpoint pH 4.5

## L949700-01 Original Sample (OS) • Duplicate (DUP)

(OS) L949700-01 11/13/17 14:28 • (DUP) R3265310-4 11/13/17 14:37

| Analyte | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| | mg/l | mg/l | | % | | % |
| Alkalinity | 232 | 235 | 1 | 1.00 | | 20 |

Sample Narrative:

OS: Endpoint pH 4.5

DUP: Endpoint pH 4.5

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3265310-2 11/13/17 12:16 • (LCSD) R3265310-3 11/13/17 14:13

| Analyte | Spike Amount | LCS Result | LCSD Result | LCS Rec. | LCSD Rec. | Rec. Limits | LCS Qualifier | LCSD Qualifier | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| | mg/l | mg/l | mg/l | % | % | % | | | % | % |
| Alkalinity | 100 | 104 | 99.3 | 104 | 99.0 | 85.0-115 | | | 5.00 | 20 |

Sample Narrative:

LCS: Endpoint pH 4.5

LCSD: Endpoint pH 4.5

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## L949411-01 Original Sample (OS) • Duplicate (DUP)

(OS) L949411-01 11/11/17 13:28 • (DUP) R3264878-3 11/11/17 13:28

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 7.82 | 7.81 | 1 | 0.128 | | 1 |

Sample Narrative:
OS: 7.82 at 18.9C
DUP: 7.81 at 18.9C

## L949834-01 Original Sample (OS) • Duplicate (DUP)

(OS) L949834-01 11/11/17 13:28 • (DUP) R3264878-4 11/11/17 13:28

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 7.84 | 7.84 | 1 | 0.000 | | 1 |

Sample Narrative:
OS: 7.84 at 18C
DUP: 7.84 at 18C

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3264878-1 11/11/17 13:28 • (LCSD) R3264878-2 11/11/17 13:28

| Analyte | Spike Amount su | LCS Result su | LCSD Result su | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | 5.96 | 5.99 | 5.98 | 101 | 100 | 98.3-102 | | | 0.167 | 1 |

Sample Narrative:
LCS: 5.99 at 18.7C
LCSD: 5.98 at 18.7C

## Method Blank (MB)

(MB) WG1041021-1 11/10/17 01:22

| Analyte | MB Result umhos/cm | MB Qualifier | MB MDL umhos/cm | MB RDL umhos/cm |
|---|---|---|---|---|
| Specific Conductance | U | | 10.0 | 10.0 |

## L949047-01 Original Sample (OS) • Duplicate (DUP)

(OS) L949047-01 11/10/17 01:22 • (DUP) WG1041021-4 11/10/17 01:22

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 323 | 323 | 1 | 0.000 | | 20 |

## L949417-01 Original Sample (OS) • Duplicate (DUP)

(OS) L949417-01 11/10/17 01:22 • (DUP) WG1041021-5 11/10/17 01:22

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 1010 | 1010 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG1041021-2 11/10/17 01:22 • (LCSD) WG1041021-3 11/10/17 01:22

| Analyte | Spike Amount umhos/cm | LCS Result umhos/cm | LCSD Result umhos/cm | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Specific Conductance | 559 | 556 | 556 | 99.5 | 99.5 | 85.0-115 | | | 0.000 | 20 |

## Method Blank (MB)

(MB) R3264529-1 11/09/17 06:43

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Bromide | U | | 0.079 | 1.00 |
| Chloride | U | | 0.0519 | 1.00 |
| Sulfate | U | | 0.0774 | 5.00 |

## L949410-01 Original Sample (OS) • Duplicate (DUP)

(OS) L949410-01 11/09/17 12:44 • (DUP) R3264529-4 11/09/17 12:59

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | ND | 0.000 | 1 | 0 | | 15 |
| Chloride | 32.8 | 32.9 | 1 | 0 | | 15 |
| Sulfate | 22.1 | 22.0 | 1 | 0 | | 15 |

## L949450-01 Original Sample (OS) • Duplicate (DUP)

(OS) L949450-01 11/09/17 17:42 • (DUP) R3264529-7 11/09/17 17:57

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | ND | 0.000 | 1 | 0 | | 15 |
| Chloride | 1.59 | 1.54 | 1 | 3 | | 15 |
| Sulfate | ND | 2.93 | 1 | 0 | | 15 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3264529-2 11/09/17 06:58 • (LCSD) R3264529-3 11/09/17 07:13

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 40.0 | 39.3 | 39.5 | 98 | 99 | 80-120 | | | 0 | 15 |
| Chloride | 40.0 | 39.3 | 39.5 | 98 | 99 | 80-120 | | | 1 | 15 |
| Sulfate | 40.0 | 39.5 | 39.7 | 99 | 99 | 80-120 | | | 0 | 15 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## L949410-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L949410-01 11/09/17 12:44 • (MS) R3264529-5 11/09/17 13:14 • (MSD) R3264529-6 11/09/17 13:29

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | ND | 49.1 | 50.0 | 98 | 100 | 1 | 80-120 | | | 2 | 15 |
| Chloride | 50.0 | 32.8 | 82.8 | 83.2 | 100 | 101 | 1 | 80-120 | | | 0 | 15 |
| Sulfate | 50.0 | 22.1 | 72.3 | 72.6 | 101 | 101 | 1 | 80-120 | | | 0 | 15 |

## L949450-01 Original Sample (OS) • Matrix Spike (MS)

(OS) L949450-01 11/09/17 17:42 • (MS) R3264529-8 11/09/17 18:12

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MS Rec. % | Dilution | Rec. Limits % | MS Qualifier |
|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | ND | 48.6 | 97 | 1 | 80-120 | |
| Chloride | 50.0 | 1.59 | 53.5 | 104 | 1 | 80-120 | |
| Sulfate | 50.0 | ND | 54.2 | 102 | 1 | 80-120 | |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3264994-1 11/12/17 21:44

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Barium | U | | 0.0017 | 0.00500 |
| Calcium | U | | 0.0463 | 1.00 |
| Iron | U | | 0.0141 | 0.100 |
| Magnesium | U | | 0.0111 | 1.00 |
| Manganese | U | | 0.0012 | 0.0100 |
| Potassium | 0.128 | J | 0.102 | 1.00 |
| Sodium | U | | 0.0985 | 1.00 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3264994-2 11/12/17 21:47 • (LCSD) R3264994-3 11/12/17 21:49

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 1.01 | 1.03 | 101 | 103 | 80-120 | | | 2 | 20 |
| Calcium | 10.0 | 9.85 | 10.0 | 99 | 100 | 80-120 | | | 2 | 20 |
| Iron | 10.0 | 9.91 | 10.1 | 99 | 101 | 80-120 | | | 1 | 20 |
| Magnesium | 10.0 | 9.99 | 10.2 | 100 | 102 | 80-120 | | | 2 | 20 |
| Manganese | 1.00 | 0.958 | 0.976 | 96 | 98 | 80-120 | | | 2 | 20 |
| Potassium | 10.0 | 9.74 | 9.88 | 97 | 99 | 80-120 | | | 1 | 20 |
| Sodium | 10.0 | 9.95 | 10.1 | 100 | 101 | 80-120 | | | 1 | 20 |

## L949545-05 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L949545-05 11/12/17 21:52 • (MS) R3264994-5 11/12/17 22:05 • (MSD) R3264994-6 11/12/17 22:08

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 0.0507 | 1.02 | 1.03 | 97 | 98 | 1 | 75-125 | | | 1 | 20 |
| Calcium | 10.0 | 222 | 229 | 229 | 72 | 70 | 1 | 75-125 | V | V | 0 | 20 |
| Iron | 10.0 | 0.639 | 10.2 | 10.4 | 96 | 97 | 1 | 75-125 | | | 1 | 20 |
| Magnesium | 10.0 | 652 | 652 | 651 | 0 | 0 | 1 | 75-125 | V | V | 0 | 20 |
| Manganese | 1.00 | 0.0326 | 0.939 | 0.952 | 91 | 92 | 1 | 75-125 | | | 1 | 20 |
| Potassium | 10.0 | 207 | 213 | 212 | 63 | 55 | 1 | 75-125 | V | V | 0 | 20 |
| Sodium | 10.0 | 5450 | 5330 | 5310 | 0 | 0 | 1 | 75-125 | E V | E V | 0 | 20 |

## Method Blank (MB)

(MB) R3264639-1 11/10/17 08:32

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Methane | U | | 0.00291 | 0.0100 |
| Ethane | U | | 0.00407 | 0.0130 |
| Ethene | U | | 0.00426 | 0.0130 |
| Propane | U | | 0.00548 | 0.0190 |

## L949049-01 Original Sample (OS) • Duplicate (DUP)

(OS) L949049-01 11/10/17 09:20 • (DUP) R3264639-2 11/10/17 09:46

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## L949414-01 Original Sample (OS) • Duplicate (DUP)

(OS) L949414-01 11/10/17 09:56 • (DUP) R3264639-3 11/10/17 10:57

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3264639-4 11/10/17 11:08 • (LCSD) R3264639-5 11/10/17 11:21

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Methane | 0.0678 | 0.0684 | 0.0848 | 101 | 125 | 85.0-115 | | J3 J4 | 21.5 | 20 |
| Ethane | 0.129 | 0.113 | 0.116 | 87.6 | 90.2 | 85.0-115 | | | 2.86 | 20 |
| Ethene | 0.127 | 0.117 | 0.120 | 92.0 | 94.1 | 85.0-115 | | | 2.26 | 20 |
| Propane | 0.186 | 0.184 | 0.190 | 99.1 | 102 | 85.0-115 | | | 3.16 | 20 |

## Method Blank (MB)

(MB) R3265221-1 11/09/17 09:57

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Benzene | U | | 0.000331 | 0.00100 |
| Ethylbenzene | U | | 0.000384 | 0.00100 |
| Toluene | U | | 0.000412 | 0.00100 |
| Xylenes, Total | U | | 0.00106 | 0.00300 |
| *(S) Toluene-d8* | *109* | | | *80.0-120* |
| *(S) Dibromofluoromethane* | *105* | | | *76.0-123* |
| *(S) a,a,a-Trifluorotoluene* | *112* | | | *80.0-120* |
| *(S) 4-Bromofluorobenzene* | *93.6* | | | *80.0-120* |

## Laboratory Control Sample (LCS)

(LCS) R3265221-2 11/09/17 12:01

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCS Rec. % | Rec. Limits % | LCS Qualifier |
|---|---|---|---|---|---|
| Benzene | 0.0250 | 0.0217 | 86.7 | 69.0-123 | |
| Ethylbenzene | 0.0250 | 0.0232 | 93.0 | 77.0-120 | |
| Toluene | 0.0250 | 0.0213 | 85.4 | 77.0-120 | |
| Xylenes, Total | 0.0750 | 0.0731 | 97.5 | 77.0-120 | |
| *(S) Toluene-d8* | | | *104* | *80.0-120* | |
| *(S) Dibromofluoromethane* | | | *122* | *76.0-123* | |
| *(S) a,a,a-Trifluorotoluene* | | | *111* | *80.0-120* | |
| *(S) 4-Bromofluorobenzene* | | | *96.8* | *80.0-120* | |

## Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

## Abbreviations and Definitions

| | |
|---|---|
| MDL | Method Detection Limit. |
| ND | Not detected at the Reporting Limit (or MDL where applicable). |
| RDL | Reported Detection Limit. |
| Rec. | Recovery. |
| RPD | Relative Percent Difference. |
| SDG | Sample Delivery Group. |
| (S) | Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media. |
| U | Not detected at the Reporting Limit (or MDL where applicable). |
| Analyte | The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported. |
| Dilution | If the sample matrix contains an interfering material, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor. |
| Limits | These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges. |
| Original Sample | The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG. |
| Qualifier | This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable. |
| Result | The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state "ND" (Not Detected) or "BDL" (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte. |
| Case Narrative (Cn) | A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report. |
| Quality Control Summary (Qc) | This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material. |
| Sample Chain of Custody (Sc) | This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis. |
| Sample Results (Sr) | This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported. |
| Sample Summary (Ss) | This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis. |

| Qualifier | Description |
|---|---|
| B | The same analyte is found in the associated blank. |
| E | The analyte concentration exceeds the upper limit of the calibration range of the instrument established by the initial calibration (ICAL). |
| J | The identification of the analyte is acceptable; the reported value is an estimate. |
| J3 | The associated batch QC was outside the established quality control range for precision. |
| J4 | The associated batch QC was outside the established quality control range for accuracy. |
| J6 | The sample matrix interfered with the ability to make any accurate determination; spike value is low. |
| P1 | RPD value not applicable for sample concentrations less than 5 times the reporting limit. |
| T8 | Sample(s) received past/too close to holding time expiration. |
| V | The sample concentration is too high to evaluate accurate spike recoveries. |

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE.**
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

## State Accreditations

| | | | |
|---|---|---|---|
| Alabama | 40660 | Nevada | TN-03-2002-34 |
| Alaska | UST-080 | New Hampshire | 2975 |
| Arizona | AZ0612 | New Jersey–NELAP | TN002 |
| Arkansas | 88-0469 | New Mexico | TN00003 |
| California | 01157CA | New York | 11742 |
| Colorado | TN00003 | North Carolina | Env375 |
| Conneticut | PH-0197 | North Carolina [1] | DW21704 |
| Florida | E87487 | North Carolina [2] | 41 |
| Georgia | NELAP | North Dakota | R-140 |
| Georgia [1] | 923 | Ohio–VAP | CL0069 |
| Idaho | TN00003 | Oklahoma | 9915 |
| Illinois | 200008 | Oregon | TN200002 |
| Indiana | C-TN-01 | Pennsylvania | 68-02979 |
| Iowa | 364 | Rhode Island | 221 |
| Kansas | E-10277 | South Carolina | 84004 |
| Kentucky [1] | 90010 | South Dakota | n/a |
| Kentucky [2] | 16 | Tennessee [1,4] | 2006 |
| Louisiana | AI30792 | Texas | T 104704245-07-TX |
| Maine | TN0002 | Texas [5] | LAB0152 |
| Maryland | 324 | Utah | 6157585858 |
| Massachusetts | M-TN003 | Vermont | VT2006 |
| Michigan | 9958 | Virginia | 109 |
| Minnesota | 047-999-395 | Washington | C1915 |
| Mississippi | TN00003 | West Virginia | 233 |
| Missouri | 340 | Wisconsin | 9980939910 |
| Montana | CERT0086 | Wyoming | A2LA |
| Nebraska | NE-OS-15-05 | | |

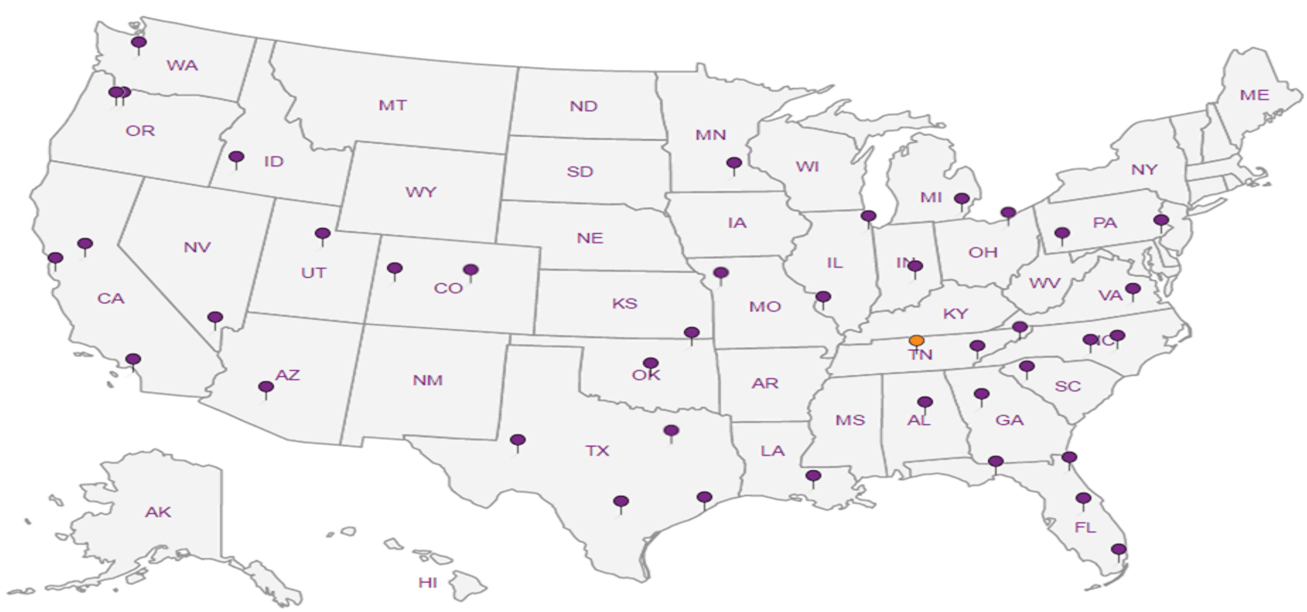
## Third Party & Federal Accreditations

| | | | |
|---|---|---|---|
| A2LA – ISO 17025 | 1461.01 | AIHA-LAP,LLC | 100789 |
| A2LA – ISO 17025 [5] | 1461.02 | DOD | 1461.01 |
| Canada | 1461.01 | USDA | S-67674 |
| EPA–Crypto | TN00003 | | |

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [n/a] Accreditation not applicable

## Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**



GES, Inc. - Sunoco

440 Creamery Way, Suite 500
Exton, PA 19341

Billing information:
Accounts Payable
440 Creamery Way, Suite 500
Exton, PA 19341

Pres Chk

Analysis / Container / Preservative

Chain of Custody Page ___ of ___

ESC LAB SCIENCES

YOUR LAB OF CHOICE

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

Report to: Holly Smoker

Email To: sgrillo@gesonline.com, hsmoker@geso

Project Description: Pre-Construction Sampling

City/State Collected: Williamsburg, PA

L# L949455

H042

Phone: 406-578-4501
Fax:

Client Project # 02047 28 -06-160-XX

Lab Project # SUNGES-GRILLO

Acctnum: SUNGES
Template: T126128
Prelogin: P611030
TSR: 134 - Mark Beasley
PB:
Shipped Via: FedEx

Collected by (print): Jaclyn Burke

Site/Facility ID #

P.O. #

Collected by (signature): Jaclyn Burke

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day

Quote #

Date Results Needed: Standard TAT

Immediately Packed on Ice N ___ Y X

| Sample ID | Comp/Grab | Matrix * | Depth | Date | Time | No. of Cntrs | **pH,SPCON,TDS,TURB* 250ml plastic NP | ALK, Br, Cl, SO4 250ml plastic NP | Total Mtls, Hardness 250ml plastic HNO3 | RSK175 + Propane 40ml vial w/ HCL | TSS 1L plastic NP | V8260BTEX 40ml vial w/ HCL | ****DW COLILERT**** microbiological | ****DW Fecal**** microbiological | Remarks | Sample # (lab only) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11082017-614-02 | Grab | DW | — | 11/08/17 | 1355 | ~~12~~ 10 | X | X | X | X | X | X | X | X | | -01 |

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other ________

Remarks:
Metals = Ba,Ca,Fe,K,Mg,Mn,Na
*****Log COLILERT & FC as DW matrix*****

pH ______ Temp ______
Flow ______ Other ______

Samples returned via: ___ UPS X FedEx ___ Courier ___

Tracking # 7474 0939 9249

Sample Receipt Checklist
COC Seal Present/Intact: NP Y N
COC Signed/Accurate: Y N
Bottles arrive intact: Y N
Correct bottles used: Y N
Sufficient volume sent: Y N
If Applicable
VOA Zero Headspace: Y N
Preservation Correct/Checked: Y N

| Relinquished by : (Signature) | Date: | Time: | Received by: (Signature) | Trip Blank Received: Yes / No HCL / MeoH TBR |
|---|---|---|---|---|
| Jaclyn Burke | 11/08/17 | 1450 | Fedex 11/08/17 1450 | |

| Relinquished by : (Signature) | Date: | Time: | Received by: (Signature) | Temp: 3.1 °C | Bottles Received: 10 | If preservation required by Login: Date/Time |
|---|---|---|---|---|---|---|
| | | | | | | |

| Relinquished by : (Signature) | Date: | Time: | Received for lab by: (Signature) | Date: 11-9-17 | Time: 8:45 | Hold | Condition: NCF / OK |
|---|---|---|---|---|---|---|---|
| | | | [signature] 936 | | | | |

# ANALYTICAL REPORT

November 20, 2017

**GES, Inc - Sunoco**

| | |
|---|---|
| Sample Delivery Group: | L950212 |
| Samples Received: | 11/11/2017 |
| Project Number: | 0204728-06-160-XX |
| Description: | Pre-Construction Sampling |
| | |
| Report To: | Holly Smoker |
| | 440 Creamery Way, Ste 500 |
| | Exton, PA  19341 |

Entire Report Reviewed By:

Jason Romer
Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

# TABLE OF CONTENTS


| | |
|---|---|
| Cp: Cover Page | 1 |
| Tc: Table of Contents | 2 |
| Ss: Sample Summary | 3 |
| Cn: Case Narrative | 4 |
| Sr: Sample Results | 5 |
| 11102017-631-01 L950212-01 | 5 |
| Qc: Quality Control Summary | 7 |
| Gravimetric Analysis by Method 2540 C-2011 | 7 |
| Gravimetric Analysis by Method 2540 D-2011 | 8 |
| Wet Chemistry by Method 130.1 | 9 |
| Wet Chemistry by Method 2130 B-2011 | 10 |
| Wet Chemistry by Method 2320 B-2011 | 11 |
| Wet Chemistry by Method 9040C | 12 |
| Wet Chemistry by Method 9050A | 13 |
| Wet Chemistry by Method 9056A | 14 |
| Metals (ICP) by Method 6010B | 16 |
| Volatile Organic Compounds (GC) by Method RSK175 | 17 |
| Volatile Organic Compounds (GC/MS) by Method 8260B | 18 |
| Gl: Glossary of Terms | 19 |
| Al: Accreditations & Locations | 20 |
| Sc: Sample Chain of Custody | 21 |

| | Collected by | Collected date/time | Received date/time |
|---|---|---|---|
| 11102017-631-01 L950212-01 GW | Kim Lapszynski | 11/10/17 11:15 | 11/11/17 08:45 |

| Method | Batch | Dilution | Preparation date/time | Analysis date/time | Analyst |
|---|---|---|---|---|---|
| Microbiology by Method 9222D | WG1041821 | 1 | 11/11/17 16:02 | 11/11/17 16:02 | KMR |
| Microbiology by Method 9223 B-1997 | WG1041819 | 1 | 11/11/17 16:00 | 11/11/17 16:00 | MH |
| Gravimetric Analysis by Method 2540 C-2011 | WG1043145 | 1 | 11/16/17 15:28 | 11/16/17 16:04 | MMF |
| Gravimetric Analysis by Method 2540 D-2011 | WG1042650 | 1 | 11/14/17 22:33 | 11/14/17 23:10 | BS |
| Wet Chemistry by Method 130.1 | WG1043014 | 5 | 11/16/17 16:36 | 11/16/17 16:36 | JER |
| Wet Chemistry by Method 2130 B-2011 | WG1041782 | 1 | 11/11/17 18:04 | 11/11/17 18:04 | GB |
| Wet Chemistry by Method 2320 B-2011 | WG1042043 | 1 | 11/14/17 13:26 | 11/14/17 13:26 | MCG |
| Wet Chemistry by Method 9040C | WG1042177 | 1 | 11/14/17 09:51 | 11/14/17 09:51 | ER |
| Wet Chemistry by Method 9050A | WG1043753 | 1 | 11/16/17 16:57 | 11/16/17 16:57 | MA |
| Wet Chemistry by Method 9056A | WG1041699 | 1 | 11/13/17 14:35 | 11/13/17 14:35 | DR |
| Metals (ICP) by Method 6010B | WG1042030 | 1 | 11/14/17 10:31 | 11/14/17 17:14 | ST |
| Volatile Organic Compounds (GC) by Method RSK175 | WG1042492 | 1 | 11/14/17 13:45 | 11/14/17 13:45 | BG |
| Volatile Organic Compounds (GC/MS) by Method 8260B | WG1041915 | 1 | 11/12/17 17:46 | 11/12/17 17:46 | LRL |

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Jason Romer
Technical Service Representative

## Sample Narrative

FC test was confirmed to be positive for both fecal coliform and E. coli. BE 11-16-17

## Microbiology by Method 9222D

| Analyte | Result col/100ml | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| Coliform,fecal | 7.00 | | 1 | 11/11/2017 16:02 | WG1041821 |

## Microbiology by Method 9223 B-1997

| Analyte | Result MPN/100ml | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| E.Coli | 7.50 | | 1 | 11/11/2017 16:00 | WG1041819 |
| Coliform,Total | 272 | | 1 | 11/11/2017 16:00 | WG1041819 |

## Gravimetric Analysis by Method 2540 C-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Dissolved Solids | 482 | | 10.0 | 1 | 11/16/2017 16:04 | WG1043145 |

## Gravimetric Analysis by Method 2540 D-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Suspended Solids | 2.70 | | 2.50 | 1 | 11/14/2017 23:10 | WG1042650 |

## Wet Chemistry by Method 130.1

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 352 | | 150 | 5 | 11/16/2017 16:36 | WG1043014 |

## Wet Chemistry by Method 2130 B-2011

| Analyte | Result NTU | Qualifier | RDL NTU | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Turbidity | 1.60 | | 0.300 | 1 | 11/11/2017 18:04 | WG1041782 |

## Wet Chemistry by Method 2320 B-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Alkalinity | 315 | | 20.0 | 1 | 11/14/2017 13:26 | WG1042043 |

**Sample Narrative:**

L950212-01 WG1042043: Endpoint pH 4.5

## Wet Chemistry by Method 9040C

| Analyte | Result su | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| pH | 7.45 | T8 | 1 | 11/14/2017 09:51 | WG1042177 |

**Sample Narrative:**

L950212-01 WG1042177: 7.45 at 18.7C

## Wet Chemistry by Method 9050A

| Analyte | Result umhos/cm | Qualifier | RDL umhos/cm | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Specific Conductance | 819 | | 10.0 | 1 | 11/16/2017 16:57 | WG1043753 |

## Wet Chemistry by Method 9056A

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Bromide | ND | | 1.00 | 1 | 11/13/2017 14:35 | WG1041699 |
| Chloride | 50.8 | | 1.00 | 1 | 11/13/2017 14:35 | WG1041699 |
| Sulfate | 25.7 | | 5.00 | 1 | 11/13/2017 14:35 | WG1041699 |

## Metals (ICP) by Method 6010B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Barium | 0.116 | | 0.00500 | 1 | 11/14/2017 17:14 | WG1042030 |
| Calcium | 92.6 | | 1.00 | 1 | 11/14/2017 17:14 | WG1042030 |
| Iron | ND | | 0.100 | 1 | 11/14/2017 17:14 | WG1042030 |
| Magnesium | 34.4 | | 1.00 | 1 | 11/14/2017 17:14 | WG1042030 |
| Manganese | ND | | 0.0100 | 1 | 11/14/2017 17:14 | WG1042030 |
| Potassium | 7.38 | | 1.00 | 1 | 11/14/2017 17:14 | WG1042030 |
| Sodium | 30.6 | | 1.00 | 1 | 11/14/2017 17:14 | WG1042030 |

## Volatile Organic Compounds (GC) by Method RSK175

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Methane | ND | | 0.0100 | 1 | 11/14/2017 13:45 | WG1042492 |
| Ethane | ND | | 0.0130 | 1 | 11/14/2017 13:45 | WG1042492 |
| Ethene | ND | | 0.0130 | 1 | 11/14/2017 13:45 | WG1042492 |
| Propane | ND | | 0.0190 | 1 | 11/14/2017 13:45 | WG1042492 |

## Volatile Organic Compounds (GC/MS) by Method 8260B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Benzene | ND | | 0.00100 | 1 | 11/12/2017 17:46 | WG1041915 |
| Toluene | ND | | 0.00100 | 1 | 11/12/2017 17:46 | WG1041915 |
| Ethylbenzene | ND | | 0.00100 | 1 | 11/12/2017 17:46 | WG1041915 |
| Total Xylenes | ND | | 0.00300 | 1 | 11/12/2017 17:46 | WG1041915 |
| *(S) Toluene-d8* | *105* | | *80.0-120* | | *11/12/2017 17:46* | WG1041915 |
| *(S) Dibromofluoromethane* | *86.8* | | *76.0-123* | | *11/12/2017 17:46* | WG1041915 |
| *(S) a,a,a-Trifluorotoluene* | *114* | | *80.0-120* | | *11/12/2017 17:46* | WG1041915 |
| *(S) 4-Bromofluorobenzene* | *96.1* | | *80.0-120* | | *11/12/2017 17:46* | WG1041915 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3266786-1 11/16/17 16:04

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Dissolved Solids | U | | 2.82 | 10.0 |

## L950206-01 Original Sample (OS) • Duplicate (DUP)

(OS) L950206-01 11/16/17 16:04 • (DUP) R3266786-4 11/16/17 16:04

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Dissolved Solids | 522 | 521 | 1 | 0.192 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3266786-2 11/16/17 16:04 • (LCSD) R3266786-3 11/16/17 16:04

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Dissolved Solids | 8800 | 8460 | 8450 | 96.1 | 96.0 | 85.0-115 | | | 0.118 | 5 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3265905-1 11/14/17 23:10

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Suspended Solids | U | | 0.350 | 2.50 |

## L950208-01 Original Sample (OS) • Duplicate (DUP)

(OS) L950208-01 11/14/17 23:10 • (DUP) R3265905-4 11/14/17 23:10

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 7.00 | 7.50 | 1 | 6.90 | P1 | 5 |

## L950211-01 Original Sample (OS) • Duplicate (DUP)

(OS) L950211-01 11/14/17 23:10 • (DUP) R3265905-5 11/14/17 23:10

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 39.3 | 40.8 | 1 | 3.75 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3265905-2 11/14/17 23:10 • (LCSD) R3265905-3 11/14/17 23:10

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Suspended Solids | 773 | 856 | 884 | 111 | 114 | 85.0-115 | | | 3.22 | 5 |

## Method Blank (MB)

(MB) R3266269-1 11/16/17 15:53

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 4.74 | J | 1.43 | 30.0 |

## L950185-01 Original Sample (OS) • Duplicate (DUP)

(OS) L950185-01 11/16/17 15:56 • (DUP) R3266269-4 11/16/17 15:57

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 54.3 | 56.0 | 1 | 3 | | 20 |

## L950240-03 Original Sample (OS) • Duplicate (DUP)

(OS) L950240-03 11/16/17 16:16 • (DUP) R3266269-5 11/16/17 16:17

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 61.8 | 62.3 | 1 | 1 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3266269-2 11/16/17 15:54 • (LCSD) R3266269-3 11/16/17 15:55

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 144 | 149 | 96 | 99 | 85-115 | | | 3 | 20 |

## L950240-04 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L950240-04 11/16/17 16:17 • (MS) R3266269-6 11/16/17 16:18 • (MSD) R3266269-7 11/16/17 16:19

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 49.1 | 181 | 185 | 88 | 91 | 1 | 80-120 | | | 2 | 20 |

Cp Tc Ss Cn Sr Qc Gl Al Sc

## Method Blank (MB)

(MB) R3264891-1 11/11/17 18:04

| Analyte | MB Result NTU | MB Qualifier | MB MDL NTU | MB RDL NTU |
|---|---|---|---|---|
| Turbidity | 0.0690 | J | 0.0310 | 0.300 |

## L950203-01 Original Sample (OS) • Duplicate (DUP)

(OS) L950203-01 11/11/17 18:04 • (DUP) R3264891-4 11/11/17 18:04

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 0.750 | 0.753 | 1 | 0.000 | | 20 |

## L950232-01 Original Sample (OS) • Duplicate (DUP)

(OS) L950232-01 11/11/17 18:04 • (DUP) R3264891-5 11/11/17 18:04

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 2.07 | 2.11 | 1 | 2.00 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3264891-2 11/11/17 18:04 • (LCSD) R3264891-3 11/11/17 18:04

| Analyte | Spike Amount NTU | LCS Result NTU | LCSD Result NTU | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Turbidity | 40.0 | 41.4 | 41.4 | 104 | 104 | 90.0-110 | | | 0.000 | 20 |

## L949986-01 Original Sample (OS) • Duplicate (DUP)

(OS) L949986-01 11/14/17 09:31 • (DUP) R3265451-2 11/14/17 09:41

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Alkalinity | 4500 | 4500 | 2.5 | 0.000 | | 20 |

Sample Narrative:

OS: Endpoint pH 4.5

DUP: Endpoint pH 4.5

## L950213-01 Original Sample (OS) • Duplicate (DUP)

(OS) L950213-01 11/14/17 13:33 • (DUP) R3265451-7 11/14/17 13:40

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Alkalinity | 52.7 | 47.3 | 1 | 11.0 | | 20 |

Sample Narrative:

OS: Endpoint pH 4.5

DUP: Endpoint pH 4.5

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3265451-3 11/14/17 11:07 • (LCSD) R3265451-6 11/14/17 12:42

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity | 100 | 109 | 99.7 | 109 | 100 | 85.0-115 | | | 9.00 | 20 |

Sample Narrative:

LCS: Endpoint pH 4.5

LCSD: Endpoint pH 4.5

## L949499-01 Original Sample (OS) • Duplicate (DUP)

(OS) L949499-01 11/14/17 09:51 • (DUP) R3265368-3 11/14/17 09:51

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 6.60 | 6.60 | 1 | 0.000 | | 1 |

Sample Narrative:

OS: 6.6 at 12.1C

DUP: 6.6 at 12C

## L950232-01 Original Sample (OS) • Duplicate (DUP)

(OS) L950232-01 11/14/17 09:51 • (DUP) R3265368-4 11/14/17 09:51

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 6.13 | 6.14 | 1 | 0.163 | | 1 |

Sample Narrative:

OS: 6.13 at 18.6C

DUP: 6.14 at 18.7C

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3265368-1 11/14/17 09:51 • (LCSD) R3265368-2 11/14/17 09:51

| Analyte | Spike Amount su | LCS Result su | LCSD Result su | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | 5.96 | 6.01 | 5.98 | 101 | 100 | 98.3-102 | | | 0.500 | 1 |

Sample Narrative:

LCS: 6.01 at 18.9C

LCSD: 5.98 at 18.8C

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) WG1043753-1 11/16/17 16:57

| Analyte | MB Result umhos/cm | MB Qualifier | MB MDL umhos/cm | MB RDL umhos/cm |
|---|---|---|---|---|
| Specific Conductance | U | | 10.0 | 10.0 |

## L950203-01 Original Sample (OS) • Duplicate (DUP)

(OS) L950203-01 11/16/17 16:57 • (DUP) WG1043753-4 11/16/17 16:57

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 664 | 664 | 1 | 0.000 | | 20 |

## L950373-02 Original Sample (OS) • Duplicate (DUP)

(OS) L950373-02 11/16/17 16:57 • (DUP) WG1043753-5 11/16/17 16:57

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 3350 | 3350 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG1043753-2 11/16/17 16:57 • (LCSD) WG1043753-3 11/16/17 16:57

| Analyte | Spike Amount umhos/cm | LCS Result umhos/cm | LCSD Result umhos/cm | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Specific Conductance | 559 | 554 | 554 | 99.1 | 99.1 | 85.0-115 | | | 0.000 | 20 |

## Method Blank (MB)

(MB) R3265237-1 11/13/17 09:40

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Bromide | U | | 0.079 | 1.00 |
| Chloride | U | | 0.0519 | 1.00 |
| Sulfate | U | | 0.0774 | 5.00 |

## L950205-01 Original Sample (OS) • Duplicate (DUP)

(OS) L950205-01 11/13/17 11:54 • (DUP) R3265237-4 11/13/17 12:07

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | ND | 0.000 | 1 | 0 | | 15 |
| Chloride | 16.8 | 16.8 | 1 | 0 | | 15 |
| Sulfate | 19.9 | 19.8 | 1 | 0 | | 15 |

## L950216-01 Original Sample (OS) • Duplicate (DUP)

(OS) L950216-01 11/13/17 15:55 • (DUP) R3265237-7 11/13/17 16:08

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | ND | 0.104 | 1 | 4 | J | 15 |
| Chloride | 23.1 | 23.4 | 1 | 1 | | 15 |
| Sulfate | 21.9 | 21.9 | 1 | 0 | | 15 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3265237-2 11/13/17 09:53 • (LCSD) R3265237-3 11/13/17 10:06

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 40.0 | 40.0 | 40.0 | 100 | 100 | 80-120 | | | 0 | 15 |
| Chloride | 40.0 | 39.6 | 39.5 | 99 | 99 | 80-120 | | | 0 | 15 |
| Sulfate | 40.0 | 39.9 | 39.7 | 100 | 99 | 80-120 | | | 0 | 15 |

## L950205-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L950205-01 11/13/17 11:54 • (MS) R3265237-5 11/13/17 12:47 • (MSD) R3265237-6 11/13/17 13:01

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | ND | 47.1 | 48.0 | 94 | 96 | 1 | 80-120 | | | 2 | 15 |
| Chloride | 50.0 | 16.8 | 66.9 | 67.2 | 100 | 101 | 1 | 80-120 | | | 1 | 15 |
| Sulfate | 50.0 | 19.9 | 69.7 | 70.0 | 100 | 100 | 1 | 80-120 | | | 0 | 15 |

## L950216-01 Original Sample (OS) • Matrix Spike (MS)

(OS) L950216-01 11/13/17 15:55 • (MS) R3265237-8 11/13/17 16:22

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MS Rec. % | Dilution | Rec. Limits % | MS Qualifier |
|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | ND | 49.6 | 99 | 1 | 80-120 | |
| Chloride | 50.0 | 23.1 | 73.1 | 100 | 1 | 80-120 | |
| Sulfate | 50.0 | 21.9 | 72.2 | 101 | 1 | 80-120 | |

## Method Blank (MB)

(MB) R3265597-1 11/14/17 15:54

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Barium | U | | 0.0017 | 0.00500 |
| Calcium | U | | 0.0463 | 1.00 |
| Iron | U | | 0.0141 | 0.100 |
| Magnesium | U | | 0.0111 | 1.00 |
| Manganese | U | | 0.0012 | 0.0100 |
| Potassium | U | | 0.102 | 1.00 |
| Sodium | U | | 0.0985 | 1.00 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3265597-2 11/14/17 15:57 • (LCSD) R3265597-3 11/14/17 16:00

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 1.00 | 0.996 | 100 | 100 | 80-120 | | | 1 | 20 |
| Calcium | 10.0 | 9.80 | 9.71 | 98 | 97 | 80-120 | | | 1 | 20 |
| Iron | 10.0 | 9.81 | 9.73 | 98 | 97 | 80-120 | | | 1 | 20 |
| Magnesium | 10.0 | 10.2 | 10.1 | 102 | 101 | 80-120 | | | 1 | 20 |
| Manganese | 1.00 | 0.944 | 0.940 | 94 | 94 | 80-120 | | | 0 | 20 |
| Potassium | 10.0 | 9.72 | 9.60 | 97 | 96 | 80-120 | | | 1 | 20 |
| Sodium | 10.0 | 9.53 | 9.41 | 95 | 94 | 80-120 | | | 1 | 20 |

## L950114-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L950114-01 11/14/17 16:04 • (MS) R3265597-5 11/14/17 16:10 • (MSD) R3265597-6 11/14/17 16:14

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 0.0296 | 1.01 | 1.01 | 98 | 98 | 1 | 75-125 | | | 1 | 20 |
| Calcium | 10.0 | 2.68 | 12.2 | 12.0 | 95 | 94 | 1 | 75-125 | | | 1 | 20 |
| Iron | 10.0 | 18.3 | 30.4 | 30.2 | 121 | 119 | 1 | 75-125 | | | 1 | 20 |
| Magnesium | 10.0 | 7.37 | 17.1 | 16.9 | 97 | 96 | 1 | 75-125 | | | 1 | 20 |
| Manganese | 1.00 | 5.60 | 6.28 | 6.29 | 68 | 68 | 1 | 75-125 | V | V | 0 | 20 |
| Potassium | 10.0 | ND | 10.2 | 10.2 | 95 | 94 | 1 | 75-125 | | | 0 | 20 |
| Sodium | 10.0 | 130 | 136 | 135 | 68 | 59 | 1 | 75-125 | V | V | 1 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3265632-1 11/14/17 11:48

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Methane | U | | 0.00291 | 0.0100 |
| Ethane | U | | 0.00407 | 0.0130 |
| Ethene | U | | 0.00426 | 0.0130 |
| Propane | U | | 0.00548 | 0.0190 |

## L950216-01 Original Sample (OS) • Duplicate (DUP)

(OS) L950216-01 11/14/17 13:52 • (DUP) R3265632-2 11/14/17 14:17

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## L950236-07 Original Sample (OS) • Duplicate (DUP)

(OS) L950236-07 11/14/17 14:35 • (DUP) R3265632-3 11/14/17 15:03

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | 0.0333 | 0.0292 | 1 | 13.2 | | 20 |
| Ethane | U | 0.000 | 1 | 0.000 | | 20 |
| Ethene | U | 0.000 | 1 | 0.000 | | 20 |
| Propane | U | 0.000 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3265632-4 11/14/17 16:04 • (LCSD) R3265632-5 11/14/17 16:07

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Methane | 0.0678 | 0.0734 | 0.0706 | 108 | 104 | 85.0-115 | | | 3.93 | 20 |
| Ethane | 0.129 | 0.114 | 0.115 | 88.3 | 89.4 | 85.0-115 | | | 1.20 | 20 |
| Ethene | 0.127 | 0.115 | 0.117 | 90.9 | 92.1 | 85.0-115 | | | 1.23 | 20 |
| Propane | 0.186 | 0.185 | 0.187 | 99.5 | 101 | 85.0-115 | | | 1.13 | 20 |

## Method Blank (MB)

(MB) R3265789-2 11/12/17 15:32

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Benzene | U | | 0.000331 | 0.00100 |
| Ethylbenzene | U | | 0.000384 | 0.00100 |
| Toluene | U | | 0.000412 | 0.00100 |
| Xylenes, Total | U | | 0.00106 | 0.00300 |
| *(S) Toluene-d8* | *105* | | | *80.0-120* |
| *(S) Dibromofluoromethane* | *85.9* | | | *76.0-123* |
| *(S) a,a,a-Trifluorotoluene* | *115* | | | *80.0-120* |
| *(S) 4-Bromofluorobenzene* | *98.4* | | | *80.0-120* |

## Laboratory Control Sample (LCS)

(LCS) R3265789-1 11/12/17 14:54

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCS Rec. % | Rec. Limits % | LCS Qualifier |
|---|---|---|---|---|---|
| Benzene | 0.0250 | 0.0213 | 85.1 | 69.0-123 | |
| Ethylbenzene | 0.0250 | 0.0237 | 94.9 | 77.0-120 | |
| Toluene | 0.0250 | 0.0231 | 92.6 | 77.0-120 | |
| Xylenes, Total | 0.0750 | 0.0730 | 97.3 | 77.0-120 | |
| *(S) Toluene-d8* | | | *101* | *80.0-120* | |
| *(S) Dibromofluoromethane* | | | *87.7* | *76.0-123* | |
| *(S) a,a,a-Trifluorotoluene* | | | *112* | *80.0-120* | |
| *(S) 4-Bromofluorobenzene* | | | *94.2* | *80.0-120* | |

## Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

## Abbreviations and Definitions

| | |
|---|---|
| MDL | Method Detection Limit. |
| ND | Not detected at the Reporting Limit (or MDL where applicable). |
| RDL | Reported Detection Limit. |
| Rec. | Recovery. |
| RPD | Relative Percent Difference. |
| SDG | Sample Delivery Group. |
| (S) | Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media. |
| U | Not detected at the Reporting Limit (or MDL where applicable). |
| Analyte | The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported. |
| Dilution | If the sample matrix contains an interfering material, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor. |
| Limits | These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges. |
| Original Sample | The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG. |
| Qualifier | This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable. |
| Result | The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state "ND" (Not Detected) or "BDL" (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte. |
| Case Narrative (Cn) | A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report. |
| Quality Control Summary (Qc) | This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material. |
| Sample Chain of Custody (Sc) | This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis. |
| Sample Results (Sr) | This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported. |
| Sample Summary (Ss) | This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis. |

| Qualifier | Description |
|---|---|
| J | The identification of the analyte is acceptable; the reported value is an estimate. |
| P1 | RPD value not applicable for sample concentrations less than 5 times the reporting limit. |
| T8 | Sample(s) received past/too close to holding time expiration. |
| V | The sample concentration is too high to evaluate accurate spike recoveries. |

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE.**
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

## State Accreditations

| | |
|---|---|
| Alabama | 40660 |
| Alaska | UST-080 |
| Arizona | AZ0612 |
| Arkansas | 88-0469 |
| California | 01157CA |
| Colorado | TN00003 |
| Conneticut | PH-0197 |
| Florida | E87487 |
| Georgia | NELAP |
| Georgia [1] | 923 |
| Idaho | TN00003 |
| Illinois | 200008 |
| Indiana | C-TN-01 |
| Iowa | 364 |
| Kansas | E-10277 |
| Kentucky [1] | 90010 |
| Kentucky [2] | 16 |
| Louisiana | AI30792 |
| Maine | TN0002 |
| Maryland | 324 |
| Massachusetts | M-TN003 |
| Michigan | 9958 |
| Minnesota | 047-999-395 |
| Mississippi | TN00003 |
| Missouri | 340 |
| Montana | CERT0086 |
| Nebraska | NE-OS-15-05 |
| Nevada | TN-03-2002-34 |
| New Hampshire | 2975 |
| New Jersey–NELAP | TN002 |
| New Mexico | TN00003 |
| New York | 11742 |
| North Carolina | Env375 |
| North Carolina [1] | DW21704 |
| North Carolina [2] | 41 |
| North Dakota | R-140 |
| Ohio–VAP | CL0069 |
| Oklahoma | 9915 |
| Oregon | TN200002 |
| Pennsylvania | 68-02979 |
| Rhode Island | 221 |
| South Carolina | 84004 |
| South Dakota | n/a |
| Tennessee [1,4] | 2006 |
| Texas | T 104704245-07-TX |
| Texas [5] | LAB0152 |
| Utah | 6157585858 |
| Vermont | VT2006 |
| Virginia | 109 |
| Washington | C1915 |
| West Virginia | 233 |
| Wisconsin | 9980939910 |
| Wyoming | A2LA |

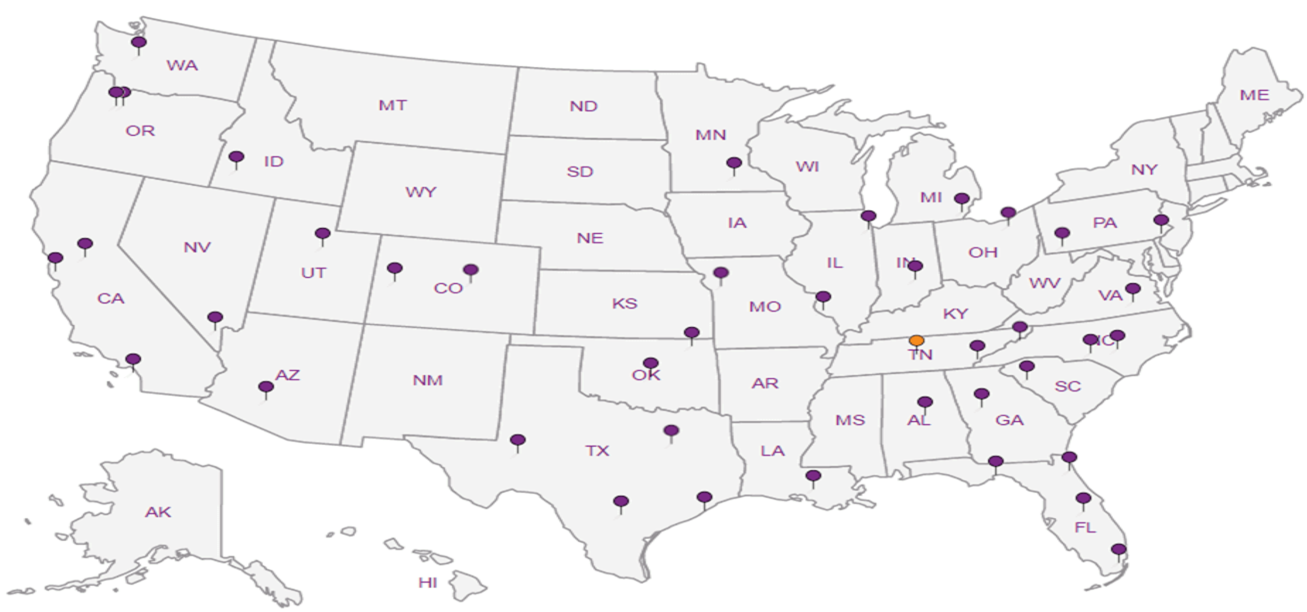
## Third Party & Federal Accreditations

| | |
|---|---|
| A2LA – ISO 17025 | 1461.01 |
| A2LA – ISO 17025 [5] | 1461.02 |
| Canada | 1461.01 |
| EPA–Crypto | TN00003 |
| AIHA-LAP,LLC | 100789 |
| DOD | 1461.01 |
| USDA | S-67674 |

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [n/a] Accreditation not applicable

## Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**



**GES, Inc. - Sunoco**

**440 Creamery Way, Suite 500**
**Exton, PA 19341**

Billing Information:
Accounts Payable
440 Creamery Way, Suite 500
Exton, PA 19341

Pres Chk

Report to:
**Holly Smoker**

Email To:
sgrillo@gesonline.com, hsmoker@geso

Project Description: **Pre-Construction Sampling**

City/State Collected: Williamsburg, PA

Phone: 406-578-4501
Fax:

Client Project #: 0204728 -06-160-XX

Lab Project #: SUNGES-GRILLO

Collected by (print): Kim Lapszynski

Site/Facility ID #

P.O. #

Collected by (signature): Kim Lapszynski

Immediately Packed on Ice N ___ Y _X_

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day

Quote #

Date Results Needed
**Standard TAT**

Analysis / Container / Preservative

| Sample ID | Comp/Grab | Matrix * | Depth | Date | Time | No. of Cntrs | **pH,SPCON,TDS,TURB* 250ml plastic NP | ALK, Br, Cl, SO4 250ml plastic NP | Total Mtls, Hardness 250ml plastic HNO3 | RSK175 + Propane 40ml vial w/ HCL | TSS 1L plastic NP | V8260BTEX 40ml vial w/ HCL | ****DW COLILERT**** microbiological | ****DW Fecal**** microbiological | | | Remarks | Sample # (lab only) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 111020171631-01 | G | DW | — | 11/10/17 | 1115 | 12 | X | X | X | X | X | X | X | X | | | | -01 |

Chain of Custody Page ___ of ___

ESC LAB SCIENCES

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L# L950212

Table: C206

Acctnum: SUNGES
Template: T126128
Prelogin: P611030
TSR: 134 - Mark Beasley
PB:
Shipped Via:

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other ________

Remarks:
Metals = Ba,Ca,Fe,K,Mg,Mn,Na
****Log COLILERT & FC as DW matrix****

pH ______ Temp ______
Flow ______ Other ______

Samples returned via:
___ UPS _X_ FedEx ___ Courier ________

Tracking # 7474 0935 9370

Sample Receipt Checklist
COC Seal Present/Intact: NP _Y_ _N
COC Signed/Accurate: _Y_ _N
Bottles arrive intact: _Y_ _N
Correct bottles used: _Y_ _N
Sufficient volume sent: _Y_ _N
If Applicable
VOA Zero Headspace: _Y_ _N
Preservation Correct/Checked: _Y_ _N

| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | | |
|---|---|---|---|---|---|
| Kim Lapszynski | 11/10/17 | 1620 | Fed Ex 11/10/17 1620 | Trip Blank Received: Yes / No HCL / MeoH TBR | |
| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Temp: 2.3° °C 40/1 | Bottles Received: 12 |
| Relinquished by: (Signature) | Date: | Time: | Received for lab by: (Signature) Kelly Menn 841 | Date: 11/11/17 | Time: 0845 |

If preservation required by Login: Date/Time

Hold:

Condition: NCF / OK

# ANALYTICAL REPORT

December 05, 2017

## GES, Inc - Sunoco

| | |
|---|---|
| Sample Delivery Group: | L953351 |
| Samples Received: | 11/28/2017 |
| Project Number: | 0204728-06-160-XX |
| Description: | Pre-Construction Sampling |
| | |
| Report To: | Holly Smoker |
| | 440 Creamery Way, Ste 500 |
| | Exton, PA  19341 |

Entire Report Reviewed By:

Mark W. Beasley

Technical Service Representative



# TABLE OF CONTENTS


| | |
|---|---|
| Cp: Cover Page | 1 |
| Tc: Table of Contents | 2 |
| Ss: Sample Summary | 3 |
| Cn: Case Narrative | 4 |
| Sr: Sample Results | 5 |
| 11272017-612-01 L953351-01 | 5 |
| Qc: Quality Control Summary | 7 |
| Gravimetric Analysis by Method 2540 C-2011 | 7 |
| Gravimetric Analysis by Method 2540 D-2011 | 8 |
| Wet Chemistry by Method 130.1 | 9 |
| Wet Chemistry by Method 2130 B-2011 | 10 |
| Wet Chemistry by Method 2320 B-2011 | 11 |
| Wet Chemistry by Method 9040C | 12 |
| Wet Chemistry by Method 9050A | 13 |
| Wet Chemistry by Method 9056A | 14 |
| Metals (ICP) by Method 6010B | 15 |
| Volatile Organic Compounds (GC) by Method RSK175 | 16 |
| Volatile Organic Compounds (GC/MS) by Method 8260B | 17 |
| Gl: Glossary of Terms | 18 |
| Al: Accreditations & Locations | 19 |
| Sc: Sample Chain of Custody | 20 |

| | Collected by | Collected date/time | Received date/time |
|---|---|---|---|
| 11272017-612-01 L953351-01 GW | Malcolm Morrin | 11/27/17 14:00 | 11/28/17 08:45 |

| Method | Batch | Dilution | Preparation date/time | Analysis date/time | Analyst |
|---|---|---|---|---|---|
| Microbiology by Method 9222D | WG1047137 | 1 | 11/28/17 15:26 | 11/28/17 15:26 | BGE |
| Microbiology by Method 9223 B-1997 | WG1047143 | 1 | 11/28/17 14:42 | 11/28/17 14:42 | BGE |
| Gravimetric Analysis by Method 2540 C-2011 | WG1047059 | 1 | 11/29/17 16:41 | 11/29/17 19:43 | BS |
| Gravimetric Analysis by Method 2540 D-2011 | WG1047052 | 1 | 11/29/17 14:07 | 11/29/17 14:34 | MMF |
| Wet Chemistry by Method 130.1 | WG1046906 | 5 | 11/28/17 15:21 | 11/28/17 15:21 | KK |
| Wet Chemistry by Method 2130 B-2011 | WG1047040 | 1 | 11/28/17 16:14 | 11/28/17 16:14 | ER |
| Wet Chemistry by Method 2320 B-2011 | WG1047131 | 1 | 11/29/17 17:28 | 11/29/17 17:28 | MCG |
| Wet Chemistry by Method 9040C | WG1046785 | 1 | 11/28/17 14:16 | 11/28/17 14:16 | GB |
| Wet Chemistry by Method 9050A | WG1046713 | 1 | 11/29/17 03:40 | 11/29/17 03:40 | JLJ |
| Wet Chemistry by Method 9056A | WG1047115 | 1 | 11/29/17 12:04 | 11/29/17 12:04 | DR |
| Wet Chemistry by Method 9056A | WG1047115 | 5 | 11/29/17 13:16 | 11/29/17 13:16 | DR |
| Metals (ICP) by Method 6010B | WG1046977 | 1 | 11/28/17 21:20 | 11/29/17 09:04 | CCE |
| Volatile Organic Compounds (GC) by Method RSK175 | WG1047013 | 1 | 11/29/17 11:00 | 11/29/17 11:00 | BG |
| Volatile Organic Compounds (GC/MS) by Method 8260B | WG1047058 | 1 | 11/28/17 18:27 | 11/28/17 18:27 | LRL |

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Mark W. Beasley
Technical Service Representative

## Microbiology by Method 9222D

| Analyte | Result col/100ml | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| Coliform,fecal | <1 | | 1 | 11/28/2017 15:26 | WG1047137 |

## Microbiology by Method 9223 B-1997

| Analyte | Result MPN/100ml | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| E.Coli | <1 | | 1 | 11/28/2017 14:42 | WG1047143 |
| Coliform,Total | 45.7 | | 1 | 11/28/2017 14:42 | WG1047143 |

## Gravimetric Analysis by Method 2540 C-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Dissolved Solids | 672 | | 10.0 | 1 | 11/29/2017 19:43 | WG1047059 |

## Gravimetric Analysis by Method 2540 D-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Suspended Solids | ND | | 2.50 | 1 | 11/29/2017 14:34 | WG1047052 |

**Sample Narrative:**

L953351-01 WG1047052: Used all available sample.

## Wet Chemistry by Method 130.1

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 500 | | 150 | 5 | 11/28/2017 15:21 | WG1046906 |

## Wet Chemistry by Method 2130 B-2011

| Analyte | Result NTU | Qualifier | RDL NTU | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Turbidity | ND | | 0.300 | 1 | 11/28/2017 16:14 | WG1047040 |

## Wet Chemistry by Method 2320 B-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Alkalinity | 376 | | 20.0 | 1 | 11/29/2017 17:28 | WG1047131 |

**Sample Narrative:**

L953351-01 WG1047131: Endpoint pH 4.5

## Wet Chemistry by Method 9040C

| Analyte | Result su | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| pH | 7.40 | T8 | 1 | 11/28/2017 14:16 | WG1046785 |

**Sample Narrative:**

L953351-01 WG1046785: 7.4 at 18.5C

## Wet Chemistry by Method 9050A

| Analyte | Result umhos/cm | Qualifier | RDL umhos/cm | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Specific Conductance | 1210 | | 10.0 | 1 | 11/29/2017 03:40 | WG1046713 |

## Wet Chemistry by Method 9056A

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Bromide | ND | | 1.00 | 1 | 11/29/2017 12:04 | WG1047115 |
| Chloride | 134 | | 5.00 | 5 | 11/29/2017 13:16 | WG1047115 |
| Sulfate | 30.7 | | 5.00 | 1 | 11/29/2017 12:04 | WG1047115 |

## Metals (ICP) by Method 6010B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Barium | 0.0775 | | 0.00500 | 1 | 11/29/2017 09:04 | WG1046977 |
| Calcium | 104 | | 1.00 | 1 | 11/29/2017 09:04 | WG1046977 |
| Iron | ND | | 0.100 | 1 | 11/29/2017 09:04 | WG1046977 |
| Magnesium | 53.4 | | 1.00 | 1 | 11/29/2017 09:04 | WG1046977 |
| Manganese | ND | | 0.0100 | 1 | 11/29/2017 09:04 | WG1046977 |
| Potassium | 3.31 | | 1.00 | 1 | 11/29/2017 09:04 | WG1046977 |
| Sodium | 73.7 | | 1.00 | 1 | 11/29/2017 09:04 | WG1046977 |

## Volatile Organic Compounds (GC) by Method RSK175

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Methane | ND | | 0.0100 | 1 | 11/29/2017 11:00 | WG1047013 |
| Ethane | ND | | 0.0130 | 1 | 11/29/2017 11:00 | WG1047013 |
| Ethene | ND | | 0.0130 | 1 | 11/29/2017 11:00 | WG1047013 |
| Propane | ND | | 0.0190 | 1 | 11/29/2017 11:00 | WG1047013 |

## Volatile Organic Compounds (GC/MS) by Method 8260B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Benzene | ND | | 0.00100 | 1 | 11/28/2017 18:27 | WG1047058 |
| Toluene | ND | | 0.00100 | 1 | 11/28/2017 18:27 | WG1047058 |
| Ethylbenzene | ND | | 0.00100 | 1 | 11/28/2017 18:27 | WG1047058 |
| Total Xylenes | ND | | 0.00300 | 1 | 11/28/2017 18:27 | WG1047058 |
| *(S) Toluene-d8* | *109* | | *80.0-120* | | *11/28/2017 18:27* | WG1047058 |
| *(S) Dibromofluoromethane* | *94.1* | | *76.0-123* | | *11/28/2017 18:27* | WG1047058 |
| *(S) a,a,a-Trifluorotoluene* | *100* | | *80.0-120* | | *11/28/2017 18:27* | WG1047058 |
| *(S) 4-Bromofluorobenzene* | *99.9* | | *80.0-120* | | *11/28/2017 18:27* | WG1047058 |

## Method Blank (MB)

(MB) R3269507-1 11/29/17 19:43

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Dissolved Solids | U | | 2.82 | 10.0 |

## L953348-01 Original Sample (OS) • Duplicate (DUP)

(OS) L953348-01 11/29/17 19:43 • (DUP) R3269507-4 11/29/17 19:43

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Dissolved Solids | 5400 | 5450 | 1 | 0.922 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3269507-2 11/29/17 19:43 • (LCSD) R3269507-3 11/29/17 19:43

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Dissolved Solids | 8800 | 8680 | 8770 | 98.6 | 99.7 | 85.0-115 | | | 1.03 | 5 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3269338-1 11/29/17 14:34

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Suspended Solids | U | | 0.350 | 2.50 |

## L953339-01 Original Sample (OS) • Duplicate (DUP)

(OS) L953339-01 11/29/17 14:34 • (DUP) R3269338-4 11/29/17 14:34

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 532 | 492 | 1 | 7.81 | J3 | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3269338-2 11/29/17 14:34 • (LCSD) R3269338-3 11/29/17 14:34

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Suspended Solids | 773 | 776 | 744 | 100 | 96.2 | 85.0-115 | | | 4.21 | 5 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3268850-1 11/28/17 14:33

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 3.82 | J | 1.43 | 30.0 |

## L953326-01 Original Sample (OS) • Duplicate (DUP)

(OS) L953326-01 11/28/17 14:39 • (DUP) R3268850-4 11/28/17 14:40

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 176 | 176 | 1 | 0 | | 20 |

## L953377-01 Original Sample (OS) • Duplicate (DUP)

(OS) L953377-01 11/28/17 15:23 • (DUP) R3268850-8 11/28/17 15:24

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 319 | 298 | 5 | 7 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3268850-2 11/28/17 14:34 • (LCSD) R3268850-3 11/28/17 14:34

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 153 | 153 | 102 | 102 | 85-115 | | | 0 | 20 |

## Method Blank (MB)

(MB) R3268842-1 11/28/17 16:14

| Analyte | MB Result NTU | MB Qualifier | MB MDL NTU | MB RDL NTU |
|---|---|---|---|---|
| Turbidity | 0.0520 | J | 0.0310 | 0.300 |

## L953315-01 Original Sample (OS) • Duplicate (DUP)

(OS) L953315-01 11/28/17 16:14 • (DUP) R3268842-4 11/28/17 16:14

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 2.74 | 2.70 | 1 | 1.00 | | 20 |

## L953518-04 Original Sample (OS) • Duplicate (DUP)

(OS) L953518-04 11/28/17 16:14 • (DUP) R3268842-5 11/28/17 16:14

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 2.81 | 2.84 | 1 | 1.00 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3268842-2 11/28/17 16:14 • (LCSD) R3268842-3 11/28/17 16:14

| Analyte | Spike Amount NTU | LCS Result NTU | LCSD Result NTU | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Turbidity | 40.0 | 42.0 | 42.6 | 105 | 107 | 90.0-110 | | | 1.00 | 20 |

## L952780-01 Original Sample (OS) • Duplicate (DUP)

(OS) L952780-01 11/29/17 13:09 • (DUP) R3269450-1 11/29/17 13:15

| | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | | % | | % |
| Alkalinity | 122 | 122 | 1 | 0.0184 | | 20 |

Sample Narrative:

OS: Endpoint pH 4.5

DUP: Endpoint pH 4.5

## L953370-04 Original Sample (OS) • Duplicate (DUP)

(OS) L953370-04 11/29/17 17:13 • (DUP) R3269450-8 11/29/17 17:21

| | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | | % | | % |
| Alkalinity | 488 | 487 | 1 | 0.207 | | 20 |

Sample Narrative:

OS: Endpoint pH 4.5

DUP: Endpoint pH 4.5

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3269450-6 11/29/17 14:28 • (LCSD) R3269450-7 11/29/17 16:57

| | Spike Amount | LCS Result | LCSD Result | LCS Rec. | LCSD Rec. | Rec. Limits | LCS Qualifier | LCSD Qualifier | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | mg/l | % | % | % | | | % | % |
| Alkalinity | 100 | 103 | 102 | 103 | 102 | 85.0-115 | | | 1.33 | 20 |

Sample Narrative:

LCS: Endpoint pH 4.5

LCSD: Endpoint pH 4.5

## L952482-01 Original Sample (OS) • Duplicate (DUP)

(OS) L952482-01 11/28/17 14:16 • (DUP) R3268811-3 11/28/17 14:16

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 7.29 | 7.28 | 1 | 0.137 | | 1 |

Sample Narrative:
OS: 7.29 at 19.7C
DUP: 7.28 at 19.7C

## L953406-02 Original Sample (OS) • Duplicate (DUP)

(OS) L953406-02 11/28/17 14:16 • (DUP) R3268811-4 11/28/17 14:16

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 7.91 | 7.91 | 1 | 0.000 | | 1 |

Sample Narrative:
OS: 7.91 at 18.4C
DUP: 7.91 at 18.4C

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3268811-1 11/28/17 14:16 • (LCSD) R3268811-2 11/28/17 14:16

| Analyte | Spike Amount su | LCS Result su | LCSD Result su | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | 5.96 | 6.00 | 5.99 | 101 | 101 | 98.3-102 | | | 0.167 | 1 |

Sample Narrative:
LCS: 6 at 19.2C
LCSD: 5.99 at 19.2C

## Method Blank (MB)

(MB) WG1046713-1 11/29/17 03:40

| Analyte | MB Result umhos/cm | MB Qualifier | MB MDL umhos/cm | MB RDL umhos/cm |
|---|---|---|---|---|
| Specific Conductance | U | | 10.0 | 10.0 |

## L953315-01 Original Sample (OS) • Duplicate (DUP)

(OS) L953315-01 11/29/17 03:40 • (DUP) WG1046713-4 11/29/17 03:40

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 358 | 352 | 1 | 1.69 | | 20 |

## L953518-04 Original Sample (OS) • Duplicate (DUP)

(OS) L953518-04 11/29/17 03:40 • (DUP) WG1046713-5 11/29/17 03:40

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 511 | 504 | 1 | 1.38 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG1046713-2 11/29/17 03:40 • (LCSD) WG1046713-3 11/29/17 03:40

| Analyte | Spike Amount umhos/cm | LCS Result umhos/cm | LCSD Result umhos/cm | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Specific Conductance | 559 | 557 | 558 | 99.6 | 99.8 | 85.0-115 | | | 0.179 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3268924-1 11/28/17 10:38

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Bromide | U | | 0.079 | 1.00 |
| Chloride | 0.0991 | J | 0.0519 | 1.00 |
| Sulfate | 0.102 | J | 0.0774 | 5.00 |

## L953318-01 Original Sample (OS) • Duplicate (DUP)

(OS) L953318-01 11/29/17 10:23 • (DUP) R3268924-6 11/29/17 10:37

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | ND | 0.000 | 1 | 0 | | 15 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3268924-2 11/28/17 10:53 • (LCSD) R3268924-3 11/28/17 11:07

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 40.0 | 39.3 | 39.3 | 98 | 98 | 80-120 | | | 0 | 15 |
| Chloride | 40.0 | 39.2 | 39.2 | 98 | 98 | 80-120 | | | 0 | 15 |
| Sulfate | 40.0 | 39.6 | 39.5 | 99 | 99 | 80-120 | | | 0 | 15 |

## L953351-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L953351-01 11/29/17 12:04 • (MS) R3268924-7 11/29/17 12:47 • (MSD) R3268924-8 11/29/17 13:01

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | ND | 48.4 | 46.1 | 97 | 92 | 1 | 80-120 | | | 5 | 15 |

## Method Blank (MB)

(MB) R3269037-1 11/29/17 08:35

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Barium | U | | 0.0017 | 0.00500 |
| Calcium | U | | 0.0463 | 1.00 |
| Iron | U | | 0.0141 | 0.100 |
| Magnesium | U | | 0.0111 | 1.00 |
| Manganese | U | | 0.0012 | 0.0100 |
| Potassium | U | | 0.102 | 1.00 |
| Sodium | 0.135 | J | 0.0985 | 1.00 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3269037-2 11/29/17 08:38 • (LCSD) R3269037-3 11/29/17 08:41

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 1.00 | 0.986 | 100 | 99 | 80-120 | | | 2 | 20 |
| Calcium | 10.0 | 9.52 | 9.40 | 95 | 94 | 80-120 | | | 1 | 20 |
| Iron | 10.0 | 9.58 | 9.46 | 96 | 95 | 80-120 | | | 1 | 20 |
| Magnesium | 10.0 | 9.90 | 9.79 | 99 | 98 | 80-120 | | | 1 | 20 |
| Manganese | 1.00 | 0.949 | 0.939 | 95 | 94 | 80-120 | | | 1 | 20 |
| Potassium | 10.0 | 9.66 | 10.4 | 97 | 104 | 80-120 | | | 7 | 20 |
| Sodium | 10.0 | 9.68 | 9.70 | 97 | 97 | 80-120 | | | 0 | 20 |

## L953469-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L953469-01 11/29/17 08:45 • (MS) R3269037-5 11/29/17 08:51 • (MSD) R3269037-6 11/29/17 08:54

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 0.0680 | 1.05 | 1.06 | 98 | 99 | 1 | 75-125 | | | 1 | 20 |
| Calcium | 10.0 | 41.8 | 51.5 | 51.2 | 97 | 94 | 1 | 75-125 | | | 1 | 20 |
| Iron | 10.0 | 0.101 | 9.63 | 9.72 | 95 | 96 | 1 | 75-125 | | | 1 | 20 |
| Magnesium | 10.0 | 24.5 | 34.2 | 33.9 | 97 | 94 | 1 | 75-125 | | | 1 | 20 |
| Manganese | 1.00 | 1.20 | 2.11 | 2.13 | 92 | 93 | 1 | 75-125 | | | 1 | 20 |
| Potassium | 10.0 | 11.1 | 20.6 | 20.6 | 94 | 94 | 1 | 75-125 | | | 0 | 20 |
| Sodium | 10.0 | 68.8 | 77.6 | 78.2 | 88 | 94 | 1 | 75-125 | | | 1 | 20 |

## Method Blank (MB)

(MB) R3269058-1 11/29/17 09:42

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Methane | U | | 0.00291 | 0.0100 |
| Ethane | U | | 0.00407 | 0.0130 |
| Ethene | U | | 0.00426 | 0.0130 |
| Propane | U | | 0.00548 | 0.0190 |

## L952796-05 Original Sample (OS) • Duplicate (DUP)

(OS) L952796-05 11/29/17 10:17 • (DUP) R3269058-2 11/29/17 10:40

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | U | 0.000 | 1 | 0.000 | | 20 |
| Ethane | U | 0.000 | 1 | 0.000 | | 20 |
| Ethene | U | 0.000 | 1 | 0.000 | | 20 |
| Propane | U | 0.000 | 1 | 0.000 | | 20 |

## L953348-01 Original Sample (OS) • Duplicate (DUP)

(OS) L953348-01 11/29/17 10:53 • (DUP) R3269058-3 11/29/17 11:20

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3269058-4 11/29/17 11:23 • (LCSD) R3269058-5 11/29/17 11:25

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Methane | 0.0678 | 0.0723 | 0.0744 | 107 | 110 | 85.0-115 | | | 2.84 | 20 |
| Ethane | 0.129 | 0.112 | 0.115 | 86.7 | 89.2 | 85.0-115 | | | 2.84 | 20 |
| Ethene | 0.127 | 0.115 | 0.117 | 90.8 | 91.8 | 85.0-115 | | | 1.12 | 20 |
| Propane | 0.186 | 0.184 | 0.188 | 98.7 | 101 | 85.0-115 | | | 2.57 | 20 |

## Method Blank (MB)

(MB) R3269069-3 11/28/17 16:05

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Benzene | U | | 0.000331 | 0.00100 |
| Ethylbenzene | U | | 0.000384 | 0.00100 |
| Toluene | U | | 0.000412 | 0.00100 |
| Xylenes, Total | U | | 0.00106 | 0.00300 |
| *(S) Toluene-d8* | *109* | | | *80.0-120* |
| *(S) Dibromofluoromethane* | *90.8* | | | *76.0-123* |
| *(S) 4-Bromofluorobenzene* | *99.7* | | | *80.0-120* |
| *(S) a,a,a-Trifluorotoluene* | *99.5* | | | *80.0-120* |

## Laboratory Control Sample (LCS)

(LCS) R3269069-1 11/28/17 15:08

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCS Rec. % | Rec. Limits % | LCS Qualifier |
|---|---|---|---|---|---|
| Benzene | 0.0250 | 0.0224 | 89.7 | 69.0-123 | |
| Ethylbenzene | 0.0250 | 0.0268 | 107 | 77.0-120 | |
| Toluene | 0.0250 | 0.0261 | 104 | 77.0-120 | |
| Xylenes, Total | 0.0750 | 0.0799 | 107 | 77.0-120 | |
| *(S) Toluene-d8* | | | *108* | *80.0-120* | |
| *(S) Dibromofluoromethane* | | | *90.5* | *76.0-123* | |
| *(S) 4-Bromofluorobenzene* | | | *105* | *80.0-120* | |
| *(S) a,a,a-Trifluorotoluene* | | | *100* | *80.0-120* | |

## Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

## Abbreviations and Definitions

| | |
|---|---|
| MDL | Method Detection Limit. |
| ND | Not detected at the Reporting Limit (or MDL where applicable). |
| RDL | Reported Detection Limit. |
| Rec. | Recovery. |
| RPD | Relative Percent Difference. |
| SDG | Sample Delivery Group. |
| (S) | Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media. |
| U | Not detected at the Reporting Limit (or MDL where applicable). |
| Analyte | The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported. |
| Dilution | If the sample matrix contains an interfering material, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor. |
| Limits | These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges. |
| Original Sample | The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG. |
| Qualifier | This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable. |
| Result | The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state "ND" (Not Detected) or "BDL" (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte. |
| Case Narrative (Cn) | A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report. |
| Quality Control Summary (Qc) | This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material. |
| Sample Chain of Custody (Sc) | This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis. |
| Sample Results (Sr) | This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported. |
| Sample Summary (Ss) | This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis. |

| Qualifier | Description |
|---|---|
| J | The identification of the analyte is acceptable; the reported value is an estimate. |
| J3 | The associated batch QC was outside the established quality control range for precision. |
| T8 | Sample(s) received past/too close to holding time expiration. |

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE.**
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

## State Accreditations

| | |
|---|---|
| Alabama | 40660 |
| Alaska | UST-080 |
| Arizona | AZ0612 |
| Arkansas | 88-0469 |
| California | 01157CA |
| Colorado | TN00003 |
| Conneticut | PH-0197 |
| Florida | E87487 |
| Georgia | NELAP |
| Georgia [1] | 923 |
| Idaho | TN00003 |
| Illinois | 200008 |
| Indiana | C-TN-01 |
| Iowa | 364 |
| Kansas | E-10277 |
| Kentucky [1] | 90010 |
| Kentucky [2] | 16 |
| Louisiana | AI30792 |
| Maine | TN0002 |
| Maryland | 324 |
| Massachusetts | M-TN003 |
| Michigan | 9958 |
| Minnesota | 047-999-395 |
| Mississippi | TN00003 |
| Missouri | 340 |
| Montana | CERT0086 |
| Nebraska | NE-OS-15-05 |
| Nevada | TN-03-2002-34 |
| New Hampshire | 2975 |
| New Jersey–NELAP | TN002 |
| New Mexico | TN00003 |
| New York | 11742 |
| North Carolina | Env375 |
| North Carolina [1] | DW21704 |
| North Carolina [2] | 41 |
| North Dakota | R-140 |
| Ohio–VAP | CL0069 |
| Oklahoma | 9915 |
| Oregon | TN200002 |
| Pennsylvania | 68-02979 |
| Rhode Island | 221 |
| South Carolina | 84004 |
| South Dakota | n/a |
| Tennessee [1,4] | 2006 |
| Texas | T 104704245-07-TX |
| Texas [5] | LAB0152 |
| Utah | 6157585858 |
| Vermont | VT2006 |
| Virginia | 109 |
| Washington | C1915 |
| West Virginia | 233 |
| Wisconsin | 9980939910 |
| Wyoming | A2LA |

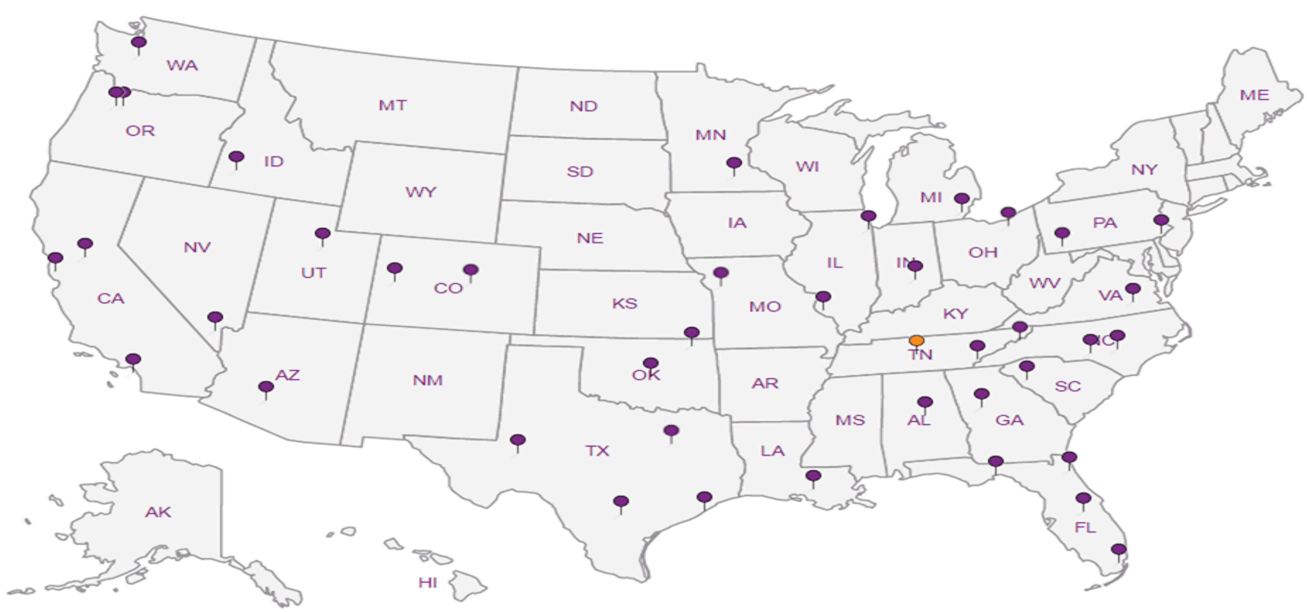
## Third Party & Federal Accreditations

| | |
|---|---|
| A2LA – ISO 17025 | 1461.01 |
| A2LA – ISO 17025 [5] | 1461.02 |
| Canada | 1461.01 |
| EPA–Crypto | TN00003 |
| AIHA-LAP,LLC | 100789 |
| DOD | 1461.01 |
| USDA | S-67674 |

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [n/a] Accreditation not applicable

## Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**



| | |
|---|---|
| **GES, Inc. - Sunoco**<br>440 Creamery Way, Suite 500<br>Exton, PA 19341 | Billing Information:<br>**Accounts Payable**<br>440 Creamery Way, Suite 500<br>Exton, PA 19341 |
| Report to: **Holly Smoker** | Email To: sgrillo@gesonline.com, hsmoker@geso |
| Project Description: **Pre-Construction Sampling** | City/State Collected: Williamsburg Pennsylvania |
| Phone: 406-578-4501<br>Fax: | Client Project # 0204728-06-160-XX |
| Lab Project # SUNGES-GRILLO | |
| Collected by (print): Malcolm Morgan | Site/Facility ID # |
| P.O. # | |
| Collected by (signature): Malcolm Morgan | Quote # |
| Immediately Packed on Ice N ___ Y X | Rush? (Lab MUST Be Notified) ___ Same Day ___ Five Day ___ Next Day ___ 5 Day (Rad Only) ___ Two Day ___ 10 Day (Rad Only) ___ Three Day |
| Date Results Needed: **Standard TAT** | |

Pres Chk

Analysis / Container / Preservative

Chain of Custody Page __ of __

ESC LAB SCIENCES

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L# 953351
H241

Acctnum: SUNGES
Template: T126128
Prelogin: P611030
TSR: 134 - Mark Beasley
PB:
Shipped Via:

| Sample ID | Comp/Grab | Matrix * | Depth | Date | Time | No. of Cntrs | **pH,SPCON,TDS,TURB* 250ml plastic NP | ALK, Br, Cl, SO4 250ml plastic NP | Total Mtls, Hardness 250ml plastic HNO3 | RSK175 + Propane 40ml vial w/ HCL | TSS 1L plastic NP | V8260BTEX 40ml vial w/ HCL | ****DW COLILERT**** microbiological | ****DW Fecal**** microbiological | Remarks | Sample # (lab only) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11272017-612-01 | Grab | DW | — | 11/27/17 | 1400 | 12 | X | X | X | X | X | X | X | X | | -01 |

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other ______

Remarks:
**Metals = Ba,Ca,Fe,K,Mg,Mn,Na**
******Log COLILERT & FC as DW matrix******

pH ______ Temp ______
Flow ______ Other ______

Samples returned via: ___ UPS X FedEx ___ Courier ______

Tracking # 4094 8308 1926

Sample Receipt Checklist:
COC Seal Present/Intact: NP Y N
COC Signed/Accurate: Y N
Bottles arrive intact: Y N
Correct bottles used: Y N
Sufficient volume sent: Y N
If Applicable
VOA Zero Headspace: Y N
Preservation Correct/Checked: Y N

| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Trip Blank Received: Yes / No HCL / MeoH TBR |
|---|---|---|---|---|
| Malcolm Morgan | 11/27/17 | 1815 | Fed-Ex 11/27/17 1815 | |
| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Temp: 0.6 °C Bottles Received: 12 |
| Relinquished by: (Signature) | Date: | Time: | Received for lab by: (Signature) Jennifer Boyd 836 | Date: 11.28.17 Time: 8.45 |

If preservation required by Login: Date/Time

Hold:

Condition: NCF / OK

# ANALYTICAL REPORT

January 25, 2018

## GES, Inc - Sunoco

| | |
|---|---|
| Sample Delivery Group: | L964144 |
| Samples Received: | 01/19/2018 |
| Project Number: | 0204728-06-160-XX |
| Description: | Pre-Construction Sampling |
| | |
| Report To: | Stephanie Grillo |
| | 440 Creamery Way, Ste 500 |
| | Exton, PA 19341 |

Entire Report Reviewed By:

Jason Romer

Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

# TABLE OF CONTENTS


| | |
|---|---|
| Cp: Cover Page | 1 |
| Tc: Table of Contents | 2 |
| Ss: Sample Summary | 3 |
| Cn: Case Narrative | 4 |
| Sr: Sample Results | 5 |
| 01182018-631-01 L964144-01 | 5 |
| Qc: Quality Control Summary | 7 |
| Gravimetric Analysis by Method 2540 C-2011 | 7 |
| Gravimetric Analysis by Method 2540 D-2011 | 8 |
| Wet Chemistry by Method 130.1 | 9 |
| Wet Chemistry by Method 2130 B-2011 | 10 |
| Wet Chemistry by Method 2320 B-2011 | 11 |
| Wet Chemistry by Method 9040C | 12 |
| Wet Chemistry by Method 9050A | 13 |
| Wet Chemistry by Method 9056A | 14 |
| Metals (ICP) by Method 6010B | 16 |
| Volatile Organic Compounds (GC) by Method RSK175 | 17 |
| Volatile Organic Compounds (GC/MS) by Method 8260B | 18 |
| Gl: Glossary of Terms | 19 |
| Al: Accreditations & Locations | 20 |
| Sc: Sample Chain of Custody | 21 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

| 01182018-631-01 L964144-01 GW | | | Collected by | Collected date/time | Received date/time |
|---|---|---|---|---|---|
| | | | Kim Lapszynski | 01/18/18 15:45 | 01/19/18 08:45 |

| Method | Batch | Dilution | Preparation date/time | Analysis date/time | Analyst |
|---|---|---|---|---|---|
| Microbiology by Method 9222D | WG1064766 | 1 | 01/19/18 11:05 | 01/19/18 11:05 | MH |
| Microbiology by Method 9223 B-1997 | WG1064764 | 1 | 01/19/18 10:42 | 01/19/18 10:42 | MH |
| Gravimetric Analysis by Method 2540 C-2011 | WG1064769 | 1 | 01/21/18 08:10 | 01/21/18 09:19 | BS |
| Gravimetric Analysis by Method 2540 D-2011 | WG1064550 | 1 | 01/20/18 11:46 | 01/20/18 14:00 | MMF |
| Wet Chemistry by Method 130.1 | WG1065087 | 5 | 01/22/18 16:46 | 01/22/18 16:46 | KK |
| Wet Chemistry by Method 2130 B-2011 | WG1064443 | 1 | 01/19/18 12:25 | 01/19/18 12:25 | ER |
| Wet Chemistry by Method 2320 B-2011 | WG1064509 | 1 | 01/22/18 16:28 | 01/22/18 16:28 | MCG |
| Wet Chemistry by Method 9040C | WG1064481 | 1 | 01/19/18 12:52 | 01/19/18 12:52 | ER |
| Wet Chemistry by Method 9050A | WG1064460 | 1 | 01/19/18 14:58 | 01/19/18 14:58 | MA |
| Wet Chemistry by Method 9056A | WG1064571 | 1 | 01/19/18 23:34 | 01/19/18 23:34 | MAJ |
| Wet Chemistry by Method 9056A | WG1064571 | 5 | 01/20/18 00:15 | 01/20/18 00:15 | MAJ |
| Metals (ICP) by Method 6010B | WG1064447 | 1 | 01/19/18 11:51 | 01/19/18 14:40 | TRB |
| Volatile Organic Compounds (GC) by Method RSK175 | WG1065147 | 1 | 01/23/18 11:25 | 01/23/18 11:25 | BG |
| Volatile Organic Compounds (GC/MS) by Method 8260B | WG1064480 | 1 | 01/19/18 16:56 | 01/19/18 16:56 | JBE |

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Jason Romer
Technical Service Representative

## Microbiology by Method 9222D

| Analyte | Result col/100ml | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| Coliform,fecal | <1 | | 1 | 01/19/2018 11:05 | WG1064766 |

## Microbiology by Method 9223 B-1997

| Analyte | Result MPN/100ml | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| E.Coli | 1.00 | | 1 | 01/19/2018 10:42 | WG1064764 |
| Coliform,Total | 126 | | 1 | 01/19/2018 10:42 | WG1064764 |

## Gravimetric Analysis by Method 2540 C-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Dissolved Solids | 668 | | 10.0 | 1 | 01/21/2018 09:19 | WG1064769 |

## Gravimetric Analysis by Method 2540 D-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Suspended Solids | ND | | 2.50 | 1 | 01/20/2018 14:00 | WG1064550 |

## Wet Chemistry by Method 130.1

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 453 | | 150 | 5 | 01/22/2018 16:46 | WG1065087 |

## Wet Chemistry by Method 2130 B-2011

| Analyte | Result NTU | Qualifier | RDL NTU | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Turbidity | 0.596 | | 0.300 | 1 | 01/19/2018 12:25 | WG1064443 |

## Wet Chemistry by Method 2320 B-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Alkalinity | 398 | | 20.0 | 1 | 01/22/2018 16:28 | WG1064509 |

**Sample Narrative:**

L964144-01 WG1064509: Endpoint pH 4.5

## Wet Chemistry by Method 9040C

| Analyte | Result su | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| pH | 7.18 | T8 | 1 | 01/19/2018 12:52 | WG1064481 |

**Sample Narrative:**

L964144-01 WG1064481: 7.18 at 14.4C

## Wet Chemistry by Method 9050A

| Analyte | Result umhos/cm | Qualifier | RDL umhos/cm | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Specific Conductance | 1240 | | 10.0 | 1 | 01/19/2018 14:58 | WG1064460 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Wet Chemistry by Method 9056A

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Bromide | ND | | 1.00 | 1 | 01/19/2018 23:34 | WG1064571 |
| Chloride | 133 | | 5.00 | 5 | 01/20/2018 00:15 | WG1064571 |
| Sulfate | 38.2 | | 5.00 | 1 | 01/19/2018 23:34 | WG1064571 |

## Metals (ICP) by Method 6010B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Barium | 0.0966 | | 0.00500 | 1 | 01/19/2018 14:40 | WG1064447 |
| Calcium | 103 | | 1.00 | 1 | 01/19/2018 14:40 | WG1064447 |
| Iron | ND | | 0.100 | 1 | 01/19/2018 14:40 | WG1064447 |
| Magnesium | 45.0 | | 1.00 | 1 | 01/19/2018 14:40 | WG1064447 |
| Manganese | 0.0369 | | 0.0100 | 1 | 01/19/2018 14:40 | WG1064447 |
| Potassium | 10.2 | | 1.00 | 1 | 01/19/2018 14:40 | WG1064447 |
| Sodium | 89.7 | | 1.00 | 1 | 01/19/2018 14:40 | WG1064447 |

## Volatile Organic Compounds (GC) by Method RSK175

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Methane | ND | | 0.0100 | 1 | 01/23/2018 11:25 | WG1065147 |
| Ethane | ND | | 0.0130 | 1 | 01/23/2018 11:25 | WG1065147 |
| Ethene | ND | | 0.0130 | 1 | 01/23/2018 11:25 | WG1065147 |
| Propane | ND | | 0.0190 | 1 | 01/23/2018 11:25 | WG1065147 |

## Volatile Organic Compounds (GC/MS) by Method 8260B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Benzene | ND | | 0.00100 | 1 | 01/19/2018 16:56 | WG1064480 |
| Toluene | ND | | 0.00100 | 1 | 01/19/2018 16:56 | WG1064480 |
| Ethylbenzene | ND | | 0.00100 | 1 | 01/19/2018 16:56 | WG1064480 |
| Total Xylenes | ND | | 0.00300 | 1 | 01/19/2018 16:56 | WG1064480 |
| *(S) Toluene-d8* | *109* | | *80.0-120* | | *01/19/2018 16:56* | WG1064480 |
| *(S) Dibromofluoromethane* | *88.0* | | *76.0-123* | | *01/19/2018 16:56* | WG1064480 |
| *(S) a,a,a-Trifluorotoluene* | *105* | | *80.0-120* | | *01/19/2018 16:56* | WG1064480 |
| *(S) 4-Bromofluorobenzene* | *105* | | *80.0-120* | | *01/19/2018 16:56* | WG1064480 |

## Method Blank (MB)

(MB) R3280848-1 01/21/18 09:19

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Dissolved Solids | 3.00 | J | 2.82 | 10.0 |

## L964121-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964121-01 01/21/18 09:19 • (DUP) R3280848-4 01/21/18 09:19

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Dissolved Solids | 3740 | 3740 | 1 | 0.134 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3280848-2 01/21/18 09:19 • (LCSD) R3280848-3 01/21/18 09:19

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Dissolved Solids | 8800 | 8580 | 8570 | 97.5 | 97.4 | 85.0-115 | | | 0.117 | 5 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3280651-1 01/20/18 14:00

| Analyte | MB Result | MB Qualifier | MB MDL | MB RDL |
|---|---|---|---|---|
| | mg/l | | mg/l | mg/l |
| Suspended Solids | U | | 0.350 | 2.50 |

## L964132-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964132-01 01/20/18 14:00 • (DUP) R3280651-4 01/20/18 14:00

| Analyte | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| | mg/l | mg/l | | % | | % |
| Suspended Solids | 170 | 176 | 1 | 3.47 | | 5 |

## L964138-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964138-01 01/20/18 14:00 • (DUP) R3280651-5 01/20/18 14:00

| Analyte | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| | mg/l | mg/l | | % | | % |
| Suspended Solids | 115 | 113 | 1 | 2.20 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3280651-2 01/20/18 14:00 • (LCSD) R3280651-3 01/20/18 14:00

| Analyte | Spike Amount | LCS Result | LCSD Result | LCS Rec. | LCSD Rec. | Rec. Limits | LCS Qualifier | LCSD Qualifier | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| | mg/l | mg/l | mg/l | % | % | % | | | % | % |
| Suspended Solids | 773 | 788 | 804 | 102 | 104 | 85.0-115 | | | 2.01 | 5 |

## Method Blank (MB)

(MB) R3280957-1 01/22/18 16:36

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 3.58 | J | 1.43 | 30.0 |

## L964128-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964128-01 01/22/18 16:42 • (DUP) R3280957-4 01/22/18 16:43

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 138 | 137 | 1 | 0.727 | | 20 |

## L964576-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964576-01 01/22/18 16:54 • (DUP) R3280957-7 01/22/18 16:56

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 62.0 | 64.3 | 1 | 3.64 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3280957-2 01/22/18 16:37 • (LCSD) R3280957-3 01/22/18 16:38

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 155 | 153 | 103 | 102 | 85-115 | | | 1.3 | 20 |

## L964362-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L964362-01 01/22/18 16:48 • (MS) R3280957-5 01/22/18 16:49 • (MSD) R3280957-6 01/22/18 16:50

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 64.3 | 199 | 198 | 89.8 | 89.1 | 1 | 80-120 | | | 0.504 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3280402-1 01/19/18 12:25

| Analyte | MB Result NTU | MB Qualifier | MB MDL NTU | MB RDL NTU |
|---|---|---|---|---|
| Turbidity | 0.0500 | J | 0.0310 | 0.300 |

## L962174-12 Original Sample (OS) • Duplicate (DUP)

(OS) L962174-12 01/19/18 12:25 • (DUP) R3280402-4 01/19/18 12:25

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 4.26 | 4.25 | 1 | 0.235 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3280402-2 01/19/18 12:25 • (LCSD) R3280402-3 01/19/18 12:25

| Analyte | Spike Amount NTU | LCS Result NTU | LCSD Result NTU | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Turbidity | 40.0 | 42.7 | 42.8 | 107 | 107 | 90.0-110 | | | 0.234 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3281008-2 01/22/18 10:25 • (LCSD) R3281008-3 01/22/18 11:49

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity | 100 | 104 | 102 | 104 | 102 | 85.0-115 | | | 1.15 | 20 |

**Sample Narrative:**

LCS: Endpoint pH 4.5

LCSD: Endpoint pH 4.5

## L964146-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964146-01 01/19/18 12:52 • (DUP) R3280423-4 01/19/18 12:52

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 6.45 | 6.41 | 1 | 0.622 | | 1 |

**Sample Narrative:**

OS: 6.45 at 15.4C

DUP: 6.41 at 15.5C

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3280423-1 01/19/18 12:52 • (LCSD) R3280423-2 01/19/18 12:52

| Analyte | Spike Amount su | LCS Result su | LCSD Result su | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | 6.38 | 6.39 | 6.38 | 100 | 100 | 98.4-102 | | | 0.157 | 1 |

**Sample Narrative:**

LCS: 6.39 at 16.8C

LCSD: 6.38 at 16.8C

## Method Blank (MB)

(MB) WG1064460-1 01/19/18 14:58

| Analyte | MB Result | MB Qualifier | MB MDL | MB RDL |
|---|---|---|---|---|
| | umhos/cm | | umhos/cm | umhos/cm |
| Specific Conductance | U | | 10.0 | 10.0 |

## L963877-01 Original Sample (OS) • Duplicate (DUP)

(OS) L963877-01 01/19/18 14:58 • (DUP) WG1064460-4 01/19/18 14:58

| Analyte | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| | umhos/cm | umhos/cm | | % | | % |
| Specific Conductance | 113 | 114 | 1 | 0.881 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG1064460-2 01/19/18 14:58 • (LCSD) WG1064460-3 01/19/18 14:58

| Analyte | Spike Amount | LCS Result | LCSD Result | LCS Rec. | LCSD Rec. | Rec. Limits | LCS Qualifier | LCSD Qualifier | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| | umhos/cm | umhos/cm | umhos/cm | % | % | % | | | % | % |
| Specific Conductance | 559 | 560 | 559 | 100 | 100 | 85.0-115 | | | 0.179 | 20 |

## Method Blank (MB)

(MB) R3280590-1 01/19/18 09:40

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Bromide | U | | 0.079 | 1.00 |
| Chloride | U | | 0.0519 | 1.00 |
| Sulfate | U | | 0.0774 | 5.00 |

## L964026-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964026-01 01/19/18 22:00 • (DUP) R3280590-4 01/19/18 22:14

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | ND | 0.000 | 1 | 0 | | 15 |
| Chloride | 19.4 | 19.2 | 1 | 1.18 | | 15 |
| Sulfate | 23.1 | 23.1 | 1 | 0.112 | | 15 |

## L964146-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964146-01 01/20/18 00:28 • (DUP) R3280590-7 01/20/18 00:41

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | ND | 0.000 | 1 | 0 | | 15 |
| Chloride | 4.96 | 4.92 | 1 | 0.808 | | 15 |
| Sulfate | 12.3 | 12.4 | 1 | 0.599 | | 15 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3280590-2 01/19/18 09:54 • (LCSD) R3280590-3 01/19/18 10:07

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 40.0 | 39.9 | 39.8 | 99.7 | 99.4 | 80-120 | | | 0.228 | 15 |
| Chloride | 40.0 | 39.8 | 39.6 | 99.5 | 99.1 | 80-120 | | | 0.433 | 15 |
| Sulfate | 40.0 | 40.1 | 40.0 | 100 | 100 | 80-120 | | | 0.228 | 15 |

## L964026-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L964026-01 01/19/18 22:00 • (MS) R3280590-5 01/19/18 22:27 • (MSD) R3280590-6 01/19/18 22:41

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | ND | 46.9 | 47.9 | 93.7 | 95.8 | 1 | 80-120 | | | 2.12 | 15 |
| Chloride | 50.0 | 19.4 | 70.3 | 70.2 | 102 | 102 | 1 | 80-120 | | | 0.0636 | 15 |
| Sulfate | 50.0 | 23.1 | 72.5 | 72.6 | 98.8 | 98.9 | 1 | 80-120 | | | 0.0464 | 15 |

## L964146-01 Original Sample (OS) • Matrix Spike (MS)

(OS) L964146-01 01/20/18 00:28 • (MS) R3280590-8 01/20/18 00:55

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MS Rec. % | Dilution | Rec. Limits % | MS Qualifier |
|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | ND | 48.1 | 96.3 | 1 | 80-120 | |
| Chloride | 50.0 | 4.96 | 55.7 | 101 | 1 | 80-120 | |
| Sulfate | 50.0 | 12.3 | 62.4 | 100 | 1 | 80-120 | |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3280489-1 01/19/18 14:05

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Barium | U | | 0.0017 | 0.00500 |
| Calcium | U | | 0.0463 | 1.00 |
| Iron | U | | 0.0141 | 0.100 |
| Magnesium | U | | 0.0111 | 1.00 |
| Manganese | U | | 0.0012 | 0.0100 |
| Potassium | U | | 0.102 | 1.00 |
| Sodium | U | | 0.0985 | 1.00 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3280489-2 01/19/18 14:08 • (LCSD) R3280489-3 01/19/18 14:11

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 1.02 | 1.03 | 102 | 103 | 80-120 | | | 0.761 | 20 |
| Calcium | 10.0 | 9.84 | 9.76 | 98.4 | 97.6 | 80-120 | | | 0.802 | 20 |
| Iron | 10.0 | 9.85 | 9.83 | 98.5 | 98.3 | 80-120 | | | 0.203 | 20 |
| Magnesium | 10.0 | 9.86 | 9.71 | 98.6 | 97.1 | 80-120 | | | 1.45 | 20 |
| Manganese | 1.00 | 0.999 | 0.999 | 99.9 | 99.9 | 80-120 | | | 0.0116 | 20 |
| Potassium | 10.0 | 9.67 | 9.56 | 96.7 | 95.6 | 80-120 | | | 1.12 | 20 |
| Sodium | 10.0 | 9.93 | 9.98 | 99.3 | 99.8 | 80-120 | | | 0.491 | 20 |

## L964181-02 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L964181-02 01/19/18 14:13 • (MS) R3280489-5 01/19/18 14:18 • (MSD) R3280489-6 01/19/18 14:21

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 0.0274 | 1.06 | 1.06 | 103 | 103 | 1 | 75-125 | | | 0.00729 | 20 |
| Calcium | 10.0 | 16.8 | 26.3 | 26.2 | 94.7 | 94 | 1 | 75-125 | | | 0.266 | 20 |
| Iron | 10.0 | 6.94 | 16.6 | 16.4 | 96.6 | 94.8 | 1 | 75-125 | | | 1.11 | 20 |
| Magnesium | 10.0 | 9.57 | 19.0 | 19.0 | 94.8 | 94.7 | 1 | 75-125 | | | 0.0306 | 20 |
| Manganese | 1.00 | 0.0400 | 1.04 | 1.05 | 100 | 101 | 1 | 75-125 | | | 0.777 | 20 |
| Potassium | 10.0 | ND | 9.80 | 9.84 | 96.2 | 96.6 | 1 | 75-125 | | | 0.443 | 20 |
| Sodium | 10.0 | 21.5 | 31.2 | 30.6 | 97.1 | 90.9 | 1 | 75-125 | | | 1.99 | 20 |

## Method Blank (MB)

(MB) R3281125-1 01/23/18 09:10

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Methane | U | | 0.00291 | 0.0100 |
| Ethane | U | | 0.00407 | 0.0130 |
| Ethene | U | | 0.00426 | 0.0130 |
| Propane | U | | 0.00548 | 0.0190 |

## L964075-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964075-01 01/23/18 10:27 • (DUP) R3281125-2 01/23/18 11:18

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | 1.34 | 1.31 | 1 | 2.11 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## L964144-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964144-01 01/23/18 11:25 • (DUP) R3281125-3 01/23/18 13:43

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3281125-4 01/23/18 13:46 • (LCSD) R3281125-5 01/23/18 13:49

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Methane | 0.0678 | 0.0744 | 0.0693 | 110 | 102 | 85.0-115 | | | 7.03 | 20 |
| Ethane | 0.129 | 0.115 | 0.118 | 89.3 | 91.4 | 85.0-115 | | | 2.30 | 20 |
| Ethene | 0.127 | 0.118 | 0.122 | 93.3 | 95.7 | 85.0-115 | | | 2.62 | 20 |
| Propane | 0.186 | 0.186 | 0.193 | 100 | 104 | 85.0-115 | | | 3.51 | 20 |

## Method Blank (MB)

(MB) R3280969-2 01/19/18 11:16

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Benzene | U | | 0.000331 | 0.00100 |
| Ethylbenzene | U | | 0.000384 | 0.00100 |
| Toluene | U | | 0.000412 | 0.00100 |
| Xylenes, Total | U | | 0.00106 | 0.00300 |
| *(S) Toluene-d8* | *106* | | | *80.0-120* |
| *(S) Dibromofluoromethane* | *86.6* | | | *76.0-123* |
| *(S) a,a,a-Trifluorotoluene* | *104* | | | *80.0-120* |
| *(S) 4-Bromofluorobenzene* | *106* | | | *80.0-120* |

## Laboratory Control Sample (LCS)

(LCS) R3280969-1 01/19/18 09:50

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCS Rec. % | Rec. Limits % | LCS Qualifier |
|---|---|---|---|---|---|
| Benzene | 0.0250 | 0.0221 | 88.5 | 69.0-123 | |
| Ethylbenzene | 0.0250 | 0.0262 | 105 | 77.0-120 | |
| Toluene | 0.0250 | 0.0260 | 104 | 77.0-120 | |
| Xylenes, Total | 0.0750 | 0.0795 | 106 | 77.0-120 | |
| *(S) Toluene-d8* | | | *104* | *80.0-120* | |
| *(S) Dibromofluoromethane* | | | *85.8* | *76.0-123* | |
| *(S) a,a,a-Trifluorotoluene* | | | *102* | *80.0-120* | |
| *(S) 4-Bromofluorobenzene* | | | *103* | *80.0-120* | |

## Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

## Abbreviations and Definitions

| | |
|---|---|
| MDL | Method Detection Limit. |
| ND | Not detected at the Reporting Limit (or MDL where applicable). |
| RDL | Reported Detection Limit. |
| Rec. | Recovery. |
| RPD | Relative Percent Difference. |
| SDG | Sample Delivery Group. |
| (S) | Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media. |
| U | Not detected at the Reporting Limit (or MDL where applicable). |
| Analyte | The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported. |
| Dilution | If the sample matrix contains an interfering material, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor. |
| Limits | These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges. |
| Original Sample | The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG. |
| Qualifier | This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable. |
| Result | The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state "ND" (Not Detected) or "BDL" (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte. |
| Case Narrative (Cn) | A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report. |
| Quality Control Summary (Qc) | This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material. |
| Sample Chain of Custody (Sc) | This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis. |
| Sample Results (Sr) | This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported. |
| Sample Summary (Ss) | This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis. |

| Qualifier | Description |
|---|---|
| J | The identification of the analyte is acceptable; the reported value is an estimate. |
| T8 | Sample(s) received past/too close to holding time expiration. |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

## State Accreditations

| | | | |
|---|---|---|---|
| Alabama | 40660 | Nevada | TN-03-2002-34 |
| Alaska | UST-080 | New Hampshire | 2975 |
| Arizona | AZ0612 | New Jersey–NELAP | TN002 |
| Arkansas | 88-0469 | New Mexico | TN00003 |
| California | 01157CA | New York | 11742 |
| Colorado | TN00003 | North Carolina | Env375 |
| Connecticut | PH-0197 | North Carolina [1] | DW21704 |
| Florida | E87487 | North Carolina [2] | 41 |
| Georgia | NELAP | North Dakota | R-140 |
| Georgia [1] | 923 | Ohio–VAP | CL0069 |
| Idaho | TN00003 | Oklahoma | 9915 |
| Illinois | 200008 | Oregon | TN200002 |
| Indiana | C-TN-01 | Pennsylvania | 68-02979 |
| Iowa | 364 | Rhode Island | 221 |
| Kansas | E-10277 | South Carolina | 84004 |
| Kentucky [1] | 90010 | South Dakota | n/a |
| Kentucky [2] | 16 | Tennessee [1 4] | 2006 |
| Louisiana | AI30792 | Texas | T 104704245-07-TX |
| Maine | TN0002 | Texas [5] | LAB0152 |
| Maryland | 324 | Utah | 6157585858 |
| Massachusetts | M-TN003 | Vermont | VT2006 |
| Michigan | 9958 | Virginia | 109 |
| Minnesota | 047-999-395 | Washington | C1915 |
| Mississippi | TN00003 | West Virginia | 233 |
| Missouri | 340 | Wisconsin | 9980939910 |
| Montana | CERT0086 | Wyoming | A2LA |
| Nebraska | NE-OS-15-05 | | |

## Third Party Federal Accreditations

| | | | |
|---|---|---|---|
| A2LA – ISO 17025 | 1461.01 | AIHA-LAP,LLC | 100789 |
| A2LA – ISO 17025 [5] | 1461.02 | DOD | 1461.01 |
| Canada | 1461.01 | USDA | S-67674 |
| EPA–Crypto | TN00003 | | |

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold n/a Accreditation not applicable

## Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. ESC Lab Sciences performs all testing at our central laboratory.

| | | | |
|---|---|---|---|
| GES, Inc. - Sunoco<br><br>440 Creamery Way, Suite 500<br>Exton, PA 19341 | Billing Information:<br>Accounts Payable<br>440 Creamery Way, Suite 500<br>Exton, PA 19341 | Pres Chk | Chain of Custody Page ___ of ___<br>ESC LAB SCIENCES<br>12065 Lebanon Rd<br>Mount Juliet, TN 37122<br>Phone: 615-758-5858<br>Phone: 800-767-5859<br>Fax: 615-758-5859 |
| Report to: Holly Smoker | Email To: sgrillo@gesonline.com, hsmoker@geso | | L964144<br>F140 |
| Project Description: Pre-Construction Sampling | City/State Collected: Williamsburg, PA | | |
| Phone: 406-578-4501<br>Fax: | Client Project #: 0204728 -06-160-XX | Lab Project #: SUNGES-GRILLO | |
| Collected by (print): Kim Lodszunski | Site/Facility ID #: | P.O. #: | Acctnum: SUNGES<br>Template: T126128<br>Prelogin: P611030<br>TSR: 134 - Mark Beasley<br>PB: |
| Collected by (signature): Kim [signature]<br>Immediately Packed on Ice N ___ Y X | Rush? (Lab MUST Be Notified)<br>___ Same Day ___ Five Day<br>___ Next Day ___ 5 Day (Rad Only)<br>___ Two Day ___ 10 Day (Rad Only)<br>___ Three Day | Quote #:<br>Date Results Needed<br>Standard TAT | Shipped Via: |

Analysis / Container / Preservative

| Sample ID | Comp/Grab | Matrix * | Depth | Date | Time | No. of Cntrs | **pH,SPCON,TDS,TURB* 250ml plastic NP | ALK, Br, Cl, SO4 250ml plastic NP | Total Mtls, Hardness 250ml plastic HNO3 (<2) | RSK175 + Propane 40ml vial w/ HCL | TSS 1L plastic NP | V8260BTEX 40ml vial w/ HCL | ****DW COLILERT**** microbiological | ****DW Fecal**** microbiological | Remarks | Sample # (lab only) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01182018-1631-01 | G | DW | — | 1/18/2018 | 1545 | 12 | X | X | X | X | X | X | X | X | | -01 |

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other________

Remarks:
Metals = Ba,Ca,Fe,K,Mg,Mn,Na
****Log COLILERT & FC as DW matrix****

pH ______ Temp ______
Flow ______ Other ______

Samples returned via:
___ UPS ___ FedEx ___ Courier ___ ______

Tracking # 4094 8308 1709

Sample Receipt Checklist
COC Seal Present/Intact: NP Y N
COC Signed/Accurate: Y N
Bottles arrive intact: Y N
Correct bottles used: Y N
Sufficient volume sent: Y N
If Applicable
VOA Zero Headspace: Y N
Preservation Correct/Checked: Y N

| | | | | | |
|---|---|---|---|---|---|
| Relinquished by: (Signature) Kim [signature] | Date: 1/18/18 | Time: 1700 | Received by: (Signature) Fed Ex 1/18/18 1700 | Trip Blank Received: Yes / No<br>HCL / MeOH<br>TBR | |
| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Temp: 1.7 °C<br>Bottles Received: 12 | If preservation required by Login: Date/Time |
| Relinquished by: (Signature) | Date: | Time: | Received for lab by: (Signature) [signature] 834 | Date: 1-19-18<br>Time: 0845 | Hold:<br>Condition: NCF / OK |

# ANALYTICAL REPORT

January 25, 2018

## GES, Inc - Sunoco

| | |
|---|---|
| Sample Delivery Group: | L964144 |
| Samples Received: | 01/19/2018 |
| Project Number: | 0204728-06-160-XX |
| Description: | Pre-Construction Sampling |
| | |
| Report To: | Stephanie Grillo<br>440 Creamery Way, Ste 500<br>Exton, PA 19341 |

Entire Report Reviewed By:

Jason Romer
Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

# TABLE OF CONTENTS


| | |
|---|---|
| Cp: Cover Page | 1 |
| Tc: Table of Contents | 2 |
| Ss: Sample Summary | 3 |
| Cn: Case Narrative | 4 |
| Sr: Sample Results | 5 |
| 01182018-631-01 L964144-01 | 5 |
| Qc: Quality Control Summary | 7 |
| Gravimetric Analysis by Method 2540 C-2011 | 7 |
| Gravimetric Analysis by Method 2540 D-2011 | 8 |
| Wet Chemistry by Method 130.1 | 9 |
| Wet Chemistry by Method 2130 B-2011 | 10 |
| Wet Chemistry by Method 2320 B-2011 | 11 |
| Wet Chemistry by Method 9040C | 12 |
| Wet Chemistry by Method 9050A | 13 |
| Wet Chemistry by Method 9056A | 14 |
| Metals (ICP) by Method 6010B | 16 |
| Volatile Organic Compounds (GC) by Method RSK175 | 17 |
| Volatile Organic Compounds (GC/MS) by Method 8260B | 18 |
| Gl: Glossary of Terms | 19 |
| Al: Accreditations & Locations | 20 |
| Sc: Sample Chain of Custody | 21 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

| | Collected by | Collected date/time | Received date/time |
|---|---|---|---|
| 01182018-631-01 L964144-01 GW | Kim Lapszynski | 01/18/18 15:45 | 01/19/18 08:45 |

| Method | Batch | Dilution | Preparation date/time | Analysis date/time | Analyst |
|---|---|---|---|---|---|
| Microbiology by Method 9222D | WG1064766 | 1 | 01/19/18 11:05 | 01/19/18 11:05 | MH |
| Microbiology by Method 9223 B-1997 | WG1064764 | 1 | 01/19/18 10:42 | 01/19/18 10:42 | MH |
| Gravimetric Analysis by Method 2540 C-2011 | WG1064769 | 1 | 01/21/18 08:10 | 01/21/18 09:19 | BS |
| Gravimetric Analysis by Method 2540 D-2011 | WG1064550 | 1 | 01/20/18 11:46 | 01/20/18 14:00 | MMF |
| Wet Chemistry by Method 130.1 | WG1065087 | 5 | 01/22/18 16:46 | 01/22/18 16:46 | KK |
| Wet Chemistry by Method 2130 B-2011 | WG1064443 | 1 | 01/19/18 12:25 | 01/19/18 12:25 | ER |
| Wet Chemistry by Method 2320 B-2011 | WG1064509 | 1 | 01/22/18 16:28 | 01/22/18 16:28 | MCG |
| Wet Chemistry by Method 9040C | WG1064481 | 1 | 01/19/18 12:52 | 01/19/18 12:52 | ER |
| Wet Chemistry by Method 9050A | WG1064460 | 1 | 01/19/18 14:58 | 01/19/18 14:58 | MA |
| Wet Chemistry by Method 9056A | WG1064571 | 1 | 01/19/18 23:34 | 01/19/18 23:34 | MAJ |
| Wet Chemistry by Method 9056A | WG1064571 | 5 | 01/20/18 00:15 | 01/20/18 00:15 | MAJ |
| Metals (ICP) by Method 6010B | WG1064447 | 1 | 01/19/18 11:51 | 01/19/18 14:40 | TRB |
| Volatile Organic Compounds (GC) by Method RSK175 | WG1065147 | 1 | 01/23/18 11:25 | 01/23/18 11:25 | BG |
| Volatile Organic Compounds (GC/MS) by Method 8260B | WG1064480 | 1 | 01/19/18 16:56 | 01/19/18 16:56 | JBE |

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Jason Romer
Technical Service Representative

## Microbiology by Method 9222D

| Analyte | Result col/100ml | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| Coliform,fecal | <1 | | 1 | 01/19/2018 11:05 | WG1064766 |

## Microbiology by Method 9223 B-1997

| Analyte | Result MPN/100ml | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| E.Coli | 1.00 | | 1 | 01/19/2018 10:42 | WG1064764 |
| Coliform,Total | 126 | | 1 | 01/19/2018 10:42 | WG1064764 |

## Gravimetric Analysis by Method 2540 C-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Dissolved Solids | 668 | | 10.0 | 1 | 01/21/2018 09:19 | WG1064769 |

## Gravimetric Analysis by Method 2540 D-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Suspended Solids | ND | | 2.50 | 1 | 01/20/2018 14:00 | WG1064550 |

## Wet Chemistry by Method 130.1

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 453 | | 150 | 5 | 01/22/2018 16:46 | WG1065087 |

## Wet Chemistry by Method 2130 B-2011

| Analyte | Result NTU | Qualifier | RDL NTU | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Turbidity | 0.596 | | 0.300 | 1 | 01/19/2018 12:25 | WG1064443 |

## Wet Chemistry by Method 2320 B-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Alkalinity | 398 | | 20.0 | 1 | 01/22/2018 16:28 | WG1064509 |

**Sample Narrative:**

L964144-01 WG1064509: Endpoint pH 4.5

## Wet Chemistry by Method 9040C

| Analyte | Result su | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| pH | 7.18 | T8 | 1 | 01/19/2018 12:52 | WG1064481 |

**Sample Narrative:**

L964144-01 WG1064481: 7.18 at 14.4C

## Wet Chemistry by Method 9050A

| Analyte | Result umhos/cm | Qualifier | RDL umhos/cm | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Specific Conductance | 1240 | | 10.0 | 1 | 01/19/2018 14:58 | WG1064460 |

## Wet Chemistry by Method 9056A

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Bromide | ND | | 1.00 | 1 | 01/19/2018 23:34 | WG1064571 |
| Chloride | 133 | | 5.00 | 5 | 01/20/2018 00:15 | WG1064571 |
| Sulfate | 38.2 | | 5.00 | 1 | 01/19/2018 23:34 | WG1064571 |

## Metals (ICP) by Method 6010B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Barium | 0.0966 | | 0.00500 | 1 | 01/19/2018 14:40 | WG1064447 |
| Calcium | 103 | | 1.00 | 1 | 01/19/2018 14:40 | WG1064447 |
| Iron | ND | | 0.100 | 1 | 01/19/2018 14:40 | WG1064447 |
| Magnesium | 45.0 | | 1.00 | 1 | 01/19/2018 14:40 | WG1064447 |
| Manganese | 0.0369 | | 0.0100 | 1 | 01/19/2018 14:40 | WG1064447 |
| Potassium | 10.2 | | 1.00 | 1 | 01/19/2018 14:40 | WG1064447 |
| Sodium | 89.7 | | 1.00 | 1 | 01/19/2018 14:40 | WG1064447 |

## Volatile Organic Compounds (GC) by Method RSK175

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Methane | ND | | 0.0100 | 1 | 01/23/2018 11:25 | WG1065147 |
| Ethane | ND | | 0.0130 | 1 | 01/23/2018 11:25 | WG1065147 |
| Ethene | ND | | 0.0130 | 1 | 01/23/2018 11:25 | WG1065147 |
| Propane | ND | | 0.0190 | 1 | 01/23/2018 11:25 | WG1065147 |

## Volatile Organic Compounds (GC/MS) by Method 8260B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Benzene | ND | | 0.00100 | 1 | 01/19/2018 16:56 | WG1064480 |
| Toluene | ND | | 0.00100 | 1 | 01/19/2018 16:56 | WG1064480 |
| Ethylbenzene | ND | | 0.00100 | 1 | 01/19/2018 16:56 | WG1064480 |
| Total Xylenes | ND | | 0.00300 | 1 | 01/19/2018 16:56 | WG1064480 |
| *(S) Toluene-d8* | *109* | | *80.0-120* | | *01/19/2018 16:56* | WG1064480 |
| *(S) Dibromofluoromethane* | *88.0* | | *76.0-123* | | *01/19/2018 16:56* | WG1064480 |
| *(S) a,a,a-Trifluorotoluene* | *105* | | *80.0-120* | | *01/19/2018 16:56* | WG1064480 |
| *(S) 4-Bromofluorobenzene* | *105* | | *80.0-120* | | *01/19/2018 16:56* | WG1064480 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3280848-1 01/21/18 09:19

| Analyte | MB Result | MB Qualifier | MB MDL | MB RDL |
|---|---|---|---|---|
| | mg/l | | mg/l | mg/l |
| Dissolved Solids | 3.00 | J | 2.82 | 10.0 |

## L964121-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964121-01 01/21/18 09:19 • (DUP) R3280848-4 01/21/18 09:19

| Analyte | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| | mg/l | mg/l | | % | | % |
| Dissolved Solids | 3740 | 3740 | 1 | 0.134 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3280848-2 01/21/18 09:19 • (LCSD) R3280848-3 01/21/18 09:19

| Analyte | Spike Amount | LCS Result | LCSD Result | LCS Rec. | LCSD Rec. | Rec. Limits | LCS Qualifier | LCSD Qualifier | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| | mg/l | mg/l | mg/l | % | % | % | | | % | % |
| Dissolved Solids | 8800 | 8580 | 8570 | 97.5 | 97.4 | 85.0-115 | | | 0.117 | 5 |

## Method Blank (MB)

(MB) R3280651-1 01/20/18 14:00

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Suspended Solids | U | | 0.350 | 2.50 |

## L964132-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964132-01 01/20/18 14:00 • (DUP) R3280651-4 01/20/18 14:00

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 170 | 176 | 1 | 3.47 | | 5 |

## L964138-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964138-01 01/20/18 14:00 • (DUP) R3280651-5 01/20/18 14:00

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 115 | 113 | 1 | 2.20 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3280651-2 01/20/18 14:00 • (LCSD) R3280651-3 01/20/18 14:00

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Suspended Solids | 773 | 788 | 804 | 102 | 104 | 85.0-115 | | | 2.01 | 5 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3280957-1 01/22/18 16:36

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 3.58 | J | 1.43 | 30.0 |

## L964128-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964128-01 01/22/18 16:42 • (DUP) R3280957-4 01/22/18 16:43

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 138 | 137 | 1 | 0.727 | | 20 |

## L964576-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964576-01 01/22/18 16:54 • (DUP) R3280957-7 01/22/18 16:56

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 62.0 | 64.3 | 1 | 3.64 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3280957-2 01/22/18 16:37 • (LCSD) R3280957-3 01/22/18 16:38

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 155 | 153 | 103 | 102 | 85-115 | | | 1.3 | 20 |

## L964362-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L964362-01 01/22/18 16:48 • (MS) R3280957-5 01/22/18 16:49 • (MSD) R3280957-6 01/22/18 16:50

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 64.3 | 199 | 198 | 89.8 | 89.1 | 1 | 80-120 | | | 0.504 | 20 |

## Method Blank (MB)

(MB) R3280402-1 01/19/18 12:25

| Analyte | MB Result NTU | MB Qualifier | MB MDL NTU | MB RDL NTU |
|---|---|---|---|---|
| Turbidity | 0.0500 | J | 0.0310 | 0.300 |

## L962174-12 Original Sample (OS) • Duplicate (DUP)

(OS) L962174-12 01/19/18 12:25 • (DUP) R3280402-4 01/19/18 12:25

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 4.26 | 4.25 | 1 | 0.235 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3280402-2 01/19/18 12:25 • (LCSD) R3280402-3 01/19/18 12:25

| Analyte | Spike Amount NTU | LCS Result NTU | LCSD Result NTU | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Turbidity | 40.0 | 42.7 | 42.8 | 107 | 107 | 90.0-110 | | | 0.234 | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3281008-2 01/22/18 10:25 • (LCSD) R3281008-3 01/22/18 11:49

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity | 100 | 104 | 102 | 104 | 102 | 85.0-115 | | | 1.15 | 20 |

Sample Narrative:

LCS: Endpoint pH 4.5

LCSD: Endpoint pH 4.5

## L964146-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964146-01 01/19/18 12:52 • (DUP) R3280423-4 01/19/18 12:52

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 6.45 | 6.41 | 1 | 0.622 | | 1 |

Sample Narrative:

OS: 6.45 at 15.4C

DUP: 6.41 at 15.5C

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3280423-1 01/19/18 12:52 • (LCSD) R3280423-2 01/19/18 12:52

| Analyte | Spike Amount su | LCS Result su | LCSD Result su | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | 6.38 | 6.39 | 6.38 | 100 | 100 | 98.4-102 | | | 0.157 | 1 |

Sample Narrative:

LCS: 6.39 at 16.8C

LCSD: 6.38 at 16.8C

## Method Blank (MB)

(MB) WG1064460-1 01/19/18 14:58

| Analyte | MB Result umhos/cm | MB Qualifier | MB MDL umhos/cm | MB RDL umhos/cm |
|---|---|---|---|---|
| Specific Conductance | U | | 10.0 | 10.0 |

## L963877-01 Original Sample (OS) • Duplicate (DUP)

(OS) L963877-01 01/19/18 14:58 • (DUP) WG1064460-4 01/19/18 14:58

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 113 | 114 | 1 | 0.881 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG1064460-2 01/19/18 14:58 • (LCSD) WG1064460-3 01/19/18 14:58

| Analyte | Spike Amount umhos/cm | LCS Result umhos/cm | LCSD Result umhos/cm | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Specific Conductance | 559 | 560 | 559 | 100 | 100 | 85.0-115 | | | 0.179 | 20 |

## Method Blank (MB)

(MB) R3280590-1 01/19/18 09:40

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Bromide | U | | 0.079 | 1.00 |
| Chloride | U | | 0.0519 | 1.00 |
| Sulfate | U | | 0.0774 | 5.00 |

## L964026-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964026-01 01/19/18 22:00 • (DUP) R3280590-4 01/19/18 22:14

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | ND | 0.000 | 1 | 0 | | 15 |
| Chloride | 19.4 | 19.2 | 1 | 1.18 | | 15 |
| Sulfate | 23.1 | 23.1 | 1 | 0.112 | | 15 |

## L964146-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964146-01 01/20/18 00:28 • (DUP) R3280590-7 01/20/18 00:41

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | ND | 0.000 | 1 | 0 | | 15 |
| Chloride | 4.96 | 4.92 | 1 | 0.808 | | 15 |
| Sulfate | 12.3 | 12.4 | 1 | 0.599 | | 15 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3280590-2 01/19/18 09:54 • (LCSD) R3280590-3 01/19/18 10:07

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 40.0 | 39.9 | 39.8 | 99.7 | 99.4 | 80-120 | | | 0.228 | 15 |
| Chloride | 40.0 | 39.8 | 39.6 | 99.5 | 99.1 | 80-120 | | | 0.433 | 15 |
| Sulfate | 40.0 | 40.1 | 40.0 | 100 | 100 | 80-120 | | | 0.228 | 15 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## L964026-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L964026-01 01/19/18 22:00 • (MS) R3280590-5 01/19/18 22:27 • (MSD) R3280590-6 01/19/18 22:41

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | ND | 46.9 | 47.9 | 93.7 | 95.8 | 1 | 80-120 | | | 2.12 | 15 |
| Chloride | 50.0 | 19.4 | 70.3 | 70.2 | 102 | 102 | 1 | 80-120 | | | 0.0636 | 15 |
| Sulfate | 50.0 | 23.1 | 72.5 | 72.6 | 98.8 | 98.9 | 1 | 80-120 | | | 0.0464 | 15 |

## L964146-01 Original Sample (OS) • Matrix Spike (MS)

(OS) L964146-01 01/20/18 00:28 • (MS) R3280590-8 01/20/18 00:55

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MS Rec. % | Dilution | Rec. Limits % | MS Qualifier |
|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | ND | 48.1 | 96.3 | 1 | 80-120 | |
| Chloride | 50.0 | 4.96 | 55.7 | 101 | 1 | 80-120 | |
| Sulfate | 50.0 | 12.3 | 62.4 | 100 | 1 | 80-120 | |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3280489-1 01/19/18 14:05

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Barium | U | | 0.0017 | 0.00500 |
| Calcium | U | | 0.0463 | 1.00 |
| Iron | U | | 0.0141 | 0.100 |
| Magnesium | U | | 0.0111 | 1.00 |
| Manganese | U | | 0.0012 | 0.0100 |
| Potassium | U | | 0.102 | 1.00 |
| Sodium | U | | 0.0985 | 1.00 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3280489-2 01/19/18 14:08 • (LCSD) R3280489-3 01/19/18 14:11

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 1.02 | 1.03 | 102 | 103 | 80-120 | | | 0.761 | 20 |
| Calcium | 10.0 | 9.84 | 9.76 | 98.4 | 97.6 | 80-120 | | | 0.802 | 20 |
| Iron | 10.0 | 9.85 | 9.83 | 98.5 | 98.3 | 80-120 | | | 0.203 | 20 |
| Magnesium | 10.0 | 9.86 | 9.71 | 98.6 | 97.1 | 80-120 | | | 1.45 | 20 |
| Manganese | 1.00 | 0.999 | 0.999 | 99.9 | 99.9 | 80-120 | | | 0.0116 | 20 |
| Potassium | 10.0 | 9.67 | 9.56 | 96.7 | 95.6 | 80-120 | | | 1.12 | 20 |
| Sodium | 10.0 | 9.93 | 9.98 | 99.3 | 99.8 | 80-120 | | | 0.491 | 20 |

## L964181-02 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L964181-02 01/19/18 14:13 • (MS) R3280489-5 01/19/18 14:18 • (MSD) R3280489-6 01/19/18 14:21

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 0.0274 | 1.06 | 1.06 | 103 | 103 | 1 | 75-125 | | | 0.00729 | 20 |
| Calcium | 10.0 | 16.8 | 26.3 | 26.2 | 94.7 | 94 | 1 | 75-125 | | | 0.266 | 20 |
| Iron | 10.0 | 6.94 | 16.6 | 16.4 | 96.6 | 94.8 | 1 | 75-125 | | | 1.11 | 20 |
| Magnesium | 10.0 | 9.57 | 19.0 | 19.0 | 94.8 | 94.7 | 1 | 75-125 | | | 0.0306 | 20 |
| Manganese | 1.00 | 0.0400 | 1.04 | 1.05 | 100 | 101 | 1 | 75-125 | | | 0.777 | 20 |
| Potassium | 10.0 | ND | 9.80 | 9.84 | 96.2 | 96.6 | 1 | 75-125 | | | 0.443 | 20 |
| Sodium | 10.0 | 21.5 | 31.2 | 30.6 | 97.1 | 90.9 | 1 | 75-125 | | | 1.99 | 20 |

## Method Blank (MB)

(MB) R3281125-1 01/23/18 09:10

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Methane | U | | 0.00291 | 0.0100 |
| Ethane | U | | 0.00407 | 0.0130 |
| Ethene | U | | 0.00426 | 0.0130 |
| Propane | U | | 0.00548 | 0.0190 |

## L964075-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964075-01 01/23/18 10:27 • (DUP) R3281125-2 01/23/18 11:18

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | 1.34 | 1.31 | 1 | 2.11 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## L964144-01 Original Sample (OS) • Duplicate (DUP)

(OS) L964144-01 01/23/18 11:25 • (DUP) R3281125-3 01/23/18 13:43

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3281125-4 01/23/18 13:46 • (LCSD) R3281125-5 01/23/18 13:49

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Methane | 0.0678 | 0.0744 | 0.0693 | 110 | 102 | 85.0-115 | | | 7.03 | 20 |
| Ethane | 0.129 | 0.115 | 0.118 | 89.3 | 91.4 | 85.0-115 | | | 2.30 | 20 |
| Ethene | 0.127 | 0.118 | 0.122 | 93.3 | 95.7 | 85.0-115 | | | 2.62 | 20 |
| Propane | 0.186 | 0.186 | 0.193 | 100 | 104 | 85.0-115 | | | 3.51 | 20 |

## Method Blank (MB)

(MB) R3280969-2 01/19/18 11:16

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Benzene | U | | 0.000331 | 0.00100 |
| Ethylbenzene | U | | 0.000384 | 0.00100 |
| Toluene | U | | 0.000412 | 0.00100 |
| Xylenes, Total | U | | 0.00106 | 0.00300 |
| *(S) Toluene-d8* | *106* | | | *80.0-120* |
| *(S) Dibromofluoromethane* | *86.6* | | | *76.0-123* |
| *(S) a,a,a-Trifluorotoluene* | *104* | | | *80.0-120* |
| *(S) 4-Bromofluorobenzene* | *106* | | | *80.0-120* |

## Laboratory Control Sample (LCS)

(LCS) R3280969-1 01/19/18 09:50

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCS Rec. % | Rec. Limits % | LCS Qualifier |
|---|---|---|---|---|---|
| Benzene | 0.0250 | 0.0221 | 88.5 | 69.0-123 | |
| Ethylbenzene | 0.0250 | 0.0262 | 105 | 77.0-120 | |
| Toluene | 0.0250 | 0.0260 | 104 | 77.0-120 | |
| Xylenes, Total | 0.0750 | 0.0795 | 106 | 77.0-120 | |
| *(S) Toluene-d8* | | | *104* | *80.0-120* | |
| *(S) Dibromofluoromethane* | | | *85.8* | *76.0-123* | |
| *(S) a,a,a-Trifluorotoluene* | | | *102* | *80.0-120* | |
| *(S) 4-Bromofluorobenzene* | | | *103* | *80.0-120* | |

## Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

## Abbreviations and Definitions

| | |
|---|---|
| MDL | Method Detection Limit. |
| ND | Not detected at the Reporting Limit (or MDL where applicable). |
| RDL | Reported Detection Limit. |
| Rec. | Recovery. |
| RPD | Relative Percent Difference. |
| SDG | Sample Delivery Group. |
| (S) | Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media. |
| U | Not detected at the Reporting Limit (or MDL where applicable). |
| Analyte | The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported. |
| Dilution | If the sample matrix contains an interfering material, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor. |
| Limits | These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges. |
| Original Sample | The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG. |
| Qualifier | This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable. |
| Result | The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state "ND" (Not Detected) or "BDL" (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte. |
| Case Narrative (Cn) | A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report. |
| Quality Control Summary (Qc) | This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material. |
| Sample Chain of Custody (Sc) | This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis. |
| Sample Results (Sr) | This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported. |
| Sample Summary (Ss) | This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis. |

| Qualifier | Description |
|---|---|
| J | The identification of the analyte is acceptable; the reported value is an estimate. |
| T8 | Sample(s) received past/too close to holding time expiration. |

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

## State Accreditations

| | |
|---|---|
| Alabama | 40660 |
| Alaska | UST-080 |
| Arizona | AZ0612 |
| Arkansas | 88-0469 |
| California | 01157CA |
| Colorado | TN00003 |
| Connecticut | PH-0197 |
| Florida | E87487 |
| Georgia | NELAP |
| Georgia [1] | 923 |
| Idaho | TN00003 |
| Illinois | 200008 |
| Indiana | C-TN-01 |
| Iowa | 364 |
| Kansas | E-10277 |
| Kentucky [1] | 90010 |
| Kentucky [2] | 16 |
| Louisiana | AI30792 |
| Maine | TN0002 |
| Maryland | 324 |
| Massachusetts | M-TN003 |
| Michigan | 9958 |
| Minnesota | 047-999-395 |
| Mississippi | TN00003 |
| Missouri | 340 |
| Montana | CERT0086 |
| Nebraska | NE-OS-15-05 |
| Nevada | TN-03-2002-34 |
| New Hampshire | 2975 |
| New Jersey–NELAP | TN002 |
| New Mexico | TN00003 |
| New York | 11742 |
| North Carolina | Env375 |
| North Carolina [1] | DW21704 |
| North Carolina [2] | 41 |
| North Dakota | R-140 |
| Ohio–VAP | CL0069 |
| Oklahoma | 9915 |
| Oregon | TN200002 |
| Pennsylvania | 68-02979 |
| Rhode Island | 221 |
| South Carolina | 84004 |
| South Dakota | n/a |
| Tennessee [1,4] | 2006 |
| Texas | T 104704245-07-TX |
| Texas [5] | LAB0152 |
| Utah | 6157585858 |
| Vermont | VT2006 |
| Virginia | 109 |
| Washington | C1915 |
| West Virginia | 233 |
| Wisconsin | 9980939910 |
| Wyoming | A2LA |

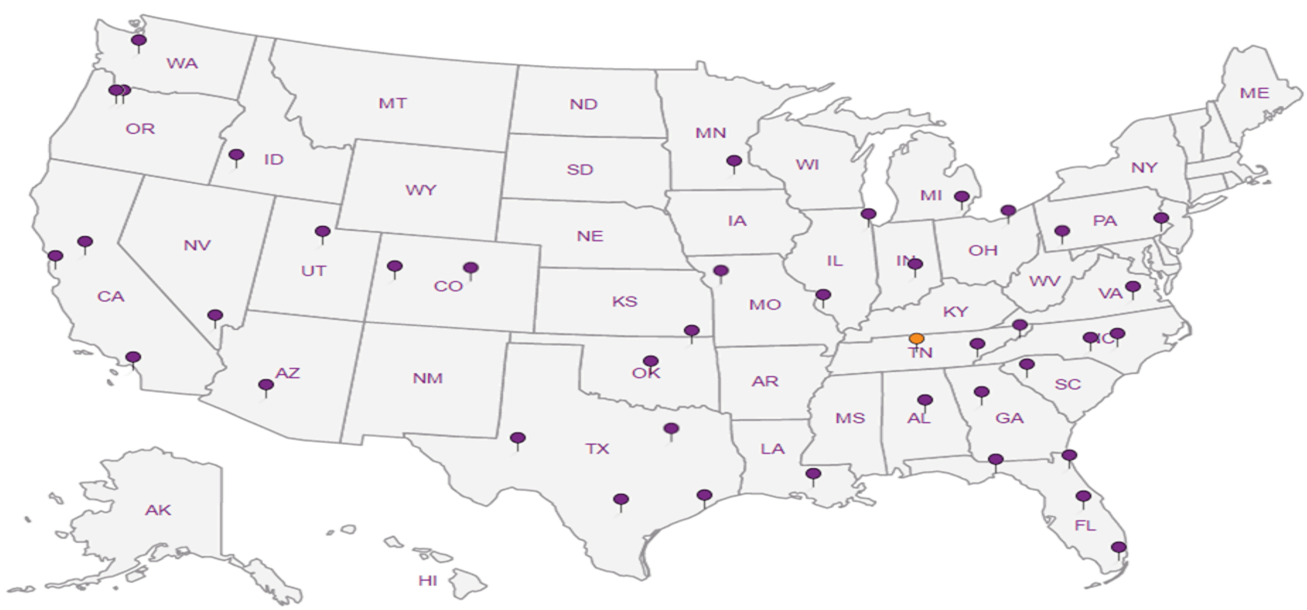
## Third Party Federal Accreditations

| | |
|---|---|
| A2LA – ISO 17025 | 1461.01 |
| A2LA – ISO 17025 [5] | 1461.02 |
| Canada | 1461.01 |
| EPA–Crypto | TN00003 |
| AIHA-LAP,LLC | 100789 |
| DOD | 1461.01 |
| USDA | S-67674 |

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold n/a Accreditation not applicable

## Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. ESC Lab Sciences performs all testing at our central laboratory.



GES, Inc. - Sunoco

440 Creamery Way, Suite 500
Exton, PA 19341

Billing Information:

Accounts Payable
440 Creamery Way, Suite 500
Exton, PA 19341

Pres Chk

Report to: Holly Smoker

Email To: sgrillo@gesonline.com, hsmoker@geso

Project Description: Pre-Construction Sampling

City/State Collected: Williamsburg, PA

Phone: 406-578-4501
Fax:

Client Project # 0204728 -06-160-XX

Lab Project # SUNGES-GRILLO

Collected by (print): Kim Lopszunski

Site/Facility ID #

P.O. #

Collected by (signature): Kim Lopszunski

Immediately Packed on Ice N ___ Y X

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day

Quote #

Date Results Needed: Standard TAT

Chain of Custody Page ___ of ___

ESC L·A·B S·C·I·E·N·C·E·S

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone 615-758-5858
Phone 800-767-5859
Fax 615-758-5859

L# L964144

F140

Acctnum: SUNGES
Template: T126128
Prelogin: P611030
TSR: 134 - Mark Beasley
PB:
Shipped Via:

Analysis / Container / Preservative

| Sample ID | Comp/Grab | Matrix * | Depth | Date | Time | No. of Cntrs | **pH,SPCON,TDS,TURB* 250ml plastic NP | ALK, Br, Cl, SO4 250ml plastic NP | Total Mtls, Hardness 250ml plastic HNO3 <2 | RSK175 + Propane 40ml vial w/ HCL | TSS 1L plastic NP | V8260BTEX 40ml vial w/ HCL | ****DW COLILERT**** microbiological | ****DW Fecal**** microbiological | | | Remarks | Sample # (lab only) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01182018-Te31-01 | G | DW | — | 1/18/2018 | 1545 | 12 | X | X | X | X | X | X | X | X | | | | -01 |

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other ________

Remarks:
Metals = Ba,Ca,Fe,K,Mg,Mn,Na
****Log COLILERT & FC as DW matrix****

pH ______ Temp ______
Flow ______ Other ______

Samples returned via:
__ UPS __ FedEx __ Courier ______

Tracking # 4094 8308 1709

Sample Receipt Checklist
COC Seal Present/Intact: NP Y N
COC Signed/Accurate: Y N
Bottles arrive intact: Y N
Correct bottles used: Y N
Sufficient volume sent: Y N
If Applicable
VOA Zero Headspace: Y N
Preservation Correct/Checked: Y N

| Relinquished by : (Signature) | Date: | Time: | Received by: (Signature) | Trip Blank Received: Yes / No (HCL / MeOH, TBR) |
|---|---|---|---|---|
| Kim Lopszunski | 1/18/18 | 1700 | Fed Ex 1/18/18 1700 | |

| Relinquished by : (Signature) | Date: | Time: | Received by: (Signature) | Temp: 1.7 °C | Bottles Received: 12 | If preservation required by Login: Date/Time |
|---|---|---|---|---|---|---|
| | | | | | | |

| Relinquished by : (Signature) | Date: | Time: | Received for lab by: (Signature) | Date: | Time: | Hold: | Condition: NCF / OK |
|---|---|---|---|---|---|---|---|
| | | | 834 | 1-19-18 | 0845 | | OK |

# ANALYTICAL REPORT

February 05, 2018

## GES, Inc - Sunoco

| | |
|---|---|
| Sample Delivery Group: | L966586 |
| Samples Received: | 01/31/2018 |
| Project Number: | 0204728-06-160-XX |
| Description: | Pre-Construction Sampling |
| | |
| Report To: | Stephanie Grillo |
| | 440 Creamery Way, Ste 500 |
| | Exton, PA  19341 |

Entire Report Reviewed By:

Olivia Studebaker
Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

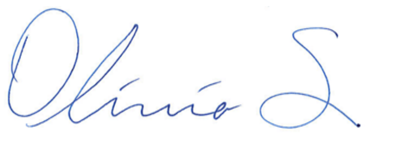
# TABLE OF CONTENTS


| | |
|---|---|
| Cp: Cover Page | 1 |
| Tc: Table of Contents | 2 |
| Ss: Sample Summary | 3 |
| Cn: Case Narrative | 4 |
| Sr: Sample Results | 5 |
| 01302018-629-01 L966586-01 | 5 |
| Qc: Quality Control Summary | 7 |
| Gravimetric Analysis by Method 2540 C-2011 | 7 |
| Gravimetric Analysis by Method 2540 D-2011 | 8 |
| Wet Chemistry by Method 130.1 | 9 |
| Wet Chemistry by Method 2130 B-2011 | 10 |
| Wet Chemistry by Method 2320 B-2011 | 11 |
| Wet Chemistry by Method 9040C | 12 |
| Wet Chemistry by Method 9050A | 13 |
| Wet Chemistry by Method 9056A | 14 |
| Metals (ICP) by Method 6010B | 16 |
| Volatile Organic Compounds (GC) by Method RSK175 | 17 |
| Volatile Organic Compounds (GC/MS) by Method 8260B | 18 |
| Gl: Glossary of Terms | 19 |
| Al: Accreditations & Locations | 20 |
| Sc: Sample Chain of Custody | 21 |

| | Collected by | Collected date/time | Received date/time |
|---|---|---|---|
| 01302018-629-01 L966586-01 GW | Robert Faccenda | 01/30/18 12:00 | 01/31/18 08:45 |

| Method | Batch | Dilution | Preparation date/time | Analysis date/time | Analyst |
|---|---|---|---|---|---|
| Microbiology by Method 9222D | WG1068512 | 1 | 01/31/18 11:40 | 01/31/18 11:40 | MH |
| Microbiology by Method 9223 B-1997 | WG1068374 | 1 | 01/31/18 10:15 | 01/31/18 10:15 | KMR |
| Gravimetric Analysis by Method 2540 C-2011 | WG1068492 | 1 | 01/31/18 16:34 | 01/31/18 17:25 | BS |
| Gravimetric Analysis by Method 2540 D-2011 | WG1068489 | 1 | 01/31/18 16:12 | 01/31/18 16:56 | EG |
| Wet Chemistry by Method 130.1 | WG1069334 | 10 | 02/02/18 13:11 | 02/02/18 13:11 | KK |
| Wet Chemistry by Method 2130 B-2011 | WG1068416 | 1 | 01/31/18 13:37 | 01/31/18 13:37 | GB |
| Wet Chemistry by Method 2320 B-2011 | WG1068941 | 1 | 02/01/18 16:08 | 02/01/18 16:08 | CSU |
| Wet Chemistry by Method 9040C | WG1068362 | 1 | 01/31/18 11:07 | 01/31/18 11:07 | GB |
| Wet Chemistry by Method 9050A | WG1067791 | 1 | 01/31/18 14:11 | 01/31/18 14:11 | TH |
| Wet Chemistry by Method 9056A | WG1068488 | 1 | 01/31/18 14:55 | 01/31/18 14:55 | DR |
| Metals (ICP) by Method 6010B | WG1068396 | 1 | 01/31/18 11:03 | 01/31/18 15:01 | TRB |
| Volatile Organic Compounds (GC) by Method RSK175 | WG1068333 | 1 | 01/31/18 12:28 | 01/31/18 12:28 | BG |
| Volatile Organic Compounds (GC/MS) by Method 8260B | WG1068403 | 1 | 01/31/18 13:28 | 01/31/18 13:28 | BMB |

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.



Olivia Studebaker
Technical Service Representative

## Sample Narrative

FC test was confirmed positive for both fecal coliform and E. coli. BE 2/5/2018

## Microbiology by Method 9222D

| Analyte | Result col/100ml | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| Coliform,fecal | 1.00 | | 1 | 01/31/2018 11:40 | WG1068512 |

## Microbiology by Method 9223 B-1997

| Analyte | Result MPN/100ml | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| E.Coli | 5.20 | | 1 | 01/31/2018 10:15 | WG1068374 |
| Coliform,Total | 93.3 | | 1 | 01/31/2018 10:15 | WG1068374 |

## Gravimetric Analysis by Method 2540 C-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Dissolved Solids | 671 | | 10.0 | 1 | 01/31/2018 17:25 | WG1068492 |

## Gravimetric Analysis by Method 2540 D-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Suspended Solids | ND | | 2.50 | 1 | 01/31/2018 16:56 | WG1068489 |

## Wet Chemistry by Method 130.1

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 564 | | 300 | 10 | 02/02/2018 13:11 | WG1069334 |

## Wet Chemistry by Method 2130 B-2011

| Analyte | Result NTU | Qualifier | RDL NTU | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Turbidity | 0.449 | B | 0.300 | 1 | 01/31/2018 13:37 | WG1068416 |

## Wet Chemistry by Method 2320 B-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Alkalinity | 411 | | 20.0 | 1 | 02/01/2018 16:08 | WG1068941 |

**Sample Narrative:**

L966586-01 WG1068941: Endpoint pH 4.5

## Wet Chemistry by Method 9040C

| Analyte | Result su | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| pH | 7.17 | T8 | 1 | 01/31/2018 11:07 | WG1068362 |

**Sample Narrative:**

L966586-01 WG1068362: 7.17 at 14.5C

## Wet Chemistry by Method 9050A

| Analyte | Result umhos/cm | Qualifier | RDL umhos/cm | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Specific Conductance | 1130 | | 10.0 | 1 | 01/31/2018 14:11 | WG1067791 |

## Wet Chemistry by Method 9056A

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Bromide | ND | | 1.00 | 1 | 01/31/2018 14:55 | WG1068488 |
| Chloride | 74.4 | | 1.00 | 1 | 01/31/2018 14:55 | WG1068488 |
| Sulfate | 69.8 | | 5.00 | 1 | 01/31/2018 14:55 | WG1068488 |

## Metals (ICP) by Method 6010B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Barium | 0.102 | | 0.00500 | 1 | 01/31/2018 15:01 | WG1068396 |
| Calcium | 122 | | 1.00 | 1 | 01/31/2018 15:01 | WG1068396 |
| Iron | ND | | 0.100 | 1 | 01/31/2018 15:01 | WG1068396 |
| Magnesium | 63.0 | | 1.00 | 1 | 01/31/2018 15:01 | WG1068396 |
| Manganese | 0.148 | | 0.0100 | 1 | 01/31/2018 15:01 | WG1068396 |
| Potassium | 15.7 | | 1.00 | 1 | 01/31/2018 15:01 | WG1068396 |
| Sodium | 11.5 | | 1.00 | 1 | 01/31/2018 15:01 | WG1068396 |

## Volatile Organic Compounds (GC) by Method RSK175

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Methane | ND | | 0.0100 | 1 | 01/31/2018 12:28 | WG1068333 |
| Ethane | ND | | 0.0130 | 1 | 01/31/2018 12:28 | WG1068333 |
| Ethene | ND | | 0.0130 | 1 | 01/31/2018 12:28 | WG1068333 |
| Propane | ND | | 0.0190 | 1 | 01/31/2018 12:28 | WG1068333 |

## Volatile Organic Compounds (GC/MS) by Method 8260B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Benzene | ND | | 0.00100 | 1 | 01/31/2018 13:28 | WG1068403 |
| Toluene | ND | | 0.00100 | 1 | 01/31/2018 13:28 | WG1068403 |
| Ethylbenzene | ND | | 0.00100 | 1 | 01/31/2018 13:28 | WG1068403 |
| Total Xylenes | ND | | 0.00300 | 1 | 01/31/2018 13:28 | WG1068403 |
| *(S) Toluene-d8* | *118* | | *80.0-120* | | *01/31/2018 13:28* | WG1068403 |
| *(S) Dibromofluoromethane* | *103* | | *76.0-123* | | *01/31/2018 13:28* | WG1068403 |
| *(S) a,a,a-Trifluorotoluene* | *105* | | *80.0-120* | | *01/31/2018 13:28* | WG1068403 |
| *(S) 4-Bromofluorobenzene* | *98.9* | | *80.0-120* | | *01/31/2018 13:28* | WG1068403 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3283889-1 01/31/18 17:25

| Analyte | MB Result | MB Qualifier | MB MDL | MB RDL |
|---|---|---|---|---|
| | mg/l | | mg/l | mg/l |
| Dissolved Solids | U | | 2.82 | 10.0 |

## L966595-06 Original Sample (OS) • Duplicate (DUP)

(OS) L966595-06 01/31/18 17:25 • (DUP) R3283889-4 01/31/18 17:25

| Analyte | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| | mg/l | mg/l | | % | | % |
| Dissolved Solids | 403 | 407 | 1 | 0.988 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283889-2 01/31/18 17:25 • (LCSD) R3283889-3 01/31/18 17:25

| Analyte | Spike Amount | LCS Result | LCSD Result | LCS Rec. | LCSD Rec. | Rec. Limits | LCS Qualifier | LCSD Qualifier | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| | mg/l | mg/l | mg/l | % | % | % | | | % | % |
| Dissolved Solids | 8800 | 8440 | 8710 | 95.9 | 99.0 | 85.0-115 | | | 3.15 | 5 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3283379-1 01/31/18 16:56

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Suspended Solids | U | | 0.350 | 2.50 |

## L966576-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966576-01 01/31/18 16:56 • (DUP) R3283379-4 01/31/18 16:56

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 257 | 257 | 1 | 0.000 | | 5 |

## L966738-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966738-01 01/31/18 16:56 • (DUP) R3283379-5 01/31/18 16:56

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 96.0 | 102 | 1 | 6.06 | J3 | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283379-2 01/31/18 16:56 • (LCSD) R3283379-3 01/31/18 16:56

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Suspended Solids | 773 | 730 | 755 | 94.4 | 97.7 | 85.0-115 | | | 3.37 | 5 |

## Method Blank (MB)

(MB) R3283661-1 02/02/18 12:58

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 5.13 | J | 1.43 | 30.0 |

## L966477-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966477-01 02/02/18 13:05 • (DUP) R3283661-4 02/02/18 13:08

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 111 | 107 | 1 | 3.67 | | 20 |

## L966808-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966808-01 02/02/18 13:14 • (DUP) R3283661-5 02/02/18 13:15

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 60.0 | 59.9 | 1 | 0.167 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283661-2 02/02/18 12:58 • (LCSD) R3283661-3 02/02/18 12:59

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 158 | 158 | 105 | 105 | 85-115 | | | 0 | 20 |

## L966862-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L966862-01 02/02/18 13:18 • (MS) R3283661-6 02/02/18 13:19 • (MSD) R3283661-7 02/02/18 13:19

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | ND | 156 | 155 | 99 | 98.3 | 1 | 80-120 | | | 0.643 | 20 |

## Method Blank (MB)

(MB) R3283057-1 01/31/18 13:37

| Analyte | MB Result NTU | MB Qualifier | MB MDL NTU | MB RDL NTU |
|---|---|---|---|---|
| Turbidity | 0.0660 | J | 0.0310 | 0.300 |

## L966586-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966586-01 01/31/18 13:37 • (DUP) R3283057-4 01/31/18 13:37

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 0.449 | 0.450 | 1 | 0.222 | | 20 |

## L966613-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966613-01 01/31/18 13:37 • (DUP) R3283057-5 01/31/18 13:37

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 0.474 | 0.468 | 1 | 1.27 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283057-2 01/31/18 13:37 • (LCSD) R3283057-3 01/31/18 13:37

| Analyte | Spike Amount NTU | LCS Result NTU | LCSD Result NTU | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Turbidity | 40.0 | 42.5 | 42.5 | 106 | 106 | 90.0-110 | | | 0.000 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## L966323-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966323-01 02/01/18 15:40 • (DUP) R3283555-1 02/01/18 15:47

| | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | | % | | % |
| Alkalinity | 147 | 152 | 1 | 2.86 | | 20 |

Sample Narrative:

OS: Endpoint pH 4.5

DUP: Endpoint pH 4.5

## L966602-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966602-01 02/01/18 17:21 • (DUP) R3283555-4 02/01/18 17:28

| | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | | % | | % |
| Alkalinity | 89.5 | 82.8 | 1 | 7.73 | | 20 |

Sample Narrative:

OS: Endpoint pH 4.5

DUP: Endpoint pH 4.5

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283555-2 02/01/18 16:34 • (LCSD) R3283555-3 02/01/18 16:43

| | Spike Amount | LCS Result | LCSD Result | LCS Rec. | LCSD Rec. | Rec. Limits | LCS Qualifier | LCSD Qualifier | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | mg/l | % | % | % | | | % | % |
| Alkalinity | 100 | 106 | 102 | 106 | 102 | 85.0-115 | | | 3.32 | 20 |

Sample Narrative:

LCS: Endpoint pH 4.5

LCSD: Endpoint pH 4.5

## L966613-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966613-01 01/31/18 11:07 • (DUP) R3283001-4 01/31/18 11:07

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 7.28 | 7.29 | 1 | 0.137 | | 1 |

Sample Narrative:
OS: 7.28 at 15.3C
DUP: 7.29 at 15.3C

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283001-1 01/31/18 11:07 • (LCSD) R3283001-2 01/31/18 11:07

| Analyte | Spike Amount su | LCS Result su | LCSD Result su | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | 6.38 | 6.36 | 6.35 | 99.7 | 99.5 | 98.4-102 | | | 0.157 | 1 |

Sample Narrative:
LCS: 6.36 at 17.9C
LCSD: 6.35 at 18C

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) WG1067791-1 01/31/18 14:11

| Analyte | MB Result umhos/cm | MB Qualifier | MB MDL umhos/cm | MB RDL umhos/cm |
|---|---|---|---|---|
| Specific Conductance | U | | 10.0 | 10.0 |

## L966284-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966284-01 01/31/18 14:11 • (DUP) WG1067791-4 01/31/18 14:11

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 793 | 797 | 1 | 0.503 | | 20 |

## L966613-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966613-01 01/31/18 14:11 • (DUP) WG1067791-5 01/31/18 14:11

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 581 | 585 | 1 | 0.686 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG1067791-2 01/31/18 14:11 • (LCSD) WG1067791-3 01/31/18 14:11

| Analyte | Spike Amount umhos/cm | LCS Result umhos/cm | LCSD Result umhos/cm | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Specific Conductance | 559 | 552 | 553 | 98.7 | 98.9 | 85.0-115 | | | 0.181 | 20 |

## Method Blank (MB)

(MB) R3283212-1 01/31/18 11:17

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Bromide | U | | 0.079 | 1.00 |
| Chloride | U | | 0.0519 | 1.00 |
| Sulfate | U | | 0.0774 | 5.00 |

## L966595-02 Original Sample (OS) • Duplicate (DUP)

(OS) L966595-02 01/31/18 15:25 • (DUP) R3283212-4 01/31/18 15:35

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | U | 0.000 | 1 | 0 | | 15 |
| Chloride | 22.0 | 22.3 | 1 | 1 | | 15 |
| Sulfate | 14.4 | 14.3 | 1 | 1 | | 15 |

## L966606-02 Original Sample (OS) • Duplicate (DUP)

(OS) L966606-02 01/31/18 17:33 • (DUP) R3283212-7 01/31/18 17:43

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | U | 0.000 | 1 | 0 | | 15 |
| Chloride | 20.6 | 21.0 | 1 | 2 | | 15 |
| Sulfate | 10.8 | 10.9 | 1 | 1 | | 15 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283212-2 01/31/18 11:27 • (LCSD) R3283212-3 01/31/18 11:37

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 40.0 | 39.3 | 39.6 | 98 | 99 | 80-120 | | | 1 | 15 |
| Chloride | 40.0 | 38.7 | 38.7 | 97 | 97 | 80-120 | | | 0 | 15 |
| Sulfate | 40.0 | 39.4 | 39.7 | 98 | 99 | 80-120 | | | 1 | 15 |

## L966595-02 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L966595-02 01/31/18 15:25 • (MS) R3283212-5 01/31/18 15:44 • (MSD) R3283212-6 01/31/18 15:54

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | U | 46.8 | 49.1 | 94 | 98 | 1 | 80-120 | | | 5 | 15 |
| Chloride | 50.0 | 22.0 | 72.4 | 72.7 | 101 | 101 | 1 | 80-120 | | | 0 | 15 |
| Sulfate | 50.0 | 14.4 | 65.0 | 64.6 | 101 | 100 | 1 | 80-120 | | | 1 | 15 |

## L966606-02 Original Sample (OS) • Matrix Spike (MS)

(OS) L966606-02 01/31/18 17:33 • (MS) R3283212-8 01/31/18 17:53

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MS Rec. % | Dilution | Rec. Limits % | MS Qualifier |
|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | U | 46.8 | 94 | 1 | 80-120 | |
| Chloride | 50.0 | 20.6 | 70.8 | 100 | 1 | 80-120 | |
| Sulfate | 50.0 | 10.8 | 64.9 | 108 | 1 | 80-120 | |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3283142-1 01/31/18 14:21

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Barium | U | | 0.0017 | 0.00500 |
| Calcium | U | | 0.0463 | 1.00 |
| Iron | U | | 0.0141 | 0.100 |
| Magnesium | 0.0346 | J | 0.0111 | 1.00 |
| Manganese | U | | 0.0012 | 0.0100 |
| Potassium | 0.173 | J | 0.102 | 1.00 |
| Sodium | 0.244 | J | 0.0985 | 1.00 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283142-2 01/31/18 14:23 • (LCSD) R3283142-3 01/31/18 14:26

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 0.980 | 0.995 | 98 | 99.5 | 80-120 | | | 1.53 | 20 |
| Calcium | 10.0 | 9.44 | 9.59 | 94.4 | 95.9 | 80-120 | | | 1.61 | 20 |
| Iron | 10.0 | 9.58 | 9.79 | 95.8 | 97.9 | 80-120 | | | 2.14 | 20 |
| Magnesium | 10.0 | 9.47 | 9.49 | 94.7 | 94.9 | 80-120 | | | 0.184 | 20 |
| Manganese | 1.00 | 0.962 | 0.976 | 96.2 | 97.6 | 80-120 | | | 1.43 | 20 |
| Potassium | 10.0 | 9.29 | 9.70 | 92.9 | 97 | 80-120 | | | 4.28 | 20 |
| Sodium | 10.0 | 9.86 | 10.3 | 98.6 | 103 | 80-120 | | | 4.29 | 20 |

## L966630-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L966630-01 01/31/18 14:30 • (MS) R3283142-5 01/31/18 14:35 • (MSD) R3283142-6 01/31/18 14:37

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 0.0200 | 0.997 | 0.999 | 97.7 | 97.9 | 1 | 75-125 | | | 0.138 | 20 |
| Calcium | 10.0 | 114 | 122 | 122 | 78.7 | 75 | 1 | 75-125 | | | 0.303 | 20 |
| Iron | 10.0 | 0.310 | 9.92 | 10.0 | 96.1 | 96.9 | 1 | 75-125 | | | 0.769 | 20 |
| Magnesium | 10.0 | 185 | 190 | 190 | 50.6 | 49.7 | 1 | 75-125 | V | V | 0.0495 | 20 |
| Manganese | 1.00 | 0.353 | 1.30 | 1.30 | 94.4 | 94.3 | 1 | 75-125 | | | 0.0559 | 20 |
| Potassium | 10.0 | 2.55 | 12.4 | 12.7 | 98.9 | 102 | 1 | 75-125 | | | 2.17 | 20 |
| Sodium | 10.0 | 123 | 130 | 129 | 75.1 | 67.6 | 1 | 75-125 | | V | 0.582 | 20 |

## Method Blank (MB)

(MB) R3283032-1 01/31/18 11:39

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Methane | U | | 0.00291 | 0.0100 |
| Ethane | U | | 0.00407 | 0.0130 |
| Ethene | U | | 0.00426 | 0.0130 |
| Propane | U | | 0.00548 | 0.0190 |

## L966289-02 Original Sample (OS) • Duplicate (DUP)

(OS) L966289-02 01/31/18 12:01 • (DUP) R3283032-2 01/31/18 12:20

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | U | 0.000 | 1 | 0.000 | | 20 |
| Ethane | U | 0.000 | 1 | 0.000 | | 20 |
| Ethene | U | 0.000 | 1 | 0.000 | | 20 |
| Propane | U | 0.000 | 1 | 0.000 | | 20 |

## L966300-05 Original Sample (OS) • Duplicate (DUP)

(OS) L966300-05 01/31/18 12:23 • (DUP) R3283032-3 01/31/18 12:38

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283032-4 01/31/18 12:50 • (LCSD) R3283032-5 01/31/18 12:53

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Methane | 0.0678 | 0.0740 | 0.0698 | 109 | 103 | 85.0-115 | | | 5.77 | 20 |
| Ethane | 0.129 | 0.124 | 0.115 | 95.8 | 89.4 | 85.0-115 | | | 6.88 | 20 |
| Ethene | 0.127 | 0.128 | 0.118 | 101 | 93.2 | 85.0-115 | | | 7.57 | 20 |
| Propane | 0.186 | 0.201 | 0.190 | 108 | 102 | 85.0-115 | | | 5.36 | 20 |

## Method Blank (MB)

(MB) R3283218-2 01/31/18 12:19

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Benzene | U | | 0.000331 | 0.00100 |
| Ethylbenzene | U | | 0.000384 | 0.00100 |
| Toluene | U | | 0.000412 | 0.00100 |
| Xylenes, Total | U | | 0.00106 | 0.00300 |
| *(S) Toluene-d8* | *107* | | | *80.0-120* |
| *(S) Dibromofluoromethane* | *101* | | | *76.0-123* |
| *(S) a,a,a-Trifluorotoluene* | *105* | | | *80.0-120* |
| *(S) 4-Bromofluorobenzene* | *98.2* | | | *80.0-120* |

## Laboratory Control Sample (LCS)

(LCS) R3283218-1 01/31/18 11:37

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCS Rec. % | Rec. Limits % | LCS Qualifier |
|---|---|---|---|---|---|
| Benzene | 0.0250 | 0.0236 | 94.4 | 69.0-123 | |
| Ethylbenzene | 0.0250 | 0.0291 | 116 | 77.0-120 | |
| Toluene | 0.0250 | 0.0265 | 106 | 77.0-120 | |
| Xylenes, Total | 0.0750 | 0.0880 | 117 | 77.0-120 | |
| *(S) Toluene-d8* | | | *105* | *80.0-120* | |
| *(S) Dibromofluoromethane* | | | *99.9* | *76.0-123* | |
| *(S) a,a,a-Trifluorotoluene* | | | *106* | *80.0-120* | |
| *(S) 4-Bromofluorobenzene* | | | *100* | *80.0-120* | |

## Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

## Abbreviations and Definitions

| | |
|---|---|
| MDL | Method Detection Limit. |
| ND | Not detected at the Reporting Limit (or MDL where applicable). |
| RDL | Reported Detection Limit. |
| Rec. | Recovery. |
| RPD | Relative Percent Difference. |
| SDG | Sample Delivery Group. |
| (S) | Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media. |
| U | Not detected at the Reporting Limit (or MDL where applicable). |
| Analyte | The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported. |
| Dilution | If the sample matrix contains an interfering material, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor. |
| Limits | These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges. |
| Original Sample | The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG. |
| Qualifier | This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable. |
| Result | The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state "ND" (Not Detected) or "BDL" (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte. |
| Case Narrative (Cn) | A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report. |
| Quality Control Summary (Qc) | This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material. |
| Sample Chain of Custody (Sc) | This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis. |
| Sample Results (Sr) | This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported. |
| Sample Summary (Ss) | This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis. |

| Qualifier | Description |
|---|---|
| B | The same analyte is found in the associated blank. |
| J | The identification of the analyte is acceptable; the reported value is an estimate. |
| J3 | The associated batch QC was outside the established quality control range for precision. |
| T8 | Sample(s) received past/too close to holding time expiration. |
| V | The sample concentration is too high to evaluate accurate spike recoveries. |

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

## State Accreditations

| | |
|---|---|
| Alabama | 40660 |
| Alaska | UST-080 |
| Arizona | AZ0612 |
| Arkansas | 88-0469 |
| California | 01157CA |
| Colorado | TN00003 |
| Connecticut | PH-0197 |
| Florida | E87487 |
| Georgia | NELAP |
| Georgia [1] | 923 |
| Idaho | TN00003 |
| Illinois | 200008 |
| Indiana | C-TN-01 |
| Iowa | 364 |
| Kansas | E-10277 |
| Kentucky [1] | 90010 |
| Kentucky [2] | 16 |
| Louisiana | AI30792 |
| Maine | TN0002 |
| Maryland | 324 |
| Massachusetts | M-TN003 |
| Michigan | 9958 |
| Minnesota | 047-999-395 |
| Mississippi | TN00003 |
| Missouri | 340 |
| Montana | CERT0086 |
| Nebraska | NE-OS-15-05 |

| | |
|---|---|
| Nevada | TN-03-2002-34 |
| New Hampshire | 2975 |
| New Jersey–NELAP | TN002 |
| New Mexico | TN00003 |
| New York | 11742 |
| North Carolina | Env375 |
| North Carolina [1] | DW21704 |
| North Carolina [2] | 41 |
| North Dakota | R-140 |
| Ohio–VAP | CL0069 |
| Oklahoma | 9915 |
| Oregon | TN200002 |
| Pennsylvania | 68-02979 |
| Rhode Island | 221 |
| South Carolina | 84004 |
| South Dakota | n/a |
| Tennessee [1,4] | 2006 |
| Texas | T 104704245-07-TX |
| Texas [5] | LAB0152 |
| Utah | 6157585858 |
| Vermont | VT2006 |
| Virginia | 109 |
| Washington | C1915 |
| West Virginia | 233 |
| Wisconsin | 9980939910 |
| Wyoming | A2LA |

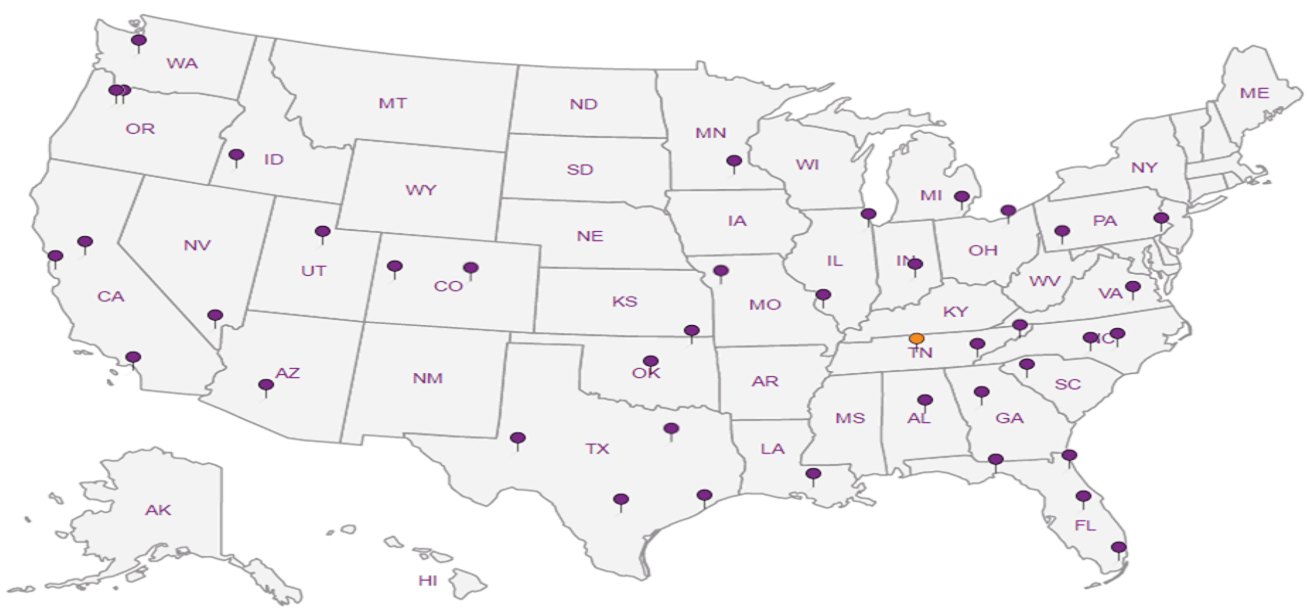
## Third Party Federal Accreditations

| | |
|---|---|
| A2LA – ISO 17025 | 1461.01 |
| A2LA – ISO 17025 [5] | 1461.02 |
| Canada | 1461.01 |
| EPA–Crypto | TN00003 |
| AIHA-LAP,LLC | 100789 |
| DOD | 1461.01 |
| USDA | S-67674 |

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold n/a Accreditation not applicable

## Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. ESC Lab Sciences performs all testing at our central laboratory.



| GES, Inc. - Sunoco<br>440 Creamery Way, Suite 500<br>Exton, PA 19341 | Billing Information:<br>Accounts Payable<br>440 Creamery Way, Suite 500<br>Exton, PA 19341 | Pres Chk |
|---|---|---|
| Report to:<br>Holly Smoker | Email To:<br>sgrillo@gesonline.com, hsmoker@geso | |
| Project Description: Pre-Construction Sampling | City/State Collected: Williamsburg PA | |
| Phone: 406-578-4501<br>Fax: | Client Project #<br>0204728 -06-160-XX | Lab Project #<br>SUNGES-GRILLO |
| Collected by (print):<br>Rob Faccenda | Site/Facility ID # | P.O. # |
| Collected by (signature):<br>Immediately Packed on Ice N ___ Y X | Rush? (Lab MUST Be Notified)<br>___ Same Day ___ Five Day<br>___ Next Day ___ 5 Day (Rad Only)<br>___ Two Day ___ 10 Day (Rad Only)<br>___ Three Day | Quote #<br>Date Results Needed<br>Standard TAT |

Analysis / Container / Preservative

| Sample ID | Comp/Grab | Matrix * | Depth | Date | Time | No of Cntrs | **pH,SPCON,TDS,TURB* 250ml plastic NP | ALK, Br, Cl, SO4 250ml plastic NP | Total Mtls, Hardness 250ml plastic HNO3 L2 | RSK175 + Propane 40ml vial w/ HCL | TSS 1L plastic NP | V8260BTEX 40ml vial w/ HCL | ****DW COLILERT**** microbiological | ****DW Fecal**** microbiological | | Remarks | Sample # (lab only) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01302018-629-01 | Grab | DW | — | 01/30/18 | 1200 | 12 | X | X | X | X | X | X | X | X | | | -01 |

Chain of Custody Page 1 of 1

ESC LAB SCIENCES

YOUR LAB OF CHOICE

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone 615-758-5858
Phone 800-767-5859
Fax 615-758-5859

L# L966586

Table G088

Acctnum: SUNGES
Template: T126128
Prelogin: P611030
TSR: 134 - Mark Beasley
PB:
Shipped Via: FEDEX

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other ______

Remarks:
Metals = Ba,Ca,Fe,K,Mg,Mn,Na
****Log COLILERT & FC as DW matrix****

pH ______ Temp ______
Flow ______ Other ______

Samples returned via: __ UPS X FedEx __ Courier ______

Tracking # 1474 0935 8004

Sample Receipt Checklist
COC Seal Present/Intact: __NP ✓Y __N
COC Signed/Accurate: ✓Y __N
Bottles arrive intact: ✓Y __N
Correct bottles used: ✓Y __N
Sufficient volume sent: ✓Y __N
If Applicable
VOA Zero Headspace: ✓Y __N
Preservation Correct/Checked: ✓Y __N

| Relinquished by : (Signature) | Date: | Time: | Received by: (Signature) | Trip Blank Received: Yes / No<br>HCL / MeoH<br>TBR |
|---|---|---|---|---|
| | 01/30/18 | 1500 | FEDEX 01/30/18 1500 | |
| Relinquished by : (Signature) | Date: | Time: | Received by: (Signature) | Temp: 1.8 °C Bottles Received: 12 |
| Relinquished by : (Signature) | Date: | Time: | Received for lab by: (Signature) | Date: 01-31-18 Time: 0845 |

If preservation required by Login: Date/Time

Hold:

Condition: NCF / OK

# ANALYTICAL REPORT

February 05, 2018

## GES, Inc - Sunoco

| | |
|---|---|
| Sample Delivery Group: | L966607 |
| Samples Received: | 01/31/2018 |
| Project Number: | 0204728-06-160-XX |
| Description: | Pre-Construction Sampling |
| | |
| Report To: | Stephanie Grillo |
| | 440 Creamery Way, Ste 500 |
| | Exton, PA 19341 |

Entire Report Reviewed By:

Mark W. Beasley
Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

# TABLE OF CONTENTS


| | |
|---|---|
| Cp: Cover Page | 1 |
| Tc: Table of Contents | 2 |
| Ss: Sample Summary | 3 |
| Cn: Case Narrative | 4 |
| Sr: Sample Results | 5 |
| 01302018-629-02 L966607-01 | 5 |
| Qc: Quality Control Summary | 7 |
| Gravimetric Analysis by Method 2540 C-2011 | 7 |
| Gravimetric Analysis by Method 2540 D-2011 | 8 |
| Wet Chemistry by Method 130.1 | 9 |
| Wet Chemistry by Method 2130 B-2011 | 10 |
| Wet Chemistry by Method 2320 B-2011 | 11 |
| Wet Chemistry by Method 9040C | 12 |
| Wet Chemistry by Method 9050A | 13 |
| Wet Chemistry by Method 9056A | 14 |
| Metals (ICP) by Method 6010B | 16 |
| Volatile Organic Compounds (GC) by Method RSK175 | 17 |
| Volatile Organic Compounds (GC/MS) by Method 8260B | 18 |
| Gl: Glossary of Terms | 19 |
| Al: Accreditations & Locations | 20 |
| Sc: Sample Chain of Custody | 21 |


1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## 01302018-629-02 L966607-01 GW

| Collected by | Collected date/time | Received date/time |
|---|---|---|
| Robert Faccenda | 01/30/18 13:00 | 01/31/18 08:45 |

| Method | Batch | Dilution | Preparation date/time | Analysis date/time | Analyst |
|---|---|---|---|---|---|
| Microbiology by Method 9222D | WG1068512 | 1 | 01/31/18 11:40 | 01/31/18 11:40 | MH |
| Microbiology by Method 9223 B-1997 | WG1068510 | 1 | 01/31/18 11:25 | 01/31/18 11:25 | MH |
| Gravimetric Analysis by Method 2540 C-2011 | WG1068493 | 1 | 01/31/18 18:51 | 01/31/18 19:34 | BS |
| Gravimetric Analysis by Method 2540 D-2011 | WG1068490 | 1 | 01/31/18 17:39 | 01/31/18 18:25 | EG |
| Wet Chemistry by Method 130.1 | WG1069334 | 5 | 02/02/18 13:12 | 02/02/18 13:12 | KK |
| Wet Chemistry by Method 2130 B-2011 | WG1068416 | 1 | 01/31/18 13:37 | 01/31/18 13:37 | GB |
| Wet Chemistry by Method 2320 B-2011 | WG1068941 | 1 | 02/01/18 17:53 | 02/01/18 17:53 | CSU |
| Wet Chemistry by Method 9040C | WG1068362 | 1 | 01/31/18 11:07 | 01/31/18 11:07 | GB |
| Wet Chemistry by Method 9050A | WG1067791 | 1 | 01/31/18 14:11 | 01/31/18 14:11 | TH |
| Wet Chemistry by Method 9056A | WG1068488 | 1 | 01/31/18 18:23 | 01/31/18 18:23 | DR |
| Metals (ICP) by Method 6010B | WG1068396 | 1 | 01/31/18 11:03 | 01/31/18 15:06 | TRB |
| Volatile Organic Compounds (GC) by Method RSK175 | WG1068846 | 1 | 02/01/18 10:38 | 02/01/18 10:38 | BG |
| Volatile Organic Compounds (GC/MS) by Method 8260B | WG1068403 | 1 | 01/31/18 14:09 | 01/31/18 14:09 | BMB |

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Mark W. Beasley
Technical Service Representative

## Microbiology by Method 9222D

| Analyte | Result col/100ml | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| Coliform,fecal | <1 | | 1 | 01/31/2018 11:40 | WG1068512 |

## Microbiology by Method 9223 B-1997

| Analyte | Result MPN/100ml | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| E.Coli | <1 | | 1 | 01/31/2018 11:25 | WG1068510 |
| Coliform,Total | <1 | | 1 | 01/31/2018 11:25 | WG1068510 |

## Gravimetric Analysis by Method 2540 C-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Dissolved Solids | 415 | | 10.0 | 1 | 01/31/2018 19:34 | WG1068493 |

## Gravimetric Analysis by Method 2540 D-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Suspended Solids | ND | | 2.50 | 1 | 01/31/2018 18:25 | WG1068490 |

## Wet Chemistry by Method 130.1

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 418 | | 150 | 5 | 02/02/2018 13:12 | WG1069334 |

## Wet Chemistry by Method 2130 B-2011

| Analyte | Result NTU | Qualifier | RDL NTU | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Turbidity | 1.05 | | 0.300 | 1 | 01/31/2018 13:37 | WG1068416 |

## Wet Chemistry by Method 2320 B-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Alkalinity | 258 | | 20.0 | 1 | 02/01/2018 17:53 | WG1068941 |

**Sample Narrative:**

L966607-01 WG1068941: Endpoint pH 4.5

## Wet Chemistry by Method 9040C

| Analyte | Result su | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| pH | 7.63 | T8 | 1 | 01/31/2018 11:07 | WG1068362 |

**Sample Narrative:**

L966607-01 WG1068362: 7.63 at 14.7C

## Wet Chemistry by Method 9050A

| Analyte | Result umhos/cm | Qualifier | RDL umhos/cm | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Specific Conductance | 731 | | 10.0 | 1 | 01/31/2018 14:11 | WG1067791 |

## Wet Chemistry by Method 9056A

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Bromide | ND | | 1.00 | 1 | 01/31/2018 18:23 | WG1068488 |
| Chloride | 11.4 | | 1.00 | 1 | 01/31/2018 18:23 | WG1068488 |
| Sulfate | 66.0 | | 5.00 | 1 | 01/31/2018 18:23 | WG1068488 |

## Metals (ICP) by Method 6010B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Barium | 0.0233 | | 0.00500 | 1 | 01/31/2018 15:06 | WG1068396 |
| Calcium | 85.0 | | 1.00 | 1 | 01/31/2018 15:06 | WG1068396 |
| Iron | ND | | 0.100 | 1 | 01/31/2018 15:06 | WG1068396 |
| Magnesium | 43.3 | | 1.00 | 1 | 01/31/2018 15:06 | WG1068396 |
| Manganese | ND | | 0.0100 | 1 | 01/31/2018 15:06 | WG1068396 |
| Potassium | 1.68 | B | 1.00 | 1 | 01/31/2018 15:06 | WG1068396 |
| Sodium | 3.89 | | 1.00 | 1 | 01/31/2018 15:06 | WG1068396 |

## Volatile Organic Compounds (GC) by Method RSK175

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Methane | ND | | 0.0100 | 1 | 02/01/2018 10:38 | WG1068846 |
| Ethane | ND | | 0.0130 | 1 | 02/01/2018 10:38 | WG1068846 |
| Ethene | ND | | 0.0130 | 1 | 02/01/2018 10:38 | WG1068846 |
| Propane | ND | | 0.0190 | 1 | 02/01/2018 10:38 | WG1068846 |

## Volatile Organic Compounds (GC/MS) by Method 8260B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Benzene | ND | | 0.00100 | 1 | 01/31/2018 14:09 | WG1068403 |
| Toluene | ND | | 0.00100 | 1 | 01/31/2018 14:09 | WG1068403 |
| Ethylbenzene | ND | | 0.00100 | 1 | 01/31/2018 14:09 | WG1068403 |
| Total Xylenes | ND | | 0.00300 | 1 | 01/31/2018 14:09 | WG1068403 |
| *(S) Toluene-d8* | *109* | | *80.0-120* | | *01/31/2018 14:09* | WG1068403 |
| *(S) Dibromofluoromethane* | *103* | | *76.0-123* | | *01/31/2018 14:09* | WG1068403 |
| *(S) a,a,a-Trifluorotoluene* | *105* | | *80.0-120* | | *01/31/2018 14:09* | WG1068403 |
| *(S) 4-Bromofluorobenzene* | *97.7* | | *80.0-120* | | *01/31/2018 14:09* | WG1068403 |

## Method Blank (MB)

(MB) R3283892-1 01/31/18 19:34

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Dissolved Solids | U | | 2.82 | 10.0 |

## L966617-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966617-01 01/31/18 19:34 • (DUP) R3283892-4 01/31/18 19:34

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Dissolved Solids | 682 | 670 | 1 | 1.78 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283892-2 01/31/18 19:34 • (LCSD) R3283892-3 01/31/18 19:34

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Dissolved Solids | 8800 | 8620 | 8570 | 98.0 | 97.4 | 85.0-115 | | | 0.582 | 5 |

## Method Blank (MB)

(MB) R3283392-1 01/31/18 18:25

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Suspended Solids | U | | 0.350 | 2.50 |

## L966599-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966599-01 01/31/18 18:25 • (DUP) R3283392-4 01/31/18 18:25

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 4.75 | 5.00 | 1 | 5.13 | P1 | 5 |

Sample Narrative:

OS: Sample split with duplicate.

## L966615-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966615-01 01/31/18 18:25 • (DUP) R3283392-5 01/31/18 18:25

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 11000 | 12000 | 1 | 8.73 | J3 | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283392-2 01/31/18 18:25 • (LCSD) R3283392-3 01/31/18 18:25

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Suspended Solids | 773 | 792 | 768 | 102 | 99.4 | 85.0-115 | | | 3.08 | 5 |

## Method Blank (MB)

(MB) R3283661-1 02/02/18 12:58

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 5.13 | J | 1.43 | 30.0 |

## L966477-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966477-01 02/02/18 13:05 • (DUP) R3283661-4 02/02/18 13:08

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 111 | 107 | 1 | 3.67 | | 20 |

## L966808-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966808-01 02/02/18 13:14 • (DUP) R3283661-5 02/02/18 13:15

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 60.0 | 59.9 | 1 | 0.167 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283661-2 02/02/18 12:58 • (LCSD) R3283661-3 02/02/18 12:59

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 158 | 158 | 105 | 105 | 85-115 | | | 0 | 20 |

## L966862-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L966862-01 02/02/18 13:18 • (MS) R3283661-6 02/02/18 13:19 • (MSD) R3283661-7 02/02/18 13:19

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | ND | 156 | 155 | 99 | 98.3 | 1 | 80-120 | | | 0.643 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3283057-1 01/31/18 13:37

| Analyte | MB Result NTU | MB Qualifier | MB MDL NTU | MB RDL NTU |
|---|---|---|---|---|
| Turbidity | 0.0660 | J | 0.0310 | 0.300 |

## L966586-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966586-01 01/31/18 13:37 • (DUP) R3283057-4 01/31/18 13:37

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 0.449 | 0.450 | 1 | 0.222 | | 20 |

## L966613-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966613-01 01/31/18 13:37 • (DUP) R3283057-5 01/31/18 13:37

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 0.474 | 0.468 | 1 | 1.27 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283057-2 01/31/18 13:37 • (LCSD) R3283057-3 01/31/18 13:37

| Analyte | Spike Amount NTU | LCS Result NTU | LCSD Result NTU | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Turbidity | 40.0 | 42.5 | 42.5 | 106 | 106 | 90.0-110 | | | 0.000 | 20 |

## L966323-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966323-01 02/01/18 15:40 • (DUP) R3283555-1 02/01/18 15:47

| | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | | % | | % |
| Alkalinity | 147 | 152 | 1 | 2.86 | | 20 |

Sample Narrative:

OS: Endpoint pH 4.5

DUP: Endpoint pH 4.5

## L966602-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966602-01 02/01/18 17:21 • (DUP) R3283555-4 02/01/18 17:28

| | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | | % | | % |
| Alkalinity | 89.5 | 82.8 | 1 | 7.73 | | 20 |

Sample Narrative:

OS: Endpoint pH 4.5

DUP: Endpoint pH 4.5

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283555-2 02/01/18 16:34 • (LCSD) R3283555-3 02/01/18 16:43

| | Spike Amount | LCS Result | LCSD Result | LCS Rec. | LCSD Rec. | Rec. Limits | LCS Qualifier | LCSD Qualifier | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | mg/l | % | % | % | | | % | % |
| Alkalinity | 100 | 106 | 102 | 106 | 102 | 85.0-115 | | | 3.32 | 20 |

Sample Narrative:

LCS: Endpoint pH 4.5

LCSD: Endpoint pH 4.5

## L966613-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966613-01 01/31/18 11:07 • (DUP) R3283001-4 01/31/18 11:07

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 7.28 | 7.29 | 1 | 0.137 | | 1 |

Sample Narrative:

OS: 7.28 at 15.3C

DUP: 7.29 at 15.3C

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283001-1 01/31/18 11:07 • (LCSD) R3283001-2 01/31/18 11:07

| Analyte | Spike Amount su | LCS Result su | LCSD Result su | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | 6.38 | 6.36 | 6.35 | 99.7 | 99.5 | 98.4-102 | | | 0.157 | 1 |

Sample Narrative:

LCS: 6.36 at 17.9C

LCSD: 6.35 at 18C

## Method Blank (MB)

(MB) WG1067791-1 01/31/18 14:11

| Analyte | MB Result umhos/cm | MB Qualifier | MB MDL umhos/cm | MB RDL umhos/cm |
|---|---|---|---|---|
| Specific Conductance | U | | 10.0 | 10.0 |

## L966284-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966284-01 01/31/18 14:11 • (DUP) WG1067791-4 01/31/18 14:11

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 793 | 797 | 1 | 0.503 | | 20 |

## L966613-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966613-01 01/31/18 14:11 • (DUP) WG1067791-5 01/31/18 14:11

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 581 | 585 | 1 | 0.686 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG1067791-2 01/31/18 14:11 • (LCSD) WG1067791-3 01/31/18 14:11

| Analyte | Spike Amount umhos/cm | LCS Result umhos/cm | LCSD Result umhos/cm | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Specific Conductance | 559 | 552 | 553 | 98.7 | 98.9 | 85.0-115 | | | 0.181 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3283212-1 01/31/18 11:17

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Bromide | U | | 0.079 | 1.00 |
| Chloride | U | | 0.0519 | 1.00 |
| Sulfate | U | | 0.0774 | 5.00 |

## L966595-02 Original Sample (OS) • Duplicate (DUP)

(OS) L966595-02 01/31/18 15:25 • (DUP) R3283212-4 01/31/18 15:35

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | U | 0.000 | 1 | 0 | | 15 |
| Chloride | 22.0 | 22.3 | 1 | 1 | | 15 |
| Sulfate | 14.4 | 14.3 | 1 | 1 | | 15 |

## L966606-02 Original Sample (OS) • Duplicate (DUP)

(OS) L966606-02 01/31/18 17:33 • (DUP) R3283212-7 01/31/18 17:43

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | U | 0.000 | 1 | 0 | | 15 |
| Chloride | 20.6 | 21.0 | 1 | 2 | | 15 |
| Sulfate | 10.8 | 10.9 | 1 | 1 | | 15 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283212-2 01/31/18 11:27 • (LCSD) R3283212-3 01/31/18 11:37

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 40.0 | 39.3 | 39.6 | 98 | 99 | 80-120 | | | 1 | 15 |
| Chloride | 40.0 | 38.7 | 38.7 | 97 | 97 | 80-120 | | | 0 | 15 |
| Sulfate | 40.0 | 39.4 | 39.7 | 98 | 99 | 80-120 | | | 1 | 15 |

Cp Tc Ss Cn Sr Qc Gl Al Sc

## L966595-02 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L966595-02 01/31/18 15:25 • (MS) R3283212-5 01/31/18 15:44 • (MSD) R3283212-6 01/31/18 15:54

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | U | 46.8 | 49.1 | 94 | 98 | 1 | 80-120 | | | 5 | 15 |
| Chloride | 50.0 | 22.0 | 72.4 | 72.7 | 101 | 101 | 1 | 80-120 | | | 0 | 15 |
| Sulfate | 50.0 | 14.4 | 65.0 | 64.6 | 101 | 100 | 1 | 80-120 | | | 1 | 15 |

## L966606-02 Original Sample (OS) • Matrix Spike (MS)

(OS) L966606-02 01/31/18 17:33 • (MS) R3283212-8 01/31/18 17:53

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MS Rec. % | Dilution | Rec. Limits % | MS Qualifier |
|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | U | 46.8 | 94 | 1 | 80-120 | |
| Chloride | 50.0 | 20.6 | 70.8 | 100 | 1 | 80-120 | |
| Sulfate | 50.0 | 10.8 | 64.9 | 108 | 1 | 80-120 | |

## Method Blank (MB)

(MB) R3283142-1 01/31/18 14:21

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Barium | U | | 0.0017 | 0.00500 |
| Calcium | U | | 0.0463 | 1.00 |
| Iron | U | | 0.0141 | 0.100 |
| Magnesium | 0.0346 | J | 0.0111 | 1.00 |
| Manganese | U | | 0.0012 | 0.0100 |
| Potassium | 0.173 | J | 0.102 | 1.00 |
| Sodium | 0.244 | J | 0.0985 | 1.00 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283142-2 01/31/18 14:23 • (LCSD) R3283142-3 01/31/18 14:26

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 0.980 | 0.995 | 98 | 99.5 | 80-120 | | | 1.53 | 20 |
| Calcium | 10.0 | 9.44 | 9.59 | 94.4 | 95.9 | 80-120 | | | 1.61 | 20 |
| Iron | 10.0 | 9.58 | 9.79 | 95.8 | 97.9 | 80-120 | | | 2.14 | 20 |
| Magnesium | 10.0 | 9.47 | 9.49 | 94.7 | 94.9 | 80-120 | | | 0.184 | 20 |
| Manganese | 1.00 | 0.962 | 0.976 | 96.2 | 97.6 | 80-120 | | | 1.43 | 20 |
| Potassium | 10.0 | 9.29 | 9.70 | 92.9 | 97 | 80-120 | | | 4.28 | 20 |
| Sodium | 10.0 | 9.86 | 10.3 | 98.6 | 103 | 80-120 | | | 4.29 | 20 |

## L966630-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L966630-01 01/31/18 14:30 • (MS) R3283142-5 01/31/18 14:35 • (MSD) R3283142-6 01/31/18 14:37

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 0.0200 | 0.997 | 0.999 | 97.7 | 97.9 | 1 | 75-125 | | | 0.138 | 20 |
| Calcium | 10.0 | 114 | 122 | 122 | 78.7 | 75 | 1 | 75-125 | | | 0.303 | 20 |
| Iron | 10.0 | 0.310 | 9.92 | 10.0 | 96.1 | 96.9 | 1 | 75-125 | | | 0.769 | 20 |
| Magnesium | 10.0 | 185 | 190 | 190 | 50.6 | 49.7 | 1 | 75-125 | V | V | 0.0495 | 20 |
| Manganese | 1.00 | 0.353 | 1.30 | 1.30 | 94.4 | 94.3 | 1 | 75-125 | | | 0.0559 | 20 |
| Potassium | 10.0 | 2.55 | 12.4 | 12.7 | 98.9 | 102 | 1 | 75-125 | | | 2.17 | 20 |
| Sodium | 10.0 | 123 | 130 | 129 | 75.1 | 67.6 | 1 | 75-125 | | V | 0.582 | 20 |

## Method Blank (MB)

(MB) R3283388-1 02/01/18 09:59

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Methane | U | | 0.00291 | 0.0100 |
| Ethane | U | | 0.00407 | 0.0130 |
| Ethene | U | | 0.00426 | 0.0130 |
| Propane | U | | 0.00548 | 0.0190 |

## L966617-06 Original Sample (OS) • Duplicate (DUP)

(OS) L966617-06 02/01/18 10:59 • (DUP) R3283388-2 02/01/18 11:40

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## L966617-06 Original Sample (OS) • Duplicate (DUP)

(OS) L966617-06 02/01/18 10:59 • (DUP) R3283388-3 02/01/18 13:38

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283388-4 02/01/18 13:41 • (LCSD) R3283388-5 02/01/18 13:48

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Methane | 0.0678 | 0.0747 | 0.0723 | 110 | 107 | 85.0-115 | | | 3.25 | 20 |
| Ethane | 0.129 | 0.114 | 0.117 | 88.5 | 90.8 | 85.0-115 | | | 2.59 | 20 |
| Ethene | 0.127 | 0.118 | 0.121 | 92.7 | 95.0 | 85.0-115 | | | 2.45 | 20 |
| Propane | 0.186 | 0.188 | 0.191 | 101 | 103 | 85.0-115 | | | 1.86 | 20 |

## Method Blank (MB)

(MB) R3283218-2 01/31/18 12:19

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Benzene | U | | 0.000331 | 0.00100 |
| Ethylbenzene | U | | 0.000384 | 0.00100 |
| Toluene | U | | 0.000412 | 0.00100 |
| Xylenes, Total | U | | 0.00106 | 0.00300 |
| *(S) Toluene-d8* | *107* | | | *80.0-120* |
| *(S) Dibromofluoromethane* | *101* | | | *76.0-123* |
| *(S) a,a,a-Trifluorotoluene* | *105* | | | *80.0-120* |
| *(S) 4-Bromofluorobenzene* | *98.2* | | | *80.0-120* |

## Laboratory Control Sample (LCS)

(LCS) R3283218-1 01/31/18 11:37

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCS Rec. % | Rec. Limits % | LCS Qualifier |
|---|---|---|---|---|---|
| Benzene | 0.0250 | 0.0236 | 94.4 | 69.0-123 | |
| Ethylbenzene | 0.0250 | 0.0291 | 116 | 77.0-120 | |
| Toluene | 0.0250 | 0.0265 | 106 | 77.0-120 | |
| Xylenes, Total | 0.0750 | 0.0880 | 117 | 77.0-120 | |
| *(S) Toluene-d8* | | | *105* | *80.0-120* | |
| *(S) Dibromofluoromethane* | | | *99.9* | *76.0-123* | |
| *(S) a,a,a-Trifluorotoluene* | | | *106* | *80.0-120* | |
| *(S) 4-Bromofluorobenzene* | | | *100* | *80.0-120* | |

## Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

## Abbreviations and Definitions

| | |
|---|---|
| MDL | Method Detection Limit. |
| ND | Not detected at the Reporting Limit (or MDL where applicable). |
| RDL | Reported Detection Limit. |
| Rec. | Recovery. |
| RPD | Relative Percent Difference. |
| SDG | Sample Delivery Group. |
| (S) | Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media. |
| U | Not detected at the Reporting Limit (or MDL where applicable). |
| Analyte | The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported. |
| Dilution | If the sample matrix contains an interfering material, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor. |
| Limits | These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges. |
| Original Sample | The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG. |
| Qualifier | This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable. |
| Result | The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state “ND” (Not Detected) or “BDL” (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte. |
| Case Narrative (Cn) | A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report. |
| Quality Control Summary (Qc) | This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material. |
| Sample Chain of Custody (Sc) | This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis. |
| Sample Results (Sr) | This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported. |
| Sample Summary (Ss) | This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis. |

| Qualifier | Description |
|---|---|
| B | The same analyte is found in the associated blank. |
| J | The identification of the analyte is acceptable; the reported value is an estimate. |
| J3 | The associated batch QC was outside the established quality control range for precision. |
| P1 | RPD value not applicable for sample concentrations less than 5 times the reporting limit. |
| T8 | Sample(s) received past/too close to holding time expiration. |
| V | The sample concentration is too high to evaluate accurate spike recoveries. |

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

## State Accreditations

| | | | |
|---|---|---|---|
| Alabama | 40660 | Nevada | TN-03-2002-34 |
| Alaska | UST-080 | New Hampshire | 2975 |
| Arizona | AZ0612 | New Jersey–NELAP | TN002 |
| Arkansas | 88-0469 | New Mexico | TN00003 |
| California | 01157CA | New York | 11742 |
| Colorado | TN00003 | North Carolina | Env375 |
| Connecticut | PH-0197 | North Carolina [1] | DW21704 |
| Florida | E87487 | North Carolina [2] | 41 |
| Georgia | NELAP | North Dakota | R-140 |
| Georgia [1] | 923 | Ohio–VAP | CL0069 |
| Idaho | TN00003 | Oklahoma | 9915 |
| Illinois | 200008 | Oregon | TN200002 |
| Indiana | C-TN-01 | Pennsylvania | 68-02979 |
| Iowa | 364 | Rhode Island | 221 |
| Kansas | E-10277 | South Carolina | 84004 |
| Kentucky [1] | 90010 | South Dakota | n/a |
| Kentucky [2] | 16 | Tennessee [1 4] | 2006 |
| Louisiana | AI30792 | Texas | T 104704245-07-TX |
| Maine | TN0002 | Texas [5] | LAB0152 |
| Maryland | 324 | Utah | 6157585858 |
| Massachusetts | M-TN003 | Vermont | VT2006 |
| Michigan | 9958 | Virginia | 109 |
| Minnesota | 047-999-395 | Washington | C1915 |
| Mississippi | TN00003 | West Virginia | 233 |
| Missouri | 340 | Wisconsin | 9980939910 |
| Montana | CERT0086 | Wyoming | A2LA |
| Nebraska | NE-OS-15-05 | | |

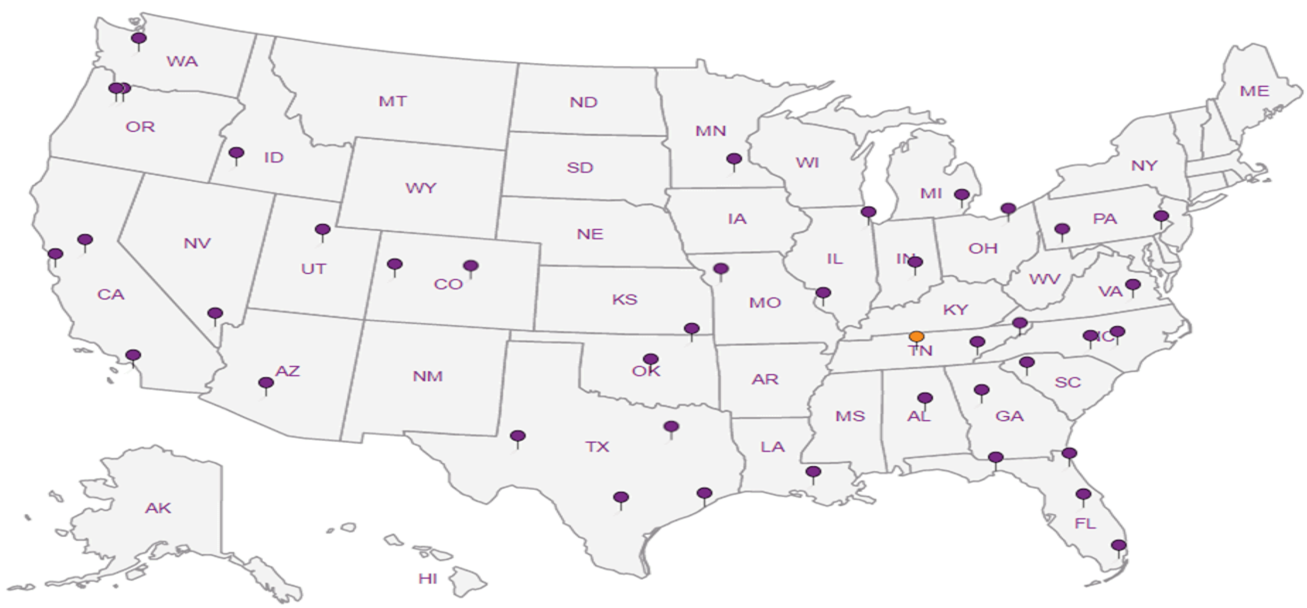
## Third Party Federal Accreditations

| | | | |
|---|---|---|---|
| A2LA – ISO 17025 | 1461.01 | AIHA-LAP,LLC | 100789 |
| A2LA – ISO 17025 [5] | 1461.02 | DOD | 1461.01 |
| Canada | 1461.01 | USDA | S-67674 |
| EPA–Crypto | TN00003 | | |

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold n/a Accreditation not applicable

## Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. ESC Lab Sciences performs all testing at our central laboratory.



GES, Inc. - Sunoco

440 Creamery Way, Suite 500
Exton, PA 19341

Billing information:

**Accounts Payable**
**440 Creamery Way, Suite 500**
**Exton, PA 19341**

Pres Chk

Report to:
**Holly Smoker**

Email To:
sgrillo@gesonline.com, hsmoker@geso

Project Description: **Pre-Construction Sampling**

City/State Collected: Williamsburg PA

Phone: 406-578-4501
Fax:

Client Project # 0204728 -06-160-XX

Lab Project # SUNGES-GRILLO

Collected by (print): Ron Faccenda

Site/Facility ID #

P.O. #

Collected by (signature):

Immediately Packed on Ice N ___ Y X

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day

Quote #

Date Results Needed
**Standard TAT**

Analysis / Container / Preservative

| Sample ID | Comp/Grab | Matrix * | Depth | Date | Time | No. of Cntrs | **pH,SPCON,TDS,TURB* 250ml plastic NP | ALK, Br, Cl, SO4 250ml plastic NP | Total Mtls, Hardness 250ml plastic HNO3 | RSK175 + Propane 40ml vial w/ HCL | TSS 1L plastic NP | V8260BTEX 40ml vial w/ HCL | ****DW COLILERT**** microbiological | ****DW Fecal**** microbiological | Remarks | Sample # (lab only) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01302018-629-D2 | Grab | DW | - | 01/30/18 | 1300 | 12 | X | X | X | X | X | X | X | X | | -01 |

Chain of Custody Page 1 of 1

ESC
LAB SCIENCES
YOUR LAB OF CHOICE
12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L# 966607
G089

Acctnum: SUNGES
Template: T126128
Prelogin: P611030
TSR: 134 - Mark Beasley
PB
Shipped Via: FEDEX

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other

Remarks:
**Metals = Ba,Ca,Fe,K,Mg,Mn,Na**
******Log COLILERT & FC as DW matrix******

pH ___ Temp ___
Flow ___ Other ___

Samples returned via:
___ UPS X FedEx ___ Courier

Tracking # 141409358904

Sample Receipt Checklist
COC Seal Present/Intact: NP Y N
COC Signed/Accurate: Y N
Bottles arrive intact: Y N
Correct bottles used: Y N
Sufficient volume sent: Y N
If Applicable
VOA Zero Headspace: Y N
Preservation Correct/Checked: Y N

| Relinquished by : (Signature) | Date: | Time: | Received by: (Signature) | Trip Blank Received: Yes / No HCL / MeoH TBR |
|---|---|---|---|---|
| | 01/30/18 | 1500 | FEDEX 01/30/18 1500 | |
| Relinquished by : (Signature) | Date: | Time: | Received by: (Signature) | Temp: 1.8 °C Bottles Received: 12 |
| Relinquished by : (Signature) | Date: | Time: | Received for lab by: (Signature) | Date: 01-31-18 Time: 0845 |

If preservation required by Login: Date/Time

Hold:

Condition: NCF / OK

# ANALYTICAL REPORT

February 05, 2018

## GES, Inc - Sunoco

| | |
|---|---|
| Sample Delivery Group: | L966612 |
| Samples Received: | 01/31/2018 |
| Project Number: | 0204728-06-160-XX |
| Description: | Pre-Construction Sampling |
| | |
| Report To: | Stephanie Grillo<br>440 Creamery Way, Ste 500<br>Exton, PA  19341 |

Entire Report Reviewed By:

Mark W. Beasley
Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory.  Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

# TABLE OF CONTENTS


| | |
|---|---|
| Cp: Cover Page | 1 |
| Tc: Table of Contents | 2 |
| Ss: Sample Summary | 3 |
| Cn: Case Narrative | 4 |
| Sr: Sample Results | 5 |
| 01302018-629-03 L966612-01 | 5 |
| Qc: Quality Control Summary | 7 |
| Gravimetric Analysis by Method 2540 C-2011 | 7 |
| Gravimetric Analysis by Method 2540 D-2011 | 8 |
| Wet Chemistry by Method 130.1 | 9 |
| Wet Chemistry by Method 2130 B-2011 | 10 |
| Wet Chemistry by Method 2320 B-2011 | 11 |
| Wet Chemistry by Method 9040C | 12 |
| Wet Chemistry by Method 9050A | 13 |
| Wet Chemistry by Method 9056A | 14 |
| Metals (ICP) by Method 6010B | 16 |
| Volatile Organic Compounds (GC) by Method RSK175 | 17 |
| Volatile Organic Compounds (GC/MS) by Method 8260B | 18 |
| Gl: Glossary of Terms | 19 |
| Al: Accreditations & Locations | 20 |
| Sc: Sample Chain of Custody | 21 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

| 01302018-629-03 L966612-01 GW | | | Collected by | Collected date/time | Received date/time |
|---|---|---|---|---|---|
| | | | Robert Faccenda | 01/30/18 13:20 | 01/31/18 08:45 |

| Method | Batch | Dilution | Preparation date/time | Analysis date/time | Analyst |
|---|---|---|---|---|---|
| Microbiology by Method 9222D | WG1068512 | 1 | 01/31/18 11:40 | 01/31/18 11:40 | MH |
| Microbiology by Method 9223 B-1997 | WG1068510 | 1 | 01/31/18 11:25 | 01/31/18 11:25 | MH |
| Gravimetric Analysis by Method 2540 C-2011 | WG1068493 | 1 | 01/31/18 18:51 | 01/31/18 19:34 | BS |
| Gravimetric Analysis by Method 2540 D-2011 | WG1068490 | 1 | 01/31/18 17:39 | 01/31/18 18:25 | EG |
| Wet Chemistry by Method 130.1 | WG1069334 | 5 | 02/02/18 13:13 | 02/02/18 13:13 | KK |
| Wet Chemistry by Method 2130 B-2011 | WG1068416 | 1 | 01/31/18 13:37 | 01/31/18 13:37 | GB |
| Wet Chemistry by Method 2320 B-2011 | WG1070017 | 1 | 02/05/18 09:28 | 02/05/18 09:28 | MCG |
| Wet Chemistry by Method 9040C | WG1068362 | 1 | 01/31/18 11:07 | 01/31/18 11:07 | GB |
| Wet Chemistry by Method 9050A | WG1067791 | 1 | 01/31/18 14:11 | 01/31/18 14:11 | TH |
| Wet Chemistry by Method 9056A | WG1068488 | 1 | 01/31/18 18:43 | 01/31/18 18:43 | DR |
| Metals (ICP) by Method 6010B | WG1068396 | 1 | 01/31/18 11:03 | 01/31/18 15:09 | TRB |
| Volatile Organic Compounds (GC) by Method RSK175 | WG1068846 | 1 | 02/01/18 10:41 | 02/01/18 10:41 | BG |
| Volatile Organic Compounds (GC/MS) by Method 8260B | WG1068403 | 1 | 01/31/18 14:29 | 01/31/18 14:29 | BMB |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Mark W. Beasley
Technical Service Representative

## Microbiology by Method 9222D

| Analyte | Result col/100ml | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| Coliform,fecal | <1 | | 1 | 01/31/2018 11:40 | WG1068512 |

## Microbiology by Method 9223 B-1997

| Analyte | Result MPN/100ml | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| E.Coli | 1.00 | | 1 | 01/31/2018 11:25 | WG1068510 |
| Coliform,Total | 20.3 | | 1 | 01/31/2018 11:25 | WG1068510 |

## Gravimetric Analysis by Method 2540 C-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Dissolved Solids | 408 | | 10.0 | 1 | 01/31/2018 19:34 | WG1068493 |

## Gravimetric Analysis by Method 2540 D-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Suspended Solids | ND | | 2.50 | 1 | 01/31/2018 18:25 | WG1068490 |

**Sample Narrative:**

L966612-01 WG1068490: Used all available sample.

## Wet Chemistry by Method 130.1

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 428 | | 150 | 5 | 02/02/2018 13:13 | WG1069334 |

## Wet Chemistry by Method 2130 B-2011

| Analyte | Result NTU | Qualifier | RDL NTU | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Turbidity | 1.35 | | 0.300 | 1 | 01/31/2018 13:37 | WG1068416 |

## Wet Chemistry by Method 2320 B-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Alkalinity | 318 | | 20.0 | 1 | 02/05/2018 09:28 | WG1070017 |

**Sample Narrative:**

L966612-01 WG1070017: Endpoint pH 4.5

## Wet Chemistry by Method 9040C

| Analyte | Result su | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| pH | 7.25 | T8 | 1 | 01/31/2018 11:07 | WG1068362 |

**Sample Narrative:**

L966612-01 WG1068362: 7.25 at 15.1C

## Wet Chemistry by Method 9050A

| Analyte | Result umhos/cm | Qualifier | RDL umhos/cm | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Specific Conductance | 772 | | 10.0 | 1 | 01/31/2018 14:11 | WG1067791 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Wet Chemistry by Method 9056A

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Bromide | ND | | 1.00 | 1 | 01/31/2018 18:43 | WG1068488 |
| Chloride | 16.3 | | 1.00 | 1 | 01/31/2018 18:43 | WG1068488 |
| Sulfate | 23.6 | | 5.00 | 1 | 01/31/2018 18:43 | WG1068488 |

## Metals (ICP) by Method 6010B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Barium | 0.0312 | | 0.00500 | 1 | 01/31/2018 15:09 | WG1068396 |
| Calcium | 88.0 | | 1.00 | 1 | 01/31/2018 15:09 | WG1068396 |
| Iron | ND | | 0.100 | 1 | 01/31/2018 15:09 | WG1068396 |
| Magnesium | 43.0 | | 1.00 | 1 | 01/31/2018 15:09 | WG1068396 |
| Manganese | ND | | 0.0100 | 1 | 01/31/2018 15:09 | WG1068396 |
| Potassium | 2.28 | | 1.00 | 1 | 01/31/2018 15:09 | WG1068396 |
| Sodium | 6.05 | | 1.00 | 1 | 01/31/2018 15:09 | WG1068396 |

## Volatile Organic Compounds (GC) by Method RSK175

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Methane | ND | | 0.0100 | 1 | 02/01/2018 10:41 | WG1068846 |
| Ethane | ND | | 0.0130 | 1 | 02/01/2018 10:41 | WG1068846 |
| Ethene | ND | | 0.0130 | 1 | 02/01/2018 10:41 | WG1068846 |
| Propane | ND | | 0.0190 | 1 | 02/01/2018 10:41 | WG1068846 |

## Volatile Organic Compounds (GC/MS) by Method 8260B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Benzene | ND | | 0.00100 | 1 | 01/31/2018 14:29 | WG1068403 |
| Toluene | ND | | 0.00100 | 1 | 01/31/2018 14:29 | WG1068403 |
| Ethylbenzene | ND | | 0.00100 | 1 | 01/31/2018 14:29 | WG1068403 |
| Total Xylenes | ND | | 0.00300 | 1 | 01/31/2018 14:29 | WG1068403 |
| *(S) Toluene-d8* | *108* | | *80.0-120* | | *01/31/2018 14:29* | WG1068403 |
| *(S) Dibromofluoromethane* | *101* | | *76.0-123* | | *01/31/2018 14:29* | WG1068403 |
| *(S) a,a,a-Trifluorotoluene* | *106* | | *80.0-120* | | *01/31/2018 14:29* | WG1068403 |
| *(S) 4-Bromofluorobenzene* | *97.6* | | *80.0-120* | | *01/31/2018 14:29* | WG1068403 |

## Method Blank (MB)

(MB) R3283892-1 01/31/18 19:34

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Dissolved Solids | U | | 2.82 | 10.0 |

## L966617-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966617-01 01/31/18 19:34 • (DUP) R3283892-4 01/31/18 19:34

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Dissolved Solids | 682 | 670 | 1 | 1.78 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283892-2 01/31/18 19:34 • (LCSD) R3283892-3 01/31/18 19:34

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Dissolved Solids | 8800 | 8620 | 8570 | 98.0 | 97.4 | 85.0-115 | | | 0.582 | 5 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3283392-1 01/31/18 18:25

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Suspended Solids | U | | 0.350 | 2.50 |

## L966599-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966599-01 01/31/18 18:25 • (DUP) R3283392-4 01/31/18 18:25

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 4.75 | 5.00 | 1 | 5.13 | P1 | 5 |

**Sample Narrative:**

OS: Sample split with duplicate.

## L966615-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966615-01 01/31/18 18:25 • (DUP) R3283392-5 01/31/18 18:25

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 11000 | 12000 | 1 | 8.73 | J3 | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283392-2 01/31/18 18:25 • (LCSD) R3283392-3 01/31/18 18:25

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Suspended Solids | 773 | 792 | 768 | 102 | 99.4 | 85.0-115 | | | 3.08 | 5 |

## Method Blank (MB)

(MB) R3283661-1 02/02/18 12:58

| | MB Result | MB Qualifier | MB MDL | MB RDL |
|---|---|---|---|---|
| Analyte | mg/l | | mg/l | mg/l |
| Hardness (colorimetric) as CaCO3 | 5.13 | J | 1.43 | 30.0 |

## L966477-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966477-01 02/02/18 13:05 • (DUP) R3283661-4 02/02/18 13:08

| | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | | % | | % |
| Hardness (colorimetric) as CaCO3 | 111 | 107 | 1 | 3.67 | | 20 |

## L966808-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966808-01 02/02/18 13:14 • (DUP) R3283661-5 02/02/18 13:15

| | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | | % | | % |
| Hardness (colorimetric) as CaCO3 | 60.0 | 59.9 | 1 | 0.167 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283661-2 02/02/18 12:58 • (LCSD) R3283661-3 02/02/18 12:59

| | Spike Amount | LCS Result | LCSD Result | LCS Rec. | LCSD Rec. | Rec. Limits | LCS Qualifier | LCSD Qualifier | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | mg/l | % | % | % | | | % | % |
| Hardness (colorimetric) as CaCO3 | 150 | 158 | 158 | 105 | 105 | 85-115 | | | 0 | 20 |

## L966862-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L966862-01 02/02/18 13:18 • (MS) R3283661-6 02/02/18 13:19 • (MSD) R3283661-7 02/02/18 13:19

| | Spike Amount | Original Result | MS Result | MSD Result | MS Rec. | MSD Rec. | Dilution | Rec. Limits | MS Qualifier | MSD Qualifier | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | mg/l | mg/l | % | % | | % | | | % | % |
| Hardness (colorimetric) as CaCO3 | 150 | ND | 156 | 155 | 99 | 98.3 | 1 | 80-120 | | | 0.643 | 20 |

## Method Blank (MB)

(MB) R3283057-1 01/31/18 13:37

| Analyte | MB Result NTU | MB Qualifier | MB MDL NTU | MB RDL NTU |
|---|---|---|---|---|
| Turbidity | 0.0660 | J | 0.0310 | 0.300 |

## L966586-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966586-01 01/31/18 13:37 • (DUP) R3283057-4 01/31/18 13:37

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 0.449 | 0.450 | 1 | 0.222 | | 20 |

## L966613-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966613-01 01/31/18 13:37 • (DUP) R3283057-5 01/31/18 13:37

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 0.474 | 0.468 | 1 | 1.27 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283057-2 01/31/18 13:37 • (LCSD) R3283057-3 01/31/18 13:37

| Analyte | Spike Amount NTU | LCS Result NTU | LCSD Result NTU | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Turbidity | 40.0 | 42.5 | 42.5 | 106 | 106 | 90.0-110 | | | 0.000 | 20 |

## L967491-01 Original Sample (OS) • Duplicate (DUP)

(OS) L967491-01 02/05/18 09:44 • (DUP) R3284035-1 02/05/18 09:52

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Alkalinity | 281 | 285 | 1 | 1.61 | | 20 |

**Sample Narrative:**

OS: Endpoint pH 4.5

DUP: Endpoint pH 4.5

## L966622-09 Original Sample (OS) • Duplicate (DUP)

(OS) L966622-09 02/05/18 12:42 • (DUP) R3284035-5 02/05/18 12:48

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Alkalinity | 269 | 269 | 1 | 0.0696 | | 20 |

**Sample Narrative:**

OS: Endpoint pH 4.5

DUP: Endpoint pH 4.5

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3284035-2 02/05/18 10:08 • (LCSD) R3284035-3 02/05/18 10:19

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity | 100 | 106 | 102 | 106 | 102 | 85.0-115 | | | 3.35 | 20 |

**Sample Narrative:**

LCS: Endpoint pH 4.5

LCSD: Endpoint pH 4.5

## L966613-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966613-01 01/31/18 11:07 • (DUP) R3283001-4 01/31/18 11:07

| | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| Analyte | su | su | | % | | % |
| pH | 7.28 | 7.29 | 1 | 0.137 | | 1 |

**Sample Narrative:**

OS: 7.28 at 15.3C

DUP: 7.29 at 15.3C

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283001-1 01/31/18 11:07 • (LCSD) R3283001-2 01/31/18 11:07

| | Spike Amount | LCS Result | LCSD Result | LCS Rec. | LCSD Rec. | Rec. Limits | LCS Qualifier | LCSD Qualifier | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | su | su | su | % | % | % | | | % | % |
| pH | 6.38 | 6.36 | 6.35 | 99.7 | 99.5 | 98.4-102 | | | 0.157 | 1 |

**Sample Narrative:**

LCS: 6.36 at 17.9C

LCSD: 6.35 at 18C

## Method Blank (MB)

(MB) WG1067791-1 01/31/18 14:11

| | MB Result | MB Qualifier | MB MDL | MB RDL |
|---|---|---|---|---|
| Analyte | umhos/cm | | umhos/cm | umhos/cm |
| Specific Conductance | U | | 10.0 | 10.0 |

## L966284-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966284-01 01/31/18 14:11 • (DUP) WG1067791-4 01/31/18 14:11

| | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| Analyte | umhos/cm | umhos/cm | | % | | % |
| Specific Conductance | 793 | 797 | 1 | 0.503 | | 20 |

## L966613-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966613-01 01/31/18 14:11 • (DUP) WG1067791-5 01/31/18 14:11

| | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| Analyte | umhos/cm | umhos/cm | | % | | % |
| Specific Conductance | 581 | 585 | 1 | 0.686 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG1067791-2 01/31/18 14:11 • (LCSD) WG1067791-3 01/31/18 14:11

| | Spike Amount | LCS Result | LCSD Result | LCS Rec. | LCSD Rec. | Rec. Limits | LCS Qualifier | LCSD Qualifier | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | umhos/cm | umhos/cm | umhos/cm | % | % | % | | | % | % |
| Specific Conductance | 559 | 552 | 553 | 98.7 | 98.9 | 85.0-115 | | | 0.181 | 20 |

## Method Blank (MB)

(MB) R3283212-1 01/31/18 11:17

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Bromide | U | | 0.079 | 1.00 |
| Chloride | U | | 0.0519 | 1.00 |
| Sulfate | U | | 0.0774 | 5.00 |

## L966595-02 Original Sample (OS) • Duplicate (DUP)

(OS) L966595-02 01/31/18 15:25 • (DUP) R3283212-4 01/31/18 15:35

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | U | 0.000 | 1 | 0 | | 15 |
| Chloride | 22.0 | 22.3 | 1 | 1 | | 15 |
| Sulfate | 14.4 | 14.3 | 1 | 1 | | 15 |

## L966606-02 Original Sample (OS) • Duplicate (DUP)

(OS) L966606-02 01/31/18 17:33 • (DUP) R3283212-7 01/31/18 17:43

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | U | 0.000 | 1 | 0 | | 15 |
| Chloride | 20.6 | 21.0 | 1 | 2 | | 15 |
| Sulfate | 10.8 | 10.9 | 1 | 1 | | 15 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283212-2 01/31/18 11:27 • (LCSD) R3283212-3 01/31/18 11:37

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 40.0 | 39.3 | 39.6 | 98 | 99 | 80-120 | | | 1 | 15 |
| Chloride | 40.0 | 38.7 | 38.7 | 97 | 97 | 80-120 | | | 0 | 15 |
| Sulfate | 40.0 | 39.4 | 39.7 | 98 | 99 | 80-120 | | | 1 | 15 |

## L966595-02 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L966595-02 01/31/18 15:25 • (MS) R3283212-5 01/31/18 15:44 • (MSD) R3283212-6 01/31/18 15:54

| | Spike Amount | Original Result | MS Result | MSD Result | MS Rec. | MSD Rec. | Dilution | Rec. Limits | MS Qualifier | MSD Qualifier | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | mg/l | mg/l | % | % | | % | | | % | % |
| Bromide | 50.0 | U | 46.8 | 49.1 | 94 | 98 | 1 | 80-120 | | | 5 | 15 |
| Chloride | 50.0 | 22.0 | 72.4 | 72.7 | 101 | 101 | 1 | 80-120 | | | 0 | 15 |
| Sulfate | 50.0 | 14.4 | 65.0 | 64.6 | 101 | 100 | 1 | 80-120 | | | 1 | 15 |

## L966606-02 Original Sample (OS) • Matrix Spike (MS)

(OS) L966606-02 01/31/18 17:33 • (MS) R3283212-8 01/31/18 17:53

| | Spike Amount | Original Result | MS Result | MS Rec. | Dilution | Rec. Limits | MS Qualifier |
|---|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | mg/l | % | | % | |
| Bromide | 50.0 | U | 46.8 | 94 | 1 | 80-120 | |
| Chloride | 50.0 | 20.6 | 70.8 | 100 | 1 | 80-120 | |
| Sulfate | 50.0 | 10.8 | 64.9 | 108 | 1 | 80-120 | |

## Method Blank (MB)

(MB) R3283142-1 01/31/18 14:21

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Barium | U | | 0.0017 | 0.00500 |
| Calcium | U | | 0.0463 | 1.00 |
| Iron | U | | 0.0141 | 0.100 |
| Magnesium | 0.0346 | J | 0.0111 | 1.00 |
| Manganese | U | | 0.0012 | 0.0100 |
| Potassium | 0.173 | J | 0.102 | 1.00 |
| Sodium | 0.244 | J | 0.0985 | 1.00 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283142-2 01/31/18 14:23 • (LCSD) R3283142-3 01/31/18 14:26

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 0.980 | 0.995 | 98 | 99.5 | 80-120 | | | 1.53 | 20 |
| Calcium | 10.0 | 9.44 | 9.59 | 94.4 | 95.9 | 80-120 | | | 1.61 | 20 |
| Iron | 10.0 | 9.58 | 9.79 | 95.8 | 97.9 | 80-120 | | | 2.14 | 20 |
| Magnesium | 10.0 | 9.47 | 9.49 | 94.7 | 94.9 | 80-120 | | | 0.184 | 20 |
| Manganese | 1.00 | 0.962 | 0.976 | 96.2 | 97.6 | 80-120 | | | 1.43 | 20 |
| Potassium | 10.0 | 9.29 | 9.70 | 92.9 | 97 | 80-120 | | | 4.28 | 20 |
| Sodium | 10.0 | 9.86 | 10.3 | 98.6 | 103 | 80-120 | | | 4.29 | 20 |

## L966630-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L966630-01 01/31/18 14:30 • (MS) R3283142-5 01/31/18 14:35 • (MSD) R3283142-6 01/31/18 14:37

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 0.0200 | 0.997 | 0.999 | 97.7 | 97.9 | 1 | 75-125 | | | 0.138 | 20 |
| Calcium | 10.0 | 114 | 122 | 122 | 78.7 | 75 | 1 | 75-125 | | | 0.303 | 20 |
| Iron | 10.0 | 0.310 | 9.92 | 10.0 | 96.1 | 96.9 | 1 | 75-125 | | | 0.769 | 20 |
| Magnesium | 10.0 | 185 | 190 | 190 | 50.6 | 49.7 | 1 | 75-125 | V | V | 0.0495 | 20 |
| Manganese | 1.00 | 0.353 | 1.30 | 1.30 | 94.4 | 94.3 | 1 | 75-125 | | | 0.0559 | 20 |
| Potassium | 10.0 | 2.55 | 12.4 | 12.7 | 98.9 | 102 | 1 | 75-125 | | | 2.17 | 20 |
| Sodium | 10.0 | 123 | 130 | 129 | 75.1 | 67.6 | 1 | 75-125 | | V | 0.582 | 20 |

## Method Blank (MB)

(MB) R3283388-1 02/01/18 09:59

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Methane | U | | 0.00291 | 0.0100 |
| Ethane | U | | 0.00407 | 0.0130 |
| Ethene | U | | 0.00426 | 0.0130 |
| Propane | U | | 0.00548 | 0.0190 |

## L966617-06 Original Sample (OS) • Duplicate (DUP)

(OS) L966617-06 02/01/18 10:59 • (DUP) R3283388-2 02/01/18 11:40

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## L966617-06 Original Sample (OS) • Duplicate (DUP)

(OS) L966617-06 02/01/18 10:59 • (DUP) R3283388-3 02/01/18 13:38

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283388-4 02/01/18 13:41 • (LCSD) R3283388-5 02/01/18 13:48

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Methane | 0.0678 | 0.0747 | 0.0723 | 110 | 107 | 85.0-115 | | | 3.25 | 20 |
| Ethane | 0.129 | 0.114 | 0.117 | 88.5 | 90.8 | 85.0-115 | | | 2.59 | 20 |
| Ethene | 0.127 | 0.118 | 0.121 | 92.7 | 95.0 | 85.0-115 | | | 2.45 | 20 |
| Propane | 0.186 | 0.188 | 0.191 | 101 | 103 | 85.0-115 | | | 1.86 | 20 |

## Method Blank (MB)

(MB) R3283218-2 01/31/18 12:19

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Benzene | U | | 0.000331 | 0.00100 |
| Ethylbenzene | U | | 0.000384 | 0.00100 |
| Toluene | U | | 0.000412 | 0.00100 |
| Xylenes, Total | U | | 0.00106 | 0.00300 |
| *(S) Toluene-d8* | *107* | | | *80.0-120* |
| *(S) Dibromofluoromethane* | *101* | | | *76.0-123* |
| *(S) a,a,a-Trifluorotoluene* | *105* | | | *80.0-120* |
| *(S) 4-Bromofluorobenzene* | *98.2* | | | *80.0-120* |

## Laboratory Control Sample (LCS)

(LCS) R3283218-1 01/31/18 11:37

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCS Rec. % | Rec. Limits % | LCS Qualifier |
|---|---|---|---|---|---|
| Benzene | 0.0250 | 0.0236 | 94.4 | 69.0-123 | |
| Ethylbenzene | 0.0250 | 0.0291 | 116 | 77.0-120 | |
| Toluene | 0.0250 | 0.0265 | 106 | 77.0-120 | |
| Xylenes, Total | 0.0750 | 0.0880 | 117 | 77.0-120 | |
| *(S) Toluene-d8* | | | *105* | *80.0-120* | |
| *(S) Dibromofluoromethane* | | | *99.9* | *76.0-123* | |
| *(S) a,a,a-Trifluorotoluene* | | | *106* | *80.0-120* | |
| *(S) 4-Bromofluorobenzene* | | | *100* | *80.0-120* | |

## Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

## Abbreviations and Definitions

| | |
|---|---|
| MDL | Method Detection Limit. |
| ND | Not detected at the Reporting Limit (or MDL where applicable). |
| RDL | Reported Detection Limit. |
| Rec. | Recovery. |
| RPD | Relative Percent Difference. |
| SDG | Sample Delivery Group. |
| (S) | Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media. |
| U | Not detected at the Reporting Limit (or MDL where applicable). |
| Analyte | The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported. |
| Dilution | If the sample matrix contains an interfering material, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor. |
| Limits | These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges. |
| Original Sample | The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG. |
| Qualifier | This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable. |
| Result | The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state "ND" (Not Detected) or "BDL" (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte. |
| Case Narrative (Cn) | A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report. |
| Quality Control Summary (Qc) | This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material. |
| Sample Chain of Custody (Sc) | This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis. |
| Sample Results (Sr) | This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported. |
| Sample Summary (Ss) | This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis. |

| Qualifier | Description |
|---|---|
| J | The identification of the analyte is acceptable; the reported value is an estimate. |
| J3 | The associated batch QC was outside the established quality control range for precision. |
| P1 | RPD value not applicable for sample concentrations less than 5 times the reporting limit. |
| T8 | Sample(s) received past/too close to holding time expiration. |
| V | The sample concentration is too high to evaluate accurate spike recoveries. |

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

## State Accreditations

| | |
|---|---|
| Alabama | 40660 |
| Alaska | UST-080 |
| Arizona | AZ0612 |
| Arkansas | 88-0469 |
| California | 01157CA |
| Colorado | TN00003 |
| Connecticut | PH-0197 |
| Florida | E87487 |
| Georgia | NELAP |
| Georgia [1] | 923 |
| Idaho | TN00003 |
| Illinois | 200008 |
| Indiana | C-TN-01 |
| Iowa | 364 |
| Kansas | E-10277 |
| Kentucky [1] | 90010 |
| Kentucky [2] | 16 |
| Louisiana | AI30792 |
| Maine | TN0002 |
| Maryland | 324 |
| Massachusetts | M-TN003 |
| Michigan | 9958 |
| Minnesota | 047-999-395 |
| Mississippi | TN00003 |
| Missouri | 340 |
| Montana | CERT0086 |
| Nebraska | NE-OS-15-05 |
| Nevada | TN-03-2002-34 |
| New Hampshire | 2975 |
| New Jersey–NELAP | TN002 |
| New Mexico | TN00003 |
| New York | 11742 |
| North Carolina | Env375 |
| North Carolina [1] | DW21704 |
| North Carolina [2] | 41 |
| North Dakota | R-140 |
| Ohio–VAP | CL0069 |
| Oklahoma | 9915 |
| Oregon | TN200002 |
| Pennsylvania | 68-02979 |
| Rhode Island | 221 |
| South Carolina | 84004 |
| South Dakota | n/a |
| Tennessee [1,4] | 2006 |
| Texas | T 104704245-07-TX |
| Texas [5] | LAB0152 |
| Utah | 6157585858 |
| Vermont | VT2006 |
| Virginia | 109 |
| Washington | C1915 |
| West Virginia | 233 |
| Wisconsin | 9980939910 |
| Wyoming | A2LA |

## Third Party Federal Accreditations

| | |
|---|---|
| A2LA – ISO 17025 | 1461.01 |
| A2LA – ISO 17025 [5] | 1461.02 |
| Canada | 1461.01 |
| EPA–Crypto | TN00003 |
| AIHA-LAP,LLC | 100789 |
| DOD | 1461.01 |
| USDA | S-67674 |

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold n/a Accreditation not applicable

## Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. ESC Lab Sciences performs all testing at our central laboratory.

**GES, Inc. - Sunoco**

440 Creamery Way, Suite 500
Exton, PA 19341

Billing Information:

Accounts Payable
440 Creamery Way, Suite 500
Exton, PA 19341

Pres Chk

Report to: Holly Smoker

Email To: sgrillo@gesonline.com, hsmoker@geso

Project Description: Pre-Construction Sampling

City/State Collected:

Phone: 406-578-4501
Fax:

Client Project # 0204728 -06-160-XX

Lab Project # SUNGES-GRILLO

Collected by (print): Rob Faccenda

Site/Facility ID #

P.O. #

Collected by (signature):

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day

Quote #

Date Results Needed: Standard TAT

Immediately Packed on Ice N ___ Y X

Analysis / Container / Preservative

Chain of Custody Page 1 of 1

ESC LAB SCIENCES
YOUR LAB OF CHOICE
12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L# 966612
G090

Acctnum: SUNGES
Template: T126128
Prelogin: P611030
TSR: 134 - Mark Beasley
PB:
Shipped Via: FEDEX

| Sample ID | Comp/Grab | Matrix * | Depth | Date | Time | No of Cntrs | **pH,SPCON,TDS,TURB* 250ml plastic NP | ALK, Br, Cl, SO4 250ml plastic NP | Total Mtls, Hardness 250ml plastic HNO3 | RSK175 + Propane 40ml vial w/ HCL | TSS 1L plastic NP | V8260BTEX 40ml vial w/ HCL | ****DW COLILERT**** microbiological | ****DW Fecal**** microbiological | Remarks | Sample # (lab only) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01302018-629-03 | Grab | DW | — | 01/30/18 | 1320 | 12 | X | X | X | X | X | X | X | X | | -01 |

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other ______

Remarks:
Metals = Ba,Ca,Fe,K,Mg,Mn,Na
****Log COLILERT & FC as DW matrix****

pH ______ Temp ______
Flow ______ Other ______

Samples returned via: __ UPS X FedEx __ Courier ______

Tracking # 7747409358904

Sample Receipt Checklist
COC Seal Present/Intact: NP Y N
COC Signed/Accurate: Y N
Bottles arrive intact: Y N
Correct bottles used: Y N
Sufficient volume sent: Y N
If Applicable
VOA Zero Headspace: Y N
Preservation Correct/Checked: Y N

| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) |
|---|---|---|---|
| [signature] | 01/30/18 | 1500 | FEDEX 01/30/18 1500 |
| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) |
| Relinquished by: (Signature) | Date: | Time: | Received for lab by: (Signature) Marina [signature] 859 |

Trip Blank Received: Yes / No
HCL / MeoH
TBR

Temp: 1.3 °C Bottles Received: 12

If preservation required by Login: Date/Time

Date: 01-31-18 Time: 0815

Hold:

Condition: NCF / OK

# ANALYTICAL REPORT

February 05, 2018

## GES, Inc - Sunoco

| | |
|---|---|
| Sample Delivery Group: | L966612 |
| Samples Received: | 01/31/2018 |
| Project Number: | 0204728-06-160-XX |
| Description: | Pre-Construction Sampling |
| | |
| Report To: | Stephanie Grillo<br>440 Creamery Way, Ste 500<br>Exton, PA  19341 |

Entire Report Reviewed By:

Mark W. Beasley
Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

# TABLE OF CONTENTS


| | |
|---|---|
| Cp: Cover Page | 1 |
| Tc: Table of Contents | 2 |
| Ss: Sample Summary | 3 |
| Cn: Case Narrative | 4 |
| Sr: Sample Results | 5 |
| 01302018-629-03 L966612-01 | 5 |
| Qc: Quality Control Summary | 7 |
| Gravimetric Analysis by Method 2540 C-2011 | 7 |
| Gravimetric Analysis by Method 2540 D-2011 | 8 |
| Wet Chemistry by Method 130.1 | 9 |
| Wet Chemistry by Method 2130 B-2011 | 10 |
| Wet Chemistry by Method 2320 B-2011 | 11 |
| Wet Chemistry by Method 9040C | 12 |
| Wet Chemistry by Method 9050A | 13 |
| Wet Chemistry by Method 9056A | 14 |
| Metals (ICP) by Method 6010B | 16 |
| Volatile Organic Compounds (GC) by Method RSK175 | 17 |
| Volatile Organic Compounds (GC/MS) by Method 8260B | 18 |
| Gl: Glossary of Terms | 19 |
| Al: Accreditations & Locations | 20 |
| Sc: Sample Chain of Custody | 21 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

| | Collected by | Collected date/time | Received date/time |
|---|---|---|---|
| 01302018-629-03 L966612-01 GW | Robert Faccenda | 01/30/18 13:20 | 01/31/18 08:45 |

| Method | Batch | Dilution | Preparation date/time | Analysis date/time | Analyst |
|---|---|---|---|---|---|
| Microbiology by Method 9222D | WG1068512 | 1 | 01/31/18 11:40 | 01/31/18 11:40 | MH |
| Microbiology by Method 9223 B-1997 | WG1068510 | 1 | 01/31/18 11:25 | 01/31/18 11:25 | MH |
| Gravimetric Analysis by Method 2540 C-2011 | WG1068493 | 1 | 01/31/18 18:51 | 01/31/18 19:34 | BS |
| Gravimetric Analysis by Method 2540 D-2011 | WG1068490 | 1 | 01/31/18 17:39 | 01/31/18 18:25 | EG |
| Wet Chemistry by Method 130.1 | WG1069334 | 5 | 02/02/18 13:13 | 02/02/18 13:13 | KK |
| Wet Chemistry by Method 2130 B-2011 | WG1068416 | 1 | 01/31/18 13:37 | 01/31/18 13:37 | GB |
| Wet Chemistry by Method 2320 B-2011 | WG1070017 | 1 | 02/05/18 09:28 | 02/05/18 09:28 | MCG |
| Wet Chemistry by Method 9040C | WG1068362 | 1 | 01/31/18 11:07 | 01/31/18 11:07 | GB |
| Wet Chemistry by Method 9050A | WG1067791 | 1 | 01/31/18 14:11 | 01/31/18 14:11 | TH |
| Wet Chemistry by Method 9056A | WG1068488 | 1 | 01/31/18 18:43 | 01/31/18 18:43 | DR |
| Metals (ICP) by Method 6010B | WG1068396 | 1 | 01/31/18 11:03 | 01/31/18 15:09 | TRB |
| Volatile Organic Compounds (GC) by Method RSK175 | WG1068846 | 1 | 02/01/18 10:41 | 02/01/18 10:41 | BG |
| Volatile Organic Compounds (GC/MS) by Method 8260B | WG1068403 | 1 | 01/31/18 14:29 | 01/31/18 14:29 | BMB |

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times, unless qualified or notated within the report. Where applicable, all MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All radiochemical sample results for solids are reported on a dry weight basis with the exception of tritium, carbon-14 and radon, unless wet weight was requested by the client. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Mark W. Beasley
Technical Service Representative

## Microbiology by Method 9222D

| Analyte | Result col/100ml | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| Coliform,fecal | <1 | | 1 | 01/31/2018 11:40 | WG1068512 |

## Microbiology by Method 9223 B-1997

| Analyte | Result MPN/100ml | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| E.Coli | 1.00 | | 1 | 01/31/2018 11:25 | WG1068510 |
| Coliform,Total | 20.3 | | 1 | 01/31/2018 11:25 | WG1068510 |

## Gravimetric Analysis by Method 2540 C-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Dissolved Solids | 408 | | 10.0 | 1 | 01/31/2018 19:34 | WG1068493 |

## Gravimetric Analysis by Method 2540 D-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Suspended Solids | ND | | 2.50 | 1 | 01/31/2018 18:25 | WG1068490 |

**Sample Narrative:**

L966612-01 WG1068490: Used all available sample.

## Wet Chemistry by Method 130.1

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 428 | | 150 | 5 | 02/02/2018 13:13 | WG1069334 |

## Wet Chemistry by Method 2130 B-2011

| Analyte | Result NTU | Qualifier | RDL NTU | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Turbidity | 1.35 | | 0.300 | 1 | 01/31/2018 13:37 | WG1068416 |

## Wet Chemistry by Method 2320 B-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Alkalinity | 318 | | 20.0 | 1 | 02/05/2018 09:28 | WG1070017 |

**Sample Narrative:**

L966612-01 WG1070017: Endpoint pH 4.5

## Wet Chemistry by Method 9040C

| Analyte | Result su | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| pH | 7.25 | T8 | 1 | 01/31/2018 11:07 | WG1068362 |

**Sample Narrative:**

L966612-01 WG1068362: 7.25 at 15.1C

## Wet Chemistry by Method 9050A

| Analyte | Result umhos/cm | Qualifier | RDL umhos/cm | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Specific Conductance | 772 | | 10.0 | 1 | 01/31/2018 14:11 | WG1067791 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Wet Chemistry by Method 9056A

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Bromide | ND | | 1.00 | 1 | 01/31/2018 18:43 | WG1068488 |
| Chloride | 16.3 | | 1.00 | 1 | 01/31/2018 18:43 | WG1068488 |
| Sulfate | 23.6 | | 5.00 | 1 | 01/31/2018 18:43 | WG1068488 |

## Metals (ICP) by Method 6010B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Barium | 0.0312 | | 0.00500 | 1 | 01/31/2018 15:09 | WG1068396 |
| Calcium | 88.0 | | 1.00 | 1 | 01/31/2018 15:09 | WG1068396 |
| Iron | ND | | 0.100 | 1 | 01/31/2018 15:09 | WG1068396 |
| Magnesium | 43.0 | | 1.00 | 1 | 01/31/2018 15:09 | WG1068396 |
| Manganese | ND | | 0.0100 | 1 | 01/31/2018 15:09 | WG1068396 |
| Potassium | 2.28 | | 1.00 | 1 | 01/31/2018 15:09 | WG1068396 |
| Sodium | 6.05 | | 1.00 | 1 | 01/31/2018 15:09 | WG1068396 |

## Volatile Organic Compounds (GC) by Method RSK175

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Methane | ND | | 0.0100 | 1 | 02/01/2018 10:41 | WG1068846 |
| Ethane | ND | | 0.0130 | 1 | 02/01/2018 10:41 | WG1068846 |
| Ethene | ND | | 0.0130 | 1 | 02/01/2018 10:41 | WG1068846 |
| Propane | ND | | 0.0190 | 1 | 02/01/2018 10:41 | WG1068846 |

## Volatile Organic Compounds (GC/MS) by Method 8260B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Benzene | ND | | 0.00100 | 1 | 01/31/2018 14:29 | WG1068403 |
| Toluene | ND | | 0.00100 | 1 | 01/31/2018 14:29 | WG1068403 |
| Ethylbenzene | ND | | 0.00100 | 1 | 01/31/2018 14:29 | WG1068403 |
| Total Xylenes | ND | | 0.00300 | 1 | 01/31/2018 14:29 | WG1068403 |
| *(S) Toluene-d8* | *108* | | *80.0-120* | | *01/31/2018 14:29* | WG1068403 |
| *(S) Dibromofluoromethane* | *101* | | *76.0-123* | | *01/31/2018 14:29* | WG1068403 |
| *(S) a,a,a-Trifluorotoluene* | *106* | | *80.0-120* | | *01/31/2018 14:29* | WG1068403 |
| *(S) 4-Bromofluorobenzene* | *97.6* | | *80.0-120* | | *01/31/2018 14:29* | WG1068403 |

## Method Blank (MB)

(MB) R3283892-1 01/31/18 19:34

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Dissolved Solids | U | | 2.82 | 10.0 |

## L966617-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966617-01 01/31/18 19:34 • (DUP) R3283892-4 01/31/18 19:34

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Dissolved Solids | 682 | 670 | 1 | 1.78 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283892-2 01/31/18 19:34 • (LCSD) R3283892-3 01/31/18 19:34

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Dissolved Solids | 8800 | 8620 | 8570 | 98.0 | 97.4 | 85.0-115 | | | 0.582 | 5 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3283392-1 01/31/18 18:25

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Suspended Solids | U | | 0.350 | 2.50 |

## L966599-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966599-01 01/31/18 18:25 • (DUP) R3283392-4 01/31/18 18:25

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 4.75 | 5.00 | 1 | 5.13 | P1 | 5 |

Sample Narrative:

OS: Sample split with duplicate.

## L966615-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966615-01 01/31/18 18:25 • (DUP) R3283392-5 01/31/18 18:25

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 11000 | 12000 | 1 | 8.73 | J3 | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283392-2 01/31/18 18:25 • (LCSD) R3283392-3 01/31/18 18:25

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Suspended Solids | 773 | 792 | 768 | 102 | 99.4 | 85.0-115 | | | 3.08 | 5 |

## Method Blank (MB)

(MB) R3283661-1 02/02/18 12:58

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 5.13 | J | 1.43 | 30.0 |

## L966477-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966477-01 02/02/18 13:05 • (DUP) R3283661-4 02/02/18 13:08

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 111 | 107 | 1 | 3.67 | | 20 |

## L966808-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966808-01 02/02/18 13:14 • (DUP) R3283661-5 02/02/18 13:15

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 60.0 | 59.9 | 1 | 0.167 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283661-2 02/02/18 12:58 • (LCSD) R3283661-3 02/02/18 12:59

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 158 | 158 | 105 | 105 | 85-115 | | | 0 | 20 |

## L966862-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L966862-01 02/02/18 13:18 • (MS) R3283661-6 02/02/18 13:19 • (MSD) R3283661-7 02/02/18 13:19

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | ND | 156 | 155 | 99 | 98.3 | 1 | 80-120 | | | 0.643 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3283057-1 01/31/18 13:37

| Analyte | MB Result NTU | MB Qualifier | MB MDL NTU | MB RDL NTU |
|---|---|---|---|---|
| Turbidity | 0.0660 | J | 0.0310 | 0.300 |

## L966586-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966586-01 01/31/18 13:37 • (DUP) R3283057-4 01/31/18 13:37

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 0.449 | 0.450 | 1 | 0.222 | | 20 |

## L966613-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966613-01 01/31/18 13:37 • (DUP) R3283057-5 01/31/18 13:37

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 0.474 | 0.468 | 1 | 1.27 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283057-2 01/31/18 13:37 • (LCSD) R3283057-3 01/31/18 13:37

| Analyte | Spike Amount NTU | LCS Result NTU | LCSD Result NTU | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Turbidity | 40.0 | 42.5 | 42.5 | 106 | 106 | 90.0-110 | | | 0.000 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## L967491-01 Original Sample (OS) • Duplicate (DUP)

(OS) L967491-01 02/05/18 09:44 • (DUP) R3284035-1 02/05/18 09:52

| | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | | % | | % |
| Alkalinity | 281 | 285 | 1 | 1.61 | | 20 |

Sample Narrative:

OS: Endpoint pH 4.5

DUP: Endpoint pH 4.5

## L966622-09 Original Sample (OS) • Duplicate (DUP)

(OS) L966622-09 02/05/18 12:42 • (DUP) R3284035-5 02/05/18 12:48

| | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | | % | | % |
| Alkalinity | 269 | 269 | 1 | 0.0696 | | 20 |

Sample Narrative:

OS: Endpoint pH 4.5

DUP: Endpoint pH 4.5

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3284035-2 02/05/18 10:08 • (LCSD) R3284035-3 02/05/18 10:19

| | Spike Amount | LCS Result | LCSD Result | LCS Rec. | LCSD Rec. | Rec. Limits | LCS Qualifier | LCSD Qualifier | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | mg/l | mg/l | mg/l | % | % | % | | | % | % |
| Alkalinity | 100 | 106 | 102 | 106 | 102 | 85.0-115 | | | 3.35 | 20 |

Sample Narrative:

LCS: Endpoint pH 4.5

LCSD: Endpoint pH 4.5

## L966613-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966613-01 01/31/18 11:07 • (DUP) R3283001-4 01/31/18 11:07

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 7.28 | 7.29 | 1 | 0.137 | | 1 |

Sample Narrative:

OS: 7.28 at 15.3C

DUP: 7.29 at 15.3C

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283001-1 01/31/18 11:07 • (LCSD) R3283001-2 01/31/18 11:07

| Analyte | Spike Amount su | LCS Result su | LCSD Result su | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | 6.38 | 6.36 | 6.35 | 99.7 | 99.5 | 98.4-102 | | | 0.157 | 1 |

Sample Narrative:

LCS: 6.36 at 17.9C

LCSD: 6.35 at 18C

## Method Blank (MB)

(MB) WG1067791-1 01/31/18 14:11

| Analyte | MB Result umhos/cm | MB Qualifier | MB MDL umhos/cm | MB RDL umhos/cm |
|---|---|---|---|---|
| Specific Conductance | U | | 10.0 | 10.0 |

## L966284-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966284-01 01/31/18 14:11 • (DUP) WG1067791-4 01/31/18 14:11

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 793 | 797 | 1 | 0.503 | | 20 |

## L966613-01 Original Sample (OS) • Duplicate (DUP)

(OS) L966613-01 01/31/18 14:11 • (DUP) WG1067791-5 01/31/18 14:11

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 581 | 585 | 1 | 0.686 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG1067791-2 01/31/18 14:11 • (LCSD) WG1067791-3 01/31/18 14:11

| Analyte | Spike Amount umhos/cm | LCS Result umhos/cm | LCSD Result umhos/cm | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Specific Conductance | 559 | 552 | 553 | 98.7 | 98.9 | 85.0-115 | | | 0.181 | 20 |

## Method Blank (MB)

(MB) R3283212-1 01/31/18 11:17

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Bromide | U | | 0.079 | 1.00 |
| Chloride | U | | 0.0519 | 1.00 |
| Sulfate | U | | 0.0774 | 5.00 |

## L966595-02 Original Sample (OS) • Duplicate (DUP)

(OS) L966595-02 01/31/18 15:25 • (DUP) R3283212-4 01/31/18 15:35

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | U | 0.000 | 1 | 0 | | 15 |
| Chloride | 22.0 | 22.3 | 1 | 1 | | 15 |
| Sulfate | 14.4 | 14.3 | 1 | 1 | | 15 |

## L966606-02 Original Sample (OS) • Duplicate (DUP)

(OS) L966606-02 01/31/18 17:33 • (DUP) R3283212-7 01/31/18 17:43

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | U | 0.000 | 1 | 0 | | 15 |
| Chloride | 20.6 | 21.0 | 1 | 2 | | 15 |
| Sulfate | 10.8 | 10.9 | 1 | 1 | | 15 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283212-2 01/31/18 11:27 • (LCSD) R3283212-3 01/31/18 11:37

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 40.0 | 39.3 | 39.6 | 98 | 99 | 80-120 | | | 1 | 15 |
| Chloride | 40.0 | 38.7 | 38.7 | 97 | 97 | 80-120 | | | 0 | 15 |
| Sulfate | 40.0 | 39.4 | 39.7 | 98 | 99 | 80-120 | | | 1 | 15 |

Cp Tc Ss Cn Sr Qc Gl Al Sc

## L966595-02 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L966595-02 01/31/18 15:25 • (MS) R3283212-5 01/31/18 15:44 • (MSD) R3283212-6 01/31/18 15:54

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | U | 46.8 | 49.1 | 94 | 98 | 1 | 80-120 | | | 5 | 15 |
| Chloride | 50.0 | 22.0 | 72.4 | 72.7 | 101 | 101 | 1 | 80-120 | | | 0 | 15 |
| Sulfate | 50.0 | 14.4 | 65.0 | 64.6 | 101 | 100 | 1 | 80-120 | | | 1 | 15 |

## L966606-02 Original Sample (OS) • Matrix Spike (MS)

(OS) L966606-02 01/31/18 17:33 • (MS) R3283212-8 01/31/18 17:53

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MS Rec. % | Dilution | Rec. Limits % | MS Qualifier |
|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | U | 46.8 | 94 | 1 | 80-120 | |
| Chloride | 50.0 | 20.6 | 70.8 | 100 | 1 | 80-120 | |
| Sulfate | 50.0 | 10.8 | 64.9 | 108 | 1 | 80-120 | |

## Method Blank (MB)

(MB) R3283142-1 01/31/18 14:21

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Barium | U | | 0.0017 | 0.00500 |
| Calcium | U | | 0.0463 | 1.00 |
| Iron | U | | 0.0141 | 0.100 |
| Magnesium | 0.0346 | J | 0.0111 | 1.00 |
| Manganese | U | | 0.0012 | 0.0100 |
| Potassium | 0.173 | J | 0.102 | 1.00 |
| Sodium | 0.244 | J | 0.0985 | 1.00 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283142-2 01/31/18 14:23 • (LCSD) R3283142-3 01/31/18 14:26

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 0.980 | 0.995 | 98 | 99.5 | 80-120 | | | 1.53 | 20 |
| Calcium | 10.0 | 9.44 | 9.59 | 94.4 | 95.9 | 80-120 | | | 1.61 | 20 |
| Iron | 10.0 | 9.58 | 9.79 | 95.8 | 97.9 | 80-120 | | | 2.14 | 20 |
| Magnesium | 10.0 | 9.47 | 9.49 | 94.7 | 94.9 | 80-120 | | | 0.184 | 20 |
| Manganese | 1.00 | 0.962 | 0.976 | 96.2 | 97.6 | 80-120 | | | 1.43 | 20 |
| Potassium | 10.0 | 9.29 | 9.70 | 92.9 | 97 | 80-120 | | | 4.28 | 20 |
| Sodium | 10.0 | 9.86 | 10.3 | 98.6 | 103 | 80-120 | | | 4.29 | 20 |

## L966630-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L966630-01 01/31/18 14:30 • (MS) R3283142-5 01/31/18 14:35 • (MSD) R3283142-6 01/31/18 14:37

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 0.0200 | 0.997 | 0.999 | 97.7 | 97.9 | 1 | 75-125 | | | 0.138 | 20 |
| Calcium | 10.0 | 114 | 122 | 122 | 78.7 | 75 | 1 | 75-125 | | | 0.303 | 20 |
| Iron | 10.0 | 0.310 | 9.92 | 10.0 | 96.1 | 96.9 | 1 | 75-125 | | | 0.769 | 20 |
| Magnesium | 10.0 | 185 | 190 | 190 | 50.6 | 49.7 | 1 | 75-125 | V | V | 0.0495 | 20 |
| Manganese | 1.00 | 0.353 | 1.30 | 1.30 | 94.4 | 94.3 | 1 | 75-125 | | | 0.0559 | 20 |
| Potassium | 10.0 | 2.55 | 12.4 | 12.7 | 98.9 | 102 | 1 | 75-125 | | | 2.17 | 20 |
| Sodium | 10.0 | 123 | 130 | 129 | 75.1 | 67.6 | 1 | 75-125 | | V | 0.582 | 20 |

## Method Blank (MB)

(MB) R3283388-1 02/01/18 09:59

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Methane | U | | 0.00291 | 0.0100 |
| Ethane | U | | 0.00407 | 0.0130 |
| Ethene | U | | 0.00426 | 0.0130 |
| Propane | U | | 0.00548 | 0.0190 |

## L966617-06 Original Sample (OS) • Duplicate (DUP)

(OS) L966617-06 02/01/18 10:59 • (DUP) R3283388-2 02/01/18 11:40

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## L966617-06 Original Sample (OS) • Duplicate (DUP)

(OS) L966617-06 02/01/18 10:59 • (DUP) R3283388-3 02/01/18 13:38

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3283388-4 02/01/18 13:41 • (LCSD) R3283388-5 02/01/18 13:48

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Methane | 0.0678 | 0.0747 | 0.0723 | 110 | 107 | 85.0-115 | | | 3.25 | 20 |
| Ethane | 0.129 | 0.114 | 0.117 | 88.5 | 90.8 | 85.0-115 | | | 2.59 | 20 |
| Ethene | 0.127 | 0.118 | 0.121 | 92.7 | 95.0 | 85.0-115 | | | 2.45 | 20 |
| Propane | 0.186 | 0.188 | 0.191 | 101 | 103 | 85.0-115 | | | 1.86 | 20 |

## Method Blank (MB)

(MB) R3283218-2 01/31/18 12:19

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Benzene | U | | 0.000331 | 0.00100 |
| Ethylbenzene | U | | 0.000384 | 0.00100 |
| Toluene | U | | 0.000412 | 0.00100 |
| Xylenes, Total | U | | 0.00106 | 0.00300 |
| *(S) Toluene-d8* | *107* | | | *80.0-120* |
| *(S) Dibromofluoromethane* | *101* | | | *76.0-123* |
| *(S) a,a,a-Trifluorotoluene* | *105* | | | *80.0-120* |
| *(S) 4-Bromofluorobenzene* | *98.2* | | | *80.0-120* |

## Laboratory Control Sample (LCS)

(LCS) R3283218-1 01/31/18 11:37

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCS Rec. % | Rec. Limits % | LCS Qualifier |
|---|---|---|---|---|---|
| Benzene | 0.0250 | 0.0236 | 94.4 | 69.0-123 | |
| Ethylbenzene | 0.0250 | 0.0291 | 116 | 77.0-120 | |
| Toluene | 0.0250 | 0.0265 | 106 | 77.0-120 | |
| Xylenes, Total | 0.0750 | 0.0880 | 117 | 77.0-120 | |
| *(S) Toluene-d8* | | | *105* | *80.0-120* | |
| *(S) Dibromofluoromethane* | | | *99.9* | *76.0-123* | |
| *(S) a,a,a-Trifluorotoluene* | | | *106* | *80.0-120* | |
| *(S) 4-Bromofluorobenzene* | | | *100* | *80.0-120* | |

## Guide to Reading and Understanding Your Laboratory Report

The information below is designed to better explain the various terms used in your report of analytical results from the Laboratory. This is not intended as a comprehensive explanation, and if you have additional questions please contact your project representative.

## Abbreviations and Definitions

| | |
|---|---|
| MDL | Method Detection Limit. |
| ND | Not detected at the Reporting Limit (or MDL where applicable). |
| RDL | Reported Detection Limit. |
| Rec. | Recovery. |
| RPD | Relative Percent Difference. |
| SDG | Sample Delivery Group. |
| (S) | Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media. |
| U | Not detected at the Reporting Limit (or MDL where applicable). |
| Analyte | The name of the particular compound or analysis performed. Some Analyses and Methods will have multiple analytes reported. |
| Dilution | If the sample matrix contains an interfering material, or if concentrations of analytes in the sample are higher than the highest limit of concentration that the laboratory can accurately report, the sample may be diluted for analysis. If a value different than 1 is used in this field, the result reported has already been corrected for this factor. |
| Limits | These are the target % recovery ranges or % difference value that the laboratory has historically determined as normal for the method and analyte being reported. Successful QC Sample analysis will target all analytes recovered or duplicated within these ranges. |
| Original Sample | The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG. |
| Qualifier | This column provides a letter and/or number designation that corresponds to additional information concerning the result reported. If a Qualifier is present, a definition per Qualifier is provided within the Glossary and Definitions page and potentially a discussion of possible implications of the Qualifier in the Case Narrative if applicable. |
| Result | The actual analytical final result (corrected for any sample specific characteristics) reported for your sample. If there was no measurable result returned for a specific analyte, the result in this column may state "ND" (Not Detected) or "BDL" (Below Detectable Levels). The information in the results column should always be accompanied by either an MDL (Method Detection Limit) or RDL (Reporting Detection Limit) that defines the lowest value that the laboratory could detect or report for this analyte. |
| Case Narrative (Cn) | A brief discussion about the included sample results, including a discussion of any non-conformances to protocol observed either at sample receipt by the laboratory from the field or during the analytical process. If present, there will be a section in the Case Narrative to discuss the meaning of any data qualifiers used in the report. |
| Quality Control Summary (Qc) | This section of the report includes the results of the laboratory quality control analyses required by procedure or analytical methods to assist in evaluating the validity of the results reported for your samples. These analyses are not being performed on your samples typically, but on laboratory generated material. |
| Sample Chain of Custody (Sc) | This is the document created in the field when your samples were initially collected. This is used to verify the time and date of collection, the person collecting the samples, and the analyses that the laboratory is requested to perform. This chain of custody also documents all persons (excluding commercial shippers) that have had control or possession of the samples from the time of collection until delivery to the laboratory for analysis. |
| Sample Results (Sr) | This section of your report will provide the results of all testing performed on your samples. These results are provided by sample ID and are separated by the analyses performed on each sample. The header line of each analysis section for each sample will provide the name and method number for the analysis reported. |
| Sample Summary (Ss) | This section of the Analytical Report defines the specific analyses performed for each sample ID, including the dates and times of preparation and/or analysis. |

| Qualifier | Description |
|---|---|
| J | The identification of the analyte is acceptable; the reported value is an estimate. |
| J3 | The associated batch QC was outside the established quality control range for precision. |
| P1 | RPD value not applicable for sample concentrations less than 5 times the reporting limit. |
| T8 | Sample(s) received past/too close to holding time expiration. |
| V | The sample concentration is too high to evaluate accurate spike recoveries. |

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our one location design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be YOUR LAB OF CHOICE.
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

## State Accreditations

| | | | |
|---|---|---|---|
| Alabama | 40660 | Nevada | TN-03-2002-34 |
| Alaska | UST-080 | New Hampshire | 2975 |
| Arizona | AZ0612 | New Jersey–NELAP | TN002 |
| Arkansas | 88-0469 | New Mexico | TN00003 |
| California | 01157CA | New York | 11742 |
| Colorado | TN00003 | North Carolina | Env375 |
| Connecticut | PH-0197 | North Carolina [1] | DW21704 |
| Florida | E87487 | North Carolina [2] | 41 |
| Georgia | NELAP | North Dakota | R-140 |
| Georgia [1] | 923 | Ohio–VAP | CL0069 |
| Idaho | TN00003 | Oklahoma | 9915 |
| Illinois | 200008 | Oregon | TN200002 |
| Indiana | C-TN-01 | Pennsylvania | 68-02979 |
| Iowa | 364 | Rhode Island | 221 |
| Kansas | E-10277 | South Carolina | 84004 |
| Kentucky [1] | 90010 | South Dakota | n/a |
| Kentucky [2] | 16 | Tennessee [1,4] | 2006 |
| Louisiana | AI30792 | Texas | T 104704245-07-TX |
| Maine | TN0002 | Texas [5] | LAB0152 |
| Maryland | 324 | Utah | 6157585858 |
| Massachusetts | M-TN003 | Vermont | VT2006 |
| Michigan | 9958 | Virginia | 109 |
| Minnesota | 047-999-395 | Washington | C1915 |
| Mississippi | TN00003 | West Virginia | 233 |
| Missouri | 340 | Wisconsin | 9980939910 |
| Montana | CERT0086 | Wyoming | A2LA |
| Nebraska | NE-OS-15-05 | | |

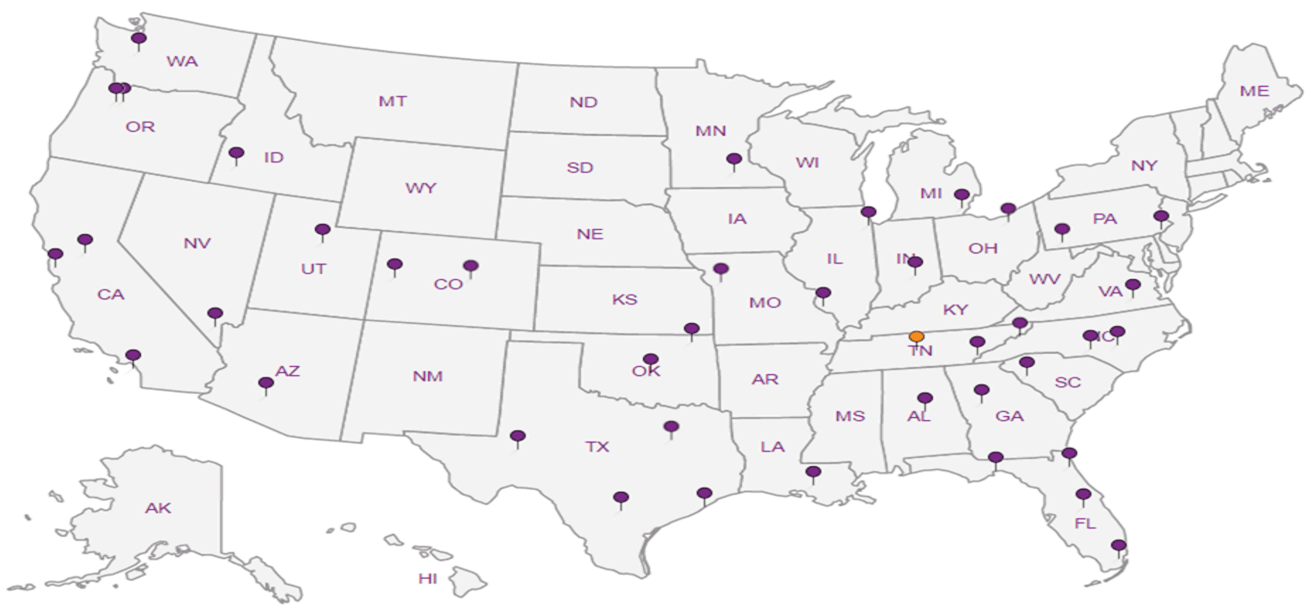
## Third Party Federal Accreditations

| | | | |
|---|---|---|---|
| A2LA – ISO 17025 | 1461.01 | AIHA-LAP,LLC | 100789 |
| A2LA – ISO 17025 [5] | 1461.02 | DOD | 1461.01 |
| Canada | 1461.01 | USDA | S-67674 |
| EPA–Crypto | TN00003 | | |

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold n/a Accreditation not applicable

## Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. ESC Lab Sciences performs all testing at our central laboratory.



GES, Inc. - Sunoco

440 Creamery Way, Suite 500
Exton, PA 19341

Billing Information:

Accounts Payable
440 Creamery Way, Suite 500
Exton, PA 19341

Pres Chk

Analysis / Container / Preservative

Chain of Custody Page 1 of 1

ESC LAB SCIENCES

YOUR LAB OF CHOICE

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

Report to: Holly Smoker

Email To: sgrillo@gesonline.com, hsmoker@geso

Project Description: Pre-Construction Sampling

City/State Collected:

Phone: 406-578-4501
Fax:

Client Project # 0204728 -06-160-XX

Lab Project # SUNGES-GRILLO

L# 966612
G090

Collected by (print): Rob Faccenda

Site/Facility ID #

P.O. #

Collected by (signature):

Rush? (Lab MUST Be Notified)
___ Same Day ___ Five Day
___ Next Day ___ 5 Day (Rad Only)
___ Two Day ___ 10 Day (Rad Only)
___ Three Day

Quote #

Date Results Needed: Standard TAT

Immediately Packed on Ice N ___ Y X

Acctnum: SUNGES
Template: T126128
Prelogin: P611030
TSR: 134 - Mark Beasley
PB:
Shipped Via: FEDEX

| Sample ID | Comp/Grab | Matrix * | Depth | Date | Time | No of Cntrs | **pH,SPCON,TDS,TURB* 250ml plastic NP | ALK, Br, Cl, SO4 250ml plastic NP | Total Mtls, Hardness 250ml plastic HNO3 | RSK175 + Propane 40ml vial w/ HCL | TSS 1L plastic NP | V8260BTEX 40ml vial w/ HCL | ****DW COLILERT**** microbiological | ****DW Fecal**** microbiological | | | Remarks | Sample # (lab only) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01302018-629-03 | Grab | DW | — | 01/30/18 | 1320 | 12 | X | X | X | X | X | X | X | X | | | | -01 |

* Matrix:
SS - Soil AIR - Air F - Filter
GW - Groundwater B - Bioassay
WW - WasteWater
DW - Drinking Water
OT - Other ______

Remarks:
Metals = Ba,Ca,Fe,K,Mg,Mn,Na
****Log COLILERT & FC as DW matrix****

pH ______ Temp ______
Flow ______ Other ______

Samples returned via:
__ UPS X FedEx __ Courier __ ______

Tracking # 747409358904

Sample Receipt Checklist
COC Seal Present/Intact: NP Y N
COC Signed/Accurate: Y N
Bottles arrive intact: Y N
Correct bottles used: Y N
Sufficient volume sent: Y N
If Applicable
VOA Zero Headspace: Y N
Preservation Correct/Checked: Y N

| Relinquished by : (Signature) | Date: | Time: | Received by: (Signature) | |
|---|---|---|---|---|
| | 01/30/18 | 1500 | FEDEX 01/30/18 1500 | Trip Blank Received: Yes / No  HCL / MeoH  TBR |
| Relinquished by : (Signature) | Date: | Time: | Received by: (Signature) | Temp: 1.3 °C  Bottles Received: 12 |
| Relinquished by : (Signature) | Date: | Time: | Received for lab by: (Signature) | Date: 01-31-18  Time: 0815 |

If preservation required by Login: Date/Time

Hold:

Condition: NCF / OK

# ANALYTICAL REPORT

April 19, 2017

## GES, Inc - Sunoco

| | |
|---|---|
| Sample Delivery Group: | L901993 |
| Samples Received: | 04/12/2017 |
| Project Number: | 0204728-06-160-XX |
| Description: | Pre-Construction Sampling |
| Site: | ME2 |
| Report To: | Holly Smoker<br>440 Creamery Way, Ste 500<br>Exton, PA 19341 |

Entire Report Reviewed By:

Mark W. Beasley
Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

# TABLE OF CONTENTS


| | |
|---|---|
| [1]Cp: Cover Page | 1 |
| [2]Tc: Table of Contents | 2 |
| [3]Ss: Sample Summary | 3 |
| [4]Cn: Case Narrative | 4 |
| [5]Sr: Sample Results | 5 |
| 04112017-520-05 L901993-01 | 5 |
| [6]Qc: Quality Control Summary | 7 |
| Gravimetric Analysis by Method 2540 C-2011 | 7 |
| Gravimetric Analysis by Method 2540 D-2011 | 8 |
| Wet Chemistry by Method 2130 B-2011 | 9 |
| Wet Chemistry by Method 2320 B-2011 | 10 |
| Wet Chemistry by Method 9040C | 11 |
| Wet Chemistry by Method 9050A | 12 |
| Wet Chemistry by Method 9056A | 13 |
| Metals (ICP) by Method 6010B | 15 |
| Volatile Organic Compounds (GC) by Method RSK175 | 16 |
| Volatile Organic Compounds (GC/MS) by Method 8260B | 17 |
| [7]Gl: Glossary of Terms | 18 |
| [8]Al: Accreditations & Locations | 19 |
| [9]Sc: Chain of Custody | 20 |

[1] Cp
[2] Tc
[3] Ss
[4] Cn
[5] Sr
[6] Qc
[7] Gl
[8] Al
[9] Sc

| | Collected by | Collected date/time | Received date/time |
|---|---|---|---|
| 04112017-520-05 L901993-01 GW | Ryan M. Bidelspach | 04/11/17 12:50 | 04/12/17 08:45 |

| Method | Batch | Dilution | Preparation date/time | Analysis date/time | Analyst |
|---|---|---|---|---|---|
| Calculated Results | WG969965 | 1 | 04/13/17 07:47 | 04/13/17 12:19 | LTB |
| Gravimetric Analysis by Method 2540 C-2011 | WG970392 | 1 | 04/14/17 17:02 | 04/15/17 08:31 | MMF |
| Gravimetric Analysis by Method 2540 D-2011 | WG970715 | 1 | 04/15/17 12:50 | 04/15/17 15:20 | AS |
| Wet Chemistry by Method 2130 B-2011 | WG969736 | 1 | 04/12/17 13:29 | 04/12/17 13:29 | MA |
| Wet Chemistry by Method 2320 B-2011 | WG969891 | 1 | 04/13/17 09:42 | 04/13/17 09:42 | AMC |
| Wet Chemistry by Method 9040C | WG969809 | 1 | 04/14/17 09:06 | 04/14/17 09:06 | MA |
| Wet Chemistry by Method 9050A | WG970006 | 1 | 04/13/17 01:29 | 04/13/17 01:29 | MZ |
| Wet Chemistry by Method 9056A | WG969853 | 1 | 04/13/17 15:28 | 04/13/17 15:28 | SAM |
| Metals (ICP) by Method 6010B | WG969965 | 1 | 04/13/17 07:47 | 04/13/17 12:19 | LTB |
| Volatile Organic Compounds (GC) by Method RSK175 | WG969641 | 1 | 04/13/17 03:00 | 04/13/17 03:00 | MJ |
| Volatile Organic Compounds (GC/MS) by Method 8260B | WG970840 | 1 | 04/16/17 03:08 | 04/16/17 03:08 | LRL |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times. All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Mark W. Beasley
Technical Service Representative

## Calculated Results

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Hardness | 61.7 | | 6.62 | 1 | 04/13/2017 12:19 | WG969965 |

## Gravimetric Analysis by Method 2540 C-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Dissolved Solids | 92.0 | | 10.0 | 1 | 04/15/2017 08:31 | WG970392 |

## Gravimetric Analysis by Method 2540 D-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Suspended Solids | 6.80 | | 2.50 | 1 | 04/15/2017 15:20 | WG970715 |

## Wet Chemistry by Method 2130 B-2011

| Analyte | Result NTU | Qualifier | RDL NTU | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Turbidity | 2.89 | | 0.100 | 1 | 04/12/2017 13:29 | WG969736 |

## Wet Chemistry by Method 2320 B-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Alkalinity | 49.3 | | 20.0 | 1 | 04/13/2017 09:42 | WG969891 |

## Wet Chemistry by Method 9040C

| Analyte | Result su | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| pH | 7.75 | T8 | 1 | 04/14/2017 09:06 | WG969809 |

**Sample Narrative:**

9040C L901993-01 WG969809: 7.75 at 20.0c

## Wet Chemistry by Method 9050A

| Analyte | Result umhos/cm | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| Specific Conductance | 139 | | 1 | 04/13/2017 01:29 | WG970006 |

## Wet Chemistry by Method 9056A

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Bromide | ND | | 1.00 | 1 | 04/13/2017 15:28 | WG969853 |
| Chloride | 5.11 | | 1.00 | 1 | 04/13/2017 15:28 | WG969853 |
| Sulfate | 13.3 | | 5.00 | 1 | 04/13/2017 15:28 | WG969853 |

## Metals (ICP) by Method 6010B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Barium | 0.0255 | | 0.00500 | 1 | 04/13/2017 12:19 | WG969965 |
| Calcium | 18.3 | | 1.00 | 1 | 04/13/2017 12:19 | WG969965 |
| Iron | 0.388 | | 0.100 | 1 | 04/13/2017 12:19 | WG969965 |
| Magnesium | 3.91 | | 1.00 | 1 | 04/13/2017 12:19 | WG969965 |
| Manganese | 0.0189 | | 0.0100 | 1 | 04/13/2017 12:19 | WG969965 |
| Potassium | 1.15 | | 1.00 | 1 | 04/13/2017 12:19 | WG969965 |
| Sodium | 2.77 | | 1.00 | 1 | 04/13/2017 12:19 | WG969965 |

## Volatile Organic Compounds (GC) by Method RSK175

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Methane | ND | | 0.0100 | 1 | 04/13/2017 03:00 | WG969641 |
| Ethane | ND | | 0.0130 | 1 | 04/13/2017 03:00 | WG969641 |
| Ethene | ND | | 0.0130 | 1 | 04/13/2017 03:00 | WG969641 |
| Propane | ND | | 0.0190 | 1 | 04/13/2017 03:00 | WG969641 |

## Volatile Organic Compounds (GC/MS) by Method 8260B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Benzene | ND | | 0.00100 | 1 | 04/16/2017 03:08 | WG970840 |
| Toluene | ND | | 0.00100 | 1 | 04/16/2017 03:08 | WG970840 |
| Ethylbenzene | ND | | 0.00100 | 1 | 04/16/2017 03:08 | WG970840 |
| Total Xylenes | ND | | 0.00300 | 1 | 04/16/2017 03:08 | WG970840 |
| *(S) Toluene-d8* | *104* | | *80.0-120* | | *04/16/2017 03:08* | WG970840 |
| *(S) Dibromofluoromethane* | *107* | | *76.0-123* | | *04/16/2017 03:08* | WG970840 |
| *(S) a,a,a-Trifluorotoluene* | *99.4* | | *80.0-120* | | *04/16/2017 03:08* | WG970840 |
| *(S) 4-Bromofluorobenzene* | *95.3* | | *80.0-120* | | *04/16/2017 03:08* | WG970840 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3211240-1 04/15/17 08:31

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Dissolved Solids | U | | 2.82 | 10.0 |

## L901413-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901413-01 04/15/17 08:31 • (DUP) R3211240-4 04/15/17 08:31

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Dissolved Solids | 219 | 221 | 1 | 0.909 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3211240-2 04/15/17 08:31 • (LCSD) R3211240-3 04/15/17 08:31

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Dissolved Solids | 8800 | 8450 | 8550 | 96.0 | 97.2 | 85.0-115 | | | 1.18 | 5 |

## Method Blank (MB)

(MB) R3211542-1 04/15/17 15:20

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Suspended Solids | U | | 0.350 | 2.50 |

## L901975-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901975-01 04/15/17 15:20 • (DUP) R3211542-4 04/15/17 15:20

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 1030 | 1020 | 1 | 1.30 | | 5 |

## L901987-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901987-01 04/15/17 15:20 • (DUP) R3211542-5 04/15/17 15:20

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 113 | 114 | 1 | 0.885 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3211542-2 04/15/17 15:20 • (LCSD) R3211542-3 04/15/17 15:20

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Suspended Solids | 773 | 892 | 876 | 115 | 113 | 85.0-115 | | | 1.81 | 5 |

## Method Blank (MB)

(MB) WG969736-1 04/12/17 13:29

| | MB Result | MB Qualifier | MB MDL | MB RDL |
|---|---|---|---|---|
| Analyte | NTU | | NTU | NTU |
| Turbidity | 0.0890 | J | 0.0310 | 0.100 |

## L901961-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901961-01 04/12/17 13:29 • (DUP) WG969736-4 04/12/17 13:29

| | Original Result | DUP Result | Dilution | DUP RPD | DUP Qualifier | DUP RPD Limits |
|---|---|---|---|---|---|---|
| Analyte | NTU | NTU | | % | | % |
| Turbidity | 1.66 | 1.67 | 1 | 0.601 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG969736-2 04/12/17 13:29 • (LCSD) WG969736-3 04/12/17 13:29

| | Spike Amount | LCS Result | LCSD Result | LCS Rec. | LCSD Rec. | Rec. Limits | LCS Qualifier | LCSD Qualifier | RPD | RPD Limits |
|---|---|---|---|---|---|---|---|---|---|---|
| Analyte | NTU | NTU | NTU | % | % | % | | | % | % |
| Turbidity | 40.0 | 40.0 | 40.0 | 100 | 100 | 90.0-110 | | | 0.000 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3210498-1 04/13/17 07:55

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Alkalinity | 2.71 | J | 2.71 | 20.0 |

## L901987-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901987-01 04/13/17 08:07 • (DUP) R3210498-3 04/13/17 08:15

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Alkalinity | 196 | 202 | 1 | 3.00 | | 20 |

## L902263-01 Original Sample (OS) • Duplicate (DUP)

(OS) L902263-01 04/13/17 10:26 • (DUP) R3210498-5 04/13/17 10:33

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Alkalinity | 254 | 258 | 1 | 2.00 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3210498-4 04/13/17 08:59 • (LCSD) R3210498-6 04/13/17 10:39

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity | 100 | 98.9 | 102 | 99.0 | 102 | 85.0-115 | | | 3.00 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## L901700-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901700-01 04/14/17 09:06 • (DUP) WG969809-3 04/14/17 09:06

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 7.73 | 7.74 | 1 | 0.129 | T8 | 1 |

## L901993-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901993-01 04/14/17 09:06 • (DUP) WG969809-4 04/14/17 09:06

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 7.75 | 7.73 | 1 | 0.258 | T8 | 1 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG969809-1 04/14/17 09:06 • (LCSD) WG969809-2 04/14/17 09:06

| Analyte | Spike Amount su | LCS Result su | LCSD Result su | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | 7.50 | 7.45 | 7.48 | 99.3 | 99.7 | 98.7-101 | | | 0.402 | 1 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) WG970006-1 04/13/17 01:29

| Analyte | MB Result umhos/cm | MB Qualifier | MB MDL umhos/cm | MB RDL umhos/cm |
|---|---|---|---|---|
| Specific Conductance | 1.59 | J | | |

## L901992-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901992-01 04/13/17 01:29 • (DUP) WG970006-4 04/13/17 01:29

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 966 | 966 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG970006-2 04/13/17 01:29 • (LCSD) WG970006-3 04/13/17 01:29

| Analyte | Spike Amount umhos/cm | LCS Result umhos/cm | LCSD Result umhos/cm | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Specific Conductance | 169 | 165 | 165 | 97.6 | 97.6 | 90.0-110 | | | 0.000 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3210785-2 04/13/17 09:34

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Bromide | U | | 0.079 | 1.00 |
| Chloride | 0.264 | J | 0.0519 | 1.00 |
| Sulfate | U | | 0.0774 | 5.00 |

## L901882-05 Original Sample (OS) • Duplicate (DUP)

(OS) L901882-05 04/13/17 13:57 • (DUP) R3210785-7 04/13/17 14:07

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | ND | 0.000 | 1 | 0 | | 15 |
| Chloride | 6.37 | 6.58 | 1 | 3 | | 15 |
| Sulfate | ND | 3.64 | 1 | 23 | J P1 | 15 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3210785-3 04/13/17 09:44 • (LCSD) R3210785-4 04/13/17 09:54

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 40.0 | 41.2 | 41.2 | 103 | 103 | 80-120 | | | 0 | 15 |
| Chloride | 40.0 | 39.9 | 40.0 | 100 | 100 | 80-120 | | | 0 | 15 |
| Sulfate | 40.0 | 40.8 | 40.9 | 102 | 102 | 80-120 | | | 0 | 15 |

## L901882-01 Original Sample (OS) • Matrix Spike (MS)

(OS) L901882-01 04/13/17 13:06 • (MS) R3210785-6 04/13/17 13:16

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MS Rec. % | Dilution | Rec. Limits % | MS Qualifier |
|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | ND | 47.7 | 95 | 1 | 80-120 | |
| Chloride | 50.0 | 10.4 | 62.9 | 105 | 1 | 80-120 | |
| Sulfate | 50.0 | ND | 52.2 | 102 | 1 | 80-120 | |

## L902037-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L902037-01 04/13/17 15:49 • (MS) R3210785-8 04/13/17 15:59 • (MSD) R3210785-9 04/13/17 16:29

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | ND | 52.4 | 48.9 | 105 | 98 | 1 | 80-120 | | | 7 | 15 |
| Chloride | 50.0 | 5.09 | 54.7 | 54.3 | 99 | 99 | 1 | 80-120 | | | 1 | 15 |

## L902037-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L902037-01 04/13/17 15:49 • (MS) R3210785-8 04/13/17 15:59 • (MSD) R3210785-9 04/13/17 16:29

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sulfate | 50.0 | ND | 55.7 | 55.6 | 104 | 104 | 1 | 80-120 | | | 0 | 15 |

## Method Blank (MB)

(MB) R3210553-1 04/13/17 11:42

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Barium | U | | 0.0017 | 0.00500 |
| Calcium | U | | 0.0463 | 1.00 |
| Iron | U | | 0.0141 | 0.100 |
| Magnesium | U | | 0.0111 | 1.00 |
| Manganese | U | | 0.0012 | 0.0100 |
| Potassium | U | | 0.102 | 1.00 |
| Sodium | U | | 0.0985 | 1.00 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3210553-2 04/13/17 11:44 • (LCSD) R3210553-3 04/13/17 11:47

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 1.06 | 1.05 | 106 | 105 | 80-120 | | | 1 | 20 |
| Calcium | 10.0 | 9.88 | 9.74 | 99 | 97 | 80-120 | | | 1 | 20 |
| Iron | 10.0 | 10.1 | 10.0 | 101 | 100 | 80-120 | | | 1 | 20 |
| Magnesium | 10.0 | 10.0 | 9.88 | 100 | 99 | 80-120 | | | 1 | 20 |
| Manganese | 1.00 | 1.02 | 1.01 | 102 | 101 | 80-120 | | | 1 | 20 |
| Potassium | 10.0 | 9.81 | 9.73 | 98 | 97 | 80-120 | | | 1 | 20 |
| Sodium | 10.0 | 10.1 | 10.0 | 101 | 100 | 80-120 | | | 1 | 20 |

## L902038-02 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L902038-02 04/13/17 11:50 • (MS) R3210553-5 04/13/17 11:55 • (MSD) R3210553-6 04/13/17 11:57

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 0.0700 | 1.12 | 1.12 | 105 | 105 | 1 | 75-125 | | | 0 | 20 |
| Calcium | 10.0 | 92.1 | 101 | 101 | 90 | 88 | 1 | 75-125 | | | 0 | 20 |
| Iron | 10.0 | 1.01 | 11.1 | 11.1 | 101 | 101 | 1 | 75-125 | | | 0 | 20 |
| Magnesium | 10.0 | 17.6 | 27.3 | 27.2 | 98 | 96 | 1 | 75-125 | | | 0 | 20 |
| Manganese | 1.00 | 2.35 | 3.28 | 3.26 | 93 | 91 | 1 | 75-125 | | | 1 | 20 |
| Potassium | 10.0 | 3.55 | 13.5 | 13.5 | 99 | 100 | 1 | 75-125 | | | 0 | 20 |
| Sodium | 10.0 | 56.5 | 65.5 | 65.6 | 90 | 91 | 1 | 75-125 | | | 0 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3210496-1 04/12/17 23:07

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Methane | U | | 0.00291 | 0.0100 |
| Ethane | U | | 0.00407 | 0.0130 |
| Ethene | U | | 0.00426 | 0.0130 |
| Propane | U | | 0.00548 | 0.0190 |

## L901416-03 Original Sample (OS) • Duplicate (DUP)

(OS) L901416-03 04/12/17 23:24 • (DUP) R3210496-2 04/13/17 02:27

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | 2.46 | 2.50 | 10 | 1.67 | | 20 |
| Ethane | U | 0.000 | 10 | 0.000 | | 20 |
| Ethene | U | 0.000 | 10 | 0.000 | | 20 |
| Propane | U | 0.000 | 10 | 0.000 | | 20 |

## L901992-01 Original Sample (OS) • Duplicate (DUP)

(OS) L901992-01 04/13/17 02:44 • (DUP) R3210496-3 04/13/17 05:31

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3210496-4 04/13/17 05:48 • (LCSD) R3210496-5 04/13/17 06:04

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Methane | 0.0678 | 0.0635 | 0.0640 | 93.6 | 94.5 | 85.0-115 | | | 0.870 | 20 |
| Ethane | 0.129 | 0.111 | 0.113 | 86.0 | 87.2 | 85.0-115 | | | 1.41 | 20 |
| Ethene | 0.127 | 0.109 | 0.110 | 86.1 | 86.8 | 85.0-115 | | | 0.840 | 20 |
| Propane | 0.186 | 0.158 | 0.160 | 85.0 | 86.2 | 85.0-115 | | | 1.39 | 20 |

## Method Blank (MB)

(MB) R3211482-3 04/16/17 00:34

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Benzene | U | | 0.000331 | 0.00100 |
| Ethylbenzene | U | | 0.000384 | 0.00100 |
| Toluene | U | | 0.000412 | 0.00100 |
| Xylenes, Total | U | | 0.00106 | 0.00300 |
| *(S) Toluene-d8* | *102* | | | *80.0-120* |
| *(S) Dibromofluoromethane* | *104* | | | *76.0-123* |
| *(S) a,a,a-Trifluorotoluene* | *101* | | | *80.0-120* |
| *(S) 4-Bromofluorobenzene* | *98.4* | | | *80.0-120* |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3211482-1 04/15/17 23:56 • (LCSD) R3211482-2 04/16/17 00:09

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Benzene | 0.0250 | 0.0227 | 0.0229 | 90.6 | 91.5 | 69.0-123 | | | 0.980 | 20 |
| Ethylbenzene | 0.0250 | 0.0215 | 0.0216 | 85.9 | 86.3 | 77.0-120 | | | 0.520 | 20 |
| Toluene | 0.0250 | 0.0217 | 0.0222 | 86.8 | 89.0 | 77.0-120 | | | 2.45 | 20 |
| Xylenes, Total | 0.0750 | 0.0646 | 0.0651 | 86.1 | 86.8 | 77.0-120 | | | 0.770 | 20 |
| *(S) Toluene-d8* | | | | *102* | *103* | *80.0-120* | | | | |
| *(S) Dibromofluoromethane* | | | | *109* | *106* | *76.0-123* | | | | |
| *(S) a,a,a-Trifluorotoluene* | | | | *100* | *100* | *80.0-120* | | | | |
| *(S) 4-Bromofluorobenzene* | | | | *97.4* | *96.2* | *80.0-120* | | | | |

## Abbreviations and Definitions

| | |
|---|---|
| SDG | Sample Delivery Group. |
| MDL | Method Detection Limit. |
| RDL | Reported Detection Limit. |
| ND | Not detected at the Reporting Limit (or MDL where applicable). |
| U | Not detected at the Reporting Limit (or MDL where applicable). |
| RPD | Relative Percent Difference. |
| Original Sample | The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG. |
| (S) | Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media. |
| Rec. | Recovery. |

| Qualifier | Description |
|---|---|
| J | The identification of the analyte is acceptable; the reported value is an estimate. |
| P1 | RPD value not applicable for sample concentrations less than 5 times the reporting limit. |
| T8 | Sample(s) received past/too close to holding time expiration. |

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE.**
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

## State Accreditations

| | |
|---|---|
| Alabama | 40660 |
| Alaska | UST-080 |
| Arizona | AZ0612 |
| Arkansas | 88-0469 |
| California | 01157CA |
| Colorado | TN00003 |
| Conneticut | PH-0197 |
| Florida | E87487 |
| Georgia | NELAP |
| Georgia [1] | 923 |
| Idaho | TN00003 |
| Illinois | 200008 |
| Indiana | C-TN-01 |
| Iowa | 364 |
| Kansas | E-10277 |
| Kentucky [1] | 90010 |
| Kentucky [2] | 16 |
| Louisiana | AI30792 |
| Maine | TN0002 |
| Maryland | 324 |
| Massachusetts | M-TN003 |
| Michigan | 9958 |
| Minnesota | 047-999-395 |
| Mississippi | TN00003 |
| Missouri | 340 |
| Montana | CERT0086 |
| Nebraska | NE-OS-15-05 |
| Nevada | TN-03-2002-34 |
| New Hampshire | 2975 |
| New Jersey–NELAP | TN002 |
| New Mexico | TN00003 |
| New York | 11742 |
| North Carolina | Env375 |
| North Carolina [1] | DW21704 |
| North Carolina [2] | 41 |
| North Dakota | R-140 |
| Ohio–VAP | CL0069 |
| Oklahoma | 9915 |
| Oregon | TN200002 |
| Pennsylvania | 68-02979 |
| Rhode Island | 221 |
| South Carolina | 84004 |
| South Dakota | n/a |
| Tennessee [1,4] | 2006 |
| Texas | T 104704245-07-TX |
| Texas [5] | LAB0152 |
| Utah | 6157585858 |
| Vermont | VT2006 |
| Virginia | 109 |
| Washington | C1915 |
| West Virginia | 233 |
| Wisconsin | 9980939910 |
| Wyoming | A2LA |

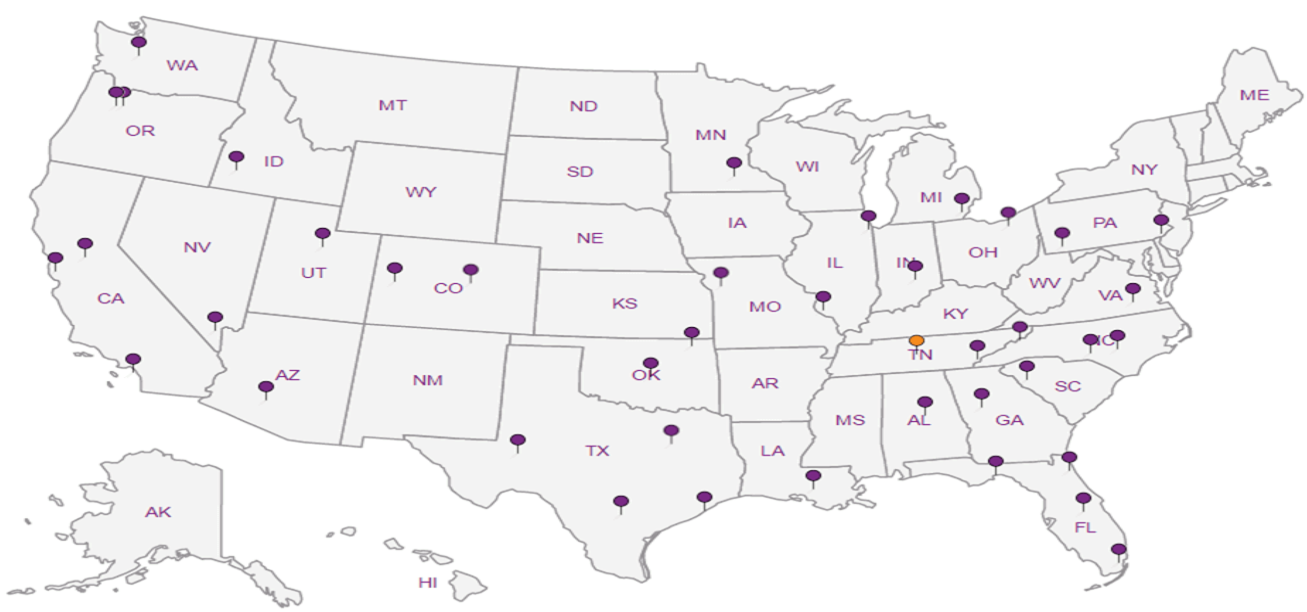
## Third Party & Federal Accreditations

| | |
|---|---|
| A2LA – ISO 17025 | 1461.01 |
| A2LA – ISO 17025 [5] | 1461.02 |
| Canada | 1461.01 |
| EPA–Crypto | TN00003 |
| AIHA-LAP,LLC | 100789 |
| DOD | 1461.01 |
| USDA | S-67674 |

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [n/a] Accreditation not applicable

## Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**



| Company Name/Address: | Billing Information: |
|---|---|
| GES, Inc - Sunoco<br>440 Creamery Way, Suite 500<br>Exton, PA 19341 | Accounts Payable<br>440 Creamery Way, Suite 500<br>Exton, PA 19341 |
| Report to: Holly Smoker | Email To: hsmoker@gesonline.com |

Project Description: Pre-Construction Sampling

City/State Collected: Williamsburg, PA

Phone: 610-458-1077

Fax: NA

Client Project #: NA

Lab Project #: SUNGES-GRILLO

Collected by (print): Ryan M. Biddlecom

Site/Facility ID #: ME2

P.O. #: NA

Collected by (signature):

Rush? (Lab MUST Be Notified)
Same Day ........ 200%
Next Day ........ 100%
Two Day ........ 50%
Three Day ........ 25%

Date Results Needed: Standard

Email? __No ✓Yes

FAX? __No __Yes

Immediately Packed on Ice N___ Y ✓

Analysis / Container / Preservative

Chain of Custody Page 1 of 1

ESC LAB SCIENCES

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

L # L901993

J062

Acctnum: SUNGES
Template: T114657
Prelogin: P564159
TSR: Mark Beasley
Cooler:
Shipped Via: Fed Ex

| Sample ID | Comp/Grab | Matrix * | Depth | Date | Time | No. of Cntrs | **pH,SPCON,TDS,TURB* 250mlHDPE-NoPres | ALK, Br, Cl, SO4 250mlHDPE-NoPres | Total Metals, Hardness 250mlHDPE-HNO3 | RSK175 + Propane 40mlAmb-HCl | TSS 1L-HDPE NoPres | V8260BTEX 40mlAmb-HCl | Rem./Contaminant | Sample # (lab only) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 04112017-520-05 | Grab | DW | – | 4/11/17 | 1250 | 8 | X | X | X | X | X | X | | -01 |

* Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other ________

pH ______ Temp ______

Flow ______ Other ______

Remarks: Metals = Ba,Ca,Fe,K,Mg,Mn,Na. Project #: 0404729 -06-160-xx Org 1402

| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Samples returned via: |
|---|---|---|---|---|
| | 4/11/17 | 1600 | Fed Ex 4/11/17 1600 | ☐ UPS ☑ FedEx ☐ Courier ☐ ____ |
| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Temp: N/7 2.3 °C Bottles Received: 8 |
| Relinquished by: (Signature) | Date: | Time: | Received for lab by: (Signature) | Date: 4-12-17 Time: 845 |

Hold #

Condition: (lab use only) OK

COC Seal Intact: ✓ Y ___ N ___ NA

pH Checked: CT

NCF

# ESC LAB SCIENCES

## Cooler Receipt Form

| | | | |
|---|---|---|---|
| Client: | SUNGES | SDG# | L901993 |
| Cooler Received/Opened On: | 4/ 12 /17 | Temperature: | 2.3 |
| Received By: | Rickey Mosley | | |
| Signature: | [signature] | | |

| Receipt Check List | NP | Yes | No |
|---|---|---|---|
| COC Seal Present / Intact? | | ✓ | |
| COC Signed / Accurate? | | ✓ | |
| Bottles arrive intact? | | ✓ | |
| Correct bottles used? | | ✓ | |
| Sufficient volume sent? | | ✓ | |
| If Applicable | | | |
| VOA Zero headspace? | | ✓ | |
| Preservation Correct / Checked? | | ✓ | |

# ANALYTICAL REPORT

June 29, 2017

## GES, Inc - Sunoco

| | |
|---|---|
| Sample Delivery Group: | L917492 |
| Samples Received: | 06/21/2017 |
| Project Number: | -06-160-XX |
| Description: | Pre-Construction Sampling |
| Site: | ME2 |
| Report To: | Holly Smoker<br>440 Creamery Way, Ste 500<br>Exton, PA 19341 |

Entire Report Reviewed By:

Mark W. Beasley

Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

# TABLE OF CONTENTS


| | |
|---|---|
| Cp: Cover Page | 1 |
| Tc: Table of Contents | 2 |
| Ss: Sample Summary | 3 |
| Cn: Case Narrative | 4 |
| Sr: Sample Results | 5 |
| 06202017-499-01 L917492-01 | 5 |
| Qc: Quality Control Summary | 7 |
| Gravimetric Analysis by Method 2540 C-2011 | 7 |
| Gravimetric Analysis by Method 2540 D-2011 | 8 |
| Wet Chemistry by Method 130.1 | 9 |
| Wet Chemistry by Method 2130 B-2011 | 10 |
| Wet Chemistry by Method 2320 B-2011 | 11 |
| Wet Chemistry by Method 9040C | 12 |
| Wet Chemistry by Method 9050A | 13 |
| Wet Chemistry by Method 9056A | 14 |
| Metals (ICP) by Method 6010B | 16 |
| Volatile Organic Compounds (GC) by Method RSK175 | 17 |
| Volatile Organic Compounds (GC/MS) by Method 8260B | 18 |
| Gl: Glossary of Terms | 19 |
| Al: Accreditations & Locations | 20 |
| Sc: Chain of Custody | 21 |

| | | | Collected by | Collected date/time | Received date/time |
|---|---|---|---|---|---|
| 06202017-499-01 L917492-01 GW | | | ZP | 06/20/17 09:20 | 06/21/17 08:45 |

| Method | Batch | Dilution | Preparation date/time | Analysis date/time | Analyst |
|---|---|---|---|---|---|
| Gravimetric Analysis by Method 2540 C-2011 | WG992515 | 1 | 06/24/17 14:20 | 06/24/17 14:48 | EG |
| Gravimetric Analysis by Method 2540 D-2011 | WG992646 | 1 | 06/26/17 21:17 | 06/26/17 22:34 | MZ |
| Wet Chemistry by Method 130.1 | WG992082 | 1 | 06/27/17 01:26 | 06/27/17 01:26 | ASK |
| Wet Chemistry by Method 2130 B-2011 | WG991557 | 1 | 06/21/17 16:43 | 06/21/17 16:43 | MA |
| Wet Chemistry by Method 2320 B-2011 | WG992368 | 1 | 06/27/17 09:20 | 06/27/17 09:20 | MCG |
| Wet Chemistry by Method 9040C | WG991483 | 1 | 06/22/17 13:16 | 06/22/17 13:16 | MA |
| Wet Chemistry by Method 9050A | WG991698 | 1 | 06/23/17 11:49 | 06/23/17 11:49 | MAJ |
| Wet Chemistry by Method 9056A | WG993019 | 1 | 06/28/17 20:06 | 06/28/17 20:06 | SAM |
| Metals (ICP) by Method 6010B | WG992089 | 1 | 06/23/17 19:24 | 06/26/17 20:05 | CCE |
| Volatile Organic Compounds (GC) by Method RSK175 | WG992015 | 1 | 06/23/17 12:02 | 06/23/17 12:02 | AMC |
| Volatile Organic Compounds (GC/MS) by Method 8260B | WG992306 | 1 | 06/27/17 02:05 | 06/27/17 02:05 | LRL |

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times. All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Mark W. Beasley
Technical Service Representative

## Gravimetric Analysis by Method 2540 C-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Dissolved Solids | 157 | | 10.0 | 1 | 06/24/2017 14:48 | WG992515 |

## Gravimetric Analysis by Method 2540 D-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Suspended Solids | 22.6 | | 2.50 | 1 | 06/26/2017 22:34 | WG992646 |

## Wet Chemistry by Method 130.1

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 111 | | 30.0 | 1 | 06/27/2017 01:26 | WG992082 |

## Wet Chemistry by Method 2130 B-2011

| Analyte | Result NTU | Qualifier | RDL NTU | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Turbidity | 34.8 | | 0.100 | 1 | 06/21/2017 16:43 | WG991557 |

## Wet Chemistry by Method 2320 B-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Alkalinity | 104 | | 20.0 | 1 | 06/27/2017 09:20 | WG992368 |

## Wet Chemistry by Method 9040C

| Analyte | Result su | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| pH | 7.41 | T8 | 1 | 06/22/2017 13:16 | WG991483 |

**Sample Narrative:**

9040C L917492-01 WG991483: 7.41 at 20.6c

## Wet Chemistry by Method 9050A

| Analyte | Result umhos/cm | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| Specific Conductance | 240 | | 1 | 06/23/2017 11:49 | WG991698 |

## Wet Chemistry by Method 9056A

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Bromide | ND | | 1.00 | 1 | 06/28/2017 20:06 | WG993019 |
| Chloride | 4.40 | | 1.00 | 1 | 06/28/2017 20:06 | WG993019 |
| Sulfate | 13.9 | | 5.00 | 1 | 06/28/2017 20:06 | WG993019 |

## Metals (ICP) by Method 6010B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Barium | 0.0422 | | 0.00500 | 1 | 06/26/2017 20:05 | WG992089 |
| Calcium | 37.4 | | 1.00 | 1 | 06/26/2017 20:05 | WG992089 |
| Iron | 1.33 | | 0.100 | 1 | 06/26/2017 20:05 | WG992089 |
| Magnesium | 5.65 | | 1.00 | 1 | 06/26/2017 20:05 | WG992089 |
| Manganese | 0.0270 | | 0.0100 | 1 | 06/26/2017 20:05 | WG992089 |
| Potassium | 1.48 | | 1.00 | 1 | 06/26/2017 20:05 | WG992089 |
| Sodium | 3.24 | | 1.00 | 1 | 06/26/2017 20:05 | WG992089 |

## Volatile Organic Compounds (GC) by Method RSK175

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Methane | ND | | 0.0100 | 1 | 06/23/2017 12:02 | WG992015 |
| Ethane | ND | | 0.0130 | 1 | 06/23/2017 12:02 | WG992015 |
| Ethene | ND | | 0.0130 | 1 | 06/23/2017 12:02 | WG992015 |
| Propane | ND | | 0.0190 | 1 | 06/23/2017 12:02 | WG992015 |

## Volatile Organic Compounds (GC/MS) by Method 8260B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Benzene | ND | | 0.00100 | 1 | 06/27/2017 02:05 | WG992306 |
| Toluene | ND | | 0.00100 | 1 | 06/27/2017 02:05 | WG992306 |
| Ethylbenzene | ND | | 0.00100 | 1 | 06/27/2017 02:05 | WG992306 |
| Total Xylenes | ND | | 0.00300 | 1 | 06/27/2017 02:05 | WG992306 |
| *(S) Toluene-d8* | *105* | | *80.0-120* | | *06/27/2017 02:05* | WG992306 |
| *(S) Dibromofluoromethane* | *91.5* | | *76.0-123* | | *06/27/2017 02:05* | WG992306 |
| *(S) a,a,a-Trifluorotoluene* | *101* | | *80.0-120* | | *06/27/2017 02:05* | WG992306 |
| *(S) 4-Bromofluorobenzene* | *99.8* | | *80.0-120* | | *06/27/2017 02:05* | WG992306 |

## Method Blank (MB)

(MB) R3229177-1 06/24/17 14:48

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Dissolved Solids | U | | 2.82 | 10.0 |

## L917496-02 Original Sample (OS) • Duplicate (DUP)

(OS) L917496-02 06/24/17 14:48 • (DUP) R3229177-4 06/24/17 14:48

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Dissolved Solids | 3670 | 3790 | 1 | 3.22 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3229177-2 06/24/17 14:48 • (LCSD) R3229177-3 06/24/17 14:48

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Dissolved Solids | 8800 | 8520 | 8730 | 96.8 | 99.2 | 85.0-115 | | | 2.43 | 5 |

## Method Blank (MB)

(MB) R3229389-1 06/26/17 22:34

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Suspended Solids | U | | 0.350 | 2.50 |

## L917418-14 Original Sample (OS) • Duplicate (DUP)

(OS) L917418-14 06/26/17 22:34 • (DUP) R3229389-5 06/26/17 22:34

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 3.80 | 3.80 | 1 | 0.000 | | 5 |

## L917621-04 Original Sample (OS) • Duplicate (DUP)

(OS) L917621-04 06/26/17 22:34 • (DUP) R3229389-4 06/26/17 22:34

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 108 | 110 | 1 | 1.10 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3229389-2 06/26/17 22:34 • (LCSD) R3229389-3 06/26/17 22:34

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Suspended Solids | 773 | 804 | 820 | 104 | 106 | 85.0-115 | | | 1.97 | 5 |

## Method Blank (MB)

(MB) R3228882-1 06/27/17 01:00

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 4.03 | J | 1.43 | 30.0 |

## L917083-01 Original Sample (OS) • Duplicate (DUP)

(OS) L917083-01 06/27/17 01:03 • (DUP) R3228882-4 06/27/17 01:04

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 59.9 | 61.0 | 1 | 2 | | 20 |

## L917376-02 Original Sample (OS) • Duplicate (DUP)

(OS) L917376-02 06/27/17 01:23 • (DUP) R3228882-7 06/27/17 01:24

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 197 | 196 | 1 | 1 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3228882-2 06/27/17 01:01 • (LCSD) R3228882-3 06/27/17 01:02

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 148 | 148 | 99 | 99 | 85-115 | | | 0 | 20 |

## L917083-02 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L917083-02 06/27/17 01:05 • (MS) R3228882-5 06/27/17 01:06 • (MSD) R3228882-6 06/27/17 01:07

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 62.6 | 188 | 188 | 84 | 84 | 1 | 80-120 | | | 0 | 20 |

## Method Blank (MB)

(MB) WG991557-1 06/21/17 16:43

| Analyte | MB Result NTU | MB Qualifier | MB MDL NTU | MB RDL NTU |
|---|---|---|---|---|
| Turbidity | 0.0890 | J | 0.0310 | 0.100 |

## L917509-01 Original Sample (OS) • Duplicate (DUP)

(OS) L917509-01 06/21/17 16:43 • (DUP) WG991557-4 06/21/17 16:43

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 9.98 | 9.97 | 1 | 0.100 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG991557-2 06/21/17 16:43 • (LCSD) WG991557-3 06/21/17 16:43

| Analyte | Spike Amount NTU | LCS Result NTU | LCSD Result NTU | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Turbidity | 40.0 | 39.7 | 39.6 | 99.3 | 99.0 | 90.0-110 | | | 0.252 | 20 |

## Method Blank (MB)

(MB) R3228961-1 06/26/17 19:22

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Alkalinity | 5.32 | J | 2.71 | 20.0 |

## L917181-09 Original Sample (OS) • Duplicate (DUP)

(OS) L917181-09 06/26/17 19:37 • (DUP) R3228961-3 06/26/17 19:44

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Alkalinity | 274 | 276 | 1 | 1.00 | | 20 |

## L917461-04 Original Sample (OS) • Duplicate (DUP)

(OS) L917461-04 06/27/17 09:00 • (DUP) R3228961-8 06/27/17 09:08

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Alkalinity | 1050 | 1050 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3228961-4 06/26/17 20:29 • (LCSD) R3228961-7 06/27/17 07:27

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity | 100 | 110 | 106 | 110 | 106 | 85.0-115 | | | 4.00 | 20 |

## L917377-01 Original Sample (OS) • Duplicate (DUP)

(OS) L917377-01 06/22/17 13:16 • (DUP) WG991483-3 06/22/17 13:16

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 8.88 | 8.86 | 1 | 0.225 | | 1 |

## L917492-01 Original Sample (OS) • Duplicate (DUP)

(OS) L917492-01 06/22/17 13:16 • (DUP) WG991483-4 06/22/17 13:16

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 7.41 | 7.41 | 1 | 0.000 | | 1 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG991483-1 06/22/17 13:16 • (LCSD) WG991483-2 06/22/17 13:16

| Analyte | Spike Amount su | LCS Result su | LCSD Result su | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | 6.38 | 6.36 | 6.38 | 99.7 | 100 | 98.7-101 | | | 0.314 | 1 |

## Method Blank (MB)

(MB) WG991698-5 06/23/17 11:49

| Analyte | MB Result umhos/cm | MB Qualifier | MB MDL umhos/cm | MB RDL umhos/cm |
|---|---|---|---|---|
| Specific Conductance | 1.19 | | | |

## L917490-01 Original Sample (OS) • Duplicate (DUP)

(OS) L917490-01 06/23/17 11:49 • (DUP) WG991698-1 06/23/17 11:49

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 91700 | 91800 | 1 | 0.109 | | 20 |

## L917515-15 Original Sample (OS) • Duplicate (DUP)

(OS) L917515-15 06/23/17 11:49 • (DUP) WG991698-4 06/23/17 11:49

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 75.9 | 76.1 | 1 | 0.263 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG991698-2 06/23/17 11:49 • (LCSD) WG991698-3 06/23/17 11:49

| Analyte | Spike Amount umhos/cm | LCS Result umhos/cm | LCSD Result umhos/cm | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Specific Conductance | 1070 | 1070 | 1070 | 100 | 100 | 90.0-110 | | | 0.000 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3229722-1 06/28/17 00:07

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Bromide | U | | 0.079 | 1.00 |
| Chloride | U | | 0.0519 | 1.00 |
| Sulfate | U | | 0.0774 | 5.00 |

## L917505-01 Original Sample (OS) • Duplicate (DUP)

(OS) L917505-01 06/28/17 10:55 • (DUP) R3229722-4 06/28/17 11:05

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | ND | 0.782 | 1 | 0 | | 15 |
| Chloride | 49.7 | 50.6 | 1 | 2 | | 15 |

## L917515-02 Original Sample (OS) • Duplicate (DUP)

(OS) L917515-02 06/28/17 12:14 • (DUP) R3229722-6 06/28/17 12:41

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | U | 0.000 | 1 | 0 | | 15 |
| Chloride | 9.77 | 9.11 | 1 | 7 | | 15 |
| Sulfate | 2.51 | 2.38 | 1 | 5 | J | 15 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3229722-2 06/28/17 00:17 • (LCSD) R3229722-3 06/28/17 00:27

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 40.0 | 39.0 | 39.1 | 97 | 98 | 80-120 | | | 0 | 15 |
| Chloride | 40.0 | 38.7 | 38.9 | 97 | 97 | 80-120 | | | 0 | 15 |
| Sulfate | 40.0 | 40.3 | 40.4 | 101 | 101 | 80-120 | | | 0 | 15 |

## L917506-02 Original Sample (OS) • Matrix Spike (MS)

(OS) L917506-02 06/28/17 11:44 • (MS) R3229722-5 06/28/17 11:54

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MS Rec. % | Dilution | Rec. Limits % | MS Qualifier |
|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | ND | 48.7 | 97 | 1 | 80-120 | |
| Chloride | 50.0 | 20.1 | 73.2 | 106 | 1 | 80-120 | |
| Sulfate | 50.0 | 17.3 | 72.6 | 110 | 1 | 80-120 | |

Cp
Tc
Ss
Cn
Sr
Qc
Gl
Al
Sc

## L917515-14 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L917515-14 06/28/17 18:56 • (MS) R3229722-7 06/28/17 19:06 • (MSD) R3229722-8 06/28/17 19:16

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | U | 47.2 | 53.0 | 94 | 106 | 1 | 80-120 | | | 12 | 15 |
| Chloride | 50.0 | 3.77 | 55.2 | 56.5 | 103 | 105 | 1 | 80-120 | | | 2 | 15 |
| Sulfate | 50.0 | 8.90 | ND | 67.2 | 0 | 117 | 1 | 80-120 | J6 | J3 | 200 | 15 |

## Method Blank (MB)

(MB) R3228910-1 06/26/17 19:47

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Barium | U | | 0.0017 | 0.00500 |
| Calcium | U | | 0.0463 | 1.00 |
| Iron | U | | 0.0141 | 0.100 |
| Magnesium | U | | 0.0111 | 1.00 |
| Manganese | U | | 0.0012 | 0.0100 |
| Potassium | U | | 0.102 | 1.00 |
| Sodium | U | | 0.0985 | 1.00 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3228910-2 06/26/17 19:49 • (LCSD) R3228910-3 06/26/17 19:52

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 1.02 | 1.02 | 102 | 102 | 80-120 | | | 0 | 20 |
| Calcium | 10.0 | 9.93 | 10.0 | 99 | 100 | 80-120 | | | 1 | 20 |
| Iron | 10.0 | 10.1 | 10.1 | 101 | 101 | 80-120 | | | 1 | 20 |
| Magnesium | 10.0 | 10.3 | 10.4 | 103 | 104 | 80-120 | | | 0 | 20 |
| Manganese | 1.00 | 0.997 | 1.01 | 100 | 101 | 80-120 | | | 1 | 20 |
| Potassium | 10.0 | 9.90 | 9.94 | 99 | 99 | 80-120 | | | 0 | 20 |
| Sodium | 10.0 | 9.94 | 10.0 | 99 | 100 | 80-120 | | | 1 | 20 |

## L917496-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L917496-01 06/26/17 19:55 • (MS) R3228910-5 06/26/17 20:00 • (MSD) R3228910-6 06/26/17 20:02

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | ND | 1.04 | 1.02 | 103 | 102 | 1 | 75-125 | | | 2 | 20 |
| Calcium | 10.0 | 2.27 | 12.2 | 12.1 | 99 | 98 | 1 | 75-125 | | | 1 | 20 |
| Iron | 10.0 | 0.138 | 10.3 | 10.2 | 101 | 100 | 1 | 75-125 | | | 1 | 20 |
| Magnesium | 10.0 | ND | 11.1 | 11.0 | 104 | 102 | 1 | 75-125 | | | 2 | 20 |
| Manganese | 1.00 | ND | 1.01 | 0.994 | 101 | 99 | 1 | 75-125 | | | 2 | 20 |
| Potassium | 10.0 | ND | 10.0 | 9.92 | 100 | 99 | 1 | 75-125 | | | 1 | 20 |
| Sodium | 10.0 | 2.28 | 12.2 | 12.1 | 99 | 99 | 1 | 75-125 | | | 0 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3228217-1 06/23/17 11:59

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Methane | U | | 0.00291 | 0.0100 |
| Ethane | U | | 0.00407 | 0.0130 |
| Ethene | U | | 0.00426 | 0.0130 |
| Propane | U | | 0.00548 | 0.0190 |

## L917718-06 Original Sample (OS) • Duplicate (DUP)

(OS) L917718-06 06/23/17 12:15 • (DUP) R3228217-2 06/23/17 12:28

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## L917785-11 Original Sample (OS) • Duplicate (DUP)

(OS) L917785-11 06/23/17 12:30 • (DUP) R3228217-3 06/23/17 12:57

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | 0.143 | 0.144 | 1 | 0.670 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3228217-4 06/23/17 12:59 • (LCSD) R3228217-5 06/23/17 13:03

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Methane | 0.0678 | 0.0700 | 0.0671 | 103 | 99.0 | 85.0-115 | | | 4.16 | 20 |
| Ethane | 0.129 | 0.123 | 0.122 | 95.1 | 95.0 | 85.0-115 | | | 0.130 | 20 |
| Ethene | 0.127 | 0.117 | 0.116 | 92.3 | 91.6 | 85.0-115 | | | 0.670 | 20 |
| Propane | 0.186 | 0.178 | 0.179 | 95.9 | 96.3 | 85.0-115 | | | 0.440 | 20 |

## Method Blank (MB)

(MB) R3228829-3 06/26/17 10:46

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Benzene | U | | 0.000331 | 0.00100 |
| Ethylbenzene | U | | 0.000384 | 0.00100 |
| Toluene | U | | 0.000412 | 0.00100 |
| Xylenes, Total | U | | 0.00106 | 0.00300 |
| *(S) Toluene-d8* | *107* | | | *80.0-120* |
| *(S) Dibromofluoromethane* | *91.7* | | | *76.0-123* |
| *(S) a,a,a-Trifluorotoluene* | *102* | | | *80.0-120* |
| *(S) 4-Bromofluorobenzene* | *97.3* | | | *80.0-120* |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3228829-1 06/26/17 09:38 • (LCSD) R3228829-2 06/26/17 09:55

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Benzene | 0.0250 | 0.0260 | 0.0258 | 104 | 103 | 69.0-123 | | | 0.860 | 20 |
| Ethylbenzene | 0.0250 | 0.0224 | 0.0231 | 89.8 | 92.4 | 77.0-120 | | | 2.93 | 20 |
| Toluene | 0.0250 | 0.0244 | 0.0242 | 97.4 | 96.7 | 77.0-120 | | | 0.790 | 20 |
| Xylenes, Total | 0.0750 | 0.0668 | 0.0676 | 89.1 | 90.1 | 77.0-120 | | | 1.19 | 20 |
| *(S) Toluene-d8* | | | | *106* | *104* | *80.0-120* | | | | |
| *(S) Dibromofluoromethane* | | | | *97.1* | *93.9* | *76.0-123* | | | | |
| *(S) a,a,a-Trifluorotoluene* | | | | *99.7* | *101* | *80.0-120* | | | | |
| *(S) 4-Bromofluorobenzene* | | | | *98.1* | *97.6* | *80.0-120* | | | | |

## Abbreviations and Definitions

| | |
|---|---|
| SDG | Sample Delivery Group. |
| MDL | Method Detection Limit. |
| RDL | Reported Detection Limit. |
| ND | Not detected at the Reporting Limit (or MDL where applicable). |
| U | Not detected at the Reporting Limit (or MDL where applicable). |
| RPD | Relative Percent Difference. |
| Original Sample | The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG. |
| (S) | Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media. |
| Rec. | Recovery. |

| Qualifier | Description |
|---|---|
| J | The identification of the analyte is acceptable; the reported value is an estimate. |
| J3 | The associated batch QC was outside the established quality control range for precision. |
| J6 | The sample matrix interfered with the ability to make any accurate determination; spike value is low. |
| T8 | Sample(s) received past/too close to holding time expiration. |

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE.**
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

## State Accreditations

| | |
|---|---|
| Alabama | 40660 |
| Alaska | UST-080 |
| Arizona | AZ0612 |
| Arkansas | 88-0469 |
| California | 01157CA |
| Colorado | TN00003 |
| Conneticut | PH-0197 |
| Florida | E87487 |
| Georgia | NELAP |
| Georgia [1] | 923 |
| Idaho | TN00003 |
| Illinois | 200008 |
| Indiana | C-TN-01 |
| Iowa | 364 |
| Kansas | E-10277 |
| Kentucky [1] | 90010 |
| Kentucky [2] | 16 |
| Louisiana | AI30792 |
| Maine | TN0002 |
| Maryland | 324 |
| Massachusetts | M-TN003 |
| Michigan | 9958 |
| Minnesota | 047-999-395 |
| Mississippi | TN00003 |
| Missouri | 340 |
| Montana | CERT0086 |
| Nebraska | NE-OS-15-05 |
| Nevada | TN-03-2002-34 |
| New Hampshire | 2975 |
| New Jersey–NELAP | TN002 |
| New Mexico | TN00003 |
| New York | 11742 |
| North Carolina | Env375 |
| North Carolina [1] | DW21704 |
| North Carolina [2] | 41 |
| North Dakota | R-140 |
| Ohio–VAP | CL0069 |
| Oklahoma | 9915 |
| Oregon | TN200002 |
| Pennsylvania | 68-02979 |
| Rhode Island | 221 |
| South Carolina | 84004 |
| South Dakota | n/a |
| Tennessee [1,4] | 2006 |
| Texas | T 104704245-07-TX |
| Texas [5] | LAB0152 |
| Utah | 6157585858 |
| Vermont | VT2006 |
| Virginia | 109 |
| Washington | C1915 |
| West Virginia | 233 |
| Wisconsin | 9980939910 |
| Wyoming | A2LA |

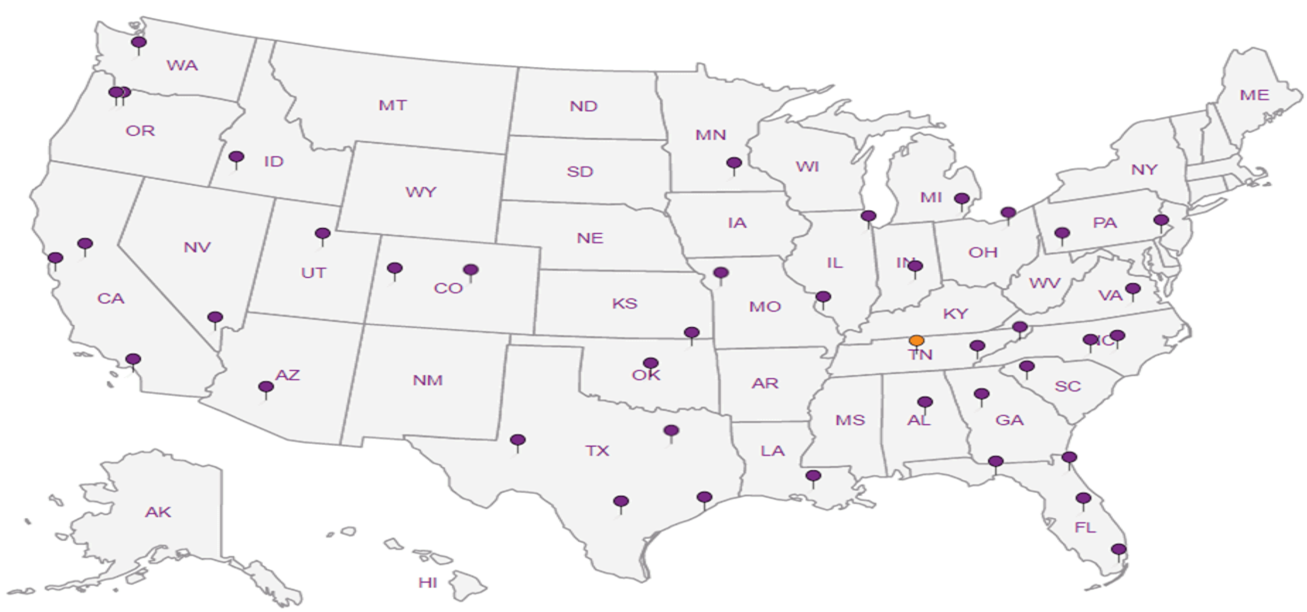
## Third Party & Federal Accreditations

| | |
|---|---|
| A2LA – ISO 17025 | 1461.01 |
| A2LA – ISO 17025 [5] | 1461.02 |
| Canada | 1461.01 |
| EPA–Crypto | TN00003 |
| AIHA-LAP,LLC | 100789 |
| DOD | 1461.01 |
| USDA | S-67674 |

[1] Drinking Water [2] Underground Storage Tanks [3] Aquatic Toxicity [4] Chemical/Microbiological [5] Mold [n/a] Accreditation not applicable

## Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**



Company Name/Address:
**GES, Inc - Sunoco**
440 Creamery Way, Suite 500
Exton, PA 19341

Billing Information:
Accounts Payable
440 Creamery Way, Suite 500
Exton, PA 19341

Analysis / Container / Preservative

Chain of Custody Page 1 of 1

ESC LAB SCIENCES

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

Report to: Holly Smoker
Email To: hsmoker@gesonline.com

Project Description: Pre-Construction Sampling
City/State Collected: Williamsburg, PA

Phone: 610-458-1077
Fax: NA
Client Project #: NA
Lab Project #: SUNGES-GRILLO

L# T1749?
E158

Collected by (print): [signature]
Site/Facility ID #: ME2
P.O. #: NA

Acctnum: SUNGES
Template: T114657
Prelogin: P564159
TSR: Mark Beasley
Cooler:
Shipped Via: Fed Ex

Collected by (signature): [signature]
Immediately Packed on Ice N ___ Y ✓

Rush? (Lab MUST Be Notified)
___ Same Day ........ 200%
___ Next Day ........ 100%
___ Two Day ........ 50%
___ Three Day ........ 25%

Date Results Needed: Standard
Email? ___No ✓Yes
FAX? ___No ___Yes

| Sample ID | Comp/Grab | Matrix * | Depth | Date | Time | No. of Cntrs | **pH,SPCON,TDS,TURB* 250mlHDPE-NoPres | ALK, Br, Cl, SO4 250mlHDPE-NoPres | Total Metals, Hardness 250mlHDPE-HNO3 (<2) | RSK175 + Propane 40mlAmb-HCl | TSS 1L-HDPE NoPres | V8260BTEX 40mlAmb-HCl | | | | Rem./Contaminant | Sample # (lab only) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06202017-499-01 | Grab | DW | — | 6/20/17 | 0920 | 8 | X | X | X | X | X | X | | | | | 01 |

* Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other ______

pH ______ Temp ______

Flow ______ Other ______

Remarks: **Metals = Ba,Ca,Fe,K,Mg,Mn,Na. Project #:______________-06-160-xx Org 1402**

Hold #

| Relinquished by : (Signature) | Date: | Time: | Received by: (Signature) | Samples returned via: | Condition: (lab use only) |
|---|---|---|---|---|---|
| [signature] | 6/20/17 | 1400 | FedEx 6/20/17 1400 | ☐ UPS ☒ FedEx ☐ Courier ☐ ______ | OK |

| Relinquished by : (Signature) | Date: | Time: | Received by: (Signature) | Temp: 1.5 °C Bottles Received: 8 | COC Seal Intact: ✓ Y ___N ___NA |
|---|---|---|---|---|---|

| Relinquished by : (Signature) | Date: | Time: | Received for lab by: (Signature) | Date: 6/21/17 Time: 0845 | pH Checked: <2 NCF: |
|---|---|---|---|---|---|
| | | | [signature] | | |

7176 9005 6748

# ESC LAB SCIENCES
## Cooler Receipt Form

| | | | |
|---|---|---|---|
| Client: SUNGES Sunges | | SDG# | 917492 |
| Cooler Received/Opened On: 06/ 21 /2017 | | Temperature: | 1.5 |
| Received By: Olivia Studebaker | | | |
| Signature: Olivia Studebaker | | | |

| Receipt Check List | NP | Yes | No |
|---|---|---|---|
| COC Seal Present / Intact? | | ✓ | |
| COC Signed / Accurate? | | ✓ | |
| Bottles arrive intact? | | ✓ | |
| Correct bottles used? | | ✓ | |
| Sufficient volume sent? | | ✓ | |
| If Applicable | | | |
| VOA Zero headspace? | | ✓ | |
| Preservation Correct / Checked? | | ✓ | |

# ANALYTICAL REPORT

August 02, 2017

**GES, Inc - Sunoco**

| | |
|---|---|
| Sample Delivery Group: | L925915 |
| Samples Received: | 08/01/2017 |
| Project Number: | 0204728-06-160-XX |
| Description: | Pre-Construction Sampling |
| Site: | ME2 |
| Report To: | Holly Smoker<br>440 Creamery Way, Ste 500<br>Exton, PA  19341 |

Entire Report Reviewed By:

Mark W. Beasley
Technical Service Representative

Results relate only to the items tested or calibrated and are reported as rounded values. This test report shall not be reproduced, except in full, without written approval of the laboratory. Where applicable, sampling conducted by ESC is performed per guidance provided in laboratory standard operating procedures: 060302, 060303, and 060304.

# TABLE OF CONTENTS


| | |
|---|---|
| Cp: Cover Page | 1 |
| Tc: Table of Contents | 2 |
| Ss: Sample Summary | 3 |
| Cn: Case Narrative | 4 |
| Sr: Sample Results | 5 |
| 07312017-604-02 L925915-01 | 5 |
| Qc: Quality Control Summary | 7 |
| Gravimetric Analysis by Method 2540 C-2011 | 7 |
| Gravimetric Analysis by Method 2540 D-2011 | 8 |
| Wet Chemistry by Method 130.1 | 9 |
| Wet Chemistry by Method 2130 B-2011 | 10 |
| Wet Chemistry by Method 2320 B-2011 | 11 |
| Wet Chemistry by Method 9040C | 12 |
| Wet Chemistry by Method 9050A | 13 |
| Wet Chemistry by Method 9056A | 14 |
| Metals (ICP) by Method 6010B | 16 |
| Volatile Organic Compounds (GC) by Method RSK175 | 17 |
| Volatile Organic Compounds (GC/MS) by Method 8260B | 18 |
| Gl: Glossary of Terms | 19 |
| Al: Accreditations & Locations | 20 |
| Sc: Chain of Custody | 21 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## 07312017-604-02 L925915-01 GW

| Collected by | Collected date/time | Received date/time |
|---|---|---|
| Jacob Gonzalez | 07/31/17 14:15 | 08/01/17 08:45 |

| Method | Batch | Dilution | Preparation date/time | Analysis date/time | Analyst |
|---|---|---|---|---|---|
| Gravimetric Analysis by Method 2540 C-2011 | WG1004724 | 1 | 08/01/17 16:38 | 08/01/17 17:13 | MMF |
| Gravimetric Analysis by Method 2540 D-2011 | WG1004726 | 1 | 08/01/17 17:31 | 08/01/17 17:57 | EG |
| Wet Chemistry by Method 130.1 | WG1005053 | 5 | 08/02/17 11:45 | 08/02/17 11:45 | JER |
| Wet Chemistry by Method 2130 B-2011 | WG1004648 | 1 | 08/01/17 15:31 | 08/01/17 15:31 | GB |
| Wet Chemistry by Method 2320 B-2011 | WG1004401 | 1 | 08/01/17 20:10 | 08/01/17 20:10 | MCG |
| Wet Chemistry by Method 9040C | WG1004742 | 1 | 08/01/17 14:17 | 08/01/17 14:17 | GB |
| Wet Chemistry by Method 9050A | WG1004681 | 1 | 08/01/17 19:13 | 08/01/17 19:13 | MAJ |
| Wet Chemistry by Method 9056A | WG1004677 | 1 | 08/02/17 00:16 | 08/02/17 00:16 | SAM |
| Metals (ICP) by Method 6010B | WG1004655 | 1 | 08/01/17 17:13 | 08/01/17 22:40 | ST |
| Volatile Organic Compounds (GC) by Method RSK175 | WG1004693 | 1 | 08/01/17 13:59 | 08/01/17 13:59 | AMC |
| Volatile Organic Compounds (GC/MS) by Method 8260B | WG1004671 | 1 | 08/01/17 14:02 | 08/01/17 14:02 | BMB |

All sample aliquots were received at the correct temperature, in the proper containers, with the appropriate preservatives, and within method specified holding times. All MDL (LOD) and RDL (LOQ) values reported for environmental samples have been corrected for the dilution factor used in the analysis. All Method and Batch Quality Control are within established criteria except where addressed in this case narrative, a non-conformance form or properly qualified within the sample results. By my digital signature below, I affirm to the best of my knowledge, all problems/anomalies observed by the laboratory as having the potential to affect the quality of the data have been identified by the laboratory, and no information or data have been knowingly withheld that would affect the quality of the data.

Mark W. Beasley
Technical Service Representative

## Gravimetric Analysis by Method 2540 C-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Dissolved Solids | 274 | | 10.0 | 1 | 08/01/2017 17:13 | WG1004724 |

## Gravimetric Analysis by Method 2540 D-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Suspended Solids | 7.37 | | 2.50 | 1 | 08/01/2017 17:57 | WG1004726 |

## Wet Chemistry by Method 130.1

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 215 | B | 150 | 5 | 08/02/2017 11:45 | WG1005053 |

## Wet Chemistry by Method 2130 B-2011

| Analyte | Result NTU | Qualifier | RDL NTU | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Turbidity | 5.01 | | 0.100 | 1 | 08/01/2017 15:31 | WG1004648 |

## Wet Chemistry by Method 2320 B-2011

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Alkalinity | 192 | | 20.0 | 1 | 08/01/2017 20:10 | WG1004401 |

## Wet Chemistry by Method 9040C

| Analyte | Result su | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| pH | 7.24 | T8 | 1 | 08/01/2017 14:17 | WG1004742 |

**Sample Narrative:**

L925915-01 WG1004742: 7.24 at 14.0c

## Wet Chemistry by Method 9050A

| Analyte | Result umhos/cm | Qualifier | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|
| Specific Conductance | 476 | | 1 | 08/01/2017 19:13 | WG1004681 |

## Wet Chemistry by Method 9056A

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Bromide | ND | | 1.00 | 1 | 08/02/2017 00:16 | WG1004677 |
| Chloride | 14.6 | | 1.00 | 1 | 08/02/2017 00:16 | WG1004677 |
| Sulfate | 20.3 | | 5.00 | 1 | 08/02/2017 00:16 | WG1004677 |

## Metals (ICP) by Method 6010B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Barium | 0.0655 | | 0.00500 | 1 | 08/01/2017 22:40 | WG1004655 |
| Calcium | 74.9 | | 1.00 | 1 | 08/01/2017 22:40 | WG1004655 |
| Iron | 0.323 | | 0.100 | 1 | 08/01/2017 22:40 | WG1004655 |
| Magnesium | 12.2 | | 1.00 | 1 | 08/01/2017 22:40 | WG1004655 |
| Manganese | ND | | 0.0100 | 1 | 08/01/2017 22:40 | WG1004655 |
| Potassium | 2.71 | | 1.00 | 1 | 08/01/2017 22:40 | WG1004655 |
| Sodium | 8.71 | | 1.00 | 1 | 08/01/2017 22:40 | WG1004655 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Volatile Organic Compounds (GC) by Method RSK175

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Methane | ND | | 0.0100 | 1 | 08/01/2017 13:59 | WG1004693 |
| Ethane | ND | | 0.0130 | 1 | 08/01/2017 13:59 | WG1004693 |
| Ethene | ND | | 0.0130 | 1 | 08/01/2017 13:59 | WG1004693 |
| Propane | ND | | 0.0190 | 1 | 08/01/2017 13:59 | WG1004693 |

## Volatile Organic Compounds (GC/MS) by Method 8260B

| Analyte | Result mg/l | Qualifier | RDL mg/l | Dilution | Analysis date / time | Batch |
|---|---|---|---|---|---|---|
| Benzene | ND | | 0.00100 | 1 | 08/01/2017 14:02 | WG1004671 |
| Toluene | ND | | 0.00100 | 1 | 08/01/2017 14:02 | WG1004671 |
| Ethylbenzene | ND | | 0.00100 | 1 | 08/01/2017 14:02 | WG1004671 |
| Total Xylenes | ND | | 0.00300 | 1 | 08/01/2017 14:02 | WG1004671 |
| *(S) Toluene-d8* | *100* | | *80.0-120* | | *08/01/2017 14:02* | WG1004671 |
| *(S) Dibromofluoromethane* | *107* | | *76.0-123* | | *08/01/2017 14:02* | WG1004671 |
| *(S) a,a,a-Trifluorotoluene* | *97.6* | | *80.0-120* | | *08/01/2017 14:02* | WG1004671 |
| *(S) 4-Bromofluorobenzene* | *109* | | *80.0-120* | | *08/01/2017 14:02* | WG1004671 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3238105-1 08/01/17 17:13

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Dissolved Solids | U | | 2.82 | 10.0 |

## L925914-01 Original Sample (OS) • Duplicate (DUP)

(OS) L925914-01 08/01/17 17:13 • (DUP) R3238105-4 08/01/17 17:13

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Dissolved Solids | 177 | 176 | 1 | 0.567 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3238105-2 08/01/17 17:13 • (LCSD) R3238105-3 08/01/17 17:13

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Dissolved Solids | 8800 | 8440 | 8490 | 95.9 | 96.5 | 85.0-115 | | | 0.591 | 5 |

## Method Blank (MB)

(MB) R3237967-1 08/01/17 17:57

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Suspended Solids | U | | 0.350 | 2.50 |

## L925941-01 Original Sample (OS) • Duplicate (DUP)

(OS) L925941-01 08/01/17 17:57 • (DUP) R3237967-4 08/01/17 17:57

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 216 | 211 | 1 | 2.34 | | 5 |

## L925943-01 Original Sample (OS) • Duplicate (DUP)

(OS) L925943-01 08/01/17 17:57 • (DUP) R3237967-5 08/01/17 17:57

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Suspended Solids | 38.0 | 37.8 | 1 | 0.660 | | 5 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3237967-2 08/01/17 17:57 • (LCSD) R3237967-3 08/01/17 17:57

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Suspended Solids | 773 | 784 | 792 | 101 | 102 | 85.0-115 | | | 1.02 | 5 |

## Method Blank (MB)

(MB) R3238017-1 08/02/17 11:15

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 5.13 | J | 1.43 | 30.0 |

## L924479-03 Original Sample (OS) • Duplicate (DUP)

(OS) L924479-03 08/02/17 11:17 • (DUP) R3238017-4 08/02/17 11:18

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 72.0 | 68.9 | 1 | 4 | | 20 |

## L925970-01 Original Sample (OS) • Duplicate (DUP)

(OS) L925970-01 08/02/17 13:47 • (DUP) R3238017-7 08/02/17 13:48

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 299 | 298 | 5 | 1 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3238017-2 08/02/17 11:15 • (LCSD) R3238017-3 08/02/17 11:16

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 149 | 148 | 99 | 99 | 85-115 | | | 1 | 20 |

## L925971-01 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L925971-01 08/02/17 11:43 • (MS) R3238017-5 08/02/17 11:44 • (MSD) R3238017-6 08/02/17 11:45

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hardness (colorimetric) as CaCO3 | 150 | 157 | 238 | 237 | 54 | 53 | 1 | 80-120 | E J6 | E J6 | 0 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) WG1004648-1 08/01/17 15:31

| Analyte | MB Result NTU | MB Qualifier | MB MDL NTU | MB RDL NTU |
|---|---|---|---|---|
| Turbidity | 0.0640 | J | 0.0310 | 0.100 |

## L925915-01 Original Sample (OS) • Duplicate (DUP)

(OS) L925915-01 08/01/17 15:31 • (DUP) WG1004648-4 08/01/17 15:31

| Analyte | Original Result NTU | DUP Result NTU | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Turbidity | 5.01 | 5.01 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG1004648-2 08/01/17 15:31 • (LCSD) WG1004648-3 08/01/17 15:31

| Analyte | Spike Amount NTU | LCS Result NTU | LCSD Result NTU | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Turbidity | 40.0 | 39.9 | 39.9 | 99.8 | 99.8 | 90.0-110 | | | 0.000 | 20 |

## Method Blank (MB)

(MB) R3237897-1 08/01/17 19:14

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Alkalinity | U | | 2.71 | 20.0 |

## L923368-23 Original Sample (OS) • Duplicate (DUP)

(OS) L923368-23 08/01/17 21:51 • (DUP) R3237897-6 08/01/17 21:59

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Alkalinity | 52.0 | 53.3 | 1 | 2.00 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3237897-4 08/01/17 20:22 • (LCSD) R3237897-5 08/01/17 21:36

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Alkalinity | 100 | 99.0 | 99.9 | 99.0 | 100 | 85.0-115 | | | 1.00 | 20 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## L924904-01 Original Sample (OS) • Duplicate (DUP)

(OS) L924904-01 08/01/17 14:17 • (DUP) WG1004742-3 08/01/17 14:17

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 7.33 | 7.30 | 1 | 0.410 | T8 | 1 |

Sample Narrative:

OS: 7.33 at 16.7c

DUP: 7.30 at 16.5c

## L925974-02 Original Sample (OS) • Duplicate (DUP)

(OS) L925974-02 08/01/17 14:17 • (DUP) WG1004742-4 08/01/17 14:17

| Analyte | Original Result su | DUP Result su | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| pH | 6.80 | 6.82 | 1 | 0.294 | T8 | 1 |

Sample Narrative:

OS: 6.80 at 18.0c

DUP: 6.82 at 18.0c

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG1004742-1 08/01/17 14:17 • (LCSD) WG1004742-2 08/01/17 14:17

| Analyte | Spike Amount su | LCS Result su | LCSD Result su | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| pH | 6.38 | 6.39 | 6.40 | 100 | 100 | 98.4-102 | | | 0.156 | 1 |

Sample Narrative:

LCS: 6.39 at 19.7c

LCSD: 6.40 at 19.7c

## Method Blank (MB)

(MB) WG1004681-5 08/01/17 19:13

| Analyte | MB Result umhos/cm | MB Qualifier | MB MDL umhos/cm | MB RDL umhos/cm |
|---|---|---|---|---|
| Specific Conductance | 1.98 | | | |

## L925730-01 Original Sample (OS) • Duplicate (DUP)

(OS) L925730-01 08/01/17 19:13 • (DUP) WG1004681-1 08/01/17 19:13

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 1710 | 1710 | 1 | 0.820 | | 20 |

## L926097-01 Original Sample (OS) • Duplicate (DUP)

(OS) L926097-01 08/01/17 19:13 • (DUP) WG1004681-4 08/01/17 19:13

| Analyte | Original Result umhos/cm | DUP Result umhos/cm | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Specific Conductance | 1.98 | 2.01 | 1 | 1.50 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) WG1004681-2 08/01/17 19:13 • (LCSD) WG1004681-3 08/01/17 19:13

| Analyte | Spike Amount umhos/cm | LCS Result umhos/cm | LCSD Result umhos/cm | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Specific Conductance | 1070 | 1080 | 1080 | 101 | 101 | 90.0-110 | | | 0.000 | 20 |

## Method Blank (MB)

(MB) R3237868-1 08/01/17 07:17

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Bromide | U | | 0.079 | 1.00 |
| Chloride | U | | 0.0519 | 1.00 |
| Sulfate | U | | 0.0774 | 5.00 |

## L925016-01 Original Sample (OS) • Duplicate (DUP)

(OS) L925016-01 08/01/17 19:46 • (DUP) R3237868-4 08/01/17 20:02

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | ND | 0.000 | 1 | 0 | | 15 |
| Chloride | 10.2 | 10.1 | 1 | 1 | | 15 |
| Sulfate | ND | 2.97 | 1 | 0 | | 15 |

## L925480-09 Original Sample (OS) • Duplicate (DUP)

(OS) L925480-09 08/01/17 22:57 • (DUP) R3237868-6 08/01/17 23:12

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Bromide | 2.38 | 1.59 | 1 | 40 | P1 | 15 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3237868-2 08/01/17 07:33 • (LCSD) R3237868-3 08/01/17 07:49

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 40.0 | 40.6 | 40.5 | 101 | 101 | 80-120 | | | 0 | 15 |
| Chloride | 40.0 | 40.3 | 40.3 | 101 | 101 | 80-120 | | | 0 | 15 |
| Sulfate | 40.0 | 40.6 | 40.5 | 102 | 101 | 80-120 | | | 0 | 15 |

## L925016-01 Original Sample (OS) • Matrix Spike (MS)

(OS) L925016-01 08/01/17 19:46 • (MS) R3237868-5 08/01/17 20:17

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MS Rec. % | Dilution | Rec. Limits % | MS Qualifier |
|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | ND | 43.8 | 88 | 1 | 80-120 | |
| Chloride | 50.0 | 10.2 | 59.4 | 98 | 1 | 80-120 | |
| Sulfate | 50.0 | ND | 47.5 | 89 | 1 | 80-120 | |

## L925480-09 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L925480-09 08/01/17 22:57 • (MS) R3237868-7 08/01/17 23:28 • (MSD) R3237868-8 08/01/17 23:44

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bromide | 50.0 | 2.38 | 46.4 | 46.8 | 88 | 89 | 1 | 80-120 | | | 1 | 15 |

1 Cp
2 Tc
3 Ss
4 Cn
5 Sr
6 Qc
7 Gl
8 Al
9 Sc

## Method Blank (MB)

(MB) R3237812-1 08/01/17 21:29

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Barium | U | | 0.0017 | 0.00500 |
| Calcium | U | | 0.0463 | 1.00 |
| Iron | U | | 0.0141 | 0.100 |
| Magnesium | U | | 0.0111 | 1.00 |
| Manganese | U | | 0.0012 | 0.0100 |
| Potassium | U | | 0.102 | 1.00 |
| Sodium | U | | 0.0985 | 1.00 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3237812-2 08/01/17 21:31 • (LCSD) R3237812-3 08/01/17 21:34

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 0.994 | 1.01 | 99 | 101 | 80-120 | | | 2 | 20 |
| Calcium | 10.0 | 9.72 | 9.84 | 97 | 98 | 80-120 | | | 1 | 20 |
| Iron | 10.0 | 9.82 | 9.96 | 98 | 100 | 80-120 | | | 1 | 20 |
| Magnesium | 10.0 | 10.3 | 10.5 | 103 | 105 | 80-120 | | | 2 | 20 |
| Manganese | 1.00 | 0.958 | 0.976 | 96 | 98 | 80-120 | | | 2 | 20 |
| Potassium | 10.0 | 9.96 | 10.0 | 100 | 100 | 80-120 | | | 1 | 20 |
| Sodium | 10.0 | 9.45 | 9.59 | 94 | 96 | 80-120 | | | 1 | 20 |

## L925028-02 Original Sample (OS) • Matrix Spike (MS) • Matrix Spike Duplicate (MSD)

(OS) L925028-02 08/01/17 21:36 • (MS) R3237812-5 08/01/17 21:41 • (MSD) R3237812-6 08/01/17 21:44

| Analyte | Spike Amount mg/l | Original Result mg/l | MS Result mg/l | MSD Result mg/l | MS Rec. % | MSD Rec. % | Dilution | Rec. Limits % | MS Qualifier | MSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Barium | 1.00 | 2.85 | 3.76 | 3.77 | 91 | 92 | 1 | 75-125 | | | 0 | 20 |
| Calcium | 10.0 | 125 | 133 | 133 | 80 | 77 | 1 | 75-125 | | | 0 | 20 |
| Iron | 10.0 | 16.9 | 29.1 | 29.1 | 122 | 122 | 1 | 75-125 | | | 0 | 20 |
| Magnesium | 10.0 | 15.4 | 25.3 | 25.3 | 99 | 99 | 1 | 75-125 | | | 0 | 20 |
| Manganese | 1.00 | 0.265 | 1.20 | 1.21 | 94 | 95 | 1 | 75-125 | | | 1 | 20 |
| Potassium | 10.0 | 4.73 | 14.6 | 14.7 | 98 | 100 | 1 | 75-125 | | | 1 | 20 |
| Sodium | 10.0 | 11.2 | 20.4 | 20.4 | 92 | 91 | 1 | 75-125 | | | 0 | 20 |

## Method Blank (MB)

(MB) R3237730-1 08/01/17 13:51

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Methane | U | | 0.00291 | 0.0100 |
| Ethane | U | | 0.00407 | 0.0130 |
| Ethene | U | | 0.00426 | 0.0130 |
| Propane | U | | 0.00548 | 0.0190 |

## L925938-01 Original Sample (OS) • Duplicate (DUP)

(OS) L925938-01 08/01/17 14:04 • (DUP) R3237730-2 08/01/17 14:30

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethane | ND | 0.000 | 1 | 0.000 | | 20 |
| Ethene | ND | 0.000 | 1 | 0.000 | | 20 |
| Propane | ND | 0.000 | 1 | 0.000 | | 20 |

## L925954-04 Original Sample (OS) • Duplicate (DUP)

(OS) L925954-04 08/01/17 14:39 • (DUP) R3237730-3 08/01/17 14:48

| Analyte | Original Result mg/l | DUP Result mg/l | Dilution | DUP RPD % | DUP Qualifier | DUP RPD Limits % |
|---|---|---|---|---|---|---|
| Methane | 0.0288 | 0.0272 | 1 | 5.70 | | 20 |
| Ethane | U | 0.000 | 1 | 0.000 | | 20 |
| Ethene | U | 0.000 | 1 | 0.000 | | 20 |
| Propane | U | 0.000 | 1 | 0.000 | | 20 |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3237730-4 08/01/17 14:53 • (LCSD) R3237730-5 08/01/17 14:57

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Methane | 0.0678 | 0.0629 | 0.0642 | 92.8 | 94.6 | 85.0-115 | | | 1.92 | 20 |
| Ethane | 0.129 | 0.117 | 0.120 | 90.9 | 93.2 | 85.0-115 | | | 2.49 | 20 |
| Ethene | 0.127 | 0.113 | 0.116 | 89.3 | 91.5 | 85.0-115 | | | 2.46 | 20 |
| Propane | 0.186 | 0.173 | 0.179 | 93.2 | 96.3 | 85.0-115 | | | 3.31 | 20 |

## Method Blank (MB)

(MB) R3237794-3 08/01/17 09:36

| Analyte | MB Result mg/l | MB Qualifier | MB MDL mg/l | MB RDL mg/l |
|---|---|---|---|---|
| Benzene | U | | 0.000331 | 0.00100 |
| Ethylbenzene | U | | 0.000384 | 0.00100 |
| Toluene | U | | 0.000412 | 0.00100 |
| Xylenes, Total | U | | 0.00106 | 0.00300 |
| *(S) Toluene-d8* | *102* | | | *80.0-120* |
| *(S) Dibromofluoromethane* | *107* | | | *76.0-123* |
| *(S) a,a,a-Trifluorotoluene* | *98.4* | | | *80.0-120* |
| *(S) 4-Bromofluorobenzene* | *113* | | | *80.0-120* |

## Laboratory Control Sample (LCS) • Laboratory Control Sample Duplicate (LCSD)

(LCS) R3237794-1 08/01/17 08:29 • (LCSD) R3237794-2 08/01/17 08:46

| Analyte | Spike Amount mg/l | LCS Result mg/l | LCSD Result mg/l | LCS Rec. % | LCSD Rec. % | Rec. Limits % | LCS Qualifier | LCSD Qualifier | RPD % | RPD Limits % |
|---|---|---|---|---|---|---|---|---|---|---|
| Benzene | 0.0250 | 0.0260 | 0.0257 | 104 | 103 | 69.0-123 | | | 1.21 | 20 |
| Ethylbenzene | 0.0250 | 0.0218 | 0.0217 | 87.3 | 86.8 | 77.0-120 | | | 0.650 | 20 |
| Toluene | 0.0250 | 0.0221 | 0.0222 | 88.2 | 88.6 | 77.0-120 | | | 0.430 | 20 |
| Xylenes, Total | 0.0750 | 0.0665 | 0.0658 | 88.7 | 87.7 | 77.0-120 | | | 1.06 | 20 |
| *(S) Toluene-d8* | | | | *99.4* | *99.7* | *80.0-120* | | | | |
| *(S) Dibromofluoromethane* | | | | *107* | *108* | *76.0-123* | | | | |
| *(S) a,a,a-Trifluorotoluene* | | | | *96.3* | *95.7* | *80.0-120* | | | | |
| *(S) 4-Bromofluorobenzene* | | | | *110* | *110* | *80.0-120* | | | | |

## Abbreviations and Definitions

| | |
|---|---|
| SDG | Sample Delivery Group. |
| MDL | Method Detection Limit. |
| RDL | Reported Detection Limit. |
| ND | Not detected at the Reporting Limit (or MDL where applicable). |
| U | Not detected at the Reporting Limit (or MDL where applicable). |
| RPD | Relative Percent Difference. |
| Original Sample | The non-spiked sample in the prep batch used to determine the Relative Percent Difference (RPD) from a quality control sample. The Original Sample may not be included within the reported SDG. |
| (S) | Surrogate (Surrogate Standard) - Analytes added to every blank, sample, Laboratory Control Sample/Duplicate and Matrix Spike/Duplicate; used to evaluate analytical efficiency by measuring recovery. Surrogates are not expected to be detected in all environmental media. |
| Rec. | Recovery. |

| Qualifier | Description |
|---|---|
| B | The same analyte is found in the associated blank. |
| E | The analyte concentration exceeds the upper limit of the calibration range of the instrument established by the initial calibration (ICAL). |
| J | The identification of the analyte is acceptable; the reported value is an estimate. |
| J6 | The sample matrix interfered with the ability to make any accurate determination; spike value is low. |
| P1 | RPD value not applicable for sample concentrations less than 5 times the reporting limit. |
| T8 | Sample(s) received past/too close to holding time expiration. |

1 Cp | 2 Tc | 3 Ss | 4 Cn | 5 Sr | 6 Qc | 7 Gl | 8 Al | 9 Sc

ESC Lab Sciences is the only environmental laboratory accredited/certified to support your work nationwide from one location. One phone call, one point of contact, one laboratory. No other lab is as accessible or prepared to handle your needs throughout the country. Our capacity and capability from our single location laboratory is comparable to the collective totals of the network laboratories in our industry. The most significant benefit to our "one location" design is the design of our laboratory campus. The model is conducive to accelerated productivity, decreasing turn-around time, and preventing cross contamination, thus protecting sample integrity. Our focus on premium quality and prompt service allows us to be **YOUR LAB OF CHOICE.**
* Not all certifications held by the laboratory are applicable to the results reported in the attached report.

## State Accreditations

| | |
|---|---|
| Alabama | 40660 |
| Alaska | UST-080 |
| Arizona | AZ0612 |
| Arkansas | 88-0469 |
| California | 01157CA |
| Colorado | TN00003 |
| Conneticut | PH-0197 |
| Florida | E87487 |
| Georgia | NELAP |
| Georgia [1] | 923 |
| Idaho | TN00003 |
| Illinois | 200008 |
| Indiana | C-TN-01 |
| Iowa | 364 |
| Kansas | E-10277 |
| Kentucky [1] | 90010 |
| Kentucky [2] | 16 |
| Louisiana | AI30792 |
| Maine | TN0002 |
| Maryland | 324 |
| Massachusetts | M-TN003 |
| Michigan | 9958 |
| Minnesota | 047-999-395 |
| Mississippi | TN00003 |
| Missouri | 340 |
| Montana | CERT0086 |
| Nebraska | NE-OS-15-05 |
| Nevada | TN-03-2002-34 |
| New Hampshire | 2975 |
| New Jersey–NELAP | TN002 |
| New Mexico | TN00003 |
| New York | 11742 |
| North Carolina | Env375 |
| North Carolina [1] | DW21704 |
| North Carolina [2] | 41 |
| North Dakota | R-140 |
| Ohio–VAP | CL0069 |
| Oklahoma | 9915 |
| Oregon | TN200002 |
| Pennsylvania | 68-02979 |
| Rhode Island | 221 |
| South Carolina | 84004 |
| South Dakota | n/a |
| Tennessee [1,4] | 2006 |
| Texas | T 104704245-07-TX |
| Texas [5] | LAB0152 |
| Utah | 6157585858 |
| Vermont | VT2006 |
| Virginia | 109 |
| Washington | C1915 |
| West Virginia | 233 |
| Wisconsin | 9980939910 |
| Wyoming | A2LA |

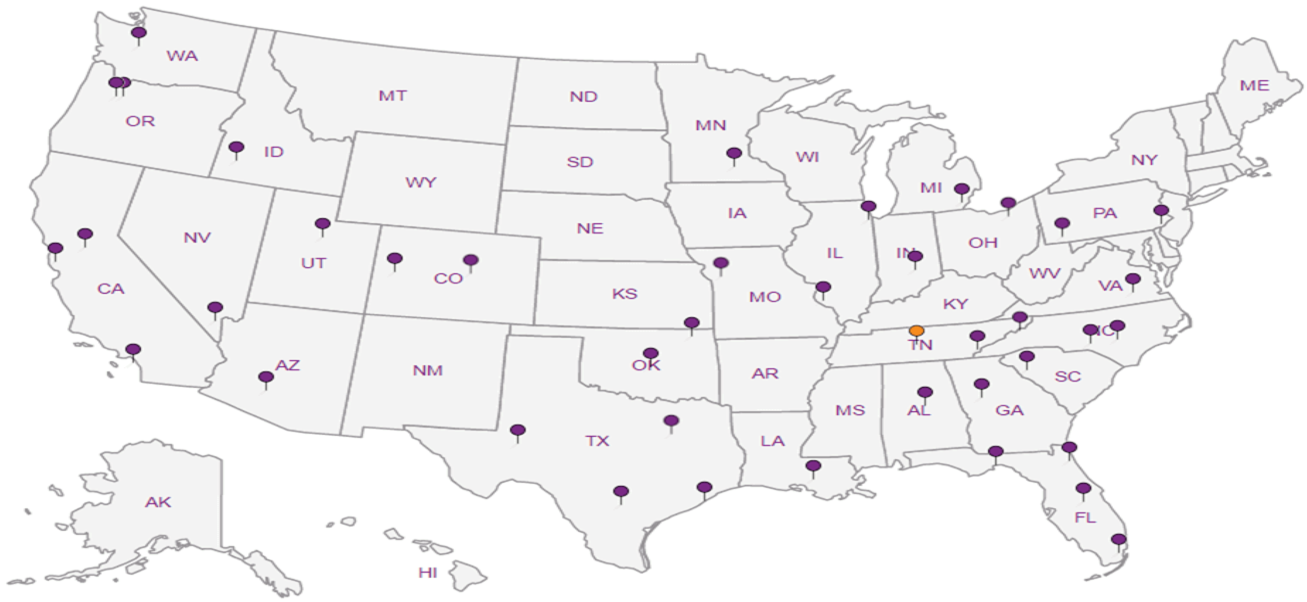
## Third Party & Federal Accreditations

| | |
|---|---|
| A2LA – ISO 17025 | 1461.01 |
| A2LA – ISO 17025 [5] | 1461.02 |
| Canada | 1461.01 |
| EPA–Crypto | TN00003 |
| AIHA-LAP,LLC | 100789 |
| DOD | 1461.01 |
| USDA | S-67674 |

1. Drinking Water 2. Underground Storage Tanks 3. Aquatic Toxicity 4. Chemical/Microbiological 5. Mold n/a Accreditation not applicable

## Our Locations

ESC Lab Sciences has sixty-four client support centers that provide sample pickup and/or the delivery of sampling supplies. If you would like assistance from one of our support offices, please contact our main office. **ESC Lab Sciences performs all testing at our central laboratory.**



Chain of Custody Page 1 of 1

ESC LAB SCIENCES

12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859

Company Name/Address:
**GES, Inc - Sunoco**
440 Creamery Way, Suite 500
Exton, PA 19341

Billing Information:
Accounts Payable
440 Creamery Way, Suite 500
Exton, PA 19341

Report to: Holly Smoker

Email To: hsmoker@gesonline.com

Project Description: Pre-Construction Sampling

City/State Collected: Williamsburg, PA

Phone: 610-458-1077
Fax: NA

Client Project #: NA

Lab Project #: SUNGES-GRILLO

Collected by (print): Jacob Gonzalez

Site/Facility ID #: ME2

P.O. #: NA

Collected by (signature): [signature]

Immediately Packed on Ice N ___ Y ✓

Rush? (Lab MUST Be Notified)
___ Same Day ......... 200%
X Next Day ......... 100%
___ Two Day ......... 50%
___ Three Day ......... 25%

Date Results Needed: 24 hr TAT
Email? ___ No ✓ Yes
FAX? ___ No ___ Yes

Analysis / Container / Preservative:
- **pH,SPCON,TDS,TURB* 250mlHDPE-NoPres
- ALK, Br, Cl, SO4 250mlHDPE-NoPres
- Total Metals, Hardness 250mlHDPE-HNO3 (2 / ✓)
- RSK175 + Propane 40mlAmb-HCl
- TSS 1L-HDPE NoPres
- V8260BTEX 40mlAmb-HCl

L# 925915
C146
Acctnum: SUNGES
Template: T114657
Prelogin: P564159
TSR: Mark Beasley
Cooler:
Shipped Via: Fed Ex

| Sample ID | Comp/Grab | Matrix * | Depth | Date | Time | No. of Cntrs | **pH,SPCON,TDS,TURB | ALK, Br, Cl, SO4 | Total Metals, Hardness | RSK175 + Propane | TSS | V8260BTEX | | | Rem./Contaminant | Sample # (lab only) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 07312017-GW-02 | Grab | DW | — | 7/31/17 | 1415 | 8 | X | X | X | X | X | X | | | | 01 |

* Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other ________

Remarks: **Metals = Ba,Ca,Fe,K,Mg,Mn,Na. Project #: 0204728 -06-160-xx Org 1402**

pH ______ Temp ______
Flow ______ Other ______

Samples returned via: ☐ UPS ☒ FedEx ☐ Courier ☐ ______

Hold #

Condition: (lab use only) [initials]

| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) |
|---|---|---|---|
| [signature] | 7/31/17 | 1730 | FedEx 7/31/17 1730 |
| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) |
| Relinquished by: (Signature) | Date: | Time: | Received for lab by: (Signature) [signature] |

Temp: 1.5 °C Bottles Received: 4 (?)

Date: 8/1/17 Time: 8:45

COC Seal Intact: ✓ Y ___ N ___ NA

pH Checked: NCF:

# ESC LAB SCIENCES
## Cooler Receipt Form

| | | |
|---|---|---|
| Client: SWGES | SDG# | 925915 |
| Cooler Received/Opened On: 8/ /17 | Temperature: | 1.5 |
| Received by : Reagan Johnson | | |
| Signature: Reagan Johnson | | |

| Receipt Check List | NP | Yes | No |
|---|---|---|---|
| COC Seal Present / Intact? | | ✓ | |
| COC Signed / Accurate? | | ✓ | |
| Bottles arrive intact? | | ✓ | |
| Correct bottles used? | | ✓ | |
| Sufficient volume sent? | | ✓ | |
| If Applicable | | | |
| VOA Zero headspace? | | ✓ | |
| Preservation Correct / Checked? | | ✓ | |

# Attachment 3

# Annular and Formation Capacity Calculations

# HORIZONTAL DIRECTIONAL CONCEPTUAL DRILL DESIGN

**PROJECT:** Sunoco Pipeline, L.P.
Mariner East Pipeline
Blair County, Pennsylvania

**CROSSING:** **LOWER PINEY CREEK HDD #S2-0142**
**20-INCH STEEL PIPE**

**ISSUE:** **APC/FPC DESIGN**

Contents:

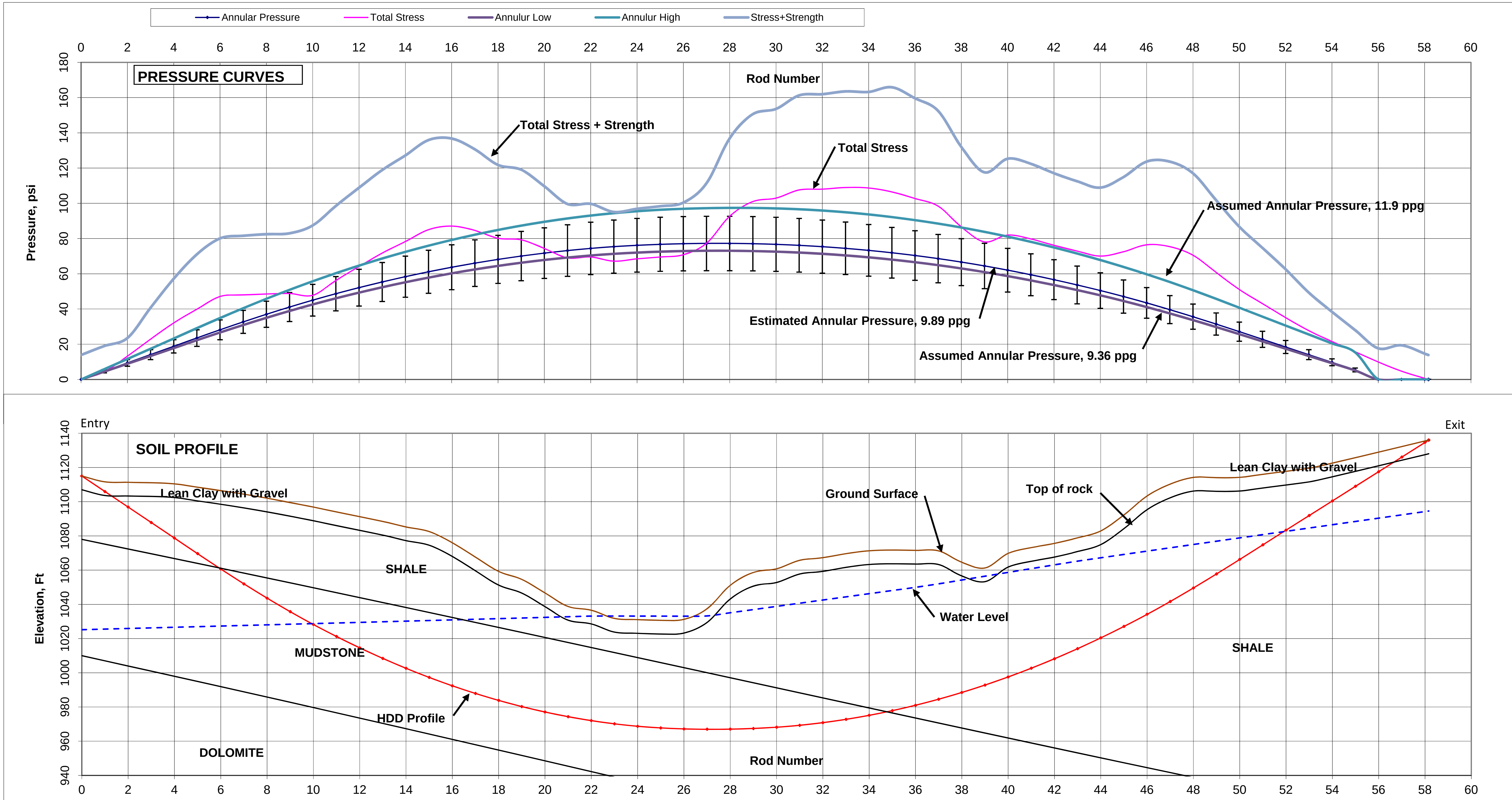

| | |
|---|---|
| | Figure 1 - Annular Pressure and Formation Pressure Capacity Curves |
| | Table 1 - Design Summary, Assumptions, Conditions |
| | Table 2 - Design Drill Path Calculation |
| | Table 3 - Estimated Annular Pressure Curve Example Calculation |
| | Table 4 - Estimated Formation Pressure Curve Example Calculation |
| | |
| | |
| | |
| | |
| | |


Prepared For: Sunoco Logistics Partners L.P.
525 Fritztown Road
Sinking Spring, PA 19608
855-430-4491


Prepared By: Directional Project Support
33311 Lois Lane, Suite A
Magnolia, Texas 77354
281.259.7819 (O) 617.510.8090 (C)
B. Dorwart


Project No: 0
Print Date: 19-Feb-2018

| Revision | ID | DESCRIPTION | BY |
|---|---|---|---|
| 10/22/2017 | 0 | APC/FPC Design | BCD |
| 2/19/2018 | 1 | Revise APC for New Drill Path | BCD |
| | | | |
| | | | |




**Notes:**
1. Geology is interpreted from project data
2. Ground surface data obtained from project survey data
3. Subsurface data from Geotechnical Report, Properties are interpreted from field and laboratory data as presented in Table 3.

**Basis of annulur pressure calculations**

| | |
|---|---|
| 12.31 in | Pilot Hole Diameter |
| 74.0 pcf | Unit Weight Drill Fluid |
| 300 gal/min | Pump Rate |
| 6.63 in | Drill Rod Diameter |
| 31 | Ft per rod |
| 20% | for APC curve |

Print Date ; 2/19/2018 9:08

**ISSUED: APC/FPC DESIGN**

Sunoco Pipeline, L.P.
Mariner East Pipeline
Blair County, Pennsylvania

**ANNULAR PRESSURE AND FORMATION PRESSURE CURVES LOWER PINEY CREEK HDD #S2-0142**

33311 Lois Lane, Suite A
Magnolia, Texas 77354
59.7819 (O) 617.510.80

Revision 1

**FIGURE 1**

**TABLE 1**
**DESIGN SUMMARY, ASSUMPTIONS, CONDITIONS**
**Sunoco Pipeline, L.P.**
**Mariner East Pipeline**
**Blair County, Pennsylvania**

**LOWER PINEY CREEK HDD #S2-0142**
**20-INCH STEEL PIPE**

| Item | Comment/Exception/Assumption |
|---|---|
| 1 | PROJECT DATA AND SUMMARY: Project data used for this submittal included two test borings. Total stress is insufficient to contain drill fluid hence an additional assessment using strength has also been used to assess the risk of drill fluid loss. Recognize that total stress is a conservative approach to confining pressure. Expect leakage as the dominate cause for lost drill fluid. Recommend as a minimum to walk the slopes to the sides of the creek during drilling to look for drill fluid. Contractor may elect to drill deeper to mitigate the risk of fluid loss however drilling deeper will not necessarally mitigate leakage. Recommend to monitor for drill fluid loss during the pilot bore and seal found leakage zones when encountered and before moving the pilot forward. |
| 2 | DRILL FLUID LOSS DURING CONSTRUCTION: Drill fluid loss during construction typically occurs as a result of one or a combination of the following: LEAKAGE, HYDRAULIC JACKING, HYDRAULIC FRACTURING. In all cases, the drill fluid finds an alternative path to the design drill path that requires a lower pressure to move the drill fluid. Drill fluid pressure at any point along a drill path is the elevation and dynamic head. The elevation head pressure is the difference in elevation between the entry pit drill fluid elevation and the measurement elevation times the weight of the drill fluid in the annular space. The dynamic head is the pressure required to move the drill fluid from the measurement location to the drill entry location when drilling is underway. The dynamic pressure required to make the drill fluid flow must be added to the elevation pressure head. Leakage occurs when there is an open pathway that intersects the drill path. Hydraulic jacking occurs when there are cracks in the formation such as rock joints or relatively high permeability zones contained within a relatively low permeability zone into which the drill fluid can flow and exert hydraulic pressure because of the confinement. When the drill fluid pressure exceeds the weight or force restraining the materials on the sides of the crack or higher permeability zone, the confining material will be hydraulically jacked further open resulting in an enlarged opening with more fluid volume capacity and eventually, the possibility of a new flow path for the fluid. Hydraulic fracturing occurs when the drill fluid pressure exceeds the static stress state in the formation plus the strength of the formation material. The result is a fracturing of the formation providing access for the drill fluid to a path that will continue to grow until the drill fluid pressure is reduced or the formation strength increases. Note that hydraulic jacking and fracturing often build pressure in the formation such that during drill rod changes, the drill fluid discharges from the decoupled down hole drill rods until the built up pressure in the formation is reduced. Drill fluid 'loss' during the drilling advance is the source of this return fluid. Continuation of this situation can result in fluid release to the surface, into structures, or movement of adjacent structures such as buildings, highways, and bridges. |

| Item | Comment/Exception/Assumption |
|---|---|
| 3 | CALCULATION OF ANNULAR PRESSURE: Drill fluids are Non-Newtonian fluids and must be modeled with specific fluid properties. Annular Pressure is based on assumptions for drill fluid rheological properties that may be expected in the field. As the field data, and the properties of various bentonitic products can vary significantly, error bars have been assigned to the estimated results to represent these unknowns between assumptions and the actual products and blends provided by the contractor. These assumptions should be confirmed in the field during construction as the changes will also change the Annular Pressure curve. Field values of drill fluid should be expected to change as different subsurface materials may require different drill fluid properties. Annular pressure has been calculated by two independent methods: METHOD A is based on the API-13D method using a Power Law to model the Dynamic pressure of a visco-plastic fluid; METHOD B uses a hydraulic model for modeling the Dynamic Pressure as a viscous flow in an annulus and is described in the HDD Good Practices Guidelines; a book available through the NASTT. Both methods are accepted in the industry. The annular pressure curves shown in Figure 1 plot the API-13D data by drill rod along the drill path. Three annular pressure curves are shown on Figure 1 representing three different drill fluid densities that range the possible field conditions that may occur: Assumed estimate of reasonable drill fluid properties, Highest reasonable drill fluid properties, Lowest reasonable drill fluid properties. The "Assumed estimate" data include a 20% error bar on each point representing the accuracy of the data with regard to the ability to predict the actual pressures. The 20% error bar is based on experience with field measurements of annular pressure vs predictions. This assessment does not offer a risk of fluid loss by leakage through natural or manmade preferred pathways such as rock joints, adjacent utility installations, and adjacent foundation systems. |
| 4 | CALCULATION OF FORMATION PRESSURE: The Formation Pressure capacity may be approximated by using one or more of four alternative calculation methods: Total Stress (used for Rock and conservatively for dense soils, Cavity Expansion (Delft Equation) (used for medium dense granular and soft to stiff cohesive soils), Total Stress plus Strength (used for Cohesive materials), and the Queens Equation (which is used for very soft or loose cohesive or granular soils). The Total Stress Method is based strictly on the dead weight of the overlying material above the drill path thus excluding any potential strength that the formation material may have. This method is considered conservative but is considered a reasonable approximation for rock. Note that in areas of high topographic relief and where the drill path approaches within about 5 times the depth below the entry to a topographic surface, then the total stress must be adjusted for both magnitude and direction as the pressure vector is no longer vertical. The cavity expansion, Stress plus Strength, and Queens methods adds the strength of the formation material to the total stress. These methods are considered more realistic however these equations require significant assumptions regarding input parameters that are not often, if ever, substantiated by field data. These three relations are not generally appropriate for rock. The sensitivity of the input data assumptions for these three approaches have been shown to be significant to the results. Significant experience is often required in determination of these input values. Thus these methods may not be conservative and can lead to overly optimistic results leading to a false impression of an unreasonably high Formation Pressure Capacity. |

| Item | Comment/Exception/Assumption |
|---|---|
| 5 | TECHNICAL APPROACH DRILL FLUID MANAGEMENT: Table 2 provides the proposed drill path for the interpreted geologic profile assumed for the crossing. Table 3 provides the calculated Annular Pressure and Table 4 the calculated Formation Pressure Capacity. Calculations are provided for each drill rod along the design drill path. The results are summarized on Figure 1. Assessment is based on comparison of the Formation Pressure Capacity to the Annular Pressure. This relation provides a tool to assess the risk of hydraulic fracturing of a formation or hydraulic jacking along pathways within a formation caused by Annular Pressure exceeding the Formation Capacity Pressure. When the Annular Pressure is higher than the Formation Pressure Capacity, then the risk of drill fluid loss by jacking or hydrofracturing is considered high for the design drill path and drill direction. Mitigation considerations may include: reversing the drill direction, adjusting the depth of the drill path in problem areas, or reduction of drill fluid pressure by methods such as reduction of drill fluid weight, use of drill foam, reduction in the elevation head pressure which may be accomplished by pumping the drill fluid elevation in the hole down to a lower elevation. |
| 6 | **Limitations:** These calculations are for HDD planning purposes only. It should be expected that the drill process will generate new data that may require adjustments to the assumed conditions used for the basis of these calculations. Adjustments to the assumed subsurface conditions may require corresponding adjustments to the various HDD drill parameters or tools to optimize production. Typical parameters that are adjusted include: drill fluid pump rate, penetration rate, drill fluid properties, along with bit dimensions and types or other tooling. |

# PATH DESIGN CALCULATIONS

| | | | |
|---|---|---|---|
| Entry Station | 17+66.35 | FT | |
| Exit Station | 0+00.00 | FT | |

**Entry and Exit Design Coordinates & Elevations (Ft) (Note 2)**

| | East | North | Elevation |
|---|---|---|---|
| Entry | 1825373.8990 | 400817.4350 | 1,115.00 ft |
| Horizontal Curve PI | 1824527.8605 | 401070.8460 | |
| Exit | 1823681.8220 | 401324.2570 | 1,136.00 ft |
| Depth to Mudline | 87.40 ft | Clearance Depth = | 60.60 ft |
| Measured Plan Length at ties = | 1766.3502 ft | | |
| Coordinate Length = | 1766.3502 ft | | |
| | OK-HORIZONTAL CURVE | | |

| | |
|---|---|
| Water Surface Elev. | 1030.00 ft |
| Mudline Elev. | 1027.60 ft |
| Lowest centerline Elev. | 967.00 ft |

**SUMMARY HORIZONTAL CURVE CALCULATIONS**

| | Start | | | End | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Station | Easting | Northing | Station | Easting | Northing | Azimuth | Length | Radius | Angle |
| Tangent | 17+66.35 | 1825373.8990 | 400817.4350 | 8+83.18 | 1824527.8605 | 401070.8460 | E 163.32565 N | 883.18 | | |
| Curve | 8+83.18 | 1824527.8605 | 401070.8460 | 8+83.18 | 1824527.8605 | 401070.8460 | E 163.32565 N | 0.00 | 0.00 | 0.000 deg. |
| Tangent | 8+83.18 | 1824527.8605 | 401070.8460 | +.00 | 1823681.8220 | 401324.2570 | E 163.32565 N | 883.18 | | |

## HORIZONTAL PLAN CALCULATIONS (FT)

| *Entry Tangent Segment* | | *Horizontal Curve Segment* | | *Exit Tangent Segment* | | |
|---|---|---|---|---|---|---|
| Plan Length, ft. | 883.18 | Input Radius, ft. | 0.00 | Plan Length, ft. | 883.18 | |
| Entry Azimuth, deg.[5] | E 163.32565 N | Curve, deg | 0.000 deg. | Exit Azimuth, deg.[5] | E 163.32565 N | |
| Entry Azimuth, rad.[5] | 2.85057 | Curve, rad | 0.00000 | Exit Azimuth, rad.[5] | 2.85057 | |
| | | **Calculate PTH** | | **Calculate Exit** | | |
| **Calculate PCH** | | Chord Length, ft. | 0.00 | Easting | 1823681.8220 | ***Check*** |
| PCH Easting | 1824527.8605 | Arc Length, ft. | 0.00 | Northing | 401324.2570 | ***Delta*** |
| PCH Northing | 401070.8460 | Chord Azimuth, deg | 163.3256 | | | **0.0000** |
| | | PI Easting = | 1824860.4903 | | | **0.0000** |
| | | PI Northing = | 400971.2145 | | | **OK CALC** |
| | | PTH Easting = | 1824527.8605 | | | |
| | | PTH Northing = | 401070.8460 | | | **Exit Station** |
| | | | | | | **+.00** |
| Cum Plan Length | 883.18 | Cum Plan Length | 883.18 | Cum Plan Length | 1766.350224 | **OK STA** |

## Pull Geometry

| Pipe Entry | EXIT | Enter the pipe entry location into the hole: Entry/Exit | | | | | |
|---|---|---|---|---|---|---|---|
| | **Elevations** | | **Vertical Angle, (-) = Clockwise** | | | **Path** | **Curve** |
| **Segment** | **Start** | **End** | **Start** | **End** | **Δ Angle** | **Length** | **Radius** |
| Entry Tangent | 1136.00 ft | 1059.97 ft | 16.00 deg | 16.00 deg | 0.00 deg | 275.83 ft | 0.00 ft |
| Entry Curve | 1059.97 ft | 967.00 ft | 16.00 deg | 0.00 deg | -16.00 deg | 670.21 ft | 2400.00 ft |
| Bottom Tangent | 967.00 ft | 967.00 ft | 0.00 deg | 0.00 deg | 0.00 deg | 26.80 ft | 0.00 ft |
| Exit Curve | 967.00 ft | 1063.13 ft | 0.00 deg | -17.00 deg | -17.00 deg | 652.75 ft | 2200.00 ft |
| Exit Tangent | 1063.13 ft | 1115.00 ft | -17.00 deg | -17.00 deg | 0.00 deg | 177.41 ft | 0.00 ft |
| | | | | | Total Check = | 1803.00 ft | OK |

**Compound Curve Assessment**

| | Vert. Plan | Horiz. Plan | |
|---|---|---|---|
| Entry | 812.88 | 883.18 | No, Horiz > Entry V(Tan+Curve) |
| Exit | 926.67 | 883.18 | Yes, Horiz < Exit V(Tan+Curve |

## VERTICLE PATH DESIGN CALCULATIONS (FT)

| *Entry Tangent Segment 1* | | *Entry Vert. Curve Segment 2* | | *Middle Tangent Segment 3* | | *Exit Vert. Curve Segment 4* | | *Exit Tangent Segment 5* | |
|---|---|---|---|---|---|---|---|---|---|
| Entry Angle | -17.000 deg. | Vertical Radius | 2200.00 | Rod Length | 26.80079 | Radius | 2400.00 | Exit Elevation | 1136.00 |
| Entry Angle, rad. | -0.2967 rad | Vert. Curve, deg. | 17.000 deg. | Inclined Bottom Tan | NO | Design Exit Angle | 16.000 deg. | | |
| Rod/Path Length | 177.41 | Vert. Curve, rad. | 0.2967 rad | | | Vert. Curve, rad. | 0.2793 rad | | |
| **Calculate Vertical PCV** | | **Calculate Vertical PTV** | | **Calculate Vertical PCV** | | **Calculate Vertical PTV** | | **Calculate Exit** | |
| Plan Length | 169.66 | Plan Length | 643.22 | Plan Length | 26.80078914 | Vert. Curve, deg | 16.000 deg. | Plan Length | 265.14 |
| Path Length | 177.41 | Arc Path Length | 652.75 | Path Length | 26.80 | Vert. Curve, rad. | 0.27925268 | Path Length | 275.83 |
| Tangent Depth | -51.87 | Curve Vert Depth | -96.13 | End Elevation | 967.00 | Plan Length | 661.53 | Elevation | 1136.00 |
| End Elevation | 1063.13 | End Elevation | 967.00 | Rise/drop | 0.00 | Path Arc Length | 670.21 | Rise/drop | 76.03 |
| | | Lowest Elevation | 967.00 | | | Lowest Elevation | 967.00 | | |
| | | End Vert Angle | 0.000 deg. | End Vert Angle | 0.000 deg. | Elevation | 1059.97 | | |
| | | End Vert Angle, rad | 0.0000 rad | End Vert Angle, rad | 0.0000 rad | Curve Vert Depth | 92.97 | ***Prop. Plan Length*** | ***1766.350224*** |

**SUMMARY VERTICLE CURVE CALCULATIONS**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Start Station | 17+66.35 | Start Station | 15+96.69 | Start Station | 9+53.47 | Start Station | 9+26.67 | Start Station | 2+65.14 |
| PVC Station | 15+96.69 | PTV Station | 9+53.47 | PCV Station | 9+26.67 | PTV Station | 2+65.14 | Exit Station | +.000 |
| Cum Plan Length | 169.66 | Cum Plan Length | 812.88 | Cum Plan Length | 839.68 ft | Cum Plan Length | 1501.21 | Cum Plan Length | 1766.350224 |
| Cum Path Length | 177.41 | Cum Path Length | 830.17 | Cum Path Length | 856.97 ft | Cum Path Length | 1527.17 | Cum Path Length | 1802.999534 |
| Cum Depth | -51.87 | Cum Depth | -148.00 | Cum Depth | -148.00 ft | Cum Depth | -55.03 | Cum Depth | 21.00 |

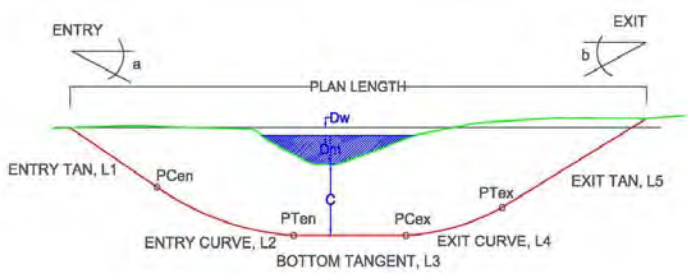
**Stationing Check**
**OK STATIONING**

**Plan Length Check**
**OK CALCULATION**

### Summary of Drill Calculations

| | |
|---|---|
| **Entry to Exit Elevation Change =** | **21.00 ft** |
| **Minimum Design Elevation =** | **967.00 ft** |
| **Invert Depth below exit =** | **169.00 ft** |
| **Invert Depth below entry =** | **148.00 ft** |
| **Path Length =** | **1,803.00 ft** |
| **Plan Length =** | **1,766.35 ft** |
| **Minimum Plan Length (No Tangent) =** | **1,739.55 ft** |
| **Entry Angle =** | **-17.00 deg** |
| **Exit Angle =** | **16.00 deg** |
| **Compound Curve at Entry =** | **NO** |
| **Compound Curve at Exit =** | **0 ft** |

**NOTES:**
1. Sign convention for angles - positive (+) angles are counterclockwise. Due East is defined as 0 degrees.
2. Coordinates are in feet and reference NAD 83 Pennsylvania South State Plane
3. Elevations are in feet and reference NAVD 88.
4. All calculation locations represent the center of the drill hole.




Indicates inputs
Indicates status on internal design checks

**ISSUE:** **APC/FPC DESIGN**

Sunoco Pipeline, L.P.
Mariner East Pipeline
Blair County, Pennsylvania

**TABLE 2**
**DESIGN DRILL PATH CALCULATION**
**LOWER PINEY CREEK HDD #S2-0142**
**20-INCH STEEL PIPE**

Directional Project Support
33311 Lois Lane, Suite A
Magnolia, Texas 77354

Revision 1 10/22/2017

C:\Users\bdorwart\Documents\DPS\Pennsylvania Pipeline\APC Designs\Spread 3\S2-0142 Lower Piney Ck\S2-0142_R2-19-18|(S2-0142_20_ 10-22-17_APC_R1.xlsx)T4 Formation Pressure

**TABLE 3**
**ESTIMATED ANNULAR PRESSURE CURVE (APC) EXAMPLE CALCULATION**
**Sunoco Pipeline, L.P.**
**Mariner East Pipeline**
**Blair County, Pennsylvania**

**LOWER PINEY CREEK HDD #S2-0142**
**20-INCH STEEL PIPE**
**INPUT**
***1. Drill path data***

| | Measured Distance | Elevations | Angles | Lengths | Angle Change | |
|---|---|---|---|---|---|---|
| Drill Entry | 0.000 ft | 1115 | -17 | Entry to PC | 177.413 ft | |
| PC | 177.413 ft | | | PC to PT | 652.753 ft | -0.026 deg/ft |
| PT | 830.166 ft | | | Invert Tangent | 26.801 ft | |
| PC | 856.967 ft | | | PC to PT | 670.206 ft | 0.024 deg/ft |
| PT | 1527.173 ft | | | PT to Exit | 275.826 ft | |
| Drill Exit | **1803.000 ft** | 1136.00 ft | 16 | | **1803.000 ft** | |
| | | | | | **Length Ck** | **OK** |

***2. Drill Fluid Hydraulic Assumptions***

| | Assumed | | Low | | High | |
|---|---|---|---|---|---|---|
| Density, $\gamma_f$ = | 74 | 9.89 lb/gal | 70 | 9.36 lb/gal | 89 | 11.90 lb/gal |
| Dynamic annulus pressure $P_d$ = | 0.0014 psi/ft | | 0.0013 psi/ft | | 0.0068 psi/ft | |
| Drill fluid viscosity, $\mu_p$ = | 2 cp | | 6 cp | | 13 cp | |
| Yield point of drill fluid, YP = | 41 | | 19 | | 5 | |

***3. Drill Data Assumptions***

| | | | |
|---|---|---|---|
| **Assumed Drill Size:** | **DD660** | | |
| Avg Rod length = | 31.0 feet | Max Rig Pump = | 1200 gpm |
| Diameter of hole, $D_h$ = | 12.31125 | Number of drill rods = | 58 |
| Drill Rod Tube Diameter, $D_r$ = | 6.625 in | Estimated annular pilot uphole drill fluid velocity, $V_{ha}$ = | 68.29 ft/min |
| Drilling Pump rate, gpm = | 300 gal/min | | |

***4. Calculate Annular Pressure, P***

**Method A - (API RP) 13D**

$P_A = [\gamma_f\,(Y_{entry} - Y)/144] + (P_d)(MD)$

**Method B - HDD Good Practices Cavity Expansion Annular Pressure**

$P_B = [\gamma_f * (Y_{entry} - Y)/144] + MD*[\mu_p*(V_{ha}/60)/(1000*(D_h-D_r)^2) + YP/[200*(D_h-D_r)]$

Start Station: 0+00.00 | -1

| Drill Path | | | Assumed Return Density | | Low Return Density | | High Return Density | |
|---|---|---|---|---|---|---|---|---|
| | | | Density, $\gamma_{fE}$ = 74 | | Density, $\gamma_{fL}$ = 70 | | Density, $\gamma_{fH}$ = 89 | |
| Rod Measured Distance MD | **Station X** | **Elevation Y** | **Annular Fluid Pressure $P_A$** | **Annular Fluid Pressure $P_B$** | **Annular Fluid Pressure $P_A$** | **Annular Fluid Pressure $P_B$** | **Annular Fluid Pressure $P_A$** | **Annular Fluid Pressure $P_B$** |
| **ft** | **ft** | **ft** | **psi** | **psi** | **psi** | **psi** | **psi** | **psi** |
| 0.00 | 0+00.00 | 1,115.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 31.00 | -0+29.65 | 1,105.94 | 4.70 | 5.78 | 4.45 | 4.93 | 5.81 | 5.75 |
| 62.00 | -0+59.29 | 1,096.87 | 9.40 | 11.55 | 8.89 | 9.86 | 11.63 | 11.50 |
| 93.00 | -0+88.94 | 1,087.81 | 14.10 | 17.33 | 13.34 | 14.79 | 17.44 | 17.26 |
| 124.00 | -1+18.58 | 1,078.75 | 18.80 | 23.11 | 17.78 | 19.72 | 23.26 | 23.01 |
| 155.00 | -1+48.23 | 1,069.68 | 23.50 | 28.89 | 22.23 | 24.65 | 29.07 | 28.76 |
| 186.00 | -1+77.89 | 1,060.68 | 28.17 | 34.63 | 26.65 | 29.55 | 34.85 | 34.48 |
| 217.00 | -2+07.63 | 1,051.94 | 32.70 | 40.25 | 30.93 | 34.32 | 40.46 | 40.03 |
| 248.00 | -2+37.50 | 1,043.62 | 37.02 | 45.64 | 35.02 | 38.89 | 45.82 | 45.32 |
| 279.00 | -2+67.47 | 1,035.72 | 41.12 | 50.82 | 38.90 | 43.25 | 50.91 | 50.35 |
| 310.00 | -2+97.56 | 1,028.25 | 45.00 | 55.78 | 42.57 | 47.41 | 55.74 | 55.12 |
| 341.00 | -3+27.75 | 1,021.20 | 48.66 | 60.52 | 46.03 | 51.36 | 60.31 | 59.63 |

| Drill Path | | | Assumed Return Density | | Low Return Density | | High Return Density | |
|---|---|---|---|---|---|---|---|---|
| | | | Density, $\gamma_{fE}$ = | 74 | Density, $\gamma_{fL}$ = | 70 | Density, $\gamma_{fH}$ = | 89 |
| Rod Measured Distance MD | **Station X** | **Elevation Y** | **Annular Fluid Pressure $P_A$** | **Annular Fluid Pressure $P_B$** | **Annular Fluid Pressure $P_A$** | **Annular Fluid Pressure $P_B$** | **Annular Fluid Pressure $P_A$** | **Annular Fluid Pressure $P_B$** |
| **ft** | **ft** | **ft** | **psi** | **psi** | **psi** | **psi** | **psi** | **psi** |
| 372.00 | -3+58.03 | 1,014.58 | 52.11 | 65.04 | 49.29 | 55.11 | 64.61 | 63.87 |
| 403.00 | -3+88.41 | 1,008.38 | 55.33 | 69.35 | 52.35 | 58.64 | 68.66 | 67.85 |
| 434.00 | -4+18.86 | 1,002.61 | 58.34 | 73.43 | 55.19 | 61.97 | 72.43 | 71.57 |
| 465.00 | -4+49.40 | 997.28 | 61.12 | 77.29 | 57.82 | 65.09 | 75.94 | 75.02 |
| 496.00 | -4+80.01 | 992.37 | 63.69 | 80.93 | 60.25 | 68.00 | 79.19 | 78.20 |
| 527.00 | -5+10.69 | 987.90 | 66.03 | 84.35 | 62.46 | 70.70 | 82.17 | 81.12 |
| 558.00 | -5+41.42 | 983.85 | 68.15 | 87.55 | 64.47 | 73.19 | 84.88 | 83.76 |
| 589.00 | -5+72.21 | 980.25 | 70.04 | 90.52 | 66.26 | 75.46 | 87.32 | 86.14 |
| 620.00 | -6+03.05 | 977.07 | 71.72 | 93.28 | 67.84 | 77.53 | 89.49 | 88.26 |
| 651.00 | -6+33.93 | 974.33 | 73.17 | 95.80 | 69.22 | 79.39 | 91.40 | 90.10 |
| 682.00 | -6+64.84 | 972.03 | 74.39 | 98.11 | 70.37 | 81.03 | 93.04 | 91.67 |
| 713.00 | -6+95.78 | 970.16 | 75.39 | 100.19 | 71.32 | 82.46 | 94.40 | 92.98 |
| 744.00 | -7+26.75 | 968.73 | 76.17 | 102.04 | 72.06 | 83.68 | 95.50 | 94.02 |
| 775.00 | -7+57.74 | 967.73 | 76.73 | 103.67 | 72.58 | 84.69 | 96.33 | 94.78 |
| 806.00 | -7+88.73 | 967.17 | 77.05 | 105.08 | 72.89 | 85.49 | 96.89 | 95.28 |
| 837.00 | -8+19.73 | 967.00 | 77.18 | 106.29 | 73.02 | 86.09 | 97.20 | 95.53 |
| 868.00 | -8+50.73 | 967.07 | 77.19 | 107.37 | 73.02 | 86.58 | 97.37 | 95.64 |
| 899.00 | -8+81.73 | 967.42 | 77.05 | 108.31 | 72.89 | 86.94 | 97.37 | 95.58 |
| 930.00 | -9+12.72 | 968.16 | 76.71 | 109.05 | 72.57 | 87.10 | 97.12 | 95.27 |
| 961.00 | -9+43.70 | 969.30 | 76.17 | 109.59 | 72.06 | 87.07 | 96.63 | 94.71 |
| 992.00 | -9+74.66 | 970.85 | 75.42 | 109.91 | 71.35 | 86.85 | 95.89 | 93.91 |
| 1023.00 | -10+05.60 | 972.79 | 74.46 | 110.03 | 70.44 | 86.43 | 94.90 | 92.86 |
| 1054.00 | -10+36.51 | 975.13 | 73.30 | 109.95 | 69.34 | 85.81 | 93.66 | 91.56 |
| 1085.00 | -10+67.39 | 977.87 | 71.93 | 109.66 | 68.05 | 85.00 | 92.18 | 90.02 |
| 1116.00 | -10+98.23 | 981.01 | 70.36 | 109.17 | 66.56 | 84.00 | 90.45 | 88.23 |
| 1147.00 | -11+29.03 | 984.55 | 68.58 | 108.47 | 64.88 | 82.80 | 88.48 | 86.19 |
| 1178.00 | -11+59.78 | 988.49 | 66.60 | 107.56 | 63.01 | 81.42 | 86.26 | 83.91 |
| 1209.00 | -11+90.47 | 992.82 | 64.42 | 106.46 | 60.94 | 79.83 | 83.79 | 81.38 |
| 1240.00 | -12+21.11 | 997.55 | 62.03 | 105.15 | 58.68 | 78.06 | 81.08 | 78.61 |
| 1271.00 | -12+51.68 | 1,002.67 | 59.44 | 103.63 | 56.23 | 76.09 | 78.13 | 75.59 |
| 1302.00 | -12+82.19 | 1,008.19 | 56.64 | 101.92 | 53.59 | 73.93 | 74.93 | 72.33 |
| 1333.00 | -13+12.62 | 1,014.11 | 53.65 | 100.00 | 50.76 | 71.58 | 71.49 | 68.83 |
| 1364.00 | -13+42.97 | 1,020.41 | 50.45 | 97.88 | 47.73 | 69.04 | 67.80 | 65.08 |
| 1395.00 | -13+73.24 | 1,027.11 | 47.05 | 95.56 | 44.52 | 66.31 | 63.88 | 61.09 |
| 1426.00 | -14+03.42 | 1,034.19 | 43.45 | 93.04 | 41.11 | 63.39 | 59.71 | 56.87 |
| 1457.00 | -14+33.50 | 1,041.67 | 39.65 | 90.31 | 37.52 | 60.28 | 55.30 | 52.40 |
| 1488.00 | -14+63.49 | 1,049.53 | 35.65 | 87.39 | 33.73 | 56.98 | 50.65 | 47.69 |
| 1519.00 | -14+93.37 | 1,057.78 | 31.45 | 84.27 | 29.76 | 53.50 | 45.77 | 42.74 |
| 1550.00 | -15+23.18 | 1,066.28 | 27.13 | 81.03 | 25.67 | 49.89 | 40.73 | 37.64 |
| 1581.00 | -15+52.98 | 1,074.82 | 22.78 | 77.76 | 21.56 | 46.26 | 35.66 | 32.51 |
| 1612.00 | -15+82.78 | 1,083.37 | 18.43 | 74.49 | 17.45 | 42.63 | 30.59 | 27.38 |
| 1643.00 | -16+12.58 | 1,091.91 | 14.08 | 71.21 | 13.33 | 39.00 | 25.52 | 22.25 |
| 1674.00 | -16+42.38 | 1,100.46 | 9.73 | 67.94 | 9.22 | 35.37 | 20.45 | 17.12 |
| 1705.00 | -16+72.18 | 1,109.00 | 5.39 | 64.67 | 5.10 | 31.74 | 15.39 | 11.98 |
| 1736.00 | -17+01.98 | 1,117.55 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1767.00 | -17+31.78 | 1,126.09 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1798.00 | -17+61.58 | 1,134.63 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1803.00 | -17+66.38 | 1,136.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**TABLE 4**
**ESTIMATED FORMATION PRESSURE CURVE (FPC) EXAMPLE CALCULATION**
**Sunoco Pipeline, L.P.**
**Mariner East Pipeline**
**Blair County, Pennsylvania**

**LOWER PINEY CREEK HDD #S2-0142**
**20-INCH STEEL PIPE**
**INPUT**

***1. Drill path data from vertical path calculations***

| | Measured Distance | Elevations | Angles | Lengths | Angle Change | | |
|---|---|---|---|---|---|---|---|
| Entry | 0.000 ft | 1115 | -17 | Entry to PC | 177.413 ft | | |
| PC | 177.413 ft | | | PC to PT | 652.753 ft | -0.026 deg/ft | |
| PT | 830.166 ft | | 0 | Invert Tangent | 26.801 ft | | |
| PC | 856.967 ft | | | PC to PT | 670.206 ft | 0.024 deg/ft | |
| PT | 1527.173 ft | | | PT to Exit | 275.826 ft | | |
| Exit | **1803.000 ft** | 1136.00 ft | 16 | | **1803.000 ft** | **Length Ck** | **OK** |

***2. Drill Fluid Hydraulic Data for Estimated Drill Fluid***

| | | | | | |
|---|---|---|---|---|---|
| Dynamic annulus pressure = | 0.00135 psi/LF | | | | |
| Uphole Drill Fluid Density = | 74 | 9.9 lb/gal | | | |
| Drill fluid viscosity, cp = | 2 cp | | | | |
| Up hole drill fluid velocity, ft/sec = | 68.29 ft/sec | | | | 62.4 |
| Pump rate, gpm = | 300 gal/min | | **Radius** | | 2.1 |
| Diameter of hole $D_H$, in = | 12.31125 | | $R_H$ = | 6.156 in | 131.04 |
| Diameter of Drill Rod $D_R$, in = | 6.625 | | $R_R$ = | 3.313 in | |
| Yield point of drill fluid, lb/100 ft^2 = | 41.00 Lb/100FT^2 | | | | |

***3. Soil Profile Data***

**Technical approach to generate data as no testing available**

| Material Layer | Dry Density $\gamma$ (pcf) | Moisture Content % | Insitu Saturated Density (pcf) | Effective UW (pcf) | Phi, $\Phi$ | Undrained Cohesion c, psf | Poisson Ratio $\mu$ | Slow Shear Modulus, G psf | OCR Cohesive (Use 0 if non-cohessive) | Model Material Layer Description | Cohesive |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 110 | 15.0% | 126.5 | 47.60 pcf | 10 | 2000 | 0.3 | 67,613 | 1 | Lean Clay with Gravel | Y |
| 2 | 158 | 8.0% | 170.64 | 95.60 pcf | 38 | 0.01 | 0.2 | 187,500 | 1 | Shale | N |
| 3 | 140 | 12.0% | 156.8 | 77.60 pcf | 35 | 0.01 | 0.2 | 93,750 | 1 | Mudstone | N |
| 4 | 175 | 3.0% | 180.25 | 112.60 pcf | 75 | 0.01 | 0.25 | 840,000 | 1 | Dolomite | N |
| 5 | 165 | 4.0% | 171.6 | 102.60 pcf | 85 | 0.01 | 0.25 | 420,000 | 1 | Limestone | N |
| 6 | | | | | | | | 0 | | | |
| 7 | | | | | | | | 0 | | | |
| 8 | | | | | | | | 0 | | | |
| 9 | | | | | | | | 0 | | | |
| 10 | | | | | | | | 0 | | | |
| Water | 62.4 | | | 62.40 pcf | | | | | | | |

Dynamic Shear Velocity, $V_s = 61.4 * N_{60}^{1/2}$ Based on Seed and Idris approximation

Dynamic Shear Modulus, $G_{max} = (\gamma/g)*Vs^2$

g = acceleration of gravity = 32.2 $ft/s^2$

Extended Strain Shear Modulus G is typically between 5% and 20% of $G_{max}$

Select Reduction Factor, RF = 15% Ref 1

***4 Select Controlling Location and list properties (Based on inspection of Figure 1 plot***

| | | | | | |
|---|---|---|---|---|---|
| Joint = | 24 | Away Distance from Entry = | 726.75 ft | Depth of Cover = | 62.36 ft |

| Layers | ***Surface 1-2*** | ***Surface 2-3*** | ***Surface 3-4*** | ***Surface 4-5*** | ***Surface 5-6*** | ***Surface 6-7*** | ***Surface 7-8*** | ***Surface 8-9*** | ***Surface 9-10*** | **TOTAL** | Total CK |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil Type in Layer = | 1 | 2 | 3 | 4 | 5 | 5 | | | | | |
| Dry Density in Layer, $\gamma_d$ = | 110.00 pcf | 158.00 pcf | 140.00 pcf | 175.00 pcf | 165.00 pcf | 165.00 pcf | | | | | |
| Insitu Density in Layer, $\gamma_s$ = | 126.50 pcf | 170.64 pcf | 156.80 pcf | 180.25 pcf | 171.60 pcf | 171.60 pcf | | | | | |
| Effective Weight in Layer, $\gamma'_e$ = | 47.60 pcf | 95.60 pcf | 77.60 pcf | 112.60 pcf | 102.60 pcf | 102.60 pcf | | | | | |
| Total Layer Thickness over drill, $h_s$ = | 8.00 ft | 14.21 ft | 40.15 ft | 0.00 ft | 0.00 ft | 0.00 ft | | | | 62.36 ft | 62.36 ft |
| Saturated Thickness over drill, $h_{sat}$ = | 8.00 ft | 14.21 ft | 40.15 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 62.36 ft | |
| Dry Thickness over drill, $h_{dry}$ = | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | |
| Contribution Effective Stress, $\sigma'$ = | 512.80 psf | 1,538.36 psf | 3,790.10 psf | 0.00 psf | 0.00 psf | 0.00 psf | | | | | |
| Contribution Total Stress, $\sigma = h_s*\gamma_s$ | 1,139.69 psf | 2,425.22 psf | 6,295.42 psf | 0.00 psf | 0.00 psf | 0.00 psf | | | | | |
| Shear Modulus, G = | 67,613 psf | 187,500 psf | 93,750 psf | 840,000 psf | 420,000 psf | 420,000 psf | | | | | |

| | |
|---|---|
| Height of Water above Soil Surface, $h_w$ = | 2.05 ft |
| Total soil and water height above drill path, $H_T$ = | 64.41 ft |
| Total water height above drill path, $H_W$ = | 64.41 ft |

**Properties At Drill Depth for Selected Joint**

| | | |
|---|---|---|
| $R_H$ = | 0.51 ft | Radius of drill hole |
| $R_{max} = h_s/FS_D$ = | 41.57 ft | Maximum allowable radius of plastic zone = Height of soil above Drill Path ($h_s$) divided by Delft & Queens Equation $FS_D$ |
| | 3 | Soil Layer At Drill Depth |
| $G_w$ = | 93,750 psf | Large Strain Shear Modulus at drill depth |
| $S_u = c = q_u/2$ | 0 psf | Cohessive material: cohession c = unconfined compressive strength ($q_u$) divided by 2 |
| $\phi$ = | 35 deg | 0.6109 rad |
| $H_W$ = | 64.41 ft | Total water height above drill path |
| $FS_D$ = | 1.5 | Factor of Safety for Delft & Queens Equation soil type: Use 1.5 for Sand and 2 for Clay at Drill Depth - Apply to $R_{max}$ and $P_{max}$ |
| $\mu$ = | 0.2 | Poisson ration ( Granular Soil: Angle of internal friction of layer at drill path depth |
| OCR = | 1 | Over Consolidation Ratio |
| $K_o$ = | 0.250 | Coefficient of lateral earth pressure at rest. For OCR = 1 use relation $K_o = \mu/(1 - \mu)$; For OCR >1 use $K_o = (K_{o\,normally\ consolidated}) * OCR^{-1/2}$ |
| $\sigma_o$ = | 9,860 psf | Total Stress at drill depth, $\sigma = \gamma_d$(above water)*hdry + $\gamma_s$(saturated)*$h_{sat}$ |
| u = | 4,019 psf | Water pressure at drill depth, $u = \gamma_W * H_W$ |
| $\sigma'$ = | 5,841 psf | Effective Stress at drill depth, $\sigma' = \sigma - u$ |

**5. Method A - Total Stress Method (Conservative)**

Calculate Allowable Controlling Formation Pressure Capacity

$P_{max} = \sigma_o = \Sigma (h_s*\gamma_s) + h_w*\gamma_w$

| | | | |
|---|---|---|---|
| $P_{maxA}$ = | 9,860 psf | 68.47 psi | |
| | | 68.47 psi | Check Calculation |

**6. Method B - Total Stress Method + Local Formation Strength**

Calculate Allowable Controlling Formation Pressure Capacity

$P_{max} = \Sigma (h_s*\gamma_s) + h_w*\gamma_w + S$

| | | | |
|---|---|---|---|
| $P_{maxB}$ | 13,950 psf | 96.88 psi | |
| | | 96.88 psi | Check Calculation |

**Based on Mohr-Coulomb**

Strength = c + $\sigma'$ * tan($\phi$)

| | |
|---|---|
| 4,090 psf | 28.40 psi |

**7. Method C - Delft Equation for cavity expansion** **(Assumes drained properties)**

$P_{max} = \mu + [p'_f + c * \cot\phi] * \{[R_o/R_{pmax}]^2 + [(\sigma_o' * \sin\phi + c * \cos\phi)/G]\}^{-\sin\phi/(1+\sin\phi)} - c*\cot(\phi)$

| | | | | | | |
|---|---|---|---|---|---|---|
| $\text{Sin}(\phi)$ = | 0.57357644 | | A = | 9191.690611 | $A = p'_f + c * \cot\phi$ | 9191.690611 |
| $\text{Cos}(\phi)$ = | 0.81915204 | | B = | 0.000152239 | $B = [R_o/R_{pmax}]^2$ | 0.000152238 |
| $\text{Cot}(\phi)$ = | 1.42814801 | | C = | 0.035737781 | $C = (\sigma_o' * \sin\phi + c * \cos\phi)/G$ | 0.035737781 |
| $\mu$ = | 4,019 psf | Initial Pore Pressure, $\mu = \gamma_w * H_w$ | D = | -0.364504973 | $D = -\sin\phi/(1+\sin\phi)$ | -0.364504973 |
| $\sigma'$ = | 5,841 psf | Effective Stress, $\sigma_o' = \Sigma [\gamma_d * h_d + \gamma' * h_s]$ | E = | 0.01428148 | $E = c*\cot\phi$ | 0.01428148 |
| $p'_f$ = | 9,192 psf | $p'_f$ = | $\sigma'$ = | 5,841.26 | Check Calculation | |

Checks: 9191.690611; 0.000152238; 0.035737781; -0.364504973; 0.01428148

| | | | | | |
|---|---|---|---|---|---|
| $P_{max}$ = | 34,930 psf | 242.57 psi | $P_{max} = \mu + A * (B + C)^D - E$ | 34,930 psf | Check Calculation |
| $P_{allC}$ = | 23,287 psf | 161.71 psi | $P_{all} = P_{max}/FS$ | | |

**8. Method D - Queens Equation (Cohesive Soils Only) better for softer clay soils** **(Assumes undrained properties)**

$K_o < 1$ $P_i = S_u + (1/2)*(3K_o-1)*\sigma_o - S_u*\ln[(R_o/R_{pmax})^2 + (S_u/G)]$

$K_o > 1$ $P_i = S_u + (1/2)*(3-K_o)*\sigma_o - S_u*\ln[(R_o/R_{pmax})^2 + S_u/G]$

**To Determine if hydraulic fracturing or blowout occurs** **(<2Su) indicates hydraulic fracturing; (>2Su) indicates blowout**

$K_o < 1$ $F_1(K_o,\sigma_o,S_u) = (3*K_o - 1)*\sigma_o$

$K_o > 1$ $F_1(K_o,\sigma_o,S_u) = (3 - K_o)*\sigma_o$

| | | | | | | |
|---|---|---|---|---|---|---|
| $K_o$ = | 0.250 | $P_i$ = | -1,232 psf | -8.56 psi | -8.56 psi | Check Calculation |
| | | $F_1$ = | Expect Hydraulic Fracturing | | | |

**9. SUMMARY and Assessment of Estimated Drilling Annular Pressure and Formation Capacity**

(See Annular Pressure Calculations for joint by joint calculations)

**Method A - (API RP) 13D**

**Method B - HDD Good Practices Cavity Expansion Annular Pressure**

| | | | | |
|---|---|---|---|---|
| $P_{annularA}$ = | 76.17 psi | $P_A = [\gamma_f (Y_{entry} - Y)/144] + (P_d)(MD)$ | | |
| $P_{annularB}$ = | 102.04 psi | $P_B = [\gamma_f * (Y_{entry} - Y)/144] + MD*[\mu_p*V_{ha}/(1000*(Dh-Dr)^2)] + YP/[200*(D_h-D_r)]$ | | |
| Method A | 68.47 psi | FS = | 1 | Total Stress |
| Method B | 96.88 psi | FS = | 1 | Total Stress + Strength |
| Method C | 161.71 psi | At $FS_D$ = | 1.5 | Delft Equation |
| Method D | -8.56 psi | At $FS_D$ = | 1.5 | Queens Equation |

***Comparitive Factor of Safety against Drill Fluid Loss at Critical Joint***

Critical Joint = 24 Depth of Cover = 62.4 ft

| Confining Pressure Calculation Method | Method A | Method B | Method C | Method D |
|---|---|---|---|---|
| Method (X)/$P_{annularA}$ | 0.90 | 1.27 | 2.12 | -0.11 |
| Method (X)/$P_{annularB}$ | 0.67 | 0.95 | 1.58 | -0.08 |

**Acceptable if Factor of Safety >=1.0**

# HORIZONTAL DIRECTIONAL CONCEPTUAL DRILL DESIGN

**PROJECT:** Sunoco Pipeline, L.P.
Mariner East Pipeline
Blair County, Pennsylvania

**CROSSING:** **LOWER PINEY CREEK HDD #S2-0142**
**16-INCH STEEL PIPE**

**ISSUE:** **APC/FPC DESIGN**

Contents:

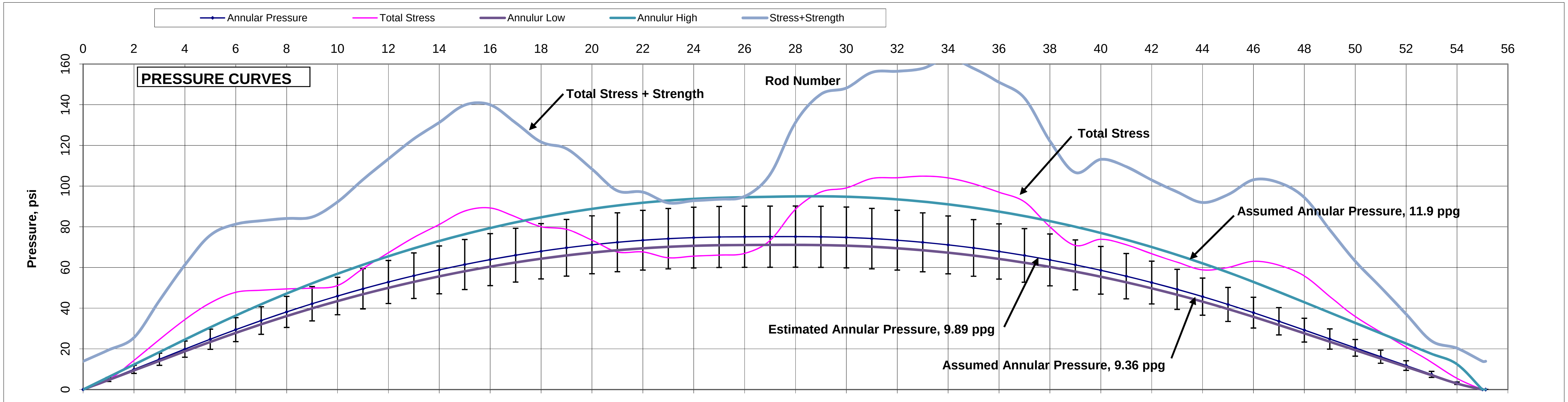

| | |
|---|---|
| | Figure 1 - Annular Pressure and Formation Pressure Capacity Curves |
| | Table 1 - Design Summary, Assumptions, Conditions |
| | Table 2 - Design Drill Path Calculation |
| | Table 3 - Estimated Annular Pressure Curve Example Calculation |
| | Table 4 - Estimated Formation Pressure Curve Example Calculation |
| | |
| | |
| | |
| | |
| | |

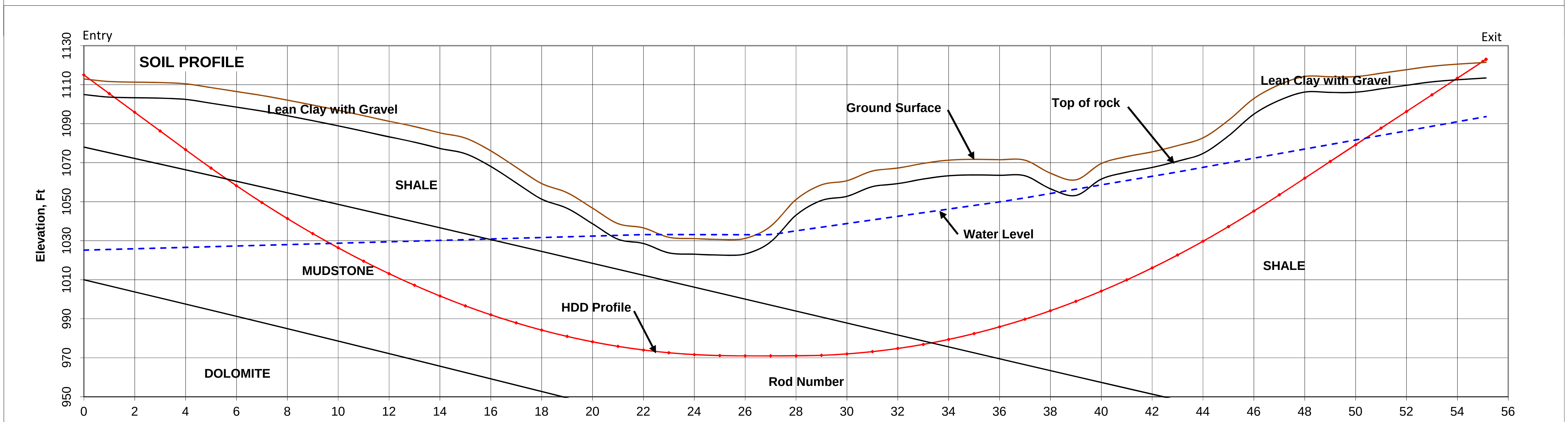

Prepared For: Sunoco Logistics Partners L.P.
525 Fritztown Road
Sinking Spring, PA 19608
855-430-4491


Prepared By: Directional Project Support
33311 Lois Lane, Suite A
Magnolia, Texas 77354
281.259.7819 (O) 617.510.8090 (C)
B. Dorwart


Project No: 0
Print Date: 19-Feb-2018

| Revision | ID | DESCRIPTION | BY |
|---|---|---|---|
| 10/22/2017 | 0 | APC/FPC Design | BCD |
| 2/19/2018 | 1 | Revise APC for New Drill Path | BCD |
| | | | |
| | | | |




**Notes:**
1. Geology is interpreted from project data
2. Ground surface data obtained from project survey data
3. Subsurface data from Geotechnical Report, Properties are interpreted from field and laboratory data as presented in Table 3.

**Basis of annulur pressure calculations**

| | |
|---|---|
| 12.31 in | Pilot Hole Diameter |
| 74.0 pcf | Unit Weight Drill Fluid |
| 300 gal/min | Pump Rate |
| 6.63 in | Drill Rod Diameter |
| 31 | Ft per rod |
| 20% | for APC curve |

Print Date ; 2/19/2018 8:32

ISSUED: APC/FPC DESIGN


33311 Lois Lane, Suite A
Magnolia, Texas 77354
59.7819 (O) 617.510.80


Sunoco Pipeline, L.P.
Mariner East Pipeline
Blair County, Pennsylvania

**ANNULAR PRESSURE AND FORMATION PRESSURE CURVES LOWER PINEY CREEK HDD #S2-0142**

Revision 1

**FIGURE 1**

**TABLE 1**
**DESIGN SUMMARY, ASSUMPTIONS, CONDITIONS**
**Sunoco Pipeline, L.P.**
**Mariner East Pipeline**
**Blair County, Pennsylvania**

**LOWER PINEY CREEK HDD #S2-0142**
**16-INCH STEEL PIPE**

| Item | Comment/Exception/Assumption |
|---|---|
| 1 | PROJECT DATA AND SUMMARY: Project data used for this submittal included two test borings. Total stress is insufficient to contain drill fluid hence an additional assessment using strength has also been used to assess the risk of drill fluid loss. Recognize that total stress is a conservative approach to confining pressure. Expect leakage as the dominate cause for lost drill fluid. Recommend as a minimum to walk the slopes to the sides of the creek during drilling to look for drill fluid. Contractor may elect to drill deeper to mitigate the risk of fluid loss however drilling deeper will not necessarally mitigate leakage. Recommend to monitor for drill fluid loss during the pilot bore and seal found leakage zones when encountered and before moving the pilot forward. |
| 2 | DRILL FLUID LOSS DURING CONSTRUCTION: Drill fluid loss during construction typically occurs as a result of one or a combination of the following: LEAKAGE, HYDRAULIC JACKING, HYDRAULIC FRACTURING. In all cases, the drill fluid finds an alternative path to the design drill path that requires a lower pressure to move the drill fluid. Drill fluid pressure at any point along a drill path is the elevation and dynamic head. The elevation head pressure is the difference in elevation between the entry pit drill fluid elevation and the measurement elevation times the weight of the drill fluid in the annular space. The dynamic head is the pressure required to move the drill fluid from the measurement location to the drill entry location when drilling is underway. The dynamic pressure required to make the drill fluid flow must be added to the elevation pressure head. Leakage occurs when there is an open pathway that intersects the drill path. Hydraulic jacking occurs when there are cracks in the formation such as rock joints or relatively high permeability zones contained within a relatively low permeability zone into which the drill fluid can flow and exert hydraulic pressure because of the confinement. When the drill fluid pressure exceeds the weight or force restraining the materials on the sides of the crack or higher permeability zone, the confining material will be hydraulically jacked further open resulting in an enlarged opening with more fluid volume capacity and eventually, the possibility of a new flow path for the fluid. Hydraulic fracturing occurs when the drill fluid pressure exceeds the static stress state in the formation plus the strength of the formation material. The result is a fracturing of the formation providing access for the drill fluid to a path that will continue to grow until the drill fluid pressure is reduced or the formation strength increases. Note that hydraulic jacking and fracturing often build pressure in the formation such that during drill rod changes, the drill fluid discharges from the decoupled down hole drill rods until the built up pressure in the formation is reduced. Drill fluid 'loss' during the drilling advance is the source of this return fluid. Continuation of this situation can result in fluid release to the surface, into structures, or movement of adjacent structures such as buildings, highways, and bridges. |

| Item | Comment/Exception/Assumption |
| --- | --- |
| 3 | CALCULATION OF ANNULAR PRESSURE: Drill fluids are Non-Newtonian fluids and must be modeled with specific fluid properties. Annular Pressure is based on assumptions for drill fluid rheological properties that may be expected in the field. As the field data, and the properties of various bentonitic products can vary significantly, error bars have been assigned to the estimated results to represent these unknowns between assumptions and the actual products and blends provided by the contractor. These assumptions should be confirmed in the field during construction as the changes will also change the Annular Pressure curve. Field values of drill fluid should be expected to change as different subsurface materials may require different drill fluid properties. Annular pressure has been calculated by two independent methods: METHOD A is based on the API-13D method using a Power Law to model the Dynamic pressure of a visco-plastic fluid; METHOD B uses a hydraulic model for modeling the Dynamic Pressure as a viscous flow in an annulus and is described in the HDD Good Practices Guidelines; a book available through the NASTT. Both methods are accepted in the industry. The annular pressure curves shown in Figure 1 plot the API-13D data by drill rod along the drill path. Three annular pressure curves are shown on Figure 1 representing three different drill fluid densities that range the possible field conditions that may occur: Assumed estimate of reasonable drill fluid properties, Highest reasonable drill fluid properties, Lowest reasonable drill fluid properties. The "Assumed estimate" data include a 20% error bar on each point representing the accuracy of the data with regard to the ability to predict the actual pressures. The 20% error bar is based on experience with field measurements of annular pressure vs predictions. This assessment does not offer a risk of fluid loss by leakage through natural or manmade preferred pathways such as rock joints, adjacent utility installations, and adjacent foundation systems. |
| 4 | CALCULATION OF FORMATION PRESSURE: The Formation Pressure capacity may be approximated by using one or more of four alternative calculation methods: Total Stress (used for Rock and conservatively for dense soils, Cavity Expansion (Delft Equation) (used for medium dense granular and soft to stiff cohesive soils), Total Stress plus Strength (used for Cohesive materials), and the Queens Equation (which is used for very soft or loose cohesive or granular soils). The Total Stress Method is based strictly on the dead weight of the overlying material above the drill path thus excluding any potential strength that the formation material may have. This method is considered conservative but is considered a reasonable approximation for rock. Note that in areas of high topographic relief and where the drill path approaches within about 5 times the depth below the entry to a topographic surface, then the total stress must be adjusted for both magnitude and direction as the pressure vector is no longer vertical. The cavity expansion, Stress plus Strength, and Queens methods adds the strength of the formation material to the total stress. These methods are considered more realistic however these equations require significant assumptions regarding input parameters that are not often, if ever, substantiated by field data. These three relations are not generally appropriate for rock. The sensitivity of the input data assumptions for these three approaches have been shown to be significant to the results. Significant experience is often required in determination of these input values. Thus these methods may not be conservative and can lead to overly optimistic results leading to a false impression of an unreasonably high Formation Pressure Capacity. |

| Item | Comment/Exception/Assumption |
|---|---|
| 5 | TECHNICAL APPROACH DRILL FLUID MANAGEMENT: Table 2 provides the proposed drill path for the interpreted geologic profile assumed for the crossing. Table 3 provides the calculated Annular Pressure and Table 4 the calculated Formation Pressure Capacity. Calculations are provided for each drill rod along the design drill path. The results are summarized on Figure 1. Assessment is based on comparison of the Formation Pressure Capacity to the Annular Pressure. This relation provides a tool to assess the risk of hydraulic fracturing of a formation or hydraulic jacking along pathways within a formation caused by Annular Pressure exceeding the Formation Capacity Pressure. When the Annular Pressure is higher than the Formation Pressure Capacity, then the risk of drill fluid loss by jacking or hydrofracturing is considered high for the design drill path and drill direction. Mitigation considerations may include: reversing the drill direction, adjusting the depth of the drill path in problem areas, or reduction of drill fluid pressure by methods such as reduction of drill fluid weight, use of drill foam, reduction in the elevation head pressure which may be accomplished by pumping the drill fluid elevation in the hole down to a lower elevation. |
| 6 | **Limitations:** These calculations are for HDD planning purposes only. It should be expected that the drill process will generate new data that may require adjustments to the assumed conditions used for the basis of these calculations. Adjustments to the assumed subsurface conditions may require corresponding adjustments to the various HDD drill parameters or tools to optimize production. Typical parameters that are adjusted include: drill fluid pump rate, penetration rate, drill fluid properties, along with bit dimensions and types or other tooling. |

# PATH DESIGN CALCULATIONS

| | | | |
|---|---|---|---|
| Entry Station | 16+74.02 | FT | |
| Exit Station | 0+00.00 | FT | |

**Entry and Exit Design Coordinates & Elevations (Ft) (Note 2)**

| | East | North | Elevation |
|---|---|---|---|
| Entry | 1825377.6350 | 400837.4500 | 1,115.00 ft |
| Horizontal Curve PI | 1824575.7800 | 401077.4855 | |
| Exit | 1823773.9250 | 401317.5210 | 1,123.00 ft |
| Depth to Mudline | 87.40 ft | Clearance Depth = | 56.60 ft |
| Measured Plan Length at ties = | 1674.0233 ft | | |
| Coordinate Length = | 1674.0233 ft | | |
| OK - NO HORIZONTAL CURVE TANGENT | | | |

| | |
|---|---|
| Water Surface Elev. | 1030.00 ft |
| Mudline Elev. | 1027.60 ft |
| Lowest centerline Elev. | 971.00 ft |

**SUMMARY HORIZONTAL CURVE CALCULATIONS**

| | Start | | | End | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Station | Easting | Northing | Station | Easting | Northing | Azimuth | Length | Radius | Angle |
| Tangent | 16+74.02 | 1825377.6350 | 400837.4500 | 8+37.01 | 1824575.7800 | 401077.4855 | E 163.33492 N | 837.01 | | |
| Curve | 8+37.01 | 1824575.7800 | 401077.4855 | 8+37.01 | 1824575.7800 | 401077.4855 | E 163.33492 N | 0.00 | 0.00 | 0.000 deg. |
| Tangent | 8+37.01 | 1824575.7800 | 401077.4855 | +.00 | 1823773.9250 | 401317.5210 | E 163.33492 N | 837.01 | | |

## HORIZONTAL PLAN CALCULATIONS (FT)

| *Entry Tangent Segment* | | *Horizontal Curve Segment* | | *Exit Tangent Segment* | | |
|---|---|---|---|---|---|---|
| Plan Length, ft. | 837.01 | Input Radius, ft. | 0.00 | Plan Length, ft. | 837.01 | |
| Entry Azimuth, deg.[5] | E 163.33492 N | Curve, deg | 0.000 deg. | Exit Azimuth, deg.[5] | E 163.33492 N | |
| Entry Azimuth, rad.[5] | 2.85073 | Curve, rad | 0.00000 | Exit Azimuth, rad.[5] | 2.85073 | |
| | | **Calculate PTH** | | **Calculate Exit** | | |
| **Calculate PCH** | | Chord Length, ft. | 0.00 | Easting | 1823773.9250 | **Check** |
| PCH Easting | 1824575.7800 | Arc Length, ft. | 0.00 | Northing | 401317.5210 | **Delta** |
| PCH Northing | 401077.4855 | Chord Azimuth, deg | 163.3349 | | | **0.0000** |
| | | PI Easting = | 1824575.7800 | | | **0.0000** |
| | | PI Northing = | 401077.4855 | | | **OK CALC** |
| | | PTH Easting = | 1824575.7800 | | | |
| | | PTH Northing = | 401077.4855 | | | **Exit Station** |
| | | | | | | **+.00** |
| Cum Plan Length | 837.01 | Cum Plan Length | 837.01 | Cum Plan Length | 1674.023276 | **OK STA** |

## Pull Geometry

Pipe Entry: **EXIT** — Enter the pipe entry location into the hole: Entry/Exit

| | Elevations | | Vertical Angle, (-) = Clockwise | | | Path | Curve |
|---|---|---|---|---|---|---|---|
| **Segment** | **Start** | **End** | **Start** | **End** | **Δ Angle** | **Length** | **Radius** |
| Entry Tangent | 1123.00 ft | 1052.35 ft | 16.00 deg | 16.00 deg | 0.00 deg | 256.31 ft | 0.00 ft |
| Entry Curve | 1052.35 ft | 971.00 ft | 16.00 deg | 0.00 deg | -16.00 deg | 586.43 ft | 2100.00 ft |
| Bottom Tangent | 971.00 ft | 971.00 ft | 0.00 deg | 0.00 deg | 0.00 deg | 73.01 ft | 0.00 ft |
| Exit Curve | 971.00 ft | 1073.78 ft | 0.00 deg | -18.00 deg | -18.00 deg | 659.73 ft | 2100.00 ft |
| Exit Tangent | 1073.78 ft | 1115.00 ft | -18.00 deg | -18.00 deg | 0.00 deg | 133.39 ft | 0.00 ft |
| | | | | | Total Check = | 1708.87 ft | OK |

**Compound Curve Assessment**

| | Vert. Plan | Horiz. Plan | |
|---|---|---|---|
| Entry | 775.79 | 837.01 | No, Horiz > Entry V(Tan+Curve) |
| Exit | 825.22 | 837.01 | No, Horiz > Entry V(Tan+Curve) |

## VERTICLE PATH DESIGN CALCULATIONS (FT)

| *Entry Tangent Segment 1* | | *Entry Vert. Curve Segment 2* | | *Middle Tangent Segment 3* | | *Exit Vert. Curve Segment 4* | | *Exit Tangent Segment 5* | |
|---|---|---|---|---|---|---|---|---|---|
| Entry Angle | -18.000 deg. | Vertical Radius | 2100.00 | Rod Length | 73.00677 | Radius | 2100.00 | Exit Elevation | 1123.00 |
| Entry Angle, rad. | -0.3142 rad | Vert. Curve, deg. | 18.000 deg. | Inclined Bottom Tan | NO | Design Exit Angle | 16.000 deg. | | |
| Rod/Path Length | 133.39 | Vert. Curve, rad. | 0.3142 rad | | | Vert. Curve, rad. | 0.2793 rad | | |
| **Calculate Vertical PCV** | | **Calculate Vertical PTV** | | **Calculate Vertical PCV** | | **Calculate Vertical PTV** | | **Calculate Exit** | |
| Plan Length | 126.86 | Plan Length | 648.94 | Plan Length | 73.00677379 | Vert. Curve, deg | 16.000 deg. | Plan Length | 246.38 |
| Path Length | 133.39 | Arc Path Length | 659.73 | Path Length | 73.01 | Vert. Curve, rad. | 0.27925268 | Path Length | 256.31 |
| Tangent Depth | -41.22 | Curve Vert Depth | -102.78 | End Elevation | 971.00 | Plan Length | 578.84 | Elevation | 1123.00 |
| End Elevation | 1073.78 | End Elevation | 971.00 | Rise/drop | 0.00 | Path Arc Length | 586.43 | Rise/drop | 70.65 |
| | | Lowest Elevation | 971.00 | | | Lowest Elevation | 971.00 | | |
| | | End Vert Angle | 0.000 deg. | End Vert Angle | 0.000 deg. | Elevation | 1052.35 | | |
| | | End Vert Angle, rad | 0.0000 rad | End Vert Angle, rad | 0.0000 rad | Curve Vert Depth | 81.35 | ***Prop. Plan Length*** | ***1674.023276*** |

**SUMMARY VERTICLE CURVE CALCULATIONS**

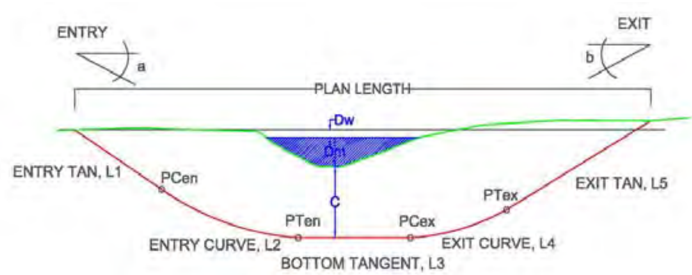
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Start Station | 16+74.02 | Start Station | 15+47.17 | Start Station | 8+98.23 | Start Station | 8+25.22 | Start Station | 2+46.38 |
| PVC Station | 15+47.17 | PTV Station | 8+98.23 | PCV Station | 8+25.22 | PTV Station | 2+46.38 | Exit Station | +.000 |
| Cum Plan Length | 126.86 | Cum Plan Length | 775.79 | Cum Plan Length | 848.80 ft | Cum Plan Length | 1427.64 | Cum Plan Length | 1674.023276 |
| Cum Path Length | 133.39 | Cum Path Length | 793.12 | Cum Path Length | 866.13 ft | Cum Path Length | 1452.56 | Cum Path Length | 1708.871773 |
| Cum Depth | -41.22 | Cum Depth | -144.00 | Cum Depth | -144.00 ft | Cum Depth | -62.65 | Cum Depth | 8.00 |

**Stationing Check**
**OK STATIONING**
**Plan Length Check**
**OK CALCULATION**

## Summary of Drill Calculations

| | |
|---|---|
| **Entry to Exit Elevation Change =** | **8.00 ft** |
| **Minimum Design Elevation =** | **971.00 ft** |
| **Invert Depth below exit =** | **152.00 ft** |
| **Invert Depth below entry =** | **144.00 ft** |
| **Path Length =** | **1,708.87 ft** |
| **Plan Length =** | **1,674.02 ft** |
| **Minimum Plan Length (No Tangent) =** | **1,601.02 ft** |
| **Entry Angle =** | **-18.00 deg** |
| **Exit Angle =** | **16.00 deg** |
| **Compound Curve at Entry =** | **NO** |
| **Compound Curve at Exit =** | **NO** |

**NOTES:**
1. Sign convention for angles - positive (+) angles are counterclockwise. Due East is defined as 0 degrees.
2. Coordinates are in feet and reference NAD 83 Pennsylvania South State Plane
3. Elevations are in feet and reference NAVD 88.
4. All calculation locations represent the center of the drill hole.




Indicates inputs
Indicates status on internal design checks

**ISSUE:** **APC/FPC DESIGN**


Sunoco Pipeline, L.P.
Mariner East Pipeline
Blair County, Pennsylvania

Directional Project Support
33311 Lois Lane, Suite A
Magnolia, Texas 77354


**TABLE 2**
**DESIGN DRILL PATH CALCULATION**
**LOWER PINEY CREEK HDD #S2-0142**
**16-INCH STEEL PIPE**

Revision 1 — 10/22/2017

**TABLE 3**
**ESTIMATED ANNULAR PRESSURE CURVE (APC) EXAMPLE CALCULATION**
**Sunoco Pipeline, L.P.**
**Mariner East Pipeline**
**Blair County, Pennsylvania**

**LOWER PINEY CREEK HDD #S2-0142**
**16-INCH STEEL PIPE**
**INPUT**
***1. Drill path data***

| | Measured Distance | Elevations | Angles | Lengths | Angle Change | |
|---|---|---|---|---|---|---|
| Drill Entry | 0.000 ft | 1115 | -18 | Entry to PC | 133.386 ft | |
| PC | 133.386 ft | | | PC to PT | 659.734 ft | -0.027 deg/ft |
| PT | 793.121 ft | | | Invert Tangent | 73.007 ft | |
| PC | 866.128 ft | | | PC to PT | 586.431 ft | 0.027 deg/ft |
| PT | 1452.558 ft | | | PT to Exit | 256.313 ft | |
| Drill Exit | **1708.872 ft** | 1123.00 ft | 16 | | **1708.872 ft** | |
| | | | | | **Length Ck** | **OK** |

***2. Drill Fluid Hydraulic Assumptions***

| | Assumed | | Low | | High | |
|---|---|---|---|---|---|---|
| Density, $\gamma_f$ = | 74 | 9.89 lb/gal | 70 | 9.36 lb/gal | 89 | 11.90 lb/gal |
| Dynamic annulus pressure $P_d$ = | 0.0014 psi/ft | | 0.0013 psi/ft | | 0.0068 psi/ft | |
| Drill fluid viscosity, $\mu_p$ = | 2 cp | | 6 cp | | 13 cp | |
| Yield point of drill fluid, YP = | 41 | | 19 | | 5 | |

***3. Drill Data Assumptions***

**Assumed Drill Size:** **DD660**

| | | | |
|---|---|---|---|
| Avg Rod length = | 31.0 feet | Max Rig Pump = | 1200 gpm |
| Diameter of hole, $D_h$ = | 12.31125 | Number of drill rods = | 55 |
| Drill Rod Tube Diameter, $D_r$ = | 6.625 in | Estimated annular pilot uphole drill fluid velocity, $V_{ha}$ = | 68.29 ft/min |
| Drilling Pump rate, gpm = | 300 gal/min | | |

***4. Calculate Annular Pressure, P***

**Method A - (API RP) 13D**

$$P_A = [\gamma_f (Y_{entry} - Y)/144] + (P_d)(MD)$$

**Method B - HDD Good Practices Cavity Expansion Annular Pressure**

$$P_B = [\gamma_f * (Y_{entry} - Y)/144] + MD*[\mu_p*(V_{ha}/60)/(1000*(D_h-D_r)^2) + YP/[200*(D_h-D_r)]$$

Start Station | 0+00.00 | -1

| Drill Path | | | Assumed Return Density | | Low Return Density | | High Return Density | |
|---|---|---|---|---|---|---|---|---|
| | | | Density, $\gamma_{fE}$ = | 74 | Density, $\gamma_{fL}$ = | 70 | Density, $\gamma_{fH}$ = | 89 |
| Rod Measured Distance MD | **Station X** | **Elevation Y** | **Annular Fluid Pressure $P_A$** | **Annular Fluid Pressure $P_B$** | **Annular Fluid Pressure $P_A$** | **Annular Fluid Pressure $P_B$** | **Annular Fluid Pressure $P_A$** | **Annular Fluid Pressure $P_B$** |
| **ft** | **ft** | **ft** | **psi** | **psi** | **psi** | **psi** | **psi** | **psi** |
| 0.00 | 0+00.00 | 1,115.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 31.00 | -0+29.48 | 1,105.42 | 4.96 | 6.04 | 4.70 | 5.18 | 6.13 | 6.07 |
| 62.00 | -0+58.97 | 1,095.84 | 9.93 | 12.09 | 9.39 | 10.36 | 12.27 | 12.14 |
| 93.00 | -0+88.45 | 1,086.26 | 14.89 | 18.13 | 14.09 | 15.54 | 18.40 | 18.21 |
| 124.00 | -1+17.93 | 1,076.68 | 19.86 | 24.17 | 18.79 | 20.72 | 24.53 | 24.28 |
| 155.00 | -1+47.46 | 1,067.25 | 24.75 | 30.13 | 23.41 | 25.83 | 30.57 | 30.26 |
| 186.00 | -1+77.11 | 1,058.20 | 29.44 | 35.91 | 27.85 | 30.76 | 36.38 | 36.01 |
| 217.00 | -2+06.89 | 1,049.58 | 33.91 | 41.46 | 32.08 | 35.47 | 41.92 | 41.49 |
| 248.00 | -2+36.79 | 1,041.40 | 38.16 | 46.78 | 36.10 | 39.97 | 47.19 | 46.69 |
| 279.00 | -2+66.81 | 1,033.67 | 42.17 | 51.88 | 39.90 | 44.25 | 52.18 | 51.62 |
| 310.00 | -2+96.94 | 1,026.37 | 45.96 | 56.74 | 43.48 | 48.32 | 56.90 | 56.28 |
| 341.00 | -3+27.17 | 1,019.53 | 49.52 | 61.38 | 46.85 | 52.18 | 61.34 | 60.66 |

| Drill Path | | | Assumed Return Density | | Low Return Density | | High Return Density | |
|---|---|---|---|---|---|---|---|---|
| | | | Density, $\gamma_{fE}$ = | 74 | Density, $\gamma_{fL}$ = | 70 | Density, $\gamma_{fH}$ = | 89 |
| Rod Measured Distance MD | **Station X** | **Elevation Y** | **Annular Fluid Pressure $P_A$** | **Annular Fluid Pressure $P_B$** | **Annular Fluid Pressure $P_A$** | **Annular Fluid Pressure $P_B$** | **Annular Fluid Pressure $P_A$** | **Annular Fluid Pressure $P_B$** |
| **ft** | **ft** | **ft** | **psi** | **psi** | **psi** | **psi** | **psi** | **psi** |
| 372.00 | -3+57.51 | 1,013.13 | 52.85 | 65.79 | 50.00 | 55.81 | 65.51 | 64.77 |
| 403.00 | -3+87.93 | 1,007.18 | 55.95 | 69.97 | 52.93 | 59.23 | 69.40 | 68.60 |
| 434.00 | -4+18.44 | 1,001.68 | 58.82 | 73.91 | 55.64 | 62.43 | 73.01 | 72.15 |
| 465.00 | -4+49.02 | 996.63 | 61.46 | 77.63 | 58.14 | 65.40 | 76.35 | 75.42 |
| 496.00 | -4+79.68 | 992.03 | 63.86 | 81.11 | 60.41 | 68.16 | 79.40 | 78.41 |
| 527.00 | -5+10.40 | 987.88 | 66.03 | 84.36 | 62.47 | 70.70 | 82.17 | 81.12 |
| 558.00 | -5+41.18 | 984.19 | 67.97 | 87.38 | 64.30 | 73.02 | 84.67 | 83.55 |
| 589.00 | -5+72.01 | 980.96 | 69.68 | 90.16 | 65.92 | 75.12 | 86.88 | 85.70 |
| 620.00 | -6+02.89 | 978.18 | 71.15 | 92.71 | 67.31 | 76.99 | 88.81 | 87.57 |
| 651.00 | -6+33.80 | 975.85 | 72.39 | 95.02 | 68.48 | 78.65 | 90.46 | 89.16 |
| 682.00 | -6+64.74 | 973.98 | 73.39 | 97.10 | 69.42 | 80.08 | 91.83 | 90.47 |
| 713.00 | -6+95.71 | 972.57 | 74.15 | 98.95 | 70.15 | 81.29 | 92.91 | 91.49 |
| 744.00 | -7+26.70 | 971.62 | 74.69 | 100.56 | 70.65 | 82.28 | 93.71 | 92.23 |
| 775.00 | -7+57.69 | 971.12 | 74.98 | 101.93 | 70.93 | 83.04 | 94.23 | 92.69 |
| 806.00 | -7+88.69 | 970.99 | 75.09 | 103.12 | 71.04 | 83.63 | 94.53 | 92.92 |
| 837.00 | -8+19.69 | 970.99 | 75.14 | 104.24 | 71.08 | 84.16 | 94.74 | 93.07 |
| 868.00 | -8+50.69 | 971.00 | 75.17 | 105.35 | 71.11 | 84.67 | 94.94 | 93.21 |
| 899.00 | -8+81.69 | 971.26 | 75.08 | 106.34 | 71.03 | 85.07 | 95.00 | 93.20 |
| 930.00 | -9+12.68 | 971.97 | 74.76 | 107.09 | 70.72 | 85.25 | 94.77 | 92.91 |
| 961.00 | -9+43.66 | 973.15 | 74.20 | 107.61 | 70.19 | 85.21 | 94.26 | 92.34 |
| 992.00 | -9+74.62 | 974.77 | 73.40 | 107.89 | 69.44 | 84.94 | 93.46 | 91.48 |
| 1023.00 | -10+05.55 | 976.86 | 72.37 | 107.94 | 68.46 | 84.45 | 92.39 | 90.34 |
| 1054.00 | -10+36.44 | 979.40 | 71.11 | 107.76 | 67.27 | 83.74 | 91.03 | 88.92 |
| 1085.00 | -10+67.30 | 982.40 | 69.61 | 107.34 | 65.85 | 82.80 | 89.39 | 87.22 |
| 1116.00 | -10+98.11 | 985.85 | 67.88 | 106.68 | 64.21 | 81.65 | 87.46 | 85.24 |
| 1147.00 | -11+28.86 | 989.76 | 65.91 | 105.79 | 62.35 | 80.27 | 85.26 | 82.97 |
| 1178.00 | -11+59.55 | 994.12 | 63.71 | 104.67 | 60.27 | 78.68 | 82.78 | 80.43 |
| 1209.00 | -11+90.17 | 998.93 | 61.28 | 103.32 | 57.97 | 76.86 | 80.02 | 77.61 |
| 1240.00 | -12+20.72 | 1,004.20 | 58.62 | 101.73 | 55.45 | 74.83 | 76.98 | 74.50 |
| 1271.00 | -12+51.19 | 1,009.91 | 55.72 | 99.92 | 52.72 | 72.57 | 73.66 | 71.12 |
| 1302.00 | -12+81.57 | 1,016.08 | 52.59 | 97.87 | 49.76 | 70.10 | 70.06 | 67.46 |
| 1333.00 | -13+11.86 | 1,022.69 | 49.24 | 95.59 | 46.58 | 67.41 | 66.18 | 63.53 |
| 1364.00 | -13+42.05 | 1,029.75 | 45.65 | 93.08 | 43.19 | 64.51 | 62.03 | 59.31 |
| 1395.00 | -13+72.12 | 1,037.25 | 41.84 | 90.35 | 39.59 | 61.38 | 57.61 | 54.83 |
| 1426.00 | -14+02.09 | 1,045.19 | 37.80 | 87.38 | 35.76 | 58.04 | 52.91 | 50.07 |
| 1457.00 | -14+31.94 | 1,053.55 | 33.55 | 84.21 | 31.74 | 54.51 | 47.96 | 45.05 |
| 1488.00 | -14+61.74 | 1,062.10 | 29.20 | 80.94 | 27.63 | 50.88 | 42.89 | 39.92 |
| 1519.00 | -14+91.54 | 1,070.64 | 24.85 | 77.67 | 23.51 | 47.25 | 37.82 | 34.79 |
| 1550.00 | -15+21.34 | 1,079.19 | 20.50 | 74.39 | 19.40 | 43.62 | 32.75 | 29.66 |
| 1581.00 | -15+51.14 | 1,087.73 | 16.15 | 71.12 | 15.28 | 39.99 | 27.68 | 24.53 |
| 1612.00 | -15+80.94 | 1,096.27 | 11.80 | 67.85 | 11.17 | 36.36 | 22.61 | 19.40 |
| 1643.00 | -16+10.74 | 1,104.82 | 7.45 | 64.58 | 7.06 | 32.73 | 17.54 | 14.27 |
| 1674.00 | -16+40.54 | 1,113.36 | 3.10 | 61.31 | 2.94 | 29.10 | 12.48 | 9.14 |
| 1705.00 | -16+70.33 | 1,121.91 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 1708.87 | -16+74.06 | 1,122.98 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**TABLE 4**
**ESTIMATED FORMATION PRESSURE CURVE (FPC) EXAMPLE CALCULATION**
**Sunoco Pipeline, L.P.**
**Mariner East Pipeline**
**Blair County, Pennsylvania**

**LOWER PINEY CREEK HDD #S2-0142**
**16-INCH STEEL PIPE**
**INPUT**

***1. Drill path data from vertical path calculations***

| | Measured Distance | Elevations | Angles | Lengths | Angle Change | |
|---|---|---|---|---|---|---|
| Entry | 0.000 ft | 1115 | -18 | Entry to PC | 133.386 ft | |
| PC | 133.386 ft | | | PC to PT | 659.734 ft | -0.027 deg/ft |
| PT | 793.121 ft | | 0 | Invert Tangent | 73.007 ft | |
| PC | 866.128 ft | | | PC to PT | 586.431 ft | 0.027 deg/ft |
| PT | 1452.558 ft | | | PT to Exit | 256.313 ft | |
| Exit | **1708.872 ft** | 1123.00 ft | 16 | | **1708.872 ft** | **Length Ck OK** |

***2. Drill Fluid Hydraulic Data for Estimated Drill Fluid***

| | | |
|---|---|---|
| Dynamic annulus pressure = | 0.00135 psi/LF | |
| Uphole Drill Fluid Density = | 74 | 9.9 lb/gal |
| Drill fluid viscosity, cp = | 2 cp | |
| Up hole drill fluid velocity, ft/sec = | 68.29 ft/sec | |
| Pump rate, gpm = | 300 gal/min | |
| Diameter of hole $D_H$, in = | 12.31125 | |
| Diameter of Drill Rod $D_R$, in = | 6.625 | |
| Yield point of drill fluid, lb/100 ft^2 = | 41.00 Lb/100FT^2 | |

**Radius**

| | |
|---|---|
| $R_H$ = | 6.156 in |
| $R_R$ = | 3.313 in |

***3. Soil Profile Data***

**Technical approach to generate data as no testing available**

| Material Layer | Dry Density $\gamma$ (pcf) | Moisture Content % | Insitu Saturated Density (pcf) | Effective UW (pcf) | Phi, $\Phi$ | Undrained Cohesion c, psf | Poisson Ratio $\mu$ | Slow Shear Modulus, G psf | OCR Cohesive (Use 0 if non-cohessive) | Model Material Layer Description | Cohesive |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 110 | 15.0% | 126.5 | 47.60 pcf | 10 | 2000 | 0.3 | 67,613 | 1 | Lean Clay with Gravel | Y |
| 2 | 158 | 8.0% | 170.64 | 95.60 pcf | 38 | 0.01 | 0.2 | 187,500 | 1 | Shale | N |
| 3 | 140 | 12.0% | 156.8 | 77.60 pcf | 35 | 0.01 | 0.2 | 93,750 | 1 | Mudstone | N |
| 4 | 175 | 3.0% | 180.25 | 112.60 pcf | 75 | 0.01 | 0.25 | 840,000 | 1 | Dolomite | N |
| 5 | 165 | 4.0% | 171.6 | 102.60 pcf | 85 | 0.01 | 0.25 | 420,000 | 1 | Limestone | N |
| 6 | | | | | | | | 0 | | | |
| 7 | | | | | | | | 0 | | | |
| 8 | | | | | | | | 0 | | | |
| 9 | | | | | | | | 0 | | | |
| 10 | | | | | | | | 0 | | | |
| Water | 62.4 | | | 62.40 pcf | | | | | | | |

Dynamic Shear Velocity, $V_s = 61.4 * N_{60}^{1/2}$ Based on Seed and Idris approximation

Dynamic Shear Modulus, $G_{max} = (\gamma/g) * Vs^2$ g = acceleration of gravity = 32.2 $ft/s^2$

Extended Strain Shear Modulus G is typically between 5% and 20% of $G_{max}$ Select Reduction Factor, RF = 15% Ref 1

*4 Select Controlling Location and list properties (Based on inspection of Figure 1 plot*

Joint = 9 | Away Distance from Entry = 266.81 ft | Depth of Cover = 47.89 ft

| Layers | *Surface 1-2* | *Surface 2-3* | *Surface 3-4* | *Surface 4-5* | *Surface 5-6* | *Surface 6-7* | *Surface 7-8* | *Surface 8-9* | *Surface 9-10* | **TOTAL** | Total CK |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil Type in Layer = | 1 | 2 | 3 | 4 | 5 | 5 | | | | | |
| Dry Density in Layer, $\gamma_d$ = | 110.00 pcf | 158.00 pcf | 140.00 pcf | 175.00 pcf | 165.00 pcf | 165.00 pcf | | | | | |
| Insitu Density in Layer, $\gamma_s$ = | 126.50 pcf | 170.64 pcf | 156.80 pcf | 180.25 pcf | 171.60 pcf | 171.60 pcf | | | | | |
| Effective Weight in Layer, $\gamma'_e$ = | 47.60 pcf | 95.60 pcf | 77.60 pcf | 112.60 pcf | 102.60 pcf | 102.60 pcf | | | | | |
| Total Layer Thickness over drill, $h_s$ = | 8.00 ft | 39.89 ft | 17.97 ft | 0.00 ft | 0.00 ft | 0.00 ft | | | | 65.85 ft | 47.89 ft |
| Saturated Thickness over drill, $h_{sat}$ = | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | |
| Dry Thickness over drill, $h_{dry}$ = | 8.00 ft | 39.89 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 0.00 ft | 47.89 ft | |
| Contribution Effective Stress, σ' = | 880.00 psf | 6,302.03 psf | 0.00 psf | 0.00 psf | 0.00 psf | 0.00 psf | | | | | |
| Contribution Total Stress, $\sigma = h_s*\gamma_s$ | 880.00 psf | 6,302.03 psf | 0.00 psf | 0.00 psf | 0.00 psf | 0.00 psf | | | | | |
| Shear Modulus, G = | 67,613 psf | 187,500 psf | 93,750 psf | 840,000 psf | 420,000 psf | 420,000 psf | | | | | |

Height of Water above Soil Surface, $h_w$ = 0.00 ft

Total soil and water height above drill path, $H_T$ = 47.89 ft

Total water height above drill path, $H_W$ = 0.00 ft

**Properties At Drill Depth for Selected Joint**

| | | |
|---|---|---|
| $R_H$ = | 0.51 ft | Radius of drill hole |
| $R_{max} = h_s/FS_D$ = | 43.90 ft | Maximum allowable radius of plastic zone = Height of soil above Drill Path ($h_s$) divided by Delft & Queens Equation $FS_D$ |
| | 3 | Soil Layer At Drill Depth |
| $G_w$ = | 93,750 psf | Large Strain Shear Modulus at drill depth |
| $S_u = c = q_u/2$ | 0 psf | Cohessive material: cohession c = unconfined compressive strength ($q_u$) divided by 2 |
| $\phi$ = | 35 deg | 0.6109 rad |
| $H_W$ = | 0.00 ft | Total water height above drill path |
| $FS_D$ = | 1.5 | Factor of Safety for Delft & Queens Equation soil type: Use 1.5 for Sand and 2 for Clay at Drill Depth - Apply to $R_{max}$ and $P_{max}$ |
| $\mu$ = | 0.2 | Poisson ration ( Granular Soil: Angle of internal friction of layer at drill path depth |
| OCR = | 1 | Over Consolidation Ratio |
| $K_o$ = | 0.250 | Coefficient of lateral earth pressure at rest. For OCR = 1 use relation $K_o = \mu/(1 - \mu)$; For OCR >1 use $K_o = (K_{onormally\ consolidated}) * OCR^{-1/2}$ |
| $\sigma_o$ = | 7,182 psf | Total Stress at drill depth, $\sigma = \gamma_d$(above water)*hdry + $\gamma_s$(saturated)*$h_{sat}$ |
| u = | 0 psf | Water pressure at drill depth, $u = \gamma_W * H_W$ |
| σ' = | 7,182 psf | Effective Stress at drill depth, σ' = σ - u |

**5. Method A - Total Stress Method (Conservative)**

Calculate Allowable Controlling Formation Pressure Capacity

$P_{max} = \sigma_o = \Sigma (h_s*\gamma_s) + h_w*\gamma_w$

| | | |
|---|---|---|
| $P_{maxA}$ = | 7,182 psf | 49.88 psi |
| | 49.88 psi | Check Calculation |

**6. Method B - Total Stress Method + Local Formation Strength**

Calculate Allowable Controlling Formation Pressure Capacity

$P_{max} = \Sigma (h_s*\gamma_s) + h_w*\gamma_w + S$

| | | |
|---|---|---|
| $P_{maxB}$ | 12,211 psf | 84.80 psi |
| | 84.80 psi | Check Calculation |

**Based on Mohr-Coulomb**

Strength = c + σ' * tan($\phi$)

| | |
|---|---|
| 5,029 psf | 34.92 psi |

**7. Method C - Delft Equation for cavity expansion** **(Assumes drained properties)**

$P_{max} = \mu + [p'_f + c * \cot\phi] * \{[R_o/R_{pmax}]^2 + [(\sigma_o' * \sin\phi + c * \cos\phi)/G]\}^{-\sin\phi/(1+\sin\phi)} - c*\cot(\phi)$

| | | | | | | Checks |
|---|---|---|---|---|---|---|
| $\sin(\phi)$ = | 0.57357644 | | A = | 11301.49481 | $A = p'_f + c * \cot\phi$ | 11301.49481 |
| $\cos(\phi)$ = | 0.81915204 | | B = | 0.000136522 | $B = [R_o/R_{pmax}]^2$ | 0.00013652 |
| $\cot(\phi)$ = | 1.42814801 | | C = | 0.043940811 | $C = (\sigma_o' * \sin\phi + c * \cos\phi)/G$ | 0.043940811 |
| $\mu$ = | 0 psf | Initial Pore Pressure, $\mu = \gamma_w * H_w$ | D = | -0.364504973 | $D = -\sin\phi/(1+\sin\phi)$ | -0.364504973 |
| $\sigma'$ = | 7,182 psf | Effective Stress, $\sigma_o' = \Sigma [\gamma_d * h_d + \gamma' * h_s]$ | E = | 0.01428148 | $E = c*\cot\phi$ | 0.01428148 |
| $p'_f$ = | 11,301 psf | $p'_f$ = | $\sigma'$ = | 7,182.03 | heck Calculation | |

| | | | | | |
|---|---|---|---|---|---|
| $P_{max}$ = | 35,264 psf | 244.89 psi | $P_{max} = \mu + A * (B + C)^D - E$ | 35,264 psf | heck Calculation |
| $P_{allC}$ = | 23,509 psf | 163.26 psi | $P_{all} = P_{max}/FS$ | | |

**8. Method D - Queens Equation (Cohessive Soils Only) better for softer clay soils** **(Assumes undrained properties)**

$K_o < 1$ $P_i = S_u + (1/2)*(3K_o-1)*\sigma_o - S_u*\ln[(R_o/R_{pmax})^2 + (S_u/G)]$

$K_o > 1$ $P_i = S_u + (1/2)*(3-K_o)*\sigma_o - S_u*\ln[(R_o/R_{pmax})^2 + S_u/G]$

**To Determine if hydraulic fracturing or blowout occurs** **(<2Su) indicates hydraulic fracturing; (>2Su) indicates blowout**

$K_o < 1$ $F_1(K_o,\sigma_o,S_u) = (3*K_o - 1)*\sigma_o$

$K_o > 1$ $F_1(K_o,\sigma_o,S_u) = (3 - K_o)*\sigma_o$

| | | | | | | |
|---|---|---|---|---|---|---|
| $K_o$ = | 0.250 | $P_i$ = | -898 psf | -6.23 psi | -6.23 psi | heck Calculation |
| | | $F_1$ = | Expect Hydraulic Fracturing | | | |

**9. SUMMARY and Assessment of Estimated Drilling Annular Pressure and Formation Capacity**

(See Annular Pressure Calculations for joint by joint calculations)

**Method A - (API RP) 13D**

**Method B - HDD Good Practices Cavity Expansion Annular Pressure**

| | | | | |
|---|---|---|---|---|
| $P_{annularA}$ = | 42.17 psi | $P_A = [\gamma_f (Y_{entry} - Y)/144] + (P_d)(MD)$ | | |
| $P_{annularB}$ = | 51.88 psi | $P_B = [\gamma_f * (Y_{entry} - Y)/144] + MD*[\mu_p*V_{ha}/(1000*(Dh-Dr)^2)] + YP/[200*(D_h-D_r)]$ | | |
| Method A | 49.88 psi | FS = | 1 | Total Stress |
| Method B | 84.80 psi | FS = | 1 | Total Stress + Strength |
| Method C | 163.26 psi | At $FS_D$ = | 1.5 | Delft Equation |
| Method D | -6.23 psi | At $FS_D$ = | 1.5 | Queens Equation |

***Comparitive Factor of Safety against Drill Fluid Loss at Critical Joint***

| | | | | |
|---|---|---|---|---|
| Critical Joint = | 9 | Depth of Cover = | 65.9 ft | |
| Confining Pressure Calculation Method | Method A | Method B | Method C | Method D |
| Method (X)/$P_{annularA}$ | 1.18 | 2.01 | 3.87 | -0.15 |
| Method (X)/$P_{annularB}$ | 0.96 | 1.63 | 3.15 | -0.12 |

**Acceptable if Factor of Safety >=1.0**

**HORIZONTAL DIRECTIONAL DRILL ANALYSIS**
**PINEY CREEK CROSSING**
**PADEP SECTION 105 PERMIT NO.: E07-459**
**PA-BL-0126.0000-RD AND PA-BL-0126.0000-RD-16**
**(SPLP HDD No. S2-0142)**

**PINEY CREEK CROSSING**
**PADEP SECTION 105 PERMIT NO.: E07-459**
**PA-BL-0126.0000-RD AND PA-BL-0126.0000-RD-16**
**(SPLP HDD No. S2-0142)**

This reanalysis of the horizontal directional drill (HDD) installation of a 20-inch and 16-inch diameter pipeline crossing under Stream S-M3, Wetland M26, Lower Piney Creek Road, Stream S-M30 (Piney Creek), and High Street (State Road 866), is in accordance with Stipulated Order issued under Environmental Hearing Board Docket No. 2017-009-L for HDDs listed on Exhibit 2 of the Stipulated Order. This HDD is number 9 on the list of HDDs included on Exhibit 2. Activities at this HDD were initiated and suspended in June of 2017, before the issuance of the Order on August 9, 2017.

## PIPE INFORMATION

20-Inch: 0.456 wall thickness; X-65

16-Inch: 0.438 wall thickness; X-70

Pipe stress allowances are an integral part of the design calculations performed for each HDD.

## ORIGINAL HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 20-INCH

- Horizontal length: 1,529 feet (ft)
- Entry/Exit angle: 16 degrees
- Maximum Depth of cover: 70 ft
- Depth under UNT to Piney Creek (Stream S-M33): 37 ft
- Depth under Piney Creek (Stream S-M30): 35 ft
- Depth under adjacent wetlands (Wetland M26): 35 ft
- Pipe design radius: 1,556 ft

## ORIGINAL HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 16-INCH

- Horizontal length: 1,575 ft
- Entry/Exit angle: 16 degrees
- Maximum Depth of cover: 75 ft
- Depth under UNT to Piney Creek (Stream S-M33): 41 ft
- Depth under Piney Creek (Stream S-M30): 35 ft
- Depth under adjacent wetlands (Wetland M26): 35 ft
- Pipe design radius: 1,600 ft

## GEOLOGIC ANALYSIS

Based upon publications by the Pennsylvania Bureau of Topographic and Geologic Survey (BTGS, 2001; and Sevon, 2000), the Piney Creek HDD location is in the Appalachian Mountain Section of the Ridge and Valley Physiographic Province of Pennsylvania, underlain by sedimentary rocks consisting of sandstone, siltstone, shale, conglomerate, limestone, and dolomite. Local topography is characterized by long narrow ridges, broad to narrow rolling valleys of low relief, and natural slopes that are gentle and stable with some karst terrane (Sevon, 2000). The Lower Piney Creek HDD is located on the west limb of an anticline that has a strike trending northeast-southwest and dipping to the northwest.

The geology underlying the western portion of the Lower Piney Creek HDD is mapped as the undivided Coburn through Loysburg Formations (Ocl) of Ordovician age. These formations include the Coburn, Salona, Nealmont, Benner, Snyder, Hatter and Loysburg. The Coburn Formation is described as a medium-gray to very dark gray, fossiliferous and shaly limestone. Bedding is described as well bedded and thick, and fissile to flaggy. Joints are moderately to highly abundant, moderately well developed with blocky and platy patterns, regular, moderately spaced, and steeply dipping to vertical.

The geology underlying the eastern portion of the Lower Piney Creek HDD is mapped as the undivided Bellefonte and Axemann Formations (Oba) of Ordovician age. The Bellefonte Formation consists primarily of light to medium gray, very fine-grained dolomite although minor sandstone, chert, and medium crystalline dolomite are also present. Bedding is described as well bedded and thick to medium. Joints occur as steep to gently dipping joint sets that are moderately abundant, moderately to well developed with blocky patterns, regular, and moderately spaced.

Descriptions of the individual formations are provided in the Hydrogeology Report included as Attachment 1.

Two geotechnical drilling investigations were conducted at this HDD. The initial investigation was performed in September and January of 2015 during the preliminary investigation of HDD S2-0142, and prior to initiating HDD operations. A second phase of geotechnical drilling was performed in August of 2017.

Karst geology is present at this HDD location, and a geophysical survey was performed. As is discussed in the Hydrogeology Report in Attachment 1, the results of this assessment indicated a high degree of fracturing in the near subsurface geology from immediately west of Piney Creek to within 200 of the west end of the HDD. As is presented in the Reconsideration of the Horizontal Directional Drill section below. The use of HDD best management practices such as annular pressure monitoring; the use of additives, and Loss Control Materials, and potentially grouting, will be implemented to maintain returns in both the pilot and reaming phases of the HDD as measure to prevent IR's to the land surface or waters of the Commonwealth.

Attachment 1 provides a report on the general geology and results of the geotechnical drilling investigations in the vicinity of this HDD.

## HYDROGEOLOGY, GROUND WATER, AND WELL PRODUCTION ZONES

Groundwater at the site occurs in a fractured carbonate and clastic sedimentary bedrock aquifer system within the geology described above. Water-bearing zones generally occur in secondary openings developed along bedding planes, joints, faults and fractures. These features provide ready pathways for transporting water in the dolomite and limestone through the enhancement of the primary and secondary openings by solution activity.

A review of published data on water wells provided information on the hydrogeology underlying HDD S2-0142. The depths of 27 domestic wells in the Coburn Formation range from 28 to 400 ft below ground surface (bgs). The median well depth is 200 ft bgs, with five wells less than 100 ft deep and four wells greater than 300 ft deep. The depths of 36 reported domestic and non-domestic wells in the Bellafonte and Axemann Formations range from 42 to 500 ft bgs, with the median well depth of 156 bgs for domestic wells. Well yields ranged from 1 to 30 gallons per minute. The production zone for water wells in this geology is from the well bottom to highest point of water inflow from the water bearing seams, joints, and fractures in the rock formation. Water wells in bedrock can only pump water from inside the surface casing and open rock interval within the bore annulus, and water volume from the top water elevation down to the pump intake.

The HDD profiles subject to this Reevaluation will physically pass through the potential "recharge zones" of water wells in vicinity to the HDD. As stated above, as referenced from the Hydrogeologic Report in Attachment 1, ***"Groundwater at the site occurs in a fractured carbonate and clastic sedimentary bedrock***

***aquifer system within the geology described above. Water-bearing zones generally occur in secondary openings developed along bedding planes, joints, faults and fractures***." To explain further, this means that available groundwater is stored within, and moves through, fissures and bedding plane partings in the bedrock. A water well in a bedrock formation is a simple vertical hole in the bedrock that intercepts water bearing fissures and bedding plane partings and provides an open vertical annulus for the water within the bedrock to flow into and fill (recharge) with a volume of water rising towards the land's surface until equilibrium with the piezometric surface in bedrock formation is achieved.

Any technically defensible analysis of the movement of groundwater in this unique geology is dependent upon information on the orientation of the fissures and bedding plane partings; their width; do they dip or incline, and to what extent hydrostatic forces or the effects of gravity influence the movement of water in these bedrock features. This information, however, cannot be determined for a given well location in this geology even with extensive geologic coring and water investigation because the bedrock characteristics for these features and behavior can vary significantly in each core. Furthermore, the private water supply yields are governed by well construction and resulting well efficiency and its relation to the available water bearing fissures and bedding plane parting horizons they intercept and does not reflect a homogenous consistency as seen in layered unconsolidated aquifers.

In addition, the effect of the HDD on a given water supply well will depend upon the level of use and resultant groundwater draw at a specific time. According to water use data published by Pennsylvania State University (https://extension.psu.edu/water-system-planning-estimating-water-needs) in general, a household will use 50 to 100 gallons per person per day (200 to 400 gallons per day for a family of four). For a drilled well, the borehole provides a significant amount of water storage. A typical 6-inch-diameter well will store about 1.5 gallons of water for every foot of standing water in the borehole and a 10-inch well stores about 4 gallons of water per foot. Therefore, a 6-inch-diameter well with about 100 feet of standing water in the borehole would contain about 150 gallons of stored water.

Use of this water and the resulting draw upon adjacent groundwater within the fractured bedrock is cyclic throughout the day, with the greatest demand occurring during morning and evening hours and on weekend days and holidays when residents are generally home.

In sum, the variability of the well yield and production can and often varies greatly over relatively short distances and time periods in these complex rock formations. The well production can be influenced by seasonal variability in precipitation, well construction, well consumption rates, recharge rates, infiltration rates, radius of influence (ROI) of other well systems, multiple production zones, and known and unknown geologic structural features (i.e., fissures, bedding planes and rock type). For these reasons discussed above, and consistent with the permit and incorporated plans, as amended, Sunoco Pipeline, L.P. (SPLP) will offer baseline, active drilling, and post drilling monitoring of all wells in the 450 feet buffer zone. This data will be used to evaluate the water chemistry and other physical characteristics of the water quality at the specific well location before, during and after construction, and if an impact occurs, the permit requires replacement of the water supply to the satisfaction of the well owner.

Attachment 1 provides an extensive discussion on the hydrogeology at this HDD location.

## INADVERTENT RETURNS DISCUSSION

An HDD was initiated at this location and an inadvertent return (IR) occurred during the HDD drilling operations in June of 2017. An initial loss of fluid circulation was observed along the HDD trajectory 82 ft from entry while drilling through limestone and shale. Drilling fluids were subsequently observed discharging into Stream S-M33 (UNT to Piney Creek). Drilling operations were shut down while containment and remedial measures were implemented. The investigation of this IR event identified the shallow depth of the original design profile for this HDD as the root cause; subsequently, this HDD was stopped for reevaluation.

The results of the new geotechnical core borings at the entry and exit points show the revised HDD profile will encounter and transition through mudstone and dolomite in the east portion and shale in the west portion. Overall rock quality parameters improve as depth below ground increases. The west core data show shale at top of bedrock with a recovery value of 30, and RQD value of 87, improving as depth increases with recovery values consistently at 60 and RQD values ranging from 77-90. At maximum profile depth, the recovery value is 60 and RQD value is 98. This is indicative of moderate to good overall rock integrity and strength at profile depth. The east core data shows the top of bedrock as shale with a recovery value of 60 and RQD value of 85. Proceeding to profile depth the HDD will enter and progress through mudstone and dolomite with recovery values ranging from 81-100, and RQD values ranging from 32 to 100.

At maximum depth of the revised profile, the geotechnical data is indicative of moderate overall rock quality, with overlying good quality rock stratum which assists in suppression of IRs.

## ADJACENT FEATURES ANALYSIS

This HDD location is approximately 3.7 miles southwest of Williamsburg, Pennsylvania. Land uses in the vicinity include managed or unmanaged forests, oil and gas (existing aboveground mainline valve), rural residential, and agriculture. The HDD would cross under two streams and one palustrine emergent (PEM) wetland. The crossings of streams S-M30 and S-M33 are located approximately 135 feet east and 270 feet west, respectively, of Lower Piney Creek Road. The crossing of Wetland M26, a PEM wetland, is located 135 feet east of Lower Piney Creek Road.

Stream S-M30 (Piney Creek) and Stream S-M33 have perennial flow regimes and are considered high quality cold water fisheries (HQ-CWF) under Chapter 93 designations and, as classified by Pennsylvania Fish and Boat Commission (PAFBC), are Class A streams, one of the Commonwealth's most high-quality trout waters. Wetland M26 is composed of PEM vegetative cover and designated as an exceptional value (EV) wetland under Pennsylvania Department of Environmental Protection (PADEP) Chapter 105.17, due to its proximity to a naturally reproducing trout stream. This HDD avoids direct surface impacts to these high quality streams and exceptional value wetlands.

Pre-construction, SPLP identified and attempted to contact all landowners with a parcel of land within 150 feet of the HDD alignments. Two (2) water wells were identified and tested as a result of that outreach.

SPLP has identified all landowners with property located within 450 feet of the HDD alignment. There are fourteen (14) individual parcels located within 450 feet of the HDD alignment. SPLP sent each of these landowners a notice letter via both certified and first class mail on October 30, 2017, that included an offer to sample the landowner's private water supply/well in accordance with the terms of the Order and the Water Supply Assessment, Preparedness, Prevention and Contingency Plan. The letter also requested that each landowner contact the right-of-way (ROW) agent for the local area and provide SPLP with information regarding: (1) whether the landowner has a well; (2) where that well is located, and its depth and size if known; and (3) whether the landowner would like to have the well sampled. In accordance with paragraph 10 of the Order, copies of the certified mail receipts for the letters sent to landowners have been provided to Karyn Yordy, Executive Assistant, Office of Programs at the Department's Central Office.

To date, eight (8) landowners responded verifying the presence of 10 private wells, of which seven (7) are within 450 ft of the HDD profile. Six of the parcels are vacant or undeveloped. A water supply illustration is included in Attachment 3 of the Hydrogeologic Report provided in Attachment 1 to this discussion.

Prior to the start of these HDDs, agents for SPLP will initiate direct contact by phone or in person, and SPLP will prepare a second communication specifically directed to all landowners with known wells, or unidentified water supplies within 450 ft of the HDD profiles. The letter will communicate our concern regarding their water supply. It will clearly state the preference to establishing communications in advance of the work; permission to perform monitoring during the HDDs, and landowners preference to installing alternative water in advance of the HDDs.

During the active HDD process, any landowner contacting SPLP with concerns about their water supply will be responded to. If an impact from the HDD is verified, then SPLP will encourage the affected landowner to allow the installation of alternative water supply.

## ALTERNATIVES ANALYSIS

As required by the Order, the reanalysis of S2-0142 includes an evaluation of open cut alternatives and a re-route analysis. As part of the PADEP Chapter 105 permit process for the Pennsylvania Pipeline Project, SPLP developed and submitted for review a project-wide Alternatives Analysis. During the development and siting of the project, SPLP considered a number of different routings, locations, and designs to determine whether there was a practicable alternative to the proposed impact. SPLP performed this determination through a sequential review of routes and design techniques, which concluded with an alternative that has the least environmental impacts, taking into consideration cost, existing technology, and logistics. The baseline route provided for the pipeline construction was to cross every wetland and stream on the project by open cut construction procedures. The Alternatives Analysis submitted to PADEP analyzed the potential feasibility of any alternative to the baseline route trenched resource crossings (e.g., reroute, conventional bore, HDD). The decision-making processes for selection of the HDD instead of an open cut crossing methodology is discussed thoroughly in the submitted alternatives analysis and was an important part of the overall PADEP approval of HDD plans as currently permitted. As described below, the open cut and re-route analyses have confirmed the conclusions reached in the previously submitted Alternatives Analysis.

### Open-cut Analysis

Conversion to an open cut trenched crossing method would result in direct but temporary impacts to: Streams S-M30 and S-M33, PADEP-designated HQ-CWFs and PAFBC-designated tributary to a Class A stream, one of the Commonwealth's most high-quality trout waters; and Wetland M26, a PEM wetland that is a PADEP-designated EV wetland, due to its proximity to a naturally reproducing trout stream.

SPLP specifications require a minimum of 48 inches of cover between the installed pipeline and the bottom of the watercourse. To meet this cover requirement, during trenched construction through the two streams (Streams S-M30 and S-M33), a workspace with a width up to 75 feet would be required to accommodate the pipelines and provide sufficient space for trench excavation, spoil storage, and sufficient separation between pipelines (including the existing 8-inch Sunoco pipeline and two proposed lines) for integrity management. The assessed area of impact by this open cut plan would directly affect approximately 0.8 acre of stream bed. Conventional crossings of these streams would require using upstream and downstream sandbag diversion dams or coffer dams, pumping stream flow around the trench/workspace, pumping out (from the in-stream workspace or excavated areas) any produced groundwater discharge or seepage around/under the dams (through water filter bags), for the duration of the crossing event. Although the temporary impacts would be controlled and managed using these appropriate best management practices, SPLP's preferred method is to drill below these resources.

Converting to an open cut trenched crossing method through this area would also result in 0.01 acre of temporary impacts to Wetland M26, a PEM wetland, designated as an exceptional value wetland under PADEP Chapter 105.17 due to its proximity to a naturally reproducing trout stream. The HDD will largely avoid surface impacts to biological features. In addition, as currently proposed, impacts from the HDD travel lane use results in 0.001 acre of temporary impacts to Wetland M26, 147 square feet (sq. ft.) of temporary impacts to Stream S-M30, and 30 sq. ft. of temporary impacts to Stream S-M33 of, resulting in a minimization of impacts to water resources. By contrast, the travel lane use associated with the open cut alternative results in 0.09 acre of temporary impacts to these water resources.

A conventional auger bore cannot replace this HDD due the length limitations of this technology and changes in elevation across its length. When considering the use of conventional auger bore to replace portions of this HDD, all the surface features listed above and Piney Creek Road have various elevational settings relative to the surrounding topography and adjacent features to be considered. A review of the HDD profile cross section illustrates that in each instance on all these, large areas of the adjacent slopes would have to be excavated to get down to the depth required to secondarily excavate a trench for the entry, receiving, and pipe segment pull back phase. At the crossing of stream S-M33 and adjacent wetlands, the presence of Lower Piney Creek Road to the east negates the ability to setup either the bore entry or pipeline pull back pits. Lower Piney Creek Road could be bored from the west side, but the east side proximity of Piney Creek prohibits either entry or pull back setup. Piney Creek itself is set too far below the adjacent slopes to cross by conventional auger bore.

### Re-Route Analysis

In accordance with state and federal guidance, SPLP has co-located the Project route within the existing SPLP pipeline or other utility corridors to avoid new “greenfield” routing alignments, to the maximum extent practicable. This avoids and minimizes new and permanent impacts on previously undisturbed land, new land use encumbrance, and site-specific and cumulative impacts on land, environmental, and community resources.

Because streams S-M30 and S-M33 extend north and south of this HDD and Wetland M26 extends further to the south of this HDD, no practicable re-route option lies to the north or south of the proposed route that would not ultimately cross streams or wetlands. Furthermore, if shifted to the north, the angle necessary to create a more northerly HDD would potentially place the pipelines parallel to or along the stream bed of Stream S-M34. As noted in the project permit application, reroutes to the north/south were not considered feasible as they would result in the clearing of additional forested lands (and potentially other wetlands) as well as previously undisturbed habitat, and potentially increased public health and safety/hazards risks to nearby residences in the area.

## RECONSIDERATION OF THE HORIZONTAL DIRECTIONAL DRILL

Additional geologic investigations have been completed and utilized in the redesign of the planned HDDs. These redesigns adjust the HDD profile deeper to place the HDD pathway through bedrock having better structural integrity than a shallower profile and increases the overall length of the HDD due to pipe design requirements. A summary of the redesign factors is provided below.

### Revised Horizontal Directional Drill Design Summary: 20-inch

- Horizontal length: 1,766 foot (ft)
- Entry/Exit angle: 16-17 degrees
- Maximum Depth of cover: 88 ft
- Depth under UNT to Piney Creek (Stream S-M33): 67 ft
- Depth under Piney Creek (Stream S-M30): 60 ft
- Depth under adjacent wetlands (Wetland M26): 61 ft
- Pipe design radius: 2,200 ft

**PINEY CREEK CROSSING**
**PADEP SECTION 105 PERMIT NO.: E07-459**
**PA-BL-0126.0000-RD AND PA-BL-0126.0000-RD-16**
**(SPLP HDD No. S2-0142)**

**Revised Horizontal Directional Drill Design Summary: 16-inch**

- Horizontal length: 1,674 foot (ft)
- Entry/Exit angle: 16-18 degrees
- Maximum Depth of cover: 86 ft
- Depth under UNT to Piney Creek (Stream S-M33): 60 ft
- Depth under Piney Creek (Stream S-M30): 56 ft
- Depth under adjacent wetlands (Wetland M26): 54 ft
- Pipe design radius: 2,100 ft

As shown on Figure 2, the redesigned HDD profile for the 20-inch pipeline is 237 ft longer, with a depth of cover below the streams and wetlands increased by 25-30 ft from the permitted design. In addition, the entry/exit angles have been increased allowing for a sharper and quicker descent into more competent rock. As shown on Figure 4 the redesigned HDD profile for the 16-inch pipeline is 99 ft longer, with a depth of cover below the streams and wetlands increased by 19-21 ft and designed for a sharp and quick entry and exit from the horizontal depth.

The redesign of the HDD will not prevent all IRs. The risk of IRs increases on entry and exit of the drilling tool and other measures are required to minimize IR potential. In particular, upon the start of these HDDs, Sunoco will employ the following HDD best management practices:

- SPLP will notify the drilling contractor of the high degree of fracturing in the karst geology west of Piney Creek, and provide them with the materials for reference against the profile such that the driller will know to pay close attention while the tools are progressing through this portion of the profile;

- SPLP will mandate rotational drilling of the pilot hole until competent bedrock is reached, such that the initial drilling at entry is performed at fluid pressures less than those required to operate the mud motor drive;

- SPLP will require and enforce the use of annular pressure monitoring during the drilling of the pilot holes, which assists in immediate identification of pressure changes indicative of loss of return flows or over pressurization of the annulus to manage development of pressures that can induce an IR;

- SPLP inspectors will ensure that an appropriate diameter pilot tool, relative to the diameter of the drilling pipe, is used to ensure adequate “annulus spacing” around the drilling pipe exits to allow good return flows during the pilot drilling;

- During the progression of the pilot hole phase on this HDD, SPLP will add DrilPlex to its drilling mud for the entire length of pilot hole progress;

- SPLP will implement short-tripping of the reaming tools as return flow monitoring indicates to ensure an open annulus is maintained to manage the potential inducement of IRs;

- SPLP will require monitoring of the drilling fluid viscosity, such that fissures and fractures in the subsurface are sealed during the drilling process;

- During the reaming phase, the use of Loss Control Materials (LCMs) can be implemented if indications of a potential IR are noted or an IR is observed; and

- If LCMs prove ineffective to mitigate loss of returns or IRs, then grouting of the pilot hole may be implemented.

## CONCLUSION

It is SPLP’s intent to modify the original profile design and to pursue a deeper and longer HDD profile. Figure 1 and 3 in Attachment 2 presents the original HDD plan and profiles. Figure 2 and 4 in Attachment 2 present the revised HDD plan and profiles.

**PINEY CREEK CROSSING**
**PADEP SECTION 105 PERMIT NO.: E07-459**
**PA-BL-0126.0000-RD AND PA-BL-0126.0000-RD-16**
**(SPLP HDD No. S2-0142)**

# ATTACHMENT 1

# GEOLOGY AND HYDROGEOLOGICAL EVALUATION REPORT

RETTEW

We answer to you.

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

Engineers

Environmental Consultants

Surveyors

Landscape Architects

Safety Consultants

December 21, 2017
**Revised March 2, 2018**

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

RE: Sunoco Pipeline, L.P. Pipeline Project - Mariner East II
Lower Piney Creek Horizontal Directional Drill Location (S2-0142)
Hydrogeological Re-evaluation Report
Woodbury Township, Blair County, Pennsylvania
RETTEW Project No. 096302011

**EXECUTIVE SUMMARY**


1. The Corrected Stipulated Order dated August 10, 2017 requires a re-evaluation of Lower Piney Creek Horizontal Directional Drill (HDD) Location S2-0142, including a geologic report.
2. The Lower Piney Creek HDD is underlain by carbonate and clastic sedimentary rocks of the undivided Coburn through Loysburg Formations (Ocl) and the undivided Bellefonte and Axemann Formations (Oba).
3. Geologic mapping, published reports, and field observations indicate the presence of jointed and fractured bedrock with low to high angle joints.
4. Water-bearing zones generally occur in secondary openings along bedding planes, joints, faults and fractures. Median well depth in the undivided Coburn through Loysburg Formations is 200 feet below the ground surface (bgs) and 156 feet bgs in the undivided Bellefonte and Axemann Formations.
5. The proposed HDD profile has been lengthened and deepened to provide additional cover beneath the streams that underlie the HDD profile.
6. Based on the hydro-structural characteristics of the underlying geology, and proposed HDD profile, the Lower Piney Creek HDD is susceptible to the inadvertent return (IR) of drilling fluids during HDD operations for the planned 16-inch and 20-inch drills. The redesigned HDD profile and HDD best management practices during drilling operations will be used to reduce the risk of an IR.


## 1.0 INTRODUCTION

The purpose of this report is to describe the geologic and hydrogeologic setting of the Lower Piney Creek (S2-0142) HDD location (the site) on the Sunoco Pipeline, L.P. (SPLP) Pennsylvania Pipeline Project-Mariner II East (PPP-ME2) Project. The Lower Piney Creek HDD is located in Woodbury Township, Blair County, Pennsylvania (refer to **Figure 1**). The HDD was designed to be drilled under a small unnamed tributary stream (S-M33) and associated wetland, Lower Piney Creek Road, Piney Creek, and High Street (SR 866). This re-evaluation report is part of the response to the Corrected Stipulated Order dated August 10, 2017 related to the inadvertent return of drilling fluids that occurred during HDD operations performed at the site on June 26, 2017.

The proposed HDD profile was lengthened and deepened on September 22, 2017 to provide additional protective cover beneath the stream and wetland crossings. The HDD entry on the eastern side of the profile is at an elevation of approximately 1,115 feet above mean sea level (AMSL) for the proposed 16-inch drill, and 1,113 feet AMSL for the proposed 20-inch drill. The HDD exit on the western side of the profile is at an elevation of approximately of 1,123 feet AMSL for the proposed 16-inch drill and 1,150 feet AMSL for the proposed 20-inch drill. The inclination of the entry and exit angles has been increased to install the pipe through these protective soils, residual soils, and bedrock; and in closer proximity to the entry and exit points than the original, shorter and shallower profile. The proposed 20-inch and 16-inch HDDs are located between Stations 6730+00 and 6749+00 on the overall pipeline alignment. The proposed S2-0142 HDD locations are shown on **Figure 1**. Based on the annular pressure and formation pressure capacity curves provided by Directional Project Support (DPS) as part of the overall re-evaluation submittal, the weakest points in the profile are the HDD entry, exit and the stream crossings. At the S-M33 crossing, the HDD profile is approximately 60 feet below the stream for the proposed 16-inch drill and 67 feet below the stream for the proposed 20-inch drill. At the Piney Creek crossing, the HDD profile is approximately 56 feet below the stream for the proposed 16-inch drill and 60 feet below the stream for the proposed 20-inch drill. Copies of the revised HDD profiles are included in **Attachment 1.**

## 2.0 GEOLOGY AND SOILS

Based upon publications by the Pennsylvania Bureau of Topographic and Geologic Survey (BTGS, 2001; and Sevon, 2000), the site is in the Appalachian Mountain Section of the Ridge and Valley Physiographic Province of Pennsylvania, underlain by sedimentary rocks consisting of sandstone, siltstone, shale, conglomerate, limestone, and dolomite. Local topography is characterized by long narrow ridges, broad to narrow rolling valleys of low relief, and natural slopes that are gentle and stable with some karst terrane (Sevon, 2000). The Lower Piney Creek HDD is located on the west limb of an anticline that has a strike trending northeast-southwest and dipping to the northwest.

According to the United States Department of Agriculture (USDA) Soil Surveys of Blair County, Pennsylvania, soils in the vicinity of the Piney Creek HDD consist of 12 separate soil units. A USDA map that depicts the area surrounding the HDD, along with soil profile descriptions, is included as **Attachment 2**.

The geology underlying the western portion of the Lower Piney Creek HDD is mapped as the undivided Coburn through Loysburg Formations (Ocl) of Ordovician age as shown on **Figure 2**. These formations include the Coburn, Salona, Nealmont, Benner, Snyder, Hatter and Loysburg. The Coburn Formation is described as a medium-gray to very dark gray, fossiliferous and shaly limestone. Bedding is described as well bedded and thick, and fissile to flaggy. Joints are moderately to highly abundant, moderately well developed with blocky and platy patterns, regular, moderately spaced, and steeply dipping to vertical. Most joints are open; however, some are filled with calcite. These rocks are moderately resistant to weathering and slightly weathered to a shallow depth. The shaly limestone is moderately weathered to a deeper depth. Weathering in the limestone results in medium-sized blocks. The shaly limestone weathers to small, pencil-like, flat fragments. The overlying mantle is moderately thick and the bedrock-mantle is usually pinnacled. From an engineering standpoint, excavation is difficult and the pinnacles present a special problem. Drilling rates are moderate in the shaly limestone of the Coburn Formation. Slope stability is good in the limestone and fair to poor in the shaly limestone; however, slope stability is fair where bedding is steeply inclined toward cut slopes. While foundation stability is fair, excavations should be completed to sound material and evaluated for areas of collapse. Subsurface drainage is good and surface drainage is poor. Sinkholes are common in the carbonate units of the Coburn Formation. Secondary porosity of moderate to high magnitude is provided by joints and solution features resulting in high permeability (Geyer and Wilshusen, 1982).

The Salona Formation is described as a dark gray to black, laminated, medium to coarse-grained, fossiliferous limestone with chert nodules. Bedding is described as well bedded and mostly fissile to flaggy with a few thick beds. Joints are moderately well developed with primary blocky patterns and secondary platy patterns, fairly regular, moderately well developed, moderately to highly abundant, and with moderate space between fractures. Most fractures are open but some are filled with calcite. Fractures are reported to be steeply dipping to vertical. These rocks are moderately resistant to weathering and slightly weathered to a shallow depth; shaly limestone beds weather moderately to a deeper depth. Limestone units weather to medium blocks and shaly limestone weathers to small, flat, pencil-like fragments. The overlying mantle is thick and characterized by bedrock pinnacles. From an engineering standpoint, excavation is difficult and the pinnacles present a special problem. Drilling rates are moderate. Slope stability is good in the limestone; however, the shaly limestone is susceptible to moisture and provides only fair, short-term stability. Foundation stability is good when excavations are completed to sound material, but should be thoroughly investigated for solution activity. Subsurface drainage is good and surface drainage is poor. Sinkholes are common in the Salona Formation. Secondary porosity is moderate to high due to joints and solution activity. Permeability is low to moderate (Geyer and Wilshusen, 1982).

The Nealmont Formation is described as a medium gray, coarsely crystalline, fossiliferous limestone at the top of the formation and a thin bedded, finely crystalline, shaly limestone at the base. The Nealmont Formation is typically well bedded and fissile to flaggy, with rare thickly bedded strata. Joints primarily exhibit blocky patterns with a few displaying platy patterns. Joints are moderately well developed, moderately to highly abundant, fairly regular and show a moderate distance between joints. Most fractures are open but some are filled with calcite. Joints are typically steeply dipping to vertical. The Nealmont Formation is moderately resistant to weathering and slightly weathered to a shallow depth. Weathering results in medium-sized blocks. The overlying mantle is moderately thick and usually characterized by sinkhole development and bedrock pinnacles. From an engineering standpoint, excavation is difficult and bedrock pinnacles present a special problem often requiring additional excavation to sound material. Drilling rates are fast. Slope stability is good, however steeply dipping beds inclined toward the cut face only provide fair stability. Foundation stability is good and should be excavated to sound material thoroughly investigated for solution activity. Subsurface drainage is good and surface drainage is poor. Secondary porosity is moderate to high due to jointing and bedrock solution activity. Permeability is moderate (Geyer and Wilshusen, 1982).

The upper portion of the Benner Formation is described as a light to dark gray, very finely crystalline limestone that includes a high-calcium limestone known as the Valentine Member and an argillaceous (shaly) limestone with metabentonite beds known as the Valley View Member. The Benner Formation is well bedded and fissile to flaggy with some locally thick beds. Joints are typically steeply dipping, moderately well developed, moderately to highly abundant, fairly regularly distributed with a moderate distance between joints. Most joints have a blocky pattern, but some are platy. Most fractures are open but some are filled with calcite. The Benner Formation is moderately resistant to weathering and is only slightly weathered to shallow depths, resulting in medium sized joint blocks. The shaly limestone is moderately weathered to a deeper depth and weathers to form small, pencil-like fragments. The mantle is moderately thick and characterized by sinkhole development and bedrock pinnacles. From an engineering standpoint, excavation is difficult and the bedrock pinnacles present a special problem often requiring additional excavation to sound material. Drilling rates are moderate. Slope stability is good; however, steeply dipping beds inclined toward the cut face provide only fair stability. Foundation stability is good and should be excavated to sound material with thorough investigation for solution activity. Subsurface drainage is good and surface drainage is poor. Secondary porosity is moderate to high due to the presence of joints and bedrock solution activity. Permeability is low (Geyer and Wilshusen, 1982).

The Snyder Formation is described as a medium to medium dark gray, coarsely crystalline limestone containing limestone conglomerate beds. There are numerous impure bands of medium medium-dark gray limestone with mud cracks and ripple marks, laminated, finely crystalline dolomitic limestone, light gray, very finely crystalline limestone, and medium dark gray, fine-grained oolitic and mud pellet limestone. The Snyder Formation is well bedded and platy to thick. Joints are moderately well developed and abundant, regularly spaced, and show a moderate distance between joints. Joints generally display a blocky pattern although a few show a platy pattern. Most joints are steeply dipping and open, but some are filled with calcite. The Snyder is moderately resistant to weathering and slightly weathered to a shallow depth. From an engineering standpoint, excavation is difficult and bedrock pinnacles present a special problem often requiring additional excavation to sound material. Drilling rates are fast. Slope stability is good, however steeply dipping beds inclined toward the cut face only provide fair stability. Foundation stability is good and should be investigated for sinkhole development and bedrock solution activity. Subsurface drainage is good and surface drainage is poor. Sinkholes are common in the Snyder Formation. Secondary porosity is moderate to high due to the presence of joints and bedrock solution activity. Permeability is low to moderate (Geyer and Wilshusen, 1982).

The Hatter Formation is described as a medium gray, silty and shaly limestone that is laminated and dolomitic. The Hatter Formation is typically well bedded, fissile to flaggy, though thick bedded in some locations. Joints are typically steeply dipping to vertical, moderately well developed, moderately to highly abundant, and fairly regularly spaced with a moderate distance between joints. Most fractures are open but some are filled with calcite. The Hatter Formation is moderately resistant to weathering and slightly weathered to a shallow depth resulting in medium-sized blocks. The shaly limestone is moderately weathered to a deeper depth. The mantle is moderately thick and characterized by bedrock pinnacles. From an engineering standpoint, excavation is difficult and bedrock pinnacles present a special problem often requiring additional excavation to sound material. Drilling rates are moderate. Slope stability is generally good, but only fair in the shaly limestone. However, steeply dipping beds inclined toward the cut face provide fair stability. Foundation stability is generally good, but due to the common occurrence of sinkholes in the Hatter Formation, foundations should be excavated to sound material and thoroughly investigated for bedrock solution activity. Subsurface drainage is good and surface drainage is poor. Secondary porosity is moderate to high due to bedrock jointing and solution activity. Permeability is moderate to high (Geyer and Wilshusen, 1982).

The Loysburg Formation is comprised of the Clover Member and the Milroy Member. The Clover Member is described as a light to medium gray, shaly limestone. The Milroy Member is described as an alternating medium-gray, limestone, dolomitic limestone, and dolomite. The Loysburg Formation is well bedded and thick. Joints are moderately well developed, moderately to highly abundant, fairly regularly spaced, and display a moderate distance between joints. Joints show a blocky pattern and platy patterns locally. Most joints are steeply dipping to vertical and open, but some are filled with calcite. The Loysburg Formation is moderately resistant to weathering and slightly weathered to a shallow depth resulting in medium-sized blocks. The mantle is moderately thick and characterized by bedrock pinnacles. From an engineering standpoint, excavation is difficult and bedrock pinnacles present a special problem often requiring additional excavation to sound material. Drilling rates are moderate. Slope stability is generally good; however, steeply dipping beds inclined toward the cut face provide only fair stability. Foundation stability is good, but due to the common occurrence of sinkholes in the Loysburg Formation, the bedrock should be investigated for solution activity. Subsurface drainage is good and surface drainage is poor. Secondary porosity is moderate to high due to joints and bedrock solution activity. Permeability is moderate (Geyer and Wilshusen, 1982).

The geology underlying the eastern portion of the Lower Piney Creek HDD is mapped as the undivided Bellefonte and Axemann Formations (Oba) of Ordovician age as shown on **Figure 2**. The Bellefonte Formation consists primarily of light to medium gray, very fine-grained dolomite although minor sandstone, chert, and medium crystalline dolomite are also present. Bedding is described as well bedded and thick to medium. Joints occur as steep to gently dipping joint sets that are moderately abundant, moderately to well developed with blocky patterns, regular, and moderately spaced. Most joints are open, however some are filled with calcite. These rocks are moderately resistant to weathering and slightly weathered to a shallow depth. Weathering results in the formation of blocky fragments. The overlying mantle displays a variable thickness and bedrock pinnacles are characteristic features of this formation. From an engineering standpoint, excavation is difficult and the bedrock pinnacles present a special problem often requiring additional excavation to sound material. Drilling rates in this formation are slow. Slope stability is generally good, but intersecting joint and bedding planes can be problematic in deep cuts. Foundation stability is good and should be evaluated for areas of collapse. Subsurface drainage is good and surface drainage is minor. Secondary porosity of low to moderate magnitude is provided by joints and bedrock solution features. Permeability is low (Geyer and Wilshusen, 1982).

The Axemann Formation consists of light gray, fossiliferous and coarsely crystalline limestone, interbedded with fine-grained dolomitic limestone, and some oolitic and conglomeratic limestone. Flint and chert concretions are found throughout the formation. This unit is described as well bedded, with individual beds ranging from thick to thin. Joints are steeply dipping, moderately abundant, well developed, regularly spaced with a blocky pattern, and with a moderate distance between joints. Most joints are open, however some are filled with calcite. These rocks are moderately resistant to weathering and only slightly weathered to a shallow depth. Weathering results in small to large blocky fragments. The thickness of the overlying mantle is variable due to the presence of bedrock pinnacles. From an engineering standpoint, excavation is difficult and the bedrock pinnacles present a special problem often requiring additional excavation to sound material. Drilling rates in this formation are moderate. Slope stability is good, however steeply dipping beds toward the cut slope may require moderate to gentle slope gradients. Secondary porosity of moderate to high magnitude is provided by joints and bedrock solution features. Permeability is moderate (Geyer and Wilshusen, 1982).

## 3.0 HYDROGEOLOGY

Groundwater at the site occurs in a fractured carbonate and clastic sedimentary bedrock aquifer system within the geology described in Section 2.0. In these rock types of Blair County, water-bearing zones generally occur in secondary openings developed along bedding planes, joints, faults and fractures. Most of the water-bearing zones penetrated by wells occur in individual fractures or groups of interconnected fractures that can be sufficiently enlarged by dissolution of the bedrock. These features provide ready pathways for transporting water in the dolomite and limestone through the enhancement of the primary and secondary openings by solution activity (Taylor, 1982).

A review of published data on water wells provided information on the hydrogeology underlying the site. The depths of 27 domestic wells in the Coburn Formation range from 28 to 400 feet bgs. Well yields ranged from 1 to 25 gallons per minute (gpm) in 25 wells, and the median well yield is 6 gpm. The median well depth is 200 feet bgs, with five wells less than 100 feet deep and four greater than 300 feet deep (Taylor, 1982).

The depths of 36 reported domestic and non-domestic wells in the Bellefonte and Axemann Formations range from 42 to 500 feet bgs, with yields ranging from 1 to 250 gpm. The median well depth for domestic wells is 156 feet bgs. Median well yields are 10 gpm for domestic wells and 30 gpm for non-domestic wells. Ten of the reported domestic wells meet domestic yield requirements at depths of less than 100 feet bgs. Eight domestic wells had to be drilled to depths greater than 300 feet to meet desired yields (Taylor, 1982).

Well records reviewed within a 0.5-mile radius of the HDD location were obtained from the Pennsylvania Groundwater Information System (PaGWIS, October 11, 2017). A total of three well records were available and are summarized below. The well locations are shown on **Figures 2** and **3.**

| Well No. | Well Use | Casing Depth | Total Depth | Water Level | Yield |
|---|---|---|---|---|---|
| 60027 | Domestic | 31 feet | 185 feet | Unknown | Unknown |
| 59929 | Domestic | 80 feet | 105 feet | Unknown | Unknown |
| 3672 | Domestic | Unknown | 1,010 feet | Unknown | Unknown |

As a condition of the corrected Stipulated Order, other Sunoco subcontractors have researched private water supplies with 450 feet of the Lower Piney Creek HDD in November of 2017. One additional spring and three wells were identified within the 450-foot buffer of the alignment. The well depths range from 149 feet bgs to 250 bgs. Information regarding depth to water is limited to one well with a reported depth to water of 70 feet bgs. A map of these locations is included as **Attachment 3.**

## 4.0 FRACTURE TRACE ANALYSIS

Fracture traces underlying, or in close proximity to, the Lower Piney Creek HDD were evaluated using historical aerial photographs from the years 1994 through 2015 (Google Earth, 2017), the Frankstown 7.5 Minute Quadrangle Geologic Map (Berg and Dodge, 1981) and United States Geological Survey (USGS) 7.5 Minute Quadrangle Topographic Map. The photographs, publications and maps were reviewed to approximate the locations of natural linear fracture trace features or lineaments expressed on the ground surface. The linear features may be the surficial representation of deeper fractures, joints, faults or bedding planes within the subsurface which can transmit groundwater through the fractured bedrock aquifer at the site.

**Figures 2** and **3** show the results of the fracture trace analysis overlain on the geologic map of the site and an aerial basemap. A total of seven fracture traces were identified within approximately one mile of the site that are likely related to the primary geologic structure of the area discussed above. Due to the nature of the ridges and folded geology near the site, several of the bedding-parallel fracture traces trend approximately Northeast-Southwest (NE-SW). Bedding-perpendicular fracture traces were identified in the approximately West-East (W-E) fracture lineaments which are presumed to be stress-related joint sets. General surface drainage patterns near the site are characterized by linear stream reaches in NE-SW or W-E trends that reflects the local geologic structure. Lower Piney Creek flows generally SW-NE where it discharges to the Juniata River, which forms a structurally controlled regional groundwater discharge boundary in Blair County.

## 5.0 GEOTECHNICAL EVALUATION

Two geotechnical drilling investigations were performed at the site; the initial investigation was performed in September and January of 2015 during the preliminary investigation of HDD S2-0142, and prior to initiating HDD operations. A second phase of geotechnical drilling was performed in August of 2017. The 2015 test borings were advanced by hollow-stem augers and NQ-sized wireline rock coring techniques. These borings are designated as SB-01, SB-02, and SB-03. The more recent 2017 test borings were advanced using mud-rotary and NQ-sized wireline rock coring methods. Soil, residual soil and weathered bedrock were sampled using split-spoon samplers. These borings are designated as B3-1W and B3-1E. Geotechnical boring logs are included in **Attachment 1**.

Boring SB-01 was located approximately 400 feet southeast of the HDD exit. SB-02 was located approximately 250 feet north of the profile on the west side of Lower Piney Creek Road. SB-03 was located approximately 50 feet north of the HDD entry. Boring B3-1W was located approximately 360 feet southeast of the HDD exit, and Boring B3-1E was located approximately 80 feet north of the HDD entry. The locations of these borings are depicted on **Figures 2** and **3.**

The generalized subsurface profile at the site, as observed in the borings, is described as follows:

- Soil and residual soil depths vary from 9 to 11 feet bgs. The residual soils are described as follows:
    - **Boring SB-01**: SILT (ML) with some fine sand and fine to coarse SAND and GRAVEL (SM/GM) with little silt. The boring was terminated at auger refusal (10 feet bgs). Two additional attempts were made and refusal was encountered at 8 feet and 8.5 feet bgs, respectively. Groundwater was not encountered.
    - **Boring SB-02:** CLAY and SILT (CL/ML), trace fine sand, trace gravel (limestone). Auger refusal was encountered at 9 feet bgs. Groundwater was not encountered.
    - **Boring SB-03:** Fine SAND (SM) with some silt, little fine gravel. CLAY and SILT (CL/ML), fine to coarse SAND and GRAVEL (SM/GM) with some silt. Auger refusal was encountered at 11 feet bgs. A second attempt was made to auger deeper, but refusal was encountered at 11.8 feet bgs. Groundwater was not encountered.
    - **Boring B3-1W:** Lean CLAY (CL) with trace sand. Refusal was encountered at 10 feet bgs. Groundwater was not encountered.
    - **Boring B3-1E:** Lean CLAY (CL) with gravel. Cobbles and weathered bedrock were encountered at 4.5 feet bgs. A roller bit was used to drill to 15 feet bgs and casing was installed to 13.5 feet bgs to facilitate coring. Groundwater was not encountered.

- At depths of auger or split-spoon refusal, and to the total depth of the NQ cores, weathered bedrock and bedrock were encountered and are described as follows:
    - **Boring SB-01:** Rock coring was not completed at this location.
    - **Boring SB-02:** SB-02 was completed to a total depth of 17 feet bgs. A gray moderately to highly fractured limestone with calcite deposits was encountered from 9 to 17 feet bgs. Fracture plane dips ranged from 15° to 45°. Rock recoveries were good (92% to 94%) and rock quality designations (RQD) were poor (17% to 54%).
    - **Boring SB-03:** Rock coring was not completed at this location.
    - **Boring B3-1W:** B3-1W was completed to a total depth of 195 feet bgs. From 10 to 195 feet bgs, a dark gray SHALE and calcareous SHALE were observed. The shale was fine grained, moderately hard to hard, and fresh to moderately weathered. Joints range from low to high angle and are closely spaced. Some joints are filled with coal, and calcareous veins were observed at 56, 71 to 73, 80, 151, 152.5, and 167.5 feet bgs. At 80 feet bgs, pyrite was observed in the veins. Quartz veins were observed from 108 to 110 feet bgs. At 135 feet bgs, a 2-inch thick seam of soft, dark, oily clay was observed with highly weathered shale present at 138 feet bgs. Rock recoveries were very poor to excellent (23% to 100%) and generally excellent below a depth of 35 feet bgs. RQDs were very poor to excellent (0% to 100%). The weakest recoveries and RQDs were reported at the transition from soil/residuum/weathered mantle and the bedrock interface. Poor RQDs were reported from 30.5 to 35 feet bgs (33%) and from 50 to 55 feet bgs (42%). From 55 feet bgs to the completion depth of 195 feet bgs, RQDs were fair to excellent (67% to 100%). Groundwater was encountered at 14.5, 24.5, and 27.5 feet bgs during, and up to 14 hours after, drilling operations.
    - **Boring B3-1E:** B3-1E was completed to a total depth of 190 feet bgs. A light gray argillaceous SHALE was observed from 15 to 35 feet bgs. The shale is described as moderately hard, slightly weathered and thinly bedded. Joints are moderately dipping and closely spaced. Some clay joint filling was also observed. In the shale, recoveries were excellent (95% to 100%) and RQDs were good to excellent (80% to 91%). A very light gray argillaceous MUDSTONE was observed from 35 to 105 feet bgs. The mudstone is described as medium to hard and slightly to moderately weathered. Moderate to high angle closely-spaced joints were identified. Some joints were filled with clay. Some quartz and calcite veins were observed. A void was encountered from 98 to 100 feet bgs. In the mudstone, recoveries were good to excellent (75% to 100%) and RQDs were poor to excellent (28% to 100%). From 105 to 180 feet bgs, a very light gray to medium gray argillaceous DOLOMITE was encountered. The dolomite is described as hard and fresh to slightly weathered. Within the dolomite unit, joints are low angle to vertical and closely spaced. Recoveries were excellent (92% to 100%) and RQDs were poor to excellent (25% to 100%). From 180 to 190 feet bgs, a medium dark gray argillaceous, calcareous LIMESTONE was encountered. The limestone is described as hard and fresh, with low angle closely spaced joints. In the limestone, recoveries were good to excellent (80% to 100%) and RQDs were fair to excellent (68% to 90%). Groundwater was observed at 64.5, 89.0, and 105.5 feet bgs during, and up to 14 hours after, drilling operations.

Unconfined compressive strength testing was performed on core samples, and these testing results are summarized in the table below.

| Boring | Sample Depth (feet bgs) | Compressive Strength (psi) |
|---|---|---|
| SB-02 | 14 | 16,180 |
| B3-1W | 29 | 19,450 |
| B3-1W | 51 | 15,770 |
| B3-1W | 72 | 23,601 |
| B3-1W | 92 | 21,473 |
| B3-1W | 112 | 20,110 |
| B3-1W | 132 | 7,937 |
| B3-1W | 137 | 1,916 |
| B3-1W | 147 | 25,319 |
| B3-1W | 157 | 25,573 |
| B3-1E | 35 | 12,575 |
| B3-1E | 54 | 6,542 |
| B3-1E | 75 | 6,771 |
| B3-1E | 95 | 19,679 |
| B3-1E | 115 | 948 |
| B3-1E | 132 | 2,490 |
| B3-1E | 147 | 25,589 |
| B3-1E | 152 | >29,829 |

It should be noted that RETTEW did not oversee or direct the geotechnical drilling program associated with the Lower Piney Creek HDD, including but not limited to, the selection of boring locations, determination of location, determination of surface elevation, target depths, observations of rock cores during drilling operations, or preparation of boring logs. The geotechnical reports, boring logs, and core photographs that resulted from these programs were generated by other Sunoco Pipeline, L.P. contractors. RETTEW relied on these reports and incorporated their data into the general geologic and hydrogeologic framework of the analysis of the Lower Piney Creek HDD in this report.

## 6.0 FIELD OBSERVATIONS

RETTEW staff were on-site on June 26, 2017 when an IR occurred during HDD drilling operations. At 12:10 PM, an initial loss of fluid circulation was observed along the HDD trajectory at a distance of 82 feet while drilling through limestone and shale. Drilling fluids were subsequently observed discharging into stream S-M33 at 2:25 P.M. Based on site observations S-M33 is a disappearing, or sinking, limestone stream located northwest of the associated wetland shown on the HDD profile (**Attachment 2**). This surface stream feature may drain to subsurface solution features underlying the HDD profile. Drilling operations were shut down while containment and remedial measures were implemented.

A field investigation was performed by RETTEW staff on October 20, 2017, to identify rock outcrops for fracture fabric analysis, evaluation and ground-truthing of fracture traces identified during the desktop exercise, and to identify potential sensitive receptors to IRs. Readily accessible bedrock outcrops were limited in the immediate vicinity of the HDD. Strike and dip structural geologic measurements were collected from a small exposure of limestone bedrock identified on **Figures 2** and **3.** The average strike of bedding measured at this outcrop was 39° with an average dip of 36° NW. The average strike of the joints identified at this outcrop was 280° with an average dip of 20° SW. These field data are consistent with the published geologic data, mapping, and fracture traces identified in Section 4.0.

Based on the initial IR event and above site reconnaissance, no additional sensitive receptors beyond the previously mapped surface stream S-M33, associated wetland, and Piney Creek were identified.

## 7.0 GEOPHYSICAL SURVEY

A non-intrusive geophysical survey was performed at the Lower Piney Creek HDD from December 6th through December $8^{th}$, 2017. The purpose of the geophysical survey was to determine the depth to bedrock, overburden thickness, and identify areas of solid and fractured rock. Seismic refraction and electrical resistivity methods were used in the survey. The multichannel analysis of surface waves (MASW) method was proposed, but not performed, due to shallow bedrock limitations. The geophysical survey report is provided as **Attachment 4**; a summary is provided below.

Results of the seismic refraction survey indicated stratigraphy of unconsolidated material and bedrock. Depth to bedrock was estimated at 20 feet bgs along to the pipeline alignment, in addition to the occurrence of karst pinnacling in the carbonate rock. Several low-velocity zones were identified in underlying bedrock that may be indicative of weathered or fractured zones. Along the pipeline profile, these zones were identified at stations 6729+00, 6731+00, 6732+50, 6734+00, and 6737+00. Seismic data returns across Piney Creek had signal interference. As a result, the data across Piney Creek are not included on the seismic profiles.

Results of the electrical resistivity survey indicated similar stratigraphy of unconsolidated material overlying bedrock. Overburden thickness was estimated at 10 to 30 feet bgs, with shallower depths more correlative to the overburden thickness observed in geotechnical borings drilled at this location and described in Section 5.0. The layer of low-resistivity zones over high-resistivity zones generally correlate to overburden overlying more competent bedrock. Low-resistivity zones observed at deeper depths within bedrock may represent weathered or fractured bedrock. Along the pipeline profile, these zones were identified at stations 6729+00, 6730+25, 6731+50, 6732+00, 6732+75, 6733+25, 6734+00, 6735+00, 6736+00, 6736+50, 6738+00, and 6739+00.

## 8.0 CONCEPTUAL HYDROGEOLOGIC MODEL AND CONCLUSION

Based on published geologic and hydrogeologic information, and the evaluation of geotechnical borings from the site, the Lower Piney Creek HDD location is underlain by carbonate and clastic sedimentary rocks of the Coburn through Loysburg Formations (undivided), and Axemann and Bellefonte Formations (undivided). The hydrogeologic setting is dominated by groundwater flow that occurs in secondary openings formed along geologic features that include bedding planes, joints, faults, and fractures. The secondary openings may be enlarged or enhanced to some degree by dissolution of the underlying carbonate rocks. Field measurements, geotechnical rock core observations, and shallow geophysical survey results confirmed that local bedrock is moderately to highly fractured with low to high angle joints. The proposed HDD profile is relatively shallow compared to the land surface and surface streambeds (S-M33 and Piney Creek), and passes through both the soil overburden and the fractured bedrock. Based on the hydro-structural characteristics of the underlying geology, the revised profile through shallow soils and bedrock, and the previous IR that occurred during HDD operations, the Lower Piney Creek HDD is susceptible to the inadvertent return of drilling fluids during HDD operations. As a result, the HDD profile was re-designed to allow for deeper crossings beneath the streams. The inclination of the entry and exit angles has been increased as a means to install the pipe through these protective soils, residual soils, and bedrock, and in closer proximity to the entry and exit points than the original, shorter and shallower profile. From a geologic perspective, the longer and deeper profile, in conjunction with the proposed engineering controls and/or drilling best management practices, will be used to reduce the risk of an IR. The locations of fracture zones identified during the geophysical survey will be monitored during HDD operations.

## 9.0 REFERENCES

Berg, T. M., and Dodge, C. M., compilers and eds., 1981, Atlas of preliminary geologic quadrangle maps of Pennsylvania: Pennsylvania Geological Survey, 4th ser., Map 61, 636 p.

Geyer, A. R., and P. J. Wilshusen, 1982, Engineering Characteristics of the Rocks of Pennsylvania, Pennsylvania Topographic and Geologic Survey, Environmental Geology Report 1, Second Edition, 300 pages.

Google Earth Pro, 2017, Version 7.1.8.3036, October 11, 2017.

Pennsylvania Bureau of Topographic and Geologic Survey, Department of Conservation and Natural Resources, 2001, Bedrock Geology of PA, Edition: 1.0, Digital Map. Retrieved from internet October 10, 2017; HTTP://www.dcnr.state.pa.us/topogeo/map1/bedmap.aspxDL Data: Page oexp.zip [HTTP://www.dcnr.state.pa.us/topogeo/map1/bedmap.aspx].

Pennsylvania Department of Conservation and Natural Resources, Pennsylvania Groundwater Information System (PaGWIS) database, website address: http://www.dcnr.pa.gov/Conservation/Water/Groundwater/PAGroundwaterInformationSystem/Pages/default.aspx, accessed October 11, 2017.

Sevon, D., 2000, Map 13, Physiographic Provinces of Pennsylvania, Pennsylvania Bureau of Topographic and Geologic Survey, Harrisburg, Pennsylvania.

Taylor, L. E., 1982, Groundwater Resources of the Juniata River Basin, Pennsylvania, Pennsylvania Geologic Survey, 4th Series, Water Resource Report 54, 144 pages.

United States Department of Agriculture, 2017, Natural Resources Conservation Service, Published Soil Surveys for Pennsylvania, Blair County, Pennsylvania: website address: https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx, accessed October 10, 2017.

## 10.0 CERTIFICATION

The studies and evaluations presented in this report (other than Section 5) were completed under the direction of a licensed professional geologist (P.G.), and are covered under the P.G. seals that follow.

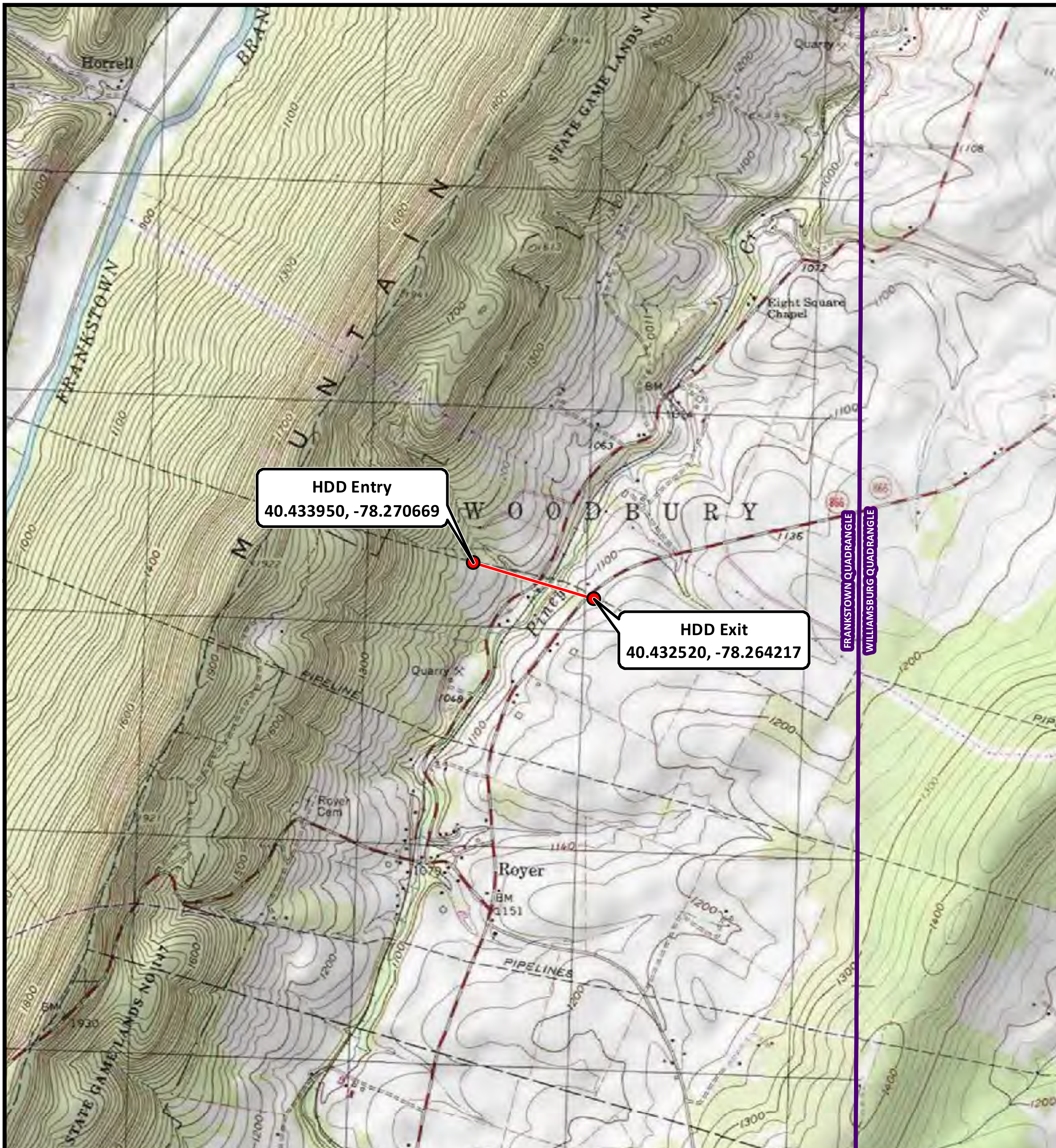
By affixing my seal to this document, I am certifying that, to my knowledge and belief, the information herein is true and correct. I further certify, that I am licensed to practice in the Commonwealth of Pennsylvania and that it is within my professional expertise to verify the correctness of the information herein.

Douglas J. Hess, PG
License No. PG000186G

Ethan E. Prout, PG
License No. PG003884

Christopher T. Brixius, PG
License No. PG004765

# FIGURES




HDD Entry/Exit

HDD Profile

Frankstown & Williamsburg, PA USGS 7.5' Topographic Quadrangles

11/9/2017

# Sunoco Pipeline, L.P.

## Lower Piney Creek HDD Location

**Figure 1 - Topographic Basemap**

Woodbury Township, Blair County, PA

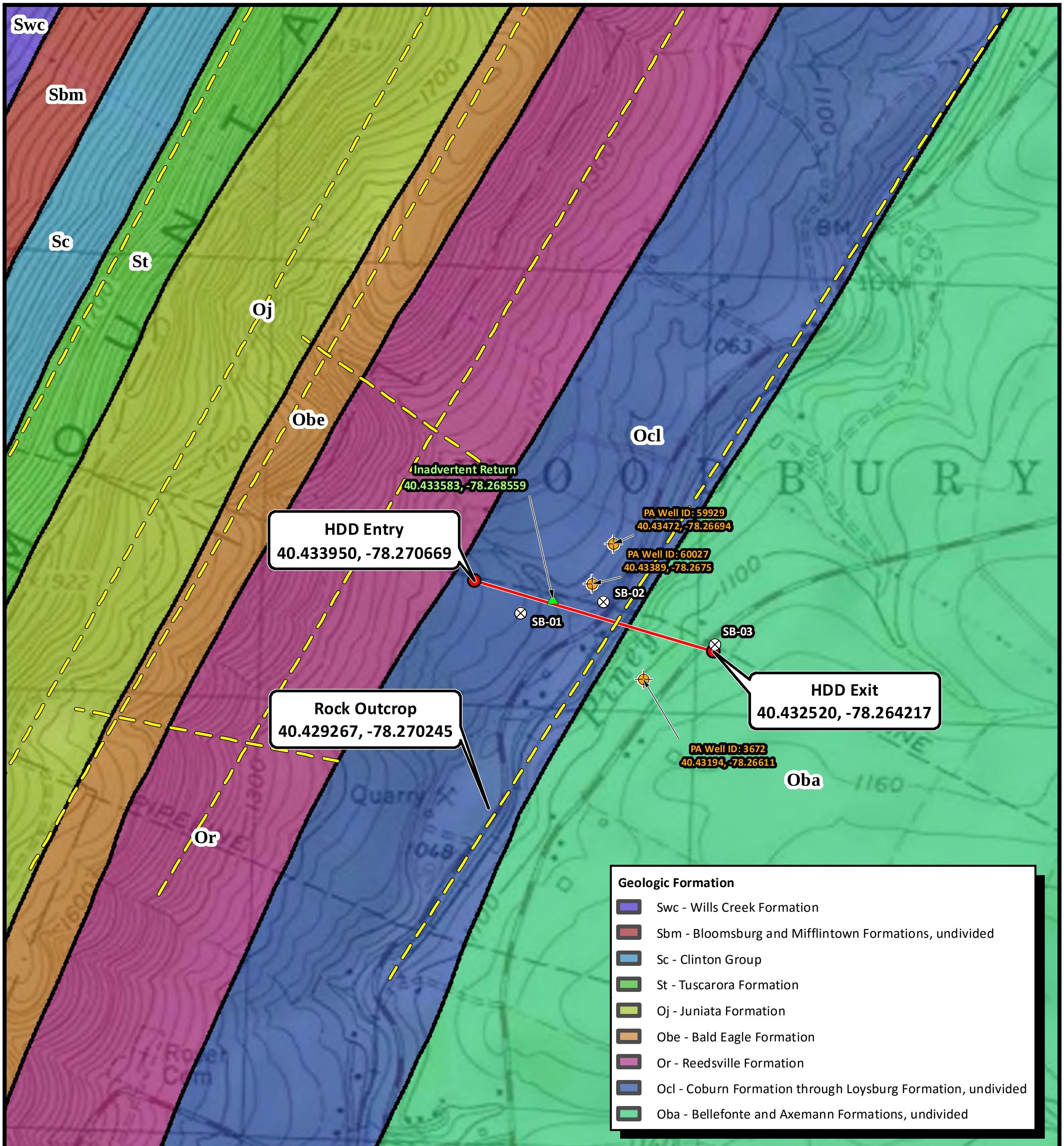
Project No. 096302011

0 1,000 2,000 Feet

1 inch = 2,000 feet

Service Layer Credits: Copyright:© 2013 National Geographic Society, i-cubed

N:\Shared\Projects\09630\096302011\GIS\MapDocs\Lower Piney Creek\096302011_LowerPineyCreek_Fig1_TopoBasemap_8x11.mxd




- Inadvertent Return
- Residential Well
- Boring Location
- HDD Entry/Exit
- HDD Profile
- Inferred Fracture Trace

Frankstown, PA USGS 7.5' Topographic Quadrangle

2/20/2018

# Sunoco Pipeline, L.P.

## Lower Piney Creek HDD Location

### Figure 2 - Geologic Map

Woodbury Township, Blair County, PA

Project No. 096302011

N S W E

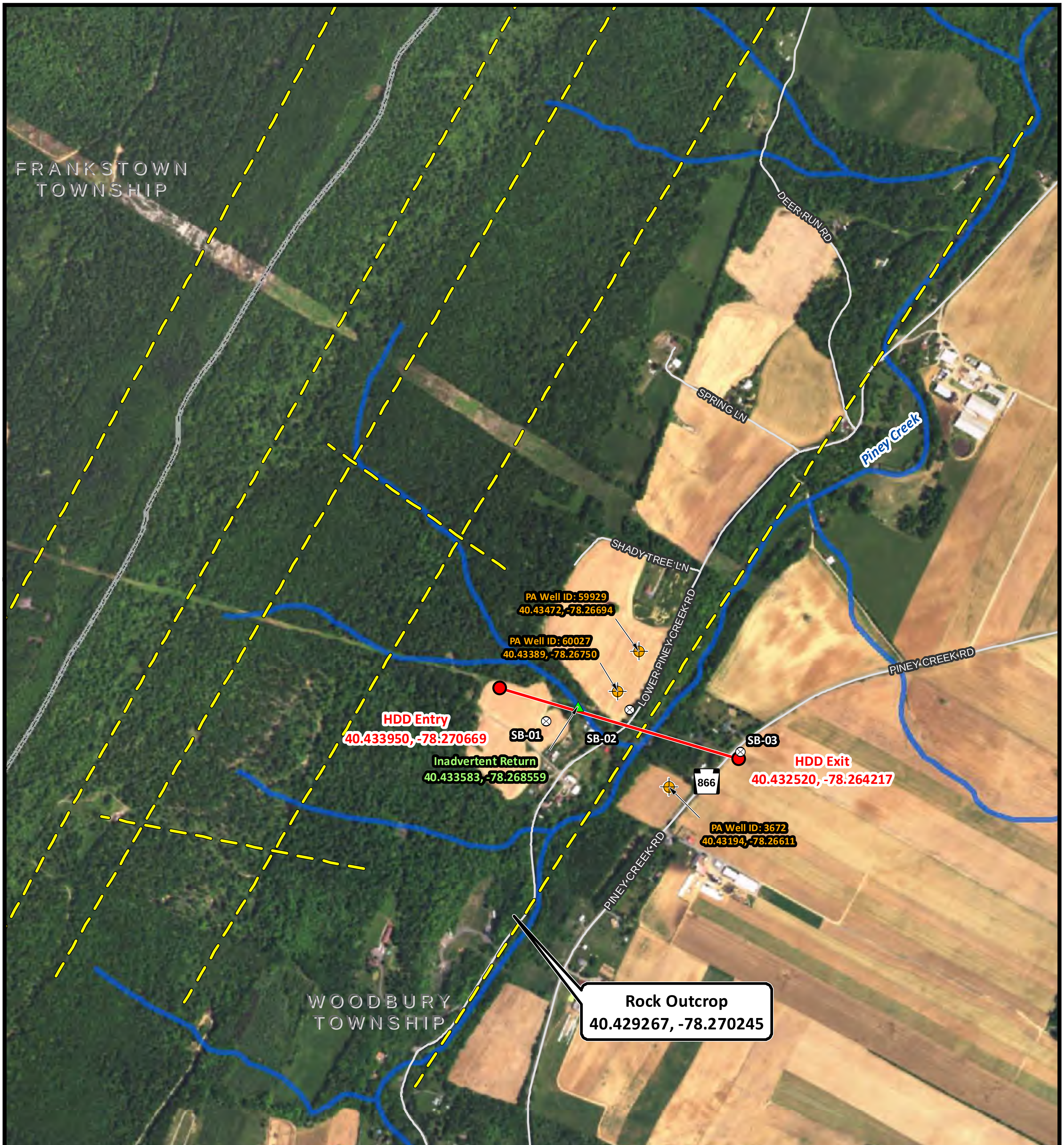
0 1,000 Feet

1 inch = 1,000 feet



Sunoco Logistics Partners L.P.

RETTEW




| | |
|---|---|
| Inadvertent Return | Inferred Fracture Trace |
| Residential Well | NHD Stream |
| Boring Location | Road |
| HDD Entry/Exit | Municipal Boundary |
| HDD Profile | |

11/9/2017

**Sunoco Pipeline, L.P.**

**Lower Piney Creek HDD Location**

**Figure 3 - Aerial Basemap**

Woodbury Township, Blair County, PA

Project No. 096302011

N S W E

0 1,000 Feet

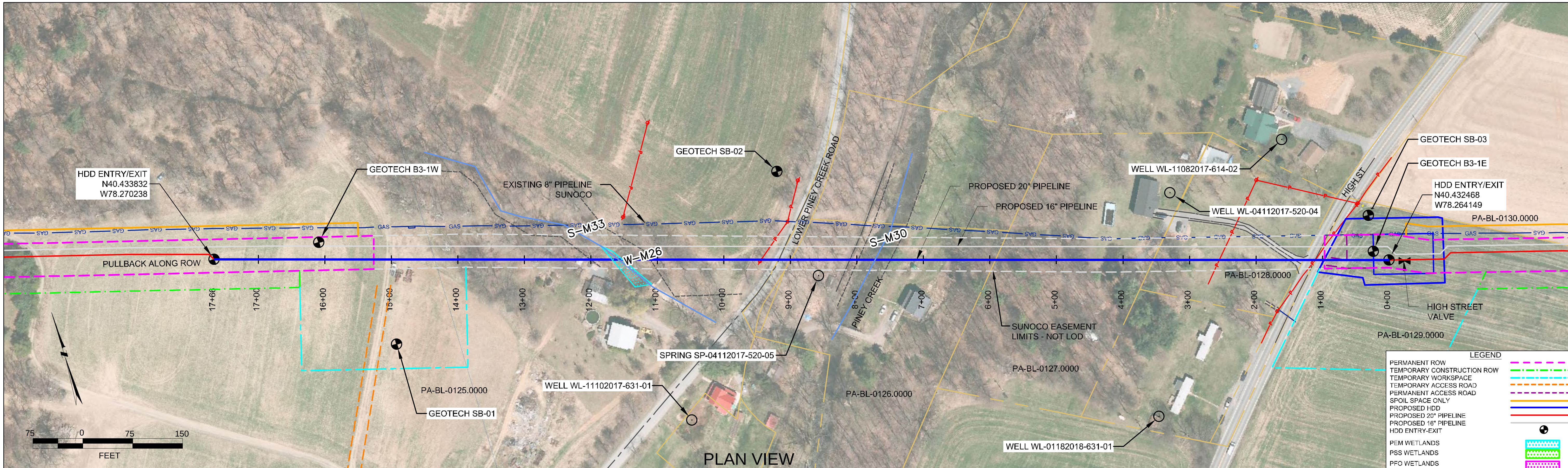
1 inch = 1,000 feet

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

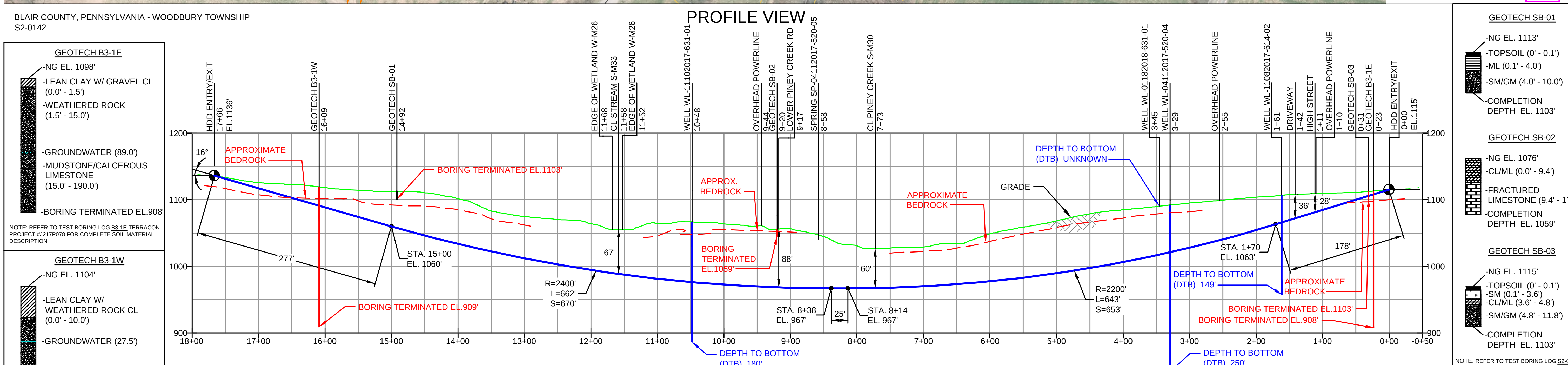
N:\Shared\Projects\09630\096302011\GIS\MapDocs\Lower Piney Creek\096302011_LowerPineyCreek_Fig3_AerialBasemap_8x11.mxd

RETTEW

# ATTACHMENT 1
# GEOTECHNICAL BORING LOGS




BLAIR COUNTY, PENNSYLVANIA - WOODBURY TOWNSHIP
S2-0142




DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=): 1766'
   HDD PIPE LENGTH (S=): 1803'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

## NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP, FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

## REF. DRAWING

| DWG NO | | DWG NO | DESCRIPTION |
|---|---|---|---|
| ES-3.57 | TO | ES-3.58 | EROSION & SEDIMENT PLAN |
| SHEET 41 | TO | SHEET 41 | AERIAL SITE PLAN |

## REVISIONS

| NO. | DESCRIPTION | BY | DATE | CHK | DATE | APP | DATE |
|---|---|---|---|---|---|---|---|
| EP5 | ADDED ADDITIONAL INFORMATION PER CLIENT REQUEST | MRS | 02/28/18 | RMB | 02/28/18 | CAG | 02/28/18 |
| EP4 | UPDATED GEOTECH INFO PROVIDED BY DPS | MRS | 11/15/17 | RMB | 11/15/17 | CAG | 11/15/17 |
| EP3 | MOVED DRILL ENTRY/EXIT LOCATION - DESIGN PER MICHELS | MRS | 09/22/17 | RMB | 09/22/17 | CAG | 09/22/17 |
| EP2 | REVISED PER PADEP COMMENTS RECEIVED 09-06-16 | DLM | 09/30/16 | RMB | 09/30/16 | AAW | 09/30/16 |
| EP1 | REVISED PER PADEP COMMENTS | MRS | 05/18/16 | RMB | 05/18/16 | AAW | 05/18/16 |
| EP | | MRS | 03/15/16 | RMB | 03/15/16 | AAW | 03/15/16 |

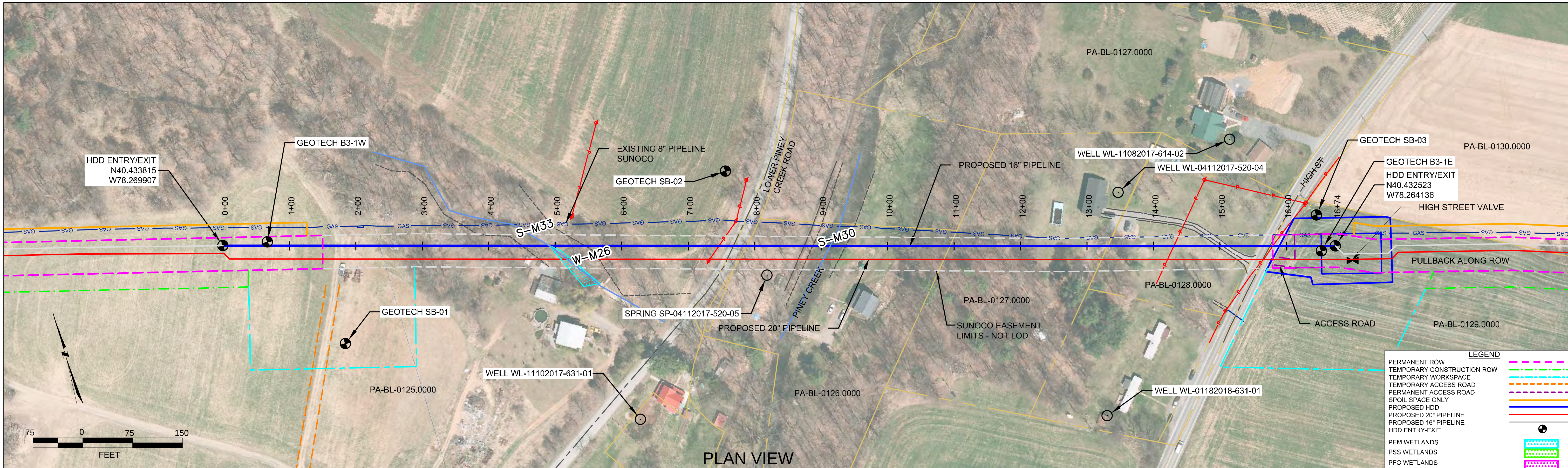
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

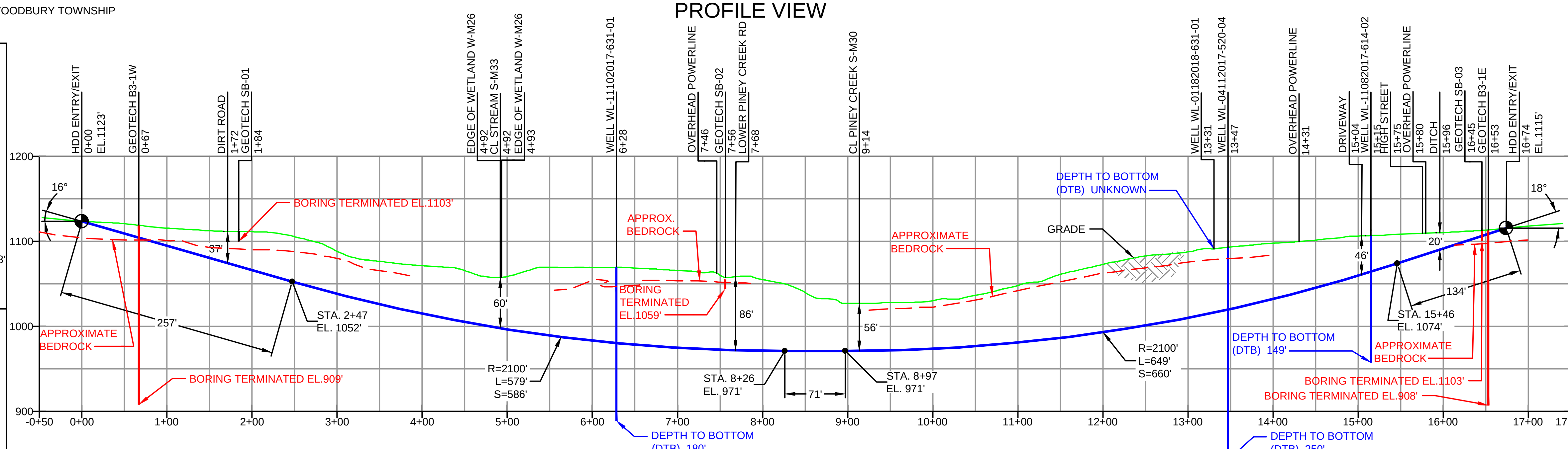
HORIZONTAL DIRECTIONAL DRILL
LOWER PINEY CREEK RD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150'
DWG. NUMBER: PA-BL-0126.0000-RD




BLAIR COUNTY, PENNSYLVANIA - WOODBURY TOWNSHIP
S2-0142-16

## PROFILE VIEW




### GEOTECH B3-1E

- NG EL. 1098'
- LEAN CLAY W/ GRAVEL CL (0.0' - 1.5')
- WEATHERED ROCK (1.5' - 15.0')
- GROUNDWATER (89.0')
- MUDSTONE/CALCEROUS LIMESTONE (15.0' - 190.0')
- BORING TERMINATED EL.908'

NOTE: REFER TO TEST BORING LOG B3-1E TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

### GEOTECH B3-1W

- NG EL. 1104'
- LEAN CLAY W/ WEATHERED ROCK CL (0.0' - 10.0')
- GROUNDWATER (27.5')
- CALCEROUS SHALE (10.0' - 195.0')
- BORING TERMINATED EL.909'

NOTE: REFER TO TEST BORING LOG B3-1W TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

### GEOTECH SB-01

- NG EL. 1113'
- TOPSOIL (0' - 0.1')
- ML (0.1' - 4.0')
- SM/GM (4.0' - 10.0')
- COMPLETION DEPTH EL. 1103'

### GEOTECH SB-02

- NG EL. 1076'
- CL/ML (0.0' - 9.4')
- FRACTURED LIMESTONE (9.4' - 17.0')
- COMPLETION DEPTH EL. 1059'

### GEOTECH SB-03

- NG EL. 1115'
- TOPSOIL (0' - 0.1')
- SM (0.1' - 3.6')
- CL/ML (3.6' - 4.8')
- SM/GM (4.8' - 11.8')
- COMPLETION DEPTH EL. 1103'

NOTE: REFER TO TEST BORING LOG S2-0142 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=): 1674'
   HDD PIPE LENGTH (S=): 1708'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

### NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP, FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

### REF. DRAWING

| DWG NO | | DWG NO | DESCRIPTION |
|---|---|---|---|
| ES-3.57 | TO | ES-3.58 | EROSION & SEDIMENT PLAN |
| SHEET 41 | TO | SHEET 41 | AERIAL SITE PLAN |

### REVISIONS

| NO. | DESCRIPTION | BY | DATE | CHK | DATE | APP | DATE |
|---|---|---|---|---|---|---|---|
| EP5 | ADDED ADDITIONAL INFORMATION PER CLIENT REQUEST | MRS | 02/28/18 | RMB | 02/28/18 | CAG | 02/28/18 |
| EP4 | UPDATED GEOTECH INFO PROVIDED BY DPS | MRS | 11/15/17 | RMB | 11/15/17 | CAG | 11/15/17 |
| EP3 | MOVED DRILL ENTRY/EXIT LOCATION - DESIGN PER MICHELS | MRS | 09/22/17 | RMB | 09/22/17 | CAG | 09/22/17 |
| EP2 | REVISED PER PADEP COMMENTS RECEIVED 09-06-16 | DLM | 10/07/16 | RMB | 10/07/16 | AAW | 10/07/16 |
| EP1 | REVISED PER PADEP COMMENTS | MRS | 05/18/16 | RMB | 05/18/16 | AAW | 05/18/16 |
| EP | | MRS | 03/15/16 | RMB | 03/15/16 | AAW | 03/15/16 |

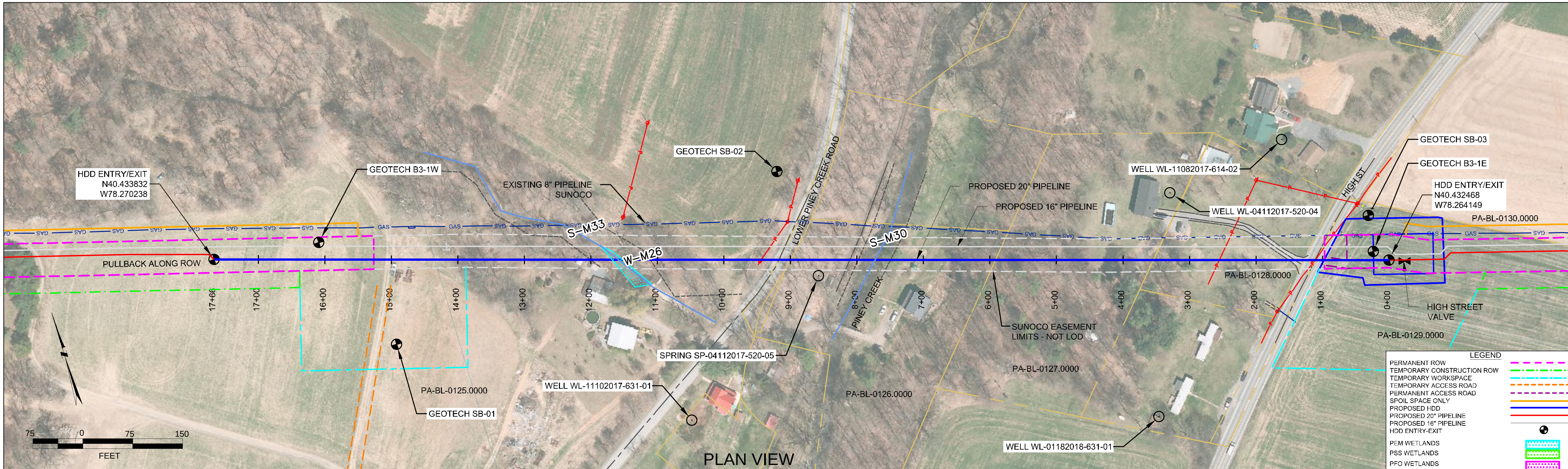
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
LOWER PINEY CREEK RD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150'
DWG. NO. PA-BL-0126.0000-RD-16




BLAIR COUNTY, PENNSYLVANIA - WOODBURY TOWNSHIP
S2-0142

## PROFILE VIEW

**GEOTECH B3-1E**

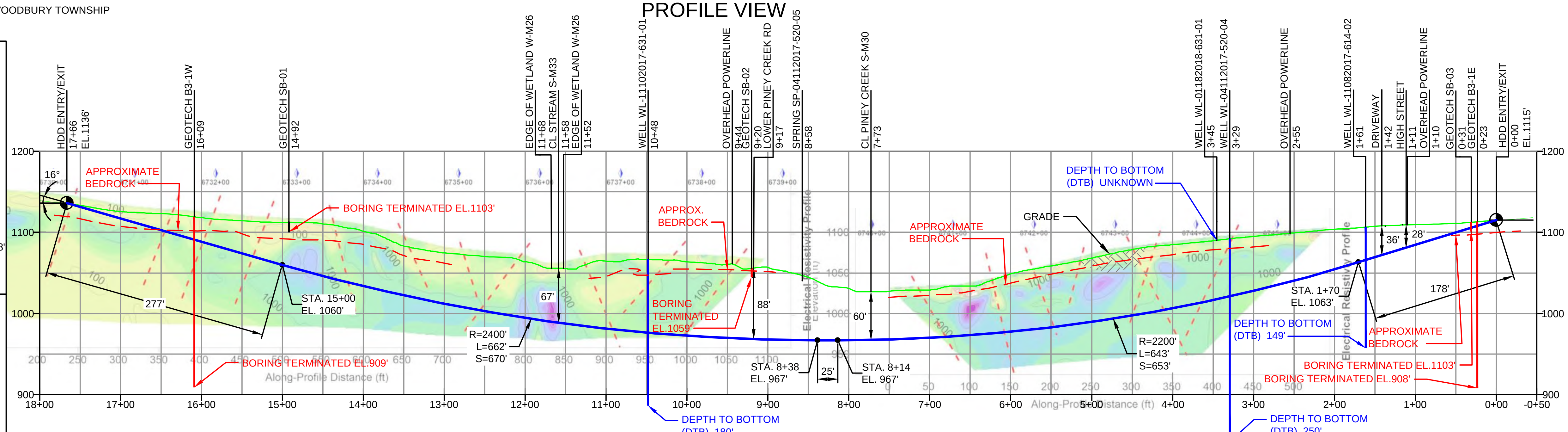
- -NG EL. 1098'
- -LEAN CLAY W/ GRAVEL CL (0.0' - 1.5')
- -WEATHERED ROCK (1.5' - 15.0')
- -GROUNDWATER (89.0')
- -MUDSTONE/CALCEROUS LIMESTONE (15.0' - 190.0')
- -BORING TERMINATED EL.908'

NOTE: REFER TO TEST BORING LOG B3-1E TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

**GEOTECH B3-1W**

- -NG EL. 1104'
- -LEAN CLAY W/ WEATHERED ROCK CL (0.0' - 10.0')
- -GROUNDWATER (27.5')
- -CALCEROUS SHALE (10.0' - 195.0')
- -BORING TERMINATED EL.909'

NOTE: REFER TO TEST BORING LOG B3-1W TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION




**GEOTECH SB-01**

- -NG EL. 1113'
- -TOPSOIL (0' - 0.1')
- -ML (0.1' - 4.0')
- -SM/GM (4.0' - 10.0')
- -COMPLETION DEPTH EL. 1103'

**GEOTECH SB-02**

- -NG EL. 1076'
- -CL/ML (0.0' - 9.4')
- -FRACTURED LIMESTONE (9.4' - 17.0')
- -COMPLETION DEPTH EL. 1059'

**GEOTECH SB-03**

- -NG EL. 1115'
- -TOPSOIL (0' - 0.1')
- -SM (0.1' - 3.6')
- -CL/ML (3.6' - 4.8')
- -SM/GM (4.8' - 11.8')
- -COMPLETION DEPTH EL. 1103'

NOTE: REFER TO TEST BORING LOG S2-0142 FOR COMPLETE SOIL MATERIAL DESCRIPTION

DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=): 1766'
   HDD PIPE LENGTH (S=): 1803'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

FOR PERMITTING ONLY

ELECTRICAL RESISTIVITY PROFILE OVERLAY IS APPROXIMATE AND BEST FIT TO SURFACE ELEVATION

### NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP, FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

### REF. DRAWING

| DWG NO | | DWG NO | DESCRIPTION |
|---|---|---|---|
| ES-3.57 | TO | ES-3.58 | EROSION & SEDIMENT PLAN |
| SHEET 41 | TO | SHEET 41 | AERIAL SITE PLAN |
| | | | |
| | | | |
| | | | |
| | | | |

### REVISIONS

| NO. | DESCRIPTION | BY | DATE | CHK | DATE | APP | DATE |
|---|---|---|---|---|---|---|---|
| EP5 | ADDED ADDITIONAL INFORMATION PER CLIENT REQUEST | MRS | 02/28/18 | RMB | 02/28/18 | CAG | 02/28/18 |
| EP4 | UPDATED GEOTECH INFO PROVIDED BY DPS | MRS | 11/15/17 | RMB | 11/15/17 | CAG | 11/15/17 |
| EP3 | MOVED DRILL ENTRY/EXIT LOCATION - DESIGN PER MICHELS | MRS | 09/22/17 | RMB | 09/22/17 | CAG | 09/22/17 |
| EP2 | REVISED PER PADEP COMMENTS RECEIVED 09-06-16 | DLM | 09/30/16 | RMB | 09/30/16 | AAW | 09/30/16 |
| EP1 | REVISED PER PADEP COMMENTS | MRS | 05/18/16 | RMB | 05/18/16 | AAW | 05/18/16 |
| EP | | MRS | 03/15/16 | RMB | 03/15/16 | AAW | 03/15/16 |

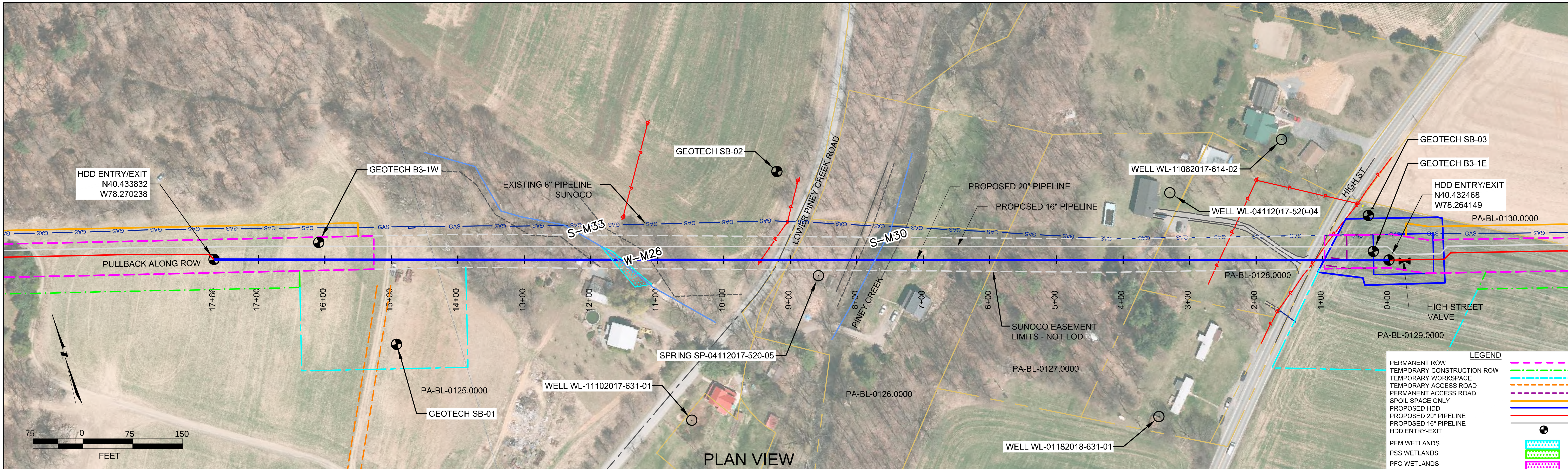
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

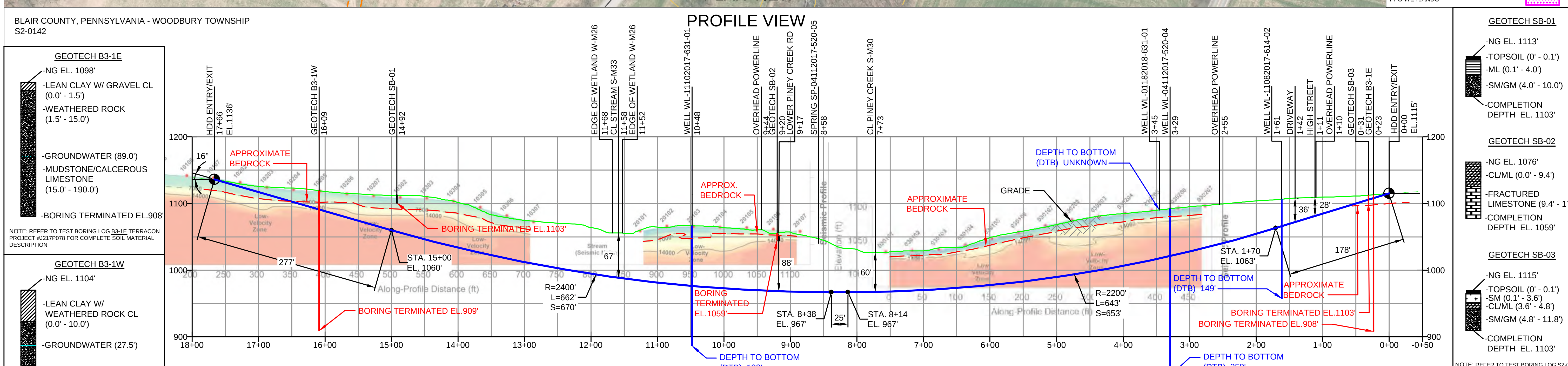
SUNOCO PIPELINE, L.P.

ELECTRICAL RESISTANCE OVERLAY
HORIZONTAL DIRECTIONAL DRILL
LOWER PINEY CREEK RD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150'
DWG. NUMBER: PA-BL-0126.0000-RD




BLAIR COUNTY, PENNSYLVANIA - WOODBURY TOWNSHIP
S2-0142




DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=): 1766'
   HDD PIPE LENGTH (S=): 1803'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

FOR PERMITTING ONLY

SEISMIC REFRACTION PROFILE OVERLAY IS APPROXIMATE AND BEST FIT TO SURFACE ELEVATION

## NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP, FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

## REF. DRAWING

| DWG NO | | DWG NO | DESCRIPTION |
|---|---|---|---|
| ES-3.57 | TO | ES-3.58 | EROSION & SEDIMENT PLAN |
| SHEET 41 | TO | SHEET 41 | AERIAL SITE PLAN |
| | | | |
| | | | |
| | | | |
| | | | |

## REVISIONS

| NO. | DESCRIPTION | BY | DATE | CHK | DATE | APP | DATE |
|---|---|---|---|---|---|---|---|
| EP5 | ADDED ADDITIONAL INFORMATION PER CLIENT REQUEST | MRS | 02/28/18 | RMB | 02/28/18 | CAG | 02/28/18 |
| EP4 | UPDATED GEOTECH INFO PROVIDED BY DPS | MRS | 11/15/17 | RMB | 11/15/17 | CAG | 11/15/17 |
| EP3 | MOVED DRILL ENTRY/EXIT LOCATION - DESIGN PER MICHELS | MRS | 09/22/17 | RMB | 09/22/17 | CAG | 09/22/17 |
| EP2 | REVISED PER PADEP COMMENTS RECEIVED 09-06-16 | DLM | 09/30/16 | RMB | 09/30/16 | AAW | 09/30/16 |
| EP1 | REVISED PER PADEP COMMENTS | MRS | 05/18/16 | RMB | 05/18/16 | AAW | 05/18/16 |
| EP | | MRS | 03/15/16 | RMB | 03/15/16 | AAW | 03/15/16 |

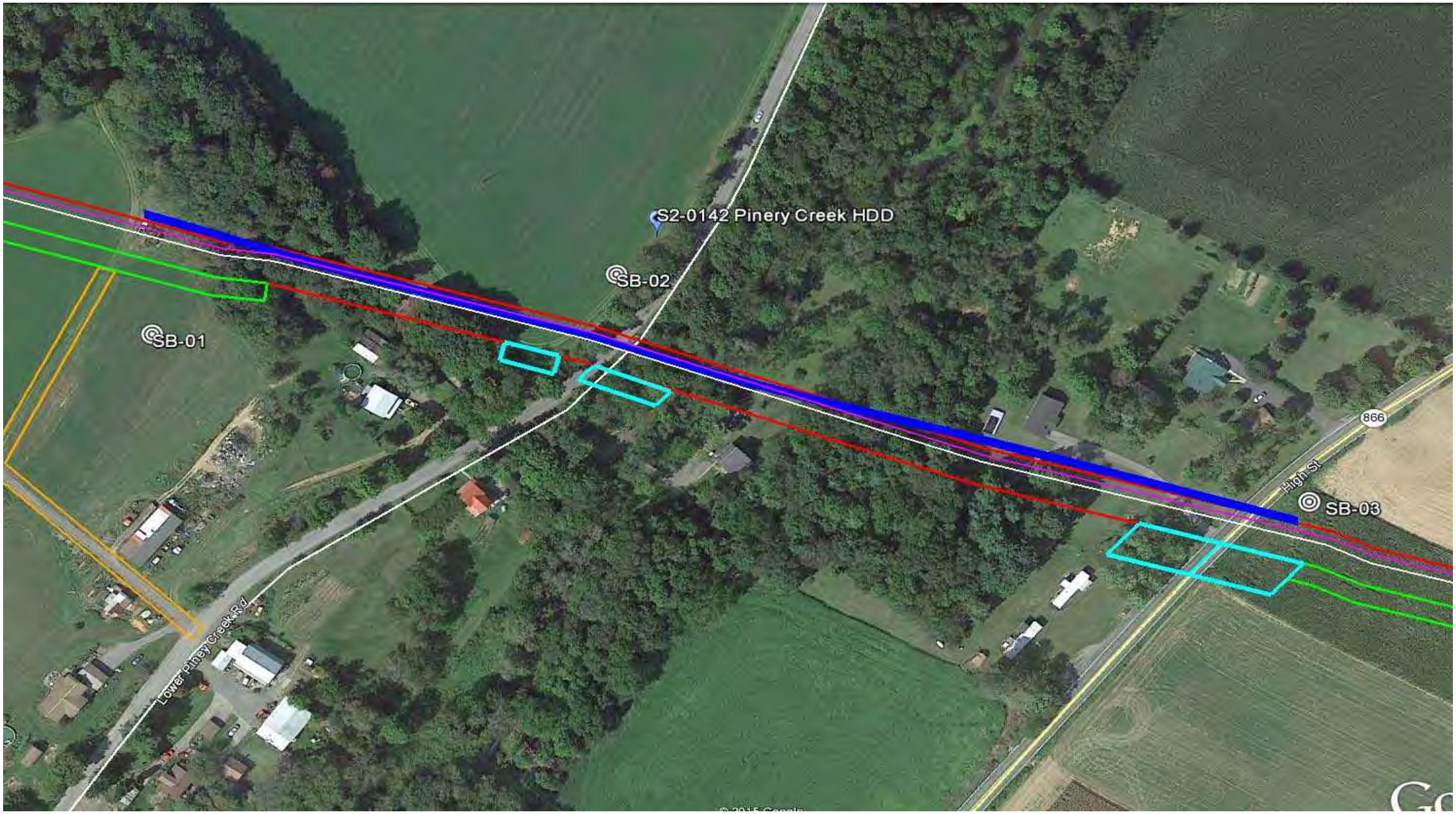
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

SEISMIC REFRACTION
HORIZONTAL DIRECTIONAL DRILL
LOWER PINEY CREEK RD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150'
DWG. NUMBER: PA-BL-0126.0000-RD




LEGEND:

Geotechnical Soil Boring (SB) Locations

TETRA TECH

GEOTECHNICAL BORING LOCATIONS
HDD S2-0142
BLAIR COUNTY, WOODBURY TOWNSHIP, PA
SUNOCO PENNSYLVANIA PIPELINE PROJECT

TETRA TECH
240 Continental Drive, Suite 200
Newark, Delaware 19713
302.738.7551
fax: 302.454.5988

# TEST BORING LOG

| | | | | | |
|---|---|---|---|---|---|
| Project Name: | SUNOCO PENNSYLVANIA PIPELINE PROJECT | | | Project No.: 103IP3406 | |
| Project Location: | LOWER PINEY CREEK ROAD, WILLIAMSBURG, PA | | | Page 1 of 1 | |
| HDD No.: | S2-0142 | Dates(s) Drilled: 01-11-15 | | Inspector: | E. WATT |
| Boring No.: | SB-01 | Drilling Method: SPT - ASTM D1586 | | Driller: | S. HOFFER |
| Drilling Contractor: | HAD DRILLING | Groundwater Depth (ft): NOT ENCOUNTERED | | Total Depth (ft): | 10.0 |

| Sample No. | Sample Depth (ft) From | Sample Depth (ft) To | Strata Depth (ft) From | Strata Depth (ft) To | Recov. (in) | Strata (USCS) | Description of Materials | 6" Increment Blows * | | | | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 0.0 | 0.1 | | | TOPSOIL (<1") | | | | | |
| 1 | 3.0 | 5.0 | 0.1 | 4.0 | 11 | ML | ORANGE BROWN SILT WITH SOME FINE SAND. | 1 | 2 | 33 | 45 | **35** |
| | | | 4.0 | | | SM/ GM | GRAY FINE TO COARSE SAND AND GRAVEL WITH A LITTLE SILT | | | | | |
| | | | | | | | (WEATHERED LIMESTONE?) | | | | | |
| 2 | 8.0 | 8.4 | | | 3 | | GRAY FINE TO COARSE SAND AND FINE GRAVEL (WEATHERED | 50/5" | | | | |
| | | | | 10.0 | | | LIMESTONE?). | | | | | |
| | | | | | | | AUGER REFUSAL AT 10'. OFF-SET BORING 21' SOUTH AND | | | | | |
| | | | | | | | CONTINUOULSY AUGERED TO REFUSAL AT 8'. OFF-SET AGAIN | | | | | |
| | | | | | | | AND CONTINUOUSLY AUGERED TO REFUSAL AT 8.5 FEET. | | | | | |
| | | | | | | | DRY AND CAVED AT 8'. | | | | | |

Notes/Comments:

Pocket Pentrometer Testing

DR: DECOMPOSED ROCK

Strata (USCS) Designations are approximated based on visual review, except where indicated in Description of Materials.

* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.
N: Number of blows to drive spoon from 6" to 18" interval.

**TETRA TECH**
*240 Continental Drive, Suite 200*
*Newark, Delaware 19713*
*302.738.7551*
*fax: 302.454.5988*

# TEST BORING LOG

| | | | | |
|---|---|---|---|---|
| Project Name: | SUNOCO PENNSYLVANIA PIPELINE PROJECT | | Project No.: 103IP3406 | |
| Project Location: | LOWER PINEY CREEK ROAD, WILLIAMSBURG, PA | | Page 1 of 1 | |
| HDD No.: | S2-0142 | Dates(s) Drilled: 01-11-15 | Inspector: | E. WATT |
| Boring No.: | SB-02 | Drilling Method: SPT - ASTM D1586 | Driller: | S. HOFFER |
| Drilling Contractor: | HAD DRILLING | Groundwater Depth (ft): NOT ENCOUNTERED | Total Depth (ft): | 17.0 |

| Sample No. | Sample Depth (ft) | | Strata Depth (ft) | | Recov. (in) | Strata (USCS) | Description of Materials | 6" Increment Blows * | | | | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | From | To | From | To | | | | | | | | |
| | | | 0.0 | 0.0 | | | NO DISCERNABLE TOPSOIL | | | | | |
| 1 | 3.0 | 5.0 | 0.0 | | 5 | CL/ ML | ORANGE BROWN CLAY AND SILT, TRACE FINE SAND. | 1 | 3 | 6 | 6 | **9** |
| | | | | 9.0 | | | | | | | | |
| 2 | 8.0 | 9.4 | 9.0 | 9.4 | 12 | | GRAY CLAY/SILT AND FINE SAND, TRACE LIMESTONE GRAVEL. | 2 | 9 | 50/5" | | **>50** |
| | | | | | | | AUGER REFUSAL AT 9'. | | | | | |
| RUN 1 | 9.0 | 12.0 | 9.0 | 10.4 | 34 | ROCK | GRAY HIGHLY FRACTURED LIMESTONE WITH CALCITE DEPOSITS. | TCR: 94%, SCR: 22%, RQD: 17% | | | | |
| | | | 10.4 | 10.9 | | | GRAY MODERATELY FRACTURED LIMESTINE WITH CALCITE DEPOSITS | | | | | |
| | | | 10.9 | 12.0 | | | GRAY HIGHLY FRACTURED LIMESTONE WITH CALCITE DEPOSITS. | | | | | |
| RUN 2 | 12.0 | 17.0 | 12.0 | | 55 | | GRAY MODERATELY FRACTURED LIMESTONE, TRACE CALCITE | TCR: 92%, SCR: 56%, RQD: 54% | | | | |
| | | | | 13.4 | | | DEPOSTS, FRATURES AT 12.65', 13.14', 13.27'. | | | | | |
| | | | 13.4 | 13.7 | | | GRAY HIGHLY FRACTURED LIMESTONE. | | | | | |
| | | | 13.7 | | | | GRAY MODERATELY FRACTURED LIMESTONE WITH CALCITE | | | | | |
| | | | | 16.5 | | | DEPOSTS, FRACTURES AT 14.96', 15.62', 16.43'. | | | | | |
| | | | 16.5 | 17.0 | | | GRAY HIGHLY FRACTURED LIMESTONE. | | | | | |
| | | | | | | | <u>CORE TESTING RESULTS (DEPTH 14'):</u> | | | | | |
| | | | | | | | COMPRESSIVE STRENGTH: 16,180 PSI | | | | | |
| | | | | | | | UNIT WEIGHT: 174.5 PCF | | | | | |

Notes/Comments:

<u>Pocket Pentrometer Testing</u>
S1: 2.5 TSF

DR: DECOMPOSED ROCK

Strata (USCS) Designations are approximated based on visual review, except where indicated in Description of Materials.

* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.
N: Number of blows to drive spoon from 6" to 18" interval.

TETRA TECH
240 Continental Drive, Suite 200
Newark, Delaware 19713
302.738.7551
fax: 302.454.5988

# TEST BORING LOG

| | | | |
|---|---|---|---|
| Project Name: | SUNOCO PENNSYLVANIA PIPELINE PROJECT | | Project No.: 103IP3406 |
| Project Location: | PA 866 (HIGH STREET), WILLIAMSBURG, PA | | Page 1 of 1 |
| HDD No.: | S2-0142 | Dates(s) Drilled: 01-13-15 | Inspector: E. WATT |
| Boring No.: | SB-03 | Drilling Method: SPT - ASTM D1586 | Driller: S. HOFFER |
| Drilling Contractor: | HAD DRILLING | Groundwater Depth (ft): NOT ENCOUNTERED | Total Depth (ft): 11.8 |

| Sample No. | Sample Depth (ft) | | Strata Depth (ft) | | Recov. (in) | Strata (USCS) | Description of Materials | 6" Increment Blows * | | | | N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | From | To | From | To | | | | | | | | |
| | | | 0.0 | 0.1 | | | TOPSOIL (1") | | | | | |
| 1 | 3.0 | 5.0 | 0.1 | | 13 | SM | LIGHT GRAY FINE SAND WITH SOME SILT, WITH A LITTLE FINE | 4 | 12 | 18 | 12 | **30** |
| | | | | 3.6 | | | GRAVEL. | | | | | |
| | | | 3.6 | 4.8 | | CL/ ML | ORANGE BROWN CLAY AND SILT, TRACE FINE SAND. | | | | | |
| 2 | 8.0 | 8.4 | 4.8 | | 3 | SM/ GM | GRAY FINE TO COARSE SAND AND GRAVEL WITH A SOME SILT | 50/5" | | | | |
| | | | | | | | (WEATHERED LIMESTONE?) | | | | | |
| 3 | 11.0 | 11.1 | | 11.8 | 0 | | NO RETURN. | 50/1" | | | | |
| | | | | | | | AUGER REFUSAL AT 11'. OFF-SET BORING AND CONTINUOUSLY | | | | | |
| | | | | | | | AUGERED TO REFUSAL AT 11.8'. | | | | | |
| | | | | | | | STARTED GRINDING BETWEEN 6 AND 7'. | | | | | |
| | | | | | | | DRY AND CAVED AT 9.5'. | | | | | |

Notes/Comments:

Pocket Pentrometer Testing
S1 (AT 4'): 2.5 TSF

DR: DECOMPOSED ROCK

S1 SAMPLE TAKEN FROM CLAY/SILT PORTION.

Strata (USCS) Designations are approximated based on visual review, except where indicated in Description of Materials.

* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.
N: Number of blows to drive spoon from 6" to 18" interval.

## GEOTECHNICAL LABORATORY TESTING SUMMARY
## SUNOCO PENNSYLVANIA PIPELINE PROJECT
## HDD S2-0142

| HDD No. | Test Boring No. | Sample No. | Depth of Sample (ft.) | | Water Content, % (ASTM D2216) | Percent Silts/Clays, % (ASTM D1140) | Atterburg Limits (ASTM D4318) | | | USCS Classif. (ASTM D2487) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | From | To | | | Liquid Limit, % | Plastic Limit, % | Plasticity Index, % | |
| S2-0142 | SB-01 | 1 | 3.0 | 5.0 | 3.1 | 19.8 | - | - | - | - |
| | | 2 | 8.0 | 8.4 | 6.2 | 30.5 | - | - | - | - |
| | SB-02 | 1 | 3.0 | 5.0 | 25.4 | 95.5 | - | - | - | - |
| | | 2 | 8.0 | 9.4 | 27.7 | 63.2 | 32 | 23 | 9 | CL/ML |
| | SB-03 | 1 | 3.0 | 5.0 | 30.5 | 96.6 | 34 | 25 | 11 | CL/ML |
| | | 2 | 8.0 | 8.4 | 3.2 | 29.6 | - | - | - | - |

| Rock Core Testing Results | | | | |
|---|---|---|---|---|
| Boring No. | Core Run | Approximate Depth (ft) | Compressive Strength (psi) | Unit Weight (pcf) |
| SB-02 | 2 | 14 | 16,180 | 174.5 |
| | | | | |
| | | | | |
| | | | | |

Notes:

1) Sample depths based on feet below grade at time of exploration.

## REGIONAL GEOLOGY SUMMARY
## SUNOCO PENNSYLVANIA PIPELINE PROJECT
## HDD S2-0140

| HDD No. | NAME | BORING NO. | REGIONAL GEOLOGY DESCRIPTION | GENERAL TOPOGRAPHIC SETTING | BEDROCK FORMATION | GENERAL ROCK TYPE | APPROX MAX FM THICKNESS (FT) | DEPTH TO ROCK (Ft bgs) based on nearby well drilling logs | NOTES / COMMENTS |
|---|---|---|---|---|---|---|---|---|---|
| S2-0142 | Piney Creek Road | SB-01<br>SB-02<br>SB-03 | **Coburn Formation** - consists of medium-gray to very dark gray, fossiliferous limestone and shaly limestone | Upland to mid-ridge | Coburn | Highly fossiliferous limestones and black shaly limestones to increasingly argillaceous | | 5-37 | Karst conditions may be present, numerous depressions are mapped<br><br>Yields 6-25 gpm<br><br>The lower and middle portions of the Coburn Formation consist of interbedded crystalline, highly fossiliferous (conodonts) limestones and black shaly limestones, and the upper Coburn becomes increasingly argillaceous as it grades into the overlying Antes Shale. |

*<u>Note</u> : Source of well log data - http://www.dcnr.state.pa.us/topogeo/groundwater/pagwis/records/index.htm. All other sources as referenced in comments section.*

**ROCK CORE DESCRIPTION SUMMARY**
**SUNOCO PENNSYLVANIA PIPELINE PROJECT**
**HDD S2-0142**

| Location | Boring No. | Core Run | Core Depth (ft) | | TCR (%) | SCR (%) | RQD (%) | Depth (ft) | | Weathering | Classification | Bedding Thickness (ft) | Color | Discontinuity Data |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | From | To | | | | From | To | | | | | |
| S2-142 | SB-2 | 1 | 9 | 12 | 94 | 22 | 17 | 9 | 12 | Moderate | Limestone | Massive | Light Gray | Slightly fractured, Avg. Dip 37° (20° - 45°); Calcite infilling of small fractures |
| S2-142 | SB-2 | 2 | 12 | 17 | 92 | 56 | 54 | 12 | 17 | Moderate | Limestone | Massive | Light Gray | Slightly fractured, Avg. Dip 28° (15° - 60°); Calcite infilling of small fractures |

# FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

## GRANULAR SOILS
(Sand, Gravel & Combinations)

| ***Density*** | ***N (blows)**** |
|---|---|
| Very Loose | 5 or less |
| Loose | 6 to 10 |
| Medium Dense | 11 to 30 |
| Dense | 31to 50 |
| Very Dense | 51 or more |

***Relative Proportions***

| *Description Term* | *Percent* |
|---|---|
| Trace | 1 - 10 |
| Little | 11 - 20 |
| Some | 21 - 35 |
| And | 36 - 50 |

***Particle Size Identification***

| | | |
|---|---|---|
| Boulders | 8 in. diameter or more | |
| Cobbles | 3 to 8 in. diameter | |
| Gravel | Coarse (C) | 3 in. to ¾ in. sieve |
| | Fine (F) | ¾ in. to No. 4 sieve |
| Sand | Coarse (C) | No. 4 to No. 10 sieve (4.75mm-2.00mm) |
| | Medium (M) | No. 10 to No. 40 sieve (2.00mm – 0.425mm) |
| | Fine (F) | No. 40 to No. 200 sieve (0.425 – 0.074mm) |
| Silt/Clay | Less Than a No. 200 sieve (<0.074mm) | |

## COHESIVE SOILS
(Silt, Clay & Combinations)

| ***Consistency*** | ***N (blows)**** |
|---|---|
| Very Soft | 3 or less |
| Soft | 4 to 5 |
| Medium Stiff | 6 to 10 |
| Stiff | 11 to 15 |
| Very Stiff | 16 to 30 |
| Hard | 31 or more |

***Plasticity***

| *Degree of Plasticity* | *Plasticity Index* |
|---|---|
| None to Slight | 0 - 4 |
| Slight | 5 - 7 |
| Medium | 8- 22 |
| High to Very High | > 22 |

## ROCK
(Rock Cores)

| ***Rock Quality Designation (RQD), %*** | ***Rock Quality Description*** |
|---|---|
| 0-25 | Very Poor |
| 25-50 | Poor |
| 50-75 | Fair |
| 75-90 | Good |
| 90-100 | Excellent |

****N - Standard Penetration Resistance.*** Driving a 2.0" O.D., 1-3/8" I.D. sampler a distance of 18 inches into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. The number of hammer blows to drive the sampler through each 6 inch interval is recorded; the number of blows required to drive the sampler through the final 12 inch interval is termed the Standard Penetration Resistance (SPR) N-value. For example, blow counts of 6/8/9 (through three 6-inch intervals) results in an SPR N-value of 17 (8+9).

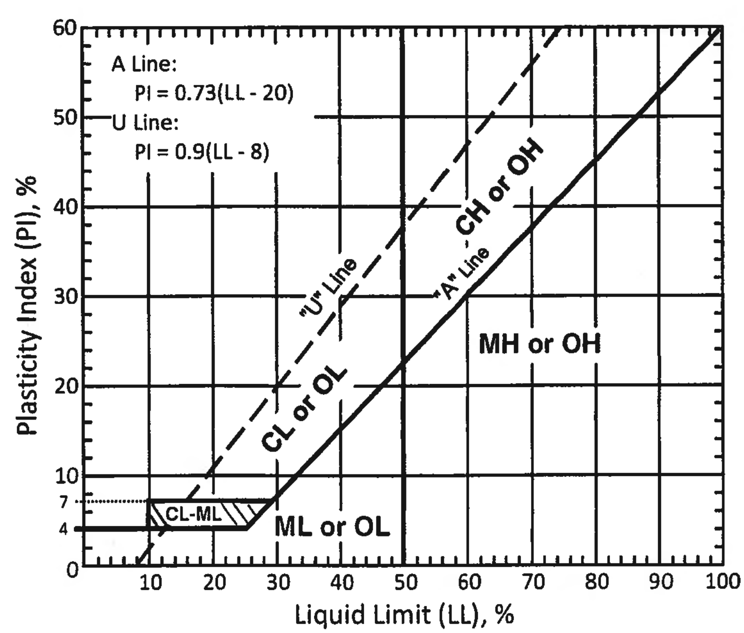
***Groundwater*** observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.

# UNIFIED SOIL CLASSIFICATION SYSTEM [Casagrande (1948)]

| Major Divisions | | | Group Symbols | Typical Descriptions | Laboratory Classifications | | |
|---|---|---|---|---|---|---|---|
| Coarse Grained Soils (More than half of material is larger than No. 200 sieve) | Gravels More than half of coarse fraction is larger than No. 4 sieve size | Clean gravel (Little or no fines) | GW | Well-graded gravels, gravel-sand mixtures, little or no fines | Determine Percentage of sand and gravel from grain size curve. Depending on Percentage of fines (fraction smaller than No. 200 sieve), coarse-grained soils are classified as follows: Less than 5 percent: GW, GP, SW, SP; More than 12 percent: GM. GC, SM, SC; 5 to 12 percent: Borderline cases requiring dual symbols[1] | $C_u = \frac{D_{60}}{D_{10}}$ greater than 4: $C_c = \frac{(D_{30})2}{D_{10} \times D_{60}}$ between 1 and 3 | |
| | | | GP | Poorly graded gravels, gravel-sand mixtures, little or no fines | | Not meeting $C_u$ or $C_c$ requirements for GW | |
| | | Gravel with fines (Appreciable amount of fines) | GM | Silty gravels, gravel-sand-silt mixtures | | Atterberg limits below A Line or $I_p$ less than 4 | Limits plotting in hatched zone with $I_p$ between 4 and 7 are borderline cases requiring use of dual symbols |
| | | | GC | Clayey gravels, gravel-sand-clay mixtures | | Atterberg limits above A line with $I_p$ greater than 7 | |
| | Sands (More than half of coarse fraction is smaller than No. 4 Sieve) | Clean sands (Little or no fines) | SW | Well graded sands, gravely sands, little or no fines | | $C_u = \frac{D_{60}}{D_{10}}$ greater than 6 $C_c = \frac{(D_{30})2}{D_{10} \times D_{60}}$ between 1 and 3 | |
| | | | SP | Poorly graded sands, gravelly sands, little or no fines | | Not meeting $C_u$ or $C_c$ requirements for SW | |
| | | Sands with fines (Appreciable amount of fines) | SM | Silty sands, sand-silt mixtures | | Atterberg limits below A Line or $I_p$ less than 4 | Limits Plotting in hatched zone with $I_p$ between 4 and 7 are borderline cases requiring use of dual symbols |
| | | | SC | Clayey sands, sand-clay mixtures | | Atterberg limits above A line with $I_p$ greater than 7 | |

| Major Divisions | | Group Symbols | Typical Descriptions |
|---|---|---|---|
| Fine–grained soils (More than half of material is smaller than No. 200 sieve) | Silts and clays (Liquid limit less than 50) | ML | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity |
| | | CL | Inorganic clays of low to medium plasticity, gravelly clays , sandy clays, silty clays, lean clays |
| | | OL | Organic silts and organic silty clays of low plasticity |
| | Silts and Clays (Liquid limit greater than 50) | MH | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts |
| | | CH | Inorganic clays of high plasticity, fat clays |
| | | OH | Organic clays of medium to high plasticity, organic silts |
| | Highly organic soils | Pt | Peat and other highly organic soils |

For soils plotting nearly on A line use dual symbols i.e ., $I_p$ = 29.5, $w_L$=60 gives CH-MH. When $w_L$ is near 50 use CL-CH or ML-MH. Take near as ± 2 percent.




(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.

October 7, 2017

Directional Project Support, Inc.
33311 Lois Lane, Suite A
Magnolia, TX 77354

Attn: Mr. Robert Sessions
P: (318) 542 6657
E: fielduspl@Hotmail.com

Re: Geotechnical Site Characterization
Mariner East 2 Pipeline Project
Spread 3 – Lower Piney Creek Rd
Commonwealth of Pennsylvania
Drawing #PA-BL-0125.0000-RD
PO #20170804-13
Terracon Project No. J217P078

Dear Mr. Sessions:

This letter provides a summary of the bedrock characterization for the Mariner East 2 Pipeline Project crossing to be located at Lower Piney Creek Rd (Drawing #PA-BL-0125.0000-RD) in the Commonwealth of Pennsylvania. Our services were performed in general accordance with our proposal number PJ2175108 dated July 28, 2017. Our scope of services included advancing two borings, designated as B3-1W and B3-1E, visual classification and photography of the rock core samples, and laboratory testing of representative rock samples.

Test borings, B3-1W and B3-1E were drilled between August 8 and 14, 2017 to depths of 195 and 190 feet, respectively as shown on the attached **Test Boring Location Plan**. Bedrock typically consisted of shale at B3-1W and interlayered sedimentary rock comprised of shale, mudstone, dolomite, and limestone at B3-1E. Final test boring logs documenting overburden soil and bedrock conditions as well as photographs of the rock core samples are attached.

Rock compressive strength testing was performed on samples from approximately 20-foot intervals within the bedrock strata at each boring location. Unconfined compressive strength test results are shown on the attached reports.

When laboratory soil testing results are available, we will submit a complete data report for the subject crossing. In the meantime, if you have questions, or if we may be of further service, please contact us.

Sincerely,
**Terracon Consultants, Inc.**

| | |
|---|---|
| Marc A. Gullison, E.I.T. | Lawrence J. Dwyer, P.E. (CT 15120) |
| Staff Geotechnical Engineer | Principal |

Attch:

**TEST BORING LOCATION PLAN**
**EXPLORATION RESULTS** (Boring Logs, Laboratory Data, Rock Core Photographs)
**SUPPORTING INFORMATION** (Unified Soil Classification System, Description of Rock Properties)

# TEST BORING LOCATION PLAN


N

APPROXIMATE BORING LOCATION

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

| | |
|---|---|
| Project Manager: JGS | Project No. J217P078 |
| Drawn by: SBL | Scale: N.T.S. |
| Checked by: LJD | File Name: J217P078 BLP |
| Approved by: LJD | Date: September. 2017 |

Terracon
Consulting Engineers & Scientists

201 Hammer Mill Road Rocky Hill, Ct 06067
PH. (860) 721-1900 FAX. (860) 721-1939

TEST BORING LOCATION PLAN

Lower Piney Creek Road HDD Cores B3-1W and B3-1E
PA-BL-0125.0000-RD
Blair County, Pennsylvania

Exhibit
A-2

# EXPLORATION RESULTS

# BORING LOG NO. B3-1W Lower Piney Creek Rd. West

**PROJECT: Mariner East Pipeline Borings**

**CLIENT: Directional Project Support Incorporated**
**Magnolia, TX 77354**

**SITE: Spread 3**

LOCATION
Latitude: 40.433778° Longitude: -78.26967°
Approximate Surface Elev: 1120 (Ft.) +/-

| DEPTH | Description | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | RQD (%) | Core rate (min/ft) | Penetrometer Test (tsf) |
|---|---|---|---|---|---|---|---|---|---|---|
| | **LEAN CLAY (CL)**, trace sand, reddish orange, medium stiff | | | | | 14 | 3-4-5 N=9 | | | 3.25 |
| | Similar, no sand, stiff, weathered rock at the tip of sampler | | 5 | | | 11 | 4-9-6 N=15 At 10-11.5' (2-50/3") | | | 1.75 |
| 10.0 | Offset borehole, augered to 8 feet, weathered rock at 5 feet, installed 4-inch casing to 10, began rock core at 10 feet<br>Run 1, Moderately hard, slightly weathered, dark gray, fine grained SHALE, moderately dipping close joints, some infilling in weathered rock | 1110+/- | 10 | | | 14 | | 0 | 2.75<br>3.0<br>1.75 | 0.75 |
| 15.0 | Run 2, Similar, very slightly weathered | 1105+/- | 15 | | | 29 | | 80 | 2.75<br>2.75<br>2.5 | |
| 17.5 | Run 3, Similar | 1102.5+/- | | | | 30 | | 87 | 1.25<br>2.75<br>2.75 | |
| 20.0 | Run 4, Similar | 1100+/- | 20 | | | 60 | | 91 | 3.0<br>2.25<br>2.25<br>4.0<br>3.0 | |
| 25.0 | Run 5, Similar | 1095+/- | 25 | | | 60 | | 71 | 2.0<br>3.25<br>3.5<br>3.75<br>3.75 | |
| | | | 30 | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**
- *14.5' AB*
- *24.5' after 20 hrs (08/09/17)*
- *27.5' after 14 hrs (08/11/17)*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

| | |
|---|---|
| Boring Started: 8/8/2017 | Boring Completed: 8/10/2017 |
| Drill Rig: CME-850 | Driller: Terracon/Peter M. |
| Project No.: J217P078 | |

# BORING LOG NO. B3-1W Lower Piney Creek Rd. West



**PROJECT: Mariner East Pipeline Borings**

**SITE: Spread 3**

**CLIENT: Directional Project Support Incorporated**
**Magnolia, TX 77354**

LOCATION
Latitude: 40.433778° Longitude: -78.26967°
Approximate Surface Elev: 1120 (Ft.) +/-

| DEPTH | Description | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | RQD (%) | Core rate (min/ft) | Penetrometer Test (tsf) |
|---|---|---|---|---|---|---|---|---|---|---|
| 30.5 | Run 6, Similar | 1089.5+/- | | | | 43 | | 33 | 4.0 4.5 5.5 7.0 4.5 | |
| 35.0 | Run 7, Hard, fresh, dark gray, fine-grained CALCAREOUS SHALE, high angle close joints | 1085+/- | 35 | | | 60 | | 97 | 4.0 3.75 4.5 5.0 5.0 | |
| 40.0 | Run 8, Similar | 1080+/- | 40 | | | 58 | | 73 | 3.0 3.5 3.25 3.5 3.75 | |
| 45.0 | Run 9, Similar | 1075+/- | 45 | | | 60 | | 83 | 2.75 2.5 2.5 2.0 1.5 | |
| 50.0 | Run 10, Hard, fresh, dark gray, fine-grained CALCAREOUS SHALE, moderately dipping close joints | 1070+/- | 50 | | | 60 | | 42 | 4.0 4.0 5.25 4.75 5.25 | |
| 55.0 | Run 11, Similar, 0.5" thick calcareous vein at 56' | 1065+/- | 55 | | | 60 | | 77 | 2.5 2.25 2.0 2.75 2.25 | |
| 60.0 | | 1060+/- | 60 | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

*14.5' AB*
*24.5' after 20 hrs (08/09/17)*
*27.5' after 14 hrs (08/11/17)*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

| | |
|---|---|
| Boring Started: 8/8/2017 | Boring Completed: 8/10/2017 |
| Drill Rig: CME-850 | Driller: Terracon/Peter M. |
| Project No.: J217P078 | |

# BORING LOG NO. B3-1W Lower Piney Creek Rd. West

**PROJECT: Mariner East Pipeline Borings**

**CLIENT: Directional Project Support Incorporated Magnolia, TX 77354**

**SITE: Spread 3**

LOCATION

Latitude: 40.433778° Longitude: -78.26967°

Approximate Surface Elev: 1120 (Ft.) +/-

| DEPTH | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | RQD (%) | Core rate (min/ft) | Penetrometer Test (tsf) |
|---|---|---|---|---|---|---|---|---|---|
| Run 12, Similar<br>65.0 | 1055+/- | 65 | | | 60 | | 84 | 2.5<br>2.25<br>2.5<br>2.0<br>2.0 | |
| Run 13, Similar<br>70.0 | 1050+/- | 70 | | | 60 | | 95 | 2.0<br>2.0<br>1.75<br>1.5<br>1.5 | |
| Run 14, Similar, 1/8" - 1" thick calcareous veins at 71'-73'<br>75.0 | 1045+/- | 75 | | | 60 | | 100 | 2.0<br>2.0<br>1.5<br>1.5<br>1.5 | |
| Run 15, Similar, some joints infilled with coal<br>80.0 | 1040+/- | 80 | | | 60 | | 100 | 3.5<br>2.0<br>2.25<br>2.5<br>2.5 | |
| Run 16, Similar, occasional calcareous veins with pyrite<br>85.0 | 1035+/- | 85 | | | 60 | | 90 | 2.5<br>2.5<br>2.5<br>2.5<br>3.0 | |
| Run 17, Similar<br>90.0 | 1030+/- | 90 | | | 60 | | 93 | 2.25<br>2.25<br>2.0<br>2.25<br>2.25 | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

*14.5' AB*
*24.5' after 20 hrs (08/09/17)*
*27.5' after 14 hrs (08/11/17)*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 8/8/2017
Boring Completed: 8/10/2017
Drill Rig: CME-850
Driller: Terracon/Peter M.
Project No.: J217P078

# BORING LOG NO. B3-1W Lower Piney Creek Rd. West



**PROJECT: Mariner East Pipeline Borings**

**CLIENT: Directional Project Support Incorporated Magnolia, TX 77354**

**SITE: Spread 3**

LOCATION

Latitude: 40.433778° Longitude: -78.26967°

Approximate Surface Elev: 1120 (Ft.) +/-

| GRAPHIC LOG | DEPTH | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | RQD (%) | Core rate (min/ft) | Penetrometer Test (tsf) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Run 18, Similar, moderately dipping and high angle joints, occasional calcareous veins, thin layer of coal in joints<br>95.0 | 1025+/- | 95 | | | 60 | | 100 | 2.25<br>2.0<br>2.0<br>2.0<br>2.0 | |
| | Run 19, Similar, low angle and moderately dipping joints<br>100.0 | 1020+/- | 100 | | | 60 | | 67 | 2.25<br>3.25<br>2.5<br>2.25<br>2.0 | |
| | Run 20, Similar<br>105.0 | 1015+/- | 105 | | | 60 | | 88 | 2.0<br>2.0<br>1.75<br>2.0<br>1.75 | |
| | Run 21, Similar, 1/4" thick quartz veins at 108' - 110'<br>110.0 | 1010+/- | 110 | | | 60 | | 83 | 2.5<br>2.75<br>2.25<br>2.0<br>2.0 | |
| | Run 22, Similar<br>115.0 | 1005+/- | 115 | | | 56 | | 85 | 2.75<br>2.5<br>2.75<br>2.75<br>2.75 | |
| | Run 23, Similar<br>120.0 | 1000+/- | 120 | | | 60 | | 100 | 2.5<br>2.5<br>2.25<br>2.25<br>2.5 | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

*14.5' AB*
*24.5' after 20 hrs (08/09/17)*
*27.5' after 14 hrs (08/11/17)*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

| | |
|---|---|
| Boring Started: 8/8/2017 | Boring Completed: 8/10/2017 |
| Drill Rig: CME-850 | Driller: Terracon/Peter M. |
| Project No.: J217P078 | |

# BORING LOG NO. B3-1W Lower Piney Creek Rd. West



**PROJECT:** Mariner East Pipeline Borings

**CLIENT:** Directional Project Support Incorporated
Magnolia, TX 77354

**SITE:** Spread 3

LOCATION
Latitude: 40.433778° Longitude: -78.26967°
Approximate Surface Elev: 1120 (Ft.) +/-

| DEPTH | DESCRIPTION | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | RQD (%) | Core rate (min/ft) | Penetrometer Test (tsf) |
|---|---|---|---|---|---|---|---|---|---|---|
| 125.0 | Run 24, Hard, fresh, dark gray, fine-grained, CALCAREOUS SHALE, low angle joints, 3/4" thick calcareous vein at 123.5' | 995+/- | 125 | | | 57 | | 93 | 2.5<br>2.0<br>2.0<br>1.75<br>2.25 | |
| 130.0 | Run 25, Similar | 990+/- | 130 | | | 60 | | 100 | 2.25<br>2.25<br>2.0<br>2.0<br>2.0 | |
| 135.0 | Run 26, Similar | 985+/- | 135 | | | 60 | | 90 | 2.0<br>2.0<br>1.75<br>1.75<br>2.0 | |
| 140.0 | Run 27, Similar, 2" thick seam of soft dark gray oily clay at 135'. At 138' highly weathered SHALE with calcareous veins and 1/8" thick light gray clay layer. | 980+/- | 140 | | | 60 | | 68 | 2.5<br>2.5<br>2.5<br>2.5<br>2.5 | |
| 145.0 | Run 28, Similar | 975+/- | 145 | | | 60 | | 100 | 2.5<br>2.5<br>2.5<br>2.5<br>2.5 | |
| 150.0 | Run 29, Similar | 970+/- | 150 | | | 60 | | 98 | 2.0<br>1.75<br>1.75<br>2.5<br>2.5 | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**
*14.5' AB*
*24.5' after 20 hrs (08/09/17)*
*27.5' after 14 hrs (08/11/17)*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

| | |
|---|---|
| Boring Started: 8/8/2017 | Boring Completed: 8/10/2017 |
| Drill Rig: CME-850 | Driller: Terracon/Peter M. |
| Project No.: J217P078 | |

# BORING LOG NO. B3-1W Lower Piney Creek Rd. West



**PROJECT: Mariner East Pipeline Borings**

**SITE: Spread 3**

**CLIENT: Directional Project Support Incorporated Magnolia, TX 77354**

LOCATION
Latitude: 40.433778° Longitude: -78.26967°
Approximate Surface Elev: 1120 (Ft.) +/-

| GRAPHIC LOG | DEPTH / DESCRIPTION | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | RQD (%) | Core rate (min/ft) | Penetrometer Test (tsf) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Run 30, Similar, 1/4" thick calcareous vein at 151' and 152.5' | | | | | 60 | | 93 | 2.5<br>2.5<br>2.0<br>1.75<br>1.75 | |
| | 155.0 | 965+/- | 155 | | | | | | | |
| | Run 31, Similar | | | | | 60 | | 93 | 2.0<br>1.75<br>1.75<br>1.75<br>1.75 | |
| | 160.0 | 960+/- | 160 | | | | | | | |
| | Run 32, Similar | | | | | 60 | | 95 | 2.25<br>2.0<br>2.25<br>2.5<br>2.5 | |
| | 165.0 | 955+/- | 165 | | | | | | | |
| | Run 33, Similar, 1/4" thick calcareous veins at 167.5' | | | | | 60 | | 95 | 2.75<br>2.25<br>2.0<br>2.0<br>2.0 | |
| | 170.0 | 950+/- | 170 | | | | | | | |
| | Run 34, Similar | | | | | 60 | | 100 | 2.75<br>2.75<br>2.5<br>2.5<br>2.0 | |
| | 175.0 | 945+/- | 175 | | | | | | | |
| | Run 35, Similar | | | | | 57 | | 90 | 3.0<br>2.75<br>3.0<br>3.0<br>2.25 | |
| | 180.0 | 940+/- | 180 | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**
- *14.5' AB*
- *24.5' after 20 hrs (08/09/17)*
- *27.5' after 14 hrs (08/11/17)*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

| | |
|---|---|
| Boring Started: 8/8/2017 | Boring Completed: 8/10/2017 |
| Drill Rig: CME-850 | Driller: Terracon/Peter M. |
| Project No.: J217P078 | |

# BORING LOG NO. B3-1W Lower Piney Creek Rd. West



**PROJECT: Mariner East Pipeline Borings**

**CLIENT: Directional Project Support Incorporated**
**Magnolia, TX 77354**

**SITE: Spread 3**

LOCATION

Latitude: 40.433778° Longitude: -78.26967°

Approximate Surface Elev: 1120 (Ft.) +/-

| DEPTH | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | RQD (%) | Core rate (min/ft) | Penetrometer Test (tsf) |
|---|---|---|---|---|---|---|---|---|---|
| Run 36, Similar<br>185.0 | 935+/- | 185 | | | 60 | | 98 | 2.25<br>1.75<br>1.75<br>1.75<br>1.75 | |
| Run 37, Similar<br>190.0 | 930+/- | 190 | | | 60 | | 97 | 2.0<br>2.0<br>2.0<br>2.0<br>1.75 | |
| Run 38, Similar<br>195.0 | 925+/- | 195 | | | 60 | | 67 | 2.0<br>2.0<br>2.0<br>2.0<br>2.0 | |
| ***Boring Terminated at 195 Feet*** | | | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

- *14.5' AB*
- *24.5' after 20 hrs (08/09/17)*
- *27.5' after 14 hrs (08/11/17)*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

| | |
|---|---|
| Boring Started: 8/8/2017 | Boring Completed: 8/10/2017 |
| Drill Rig: CME-850 | Driller: Terracon/Peter M. |
| Project No.: J217P078 | |

# BORING LOG NO. B3-1E Lower Piney Creek Rd. East



**PROJECT: Mariner East Pipeline Borings**

**CLIENT: Directional Project Support Incorporated**
**Magnolia, TX 77354**

**SITE: Spread 3**

LOCATION
Latitude: 40.43252° Longitude: -78.264217°
Approximate Surface Elev: 1114 (Ft.) +/-

| GRAPHIC LOG | DEPTH | DESCRIPTION | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | RQD (%) | Core rate (min/ft) | Penetrometer Test (tsf) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.5 | **LEAN CLAY WITH GRAVEL (CL)**, red, medium stiff | 1112.5+/- | | | | 7 | 3-3-5 N=8 | | | |
| | 4.5 | Pieces of cobbles and weathered rock in top 4.5 feet | 1109.5+/- | 5 | | | | | | | |
| | 15.0 | Roller bit to 15 feet<br>4-inch casing installed to 13.5 feet<br>Severely weathered rock | 1099+/- | 10, 15 | | | | | | | |
| | 20.0 | Run 1, Moderately hard, slightly weathered, very light gray, argillaceous SHALE, moderately dipping close joints, highly weathered 1/4" thick layer at 19.5 feet, thinly bedded. Some joints infilled with clay | 1094+/- | 20 | | | 60 | | 85 | 3.25<br>2.75<br>2.75<br>2.75<br>2.75 | |
| | 25.0 | Run 2, Similar | 1089+/- | 25 | | | 60 | | 88 | 2.5<br>2.5<br>2.5<br>2.75<br>3.0 | |
| | 30.0 | Run 3, Medium hard, moderately weathered, very light gray, argillaceous, moderately dipping close joints | 1084+/- | 30 | | | 57 | | 80 | 2.25<br>2.25<br>2.25<br>2.25<br>1.75 | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**
*64.5' AB (8/12/17)*
*105.5' after 14 hrs (08/13/17)*
*89.0' after 14 hrs (08/14/17)*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

| | |
|---|---|
| Boring Started: 8/11/2017 | Boring Completed: 8/14/2017 |
| Drill Rig: CME-850 | Driller: Terracon/Peter M. |
| Project No.: J217P078 | |

# BORING LOG NO. B3-1E Lower Piney Creek Rd. East



**PROJECT: Mariner East Pipeline Borings**

**CLIENT: Directional Project Support Incorporated**
**Magnolia, TX 77354**

**SITE: Spread 3**

LOCATION

Latitude: 40.43252° Longitude: -78.264217°

Approximate Surface Elev: 1114 (Ft.) +/-

| DEPTH | Description | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | RQD (%) | Core rate (min/ft) | Penetrometer Test (tsf) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Run 4, Similar | | | | | 60 | | 91 | 2.0<br>2.25<br>2.25<br>1.75<br>1.75 | |
| 35.0 | | 1079+/- | 35 | | | | | | | |
| | Run 5, Hard, slightly weathered, very light gray, argillaceous MUDSTONE, moderately dipping close joints, some joints infilled with clay vugs present | | | | | 60 | | 63 | 3.0<br>3.0<br>3.0<br>3.0<br>3.0 | |
| 40.0 | | 1074+/- | 40 | | | | | | | |
| | Run 6, Similar | | | | | 60 | | 78 | 3.25<br>3.25<br>3.25<br>3.25<br>3.25 | |
| 45.0 | | 1069+/- | 45 | | | | | | | |
| | Run 7, Similar | | | | | 60 | | 75 | 3.0<br>3.25<br>2.5<br>2.75<br>2.5 | |
| 50.0 | | 1064+/- | 50 | | | | | | | |
| | Run 8, Similar | | | | | 60 | | 83 | 3.0<br>3.0<br>2.75<br>2.75<br>3.0 | |
| 55.0 | | 1059+/- | 55 | | | | | | | |
| | Run 9, Slightly weathered, moderately dipping to high angle Joints, infilled with clay | | | | | 60 | | 100 | 3.25<br>3.25<br>3.5<br>2.5<br>2.75 | |
| 60.0 | | 1054+/- | 60 | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

*64.5' AB (8/12/17)*
*105.5' after 14 hrs (08/13/17)*
*89.0' after 14 hrs (08/14/17)*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

| | |
|---|---|
| Boring Started: 8/11/2017 | Boring Completed: 8/14/2017 |
| Drill Rig: CME-850 | Driller: Terracon/Peter M. |
| Project No.: J217P078 | |

# BORING LOG NO. B3-1E Lower Piney Creek Rd. East

**PROJECT: Mariner East Pipeline Borings**

**CLIENT: Directional Project Support Incorporated
Magnolia, TX 77354**

**SITE: Spread 3**

LOCATION

Latitude: 40.43252° Longitude: -78.264217°

Approximate Surface Elev: 1114 (Ft.) +/-

| DEPTH | Description | ELEVATION (Ft.) | DEPTH (Ft.) | RECOVERY (In.) | FIELD TEST RESULTS | RQD (%) | Core rate (min/ft) | Penetrometer Test (tsf) |
|---|---|---|---|---|---|---|---|---|
| 65.0 | Run 10, Medium hard, moderately weathered, very light gray to greenish gray, argillaceous MUDSTONE, moderately dipping close joints at 63'-64' | 1049+/- | 65 | 60 | | 90 | 3.0<br>3.0<br>2.25<br>2.25<br>2.25 | |
| 70.0 | Run 11, Similar | 1044+/- | 70 | 60 | | 90 | 2.5<br>3.0<br>3.5<br>3.25<br>3.25 | |
| 75.0 | Run 12, Similar | 1039+/- | 75 | 60 | | 100 | 3.5<br>3.75<br>3.75<br>3.0<br>2.5 | |
| 80.0 | Run 13, Hard, slightly weathered, very light gray, argillaceous MUDSTONE, moderately dipping close joints, quarts intrusions 79.5' -80' | 1034+/- | 80 | 56 | | 83 | 2.5<br>2.75<br>2.5<br>2.5<br>3.0 | |
| 85.0 | Run 14, Similar, moderately weathered zone 84.0'-85.0', 1/4" thick calcareous vein at 83' | 1029+/- | 85 | 60 | | 80 | 2.75<br>2.75<br>2.75<br>2.75<br>2.5 | |
| 90.0 | Run 15, Similar | 1024+/- | 90 | 60 | | 87 | 3.0<br>3.0<br>2.75<br>3.0<br>2.5 | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

*64.5' AB (8/12/17)*
*105.5' after 14 hrs (08/13/17)*
*89.0' after 14 hrs (08/14/17)*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

Boring Started: 8/11/2017 | Boring Completed: 8/14/2017
Drill Rig: CME-850 | Driller: Terracon/Peter M.
Project No.: J217P078

# BORING LOG NO. B3-1E Lower Piney Creek Rd. East



**PROJECT: Mariner East Pipeline Borings**

**CLIENT: Directional Project Support Incorporated**
**Magnolia, TX 77354**

**SITE: Spread 3**

LOCATION
Latitude: 40.43252° Longitude: -78.264217°
Approximate Surface Elev: 1114 (Ft.) +/-

| GRAPHIC LOG | DEPTH | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | RQD (%) | Core rate (min/ft) | Penetrometer Test (tsf) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Run 16, Similar, moderately weathered zone with quartz veins 93-94' | | | | | 60 | | 73 | 3.0 2.75 2.75 2.75 2.75 | |
| | 95.0 | 1019+/- | 95 | | | | | | | |
| | Run 17, Similar, 5-inch layer of clay at 97', encountered void at 98-100' | | | | | 45 | | 28 | 3.0 3.0 2.75 0.25 0.25 | |
| | 100.0 | 1014+/- | 100 | | | | | | | |
| | Run 18, Moderately hard, moderately weathered, moderately dipping to high angle joints, infilled with clay. 1" thick clay layer at 102'. | | | | | 49 | | 30 | 3.5 3.25 2.75 2.5 2.5 | |
| | 105.0 | 1009+/- | 105 | ▽ | | | | | | |
| | Run 19, Hard, fresh, medium light gray argillaceous DOLOMITE, moderately dipping close joints | | | | | 60 | | 90 | 3.0 3.0 2.75 2.75 2.75 | |
| | 110.0 | 1004+/- | 110 | | | | | | | |
| | Run 20, Similar, medium light gray to gray | | | | | 60 | | 100 | 2.75 2.25 2.25 2.25 2.25 | |
| | 115.0 | 999+/- | 115 | | | | | | | |
| | Run 21, Similar, | | | | | 60 | | 85 | 2.75 2.5 2.5 2.5 2.5 | |
| | 120.0 | 994+/- | 120 | | | | | | | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

▽ *64.5' AB (8/12/17)*
▽ *105.5' after 14 hrs (08/13/17)*
▼ *89.0' after 14 hrs (08/14/17)*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

| | |
|---|---|
| Boring Started: 8/11/2017 | Boring Completed: 8/14/2017 |
| Drill Rig: CME-850 | Driller: Terracon/Peter M. |
| Project No.: J217P078 | |

# BORING LOG NO. B3-1E Lower Piney Creek Rd. East

**PROJECT: Mariner East Pipeline Borings**

**SITE: Spread 3**

**CLIENT: Directional Project Support Incorporated**
**Magnolia, TX 77354**

LOCATION
Latitude: 40.43252° Longitude: -78.264217°

Approximate Surface Elev: 1114 (Ft.) +/-

| DEPTH | Description | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | RQD (%) | Core rate (min/ft) | Penetrometer Test (tsf) |
|---|---|---|---|---|---|---|---|---|---|---|
| 125.0 | Run 22, Similar, | 989+/- | 125 | | | 60 | | 80 | 2.5<br>2.5<br>2.25<br>2.25<br>2.25 | |
| 130.0 | Run 23, Similar | 984+/- | 130 | | | 60 | | 100 | 3.0<br>2.75<br>2.5<br>2.75<br>2.5 | |
| 135.0 | Run 24, Similar, low to high angle joints, clay/silt layer 130' - 130.5' | 979+/- | 135 | | | 60 | | 63 | 2.25<br>2.5<br>2.5<br>2.5<br>2.5 | |
| 140.0 | Run 25, Hard, fresh, very light gray argillaceous DOLOMITE, moderately dipping close joints, 1" quartz vein at 148' | 974+/- | 140 | | | 60 | | 90 | 2.5<br>2.5<br>2.75<br>2.75<br>2.5 | |
| 145.0 | Run 26, Similar, very slightly weathered, joints with thin clay coating | 969+/- | 145 | | | 55 | | 32 | 2.75<br>2.75<br>3.0<br>3.25<br>5.0 | |
| 150.0 | Run 27, Hard, very slightly weathered, medium gray, argillaceous DOLOMITE, vertical close joints | 964+/- | 150 | | | 56 | | 25 | 2.75<br>2.75<br>3.25<br>2.75<br>3.25 | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**
*64.5' AB (8/12/17)*
*105.5' after 14 hrs (08/13/17)*
*89.0' after 14 hrs (08/14/17)*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

| | |
|---|---|
| Boring Started: 8/11/2017 | Boring Completed: 8/14/2017 |
| Drill Rig: CME-850 | Driller: Terracon/Peter M. |
| Project No.: J217P078 | |

# BORING LOG NO. B3-1E Lower Piney Creek Rd. East

**PROJECT: Mariner East Pipeline Borings**

**SITE: Spread 3**

**CLIENT: Directional Project Support Incorporated Magnolia, TX 77354**

LOCATION

Latitude: 40.43252° Longitude: -78.264217°

Approximate Surface Elev: 1114 (Ft.) +/-

| DEPTH | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | RQD (%) | Core rate (min/ft) | Penetrometer Test (tsf) |
|---|---|---|---|---|---|---|---|---|---|
| Run 28, Hard, fresh, medium dark gray, argillaceous DOLOMITE, moderately dipping, moderately close joints with coal coating<br>155.0 | 959+/- | 155 | | | 57 | | 95 | 3.5<br>2.75<br>3.0<br>3.0<br>3.0 | |
| Run 29, Similar, no joints present in this run, (solid core)<br>160.0 | 954+/- | 160 | | | 60 | | 100 | 3.5<br>3.0<br>3.0<br>3.0<br>3.0 | |
| Run 30, Similar, grayish black 160'- 162', medium dark gray 162'-165', low angle joints<br>165.0 | 949+/- | 165 | | | 60 | | 87 | 2.5<br>2.5<br>2.5<br>3.0<br>3.0 | |
| Run 31, Hard, fresh, medium dark gray, argillaceous DOLOMITE, low angle close joints<br>170.0 | 944+/- | 170 | | | 60 | | 85 | 4.5<br>4.75<br>4.0<br>3.75<br>3.75 | |
| Run 32, Similar, moderately dipping to vertical joints<br>175.0 | 939+/- | 175 | | | 60 | | 85 | 4.75<br>3.25<br>3.0<br>2.75<br>2.75 | |
| Run 33, Change at 178', medium dark gray, at 179' light gray, moderately dipping close joints<br>180.0 | 934+/- | 180 | | | 60 | | 100 | 3.5<br>3.5<br>3.5<br>3.25<br>3.25 | |

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

*64.5' AB (8/12/17)*
*105.5' after 14 hrs (08/13/17)*
*89.0' after 14 hrs (08/14/17)*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

| | |
|---|---|
| Boring Started: 8/11/2017 | Boring Completed: 8/14/2017 |
| Drill Rig: CME-850 | Driller: Terracon/Peter M. |
| Project No.: J217P078 | |

# BORING LOG NO. B3-1E Lower Piney Creek Rd. East

**PROJECT: Mariner East Pipeline Borings**

**SITE: Spread 3**

**CLIENT: Directional Project Support Incorporated Magnolia, TX 77354**

LOCATION

Latitude: 40.43252° Longitude: -78.264217°

Approximate Surface Elev: 1114 (Ft.) +/-

| DEPTH | ELEVATION (Ft.) | DEPTH (Ft.) | WATER LEVEL OBSERVATIONS | SAMPLE TYPE | RECOVERY (In.) | FIELD TEST RESULTS | RQD (%) | Core rate (min/ft) | Penetrometer Test (tsf) |
|---|---|---|---|---|---|---|---|---|---|
| Run 34, Similar, change at 180': Hard, fresh, medium dark gray, argillaceous CALCAREOUS LIMESTONE, low angle moderately close joints. Moderately weathered at 185' | | | | | 60 | | 90 | 3.5<br>3.75<br>2.75<br>2.75<br>2.75 | |
| 185.0 | 929+/- | 185 | | | | | | | |
| Run 35, Similar, medium gray, | | | | | 48 | | 68 | 3.0<br>3.0<br>3.25<br>3.25<br>3.25 | |
| 190.0 | 924+/- | 190 | | | | | | | |

***Boring Terminated at 190 Feet***

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Mud rotary with wireline

Abandonment Method:
Grouted to surface

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

**WATER LEVEL OBSERVATIONS**

- *64.5' AB (8/12/17)*
- *105.5' after 14 hrs (08/13/17)*
- *89.0' after 14 hrs (08/14/17)*

Terracon
201 Hammer Mill Rd
Rocky Hill, CT

| | |
|---|---|
| Boring Started: 8/11/2017 | Boring Completed: 8/14/2017 |
| Drill Rig: CME-850 | Driller: Terracon/Peter M. |
| Project No.: J217P078 | |

## ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

| | | | |
|---|---|---|---|
| Boring No.: | B3-1W | Lithology : | Shale |
| Sample No.: | 1 | Moisture Content : | As received |
| Sample Depth: | 29 feet | Lab Temperature : | 70° F |
| Sampling Date: | 8/8/17 | Loading Rate: | 55 psi/s |
| | | Time to Failure: | 16 min |

| | | | |
|---|---|---|---|
| Diameter: | 1.87 in | Maximum Axial Load at Failure: | 53,420 lb |
| Length: | 4.41 in | Compressive Strength: | 19,450 psi |
| L/D: | 2.36 | Compressive Strength: | 134.11 Mpa |
| End Area: | 2.75 $in^2$ | Unit Weight | 167 pcf |

Before the Test


After the Test


| | |
|---|---|
| Drawing # : | PA-BL-0125.0000-RD |
| PO # : | 20170804-13 |
| Crossing : | Lower Piney Creek Rd |
| Spread : | Spread 3 |

| | | | | |
|---|---|---|---|---|
| Project: | Mariner East Pipeline | Terracon | Performed by: | A.Suprunenko |
| Project No. | J217P078 | | Test Date: | 10/3/2017 |
| Location: | Spread 3 | | Reviewed By : | L.Dwyer |
| Client : | Directional Project Support Inc. | 77 Sundial Ave., Suite 401 W Manchester, New Hampshire | Review Date : | 10/7/2017 |

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

| | | | |
|---|---|---|---|
| Boring No.: | B3-1W | Lithology : | Shale |
| Sample No.: | 2 | Moisture Content : | As received |
| Sample Depth: | 51 feet | Lab Temperature : | 70° F |
| Sampling Date: | 8/8/17 | Loading Rate: | 55 psi/s |
| | | Time to Failure: | 14 min |

| | | | |
|---|---|---|---|
| Diameter: | 1.92 in | Maximum Axial Load at Failure: | 45,660 lb |
| Length: | 4.05 in | Compressive Strength: | 15,770 psi |
| L/D: | 2.11 | Compressive Strength: | 108.73 Mpa |
| End Area: | 2.90 $in^2$ | Unit Weight | 167 pcf |

Before the Test


After the Test


Drawing # : PA-BL-0125.0000-RD
PO # : 20170804-13
Crossing : Lower Piney Creek Rd
Spread : Spread 3

| | | | | |
|---|---|---|---|---|
| Project: | Mariner East Pipeline | Terracon | Performed by: | A.Suprunenko |
| Project No | J217P078 | 77 Sundial Ave., Suite 401 W | Test Date: | 10/3/2017 |
| Location: | Spread 3 | Manchester, New Hampshire | Reviewed By : | L.Dwyer |
| Client : | Directional Project Support Inc. | | Review Date : | 10/7/2017 |

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

| | | | |
|---|---|---|---|
| Boring No.: | B3-1W | Lithology : | Shale |
| Sample No.: | 3 | Moisture Content : | As received |
| Sample Depth: | 72 feet | Lab Temperature : | 70° F |
| Sampling Date: | 8/8/17 | Loading Rate: | 55 psi/s |
| | | Time to Failure: | 22 min |

| | | | |
|---|---|---|---|
| Diameter: | 1.98 in | Maximum Axial Load at Failure: | 72,670 lb |
| Length: | 4.41 in | Compressive Strength: | 23,601 psi |
| L/D: | 2.23 | Compressive Strength: | 162.72 Mpa |
| End Area: | 3.08 $in^2$ | Unit Weight | 166 pcf |

Before the Test


After the Test


Drawing # : PA-BL-0125.0000-RD
PO # : 20170804-13
Crossing : Lower Piney Creek Rd
Spread : Spread 3

| | | | | |
|---|---|---|---|---|
| Project: | Mariner East Pipeline | Terracon<br>77 Sundial Ave., Suite 401 W<br>Manchester, New Hampshire | Performed by: | A.Suprunenko |
| Project No. | J217P078 | | Test Date: | 10/3/2017 |
| Location: | Spread 3 | | Reviewed By : | L.Dwyer |
| Client : | Directional Project Support Inc. | | Review Date : | 10/7/2017 |

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

| | | | |
|---|---|---|---|
| Boring No.: | B3-1W | Lithology : | Shale |
| Sample No.: | 4 | Moisture Content : | As received |
| Sample Depth: | 92 feet | Lab Temperature : | 70° F |
| Sampling Date: | 8/8/17 | Loading Rate: | 55 psi/s |
| | | Time to Failure: | 20 min |

| | | | |
|---|---|---|---|
| Diameter: | 1.97 in | Maximum Axial Load at Failure: | 65,450 lb |
| Length: | 4.42 in | Compressive Strength: | 21,473 psi |
| L/D: | 2.24 | Compressive Strength: | 148.05 Mpa |
| End Area: | 3.05 $in^2$ | Unit Weight | 167 pcf |

Before the Test


After the Test


Drawing # : PA-BL-0125.0000-RD
PO # : 20170804-13
Crossing : Lower Piney Creek Rd
Spread : Spread 3

| | | | | |
|---|---|---|---|---|
| Project: | Mariner East Pipeline | Terracon | Performed by: | A.Suprunenko |
| Project No. | J217P078 | 77 Sundial Ave., Suite 401 W | Test Date: | 10/3/2017 |
| Location: | Spread 3 | Manchester, New Hampshire | Reviewed By : | L.Dwyer |
| Client : | Directional Project Support Inc. | | Review Date : | 10/7/2017 |

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

| | | | |
|---|---|---|---|
| Boring No.: | B3-1W | Lithology : | Shale |
| Sample No.: | 5 | Moisture Content : | As received |
| Sample Depth: | 112 feet | Lab Temperature : | 70° F |
| Sampling Date: | 8/8/17 | Loading Rate: | 55 psi/s |
| | | Time to Failure: | 19 min |

| | | | |
|---|---|---|---|
| Diameter: | 1.98 in | Maximum Axial Load at Failure: | 61,920 lb |
| Length: | 4.21 in | Compressive Strength: | 20,110 psi |
| L/D: | 2.13 | Compressive Strength: | 138.65 Mpa |
| End Area: | 3.08 $in^2$ | Unit Weight | 167 pcf |

Before the Test


After the Test


Drawing # : PA-BL-0125.0000-RD
PO # : 20170804-13
Crossing : Lower Piney Creek Rd
Spread : Spread 3

| | | | | |
|---|---|---|---|---|
| Project: | Mariner East Pipeline | Terracon<br>77 Sundial Ave., Suite 401 W<br>Manchester, New Hampshire | Performed by: | A.Suprunenko |
| Project No | J217P078 | | Test Date: | 10/3/2017 |
| Location: | Spread 3 | | Reviewed By : | L.Dwyer |
| Client : | Directional Project Support Inc. | | Review Date : | 10/7/2017 |

ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

| | | | |
|---|---|---|---|
| Boring No.: | B3-1W | Lithology : | Shale |
| Sample No.: | 6 | Moisture Content : | As received |
| Sample Depth: | 132 feet | Lab Temperature : | 70° F |
| Sampling Date: | 8/8/17 | Loading Rate: | 55 psi/s |
| | | Time to Failure: | 7 min |

| | | | |
|---|---|---|---|
| Diameter: | 1.98 in | Maximum Axial Load at Failure: | 24,440 lb |
| Length: | 4.32 in | Compressive Strength: | 7,937 psi |
| L/D: | 2.18 | Compressive Strength: | 54.73 Mpa |
| End Area: | 3.08 $in^2$ | Unit Weight | 167 pcf |

Before the Test


After the Test


Drawing # : PA-BL-0125.0000-RD
PO # : 20170804-13
Crossing : Lower Piney Creek Rd
Spread : Spread 3

| | | | | |
|---|---|---|---|---|
| Project: | Mariner East Pipeline | Terracon | Performed by: | A.Suprunenko |
| Project No. | J217P078 | 77 Sundial Ave., Suite 401 W | Test Date: | 10/3/2017 |
| Location: | Spread 3 | Manchester, New Hampshire | Reviewed By : | L.Dwyer |
| Client : | Directional Project Support Inc. | | Review Date : | 10/7/2017 |

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

| | | | |
|---|---|---|---|
| Boring No.: | B3-1W | Lithology : | Shale |
| Sample No.: | 7 | Moisture Content : | As received |
| Sample Depth: | 137 feet | Lab Temperature : | 70° F |
| Sampling Date: | 8/8/17 | Loading Rate: | 55 psi/s |
| | | Time to Failure: | 2 min |

| | | | |
|---|---|---|---|
| Diameter: | 1.97 in | Maximum Axial Load at Failure: | 5,840 lb |
| Length: | 2.68 in | Compressive Strength: | 1,916 psi |
| L/D: | 1.36 | Compressive Strength: | 13.21 Mpa |
| End Area: | 3.05 $in^2$ | Unit Weight | 159 pcf |

Comments : Due to lack of available specimens, the length to diameter ratio of the tested specimen is not conformant with ASTM D7012. The results obtained during testing may differ from those obtained from the test specimens that meet the requirements.

Before the Test


After the Test


Drawing # : PA-BL-0125.0000-RD
PO # : 20170804-13
Crossing : Lower Piney Creek Rd
Spread : Spread 3

| | | | | |
|---|---|---|---|---|
| Project: | Mariner East Pipeline | Terracon | Performed by: | A.Suprunenko |
| Project No | J217P078 | 77 Sundial Ave., Suite 401 W | Test Date: | 10/3/2017 |
| Location: | Spread 3 | Manchester, New Hampshire | Reviewed By : | L.Dwyer |
| Client : | Directional Project Support Inc. | | Review Date : | 10/7/2017 |

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

| | | | |
|---|---|---|---|
| Boring No.: | B3-1W | Lithology : | Shale |
| Sample No.: | 8 | Moisture Content : | As received |
| Sample Depth: | 147 feet | Lab Temperature : | 70° F |
| Sampling Date: | 8/8/17 | Loading Rate: | 55 psi/s |
| | | Time to Failure: | 24 min |

| | | | |
|---|---|---|---|
| Diameter: | 1.98 in | Maximum Axial Load at Failure: | 77,960 lb |
| Length: | 4.34 in | Compressive Strength: | 25,319 psi |
| L/D: | 2.19 | Compressive Strength: | 174.57 Mpa |
| End Area: | 3.08 $in^2$ | Unit Weight | 168 pcf |

Before the Test


After the Test


Drawing # : PA-BL-0125.0000-RD
PO # : 20170804-13
Crossing : Lower Piney Creek Rd
Spread : Spread 3

| | | | | |
|---|---|---|---|---|
| Project: | Mariner East Pipeline | Terracon | Performed by: | A.Suprunenko |
| Project No. | J217P078 | 77 Sundial Ave., Suite 401 W | Test Date: | 10/3/2017 |
| Location: | Spread 3 | Manchester, New Hampshire | Reviewed By : | L.Dwyer |
| Client : | Directional Project Support Inc. | | Review Date : | 10/7/2017 |

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

| | | | |
|---|---|---|---|
| Boring No.: | B3-1W | Lithology : | Shale |
| Sample No.: | 9 | Moisture Content : | As received |
| Sample Depth: | 157 feet | Lab Temperature : | 70° F |
| Sampling Date: | 8/8/17 | Loading Rate: | 55 psi/s |
| | | Time to Failure: | 24 min |

| | | | |
|---|---|---|---|
| Diameter: | 1.98 in | Maximum Axial Load at Failure: | 78,740 lb |
| Length: | 4.43 in | Compressive Strength: | 25,573 psi |
| L/D: | 2.24 | Compressive Strength: | 176.32 Mpa |
| End Area: | 3.08 $in^2$ | Unit Weight | 169 pcf |

Before the Test


After the Test


Drawing # : PA-BL-0125.0000-RD
PO # : 20170804-13
Crossing : Lower Piney Creek Rd
Spread : Spread 3

| | | | | |
|---|---|---|---|---|
| Project: | Mariner East Pipeline | Terracon<br>77 Sundial Ave., Suite 401 W<br>Manchester, New Hampshire | Performed by: | A.Suprunenko |
| Project No. | J217P078 | | Test Date: | 10/3/2017 |
| Location: | Spread 3 | | Reviewed By : | L.Dwyer |
| Client : | Directional Project Support Inc. | | Review Date : | 10/7/2017 |

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

| | | | |
|---|---|---|---|
| Boring No.: | B3-1E | Lithology : | Mudstone |
| Sample No.: | 1 | Moisture Content : | As received |
| Sample Depth: | 35 feet | Lab Temperature : | 70° F |
| Sampling Date: | 8/11/17 | Loading Rate: | 55 psi/s |
| | | Time to Failure: | 12 min |

| | | | |
|---|---|---|---|
| Diameter: | 1.98 in | Maximum Axial Load at Failure: | 38,720 lb |
| Length: | 4.51 in | Compressive Strength: | 12,575 psi |
| L/D: | 2.28 | Compressive Strength: | 86.70 Mpa |
| End Area: | 3.08 $in^2$ | Unit Weight | 174 pcf |

Before the Test


After the Test


Drawing # : PA-BL-0125.0000-RD
PO # : 20170804-13
Crossing : Lower Piney Creek Rd
Spread : Spread 3

| | | | | |
|---|---|---|---|---|
| Project: | Mariner East Pipeline | Terracon | Performed by: | A.Suprunenko |
| Project No. | J217P078 | | Test Date: | 9/28/2017 |
| Location: | Spread 3 | 77 Sundial Ave., Suite 401 W | Reviewed By : | L.Dwyer |
| Client : | Directional Project Support Inc. | Manchester, New Hampshire | Review Date : | 10/7/2017 |

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

| | | | |
|---|---|---|---|
| Boring No.: | B3-1E | Lithology : | Mudstone |
| Sample No.: | 2 | Moisture Content : | As received |
| Sample Depth: | 54 feet | Lab Temperature : | 70° F |
| Sampling Date: | 8/11/17 | Loading Rate: | 55 psi/s |
| | | Time to Failure: | 6 min |

| | | | |
|---|---|---|---|
| Diameter: | 1.97 in | Maximum Axial Load at Failure: | 19,940 lb |
| Length: | 3.82 in | Compressive Strength: | 6,542 psi |
| L/D: | 1.94 | Compressive Strength: | 45.10 Mpa |
| End Area: | 3.05 $in^2$ | Unit Weight | 174 pcf |

Comments : Due to lack of available specimens, the length to diameter ratio of the tested specimen is not conformant with ASTM D7012. The results obtained during testing may differ from those obtained from the test specimens that meet the requirements.

Before the Test


After the Test


Drawing # : PA-BL-0125.0000-RD
PO # : 20170804-13
Crossing : Lower Piney Creek Rd
Spread : Spread 3

| | | | | |
|---|---|---|---|---|
| Project: | Mariner East Pipeline | Terracon | Performed by: | A.Suprunenko |
| Project No. | J217P078 | | Test Date: | 9/28/2017 |
| Location: | Spread 3 | | Reviewed By : | L.Dwyer |
| Client : | Directional Project Support Inc. | 77 Sundial Ave., Suite 401 W Manchester, New Hampshire | Review Date : | 10/7/2017 |

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

| | | | |
|---|---|---|---|
| Boring No.: | B3-1E | Lithology : | Mudstone |
| Sample No.: | 3 | Moisture Content : | As received |
| Sample Depth: | 75 feet | Lab Temperature : | 70° F |
| Sampling Date: | 8/11/17 | Loading Rate: | 55 psi/s |
| | | Time to Failure: | 6 min |

| | | | |
|---|---|---|---|
| Diameter: | 1.95 in | Maximum Axial Load at Failure: | 20,220 lb |
| Length: | 4.09 in | Compressive Strength: | 6,771 psi |
| L/D: | 2.10 | Compressive Strength: | 46.68 Mpa |
| End Area: | 2.99 $in^2$ | Unit Weight | 71 pcf |

Before the Test


After the Test


Drawing # : PA-BL-0125.0000-RD
PO # : 20170804-13
Crossing : Lower Piney Creek Rd
Spread : Spread 3

| | | | | |
|---|---|---|---|---|
| Project: | Mariner East Pipeline | Terracon | Performed by: | A.Suprunenko |
| Project No | J217P078 | | Test Date: | 9/28/2017 |
| Location: | Spread 3 | 77 Sundial Ave., Suite 401 W | Reviewed By : | L.Dwyer |
| Client : | Directional Project Support Inc. | Manchester, New Hampshire | Review Date : | 10/7/2017 |

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

| | | | |
|---|---|---|---|
| Boring No.: | B3-1E | Lithology : | Mudstone |
| Sample No.: | 4 | Moisture Content : | As received |
| Sample Depth: | 95 feet | Lab Temperature : | 70° F |
| Sampling Date: | 8/11/17 | Loading Rate: | 55 psi/s |
| | | Time to Failure: | 18 min |

| | | | |
|---|---|---|---|
| Diameter: | 1.95 in | Maximum Axial Load at Failure: | 58,770 lb |
| Length: | 3.77 in | Compressive Strength: | 19,679 psi |
| L/D: | 1.93 | Compressive Strength: | 135.68 Mpa |
| End Area: | 2.99 $in^2$ | Unit Weight | 175 pcf |

Comments : Due to lack of available specimens, the length to diameter ratio of the tested specimen is not conformant with ASTM D7012. The results obtained during testing may differ from those obtained from the test specimens that meet the requirements.

Before the Test


After the Test


Drawing # : PA-BL-0125.0000-RD
PO # : 20170804-13
Crossing : Lower Piney Creek Rd
Spread : Spread 3

| | |
|---|---|
| Project: | Mariner East Pipeline |
| Project No. | J217P078 |
| Location: | Spread 3 |
| Client : | Directional Project Support Inc. |

Terracon
77 Sundial Ave., Suite 401 W
Manchester, New Hampshire

| | |
|---|---|
| Performed by: | A.Suprunenko |
| Test Date: | 9/28/2017 |
| Reviewed By : | L.Dwyer |
| Review Date : | 10/7/2017 |

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

| | | | |
|---|---|---|---|
| Boring No.: | B3-1E | Lithology : | Mudstone |
| Sample No.: | 5 | Moisture Content : | As received |
| Sample Depth: | 115 feet | Lab Temperature : | 70° F |
| Sampling Date: | 8/11/17 | Loading Rate: | 55 psi/s |
| | | Time to Failure: | 1 min |

| | | | |
|---|---|---|---|
| Diameter: | 1.97 in | Maximum Axial Load at Failure: | 2,890 lb |
| Length: | 4.13 in | Compressive Strength: | 948 psi |
| L/D: | 2.10 | Compressive Strength: | 6.54 Mpa |
| End Area: | 3.05 $in^2$ | Unit Weight | 160 pcf |

Before the Test


After the Test


Drawing # : PA-BL-0125.0000-RD
PO # : 20170804-13
Crossing : Lower Piney Creek Rd
Spread : Spread 3

| | | | | |
|---|---|---|---|---|
| Project: | Mariner East Pipeline | Terracon | Performed by: | A.Suprunenko |
| Project No | J217P078 | 77 Sundial Ave., Suite 401 W | Test Date: | 9/28/2017 |
| Location: | Spread 3 | Manchester, New Hampshire | Reviewed By : | L.Dwyer |
| Client : | Directional Project Support Inc. | | Review Date : | 10/7/2017 |

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

| | | | |
|---|---|---|---|
| Boring No.: | B3-1E | Lithology : | Mudstone |
| Sample No.: | 6 | Moisture Content : | As received |
| Sample Depth: | 132 feet | Lab Temperature : | 70° F |
| Sampling Date: | 8/11/17 | Loading Rate: | 55 psi/s |
| | | Time to Failure: | 1 min |

| | | | |
|---|---|---|---|
| Diameter: | 1.97 in | Maximum Axial Load at Failure: | 2,490 lb |
| Length: | 4.48 in | Compressive Strength: | 817 psi |
| L/D: | 2.27 | Compressive Strength: | 5.63 Mpa |
| End Area: | 3.05 $in^2$ | Unit Weight | 176 pcf |

Before the Test


After the Test


Drawing # : PA-BL-0125.0000-RD
PO # : 20170804-13
Crossing : Lower Piney Creek Rd
Spread : Spread 3

| | | | | |
|---|---|---|---|---|
| Project: | Mariner East Pipeline | Terracon | Performed by: | A.Suprunenko |
| Project No | J217P078 | | Test Date: | 10/6/2017 |
| Location: | Spread 3 | 77 Sundial Ave., Suite 401 W | Reviewed By : | L.Dwyer |
| Client : | Directional Project Support Inc. | Manchester, New Hampshire | Review Date : | 10/7/2017 |

## ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

| | | | |
|---|---|---|---|
| Boring No.: | B3-1E | Lithology : | Dolomite |
| Sample No.: | 7 | Moisture Content : | As received |
| Sample Depth: | 147 feet | Lab Temperature : | 70° F |
| Sampling Date: | 8/11/17 | Loading Rate: | 55 psi/s |
| | | Time to Failure: | 22 min |

| | | | |
|---|---|---|---|
| Diameter: | 1.97 in | Maximum Axial Load at Failure: | 71,900 lb |
| Length: | 3.19 in | Compressive Strength: | 23,589 psi |
| L/D: | 1.62 | Compressive Strength: | 162.64 Mpa |
| End Area: | 3.05 $in^2$ | Unit Weight | 175 pcf |

Comments : Due to lack of available specimens, the length to diameter ratio of the tested specimen is not conformant with ASTM D7012. The results obtained during testing may differ from those obtained from the test specimens that meet the requirements.

Before the Test


After the Test

Drawing # : PA-BL-0125.0000-RD
PO # : 20170804-13
Crossing : Lower Piney Creek Rd
Spread : Spread 3

| | | | | |
|---|---|---|---|---|
| Project: | Mariner East Pipeline | Terracon | Performed by: | A.Suprunenko |
| Project No | J217P078 | | Test Date: | 10/6/2017 |
| Location: | Spread 3 | | Reviewed By : | L.Dwyer |
| Client : | Directional Project Support Inc. | 77 Sundial Ave., Suite 401 W Manchester, New Hampshire | Review Date : | 10/7/2017 |

# ASTM D7012 (Method C) Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens

| | | | |
|---|---|---|---|
| Boring No.: | B3-1E | Lithology : | Dolomite |
| Sample No.: | 8 | Moisture Content : | As received |
| Sample Depth: | 152 feet | Lab Temperature : | 70° F |
| Sampling Date: | 8/11/17 | Loading Rate: | 55 psi/s |
| | | Time to Failure: | 27 min |

| | | | |
|---|---|---|---|
| Diameter: | 1.96 in | Maximum Axial Load at Failure: | >90,000 lb |
| Length: | 3.92 in | Compressive Strength: | >29,829 psi |
| L/D: | 2.00 | Compressive Strength: | >205.66 Mpa |
| End Area: | 3.02 $in^2$ | Unit Weight | 177 pcf |

Machine reached loading capacity before specimen broke

Before the Test


After the Test


Drawing # : PA-BL-0125.0000-RD
PO # : 20170804-13
Crossing : Lower Piney Creek Rd
Spread : Spread 3

| | | | | |
|---|---|---|---|---|
| Project: | Mariner East Pipeline | Terracon | Performed by: | A.Suprunenko |
| Project No | J217P078 | | Test Date: | 10/6/2017 |
| Location: | Spread 3 | | Reviewed By : | L.Dwyer |
| Client : | Directional Project Support Inc. | 77 Sundial Ave., Suite 401 W Manchester, New Hampshire | Review Date : | 10/7/2017 |


**Photograph 1:** B3-1W, Samples C-1 to C-6 (10 to 35 feet)


**Photograph 2:** B3-1W, Samples C-6 to C-10 (35 to 50 feet)

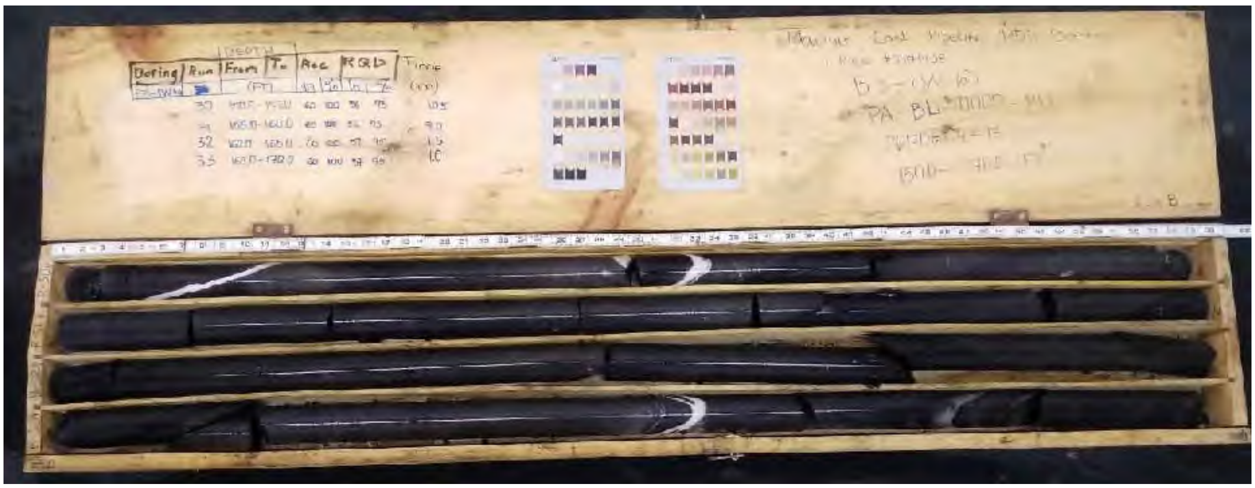

**Photograph 3:** B3-1W, Samples C-10 to C-13 (50 to 70 feet)


**Photograph 4:** B3-1W, Samples C-14 to C-17 (70 to 90 feet)


**Photograph 5:** B3-1W, Samples C-18 to C-21 (90 to 110 feet)

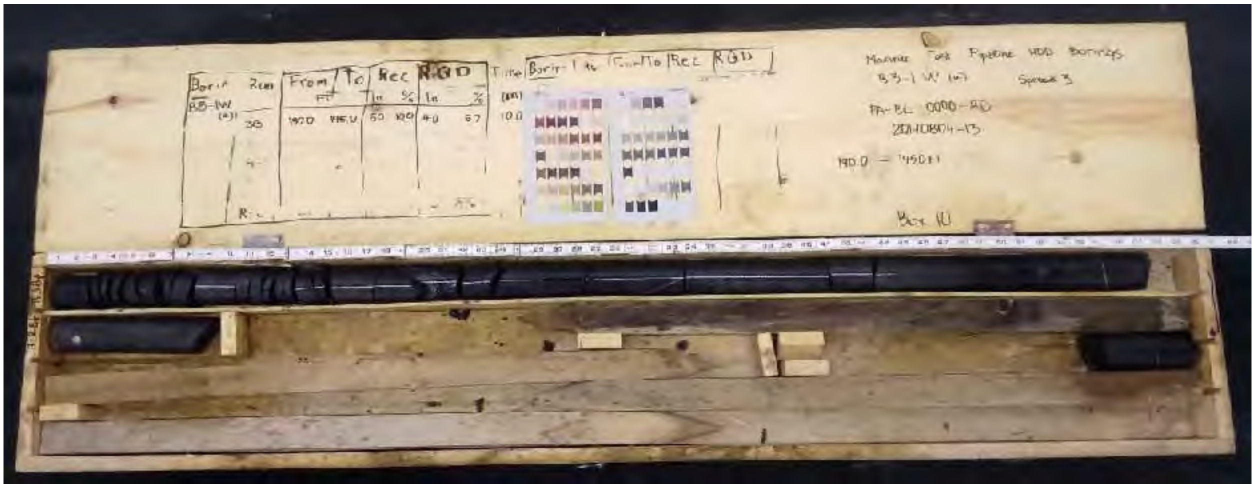

**Photograph 6:** B3-1W, Samples C-22 to C-24 (110 to 130 feet)

**Photograph 7:** B3-1W, Samples C-26 to C-29 (130 to 150 feet)



**Photograph 8:** B3-1W, Samples C-30 to C-33 (150 to 170 feet)

**Photograph 9:** B3-1W, Samples C-34 to C-37 (170 to 190 feet)



**Photograph 10:** B3-1W, Sample 38 (190 to 195 feet)

**Photograph 1:** B3-1E, Samples C-1 to C-4 (15 to 35 feet)

**Photograph 2:** B3-1E, Samples C-5 to C-8 (35 to 55 feet)

**Photograph 3:** B3-1E, Samples C-9 to C-12 (55 to 75 feet)


**Photograph 4:** B3-1E, Samples C-13 to C-16 (75 to 95 feet)


**Photograph 5:** B3-1E, Samples C-17 to C-20 (95 to 115 feet)


**Photograph 6:** B3-1E, Samples C-21 to C-24 (115 to 135 feet)

**Photograph 7:** B3-1E, Samples C-25 to C-28 (135 to 155 feet)

**Photograph 8:** B3-1E, Samples C-29 to C-32 (155 to 175 feet)

**Photograph 9:** B3-1E, Samples C-33 to C-35 (175 to 190 feet)

# SUPPORTING INFORMATION

## UNIFIED SOIL CLASSIFICATION SYSTEM

| Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A] | | | | Soil Classification: Group Symbol | Soil Classification: Group Name [B] |
|---|---|---|---|---|---|
| **Coarse-Grained Soils:** More than 50% retained on No. 200 sieve | **Gravels:** More than 50% of coarse fraction retained on No. 4 sieve | **Clean Gravels:** Less than 5% fines [C] | Cu ³ 4 and 1 £ Cc £ 3 [E] | GW | Well-graded gravel [F] |
| | | | Cu < 4 and/or 1 > Cc > 3 [E] | GP | Poorly graded gravel [F] |
| | | **Gravels with Fines:** More than 12% fines [C] | Fines classify as ML or MH | GM | Silty gravel [F,G,H] |
| | | | Fines classify as CL or CH | GC | Clayey gravel [F,G,H] |
| | **Sands:** 50% or more of coarse fraction passes No. 4 sieve | **Clean Sands:** Less than 5% fines [D] | Cu ³ 6 and 1 £ Cc £ 3 [E] | SW | Well-graded sand [I] |
| | | | Cu < 6 and/or 1 > Cc > 3 [E] | SP | Poorly graded sand [I] |
| | | **Sands with Fines:** More than 12% fines [D] | Fines classify as ML or MH | SM | Silty sand [G,H,I] |
| | | | Fines classify as CL or CH | SC | Clayey sand [G,H,I] |
| **Fine-Grained Soils:** 50% or more passes the No. 200 sieve | **Silts and Clays:** Liquid limit less than 50 | **Inorganic:** | PI > 7 and plots on or above "A" | CL | Lean clay [K,L,M] |
| | | | PI < 4 or plots below "A" line [J] | ML | Silt [K,L,M] |
| | | **Organic:** | Liquid limit - oven dried / Liquid limit - not dried < 0.75 | OL | Organic clay [K,L,M,N] |
| | | | | | Organic silt [K,L,M,O] |
| | **Silts and Clays:** Liquid limit 50 or more | **Inorganic:** | PI plots on or above "A" line | CH | Fat clay [K,L,M] |
| | | | PI plots below "A" line | MH | Elastic Silt [K,L,M] |
| | | **Organic:** | Liquid limit - oven dried / Liquid limit - not dried < 0.75 | OH | Organic clay [K,L,M,P] |
| | | | | | Organic silt [K,L,M,Q] |
| **Highly organic soils:** | Primarily organic matter, dark in color, and organic odor | | | PT | Peat |

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ³ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ³ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ³ 30% plus No. 200 predominantly sand, add "sandy" to group name.

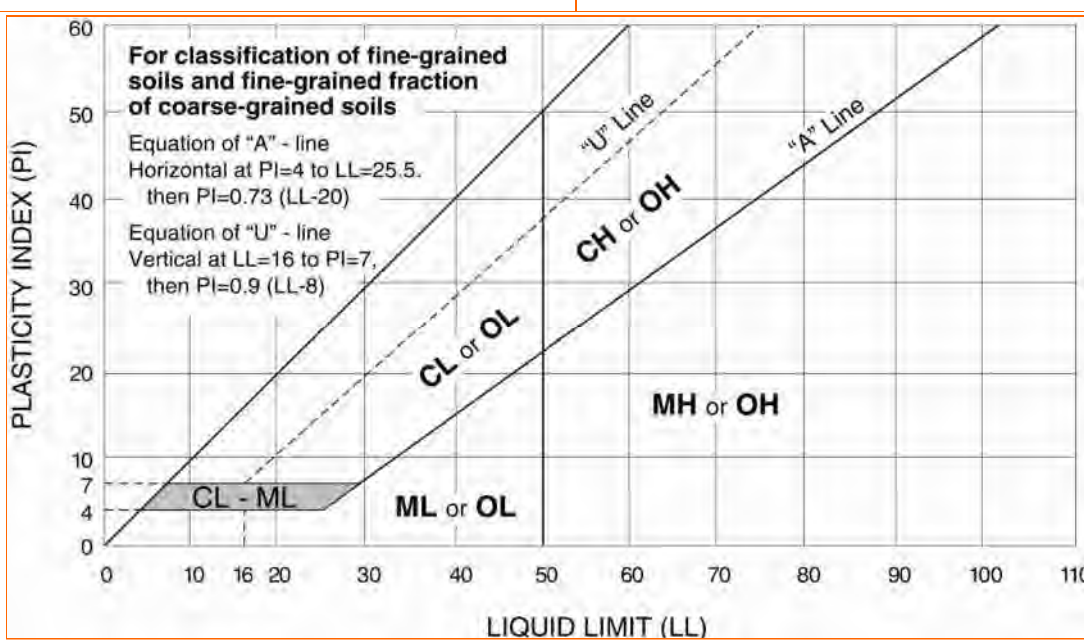
[M] If soil contains ³ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ³ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



# DESCRIPTION OF ROCK PROPERTIES

| WEATHERING | |
|---|---|
| **Fresh** | Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline. |
| **Very Slight** | Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline. |
| **Slight** | Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer. |
| **Moderate** | Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock. |
| **Moderately Severe** | All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick. |
| **Severe** | All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left. |
| **Very Severe** | All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining. |
| **Complete** | Rock reduced to "soil". Rock "fabric" no discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers. |

| HARDNESS (for engineering description of rock – not to be confused with Moh's scale for minerals) | |
|---|---|
| **Very Hard** | Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick. |
| **Hard** | Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen. |
| **Moderately Hard** | Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow. |
| **Medium** | Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick. |
| **Soft** | Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure. |
| **Very Soft** | Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail. |

**Joint, Bedding, and Foliation Spacing in Rock** [1]

| Spacing | Joints | Bedding/Foliation |
|---|---|---|
| Less than 2 in. | Very close | Very thin |
| 2 in. – 1 ft. | Close | Thin |
| 1 ft. – 3 ft. | Moderately close | Medium |
| 3 ft. – 10 ft. | Wide | Thick |
| More than 10 ft. | Very wide | Very thick |

1. Spacing refers to the distance normal to the planes, of the described feature, which are parallel to each other or nearly so.

**Rock Quality Designator (RQD)** [1]

| RQD, as a percentage | Diagnostic description |
|---|---|
| Exceeding 90 | Excellent |
| 90 – 75 | Good |
| 75 – 50 | Fair |
| 50 – 25 | Poor |
| Less than 25 | Very poor |

1. RQD (given as a percentage) = length of core in pieces 4 inches and longer / length of run

**Joint Openness Descriptors**

| Openness | Descriptor |
|---|---|
| No Visible Separation | Tight |
| Less than 1/32 in. | Slightly Open |
| 1/32 to 1/8 in. | Moderately Open |
| 1/8 to 3/8 in. | Open |
| 3/8 in. to 0.1 ft. | Moderately Wide |
| Greater than 0.1 ft. | Wide |

References: American Society of Civil Engineers. Manuals and Reports on Engineering Practice - No. 56. Subsurface Investigation for Design and Construction of Foundations of Buildings. New York: American Society of Civil Engineers, 1976. U.S. Department of the Interior, Bureau of Reclamation, Engineering Geology Field Manual.

RETTEW

**ATTACHMENT 2**
**SOIL RESOURCES MAP AND PROFILE DESCRIPTIONS**

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

# Custom Soil Resource Report for Blair County, Pennsylvania

## Lower Piney Creek Road


October 10, 2017

# Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

# Contents

**Preface**.......... 2
**How Soil Surveys Are Made**.......... 5
**Soil Map**.......... 8
Soil Map.......... 9
Legend.......... 10
Map Unit Legend.......... 11
Map Unit Descriptions.......... 11
Blair County, Pennsylvania.......... 14
BuB—Buchanan gravelly silt loam, 3 to 8 percent slopes.......... 14
HeD—Hagerstown-Rock outcrop complex, 8 to 25 percent slopes.......... 15
HuB—Hublersburg cherty silt loam, 3 to 8 percent slopes.......... 16
HuC—Hublersburg cherty silt loam, 8 to 15 percent slopes.......... 17
MuB—Murrill gravelly silt loam, 3 to 8 percent slopes.......... 18
MuC—Murrill gravelly silt loam, 8 to 15 percent slopes.......... 19
MuD—Murrill gravelly silt loam, 15 to 25 percent slopes.......... 20
MxD—Murrill extremely stony silt loam, 8 to 25 percent slopes.......... 21
OuD—Opequon silty clay loam, 15 to 25 percent slopes.......... 23
OxF—Opequon-Hagerstown-Rock outcrop complex, 25 to 50 percent slopes.......... 24
Qu—Quarries-Dumps complex.......... 26
UD—Udifluvents-Dystrochrepts complex.......... 27
**References**.......... 30

# How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

# Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map


Map Scale: 1:4,150 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 50, 100, 200, 300

Feet: 0, 200, 400, 800, 1200

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

## MAP LEGEND

**Area of Interest (AOI)**
- Area of Interest (AOI)

**Soils**
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

**Special Point Features**
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

**Water Features**
- Streams and Canals

**Transportation**
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

**Background**
- Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Blair County, Pennsylvania
Survey Area Data: Version 10, Sep 19, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 23, 2010—Feb 22, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

# Map Unit Legend

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| BuB | Buchanan gravelly silt loam, 3 to 8 percent slopes | 0.4 | 0.6% |
| HeD | Hagerstown-Rock outcrop complex, 8 to 25 percent slopes | 4.4 | 6.3% |
| HuB | Hublersburg cherty silt loam, 3 to 8 percent slopes | 2.8 | 4.1% |
| HuC | Hublersburg cherty silt loam, 8 to 15 percent slopes | 13.9 | 20.2% |
| MuB | Murrill gravelly silt loam, 3 to 8 percent slopes | 7.1 | 10.3% |
| MuC | Murrill gravelly silt loam, 8 to 15 percent slopes | 16.0 | 23.2% |
| MuD | Murrill gravelly silt loam, 15 to 25 percent slopes | 7.7 | 11.1% |
| MxD | Murrill extremely stony silt loam, 8 to 25 percent slopes | 2.2 | 3.2% |
| OuD | Opequon silty clay loam, 15 to 25 percent slopes | 5.0 | 7.3% |
| OxF | Opequon-Hagerstown-Rock outcrop complex, 25 to 50 percent slopes | 1.9 | 2.7% |
| Qu | Quarries-Dumps complex | 0.5 | 0.7% |
| UD | Udifluvents-Dystrochrepts complex | 7.1 | 10.2% |
| **Totals for Area of Interest** | | **69.0** | **100.0%** |

# Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

# Blair County, Pennsylvania

## BuB—Buchanan gravelly silt loam, 3 to 8 percent slopes

### Map Unit Setting

*National map unit symbol:* l6bk
*Elevation:* 300 to 3,000 feet
*Mean annual precipitation:* 35 to 55 inches
*Mean annual air temperature:* 45 to 59 degrees F
*Frost-free period:* 120 to 217 days
*Farmland classification:* All areas are prime farmland

### Map Unit Composition

*Buchanan and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Buchanan

#### Setting

*Landform:* Mountain slopes, valley sides
*Landform position (two-dimensional):* Footslope
*Landform position (three-dimensional):* Lower third of mountainflank, base slope
*Down-slope shape:* Concave, linear
*Across-slope shape:* Linear, concave
*Parent material:* Mountain slope colluvium derived from sedimentary rock

#### Typical profile

*H1 - 0 to 8 inches:* gravelly loam
*H2 - 8 to 32 inches:* gravelly loam
*H3 - 32 to 65 inches:* gravelly loam

#### Properties and qualities

*Slope:* 3 to 8 percent
*Depth to restrictive feature:* 20 to 36 inches to fragipan
*Natural drainage class:* Moderately well drained
*Runoff class:* High
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)
*Depth to water table:* About 18 to 36 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water storage in profile:* Low (about 4.3 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 2w
*Hydrologic Soil Group:* C
*Hydric soil rating:* No

### Minor Components

#### Andover

*Percent of map unit:* 6 percent
*Landform:* Depressions
*Landform position (three-dimensional):* Mountainbase

*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Hydric soil rating:* Yes

**Berks**
*Percent of map unit:* 3 percent
*Hydric soil rating:* No

**Bedington**
*Percent of map unit:* 3 percent
*Hydric soil rating:* No

**Philo**
*Percent of map unit:* 3 percent
*Hydric soil rating:* No

## HeD—Hagerstown-Rock outcrop complex, 8 to 25 percent slopes

### Map Unit Setting
*National map unit symbol:* l6c9
*Elevation:* 400 to 3,000 feet
*Mean annual precipitation:* 30 to 46 inches
*Mean annual air temperature:* 44 to 57 degrees F
*Frost-free period:* 130 to 200 days
*Farmland classification:* Not prime farmland

### Map Unit Composition
*Hagerstown and similar soils:* 50 percent
*Rock outcrop:* 30 percent
*Minor components:* 5 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Hagerstown

#### Setting
*Landform:* Hills
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Side slope
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Residuum weathered from limestone

#### Typical profile
*H1 - 0 to 14 inches:* silty clay loam
*H2 - 14 to 40 inches:* clay
*H3 - 40 to 60 inches:* silty clay loam

#### Properties and qualities
*Slope:* 8 to 25 percent
*Depth to restrictive feature:* 40 to 84 inches to lithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* Medium

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water storage in profile:* High (about 10.6 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 6s
*Hydrologic Soil Group:* B
*Hydric soil rating:* No

**Description of Rock Outcrop**

**Setting**

*Landform:* Valley sides
*Landform position (two-dimensional):* Shoulder, backslope
*Landform position (three-dimensional):* Mountainflank
*Down-slope shape:* Linear, convex
*Across-slope shape:* Linear, convex
*Parent material:* Bedrock exposures

**Properties and qualities**

*Depth to restrictive feature:* 0 to 4 inches to lithic bedrock

**Minor Components**

**Opequon**

*Percent of map unit:* 5 percent
*Hydric soil rating:* No

## HuB—Hublersburg cherty silt loam, 3 to 8 percent slopes

**Map Unit Setting**

*National map unit symbol:* l6cj
*Elevation:* 300 to 1,500 feet
*Mean annual precipitation:* 34 to 45 inches
*Mean annual air temperature:* 46 to 59 degrees F
*Frost-free period:* 139 to 199 days
*Farmland classification:* All areas are prime farmland

**Map Unit Composition**

*Hublersburg and similar soils:* 90 percent
*Minor components:* 5 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Hublersburg

**Setting**

*Landform:* Ridges on valleys
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Side slope
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Residuum weathered from cherty limestone

**Typical profile**

*H1 - 0 to 10 inches:* gravelly silt loam
*H2 - 10 to 60 inches:* gravelly silty clay loam

**Properties and qualities**

*Slope:* 3 to 8 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water storage in profile:* Moderate (about 8.6 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 2e
*Hydrologic Soil Group:* B
*Hydric soil rating:* No

#### Minor Components

**Clarksburg**

*Percent of map unit:* 5 percent
*Hydric soil rating:* No

### HuC—Hublersburg cherty silt loam, 8 to 15 percent slopes

#### Map Unit Setting

*National map unit symbol:* l6ck
*Mean annual precipitation:* 36 to 46 inches
*Mean annual air temperature:* 46 to 59 degrees F
*Frost-free period:* 139 to 199 days
*Farmland classification:* Farmland of statewide importance

#### Map Unit Composition

*Hublersburg and similar soils:* 90 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Hublersburg

##### Setting

*Landform:* Ridges on valleys
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Side slope
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Residuum weathered from cherty limestone

##### Typical profile

*H1 - 0 to 10 inches:* gravelly silt loam
*H2 - 10 to 60 inches:* gravelly silty clay loam

##### Properties and qualities

*Slope:* 8 to 15 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water storage in profile:* Moderate (about 8.6 inches)

##### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 3e
*Hydrologic Soil Group:* B
*Hydric soil rating:* No

### MuB—Murrill gravelly silt loam, 3 to 8 percent slopes

#### Map Unit Setting

*National map unit symbol:* l6dm
*Elevation:* 600 to 1,800 feet
*Mean annual precipitation:* 35 to 46 inches
*Mean annual air temperature:* 46 to 59 degrees F
*Frost-free period:* 120 to 180 days
*Farmland classification:* All areas are prime farmland

#### Map Unit Composition

*Murrill and similar soils:* 90 percent
*Minor components:* 5 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Murrill

##### Setting

*Landform:* Valley sides
*Landform position (two-dimensional):* Footslope

*Landform position (three-dimensional):* Base slope
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Parent material:* Colluvium derived from sandstone over residuum weathered from limestone

**Typical profile**

*H1 - 0 to 11 inches:* channery silt loam
*H2 - 11 to 60 inches:* channery silty clay loam
*H3 - 60 to 64 inches:* gravelly sandy clay loam

**Properties and qualities**

*Slope:* 3 to 8 percent
*Depth to restrictive feature:* 72 to 99 inches to lithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 2.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water storage in profile:* Moderate (about 7.4 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 2e
*Hydrologic Soil Group:* B
*Hydric soil rating:* No

### Minor Components

**Buchanan**

*Percent of map unit:* 5 percent
*Hydric soil rating:* No

## MuC—Murrill gravelly silt loam, 8 to 15 percent slopes

### Map Unit Setting

*National map unit symbol:* l6dn
*Elevation:* 600 to 1,800 feet
*Mean annual precipitation:* 35 to 46 inches
*Mean annual air temperature:* 46 to 59 degrees F
*Frost-free period:* 120 to 180 days
*Farmland classification:* Farmland of statewide importance

### Map Unit Composition

*Murrill and similar soils:* 90 percent
*Minor components:* 5 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Murrill

#### Setting

*Landform:* Valley sides
*Landform position (two-dimensional):* Footslope
*Landform position (three-dimensional):* Base slope
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Parent material:* Colluvium derived from sandstone over residuum weathered from limestone

#### Typical profile

*H1 - 0 to 11 inches:* channery silt loam
*H2 - 11 to 60 inches:* channery silty clay loam
*H3 - 60 to 64 inches:* gravelly sandy clay loam

#### Properties and qualities

*Slope:* 8 to 15 percent
*Depth to restrictive feature:* 72 to 99 inches to lithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 2.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water storage in profile:* Moderate (about 7.4 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 3e
*Hydrologic Soil Group:* B
*Hydric soil rating:* No

### Minor Components

#### Buchanan

*Percent of map unit:* 5 percent
*Hydric soil rating:* No

## MuD—Murrill gravelly silt loam, 15 to 25 percent slopes

### Map Unit Setting

*National map unit symbol:* l6dp
*Elevation:* 400 to 3,800 feet
*Mean annual precipitation:* 34 to 60 inches
*Mean annual air temperature:* 48 to 57 degrees F
*Frost-free period:* 120 to 180 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Murrill and similar soils:* 90 percent
*Minor components:* 5 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Murrill**

**Setting**

*Landform:* Valley sides
*Landform position (two-dimensional):* Footslope
*Landform position (three-dimensional):* Base slope
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Parent material:* Colluvium derived from sandstone over residuum weathered from limestone

**Typical profile**

*H1 - 0 to 11 inches:* channery silt loam
*H2 - 11 to 60 inches:* channery silty clay loam
*H3 - 60 to 64 inches:* gravelly sandy clay loam

**Properties and qualities**

*Slope:* 15 to 25 percent
*Depth to restrictive feature:* 72 to 99 inches to lithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* High
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 2.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water storage in profile:* Moderate (about 7.4 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 4e
*Hydrologic Soil Group:* B
*Hydric soil rating:* No

**Minor Components**

**Laidig**

*Percent of map unit:* 5 percent
*Hydric soil rating:* No

## MxD—Murrill extremely stony silt loam, 8 to 25 percent slopes

**Map Unit Setting**

*National map unit symbol:* l6dr
*Elevation:* 600 to 2,400 feet

*Mean annual precipitation:* 35 to 46 inches
*Mean annual air temperature:* 46 to 57 degrees F
*Frost-free period:* 120 to 180 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Murrill and similar soils:* 90 percent
*Minor components:* 5 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Murrill**

**Setting**

*Landform:* Valley sides
*Landform position (two-dimensional):* Footslope
*Landform position (three-dimensional):* Base slope
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Parent material:* Colluvium derived from sandstone over residuum weathered from limestone

**Typical profile**

*H1 - 0 to 11 inches:* gravelly silt loam
*H2 - 11 to 60 inches:* channery silty clay loam
*H3 - 60 to 64 inches:* gravelly sandy clay loam

**Properties and qualities**

*Slope:* 15 to 25 percent
*Percent of area covered with surface fragments:* 9.0 percent
*Depth to restrictive feature:* 72 to 99 inches to lithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* High
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 2.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water storage in profile:* Moderate (about 7.4 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* B
*Hydric soil rating:* No

**Minor Components**

**Buchanan**

*Percent of map unit:* 5 percent
*Hydric soil rating:* No

## OuD—Opequon silty clay loam, 15 to 25 percent slopes

### Map Unit Setting

*National map unit symbol:* 2sg9t
*Elevation:* 300 to 3,000 feet
*Mean annual precipitation:* 39 to 50 inches
*Mean annual air temperature:* 47 to 56 degrees F
*Frost-free period:* 155 to 192 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Opequon and similar soils:* 90 percent
*Minor components:* 10 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Opequon

#### Setting

*Landform:* Hills
*Landform position (two-dimensional):* Shoulder, summit, backslope
*Landform position (three-dimensional):* Nose slope, side slope
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Parent material:* Clayey residuum weathered from limestone and dolomite

#### Typical profile

*Ap - 0 to 5 inches:* silty clay loam
*Bt1 - 5 to 13 inches:* silty clay
*Bt2 - 13 to 16 inches:* silty clay
*R - 16 to 26 inches:* bedrock

#### Properties and qualities

*Slope:* 15 to 25 percent
*Depth to restrictive feature:* 12 to 20 inches to lithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 2.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Salinity, maximum in profile:* Nonsaline (0.0 to 0.2 mmhos/cm)
*Available water storage in profile:* Very low (about 1.3 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 6s
*Hydrologic Soil Group:* D
*Hydric soil rating:* No

**Minor Components**

**Hagerstown**

*Percent of map unit:* 5 percent
*Landform:* Ridges
*Landform position (two-dimensional):* Backslope, footslope
*Landform position (three-dimensional):* Side slope, base slope
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Hydric soil rating:* No

**Rock outcrop**

*Percent of map unit:* 5 percent
*Landform:* Hills
*Landform position (two-dimensional):* Shoulder, summit, backslope
*Landform position (three-dimensional):* Nose slope, side slope, crest
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Hydric soil rating:* No

## OxF—Opequon-Hagerstown-Rock outcrop complex, 25 to 50 percent slopes

**Map Unit Setting**

*National map unit symbol:* l6dv
*Elevation:* 300 to 3,000 feet
*Mean annual precipitation:* 30 to 46 inches
*Mean annual air temperature:* 44 to 59 degrees F
*Frost-free period:* 130 to 200 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Opequon and similar soils:* 40 percent
*Hagerstown and similar soils:* 30 percent
*Rock outcrop:* 20 percent
*Minor components:* 8 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Opequon**

**Setting**

*Landform:* Hills
*Landform position (two-dimensional):* Backslope, shoulder, summit
*Landform position (three-dimensional):* Side slope, crest
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Parent material:* Residuum weathered from limestone

**Typical profile**

*H1 - 0 to 8 inches:* silty clay loam

*H2 - 8 to 16 inches:* silty clay
*H3 - 16 to 20 inches:* bedrock

**Properties and qualities**

*Slope:* 35 to 50 percent
*Depth to restrictive feature:* 12 to 20 inches to lithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* High
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 2.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water storage in profile:* Very low (about 2.7 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7e
*Hydrologic Soil Group:* D
*Hydric soil rating:* No

### Description of Hagerstown

**Setting**

*Landform:* Valley floors, ridges
*Landform position (two-dimensional):* Shoulder, backslope
*Landform position (three-dimensional):* Side slope
*Down-slope shape:* Linear, convex
*Across-slope shape:* Linear, convex
*Parent material:* Residuum weathered from limestone

**Typical profile**

*H1 - 0 to 8 inches:* silty clay loam
*H2 - 8 to 41 inches:* clay
*H3 - 41 to 60 inches:* clay

**Properties and qualities**

*Slope:* 35 to 45 percent
*Depth to restrictive feature:* 40 to 84 inches to lithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* High
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water storage in profile:* High (about 10.4 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 6e
*Hydrologic Soil Group:* B
*Hydric soil rating:* No

### Description of Rock Outcrop

**Setting**

*Landform:* Valley sides

*Landform position (two-dimensional):* Backslope, shoulder
*Down-slope shape:* Convex, linear
*Across-slope shape:* Convex, linear
*Parent material:* Bedrock exposures

#### Minor Components

**Hublersburg**

*Percent of map unit:* 5 percent
*Landform:* Ridges on valleys
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Side slope
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Hydric soil rating:* No

**Clarksburg**

*Percent of map unit:* 2 percent
*Hydric soil rating:* No

**Holly**

*Percent of map unit:* 1 percent
*Landform:* Flood plains
*Landform position (two-dimensional):* Toeslope
*Landform position (three-dimensional):* Base slope
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Hydric soil rating:* Yes

### Qu—Quarries-Dumps complex

#### Map Unit Setting

*National map unit symbol:* l6dy
*Elevation:* 300 to 1,300 feet
*Mean annual precipitation:* 35 to 50 inches
*Mean annual air temperature:* 44 to 57 degrees F
*Frost-free period:* 120 to 214 days
*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Quarries:* 50 percent
*Dumps:* 30 percent
*Minor components:* 2 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Quarries**

**Setting**

*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Variable

**Description of Dumps**

**Setting**

*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Mine spoil or earthy fill

**Minor Components**

**Aquents**

*Percent of map unit:* 2 percent
*Landform:* Hills
*Landform position (two-dimensional):* Footslope
*Landform position (three-dimensional):* Base slope
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Hydric soil rating:* Yes

## UD—Udifluvents-Dystrochrepts complex

**Map Unit Setting**

*National map unit symbol:* l6f0
*Elevation:* 200 to 1,300 feet
*Mean annual precipitation:* 30 to 50 inches
*Mean annual air temperature:* 45 to 55 degrees F
*Frost-free period:* 120 to 214 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Udifluvents and similar soils:* 50 percent
*Dystrochrepts and similar soils:* 30 percent
*Minor components:* 4 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Udifluvents**

**Setting**

*Landform:* Flood plains
*Landform position (two-dimensional):* Toeslope
*Landform position (three-dimensional):* Base slope
*Down-slope shape:* Linear
*Across-slope shape:* Linear

*Parent material:* Alluvium

**Typical profile**

*H1 - 0 to 6 inches:* channery silt loam
*H2 - 6 to 42 inches:* gravelly loam
*H3 - 42 to 60 inches:* silt loam

**Properties and qualities**

*Slope:* 0 to 3 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Moderately well drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)
*Depth to water table:* About 36 inches
*Frequency of flooding:* Frequent
*Frequency of ponding:* None
*Available water storage in profile:* Moderate (about 6.1 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* C
*Hydric soil rating:* No

### Description of Dystrochrepts

**Setting**

*Landform:* Mountain slopes
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Mountainflank
*Down-slope shape:* Linear, convex
*Across-slope shape:* Linear, convex
*Parent material:* Residuum weathered from sandstone and shale

**Typical profile**

*H1 - 0 to 6 inches:* loam, flagstones
*H2 - 6 to 42 inches:* gravelly loam
*H3 - 42 to 60 inches:* silt loam

**Properties and qualities**

*Slope:* 0 to 3 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Moderately well drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)
*Depth to water table:* About 36 inches
*Frequency of flooding:* Frequent
*Frequency of ponding:* None
*Available water storage in profile:* Low (about 6.0 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* C
*Hydric soil rating:* No

### Minor Components

**Brinkerton**

*Percent of map unit:* 2 percent
*Landform:* Hills
*Landform position (two-dimensional):* Footslope
*Landform position (three-dimensional):* Base slope
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Hydric soil rating:* Yes

**Holly**

*Percent of map unit:* 2 percent
*Landform:* Backswamps, depressions on flood plains
*Landform position (two-dimensional):* Toeslope
*Landform position (three-dimensional):* Base slope
*Down-slope shape:* Concave
*Across-slope shape:* Linear
*Hydric soil rating:* Yes

# References


American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

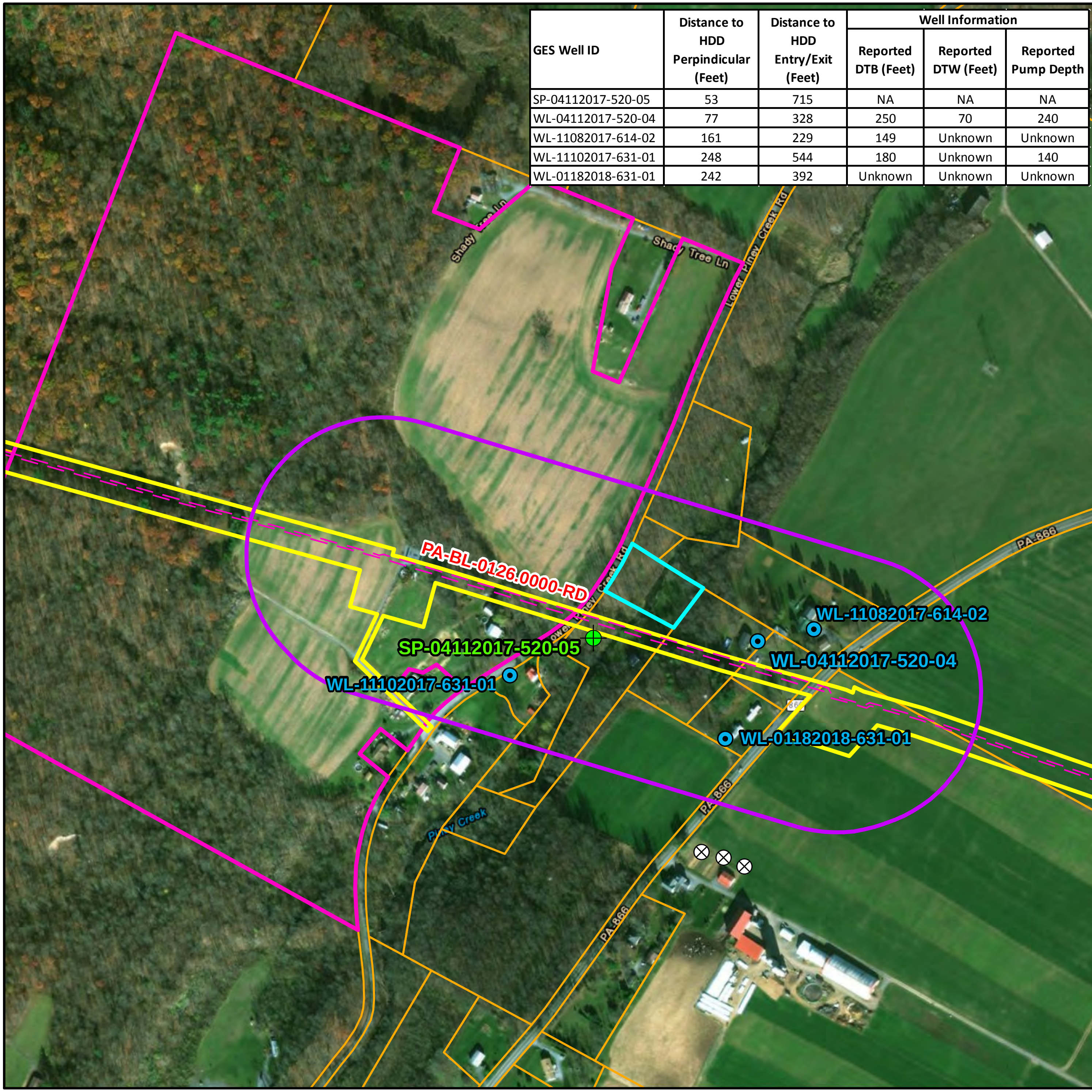
United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

RETTEW

# ATTACHMENT 3
# SUPPLEMENTAL WATER SUPPLY INFORMATION

| 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 |
| SP-04112017-520-05 | 53 | 715 | NA | NA | NA |
| WL-04112017-520-04 | 77 | 328 | 250 | 70 | 240 |
| WL-11082017-614-02 | 161 | 229 | 149 | Unknown | Unknown |
| WL-11102017-631-01 | 248 | 544 | 180 | Unknown | 140 |
| WL-01182018-631-01 | 242 | 392 | Unknown | Unknown | Unknown |



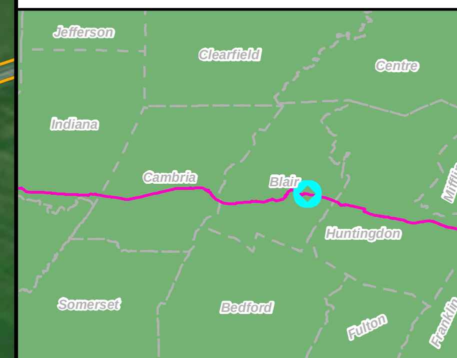

## Legend

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

****Testing locations current as of 02/12/2018**

- GES Testing Location
- GES Spring Testing Location
- Approximate GPS Location for GES Well Testing

**Location**




N

0 250 500 Feet

**Well Location Map**
**HDD# PA-BL-0126.0000-RD**
**Blair County, PA.**

**Prepared By:** TETRA TECH

**Date:** 2/19/2018

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

**Coordinate System: NAD 83 Stateplane, PA South, Feet**

RETTEW

# ATTACHMENT 4
# GEOPHYSICAL SURVEY RESULTS

# Final Report
# Geophysical Survey
# Bedrock Fracture Zone Detection
# ~1800 Linear Feet of Proposed Pipeline – Piney Creek Site
# Hollidaysburg Environs, PA
# Enviroscan Project Number 121701

**Prepared For: Gremminger & Associates, Inc.**
**Prepared By: Enviroscan, Inc.**
**December 11, 2017**

1051 Columbia Avenue ● Lancaster, PA 17603 ● 717.396.8922 ● Fax 717.396.8746 ● email@enviroscan.com ● www.enviroscan.com

December 11, 2017

Mr. Larry Gremminger
**Gremminger & Associates, Inc.**
226 South Live Oak Street
Belleville, TX 77418

**RE:** Geophysical Survey
Bedrock Fracture Zone Detection
~1800 Linear Feet of Proposed Pipeline – Piney Creek Site
Hollidaysburg Environs, PA
Enviroscan Project Number 121701

Dear Mr. Gremminger:

Pursuant to our proposal dated December 1, 2017, Enviroscan, Inc. (Enviroscan) has completed a combined seismic refraction and electrical resistivity survey at the above-referenced site. The purpose of the survey was to map the locations of potential bedrock factures along client-designated sections of a proposed pipeline alignment totaling ~1800 lineal feet (separated into a ~1100-foot transect to the west of Piney Creek Road, and a ~630-foot transect to the east of Piney Creek Road). Fieldwork was conducted December 6 through 8, 2017 in the client-designated areas.

## Site Description

The geophysical survey area is the alignment of an approximate 1800-foot-long proposed pipeline route; however, due to access issues caused by roads, creeks, steep terrain, densely-wooded areas, and a stream, the alignment was discontinuous. Section 1 was located to the east of Piney Creek, while Section 2 was west of the creek (see Figure 1). The Geologic Map of Pennsylvania (Berg, T. M., Edmunds, W. E., Geyer, A. R., and others, 1980) indicates that these two areas are located within multiple formations, starting with the Reedsville Formation in the west, through the Coburn, Nealmont, Benner, and Loysburg Formations which are undivided, and end in the Bellefonte and Axemann Formations (also undivided). The divides are shown on Figure 1 (Ibid). All the formations are Ordovician in age and except for the Reedsville Formation (which is a sandstone/mudstone), are primarily carbonate rock types (limestone and dolomite).

# Survey Methods

In order to provide the highest level of confidence and greatest cost-effectiveness, Enviroscan proposed a combined seismic refraction, MASW, and electrical resistivity survey. Seismic refraction can be used to determine the depth to bedrock and overburden thickness, as well as to show variations of the velocity of the bedrock. MASW data are used to provide information below the top of the rock, so that weathered fractures may be visible. Electrical resistivity imaging was used to map the electrical properties of the subsurface, revealing areas of fractured rock and solid bedrock. However, based on the shallow bedrock depths and rock type and conference with the client's on-site representative, MASW was not performed due to the limiting nature of the technique in such conditions.

## Seismic Refraction Survey

The principles of seismic refraction are described in the accompanying Introduction to Seismic Refraction (Appendix A), and generally involve measuring the travel times of shock waves traveling from a surficial source (shot point) to a linear array of ground motion sensors (geophones). The first arrival (P-wave) travel times can be inverted to provide a cross-sectional profile of the density stratification beneath the geophone array. While seismic P-wave velocity ($V_p$) is – formally – inversely proportional to density, the strength of Earth materials increases with density such that in general the higher the density, the faster the P-wave velocity.

### *Field Procedure*

To perform the seismic refraction field survey, Enviroscan completed the following specific tasks:

- Enviroscan recorded seismic records along three profiles (two west of the stream/road, and one east of the stream/road) oriented roughly west-east. The survey profiles are shown on the attached Figure 1.

- Recording employed a Geometrics Geode 24-channel digital signal stacking seismograph and successive linear arrays of 4.5 Hertz geophones with a constant 10-foot interval.

- Seismic travel times were recorded from shots at 40-foot intervals along the arrays, to ensure full data coverage and highly redundant, low-noise data. The seismic energy source was a seismic slide sledge hammer, in order to generate both an impulsive source for refraction waves.

- Location control (with sub-meter accuracy) was maintained for each geophone and shot point using a Topcon Hyper-SR differential global positioning system (DGPS).

- The seismic wiggle trace data from each geophone, for each shot point, was recorded on the internal hard drive of the laptop controlling the seismograph, and was downloaded daily to USB drives for backup.

***Data Processing***

The data were subjected to refraction seismic processing.

- Refraction processing employed the SeisImager (by OYO Corporation) software suite. First arrival picking was done using the automatic function in Pickwin with minor manual adjustment. Traces without clear first arrivals were typically deleted, since the data collection was highly redundant, and the missing arrivals would be more than compensated by multiple arrivals sampling the same portion of the subsurface using other shot-receiver pairs.

- The arrival time data were subjected to tomographic inversion with no a-priori layer assignments to ensure objective results. Each inversion was run for a minimum of seven iterations, and continued until the root mean square (RMS) residual between the observed travel times and those predicted for the model ceased to decline between iterations. In all cases, the RMS was less than 4 milliseconds.

- Each model was also subjected to mild horizontal smoothing (Gaussian-weighted, 70-foot window) to eliminate potential artifacts due to over-fitting of the models.

- The final seismic refraction velocity ($V_p$) model cross sections are shown on Figures 2A and 2B (bottom panel).

## Electrical Imaging Survey

Surface resistivity measurements involve driving an electrical current in the ground using two current electrodes at the ground surface. The apparent resistivity of the subsurface (essentially 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. The principles of electrical imaging are described in the accompanying Introduction to Electrical Imaging (Appendix B).

Using an AGI Super Sting R8/IP resistivity meter, apparent resistivity readings were collected along two profiles, mimicking the seismic arrays (Figure 1). Along each profile, electrodes were spaced at the ground surface at 10-foot intervals. The locations of profile endpoints, as well other electrodes and topography changes, were surveyed using the Topcon Hyper-SR DGPS.

The measured apparent resistivities ($\rho_a$) 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 apparent resistivity pseudosections were mathematically inverted using EarthImager 2D Resistivity Software by Advanced Geosciences, Inc., to provide electrical images of true resistivity versus true depth along each profile. The 2D resistivity data are presented as a series of color contours of the true resistivity versus depth along each profile (Figures 2A and 2B, top panel).

## Results

The seismic refraction cross sections (Figures 2A and 2B, bottom panel) indicate a generalized two-layer stratigraphic model with a relatively slow transition from unconsolidated materials to competent rock based on the gradual change in velocity at the inferred rock boundary. The uppermost layer has a weighted averaged P-wave velocity (the **P**ressure **wave** created by the source hammer that travels through the soil and bedrock) of less than 1500 feet per second (fps), with a thickness of approximately 10 to 30 feet (shaded blue, with its lower extent bounded by a dashed black line). The deeper layer has a weighted averaged velocity of over 15000 fps (shaded orange to red), with its upper extent bounded by a solid black line. The uppermost layer velocities are consistent with unconsolidated soils, while the bottom layer velocities are consistent with bedrock (Carmichael, R. S., 1989). Please note that the seismic profiles represent an average velocity profile, with contours representing a smoothed and gradual interface between the unconsolidated soils and rock, with rock pinnacles and cutters typically extending both above and below the contour lines (depicted by the yellow-shaded “epikarst” zone, and bounded by the solid and dashed black lines). The seismic refraction data show a relatively consistent inferred bedrock surface with a depth of ~20 feet. Several areas along the seismic profiles show low-velocity zones that may be indicative of possible weathered or fractured zones.

The electrical imaging data (Figures 2A and 2B, top panel) show a general depth-to-rock correlation with the seismic data at approximately 10 to 30 feet below grade. The resistivity profiles show a general low-resistivity zone at the surface over a relative high-resistivity zone along the profiles representing the suspected overburden and bedrock respectively. The high-resistivity zones likely represent competent bedrock, while the low-resistivity zones at the surface represent soils (more conductive). Deeper low-resistivity zones within the suspected bedrock most likely represent weathered or fractured zones – which may indicate potential migration pathways.

In conclusion, the electrical resistivity survey identified low-resistivity zones along the two profiles that may indicate the presence of fractures and migration pathways. These zones are shown highlighted with red dashed lines on Figures 2A and 2B. In general, the seismic profiles correlate well with low-velocity zones aligned in the same areas along the profiles. Please note that the geophysical survey alone cannot predict if a suspected fracture zone will or will not be a potential fluid pathway.

## Limitations

The geophysical survey described above was completed using standard and/or routinely accepted practices of the geophysical industry and equipment representing the best available technology. Enviroscan does not accept responsibility for survey limitations due to inherent technological limitations or unforeseen site-specific conditions. In particular, Enviroscan cannot make any warranties concerning the future occurrence or development of soil piping activity. However, we make every effort to identify and notify the client of such limitations or conditions.

Mr. Gremminger
December 11, 2017
Page 6

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

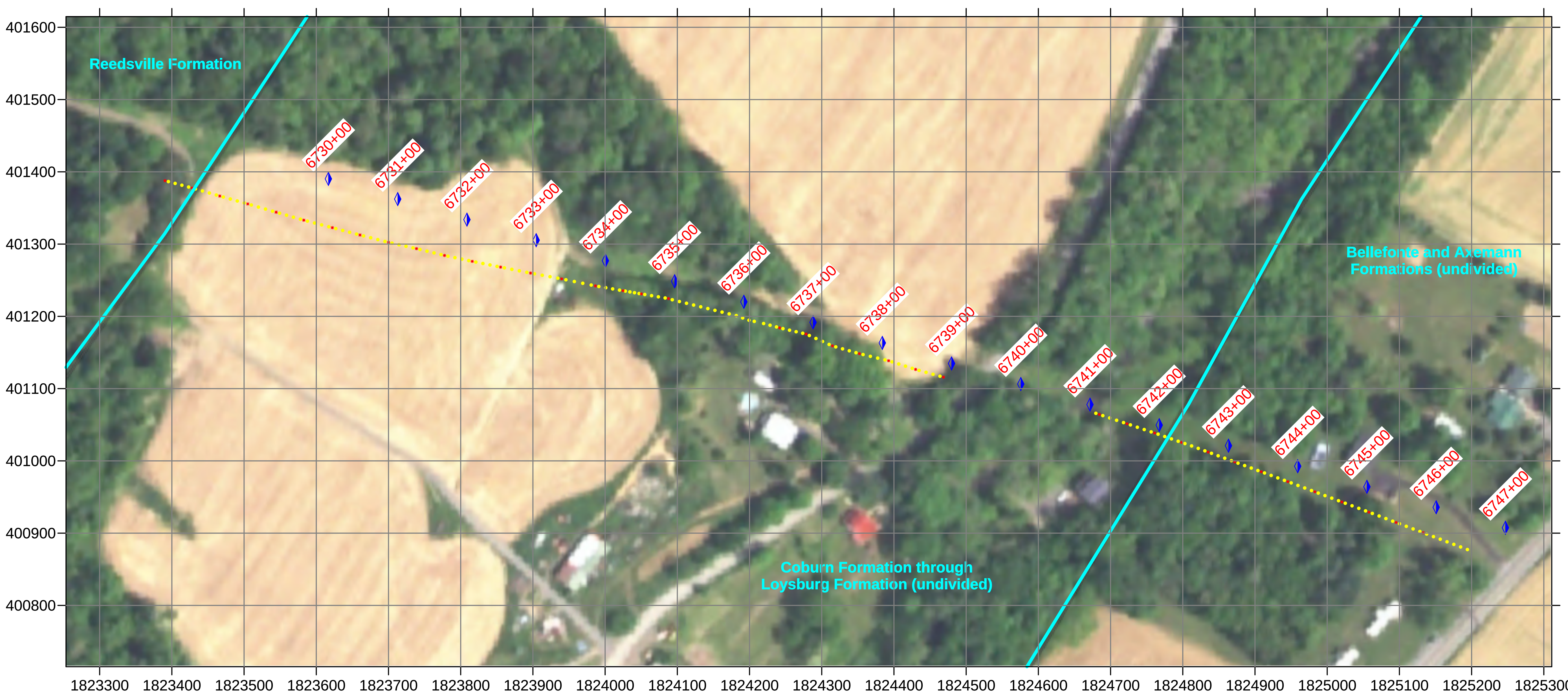
Sincerely,
**Enviroscan, Inc.**

Charles H. Rhine, M.Sc., P.G.
Senior Geophysics Project Manager

Technical Review By:
**Enviroscan, Inc.**

Felicia K. Bechtel, M.Sc., P.G.
President


enc.: Figure 1: Geophysical Data Coverage and Geologic Map
Figure 2A: Seismic & Electrical Resistivity West of Piney Creek
Figure 2B: Seismic & Electrical Resistivity East of Piney Creek
Appendix A: Introduction to Seismic Refraction
Appendix B: Introduction to Electrical Imaging
References




Notes:

Basemap image and geology from USGS WMS Servers (extracted Dec. 2017).

Coordinates in PA South State Plane, NAD38.

Seismic data from Geometrics 24-channel Geode System, 10-foot geophone spacing, 10-foot shot spacing.

Resistivity from AGI SuperSting resistivity meter, 56 electrodes, dipole-dipole array.

Geologic mapping information from Berg, et al., 1980.

**Geophysical Survey Legend**

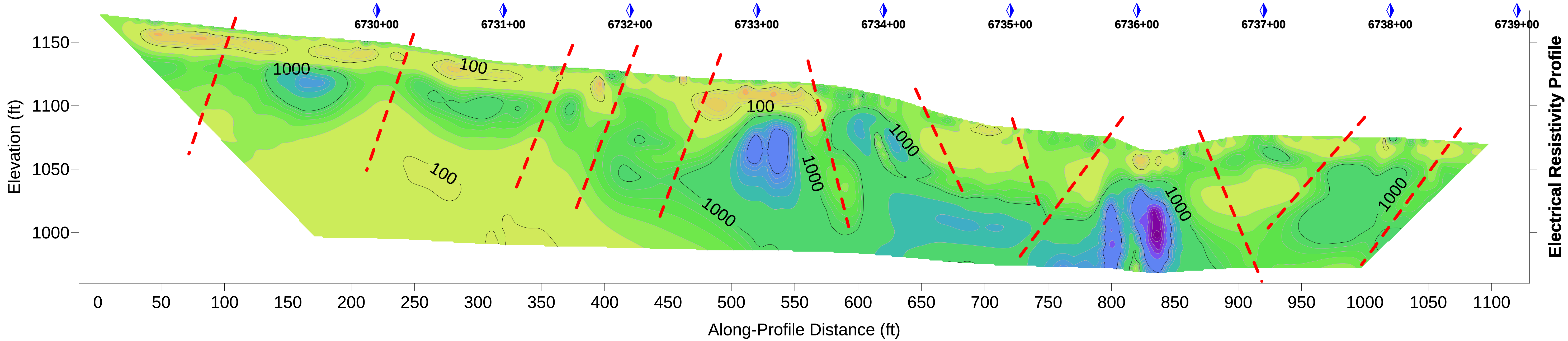
- Electrical Resistivity Electrodes
- Seismic Shot Locations
- Geologic Formational Contact
- Client-Provided Pipeline Stationing

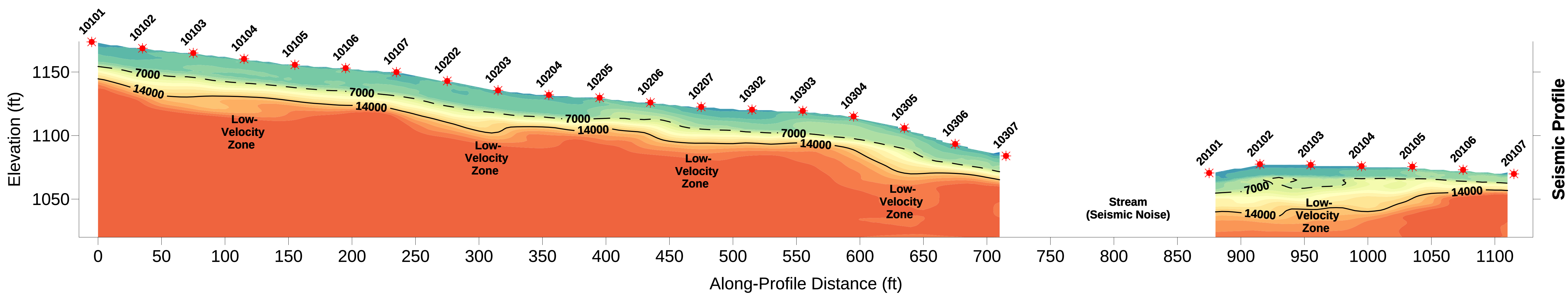
N

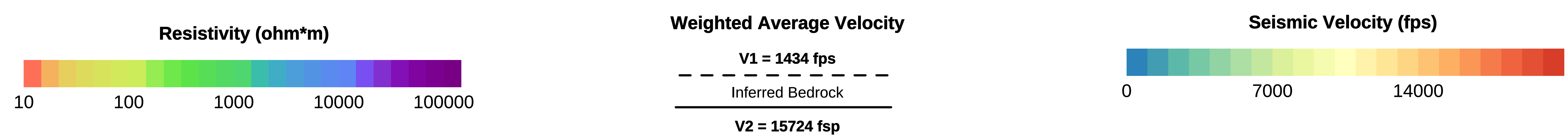
Scale (ft)

0 75 150 225 300

| Prepared by: | Title: | Project Location: | | Figure |
|---|---|---|---|---|
| **Enviroscan, Inc.**<br>1051 Columbia Ave.<br>Lancaster PA 17603<br>717-396-8922<br>www.enviroscan.com<br>ENVIROSCAN, INC. | **Geophysical Data Coverage & Geologic Map** | **Proposed Sunoco Pipeline Route Williamsburg, PA** | | 1 |
| | | Project Number<br>121701 | Revision/Issue<br>12/15/2017 | |
| | | Original Scale<br>1" = 150' | Survey Ending Date<br>12/09/2017 | Drawn by: CHR<br>Approved by: FKB |




Notes:

Seismic data from Geometrics 24-channel Geode system, 10-foot geophone spacing, 10-foot shot spacing.

Resistivity from AGI SuperSting resistivity meter, 56 electrodes, dipole-dipole array.

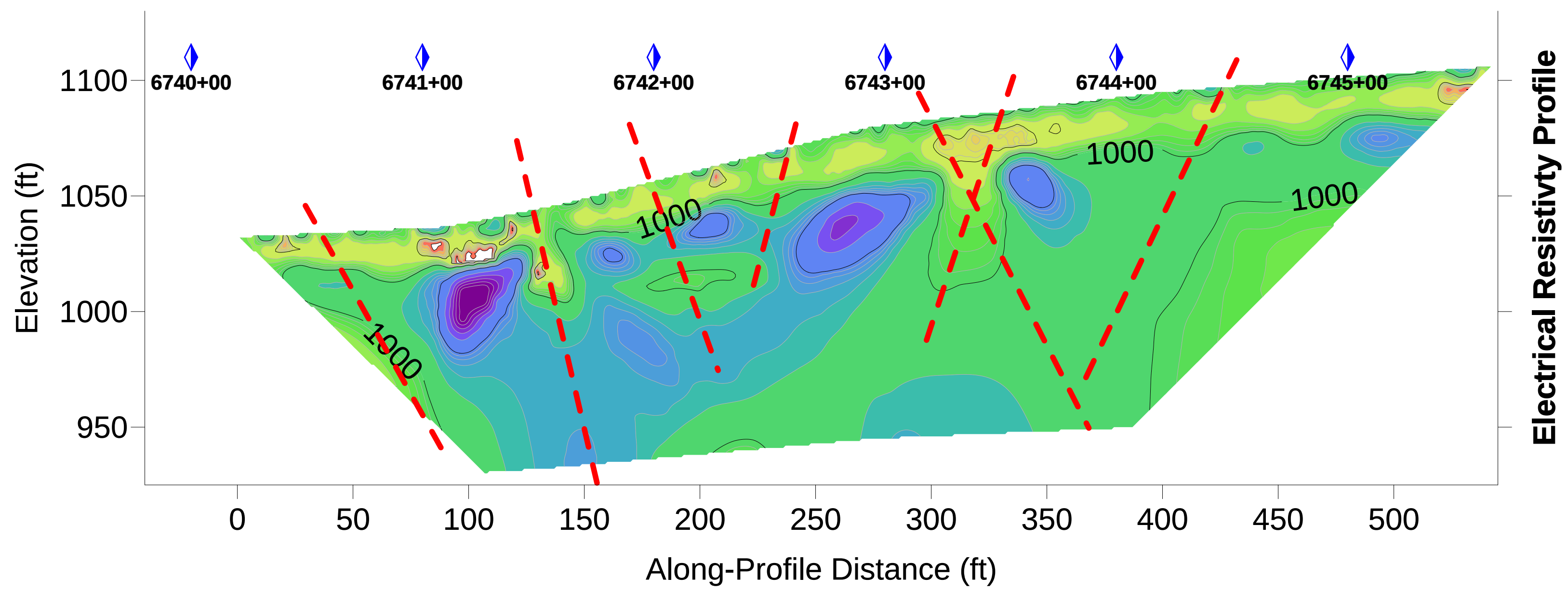
**Geophysical Survey Legend**

- Possible Fracture Zone
- Seismic Shot Location
- Survey Stakes (by others)

Scale (ft)

0 40 80 120 160

| Prepared by: | Title: | Project Location: | | Figure | |
|---|---|---|---|---|---|
| **Enviroscan, Inc.** 1051 Columbia Ave. Lancaster PA 17603 717-396-8922 www.enviroscan.com | **Seismic & Electrical Resistivty Profiles West of Piney Creek** | **Proposed Sunoco Pipeline Route Williamsburg, PA** | | 2A | |
| | | Project Number: 121701 | Revision/Issue: 12/15/2017 | | |
| | | Original Scale: 1" = 80' | Survey Ending Date: 12/09/2017 | Drawn by: CHR | Approved by: FKB |

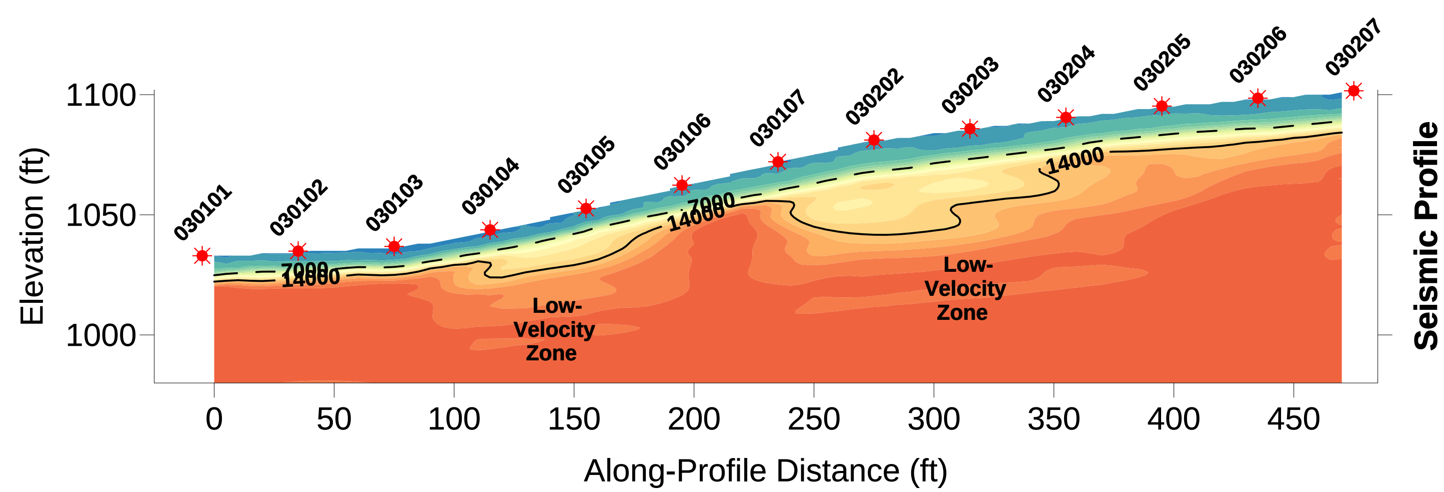



**Weighted Average Velocity**

**V1 = 1434 fps**

Inferred Bedrock

**V2 = 15724 fsp**




**Geophysical Survey Legend**

- Possible Fracture Zone
- Seismic Shot Location
- Survey Stakes (by others)

**Resistivity (ohm*m)**

10 100 1000 10000 100000

**Seismic Velocity (fps)**

0 7000 14000

Notes:

Seismic data from Geometrics 24-channel Geode System, 10-foot geophone spacing, 10-foot shot spacing.

Resistivity from AGI SuperSting resistivity meter, 56 electrodes, dipole-dipole array.

Scale (ft)

0 40 80 120 160

Prepared by:

**Enviroscan, Inc.**
1051 Columbia Ave.
Lancaster PA 17603
717-396-8922
www.enviroscan.com

ENVIROSCAN, INC.

Title:

**Seismic & Electrical Resistivty Profiles East of Piney Creek**

Project Location:

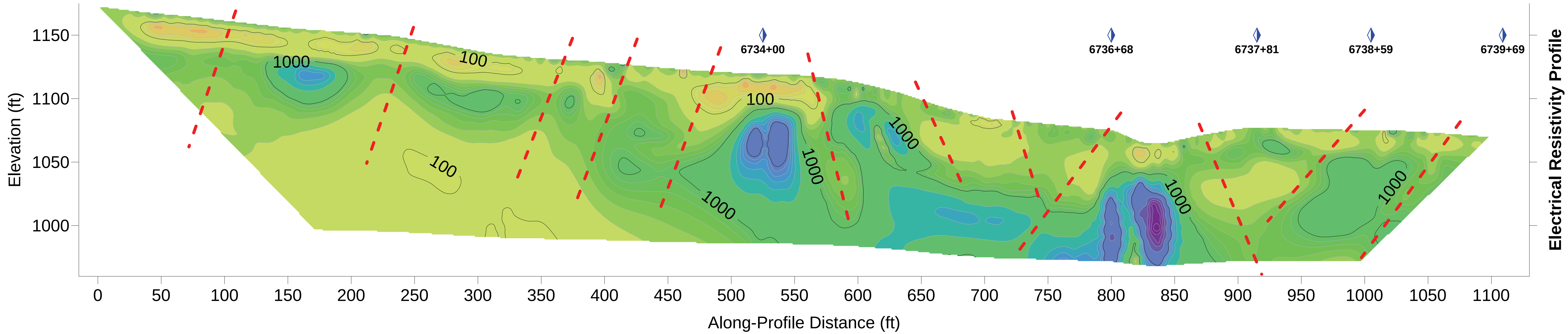
**Proposed Sunoco Pipeline Route Williamsburg, PA**

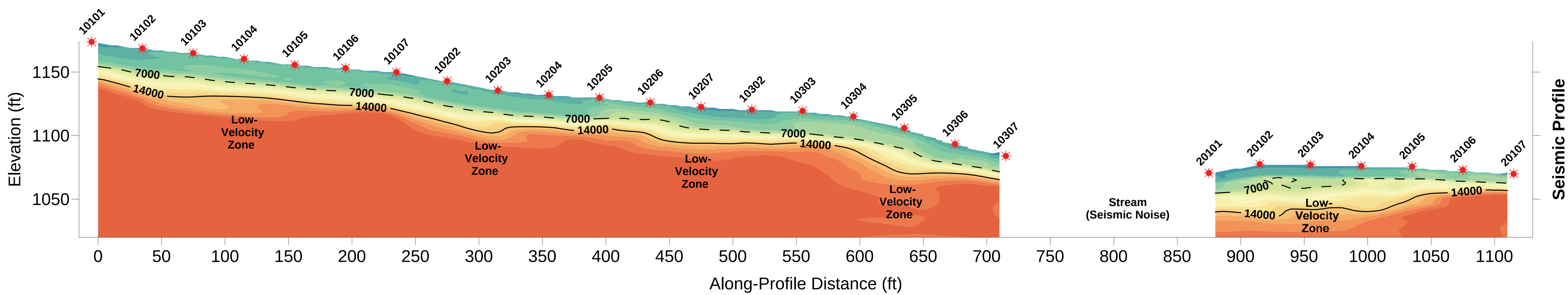
| Project Number | Revision/Issue |
|---|---|
| 121701 | 12/15/2017 |

| Original Scale | Survey Ending Date | Drawn by: | Approved by: |
|---|---|---|---|
| 1" = 80' | 12/09/2017 | CHR | FKB |

Figure

2B




**Resistivity (ohm*m)**

10 100 1000 10000 100000

**Weighted Average Velocity**

**V1 = 1434 fps**

Inferred Bedrock

**V2 = 15724 fsp**

**Seismic Velocity (fps)**

0 7000 14000

**Geophysical Survey Legend**

Possible Fracture Zone

Seismic Shot Location

Survey Stakes (by others)

Scale (ft)

0 40 80 120 160

Notes:

Seismic data from Geometrics 24-channel Geode system, 10-foot geophone spacing, 10-foot shot spacing.

Resistivity from AGI SuperSting resistivity meter, 56 electrodes, dipole-dipole array.

| Prepared by: | Title: | Project Location: | | Figure |
|---|---|---|---|---|
| **Enviroscan, Inc.** 1051 Columbia Ave. Lancaster PA 17603 717-396-8922 www.enviroscan.com | **Seismic & Electrical Resistivty Profiles West of Piney Creek** | **Proposed Sunoco Pipeline Route Williamsburg, PA** | | 2A |
| | | Project Number: 121701 | Revision/Issue: 12/11/2017 | |
| | | Original Scale: 1" = 80' | Survey Ending Date: 12/09/2017 | Drawn by: CHR / Approved by: FKB |

# Appendix A

## Introduction to Seismic Refraction

# Introduction to Seismic Refraction

**By**

**Timothy D. Bechtel, Ph.D., P.G.**

## Energy

Mechanical elastic (seismic) waves generated by a hammer blow, weight drop, or explosion.

## Sensitivity

Sensitive to elastic properties or moduli – generally strongly correlated with density.

## Basic Equipment

Recording Seismograph (generally 24 or more channels); Geophones (one for each channel); Geophone cable; Hammer or weight plus strike plate or explosives; Trigger switch.

## Common Applications

Determination of the depth and dip of soil horizons and bedrock surfaces. Recent processing advances allow some detection and delineation of discrete targets.

## Principles

In a uniform isotropic earth, the shock wave from a blow or explosion at the surface travels outward and downward in a hemispherical wave front like a three-dimensional ripple from a pebble in a still pond. At any point on the wave front, a straight line from the shock source to the wave front depicts the path of the seismic wave, and is called a ray path (see Figure SR-1). In reality, there are several independent shock waves; the fast-moving primary, compressional or P wave front; the slower moving secondary, shear or S wave (both of which form hemispherical wavefronts); and several disk-like wave fronts that travel only along the surface of the earth (called surface waves or ground roll). For the purposes of most seismic refraction surveys, only the fastest moving wave front — the P wave — is considered. S-wave refraction is used in selected circumstances where complete determination of elastic moduli is desired – particularly when it may be desirable to eliminate the effects of water saturation.

In a layered earth, the hemispherical P shock wave defined by the radially distributed P ray paths are deflected according to the laws of optics (Snell's Law) at interfaces between materials with differing seismic velocities (i.e. densities or elastic properties). Figure SR-2 depicts the deflection of ray paths due to an increase in P velocity at a bedding plane. The type of deflection that a ray path will undergo is dependent upon the angle at which it strikes the interface, and falls into one of four categories:

1) Some direct rays (green in Figures SR-2 and SR-3) travel parallel to the ground surface at the seismic velocity of the upper layer, do not strike the underlying interface, and consequently are not deflected.

2) Reflected rays (purple in Figures SR-2 and SR-3) arise where direct rays strike the interface, and a portion of the energy is reflected symmetrically back towards the surface.

3) The portion of the energy of the incident direct wave that is not reflected upward is refracted, or bent as it crosses the interface – making refracted waves in the lower layer (red in Figures SR-2 and SR-3).

4) At a precise angle called the critical angle, the incident ray is refracted directly along the interface, and travels at the higher seismic velocity of the lower layer (see Critically Refracted Wave in Figure SR-3). As this critically refracted or head wave races along beneath the interface, it generates a secondary elastic disturbance that travels back to the surface along ray paths that define a wave front analogous to the bow wake of a ship. These returning rays again travel at the slower velocity of the upper layer.

To perform a refraction survey, a linear array of ground motion sensors or geophones is spaced out from the seismic source or shot point, forming a geophone spread. Each geophone is connected to a separate channel in a seismograph which records a wiggle trace representing the ground motion resulting from the passage of the various seismic rays.

As depicted in the time-distance (T-X) curve in Figure SR-4, the layered earth structure can be determined by analyzing the seismographic wiggle traces. At distances close to the seismic source, the first wiggle or ground motion (the first arrival after the shot) is due to passage of the direct wave travelling at the velocity of the upper layer. Reflected waves arrive later since they have by definition traveled a greater distance at the same velocity (additional later wiggles are caused by passage of the more slowly travelling S and surface waves). Beyond a distance dictated by the critical angle, the first arrival of seismic energy represents the head wave of the critically refracted ray. These refracted rays also by definition travel a greater distance than the direct wave. However, along part of their path, they have traveled at the higher velocity of the underlying more consolidated layer. At greater distances from the shot point, where the path length in the higher velocity layer becomes significant, the head wave arrivals actually race past the direct wave and become the first arrival (see labeled crossover in Figure SR-4). By extension, it can be shown that if a third layer with even greater velocity lies at greater depth, the head wave from this layer will become the first arrival at a sufficient distance from the shot point.

In conventional seismic refraction, only the first P wave arrivals can be reliably selected on a wiggle trace record. The later reflected P wave arrivals are generally obscured by the slower-travelling S and surface waves, and the very slow air blast or sound wave from the shot. To interpret a seismic refraction record, the first arrival travel times are measured for each wiggle trace and plotted at the appropriate point on a time-distance (T-X) curve (see Figure SR-4). In a plane-layered earth, these first arrivals define a series of line segments, each representing a discrete layer. The seismic velocity of each layer is simply the reciprocal of the slope of the associated line segment. The thickness of each layer can be calculated from the distances where the line segments intersect. The mathematics for these calculations are easily derived, and can be found in any introductory geophysics text.

True geologic strata are rarely perfectly horizontal. The effect of a dipping interface on a travel time curve cannot be recognized using a single shot point. Calculations based on a T-X curve from a single shot point should always be considered as producing apparent depths to interfaces and apparent seismic velocities for all but the uppermost layer. To determine the true depths and dips of interfaces and the true seismic velocities, it is necessary to reverse the seismic line; that is, move the shot point to a location at or beyond the farthest geophone in the spread, and repeat the shot. The calculation of true depths, dips and velocities from reversed seismic lines is also readily performed.

## Capabilities

Conventional seismic refraction can yield accurate measurements of depths and attitudes of soil horizons, groundwater tables, and other relatively distinct and planar strata. Modern computer analysis of multi-fold seismic refraction data (i.e. with many and overlapping shot points) can provide delineation of undulating or even irregular (as opposed to simply planar) interfaces. The latest generation of computer processing techniques require very high-fold data, but in favorable conditions, are capable of resolving even discrete targets such as foundation elements, tunnels or cavities, and can resolve gradational boundaries as well as distinct interfaces. The seismic P-wave velocities of materials are generally an indication of relative density or compaction. S-wave refraction data (collected using specialized geophones, shock sources and field procedures) can provide S-wave velocities that bear a well-constrained empirical relationship to standard penetration test (SPT) N values and therefore bearing capacity. For surveys where matching P- and S-wave velocities are determined, the dynamic elastic moduli of subsurface materials can be calculated (including Poisson's Ration, Young's or Bulk Modulus, and Shear Modulus or Rigidity).

## Limitations

Seismic data is collected at spaced geophones, and therefore does not provide continuous profile data. If geophones are spaced too widely, thin layers can be missed entirely.

Conventional refraction interpretations are only accurate where the velocity of strata increase with depth. Velocity inversions not only alter the data, but are particularly insidious since the presence of a low velocity zone at depth is not apparent in first arrival data. The latest generation of computer processing techniques do allow detection and delineation of laterally restricted low velocity zones (e.g. tunnels, cavities, gravel lenses, etc.).

Sharp or dramatic interface relief such as limestone pinnacles cannot always be resolved even with very tight geophone spacing. Therefore, refraction profiles of expectedly irregular interfaces should be assumed to represent somewhat smoothed versions of actual relief (see e.g. Figure SR-5).

Seismic records can contain noise due to heavy machinery vibrations, vehicular traffic, and sometimes even wind or distant earthquakes. Care must be taken to identify potential sources of seismic noise prior to beginning a survey.

The effective survey depth is limited to approximately 1/5 of the greatest shotpoint to geophone distance. Therefore, very deep surveys may require impractically long lines (requiring consideration of other geophysical techniques such as seismic reflection).

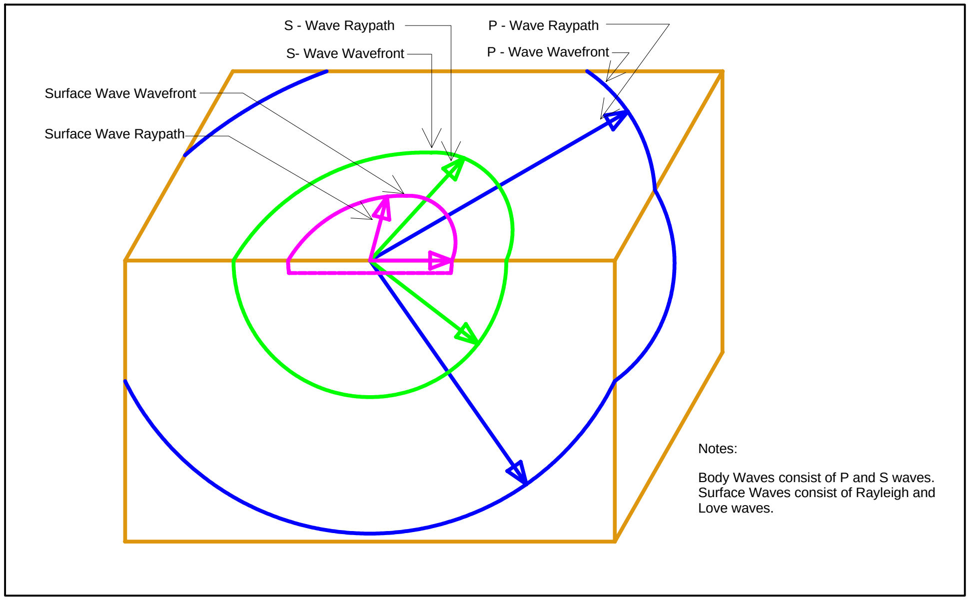



**Figure SR-1** Seismic Wave Types Rev. 01/2001

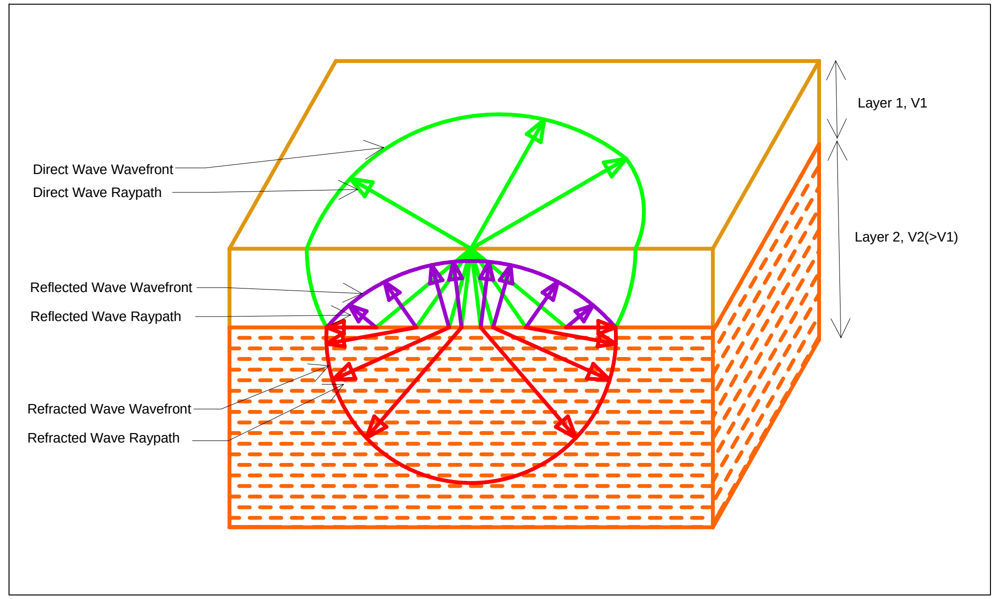



**Figure SR-2** Effect of Layering on Body Wave Raypath Rev. 01/2001

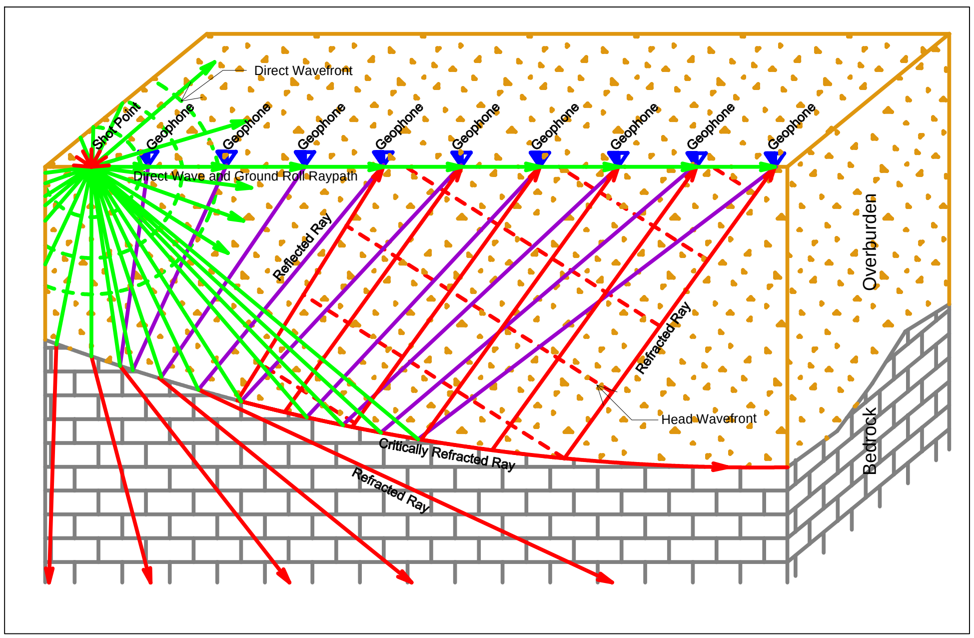



**Figure SR-3** Seismic Ray Path Geometry Rev. 01/2001

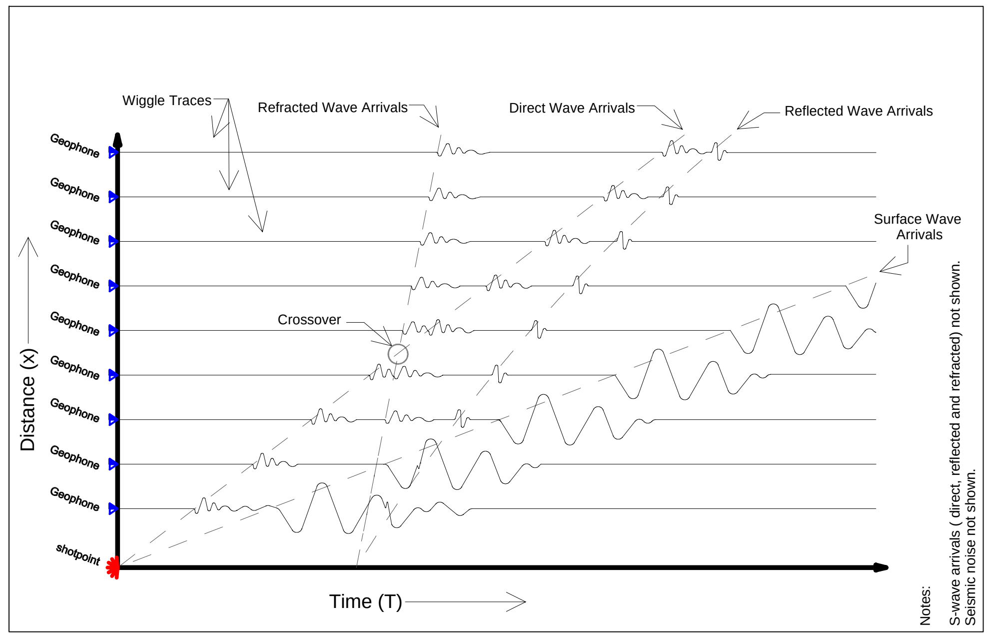



**Figure SR-4** Idealized Seismic Record and T- X Graph Rev. 01/2001

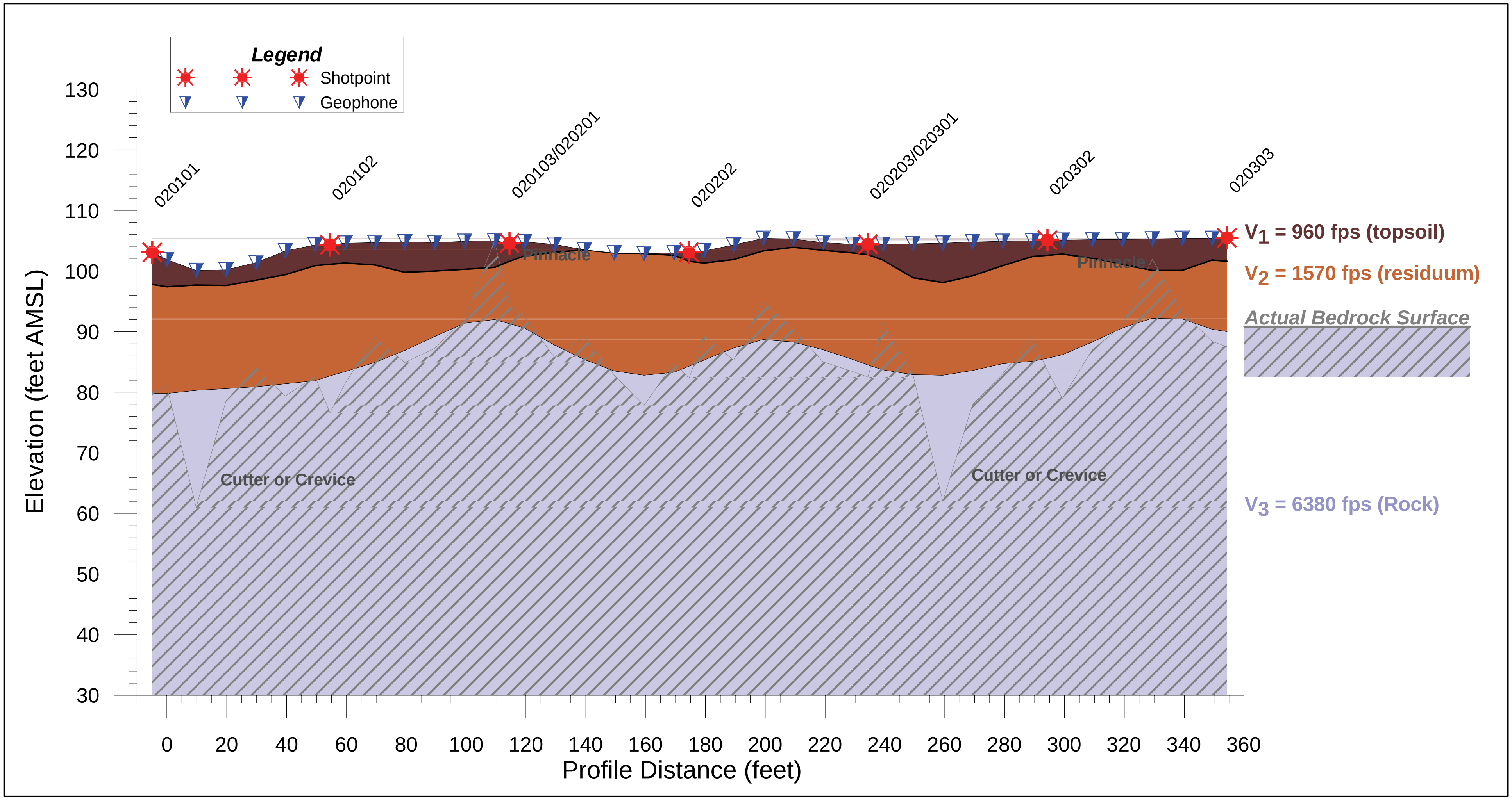



**Figure SR-5** **Example Karst Terrane Seismic Profile** **Revised 01/2001**

ENVIROSCAN, INC.

# Appendix B

## Introduction to Electrical Imaging

# Introduction to Electrical Imaging

**by**

**Timothy D. Bechtel, Ph.D., P.G.**

## Energy

Electrical currents injected into the subsurface between electrodes pushed into the ground surface or non-intrusive, protected capacitors.

## Sensitivity

Detects changes in electrical resistivity (the inverse of conductivity).

## Basic Equipment

*Either (traditional "steel spike electrode" method):*

Steel spike electrodes (called current electrodes) connected by wires to a current source (to inject current), and steel spike electrodes (called voltage electrodes) connected to a microvolt meter (to measure the surficial distribution of electrical potentials). Note that current and voltage electrodes differ only by that to which they are connected (i.e. current source or microvolt meter, respectively.) Modern systems use arrays of electrodes (connected to multi-channel cables and an automated electrode-switching/recording system) to take measurements from electrodes at different locations and spacings (which adjusts the survey depth and resolution). Electrodes are hand-pushed into the ground surface along desired survey profiles.

*Or (innovative "capacitively-coupled electrode" method):*

Straight-wire capacitors which are capable of driving subsurface electrical currents and measuring surface potentials. The wire lengths and the distance between wires can be varied to adjust the survey depth and resolution. Capacitors are encased in torpedo-like protectors between the wire lengths, and the entire array (similar to a swimming rope with flotation buoys) is hand- or vehicle-towed along desired survey profiles.

## Common Applications

Electrical imaging produces color-contour cross sections (commonly called electrical images) of subsurface electrical resistivity variations. These images can depict a target that has a different electrical resistivity from its surroundings, such as: buried wastes (pits, trenches, etc.); conductive groundwater plumes; resistive hydrocarbon plumes; foundation elements; water-bearing or mineralized faults or fractures; clay seams in bedrock; soil moisture anomalies; soil voids; clay layers bounded by sand or sand lenses bounded by clay; the top of competent (non-water-bearing) rock.

## Principles

Electrical imaging can be performed by driving a harmless, very low amperage (e.g. 1 milliamp) DC electrical current in the ground between two steel spike electrodes. The depth to which the current flows is dictated by the separation of the two electrodes, and by the resistivity of subsurface materials. The flow of electrical current is mapped by measuring the electrical potential at various points of the ground surface using a very high impedance microvolt meter. Data suitable for determining a cross-sectional electrical image can be collected by taking many voltage readings with differing current electrode separations (i.e. different effective measurement depths) using different current electrode positions and voltage electrode positions (i.e. different locations along a profile). A two-dimensional image or cross-section is produced by employing electrodes in a linear array. Three-dimensional images (or color-contoured blocks of data) can be calculated using multiple linear arrays or grids of electrodes. The field-measured voltages, together with associated electrode positions, are mathematically inverted to provide the statistically best-fitting model of the subsurface resistivity distribution.

Electrical imaging can also be performed using straight-wire capacitors to drive currents and measure voltages. In this case, the length of the transmitter wire and the separation between the transmitter and receiver wires dictate the effective survey depth. Two- or three-dimensional data is collected by varying the lengths and separations of the transmitter and receiver capacitor wires for a given survey profile (i.e. the same profile is traversed several times using different wire lengths and separations).

## Capabilities

Electrical imaging can detect and delineate a target that has a different electrical resistivity from its surroundings. Particularly good targets for electrical imaging include: electrically conductive clay seams, and water-bearing or mineralized faults or fractures in resistive bedrock; electrically resistive hydrocarbon plumes in moist electrically conductive soils; highly conductive electrolytic groundwater plumes (e.g. leachate or saltwater intrusion); highly conductive or resistive wastes buried in "normal" soils; soil moisture anomalies (e.g. dam seepage or incipient sinkholes).

Where site conditions allow, capacitively-coupled electrode systems can collect greater quantities of data in a given time (or at a given cost) than the traditional steel spike systems. The capacitive systems can also be used on asphalt pavement (where steel spike systems would require drilling many electrode holes).

## Limitations

Electrical resistivities of differing materials have wide and overlapping ranges, making it impossible to positively identify a subsurface material based on its resistivity alone. For instance, profiling of the top-of-rock can be done by electrical imaging, but it is often difficult to specify exactly what resistivity contour corresponds with the top of rock (particularly where there is a weathering or saprolite zone). Since electrical resistivity (unlike seismic velocity) does not correlate with rippability or density, it is not typically the method of choice for rock profiling.

Based largely on a single well-publicized incident, electrical imaging has been promoted (by others) as a method for detecting bedrock cavities. However, since an air-filled cavity and competent rock are both electrical resistors, many cavities are not detectable using electrical methods (in this case, gravity would be the method of choice since air and competent rock have very different densities).

Electrical imaging data is susceptible to interference from underground utilities that capture and channel the subsurface current flow. This can be minimized in two-dimensional surveys by orienting the trace of an image perpendicular to any existing utilities.

Capacitively-coupled electrode systems suffer loss of signal penetration depth in highly conductive terranes. In addition, they are difficult to use in rugged or brushy terrain.

Survey depths using steel spike electrode systems can be limited by high contact resistances between the spikes and highly resistive surficial material.

# References

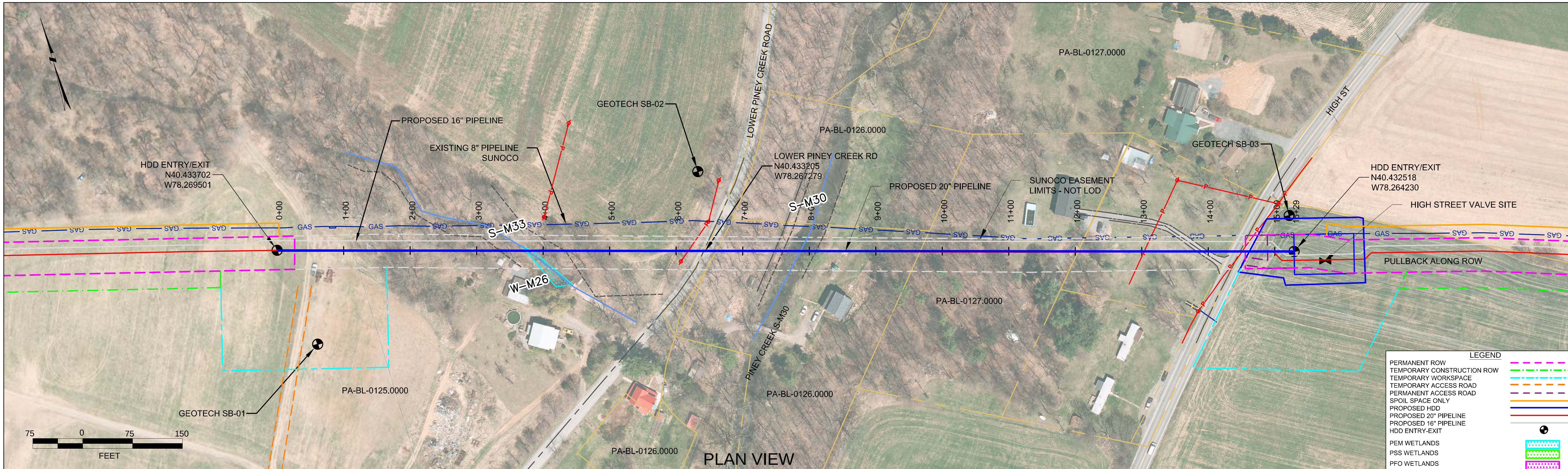
Berg, T. M., Edmunds, W. E., Geyer, A. R., and others, compilers, 1980, Geologic map of Pennsylvania: Pennsylvania Geological Survey, 4th ser., Map 1, 2nd ed., 3 sheets, scale 1:250,000.

Carmichael, R. S. (1989), Physical Properties of Rocks and Minerals, CRC Press.

**PINEY CREEK CROSSING**
**PADEP SECTION 105 PERMIT NO.: E07-459**
**PA-BL-0126.0000-RD AND PA-BL-0126.0000-RD-16**
**(SPLP HDD No. S2-0142)**

# ATTACHMENT 2

## ORIGINAL AND REVISED HORIZONTAL DIRECTIONAL DRILL PLAN AND PROFILES



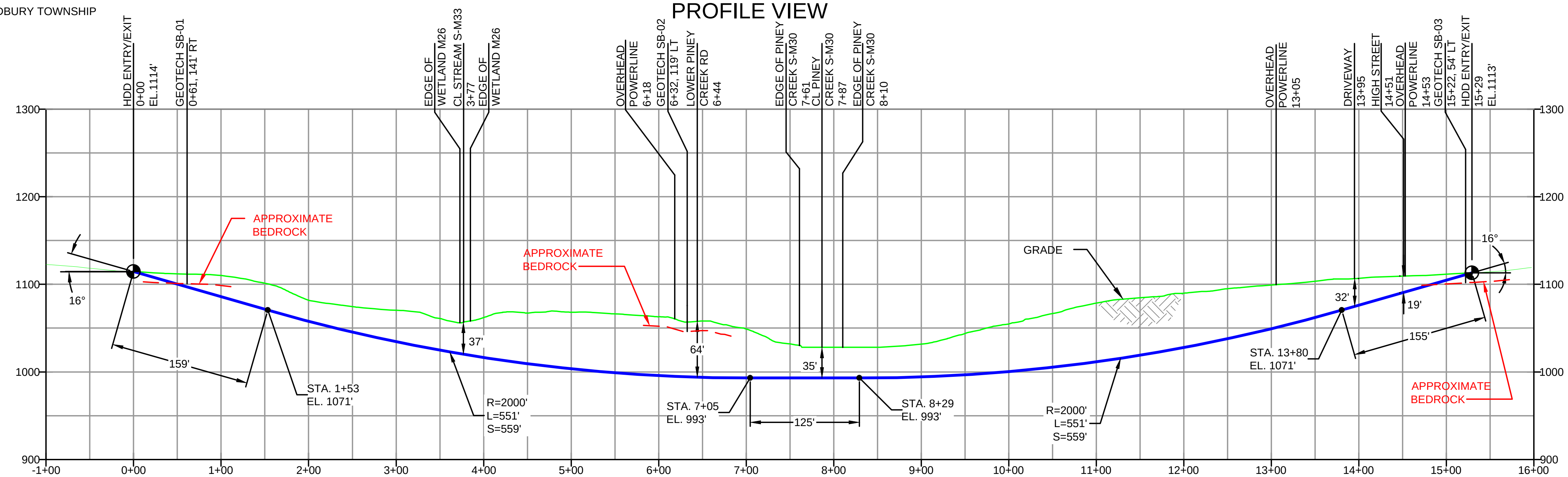

BLAIR COUNTY, PENNSYLVANIA - WOODBURY TOWNSHIP
S2-0142

GEOTECH SB-01
- NG EL. 1113'
- TOPSOIL (0' - 0.1')
- ML (0.1' - 4.0')
- SM/GM (4.0' - 10.0')
- COMPLETION DEPTH EL. 1103'

GEOTECH SB-02
- NG EL. 1076'
- CL/ML (0.0' - 9.4')
- FRACTURED LIMESTONE (9.4' - 17.0')
- COMPLETION DEPTH EL. 1059'

GEOTECH SB-03
- NG EL. 1115'
- TOPSOIL (0' - 0.1')
- SM (0.1' - 3.6')
- CL/ML (3.6' - 4.8')
- SM/GM (4.8' - 11.8')
- COMPLETION DEPTH EL. 1103'

NOTE: REFER TO TEST BORING LOG S2-0142 FOR COMPLETE SOIL MATERIAL DESCRIPTION




DESIGN AND CONSTRUCTION:
1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXITING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=):1529'
   HDD PIPE LENGTH (S=):1556'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGH FACTOR 0.50).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

Figure 1. Original 20-Inch HDD Plan and Profile

NOTES
1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP, FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

| DWG NO | | DWG NO | DESCRIPTION |
|---|---|---|---|
| ES-3.57 | TO | ES-3.58 | EROSION & SEDIMENT PLAN |
| SHEET 41 | TO | SHEET 41 | AERIAL SITE PLAN |

REVISIONS

| NO. | DESCRIPTION | BY | DATE | CHK | DATE | APP | DATE |
|---|---|---|---|---|---|---|---|
| EP2 | REVISED PER PADEP COMMENTS RECEIVED 09-06-16 | DLM | 09/30/16 | RMB | 09/30/16 | AAW | 09/30/16 |
| EP1 | REVISED PER PADEP COMMENTS | MRS | 05/18/16 | RMB | 05/18/16 | AAW | 05/18/16 |
| EP | | MRS | 03/15/16 | RMB | 03/15/16 | AAW | 03/15/16 |
| C | ADDED GEOTECH INFO | MRS | 09/04/15 | RMB | 09/04/15 | AAW | 09/04/15 |
| B | ISSUED FOR BID | JAM | 07/31/15 | RMB | 07/31/15 | AAW | 07/31/15 |
| A | ISSUED FOR REVIEW | JAM | 03/24/15 | RMB | 03/24/15 | AAW | 03/24/15 |

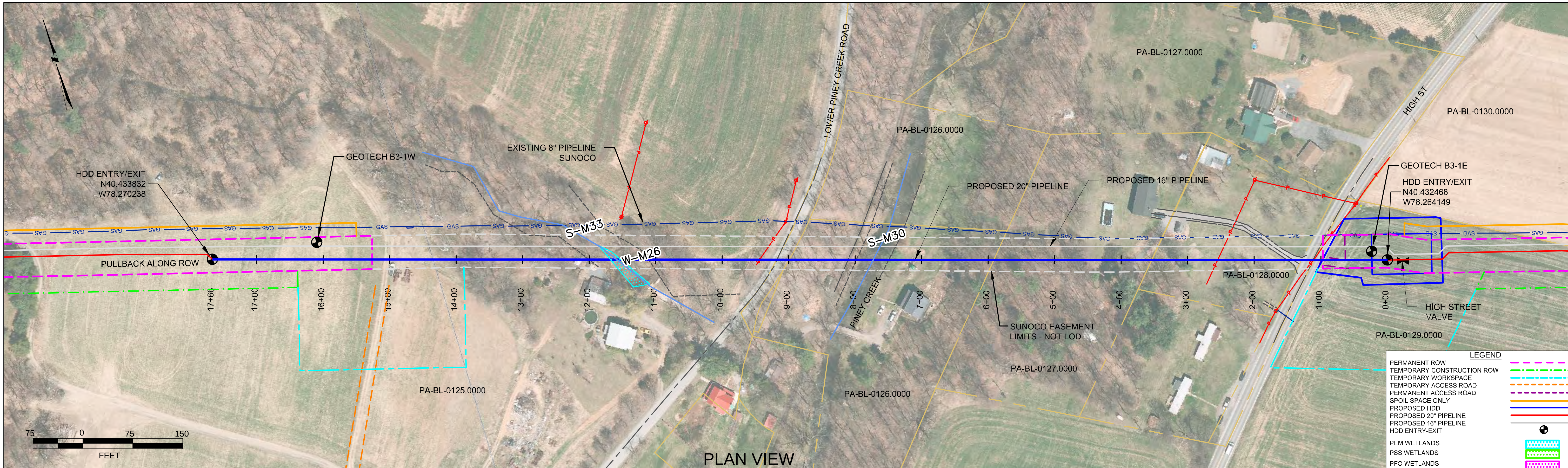
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

20-INCH HORIZONTAL DIRECTIONAL DRILL
PINEY CREEK
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150'
DWG. NO: PA-BL-0126.0000-RD




BLAIR COUNTY, PENNSYLVANIA - WOODBURY TOWNSHIP
S2-0142

PROFILE VIEW

GEOTECH B3-1E

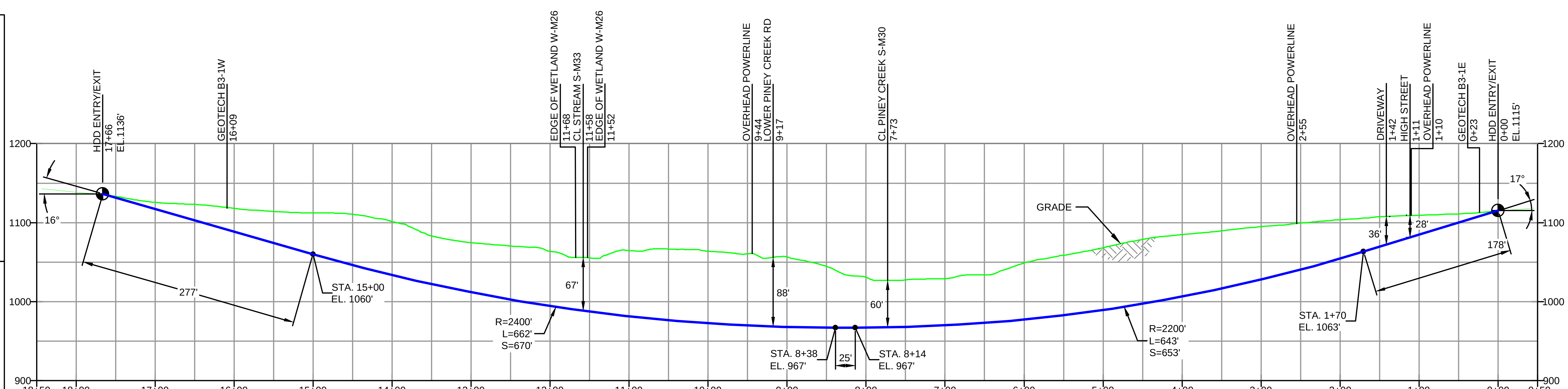
-NG EL. 1113'
-LEAN CLAY W/ GRAVEL CL (0.0' - 1.5')
-WEATHERED ROCK (1.5' - 15.0')
-GROUNDWATER (89.0')
-MUDSTONE/CALCEROUS LIMESTONE (15.0' - 190.0')
-BORING TERMINATED EL.923'

NOTE: REFER TO TEST BORING LOG B3-1E TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B3-1W

-NG EL. 1119'
-LEAN CLAY W/ WEATHERED ROCK CL (0.0' - 10.0')
-GROUNDWATER (27.0')
-CALCEROUS SHALE (10.0' - 195.0')
-BORING TERMINATED EL.924'

NOTE: REFER TO TEST BORING LOG B3-1W TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION




DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=): 1766'
   HDD PIPE LENGTH (S=): 1803'
   20" x 0.456" W.T., X-65, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

Figure 2. Revised 20-Inch HDD Plan and Profile

## NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP, FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

## REF. DRAWING

| DWG NO | | DWG NO | DESCRIPTION |
|---|---|---|---|
| ES-3.57 | TO | ES-3.58 | EROSION & SEDIMENT PLAN |
| SHEET 41 | TO | SHEET 41 | AERIAL SITE PLAN |

## REVISIONS

| NO. | DESCRIPTION | BY | DATE | CHK | DATE | APP | DATE |
|---|---|---|---|---|---|---|---|
| EP3 | MOVED DRILL ENTRY/EXIT LOCATION - DESIGN PER MICHELS | MRS | 09/22/17 | RMB | 09/22/17 | CAG | 09/22/17 |
| EP2 | REVISED PER PADEP COMMENTS RECEIVED 09-06-16 | DLM | 09/30/16 | RMB | 09/30/16 | AAW | 09/30/16 |
| EP1 | REVISED PER PADEP COMMENTS | MRS | 05/18/16 | RMB | 05/18/16 | AAW | 05/18/16 |
| EP | | MRS | 03/15/16 | RMB | 03/15/16 | AAW | 03/15/16 |
| C | ADDED GEOTECH INFO | MRS | 09/04/15 | RMB | 09/04/15 | AAW | 09/04/15 |
| B | ISSUED FOR BID | JAM | 07/31/15 | RMB | 07/31/15 | AAW | 07/31/15 |

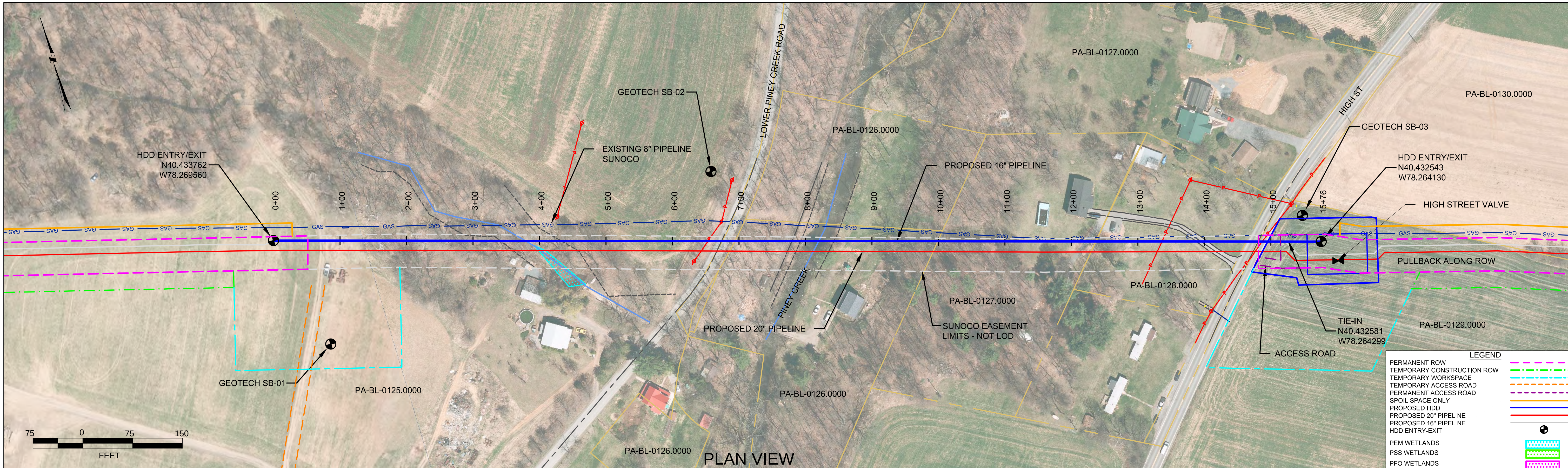
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
LOWER PINEY CREEK RD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150'
DWG. NUMBER: PA-BL-0126.0000-RD




BLAIR COUNTY, PENNSYLVANIA - WOODBURY TOWNSHIP
S2-0142-16

## PROFILE VIEW

**GEOTECH SB-01**

- NG EL. 1113'
- TOPSOIL (0' - 0.1')
- ML (0.1' - 4.0')
- SM/GM (4.0' - 10.0')
- AUGER REFUSAL LIMESTONE (10.0')
- COMPLETION DEPTH EL. 1103'

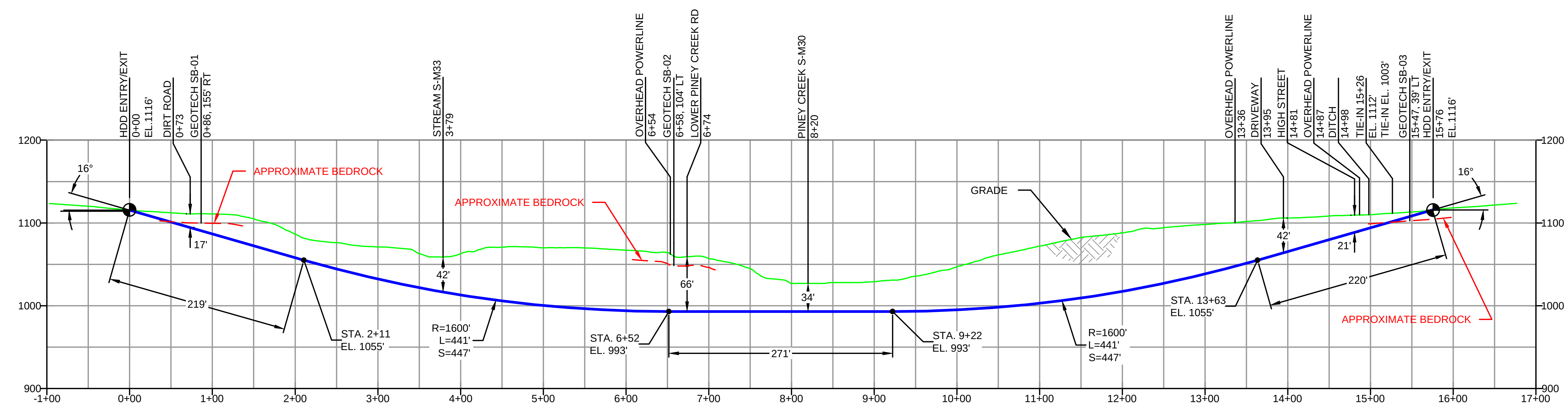
**GEOTECH SB-02**

- NG EL. 1076'
- CL/ML (0.0' - 9.4')
- FRACTURED LIMESTONE (9.4' - 17.0')
- COMPLETION DEPTH EL. 1059'

**GEOTECH SB-03**

- NG EL. 1115'
- TOPSOIL (0' - 0.1')
- SM (0.1' - 3.6')
- CL/ML (3.6' - 4.8')
- SM/GM (4.8' - 11.8')
- AUGER REFUSAL LIMESTONE (11.8')
- COMPLETION DEPTH EL. 1103'

NOTE: REFER TO TEST BORING LOG S2-0142 FOR COMPLETE SOIL MATERIAL DESCRIPTION




DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=): 1575'
   HDD PIPE LENGTH (S=): 1604'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

Figure 3. Original 16-Inch HDD Plan and Profile

### NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP, FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

### REVISIONS

| NO. | DESCRIPTION | BY | DATE | CHK | DATE | APP | DATE |
|---|---|---|---|---|---|---|---|
| 2 | REVISED PROFILE WITH 2017 LIDAR | MRS | 03/21/17 | RMB | 03/21/17 | CAG | 03/21/17 |
| 1 | REVISED PER ENGINEERING COMMENTS | MRS | 08/26/16 | RMB | 08/26/16 | AAW | 08/26/16 |
| 0 | ISSUED FOR CONSTRUCTION | MRS | 12/22/15 | RMB | 12/22/15 | AAW | 08/31/15 |

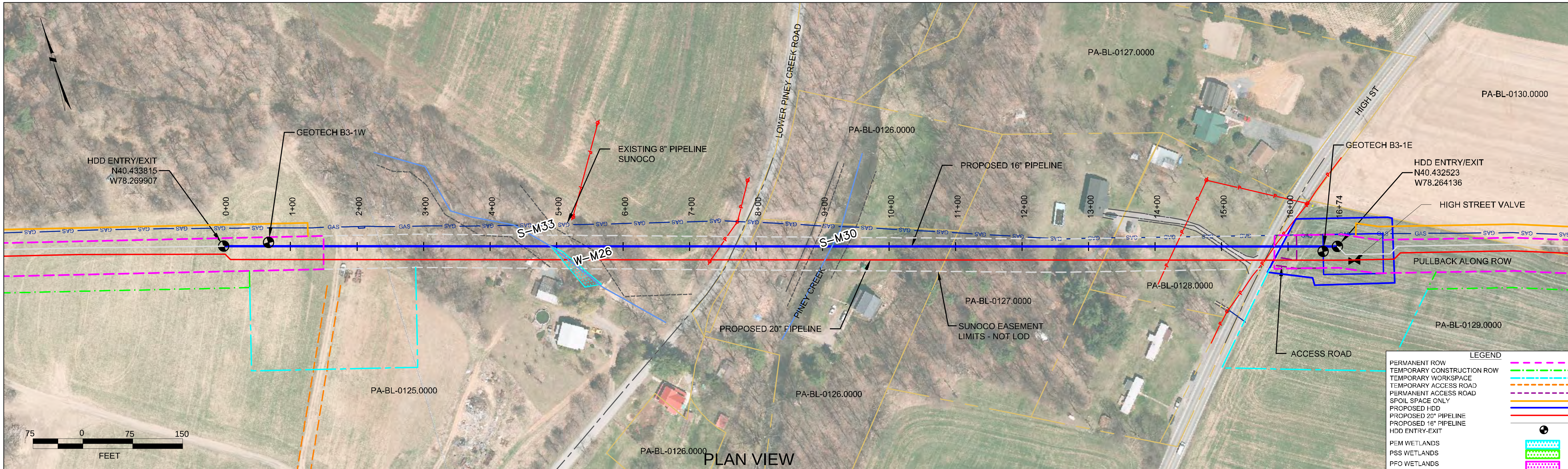
Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
LOWER PINEY CREEK RD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150'
DWG. NO. PA-BL-0125.0000-RD-16




PLAN VIEW

BLAIR COUNTY, PENNSYLVANIA - WOODBURY TOWNSHIP
S2-0142-16

PROFILE VIEW

**GEOTECH B3-1E**

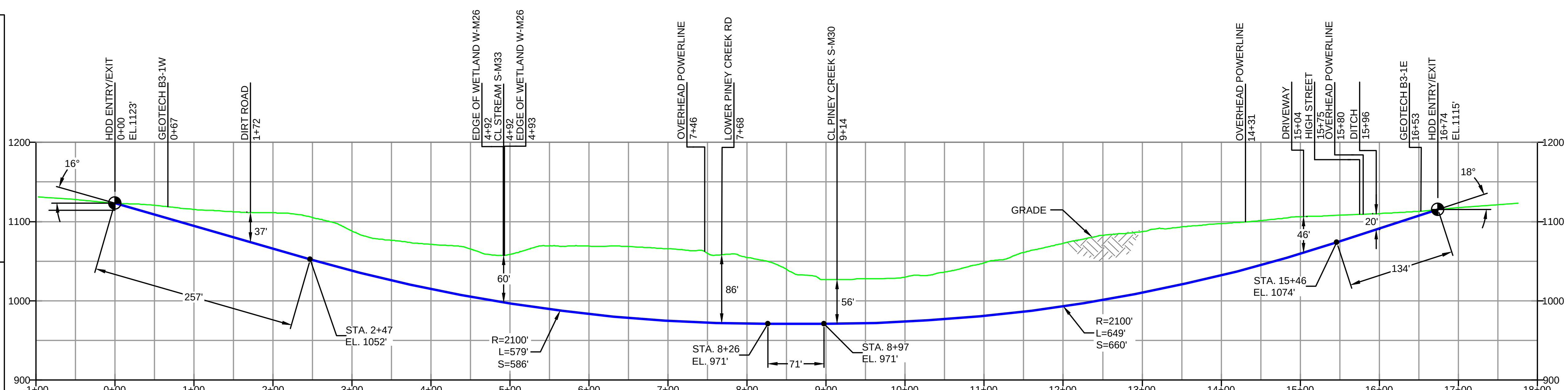
- -NG EL. 1113'
- -LEAN CLAY W/ GRAVEL CL (0.0' - 1.5')
- -WEATHERED ROCK (1.5' - 15.0')
- -GROUNDWATER (89.0')
- -MUDSTONE/CALCEROUS LIMESTONE (15.0' - 190.0')
- -BORING TERMINATED EL.923'

NOTE: REFER TO TEST BORING LOG B3-1E TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

**GEOTECH B3-1W**

- -NG EL. 1119'
- -LEAN CLAY W/ WEATHERED ROCK CL (0.0' - 10.0')
- -GROUNDWATER (27.0')
- -CALCEROUS SHALE (10.0' - 195.0')
- -BORING TERMINATED EL.924'

NOTE: REFER TO TEST BORING LOG B3-1W TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION




DESIGN AND CONSTRUCTION:

1. CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
2. THE MINIMUM SEPARATION DISTANCE FROM EXISTING SUBSURFACE UTILITIES SHALL NOT BE LESS THAN 10 FEET AS MEASURED FROM THE OUTSIDE EDGE OF THE UTILITY TO OUTSIDE OF PROPOSED PIPELINE.
3. DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
4. CROSSING PIPE SPECIFICATION:
   HDD HORZ. LENGTH (L=): 1674'
   HDD PIPE LENGTH (S=): 1708'
   16" x 0.438" W.T., X-70, API5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R95)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50 (HOOP STRESS)).
6. INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD).
7. PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
8. CARRIER PIPE NOT ENCASED.
9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
10. CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
11. SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.
12. SUNOCO PIPELINE, L.P.'S HORIZONTAL DIRECTIONAL DRILL INADVERTENT RETURN CONTINGENCY PLAN WILL BE IMPLEMENTED AT ALL TIMES.
13. SUNOCO PIPELINE, L.P.'S EROSION AND SEDIMENTATION CONTROL PLAN WILL BE IMPLEMENTED AT ALL TIMES.

Figure 4. Revised 16-Inch HDD Plan and Profile

NOTES

1. ALL COORDINATES SHOWN ARE IN LATITUDE AND LONGITUDE. ALL MSL ELEVATIONS ARE NAD83
2. STATIONING IS BASED ON HORIZONTAL DISTANCES.
3. ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP ARE NOT RESPONSIBLE FOR LOCATION OF FOREIGN UTILITIES SHOWN IN PLOT PLAN OR PROFILE. THE INFORMATION SHOWN HEREON IS FURNISHED WITHOUT LIABILITY ON THE PART OF ROONEY ENGINEERING, INC. AND SUNOCO PIPELINE, LP, FOR ANY DAMAGES RESULTING FROM ERRORS OR OMISSIONS THEREIN.
4. CONTRACTOR IS RESPONSIBLE FOR LOCATING ALL UTILITIES. CONTACT ONE CALL AT 811 PRIOR TO DIGGING.
5. SUNOCO EMERGENCY HOTLINE NUMBER IS #1-800-786-7440.

REF. DRAWING

| DWG NO | | DWG NO | DESCRIPTION |
|---|---|---|---|
| ES-3.57 | TO | ES-3.58 | EROSION & SEDIMENT PLAN |
| SHEET 41 | TO | SHEET 41 | AERIAL SITE PLAN |

REVISIONS

| NO. | DESCRIPTION | BY | DATE | CHK | DATE | APP | DATE |
|---|---|---|---|---|---|---|---|
| EP3 | MOVED DRILL ENTRY/EXIT LOCATION - DESIGN PER MICHELS | MRS | 09/22/17 | RMB | 09/22/17 | CAG | 09/22/17 |
| EP2 | REVISED PER PADEP COMMENTS RECEIVED 09-06-16 | DLM | 10/07/16 | RMB | 10/07/16 | AAW | 10/07/16 |
| EP1 | REVISED PER PADEP COMMENTS | MRS | 05/18/16 | RMB | 05/18/16 | AAW | 05/18/16 |
| EP | | MRS | 03/15/16 | RMB | 03/15/16 | AAW | 03/15/16 |
| B | ADDED GEOTECH INFO | MRS | 09/04/15 | RMB | 09/04/15 | AAW | 09/04/15 |
| A | ISSUED FOR BID | MRS | 08/31/15 | RMB | 08/31/15 | AAW | 08/31/15 |

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
LOWER PINEY CREEK RD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150' | DWG. NO. PA-BL-0126.0000-RD-16