USDA United States Department of Agriculture | Forest Service | Monongahela National Forest | 200 Sycamore Street
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File Code: 1900; 2700
Date: September 30, 2016

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First St., N.E., Room 1A
Washington, DC 20426

Dear Ms. Bose:

Subject: Forest Service Comments on the Geohazard Analysis Program Phase 1 and Phase 2 Reports for the Monongahela National Forest and George Washington National Forest
OEP/DG2E/Gas 4
Atlantic Coast Pipeline, LLC
Docket Nos. CP15-554-000 and CP15-554-001

The Forest Service provides comments on the Geohazard Analysis Program Phase 1 and Phase 2 Reports filed with the Federal Energy Regulatory Commission (FERC) on March 4, 2016 and August 2, 2016, respectively, by Atlantic Coast Pipeline, LLC for the proposed Atlantic Coast Pipeline Project. The proposed project would affect National Forest System lands in the Monongahela National Forest and George Washington National Forest.

Our comments on the Geohazard Analysis Program Phase 1 and Phase 2 Reports are contained in the two attachments to this letter. We recommend revising the reports based on our comments, and filing the revised reports with FERC. We look forward to reviewing the final draft of the Geohazard Analysis Program Phase 1 and Phase 2 Reports.

For questions, please contact Jennifer Adams, Special Project Coordinator, by phone at (540) 265-5114 or by email at jenniferpadams@fs.fed.us.

Sincerely,

CLYDE THOMPSON
Forest Supervisor

cc: Atlantic Coast Pipeline, LLC

U.S. FOREST SERVICE REVIEW OF THE GEOHAZARD ANALSYIS PROGRAM PHASE 2 REPORT

ATLANTIC COAST PIPELINE PROJECT

Page #	Section #	Comment
		General comment: Many of the comments (below) on ACP Geohazard Analysis Program Phase 1 Report reflect issues that were identified in previous Forest Service comments. The Forest Service provided comments on geologic hazards in response to 1) ACP's draft Resource Report 6, and 2) the initial FERC scoping notice. Those comments should be considered along with the comments (below) to provide context and more information on ways to resolve the issues.
i	Table of Contents	ACP's Sept 2015 Resource Report 6 Geological Resources identified each type of geologic hazard in clearly titled sections. However, the Geohazard Analysis Program Phase 1 Report lacks the clarity of Resource Report 6. The terminology and organization of the Phase 1 Report is different and unnecessarily opaque compared with Resource Report 6. Phase 1 Report section has titles and terminology like "hydrotechnical hazard" or "geotechnical hazard" which are too general and vague in specifying geologic hazards, and add a layer of obscurity to the Phase 1 Report. 1. Identify each type of geologic hazard in terms commonly used for the hazard, and title each section of the report accordingly. Revise the Desktop Analysis section 2.2 in Table of Contents in a manner similar to the following: 2.2.1 Compile Available Datasets and Construct the GIS Framework 2.2.2 Earthquake (Seismic) Hazards Desktop Analysis 2.2.3 Landslide Hazards Desktop Analysis 2.2.4 Ground Settlement and Subsidence Hazards Desktop Analysis 2.2.5 Flooding and Stream Hazards Desktop Analysis Revise the titles and discussion in the rest of the Phase 1 report to conform to the revised titles of the Table of Contents (above). In addition, ACP's Sept 2015 Resource Report 6 Geological Resources included two other geohazards 1) Consolidated rock/blasting (Sections 6.2 and 6.6.1), and 2) Acid-producing rocks and soils (Sections 6.4.6 and 6.6.8). Add these geohazards to TOC: 2.2.6 Consolidated Rock/Blasting Hazards Desktop Analysis 2.2.7 Acid-Producing Rocks and Soils Hazards Desktop Analysis Add sections analyzing these geohazards to the Phase 1 report.

2-2	2.2.1.1	Datasets sections states: “Table 1 provides a list of the datasets used for Phase 1 of the geohazard study.” In Table 1 (p. T-2), the Geology Layer Description states, “Features include dikes, sills, faults boundaries obtained from CEUS database and some geology layers obtained from Geosyntec” and states as Source: “Geological Society of America (Reed et al., 2005) and Geosyntec”. 1. The citation “Reed et al., 2005” is not cited in Section 7 References. Add full citation to References. 2. The U.S. Geological Survey (USGS) digitized the geologic unit boundaries for the area depicted in the Geologic Map of North America, published by the Geological Society of America in 2005 (Reed et. al, 2005). The USGS cautions: “Digital data were compiled from source data at a scale of 1:5,000,000 and are not intended to be used at a larger (greater detail) scale.” https://catalog.data.gov/dataset/map-service-database-of-the-geologic-map-of-north-america-adapted-from-the-map-by-j-c-reed-2005 3. For sedimentary rocks, the Geologic Map of North America (Reed et. al, 2005) geologic map units are geologic time units, not lithologic units. Use geologic maps that have map units relevant to geologic hazards, such as lithology, geologic structures, surficial deposits, etc. 4. Do not use Geologic Map of North America (Reed et. al, 2005) 1:5,000,000 scale map as a Geology map layer for the site-specific geologic hazards analysis on the National Forests. Do not enlarge the 1:5,000,000 scale geologic map to a more detailed scale such as 1:24,000 and attempt to use it for analysis at 1:24,000 scale or more detailed scale. For desktop study part of Geohazard Analysis Program Phase 1 on National Forests, use the most detailed scale geologic maps available for desktop analysis. Identify the geologic map reference(s) and state the quadrangle name and pipeline mileposts the maps were used for in the desktop study on the National Forest.
2-2	2.2.1.1	Datasets sections states: “Table 1 provides a list of the datasets used for Phase 1 of the geohazard study.” In Table 1 (p. T-5), the Consolidated Geologic Units Layer Description states, “Integrated database of geologic units and structural features with lithology, age” and states as Source: “USGS mineral resources and LCI”. 1. The citation ““USGS mineral resources” is not cited in Section 7 References, and is too vague. Add full citation to References, including the map scale of the USGS map(s). 2. The citation ““LCI” is not cited in Section 7 References, and is too vague. In Section 1.2 Geohazard Analysis Team, “LCI” is identified as Lettis Consultants International, Inc. (LCI) of Walnut Creek, CA. If LCI conducted geologic field investigations and produced a geologic map, then LCI could be cited as a source. However, if LCI is using geologic maps produced by other parties, such as State geological surveys or USGS, then it is the maps produced by these parties that need to be cited as the source(s) and listed in the References with the map scale for each reference. 3. For desktop study part of Geohazard Analysis Program Phase 1 on National Forests, use the most detailed scale geologic maps available for desktop analysis. Identify the geologic map reference(s) by quadrangle name and pipeline mileposts used in the desktop study on the National Forest.
2.3	2.2.3	The Geotechnical Hazards Desktop Analysis states: “These attributes were utilized to assess potential hazards elsewhere along the route.” However, the Phase 1 Report primarily displays and assesses discrete features, not the whole corridor. The Phase 1 Report does not display and assess all the slopes along the pipeline corridor for 1) the potential for landslides to

		occur and impact the pipeline, 2) the potential for the pipeline and project facilities including access roads to impact slope instability. For more detailed comments, see comments on Results section 4.5.
4-1	4.2.1	The Slope Instability section states: "Slope instability that can affect pipeline corridors vary widely in type and size, but because pipelines are typically buried, a large portion of commonly occurring landslides are shallow, and present significantly less threat to pipelines than deep seated slope instability." 1. This statement mischaracterizes the hazard of shallow landslides and underestimates the threat to the pipeline. Shallow landslides include debris slides, debris avalanches, and debris flows resulting from failures of colluvium and weathered bedrock. Shallow landslides in the steep mountains of western Virginia and West Virginia commonly reach depths of 3-feet or more. Pipelines typically buried 3 feet, and in some cases a little deeper, are shallow burial, not deep-seated burial. The shallow burial depth of pipelines is well-within the depth that shallow landslides would pose a hazard and be a risk to the pipeline. Historic debris flows events in western Virginia and West Virginia demonstrate each debris flow event typically has many debris slides and debris flows impacting a wide area. Considering the frequency and widespread occurrence, large numbers, and destructive force of shallow landslides compared with deep seated landslides, the shallow landslides can be considered a threat to pipelines as much or even more than deep seated landslides in western Virginia and West Virginia. Revise the Slope Instability section to properly characterize the hazard of shallow landslides and the risk (threat) to the pipeline.
4-2	4.3.1	The Data Compilation refers to "Bedrock and surficial geology maps" and "Landslide susceptibility maps and available previously mapped data". Identify the map reference(s) by quadrangle name and mileposts used in the desktop study on the National Forest. For desktop study part of Geohazard Analysis Program Phase 1 on National Forests, use the most detailed scale maps available for desktop analysis.
4-3	4.3.2	The Evaluation of Potential Slope Instability Hazard Phase 1 section states the desktop study "initially identified 211 discrete locations (76 along the TL-635 segment and 135 along the AP-1 segment), or areas, along the pipeline route with the potential for or exhibiting evidence of previous slope instability. These locations (or potential slope instability features) were assigned a semi-quantitative relative threat (Low-1 to High-3) as described below:…". The Low threat level includes "slope instability features that appear to be shallow (slip surface appears to be no deeper than about 3-feet such as surficial slumping – probably passing above the proposed pipeline installation depth)...". 1. Explain how a desktop analysis can be so accurate as to identify the 3-feet depth in order to classify a landslide (slope instability feature) as no deeper than 3-feet in depth. Debris slides and debris flows in the steep mountains of western Virginia and West Virginia commonly reach depths of 3-feet or more (in the rupture depth in zone of initiation of debris slides and/or in scour depth of debris flows bulldozing down slopes).

		2. Even if it were possible for desktop study to identify existing landslides no deeper than 3-feet in depth, many landslides have the potential to increase in area as well as depth. A landslide less than 3-feet deep may have potential to grow to 4-feet deep or 6-feet deep or +10 feet deep. 3. An existing landslide less than 3-feet deep may be the early stage of a progressive slope failure of much greater depth. 4. It would be prudent for the desktop study to recognize the "shallow landslide" as a potential hazard and a potential Moderate or High threat to the pipeline. Pipelines typically buried 3 feet, and in some cases a little deeper, are shallow burial, not deep-seated burial. The shallow burial depth of pipelines is well-within the depth that shallow landslides (debris slides, debris avalanches, and debris flows) pose a hazard. These "shallow" slope instability features need to have engineering geologic field investigations along with the other Moderate and High threat level features.
4-3	4.3.2	The Low threat level states: "More significant slope instability features that were identified adjacent to, or down slope of the proposed centerline were also ranked as a low threat level. In the event of potential future realignments of the proposed centerline, these identified features ranked as low may warrant elevated risk levels." 1. Landslide activity can migrate upslope or downslope, especially on steep slopes. Where "significant slope instability features" are "identified adjacent to, or down slope of" the proposed centerline, then more investigation and justification is needed before assessing it as a Low threat level. These features need to have engineering geologic field investigations along with the Moderate and High threat level features.
4-3	4.3.2	1. A general difficulty with the Evaluation of Potential Slope Instability Hazard section is that its primary product (threat levels) is about risks to the pipeline, not the "Evaluation of Potential Slope Instability Hazard" which is labeled as the section title. The Low, Medium and High threat levels consider landslide hazards but are assessing risks to the pipeline. There is a difference between assessing landslide hazards and assessing risks (threats) to the pipeline. For clarity, the two-step process needs to be discussed with better explanation and displays: 1) identify the landslide hazards, 2) then, identify the risks to the pipeline. In addition, the section title should be revised to: "Evaluation of Potential Slope Instability Hazards and Risks". 2. Explain the relationship of the Low, Medium and High threat levels to the risk matrix in Risk Analysis section 6.6 and Table 18 – Example Risk Matrix.
4-3	4.3.2	"Geosyntec prepared a summary table by milepost and coordinates of pre-existing or potential slope instability features, i.e., locations where slopes have the potential to become unstable... This summary table is presented in Appendix B1." 1. The Table in Appendix B1 is titled: POTENTIAL GEOHAZARDS SUMMARY TABLES. One column in the table is titled: Preliminary Hazard Ranking. The titles of the table and the column are not accurate because the table is a mixture of geologic hazards and risks to the pipeline. The Preliminary Hazard Rankings of High, Medium, and Low are not the probability of a hazard to occur but instead are the threat levels of High, Medium, and Low to the pipeline. As discussed in preceding comments, the threat level mixes together geologic hazards vs risks to the pipeline. As a result, the table is not what

		its title and hazard column label it to be. Revise the table title and hazard column label for clarity. Provide footnotes to explain the nature of the table and the hazard column. 2. This problematic table provides another reason for the recommendation in the preceding comment: For clarity, the two-step process needs to: 1) identify the landslide hazards, 2) then, identify the risks to the pipeline.
4-5	4.5	In regard to slope instability, the Phase 1 Report including the Results section is focused on existing landslides, which are important but are only a small portion of the pipeline corridor slopes that need to be assessed for potential slope instability. The existing geologic information and elevation data (for slope gradient) available at the desktop stage was sufficient for the Phase 1 report to make an initial assessment of potential slope instability for all the slopes along the pipeline corridor on the National Forests. Unfortunately, the Phase 1 report limited itself to "potential slope instability features" at discrete locations and did not make an initial assessment for all the slopes along the pipeline corridor. The Phase 1 Report (Section 6.3) recommendations for Phase 2 geotechnical hazard analysis appear to include some measures to extend the analysis to slopes beyond the existing landslides. However, the recommendation's focus on a limited number of Phase 2 sites and the recommendation's lack of explicit measures for geologic assessment of landslide potential on all slopes beyond the existing landslides raise concern about whether the scope of work to address slope instability was properly identified, tasked or understood. Two major deficiencies need to be addressed. The first major deficiency is the Phase 1 report addresses some, but not all the slopes along the pipeline corridor on NFS lands for the potential for natural landslides to occur and impact the pipeline and project facilities. 1. Assess all the slopes along the pipeline project for potential for natural landslides to occur and impact the pipeline and project facilities including access roads. Assess all the slopes along the pipeline corridor, not just the slopes on or next to existing landslides (or existing slope instability features). 2. Assess the potential for a variety of landslides, such as debris slides, debris flows, slumps, debris slumps, earth slumps, earth slides, earth flows, debris avalanches, and rockslides including dip slope bedrock rockslides. Cite references relevant to the types, frequency, and magnitude of landslides in the Appalachian Plateau, Valley and Ridge, and Blue Ridge physiographic provinces, such as: Jacobson, R.B., McGeehin, J.P., Cron, E.D., Carr, C.E., Harper, J.M., and Howard, A.D., 1993, Landslides triggered by the storm of November 3-5, 1985, Wills Mountain Anticline, West Virginia and Virginia: in, Jacobson, R.B., editor, 1993, Geomorphic studies of the storm and flood of November 3-5, 1985, in the upper Potomac and Cheat River Basins in West Virginia and Virginia: U.S. Geological Survey Bulletin 1981, Chapter C, p. C1-C33. Eaton, L.S., Morgan, B. A., Kochel, R.C. and Howard A. D., 2003, Role of debris flows in long-term landscape denudation in the central Appalachians of Virginia, *Geology* 2003;31;339-342. http://geology.gsapubs.org/content/31/4/339.short

		Wooten, R.M., Witt, A.C., Miniat, C.F., Hales, T.C., Aldred, J.A., 2015, Frequency and Magnitude of Selected Historical Landslide Events in the Southern Appalachian Highlands of North Carolina and Virginia: Relationships to Rainfall, Geological and Ecohydrological Controls, and Effects, *In*: Natural Disturbances and Historic Range of Variation: Type, Frequency, Severity, and Post-disturbance Structure in Central Hardwood Forests USA (Greenberg, C.H. and Collins, B.S. eds), pp 203-262. Clark, G.M., 1987, Debris slide and debris flow historical events in the Appalachians south of the glacial border *in* J.E. Costa and G.F. Wieczorek, (eds), Debris Flows/Avalanches: Process, Recognition and Mitigation: Geological Society of America Reviews in Engineering Geology, Vol. VII, p. 125-138. Hack J.T., and Goodlett, J.C., 1960, Geomorphology and forest ecology of a mountain Region in the central Appalachians: U. S. Geological Survey Professional Paper 347, 66 p. Plate 1 http://pubs.er.usgs.gov/publication/pp347 Morgan, B.A. et al., 1999, Inventory of debris-flow and floods in Lovingston and Horseshoe Mountain, VA: 7.5 minute quadrangles from the August 19/20, 1969 storm in Nelson County, VA, USGS OFR-99-518. http://geology.er.usgs.gov/eespteam/terrainmodeling/ofr99_518.htm Sas, R.J. Jr. and Eaton, L.S., 2008, Quartzite terrains, geologic controls, and basin denudation by debris flows: their role in long-term landscape evolution in the central Appalachians. Landslides. Springer-Verlag. 5:97–106 http://link.springer.com/article/10.1007%2Fs10346-007-0108-x
4-5	4.5	The second major deficiency is the Phase 1 report does not address the potential for the pipeline and project facilities including access roads to impact slope instability. 1. Assess the potential instability of cut slopes (excavated slopes) for access roads, pipeline trenches, and roads or passageways within the corridor to allow heavy equipment to move along the corridor. Assess potential cut slope instability during construction and in the long-term (during operation of the pipeline and beyond), and assess associated risks to public safety, infrastructure, streams and other resources. 2. Assess the potential instability of fill slopes created by the project (including access road fill slopes, corridor road or “passageway” fill slopes, trench backfill, spoil, excess excavation disposal areas, and restoration backfill). Assess the potential for debris flows caused by failure of fill slopes, spoil piles, and restoration backfill in the short-term (during construction of the pipeline) and in the long-term (during operation of the pipeline and beyond), and assess associated risks to public safety, infrastructure, streams and other resources. See reference: Collins, T. K., 2008,

		Debris flows caused by failure of fill slopes: early detection, warning, and loss prevention. Landslides. Springer-Verlag. 5:107–120. http://link.springer.com/article/10.1007/s10346-007-0107-y#page-1). 3. Because slope steepness is important in the analysis of slope instability, provide a display and analysis of slope gradients on the National Forest for all ground disturbing sites including pipeline corridor as well as access road construction, reconstruction, and upgrades minor or major. Quantify and classify the slope gradients by using the best DEM or elevation data available. Prepare a slope map covering ground disturbing sites and the areas upslope and downslope of the ground disturbing sites that are relevant to assessing project-induced slope instability and associated risks to public safety, infrastructure, and resources. In classifying slopes on the slope map, include slope breaks relevant to slope stability and/or used in project design. For example, one slope break should be the slope % at which cut-and-fill road construction or reconstruction would change to full bench road construction. The slope map is also needed to assess slope stability of any proposed disposal sites for excess excavation (such as from full bench construction).
6.2	6.3	The Recommendations for Phase 2 Geotechnical Hazard Analysis states: "The potential sites recommended for Phase 2 analysis exhibit strong geomorphic evidence of pre-existing or recent slope movement which could affect the proposed pipeline at the proposed burial depth." The Recommendations section 6.3 reflects the same major deficiencies discussed in comments on the Results section 4.5. The Phase 1 Report did not display an assessment of all the slopes along the pipeline corridor for 1) the potential for landslides to occur and impact the pipeline, and 2) the potential for the pipeline and project facilities including access roads to impact slope instability. For more detailed comments, see comments on Results section 4.5. While the Phase 2 sites identified are a needed part of the analysis, they are insufficient for a comprehensive analysis of the slopes along the pipeline corridor. The Phase 2 sites identified may or may not be representative of the intervening slopes along the pipeline corridor. The Recommendations section 6.3 does not clearly indicate the needed tasks for a comprehensive analysis of slope instability along the whole corridor on NFS lands and raises a concern about whether the scope of work to address slope instability was properly identified. 1. Revise the recommendations for Phase 2 Geotechnical Hazard Analysis to address the deficiencies identified in Forest Service comments on Phase 1 Geotechnical Hazards. 2. Provide an assessment of the suitability of existing geologic information (scale; type of geologic map; etc.) and the need for additional geologic field information in order to assess slope instability along the corridor, not just at the Phase 2 sites. 3. Phase 1 and 2 analysis of slope instability needs to 1) recognize the geologic slope forming processes operating in the Pleistocene as well as the Holocene, 2) identify the resulting landforms and surficial geologic materials (slope-

		forming materials), and 3) assess potential impact of the project on slope stability of the surficial geologic materials (slope-forming materials). Surficial geology includes talus deposits; landslides deposits; different types of colluvial deposits in hollows, on planar slopes, and on ridge noses; residual regolith; terrace deposits; alluvial fans; debris flow deposits; alluvium, stratified slope deposits, and periglacial deposits such as block fields; block slopes; block streams. Surficial geologic materials include soils but also extend downward to include all the material and stratigraphy of any slope deposit underlying the soil. Phase 1 and 2 slope instability analysis needs to consider not only bedrock, but also surficial geology materials and map units. Incorporate surface geology with references such as: Clark, M.G. and Ciolkosz, E.J., 1988, Periglacial geomorphology of the Appalachian Highlands and Interior Highlands south of the glacial border—A review, Geomorphology 1, p. 191-220. http://pages.geo.wvu.edu/~kite/ClarkCiolkosz1988pt1.pdf Hack J.T., and Goodlett, J.C., 1960, Geomorphology and forest ecology of a mountain Region in the central Appalachians: U. S. Geological Survey Professional Paper 347, 66 p. Mills, H.H., 1988, Surficial geology and geomorphology of the Mountain Lake area, Giles County, Virginia, including sedimentological studies of colluvium and boulder streams, U.S. Geological Survey,Professional Paper 1469, 57 p. Morgan B.A.,Eaton L.S., *and* Wieczorek, G.F., 2004, Pleistocene and Holocene Colluvial Fans and Terraces in the Blue Ridge Region of Shenandoah National Park, Virginia, U.S. Geological Survey, Open-File Report 03-410, Online Only, Version 1.0 http://pubs.usgs.gov/of/2003/of03-410/ Southworth, Scott, Aleinikoff, J.N., Bailey, C.M., Burton, W.C., Crider, E.A., Hackley, P.C., Smoot, J.P., and Tollo, R.P., 2009, Geologic map of the Shenandoah National Park region Virginia: U.S. Geological Survey Open-File Report 2009–1153, 96 p., 1 plate, scale 1:100,000 http://pubs.usgs.gov/of/2009/1153/ Sas, R.J. Jr. and Eaton, L.S., 2008, Quartzite terrains, geologic controls, and basin denudation by debris flows: their role in long-term landscape evolution in the central Appalachians. Landslides. Springer-Verlag. 5:97–106 http://link.springer.com/article/10.1007%2Fs10346-007-0108-x Whittecar, G.R., (Ed.), 1992, Alluvial fans and boulder streams of the Blue Ridge Mountains, west-central Virginia, Southeastern Friends of the Pleistocene, 1992 Field Trip Guidebook, 128 p.

	Appendix A	The Potential Geohazards Map Book is missing long sections of the pipeline corridor on the George Washington National Forest between Sheet 48 and Sheet 49; between Sheet 49 and Sheet 50; between Sheet 51 and Sheet 52; between Sheet 52 and Sheet 53. Provide the missing sheets and include the sheets in an updated Potential Geohazards Map Book.
	Appendix A	In the Potential Geohazards Map Book, the geotechnical hazard rating uses map symbols of green, yellow and red outline with cross-hatching. The cross-hatching obscures the underlying topographic features, especially on Lidar. Delete the cross-hatching from geotechnical hazard rating map symbols.
2-4	2.2.4	PHMSA – is this defined somewhere previously? Did not notice it. If not, please spell out.
5-1	5.2	Previously on p 2-4 other structural hazards were described: pipeline stress, static failure, and dynamic failure. Please bring forward and possibly expand on in this section as well.
5-1	5.2	Historical and current land use – especially road density, road proximity to pipeline, location/number of upstream impoundments in the watershed, and land cover types (NLCD) - may be important functions of hazards. Please ensure that these are addressed
5-1	5.2	
5-1	5.2	The analysis of active floodplain width should include historic widths and 100-year floodplain characteristics, which could be important for certain channel types.
5-2	5.3	Please define the "design life of the project." Discuss the threat level that would exist if/when the project goes beyond that time period, which could occur with a major infrastructure project such as ACP.
5-2	5.3	6% manual inspection – were these random, or based on access? How confident are the adjustments for the majority of the crossings that were not inspected?
5-2	5.3	Provide literature references for regional bankfull regression equations. The best available science and most current and local watershed equations should be used. See *Peak flow Characteristics for Virginia Streams*, 2011 USGS publication found here: https://pubs.er.usgs.gov/publication/sir20115144. Also see: http://pubs.usgs.gov/sir/2010/5033/ for West Virginia as this is similar terrain to the GWJ NF. Bankfull is a measure of routine hazard (i.e. 1-3 year recurrence interval), but unfortunately the majority of hydrotechnical hazards on the GWJ NF are from flash floods and major storm events with mass wasting and debris flows. The Hazard Assessment should address these less predictable events and hazards such as: flood intervals and flood peak flows (25 year, 50 year, 100year+), local flooding history, significant rainfall events, Annual Exceedance Probabilities (AEP) of rainfall, 24-hour AEP, etc. Also, the analysis should address the life of the project under a predicted climate change regime with more extreme events. Please discuss in more detail how flooding and climate change hazards are incorporated in this assessment.

		In light of the June 23, 2016 flood in WV and VA, which was estimated to have been a 1,000 year flood event in some areas, extreme flooding hazards are real and impacts from similar events should be addressed.
5-3	5.3.1	Across the George Washington and Jefferson National Forests, numerous unnamed and undocumented perennial, intermittent and channeled ephemeral streams exist on the ground that have not been identified by the USGS or NHD maps. In an attempt to document these drainages (often from small spring sources), a USFS watershed model was developed that produced an ArcMap shapefile called “Drainage and Flows”. The Pre-Screen effort should utilize this spatial dataset as an additional pre-screening step. The Forest Service can provide this shape file to ACP. Several additional stream crossings may potentially exist that need review or field reconnaissance. For example, in crossing tributaries to the Calfpasture River, there could be 2 additional intermittent channels crossed by the pipeline. Additionally, it is recommended to use infrared imagery overlay, as it appears to be more useful than aerial photography, as a desktop exercise for determining presence/absence of water features.
5-3	5.3.1	This section contains another reference to regional bankfull regression equations without citing the literature source. Please use the regression equations most recently calculated for Virginia.
5-5	5.4.2	Limitations – as currently written this assessment does not appear to address flooding hazards. This is a major limitation that needs to be thoroughly evaluated. A major limitation with the NHD layer is that numerous small springs and headwater drainages are not mapped across the GWJ NF. Supplementing the NHD layer with USFS modeled “drainage and flow” data would produce an assessment that is more accurate at the site-specific level.
6-4	6.4.1	Please expand and clarify the discussion of flood peak scour and long-term scour. Indicate the frequency of events that are being described (i.e. 25, 50, 100 + year events).
6-4	6.4.1	Depth to bedrock is critical and we recommend geotechnical subsurface exploration to characterize bedrock competency, or what additional construction elements will be necessary. Across the GW, some bedrock formations are highly weathered.
6-5	6.4.2	Regarding scour calculations: as noted previously, the most serious hazard is not bankfull scour but major flood flows. – Please explain how the referenced documents (FHWA and TS14B) address major flood flows.
6-5	6.5.2	As additional mitigation, re-route sections for better location, where possible.
7-1	7	Update references to include sources of regional bankfull regression equations.
Appendix B2		Update based on any additional crossings that may be present upon pre-screening when using the USFS modeled shapefile called “Drainage and Flow.” This update may reveal several potential new channel crossings if presence of small springs/seeps do occur. Ground-truthing will be necessary, as the shape file has not been field-verified.

U.S. FOREST SERVICE REVIEW OF THE GEOHAZARD ANALSYIS PROGRAM PHASE 2 REPORT

ATLANTIC COAST PIPELINE PROJECT

Page #	Section #	Comment
i	Table of Contents	ACP's Sept 2015 Resource Report 6 Geological Resources identified each type of geologic hazard in clearly titled sections. However, the Geohazard Analysis Program Phase 1 Report lacks the clarity of Resource Report 6. The terminology and organization of the Phase 1 Report and Phase 2 Reports are different and unnecessarily opaque compared with Resource Report 6. Phase 2 Report section has titles and terminology like "hydrotechnical hazard" or "geotechnical hazard" which are too general and vague in specifying geologic hazards, and add a layer of obscurity to the Phase 2 Report. 1. Identify each type of geologic hazard in terms commonly used for the hazard, and title each section of the report accordingly. In Table of Contents, revise the Phase 1 Desktop Analysis section 3.2 in a manner similar to the following: 3.2.1 Phase 1 Earthquake (Seismic) Hazards Desktop Analysis 3.2.2 Phase 1 Landslide and Ground Subsidence Hazard Desktop Analysis 3.2.3 Phase 1 Flood and Stream Hazards Desktop Analysis 2. In TOC revise main section titles in manner similar to the following: SECTION 5 PHASE 2 EARTHQUAKE (SEISMIC) HAZARD ANALYSIS SECTION 6 PHASE 2 LANDSLIDE AND GROUND SUBSIDENCE HAZARD ANALYSIS SECTION 7 PHASE 2 FLOOD AND STREAM HAZARD ANALYSIS Revise the titles and discussion in the rest of the Phase 2 report to conform to the revised titles of the Table of Contents (above). In addition, ACP's Sept 2015 Resource Report 6 Geological Resources included two other geohazards 1) Consolidated rock/blasting (Sections 6.2 and 6.6.1), and 2) Acid-producing rock and soils (Sections 6.4.6 and 6.6.8). Add these geohazards as "3.2.4 Phase 1 Consolidated Rock/Blasting Hazards Desktop Analysis" and "3.2.5 Phase 1 Acid-Producing Rock and Soils Hazards Desktop Analysis" to the Table of Contents for Section 3.2 (above).

		Add TOC main section titles: SECTION 8 PHASE 2 CONSOLIDATED ROCK/BLASTING HAZARD ANALYSIS SECTION 9 PHASE 2 ACID-PRODUCING ROCKS AND SOILS HAZARD ANALYSIS Add analysis of these two geohazards to the Phase 2 report. Retitle References as "SECTION 10 REFERENCES."
3-1	3	For comments on Section 3 Summary of Phase 1 Study on Rev 8A, refer to Forest Service comments on ACP Geohazard Analysis Program Phase 1 Report which contain numerous comments relevant to Phase 1 and Phase 2.
3-3	3.2.2.1.1	The Slope Instability section states: "Slope instability that can affect pipeline corridors vary widely in type and size, but because pipelines are typically buried, a large portion of commonly occurring landslides are shallow, and present significantly less threat to pipelines than deep seated slope instability." 1. This statement mischaracterizes the hazard of shallow landslides and underestimates the threat to the pipeline. Shallow landslides includes debris slides and debris flows resulting from failures of colluvium and weathered bedrock. Debris slides and debris flows in the steep mountains of western Virginia and West Virginia commonly reach depths of 3-feet or more. Pipelines typically buried 3 feet, and in some cases a little deeper, are shallow burial, not deep-seated burial. The shallow burial depth of pipelines is well-within the depth that shallow landslides (debris slides and debris flows) would pose a hazard and be a risk to the pipeline. Historic debris flows events in western Virginia and West Virginia demonstrate each debris flow event typically has many debris slides and debris flows impacting a wide area. Considering the frequency and widespread occurrence, large numbers, and destructive force of shallow landslides (debris slides and debris flows) compared with deep seated landslides in VA and WV, shallow landslides can be considered a threat to pipelines as much or even more than deep seated landslides. Revise the Slope Instability section to properly characterize the hazard of shallow landslides and the risk (threat) to the pipeline. 2. A common geologic group to this area is Mauch Chunk. This group is comprised of primarily shale with a secondary rock type of sandstone, and it is susceptible to slides during heavy rainfall events. In many exposures of this geologic formation from existing slides, including those that have just recently occurred from the 2016 flood event, exposures are 50 to 100 feet deep. Assess the threat posed by such slides.
3-4	3.2.2.2.2	The Slope Instability Hazard section states that a semi-quantitative geomorphic approach considered various factors (including underlying geology and soil type) to "identify surface expression that, based on experience and professional judgment, are indicators of potential or pre-existing slope instability. Phase 1 of the study initially identified 211 discrete locations (76 along the Segment TL-635 and 135 along the Segment AP-1), or areas, along the pipeline route with the potential for or exhibiting evidence of previous slope instability. These locations (or potential slope instability features) were assigned a semi-quantitative relative hazard potential ranking…" As we noted in earlier discussions with ACP on protocol for Geohazards Analysis Program (Forest Service comments on meeting notes of November 3, 2015 conference call with ACP), existing landslides or pre-existing slope instability features

		are important but are only a small portion of the pipeline corridor slopes that need to be assessed for potential slope instability. The existing geologic information and elevation data (for slope gradient) available at the desktop stage was sufficient for the Phase 1 report to make an initial assessment of potential slope instability for all the slopes along the pipeline corridor on the National Forests. The Phase 1 report limited itself to "potential slope instability features" at discrete locations and did not make an initial assessment for all the slopes along the pipeline corridor. Provide an analysis of the Instability Hazard Potential for all the slopes within 600 feet on either side of the pipeline route centerline on NFS lands. Information from the Order 1 Soil Survey must be used given that field data is showing locations of active soil slippage within the ROW. The statement above says "or"…it should read…"and". Soil type should be based off of Order 1 Soil Survey information.
3-4	3.2.2.2.1	The Data Compilation refers to "Bedrock and surficial geology maps" and "Landslide susceptibility maps and available previously mapped data". Identify the map reference(s) by quadrangle name and mileposts used in the desktop study on the National Forest. For desktop study part of Geohazard Analysis Program Phase 1 on National Forests, use the most detailed scale geologic maps available. If that information was not identified and used in Phase 1, identify and update that information.
3-4	3.2.2.2.1	Resources list LiDAR available at the time of analysis and USGS National Elevation Dataset (NED) data. Please provide such data or where to find it.
3-4	3.2.2.2.2	The Slope Instability Hazard section states that a semi-quantitative geomorphic approach considered various factors (including underlying geology and soil type) to "identify surface expression that, based on experience and professional judgment, are indicators of potential or pre-existing slope instability. Phase 1 of the study initially identified 211 discrete locations (76 along the Segment TL-635 and 135 along the Segment AP-1), or areas, along the pipeline route with the potential for or exhibiting evidence of previous slope instability. These locations (or potential slope instability features) were assigned a semi-quantitative relative hazard potential ranking…" As we noted in earlier discussions with ACP on protocol for Geohazards Analysis Program (Forest Service comments on meeting notes of November 3, 2015 conference call with ACP), existing landslides or pre-existing slope instability features are important but are only a small portion of the pipeline corridor slopes that need to be assessed for potential slope instability. The existing geologic information and elevation data (for slope gradient) available at the desktop stage was sufficient for the Phase 1 report to make an initial assessment of potential slope instability for all the slopes along the pipeline corridor on the National Forests. The Phase 1 report limited itself to "potential slope instability features" at discrete locations and did not make an initial assessment for all the slopes along the pipeline corridor.

		Provide an analysis of the Instability Hazard Potential for all the slopes within 600 feet on either side of the pipeline route centerline on NFS lands. Information from the Order 1 Soil Survey must be used given that field data is showing locations of active soil slippage within the ROW. The statement above says "or"…it should read…"and". Soil type should be based off of Order 1 Soil Survey information.
3-4	3.2.2.2.2	The Phase 1 Report did not address potential instability hazards along the access roads on NFS lands. Provide an analysis of the Instability Hazard Potential along the access roads on NFS lands with special attention to any proposed new access road and to any proposed reconstruction or upgraded sections of access roads.
3-4	3.2.2.2.2	The Low Hazard Potential includes "slope instability features that appear to be shallow (slip surface appears to be no deeper than about 3-feet such as surficial slumping – probably passing above the proposed pipeline installation depth)...". 1. Explain how a desktop analysis can be so accurate as to identify the 3-feet depth in order to classify a landslide (slope instability feature) as no deeper than 3-feet in depth. Debris slides and debris flows in the steep mountains of western Virginia and West Virginia commonly reach depths of 3-feet or more (in the rupture depth in zone of initiation of debris slides and/or in scour depth of debris flows bulldozing down slopes). 2. Even if it were possible for desktop study to identify existing landslides no deeper than 3-feet in depth, many landslides have the potential to increase in area as well as depth. A landslide less than 3-feet deep may have potential to grow to 4-feet deep or 6-feet deep or +10 feet deep. 3. An existing landslide less than 3-feet deep may be the early stage of a progressive slope failure of much greater depth. 4. It would be prudent for the desktop study to recognize the "shallow landslide" as Moderate or High Hazard Potential. Pipelines typically buried 3 feet, and in some cases a little deeper, are shallow burial, not deep-seated burial. The shallow burial depth of pipelines is well-within the depth that shallow landslides (debris slides and debris flows) pose a hazard. These "shallow" slope instability features need to have engineering geologic field investigations along with the other Moderate and High Hazard Potential features.
3-4	3.2.2.2.2	The Low Hazard Potential includes "…those features that are judged to be ancient (no movement in over 1,000 years...". Explain how a desktop analysis can assess that a feature has had no movement in over 1,000 years (rather than 200, 500, or 800 years).
3-4	3.2.2.2.2	The Low Hazard Potential states: "More significant slope instability features that were identified adjacent to, or down slope of the proposed centerline were also ranked as a low hazard potential. In the event of potential future realignments of the

		proposed centerline, these identified features ranked as low may warrant being assigned a moderate or high hazard potential level." 1. Landslide activity can migrate upslope or downslope, especially on steep slopes. Where "significant slope instability features" are identified "adjacent to, or down slope of" the proposed centerline, then more investigation and justification is needed before assessing it as a Low Hazard Potential. These features need to have engineering geologic field investigations along with the Moderate and High threat level features. 2. The statement also illustrates a general difficulty of conflating landslides hazards with risks to pipeline. There is a difference between assessing landslide hazards and assessing risks (threats) to the pipeline. For clarity, the Report needs a two-step process needs to : 1) identify the landslide hazards, 2) then, identify the risks to the pipeline.
3-5	3.2.2.2.2	The Geotechnical Hazards Desktop Analysis states: "These attributes were utilized to assess potential hazards elsewhere along the route." However, the Phase 1 Report primarily displays and assesses discrete instability features, not the whole corridor. Provide an analysis of the Instability Hazard Potential for all the slopes along the pipeline corridor for 1) the potential for landslides to occur and impact the pipeline, 2) the potential for the pipeline and project facilities including access roads to impact slope instability. One reason to assess discrete instability features, such as recent, historic, and ancient landslides, is to learn about the geologic conditions that contributed to the instability and then apply that geologic information to assess the potential instability of the rest of the slopes along the pipeline corridor and access roads. Discuss the site specific geologic conditions of the discrete instability features and then apply that geologic information to assess the potential instability of the rest of the slopes along the pipeline corridor and access roads. Such geologic conditions include: geologic map unit; mass strength of surface and subsurface geologic materials; bedrock structure; slope gradient; surface and groundwater; nature of the contact between bedrock and surficial materials such as colluvium; etc. The pipeline corridor on the National Forests crosses the Appalachian Plateau, Valley and Ridge, and Blue Ridge physiographic provinces. The natural landslides and construction-induced landslides, such as road cut or fill slope failures, in these physiographic provinces reflect a variety of geologic conditions. The pipeline corridor is a very narrow slice of three physiographic provinces, and, by itself, is too small a land base to understand and characterize the potential for natural landslides to affect the pipeline project and the potential for construction-induced landslides to affect public safety, resources, and infrastructure downslope. Broaden the base of slope instability data from the pipeline corridor to a wider area to include a field recon of natural landslides and construction-induced landslides in geologic surface and subsurface materials relevant to the pipeline corridor and access roads. The wider area for field recon of natural landslides and construction-induced landslides includes: 1. Pipeline project access roads (existing and proposed) on NFS lands. 2. Public roads and stream banks on public lands in counties where the pipeline crosses NFS lands. 3. Landslide sites identified by the public in counties where the pipeline crosses NFS lands as part of the FERC scoping and NEPA process.

		4. Landslides from June 23, 2016 storm in WV and VA.
3-6 and 3-7	3.2.3	Update this summary section based on the USFS comments from the Geohazard Analysis Program Phase 1 REPORT - Hydrotechnical Hazard Analysis sections.
3-7	3.2.3 Phase 1 Hydrotechnical Hazards Desktop Analysis	*"For the purposes of this study three qualitative hydrotechnical hazard levels were defined by Geosyntec as follows:* *• **Low Hazard**: the stream has a low likelihood of horizontal or vertical mobility over the design life of the project (i.e., water crossings that can be addressed through standard design rules such as 5 feet of cover, 15 feet of set-back, and nominal bank protection). We anticipate that the vast majority of water crossings will fall into this category. • **Medium Hazard**: the stream has a moderate likelihood of horizontal or vertical mobility over the design life of the project (i.e., water crossings that will require additional engineering assessment, design and mitigations such as additional cover and/or bank protection). • **High Hazard**: the stream has a high likelihood of horizontal or vertical mobility over the design life of the project (i.e., water crossings that will require specialized engineering assessment and design or specialized construction methods such as directional drilling)."* Describe the criteria and information sources that were used to make these classifications. Based on the rapid field surveys, some crossings that were initially deemed "low hazard" from the desktop analysis did not in fact fall under these design rules. One example is MP 115.81 Barn Lick Branch. The hazard ratings should be an iterative process with what the field work confirms, and therefore not underestimate the number of moderate crossings. Update the final hazard ratings.
3-8	3.2.3.1	Across the George Washington and Jefferson National Forests, numerous unnamed and undocumented perennial, intermittent and channeled ephemeral streams exist on the ground that are not identified by NHD or quads maps. In attempt to document these drainages (often from small spring sources), a USFS watershed model was developed that produced an ArcMap shapefile called "Drainage and Flows". Geosyntec and Tessellations should utilize this spatial dataset as an additional screening step to identify all streams of interest. The Forest Service can provide a copy of this shape file. Several stream crossings may potentially exist that need review and field reconnaissance. For example, in crossing tributaries to the Cowpasture River, there appear be 2 additional channels crossed by the pipeline that intersect with the USFS "Drainage and Flows" shapefile. Additional field verification is advised for tributaries to Campbell Run near MP 96-98 and tributaries to East Branch Dowells Draft near MP 117.
3-8	3.2.3.1	Update Table 3-1 to show any additional stream crossings identified via pre-screening with USFS shapefile called "Drainage and Flow" and field reconnaissance.
3-8	3.2.3.1	Step 2: The selection of the seven watershed parameters were not disclosed fully in the Phase 1 Report. Describe the basis for the selection of these specific parameters and update accordingly. For the Valley and Ridge physiographic region and US Forest Service land in WV and VA, percent sand and swamp areas are not defining factors. Use parameters that are pertinent by physiographic region, such that more of the parameters apply and

		are more accurately weighted to reflect the hazard rating. Possibly wetlands would provide a more meaningful metric as opposed to swamps areas. Depth to bedrock is only relevant depending on the method used to bury the pipeline. If ACP plans to trench streams to dig up bedrock to bury the pipeline, then the material used to bury the pipeline (i.e., broken up bedrock) will not provide stability or help control hydrology. Bedrock in streams can only serve as a control for energy and hydrology if it is not dug up or disturbed. “Mountainous Area” is not a very descriptive term. The more important factor here is slope.
3-9	3.2.3.1 Hazard Analysis Approach Step 2: Selection of parameters and their Estimation: Drainage Area	*“We assigned a low hazard to watersheds with a drainage area smaller than 4 square miles, a high hazard to watersheds with a drainage area greater than 10 square miles, and a medium hazard to watersheds with a drainage area between 4 and 10 square miles.”* Please provide a rationale for the categories.
3-9	3.2.3.1 Hazard Analysis Approach Step 2: Selection of parameters and their Estimation: Slope at Crossing	*“Streams in the project area with an average slope less than 2% are considered by Geosyntec to exhibit low hazard, whereas streams with an average slope greater than 4% are considered to exhibit high hazard. Streams with an average slope between 2% and 4% are considered to exhibit moderate hazard. “* Please provide a rationale for the categories.
3-10	3.2.3.1 Hazard Analysis Approach Step 2: Selection of parameters and their Estimation: Depth to Bedrock	*“Streams in the project area with a depth to bedrock of less than 5 ft (150 cm) are considered by Geosyntec to exhibit low hazard, whereas streams with bedrock depth exceeding 6.6 ft (200 cm) are considered to exhibit high hazard. Streams with bedrock depth between 5 ft and 6.6 ft are considered to exhibit moderate hazard. ”* Please provide a rationale for the categories. Depth to bedrock is only relevant depending on the method used to bury the pipeline. If ACP plans to trench streams to dig up bedrock to bury the pipeline, then the material used to bury the pipeline (i.e., broken up bedrock) will not provide stability or help control hydrology. Bedrock in streams can only serve as a control for energy and hydrology if it is not dug up or disturbed.

3-10	3.2.3.1 Hazard Analysis Approach Step 2: Selection of parameters and their Estimation: Percent Sand	*"Streams in the project area with percent sand less than 40% are considered by Geosyntec to exhibit low hazard, whereas streams with percent sand exceeding 60 % are considered to exhibit high hazard. Streams with percent sand between 40% and 60% are considered to exhibit moderate hazard. "* Please provide a rationale for the ranges listed for the hazards ratings. Percent sand is not a defining channel characteristic across a large portion of the pipeline. Why was this parameter chosen? Rosgen Stream Classification or a similar metric weighted on channel stability or substrate may have been more relevant across the entire pipeline. Identify references that support the assumptions "percent sand less than 40% are considered low hazard, whereas percent sand exceeding 60 % are high hazard".
3-10	3.2.3.1 hazard Analysis Approach: Step 2 Selection of Parameters and their Estimation: **Depth to Bedrock**	*"The depth to lithic bedrock for the project area was compiled by Tessellations from the Soil Survey Geographic Database (SSURGO), which contains information collected by the National Cooperative Soil Survey, which is part of the Natural Resources Conservation Service (NRCS) of the United States Department of Agriculture (USDA). The SSURGO database was accessed on 12 May 2015. "* Use the Order 1 Soil Survey results, which should provide more accurate information if pits were excavated to bedrock in locations where the pipeline would intersect areas such as stream crossings. The SSURGO data are coarse-scale and are not appropriate for informing site-specific project design and analysis.
3-11	3.2.3.1	"…debris flows are common in the project area". This is especially true for the Valley and Ridge physiographic region as illustrated by Figure 3-1, and these flows present major hazards. Therefore, describe the assumptions that were used to create Table 3-2. Further clarify this section on debris flow.
3-11	3.2.3.1	Swamp Area is not pertinent to a large portion of the pipeline. Describe why was this parameter chosen, versus something more relevant across the entire pipeline. Possibly a more appropriate parameter for this area would be focused on wetlands as opposed to swamps areas.
3-11	3.2.3.1 Hazard Analysis Approach Step 2: Selection of parameters and their Estimation: Mountainous Areas	*Mountainous Areas Section* This section is very vague as to what is being measured. In summary, the section appears to say that all else being equal, mountainous areas have steeper slopes with short duration, higher peak flows (stream flashiness) than low-lying coastal areas with gentle slopes. As a result, streams in the Appalachian Plateau, Valley and Ridge, and Blue Ridge province are assigned a higher hazard rating (+3) than streams outside these provinces as shown in Table 3-3. However, the section does not provide information on how this characteristic will be measured, and no rationale is provided for the hazard scoring categories. Also, watersheds are treated as if soil, vegetation, and precipitation are uniform throughout, which is not the case. Please explain how the hydrologic risks will be measured, including site-specific variation.
3-12 to 3-14	3.2.3.1 Hazard Analysis	*Scoring Classification, Expert Classification, and manual Expert Classification*

	Approach Step 3, Step 4, and Step 5	Please provide justification, documentation, or support for the numbers used for scoring in these analyses, as well as the values for each parameter.
3-15	3.3.2	The "Ground Reconnaissance" section discusses examining a subset of identified hazard sites that are most readily accessible. Discuss or better explain identified hazard sites not easily accessed and whether the closer ones near access are representative of all sites.
4-3	4.3.1	This Steep Slopes section using slope inclination is a much needed addition to the geohazards analysis. We agree about the importance of slope inclination in assessing slope stability, as we have noted in previous comments. Identify the rationale for the chosen slope breaks.
4-4	4.4.2	Table 4-1 shows results of the slope inclination analysis. Provide similar tables for NFS lands in WVA and VA.
4-4	4.4.2	"The distribution of steep slopes along the route is illustrated graphically in Figure 4-1." Provide the U.S. Forest Service with a pipeline shapefile coded with the slope classes as in Figure 4-1 and other features in Geologic Hazards Mapbook (Appendix 6-2) for the counties where the pipeline crosses NFS lands.
4-5	4.4.3	The Potential Slope Instability Hazard section states: "For Phase 2 Geosyntec used a similar semi-quantitative geomorphic approach to the assessment of slope instability hazards as was used in Phase 1 and as is described in Section 3.2.2.2.2." The comments we made on the Phase 1 Report and on Section 3.2.2.2.2 of Phase 2 Report also apply here. Address those comments here also.
4-5	4.4.3	The Low Hazard Potential includes "…slopes that have no existing instability features, are moderately to very steep, and where conventional steep slope design and construction techniques can likely be used to mitigate the potential for construction induced instability." The Moderate Hazard Potential includes "…slopes that have no existing instability features, are moderately to very steep, but where site-specific design and specialized construction techniques are likely required to stabilize trench backfill and right-of-way slopes." The Low and Moderate Hazard Potential both include moderately to very steep slopes (30-58% slope inclination) with the difference between Low and Moderate based on whether conventional steep slope design and construction techniques would likely be used or whether site-specific design and specialized construction techniques would likely be required. Describe the criteria used to determine whether conventional construction techniques or specialized construction techniques are likely to be used within areas of 30-58% slope inclination. What information other than slope inclination was

		used to determine conventional vs specialized construction techniques? Explain how the information available in desktop analysis were suitable for applying the criteria to the 30-58% slope inclination. A similar issue is that the Moderate and High Hazard Potential both include very steep slopes (40-58% slope inclination) with the difference between Moderate and High based on whether site-specific design and specialized construction techniques would likely be required to stabilize trench backfill and right-of-way slopes or to address complex geologic and/or hydrologic conditions and potential offsite impacts. These differences do not appear to be mutually exclusive, and there is need to explain how these differences can be understood and applied. Explain how the information available in desktop analysis was suitable and used to divide the 40-58% slopes into Moderate and High Hazard Potential. Another issue is the Hazard Potential classification did not mention slopes less than 30% slope inclination, and classified 30-58% slopes (moderately to very steep) in Low Hazard Potential. One way to address the above issues would be to revise the classification in a manner such as: 1. The Low Hazard Potential is restricted to slopes less than 30% slope inclination; 2. The Moderate Hazard Potential is for 30-40% slope inclination (regardless of whether conventional or specialized construction techniques would be used). 3. The High Hazard Potential is for 40-58% slope inclination and steeper than 58% slope inclination. Moreover, this revised classification based on slope inclination is a better foundation for a Slope Instability Hazard classification than the classification in section 3.2.2.2.2 or in the Phase 1 report which use problematical estimates of 3 foot slip surfaces and 1,000 year old movements, and which focused on a few slopes with evidence of past or present instability. The revised classification can be supplemented with additional information. For example, all the slope instability features identified by the Phase 1 report desktop analysis could be considered as High Potential Hazard pending a field inspection. In other words, rather that supplement the problematical Slope Instability Hazard classification of Phase 1 with the Phase 2 Steep Slope classification in section 4.3.1, use the Steep Slope classification in section 4.3.1 as the foundation of Slope Instability Hazard classification, and supplement it with other slope instability factors as appropriate.
4-6	4.4.5 Phase 2 Geotechnical Field Reconnaissance	*"• Consideration of slope inclination and length;* *• Assessment of slope condition based on evident overlying soil and underlying rock materials and consideration of surface runoff and groundwater flow;"* Assessment of slope condition based on overlying soil should come from Order 1 Soil Survey information.
6-2	6.4.1	"Of the 55 potential slope instability hazard and steep slope sites visited during the Phase 2 field reconnaissance, 17 were on the TL-635 segment and 38 were on the AP-1 segment… For these 55 sites new hazard rankings were assigned to reflect both the assessment of existing stability conditions and the anticipated impacts of construction in accordance with the revised hazard potential level category definitions outlined in Section 4.4.3."

		In Appendix 6-1, the change (or lack of change) from Initial Hazard Ranking to New Hazard Ranking needs more explanation for sites on NFS lands. For example, the Rev 11 Milepost 84.7 to 85.6 site has an Initial Hazard Ranking of >40% and New Hazard Ranking of Low. However, based on the Comments and Recommendations in the Appendix 6-1 Table for this site, it would seem the New Hazard Ranking should be High rather than Low. Another example, the Rev 11 Milepost 120.1 site has an Initial Hazard Ranking of >58% and New Hazard Ranking of Moderate. However, based on the Comments and Recommendations in the Appendix 6-1 Table for this site, the New Hazard Ranking should have remained High and not lowered to Moderate. Review and reassess the Initial Hazard Ranking and New Hazard Ranking for all sites on NFS lands.
6-3	6.4.1	"In spite of the geologic conditions and steep slope inclinations, very few slopes observed along the proposed pipeline route were classified as landslides." Existing landslides are important but are only a small portion of the pipeline corridor slopes that need to be assessed for potential slope instability. We have made previous comments about the need to assess all the slopes for potential instability, not just existing landslides. When major storm events trigger many landslides, it is often the case that most of the landslides are new landslides rather than reactivation of old landslides. Thus it is important to assess the landslide potential of all slopes based on a variety of geologic conditions including: slope inclination; strength properties of surface and subsurface geologic materials and geologic map units; bedrock structure; surface and groundwater; nature of the contact between bedrock and surficial materials such as colluvium; etc.). The addition of slope inclination along the centerline in Phase 2 is a step in the right direction. Provide a slope inclination map covering all the slopes within 600 feet on either side of the pipeline route centerline on NFS lands. Based on the slope inclination and the other geologic conditions, assess the landslide potential for slopes within 600 feet on either side of the pipeline route centerline on NFS lands. Assess the potential for a variety of landslides, such as debris slides, debris flows, slumps, dip slope bedrock rockslides, debris slumps, earth slumps, earth slides, earth flows, and debris avalanches. This landslide potential information is needed even where the centerline is along a ridgetop. In terms of slope instability, a ridgetop pipeline location generally is far preferable to a side slope location. That said, a ridgetop pipeline does have some potential instability issues that need to be analyzed, including the potential to destabilize areas downslope, for example, by concentrating surface and subsurface water flows and discharging water flows downslope into areas that may become destabilized. One side of the ridge may have lesser potential slope instability than the other side of the ridge, and that information can be used in design of drainage discharge along the pipeline corridor. In addition, on narrow ridgetops, there is potential for spoil or fill material to spill down the side slopes and destabilize areas downslope.
6-3	6.4.1	"Across most of the steep slopes, some colluvium accumulation (soil material moved by gravity) was observed. This colluvium is generally quite thin, overlying bedrock, and even though it exhibits creep, this type of mass movement is not associated with naturally occurring landslides."

		On the contrary, colluvium overlying bedrock can be associated with naturally occurring landslides, such as 1) debris slides, 2) debris avalanches, 3) debris flows originating as debris slides or debris avalanches. If the colluvium exhibits creep, then it indicates active slope movement and a need to assess the potential for creep to accelerate into a debris slide or debris avalanche, for example, during a storm event. Thin colluvium overlying bedrock is a common initiation zone for debris slides, debris avalanche, and debris flows. Moreover, creep itself is a potential slope instability hazard, and is one of five basic categories of the flow type of landslide movement (USGS, 2004; Cruden and Varnes, 1996). As noted by Turner, A.T. (1996), "Creep Is a phenomenon of concern when structures are placed on colluvial deposits. It is known that some long-term translation or movement of materials can occur, especially in the near-surface region." While pipelines do have some tolerance for displacement, the differential or cumulative displacement from creep over the decades of pipeline operation is a slope instability hazard and can be a risk to the pipeline. In addition, the potential impact of the pipeline on the rate of creep also needs to be considered. The construction of the pipeline trench and the cut and fill slopes in the R-O-W, and the resulting changes in surface and subsurface water flows, may adversely influence the rate of creep in the years and decades post-construction. The dismissive treatment of thin colluvium overlying bedrock and exhibiting creep raises concern about the adequacy of Potential Instability Hazard analysis. Creep is a well-known hazard to structures on steep slopes. Debris slides, debris avalanches, and debris flows are dominant landslide processes in the physiographic provinces crossed by the ACP project on NFS lands. Many of these landslides originate in thin colluvium overlying bedrock. In contrast to the Potential Instability Hazard's dismissive treatment of potential debris slide and debris flow source areas in thin colluvium in upland areas, the Hydrotechnical Hazards Analysis recognizes the need to consider the potential for debris flows at stream crossings. Revise the Potential Instability Hazard analysis to assess the potential for debris slides, debris avalanches, and debris flows on the slopes within 600 feet on either side of the pipeline route centerline on NFS lands. Revise the desktop analysis and conduct ground reconnaissance with geologic specialists in assessing potential for debris slides, debris avalanches, and debris flows as well as other types of landslides. Conduct on-site engineering geologic investigation and mapping such as described by Keaton, J.R. and DeGraff, J.V., 1996, Surface Observation and Geologic Mapping, pp. 178-230, in Landslides Investigations and Mitigation, Special Report 247, Turner A.K. and Schuster R.L. editors, 1996, Transportation Research Board, National Research Council, National Academy Press, Washington, D.C., pp. 674. Incorporate in the Geohazards Analysis Program relevant references such as: Turner, A.K., Colluvium and Talus, pp. 525-554, in Landslides Investigations and Mitigation, Special Report 247, Turner A.K. and Schuster R.L. editors, 1996, Transportation Research Board, National Research Council, National Academy Press, Washington, D.C., pp. 674.

Cruden, D.M. and Varnes, D.J., Landslide Types and Process, pp. 36-75, in Landslides Investigations and Mitigation, Special Report 247, Turner A.K. and Schuster R.L. editors, 1996, Transportation Research Board, National Research Council, National Academy Press, Washington, D.C., pp. 674.

United States Geologic Survey (USGS), 2004, "Landslide Types and Processes", Fact Sheet 2004-3072. http://pubs.usgs.gov/fs/2004/3072/pdf/fs2004-3072.pdf

Jacobson, R.B., McGeehin, J.P., Cron, E.D., Carr, C.E., Harper, J.M., and Howard, A.D., 1993, Landslides triggered by the storm of November 3-5, 1985, Wills Mountain Anticline, West Virginia and Virginia: in, Jacobson, R.B., editor, 1993, Geomorphic studies of the storm and flood of November 3-5, 1985, in the upper Potomac and Cheat River Basins in West Virginia and Virginia: U.S. Geological Survey Bulletin 1981, Chapter C, p. C1-C33.

Clark, G.M., 1987, Debris slide and debris flow historical events in the Appalachians south of the glacial border *in* J.E. Costa and G.F. Wieczorek, (eds), Debris Flows/Avalanches: Process, Recognition and Mitigation: Geological Society of America Reviews in Engineering Geology, Vol. VII, p. 125-138.

Eaton, L.S., Morgan, B. A., Kochel, R.C. and Howard A. D., 2003, Role of debris flows in long-term landscape denudation in the central Appalachians of Virginia, *Geology* 2003;31;339-342. http://geology.gsapubs.org/content/31/4/339.short

Wooten, R.M., Witt, A.C., Miniat, C.F., Hales, T.C., Aldred, J.A., 2015, Frequency and Magnitude of Selected Historical Landslide Events in the Southern Appalachian Highlands of North Carolina and Virginia: Relationships to Rainfall, Geological and Ecohydrological Controls, and Effects, *In*: Natural Disturbances and Historic Range of Variation: Type, Frequency, Severity, and Post-disturbance Structure in Central Hardwood Forests USA (Greenberg, C.H. and Collins, B.S. eds), pp 203-262.

Hack J.T., and Goodlett, J.C., 1960, Geomorphology and forest ecology of a mountain Region in the central Appalachians: U. S. Geological Survey Professional Paper 347, 66 p.
Plate 1
http://pubs.er.usgs.gov/publication/pp347

Morgan, B.A. et al., 1999, Inventory of debris-flow and floods in Lovingston and Horseshoe Mountain, VA: 7.5 minute quadrangles from the August 19/20, 1969 storm in Nelson County, VA, USGS OFR-99-518.
http://geology.er.usgs.gov/eespteam/terrainmodeling/ofr99_518.htm

Sas, R.J. Jr. and Eaton, L.S., 2008, Quartzite terrains, geologic controls, and basin denudation by debris flows: their role in long-term landscape evolution in the central Appalachians. Landslides. Springer-Verlag. 5:97–106
http://link.springer.com/article/10.1007%2Fs10346-007-0108-x

6-3	6.4.1	"However, the observed creep of the colluvium is indicative the potential for instability to be created by the disturbance that will occur during right-of-way grading and trenching operations and this is the primary slope instability issue that needs to be addressed on the project." In our comments on the draft Resource Report on Geologic Resources, as well as subsequent informal communications during the review of protocol for Geohazards Analysis Program (Forest Service comments on meeting notes of November 3, 2015 conference call with ACP), we stressed the need to assess project-related slope failures in addition to natural landslides. We requested an assessment of potential slope instability of cut slopes and fill slopes during construction and operation of the pipeline, access roads, and associated facilities on NFS lands. The brief quote above recognizing the magnitude of potential slope instability issues related to project slope disturbance is a welcome sign. Another step forward is the recommendations on right-of-way grading and pipeline trench excavation at some sites on NFS lands in the Potential Geotechnical Hazards Summary Table (Appendix 6-1). While this information is a start, more detail is needed to provide a comprehensive analysis of project-related potential slope failure hazards and associated risks to people, infrastructure, and resources. 1. Assess the potential instability of cut slopes (excavated slope) for access roads, pipeline trenches, and roads or passageways within the corridor to allow heavy equipment to move along the corridor. Assess potential cut slope instability during construction and in the long-term (during operation of the pipeline and beyond). 2. Assess the potential instability of fill slopes created by the project (including access road fill slopes, corridor road or "passageway" fill slopes, trench backfill, spoil, excess excavation or excess fill disposal areas, backfill slopes created for reclamation). Assess the potential for debris flows caused by failure of fill slopes, spoil piles, and restoration backfill in the short-term (during construction of the pipeline) and in the long-term (during operation of the pipeline and beyond), and assess associated risks to public safety, infrastructure, streams and other resources: Collins, T. K., 2008, Debris flows caused by failure of fill slopes: early detection, warning, and loss prevention. Landslides. Springer-Verlag. 5:107–120 http://link.springer.com/article/10.1007/s10346-007-0107-y#page-1). 3. The analysis of slope instability needs to 1) recognize the geologic slope forming processes operating in the Pleistocene as well as the Holocene, 2) identify the resulting landforms and surficial geologic materials (slope-forming materials), 3) assess potential impact of project on slope stability of the surficial geologic materials (slope-forming materials). Surficial geology includes talus deposits; landslides deposits; different types of colluvial deposits in hollows, on planar slopes, and on ridge noses; residual regolith; terrace deposits; alluvial fans; debris flow deposits; alluvium, stratified slope deposits, and periglacial deposits such as block fields; block slopes; block streams. Surficial geologic materials include soils but also extend downward to include all the material and stratigraphy of any slope material underlying the soil. Incorporate surface geology with references such as:

		Clark, M.G. and Ciolkosz, E.J., 1988, Periglacial geomorphology of the Appalachian Highlands and Interior Highlands south of the glacial border—A review, Geomorphology 1, p. 191-220. http://pages.geo.wvu.edu/~kite/ClarkCiolkosz1988pt1.pdf Hack J.T., and Goodlett, J.C., 1960, Geomorphology and forest ecology of a mountain Region in the central Appalachians: U. S. Geological Survey Professional Paper 347, 66 p. Mills, H.H., 1988, Surficial geology and geomorphology of the Mountain Lake area, Giles County, Virginia, including sedimentological studies of colluvium and boulder streams, U.S. Geological Survey,Professional Paper 1469, 57 p. Morgan B.A., Eaton L.S., *and* Wieczorek, G.F., 2004, Pleistocene and Holocene Colluvial Fans and Terraces in the Blue Ridge Region of Shenandoah National Park, Virginia, U.S. Geological Survey, Open-File Report 03-410, Online Only, Version 1.0 http://pubs.usgs.gov/of/2003/of03-410/ Southworth, Scott, Aleinikoff, J.N., Bailey, C.M., Burton, W.C., Crider, E.A., Hackley, P.C., Smoot, J.P., and Tollo, R.P., 2009, Geologic map of the Shenandoah National Park region Virginia: U.S. Geological Survey Open-File Report 2009–1153, 96 p., 1 plate, scale 1:100,000 http://pubs.usgs.gov/of/2009/1153/ Sas, R.J. Jr. and Eaton, L.S., 2008, Quartzite terrains, geologic controls, and basin denudation by debris flows: their role in long-term landscape evolution in the central Appalachians. Landslides. Springer-Verlag. 5:97–106 http://link.springer.com/article/10.1007%2Fs10346-007-0108-x Whittecar, G.R., (Ed.), 1992, Alluvial fans and boulder streams of the Blue Ridge Mountains, west-central Virginia, Southeastern Friends of the Pleistocene, 1992 Field Trip Guidebook, 128 p.
6-3	6.4.1	In order to assess potential impact of the project on slope stability, provide the plans and typical drawings for the location and magnitude of the proposed slope modifications (excavations and fills) on National Forests for: a) access roads to pipeline right-of-way corridor (incudes new construction and reconstruction); b) pipeline right-of-way excavation for trench (ditch); c) pipeline right-of-way excavation for roads (travel area and working area); d) pipeline right-of-way loose material from trench excavation (ditch spoil storage); e) pipeline right-of-way topsoil (topsoil storage); f) pipeline right-of-way loose material from construction road excavation (travel area and working area); g) ATWS; h) contractor yards and equipment staging/storage areas; and i) disposal areas for excess excavation or other materials. The construction typical drawings provided in final Resource Reports are largely for flat land, and are not adequate for the steeper slopes typical of the National Forests. The construction drawing provided in Resources Report Appendix 1D for cut-

		and-fill construction (pages 1D-17 and 1D-36) lacked specific dimensions needed to assess the magnitude of the proposed slope modifications (excavations and fills) on National Forests. The schematic for ridgetop excavation (Figure 1.4.1-1) in Resource Report 1 was too generalized to assess the magnitude of the proposed slope modifications (excavations and fills) on National Forests. ACP now needs to provide the typical plans and drawings with dimensions needed for the Geohazard Analysis Report to assess the potential impact of the project on slope stability. While additional field information may refine the designs, the slope inclination and other information currently available should allow ACP to provide initial typical drawings with dimensions suitable for assessing the location and magnitude of proposed slope modifications (excavations and fills) on National Forests. Side hill: Provide construction typical drawings with dimensions for each slope class (in 10% increments) where side hill cut-and-fill construction would occur on the National Forests. For example, if cut-and-fill construction is planned on slopes ranging from 10% to 78%, then provide a construction typical drawing for each of these construction slopes: 10%, 20%, 30%, 40%, 50%, 60%, 70%, and 80%. Ridgetop: Provide construction typical drawings with dimensions for each typical ridgetop where construction would occur on the National Forests. For example, if construction would be on six ridgetop with symmetric side-slopes of 10%, 20%, 30%, 40%, 50%, 60%, then provide a typical drawing for these six ridgetops symmetric slope classes. Provide similar construction drawings for each typical ridgetop with asymmetric side-slopes (such as 30% on one side-slope and 50% on other side-slope of ridgetop. Of special concern is the potential for failure of loose excavated material during construction and the potential for failure of fill slopes (including backfill in reclaimed slopes) in the years and decades after construction. Display in the typical drawings the maximum extent (dimensions) of the loose excavated material (fill; spoil; backfill). Perpendicular to slope contours: Provide typical drawings similar to ridgetops for all construction that is perpendicular to slope contours. Winch line construction is a subset of construction perpendicular to slope contours. Identify the slope % and any other criteria that would be used to switch from regular construction to winch line construction. Display how the dimensions of cut-and-fill would be different for construction with or without winch line. For each typical drawing for construction perpendicular to contour, provide dimensions and label the drawing as to whether or not it is winch line construction. Provide the mileposts and a map showing the location (length along centerline) to which each typical drawing applies. For each construction typical drawing of side hill, ridgetop or perpendicular to contour construction, provide a typical drawing for reclamation with dimensions showing a cross-section of reclamation in relation to construction cut-and-fill, backfill, and original ground surface. Recognize that returning to original contour using fill on steep slopes may be unstable and subject to slope failure. Describe criteria that will be used to determine whether excavated material will be stable if returned to original contour. Assess the potential for failure of fill slopes resulting from reclamation on steep slopes. If fill for reclamation on steep slopes would be unstable, describe alternative reclamation method.

6-6	6.5	Areas where LiDAR is not available and “once available”. Explain how these sites will be addressed properly and any time line when LiDAR will be available. Discuss how this will affect the data and results.
7-1	7.1.1	8 of 43 high hazard crossings will be HDD (less than 20 percent). Describe how the rest of the high hazard crossings will be addressed.
7-1	7.1.1	The Valley and Ridge physiographic region in WV and VA does frequently experience major flood events and debris flows. This finding should then direct next steps and mitigation measures in phase 2. For example, within the Valley and Ridge physiographic region in WV and VA, more moderate sites need to be evaluated with the rapid field reconnaissance, and perhaps even a sampling of low hazard rated sites as well. Additional evaluations are needed in Table 7-3.
7-1	7.1.1	Clarify the last sentence. How were “some of the sites with moderate and high hazard” selected? Explain why the following page 7-3 shows 9 locations selected that have low hazard ratings.
7-1	7.1.1	Rapid field surveys were completed for some sites. Explain whether, after processing that collected field data, a final adjustment was made to the hazard rating for those sites. If no adjustments were made, update the hazard ratings according to field parameters and recommendations. Avoid underestimating “low” hazards, particularly in the Valley and Ridge physiographic region.
7-2	7.1.1	Update Table 7-1, if any additional stream crossings were identified via pre-screening with USFS shapefile called “Drainage and Flow” and field reconnaissance.
7-4	7.1.2	“Together with data sets acquired during the automated desktop efforts, additional data collected and assessed during rapid field surveys allowed for the development of recommendations provided in Section 7.4 including the identification of need for additional data to support final erosion depth calculations and recommendations for construction planning.”—Describe or direct where this additional data can be found.
7-5	7.3	Table 7-3 lists the remaining potential medium and high hazard stream crossings where a Phase 2 evaluation remains to be conducted—Discuss when such evaluations will be conducted and what effects the current lack of this data will have on the overall assessment.
8-1	8	Move References to SECTION 10. Insert a SECTION 8 PHASE 2 CONSOLIDATED ROCK/BLASTING HAZARD ANALYSIS. Assess the excavation characteristics of different bedrock formations on NFS lands in terms of suitability for various non-blast techniques available to excavate bedrock (rock trenchers, rippers, rock impact hammers, hydraulic breakers, rock breaker attachments). Advances in non-blast excavation equipment in recent decades have reduced the areas where blasting is required. Some bedrock formations can be excavated by non-blast techniques, and do not require blasting. Identify by milepost the bedrock formations (or stratigraphic portions of bedrock formations) where blasting is likely needed for excavation in the pipeline corridor and along access roads. Exposures of bedrock (such as in bedrock outcrops, road cuts, or soil survey pits) along the pipeline corridor provide limited information about excavation characteristics of the different bedrock formations. The pipeline corridor is a very narrow slice through many different geologic bedrock formations. However, these bedrock formations extend for many miles to the northeast and southwest from the corridor and are exposed in road cuts, quarries and other excavations along the strike

		(trend) of the geologic formations outside the project footprint. Supplement the information from limited exposures of bedrock formations in the corridor with information from more extensive exposures of the same bedrock formations outside the project footprint. Conduct engineering geologic Inspections of existing exposures of bedrock (natural or excavated) inside and outside the project footprint sufficient to estimate the excavation characteristics of the geologic formations in the project footprint, and to estimate by mileposts the sections of rippable rock vs non-rippable rock requiring blasting. Evaluate the results of the excavation characteristics assessment (above) and determine whether a seismic velocity survey is warranted to estimate rippable rock vs non-rippable rock and depth to bedrock. A seismic velocity survey would be useful in estimating length and depth of common excavation vs rippable excavation vs blast excavation along the pipeline corridor, and estimating the volumes of bedrock swell and excess excavation needing to be disposed.
9-1	9	Insert a SECTION 9 PHASE 2 ACID-PRODUCING ROCKS AND SOILS HAZARD ANALYSIS. Identify by milepost the location of any acid-producing rocks and soils on NFS lands. Assess the potential for project construction in acid-producing rocks and soils to impact water and other resources.
Appendix 7-1		Appendix is not ordered sequentially by Mile Posts, which creates difficulty in finding stream crossings of particular interest. Reorganize by MP, not SC#, which has not been provided as spatial data.
Appendix 7-1		Update Appendix 7-1, if any additional stream crossings were identified via USFS shapefile called “Drainage and Flow” and field reconnaissance.
Appendix 7-1	SC_06664	MP 84.98 – stream crossing on National Forest. This is a moderate hazard rating within the Valley and Ridge physiographic region. The cross-section indicates very steep valley slopes on both sides of the crossing. Recommendations include evaluating potential scour depth and burial in bedrock across valley bottom, given potential for debris flow. Consider a route variation to avoid multiple similar crossings in a short distance. MP 84-86 realignment - Utilize the USFS shapefile called “Drainage and Flow” to find the best realignment that will avoid headwater areas.
Appendix 7-1	SC_06665	MP 85.11 – stream crossing on National Forest. This is a moderate hazard rating within the Valley and Ridge physiographic region. The cross-section indicates very steep valley slopes on both sides of the crossing. Recommendations include evaluating potential scour depth and burial in bedrock across valley bottom, given potential for debris flow. Consider a route variation to avoid multiple similar crossings in a short distance. MP 84-86 realignment - Utilize the USFS shapefile called “Drainage and Flow” to find the best realignment that will avoid headwater areas.
Appendix 7-1	SC_0719	MP 85.44 – stream crossing on National Forest. This is a moderate hazard rating within the Valley and Ridge physiographic region. The cross-section indicates a steep slope on one side of the crossing. Recommendations include evaluating potential scour depth and burial in bedrock across valley bottom, given potential for debris flow. Consider a route variation to avoid multiple similar crossings in a short distance. MP 84-86 realignment - Utilize the USFS shapefile called “Drainage and Flow” to find the best realignment that will avoid headwater areas.
Appendix 7-1	SC_0788	MP 115.81– stream crossing on National Forest. Barn Lick Branch was initially classified as a low hazard rating according to the desktop analysis. Within the Valley and Ridge physiographic region there is often a higher hazard due to flood/debris flow seasonal events. The rapid field survey of this location indicated meander migration across floodplain.

		Recommendations include sag bends at each valley edge and pipeline buried in bedrock. According to the definition of “Medium Hazard” on p3-7, it appears that this location should be re-classified as a “medium” hazard. Update final hazard ratings according to field parameters and recommendations, and avoid underestimating “low” hazards, particularly in the Valley and Ridge physiographic region.
Figure 3-1		Debris Flow Affected areas. Describe the criteria that were used to evaluate debris-flows. Figure 3-1 illustrates very large events. The analysis should also address smaller flooding and landslide events that happen more predictably with seasonal thunderstorms. In Appendix 7-1 there are multiple recommendations with regards to presence of debris flow hazards at pipeline/stream crossings. Address how these smaller debris flow events relate to the Phase 2 analysis. In light of the June 23, 2016 flood in WV and VA (predicted 1,000 years event in certain locations), major flood events, in addition to debris flow, appear to be pertinent and should be addressed.

Document Content(s)