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Evaluation of Restoration and Rehabilitation Plans for the Atlantic Coast Pipeline Project

By

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Introduction and Background

I (W. Lee Daniels) have prepared this report at the request of the Friends of Nelson County. I have performed this work as an independent consultant (as TerraScience LLC) with the prior approval of my employer, Virginia Tech. Therefore, all opinions expressed herein reflect my personal views and scientific opinion on these matters and in no way reflect those of the university, my department, or any other Virginia Tech employees.

For this report, I was asked to review the original December 2016 Draft Environmental Impact Statement (DEIS) for the Atlantic Coast Pipeline Project (ACP) and subsequent revisions and submittals up through January 27, 2017. I was also asked to review a related consulting report prepared by Mr. Alex Blackburn entitled *Report Analysis and Field Verification of Soil and Geologic Concerns with the Atlantic Coast Pipeline (ACP) in Nelson County, VA.*

I have spent over thirty years leading a major research and outreach program at Virginia Tech focused on the rehabilitation of drastically disturbed lands including those affected by mining, highway corridor development, urbanization, waste application, wetland creation, and dredge spoil management. My primary focus has been the reclamation of lands disturbed by surface mining and on the recognition and remediation of acid-forming materials. Much of my work has concentrated on understanding and predicting the effects of the weathering of various geologic materials on subsequent reconstructed soil properties and local water quality impacts. I have spent decades developing and implementing novel soil reconstruction and revegetation strategies for the mining industry. I was also actively involved with VDOT's right-of-way (ROW) revegetation and acid forming materials management protocol development for over 15 years. Details on these collective programs and full reports and publications related to issues discussed in this report are available at http://landrehab.org/.

During my review of the full suite of documents provided by the ACP project to date, I found dozens of issues that potentially warrant a further detailed response. However, in this report I am focusing on those that I feel are most important and relevant to my core areas of expertise and that are most applicable to issues of importance for the Friends of Nelson County.

Detailed Summary of Critical Issues and Deficiencies

Failure to account for net swell of backfill materials and associated issues

First and foremost, the existing documents provided to date for the ACP fail to recognize the fact that the routine trenching and backfill operations will generate a significant amount of "excess spoil material" that will not fit back into the trench and will need to be managed within the active ROW or placed off ROW into stable fills. As mentioned above, I have worked with the rehabilitation of coal mine impacts for over thirty years and the routine industry assumption is for approximately 20 to 30% "swell" of their spoil materials that then generates the necessity for excess spoil fills. These materials are typically placed into stable head of valley fill configurations which frequently generate associated discharge water quality concerns (principally total dissolved solids – TDS; Daniels et al., 2016). Even with a conservative assumption of a 10 foot wide x 8 foot deep trench, the total bank (*in situ*) volume of excavated materials will exceed 15,000 CY per linear mile. Once the pipe and any underlayment or "padding" material are returned to the trench, the volume available for backfill will be reduced by 10% or more. Given even a low estimate of net swell (e.g. 20%), this indicates that 5000 CY or more of material will need to be disposed of in some manner other than "return to original grade" per linear mile.

The original December 2016 DEIS document (p. 4-36) does discuss the need to manage "excess spoil", but only on narrow ridgetop locales. Strikingly, the geotechnical study materials provided in the January 10 Appendix C submission (in the 12/22/16 cover letter) clearly state that "*Geosyntec* (the Dominion consultant) *has not developed a detailed mass-balance based grading design and the profile and cross-sections remain illustrative*". My personal review of the ACP documents has not uncovered evidence that cut/fill mass balance calculations have been included in the current designs. If in fact this fundamental civil engineering task has not been performed for the entire pipeline corridor, this is a critical deficiency that affects almost all aspects of the restoration and rehabilitation planning process.

Unless excess spoils are hauled completely away from the ROW, they would most likely be managed by either (A) mounding them up over the backfilled trench or (b) uniformly spreading them out over the cleared ROW. Another option would be to (C) construct above-grade fill terraces parallel to the slope. Options A and C will lead to areas of much higher slopes than pre-disturbance landforms while option B will lead to a much larger zone of heavy soil disturbance and greatly complicate soil restoration operations. All options will increase erosion hazard due to extent of disturbance and more exposed bare soils for some period of time. If the materials are hauled completely out of the ROW, they will need to be placed into stable fill configurations which will increase the overall disturbance footprint and potentially pose local water quality discharge concerns. Handling these excess spoil materials will be particularly difficult on the very steep landforms found in Nelson County and the appropriate location and development of off-site fills could greatly expand the overall disturbance footprint.

Failure to adequately recognize and treat acid forming materials

While the original DEIS (December 2016) document does recognize (in text on p. 4-21 and the table on p. 4-31) that acid forming materials (AFM) will be encountered along the pipeline corridor, the level of risk is significantly understated and the mitigation measures proposed on page 4-32 are insufficient to manage the risk. The AFM risk categorization given in Table 4.1.4-1 (for Virginia) is based on research performed by my group at Virginia Tech (Orndorff and Daniels, 2004) but the report authors obviously did not read the underlying documents sufficiently to adequately understand them. While the authors have recognized that several formations in Virginia do have well-defined and documented AFM risk, they have missed the fact that locally occurring AFM materials can and do occur throughout the Blue Ridge and Piedmont geologic provinces as well.

First of all, while not a specific risk to Nelson County, the most extensive exposure to AFM in western Virginia will be associated with the shales from the Millboro and Needmore formations. These shales tend to be quite variable in their reactive sulfur (S in pyrite – FeS_2) content, but levels as high as 2% or more have been documented by my research program and by a recent study associated with the widening of U.S. Route 220 in western Botetourt County. In the Blue Ridge materials around and in Nelson County, the Ashe formation is noted to be locally high in S (e.g. > 1%), but there are also numerous other minor occurrences of AFM that are associated with long dormant (and frequently unmapped) faults that often are associated with former gold and metal mining activity (Sweet & Lovett, 1985). Reactive S content of the Ashe formation materials are highly variable, but those associated with gold and other metal sulfide assemblages can be much higher. It is also important to note that the pipeline corridor passes through a zone of extensive sulfide enrichment and associated gold and metal mining in the western Piedmont (Sweet & Lovett, 1985) that is not recognized at all in the ACP documents.

To put these S levels into an appropriate management perspective, 1% reactive S will produce enough sulfuric acid to require 32 tons of agricultural lime requirement per 1000 tons of excavated materials. This is also equivalent to 32 tons of agricultural lime per acre incorporated six inches deep. Once these materials are excavated and exposed to surface oxygen levels and rainfall, the oxidation reactions occur quickly and materials that are typically pH 6.0 to 7.5 *in situ* before excavation can fall to pH levels less than 3.5 in weeks to months following exposure. This kills existing vegetation, prevents revegetation/restoration, and leads to significant local groundwater and surface water runoff quality issues, particularly due to high levels of dissolved metals (Al, Fe, Mn and sometimes As and Se) and TDS. In addition to their negative impacts on soils, water quality and vegetation, AFM also directly attack concrete, steel and iron materials that are allowed to come in contact with their acidified pore waters (Orndorff & Daniels, 2004). I have personally observed significant structural damage to concrete and corrosion of galvanized metal and ductile iron at Stafford Airport (Fanning et al., 2004) and surrounding localities occurring within several years of placement.

At a given location along the pipeline corridor, the site-specific AFM risk for a given S containing geologic material will be governed by the current depth of weathering. Generally, we can safely assume that the surface two to three feet or more (e.g. the weathered soil profile) has been oxidized over time and does not pose a primary risk. These soil and saprolite materials tend to be yellow, red, or brown in color due to their accumulation of weathered Fe-oxides. However, non-oxidized (e.g. chemically reduced; often gray to black) materials can be encountered within ten feet of the current surface, particularly in tight dark shales and/or areas where saturation has prevented oxidation. Thus, the combined risk of AFM can only be assessed via a combination of (a) accurate interpretation of available geologic mapping, (b) on-site interpretation of soil and saprolite/rock color patterns and (c) proper laboratory testing of non-weathered materials. None of these procedures are specified in the current ACP documents. The indicators that are discussed in the ACP original DEIS document on page 4-31 (red seepage, Fe staining etc.) are generally not applicable to freshly exposed soil/geologic profiles, but are useful for evaluating previously disturbed materials following several weeks to months of exposure.

Furthermore, the AFM mitigation procedures described on page 4-32 are totally inadequate to offset the effects of pyrite oxidation on local groundwater (in the trench and at discharge points), in surface soils (where exposed), and in surface water runoff. Over forty years of experience with these materials in a wide array of mining and construction environments has clearly proven that there are only three viable ways to prevent or mitigate the impact of S oxidation in these materials:

1. Use appropriate *a priori* sampling and lab analytical procedures (e.g. acid-base-accounting; Skousen et al., 2002) to determine lime needs and **bulk-blend** the lime with the acid-forming materials. *Simply adding lime to the surface is not effective*.

2. Dispose of the materials below the permanent water table and eliminate the possibility of them being influenced by oxidized groundwater influx.

3. Seal the materials in an impermeable lined disposal area to prevent water and oxygen from reaching the AFM.

If one of (or combination) of these approaches is not taken, then long-term water treatment for trench and backfill discharges will be required and should be planned for. Acidic discharges from VDOT's uncontrolled AFM cuts and fills have persisted for decades.

The current proposed approach (simple backfill of AFM into the trench without lime additions or seepage barriers) will generate very low pH groundwater in the trenches where these materials occur which will then subsequently affect local groundwater and/or discharge from trench outlets on slopes. Furthermore, as discussed above, since large amounts of excess spoil will not be able to be returned to the original trench, these materials will pose a significant revegetation and local water quality challenge wherever they are eventually placed. These risks will be amplified where non-treated (by lime) AFM are placed into fills or where they are exposed at the final revegetation surface (e.g. forested private lands where topsoil is not returned). Even if limed appropriately, these materials will still generate significant TDS levels in any waters that are allowed to percolate through them (Daniels et al., 2016) which could potentially impact the biotic integrity of receiving headwater streams.

In fairness, it is recognized that these materials are not extensively exposed along the pipeline corridor when viewed in its entirely. However, where they occur, the associated risks are potentially severe. With respect to Nelson County, the relative uncertainty of the location of AFM occurrence also poses an active management challenge for contractors since these materials are frequently not noted on current geologic maps, but their local occurrence is clearly noted by Sweet & Lovett (1985) in the region. Extensive materials on recognizing and remediation of AFM are available at http://landrehab.org/.

Inadequate topsoil recognition and soil reconstruction/seeding protocols

The combined sequence of ACP documents provided to date contains numerous different sections describing the overall restoration and rehabilitation protocols that have been proposed for both federal and private lands. Many of these sections conflict with one another or between subsequent revisions, and the rationale for many of the differences between recommendations for federal vs. private lands is not provided. Furthermore, the overall soil reconstruction and rehabilitation protocols that are recommended in various sections of both the original December 2016 and subsequent revisions (including January 10 Appendix G - Restoration and Rehabilitation Plan) are deficient in many fundamental aspects. Following is a short summary of major shortcomings that I have noted with the current procedures and protocols. There are dozens more inaccurate statements and inconsistencies across these summed documents.

1. The authors of the various sections appear to have little understanding of basic soil science and morphology. In the original December 2016 document, topsoil is referred to, but not defined. Later documents including various restoration plans define topsoil as the O plus A horizon while others (later USFS plans) include the AB and BA horizons, which in fact are subsoil layers. Nowhere in any document is the occurrence of the E horizon included. Many of our soils, particularly under intact forest cover and in deeper sandy regions of the Coastal Plain, contain significant E horizons that should be recognized and included as "topsoil". Associated with this, the contention in the original DEIS that 77% of Virginia contains topsoil deeper than 12 inches is simply false; our topsoils are typically much thinner.

2. The January 10 Appendix G document (Restoration and Rehabilitation Plan) indicates that topsoil will not be salvaged on forested lands, but no rationale is given. This will definitely have a negative impact on long-term reclamation success since topsoil salvage and re-spreading is an internationally recognized BMP for rehabilitation of disturbed lands. This will mean that a mix of various soil horizons and geologic substrates will be left at the surface for final revegetation. This will negatively affect both herbaceous and forest reestablishment efforts.

3. The ability of bulldozers etc. to salvage and re-spread topsoil on steep slopes (> 30 to 40%) is presumed in a number of documents, particularly those pertaining to federal lands. Our experience in coal mining environments is that frequently this is simply not possible and often poses an operator risk. Similar assumptions appear in other sections with respect to the ability to use seed drills and culti-packers on extremely steep slopes. It is much more likely that (a) extremely steep areas will need to rely on mixed soil and geologic materials to serve as "topsoil substitutes", and (b) many areas will need to be either hydro-seeded or mulched and broadcast seeded by hand.

4. As noted earlier, the presence of excess spoil within the ROW has not been accounted for in any of the restoration protocols. When this is combined with the possibility of these excess spoils being potentially acid-forming, the risk of major erosion losses and/or slope failures will be greatly amplified.

5. While the current restoration section does appropriately recognize that compaction will be a significant limitation requiring remediation, the procedures for recognizing and remediating compaction are insufficient. First of all, virtually all soil types are potentially subject to significant compaction, not just the limited groups specified on page 4-47 of the original DEIS. All replaced and regraded subsoil materials will likely be significantly compacted and will need to be loosened with a ripper etc. before topsoil placement. Subsequently, the replaced topsoil layer will need to be loosened again with a chisel-plow or other appropriate tillage implement. Simple surface disking is not adequate to loosen re-compacted topsoil layers.

6. Certain protocol sections appear to be "cut and paste" from other documents and offer directly conflicting recommendations. For example the following text appears in section 5.7.1 Seedbed Preparation, pages 7 and 8 of Appendix G (Jan 10):

   Unless otherwise specified by land managing agencies or landowners or as needed to support the establishment of pollinator habitat, the seedbed will be prepared in disturbed areas to a depth of 3 to 4 inches using appropriate equipment (e.g., cultipacker roller) to provide a seedbed that is firm, yet rough. Atlantic and DTI will imprint exposed soils with a sheepsfoot, landfill compactor, tractor with studded tires, or land imprinter equipment. Soil imprinting, or tracking, leaves divots on the ground surface that trap moisture and seeds, creating catchments for native plant material to be spread across the seeded area (West Virginia Department of Environmental Protection, 2012). In addition, a seedbed with a rough surface is conducive to the capturing or lodging of seed when broadcasted or hydroseeded, and can reduce runoff and erosion potential. The rough seedbed surface will also retain soil moisture for seedling germination and promote faster establishment of vegetation.

   This text contains directly conflicting protocols in that the first part instructs the operator to intentionally compact the surface soil but also leave it rough? Rough surfaces are definitely superior for establishing vegetation and all recent WV and VA protocols have called for this (Booze-Daniels et al., 2000). However, the use of a sheepsfoot roller or landfill compactor would generate the opposite of intended results. Whomever wrote this section did not understand the fundamentals of soil placement and revegetation protocols.

7. Similarly, Section 5.8.1 calls for lime and fertilizer applications to be mixed into upper 2 inches but gives no rationale or method for this. In this same section, the upland default fertilization rate is given as 150 lbs of 10-20-20, but the next line calls for P and K in the subsequent/same installation? The authors apparently do not understand that the 20-20 in the fertilizer ratio specifies the P_2O_5 and K_2O content of the material as applied. Overall, these sections along with many others throughout indicate that the authors had a negligible understanding of actual soil amendment and seeding practices.

8. The potential for disturbance of prime farmland along the corridor (although not an issue in Nelson County) is a significant concern. Various submissions estimate total impacts of between approximately 7,500 and 11,000 acres. Other than urbanization, the largest single impact to prime farmland in our region to date has been the recent mineral sands mining operations in southern Virginia that have disturbed approximately 3,500 acres (Schroeder et al., 2010). Despite the stated importance of prime farmlands, no detailed

protocols are provided for these lands in the current (January 10, Appendix G) document. I have worked on developing soil reconstruction protocols for these kinds of lands since the early 1990s and have found that (a) significant subsoil and surface soil ripping and tillage will be essential along with (b) large applications of lime and P to the subsoil and replaced topsoil layers. Even with these approaches, post-disturbance crop yields will be decreased by 20 to 30% in most years and this should be clearly communicated to all stakeholders.

9. The monitoring protocol as described in Section 8.1 is simply inadequate for all post-disturbance land uses. Areas returned to forest species will need to be monitored for at least five years to assure long-term survival and post-establishment productivity. Forest species are particularly sensitive to soil compaction and our experience in coal mining landscapes indicates that multiple years of monitoring are required. Similarly, rehabilitation success in areas returned to agriculture should be based on actual yield measurements taken over several growing seasons in comparison to nearby non-disturbed areas.

Review of Blackburn Report

As a part of my efforts, I have reviewed the report by Alex Blackburn and associates entitled *Report Analysis and Field Verification of Soil and Geologic Concerns with the Atlantic Coast Pipeline (ACP) in Nelson County, VA* in its entirety. I am in general agreement with his findings regarding the overall predicted effect of pipeline construction on the potential for increased landslide risk and increased soil erosion potentials. Per my detailed comments above, I also agree with his report's limited assessment of issues associated with "excess spoils" and acid-forming materials which I see as major issues with the current pipeline proposal and supporting documents.

Overall Conclusions

1. As proposed, the pipeline trenching procedures will generate significant amounts of "excess spoil" material that will adversely impact surface soil, revegetation, and erosion potentials within the right of way corridor unless properly placed and managed in stable off-site fills.

2. The ACP documents to date do not appear to document appropriate mass balance considerations for all cuts and fills and the issues associated with managing excess materials.

3. The original DEIS and subsequent revisions do not adequately address the risk, recognition protocols, or remediation strategies for potentially acid-forming materials.

4. Acid-forming materials potentially pose localized, but significant soil and water quality risks at multiple locations along the proposed corridor, including Nelson County.

5. The criteria for recognizing topsoil and subsequently reconstructing productive post-disturbance soils are in conflict in various ACP documents and the overall procedures recommended will not be effective to properly restore post-disturbance soil productivity.

6. Final soil placement, soil amendment and seeding protocols are improperly specified or incorrect in many locations across multiple documents, including the most recent January 2017 revisions.

References

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