SUNOCO PIPELINE
An ENERGY TRANSFER Company

535 Fritztown Road
Sinking Spring, PA 19608

March 30, 2018

Via Electronic and First-Class Mail
Dana Drake, P.E.
Environmental Program Manager
Waterway and Wetlands Program
Pennsylvania Department of Environmental Protection
Southwest Regional Office
400 Waterfront Drive
Pittsburgh, PA 15222-4745

Re: Hydrogeological Reevaluation Report
Goldfinch Lane Crossing (S2-0069)
Permit No. E11-352
Jackson Township, Cambria County

Dear Ms. Drake:

In compliance with the Corrected Stipulated Order dated August 10, 2017 a Reevaluation Report on the above-referenced horizontal directional drill ("HDD") was submitted to the Department on January 26, 2018. In a letter dated February 16, 2018, the Department requested further information. Please accept this letter as a response. Your requests are bolded below followed by the response.

1. **Sunoco Logistics, L.P. (SPLP) states that it sent all landowners with property located within 450 feet of the Right-of-Way a notification letter. Please provide the DEP with copies of all letters SPLP sent to individual landowners within 450 feet of the HDD. Please provide both a redacted copy of each letter for the DEP to post on its webpage and an unredacted copy of each letter for the DEP's internal review. In addition, please provide any property owners' responses to SPLP's notifications. Please provide both a redacted copy of each response (removing landowner information) and an unredacted copy of each response.**

   Attachment 1 to this letter provides SPLP's landowner communications as requested. No landowner has responded in writing to these letters. All subsequent communications have been by phone or in person.

2. **SPLP states that it identified four domestic supply wells within 1,000 feet of the HDD alignment based on the Pennsylvania Groundwater Information System (PaGWIS). The PaGWIS database also indicates that an additional domestic water well may lie approximately 333 feet north of the HDD, along Goldfinch Lane (PA Well ID 81647). SPLP did not identify PA Well ID 81647 in its report. Please investigate the status of**

this well and, if necessary, provide the required notifications to the landowner. Please provide this information to the DEP, including a redacted and unredacted copy (as mentioned in Paragraph 1). In addition, please provide the DEP with a redacted and unredacted copy of any property owner response to SPLP's notification (as mentioned in Paragraph 1).

Due to the inaccuracies of the PAGWIS data, SPLP conducts a 450-ft water supply ground survey, identifies water supplies for which the land owner desires pre-construction, during construction, and post-construction sampling and offers to provide an alternative water supply during HDD construction. PAGWIS coordinate data indicates Well ID 81647 as occurring on the same property as SPLP spring water source ID No. SP-03072017-520-01. Agents for SPLP conducted an inspection and sampled the spring water source on March 28, 2018, and during this inspection the agents did not observe a well on the property. Moreover, this landowner has been visited for sampling on two prior occasions. SPLP agents have inquired during each sampling event and the landowner has affirmed each occasion that the spring, which is not used for drinking water, is the only water supply source. Based upon our ground review, and landowner interviews SPLP can only conclude that the PAGWIS data is inaccurate.

The redacted copies of letters to all land owners with property within 450 feet of the alignment, including the owner of spring source ID No. SP-03072017-520-01, are provided in Attachment 1.

3. **Please provide DEP with information related to the Goldfinch Lane Crossing's potential effect on well production zones and water supplies, including an analysis of private water supply well production zones and how the proposed HDD activities interact with them. Please note that listing the depths of wells and pumps in insufficient.**

As shown on the updated Water Supply illustration provided as Attachment 2 there is one (1) private water supply, a spring, located within 450 ft of the HDD profile.

As stated in paragraph 1 on page 4 in Reevaluation report for this HDD, *"Groundwater in Cambria County is in aquifers comprised of both the unconsolidated sediments and bedrock, and can also occur as perched water. In general, groundwater flow proximal to HDD S2-0069 moves along gradients established by a water table surface that is a subdued reflection of the local topography"*.

Professionally licensed geologists in the state of PA contracted by SPLP believe the intended subject matter of the question listed in Item 3 is the source of water feeding the spring (sole identified water supply). The spring is located due north of the west to east trending HDD alignment, at the bottom of a slope rising west and southwest from the location of the spring. GES has sampled this spring twice; once in March 2017 and again on March 28, 2017. The observed conditions of the spring were similar between events. A black PVC intake pipe with

a screened end was observed lying on a bed of sediment and sediment was observed coating the intake pipe. The spring is a marginal water supply as there is no door on the spring house, sediment has built up on the spring floor and the intake sits on the sediment. During the sampling visit on March 28, 2018, the property owner stated he had not used the spring for drinking for two years and had been using bottled water.

Groundwater recharge to springs varies greatly. Large springs can be discharge points for regional groundwater flow systems. The recharge to this spring (and the small pond west of the spring) is coming from the hillsides to the west and southwest. It is common for groundwater discharge points in this type of hydrogeologic setting to occur at breaks in slope and at the contacts between bedrock bedding planes. Recharge to the spring is likely a combination of the discharge from a shallow groundwater flow system with some contribution from surface water runoff. As such, the recharge and chemical quality of the water is expected to be highly variable or "flashy".

The alignments for HDD S2-0069 and HDD S2-0069-16 run south and within 100 feet of the spring house. The planned profiles for the pipelines are approximately 45 feet and 65 feet (20-inch and 16-inch pipelines, respectively) below the elevation of the spring house. Given the local hydrogeologic setting SPLP cannot completely rule out the possibility that the quantity and quality of water emitting from the spring may be temporarily affected by the drill. Even though this water source is considered marginal and is not used for drinking water purposes, the land owner has been offered a temporary replacement supply during HDD construction, and thereafter, until it can be demonstrated that the quantity and quality of the water supply are similar to preconstruction conditions.

Furthermore, considering this water source's proximity to the HDD profile, 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 3 for the Department's reference.

4. **The evaluation of the underground coal mining and subsidence contained on pages 2 & 3 of the summary document extend beyond the evaluation contained in the GES Hydrologic Evaluation Report. Consequently, please provide DEP with an updated document identifying the SPLP Mine Geologists and Mine Engineers who provided the evaluation. Please affix their professional seals and signatures to the document.**

As stated in the Reevaluation report, the HDD profile has been studied by PA Registered Mine Engineers for subsidence affects and PA Registered Pipeline Engineers for risk to

pipeline integrity. The finding from both the mine and pipeline engineers has concluded "no effect". These studies and conclusions, signed and sealed by the engineers, are provided as Attachment 4 to this response.

5. **A portion of Design and Construction note #9 as shown on the revised HDD Plans and Profiles (Attachment #3) is unreadable. Please provide DEP with a revised legible document.**

   Construction Design Note 9 appears legible on our electronic version of the file provided, regardless, Note 9 reads as follows:

   9. PIPE / AMBIENT TEMPERATURE MUST BE NO LESS THAN 30°F DURING PULLBACK WITHOUT PRIOR WRITTEN APPROVAL FROM THE ENGINEER.

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. SPLP therefore requests that the Department approve the Reevaluation Report for Goldfinch Lane Horizontal Directional Drills (S2-0069) as soon as possible.

Sincerely,

Matthew Gordon
Project Director

Attachment 1

Landowner Communications

SUNOCO PIPELINE
An ENERGY TRANSFER Partnership

P.O. Box 2218
Altoona, PA 16602

February 8, 2018

BY CERTIFIED AND FIRST CLASS MAIL
Donald D. Mayer, Gary Mayer, and Dolores A. Bracken
3052 Benshoff Hill Road
Johnstown, PA 15909

Re: Mariner East 2 – Pennsylvania Pipeline Project
Horizontal Directional Drilling Construction Notification
and Offer of Alternative Temporary Water Supply

Dear Donald D. Mayer, Gary Mayer, and Dolores A. Bracken:

Previously, Sunoco Pipeline L.P. ("SPLP") wrote to inform you that certain construction activity known as Horizontal Directional Drilling ("HDD") for Mariner East 2, also known as the Pennsylvania Pipeline Project, is located within 450 feet of your property boundary. In that letter, SPLP offered private water supply/well testing at SPLP's expense if you have a private water supply/well located within 450 feet of the HDD alignments. If you have not yet requested testing of your qualifying private water supply/well, but now would like SPLP to have your private water supply/well tested, please contact the Sunoco representative for your area by calling Amy Abramowich at (814) 204-0450.

In addition, as part of this construction activity, SPLP is offering landowners with a private water supply/well located within 450 feet of the HDD alignments to be connected to an alternative temporary water supply, such as a water buffalo, that will be installed and maintained at SPLP's expense for the entire period of HDD operations.

If you would like to be connected to an alternative temporary water supply, please contact the Sunoco representative for your area by calling Amy Abramowich at (814) 204-0450.

Thank you for your cooperation.

Mark McConnell
Land Project Manager
Representing Sunoco Pipeline L.P.
Office: (814) 204-0450

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3052 Benshoff Hill Road
Johnstown PA 15909-3604

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Donald D. Mayer, Delores (Mayer) Bracken, & Gary Ma
3052 Benshoff Hill Road
Johnstown PA 15909-3604

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SUNOCO PIPELINE
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P.O. Box 2218
Altoona, PA 16602

February 8, 2018

BY CERTIFIED AND FIRST CLASS MAIL
Daniel Ed Trantham and Rose Mary Trantham
138 Goldfinch Lane
Johnstown, PA 15909

Re: Mariner East 2 – Pennsylvania Pipeline Project
Horizontal Directional Drilling Construction Notification
and Offer of Alternative Temporary Water Supply

Dear Daniel Ed Trantham and Rose Mary Trantham:

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Land Project Manager
Representing Sunoco Pipeline L.P.
Office: (814) 204-0450

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SUNOCO PIPELINE
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P.O. Box 2218
Altoona, PA 16602

February 8, 2018

BY CERTIFIED AND FIRST CLASS MAIL
Charles P. and Patricia R. Scanlan
2915 Benshoff Hill Road
Johnstown, PA 15909

Re: Mariner East 2 – Pennsylvania Pipeline Project
Horizontal Directional Drilling Construction Notification
and Offer of Alternative Temporary Water Supply

Dear Charles P. and Patricia R. Scanlan:

Previously, Sunoco Pipeline L.P. ("SPLP") wrote to inform you that certain construction activity known as Horizontal Directional Drilling ("HDD") for Mariner East 2, also known as the Pennsylvania Pipeline Project, is located within 450 feet of your property boundary. In that letter, SPLP offered private water supply/well testing at SPLP's expense if you have a private water supply/well located within 450 feet of the HDD alignments. If you have not yet requested testing of your qualifying private water supply/well, but now would like SPLP to have your private water supply/well tested, please contact the Sunoco representative for your area by calling Amy Abramowich at (814) 204-0450.

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If you would like to be connected to an alternative temporary water supply, please contact the Sunoco representative for your area by calling Amy Abramowich at (814) 204-0450.

Thank you for your cooperation.

Mark McConnell
Land Project Manager
Representing Sunoco Pipeline L.P.
Office: (814) 204-0450

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P.O. Box 2218
Altoona, PA 16602

February 8, 2018

BY CERTIFIED AND FIRST CLASS MAIL
David R. and Joanne C. Grata
217 Goldfinch Lane
Johnstown, PA 15909

Re: Mariner East 2 – Pennsylvania Pipeline Project
Horizontal Directional Drilling Construction Notification
and Offer of Alternative Temporary Water Supply

Dear David R. and Joanne C. Grata:

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Mark McConnell
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P.O. Box 2218
Altoona, PA 16602

February 8, 2018

BY CERTIFIED AND FIRST CLASS MAIL
Gary L. Stevens and Paulette June Stevens
2755 Benshoff Hill Road
Johnstown, PA 15909

Re: Mariner East 2 – Pennsylvania Pipeline Project
Horizontal Directional Drilling Construction Notification
and Offer of Alternative Temporary Water Supply

Dear Gary L. Stevens and Paulette June Stevens:

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★ USA CMF - 134 04/17 ★

SUNOCO PIPELINE
An ENERGY TRANSFER Partnership

P.O. Box 2218
Altoona, PA 16602

February 8, 2018

BY CERTIFIED AND FIRST CLASS MAIL
Gary L. Stevens and Paulette June Stevens
2755 Benshoff Hill Road
Johnstown, PA 15909

Re: Mariner East 2 – Pennsylvania Pipeline Project
Horizontal Directional Drilling Construction Notification
and Offer of Alternative Temporary Water Supply

Dear Gary L. Stevens and Paulette June Stevens:

Previously, Sunoco Pipeline L.P. ("SPLP") wrote to inform you that certain construction activity known as Horizontal Directional Drilling ("HDD") for Mariner East 2, also known as the Pennsylvania Pipeline Project, is located within 450 feet of your property boundary. In that letter, SPLP offered private water supply/well testing at SPLP's expense if you have a private water supply/well located within 450 feet of the HDD alignments. If you have not yet requested testing of your qualifying private water supply/well, but now would like SPLP to have your private water supply/well tested, please contact the Sunoco representative for your area by calling Amy Abramowich at (814) 204-0450.

In addition, as part of this construction activity, SPLP is offering landowners with a private water supply/well located within 450 feet of the HDD alignments to be connected to an alternative temporary water supply, such as a water buffalo, that will be installed and maintained at SPLP's expense for the entire period of HDD operations.

If you would like to be connected to an alternative temporary water supply, please contact the Sunoco representative for your area by calling Amy Abramowich at (814) 204-0450.

Thank you for your cooperation.

Mark McConnell
Land Project Manager
Representing Sunoco Pipeline L.P.
Office: (814) 204-0450

Each sheet can be used for one Certified Mail piece, which can be sent without Physical Return Receipt Service (Option A) or with Physical Return Receipt Service (Option B).

CERTIFIED MAIL

Percheron Field Services
Representing Sunoco Logistics
P.O. Box 2218
Altoona PA 16602

9407 1118 9956 0596 3220 36

PS Form 3800 6/02

$3.920
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Top of the page

U.S. Postal Service
Certified Mail Receipt

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9407 1118 9956 0596 3220 36

FEES

Postage per piece	$0.470
Certified Fee	$3.450
Total Postage & Fees:	$3.920

ARTICLE ADDRESS TO:

Gary L. Stevens & Paulette June Stevens
2755 Benshoff Hill Road
Johnstown PA 15909-3608

Postmark Here

Gary L. Stevens & Paulette June Stevens
2755 Benshoff Hill Road
Johnstown PA 15909-3608

Delivery Address when used with A or Return Address when used with B

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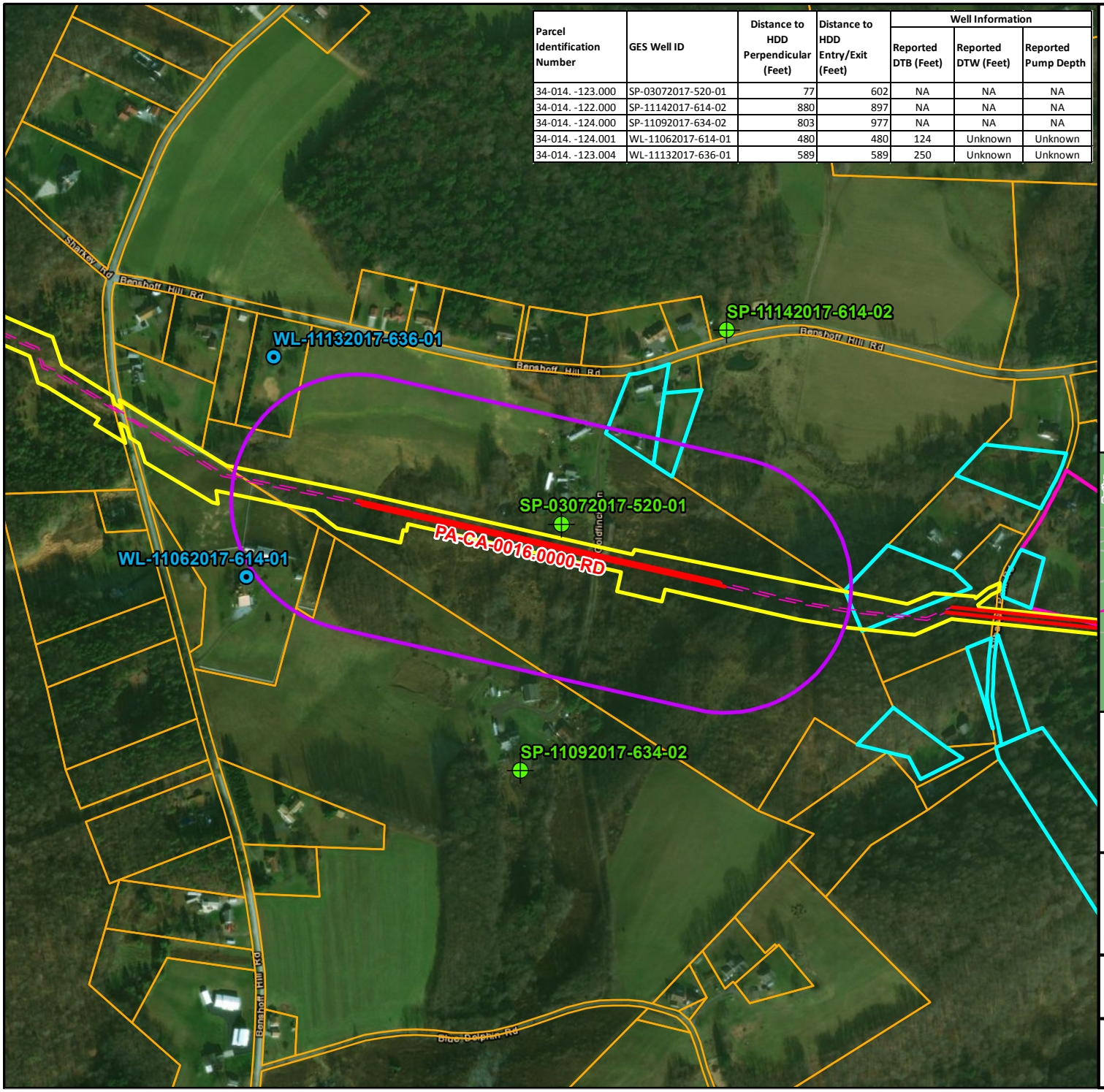
Attachment 2

Water Supply Illustration

Parcel Identification Number	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
34-014. -123.000	SP-03072017-520-01	77	602	NA	NA	NA
34-014. -122.000	SP-11142017-614-02	880	897	NA	NA	NA
34-014. -124.000	SP-11092017-634-02	803	977	NA	NA	NA
34-014. -124.001	WL-11062017-614-01	480	480	124	Unknown	Unknown
34-014. -123.004	WL-11132017-636-01	589	589	250	Unknown	Unknown



Legend

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

****Testing locations current as of 03/19/2018**

- GES Testing Location
- GES Spring Testing Location

Location

0 250 500 Feet

Well Location Map
HDD# PA-CA-0016.0000-RD
Cambria County, PA.

Prepared By: TETRA TECH

Date: 3/22/2018

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

Coordinate System: NAD 83 Stateplane, PA South, Feet

P:\GIS\projects\112\0393\8-PPP\MXD\WellLocations\Well_Location_PA_CA_0016_0000.mxd JL

Attachment 3

DrilPlex™: Additive Use and Safety Data Sheet

MI SWACO
A Schlumberger Company

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/ft³ (648 kg/m³)

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

M-I SWACO
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) Not classified.	Classification (67/548/EEC) Not classified.

UREA		10-30%
CAS-No.: 57-13-6	EC No.: 200-315-5	

Classification (EC 1272/2008)	Classification (67/548/EEC)
Not classified.	Not classified.

MAGNESIUM OXIDE		10-30%

Classification (EC 1272/2008)	Classification (67/548/EEC)
Not classified.	Not classified.

SODIUM CARBONATE		1-5%
CAS-No.: 497-19-8	EC No.: 207-838-8	

Classification (EC 1272/2008)	Classification (67/548/EEC)
Eye Irrit. 2 - H319	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.

Hazard Statements In Full

H319	Causes serious eye irritation.

Attachment 4

Coal Mine Subsidence Study

SUBSIDENCE POTENTIAL REVIEW

GOLDFINCH LANE

HORIZONTAL DIRECTIONAL DRILLED PIPELINE PROJECT

JACKSON TOWNSHIP, CAMBRIA COUNTY, PA

March 2018

PRESENTED FOR

Sunoco Logistics, L.P.
525 Fritztown Road
Sinking Spring, PA

PRESENTED BY

Tetra Tech
661 Anderson Drive
Foster Plaza 7
Pittsburgh, PA 15220

TABLE OF CONTENTS

FIGURES

TABLES

INTRODUCTION

Tetra Tech, Inc. (Tetra Tech) was retained by Sunoco Logistics L.P. (Sunoco) to review the mining activity and subsidence potential of the abandoned coal mines below the two planned Goldfinch Lane horizontal directional drilled pipelines (HDDPs) located in Jackson Township, Cambria County, Pennsylvania. Our report follows.

BACKGROUND

Mine subsidence is defined by Pennsylvania Department of Environmental Protection (PA DEP) as "movement of the ground surface as a result of readjustments of the overburden due to collapse or failure of underground mine workings." Overburden is the soil and rock lying between the coal and the surface. When subsidence occurs at or near the location of an overlying structure, damage to the structure may occur. The potential impacts to surface structures are "generally classified as cosmetic, functional, or structural. Cosmetic damage refers to slight problems where only the physical appearance of the structure is affected, such as cracking in plaster or drywall. Functional damage refers to situations where the structure's use has been impacted, such as jammed doors or windows. A more significant impact on structural integrity is classified as structural damage. This includes situations where entire foundations require replacement due to severe cracking of supporting walls and footings." (PADEP, 2017). When a new structure is designed over areas where potential mine subsidence could result in structural damage, structural engineers can mitigate the damage concerns by improving the structural integrity of the structure or by isolating the structure from the subsidence. When structural improvement or isolation is not possible or is cost prohibitive, the hazards posed by mine subsidence can be mitigated by grouting the remnant mined entries (filling voids with concrete like material to prevent settling) to reduce the potential for subsidence.

The most effective mitigation method is to relocate the structure over areas where the coal has not been mined; however, in Pennsylvania mining regions, this is not always a possibility. When a structure is located over abandoned mine workings, predicting the probability and timing of future subsidence is not a clearly defined science. The probability of future subsidence depends on the remaining stability of the mine pillars, the columns of coal left in place to support the overlying overburden. The timing of any future failure of the pillars would depend on knowing the exact failure strength, the geometry of the mine pillars and the reduction in the strength of the mine pillars over time. There is no specific way to know when pillar failure and subsequently subsidence will occur. Mining maps are prepared by active mining companies when the mine was operating to indicate where mining occurred and the type of mining conducted. Maps of abandoned mines are used by mining engineers to verify the mine layout and to estimate the size of remaining voids and pillars. These maps often lack complete details of the mining and are sometimes inaccurate. Incomplete or inaccurate knowledge of mine configuration can introduce additional errors into any future subsidence prediction.

Most abandoned mine subsidence impacts to structures that result in structural damage have occurred in areas of limited overburden, such as where the mine depth is less than 100 feet. Although the subsidence damage classifications above refer to surface impacts, similar

classifications might be applicable for impacts to underground pipelines located below the ground surface. As an example, areas of minor ground movement after a pipeline has been installed within a horizontal drilled borehole may cause movement of the pipeline (similar to cosmetic or functional damage to a surface structure) but may not cause structural damage such as a break in the pipeline resulting in a loss of fluids or gas. Areas of potential structural damage should be avoided or mitigated.

The Bethlehem Mines Corporation's Cambria Division operated the Mine #31 underground mine in Jackson Township, Cambria County in the 1960's and 1970's. Their primary mining method was room and pillar mining. No mining was conducted directly under the planned HDDP. The Lower Kittanning seam is solid coal directly below the HDDP. However, the Lower Kittanning seam was mined in Mine #31 approximately 100 feet to the north of Station 0+00 (the beginning of the HDDP), and about 415 feet north of Station 1570 (the end of the HDDP). The depth of the coal from surface is about 545 feet at Station 0.0 and about 620 feet at Station 15+70.

The mining method employed at Mine #31 was room and pillar mining utilizing a mechanized continuous mining machine. The rooms closest to the HDDP were utilized exclusively for coal recovery and were only configured for short term stability. The small support pillars between the mining entries were systemically removed (mined) as the mines retreated, allowing the roof to collapse behind them. When this happened, surface subsidence would occur. Most subsidence would occur almost immediately, and all ground movements would be completed within a few weeks. Some of the small pillars remained after mining – primarily to support mine entries for ventilation purposes. These areas have the highest risk of future subsidence because the pillars in these areas were not designed to provide long-term support.

TYPES OF MINE SUBSIDENCE

Mine subsidence occurs in one of two physical forms; a trough or a sinkhole. A trough is a shallow, often broad, dish-shaped depression that develops when the overburden sags downward into a mine opening in response to roof collapse, the crushing of mine pillars, or the punching (pushing) of pillars into the mine floor. There can also be areas of surface heave around the edges of the subsidence troughs. Trough subsidence typically occurs in areas of deeper overburden, typically in areas of more than 100 feet of overburden. The depth and extent of the trough are closely related to the dimensions and thickness of the extracted coal, and the physical properties of the overburden.

A sinkhole is a depression in the ground surface that occurs due to localized collapse of the overburden directly into a mine opening (a room or entry). This is often called "chimney" type subsidence. Boundaries between the ground surface and the vertical walls of the sinkhole are often abrupt, and because sinkhole diameter generally increases with depth, the sinkhole in profile may initially resemble an open bottle with the top at the ground surface. Erosion of soil at the sinkhole's periphery may increase the diameter near the ground surface to create an hourglass profile. Sinkhole subsidence typically occurs in areas of shallow overburden, primarily 100 feet or less. Sinkhole-prone areas are the primary locations where subsidence causes severe structural damage to buildings on the surface. Sinkhole subsidence in an area of single-seam mining is usually limited to areas where the total thickness of the rock layers above the

coal is no more than 6 to 10 times the thickness of the coal mined in the area. The soil thickness overlying the rock is not included in this estimate. (Kendorski, 2006).

CATEGORIES OF MINE SUBSIDENCE POTENTIAL

Mining-induced subsidence is caused when a seam of coal is extracted and overlying rock layers cave into the voids left by mining such that there is movement on the ground surface. The probability of subsidence is greater in areas where a high percentage of coal is removed. In an analysis of underground mines, subsidence potential can be classified into the following three general categories:

Category 1 – Subsidence probably occurred during or soon after mining.

Category 2 – Support area where subsidence is unlikely.

Category 3 – Area where subsidence may occur in the future if it has not already occurred.

Room and pillar mining, the method of mining commonly used in the project area, is a method of mining where mine entries were excavated through the coal seam. The unmined coal, or coal pillars, remained in place to support the roof. As the mine workings reach the extent of the mine boundaries, some areas are "retreat mined." In areas where retreat mining is employed, coal pillars are extracted for nearly full recovery (generally 80 to 90 percent recovery) of the coal seam. To accomplish full recovery in a safe manner, the roof of the mine is allowed to cave in a predictable controlled manner immediately following coal extraction. This controlled caving process systematically relieves built-up stresses caused by the cantilever action of the mine roof thereby reducing the risk of catastrophic strata failure where men are working. The limits and extents of the subsidence are relatively predictable where retreat mining is employed because subsidence normally occurs soon after mining. Category 1 refers to areas where nearly full extraction of the coal occurred as a result of retreat mining and there is very low probability of extensive future subsidence, although subsidence can occur at the edges of these areas due to failure of adjacent, highly stressed, supporting pillars.

Category 2 refers to areas where the mine configuration and pillars are adequately designed to provide permanent support to the ground surface. The amount of coal removed in these areas is generally low to moderate. These areas, although mined, generally remain stable over the long term and typically include main entries and haulage routes as well as low-extraction-ratio room and pillar areas of the mines where retreat mining did not occur. Areas of mines delineated as Category 2 would have a relatively low probability of future subsidence.

Category 3 refers to areas underlain by room and pillar mines with a high percentage of coal removed and where retreat mining was not performed. In Category 3 areas, it is uncertain whether subsidence occurred and whether there remains a likelihood of subsidence in the future. In these areas, entries were driven through the coal, and the pillar sizes were smaller than what would generally be required to provide permanent support. In other words, the pillars were designed with a low factor of safety (caused by the high extraction ratio), and there would be an elevated risk of pillar, roof, or floor failure. If subsidence already occurred, the possibility of future subsidence is very unlikely. However, if subsidence has not previously occurred, the possibility

of future subsidence remains high. Of the three categories, Category 3 would have the highest probability for future subsidence.

In mining subsidence terms, the extent of the potential area impacted by subsidence can be defined using a specific angle from the coal seam to the ground surface that could be affected if roof or pillar failure occurred at the mine level. The potential subsidence affected area can be directly overhead but could also be offset a certain horizontal distance from the roof failure location. The angle, termed the "angle-of-draw," can vary depending on the overburden rock type (Peng, 1978). PA DEP accepts 20 degrees as the angle-of-draw for the flat-lying coal seams in the bituminous coal region; however, up to 35-degree angle-of-draws have been found in numerous subsidence publications. In an effort to provide conservative analysis to protect the HDDP, both angle-of-draws will be used in this report. The angle-of-draw can also be projected downward from a surface structure or a pipeline in the ground to determine what area within a mine could, if pillar or roof failure occurred, cause subsidence that may impact the surface or pipeline.

Tetra Tech reviewed the mine maps and the location and elevation of the two planned HDDPs. Figure 1 depicts the areas where potential roof failure at mine level could impact the strata at the level of both planned HDDPs. Both angle-of-draws (20° and 35°) were shown on Figure 1. The area shown was created by using an angle-of-draw from the pipeline's bottom elevation to the top of the coal seam. A mining height of four feet (4') was assumed based on information from the mine map. A 15' horizontal zone on each side of the two HDDPs (30' total) was also included. Figure 2 depicts each category of potential mine subsidence. A total of 0.9 acres lies within the 20° angle-of-draw influence area, while 6.0 acres lie within a 35° angle-of-draw influence area. Most of the area within each angle-of-draw is solid coal. A summary of subsidence category areas are shown on Table 1.

Table 1: Summary of Categories of Subsidence Potential within Angle-of-Draw

Subsidence Category	Subsidence Potential	20° Angle-of-Draw (Acres)	35° Angle-of-Draw (Acres)
1	Subsidence probably occurred during or soon after mining	0.2	4.0
2*	Support area where subsidence is unlikely	0.0	0.0
3	Area where subsidence may occur in the future if it has not already occurred	0.7	2.0
Total		**0.9**	**6.0**

*Solid coal is not included but are 17.1 and 33.6 acres respectively.

When roof or pillar failure occurs, strata above the mined area will collapse and/or sag downward to fill the voids left in the mine. Mining research has classified these areas as different zones based on the degree of fracturing expected. These zones depend on the width and height of the extraction, the overburden rock types, and the vertical height above the mine. A caved zone occurs from the roof of the mined coal and typically extends upwards for 6 to 10 times the mining thickness (Kendorski, 2006), and outward laterally within the angle-of-draw. In the case of Mine #31 where the mined thickness is assumed to be a maximum of 4 feet, this zone would be from

24 to 40 feet above the top of coal. Rock in this zone would have extensive fracturing and sizable voids.

Above the cave zone a fracture zone occurs and extends for 24 to 30 times the mining thickness. In this zone, a lot of fractures would be present but the rock strata would remain as a single unit without extensive dislocated rock or voids present. At the Mine #31, this zone would extend from 24 to 40 feet to 96 to 120 feet above the top of mining.

The next zone would extend from the top of the fractured zone to about 60 times the mining thickness. This zone is termed the dilated zone. This zone would have small temporary fractures that would heal over time. The rock again would remain as a single unit. At Mine #31, this dilation zone would extend from 96 to 120 feet up to 240 feet above the top of the coal.

The zone above that is termed the constrained or bending zone where no fracturing would occur. In this case, the minimum distance between the HDDP's and the coal seam is 450 feet vertically. Both HDDP's would be in this zone.

Table 2: Zones of Strata Fracturing During Subsidence

Zone	Extent Above Coal Seam (ft.) (x mining height)	Impact to Strata	Voids Created
Constrained	>60	No Fractures	None
Dilation	Up to 60	Small Fractures	Micro
Fracture	Up to 30	Fractured	Minimal
Caved	Up to 10	Fractured	Sizable
Mined Coal Seam			

Determining induced strains from subsidence during active mining has become a relatively accurate prediction, especially for longwall mines. There are numerous computer program models that were developed by mining agencies and universities that use variations in the rock type within the overlying strata, mining thickness, and mine geometry at coal seam level to predict ground movements at the surface during active full-recovery mining. These models not only predict the extent and amount of subsidence but can predict tilts and strains occurring at ground level. They can also be used to predict maximum strains when subsidence occurs. Abandoned mines are less predictable as to the time when subsidence would occur as well as the extent of subsidence. Mine subsidence from abandoned mine is less uniform or predictable than that of active mines. However, the use of models for active mining can be adapted to estimate subsidence and stress if subsidence would occur at abandoned mine sites.

FINDINGS

The mine maps were reviewed by experienced mining engineers. Even though the mining in the maps covering the area under the planned pipeline occurred nearly 50 years ago, the maps were found to be very detailed regarding the mining type and location of mining. The maps were georeferenced by PA DEP. In our opinion, the mine maps are a reliable indication of what was mined. We have reviewed several of the different maps available on the Pennsylvania Mine Map

Atlas website. They all indicated the same depiction of the mine workings under the planned pipeline area.

The HDDP starts on its eastern most location at about 550 feet above the coal. The descending boring will be approximately 450 feet above the coal when it levels about 760 feet horizontally from its start. The boring would then be fairly level for another 120 feet to a location where it will be approximately 510 feet above the coal. From there the boring will ascend upward until it reaches the surface 1,570 feet from its start. At that this surface exit location the boring would be about 625 feet above the coal. The entre route of the HDDP lies above solid coal. However, for the initial 750 feet the HDDP Subsidence Category 1 (subsidence probably occurred during or soon after mining) and Subsidence Category 3 (area where subsidence may have occurred or may occur in the future) areas lie a few hundred feet to the north and are within the angle-of-draw. From 750 feet to the end (@ 1,570 feet) a small amount of Subsidence Category 1 area occurs several hundred feet to the north of the HDDP and are within the angle-of-draw.

Figures 3 and 4 depict the planned HDDP profiles. Since the coal level was much deeper than Figures 3 or 4 could show Figure 5 was prepared to show the top of each fracture zone. To be conservative, the top of each fracture zone was selected as the maximum value based on the Kendorski's research (Kendorski, 2006). The two HDDPs are exclusively within the constrained zone and do not cross through the dilated or the fractured zones.

The PA DEP Bureau of Abandoned Mine Land Reclamation (BAMR) is responsible for maintaining an inventory of all abandoned mine related incidents in Pennsylvania. This includes mine subsidence incidents above abandoned mines such as Mine #31. It is our understanding that their recording of these incidents began shortly after 1977. To our knowledge there have been no subsidence incidents reported to PA DEP since 1977 anywhere near the planned HDDP.

When the earth subsides, the curvature of the strata can produce a horizontal strain within the strata. Some of this strain can be transferred to a rigid pipeline that is placed within the strata. Strain is defined as the amount of deformation in the direction of applied force divided by the initial length of the material. This results in a unitless number such as inches per inch. Strain can be induced by compression, tension, pipe bending, pipe placed in torsion or shear. Using historical subsidence data from primarily known conditions during longwall mining, models have been developed to predict the strains at ground surface. These models, although not a perfect translation, can be adapted to estimate strains within the relatively undisturbed rock strata at the elevations where the HDDP would be placed. Since the caved zone would be heavily fractured during subsidence, local strains within the caved zone cannot be accurately estimated. To estimate the strains that may be seen at the pipeline level in the zones about the caved zone, Tetra Tech engaged Dr. Andrew Schissler, a mining engineer that has experience using subsidence models to predict the possible strains. Dr. Schissler is associated with the Colorado School of Mines and a part-time employee of Tetra Tech.

Modeling of Mine #31 was conducted using a base coal strength of 900 psi to simulate the strength of the coal at the time of mining, and later pillar failure to simulate maximum subsidence over time. Coal pillar compressive strength degrades over time. Mine subsidence due to this degradation may have already occurred, may occur at some time in the future, or may never

reach the pipeline or the surface. Predicting the actual condition of the mine at this time, or at any given time in the future is not possible.

Rocscience Inc.'s RS^2 was selected as the mining induced stress analysis program to evaluate strain on the pipeline. RS^2 is a 2D finite element program for soil and rock applications which can be used for a wide range of engineering projects and includes excavation design, slope stability, groundwater seepage, probabilistic analysis, consolidation, and dynamic analysis. Complex, multi-stage models can analyze mine entries in weak or jointed rock, underground and open pit mines. Progressive failure, support interaction and a variety of other problems can be addressed.

To the north of the two HDDP's there are small unmined pillars located at the edge of mining. This area is classified as Category 3 subsidence zone (where subsidence may have occurred or may occur in the future). Using the original strength of coal (900 psi) and the small size of these pillars it is highly probably that subsidence has already occurred directly over this mined areas. The pillars are calculated to be loaded at 167% of their capacity, assuming that the coal had 900 psi compressive strength at the time of mining. Subsidence could have extended over the solid coal to the south to the edge of the angle-of-draw. However, the magnitude of subsidence decreases as the distance from the mine increases.

However, if subsidence has not already occurred, the model was run for the worst case scenario that the remaining pillars failed after installation of the pipeline. Our evaluation indicates that modest subsidence and induced strain levels would be present at the pipeline if the perimeter pillars fail. The estimated maximum subsidence is approximately 0.01' at station 0+00 of the HDDP's and maximum strata strain would be 0.00003 at station 3+49, approximately 473 feet above the coal seam.

The results are shown in Table 3.

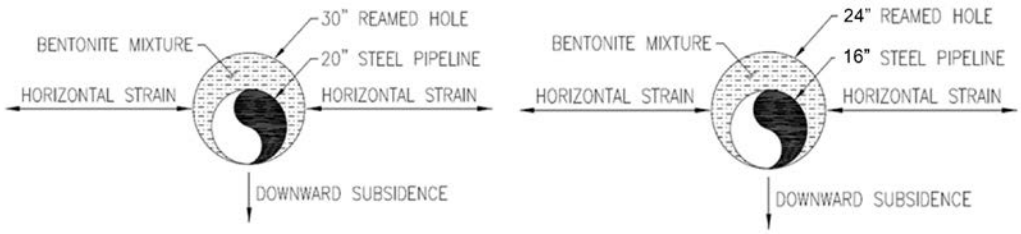
Table 3: Estimated Strain and Subsidence

Station	Strain	Subsidence
15+70	0.000002	0.00 feet
13+96	0.000002	0.00 feet
12+21	0.000001	0.00 feet
10+47	0.000001	0.00 feet
8+72	0.000003	0.00 feet
6+98	0.000004	0.00 feet
5+23	0.000010	0.00 feet
3+49	0.000030	0.00 feet
1+74	0.000000	0.00 feet
0+00	0.000000	0.01 feet

The modeled failure of the pillars shows an insignificant increase in strain within the strata at the HDDP level ($x10^{-6}$ levels), and a minimal subsidence (0.01 feet or about 1/8") is at 0+00.

The modeled strains are in the strata at the location of the HDDP in the earth. The bored excavation for both HDDP's will be larger than the pipe to be installed. As illustrated on Figure 6, the strain in the strata encompassing the hole, is not directly correlated to the strain imparted to the pipeline. The overbore (larger diameter of the hole compared to the pipe) leaves room for

potential movement of the pipe within the strata. Transmission of the strain from the strata to the pipe has been reviewed by pipeline engineers and reported that it would be expected to be less than the predicted strain within the strata.



HDDP 20” HDDP 16”

Figure 6 – Borehole and Pipeline Cross Section

RECOMMENDATIONS

The results of this report have been provided to pipeline designers at Tetra Tech Rooney and they have confirmed that if the estimated subsidence does occur in the future, the resulting stresses within the HDD pipes will still be within the design tolerances of the pipelines.

CLOSURE

The strains and subsidence within the strata near the two HDDPs were estimated as described in the report by using finite element modeling. Using these methods to predict surface and near-surface conditions (within 10 ft. of the surface) are valid. However, predicting strain and subsidence in ground regions intermediate in elevation between the mining horizon and the surface has not been validated due to the lack of in-ground measurements to support and validate predictions. This condition does not apply to the surface or near surface analysis as historical case studies are numerous that validate calculation results. Hence, the strain and other calculations are estimates only and cannot be guaranteed.

It is our understanding that where the pipeline is to be located greater than 50 ft. deep a hole bigger than the pipeline will be employed. This would decrease the frictional drag between the earth and the pipeline. Maintaining this low friction environment over the life of the pipeline would help decouple the pipeline from any subsidence induced ground movements and strains.

This report was prepared to assist Sunoco in the evaluation of the subject project. The scope of this report is limited to the specific project, location, and time described herein. The report presents Tetra Tech’s understanding of site conditions as discernible from information provided by others and obtained by Tetra Tech. Maps in this report are included only to aid the reader and should not be considered surveys. If additional data concerning this site become available, Tetra Tech should be informed so that we may examine the information and, if necessary, modify this report accordingly.

Respectfully submitted,

Thomas A. Gray, P.E.
Mining Engineer

Farley Wood, P.E.
Mining Engineer

Andrew P. Schissler

Andrew Schissler, PhD, P.E.
Mining Engineer

Jeff Lowy, P.E.

Civil Engineer – Tetra Tech Rooney

For Review of Subsidence Effects on the HDD Pipelines

REFERENCES

Kendorski, F. S. (2006) Effect of Full-Extraction Underground Mining on Ground and Surface Waters a 25-Year Retrospective, 25th International Conference on Ground Control Mining, Morgantown WV 2006

PADEP (2017) Technical Guide to Mine Subsidence, Pennsylvania Department of the Environment Website http://www.dep.state.pa.us/msi/technicalguidetoms.html

The Pennsylvania State University (2014) Pennsylvania Mine Map Atlas, http://www.minemaps.psu.edu/

Peng, Syd S. (1978) Coal Mine Ground Control, John Wiley and Sons, Inc.

Peng, Syd S. (1992) Surface Subsidence Engineering, Society for Mining, Metallurgy, and Exploration, Inc.

National Coal Board, Mining Department (1975). Subsidence Engineers' Handbook. National Coal Board, London.

CERTIFICATION

SUBSIDENCE POTENTIAL REVIEW
GOLDFINCH COAL HORIZONTAL DIRECTIONAL DRILLED PIPELINE PROJECT

By affixing my seal to this document I am confirming that the project conditions were reviewed and that accepted engineering practices were used to arrive at the reported results. Subsidence engineering is not an exact science and professional judgement was used to assess the many variables that exist, and is subject to those limitations that may be included in the Subsidence Report and information provided by third parties .

Thomas A Gray

3/26/18

Thomas Gray, P.E. Date

License No. 26978-E

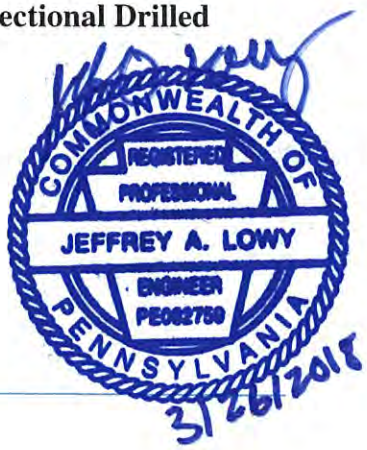
The term certify as used herein is defined as follows: An engineer's certification of condition is a declaration of professional judgement. It does not constitute a warranty or guarantee, either expressed or implied.

TETRA TECH ROONEY

Date: 3/26/2018

Subject: **Subsidence Potential Review Goldfinch Lane Horizontal Directional Drilled Pipeline Project - Jackson Township, Cambria County, PA**
Mariner East II TTR Project: 204-3110 1.1 PPP1

To: Mathew Gordon
Project Manager
Sunoco Logistics, L.P.
525 Fritztown Road
Sinking Spring, PA



Mr. Gordon,

Tetra Tech Rooney has reviewed the above referenced subsidence report and we have confirmed that if the predicted subsidence does in fact occur in the future, the resulting stresses within the horizontally drilled pipes will still be within the design tolerances of the pipelines.

Sincerely,

Jeff Lowy, P.E.
Civil Engineer
Tetra Tech Rooney

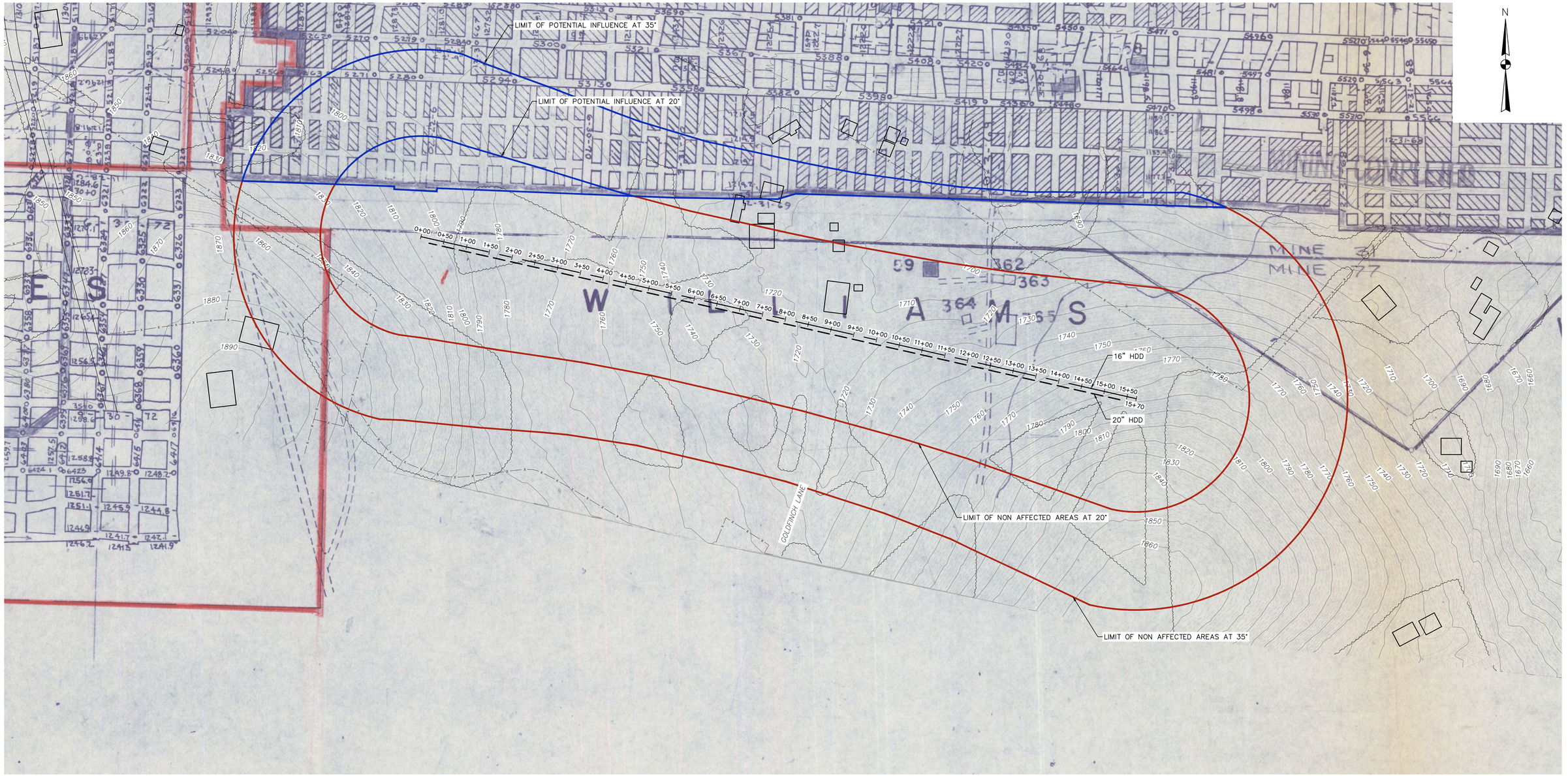
Attachments:

Geotechnical Report: Subsidence Potential Review Goldfinch Lane Horizontal Directional Drilled Pipeline Project. Jackson Township, Cambria County, PA

CC:

Larry Gremminger, CWB, Environmental Project Consultant
Dean Shauers, P.E., President, Tetra Tech Rooney

Tetra Tech Rooney
115 Inverness Drive East, Suite 300, Englewood, CO 80112
Tel 303.792.5911 Fax 303.792.0227 rooney-eng.com tetratech.com



LEGEND

LIMIT OF POTENTIAL INFLUENCE AREA ON PIPELINE

LIMIT OF NON AFFECTED AREAS

REFERENCE: BETHLEHEM MINES CORPORATION'S CAMBRIA DIVISION – MINE #31 MAP – OBTAINED FROM PA DEP – UNDATED

0 100 200
SCALE IN FEET

TETRA TECH
www.tetratech.com
661 ANDERSEN DRIVE – FOSTER PLAZA 7
PITTSBURGH, PA 15220
T: (412) 921-7090 | F: (412) 921-4040

REVISIONS

NO.	BY	DATE	REMARKS

SUNOCO PIPELINE L.P.
SINKING SPRING, PENNSYLVANIA

PENNSYLVANIA PIPELINE PROJECT

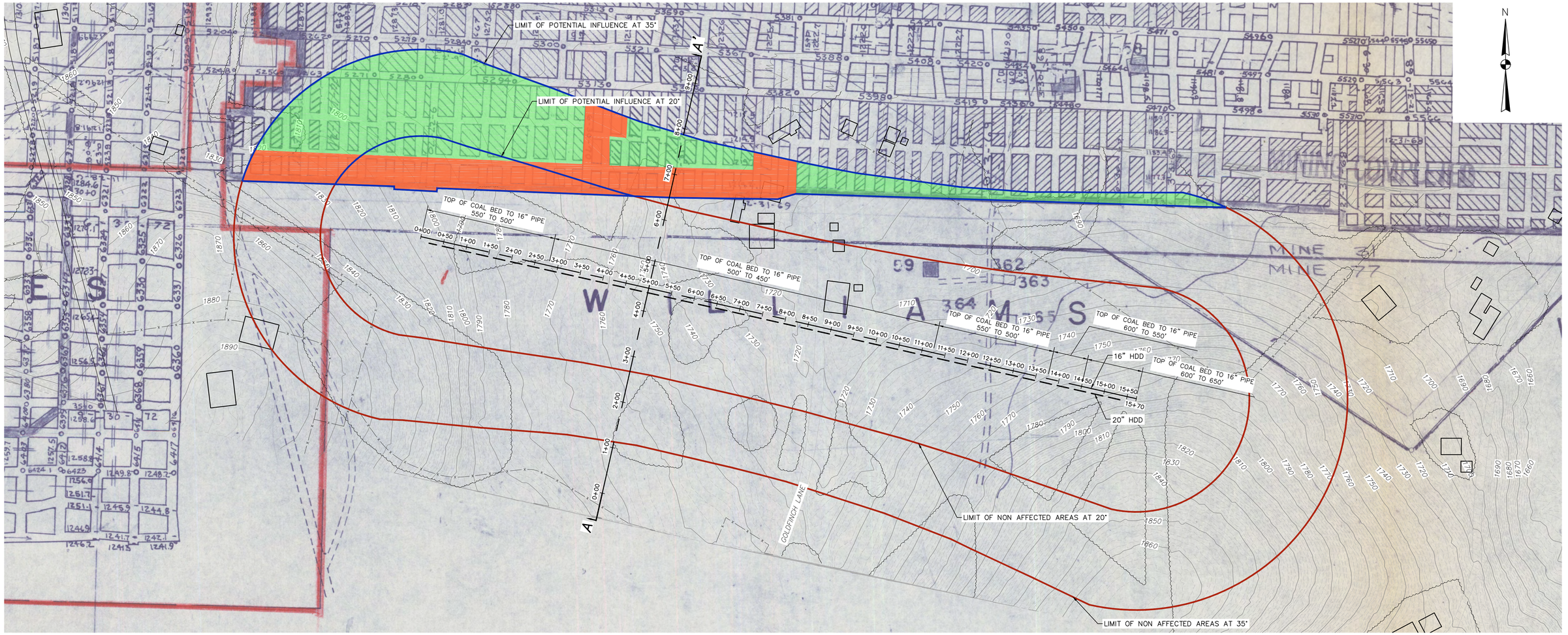
PROJECT LOCATION WITH ANGLE OF DRAW

CAMBRIA COUNTY
GOLDFINCH LANE
MINE AREA

DATE:	2/20/18
PROJECT NO.:	
DESIGNED BY:	TG
DRAWN BY:	JSM
CHECKED BY:	TG

FIGURE 1

R:_Marcellus Shale Projects\Sunoco\5958 – Penn Pipeline Project\5 – Cambria\HDD Mining Review\Figures\PA-CA-HDD-FG001.dwg PIT JOY.SCABILLONI 3/22/2018 12:59:34 PM



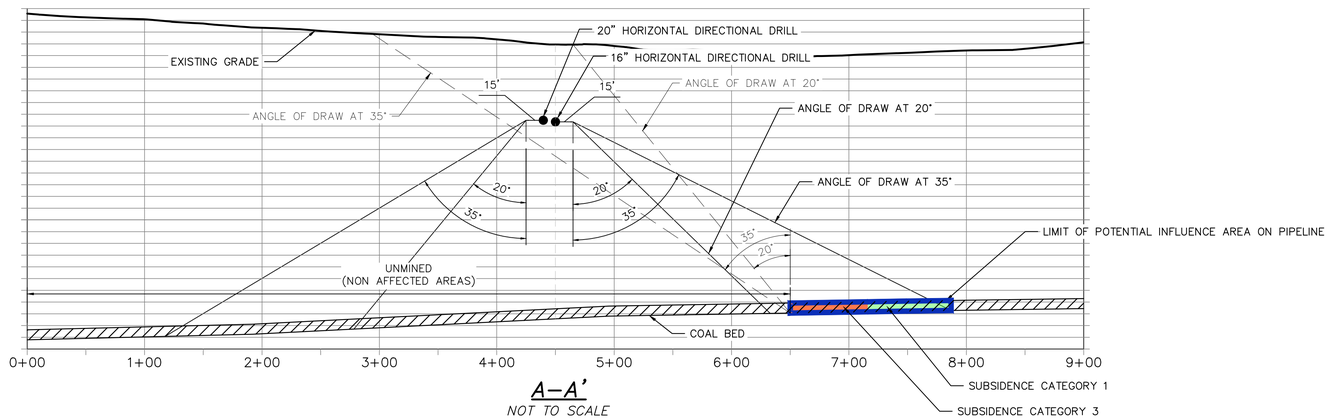
LEGEND

- LIMIT OF POTENTIAL INFLUENCE AREA ON PIPELINE
- LIMIT OF NON AFFECTED AREAS
- SUBSIDENCE CATEGORY 1
- SUBSIDENCE CATEGORY 2
- SUBSIDENCE CATEGORY 3

CATEGORIES OF MINE SUBSIDENCE POTENTIAL

CATEGORY 1: SUBSIDENCE PROBABLY OCCURRED DURING OR SOON AFTER MINING.
CATEGORY 2: SUPPORT AREA WHERE SUBSIDENCE UNLIKELY.
CATEGORY 3: AREAS WHERE SUBSIDENCE MAY HAVE OCCURRED OR MAY OCCUR IN THE FUTURE.

REFERENCE: BETHLEHEM MINES CORPORATION'S CAMBRIA DIVISION –MINE #31 MAP – OBTAINED FROM PA DEP – UNDATED



A–A'
NOT TO SCALE

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REVISIONS

NO.	BY	DATE	REMARKS

SUNOCO PIPELINE L.P.
SINKING SPRING, PENNSYLVANIA

PENNSYLVANIA PIPELINE PROJECT

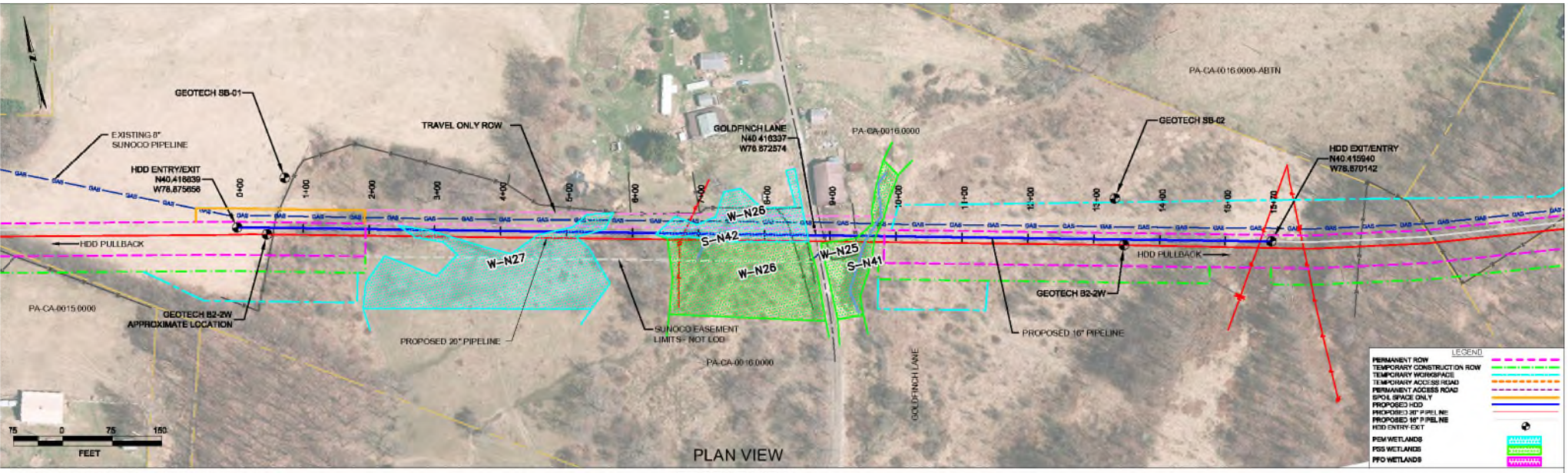
PROJECT LOCATION WITH SUBSIDENCE CATEGORIES

CAMBRIA COUNTY
GOLDFINCH LANE
MINE AREA

DATE:	2/20/18
PROJECT NO.:	
DESIGNED BY:	TG
DRAWN BY:	JSM
CHECKED BY:	TG

FIGURE 2

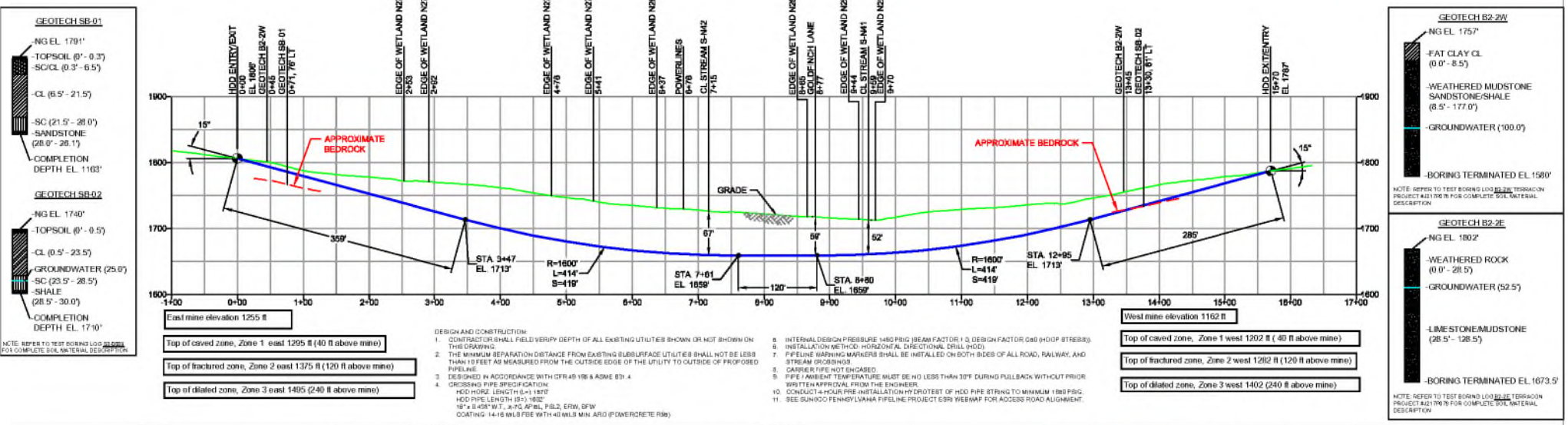
R:_Marcellus Shale Projects\Sunoco\5958 – Penn Pipeline Project\5 – Cambria\HDD Mining Review\Figures\PA-CA-HDD-FG002.dwg PIT JOY.SCABILLONI 3/22/2018 12:58:56 PM



PLAN VIEW

PROFILE VIEW

CAMBRIA COUNTY PENNSYLVANIA, JACKSON TOWNSHIP
S2-0069-16



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 1.0 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+) 1870'
   HDD PIPE LENGTH (S+) 1932'
   16" x 0.456" W.T., X-70, API 5L, PSL2, ERW, BFW
   COATING: 14-16 MILS FBE WITH 40 MILS MIN. ARO (POWERCRETE R9a)
5. INTERNAL DESIGN PRESSURE 1480 PSIG (BEAM FACTOR I.0, DESIGN FACTOR 0.80 (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.

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 877-969-7862.

REF. DRAWING				
ES-2.14	TO	ES-2.15	EROSION & SEDIMENT PLAN	
SHEET 9	TO	SHEET 9	AERIAL SITE PLAN	
DWG NO		DWG NO	DESCRIPTION	

NO	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP3	RELOCATED DRILL ENTRY/EXIT - DESIGN CHANGE PER DPS	MRS	10/30/17	RMB	10/30/17	CAG	10/30/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-18	DLM	10/02/18	RMB	10/02/18	AAW	10/02/18
EP1	REVISED PER PADEP COMMENTS	MRS	09/18/18	RMB	09/18/18	AAW	09/18/18
EP		DLM	03/18/18	RMB	03/18/18	AAW	03/18/18
B	ADDED GEOTECH INFO	MRS	09/06/18	RMB	09/06/18	AAW	09/06/18
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

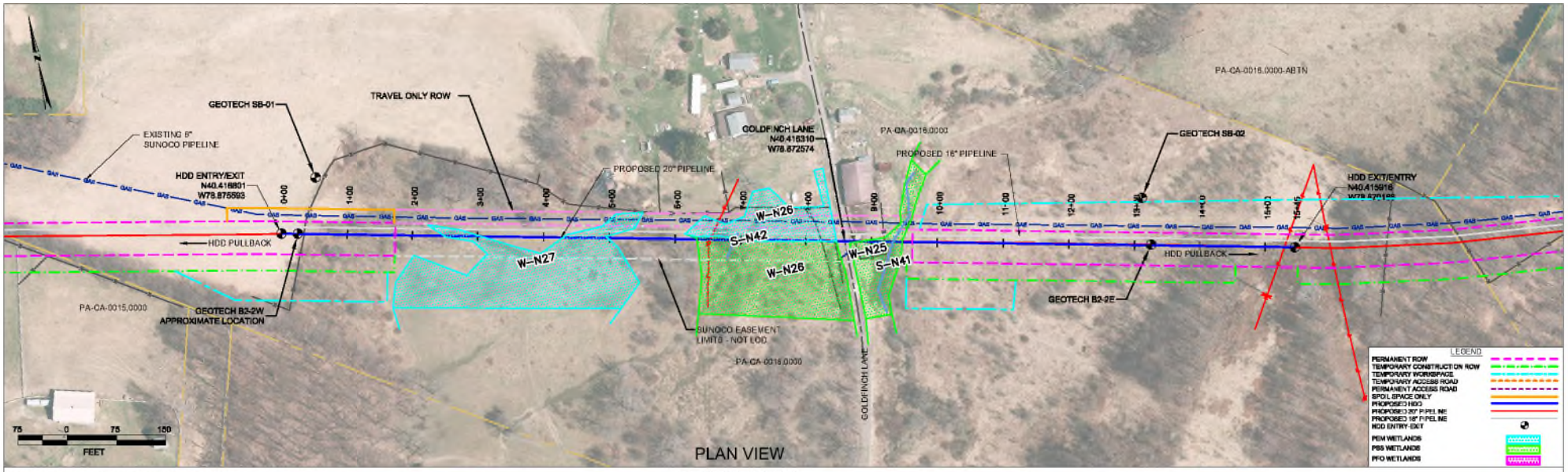
SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
GOLDFINCH LANE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150' | DWG NO: PA-CA-0016.0000-RD-16

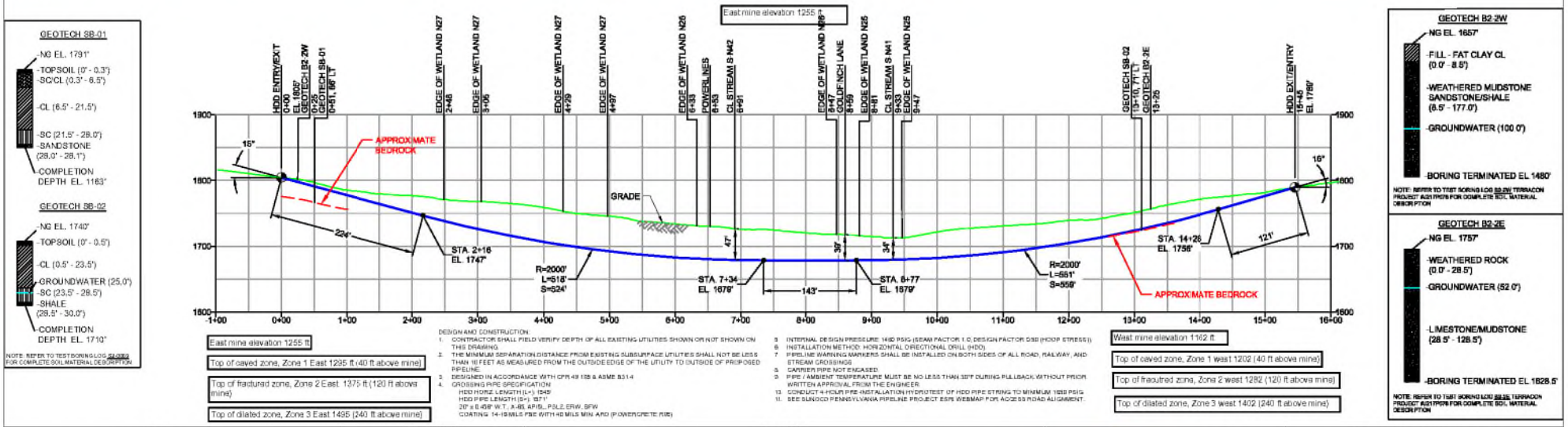
Reference: Tetra Tech Rooney Drawing PA-CA-0016.0000-RD-16 - Date 10/30/17

Figure 3 - Plan and Profile - HDDP - 16"



CAMBRIA COUNTY PENNSYLVANIA, JACKSON TOWNSHIP
S2-0069

PROFILE VIEW



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-2.14	TO	ES-2.15	EROSION & SEDIMENT PLAN
SHEET 9	TO	SHEET 9	AERIAL SITE PLAN

REVISIONS

NO	DESCRIPTION	BY	DATE	CHK	DATE	APP	DATE
EP4	UPDATED GEOTECH INFO PROVIDED BY DPS	MRS	11/14/17	RMB	11/14/17	GAG	11/14/17
EP3	RELOCATED DRILL ENTRY/EXIT - DESIGN CHANGE PER DPS	MRS	09/21/17	RMB	09/21/17	GAG	09/21/17
EP2	REVISED PER PADEP COMMENTS RECEIVED 09-06-16	MRS	09/30/16	RMB	09/30/16	AAW	09/30/16
EP1	REVISED PER PADEP COMMENTS	MRS	05/16/16	RMB	05/16/16	AAW	05/16/16
EP		DLM	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

Sunoco Logistics Partners L.P.

TETRA TECH ROONEY
(303) 792-5911

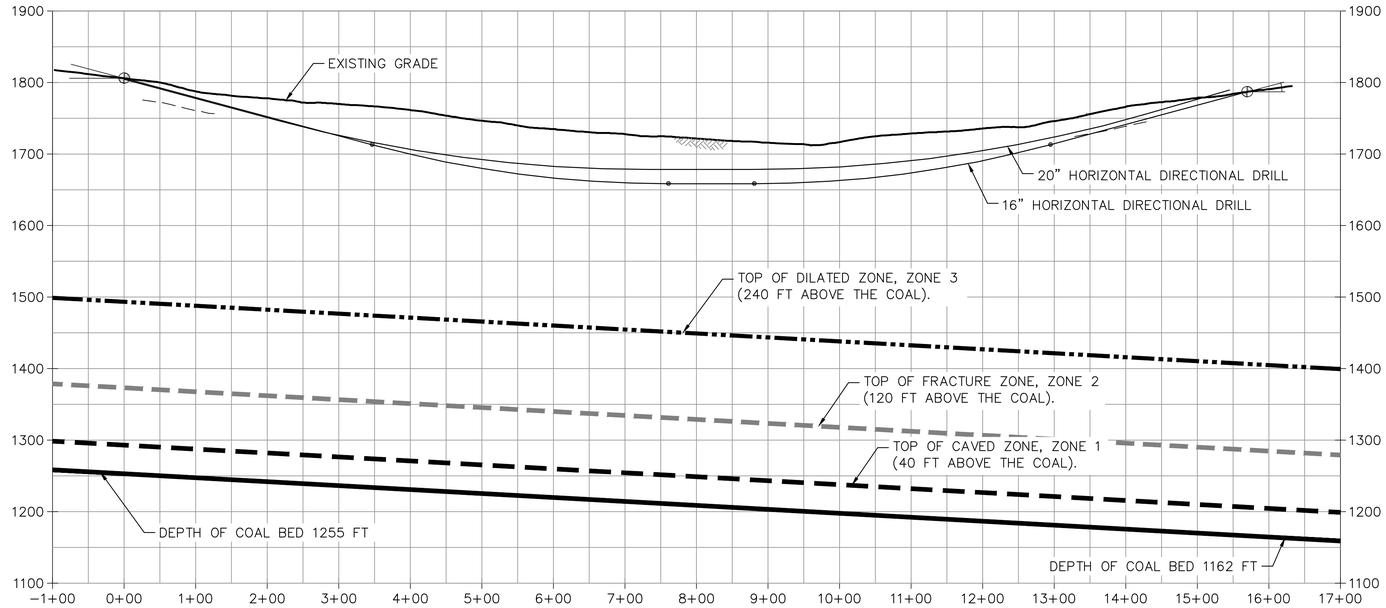
SUNOCO PIPELINE, L.P.

HORIZONTAL DIRECTIONAL DRILL
GOLDFINCH LANE
PENNSYLVANIA PIPELINE PROJECT

SCALE: 1"=150' | DWG NUMBER: PA-CA-0016.0000-RD

Reference: Tetra Tech Rooney Drawing PA-CA-0016.0000-RD - Date 10/30/17

Figure 4 - Plan and Profile - HDDP - 20"



THE ELEVATIONS NOTED IN THIS DRAWING ARE TAKEN FROM MINE WORKINGS 300 FEET TO THE NORTH OF HDD

0 100 200
SCALE IN FEET

TETRA TECH
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PITTSBURGH, PA 15220
T: (412) 921-7090 | F: (412) 921-4040

REVISIONS			
NO.	BY	DATE	REMARKS

SUNOCO PIPELINE L.P.
SINKING SPRING, PENNSYLVANIA

PENNSYLVANIA PIPELINE PROJECT

FRACTURE ZONE CROSS SECTION

CAMBRIA COUNTY
GOLDFINCH LANE
MINE AREA

DATE:	2/20/18
PROJECT NO.:	
DESIGNED BY:	TG
DRAWN BY:	JSM
CHECKED BY:	TG

FIGURE 5

R:_Marcellus Shale Projects\Sunoco\5958 – Penn Pipeline Project\5 – Cambria\HDD Mining Review\Figures\PA-CA-HDD-FG003.dwg PIT JOY.SCABILLONI 3/22/2018 1:28:43 PM