The Scientific Consensus on the Threats Posed by Large Gas Pipelines to Virginia Waters:
Compound Geo-Hazards
(Respectfully submitted by Richard D. Shingles)

Introduction

The threat posed by construction of the Mountain Valley Pipeline (MVP) to Virginia's waters is well known and well understood. It is based on science and site specific observations along the proposed route through the *ridge and valley system* extending in Virginia from Peters Mountain in Giles County through Bent Mountain in the Roanoke Valley.

The science is well established and documented in the following reports by four distinguished, highly trained and experienced experts: Dr. Ernst Kastning, Dr. Chris Groves, Dr. Pamela Dodds, and Paul Rubin. All four are hydrogeologists. The first two are professors of geology with over 80 years of practice, including teaching and research on this and related subjects. The latter two are independent professional consultants with over 67 years of practice, including their work for state environmental protection agencies in Virginia and New York respectively. After careful study, the four experts have independently arrived at very similar conclusions. Their collective assessment is that the construction, operation and maintenance of a 42-inch diameter natural gas pipeline through an area replete with the compound geological hazards prominent in the region would inflict serious environmental damage.

As Dr. Carl E. Zipper has established, the initial routing of the MVP was inadequate, made from desktop analyses and a poor knowledge of the geology and topography of this region and specific impacted locations (FERC submissions 20151125 5156 and 20170110 5019 to CP16 10). Ever since MVP public relations professionals and technicians have tried to rationalize a fundamentally flawed route. The Federal Energy Regulatory Commission, under pressure to approve gas pipelines from the Marcellus and Utica shale beds, has turned a blind eye to the reports cited here. This leaves only the Virginia Department of Environmental Quality (DEQ) to protect the Commonwealth's waters.

Unfortunately, despite the receipt of numerous reports to the contrary, last December, the State Water Control Board (WCB) granted the MVP a water quality certification after determining, by a 5-2 vote, that there was a "reasonable assurance" that construction of the pipeline will not violate Virginia water quality standards and contaminate streams and other bodies of water along its path. Subsequently, after more closely reviewing the science, the Board decided to revisit certification by granting a 30-day written public comment period. However, the rules for submitting comments - limited to technical information for *specific* wetland or stream crossings - reveals a fundamental misunderstanding of the nature of the threat, in particular karst (see the attached karst map of the MVP route).

Karst is porous bedrock (e.g. limestone) that exchanges ground and surface waters. It is evident on the surface by sinkholes, caves, sinking streams, seeps, dry valleys and solution valleys. Similar to icebergs, what cannot be readily observed, and therefore *cannot be specified*, is the mass of the karst below the surface. In heavily karst terrain, surface and subsurface waters inter-flow as a

hydrological system. Storm water runoff and sediment readily flow through openings in the bedrock (zones of recharge) and eventually re-emerges at the surface in zones of discharge (springs, wells). The WCB's charge to limit public comments to specific stream and other surface water body crossing (specified in Table 2.2 "Field Survey Stream Impacts") *precludes* testimony about adverse construction impacts on the much larger bodies of subsurface waters which have been shown (by dye testing) to extend miles beyond individual stream crossing and proximte zones of discharge and recharge. The fact is that, as Dr. Kastning (who is paraphrased above) and other experts state, the extent and exact nature of karst in any location cannot be precisely known. We cannot precisely know what we cannot adequately measure. Therefore the science *cannot possibly* allow the anyone to conclude that construction of a large diameter pipeline through a predominately karst region will *not* impair Virginia waters

The citizens monitoring program, Mountain Valley Watch, has been formed in response to WCB/DEQ failure to understand this fundamental fact and, (despite being provided with an version of this document prior to certification) its failure to appreciate the magnitude of the *other geo-hazards* discussed below - steep slopes, poor soils (prone to slippage and slope slide and to compaction and runoff), and ground movement associated with relatively frequent, moderate seismic activity of the Giles Seismic Zone - the how they accentuate and compound threats to water posed by the karst terrain. Trained volunteers will monitor identify and report to the DEQ engineering failures and follow through to determine whether they are adequately remedied.

Moving forward, DEQ can best perform its regulator role by providing careful consideration to two primary concerns in the hydrologists' reports summarized below. **First**, at certain locations (specified therein) *multiple* geological hazards will likely impair the construction and integrity of a gas pipeline of this size, negatively impacting water systems. It is incumbent on DEQ to assess contingencies involving various combinations of these hazards that might result in *synergistic effects* challenging even the best engineering practices. **Second**, the significance of these hazards for Virginia waters is not limited to specific stream crossings. Wherever extensive karst terrain (80% of Giles) extends below and well beyond surface water crossings and there are upland first order tributaries contributing to higher order downstream water bodies, there are likely to be *cumulative adverse effects* from large buried gas pipelines.

Experts and Their Reports

1. **Dr. Ernst Kastning, Ph.D., P.G.**
Professor of Geology, Radford University (retired), Professional Geological Consultant; Certified Professional Geologist of the Commonwealth of Virginia. Dr. Kastning has over 50 years of experience studying karst in the Appalachia region. His publications on karst number over 100 and many directly address karst processes and environmental impacts in the area currently affected by the proposed pipeline.

Kastning Report 1. *An Expert Report on Geological Hazards in the Karst Regions of Virginia and West Virginia: Investigations and Analysis Concerning the Proposed Mountain Valley Gas Pipeline* (FERC Accession No. 2016713-5029).

This report addresses the challenges of building large interstate gas pipelines through extensive *karst regions* like the proposed MVP corridor from Monroe County, West Virginia through Giles, Montgomery and Roanoke Counties, Virginia. The danger posed by karst in this Valley and Ridge province are exacerbated by *additional geological-hazards,* such as steep slopes, shallow bed rock, poor soils and seismic activity, all common to the region. Kastning provides extensive documentation of *specific* karst systems and co-located geo-hazards along the proposed route.

The report concludes that *compound environmental hazards* constitute serious threats to the proposed construction regardless of the applicant's best engineering practices. The significance of these threats for the emplacement and maintenance of the line, as well as the potential hazards the line presents for the natural environment, render this region a *no-build zone* for large diameter gas pipelines.

Kastning indicates the locations of karst terrain and other hazards in the effected region that likely will disturb groundwater recharge, enhance storm water runoff and accelerate erosion, contributing to slope instability and groundwater contamination. He identifies areas, particularly in Giles County and northwest Montgomery County, where these outcomes will likely be enhanced by weak soils and ground shaking, associated with an active seismic zone, contributing to landslides. Table 1 below specifies the compound geo-hazards in Giles by mile post.

Regrettably, neither the applicant nor FERC's Final Environmental Impact Statement (FEIS) candidly considers the extent of compound geologic-hazards, despite the expeditious submission to FERC of the Kastning and subsequent expert reports. MVP mitigation plans underestimate the geological hazards and address each type of hazard in isolation from one another. Supplementary filings to FERC (e.g., FERC Accession No. 20171115-5155), document numerous omissions, unsubstantiated assumptions, errors in measurement and deficient methodologies underling FERC's conclusion that significant long term or permanent harm is unlikely.

Kastning Report 2. *Revised Report on the Potential Damage to the Karst Aquifer of the Mount Tabor, Virginia Area* (with Robert M. Jones, B.S.C.E., M.S. (Civil Engineering), Ph.D. (Theoretical and Applied Mechanics) (FERC Accession No. 20170310-5024).

This report is written by two people well-qualified to comment authoritatively on the various aspects of the impact of the Mountain Valley Pipeline on the Mount Tabor area (MTA). Both have B.S. degrees in engineering with a variety of advanced degrees including one with an M.S. in Civil Engineering and Ph.D. in Theoretical and Applied Mechanics and the other with an M.S. and Ph.D. in Geology. Both have extensive accomplishments in engineering and geology, respectively.

Their report provides a highly detailed investigation of the almost certain impairment that would result from construction of the pipeline. The MTA is identified in the first Kastning report as the most extensive karst system along the route through Virginia. The headwaters of Mill Creek originate in the Jefferson National Forest on the south side of Brush Mountain. Several First-order tributaries converge into Mill Creek, which flows down steep slopes with poor soils,

through a heavily forested area to a sinkhole emptying into Slussers Chapel Cave. This cave is a central feature of the MTA and it empties into another significant cave, Mill Creek Cave, and eventually into the North Fork of the Roanoke River.

Their report discusses the extensive dye trace testing conducted by the Virginia Department of Conservation and Recreation, documenting in broad outlines the extent and complexity of the MTA, and concludes pipeline construction traversing the area will pose a threat to a large community which depends solely on the aquifer.

Kastning Report 3. *Supplemental Report by Dr. Ernst Kastning regarding Geologic Issues with the Proposed Mountain Valley Pipeline* (FERC Accession No. 20170524-5177).

In this paper Dr. Kastning's replies to a critique of Draper Aden Associates (an MVP consulting engineering firm) of his original report. He restates his credentials, asks for those of his unidentified critics and points out the obvious amateurish flaws in their analysis. Providing professional credentials for any Engineering firm is standard, and they have yet to be provided by the applicant or Draper Aden Associates.

2. **Dr. Chris Groves, PhD, PG.**

Registered Professional Geologist at Western Kentucky University - Bowling Green with more than 30 years of professional experience in the study of karst landscape and aquifer systems. In 2010 he was appointed University Distinguished Professor of Hydrogeology at WKU, where since 1991 he has written or coauthored 25 peer-reviewed journal papers or book chapters and 49 other technical publications, as well as given presentations at 157 international, national, and regional scientific conferences. Since 1995 he has been active with participation in, and leadership of, several karst-focused United Nations scientific programs within the UNESCO International Geoscience Program, having undertaken cave and karst fieldwork in 25 countries.

Report: *Karst Landscapes and Aquifers of the Central Appalachian Mountains and Implications for the Proposed Mountain Valley Pipeline* (FERC Accession No. 20161223-5058)

Dr. Groves provides a insightful discussion of the hydrological conditions in the Central Appalachian Mountains that create a variety of environmental challenges to pipeline construction and operation. This includes an excellent review of the karst landscapes along the proposed route as extensive, *integrated flow systems* among surface and subsurface streams and aquifers consisting mostly of fractures in porous rock, of which caves and sinkholes are primarily the most visual components. Clearly the threat posed by buried pipelines to integrated flow systems endangers the rare species they harbor.

Table 1. Coterminous Severe Slopes >30%, Active Soils, Karst Complexes with Waterbody Crossings along the MVP route in Giles County

Mile Posts	Length miles	Mountain	Ave. Max Vertical Slope	Active Soils	Waterbodies in Karst Area	Karst Complex
194.7 - 196.0	1.30	Peters Mountain NW slope	40.9	None	Kimbalton Branch^{IP}	Sinkholes, one open throat
196.94 - 198.03	1.09	Peters Mountain SE slope	59.4	Nolichucky very stony loam	Kimbalton Branch^{EP} Curve Branch^{I} Big Stony Creek^{IP}	
198.3- 199.92	1.62	Kimbalton slopes	41.4	Frederick very stony silt - Carbo-Rock Outcrop complex	Clendennin Creek^{P} Big Stony Creek^{P}	Lhoist Cave -sinkhole complex, shallow bedrock
200.9 - 201.04	0.50	2317 ft Mountain	39.0	Carbo-Rock outcrop complex - Carbo silty clay	Dry Branch^{P}	Shallow bedrock, Possible cave
201.43 - 202.42	0.99	2330 ft Mountain	39.0	Carbo-Rock outcrop complex - Faywood silt loam	Dry Branch^{IP}	Shallow bedrock, Crooks Crevice Cave
203.4 - 205.3	1.90	2500 ft Mountain	45.1	Carbo-Rock outcrop - Nolichucky very stony sandy loam	Little Stony Creek^{P}	Shallow bedrock, 3-4 caves, sinkholes, shallow bedrock
206.7 - 207.3	0.60	2683 ft Mountain	43.3	Sequoia silt loam	Sinking Creek^{IP}	shallow bedrock, losing stream
207.8 - 208.4	0.60	Down and cross slopes	47.3	Frederick gravely silt loam	Sinking Creek^{IP}	Pig Hole Cave System, including Echols Cave, sinkholes, losing stream
209.4 - 209.9	0.50	Down slope to Rt 700&Rt 604	42.3	Frederick gravely silt loam	Sinking Creek^{IP}	Tawneys and Smokehole caves, sinkholes, losing stream
211.4 - 212.4	1.0	Newport: Rt 700 to Rt 42	47.0	Frederick gravely silt loam	Greenbrier Branch^{I}	Sinkholes
213.6 - 214.8	1.2	Mountains - Rocky Outcrop	40.2	Frederick gravely silt loam - Carbo-Rock outcrop complex	Large spring	Canoe Cave, sinkholes, underground stream

Table derived from plus 7.5 MinsTopo Maps, and the Mountain Valley Pipeline Exploratory GIS Map.

Stream flow: E = ephemeral, I = intermittent, P = perennial (Sinking and losing streams appear intermittent or ephemeral.)

Source: MVP FEIS appendices K, N-2, F-4 1 and L

Groves seconds Kastning's observations about the naivety of MVP mitigation plans which suggests buried pipelines can avoid karst simply by-passing or spanning individual sinkholes and caves. The extent of karst-flow networks cannot be reliably detected or measured by surface feature and Electrical Resistivity (ER) cannot always provide adequate data to determine. connections to the aquifer. Only extensive dye-tracing can adequately map the general parameters of these systems.

Groves, like Kastning, is troubled by how poorly MVP engineers appear to understand karst and their alleged confidence that trenching will not adversely impact aquifers and downstream. With the important exceptions of locations with shallow unfractured bed rock and soils compacted by construction, karst systems are incredibly porous. Water fouled by spills or leaks can infiltrate essentially nearly everywhere. Blasting in shallow bedrock poses a threat of further fracturing, enhanced turbidity and altered flow patterns

Groves re-affirms Kastnings concerns about *synergistic effects* of karst valleys and steep mountains and other geo-hazards prominent to the region (perilous soil and rock types and ground shaking associated with an active seismic zone) and the enhanced likelihood of fouled water.

3. **Paul A. Rubin, MA (Geology)**

Mr. Rubin is an independent geologic and hydrologic consultant with thirty-five years of experience. His consulting firm, HydroQuest, assists groups in identifying issues and developing strategies designed to protect groundwater, surface water, community character, and wildlife habitat. Prior to that he was a hydrologists for the New York City Department of Environmental Protection (1993-2001), an instructor at the State University of New York - Ulster, Stone Ridge (2001-2004), a research scientists at Oak Ridge Reservation hazardous waste sites, where he was responsible for hydrogeologic evaluation of groundwater issues (1991-1993), and from 1983 to 1991 he worked for the New York State Attorney General's Office's Environmental Protection Bureau where he was responsible for the design, protocols, coordination, implementation, evaluation, characterization and remediation of many major water and soil contamination sites throughout New York State (e.g., Love Canal, Superfund sites). Mr. Rubin began his career at Stone & Webster Engineering Corp., Geotechnical Division in Boston, Massachusetts (1981-1983). He has over 50 technical publications and over 100 reports and affidavits, many for private clients, environmental groups, towns, and law firms.

Rubin Report 1: *Expert Report of Paul A. Rubin on behalf of Giles and Roanoke Counties, Virginia* (FERC Accession Nos. 20161222-5458 and 20161222-5459).

Rubin concurs with Dr. Kastning's assessment of the karst setting, its vulnerability and other geologic hazards as individually and collectively posing risk to pipeline integrity. Rubin cites numerous examples, documented by experts, of the risk of pipeline failure resulting from faulty engineering that alters the equilibrium of the landscape in and around sinkholes, trenching to contain pipelines, leaks resulting from material failure, subsidence, and earthquakes in karst settings similar to the proposed MVP route.

He too takes exception with MVP's "karst identification" work that merely plots surficial sinkhole, cave, swallet and spring locations. MVP, he observes, has not conducted the detailed assessments of subsurface hydrogeology, groundwater flow paths, and karst stream discharge locations to adequately identify the *interconnectivity* of above ground karst features with the karst plumbing network below ground and the sensitive and endangered species present within.

Rubin expresses bewilderment that, considering the environmental risk involved, so very little mitigation detail is provided in the Karst Mitigation Plan. The DEIS does refer to using a particular method to stabilize karst features by construction of "reverse-gradient aggregate fill". However, no engineering detail is provided, nor is there discussion as to how this method would prevent the continued loss of soil below ground into the bedrock and underlying conduits. As such, the development process of sinkhole formation is not taken into account. He concludes that MVP's "karst feature stabilization" measures are not likely to avoid or reduce natural subsidence within or proximal to sinkholes, especially in extensive karst terrain.

His conclusion: the environmental risks to cave and groundwater resources in project area karst terrains are high. He is not assured that the MVP Project can be routed through these well-karsted areas without significant and potentially catastrophic consequences.

Rubin Report 2*: Giles and Roanoke Counties' Supplemental Comments Regarding the Potential Impacts of Construction and Operation of the Mountain Valley Pipeline Project in Karst Terrain*. (FERC Accession Nos. 20170602-5147)

After MVP responded to his first report, as directed by FERC staff, Rubin provides a brief supplementary report, stating that MVP's comments do not alter his original findings and recommendations. He presents further published examples of pipeline failures associated with sinkhole collapse, subsidence and slumping of soils in steep terrain. Many of these failures were complicated by faulty construction and materials: corrosion, mechanical failure (such as over-pressure and weld failures), equipment failure (e.g., valves and flanges) and operational/human error. Rubin reasserts that MVP's optimism that the pipeline alignment and construction would avoid or mitigate all karst issues is unsubstantiated. It has not adequately or directly addressed the threats posed by the proposed pipeline in terms of likely, real-world consequences or presented scientific evidence to support its claims.

4. Dr. Pamela C. Dodds, Ph.D.

Dr. Dodds is a Licensed Professional Geologist and Hydrogeological Consultant (2000 – Present), and serves as an expert witness on hydrogeology before West Virginia government agencies. During the period 1997 to 1999 she was a Senior Geologist for the Virginia Department of Environmental Quality. From 1992 until 1997 she was a Senior Geologist and Project Manager for the Environmental Department at S&ME, Inc. (Blountville, TN), conducting geology and ground water investigations, and from 1985 to 1992, she served as the District Geologist for the Virginia Department of Transportation.

As a Consulting Hydrogeologist, Dr. Dodds has written several hydrogeological assessments of impacts to water resources that would result from the proposed Mountain Valley Pipeline construction. The reports were submitted to FERC by Indian Creek Watershed Association, Preserve Bent Mountain, and the Roanoke County Board of Supervisors. The following reports most pertinent to Virginia are listed in the FERC Docket No. CP16-10-000. Also see document 20161222-5459.

Dodds Report 1. *Hydrogeological Assessment of the Proposed Mountain Valley Pipeline Construction Impacts to Mill Creek, Bent Mountain Area, Roanoke, Virginia* (FERC Accession No. 20170622-5028).

This report takes issue with the MVP and FEIS conclusion that there is a minimal potential for adverse impacts on water for land owners and communities affected by the project. It finds that there would be significant adverse impacts to Mill

Creek and its tributaries. Cumulative adverse impacts will likely result from construction of a large diameter gas pipeline throughout the numerous watersheds of first order tributaries that feed Mill Creek.

The proposed MVP will traverse the Mill Creek watershed area (consisting of Mill Creek and at least 7 headwater areas and first order tributaries) on Bent Mountain, between MP 243 and 246. These waters flow into Bottom Creek, the South Fork of the Roanoke River and ultimately the Roanoke River. Thus, the construction across Bent Mountain has the potential of effecting the water quality and habitat quality of the watershed serving the entire Roanoke Valley.

Construction at higher elevations and on steep slopes that results in deforestation, ground cover removal and soil compaction from heavy machinery will make soils impervious to rain water and increase storm water run off and stream bank erosion. Where there is shallow bedrock, blasting will alter the rate and route of ground water flow. Streams are impaired when impervious surfaces are just 10 percent of a watershed. At 8 to 10 percent impervious cover streams double in size due to increased volume, leading to the loss of riparian buffers and habitat, and to accelerated erosion.

Accurate calculations of the rate of storm water discharge in first order tributary systems is critical for determining the likely impact of construction on downstream habitat and water quality. However, MVP's mitigation plans omit the Mill Creek headwaters in estimating the impact of storm water discharge. Using MVP's own tables, Dr. Dodds shows discharge from the omitted areas will likely be substantial, posing a significant threat to the Roanoke Valley watershed. Additionally, she specifies omissions (e.g. weak soils) and other limitations of MVP's erosion, sedimentation and storm water mitigation procedures which contributes to an underestimation of long term and permanent adverse impacts. The limitations of MVP's "best practices" for managing storm water runoff are also critiqued.

Dodds concludes: The findings of this report provide evidence that construction of the proposed MVP gas pipeline will result in adverse impacts on the environment within the Mill Creek watershed. The adverse impacts would be cumulative because of the expansive area of the proposed gas pipeline corridor, access roads, and additional work space within headwater areas, wetlands and steep areas with perched aquifers that provide groundwater to maintain seeps, springs, and wetlands. The MVP mitigation approach does not incorporate an understanding of the importance of headwater areas that supply surface and groundwater to the headwater streams and wetlands. Additionally, the MVP mitigation approach does not recognize the importance of headwater aquatic organisms as being the base of the food chain in the river continuum.

MVP's mitigation plan to purchase mitigation credits in areas outside of the actual watersheds for first order high gradient streams will not compensate for the cumulative damage to the specific watershed impacted or to the receiving water bodies downstream.

Dodds Report 2. *Objections to the Draft Record Of Decision for the Mountain Valley Project Land and Resource Management Plan Amendment for the Jefferson National Forest, Monroe County, West Virginia And Giles And Montgomery Counties, Virginia by Pamela C. Dodds, Ph.D., Licensed Professional Geologist* (FERC Accession No. 20170731-5067). The full report with references is Accession No. 20170807-5080.

In this report Dodds discusses the degradation to upland streams in the highlands of Monroe County West Virginia and Giles and Montgomery Counties Virginia that would be caused by the construction of the MVP. Deforestation, soil compaction and trench dewatering would negatively impact the flow and quality of water and stream habitat in these headwaters and subsequently downstream in surface and subsurface waters. Impacted creeks in Giles County are tributaries to the New River. Mill Creek in the Mount Tabor Areas is a tributary to the North Fork of the Roanoke River.

The loss of water flow and quality would deteriorate habitat in the headwaters and thus the ecological connectivity for the river continuum, diminishing the food chain for downstream aquatic organisms.

Even though Dodds report was written to address the Forest Service Plan amendment proposed in the Draft Record of Decision and specifically addresses the waters of Jefferson National Forest, the facts and logic apply to all headwaters crossed by the pipeline in this region.

Permitting such degradation would be inconsistent with the 36 CFR 219 planning rule §219.8(a)(2)(iv) to include plan components to "maintain and restore the ecological integrity of riparian areas in the plan area," and Code of Virginia, Title 62.1. Waters of the State, Ports and Harbors" under "§ 62.1-11.

Dodds provides a detailed discussion of how seismic activity and landslide potential on steep slopes in the highlands further increases the probability of water degradation. The impact is cumulative because numerous first order stream tributaries to higher order streams will increase sediment transport and stream bank erosion downstream. She recommends comprehensive calculations for storm water discharge that improve upon the MVP mitigation plans.

Unfortunately, neither the MVP FEIS or MVP reports adequately consider the consequences of degraded highland streams for downstream watersheds. MVP mitigation plans, on which the FEIS finding of *"no permanent harm"* is based, are found to be inadequate, based on erroneous assumptions, inaccurate information and calculations, and inconsistent with normally accepted best practices.

Site-Specific Submissions to FERC Supporting the Scientific Consensus

The research reports of the four experts are supplemented by scores of additional *site* investigations (many by other scientists) along the proposed route. Below is listed a small, selected sample of pertinent comments to FERC.

Subject: Karst, Aquifer, Ground Water, & Well affects, Waterbody Crossings

20151125-5156 Dr. Carl Zipper; Protest: Karst, Aquifer, Deforestation, etc

20151127-5115 Louisa Gay; Mount Tabor Sinkhole Plain

20151130-5432 Dr. Ricard Shingles; Protest: Karst, aquifer, slopes, soils, deforestation

20151207-0084 Harold Parsons; Geologist Red Sulphur PSD affects from Virginia Karst

20160112-5139 Roberta Johnson; Bent Mountain watershed, Bottom Creek

20160119-5095 Tim Ligon; Karst in the Mount Tabor Sinkhole Plain

20160411-5323 Thomas Gates; Roanoke County Administrator, concern for Spring Hollow Reservoir; steep slopes, soil erosion, waterbody crossings, wetland mitigation

20161116-5034 Robert Johnson; Retired VDEQ Environmental Engineer; Bent Mtn, Bottom Creek impacts to Tier III streams; wetlands on Poor & Bent Mtns.

20161123-5028 Smith Mountain Lake Association; surficial groundwater flow concerns

20161213-5108 New River Trout Unlimited; Waterbody crossings, sedimentation & toxins

20161214-5045 Mark Hileman; Catawba VA; karst and wells

20161219-5368 The Nature Conservancy; Poor Mtn Conservation easement to protect Bottom Creek Gorge Preserve (rare species) and Exceptional State Water (Tier III)

20161221-5087 EPA; Karst Stream Crossings, Ground & Drinking Water Protection,

20161221-5179 Preserve Craig; Erosion & Sedimentation issues

20161222-5487 Trout Unlimited; Waterbody crossings, sedimentation & steep slopes

20161223-5089 POWHR, Comment on the DEIS for the Mountain Valley Pipeline

20170127-5019 Dr. Carl Zipper; Karst (Kastning & Rubin), Watersheds, soils & slopes

20170302-5043 Dr. Carl Zipper; Slussers Chapel Cave and Mill Creek

20170426-5110 Robert Johnson; Retired VDEQ Environmental Engineer; 401 Certification

20170623-5031 Roberta Bondurant, Esquire; Watershed, springs and wells, steep slopes

20161222-5459 Dodds, Ph.D. Hydrogeological Assessment of Watershed Impacts Caused by Constructing the MVP Through Roanoke County

20170731-5096 Blue Ridge Land Conservancy; Ground and surface water, wetlands

20170801-5043 Wild Virginia; Water Quality Standards not ensured

20170807-5080 Dodds, Ph.D. on objections to JNF Draft Record of Decision for MVP pipeline in Monroe County, WV and Giles And Montgomery Counties, VA, including References

Subject Wetlands

20160510-5008 James Chandler; Watershed Strategies LLC Report on Wetlands Bent Mtn.

20170612-5028 James and Karen Scott R.A (Soil Scientist); Bent & Poor Mtn Wetlands

20170622-5015 James and Kathy Chandler; Bent & Poor Mtn Wetlands

Subject: TES, Roanoke logperch 20161220-5120 Dr. Steven Powers; Roanoke College; Evolution of stream fishes of SE, US

20170221-5333 Louisa Gay

20170317-5115 Louisa Gay

20170413-5160 Louisa Gay

20170630-5179 Louisa Gay

20170712-5097 Louisa Gay

20170801-5043 Wild Virginia

Critiques of FERC's Reliance on Unsound MVP Information (Geo-Hazards)

(Selected list, limited submissions to FERC up to 2017)

FERC Accession number and Summiteer ID:

20170110-5019(31890645): Dr. Carl Zipper

20170127-5019(31925440): Dr. Carl Zipper

20170221-5099(31977481): Indian Creek Water Association

20170221-5116(31977600): Preserve Craig and Preserve Monroe

20170406-5122(32082364): Dr. Carl Zipper

20170406-5068(32082012): Thomas Bouldin

20170426-5200(32130921: USFS

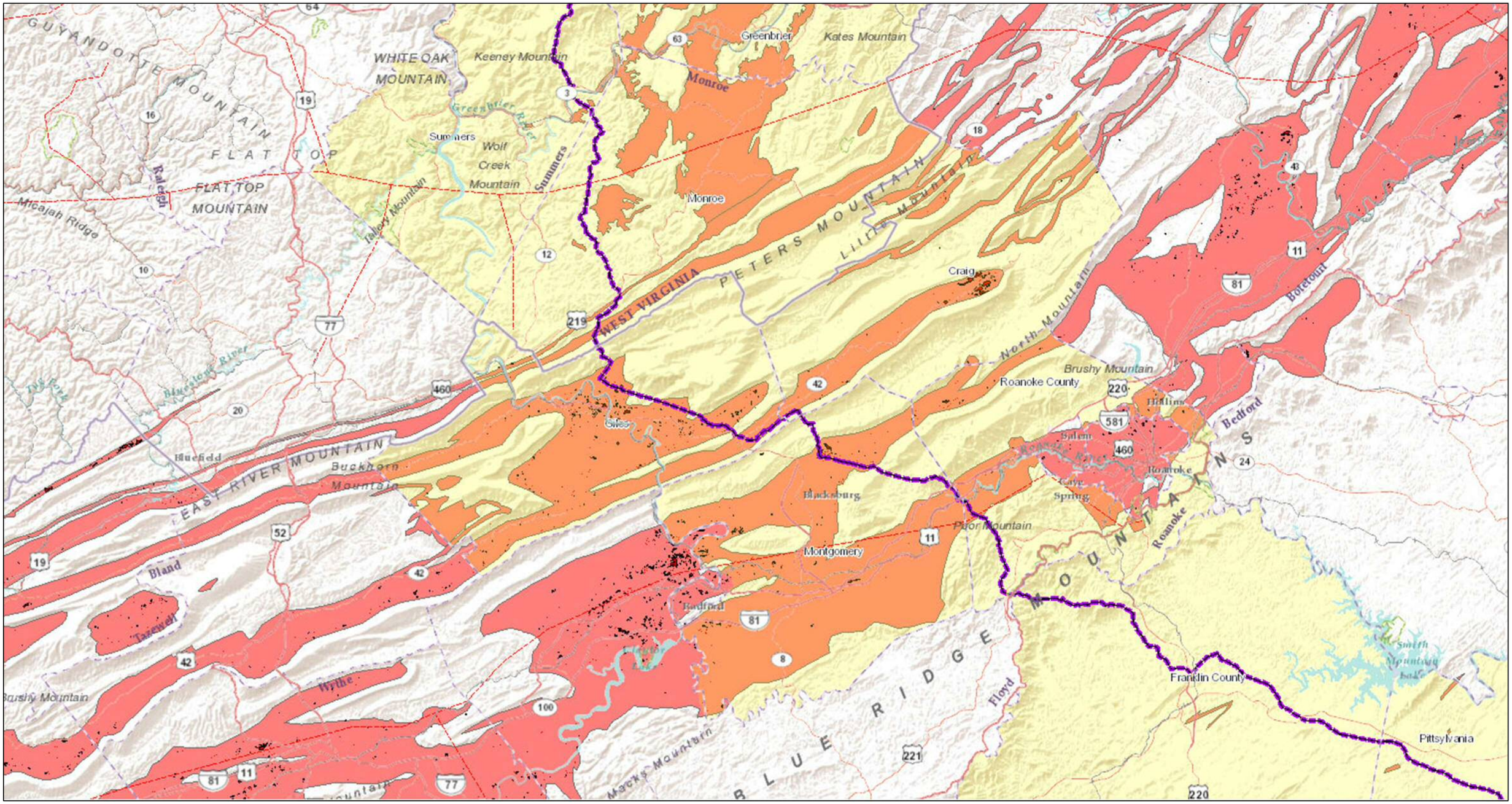
20170515-5039(32161025): USFS

20170622-5201(32228778): The Wilderness Society

20170713-5129(32267189): Robert K. Johnson, Retired VDEQ Senior Engineer

20170720-5143(32289092): Virginia Department of Conservation and Recreation
20170721-5055(32291349): VDGIF Raymond Fernald, Manager Environmental Programs
20170725-5023(32295931): Dr. Carl Zipper
20170728-5013(32301224): Roanoke Appalachian Trail Club (Diana Christopulos)
20170731-5096(32304720): Blue Ridge Land Conservancy (William Hackworth)
20170801-5043(32307855): Wild Virginia
20170801-5174(32309737): Tammy Belinsky, Esquire
20170801-5164(32309738): Thomas Adams
20170918-5180(32403982): Water and Power Law Filing for Giles and Roanoke Counties
20170918-5040(32402480): Sierra Club
20170919-5021(32404463): Dr. Pamela Dodds for Preserve Bent Mountain
20190919-5133(32405304) and 20190919-5133(32405303): Roanoke Appalachian Trail Club
20170920-5051(32406018): Dr. Carl Zipper
20171002-5076(32430554): Tammy Belinksy for Save Monroe
20171101-5205(32500838): Dr. Robert Jones
20171115-5155: Dr. Richard D. Shingles

Figure1. Valley and Ridge Province: Karst-Bedrock and Sinkholes



June 27, 2016

1:577,791

0 5 10 20 mi

0 10 20 40 km

MVP_125ft_buffer

MVP_Route_Most_Recent

Natural_Gas_Market_Hubs

Natural_Gas_Liquid_Pipelines

Affected Counties

Sinkholes from VDMR

Karst Bedrock

Karst in MVP Project Area

Sources: Esri, DeLorme, USGS, NPS
Sources: Esri, USGS, NOAA