ATLANTIC COAST PIPELINE, LLC
ATLANTIC COAST PIPELINE

and

DOMINION ENERGY TRANSMISSION, INC.
SUPPLY HEADER PROJECT

Implementation Plan

EC51 Attachment 2

Supplemental Phase 2 Geohazard Analysis Report

Geosyntec consultants

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30 August 2017
TXG0007-012-5508

VIA EMAIL

Colin Olness, Contractor
Atlantic Coast Pipeline
99 Edmiston Way
Buckhannon, WV 26201

Subject: **Supplemental Phase 2 Geohazard Analysis Program**
Supply Header Pipeline and Atlantic Coast Pipeline Projects
SHP Segment TL-635 and ACP Segment AP-1
Virginia and West Virginia, United States

Dear Mr. Olness:

This letter report has been prepared by Geosyntec Consultants, Inc. (Geosyntec) for Dominion Transmission, Inc. (DTI) as a supplement to the August 2016 Geohazard Analysis Program Phase 2 report on the Supply Header Pipeline (SHP) and Atlantic Coast Pipeline (ACP) Alignments [Geosyntec, 2016][1]. The purpose of this supplemental report is to present the findings of additional Phase 2 fieldwork performed at geohazard sites located in West Virginia and Virginia along the SHP Segment TL-635 and the ACP Segment AP-1 of alignments. Furthermore, this letter report addresses the request by the Federal Energy Regulatory Commission (FERC) in the July 21, 2017 Project Final Environmental Impact Statement (FEIS) to provide an update on 30 potential geohazard sites that had been identified in Geosyntec's Phase 1 desktop study [Geosyntec, 2015][2], and in Table 6-2 on Page 6-6 of the Phase 2 report, but not reviewed in the field at the time of submitting the Phase 2 report.

BACKGROUND

Volume 1 Section 4.1.4.2 (Slope Stability) of the Project FEIS, includes a FERC recommendation requesting updated information on the status of geohazard analysis field

[1] Geosyntec Consultants, 2016. "Geohazard Analysis Program Phase 2 Report, Atlantic Coast Pipeline and Supply Header Project", submitted to Dominion Transmission Inc., dated August 2016.

[2] Geosyntec Consultants, 2015. "Geohazard Analysis Program Phase 1 Report, Atlantic Coast Pipeline and Supply Header Project", submitted to Dominion Transmission Inc., dated December 2015.

reconnaissance of the 25 sites on the ACP mainline Segment AP-1 and 5 sites on the SHP loopline Segment TL-635 (as well as any additional geotechnical studies proposed following completion of site reconnaissance of these sites) [FERC, 2017] [3]. This supplemental report provides an update on the status of the remaining 30 potential geohazard sites identified in the Phase 2 report, and summarizes activities completed in the field since submittal of the Phase 2 report, a description of the geohazard sites visited, provides general construction considerations at the geohazard sites, and presents recommendations for further study where applicable.

The objective of the additional Phase 2 work was to verify the location, limits, characteristics, and refine and calibrate the relative hazard rankings of the identified Phase 2 potential slope instability hazard site locations based on detailed field observations. The geohazard sites described herein were evaluated after submittal of the August 2016 Phase 2 Report and April 2017 Phase 2 Addendum Report [Geosyntec, 2017][4].

PHASE 1 GEOTECHNICAL HAZARDS DESKTOP ANALYSIS

The original focus of the Phase 1 desktop analysis was along the Rev 8a alignment, although additional Phase 1 type geotechnical desktop analysis was conducted along reroutes and route revisions associated through the current alignment that were not previously evaluated during the initial Phase 1 analysis. As described in the Phase 2 Addendum Report [Geosyntec, 2017], this additional Phase 1 analysis was primarily conducted along the approximate 97-mile-long Forest Service reroute on ACP Segment AP-1 between approximately MP 47.5 and MP 115.0, but also included a review of several smaller reroutes with minor deviations from the Rev 8a route. The analysis was performed to document areas of concern and to develop a revised hazard site tabulation for the pipeline route along a corridor extending approximately 600 feet on either side of the route centerline. Phase 2 analysis extended the Phase 1 analysis, and included evaluation of subsequent reroutes and route revisions up to the current alignment. Locations where desktop analysis identified existing slope instability hazard features and locations with the potential for slope instability hazard occurrence were assigned a semi-quantitative potential hazard ranking value in accordance with the criteria described previously in Phase 2 Addendum Report [Geosyntec, 2017] to support selection of sites requiring Phase 2 field verification.

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[3] FERC, 2017. "Atlantic Coast Pipeline and Supply Header Project – Final Environmental Impact Statement, Volume I", Federal Energy Regulatory Commission Docket Nos. CP15-554-000, CP15-554-001, CP15-555-000, and CP15-556-000. FERC/EIS-0274F

[4] Geosyntec Consultants, 2017. "Geohazard Analysis Program Phase 2 Addendum Report, Atlantic Coast Pipeline and Supply Header Project", submitted to Dominion Transmission Inc., dated April 2017.

PHASE 2 GEOTECHNICAL HAZARD ANALYSIS

The following sections summarize our findings from the additional Phase 2 field reconnaissance for this study. This report presents the additional Phase 2 results that were completed after the Phase 2 Addendum Report was submitted.

Health and Safety

Prior to conducting our Phase 2 field reconnaissance, Geosyntec updated our existing site-specific Health and Safety Plan (HASP) in accordance with Occupational Safety & Health Administration (OSHA) requirements. The updated HASP addressed potential hazards at the geohazard site locations, including requirements for worker protection based on the anticipated activities. Additionally, the HASP also included directions to nearest emergency medical facility.

Ground Reconnaissance

Ten days of ground reconnaissance were conducted in the field during two mobilizations by Geosyntec from 24 to 27 October 2016 and from 17 to 22 June 2017 to evaluate sites in which property access had previously been unavailable. During these two subsequent ground reconnaissance visits, 22 of the 30 identified potential geohazard sites were reviewed in the field along the current alignment of SHP Segment TL-635 between MP 29.36 and MP 1.85 and on ACP Segment AP-1 between MP 57.15 and MP 169.28. Of the remaining eight sites, three sites (Geohazard IDs SS051, SS052, and SS069) are no longer on the alignment due to subsequent route adjustments, and two sites (Geohazard IDs SS063 and SS064) are bypassed by the proposed Blue Ridge Parkway HDD and therefore not applicable. The remaining three sites (Geohazard IDs SL296, SS065, and SS069), could not be accessed due to land access restrictions that still existed at the time the two ground reconnaissance visits were performed. A list of the 30 identified sites and current status is included in Table 1 below.

Table 1. Additional Phase 2 Geohazard Sites Visited

Pipeline Segment	Alignment[5,6] Milepost	Geohazard ID	Geohazard Type	Latitude	Longitude	Date Visited
TL-635	29.36-28.77	SS010	Steep Slope	39.513075	-80.623194	10/24/2016
TL-635	28.61-28.37	SS011	Steep Slope	39.511713	-80.616818	10/24/2016
TL-635	28.09-27.81	SS012	Steep Slope	39.506026	-80.610805	10/24/2016
TL-635	2.38-2.07	SS019	Steep Slope	39.192582	-80.586311	10/24/2016
TL-635	2.02-1.85	SS020; SL303	Steep Slope; Potential Slope Instability	39.190274	-80.582943	10/24/2016
AP-1	57.15-57.25	SS023	Steep Slope	38.604535	-80.164868	10/25/2016
AP-1	57.99-58.18	SS024	Steep Slope	38.589964	-80.160867	10/25/2016
AP-1	61.31-61.47	SS027	Steep slope	38.528048	-80.134069	6/18/2017
AP-1	76.66-76.74	SS033	Steep Slope	38.331607	-79.949678	10/25/2016
AP-1	89.66-89.76	SS048	Steep Slope	38.253107	-79.721801	10/26/2016
AP-1	89.75-89.97	SL294	Potential Slope Instability	38.249619	-79.719955	10/26/2016
AP-1	89.97-90.05	SS049	Steep Slope	38.247585	-79.717305	10/26/2016
AP-1	92.79-92.90	SS050	Steep slope	38.198759	-79.695873	6/19/2017
AP-1	93.15-93.48	SL296	Potential Slope Instability	38.191175	-79.685871	No access
AP-1	NA	SS051	Steep slope	No longer on alignment		
AP-1	NA	SS052	Steep slope	No longer on alignment		
AP-1	98.06-98.14	SS053	Steep slope	38.136348	-79.603883	6/20/2017
AP-1	98.27-98.32	SS054	Steep slope	38.133212	-79.600488	6/20/2017
AP-1	98.67-98.69	SL298	Potential Slope Instability	38.122778	-79.597104	6/20/2017
AP-1	98.96-99.00	SS055	Steep slope	38.117007	-79.598082	6/20/2017
AP-1	99.39-99.47	SS056	Steep Slope	38.111028	-79.589416	10/26/2016
AP-1	113.02-113.06	SS057	Steep Slope	38.242609	-79.346630	10/27/2016
AP-1	154.98-155.03	SL299	Potential Slope Instability	37.945780	-78.957774	6/21/2017
AP-1	158.00-158.20	SS063	Steep slope	Located on Blue Ridge Pkwy HDD		
AP-1	158.25-158.60	SS064	Steep slope	Located on Blue Ridge Pkwy HDD		
AP-1	158.94-159.32	SS065	Steep slope	37.900260	-78.968633	No access
AP-1	164.51-164.78	SS067	Steep slope	37.871396	-78.886687	6/21/2017
AP-1	168.38-168.47	SL259	Potential Slope Instability	37.838514	-78.841183	No access
AP-1	169.25-169.28	SL261	Potential Slope Instability	37.828973	-78.831815	6/21/2017
AP-1	NA	SS069	Steep slope	No longer on alignment		

[5] Geosyntec Milepost intervals shown for alignment Segment TL-635 are with respect to REV 8A

[6] Geosyntec Milepost intervals shown for alignment Segment AP-1 are with respect to REV 11 (2016.06.08)

The primary purpose of the ground reconnaissance was to verify the location, limits, characteristics, and refine and calibrate the relative hazard rankings of the identified Phase 2 potential slope instability hazard site locations based on detailed field observations. Phase 2 field reconnaissance consisted of visiting potential slope instability sites identified during desktop analysis as having moderate or high hazard potential. Field reconnaissance also included visiting steep slopes that met the criteria described in the Phase 2 Addendum report. At each site, Geosyntec staff collected relevant geologic information and evaluated potential triggers for slope instability. The evaluation of potential effects on the pipeline from slope instability consisted of the following:

- Consideration of slope inclination and length;
- Consideration of the geomorphic character of the slope(s);
- Assessment of slope condition based on evident overlying soil and underlying rock materials and consideration of surface runoff and groundwater flow;
- Collection of structural geologic data to evaluate the potential for dip-slip failure conditions; and
- Interpretation of the chronology of past slope development and potential changes from future disturbance impacts.

The selected geotechnical hazard locations were accessed by public and private roads and traversed on foot within the study corridor where private property access was permitted. The ground reconnaissance focused on directly observing, obtaining photographic documentation, and characterizing the nature of potential slope instability indicators such as saturated ground conditions and geomorphic expression of surficial movement through the observation of localized tree growth distortion, and identification of scarps or erosional features associated with previous instability.

A detailed summary of the potential geohazard sites that were inspected and rankings based on the findings of our ground inspections is included in Attachment A.

RESULTS

Of the twenty-two potential slope instability hazard and steep slope sites visited during the additional Phase 2 field reconnaissance five were located on the SHP Segment TL-635 and 17 were on the ACP Segment AP-1. A summary of findings and general recommendations for each of the sites is included in Attachment A. The distribution of these geohazard sites across the Project area are illustrated on the detailed strip maps compiled in Appendix 6-2 (Geologic Hazards Mapbook) of the Phase 2 Addendum report. For these 22 sites, desktop hazard rankings were revised based on field observations to reflect both the analysis of existing stability

conditions and the anticipated impacts of construction in accordance with the revised hazard potential level category definitions described in the Phase 2 Addendum Report. Four sites were ranked as having moderate potential slope instability hazard, 17 were ranked as having low potential slope instability hazard, and one potential hazard site identified was dismissed (now ranked "None") based on the results of the supplemental Phase 2 ground reconnaissance.

Segment TL-635 and Segment AP-1 of the proposed pipeline route are underlain by highly variable and locally deformed geologic bedrock units ranging from Paleozoic age shale, siltstone, and sandstone units associated with the Appalachian Plateaus and Valley and Ridge, to Pre-Cambrian metamorphosed sedimentary and crystalline rocks associated with the Blue Ridge. Many of the existing slope instability hazards identified along the study route are generally situated in areas adjacent and downslope of the proposed centerline. The four sites ranked as having a "moderate" slope instability hazard are located in areas where the proposed centerline crosses or extends along potential or pre-existing slope instability, or along very steep to extremely steep slopes with complex geologic or hydrologic conditions. These areas are typically associated with sections of the proposed centerline which extend across steep slopes that are more susceptible to slope instability because of weak underlying siltstone and shale deposits, highly deformed and weathered crystalline rock, fine grained surficial soils, or saturated ground conditions.

Recommendations for Site-Specific Subsurface Investigations

The Phase 2 geotechnical analysis identified one site for which Geosyntec recommends additional site-specific subsurface geotechnical investigation to characterize identified landslides and to obtain data that can be used to conduct engineering analysis and prepare mitigation designs. This site is described in the paragraph below.

AP-1 MP 89.75 to 89.97 (SL294)

The SL294 site was identified as a potential slope instability hazard with a hazard potential ranking of "Moderate". The site is underlain by Silurian-age arenite and shale associated with the Keefer, Rose Hill, and Tuscarora Formations (undifferentiated). Geosyntec geologists and engineers visited the site on 26 October 2016. SL294 is characterized by gentle to very steep slope sections of approximately 17 degrees (30%) to 22 degrees (40%) with a maximum inclination of approximately 27 degrees (50%) broken up by a series of benches with localized closed depressions. Large hummocks and chaotic, uneven terrain observed on LiDAR topography and in the field suggest that this is an ancient deep-seated landslide possibly controlled by dip slope structure with large blocks of arenite talus below steep potential scarp features. Abundant lichen growth on the talus blocks below potential scarps suggest that mass movement deposit has been stable for some time, however given the dip slope conditions construction disturbance could result in localized slope instability. Due to the significant size of SL294, potential route adjustments would need to be significant to avoid the feature. Geosyntec recommends a detailed geotechnical investigation of the site, including drilling and

instrumentation (inclinometers) to determine bottom of the ancient landslide, followed by laboratory testing on representative samples of the subsurface materials, stability analysis.

Remaining Phase 2 Sites

Due to land access constraints, Geosyntec was unable to visit all 30 of the steep slope and potential slope instability hazard sites identified in the Phase 2 Report. As listed in Table 1, three sites are no longer on the alignment due to reroutes and two sites were removed due to the proposed HDD method of construction beneath the Blue Ridge Parkway. A list of three remaining slope instability hazard or steep slope sites are presented in Table 2 below. However, based on our additional desktop review of available LiDAR data, previous aerial reconnaissance, and our understanding of similar conditions these sites have been ranked as having a low hazard potential and are recommended for review following ROW clearing activities.

Table 2. Remaining Phase 2 Geohazard Sites

Pipeline Segment	Approximate Milepost	Hazard ID	Slope Inclination or Hazard Potential Rank
AP-1	MP 93.15 to 93.48	SL296	Low Instability Hazard
AP-1	MP 158.94 to 159.32	SS065	40%-58% Steep Slope
AP-1	MP 168.38 to 168.47	SL259	Low Instability Hazard

CLOSING

Geosyntec appreciates the opportunity to provide Dominion Transmission, Inc. with this supplement to the Phase 2 report, and we look forward to working together on this important project. If you have any questions or require additional information, please contact Tony Rice (trice@geosyntec.com, 206.496.1456) or Alexander Greene (agreene@geosyntec.com, 858.716.2911).

Sincerely,

Geosyntec Consultants, Inc.

Tony Rice
Senior Principal Geotechnical Engineer

Alexander Greene, C.E.G., P.G.
Principal Engineering Geologist

Attachments: Attachment A – Remaining Potential Geotechnical Geohazards Summary Table

ATTACHMENT A

REMAINING POTENTIAL GEOTECHNICAL GEOHAZARDS SUMMARY TABLE

Phase 2 Geohazard Analysis Program

Remaining Potential Geotechnical Geohazards Summary Table

Pipeline Segment	Alignment Milepost	Geohazard ID	Geohazard Type	Hazard Ranking	Geology	Latitude	Longitude	Comments	Recommendations	Date Visited
TL-635	29.36-28.77	SS010	Steep Slope	Low	Pd - Dunkard Group (Permian/Pennsylvanian) sandstone, siltstone, red and gray shale, limestone, and coal	39.513075	-80.623194	Centerline follows a convex ridgecrest from MP 28.77 to approximately MP 29.0, along which no slope hazard has been identified. From MP 29.0 to MP 29.3, the centerline follows a relatively narrow convex ridge, which is considered stable. From MP 29.3 down to the South Fork River at the base of the slope, the slope is covered with wet, soft clayey soil. The lower slope is planar, rather than on a ridge nose. The lower slope may become unstable if disturbed.	BIC trenchline drainage provisions required to address shallow groundwater conditions and localized seeps on lower portion of slope between MP 29.3 and 29.35	10/24/2016
TL-635	28.61-28.37	SS011	Steep Slope	Moderate	Pd - Dunkard Group (Permian/Pennsylvanian) sandstone, siltstone, red and gray shale, limestone, and coal	39.511713	-80.616818	The centerline is located just downslope to the northeast of the convex ridgecrest. Below is a side slope that could be avoided by locating the centerline directly on the ridgecrest. The reidgecrest is very narrow (~30 feet wide) in some places. The portions of the northeast slope below the centerline are unstable. SL104 was observed and confirmed to be a recent slope failure. Near the bottom of the northeast slope (away from the centerline), we observed widespread instability, including landslides and soil creep, in areas underlain by siltstone.	Shift centerline upslope 25-50 feet upslope onto stable convex ridgecrest to avoid constructability issues and avoid sidecasing grading spoil onto steeper slope above SL-104.	10/24/2016
TL-635	28.09-27.81	SS012	Steep Slope	Low	Pd - Dunkard Group (Permian/Pennsylvanian) sandstone, siltstone, red and gray shale, limestone, and coal	39.506026	-80.610805	The centerline follows a convex ridge nose that appears to be stable. The lower slope is steep and covered by wet clayey soil. The lower slope may become unstable if disturbed. Recent slope instabilities were observed on the side slopes descending from both sides of the ridge nose along which the centerline is located.	BIC trnchline drainage provisions required to address shallow groundwater conditions and localized seeps on lower portion of slope between MP 28.10 and 28.12	10/24/2016
TL-635	2.38-2.07	SS019	Steep Slope	Low	Pd - Dunkard Group (Permian/Pennsylvanian) sandstone, siltstone, red and gray shale, limestone, and coal	39.192582	-80.586311	Dry soil, stable slope. Smooth slope, no sign of instability on the centerline. Recent failures on both sides of centerline, ~80 feet away. Centerline route appears to be in ideal location, where the nose of slope is stable. The bottom of the slope is underlain by shallow sandstone bedrock, which is exposed near the centerline. While the slope is currently stable, evidence of exisiting instability on both sides of the centerline suggests that there is need to mitigate the potential for instability on to develop on the slope when disturbed.	Existing route appears to be stable but BIC mitigations may need to be implemented if instability develops.	10/24/2016
TL-635	2.02-1.85	SS020; SL303	Steep Slope; Potential Slope Instability	Moderate	Pd - Dunkard Group (Permian/Pennsylvanian) sandstone, siltstone, red and gray shale, limestone, and coal	39.190274	-80.582943	Lower slope is wet and has the potential to become unstable if disturbed. Mid-slope area has evidence of recent shallow instability, possibly on/across the centerline. Several shallow landslides are clearly visible on both sides of the centerline. Soil is wet and clayey. The Upper slope appears stable and is characterized by shelf-and-slope profile that is controlled by lithology (steep slopes on sandstone outcrop, and gentler slopes on siltstone and clay). Several slope instabilities were observed on LiDAR and in the field, and mapped onto the LiDAR slope map (SL301, SL302, SL303). SL303 appeared to be a shallow surficial instability that crossed the proposed centerline and is ranked as a Moderate hazard.	BIC trenchline drainage provisions required to address shallow groundwater conditions and localized seeps on lower portion of slope between MP 2.02 to 1.98	10/24/2016

Geosyntec Milepost intervals shown for Alignment Segment TL-635 are with respect to REV 8A.,
Geosyntec Milepost intervals shown for Alignment Segment AP-1 are with respect to REV 11 (2016.06.08).

Pipeline Segment	Alignment Milepost	Geohazard ID	Geohazard Type	Hazard Ranking	Geology	Latitude	Longitude	Comments	Recommendations	Date Visited
AP-1	57.15-57.25	SS023	Steep Slope	Low	Pnk - Kanawha Formation (Pennsylvanian) sandstone and shale	38.604535	-80.164868	The slope is located below a strip mine; most of the slope is likely underlain by angular mine waste boulders. The slope is wet and heavily vegetated. Centerline crosses the slope obliquely. Several haul roads cross the slope. Water was heard flowing below the surface in the interstitial spaces between boulders. No obvious signs of instability were observed, but surface and subsurface drainage provisions will be necessary. The stream at the base of the slope is in a bedrock channel.	Drainage provisions required to address shallow groundwater conditions through mine waste. Shifting centerline 200 feet south along stable natural ridge covered with conifers would potential avoid issues related to subsurface flow through mine waste deposit.	10/25/2016
AP-1	57.99-58.18	SS024	Steep Slope	Low	Pnnr - New River Formation (Pennsylvanian) sandstone and shale	38.589964	-80.160867	There is abundant work space on the floodplain at the bottom of the slope. The lower slope is relatively dry, with some possible evidence of shallow creep. Many logging/haul roads cross the slope. Most mature tree trunks are straight. Sandstone is exposed near the top of the slope in a cliff band. The lower slope inclination was measured to be 65%.	Conventional steep slope construction	10/25/2016
AP-1	61.31-61.47	SS027	Steep slope	Low	Mh - Hinton Formation (Mississippian) red, green, and gray shale and sandstone with few limestone beds	38.528048	-80.134069	Alignment climbs a steep to very steep slope along ridgline nose underlain by instabilty prone material. Localized instability observed outside of ROW primarily along slope to NNW. Centerline crosses minor drainage swales.	Conventional steep slope construction with BIC drainage mitigations required where centerline crosses drainage swales. Maintain maximum possible distance from top of slope to NNW.	6/18/2017
AP-1	76.66-76.74	SS033	Steep Slope	Low	Dhs - Hampshire Formation (Devonian) fine micaceous sandstones, mostly red to brownish-gray, including siltstone, sandstone, and conglomerate	38.331607	-79.949678	Alignment climbs a very steep to extremely steep northwest facing slope from Greenbrier River which appears to be dry and stable and underlain at shallow depth by sandstone. The alignment crosses the crest of a ridge and drops down a moderately steep to extremely steep east facing slope that is crossed by multiple logging trails.	Conventional steep slope construction	10/25/2016
AP-1	89.66-89.76	SS048	Steep Slope	Low	Skrt - Keefer, Rose Hill, and Tuscarora Formations (Silurian) arenite and shale	38.253107	-79.721801	Short, steep slope from the ridgecrest down to the top of SL294. The slope is planar and smooth, with no evidence of instability. Slope surface is composed of loose, angular boulders and cobbles derived locally. Loose material is interpreted to be the product of in situ processes (freeze-thaw or periglacial). Sandstone bedrock outcrops at ridgecrest and dips down slope (dipping to the southeast). The centerline is slightly oblique to the fall line of the slope.	Out of slope dip angle could potentially result in localized bedding plane slips and rockfall during ROW construction. Conventional steep slope construction required.	10/26/2016

Geosyntec Milepost intervals shown for Alignment Segment TL-635 are with respect to REV 8A.,
Geosyntec Milepost intervals shown for Alignment Segment AP-1 are with respect to REV 11 (2016.06.08).

Pipeline Segment	Alignment Milepost	Geohazard ID	Geohazard Type	Hazard Ranking	Geology	Latitude	Longitude	Comments	Recommendations	Date Visited
AP-1	89.75-89.97	SL294	Potential Slope Instability	Moderate	Skrt - Keefer, Rose Hill, and Tuscarora Formations (Silurian) arenite and shale	38.249619	-79.719955	The slope is moderately to extremely steep, uneven, and hummocky. The surface is composed on angular bedrock blocks covering a significant area. Underlying bedrock, comprising arenite and shale, is exposed near the top of the ridge and is dipping downslope (N55E/41SE), creating a dip slope. Large hummocks and uneven terrain observed on LiDAR and in the field suggest that this slope is a deep-seated ancient landslide, possibly controlled by the dip slope bedrock structure. Bedrock is arentie and shale. The geomorphic expression convincingly suggests that this is an ancient landslide deposit. Given the dip slope conditions, construction distrubance may cause localized instability.	Options to follow more stable terrain would require significant route adjustment . Recommend a detailed , site-specific geotechnical investigation of this site, including drilling to cofirm depth of ancient landslide deposit and instumentation installation (inclinometers) as a precaution in the unlikely event that any residual movement is occuring on this slope.	10/26/2016
AP-1	89.97-90.05	SS049	Steep Slope	Low	Skrt - Keefer, Rose Hill, and Tuscarora Formations (Silurian) arenite and shale	38.247585	-79.717305	Extremely steep slope; measured in the field to be 100% inclination at mid-slope and steeper near base of slope. The slope is controlled by shallow bedrock and the slope is stable. Construction disturbance may result trench backfill instability due to the steep inclination. The channel at the toe of the slope is narrow, with a shallow veneer of cobbles on top of bedrock. Tree trunks on the slope were straight.	Extremely steep slope underlain at shallow depth by bedrock appears to be stable. BIC trench backfill stabilizaiton measures recommended.	10/26/2016
AP-1	92.79-92.90	SS050	Steep slope	Low	Oun - Juniata, Oswego, Martinsburg, and Eggleston Formations (Ordovician) red shale and mudstone and sandstone	38.198759	-79.695873	Steep south-southeast facing slope is inclined at 25-35 degrees (45%-67%) on the northwest side of Little Valley. Centerline extends through localized areas of minor slope instability with tree growth distortion. A recently active landside exists on an extremely steep slope to the north of, and well removed from, the alignment but this feature will not affect the alignment.	Conventional steep slope construction. Do not encroach on adjacent drainage swale to southwest of alignment or extremely steep slope to the north.	6/19/2017
AP-1	93.15-93.48	SL296	Potential Slope Instability	Low	Oun - Juniata, Oswego, Martinsburg, and Eggleston Formations (Ordovician) red shale and mudstone and sandstone	38.191175	-79.685871	Suspect geomorphic expression suggests large scale bedrock paleoslide along northwest flank of Jack Mountain. Phase 1 review of LiDAR imagery and aerial reconnaissance did not identify evidence of recent or shallow instability. Paleoslide appears stable.	Phase 2 field reconnaissance to be performed once land access is available.	No access at time of Phase 2 Recon
AP-1	98.06-98.14	SS053	Steep slope	Moderate	Db - Brallier Formation (Devonian) shale, siltstone, and sandstone	38.136348	-79.603883	Proposed centerline extends along very steep to extremely steep side slope above Foxtail Hollow near top of slope. Chaotic tree growth on steep slope below centerline.	Recommend minor alignment shift approximately 30-50 feet to south-southwest on to gentle sloping ground at top of slope to avoid constructability concerns on steep side slope. Slope is not located on centerline Rev 00 (20170801).	6/20/2017
AP-1	98.27-98.32	SS054	Steep slope	Low	Db - Brallier Formation (Devonian) shale, siltstone, and sandstone	38.133212	-79.600488	Extemely steep slope conditions inclined at 43 degrees (99 %) on northeast facing slope adajcent to bedrock creek channel, approximately 40 feet from toe of slope.	Conventional steep slope construction. Slope is not located on centerline Rev 00 (20170801).	6/20/2017

Geosyntec Milepost intervals shown for Alignment Segment TL-635 are with respect to REV 8A.,
Geosyntec Milepost intervals shown for Alignment Segment AP-1 are with respect to REV 11 (2016.06.08).

Pipeline Segment	Alignment Milepost	Geohazard ID	Geohazard Type	Hazard Ranking	Geology	Latitude	Longitude	Comments	Recommendations	Date Visited
AP-1	98.67-98.69	SL298	Potential Slope Instability	Low	Db - Brallier Formation (Devonian) shale, siltstone, and sandstone	38.122778	-79.597104	Southwest facing steep colluvial hollow below saddle that the centerline crosses. Localized evidence of shallow/near surface fissile shale at head of feature. Abundant fine angular shale fragments on slope face. Evidence of localized surficial slumping in slope wash material. No significant instability observed.	Alignment along saddle appears stable with low potential for up slope progression/head cutting resulting in slope instability within proposed work limits.	6/20/2017
AP-1	98.96-99.00	SS055	Steep slope	Low	Db - Brallier Formation (Devonian) shale, siltstone, and sandstone	38.117007	-79.598082	Steep to very steep southeast facing slope. Ephemeral creek located at toe of slope. Ample work space on southeast side of creek. Limited workspace on northwest side. Extremely steep slope drops into narrow drainage approximately 10 feet wide at MP 98.86 to MP 98.87.	Conventional steep slope construction.	6/20/2017
AP-1	99.39-99.47	SS056	Steep Slope	None	Db - Brallier Formation (Devonian) shale, siltstone, and sandstone	38.111028	-79.589416	LiDAR hill shade and slope maps show a very smooth, rounded slopes. The centerline follows a rounded ridge nose down toward the valley bottom. The soil is dry; many conifers growing on slope and ridges. No evidence of instability. Tree trunks are straight. The ridge nose is approximately 50-60 feet wide at its narrowest. This slope does not appear to be a slope instability hazard.	Conventional steep slope construction but care required to prevent spoil from spilling over sides of narrow portions of ridge.	10/26/2016
AP-1	113.02-113.06	SS057	Steep Slope	Low	Db - Brallier Formation (Devonian) shale, siltstone, and sandstone	38.242609	-79.346630	Short, smooth, planar slope observed in LiDAR and in the field. No evidence of significant instability, but many trees are leaning downslope, suggesting shallow soil creep. The soil is dry and firm. No hummocky topography, scarps, or toe bulge observed. The slope inclination was measured in the field to be 64%. No bedrock exposures were observed.	Conventional steep slope construction.	10/27/2016
AP-1	154.98-155.03	SL299	Potential Slope Instability	Low	Ch - Cambrian quartzite, conglomerate, and sandstone	37.945780	-78.957774	No evidence of slope instability observed within limits of SL299 feature. Low potential for instability along northwest facing steep to very steep slope adjacent to north side of primary drainage. Localized evidence of tree growth distortion on north facing slope above small tributary drainage.	Conventional construction, drainage provisions required within tributary drainage crossing due to shallow groundwater conditions.	6/21/2017
AP-1	158.94-159.32	SS065	Steep slope	Low	Yc - Proterozoic gneiss	37.900260	-78.968633	Steep western facing slope off of Fortunes Ridge above Beech Grove Road near Wintergreen Resort. Phase 1 review of LiDAR imagery and aerial reconnaissance suggests potential for surficial instability along thin soil mantle overlying bedrock. However, this is anticipated to be above standard pipe burial depths.	Phase 2 field reconnaissance to be performed after ROW clearing activities.	No access at time of Phase 2 Recon

Geosyntec Milepost intervals shown for Alignment Segment TL-635 are with respect to REV 8A.,
Geosyntec Milepost intervals shown for Alignment Segment AP-1 are with respect to REV 11 (2016.06.08).

Pipeline Segment	Alignment Milepost	Geohazard ID	Geohazard Type	Hazard Ranking	Geology	Latitude	Longitude	Comments	Recommendations	Date Visited
AP-1	164.51-164.78	SS067	Steep slope	Low	Ybg - Proterozoic augen gneiss	37.871396	-78.886687	Steep slope conditions along north facing ridge on southside of Rockfish Valley in area of historic slope instability.	Conventional steep slope construction. Maintain alignment along center of north facing ridgeline nose to maximize distance from side slopes given potential hazard associated within heads of adjacent steep drainages. Centerline Rev 00 (20170801) shifted to west along favorable route.	6/21/2017
AP-1	168.38-168.47	SL259	Potential Slope Instability	Low	Ybg and Yc - Proterozoic gneiss	37.838514	-78.841183	Phase 1 review suggested suspect geomorphology related to colluvial hollow with minor instability along southeast facing slope.	Phase 2 field reconnaissance to be performed once land access is available.	No access at time of Phase 2 Recon
AP-1	169.25-169.28	SL261	Potential Slope Instability	Low	Yc - Proterozoic gneiss	37.828973	-78.831815	Southeast facing steep to locally very steep slope that drops down to creek crossing (25-30 feet across). On northwest side of crossing 2 feet bank to low fluvial terrace/approx. 5 foot bank to upper terrace (from water level). Evidence of bank cutting/failure on southeast side of creek crossing (approx. 6-7 feet) cut bank. Slope along SL261 contains localized evidence of minor surficial slumping. Morphology created by series of fluvial cut terraces.	Conventional construction, drainage provisions required along east facing slope adjacent to drainage crossing at toe due to shallow groundwater conditions	6/21/2017

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