December 11, 2016

Ms. Kibberly Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Dear Ms. Bose ad Members of the Commission:

Subject: MVKKP CP16-10-000 Draft Environmental Impact Statement

Preserve Giles County submits the following protest on behalf of Dr. Ernst Kastning, a renowned expert on the geology of the Appalachian Mountains. Dr. Kastning submitted to the FERC, prior to the publication of the DEIS, a thorough and comprehensive document on the hazards of attempting to build a 42" gas pipeline through the Appalachian counties of Monroe Co., WVA, Giles, Montgomery and Roanoke Co., Va.

With the publication of the DEIS, it is clear that the Commission and it's consultants either failed to study that document, or chose to ignore the hard science behind it, mentioning the document only in passing on page 4-72 as part of the discussion of groundwater. This was a flagrant disregard of a respected scientist's knowledge and advice based on his detailed study and publications on the subject matter.

Due to this biased and unconscionable disregard for serious scientific evidence presented by a known expert in the field, Preserve Giles County submits this protest and comment.

Respectfully,

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Kastning Response to DEIS

Karst Features Visible on the Surface Are Not a Sufficient Measure of a Well-Integrated Flow System in the Subsurface

A Critical Analysis of Interpretation in the Draft Environmental Impact Statement Regarding the Proposed Mountain Valley Gas Pipeline

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FERC DOCKETS CP16-10-000 and CP16-13-000

Prepared as a Deposition of Record

for the Federal Energy Regulatory Commission

on behalf of

Protect Our Water, Heritage, Rights (The POWHR Coalition)
www.powhr.org

10 December 2016

Executive Summary

This discourse is a follow-up to a comprehensive report on geologic hazards previously submitted to the Federal Energy Regulatory Commission by this author on 3 July 2016 (Submittal 20160713-5029). It is entitled:

> ***An Expert Report on Geologic Hazards in the Karst Regions of Virginia and West Virginia: Investigations and Analysis Concerning the Proposed Mountain Valley Gas Pipeline*** (Referred to here as the Kastning Report)

The Draft Environmental Impact Statement (DEIS) for the proposed Mountain Valley Pipeline (MVP), released by the Federal Energy Regulatory Commission on 16 September 2016 makes no mention nor reference to the *substantive* information and raised concerns discussed in detail in the Kastning Report.

The salient points of the following supplemental report are:

- The Kastning Report is not referenced at in the DEIS, other than to cite a minor factual claim by MVP. The reasons for this omission are not clear; however, it appears that the report was ignored by the FERC staff in compiling the DEIS.

- This omission, intentional or not, has major consequences for the completeness, integrity, and accuracy of the DEIS.

- Karst is a complicated geologic, hydrologic, and biologic environment. The DEIS does not fully address the extent, complexity, and integrated nature of the karst systems within or near the corridor for the pipeline, particularly karst in the subsurface.

- Merely identifying and cataloging karst features on the surface (DEIS Appendix L) does little to characterize and evaluate the environmental significance and potential hazards of karst that would be encountered by the Mountain Valley Pipeline. The subsurface regime of the karst is all-important with respect to groundwater and land-stability issues.

- The conclusions in the DEIS about the nature and impact of karst as it pertains to the proposed pipeline are largely insufficient owing to the lack of supportive data (particularly regarding the subsurface).

- Many of the mitigation methods proposed in the DEIS for specific karst features on the surface (Appendix L) are unacceptable and deemed to be improper by experts and scientists who work with karst. Well-established, published best-management-practices (BMPs) regarding karst are ignored in the DEIS.

Based on the above, the original conclusion of the Kastning Report is re-emphasized:

"Karst and associated hazards constitute a serious incompatibility with the proposed pipeline. The effect of these threats on the emplacement and maintenance of the pipeline, as well as the potential hazards of the line on the natural environment, renders this region as a 'no-build' zone for the project."

Introduction

The Draft Environmental Impact Statement (DEIS) for the proposed Mountain Valley Pipeline (MVP), released by the Federal Energy Regulatory Commission on 16 September 2016 has grossly misinterpreted the potential threat of karst terrain on the siting, construction, and maintenance of the pipeline along the proposed corridor. Karst features visible on the surface within a 0.25-mile distance of the corridor centerline have been listed in 25 pages of tables in Appendix L of the DEIS. The data includes the milepost position, county, type of karst feature (*e.g.* cave, sinkhole, spring, insurgences (including swallets and losing streams)), description of the feature, level of concern, potential hazard, and construction recommendations, (*i.e.* mitigation).

The proposed corridor of the MVP passes through a significant area of karst as it crosses the mountainous Valley and Ridge Province (the Appalachian Fold Belt). The areas of karst underlying the proposed corridor are well documented in maps found both in the DEIS and in my report of 3 July 2016, entitled ***An Expert Report on Geologic Hazards in the Karst Regions of Virginia and West Virginia: Investigations and Analysis Concerning the Proposed Mountain Valley Gas Pipeline*** (henceforth referred to as the Kastning Report, Submittal 20160713-5029).

Altogether, in Appendix L, there were approximately 28 caves, 68 sinkholes, 17 springs, and 10 insurgences so enumerated within five counties with karst (Summers and Monroe counties in West Virginia and Giles, Craig, and Montgomery counties in Virginia). This adds to 123 karst features that occur along a combined distance of 22.0 miles along the proposed corridor identified as crossing karst. These numbers do not include estimates given for sinkholes within clusters, compounded sinkholes, large areas of sinkholes (such as the Mount Tabor Sinkhole Karst Plain in Montgomery County) and the like. Therefore, the number of surface karst features may conservatively be higher than 130 in the karst crossed by the proposed corridor. This amounts to an average of about six identified and confirmed karst features per mile within a half-mile wide zone within karst (*i.e.* within 0.25 mile of the project). Another way to visualize this is to note that the average spacing among the cataloged karst features is less than 0.2 mile (or slightly more than 900 feet).

Hazards in Karst Terrain

"Karst is a landscape that is formed by the dissolving of bedrock. Karst can create hazards for structures that are built on or across it. The environment, both on the surface and in the subsurface, is more easily degraded in karst than in most other terrains. Karst poses severe constraints on engineering, construction, and maintenance of large-scale structures built upon it or across it. Moreover, the karst in this mountainous region is much different than that in other areas. Siting a pipeline through the Appalachian karst poses significantly greater hazards than in karst areas where the terrain has lower topographic relief." (Restated from Kastning Report)

The most significant hazards in karst terrain include (1) contamination of groundwater aquifers in karst, (2) vulnerability of recharge zones that contribute to karst aquifers, (3) potential of collapse into subsurface cavities, (4) potential of collapse owing to suffusion (piping) in surficial materials overlying karsted bedrock, (5) siltation and infilling of sinkholes and zones of recharge from accelerated erosion and deposition of materials on the surface, (6) induced flooding of sinkholes upon blockage of points of discrete recharge, (7) derangement of surface and subsurface drainage patterns owing to surficial modifications, and (8) destruction or degradation of cave systems and their mineralogic and biologic content. (*See* Kastning Report, Section 3, for detailed discussion of these hazards, including their importance along the proposed pipeline.)

Recognizing Karst Features on the Surface

The following comments are modified from the Kastning Report (Section 1, pages 12-14):

Karstic features on the surface can range from the extremely obvious (*e.g.,* large sinkholes, sinking streams, swallets and/or springs), often overlooked features (*e.g.,* small sinkholes or dry valleys), subtle features (*e.g.,* swales), and very small features (*e.g.,* solutional sculpting of rock surfaces such as karren features). Karst landforms of any size on the surface can sometimes be hidden from the casual observer. Large, dry valleys and solution valleys can inadvertently go unrecognized as karst. Although they may be obvious on a topographic map or from aerial photographs, especially for those persons familiar with karst, the normal valley shape sometimes disguises the true nature of a solution valley. In tall, thick forests, tree-coverage may hide even large sinkholes (closed depressions) from being detected with aerial photography or at times while travelling on the surface.

Other karstic features are too small to be discovered by aerial photography or illustrated on a topographic map, especially on standard 7.5-minute quadrangles constructed with typical contour intervals of twenty or more feet. In some cases, even smaller contour intervals may not indicate closed depressions. Site visits are mandatory to research a potentially karstic area; one cannot rely solely on sinkholes depicted on a topographic map or mapped with aerial photography. This is an especially important point for environmental assessments where karst is a factor of risk (Hubbard, 1984, 1991). Performing *ground truth* is the only proven way to detect the presence and abundance of small sinkholes. The proposed MVP corridor crosses numerous places in karst terrain where subtle, barely detectable sinkholes are present. Even very small sinkholes are important indicators of karst development, especially where subsurface features (such as caves and other openings) occur. In general, the presence of sinkholes of any size in a soluble rock terrain is an indicator of a subsurface hydrologic (karstic) flow system (a network of enlarged openings that conduct groundwater).

Karstic terrains often have very thin layers of soil overlying them because the soil may be piped away almost as fast as it develops. But this is not always the case. For example, where nearby steeply sloping hills drain onto karstic terrain, thick deposits of clay (or other alluvium and/or colluvium) may mantle the karstic landforms, especially in areas with relatively few small fractures in the bedrock. The only discernable evidence of karst may be wet-weather springs or swales (slightly sagging areas, too shallow for most people to refer to them as sinkholes). These slight depressions are sometimes detectable after a heavy rain when water ponds in them briefly or in early spring when the vegetation starts to grow in the swales earlier than on the surrounding area. As the soil is removed from below the vegetative root mat, these areas sag and may eventually collapse into the piping cavities below. Sinkholes formed by the physical process of piping (an engineering; geologists generally name the process 'suffosion') are associated with the soil and regolith zone that overlies porous bedrock. In this process, particles are slowly plucked from the unconsolidated material and carried away by groundwater, leaving behind a void that may eventually collapse (*see* discussion in the Kastning Report, Section 1, page 13 and Section 3, pages 28-29).

Even though sinkholes may have formed in soft, loose, insoluble materials, they are still considered features of karst. The reason for this is that during the slow process of piping, tiny particles in these horizons tend to move downward into true karstic openings in the underlying bedrock (namely fractures) and be carried away as part of the groundwater flow. Over time cavities grow in the regolith and soil, including upward growth (termed *stoping*), until their thin roofs collapse, forming the sinkholes. Suffosion (piping) collapses are very common in the karst regions of the Appalachians. It is usually wrong to consider this kind of subsidence to be an insignificant indicator of karst. On the contrary, most of these sinkholes would not have formed if there were no openings in the bedrock beneath to carry off particles.

Wet-weather springs may flow when wetter-than-usual conditions cause a temporarily high water table. A wet-weather spring may represent a former spring that flowed when local base level was at a higher elevation. Seeps and small gravity springs exist where groundwater flow, generally just below the water table, intersects the natural ground surface. These areas of discharge also occur in outcropping rocks, where water that has been perched on an impermeable bed discharges at the surface where the beds are exposed. Seeps will sometimes develop where quarries, roads, railroad cuts, and other excavations (*e.g.,* for pipelines) cut through a hillside and into the bedrock. Discharge may be significant and result in major springs in some cases where major flow paths are intersected (such as caves having large streams).

The above characteristics are all found in abundance in the karst landscapes of the Appalachian Valley and Ridge region (Kastning, 1988, 1989a). It would be very difficult to find a path or corridor for any use (roads, power lines, natural gas transmission lines) through this fold belt that would totally avoid karst. Some areas within this region have more intensive karst than others, but by and large, even subdued areas of karst raise important environmental concerns.

Underestimation of Potential Karst Hazards

The following comments are modified from the Kastning Report (Section 1, pages 14-15):

The strongest surficial evidence for the presence of an efficient and well-integrated subsurficial drainage network is where sinkholes have formed at discrete points of recharge. Sinkholes form in response to surficial waters draining through the ground via the easiest pathway toward the local base level. Water does not travel into and through a sinkhole because the sinkhole has pre-existed – rather, as water travels through established zones of weakness (*e.g.,* fractures, faults, or bedding-plane partings), it gradually dissolves the bedrock and carries the solute away to points of discharge on the surface. Thus, sinkholes are formed contemporaneously at points of active, concentrated recharge (Kastning and Kastning, 2001). Tiny soil and rock fragments are also piped away, augmenting the development of sinkholes in the process. Thus, dissolutionally enlarged openings (owing to chemical weathering) and mass wasting of soil cover and break up of bedrock (owing to physical weathering) both contribute to form hollowed-out closed topographic depressions that we call sinkholes (and are internationally known as dolines).

Sinkholes can be of any size, as large or small as local geologic or other natural conditions and time permit. The shapes of sinkholes or clusters of sinkholes may provide clues to their origins, if they are mapped thoroughly and analyzed carefully (Kastning, 1989b; Kastning and Kastning, 2003). Sinkholes and other surficial karst features are often highly useful in interpreting geologic structure in the subsurface (Kastning and Kastning, 1981). Structural control is crucial in the establishment of hydrologic continuity among surficial features, such as sinkholes and other recharge zones, subsurficial drainage such as through caves and other conduits, and discharge zones such as springs or seeps (Kastning, 1999).

Caves formed in soluble rock are indicators of karst (Curl, 1958, 1966). Sinkholes are also used as measures of karst in many site evaluations. The observed presence of closed depressions in soluble-rock terrain is correctly interpreted as evidence for karstic groundwater flow in the subsurface. These represent places of discrete recharge where water enters the ground at specific points. Conversely, the absence of closed depressions on the surface is too often interpreted as an indicator of poor or no development of karst in the subsurface. The latter view is a proven erroneous assumption in many karst regions, especially in areas of diffuse recharge where water derived from precipitation percolates uniformly into the ground over an area, perhaps through an overlying insoluble bed (*e.g.,* sandstone) or through a thick mantle of soil and regolith. This can result in a surficial landscape with few if any noticeable sinkholes. The absence of surficial karst features such as sinkholes, or the dismissal of small, shallow, and otherwise subtle sinkholes often leads to flawed conclusions about the presence of substantial karst in environmental studies and assessment. Even if subtle sinkholes are very numerous (and therefore important indicators of karst), not recognizing them or overlooking them can greatly alter conclusions about the presence and extent of karst in an area, including proposed construction sites. There are many documented regions of karst where extensively explored and mapped caves lie beneath a surface devoid of sinkholes. **In areas underlain by soluble rock, the absence of sinkholes on the surface cannot be categorically interpreted as the absence of karst.**

Inadequacy of Karst Feature Identification, Interpretation, and Mitigation Measures in the DEIS

The characteristics of surficial karst features are discussed above, as well as the spectrum of size associated with them. The discussion emphasizes the importance of identifying even the subtlest features in assessing the extent of karst and its vulnerability.

The tables in Appendix L of the DEIS list karst features as identified by Draper Aden Associates in their 2015 consulting report to MVP (Karst Hazards Assessment Report, Attachment DR2 RR2-12, filed by MVP in 2016). These karst features were identified by ‘desk-top’ methods (including maps, areal imagery, and search of published and unpublished material). Many of those features were checked in the field (as noted in the tables) and some other features were identified during fieldwork. **The data in Appendix L of the DEIS apparently has not been updated since the 2015 Draper Aden Associates study, despite supplementary input from several contributors in their depositions to FERC since that time.**

Based on the experiences of many karst researchers (including this author), there are only three general approaches to determine the true extent of karst in the subsurface and thus fully delimit integrated networks and paths of groundwater flow from zones of recharge to zones of discharge. These are: (1) a high-resolution surveying and mapping of surficial features (*i.e.* including the very subtle features discussed above), (2) extensive and detailed geotechnical methods such as dye tracing and a variety of established geophysical techniques (*e.g.* seismic exploration, electrical resistivity, microgravity measurements, and ground-penetrating radar), and (3) exploration and surveying of enterable caves. Even at best, the employment of any, or all, of these methods may not adequately determine precise locations where potential impacts from construction and land alteration will not be a problem or even have a minimal effect.

The paucity of detailed data in Appendix L is testimony that the karst inventory is insufficient for routing the proposed pipeline corridor. The real density of karst features is undoubtedly considerably more than six per mile (as stated in the above introduction) and the average spacing would be much less than 900 feet if subtle karst features were included.

There are areas along the proposed MVP corridor where sinkhole density is high (Hayman, 1972; Hubbard, 1988; Miller and Hubbard, 1986). The Mount Tabor Karst Sinkhole Plain has been identified as a significant and sensitive area of karst, by FERC, Draper Aden Associates, cave researchers, and this author. Several dye tracings there confirm the extent of flow paths beneath the karst plain. In fact, the extent of this complex karst aquifer very likely exceeds the area that exhibits sinkholes. Therefore, for the MVP corridor to effectively avoid producing environmental impacts to the system would necessitate considerable geotechnical study to determine the parameters of the karst as well as the extent of contributing recharge area.

Even though the Mount Tabor Karst Sinkhole Plain has been recognized in the DEIS and by MVP to be a major concern, there are other areas along the proposed pipeline corridor that have very similar environmental and hazardous consequences brought on by karst. The Kastning Report discusses several additional sites, including some in Monroe County in West Virginia, and Giles County in Virginia (Section 4, pages 47-52).

For the DEIS discussion of hazrds and mitigation to merely dance around and past individual sinkholes and other karst features ignores the interconnectivity of surficial and subsurficial paths of water flow. By analogy, if an army were to encounter a mine field in battle, it would be prudent for it to skirt the area completely rather than tip-toe through it in the hopes that a catastrophic event would not be triggered. A pipeline that zigs and zags through a plain of sinkholes may easily encounter karst features that are subtle of not recognizable from surface recognizance.

Recharge in karst occurs is complex. It is not only in large obvious discrete inputs (*e.g.* sinkholes, swallets, and insurgent streams), but diffusely into the intervening terrain among those features. The latter is characterized by seepage of meteoric water into the soil zone and epikarst, eventually migrating downward into and along fractures (in both the vadose and phreatic groundwater zones) until it encounters the water table where horizontal movement will carry discharge to springs and wells.

As discussed in the Kastning Report, it is remiss not to include the contributing surficial drainage basins, *including allogenic recharge contributed as runoff from upland non-karstic areas*, in the delineation of areas of potential impact to fragile karst terrains. The DEIS provides little discussion of this aspect, let alone suggesting how buffer zones may be determined.

Major Karst Report Was Not Addressed in DEIS

The Kastning Report was submitted to FERC in July 2016. Based on comments made after that date (including personally to me in Roanoke, Virginia, on 3 November 2016 by a FERC representative), that the report was received and reviewed. However, *substantial* information and findings in the Kastning Report have been completely left out of the DEIS.

The following statement occurs in the DEIS (Section 4.13.2.1, p. 4-500 to 4-501, "Water Resources"). The **bold** emphasis is mine:

> **"We do not have data about impacts on karst features and related groundwater resources for all of the other projects within the HUC10 watersheds crossed by the MVP and the EEP.** However, a review of information available regarding karst features crossed by other FERC jurisdictional projects shows whether or not there are karst impacts associated with any of those other projects. The Columbia Smithfield Expansion III and the Virginia Southside projects do not cross karst terrain. And while the ACP Project and Supply Header do cross karst terrain, it is unclear whether any of it occurs within the HUC10 watersheds shared by the MVP or the EEP. The Rover Pipeline would cross 89.4 miles of potential karst terrain, most of which is in northwest Ohio, outside of the geographic scope of analyses for the MVP or the EEP. Other projects that may also cross karst terrain include transportation or other energy projects.
>
> **"The MVP pipeline route would cross considerable karst terrain between about MPs 190 to 237.** Mountain Valley has developed a Karst Mitigation Plan to reduce the impacts on karst terrain (see discussion in section 4.1.2). In consideration of available information for other projects, and the protective measures proposed by MVP, **we have not identified any cumulative impacts on karst terrain that would result from construction and operation of the projects.**
>
> "Given the nature of shallow pipeline trenching relative to deeper aquifers, Mountain Valley's Karst Mitigation Plan, as well as the protective permitting requirements of other agencies for other projects such as oil and gas well development, **we conclude**

that the combined cumulative effects upon groundwater would be less than significant."

The above quotation from the DEIS states that FERC **had no data** on the impact of karst features within the HUC10 watersheds crossed by the MVP. In conclusion, the above quote says that the cumulative effects on groundwater would be less that significant.

This is an admission that the Kastning Report was either not read or considered, or it was intentionally ignored. The Kastning Report includes very substantial and significant data about the co-impacts between karst and the proposed pipeline. It included specific examples of potential problems in several localities of karst. FERC does have the data in the Kastning Report. So, why was it not acknowledged or addressed in the DEIS?

Conclusions

With respect to the assessment of karst, the DEIS fails in the following respects:

- Identified karst features in Appendix L are only those that are most obvious. A large and mostly unmeasured, population of features is not represented. The karst inventory does not include a high-resolution survey of smaller (but very important) features, especially in the 'ground-truth' phase.

- Contributions from several correspondents to FERC that included additional site information have not been included in Appendix L (or elsewhere in the DEIS). Therefore, the data set is incomplete and scant and was not current when the DEIS was released.
  (Submittals: 20160516-5157, 20160714-5027, 20160801-5042, 20160909-5315, 20160915-5084)

- The integration of surficial features with extensive groundwater flow systems is not addressed in the DEIS. This would be like installing sinks in a home without considering the plumbing that they would need to be connected with.

- The concept that subsurface karst systems typically extend well beyond the relatively large and isolated surface features is not addressed. It is well known (through dye tracing) that karst groundwater in the region can (and does) flow long distances (*e.g. see* Saunders and others, 1981; Savko, 2001; *see also* Figure 4.1-3 on page 4-37 of the DEIS that shows traces in the Mt. Tabor Sinkhole Karst Plain).

- Observed karst areas crossed by the proposed MVP corridor are not viewed as integrated karst aquifers, but instead specific karst features are treated as independent entities that can be isolated, avoided, and mitigated.

- Not only are smaller, unmapped features left unreported, pervasive areas of diffuse recharge among the discrete points of recharge are not discussed in the DEIS nor identified in the appendices. The entire concept of buffer zones around recharge zones is ignored (*see* Kastning and Kastning, 1997).

- The proposed methods of avoidance and/or mitigation for each feature listed in DEIS Appendix L are merely 'band-aid' fixes. They would fail to solve the overall impact of the pipeline and its corridor as they cross zones of karst. This is akin to the proverbial medical adage of "treating symptoms rather than finding a cure."

- Many of the mitigation measures proposed for specific karst features in Appendix L are contrary to accepted 'best management practices (BMPs)' as documented in various published papers and reports on karst management. (For management of karst terrains, *see* Kastning and Kastning, 1991, 1993; Zokaites, 1997; Veni and others, 2001.)

To reiterate the conclusion in the Kastning Report:

"Karst and associated hazards constitute a serious incompatibility with the proposed pipeline. The effect of these threats on the emplacement and maintenance of the line, as well as the potential hazards of the line on the natural environment, renders this region as a 'no-build' zone for the project."

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