UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

In the Matter of

MOUNTAIN VALLEY PIPELINE, LLC Docket Nos. CP16-10-000
EQUITRANS, LP

COMMENTS OF THE VIRGINIA CHAPTER OF THE SIERRA CLUB ON HAZARDS ASSOCIATED WITH PIPELINE CONSTRUCTION IN KARST

Appalachian Mountain Advocates hereby files the following comments on behalf of the Virginia Chapter of the Sierra Club. These comments constitute the response of Dr. Ernst Kastning to the critique performed by Mountain Valley Pipeline's consulting engineering firm Draper Aden Associates (Accession No. 20161222-5442) of Kastning's previously submitted report 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* (Accession No. 20160713-5029). In this response, Dr. Kastning maintains his expert opinion that construction of the Mountain Valley Pipeline through the extensive karst terrain of southern West Virginia and southwestern Virginia would create serious risks to both the pipeline and the environment that cannot be adequately mitigated through the use of best management practices or other engineering techniques. That opinion is supported by other leading karst experts who prepared reports for submission into the FERC docket for the Mountain Valley Pipeline, such as Western Kentucky University professor Chris Groves' report entitled *Karst Landscapes and Aquifers of the Central Appalachian Mountains and Implications for the Proposed Mountain Valley Pipeline* (Accession No. 20161223-5058) and the

expert report prepared for Giles and Roanoke Counties, Virginia by karst hydrogeology expert consultant Paul A. Rubin (Accession No. 20161222-5458).

Respectfully submitted,

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Supplemental Report by Dr. Ernst Kastning regarding Geologic Issues with the Proposed Mountain Valley Pipeline

15 May 2017

On July 3, 2016, the Sierra Club filed a report that I authored, 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* (20160713-5029 (31577964)). Based on my review of the administrative record, my education and experience, and related research, I made the following findings (excerpted from the July 2016 report):

1. The proposed corridor of the Mountain Valley Pipeline (MVP) passes through a significant area of karst as it crosses the mountainous Valley and Ridge Province (the Appalachian Fold Belt) in Summers and Monroe counties, West Virginia and Giles, Craig, Montgomery, and Roanoke counties in Virginia. Karst is a landscape that is formed by the dissolving of bedrock. Severe 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. 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.

2. Karst is a critical factor in the siting and management of a high-pressure gas pipeline such as the one proposed. However, other potential hazards such as land instability, steep slopes, weak soils, and potential seismicity are also highly significant in this region. When two or more of these elements act together, the resulting environmental threat from the pipeline is compounded and exacerbated.

   The Mountain Valley Pipeline application is deficient and inadequate because it fails to address significant environmental hazards that would be created by the pipeline if constructed as proposed. It fails to address geologic hazards that occur within areas in or near the proposed corridor and their potential impacts on the pipeline itself. Geologic hazards that are not adequately addressed by the application include:

   - *Groundwater Contamination*: Karst terrains are uniquely vulnerable to augmented groundwater contamination owing to the nature of the groundwater aquifers that form in such areas. Thousands of people living in these potentially impacted areas depend on groundwater to supply their homes. The risk of severe groundwater contamination is increased during construction and may occur should a pipeline rupture in this karst terrain.

   - *Vulnerability of Groundwater Recharge:* Allogenic recharge areas (where surface water from steep, upland mountain slopes enters karst aquifers at the base of those slopes) are especially vulnerable to disruption owing to hydrologic alterations that would be caused by the construction of the pipeline.

- *Enhanced Potentials for Surface Collapse:* Construction of the pipeline in mountainous terrain would likely alter hydrologic flows by channelizing subsurface waters. Should the pipeline trench intersect with below-ground karst features, results would include enhanced potential for collapse in the karst.

- *Accelerated Erosion:* Pipeline construction on steep slopes will remove native vegetation, cut into the slopes, alter soils via compaction, remove surface soil over the pipeline trench and access roads, and will thus create potential for accelerated erosion.

- *Slope Instability:* Unconsolidated geologic material present throughout the area on steep slopes should not be considered as stable. Movement of such materials, especially if stimulated by excess rainfall or by seismic activity, can be expected to threaten the integrity of the proposed pipeline. Over half of the preferred route from Monroe to Roanoke counties has slopes that are 20 percent grade or greater. Almost 20 percent of the slopes along this route are 35 percent grade or greater.

- *Weak Soils:* Even if in the absence of such extreme weather or seismic events, soils on steep slopes can be subject to the slow and persistent downslope movement known as "soil creep". This would threaten the integrity of underground structures such as pipelines, especially where those structures run parallel to a slope. Soils on steep slopes should not be considered as stable. Several soil groups are high in plasticity and shrink-swell characteristic, resulting in poor drainage and low bearing strength that can induce downslope movement.

- *Seismic Risks:* The proposed route of the pipeline passes through an area with a history of severe seismic activity and enhanced seismic risk as determined by recent geophysical studies. A major seismic event would clearly threaten the integrity of the pipeline. However, even moderate seismic activity, in combination with other conditions, such as karst, severe slopes, and weak soils, pose elevated risks. By extension, in karst areas, the quality of groundwater may be threatened as well.

The above hazards occur as a direct result of the terrain typical to the region being traversed by the proposed pipeline corridor. Multiple geologic hazards are inherent to karst in mountainous regions such as that of concern here. There are numerous locations in this region where multiple hazards coexist and there is a high potential that they may interact synergistically. Therefore, even the best engineering practices will likely fail to mitigate all threats. For these reasons, large karst systems must be avoided during pipeline construction.

3. The overriding conclusion of my report is that the karst and associated hazards in this region 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 the region as a 'no-build' zone for the project.

In December 2016, Mountain Valley Pipeline's consulting engineering firm, Draper Aden Associates responded to my report (DAA Project Number: B14188B-01, Submittal 20161222-5442 to FERC). The purposes of this supplemental report are to (1) confirm that I stand by the analysis and findings in my July 2016 report, and (2) to reply to the statements in Draper Aden's response

that I believe are false or misleading. I do not respond point-by-point to Draper Aden's response (20161222-5442). Instead I focus on those statements that I believe are important to the evaluation of the risks posed by the proposed construction of the MVP pipeline through the Valley and Ridge Province.

The body of this supplemental report is organized into three main sections. The first section summarizes my expertise with respect to geological processes and potential environmental hazards germane to the proposed pipeline. I have 50-plus years of experience in dedicated karst research, including the last 31 years in the Appalachian fold belt and Valley and Ridge Province. Moreover, the extensive body of literature on karst supports my opinions.

The second section states my main conclusion that the proposed 42-inch, high-pressured natural-gas pipeline is environmentally hazardous and poses a significant risk to the natural setting and to the citizens who live within or near the proposed route. In my opinion, the pipeline should not be constructed along the preferred route or its vicinity because it would cross a significant mountain range, extensive and sensitive areas of karst, steep and unstable slopes, and a documented seismic zone. As I emphatically stated in my July 2016 report, specific hazards are compounded along much of the proposed pipeline route. MVP has failed to adequately address these compound effects. Building such a very large conduit through the Valley and Ridge Province is without precedent and untested in this kind of foreboding terrain.

The third section states my recommendation that decisionmakers should err both on the side of human health and safety and environmental integrity. A hazardous event may easily cause large-scale irreversible damage that would be at least an order of magnitude greater than already experienced by numerous well-documented failures of smaller natural-gas pipelines in many regions of the country. Many of those have occurred in less severe natural settings. To decide on the side of construction, replete with questionable mitigation methods, could well result in a catastrophic failure and/or concomitant contamination of groundwater. The prudent and common-sense decision is to heed the many identified threats and forgo construction.

I. Draper Aden's comments regarding my qualifications are unfounded.

A. My qualifications are well-documented.

I am a Professor of Geology and a Professional Geological Consultant, with over 40 years of experience in these capacities. Despite this, Draper Aden Associates has insinuated that I do not possess the credentials required for assessment of the technical aspects of the proposed MVP pipeline. I summarize my qualifications below. My curriculum vitae is also attached.

I have an undergraduate degree in Electrical Engineering from Rensselaer Polytechnic Institute. Requirements for that degree are standard for engineering: four semesters of physics, two of chemistry, six of calculus, two of solid mechanics (statics and dynamics), and courses in fluid mechanics, strength of materials, and thermodynamics. I am sufficiently trained in engineering to understand and practice the components of engineering geology or geological engineering. My Master's and doctorate degrees included advanced courses in hydrogeology, geomorphology, structural geology, **engineering geology**, petrology, field methods, spatial analysis, environmental geology, remote sensing, geochemistry, and economic geology.

My Master's thesis and PhD dissertation were extensive and dedicated studies in karst. My thesis

focused on upstate New York (the northern end of the Appalachian fold belt), and my dissertation focused on central Texas (one of the most extensive karst areas in the United States).

While on the faculties of Murray State University (Murray, Kentucky), the University of Connecticut (Storrs, Connecticut), and Radford University (Radford, Virginia) I taught undergraduate and graduate courses in hydrogeology, field problems in hydrogeology, geomorphology, **engineering geology**, structural geology, environmental geology, geochemistry, and karst processes. I have supervised and served on graduate committees for several graduate students, several of whom specifically studied karst.

I have studied caves and karst academically and environmentally for over 50 years. As such, karst has been the primary focus of my research. In the process, I have come to personally know most of the established experts in karst in the United States, and many abroad. I am very familiar with the extensive body of karst literature, and have authored over 100 technical papers on karst (not merely descriptive cave reports), as cited in my July 2016 report. I have served as editor for many peer-reviewed karst papers and various geological and hydrological books. I also have presented my findings at many technical meetings. Over the course of my academic and consulting work, I have been sought after by the media for my expertise on karst and related environmental issues.

Over the last 30-plus years, as a consultant, I have worked on over 35 real-world projects involving karst problems – e.g., quarries, real-estate development, governmental agency projects, power lines, natural-gas pipelines, parklands, and educational institutions. In each case, I have authored a report for the client and/or an agency, providing a written report of my findings. I have worked on both sides of issues, for developers and citizen-action opponent groups alike. I have both supported and rejected proposed development plans, depending solely on the merits of the given project.

B. <u>My July 2016 report has undergone some informal peer review</u>.

Two of the most respected karst researchers in North America and internationally, Dr. Arthur N. Palmer of New York and Dr. Derek C. Ford of Ontario, supported the analysis and findings of my July 2016 report. They also acknowledged my expertise and credentials in karst work. I did not solicit their opinions. They each responded to an independent query from Duncan Adams of the *Roanoke Times* for an article he wrote (published on July 7, 2016) regarding my first report. I was not aware that he was following up on my reputation in the scientific community until I read his article in the newspaper. There is no greater confirmation of my credentials in karst than to receive endorsements from these two eminent scientists.

Paul Rubin, another highly respected and experienced karst researcher and consultant, has also authored a report on the MVP pipeline that was submitted to FERC by Giles County (20161222-5458 (31856158)). In this filing, he expresses similar concern regarding the compounding geologic risks associated with building in this area. He has added additional concerns about the pipeline based on his personal expertise. Although I have known Mr. Rubin personally and professionally for many years owing to our shared interest and scholarship in karst, he and I have not communicated on the MVP project. It is important to note that both of us have independently concluded that construction of the MVP pipeline as proposed would have potentially serious and grave consequences. This mutual corroboration is noteworthy.

C. MVP has not disclosed the credentials of its karst experts or the specific scientific basis for their opinions.

I described my credentials in my July 2016 Report. I have summarized them again above, and am once more attaching my curriculum vitae. By contrast, MVP has not disclosed the credentials of the Draper Aden employees who are being offered as experts. Aside from general statements about cumulative years of experience by the "karst specialist team," there is no concrete information about the individual specialists' education, training, or professional experience. This is inconsistent with accepted practice in the scientific community whereby experts furnish their credentials during peer review so others can evaluate the weight to be given to an opinion.

Moreover, the Draper Aden response does not cite any specific scientific publications as the basis for the statements made in the report. Again, this is inconsistent with accepted practice in the scientific community which requires disclosure of sources being relied upon as the basis for a professional opinion so others can independently verify the source, and evaluate the credence to place in an opinion.

II. There are Significant Impacts Related to Construction in Karst that Still Have Not Been Addressed.

There are many points in the MVP application to FERC and the Draper Aden Associates Report that can and should be contested. I and others have already done so. These submittals are part of the record in the FERC docket. I respond to four main points in Draper Aden's rebuttal that I believe are critical to an accurate understanding of the potential geologic and hydrogeologic impacts of the MVP project.

A. There is inadequate information to show that proposed mitigation will be effective.

Draper Aden uses the words 'mitigate' and 'mitigation' 11 times in the 19 pages of their response. Draper Aden and MVP too readily promise mitigation without detailed explanation and sound evidence of efficacy when it comes to the many karst (and other) issues that they have identified along the route. Such facile references to mitigation exemplify an all but too common engineering mindset, which is that any hindrance or construction challenge can be mitigated. This mindset reduces mitigation to a "band-aid" solution. It ignores the fact that the fix may only be temporary, that consequential damage to the karst environment may still occur, or that, with compound threats, an effort to patch one problem may inadvertently create another.

MVP, the U.S. Forest Service, the Virginia Departments of Environmental Quality and Conservation and Recreation, and others have identified a significantly large number of potential karstic problem sites in their submittals to the FERC docket. MVP acknowledges that there are many identified sites that would have to be mitigated in some way or other. In my opinion, MVP and regulatory decisionmakers need to address this important question: "If relentless and widespread mitigation (both during construction and in future operation of the pipeline) is required, should the pipeline be built as proposed in the first place?" I stand by my previous statement that the proposed pipeline should not be built as proposed.

B. Karst is not Localized to Small, Discrete Features.

Draper Aden's response suggests that any karst features encountered along the proposed route are merely isolated and not interrelated. It bears repeating that in the subsurface a karst system is typically more extensive than a smattering of surficial features (sinkholes, swallets, springs, etc.) might suggest. Karst in the New River Valley is well integrated into efficient groundwater flow systems that extend well beyond a single surficial feature. Successful, positive dye traces in the New River Valley substantiate this. Dye tracing is the only sure way to delineate the extent and paths of flow in an anisotropic, inhomogeneous karst aquifer. Mitigating a single sinkhole would be analogous to removing a tumor from a person when cancer has already metastasized throughout the body.

Numerous field investigations and other studies have substantiated that most areas of karst are far more extensive than surface reconnaissance or 'desk-top' reviews would suggest. The extensive scientific literature on karst provides undeniable documentation of this fact, including countless case histories. Even a few geophysical efforts, such as electrical-resistivity, ground-penetrating-radar, or exploratory boreholes (as advanced in the Draper Aden reports) cannot adequately assess the true scope of karst in the subsurface. Because karst aquifers are highly anisotropic and inhomogeneous, they are very unlike other aquifers, such as sand and gravel. As proven in many case studies and in the vast karst literature, so-called "standard" techniques, such as bore-hole analysis, and pump tests do not yield meaningful results in karst.

C. Pipelines Can Impact Karst and Hydrogeology even if Placed Near the Surface Zone.

Draper Aden's response asserts that groundwater flow in the karst will not be affected by the proposed pipeline that is limited to emplacement within 10 feet of the surface. There assumption is that flow in the karst aquifer is much deeper and thus out of range of impact. In places, the pipeline may significantly impact groundwater flow in the shallow subsurface, where excavation would occur in bedrock and within the environmentally sensitive epikarst zone. However, more importantly, any foreign substances produced during construction and operation of the pipeline would be efficiently transmitted to lower depths and phreatic zone of extensive karst aquifers. A pipeline of this design may or may not significantly change patterns of flow in the deep subsurface. However, this is primarily a contaminant issue

Water enters the surface within an area of karst, whether it enters discretely as a sinking stream into a sinkhole or swallet, or whether it diffusely percolates into the ground over a wide area and then downward into underlying bedrock factures, below the soil or regolith. Water in the shallow zone migrates into the deeper zone under the influence of gravity.

Any disturbance in the zone of infiltration at the surface will be manifested within the downward avenues in the vadose zone as water makes its way to the deeper flow system. The concept is simple. We all know that rain soaks into the ground and contributes to groundwater deeper in an aquifer. It should be no surprise that this also happens in a fractured karstified bedrock medium. So, to say that the pipeline is well above the water table (including existing streams in caves) and therefore will not impact the deeper water defies reason. It would be akin to claiming that your water well will always yield water, even if it never rains again.

D. Hazards Do Not Occur as Isolated Situations.

The hazards that I described in my July 2016 report are compounded in the steep terrain of the Valley and Ridge Province, especially in the presence of karst. Earthquakes (even low magnitude ones, like the 2.8 magnitude tremblor that occurred in Giles County on May 12, 2017) could trigger landslides and rockfalls on metastable slopes. Steep slopes underlain by poorly resistant soil and regolith abound in the mountainous terrain of the New River Valley region. Mass movements, whether induced by an earthquake, a large precipitation event, or by other means, may be large enough to damage and compromise a pipeline. Rupture of a large high-pressure natural-gas pipeline may easily result in a disastrous explosive conflagration. Many explosions associated with ruptured pipelines have been documented in the news over the years, including some significant occurrences in the last few years. In some cases, collateral damage has been major.

III. Recommendations

In summary of the foregoing, I reiterate the conclusions and recommendations from my July 2016 report as follows:

1. Karst is one of the most environmentally sensitive geologic landscapes on Earth. It is a major underlying component in the region of this report. Mountain Valley Pipeline and its consultants have literally barely scratched the surface in adequately assessing the three-dimensional attributes of karst and identifying the hazards that it imposes on construction and safe maintenance of the pipeline. Merely mapping sinkholes that appear on topographic maps and aerial imagery not only misses subtle karst features on the surface, but totally ignores the complex, well-integrated, efficient networks of groundwater flow through extensive karst aquifers prominent throughout this region. Detailed inventories of all sinkholes, caves, recharge areas, and springs, along with systematic dye-tracing, are necessary to design a route through a veritable gauntlet of such features. Based on lengthy experience in studying this region and professional familiarity with karst processes in general, I am confident that a safe and environmentally sound route for a pipeline of this magnitude cannot be identified, engineered, constructed, or maintained through the karst of the rugged Valley and Ridge Province.

2. I strongly suggest that FERC, as part of due diligence, closely examine the environmental problems that have occurred shortly after the recent construction of the Columbia Gas of Virginia (CGV) pipeline on Peters Mountain servicing the Celanese plant near Narrows, Virginia. This example, existing in the very setting of the proposed MVP route, serves as an omen. The CGV pipeline is a 10-inch-in-diameter pipe. The proposed MVP 42-inch pipe is 4.2 times larger in diameter and 17.6 times the cross-sectional area than a 10-inch pipe. In turn, the amount of construction and movement of material during trenching would be much greater, adding to the enormity of erosion, groundwater disruption, and failure of slopes. More ominously, if the integrity of this large pipe were to be compromised, the resulting catastrophic events would be at least on order of magnitude greater than with a 10-inch pipe. These are reasons enough to seriously weigh the potential consequences of constructing the MVP pipeline through the hazardous terrain of the Valley and Ridge Province.

Before giving any credence to the Draper Aden Associates Report of December 2016, it is necessary to identify the individuals who comprise the Karst Specialist Team, and most importantly, to ascertain the depth of their experience and expertise in detail. This includes scrutiny of citable professional contributions (published papers and reports) and any unpublished work specifically related to problems in karst.

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GEOSCIENTIST….HYDROGEOLOGIST….ENGINEER, HISTORIAN….FREELANCE WRITER

Resource Management …. Education and Interpretation …. Natural and Human History

Summary of Qualifications

Ph. D. and M. S. Degrees in Geology with extensive professional experience as a Scientist and Educator in resource management including environmental problems associated with land use and hydrogeological problems associated with management of fragile ecosystems both above and below ground. Demonstrated ability to lead cross-functional teams, to coordinate and manage complex problems. Designed and implemented policies and procedures with respect to applied geosciences, engineering geology, and hydrogeology. Outreach education and interpretation regarding geologic, environmental, and historic resources. Includes over forty-seven years of experience with karst processes. Retired from university teaching.

Expertise and ***Knowledge***:

- *Project Leadership*
- *Administration & Planning*
- *Program Development*
- *Needs Assessment/Evaluation*
- *Alliances/Partnerships*
- *Performance Analysis*
- *Regulatory Issues/Compliance*
- *Risk Assessment/Evaluation*
- *Instructor/Facilitator*
- *Data Collection/Analysis*
- *Presentations*
- *Report Writing*
- *Community Relations*
- *Problem Solver*
- *Computer Proficient*

Selected Accomplishments

Produced high-quality geotechnical and hydrogeologic studies for a wide range of clients including engineering/environmental consulting firms, governmental organizations (local, state, and federal), and developers. Have authored over 40 technical consulting reports and cartographic products. Recognized expert in my field, providing input to governmental agencies, military bases, planning committees, civic organizations, citizen-action groups, and educational institutions. *

Managed and ***advised*** projects, including the geologic mapping program of the New Hampshire Geological Survey, projects of geotechnical consulting companies, and graduate-thesis research of a number of graduate students. These have included grant and proposal writing, budget management, and public outreach and education. *

Regularly presented and ***submitted*** results of research and geotechnical findings at professional and technical meetings, symposia, public hearings, and as an expert witness in courts of law. Have authored approximately 15 monographs, 80 articles and geologic maps, and 60 abstracts in the geologic literature. Have led over 30 field trips. Designed and scripted high-profile, museum-quality displays and exhibits. Accomplished cartographer, photographer, editor, and media spokesperson. *

* Detailed supportive information available on request.

Professional Experience

NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICE, Concord, NH 2007-2011
Manager of Geologic Mapping –New Hampshire Geological Survey
Water Consevationist – Drinking Water and Groundwater Bureau

- Managed bedrock and surficial geologic mapping (1:24,000-scale-quadrangles) under the National Cooperative Geologic Mapping Program (StateMap) of the U.S. Geological Survey.
- Supervised 4 to 5 contract geologists as well as personally mapping surficial geology.
- Provided for GIS compilation and assembly of maps for on-demand availability.
- Worked with various federal and state agencies as well as with local governments.
- Gave presentations at professional meetings and leading geological field trips including public outreach and education programs.
- Involved in grant proposal writing, budgeting, financial operations, and personnel allocation.

ENVIRONMENTAL ENGINEERING, INC., Blacksburg, VA 2007
Consulting Engineer.

- Conducted various geophysical investigations.
- Provided for remediation of ground-water contamination, in cooperation with the Virginia Department of Environmental Quality.

RADFORD UNIVERSITY, Radford, VA 1985-2006
Professor/Associate Professor – Department of Geology

- Taught Geomorphology, Hydrogeology, Advanced Groundwater Hydrogeology (graduate course), Environmental Geology (beginning and intermediate), Physical Geology, Historical Geology, and occasionally special topics (e.g. Karst Geology).
- Advised graduate students, 1996-2006 (Senior advisor for two completed M.S. degrees).
- Instructor, Elderhostel courses, Department of Continuing Education.
- University service: Departmental, college, and university-wide committees.
- Highly active in research, publishing, outreach, and consulting.

UNIVERSITY OF CONNECTICUT, Storrs, CT 1981-1985
Assistant Professor/Instructor – Department of Geology and Geophysics

- Taught Hydrogeology, Engineering Geology, Advanced Hydrogeology, Field Problems in Hydrogeology, Geomorphology, and introductory and seminar courses.
- Advised graduate students (Senior advisor for five completed M.S. degrees).
- Served on various departmental, college, and university-wide committees.
- Highly active in research, publishing, outreach, and consulting.

Previous positions included Assistant Professor at Murray State University (KY), Geologist, Environmental Geologist, Geophysicist, Hydrogeologist, Research Scientist, and Analytical Engineer at organizations including the University of Texas, Radian Corporation, Texaco, Inc., and Pratt and Whitney Aircraft

Education & Certification

Doctor of Philosophy in Geology, The University of Texas at Austin, Austin, Texas, 1983
Master of Science in Geology, The University of Connecticut at Storrs, Storrs, Connecticut, 1975
Bachelor of Electrical Engineering, Rensselaer Polytechnic Institute, Troy, New York, 1966

Certified Professional Geologist (Commonwealth of Virginia) – Active

CERTIFICATE OF SERVICE

I hereby certify that on May 24, 2017, I caused the foregoing document to be served by electronic mail upon each person designated on the official service list compiled by the Secretary in this proceeding.

/s/ Benjamin A. Luckett

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