

May 12, 2018

Via Electronic Mail

Mr. John Hohenstein, P.E.
Chief, Dams and Waterway Section
Pennsylvania Department of Environmental Protection
2 East Main Street
Norristown, PA 19401

**Re: SPLP Response to Comments
Hydrogeological Reevaluation Report
Strasburg Road/Bow Tree Drive HDD (S3-0520)
DEP Permit Nos. E15-862
East Goshen Township
Chester County, Pennsylvania**

Dear Mr. Hohenstein:

In compliance with the Corrected Stipulated Order dated August 10, 2017 (the “Order”), a Reevaluation Report on the above-referenced horizontal directional drill (“HDD”) was submitted to the Department on January 23, 2018. In a letter dated March 13, 2018, the Department has requested further information. Please accept this letter as a response. Your requests are bolded below followed by the response.

- 1. There are two reports included in the Report. The First Report is titled “Horizontal Direction Drill Analysis Strasburg Road/Bow Tree Drive Crossing,” and the other (the GES Report) was produced by GES, Inc. (GES), in January 2018. While the GES Report is sealed and signed by a Pennsylvania-Licensed Professional Geologist (P.G.), it is not clear who produced the First Report. The First Report appears to represent Sunoco’s plans and intentions. The GES Report is signed and sealed and makes some recommendations not committed to in the First Report. A Pennsylvania-Licensed Professional Geologist and Engineer will have to sign and seal the First Report as well.**

The Horizontal Direction Drilling (HDD) Reevaluation Report, First Report, is the work product, or summarized portions of, the work of several individuals. These include at minimum a Pennsylvania Professional Geologist (PG), a pipeline engineer licensed in the State of Pennsylvania, and an HDD expert who learned this construction craft through years of experience. Therefore, the information presented in the reevaluation report is not solely within the professional expertise of a geologist, but rather is the product of a team of individuals. Every HDD Reevaluation Report previously submitted to the Department pursuant to the Order has used the same format as the Reevaluation Report submitted for HDD S3-0520 (*i.e.*, an overall Reevaluation Report attaching a signed and sealed Hydrogeological Evaluation Report). However, if the Department would prefer, SPLP can have all participating individuals sign the Reevaluation Report.

- 2. Two small IRs were already reported associated with the reaming of the 20-inch pilot hole. Fracture trace analysis suggest that there is a subsurface structure in this area that may facilitate IRs. DEP believes that the previous IRs will likely reappear when drilling resumes. Recommendations made by the P.G. in the GES Report should be followed to minimize the risk of future IRs. Please indicate whether Sunoco intends to follow those recommendations.**

Very little reaming of the pilot hole as referenced by Item 2 occurred on this HDD. The HDD was in the pilot phase and had made 2,686 feet (ft) of progress by July 2017. Approximately 100 ft of casing was set into the pilot run at the entry. The HDD was stopped following issuance an order by the Environmental Hearing Board, and the pilot hole was grouted while removing the drilling tools and stem. This action likely sealed those minor pathways above and below the profile in that location.

No annular pressure monitor (APM) was used during the original HDD pilot attempt. Upon the start of this HDD the use of an APM tool is mandatory. This tool will provide data to the operator to detect a reduction of pressure in the annulus which is indicative of fluid loss outside the borehole and initiation of a potential IR, and allow for the drilling to be stopped and corrective action implemented.

Regarding the integration of the conclusion and best management practices provided by the PG into the construction activities associated with HDD S3-0520, please see the response to Item 31.

- 3. The Report mentions that fracturing in the rock along the pipe run has areas of very close fracturing. However, it makes no mention of any predominant strike and dip of fractures and joints. Downhole geophysics were not performed. Geophysical techniques, including, but not limited to, caliper tests and ATV should be employed to determine fracture dips and strikes to determine a predominant fracture trace in a resubmitted Report. This will provide data that will assist in determining the direction of groundwater flow and likely paths of drilling fluids in the subsurface.**

Past experience has demonstrated that IR risk increases where major lithologic boundaries, fracture traces, or faults cross the HDD path. These large, hydraulically-active features are generally well-mapped or are readily identified using standard fracture trace analysis. Although borehole geophysics is useful for quantifying fracture orientation, aperture, and intensity, the technique is limited because wells may not intercept large vertical fractures or determine the spatial connection between features that connect the HDD and potential receptors.

The Report discusses predominant strikes in Section 2.2.2 (“Regional fabric (relict bedding and structure) strikes northeast/southwest.”); Section 2.2.3 (“At least three sets of fracture patterns (striking approximately N25-35°W, N65-80°W, and N10-40°E) are indicated by fracture traced analysis.”). The Terracon borings (in Attachment B of the Report) indicate a primary low-angle

fracture/joint set and a secondary high-angle to vertical fracture/joint set for most of the run for both borings (from approximately 47-67.5' deep to the bottom of the cores at depths of 158' and 120').

Geologic maps of the area (Blackmer, 2005; Bosbyshell, 2006) indicate near-vertical fracturing in this formation (granulite facies gneiss of the Baltimore Gneiss complex), due to its regional situation between the Cream Valley and Rosemont Faults.

Groundwater in the area is known to flow generally toward the south-southwest (Section 2.3.1 of the Report), and is generally a subdued replica of the topographical surface (Sloto, 1994). In a fractured system, however, drilling mud is more likely to travel up dip to the surface and may not be influenced by the hydraulic gradient.

Overall, SPLP believes it has enough information from the geotechnical borings already performed, supplemented by the peer-reviewed literature, to determine likely subsurface fluid flow paths.

4. A borehole geophysical suite should be performed in geotechnical borings to verify the fracture trace analysis and determine if any local fracture sets that exist. This may help determine preferential pathways of groundwater and potential drilling fluids.

As stated in Item 3 above, SPLP believes it has enough information from the geotechnical borings already performed, supplemented by the peer-reviewed literature, to determine likely subsurface fluid flow paths. SPLP believes that the risk of creating new preferential pathways for fluid migration through the installation of a suite of boreholes along the drill path significantly outweighs the marginal utility of any additional information that could be derived from borehole geophysics.

5. Five geotechnical borings were drilled along the pipe run to depths of 56 to 105 feet bgs. No analysis was provided describing depths of what could be considered "competent" bedrock in each of the borings. In fact, the borings only encountered highly fractured bedrock down to a depth of 105 feet. The Report suggests that bedrock competency values are poor in some areas of the pipe run. An analysis describing the depths of what could be considered "competent" bedrock should be completed.

As presented in the last paragraph of Section 2.2 of the Hydrogeology Report "*Rock Quality Designation (RQD) of core collected from boring B6-7W showed a general increase in RQD from 17% at 60 to 65 ft bgs to 100% at 85 to 90 ft bgs. However, it decreased below this interval, to a value of 63% at 90 to 95 ft bgs. Thus, bedrock strength as indicated by RQD is variable at the location of the boring and is expected for bedrock in the area of the HDD site, in general. No bedrock coring was performed at boring B6-7E*". The geotechnical data report prepared by Terracon states that no competent rock was encountered in core B6-7E. No statement is made

was made regarding B6-7W; however testing was performed on a sample from 70 ft below ground.

SPLP is not aware of any established regulatory or HDD industry definition of “competent bedrock”. HDDs are completed through all types of soils and rock strata without problems, such as IRs, by analyzing subsurface characteristics and establishing an engineered profile that minimizes IR potential.

6. Surface geophysics should be employed to provide evidence of the top of bedrock along the whole run of the pipeline. The six geotechnical borings installed, while very useful in determining fracture density and lithology, are insufficient to determine the top of bedrock outside of their sample locations.

To date on the Mariner II project, SPLP has performed a suite of geophysics studies at five (5) locations. These were performed at four (4) locations with karst geology, and one (1) location of 1/3rd karst and 2/3rds non-karst geology. At the five karst locations, the results of the geophysics provided usable data to a depth of 15 ft to 60 ft bgs. At the non-karst location the geophysics results indicating voids and soft spots were subsequently investigated by cone penetrometers and geologic coring. The penetrometer and core investigation resulting in no verification of the geophysics indicated soft spots and voids.

Since the 20-inch profile has an averaged horizontal depth of 94 ft bgs, and the 16-inch profile has an averaged horizontal depth of 79 ft bgs, based on SPLP’s experiences, geophysics will provide no functional information at this HDD location.

7. Specific points of potential weak bedrock and soils were not individually identified. This should be done. Predetermined areas of weakness should be addressed by a description of the prescriptive approach Sunoco will use when drilling.

As stated in the response to Item 6 above, the 20-inch profile has an averaged horizontal depth of 94 ft bgs, and the 16-inch profile has an averaged horizontal depth of 79 ft bgs. SPLP and the Department understand from the results of the geotechnical cores that substantial transition of the underground formation occurs between the west and east ends of the HDD. However, areas of bedrock/soil weakness consist of fractures and joints, zones of weathering, and areas of formational transitioning, all of which can be predicted with fair success using available resources. These resources include fracture trace analysis, existing geologic and hydrologic studies, and the geotechnical borings already performed. Familiarity with this information allows reasonable prediction and interpolation of zones of weakness, which will be discussed ahead of drilling, with a plan devised to address such zones, and monitored closely as drilling progresses, per the Operations Plan and revised IR Plan.

SPLP does not believe that there are additional technically feasible methods to acquire additional useful data that would identify zones of weakness at the average depth of the pilot hole (79 ft bgs) across the length of the pilot hole (2,750 linear ft).

8. The implementation of an early detection groundwater monitoring program using domestic wells was not incorporated. A map of wells along with a time frame of drilling activities should be presented in such a monitoring plan.

SPLP assumes Item 8 is discussing the potential for drilling fluid migration into a water well, and early detection of any such occurrence?

A new Water Supply Illustration is provided with this response as Attachment 1. As shown on this illustration there are eleven (11) landowner identified private water wells within 450 ft of the HDD profile. Of these, two (2) are vacant properties. The remainder of the properties are served by public water supply.

Considering the immediate proximity of public water supplies to the properties reporting private water wells, SPLP is re-contacting these owners to determine if the residence relies on the water wells as the “sole source” of water, or if the water well is for secondary non-consumptive use.

During active drilling, SPLP implements regular monitoring of adjacent water wells. Additionally, SPLP agents are “on-call” and immediately respond to any individual in vicinity to an HDD complain about a water quality or quantity issue in accordance with the project’s Operations Plan and Water Supply Plan.

9. The Report contains limited site-specific information. Specifically, items such as pilot bore and reaming diameters, annular pressures, mud viscosities, action levels, and specific IR response actions should be included.

The typical mud motor cutting tool diameter used for HDDs of this linear extent is 12.3 inches in diameter.

The ultimate reaming diameter for the 20-diameter pipeline is 30 inches. The reaming could be done in incremental diameters ranging from 16 to 24-inches before progressing to a 30-inch diameter ream. The ultimate reaming diameter for the 16-inch pipeline is 24-inches in diameter, which typically is not pre-reamed at a smaller diameter. The decision to pre-ream at smaller diameters, or not, is based upon real time data acquired during the pilot hole phase.

Annular pressures vary by depth of profile due to the effect of gravity, increasing as the depth of profile increases. At profile depth the annular pressure could vary between 50 and 90 pounds per square inch varying on drilling conditions encountered, and pressures required to maintain the flow of returns.

Mud viscosity is measured using a “Marsh Funnel” which is based on time in seconds for 1-quart of fluids to pass through the funnel and is reported in total seconds. In real world terminology, viscosity typically varies from 5-15% percent varying the nature of the material being drilled through so that continued removal of the cuttings within the annulus is efficient. What is actively managed in the drilling process is not only viscosity, but returning mud weight so that the cuttings removal is verified before recycling the drilling fluids into the HDD process. The target cleaning level of the drilling fluids is 9.5-10.5 lbs per gallon.

There are no pre-set “action levels” in an HDD except as discussed above. An HDD is an actively managed process.

Responses to an IR event would adhere to the procedures of the latest version (April, 2018) of the “*Pennsylvania Pipeline Project: HDD Inadvertent Return Assessment, Preparedness, Prevention and Contingency Plan (IR Plan)*”.

10. The Report states that loss control materials (LCM) can be used to manage the loss of fluids during the pilot hole phase. As bedrock is generally highly fractures to 65 of more feet below the existing ground surface, the use of LCMs during drilling appears appropriate. The discussion also states that loss of fluids may be managed by grouting. A discussion of the timing of the potential grouting program is not provided. Grouting of highly fractured zones of rock or fracture traces as a preventative measure may be prudent, whereas, grouting after an inadvertent return (IR) already occurs may not be desirable. If grouting is necessary, it may be better to identify and remediate the zones along the alignment that should be grouted prior to drilling the pilot holes. A conceptual description of the proposed grouting program, if any, should be provided.

The use of Loss Control Materials (LCMs) cannot be “pre-planned” since it is impossible through the use of existing technologies to precisely determine where below ground conditions occur that would warrant an application of LCM’s in advance.

Due to this inability to “pre-determine” a location in an HDD profile where an application of LCMs would be appropriate, the HDD operator uses tooling, in this instance the Annular Pressure Monitor (APM), to actively observe conditions in the profile while drilling. An abrupt drop in annular pressure, which is indicative of a potential IR event, and in accordance with the IR Plan, requires the drilling to stop, assess down hole conditions, and implement a cure to the problem based upon the drilling data.

LCMs are mixed as a “pill” to use the industry term. A pill is a tank mixed LCM volume of drilling fluids with the LCM introduced, typically 1,000 to 2,000 gallons in volume that is pumped through the stem to the point of injection, then followed by a batch of normal drilling fluids to set the pill and clear the stem. LCMs work best in minor fissures and bedding plan partings.

The use of grouting cannot be “pre-planned” since it is impossible through the use of existing technologies to precisely determine where below ground conditions occur that would warrant a grout injection in advance. The APM tool is used for this purpose. Depending on the specific circumstances while drilling, a grout injection may be the only solution to resolve an occurrence of an IR. SPLP does not “desire” any IRs and the whole objective of the Reevaluation process is to eliminate or minimize the potential occurrence of an IR during an HDD by analysis of the permitted profile compared to redesign options for improvement.

The determination for the use of grouting or LCM’s is all based upon the downhole data recorded while drilling. Minor Loss of Circulation (LOC) events, indicative of fractures or larger bedding plan partings in the bedrock, can be effectively treated using a combination of NFS 60 certified fluids with control properties such as “SuperSwell” and “Magma Fiber”. Set time requirements are relatively short before re-advancement of the tool can commence.

Significant fractures or voids can 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 this HDD will be the use of a low mobility grout based on bentonite types of products such as “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 limit 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. Fill 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.

11. IR prevention typically includes linking the respective proposed HDD geometry with site-specific geotechnical data. This approach will allow the HDD designer and driller to understand what specific HDD station ranges will be most vulnerable to IRs. Questions regarding the linking of the proposed HDD geometry and the site-specific geotechnical data for this specific bore include the following:

a. Has the possibility of IRs via weak subsurface soil/weathered rock/fill zones at existing utility trenches (if present) been considered?

Existing utility lines that would be undercrossed by the HDD at less than 30 ft of depth include:

- A storm sewer line at Station 1+02, with the HDD at 29 foot of depth below ground surface (bgs), and
- A storm sewer line at Station 37+36 with the HDD at 23 ft of depth bgs.

These sewer lines are in near proximity to the entry and exit pits, which is not a point of high pressure once the pilot phase has passed this point in the profile.

The remaining utility under crossings by the HDD profiles are substantially deeper and not of concern for the stated issue.

- b. The Report explicitly states that “SPLP will mandate rotational drilling of the pilot hole until competent bedrock is reached.” Based on the test boring results, there is little competent bedrock along the alignments and weathering of bedrock along the majority of the HDD appears to be very deep and highly variable. Has a preliminary station number been assigned where the rotational drilling will terminate?**

Rotational drilling can only be performed to the depth of profile where no steering corrections are required to follow the profile design. The extent of the profile where no steering during drilling may be required is 150 ft into the entry, and at 180 ft before the exit.

- 12. Page 2 of the Terracon Report (Attachment 2 of GES Report) states: “When laboratory soil testing results are available, we will submit a complete data report for the subject crossing.” This report appears to be preliminary, and an update may be available by now. Any final report from Terracon should be offered as part of the Report.**

The November 30, 2017 version of the Terracon report is the most up to date version in our possession. SPLP is inquiring with this contractor on a final report as referenced.

- 13. This plan is to address a specific HDD bore at a specific location. Previous history with IRs in this area suggests that soil cover alone may not provide sufficient resistance to prevent future IRs and that a profile that penetrates sound rock may be more appropriate. As a result, discussion regarding sufficient depth of soil cover versus maximum allowable mud pressure should be included for portions of the HDD where the HDD path does not penetrate rock (as may be the case for the entirety of the 16-inch HDD).**

During the initial pilot attempt for installation of the 20-inch pipeline, the drilling contractor completed 1,776 linear feet of the profile before any IR occurrence. Two IR's occurred at 1776 feet and 2686 from the entry (northwest end), i.e. at stations 21+14 and 12+04 from the exit (southeast end). This section is in the area of thinnest overburden (approximately 45 feet thick for the 20" profile and 60 feet thick for the 16" profile). Upon the approval to start these HDDs, the contractor is required to use an APM tool and carefully record drilling fluid injection and return compared to the total annular space as the HDD pilot phase progresses. Using these tools and methods will assist the driller and inspectors in determining loss of fluids in softer materials and take corrective action, such as increasing fluid viscosities, and tripping the tooling and drill string to ensure the annulus is the pathway of least pressure to ensure the flow of returns.

14. The Report states: “No geophysical studies were recommended or performed for the reevaluation of HDD S3-0520 as the alignment is not in a karst area.” Geophysical surveys should not be limited to karst environments, as they may be useful and provide valuable data in this instance. Specifically, a geophysical survey could be helpful to interpolate between geotechnical boring points, identifying areas of soft soils, confirming the top of rock configuration, and in delineating/characterizing the fractures identified by GES.

Geophysical assessments provide only limited data below bedrock levels even in karst formations, and are utilized more appropriately as a “tool” to identify locations for drilled core investigations of suspect fractures and voids in karst formations.

As discussed in the response to Item 6 above, SPLP has performed a suite of geophysics studies at five (5) locations. These were performed at four (4) locations with karst geology, and one (1) location of 1/3rd karst and 2/3rds non-karst geology. At the five karst locations, the results of the geophysics provided usable data to a depth of 15 ft to 60 ft bgs. At the non-karst location the geophysics indicated voids and soft spots were subsequently investigated by cone penetrometers and geologic coring. The physical investigation resulting in complete invalidation of geophysics indicated soft spots and voids.

Because the 20-inch profile has an average horizontal depth of 94 ft bgs, and the 16-inch profile has an average horizontal depth of 79 ft bgs, based on SPLP’s experiences, geophysics will provide no functional data at this non-karst HDD location.

15. Evaluation of water levels should be performed prior to initiating the HDD bore to provide information regarding potential diminution of flow issues and the ability to determine if any future potential impact is related to head differentials or plugging of a potential water-bearing zone.

The HDD plan and profiles provided in Attachment 2 have been modified to include known groundwater levels obtained during geotechnical investigation and from adjacent water well data.

As shown on these illustrations, the HDD entry and exit points are above the static groundwater level; therefore, no hydrostatic head differential should exist. Additionally, the entire substrate overlying the HDD has free groundwater; therefore there is no specific water bearing zone that could be plugged by HDD activities.

16. Given the developed nature of this area and proximity of residential groundwater supply wells, further discussion is warranted regarding this topic. Potential actions could include the following:

- a. Evaluate and project water well depths, casing depths, and water-level depths (based on a water-level survey) on cross sections/profile views.

As referenced in Item 16a, the HDD plan and profiles provided in Attachment 2 present the water well locations, well depths, and static water levels.

- b. The GES Report identifies the fractures on a plan view. The Report should also identify potential zones of fractures or fracture trace intercepts on the profile views, along with residential water supply well locations.**

As referenced in Item 16a, the HDD plan and profiles provided in Attachment 2 present the fracture trace intercepts along with water well locations and depths.

- c. At least 10 properties have private water supply wells within 450 feet of the proposed HDD. Two additional properties have private water-supply wells located just beyond the identified 450-ft boundary. An additional 13 properties are located within 450 feet of the proposed HDD and may or may not have private water supply wells. The Report should include a specific plan for temporary supply replacements, as the bedrock is highly fractured, even at depth, and residential water supply wells are located as close as 55 feet from the planned bore path. To limit potential impact on residential water well users, there should be a well-conceived response plan in place and ready to execute.**

As presented in SPLP's response to Item 8, there are eleven (11) landowner identified private water wells within 450 ft of the HDD profile and two (2) of these are vacant properties. The remainder of the properties are served by public water supply. Four properties with private water wells occur adjacent to, but outside, the 450 ft buffer.

Considering the immediate proximity of public water supply to the properties reporting private water wells, SPLP is re-contacting these owners to determine if the residence relies on the water wells as the "sole source" of water, or if the water well is for secondary non-consumptive use. SPLP agents have confirmed public and well water sources being present at single residences at other HDD locations.

Both the Inadvertent Return Assessment, Preparedness, Prevention and Contingency Plan ("IR Plan") and the Operations Plan require SPLP to offer alternative water supplies to landowners with water supply wells within 450 ft of the drill profile. Obviously, to the extent a landowner accepts this offer, their water supply should not be adversely affected during HDD activities. Moreover, even if the landowner does not accept an offer of alternative water supply, the IR Plan requires SPLP to address to the satisfaction of the landowner any complaints associated with water quantity during HDD activities. Finally, if a landowner identifies any impact to a private water supply attributable to pipeline construction after post-construction sampling, including impacts to yield, the IR Plan obligates SPLP to restore or replace the impacted water supply to the satisfaction of the private water supply owner.

17. The Report indicates Sunoco will monitor downhole pressures, viscosities, mud loss, and nearby water wells. However, there are no specific values or action levels such as how often mud loss is calculated or what viscosity would be maintained during the bore or at what point an IR contingency plan would be implemented (i.e., if there is X pressure increase or X mud loss, an IR contingency plan would be started). The specific viscosities and action values and pressures should be defined and documented to facilitate prompt actions during the HDD bore.

SPLP is committed to following the practices and procedures of the April 2018 version of the IR Plan. The IR plan contains procedures for monitoring and reporting on Loss of Circulation (mud loss). As answered in Item 11 above, mud viscosity typically varies from 5-15% percent varying the nature of the material being drilled through so that continued removal of the cuttings within the annulus is efficient. What is actively managed in the drilling process is the mud weight so that the cuttings removal is verified before recycling the drilling fluids into the HDD process. The target cleaning level of the drilling fluids is 9.5-10.5 lbs per gallon.

Loss of circulation or returns (mud loss) is continually observed during active drilling. Water use, bentonite volumes added, and mud volume pump rates are tracked during active drilling.

The drilling operator monitors the APM data while drilling. There are no “preset” pressure values. An abrupt pressure spike indicates a clogged annulus and the operator will stop the mud pump to relieve pressure, and the take corrective action, such as tripping back the drill string and tool at minimum pressure to attempt clearing of the blockage, or further actions as necessary, including if needed, the complete removal of the drill string and tooling to clear the hole. An abrupt drop in pressure indicates the penetration of a significant fracture or void or potentially a tool failure. If a loss of circulation occurs at the same time, then that is positive evidence of penetrating a fracture or void. If the data indicates a fracture or void, then the operator will attempt corrective action to seal the feature and restore circulation by using an LCM or grout injection.

18. The Report discusses potential changes in water quality, but should also discuss potential changes to water quantity, as the potential exists for the HDD bore to adversely impact the yield of private water supply wells.

The best means to protect water well quality or quantity during the HDD is non-use. SPLP assumes that the Department has requested a description of what actions SPLP intends to take to address any potential adverse effects on water quantity. The use of Aquabloc as a component of the drilling fluids in the pilot phase of the HDD should reduce the risk that HDD activities will create additional preferential pathways for groundwater that could cause groundwater to migrate away from the bore hole towards the recharge zone for each of these water supplies. Aquabloc is an NSF/ANSI-60 approved drinking water certified starch based drilling fluid that enhances the standard bentonite based drilling fluids ability to gel and seal fissures and fractures in rock outside the working bore hole, thereby minimizing the risk of impact to any of the nearby wells in question. SPLP will follow the manufacturers recommended dosage and add Aquabloc at

1.5-2.5 lbs per 100 lbs of bentonite while mixing the drilling fluid for use. The NSF/ANSA-60 certification and Safety Data Sheet for Aquabloc is provided in Attachment 3 for the Department's reference.

In addition, both the Inadvertent Return Assessment, Preparedness, Prevention and Contingency Plan ("IR Plan") and the Operations Plan require SPLP to offer alternative water supplies to landowners with water supply wells within 450 ft of the drill profile. Obviously, to the extent a landowner accepts this offer, their water supply should not be adversely affected during HDD activities. Moreover, even if the landowner does not accept an offer of alternative water supply, the IR Plan requires SPLP to address to the satisfaction of the landowner any complaints associated with water quantity during HDD activities. Finally, if a landowner identifies any impact to a private water supply attributable to pipeline construction after post-construction sampling, including impacts to yield, the IR Plan obligates SPLP to restore or replace the impacted water supply to the satisfaction of the private water supply owner.

19. In the Report, Sunoco encourages private well owners to make arrangements for alternative water supplies due to the risk of an IR. Sunoco should supply water to these residents prior to drilling, as a precautionary measure, as recommended in the GES Report and provided for in the February 6, 2018, HDD Inadvertent Return Assessment, Preparedness, Prevention and Contingency Plan (Inadvertent Return PPC Plan) incorporated into the February 8, 2018, Consent Order and Agreement entered into between Sunoco and DEP.

As stated in Paragraph 6 on Page of the Reevaluation report, SPLP has, and is continuing to contact landowners with private water supplies to offer replacement water services for the duration of each HDD. The water replacement service is provided at SPLP's expense.

20. The Report should designate, based on the geotechnical data, the depth at which full mud pressure can be used to power the motor without blowing out the soils and/or the low RQD weathered rock above the HDD.

There is no set level of "full mud pressure" since an HDD pumping unit easily has the pump pressure capability to inject pressures well beyond bedrock strength at maximum depth of profile. Rather, the drilling operator operates at the minimum pressure required to have "good return flows" to the entry pit, and then monitors that pressure for spikes or drops. Typical annulus pressure during this drill at maximum profile depth could vary from 50-90 pounds per square inch (psi) varying by the weight of return fluids.

Typical drilling fluid loss during an HDD occurs as a result of one or a combination of "leakage" or "Hydraulic Jacking". In these cases, the drill fluid finds an alternative path to the design drill path annulus that requires a lower pressure to move the drill fluid. Drill fluid pressure at any point along a drill path is a function of 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 multiplied by 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.

- 21. Although the drilling practices are intended to minimize the risk of an IR occurring, there is a possibility that an IR could reach the ground surface. Given the highly developed nature of this area and the close proximity to residential water supply wells, the Report should reference the February 6, 2018, Inadvertent Return PPC Plan.**

The April 2018 version of the IR Plan is the primary document addressing the measure to prevent or minimize the occurrence of IR's, and reporting and responding action requirements in the event of an IR. The IR Plan applies to all HDDs project wide and will be followed at this HDD.

- 22. The terms pressure, fluid pressure, drilling pressure, and mud pressure may refer to either the injection pressure of the drilling fluid (mud) inside the drill string or to the pressure outside the drill string but within the borehole. Most HDD drillers measure the injection pressure of the mud/drilling fluid within the drill string and do not measure the pressure of the bore outside the drill string but within the borehole. The Report should clarify which pressure values are being monitored as part of this proposed HDD bore.**

SPLP has mandated that Annular Pressure Monitors will be used on every HDD project wide during the pilot hole phase. The April 2018 version of the IR plan includes this requirement as well. The drilling operator also routinely records pump/stem pressure as part of their standard record keeping.

- 23. When applying the cavity expansion model, maximum allowable mud pressures in soil will likely be exceeded near the exit point (and possibly at other locations) due to the length of the bore through which cuttings must be transported. The Report should consider options for lowering mud pressures to help minimize the risk of IRs. For example, perhaps the pilot holes could be initiated from both ends.**

Standard drilling best management practices account for the concern of reduced pressures while proceeding down to bedrock as well as exiting bedrock and proceeding to the exit point. The normal procedure is to use minimal pressure to operate the mud motor as needed and to keep the

cutting bits from clogging. At the discretion of the driller, and based upon the nature of the overburden material, the driller may elect to not engage the mud motor and use rotational drilling while entering or exiting the HDD profile, again at minimal pressure to prevent clogging of the tools.

24. The Report indicates the 16-inch HDD will be deeper than originally planned and it is shown that way on the revised profile. However, the summary text of Sunoco's discussion indicates the maximum depth of cover has not changed. The summary text of Sunoco's discussion of the original design provides the average depth of cover for both the 20-inch HDD and the 16-inch HDD. However, the revised design does not provide the average depth of cover for either HDD bore. These discrepancies should be clarified.

Page 2 of the Reevaluation summarizes the original permitted HDD design profile data as follows:

HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 20-INCH

- Horizontal length: 3,800 feet (ft)
- Entry angle: 10 - 12 degrees
- Maximum depth of cover: 80 ft
- Average depth of cover: 45 ft
- Pipe design radius: 2,000 ft

HORIZONTAL DIRECTIONAL DRILL DESIGN SUMMARY: 16-INCH

- Horizontal length: 3,807 ft
- Entry angle: 10 - 12 degrees
- Maximum depth of cover: 85 ft
- Average depth of cover: 45 ft
- Pipe design radius: 1,600 ft

Page 6 of the Reevaluation summarizes the revised HDD design data as follows:

Revised Horizontal Directional Drill Design Summary: 20-inch

- Horizontal length: 3,842 foot (ft)
- Entry/Exit angle: 15 degrees
- Maximum Depth of cover: 111 ft
- Pipe design radius: 2,000 – 2,400 ft

Revised Horizontal Directional Drill Design Summary: 16-Inch

- Horizontal length: 3,890 ft
- Entry/Exit angle: 10 - 12 degrees
- Maximum Depth of cover: 85 ft
- Pipe design radius: 2,000 – 2,200 ft

The 20-inch profile has an averaged horizontal depth of 94 ft bgs, and the 16-inch profile has an averaged horizontal depth of 79 ft bgs.

25. The Report should provide details regarding the proximity of the original 20-inch pilot bore to the revised HDDs and how the original 20-inch pilot bore will be decommissioned/abandoned. The Report should also detail what steps will be taken to minimize the potential for IRs associated with the original pilot bore.

The original pilot hole underway in 2017 made 2,686 ft of progress before being stopped as a result of the order issued by the Environmental Hearing Board. After several weeks of work stoppage, the drilling contractor elected to remove their equipment and move to another project. Upon the removal of the drilling motor and stem, an open ended stem was reinserted and the pilot hole was grouted with a sand/cement mix. There is no open pilot hole remaining to create an IR potential.

26. The revised profile shows the 16-inch bore has been deepened slightly, apparently along the soil/bedrock interface. This is typically not a desired location for an HDD bore, as drilling along the soil/rock interface will likely result in difficult drilling conditions (in and out of bedrock) and an increase in the risk of an IR, especially in the areas where the fracture zones intersect the HDDs.

SPLP's drilling contractor previously adjusted the initial pilot hole profile for the 20-inch pipeline to what is shown now within the Reevaluation Report as the profile for the 16-inch pipeline. There were no reported steering or formation transition difficulties during the drilling of this pilot hole to 2,686 ft of length. Repeating this profile run with a new pilot hole is not expected to encounter different conditions.

27. Sunoco's Report states the HDD "could affect individual well use during active drilling for wells located within 150 linear ft." Sunoco needs to explain why it focuses only on wells located within 150', and must address whether other water supplies outside of 150' could be affected. Please provide justification sealed by a Pennsylvania-Licensed Professional Geologist that wells outside of the 150' profile will not be impacted.

As a result of the Consent Order Agreement executed February 8, 2018, SPLP has authored and DEP has approved a new Operations Plan that provides that SPLP will offer all landowners with only a private water supply source located within 450 ft of the HDD alignment, an alternative temporary water supply. Accordingly, the previous statement concerning the potential effects within 150 ft is now moot. In accordance with the Operations Plan, SPLP has made this offer via letter to the 33 landowners with identified private water supply wells within 450 ft of the HDD profile. SPLP's offer to the landowners for the temporary supply of water during the HDD operations will remain open until HDD operations are complete. Moreover, in accordance with its Chapter 105 permit, during HDD activities SPLP will address to the satisfaction of the

landowner any landowner complaints concerning water supply that are shown to be associated with HDD activities.

28. With regard to water supplies that might be impacted by these HDD activities, Sunoco must address those impacts in an acceptable manner. Sunoco has the option to enter into written agreements with all private water supply owners whose water supplies may be impacted by this Drill, regardless of their location from the Drill, as part of this reevaluation, and in advance of commencing the HDD. Under the agreements, Sunoco must provide short and long-term replacement potable water supplies adequate in quantity and quality for the purposes served, to the satisfaction of all potentially affected water supply owners. 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. Sunoco needs to provide proof of these agreements to DEP with a response to this letter.

Please see the response to Item 29 below.

29. In the alternative, if Sunoco chooses not to pursue these agreements with the private water supply owners, it must provide a discussion of actions to be taken by Sunoco to prevent water supply impacts from occurring. Sunoco needs to demonstrate how, in the absence of the agreements described above, Sunoco will avoid impacts to all water supplies. Sunoco's approach should include the utilization of technical and nontechnical measures to avoid such impacts, including, but not limited to, the conversion of the HDD to a trench installation, use of other trenchless construction methods, the use of NSF-60 approved gels or other approved additives that could prevent such impacts from the Drill, or some combination of all of the above. To the extent Sunoco proposes to use any ANSI/NSF 60 certified HDD additives, consistent with Special Condition NN contained in DEP Permit No. E15-862, Sunoco will only be able to use the additives in the manner indicated in the certification of the proposed additive. The manner in which the proposed additive is to be used, as indicated in its ANSI/NSF 60 certification, should be submitted with your response. In addition, Sunoco should indicate whether it will be following all conditions included as part of the additive's certification or, if not, provide an explanation as to why it is not and why that deviation is acceptable.

The new Operations Plan provides that SPLP will offer all landowners with only a private water supply source located within 450 ft of the HDD alignment an alternative temporary water supply.

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 eleven (11) parcels with a water supply well as the sole source within 450 feet of this HDD profile, of which two are located on properties that have no structure of any

type and are therefore vacant or unoccupied. All eleven landowners have received written notification that they are entitled to temporary water supplies at SPLP's expense.

- (ii) So far, none of these landowners have agreed to accept temporary water supply during the HDD process; however, SPLP has not re-approached the outstanding well owners recently, and is in the process of re-contacting these owners.
- (iii) Ninety-four (94) of these parcels are on public water.

Considering the immediate proximity of public water supplies to the properties reporting private water wells, SPLP is re-contacting these owners to determine if the residence relies on the water wells as the "sole source" of water, or if the water well is for secondary non-consumptive use.

Despite these facts, SPLP's goal is to minimize any potential impacts to water supply wells. To that end, with the Departments approval, SPLP will utilize a blend of standard bentonite and Aquabloc as the drilling fluid blend for use during pilot hole progress.

30. The Report discusses potential changes in water quality, but also needs to discuss potential changes to water quantity, as the potential exists for the HDD bore to adversely impact the yield of private water supply wells. Please describe how this will be done consistent with applicable provisions of the latest versions (February 6, 2018) of the IR PPC Plan, and the Operations Plan (January 2018).

It is unclear what the Department has requested in asking for a description as to "how this will be done" with respect to potential adverse effects to water supply well yields. SPLP assumes that the Department has requested a description of what actions SPLP intends to take to address any potential adverse effects on water quantity. To that end, SPLP notes that the drilling best management practices discussed in the Reevaluation report serve to reduce the risk of any potential adverse impacts to water quantity. Additionally, the use of Aquabloc in the pilot phase of the HDD should reduce the risk that HDD activities will create additional preferential pathways for groundwater that could cause groundwater to migrate away from the bore hole towards the recharge zone for each of these water supplies. In addition, both the Inadvertent Return Assessment, Preparedness, Prevention and Contingency Plan ("IR Plan") and the Operations Plan require SPLP to offer alternative water supplies to landowners with water supply wells within 450 ft of the drill profile. The best means to protect a water well during the HDD is non-use. Obviously, to the extent a landowner accepts this offer, their water supply should not be adversely affected during HDD activities. Moreover, even if the landowner does not accept an offer of alternative water supply, the IR Plan requires SPLP to address to the satisfaction of the landowner any complaints associated with water quantity during HDD activities. Finally, if a landowner identifies any impact to a private water supply attributable to pipeline construction after post-construction sampling, including impacts to yield, the IR Plan obligates SPLP to restore or replace the impacted water supply to the satisfaction of the private water supply owner.

31. The recommendations of Section 4.2 of the GES Report should be fully integrated into the redesign plan and resubmitted Report. Presently, only a portion of these appear to have been included.

The seven recommendations from the GES Report are below followed by SPLP's consideration of each recommendation.

- *The drill crew should be oriented to the location(s) of zones of higher risk for fluid loss and IRs, including the area related to previous IRs, and potential zones of fracture concentration identified by the fracture trace analysis along the drill path. Other zones of elevated risk include the borehole entry/exit points where drilling fluids may migrate through shallow soils and saprolite.*

This recommendation is already included as a best management practice for these HDDs.

- *Given the potential increased risk for fluid losses and IRs, a fluid loss mitigation plan (i.e., grouting or sealing) should be readied for implementation during construction.*

SPLP's IR plan already includes these measures, and they are listed best management practice within the Reevaluation report.

- *The results of residential well survey performed, where notification letters were mailed to all property owners within the 450' buffer of the HDD, by ETP Land agents, indicates 13 properties where no information was available to confirm the presence, absence or connection to a public water supply. A follow up door-to-door survey should be conducted to confirm the status of these locations and the nature of their respective water supplies.*

This recommendation is not a geology or hydrogeology task related to the success or failure of the proposed HDDs. SPLP, prior to any recommendation from the professional geologist, had directed the land agents to engage in this task. This information is updated as agents are able to confirm the water source on each tract.

- *A plan to connect at-risk residents to a temporary alternative water supply should be prepared in case this is deemed necessary from the verification of complaints of impacted water observed during HDD operations.*

This recommendation is not geology or hydrogeology task related to the success or failure of the proposed HDDs. SPLP's Water Supply Assessment, Preparedness, Prevention and Contingency Plan, and Operations Plan satisfy this concern.

- *Properties that lie beyond the 450-foot buffer and are in alignment with the mapped geologic structural features (fracture traces/zone, faults), intersecting water bodies, or other identified high risk indicator for the incidence of IRs should be identified. The locations of these properties should be surveyed for information on water supply type.*

This recommendation is not a geology or hydrogeology task as related to the success or failure of the proposed HDDs. SPLP, prior to any recommendation from the professional geologist, had directed the land agents to engage in this task. This information is updated as agents are able to confirm the water source on each tract.

- *Existing surface drainage control and storm runoff management infrastructure in the areas of the HDD entry/exit should be evaluated. Prior operation experienced significant surface water flooding at the drill entry point following large rain events and snow melts.*

This recommendation is not a geology or hydrogeology task related to the success or failure of the proposed HDDs. Furthermore, SPLP previously evaluated drainage control and stormwater runoff at this location in conjunction with its application for a Chapter 102 permit, and through issuance of this permit the Department has concurred with the evaluation and controls recommended by SPLP for this location. SPLP has contract erosion and sedimentation professionals to install and maintain the necessary controls, and has a staff of Environmental Inspectors to oversee the implementation of these controls.

- *An effective traffic control plan should be maintained to allow safe inspection of the LOD during drilling, as the drill path lies directly along SR 352 and provides no off-shoulder walkways. This will also allow efficient response to any potential IR event and will allow safe ingress/egress to the drill pad location.*

This recommendation is not a geology or hydrogeology task related to the success or failure of the proposed HDDs. SPLP has directly employed and contract safety professionals who manage these concerns and work with public officials on necessary controls.

32. The IRs Discussion in the Summary Report discusses bedrock near the southeast entry point as being poor throughout the entire depth of core to 70 ft. No rock coring was conducted on B6-7E. Please revise the narrative to explain the conclusion regarding the rock strength at the southwest end of the profile.

As reported by Terracon, geotechnical bore B6-7E entered degraded and weathered gneiss at 40 ft of depth, continuing to 70 ft of depth upon which the bore was terminated. The materials above 40 ft of depth is reported by Terracon as Sandy Lean Clay. Gneiss is a type of rock; therefore the qualities of this gneiss were discussed as rock strength.

33. The 150- to 175-foot “impact area” relied upon in the geologic report and the Adjacent Features Analysis does not appear to be supported by site-specific Geologic or Hydrologic data or other competent data. Provide the basis for this determination.

As a result of the Consent Order Agreement executed February 8, 2018, SPLP has authored and DEP has approved a new Operations Plan that provides that SPLP will offer all landowners with

only a private water supply source located within 450 ft of the HDD alignment, an alternative temporary water supply. Accordingly, the previous statement concerning the potential effects within 150-175 ft is now moot. In accordance with the Operations Plan, SPLP has made this offer via letter to the 11 landowners with identified private water supply wells within 450 ft of the HDD profile. SPLP's offer to the landowners for the temporary supply of water during the HDD operations will remain open until HDD operations are complete. Moreover, in accordance with its Chapter 105 permit, during HDD activities SPLP will address to the satisfaction of the landowner any landowner complaints concerning water supply that are shown to be associated with HDD activities.

34. Please revise the appropriate sections of the reevaluation document to consider the presence of the abandoned July 2017, 2600+ ft long pilot bore. Please discuss the potential for this drill hole to facilitate and or transmit an IR and the methods to prevent or minimize this potential.

As discussed in the response to Item 25 above, the original pilot hole underway in 2017 made 2,686 ft of progress before being stopped as a result of the order issued by the Environmental Hearing Board. After several weeks of work stoppage, the drilling contractor elected to remove their equipment and move to another project. Upon the removal of the drilling motor and stem, an open ended stem was reinserted and the pilot hole was grouted with a sand/cement mix. There is no open pilot hole remaining to create an IR potential.

35. The following best management practices (BMPs) should be incorporated into the Report. If Sunoco feels it is inappropriate to include any of these BMPs, Sunoco should provide an explanation as to why it is inappropriate to do so.

- a. Sunoco will provide the drilling crew and company inspectors the location(s) data on potential zones of higher risk for fluid loss and IRs, including the area related to previous IRs, and potential zones of fracture concentration identified by the fracture trace analysis along the drill path so that monitoring can be enhanced when drilling through these locations.**
- b. Sunoco 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.**
- c. Sunoco will mandate the use of annular pressure monitoring during the drilling of the pilot hole, which assists in immediate identification of pressure changes indicative of loss of return flows or over pressurization of the annulus, managing development pressures that can induce an IR.**

- d. Sunoco 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.**
- e. Sunoco will mandate short-tripping of the drilling tools to ensure an open annulus is maintained to manage the potential inducement of IRs.**
- f. Sunoco will require monitoring of the drilling fluid viscosity, such that fissures and fractures in the subsurface are sealed during the drilling process.**
- g. If necessary, the pilot hole and reaming phases at the point of entry for the HDD may utilize casing, hammered into the substrate down to structurally better rock, to prevent vertical or lateral movement of drilling fluids at shallow depths.**
- h. During the reaming phase, the use of LCMs can be implemented if indications of a potential IR are noted or an IR is observed.**
- i. If LCMs prove ineffective to mitigate loss of returns or IRs, then grouting of the pilot hole may be implemented.**

Items 35 “a” through “i” listed above are copied from SPLP’s Reevaluation Report for HDD S3-0520 and therefore are incorporated into the Report.

36. DEP requests that Sunoco provide the following information related to the project’s potential effect on well production zones and water supplies:

- a. 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 waters wells in this formation is from the well bottom to highest point of water inflow from the water bearing overburden above competent bedrock, and seams, joints, and fractures in the upper bedrock of the formation*”. Water wells in bedrock can only pump water from inside the surface casing within overburden if it is screened and open rock interval within the bore annulus, and water volume from the top water elevation down to the pump intake.

Based upon water levels recorded in the geotech cores, and water levels within landowner private water wells, depth to water varies from 15 to 29 ft below ground surface (bgs). Information provided by landowners indicates well depths of 70 to 270 ft bgs.

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.

Based upon known information, the majority of the HDD profile will be within the groundwater zone, and within a perpendicular distance of the HDDs such that use of the wells could result in the draw of diluted drilling fluids into the well.

Non-use of the water wells during drilling activities is the best protective measure. For this reason, SPLP has sent each landowner with a private water well within 450 ft a letter offering temporary water replacement at SPLP's expense for the duration of the HDDs.

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

The water supply illustration provided as Attachment 1 to this response is an accurate presentation of the known water supply wells. The well locations were recorded by GPS.

c. 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.

By contrast, during a routine "short-tripping" of the drilling stem and tooling, the length of tripping is only as long as needed, typically 2-5 joints of drilling stem (60-150 ft long), to ensure that the annulus surrounding the drill stem is not blocked and full circulation of return 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.

Similarly, there is no plunger effect during the reaming phase of an HDD since an open pathway exists between the entry and exit.

There is little risk to private water supplies from a "plunger effect" event. The usual result of such an event is a surge of returning fluids to the entry pit.

Mr. John Hohenstein, P.E.

May 12, 2018

Page 23

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

Attachment 4 to this response presents a summary of all water quality sample results from water supply wells within 450 ft of the HDD profile that SPLP has obtained to date.

e. 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 to perform any water quantity tests at any well location.

SPLP submits that we have been, and are, in compliance with the 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. SPLP therefore requests that the Department approve the Reevaluation Report for Strasburg Road/Bow Tree Drive HDD (S3-0520) as soon as possible.

Sincerely,

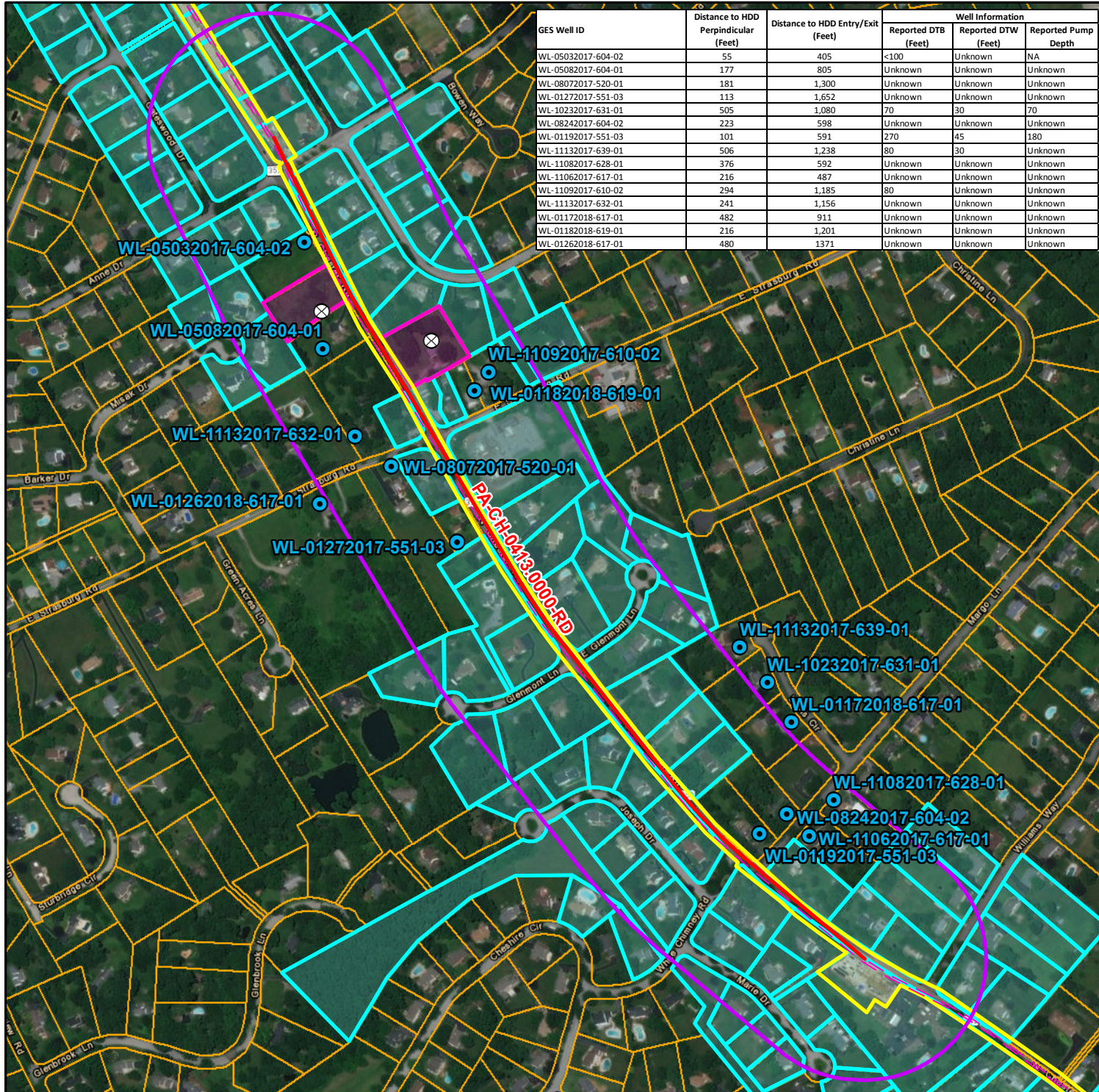


Larry J. Gremminger, CWB
Geotechnical Evaluation Leader
Mariner II Pipeline Project

Attachments:

- 1-Water Supply Illustration
- 2-HDD Plan and Profiles, with fracture trace lines, and well/water data
- 3-Aquabloc Information
- 4-Water Well Testing Result

ATTACHMENT 1
WATER SUPPLY ILLUSTRATION



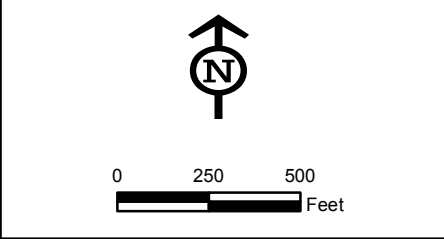
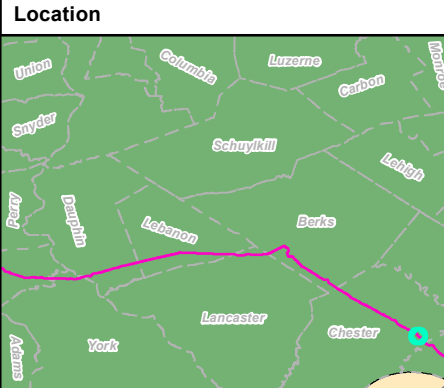
GES Well ID	Distance to HDD Perpendicular (Feet)	Distance to HDD Entry/Exit (Feet)	Well Information		
			Reported DTB (Feet)	Reported DTW (Feet)	Reported Pump Depth
WL-05032017-604-02	55	405	<100	Unknown	NA
WL-05082017-604-01	177	805	Unknown	Unknown	Unknown
WL-08072017-520-01	181	1,300	Unknown	Unknown	Unknown
WL-01272017-551-03	113	1,652	Unknown	Unknown	Unknown
WL-10232017-631-01	505	1,080	70	30	70
WL-08242017-604-02	223	598	Unknown	Unknown	Unknown
WL-01192017-551-03	101	591	270	45	180
WL-11132017-639-01	506	1,238	80	30	Unknown
WL-11082017-628-01	376	592	Unknown	Unknown	Unknown
WL-11062017-617-01	216	487	Unknown	Unknown	Unknown
WL-11092017-610-02	294	1,185	80	Unknown	Unknown
WL-11132017-632-01	241	1,156	Unknown	Unknown	Unknown
WL-01172018-617-01	482	911	Unknown	Unknown	Unknown
WL-01182018-619-01	216	1,201	Unknown	Unknown	Unknown
WL-01262018-617-01	480	1,371	Unknown	Unknown	Unknown

Legend

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

****Testing locations current as of 04/23/2018**

- GES Testing Location
- Known Well, Testing Refused (Location Approximate)



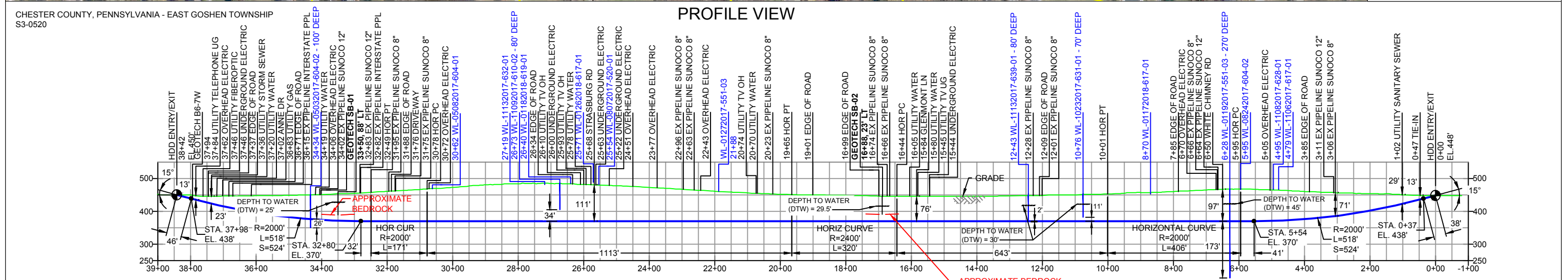
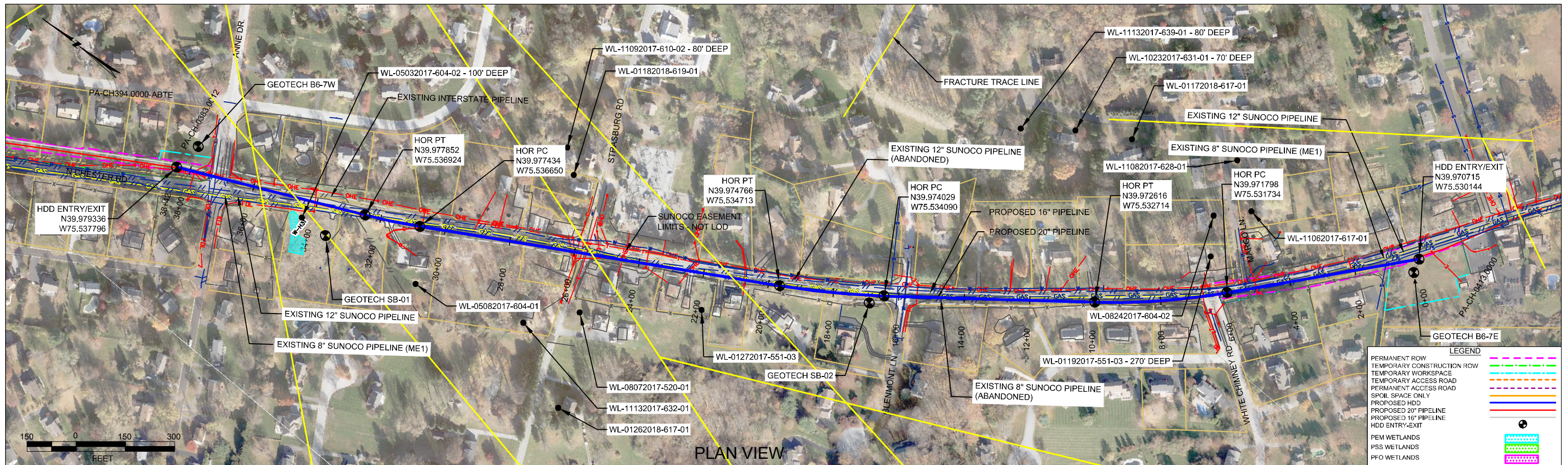
Well Location Map
 HDD# PA-CH-0413.0000-RD
 Chester County, PA.

Prepared By: **TETRA TECH** Date: 4/23/2018

Base Map: ESRI World Imagery, 09/24/2015
 Coordinate System: NAD 83 Stateplane, PA South, Feet

G:\GIS\workspace\PA-CH-0413\workspace\WellLocation_PA_CH-0413_0000.mxd

ATTACHMENT 2
HDD PLAN AND PROFILES, WITH FRACTURE TRACE LINES, AND WELL/WATER
DATA



GEOTECH SB-01	GEOTECH SB-02
-NG EL. 453'	-NG EL. 446'
-GRAVEL (0' - 0.5')	-TOPSOIL (0' - 0.1')
-ML (0.5' - 7.0')	-ML (0.1' - 9.0')
	-SM (9.0' - 12.0')
-GROUNDWATER (25.0')	-GROUNDWATER (29.5')
-SM (7.0' - 53.0')	-SILT (USCS:MH) (12.0' - 36.5')
-WEATHERED GNEISS (53.0' - 64.0')	-SM (36.5' - 56.0')
-AUGER REFUSAL (64.0')	-AUGER REFUSAL (56.0')
-WHITE/GRAY GNEISS (64.0' - 70.0')	
COMPLETION DEPTH EL. 383'	COMPLETION DEPTH EL. 390'

FOR GEOLOGIC ANALYSIS ONLY

DESIGN AND CONSTRUCTION:

- CONTRACTOR SHALL FIELD VERIFY DEPTH OF ALL EXISTING UTILITIES SHOWN OR NOT SHOWN ON THIS DRAWING.
- 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.
- DESIGNED IN ACCORDANCE WITH CFR 49 195 & ASME B31.4
- CROSSING PIPE SPECIFICATION:
 HDD HORZ. LENGTH (L)=3842'
 HDD PIPE LENGTH (S)=3858'
 20" X 0.456" W.T., X-65, API 5L, PSL2, ERW, BFW
 COATING: 14-16 MILS FBE WITH 30-35 MIL ARO (POWERCRETE OR ENGINEER APPROVED EQUAL)

IR at 14+00, 92 ft N

- INTERNAL DESIGN PRESSURE 1480 PSIG (SEAM FACTOR 1.0, DESIGN FACTOR 0.50).
- INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILL (HDD)
- PIPELINE WARNING MARKERS SHALL BE INSTALLED ON BOTH SIDES OF ALL ROAD, RAILWAY, AND STREAM CROSSINGS.
- CARRIER PIPE NOT ENCASED.
- PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.
- CONDUCT 4-HOUR PRE-INSTALLATION HYDROTEST OF HDD PIPE STRING TO MINIMUM 1850 PSIG.
- SEE SUNOCO PENNSYLVANIA PIPELINE PROJECT ESRI WEBMAP FOR ACCESS ROAD ALIGNMENT.

GEOTECH B6-7W
-NG EL. 439'
-LEAN CLAY W/ SILT CL (0.0' - 15.0')
-SCHIST/GNEISS (15.0' - 105.0')
-BORING TERMINATED EL. 334'

NOTE: REFER TO TEST BORING LOG B6-7W TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

GEOTECH B6-7E
-NG EL. 448'
-SANDY LEAN CLAY CL (0.0' - 40.0')
-GNEISS (40.0' - 70.3')
-BORING TERMINATED EL. 377.7'

NOTE: REFER TO TEST BORING LOG B6-7E TERRACON PROJECT #J217P078 FOR COMPLETE SOIL MATERIAL DESCRIPTION

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	EROSION & SEDIMENT PLAN	REVISIONS
ES-6.66	TO ES-6.68	EP6 ADDED FRACTURE TRACE LINE AND WELL DATA PER CLIENT REQUEST
SHEET 43	TO SHEET 45	EP5 UPDATED EXISTING PIPELINES LABELS
		EP4 UPDATED GEOTECH INFO PROVIDED BY DPS
		EP3 UPDATED TO 20" PIPE SPEC AND CENTERLINE LOCATION PER PM, ADDED DPS GEOTECH
		EP2 REVISED PER PADEP COMMENTS RECEIVED 09-06-16
		EP1 REVISED PER PADEP COMMENTS

BY	DATE	CHK	DATE	APP	DATE
MRS	04/30/18	RMB	04/30/18	AMC	04/30/18
MRS	01/05/18	RMB	01/05/18	AMC	01/05/18
MRS	11/15/17	RMB	11/15/17	AMC	11/15/17
MRS	11/09/17	RMB	11/09/17	AMC	11/09/17
MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
JTW	05/10/16	RMB	05/10/16	AAW	05/10/16

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
SR 352 / STRASBURG ROAD
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=300' DWG. NO: PA-CH-0413.0000-RD

ATTACHMENT 3
AQUABLOC INFORMATION



730 North Anderson Road
Rock Hill, South Carolina 29730
P: 803.327.3833
F: 866.402.0133
www.AquaSolCorp.com

Water Well Drilling Products

AquaSol's Water Well Drilling Products provide bio-based innovative solutions for fluid loss control, and shale inhibition when drilling in reactive shales and clays. All products are NSF approved for use in potable water well drilling and water treatment. Dispersible forms of these products are also offered.

- Residential
- Commercial/Industrial
- Municipal



Our products are field proven to provide significant benefits to groundwater drilling operations over competitive products:

- Increased productivity
- Improved drilling performance
- Lower cost

Available Products:

- Aquabloc LC and Aquadril LC- provide fluid loss control and more cost effective performance than CMC's or PACs. Both products are NSF certified.
- Aquabloc D and Aquadril D—provide dispersibility in addition to fluid loss for limited mixing applications and when more rapid hydration is desired. Both products are NSF certified.
- ClayCutter - a shale inhibitor that prevents bit balling and delivers faster drilling performance in reactive shales and clays.

Characteristics

- | | |
|-------------------|----------------------|
| • Appearance | Off White Powder |
| • Ionic Character | Cationic and anionic |
| • Moisture | <12% |
| • pH | 8-10 |
| • Density | 1.2 |

Applications

- River crossings
- Horizontal drilling
- Water well drilling
- Mining
- Construction

Environmental

- Fully biodegradable

Packaging and Product Form

- 50 lb paper sacks
- 25 lb pails



The Public Health and Safety Organization

NSF Product and Service Listings

These NSF Official Listings are current as of **Friday, April 20, 2018** at 12:15 a.m. Eastern Time. Please [contact NSF International](#) to confirm the status of any Listing, report errors, or make suggestions.

Alert: NSF is concerned about fraudulent downloading and manipulation of website text. Always confirm this information by clicking on the below link for the most accurate information: <http://info.nsf.org/Certified/PwsChemicals/Listings.asp?TradeName=Aquabloc&>

NSF/ANSI 60 Drinking Water Treatment Chemicals - Health Effects

AquaSol Corporation

730 North Anderson Road

Rock Hill, SC 29730

United States

803-327-3833

[Visit this company's website \(http://www.aquasolcorp.com\)](http://www.aquasolcorp.com)

The recommended dosage by the manufacturer is 1.5-2.5 lbs of Aquabloc LC or D per 100 gallons with 25 lbs/100 gallon of standard bentonite.

Facility : Rock Hill, SC

Miscellaneous Water Supply Products[1]

Trade Designation

Aquabloc D

Product Function

Well Drilling Aid

Drilling Fluid

Max Use

NA

Aquabloc LC

Well Drilling Aid

Drilling Fluid

NA

[1] These products are designed to be flushed out prior to using the system for drinking water. Before being placed into service, the well is to be properly flushed according to the manufacturer's use instructions. Certification of these products is based on well drilling model with the following assumptions:

- The amount of well drilling fluid used to 3780 L (1000 U.S. gallons) to which the drilling fluid has been added at the manufacturer's recommended level.
- The aquifer contains 3.1 million liters of water (815,000 gallons) based on a 0.5 acre aquifer of 6.1 meter depth (20 ft.) and 25% porosity.
- The bore hole is 61 meters in total depth (200 ft.), the screen is 6.1 meters in length (20 ft.), and the bore hole is 25.4 cm in diameter (10 in.).
- The amount of well drilling fluid removed from the well during construction is equal to the combined volumes of the casing and the screen, plus an additional amount removed through the well disinfection and development

ATTACHMENT 4
WATER WELL TESTING RESULT

Landowner:														
Parcel Number:		53-04-0126.0000		53-04-0126.0200		53-04-0126.0200		53-04-0126.0200		53-04-0146.0000				
Location Code:		WL-05032017-604-02		WL-05082017-604-01		WL-05082017-604-01		WL-05082017-604-01		WL-01272017-551-03				
Sample Phase:		Pre-Construction		During Construction		Pre-Construction		During Construction		Pre-Construction		During Construction		
Sample Treatment:		No Treatment		No Treatment		Post-Treatment Softening, In-Line Sediment Filter		Post-Treatment Softening, In-Line Sediment Filter		Pre-Treatment		Pre-Treatment		
Treatment Type (Post-Treatment Samples Only):		-		-		-		-		-		-		
Lab Sample ID		L906847-01		L915688-01		L907811-01		L916478-01		L886642-01		L916474-01		
Client Sample ID		05032017-604-02		06132017-606-02		05082017-604-01		06152017-475-01		01272017-551-03		06152017-475-02		
Date Collected		05/03/2017		06/13/2017		05/08/2017		06/15/2017		01/27/2017		06/15/2017		
Method	Analyte	Units	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier
130.1	HARDNESS	mg/l	89.7		91.3		<30.0		36.3	B	182		187	
2130 B-2011	TURBIDITY	NTU	49.2		16.0		0.142		0.164	B	1.22		0.227	B
2320 B-2011	ALKALINITY	mg/l	39.1		38.7		60.0		62.3		46.2		59.0	
2540 C-2011	DISSOLVED SOLIDS	mg/l	159		134		313		301		376		461	
2540 D-2011	SUSPENDED SOLIDS	mg/l	30.3	Q	11.0		<2.50		<2.50		5.50		<2.50	
6010B	BARIUM	mg/l	0.0925		0.0969		<0.00500		<0.00500		0.174		0.199	
6010B	CALCIUM	mg/l	16.0		16.8		<1.00		5.02		37.3		50.3	
6010B	IRON	mg/l	4.77		4.88		<0.100		<0.100		0.415		<0.100	
6010B	MAGNESIUM	mg/l	10.5		10.9		<1.00		5.99		21.2		23.0	
6010B	MANGANESE	mg/l	0.0708		0.0731		<0.0100		<0.0100		<0.0100		<0.0100	
6010B	POTASSIUM	mg/l	4.15		4.45		<1.00		1.19		3.01		3.10	
6010B	SODIUM	mg/l	5.40		5.84		104	V	83.1		23.2		27.5	
8260B	BENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	TOLUENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	ETHYLBENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100	
8260B	XYLENES, TOTAL	mg/l	<0.00300		<0.00300		<0.00300		<0.00300		<0.00300		<0.00300	
9040C	pH	su	8.38	T8	7.95	T8	6.59	T8	6.39	T8	6.42	T8	6.31	T8
9050A	SPECIFIC CONDUCTANCE	umhos/cm	246		251		518		501		536		615	
9056A	BROMIDE	mg/l	<1.00		<1.00		<1.00		<1.00		<1.00		<1.00	
9056A	CHLORIDE	mg/l	49.5		52.1		107		99.5		108		119	
9056A	SULFATE	mg/l	<5.00		<5.00		<5.00		5.74		32.3		30.5	
9222D	COLIFORM,FECAL	col/100ml	NA		NA		NA		NA		NA		NA	
9223 B-1997	E.COLI	MPN/100ml	NA		NA		NA		NA		NA		NA	
9223 B-1997	COLIFORM,TOTAL	MPN/100ml	NA		NA		NA		NA		NA		NA	
RSK175	METHANE	mg/l	<0.200		4.18		<0.0100		<0.0100		<0.0100		<0.0100	
RSK175	ETHANE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	ETHENE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130	
RSK175	PROPANE	mg/l	<0.0190		<0.0190		<0.0190		<0.0190		<0.0190		<0.0190	

Qualifiers:

B: The same analyte is found in the associated blank.

T8: Sample(s) received past/too close to holding time expiration.

U: Below Detectable Limits: Indicates that the analyte was not detected.

Q: Sample was prepared and/or analyzed past recommended holding time. Concentrations should be considered minimum values.

NA: Not Analyzed

Positive bacteria detections are shaded gray

Landowner:																	
Parcel Number:				53-06C-0009.0000				53-06C-0010.0000				5306C00150000		5306C00160000		53-4-127.1	
Location Code:				WL-08242017-604-02				WL-01192017-551-03				WL-11062017-617-01		WL-11082017-628-01		WL-11132017-632-01	
Sample Phase:				Pre-Construction Restart				Pre-Construction		During Construction		Pre-Construction Restart		Pre-Construction Restart		Pre-Construction Restart	
Sample Treatment:				Post-Treatment				No Treatment		No Treatment		Post-Treatment Softening, In-line Sediment Filter		Pre-Treatment		No Treatment	
Treatment Type (Post-Treatment Samples Only):				In-line Sediment Filter				-		-		Softening, In-line Sediment Filter		-		-	
Lab Sample ID				L931898-01				L885033-01		L916476-01		L948720-01		L949413-01		L950551-01	
Client Sample ID				08242017-604-02				01192017-551-03		06152017-475-03		11062017-617-01		11082017-628-01		11132017-632-01	
Date Collected				08/24/2017				01/19/2017		06/15/2017		11/06/2017		11/08/2017		11/13/2017	
Method	Analyte	Units	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier			
130.1	HARDNESS	mg/l	250		259		188		<30.0		255		241				
2130 B-2011	TURBIDITY	NTU	0.302	B	0.837		1.04		<0.300		0.839		<0.300				
2320 B-2011	ALKALINITY	mg/l	176		103		103		161		235		40.4				
2540 C-2011	DISSOLVED SOLIDS	mg/l	381		371		365		351		424		590				
2540 D-2011	SUSPENDED SOLIDS	mg/l	<2.50		<2.50		<2.50		<2.50		5.44		<2.50				
6010B	BARIUM	mg/l	0.0707		0.0650		0.0939		<0.00500		0.200		0.0305				
6010B	CALCIUM	mg/l	86.8		80.0		58.5		<1.00		84.0		63.5				
6010B	IRON	mg/l	<0.100		0.698		1.16		<0.100		<0.100		<0.100				
6010B	MAGNESIUM	mg/l	16.6		18.8		18.0		<1.00		18.1		26.5				
6010B	MANGANESE	mg/l	<0.0100		<0.0100		0.0245		<0.0100		<0.0100		<0.0100				
6010B	POTASSIUM	mg/l	1.96		2.62		3.57		<1.00		69.6		3.06				
6010B	SODIUM	mg/l	12.0		10.3		17.5		141		19.0		31.7				
8260B	BENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100				
8260B	TOLUENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100				
8260B	ETHYLBENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100				
8260B	XYLENES, TOTAL	mg/l	<0.00300		<0.00300		<0.00300		<0.00300		<0.00300		<0.00300				
9040C	pH	su	7.28	T8	7.41	T8	6.38	T8	6.81	T8	8.11	T8	6.01	T8			
9050A	SPECIFIC CONDUCTANCE	umhos/cm	618		660		555		663		795		765				
9056A	BROMIDE	mg/l	<1.00		<1.00		<1.00		<1.00		<1.00		<1.00				
9056A	CHLORIDE	mg/l	78.7		102		90.2		108		82.2		192				
9056A	SULFATE	mg/l	14.4		25.1		32.3		<5.00		13.9		12.4				
9222D	COLIFORM,FECAL	col/100ml	<1		NA		NA		<1		<1		<1				
9223 B-1997	E.COLI	MPN/100ml	<1		NA		NA		<1	U	<1		<1				
9223 B-1997	COLIFORM,TOTAL	MPN/100ml	2.00		NA		NA		3.10	U	<1		3.10				
RSK175	METHANE	mg/l	<0.0100		<0.0100		<0.0100		<0.0100		0.0815		<0.0100				
RSK175	ETHANE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130				
RSK175	ETHENE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130				
RSK175	PROPANE	mg/l	<0.0190		<0.0190		<0.0190		<0.0190		<0.0190		<0.0190				

Qualifiers:

- B: The same analyte is found in the associated blank.
 - T8: Sample(s) received past/too close to holding time expiration.
 - U: Below Detectable Limits: Indicates that the analyte was not det
 - Q: Sample was prepared and/or analyzed past recommended hol
 - NA: Not Analyzed
- Positive bacteria detections are shaded gray

Landowner:															
Parcel Number:				53-4-140		53-4-141		53-6-96		53-6C-5		53-6C-6		53-6C-7	
Location Code:				WL-11092017-610-02		WL-01182018-619-01		WL-01262018-617-01		WL-11132017-639-01		WL-10232017-631-01		WL-01172018-617-01	
Sample Phase:				Pre-Construction Restart		Pre-Construction Restart		Pre-Construction Restart		Pre-Construction Restart		Pre-Construction Restart		Pre-Construction Restart	
Sample Treatment:				No Treatment		No Treatment		Pre-Treatment		Post-Treatment		No Treatment		Pre-Treatment	
Treatment Type (Post-Treatment Samples Only):				-		-		-		In-line Sediment Filter		-		-	
Lab Sample ID				L949816-01		L964128-01		L966070-01		L950550-01		L945703-01		L963877-01	
Client Sample ID				11092017-610-02		01182018-619-01		01262018-617-01		11132017-639-01		10232017-631-01		01172018-617-01	
Date Collected				11/09/2017		01/18/2018		01/26/2018		11/13/2017		10/23/2017		01/17/2018	
Method	Analyte	Units	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	Result	Qualifier	
130.1	HARDNESS	mg/l	264		138		126		130		82.9		35.3		
2130 B-2011	TURBIDITY	NTU	7.60		0.638		4.78		1.94		1.68		0.400	B	
2320 B-2011	ALKALINITY	mg/l	32.2		32.4		22.0		42.5		<20.0		<20.0		
2540 C-2011	DISSOLVED SOLIDS	mg/l	728		308		340		311		153		89.0		
2540 D-2011	SUSPENDED SOLIDS	mg/l	6.42		<2.50		<2.50		<2.50		2.50		<2.50		
6010B	BARIUM	mg/l	0.339		0.0909		0.319		0.182		0.259		0.122		
6010B	CALCIUM	mg/l	50.2		26.0		26.1		32.2		14.0		6.46		
6010B	IRON	mg/l	0.919		<0.100		0.496		<0.100		0.220		<0.100		
6010B	MAGNESIUM	mg/l	31.6		15.4		12.1		13.4		11.3		3.74		
6010B	MANGANESE	mg/l	0.0533		<0.0100		0.0164		<0.0100		<0.0100		0.0228		
6010B	POTASSIUM	mg/l	3.45		2.73		3.35		2.04		2.86		1.82		
6010B	SODIUM	mg/l	43.7		32.4		58.9		15.4		6.18		6.01		
8260B	BENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		
8260B	TOLUENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		
8260B	ETHYLBENZENE	mg/l	<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		<0.00100		
8260B	XYLENES, TOTAL	mg/l	<0.00300		<0.00300		<0.00300		<0.00300		<0.00300		<0.00300		
9040C	pH	su	6.29	T8	6.25	T8	5.94	T8	5.83	T8	6.26	T8	5.96	T8	
9050A	SPECIFIC CONDUCTANCE	umhos/cm	864		465		573		387		234		113		
9056A	BROMIDE	mg/l	<1.00		<1.00		<1.00		<1.00		<1.00		<1.00		
9056A	CHLORIDE	mg/l	210		91.2		128		81.3		52.2		6.18		
9056A	SULFATE	mg/l	36.8		31.3		5.88		6.29		<5.00		<5.00		
9222D	COLIFORM,FECAL	col/100ml	<1		<1		<1		<1		<1		<1		
9223 B-1997	E.COLI	MPN/100ml	<1		<1		<1		<1		<1		<1		
9223 B-1997	COLIFORM,TOTAL	MPN/100ml	<1		<1		<1		<1		<1		1.00		
RSK175	METHANE	mg/l	<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		<0.0100		
RSK175	ETHANE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		
RSK175	ETHENE	mg/l	<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		<0.0130		
RSK175	PROPANE	mg/l	<0.0190		<0.0190		<0.0190		<0.0190		<0.0190		<0.0190		

Qualifiers:

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