

January 18, 2018

Mr. Dominic Rocco, P.E.
Regional Manager; Waterways and Wetlands
Southeast Regional Office
Pennsylvania Department of Environmental Protection;
2 East Main Street
Norristown, Pennsylvania 19401-4915

**Response to Data Request and Comments
Hydrogeological Reevaluation Report
East Swedesford Road and Horizontal Directional Drill (S3-0381)
DEP Permit No. E 15-862
West Whiteland Township, Chester County, PA**

Dear Mr. Rocco:

On November 3, 2017, Sunoco Pipeline, L.P. (SPLP) submitted for public review and comment a Reevaluation Report for the proposed Horizontal Direction Drill (HDD) of a segment of the Mariner East II Pipeline Project (Mariner II) known as the Swedesford Road HDD, S3-0381 as referenced above. This Reevaluation Report provided an analysis concerning a change in crossing methodology that was consistent with a permit modification request previously submitted to the Department in October 2017, in response to a request to SPLP from Aqua America to consider an alternative design for this segment of the pipeline project. Following submission of the Reevaluation Report, SPLP's preferred FlexBor contractor reviewed the new crossing (S3-0382), and based on that review SPLP proposes to further modify the crossing and will submit minor amendments to the October 17 permit modification request. In the interim, SPLP has received and reviewed your letter dated December 4, 2017, requesting explanations and additional information relative to our analysis and use of a FlexBor for a minor portion of the pipeline segment. Please accept this letter as a response to your request for further information. Below you will find your specific request in bolded italics, followed by SPLP's response.

1. Provide additional information on the "flex bore" proposal:

a. Will the pilot phase involve a flex bore set-up or regular HDD setup?

The pilot phase will be performed using a FlexBor unit driving a 7-inch diameter percussion hammer (hammer bore) in front of 6-inch diameter casing that houses the drive stem.

As noted above, following submission of the Reevaluation Report to the Department, a review of the Lincoln Highway (S3-0382) crossing was undertaken by SPLP's preferred

FlexBor contractor. Based on this review, the proposed HDD has been modified from the design set forth in the Reevaluation Report to what is considered a conventional bore by industry standards, as depicted on the attached revised project plans, using FlexBor equipment.

As you will see upon review of the attached revised plans, the installation plans no longer follow a profile or subsurface radius representative of an HDD, but rather is a straight pit launched bore approximately 497 ft in length, with a minimum depth of cover of 7 foot (ft), and maximum depth of cover of 17 ft. The entire length of this bore would pass through overburden materials.

b. Will the pilot phase include any type of lubricants or additives? If so describe and explain and include, where applicable, MSDS sheets for any such substances.

No lubricants or additives will be utilized in the pilot phase of the modified plans for the bore of Lincoln Highway as discussed above in the response to question 1.a.

During the reaming phase, the intent is to utilize a FlexBor reamer in front of full size (16 and 20-inch diameter) casing to complete the ream. Reaming with attached casing maintains the subsurface support under the highway during reaming and pullback of the pipeline segment. A bentonite solution will be applied to the exterior of the casing during reaming, and to the pipeline segment during pullback, to prevent binding with the surrounding subsurface materials.

“Bara-Kade” bentonite will be used for the casing lubricant which is listed on DEP’s published list of approved drilling materials and additives. A MSDS has been provided for your review.

c. Will the high pressure air and water used in “flex bore” lead to a higher risk of discharges of any kind at the surface, when compared to regular HDD, including, specifically, during higher risk work, including the pilot drilling and in the vicinity of the entry/exit points?

The FlexBor system is specifically designed to minimize the risk of discharges of any kind during the reaming phase.

As stated previously, no air, water, or bentonite slurry will be used in the pilot phase. The pilot will be made using a small diameter hammer bore.

The air and water injection during a FlexBor occurs during the reaming phase through the 6-inch diameter casing installed during the pilot, which upon completion of the pilot, the percussion drive stem is removed, and the casing is connected to the reamer immediately in front of the cutters. During the ream, the FlexBor reamer “ingests” the cuttings. The ingested cuttings are blown back to the reamer drive unit through the large diameter casing, by high air pressure with water injection blown through the 6-inch casing into the reamer

face. There is an outlet duct in the casing immediately before the drive unit, where the blown cuttings exit the casing. The cuttings are captured, transferred to a roll off box, and disposed of at a licensed facility. There are only a couple of inches of open space separating the 6-inch casing and reamer face, and the pathway of least resistance is into the reaming tool and through the reamer casing. As a result, the risk of a discharge of any kind near the entry/exit points or along any point of this bore is lower as compared to a regular HDD.

d. Has Sunoco done any studies regarding the geology and/or this proposed technology to determine the suitability of “flex bore” at this location (i.e. geophysical studies, etc.)? Please explain and detail any such studies and explain how they factored into the reevaluation and they demonstrate that “flex bore” is suitable for this location.

No additional geologic or geophysical studies have been performed specifically to analyze the implementation of a FlexBor for crossing under Lincoln Highway.

As is stated in the hydrogeological evaluation, *“The overburden thickness, measured in five geotechnical borings advanced to support the original HDD design, ranged from 18 to 52 feet thick or greater. The textures of the materials described in the overburden range were silty sands to sandy silts with minor amounts of gravel.”*

Since the proposed FlexBor is designed to be completed at depths below ground varying from 7 to 17 ft, the entire length of the bore should be within overburden materials. If any bedrock pinnacles are encountered, the FlexBor system is capable of advancing through these features if present without any alteration to its operation.

Additional geotechnical or geophysical studies would not provide additional information for planning of this bore. Currently, there exists 2 geophysical studies completed for the geologic formations (Ledger & Conestoga formations) in which the FlexBor will be completed (HDD 400- Quantum Geophysics- 10-12-17 & HDD 370-SET Geophysics 8-24-17). Both studies sufficiently characterize the horizons in which the FlexBor will be constructed.

e. Provide a specific detail on how the “flex bore” unit will be set up at the entry/exit points, including any necessary bore or “relief” pits.

The revised plan of installation attached to this response indicates the location and size of the pits that will be utilized during the bore. A plan view and cross section typical for a FlexBor is attached to show the arrangement of equipment. No relief pits are planned, nor should any be required.

f. Explain additional measures Sunoco is proposing to implement during “flex bore” operations to address any threats to the environment, public health, or water supplies that may arise from such operations. DEP recommends protocols at least as protective as what was done for the pullback work at HDD 290.

SPLP asserts that since the work plan for this portion of the project has been modified to a horizontal bore using FlexBor equipment, then no additional measures to address threats to the environment, public health, or water supplies should be necessary.

The protocols implemented at HDD 290, as referenced by the DEP include:

- A vacuum truck will be stationed onsite to remove drilling fluid in the event of reactivation of an IR;
- Additional crew will be stationed along the drill path for pipe pull monitoring;
- The containment structures will remain in place until the pipe pull is complete, and
- Additional containment materials will be on hand if needed

SPLP agrees that control and containment materials should be on hand if needed. These are staged along most work locations, and are specifically staged at the locations of HDDs and bores. Vacuum trucks are already on call; although as discussed above in the response to Item 1c, the risks of an IR by this method are substantially less than for an HDD. SPLP believes the normal staffing level for inspection will be sufficient for this bore.

2. Explain what alternatives have been considered, aside from the Pipeline Infrastructure Task Force (PITF) recommendation of co-locating the route. Particularly, what alternatives (including alternative routing) have been considered to avoid or minimize impacts to residential, commercial, institutional areas, woodlands, and surface waters such as S-B79 and S-B81, and including wetlands such as B71? Additional stream or wetland impacts will need a separate permit modification request to both DEP and ACOE that specifically meet the regulatory requirements.

As noted in the previously submitted HDD reanalysis, considerable effort was expended in the permitting phase of the Mariner II project to review and account for alternative placement of the new pipelines, and that initial analysis was incorporated into the HDD reanalysis. More specifically, as stated in the Alternative Analysis section of the HDD Reevaluation Report referenced above, the original Swedesford Road HDD (S3-0381) was co-located with the existing SPLP pipeline right-of-way (ROW). Given the length and general perpendicular direction of streams S-B79 and S-B81, no practicable re-route option lies to the northeast or southwest of the proposed route that would not ultimately cross these streams. No reasonably practicable re-route option lies immediately to the northeast or southwest of the proposed route that would not ultimately cross additional water resources regulated by the Department. The changes in the construction plans as presented in the Major Modification Permit request submitted by SPLP to the Department and USACE on October 3, 2017, still result in avoidance of impacts to stream S-B79 and wetland B71, and the proposed minor changes to the request will not alter the impacts analysis.

In a broader view rerouting, away from the existing SPLP easement would first require routing through residential, commercial, and infrastructure developments in the Exton area to reach lands devoid of such developments. Once the re-route entered undeveloped lands, it would then result in new impacts by creating a new greenfield utility corridor in areas that are not currently encumbered, and then at some unspecified point, a reroute would have to return to the existing route of the Mariner II project or utilize an alternate route that achieves the same end point. SPLP does not recommend the transfer of a utility encumbrance from a pre-existing location, where the presence of pipeline utilities is well known to past and current landowners, to a new set of previously unencumbered lands and landowners.

As noted above, SPLP previously submitted a permit modification request to the Department and USACE to address the stream or wetlands impacts resulting from the change in crossing methodology proposed by SPLP, and the proposed minor changes to the request will not alter the impacts analysis.

3. Provide additional information on studies conducted and/or measures taken to specifically address concerns with potential impacts to public and private water supplies, including well production zones, from conventional boring and open trenching, including an explanation of how the implementation of such measures will avoid private and public water supply impacts.

Information concerning potential impacts to public and private water supplies, and well production zones from the proposed construction methodologies was initially provided to the Department as part of the Major Modification Permit request submitted by SPLP to the Department on October 3, 2017, and in the Reevaluation Report.

As is stated in the hydrogeological evaluation, *"The overburden thickness, measured in five geotechnical borings advanced to support the original HDD design, ranged from 18 to 52 feet thick or greater (as some borings did not achieve top of rock). The textures of the materials described in the overburden range were silty sands to sandy silts with minor amounts of gravel."*

As stated in the Reevaluation Report, average well depths in the project area vary from 120 to 180 ft below the ground. The well production zone is from the bottom of the well to the highest point of water inflow into the well from adjacent water bearing fractures and bedding plane partings in the bedrock.

As noted above, SPLP intends to revise crossing methodology for S3-0382 to a shorter FlexBor. Conventional construction techniques such as open trench, auger boring, and FlexBor typically take place within 15 ft of depth or less below the ground surface. In this instance, the new plan contemplates a straight pit launched bore approximately 497 ft in length, with a minimum depth of cover of 7 ft, and maximum depth of cover of 17 ft. The entire length of this bore would pass through overburden materials. This depth of construction disturbance is well above any well production zone or water bearing zone in bedrock within public or private water supply wells. The Mariner II Spill Prevention,

Containment, Control, and Countermeasure Plan is utilized and implemented to prevent or remediate any surface contamination that could leach to water bearing zones below ground.

4. Provide proof that SPLP has complied with the “Adjacent Features Analysis” part of the Report providing that “if any landowner within the 450 ft radius of the HDD radius fails to respond, agents for SPP will initiate direct contact by phone or in person to engage the owners for a determination of potable water source”, and explain how such measures satisfy the “analysis of well production zones” provisions of paragraph 4.ii, of the August 10, 2017 Corrected Stipulated Order (“Order”), alone, or in combination with, other measures detailed in your response.

The Reevaluation Report submitted to the Department on November 3, 2017, was sent via certified mail to every landowner within 450 ft of the alignment proposed in the Reevaluation Report. As noted previously, however, the proposed HDD has been modified from the design submitted in November to what is considered a conventional bore by industry standards, as depicted on the attached revised project plans, using FlexBor equipment. Accordingly, a response from these landowners was no longer necessary, and therefore direct contact with the landowners that did not respond was not initiated.

In conjunction with the Reevaluation Report, SPLP analyzed well production zones in vicinity to the previously proposed Swedesford Road HDD (HDD No. S3-381) using available private and public water supply well data. Based on that information, SPLP ultimately concluded that the risk to groundwater well production zones can be reduced by using conventional construction techniques such as open trench, auger boring, and horizontal FlexBor since the depth of disturbance will take place within 17 ft of depth or less below the ground surface. This depth is sufficiently above any well production zone or water bearing zone in the bedrock relied upon for by public or private water supply wells.

5. Detail the measures undertaken in the reevaluation to ensure that issues SPLP has experienced with the operation of HDDs, including inadvertent returns, and impacts to private water supplies in West Whiteland Township, have been adequately considered and addressed by Sunoco, in conducting it reevaluation, and explain how these measures comply with paragraph 4 of the Order.

The HDD reanalysis performed by SPLP in compliance with Paragraph 4 of the Order confirmed the use of an alternative construction method, which SPLP had previously proposed in the Major Modification permit request submitted to the Department in October 2017. SPLP considered its previous experience with HDDs across the project in deciding to propose an alternative construction technique. The previously submitted permit modification request addresses potential risks to public and private water supplies resulting from the change in crossing methodology proposed by SPLP. The proposed minor change to the permit modification request will not change this analysis.

6. The Report indicates that Karst geology is present in the area. Detail the measures undertaken to ensure that the proposed alternative from the reevaluation of “flex bore” and open cut will not result in sinkholes, and how these measures comply with paragraphs 4.iii and iv of the Order.

Soil and bedrock data developed from the installation of geotech borings and completion of 2 geophysical studies in the geologies (Ledger & Conestoga Formations) to be encountered by the FlexBor show no mappable subsidence or sinkhole features in the current pipeline alignment either to the northwest or southeast of the bore path. The horizon in which the FlexBor will operate is in an unconsolidated soil horizon with variable thicknesses greater than 20ft. which is beyond deeper than the maximum bore depth as planned.

Open cut excavation and pipeline installation in karst environments are managed by construction protocols that include but are not limited to: 1) management of surface water runoff/discharge as not to allow infiltration within the excavated areas; and 2) inspection and contingency planning for any soils subsidence related to excavation activities to mitigate cavitation propagation.

7. The Report concludes that “a geophysics study is required to determine the extent of karst development along the profile of HDD S3-0382”, especially in light of installation challenges that are being experienced at HDD S3-400 due south of HDD S3-0382, including excessive groundwater discharge; loss of fluids, with no IRs to date; and difficulties steering the pilot hole”. Explain why no geophysical study has been conducted. Further explain how SPLP can, in the absence of a geophysical study, proceed with the methods proposed in the reevaluation without adversely impacting public or private water supplies, resulting in returns or loss of returns of drilling fluids, or causing other adverse environmental impacts, including impacts to water resources such as streams, groundwater, or wetlands.

Both geologic formations (Ledger at the entry point and the Conestoga near the drill exit) have been evaluated from prior geophysical studies and provide representative characteristics relative to each formations horizon where the FlexBor will be performed and indicated the absence of subsidence or sinkhole prone areas along the pipeline LOD. Additionally, geotech boring SB-04 lies near the eastern end of the FlexBor path near the area of transition between both geologic formations and provides data to 30ft. in depth beyond the maximum depth of the FlexBor. Neither of the studies or geotechnical data has indicated any near surface data that would indicate a high probability development of sinkholes from FlexBor activity. Moreover, obtaining additional geophysics along this drill path would provide little additional useful information because: 1) the area available for the geophysical transect run is limited by Lincoln Highway (Route 30); and 2) proximity of highway traffic and vibrations on geophysical equipment (MASW) negatively affects acquisition of quality data within 300 ft. of the road. In light of the foregoing, as noted in the Reevaluation report, the results of additional geophysical surveys in such a small area will not provide additional information that will meaningfully reduce the risk of an IR at this location. Engineering controls, alternate drilling technology and drilling best management practices will be utilized to minimize the risk of IRs and impacts to water resources.

8. The Report concludes that “the risk of losing fluids, IRs, of groundwater flowback discharges and lowering the local water table could not be assessed given the available information.” Explain why such information was not obtained as part of the reevaluation. Further explain how SPLP can, in the absence of such information proceed with the methods proposed in the reevaluation without adversely impacting public or private water supplies, resulting in returns or loss of returns of drilling fluids, or causing other adverse environmental impacts, including impacts to water resources such as streams, groundwater, or wetlands.

The proposed method for the 497 ft. of pipe installation significantly reduces the risk of an adverse impact on public or private water supplies or other water resources because 1) the proposed construction method utilizes FlexBor technology, which eliminates the use of pressurized re-circulated drilling mud; 2) the depth of the boring occurs at a maximum of 17 ft. below land surface and remains in the unconsolidated overburden materials; and 3) the bore does not intercept the water table at reported depths. This methodology mitigates any impact to public or private wells due to the shallow soils horizon in which it will be constructed and lies above bedrock horizons where wells, of these types, are constructed and withdraw groundwater at significant deeper depths. The bore will cross beneath stream S-B79 midway in boring advancement at approximately 10 ft. below ground surface. The FlexBor operation accounts for any surface water intrusion at such crossings by providing isolation via casing installation during bore advancement.

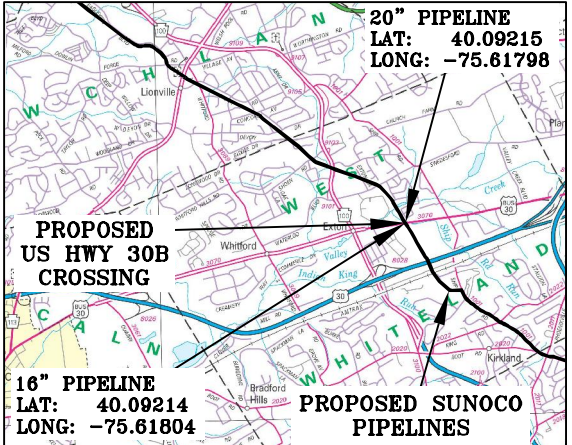
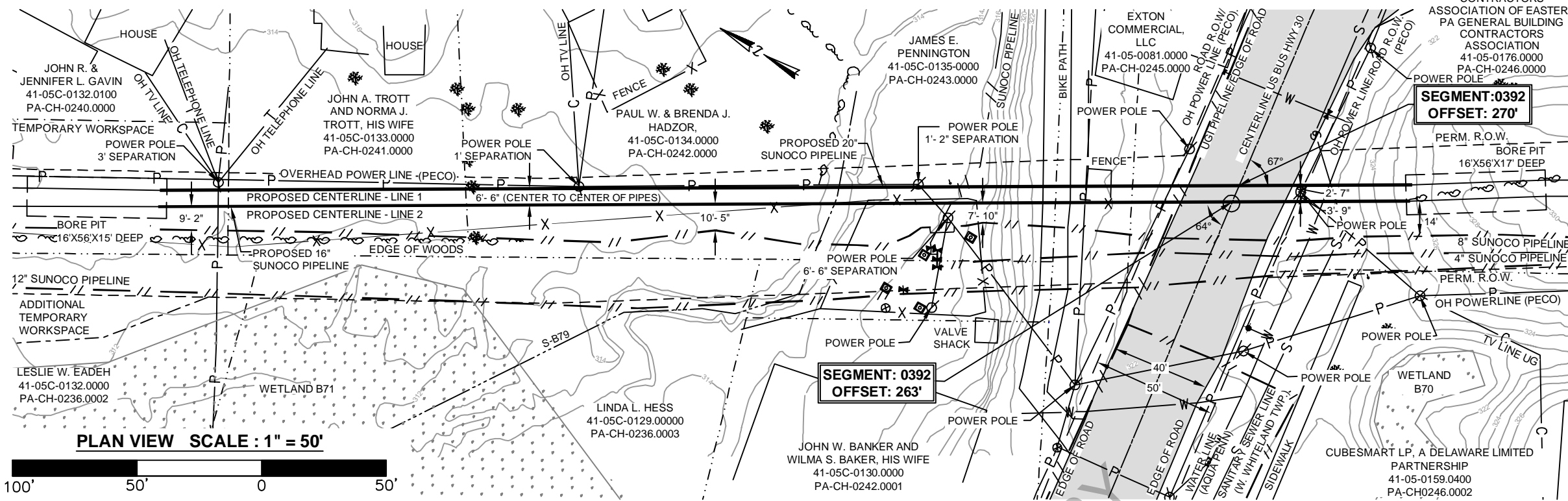
SPLP appreciates the Department’s review of the reevaluations of the Swedesford Road HDD. Respectfully, in light of SPLP’s decision to change the crossing methodology based on the reanalysis, we request the Department to cease any further consideration of the HDD construction method initially proposed at this location, and to commence review of the Major Modification Permit submittal dated October 17, 2017, as soon as SPLP submits the minor amendment to the permit modification request.

Sincerely,



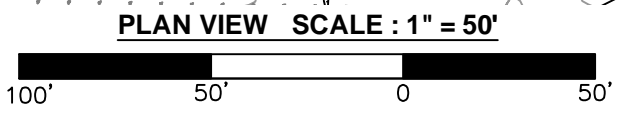
Matthew Gordon
Project Director

WEST WHITELAND TOWNSHIP, CHESTER COUNTY, PENNSYLVANIA

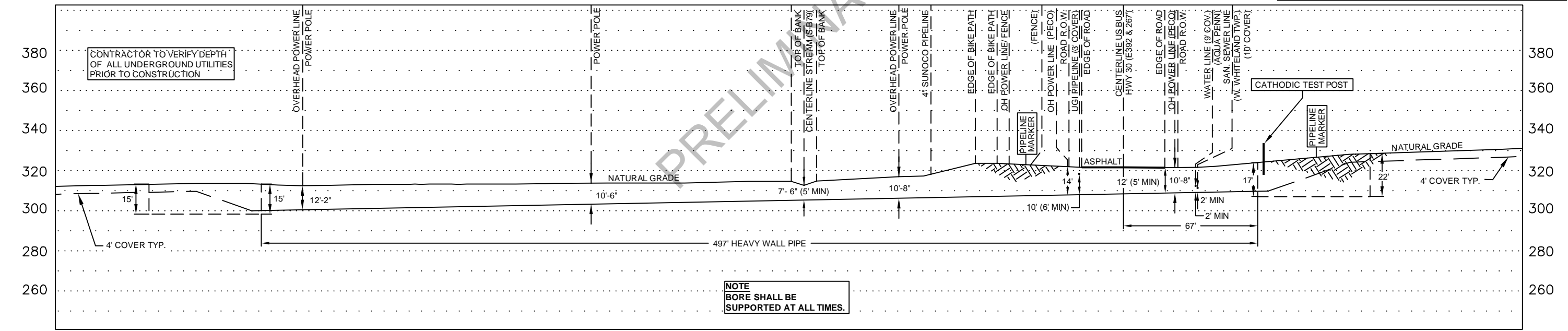


AERIAL VIEW
SCALE: 1" = 2MI

DRAWING LEGEND	
	PERMANENT R.O.W.
	ROAD R.O.W.
	PROPERTY LINE
	OVERHEAD POWER LINE
	TEMPORARY WORKSPACE
	ADDITIONAL TEMPORARY WORKSPACE
	SEWER LINE
	WATER LINE
	FENCE
	TV LINE
	PIPELINE
	EDGE OF WOODS
	FIRE HYDRANT
	MANHOLE
	POWER POLE
	TREE
	LIGHT POLE
	PEDESTAL
	VALVE



E LINCOLN WAY/US BUS HWY 30/S.R. 3070



- ROAD NOTES**
(APPLIES TO BOTH 16" & 20" PIPELINES)
- 20" WELDED STEEL PIPE 20" OD x .456 WT., X-65, API 5L, PSL2, ERW, DRL
 - 16" WELDED STEEL PIPE 16" OD x .438 WT., X-70, API 5L, PSL2, ERW, BFW
 - COATING: 14-16 MILS OF 3M SCOTCHKOTE TM 6233 FBE WITH 40 MILS MIN. DFT POWERCRETE R95
 - DESIGN FACTOR: 0.50 (HOOP STRESS)
 - DESIGN PSI: 1480 PSIG TEST PSI: 1850
 - WELDING PROCESS(ES): ALL WELDING IS DONE IN ACCORDANCE TO PENNDOT AND APPROVED SUNOCO PROCEDURES.
 - THE COATING ON THE CARRIER PIPE SHALL BE INSPECTED IMMEDIATELY PRIOR TO ITS INSTALLATION AND ALL DAMAGED COATING SHALL BE REPAIRED IN ACCORDANCE WITH SUNOCO PIPELINE SPECIFICATIONS
 - PIPELINE CROSSING SHALL BE AS NEAR TO PERPENDICULAR TO THE ROADWAY CENTERLINE AS PRACTICAL
 - INSTALL CATHODIC PROTECTION TEST LEADS AS SPECIFIED ON THE ALIGNMENT SHEETS OR SUNOCO CORROSION TECHNICIAN STANDARDS
 - WELDED JOINTS INSIDE R.O.W. SHALL BE 100% X-RAYED
 - ROAD R.O.W. WIDTHS SHOWN ARE BASED ON VISUAL EVIDENCE.
 - BORE LENGTH: +/- 953' (20") / +/- 953' (16") (APPROX).

- CONSTRUCTION NOTES**
- CONTRACTOR WILL MAINTAIN 4' OF COVER TO THE TOP OF PIPE OUTSIDE OF ROAD R.O.W. USING FIELD BENDS
 - CONTRACTOR SHALL USE THE "ONE CALL" SYSTEM PRIOR TO BEGINNING WORK. CONTRACTOR SHALL BE RESPONSIBLE TO LOCATE AND VERIFY ALL PARALLEL AND CROSSED UTILITIES PRIOR TO EXCAVATION OR CONSTRUCTION (AND MONITOR DURING EXCAVATION OR CONSTRUCTION). THIS DRAWING SHALL NOT CONSTITUTE VERIFICATION OF LOCATION, QUANTITY, SIZE, DEPTH, OR TYPES OF EXISTING UTILITIES.
 - EMERGENCY CONTACT INFORMATION: SEE INCLUDED COMPANY INFORMATION
 - UPON COMPLETION, UTILITY WILL BE REGISTERED WITH PENNSYLVANIA ONE-CALL SYSTEM
 - ALL WORK AND MATERIALS SHALL CONFORM WITH PENNDOT AND ALL FEDERAL REGULATIONS AND STANDARDS
 - PUBLICATION 213 PATA 5 & PATA 10A APPLIES
 - SUNOCO PIPELINE, L.P. WILL BE AVAILABLE 24/7 FOR EMERGENCY AT 800-786-7440 IF SUCH A PROBLEM SHOULD ARISE.
 - THIS PLAN IS FOR PERMITTING PURPOSES ONLY
 - FOR HDD DESIGN SEE: PA-CH-0245.0000-RD & PA-CH-0245.0000-RD-16

- PER PUBLICATION 16M; DESIGN MANUAL PART 5, CHAPTER 1.3.D FOR UNCASED PIPELINE:**
- CATHODIC PROTECTION TEST LEADS ARE INSTALLED AS SPECIFIED ON THE ALIGNMENT SHEETS PER SUNOCO'S CORROSION PROGRAM.
 - PLASTIC PIPE WILL NOT BE USED; ONLY WELDED STEEL DUCTILE IRON OR REINFORCED CONCRETE WILL NOT BE USED; ONLY WELDED STEEL.
 - THE WALL THICKNESS SHOWN ON THE DRAWINGS MEET OR EXCEED ALL APPLICABLE FEDERAL AND INDUSTRY STANDARDS.
 - THE OPERATING STRESS LEVELS INDICATED ON THE DRAWINGS ARE IN ACCORDANCE WITH THE FEDERAL PIPELINE SAFETY REGULATIONS.
 - IT IS ACKNOWLEDGED THAT IF IN THE FUTURE THE CROSSING NEEDS REPLACEMENT, THE REPLACEMENT LINE WILL BE BORED AT A NEW LOCATION.

PROFILE
HORIZ. SCALE : 1" = 50'
VERT. SCALE : 1" = 50'

COORDINATE SYSTEM
PENNSYLVANIA STATE PLANE SOUTH NAD 83 US FEET

24/7 CONTACT INFO & PIPE MARKER INFO:
SUNOCO PIPELINE L.P.
525 FRITZTOWN ROAD
SINKING SPRING, PA 19608
PHONE NUMBER: 800-786-7440
NATURAL GAS PIPELINE

R.O.W. INGRESS X=2565474.64 Y=260704.32
R.O.W. EGRESS X=2565503.07 Y=260657.18

CENTERLINE REV DATE: 11-21-2017

SUNOCO
E LINCOLN WAY/US BUS HWY 30/S.R. 3070
WEST WHITELAND TOWNSHIP, CHESTER CO., PA

06/11/15 REVISED	SCALE AS NOTED	DWG #: PPP-PA-CH-0245.0000-RD
12/14/17		

Prepared by TRICO SURVEYING AND MAPPING
BLOOMINGTON, INDIANA
WWW.TRICOSURVEYING.COM

7



MATERIAL SAFETY DATA SHEET

Product Trade Name: **BARA-KADE® BENTONITE**

Revision Date: 01-Dec-2014

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Trade Name: BARA-KADE® BENTONITE
Synonyms: None
Chemical Family: Mineral
Application: Additive

Manufacturer/Supplier BENTONITE Performance Minerals LLC
3000 N Sam Houston Parkway East
Houston, TX 77032

Telephone: (281) 871-7900
Fax: (281) 871-7940
Emergency Telephone: (281) 575-5000

Prepared By Chemical Compliance
Telephone: 1-580-251-4335
e-mail: fdunexchem@halliburton.com

2. COMPOSITION/INFORMATION ON INGREDIENTS

Substances	CAS Number	PERCENT (w/w)	ACGIH TLV-TWA	OSHA PEL-TWA
Bentonite	1302-78-9	60 - 100%	TWA: 1 mg/m ³	Not applicable
Crystalline silica, quartz	14808-60-7	1 - 5%	TWA: 0.025 mg/m ³	10 mg/m ³ %SiO ₂ + 2
Crystalline silica, cristobalite	14464-46-1	0.1 - 1%	TWA: 0.025 mg/m ³	1/2 x 10 mg/m ³ %SiO ₂ + 2
Crystalline silica, tridymite	15468-32-3	0.1 - 1%	0.05 mg/m ³	1/2 x 10 mg/m ³ %SiO ₂ + 2

More restrictive exposure limits may be enforced by some states, agencies, or other authorities.

3. HAZARDS IDENTIFICATION

Hazard Overview

CAUTION! - ACUTE HEALTH HAZARD

May cause eye and respiratory irritation.

DANGER! - CHRONIC HEALTH HAZARD

Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposures below recommended exposure limits. Wear a NIOSH certified, European Standard EN 149, AS/NZS 1715, or equivalent respirator when using this product. Review the Safety Data Sheet (SDS) for this product, which has been provided to your employer.

4. FIRST AID MEASURES

Inhalation	If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.
Skin	Wash with soap and water. Get medical attention if irritation persists.
Eyes	In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.
Ingestion	Under normal conditions, first aid procedures are not required.
Notes to Physician	Treat symptomatically.

5. FIRE FIGHTING MEASURES

Flash Point/Range (F):	Not Determined
Flash Point/Range (C):	Not Determined
Flash Point Method:	Not Determined
Autoignition Temperature (F):	Not Determined
Autoignition Temperature (C):	Not Determined
Flammability Limits in Air - Lower (%):	Not Determined
Flammability Limits in Air - Upper (%):	Not Determined

Fire Extinguishing Media All standard firefighting media.

Special Exposure Hazards Not applicable.

Special Protective Equipment for Fire-Fighters Not applicable.

NFPA Ratings: Health 0, Flammability 0, Reactivity 0
HMIS Ratings: Health 0*, Flammability 0, Physical Hazard 0, PPE: E

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures Use appropriate protective equipment. Avoid creating and breathing dust.

Environmental Precautionary Measures None known.

Procedure for Cleaning / Absorption

Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

7. HANDLING AND STORAGE

Handling Precautions This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet.

Storage Information Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Do not reuse empty container.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits.

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection Not normally needed. But if significant exposures are possible then the following respirator is recommended:
Dust/mist respirator. (N95, P2/P3)

Hand Protection Normal work gloves.

Skin Protection Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.

Eye Protection Wear safety glasses or goggles to protect against exposure.

Other Precautions None known.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Solid
Color:	Various
Odor:	Odorless
pH:	8-10
Specific Gravity @ 20 C (Water=1):	2.65
Density @ 20 C (lbs./gallon):	Not Determined
Bulk Density @ 20 C (lbs/ft3):	50-70
Boiling Point/Range (F):	Not Determined
Boiling Point/Range (C):	Not Determined
Freezing Point/Range (F):	Not Determined
Freezing Point/Range (C):	Not Determined
Vapor Pressure @ 20 C (mmHg):	Not Determined
Vapor Density (Air=1):	Not Determined
Percent Volatiles:	Not Determined
Evaporation Rate (Butyl Acetate=1):	Not Determined

Solubility in Water (g/100ml):	Insoluble
Solubility in Solvents (g/100ml):	Not Determined
VOCs (lbs./gallon):	Not Determined
Viscosity, Dynamic @ 20 C (centipoise):	Not Determined
Viscosity, Kinematic @ 20 C (centistokes):	Not Determined
Partition Coefficient/n-Octanol/Water:	Not Determined
Molecular Weight (g/mole):	Not Determined

10. STABILITY AND REACTIVITY

Stability Data:	Stable
Hazardous Polymerization:	Will Not Occur
Conditions to Avoid	None anticipated
Incompatibility (Materials to Avoid)	Hydrofluoric acid.
Hazardous Decomposition Products	Amorphous silica may transform at elevated temperatures to tridymite (870 C) or cristobalite (1470 C).
Additional Guidelines	Not Applicable

11. TOXICOLOGICAL INFORMATION

Principle Route of Exposure Eye or skin contact, inhalation.

Symptoms related to exposure

Acute Toxicity

Inhalation

Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A).

Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).

Eye Contact

May cause eye irritation

Skin Contact

May cause mechanical skin irritation.

Ingestion

None known

Chronic Effects/Carcinogenicity

Silicosis: Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis.

Cancer Status: The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2).

There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

Toxicology data for the components

Substances	CAS Number	LD50 Oral	LD50 Dermal	LC50 Inhalation
Bentonite	1302-78-9	> 5000 mg/kg (Rat) > 2000 mg/kg (Rat)	No data available	> 5.27 mg/L (Rat)
Crystalline silica, quartz	14808-60-7	> 5000 mg/kg (Rat)	No data available	No data available
Crystalline silica, cristobalite	14464-46-1	> 5000 mg/kg (Rat)	No data available	No data available
Crystalline silica, tridymite	15468-32-3	> 5000 mg/kg (Rat)	No data available	No data available

12. ECOLOGICAL INFORMATION

Ecotoxicological Information

Ecotoxicity Product

Acute Fish Toxicity:	TLM96: 10000 ppm (Oncorhynchus mykiss)
Acute Crustaceans Toxicity:	Not determined
Acute Algae Toxicity:	Not determined

Ecotoxicity Substance

Substances	CAS Number	Toxicity to Algae	Toxicity to Fish	Toxicity to Microorganisms	Toxicity to Invertebrates
Bentonite	1302-78-9	EC50(72h): > 100 mg/L (freshwater algae)	TLM96: 10000 ppm (Oncorhynchus mykiss) LC50(96h): 16000 - 19000 mg/L (Oncorhynchus mykiss) LC50(24h): 2800 - 3200 mg/L (black bass, warmouth bass, blue gill and sunfish)	No information available	EC50(96h): 81.6 mg/L (Metacarcinus magister) EC50(96h): 24.8 mg/L (Pandalus danae) EC50(48h) > 100 mg/L (Daphnia magna)
Crystalline silica, quartz	14808-60-7	No information available	LL0(96h): 10000 mg/L (Danio rerio) (similar substance)	No information available	LL50(24h): > 10000 mg/L (Daphnia magna) (similar substance)
Crystalline silica, cristobalite	14464-46-1	No information available	LL0(96h): 10000 mg/L (Danio rerio) (similar substance)	No information available	LL50(24h): > 10000 mg/L (Daphnia magna) (similar substance)

Crystalline silica, tridymite	15468-32-3	No information available	LL0(96h): 10000 mg/L(Danio rerio) (similar substance)	No information available	LL50(24h): > 10000 mg/L (Daphnia magna) (similar substance)
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12.2. Persistence and degradability

Substances	CAS Number	Persistence and Degradability
Bentonite	1302-78-9	The methods for determining biodegradability are not applicable to inorganic substances.
Crystalline silica, quartz	14808-60-7	The methods for determining biodegradability are not applicable to inorganic substances.
Crystalline silica, cristobalite	14464-46-1	The methods for determining biodegradability are not applicable to inorganic substances.
Crystalline silica, tridymite	15468-32-3	The methods for determining biodegradability are not applicable to inorganic substances.

12.3. Bioaccumulative potential

Substances	CAS Number	Log Pow
Bentonite	1302-78-9	No information available
Crystalline silica, quartz	14808-60-7	No information available
Crystalline silica, cristobalite	14464-46-1	No information available
Crystalline silica, tridymite	15468-32-3	No information available

12.4. Mobility in soil

No information available

12.5. Results of PBT and vPvB assessment

No information available.

Substances	PBT and vPvB assessment
Crystalline silica, quartz	Not PBT/vPvB

12.6. Other adverse effects

13. DISPOSAL CONSIDERATIONS

Disposal Method Bury in a licensed landfill according to federal, state, and local regulations.

Contaminated Packaging Follow all applicable national or local regulations.

14. TRANSPORT INFORMATION

US DOT

UN Number: Not restricted
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable

US DOT Bulk

DOT (Bulk) Not applicable

Canadian TDG u10

UN Number: Not restricted
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable

IMDG/IMO

UN Number: Not restricted

UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable

IATA/ICAO

UN Number: Not restricted
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code: Not applicable

Special Precautions for User: None

15. REGULATORY INFORMATION

US Regulations

US TSCA Inventory All components listed on inventory or are exempt.

EPA SARA Title III Extremely Hazardous Substances Not applicable

EPA SARA (311,312) Hazard Class Acute Health Hazard
Chronic Health Hazard

EPA SARA (313) Chemicals This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).

EPA CERCLA/Superfund Reportable Spill Quantity Not applicable.

EPA RCRA Hazardous Waste Classification If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.

California Proposition 65 The California Proposition 65 regulations apply to this product.

MA Right-to-Know Law One or more components listed.

NJ Right-to-Know Law One or more components listed.

PA Right-to-Know Law One or more components listed.

Canadian Regulations

Canadian DSL Inventory All components listed on inventory or are exempt.

WHMIS Hazard Class Crystalline silica

16. OTHER INFORMATION

The following sections have been revised since the last issue of this SDS
Not applicable

Additional information

For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Compliance at 1-580-251-4335.

Disclaimer Statement

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*****END OF MSDS*****