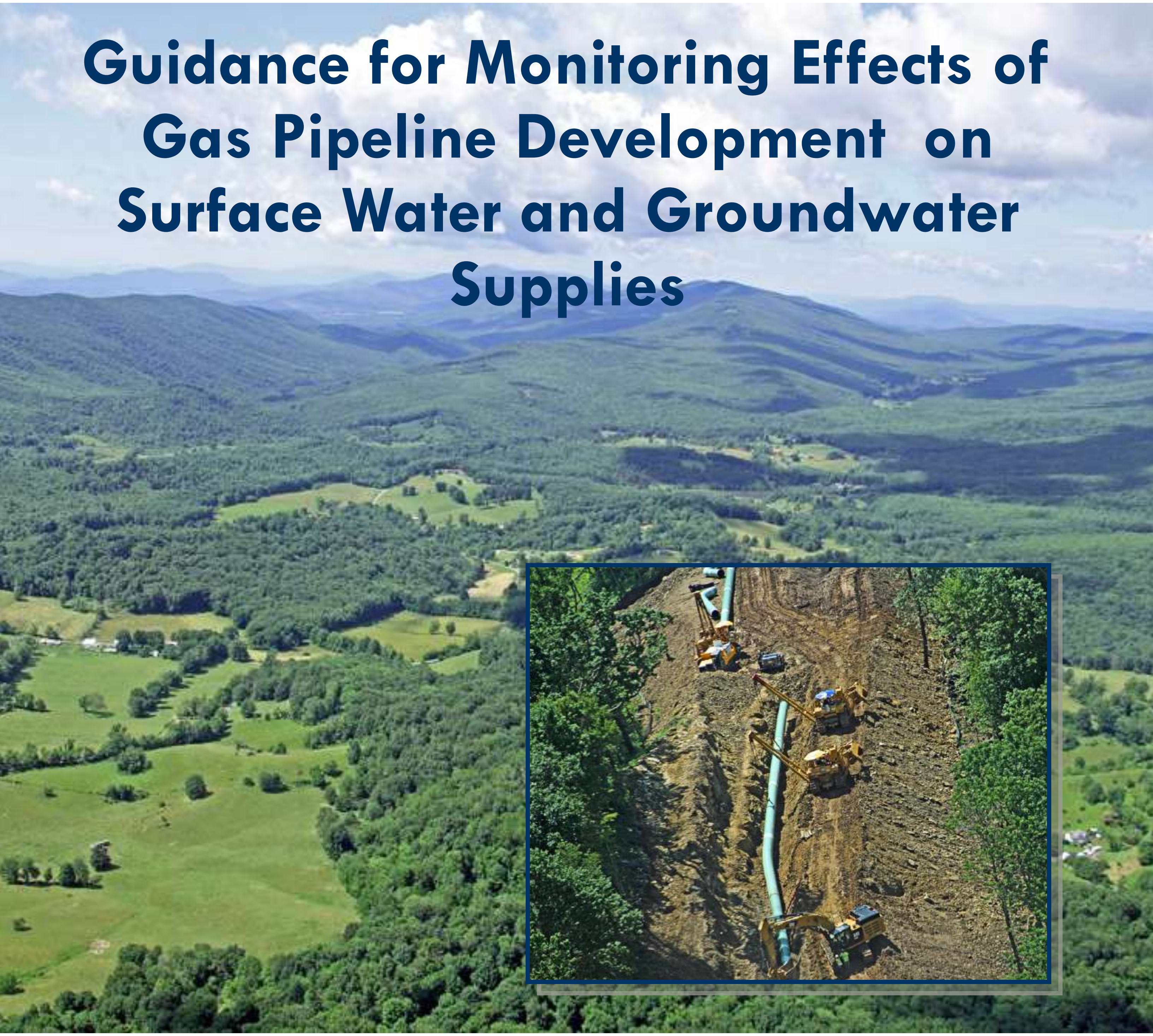
Guidance for Monitoring Effects of Gas Pipeline Development on Surface Water and Groundwater Supplies



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Downstream Strategies

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Main photo: The Burnsville Cove Significant Karst Area in Virginia's Bath and Highland Counties. The proposed ACP would cross karst recharge areas in the Burnsville Cove area. **Inset photo:** Pipeline construction on the Stonewall Gathering Pipeline, a 36-inch pipeline in central West Virginia in an area that would be crossed by the larger Atlantic Coast and Mountain Valley Pipelines. **Source for both photos**: Pipeline Air Force.

Sponsors

Organizational sponsors include: Allegheny-Blue Ridge Alliance, Dominion Pipeline Monitoring Coalition, Cowpasture River Preservation Association, Friends of Middle River, Friends of Nelson, Greenbrier River Watershed Association, Highlanders for Responsible Development, Virginia Organizing, West Virginia Highlands Conservancy, and West Virginia Rivers Coalition. Support was also provided by individual contributors.

ABOUT DOWNSTREAM STRATEGIES

Downstream Strategies (DS) is a West Virginia-based consulting firm with offices in Morgantown and Alderson. Since 1997, DS has provided environmental services combining sound interdisciplinary skills with a core belief in the importance of protecting the environment and linking economic development with natural resource stewardship.

Our projects fit within one or more of our program areas—water, land, and energy—and most projects also utilize one or more of our tools, which include geographic information systems, monitoring and remediation, and stakeholder involvement and participation. Our primary service area includes West Virginia and Appalachia. DS has considerable background in environmental science and policy, environmental site assessments, geographic information systems, permitting, field monitoring, community and stakeholder facilitation, watershed planning, and other areas.

DS is experienced at conducting both water sampling and biological sampling. We frequently perform sampling of the air, soil, and water in support a wide range of environmental projects including underground storage tank corrective actions, contaminated site characterization, stream monitoring, drinking water monitoring, delineation of microbial impacts, and microbial remediation.

1. INTRODUCTION

Following the recent spike in natural gas development in the Appalachian region, pipeline plans are being developed to move gas out of the region and into national and international markets. Several dozen projects are in various stages of development across the region. Two major projects are currently working through the regulatory process in West Virginia and Virginia: the Mountain Valley Pipeline (MVP) and the Atlantic Coast Pipeline (ACP).

While pipeline developers tout the economic benefits, many are concerned about the potential environmental and human health impacts of these projects. Concerns are diverse and include surface water and groundwater impairment, habitat fragmentation, forest degradation, and private property rights. This report will focus on the potential impact on the quality and quantity of water supplies along the pipeline routes.

1.1 Intended audience and purpose

This report serves as an informational guide to landowners and water providers about the potential impacts of pipeline development on water supplies. **It provides information concerning:**

- **Risks, potential impacts, and other water supply issues related to pipeline development;**
- **Collection of the data that will be needed to hold pipeline developers responsible for harm to water supplies;**
- **Methods for establishing baseline information on water quantity and quality and for long-term monitoring to detect change; and**
- **Laboratories and consultants that can conduct monitoring and analysis.**

For landowners, this guide describes a tiered approach to water supply monitoring that incorporates collection of defensible data by water resource professionals and landowner collection of screening or early-detection data.

For water providers, a primary benefit of this guide is to document likely contaminants and the potential impacts to source water from pipeline development that may affect their treatment processes or finished (post-treatment) drinking water distributed to customers.

Although some of the information in this report is specific to the MVP and ACP pipelines, the guidelines for monitoring water resources is applicable to any landowners and water providers who may be impacted by pipeline development.

1.2 Development of Atlantic Coast and Mountain Valley Pipelines

If approved, the MVP would be constructed and owned by Mountain Valley Pipeline, which is a conglomeration of EQT Midstream Partners, NextEra US Gas Assets, Con Edison Gas Midstream, WGL Midstream, Vega Midstream MVP, and RGC Midstream. The MVP would begin in Wetzel County, West Virginia, run south through Monroe County to the Virginia border, and then head southeast into Giles County, Virginia. It would connect with the Transco Pipeline in Pittsylvania County, Virginia.

The ACP is being developed by Dominion Resources, Duke Energy, Piedmont Natural Gas, and AGL Resources. If approved, it would be supplied by another proposed Dominion gas pipeline project, the Supply Header Project, which would traverse through Harrison, Doddridge, Tyler, and Wetzel counties in West Virginia. The ACP will then begin on the border of Harrison and Lewis counties in West Virginia, and then run southeast through Pocahontas County and into Highland County, Virginia. It will continue to the east and southeast through Virginia, connect with the Transco Pipeline in Buckingham

County, and continue to the North Carolina border before heading southwest and ending in Robeson County, North Carolina. Plans also include a spur line, which would extend east from the Virginia-North Carolina border to Portsmouth, Virginia.

Both proposed routes cross steep, mountainous landscapes with highly erodible soils and numerous rivers and small headwaters streams. Further, the projected pipeline routes traverse significant areas characterized by a karst geology. The current proposed routes are depicted in **Figure 1**.

Contingent upon completion of environmental reviews and receipt of required permits and approvals, both pipelines are scheduled to be under construction in 2017 and to be operational by late 2018.

2. POTENTIAL IMPACTS OF PIPELINE DEVELOPMENT ON WATER RESOURCES

Any large-scale construction project or development will have some environmental impacts, and pipelines are no exception. The MVP and ACP pipelines will be buried seven to ten feet below the surface, removing vegetation, soil, and bedrock along the path. The construction right of way will be 125-feet wide, and an extensive network of access roads and staging areas will be required. This disturbance to the surface has implication for both surface water and groundwater resources.

Environmental risks associated with pipeline construction that may have direct impacts on water resources include the following:

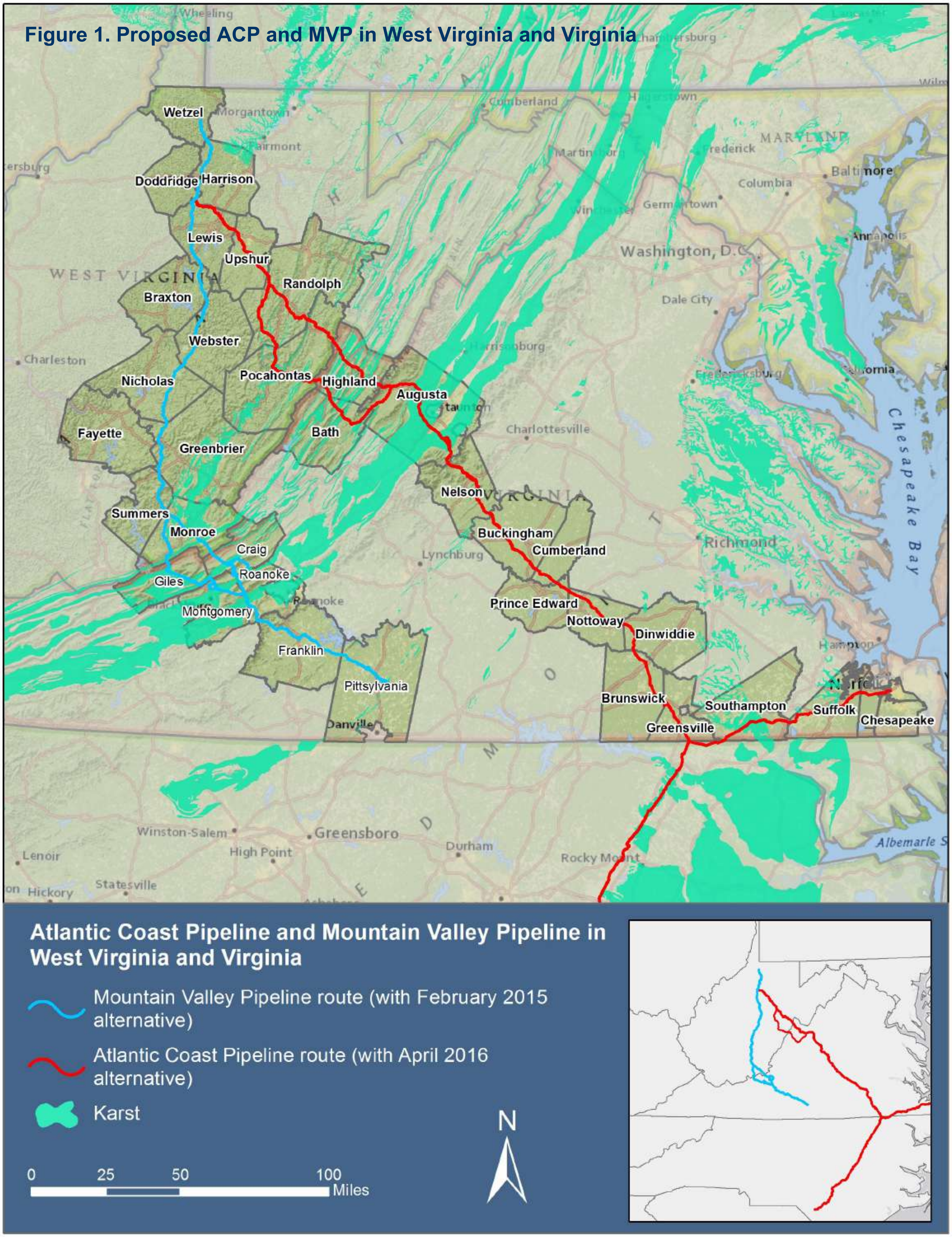
- Soils can be excavated or eroded, disturbed and compacted, or contaminated, which can impact water quality or flow patterns.
- Geology and topography can be altered, leading to landslides and increased sedimentation.
- Water quality and quantity can be impacted by sedimentation from erosion and excavation.
- Herbicides used to manage vegetation growth on the pipeline right-of-way may contaminate water resources.
- Fish and macroinvertebrate habitat quality may be diminished by removal of vegetation, disturbance of substrate, grading of the channel, and placement of structures.
- Blasting and grading could alter surface and groundwater flow due to an increase in fractures.
- Exposed geology could erode and leach acid or metals. (Williams, 2012).

These alterations can lead to increased turbidity and total dissolved solids in both surface and groundwater resources.

Alterations caused by pipeline construction can lead to increased turbidity and total dissolved solids, as well as changes in flow patterns, in both surface and groundwater resources.

Another concern is the potential for spills—of fuel or other petrochemicals from the machinery used to construct the pipeline—which could make their way into surface water or groundwater.

Figure 1. Proposed ACP and MVP in West Virginia and Virginia



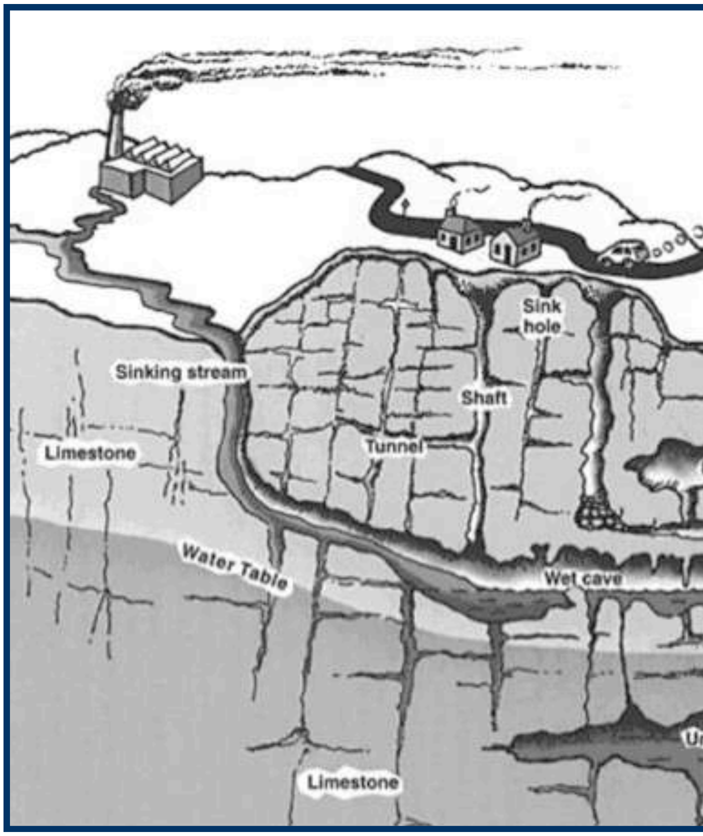
Data sources: ACP route: GIS data developed from documents provided to the United States Forest Service by Dominion in September 2015 and developed by Dominion Pipeline Monitoring Coalition from maps provided by Dominion in April 2016. MVP route: EQT/Equitrans MVP Project Shapefiles Proposed Route October 2015 and Alternate Route February 2015.

2.1 Karst topography presents special concerns for water quality protection

Karst-related potential impacts are of special concern through karst areas in eastern West Virginia and western Virginia, as shown in **Figure 1**. Karst topography is created by solution of karst geology. Karst geology is made of limestone or dolomite bedrock, which is highly soluble. The topography and geology in karst areas can form depressions, caverns, and channels (**Figure 2**) as water dissolves these rocks. These conduits can allow significant and rapid water flow, sometimes over large distances and in directions that do not follow surface topography.

However, even when surface features characteristic of karst topography are not found, seepage into the very shallow upper boundary of the karst zone may also provide for rapid channeling of pollutants into groundwater and springs or may store water and pollutants for later, sudden discharges during wet weather periods. **Figure 2** illustrates the complexity of the relationship between surface water and groundwater in karst systems.

Figure 2. Karst system

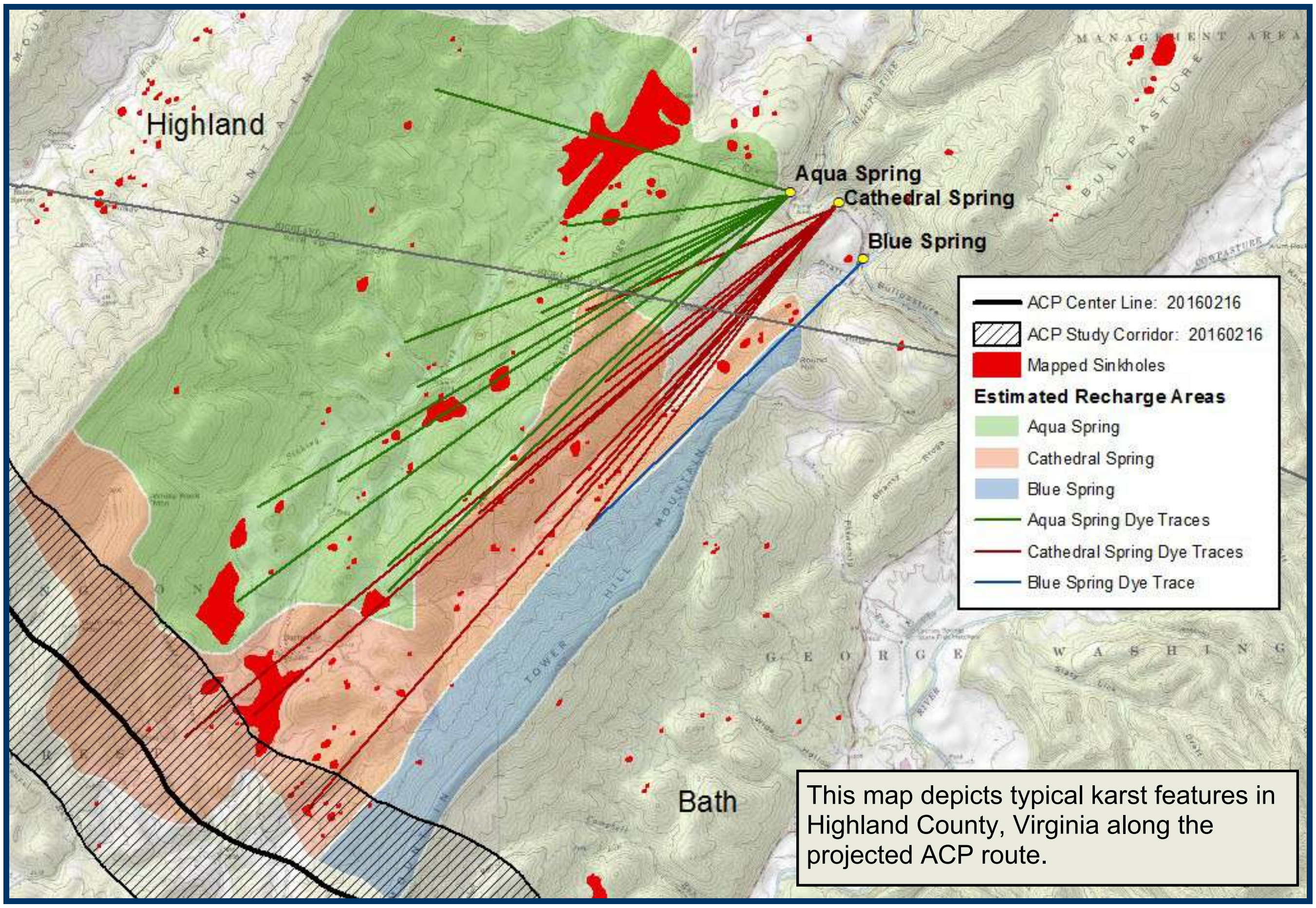


This diagram depicts features of a karst landscape similar to that found along the projected MVP and ACP routes in southeastern West Virginia and eastern Virginia.

Source: Figure obtained from Groundwater Resources Plan, Clark County, Virginia Comprehensive Plan Implementing Component Article 5a. Accessed June 6, 2016 http://clarkecounty.gov/government/county-documents/planning-department/documents/80-groundwater-resources-plan/file.html

Pollution from construction or spills in karst areas is especially challenging to trace because the source area and flow paths are not always clear and because karst recharge areas and flow paths often do not follow surface watersheds.

Figure 3. Dye trace test results near Burnsville Cove in Virginia



Source: Based on material included in Lambert, R.A. 2016. Assessments of Four Karst Systems in Highland-Bath Counties, Virginia Along the GWNF-6 Route of the Proposed Atlantic Coast Pipeline, Submission to FERC Docket No. CP15-554 by Highland Cave Survey, Monterey, VA.

Pollution from construction or spills in karst areas is especially challenging to trace because the source area and flow paths are not always clear and because karst recharge areas and flow paths often do not follow surface watersheds. Further, underground flow paths may change from one season to another and may be affected by construction. For example, when karst systems are exposed to changing runoff patterns, new solution channels may form or existing channels may be altered. **Figure 3** shows the extent of estimated recharge areas and the complexity of flow paths as demonstrated by dye trace tests near Burnsville Cove in Virginia. The proximity of pipeline construction to recharge areas and groundwater systems is not as well documented in locations along the path of the proposed ACP and MVP pipelines.

For any karst or non-karst bedrock-groundwater system, mechanical construction forces such as blasting or percussive forms of excavation (hammering) also have the potential to introduce new fractures that may affect the transport time for contaminants to reach water resources (Natural Resources Group, 2015).

The examples on the following page highlight the complexity and potential distance of contaminant transport in karst topography.

Surface contamination has already led to pollution of groundwater and drinking water supplies due to pipeline development and other construction projects:

- The Environmental Impact Statement for the Extension of the Highland Scenic Highway cited sedimentation issues at the Bowden National Fish Hatchery associated with construction of US Route 33. It also cited impacts to the Edray Hatchery during previous construction on the Highland Scenic Highway. Springs used at these facilities were significantly impacted at considerable distance—over two miles in the case of the Edray Hatchery—where sediment-laden water traveled by surface streams before sinking into karst groundwater. (USDA, 1981)

- Red Sulphur Spring Public Service District's water supply was contaminated in 2015 by diesel fuel spilled at a pipeline staging area near a sinkhole, causing the plant to be offline for over two weeks and requiring purchasing of water to supply the system's approximately 4,000 customers. The spill area was approximately one-half mile from the system's primary supply spring. For more information, see: http://pipelineupdate.org/2015/11/29/we-do-the-right-thing-always-have/

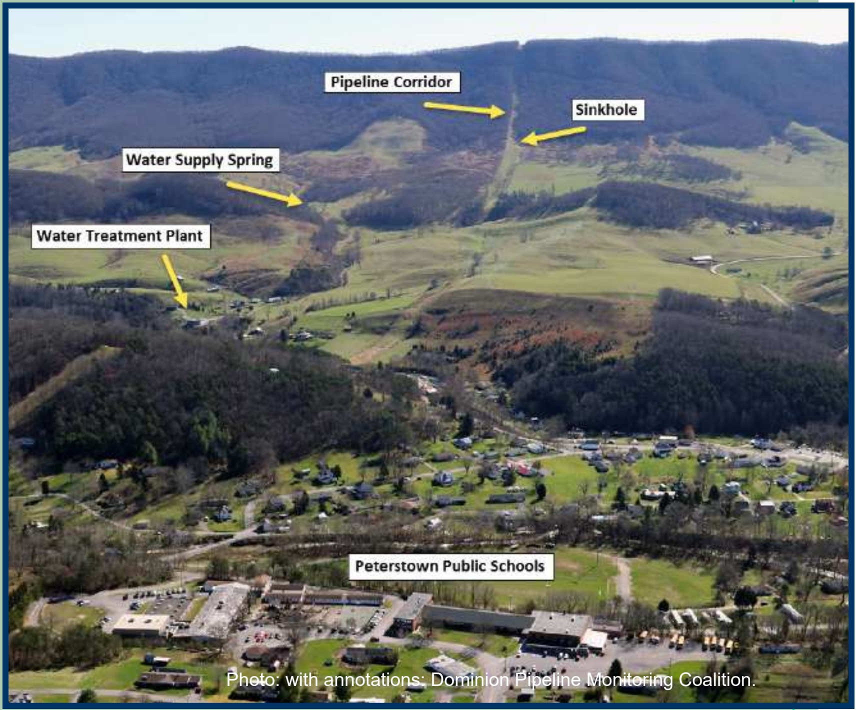
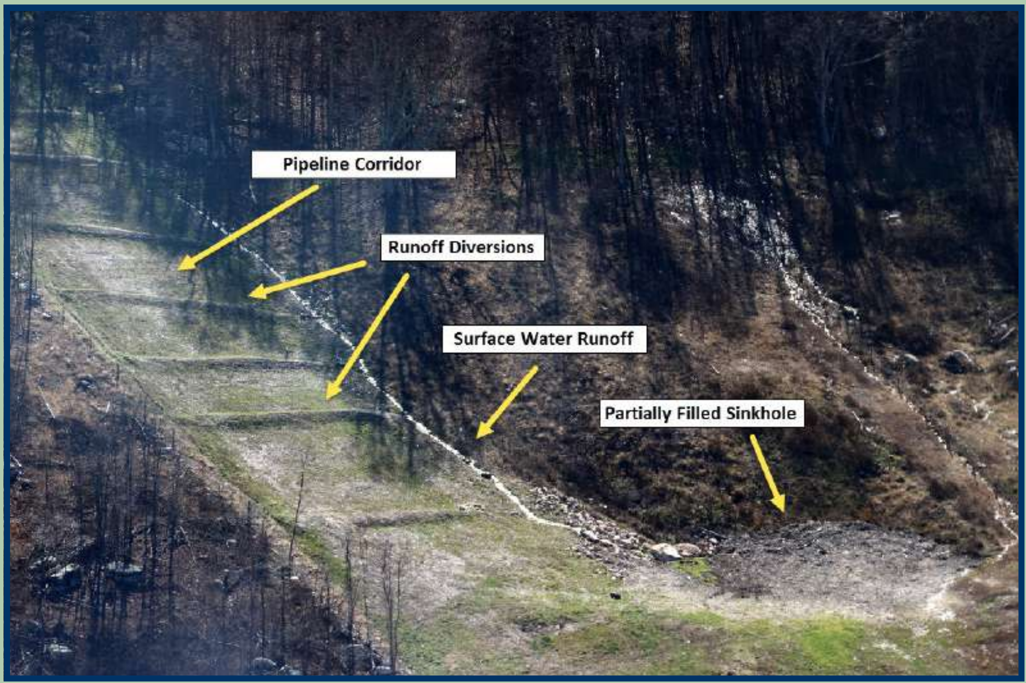


Photo: with annotations: Dominion Pipeline Monitoring Coalition.



This image depicts a downslope discharge from the Columbia Gas pipeline corridor at the foot of Peters Mountain, which runs along the Virginia and West Virginia border. Water entering this sinkhole re-emerges approximately one half of a mile away in a spring used as the Red Sulphur PSD's primary source. Source: Dominion Pipeline Monitoring Coalition.

2.2 Hydrostatic testing

Hydrostatic testing can also cause water contamination. Hydrostatic testing is necessary to test the integrity of the pipeline before it is put online. Sections of pipeline are filled with water and pressurized to ensure that there are no leaks. Particularly for a 42-inch pipeline, this will require a substantial quantity of water.

Water resource concerns include:

- insufficient flow downstream from the location where water is withdrawn for use in hydrostatic testing;
- whether the water used in testing is returned in a manner that causes sedimentation and erosion; and
- contamination by invasive species if the water is not returned to the same water body.

A gas pipeline developer in West Virginia was recently cited by the WVDEP for allowing sedimentation of a receiving stream after water used for hydrostatic testing was not properly filtered before it was returned to a stream (WVDEP, 2016).

Mackey Spring, on the left in the photo, flows into the upper Jackson River in Highland County, Virginia. This spring is known to run muddy due to disturbance in the karst recharge area extending several miles further up the valley. The proposed MVP and ACP will cross many similar areas. Photo: Rick Webb.

2.3 Springs

Much of the landscape projected to be crossed by the MVP and ACP is characterized by an abundance of springs—many of which originate in karst formations. Many of these springs act as drinking water sources for people living near the projected pipeline routes. Blasting and excavation of the pipeline corridor can have significant impacts to both water quality and quantity at nearby springs. **Figure 4** depicts numerous springs on Peter's Mountain on the border of Virginia and West Virginia (Richards, 1997). The majority of springs and groundwater recharge areas that exist in the region have not been mapped.

Figure 4. Springs near the projected MVP route

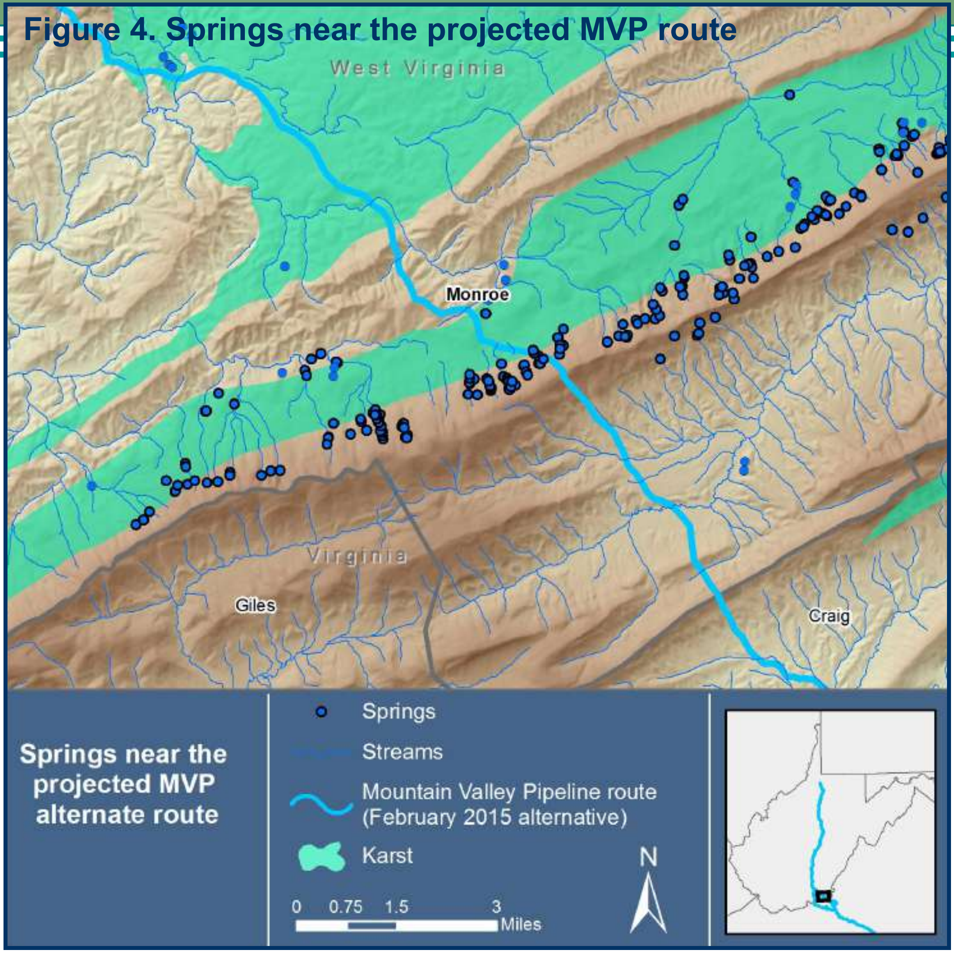
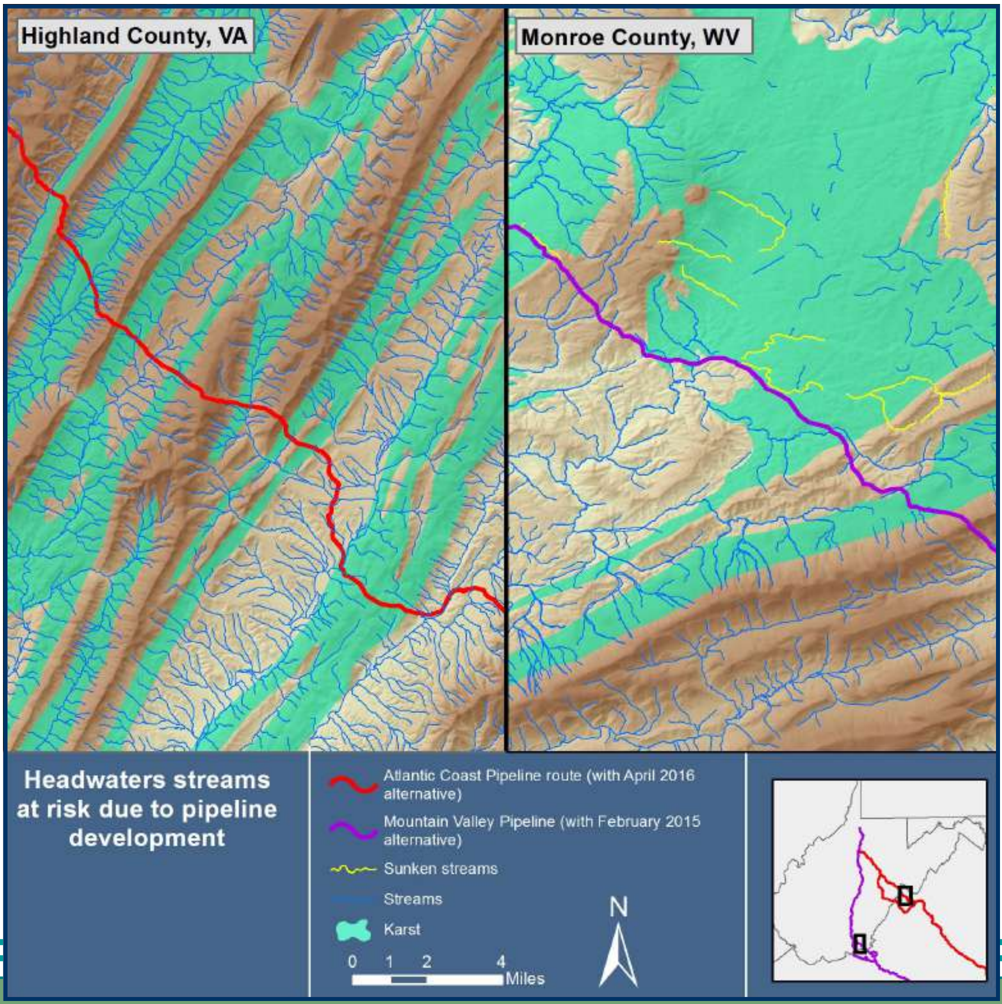


Figure 5. Streams along the MVP and ACP projected routes



2.4 Stream crossings

Both the MVP and ACP are projected to cross hundreds of rivers and streams—many of which are sensitive headwaters streams. Additionally, numerous sinking streams, streams that flow underground through karst formations, will be crossed or are in close proximity to the projected pipeline routes. Each crossing poses potential for water quality impacts to the stream crossed as well as all downstream waterways. Additionally, clearing of forest vegetation near sensitive headwaters streams can lead to increases in water temperature. **Figure 5** depicts examples of the stream density in Highland County, Virginia and Monroe County, West Virginia.

3. GENERAL PROTECTIONS FOR WATER RESOURCES

3.1 State and federal permitting requirements

The following brief description of permitting requirements does not address the effectiveness of regulatory review or implementation. Concerns about regulatory system performance have been raised by a number of conservation groups and pipeline opponents.

Federal Energy Regulatory Commission

Companies must file with the Federal Energy Regulatory Commission (FERC) to obtain approval to construct a new pipeline. FERC will issue a Certificate of Convenience and Necessity if these projects are approved. The FERC filing is a long regulatory process with many steps, and it includes environmental impact reviews, documentation of natural resources along the proposed route, and proposed mitigation activities.

Clean Water Act State 401 Certification

FERC approval requires that pipeline applicants obtain a number of permits or approvals from federal agencies and the states crossed by the pipelines. Pipelines must receive 401 certifications, as required by the Clean Water Act but issued by individual states, which must confirm that that the project will not cause violations of state water quality standards.

US Army Corps of Engineers Section 404 permits

US Army Corp of Engineers (USACE) Section 404 permits ("dredge and fill" permit) are also required for pipeline projects. These permits describe methods for removal of material from stream channels and replacement of the material back into stream channels without impacting water quality. 404 permits can be either "general" permits or "individual" permits. Individual permits require site-specific conditions and undergo greater scrutiny by USACE permit writers.

These permits have not been issued for either pipeline as of the writing of this report.

State construction stormwater permits

Construction stormwater permits are also required by both West Virginia and Virginia. These permits require the permittee to describe methods that will be implemented to minimize erosion and best management practices (BMPs) to keep sediment and other potential contaminants out of streams. In West Virginia, oil and gas construction stormwater permits for natural gas pipelines are issued through the West Virginia Department of Environmental Protection (WVDEP) Division of Water and Waste Management. In Virginia, the permits are for general construction activities and are issued by the Virginia Department of Environmental Quality (VADEQ).

Both West Virginia and Virginia require a Stormwater Pollution Prevention Plan (SWPPP) as part of the construction stormwater permit process. SWPPPs require inspection of BMPs, a spill prevention and response plan, erosion and sediment controls, and a stormwater management plan (Downstream Strategies, 2015; VADEQ, 2014; WVDEP, 2015).

West Virginia also requires a Groundwater Protection Plan (GPP), which may be part of the SWPPP. The GPP identifies operations that may potentially impact groundwater resources as well as procedures to protect groundwater from the potential contamination (Downstream Strategies, 2015; WVDEP 2015).

Greenbrier River in West Virginia. Photo: Annie Stroud.

3.2 State and federal legal protections: Water quality standards

Surface water protections

All construction projects must adhere to state and federal laws that protect water quality. The federal Clean Water Act states that the integrity of the Nation's waters must be maintained and both point and nonpoint sources of pollution. States must adopt water quality standards for surface waters under the Clean Water Act, which must meet minimum requirements and be approved by the USEPA. West Virginia and Virginia have both adopted surface water quality standards, which include designated uses, numeric criteria that set limits for specific physical, chemical, biological or radiological characteristics of water, and narrative standards, which include additional, non-numeric requirements.

Groundwater protections

The Safe Drinking Water Act describes protections for groundwater resources that are used as a public drinking water source. In addition, both West Virginia and Virginia have implemented standards for all groundwater resources.

Virginia groundwater standards

The regulations adopted by the Virginia State Water Control Board to define the required quality of groundwater are found at 9VAC25-280. The groundwater standards include general requirements, antidegradation provisions, and criteria. The general requirements state that "[e]xcept where otherwise specified, groundwater quality standards shall apply statewide and shall apply to all groundwater occurring at and below the uppermost seasonal limits of the water table" and "[i]n order to prevent the entry of pollutants into groundwater occurring in any aquifer, as soil zone or alternate protective measure or device sufficient to preserve and protect present or anticipated uses of groundwater shall be maintained at all times (9VAC25-280-20)." Numeric criteria included in the standards are not mandatory, but both the general requirements and the antidegradation provisions must be enforced.

West Virginia groundwater standards

The West Virginia legislative rules contain concentrations of certain constituents, which shall be maintained, except in certain situations specified in the rule. If the concentration of any of these constituents exceeds the concentrations listed, "due to human-induced contamination, no further contamination by that constituent shall be allowed and every reasonable effort shall be made to identify, remove or mitigate the source of such contamination and to strive, where practical, to reduce the level of contamination over time to support drinking water use (47CSR12-3.1)."

3.3 Legal actions

Legal actions can also be used to protect water resources during various stages of the pipeline development process. For example, the Dominion Pipeline Monitoring Coalition (DPMC) is conducting an investigation of the requirements and implementation of water resource laws and regulations related to pipeline construction. DPMC filed a legal petition in Virginia Circuit Court in Richmond in May 2016 to force the State of Virginia to release information about its regulatory review of pipeline proposals. This case led to the release of critical information before additional action was necessary (DPMC, 2016).

Suits could be filed by individual landowners in the event of contamination or loss of water quantity, but potential impacts may be hard to prove without thorough documentation and records of previous monitoring. A primary purpose of the current report is to provide guidance for collection of legally defensible monitoring data.

3.4 Water resource protection areas in West Virginia and Virginia

Amendments to the Safe Drinking Water Act in 1996 required states to assess the source water areas for public water utilities, including both surface and groundwater sources. In both West Virginia and Virginia, these were completed by the state health departments. However, the exact format for assessment varies between the states.

In West Virginia, these plans established Source Water Protection Areas (SWPAs) and zones of critical concern (ZCCs). SWPAs are the area around a groundwater source, which may be a fixed radius, or the area may be defined by the West Virginia Bureau for Public Health (WVBPH) depending on geology and topography. ZCCs include riparian areas up to a five-hour travel time to the water intake for surface water sources. Potential contaminant sources were inventoried within the SWPAs and ZCCs.

"The Zone of Critical Concern (ZCC) for a public water supply source is a corridor along streams within a watershed that warrants detailed scrutiny due to its proximity to the surface water intake (WVDEP, 2016)." The projected MVP route crosses four ZCCs and the projected ACP crosses two ZCCs in West Virginia. Impacts in these areas must be monitored closely.

Virginia defines the source water protection areas in terms of "Zones". For groundwater sources, a fixed radius of 1,000 feet is Zone 1, and a fixed radius of 1 mile is Zone 2. For non-tidal surface water sources, Zone 1 is a 5-mile radius contained by watershed boundaries. Zone 2 is within the watershed boundary, but beyond the 5-mile radius. Potential contaminant sources were inventoried within all of these zones.

States were also required to establish Wellhead Protection Programs for public water providers that use groundwater as their source water.

The states and individual utilities were encouraged to develop Source Water Protection Plans, but these plans are not required by the Safe Drinking Water Act and the program remains voluntary in most states.

This voluntary approach has not always provided enough preparation or protection of drinking water resources. In January 2014, a chemical leak was discovered just upstream of the intake on the Elk River, which supplied drinking water to Charleston, West Virginia and nine surrounding counties. The water treatment plant was contaminated, and 300,000 people and thousands of businesses were without water for at least four days.

This led to the passage of West Virginia Senate Bill 373, which required most public systems in West Virginia to complete a Source Water Protection Plan by June 30, 2016. Grants and a template provided by the WVBPH have allowed most public systems in West Virginia to work toward completing their plans by the deadline.

While Source Water Protection Plans do not provide legal protections or limit development within protection areas, they do provide an opportunity for water utilities to be informed and involved in potential development in areas that could impact their source water. *Water utilities may provide influential voices of concern regarding pipeline development projects.*

Source Water Protection Plans do not provide legal protections for the water utility or the source water, nor do they limit development within the protection area. However, the plans do provide an opportunity for water utilities to be more informed and involved in potential development within their source water areas. In the case of pipeline development, for example, the water utility may provide an influential voice of concern if the pipeline path crosses its source water protection area.

County and local agencies may develop ordinances to control development in delineated source water areas, and some have purchased land or used conservation easements as a method of protection. While it is beyond the scope of this report to identify each of these local protections, they may have bearing on the final route selection for pipelines. The ACP rerouted a section of the proposed pipeline route through Augusta County in Virginia due to a request from the Augusta County Service Authority, which had expressed concern about the potential impact of pipeline development on drinking water supplies for the Lyndhurst Source Water Protection Area (**Figure 6**). The City of Staunton has also voiced concerns about potential impacts to its water supply and is exploring legal strategies to protect its drinking water.

ZCCs are also crossed by the projected pipeline routes in Braxton, Nicholas, Webster, Summers, Monroe, Upshur, and Randolph counties of West Virginia, but it is not known how the water providers in these areas will address the pipeline development (**Figure 7**).

Figure 6. Source water protection area near the ACP in Augusta County, Virginia

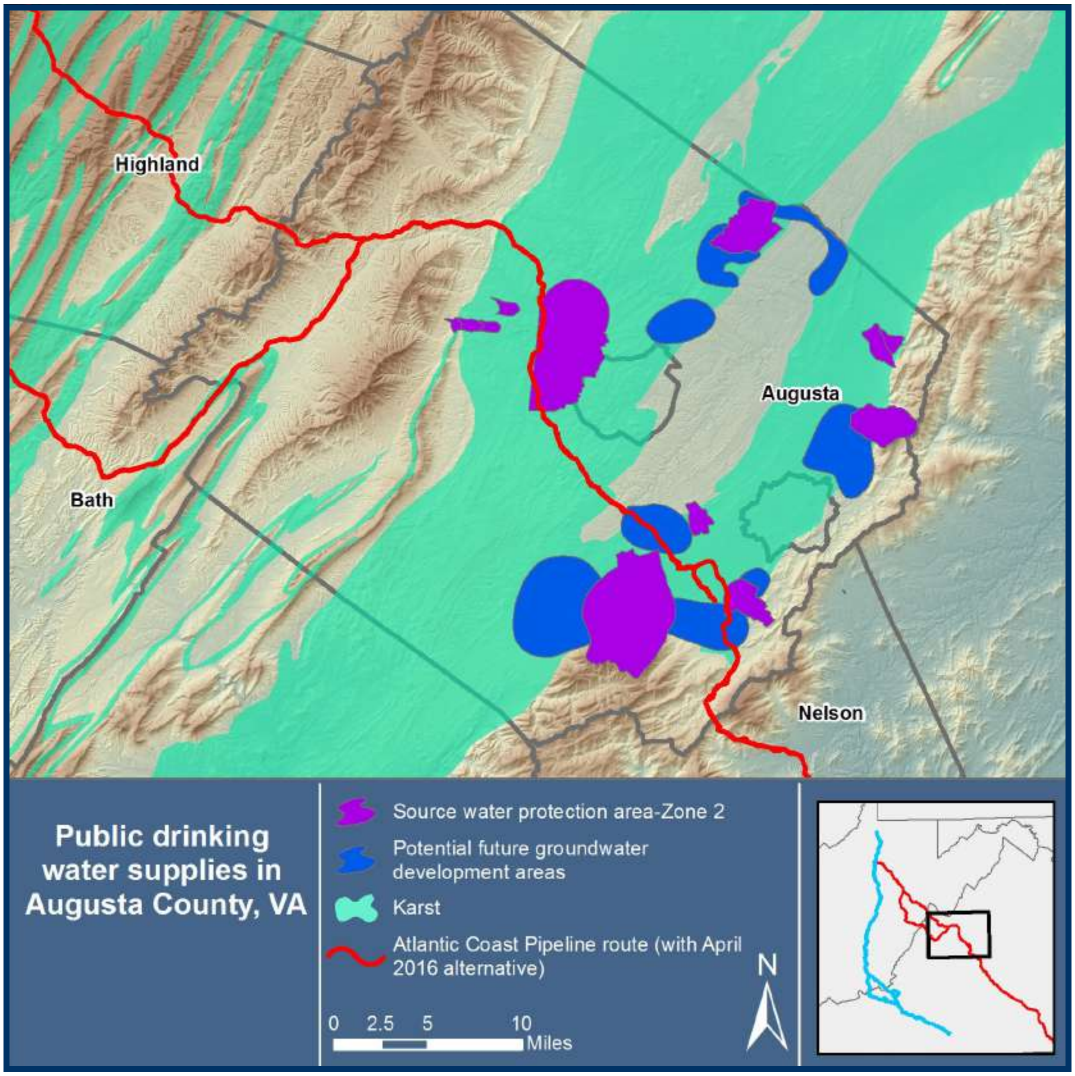
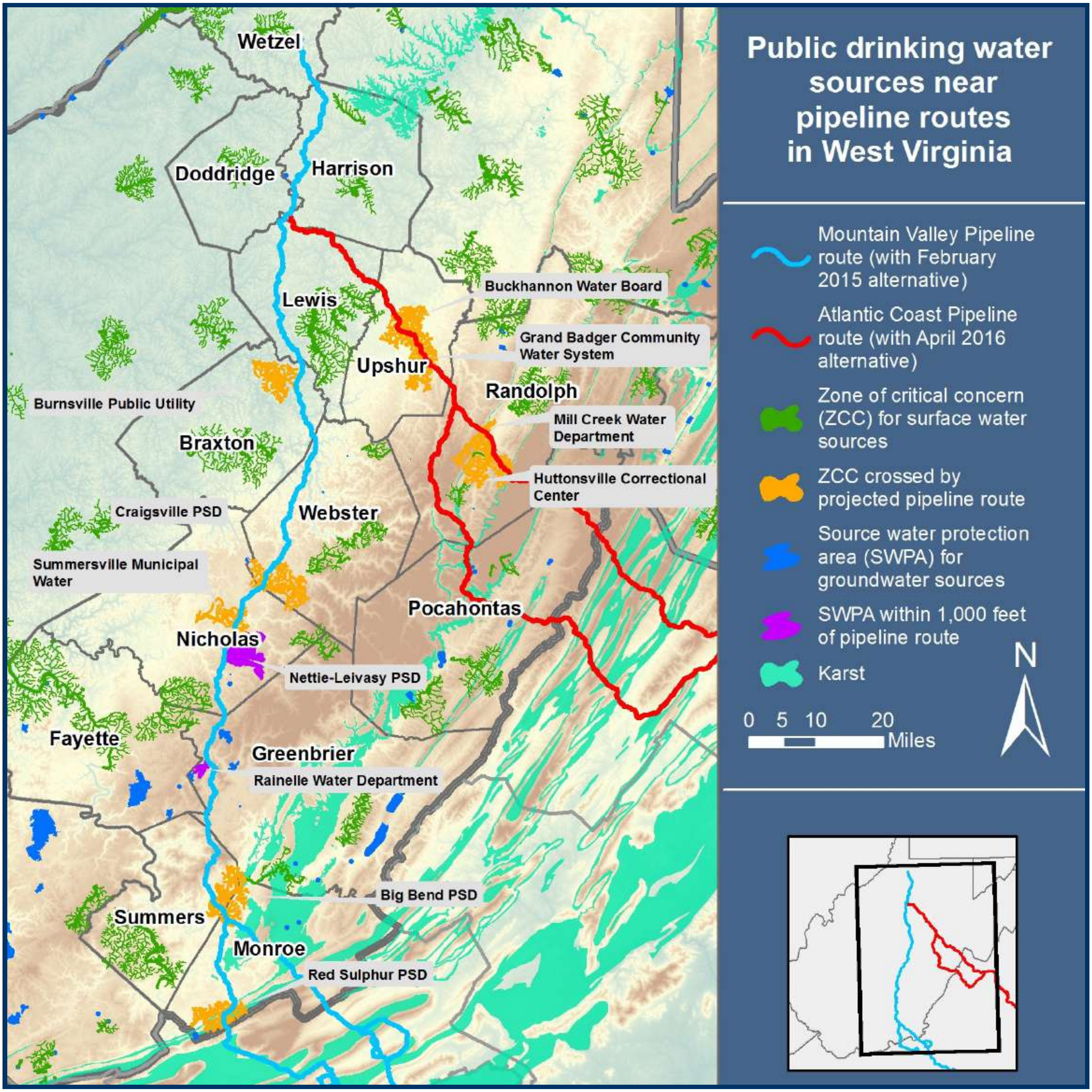


Figure 7. Source water protection areas in West Virginia near the proposed MVP and ACP routes



4. ONGOING MONITORING

To gain FERC approval, pipelines must obtain a number of permits. However, water quality monitoring is not explicitly required for any of the permits, although water quality standards must be maintained. Site inspections, reports of violation, or citizen complaints may lead to samples being collected as part of investigations by state agencies. In West Virginia, WVDEP should be contacted by anyone having concern of contamination or improper site management. In Virginia, VADEQ should be informed. (Emergency contact information is provided on page 35.)

4.1 Monitoring by the ACP and MVP developers

FERC requires pipeline developers to complete an inventory of wells, springs, streams, wetlands, and public water supplies. While not a specific requirement of the permitting process, both the MVP and ACP have proposed to collect information about private landowner wells and water supply springs along the route of each pipeline, *with landowner permission*. The decision to allow or not allow the pipeline developers on private property for water supply testing is personal, but if development is to occur, baseline water quality and quantity information is important.

Some questions and considerations concerning data collection by pipeline developers or their contractors include the following:

- What will they test for? Is it limited to potential impacts from the pipeline, or does it look for other potential sources of contamination?
- How will they measure quantity or yield?
- Who will have access to the sample results and yield data? Will they be shared in public? What rights does the company reserve to use the information?
- Who will have access to your property to conduct sampling and data collection? Will access be limited to one or a few specific sampling events, or does it allow entrance to your property at other times?
- Does the landowner need to be home when sampling is conducted?
- Consider consulting an attorney for advice on your legal rights and advantages and disadvantages of allowing access for sampling.

Both the ACP and MVP developers have proposed to collect water quality samples for wells that are within 150 feet of each pipeline route and within 500 feet of a pipeline route in karst terrain in FERC filings. These are arbitrary distances and may not be sufficient. Alteration of quality and flow in karst springs, for example, can and has occurred due to construction activities at much greater distances. See examples on page 9.

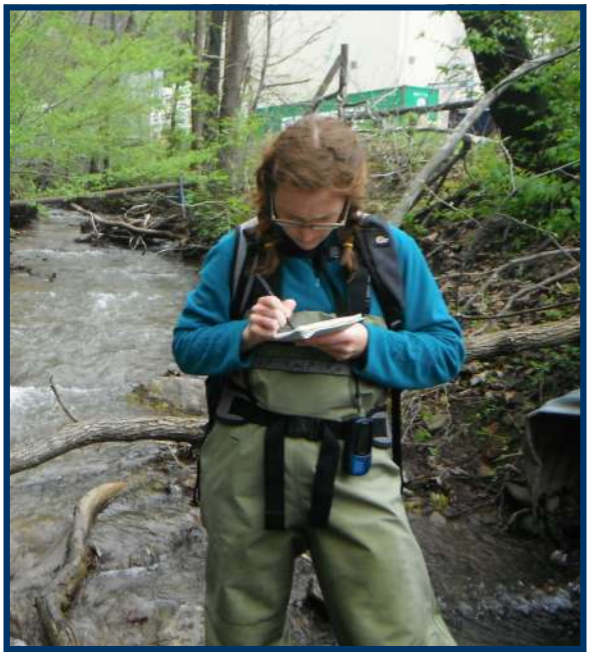
Samples would be collected prior to construction, presumably as a baseline condition for future comparison. However, using only a few sampling events to determine a baseline may not capture year to year, seasonal, or other hydrologic variation. ***The ACP developers plan to collect quarterly samples one year prior to construction. The MVP developers plan to only collect two samples: one six months prior to construction and one three months prior to construction.***

The ACP filing with FERC also mentions water quantity monitoring, but is not clear how this will be accomplished. MVP plans to also collect water quality information for public water utility sources.

Table 1. Water sampling parameters and conditions proposed for each pipeline

	Mountain Valley (MVP)	Atlantic Coast Pipeline (ACP)
General chemistry	pH, Conductivity, Temperature, Turbidity, Hardness, Alkalinity, Total Suspended Solids, Total Dissolved Solids	pH, Conductivity, Alkalinity, Acidity, Total Suspended Solids, Total Dissolved Solids
Organic Compounds		Oil/grease, Phenolic
Ions	Chloride, Sulfate	Sulfates
Nutrients	Nitrate,	
Biologicals	Total and Fecal Coliform	Fecal Coliform
Metals	Calcium, Magnesium, Sodium, Potassium, Iron Manganese	Aluminum, Antimony, Beryllium, Cadmium, Chromium, Copper, Iron, Manganese, Lead, Nickel, Silver, Thallium, Zinc
Applicability	Private wells and springs within 150 feet of work space, 500 feet in karst. Public water supplies.	Private wells and springs within 150 feet of work space, 500 feet in karst, within 0.24 miles of horizontal directional drill entry/exit locations
Term	Pre-construction, baseline water quality	Pre-construction, seasonal sampling for all seasons

Sources: MVP from Table 5.3-Proposed target analytes for water resource baseline sampling. ACP from Resource Report 2-Water Use and Quality, Natural Resource Group, September 2015, Groundwater monitoring.



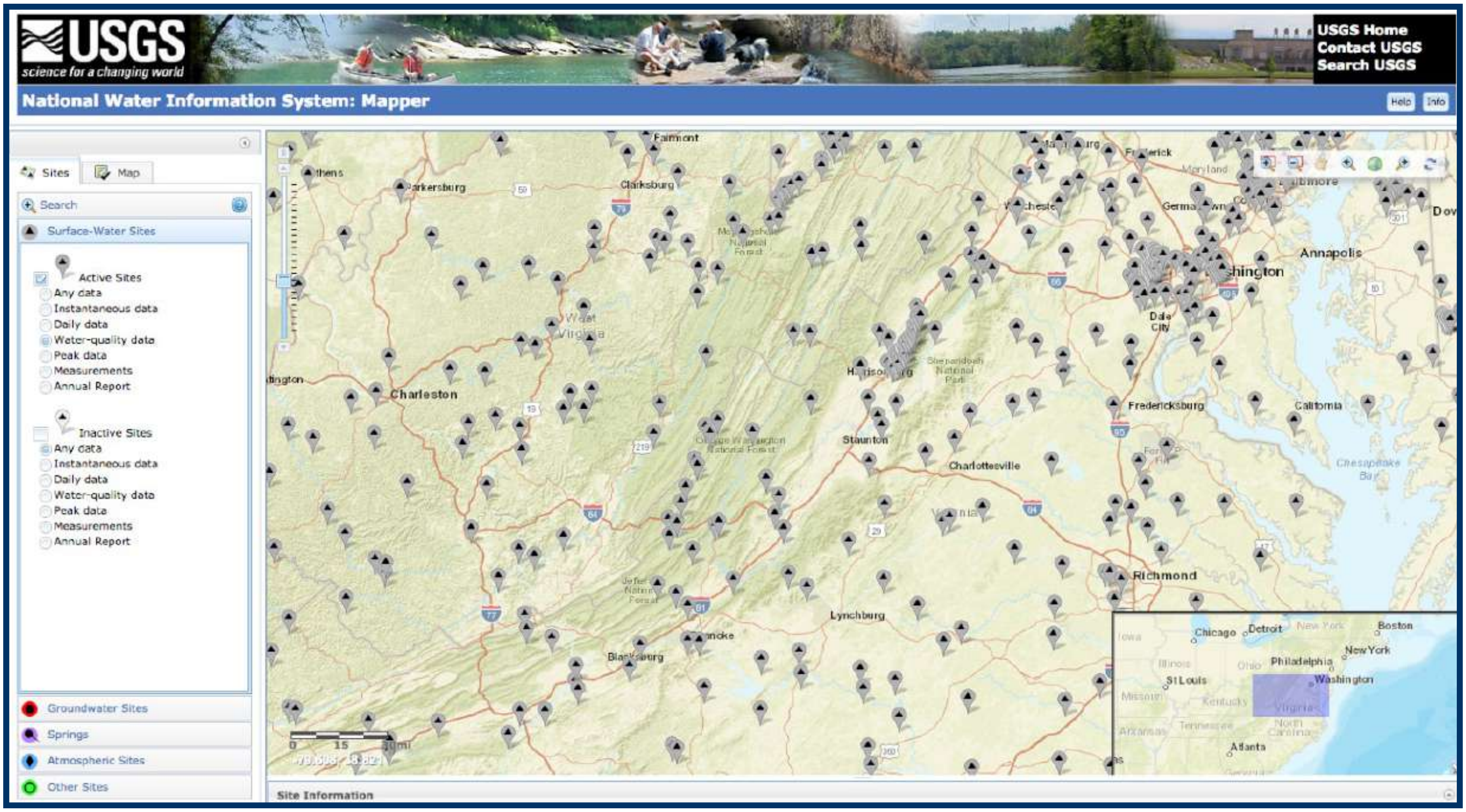
4.2 United States Geological Survey (USGS)

Surface Water

USGS has an extensive network of stream gages around the country. While most gages solely collect stream flow data, many also collect additional parameters, such as temperature, pH, and/or conductivity. These sites could provide long-term background data on the condition of local surface water if they are located near pipeline development.

Stream flow records can be researched at http://waterdata.usgs.gov/nwis/sw. The screen shot in **Figure 8** shows USGS stream gages near the pipeline routes with water quality data, but these sites would need to be researched to determine what data is maintained and the length of the data record.

Figure 8. Screen shot of USGS stream gaging stations with water quality data



Groundwater

USGS also maintains groundwater monitoring wells, but they are much fewer and more dispersed than stream gages. These wells may have static water level information as well as additional water quality data.

Groundwater monitoring records can be found at http://waterdata.usgs.gov/nwis/gw. Groundwater monitoring well locations with water quality data are sparse in the region projected to be crossed by the MVP and ACP. These sites would need to be researched to determine what data is maintained and the length of the data record.

Although USGS provides reliable, quality-controlled data, the use of these datasets is probably limited to few areas within the area of MVP and ACP development. Data for USGS sites may also provide information on regional hydrologic conditions or variation, which can help with evaluation of data obtained for individual sites.

4.3 Environmental groups

Informational materials and events

A number of groups have provided workshops and materials about how to monitor waterways.

Save Our Streams provides online materials about monitoring, including water sampling, visual inspections, and benthic (stream-bottom fauna) surveys. The organization also provides data sheets and other materials. http://www.iwla.org/conservation/water/save-our-streams

West Virginia Rivers Coalition Wvrivers.org and **Trout Unlimited** http://www.tu.org/tu-projects/eastern-shale-gas-monitoring-program have recently held workshops specifically about monitoring streams for pipeline development impacts. In addition, these two groups coordinate volunteers and provide data analysis and QA/QC for the monitoring program. Some of the methods and equipment used for this stream monitoring program could be useful for water monitoring on a screening basis by landowners.

Stream monitoring

Some watershed groups have collected water quality information on local waterways. These groups include:

Friends of the Lower Greenbrier
Lowergreenbrierriver.org

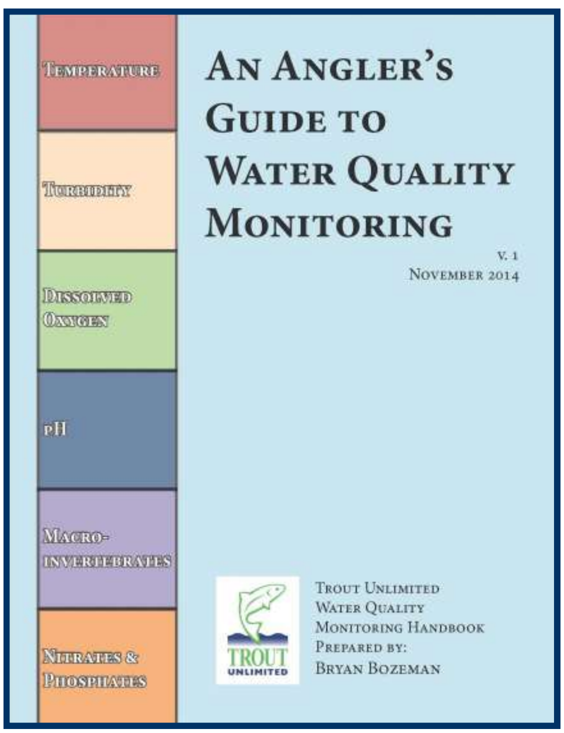
Cowpasture River Preservation Association
Cowpastureriver.org

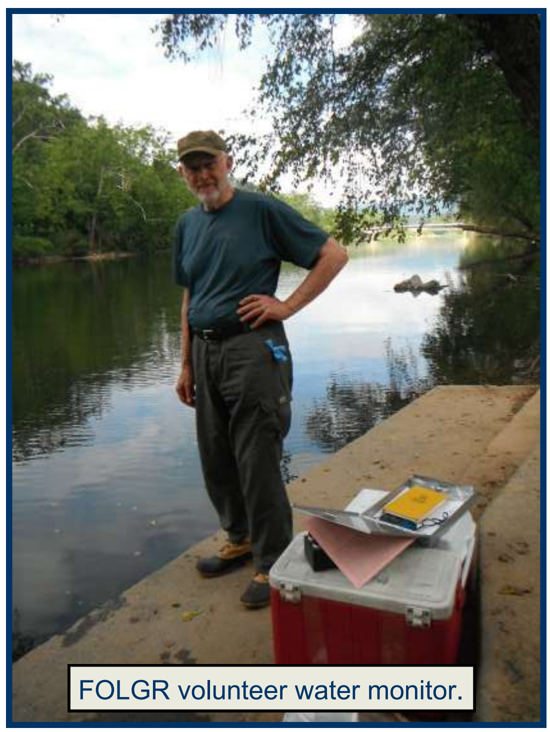
Friends of the Middle River
Friendsofthemiddleriver.org

Indian Creek Watershed Association
Indiancreekwatershedassociation.org

Groundwater

Most watershed groups have not collected groundwater samples in the areas of the proposed pipelines. One exception is the **Indian Creek Watershed Association,** which has begun to monitor a series of springs located in the vicinity of the proposed MVP.




FOLGR volunteer water monitor.

4.4 Public water providers

The federal Safe Drinking Water Act defines a public water system as an entity that provides water for human consumption through pipes or other constructed conveyances to at least 15 service connections or serves an average of at least 25 people for at least 60 days a year. Public water suppliers are already required under the Act to conduct water quality sampling at regular intervals. Public drinking water systems must meet health-based federal standards for contaminants, including performing regular monitoring and reporting. The specific parameters and testing frequency varies somewhat, based on the size of the supplier.

Many providers also conduct source water monitoring to guide their treatment processes. Public water providers and utilities collect water samples frequently to monitor for changes that may impact treatment options. Samples are generally collected at the plant and samples of both raw water and the finished product are collected. Public water providers in most cases will have the most comprehensive dataset of water quality information, although it will be limited to their source water and tap water. The frequency and consistency of sampling creates a thorough record of water quality trends, and changes in trends may indicate that changes are occurring in the source water area.

It is intended that public water system operators can utilize this document to better understand the potential risks from pipeline development and to use this knowledge in helping to interpret the results of their water quality monitoring programs. Operators may also consider increasing the frequency of monitoring, including additional parameters (**Table 3**), or even adding additional sampling locations to monitor for potential impacts, particularly during construction phases.

Drinking water treatment plant in West Virginia

5. RECOMMENDATIONS FOR LANDOWNER MONITORING

Monitoring is essential to ensure that surface and groundwater can produce a safe and adequate supply, to help understand potential sources of contamination, and to inform use and management decisions. Monitoring can be done by normal observation (appearance, taste, and odor), collecting field measurements, and/or conducting laboratory tests. It can be done by landowners or others. Assessments can be qualitative (observed but not measured) or quantitative (measured). Each type of monitoring is useful, and there are costs and benefits to each. Ideally, a combination of approaches over time provides the best and most efficient result.

This report recommends a tiered approach involving data collection by both landowners and third-party consultants as described in Figure 9.

Use of third-party consultants or contractors offers numerous advantages, and is recommended for collecting quantifiable measurements, such as water quality samples or sustained yield tests. Properly qualified third-party consultants are independent of the results, which helps to improve defensibility. They are also experienced with equipment operation, collection and handling of samples, and should be able to clearly explain and document results and methods of data collection and analysis. The disadvantage is that consultants will add cost, which also tends to limit the frequency.

However, landowners can implement their own qualitative monitoring plan as often as is reasonable, which provides several advantages. It helps landowners become intimately familiar with the water source and generally allows landowners to monitor more often and less expensively. It allows landowners to quickly recognize if there is a change in water quality or quantity. Disadvantages are that self-monitoring is not independent and may come into question in legal or regulatory situations.

One of the most important aspects of monitoring, whether done by the landowner or a third-party consultant, is **thorough, appropriate documentation of conditions and methods**. In the event that there is impact on water quality or quantity, it may be necessary to prove that the observed changes are not a result of natural variation or other causes. **Photographs, videos, log books, and laboratory reports in digital and/or hard copy are all evidence of water quality and quantity trends through time.**

A monitoring program will have a starting point and end point, or it may continue indefinitely. In either event, a starting point or baseline condition should be established. Once there is a baseline, additional surveillance or screening assessments can be performed over time, and if screening indicates concern, specific assessment can be done for confirmation.

This report describes three phases of monitoring:

1. **Baseline** sampling to establish conditions prior to any contamination,
2. **Surveillance** monitoring to determine any changes in water quality or quantity, and
3. **Event** sampling, to document an occurrence of contamination.

WHO should have their water tested?
You should have your water tested if:

- The pipeline will cross your property
- You are downgradient of a location where the pipeline will cross a stream
- Your water resources are within the specified distances for sampling by ACP or MVP representatives
- Your property overlies karst and is in the vicinity of a pipeline
- Your drinking water source is located near one of the pollution hotspots included in **Table 2.**
- You are concerned about your water quality related to pipeline development
- Your well or spring is your only source of potable water

WHY should you monitor your water resources?

- To provide baseline data for comparison to future monitoring
- To provide support for or highlight discrepancies in sampling results collected by ACP and MVP
- To identify changes in water quality that may be a result of pipeline development

WHEN should you monitor?

- NOW, prior to pipeline construction, to obtain BASELINE data, which includes water sampling and observation.
- During construction you should conduct SURVEILLANCE monitoring to look for changes in water quality or quantity.
- If there appears to be a change in appearance, taste, or smell of water, EVENT sampling may be necessary to confirm potential contamination in your water.

WHAT should be monitored?

- Recommendations for sampling are in **Table 3**.
- For BASELINE monitoring, you should have water analyzed for as many parameters as practical.
- Observations should be collected for water quantity, appearance, smell, and taste.
- For SURVEILLANCE monitoring you should continue to record observations and collect select field measurements.
- EVENT sampling parameters should be based on the suspected contamination source, if known.

HOW to conduct monitoring:

For defensible results that could be used in a legal situation, a third party independent consultant should be used to collect water quality and/or quantity samples. However, landowners can collect observation information, such as quantity, appearance, taste, or smell, as often as is practical. All observations should be carefully recorded, and should be maintained, along with any sampling results, by the landowner. Photos and/or video should also be used to document conditions.

5.1 Who should have their water monitored?

If a property is within the distances proposed by ACP and MVP—150 feet or 500 feet in karst—wells or springs will be sampled by developers for water quality. However, this distance is arbitrary from an environmental transport point of view—it is difficult to predict how far downstream a contamination event may travel once it reaches a stream or river. In karst areas, transport of contaminants can be even more unpredictable as to how far, and even which direction, contamination can travel if it reaches groundwater. These complexities make recommending a specific distance from a pipeline project that is best to monitor impractical. The most accurate approach would be to have an individual assessment by a professional geologist or hydrologist. But, this requires time and possibly significant expense. As the pipeline route continues to be adjusted, a precautionary approach is recommended for anyone within the counties being traversed by new pipeline construction. As we have seen, in karst areas, caution for much larger areas is well warranted.

It is recommended that landowners within the distances specified by the pipeline companies should certainly have their drinking water resources monitored, and possibly double or triple these distances. Due to the unpredictability of groundwater flow in karst, those who are regionally close to pipeline development, even within a few miles, should consider monitoring, if possible. If a pipeline crosses a property, water resources on that property should be monitored. If a stream of concern or importance located on a property is crossed by a pipeline, downstream of the crossing should be monitored. In general, monitoring is recommended if you have the means to monitor water resources, and you are concerned about potential impacts from pipeline development. This may be especially important if the only source of water is a well or spring.

Table 2. Contaminant sources and sensitive receptors
This table describes locations with high potential for pollution to reach water resources.
These areas should be high priorities for water monitoring.

Source or receptor	Potential Impact
Hydrostatic test water discharge points	Concentrated discharge may cause erosion, sedimentation, and/or turbidity
Fuel or lubricant storage areas	Release of diesel or other chemical spills
Truck and construction equipment storage or staging	Diesel or other chemical spills, erosion and sedimentation from site construction
Streams or springs crossed by a pipeline	Sedimentation and erosion, increased turbidity, change in flow patterns-loss or flow or flooding
Sinkholes downgradient from construction	Sediments or surface spills may quickly reach groundwater or transmit contaminants such as diesel or chemicals to surface water

5.2 Defensible data

Obtaining defensible data is a function of how it is collected, analyzed, and documented. Defensible, as used here, refers to whether data was collected in a reliable, accurate, and repeatable manner. Different levels of defensibility may be necessary for different uses. For example, data used to support legal or regulatory decisions will need to be the most defensible. Consider that in the future, you may need to rely on your data in a legal setting.

Another question pertaining to defensibility is whether a sufficient amount of data has been collected to support a conclusion. For example, it might take additional data to indicate whether changes are due to contamination or seasonal variation. Determining a "defensible" amount of data can be difficult. Some data is better than no data. Without the limitations of cost and time, homeowners and water providers alike could sample for an extensive list of parameters by third-party consultants monthly, have a well yield test performed by professionals, and collect surveillance data weekly. However, this is not practical or obtainable for many homeowners. This does not mean that steps cannot be taken to protect water resources.

The degree to which the ACP and MVP developers will assume responsibility for harm to water supplies is unclear. For example, information provided in ACP Resource Report 2, Water Use and Quality, indicates that temporary or permanent water supplies will be provided to well owners if an investigation shows that damage to water supplies was caused by pipeline construction. (Natural Resource Group, 2015). It is not clear, though, how such an investigation will be conducted, and there is no mention of replacing damaged spring water supplies.

To collect the most "defensible" data practical for your situation, follow the suggestions listed below:

- If budget allows, have a third-party consultant collect samples. This is highly recommended for baseline water quality or if contamination is suspected. Ensure that the consultant uses standard operating procedures that are based on approved regulatory guidance. Discuss quality assurance/quality control methods with them to make sure the sampling will support your future needs.
- Ensure that all laboratory analyses are conducted by a state-certified laboratory. Both West Virginia and Virginia maintain current databases for certified laboratories:

  Virginia: http://www.dgs.state.va.us/EnvironmentalLaboratoryCertification2/tabid/1503/Default.aspx?#information_on_velap-accredited_commercial_laboratories

  West Virginia: http://www.dep.wv.gov/WWE/Programs/lab/Pages/default.aspx

- Conduct surveillance monitoring as often as practical. The more data you have, the better you can interpret your data, identify seasonal trends, and support conclusions.
- Carefully record on the **Water Monitoring Log**, or other form or notebook, any observations collected. Record date, time, and who was present. Take photos and videos. Back up data in digital form.
- If contamination is suspected, call state agencies as soon as possible (contact information on page 35). Carefully record relevant information, including who was contacted and when agencies were contacted.
- Consider allowing the pipeline companies to collect their own samples. When they visit, be present and document their activities. Be sure that you are provided with a complete record of any information they collect about your water sources.

5.3 Establishing a baseline

To evaluate water quality and quantity, it is necessary to establish a baseline condition. The best time to do this is now, prior to any pipeline construction. This is needed to confirm that contamination or supply problems do or do not already exist, to allow detection of future problems should they occur, and to document the range and pattern of natural conditions.

Baseline Water Quality

Because there are so many potential sources for contamination, it is ideal to establish a baseline for as many as possible. However, this can quickly become very expensive. **Table 3** shows a recommended set of testing parameters most likely to be affected by natural gas pipeline development. This list has been developed through monitoring experience and research (40CFR § 450.21; USEPA, 1999a; USEPA 1999b; USEPA, 2005; WVDEP, 2014), and it has been divided into **three sets, or "tiers" of analytical parameters**. **Tier 1** includes the recommended set of parameters that should be collected during each sampling event. These parameters are all good indicators of a change in water quality, and they are likely to be impacted if contamination from pipeline development occurs. **Tier 2** parameters provide more information about the water source and create a more robust dataset. They may be impacted by contamination from pipeline development. **Tier 3** parameters are recommended if there is concern that contamination of the water supply has occurred. Other than the metals, each of these parameters has a specific source that can usually be identified.

A quantitative approach should be used to establish a baseline for water quality and quantity, although landowner observations should be recorded during this period as well. Independent contractors should collect samples for water quality analyses and landowners can collect qualitative data on a regular basis.

Approximate analytical costs

Laboratory analysis costs for a single analysis of the entire recommended sampling parameters in Table 3 (Tiers 1-3) would normally range between $500 and $600. The cost for just the Tier 1 analyses would be between $150 and $200.

Having a consultant or contractor conduct the sampling and interpret results could bring the total cost to $1,000 to over $2,000, depending on a variety of factors, including number of samples or travel time. Costs would include labor, travel, and equipment expenses, along with the laboratory costs and documentation of methods and analytical accuracy.

The Greenbrier River—one of many which would be crossed by the MVP. Photo: Annie Stroud.

Table 3. Recommended sampling parameters (continued on following page)

Parameter	Information provided	Tier 1 Likely indicators of change in water quality-sample every time	Tier 2 Provides more comprehensive water quality information-include parameters from Tier 1	Tier 3 If observation suggests contamination or for confirmation of contamination-include parameters from Tier 1
Meter measurements				
pH	Physical and chemical character of the sample. Good indicators of contamination and helps interpret other results.		x	
Specific conductivity		x		
Temperature			x	
Dissolved oxygen			x	
Turbidity		x		
General chemistry				
Hardness	Laboratory parameters that are good indicators of change.		x	
Total dissolved solids		x		
Major ions				
Chloride	Major ions are good indicators of contamination and have federal secondary standards for comparison.	x		
Sulfate		x		
Nutrients and biologicals				
Nitrate	Indicators of contamination from surface runoff (sewage, agriculture).			x
Total and fecal coliform			x	
Metals				
Aluminum	Absent existing baseline data, analyzing for these metals is recommended based on our experience as those likely to impact water quality from surface and subsurface land disturbances. The source for most are natural deposits (geology) but they may be concentrated in man-made products. Natural amounts will vary based on location. Tier 1 metals include good indicator parameters and/or they have very low water quality standards.		x	
Antimony				x
Arsenic		x		
Barium				x
Beryllium				x
Cadmium			x	
Chromium		x		
Copper		x		
Iron			x	
Lead		x		
Manganese		x		
Mercury		x		
Nickel			x	
Potassium		x		
Selenium		x		

Table 3. Recommended sampling parameters (continued from previous page)

Parameter	Information provided	Tier 1 Likely indicators of change in water quality-sample every time	Tier 2 Provides more comprehensive water quality information-include parameters from Tier 1	Tier 3 If observation suggests contamination or for confirmation of contamination-include parameters from Tier 1
Organic compounds				
Volatile Organic Compounds	Although these tests are relatively expensive, we recommend testing for the full method Target Analyte Lists (TAL)* since the cost is not significantly greater than for testing just a few, and there is more specific information than from indicator group tests, such as Oil and Grease or Total Petroleum Hydrocarbons (TPH).			x
Semi-volatile Organic Compounds				x
BTEX	Benzene, toluene, ethylbenzene, and xylenes (BTEX) - a subset of the full VOC list including four of the most important compounds associated with petroleum contamination. Test for these if the full VOC list is not affordable.			x
Additional parameters				
Pesticides and herbicides	ACP indicated in FERC filings that pesticides and herbicides won't be used and that mowing will be the method for right-of-way maintenance. However, this could change over time.			x
Blasting agents	Explosives may be used to excavate rock.			x

Note: *The Target Analyte List is defined by the USEPA Hazardous Waste Methods SW-846 for a specific set of volatile organic parameters that may be analyzed by this method.

Confirm with the lab or your consultant that the appropriate and acceptable analytical methods are used for each parameter. The lab should be certified by the state for each parameter.

Assessing the results

Laboratories will provide the results of the sampling in a report, which includes sampling results and QA/QC data. The third-party contractor who collected the samples should explain the results and possibly provide a summary report to the landowner.

When testing drinking water—either a well, spring, or surface water—the best criteria for evaluation are provided by the USEPA Federal Drinking Water Standards. The drinking water standards establish maximum contaminant levels (MCLs), which are legal, health-based, enforceable limits for certain contaminants in drinking water. While the USEPA standards apply specifically to public drinking water supplies, they provide a point of comparison for water quality in the samples collected. The USEPA also issues Secondary Standards, which are not health-based and are non-enforceable. Still, secondary standards provide recommended thresholds for aesthetic qualities, such as taste, odor, and appearance. The most recent version of the drinking water standards can be found on the USEPA website.

https://www.epa.gov/ground-water-and-drinking-water/table-regulated-drinking-water-contaminants

When testing surface water, West Virginia or Virginia surface water quality standards can be used for comparison. These standards are established for different designated uses to protect human health and aquatic life, among other things.

The current West Virginia numeric water quality standards can be found here:
http://www.dep.wv.gov/WWE/getinvolved/sos/Documents/WQS/Standards.pdf

The current Virginia standards can be found here:
http://law.lis.virginia.gov/admincode/title9/agency25/chapter260/section140/

Qualitative, observable conditions

While quantitative methods are important for baseline testing, qualitative observations should not be overlooked. These are often the simplest and least expensive method for monitoring water quality.

At some routine interval, make it a point to document characteristics you can readily observe, such as the appearance, odor, and if potable, the taste of your water source. An example record form for routine surveillance monitoring of your water source is provided as Appendix B “**Water Monitoring Log**.” Complete this at regular intervals, as frequently as is convenient, and maintain the record for future reference. This should be completed at least monthly, but weekly or even daily can be very useful, especially when a potential stressor, such as pipeline construction, is occurring nearby.

Baseline monitoring can be enhanced substantially by self-testing using relatively inexpensive meters or by collecting samples yourself and submitting them to a laboratory for analysis. Self-collected samples by non-professionals may not be defensible in legal settings, but remember that surveillance monitoring is intended to determine whether conditions are changing from the baseline and if additional data collection steps are warranted. One good way to do this is to purchase a meter than can measure the temperature and conductivity (specific conductance) of your water source. Simple devices are also available for measuring turbidity (more information is available in the Water monitoring procedures document included with this guide in Appendix A).

Tools landowners can use to measure water quality

Conductivity meter: Specific conductance, often referred to as conductivity, is a measure of how electricity can move through the water. The more ions (charged particles) that are in the water, the higher the conductivity. Many, but not all, potential contaminants can affect conductivity. While specific conductance does not identify specifically what is in the water, changes or very high levels can indicate the presence of contaminants.

Many reliable meters are commercially available at costs below $200. Include meter readings on your monitoring records and compare them over time for variation.


Secchi tube.
Photo: www.pca.state.mn.us

Secchi tube: Another inexpensive tool that is available to landowners is a Secchi tube. Secchi tubes measure turbidity. They work by pouring sample water into a clear tube and assessing the depth at which a small disk can be clearly observed. The depth relates to the turbidity of the water. Secchi tubes can be constructed or purchased, and many non-profits, such as Trout Unlimited or West Virginia Rivers Coalition, may make them available for use, along with the other meters mentioned in this report. (See Water Monitoring Procedures document in Appendix A included with this guide to learn how to measure turbidity with a Secchi tube.)

This section describes recommended approaches to implementing a monitoring program for water resources through a combination of both qualitative and quantitative measurements. This section has generally been crafted towards owners of private water resources, but may also serve to help inform public water managers, particularly about the types of parameters to consider for sampling.

Water providers are typically required to conduct baseline water quality monitoring. However, a comparison of the recommended parameters for sampling related to pipeline development against their required monitoring may suggest additional parameters to include. Adding additional parameters may add a minimal cost, but could provide a more thorough dataset.

Establishing a source water monitoring program upstream of a public water supply intake (in the case of a surface water intake) may also provide additional information about the water source.

Baseline water quantity

As discussed, pipeline development may affect water quantity by altering local soils, geology, and the hydro-geological cycle in general. In terms of quantity, one should consider not only the rate of flow, but also how long it can be maintained. Each can be assessed qualitatively or quantitatively.

Flow rate can be assessed qualitatively (appears to be more or less than before) or quantitatively (measured in volume per time). Self-measured methods can be used, such as how long it takes to fill a container (5-gallon bucket, swimming pool, bathtub). Alternatively, third-party contractors can be hired to conduct independent, and typically more detailed, measurements.

For surface water, quantity can be assessed as a water level of a pond, lake, or river. Quantity can also be assessed as a flow rate (volume/time) in a stream. For groundwater, the volume of flow from springs may be assessed in much the same way. Flow rate can be affected by many factors and often changes seasonally or based on weather.

Sustained yield

Particularly in the case of water wells, water quantity is more accurately assessed as sustained yield or simply, how long a flow rate can actually be maintained by an aquifer. With the exception of artesian wells, defensibly documenting sustainable yield for a water well requires an aquifer pumping test. This should not be confused with a well yield test, which does not accurately represent the true sustainable yield of the groundwater resource, and instead is a function of the well pump and plumbing.

Sustained yield tests normally involve using specialized equipment and knowledge under a prescribed methodology and demonstrate what can be produced by the well, not what is stored in a plumbing system. Most state, local, and county jurisdictions require that sustained yield tests be performed by licensed professionals. For example, WVDEP recently specified requirements for developers of water supply wells for oil and gas operations to conduct detailed aquifer tests, which includes a sustained yield test. These tests must be conducted by licensed groundwater professionals or water system installers and require 72 hours to properly complete (WV 35CSR8 9.1.a.4). **This type of test comes at a considerable cost, which can be $5,000 or more. For these and other reasons, we do not recommend that homeowners perform sustained yield tests themselves**. Typically, a pump test is performed by the well driller when a new well is installed, and you may have a record of this historical information as a baseline to refer to.

If cost were not a factor, sustained yield tests could be performed during different times of the year to assess seasonal variation. However, if one test could be performed, the late summer or early fall dry season should be prioritized.

Public water providers that use wells for source water should have a previous sustained yield test from when the well was installed and originally permitted by the State. Depending on how long ago it was conducted, it may be prudent to perform an updated sustained yield test prior to pipeline construction.

5.4 Surveillance/screening

Once a baseline condition has been established, surveillance monitoring or periodic screening can be performed. This helps to indicate if conditions have changed since the baseline and generally involves less effort and lower cost. This can be done prior to or during pipeline development and construction. Surveillance monitoring is intended to detect changes rather than to “prove” contamination.

Surveillance for water quality

Qualitative observations, as described in the “Establishing a baseline” section, are also important during surveillance monitoring and can be performed as often as practical. Surveillance monitoring is a good time to collect specific conductivity and turbidity measurements with a Secchi tube to look for the range of variation and any trends in the data. It is important to note any changes observed in water quality through time. It is also important to note any physical changes, such as when construction occurs, near the water source that may impact water quality or quantity.

Surveillance water quality sampling can also be performed. The Tier 1 parameters listed in **Table 3** are a limited suite of “indicator parameters” that would provide good information and limit cost.

Surveillance for water quantity

For water wells, the static water level can also be recorded on a regular basis. This can be done by purchasing a water level meter, which is a sensor on a measuring tape that is unwound into a well. It beeps when the water is reached, and the depth to the water can then be recorded. However, water level meters generally cost several hundred dollars or more and require homeowners to introduce equipment inside the well casing, which can potentially cause damage or introduce contaminants. For these reasons and others, we recommend hiring a licensed well driller or consultant to monitor your water level.

Water levels in surface water bodies or groundwater can also be monitored using transducer data loggers, which are sensors that, once deployed, can automatically record water level or other measurements frequently and over long time periods. These systems, including the software to manage the data, are generally too expensive to be considered by individual landowners and will require training to program, properly deploy, and interpret the data. If there are multiple homeowners in an area interested in having data loggers installed in their wells or streams, collectively negotiating with a contractor or consultant may provide a way to overcome the barriers of cost and training requirements. In this way, local or even regional water level trends can be assessed at the same time, while costs can be distributed between several landowners.

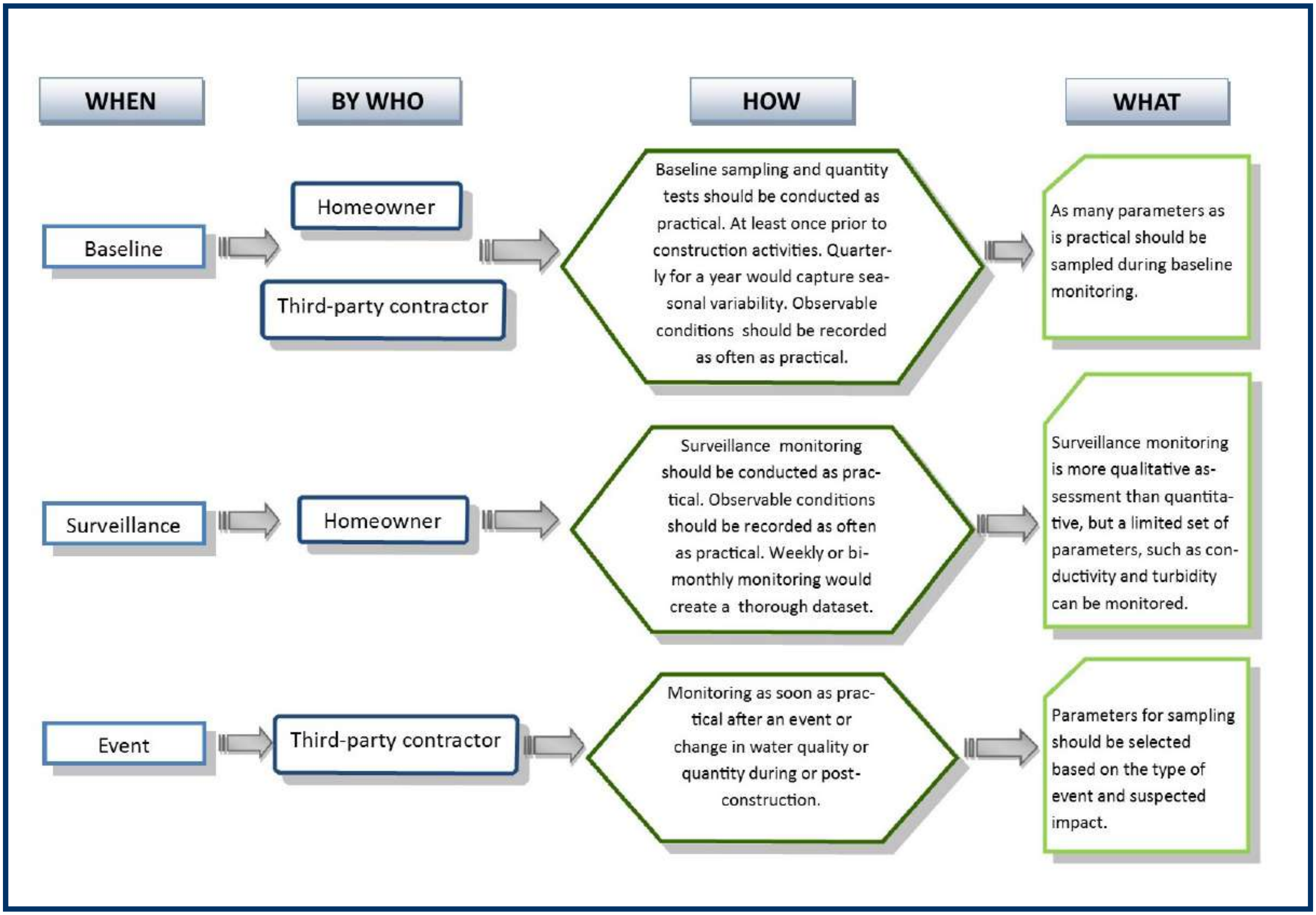
Qualitative assessments about stream or spring quantity can be recorded by the homeowner. Assessing whether flow is “typical” or more or less than “typical” can be recorded on a regular basis. A depth, or stage, at an established location, can also be noted as a way to monitor flow. The “**Water Monitoring Log**” in Appendix B allows this information to be recorded.

5.5 Event monitoring

If surveillance monitoring indicates a sudden change or deviation from baseline, this is the time to document water quality or quantity with a quantitative assessment (measurement). This may involve a case-by-case decision as to which type of assessment or set of analytical parameters is most appropriate, or as default, you may defer to the approach and methods used for the baseline assessment. This may be the most important time to consider use of a third party for guidance and to conduct the sampling or measurement to ensure defensibility and credibility to others. If results indicate an impact to water quality or quantity, then it is time to contact your regulatory agency for assistance in resolving the problem.

Figure 9 outlines each of the types of sampling described above and summarizes recommended actions.

Figure 9. Sampling flow chart



5.6 Emergency response reporting information

If there is a suspected spill or contamination of your water, the WVDEP or VADEQ should be contacted immediately. Be prepared to provide as much information as possible such as date and time of incident, exact location of spill or location of impacted water source, responsible party if known, and potential contaminant. If you have photos or videos, these should be shared as well.

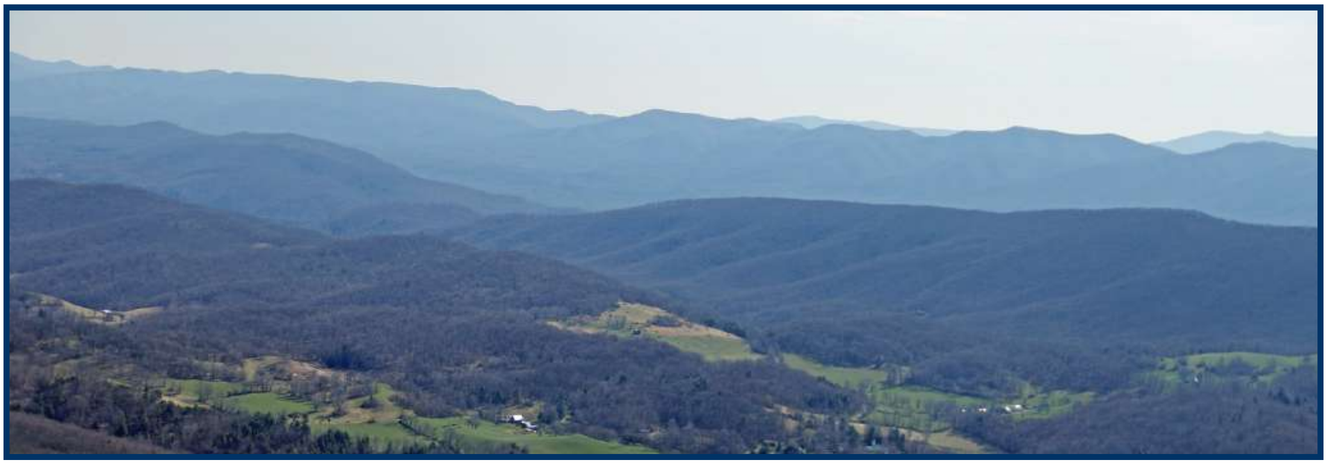
WVDEP or VADEQ should send a representative to the site to investigate. If this is on your property, plan to meet the inspector, and document their investigation. Request to have any information collected, as well as follow up information, sent to you as well.

National Response Center

The National Response Center (NRC) is the federal government's national communications center, which is staffed 24 hours a day by U.S. Coast Guard officers and marine science technicians.

Use this contact for emergencies and other sudden threats to public health, such as:

- oil and/or chemical spills,
- radiation emergencies, and
- biological discharges.



Emergency contact information

West Virginia

To report a suspected contamination event, call the West Virginia Department of Environmental Protection Spill Response Hotline.

WVDEP Spill Response Hotline
1-800-642-3074
Email: Rusty Joins, Rusty.T.Joins@wv.gov

Virginia

In Virginia there are several ways to report a pollution incident:

1. During ***normal work hours*** call the number listed for the Virginia Department of Environmental Quality Pollution Response Program (PREP) for the PREP Regional Contact that covers the area where the incident occurred.

A map of PREP regions and contacts is available here: http://www.deq.virginia.gov/Programs/PollutionResponsePreparedness/Contacts.aspx

2. Alternatively, the new on-line Pollution Reporting Form allows citizens and permittees to report pollution events on-line. Once you complete the form, a unique reference number is provided. **IMPORTANT** – citizens and permittees should make note of this number. The number will be required for follow-up on any pollution report.

The **Pollution Reporting Form** is available here: http://www.deq.virginia.gov/Programs/PollutionResponsePreparedness/PollutionReportingForm.aspx

*3. **Nights, holidays, and weekends***, call the **D**epartment of **E**mergency **M**anagement's (**DEM**) 24 hour reporting number.
In-state calls only: 1 800 468-8892
Out-of-state calls: 1 804 674-2400

National Response Center

Contact this center for emergencies or sudden threats to public health.

1-800-424-8802

6. GUIDE FOR SERVICES

This list is not intended to be comprehensive, but includes a variety of options for contractors in the vicinity of the MVP and ACP routes who can provide water sampling, laboratory analysis of water quality, wetland delineation, and biological surveys.

Consultants.
The following service providers offer a range of services including sample collection, wetland delineations, biological assessments, and data analysis and interpretation.

All Star Ecology, Fairmont, WV
allstarecology.com

Services: Stream and wetland delineation, macroinvertebrate assays, endangered species surveys, water quality monitoring, vegetation surveys.

Address:1582 Meadowdale Road, Fairmont, WV 26554
Phone: 304-816-3490

Downstream Strategies, Morgantown and Alderson, WV
Downstreamstrategies.com

Services: Sample collection, data analysis and interpretation, report preparation.

Morgantown office
Address: 295 High St., Suite 3, Morgantown, WV 26505
Phone: 304-292-2450

Alderson office
Address: 100 Railroad Ave., Alderson, WV 24910
Phone: 304-445-7200

Environmental Services and Consulting (ES&C), Christiansburg, VA
http://www.es-and-c.com

Services: Stream assessments, wetland delineation, drinking water analysis, water quality sampling, and laboratory analysis of total coliform bacteria and total heterotrophic bacterial counts only.

Address: New River Valley Office, 516 Roanoke St., Christiansburg, VA 24073
Phone: 540-552-0144
Email: nrv@es-and-c.com

Environmental Standards, Charlottesville, VA
http://www.envstd.com/

Services: Water sampling and results analysis.

Address: 1412 Sachem Place, Suite 100, Charlottesville, VA 22901
Phone: 434.293.4039

Green Rivers, Thomas, WV
Greenrivers.net

Services: Stream and wetland delineations, water supply inventories, biological inventories (endangered species and benthic macroinvertebrates), aquatic surveys, water sampling

Address: PO Box 106, Thomas, WV 26292
Phone: 304.704.4283

REIC, Beckley and Morgantown, WV and Roanoke and Staunton, VA
http://www.reiclabs.com/

Services: Laboratory analysis of samples, sample collection, wetland delineation, and macroinvertebrate surveys.

Address:
REI Consultants, Inc. (Corporate Headquarters), 225 Industrial Park Road, Beaver, WV 25813
Phone: 800-999-0105 or 304-255-2500
Email: info@reiclabs.com or fill out an online form here: http://www.reiclabs.com/contact.html

TNT Environmental, Chantilly, VA
https://tntenvironmentalinc.com/

Services: Wetland delineations and endangered species surveys.

Address: 13996 Parkeast Circle, Suite 101, Chantilly, Virginia 20151
Email: Info@TNTenvironmentalinc.com
Phone: 703-466-5123

Watershed Strategies, Bent Mountain, VA
http://www.watershed-strategies.com/#

Services: Wetland delineation.

Address: 10468 Fortune Ridge Rd., Bent Mountain, VA 24059
or
P.O. Box 21302, Roanoke, VA 24018
Phone: 540-420-4322
Email: dtrible@watershed-strategies.com

Wetland Studies and Solutions, Roanoke, VA
Wetlandstudies.com

Services: Wetland delineation, endangered species surveys, benthic macroinvertebrate surveys, vegetation assessments, and biological water quality assessments.

Address: Southwestern Virginia Office, 1402 Grandin Road SW, Suite 211, Roanoke, Virginia 24015
Phone: 703.679.5718 or 540.795.6180 (cell)
E-mail: Nathan Staley nstaley@wetlandstudies.com

Analytical laboratories.

The following laboratories perform analysis of samples collected by contractors or citizens.

ALS Environmental, South Charleston, WV
Alsglobal.com

Services: Laboratory analysis of samples, will provide a client with bottleware for sample collection.

South Charleston Service Center
Address: 1740 Union Carbide Drive, South Charleston, WV 25303
Phone: 1 304 356 3168 or 1 304 989 2643
Email: rebecca.kiser@alsglobal.com

Pace Analytical, Richmond, VA, Eden, NC, Greensburg, PA and Hurricane, WV
Pacelabs.com

Services: Laboratory analysis. Will provide bottleware prior to sample collection. Some locations offer field support.

Richmond, VA Service Center
Address: 7130 Mechanicsville Turnpike, Richmond, VA 23111
Phone: 804.559.9004

Eden, NC: Environmental Lab
Address: 205 East Meadow RoadSuite A, Eden, NC 27288
Phone: 336.623.8921

Greensburg, PA: Environmental Lab
Address: 1638 Roseytown RdSuite 2, 3, 4, Greensburg, PA 15601
Phone: 724.850.5600

Hurricane, VA: Environmental Lab
Address: 5 Weatherridge Drive, Hurricane, WV 25526
Phone: 304.757.8954

REIC, Beckley and Morgantown, WV and Roanoke and Staunton, VA
http://www.reiclabs.com/

Services: Laboratory analysis of samples, sample collection, wetland delineation, and macroinvertebrate surveys.

Address: REI Consultants, Inc. (Corporate Headquarters), 225 Industrial Park Road, Beaver, WV 25813
Phone: 800-999-0105 or 304-255-2500
Email: info@reiclabs.com or fill out an online form here: http://www.reiclabs.com/contact.html

Well drillers. The following well drilling companies can be contacted for groundwater sustained yield testing.

Foster Well & Pump Company, Inc, Across western VA
http://fosterwellandpump.clickforward.com/drilling-installation/4063818

Services: Water well drilling and related services.

Phone: 434-326-1481
Email: sffosterwell@gmail.com

Virginia Well Drilling, Harrisonburg, VA
http://Vawelldrilling.com

Services: Residential well drilling and related services.

Address: 517 Captain Shands Rd. Weyers Cave, VA 24486
Phone: 540-434-1167 (Harrisonburg) or 540-280-6946 (Augusta County, Staunton, Waynesboro)

Hyre's Well & Pump Service, Rock Cave, WV
http://hyrewater.com/well-drilling/

Services: Water well drilling and related services.

Address: 12849 Route 20 South Road, Rock Cave, WV 26234
Phone: 304-924-6898 or 800-924-3360
Email: info@hyrewater.com or Jason@hyrewater.com

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WATER MONITORING PROCEDURES

1. PREPARATION

When planning to collect water samples, the parameters should be established first. Table 3 in the Guidance for Monitoring Effects of Gas Pipeline Development on Surface Water and Groundwater Supplies provides a recommended list for sampling parameters related to natural gas pipeline development. Budget, desired results, and consultation with the laboratory should guide the final parameter list for sampling.

The laboratory that is chosen for chemical analysis should be certified by the state for each of the parameters that will be tested and they should be aware of the proper testing methodology. A third-party consultant will be aware of the appropriate sampling preparation and procedures, and should make arrangements with the laboratory themselves. If you choose to collect water samples yourself, a consultant or a laboratory can assist you in proper procedures.

2. COLLECTION AND RECORDS

2.1 Documentation of monitoring

Water monitoring events should be thoroughly documented each time they are conducted. The frequency may vary depending on the situation of the landowner, but it should be consistent. For example, every week or every month. Monitoring on a monthly basis, for as long as practical, will provide a good baseline and show the inherent variability in the data. It is also enough information to observe trends, or changes, in the data.

Notes can be recorded in a dedicated notebook, or on a log form designed to collect monitoring information. Many examples can be found online, but the "Water Monitoring Log" included with this report may also be used. A form, such as the "Water Monitoring Log" has the advantage that it provides a template for information to include.

The date, time, name of the person collecting the sample, and the weather should always be included in documentation. Other information may include field measurements, including flow or water level, collected or any observations about the water source or conditions near the water source. Any outside activities, such as construction, should also be recorded.

Photos or videos taken should be properly labeled and time stamped, if possible.

If water samples are being collected, the event should be documented in a written record and with photos and/or videos. Laboratory submittal information should also be recorded, such as the name of the laboratory and the date submitted to the laboratory. A third-party consultant collecting the samples should also keep records of the sampling event, but documentation by the landowner is also recommended.

2.2 Field measurements

A monitoring program is intended to determine whether conditions are changing from the baseline and if additional data collection steps are warranted. One good way to do this is to purchase a meter that can measure the temperature and conductivity (specific conductance) of your water source. Simple devices are also available for measuring turbidity. These meters can often be found for around $100 or less and are easy to use.

Temperature and conductivity

Conductivity can be determined with laboratory analysis or through field measurements using a hand-held electronic meter.

To determine the conductivity of the water, place the conductivity probes into the water where there is some current renewing the water in contact with the probes.

Read the temperature from the meter.

Observe the conductivity readings to make sure they are stable. Even after stabilizing, readings may drift up and down. If that is the case, select a value in the center of the range, but also record the top and bottom of the range.

Turbidity

Turbidity can also be determined with laboratory analysis or through field measurements. Field measurements can be collected with a Secchi tube (

Figure 1). Water is poured into the tube, and the depth at which a small black and white disk (the Secchi disk) cannot be seen correlates to the nephelometric turbidity units (NTUs), which is the measure of turbidity.

To measure turbidity (adapted from Trout Unlimited Water Monitoring Manual):

1. Collect a water sample and pour it into the tube until filled. If you are collecting a sample from a stream or spring, be careful to not stir up sediment from the bottom. The sample should be collected from a flowing portion of the water in a stream or spring.
2. Stand out of direct sunlight. Sunglasses should be removed.
3. Hold the Secchi tube vertically and look straight down into the tube.
4. Lower the Secchi disk into the tube using an attached string.

Lower the disk until the it disappears from view. Raise and lower the disk until you can confirm the point at which it disappears, and record the measurement on the side of the tube. This measurement will be correlated with a NTU number, which should also be recorded. Table 1 below shows the conversion from centimeters to NTUs.

Figure 1: Secchi tube

Table 1: Conversion of centimeters (cm) to nephelometric turbidity units (NTUs)

Depth to Turbidity Conversion					
cm	to	NTU	cm	to	NTU
6	=	240	39	=	16
7	=	200	41	=	15
9	=	150	43	=	14
12	=	100	46	=	13
18	=	50	48	=	12
19	=	45	51	=	11
20	=	40	53	=	10
23	=	35	57	=	9
26	=	30	62	=	8
29	=	25	67	=	7
33	=	21	76	=	6
35	=	19	85	=	5
36	=	18	97	=	4
38	=	17	118	=	3

Flow

Flow volume or flow rate of surface water or springs can be estimated by volume or by comparing to an established marker. Descriptions, such the flow is higher or lower than normal, can be recorded. A yard stick or other measuring device can be installed and the level of the water on the measuring device can be recorded at regular intervals.

For a spring, flow can also be measured using a bucket or other container of known volume and a stop watch. The procedure to measure flow in this manner is to record the seconds it takes to fill the bucket to a known volume. Flow can then be calculated by dividing the volume of water captured by the number of seconds. It is recommended that you make at least three measurements, averaging the calculated flows to arrive at a flow estimate.

For water wells, the static water level can also be recorded on a regular basis. This can be done by purchasing a water level meter, which is a sensor on a measuring tape that is unwound into a well. It beeps when the water is reached, and the depth to the water can then be recorded. However, water level meters generally cost several hundred dollars or more and require homeowners to introduce equipment inside the well casing, which can potentially cause damage or introduce contaminants. For these reasons and others, we recommend hiring a licensed well driller or consultant to monitor your water level.

Water levels in surface water bodies or groundwater can also be monitored using transducer data loggers, which are sensors that, once deployed, can automatically record water level or other measurements frequently and over long time periods. These systems, including the software to manage the data, are generally too expensive to be considered by individual landowners and will require training to program, properly deploy, and interpret the data.

Even recorded observations, such as the well going dry for some period of time, particularly if it never has, are important. Again, any information should be thoroughly documented with notes and photos or videos.

3. RESULTS AND INTERPRETATION

3.1 Maintaining data

Paper copies and electronic versions of the sampling records should be maintained if possible. A three-ringed binder or folder would be appropriate for filing all the paperwork if multiple records will be kept. Laboratories can send data in both paper and digital copies as well for your records.

3.2 Results

The laboratory may offer some information or interpretation of the results; however, this information may be limited since they do not have information about your particular water source. One way to interpret the results is to compare them to state or federal water quality standards.

When testing drinking water—either a well, spring, or surface water—the best source is the USEPA Federal Drinking Water Standards. The drinking water standards establish maximum containment levels (MCLs), which are legal, health-based, enforceable limits for certain contaminants in drinking water. While the USEPA standards apply specifically to public drinking water supplies, they provide a point of comparison for water quality in the samples collected. The USEPA also issues Secondary Standards, which are not health-based and non-enforceable, but provide recommended thresholds for aesthetic qualities, such as taste, odor, and appearance. The most recent version of the drinking water standards can be found on the USEPA website.

https://www.epa.gov/ground-water-and-drinking-water/table-regulated-drinking-water-contaminants

When testing drinking water, West Virginia or Virginia surface water standards can be used for comparison. Surface water standards are established to protect waterways for public health and recreation, aquatic life, and for use in economic pursuits, such as agriculture or fisheries.

The current West Virginia standards can be found here:

http://www.dep.wv.gov/WWE/getinvolved/sos/Documents/WQS/Standards.pdf

The current Virginia standards can be found here:

http://law.lis.virginia.gov/admincode/title9/agency25/chapter260/section140/

4. TOOLS FOR WATER MONITORING

Below are a few recommended meters and a Secchi tube for monitoring water resources.

Conductivity meters

- LaMotte Company Salt/EC/TDS Pocket Tester, Code 1749
  http://www.lamotte.com/en/browse/1749.html

  Online prices range from $150 to $174 for the meter, a carrying case, and calibration solution.

- Oakton WD-35425-10 Waterproof Multiparameter PCSTestr35
  http://www.4oakton.com/proddetail.asp?parent=2&prod=352&seq=2&Totrec=13

  Online prices range from $141 to $165 for the meter and a carrying case.

Secchi tube

- Secchi-Tube (Code ST-60) or (ST-120)
  http://www.watermonitoringequip.com/pages/stream.html

  Online price is $57 for 120 cm tube.

- Secchi tube 120 cm
  http://www.forestry-suppliers.com/product_pages/Products.asp?mi=83631

  Online price is $59.

WATER MONITORING LOG Date: ____________________

Name of observer: ______________________________________

Site Name: ______________________________

Site Type: _____ **Well** _____ **Spring** _____ **Surface water**

Event: _____ **Observation** _____ **Sampling**

Sampler(s): ____

____

Begin Time: _________ End ____________________ Page___ of ___

Weather Observation

Air Temperature (°F): ______

Cloud cover: _________________________

Preciptation (None, Light, Heavy, etc.): ____________________ Date of last rain:_____________________

Approximate amount of rain (in.):_______

Other weather notes:____

____

Observations

Water clarity (clear, cloudy, etc.):___________________________________

Water odor:_____________________________

Water taste:_____________________________

Has there been a change since last observation? ____Yes ____ No

If yes, describe and provide date of last observation:

____

____

____

____

____

____

Sample collection

Water sample collected? ____ Yes ____ No

Sample ID:_______________________

Laboratory for analysis:_____________________

Date submitted to the lab:___________________

Chain of custody number:____________________

Field Measuerments

Conductivity (µS): __________________

Temperature (°C): ______________

Turbidity (Secchi tube): centimeters _____________ NTUs ______________

Flow/Water Level

_____ Observed

Surface or spring flow

_____ Higher than normal _____ Lower than normal _____ About normal

Surface or spring clarity

Describe water clarity:____

Other observations (flow, smell, taste, etc):_______________________________

____

____

____

Well yield

_____ Higher than normal _____ Lower than normal _____ About normal

Well water clarity

Describe water clarity:____

Other observations (flow, pressure, smell, taste, etc):______________________

____

____

____

_____ Measured

Surface or spring flow

Measurement method: _____ Depth/stage _____ Bucket and stopwatch _____ Other

If other, describe:____

Depth/stage: __________ Depth/stage measured by: _____________________________________

Bucket and stopwatch

	Time (seconds)	Volume (mL)
Trial 1		
Trial 2		
Trial 3		

Average flow (mL/sec): _____________

Other technique notes: ___________________

____

____

____

____

____