Pipeline Impacts to Water Quality

Documented impacts and recommendations for improvements

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Downstream Strategies
Ideas that sustain.

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Stormwater & Stewardship

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ABBREVIATIONS

BMP	best management practice
ESC	erosion and sediment control
ETP	Energy Transfer Partners
FERC	Federal Energy Regulatory Commission
HDD	horizontal directional drilling
IR	inadvertent return
MDEQ	Michigan Department of Environmental Quality
ME2	Mariner East II
MVP	Mountain Valley Pipeline
NOV	notice of violation
OEPA	Ohio Environmental Protection Agency
PADEP	Pennsylvania Department of Environmental Protection
PPCP	Prevention Preparedness Contingency Plan
SPLP	Sunoco Pipeline, L.P.
SWM	stormwater management
SWPPP	Stormwater Pollution Prevention Plan
VDEQ	Virginia Department of Environmental Quality
WVDEP	West Virginia Department of Environmental Protection

EXECUTIVE SUMMARY

The natural gas boom in the Appalachian region in recent years has led to an increase in the number and size of natural gas pipelines constructed to carry natural gas out of the region to national and international markets. Even when care is taken to minimize impacts, any construction project of this scale will have impacts on the environment, and pipelines are no exception. Detrimental effects to water quality can be temporary or lasting and include increased sedimentation and erosion; inadvertent returns of drilling fluid at river crossings; and reduction of important aquatic life habitat through the removal of vegetation, disturbance to substrates, sedimentation, and placement of structures.

This report describes water quality impacts observed along the routes of four pipelines that have been recently completed or are under construction. Pipelines discussed herein include the Mountain Valley Pipeline and WB Xpress Pipeline in West Virginia and Virginia, the Rover Pipeline in West Virginia and Ohio, and the Mariner East II Pipeline in Pennsylvania.

The most significant water quality problems faced along both the WB Xpress and Mountain Valley pipelines have included inputs of sediment-laden water to streams. Most of the routes for these two pipelines cross mountainous terrain characterized by steep slopes, headwaters streams, and highly erodible soils. Reasons for failure of erosion and sedimentation controls that led to sedimentation in waterways were notably improper installation and lack of maintenance of the structures.

Mariner East II and Rover Pipelines both experienced significant water quality issues related to spilled drilling fluid during horizontal directional drilling, which contaminated streams and wetlands. Additionally, failure of erosion and sediment controls due to improper installation or insufficient maintenance, as well as a lack of approved erosion and sediment control best management practices, were major sources of violations for both pipelines.

This report also offers recommendations for improving regulation and oversight, best management practice design and implementation, and construction techniques for large-scale pipeline projects. These recommendations are based on observations of what went wrong during construction of the four pipelines, and techniques and requirements that are working to minimize water quality impacts. Notable recommendations include requiring site-specific stormwater plans for all stream and wetland crossings, encouraging companies to complete construction projects in shorter sections, and increasing regulatory inspections at the expense of the pipeline companies.

1. INTRODUCTION

With the recent spike in natural gas development in the Appalachian region, pipelines are being built 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. Any large-scale construction project will have impacts on the environment, and pipelines are no exception. Concerns are diverse and include surface water and groundwater impairment, habitat fragmentation, forest degradation, and private property rights.

As illustrated in Figure 1, four of the many pipelines completed or currently under construction in Appalachia are discussed in this report. The Mountain Valley Pipeline (MVP) is currently under construction in West Virginia and Virginia, and the Mariner East II (ME2) Pipeline is currently being constructed in Pennsylvania. The Rover Pipeline—located in West Virginia and Ohio—and the WB Xpress Pipeline in West Virginia and Virginia are currently complete.

These pipelines are buried up to ten feet below the surface, removing vegetation, soil, and bedrock along the construction right-of-way. An extensive network of access roads and staging areas are required. These surface disturbances impact both surface water and groundwater resources.

This report describes the environmental impacts observed during and following construction of these four pipelines. Recommendations are then provided for regulatory changes and improvements to best management practices (BMPs) that would allow pipeline construction to proceed with fewer harmful environmental impacts.

1.1 Types of pipeline impacts on water quality

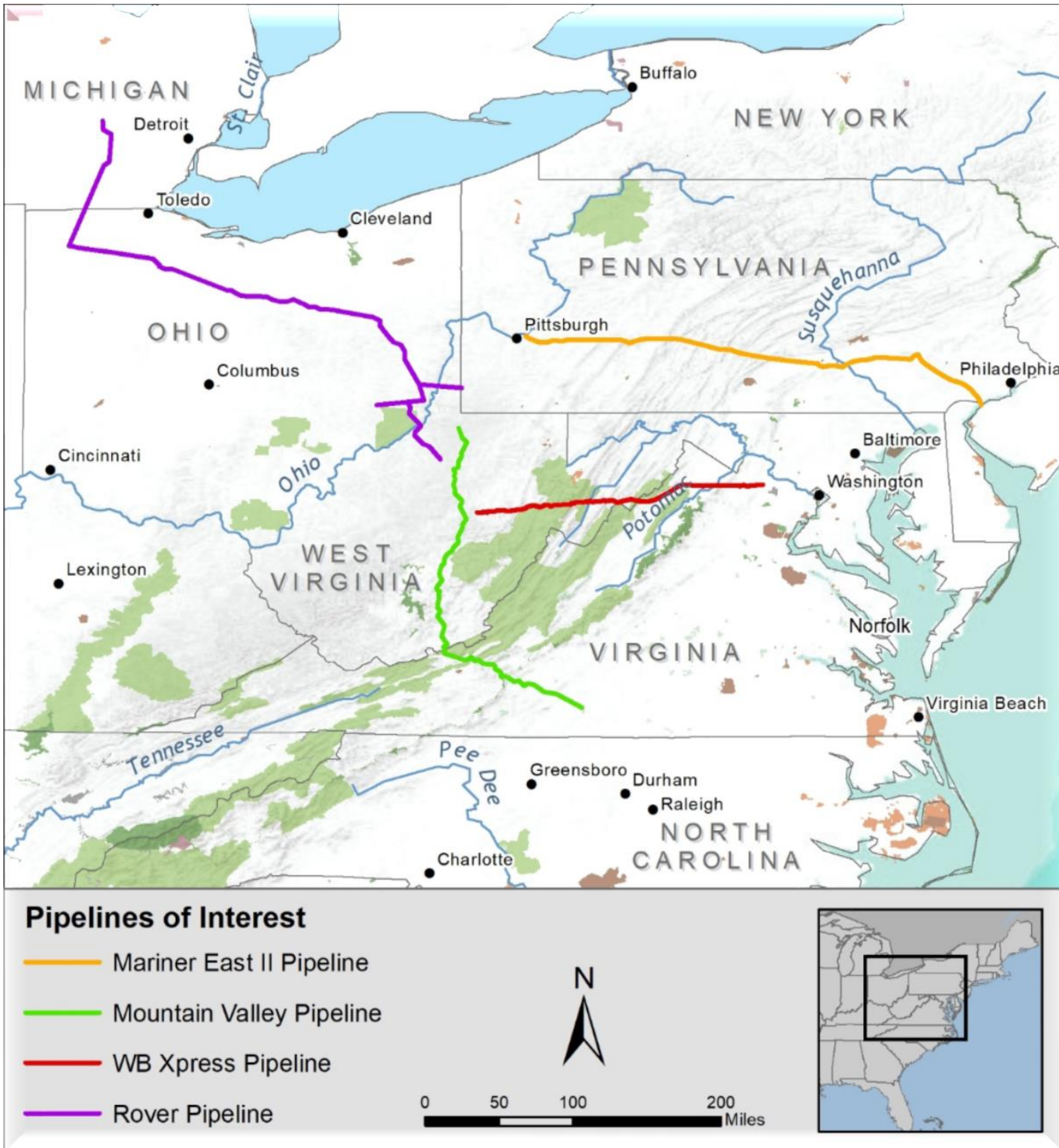
Pipelines are long, linear projects, often traversing hundreds of miles. They cannot avoid crossing streams and headwaters areas; thus, proper stormwater management practices must be planned for, constructed, and maintained to avoid impacts to water quality. Stream crossings and impacts to streambanks and upland areas from pipeline and access road construction can cause substantial erosion and sedimentation, increase instream turbidity, and harm aquatic life by, among other things, smothering spawning beds and fish eggs, reducing juvenile fish survival, and reducing benthic community diversity and health. (Weltman-Fahs and Taylor, 2013; Entrekin et al., 2011; Abrahams et al., 2015; Fesenmyer et al., 2018)

In addition to these permanent and temporary impacts, wetland crossings can result in conversions from forested to either scrub-shrub or herbaceous wetlands, which will nearly always result in a loss of important wetland functions.

Pipeline construction may impact environmental resources through a number of processes:

- Soil erosion contributes sediment to waterways, thus increasing sediment loading in streams (Environmental Solutions & Innovations, 2017; Clingerman and Hansen, 2016).
- Inadvertent returns (IRs) from horizontal directional drilling (HDD) at river crossings can introduce polluted water into streams and rivers being crossed (PADEP, 2017a).
- Fish and macroinvertebrate habitat quality may be diminished by removal of vegetation, disturbance of substrates, grading of channels, increased sedimentation, and placement of structures (United States Fish and Wildlife Service, 2019).
- Excavation, compaction, and disturbance of soils can impact water flow patterns and can increase the quantity of stormwater runoff from the right-of-way and access roads, causing downstream erosion (Glass et al., 2016; Williams, 2012).
- Alteration of geology and topography can lead to landslides, which can introduce sediment-laden water and create sediment deposits in streams (Glass et al., 2016; Williams, 2012).

Figure 1: Pipelines reviewed in this report



- Spills of petroleum products utilized by construction machinery may enter waterways, if not properly contained (Glass et al., 2016; Williams, 2012).
- Blasting and grading could alter surface and groundwater flow due to an increase in fractures (Glass et al., 2016; Williams, 2012).
- Karst formations can transport sediment-laden water to surface and groundwater resources located away from the construction zone (Glass et al., 2016; Williams, 2012).
- Exposed rocks could leach acid or metals into waterways. (Glass et al., 2016; Williams, 2012).

Erosion and sedimentation are some of the most significant and visible impacts from pipeline construction. While some amount of sedimentation occurs naturally, excess sediment in streams—which is considered a pollutant—will be caused by pipeline construction activities and by erosion of exposed soils after active construction has ended. Construction activities, including pipeline and road construction, cause erosion and sedimentation—even when best management practices are used. These activities include stream crossings, wetland crossings, and upland pipeline and access road construction. In some cases, pipeline and access road crossings pollute pristine waters. In others, it would exacerbate already-existing impairments tied to sediment.

Pipeline impacts on recreation, drinking water, and aquatic life

Recreation: Increased turbidity may impact fishing, boating, and swimming opportunities in waterways.

Drinking water: Pipeline construction can impact both surface and groundwater resources utilized by public water providers and private drinking water wells.

Aquatic species: Pipeline routes may cross spawning areas for many types of fish, including important trout spawning areas. The native Eastern brook trout lives and reproduces in only the cleanest, coldest streams. Removal of forest canopy and sedimentation will diminish trout habitat.

Increased sedimentation and turbidity—often visible to the naked eye as "muddy" water—have real impacts on recreation, drinking water, and aquatic life. For example, the Federal Energy Regulatory Commission's (FERC's) Final Environmental Impact Statement for the MVP states the following:

> "Increased sedimentation and turbidity resulting from in-stream and adjacent construction activities could displace and impact fisheries and aquatic resources. Sedimentation could smother fish eggs and other benthic biota and alter stream bottom characteristics, such as converting sand, gravel, or rock substrate to silt or mud. These habitat alterations could reduce juvenile fish survival, spawning habitat, and benthic community diversity and health. Increased turbidity could also temporarily reduce dissolved oxygen levels in the water column and reduce respiratory functions [for] in-stream biota. Turbid conditions could also reduce the ability for biota to find food sources or avoid prey... Benthic invertebrates and freshwater mussels could also be affected by elevated turbidity and suspended sediments. Although freshwater mussels in the construction zone would be relocated by qualified biologists and in accordance with both West Virginia and Virginia mussel protocols, downstream sessile species could be affected. Aquatic invertebrates, including insect larvae, would generally be unable to avoid work areas." (FERC, 2017, p. 4-216-217)

Pipeline-related impacts to water quality can be long-term and lasting. Initially, there are impacts when disturbance begins and, where streams are trenched using dry crossing methods, when flow is reestablished over the construction area. In the medium-term, moderate (perhaps intermittent) increases in sedimentation and turbidity continue from the streambed and streambank until revegetation occurs in the area immediately adjacent to the construction site. In the long term, the sediment contribution from upland pipeline corridors can still result in measurable increases in sedimentation and turbidity, dependent upon soil type, slope, and success of revegetation in the upland corridor. Peer-reviewed journal articles have documented short-, medium-, and long-term impacts to benthic macroinvertebrates and fish; one article documented effects that lasted over four years (Lévesque and Dubé, 2007).

1.2 Overview of best management practices

BMPs utilized for erosion and sediment control (ESC) during pipeline construction are similar to those implemented on other types of construction projects. Commonly used pipeline construction BMPs include waterbars, compost filter socks, silt fences, and diversion dikes or ditches.

Commonly used pipeline construction BMPs

Compost filter sock - A mesh tube filled with composted material that is placed below a disturbed area, perpendicular to sheet flow, to filter runoff before it leaves the site.

Cross drain - A structure, usually a culvert pipe, used to convey runoff from a roadside ditch to a discharge point below the roadway

Diversion ditch or dike - A barrier or channel constructed for the purpose of diverting upslope runoff around a work area.

Drop inlet - A system that directs water through a box or pipe structure, dissipating most of the energy produced by the water.

Perimeter control - BMPs installed at or near the project boundaries to prevent runoff from entering the disturbed area or to capture and treat runoff from disturbed areas prior to leaving the site.

Sediment trap - A small impoundment constructed for removal of sediment from runoff.

Silt fence - A sediment barrier constructed from filter fabric attached to support stakes.

Sump - A pit, cistern, or other small containment structure used to collect or drain surface water.

Underdrain - A backfilled trench containing a perforated pipe for the purpose of intercepting groundwater or seepage.

Waterbar - A low berm constructed at an angle across the right-of-way to direct runoff onto a well-vegetated area.

Source: PADEP (2012), except drop inlet definition from National Park Service (2019).

However, typical construction projects adhere to defined design standards—those mandated by state ESC manuals, for example—which provide limits on the size of a drainage area, among other specifications. Pipelines may use similar techniques but may not be held to the same design standards due to variances and exemptions in state permitting processes. Additionally, construction of the pipelines described here have presented unique challenges, given the steep slopes traversed in mountainous regions, the numerous headwater streams crossed, and the occurrence of short-duration storms with heavy rainfall.

One challenge faced by pipeline construction is the need to cross numerous streams and wetlands of various sizes. Many pipelines use some type of open-trench method to cross most streams and wetlands. Dam-and-pump crossing methods involve building a dam above the construction site and pumping stream water to the downstream side. Similarly, a flume method utilizes pipes to dewater the construction site (PennEast Pipeline, 2019; Pharris and Kopla, 2007). Wet open-cut methods are undertaken in a flowing stream and usually result in sedimentation downstream during the construction activities (NEB, 2019). Regardless of the exact open-trench method utilized, or the care taken during construction, disturbance of the streambank and streambed can cause a marked increase in sedimentation and turbidity over the short- and long-term.

Horizontal directional drilling (HDD)—a stream crossing method in which a tunnel to house the pipeline is drilled underneath a surface water, road, or other feature—is often touted as having minimal impacts to surface waters (PennEast Pipeline, 2019; NEB, 2019). However, this method is not without risk; drilling fluid spills and runoff from work areas pose threats to waterways. Drilling fluid is composed of bentonite, water, and additives chosen by the company from a list of approved compounds that can be used when drilling public water supply wells (PADEP, 2018a). Though bentonite is a type of natural clay, releasing it into streams and wetlands can increase sediment in those areas.

BMPs for prevention of water pollution may not properly prevent contamination events for a number of reasons:

1. the correct BMPs were planned, but were not installed correctly or at all;
2. inappropriate BMPs were installed, or BMPs were inadequate for the conditions; or
3. BMPs were improperly operated and maintained.

As discussed in the following chapters, all four pipelines reviewed for this report struggled with each of these issues to some extent.

2. MOUNTAIN VALLEY PIPELINE

As illustrated in Figure 2, the MVP would cross two states: West Virginia and Virginia. The route extends from Wetzel County, West Virginia to Pittsylvania County, Virginia—a distance of approximately 300 miles. This 42-inch pipeline requires a 50-foot permanent easement and a 125-foot temporary easement during construction (MVP, 2017). Water and wetland crossings will be reduced to a 75-foot construction width (VDEQ, 2017). Construction began in 2017, and as of June 2019, necessary permits and certifications for this project had been vacated and MVP was working with regulatory agencies to improve plans and re-establish approvals to allow crossing of national forest lands, the Appalachian Trail, and rivers, streams, and wetlands.

The MVP traverses mountainous terrain characterized by steep slopes, highly erodible soils, and numerous headwaters streams. Even well-maintained ESC measures may not be able to adequately protect water quality under these circumstances. Thus, extra care must be taken during the design phase and during construction and maintenance of ESCs to ensure that water quality is not impacted. In the most challenging terrain, some areas may simply not be appropriate for pipeline construction.

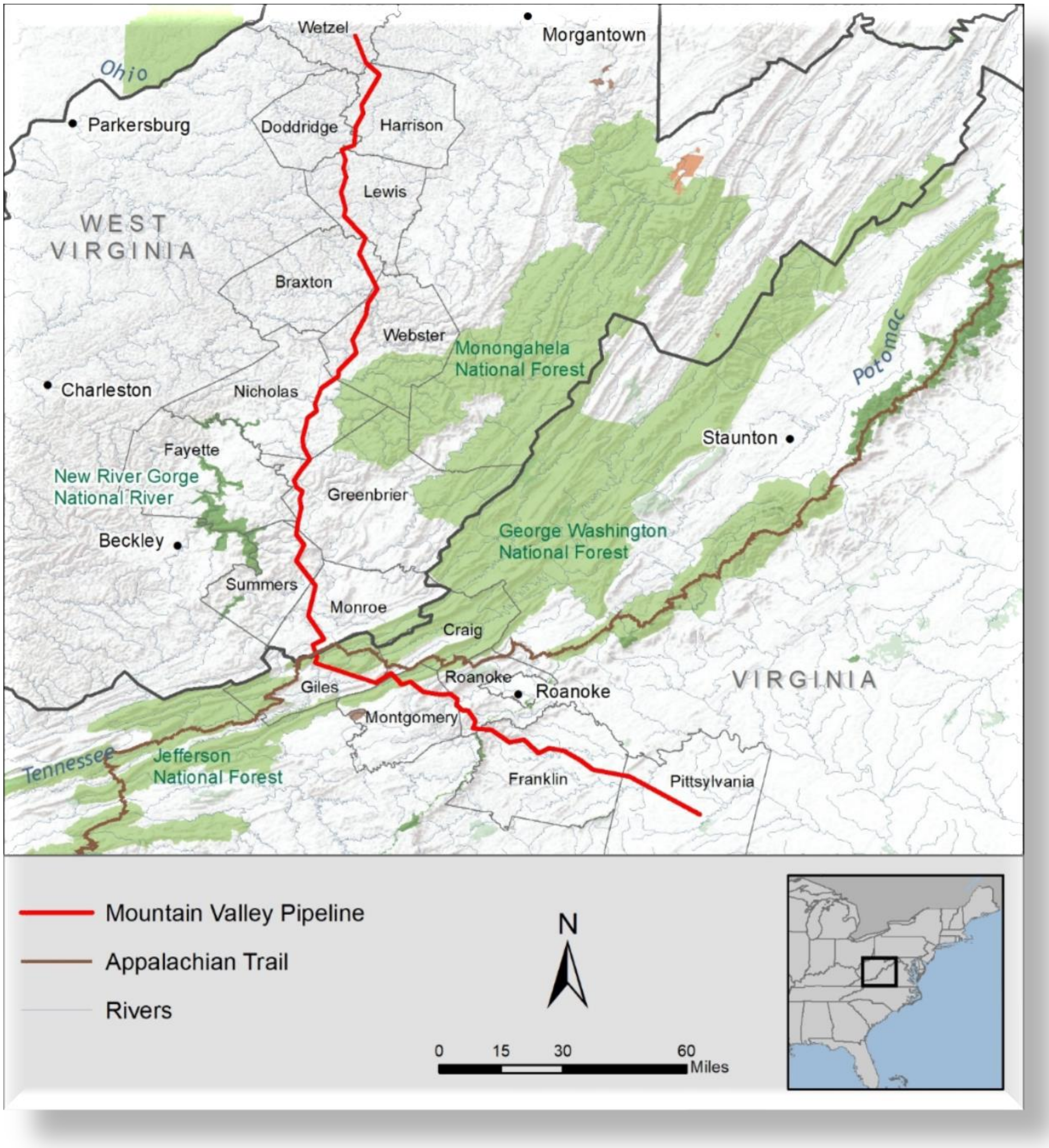
Portions of the MVP route are underlain with karst. These formations contain underground channels that can quickly transport polluted water to surface and groundwater systems outside the immediate vicinity of the pipeline. Extra precautions must be taken in karst areas to avoid surface and groundwater contamination.

2.1 State-specific water pollution prevention measures

WVDEP requires a Water Pollution Control Permit for Stormwater Associated with Oil and Gas Related Construction Activities for pipeline work. Terms of this permit stipulate that sediment-laden water must not leave the construction site, that ESCs must be in place and properly operated and maintained, that conditions of the Stormwater Pollution Prevention Plan (SWPPP) must be met and the SWPPP must be updated if plans are inadequate, and that state water quality standards must not be violated. Each of these terms has been violated at least once by MVP.

WVDEP chose to waive the State 401 certification, but in Virginia, VDEQ imposed extra requirements in its state 401 certification to address karst features, hydrostatic testing, acid soils mitigation, steep slopes, spill prevention control and countermeasures, riparian buffer protections, and surface water withdrawals (VDEQ, 2017). This certification requires that MVP abide by requirements of the Stormwater Management Act, Erosion and Sediment Control Law and the Virginia Water Protection Permit Program Regulations. The Virginia Stormwater Management Act requires that MVP obtain approval of its Annual Standards and Specifications related to ESC and stormwater management. These Annual Standards and Specifications required MVP to submit site-specific ESC and stormwater management (SWM) plans to VDEQ for review and approval. Additionally, the Annual Standards and Specifications state that the agency will perform pre-scheduled and random site inspections and that a third-party contractor will also be utilized to evaluate compliance with site-specific ESC and SWM plans (Paylor v. MVP, 2018; VDEQ, 2019a).

Figure 2: The Mountain Valley Pipeline



2.2 Summary of issues observed

2.2.1 *Virginia*

VDEQ and the Virginia State Water Control Board filed a lawsuit against MVP in December 2018 (Paylor v. MVP, 2018). The suit states that MVP construction activities had violated state environmental regulations more than 300 times between May and November 2018 (Paylor v. MVP, 2018; *Roanoke Times*, 2018). The legal complaint describes numerous instances of failure to install diversion ditches or dikes, failure to apply temporary or permanent stabilization, failure to maintain and repair ESC structures, sediment leaving the construction right-of-way, and unpermitted discharges (Paylor v. MVP, 2018). As of June 2019, parties were negotiating a settlement (Luckett, 2019).

VDEQ maintained a database (VDEQ, 2019b) that documented complaints received, and actions taken, by the agency. This database included 233 complaints relating to construction of the MVP from March 2018 through May 2019. These reports were investigated by agency inspectors and some may be included in the legal complaint described above. Sediment releases and/or inadequate ESCs are the subject of 166 of these complaints. Five additional complaints describe wetland disturbances.

According to VDEQ, all complaints received are investigated by agency staff. In most cases, the contractors were in the process of remedying the situation when inspectors arrived, or inspectors did not observe environmental impacts when they reached the sites. In those cases, violations were not issued. Quick repair and improvements of ESC structures is important; however, to adequately protect water resources, companies must avoid impacts in the first place.

2.2.2 *West Virginia*

WVDEP issued a consent order to MVP that describes 25 notices of violation (NOVs) issued between April and November 2018. All violations referenced releases of sediment-laden water to the environment. Most of these releases occurred because ESC structures were not installed correctly. The NOVs also note numerous occurrences of releases due to improper maintenance and operation of structures, situations where ESC structures were not installed at all, and situations where the installed structures were inadequate for the conditions, due to heavy rainfall events, for example, or incorrect calculation of the drainage area accommodated by a control (WVDEP, 2019a).

Numerous NOVs referred to waterbar failures. In many cases, waterbars did not shed stormwater off the project area properly. Reasons for this included installation of waterbars at angles that were too steep to allow them to properly transport water across the disturbed area, failure to construct outlets on waterbars, not constructing a sufficient number of waterbars, and placement of waterbars that did not extend past the disturbed area, which channeled stormwater onto denuded slopes instead of onto to the vegetated area adjacent to the disturbed construction zone.

Improper construction and maintenance of perimeter controls, such as silt fences and compost filter socks, were often the reason for releases of sediment-laden water. One NOV stated that a silt fence, which is designed to control sheet flow, was being used in concentrated flow areas. Many NOVs described perimeter controls that were not maintained frequently enough. They were therefore clogged with sediment, allowing stormwater to flow over the top of the control. Another problem observed by inspectors was that silt fences were not properly joined and trenched. If perimeter controls are not properly maintained and are placed along the edge of a pipeline parallel to the slope, they can act as channels for stormwater runoff, leading to erosion at the work site.

WVDEP inspectors observed ESCs that were not installed as planned or were not installed correctly:

- Cross drains were not in place.
- Installation of an underdrain outlet remained unfinished while the underdrain was operational.
- An improperly installed washout device was filtering particles, but not adjusting pH as planned.
- ESCs were not installed at sumps.

Mountain Valley Pipeline case study

On August 10, 2018 a WVDEP inspection revealed multiple failures of ESCs that led to sediment pollution in five streams and three wetlands in Doddridge, Harrison, and Lewis Counties. Inspectors observed waterbars installed at angles too steep to properly convey water away from disturbed areas. Many waterbars discharged stormwater into unstable diversions and/or terminated prior to the edge of the disturbed area. These problematic waterbars thus did not properly discharge stormwater off site. Additionally, many ESC devices were not properly maintained, which resulted in offsite sediment deposits. Inspectors also observed fill slope erosion due to concentrated flow that had been directed over fill slopes and/or unstable diversions. These ESC failures resulted in violations of water quality standards for distinctly visible settleable solids in five streams and three wetlands.

Sediment trail leading to Laurel Run as a result of perimeter controls that were overwhelmed due to improperly installed and maintained waterbars

Sedimentation that violates water quality standards in the Unnamed Tributary Kincheloe Creek wetland

Mountain Valley Pipeline case study, continued

Diversion running parallel to the slope.

Waterbar outlet that has been overwhelmed, causing violations of water quality standards in the receiving stream.

Source: WVDEP (2018).

2.3 Specific water quality issues

Sedimentation is the most significant water quality problem resulting from construction of the MVP, which is likely due to the steep terrain with highly erodible soils found along its route. All 25 NOVs issued by WVDEP state that “MVP failed to prevent sediment-laden water from leaving the site without going through an appropriate device.” (WVDEP, 2019a) Many of the NOVs describe visible sediment deposits and distinctly visible settleable solids in receiving streams.

One NOV in West Virginia describes standing water collecting in a fueling area due to improper ESCs, which may have caused petroleum products to enter surface waters.

MVP has been cited for violations of West Virginia’s surface water quality standards at 38 locations in streams, wetlands, and a pond. These citations were due to sediment deposits or distinctly visible settleable solids (WVDEP, 2019a).

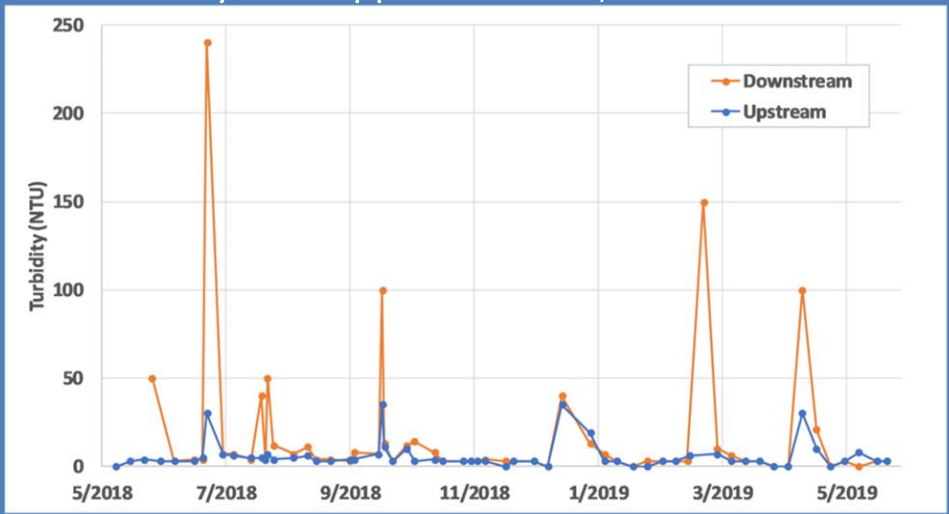
Similarly, in Virginia, more than 70 percent of the complaints submitted to VDEQ between March 2018 and May 2019 describe noticeable sedimentation, turbidity, and/or erosion associated with failed ESCs.

Citizen monitoring data and observations

Trout Unlimited and West Virginia Rivers Coalition have teamed up to train citizen volunteers in West Virginia and Virginia to monitor streams that support trout as well as high-quality warmwater fisheries at risk from oil and gas development. The WV-VA Water Quality Monitoring Project has developed a protocol specific to natural gas pipeline construction. This protocol provides volunteers with the tools needed to identify erosion and sediment impacts before, during, and after construction activities (West Virginia Rivers Coalition, 2019). As illustrated below, citizen-collected photos show sediment impacts in streams, and citizen-collected data demonstrate increased turbidity downstream of MVP construction.

A sediment-laden tributary enters Blue Lick in Monroe County, West Virginia, downstream from MVP construction, as documented by volunteers

Volunteer turbidity data near pipeline construction, North Fork Roanoke River



Source: Photo and data from Lemon (2019). Note: Values of 0 are actually less than 3, the minimum detection level of the secchi tubes.

United States Geological Survey real-time data

The United States Geological Survey, in collaboration with VDEQ, has installed a network of real-time water quality monitoring stations at locations upstream and downstream of MVP stream crossings. These monitoring stations measure temperature, turbidity, specific conductance, pH, and dissolved oxygen every five minutes. These data are made available to the public and provide information useful in assessing water quality impacts due to pipeline construction. (United States Geological Survey, 2019)

2.4 Regulatory agency actions

Regulatory agency inspectors in both Virginia and West Virginia have made routine inspections at construction sites along the entire route of the MVP. Additionally, both agencies have generally been responsive to citizen complaints submitted to the agency and investigated citizen complaints (VDEQ, 2019b). Understaffing at WVDEP prevents inspectors from visiting sites as frequently as necessary.

WVDEP's 25 NOVs included a total of $265,972 in fines. The outcome of the lawsuit filed by VDEQ against MVP (see Section 2.2.1) in Virginia may result in improvements to practices on the ground and additional fines.

3. WB XPRESS PIPELINE

Columbia Natural Gas's WB Xpress Pipeline crosses northeast West Virginia and extends into northern Virginia (Figure 3) and has been operational since fall 2018. The project consisted of construction of three miles of various diameter pipeline, replacement of 26 miles of various-diameter pipeline, two new compressor stations, and modifications and alterations to seven additional compressor stations. (Reuters, 2018 and FERC, 2015). The majority of the construction work on this pipeline project occurred in West Virginia in the vicinity of the Monongahela National Forest; only two miles of new pipe and one compressor station were constructed in Virginia (FERC, 2015). The project received several NOVs from WVDEP during its construction due to releases of sediment-laden water. Like the MVP, this pipeline crosses steep terrain, headwaters watersheds, and karst features. Construction in this challenging terrain can lead to erosion and sedimentation problems if extreme care is not taken in design, implementation, and operation and maintenance.

3.1 State-specific water pollution prevention measures

WVDEP requires a Water Pollution Control Permit for Stormwater Associated with Oil and Gas Related Construction Activities. Terms of this permit stipulate that sediment-laden water must not leave the construction site, ESCs must be in place and properly operated and maintained, conditions of the SWPPP must be met and the SWPPP must be updated if plans are inadequate, and state water quality standards must not be violated. Each of these terms has been violated at least once by the WB Xpress Pipeline.

Pipeline projects in Virginia must meet specifications of the Stormwater Management Act, Erosion and Sediment Control Law, and the Virginia Water Protection Permit Program Regulations. Additional measures taken to protect water quality during construction of large-scale pipelines, such as third-party inspections and site-specific ESC and SWM plans, were not required for the portion of this project located in Virginia (VDEQ, 2019).

3.2 Summary of issues observed

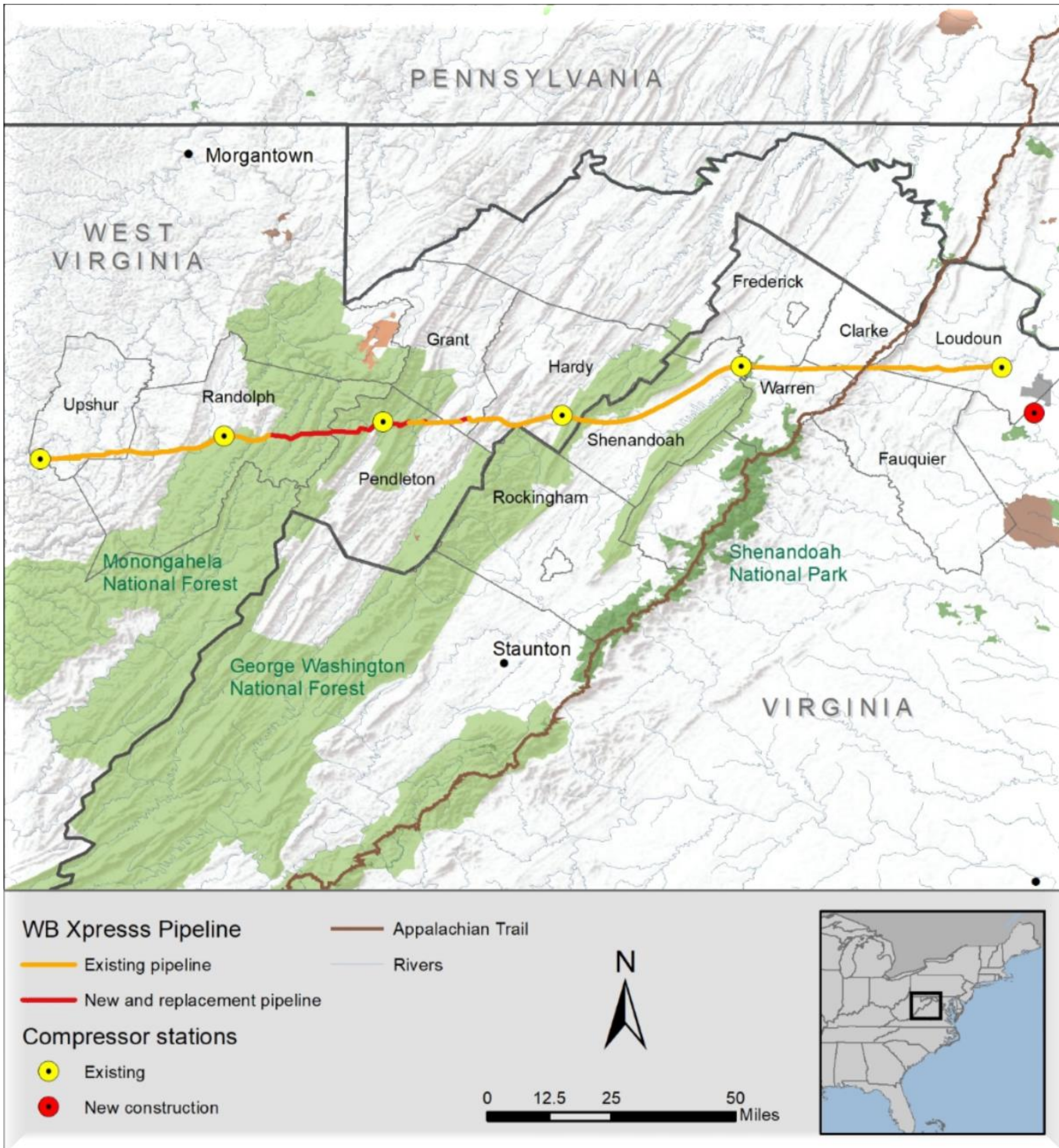
Erosion and sedimentation were the most significant water quality problems associated with construction of the WB Xpress Pipeline. NOVs described numerous ESC failures or inadequacies that led to water quality impacts. Similar to the issues associated with the MVP, improper installation, maintenance, and operation of ESCs led to sediment releases into waterways.

Examples described in NOVs included instances where drop inlets were not properly maintained. In one case, the silt sock protection was flattened, allowing sediment to get into the drop inlet, which was then overwhelmed. Perimeter controls and waterbars were inundated due to a lack of maintenance, causing multiple releases of sediment-laden water. Instances of waterbars that were not properly constructed, and thus were not adequately transporting water off-site, were documented on multiple occasions.

In another case, a filter sock was not properly attached to a temporary bridge and straw bales—which are not an allowable BMP in any case, according to WVDEP. This technique failed to control sediment and led to a pollution event.

At least two wetlands were impacted as a result of improper installation and maintenance of BMPs. In one instance, a compost filter sock at a waterbar outlet was not maintained. In the other instance, a wetland received sediment-laden because a timber mat crossing was not properly tied in and filter sock perimeter controls were not installed.

Figure 3: The WB Xpress Pipeline



Source: FERC (2015). The Elk River Compressor Station--a newly constructed compressor station associated with WB Express—is located in Kanawha County, West Virginia and is not shown on this map. Two miles of new pipeline construction in Fairfax County, Virginia, and existing pipeline connecting the pipeline shown here to the Elk River Compressor Station is not included on this map.

3.3 Specific water quality issues

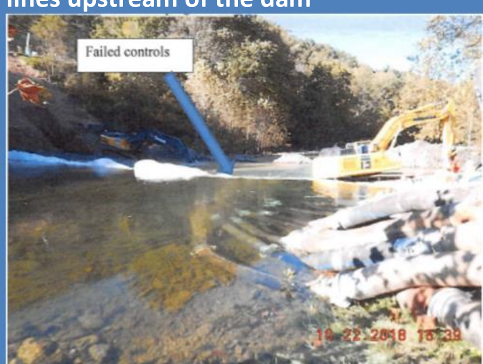
Sedimentation was the major water quality issue associated with construction of the WB Xpress. Sediment-laden water left the work site on multiple occasions, resulting in observations of distinctly visible solids in the water column of streams and sediment deposits in streams and wetlands. One incident, described below in more detail, resulted in increased turbidity in a stream at least 19 miles downstream from the work site (WVDEP, 2019b).

WB Xpress Pipeline case study

On October 22, 2018, a pump-around dam at the site of construction on the Seneca Rocks Compressor Station failed, and pumps were overwhelmed. This resulted in a sediment release to the North Fork of the South Branch of the Potomac River. The release violated West Virginia's water quality standards and three sections of the company's water pollution control permit. The NOV indicates that the company failed to report noncompliance to the state spill alert hotline and that the company failed to prevent sediment-laden water from leaving the site without going through an appropriate device.

The North Fork of the South Branch of the Potomac River flows through the popular Seneca Rocks Recreation Area and is a highly-utilized trout fishery. Settleable solids from this release were observed 19 miles downstream in the South Branch of the Potomac River.

Failed dam with approximately 20 intake lines upstream of the dam



Construction continued and sediment-laden water caused violations of water quality standards in the North Fork of the South Branch of the Potomac River

Source: WVDEP (2019b).

3.4 Regulatory agency actions

WVDEP issued a Consent Order to Columbia Natural Gas in February 2019 for violations that occurred in 2018 at the Seneca Compressor Station, resulting in fines of $13,340.

WVDEP completed inspections at various sites along the WB Xpress during construction. Many of the inspections were in response to complaints submitted by citizens and West Virginia Department of Natural Resources staff and resulted in warnings to the company.

4. MARINER EAST II PIPELINE

The ME2 Pipeline is a 350-mile long, 20-inch natural gas liquids pipeline that serves as an expansion to the existing Sunoco Mariner East pipeline system (ETP, 2019; PADEP, 2019a). This pipeline was not subject to FERC approval. Most of this pipeline (230 miles) follows the same pipeline corridor as the Mariner East pipeline, traversing 17 counties in Pennsylvania (PADEP, 2019a). The route crosses complex geologic formations, including karst, and construction called for extra diligence to prevent environmental damage.

The ME2 Pipeline came into service in December 2018. Construction was still ongoing in the summer of 2019; however, the final part of the pipeline was routed using alternative pipelines to allow for the start of transmission while construction was completed (Hurdle, 2018a). This pipeline is owned by Energy Transfer Partners' (ETP's) subsidiary Sunoco Pipeline, L.P. (SPLP) (ETP, 2019; PADEP, 2019a). The Pennsylvania attorney general and the Delaware County district attorney's office opened a joint investigation into SPLP and ETP in 2019 over alleged criminal misconduct related to the Mariner East Pipeline projects, including ME2 (Phillips, 2019).

4.1 State-specific water pollution prevention measures

The Pennsylvania Department of Environmental Protection (PADEP) required several permits for the ME2 Pipeline, including Chapter 105 water obstruction and encroachment permits and Chapter 102 ESC permits, among others (PADEP, 2017b). Chapter 105 permits are required for activities located in, along, across, or projecting into a watercourse, floodway, or body of water. The Chapter 102 permit is required for earth disturbances of five acres or greater associated with oil and gas operations. This permit is required in part due to the use of conventional open-cut trenches created during construction (PADEP, 2017b).

ME2 proposed utilizing HDD at 230 sites along its 350 miles, an unusually high number (FracTracker, 2018). By comparison, the 713-mile Rover Pipeline, which crosses much of Ohio and extends into West Virginia and Michigan, used HDD at 67 locations (Litvak and Legere, 2018).

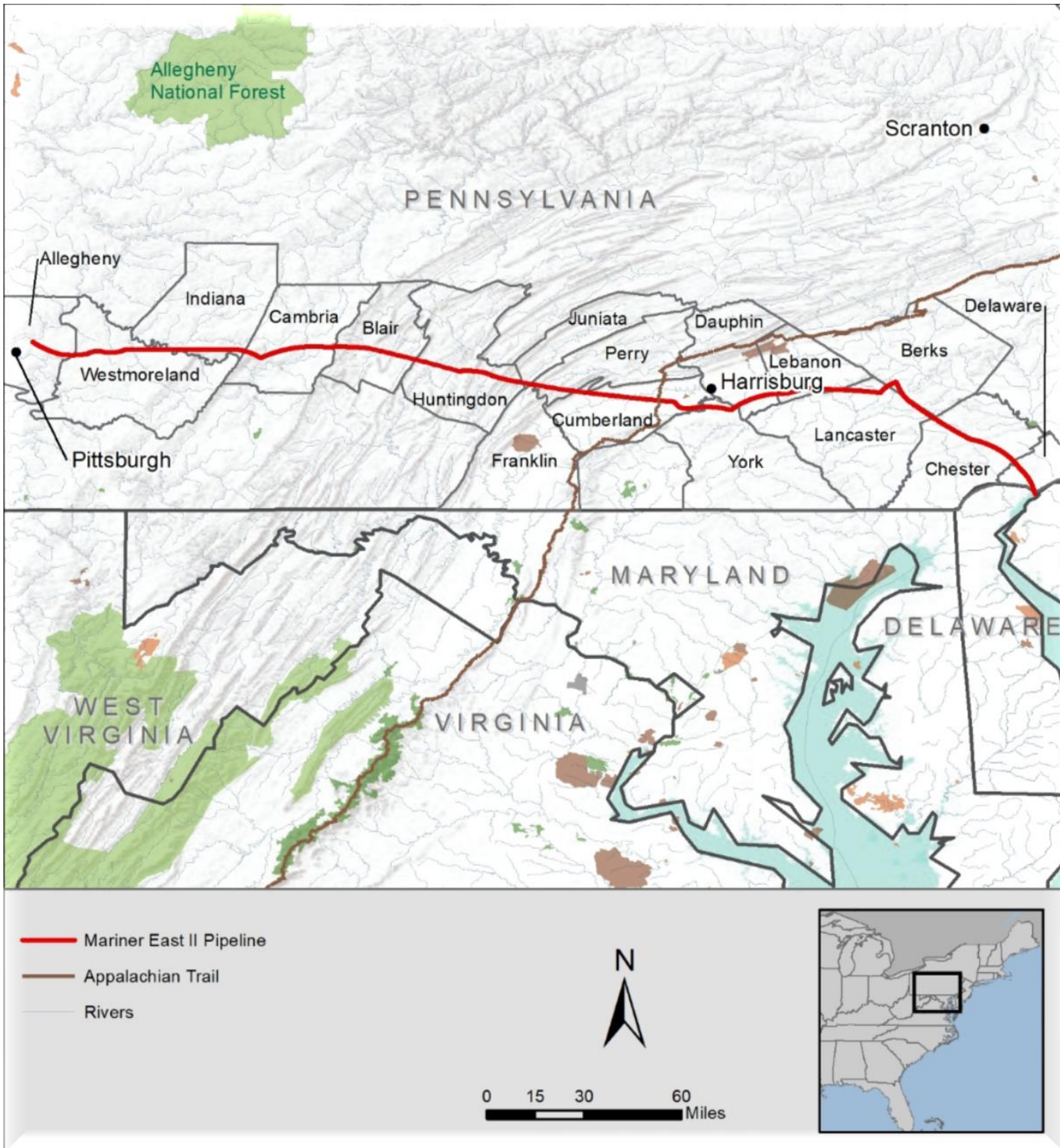
Feasibility studies were done by SPLP for each proposed HDD site to determine whether it would be the construction method with the least environmental impact (Tetra Tech, 2018). However, the feasibility studies were often very limited and failed to include adequate geologic and habitat information. ME2 was estimated to cross 570 wetlands and over 1,200 streams, some of which were classified as High Quality or Exceptional Value under Pennsylvania regulations—including wild trout streams and wetlands that serve as habitat for the endangered bog turtle (FracTracker, 2016; Crable, 2018).

SPLP developed four supplemental plans to accompany its ESC Plan to prevent, control, contain, and collect any discharge of drilling fluid to minimize impacts to waters during construction—in part as a requirement of the Chapter 102 permit (Rocco, 2019; PADEP, 2018a):

1. a General Prevention Preparedness Contingency Plan (PPCP) to address general spill and leak prevention and response, and to address possible impacts to surface waters and water supplies;
2. a Water Supply Assessment PPCP to assess the public and private water supplies along the route and measures taken to protect those supplies;
3. an HDD IR Assessment PPCP that presented "methodologies to control and minimize the impacts to sensitive environmental resources from IRs of drilling fluids associated with the proposed horizontal directional drill (HDD) crossings;" and
4. a Void Mitigation Plan for Karst Terrain and Underground Mining that examined the potential impacts of construction in these areas as well as ways to avoid these impacts and mitigation measures.

The Water Supply Assessment PPCP, HDD IR Assessment PPCP, and Void Mitigation Plan for Karst Terrain and Underground Mining were revised as part of a legal settlement (Clean Air Council, The Delaware Riverkeeper Network, and Mountain Watershed Association, Inc. v. PADEP and Sunoco Pipeline L.P., 2018a).

Figure 4: The Mariner East II Pipeline



Source: FracTracker (2016).

4.2 Summary of issues observed

A total of 97 NOVs had been issued in Pennsylvania for the ME2 Pipeline through the summer of 2019 (PADEP, 2019a). Of these, 87 involved at least one IR, and many cited several IRs on the same NOV. An IR occurs when drilling fluid used in HDD is accidentally released to the ground or any surface water at the drill site or adjacent to the drill site. This includes releases to wetlands, streams, and upland areas, among others (PADEP, 2018a). Allowing the unauthorized discharge of industrial waste, such as IRs, into the waters of Pennsylvania is a violation of the Clean Streams Law and the Dam Safety and Encroachments Act (PADEP, 2018b).

As of June 19, 2019, 125 IRs were recognized by PADEP, resulting in NOVs, with 40 percent of these IRs impacting wetlands, 52 percent impacting streams, 12 percent impacting uplands and 14 percent impacting another area or unnamed area. Many IRs impacted more than one location—for example, drilling fluids from the same IR were released into a stream and a wetland on or near the site (PADEP, 2019a).

Tens to hundreds of thousands of gallons of drilling fluid had been released into surrounding areas. According to NOVs in which the amount of fluid released was quantified, an estimated 83,000 to 110,900 gallons of drilling fluid were released into the surrounding areas (PADEP, 2019a). This is a conservative number, because the NOVs also document 41 occasions when an unknown amount of drilling fluid was released during IRs.

PADEP maintained databases detailing IRs to waters (PADEP, 2019b) and upland areas (PADEP, 2019c). According to these databases, almost 275,000 gallons of drilling fluid were released via IRs to Pennsylvania waters during construction of ME2, with 30 instances that did not result in a NOV or Consent Order Agreement. Almost 58,000 gallons were released in upland areas, with 114 instances that did not appear to have resulted in a NOV or Consent Order Agreement (PADEP, 2019b; PADEP, 2019c).

PADEP requires all IRs to be contained and the fluids removed from the site where possible, such as in a wetland (Blosser, 2019). However, containment and removal from streams can be more difficult.

A major concern with the construction of the ME2 Pipeline directly related to IRs was impacts to drinking water supplies. From July through September 2017, 17 complaints of impacts to private water supplies were received by PADEP in Lebanon, Berks, and Chester counties (PADEP, 2018c). Adverse effects included cloudy water, turbid water, discolored water, loss of water pressure, and diminution of water. Furthermore, SPLP failed to notify PADEP immediately of known adverse impacts to a private water supply at one of the drilling sites, as required in its permit (PADEP, 2018c). Pennsylvania levied a $148,000 civil penalty against SPLP.

Following a lawsuit, PADEP and SPLP revised the HDD IR Assessment PPCP to require SPLP to notify landowners with water wells located within 450 feet of an HDD site, and to pay for temporary water for those properties (Tetra Tech, 2018).

Failure of ESCs was also a major source of problems and violations on the ME2 Pipeline (Blosser, 2019). In 2018, a very wet year, many heavy thunderstorms overwhelmed ESCs. Even when the appropriate ESC was installed, it was often unable to withstand heavy rainfalls. Additionally, BMPs require weekly inspections, as well as inspections following heavy rain events. These inspections were not always performed, according to PADEP (Blosser, 2019).

4.3 Specific water quality issues

Sediment releases into three streams in Lebanon County were settled as part of a consent agreement (PADEP, 2017a). One NOV for a sediment release into Bachman Run was the result of failure to install and maintain appropriate ESC BMPs. A second NOV indicated discharge of sediment into an unnamed tributary of Killinger Creek; this was caused by failure to install and maintain appropriate ESC BMPs for pipeline construction. The third ESC issue impacting Middle Creek in Lebanon County was discovered during a routine partial inspect of pipeline construction activities.

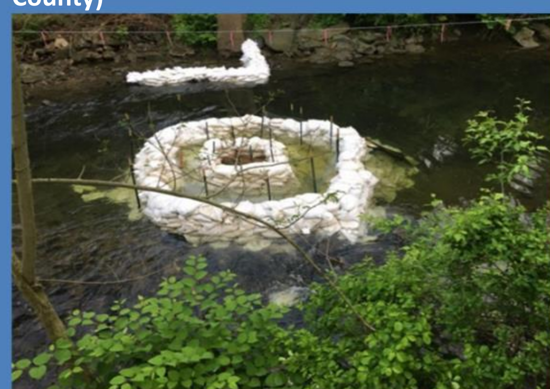
SPLP did not implement effective controls to minimize accelerated erosion and sedimentation at the sites, did not maintain BMPs to effectively minimize accelerated erosion and sedimentation at the sites, conducted earth disturbance activities in a manner contrary to the conditions in its Erosion and Sediment permit, and caused or allowed accelerated erosion and resulting sedimentation from earth disturbance activities at the sites. This resulted in a civil penalty of $43,953, which was split between the Commonwealth of Pennsylvania Clean Water Fund and the Lebanon County Conservation District (PADEP, 2017a).

Mariner East II Pipeline case study

Drilling fluid releases via IRs were a significant source of violations for the ME2 Pipeline. One specific instance in Franklin Township of Blair County resulted in drilling fluids being released into the Frankstown Branch of the Juniata River (PADEP, 2018d). The drilling fluid was visible in the river for 1.5 miles downstream. This occurred when drilling activities caused groundwater to be released into the drill pit at a rate of 500 gallons per minute, which exceeded the onsite capacity to manage it effectively. The drill pit overflowed. The water table was higher on the landscape than expected according to the HDD feasibility study. The construction method at this site was then reevaluated, and the permit was modified to utilize a different approach. (Blosser, 2019)

Drilling mud released during an IR in Middletown (Dauphin County)

Sand bags used to contain leak of drilling fluid on Chester Creek in Brookhaven (Delaware County)



Sources: Laura Evangelisto and Middletown Coalition for Community Safety.

4.4 Regulatory agency actions

County conservation district staff inspects construction sites. In addition, PADEP responds to citizen complaints and notices from SPLP of construction issues like IRs and ESC failure. Furthermore, the HDD IR Assessment PPCP required PADEP to be notified immediately when an IR occurred, using the regional office's 24-hour emergency response line (Tetra Tech, 2018). Unfortunately, PADEP was not always notified of IRs in a timely manner, and at other times PADEP was not notified at all (PADEP, 2017c; PADEP, 2018e).

PADEP entered into three Consent Assessment of Civil Penalty agreements with SPLP as a result of violations (PADEP, 2019a). In total, construction of the ME2 Pipeline accumulated 97 NOVs and almost $13.2 million in fines for "egregious and willful" violations (PADEP, 2018f; Hurdle, 2018b).

PADEP used the ME2 Pipeline construction as a learning opportunity and was working to improve pipeline construction guidance and recommendations. A legal settlement between PADEP and three organizations resulted in the formation of a group of stakeholders to assist PADEP's new Regional Permit Coordination Office with the development and limited implementation of new guidance documents for pipeline companies and construction projects (Clean Air Council et al. v. PADEP, 2018b). Specific areas of concern for these new guidance documents include ESC permits and HDD construction and operation.

4.5 Preventing environmental damage during construction

The biggest issue related to ESCs on the ME2 Pipeline was improper installation and maintenance of ESCs, as well as inadequate monitoring and oversight (Blosser, 2019). Frequent, heavy rainstorms overran ESCs, even when they were correctly installed and maintained. However, inspections and maintenance following rainstorms did not always occur in a timely enough manner to stop the sediment releases and repair the controls. Additionally, the permit-required weekly inspections did not always take place. It is unclear whether this was the result of too few pipeline staff onsite for ESC oversight or a lack of prioritization of ESC maintenance (Blosser, 2019).

Reducing the likelihood and impacts of IRs was a priority for PADEP during construction of the pipeline. According to SPLP, IRs are not uncommon and are often considered an expected part of HDD (Litvak and Legere, 2018). Additionally, the unusual and complex geology in Pennsylvania led to unexpected issues that resulted in IRs (Rocco, 2019). However, recognizing areas where IRs are likely, monitoring the drill carefully, and responding rapidly to IRs when they occur can reduce their environmental impact.

As part of the HDD IR Assessment, Preparedness, Prevention and Contingency Plan, a certified professional geologist was expected to be onsite or near the site for HDD operations to monitor the drill, log drill cuttings, and help determine how to proceed when issues or difficulty were encountered (Tetra Tech, 2018; Rocco, 2019; Blosser, 2019). The geologist should also be in a position to help determine when and where IRs and other environmental issues are likely to occur. Before construction of the ME2 Pipeline, PADEP did not have a professional geologist on staff to advise on permits and review reports. PADEP hired a professional geologist as a direct result of needs observed early in ME2 construction (Rocco, 2019).

A common problem with pipeline development in Pennsylvania using conventional cut methods is the speed of construction. Typically, there are at least two crews: one digging the trench and another laying the pipe. The trench-digging crew moves faster than the pipe-laying crew, resulting in erosion and sediment pollution issues as well as violations of permit conditions that only allow the trench to be open for a specific period of time (Rocco, 2019).

The expected rate of construction for the ME2 pipeline was 50 miles per month, which far exceeded industry norms. An examination of four other similar pipeline projects—all of which cost over $1.5 billion and ran at least 150 miles—were found to have an average pace of 17 miles per month, with an average of only 19 violations each during construction (DiSavino and Kelly, 2018). This would suggest that regulators should consider a pipeline's projected schedule in assessing whether a project is likely be successful in avoiding environmental impacts and violations of water quality standards.

One lesson learned by PADEP was the importance of requiring precise, site-specific stream crossing plans from pipeline companies. Three crossing methods were approved for the ME2 Pipeline (open cut, HDD, and conventional dry auger bore). PADEP did not realize that a hybrid drill technology, which combines at least two different methods at the same site, might be used. For example, a builder using a hybrid technology might start by using HDD, then switch to a conventional dry auger bore. The site would be described and permitted as a conventional dry auger bore only, so the use of HDD led to misunderstandings and violations being issued, including some of the NOVs issued for unapproved drilling (Blosser, 2019).

5. ROVER PIPELINE

The Rover Pipeline, owned by ETP, is a 713-mile pipeline that transports natural gas from processing plants in West Virginia, eastern Ohio, and western Pennsylvania. Smaller, lateral line pipelines (24-inch, 30-inch, or 36-inch) running from the processing plants merge to form Mainlines A and B, which are two parallel 42-inch pipelines. These pipelines cross Ohio to Defiance County, where they turn north and terminate in Livingston County, Michigan, at the connection with the Vector Pipeline (Rover Pipeline, 2019a; Rover Pipeline, 2019b).

Rover transverses a wide variety of habitats and geologic formations, including areas with current and historic coal mining, which required extra precautions—especially to prevent the accidental release of acid mine drainage. Sections of Rover were put into service starting in August 2017, with the full project completed in November 2018.

5.1 State-specific water pollution prevention measures

In Ohio, Rover was not required to secure any stormwater permits, only an NPDES discharge permit to test the pipeline for leaks (State of Ohio v. Rover Pipeline, 2017; Rover Pipeline, 2017). The Ohio Environmental Protection Agency (OEPA) later tried unsuccessfully to require Rover to apply for a stormwater permit (Hendrix and Renault, 2017).

In Michigan, Rover applied for and received a Michigan Department of Environmental Quality (MDEQ) Water Resources Division Permit. The permit included detailed plans for the three HDD sites and required BMPs for 44 stream crossings. MDEQ expected temporary and permanent impacts to 121 wetlands and outlined restoration and monitoring requirements for these wetlands. (Rover Pipeline, 2017).

In West Virginia, Rover was permitted under the general construction stormwater permit. This permit requires that sediment-laden water must not leave the construction site, ESCs must be in place and properly operated and maintained, conditions of the SWPPP must be met, the SWPPP must be updated if plans are inadequate, and water quality standards must not be violated. Rover violated each of these terms at least once (WVDEP, 2018).

5.2 Summary of issues observed

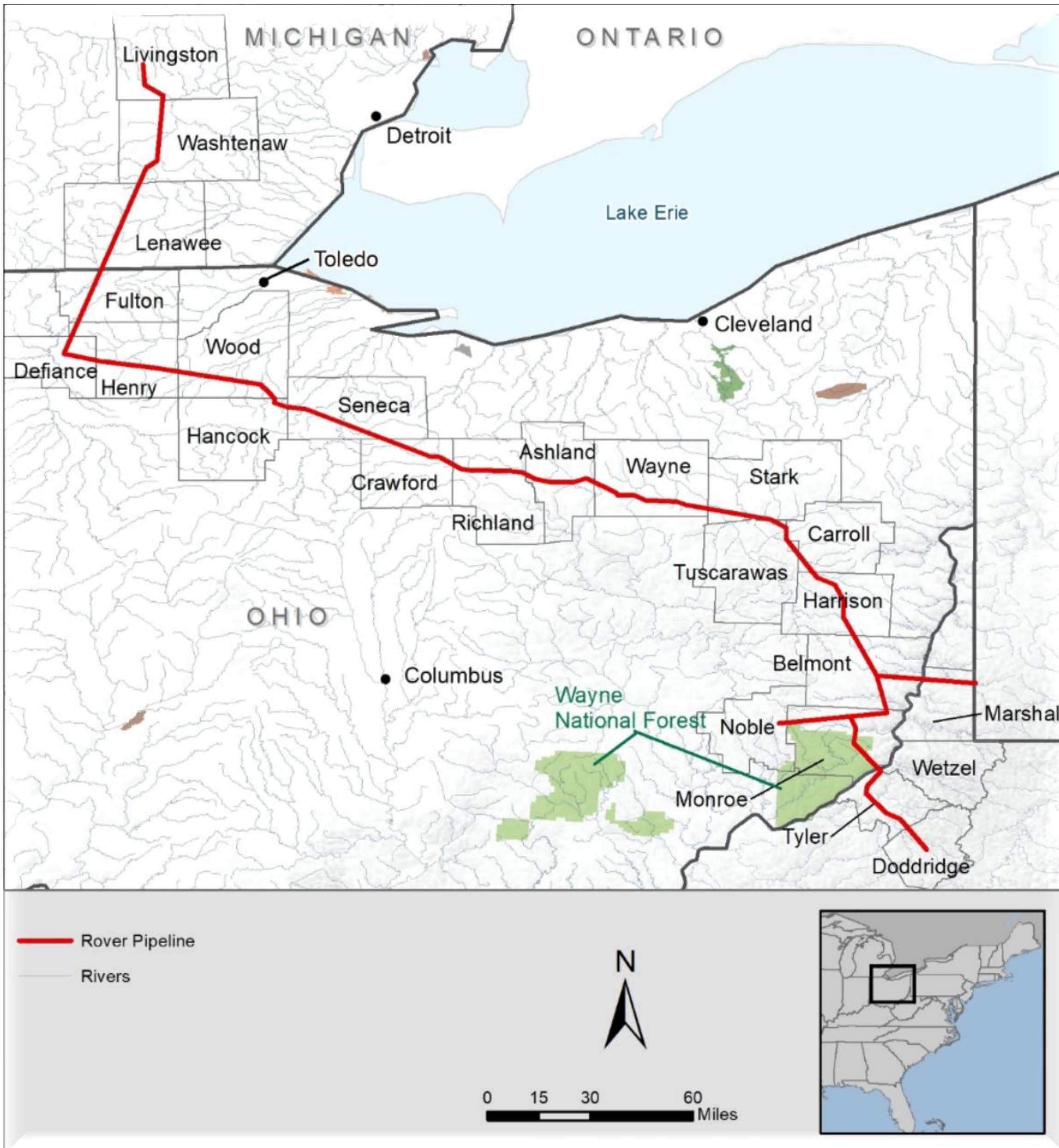
FERC approved the Rover Pipeline in February 2017, construction began in March, and by August 2017, Rover had accumulated 104 violations. At the time, that was more environmental violations than any other interstate pipeline constructed from 2015 through 2017 (Malik and Trawick, 2017).

Throughout construction, Rover accumulated 681 violations: 279 for insufficient run-off/erosion controls, 102 for improper/unauthorized use of areas or equipment, 86 for inadequate environmental restoration/damage mitigation practices, 25 for lack of infrastructure, 18 for spills/leaks, 12 for improper disposal techniques, and 5 for other violations (Kelly, 2018). By comparison, Enbridge Inc. and DTE Energy built the 256-mile NEXUS pipeline, which also runs across Ohio and into Michigan, with just 17 violations (DiSavino and Kelly, 2018).

Environmental issues associated with Rover construction included improperly maintained controls or a lack of required ESCs. This led to sediment-filled streams in West Virginia; the release of drilling fluid and sediment-laden waters into wetlands and rivers of Ohio; and the discharge of water containing petroleum into wetlands in Michigan (OEPA, 2017; WVDEP, 2018; Slagter, 2017).

WVDEP issued 24 NOVs against Rover. The company failed to notify WVDEP of construction problems, such as earthen slips. Visible sediment deposits or settleable solids were reported in at least 37 streams. Many streams were impacted multiple times. Between 25 and 74 unnamed tributaries were polluted with visible sediment (WVDEP, 2018).

Figure 5: The Rover Pipeline



The 24 WVDEP NOVs specified 105 different incidents that violated permits. The most common issues were sediment deposits or settleable solids in streams, poor maintenance of ESC devices, failure to comply with the SWPPP, and failure to prevent sediment-laden water from leaving the site. Table 1 summarizes the reasons for these violations.

Table 1: West Virginia Rover violations and causes

Reason for violation	Number of violations	Percent of violations
Poor installation	14	13%
Lack of maintenance	26	25%
Improper BMP used	3	3%
BMP not used	32	30%
Multiple reasons lead to violation*	30	29%

Note: * Generally, both poor installation and lack of maintenance led to violations such as visible sediment deposits or settleable solids in streams and failure to prevent sediment-laden water from leaving the site.

In Ohio, Rover spilled millions of gallons of drilling fluid in protected wetlands, released drilling fluid containing petroleum hydrocarbon constituents mainly found in diesel fuel into the Tuscarawas River, released sediments into streams, and spilled drilling fluid near a drinking water source for the City of Canton (Felan, 2017; Norris, 2017). Heavy—but not unprecedented—rains also filled construction trenches with water and spilled onto a nearby farmer's fields (Hendrix and Renault, 2017).

In Michigan, drilling disrupted groundwater that had been contaminated with petroleum from a nearby former gas station and caused the contaminated groundwater to spread into nearby wetlands near Pickney. MDEQ received complaints about a gasoline odor and issued a NOV (Slagter, 2017).

5.3 Regulatory agency actions

Rover construction occurred in five counties in West Virginia and resulted in 13 NOVs, with WVDEP fining Rover over $430,000 for water pollution violations (WVDEP, 2018).

OEPA fined Rover $2.3 million for dozens of water pollution violations, most notably the Stark County wetland spill; however, ETP argued that OEPA did not have jurisdiction to fine them and refused to pay the fine (Whitmire, 2017). Ohio's attorney general filed a lawsuit against Rover (Associated Press, 2017). A Stark County judge dismissed the lawsuit, saying it lacked the jurisdiction to hear the case because OEPA waived its right to regulate pipeline construction under the Clean Water Act. OEPA had had one year to act on Rover's state 401 certification request; however, OEPA waited 15 months before asking Rover to resubmit its application. The court found that this delay resulted in a waiver of the Ohio's authority to enforce the limitations and monitoring requirements via the 401 certification (Hoover, 2019; Hewell, 2019). Ohio appealed the decision to dismiss the lawsuit (Hewell, 2019).

James Lee, a spokesman for OEPA, said "Ohio's negative experience with Rover has fundamentally changed how we will permit pipeline projects." (DiSavino and Kelly, 2018)

5.4 Preventing environmental damage during construction

Like the ME2 Pipeline, the Rover Pipeline was scheduled to be constructed at an unprecedented rate of 89 miles per month, which is much higher than the 17 miles per month observed in similar pipelines (DiSavino and Kelly, 2018). When discussing the multitude of mistakes related to Rover construction, OEPA Director Craig Butler said, "We have just seen a pattern of non-compliance and where we think they're rushing and they're not paying attention to even the best management practices." (Chow, 2017). Violations in West Virginia also indicated a blatant lack of BMP use and maintenance (WVDEP, 2018). Proper installation and maintenance of ESC BMPs is vital for the prevention of environmental damage during construction.

Additionally, OEPA's approval of Rover without water discharge permits made it difficult to seek action for environmental construction issues and enforce laws to protect state waters. Better state oversight and more thorough permitting requirements at the state level for pipelines, including FERC-regulated pipelines, would have helped prevent environmental damage and given the state more leverage to require mitigation and fees for damages.

Rover Pipeline case study

In April 2017, while using HDD to drill under the Tuscarawas River in Stark County, Ohio, an estimated two million gallons of drilling fluid contaminated with diesel fuel were spilled into a pristine, protected wetland and covered it in up to 13 inches of drilling mud (State of Ohio v. Rover Pipeline, 2017; Rudell, 2017a; Rudell, 2017b).

These were not isolated incidents. In January 2018, almost 150,000 gallons of drilling fluid were spilled at the same Tuscarawas River drill site (Chow, 2018). Additionally, 50,000 gallons of drilling fluid were spilled one day after the 2017 Stark County incident in Richland County, Ohio, and the following month 10,000 gallons of drilling fluid were spilled into a Harrison County pond and stream (Associated Press, 2017; Hendrix and Renault, 2017). Eleven incidents of drilling fluid being discharged into state waters were listed in legal proceedings (State of Ohio v. Rover Pipeline, 2017).

Cleanup of drilling fluid in Tuscarawas River wetlands

Source: OEPA.

6. RECOMMENDATIONS

The four pipelines described in previous chapters have faced challenges in preventing impacts to water quality, largely from ESC problems and IRs associated with HDD. In this chapter we present potential solutions to minimize impacts to water quality during large-scale natural gas pipeline development. Problems and potential solutions are summarized in Table 2 and described in the sections below.

Table 2: Pipeline construction problems and potential solutions

Pipeline construction problems	Potential solutions
Controls are not installed or maintained properly	More inspectors, more frequent inspections, construction of pipeline in smaller segments, and taking an appropriate amount of time for completion
Controls are not in place	More inspectors, more frequent inspections, and stiffer penalties for violations
Large-scale projects with extremely large areas concurrently under construction	Construct pipeline in smaller sections and at a slower rate
Intense storms: heavy rain, short duration	Include more intense storm events in calculations during the design phase
ESCs not sized correctly in headwaters watersheds	More focus on the specific environments during design phase
Management and communication problems result in a delay in addressing problems on the ground	Construct pipeline in smaller sections
IRs associated with HDD	More detailed site analysis prior to drilling and an onsite professional geologist during drilling
Construction across ridgetops and headwaters watersheds	Extra attention to drainage area calculations during the design phase and implementation of ESCs specially designed for these sensitive environments.

6.1 Permitting oversight and enforcement

- **Additional inspections.** Require third-party inspectors or provide funding for additional regulatory agency inspectors, who should be on site very frequently—especially before and following large storm events. Frequent inspections are more effective in preventing impacts to water quality than fines assessed by regulatory agencies. VDEQ required that pipeline companies fund third-party inspectors for two large pipelines: MVP and the Atlantic Coast Pipeline (See Section 2.1). In West Virginia, inspections are only completed by WVDEP, which has an insufficient number of inspectors to adequately monitor large-scale pipeline construction. In Pennsylvania, the county conservation districts perform ESC inspections, while PADEP performs inspections upon receipt of complaints and when the pipeline company notifies PADEP of environmental issues such as IRs.

- **Site-specific stormwater management plans.** Site-specific stormwater management plans for all stream and wetland crossings should be a mandatory aspect of the permitting process. These plans ensure that careful consideration is given to uniquely sensitive environments—steep slopes and highly erodible soils, for example—at all crossing locations, and that planned controls are adequate. Site-specific plans also help regulators hold companies accountable for environmental impacts. Virginia required site-specific stormwater plans for two large-scale pipelines crossing the state. Thus far, other states have not initially required additional site-specific plans. As the result of a lawsuit settlement, PADEP required site-specific plans for some high-risk HDD sites for ME2.

- **Full evaluation of trenchless stream crossings.** Companies should be required to fully evaluate the use of trenchless stream crossings, which do not require disturbing streambeds, and to justify decisions to use other methods. When HDD is proposed for stream crossings, thorough site analyses should be conducted, including geotechnical analyses, boring tests, and fracture trace analyses.

- **Designated stormwater manager.** Each pipeline should have a designated stormwater manager whose focus is solely on environmental impacts. This manager should oversee the project and facilitate communication between regulatory agencies and pipeline companies. Company stormwater managers are influenced by profit and pressured by the short timeline available to complete the project, while regulatory agencies do not have staff to take on this role on large-scale projects. The stormwater manager could be a position at a regulatory agency or a third-party consultant; ideally this person would be funded by the pipeline company. Usually, stormwater management is addressed by the pipeline company and its contractors. While they communicate with regulatory agency staff during the permitting process, management during construction is handled by the construction company.

- **Improved communications strategy.** A communications strategy that allows on-site company staff to quickly act when a problem arises must be in place prior to construction. Management of large-scale pipeline projects is often spread out across pipeline construction management staff, making it difficult to take quick action when ESCs fail. It is often difficult for regulatory agency staff to communicate with appropriate company staff in a timely manner.

- **Online mapping tools.** Online mapping tools should be designed and maintained by companies to inform agency staff of their daily construction activities, because it is often difficult for agency regulators to know exactly where work is occurring on a day-to-day basis on large-scale projects.

- **Acknowledge that some areas are not suitable for pipeline construction.** It should be acknowledged that there are some areas where conditions are not suitable for pipeline construction, regardless of the BMPs utilized. Steep slopes, highly erodible soil, high-quality streams, and other key environmental factors should be considered when evaluating pipeline construction plans. If BMPs cannot ensure that water quality is protected, the route should be re-assessed. Currently, there are no guidelines for areas that must be avoided completely due to these factors. As long as the company states that water quality will be protected through implementation of BMPs, any area may be crossed by a pipeline.

- **Real-time water quality monitoring stations.** A network of real-time water quality monitoring stations should be installed upstream and downstream of sensitive stream and river crossings. Ideally, this would be funded by the pipeline companies. These monitoring stations should be put in place ahead of construction of the relevant stream crossing and should be installed with as much time prior to construction as possible to establish baseline conditions and natural variation in stream conditions. Monitoring should continue until all vegetation is established in the area, at a minimum, and longer for a complete assessment of impacts. As a model, VDEQ and the United States Geological Survey have implemented a series of real-time water quality monitoring stations at crossings of selected streams along the routes of two large-scale pipelines in Virginia.

- **Increased fines and permit fees.** Fines and permit fees should be increased. The amount of state agency staff time needed to oversee large-scale construction projects is immense, and fines on billion-dollar projects generally do little to encourage sound construction practices.

- **Stop-work orders.** Stop-work orders should be issued when a company and its contractors demonstrate multiple and repeated noncompliance with permit requirements.

6.2 Best management practice selection, construction, and maintenance

- **<u>Proper BMP selection for large drainage areas and across ridgetops and headwaters watersheds</u>.** BMPs must be properly selected and sized based on the drainage area. A set of practices with specifications that address large drainage areas should be followed. Construction across ridgetops and headwaters watersheds poses a challenge to stormwater control. Extra attention to drainage area calculations during the design phase and utilization of ESCs specially designed for these sensitive environments can help protect water quality in these areas. These practices can include, for example, diversion ditches or dikes on the uphill side of a construction area that transport water away from the right-of-way and help prevent controls from being overwhelmed.

- **<u>Access road BMPs</u>.** Controls to adequately handle flow associated with access roads must not be overlooked. This report documented instances where BMPs directed flow off the right-of-way and onto access roads, causing significant erosion and sedimentation of waterways. Like the pipeline corridor itself, access roads can channel runoff and sediment, often directly into streams and waterbodies, if ESC practices are not in place for the road surface and associated ditches and conveyances. Large pipeline projects typically have many miles of access roads.

- **<u>Vegetative stabilization specifications</u>.** Specifications regarding vegetative stabilization in challenging conditions, such as steep slopes or shade, should be developed and followed during construction. Erosion resulting from vegetation that did not grow was observed on the MVP.

- **<u>State-certified professional geologist</u>.** A state-certified professional geologist should be on site to monitor HDD activities and to help guide responses should an IR occur.

- **<u>Sufficient company staff to properly oversee and quickly respond to BMP failures</u>.** When company staff are spread across an extremely large construction site, as is the case with many of these long pipelines, it can be difficult to mobilize and correct BMP failures before waterways are impacted. When staff are responsible for managing and monitoring very large areas, it can also take time to notice failures. Additionally, management structures often require that managers who are not on site make decisions necessary to quickly remedy failing BMPs or to adjust construction plans based on on-site conditions. Improving this management structure to allow for quick adjustments at a construction site would help prevent impacts due to failing BMPs or when the conditions on the ground necessitate additional controls than are described in plans.

- **<u>Sufficient time on design and planning</u>.** Perimeter controls, such as silt fences and filter socks, can act as channels when not utilized correctly. To remedy this, more time should be spent in the design and planning phase. The drainage area must be properly calculated. Additional ESCs—such as J-hooks, diversions, and outlet sediment traps—can be used to accommodate large drainage areas.

- **<u>Use of short pipeline sections</u>.** Large-scale pipelines should be built to completion in short sections, thereby limiting the total area disturbed at any one time. The pipeline projects described here utilized a construction method that left very long stretches of the pipeline route with active construction areas. For example, trees were cleared along most of the routes, then the trenches were dug along most of the routes. ESCs were installed as work progressed, but very large areas were denuded at one time. Typical construction projects must stabilize open areas before moving to new areas; this same strategy should be applied to pipeline projects. This would allow attention to be given to a smaller disturbed area during intense storm events by staff and ensure controls are properly constructed and maintained. The extremely large construction sites also pose a challenge for regulatory agency inspectors.

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