Landslide Hazard Evaluation and Temporary Slope Stabilization Plan

Revolution Pipeline
Butler, Beaver, Allegheny, and
Washington Counties, Pennsylvania

for

ETC Northeast Pipeline, LLC

February 23, 2019

GeoEngineers
Earth Science + Technology

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File No. 18782-026-01

February 23, 2019

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Table of Contents

LIST OF FIGURES

APPENDICES

EXECUTIVE SUMMARY

GeoEngineers, Inc. (GeoEngineers) is pleased to present this Landslide Hazard Evaluation and Temporary Slope Stabilization Plan for the existing Revolution Pipeline Alignment in Butler, Beaver, Allegheny and Washington Counties, Pennsylvania. We understand that ETC Northeast Pipeline, LLC (ETC) is submitting plans to meet the requirements of the Compliance Order, dated October 29, 2018, issued by the Pennsylvania Department of Environmental Protection (PADEP). Our work was performed, and our recommendations are provided, to assist in the development of these plans.

To assess the risk of landsliding and associated sediment delivery to Waters of the Commonwealth of Pennsylvania, GeoEngineers performed the following primary tasks:

1. Performed a desktop review and evaluation of existing published mapping and reports for the entire Revolution Pipeline alignment, including:
    a. Publicly-available geological mapping, light detection and ranging (LiDAR) data, landslide mapping data and aerial photography.
    b. ETC-provided design-, construction- and restoration-phase reports.
2. Interpreted a LiDAR-generated hillshade model in order to map historic, deep-seated landslides along or near the entire Revolution Pipeline alignment.
3. Identified areas along the Revolution Pipeline alignment where steep (greater than 40 percent) fill slopes were constructed based on LiDAR-generated digital elevation model (DEM).
4. Performed site reconnaissance of slope failures documented by ETC and other areas of potential landslide risk identified in the desktop study.

The results of GeoEngineers desktop study indicate the pipeline alignment crosses or is near 16 historical landslides and includes 12 steep fill slope segments of varying length.

During our site reconnaissance work, GeoEngineers did not identify additional slope failures or active slope movement beyond the 39 areas documented by ETC. However, two of the previously identified slope failure sites (Elkhorn Run #1 and Penny Hollow Road) are considered complex, involving both recent pipeline construction related slope failures as well as historical landsliding. GeoEngineers plans to continue to study these sites, and others as part of our work on the development of the Permanent Stabilization Plan for the project.

As documented in Appendix B, of the 39 slope-failure sites evaluated by GeoEngineers, 26 are considered relatively stable, and/or appear to have a low risk for imminent delivery of sediment to Waters of the Commonwealth. For those sites, Erosion and Sediment (E&S) Controls, including temporary and permanent waterbars presented in the E&S Plans, will be used to address the risk of erosion, sliding or other movement until permanent stabilization measures can be developed. Additionally, we recommend that these sites be subject to a monitoring program as described in detail in this report. The remaining 12 slope failure sites require additional temporary stabilization controls. GeoEngineers developed site-specific, interim stabilization recommendations for engineering controls to reduce the risk of sediment delivery to the Waters of the Commonwealth at these 13 sites, until they can be permanently stabilized. These measures

are included in the Temporary Stabilization Plan, which is intended to be implemented prior to the forthcoming Permanent Stabilization Plan.

The temporary engineering control recommendations are primarily intended to improve surface and subsurface drainage at the sites of concern. A summary of the site-specific temporary stabilization measures is presented in Table B-1 in Appendix B of this report. We understand that surface water runoff controls and erosion hazards for the entirety of the alignment will be addressed in an Erosion and Sedimentation Control Plan, which is being prepared by others.

The Temporary Stabilization Plan elements are included as 1:50 scale plan-view Sheets TS-1 through TS-220; Specifications and Notes Sheets NT-1 through NT-14 (one for each site); and Detail and Section Sheets DT-01 through DT-10. Please note that historic landslides mapped by GeoEngineers are also shown in the Temporary Stabilization Plan drawings.

This Executive Summary should be used only in the context of the full report for which it is intended.

INTRODUCTION

GeoEngineers, Inc. (GeoEngineers) is pleased to present this Landslide Hazard Evaluation and Temporary Slope Stabilization Plan for the existing Revolution Pipeline Alignment in Butler, Beaver, Allegheny and Washington Counties, Pennsylvania. We understand that ETC Northeast Pipeline, LLC (ETC) is submitting plans to meet the requirements of the Compliance Order, dated October 29, 2018, issued by the Pennsylvania Department of Environmental Protection (PADEP). Our work was performed, and our recommendations are provided, to assist in the development of these plans.

The Revolution Pipeline stationing presented in this report is based on January 5, 2019 project alignment stationing. This pipeline alignment is shown in the attached Vicinity Map, Figure 1. As part of landslide hazard evaluation, we have completed a due diligence evaluation of the entire pipeline alignment to assess the presence and status of historical, deep-seated landslides and to identify areas where the pipeline is oriented along the contour (side slope) across steep slopes inclined at gradients of greater than 40 percent where substantial cutting and filling is required for pipeline construction.

We have reviewed the mapped landslide and side-slope areas of potential concern in the field along with areas of recent slope failure activity identified by ETC. We have evaluated and mapped landslide features observable from the ground surface. We focused our work on assessing the risk of: (1) discharge of sediment to the Waters of the Commonwealth of Pennsylvania; and (2) impacting the integrity of the Revolution Pipeline.

SCOPE OF SERVICES

GeoEngineers completed the following scope of services:

1. Reviewed publicly-available geological and landslide mapping resources.
2. Reviewed and interpreted historical aerial photography available from the United States Geological Survey (USGS), Google Earth and from other public sources.
3. Reviewed and interpreted existing, publicly-available Light Detection and Ranging (LiDAR) data, to generate a bald-earth hillshade model of the terrain along the pipeline alignment. The LiDAR hillshade model was interpreted for indications of deep-seated landslide topography along the pipeline alignment.
4. Completed a geographic information system (GIS) based analysis of the pipeline alignment to identify pipeline segments where the pipeline traverses roughly parallel to slope contours (side slope) at average grades of 2.5H:1V (horizontal to vertical) (40 percent) or steeper.
5. Reviewed ETC-provided field reports for both the excavation/pipeline construction and site restoration operations.
6. Performed a site reconnaissance of specific areas of concern identified in the previous scope items.
7. Provided this report summarizing the results of our office and field studies and recommendations as outlined below.

REVIEW OF REVOLUTION PIPELINE DESIGN/PRE-CONSTRUCTION DOCUMENTS

GeoEngineers completed a desktop review of the following pre-construction design and geotechnical reports for the Revolution Pipeline Project provided by ETC.

- Terracon Consultants, Inc. (Terracon), Geohazard Evaluation Report, Revolution and C3 Pipelines, PIFs 15067 and 15085, Western Pennsylvania, January 19, 2016.
- Energy Transfer, Volume 4- Pipeline Construction, Engineering Standards- Interstate/Intrastate Title 49 Part 192, November 1, 2016.
- Energy Transfer, Revolution Project Alignment Sheets prepared by Project Consulting Services (PCS), Issued for Construction, February 24, 2017.

Terracon Geohazard Report Summary

The 2016 Terracon report was prepared for PCS and provides a description of geologic conditions along the Revolution Pipeline alignment and surrounding area. Specifically, the report identifies areas of the project alignment that are "prone to landslide and subsidence hazards" based on a GIS-based landslide hazard model. The model calculates and displays a landslide susceptibility score of 1 through 9 based on a variety of input parameters, including the USGS bedrock type, slope angle and stream proximity. The results of the model were presented in map form with the landslide susceptibility score represented by various colors ranging from Green (1) to Red (9). Based on the scale of the map, it is difficult to observe specific areas that were identified with a high landslide susceptibility score. Qualitatively, most of the subject pipeline segment traverses slopes mapped as low to moderate landslide susceptibility.

Terrracon performed a "scan line review" involving a reconnaissance of four segments along the proposed Revolution alignment. The scan line segments were reported to have been selected for observation based on "a GIS desktop review of terrain features in the various geologic settings along with coordination with PCS." The following provides a summary of the findings from Terracon's Scan Lines.

Scan Line 1

Scan Line 1 is located between approximate pipeline stations 1102+00 and 1123+00, which includes the Incident Site. Scan Line 1 consists of three locations (Locations 1, 2 and 3). No indications of landsliding were noted at Locations 1 and 3. At Location 2, Terracon noted overburden creep associated with a spring or seepage from bedrock, sour materials in a swale downslope from the seepage zone, a rotational slip in the south face of the swale and hummocky topography and undrained depressions.

Scan Line 2

Scan line 2 is located at approximate pipeline station 2045+00 at the Campbell Hill Road site, which was affected by slope failures after the pipeline was installed. Terracon noted a landslide hazard at Scan Line 2. Indications of landsliding noted by Terracon include surficial sloughing that was noted at various locations of the recently reclaimed MarkWest pipeline, a very steep slope adjacent to the Revolution Pipeline right-of-way (ROW) and generally flat, poorly drained terrain with ponded water.

Scan Line 3

Scan Line 3 is located between approximate pipeline stations 662+00 and 673+50. Terracon noted that no hazards were observed along Scan Line 3. However, at Scan Line 3 Location 4, Terracon noted that a "possible ancient slip on north slope roughly 150 feet west of centerline" and "hummocky topography with scour features evident upstream of crossing."

Scan Line 4

Scan Line 4 is located approximately 0.3 miles southeast of the southern extent of the Revolution Pipeline. Terracon noted that no hazards were observed along Scan Line 4.

REVIEW OF REVOLUTION CONSTRUCTION DOCUMENTS

GeoEngineers reviewed the Revolution Pipeline Project Inspector's Daily Reports provided by ETC. The following summarizes information identified in the daily reports that are relevant to the pipeline.

Trenching Operations

We reviewed the lowering-in and tie-in reports that were prepared during for the pipeline construction. We did not find any discussion of landsliding in the trenching field reports we reviewed for the subject pipeline segment.

Restoration Operations

We specifically reviewed the ETC-provided Cleanup and Restoration Inspector's Daily Field Reports from October 10, 2017 to September 20, 2018. Based on our review of daily reports, we identified unstable areas following construction as listed and described in Table 1. Stationing has been updated for the current alignment except as noted.

TABLE 1. SUMMARY OF PREVIOUSLY REPORTED UNSTABLE AREAS FROM CLEANUP AND RESTORATION REPORTS

Site ID	Date(s)	Location (Station)	Summary
Crows Run Road	June 29, July 7 and 10, 2017	765+00 to 775+00	These reports document the development and restoration of surface failures along approximate pipeline stationing 765+00 to 775+00.
Zeigler Road	June 29, 2018	330+00	This report documents restoration efforts to a surface failure near approximate pipeline stationing 330+00.
Freedom Crider Road	May 7, 2018	689+40	This report documents a minor surface failure along the shoulder of Freedom Crider Road.
Glen Eden Road	May 4, 2018	Unidentified in Inspection Report	This report documents a surface failure near Glen Eden Road.

Site ID	Date(s)	Location (Station)	Summary
Park Quarry Road	July 26, 28, August 10 and 19, 2017, September 14 and October 5, 2018	732+00 to 737+00	These reports document the development and restoration of surface failures, as well as efforts made to prevent surface failures along approximate pipeline stationing 732+00 to 737+00.
Ivy Lane - Incident Site	July 16, 19, 24, August 4, 9, 13, 14, 17, 20, 23, 25 and 28 2018	1091+00 to 1125+00	These reports document the development and restoration of surface failures, as well as the development of a sunken ditch line, along approximate pipeline stationing 1091+00 to 1125+00.
Penny Hollow Road	August 8, 17, 20, 24, 26, 27, 28, 29, September 5, 10, 13, 19, October 1, 11 and 15, 2018	1212+00 to 1214+00	These reports document the development and restoration of ground cracks as well as recurring surface failures along approximate pipeline station 1214+00.
CIS (Coming In Side) McKibben	August 17, 19, 20 and 25, 2018	1239+00	These reports document the discovery and restoration of slope failures along approximate pipeline stationing 1239+00.
GAS (Going Away Side) McKibben	November 10, 2017	1262+00 to 1264+00	This report documents erosion and a slope failure near approximate pipeline stationing 1262+00 to 1264+00.
SR151	June 11, August 18, 30, September 9, October 9, 17, November 26 and December 7, 2018	1495+00 to 1496+00	These reports document multiple slope failures, restorations to slope failures, and maintenance to erosion control devices near approximate pipeline stationing 1495+00.
CIS of Backbone Road	August 26, 28 and 29, 2018	1631+00 to 1632+00	These reports document restoration efforts made to slope failures near approximate pipeline stationing 1631+00 to 1632+00.
GAS of Backbone Road	June 26, August 24, 25, September 22, 2018 and January 31, 2019	1641+00 to 1642+00	These reports document the installation of erosion control devices and restoration of slope failures to their original grade near approximate pipeline stationing 1641+00 to 1642+00.
Route 30	September 21, 22, 23, 24, 25, 27 and 28, 2018	1697+50 to 1698+00	These reports document restoration efforts to slope failures near approximate pipeline stationing 1697+50 to 1698+00.
CIS Clinton Frankfort	September 29 and 30, 2018	1737+00	These reports document restoration efforts made to slope failures near approximate pipeline stationing 1734+00.
Clinton Frankfort Road	November 28, 2018	1777+50 to 1778+00	This report documents restoration efforts made by hand to a small slope failure near approximate pipeline stationing 1778+00.
GAS Clinton Frankfort	September 7 and October 2, 2018	1809+00	These reports document restoration efforts made to slope failures near approximate pipeline stationing 1809+00.

Site ID	Date(s)	Location (Station)	Summary
Campbell Hill Road	August 4, 6, 9, September 12, 16 and October 25, 2018	2013+00 to 2045+00	These reports document the discovery of slope failures and restoration efforts made to slope failures near approximate pipeline stationing 2013+00 to 2045+00.

The sites described above are included in the inventory of slope failure sites provided to GeoEngineers by ETC for further evaluation in the field. The results of our site reconnaissance are presented further in this report.

SITE CONDITIONS

Geological Conditions

Regional Geologic Setting

Regionally, the site embraces sedimentary geologic sediments of Pennsylvanian age (323 to 299 million years ago). On this larger scale, the rocks and deposits in the area are generally composed of the Allegheny Group, the Casselman and Glenshaw Formations of the Conemaugh Group, and the Uniontown and Pittsburgh Formations of the Monongahela Group.

The underlying sedimentary geology of the region strongly controls the surface features of the area. Within the project vicinity, the underlying rock types and their structure control the presence of ridges and valleys and the steepness of slopes. On a smaller scale, long-term stream meandering and undercutting causes valley widening and bank undercutting and oversteepened slopes. The main rock types present in the region are shale, siltstone, sandstone, limestone and coal.

Surficial Geology

Regionally, the Pittsburgh Low Plateau is dominated by soils developed in acid clay shales and interbedded shales and sandstones. These soils contain more clay and silt than those derived from sandstone. The surface texture of these soils is predominantly silt loam that are usually well drained. Many of the soils in the region can also contain substantial amounts of rock fragments.

Bedrock Geology

Bedrock mapping (Wagner et al. 1975) shows that the Pennsylvanian-age sedimentary rock associated with the Allegheny, Conemaugh and Monongahela Groups underlies the Revolution Pipeline alignment. The Allegheny Group consists of interbedded clay shale, claystone, siltstone, sandstone, limestone and coal. The Conemaugh Group includes the Casselman and Glenshaw Formations. The Casselman Formation is characterized by calcareous claystone, freshwater limestone, sandstone, shale and siltstone. The Glenshaw Formation consists predominantly of sequences of sandstone, shale and mud-rocks with thin limestones and coals. The Monongahela Group consists of the Uniontown and Pittsburgh Formations, both of which consist of interbedded sequences of limestone, shale, sandstone and coal.

Landslide Hazard Mapping

We reviewed a landslide hazard map of the project area (Pomeroy 1979). The map indicates that landslides were interpreted using black and white aerial photography from 1975.

The map shows three types of landslide hazards at the subject slope: (1) Recent Landslides (well-defined, characterized by fresh scars, may still be active); (2) Older Landslides (boundaries approximately located or inferred); and (3) Areas Most Susceptible to Landsliding (underlain mostly by red mudstones of Conemaugh Group).

The landslide hazard map shows that the subject pipeline segment crosses numerous “Older Landslide” sites and “Areas Most Susceptible to Landsliding.” As described in the following section of the report, GeoEngineers interpreted a LiDAR hillshade model to validate the landslide mapping since it was completed prior to development of LiDAR imaging technology. Historic landslides identified along the alignment using LiDAR interpretation are described below and shown in the Temporary Stabilization Plan Drawings.

REVIEW OF LIDAR AND HISTORICAL AERIAL PHOTOGRAPHS

GeoEngineers reviewed and interpreted a hillshade model based on LiDAR and historical orthographic photographs of the subject pipeline segment for indications of landsliding and/or erosion. The following summarizes our observations and interpretations.

LiDAR Hillshade Model

GeoEngineers interpreted a bald-earth hillshade model in order to identify topographic indications of historic, deep-seated landsliding, if present, within or near the pipeline alignment, LiDAR-generated bald earth models are an effective tool for identifying indications of landsliding because they reveal fine details of the landscape normally obscured by the tree canopy. The following Table 2 summarizes the historic landslides that GeoEngineers mapped along the Revolution Pipeline alignment which pre-date its construction.

TABLE 2. SUMMARY OF PRE-EXISTING DEEP-SEATED (HISTORIC) LANDSLIDES IDENTIFIED USING LIDAR HILLSHADE MODEL

ID	Comment	From Station	To Station	Crosses Pipeline Alignment
LS-1	Relatively well-defined landslide starting at the downslope side of the pipeline ROW and extending to Elkhorn Run. The pipeline alignment is oriented sidehill on steep slopes.	864+78	865+79	Yes
LS-2	Possible landslide shown in Landslide Hazard Map. Area is slightly hummocky but LiDAR hillshade interpretation is inconclusive. Pipeline is located adjacent to and north of northern slide boundary.	893+14	896+68	No

ID	Comment	From Station	To Station	Crosses Pipeline Alignment
LS-3	Area mapped as most susceptible to landsliding in Landslide Hazards Map. Interpretation of LiDAR hillshade reveals well-defined margins of a deep-seated landslide situated within the convergent headwall of an unnamed tributary to Raccoon Creek. Landslide margin is located approximately 100 feet east of pipeline ROW. Site reconnaissance required to assess impacts.	1214+00	1218+00	No
LS-4	Indications of deep-seated landsliding, including hummocky topography and partially defined margins. The pipeline crosses the inferred landslide oblique to slope orientation. Feature is located within a larger area mapped as Most Susceptible to Landsliding on Landslide Hazard Map on southwest-facing slopes leading to an unnamed tributary to Raccoon Creek.	1237+90	1241+38	Yes
LS-5	An older landslide mapped in Landslide Hazard Map. Landslide features are poorly defined in LiDAR hillshade. The potential landslide is situated within the convergent headwall of an unnamed tributary to Frame Run. The pipeline is situated on what appears to be a stable ridge adjacent to and above the landslide.	1256+28	1259+49	No
LS-6	Relatively well-defined landslide characterized by mid slope bench on southwest-facing slopes associated with an unnamed second order stream drainage. Pipeline appears to be located on stable ground adjacent to and upslope of feature.	1404+88	1409+13	No
LS-7	Well-defined deep-seated landslide located on south-facing slopes above and north of Bucktown Road. This landslide is also shown as an Older Landslide in the Landslide Hazard Map. Upper headscarp, side margins and slide mass are clearly visible in the LiDAR hillshade. The pipeline crosses the landslide roughly along its axis, parallel to slope (direction of movement).	1488+78	1492+72	Yes

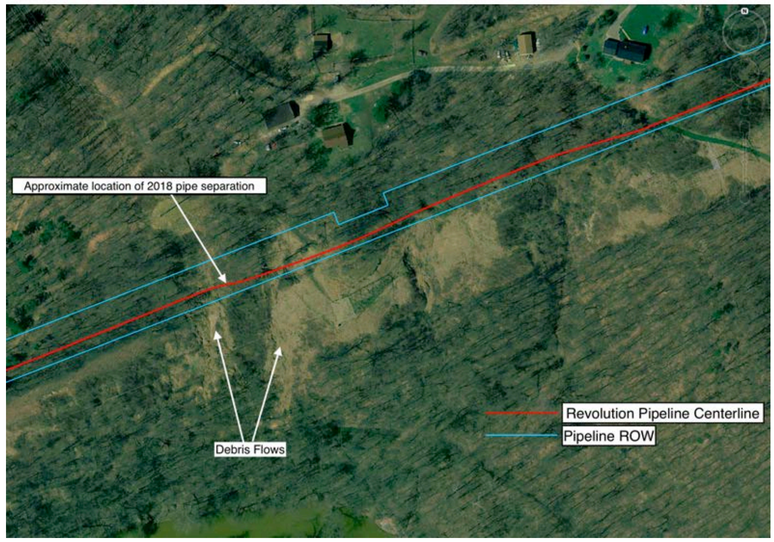
ID	Comment	From Station	To Station	Crosses Pipeline Alignment
LS-8	Indications of an older shallow-rapid type landslide on south-facing slopes above and north of Park Road. The area is mapped as Most Susceptible to Landsliding. The pipeline is located upslope and outside of landslide boundaries.	1609+13	1614+00	No
LS-9	Relatively well-defined landslide observed in west-facing slopes in eastern valley wall of Raccoon Creek. The pipeline appears to cross the zone of evacuation above the landslide deposits.	1644+70	1646+50	Yes
LS-10	Relatively well-defined landslide adjacent to and south of LS-9. The pipeline crosses apparently stable slopes several hundred feet upslope and east of feature.	1646+57	1647+53	No
LS-11	Well-defined landslide on divergent west-facing slopes on eastern valley wall of Raccoon Creek. The pipeline is located about 200 feet downslope of this landslide.	1754+87	1756+00	No
LS-12	Deep-seated landslide characterized by hummocky slide mass and well-defined, oversteepened landslide toe. The landslide is located on west-facing slopes on the eastern valley wall of Raccoon Creek. The pipeline crosses the southern (left) margin of the slide mass.	1769+11	1770+76	Yes
LS-13/LS-15	Two of a series of landslides situated along a steep terraced bluff slope along the eastern valley wall of Raccoon Creek. The pipeline traverses between the two landslides and is oriented parallel to movement.	2040+63	2041+47	No
LS-14	Debris fan at the foot of a steep terraced bluff along the eastern valley wall of Raccoon Creek. These deposits are situated downslope of LS-13 and LS-15. The pipeline crosses and then extends through these deposits for approximately 350 feet.	2043+22	2046+60	Yes
LS-16	Poorly defined, ancient landslide characterized by subtle and weathered headscarp above convergent slope form on north-facing slope leading to drainage in which SR 151 is located. The pipeline parallels just outside the right (east) slide margin.	1496+00	1499+00	No

ID	Comment	From Station	To Station	Crosses Pipeline Alignment
LS-17	Well-defined, relatively small landslide on west-facing slope on east valley wall of Crow's Run. The landslide occurs adjacent and downslope of a linear bench that represents a geologic contact between the upper Glenshaw Formation and the lower Allegheny Formation. It is common for perching water, seeps and instability to occur at such contacts. The pipeline crosses through the central portion of the landslide.	785+90	787+60	Yes
LS-18	Midslope bench and slightly hummocky ground surface on east-facing slope in unnamed tributary drainage to Crow's Run. The pipeline crosses the right (south) margin of the suspected historic landslide.	766+00	766+80	Yes
LS-19	Hummocky topography on gentle moderately steep southwest facing slope above Raccoon Creek. Inferred historic landslide is about 80 feet south of and outside the pipeline ROW. Landslide is approximately 100 feet wide by 100 feet long. Subsequent field reconnaissance indicates the slide has been recently active. Additional evaluation required to assess risk to pipeline.	1158+00	1161+00	No

Historical Aerial Photographs

GeoEngineers reviewed historical aerial photographs from 1993, 2004, 2005, 2007, 2012, and 2014 through 2016 available in Google Earth Pro Software. In addition, we reviewed black and white aerial photographs from the USGS (1969, 1975) that cover the Incident Site. We observed indications of mass wasting and shallow landsliding from the steep south-facing slope identified as the "Incident Site" herein, where the pipeline rupture occurred in September 2018. We did not observe indications of past landsliding such as linear scars or voids in the tree canopy in the aerial images along other pipeline segments outside of the slope at the Incident Site. The following summarizes our observations of construction and landslide features observed within historical aerial photographs at the Incident Site.

Landslide features were first observed in the photograph record in the December 7, 1975 black and white aerial photograph. A relatively large void in the canopy is apparent, starting from the First Energy powerline corridor and extending to the base of the slope as shown in the adjacent photograph. We interpret this void to represent a shallow-rapid debris flow that appears to have emanated from the cleared powerline ROW near the location of the slope failure that caused the pipeline separation.



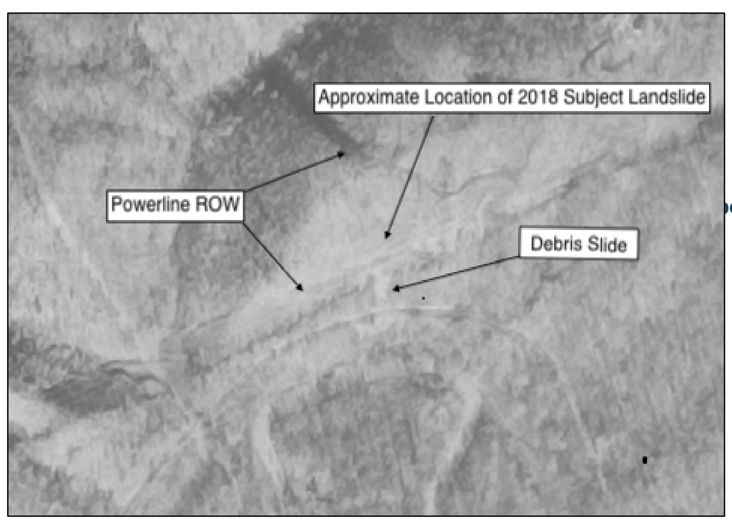
December 1975 Aerial Photograph (USGS 1975)

The 2005 imagery represents the first image in the historical photographic record with a relatively high resolution and quality. The portion of the First Energy powerline corridor where the pipeline separation occurred (approximate pipeline stations 1116+00 to 1118+00) appears to be affected by significant mass wasting as shown in the image to the right. Erosional gullies and small earth flows are apparent from bare soils exposed within the powerline corridor. Specifically, indications of landsliding at the approximate location of the 2018 Incident Site landslide are visible. Landslide and eroded sediment deposits are seen up to about 150 feet downslope of the powerline corridor and extending to the unpaved access road located below. A well-defined debris flow scar is visible within the First Energy powerline corridor approximately 120 feet east of the lattice transmission line tower at the subject site. These features appear to have occurred recently, likely within the previous six months.

In the April 14, 2016 aerial photograph, an erosional gully is apparent within the First Energy powerline corridor at the approximate location of the 2018 slope failure. Another gully can be seen in the powerline corridor approximately 450 feet to the west.

IDENTIFICATION OF STEEP FILL SLOPES

In addition to evaluating the potential presence of pre-existing landslide hazards along the pipeline alignment, GeoEngineers completed an evaluation of fill slopes along the subject pipeline segment. During pipeline installation, a level working surface (referred to as the construction corridor) must be constructed to support construction equipment. Where the pipeline is oriented with the fall line of the slope (perpendicular to contour), both sides of this construction corridor are at the same elevation, but if the pipeline is oriented parallel to contour (side



slope) or oblique to contour, temporary excavations must be made to provide a level working surface from side-to-side. After the pipeline is installed, these excavations are backfilled with the native spoils in order to restore the pipeline ROW to preconstruction grades. Based on our experience, fill slopes of the height/depth typically placed for pipeline ROW restoration have a higher risk of instability at gradients of 40 percent and steeper. Therefore, GeoEngineers identified areas along the pipeline ROW that likely contain fill slopes inclined at gradients of 40 percent or steeper using a LiDAR based digital elevation model (DEM) of the ground surface.

Twelve segments along the pipeline alignment were found to meet this criteria. By station of location these are: 603+80 to 605+85; 665+77 to 670+24; 711+74 to 714+29; 864+26 to 867+28; 1098+81 to 1099+28; 1102+79 to 1103+20; 1111+71 to 1120+28; 1126+74 to 1128+24; 1130+50 to 1131+76; 1599+62 to 1607+27; 1734+26 to 1736+79; and 1793+24 to 1793+73. These segments are identified in Figure 1 and the Temporary Stabilization Plan Sheets.

SITE RECONNAISSANCE

General

GeoEngineers performed a reconnaissance of the deep-seated historical landslides and steep fill slope locations identified from the desktop study. In addition, GeoEngineers observed 39 specific sites along the Revolution Pipeline alignment where ETC reported significant mass wasting activity. The locations of these sites are summarized below and shown in the Vicinity Map, Figure 1. The fieldwork was completed by staff and senior geologists and geotechnical engineers from January 9 through February 8, 2019. Representative photographs of these sites are presented in Appendix A.

GeoEngineers qualitatively assessed the stability of the steep fill slopes in the field based on the presence or absence of common indicators of slope movement such as ground cracks, scarps, seeps toe bulges, or other forms of displacement. The stability, the state of activity, and age of historical landslides is challenging to assess based on surface reconnaissance alone. However, GeoEngineers interpreted the geomorphology and noted the presence or absence of indicators of active movement at the historical landslide sites.

At the sites where active or recently active slope movement (slope failures) was identified by ETC, GeoEngineers mapped the inferred limits of slide movement, ground cracks, scarps, seeps and other relevant surface features using commercial-grade global positioning system- (GPS) enabled tablets. GeoEngineers also evaluated the risk of potential for sediment delivery to the Waters of the Commonwealth.

Table B-1 in Appendix B presents GeoEngineers' observations at the slope failure sites. Relatively complex conditions were identified at three sites identified as the Elkhorn Run #1, Incident Site and Penny Hollow Road. The following provides a summary of observations and findings relative to those three, complex sites.

Elkhorn Run #1

The Elkhorn Run #1 site is located from approximate pipeline station 864+00 to 868+00 where the pipeline alignment traverses convergent north-facing slopes above Elkhorn Run. The pipeline alignment is oriented "sidehill" (east-west) such that a significant excavation and subsequent fill slope construction was completed for the pipeline construction. GeoEngineers identified a well-defined deep-seated landslide

(LS-1) adjacent and downslope of the pipeline alignment as shown on the Temporary Stabilization Plan Sheets. Indications of fill slope instability, including ground cracks and groundwater seepage emerging from the slope, were observed. The fill slope is inclined at a gradient of about 50 percent, which matches native slope grades. The slope gradient decreases to 30 percent or less downslope to the north into the deep-seated landslide.

A portion of the LS-1 headscarp was apparent on the downslope (north) side of the ROW. We observed a near vertical scarp about 25 feet high and 50 feet wide. The scarp exposed about 7 feet of colluvium overlying fractured bedrock. A flat bench representing the slide mass was situated at the base of the scarp. Based on observations, the landslide is classified as a dormant-young rotational earth slide.

GeoEngineers observed arcuate ground cracks at the upslope (south) side of the ROW exhibiting up to 6 inches of vertical displacement (see photo to the right). A spring emerges from within the ROW and flows north towards the scarp of LS-1. Based on our observations, it is our opinion that the ground cracks indicate that a segment of the fill placed for the pipeline ROW restoration is failing.

Looking West along Pipeline ROW at Elkhorn Run Site 1.

We did not identify the toe or base of the slide plane and could not determine if it daylights in the scarp of LS-1. Based on the pipeline markers being located near the downslope (north) side of the ROW, it appears that the pipeline was installed on the outboard (downslope) side of the ROW. Therefore, there is an increased risk that failure of the ROW fill could also displace the pipeline if it was not installed within underlying competent soils or bedrock. It is GeoEngineers' opinion that there is a high risk for the failing fill to rapidly mobilize into a debris flow that could travel to the base of the slope and enter Elkhorn Run. Therefore, this site is considered a high priority for temporary and permanent stabilization.

Landslide LS-1 is characterized by hummocky topography. Although, no clear indications of active movement were observed within the deep-seated landslide, the geomorphology suggests that the landslide is dormant-young and could potentially be a slow-moving, active landslide. Additional study is necessary to confirm the presence or absence of slope movement within the deep-seated landslide.

Incident Site

The Incident Site is located from approximate pipeline stations 1109+00 to 1121+40, where the pipeline alignment traverses a steep, south-facing slope forming the north valley wall above an outside meander bend of Raccoon Creek. The Revolution Pipeline alignment is oriented along contour (side slope) as it traverses across the slope in a roughly east-west direction. GeoEngineers initially observed the site conditions on September 13, 2018, after slope movement caused the pipeline to separate at approximate station 1116+09, following a period of heavy precipitation.

At this site, the pipeline alignment is located adjacent to an existing powerline ROW, which traverses the middle part of the slope in a northeast-southwest direction (perpendicular to the fall line of the slope). The pipeline centerline was constructed near the upslope (northern) edge of the existing, maintained First Energy powerline ROW. Pipeline construction required additional tree removal and clearing further upslope of the First Energy powerline ROW. However, a portion of the temporary extra workspace required for constructing the level working surface is partially located in the existing powerline ROW. Another powerline ROW, identified as the Duquesne ROW, crosses roughly perpendicular to the pipeline ROW between approximate stations 1116+00 and 1117+00. Natural slope gradients between pipeline stations 1115+00 and 1121+00 generally range between about 70 and 80 percent (roughly 1.5H:1V).

The slope failure that contributed to the pipeline separation is located between approximate pipeline stations 1116+40 and 1118+00. However, ground cracks and other disruption indicating fill slope failure was observed within the pipeline ROW between approximate pipeline stations 1115+30 and 1121+40. For the purposes of the GeoEngineers study, the defined limits of the Incident Site extend east of the limits of active slope movement, to the full extent of the steep, south-facing convergent slope where steep fill slopes were constructed for pipeline corridor restoration.

The slope failure that caused the pipeline separation is characterized as a translational earthflow that occurred from within the fill that was placed to restore the construction corridor to pre-construction grades. Based on measurements of the adjacent undisturbed slope, the fill was inclined at gradients ranging between 70 and 80 percent, matching native slopes on site. The upper extent of movement is defined by a linear, near vertical, 150-foot-wide scarp that aligns with the top of the excavation cut for the pipeline construction corridor working surface. Much of the slide mass came to rest on the downslope (south) side of the pipeline ROW. However, some of the landslide debris mobilized into a debris flow that traveled downslope approximately 200 feet before being deposited within an old road grade at the base of the slope and into Raccoon Creek below. We observed standing water (sag ponds) within the primary slide mass immediately below the scarp and tension cracks up to about 2 feet wide and 2 feet deep within the landslide mass.

Subsurface conditions exposed by the landslide displacement consisted of approximately 6 to 8 feet of soil overburden overlying shale and sandstone bedrock. We observed water seepage flowing out of the contact between the overburden soils and underlying bedrock. The two sag ponds we observed within the landslide appear to be fed by near surface groundwater seepage.

We observed a linear ground crack at the top of the ROW fill exhibiting 1 to 2 feet of vertical displacement extending along the pipeline alignment west of the landslide between approximate pipeline stations 1118+00 and 1120+00 as shown on the Temporary Stabilization Plan Sheet. We observed shallow raveling and sloughing of the fill slope within this portion of the pipeline ROW. The ground cracks generally showed less than 2 inches of horizontal and vertical displacement, although GeoEngineers has noted continued expansion of the cracks in subsequent site visits as recent as February 12, 2019.

We also observed ground cracks that appeared to correspond with the cut side of the pipeline construction bench across a minor drainage east of the landslide from approximate pipeline stations 1115+00 to 1115+50. This ground crack showed up to about 2½ feet of vertical displacement. We observed two seeps upslope of the ground crack within the base of a headwall associated with a drainage that crosses the pipeline alignment between approximate pipeline stations 1115+00 and 1115+75, and one seep at the location of the referenced ground crack.

During our reconnaissance, we observed indications of historic slope movement within a bowl-shaped, closed depression about 100 feet upslope of the landslide and within the Duquesne Powerline Corridor that crosses the pipeline ROW. We did not observe indications of recent movement within this bowl-shaped area. Based on the weathering of the bowl-shaped feature, we estimate that the bowl-shaped landslide is likely 50 to 100 years old and may have occurred around the time of the Duquesne Powerline Corridor construction in the late 1950s.

We did not observe surface indications of deep-seated, global slope instability of the south-facing hillslope during our reconnaissance.

Penny Hollow Road

The Penny Hollow Road site is located from approximate pipeline station 1212+00 to 1219+00 where the pipeline alignment crosses Penny Hollow Road and descends downslope (eastward) into a drainage basin for an unnamed tributary of Raccoon Creek. The pipeline alignment turns south and crosses a wetland at the headwaters of the unnamed tributary before climbing the steep slopes at the headwall of the drainage.

Based on GeoEngineers evaluation, the Penny Hollow Road site is complex with a combination of recent construction-related slope movement as well as older, pre-existing indications of deep-seated slide movement inside and outside of the pipeline ROW.

Looking northwest at regraded landslide below Penny Hollow Road and H-piles installed at toe.

A fill slope failure within the ROW (first observed February 2018) initiated near the outboard edge of Penny Hollow Road but north of the pipeline centerline from approximate stations 1212+00 to 1213+50. Geo-Mechanics, Inc. performed a subsurface exploration program and designed slope stabilization measures, which included a soldier pile wall near the toe of the slope failure. Prior to the stop work order being issued, the H-piles for the wall had been installed along with construction access roads and timber matting to facilitate the wall construction.

A few inches of recently fallen snow obscured the ground surface at the time of GeoEngineers visit, so fine details such as ground cracks were not observable. From the road shoulder, the slope failure scarp descends to the east at a gradient of about 2H:1V for approximately 8 feet, at which point the slope gradient decreases to about 2.5H:1V. It appears that the landslide mass and adjacent margins had been at least partially regraded. The slope failure extends from approximate pipeline station 1212+00 to 1214+00. Although obscured by light snow cover, we did not observe ground cracks, scarps or other indicators that would suggest that the slope failure has moved significantly since the slope was regraded and the H piles were installed.

A temporary access road had been excavated into the hillside to facilitate access to the slide toe for the wall installation. The access road was constructed by cut and fill methods descending from Penny Hollow

Road to the south for about 300 feet before making a switch back to the north and terminating at the slope failure toe as shown in the photograph above. The cutslope along the first approximately 100 feet of the temporary access road is situated immediately below (east) of Penny Hollow Road, such that the cutslope extends from the outboard edge of Penny Hollow Road down to the access road. A shallow slope failure occurred from this cutslope, starting at the outboard shoulder of Penny Hollow Road. The slope failure is about 10 feet wide by about 25 feet long.

South of the H-pile wall, the access road crosses an ephemeral stream where timber matting and a culvert was placed to facilitate the crossing (stations 1214+00 to 1214+75). Immediately upslope of this crossing, a shallow slow-moving earth flow of saturated fill soils was observed. These failing fill soils are encroaching into the culvert crossing and require both temporary and permanent stabilization.

Further south, the pipeline ROW traverses a low-lying wetland from about station 1216+00 to 1217+20. Timber mats had been placed along this segment of the ROW. The slopes immediately above and to the west of this segment were inclined at gradients of about 40 percent, were saturated and vegetated with hydrophyllic (water loving) vegetation. We observed ground cracks at the upslope limit of the wetland (outside of the ROW) suggesting that slope movement has occurred within this area. It is GeoEngineers opinion that these ground cracks likely pre-date pipeline construction and are indicative of deep-seated natural landslide movement.

Looking east at a concrete vault on natural slopes north of the pipeline ROW.

Based on interpretations of a LiDAR hillshade, GeoEngineers identified a well-defined deep-seated landslide (LS-3) east of the pipeline alignment, roughly centered along the axis of the convergent headwall of the drainage. East of the pipeline ROW, slopes are inclined at gradients ranging from about 25 to 45 percent and vegetated with a mature stand of deciduous trees. GeoEngineers observed what appears to be a spring box on the hillside immediately upslope and adjacent to the mapped and observed headscarp of the deep-seated landslide LS-3. Water was being discharged from a metal pipe extending from the spring box. This water flows along the ground surface northward to LS-3 and the headwaters of the unnamed tributary of Racoon Creek. GeoEngineers observed indications of recent slope movement activity within the limits of LS-3, including scarps and hummocky topography.

GeoEngineers observed what we interpret to be intact bedrock exposed within the cutslope of Penny Hollow Road, which suggests that historic landslide movement does not extend upslope and west of Penny Hollow Road. Additional study is necessary to confirm the current state of activity and lateral extent of slope movement within the historic landslide area.

Findings of Site Reconnaissance

During our site reconnaissance work, GeoEngineers did not identify additional slope failures or active slope movement beyond the 39 areas documented by ETC. However, two of the previously identified slope failure sites (Elkhorn Run #1 and Penny Hollow Road) are considered complex, involving both pipeline construction related slope failures as well as historical landsliding. GeoEngineers plans to continue to study these 39 sites as part of our work on the development of the Permanent Stabilization Plan for the project.

In general, the vast majority of the slope failures are characterized as relatively shallow fill failures or shallow translational sliding of top soil placed on steep slopes.

TEMPORARY STABILIZATION PLAN

General Methodology

In general, the objective of temporary stabilization is to identify measures to improve stability that can be implemented relatively quickly. These measures typically are focused on: (1) routing water (surface water and shallow subsurface water) away from the unstable area; and (2) controlling surface erosion of exposed disturbed soils and reducing sediment delivery with typical erosion and sediment (E&S) control best management practices (BMPs).

When selecting measures that will be included in the Temporary Stabilization Plan, GeoEngineers considered the possibility of additional sediment delivery to waters of the state, as well as the practicality and disturbance associated with heavy equipment access. Of the 39 potential slope-failure sites evaluated by GeoEngineers, 26 are considered relatively stable and/or posing a low risk for sediment delivery to the Waters of the Commonwealth, sliding or other movement. For those sites, E&S Controls, including temporary and permanent waterbars presented in the E&S Plans, will be used to address the risk of erosion, sliding or other movement. Additionally, we are recommending that these sites be subject to a monitoring program. The remaining 13 sites require additional temporary stabilization controls that are included in the Temporary Stabilization Plan drawing package.

The Temporary Stabilization Plan elements are included as 1:50 scale plan-view Sheets TS-1 through TS-220, Specifications and Notes Sheets NT-1 through NT-15 (one for each site), and Detail and Section Sheets DT-01 through DT-08. Please note that recent and historic landslides mapped by GeoEngineers are also shown in the Temporary Stabilization Plan drawings.

Surface Water Controls

As presented in the site-specific descriptions in Table B-1, GeoEngineers found that waterbar construction will reduce the risk of slope failure on the project. Therefore, stabilization of these sites fundamentally involves construction of closely spaced temporary waterbars and permanent waterbars as site access and phasing allow. GeoEngineers coordinated and consulted with the project Environmental and Sedimentation Controls Consultant, Environmental Solutions and Innovations, Inc. (ESI), to confirm that the updated E&S Control Plan includes the construction of temporary and permanent waterbars. In addition to surface diversion structures, other BMPs to reduce water input into unstable areas include plastic sheeting surface treatment.

Subsurface Water Controls

GeoEngineers observed springs and/or seepage at many of the slope failure sites, suggesting that shallow perched groundwater is contributing to instability at those locations. Accordingly, GeoEngineers specified French drains and/or slot drains in the Temporary Stabilization Plan to direct subsurface water off the unstable slope to undisturbed, stable and vegetated slopes at the downslope edge of the pipeline ROW. Appendix C presents GeoEngineers' calculations and analysis supporting the design of the subsurface drainage systems for the Temporary Stabilization Plan.

Buttressing and Barriers

For those sites where GeoEngineers believes there is a very high risk of continued mass wasting resulting in future delivery of sediment to Waters of the Commonwealth, and where drainage improvements are thought to be insufficient to prevent such sediment delivery, GeoEngineers has provided recommendations for structural and/or earthwork-based measures. Such measures include buttressing and barrier construction with large concrete blocks and rip rap buttressing.

Please refer to Appendix E for project construction scheduling information provided by ETC.

SITE MONITORING

We understand that the entire Revolution alignment is and will be monitored by ETC environmental inspectors within 24 hours of a runoff event per permit requirement. Additionally, GeoEngineers recommends that the steep fill slope sites, and the 39 slope failure sites (as shown on Figure 1) be visually monitored, as described in Appendix D, by trained personnel for ground movement, sloughing, tension cracks, and other signs of instability on a regular basis in accordance with the following schedule for a period of 1 year following permanent stabilization.

Site Observation/Monitoring Frequency

- At least once per week (prior to permanent stabilization) and at least once per month thereafter.
- Within 48 hours after 1.5 or more inches in 48 hours.
- Within 48 hours after 6 or more inches in 30 days.
- Within 48 hours after a rain on snow event.

Appendix D provides a detailed description of the features to be documented during site monitoring. At ETC's request, GeoEngineers anticipates providing training for field staff who will be monitoring the sites.

GeoEngineers intends to complete additional geotechnical evaluations of the historic landslide areas and will provide site-specific recommendations, including instrumentation to monitor subsurface movement and pipe strain, where appropriate. This work will constitute part of the Permanent Stabilization Plan for the project. Continued monitoring after one year will likely be required, with frequency subject to review and assessment at the end of the year.

LIMITATIONS

We have prepared this report for use by ETC for evaluating slope failures and historic landslide conditions along the Revolution Pipeline alignment. ETC may distribute copies of this report to their authorized agents and regulatory agencies as may be required for the project.

GeoEngineers services are intended to identify sites along the Revolution Pipeline that have an elevated risk for future slope movement because the site has experienced past slope failure, historical landsliding or is composed of steep fill slopes. Our conclusions are based on a desktop review of readily available data and limited reconnaissance of select areas. Although GeoEngineers has identified sites with elevated risk, all slopes, particularly those that have been disturbed by construction activities, have a risk of slope movement. Construction on slopes involves risk, only part of which can be mitigated through the use of engineering controls and BMPs. Favorable performance of slopes in the near term does not imply a certainty of long-term performance, especially under conditions of adverse weather or seismic activity. GeoEngineers' recommendations for preliminary stabilization measures are intended to reduce but not eliminate the risk of additional slope movement and delivery of sediment to Waters of the Commonwealth.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in the field of geotechnical engineering and engineering geology in this area at the time this report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment, and experience. No warranty or other conditions, express or implied, should be understood.

Please refer to Attachment F titled "Report Limitations and Guidelines for Use" for additional information pertaining to use of this report.

REFERENCES

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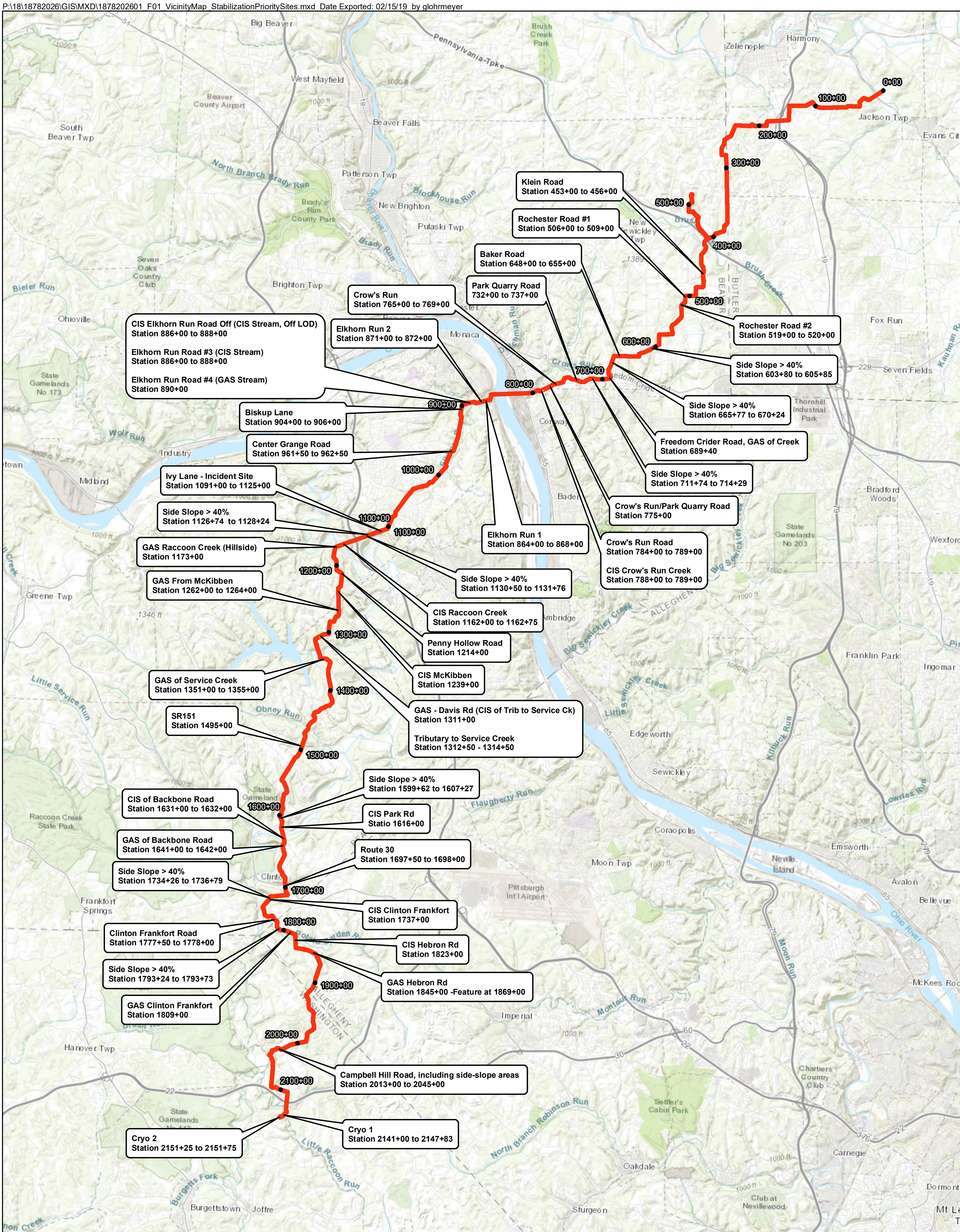
FIGURES

GeoEngineers

P:\18\18782026\GIS\MXD\1878202601_F01_VicinityMap_StabilizationPrioritySites.mxd Date Exported: 02/15/19 by glohrmeyer



Legend

- Station
- Revolution Pipeline Corridor

N W E S

3 0 3

Miles

Vicinity Map - Stabilization Priority Sites

Revolution Pipeline
Butler, Beaver, Allegheny and
Washington Counties, Pennsylvania

GEOENGINEERS

Figure 1

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: Topo from ESRI

Projection: NAD 1983 StatePlane Pennsylvania South FIPS 3702 Feet

APPENDICES

APPENDIX A
Site Photographs

Looking south along the Revolution alignment from near station 451+00

Looking north at the shallow fill failure near station 451+00

Revolution Pipeline
Site Photographs

Klein Road
Beaver County, Pennsylvania

GeoEngineers

Figure A-1

18782-026-01 Date Exported: 2/11/19

Looking east along the Revolution alignment near station 648+50

Looking east along the alignment at side slope near station 652+00

Revolution Pipeline
Site Photographs

Baker Road
Beaver County, Pennsylvania

GeoEngineers

Figure A-2


Looking west along the Revolution alignment from near station 655+50

Revolution Pipeline
Site Photographs

Baker Road
Beaver County, Pennsylvania

GeoEngineers

Figure A-3

Looking northwest along the Revolution alignment near station 732+50

Fill failure near station 734+50

Revolution Pipeline
Site Photographs

Park Quarry Road
Beaver County, Pennsylvania

GEOENGINEERS

Figure A-4

18782-026-01 Date Exported: 2/11/19

Shallow surface raveling near station 735+50

Revolution Pipeline
Site Photographs

Park Quarry Road
Beaver County, Pennsylvania

GeoEngineers

Figure A-5

18782-026-01 Date Exported: 2/11/19

Looking northeast at the site stabilization point near station 768+00

Looking east along the pipeline alignment near station 768+25

Revolution Pipeline Site Photographs
Crow's Run Beaver County, Pennsylvania
GEOENGINEERS — **Figure A-6**

18782-026-01 Date Exported: 2/11/19

Looking east along the pipeline alignment near station 775+00

Looking south near station 775+00

Revolution Pipeline
Site Photographs

Crow's Run/Park Quarry Road
Beaver County, Pennsylvania

GEOENGINEERS

Figure A-7

Looking east towards the surface failure near station 789+00

Looking north towards the slope near station 788+00

Revolution Pipeline
Site Photographs

Crow's Run Road
Beaver County, Pennsylvania

GeoEngineers

Figure A-8

18782-026-01 Date Exported: 2/11/19

Looking east towards Elkhorn Run 1 near station 868+00

Looking west towards Elkhorn Run 1 near station 864+00

Revolution Pipeline **Site Photographs**	
Elkhorn Run 1 Beaver County, Pennsylvania	
GeoEngineers	**Figure A-9**

18782-026-01 Date Exported: 2/11/19

Looking west towards the slump material at Elkhorn Run 2 near station 872+00

Looking north towards the slump material at Elkhorn Run 2 near station 872+00

Revolution Pipeline
Site Photographs

Elkhorn Run 2
Beaver County, Pennsylvania

GeoEngineers

Figure A-10

18782-026-01 Date Exported: 2/11/19

Looking south towards CIS Elkhorn Run Road near station 888+00

Looking upslope along CIS Elkhorn Run Road near station 888+00

Revolution Pipeline
Site Photographs

CIS Elkhorn Run Road
Beaver County, Pennsylvania

GeoEngineers

Figure A-11

18782-026-01 Date Exported: 2/11/19

Looking upslope near station 890+00

Looking downslope near station 890+00

Revolution Pipeline
Site Photographs

GAS Stream Elkhorn Run Road #4
Beaver County, Pennsylvania

GeoEngineers

Figure A-12

18782-026-01 Date Exported: 2/11/19

Looking northwest at the shallow surface slump near station 962+50

Looking west at the shallow surface slump near station 962+50

Revolution Pipeline Site Photographs	
Center Grange Road Beaver County, Pennsylvania	
GeoEngineers	Figure A-13

18782-026-01 Date Exported: 2/11/19

Looking east near station 1118+00

Looking upslope at the shallow landslide near station 1115+50

Revolution Pipeline
Site Photographs

Ivy Lane – Incident Site
Beaver County, Pennsylvania

GeoEngineers

Figure A-14

18782-026-01 Date Exported: 2/11/19

Looking east at groundwater seepage near station 1162+75

Looking southwest near station 1163+00

Revolution Pipeline
Site Photographs

CIS Raccoon Creek
Beaver County, Pennsylvania

GeoEngineers

Figure A-15

18782-026-01 Date Exported: 2/11/19

Looking south at the landslide near station 1173+00

Looking west at the landslide near station 1173+00

Revolution Pipeline
Site Photographs

GAS Raccoon Creek
Beaver County, Pennsylvania

GEOENGINEERS

Figure A-16

18782-026-01 Date Exported: 2/11/19

Looking downslope near station 1212+50 along the pipeline alignment

Looking upslope at the soldier pile wall near station 1213+50

Revolution Pipeline
Site Photographs

Penny Hollow
Beaver County, Pennsylvania

GeoEngineers

Figure A-17

Looking downslope near station 1262+50 along the pipeline alignment

Looking upslope near station 1264+00

Revolution Pipeline
Site Photographs

GAS from McKibben
Beaver County, Pennsylvania

GEOENGINEERS

Figure A-18

18782-026-01 Date Exported: 2/11/19

Looking downslope near station 1311+00 along the pipeline alignment

Looking upslope at station 1311+00

Revolution Pipeline
Site Photographs

GAS of Davis Road
Beaver County, Pennsylvania

GEOENGINEERS

Figure A-19

18782-026-01 Date Exported: 2/11/19

Looking at the landslide near station 1313+00

Looking at the landslide near station 1313+00

Revolution Pipeline
Site Photographs

Tributary of Service Creek
Beaver County, Pennsylvania

GeoEngineers

Figure A-20

Looking upslope at the slope failure near station 1351+00

Looking upslope at the slope failure near station 1353+00

Revolution Pipeline
Site Photographs

GAS of Service Creek
Beaver County, Pennsylvania

GeoEngineers

Figure A-21

Looking south at station 1495+00

Looking south at the bedrock outcrop near station 1495+00

Revolution Pipeline
Site Photographs

SR151
Beaver County, Pennsylvania

GeoEngineers | **Figure A-22**

18782-026-01 Date Exported: 2/11/19

Looking northwest at the landslide near station 1632+00

Looking north at the landslide near station 1632+00

Revolution Pipeline
Site Photographs

CIS of Backbone Road
Beaver County, Pennsylvania

GeoEngineers

Figure A-23

Looking north near station 1642+00

Looking northeast at the sediment delivery near station 1641+00

Revolution Pipeline
Site Photographs

GAS of Backbone Road
Beaver County, Pennsylvania

GEOENGINEERS

Figure A-24

18782-026-01 Date Exported: 2/11/19

Looking south towards station 1698+00

Looking east toward the surface failure near station 1698+00

Revolution Pipeline
Site Photographs

Route 30
Beaver County, Pennsylvania

GeoEngineers

Figure A-25

18782-026-01 Date Exported: 2/11/19

Looking north towards the rock outcrop near station 1737+00

Looking south along the pipeline alignment near station 1737+00

Revolution Pipeline
Site Photographs

CIS Clinton Frankfort
Beaver County, Pennsylvania

GEOENGINEERS

Figure A-26

18782-026-01 Date Exported: 2/11/19

Looking east towards station 1809+00

Looking north at the bedrock outcrop near station 1809+00

Revolution Pipeline
Site Photographs

GAS Clinton Frankfort
Beaver County, Pennsylvania

GEOENGINEERS

Figure A-27

18782-026-01 Date Exported: 2/11/19

Looking east towards station 1845+00

Looking south towards feature near station 1868+50

Revolution Pipeline
Site Photographs

GAS Hebron Road
Beaver County, Pennsylvania

GeoEngineers

Figure A-28

18782-026-01 Date Exported: 2/11/19

Looking northeast from approximate station 2045+00

Looking west from approximate station 2040+00

Revolution Pipeline
Site Photographs

Campbell Hill Road
Beaver County, Pennsylvania

GEOENGINEERS

Figure A-29

Looking south from approximate station 2145+00

Looking north from approximate station 2147+00

Revolution Pipeline
Site Photographs

Cryo 1
Beaver County, Pennsylvania

GEOENGINEERS

Figure A-30

18782-026-01 Date Exported: 2/11/19

Looking south at the surface slump near station 2151+50

Looking west from approximate station 2151+50

Revolution Pipeline
Site Photographs

Cryo 2
Beaver County, Pennsylvania

GEOENGINEERS

Figure A-31

18782-026-01 Date Exported: 2/11/19

APPENDIX B
Summary of Landslide Sites

Table B-1

Temporary Stabilization Plan

Revolution Pipeline

Butler, Beaver, Alleghany and Washington Counties, Pennsylvania

Station	Name	GeoEngineers Description of Site	Type of Ground Movement	Risk of Water Quality Impacts	Temporary Stabilization Plan	Applicable Details and Specifications	Access
453+00 to 456+00	Klein Road	The pipeline construction corridor along this segment is oriented roughly north-south and traverses a west-facing slope inclined at a gradient of approximately 40 percent. This area has been temporarily stabilized by the Contractor utilizing seeding, mulching and installing an erosion control blanket. Additional compost filter socks had been installed for water quality controls. At the time of our visit on February 7, 2019, the pipeline LOD was covered with straw covered by erosion control matting and vegetated with young grass. No indications of slope instability observed.	No feature observed	Low	NA	NA	NA
506+00 to 509+00	Rochester Road #1	Previously reported slope failure area, as documented in construction inspector's report. Reported as Sta. 509+00. Visited segment between Sta 506+00 and 509+00 using current stationing. No observed feature or seepage at this location. Area appears to be stable.	No feature observed	Low	NA	NA	NA
519+00 to 520+00	Rochester Road #2	Area mapped as a slope failure per Vegetative Cover Inventory Mapping for the Revolution Pipeline Project Sheet Map 24 of 101, dated November 2018. GeoEngineers visited site in January 2019 and observed no unstable feature or seepage at this location. The area upslope and north of unnamed drainage is stable with one functioning waterbar collecting water.	No feature observed	Low	NA	NA	NA
648+00 to 655+00	Baker Road	Previously reported slope failure as Sta. 655+00. No observed ground movement or sediment delivery to Pine Creek on 1/23/19. Steep slope leading from terrace of Pine Creek within LOD to waterbar area upslope and to the east is steep but restored with mulch, straw and hydroseed. Snow on ground so conditions obscured. Slope of repair matches natural grades adjacent to either side of the LOD. Upper waterbar is diverting surface water to a side slope paralleling the south side of LOD. This area has been temporarily stabilized by the Contractor utilizing Curlex and seeding and mulching. Additional CFS has been installed to provide additional protection to WOC. No stockpile locations or access are necessary.	No feature observed	Low	NA	NA	NA
689+40	Freedom Crider Road, GAS of Creek	Approximate 20-ft. high, steep bank on GAS of stream. Slope failure composed of fill approximately 30 feet wide. Failure toe is below water level. Will require in-water work to stabilize.	Fill failure	High	Cover with Plastic Sheeting per Detail DT-05	Plastic Sheeting per Detail DT-05	Along ROW from Freedom Crider Road
732+00 to 737+00	Park Quarry Road	A small slope failure occurred on east side of Park Road apparently from poor surface water management within LOD. On west side of road, one deeper earthflow and two shallow surface slumps have occurred below the pipeline in apparent fill. Significant water runoff observed flowing down ROW and trickling over headscarps of failures. Standing/ponding water runoff observed on flat ground at base of slope but not delivering to adjacent creek. Curlex covers the entire slope of the three earthflows/slumps on west side of road. Several layers of silt fence installed at base. Other than additional temporary waterbars recommended in E&S plan to address this site, no additional temporary stabilization measures recommended. Earthwork-based permanent stabilization will be required.	Fill failure	Low	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	NA	NA
765+00 to 769+00	Crow's Run	Saturated midslope bench at suspected historic landslide LS-17. Seepage observed from slope throughout ROW width. Slow shallow soil movement into head of ephemeral drainage. Seepage leads to ephemeral stream that flows down the ROW. This ephemeral channel conveys water directly downgradient to east, then northeast and across alignment.	Shallow soil creep and historic landslide.	High	● Install French drain to capture seepage and subsurface water and divert it to Riprap apron at ephemeral stream. ● Perform one geotechnical boring to evaluate both shallow and deep-seated stability risk and to support permanent stabilization plan.	French drain per Detail DT-01 Riprap Apron per Detail DT-07	Access from Park Quarry Road or Crow's Run Road Along ROW
775+00	Crow's Run/Park Quarry Road	This location on the CIS of Crows Run Road had a slip caused by a heavy rain event. The slip was repaired by hand, seeded, and erosion control blanket was installed on 10/16/18. The repairs are still holding and vegetation is emerging as reported by others on 11/23/18. GeoEngineers staff visited the site on 1/24/2019 and noted that the site was stable and not requiring additional work at this time. Original reported Station 772+50.	Shallow fill failure	Low	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	NA	NA
784+00 to 789+00	Crow's Run Road	This location on the CIS of Crows Run Rd. had a slip caused from a waterbar failure. The slip was repaired by hand, re-seeded, and covered with erosion control blanket on 10/16/18. The repairs are still holding and vegetation is emerging based on site visit by others on 11/23/18. GeoEngineers visited the site on January 23, 2019. There is slight surface creep and raveling with approximate dimensions of 30 feet wide by 120 feet long. The surficial movement appears to be related to seepage from failure of upslope waterbar. Original reported Station 779+00 to 789+00.	Shallow fill failure	Low	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	NA	NA

Station	Name	GeoEngineers Description of Site	Type of Ground Movement	Risk of Water Quality Impacts	Temporary Stabilization Plan	Applicable Details and Specifications	Access
788+00 to 789+00	CIS Crow's Run Creek	Feature appears to be on CIS of Crow's Run Creek not Crow's Run Road. Previous slope failure that was repaired by hand, re-seeded, and covered with erosion control blanket (Curlex) on 10/16/18. On west facing slope at approximately 50 percent gradient leading down to creek. Too steep to traverse on 1/28/2018 because of snow and ice, but no indication of seepage while viewing from across the creek. On approximately 2/9/19, the area experienced a shallow fill failure of approximately half of the previously repaired area. Failure destroyed two rows of Super Silt Fence at the base of the slope and impacted the WOC. Formerly known as Station 792+50.	Shallow fill failure	High	● Install French drain per DT-01 and slope pipe per DT-02 to capture subsurface water and divert it to riprap apron per DT-07 to vegetated valley floor below ROW. ● Perform two geotechnical borings to evaluate both shallow and deep-seated stability risk and to support permanent stabilization plan.	French Drain per Detail DT-01 Slope Pipe per Detail DT-02 Riprap Apron per Detail DT-07	Access from Crows Run Road.
864+00 to 868+00	Elkhorn Run 1	Cracking and failing fill (roughly 200 feet wide by 100 feet long) in ROW at side slope from approximate station 864+00 to 866+00. Side slope inclined at roughly 50 percent gradient. Seep emerging from ground in failing fill. High risk of fill failure mobilizing into a debris flow that could reach and discharge sediment into Elkhorn Run. Deep-seated landslide LS-1 mapped downslope and adjacent to pipeline ROW. The state of activity of the deep-seated landslide is not currently known-pending additional evaluation.	Deep fill failure, possible deep-seated landslide	High	● Install French drain per DT-01 and slope pipe per DT-02 to capture seep and divert it to Riprap apron and compost filter sock sediment trap at downslope side of ROW. ● Perform three geotechnical borings to evaluate both shallow and deep-seated stability risk and to support permanent stabilization plan.	French drain per Detail DT-01 Slope pipe per Detail DT-02 Riprap Apron per Detail DT-07	Along pipeline ROW from Elkhorn Run Road.
871+00 to 872+00	Elkhorn Run 2	Pipeline is oriented sidehill on steep 50 percent slopes. Fill placed during site restoration is failing as evidenced by a set of two vertical, arcuate scarps approximately 90 feet wide and exhibiting up to 18 inches of vertical displacement. Seepage observed from headscarp. The fil failure is centered at the head of an ephemeral drainage crossing. Because fill was placed at head of drainage, fill is likely becoming saturated by surface and subsurface water. On February 14th, saturated fill from this site mobilized in to a slow moving earth flow. ETC. crews mobilized to the site and installed E&S controls to reduce offsite transport of sediment.	Deep fill failure and secondary earthflow	High	● Install French drain upslope of upper mass-wasting area per DT-01. ● Route water from French drain through temporary 12-inch-diameter slope pipe per DT-02 to Riprap apron at base of slope.	French drain Detail DT-01 Slope Pipe Detail DT-02 Riprap Apron Detail DT-07	Along pipeline ROW from Elkhorn Run Road.
885+00 to 888+00	CIS Elkhorn Run Road Off (CIS Stream, Off LOD)	There is a moderately deep debris slide-earth flow along the Power Line ROW that is locally within 10 to 100 feet of and adjacent to station left of the Revolution Pipeline ROW. Slope is inclined roughly 60 to 70 percent. Landslide is about 50 feet wide and 250 feet long. slide deposit on stream terrace. In general, surficial sliding appears to be caused by a lack of effective waterbars. No indication that slope failure was caused by Revolution Pipeline construction. Site access is challenging from east due to steep terrain. Earthwork-based permanent stabilization will be required. Temporary stabilization requires E&S controls only at this time (temporary waterbars and blanket).	Moderately deep, slow to rapid natural soil failure	Moderate	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	NA	NA
885+00 to 888+00 and 890+00	Elkhorn Run Road #3 (CIS Stream) and GAS Stream	Very shallow (less than 2 feet deep) debris slide composed of topsoil on Revolution ROW with failed erosion control blanket. Pipeline is oriented with fall line of slope. Little to no fill required to restore ROW. Slope gradients inclined up to approximately 75 percent (1.5H:1V). The slide occurred within the pipeline ROW where it descends the very steep west facing slopes on the south side of Elkhorn Run. The slide is approximately 20 feet wide, 12 to 18 inches deep and about 150 feet long. The slide debris came to rest near the base of the slope. Silt fence had been installed in an effort to contain the debris. Temporary stabilization requires E&S controls only at this time (temporary waterbars and blanket).	Shallow-rapid fill failure	Moderate	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	NA	NA
890+00	Elkhorn Run Road #4 (GAS Stream)	Reported as a previously stabilized area. One small area on station left where surface water that is confined to one side by bedrock has caused a 2- to 5-foot wide, 15- to 20-foot-long flow at the edge of the LOD. Remainder of slope appears to be stable.	Shallow fill failure	Low	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	NA	NA
904+00 to 906+00	Biskup Lane	Significant seepage is observed traversing the LOD east to west causing surface erosion across LOD. Inadequate waterbar spacing/construction from slope leading to the north and toward the seep area. waterbars pointing to the seep area upgradient of where it crosses pipeline. Temporary stabilization requires E&S controls only at this time (temporary waterbars and blanket).	No slope failure observed	Low	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	NA	NA
961+50 to 962+50	Center Grange Road	At Station 961+50, observed a small shallow slump with dimensions of approximately 30 feet by 30 feet. Loose fill and inadequate waterbar spacing appears to be contributing factors. Only one waterbar upslope of area. Slump contained by silt fence and wattles. Slope failure located upslope of pipeline. Temporary stabilization requires E&S controls only at this time (temporary waterbars and blanket).	Shallow fill failure	Low	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	NA	NA
1091+00 to 1125+00	Ivy Lane - Incident Site	Very steep south facing slope above outside meander bend of Raccoon Creek. Pipeline alignment generally east-west so that deep cuts and fills were required for pipeline construction. The slope is affected by numerous fill slope failures emanating from the pipeline ROW. Many of the fill slope failures have mobilized into debris flows that reached Raccoon Creek. Unstable fill and slide debris remains throughout the slope. There is a high risk for additional debris flows to occur from the slope. Personnel should avoid the subject site during or within 24 hours after measurable precipitation.	Deep fill failures, debris flows	High	● Excavate unstable fill and debris from within LOD. ● Install interceptor drainage trench at base of original excavation for pipeline installation. ● Restore slope within LOD by constructing engineered fill slope. ● Install concrete block barrier at lower road to reduce risk of landslide debris reaching Raccoon Creek.	Section A-A' Detail DT-09 Section B-B' Detail DT-10 Riprap Apron Detail DT-07	Access from Ivy Lane.

Station	Name	GeoEngineers Description of Site	Type of Ground Movement	Risk of Water Quality Impacts	Temporary Stabilization Plan	Applicable Details and Specifications	Access
1162+00 to 1162+75	CIS Raccoon Creek	Surface features obscured due to snow. Observed ground surface within LOD. Area appears saturated, standing surface water across ROW and adjacent ground surface. We did not observe indications of slope movement within the pipeline ROW. No additional temporary stabilization recommended. A translational landslide was observed approximately 80 feet south of the pipeline farther upslope and outside of the LOD. Slide is observable in LiDAR that predates pipeline. Slide is approximately 100 feet wide by 100 feet long, defined by scarp exhibiting approximately 8 to 12 inches of vertical displacement. Based on our observations, the landslide off the LOD is not related to pipeline construction; rather possibly related to the unimproved road upslope. Additional evaluation required to assess risk to pipeline. Temporary stabilization requires E&S controls only at this time (temporary waterbars and blanket).	Historic landslide off of ROW	Low	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	NA	NA
1173+00	GAS Raccoon Creek (Hillside)	Pipeline oriented with the fall line of a very steep south facing slope situated above an outside meander of Raccoon Creek. GeoEngineers observed a scarp with roughly 15-foot vertical displacement. A shallow secondary earthflow below scarp mobilized and traveled about 50 feet down the ROW before coming to rest without leaving ROW/LOD. The fill failure is about 60 feet wide by about 80 feet long. Natural slope is inclined at approximately 60 percent. Super Silt Fence and other erosion control measures installed at the base of earthflow. Area requires equipment to repair. Presents high risk for future debris flow that could deliver to Raccoon Creek.	Deep fill failure with potential for debris flow.	High	• Install French drain to slope pipe. Slope pipe to discharge to riprap apron. • Temporarily cover slope failure with plastic sheeting. • Install super silt fence as shown in E&S plans.	French Drain Detail DT-01 Slope Pipe Detail DT-02 Riprap Apron Detail DT-07 Plastic Sheeting per Detail DT-05	Along pipeline ROW from Penny Hollow Road.
1214+00	Penny Hollow Road	The Penny Hollow Road site is complex with a combination of recent, construction-related slope movement as well as older, pre-existing indications of deep-seated ground movement inside and outside of the pipeline ROW. A relatively large fill slope failure within the pipeline ROW, initiated near the outboard edge of Penny Hollow Road. Geo-Mechanics performed a subsurface exploration program and designed slope stabilization measures, which included a soldier pile wall near the toe of the landslide. Prior to the stop work order being issued, the H-piles for the wall had been installed along with construction access roads and timber matting to facilitate the wall construction. A temporary access road had been excavated into the hillside to facilitate access to the slide toe for the wall installation. The access road was constructed by cut and fill methods descending from Penny Hollow Road to the south for about 300 feet before making a switch back to the north and terminating at the landslide toe. The cutslope along the first approximately 100 feet of the temporary access road is situated immediately below (east) of Penny Hollow Road, such that the cutslope extends from the outboard edge of Penny Hollow Road down to the access road. A shallow slide occurred from this cutslope, starting at the outboard shoulder of Penny Hollow Road. The slide is about 10 feet wide by about 25 feet long. South of the H-pile wall, the access road crosses an ephemeral stream where a timber matting and culvert was placed to facilitate the crossing (Stations 1214+00 to 1214+75). Immediately upslope of this crossing, a shallow slow-moving earth flow of saturated fill soils was observed. These failing fill soils are encroaching into the culvert crossing and requires both temporary and permanent stabilization. GeoEngineers observed indications of active movement within the deep-seated landslide LS-3. Additional geotechnical borings and analysis is required to evaluate the risk to the pipeline ROW.	Deep fill failure, shallow fill failures, deep-seated landslide	High	• Install Sheet pile and rock buttress at base of slump currently sliding into ephemeral stream south of partially constructed H-pile wall.	Sheet Pile Buttress per Detail DT-08 Class 4 Geotextile Penn DOT Sections 212 and 735 Class R-5 Rock PennDOT Section 850.2	Penny Hollow Road and travel lane.
1239+00	CIS McKibben	Previously reported slope failure by ETC. GeoEngineers visited the site in January and February 2019. We observed no indicators of recent slope failure. Site appears to be stable with covering of erosion control blanket across length and width of the LOD. Pipeline crosses historical landslide LS-4. No indications of activity from historical landslide.	Historic landslide	Low	NA	NA	NA
1262+00 to 1264+00	GAS From McKibben	The slope is affected by shallow translational sliding along upper 1 to 2 feet of topsoil. Approximately eight rows of silt fence are retaining slide debris. Moderate seepage and/or surface runoff observed along most of the slope, which is generally inclined at 60 percent to the north. Only one functioning waterbar was observed traversing slope that traverses slope at 25 percent grade. A portion of the waterbar is washed out with sloughed material extending downslope. In general, surficial sliding appears to be caused by a lack of sufficient number and properly installed waterbars.	Shallow fill failure	Low	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	NA	NA
1311+00	GAS - Davis Rd (CIS of Trib to Service Ck)	A small, shallow slope failure occurred along a steep slope. Slump area about 30 feet wide and 30 feet long and is restrained by silt fence. In general, surficial sliding appears to be caused by a lack of sufficient number and properly installed waterbars.	Shallow slope failure	Low	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	NA	NA

Station	Name	GeoEngineers Description of Site	Type of Ground Movement	Risk of Water Quality Impacts	Temporary Stabilization Plan	Applicable Details and Specifications	Access
1312+50 - 1314+50	Tributary to Service Creek GAS	Multiple shallow slope failures throughout LOD along a roughly 32 to 38 degree steep slope. Existing, widely spaced waterbars are impacted and failing. Braced Super Silt fence currently retaining slide debris back at base of slope. Moderate risk of sediment delivery to UNT of Service Creek if landsliding continues. Area requires equipment for repair.	Shallow fill failure	Low	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	NA	NA
1351+00 to 1355+00	GAS of Service Creek	A shallow slope failure occurred along a steep slope and has overwhelmed multiple waterbars. Several small failures along left side of LOD. Pronounced seepage in head of scarp with combined flows of estimated 10-20 gallons/min. Area requires equipment for repair.	Shallow fill failure	Moderate	● Install French drain upslope of head of mass-wasting area in two-track road per DT-01. ● Install 12-inch-diameter slope pipe per DT-02 to toe of slope and install level spreader per DT-06. ● Cover upper slope movement area with plastic sheeting per DT-05.	French drain Detail DT-01 Slope drain Detail DT-02 Riprap Apron per Detail DT-07 Plastic Sheeting per Detail DT-05	Access from Tank Farm Road to unimproved TAR comes into alignment at approximate Station 1363+00
1495+00 to 1496+00	SR151	Slope failure has occurred within two areas. One within the ROW and one within the ATWS utilized to stockpile overburden from the initial failure. Shallow slope movement along and adjacent to original LOD for pipeline is caused by poor water management flowing from a wetland area adjacent to LOD. Formerly flowed over rock outcrops along stream. Now flows over backfill material. Currently Impacting Resource- UNT to Raccoon Creek. Silt fence and compost socks at toe of slope at pipeline crossing is compromised and undermined. Permanent stabilization will require regrading of slope.	Fill failure	High	● Install 12-inch-diameter temporary slope pipe per DT-02 to drain upgradient surface flows. ● Install discharge structure at base of slope to receive pipe discharge. ● Cover slope failure with plastic sheeting.	Temporary Slope Pipe Detail DT-02 Riprap Apron Detail DT-07 Plastic Sheeting per Detail DT-05	Access off of Hooks Town Grade Road at Approximate Station 1524+00
1616+00	CIS Park Rd	Slope failure that was subsequently repaired. No indications of slope failure at the time of GeoEngineers' January 26, 2019 site visit. Slopes lacks properly spaced and constructed waterbars. Erosion control blanket material is not overlapped in places.	No slope failure observed	Low	NA	NA	NA
1631+00 to 1632+00	CIS of Backbone Road	As reported by ETC, discharge was causing an erosion area of concern near the bankfull terrace of Raccoon Creek. At the time of GeoEngineers' visit, the feature described by ETC had been addressed and was no longer visible. However, we observed two significant seep zones with two areas of shallow translational sliding. One shallow slide, located approximately mid slope, is approximately 60 feet wide by 150 feet long at approximate station 1631+00 to 1632+00. Two smaller shallow surface slumps were observed closer to the base of the slope. In general, surficial sliding appears to be caused by a lack of properly spaced and constructed waterbars. Temporary stabilization requires E&S controls only at this time (temporary waterbars and blanket).	Shallow fill failure	Low	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	NA	NA
1641+00 to 1642+00	GAS of Backbone Road	Bottom two waterbars at base of south-facing slope terminate before reaching the east edge of the LOD. At eastern termination of waterbars, a shallow earthflow of fill soils extends approximately 100 feet, entering stream channel at base of slope. We also observed two shallow failures that are 30 feet or less in diameter located on the south side of the creek that are currently contained with silt fence and wattles but will need repair.	Shallow fill failure	High	● Extend waterbar to eastern edge of LOD using hand tools. ● Remove slope failure debris from within stream 9-36 by hand.	NA	NA
1697+50 to 1698+00	Route 30	Deep fill failure. Overall dimensions are about 80 feet wide at toe and about 60 feet long. Approximate displacement along headscarp ranges from 1 to 4 feet vertical offset. Natural slope is slightly less than 34 degrees, with head of mass inclined at 30 to 32 degrees. Debris at toe supported by silt fencing is inclined at about 12 to 13 degrees. No seepage observed.	Fill failure	High	● Cover slope failure with plastic sheeting.	Plastic Sheeting per Detail DT-05	Access from temporary access road off of Clinton Frankfort Road.
1734+50 to 1739+00	CIS Clinton Frankfort	Slope failure along side slope. Two small, shallow translational slope failures observed in January 2019. Each approximately 20 ft wide by 25-30 ft long. Seepage observed at head of both scarps. Deposits of first slide on floodplain of Service Creek.	Shallow fill failure/ Possible deep prior fill failure	Moderate	● Install French drains above two small slumps. ● Route French drain discharge to toe of slope through slope pipes and discharge to riprap apron.	French Drain Detail DT-01 Slope Pipe Detail DT-02 Riprap Apron Detail DT-07	Access along alignment from Clinton Frankfort Road.
1777+50 to 1778+00	Clinton Frankfort Road #2	Two small shallow fill failures covered with straw mulch. One 40-ft-wide by 15-ft long. Second 15-ft wide by 15- to 16-ft long on slopes inclined at 55 to 60 percent. Temporary stabilization requires E&S controls only at this time (temporary waterbars and blanket).	Shallow fill failure	Low	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	NA	NA
1809+00	GAS Clinton Frankfort	Slope failure that was subsequently repaired. GeoEngineers visited the site on February 4, 2019 and observed no slope failures or other evidence of ground movement, or seepage on either the east- or west-facing slopes leading into ravine.	No slope failure observed	Low	NA	NA	NA
1823+00	CIS Hebron Rd	Slope failure that was subsequently repaired. GeoEngineers visited the site on January 26 and February 2, 2019. On initial visit, slope was covered with snow but no indications of slope failure. Visited again on February 2, 2019 and site appeared stable. No indications of slope failures observed.	No slope failure observed	Low	NA	NA	NA

Station	Name	GeoEngineers Description of Site	Type of Ground Movement	Risk of Water Quality Impacts	Temporary Stabilization Plan	Applicable Details and Specifications	Access
1869+00	GAS Hebron Rd	Shallow surface sloughing observed at Station 1869+00 during visit on February 4, 2019. Feature is shallow fill failure on east side of LOD and does not appear to be delivering sediment to stream. Several waterbars observed in area at approximately 25 percent all diverting water from west to east directly toward the failure. Small failure located below eastern margin of waterbar termination point. In general, surficial sliding appears to be caused by a lack of effective waterbars. Temporary stabilization requires E&S controls only at this time (temporary waterbars and blanket).	Shallow fill failure	Low	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	NA	NA
2042+00 to 2047+00	Campbell Hill Road	A slope failure occurred and was in the process of being repaired at the time of the Compliance Order Issuance. Southeast facing steep slope is affected by apparent shallow but widespread translational landsliding. waterbar spacing and gradient does not appear adequate. The ground surface becomes increasingly saturated towards the base of the slope. Apparent drain pipes in adjacent utility ROW observed daylighting at the base of the slope. Historic landslide LS-14 deposits mapped across the ROW at base of the slope. In general, surficial sliding appears to be caused by a lack of effective waterbars. No indications of deep-seated, global slope movement associated with LS-14 were observed at the time of our visit, however additional geotechnical investigation will be performed to evaluate global stability.	Fill failure, Historic Landslide	Low	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	Perform two geotechnical borings to evaluate slide depth for permanent stabilization plan.	Access along pipeline ROW from Northeast
2141+00 to 2147+83	Cryo 1	Shallow fill failure from outboard side of waterbar observed about 20- to 25-ft wide by 20- to 30-ft long. Fill failure is approximately 1 to 2 feet deep and is located between Station 2141+00 and 2142+00 approximately 30 feet east of the pipeline. A small erosional rill has formed traversing the feature in a downslope direction that was conveying approximately 2 gpm at time of site visit during heavy rain event. In general, surficial sliding appears to be caused by a lack of effective waterbars. Temporary stabilization requires E&S controls only at this time (temporary waterbars and blanket).	Shallow fill failure	Low	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	NA	NA
2151+25 to 2151+75	Cryo 2	Shallow fill failure, approximately 1 to 2 feet in thickness observed just downslope of the Cryo Plant pad. Feature is approximately 70 feet wide by 20 feet long and inclined at a gradient of roughly 30 percent. The fill failure appears to be caused by water ponding on the finished gravel-surface grade of the Cryo Plant facility that is routed down a rock-lined channel to a former access road. Once water reaches the access road, water travels west to a point approximately 8 feet vertically upslope of the feature. Feasibility of routing runoff from Cryo Plant pad to permanent stormwater drain to be evaluated in permanent stabilization plan. Temporary stabilization requires E&S controls only at this time (temporary waterbars and blanket).	Shallow fill failure	Low	Flexterra hydroseeding and erosion control blanket. Install compost filter sock temporary waterbars at close spacing.	NA	NA

Note:
Orange indicates temporary stabilization measures provided (as shown in the Temporary Stabilization Plan).

APPENDIX C
Subsurface Discharge, Conveyance, and Outlet Protection Calculations

APPENDIX C
SUBSURFACE DISCHARGE, CONVEYANCE AND OUTLET PROTECTION CALCULATIONS

GeoEngineers completed site-specific runoff, conveyance and outlet protection calculations to inform the design of subsurface drainage and discharge for the Northeast Pipeline Incident Site near Aliquippa, Pennsylvania. We have also completed an analysis of runoff, conveyance and outlet protection for a series of French drain facilities along the Revolution Pipeline project to inform a typical installation. For the typical installation calculations, we assumed a conservative worst-case scenario and applied results of the analysis to the design.

Collection, Conveyance and Outlet Description

GeoEngineers has proposed subsurface drain systems to collect and reroute subsurface water that is contributing to slope instability at numerous sites along the Revolution Pipeline alignment. Specifically, subsurface drains are proposed as part of the Temporary Stabilization Plan at the Incident Site, CIS Crow's Run Creek, Elkhorn Run 1, Elkhorn Run 2, CIS Elkhorn Run Rd, GAS Raccoon Creek (Hillside), GAS of Service Creek, and CIS of Clinton Frankfurt.

The subsurface drain for the Incident Site includes a 6-inch-diameter perforated pipe within a gravel bedding, connected to a 6-inch-diameter, solid-wall pipe that will discharge to a riprap apron at an unnamed tributary to Raccoon Creek west of the site. The proposed subsurface drain system will be installed between approximate stations 1113+00 and 1121+00.

All other subsurface drains specified for temporary stabilization along the Revolution Pipeline alignment will include subsurface drain systems with either 4-inch or 6-inch-diameter perforated pipes, connected to a 12-inch- diameter slope pipe constructed in accordance with Detail #6-5 of the Pennsylvania Department of Environmental Protection (PADEP) Erosion and Sediment Pollution Control Program Manual (Manual) (PADEP 2012). The slope pipe will discharge to a riprap apron in accordance with Detail #9-2 of the PADEP Manual.

Design Discharge

Without the benefit of subsurface explorations and groundwater testing, there is no well-established, reliable method for estimating discharge from a subsurface drain due to the numerous unknown and geologically complex variables that influence perched groundwater. For sizing and designing the subsurface drains, GeoEngineers estimated discharge using a modified approach based on the Rational Method as described in the PADEP Manual. The Rational Method calculated peak discharge using the following equation:

$$Q = C \times I \times A$$

Q = Peak discharge in cubic feet per second (cfs)

$C = C_w$ = Runoff Coefficient (dimensionless)

I = Rainfall intensity (inches per hour)

A = Drainage are (acres)

The drainage basin soils type for all sites is a GsF, Gilpin-Weikert channery silt loam with 25 to 70 percent slopes except for the CIS Clinton Frankfort site drainage, which is a Gilpin Upshire Complex 25 to 60 percent slope. The silty loam classifies as a class B hydrologic soil and the Gilpin Upshire Complex classifies as an A hydrologic soil. Based on Table 5.2 from the Manual, the runoff coefficient for class B soil type is 0.35 and the class A soil type is 0.30. The contributing basin consists of newly filled material for all sites. Therefore, we assumed the overland flow travel time to be zero. We calculated the time of concentration, including shallow concentrated subsurface flow and channel flow. We used Darcy's law to approximate the travel time required for runoff to travel through the subsurface to the subsurface drain pipe. Hydraulic conductivity for soils can vary significantly and we assumed a hydraulic conductivity of 0.005 feet per second as a worst case scenario for the existing Gilpin-Weikert channery silt loam material that predominantly exists at the project sites in all cases . Tables C-1 and C-2 present the time of concentration used.

TABLE C-1. TIME OF CONCENTRATION – SHALLOW CONCENTRATED FLOW (SUBSURFACE)

Path Number	Length (ft)	Hydraulic Conductivity (fps)	Hydraulic Gradient (ft/ft)	Porosity (Percent)	Velocity (fps)	Time (min)
Incident Site	300	0.005	0.4	49	0.0041	1,220
Typical Sites[1]	500	0.005	0.3	49	0.0031	2,688

Note:

[1] Typical site calculations account for the most conservative of the six project sites, excluding the Incident Site, using subsurface drains and riprap aprons. The most conservative site for runoff was considered to be the CIS of Clinton Frankfort site.

TABLE C-2. TIME OF CONCENTRATION – CHANNELIZED FLOW (DRAIN PIPE)

Path Number	Length (ft)	Area (sq. ft.)	Average Slope (ft/ft)	Wetted Perimeter (ft)	Hydraulic Radium (ft)	Manning's n	Velocity (fps)	Channel Time (min)	Tc (min)
Incident Subsurface Drain	800	0.03	0.05	0.4	0.06	0.015	3.2	4.2	
Incident Solid Wall	400	0.01	0.36	0.3	0.04	0.015	6.5	1.0	1,225
Typical Sites[1] Subsurface Drain	250	0.01	0.05	0.3	0.3	0.015	2.3	1.8	
Typical Sites[1] Solid Wall	300	0.01	0.33	0.3	0.02	0.015	3.7	1.4	2,691

Note:

[1] Typical site calculations account for the most conservative of the six project sites, excluding the Incident Site, using subsurface drains and riprap aprons. The most conservative site for runoff was considered to be the CIS of Clinton Frankfort site.

We calculated a 2-year rainfall intensity using the 2-year intensity equation provided in the Manual.

$$I = 106/(T_c+17)$$

I = Rainfall intensity in inches per hour

T_c = Time of concentration in minutes

We calculated a rainfall intensity of 0.09 inches per hour for the Incident Site and 0.04 inches per hour for the remaining typical sites.

The contributing surface drainage area for the Incident Site is 2.47 acres and the most conservative contributing surface area for the remaining typical sites is approximately 1.50 acres. Therefore, we calculated the 2-year discharge to be 0.08 cfs for the Incident site and 0.02 cfs for the remaining typical drain sites.

Conveyance System

We analyzed conveyance capacity of the proposed subsurface drain reach and the solid-wall reach. We calculated hydraulic parameters using Manning's equation for normal depth. Hydraulic output from the analysis are identified in Table C-3. Based on the results of our analysis, a 6-inch-diameter perforated pipe and a 6-inch-diameter solid-wall pipe will meet the conveyance requirements for the design storm event for the Incident Site. The remaining typical sites will be constructed with either a 4-inch or a 6-inch-diameter perforated pipe. We analyzed the conveyance capacity of a 4-inch-diameter perforated pipe to account for the more conservative of the two pipes. A 4-inch-diameter perforated pipe and a 12-inch-diameter solid-wall pipe will meet the conveyance requirements for the most conservative of the remaining typical sites.

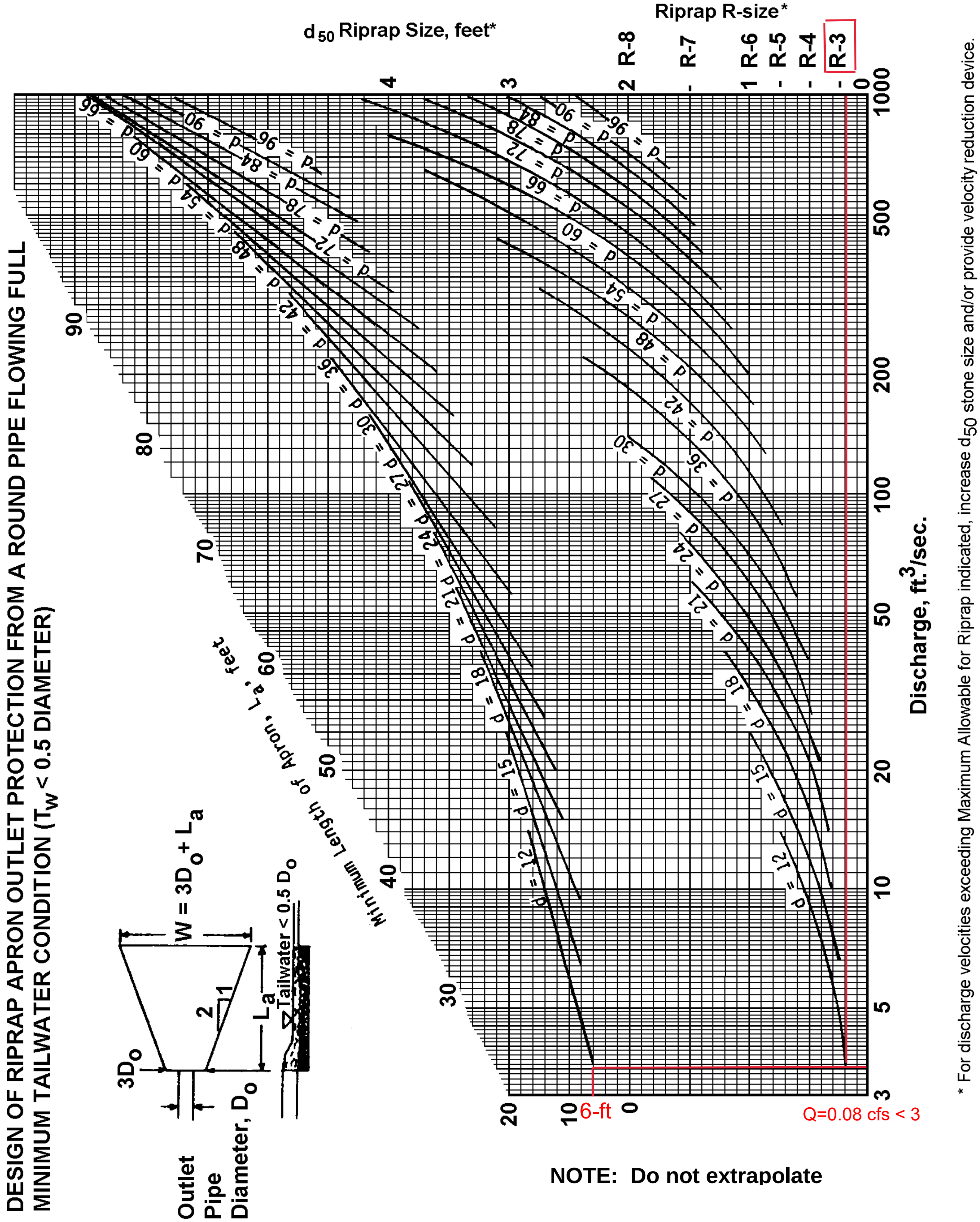
Riprap Apron Outlet Protection

The proposed outlet protection facilities generally match standard construction detail #9-2 from the Manual. GeoEngineers calculated the material gradation and size of the proposed riprap apron using the nomograph shown in Figure 9.3 with a 6-inch-diameter outlet pipe and a discharge of 0.08 cfs and a 12-inch-diameter outlet pipe and a discharge of 0.02 cfs. Both discharge values and pipe diameters are smaller than the nomograph limits so we conservatively used dimensions and riprap sizes from the smallest scenarios. We included the resulting minimum riprap apron geometry and riprap size in Table C-3. For ease of construction, we propose to use the more conservative dimensions associated with the remaining typical sites for all seven sites, including the Incident Site.

TABLE C-3. MINIMUM RIPRAP APRON DESIGN PARAMETERS

Outlet	Pipe Diameter (in)	Riprap		Apron		
		Material Size (R-)	Thickness (in)	Length (ft)	Initial Width (ft)	Terminal Width (ft)
Incident Site	6	R-3	9	6	1.5	7.5
Typical Site	12	R-3	9	6	3.0	9.0

FIGURE 9.3
Riprap Apron Design, Minimum Tailwater Condition



Adapted from USDA - NRCS

Not to be used for Box Culverts

Calculated 2-YR Discharge = 0.08 CFS,
Diameter of Outlet = 12 IN,
Minimum Length (La) = 6 FT,
Riprap = R-3

APPENDIX D
Monitoring of Slopes

APPENDIX D
MONITORING OF SLOPES

Monitoring Of Potential Arreas of Slope Movement

There are several types of monitoring that can be done to determine whether slope movement is occurring and to help evaluate the significance of those movements. This is not intended to be a comprehensive list for monitoring of an active pipeline, nor is it intended to cover slope instrumentation or other tools of the geotechnical professional. It is intended primarily as a basis for developing a preliminary understanding of ground-based, visual assessment of areas that have experienced recent slope movement so that necessary mitigation steps can be identified and initiated. The following provides common topographic and vegetative features indicative of slope movement along with methods to identify and interpret those features.

Recognition Of Slope Movement

Slope movement features as described below can indicate the reactivation or the initiation of ground movement in sloped areas. Slope movements can be recognized by many characteristics – some obvious and some very subtle. Here are some common terms that help describe the features of a landslide and elements geologists look for to identify new or renewed movement:

Escarpment (scarp) – A steep face of exposed soil marking the outermost edge of a slide mass, usually at the uphill and lateral limits of a slide, where differential ground offsets have occurred.

Ground Crack or Tension Crack – Areas of ground surface breakage, usually with horizontal and/or vertical separation.

Hummocky Topography – An irregular topographic ground surface characterized by rounded or conical mounds and closed depressions not associated with drainages.

Toe Bulge – Area of uplifted ground at the downhill end of a landslide. May occur from rotational uplift, from ground compression, or from a landslide mass overriding otherwise undisturbed ground.

Sag Pond – Area where uneven ground settlement has occurred, or back-tilting, with water occupying the low area.

Failure Surface or Slip Surface – The surface along which landslide movements occur.

Debris Fan – a mass of debris that occurs at the downhill limits of an earth flow, debris flow or mudflow.

Debris Slide Scar – The zone of evacuation of a shallow rapid landslide, whereby the slide mass mobilizes into a flow, leaving a scoured depression void of vegetation and topsoil.

Field Identification of Landslides

Many features in the field are indicators of possible slope movement. Field identification of landslides and slope movement is like being a detective. Some evidence may be obvious, but others may be subtle and, when combined with other factors, result in an interpretation of landslide activity. Features to be aware of include:

Ground Breakage – Scarps or ground cracking that cannot be attributed to erosion or human activities. Cracked, offset or buckled pavements.

Surface Topography – Hummocky topography, sag ponds, unusual changes in slope inclination, bulges in toes, debris flow scars, debris fans, sinkholes.

Vegetation – Bent or "jackstrawed" trees (observe coniferous trees; deciduous trees are not reliable indicators of ground movement). Water-loving plants (horsetails, devils club, skunk cabbage, cedars) growing on slopes. Anomalous areas with young stands of alders on slopes.

Seeps or Springs – Groundwater can significantly reduce resisting forces of a soil mass. The presence of springs or seepage is commonly observed at landslides.

Visual Monitoring

Some obvious areas of slope movement, including landslide features, mudflows or debris flows, can be identified by overflights of helicopters, fixed-wing aircraft or unmanned aerial vehicles. However, many potentially critical but more subtle landslide features are readily observable only from the ground.

In general, field visits should be conducted for identified areas of concern or potential concern on a regular basis and after specified precipitation thresholds are met. Site visits should consist of observing an area of concern and obtaining photographic records of the slope conditions and documenting the following:

Ground Cracks:

- Identify new ground cracks.
- Document changes in length, the width of the opening of crack at the ground surface and depth.
- Set stakes or lathes at the ends of long cracks can help to establish potential expansion or lengthening of the cracks.
- Look for new cracks that may be forming upslope of a known crack that may indicate that a feature is expanding upslope.

Toe of Feature:

- Does the toe have a well-pronounced (typically exhibited as a convex profile).
- Some slope movements have poorly developed toes, that may look like thin sheets of earth that is starting to fold or flow over the ground surface downslope.

Seeps:

- Look for areas of new seeps.
- Look for changes in flow rates of known seepage.

Direct Movement Monitoring

There are several methods for directly monitoring areas of slope movements. These include using stakes that can be measured by hand tapes, surveyed stake systems and extensometers.

Movement can be assessed by placing stakes along a line or lines down the fall line of areas with known or suspected movement. It is important that reference stakes at the ends are established outside the limits of movement. The distance between stakes should be measured on a periodic basis, which might vary from several times a day, daily or weekly, depending on the known or suspected activity of the site or if there is a need to monitor for worker safety.

Professionally surveyed lines or monuments can be placed at important locations on or near the pipeline ROW for future reference. Later surveys compare the elevation and/or coordinate locations of the survey points to prior positions. Survey data are particularly useful in defining the relative motions of different slide blocks within a landslide mass.

APPENDIX E
ETC Provided Project Schedule

PADEP Revolution Pipeline Temporary Stabilization Plan Schedule

ID	Task Name	Duration
1	**Preapproval Activity**	**34 days**
2	Survey Travel Lanes	20 days
3	Survey 70% Vegetated Areas	20 days
4	Fence 70% Vegetated Areas	30 days
5	**Temporary Stabilization Plan Construction Schedule**	**140 days**
6	PADEP Approval Receipt & Completion of 7-day Pre-construction Notice	0 days
7	**Work Zone 01 (Sta. Nos. 0+00 - 850+00)**	**117 days**
8	Identify Existing Revolution and Foreign Pipelines	5 days
9	RCE, Travel Lane, & Perimeter ECD Installation	100 days
10	Temporary Access Road Installation	70 days
11	Seed, Mulch, & Remaining ECD Installation	100 days
12	**CIS Crow's Run Creek (Sta. Nos. 788+00 to 789+00)**	**26 days**
13	RCE & Temporary Access Road Installation	1 day
14	Travel Lane, & Perimeter ECD Installation	20 days
15	French Drain Installation & Geotechnical Boring	5 days
16	**Crow's Run Slope Failure (Sta. Nos. 765+00 to 769+00)**	**4 days**
17	French Drain Installation & Geotechnical Borings	4 days
18	**Freedom Crider Road, GAS of Creek Slope Failure (Sta. No. 689+40)**	**14 days**
19	RCE & Temporary Access Road Installation	4 days
20	Travel Lane, & Perimeter ECD Installation	5 days
21	Install Plastic Sheeting	1 day
22	**Work Zone 02 (Sta. Nos. 850+00 - 1090+00)**	**77 days**
23	Identify Existing Revolution and Foreign Pipelines	4 days
24	RCE, Travel Lane, & Perimeter ECD Installation	60 days
25	Temporary Access Road Installation	20 days

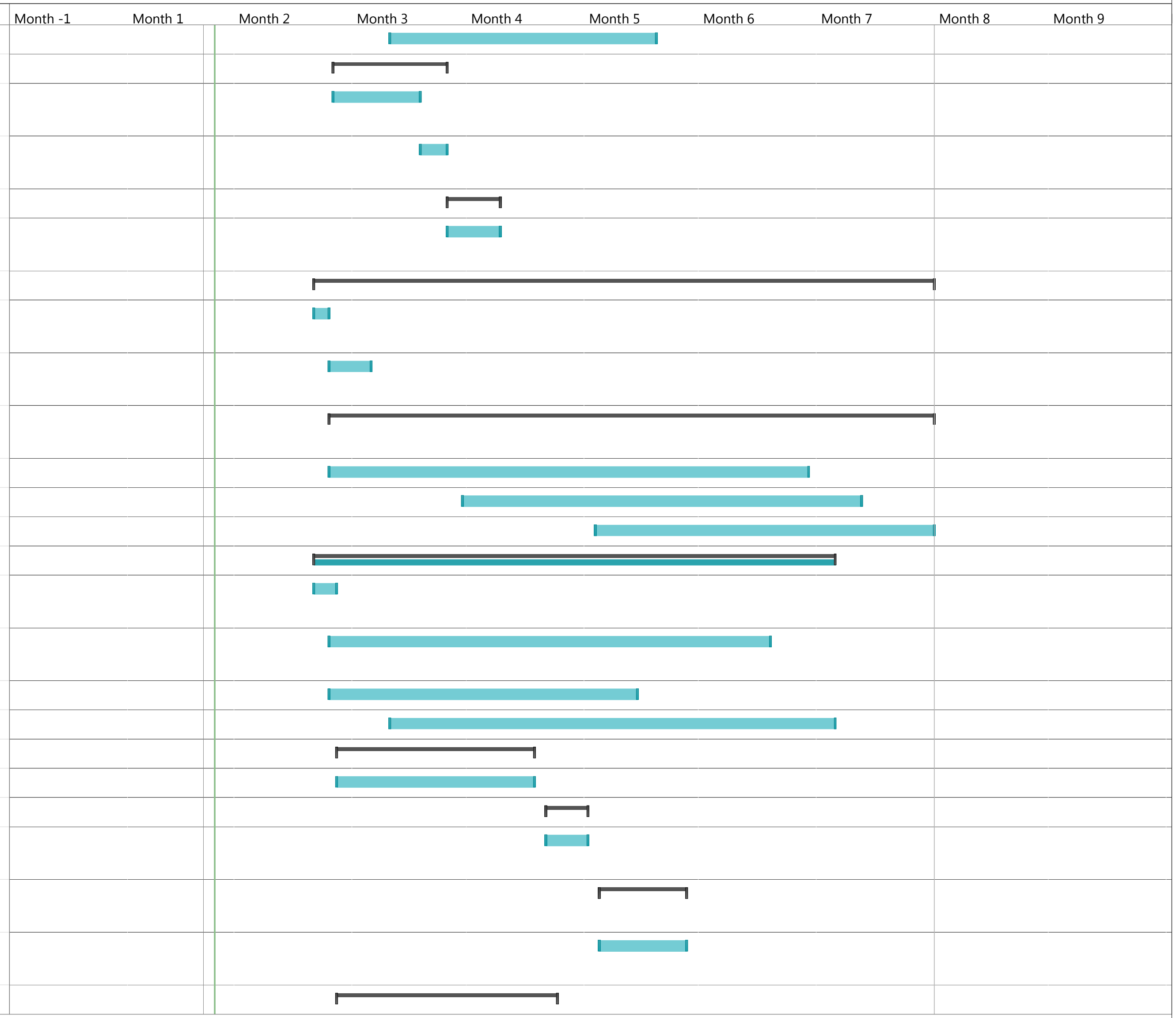
Rev0

2/25/2019

ETC Northeast Pipeline, LLC

PADEP Revolution Pipeline Temporary Stabilization Plan Schedule

ID	Task Name	Duration
26	Seed, Mulch, & Remaining ECD Installation	60 days
27	**Elkhorn Run 2 (Sta. Nos. 871+00 to 872+00)**	**26 days**
28	RCE, Travel Lane, & Perimeter ECD Installation	20 days
29	French Drain & Temporary Diversion Pipe Installation	6 days
30	**Elkhorn Run 1 (Sta. Nos. 864+00 to 868+00)**	**12 days**
31	French Drain Installation & Geotechnical Borings	12 days
32	**Work Zone 03 (Sta. Nos. 1090+00 - 1146+00)**	**140 days**
33	Identify Existing Revolution and Foreign Pipelines	3 days
34	RCE, Travel Lane, & Perimeter ECD Installation	10 days
35	**Ivy Lane - Incident Site (Sta. Nos. 1091+00 to 1125+00)**	**137 days**
36	Excavate Unstable Fill	108 days
37	Install Keyway (Toe Key) & Slope Benches	90 days
38	Interceptor Drainage Trench Installation	77 days
39	**Work Zone 04 (Sta. Nos. 1146+00 - 2152+58)**	**117 days**
40	Identify Existing Revolution and Foreign Pipelines	5 days
41	RCE, Travel Lane, & Perimeter ECD Installation	100 days
42	Temporary Access Road Installation	70 days
43	Seed, Mulch, & Remaining ECD Installation	100 days
44	**Penny Hollow Road (Sta. No. 1214+00)**	**45 days**
45	Sheet Pile & Rock Buttress Installation	45 days
46	**GAS Raccoon Creek (Sta. No. 1173+00)**	**10 days**
47	French Drain, Temporary Diversion Pipe, & Plastic Sheeting Installation	10 days
48	**GAS of Service Creek (Sta. Nos. 1351+00 to 1355+00)**	**20 days**
49	French Drain, Temporary Diversion Pipe, & Plastic Sheeting Installation	20 days
50	**SR 151 (Sta. Nos. 1495+00 to 1496+00)**	**50 days**



Rev0

2/25/2019

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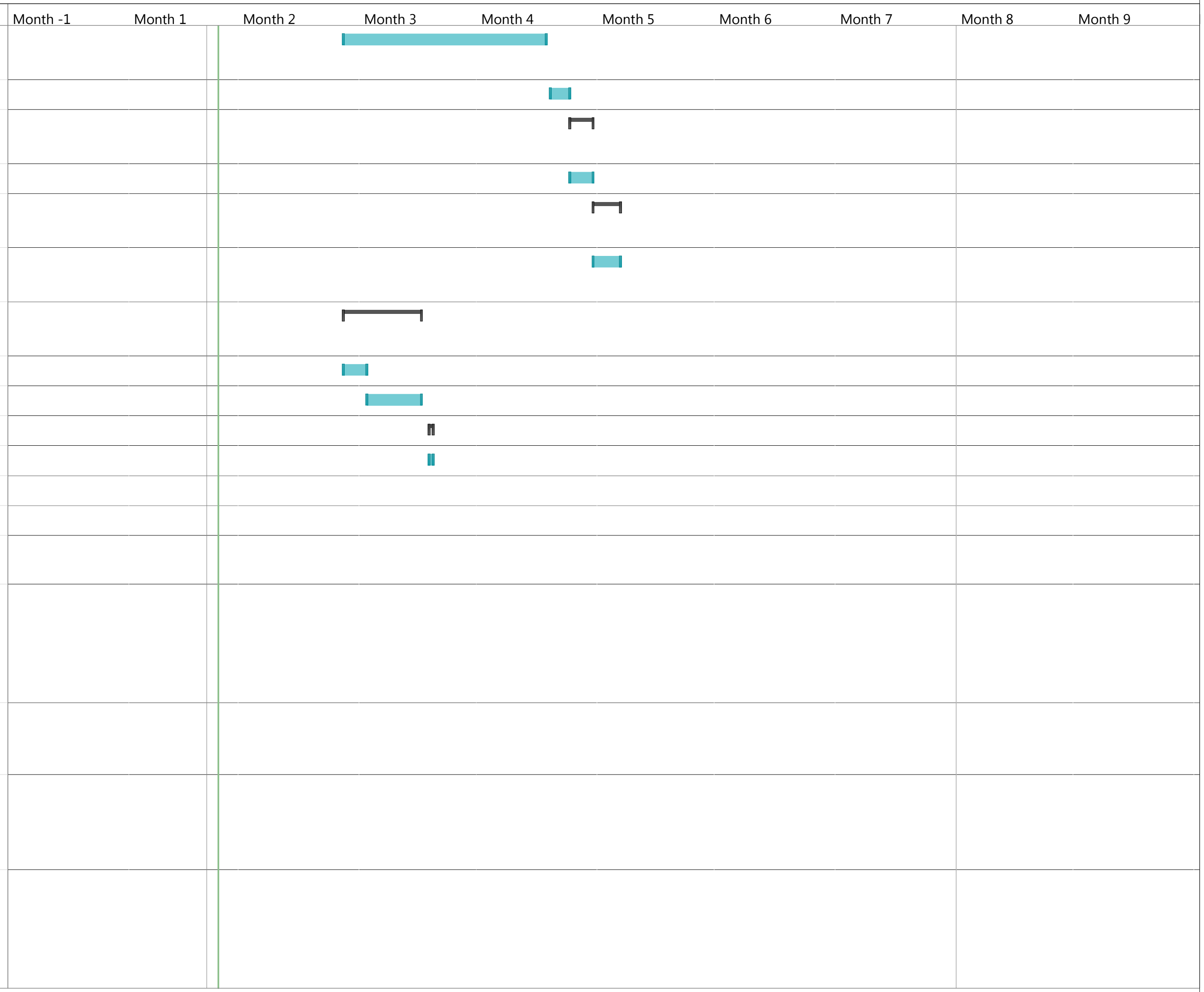
PADEP Revolution Pipeline Temporary Stabilization Plan Schedule

ID	Task Name	Duration
51	Temporary Diversion Pipe & Discharge Structure	45 days
52	Install Plastic Sheeting	5 days
53	**GAS of Backbone Road (Sta. Nos. 1641+00 to 1642+00)**	**5 days**
54	Waterbar Installation & Debris Removal	5 days
55	**CIS Clinton Frankfort (Sta. Nos. 1734+50 to 1739+00)**	**6 days**
56	French Drain & Temporary Diversion Pipe Installation	6 days
57	**Campbell Hill Road (Sta. Nos. 2042+00 to 2047+00)**	**17 days**
58	Geotechnical Borings	5 days
59	Hydroseed, ECB, & Waterbar Installation	12 days
60	**US 30 (Sta. Nos. 1697+50 to 1698+00)**	**1 day**
61	Install Plastic Sheeting	1 day



Notes & Assumptions:

(1) Schedule is based on a six (6) day, 10-hours/day work week.

(2) Durations are assumed to be working days and not calendar days. Therefore, no weather days are assumed. Durations were generated using known variables and are subject to change based on field conditions.

(3) Preapproval Activities are assumed to commence prior to the Temporary StabilizationPlan PADEP approval.

(4) Construction Activities are assumed to commence subsequent to the Temporary Stabilization Plan PADEP approval and a seven (7) day pre-construction notice.

(5) The Incident Area Temporary Sediment Barrier execution plan (Sta. Nos. 1090+00 - 1146+00) is proposed for completion prior to approval of the Temporary Stabilization Plan and consequently not included as part of this schedule.

Rev0

2/25/2019

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APPENDIX F
Report Limitations and Guidelines for Use

APPENDIX F
REPORT LIMITATIONS AND GUIDELINES FOR USE[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

Read These Provisions Closely

It is important to recognize that the geoscience practices (geotechnical engineering and geology) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

Geotechnical Services Are Performed for Specific Purposes, Persons and Projects

This report has been prepared for ETC Northeast Pipeline, LLC and for the project specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for this Project, and its schedule and budget, our services have been executed in accordance with our Agreement with ETC Northeast, LLC dated September 11, 2018 and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A Geotechnical Engineering or Geologic Report is Based on a Unique Set of Project-Specific Factors

This report has been prepared for part of the Revolution Pipeline 2018 Landslide Evaluation. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

[1] Developed based on material provided by ASFE, Professional Firms Practicing in the Geosciences; www.asfe.org.

Subsurface Conditions Can Change

This report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

Geotechnical and Geologic Findings Are Professional Opinions

Our interpretations of subsurface conditions are based on field observations from our observations at the site and our review of publicly-available and company-owned documents and mapping. GeoEngineers applied its professional judgment to render an informed opinion about subsurface conditions. Actual subsurface conditions may differ, sometimes significantly, from the opinions presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

GeoEngineers