Mountain Valley Watch (MVW)
Assessment Guide

Credit: Kate Hennion

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Abstract

MVW is a group of volunteers who monitor the Mountain Valley Pipeline (MVP), a natural gas pipeline that is being built from northwestern West Virginia to southern Virginia and spans approximately 303 miles. When this project began, there was controversy as to who had ownership of the land the pipeline was being built on, and how the construction could impact the environment and surrounding communities in the short and long term. The goal of the MVW is "to hold the [Mountain Valley Pipeline, LLC] company responsible for what is actually happening on the construction site" (Wilkin, K. (2020, March 4th). Personal Interview.).

The MVW is considered a nonprofit group, operating on a completely volunteer basis. The goals of the group are to "observe and document construction activity of the Mountain Valley Pipeline to assure compliance with environmental regulations during construction" (Mountain Valley Watch, 2020). Community members eager to contribute to this goal can do so through a number of volunteer opportunities that include water monitoring, image reviewing, drone piloting, GIS story mapping, and visual assessment.

The following sections of the volunteer assessment guide focus on the role and responsibilities of the different volunteer assessment teams as well as an analysis of their volunteer tasks. Answering potential questions and providing additional sources for any assessment volunteer are the aims of this document. For further questions or inquiries please contact MVW via Facebook, online at mountainvalleywatch.com or email at mountainvalleywatch@gmail.com.

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Image Reviewer

Description of Role

Figure 1: Image by Tayten Allison

The Image Reviewer role is one of many volunteer positions available through MVW. Other volunteers visit the pipeline construction site and take photos in person or via drone for the Image Reviewer to inspect. MVW uses a web mapping application that uses geospatial tools and combines the data from drone flights and the Erosion and Sediment Control Plans provided by the Virginia Department of Environmental Quality (VA DEQ). Image Reviewers then review and revise the images to flag potential dangers to the land and the residents. Mountain Valley Watch (MVW) Image Reviewers are volunteers from the community who donate their time to helping MVW achieve their goals. The Image Reviewer examines footage collected from piloted drones and geo mapping (Figure 1) to flag areas where erosion and water quality may negatively impact either the pipeline or the residents near the pipeline.

All members of the community have the opportunity to become Image Reviewers simply by reaching out to MVW individually. The organization may post openings for volunteers to review aerial images, and they work one-on-one with those who respond.

This role allows Image Reviewers of any range and physical ability to review the pipeline free from danger. Image Reviewers inform MVW's understanding of the state of the pipeline and the route. In addition, the work of the Image Reviewer allows MVW to assess areas containing problems that they may be unaware of or that could be difficult to access on foot.

Process and Training

Katherine Wilkin (personal communication, April 3, 2020) discusses the role and training of an Image Reviewer.

Training involves teaching each Image Reviewer about the controls and requirements from the Erosion and Sediment Control (ESC). The majority of expertise comes from being able to identify what a problem looks like and when to flag it down. In support of this skill, MVW provides trainees with examples of issues from drone shots. Therefore, volunteers know what to look for in terms of sediment or larger features like construction entrances or water bars not being in place.

However, initial exposure to problematic imaging is not the extent of the training the Image Reviewers receive. Throughout their tenure, MVW constantly works with Image Reviewers to develop their skills, suggest areas for improvement, and provide troubleshooting for any problems that arise.

Once an Image Reviewer has received initial training, MVW staff assigns the volunteer to a specific area of pipeline construction. The volunteer is then responsible for monitoring the land impacted by the pipeline through the geomapping tool and images provided by other volunteers and staff. He or she will collect data through MVW's aerial image applications. The image applications are composed of compilations of images from drone pilots.

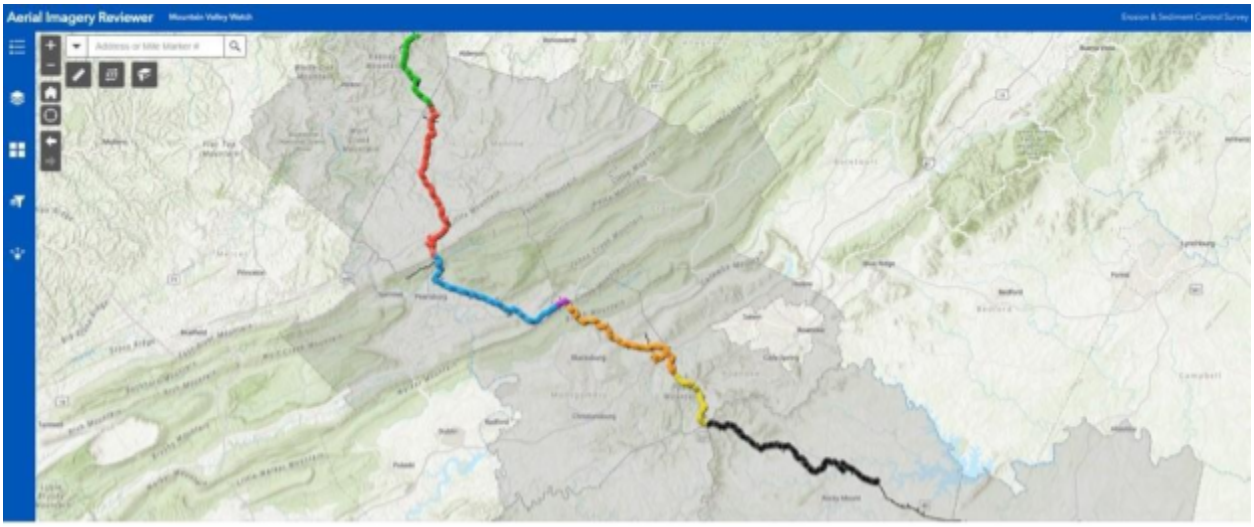


Figure 2: Screenshot of Erosion & Sediment Control Survey

Every location along the pipeline has a specific VA DEQ Erosion and Sediment Control Plan to protect the area. The MVW geo mapping tool allows volunteers to download each plan. The volunteers review the plan then analyze areas of the MVP that are under construction. If an image the volunteer reviews displays a possible violation of erosion and sediment control law, they download the image, highlight the relevant area, and add a description explaining how it violates the plan. This information is then submitted as a citizen report through a Survey123 form. On the survey, the volunteer logs their name, the date of the flight, the time the photo was taken, and the photo location's latitude and longitude.

Analysis of Duties and Recommendations

Personal interviews, an audit of MVW online materials, and research of other similar nonprofits have led to the conclusion the MVW Image Reviewer volunteer program is effective and beneficial to the organization's overall mission. The Image Reviewer position is certainly vital to the success of MVW and should by no means be considered being removed from the program. However, there remains room for improvement within a few key areas of the organizational structure.

The practice of using volunteers from the community is highly cost effective and efficient when taking MVW's resources and budget into consideration. Furthermore, bringing in volunteers allows concerned and invested members of the community to play a role in saving their land and environment. MVW use of members of the community allows their energy to be focused on a common goal, rather than directed in a variety of different directions. This is the case for all those opposing the pipeline that are not actively involved in a group working to stop construction. For this reason, it is important that the volunteer position is advertised properly and comprehensively to the public.

Recruiting specifically for the Image Reviewer position may increase the average skillset and productivity of the volunteer base. Seeking out individuals with prior skills and knowledge of the situation would increase accuracy and efficiency. This would eliminate the need for

extensive training and allow MVW staff to simply focus on the elements of the job specific to the goals of MVW and continue to hone the skills of the volunteer as time progresses.

The use of imagery review is becoming increasingly popular in the scientific community for allowing specialists to monitor areas that may be dangerous to visit in person. In Attard et al's 2018 article, "Tunnel inspection using photogrammetric techniques and image processing: A review," experts used photographic equipment and photogrammetric techniques to study tunnel profile deformation, tunnel interior visualization, crack and defect detection, water leakage detection, and general change detection, as well as to predict future trends. Their success in this area provides a precedent that MVW could follow.

By linking each photograph to a specific section on the MVP route, and then providing the ESC plan for that section, MVW is able to adjust their methods based on the needs of the land. However, because each volunteer is only responsible for the ESC plan of their county, inconsistencies may arise in the kinds of images flagged. This could be solved by allowing volunteers to view a library of flagged images and the plans that are paired with them.

Visual Assessment and Companion

Description of Roles

A visual assessment volunteer's role is to monitor the MVP construction route and assess potential hazards. Reporting pipeline-related incidents can require a lengthy recording and observation processes that often becomes physically demanding. Volunteers are frequently required to scale difficult terrain to record the conditions at construction sites while capturing images and ensuring that proper documentation of infractions reach the MVW leadership team. This data, vetted for accuracy by various members of MVW is then sent to the Virginia Department of Environmental Quality (VA DEQ), the state agency in charge of regulating the MVP.

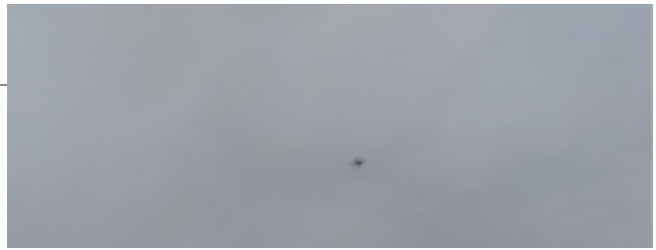
Responsibilities

The primary responsibilities of the visual assessment and companion volunteers include, but are not limited to

- Stream runoff documentation, specifically sediment plumes where muddy water breaches an otherwise clear stream
- Observation of physically harmed living organisms as a result of sediment plumes or inadequately maintained streambanks
- Observation of inadequately applied mulching or restoration efforts (washed away after hard rain)
- Monitoring the condition of green filter socks
- Providing images of possible infractions
- Using Solocator app to give exact position of incident on construction site
- Accompanying a Drone or Water Quality assessor

Essential Skills

As visual assessment and companion volunteers are trekking to sites in difficult terrain and observing possible violations at a construction site, there are certain skills they should



possess to ensure their safety and successful data collection. First and foremost, volunteers must be physically able to navigate the forest terrain. This includes being able to partake in long hikes in various terrains. Competence navigating via paper map is also important as the trails and construction site are not always updated on GPS systems. A broad understanding of the terrain, environmental conditions, and surrounding communities is highly beneficial as volunteers need to be prepared for whatever challenges arise during the assessment. In particular, visual assessment volunteers need to be detail oriented and have a keen eye for noticing what is out of place. This is exceptionally important as the goals of MVW are oriented around ensuring corporate accountability and provide solid examples of violations from the company to the VA-DEQ. Finally, the visual assessment team should have strong interpersonal skills as they often interact with community members for area permissions.

Challenges

There can be several challenges in this line of volunteer work. Besides the physical challenges of trekking through varying terrains and the possibility of injury, these volunteers must also be aware of the legal risks being taken by monitoring these construction sites. Volunteers need to be aware if the land they are walking on is private or public to be in the area associated with MVW. If the land is public and only accessible through private, they must obtain permission from nearby landowners to be able to legally walk through private land for site documentation. Additionally, the volunteers need to be aware of the legal guidelines in place regarding specific public areas like the national parks, and be aware of certain land closures that may be in place by the state. As of Spring 2020, the MVW does not have any protections for volunteers who experience legal issues.

Significance

The visual assessment and Companion volunteer role is vital to the mission of the MVW because these volunteers collect the physical and geographical data that is sent to VA

DEQ. The data collected by the visual assessment volunteer is compiled and stored as a record of the construction site's progress and document recurrent problems. The MVW hopes to create a visual time-lapse and eventually create a storyboard of the construction and environmental effects for the general public to see. This is to better communicate the effects of the MVP to the surrounding communities. Though many reported issues do not get handled immediately by VA DEQ, the continued dedication to collecting visual and geographical information through reports is vital to providing a voice and supporting the mission of the MVW.

Process and Training

Performing visual assessments, from obtaining any necessary legal permissions to reporting information, has the potential to feel like a lengthy process for volunteers. MVW provides several short videos and descriptions of the role and reporting expectations on their website.

Training

The training process for visual assessment is independent for the volunteers. There is no in-person training for new volunteers learning how to carry out a visual assessment; instead, volunteers must watch three short videos that provide background knowledge of policies and violations that the volunteer is required to look for as they collect their data. If volunteers want to be trained in more specific areas, such as water quality testing, drone flying, or GIS mapping, different training requirements apply and can be found in their respective sections of the volunteer guide. The three training videos for the visual assessment volunteer are broken down below:

Video 1

The first video provides definitions for erosion and sediment as well as their causes. It also talks about the Virginia environmental safety laws in place that the construction companies must adhere to and the consequences of breaking those laws. The video discusses the

preventative and corrective measures of erosion and sediment control that should be practiced on site. It mentions the Stormwater Pollution Prevention Plan and Erosion and Sediment Control Sheet that both volunteers and the MVP construction workers should be familiar with. The first video informs volunteers of the restrictions placed on the MVP and the standards they should be held to (Training Videos n.d.).

Video 2

This video goes into detail about the different devices and technologies used on construction sites to prevent erosion, sediment leakage, and other issues. The video educates volunteers on what a construction site should look like and how to identify things that are amiss. It covers possible violations and issues that volunteers should look for when they are documenting on site (Training Videos n.d.).

Video 3

Building on the two previous videos, this video explains the top 10 list of common violations seen while performing visual assessments. This video includes pictorial examples so volunteers can see the violations they are looking to report (Training Videos n.d.).

Reporting Process

The reporting process for MVW volunteers is not explicitly explained in the training videos, but can be picked up through navigating the website and reading provided documents. Once volunteers find a violation on the MVP construction site, they must document it on the Solocator app that will give the exact latitude and longitude of the violation. Images of the violation can also be taken by the assessor and uploaded into the app. This information is then sent to the MVW leadership team where the images and violations are examined. If the MVW leaders deem the violation significant enough, they will write a report to send to VA DEQ who will decide if investigation is needed further. The information and incident number is also recorded in an Excel file to track recurring issues.

Provided on the MVW website there is also an MVW Erosion Control Survey that can be completed on a smartphone. This survey offers step-by-step instructions on what and how to document information. Specifically, the survey includes six sections for users to refer to. Section one contains explicit instructions for the volunteer to follow while filling out the form. Section two is the inspection date and location. Section three is the inspection checklist where users describe the conditions of the site. Section four is where users add pictures. Section five includes training materials which have screenshots of the training videos with examples of violations and the required devices that must be present on site. Section six gives credit to the MVW, its partners, and volunteers.

Additional Resources

If volunteers continue to navigate the MVW website, they will eventually find another page that leads to the West Virginia Rivers volunteer training page. This site includes an additional training video that talks about the volunteer roles, expectations, and violations to look out for. In addition to this video, there are also two documents provided for volunteers to reference as needed.

- The Pipeline Visual Assessment Checklist form provided by West Virginia Rivers Organization and Trout Unlimited provides volunteers with a checklist of what to look for and how to report the information.
- The second document is a short PDF of what, how, and who to report to. It is very

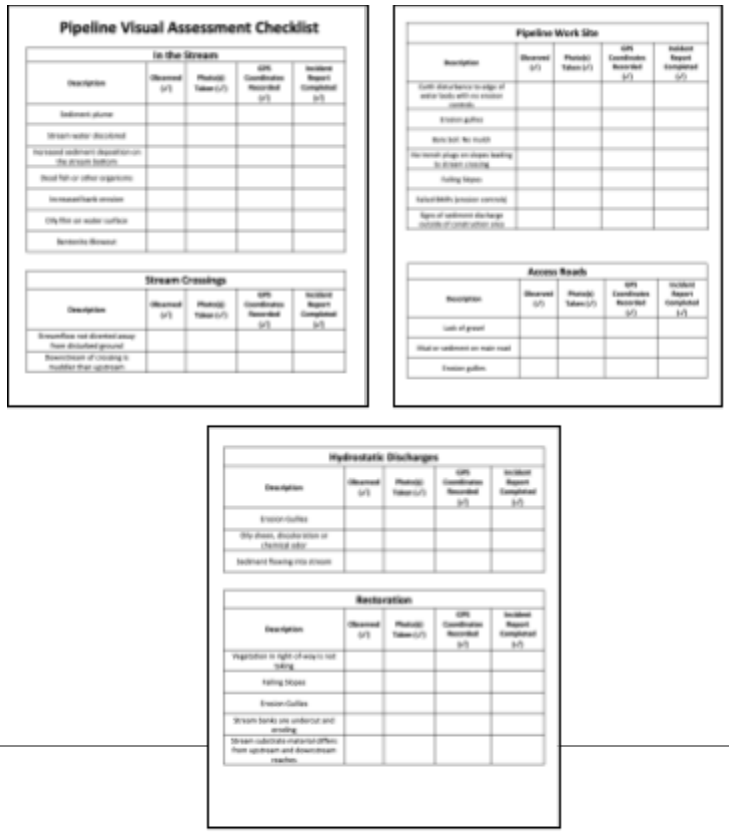


Figure 5: West Virginia Rivers Pipeline Visual Assessment Document.

brief, but contains enough information for the volunteer to utilize.

Again, it is important to note that these documents and reporting procedures are published in association with West Virginia Rivers, not MVW. Further utilization of the following documents and webpages as reference guides should be viewed as supplemental.

Analysis of Duties and Recommendations

There are several areas where the visual assessment role of the MVW could use attention. Improvements include broadening this volunteer section for more accessibility and providing a stronger training program with more straightforward reporting guidelines. The far reaching consequences of the work done to assist volunteer efforts with MVW spans noticeably from Appalachia. As the proposed Atlantic Coast Pipeline would link to the MVP should construction proceed, these tools have the potential to keep accountability among the forefront of multiple pipeline construction goals.

Description

The description of the role is very thorough and provides strong examples of what volunteers should be reporting on assessments. Following the check-sheets as a general guide provides a relatively clear example to follow. In this regard, no improvements need to be made.

Training Process

The training process is highly insufficient, with much room for improvement. There are many intersections between this role and the other volunteer roles in the three training videos, so dividing each into more concise roles could prove effective in helping volunteers. Scripting and drafting content for future videos could be a useful tool in updating the training videos and making them a better virtual training platform. Also, to address the accessibility issues, providing closed captions through certain video servicing platforms would make it a lot easier for many audiences to understand the material. The videos are easy to follow and have clear visuals, however the presenter is monotone and speaks very slowly which can cause an audience to lose

interest and not engage with the training well. The training video posted on the West Virginia Rivers training page offers a good example should MVW choose to update their training documents and videos. The West Virginia Rivers video utilizes multiple speakers and was originally broadcasted as an interactive webinar where volunteers would be able to virtually interact with the presenters, ask questions, answer questions on the screen, and complete a short survey afterwards.

Throughout the training videos, there is no mention of the reporting process or applications used to communicate information. This information is either missing from MVW's website or cannot be easily located. It is not clear to new visual assessment volunteers that they must use the Solocator App to report important information about violations. The only mention of the Solocator App was during the in-person class interview and the trip to the MVP construction site. Since reporting is such a pertinent part of the visual assessment team and the MVW has such a specific way of recording and communicating information, there should be a separate training video that clearly explains the expectations of reporting to avoid miscommunications.

Community members who want to contribute to MVW's mission will need to familiarize themselves with jargon and legal verbiage, so MVW may want to supply a glossary page to assist with this. Additional websites and sources that can be offered as optional training for volunteers on the MVW website are shared below. These tools offer additional opportunities and ideas for volunteers and address pertinent issues applicable to a visual assessment volunteer and the general goals of MVW.

1. Environmental Protection Agency's Water webpage, explains stream/watershed monitoring in concise, straightforward steps. Emphasis is placed on preparation before assessment, utilizing all potential mapping tools, weather predictor technologies, and understanding baseline standards before physically addressing arising issues. Practical steps for walking and documenting watershed conditions through land uses, changes over

time, and water conditions are presented with clarity are also discussed through this webpage.

2. The Department of Transportation hearing on cased piping illustrates the steps involved in the assessment of cased pipe quality for gas pipelines in areas of high consequence. Pipelines crossing roadways, railways, or other areas constitute HCAs and must have integrity management programs as mandated by the Department of Transportation. The Pipeline and Hazardous Materials Administration approves of and elaborates on methods for pressure testing, in-line assessment, direct assessment, and "other technologies", citing the 2002 Pipeline Safety and Improvement Act. These methods are made to use electrode technologies that test the casings coating pipes required in HCAs. Methods are not equally reliable in all areas, thus multiple testing methods are encouraged to assess pipeline integrity. The document serves as a useful tool in understanding what professionals look for and how they test what volunteers are also trying to comprehend.

3. FractTracker Alliance provides greater background information on the construction of a natural gas pipeline. The following site is a resource provided to the public by people to have an understanding of the construction of a pipeline as well as other information about Fracking. This specific page discusses the construction of a pipeline from start to finish so the public understands the steps involved throughout the process. The website gives short descriptions of each of the six stages of pipeline construction and includes images of what viewers can expect (Oil and Gas Pipeline Construction, 2020). This source could be useful to volunteers who go out to the MVP site because it can help them become familiar with the stages of pipeline construction, know what to expect, and when things deviate from the norm.

In terms of the cause and effect act of collecting and reporting data, this training prepares volunteers on the bare basics and could be oriented towards MVW's goals much more

effectively through the use of these additional sources and reporting training. It would be most efficient if these materials could all be found in a single location on the website for volunteers that is easy to find.

Volunteer Legal Protections

In any volunteer work and actively monitoring construction sites on public and private properties, it is important to know the risks, laws, and protections volunteers have. Noticeably there is no mention of the risks and protections in place by the government for volunteers. As volunteers venturing to the MVP construction site and crossing in public and private land, the possibility of violating a law exists. It is possible that volunteers could accidentally run into legal issues such as trespassing, vandalism, misconduct, and more. Acting as a visual assessment volunteer can be risky, and it is important that these volunteers feel protected and supported by the Mountain Valley Watch. It would be beneficial for the MVW to have a system in place that protects volunteers should they run into legal issues, or a document explaining the protections in place. This is so that volunteers can prevent accidental violations of the law and defend themselves if there are issues. Currently the MVW states that they are not held liable for the actions of individuals acting on behalf of their goals.

As of 1997, Congress issued the Volunteer Protection Act to encourage volunteers to work for nonprofits by providing certain protections from liability abuses. The exact purpose is stated below:

> The purpose of this Act is to promote the interests of social service program beneficiaries and taxpayers and to sustain the availability of programs, nonprofit organizations, and governmental entities that depend on volunteer contributions by reforming the laws to provide certain protections from liability abuses related to volunteers serving nonprofit organizations and governmental entities (Cohen, 1997).

In order to encourage visual assessment volunteers to feel comfortable in their role and accessing these construction sites, it is important that they know what they can and cannot be held responsible for. This is to ensure that they are clear on their expectations as a volunteer of the MVW and a US citizen who is working against a government funded construction project. The most important aspect of the document for volunteers to be aware of is what they are and are not liable for. This liability is clearly stated in the document and summarized below:

A volunteer of a nonprofit or governmental entity will not be liable if

1. The volunteer was following the responsibilities in place by the nonprofit organization
2. The volunteer has all proper licenses, certifications, and authorizations for volunteer activities and is adhering to state policies as well as volunteer responsibilities at the time of a possible infraction
3. The violation was not intentional, criminal, negligence, misconduct, or conscious disregard for the law and
4. The harm volunteer was not operating a motor vehicle, aircraft, or vessel of any sort where the operator must have the proper certifications and insurance (Cohen, 1997).

Above is a very gross summary of Section four of the Volunteer Protection Act of 1997, but again it is very important for volunteers to be aware of all aspects of their responsibilities. The MVW leadership team should provide information talking about the legal risks volunteers make when they go out to the construction sites as well as information for how the MVW will assist volunteers should they run into legal action.

Accessibility

As this position requires certain physical characteristics that support navigating rough terrain, it is not the most accessible job. Individuals who have difficulty walking, hearing, seeing,

etc would not be recommended for this position because the terrain may not be accommodating to their needs. With this in mind, the Mountain Valley Watch shared that they try to make this volunteer position as accessible as possible for those who want to volunteer but may not be able due to physical limitations. For example, Katherine Wilkin MWV organizer, said that there are a lot of older volunteers in the community who are not able to contribute to the visual assessment because they are unable to navigate the demanding construction sites. Katherine said these volunteers often assume the role of image reviewers and go over the data collected by those who took images in the field. This is a great way to get people of all skill levels and expertise involved in the work of MVW.

Much more can be done to make volunteering for the MVW more accessible outside of the visual assessment and companion volunteer role. Volunteers who cannot go to the MVP site can

- review collected data,
- partake in recruitment, networking, and raising awareness on the organization's goals,
- provide in person training for new volunteers,
- fundraise money for the nonprofit to purchase supplies and support the needs of the group,
- maintain the MVW website and make it more user friendly
- remain updated on all policies and regulations regarding the construction of pipelines on a state and national level to educate volunteers

The primary focus of reporting issues related to the pipeline has resulted in accessibility becoming a secondary issue, but it should become a greater priority if the nonprofit hopes to expand and attract more volunteers. MVW insists there are spots for all those who wish to volunteer and is working towards broadening the options available to potential volunteers.

Water Monitoring Volunteer and Companion

Description of Roles

Mountain Valley Watch (MVW) relies on a network of volunteers to identify, document, and report instances of non-compliance with environmental regulations during the construction of the Mountain Valley Pipeline. More specifically, water monitoring volunteers are in charge of measuring a variety of quality standard details of at-risk bodies of water that may be contaminated during the pipeline's construction, the most notable of which are turbidity and pH. According to Elizabeth Struthers-Malbon, a professor at Virginia Tech who is a Catawba Valley Water Monitor trained through Trout Unlimited and a colleague of MVW, measuring turbidity at sites upstream and downstream of pipeline construction sites is of "primary interest," because this data may yield definitive evidence that pipeline activity is negatively impacting downstream water quality, a metric that can (and has) been reported on to the Virginia Department of Environmental Quality and the Federal Energy Regulatory Commission (Simpson & Struthers-Malbon).

Fig. 6: Example of a tributary with turbidity levels that violate West Virginia standards due to construction of a local pipeline ("Numeric Turbidity Water Quality Standards: A Tool to Protect Aquatic Life").

Turbidity

Turbidity, more commonly known as cloudiness, is the degree to which water loses its transparency due to suspended particles. Turbidity can be caused by a number of factors, including erosion, urban runoff, waste discharge, and algae growth. High turbidity in bodies of water can harm living organisms, as suspended particles absorb heat, making water warmer and thus decreasing oxygen levels. High turbidity also causes light to scatter in water, decreasing photosynthetic activity of underwater plantlife ("Turbidity," n.d.). Consequently, water monitoring volunteers measure turbidity as a result of erosion and contamination due to the construction of the Mountain Valley Pipeline. Water monitors working with Mountain Valley Watch that are trained by Trout Unlimited utilize a 120cm Secchi tube—a plastic, marked cylindrical tube with a disk in it that allows the user to visually determine the clarity of the water—to measure turbidity (Struthers-Malbon).

pH Levels

Water monitoring volunteers are also responsible for the measurement of pH levels in at-risk bodies of water, as they are a direct relation to water quality. The pH scale ranges from 0 to 14, with 0 being the most acidic, 7 being neutral, and 14 being the most alkaline (or basic). In its most basic definition, pH is the count of free hydrogen and hydroxyl ions, which determines its solubility and ability to support life. Pollution can drastically change the pH balance of water, causing it to rise in acidity ("pH and Water," n.d.). That being said, water monitoring volunteers have the responsibility of checking pH levels of at-risk bodies of water to report irregular pH levels as a possible result of the Mountain Valley Pipeline.

Process and Training

Overview

The first step for an individual interested in becoming a water monitor is to attend a training session organized by Trout Unlimited (in cooperation with Appalachian Voices), a nonprofit dedicated to the preservation and conservation of freshwater fisheries in North

America (About Trout Unlimited). This all-day training covers topics both theoretical and practical, and provides hands-on experience in using the equipment necessary to measure and record a variety of water monitoring data in the field (Simpson & Struthers-Malbon). Once training is complete, volunteers are provided with a Trout Unlimited water monitoring manual on water monitoring. They are then assigned sets of water monitoring equipment and given detailed instructions on how to upload their collected data onto CitSci.org, a citizen science project management resource developed through Colorado State University's Natural Resources Ecology Lab (CitSci.org). After it's uploaded, the data may then be utilized in reports sent to the Virginia Department of Environmental Quality and/or the Federal Energy Regulatory Commission to call attention to problematic water quality measurements, such as high, long-lasting turbidity in areas downstream of MVP construction.. Annually, trained water monitors take measurements and send them to a third party for quality assurance and to ensure the continued integrity of their equipment.

Water quality monitoring at any given site is done in pairs, though multiple water monitoring pairs may team up to increase their collective site survey capacity on a given day.

One member of every pair must have successfully completed Trout Unlimited's day-long training; this is the team leader, who will be in charge of the well-being of the equipment they were assigned at the end of their training; accountable for the accuracy of data collected; and responsible for uploading data to CitSci.org after the outing is complete (Simpson & Struthers-Malbon). The second team member, the assistant, may or may not be officially trained through Trout Unlimited, but must be willing to respect the data collection protocols. The role of water monitor assistant may be a good starting point for MVW volunteers who are interested in learning more about the water monitor role before taking the full training themselves. As for site locations, sites in MVW region of interest surrounding the MVP are determined by Trout Unlimited based on location and activity of pipeline construction. When possible, sites are selected both above and below the construction area, so volunteers can collect relevant data comparing water quality prior to and after pipeline interference. Wetlands or other regions where

pipeline construction is likely to impact water quality may also be selected (Simpson & Struthers-Malbon).

Day in the Life: Water Monitor

On an agreed-upon water monitoring day, teams of two travel to the designated sites. Under pandemic conditions, all water monitor duos must remain six feet apart at all times, and only one person—the leader—may handle the equipment, while the assistant records data. Under normal circumstances, both team members may handle the equipment, though it is most efficient for one person to record information on the Field Data sheet while the other is in the water doing the readings. According to Elizabeth Struthers-Malbon, a monitoring team that is familiar with each other and the site may complete their data recording in ten to fifteen minutes. For days when multiple sites are being monitored one after the other, the outing may last several hours, depending on how many sites there are and their distance from each other (Simpson & Struthers-Malbon).

According to the Field Data sheet provided to trained water monitors by Trout Unlimited and Struthers-Malbon's experience, volunteers on a typical monitoring outing record names of monitors; date, time, and location; current precipitation and weather, along with details on the last 48 hours of precipitation; stream flow (high, low, etc.); water condition (clear vs. muddy based on visual inspection); conductivity; air and water temperatures; pH; stage (water depth); and turbidity. Once at a site, one volunteer wades into the center of the water (stream, creek, watershed, or wetland) to collect water in small vials for pH testing. This person also brings the Secchi tube to measure turbidity, a pole for marking water depth, and all the other equipment necessary for the water-specific measurements, like temperature. The monitor in the water takes the measurements and calls them out to the monitor on land, who records them in pencil on the Field Data sheet. The on-land monitor also records air temperature. Customarily, both monitors take their own measurements for pH and turbidity, which are visually determined with the equipment, and the consensus number is recorded on the sheet. After all measurements at all sites for one day are collected, the team leader is responsible for uploading the data to CitSci.org,

which takes approximately half an hour, depending on how many sites were monitored (Simpson & Struthers-Malbon).

Analysis of Duties and Recommendations

Effectiveness

The data collection process for MVW water monitors is generally sound. The duties that are divided up among the standard team of two members allow for checks on one another as well as opportunities to collaborate with one another to ensure validity. By using pencil and paper to log certain data such as turbidity and stream flow, though, MVW is opening the door for risks due to the event of rainfall. The process that Trout Unlimited conducts in authorizing each trained monitor who will upload the data is both necessary and effective. The process of recruiting and on-boarding volunteers, as well as training volunteers, has shown to be quite murky, due mostly to the fact that no real communication or knowledge is given regarding the relationship between MVW and Trout Unlimited.

When contacting a water monitor volunteer who has done work with MVW volunteers, Elizabeth Struthers-Malbon, she stressed numerous times how she was not affiliated with MVW; rather, she emphasized that she had been trained by Trout Unlimited and Appalachian Voices in conjunction with each other (before MVW was initiated), and noted that there is no formal or reporting relationship between MVW and any water monitors (Simpson & Struthers-Malbon). This relationship is unclear and can be confusing for volunteers hoping to contribute to MVW. In addition, the murkiness of this relationship is also reflected in how MVW water monitors are trained for their role. For example, on Trout Unlimited's website, they provide an extremely thorough and usable water monitoring handbook ("An Angler's Guide to Water Quality Monitoring"). MVW does not have this resource available and does not direct its volunteers to this website. MVW would be wrong in assuming that its current and future volunteers would know to access this handbook through a different organization's website.

Recommendations for Change

MVW needs to provide more clarity regarding the relationship between itself, Trout Unlimited, and Appalachian Voices. A clearer understanding of this relationship will allow potential volunteers to know more about the distinctions between all the organizations and who they are reporting to during the training process. In regard to the water monitor handbook created by Trout Unlimited, MVW should make that resource accessible on their website. At the very least MVW should prioritize directing volunteers to Trout Unlimited's website for this resource.

MVW should change how they present their results and how they go about achieving their objectives in order to augment recruitment. Struthers-Malbon noted how their efforts have done little to affect the VA DEQ and the Mountain Valley Pipeline (Simpson & Struthers-Malbon); however, she also pointed out how some of the data collected by her team was used by Trout Unlimited and the West Virginia Rivers Coalition to create a co-written report ("Numeric Turbidity Water Quality Standards: A Tool to Protect Aquatic Life") and has informed the content of several official notifications submitted to the Virginia Department of Environmental Quality and the Federal Energy Regulatory Commission. A study (Alender, 2016) published in the Journal of Science Communication vied to understand what motivates volunteer participation in order to improve recruitment and retention. The results indicated that volunteers value the communication of tangible results more than recognition or rewards. So, if MVW could improve their ability to show any small impact that volunteers' work has in contributing to tangible goals, volunteers would be more fulfilled and more volunteers would be attracted to MVW purpose and objectives.

A 2014 article in the Journal of Environmental Studies and Sciences asserts that water monitoring organizations can be either centralized or decentralized, and advocacy-oriented or knowledge-oriented. According to their classification system, MVW would be considered a decentralized, advocacy-oriented organization; for comparison, Trout Unlimited--with its multiple national chapters across the country--would be a centralized, knowledge-oriented organization. MVW could potentially benefit from a detailed review of this article in concert with a self-analysis of its own objectives according to the classification systems outlined in it.

The article additionally highlights, again, the positive impacts that being a water monitor can have on the volunteers who take up the role. One of these benefits mentioned is higher "awareness of environmental issues and broader community engagement in local government" (Jalbert et. al.), a sentiment remarkably similar to one of Struthers-Malbon's takeaways from her experience as a water monitor. In a written interview response, she noted that she "increased her ""stream consciousness"" everywhere;"; "became a citizen scientist;"; and eventually applied her multifaceted professional skills "to the field of environmental action, including moving from fighting a specific pipeline… to working for climate justice in broader ways" (Simpson & Struthers-Malbon). Emphasizing these kinds of positive personal impacts that can be brought about through volunteer activity as a water monitor, in combination with the above-mentioned active communication of tangible results of collected data, may prove a valuable enticement for volunteers to join MVW in a water monitor capacity.

Administrative Team

Description of Role

The administrative team of the Mountain Valley Watch focuses on the leadership, responsibilities, and tasks of the organization. These administrative volunteers are either members of Protect Our Water Heritage Rights (POWHR) or New River Geographics and collaborate to continue the mission of Mountain Valley Watch to monitor and document the Mountain Valley Pipeline construction. This team communicates with outside publics, such as governmental officials, potential volunteers, and community members living close to the Mountain Valley Pipeline (MVP), to report on environmental issues, continue relationships, or promote the MVW. The members of the MVW administrative team include:

- Russell Chisholm, Co-Chair, Protect Our Water Heritage Rights (POWHR)
- Jason Shelton, New River Geographics
- Mannin Dodd, New River Geographics
- Katherine Wilkin, Coordinator, Protect Our Water Heritage Rights (POWHR)

The MVW administrative team works to identify, document, and report potential violations to the appropriate regulatory agency. Citizen volunteers share these potential violations with the MVW administrative team to make them aware of such incidents.

The everyday administrative volunteers will have tasks in one or more of the following aspects of the project to monitor the Mountain Valley Pipeline and provide information on this project on a daily basis. Volunteers of MVW help with every aspect of monitoring, documenting, and reporting potential violations. Various responsibilities of administrative duties and MVW volunteers can include project management, website analysis, water monitoring, drone piloting, image reviewing, visual assessment, and GIS & story mapping. All administrators aim to observe, document, and report to appropriate authorities any environmental issues related to MVP construction.

MVW volunteers play a vital role in the work that gets done. Volunteers help in the project management roles by identifying the goals of the organization, and promoting that across all aspects. Volunteers who help in the website analysis help MVW examine how effective their website is, the content that is provided, and what audiences they are reaching. Volunteers who assist in water monitoring will be going out in the field to examine erosion with help from the MVW Water Erosion Control Survey and videos that take them through steps in how to complete this task. Volunteers a part of the drone piloting will be trained in drone usage and equipment, and will be tasked with providing aerial imagery of the Mountain Valley Pipeline. The image reviewing volunteers will then examine the pictures taken to assess environmental upkeep and impact. The GIS and story mapping volunteers will then help to add to the virtual Map of Volunteer Reports to MVW. The administrative team of the MVW is tasked with continually managing responsibilities to monitor the MVP construction and promoting environmental upkeep of the project. This team is also responsible for the training and organizing of the volunteers so they are ready and qualified to complete their tasks.

In order to recruit volunteers, these administrators make organic connections with other community members who are impacted by the MVP, particularly those who own property near the construction route.

The administrators then conduct training for the volunteers. Most of the volunteers are primarily involved in the GIS system and story mapping in order to improve the Virtual Map of Volunteer Reports MVW. The MVW administrators provide the erosion control survey form and the erosion and sediment control training videos on the MVW website for this task. The administrators additionally assist the volunteers in utilizing the simple cell phone application "Solocator" to conduct these tasks effectively.

With the data provided by volunteers in every other category, the administrators are able to communicate more efficiently with the publics mentioned above. The data that MVW collects allows administrators to report environmental issues and risks, continue relationships with other organizations (including POWHR, West Virginia Rivers, and Trout Unlimited), and the community. The data is additionally used to promote the MVW and its mission.

Analysis and Recommendations

Currently, MVW's administrative volunteer group consists of a leadership board of four individuals who oversee the activity of the whole project. These administrative volunteers are either members of POWHR or New River Geographics and use their skills and knowledge to spearhead the mission of Mountain Valley Watch to monitor and document the Mountain Valley Pipeline construction. The volunteers have taken an approach to take situations as they come and adapt and adjust quickly. These volunteers have taken on the responsibility of creating the MVW website, producing press releases, contacting local government officials, environmental agencies, and training and overseeing the work of other volunteers who work on various projects within the program. The administrative volunteer group could benefit from recruiting volunteers to delegate various tasks to, so that the leadership board can focus on driving the mission of Mountain Valley Watch forward.

While the administrative volunteers do a great job of conveying information and strategizing for MVW, the addition of a subset of volunteers who can take on the time-consuming tasks that the leadership board members perform would streamline the volunteer structure and activity within MVW. There may be a great number of citizens within the community wanting to volunteer with MVW, but may not be able to take on the physical tasks such as monitoring the pipeline's construction in areas with steep terrain, or perhaps cannot afford to donate to the project at this time.

MVW could consider creating branches of volunteers off of the administrative group, including website development and updating, creating reports for government officials through provided data, organizing training programs that the leadership team would administer, and writing press releases and creating other content for the website to further the reach of the work of MVW. Virginia Tech students, in particular, will likely have a broad array of skills that could be used to assist the administrative volunteer team. The leadership board would likely have success recruiting students who identify with the project's initiative and could bring value to the administrative tasks. Reaching out to department heads in the Computer Science, English, and

Public Policy and Administration departments at Virginia Tech could turn out a large number of volunteers hoping to assist with various administrative tasks.

Ultimately, MVW and POWHR have done a great job thus far of communicating the project's initiative and reaching out to the community to communicate about the issues with pipeline construction. This could be amplified by creating clearly defined volunteer positions as a branch off of the administrative group. Creating this will streamline the work that the leadership board envisions, and will allow the organization to move forward quickly to demand accountability from government officials in the construction of the MVP.

Drone Pilot & Companion Volunteer Assessment Guide

Description of Roles

The drone pilot and companion are two Mountain Valley Watch (MVW) volunteers who operate the drones owned by MVW to help survey areas along the pipeline. The pilot operates the drone using a touchscreen tablet that can make the drone fly around rapidly in all directions. The camera attached to the drone feeds video to the tablet so the pilot can see everything from the drone's perspective.

Figure 7: A drone in the air. Credit: Stephen Moxley

The companion that accompanies the pilot is there for safety reasons. It also helps to have another set of eyes on the drone to help make sure nothing goes wrong as the pilot is flying. The pilot is completely focused on flying the drone, while the companion is focused on observing and gathering information. It is important to never go out and fly a drone alone.

The pilots are recruited just like the other volunteers. Volunteers have access to the drones owned by MVW, so it is not necessary for volunteers to own their own drones. The drone pilots have to have their FAA license in order to be able to legally fly drones. The FAA license is commercial and the pilot must pass the FAA's Aeronautical Knowledge Test (Drone Laws in Virginia, 2020). When in the field, drone pilots must have a companion volunteer with them at all times. There is a large fine for flying without a license and a companion.

The drones are used to help the volunteers assess certain areas for environmental damage. The drone pilots are trained to "identify, document, and report incidents to MVW," who then "reports potential violations to the appropriate regulatory agency" (Mountain Valley Watch, n.d.).

Process and Training

Every volunteer that wants to be a drone pilot for MVW must have a Federal Aviation Administration (FAA) license. A volunteer must show proof that they are a certificated remote

pilot or commercial operator before conducting drone-flying activities for MVW. Having an FAA license means that MVW pilots can fly a small drone that is less than 55 pounds by following the FAA's Part 107 guidelines. There are three steps to gain this certification.

Figure 8: A view through the drone's camera. Credit: Tayten Allison

Step 1: Learn the Rules

1. Make sure you understand what is and is not allowed under Part 107 rules. Review a summary of the Part 107 rules (PDF). Still unsure if Part 107 rules work for you and your intended operation? Check our user identification tool.
2. Some operations are not covered by Part 107 and will require a waiver. Here are some common examples of Part 107 sections that are subject to waiver:
    a. Operation from a moving vehicle or aircraft (§ 107.25) *
    b. Daylight operation (§ 107.29)
    c. Visual line of sight aircraft operation (§ 107.31) *
    d. Visual observer (§ 107.33)
    e. Operation of multiple small unmanned aircraft systems (§ 107.35)
    f. Yielding the right of way (§ 107.37(a))
    g. Operation over people (§ 107.39)
    h. Operation in certain airspace (§ 107.41)
    i. Operating limitations for small unmanned aircraft (§ 107.51)
3. *The FAA will not waive this section to allow the carriage of property of another by aircraft for compensation or hire.

4. If your operation will require a waiver, read about the Part 107 Waiver application process.

Step 2: Become an FAA-Certified Drone Pilot by Passing the Knowledge Test

1. To be eligible to get your Remote Pilot Certificate, you must be:
    a. ○ At least 16 years old
    b. ○ Able to read, write, speak, and understand English
    c. ○ Be in a physical and mental condition to safely fly a UAS
2. Review the full process to get your Remote Pilot Certificate.
3. Study for the Knowledge Test by reviewing the Test Prep materials provided by the FAA.
4. Obtain an FAA Tracking Number (FTN) by creating an Integrated Airman Certification and Rating Application (IACRA) profile prior to registering for a knowledge test.
5. Schedule an appointment to take the Knowledge Test at an FAA-approved Knowledge Testing Center.
6. Once you've passed your test, complete FAA Form 8710-13 for a remote pilot certificate (FAA Airman Certificate and/or Rating Application) using the electronic FAA Integrated Airman Certificate and/or Rating Application system (IACRA)*

Step 3: Register your Drone with the FAA

- Registration costs $5 and is valid for 3 years. You'll need a credit or debit card and the make and model of your drone handy in order to register.
- Visit dronezone.faa.gov and select "Fly sUAS under Part 107" to create an account and register your drone.
- Once you've registered, mark your drone (PDF) with your registration number in case it gets lost or stolen.

Remember:

- Always be sure to fly your drone safely and within FAA guidelines and regulations.
- It is up to you as a drone pilot to know the Rules of the Sky, and where it is and is not safe to fly.
- Aren't sure if Part 107 is right for you and your operation? Try our user identification tool or contact us for more information (Federal Aviation Administration, 2020).

Although Step 3 is to "register your drone with the FAA," MVW has drones available for certified pilots to use for this initiative. If a pilot has their own drone and wants to assist MVW, they may do so by contacting mountainvalleywatch@gmail.com or calling (540) 251-2169.

As of April 5, 2020, all FAA-approved Knowledge Testing centers have been closed due to COVID-19. The two testing centers in the MVW area are:

- PSI Examination Services-Roanoke
    - Address: 5115 Bernard Dr Roanoke, VA 24018
- General Aviation Inc.
    - Address: 424 Airport Drive Danville, VA 24540

Information found at FAA Airman Knowledge Testing website (Login, 2020).

MVW does not hold any training sessions for volunteers to attain the remote pilot certificate. Volunteers must schedule appointments to take the Knowledge Test at an FAA-approved Knowledge Testing Center. After a volunteer passes their test and gains their certification, an experienced pilot from MVW will then instruct the new pilot with aerial training on how to use the drones properly, what footage is needed, etc. One of the features of the drone is to write a pattern into the application map, then the map goes on the trail, which results in making models with software.

Each pilot is required to travel with a visual observer (companion). An added benefit of having a visual observer as a partner is so each role can focus on their tasks. For example, a pilot may be flying the drone to a location needed, while the visual observer is taking notes on the surrounding area or location the drone is viewing.

When a drone is down, the application to control it will indicate where the drone has dropped, and the volunteer must then retrieve it.

Pilots are allowed to operate a drone anywhere in public lands, including along the MVP route, as long as there are no workers at the site. If an MVW pilot wants to go into private land, they must obtain landowner's permission. Permission is not needed to fly over houses; however, MVW requires drone operators that fly over any type of private property to get permission from the owner.

After footage has been collected, MVW leaders are responsible for analyzing and processing the footage.

Analysis of Duties and Recommendations

Mountain Valley Watch makes good use of drone technology in their mission to be a citizen watchdog on the construction of the MVP. All things considered, drone photography is a relatively inexpensive method of aerial photography as compared to solutions like satellite photography or private aviation imaging. Related research in this field supports this. However, MVW's aerial imaging program can be improved in a number of ways. In general, it is difficult for newcomers to get background information on the project like "what is this imagery used for?", "what do I need to do to get involved with this part of the project?", and "how can I get trained to use this equipment and gather imagery?" To improve interest rates and volunteer rates in the drone aerial imaging program, this information needs to be easier for newcomers to find, either on the website or in personal communication with MVW staff.

Information on the prerequisites required to pilot for MVW was lacking on MVW's website. The FAA licensing and training info was not clear on the website or in our communications with MVW. Although it was made clear that drone pilots needed to be licensed,

it wasn't very clear how a prospective pilot was to go about that process. The training process included in this document hopes to fill that hole.

In addition, it was not clear how drone images were used after flights were completed. To help retain interested volunteers, it could help to provide a concrete example of how drone imagery is used, whether that is in the form of a State Water Control Board report or even just credited in the imagery on the MVW website. If prospective volunteers can see exactly how their efforts are used, having a "goal post" so to speak for their contribution could keep them interested and motivated.

GIS and Story Mapping

Description of Role

Geographic Information System (GIS) is an electronic system that stores and visually organizes spatial data in order to allow individuals to easily identify spatial patterns, relationships, and details.

Mountain Valley Watch uses GIS to track and create maps of any data with a spatial reference including:

- The pipeline route including:
  - blast zones,
  - evacuation zones,
  - construction sites,
  - parcels (area of land broken up by landowner),
  - etc. (Parcel/Pipeline Zone Intersections, n.d.)
- Environmental and construction violations (Shelton, 2018a, Mountain Valley Watch Submissions)
- Permit violations (Mountain Valley Watch, Trout Unlimited, and West Virginia Rivers, 2019, Citizen Science Blitz Pipeline Route)
- Erosion and sediment control plans (Erosion and Sediment Control Plans, n.d.)
- Field observations (Shelton, 2018b, Giles County, VA Field Observations)
- Geological makeup of the area (Geologic Map, n.d.)
- Watersheds (Watershed Connections, n.d.)

A story map (Figure 9) is an interactive presentation that allows users to click on data points on a map for more information while reading a narrative surrounding the map. The purpose of the story map is to present data from GIS to a non-expert audience consisting of community members who may want to know more about the pipeline.

Volunteer Duties

Figure 9: Example of a story map on Mountain Valley Pipeline permit violations (Mountain Valley Watch, Trout Unlimited, and West Virginia Rivers, 2019, Citizen Science Blitz Pipeline Route) Story map by Mountain Valley Watch, Trout Unlimited, and West Virginia Rivers

- Inserting data collected from volunteers in the field into GIS
- Data analysis
- Mapping spatial data in both vector and raster formats
    - Vector: uses polygons (closed 2d shape), nodes, and lines to store data (National Geographic, 2020, para. 14). This format is used to map the pipeline route, blast zones, evacuation zones, and parcels.
    - Raster: pixelated data. This format is used in aerial images and mapping surface permeability.
- Creating maps from aerial flight images (Shelton, 2019, Mvw20190903flight)
- Creating story maps for the general public's use
- Keeping a record of violations for the regulators' use

Qualifications

- Knowledge of GIS
- Data analysis skills
- Technology/computer skills
- Writing and editing skills

- A grasp on plain language (Writing that is concise and understandable to non-expert audiences. More information can be found here: Plain Language Guidelines)
- An ability to orient content to certain audiences
- A knowledge on or willingness to learn the following applications:
    - Solocator
    - Survey123
    - ArcGIS (including ArcGIS StoryMaps)

The Story Mapping Process

Story maps, shown in Figure 9, are interactive presentations that allow creators to add pop-up dialogue windows, revealing more information about a picture or data point. These story maps are created with GIS technology and "combine geospatial data with photos, videos, audio and text to visualize a theme or sequential events," (GIS story maps).

Creating story maps requires extensive training for volunteers, who are trained for story mapping with the help of story map and GIS experts within the MVW. Volunteers interested in GIS attend weekly meetings where story maps are often presented to other preservation groups. Before volunteers can participate in the story mapping process, volunteers must be properly trained in visual inspection assessments—including in-person inspections and drone imaging—in order to make informed decisions regarding how essential information will be included and presented in the story maps. In addition to visual assessments, volunteers are also trained in measuring sediment impact, taking samples, looking for failures or blowout in diversion berms among other means of recording information in order to properly track the frequency and location of occurrences related to the pipeline.

Once this information is collected, MVW organizes the information and presents the narrative of the data. The images of blowouts and failures, or recorded sediment samples reveal the timeline of complications and recorded events related to the pipeline. Story maps are MVW's interactive way of conveying the narrative of events, allowing an audience to visualize the data

and understand the effects of the pipeline. Audience members can then scroll through a story map and interact as much or as little as they want when reading content or viewing information, allowing the audience to control their level of participation.

MVW uses visual story maps that include notes, data, photographs or videos in order to identify patterns, details, relationships and problems related to the pipeline project. For example, the MVW has recently identified a new sinkhole near a pipeline site in Newport, Virginia. MVW then documents photos from this sinkhole site to provide the audience with a timelapse overview of recorded events in an interactive way (Chisholm).

Figure 10: This Solocator app is used to take photographs and record information such as latitude, longitude, date and time.

Story mapping volunteers work regularly with GIS applications such as Solocator (Civijovski), Figure 10, which reveals the latitude, longitude, direction, time and date to document a photo taken of complications along the pipeline site. They also work with Survey123 (Survey123), an app that uses geospatial coordinates to create web maps where users choose which relevant information is shown on the map. Lastly, some volunteers work with ArcGIS (ArcGIS), which allows users to create interactive, visual story maps by input of locations onto a spreadsheet. These applications can be downloaded on member or volunteer's phones (Solocator) or data can be uploaded online to the ArcGIS website and layered with geospatial coordinates, images, and text (Shelton).

Some MVW volunteers also use Living Atlas (https://livingatlas.arcgis.com/en/) because it "gives access to a host of federally funded data, projections on populations and demographics, endangered species, and rivers," (Shelton). Tools like Living Atlas are important in the training process because they provide step-by-step instructions on the creation of story maps for

interested volunteers. For instance, the ArcGis website describes story maps construction and explains 3D scenes, spatial analysis tools, and how to add layers.

MVW also frequently flies a drone over or around the pipeline area and surrounding land. Aerial images from drone flights, Figure 11, are used in raster data story maps. MVW aims to highlight current problem areas in a story map timelapse that can be included in quarterly-reports. This information is important in providing recorded information in a visual format that is often presented to other regulators and preservation organizations in the area. Story maps can be referenced by regulators who vote in regards to the pipeline or board-members to quickly grasp the impact of the pipeline on the land (Shelton).

Figure 11: Aerial images captured from drone flights are used in raster data story maps.

The story map narrative also allows volunteer members to involve community members. Some complications related to the pipeline happen on community members' properties. Volunteers can integrate the progression of pipeline complications through story maps in an article, including photographs and quotes from the community members themselves, while including a timelapse overview of the events that have happened directly on a community member's property. Because these events affect people in the community, MVW aims to use GIS technology in understanding the progression and frequency of events. Recording the events and data in this way, also provides community members with a visual reference (Shelton).

Analysis of Duties and Recommendations

In recent years GIS and story mapping have influenced many fields from education to meteorology and much in between. GIS is a tool that allows people to acquire a fuller

understanding of spatial data, both for statistical purposes and conceptual ones. Story mapping uses the GIS to create a narrative. Human beings have spatial understanding hardwired into their brains. Our environment is also largely spatial, and non-spatial means of understanding the rich data the information age has given could leave many with a lack of understanding and insight (Goodchild). This is especially true for MVW where the spatial context of the pipeline is important in understanding its environmental impacts. MVW offers rich spatial data on their website. They have information about watersheds, pipeline routes, access roads, and location of volunteer reports. This information is extremely helpful in the distribution of resources (mainly volunteers and drones). MVW has done a fantastic job of collecting data from multiple sources, specifically from citizen scientists, and turning that data into a form that is easy to navigate and understand. For those that understand the context and significance of land parcels and watersheds, these maps provide an intuitive way to direct monitoring efforts to areas of greater risk and consequence. This is being done across many fields, notably disaster prevention and relief.

Figure 12 shows an example where GIS data is used to protect Nigerians at risk due to flooding over the Niger-Benue river system. This map displays two pieces of spatially tagged information concurrently, the risk of flooding and population density. With limited resources, disaster planners can use this data to distribute preparation efforts to areas most likely to

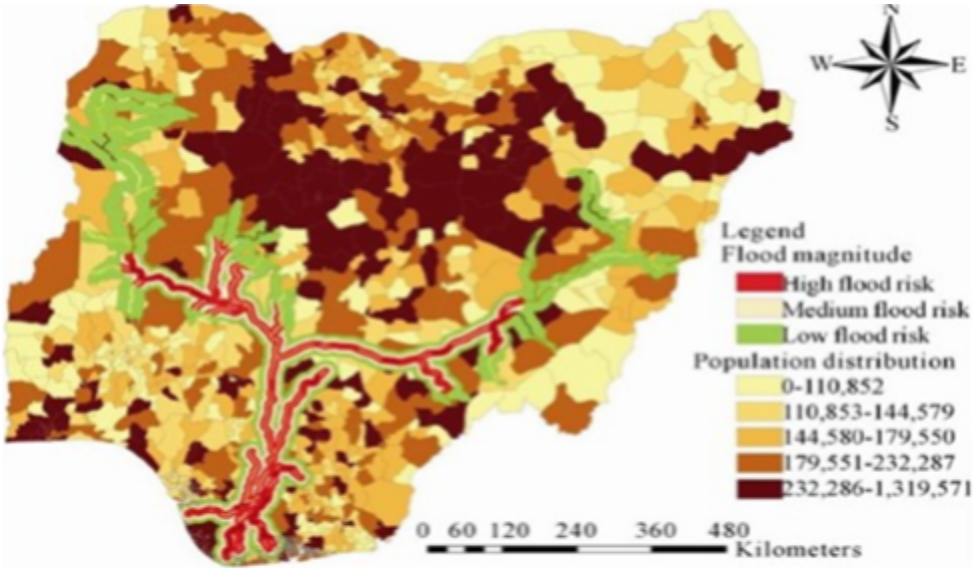


Figure 12: GIS data from along the Niger-Benue river system, Nigeria that shows the risk of flood and population density, used to assess large scale risk (Nkeki).

affect the most number of people (Nkeki). As a tool for planning, MVW excels at their GIS efforts, with opportunities for including more data such as population densities, water sources, and farms. The inclusion of data like this would allow for more targeted monitoring efforts potentially protecting more people and natural resources from. (Greenough).

One study shows that only 24% of the public have knowledge of living within 25 miles of an oil refinery and 30% have knowledge of living within 25 miles of a fracking site. This data may also apply to people's awareness of being close to a pipeline. Making people more aware of their proximity to risk is an important part of GIS and story mapping (Lyons). Providing this data in an easily accessible way allows the general population to more easily grasp the implications of a pipeline failure. This is where MVW could use some improvement in their application of GIS. In Figure 12, the map isolates two variables and zooms in on a static geographic region which provides a very clear illustration of potential risk. Story mapping can be used to guide citizens through many layers of data without overwhelming them with too much at one time. Well communicated GIS information can be an effective risk communication tool. Information about other public utilities, like water treatment plants and the overlap of the MVP and floodplains, can further help people evaluate risk to their community.

From analysis of your website, one criticism is that it acts more as a repository of data and GIS maps than a tool for education for those with minimal experience in understanding and contextualizing such information. The story map that displays a slideshow of incident reports with locations and imagery is a good start, but more could be done to include context and personal narrative. Adding context to terms like land parcels and watersheds and describing the consequences of disrupting them will be vital to educate the public. MVW has done a great job collecting extensive data along the pipeline and spatially indexing all data, this provides you with a great opportunity to create rich story maps with narrative context in order to provide the general public with information they can understand and fully process.

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