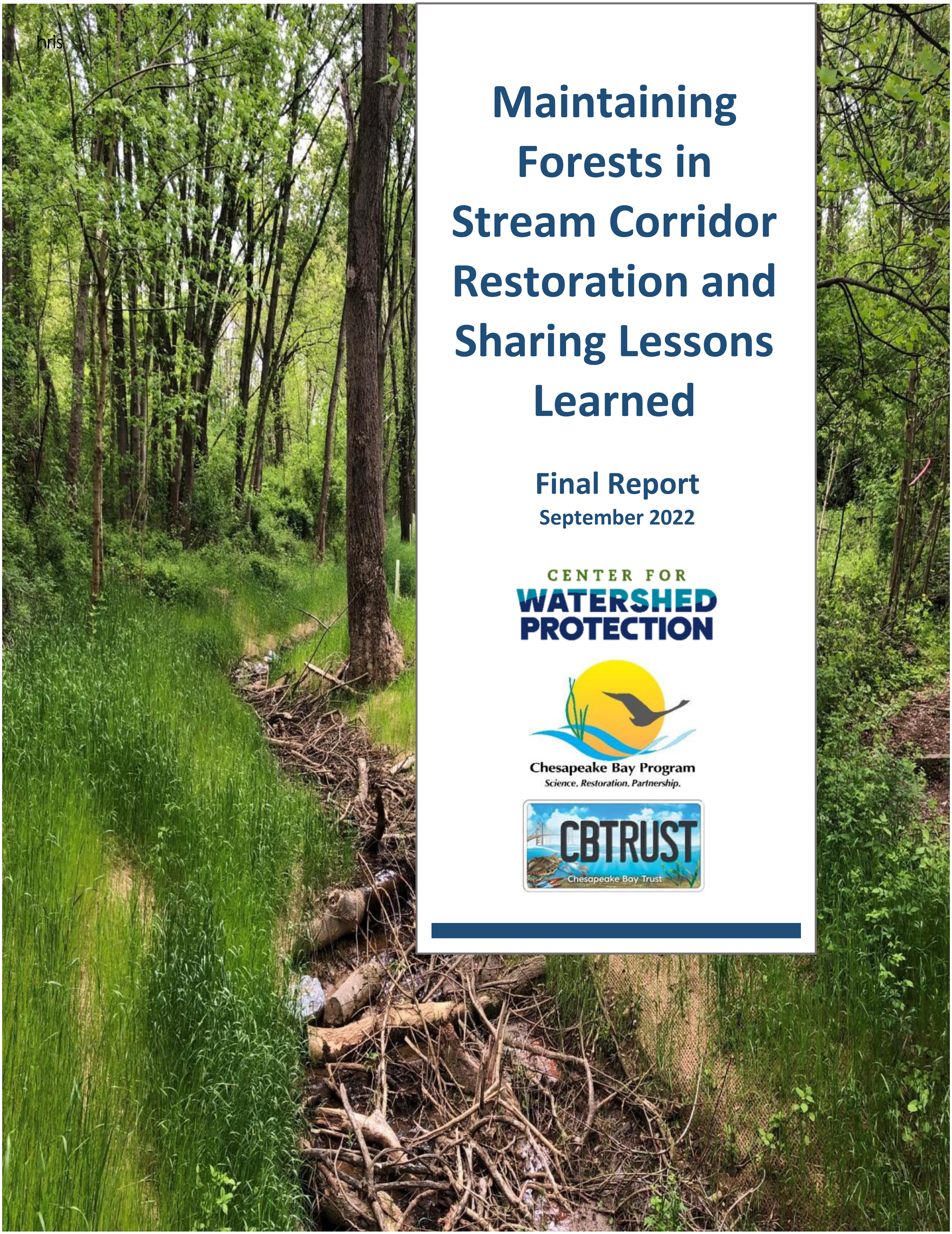

Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned

Final Report

September 2022

CENTER FOR WATERSHED PROTECTION

Chesapeake Bay Program
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Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned

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Acronyms and Abbreviations

Acronym/Abbreviation	Definition
BIBI	Benthic Index of Biotic Integrity Score
BMP(s)	Best Management Practice(s)
CAD	PLACEHOLDER
CAST	Chesapeake Assessment Scenario Tool
CBP	Chesapeake Bay Program
CBP STAC	Chesapeake Bay Program Scientific and Technical Advisory Committee
CLOMR	Conditional Letter of Map Revision
CTP	Cooperating Technical Partner
CWP	Center for Watershed Protection, Inc.
FBFM	Flood Boundary and Floodway Map
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
GIS	Geographic Information System
IRT	Interagency Review Team at Maryland Department of Natural Resources
LOD(s)	Limit(s) of Disturbance
LOMR	Letter of Map Revision
MD DNR	Maryland Department of Natural Resources
MD FCA	Maryland Forest Conservation Act
MDE	Maryland Department of the Environment
MS4	Municipal Separate Storm Sewer System
MWCOG	Metropolitan Washington Council of Governments
NAIP	National Agriculture Imagery Program
NCD	Natural Channel Design
NFIP	National Flood Insurance Program

Acronym/Abbreviation	Definition
NRCS	Natural Resources Conservation Service
NWP	Nationwide Permit
PA DCED	Pennsylvania Department of Community and Economic Development
PA DCNR	Pennsylvania Department of Conservation and Natural Resources
PA DEP	Pennsylvania Department of Environmental Protection
PEMA	Pennsylvania Emergency Management Agency
QA	Quality Assurance
QC	Quality Control
QAPP	Quality Assurance Project Plan
QMP	Quality Management Plan
TMDL	Total Maximum Daily Load
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
US EPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VA DCR	Virginia Department of Conservation and Recreation
VA DEQ	Virginia Department of Environmental Quality
WIP(s)	Watershed Implementation Plan(s)
WQGIT	Water Quality Goal Implementation Team

Executive Summary

The importance of forest buffers for stream health has been widely documented. With growing interest and implementation of stream restoration in the Chesapeake Bay Watershed, there is an increasing need for research about how to protect riparian buffers and minimize impact on those buffers, especially healthy, mature trees, during stream restoration construction. The CBP Stream Restoration Expert Panel Report (Schueler and Stack, 2014) and recent work group updates (Wood et al., 2021) intended for the stream restoration crediting protocols to be part of a holistic watershed approach and included qualifying conditions that offer some protection for riparian vegetation. However, stream restoration projects are commonly implemented with the main goal of obtaining TMDL credits and the qualifying conditions for riparian vegetation have not been consistently met. The rapid increase in stream restoration implementation has led to growing concern and controversy about the effects of stream restoration on whole-ecosystem health and services. Because stream restoration and expanding forest buffers are both a large component of state Watershed Implementation Plans (WIPs) and the 2014 Chesapeake Bay Agreement, it is imperative the Bay Program leadership ensures the crediting protocols are applied correctly and more cross-program synergism minimizes negative trade-offs impacts/outcomes of stream restoration to the riparian area and overall stream health.

The Center for Watershed Protection, Inc. (CWP) worked collaboratively with the CBP and stakeholders to evaluate methods to reduce impacts of stream restoration projects on existing riparian ecology and forest buffers in Maryland, Pennsylvania, and Virginia. This report was developed to support the "Scope of Work 3: Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned" project identified in the 2020 Chesapeake Bay Trust-Technical Assistance - Chesapeake Bay Program Goals and Outcomes request for proposals. Results from the final project report were used to help develop a guidance document for local governments on the best practices to minimize unintended adverse outcomes to riparian forests/ecosystems and identify opportunities for coupling these practices to improve water quality and habitat improvements. The intention of the project is to help improve site selection, permitting, design, and construction of stream restoration projects in the Chesapeake Bay watershed. A summary of the best practices for minimizing impacts to riparian forests/ecosystems, as well as programmatic and research recommendations are provided in Table 1.

Table 1. Summary of best practices and programmatic and research recommendations		
General Best Practice	**Specific Best Practices**	**Programmatic and Research Recommendations**
Site Selection	a. Follow a watershed-based approach for screening and prioritizing stream restoration projects that target restoration to areas in need (generally, streams with poor biological quality) and avoid existing high-quality areas with healthy stream and riparian conditions. b. Evaluate options for combining stream restoration with stormwater infiltration, other upland stormwater management practices, forestry, wetland, and agricultural BMPs in the contributing watershed. c. Combine stream restoration with sanitary sewer rehabilitation.	a. State agencies should develop clear definitions of existing "low-quality" streams and riparian areas that need restoration and corresponding guidance that includes best practices and designs to minimize resource tradeoffs and other undesirable consequences of stream restoration projects. b. Conduct a comprehensive review of the scientific and gray literature related to stream restoration and upland stormwater controls to determine if guidelines can be developed for conditions when one practice is recommended over the other or a combination of the practices is most effective.
Establishing Goals and Objectives	a. Develop stream restoration projects through a functional assessment process. b. Review the project goals with all stakeholders to determine if forested riparian conditions are appropriate and achievable. c. Coordinate with forest agencies to incorporate riparian forest/ecosystem goals and objectives. d. Consider the thermal impact of the project on the affected stream and incorporate thermal refugia.	a. Define and test new metrics that can effectively predict and rapidly measure the degree of functional uplift and/or functional losses achieved by floodplain restoration projects over short- and longer time frames. These methods should incorporate functional assessment related to stream temperature. b. State agencies should consider integrating CBP riparian buffer goals as part of the review process for stream restoration projects by evaluating the extent to which healthy riparian forest buffers are protected within the proposed project area and new riparian buffers are planted where none currently exists. c. Agencies within each state that are involved with forestry and stream restoration should collaborate to establish a unified definition of stream restoration and develop corresponding expectations for acceptable goals and objectives. d. The CBP should consider distinguishing forested wetlands as a separate land use classification within the Chesapeake Bay Watershed Model. e. The CBP should consider adding a reporting requirement for stream restoration projects related to associated land use conversion.
Design and Permitting	a. Conduct pre-application meetings with state and federal permitting agencies.	a. The CBP should establish criteria for successful stream restoration projects, including the riparian area, that state permitting agencies can use to conduct a self-audit and

Table 1. Summary of best practices and programmatic and research recommendations		
General Best Practice	**Specific Best Practices**	**Programmatic and Research Recommendations**
	b. Configure the restoration design to unique site conditions instead of the site to a specific type of practice. c. Conduct a comparative analysis of different restoration approaches to evaluate the impacts of both temporary construction and completed construction landscaping, as well as maintaining existing forest, relative to the creation of a long-term, sustainable system. d. Coordinate with forest agencies to ensure that the stream restoration design does not impact the established riparian forest/ecosystem goals and objectives and to identify site-specific best practices for minimizing impacts to the riparian area. e. Prioritize the protection of high-quality mature trees to the extent possible and rank on-site trees during the planning process. f. Develop (and implement) planting plans that prioritize native species and consider impacts of invasive species. Use planting plans that track survivability and post-construction vegetative management (including supplemental plantings and invasives control). g. Consider planting techniques to provide higher degrees of canopy coverage in shorter amounts of time while still being amenable to maintenance of plantings. h. Consider assisted migration in planting plans to incorporate species adapted to changing climate conditions.	identify areas of improvement (including permitting) that will help ensure greater project success. b. The CBP should explore options to better enforce proper application of the stream restoration crediting protocols. c. A comprehensive review of county-level regulations should be conducted to determine how well they incorporate state-level requirements to protect forests, such as the MD Forest Conservation Act, and the extent to which they include enforceability measures. d. State agencies should encourage and coordinate collaboration between forest agencies and local governments to ensure they are involved with project design. e. State agencies should develop checklists based on the best practices recommended in this report. f. Local governments and funding agencies should include costs for alternative design analysis as part of the total project cost and thoroughly review project proposals to ensure that lower bids are not cutting corners at the expense of the best practices outlined in this report for minimizing impacts to riparian forests/ecosystems. g. Develop riparian vegetation guidance for stream restoration design based on the best available knowledge. h. Establish guidelines/constraints for stream floodplain reconnection, particularly related to floodplain tree health. i. CBP should discuss with FEMA the development of a more streamlined Letter of Map Change (LOMC) process related to the "no-rise" criteria for federally regulated floodways for stream restoration projects.
Stakeholder Engagement	a. Conduct pre-restoration community engagement, including getting local stakeholders involved, communication about the project, setting expectations, and gathering consensus on the project's goals and objectives. Community outreach should consider strategies for inclusive engagement, such as developing outreach materials in languages other than English. b. Coordinate with federal, state, and local governments, as well as practitioners, forest agencies, contractors, landowners, and local community stakeholders to	a. State agencies and local governments should consider developing outreach materials to help the public and landowners better understand the stream restoration process.

Table 1. Summary of best practices and programmatic and research recommendations		
General Best Practice	**Specific Best Practices**	**Programmatic and Research Recommendations**
	come to consensus on the preferred design approach and project goals/objectives.	
Construction	a. Site managers responsible for riparian forest/ecosystem impacts should be present on site. b. Carefully draw and manage Limits of Disturbance (LODs) so they are as small as possible, and the construction sequence is organized to prevent equipment from repeating trips over the same area many times. c. Flag and mark individual trees and swaths of trees to be protected and those to be removed. d. Plan access routes to retain marked desired trees and verify plans with regulatory agencies. Utilize the existing channel as the primary access road to the extent practicable. e. Apply additional protection measures to trees that are at risk of being impacted by construction activities. f. Use rubber-tire construction vehicles to minimize compaction. Ideally, those vehicles should be as small as possible. g. Carefully trim roots if impact from construction equipment is unavoidable and minimize pruning to 30% of the critical root zone or less. h. Install water gators (bags of water attached to the tree that slowly drip down) and apply mulch around the trees to keep underlying soil moist. i. Implement ground protection practices. j. Reuse downed or removed trees on-site. k. Retain an independent environmental inspector or monitor answerable to regulatory agencies.	a. Local governments and funding agencies should include tree preservation standards in their RFPs for stream restoration.
Monitoring and Maintenance	a. Set aside a minimum of 10% of total project costs for post-construction monitoring and maintenance. b. Utilize performance-based contracting and warranty monitoring for plant survival and contractual requirements. c. Monitor beyond the LOD, and include a site's undisturbed areas, and adjacent upstream and downstream areas. d. Develop clear monitoring metrics as a way of evaluating goals and the degree of project success.	a. Long-term monitoring of riparian benefits and total ecosystem benefits done by professionals/scientists. When appropriate, a pooled monitoring approach may be recommended. b. Local governments and funding agencies should allow for a percentage of funds to be allocated for post-construction monitoring and maintenance and extend the allowable project period so that monitoring can occur over the long-term.

Table 1. Summary of best practices and programmatic and research recommendations		
General Best Practice	**Specific Best Practices**	**Programmatic and Research Recommendations**
	e. Implement both a short and long-term vegetation management plan to maintain the post-restoration vegetation target for the banks and floodplain. f. Maintain a designated maintenance trail when appropriate and agreed upon by regulatory agencies on projects to allow practitioners to monitor and maintain constructed projects without contributing additional disturbance.	c. Identify/develop metrics to characterize forest health applicable to stream restoration. Develop a riparian vegetation training program to increase the number of staff in localities that are qualified to conduct vegetative community classification and condition assessments. d. Develop short-and long-term maintenance guidance for stream restoration projects based on the best available knowledge.

Introduction

The importance of forest buffers for stream health has been widely documented. Healthy riparian buffers in stream systems influence the degree of in-stream ecosystem services related to water quality, physical stream characteristics, and biological characteristics (Palmer et al., 2014; Mayer et al., 2022). Mayer et al. (2010) summarizes research on additional functions of riparian buffers, including stream temperature moderation, urban noise reduction, and creation of critical habitat corridors for wildlife. There is existing comprehensive research that summarizes the importance of stream-riparian complexes, including the value of stream restoration that extends beyond the channel (Wohl et al., 2021). Many of these riparian buffer benefits are acknowledged by and incorporated into state-level strategic planning and goal-setting documents, like the State of Maryland's 2020 – 2025 Forest Action Plan (MD DNR, 2020).

In 2007, Chesapeake Bay Program (CBP) partners set a goal to restore 900 miles of riparian forests in the watershed each year in response to the Chesapeake Executive Council Directive 06-1, Protecting the Forests of the Chesapeake Watershed (CBP, 2007). This goal was renewed in the 2014 Chesapeake Bay Watershed Agreement (CBP, 2014), which was signed by all six Bay states and the District of Columbia. The agreement also calls for the conservation of existing buffers and for at least 70 percent of riparian areas throughout the watershed to be forested. With growing interest and implementation of stream restoration in the Chesapeake Bay Watershed, there is an increasing need for greater attention to be paid to the protection of riparian buffers and minimizing their loss during siting, planning, and construction of stream restoration projects.

Stream restoration for the purposes of this report is defined according to the CBP stream restoration expert panel recommendations (Schueler and Stack, 2014; Wood et al., 2021) as "any natural channel design, regenerative stormwater conveyance, legacy sediment removal or other restoration project that meets the qualifying conditions for credits, including environmental limitations and stream functional improvements." It is important to note that the term "restoration" can be misleading because it has the connotation that the stream will be returned to a historical condition, which is often not possible due to changes in hydrology, soils, flow and general pattern and profile. In these cases, the result would be rehabilitation instead of restoration. However, for simplicity and to remain consistent with existing CBP stream restoration guidance, the term restoration will be used throughout this document.

The evolution of stream restoration projects in the Chesapeake Bay watershed was initiated by the 1972 Clean Water Act, 33 U.S.C. §§ 1251–1387, which requires states to develop Total Maximum Daily Loads (TMDLs) specifying the maximum pollution levels allowable to meet water quality standards, as well as Municipal Separate Storm Sewer System (MS4) requirements. Nitrogen, phosphorus, and sediment load reduction credits provided by stream restoration projects have become a driver of project implementation for meeting Chesapeake Bay TMDL requirements. In addition, sediment is one of the main stressors associated with biological impairment, which has led to stream restoration project implementation to meet local TMDLs (Noe et al., 2020; Governor et al., 2017; Paulsen et al., 2008). According to the 2019 Progress Report from the Chesapeake Assessment Scenario Tool (CAST), jurisdictions throughout the Chesapeake Bay Watershed have implemented approximately 224 miles of stream restoration with an additional 84 miles planned as reported in the Phase 3 Watershed Implementation Plans. **This rapid increase in stream restoration implementation has led to growing concern and controversy about the effects of stream restoration on whole-ecosystem health and services.**

Loss of existing trees in the riparian zone from stream restoration implementation occurs either through direct removal during construction or mortality afterwards due to increased groundwater elevations and/or extended inundation of the floodplain, compaction, and root disturbance from construction activities. The amount of clearing that occurs during construction is related to the selected design approach while some clearing may be necessary to provide access pathways. For projects that involve floodplain reconnection, mortality of trees in the riparian zone may occur as soils are inundated over time. Additional losses may be necessary to remove trees that are dead or falling over due to eroding banks, invasive species, or those that pose a threat to the sanitary sewer infrastructure. When mature trees are removed, they cannot be replaced with similar-sized trees that perform the same ecological functions. Depending on the pre-restoration condition and level of construction disturbance, years of ecosystem maturation may be needed before a project fully meets its long-term restoration objectives and realizes its full environmental benefits (Kaushal et al., 2021; Wood et al., 2021). Riparian tree loss from stream restoration implementation can be exacerbated by regional decreases in forest health and the resulting need for additional maintenance and management in many settings due to numerous factors such as dominance by invasive and native vines, loss to invasive diseases/pests, competition from non-vine invasives, excess herbivory, and climatic-induced loss (Hildebrand et al., 2020; Doll et al., 2016; Stranko et al., 2011).

The significance of forest and riparian vegetation protection during stream restoration is noted in the CBP stream restoration crediting protocols. The stream restoration Expert Panel developed crediting protocols (Schueler & Stack, 2014) that were approved in 2014 and since that time, states and municipalities within the Chesapeake Bay watershed have been implementing them to help meet their respective TMDL load reductions. It was outside the panel's charge to resolve the scientific debate over the prospects of functional uplift and potential unintended consequences associated with riparian cover. However, the panel did recognize that:

- Maintenance of riparian cover is a critical element in the ultimate success of any stream restoration project. Projects that involve extensive channel reconfiguration or remove existing riparian cover are likely to see less functional uplift, including nutrient removal, at least until the replanted areas achieve maturity (Orzetti et al., 2010).
- The research reinforces the notion that stream restoration should not be a stand-alone strategy for watersheds, and that coupling restoration projects with upland retrofits and other practices can help manage the multiple stressors that impact urban streams (Palmer et al., 2007).
- Some form of stream functional assessment should be a part of both project design and post-project monitoring of individual restoration projects to provide better scientific understanding of the prospects for functional uplift over time.

The stream restoration expert panel recommendations include a qualifying condition that projects must demonstrate they will maintain or expand existing riparian vegetation in the stream corridor and compensate for any project-related riparian losses in project work areas as determined by regulatory agencies. The panel also recommended that proposed stream restoration projects be developed through a functional assessment process, such as the stream functions pyramid (Harman et al., 2011) or functional equivalent.

Recent CBP technical work groups were convened and resulted in a series of recommendations to improve the stream restoration protocols previously approved in 2014. The groups that specifically expanded upon forest and riparian vegetation management as it relates to stream restoration include the outfall and gully stabilization work group (Bahr et al., 2019) and the Protocols 2 and 3 work group (Wood & Schueler, 2020). The outfall and gully stabilization work group (Bahr et al., 2019) noted that disturbance to trees should be minimized where possible to avoid unintended consequences. In addition, the group recommended that project documentation should indicate how future vegetation will be managed within the project limits to promote enhanced forest cover where appropriate, while allowing for vegetation management to ensure stability of the restored channel over time. The Protocols 2 and 3 work group (Wood & Schueler, 2020) expanded on the unintended consequences of stream restoration on riparian vegetation included in the original stream restoration expert panel report through a literature review and developed recommended best practices for stream restoration projects over the entire project life cycle.

These qualifying conditions and best practices offer some protection for riparian vegetation if implemented, but they have not been consistently applied. While many stream restoration projects have been successful in minimizing riparian impacts, there have also been many projects that resulted in the loss of riparian forests and vegetation.[1] Because stream restoration, stream health, and expanding forest buffers are a large component of state Watershed Implementation Plans (WIPs) and the 2014 Chesapeake Bay Agreement, it is imperative to better synergize efforts and investments to minimize negative trade-offs impacts/outcomes.

To help address these concerns, the Center for Watershed Protection, Inc. (CWP) worked collaboratively with the CBP and stakeholders to evaluate methods to reduce impacts of stream restoration projects on existing riparian ecology and forest buffers in Maryland, Pennsylvania, and Virginia. This document serves as the final report for the project "Scope of Work 3: Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned" project identified in the 2020 Chesapeake Bay Trust-Technical Assistance - Chesapeake Bay Program Goals and Outcomes request for proposals. Results from this project were used to inform development of a guidance document for local governments on the best practices to minimize unintended adverse outcomes to riparian forests/ecosystems and identify opportunities for coupling these practices to improve water quality and habitat improvements. This report and corresponding guidance document are advisory in nature and are intended to promote best practices for consideration by agencies[2] overseeing the implementation of stream restoration projects, as well as seasoned professionals to help improve selection, permitting, and funding processes for stream restoration projects in the Chesapeake Bay watershed.

Methods

This project was guided by input from a Stakeholder Team (Table 2) consisting of members from the CBP Urban Stormwater, Stream Health, Wetlands, and Forestry Workgroups, the Water Quality and Maintain Healthy Watersheds Goal Implementation Teams, as well as representatives from EPA, the Army Corps of Engineers, Maryland Department of the Environment (MDE), Pennsylvania Department of Environmental Protection (PA DEP), Virginia Department of Environmental Quality (VA DEQ), and local government representatives. CWP coordinated closely with the Stakeholder Team over the course of the project to provide guidance, review progress, and discuss findings.

[1] Note that it was outside the scope of this project to inventory the extent of successful vs. unsuccessful projects with regards to riparian forest and vegetation impacts.

[2] State and federal permitting agencies reserve the discretion to apply this guidance to support better permit decisions and always retain the authority to make permit decisions and/or establish permit conditions for TMDL-driven stream restoration projects. Likewise, decisions about how to weigh the potential for temporary adverse impacts on existing site environmental qualities against the long-term environmental benefits is left to the appropriate regulatory agencies.

Table 2. Project stakeholder team		
Name	**Organization**	**CBP Workgroup(s)/Team(s)**
Katherine Brownson	U.S. Forest Service	CBP Forestry Workgroup
Sally Claggett	U.S. Forest Service	CBP Forestry Workgroup
Rebecca Hammer	U.S. Environmental Protection Agency (retired)	CBP Forestry Workgroup
Anne Hairston-Strang	MD Forest Service	CBP Forestry Workgroup
Judy Okay	Okay Consulting	CBP Forestry Workgroup
Frank Rodgers	Cacapon Institute	CBP Forestry Workgroup
Denise Clearwater	MD Department of the Environment	CBP Wetlands Workgroup CBP Stream Health Workgroup
Pam Mason	VA Institute of Marine Science	CBP Wetlands Workgroup
Brock Reggi	VA Department of Environmental Quality	CBP Stream Health Workgroup
Chris Spaur	U.S. Army Corps of Engineers	CBP Stream Health Workgroup
Norm Goulet	Northern VA Regional Commission	CBP Urban Stormwater Workgroup
David Wood	Chesapeake Stormwater Network	CBP Urban Stormwater Workgroup
Suzanne Trevena	U.S. Environmental Protection Agency	CBP Water Quality Goal Implementation Team
Megan Fitzgerald	U.S. Environmental Protection Agency	CBP Water Quality Goal Implementation Team
Renee Thompson	USGS Chesapeake Bay Program	CBP Maintain Healthy Watersheds Goal Implementation Team
Dave Goerman	PA Department of Environmental Protection	State and Local Government Agencies and Jurisdictions
Christin Jolicoeur	Arlington County, VA	State and Local Government Agencies and Jurisdictions
Sara Weglein	MD Department of Natural Resources	State and Local Government Agencies and Jurisdictions
Elmer Weibley, CPESC	Washington County Soil Conservation District	State and Local Government Agencies and Jurisdictions
Justin Williams	VA Department of Environmental Quality	State and Local Government Agencies and Jurisdictions

Based on feedback from the Stakeholder Team and an informal, online survey of regulators, practitioners, and local governments in the Chesapeake Bay Watershed, CWP developed a Project Plan (Appendix A). The plan outlined the key documents to review and information to extract, individuals to be interviewed and interview questions, and potential focal areas and timeframe for detailed stream restoration evaluations. CWP also developed a quality assurance project plan (QAPP; Appendix B) that documents the planning, implementation, assessment procedures, and how specific quality assurance (QA) and quality control (QC) activities were applied during this project. The QAPP was developed in accordance with EPA's "Elements of a Quality Assurance Project Plan for Collecting, Identifying and Evaluating Existing Scientific Data/Information" and aligns with the EPA Region 3 Quality Management Plan (QMP).

Following EPA approval of the QAPP, the key project tasks were completed, including:

- Policy and Document Review: Policy and guidance documents were reviewed to better understand the requirements of each state for protecting and mitigating damage to stream buffers associated with stream restoration projects. In addition, the requirements of three

selected counties included as part of the case study analysis (see task description below) were evaluated.
- Interviews: Interviews were conducted of various stakeholders involved in stream restoration to better understand how the requirements identified from the review of regulatory and policy documents are (or are not) implemented in each jurisdiction and help to identify and refine best practices to minimize adverse impacts to riparian forests/ecosystems.
- Case Study Analysis: Ten stream restoration projects were selected to evaluate changes in riparian vegetation associated with stream restoration projects, including the level of post-construction riparian vegetation success. Changes in nutrient and sediment pollutant loads associated with any land cover modifications were also compared to load reductions from the stream restoration projects, to evaluate if there were any trade-offs due to project implementation.
- Webcasts: Three half-day state-focused webcasts (one each in PA, MD, and VA) were conducted in May 2022 to present the current project findings and discuss how to improve stream restoration practices to minimize impacts to habitat and maximize water quality benefits. The webcasts were intended for Bay partners, stream restoration practitioners, and local officials involved with stream restoration at the state and local level.

Specific methods for these tasks are further described in the sections below.

Policy and Document Review

CWP reviewed policy documents recommended from the Stakeholder Team and an online survey as outlined in the Project Plan. This included local forest conservation ordinances (in MD), Joint Wetlands and Waterways permits in PA, MD, and VA, codes and regulations for all three states, as well as the local jurisdictions that were selected for further analysis, and technical guidance documents that accompany the relevant regulations. Additional sources of information were identified and reviewed as needed to support project objectives, including publications from USDA, USFWS, US EPA, USACE, and state program partners, and peer-reviewed journals. A total of 40 regulatory and 78 technical/guidance documents were reviewed to attempt to answer the questions defined in the scope of this project. The questions include:
- How are riparian areas and forests defined by various agencies and organizations and what definition should be applied to this study?
- What inventory requirements are in place and how are these inventories used in project planning?
- Are forest agencies engaged and how?
- How are existing forests addressed in project permits?
- What re-vegetation or other mitigation requirements are in place for impacts to streamside forests?
- What are the monitoring requirements and who is responsible for monitoring?
- Are best practices recommended to minimize impacts to riparian forests?

Documents and policies reviewed include the data source characterization required in the WQGIT-approved document, *Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model* (CBP, 2015) to help determine if a document was appropriate and how much influence each document should have on the final recommendations. The documents reviewed were primarily from peer-reviewed reports, and federal, state, and local agency sources. Refer to the QAPP (Appendix B) for additional information about the document acceptance criteria.

Interviews

A list of recommended individuals to interview was compiled in the Project Plan based on Stakeholder Team input and an online survey. Additional interviewees were identified from discussions with the three selected counties for stream restoration evaluation (Lancaster County, PA; Anne Arundel County, MD; and Fairfax County, VA). Interviewees were selected to provide a representative sample of state agency, practitioner and MS4 perspectives.

Interviews were conducted from December 21st, 2021, to January 13th, 2022, and were done via Zoom or Microsoft Teams to enable the project team to record the interviews for accuracy. Each interviewer was provided a list of standard questions that were developed to allow comparison across the different jurisdictions. The interviews also included the opportunity for relevant follow-up questions to be asked of the interviewees as needed. The list of interview questions developed cooperatively with the Stakeholder Team to address the project objectives are provided below. The questions are mostly open-ended since the goal of the interview was for the respondent to provide their experiences and expertise for their local jurisdiction regarding stream restoration implementation and impacts on forest resources.

Interview questions for <u>all individuals</u> include:

- What is your experience or involvement with stream restoration projects?
- In your experience, how are sites selected for stream restoration projects? Who identifies the sites?
- Is a riparian forest assessment done prior to restoration to determine forest health, and, if so, what indicators are used?
- How is tree and tree canopy protection deliberated during site selection, design, and installation? Are there scenarios when protecting trees, forest stability, and forest longevity are given priority over streambank reconstruction?
- Are there typical scenarios where entire buffers or mature trees are removed and why?
- When trees are removed during restoration, to what extent are riparian tree cover and structure restored after restoration? How quickly does this occur?
- What best practices are used to minimize impacts to riparian forests (this would include post-restoration maintenance)? To what extent are they implemented?

Interview questions <u>specific to stream restoration practitioners</u>:

- What are the decision processes for selecting the type of restoration?
- How are discrepancies between project design and implementation (such as expected vs. actual forest change) handled?
- What are the parameters for plants/rocks/woody debris used for restoration and where it is sourced? How are decisions regarding the use of "natural" materials and quality of materials made?
- What is done with the trees that are removed (e.g., are they sold? Are any used for restoration off-site or on-site)?
- What post-construction monitoring is conducted and what is the purpose of the monitoring? Do monitoring requirements vary?
- Have you designed or managed projects that you deem successful? If so, what made them successful?

- Have you designed or managed projects that were less successful or unsuccessful? If so, what were some challenges or issues?

Interview questions specific to non-stream restoration practitioners:

- Are you aware of cases where there have been discrepancies between project design and implementation? If so, how were these discrepancies handled?
- In your experience, what sort of post-construction monitoring is conducted for stream restoration projects in your area?
- Are you aware or have you been involved with stream restoration projects that were successful? If so, what made them successful?
- Are you aware or have you been involved with stream restoration projects that were less successful or unsuccessful? If so, what were some challenges or issues?

The following additional questions for all individuals were sent to the interviewees in June 2022 for further clarification on some of the initial interview results:

- What regulations (federal, state, and local) do you typically follow for stream restoration projects? Are there any gaps that you know of in the regulations that result in the loss of forest cover? Which policies have "teeth", and which do not?
- From your experience, how involved are forest agencies in the stream restoration process? Indicate which agencies you work with and their role.
- What are the typical stream mitigation requirements and are they enforced?
- If you work in MD, do you follow the recommendation from the MD DNR policy document on stream restoration that a 10-year monitoring plan be implemented and conducted by an expert?
- What are the typical funding sources for stream restoration projects you've been involved with (grants, federal, state, in-kind, etc.)?
- What are the typical funding sources for monitoring and maintenance?

Case Study Analysis

Three counties (Lancaster County, PA; Anne Arundel County, MD, and Fairfax County, VA) were identified for the case study analysis to represent each of the three states, and a variety of physiographic regions and stream restoration design types. The counties were selected based on the availability of stream restoration projects, feedback from a Stakeholder Team survey, and available monitoring data. Each county provided a list of stream restoration projects that were considered representative[3] of projects occurring in the county and for which GIS/CAD data, as-builts, permitting documents, design reports, and/or monitoring data were available. CWP ultimately selected ten of these projects for which sufficient data was able to be obtained

CWP used a combination of geospatial analysis, modeling, and document review to develop the case studies. To assess vegetation change at each study site, CWP used the currently available 2013/2014 1-m resolution land use data from the Chesapeake Conservancy,[4] as well as NAIP imagery and leaf-off aerial imagery to delineate the land cover within the limit of disturbance (LOD) of each

[3] MDE disagrees that the Maryland examples were representative. Dam removal and removal of a concrete channel respectively in two of the examples are rare. Also, the remaining project at Muddy Creek was a serious violation of the permit.

[4] https://www.chesapeakeconservancy.org/conservation-innovation-center/high-resolution-data/land-use-data-project/

project site before and after restoration. To assist with this process, Peter Claggett from USGS provided a link to an online land use change viewer[5] that shows areas where change occurred between the 2013/2014 dataset and the forthcoming 2017/2018 land cover dataset. Because the pre-construction timeframe of the stream restoration projects did not always align with the timeframe of the 2013/2014 dataset, best professional judgment was used to determine the pre-construction land cover for some projects.

To quantify changes in nutrient and sediment pollutant loads, CWP used loading rates from the Chesapeake Assessment and Scenario Tool (CAST) for the Phase 6 land-river segment where each project is located. The loading rates were used with the quantified pre- and post-restoration land cover types to calculate the change in loads associated with land cover conversion due to project construction. The nutrient and sediment pollutant load reductions associated with each stream restoration project were calculated using both the CBP stream restoration planning rate, as well as those calculated using the stream restoration crediting protocols (Schueler and Stack, 2014; Wood et al., 2021) for comparison purposes when that information was included with the project data. The planning rate provides for a consistent stream restoration load reduction across all projects based on the pounds of nutrient and sediment reduction per foot of stream restoration project, whereas the load reductions reported for using the CBP crediting protocols are a more accurate estimate based on specific-site conditions and the restoration approach at each site.

CWP reviewed project information, including permitting documents and monitoring reports, to summarize regulatory requirements related to vegetation on the project sites, whether the requirements were met, and the level of post-construction riparian vegetation success. The Nationwide Permit 27 (NWP 27) applied to all but one of the case study projects. NWP 27 includes activities in waters of the United States associated with aquatic habitat restoration, enhancement, and establishment activities, provided those activities result in net increases in aquatic resource functions and services.

Webcasts

Webcasts were planned in coordination with the project's Stakeholder Team, who provided input on potential speakers, attendees, and discussion topics. Speakers that provided state agency perspectives included members from the Stakeholder Team that represented the PA Department of Environmental Protection (PA DEP), MD Department of the Environment (MDE), and VA Department of Environmental Quality (VA DEQ). Local government speakers represented the County in each state that was selected as a focal area for the project's recently completed case study analysis and included Lancaster County, PA, Anne Arundel County, MD, and Fairfax County, VA. These three counties were identified to represent each of the three states, and a variety of physiographic regions and stream restoration design types. The counties were selected based on the availability of stream restoration projects, feedback from a Stakeholder Team survey, and available monitoring data. Speakers providing the practitioner perspective were those identified that have implemented multiple stream restoration projects within the focus state of each webcast.

The agenda for each webcast was similar, with the state agency, local government, and practitioner presentations focused on the state in which each webcast was held and included the following:

- Welcome and Project Overview
- State Agency, Local Government, and Practitioner Presentations

[5] Land Use Change Viewer (cicapps.org)

- Presentation of Project Results
- Facilitated Discussion
- Wrap Up and Next Steps

Literature Review of Stream Restoration Impacts on Riparian Vegetation and Best Practices

Introduction

Stream restoration is extremely complex with numerous approaches due to the interaction of hydraulic, morphologic, physiochemical, biological, social, political, and other systems to varying degrees. This complexity is exemplified by the USDA NRCS Stream Restoration Design guidance document (USDA NRCS, 2007), Part 654 of the National Engineering Handbook, which is 714 pages in total. The USDA's more distilled "Guide for Stream Restoration" (Yochum, 2018) provides a more current overview as opposed to step-by-step guidance, but it is still over 100 pages in total. Even the "Natural Channel Design Review Checklist" (Harman & Starr, 2011) is nearly 100 pages. Given the complexity of stream restoration design, it is important to understand the impacts of restoration-related activities on riparian forest cover, and to accurately value associated tree trade-offs during project prioritization. This literature review includes a summary of potential riparian buffer impacts due to stream restoration, as well as a review of available guidance that includes best practices for minimizing impacts to riparian forests/ecosystems.

Temperature Impacts

There is a direct link between riparian forests and stream temperature, which is a critical metric of stream health. Therefore, in planning for stream restoration projects, the potential impact to a stream's thermal regime must be considered. In-stream water temperature is considered especially important in the context of climate change and impacts of urbanization (Mayer et al., 2010). According to a USGS report (Rice & Jastram, 2015) cited in the current CBP Scientific and Technical Advisory Committee (STAC) workshop project on Rising Watershed and Bay Water Temperatures (Draft CBP RWT STAC, 2022[6]), temperatures of both water and air have been increasing in the Chesapeake Bay Watershed for over 60 years, and in-stream water temperatures are increasing faster than air temperatures in most areas. Rice & Jastram (2015) reported that air temperatures have increased 1.99 °F from 1960 to 2010, while non-tidal stream temperatures increased 2.52 °F in that timeframe due to the influence of land use and other watershed-specific characteristics (Draft CBP RWT STAC, 2022). Protecting thermal regimes in streams is important for a variety of reasons, including maintaining spawning habitat and healthy conditions for fish, reducing algal growth, reducing populations of parasites that favor warmer temperatures, and regulating nutrient/carbon/oxygen dynamics, since temperature affects the dynamics of many gaseous and aqueous compounds (Demars et al., 2011; Mayer et al., 2010; Wilkerson et al., 2006).

The effects of stream restoration on stream-water temperature are still being researched, as well as the best approaches for reducing stream-water temperatures. There is evidence that stream

[6] All 10 of the synthesis draft element reports produced by the Rising Watershed and Bay Water Temperatures (Draft CBP RWT STAC, 2022) can be found here: https://www.chesapeake.org/stac/events/day-1-rising-watershed-and-bay-water-temperatures-e2-80-94ecological-implications-and-management-responses-a-proactive-programmatic-cbp-stac-workshop/. Note: As of the time of the writing of this report, the CBP RWT STAC reports are still draft results.

temperatures increase post-restoration (Fanelli et al., 2017; Sudduth et al., 2011). Many consider decreased streamflow, widened channels, and reduced riparian cover to be primary drivers of rising in-stream water temperatures (Justice et al., 2017; Wilkerson et al., 2006). These drivers are supported by the cumulative findings of the Draft CBP RWT STAC (2022) workshop project. One of the general findings of the project is that riparian trees along narrower stream channels can provide shading (from the canopy cover) and cooling (from evapotranspiration), in addition to increasing the infiltration of stormwater runoff. One of the synthesis papers from the Draft CBP RWT STAC (2022) workshop project identified infiltration as a process that may regulate the temperature of stormwater before it enters a stream. This paper also explains how certain types of BMPs, like tree planting and riparian buffers, decrease temperatures of stormwater, while other types of BMPs (e.g., wet ponds, created wetlands, dry extended detention ponds, sand filters, etc.) may have a heating effect on stormwater runoff.

The evidence supporting these primary drivers does vary from study-to-study, and additional site-specific monitoring in the Chesapeake Bay watershed is needed. An Oregon-based study of the effects of both natural beaver dams and beaver dam analog (BDA) structures on stream-water temperature cycles found that surface water storage is a primary driver of stream-water temperature moderation. Weber et al. (2017) monitored water temperature for eight years across over 21 miles of stream with natural beaver dams as well as approximately 2.5 miles of stream with a high density of BDA structures. This study found that, while natural beaver dams/BDAs may reduce canopy cover, "the increase in radiant heating of surface water may have been offset by the buffering effect of increased surface water storage." Weber et al. (2017) further found that the most significant increases in summer maximum temperatures were observed in downstream locations when no active beaver dams or BDAs were present. One of the reports in the Draft CBP RWT STAC's review indicated that trends of increasing in-stream water temperatures were detected alongside trends of increasing streamflow in portions of the Chesapeake Bay; although this report is unrelated to beaver dams, it may relate to Weber et al. (2017)'s conclusion that periods of low surface flow and increased water storage encourage surface- and ground-water exchange, which can moderate temperature cycles.

Each of these primary drivers—streamflow, channel width, and riparian cover—are typically impacted in some way by stream restoration projects. Generally, stream restoration projects aim to regulate streamflow by reducing flashiness, stabilize channels, reconnect to the floodplain, and/or replacing dying or at-risk trees. In many stream restoration projects, temporarily reduced riparian cover is an expected outcome, though assessments are still underway and there is limited information on how well mature riparian forest actually recovers. While the canopy is expected to expand over time as newly planted vegetation matures, temporary canopy reduction still impacts stream-water temperatures. Sudduth et al. (2011) and Violin et al. (2011) compared the functional uplift provided by four forest reference streams, four natural channel design (NCD)-restored streams, and four non-restored urban streams in the North Carolina Piedmont. The studies concluded that the heavy machinery used to reconfigure channels and banks led to significant losses of riparian canopy cover and corresponding increases in stream temperatures. These thermal impacts were a major factor in the lack of functional uplift observed in restored streams compared to non-restored, forested streams.

One of the synthesis papers from the Draft CBP RWT STAC (2022) workshop project describes the importance of incorporating water temperature considerations and creation of thermal refugia in stream restoration design using a case study from several projects in the District of Columbia. The District-based projects incorporated channel features for fish to access cooler water (e.g., deeper channels areas, overhangs) and the preservation/planting of riparian trees to cool the stream-water. Upstream stormwater infiltration was added where feasible. In current post-construction monitoring data, stream biota improvements have been observed. This case study supports the premise that stream restoration that considers and prioritizes the temperature effects of riparian canopy and incorporates thermal refugia into channel design can offset thermal impacts typically associated with restoration.

Some research emphasizes the role of microtopography and groundwater interactions as drivers of stream-water temperatures (Torgersen et al. 2012; Ward & Stanford, 1995; Brunke & Gonser, 1997). Microtopography can be generally defined as variations in topography that are on the scale of individual plants, and it encompasses both surficial roughness and vertical relief (Moser et al., 2007). In the context of stream restoration, the term can be used to refer to topographic variation within the stream channel (e.g., deeper pools and shallower submerged bars) and within the stream's riparian areas. These microtopographic variations provide habitat benefits. While microtopography can be considered as part of stream restoration design, it can be difficult to mimic the complex microtopography found at natural sites using large construction equipment. Site-specific evaluation of stream temperature drivers is always appropriate, as temperature increases could be influenced by a variety of factors that are unrelated to riparian vegetation or stream restoration as well, including but not limited to climate change, heated discharges, hydrologic regime modifications (including interactions with groundwater), land use/land cover, topography, and tidal influences (Draft CBP RWT STAC, 2022).

Ward & Stanford (1995) explain that a combination of openings in canopy cover, groundwater interactions, and volume influence thermal heterogeneity in streams. Within headwater channels, "thermal heterogeneity peaked in the middle reaches where canopy is open, the influence of groundwater is minimal, yet the volume of water is small enough to rapidly respond to changes in ambient conditions" (Ward & Standford, 1995). In a US EPA report on thermal diversity of riverine landscapes in Washington state, Torgersen et al. (2012) explain that alluvial valleys are more likely to contain "reach-scale cold-water refuges formed by hyporheic processes," whereas cold-water refuges in bedrock-dominated reaches are more likely to be influenced by lateral tributary inputs. Brunke & Gonser (1997) place more emphasis on groundwater interactions as a primary driver of stream-water temperature, explaining that "annual temperature regimes show characteristic fluctuations depending on the temperature and volume of groundwater they receive." However, they describe their "hyporheic corridor concept" as "[emphasizing] connectivity and interactions between subterranean and surface flow [… which] is a complementary concept to others which focus on surficial processes in the later and longitudinal dimensions." This indicates that both concepts—focusing on groundwater interactions and focusing on surface-level characteristics like canopy cover—are complementary and should both inform management decisions. There is additional pre- and post-restoration comparison from the Big Spring Run legacy sediment removal project in Lancaster County, Pennsylvania that support the influence of groundwater interactions and microtopography on stream-water temperatures; however, that research has not yet been published.[7]

Biologic, Habitat, & Water Quality Impacts

Streams provide critical habitat for many wildlife species, and healthy, native riparian vegetation is essential for maintaining that habitat. The species composition of riparian vegetation and the

[7] Email correspondence with Dave Goerman (PA DEP); August 2, 2022.

distribution/density of plants within the riparian buffer are two metrics that influence both the species and quantities of fish, insects, macroinvertebrates, and other wildlife that can be supported by a stream-riparian system. While there are a variety of assessment techniques to evaluate the quality of stream-riparian habitat, most involve biological monitoring. Macroinvertebrate assemblages are most widely used (Doll et al., 2016); however, fish assemblages are also important indicators of habitat quality, especially in restored streams where canopy cover may be temporarily reduced prior to regrowth.

When trees are removed for stream restoration projects, the critical habitat provided by their canopy and root systems is also removed. Although removed trees are typically replanted in-kind, the maturation of the restored vegetation can take many years. Recent work by Wood et al. (2021) and Kaushal et al. (2021) demonstrated that tree removal during stream restoration construction can trigger sub-surface fluxes of nutrients out of the riparian zone and into the stream and that there is an ecosystem recovery period for groundwater processes following tree removal that lasts at least 5 years. These shifts in nutrient dynamics can also affect concentrations of both nutrients and organic carbon in groundwater (Kaushal et al., 2021). It is important to note that the post-restoration recovery of the ecosystem as a whole typically takes many years.

Selvakumar et al. (2010) studied various functional metrics above and below ground, and before and after a NCD stream restoration was installed on an 1,800-foot reach in the North Fork of Accotink Creek in Fairfax County, Virginia. The conclusion from the two-year study was that the restoration project had reduced stream bank degradation and slightly increased Benthic Index of Biological Integrity (BIBI) scores, but made no statistical difference in water quality parameters, including nutrients and bacteria. The loss of riparian cover associated with project construction was hypothesized to be a factor in the low biological uplift observed.

It is difficult to develop a predictive relationship between metrics of stream-wetland habitat quality and indicators of biological success due to the inextricable influence of areas upland in the watershed (Doll et al., 2016; Stranko et al., 2011). Some studies have found either no evidence or very limited evidence that stream restoration projects in urban watersheds have the potential to improve habitat quality in a meaningful or reliable way, partially due to the influence of the contributing drainage area to the stream (Hilderbrand, 2020; Hilderbrand et al., 2015; Violin et al., 2011). Current programs and ongoing research are working to improve our knowledge of stressors that may impact stream health recovery (US EPA, 2022). They are also identifying and recommending interventions and watershed actions that can address these stressors (CBP SHWG, 2019). However, it is clear that the removal of mature trees during restoration physically alters the available habitat in a stream-riparian system, and those physical alterations have coincidental effects on stream-water chemistry. Both of these restoration-related changes—physical and chemical—affect the biological uplift provided by a restored stream.

Inundation Impacts from Floodplain Reconnection

Stream restoration projects that enhance floodplain reconnection can impact existing riparian vegetation species due to increased groundwater elevations and/or extended inundation of the floodplain. Flooding may reduce upland tree species root growth which may lead to decline, death, and decay over time (Coder, 1994). Bottomland and wetland trees, however, are more tolerant to flood conditions through a variety of adaptations, including root adaptations that allow for increased root porosity. This "lessens the resistance to gas flow and allows the root to penetrate deeper into anaerobic soil," which increases oxygen supply to the tree and plays a role in bank stabilization

(Teskey & Hinckley, 1977). The severity of impact to the plant community is dependent on the tree's tolerance level to flooding, "the soil conditions present and the nature, timing and duration of the water level change" (Teskey & Hinckley, 1977). For example, Bald Cypress trees "showed superior performance under frequent intermittent flooding regimes due to rapid recovery of gas exchange soon after soil was drained" (Anderson & Pezeshki, 1999). Similarly, Angelov et al. (1995) saw 95% of Swamp Tupelo and Sweetgum seedlings survive continuous root flooding for more than two years whereas Swamp Chestnut Oak and Cherry Bark Oak seedlings only survived one year of flooding. Hudson et al. (2015) recommends planting multiple primary successional species, excluding the American Sycamore, grown in gallon containers as the best choice for establishing productive trees in created forested wetlands.

Given the scarcity of fully functional floodplains in urbanized portions of the Chesapeake Bay watershed, floodplains are a unique habitat that may be prioritized over other habitat conservation efforts. Therefore, stream restoration projects that include floodplain reconnection—converting upland forest into riparian or floodplain forest—should, in theory, "represent a net gain of species diversity and the overall ecological health of the watershed" (Budelis et al., 2020). Unfortunately, these benefits are less likely when habitat fragmentation and other effects from urbanization prevent the normal dispersal of native species throughout a watershed. Research conducted by Januschke et al. (2014) suggests that hydro-geomorphological restoration, or floodplain reconnection, results in different community assemblages. The above reasoning may explain why upland tree loss within this context may occur. In comparison, Budelis et al. (2020) found no clear evidence that floodplain reconnection altered functional composition and diversity in plant communities in a Maryland study that evaluated metrics of woody/tree and herbaceous plant communities using data from four stream restoration projects with varying project designs and watershed characteristics. However, this study showed mixed results for other metrics, with two sites showing declines in basal area. Overall tree condition and canopy condition, though measured, did not have accompanying results in the report. The percentage of invasive species post-restoration was also not clearly indicated.

Best Practices for Minimizing Impacts to Riparian Forests/Ecosystems

Federal, state, and local guidance documents were reviewed to identify best practices for accounting for forest health as part of stream restoration projects. All three states had technical guidance documents that detailed recommended practices for stream restoration and accompanying information on design techniques. The recommended best practices were reviewed and organized by the following categories corresponding to the various stages of the stream restoration process:

- Site Selection
- Establishing Goals and Objectives
- Design and Permitting
- Stakeholder Engagement
- Construction
- Monitoring and Maintenance

Table 3 provides an overview of the guidance documents reviewed and which best practices they address.

Table 3. Guidance documents that incorporate best practices for minimizing riparian forest/ecosystem impacts.									
Citation	**Title**	**Jurisdiction**	**Description**	**Site Selection**	**Establishing Goals and Objectives**	**Design and Permitting**	**Stakeholder Engagement**	**Construction**	**Maintenance and Monitoring**
Keystone Stream Team (2007)	Guidelines For Natural Stream Channel Design for Pennsylvania Waterways	PA	These guidelines will assist watershed organizations with the planning and implementation of stream restoration projects and professionals with stream restoration design, construction, and permitting in PA. The guidelines were developed by the Keystone Stream Team, an informal group comprised of government and environmental resource agencies, university researchers, sportsmen, citizen-based watershed groups, and private companies.				X	X	X
MD DNR (2015)	Principles and Protocols to Guide the Department of Natural Resources' Actions Regarding Stream Restoration Projects in Maryland	MD	MD DNR developed criteria to guide their actions to review, support, fund, and /or construct stream restoration projects in Maryland.			X		X	X
MD DNR (2018)	Regenerative Stream Conveyance Construction Guidance	MD	Presents guidance on the development and implementation of regenerative stream conveyance projects. Provides construction guidance to aid contractors' regenerative stream restoration efforts. Serves as a common reference for various professionals in the field of water resources and watershed restoration.			X		X	X
MD DNR (2014)	River/Stream Management Strategy: Guiding Principles	MD	Outlines the "guiding principles" that provide a science-based perspective on rivers and streams intended to help MD DNR's Environmental Review Unit						X

Table 3. Guidance documents that incorporate best practices for minimizing riparian forest/ecosystem impacts.

Citation	Title	Jurisdiction	Description	Site Selection	Establishing Goals and Objectives	Design and Permitting	Stakeholder Engagement	Construction	Maintenance and Monitoring
			effectively evaluate and consistently formulate sound recommendations on proposed projects that could adversely affect the State's rivers and streams.						
MDE (n.d.)	MS4/Chesapeake Bay TMDL/Trust Fund Restoration Project Wetlands & Waterways Permit Package Checklist	MD	Details the permit package that must be submitted for stream restoration projects in nontidal areas.	X		X	X	X	
MDE (2022)	Guidance for Stream Restoration Based on Key Wildlife Habitats: Upper Coastal Plain Stream-Associated Wetlands	MD	Stream restoration guidance document developed by MDE to better ensure that restoration projects are designed to protect aquatic/wetland resources that may be present or dependent on the site while still allowing for projects which can receive credit toward nutrient and sediment reduction.	X	X	X	X	X	X
MW COG Berger et al. (2021)	Draft Recommended Stream Restoration Best Practices	DC, MD, VA	Details a set of practices for how local governments can best implement stream restoration projects, focusing on planning/design, siting and final project selection, public engagement, construction, monitoring, and maintenance.	X	X	X	X	X	X
PA DEP (2022)	Pennsylvania Function-Based Aquatic Resource Compensation Protocol	PA	New guidance regarding compensatory mitigation for projects that must replace natural resources impacted during permitted projects	X	X	X	X		
US EPA	A Function-Based Framework for Stream Assessment & Restoration Projects	Nationwide	Provides a framework for approaching stream assessment and restoration from a function-based perspective. The	X	X				

Table 3. Guidance documents that incorporate best practices for minimizing riparian forest/ecosystem impacts.									
Citation	**Title**	**Jurisdiction**	**Description**	**Site Selection**	**Establishing Goals and Objectives**	**Design and Permitting**	**Stakeholder Engagement**	**Construction**	**Maintenance and Monitoring**
Harman et al. (2012)			document is meant to help the restoration community understand the interrelationships and functional hierarchy that exists between stream functions and other structural measures. Provides informal guidance and ideas on how standard operating procedures may incorporate stream functions into debit/credit determination methods, function-based assessments and performance standards.						
USACE USBR & ERDC (2016)	National Large Wood Manual—Assessment, Planning, Design, and Maintenance of Large Wood in Fluvial Ecosystems: Restoring Process, Function, and Structure	Nationwide	Provides a basic understanding of the role of wood in fluvial aquatic and riparian ecosystems. Explains how wood should be maintained, reintroduced, and managed while also evaluating the best policies behind restoring wood in rivers and streams. Provides resource manager and restoration practitioners with guidelines for the planning, design, placement, and maintenance of large wood in streams with a focus on ecosystem restoration.		X	X		X	
USDA FS Yochum (2018)	Guidance for Stream Restoration	Nationwide	Provides a guide for the available guidance via a series of short literature reviews on the topics of general methods of stream restoration, stream processes, restoration case studies, data compilations, preliminary assessments, and field data collection. Serves as a technical note to assist		X			X	

Table 3. Guidance documents that incorporate best practices for minimizing riparian forest/ecosystem impacts.									
Citation	**Title**	**Jurisdiction**	**Description**	**Site Selection**	**Establishing Goals and Objectives**	**Design and Permitting**	**Stakeholder Engagement**	**Construction**	**Maintenance and Monitoring**
			professionals in stream restoration projects.						
USDA FS Palone & Todd (1998)	Chesapeake Bay Riparian Handbook: A Guide for Maintaining Riparian Forest Buffers	Chesapeake Bay	Contains information on the functions, design, creation, and management of riparian forest buffers to be utilized by land managers and planners. The document is to be used by Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia, all of which are in the Chesapeake Bay watershed, as well as Bay adjacent states. Uses a three-zone riparian buffer concept as the organizational guideline for buffer establishment.				X	X	
USDA NRCS (2007)	Stream Restoration Design (National Engineering Handbook 654)	Nationwide	Contains comprehensive guidance for the planning and designing of projects intended to improve streams and their functions. Provides engineering and ecological assessment tools used perform analyses and designs in the field of stream restoration that are representative of green techniques and structural approaches.		X	X	X	X	
USFWS Pollock et al. (2015)	The Beaver Restoration Guidebook: Working with Beaver to Restore Streams, Wetlands, and Floodplains	Nationwide	Contains an overview of the best available science for improving ecosystems using beavers to restore streams, floodplains, wetlands, and riparian ecosystems. Mainly covers beaver ecology and beaver restoration and management.		X				
VA DCR	Riparian Buffers Modification & Mitigation Guidance Manual	VA	Provides assistance to local government staff for the implementation of buffer modification			X	X		X

Table 3. Guidance documents that incorporate best practices for minimizing riparian forest/ecosystem impacts.									
Citation	**Title**	**Jurisdiction**	**Description**	**Site Selection**	**Establishing Goals and Objectives**	**Design and Permitting**	**Stakeholder Engagement**	**Construction**	**Maintenance and Monitoring**
Baird & Wetmore (2003)			provisions of the Chesapeake Bay Preservation Area Designation and Management Regulations. The document is meant to be used with riparian landowners on buffer establishment, management, and restoration issues. The manual is meant to improve buffer management strategies to help improve the water quality of the Chesapeake Bay and its tributaries.						
VA DCR (2004)	The Virginia Stream Restoration & Stabilization Best Management Practices Guide	VA	Provides information on the permitting issues, planning and design guidelines, costs, and individual best management practices for stream restoration. The guide is intended for use as technical resource in the constructing of stream channels and bank stabilization and restoration projects.	X		X			
VA DEQ (1992)	Virginia Erosion and Sediment Control Handbook	VA	Establishes new standards and guidelines for the control of soil erosion and sedimentation on land disturbing activities. It is intended to serve as a technical guide in the effort to meet the requirements dictated by the Virginia Erosion and Sediment Control law and the Virginia Erosion and Sediment Control Regulations (9VAC25-840). Additionally, the handbook contains specific guidance on the application of conservation practices.			X		X	

Key Findings and Recommendations

The results and lessons learned from each of the project tasks are summarized in separate documents included as appendices to this report:

- Policy/Document Review and Interview Results Technical Memorandum (Appendix C)
- Case Studies Summary (Appendix D)
- State Webcast Summary (Appendix E)

The key findings from these project tasks are summarized below and are organized by six recommended best practice categories.

Site Selection

Site selection for stream restoration projects is typically done by either municipalities or planning-oriented organizations working in coordination with the municipalities. Stream restoration practitioners are often not involved in the planning, prioritization, or selection of sites, other than to provide comment on the applicability of a pre-identified site for restoration design and grant funding. Generally, sites are selected using one or a combination of the following methods: 1) opportunistic considerations, 2) watershed assessments conducted as part of a watershed planning initiative, or 3) mitigation banking efforts. In terms of mitigation banking projects, site selection is driven by the market and less through prioritization of a region/watershed.

Funding availability and landowner willingness were commonly identified as key parameters for site selection. Restoring lengths of stream that are significant at the landscape-scale is dependent on having agreement by multiple willing landowners. In some cases, a site is not necessarily the most optimal in relation to the rest of the watershed, but it is prioritized due to the likelihood that it will be implemented.

When considering site selection, upland stormwater controls were questioned during the webcasts as a potential alternative option to conducting stream restoration projects. Stream degradation is almost always the result of upland modification, particularly the development of urbanized areas and the increase of impervious surface cover. There are many older developed areas that have minimal or no stormwater management. Implementing enough stormwater controls at the watershed scale to be effective is challenging and depending on the watershed may not be feasible due to property ownership and enforcement concerns, but it should be considered. Retrofitting older stormwater facilities can also be beneficial, but the area benefitted is often small and localized.

The difficulty with solely implementing upland stormwater controls is that even if the stormwater flows are reduced, degradation to the stream systems has already occurred and will take years to adjust to new conditions and a new dynamic equilibrium. Without fully addressing these causal factors, stream restoration projects will not be able to restore all the ecological stream functions (e.g., restoring biota) to reference conditions, and stream restoration can often fail over time. It still may be advantageous to "restore" certain functions of a stream that is rapidly eroding causing property damage and increased sediment and nutrient loadings to downstream waters, after giving careful consideration to any resource tradeoffs and as much of an ecosystem approach as is practicable. There is often a cost to not doing a stream project in terms of damage to infrastructure, threats to public safety and further loss of trees as streams continue to erode.

Table 4 contains identified best practices related to site selection for maintaining forests and riparian vegetation, and Table 5 contains programmatic and research recommendations related to site selection.

Table 4. Site Selection Best Practices
Follow a watershed-based approach for screening and prioritizing stream restoration projects that target restoration to areas in need (generally streams with poor biological quality) and avoid existing high-quality areas with healthy stream and riparian conditions. Guidance should be followed from the appropriate federal, state, or local regulatory authorities regarding assessment and incorporation of existing high-quality habitat and ecosystem functions into project design. In addition, stream restoration projects should be avoided in watersheds where significant land use change is planned that may cause adverse effects to the project.
Evaluate options for combining stream restoration with stormwater infiltration, other upland stormwater management practices, forestry, wetland, and agricultural BMPs in the contributing watershed.
Combine stream restoration with sanitary sewer rehabilitation. Sanitary sewer main lines that are gravity flow often physically lie in streams and floodplains. Older lines cause problems with exfiltration of sewage into the stream and infiltration of stream/groundwater flows into the sewer. Repair of sanitary sewer lines in the stream or floodplain could be aligned with stream restoration to target restoration to locations where disturbance will already be occurring. The longest/largest opportunities presumably would be in association with USEPA consent decree repairs, such as in Baltimore City, Baltimore County, WSSC, etc.

Table 5. Site Selection Programmatic and Research Recommendations
State agencies should develop clear definitions of existing "low-quality" streams and riparian areas that need restoration and corresponding guidance that includes best practices and designs to minimize resource tradeoffs and other undesirable consequences of stream restoration projects. The definition of "high-quality" is subjective and can be interpreted in different ways depending on stakeholders involved. Thresholds for identifying these areas should also be developed, for example using metrics related to BEHI and NBS scores from BANCS assessments, IBI indices, stream riparian forest indices, location of rare forest species, or based on existing identification of high-quality streams in state water quality standards, healthy Watersheds initiatives, mapping of areas important for biodiversity and conservation, etc. Clear definitions and guidance from the state regulatory agencies would help inform stream corridor assessments, outline the expectations for areas that should be avoided, and provide a more consistent site selection approach to target areas that are truly in need of restoration. Recent guidance from MDE (2022), "Guidance for Stream Restoration Based on Key Wildlife Habitats: Upper Coastal Plain Stream-associated Wetlands" is a good example.
Conduct a comprehensive review of the scientific and gray literature related to stream restoration and upland stormwater controls to determine if guidelines can be developed for conditions when one practice is recommended over the other or a combination of the practices is most effective. Many research studies are either underway or have recently been completed on this topic suggesting it may be good timing for synthesizing all the available findings. For example, Lammers et al. (2020) developed a set of recommendations for integrated planning of stormwater control measures and stream restoration to simultaneously achieve water quality and channel protection goals based on a modeling study. Dr. Tess Thompson is also currently conducting on a Chesapeake

Table 5. Site Selection Programmatic and Research Recommendations
Bay Trust (CBT) funded modeling study, "Effectiveness of Stormwater Management Practices in Protecting Stream Channel Stability." In addition, CWP completed a monitoring study, "The Self-Recovery of Stream Channel Stability in Urban Watersheds due to BMP Implementation" (CWP, 2021) and was recently awarded additional funding from CBT to continue long-term monitoring of the study sites.

Establishing Goals and Objectives

Establishing achievable goals and objectives is one of the most important steps in a stream restoration project that determines not only the design, but the data collection effort and methodologies for assessments. The CBP stream restoration expert panel and subsequent work groups recommended that proposed stream restoration projects be developed through a functional assessment process, such as the Stream Functions Pyramid (Harman et al., 2012) or functional equivalent. Most stream restoration projects in urban areas are incentivized by permitting to improve water quality through TMDL and MS4 permit requirements. Therefore, it is critical that projects incorporate goals that provide some type of functional lift in addition to providing water quality benefits.

Stream restoration projects are commonly implemented with the goal of obtaining nutrient and sediment load reductions for TMDL credit only. The case study analysis[8] found that the nutrient and sediment load reduction benefits of restoration significantly outweighed any increase in loads from land use conversion within the context of the Chesapeake Bay Watershed Model land use and loading rate framework due to the restoration (forest to wetlands or tree canopy over turf), further incentivizing their use for TMDL credit. However, this was not the intention of the CBP Stream Restoration Expert Panel and subsequent work groups, which contain a qualifying criterion that, "Stream restoration is intended to be a carefully designed intervention to improve the hydrologic, hydraulic, geomorphic, water quality, and ecological condition of degraded urban streams, and must not be implemented for the sole purpose of nutrient or sediment reduction" (Schueler and Stack, 2014; Wood et al., 2021).

Establishing appropriate goals and objectives is dependent on the definition of stream restoration, which varies among the states. For PA DEP, restoration addresses the underlying causes of resource degradation within the modern constraints and acceptable vegetative outcomes are driven by addressing the underlying cause of degradation. Targeting symptoms of degradation would not be considered restoration under this definition. PA DEP also recognizes that natural aquatic resources buried beneath legacy sediment are not exclusively forested and may provide substantial habitat and water quality benefits (Voli et al., 2009; Hilgartner et al., 2010; Merrits et al., 2011; Hartranft et al.,

[8] MDE did not agree with some statements in the case study report, noting several areas of concern: 1) The case study analysis relied on Chesapeake Conservancy 2013/2014 land use data used in the Chesapeake Bay Watershed Model. An overall concern is that "forest" is presented as something different than floodplain wetland within the land use categories. They are not mutually exclusive. In Maryland most of the forest adjacent to streams in the study area are forested wetlands. If additional data was available, it would be more beneficial for the case study analysis to distinguished between existing upland forest, former wetland forest, and existing wetland forest for pre- and post-construction conditions when describing change; 2) MDE is aware that some practitioners have the viewpoint that tulip poplar is not appropriate for floodplains. MDE disputes this contention from experience and regional data records from the Maryland Natural Heritage Program, which supports the frequent occurrence of tulip poplar in floodplains, including many floodplain wetlands.

2011). In comparison, the Pennsylvania Department of Conservation and Natural Resources (PA DCNR) perspective is that existing upland conditions impacting streamflow and stormwater runoff—as opposed to the site's historic conditions—should be the primary informant of the degree to which a legacy sediment removal project site is reforested. MD DNR adopted guiding principles related to stream restoration in June 2015 that defines and reviews distinct criteria for various types of stream treatments (e.g., restoration, rehabilitation, engineering, reclamation, stabilization, and enhancement) and noted that not all projects should be considered stream restoration. Historic or predevelopment conditions for setting vegetation restoration goals do not play a major part in MDE's considerations, which instead evaluates projects based on the value of current conditions. In VA, the definition of stream restoration is the process of converting an unstable, altered, or degraded stream corridor, including adjacent areas and floodplains to its natural conditions.

Table 6 contains the identified best practices related to establishing goals and objectives for maintaining forests and riparian vegetation, and Table 7 contains programmatic and research recommendations related to establishing goals and objectives.

Table 6. Establishing Goals and Objectives Best Practices
Develop stream restoration projects through a functional assessment process, such as the Stream Functions Pyramid (Harman et al., 2012) or functional equivalent.
Review the project goals with all stakeholders to determine if forested riparian conditions are appropriate and achievable within the context of the stream and floodplain condition that would naturally form given existing and likely future watershed and reach conditions and be self-sustaining over time. Additional stakeholder considerations should include aesthetics, recreation, and cultural concerns.
Coordinate with forest agencies to incorporate riparian forest/ecosystem goals and objectives. Coordination between foresters and stream restoration practitioners at this stage of project development will help avoid conflicting riparian forest and stream restoration goals and objectives.
Consider the thermal impact of the project on the affected stream and incorporate thermal refugia. Climate has a large influence on rising stream temperatures across the Chesapeake Bay watershed. Evaluating and limiting the thermal impact of stream restoration projects can help mitigate the effects of climate-related stream temperature increases, which aligns with Chesapeake Executive Council Directive No. 21-1 Collective Action for Climate Change[9] calling for the threats of climate change to be addressed in all aspects of the partnership's work to restore the Chesapeake Bay and its watershed.

Table 7. Establishing Goals and Objectives Programmatic and Research Recommendations
Many current functional assessment methods have not yet been fully calibrated and standardized for floodplain restoration projects. The CBP Protocol 2 and 3 Workgroup (Wood and Schueler, 2020) identified a research need to **define and test new metrics that can effectively predict and rapidly measure the degree of functional uplift and/or functional losses achieved by floodplain restoration projects over short- and longer time frames. This method should incorporate functional assessment related to stream temperature**.

[9] https://www.chesapeakebay.net/documents/43419/climatedirective_final.pdf

Table 7. Establishing Goals and Objectives Programmatic and Research Recommendations
The CBP Stream Restoration Expert Panel (Schueler and Stack, 2014) intended for stream restoration projects to be part of a holistic watershed approach that includes the riparian area. **State agencies should consider integrating CBP riparian buffer goals as part of the review process for stream restoration projects** by evaluating the extent to which healthy riparian forest buffers are protected within the proposed project area and new riparian buffer is planted where none currently exists.
Agencies within each state that are involved with forestry and stream restoration should collaborate to establish a unified definition of stream restoration and develop corresponding expectations for acceptable goals and objectives.
The CBP should consider distinguishing forested wetlands as a separate land use classification within the Chesapeake Bay Watershed Model. Currently, forests that are also wetlands are included within the Forest land use category. Since many of the regulations governing stream restoration and development projects do not specifically protect forests but do have provisions for wetland protection, including forested wetlands, differentiating between these land use types would help to better quantify the impact of proposed projects on forest loss.
The CBP should consider adding a reporting requirement for stream restoration projects related to associated land use conversion. Currently, only the load reduction for stream restoration projects is reported. However, documenting the land use conversion would enable the ability to track riparian vegetation changes associated with stream restoration projects.

Design and Permitting

The decision processes for the types of stream restoration vary widely among jurisdictions and practitioners. In some cases, a municipality, organization, or practitioner specializes in and only performs one type of restoration. There are some trends by state as well. For example, legacy sediment removal projects, which involve a high amount of disturbance and remove existing surface vegetation, appear to mainly be pursued in Pennsylvania and are typically avoided in Maryland and Virginia. The way in which practitioners described their decision-making process was also variable; however, most do not arrive at a new site with a preconceived preference for the type of restoration. They allow the assessment, site constraints, and goals to drive the selected method. This can only occur when the practitioners are equally familiar and experienced with multiple restoration approaches.

Regulations at the federal, state, and local levels impact the ways in which riparian forest cover is considered in stream restoration design as well. Some of these regulations are more specific and/or enforceable than others, especially at the county level. Practitioners in Virginia indicated that local regulations are typically the most specific and robust as a result of locally implemented Chesapeake Bay Preservation Ordinances administered through Virginia's Chesapeake Bay Act. However, local governments indicated there is a lack of state guidance on the topic, which would be a valuable resource as localities provide internal review of stream restoration projects. In Maryland, the Forest Conservation Act is enforced at the county level; however, practitioners described notable differences in the ease of implementation across counties in the state. This is partially due to the variation in counties' personnel resources for enforcement and partially due to the presence/absence of county-specific supplemental regulations. In addition, some counties exempt stream restoration projects from the regulations.

In terms of pre-restoration riparian assessments, inventory of environmental features is necessary if a federal project permit is required. At the state and local level, pre-restoration assessments are typically not formally required, but are encouraged. An assessment of some pre-restoration site condition is required in Maryland by MDE. Funding limitations are likely to necessitate a choice between conducting a full forest inventory or a survey of trees adjacent to the specific project area. At the minimum, riparian assessments are informal, may or may not be documented, and are conducted by professional judgment. When practitioners conduct more detailed assessments, factors like dead/at-risk trees, root coverage, bank stability, habitat, soil type, and invasive species presence may be considered.

Most regulations at the federal and state level specify the need to preferentially preserve existing forest as much as possible and/or replant to meet mitigation requirements in instances when trees are removed, as opposed to regulating the degree to which forests at project sites can be cleared. This does not mean that vegetation can be cleared haphazardly. Rather, it permits flexibility in design approaches, like legacy sediment removal, which would otherwise be much more difficult to implement since it typically requires substantial vegetation clearing and indicates the importance of adapting regulations to suit restoration needs.

The removal of entire buffers or mature trees is a value decision made by the municipality or other authorizing entities that uses the best available information and is typically avoided as much as possible. Multiple practitioners noted that if a site has an exceptionally high-quality forest stand and a project is likely to cause extensive tree loss, then that site is reconsidered altogether. The removal of entire buffers was largely mentioned in association with legacy sediment removal, dam removal, and infrastructure protection projects, in which case it is accepted as part of the restoration process. In addition, floodplain restoration projects in a fully forested floodplain tend to be constructed if it is determined that minimal tree loss is possible. However, in cases where dry, upland species are occupying a stream terrace that has dried out over time, those trees wouldn't necessarily be targeted for removal, but their death as a result of stream restoration may or may not be considered an acceptable outcome. It should be noted that upland species are often found in floodplains which are in reference condition, so their presence should not automatically be considered indicative of a disconnected floodplain or as an undesirable component of a forest community. For sites where tree impacts cannot be avoided, the protection of larger trees with good root structure or canopy cover are prioritized. However, there is no standard method or process for deciding how to minimize the impact to trees, which this project is attempting to address by identifying best practices that are available to the stream restoration community for minimizing riparian buffer loss.

Buffers replanting when impacts are considered unavoidable is one method to mitigate loss of streamside forests. Replanting the buffers may be required by the 404 permits, 401 certification requirements, and state permits after the restoration is complete. Some jurisdictions like Fairfax County experiment with different planting techniques to provide higher degrees of canopy coverage in shorter amounts of time. For mitigation bank projects, the Interagency Review Team (IRT) in Maryland for mitigation banking requires that impacts associated with waters of the U.S. are mitigated. There are also more specific mitigation requirements for impacts to wetlands. Especially in the case of TMDL projects, many practitioners indicated that their projects are designed to be self-mitigating, meaning that restoration-related impacts are offset by the restored resources. Additional post-construction maintenance, including protection from invasive plant species, vines, and herbivory, is increasingly necessary to re-establish native tree species. There still remains considerable debate and concern about resource trade-offs and whether or not the restoration projects are "self-mitigating."

One of the predominant recommendations for minimizing impacts to riparian forests/ecosystems during the design and permitting phase of stream restoration projects is to conduct pre-application meetings with federal and state permitting agencies to help the applicant design a project that will minimize environmental impacts before a final design is committed to and a great deal of money is spent. This early feedback also helps to identify aspects of the proposed project that may affect permit approval and possible alternatives to streamline the approval process. Pre-application meetings can also apply to public outreach and education where they may help to reduce and/or address community concerns about the project. The minimization of impacts and more efficient permit review process will then also depend on the degree to which the applicants adhere to agency recommendations and concerns.

The participation of forest agencies in the design and permitting process is also critical for minimizing impacts to riparian forests/ecosystems, however, the types of agencies and their current level of involvement is highly variable among jurisdictions. In Maryland, local government offices who administer the Forest Conservation Act are generally regarded as a forest agency, and so is DNR's Forest Service, who typically works alongside those local government offices. However, this varies greatly by county and by project. Additionally, counties with Critical Areas tend to be heavily involved in the review of stream restoration projects. In Pennsylvania, forest agencies like the Department of Conservation and Natural Resources (DCNR) are not typically involved with stream restoration projects, and collaboration with non-local entities is typically limited to working with DEP and the ACOE on permitting. In Virginia, there are generally county-level Urban Forestry departments that are actively involved in stream restoration projects implemented by the counties. These Urban Forest Management groups within counties in Virginia typically:

1) Participate or are represented as a stakeholder during the design phase,
2) Provide regulatory inspections for tree and hazard inspection, including conducting formal plan reviews of tree inventories and tree protection/replacement plans,
3) Provide technical guidance and expertise to project managers and construction managers about forestry/arboriculture, including tree installation and maintenance.

One of the regulations that may also significantly affect stream restoration design and impact the riparian forest/ecosystems is the Federal Emergency Management Agency (FEMA) No-rise Certification requirement for federally regulated floodways. A floodplain is comprised of the floodway and the floodway fringe. The floodway includes the channel and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height that is prescribed by FEMA and state regulations. The area within the floodplain but outside the floodway is called the floodway fringe. The National Flood Insurance Program (NFIP) that is managed by FEMA requires the completion of an engineering analysis to confirm that there will be no impact to the pre-project base flood elevations, regulatory floodway elevations, or regulatory floodway widths. This analysis often takes the form of a No-rise Certification that is based on the standard step-backwater computer model used to develop the 100-year floodway shown on the Flood Insurance Rate Map (FIRM) or Flood Boundary and Floodway Map (FBFM). As a result, most local ordinances require encroachments (i.e., any project that modifies, cuts, or fills land) to conduct a 'no-rise' or 'impact' study to evaluate whether a project will alter the regulatory floodway. If the initial analysis indicates that there will be an associated impact, there are two options: 1) either the project must go through FEMA's Flood Insurance Rate Map (FIRM) change process, or 2) the project design must be altered, and the 'no-rise' study must be repeated until it produces no impact. If the project proceeds with the FIRM change process, a Conditional Letter of Map Revision (CLOMR) is submitted to FEMA, which typically has a review period of 6 months. Once the project is completed, a Letter of Map Revision (LOMR) must also be submitted to FEMA using as-built conditions; this LOMR has a similar review structure to the CLOMR.

In Pennsylvania, most projects are either valley or legacy sediment restoration projects, and these design approaches typically result in either no increase or a net decrease in the overall flood height elevation. As a result, these Pennsylvania projects would generally not require anything further than an initial no-rise study. In Maryland, the process for FIRM changes is aligned with the State's stream permitting process since Maryland became a Cooperating Technical Partner (CTP) with FEMA in the early 2000s;[10] however, changes to FEMA-mapped floodplains in Maryland must still follow the appropriate LOMR process. In both states, the impact of the NFIP process requirements for FIRM changes on stream restoration design choices is relatively minimal.

In Virginia, however, this requirement has primarily affected stream restoration projects on larger streams (third order and higher) that often have associated FEMA regulated floodways. The No-rise Certification has become a driver toward projects designed following Natural Channel Design (NCD) Priority 2 design that creates a new channel and lowers the floodplain in order to avoid requesting a CLOMR or variance to the No-rise requirements. The new floodplain bench associated with NCD Priority 2 restoration designs often requires a much greater clearing footprint resulting in greater tree loss, hardened or armored restoration to provide stability for the bankfull storm flows, and subsequently a lack of improved habitat. When constructed on county or state property, the estimated rise is often found not to cause any property damage, and/or is fully contained in a floodplain, but it is still considered a 'rise' nonetheless. The issuance of a variance to the no-rise criteria is often accompanied by an increase in the cost of flood insurance for the residents of the community based on the NFIP formula used to calculate coverage rates.

Table 8 contains identified best practices related to design and permitting for maintaining forests and riparian vegetation, and Table 9 contains programmatic and research recommendations related to design and permitting.

Table 8. Design and Permitting Best Practices
Conduct pre-application meetings with state and federal permitting agencies.
Configure the restoration design to unique site conditions instead of the site to a specific type of practice.
Conduct a comparative analysis of different restoration approaches to evaluate the impacts of both temporary construction and completed restoration landscaping, as well as maintaining existing forest, relative to the creation of a long-term, sustainable system. This comparative analysis of restoration approaches should also consider the level of risk a client or landowner is willing to accept for both routine and restorative maintenance.

[10] More information on the flood map development and revision process in Maryland can be found here: https://www.fema.gov/case-study/maryland-flood-mapping-website

Table 8. Design and Permitting Best Practices
Coordinate with forest agencies to ensure that the stream restoration design does not impact the established riparian forest/ecosystem goals and objectives and to identify site-specific best practices for minimizing impacts to the riparian area. Forest agency input is critical because each site/project is unique and decisions on tree removal vary depending on factors such as the quality of the tree, what needs to be done for the stream restoration, input from stakeholders, etc.
Prioritize the protection of high-quality mature trees to the extent possible and rank on-site trees during the planning process based on factors such as tree health, location, size, value, bank proximity, root mass erosion status, and amount of shade cast.
Develop (and implement) planting plans that prioritize native species and consider impacts of invasive species. Use planting plans that track survivability and post-construction vegetative management (including supplemental plantings and invasives control) as tools to handle discrepancies, which allows for fine-tuning as the forest and vegetation re-establishes.
Consider planting techniques to provide higher degrees of canopy coverage in shorter amounts of time while still being amenable to maintenance of plantings. Plantings need maintenance for years to succeed and planting configurations should be management friendly.
Consider assisted migration in planting plans to incorporate species adapted to changing climate conditions. Check for riparian tree candidates that may be suitable for migration, depending on location in Chesapeake Bay Watershed and projected movement due to changing climate conditions and hydrology..

Table 9. Design and Permitting Programmatic and Research Recommendations
The CBP should establish criteria for successful stream restoration projects, including the riparian area, that state permitting agencies can use to conduct a self-audit and identify areas of improvement (including permitting) that will help ensure greater project success.
The CBP should explore options to better enforce proper application of the stream restoration crediting protocols. For example, reducing the credit received if certain best practices outlined in this report have not been followed.
A comprehensive review of county-level regulations should be conducted to determine how well they incorporate state-level requirements to protect forests, such as the MD Forest Conservation Act, and the extent to which they include enforceability measures. State agencies should develop guidance documents to assist local governments with implementation of state-level requirements.
State agencies should encourage and coordinate collaboration between forest agencies and local governments to ensure they are involved with project design. Forest agency participation during the pre-application meetings should also be encouraged or required.
State agencies should develop checklists based on the best practices recommended in this report that can be used at the state and county level during stream restoration project review. This report summarizes information and many valuable guidance documents and recommendations for best practices. Review checklists would provide a strategy by which these best practices are considered and implemented.
Local governments and funding agencies should include costs for alternative design analysis as part of the total project cost and thoroughly review project proposals to ensure that lower bids are

Table 9. Design and Permitting Programmatic and Research Recommendations
not cutting corners at the expense of the best practices outlined in this report for minimizing impacts to riparian forests/ecosystems.
Develop riparian vegetation guidance for stream restoration design based on the best available knowledge. This guidance would include specific techniques, such as proper tree selection based on restoration type or hydrogeomorphic region, considerations for protection of specimen trees, prevention/minimizing the spread of invasive species, and consideration of buffers when working around existing infrastructure, such as roadways and utilities. The CBT Restoration Research program includes key research questions related to vegetation success, survival, and ecological benefit, as well as invasive species in stream restoration projects that may provide additional information in the future for development of detailed best practice guidance.
Establish guidelines/constraints for stream floodplain reconnection, particularly related to floodplain tree health. Higher floodplain groundwater level is associated with floodplain reconnection projects. The vertical distance between floodplain soil surface and groundwater table is likely a critical factor controlling floodplain vegetation that warrants additional consideration.
CBP should discuss with FEMA the development of a more streamlined Letter of Map Change (LOMC) process related to the "no-rise" criteria for federally regulated floodways for stream restoration projects. This more streamlined process would be in recognition of stream restoration project benefits, including lowering shear stress zones that can provide downstream benefits to areas that previously experienced excessive bedload transport/deposition. It would also help minimize stream restoration design that attempts to avoid the map revision process, but in doing so results in excessive tree loss, hardened designs, and a corresponding lack of habitat improvement.

Stakeholder Engagement

Stakeholders include a range of individuals from internal and external groups. Internal stakeholders may include outreach managers, reviewers and permitting agencies, staff from various government departments and agencies, and elected officials. External stakeholders may include local residents and landowners near the site, community groups, non-profit organizations, others in the planning and design process, and schools.

Landowner engagement and public outreach/education are essential components of stream restoration projects and should be done early in the project process prior to the submission of permit applications to the state. Many community concerns are related to tree loss and Impacts to the terrestrial system in public areas where larger floodplain reconnection projects are proposed. It's important to understand what the public wants and then include those desires into overall considerations for what is appropriate for the site or not within the regulatory requirements. It's also important that the community be involved in reviewing project documents and assisting with decision making.

Table 10 contains identified best practices related to stakeholder engagement for maintaining forests and riparian vegetation, and Table 11 contains programmatic and research recommendations related to stakeholder engagement.

Table 10. Stakeholder Engagement Best Practices
Conduct pre-restoration community engagement, including getting local stakeholders involved, communication about the project, setting expectations, and gathering consensus on the project's goals and objectives. It is critical that community members understand the project during the early stages of concept development so they are aware of how and why the forest may be impacted in their neighborhood and what can be done to prevent or mitigate the impacts. Community outreach should consider strategies for inclusive engagement, such as developing outreach materials in languages other than English.
Coordinate with federal, state, and local governments, as well as practitioners, forest agencies, contractors, landowners, and local community stakeholders to come to consensus on the preferred design approach and project goals/objectives.

Table 11. Stakeholder Engagement Programmatic and Research Recommendations
State agencies and local governments should consider developing outreach materials to help the public and landowners better understand the stream restoration process. For example, an ArcGIS StoryMap highlighting what the agencies consider successful projects, the stages of stream restoration, and what the restoration site typically looks like during each stage would help to generate realistic expectations and better enable stakeholders to provide input.

Construction

Multiple practitioners described that their primary approach to handling discrepancies between design and implementation is to avoid discrepancies to begin with by conducting comprehensive planning. This was especially the case for discrepancies between expected and actual forest change, which would require a project change order and may also trigger permit violations. Other practitioners may devise a new design altogether and/or submit a change order. "Smaller" discrepancies, such as the plant palette/species list, may be modified during construction depending on hydrology—for example, shifting locations of specific plant species from areas with dry to wetter regimes based on post-construction conditions. Additionally, some practitioners rely on adaptive management, meaning that discrepancies between design, implementation, and post-construction outcomes that may result due to changing site conditions and constraints are addressed as the site is monitored over time. Multiple practitioners also noted that effective adaptive management can be a determinant of project success, but not all projects have the budget to support long-term adaptive management. MDE has found discrepancies after or during implementation to be a violation of the permit and subject to enforcement action or through the permit modification process and has taken compliance actions for some projects.

In terms of woody debris, most practitioners prefer to source this from trees harvested on-site, or they will use trees harvested across the multiple sites that they are working on interchangeably. Trees harvested on-site are typically reused on-site for in-bed woody debris, stability or energy management structures, habitat creation, soil substrate integration, and/or mulch (for tree root protection or ground protection for construction access roads).

There are many available guidance documents that include information for best practices during stream restoration implementation. Some of the predominant best practices for maintaining forests and riparian vegetation during construction that were identified from the document review and interviews are summarized in Table 12 and Table 13 below.

Table 12. Construction Best Practices
Site managers responsible for riparian forest impacts should be present on site.
Carefully draw and manage Limits of Disturbance (LODs) so they are as small as possible, and the construction sequence is organized to prevent equipment from repeating trips over the same area many times.
Flag and mark individual trees and swaths of trees to be protected and those to be removed.
Plan access routes to retain marked desired trees and verify plans with regulatory agencies. Utilize the existing channel as the primary access road to the extent practicable.
Apply additional protection measures to trees that are at risk of being impacted by construction activities. Some practitioners use bracing/wood posts around the trunks to prevent equipment damage, and others use a combination of foam and wood for protection. Sturdy metal cages may be installed around trees and shrubs on sites with large deer populations. All trees within 5 feet of the LOD should be armored.
Use rubber-tire construction vehicles to minimize compaction. Ideally, those vehicles should be as small as possible. Mulch beds of sufficient depth and/or mats may be needed to prevent compaction.
Carefully trim roots if impact from construction equipment is unavoidable and minimize pruning to 30% of the critical root zone or less.
Install water gators (bags of water attached to the tree that slowly drip down) and apply mulch around the trees to keep underlying soil moist.
Implement ground protection practices to minimize rutting and compaction from construction and reinforce the organic content of the forest floodplain soils, which benefits native species.
Reuse downed or removed trees on-site. Leaving cut trees in the floodplain to serve as coarse woody debris can help restore habitat features and serve as a source of carbon.
Use planting plans that track survivability and post-construction vegetative management (including supplemental plantings and invasives control) as tools to handle discrepancies, which allows for fine-tuning as the forest and vegetation re-establishes.
Retain an independent environmental inspector or monitor answerable to regulatory agencies when required, or in sensitive areas with special resource needs and construction practices.

Table 13. Construction Programmatic and Research Recommendations
Local governments and funding agencies should consider incorporating tree preservation standards in their RFPs for stream restoration design and construction. One of the review criteria for

Table 13. Construction Programmatic and Research Recommendations
selection of a contractor could then be the extent to which existing trees are preserved, as evidenced through the design concept.

Monitoring and Maintenance

Monitoring and maintenance were noted as critical components of stream restoration projects that are often overlooked and vary among local governments. Post-construction monitoring is required for permitted projects, but policies and regulations do not always specifically mention forest resources. Nationwide Permit 27 success criteria developed by the U.S. Army Corps of Engineers and the Chesapeake Bay Program Stream Restoration Expert Panel guidance are typically referenced in order to outline monitoring protocols that are required for different types of projects. In addition, there is a post-construction verification process for the pollutant reduction performance of individual stream restoration projects built to meet the Chesapeake Bay TMDL (Burch et al., 2019). At a minimum, most local governments conduct monitoring to meet NWP or state programmatic general permit requirements, with more comprehensive monitoring conducted at project sites of interest for research purposes.

Mitigation banking sites were described as requiring intensive monitoring, with performance-based credit release cycles after construction until performance standards are met, which is typically for 5 to 10 years. In addition, state monitoring requirements vary, with the MD FCA post-construction monitoring requirements considered by practitioners to be more stringent than the requirements in VA or PA.

Many practitioners reported conducting monitoring and maintenance for 5 years post-construction, corresponding to NWP permit requirements; however, it is variable amongst practitioners and jurisdictions. Monitoring is also conducted every 5 years to meet CBP stream restoration verification requirements, which includes visual inspections to eliminate projects that fail or no longer meet their restoration objectives and to reduce or eliminate their sediment and nutrient reduction credit. Local governments also monitor projects they implement in perpetuity, as required for MS4 permit compliance. While all these monitoring requirements are valuable, they are typically focused on stream stability as the biggest determinant of project success.

There is a policy document from MD DNR (MD DNR, 2015) that recommends having an expert (e.g., forester, arborist, or botanist) conduct up to 10 years of monitoring for forest or tree cover evaluation after stream restoration construction or be in conformance with the 1991 Forest Conservation Act. However, MD DNR indicated that they work within the guidelines of other regulatory frameworks, so the 10-year monitoring requirement is not always recommended. Even if more robust monitoring is recommended, it is not always accomplished with the lack of funding a highly limiting factor. More programmatic coordination would be necessary to make significant advances with longer-term monitoring requirements.

Monitoring and maintenance include post-construction vegetation management (site inspections, removal of invasives, mowing, herbicide application, installing permanent vegetation replacements). However, local governments use a variety of different methods to assess the riparian community, making it difficult to draw comparisons across sites. Some practitioners reported moving towards more of a function-based monitoring approach, where the metrics are designed to demonstrate that the restored stream is providing its designated functions (e.g., ecological uplift, stability). The Stream Function Pyramid Framework is an excellent reference that describes assessment methods for post construction monitoring of the stream channel and there are several methods to determine the health of the riparian forest/ecosystem that can be applied to the post-construction period. However, there is a need for better overarching guidance within the Bay watershed and requirements by regulatory agencies. For example, there isn't an agreed upon functional metric to define a healthy forest. Developing regionally specific riparian monitoring protocols and forest quality indices was suggested. With advances in technology, remote-sensing tools are also useful for broad scale monitoring to supplement on-the-ground investigations.

Funding was frequently mentioned as a limiting factor for extensive post-construction monitoring. The immediate costs of monitoring, maintenance, and management are a major factor in the lack of citizen support for stream restoration and complaints about projects, but the initial costs of design, coordination, and construction are typically so high that the maintenance should be a standard requirement. The monitoring and maintenance for projects constructed to meet MS4 compliance is strongly incentivized because it is necessary to maintain credits. However, there is a significant lack of funding for monitoring or maintenance of grant-funded projects. Municipal-funded projects typically include local funding for post-construction monitoring and maintenance, and mitigation banking projects are often required to have both short- and long-term monitoring and maintenance funds. A recommendation from discussion during the state webcasts was that municipalities set aside a minimum of 10% of project costs for monitoring and maintenance post-construction.

Incorporating maintenance into the project design and having it contracted is encouraged because landowners are unlikely to conduct maintenance themselves. Within localities, one of the identified needs is for long-term programs with appropriate funding to keep trained staff available that can conduct community classification and condition assessments. Performance-based contracting and warranty monitoring for plant survival and contractual requirements were noted as options to increase successful projects.

Invasive species management is also an important consideration. Stream restoration projects can result in open space for invasive encroachment, with invasive species growth common in the first 2 years post-construction. Many forested riparian areas will only persist in a healthy condition if actively managed. Invasive species often have attributes that allow them to outcompete native species, including rapid growth and limited natural controls on population from predation and disease. This affects watershed forest health by reducing the number of native trees that may successfully regenerate due to being outcompeted for resources (MD DNR, 2022). Disturbed riparian areas are particularly susceptible to invasive species and an approach is needed to address how to deal with the presence of unwanted species that explains the control strategy (eradication, containment, or suppression) and the site management plan for each species type found in the area. For example, as carbon dioxide levels continue to rise, vines pose a potentially existential threat to deciduous forests in urban and suburban areas as they gradually convert to what is being called a "vine tangle." Development of invasive species control plans using appropriate methods are an important part of maintenance (hand pulling or cutting, mechanical controls, prescribed fire, grazing/goats, and/or chemical applications). Forest mitigation plans often required of stream restoration projects can help keep invasives under control with repeated treatment measures, and in coordination with native plantings, can improve the ecological health of the riparian area.

Table 14 contains the identified best practices related to monitoring and maintenance for maintaining forests and riparian vegetation, and Table 15 contains programmatic and research recommendations related to monitoring and maintenance.

Table 14. Monitoring and Maintenance Best Practices
Set aside a minimum of 10% of total project costs for post-construction monitoring and maintenance. Costs should be sufficient to replace or repair failed structures, adjust water levels, or undertake other remedial measures and undertake specialized monitoring in sensitive areas. This may include water chemistry measures and habitat surveys.
Utilize performance-based contracting and warranty monitoring for plant survival and contractual requirements.
Monitor beyond the LOD, and include a site's undisturbed areas, and adjacent upstream and downstream areas.
Develop clear monitoring metrics as a way of evaluating goals and the degree of project success.
Implement both a short and long-term vegetation management plan to maintain the post-restoration vegetation target for the banks and floodplain that includes invasive species management, climate change impact management, deer predation protection, and other predation and pest control measures.
Maintain a designated maintenance trail when appropriate and agreed upon by regulatory agencies on projects to allow practitioners to monitor and maintain constructed projects without contributing additional disturbance.

Table 15. Monitoring and Maintenance Programmatic and Research Recommendations
Long-term monitoring of riparian benefits and total ecosystem benefits should be done by professionals/scientists. When appropriate, a pooled monitoring approach may be recommended. The adoption of a pooled monitoring approach would work with researchers, practitioners, and the regulatory agencies to review monitoring needs to evaluate restored or enhanced stream functions.
With the high cost of stream restoration projects, post-construction monitoring and maintenance is a small component that should be included as part of standard project expenses**. Local governments and funding agencies should allow for a percentage of funds to be allocated for post-construction monitoring and maintenance and extend the allowable project period so that monitoring can occur over the long-term.**
Identify/develop metrics to characterize forest health applicable to stream restoration.
Develop a riparian vegetation training program to increase the number of staff in localities that are qualified to conduct vegetative community classification and condition assessments.
Develop short-and long-term maintenance guidance for stream restoration projects based on the best available knowledge. This guidance would include specific techniques, such as mowing

Table 15. Monitoring and Maintenance Programmatic and Research Recommendations
and/or herbicide application rates that are the most beneficial, variations in maintenance needs based on planting or restoration type, considerations for tree tubes, etc.

Conclusion

The goal of this research project was to evaluate the extent to which current regulations, planning and design approaches, and construction and maintenance practices can minimize adverse impacts on riparian forests from stream restoration projects in Pennsylvania, Maryland, and Virginia. We found that while there are a number of regulations at the federal and state levels that are intended to protect streams, riparian buffers, and/or forests from impacts, whether or not a given regulation is triggered by a stream restoration project depends on its location, area of disturbance, and other project-specific factors. In some cases, stream restoration projects are exempted from the regulations, and in others it depends on how the local government has chosen to implement the state or federal requirement. This makes it difficult to say with any certainty which regulations apply to stream restoration projects in each state. Our review of these regulations found very few requirements that explicitly focus on protection of existing forests from impacts. Many of the requirements do serve to indirectly protect riparian buffers, for example by limiting impacts to wetlands, which are often forested.

Some of the key observations on forest loss from stream restoration in the Chesapeake Bay include:

- Some stream restoration sites are not severely degraded and therefore result in significant forest losses that could have been avoided with better site selection.
- Sites where the quality of the riparian community is poor (e.g., invasive species, poor habitat conditions) may be good candidates for stream restoration project design that incorporates native plantings and habitat improvements. The trade-off here is that short-term forest loss may be necessary to achieve longer-term habitat improvement goals.
- Certain stream restoration designs may include extensive removal of riparian vegetation or subsequent tree loss through increased groundwater elevations and/or extended inundation (e.g., floodplain reconnection projects) while others (e.g., legacy sediment removal) may not be intended to include a fully forested riparian area, but instead include a diverse mosaic of herbaceous plants, shrubs, and water-loving trees that represent pre-development site conditions. The specific project goals, objectives, and design approach therefore have an important bearing on how much forest loss results from the project.

Through this project, we identified a set of best practices for agencies overseeing the implementation of stream restoration projects, as well as for restoration contractors to minimize unintended impacts to riparian forests from stream restoration projects. These best practices cover all stages of a stream restoration project from site selection, establishment of goals and objectives, design and permitting, stakeholder engagement, and construction practices, through monitoring and maintenance. Importantly, many of the best practices included here relate to developing effective stream restoration projects but are not completely specific to forest protection. We have included these more general recommendations in this report so that state agencies, local governments, and practitioners can use them to improve their projects. This is important because stream restoration for TMDL credit is still a relatively new practice and there are currently no set standards in place across the Chesapeake Bay watershed.

Of the recommended best practices, one of the top priorities is to improve the site selection process and establish appropriate goals and objectives to avoid locating stream restoration projects in existing high-quality stream and riparian buffer areas. This is key to minimizing impacts to existing healthy riparian forests. To implement this best practice, state agencies will need to develop clear definitions of existing "high-quality" streams and riparian areas to avoid. Another priority best practice is for state agencies to adopt guidance for stream restoration based on the best practices and recommendations in this report. As a next step, these and other best practices and programmatic recommendations will be explored further with the project stakeholder team to develop a more specific action plan with next steps, responsibilities, and a timeline.

This guidance is designed to help the Chesapeake Bay Partners meet their commitment to the restoration of riparian forests and to provide methods that stream practitioners can use that are not contrary to meeting this goal. Stream restoration practitioners must view the stream and riparian area as an integrated ecosystem that should be managed together requiring an interdisciplinary approach. It is ultimately up to the state and local agencies to provide the resources and direction to assure this is done.

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Appendix A. Project Plan

Project Plan: Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned

Stakeholder Team Review Draft: 6/1/2021
Revisions Provided by Stakeholder Team: 6/15/2021
Final Revised Draft: 7/1/2021

Introduction

The Center for Watershed Protection, Inc. (CWP) is working collaboratively with the Chesapeake Bay Program (CBP) and stakeholders to evaluate impacts of stream restoration projects on existing riparian ecology and forest buffers in Maryland, Pennsylvania, and Virginia. This project will produce guidance for local governments on the best practices to minimize unintended adverse outcomes to riparian forests and identify opportunities to improve water quality and habitat outcomes. The results will help improve selection, permitting, and funding processes for stream restoration projects in the Chesapeake Bay watershed.

This project plan was developed to support the "Scope of Work 3: Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned" project identified in the 2020 Chesapeake Bay Trust-Technical Assistance - Chesapeake Bay Program Goals and Outcomes request for proposals. The plan is based on input from the stakeholder team kickoff meeting held on May 11, 2021, as well as an informal online survey of regulators, practitioners, and local governments in the Chesapeake Bay watershed that was conducted from May 20-28, 2021. The survey was distributed through CWP and stakeholder team member networks and received 179 responses from respondents in 18 states; 106 of those responses were from respondents located in Maryland, Virginia, or Pennsylvania. Of all respondents, nearly 47% have over 10 years of experience with stream restoration projects (35% have 3 – 10 years, 7% have 1 – 3 years, and 11% have 0 – 1 year). In terms of experience specifically with stream restoration projects in mature forests, 28% of respondents have over 10 years of experience (24% have 3 – 10 years, 19% have 1– 3 years, and 29% have 0 – 1 year). In terms of experience specifically in the Chesapeake Bay states, 60 respondents reported having experience in Maryland, 50 in Virginia, and 37 in Pennsylvania.

This project plan outlines the key documents to review and information to extract, individuals to be interviewed and interview questions, and potential focal areas and timeframe for detailed stream restoration evaluations.

Key Documents to Review

The goal of the key documents review is to investigate how the states of Pennsylvania, Maryland, and Virginia account for forests at multiple stages of the stream restoration process, as well as to identify best practices to minimize impacts to riparian forests. The regulatory requirements of three selected focal areas will also be reviewed. The documents to review include both technical guidance/research (peer-reviewed journals, research reports, white papers, etc.) and regulatory/permit documents. A spreadsheet was developed to summarize the documents reviewed and is included as an attachment to this project plan. This spreadsheet includes the data source characterization required in the WQGIT-approved document, "Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model" to help determine if a document is appropriate and how much influence each document should have on the final recommendations.

The review of key documents will be used to address the following questions:

- How are forests defined by various agencies and organizations and what definition should be applied to this study?
- What inventory requirements are in place and how are these inventories used in project planning?
- Are forest agencies engaged and how?
- How are existing forests addressed in project permits?
- What re-vegetation or other mitigation requirements are in place for impacts to streamside forests?
- What are the monitoring requirements and who is responsible for monitoring?
- Are best practices recommended to minimize impacts to riparian forests and to what extent are they implemented?

Table 1 includes the technical guidance and research documents, and Table 2 includes the regulatory and permit documents recommended by the Stakeholder Team and obtained from the survey results. Note that the document names and information in these tables are listed according to how they were provided by the stakeholders and survey respondents. Complete citations will be developed as part of the document review conducted 9/2/2021 – 12/15/2021 and recorded in in the summary spreadsheet.

Table 1. Technical guidance and research documents		
Author(s)	**Year**	**Document**
Altland et al.	2020	Consensus Recommendations for Crediting Floodplain Restoration Projects Involving Legacy Sediments
Anderson and Pezeshki	1999	The effects of intermittent flooding on seedlings of three forest species
Angelov et al.	1996	Long- and short-term flooding effects on survival and sink – source relationships of swamp-adapted tree species
Bahr et al.	2019	Recommendations for Crediting Outfall and Gully Stabilization Projects in the Chesapeake Bay Watershed
Beauchamp et al.	2020	Effects of stream restoration by legacy sediment removal and floodplain reconnection on water quality and riparian vegetation
Bledsoe et al.	2016	Stream Restoration as a BMP
Budelis et al.	2020	An evaluation of forest impacts compared to benefits associated with stream restoration
Burch et al.	2019	Recommended Methods to Verify Stream Restoration Practices Built for Pollutant Crediting in the Chesapeake Bay Watershed
Callahan et al.	2012	Pathways to environmental justice advancing a framework for evaluation
Virginia Chesapeake Bay Local Assistance Department		Local Assistance Manual
Chesapeake Stormwater Network	2009	Stormwater Design Guidelines for Karst Terrain in the Chesapeake Bay Watershed Version 2.0 http://observatoriaigua.uib.es/repositori/suds_virginiai.pdf
Claggett, S., and TetraTech	2014	Recommendations of the Expert Panel to Reassess Removal Rates for Riparian Forest and Grass Buffers Best Management Practices
Coder	1994	Flood damage to trees
Cramer, M.L.	2012	Stream Habitat Restoration Guidelines – Washington State
CWP	2021	The Self-Recovery of Stream Channel Stability in Urban Watersheds due to BMP Implementation
Doll	2016	Biotic conditions of restored streams
Doug Tallamy		Nature's Best Hope (book)
Filoso	2020	Evaluating the effectiveness and sustainability of novel stream restoration designs for coastal plain streams in MD
Fischenich	2006	Functional objectives for stream restoration
Fischenich and Copeland	2001	Environmental considerations for vegetation in flood control channels

Table 1. Technical guidance and research documents		
Author(s)	**Year**	**Document**
Garssen et al.	2015	Riparian plant community responses to increased flooding – a meta-analysis
Harman, W., R. Starr.	2011	Natural Channel Design Review Checklist
Harman et al.	2011	A function-based framework for developing stream assessments, restoration goals, performance standards and standard operating procedures
Hart-Smith	2012	Paleoecological Evidence of a Pre-Settlement Sedge Wetland in a Piedmont River Valley https://jscholarship.library.jhu.edu/handle/1774.2/36075
Hilderbrand	2020	Determining realistic ecological expectations in urban stream restorations
Hilderbrand et al.	2015	Quantifying the ecological uplift and effectiveness of differing stream restoration approaches in Maryland
Hilgartner et al.	2010	Presettlement habitat stability and postsettlement burial of a tussock sedge wetland in a Maryland Piedmont river valley. In 95th ESA Annual Meeting. Pittsburgh, PA.
Hoag	2007	How to plant willows and cottonwoods for riparian restoration
Hudson et al.	2015	Assessment of woody vegetation for replacement of ecological functions in created forested wetlands of the Piedmont Province of VA
James Karr & Ellen Chu		Restoring Life in Running Waters (book)
Keeton	2007	Evaluation of tree seedling mortality and protective strategies in riparian forest restoration
Law, N.	2014	Recommendations of the Expert Panel to Define Removal Rates for Urban Filter Strips and Stream Buffer Upgrade Practices
Mayer et al.	2005	Riparian buffer width, vegetative cover, and nitrogen removal effectiveness: a review of current science and regulations.
Mayer et al.	2007	Meta-analysis of nitrogen removal in riparian buffers. Journal of Environmental Quality 36:1172-1180
Mayer PM, AH Todd, JA Okay, KA Dwire.	2010	Introduction to the Featured Collection on Riparian Ecosystems & Buffers. Journal of the American Water Resources Association 46:207-210
Mayer PM, JE Compton, G Wilhere	2020	Nutrient Dynamics in Riparian Ecosystems. Pages 163-194 (Chapter 6) in T. Quinn, G.F. Wilhere, and K.L. Krueger, technical editors. Riparian Ecosystems, Volume 1: Science Synthesis and Management Implications. Habitat Program, Washington Department of Fish and Wildlife, Olympia. https://wdfw.wa.gov/sites/default/files/publications/01987/wdfw01987.pdf
MD DNR	2020	Forest Action Plan, Part I Forest Resource Assessment
MD DNR	2020	2020 – 2025 Forest Action Plan, Part II Strategy

Table 1. Technical guidance and research documents		
Author(s)	**Year**	**Document**
MD DNR	(n.d.)	Regenerative Stream Conveyance: Construction Guidance https://dnr.maryland.gov/ccs/Documents/RSC_Training/RSC-Guidance.pdf
MD DNR Forest Service	2001	Riparian Forest Buffer Survival and Success in Maryland
Merganičová, Katarína & Merganič, Ján & Svoboda, Miroslav & Bače, Radek & Šebeň, Vladimír	2012	Deadwood in Forest Ecosystems
Montgomery County, PA	(n.d.)	Guidebook for Riparian Corridor Conservation
NC Stream Restoration Institute & NC Sea Grant	(n.d.)	Stream Restoration: A Natural Channel Design Handbook https://semspub.epa.gov/work/01/554360.pdf
NCHRP	(n.d.)	A watershed Approach to Mitigating Stormwater Impacts http://www.trb.org/Publications/Blurbs/175861.aspx
NCSU		Guide for installation of riparian vegetation on restoration projects
Neugebauer, A.	2011	Paleoecological Reconstruction of Big Spring Run, Lancaster, PA http://www.bsr-project.org/uploads/2/6/5/2/26524868/neugebauerthesis_-_2011_-_paleoecological_reconstruction_of_big_spring_run_lancaster_pa.pdf
Niezgoda et al.	2014	Defining a stream restoration body of knowledge
ODNR	(n.d.)	Ohio Stream Management Guide
PA DCNR	2016	Planting and Seeding Guidelines
PA DEP	(n.d.)	Guidelines for Maintaining Streams in Your Community
PA DEP		PADEP BMP Manual
PA DEP	2018	Considerations of Stream Restoration Projects in Pennsylvania for eligibility as an MS4 Best Management Practice https://files.dep.state.pa.us/Water/BPNPSM/StormwaterManagement/MunicipalStormwater/PRP_TMDL_Plans/Stream%20Restoration%20Eligibility%20for%20MS4%205.11.2018.pdf

Table 1. Technical guidance and research documents		
Author(s)	**Year**	**Document**
Palone, R. and Todd, A.H.	1997	Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers. http://www.chesapeakebay.net/content/publications/cbp_13019.pdf
Palmer et al.	2017	Ecological Restoration of Streams and Rivers: Shifting Strategies and Shifting Goals
Pizzuto et al.	2010	On the retreat of forested, cohesive riverbanks
Pollock et al.	2015	Chapter 6 – Beaver Dam Analogues BDAs
Polvi & Wohl	2013	Biotic drivers of stream planform
Richardson and Beraud	2014	Effects of riparian forest harvest on streams – meta-analysis
River Restoration Centre	2011	Practical river restoration appraisal guidance for monitoring options (PRAGMO)
Roni et al.	2002	A review of stream restoration techniques and a hierarchical strategy for prioritizing restoration in Pacific Northwest watersheds
Schueler, T. and Stack, B.	2014	Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects
SER International	(n.d.)	Primer on Ecological Restoration https://cdn.ymaws.com/www.ser.org/resource/resmgr/custompages/publications/SER_Primer/ser_primer.pdf
Southerland et al.	2017	Meta-analysis of biological monitoring data to determine the limits on biological uplift from stream restoration imposed by the proximity of source populations
Stanford et al.	1996	A general protocol for restoration of regulated rivers
Stranko et al.	2011	Comparing the fish and benthic macroinvertebrate diversity of restored urban streams to reference streams
Thomas Dunne & Luna Leopold, W.H Freenan	1978	Water in Environmental Planning
University of Washington Center for Urban Horticulture	2002	An introduction to using native plants in restoration projects
USACE	2015	Large Wood National Manual
USDA	2018	Guidance for Stream Restoration https://www.fs.fed.us/biology/nsaec/assets/yochumusfs-nsaec-tn102-4guidancestreamrestoration.pdf

Table 1. Technical guidance and research documents		
Author(s)	**Year**	**Document**
USDA	2018	Mid-Atlantic Forest Ecosystem Vulnerability Assessment and Synthesis: A Report from the Mid-Atlantic Climate Change Response Framework Project. General Technical Report NRS-181. https://www.fs.fed.us/nrs/pubs/gtr/gtr_nrs181.pdf
USDA NRCS		Stream Restoration Design (National Engineering Handbook 654) https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/water/manage/restoration/?cid=stelprdb1044707
USEPA	2012	A Function-Based Framework for Stream Assessment & Restoration Projects (EPA 842-K-12-006)
USFS	2017	Guidance for stream restoration
USFS	(n.d.)	General Technician Report NRS-96 Manual Herbicide Application Methods for Managing Vegetation in Appalachian Hardwood Forest
USFS Southern Research Station	(n.d.)	General Technical Report SRS-119
USFWS Biological Services Program	1977	Impact of Water Level Changes on Woody Riparian and Wetland Communities, Vol II the Southern Forest Region
USFWS Biological Services Program	1977	Impact of Water Level Changes on Woody Riparian and Wetland Communities, Vol I Plant and Soil Responses
USFWS Biological Services Program	1978	Impact of Water Level Changes on Woody Riparian and Wetland Communities, Vol IV Eastern Deciduous Forest Region
USFWS et al.	2017	The Beaver Restoration Guidebook https://www.fws.gov/oregonfwo/Documents/BRGv.2.0_6.30.17_forpublicationcomp.pdf
USFWS/USEPA	2012	A Function-Based Framework for Stream Assessment and Restoration Projects https://www.spk.usace.army.mil/Portals/12/documents/regulatory/pdf/A_Function-Based_Framework.pdf
VA DCR	2003	Riparian Buffers Modification & Mitigation Guidance Manual https://static1.squarespace.com/static/55c211c8e4b06ea5799e6c03/t/56098ce1e4b080746e848fbf/1443466465396/DCR-BufferManual_06Rev.pdf
VA DCR	2004	The Virginia Stream Restoration and Stabilization BMP Guide
VA DCR	2021	The Natural Communities of Virginia Classification of Ecological Groups and Community Types https://www.dcr.virginia.gov/natural-heritage/natural-communities/
VA DCR		Virginia Stormwater Handbook
VA DEQ		Virginia Erosion and Sediment Control Handbook
Voli et al.	2009	Preliminary reconstruction of a PreEuropean Settlement Valley Bottom Wetland, Southeastern Pennsylvania

Table 1. Technical guidance and research documents		
Author(s)	**Year**	**Document**
Wheaton et al.	2019	Wheaton et al. (2019), Low-Tech Process-Based Restoration of Riverscapes Design Manual https://lowtechpbr.restoration.usu.edu/manual/
Wood, D.	2020	Consensus Recommendations for Improving the Application of the Prevented Sediment Protocol for Urban Stream Restoration Projects Built for Pollutant Removal Credit
Wood, D., and Schueler, T.	2020	Consensus Recommendations to Improve Protocols 2 and 3 for Defining Stream Restoration Pollutant Removal Credits
Wood KL, SS Kaushal, PG Vidon, PM Mayer, JG Galella.	In Review	Tree trade-offs in stream restoration projects: Impact on riparian groundwater quality. Urban Ecosystems/
WV DEP	2012	WV Stormwater Management and Design Guidance Manual http://chesapeakestormwater.net/wp-content/uploads/downloads/2013/01/West_Virginia_Stormwater_Management_Design_Guidance_Manual_FULL_11-2012.pdf
Yochum, S.	2018	Guidance for Stream Restoration https://www.fs.fed.us/biology/nsaec/assets/yochumusfs-nsaec-tn102-4guidancestreamrestoration.pdf

Table 2. Regulatory and permit documents	
State	**Document**
Nationwide	USACE Nationwide 27
Nationwide	FEMA Floodplain regulations
MD	Forest Conservation Act and Regulations https://dnr.maryland.gov/forests/Pages/programapps/newfca.aspx
MD	MDE-WMA/US-ACOE Joint Wetlands & Waterways Permits
MD	Maryland Waterway Construction regulations COMAR 26.17.04
MD	Maryland Nontidal Wetland regulations COMAR 26.23
MD	Gaithersburg's ordinance
MD	City of Frederick Land Management Code Section 721 Forest Conservation
MD	Anne Arundel County Code Article 17, Title 6, Subtitles 3 and 4 are important to stream restoration projects. These are the main Code sections used to protect environmental features on a development site.
PA	Delaware Valley Regional Planning Commission (2013), Stream Buffer Protection Ordinance

Table 2. Regulatory and permit documents	
State	**Document**
PA	Model Ordinance Riparian Corridor Conservation District (n.d.)
PA	PA Land Trust Association (2014), A scientific foundation for shaping riparian buffer protection regulations
PA	PA Land Trust Association (2014), Riparian buffer protection via local regulation – a guide and model ordinance for PA municipalities
PA	Waterways Permitting https://www.dep.pa.gov/Business/Water/Waterways/Encroachments/Pages/default.aspx
VA	Virginia Regulation and Guidance for Stream Restoration (n.d.) This paper represents the Agencies and Organizations with oversight for Virginia stream restoration projects. The list includes the permits needed who distributes them and contact information. It was compiled by Judy Okay, Virginia Department of Forestry Consultant.
VA	Fairfax County Chesapeake Bay Preservation Ordinance: https://www.fairfaxcounty.gov/landdevelopment/chesapeake-bay-preservation-ordinance
VA	VWP Water Protection General Permits and Time of Year Restriction
VA	Virginia Construction General permit
WV	West Virginia Rivers https://wvrivers.org/policy-2/policy/
WV	West Virginia Stream Disturbance Permitting Requirements https://dep.wv.gov/WWE/Programs/nonptsource/streamdisturbance/Documents/StreamDisturbancePermittingGuide.pdf
NC	NC Forest Service Regulations https://www.ncforestservice.gov/water_quality/regulations.htm

Interviews

Approximately 4-6 individuals will be interviewed in three selected jurisdictions who are considered experts in stream restoration and/or forest buffers. The types of individuals to interview include designers, practitioners, MS4 representatives, soil and water conservation districts, state agencies, etc. The same types of people will be interviewed in each focal area to obtain representation across the different interviewee categories. The goal of the interviews is to better understand how the requirements identified from the review of regulatory and policy documents are (or are not) implemented in each jurisdiction and help to identify and refine best practices to minimize adverse impacts to riparian forests. The interviews will also help to document the practices and procedures that are not “on the books” but are commonly practiced in the field. Interviews will be conducted from 9/2/2021 – 12/15/2021. Table 3 provides a list of potential individuals to interview that were recommended by the Stakeholder Team and from the survey results. In addition, representative individuals from the following organizations were suggested to identify and interview:

- Trout Unlimited
- Alliance for the Chesapeake Bay
- Western Pennsylvania Conservancy
- PA Association of Conservation Districts

Interview questions for all individuals include:

- What is your experience or involvement with stream restoration projects?
- In your experience, how are sites selected for stream restoration projects? Who identifies the sites?
- Is a riparian forest assessment done prior to restoration to determine forest health and if so, what indicators are used?
- How is tree and tree canopy protection deliberated during site selection, design, and installation? Are there scenarios when protecting trees, forest stability, and forest longevity are given priority over streambank reconstruction?
- Are there typical scenarios where entire buffers or mature trees are removed and why?
- When trees are removed during restoration, to what extent are riparian tree cover and structure restored after restoration? How quickly does this occur?
- What best practices are used to minimize impacts to riparian forests (this would include post restoration maintenance)? To what extent are they implemented?

Interview questions specific to stream restoration practitioners:

- What are the decision processes for selecting the type of restoration?
- How are discrepancies between project design and implementation (such as expected vs actual forest change) handled?
- What are the parameters around plants/rocks/woody debris used for restoration and where it is sourced? What are the bounds on making materials “natural”or as high quality as possible?
- What is done with the trees that are removed (e.g., are they sold? Are any used for restoration off-site or on-site?)?
- What post-construction monitoring is conducted and what is the purpose of the monitoring? Do monitoring requirements vary?
- Have you designed or managed projects that you deem successful? If so, what made them successful?

- Have you designed or managed projects that were less successful or unsuccessful? If so, what were some challenges or issues?

Interview questions for non-stream restoration practitioners:

- Are you aware of cases where there have been discrepancies between project design and implementation? If so, how were these discrepancies handled?
- In your experience, what sort of post-construction monitoring is conducted for stream restoration projects in your area?
- Are you aware or have you been involved with stream restoration projects that were successful? If so, what made them successful?
- Are you aware or have you been involved with stream restoration projects that were less successful or unsuccessful? If so, what were some challenges or issues?

Table 3. Potential individuals to interview		
Organization	**Interviewee**	**Notes**
	Kelsey Wood	woodkelseylynn@gmail.com
	Todd Moses	Practitioner who has done urban stream design work since 1986.
	William Hilgartner	whilgarnter@comcast.net
AMT Engineering	Ken Brown	kbrown@amtengineering.com
	Joe Howard	jhoward@amtengineering.com
	Greg Fox	Has experience avoiding and saving trees both in the design and in access.
Anne Arundel County, MD, Watershed Protection and Restoration Program	Eric Michelson	410-222-4240, pwmich20@aacounty.org
Arlington County, VA	Jason Papacosma	Jpapacosma@arlingtonva.us
Biohabitats, Inc.	Joe Berg	jberg@biohabitats.com
	Lee Mallonee	lmallonee@biohabitats.com, (804) 750-1082
	Ted Brown	
	Bryon Salladin	bsalladin@biohabitats.com
	Mike Trumbauer	mtrumbauer@biohabitats.com
Chesapeake Stormwater Network	Tom Schueler	watershedguy@hotmail.com
City of Alexandria, VA	Jesse Maines	jesse.maines@alexandriva.gov
City of Frederick, MD	Jenny Willoughby	
City of Harrisonburg, VA	Wes Runion	Wesley.Runion@harrisonburgVA.gov
City of Richmond, VA	Grace LeRose	
City of Roanoke, VA	Marcus Aguilar	Marcus.Aguilar@roanokeva.gov
Clauser Environmental	Aaron Clauser	aclauser@verizon.net , (570) 294-0669
DC Department of Energy & Environment	Josh Burch	josh.burch@dc.gov
	Stephen Reiling	stephen.reiling@dc.gov
	Steve Saari	steve.saari@dc.gov
Ecosystem Services	Kip Mumaw	kip@ecosystemservices.us
	Kyle Ashmun	kyle@ecosystemservices.us
Ecotone	Scott McGill	
Ecosystem Planning and Restoration	Rich Starr	

Table 3. Potential individuals to interview		
Organization	**Interviewee**	**Notes**
Environmental Quality Resources	Liam O'Meara	lomeara@eqrllc.com
Fairfax County, VA	Meghan Fellows	meghan.fellows@fairfaxcounty.gov
	Charles Smith	Charles.Smith@fairfaxcounty.gov
	Suzanne Foster	suzanne.foster@fairfaxcounty.gov
Finish Line Environmental	Kristen Pruitt	k.pruitt@flcva.com, 540-371-3500
Franklin and Marshall	Dorothy Merritts	Interview about the appropriateness of expecting upland forest in stream valley bottoms.
Franklin and Marshall	Robert Walter	robert.walter@fandm.edu
Hanover Land Services	Christina Casole	ccasole@hanoverlandservices.com
Hazen and Sawyer	Keven Arrance	
Kimley-Horn	Matt Hubbard	Matt.hubbard@kimley-horn.com
MD Department of the Environment	Jim George Denise Clearwater	denise.clearwater@maryland.gov
MD Department of Natural Resources	Greg Golden	Environmental review
	Tony Redman	Environmental review
MD DNR Forest Service	Anne Hairston-Strang	
	Marian Honeczy	marian.honeczy@maryland.gov For standards for Forest Conservation Act compliance for stream restoration projects.
MD Department of Transportation State Highway Administration	Bill Buettner	He has a wealth of experience as a director of mitigation monitoring programs.
Metropolitan Washington Council of Governments	Phong Trieu	ptrieu@mwcog.org
NC State University	Greg Jennings	
Northcentral PA Conservancy	Renee Carey	Has coordinated many stream projects in conjunction with DEP, counties, landowners, PAFBC. rcarey@npcweb.org
Northern VA Regional Commission	Normand Goulet	NGoulet@novaregion.org

Table 3. Potential individuals to interview		
Organization	**Interviewee**	**Notes**
PA Department of Conservation and Natural Resources	Nate Reagle	nreagle@pa.gov
	Teddi Stark	
PA Department of Environmental Protection	Jeff Hartranft	jhartranft@pa.gov Expert on stream restoration projects involving legacy sediment removal
	Jamie Eberl	I do not have expertise to offer on the implementation of stream restoration/forest buffers but as the Section Chief for the PADEP MS4 Program I can offer some insight on the challenges that municipalities face when trying to implement these types of projects. (jeberl@pa.gov)
	Jason Fellon	
	Dave Goerman	dgoerman@pa.gov
PA Fish and Boat Commission	Tyler Neimond	tneimond@pa.gov
Resource Environmental Solutions	Bob Siegfried	bsiegfried@res.us
Stantec	Josh Running	
	Mike Adams	Has 20+ years of experience. michael.adamsjr@stantec.com
Stroud Water Research Center	David Wise	dwise@stroudcenter.org
	Lamonte Garber	lgarber@stroudcenter.org
	John Jackson	jkjackson@stroudcenter.org
Trutta Environmental Solutions	Jim Parham Brett Connell	Dr Jim Parham and I have been developing the High Definition Stream Survey which has vastly improved data collection and modeling. https://truttasolutions.com/hdss-overview/ Jim.Parham@truttasolutions.com Brett.Connell@truttasolutions.com
University of MD College Park	Kaye Baker	
	Dr. Joseph Sullivan	
University of MD Center for Environmental Science	Robert Hilderbrand	rhilderbrand@umces.edu
USDA NRCS	Jim Gillis	
VA Natural Heritage Program	Todd Janeski	
VA Commonwealth University	Paul Bukaveckas	

Table 3. Potential individuals to interview		
Organization	**Interviewee**	**Notes**
	Greg Garman	
VA Department of Transportation	Randy Baker	randy.baker@vdot.virginia.gov
VA Tech	Tess Thomson	thwynn@vt.edu
Washington County, MD	Elmer Weibley	Has facilitated the construction of 6-7 agricultural stream restoration projects. elmer@conservationplace.com
Water & Land Solutions	Kayne Van Stell	
Wetland Research Initiative	Mike Rolband	
Wetland Studies & Solutions	Frank Graziano Nathan Staley	FGraziano@wetlands.com nstaley@wetlands.com
Wood Environment and Infrastructure	Troy Biggs	troy.biggs@woodplc.com
Woods and Waters Consulting	Katie Ombalski	(814) 574-7281, www.woodswaters.com

Potential Focal Areas for Analysis

One focal area (county or jurisdiction) will be selected in Pennsylvania, Maryland, and Virginia. These areas will be where stream restoration has been occurring and where information is available from local government staff, stream restoration firms and other sources is available (e.g., MS4 reports, CBT projects, etc.). Up to 12 projects (4 in each state) will be selected from the target geographies in consultation with the Stakeholder Team based on data availability, representativeness of different project types, level of urbanization, and/or timeframe. Table 4 provides the potential focal areas for analysis that were recommended by the Stakeholder Team and the survey results. CBT Pooled Monitoring Restoration Research projects are also noted in the table in blue.

The survey results also provided the following considerations when identifying focal areas and projects for evaluation:

- Compare coastal plain projects vs. piedmont region projects vs. mountain projects in terms of approach and efficacy.
- Evaluate the value and impact of commonly used "fish habitat enhancement structures" to prioritize restoration goals (i.e., increase long-term system resiliency, bank stabilization/sediment load reduction, improve EBT habitat)
- Evaluate projects with different design approaches that have been in the ground as long as possible (e.g., 5-10 years).
- Trout Unlimited has done a lot of work in the Potomac and Shenandoah headwaters. https://www.tu.org/project/shenandoah-valley-headwaters-conservation/
- Mitigation monitoring reports would be a good source of information.
- VDOT has conducted a number of stream restoration projects in the Potomac, Rappahannock and James River Basins of the ChesBay over the last few years. These projects range from small ephemeral/intermittent watersheds to large multi-square mile perennial streams in urban, suburban and rural settings.

Table 4. Potential focal areas for analysis

State	Focal Area (County or Jurisdiction)	Description of Focal Area (level of urbanization, types of restoration projects, monitoring data available, etc.)
MD	Montgomery County	Has extensive and learned history of stream restoration practices, as well as strong preservation /mitigation policies. More urbanized than most watersheds, so can show what happens and how strong the policies really need to be to implement protection of the resource. However, another survey respondent noted that policy has limited the effectiveness of projects. There were many stream restoration projects associated with construction of the Inter-County Connector with detailed preassessments and post-construction monitoring documents. CBT-funded project: Southerland et al. 2017.
MD	Prince George's County	Extensive and learned history of stream restoration practices. There were many stream restoration projects associated with construction of the Inter-County Connector with detailed preassessments and post-construction monitoring documents.
MD	Frederick County	CBT-funded project: Southerland et al. 2017.

Table 4. Potential focal areas for analysis		
State	**Focal Area (County or Jurisdiction)**	**Description of Focal Area (level of urbanization, types of restoration projects, monitoring data available, etc.)**
MD	Howard County	Howard county has just revised its forest conservation and some of their other regulations related to land use changes and environmental impacts. CBT-funded project: Southerland et al. 2017.
MD	Baltimore County	CBT-funded project: Southerland et al. 2017.
MD	Anne Arundel County	Anne Arundel County regenerative stream conveyance systems. The County is in the process of putting together a monitoring study for tree canopy preservation/loss for projects in the County. CBT-funded project: Budelis et al. 2020 studied Church Creek and Dividing Creek in Anne Arundel County. They also studied Red Hill Branch (Howard County) and Wheel Creek (Harford County). CBT-funded project: Southerland et al. 2017.
MD	Carroll County	CBT-funded project: CWP 2021 studied streams in Carroll County.
MD	Washington County	Conducting stream restoration projects in agricultural areas.
MD	Leonardtown	McIntosh Run
PA	York County	Has done extensive valley restoration/legacy sediment removal projects, although PADEP has approved throughout the Commonwealth.
PA	Union County	Turtle Creek, Union CO PA. Ask Renee Carey or Jason Fellon about it. https://padep-1.maps.arcgis.com/apps/Cascade/index.html?appid=e99f1e95560f4ffebcb52905bc1be1e7
PA	Lancaster County	Has decades of data and experience through Conservation District, Penn State University, nonprofits, and municipalities. Legacy sediment projects include Big Spring Run, Brubaker Run, Swarr Run, Banta/Lititz Run, Lancaster County PA.
PA	Dauphin County	Black Run legacy sediment removal project.
PA	Green and Washington Counties	Robinson Fork legacy sediment removal project.
PA	Montgomery County	Bensalem Twp School District legacy sediment removal project.
PA	Spotsylvania County	Booming development area.
PA	Mifflin County	Upper Kish watershed
PA	Cumberland County	Michaux State Forest
PA	Adams County	Michaux State Forest
PA	Franklin County	Michaux State Forest

Table 4. Potential focal areas for analysis		
State	**Focal Area (County or Jurisdiction)**	**Description of Focal Area (level of urbanization, types of restoration projects, monitoring data available, etc.)**
VA	Fairfax County	Has a large data set going back more than a decade. The County has been evaluating pre/post restoration forest metrics of success for 4-5 years and has several projects that have minimized tree loss while still providing useful restoration. Has strong preservation/mitigation policies. More urbanized than most watersheds, so can show what happens and how strong the policies need to be to implement protection of the resource.
VA	City of Richmond	
VA	Arlington County	
VA	Prince William County	Prince William County has several projects that have minimized tree loss.
VA	Charlottesville, Lynchburg	Lynchburg and Charlottesville are good candidates as they have major tributaries to the Ches. Bay running through them, they have solid and rapidly growing tax base with increasingly more green minded citizens. Charlottesville is further along on implementing stream projects while Lynchburg is newer to it but the amount of water resources in a very small area with high potential for restoration and the trail systems in both cities are well established.
VA	Albemarle County	Appalachian plateau Shenandoah Valley because of the headwater streams. Albemarle County seems to have highly eroded streams that contribute tons of sediment to the downstream waters including the Bay.
VA	James City County	James City County has also been very progressive with stream restoration projects. For a smaller population County, they have completed more than 10 projects.
MD		CBT-funded project: Filoso 2020 studied streams in the Magothy, Severn, South, Rock Creek, Anacostia, and Patuxent watersheds. CBT-funded project: Beauchamp et al. 2020 studied Beetree Run, First Mine Run, Rigdon/North Stirrup Run, Edwards/Cabbage Run, Bear Cabin Branch, Plumtree Run, Pond Branch, and Baisman Run.
MD	Baltimore/ Washington DC Metropolitan Area	CBT-funded project: Kaushal et al. 2021 studied Campus Creek, Scotts Level, Paint Branch, Stony Run, and Minebank Run (in the Washington DC and Baltimore metropolitan areas). CBT-funded project: Hilderbrand et al. 2015 studied 40 urban stream restorations in the greater Baltimore/Washington DC metropolitan area.

A survey was sent to the Stakeholder Team to determine their preferred focal areas. Four responses were received and are summarized in Figure 1 below.

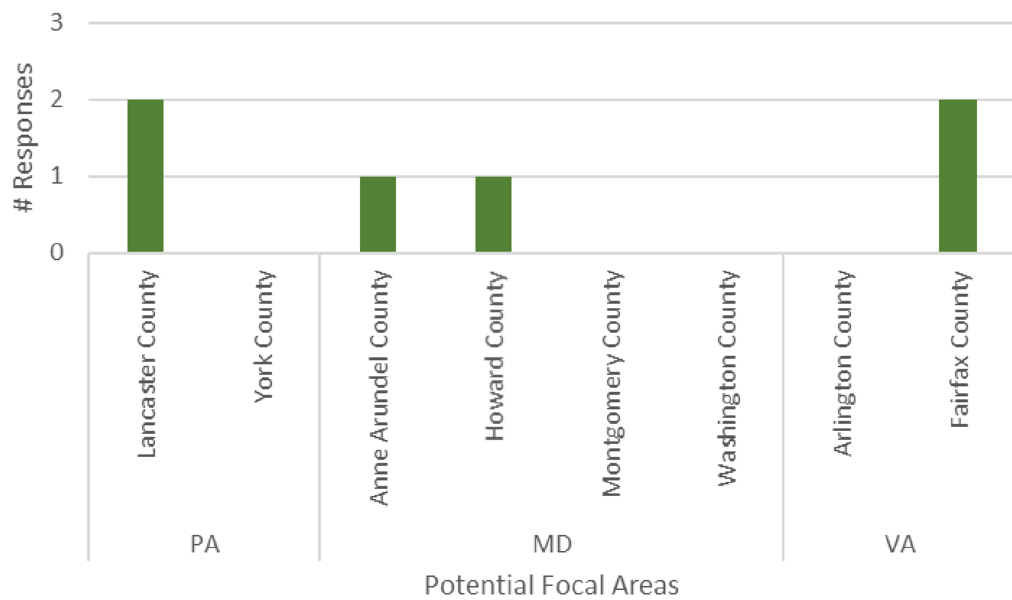

Figure 1. Stakeholder Team focal area survey responses

The following focal areas were selected based on the availability of stream restoration projects, feedback from the Stakeholder Team survey, and available monitoring data: Lancaster County, PA; Anne Arundel County, MD; and Fairfax County, VA. The next steps will be to contact local government staff from each of the focal areas to obtain information about their stream restoration projects, including geospatial data and project details. After all potential candidate restoration projects have been identified, a meeting will be held with the Stakeholder Team to review the projects and available data and narrow down the sites for analysis. The process for the analysis will also be discussed, as there were concerns previously raised by the Stakeholder Team over the accuracy and representativeness of a geospatial land cover change analysis. Upon final selection of the projects and consensus of the evaluation methodology, additional information about the selected project sites will be obtained from local government staff or the restoration contractor, including project designs and permits, as-built plans, inspection forms, and any monitoring data from before, during and after restoration. The detailed stream restoration evaluation, including the Stakeholder Team meeting, will be conducted from 12/16/2021 – 1/14/2022.

Synthesize and Distribute Results

The findings from the interviews and focal area analysis will be synthesized into a draft project report that includes recommendations on opportunities to improve consideration of riparian forests in stream corridor restoration projects to minimize unintended adverse consequences that includes both state-specific and bay-wide recommendations. Feedback from the CBP GIT and Stakeholder Team will be used to develop a final draft.

Recommendations from the project report will be used to update and finalize the best practices guidance document that has been initially drafted as part of the project planning and preparation task of this project. The guidance document will summarize opportunities to improve consideration of forests in stream corridor restoration and will be short and written in a manner to be easily understood by local and state government managers. Stakeholder Team feedback will be used to revise and finalize the document. Both the draft and final project report and best practices guidance document will be developed 3/2/2022 – 7/8/2022.

The results will be disseminated to key stakeholders in the Chesapeake Bay through distribution of the best practices guidance document and project report, as well as through a series of webcasts. The Stakeholder Team will help to plan three half day webcasts (one each in PA, MD, and VA). The webcasts will present the findings and recommendations from this study, provide examples of projects that incorporate the recommended best practices, and begin the conversation to improve stream restoration projects to minimize the impacts to habitat and maximize water quality benefits. Webcasts will be conducted 1/15/2022 – 3/1/2022.

Appendix B. Quality Assurance Project Plan (QAPP)

Quality Assurance Project Plan

for

Technical Assistance to Support Chesapeake Bay Program Goals and Outcomes - Fisheries, Habitat, Water Quality, Stewardship, Leadership, And Climate, Scope #3: Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned

Prepared for:
Chesapeake Bay Program Goal Implementation Team Project Initiative
410 Severn Avenue
Annapolis, MD 21403

Prepared by:
Center for Watershed Protection, Inc.
11711 E. Market Place, Suite 200
Fulton, MD 20759

September 22, 2021

This quality assurance project plan (QAPP) has been prepared according to guidance provided in the following documents to ensure that environmental and related data collected, compiled, and/or generated for this project are complete, accurate, and of the type, quantity, and quality required for their intended use:

- *USEPA (U.S. Environmental Protection Agency). 1999. QAPP Requirements for Secondary Data Research Projects. U.S. Environmental Protection Agency, Office of Research and Development, National Risk Management Research Laboratory, Cincinnati, OH, Washington, DC.*
- *USEPA (U.S. Environmental Protection Agency). No date. Elements of a Quality Assurance Project Plan (QAPP) For Collecting, Identifying and Evaluating Existing Scientific Data/Information. United States Environmental Protection Agency, Office of the Science Advisor, Washington, DC.https://www.epa.gov/sites/default/files/2015-05/documents/assess4.pdf*
- *EPA Requirements for Quality Assurance Project Plans* (EPA QA/R-5, EPA/240/B-01/003). U.S. Environmental Protection Agency, Office of Environmental Information, Washington DC, March 2001a (Reissued May 2006).
- *Guidance for Quality Assurance Project Plans* (EPA QA/G-5, EPA 240/R-02/009). U.S. Environmental Protection Agency, Office of Environmental Information, Washington, DC, 2002.

CWP will conduct work in conformance with the quality assurance program described in this QAPP.

Approvals:

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Quality Assurance Officer
Chesapeake Bay Program

9/22/2021
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Document Revision History

QAPP Submittal	Summary of Edits Received/Changes Made
QAPP Draft Revision 0 submitted on 8/23/21	
QAPP Draft Revision 1 submitted on 9/22/21	Received and addressed minor comments from the Chesapeake Bay Program's QA Coordinator about correcting numbering for Section 3.3 and adding language in Section 1.3 that all data-related tasks being carried out as a part of this project follow guidelines described in the Chesapeake Bay Program Quality Manual and are in conformance with the EPA Region 3 Quality Management Plan.

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ACRONYMS AND ABBREVIATIONS

CBP	Chesapeake Bay Program
CBT	Chesapeake Bay Trust
CWP	Center for Watershed Protection, Inc.
EPA	U.S. Environmental Protection Agency
WQGIT	Water Quality Goal Implementation Team
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control

DISTRIBUTION

The following individuals will receive a copy of this Quality Assurance Project Plan (QAPP) and any subsequent revisions:

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1.0 PROJECT OBJECTIVES, ORGANIZATION, AND RESPONSIBILITIES

1.1 Purpose of Study

The Chesapeake Bay Trust (CBT) has been designated to receive federal funds from the U.S. Environmental Protection Agency (EPA) as part of the Chesapeake Bay Program (CBP) Goal Implementation Team (GIT) Project Initiative. The work to be supported will advance specific outcomes from the 2014 Chesapeake Bay Watershed Agreement that have been identified as top priorities to address. The funding is supplied by the EPA to Center for Watershed Protection, Inc. (CWP) to complete the project titled "Scope of Work 3: Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned."

With growing interest and implementation of stream restoration practices in the Chesapeake Bay Watershed, there is an increasing need for research about the "trade-off" value for these practices and adjacent forest buffers. Forest buffers are critical for stream health. They improve the stability of stream banks, provide shade, filter nutrients and sediments, and contribute organic material for aquatic food webs. Qualifying conditions for stream restoration Best Management Plans (BMPs) offer some protection for riparian vegetation but these conditions have not been consistently met. Because there are large goals for stream restoration and forest buffers in state Watershed Implementation Plans (WIPs) and the 2014 Chesapeake Bay Agreement, it is imperative to better synergize our efforts and investments to minimize negative trade-offs impacts/outcomes. This project will involve the CBP Urban Stormwater, Stream Health, Wetlands, and Forestry Workgroups to comprehensively assess how forests are accounted for at multiple stages of stream restoration. Guidance will be developed for local governments on the best practices to minimize unintended adverse outcomes to riparian forests and identify opportunities for coupling these practices to improve water quality and habitat improvements. The results will help the CBP partnership to improve selecting, permitting, and funding processes for stream restoration projects.

1.2 Project Objectives

The overall project goal includes working collaboratively with the CBP and stakeholders to evaluate impacts of stream restoration projects on existing riparian ecology and forest buffers in both urban and rural areas of Maryland, Pennsylvania, and Virginia. This will include a comprehensive assessment of how forests are accounted for at multiple stages of stream restoration, including planning, permitting, implementation, and post restoration. The project includes a literature and policy review, interviews with stream restoration/forest buffer experts, representative stream restoration project evaluations, synthesis of results, and delivery of three webcasts to disseminate results. The three main project objectives are:

- Objective 1: Identify how forests are accounted for at multiple stages of stream restoration, including planning, permitting, implementation, and post restoration.
- Objective 2: Determine the impacts of stream restoration projects on existing riparian ecology and forest buffers.
- Objective 3: Develop best practices guidance for minimizing and mitigating impacts to forests in stream corridor restoration.

This project approach includes the component steps described below. In addition, refer to the project schedule provided in Appendix A and the project plan provided in Appendix B.

Task 1. Project Planning and Preparation: This project will be guided by input from a Stakeholder Team consisting of members from the CBP Urban Stormwater, Stream Health, Wetlands, and Forestry Workgroups, the Water Quality and Maintain Healthy Watersheds Goal Implementation Teams, as well as representatives from EPA, the Army Corps of Engineers, Maryland Department of the Environment (MDE), Pennsylvania Department of Environmental Protection (PA DEP), Virginia Department of Environmental Quality (VA DEQ), and a local government representative from each of the three states included in this project. CWP led a kick-off meeting with the Stakeholder Team on May 11, 2021, to introduce the CWP team and review the project scope, discuss contents to be incorporated in the Quality Assurance Project Plan (QAPP) (Task 2), brainstorm key documents to review and individuals to interview (Task 3), and discuss focal area(s) for the geospatial analysis (Task 4).

Following the kick-off meeting, CWP conducted an informal, online survey of regulators, practitioners, and local governments in the Chesapeake Bay watershed from May 20-28, 2021to identify additional individuals to interview, literature to review, and stream restoration projects to evaluate, as well as to begin to identify best practices for local and state governments to consider when planning for stream restoration to minimize adverse impacts to riparian forests. The survey was distributed through CWP's extensive contact database, the CBP workgroups, and through regional networks such as the Chesapeake Network.

CWP used input from the kickoff meeting and the survey results to develop a project plan (Appendix B) that identifies: a list of documents to review (state and local policies, permits, etc.); key information to extract from documents to be reviewed; a list of individuals to be interviewed (regulators, practitioners, and local governments) and interview questions; and the focal area(s) and time frame for geospatial analysis. The Stakeholder Team reviewed the draft project plan and CWP finalized the plan after addressing comments from the team.

Input from the kickoff meeting, the survey results, and a cursory review of the literature was also used by CWP to develop a draft Best Practices document that will be further refined in Task 5.

CWP will coordinate closely with the Stakeholder Team over the course of the project to review progress and discuss findings. A total of six 1.5-hour progress meetings will be led by CWP to review specific deliverables and present findings. Presentations to the Stakeholder Team are important to incorporate feedback from the CBP Workgroups involved with this project, as opposed to making separate presentations to each individual Workgroup. All meetings will be held via Zoom or other virtual formats.

Task 2. Develop Quality Assurance Project Plan: CWP has developed this draft QAPP and provided it to the Stakeholder Team for review. The draft will be revised based on feedback from the Stakeholder Team and then submitted to EPA for review. Upon receiving comments from EPA, CWP will prepare a final version.

Task 3. Conduct Policy Review and Interviews: CWP will investigate how the states of Pennsylvania, Maryland, and Virginia account for forests at multiple stages of the stream restoration process. The first step is to conduct a review of the key documents identified in Task 1 to better understand what each state requires, as well as what is required by the three selected counties of focus for evaluation as part of Task 4. Documents that may be reviewed include local forest conservation ordinances (in MD), Joint Wetlands and Waterways permits, Chapter 102 regulations and Bureau of Waterways, Engineering and Wetlands General Permits in PA, Virginia Water Protection Permits, and any technical guidance documents that accompany the relevant regulations. Refer to the Project Plan in Appendix B for a complete list of documents to review. The document review will be summarized in a spreadsheet format that includes the data source characterization required in the WQGIT-approved document, "Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model" to help determine if a document is appropriate and how much influence each document should have on the final recommendations. The review will address questions such as:

- What inventory requirements are in place and how are these inventories used in project planning?
- Are forest agencies engaged and how?
- How are existing forests addressed in project permits?
- What re-vegetation or other mitigation requirements are in place for impacts to streamside forests?
- What are the monitoring requirements and who is responsible for monitoring?

The next step in this task is to interview 4-6 individuals in each of the three selected counties for evaluation in Task 4 who are considered experts in stream restoration and/or forest buffers. The types of individuals to interview include designers, practitioners, MS4 representatives, soil and water conservation districts, state agencies, etc. The same types of people will be interviewed in each focal area to obtain representation across the different interviewee categories. The Project Plan in Appendix B includes a list of potential individuals identified to interview. The goal of the interviews is to better understand how the requirements reviewed above are (or are not) implemented in each jurisdiction and to expand upon the best practices identified in Task 1. The interviews will help to document the practices and procedures that are not "on the books" but are commonly practiced in the field. These may include typical processes for site selection, decision processes for selecting the type of restoration, how discrepancies between project design and implementation (such as expected vs actual forest change) are handled, typical scenarios where buffers are removed or projects are not implemented according to their approved design and why, to what extent riparian tree cover and structure are restored after restoration and how quickly this occurs. CWP will summarize key insights from the policy review and interviews from project planning through permitting, implementation and post restoration in a technical memo.

<u>Task 4. Geospatial Analysis of Stream Restoration Projects:</u> Using the understanding of what the different jurisdictions require from Task 3, CWP will perform an analysis of representative stream restoration projects using geospatial data, monitoring and construction records, and local knowledge of the projects to determine the extent to which these requirements are implemented. The impacts stream restoration has on forest buffers will also be quantified, including the extent and speed with which riparian forests recover post-restoration. Up to 12 projects (4 in each state) will be selected from the focal areas in consultation with the Stakeholder Team based on data availability, and representativeness of different project types, level of urbanization, and/or timeframe. Factors that affect riparian forests and vegetation independently of stream restoration impacts, including climate change, invasive species, and deer populations (e.g., using control sites and long-term monitoring) will be considered as part of the project evaluations depending on available data and resources from each of the jurisdictions. The following focal areas were selected based on the availability of stream restoration projects, feedback the Stakeholder Team, and available monitoring data: Lancaster County, PA; Anne Arundel County, MD; and Fairfax County, VA. Information about these selected focal areas is included in the Project Plan in Appendix B.

CWP will contact local government staff from each of the focal areas to obtain information about their stream restoration projects, including geospatial data and project details. After all potential candidate restoration projects have been identified, a meeting will be held with the Stakeholder Team to review the projects and available data and narrow down the sites for analysis. The process for the analysis will also be discussed, as there were concerns raised during the Stakeholder Team kick-off meeting over the accuracy and representativeness of a geospatial land cover change analysis. Upon final selection of the projects and consensus of the evaluation methodology, additional information about the selected project sites will be obtained from local government staff or the restoration contractor, including project designs and permits, as-built plans, inspection forms, and any monitoring data from before, during and after restoration. CWP will also consult with the Chesapeake Bay Program Land Data Team for guidance on the availability and application of appropriate land cover datasets that can be used as part of the project evaluations.

The result of this analysis will be a series of quantitative metrics for each project (e.g., number of trees removed or planted; length of stream restored; acres of wetland created; project cost; changes in key metrics such as basal area, species richness or invasive species). Metrics derived from the analysis will be used to develop scenarios in the Chesapeake Assessment Scenario Tool (CAST) to determine the changes in nutrient and sediment loading from both the stream restoration project and any impacts to the riparian forest buffer due to project implementation. The results of this task will be summarized in 1–2-page summaries for each site that present the change metrics (including changes in pollutant loading) and include a short narrative summary and a map.

<u>Task 5. Synthesize Results:</u> CWP will synthesize the findings from Task 3 and Task 4 into a draft Project Report that includes recommendations on opportunities to minimize the impact of riparian forests in stream corridor restoration projects and to mitigate any unintended adverse impacts. This may include opportunities to better incentivize practices that minimize riparian impacts, couple these practices to improve water quality and habitat improvements, or improve safeguards to minimize the loss of riparian forest cover and forest structure during and after stream restoration project implementation. We expect that the report will include both state-specific and Bay-wide recommendations. The report will also discuss whether and how CBP buffer goals are accounted for in local decision-making, and tradeoffs regarding stream restoration and riparian buffers. For example, regarding removal of trees along the stream bank to accommodate restoration: the roots of trees along channel provide valuable habitat but are more vulnerable. Therefore, if retained, there is a greater risk of these trees falling later on and blocking a newly completed restoration project. The Project Report will include an executive summary, introduction, literature review of effective stream restoration techniques, methods used to assess riparian impact, data generated, results and analysis, and conclusion, and be written in a manner to be easily understood by local government managers. CWP will provide a review draft to the Stakeholder Team and discuss their feedback during a progress call. CWP will also make one virtual presentation to the CBP GIT and will address feedback from the GIT and the Stakeholder Team in a revised Project Report.

The recommendations from the Project Report will be used to update and finalize the Best Practices document for Local Governments begun in Task 1. This document will summarize opportunities to minimize the impacts to forests in stream corridor restoration and will be designed specifically for local government managers. CWP will submit a draft of the Best Practices document to the Stakeholder Team for review and will revise and finalize the document to address their feedback as well as any significant and relevant lessons learned from the webcasts (Task 6). CWP will also work with the CBP Forestry Workgroup and the CBP Communications Workgroup to assure that the Best Practices document meets CBP standards with respect to local engagement, document layout etc. The Best Practices document will be disseminated through coordination with the Stakeholder Team to key stakeholders in the Chesapeake Bay, such as state and local government managers, program staff in affected fields of habitat and water quality, engineers, practitioners, and regulators. We will use CWP's e-newsletter, emails, and social media accounts, which have a combined reach of more than 15,000 watershed professionals.

<u>Task 6. Deliver Webcasts:</u> CWP will coordinate with the Stakeholder Team and CBP Communications Workgroup to plan three half day webcasts via Zoom (one each in PA, MD, and VA). This will include development of the webcast agenda, recruitment of speakers, coordination, and hosting of the webcasts (advertising, registration, website support, and evaluations). CWP will identify and invite key stakeholders to participate, including Bay partners, stream restoration practitioners, and local officials

involved with stream restoration at the state and local level. These identified participants will participate in the webcast planning meetings as appropriate. A target of 40-60 attendees is anticipated for each webcast but could potentially be extended to more depending upon interest. The webcasts will present the findings and recommendations from this study, provide examples of projects that incorporate the recommended best practices, and begin the conversation to improve stream restoration practices to minimize impacts to habitat and maximize water quality benefits. Upon the completion of each webcast, CWP will provide summary notes, webcast recordings, and a summary of the evaluations.

Task 7. Webcast Follow-up: CWP will meet with the Stakeholder Team to discuss the lessons learned from the webcasts and recommendations for next steps. CWP will also draft a Next Steps document that identifies follow-up steps for partners including state and local governments, researchers, and other partners.

1.3 Secondary Data Needed to Satisfy the Project Objectives

CWP, in consultation with the Stakeholder Team will identify the necessary documentation to satisfy the project objectives. This includes identifying key literature and policy documents, individuals to interview, as well as site-specific monitoring and construction documentation and available geospatial data within the Chesapeake Bay watershed that are relevant to the restoration project assessments. All data-related tasks being carried out as a part of this project follow guidelines described in the Chesapeake Bay Program Quality Manual and are in conformance with the EPA Region 3 Quality Management Plan.

1.4 Planned Approach for Evaluating Project Objectives

All data collected and used for this project will be from pre-existing sources. The defined data characterization criteria in Section 3.3 will be used to evaluate the relevance and application of the information. The CWP Project Team will conduct literature reviews, interviews, and stream restoration project evaluations, as well as gather other relevant information in support of Objectives 1, 2, and 3. The quality control officer will review this information to ensure it is representative and its compilation, analysis and synthesis is appropriately applied in project tasks to meet project objectives. Data sources that do not pass this review process will not be included in the project deliverables.

All data collected during the project shall be observed with the protocols contained in the QAPP. Updates to the QAPP will be led by the CWP Project Manager with oversight by the Quality Control Officer, vetted with the project team, and other appropriate stakeholders.

The following QC protocols and general project procedures will be used by CWP staff to ensure the completeness and correctness of data used in the deliverables:

- Members of the CWP staff will be selected for their experience and capability in collecting technical data and managing data sources.
- Whenever possible, data will be downloaded electronically from various electronic sources to reduce digitization of spatial data or scanning of hard copy documents. CWP technical staff will develop dedicated hard copy (as needed/requested) and electronic files.
- CWP ensures that appropriate metadata accompany every data set, in accordance with FGDC standards (*Content Standard for Digital Geospatial Metadata*, HTML Version [FGDC 1998]), including product identification, data quality information, spatial data organization, spatial reference information, entity and attribute information, and metadata reference information; refer

to CWP's Standard Operating Procedure (SOP) on Geospatial and Data Management (Appendix B).

- The CWP Project Manager will maintain a continuing dialog with Stakeholder Team on technical issues, including discussions regarding the inclusiveness and comprehensiveness of the data sources collected for the project.

1.5 Responsibilities of Project Participants

The CWP utilizes a Q-P-T team approach to manage all projects and functions that are conducted by the organization. When new work comes to the CWP, a team is formed that includes a minimum of three people designated as the Q (Quality Control Manager), P (Project Manager) and T (Team Support staff), which may be technical and/or administrative. This staff represents the core project team with additional staff joining the project as "Ts" based on project-area expertise. A description of the Quality Control, Project Manager and Team staff follows. For this project, we are also working closely with a Stakeholder Team that will help to guide the project, review progress, and discuss findings. The project organization chart, presented as Figure 1, includes the relationships between the project participants and data users. The responsibilities of those persons are described below.

The CBP Goal Implementation Team Lead, Katherine Brownson, will provide overall project and program oversight. She will review and approve the QAPP, and other materials developed to support the project. She will also ensure technical quality in all deliverables and adherence to the contract, as appropriate throughout the period of performance.

The CBT Senior Program Officer, Sarah Koser, will be the point of contact for the grant and provide overall grant administration, review and approve project deliverables, and ensure compliance with grant requirements.

The CBP Quality Assurance (QA) Officer is Lee McDonnell and QA Coordinator is Durga Ghosh. Their responsibilities include reviewing and approving the project QAPP and participating in any CBP quality reviews of the project.

The CWP Quality Control Officer (Q) is Bill Stack. He is responsible for overall quality control for the project in accordance with procedures and standards defined by the project QAPP. In this role, he reviews all deliverable products prior to their release and most importantly, attends all team meetings scheduled during the project to advise, track, and prevent future project management issues. As the Q, he will oversee the P and T roles, products, timelines, budgets, and other related items, as needed. He will also work with the P and Ts to ensure standards are identified and met, corrective actions are identified and performed, and improvements are integrated in the project.

The CWP Project Manager (P) is Lisa Fraley-McNeal, who is responsible for the day-to-day administration of the project, including scheduling, budgeting, convening team meetings, coordinating project tasks and preparing progress reports. As the P, she will also maintain the project file including scope, meeting minutes, products, client correspondence, products, and other project materials. She will supervise all team members' work and seek advice from the Q as needed. She will also be responsible for maintaining and distributing the QAPP and ensuring the technical quality requirements are met in accordance with the project objectives.

The CWP Team Members (T) provide technical and/or administrative support to the project. Chris Swann will lead the review of PA and MD policies and interviews, assist with synthesis of policy review and interviews, conduct CAST modeling, assist with project report, present results on PA and MD webcasts, and provide overall technical support on webcasts. Ari Daniels will lead the review of VA policies and interviews, assist with the project report and Best Practices document, and present results on VA webcast. Jordan Fox will Assist with the literature review and interviews, conduct geospatial analysis, assist with project report and Best Practices document, and organize webcast logistics. Kim Roberts will provide graphic design services for the Best Practices document. Other CWP staff may work on the project based on project-area expertise and will be provided with a copy of the QAPP.

This project Stakeholder Team consists of members from the CBP Urban Stormwater, CBP Stream Health, CBP Wetlands, and Forestry Workgroups, the Water Quality and Maintain Healthy Watersheds Goal Implementation Teams, as well as representatives from EPA, the Army Corps of Engineers, Maryland Department of the Environment (MDE), Pennsylvania Department of Environmental Protection (PA DEP), Virginia Department of Environmental Quality (VA DEQ), and a local government representative from each of the three states included in this project. The Stakeholder Team will attend six progress meetings throughout the course of the project to provide guidance, review progress, and discuss findings.

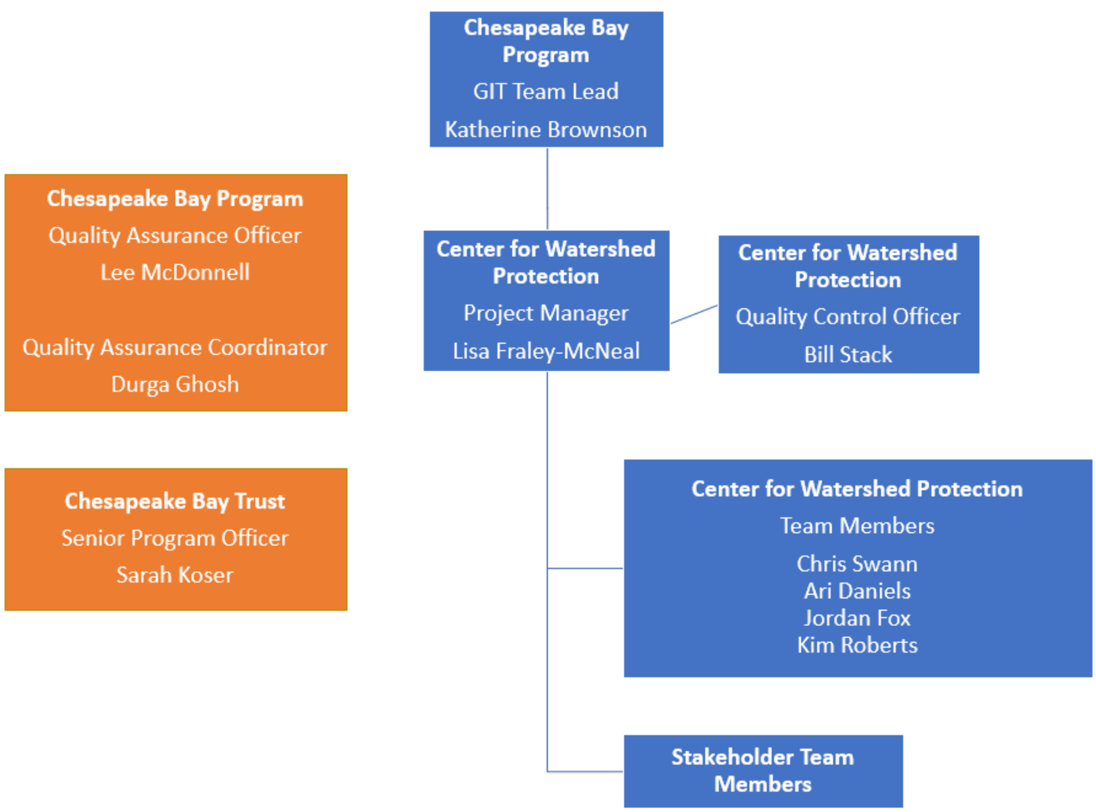

Figure 1. Project Organization

2.0 SOURCES OF SECONDARY DATA

Sources of data for this project are identified in Table 1. As depicted in the table, different sources of data are appropriate for each data type.

Table 1. Data Sources

Type	Source(s)
Literature and Policy Documents	• Technical guidance/research documents (peer-reviewed journals, research reports, white papers, etc.) • Regulatory/permit documents
Interviews	• Approximately 4-6 individuals will be interviewed in the three selected counties who are considered experts in stream restoration and/or forest buffers. • The types of individuals to interview include designers, practitioners, MS4 representatives, soil and water conservation districts, state agencies, etc.
Stream Restoration Evaluation Data	• Chesapeake Conservancy land use/land cover data (forthcoming in 2021) • Stream networks and ditches geospatial data • Project designs and permits • As-built plans • Inspection forms • Monitoring data

CWP collected literature and policy documents recommended from the Stakeholder Team and an online survey as outlined in the Project Plan (Appendix B). Additional sources of information will be identified and reviewed as needed to support project objectives, such as publications from USGS, NOAA, state program partners, and peer-reviewed journals. Data may also be identified and obtained using Google, Google Scholar, EBSCO Host, and university library database searches.

A list of recommended individuals to interview was also obtained from the Stakeholder Team and an on-line survey. The compiled list of individuals is included in the Project Plan (Appendix B). Approximately 4-6 individuals will be interviewed in the three selected counties for stream restoration evaluation (Lancaster County, PA; Anne Arundel County, MD; and Fairfax County, VA) and will include designers, practitioners, MS4 representatives, soil and water conservation districts, state agencies, etc. The specific individuals to interview will be determined through discussion with the Stakeholder Team. Interview transcripts will be included in an appendix to the final project report.

The data used for stream restoration evaluations will consist of geospatial sources, as well as documents that include project designs and permits, as-built plans, inspection forms, and monitoring data. The specific data sources will be identified through discussions of representatives from each of the three counties familiar with the project sites and vetted through the Stakeholder Team.

3.0 QUALITY OF SECONDARY DATA

The quality control of secondary data will include a review by the CWP project team Q. Oversight will include quality control of information from reported sources and associated summaries to ensure its accuracy, representative and applicable to the project objectives. CWP will follow the practices of using existing data described in EPA's (2002) *Guidance for Quality Assurance Project Plans.* When the quality of the data is not known, a disclaimer will be made on all project work that reports when the quality cannot be confirmed.

3.1 Acceptance Criteria for Document and Policy Review

Documents and policies reviewed will include the data source characterization required in the WQGIT-approved document, *Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model* to help determine if a document is appropriate and how much influence each document should have on the final recommendations (see Table 2).

The documents gathered for review will be preferentially from peer-reviewed journals, peer-reviewed books, peer-reviewed reports, and federal, state, and local agency sources. Therefore, it is assumed that the documents have already been screened for appropriateness and rigor of study design and methods and for appropriate application of statistical analyses and modeling methods. Acceptance criteria for the documents reviewed are as follows:

Relevance to the study— Relevant data will support the project goal of evaluating impacts of stream restoration projects on existing riparian ecology and forest buffers in both urban and rural areas of Maryland, Pennsylvania, and Virginia.

Representative of the areas and times of study— The focus will be on documents relevant to the Chesapeake Bay watershed and specifically Maryland, Pennsylvania, and Virginia. Other salient work relevant to general, or "theoretical," overarching principles will be considered and evaluated for their applicability to the Chesapeake Bay. Both recent and long-term data will be considered in consultation with the Stakeholder Team.

Individual observations: anomalous or extreme outliers—Individual data values might be in error due to variables such as transcription errors or equipment malfunctions. Data will be examined for anomalous values and reject values reported well beyond the range of observed variability. The number of exclusions, the source of the data excluded, and the suspected cause of error or rationale for exclusion will be documented in the final report.

Table 2. Data Source Characterization (Source: CBP, 2015)

	High Quality	**Medium Quality**	**Low Quality**
Extent of Replication	Clearly documented and well-controlled past work that has since been replicated or strongly supported by the preponderance of other work; recent (< 5-year old) work that was clearly documented and conducted under well-controlled conditions and thus conducive to possible future replication	Clearly documented older (>5-yr old) work that has not yet been replicated or strongly supported by other studies, but which has also not been contraindicated or disputed	Work that was not clearly documented and cannot be reproduced, or older (>5-yr old) work for which results have been contraindicated or disputed by more recent results in peer- reviewed publication or by other studies that are at least equally well documented and reproducible
Applicability	Purpose/scope of research/publication matches information/data need	Limited application	Does not apply
Study location	Within Chesapeake Bay	Characteristic of CB, but outside of watershed	Outside of CB watershed and characteristics of study location not representative
Data collection & analysis methods	Approved state or federal methods used; statistically relevant	Other approved protocol and methods; analysis done but lacks significance testing	Methods not documented; insufficient data collected
Conclusions	Scientific method evident; conclusions supported by statistical analysis	Conclusions reasonable but not supported by data; inferences based on data	Inconclusive; insufficient evidence
References	Majority peer-review	Some peer-review	Minimal to no peer-review

3.2 Interviews

The interviews conducted will be focused on individuals from the three selected counties for stream restoration evaluation (Lancaster County, PA; Anne Arundel County, MD; and Fairfax County, VA) who are considered experts in stream restoration and/or forest buffers. Interviews will be done via Zoom or Microsoft Teams to enable the project team to record the interviews for accuracy when conveying the data to the project data set. Each interviewer will have a list of standard questions that will be developed to allow comparison across the different jurisdictions. The interviews will also include opportunity for relevant follow-up questions to be asked of the interviewees as needed. The Project Plan (Appendix B) includes the list of interview questions that were developed cooperatively with the stakeholder team to address the project objectives. The questions are mostly open-ended, since the goal of the interview is for the respondent to provide their experiences and expertise for their local jurisdiction regarding stream restoration implementation and impacts on forest resources.

3.3 Geospatial Data

Geospatial data in datasets used for the project will be reviewed to ensure that they conform to data exchange protocols and applicable data standards as defined and maintained by EPA's Office of Environmental Information (USEPA, 2003). CWP will also check whether metadata are available for geospatial data used in this project in accordance with the provisions of FGDC-STD-001-1998, Content Standard for Digital Geospatial Metadata. If CWP determines that a particular dataset or data layer obtained from a secondary source is provided at a scale that does not fit into the overall dataset or area of interest, CWP (in consultation with the Stakeholder Team) will describe the extent to which the dataset can be used or applied.

4.0 DATA REPORTING, DATA REDUCTION, AND DATA VALIDATION

4.1 Data Reduction and Validation

Data reduction procedures specific to this project will be related to stream restoration project evaluations. Specific methods of reducing data for the stream restoration project evaluations will be determined in consultation with the Stakeholder Team, but it is anticipated that it will involve a combination of geospatial analysis and summarization of available project related data, such as monitoring reports, as-builts, permit documents, etc. The result of this analysis will be a series of quantitative metrics for each project (e.g., number of trees removed or planted; length of stream restored; acres of wetland created; project cost; changes in key metrics such as basal area, species richness or invasive species). The results will be summarized in 1–2-page summaries for each site that present the change metrics and include a short narrative summary and a map.

The quality of all geospatial data used will be reviewed according to the criteria in Section 3.2. Data that do not meet the established criteria will be rejected and not used. Any limitations on the use of individual datasets will be documented in the final project report. CWP staff will ensure geospatial data management and calculations are performed in accordance with CWP's SOPs for Geospatial and Data Management (Appendix C).

4.2 Expected Product Document that Will Be Prepared

CWP will work collaboratively with the Stakeholder Team to evaluate processes and protocols in parts of the Chesapeake Bay watershed to determine what impact stream restoration projects have on existing riparian ecology and forest buffers. This will include a comprehensive assessment of how forests are accounted for at multiple stages of stream restoration, including planning, permitting, implementation, and post restoration. The final report will include a description of the data employed and will document project findings and recommendations for the CBP and project partners. A best practices guidance document will also be developed for local governments to minimize unintended adverse outcomes to riparian forests and identify opportunities for coupling these practices to improve water quality and habitat improvements. Project results will be disseminated and discussed through a series of webcasts focused on stream restoration in both urban and rural areas of Maryland, Pennsylvania, and Virginia.

REFERENCES

USEPA (U.S. Environmental Protection Agency). 2001a (Reissued May 2006). *EPA Requirements for Quality Assurance Project Plans*. EPA QA/R-5. EPA/240/B-01/003. U.S. Environmental Protection Agency, Office of Environmental Information, Washington, DC. https://www.epa.gov/sites/production/files/2016-06/documents/r5-final_0.pdf

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USEPA (U.S. Environmental Protection Agency). 2003. *Guidance for Geospatial Data Quality Assurance Project Plans.* EPA QA/G-5G. EPA 240/R-03/003. U.S. Environmental Protection Agency, Office of Environmental Information, Washington, DC. https://www.epa.gov/sites/production/files/2014-08/documents/epa_geospatialdataqualityassuranceprojectplansqa_g-5g_0.pdf

USEPA (U.S. Environmental Protection Agency). 1999. *QAPP Requirements for Secondary Data Research Projects*. U.S. Environmental Protection Agency, Office of Research and Development, National Risk Management Research Laboratory, Cincinnati, OH, Washington, DC.

USEPA Chesapeake Bay Program (CBP) WQGIT. 2015. Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model. U.S. Environmental Protection Agency, Chesapeake Bay Program, Annapolis, MD.

Appendix A.
Project Schedule:
Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned

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Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned Schedule as of August 23, 2021

Report # and Reporting Period	Project Deliverables	Date of Delivery
Report #1: 3/15/2021 – 7/10/2021	Project plan (up to 10 pages), draft Report of Best Practices for local governments for review and discussion	7/10/2021
Report #2: 6/11/2021 – 9/1/2021*	Draft QAPP/QMP for EPA comment, final (signed) QAPP	9/1/2021*
Report #3: 9/2/2021 – 12/15/2021	Excel spreadsheet with results of the documents review; technical memo summarizing the document review and interview results	12/15/2021
Report #4: 12/16/2021 – 1/14/2022	Maps and details on selected projects including evaluation of riparian area vegetation change, and other water quality and habitat implications of the selected projects from the monitoring efforts and CAST analysis.	1/14/2022
Report #5: 1/15/2022 – 3/1/2022	Draft and final webcast agendas, invitations, speaker list/bios and summary for three half-day webcasts (e.g., meeting notes, summary of evaluations, and webcast recordings)	3/1/2022
Report #6: 3/2/2022 – 7/8/2022	Draft and final Project Report and final Best Practices document	7/8/2022
Report #7: 7/9/2022 – 8/1/2022	Next Steps document	8/1/2022

**A request to extend the deadline from 9/1/2021 to 10/15/2021 has been submitted to the CBT grant officer and is pending approval as of 8/23/2021.*

Appendix B.

Project Plan: Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned

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Project Plan:
Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned

Stakeholder Team Review Draft: 6/1/2021
Revisions Provided by Stakeholder Team: 6/15/2021
Final Revised Draft: 7/1/2021

Introduction

The Center for Watershed Protection, Inc. (CWP) is working collaboratively with the Chesapeake Bay Program (CBP) and stakeholders to evaluate impacts of stream restoration projects on existing riparian ecology and forest buffers in Maryland, Pennsylvania, and Virginia. This project will produce guidance for local governments on the best practices to minimize unintended adverse outcomes to riparian forests and identify opportunities to improve water quality and habitat outcomes. The results will help improve selection, permitting, and funding processes for stream restoration projects in the Chesapeake Bay watershed.

This project plan was developed to support the "Scope of Work 3: Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned" project identified in the 2020 Chesapeake Bay Trust-Technical Assistance - Chesapeake Bay Program Goals and Outcomes request for proposals. The plan is based on input from the stakeholder team kickoff meeting held on May 11, 2021, as well as an informal online survey of regulators, practitioners, and local governments in the Chesapeake Bay watershed that was conducted from May 20-28, 2021. The survey was distributed through CWP and stakeholder team member networks and received 179 responses from respondents in 18 states; 106 of those responses were from respondents located in Maryland, Virginia, or Pennsylvania. Of all respondents, nearly 47% have over 10 years of experience with stream restoration projects (35% have 3 – 10 years, 7% have 1 – 3 years, and 11% have 0 – 1 year). In terms of experience specifically with stream restoration projects in mature forests, 28% of respondents have over 10 years of experience (24% have 3 – 10 years, 19% have 1– 3 years, and 29% have 0 – 1 year). In terms of experience specifically in the Chesapeake Bay states, 60 respondents reported having experience in Maryland, 50 in Virginia, and 37 in Pennsylvania.

This project plan outlines the key documents to review and information to extract, individuals to be interviewed and interview questions, and potential focal areas and timeframe for detailed stream restoration evaluations.

Key Documents to Review

The goal of the key documents review is to investigate how the states of Pennsylvania, Maryland, and Virginia account for forests at multiple stages of the stream restoration process, as well as to identify best practices to minimize impacts to riparian forests. The regulatory requirements of three selected focal areas will also be reviewed. The documents to review include both technical guidance/research (peer-reviewed journals, research reports, white papers, etc.) and regulatory/permit documents. A spreadsheet was developed to summarize the documents reviewed and is included as an attachment to this project plan. This spreadsheet includes the data source characterization required in the WQGIT-approved document, "Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model" to help determine if a document is appropriate and how much influence each document should have on the final recommendations.

The review of key documents will be used to address the following questions:

- How are forests defined by various agencies and organizations and what definition should be applied to this study?
- What inventory requirements are in place and how are these inventories used in project planning?
- Are forest agencies engaged and how?
- How are existing forests addressed in project permits?
- What re-vegetation or other mitigation requirements are in place for impacts to streamside forests?
- What are the monitoring requirements and who is responsible for monitoring?
- Are best practices recommended to minimize impacts to riparian forests and to what extent are they implemented?

Table 1 includes the technical guidance and research documents, and Table 2 includes the regulatory and permit documents recommended by the Stakeholder Team and obtained from the survey results. Note that the document names and information in these tables are listed according to how they were provided by the stakeholders and survey respondents. Complete citations will be developed as part of the document review conducted 9/2/2021 – 12/15/2021 and recorded in in the summary spreadsheet.

Table 1. Technical guidance and research documents		
Author(s)	**Year**	**Document**
Altland et al.	2020	Consensus Recommendations for Crediting Floodplain Restoration Projects Involving Legacy Sediments
Anderson and Pezeshki	1999	The effects of intermittent flooding on seedlings of three forest species
Angelov et al.	1996	Long- and short-term flooding effects on survival and sink – source relationships of swamp-adapted tree species
Bahr et al.	2019	Recommendations for Crediting Outfall and Gully Stabilization Projects in the Chesapeake Bay Watershed
Beauchamp et al.	2020	Effects of stream restoration by legacy sediment removal and floodplain reconnection on water quality and riparian vegetation
Bledsoe et al.	2016	Stream Restoration as a BMP
Budelis et al.	2020	An evaluation of forest impacts compared to benefits associated with stream restoration
Burch et al.	2019	Recommended Methods to Verify Stream Restoration Practices Built for Pollutant Crediting in the Chesapeake Bay Watershed
Callahan et al.	2012	Pathways to environmental justice advancing a framework for evaluation
Virginia Chesapeake Bay Local Assistance Department		Local Assistance Manual
Chesapeake Stormwater Network	2009	Stormwater Design Guidelines for Karst Terrain in the Chesapeake Bay Watershed Version 2.0 http://observatoriaigua.uib.es/repositori/suds_virginiai.pdf
Claggett, S., and TetraTech	2014	Recommendations of the Expert Panel to Reassess Removal Rates for Riparian Forest and Grass Buffers Best Management Practices
Coder	1994	Flood damage to trees
Cramer, M.L.	2012	Stream Habitat Restoration Guidelines – Washington State
CWP	2021	The Self-Recovery of Stream Channel Stability in Urban Watersheds due to BMP Implementation
Doll	2016	Biotic conditions of restored streams
Doug Tallamy		Nature's Best Hope (book)
Filoso	2020	Evaluating the effectiveness and sustainability of novel stream restoration designs for coastal plain streams in MD
Fischenich	2006	Functional objectives for stream restoration
Fischenich and Copeland	2001	Environmental considerations for vegetation in flood control channels
Garssen et al.	2015	Riparian plant community responses to increased flooding – a meta-analysis
Harman, W., R. Starr.	2011	Natural Channel Design Review Checklist

Table 1. Technical guidance and research documents		
Author(s)	**Year**	**Document**
Harman et al.	2011	A function-based framework for developing stream assessments, restoration goals, performance standards and standard operating procedures
Hart-Smith	2012	Paleoecological Evidence of a Pre-Settlement Sedge Wetland in a Piedmont River Valley https://jscholarship.library.jhu.edu/handle/1774.2/36075
Hilderbrand	2020	Determining realistic ecological expectations in urban stream restorations
Hilderbrand et al.	2015	Quantifying the ecological uplift and effectiveness of differing stream restoration approaches in Maryland
Hilgartner et al.	2010	Presettlement habitat stability and postsettlement burial of a tussock sedge wetland in a Maryland Piedmont river valley. In 95th ESA Annual Meeting. Pittsburgh, PA.
Hoag	2007	How to plant willows and cottonwoods for riparian restoration
Hudson et al.	2015	Assessment of woody vegetation for replacement of ecological functions in created forested wetlands of the Piedmont Province of VA
James Karr & Ellen Chu		Restoring Life in Running Waters (book)
Keeton	2007	Evaluation of tree seedling mortality and protective strategies in riparian forest restoration
Law, N.	2014	Recommendations of the Expert Panel to Define Removal Rates for Urban Filter Strips and Stream Buffer Upgrade Practices
Mayer et al.	2005	Riparian buffer width, vegetative cover, and nitrogen removal effectiveness: a review of current science and regulations.
Mayer et al.	2007	Meta-analysis of nitrogen removal in riparian buffers. Journal of Environmental Quality 36:1172-1180
Mayer PM, AH Todd, JA Okay, KA Dwire.	2010	Introduction to the Featured Collection on Riparian Ecosystems & Buffers. Journal of the American Water Resources Association 46:207-210
Mayer PM, JE Compton, G Wilhere	2020	Nutrient Dynamics in Riparian Ecosystems. Pages 163-194 (Chapter 6) in T. Quinn, G.F. Wilhere, and K.L. Krueger, technical editors. Riparian Ecosystems, Volume 1: Science Synthesis and Management Implications. Habitat Program, Washington Department of Fish and Wildlife, Olympia. https://wdfw.wa.gov/sites/default/files/publications/01987/wdfw01987.pdf
MD DNR	2020	Forest Action Plan, Part I Forest Resource Assessment
MD DNR	2020	2020 – 2025 Forest Action Plan, Part II Strategy
MD DNR	(n.d.)	Regenerative Stream Conveyance: Construction Guidance https://dnr.maryland.gov/ccs/Documents/RSC_Training/RSC-Guidance.pdf
MD DNR Forest Service	2001	Riparian Forest Buffer Survival and Success in Maryland

Table 1. Technical guidance and research documents		
Author(s)	**Year**	**Document**
Merganičová, Katarína & Merganič, Ján & Svoboda, Miroslav & Bače, Radek & Šebeň, Vladimír	2012	Deadwood in Forest Ecosystems
Montgomery County, PA	(n.d.)	Guidebook for Riparian Corridor Conservation
NC Stream Restoration Institute & NC Sea Grant	(n.d.)	Stream Restoration: A Natural Channel Design Handbook https://semspub.epa.gov/work/01/554360.pdf
NCHRP	(n.d.)	A watershed Approach to Mitigating Stormwater Impacts http://www.trb.org/Publications/Blurbs/175861.aspx
NCSU		Guide for installation of riparian vegetation on restoration projects
Neugebauer, A.	2011	Paleoecological Reconstruction of Big Spring Run, Lancaster, PA http://www.bsr-project.org/uploads/2/6/5/2/26524868/neugebauerthesis_-_2011_-_paleoecological_reconstruction_of_big_spring_run_lancaster_pa.pdf
Niezgoda et al.	2014	Defining a stream restoration body of knowledge
ODNR	(n.d.)	Ohio Stream Management Guide
PA DCNR	2016	Planting and Seeding Guidelines
PA DEP	(n.d.)	Guidelines for Maintaining Streams in Your Community
PA DEP		PADEP BMP Manual
PA DEP	2018	Considerations of Stream Restoration Projects in Pennsylvania for eligibility as an MS4 Best Management Practice https://files.dep.state.pa.us/Water/BPNPSM/StormwaterManagement/MunicipalStormwater/PRP_TMDL_Plans/Stream%20Restoration%20Eligibility%20for%20MS4%205.11.2018.pdf
Palone, R. and Todd, A.H.	1997	Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers. http://www.chesapeakebay.net/content/publications/cbp_13019.pdf
Palmer et al.	2017	Ecological Restoration of Streams and Rivers: Shifting Strategies and Shifting Goals
Pizzuto et al.	2010	On the retreat of forested, cohesive riverbanks
Pollock et al.	2015	Chapter 6 – Beaver Dam Analogues BDAs
Polvi & Wohl	2013	Biotic drivers of stream planform
Richardson and Beraud	2014	Effects of riparian forest harvest on streams – meta-analysis

Table 1. Technical guidance and research documents		
Author(s)	**Year**	**Document**
River Restoration Centre	2011	Practical river restoration appraisal guidance for monitoring options (PRAGMO)
Roni et al.	2002	A review of stream restoration techniques and a hierarchical strategy for prioritizing restoration in Pacific Northwest watersheds
Schueler, T. and Stack, B.	2014	Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects
SER International	(n.d.)	Primer on Ecological Restoration https://cdn.ymaws.com/www.ser.org/resource/resmgr/custompages/publications/SER_Primer/ser_primer.pdf
Southerland et al.	2017	Meta-analysis of biological monitoring data to determine the limits on biological uplift from stream restoration imposed by the proximity of source populations
Stanford et al.	1996	A general protocol for restoration of regulated rivers
Stranko et al.	2011	Comparing the fish and benthic macroinvertebrate diversity of restored urban streams to reference streams
Thomas Dunne & Luna Leopold, W.H Freenan	1978	Water in Environmental Planning
University of Washington Center for Urban Horticulture	2002	An introduction to using native plants in restoration projects
USACE	2015	Large Wood National Manual
USDA	2018	Guidance for Stream Restoration https://www.fs.fed.us/biology/nsaec/assets/yochumusfs-nsaec-tn102-4guidancestreamrestoration.pdf
USDA	2018	Mid-Atlantic Forest Ecosystem Vulnerability Assessment and Synthesis: A Report from the Mid-Atlantic Climate Change Response Framework Project. General Technical Report NRS-181. https://www.fs.fed.us/nrs/pubs/gtr/gtr_nrs181.pdf
USDA NRCS		Stream Restoration Design (National Engineering Handbook 654) https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/water/manage/restoration/?cid=stelprdb1044707
USEPA	2012	A Function-Based Framework for Stream Assessment & Restoration Projects (EPA 842-K-12-006)
USFS	2017	Guidance for stream restoration
USFS	(n.d.)	General Technician Report NRS-96 Manual Herbicide Application Methods for Managing Vegetation in Appalachian Hardwood Forest
USFS Southern Research Station	(n.d.)	General Technical Report SRS-119

Table 1. Technical guidance and research documents		
Author(s)	**Year**	**Document**
USFWS Biological Services Program	1977	Impact of Water Level Changes on Woody Riparian and Wetland Communities, Vol II the Southern Forest Region
USFWS Biological Services Program	1977	Impact of Water Level Changes on Woody Riparian and Wetland Communities, Vol I Plant and Soil Responses
USFWS Biological Services Program	1978	Impact of Water Level Changes on Woody Riparian and Wetland Communities, Vol IV Eastern Deciduous Forest Region
USFWS et al.	2017	The Beaver Restoration Guidebook https://www.fws.gov/oregonfwo/Documents/BRGv.2.0_6.30.17_forpublicationcomp.pdf
USFWS/USEPA	2012	A Function-Based Framework for Stream Assessment and Restoration Projects https://www.spk.usace.army.mil/Portals/12/documents/regulatory/pdf/A_Function-Based_Framework.pdf
VA DCR	2003	Riparian Buffers Modification & Mitigation Guidance Manual https://static1.squarespace.com/static/55c211c8e4b06ea5799e6c03/t/56098ce1e4b080746e848fbf/1443466465396/DCR-BufferManual_06Rev.pdf
VA DCR	2004	The Virginia Stream Restoration and Stabilization BMP Guide
VA DCR	2021	The Natural Communities of Virginia Classification of Ecological Groups and Community Types https://www.dcr.virginia.gov/natural-heritage/natural-communities/
VA DCR		Virginia Stormwater Handbook
VA DEQ		Virginia Erosion and Sediment Control Handbook
Voli et al.	2009	Preliminary reconstruction of a PreEuropean Settlement Valley Bottom Wetland, Southeastern Pennsylvania
Wheaton et al.	2019	Wheaton et al. (2019), Low-Tech Process-Based Restoration of Riverscapes Design Manual https://lowtechpbr.restoration.usu.edu/manual/
Wood, D.	2020	Consensus Recommendations for Improving the Application of the Prevented Sediment Protocol for Urban Stream Restoration Projects Built for Pollutant Removal Credit
Wood, D., and Schueler, T.	2020	Consensus Recommendations to Improve Protocols 2 and 3 for Defining Stream Restoration Pollutant Removal Credits
Wood KL, SS Kaushal, PG Vidon, PM Mayer, JG Galella.	In Review	Tree trade-offs in stream restoration projects: Impact on riparian groundwater quality. Urban Ecosystems/
WV DEP	2012	WV Stormwater Management and Design Guidance Manual http://chesapeakestormwater.net/wp-content/uploads/downloads/2013/01/West_Virginia_Stormwater_Management_Design_Guidance_Manual_FULL_11-2012.pdf

Table 1. Technical guidance and research documents		
Author(s)	**Year**	**Document**
Yochum, S.	2018	Guidance for Stream Restoration https://www.fs.fed.us/biology/nsaec/assets/yochumusfs-nsaec-tn102-4guidancestreamrestoration.pdf

Table 2. Regulatory and permit documents	
State	**Document**
Nationwide	USACE Nationwide 27
Nationwide	FEMA Floodplain regulations
MD	Forest Conservation Act and Regulations https://dnr.maryland.gov/forests/Pages/programapps/newfca.aspx
MD	MDE-WMA/US-ACOE Joint Wetlands & Waterways Permits
MD	Maryland Waterway Construction regulations COMAR 26.17.04
MD	Maryland Nontidal Wetland regulations COMAR 26.23
MD	Gaithersburg's ordinance
MD	City of Frederick Land Management Code Section 721 Forest Conservation
MD	Anne Arundel County Code Article 17, Title 6, Subtitles 3 and 4 are important to stream restoration projects. These are the main Code sections used to protect environmental features on a development site.
PA	Delaware Valley Regional Planning Commission (2013), Stream Buffer Protection Ordinance
PA	Model Ordinance Riparian Corridor Conservation District (n.d.)
PA	PA Land Trust Association (2014), A scientific foundation for shaping riparian buffer protection regulations
PA	PA Land Trust Association (2014), Riparian buffer protection via local regulation – a guide and model ordinance for PA municipalities
PA	Waterways Permitting https://www.dep.pa.gov/Business/Water/Waterways/Encroachments/Pages/default.aspx
VA	Virginia Regulation and Guidance for Stream Restoration (n.d.) This paper represents the Agencies and Organizations with oversight for Virginia stream restoration projects. The list includes the permits needed who distributes them and contact information. It was compiled by Judy Okay, Virginia Department of Forestry Consultant.
VA	Fairfax County Chesapeake Bay Preservation Ordinance: https://www.fairfaxcounty.gov/landdevelopment/chesapeake-bay-preservation-ordinance
VA	VWP Water Protection General Permits and Time of Year Restriction
VA	Virginia Construction General permit
WV	West Virginia Rivers https://wvrivers.org/policy-2/policy/
WV	West Virginia Stream Disturbance Permitting Requirements

Table 2. Regulatory and permit documents	
State	**Document**
	https://dep.wv.gov/WWE/Programs/nonptsource/streamdisturbance/Documents/StreamDisturbancePermittingGuide.pdf
NC	NC Forest Service Regulations https://www.ncforestservice.gov/water_quality/regulations.htm

Interviews
Approximately 4-6 individuals will be interviewed in three selected jurisdictions who are considered experts in stream restoration and/or forest buffers. The types of individuals to interview include designers, practitioners, MS4 representatives, soil and water conservation districts, state agencies, etc. The same types of people will be interviewed in each focal area to obtain representation across the different interviewee categories. The goal of the interviews is to better understand how the requirements identified from the review of regulatory and policy documents are (or are not) implemented in each jurisdiction and help to identify and refine best practices to minimize adverse impacts to riparian forests. The interviews will also help to document the practices and procedures that are not "on the books" but are commonly practiced in the field. Interviews will be conducted from 9/2/2021 – 12/15/2021. Table 3 provides a list of potential individuals to interview that were recommended by the Stakeholder Team and from the survey results. In addition, representative individuals from the following organizations were suggested to identify and interview:

- Trout Unlimited
- Alliance for the Chesapeake Bay
- Western Pennsylvania Conservancy
- PA Association of Conservation Districts

Interview questions for all individuals include:

- What is your experience or involvement with stream restoration projects?
- In your experience, how are sites selected for stream restoration projects? Who identifies the sites?
- Is a riparian forest assessment done prior to restoration to determine forest health and if so, what indicators are used?
- How is tree and tree canopy protection deliberated during site selection, design, and installation? Are there scenarios when protecting trees, forest stability, and forest longevity are given priority over streambank reconstruction?
- Are there typical scenarios where entire buffers or mature trees are removed and why?
- When trees are removed during restoration, to what extent are riparian tree cover and structure restored after restoration? How quickly does this occur?
- What best practices are used to minimize impacts to riparian forests (this would include post restoration maintenance)? To what extent are they implemented?

Interview questions specific to stream restoration practitioners:

- What are the decision processes for selecting the type of restoration?
- How are discrepancies between project design and implementation (such as expected vs actual forest change) handled?
- What are the parameters around plants/rocks/woody debris used for restoration and where it is sourced? What are the bounds on making materials "natural"or as high quality as possible?
- What is done with the trees that are removed (e.g., are they sold? Are any used for restoration off-site or on-site?)?
- What post-construction monitoring is conducted and what is the purpose of the monitoring? Do monitoring requirements vary?
- Have you designed or managed projects that you deem successful? If so, what made them successful?
- Have you designed or managed projects that were less successful or unsuccessful? If so, what were some challenges or issues?

Interview questions for non-stream restoration practitioners:

- Are you aware of cases where there have been discrepancies between project design and implementation? If so, how were these discrepancies handled?
- In your experience, what sort of post-construction monitoring is conducted for stream restoration projects in your area?
- Are you aware or have you been involved with stream restoration projects that were successful? If so, what made them successful?
- Are you aware or have you been involved with stream restoration projects that were less successful or unsuccessful? If so, what were some challenges or issues?

Table 3. Potential individuals to interview		
Organization	**Interviewee**	**Notes**
	Kelsey Wood	woodkelseylynn@gmail.com
	Todd Moses	Practitioner who has done urban stream design work since 1986.
	William Hilgartner	whilgarnter@comcast.net
AMT Engineering	Ken Brown	kbrown@amtengineering.com
	Joe Howard	jhoward@amtengineering.com
	Greg Fox	Has experience avoiding and saving trees both in the design and in access.
Anne Arundel County, MD, Watershed Protection and Restoration Program	Eric Michelson	410-222-4240, pwmich20@aacounty.org
Arlington County, VA	Jason Papacosma	Jpapacosma@arlingtonva.us
Biohabitats, Inc.	Joe Berg	jberg@biohabitats.com
	Lee Mallonee	lmallonee@biohabitats.com, (804) 750-1082
	Ted Brown	
	Bryon Salladin	bsalladin@biohabitats.com
	Mike Trumbauer	mtrumbauer@biohabitats.com
Chesapeake Stormwater Network	Tom Schueler	watershedguy@hotmail.com
City of Alexandria, VA	Jesse Maines	jesse.maines@alexandriva.gov
City of Frederick, MD	Jenny Willoughby	
City of Harrisonburg, VA	Wes Runion	Wesley.Runion@harrisonburgVA.gov
City of Richmond, VA	Grace LeRose	
City of Roanoke, VA	Marcus Aguilar	Marcus.Aguilar@roanokeva.gov
Clauser Environmental	Aaron Clauser	aclauser@verizon.net , (570) 294-0669
DC Department of Energy & Environment	Josh Burch	josh.burch@dc.gov
	Stephen Reiling	stephen.reiling@dc.gov
	Steve Saari	steve.saari@dc.gov
Ecosystem Services	Kip Mumaw	kip@ecosystemservices.us
	Kyle Ashmun	kyle@ecosystemservices.us
Ecotone	Scott McGill	
Ecosystem Planning and Restoration	Rich Starr	
Environmental Quality Resources	Liam O'Meara	lomeara@eqrllc.com

Table 3. Potential individuals to interview		
Organization	**Interviewee**	**Notes**
Fairfax County, VA	Meghan Fellows	meghan.fellows@fairfaxcounty.gov
	Charles Smith	Charles.Smith@fairfaxcounty.gov
	Suzanne Foster	suzanne.foster@fairfaxcounty.gov
Finish Line Environmental	Kristen Pruitt	k.pruitt@flcva.com, 540-371-3500
Franklin and Marshall	Dorothy Merritts	Interview about the appropriateness of expecting upland forest in stream valley bottoms.
Franklin and Marshall	Robert Walter	robert.walter@fandm.edu
Hanover Land Services	Christina Casole	ccasole@hanoverlandservices.com
Hazen and Sawyer	Keven Arrance	
Kimley-Horn	Matt Hubbard	Matt.hubbard@kimley-horn.com
MD Department of the Environment	Jim George Denise Clearwater	denise.clearwater@maryland.gov
MD Department of Natural Resources	Greg Golden	Environmental review
	Tony Redman	Environmental review
MD DNR Forest Service	Anne Hairston-Strang	
	Marian Honeczy	marian.honeczy@maryland.gov For standards for Forest Conservation Act compliance for stream restoration projects.
MD Department of Transportation State Highway Administration	Bill Buettner	He has a wealth of experience as a director of mitigation monitoring programs.
Metropolitan Washington Council of Governments	Phong Trieu	ptrieu@mwcog.org
NC State University	Greg Jennings	
Northcentral PA Conservancy	Renee Carey	Has coordinated many stream projects in conjunction with DEP, counties, landowners, PAFBC. rcarey@npcweb.org
Northern VA Regional Commission	Normand Goulet	NGoulet@novaregion.org
PA Department of Conservation and Natural Resources	Nate Reagle	nreagle@pa.gov
	Teddi Stark	
PA Department of Environmental Protection	Jeff Hartranft	jhartranft@pa.gov Expert on stream restoration projects involving legacy sediment removal

Table 3. Potential individuals to interview		
Organization	**Interviewee**	**Notes**
	Jamie Eberl	I do not have expertise to offer on the implementation of stream restoration/forest buffers but as the Section Chief for the PADEP MS4 Program I can offer some insight on the challenges that municipalities face when trying to implement these types of projects. (jeberl@pa.gov)
	Jason Fellon	
	Dave Goerman	dgoerman@pa.gov
PA Fish and Boat Commission	Tyler Neimond	tneimond@pa.gov
Resource Environmental Solutions	Bob Siegfried	bsiegfried@res.us
Stantec	Josh Running	
	Mike Adams	Has 20+ years of experience. michael.adamsjr@stantec.com
Stroud Water Research Center	David Wise	dwise@stroudcenter.org
	Lamonte Garber	lgarber@stroudcenter.org
	John Jackson	jkjackson@stroudcenter.org
Trutta Environmental Solutions	Jim Parham Brett Connell	Dr Jim Parham and I have been developing the High Definition Stream Survey which has vastly improved data collection and modeling. https://truttasolutions.com/hdss-overview/ Jim.Parham@truttasolutions.com Brett.Connell@truttasolutions.com
University of MD College Park	Kaye Baker	
	Dr. Joseph Sullivan	
University of MD Center for Environmental Science	Robert Hilderbrand	rhilderbrand@umces.edu
USDA NRCS	Jim Gillis	
VA Natural Heritage Program	Todd Janeski	
VA Commonwealth University	Paul Bukaveckas	
	Greg Garman	
VA Department of Transportation	Randy Baker	randy.baker@vdot.virginia.gov
VA Tech	Tess Thomson	thwynn@vt.edu
Washington County, MD	Elmer Weibley	Has facilitated the construction of 6-7 agricultural stream restoration projects. elmer@conservationplace.com
Water & Land Solutions	Kayne Van Stell	

Table 3. Potential individuals to interview		
Organization	**Interviewee**	**Notes**
Wetland Research Initiative	Mike Rolband	
Wetland Studies & Solutions	Frank Graziano Nathan Staley	FGraziano@wetlands.com nstaley@wetlands.com
Wood Environment and Infrastructure	Troy Biggs	troy.biggs@woodplc.com
Woods and Waters Consulting	Katie Ombalski	(814) 574-7281, www.woodswaters.com

Potential Focal Areas for Analysis
One focal area (county or jurisdiction) will be selected in Pennsylvania, Maryland, and Virginia. These areas will be where stream restoration has been occurring and where information is available from local government staff, stream restoration firms and other sources is available (e.g., MS4 reports, CBT projects, etc.). Up to 12 projects (4 in each state) will be selected from the target geographies in consultation with the Stakeholder Team based on data availability, representativeness of different project types, level of urbanization, and/or timeframe. Table 4 provides the potential focal areas for analysis that were recommended by the Stakeholder Team and the survey results. CBT Pooled Monitoring Restoration Research projects are also noted in the table in blue.

The survey results also provided the following considerations when identifying focal areas and projects for evaluation:

- Compare coastal plain projects vs. piedmont region projects vs. mountain projects in terms of approach and efficacy.
- Evaluate the value and impact of commonly used "fish habitat enhancement structures" to prioritize restoration goals (i.e., increase long-term system resiliency, bank stabilization/sediment load reduction, improve EBT habitat)
- Evaluate projects with different design approaches that have been in the ground as long as possible (e.g., 5-10 years).
- Trout Unlimited has done a lot of work in the Potomac and Shenandoah headwaters. https://www.tu.org/project/shenandoah-valley-headwaters-conservation/
- Mitigation monitoring reports would be a good source of information.
- VDOT has conducted a number of stream restoration projects in the Potomac, Rappahannock and James River Basins of the ChesBay over the last few years. These projects range from small ephemeral/intermittent watersheds to large multi-square mile perennial streams in urban, suburban and rural settings.

Table 4. Potential focal areas for analysis

State	Focal Area (County or Jurisdiction)	Description of Focal Area (level of urbanization, types of restoration projects, monitoring data available, etc.)
MD	Montgomery County	Has extensive and learned history of stream restoration practices, as well as strong preservation /mitigation policies. More urbanized than most watersheds, so can show what happens and how strong the policies really need to be to implement protection of the resource. However, another survey respondent noted that policy has limited the effectiveness of projects. There were many stream restoration projects associated with construction of the Inter-County Connector with detailed preassessments and post-construction monitoring documents. CBT-funded project: Southerland et al. 2017.
MD	Prince George's County	Extensive and learned history of stream restoration practices. There were many stream restoration projects associated with construction of the Inter-County Connector with detailed preassessments and post-construction monitoring documents.
MD	Frederick County	CBT-funded project: Southerland et al. 2017.
MD	Howard County	Howard county has just revised its forest conservation and some of their other regulations related to land use changes and environmental impacts. CBT-funded project: Southerland et al. 2017.
MD	Baltimore County	CBT-funded project: Southerland et al. 2017.

Table 4. Potential focal areas for analysis		
Stat e	**Focal Area (County or Jurisdiction)**	**Description of Focal Area (level of urbanization, types of restoration projects, monitoring data available, etc.)**
MD	Anne Arundel County	Anne Arundel County regenerative stream conveyance systems. The County is in the process of putting together a monitoring study for tree canopy preservation/loss for projects in the County. CBT-funded project: Budelis et al. 2020 studied Church Creek and Dividing Creek in Anne Arundel County. They also studied Red Hill Branch (Howard County) and Wheel Creek (Harford County). CBT-funded project: Southerland et al. 2017.
MD	Carroll County	CBT-funded project: CWP 2021 studied streams in Carroll County.
MD	Washington County	Conducting stream restoration projects in agricultural areas.
MD	Leonardtown	McIntosh Run
PA	York County	Has done extensive valley restoration/legacy sediment removal projects, although PADEP has approved throughout the Commonwealth.
PA	Union County	Turtle Creek, Union CO PA. Ask Renee Carey or Jason Fellon about it. https://padep-1.maps.arcgis.com/apps/Cascade/index.html?appid=e99f1e95560f4ffebcb52905bc1be1e7
PA	Lancaster County	Has decades of data and experience through Conservation District, Penn State University, nonprofits, and municipalities. Legacy sediment projects include Big Spring Run, Brubaker Run, Swarr Run, Banta/Lititz Run, Lancaster County PA.
PA	Dauphin County	Black Run legacy sediment removal project.
PA	Green and Washington Counties	Robinson Fork legacy sediment removal project.
PA	Montgomery County	Bensalem Twp School District legacy sediment removal project.
PA	Spotsylvania County	Booming development area.
PA	Mifflin County	Upper Kish watershed
PA	Cumberland County	Michaux State Forest
PA	Adams County	Michaux State Forest
PA	Franklin County	Michaux State Forest
VA	Fairfax County	Has a large data set going back more than a decade. The County has been evaluating pre/post restoration forest metrics of success for 4-5 years and has several projects that have minimized tree loss while still providing useful restoration. Has strong preservation/mitigation policies. More urbanized than most watersheds, so can show what happens and how strong the policies need to be to implement protection of the resource.
VA	City of Richmond	
VA	Arlington County	
VA	Prince William County	Prince William County has several projects that have minimized tree loss.

Table 4. Potential focal areas for analysis		
State	**Focal Area (County or Jurisdiction)**	**Description of Focal Area (level of urbanization, types of restoration projects, monitoring data available, etc.)**
VA	Charlottesville, Lynchburg	Lynchburg and Charlottesville are good candidates as they have major tributaries to the Ches. Bay running through them, they have solid and rapidly growing tax base with increasingly more green minded citizens. Charlottesville is further along on implementing stream projects while Lynchburg is newer to it but the amount of water resources in a very small area with high potential for restoration and the trail systems in both cities are well established.
VA	Albemarle County	Appalachian plateau Shenandoah Valley because of the headwater streams. Albemarle County seems to have highly eroded streams that contribute tons of sediment to the downstream waters including the Bay.
VA	James City County	James City County has also been very progressive with stream restoration projects. For a smaller population County, they have completed more than 10 projects.
MD		CBT-funded project: Filoso 2020 studied streams in the Magothy, Severn, South, Rock Creek, Anacostia, and Patuxent watersheds. CBT-funded project: Beauchamp et al. 2020 studied Beetree Run, First Mine Run, Rigdon/North Stirrup Run, Edwards/Cabbage Run, Bear Cabin Branch, Plumtree Run, Pond Branch, and Baisman Run.
MD	Baltimore/ Washington DC Metropolitan Area	CBT-funded project: Kaushal et al. 2021 studied Campus Creek, Scotts Level, Paint Branch, Stony Run, and Minebank Run (in the Washington DC and Baltimore metropolitan areas). CBT-funded project: Hilderbrand et al. 2015 studied 40 urban stream restorations in the greater Baltimore/Washington DC metropolitan area.

A survey was sent to the Stakeholder Team to determine their preferred focal areas. Four responses were received and are summarized in Figure 1 below.

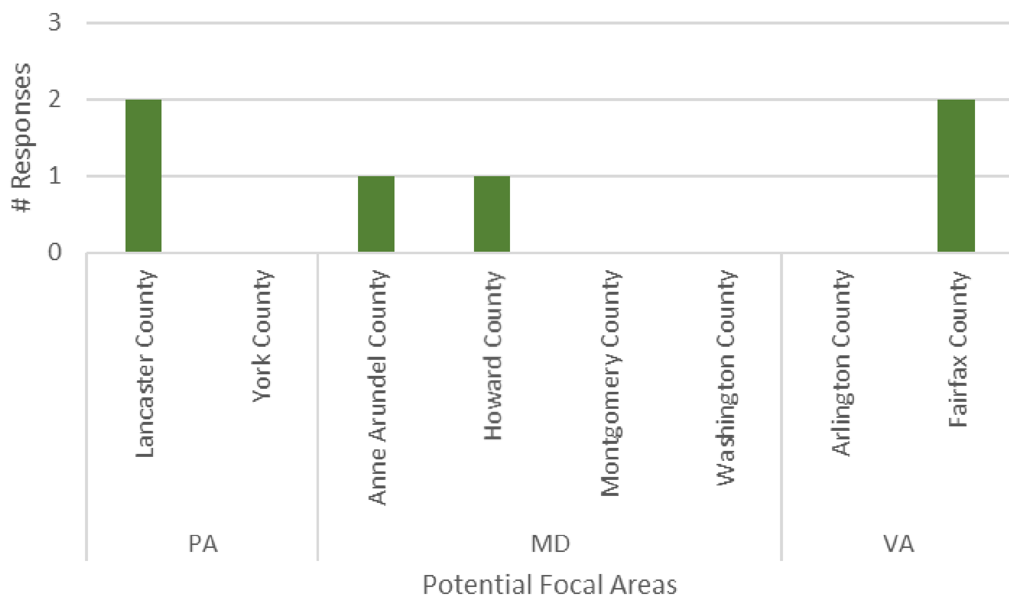

Figure 1. Stakeholder Team focal area survey responses

The following focal areas were selected based on the availability of stream restoration projects, feedback from the Stakeholder Team survey, and available monitoring data: Lancaster County, PA; Anne Arundel

County, MD; and Fairfax County, VA. The next steps will be to contact local government staff from each of the focal areas to obtain information about their stream restoration projects, including geospatial data and project details. After all potential candidate restoration projects have been identified, a meeting will be held with the Stakeholder Team to review the projects and available data and narrow down the sites for analysis. The process for the analysis will also be discussed, as there were concerns previously raised by the Stakeholder Team over the accuracy and representativeness of a geospatial land cover change analysis. Upon final selection of the projects and consensus of the evaluation methodology, additional information about the selected project sites will be obtained from local government staff or the restoration contractor, including project designs and permits, as-built plans, inspection forms, and any monitoring data from before, during and after restoration. The detailed stream restoration evaluation, including the Stakeholder Team meeting, will be conducted from 12/16/2021 – 1/14/2022.

Synthesize and Distribute Results

The findings from the interviews and focal area analysis will be synthesized into a draft project report that includes recommendations on opportunities to improve consideration of riparian forests in stream corridor restoration projects to minimize unintended adverse consequences that includes both state-specific and bay-wide recommendations. Feedback from the CBP GIT and Stakeholder Team will be used to develop a final draft.

Recommendations from the project report will be used to update and finalize the best practices guidance document that has been initially drafted as part of the project planning and preparation task of this project. The guidance document will summarize opportunities to improve consideration of forests in stream corridor restoration and will be short and written in a manner to be easily understood by local and state government managers. Stakeholder Team feedback will be used to revise and finalize the document. Both the draft and final project report and best practices guidance document will be developed 3/2/2022 – 7/8/2022.

The results will be disseminated to key stakeholders in the Chesapeake Bay through distribution of the best practices guidance document and project report, as well as through a series of webcasts. The Stakeholder Team will help to plan three half day webcasts (one each in PA, MD, and VA). The webcasts will present the findings and recommendations from this study, provide examples of projects that incorporate the recommended best practices, and begin the conversation to improve stream restoration projects to minimize the impacts to habitat and maximize water quality benefits. Webcasts will be conducted 1/15/2022 – 3/1/2022.

Appendix C
Center for Watershed Protection's Procedures for Geospatial and Secondary Data Management

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Center for Watershed Protection's Procedures for Geospatial and Secondary Data Management

Procedures for Geospatial and Data Management

Scope and Applicability: These procedure(s) are designed for Center for Watershed Protection (CWP) project managers and staff to have quality assurance/quality control (QA/QC) information readily available during the development of quality assurance project plans (QAPPs), as well as in closing out projects and in documenting QC tasks. Data handling procedures are project-specific and require the input of project managers to determine the best course of QC measures to apply. The information and procedures described in this document may not apply to each project, but rather project managers can pick and choose which procedures apply to their project. The information described in this document is designed to provide general QA/QC background material related to geospatial and secondary data management tasks.

These procedures also provide an overview of secondary data acquisition and management techniques employed by CWP. Secondary data is defined in this context as data that was collected under a separate effort for some other purpose but have some relevance to the specific project. Secondary data is typically data compiled from existing data sources. Information on evaluating secondary data sources for quality is provided in the QAPP or equivalent documentation prepared for a particular project.

Responsibility and Personnel Qualifications: The Center for Watershed Protection Project Manager, Geographic Information System (GIS) Manager and QC Officer should refer to this procedure to ensure that QA/QC requirements set by the client are met. The CWP Project Manager supervises the overall project and is responsible for coordinating project assignments; establishing priorities and schedules; ensuring completion of high-quality projects within established budgets and schedules ; providing guidance, technical advice, and evaluating the performance of those assigned to the project; implementing corrective actions; preparing or overseeing preparation and review of project deliverables; and providing support to the client ininteracting with the project team, technical reviewers, and others to ensure that technical quality requirements are met in accordance with the client's objectives. The CWP Project Managerwill have the primary day-to-day contact with the client Project Manager. This approach allows the client to work directly with the person conducting or supervising the project. The CWP GIS Manager will supervise the geospatial information operations performed for the project andthe CWP QC Officer is responsible for checking those activities. A QC Officer is a technical staff member who is familiar with the project tasks but does not participate in the taskor subtask that he or she checks.

Procedures

1. Project Setup Procedures: The Center for Watershed Protection Project Manager will circulate copies of the client statement of work to the project team, including the QC Officer and key personnel for their input on logistical issues identified in the statement of work.

2. Data Acquisition and Documentation: Data acquisition involves the process

of obtaining anddocumenting data of various types (e.g., water quality sampling data, spatial data, remote sensing imagery, survey results, 303(d) impairment or 305(b) assessment data, TMDLs, discharger data) using search criteria for the project determined in consultation with the client. Data acquisition must be a repeatable and transparent process. At the beginning of a project, the CWP Project Manager will consult with the CWP QC Officer to determine applicable documentation requirements and establish the project protocol for applicable data quality considerations.

The Project Manager will consider this series of general questions when evaluating the quality of any secondary data source and the applicability of the data to the current project (USEPA 2009):

- Were the data generated under an approved QAPP or other documented sampling procedure?
- If multiple data sets are being combined, were the data sets generated using comparable sampling and analytical methods?
- Were the analytical methods sensitive enough (detection limits) to meet project needs?
- Is the sampling method indicated (e.g., grab, composite, calculated)?
- Was the sampling effort representative of the waterbodies of interest in a random way, or could bias have been introduced by targeted sampling?
- Are the data qualified? Are sampling and laboratory qualification codes or comments included? Are the qualification codes defined?
- Is sufficient metadata available about variables like sampling station location, date, time, depth, rainfall, or other confounding variables?

The important aspects of data documentation include keeping records of the data source (e.g.,URL, agency providing the data, version), the access date, and the access procedure. At the beginning of the project, the CWP Project Manager will consult with the CWP QC Officer to determine applicable documentation requirements. Screen captures of search results can be a quick and effective way to document aspects of the download procedure or a text file or Excel spreadsheet can be saved with the original data to document this information including author name, name of publication, and URL for literature searches if electronic. If data are acquired via e-mail or file transfer protocol (FTP), save a copy of the original e-mail or FTP access instructions.

3. Data Check-In:
    a. *Input Data Integrity*: Data are spot-checked to detect potential data entry errors.In addition, Center for Watershed Protection may use a customized user input interface to manually enter data when a project involves the input of large quantities of data, thereby reducing the potential for incorrect data entry. It is also important to visually inspect the GIS data to check for adherence to database design, attribute accuracy, logical consistency and referential integrity.

b. *Assessments of Processed Data*: The ability of a desktop geospatial product to accurately characterize the conditions in the project area are dependent on the quality of data entering the process and imported into a GIS. QC procedures are implemented during data processing activities, and technical reviews of processeddata are conducted by qualified personnel. The Center for Watershed Protection follows guidance on data management, information security, record management, and data processing provided or referenced by the client, including the guidance provided by the documents in the reference section.

4. Data Organization: All project information will be tracked and maintained from the moment of receipt, even if it is not used in the final products for various reasons. Submitted and retrieved information, including suggested data sources and citations, will be immediately recorded organized and stored after acquisition to allow traceability. The original unaltered data and "as analyzed" data files will be archived to ensure replicability of any analysis that is conducted. If data is combined from multiple sources information documenting the source of the data will be included in spreadsheets or databases. Collected data will be stored via a directory structure that will allow the Center for Watershed Protection to work on and analyze copies of the data, while preserving the original versions. This will be accomplished by creating a 'RAW' and 'WORKING' file designation that Center for Watershed Protection has successfully used in the past.

5. Product Review: Center for Watershed Protection will document the data collected in the final report of each project along with a description of QC activities and data analyses with assumptions about the data. Summary statistics and discussion will include the following:
   - Quality of secondary data (requirements will be determined in consultation withthe client).
   - Accuracy of data transfers. The Center for Watershed Protection QC Officer his or her designee will independently check transferred data using a standard-level review, consisting of independently checking the different file types (i.e., a file with different structureor legacy), and confirming that the first, last, and a selected middle portion of thedata were transferred correctly. All identified data processing errors will be corrected, and the Center for Watershed Protection QC Officer will perform a follow-up review of the correct components to ensure that the errors have been corrected. All hand-entered data will be checked (100 percent of discrepancies will beresolved).
   - Accuracy of data conversions, including reformatting, will be checked. The Center for Watershed Protection QC Officer or his or her designee will perform independent recalculations of up to 10 percent of computations (including conversions) and graphs, but no less than

two examples of each type of computation and two examples of each graphictype. All identified data calculation errors will be corrected and the CWP QC Officer or his designee will perform a follow-up review of the corrected components to ensure that the errors have been corrected.

6. Data Management: Most work that Center for Watershed Protection conducts involves acquiring and processing data, and generating reports and documents, all of which require the maintenance of computer resources. CWP's computers are covered by on-site service agreements and managed by a Managed IT specialist organization. When a problem with a computer occurs, a ticket is opened so a computer specialist can diagnose the trouble and correct it if possible.

   When outside assistance is necessary, the computer specialists will call the appropriate vendor. For other computer equipment requiring outside repair and not covered by a service contract, local computer service companies will be used on a time-and-materials basis. Routine maintenance of computers is performed by the Managed IT computer specialist. All staff are provided with surge suppressors to protect electronic components from potentially damaging voltage spikes. The Center for Watershed Protection uses cloud-based servers that are backed up daily. Copies of the backed-up data are kept off-site. Automated screening systems (malware and anti-virus) have been placed on all CWP systems and are updated regularly to ensure that viruses are identified and destroyed. Annual maintenance of software is performed to keep up with changes in computer storage, media, and programs.

7. Data Transfer/Transmittal: Data transferred among databases will be checked for accuracy at the time of transfer by confirming the numbers of records in the original and final data sets. Data transfers will be tagged with upload dates and times to accommodate reviews and if data transfer is incomplete, the missing records will be sought and transferred individually. A final round of completeness checks will ensue after all data transfers are confirmed. Once data sets are compiled, the data value distributions will be analyzed to identify outliers that may result from data entry errors or erroneous unit conversions. All outliers will be identified and resolved, but valid outliers will not be eliminated if the analyst thinks they are plausible. Outliers that are not plausible or show a pattern of potential error will be brought to the attention of the data supplier and excluded from analysis until the original data supplier can confirm their validity.

   The accuracy of the transfer of data from electronic databases to the project database(s) will be determined by checking whether data from the original database have been transferred to appropriate rows and columns, whether the same number of records are present, if the number of decimal places match the original database, and whether the same units fromthe original database have been used. The Center for Watershed Protection QC Officer or their designee will independently check transferred data using a standard-level review, consisting of independently checking each different file type (i.e., a file with different structure or legacy), confirmingthe first, last, and a selected middle portion of the data were transferred correctly.

Spatial data such as shapefiles may be composed of a family of files that need to be stored together to function. When transferring spatial data, the use of geodatabases is preferred for storing multiple spatial data sets for a project while maintaining data set relationships, behaviors, annotations, and metadata.

Data generated within a GIS platform will likely be too large to deliver over email. In these cases, transfer is done via an online service such as Dropbox or One Drive depending on file size.

8. <u>Data Projections</u>: All spatial data should have the same coordinate system for comparison, so transformations are often necessary so that both the geodetic datum and a projection type match to ensure accurate projection. Geodetic datum refers to the model used to match the location of features on the earth's surface to coordinates on the map. There are many common datum models. A state plane system or other state system is typically the most accurate system for a particular project area. Spatial data sets can be in the same projection but be referenced to different datums and therefore have different coordinate values (e.g., latitude and longitude or UTM). To fully represent a location spatially and avoid errors or confusion, coordinates are needed along with the datum. Significant error can be introduced when data with different or unknown datums are introduced, including errors in distance or area measurement and errors in relating the spatial location of features between data sets. GIS software allows for the conversion of spatial data from one coordinate system to another.

9. <u>Storage and Archives</u>: Data storage involves keeping the data in such a way that they are not degraded or compromised and that any datum desired can be retrieved. A permanent collection of data is stored online in our secure server, and a separate copy is maintained for purposes of integrity and security and securely archived. Aspects such as storage media, conditions, location, access by authorized personnel, and retention time are addressed in consultation with the client. Before archiving, the Center for Watershed Protection Project Manager ensures that all data sets are complete, with all the client-required data standards honored.

   CWP will store all computer files associated with the project in a project subdirectory (subject to regular system backups) on our cloud based Sharepoint site. CWP will also maintain version control of draft and final deliverables by indicating the preparation date or revision number in the file name. The length of archival will be decided upon consultation with the client specifications.

10. Training Requirements: Project statements of work, work plans, and quality assurance documents will be distributed to all project participants for review and reference. All relevant project personnel will have expertise in collecting and evaluating and analyzing data and will have working knowledge of additional software necessary to complete the project requirements.

    CWP GIS Analysts will have access to ArcGIS software no earlier than version 10.7 for filecompatibility purposes. All project personnel will have expertise in environmental sciences, as well as knowledge of the quality system for the project and this knowledge and expertise will be detailed in project documentation.

Pertinent QA and QC Procedures

1. Spatial Data QA/QC: There are many considerations for spatial data QA/QC that must be considered for each geospatial project. These considerations include the following, which are adapted from ESRI GIS guidance *QA/QC for Your GIS Data* (ESRI. No date):
    a. GIS data completeness, consistency, accuracy, and precision (includingprojection).
    b. Visual identification of errors.
    c. Data workflow for project processes, including QC workflow for associated processes.
    d. Tracking data errors using Data Reviewer or a similar extension
    e. Checking schema in attribute tables (names, fields, and coordinate systems); checking attribute accuracy(missing or bad values).
    f. Visual QC of products such as maps; setting symbols and labels; labeling techniques for points, lines, and polygons.
    g. The Center for Watershed Protection Project Manager will determine in consultation with the client ProjectManager how spatial data QA/QC will be implemented for a particular project.

2. Attribute Data QA/QC: All geospatial data downloaded from publicly available online data sources will have associated attribute data contained within their respective database files that quantify and occasionally narratively describe the spatial data within tabular fields. These data should be evaluated using the same measurement performance criteria as traditional data sources (spreadsheets and databases) are evaluated.

    Measurement performance criteria that will be used for data handling for any given project will include accuracy and completeness and the Center for Watershed Protection will evaluate GIS metadata against USEPA *Guidance for Geospatial Data Quality Assurance Project Plans* (USEPA, 2003) as to whether the GIS data are suitable for use for a given project. CWP will provide a description of the data evaluation factors and limits (as determined in consultation with the client) in the report of data collected and preferentially download data electronically to reduce scanning of hardcopy data.

3. Metadata QA/QC: Many projects will rely on secondary data and geospatial metadata will be used throughout the project lifecycle. All Center for Watershed Protection GIS analysts that download geospatial secondarydata will evaluate the GIS metadata against the USEPA guidance for metadata standards to determine whether the GIS data are suitable for usefor any given project.

4. Version Control: Data can be managed in a number of different platforms. GIS versioning can be managed via folder and file naming conventions. Date of creation, ArcGIS processing tool, and project name are file naming methods used to reflect the version and including spaces and non-traditional characters in file names is often necessary for GIS processing and management.

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Appendix C. Policy/Document Review and Interview Results Technical Memorandum

MEMORANDUM

To: Chesapeake Bay Trust

From: Center for Watershed Protection, Inc.

Date: February 28, 2022 (submitted to CBT); September 12, 2022 (revised)

Re: Summary of Task 3 Policy/Document Review and Interview Results

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This technical memorandum was developed to support the "Scope of Work 3: Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned" project identified in the 2020 Chesapeake Bay Trust-Technical Assistance - Chesapeake Bay Program Goals and Outcomes request for proposals. It summarizes key insights from the Task 3 policy/document review and interviews from project planning through permitting, implementation and post restoration.

This memorandum is organized into the following sections:

- Introduction
- Methodology
- Policy and Document Review
- Interviews
- Discussion and Conclusion

To assist with navigation of this document, below is a table of contents.

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Definitions of Acronyms/Abbreviations

Acronym/Abbreviation	Definition
BANCS	Bank Assessment for Non-Point Source Consequences of Sediment
BEHI	Bank Erosion Hazard Index
BIBI	Biotic Integrity Score
BMP(s)	Best Management Practice(s)
CBP	Chesapeake Bay Program
DBH	Diameter at Breast Height
DPWES, SWPD	Fairfax County, Virginia, Department of Public Works and Environmental Services, Stormwater Planning Division
EPR	Ecosystem Planning & Restoration
ESC	Erosion & Sediment Control
FCAM	Functional or Conditional Assessment Methodology
FCP	Forest Conservation Plan
FSD	Forest Stand Delineation
GIS	Geographic Information System
JPA(s)	Joint Permit Application(s)
KWH	Key Wildlife Habitat
LCCD	Lancaster County Conservation District
LiDAR	Light Detection and Ranging
LOD(s)	Limit(s) of Disturbance
(MD) DNR	(Maryland) Department of Natural Resources
(MD) FCA	(Maryland) Forest Conservation Act
MDE	Maryland Department of the Environment
MS4	Municipal Separate Storm Sewer System
MWCOG	Metropolitan Washington Council of Governments
NCD	Natural Channel Design
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRI	Natural Resource Inventory
NWP	Nationwide Permit
(PA) DCNR	(Pennsylvania) Department of Conservation and Natural Resources
(PA) DEP	(Pennsylvania) Department of Environmental Protection
PFM	Fairfax County's Public Facilities Manual
PNDI	Pennsylvania Natural Diversity Inventory
RFP(s)	Request(s) for Proposals
RPA(s)	Resource Protection Area(s)
SAV	Submerged Aquatic Vegetation
SHA(s)	State Highway Administration(s)
TMDL	Total Maximum Daily Load
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
US EPA	United States Environmental Protection Agency

Acronym/Abbreviation	Definition
UFMD	(Fairfax, Virginia) Urban Forest Management Division
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VA DCR	Virginia Department of Conservation and Recreation
VA DEQ	Virginia Department of Environmental Quality
VWP	Virginia Water Protection
WIP(s)	Watershed Implementation Plan(s)
WOTUS	Waters of the United States
WPIB	Watershed Project Implementation Branch (of Fairfax County's Stormwater Planning Division)
WQGIT	Water Quality Goal Implementation Team
WWP	Wetlands & Waterways Program (of Maryland Department of the Environment)
ZOI	Zone of Influence

Introduction

With growing interest and implementation of stream restoration practices in the Chesapeake Bay Watershed, there is an increasing need for research about the "trade-off" value for these practices and adjacent forest buffers. Forest buffers are critical for stream health. They improve the stability of stream banks, provide shade, filter nutrients and sediments, and contribute organic material for aquatic food webs. Qualifying conditions for stream restoration Best Management Practices (BMPs) offer some protection for riparian vegetation but these conditions have not been consistently met. Because stream restoration and expanding forest buffers are a large component of state Watershed Implementation Plans (WIPs) and the 2014 Chesapeake Bay Agreement, it is imperative to better synergize efforts and investments to minimize negative trade-offs impacts/outcomes.

The Center for Watershed Protection, Inc. (CWP) is working collaboratively with the Chesapeake Bay Program (CBP) and stakeholders to evaluate impacts of stream restoration projects on existing riparian ecology and forest buffers in Maryland, Pennsylvania, and Virginia. Although "restoration" has many different meanings, stream restoration in the context of this project is defined according to the Chesapeake Bay Program (CBP) stream restoration expert panel recommendations (Schueler and Stack, 2014) as "any natural channel design, regenerative stormwater conveyance, legacy sediment removal or other restoration project that meets the qualifying conditions for credits, including environmental limitations and stream functional improvements." This technical memorandum was developed to support the "Scope of Work 3: Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned" project identified in the 2020 Chesapeake Bay Trust-Technical Assistance - Chesapeake Bay Program Goals and Outcomes request for proposals. It summarizes key insights from the Task 3 policy/document review and interviews from project planning through permitting, implementation and post restoration.

The goal of the policy and document review is to better understand the requirements of each state for protecting and mitigating damage to stream buffers associated with stream restoration projects. In addition, the requirements of three selected counties that will be included as part of a case study analysis during a future project task were evaluated. The following counties were identified in the Project Plan developed under Task 1 based on the availability of stream restoration projects, feedback from a Stakeholder Team survey, and available monitoring data: Lancaster County, PA; Anne Arundel County, MD; and Fairfax County, VA. Interviews were conducted of various stakeholders involved in stream restoration to better understand how the requirements identified from the review of regulatory and policy documents are (or are not) implemented in each jurisdiction and help to identify and refine best practices to minimize adverse impacts to riparian forests.

Results from the policy/document review and interviews will be used in development of a final project report, as well as a guidance document for local governments on the best practices to minimize unintended adverse outcomes to riparian forests and identify opportunities for coupling these practices to improve water quality and habitat improvements. This will help improve selection, permitting, and funding processes for stream restoration projects in the Chesapeake Bay watershed.

Methodology

Policy and Document Review

The Center reviewed policy documents recommended from the Stakeholder Team and an online survey as outlined in the Project Plan developed under Task 1 of the project. This included local forest conservation ordinances (in MD), Joint Wetlands and Waterways permits in PA, MD, and VA, codes and regulations for all three states as well as the local jurisdictions that were selected for further analysis, and technical guidance documents that accompany the relevant regulations. Additional sources of information were identified and reviewed as needed to support project objectives, including publications from USDA, USFWS, US EPA, USACE, and state program partners, and peer-reviewed journals. A total of 40 regulatory and 78 technical/guidance documents were reviewed to attempt to answer the questions defined in the scope of this project. The questions include:

- How are riparian areas and forests defined by various agencies and organizations and what definition should be applied to this study?
- What inventory requirements are in place and how are these inventories used in project planning?
- Are forest agencies engaged and how?
- How are existing forests addressed in project permits?
- What re-vegetation or other mitigation requirements are in place for impacts to streamside forests?
- What are the monitoring requirements and who is responsible for monitoring?
- Are best practices recommended to minimize impacts to riparian forests?

Documents and policies reviewed include the data source characterization required in the WQGIT-approved document, *Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model* to help determine if a document was appropriate and how much influence each document should have on the final recommendations (Table 1).

The documents gathered for review were preferentially from peer-reviewed reports, and federal, state, and local agency sources. Therefore, it is assumed that the documents have already been screened for appropriateness and rigor of study design and methods. Acceptance criteria for the documents reviewed are as follows:

- Relevance to the study. Relevant data will support the project goal of evaluating impacts of stream restoration projects on existing riparian ecology and forest buffers in both urban and rural areas of Maryland, Pennsylvania, and Virginia.
- Representative of the areas and times of study. The focus will be on documents relevant to the Chesapeake Bay watershed and specifically Maryland, Pennsylvania, and Virginia. Other salient work relevant to general, or "theoretical," overarching principles will be considered and evaluated for their applicability to the Chesapeake

Bay. Both recent and long-term data will be considered in consultation with the Stakeholder Team.

- Individual observations: anomalous or extreme outliers. Individual data values might be in error due to variables such as transcription errors or equipment malfunctions. Data will be examined for anomalous values and reject values reported well beyond the range of observed variability. The number of exclusions, the source of the data excluded, and the suspected cause of error or rationale for exclusion will be documented in the final report.

Table 1. Data source characterization (CBP, 2015)

Data Attribute	High Quality	Medium Quality	Low Quality
Extent of Replication	Clearly documented and well-controlled past work that has since been replicated or strongly supported by the preponderance of other work; recent (< 5-year-old) work that was clearly documented and conducted under well-controlled conditions and thus conducive to possible future replication	Clearly documented older (>5-yr old) work that has not yet been replicated or strongly supported by other studies, but which has also not been contraindicated or disputed	Work that was not clearly documented and cannot be reproduced, or older (>5-yr old) work for which results have been contraindicated or disputed by more recent results in peer- reviewed publication or by other studies that are at least equally well documented and reproducible
Applicability	Purpose/scope of research/publication matches information/data need	Limited application	Does not apply
Study location	Within Chesapeake Bay	Characteristic of CB, but outside of watershed	Outside of CB watershed and characteristics of study location not representative
Data collection & analysis methods	Approved state or federal methods used; statistically relevant	Other approved protocol and methods; analysis done but lacks significance testing	Methods not documented; insufficient data collected
Conclusions	Scientific method evident; conclusions supported by statistical analysis	Conclusions reasonable but not supported by data; inferences based on data	Inconclusive; insufficient evidence
References	Majority peer-review	Some peer-review	Minimal to no peer-review

Interviews

A list of recommended individuals to interview was compiled in the Project Plan based on Stakeholder Team input and an online survey. Additional interviewees were identified from discussions with the three selected counties for stream restoration evaluation (Lancaster County, PA; Anne Arundel County, MD; and Fairfax County, VA). Interviewees were selected to provide a representative sample of state agency, practitioner and MS4 perspectives.

Interviews were conducted from December 21st, 2021, to January 13th, 2022, and were done via Zoom or Microsoft Teams to enable the project team to record the interviews for accuracy. Each interviewer was provided a list of standard questions that were developed to allow comparison across the different jurisdictions. The interviews also included the opportunity for relevant follow-up questions to be asked of the interviewees as needed. The list of interview questions developed cooperatively with the Stakeholder Team to address the project objectives are provided below. The questions are mostly open-ended since the goal of the interview was for the respondent to provide their experiences and expertise for their local jurisdiction regarding stream restoration implementation and impacts on forest resources. Key findings from the interviews are summarized in this technical memorandum and the complete interview transcripts are included in Attachment B.

Interview questions for all individuals include:

- What is your experience or involvement with stream restoration projects?
- In your experience, how are sites selected for stream restoration projects? Who identifies the sites?
- Is a riparian forest assessment done prior to restoration to determine forest health, and, if so, what indicators are used?
- How is tree and tree canopy protection deliberated during site selection, design, and installation? Are there scenarios when protecting trees, forest stability, and forest longevity are given priority over streambank reconstruction?
- Are there typical scenarios where entire buffers or mature trees are removed and why?
- When trees are removed during restoration, to what extent are riparian tree cover and structure restored after restoration? How quickly does this occur?
- What best practices are used to minimize impacts to riparian forests (this would include post-restoration maintenance)? To what extent are they implemented?

Interview questions specific to stream restoration practitioners:

- What are the decision processes for selecting the type of restoration?
- How are discrepancies between project design and implementation (such as expected vs. actual forest change) handled?
- What are the parameters for plants/rocks/woody debris used for restoration and where it is sourced? What are the bounds on making materials "natural" or as high quality as possible?
- What is done with the trees that are removed (e.g., are they sold? Are any used for restoration off-site or on-site?)?
- What post-construction monitoring is conducted and what is the purpose of the monitoring? Do monitoring requirements vary?
- Have you designed or managed projects that you deem successful? If so, what made them successful?

- Have you designed or managed projects that were less successful or unsuccessful? If so, what were some challenges or issues?

Interview questions for non-stream restoration practitioners:

- Are you aware of cases where there have been discrepancies between project design and implementation? If so, how were these discrepancies handled?
- In your experience, what sort of post-construction monitoring is conducted for stream restoration projects in your area?
- Are you aware or have you been involved with stream restoration projects that were successful? If so, what made them successful?
- Are you aware or have you been involved with stream restoration projects that were less successful or unsuccessful? If so, what were some challenges or issues?

Policy and Document Review

This section summarizes the key findings from the policy and document review. The complete list of policies and documents reviewed is included in Attachment A.

How are riparian areas and forests defined by various agencies and organizations and what definition should be applied to this study?

The definitions of riparian areas and forests were examined as part of this review to help establish criteria that will be used for the stream restoration case study analysis in Task 4, as well as to provide context for the best practices guide to be developed as part of this study. Definitions were reviewed for Maryland, Virginia, and Pennsylvania. In addition, documents recommended by the stakeholder group for West Virginia, North Carolina, and at the federal level were also examined. The definitions reviewed are compiled in Table 2.

State agencies typically define riparian areas to regulate land disturbance activities, to protect water quality and comply with regulatory requirements. From a policy perspective, riparian forest buffers are a type of forest that is adjacent to a stream corridor. While the definition of a forest (sometimes called forest trees) could include mention of commercial activities or silviculture, riparian buffers was defined by varying factors including their geographic location (border of a stream), their width, and their composition.

The definition of riparian areas and forests to be used for this project was discussed during a Stakeholder Team meeting held on February 9th, 2022. The Team agreed that the definition of riparian areas should extend beyond regulatory-based definitions to also include the environmental and societal values that the buffers provide, such as water quality benefits, flood protection, living resource function, habitat, open space access, etc. The Team also discussed the importance of acknowledging the value of both forested and non-forested riparian areas (e.g., herbaceous vegetation) and the need to determine when tree trade-offs from stream restoration projects are considered negative. It was noted that additional considerations to examine as part of this project include the distinction between native and non-native vegetation, as well as the public's perception of riparian area value.

Ilhardt et al. (2000) examined the definitions of riparian area used by state agencies and other entities and concluded—as did the Stakeholder Team—that riparian areas are often defined for regulatory purposes. They proposed the following definition to recognize riparian areas by the ecological functions that occur at various scales, "Riparian areas are three-dimensional ecotones of interaction that include terrestrial and aquatic ecosystems, that extend down into the groundwater, up above the canopy, outward across the floodplain, up the near-slopes that drain to the water, laterally into the terrestrial ecosystem, and along the water course at a variable width." Ilhardt et al. (2000) noted that adopting a functional definition means recognizing that the riparian boundary does not stop at an arbitrary, uniform distance away from the channel or bank, but varies in width and shape.

Similarly, the Natural Resources Conservation Service (NRCS) defines riparian areas in its General Manual as "ecosystems that occur along watercourses and water bodies. They are distinctly different from the surrounding lands because of unique soil and vegetation characteristics that are strongly influenced by free or unbound water in the soil. Riparian ecosystems occupy the transitional area between the terrestrial and aquatic ecosystems. Typical examples would include floodplains, streambanks, and lakeshores" (190-GM, Part 411). Riparian areas typically are vegetated with grasses, forbs, shrubs, and trees that are tolerant of periodic flooding. However, in some locations, trees may not be part of the historic riparian community, such as areas with saline soils or heavy, nearly-anaerobic soils (wet meadow environments and high elevations) that are dominated by herbaceous vegetation (NRCS and WHC, 2007).

For the purposes of this project the riparian area is the forested or herbaceous vegetative area that is impacted by stream restoration projects. The case study analysis to be conducted in Task 4 will rely on high resolution CBP land use/land cover data. Therefore, the definitions of forest and herbaceous (shrubland) within the riparian area will follow those of the CBP data:

- Forest: All standing trees and areas of tree harvest farther than 30' to 80' from non-road impervious surfaces and forming contiguous patches >=1-acre in extent.
- Shrubland: Heterogeneous area of both/either deciduous and/or evergreen woody vegetation. Characterized by variation in height of vegetation through patchy coverage of shrubs and young trees interspersed with grasses and other lower vegetation. Discrete clumps and small patches of interlocking individuals are included, as are true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions, when intermingled in a heterogeneous landscape with low vegetation.

Table 2. Riparian area and associated definitions from federal, state, and local sources.

Entity	Definition
USACE	Nationwide Permit 27 Riparian Areas: Riparian areas are lands next to streams, lakes, and estuarine-marine shorelines. Riparian areas are transitional between terrestrial and aquatic ecosystems, through which surface and subsurface hydrology connects riverine, lacustrine, estuarine, and marine waters with their adjacent wetlands, non-wetland waters, or uplands. Riparian areas provide a variety of ecological functions and services and help improve or maintain local water quality. National Large Wood Manual Riparian Forest: Forested or wooded area of land adjacent to a body of water such as a river, stream, pond, lake, marshland, estuary, canal, sink, or reservoir.
Chesapeake Bay Program	Recommendations of the Expert Panel to Reassess Removal Rates for Riparian Forest and Grass Buffers Best Management Practices (Claggett and Tetra Tech, 2014) Agricultural Riparian Forest Buffers: Linear wooded areas adjacent to a body of water and managed to reduce the impacts of upland sources of pollution by trapping, filtering, and converting sediments, nutrients, and other chemicals, to supply food, cover, and thermal protection to fish and other wildlife. The recommended buffer width for riparian forest buffers (agriculture) is 100 feet, with 35 feet minimum width required. A separate practice defined as a Narrow Forest Buffer Strip includes linear strips of wooded areas maintained on agricultural land between the edge of fields and streams, rivers or tidal waters that help filter nutrients, sediment, and other pollutants from runoff. Narrow forest buffer strips are between 10 and 35 feet in width. A Guide for Forestry Practices in the Chesapeake TMDL Phase III WIPs (CBP Forestry Workgroup, 2018) Urban Forest Buffers: Linear wooded areas that help filter nutrients, sediments and other pollutants from runoff as well as remove nutrients from groundwater. The recommended buffer width is 100 feet, with a 35 feet minimum width. 2013/2014 Phase 6 Mapped 1-m Resolution Land Cover Definitions Tree Canopy: Deciduous and evergreen woody vegetation of either natural succession or human planting that is over approximately 3-5 meters in height. Stand-alone individuals, discrete clumps, and interlocking individuals are included. Shrubland: Heterogeneous area of both/either deciduous and/or evergreen woody vegetation. Characterized by variation in height of vegetation through patchy coverage of shrubs and young trees interspersed with grasses and other lower vegetation. Discrete clumps and small patches of interlocking individuals are included, as are true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions, when intermingled in a heterogeneous landscape with low vegetation. Minimum Mapping Unit = 225 square meters. 2013/2014 Phase 6 Mapped 1-m Resolution Land Use Definitions Forest: All standing trees and areas of tree harvest farther than 30' to 80' from non-road impervious surfaces and forming contiguous patches >= 1 acre in extent. The variable range of distances result from the application of multiple filtering algorithms (e.g., focal moving windows) to identify areas covered by tree canopy with an undisturbed/unmanaged understory.

Table 2. Riparian area and associated definitions from federal, state, and local sources.	
Entity	**Definition**
USDA Forest Service	Guidance for Stream Restoration Riparian: Relating to or living on or near the bank of a watercourse. These zones range in width from narrow bands in arid or mountainous areas to wide bands which occur in low-gradient valleys and more humid regions. Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers Forest: A descriptive classification of land type predominated by trees and woody vegetation and characterized by high structural diversity, greater than 25 percent canopy shading, and by the significant accumulation of organic duff on the soil surface. Forest Buffer Conservation: Retaining and managing existing riparian forests so that they continue to provide the benefits of a forest buffer. Forest Buffer Restoration: The re-establishment of a sustainable community of native trees, shrubs, and other vegetation capable of providing multiple buffer functions adjacent to a body of water where forest cover was converted to other uses. Forest Buffer Width: A fixed or variable distance measured from the edge of the streambank or shoreline within which the vegetation and land is retained and managed for the purpose of sustaining specific or multiple buffer functions. Riparian: Pertaining to anything connected with or immediately adjacent to the banks of a stream or other body of water. Riparian Area: The area of land adjacent to streams, rivers, and other bodies of water that serves as a transition between aquatic and terrestrial environments and directly affects or is affected by that body of water. Riparian Forest Buffer: An area of trees, usually accompanied by shrubs and other vegetation, adjacent to a body of water and managed to maintain the integrity of stream channels and shorelines to 1) reduce the impact of upland sources of pollution by trapping, filtering, and converting sediments, nutrients, and other chemicals, and 2) supply food, cover, and thermal protection to fish and other wildlife.
USDA NRCS	Stream Restoration Design (National Engineering Handbook 654) Riparian Zones: The areas between aquatic and upland habitats. NRCS policy (190-GM, Part 411) – Policy for Riparian Area Recognition and Management Riparian Area: Ecosystems that occur along watercourses and water bodies. They are distinctly different from the surrounding lands because of unique soil and vegetation characteristics that are strongly influenced by free or unbound water in the soil. Riparian ecosystems occupy the transitional area between the terrestrial and aquatic ecosystems. Typical examples would include floodplains, streambanks, and lakeshores. Riparian areas may exist within all land uses, such as cropland, hay land, pastureland, rangeland, and forestland.

Table 2. Riparian area and associated definitions from federal, state, and local sources.	
Entity	**Definition**
USEPA	A Function-Based Framework for Stream Assessment & Restoration Projects Riparian Areas: Lands adjacent to streams, rivers, lakes, and estuarine shorelines that provide a variety of ecological functions and services and help improve or maintain water quality.
Virginia	Code of Virginia § 58.1-3666 Riparian buffer means an area of trees, shrubs, or other vegetation, subject to a perpetual easement permitting inundation by water, that is (i) at least thirty-five feet in width, (ii) adjacent to a body of water, and (iii) managed to maintain the integrity of stream channels and shorelines and reduce the effects of upland sources of pollution by trapping, filtering, and converting sediments, nutrients, and other chemicals. Chesapeake Bay Preservation Act Buffer area means an area of natural or established vegetation managed to protect other components of a Resource Protection Area and state waters from significant degradation due to land disturbances. Resource Protection Area or RPA means that component of the Chesapeake Bay Preservation Area comprised of lands adjacent to water bodies with perennial flow that have an intrinsic water quality value due to the ecological and biological processes they perform or are sensitive to impacts which may result in significant degradation of the quality of state waters. In their natural condition, these lands provide for the removal, reduction, or assimilation of sediments, nutrients, and potentially harmful or toxic substances from runoff entering the Bay and its tributaries and minimize the adverse effects of human activities on state waters and aquatic resources. Virginia Water Permit Program "Forested wetland" means a class of wetlands dominated by woody vegetation that is approximately 20 feet (six meters) tall or taller and three inches (7.6 centimeters) or larger in diameter at breast height (DBH). These areas typically possess an overstory of trees, an understory of trees or shrubs, and an herbaceous layer. Fairfax County Code Forested Area: Areas comprised of self-supporting tree and woody plants that exceed five feet in height at time of plan submission and meet criteria for health, condition and suitability as further defined in this section. Areas that meet the administrative definition provided above usually represent native forest or woodland plant communities that occur in a range of successional stages from rapidly changing early successional pioneer woodlands (often described as "scrub") to stable long-term sub-climax and climax forests. During mid to late successional stages, these plant communities typically consist of multiple layers of vegetation and other natural features including: super- and sub-canopy tree species; woody shrubs, herbaceous plants, vines, non-vascular plants and epiphytes; decaying leaf litter, root mass, fungi, soil biota; and abiotic components which the vegetation is dependent upon such as: soils, hydrologic conditions, and underlying geomorphic features. VA DCR Virginia Stream Restoration & Stabilization Best Management Practices Guide Riparian: The area adjacent to flowing water (e.g., rivers, perennial or intermittent streams, seeps or springs) that contains elements of both aquatic and terrestrial ecosystems

Entity	Definition
	Riparian Buffer: A swath of riparian vegetation along a channel bank that provides some measure of protection from the erosive forces of water along the channel margins.
Maryland	Forest Conservation Act (1) "Forest" means a biological community dominated by trees and other woody plants covering a land area of 10,000 square feet or greater. (2) "Forest" includes: (i) Areas that have at least 100 trees per acre with at least 50% of those trees having a 2 inch or greater diameter at 4.5 feet above the ground; and (ii) Forest areas that have been cut but not cleared. (3) "Forest" does not include orchards. Critical Areas Law Buffer" means an existing, naturally vegetated area, or an area established in vegetation and managed to protect aquatic, wetlands, shoreline, and terrestrial environments from man-made disturbances. Anne Arundel County Code "Forest" has the meaning stated in Natural Resources Article, § 5-1601 (Forest Conservation Act), of the State Code. "Stream buffer" means all lands lying within 50 feet, measured from the top of each normal bank of a perennial or intermittent stream. MDDNR Principles and Protocols to Guide the Department of Natural Resources' Actions Regarding Stream Restoration Projects in Maryland Riparian Area: Lands adjacent to streams, rivers, lakes and estuarine shorelines that provide a variety of ecological functions and services and help improve or maintain water quality (Harman et al. 2012). Nontidal Wetlands Act Forested Nontidal Wetland: Portion of a nontidal wetland dominated by woody vegetation greater than 20 feet in height. Scrub-Shrub Wetland: Portion of a nontidal wetland dominated by woody vegetation less than 20 feet in height as the uppermost strata.
Pennsylvania	Chapter 102 Erosion and Sediment Control *Note: This regulation and definition is for riparian areas that function as a BMP for the purposes of post construction stormwater management and not restoration of natural resources (PA DEP, 2022).* Riparian Buffer: A BMP that is an area of permanent vegetation along surface waters.

Table 2. Riparian area and associated definitions from federal, state, and local sources.

Table 2. Riparian area and associated definitions from federal, state, and local sources.

Entity	Definition
	Riparian Forest Buffer: A type of riparian buffer that consists of permanent vegetation that is predominantly native trees, shrubs and forbs along surface waters that is maintained in a natural state or sustainably managed to protect and enhance water quality, stabilize stream channels and banks, and separate land use activities from surface waters. <u>Lancaster County Model Ordinance</u> Riparian Buffer: A BMP that is an area of permanent vegetation along a watercourse. Riparian Forest Buffer: A type of riparian buffer that consists of permanent vegetation that is predominantly native trees, shrubs and forbs along a watercourse that is maintained in a natural state or sustainably managed to protect and enhance water quality, stabilize stream channels and banks, and separate land use activities from surface waters. <u>PA DEP Riparian Forest Buffer Guidance</u> Riparian Buffer: A BMP that is an area of permanent vegetation along surface waters. A riparian buffer may consist of grasses and forbs only, or a combination of vegetation types to include grasses, forbs, shrubs, and trees. Riparian Forest Buffer: A type of riparian buffer that consists of permanent vegetation that is predominantly native trees and shrubs along surface waters that is maintained in a natural state or sustainably managed to protect and enhance water quality, stabilize stream channels and banks, and separate land use activities from surface waters. <u>PA DEP Chapter 105 Level 2 Riverine Assessment Protocol (310-2137-003)</u> Riparian Ecotones: Three-dimensional space of interaction that include terrestrial and aquatic ecosystems that extend down into the groundwater, up above the vegetative canopy, outward across the floodplain, up the near-slopes that drain water, laterally into the terrestrial ecosystem, and along the water course at a variable width. The riparian ecotone includes the 100-year floodplain and 100 feet landward along the valley, whereas obvious slumps or landslides are added with a 45-foot band around their edge adapted from Verry et al. (2004). Riparian Vegetation Condition Index: The optimal riparian vegetation (Scoring: Optimal 20 – 16) would include land cover areas comprised of hardwood/conifer trees, wetlands, waterways and/or lacustrine resources (≥ 10 acres). All areas comprised of stream channels, wetlands (regardless of classification or condition) and lacustrine resources ≥ 10 acres are categorized as optimal. Riparian Zone of Influence (ZOI): The optimal riparian ZOI vegetation would include land cover areas comprised of hardwood/conifer trees, wetlands, waterways and/or lacustrine resources (≥ 10 acres). All areas comprised of stream channels, wetlands (regardless of classification or condition) and lacustrine resources ≥ 10 acres are categorized as optimal. <u>PA DEP Chapter 105 Level 2 Wetland Assessment Protocol (310-2137-002)</u> Wetland Zone of Influence (ZOI) (Scoring: Optimal 20 – 16): The land extending 300 feet from the perimeter of the assessment area previously established in Section 1.0. The Wetland ZOI may be comprised of wetlands, uplands, waterways and/or floodplains. ZOI

Table 2. Riparian area and associated definitions from federal, state, and local sources.	
Entity	**Definition**
	area vegetation consists of a tree stratum (diameter at breast height (DBH) > 3 inches) with greater than or equal to 60% tree canopy cover. Areas comprised of stream channels, wetlands (regardless of classification or condition) and lacustrine resources ≥ 10 acres are scored as optimal.

What inventory requirements are in place and how are these inventories used in project planning?

Federal Requirements

Unless exempted, all projects that are covered under *Nationwide Permit 27 – Aquatic Habitat Restoration, Enhancement, and Establishment Activities* must submit a pre-construction notification to the district engineer that includes description of the proposed activity; the activity's purpose; direct and indirect adverse environmental effects the activity would cause, including the anticipated amount of loss of wetlands, other special aquatic sites, and other waters expected to result from the NWP activity, in acres, linear feet, or other appropriate unit of measure. The notification must also include a delineation of wetlands, other special aquatic sites, and other waters, such as lakes and ponds, and perennial, intermittent, and ephemeral streams, on the project site. For those activities that do not require pre-construction notification, a permittee must submit materials and agreements that include information on baseline ecological conditions on the project site, such as a delineation of wetlands, streams, and/or other aquatic habitats.

Additionally, the Regional General Permit for Chesapeake Bay Total Maximum Daily Load (TMDL) Activities from the USACE includes Nontidal Streams and Wetland Restoration Activities in nontidal WOTUS in the watershed within the State of Maryland (with some exceptions), the District of Columbia, Fort Belvoir, Fort Myer, and the Pentagon in Virginia. The permit authorizes stream and wetland restoration and enhancement activities in waters of the United States, where the activity is part of an acceptable watershed strategy to reduce nutrients and sediment pollution and produces functional lift within the project site. Permanent impacts may not exceed 3 acres of nontidal wetlands and/or nontidal streams, or 5,000 linear feet of nontidal streams for projects requiring Corps verification. As part of the activity a permit application must include documentation that the existing (pre-construction) stream reach is in a degraded condition using a Corps-approved Functional or Conditional Assessment Methodology (FCAM) or Benthic Index of Biotic Integrity (BIBI) Score in combination with geomorphic evidence of stream quality degradation. The applicant must also provide a rationale for stream site selection and the proposed design approach using applicable evidence, prioritization tools (i.e., excessive erosion as indicated by BEHI/BANCS, impaired stream conditions and/or functions as documented by a FCAM), and literature.

In some instances, restoration projects may require individual permits from the USACE. The need for an individual permit is determined on a case-by-case basis and can be required in circumstances where the USACE determines that the potential consequences of the proposed project warrant individual review or that the cumulative environmental impacts are more than minimal. Individual permits may also be required if there is a special resource or concern associated with a project, which is not addressed in the language of a Nationwide or Regional General permit and is deemed to warrant a greater review.

State Requirements

All three states have requirements to inventory natural features prior to approval of a development project that is subject to permitting. Inventory of environmental features is necessary if a federal joint project permit is required, and inventory requirements are often implemented as well for permitted projects at the state and local level. Below is a summary of the inventory requirements that specifically mention forest or riparian forest buffers in each of the three target states and three selected counties for stream restoration evaluation. Note that while the policies include inventory requirements, the methodologies to conduct the inventories are not specified.

Pennsylvania

The Bureau of Waterways Engineering and Wetlands BWEW-GP-3 Bank Rehabilitation, Bank Protection and Gravel Bar Removal General Permit may have some influence on a limited set of projects (bank rehabilitation, bank protection projects or removal of a gravel bar not exceeding 500 feet in length). PA DEP noted that the projects covered by this permit are not considered stream restoration and that inconsistent terminology causes confusion across agencies and the public as it relates to stream restoration (PA DEP, 2022).

Pennsylvania Code *Chapter 105 Dam Safety and Waterway Management* General Permit applications, while not mentioning riparian forest specifically, does require an impacts analysis for a proposed water quality project on stream flow, fish and wildlife, aquatic habitat, Federal and State forests, parks, recreation, instream and downstream water uses, prime farmlands, areas or structures of historic significance, streams which are identified candidates for or are included within the Federal or State wild and scenic river systems and other relevant significant environmental factors.

One of the more important policies that impacts riparian forest buffers is *Title 25, Chapter 102 of Pennsylvania Code – Erosion and Sediment Control*. This policy includes the following sections regarding inventory of riparian forest:

- *§ 102.4 Erosion and Sediment Control Requirements* indicates that an E&S plan must contain drawings and narrative which include the identification of existing and proposed riparian forest buffers. It is critical to note that under *§ 102.5(i)* A person proposing or conducting an earth disturbance activity associated with discharging dredged or fill material to waters of the United States which is required to obtain a permit or coverage under a permit under section 404 of the Federal Clean Water Act *(33 U.S.C.A. § 1344*) need not obtain an additional E&S Permit or NPDES Permit for Stormwater Discharges Associated With Construction Activities for the area of disturbance covered by the Clean Water Act section 404 permit.
- *§ 102.14. Riparian Buffer Requirements* indicates that a waiver may be allowed by PA DEP when demonstrated by the applicant that there are reasonable alternatives for compliance with this section, so long as any existing riparian buffer is undisturbed to the extent practicable for projects that include (i)construction or placement of roads,

bridges, trails, storm drainage, utilities, or other structures, (ii)water obstructions or encroachments (Ch. 105 regulatory authority), or (iii)restoration projects (Ch. 105 regulatory authority).

- *§ 102.8. PCSM (Post Construction Stormwater Management) Requirements* indicates that a riparian forest buffer management plan may be required under § 102.14 (relating to riparian buffer requirements).

The Pennsylvania Department of Environmental Protection Bureau of Clean Water *2022 Model Stormwater Management Ordinance* also states that "In order to protect and improve water quality, a Riparian Buffer Easement shall be created and recorded as part of any subdivision or land development that encompasses a Riparian Buffer." This implies that an inventory of existing buffer area must take place as part of the project.

Virginia

Projects that are subject to federal joint permit applications (JPAs) from the USACE and VA DEQ have several inventory requirements primarily focused on wetlands. This includes an inventory of all delineated wetlands and all surface waters on the site, including the Cowardin classification (i.e., emergent, scrub-shrub, or forested; Cowardin et al., 1979) for those surface waters and waterway name, if designated. Specific inventory requirements regarding riparian areas include showing the limits of existing, non-delineated wetlands, open water, or streams, including submerged aquatic vegetation (SAV), riffle/pool complexes, or bars; Chesapeake Bay Preservation Act Resource Protection Area(s) (RPA), including the 100-foot buffer; proposed clearing within the RPA buffer; and any areas that are under a deed restriction, conservation easement, restrictive covenant, or other land use protective instrument (i.e., protected areas). The permit also calls for showing the location and type of existing vegetation within the 100-foot RPA buffer and location of proposed wetland planting areas (as restoration for temporary impacts or mitigation for permanent impacts).

Fairfax County has several policies that include inventory requirements that especially call out forest or riparian areas. These include:

- The Stormwater Management Ordinance *Section 124-2-7. Stormwater Management Plans* indicates that one of the requirements for an approved plan is a map or maps of the site that depicts the topography of the site and includes soil types, forest cover, and other vegetative areas.
- Fairfax Tree Conservation Ordinance *Section 122-3-1. Tree Conservation Plans* calls for tree conservation plans to be submitted for review and approval. The plans are required when land disturbing activity requiring a conservation plan involves the removal, preservation or replacement of trees or forested areas.
- Chapter 104 (Erosion and Sedimentation Control Ordinance) *Section 104-1-2* states that a conservation plan is required of anyone engaging in land disturbing activities in the County.

- Fairfax Chesapeake Bay Preservation Ordinance *Section 118-3-3*. Additional Performance Criteria for Resource Protection Areas calls for a Water Quality Impact Assessment for any proposed land disturbance, development, or redevelopment within an RPA that is not exempt.

Maryland

The Code of Maryland *26.17 Chapter 04 Construction on Nontidal Waters and Floodplains* gives a lot of latitude regarding what is required and allows MDE to decide the level of investigation necessary. The policy does note that an environmental study of the significant effects of the project may be required of the applicant by the Administration. The study can include an inventory of the existing vegetation, fish, wildlife, scenic, recreational, and historic values located within the project area. The study shall also include a description of mitigation measures proposed to minimize the potential adverse effects of the project.

The Code of Maryland Regulations *26.23. Nontidal Wetlands* requires wetland delineations and the amount of proposed temporary and permanent impacts. This may include forested wetlands and their 25- or 100-foot buffer. An assessment of function/condition may be required, along with special surveys in sensitive areas. The nontidal wetland permit application does require applicants to indicate if there will be temporary or permanent tree clearing (upland or wetland) occurring on the overall project site and the total estimated acres of tree clearing. This includes for applications for restoration.

The Maryland Department of the Environment (MDE) also requires an assessment of biological and hydraulic condition in stream proposed for restoration under the Chesapeake Bay TMDL. An assessment of riparian condition is also required. Maryland released a new recommended assessment for the Upper Coastal Plain in 2022.

The Code of Maryland Title 8, Subtitle 19 *Forest Conservation Act* requires any person applying for a subdivision plan, grading permit or sediment control plan on a tract of 40,000 square feet or more to submit a Forest Stand Delineation (FSD) and a Forest Conservation Plan (FCP). Stream restoration projects are excluded from the Forest Conservation Act if they have a binding 5-year maintenance agreement. The FSD entails the identification of existing forest cover and the environmental features of a proposed development site, while the FCP requires a map and narrative describing the limits of disturbance for the proposed project and the measures to protect existing forested and sensitive areas during and after development.

Anne Arundel County Code *§ 17-6-302* requires as part of the permitting process a Forest stand delineation that includes:

(a) a topographic map delineating intermittent and perennial streams and steep slopes
(b) a soils map delineating soils with structural limitations, hydric soils, or highly erodible soils

(c) forest stand data indicating the species, location, and size of trees and showing dominant and co-dominant forest types
(d) the location of 100-year floodplains
(e) information required by the State Forest Conservation Technical Manual

In addition, Anne Arundel County *§ 17-6-303* requires a FCP after the FSD is complete that includes a table that lists the proposed values, measured to the nearest one-tenth acre, of the site, excluding the 100-year floodplain, the area of required forest conservation, and the onsite and offsite areas of forest conservation that the developer will provide and a graphic scale drawing of the site that shows the forest conservation to be provided, areas where existing forest is to be retained, areas proposed for afforestation or reforestation and their relationship to priority areas, any offsite areas proposed for afforestation or reforestation to meet forest conservation requirements, the limits of disturbance to the site, and stockpile areas.

The City of Gaithersburg Maryland *Environmental Standards for Development Regulation* calls for a Natural Resource Inventory (NRI) which is a complete analysis of existing conditions, natural features, forests, and tree cover on site that is used as a screening tool for site specific assessments, identification of forests and habitat, and the basis of stormwater and environmental site design.

Are forest agencies engaged and how?

The Maryland Forest Conservation Act (MD FCA) requires a Forest Conservation Plan to be prepared by a licensed forester, licensed landscape architect, or other qualified professional approved by MD DNR unless granted an exemption. Exemptions are granted by state or local FCA professionals from DNR, which would involve review of plans. Stream restoration projects are excluded from the Forest Conservation Act if they have a binding 5-year maintenance agreement. In addition, MDE coordinates with DNR on nontidal wetland/waterway regulatory actions which may affect forest resources related to sensitive species.

The Forestry Program for Anne Arundel County, Maryland is housed within the Code Compliance Division. The Forestry Program administers the reforestation and afforestation requirements of the Critical Area Program, and the MD FCA.

The Pennsylvania Natural Heritage Program administers the Pennsylvania Natural Diversity Inventory (PNDI) program. This includes the Pennsylvania Conservation Explorer, which also reviews silviculture projects, conservation information on biological diversity, protected lands, streams, and other natural resources for planning purposes and allows users to screen a project area for potential impacts to threatened, endangered, and special concern species. The Pennsylvania Department of Conservation and Natural Resources (PA DCNR) Bureau of Recreation and Conservation administers the Pennsylvania Rivers Conservation Program designed to protect and enhance Pennsylvania’s waterways. The program provides technical and financial assistance to partners to carry out activities that improve watershed health and/or provide water-based outdoor recreation opportunities including planting riparian buffers. The DCNR's Bureau of Forestry is charged with protecting the long-term health, viability, and productivity of the state forest system which includes riparian forest areas.

In Fairfax, VA the Urban Forest Management Division (UFMD) is the primary county agency responsible for ensuring that development plans comply with the Tree Conservation Ordinance. They also monitor tree canopy and forest inventory data to understand how development and other factors may be impacting tree health and forest ecosystem services

How are existing forests addressed in project permits?

The USACE Regional General Permit for Chesapeake Bay TMDL Activities that applies to nontidal WOTUS in the watershed within the State of Maryland (with some exceptions), the District of Columbia, Fort Belvoir, Fort Myer, and the Pentagon in Virginia includes as part of its general requirements that riparian and wetland vegetation in the authorized project area shall be protected from unnecessary clearing and disturbance to the maximum extent practicable through:

I. Minimization of project and impact footprint;
II. Designation of staging areas and access points in open, upland areas;
III. Fencing or other barriers demarking construction areas; or
IV. Use of alternative equipment (e.g., crane, portable bridges).

The jurisdictions we examined all had inventory requirements of existing resources at a proposed project site as discussed previously. While forest resources may not be called out specifically in codified policy, generally there will be a requirement to assess the impacts of a project on the natural resources or on the floodplain that effectively requires evaluation of the riparian corridor.

Another focus of policies in the target states is for retention of existing forest or tree resources over replacement or replanting. For example, *Section 122-2-2* of the Fairfax County Tree Conservation Ordinance states that the 10-year tree canopy requirement may be met through the preservation or planting of trees. However, when existing trees meet standards of health, condition, and suitability, and when it is feasible to preserve those trees within the framework of permissible uses, densities, design standards, and construction practices, all efforts shall first be made to meet the tree canopy requirement through the preservation of trees before tree planting is allowed to meet any portion of the tree canopy requirement.

Maryland's Forest Conservation Act *08.19.04.07* specifically says that the following trees, shrubs, plants, and specific areas are considered priority for retention and protection and shall be left in an undisturbed condition unless the applicant has demonstrated, to the satisfaction of the Department, that all reasonable efforts have been made to protect them and the plan cannot reasonably be altered:

(1) Trees, shrubs, and plants located in sensitive areas including the 100-year floodplain, intermittent and perennial streams and their buffers, coastal bays and their buffers, steep slopes, nontidal wetlands, and critical habitats; and
(2) Contiguous forest that connects the largest undeveloped or most vegetated tracts of land within and adjacent to the site.

Maryland's Nontidal Wetlands Act and regulations (COMAR *26.23*) require that activities first avoid, or if avoidance is not possible, to minimize adverse impacts to regulated resources. The forest must meet the definition of a nontidal wetland or its buffer for considerations. Losses of forest typically require compensatory mitigation at a 2:1 replacement ratio, which is increased when the wetland is designated as a nontidal wetland of special State concern. Best management practices to reduce construction impacts may also be required. Mitigation has not yet been required for forest loss from stream restoration projects, but minimization of losses is expected, and a net functional uplift is necessary, otherwise, mitigation may be required on a case-by-case basis.

Maryland Water Quality standards regulation COMAR *26.08.02.03-3* for designated uses states that it is the policy of the State that riparian forest buffer adjacent to natural trout waters or recreational trout waters shall be retained whenever possible to maintain the temperatures essential to meeting this criterion.

Maryland's new recommended assessment for the Upper Coastal Plain released in 2022 evaluates plant communities at restoration sites according to Key Wildlife Habitat (KWH) types. Most KWH types adjacent to nontidal streams are forested. MDE's assessment and guidance recommendations for restoration focus on the quality of the habitat. Higher quality areas or those with a designation that the resource is particularly important (e.g., nontidal wetland of special state concern) focus on restoration, which would continue to maintain the high-quality habitat. MDE's Wetlands & Waterways permit package checklist also requests information on minimizing tree loss.

Code of Pennsylvania Title 25 § 105.15. *Environmental Assessment* while not mentioning riparian forest specifically, does require an impacts analysis for a proposed water quality project on the following: stream flow, fish and wildlife, aquatic habitat, Federal and State forests, parks, recreation, instream and downstream water uses, prime farmlands, areas or structures of historic significance, streams which are identified candidates for or are included within the Federal or State wild and scenic river systems and other relevant significant environmental factors. This requires a characterization of the riverine, wetland and lacustrine aquatic resources present on the project site that are proposed to be directly or indirectly affected by the project, including but not limited to the following: resource classification information, Level 2 rapid condition assessment results, discussion of resource functions, characterization of riparian properties and any other relevant information or studies conducted.

Code of Pennsylvania Title 25 § *102.14. Riparian Buffer Requirements* affords protection to riparian buffers being used for post-construction management in exceptional value or high-quality watersheds by restricting earth disturbance activities at a project site if within 150 feet of a perennial or intermittent river, stream, or creek, or lake, pond or reservoir when the watershed is attaining its designated use and states that, "persons proposing or conducting earth disturbance activities shall protect any existing riparian buffer in accordance with this section." Project sites located in an exceptional value or high-quality watershed where there are waters failing to attain one or more designated uses as listed in Category 4 or 5 on Pennsylvania's Integrated Water Quality Monitoring and Assessment report, and that contain, or are along or within 150 feet of a perennial or intermittent river, stream, or creek, lake, pond, or reservoir either need to:

1. Protect an existing riparian forest buffer;
2. Convert an existing riparian buffer to a riparian forest buffer; or,
3. Establish a new riparian forest buffer.

It is important to note that this language does not apply to stream restoration projects, which are permitted under Chapter 105 of the Code (PA DEP 2022).

What re-vegetation or other mitigation requirements are in place for impacts to streamside forests?

Popular mitigation measures for riparian forest impacts are similar to those often allowed for wetlands. The most common appear to be 1) purchase of available credits from an approved mitigation bank with a service area located near the area of impact, 2) payment into a fee-in-lieu program or fund, or 3) completing a mitigation project approved by the appropriate agency to replace resource losses. The Pennsylvania Erosion and Sediment Control code also allows for the voluntary preservation or creation of riparian buffers which may generate credits for trading or offsets.

Another method to reduce loss of streamside forests is to require replanting of buffers when impacts to the buffer are considered unavoidable. Examples of language found in the codes reviewed can be found in Table 3.

Table 3. Example language for mitigation or replanting of riparian areas.

Code/Policy	Example
USACE Nationwide Permit 27	Compensatory mitigation plans for NWP activities in or near streams or other open waters will normally include a requirement for the restoration or enhancement, maintenance, and legal protection (e.g., conservation easements) of riparian areas next to open waters. In some cases, the restoration or maintenance/protection of riparian areas may be the only compensatory mitigation required. Restored riparian areas should consist of native species. The width of the required riparian area will address documented water quality or aquatic habitat loss concerns. Normally, the riparian area will be 25 to 50 feet wide on each side of the stream, but the district engineer may require slightly wider riparian areas to address documented water quality or habitat loss concerns. If it is not possible to restore or maintain/protect a riparian area on both sides of a stream, or if the waterbody is a lake or coastal waters, then restoring or maintaining/protecting a riparian area along a single bank or shoreline may be sufficient. Where both wetlands and open waters exist on the project site, the district engineer will determine the appropriate compensatory mitigation (e.g., riparian areas and/or wetlands compensation) based on what is best for the aquatic environment on a watershed basis.
Maryland Code Natural Resources § 5-1607	Afforestation and reforestation requirements, priorities d) The following shall be considered priority for afforestation or reforestation: (1) Establish or enhance forest buffers adjacent to intermittent and perennial streams and coastal bays to widths of at least 50 feet; (2) Establish or increase existing forested corridors to connect existing forests within or adjacent to the site and, where practical, forested corridors should be a minimum of 300 feet in width to facilitate wildlife movement. (3) Establish or enhance forest buffers adjacent to critical habitats where appropriate. (4) Establish or enhance forested areas in 100-year floodplains.
Code of Maryland Title 8, Subtitle 19 Forest Conservation Act	For stream restoration projects, an equivalent number of trees are required to be planted on-site as the number removed.
Maryland Nontidal Wetland COMAR 26.23.04	When mitigation is required (although it is not typical to require mitigation for stream restoration projects): *C(1)* (c) Forested nontidal wetlands—2:1 or 3:1 when using credit from an approved mitigation bank; C(1) (f) Forested nontidal wetlands designated as nontidal wetlands of special State concern—3:1 or 4.5:1 when using credit from an approved mitigation bank; C(2) A minimum in-kind acreage replacement ratio of 1:1 has been met, and lost nontidal wetland functions have been replaced by additional creation, restoration, or enhancement activities including best management practices for agricultural activities; F. Enhancement activities may be accepted to replace the loss of nontidal wetland functions when an enhancement activity provides additional protection to, creates, or improves the functions of, nontidal wetlands. Activities may include: (1) Enhancement of farmed wetlands; (2) Enhancement of degraded nontidal wetlands;

Table 3. Example language for mitigation or replanting of riparian areas.

Code/Policy	Example
	(3) Best management practices for agricultural activities; (4) Department-approved wildlife ponds; (5) Purchase or preservation of upland buffers adjacent to existing, created, restored, or enhanced nontidal wetlands; (6) Purchase or preservation of existing nontidal wetlands; and (7) Activities consistent with plans and agreements to create or improve waterfowl habitats in Maryland. Loss due to restoration projects is considered in functional uplift determinations, however, additional consideration is now given to maintaining existing forest.
MD DNR Principles and Protocols to Guide the Department of Natural Resources' Actions Regarding Stream Restoration Projects in Maryland	Mitigation for removal of riparian forest and tree cover for stream restoration purposes should be targeted toward restoring and improving canopy cover and subsequent stream shading, as well as soil stabilization. Standards should be focused on Buffer restoration and enhancement, rather than a specific mitigation ratio. Mitigation should be provided as follows: a. All areas disturbed (graded, cleared, etc.), including access routes, shall be re- established in multi-layered forest vegetation (canopy, understory, shrub, and herbaceous layers) such that habitat, soil stabilization and water quality functions of the riparian buffer are restored as soon as feasible after construction. Species composition shall be native and based on nearby reference sites. This "restoration " shall occur on a square footage basis for the entire limit of disturbance. b. In addition to the required restoration in (a) above, further buffer restoration and enhancement is required for the loss of tree canopy within 50 feet of a stream channel (loss of shading). This shall be provided on a square footage basis and calculated based on the actual canopy trees that are being removed for a project. This mitigation can either be additional planting of buffers in nearby stream reaches (where canopy currently does not exist) or can consist of enhancement or restoration work such as invasive species control or adding complexity to existing Buffers (e.g., adding a shrub layer where one may not currently exist). c. When these provisions are less restrictive than the requirements of the Forest Conservation Act of 1991 or the Critical Area Law and Regulations, the provisions of said laws shall apply.
MDE's Guidance for Stream Restoration Based on Key Wildlife Habitats: Upper Coastal Plain Stream-Associated Wetlands	Plantings must be species native to the physiographic region. Tree and shrub plantings must be protected from herbivory and replaced as needed. Repeated monitoring, maintenance, and remediation may be necessary to achieve success of planted vegetation. After the activity is completed, it may be necessary to monitor for non-native invasive plant species (NNIS) and follow up with treatments. Plan ahead to obtain resources to monitor the site for new NNIS or the spread of existing populations, and to treat NNIS as needed. Protection from white-tailed deer and other herbivores may be necessary to protect tree plantings. Recommendations are summarized in Bulletin 354 Managing Deer Damage in Maryland, Maryland Cooperative Extension: https://extension.umd.edu/sites/extension.umd.edu/files/publications/EB354_ManagingDeerDamage.pdf.

Table 3. Example language for mitigation or replanting of riparian areas.

Code/Policy	Example
	Modify structures as needed to ensure that surface and ground water are at approved and desired levels to maintain desired vegetation.
Anne Arundel Code Article 17 Subdivision and Development	Afforestation and Reforestation requirements *§ 17-6-305 and § 17-6-306* The amount of reforestation required is be determined according to the amount of existing forest cover cleared in relation to the forest conservation threshold for the site. The amount of afforestation is All afforestation or reforestation shall occur in an area of the County that is at least 10,000 square feet and at least 35 feet wide. If practical, afforestation or reforestation shall occur in the watershed in which the development is located. § 17-9-308 Forest Conservation Fund Money in the Forest Conservation Fund may only be spent on: costs associated with reforestation or afforestation, including those costs directly related to site identification, acquisition, prepurchase, preparation of conservation property, maintenance of existing forests, and achieving urban canopy goals; and § 17-6-304 Forest mitigation banks. If reforestation or afforestation requirements cannot reasonably be accomplished onsite or offsite, the Office of Planning and Zoning may allow the use of credits from an approved forest mitigation bank. A forest mitigation bank may not be used unless approved in advance by the Office of Planning and Zoning.
USACE Unified Stream Methodology (USM) for Virginia	The purpose of the USM is to outline a method to rapidly assess the stream compensation requirements for permitted stream impacts and the amount of stream credits obtained through implementation of various stream mitigation activities. Section 5.3: Riparian Buffer This compensation activity includes improvements to riparian zones and includes their preservation in perpetuity. This activity includes: Buffer Re-Establishment, Heavy Buffer Planting, Light Buffer Planting, and Preservation Only.
Fairfax County Public Facilities Manual	Fairfax County has a 10 Year Tree Canopy requirement that all land development projects that require submission of a site plan, preliminary subdivision plat, subdivision construction plan, conservation plan, grading plan, or a rough grading plan need to provide for the conservation of trees so that the minimum tree canopy for the site reaches a projected canopy percentage. These percentages range from 10% - 30% depending on the zoning or use classification. 12-0204.4 Post-Development Forested Area Size and Dimension Standard for 10-year Tree Canopy Credits. In order to ensure long-term survival and regenerative capacity of forest communities, forested areas intended to count towards the 10-year Tree Canopy requirement should meet minimum size and area requirements described in Table 12.1. Forested areas consisting of sizes or dimensions smaller than these minimal standards, if approved by the Director as described in § 12-0204.4A, may count towards meeting

Table 3. Example language for mitigation or replanting of riparian areas.	
Code/Policy	**Example**
	10- year Tree Canopy requirements; however, these areas are not eligible for the default canopy credit multiplier of 1.25 or any of the additional canopy credit multipliers listed in § 12-0310.3B.
PA Chapter 105 § 105.15. Environmental Assessment and Assessment Form	EA MODULE S4: MITIGATION PLAN This module is intended to organize and present information concerning actions undertaken in accordance with the definition of Mitigation in Title 25 Pa. Code Chapter 105- 105.1, 105.16, 105.18a(a)(3), 105.18a(b)(7), 105.20a, and 105.21 as related to the potential impacts or effects of the proposed project in this application. Note: Impacts related to the "overall" project that are proposed under related but separate application(s) should be addressed as part of the CEA Policy response under S1.A.1. The following regulatory requirements and Department policies are applicable to this Module: 105.1; 105.13(e)(1)(ix); 105.16; 105.18a(a)(3); 105.18a(a)(7); 105.18a(b)(2); 105.18a(b)(3); 105.18a(b)(7); 105.20a; 105.21; Department's Design Criteria – Wetlands Replacement/Monitoring Policy (Wetland Design Criteria Policy: Document No. 363-0300-001). Definition of Mitigation (i) An action undertaken to accomplish one or more of the following: (A) Avoid and minimize impacts by limiting the degree or magnitude of the action and its implementation. B) Rectify the impact by repairing, rehabilitating, or restoring the impacted environment. (C) Reduce or eliminate the impact over time by preservation and maintenance operations during the life of the action. (ii) If the impact cannot be eliminated by following clauses (A) – (C), compensate for the impact by replacing the environment impacted by the project or by providing substitute resources or environments. Chapter 105 Environmental Assessment Form Module S4: Mitigation Plan B. Provide a detailed response for individual proposed impact area(s) and for the whole project that address the following: 1. Identify and describe any repair, rehabilitation, or restorative actions taken to rectify an impacted resource.
PA Chapter 102 § 102.14. Riparian Buffer Requirements (only applies to riparian areas used for post-construction management not stream restoration)	(b) Riparian forest buffer criteria. To qualify as a riparian forest buffer under this chapter, an existing, converted or newly established riparian forest buffer, whether mandatory or voluntary, must meet the following requirements related to composition, width and management: (1) Composition. A riparian forest buffer is a riparian buffer that consists predominantly of native trees, shrubs, and forbs that provide at least 60% uniform canopy cover. An existing riparian forest buffer does not have to be altered to establish individual Zones 1 and 2 under subparagraph (iii). At a minimum, it must have a total aggregate width of the combined zones under paragraph (2). (ii) Riparian forest buffer establishment. On sites without native woody vegetation, a riparian forest buffer shall be established and be composed of zones in accordance with subparagraph (iii), and meet the width requirements in paragraph

Table 3. Example language for mitigation or replanting of riparian areas.	
Code/Policy	**Example**
	(iii) Zones. (A) Zone 1. Undisturbed native trees must begin at the top of the streambank or normal pool elevation of a lake, pond or reservoir and occupy a strip of land measured horizontally on a line perpendicular from the top of streambank or normal pool elevation of a lake, pond, or reservoir. Predominant vegetation must be composed of a variety of native riparian tree species. (B) Zone 2. Managed native trees and shrubs must begin at the landward edge of Zone 1 and occupy an additional strip of land measured horizontally on a line perpendicular from the top of streambank or normal pool elevation of a lake, pond, or reservoir. Predominant vegetation must be composed of a variety of native riparian tree and shrub species. (i) Existing riparian buffer conversion to a riparian forest buffer. Riparian buffers that consist predominantly of native woody vegetation that do not satisfy the composition of this paragraph or the width requirements in paragraph (2) shall be enhanced or widened, or both, by additional plantings in open spaces around existing native trees and shrubs that provide at least 60% uniform canopy cover. An existing riparian forest buffer does not have to be altered to establish individual Zones 1 and 2 under subparagraph (iii).
Pennsylvania Function-Based Aquatic Resource Compensation Protocol	To provide standard guidelines for evaluating aquatic resource compensatory mitigation for the purpose of meeting applicable regulatory requirements contained in 25 Pa. Code Chapter 105. The guidance outlines how evaluations should be conducted using this methodology and the factors to consider when doing so. It also establishes a system for quantifying compensatory mitigation requirements and proposals intended to meet the 25 Pa. Code Chapter 105 regulations. This guidance is intended for use with the three Aquatic Resource Condition Level 2 Rapid Assessment Protocols (310-2137-002, 310-2137-003 and 310-2137-004). The Dam Safety and Encroachments Act requires a person to obtain a permit from the Department to construct, operate, maintain, modify, enlarge, or abandon a dam, water obstruction or encroachment which alters the course, current or cross section of a body of water. 32 P.S. § 693.6(a). See also 25 Pa. Code § 105.11. This protocol applies to all intermittent and perennial watercourses (wadeable and nonwadeable), floodways and floodplains, wetlands, and other bodies of water such as lakes and reservoirs, wholly or partly within or forming part of the boundary of this Commonwealth. These regulated waters of this Commonwealth as defined in 25 Pa. Code § 105.1 have been separated into three distinct aquatic resource groups based on the predominant functions of each aquatic resource type (riverine, lacustrine, and palustrine resources) for the purposes of this guidance.

What are the monitoring requirements and who is responsible for monitoring?

Monitoring is required for many permitted projects in all three states, but policies and regulations did not always specifically mention forest resources. The most common monitoring mentioned was the 5-year monitoring required for MS4 permit compliance. Monitoring reports are also required for projects that fall under the Nationwide Permit 27 from the USACE to determine if a project is successfully meeting its objectives. The level of required monitoring will be determined by the Corps on a case-by-case basis commensurate with the scale and risks of the proposed restoration project and the quality of regulated resources under review. A regulatory guidance letter on "Minimum Monitoring Requirements for Compensatory Mitigation Projects Involving the Restoration, Establishment, and/or Enhancement of Aquatic Resources" also indicates that the monitoring period for projects must be sufficient to demonstrate that the compensatory mitigation project has met performance standards, but not less than five years (see 33 CFR 332.6(b)). The USACE Regional General Permit for Chesapeake Bay TMDL Activities includes a 3-year monitoring requirement following construction completion, and that may be extended if monitoring shows that a project is not trending towards success in meeting the project goals and objectives.

Maryland may require up to 10 years of monitoring for permittee-responsible nontidal wetland mitigation projects. This is generally not applicable to voluntary restoration projects, though MDE may on occasion require monitoring for these types of projects. In addition, a MD DNR policy document on stream restoration includes recommendations that a monitoring plan will include the following timeframe:

- <u>Forest or tree cover</u>. Ten (10) years after construction by an expert (e.g., forester, arborist, or botanist) or in conformance with the 1991 Forest Conservation Act.

The Maryland Forest Conservation Act does have a Forest Planting and Maintenance Agreement policy. This policy includes a requirement to monitor and maintain plantings for a minimum period of 2 years after the date or certification that all required afforestation and reforestation plantings have been installed as required and allows for extension of the period at the DNR's discretion in the event replacement plantings are required to ensure the required survival rate.

The Pennsylvania Riparian Forest Buffer Guidance section on Riparian Forest Buffer Management Plans also notes that ongoing maintenance, inspection, and monitoring practices are necessary for at least 5 years to ensure establishment of a thriving riparian forest buffer, especially if smaller seedling plant material has been used. The guidance suggests that maintenance, inspection, and monitoring plans should be written for each specific site. The guidance document is not code policy but is referenced in the Pennsylvania code in Chapter 102 on Erosion and Sediment Control. According to PA DEP, this guidance does not apply to stream restoration projects which are covered under

Chapter 105 of the PA Code. The Chapter 105 program has a 3- to 5-year monitoring period for most restoration projects (depending on circumstances) that evaluates a suite of parameters related to the project-specific proposal including vegetation community establishment (PA DEP, 2022).

Virginia Water Protection (VWP) permits have a general monitoring requirement for permittees to do monitoring of projects and retain records of all monitoring information, including all calibration and maintenance records. This includes copies of all reports required by the VWP general permit, and records of all data used to complete the application for coverage under the VWP general permit, for a period of at least three years from the date of general permit expiration. This period may be extended by request of the board at any time.

The Fairfax County Code has a section in the Tree Conservation Ordinance *Section 122-4-1. - Monitoring and Inspections* that allow the Director of Land Development Services to require periodic inspections of tree conservation activities in accordance with Public Facilities Manual § 12-0500 Standards for Field Practices, and Chapter 104 (Erosion and Sedimentation Control Ordinance) of the Code.

Are best practices recommended to minimize impacts to riparian forests?

Federal, state, and local guidance documents were reviewed to identify best practices for accounting for forest health as part of stream restoration projects. All three states had technical guidance documents that detailed recommended practices for stream restoration and accompanying information on design techniques. While recommended best practices were not found in the actual codes for the states, the code sometimes did reference a manual or contained language that allowed the Agency charged with enforcement of the code to provide compliance documents or guidance as necessary. Table 4, Table 5, and Table 6 provide a summary of the general best practices included in each of the guidance documents categorized by pre-restoration assessment and planning, construction, and post-construction maintenance. Specific best practices from the guidance documents will be further summarized and incorporated into the final project report and best practices guide.

Table 4. Pre-restoration assessment and planning best practices identified in guidance documents. Cells with an "X" indicate that the guidance document referenced the best practice.

Agency	Guidance Document	Select appropriate restoration sites	Establish goals and objectives	Coordinate on tree removal/protection with all involved parties (designer, construction manager, state agency, etc.)	Design for minimum LOD and mark on-site plans	Select appropriate restoration type based on site conditions	Identify appropriate trees to remove (based on size, type, location, etc.)
USDA FS	Guidance for Stream Restoration		X				
USDA FS	Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers			X			
USFWS	The Beaver Restoration Guidebook: Working with Beaver to Restore Streams, Wetlands, and Floodplains		X				
USACE	National Large Wood Manual		X			X	
USEPA	A Function-Based Framework for Stream Assessment & Restoration Projects	X	X				
USDA NRCS	Stream Restoration Design (National Engineering Handbook 654)		X	X	X		X
VA DCR	Virginia Riparian Buffers Modification & Mitigation Guidance Manual			X	X		
VA DCR	The Virginia Stream Restoration & Stabilization Best Management Practices Guide	X				X	
VA DEQ	Virginia Erosion and Sediment Control Handbook				X		
MD DNR	Principles and Protocols to Guide the Department of Natural Resources' Actions Regarding Stream Restoration Projects in Maryland					X	
MDE	Guidance for Stream Restoration Based on Key Wildlife Habitats: Upper Coastal Plain Stream-associated Wetlands	X		X	X	X	X
MDE	MS4/Chesapeake Bay TMDL/Trust Fund Restoration Project	X		X	X	X	X

Table 4. Pre-restoration assessment and planning best practices identified in guidance documents. Cells with an "X" indicate that the guidance document referenced the best practice.

Agency	Guidance Document	Select appropriate restoration sites	Establish goals and objectives	Coordinate on tree removal/protection with all involved parties (designer, construction manager, state agency, etc.)	Design for minimum LOD and mark on-site plans	Select appropriate restoration type based on site conditions	Identify appropriate trees to remove (based on size, type, location, etc.)
	Wetlands & Waterways Permit Package Checklist						
MD DNR	RSC Construction Guidance				X		X
PA DEP	Pennsylvania Function-Based Aquatic Resource Compensation Protocol	X	X			X	
Keystone Stream Team	Guidelines For Natural Stream Channel Design for Pennsylvania Waterways			X			
MW COG	Draft Recommended Stream Restoration Best Practices	X	X	X	X	X	X

Table 5. Construction best practices identified in guidance documents. Cells with an "X" indicate that the guidance document referenced the best practice.

Agency	Guidance Document	Implement construction techniques for minimizing impacts	Identify proper access road location and type	Retain woody material on-site	Install tree protection measures for retained trees	Leave root system in ground for removed trees	Revegetate with native species
USDA FS	Guidance for Stream Restoration			X			X
USDA FS	Chesapeake Bay Riparian Handbook: A Guide for Establishing and Maintaining Riparian Forest Buffers	X					X
USACE	National Large Wood Manual			X			
USDA NRCS	Stream Restoration Design (National Engineering Handbook 654)						X
VA DCR	Virginia Riparian Buffers Modification & Mitigation Guidance Manual						X
VA DEQ	Virginia Erosion and Sediment Control Handbook				X		
MD DNR	River/Stream Management Guiding Principles						X
MD DNR	Principles and Protocols to Guide the Department of Natural Resources' Actions Regarding Stream Restoration Projects in Maryland	X	X				X
MDE	Draft Guidance for Stream Restoration Based on Key Wildlife Habitats: Upper Coastal Plain Stream-associated Wetlands	X	X	X	X	X	X

Table 5. Construction best practices identified in guidance documents. Cells with an "X" indicate that the guidance document referenced the best practice.

Agency	Guidance Document	Implement construction techniques for minimizing impacts	Identify proper access road location and type	Retain woody material on-site	Install tree protection measures for retained trees	Leave root system in ground for removed trees	Revegetate with native species
MDE	MS4/Chesapeake Bay TMDL/Trust Fund Restoration Project Wetlands & Waterways Permit Package Checklist	X	X	X	X	X	X
MD DNR	RSC Construction Guidance	X	X				X
Keystone Stream Team	Guidelines For Natural Stream Channel Design for Pennsylvania Waterways	X	X				
MW COG	Draft Recommended Stream Restoration Best Practices	X		X	X		X

Table 6. Post-construction best practices identified in guidance documents. Cells with an "X" indicate that the guidance document referenced the best practice.

Agency	Guidance Document	Conduct repeated monitoring, maintenance, and remediation	Remove invasives
USDA NRCS	Stream Restoration Design (National Engineering Handbook 654)	X	
VA DCR	Virginia Riparian Buffers Modification & Mitigation Guidance Manual		X
MD DNR	River/Stream Management Guiding Principles	X	
MD DNR	Principles and Protocols to Guide the Department of Natural Resources' Actions Regarding Stream Restoration Projects in Maryland	X	X
MDE	Guidance for Stream Restoration Based on Key Wildlife Habitats: Upper Coastal Plain Stream-associated Wetlands	X	X
MD DNR	RSC Construction Guidance	X	X
Keystone Stream Team	Guidelines For Natural Stream Channel Design for Pennsylvania Waterways	X	
MW COG	Draft Recommended Stream Restoration Best Practices	X	X

Interviews

This section summarizes the key findings from the interviews, with the complete interview transcripts included in Attachment B. A total of 19 individuals were interviewed, including 5 at the county-level (4 MS4 representatives and one conservation district), 6 from state agencies, and 8 designers/practitioners with expertise across the Chesapeake Bay watershed (Table 7). It is important to note that all interviewees, especially those affiliated with state agencies, are not necessarily responding on behalf of their entire organization—they are answering based on their professional experience within their specific bureau, division, or program.

Table 7. Details on interviewees, including organizational affiliations and areas of expertise.

Organization	Interviewee	Job Title	Area of Expertise
RK&K	Drew Altland, PE	Senior Manager of Water Resources	Drew Altland is a practitioner with 29 years of experience as a water resources engineer. As a stream restoration practitioner, he has focused on ecological restoration and hydrodynamic modeling of stream and floodplain systems for the past 24 years.
Biohabitats, Inc.	Joe Berg, CERP, PWS, CSE	Senior Ecologist, Practice Leader	Joe Berg's first stream restoration project was in 1994 with Jim Gracie and Dave Rosgen, and he's been working on these kinds of projects ever since. He currently manages stream restoration projects (develops restoration concepts and works with project team for implementation).
Underwood & Associates	Keith Binsted	Partner, Lead Designer	Keith Binsted has 7 years of experience in the stream restoration industry and is educated in water resources, ecology, and urban environmental science. Underwood & Associates pioneered the Regenerative Stream Channel (RSC) design technique; the firm has been in business for over 25 years and has designed over 500 ecological restoration projects of varying types and scales.
MDE	Denise Clearwater	Special Projects Coordinator, Wetlands & Waterways Program	Denise Clearwater is the Special Projects Coordinator in the Wetlands & Waterways Program, and she manages grants to develop new guidance for stream restoration. She represents MDE on various Chesapeake Bay Program workgroups involved with stream restoration, and she provides technical review and research support for selected restoration projects.
	William Seiger	Division Chief, Waterway Construction Division	William Seiger is the Division Chief of the Waterway Construction Division in the Wetlands & Waterways Program, which reviews stream restoration projects.

Table 7. Details on interviewees, including organizational affiliations and areas of expertise.

Organization	Interviewee	Job Title	Area of Expertise
Fairfax County, VA, DPWES, SWPD	Meghan Fellows	Ecological Restoration Specialist	Before joining Fairfax County's Stormwater Planning Division in 2016, Meghan Fellows had 14 years of experience with vegetation control, invasives management, and riparian buffer replanting and monitoring. In her current role, she oversees the design of stream restoration projects and monitors stream health before and after restoration.
	Martin Hurd	MS4 Program Coordinator	Martin Hurd works with Fairfax County staff managing stream restoration projects to determine the TMDL pollutant reductions associated with projects. He participates in the CBP Urban Stormwater Workgroup and is familiar with VA DEQ Chesapeake Bay TMDL Special Condition guidance.
PA DEP, Bureau of Waterways Engineering & Wetlands	Dave Goerman	Water Program Specialist	Dave Goerman conducts all of PA DEP's mitigation banking restoration plan reviews and approvals, conducts reviews for special watershed scale aquatic resources restoration projects that include integrated stream, wetland, and floodplain restoration projects.
	Jeffrey Hartranft	Ecologist	Jeff Hartranft reviews and approves aquatic resources restoration projects, including integrated stream, wetland, and floodplain restoration projects. He has co-chaired PA DEP's legacy sediment workgroup since 2006.
MD DNR, Environmental Review Program	Greg Golden	Senior Environmental Review Manager	Greg Golden is involved with DNR's review protocols document for stream restoration. He is on the interagency review team for mitigation banking. Greg reviews many types of projects, including stream restoration projects.
Lancaster County Conservation District	Matt Kofroth	Watershed Specialist	Matt Kofroth has been with the Lancaster County Conservation district for 20 years. They started working on stream restoration projects about 17 years ago because it was seen as a need in the county.
LandStudies, Inc.	Mike LaSala	Senior Project Manager, MS4 Program Analyst	Mike LaSala started his professional career in the early 2000s in Southern California. He joined LandStudies, Inc. in 2013, and has been involved in business development, water quality monitoring, and site identification assessment of stream restoration projects.
Ecotone, Inc.	Scott McGill	CEO	Scott McGill has been working in the stream restoration field for 31 years. He was involved in the first natural channel design (NCD) project in MD in 1990. Ecotone uses many design techniques

Table 7. Details on interviewees, including organizational affiliations and areas of expertise.			
Organization	**Interviewee**	**Job Title**	**Area of Expertise**
			(including NCD, legacy sediment removal, floodplain reconnection, and process-based nature-based approaches) for stream restoration, and the firm is a big proponent of leveraging the ecosystem services of the north American beaver.
Anne Arundel County, MD, Bureau of Watershed Protection & Restoration	Erik Michelson	Deputy Director	Erik Michelson has been working on stream restoration projects for over 15 years. Formerly, he served as the Executive Director of the South River Federation, where he was a program manager and grant writer. That experience is applied to his position with Anne Arundel County, where he also oversees the bureau, works with the capital implementation team to identify sites, and oversees execution and ongoing monitoring.
Ecosystem Services	Kip Mumaw, PE	Principal Engineer	The majority of Kip Mumaw's work specializes in stream and wetland restoration. Most of Ecosystem Services' projects are associated with the Chesapeake Bay TMDL and work with municipalities. However, the firm also works in the public sector (through funding from state, federal, and/or regional grants) and in the mitigation banking sector (including developing projects for Section 404 impacts). Kip and others at the firm have also implemented water quality mitigation and nutrient trading projects in Virginia.
Arlington County, VA	Jason Papacosma	Watershed Programs Manager	Jason Papacosma currently oversees a watershed management program that includes MS4 permit compliance, land development regulation, and a capital projects portfolio of green stormwater infrastructure, stream, and outfall projects. One of Arlington County's first stream restoration projects was completed in 2006/7.
VA DEQ, Department of Water, Wetlands, & Streams	Brock Reggi	Stream Restoration Specialist	Brock Reggi has a background in stream restoration education, and environmental consulting in Virgina and West Virginia. With over 22 years' experience, he has been involved in site selection, permitting, assessment, design, construction oversight, and post construction monitoring.

Table 7. Details on interviewees, including organizational affiliations and areas of expertise.			
Organization	**Interviewee**	**Job Title**	**Area of Expertise**
Stantec	Joshua Running	Senior Environmental Planner and Project Manager	Joshua Running began his career with the Williamsburg Environmental Group 18 years ago, before it was purchased by Stantec in 2014. With a degree in hydrology and social science, he and a supervisor started a stream project team in 2003. He has completed at least 25 mitigation banks, and over 80 or 90 miles of stream restoration in VA. He has experience with construction oversight, monitoring, and project management on over 150 projects.
Ecosystem Planning & Restoration (EPR)	Rich Starr	Senior Water Resource Scientist	Rich Starr has been working with streams for 31 years. He has worked in various applications, including conducting assessments, developing protocols, delivering training, developing designs, and implementing projects. Additionally, he has sat on several Expert Panels and technical committees that dealt with stream challenges, and he has developed protocols and recommendations for improving stream restoration and assessment.

Site Selection

The interview question addressing site selection is below.

> In your experience, how are sites selected for stream restoration projects? Who identifies the sites?

In many cases, stream restoration practitioners themselves are not involved in the planning, prioritization, or selection of sites. Sometimes, either municipalities or planning-oriented firms conduct that process before the designer is involved at all.

Some projects reach practitioners through requests-for-proposals (RFPs), which present the opportunity to design a project on an already-selected site. In this case, it is up to the practitioner to determine whether they agree that the site is suitable prior to moving forward with the project design. This is often the case with mitigation banking projects, where a landowner hires a practitioner to evaluate the feasibility of their specific site prior to beginning the design process. Ecological restoration firms are often not involved in the site selection process other than to provide comment on the applicability of a pre-identified site for restoration design and grant funding. Kip Mumaw, PE (Principal Engineer for Ecosystem Services) explained, “The market is usually coming to us with properties/projects to evaluate and then implement—it’s less of a region/watershed coming to us to prioritize project sites within.” However, he also noted that being limited to smaller sections of streams can affect the firm's ability to evaluate and restore the watershed as a whole. In the case of sites on public land, typically public agencies will identify sites and present them to practitioners or collaborate with planning-oriented firms to identify sites.

In cases where stream restoration practitioners are involved in the site selection process, there are several factors that inform decision-making. Across jurisdictions, the methods for site selection vary from project to project. Generally, sites are selected using one or a combination of the following methods: 1) opportunistic considerations, 2) watershed assessments conducted as part of a watershed planning initiative, or 3) mitigation banking efforts.

Opportunistic Considerations

The opportunistic considerations for site selection are broadly varied, encompassing funding availability, landowner willingness, cost-effectiveness/competitiveness, and/or practitioner/specialist recommendations. These opportunistic considerations are acknowledged as drivers from a regulatory perspective as well—MDE noted that site selection is conducted by permit applicants and appears to be based on a combination of opportunity and accessibility. These opportunistic considerations can be the sole driver for a selected site, or they can contribute to the decision-making process for prospective sites identified as part of watershed planning or mitigation banking efforts.

Funding availability and landowner willingness were commonly identified in responses from a variety of interviewees. Scott McGill (CEO at Ecotone, Inc.) noted how essential landowner buy-in is, and he explained that he prioritizes cohorts of landowners who are interested in seeing their stream/floodplain/riparian valley function better from an ecological perspective. He explained that willingness from multiple landowners is the primary limiting factor for restoring lengths of stream that are significant at the landscape-scale. MD DNR also observed that landowner willingness was a very important factor, as it has the potential to limit the potential of sites that are identified through watershed planning efforts.

Cost-effectiveness and site competitiveness are important in multiple scenarios. When a municipality distributes an RFP looking for a turnkey project, site selection is often based on cost competitiveness (i.e., which site(s) can maximize achieved credit while minimizing costs; or, in the case of extremely constrained budgets, cost competitiveness simply refers to proposed project sites with the lowest cost). In these cases, the site is not necessarily the most optimal in relation to the rest of the watershed, but it becomes the best because it's competitive and likely to be implemented. This is similar to the selection process for mitigation banking projects. The entity conducting the mitigation work (either a bank or the permittee) will base their decision on cost-effectiveness in most cases.

The professional opinions of practitioners and specialists are also included in the list of opportunistic considerations. Kip Mumaw, PE (Principal Engineer for Ecosystem Services) described his prioritization metrics as primarily considering water quality improvements, but also considering ecological uplift, aesthetics, safety, and tree removal. Sometimes, in the process of completing a project at one site, a practitioner may identify the need for an additional project at a nearby site, in which case they will propose it to a client (like the county, a mitigation banker, or a watershed group) to evaluate it and present it for a grant application.

Representatives from PA DEP described a combination of an evidence-based approach and a triage approach, both of which depend on the professional experience of industry-recognized practitioners. The evidence-based approach is informed by "industry-leading consultants that have invested heavily in expanding their resource knowledge base and use sound science to evaluate causes of degradation and propose retrofit designs." Jeff Hartranft (Chief, Environmental & Geotechnical Services Section for PA DEP) described the triage approach as identifying an urgent stream problem with a willing landowner and being able to secure funding. The evidence-based and triage approaches described by PA DEP are used to identify sites and appropriate restoration techniques in a holistic way that considers the underlying causes of degradation.

Watershed Planning

Anne Arundel County selects sites through an identification process based on watershed assessments that are conducted as part of their MS4 requirements. Those watershed assessments consider factors like the degree of physical degradation, biological impairment, and overall watershed conditions. Contemporary desktop analysis tools like LiDAR differencing are also used for site selection.

Fairfax County also assesses, prioritizes, and selects site in-house. Fairfax County funds their restoration work through tax revenue, and they have a site selection team and process within their Stormwater Planning Division under the Watershed Project Implementation Branch (WPIB). Projects are nominated in multiple ways, but they are selected after conducting site visits and stream condition assessments. The WPIB has a complex evaluation and selection process that includes metrics like feasibility and degree of degradation to inform prioritization. At the state level in Virginia, projects are primarily selected by consultants or brought to the attention of VA DEQ through complaints from community stakeholders.

Matt Kofroth (Watershed Specialist for the Lancaster County Conservation District) explained that they work to prioritize stream projects or interested landowners in watersheds that are identified in watershed implementation plans (WIPs) for numerous watersheds in the County. They also work to pair their stream work with other ongoing conservation efforts within the identified watersheds.

Practitioners use insights from watershed planning and municipality-driven restoration initiatives to inform site selection as well. Many water quality TMDL projects include sites that were identified and prioritized based on watershed-level assessments, which are typically conducted alongside the development of a watershed plan. Joe Berg, CERP, PWS, CSE (Senior Ecologist and Practice Leader for Biohabitats, Inc.) explained that 50% – 60% of their stream restoration projects result from a municipal client hiring them to work on a prioritized list of stream sites that were identified in a completed watershed plan. In describing the site selection metrics for TMDL credit projects other interviewees emphasized their consideration of ecological, regulatory, and opportunistic considerations, including: the degree of degradation, anticipated credits after project completion, project cost, accessibility constraints, and landowner willingness. Practitioners and MS4 representatives in Pennsylvania echoed similar site selection processes, stating that it often depends on the type of project (on-call contracts or full-delivery/mitigation banking), the project client (public or private), funding availability, stream geomorphic characteristics, ecological condition, or areas prioritized by watershed implementation plans.

Mitigation Banking

Mitigation banking projects appear to be most common in working with State Highway Administrations (SHAs), as they need both mitigation and credit for their projects. In Maryland, SHA has its own method for identifying viable sites. Additionally, practitioners may collaborate directly with entrepreneurial bankers to identify sites and submit. Dave Goerman, Jr. (Water Program Specialist for PA DEP) explained that Pennsylvania's mitigation banking program prioritizes demonstration of resource degradation in a way that encompasses physical, chemical, and biological considerations. Following the demonstration of degradation, mitigation banking projects shift their focus to evaluating the appropriate intervention action to address the identified underlying cause(s) of degradation.

The site considerations that inform selection for mitigation projects include continuity across large pieces of land, opportunities to implement cattle exclusion or other practices for additional credit, and funding availability. Additionally, mitigation projects in Pennsylvania emphasize a site's departure from natural reference conditions (related to physical attributes of fluvial systems) more strongly than chemical or biological considerations. However, water quality and biological characteristics are still considered using Pennsylvania's evidence-based approach, and they are incorporated into the analysis of a potential project site, just at a lower priority than restoration of physical stream attributes, which are more likely to address underlying causes of degradation.

Tools used for site selection include:

- GIS analyses (including LiDAR differencing)
- Personal networking with landowners
- Watershed assessments conducted as part of watershed planning initiatives

Tree and Canopy Protection

The interview questions addressing tree and tree canopy protection are below.

Is a riparian forest assessment done prior to restoration to determine forest health and if so, what indicators are used?
How is tree and tree canopy protection deliberated during site selection, design, and installation? Are there scenarios when protecting trees, forest stability, and forest longevity are given priority over streambank reconstruction?
Are there typical scenarios where entire buffers or mature trees are removed and why?

When trees are removed during restoration, to what extent are riparian tree cover and structure restored after restoration? How quickly does this occur?

Interviewee responses on whether they conduct pre-restoration riparian assessments was highly variable. At the minimum, riparian assessments are informal, may or may not be documented, and are conducted by professional judgment. For example, when cold-water streams are being restored, some but not all practitioners will assess shade and canopy for temperature reasons. When practitioners conduct more detailed assessments, factors like dead/at-risk trees, root coverage, bank stability, habitat, soil type, and invasive species presence may be considered.

State Agency Responses

Greg Golden (Senior Environmental Review Manager for MD DNR) noted that pre-restoration riparian assessments are not formally required but they are encouraged. Representatives from MDE indicated that the Wetlands & Waterways Program (WWP) has recently begun requiring a riparian condition assessment as part of the application package; this assessment does not have specified indicators, but details on the assessment are included in MDE's updated guidance for stream restoration projects. These assessments are done to variable degrees from project to project. Tree canopy is typically more heavily considered and assessed on cold-water trout streams.

According to MD DNR, the clearing of entire buffers in Maryland is most frequently seen in association with projects that alter the floodplain elevation to reconnect with the stream channel, particularly with legacy sediment removal approaches (which are relatively rare in Maryland). Entire buffers or mature trees can also be indirectly lost with RSC projects or other projects resulting in additional inundation of the floodplain—where existing tree species in riparian areas are subjected to frequent inundation once the channel is raised and may not survive. MDE representatives indicated that Wetlands and Waterways permit applicants are typically asked to justify riparian and tree impacts throughout the permit process, and these justifications are often accepted. Occasionally, permit applicants justify the removal of entire buffers or mature trees due to construction access or functional uplift, and these justifications are approved or denied by MDE on a case-by-case basis. MDE representatives noted that a planting plan is usually included as part of the permit since there are compliance terms that require stabilization, require the implementation of the planting plan, and require compliance inspections; however, the WWP does not typically receive information about the timing or success of that replanting. MDE plans to conduct more follow up, beginning in 2022, to evaluate the success of restoration projects, including restoration after temporary impacts and re-planting. Additionally, since the time of the interview, MDE has finalized and recommends use of a new assessment for the Upper Coastal Plain.

Dave Goerman, Jr. (Water Program Specialist for PA DEP) indicated that Pennsylvania requires mitigation banking projects to characterize the general conditions of the resources within the proposed project limits. While there is no defined riparian forest assessment protocol, Chapter 105 permit applications require a Pennsylvania Riverine Condition Level 2 Rapid Assessment, which evaluates the conditions of the floodplain and riparian zone. Under the Pennsylvania state mitigation banking program, the deliberation of tree and tree canopy protection is typically not evaluated as a priority. Their program prioritizes the demonstration of resource degradation, which encompasses a variety of other assessment metrics including tree canopy. Jeffrey Hartranft (Chief, Environmental & Geotechnical Services Section for PA DEP) elaborated on the degree of prioritization for tree protection related to streambank reconstruction by saying, "It is possible—after a more comprehensive consideration of impacts and appropriateness of the restoration approach in addressing the degradation—that protecting trees, forest stability, or longevity are desired and should be prioritized. However, this should not be the case at the cost of preventing the restoration of physical characteristics and processes."

Representatives from PA DEP emphasized that trees are not always the appropriate reference plant community in riparian zones, and reconstructed plant communities from paleo-seed analysis, paleosol inferences, and historical documentation clearly illustrate that natural plant communities in riparian zones are not exclusively forested or closed canopy. As stated by Dave Goerman, Jr., "the final ecological form associated with an appropriately restored fluvial section, in many instances, is not forested in the various physiographic provinces in PA or the community is composition is significantly different than those that exist under degraded conditions." Moreover, PA DEP representatives explained that changes to forested buffers as a result of stream restoration should not be presumed as an adverse outcome. Dave Goerman, Jr. noted that he has approved the removal of trees along the entire floodplain in many instances. He explained that removing entire buffers of trees is sometimes necessary to address the underlying causes of degradation; however, this extensive tree removal is not done out of a lack of regard for existing conditions—it is done following a rigorous, evidence-based analysis that identifies and resolves the underlying causes of degradation.

For mitigation banking projects, PA DEP uses a broad design performance standard that requires the overplanting of the entire site with herbaceous, shrub, and tree species. This approach has been successfully employed for 10 years and promotes the establishment of species sorted by the project site's local conditions. PA DEP is further refining this design performance standard approach through the "Pennsylvania Community Prediction Tool for Site Restoration" and additional guidance to be completed in 2022.

Brock Reggi (Stream Restoration Specialist for VA DEQ) states that it largely depends on the situation how tree and tree canopy protection is deliberated. There are always trees that they avoid completely on project sites, typically older growth or specimen trees. Brock Reggi also emphasized that he had never seen a project not go forward because the riparian buffer takes precedence over the streambank reconstruction, nor had he witnessed a project in Virginia or West Virginia that had removed an entire buffer. "The task is to fix the stream and part of that is saving as much of the forest buffer as possible," he explained during the interview. Replanting the buffers is required by the 404 permits, 401 certification requirements, and Virginia's permits after the restoration is complete.

County Responses

In Anne Arundel County, pre-restoration riparian assessments are conducted, but they are fairly coarse at the initial level. These assessments primarily include factors like extent of coverage and generalized forest quality. Additionally, high-quality wetland resources and other significant characteristics would be identified and may disqualify a project. Tree and canopy protection is considered during site selection, design, and implementation; however, it is not the County's highest priority. When high-quality resources are present, those areas are typically either avoided or integrated into the project design. In cases where dry, upland species are occupying a stream terrace that has dried out over time, those trees wouldn't necessarily be targeted for removal, but their death as a result of stream restoration is considered an acceptable outcome. Because Anne Arundel County typically aims to create stable valley bottom configurations that can require grading, there are cases where significant portions of the buffer are cleared in order to ensure that the channel can withstand shear stress and carry flows in a broad, sheet-flow fashion. The County implements in-kind replanting whenever there is tree loss during a project, and they aim to install additional vegetative cover if it can be achieved. The timeline for full revegetation is typically 6 to 12 months; trees planted are generally 3 to 4 years old, so returning to a mature forest condition can take upwards of 30 years.

In Fairfax County, a condition assessment of the vegetation community is used as a pre-restoration riparian assessment. According to Meghan Fellows (Ecological Restoration Specialist for Fairfax County), each vegetation community is assigned a community type as defined by the Department of Natural Heritage during a field visit. Then they review the metrics of condition which include invasive covers, disturbance, and a history of ongoing threats. They examine both the type and condition of the vegetation around and in the riparian area. Marty Hurd (Environmental Protection Specialist for Fairfax County) explained that the Fairfax County Public Facilities Manual (PFM) contains standards for preserving trees and forested areas, as well as specifications for tree conservation and tree preservation targets for the county. The vegetative community assessment also includes a tree inventory/survey for all trees with a DBH greater than 12 inches. Some projects also include the herbaceous and shrub community as well as the forest floor dynamics.

The Lancaster County Conservation District (LCCD) does not conduct riparian forest assessments prior to restoration. Most of their stream projects are on agricultural lands, which as Matt Kofroth (Watershed Specialist for LCCD) details, "have maybe 2 trees in a 3,000-foot section." However, LCCD does require a buffer component on all stream projects that they are involved in. During construction, trees are evaluated for stress to prevent trees dying after project completion. Since most of their projects are habitat work or bank stabilization, they prioritize the protection of larger stock trees that have good root structure or good canopy cover. Essentially, they protect the trees that possess/provide value, that can be preserved, and that will not become a detriment to the project. For any kind of stream work, LCCD asks that at least a 35-foot buffer be added, but they are flexible on buffer width based on the pasture, field, or property size. The buffer is installed within a month of two of the stream projects final implementation. Funding availability often restricts them from replanting larger trees, which can be seen as a detriment by the Amish and Mennonite communities in the area.

Practitioner Responses

Practitioners conduct pre-restoration riparian assessments to highly variable degrees, and the acceptability of removing entire buffers or mature trees varied both from state-to-state and from project-to-project. The following list includes parameters identified as components of pre-restoration riparian assessments from all interviewees:

- Floodplain area
- Wetland distribution
- Forest distribution
- Utility constraints
- Forest resources inventory (to identify harvestable wood for stability structures on-site)
- Inventory of standing, dead, and at-risk trees
- Species composition
- Species size classes
- Habitat quality (including percentages of each stratum, presence/absence of exotic species)
- Species suitability (e.g., noting upland species within a stream corridor)

In Maryland, the extent of a pre-restoration riparian assessment is largely defined by the requirements in the Maryland Forest Conservation Act (MD FCA), which are relatively minimal and include parameters like a forest stand assessment and tree diameter measurement. In other areas with special requirements from property owners, assessment requirements may be more stringent. For example, project sites on National Park Service (NPS)-owned property require practitioners to measure and map all trees with DBHs greater than 6 inches. Some MD practitioners conduct more comprehensive assessments than what's required by the MD FCA regardless of property owner requirements. For example, Keith Binsted (Partner and Lead Designer for Underwood & Associated) noted that riparian assessments are always conducted, and site visits inherently include an analysis and characterization of the forest stand and natural resources. Kip Mumaw, PE (Principal Engineer for Ecosystem Services) has observed that concerns about trees catalyzing increased consideration of tree impacts during stream restoration projects are typically brought to light in one of two ways: 1) conversations initiated by practitioners directly, or 2) adjacent landowners of community stakeholders bring up tree impacts during the public outreach stage of the project. MDE began requiring a riparian condition assessment in late 2021 and recommends use of its assessment in the Upper Coastal Plain.

For practitioners in Virginia, the use of a pre-restoration riparian assessment depends on the consultant and/or client preferences as well as funding availability. Funding limitations are likely to necessitate a choice between conducting a full forest inventory or a survey of trees adjacent to the specific project area. Sometimes the riparian health considerations will be minimally examined or limited to concerns about the lateral constraints to building.

In Pennsylvania, the most comprehensive pre-restoration riparian assessment reported by an interviewed practitioner included a forest stand delineation and evaluation of species composition, significant tree size, and tree health. Multiple interviewees who work in PA indicated that they would like to conduct some form of a riparian forest assessment, but it may not occur due to feasibility constraints like client preferences, funding availability, and/or the absence of riparian tree stands near their project sites. None of the PA-based practitioners that were interviewed reported prioritizing tree health, forest stability, of forest longevity over streambank reconstruction. However, these considerations are deliberated as part of the project planning process. Practitioners in Pennsylvania pursue restoration projects that are informed by an evidence-based approach, which considers the appropriate vegetative community for the restored site and prioritizes addressing underlying causes of degradation rather than treating the symptoms of degradation.

As the degree of pre-restoration riparian assessments varies by state, practitioner, and project, so does the degree to which tree and canopy protection is considered. In Maryland, the vast majority of practitioners who were interviewed strongly consider tree and canopy protection in all phases of a project, especially on sites with cold-water trout habitat. Multiple practitioners explained that they assess and evaluate every tree on a site prior to making removal decisions. Multiple practitioners also noted that if a site has an exceptionally high-quality forest stand and a project is likely to cause extensive tree loss, then that site is reconsidered altogether. However, if construction with minimal tree loss is possible in a fully forested floodplain, then the project continues. A practitioner’s decision about whether to remove a tree depends on numerous characteristics, including accessibility constraints, tree size, tree health, invasive species, reusability for materials on-site during construction, etc. Two additional considerations mentioned by multiple practitioners were the effects of increased sunlight after clearing on the growth of invasive species and the effects of tree removal on soil structure and stability.

One practitioner in Virginia stated, “Tree canopy coverage is understood, but it's not typically considered. We design within a set of ranges, and we understand those ranges based on the channel size and the type of channel we're trying to create. If there's flexibility within the design as you move through the construction process, we do everything we can to avoid clearing large specimen trees. It's really the nature of the goals and objectives set out for the project itself, and then understanding them as you move forward.”

The removal of entire buffers or mature trees is typically avoided as much as possible but does occur in some situations. The removal of entire buffers was largely mentioned in association with legacy sediment removal projects. While many tend to avoid removing entire buffers, some practitioners in PA accept the removal as a necessary step in addressing the underlying causes of degradation for legacy sediment removal projects. The design goals for legacy sediment removal projects include removal of legacy sediment down to the historic floodplain elevation and reconnection to the gravel basal layer, which usually requires removing the whole forest if one exists. Another instance of entire buffer or mature tree removal is in association with risks to infrastructure where streams must be moved horizontally away from a utility, which means entire areas of forest may require removal. MD and PA practitioners noted that removal of entire buffers may also be necessary in preparation for dam removals, in which case the stream channel and riparian areas will need to be completely reconstructed after the removal of the dam. Building dams across the floodplain increases wetness, which can cause the death of entire buffers in the floodplain. The impacts of dams and resultant loss of species was also compared to the effects of building RSC berms in perennial systems. While Keith Binsted (Partner and Lead Designer for Underwood & Associates) who specializes in RSC design indicated that there is no typical scenario for RSC design where entire buffers or mature trees are removed because RSC design/construction is contingent upon the health of the riparian buffer, Josh Running (Senior Environmental Planner and Project Manager for Stantec) indicated that removal of entire buffers and mature trees can occur unintentionally after project completion. This might happen when a stream restoration strategy is used in an area "where it is not a good fit." For example, a stream designed to encourage more overland flow onto a riparian area where the current tree community and vegetation is not equipped to deal with the level of inundation will result in dead trees. Rich Starr (Senior Water Resource Scientist for EPR) noted that in these situations, the existing forested palustrine wetland pre-restoration will be replaced with an emergent type of wetland. This outcome potentially exists for beaver analog approaches as well.

Across all jurisdictions, practitioners largely agree on the time it takes for the riparian tree cover and structure to be restored. The timing of post-restoration replanting is usually fairly prompt and depends on the season, but the complete restoration to a full canopy or mature forest takes a very long time. The full restoration of the canopy and structure is multi-decadal and can take up to 40 years. In Fairfax County, stream restoration practitioners experiment with different planting techniques to provide higher degrees of canopy coverage in shorter amounts of time. One method is called clustering, and it involves planting several tree saplings very close together, which forces them to grow vertically instead of laterally. Planting plans developed by Underwood & Associates intentionally include each stratum to ensure robust plantings that provide immediate habitat and set the stage for long-term regeneration. The rebound time for revegetation depends on available planting budget, species composition, and general productivity of the specific ecosystem being restored. The first few years after project completion requires the aggressive maintenance of invasive species, assessment of survivability, and replacement of dead or at-risk vegetation as necessary. The structure of replanted vegetation is largely considered to be established (and in need of less intensive maintenance) after 3 to 5 years. Under the MD FCA, observation and maintenance—which involves invasive species suppression and additional planting—are required for 2 growing seasons after project completion (or 5 years for wetland planting). One important consideration mentioned by Scott McGill (CEO of Ecotone, Inc.) is the role of deer herbivory, which dramatically affects the survivability and species composition of replanted vegetation.

Best Practices

The interview question addressing best practices is below.

> What best practices are used to minimize impacts to riparian forests (this would include post-restoration maintenance)? To what extent are they implemented?

A broad variety of best practices for minimizing tree impacts during stream restoration projects were identified throughout the interviews. Typically, the best practices identified by representatives of state agencies echoed those identified by practitioners in their respective states. Additionally, the best practices reported by interviewees were relatively consistent across jurisdictions; the variation was mostly due to practitioner priorities. These best practices are grouped by project phase and summarized below.

Pre-Restoration Assessment & Planning

- From a high-level planning standpoint, comparing different restoration approaches to evaluate the impacts of temporary construction landscaping relative to the creation of a long-term, sustainable system is important. This comparative analysis of restoration approaches should also consider the level of risk a client or landowner is willing to accept for both routine and restorative maintenance.
- Limits of Disturbance (LODs) should be carefully drawn and managed. They should be kept as small as possible, and the construction sequence should be organized to prevent equipment from repeating trips over the same area many times.
- Trees on-site should be ranked during planning. Some factors for consideration in this ranking are tree health, location, size, value, bank proximity, root mass erosion status, and amount of shade cast.
- Developing (and implementing) planting plans that prioritize native species and consider impacts of invasive species is also a best practice.

Pre-Construction & During Construction

- Site managers responsible for riparian forest impacts should be present on site. Greg Golden (Senior Environmental Review Manager for MD DNR) noted that one of the best practices he has seen in Maryland is having "independent environmental managers" (IEPs) present on site. This ensures that the contractors responsible for tree removal only remove trees that are intended to be removed.
- Individual trees and swaths of trees to be protected should be flagged and marked.
- Trees that are at risk of being impacted by construction activities should have additional protection measures applied. Some practitioners use bracing/wood posts around the trunks to prevent equipment damage, and others use a combination of foam and wood for protection. Rich Starr (Senior Water Resource Scientist for EPR) explained that sturdy metal cages may be installed around trees and shrubs on sites

with large deer populations. Meghan Fellows (Ecological Restoration Specialist for Fairfax County) noted that all trees within 5 feet of the LOD should be armored.

- Root trimming was mentioned by a practitioner in Maryland as a best practice if running over a tree's roots with construction equipment is inevitable.
- One practitioner mentioned the installation of water gators (bags of water attached to the tree that slowly drip down) and mulch application around the trees to keep underlying soil moist.
- Rubber-tire construction vehicles should be used to minimize compaction. Ideally, those vehicles should be as small as possible.
- Various configurations of ground protection were also mentioned. These ground protection practices are intended to minimize rutting and compaction from construction and reinforce the organic content of the forest floodplain soils, which benefits native species. Multiple practitioners install a layer of woodchips (approximately 6 to 12 inches) on construction access paths. Some also install wood mats over the woodchip layer in wet areas. Joe Berg, CERP, PWS, CSE (Senior Ecologist and Practice Leader for Biohabitats, Inc.) noted that many Soil Conservation Districts are satisfied with just a light application of straw, but woodchips and mats are preferable. Joe Berg and Kip Mumaw, PE (Principal Engineer for Ecosystem Services) also mentioned that many invasive species are well-adapted to capitalizing on exposed mineral sediment, which is seen after running equipment through the forest without ground protection.
    - One practitioner based in MD noted that mulch access roads are effective but may be overused, noting concerns about associated costs.
- The reuse of downed or removed trees was also mentioned by many practitioners as a best practice. Reusing these trees on-site for stability controls or habitat creation is considered a best practice, both in terms of the stream's functional uplift and in terms of cost savings.
- MDE's new guidance includes additional provisions for the siting and components of access roads to maintain trees.

Post-Construction Maintenance & Monitoring

- One practitioner in Maryland mentioned that, as of the time of the interview, MD DNR does not pay for monitoring or maintenance for projects they fund. However, based on discussions with MD DNR, this practitioner believes they are going to start putting a percentage of their contract grants into a monitoring/maintenance fund. Steps like this and other funding sources for post-construction monitoring and maintenance would likely catalyze the implementation of best practices in this section. Interviewees from Pennsylvania and Virginia did not specifically address their funding sources for monitoring or maintenance.
- Many practitioners reported conducting monitoring and maintenance for 5 years post-construction. This includes post-construction vegetation management (consistent site inspections, removal of invasives, installing permanent vegetation replacements).

In Maryland, Wetlands and Waterways permitting requires the site to have 85% survival within the 5-year monitoring period; however, monitoring and performance standards are not always required by MDE. This vegetation management is especially important during the first 1 to 2 years post-construction since disturbance typically creates favorable conditions for invasive species. Meghan Fellows (Ecological Restoration Specialist) noted that Fairfax County attempts to control invasives 25 feet outside of the project's LOD.

- Keith Binsted (Partner and Lead Designer for Underwood & Associates) noted that his firm maintains a designated maintenance trail on projects, which allows practitioners to monitor and maintain constructed projects without contributing additional disturbance.

Design and Implementation

The interview questions addressing design and implementation are below.

What are the decision processes for selecting the type of restoration?
How are discrepancies between project design and implementation (such as expected vs. actual forest change) handled?
Are you aware of cases where there have been discrepancies between project design and implementation? If so, how were these discrepancies handled?
What are the parameters around plants/rocks/woody debris used for restoration and where it is sourced? What are the bounds on making materials "natural" or as high quality as possible?
What is done with the trees that are removed (e.g., are they sold? Are any used for restoration off-site or on-site?)?

Decision Processes for Restoration Type Selection

Decision processes for the selection of the type of restoration is widely variable. In some cases, a municipality, organization, or practitioner specializes in and only performs one type of restoration. There are some trends by state as well; for example, legacy sediment removal projects appear to only be pursued in Pennsylvania and are typically avoided in Maryland and Virginia.

Anne Arundel County considers watershed size, corridor type, velocities and energy through the system, hydrology, and other urbanization-associated impacts (e.g., encroachment, utility crossings, etc.) to determine the most appropriate type of restoration. As of the time of their interview, they have not yet developed any formal written guidance for this decision-making process.

Fairfax County typically does natural channel design (NCD) and occasionally regenerative stormwater conveyance (RSC). The restoration type decision process begins with the scoping and prioritization team whose thoughts provide direction during the early design and scoping phases once it is assigned to a project manager. A pre-concept plan further defines the restoration options and potential as they move forward with the project.

Lancaster County Conservation District (LCCD) works mostly on habitat and resource improvement, so their decision process is based on visual assessments and collaboration with the landowner.

The decision processes and preferred types of restoration vary immensely from practitioner-to-practitioner, both within and between these jurisdictions. The way in which practitioners described their decision-making process was also variable—some offered high-level, conceptual approaches, and others described how specific site conditions influence their restoration approach. Generally, most practitioners do not arrive at a new site with a preconceived preference for the type of restoration; they allow the assessment, site constraints, and goals drive the selected method. Practitioners mentioned the following factors as considerations for their selected restoration type:

- Geographic location/landscape position. Whether a stream is located in the mountains, piedmont, or coastal plain affects the restoration approach. With mountain streams, the approach would incorporate step pools, boulders, and cobble. With piedmont streams, the approach would create a meandering channel with wider floodplains. With coastal plain streams, the approach would create flat streams with high sinuosity and sand beds. Whether the valley is colluvial or alluvial is an important factor to consider.
- Stream type. An ephemeral stream—which is receiving a lot of stormwater, is eroding, and is transporting sediment and nutrients to a receiving stream—would have a different approach than a perennial stream that's incised to a point where it lacks groundwater support of flow.
- Land cover. Restoration is approached differently in forested vs. non-forested environments.
- Utility and accessibility constraints. Sometimes, a project is pursued because the stream is threatening existing utilities, in which case the channel would be moved to avoid those utilities. Additionally, when utilities or other site characteristics present accessibility constraints, those are considered in the restoration approach.
- Physical constraints. Physical constraints like low inverts on culverts can require floodplain excavation since the streambed elevation cannot be raised, and high inverts on culverts may require raising the streambed elevation.
- Overall/stakeholder goals. The restoration approach is informed by the goals and priorities of the project's client, landowner, and funder.
- Anticipated future condition. Multiple practitioners described that they consider the likely future condition of the site. Thinking beyond 5 years of post-construction monitoring is essential to the long-term sustainability and success of the project.

Rich Starr (Senior Water Resource Scientist for EPR) began describing his decision process for selecting a type of restoration with the following stance: "I want to develop a restoration solution that represents a stream and floodplain condition that would naturally form given existing and likely future watershed- and reach-level conditions and will be self-sustaining over time. I want to do this in a way that meets stakeholder goals and objectives. […] I do not always go to a site and say I'm going to try to do XYZ approach. I choose what will be self-sustaining for the site and meets stakeholder goals."

Discrepancies between Design & Implementation

Multiple practitioners described that their primary approach to avoid discrepancies between design and implementation is to conduct comprehensive planning. This was especially the case for discrepancies between expected and actual forest change that would require a permit modification or be considered a violation. Representatives from MDE explained, "Discrepancies after or during implementation are a violation of the permit and subject to enforcement action or through the permit modification process. MDE has taken compliance actions for some projects."

One MD practitioner explained that making a change on-site to protect additional trees is often unfeasible since it would require a change order (which is a formal, documented amendment to a contract, permit, or scope of work), which the client may refuse. As a result, discrepancies between the project's design and implementation simply lead to a learning outcome and a change in the practitioner's decision-making in the future.

However, multiple other practitioners described that they handle these discrepancies during the construction phase in a number of ways. Some practitioners explained that they are almost always on-site for construction oversight, so they are able to make changes to protect additional trees on-site with the contractor and client's representative; these changes are decided by consensus and as an appropriate response to a site condition. Another practitioner emphasized the importance of "making the plans match the site instead of changing the site to match the plans." Erik Michelson (Deputy Director for Anne Arundel County's Bureau of Watershed Protection & Restoration) described that planting plans that track survivability and post-construction vegetative management (including supplemental plantings and invasives control) can be used as a tool to handle discrepancies. Practitioners in PA echoed this approach, describing that it allows for fine-tuning as the forest and vegetation re-establishes. Some practitioners approach these changes with more associated documentation; they may devise a new design altogether and/or submit a change order. "Smaller" discrepancies, such as the plant palette/species list, may be modified during construction depending on hydrology—for example, shifting locations of specific plant species from areas with dry to wetter regimes based on post-construction conditions. Additionally, some practitioners rely on adaptive management, meaning that the discrepancies on-site "settle in" over time and resolve themselves. MDE recommends that they be notified of changes and determine whether or not the modification is acceptable and the extent of formal modification to an authorization.

Sourcing Materials for Restoration & Fate of Removed Trees

Nearly all interviewees explained that they aim to source all materials as close to the site as possible, with materials harvested on-site and reused being the most preferable. This is explained as providing more appropriate and effective functional uplift for the site and being preferable from a cost savings perspective. However, because solely using materials sourced on-site is not typically possible, materials from off-site must be sourced and utilized.

The materials sourced off-site vary from project-to-project. For example, the use of rocks is typically avoided in coastal plain projects. When rock is used in coastal plain projects, either wood, native sandstone, or granite is used for structural support to the maximum extent possible. Multiple interviewees mentioned that rock materials are chosen based on chemical composition, hardness, longevity, and density/weight per cubic yard.

In terms of woody debris, most practitioners prefer to source this from trees harvested on-site, or they will use trees harvested across the multiple sites that they are working on interchangeably. However, the same concept of "the closer to the site the better" applies across all types of materials. Trees harvested on-site are typically reused on-site for in-bed woody debris, stability or energy management structures, habitat creation, soil substrate integration, and/or mulch (for tree root protection or ground protection for construction access roads). Contractors are typically responsible for the removal of materials from the project site. One practitioner in Maryland described that, if trees are needed from off-site, they are typically sourced by the contractors; when possible, contractors watch where development is occurring nearby and purchase trees from there instead of removing trees from other areas. Some practitioners in Virginia also noted that a contractor may sell trees to a lumberyard depending on the tree's size and quality. Joshua Running (Senior Environmental Planner for Stantec) mentioned funds gained from this sale "just goes back into [the contractor's] project money." Only one Maryland practitioner reported ever having sold trees removed on site, and in that one case, removed trees were sold due to an explicit request from the landowner.

Plant materials also have specifications for use, and, again, practitioners prefer to use plants sourced as close to the site as possible. One practitioner in Maryland noted that vegetation sourcing is almost entirely based on which nurseries the project's contractors are familiar with, and that greater control of plant materials is more feasible for private projects. A few interviewees from a consulting firm in PA and Fairfax County mentioned the strict specifications for plant materials sourced from local vendors. In Fairfax County, plants are often protected by warranties in case the plants die after planting, and the plants are inspected for health and quality before being installed at the project site. This practice is often also done by practitioners associated with environmental consulting firms.

Post-Construction Monitoring

The interview questions addressing post-construction monitoring are below.

What post-construction monitoring is conducted and what is the purpose of the monitoring? Do monitoring requirements vary?

In your experience, what sort of post-construction monitoring is conducted for stream restoration projects in your area?

Post-construction monitoring requirements vary both by jurisdiction and by project goals, and they are largely considered to be ever evolving. Across all jurisdictions, mitigation banking sites were described as requiring intensive monitoring, and some interviewees described performance-based credit release cycles after construction until performance standards are met, which is typically for 5 to 10 years. In Pennsylvania, after 10 years, monitoring requirements can be released if a long-term steward walks the project site annually.

In Anne Arundel County, post-construction monitoring requirements vary slightly from project-to-project. The primary metrics included in this monitoring are those that MDE and the Corps of Engineers have expressed interest in, like project stability, plant survivability over 3 to 5 years, wetland development, and generalized vegetation establishment. The County conducts its own post-construction monitoring for the efficiency and cost-effectiveness purposes. The MD FCA includes post-construction monitoring requirements that are considered by practitioners to be more stringent than the requirements in VA or PA. Greg Golden (Senior Environmental Review Manager for MD DNR) described that post-construction monitoring is most valuable when paired with pre-design and pre-construction monitoring; however, that is frequently unfeasible due to the timing of site selection and finalization.

MDE representatives explained that the Wetlands & Waterways Program plans to conduct more follow-up for stream channel stability, structural integrity, and riparian condition, including restoration after temporary impacts. Additionally, MDE representatives explained that, for both MS4 projects and TMDL crediting projects, jurisdictions claiming credit are required to inspect the project at 5-year intervals and submit reports for continued crediting; however, at the time of the interview, MDE performs limited independent follow-up of this. MDE also has the ability to perform compliance checks after project authorization.

The state of Virginia requires the restored stream to be functional. In Fairfax County, post-construction inspections are conducted to ensure that restored streams are functioning as design and have not failed. County employees visit the project site anywhere from 6 to 30 times in the first year after restoration. Monitoring is conducted using maintenance cards and a stream condition assessment scorecard. Additionally, there is warranty monitoring to ensure the terms of the contract have been fulfilled (80% vegetated, 85% survival of woody vegetation, 90% survival of stakes, and minimal presence of invasive species).

In Pennsylvania, post-construction monitoring requirements may be dictated by permitting requirements, project site location and purpose, or the source of funding. Pennsylvania's Chapter 105 permits stipulate their monitoring and maintenance requirements. Other permitting requirements may include an as-built survey to confirm proper construction, photographic documentation of channel/floodplain stability over a 5-year period, and a measurement of the rate of native species establishment over a 5-year period. Additionally, operation and maintenance reports may be required for riparian buffers, and both longitudinal profiles and cross-sections typically apply to stream restoration projects greater than 1,000 linear feet. Dave Goerman Jr. (Water Program Specialist for PA DEP) explained that mitigation banking sites in Pennsylvania require intensive post-construction monitoring and performance-based credit release cycles. These sites are required to be monitored until all credits are sold or until they are no longer selling credits, which is typically for 5–10 years.

Responses from practitioners largely echoed the requirements outlined by their respective jurisdictions. Funding was frequently mentioned as a limiting factor for extensive post-construction monitoring. Some practitioners reported moving towards a function-based monitoring approach, where the metrics are designed to demonstrate that the restored stream is providing its designated functions (e.g., ecological uplift, stability). Typically, stream stability is the biggest determinant of project success. Some practitioners also noted that they monitor some projects more intensively to collect data that will inform and improve future projects. Kip Mumaw, PE (Principal Engineer for Ecosystem Services) summarized the monitoring requirements across project types very clearly: "For mitigation and nutrient trading, [monitoring is required for] 10 years. For TMDL projects, it's every 5 years in perpetuity, and if they're an MS4, they have additional annual reporting requirements. There are success criteria developed in the form of maintenance and monitoring plans for all of these project types—the contents of those plans vary from project to project and from practitioner to practitioner. Nationwide Permit 27 success criteria developed by the U.S. Army Corps of Engineers and the Chesapeake Bay Program Expert Panel guidance are typically referred to in order to outline monitoring protocols that are required for different types of projects."

Project Success

The interview questions addressing project success are below.

Have you designed or managed projects that you deem successful? If so, what made them successful?
Have you designed or managed projects that were less successful or unsuccessful? If so, what were some challenges or issues?
Are you aware or have you been involved with stream restoration projects that were successful? If so, what made them successful?
Are you aware or have you been involved with stream restoration projects that were less successful or unsuccessful? If so, what were some challenges or issues?

Metrics of Success

The operational definition of project success is variable, and success metrics depend on the goals of each project. Throughout the interviews, the following success metrics were identified:

- Streambank stability through a range of flow conditions
- Ecological uplift
- Habitat development, especially riparian wetland development
- Biological success and increased fish presence/species diversity

- Water quality improvements
- Good timing of construction/planting (in terms of seasonality and weather)
- Cooperative relationship between clients/landowners, practitioners, funders, and regulators
- Projects with goals to restore ecosystems rather than to achieve TMDL reductions or acquire profit
- Comprehensive planning (including proper site selection and consideration of existing resource quality)
- Projects that allow flexibility from contractors and permit reviewers
- Aesthetic value
- increased stability and resilience over time

Anne Arundel County explained, "Sites we're most happy about are those with robust vegetative response usually as a result of a dramatically increased groundwater hydrology. Stability is the bare minimum for project success." Greg Golden (Senior Environmental Review Manager for MD DNR) described that what made projects a stand-out success was "a comprehensive approach that […] focused on on-site resources from the beginning." Greg Golden also explained that projects that are most successful are those that are able to evolve over time.

Fairfax County has devised a "restoration recovery wheel" to help define success across values. The higher a project scores on a variety of different metrics and measurements determines if the project is successful. Community involvement also plays a role. The projects that the community get involved in and take ownership of are the ones that have the longest viability and sustainability. Pre-restoration community engagement is likely a key success factor; getting the local stakeholders involved, communicating, setting expectations, with consensus and on the project's goals.

Lancaster County Conservation District's successful projects are due to the cooperation of landowners and partners involved in the project. Matt Kofroth emphasized that "there has to be a give and take both from the contractor and the folks implementing but also the permits and permittees reviewing the permit. There needs to be some flexibility there to allow for changes on the fly." Maintenance also plays a vital role in advertising projects to the plain sect community in Lancaster County. A practitioner working in PA commented that "sites that have limited constraints and less landowner, client, or regulatory mandates to reduce impacts to land or existing trees, wetlands and other resources are typically much more successful in [their] experience as more holistic restoration approaches are afforded." Dave Goerman Jr. (Water Program Specialist for PA DEP) explained that all but one of the banking projects that he has reviewed in Pennsylvania have been deemed successful. He attributes this widespread success to the evidence-based process utilized by PA DEP that requires the demonstration of degradation, identification of underlying causes, and proposition of restorative actions that address the identified cause(s) of degradation.

Challenges to Success

Interviewees were forthcoming with the challenges they have observed in the course of their involvement with stream restoration. Multiple practitioners described that

A variety of challenges to project success were identified:

- Flashy, urban hydrology
- Constrained project areas
- Intense weather events causing structural failure
- Structures unable to dissipate energy as anticipated
- Planning downfalls
- Funding limitations, particularly in relation to post-construction maintenance or monitoring
- Ineffective coordination between landowner, designer, and contractor
- Incongruence between landowner, practitioner, and client objectives
- Ineffective landowner management post-construction
- Inability to adaptively manage due to a variety of logistical limitations
- Project goals of "checking the box off" for credits or regulatory reasons

Anne Arundel County explained that their least successful projects were largely associated with a challenging hydrologic regime with flashy, urban hydrology. Fairfax County's projects are challenged by community involvement and/or actions that negatively impact the regrowth in a restored area. Another measure of less successful projects in that county would be any project that presents low scores on measurements for different metrics. Lancaster County Conservation District's projects are often less successful when landowners change or when landowners' mindsets change because it can limit their ability to achieve the goals established for the project. At the PA state level, they explain that failure of stream restoration projects is rooted in the fact that the primary source of degradation that results from the physical/valley geomorphic characteristics or processes were not resolved or addressed (i.e., legacy sediment remained in place). MDE described that, since most restoration projects are driven by the pursuit of the most credits possible, restoration outcomes would benefit from a revised crediting process that considers an ecosystem crediting approach and the functionality of the entire riparian system as opposed to modeled nutrient/sediment reductions in the stream channel.

Summary

The intention of this policy/document review and interviews is to characterize the state of the science and not to designate any policy or interviewee as good/bad or right/wrong. As one of the interviewees, Greg Golden indicated, the topic of maintaining forests in stream restoration is a "wicked problem." In 1973, design theorists Horst Rittel and Melvin M. Webber used the term "wicked problem" to refer to problems that are difficult to define and inherently unsolvable (Rittel and Webber, 1973). Wicked problems are crosscutting in that they have many overlapping stakeholders with different perspectives, which for stream restoration includes federal, state, and local government agencies, practitioners, landowners, and other stakeholders within the community.

This section summarizes the findings from the policy/document review and interviews to identify any trends and best practices. The findings will be further synthesized as part of the final project report and recommendations for improving how forest health is accounted for stream restoration projects will be incorporated into the Best Practices Guide to be completed as part of a future project task. The summary is organized by the multiple stages of stream restoration, including site selection, design and permitting, implementation, and post restoration. Typically, the best practices identified were consistent among jurisdictions and those interviewed.

Site Selection

Site selection for stream restoration projects is typically done by either municipalities or planning-oriented organizations working in coordination with the municipalities. Stream restoration practitioners are often not involved in the planning, prioritization, or selection of sites, other than to provide comment on the applicability of a pre-identified site for restoration design and grant funding. Generally, sites are selected using one or a combination of the following methods: 1) opportunistic considerations, 2) watershed assessments conducted as part of a watershed planning initiative, or 3) mitigation banking efforts. In terms of mitigation banking projects, site selection is driven by the market and less through prioritization of a region/watershed.

Funding availability and landowner willingness were commonly identified as key parameters for site selection. Restoring lengths of stream that are significant at the landscape-scale is dependent on having agreement by multiple willing landowners. In some cases, a site is not necessarily the most optimal in relation to the rest of the watershed, but it is prioritized due to the likeliness that it will be implemented.

The identified best practices as part of project planning include:

- Targeting restoration to areas in need instead of existing high-quality areas.
- Pre-restoration community engagement, including getting local stakeholders involved, communication about the project, setting expectations, and gathering consensus on the project's goals.

Design and Permitting

The decision processes for the types of restoration vary widely among jurisdictions and practitioners. In some cases, a municipality, organization, or practitioner specializes in and only performs one type of restoration. There are some trends by state as well. For example, legacy sediment removal projects, which involve a high amount of disturbance and remove existing surface vegetation, appear to mainly be pursued in Pennsylvania and are typically avoided in Maryland and Virginia. The way in which practitioners described their decision-making process was also variable, however, most do not arrive at a new site with a preconceived preference for the type of restoration. They allow the assessment, site constraints, and goals to drive the selected method.

In terms of pre-restoration riparian assessments, inventory of environmental features is necessary if a federal project permit is required. At the state and local level, pre-restoration assessments are typically not formally required, but are encouraged. Funding limitations are likely to necessitate a choice between conducting a full forest inventory or a survey of trees adjacent to the specific project area. At the minimum, riparian assessments are informal, may or may not be documented, and are conducted by professional judgment. When practitioners conduct more detailed assessments, factors like dead/at-risk trees, root coverage, bank stability, habitat, soil type, and invasive species presence may be considered. In addition, states and local governments have forest agencies involved in stream restoration projects to some degree, but it’s not clear to what extent they coordinate with the other project partners in riparian assessment and developing an appropriate restoration strategy.

As the degree of pre-restoration riparian assessments varies by state, practitioner, and project, so does the degree to which tree and canopy protection is considered. Many of the state and local ordinances reviewed include criteria for the retention of existing forest or tree resources over replacement or replanting. Multiple practitioners noted that if a site has an exceptionally high-quality forest stand and a project is likely to cause extensive tree loss, then that site is reconsidered altogether. The removal of entire buffers or mature trees is also typically avoided as much as possible. However, the removal of entire buffers was largely mentioned in association with legacy sediment removal, dam removal, and infrastructure protection projects, in which case it is accepted as part of the restoration process. For sites where tree impacts cannot be avoided, the protection or larger trees with good root structure or canopy cover are prioritized.

Floodplain restoration projects in a fully forested floodplain tend to be constructed if it is determined that minimal tree loss is possible. However, in cases where dry, upland species are occupying a stream terrace that has dried out over time, those trees wouldn’t necessarily be targeted for removal, but their death as a result of stream restoration is sometimes considered an acceptable outcome.

One method to reduce loss of streamside forests is to require replanting of buffers when impacts to the buffer are considered unavoidable. Replanting the buffers is required by the 404 permits, 401 certification requirements, and state permits after the restoration is complete. Some jurisdictions like Fairfax County, experiment with different planting techniques to provide higher degrees of canopy coverage in shorter amounts of time. Planting plans developed by Underwood & Associates intentionally include each stratum to ensure robust plantings that provide immediate habitat and set the stage for long-term regeneration. However, it can be a challenge to successfully replace lost forest and not all efforts are successful without additional post-construction maintenance and protection from herbivory and establishment of water levels supportive of tree species.

The identified best practices as part of design and permitting include:

- Configuring the restoration design to unique site conditions instead of the site to a specific type of practice.
- Conducing a comparative analysis of different restoration approaches to evaluate the impacts of temporary construction landscaping relative to the creation of a long-term, sustainable system is important. This comparative analysis of restoration approaches should also consider the level of risk a client or landowner is willing to accept for both routine and restorative maintenance.
- Coordination among federal, state, and local governments, as well as practitioners, forest agencies, contractors, landowners, and local community stakeholders to come to consensus on the preferred design approach and project goals/objectives.
- Ranking of on-site trees during the planning process based on factors such as tree health, location, size, value, bank proximity, root mass erosion status, and amount of shade cast.
- Developing (and implementing) planting plans that prioritize native species and consider impacts of invasive species.
- Consideration of planting techniques to provide higher degrees of canopy coverage in shorter amounts of time. One method called involves planting several tree saplings very close together, which forces them to grow vertically instead of laterally.

Implementation

Multiple practitioners described that their primary approach to handling discrepancies between design and implementation is to avoid discrepancies to begin with by conducting comprehensive planning. This was especially the case for discrepancies between expected and actual forest change, which would require a project change order and may also trigger permit violations. Other practitioners may devise a new design altogether and/or submit a change order. “Smaller” discrepancies, such as the plant palette/species list, may be modified during construction depending on hydrology—for example, shifting locations of specific plant species from areas with dry to wetter regimes based on post-construction conditions. Additionally, some practitioners rely on adaptive management, meaning that the discrepancies on-site “settle in” over time and resolve themselves. MDE has found discrepancies after or during implementation to be a violation of the permit and subject to enforcement action or through the permit modification process. MDE has taken compliance actions for some projects.

In terms of woody debris, most practitioners prefer to source this from trees harvested on-site, or they will use trees harvested across the multiple sites that they are working on interchangeably. Trees harvested on-site are typically reused on-site for in-bed woody debris, stability or energy management structures, habitat creation, soil substrate integration, and/or mulch (for tree root protection or ground protection for construction access roads).

There are many available guidance documents that include information for best practices during stream restoration implementation. Some of the predominant best practices for maintaining forests and riparian vegetation during construction that were identified from the document review and interviews include:

- Site managers responsible for riparian forest impacts should be present on site.
- Limits of Disturbance (LODs) should be carefully drawn and managed. They should be kept as small as possible, and the construction sequence should be organized to prevent equipment from repeating trips over the same area many times.
- Individual trees and swaths of trees to be protected should be flagged and marked.
- Trees that are at risk of being impacted by construction activities should have additional protection measures applied. Some practitioners use bracing/wood posts around the trunks to prevent equipment damage, and others use a combination of foam and wood for protection. Sturdy metal cages may be installed around trees and shrubs on sites with large deer populations. All trees within 5 feet of the LOD should be armored.
- Rubber-tire construction vehicles should be used to minimize compaction. Ideally, those vehicles should be as small as possible.
- Root trimming if impact from construction equipment is unavoidable.
- Installation of water gators (bags of water attached to the tree that slowly drip down) and mulch application around the trees to keep underlying soil moist.
- Implementation of ground protection practices to minimize rutting and compaction from construction and reinforce the organic content of the forest floodplain soils, which benefits native species.
- Reuse downed or removed trees on-site.
- Use planting plans that track survivability and post-construction vegetative management (including supplemental plantings and invasives control) as a tool to handle discrepancies, which allows for fine-tuning as the forest and vegetation re-establishes.

Post Construction

Post-construction monitoring is required for permitted projects, but policies and regulations did not always specifically mention forest resources. Nationwide Permit 27 success criteria developed by the U.S. Army Corps of Engineers and the Chesapeake Bay Program Expert Panel guidance are typically referenced in order to outline monitoring protocols that are required for different types of projects. Mitigation banking sites were described as requiring intensive monitoring, with performance-based credit release cycles after construction until performance standards are met, which is typically for 5 to 10 years. In addition, state monitoring requirements vary, with the MD FCA post-construction monitoring requirements considered by practitioners to be more stringent than the requirements in VA or PA.

Typically, stream stability is the biggest determinant of project success. Some practitioners reported moving towards more of a function-based monitoring approach, where the metrics are designed to demonstrate that the restored stream is providing its designated functions (e.g., ecological uplift, stability). However, funding was frequently mentioned as a limiting factor for extensive post-construction monitoring.

Across all jurisdictions, practitioners largely agree on the time it takes for the riparian tree cover and structure to be restored. The full restoration of the canopy and structure is multi-decadal and can take up to 40 years. Many practitioners reported conducting monitoring and maintenance for 5 years post-construction. This includes post-construction vegetation management (consistent site inspections, removal of invasives, installing permanent vegetation replacements).

The identified best practices during the post-construction period include:

- Establishment of funding sources for post-construction monitoring and maintenance.
- Maintain a designated maintenance trail on projects, to allow practitioners to monitor and maintain constructed projects without contributing additional disturbance.

Next Steps

The Center will synthesize the policy/document review and interviews into a project report that includes recommendations on opportunities to improve consideration of riparian areas in stream corridor restoration projects to minimize unintended adverse consequences. This may include opportunities to better incentivize practices that minimize riparian impacts, couple these practices to improve water quality and habitat improvements, or improve safeguards to minimize the loss of riparian forest cover and forest structure during and after stream restoration project implementation. The results will also be used to help develop a best practices guidance document for local governments that will summarize opportunities to improve consideration of the riparian area and forests in stream corridor restoration.

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Appendix D. Case Studies Summary

Maintaining Forests in Stream Corridor Restoration
Case Studies

Introduction and Purpose

With growing interest and implementation of stream restoration in the Chesapeake Bay Watershed, there is an increasing need for research about the "trade-off" value of these practices compared to impacts on adjacent forest buffers. The Center for Watershed Protection (CWP) developed a set of case studies to support the project "Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned," a collaborative effort with the Chesapeake Bay Program (CBP) and stakeholders to evaluate impacts of stream restoration projects on existing riparian ecology and forest buffers in Maryland, Pennsylvania, and Virginia.

The purpose of the case studies was to evaluate changes in riparian vegetation associated with stream restoration projects, including the level of post-construction riparian vegetation success. Another goal was to quantify the change in pollutant loads associated with any land cover modifications compared to pollutant load reductions from the stream restoration projects, to evaluate if there were any trade-offs due to project implementation. Results from this case study analysis will be used in the development of guidance for local governments on the best practices to minimize unintended adverse outcomes to riparian forests and help improve selection, permitting, and funding processes for stream restoration projects in the Chesapeake Bay watershed.

Three counties were identified for the case study analysis to represent each of the three states, and a variety of physiographic regions and stream restoration design types. The counties were selected based on the availability of stream restoration projects, feedback from a Stakeholder Team survey, and available monitoring data. Each county provided a list of stream restoration projects that were considered representative of projects occurring in the county and for which GIS/CAD data, as-builts, permitting documents, design reports, and/or monitoring data were available. CWP ultimately selected ten of these projects for which sufficient data was able to be obtained

Methods

CWP used a combination of geospatial analysis, modeling, and document review to develop the case studies. To assess vegetation change at each study site, CWP used the currently available 2013/2014 1-m resolution land use data from the Chesapeake Conservancy[1], as well as NAIP imagery and leaf-off aerial imagery to delineate the land cover within the limit of disturbance (LOD) of each project site before and after restoration. To assist with this process, Peter Claggett from USGS provided a link to an online land use change viewer[2] that shows areas where change occurred between the 2013/2014 dataset and the forthcoming 2017/2018 land cover dataset. Because the pre-construction timeframe of the stream restoration projects did not always align with the timeframe of the 2013/2014 dataset, best professional judgement was used to determine the pre-construction land cover for some projects.

To quantify changes in pollutant loads, CWP used pollutant loading rates from the Chesapeake Assessment and Scenario Tool (CAST) for the Phase 6 land-river segment where each project is

[1] https://www.chesapeakeconservancy.org/conservation-innovation-center/high-resolution-data/land-use-data-project/
[2] Land Use Change Viewer (cicapps.org)

located. The loading rates were used with the quantified pre- and post-restoration land cover types to calculate the change in loads associated with land cover conversion due to project construction. The pollutant load reductions associated with each stream restoration project were calculated using the CBP stream restoration planning rate, as well as those calculated using the stream restoration crediting protocols (Schueler and Stack, 2014[3]; Wood et al., 2021[4]) when that information was included with the project data. The planning rate provides for a consistent stream restoration load reduction across all projects based on the pounds of nutrient and sediment reduction per foot of stream restoration project, whereas the load reductions reported for using the CBP crediting protocols are a more accurate estimate based on specific-site conditions and the restoration approach at each site.

CWP reviewed project information, including permitting documents and monitoring reports, to summarize regulatory requirements related to vegetation on the project sites, whether the requirements were met, and the level of post-construction riparian vegetation success. The Nationwide Permit 27 (NWP 27) applied to all but one of the case study projects. NWP 27 includes activities in waters of the United States associated with aquatic habitat restoration, enhancement, and establishment activities, provided those activities result in net increases in aquatic resource functions and services.

Case Studies

The case studies, including the type of restoration and year completed are provided in Table 1 below. Click on the link to each case study to navigate to its location within this document.

Table 1. Stream restoration case studies.

County	Site Name	Stream Restoration Design Type	Year Completed
Lancaster County, PA	Big Spring Run	Legacy Sediment Removal	2011
	Rock Lititz	Legacy Sediment Removal	2014
Anne Arundel County, MD	Bacon Ridge	Beaver Dam Analog	2019
	Cowhide Branch	Regenerative Stormwater Conveyance	2018
	Furnace Creek	Floodplain Reconnection	2020
	North Muddy Branch	Regenerative Stormwater Conveyance	2016
Fairfax County, VA	Big Rocky Run	Natural Channel Design	2015
	Flatlick Branch	Natural Channel Design	2018
	Paul Spring Branch	Natural Channel Design	2015
	Pohick Creek	Natural Channel Design	2014

Key Findings

The key findings from the case studies include:

[3] Schueler, T. and Stack, B. 2014. Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects. https://www.chesapeakebay.net/documents/Stream_Panel_Report_Final_08282014_Appendices_A_G.pdf

[4] Wood, D., Schueler, T., and B. Stack. 2021. A Unified Guide for Crediting Stream and Floodplain Restoration Projects in the Chesapeake Bay Watershed. https://chesapeakestormwater.net/download/11608/

- The level of pre- and post-construction monitoring varied among communities. At a minimum, monitoring was conducted to meet NWP or state programmatic general permit requirements. More comprehensive monitoring was conducted at some project sites of interest for research purposes, such as Big Spring Run in Lancaster County, and North Muddy Branch in Anne Arundel County.
- Each community used a variety of different methods to assess the riparian community before and after the project, making it hard to compare across sites.
- The most common land cover conversion in the Anne Arundel County projects was forest to floodplain wetlands (as a result of raising the stream bed and reconnecting the channel to the floodplain).
- The most common land cover conversion in Fairfax County was forest to mixed open and/or "tree canopy over turf," which, in the Chesapeake Conservancy land cover dataset, includes individual trees or groups of trees planted over pervious surfaces. It is important to note that the post-construction land cover at these sites is not turf but areas that were cleared during construction and replanted, but the new plantings have not matured enough to be classified as a forest yet.
- For most projects, there hasn't been enough time post-construction to evaluate the conversion of areas disturbed during construction back to a forested condition. However, some of the projects indicate a slight conversion of "tree canopy over turf" back to forest, indicating a trajectory toward reforestation.
- Both Lancaster County projects involved conversion of agricultural land to floodplain wetland (wet meadow in one case, the other intended to convert to forest eventually).
- In cases where forest was converted to tree canopy over turf, the nutrient and sediment load reduction benefits of restoration significantly outweighed any negative water quality impacts from the land use conversion. Some of the projects converted forest to wetlands, in which case there was no water quality impact from the land use conversion. The legacy sediment projects in Lancaster converted agricultural land to wetland, which resulted in a water quality benefit from the land use conversion due to agricultural land having a higher loading rate than wetlands. Overall, the benefits of the stream restoration projects outweighed any negative impacts from the land cover changes.
- Many of the sites had not been in place long enough to see any real changes in the post-construction riparian community from the land use analysis. However, sites where monitoring was conducted indicate that planting success requirements have been met and full revegetation is anticipated over a longer time period.

This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement CB96374201 to the Chesapeake Bay Trust. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document.

Project Background

This project involved the restoration of approximately 2,000 linear feet of the Big Spring Run mainstem and 1,000 feet of a tributary through the removal of 22,000 tons of legacy sediment. The post-restoration stream and floodplain wetland ecosystem established at the level of the original wetland hydric soil consists of small channels with low banks that frequently flow overbank. Specific objectives of the Big Spring Run restoration project were to:

1) Restore the Big Spring Run valley bottom back to its natural ecological condition.
2) Create a stable reach using a natural restoration approach and applicable geomorphic principles.
3) Reduce deposition/aggradation and bank degradation/lateral migration within the project reach.
4) Reduce levels of non-point source pollution from streambank erosion and improve water quality.
5) Improve aquatic and riparian habitat and create/restore and enhance wetlands.
6) Educate the community of the importance of environmental conservation, help demonstrate the value of water resources, and raise environmental awareness.

A map of the stream restoration project site is provided in Figure 1 and the key background information is included in Table 2.

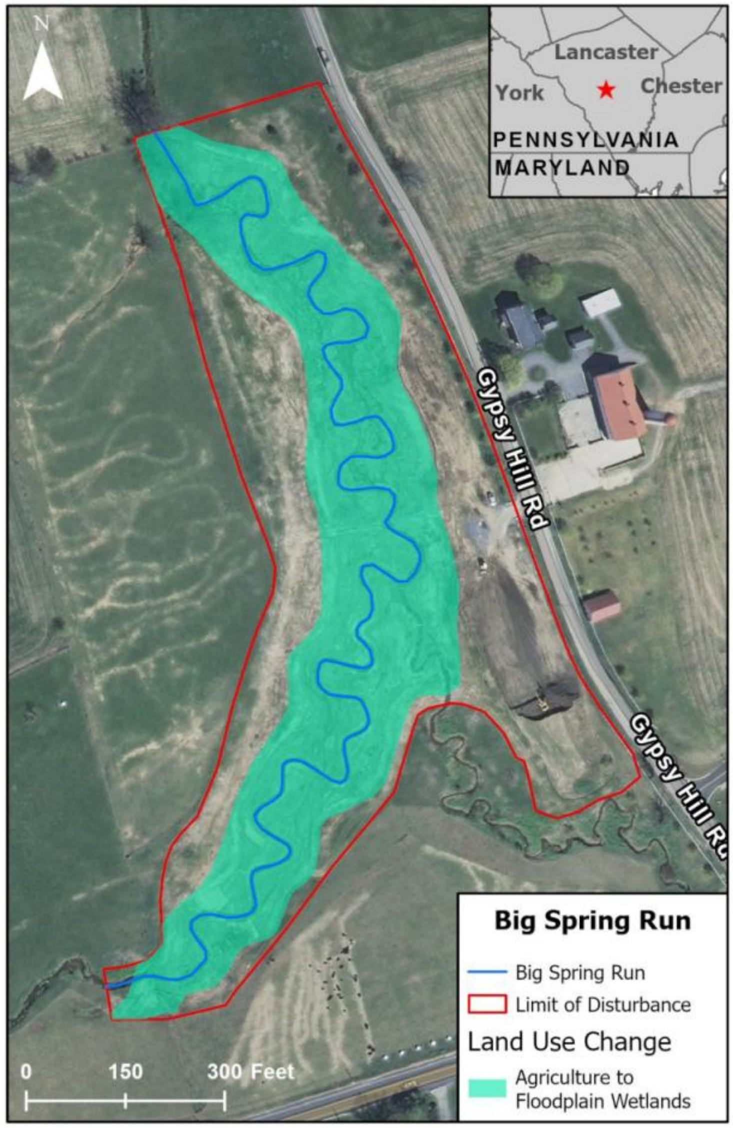


Figure 1. Big Spring Run pre- to post-restoration land use change with post-restoration 2012 aerial imagery.

Regulatory Requirements

Nationwide permit 27 was required, but permitting information was unavailable for this project. It is assumed that the standard requirement of 5 years of monitoring for success, with the site released after three years with Corps approval.

Table 2. Background information about the Big Spring Run stream restoration project in Lancaster County, PA.

Address	Route 222 and Gypsy Hill Rd, West Lampeter Township
Restoration Design Type	Legacy Sediment Removal
Year Completed	2011
Physiographic Region	Piedmont
Watershed Land Use	Agricultural
Project Length	3,000 ft

Riparian Vegetation Change

Land use changes within the Big Spring Run project's Limits of Disturbance (LOD)[5] are summarized in Figure 2. Prior to restoration, the land use within the Big Spring Run LOD was entirely agricultural pastureland. Construction resulted in the conversion of 5.7 acres of pasture to floodplain wetland.

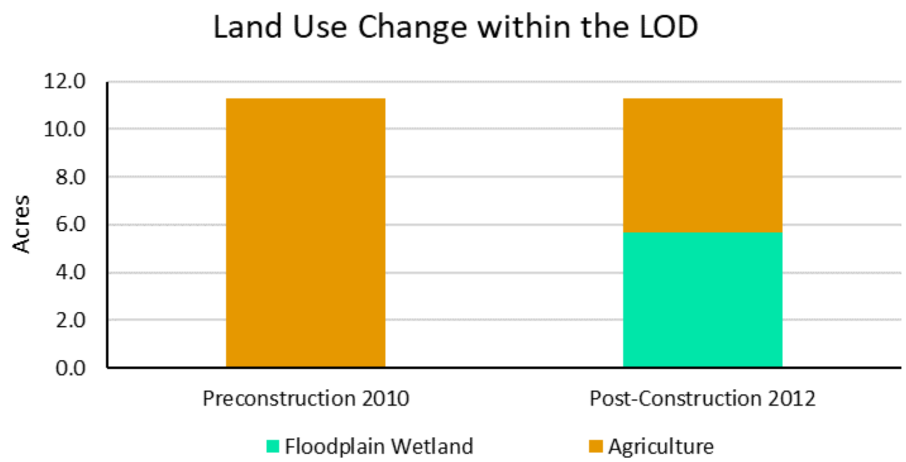


Figure 2. Land use change within the Big Spring Run stream restoration limits of disturbance.

The pre-restoration vegetation at this site was growing on legacy sediment accumulated within the last ~300 years and was dominated by non-native agricultural grasses and the native Canada thistle. The area contained only a handful of hydric species around the channel margins and a few scattered patches of other wetland species near a spring.

By removing legacy sediment to restore the natural valley morphology, and thereby restore natural hydrologic and hydric soil conditions, the target post-restoration condition consists of natural wetland plant communities similar to the pre-settlement palustrine emergent marsh that is predominantly an open canopy wet meadow. A commercial wetland seed mixture that included species indicative of wet-meadow herbaceous plant communities in the region and those in the paleo-seed record was applied to the entire site. In addition, approximately 10,000 commercially available container grown herbaceous plants, commonly referred to as plugs and predominantly sedges and rushes typical of tussock forming sedge meadows, were installed. Some woody species (shrubs and trees) were added to the perimeter of the wet meadow, forming a riparian buffer for the restored palustrine emergent wetland.

Analysis of vegetation transects before and after restoration at Big Spring Run reveals a major ecological change after legacy sediment was removed. Vegetation shifted from a dry, upland pasture environment to a low, hydric wet meadow that is still undergoing succession as vegetation stabilizes within the hydrologic regime. The wetland has expanded from essentially a 5-meter area around a single channel meander before 2011 to a 40-50-meter-wide wetland with considerable increase in hydric plant diversity since 2012. A strictly sedge meadow similar to that which existed for thousands of years prior to burial by legacy sediment has not yet been established; instead, a species-rich "wet meadow" has emerged with rice cutgrass, jewelweed, cattail, scattered flowering composites and sedge dominated patches providing a diverse wetland habitat that has the potential to be "equally as valuable" from an ecological and plant diversity standpoint.

[5] The Big Spring Run LOD was not included on the project plans. For the purposes of this case study, it was approximated by the floodplain area indicated on the plans and disturbance observed on aerial photographs.

Water Quality Impacts

Changes in TN, TP, and TSS loads associated with both the land use conversion pre- to post-restoration and the stream restoration project are provided in Table 3. Stream restoration reductions using both the CBP stream restoration planning rate and monitoring of surface water quality are provided for comparison. Both the land use conversion and stream restoration result in load reductions. The land use loading reductions for TN and TP are the result of conversion of pre-restoration agricultural pastureland with higher loading rates to post-restoration floodplain wetlands with lower loading rates. In comparison, TSS load increased as a result of the land use change due to higher loading rates for floodplain wetlands than pastureland.

Table 3. Load change comparison for TN, TP, and TSS (lbs/yr) of land use conversion and stream restoration.

Edge-of-Stream (EOS) Load (lbs/yr)	Change in Load from Land Use Conversion Pre- to Post-Restoration[1]	Load Reduction from Stream Restoration (Planning Rate)	Load Reduction from Surface Water Monitoring[2]
TN	-272	-225	-1,740
TP	-24	-204	-1,380
TSS	280	-744,000	-1,200,000

[1] Loads from land use conversion were calculated from loading rates obtained from CAST using the P6 land-river segment where the project is located and the progress scenario of the year prior to completion of the stream restoration project.
[2] Load reductions obtained from Big Spring Run example documentation included in Altland et al. (2020). Consensus Recommendations for Crediting Floodplain Restoration Projects Involving Legacy Sediments.

Summary

The Big Spring Run stream restoration was a legacy sediment removal project constructed in 2011 in an agricultural area. Predominant riparian vegetation change was the conversion of approximately 6 acres of pasture to floodplain wetland. Both the land use conversion and stream restoration result in load reductions for TN and TP. However, TSS load increased as a result of the land use change due to higher loading rates for floodplain wetlands than pastureland. Restoration resulted in the creation of a hydric wet meadow that provides a diverse wetland habitat.

Preconstruction

http://www.bsr-project.org/photos.html

Post-Construction

Land Studies, Inc.

Figure 3. Pre- and post-construction photos of Big Spring Run.

Rock Lititz/Santo Domingo Creek Stream Restoration Lancaster County, PA

Maintaining Forests in Stream Corridor Restoration Case Study

Project Background

This project involved the restoration of approximately 3,555 linear feet of predominantly ephemeral stream channel within the Santo Domingo Creek watershed that had been straightened to accommodate agricultural activities. The primary goal was to remove 55,371 cubic yards of legacy sediment and restore the floodplain to conditions that resemble pre-settlement bottomland hardwood forest conditions that likely existed with anastomosed channels. As a secondary benefit, this project was designed to manage the additional stormwater runoff volume and peak rate associated with adjacent development on the 96-acre Rock Lititz commercial development. Additional benefits include enhanced groundwater recharge, suspended sediment reduction, as well as ecological and aesthetic improvements.

A map of the stream restoration project site is provided in Figure 4 and the key background information is included in Table 4.

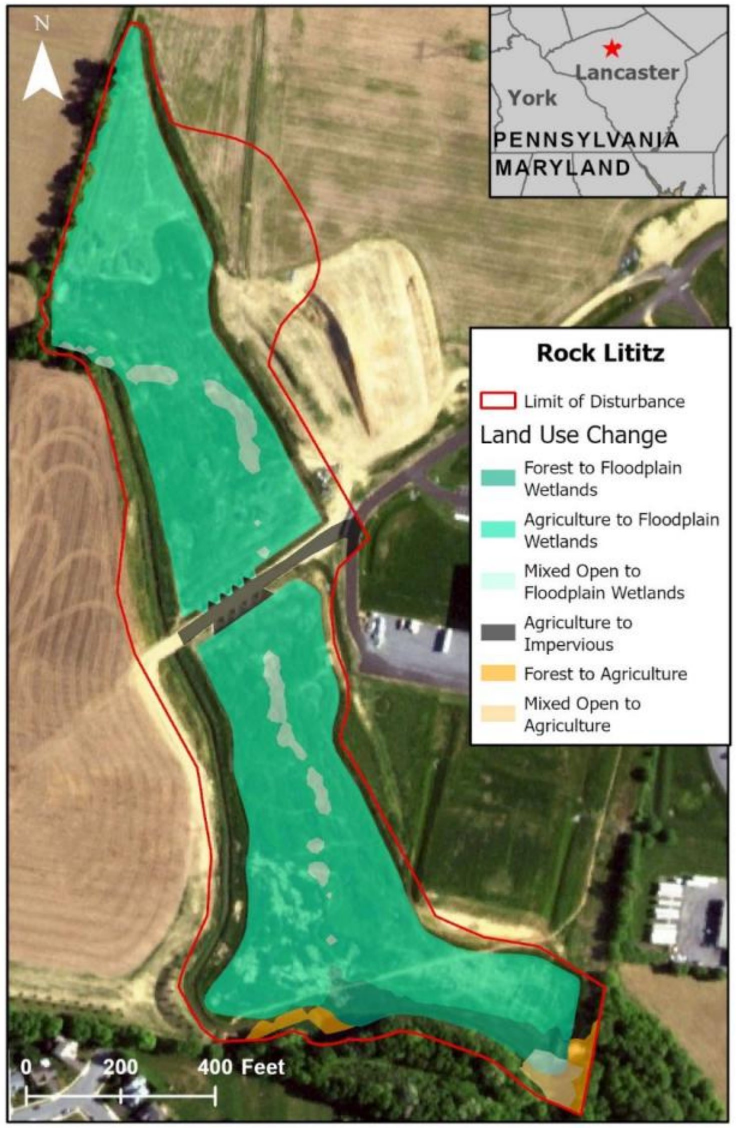


Figure 4. Rock Lititz pre- to post-restoration land use change with post-restoration 2016 aerial imagery.

Table 4. Background information about the Rock Lititz/Santo Domingo Creek stream restoration project in Lancaster County, PA.

Address	Rock Lititz Property, West Newport Road and SR 501
Restoration Design Type	Legacy Sediment Removal
Year Completed	2014
Physiographic Region	Piedmont
Watershed Land Use	Agricultural
Project Length	3,555 ft

Regulatory Requirements

Pennsylvania State Programmatic General Permit – 4 (PASPGP-4) applied to this project. Requirements included the establishment/restoration of approximately 3,555 linear feet of anastomosed channel system and associated bottomland hardwood forest community. The stream and floodplain restoration area were also required to be surveyed prior to any planting or seeding to ensure the elevations of the newly graded surfaces were correct for the successful growth of the plants selected. All temporarily impacted areas were required to be restored and /or replanted to their preconstruction contours within 15 days following construction. Five years of monitoring were conducted to demonstrate project success following the post-construction stormwater manual plan vegetation success criteria of total aerial cover >60% of native species after the first annual inspection and >85% after two years and thereafter.

This project did not require a separate Nationwide Permit 27 (NWP 27). According to U.S. Army Corps of Engineers, Baltimore District, most NWPs have been suspended in Maryland and the Baltimore and Philadelphia District's area of responsibility within Pennsylvania since the State Programmatic General Permits provide comparable Department of the Army authorization.

An NPDES permit was also required because the floodplain restoration was acting as the primary stormwater management for the site.

Riparian Vegetation Change

Land use changes within the Rock Lititz project's Limits of Disturbance (LOD) are summarized in Figure 5. Prior to restoration, the land use within the Rock Lititz LOD was predominantly agricultural (cropland). Construction resulted in the conversion of approximately 20 acres of agriculture, 0.91 acres of forest and 0.87 acres of mixed open land to floodplain wetland with some impervious non-road and road additions.

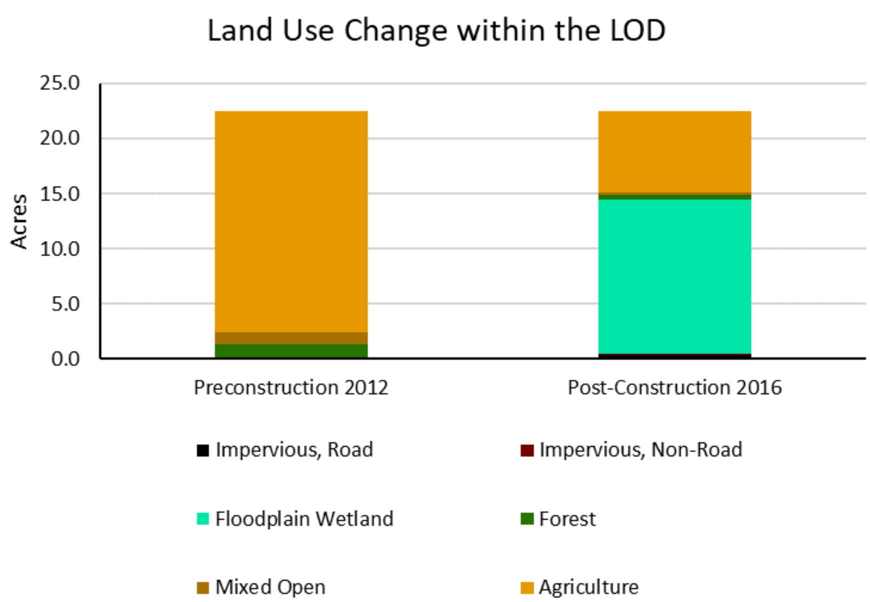


Figure 5. Land use change within the Rock Lititz stream restoration limits of disturbance.

The restored floodplain was seeded with a mix of warm season grasses, cool season grasses, sedges, and other select herbaceous species. A mix of native conservation grade trees were planted with the intent of establishing a robust forest as the trees mature. The most recent monitoring report (2021) indicates overall good conditions for the vegetation. Total riparian vegetation aerial coverage of 99% was reported, which exceeds the vegetation success criteria of the stormwater management plan. Willow and other tree species are well established and expanding in upper portion of floodplain. 100% tree and plant survival is now reported and volunteer species and additional planting far exceeds the original tree and shrub mortality. Some invasives such as Reed Canary Grass (RCG) are becoming established in areas of the floodplain and Canada Thistle and Poison Hemlock are also present in small quantities. Invasives control was recommended in the form of treatment of isolated patches of RCG to prevent expansion and treatment next to patches of desirable herbaceous material to facilitate replacement with native species.

Water Quality Impacts

Changes in TN, TP, and TSS loads associated with both the land use conversion pre- to post-restoration and the stream restoration project are provided in Table 5. Stream restoration reductions using both the CBP stream restoration planning rate and the crediting protocols are provided for comparison. Both the land use conversion and stream restoration result in load reductions. The land use load reductions are the result of conversion of pre-restoration agricultural cropland with higher loading rates to post-restoration floodplain wetlands with lower loading rates.

Table 5. Load change comparison for TN, TP, and TSS (lbs/yr) of land use conversion and stream restoration.

Edge-of-Stream (EOS) Load (lbs/yr)	Change in Load from Land Use Conversion Pre- to Post-Restoration[1]	Load Reduction from Stream Restoration (Planning Rate)	Load Reduction from Stream Restoration (CBP Crediting Protocols)[2]
TN	-1,820	-267	-1,007
TP	-35	-242	-155
TSS	-14,939	-881,640	-248,000

[1] Loads from land use conversion were calculated from loading rates obtained from CAST using the P6 land-river segment where the project is located and the progress scenario of the year prior to completion of the stream restoration project.
[2] CBP Crediting Protocols 1 and 3.

Summary

The Rock Lititz stream restoration was a legacy sediment removal project constructed in 2014 in an agricultural area. Predominant riparian vegetation change was the conversion of approximately 20 acres of cropland to floodplain wetland. Both the land use conversion and stream restoration result in load reductions, with higher TN load reduction for the land use conversion and TP and TSS load reductions higher for the stream restoration. Results from monitoring conducted 7 years post-construction indicate vegetation success has exceeded criteria of the post-construction stormwater management plan.

Preconstruction	Post-Construction

Figure 6. Pre- and post-construction photos of Rock Lititz.

Bacon Ridge Stream Restoration
Anne Arundel County, MD
Maintaining Forests in Stream Corridor Restoration Case Study

Project Background

This project involved the restoration of approximately 4,350 linear feet of eroding stream using a beaver dam analog in the South River Watershed. The project reconnected the stream to its floodplain, provides improved stabilization, enhanced and restored habitat, and provided nutrient-reduction benefits. The design is a natural, low-impact approach that features interlocking log jams placed at various points in the stream where they act as grade control structures in place of typical rock weirs. The objectives of the project were to:

1) Modify the hydraulics of the stream channel and valley to optimize floodplain reconnections of stormflows
2) Improve geomorphic conditions of the stream channel to ensure long-term bed and bank stability
3) Detain and slow stormwater flows throughout the full width of the valley bottom, assisting with the improvement in physiochemical functions and water quality
4) Create and enhance the ecological functions of existing and historic non-tidal wetlands and stream habitats and functions

A map of the stream restoration project site is provided in Figure 7 and the key background information is included in Table 6.

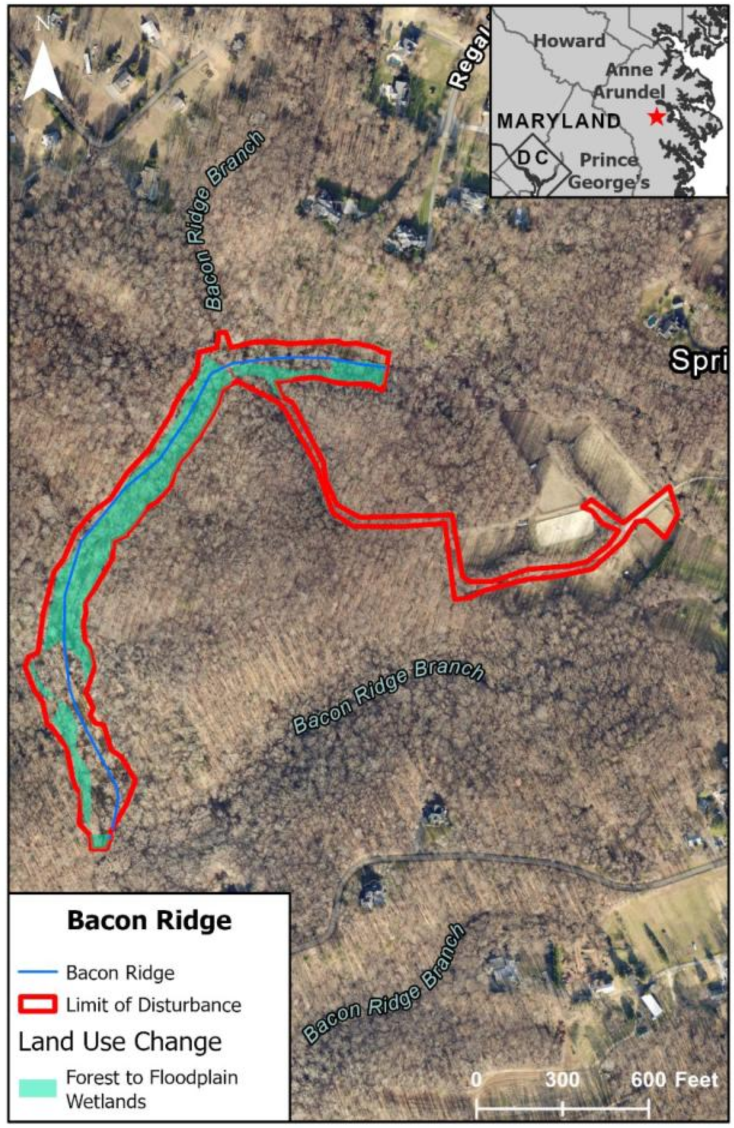


Figure 7. Bacon Ridge pre- to post-restoration land use change shown with post-restoration 2021 aerial imagery.

Regulatory Requirements

Nationwide Permit 27 applies to this project. Requirements include 3 years of monitoring for success. Vegetation species richness and cover was required to be included in monitoring reports, with an 85% survival rate of all plantings for 3 years post-construction. In addition, wetland vegetation dominance must be achieved, where more than 50% of

Table 6. Background information about the Bacon Ridge stream restoration project in Anne Arundel County, MD.

Address	Intersection of Severn Chapel Rd & Waterbury Rd, Crownsville
Restoration Design Type	Beaver Dam Analog
Year Completed	2019
Physiographic Region	Western Coastal Plain
Watershed Land Use	Agricultural/Forest
Project Length	4,350 ft

all dominant plant species are rated obligate, facultative wet, or facultative.

MDE issued a General Permit for Stormwater Associated with Construction Activity, but riparian vegetation requirements were not specified.

Riparian Vegetation Change

Land use changes within the Bacon Ridge project's Limits of Disturbance (LOD) are summarized in Figure 8. Prior to restoration, the land use within the Bacon Ridge LOD was predominantly forested. Construction resulted in the conversion of about 4 acres of forest to floodplain wetlands.

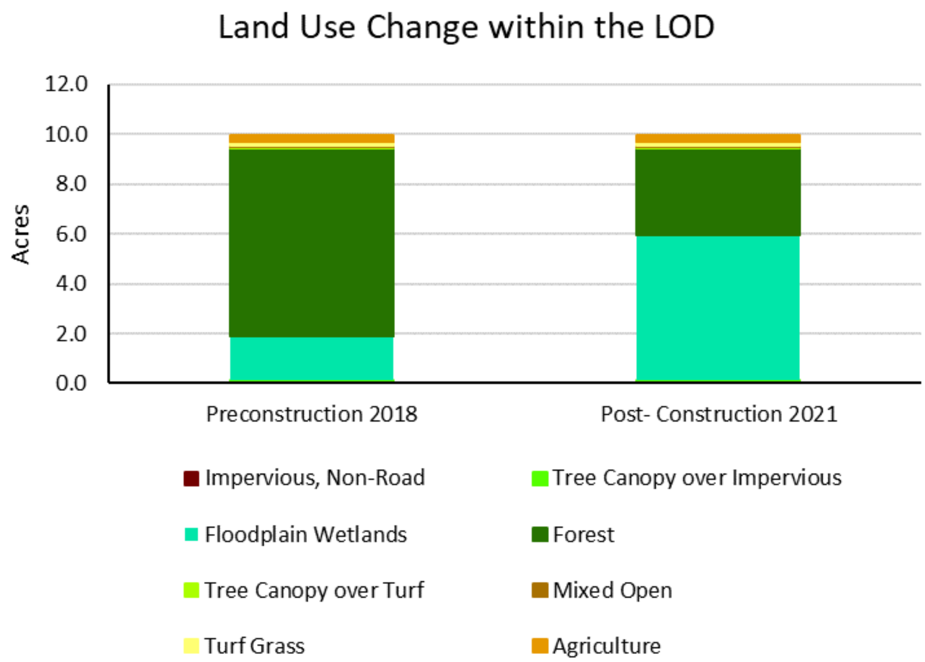


Figure 8. Land use change within the Bacon Ridge stream restoration limits of disturbance.

The entire project area was composed of one continuous forest stand prior to restoration that consisted of upland dominant species. Numerous trees were found to be at-risk due to leaning more than 45 degrees, having half exposed root masses on the stream banks, and/or were broken at the top. In addition, about 145 tulip trees were located within the floodplain, which are not appropriate species for a forested floodplain wetland. The project design anticipated removing at-most 17% of the standing stock of the existing forest stand, with most of these incorporated into the on-site design structures.

Restoration of the site included some conversion to a more wet-adapted community, but the existing community was sufficiently tolerant of increased hydro periods of short duration wetting. The landscape plan contained a mix of wet meadow and floodplain forest, with a small amount of wet shrub mix for the depressions. Approximately 0.2 acres of seed for floodplain depression were planted as well as 3 acres for both the floodplain clearing and shaded floodplain areas. Post-restoration vegetation monitoring data was not available for this project.

One of the noted lessons learned from this project was that it is more efficient to purchase cedar posts for the logs that were driven into the ground vertically. Harvesting them onsite and sharpening them properly would have been too time intensive and lead to project delays.

Water Quality Impacts

Changes in TN, TP, and TSS loads associated with both the land use conversion pre- to post-restoration and the stream restoration project are provided in Table 7. Stream restoration reductions using both the CBP stream restoration planning rate and the crediting protocols are provided for comparison. There was no change in load from land use conversion, except a minimal increase for TSS, due to the comparable loading rates of forest and floodplain wetlands.

Table 7. Load change comparison for TN, TP, and TSS (lbs/yr) of land use conversion and stream restoration.

Edge-of-Stream (EOS) Load (lbs/yr)	Change in Load from Land Use Conversion Pre- to Post-Restoration[1]	Load Reduction from Stream Restoration (Planning Rate)	Load Reduction from Stream Restoration (CBP Crediting Protocols)[2]
TN	0	-326	-633
TP	0	-296	-292
TSS	0.2	-1,078,800	-78,300,000

[1] Loads from land use conversion were calculated from loading rates obtained from CAST using the P6 land-river segment where the project is located and the progress scenario of the year prior to completion of the stream restoration project.
[2] CBP Crediting Protocol 1.

Summary

The Bacon Ridge stream restoration was a beaver dam analog project constructed in 2019 in watershed consisting primarily of agriculture and forest. Predominant riparian vegetation change was the conversion of approximately 4 acres of forest to floodplain wetland. No change in load from land use conversion was observed due to the comparable loading rates of forest and floodplain wetlands.

Figure 9. Preconstruction photo of Bacon Ridge.

Cowhide Branch Lower Stream Restoration Anne Arundel County, MD

Maintaining Forests in Stream Corridor Restoration Case Study

Project Background

This project involved the restoration of 940 feet of an existing impounded stream through the removal of an existing stone riprap dam and conversion the former dam system into a wetland seepage system consisting of a series of low stage weirs, installed up and downstream of the dam site, intended to restore full fish passage to the reach. The restoration included construction of a step pool stormwater conveyance system, reconnection of the stream to the adjacent floodplain, removal of existing riprap from the stream channel, enhancement of existing wetlands with the addition of native hydrophytic vegetation, and creation of additional wetlands. The flow regime from Cowhide Branch to tidal Weems Creek is occasionally influenced by tidal action in the downstream estuary, exclusively in the reach downstream of Admiral Drive. However, this influence is rare.

A map of the stream restoration project site is provided in Figure 10 and the key background information is included in Table 8.

Figure 10. Cowhide Branch Lower limit of disturbance shown with post-restoration 2021 aerial imagery.

Regulatory Requirements

A US Army Corps of Engineers Nationwide Permit 27 applied to this project. Requirements that involve riparian vegetation include:

- Implementation of an invasive species eradication and maintenance plan for bamboo and phragmites
- 5 years of post-construction monitoring that includes wetland delineations, vegetation viability measurements
- 85% survival rate of all plantings for 5 years post-construction. Non-planted natural woody plants (commonly

Table 8. Background information about the Cowhide Branch stream restoration project in Anne Arundel County, MD.

Address	North of Jennifer Road, in Annapolis, MD
Restoration Design Type	Regenerative Stormwater Conveyance
Year Completed	2018
Physiographic Region	Coastal Plain
Watershed Land Use	Suburban
Project Length	940 ft

referred to as "volunteers") of native/non-nuisance species are permitted to count towards the overall survival rate

MDE Tidal Authorization requirements include:

- Coverage of 85% of the planted area after a period of 1-year. The planted area shall be maintained as a wetland, with nonnuisance species coverage of at least 85% for 3 consecutive years.
- Submission and approval of a detailed marsh maintenance plan. The maintenance plan developed by the County includes 5 years of monitoring and the removal and control of bamboo in addition to the 85% planting coverage requirements included in the MDE tidal authorization.

Additional permits without riparian vegetation requirements specified include MDE Non-Tidal Authorization and General Permit for Stormwater Associated with Construction Activity.

Riparian Vegetation Change

Land use within the Cowhide Branch Lower project's Limits of Disturbance (LOD) consists predominantly of tidal wetlands as summarized in Figure 11. The analysis does not show a change in riparian vegetation after the restoration. Note that the information included in permitting documents indicates predominantly temporary non-tidal forested wetland impacts, but the summary of the 2013/2014 high resolution land use data within the Chesapeake Bay watershed used for this analysis indicates this site is mostly tidal wetland. This is most likely due to inconsistencies in the classification wetlands at this site between the land use dataset and the wetland delineations conducted for permitting. Regardless, there appears to be no land use change associated with this restoration project.

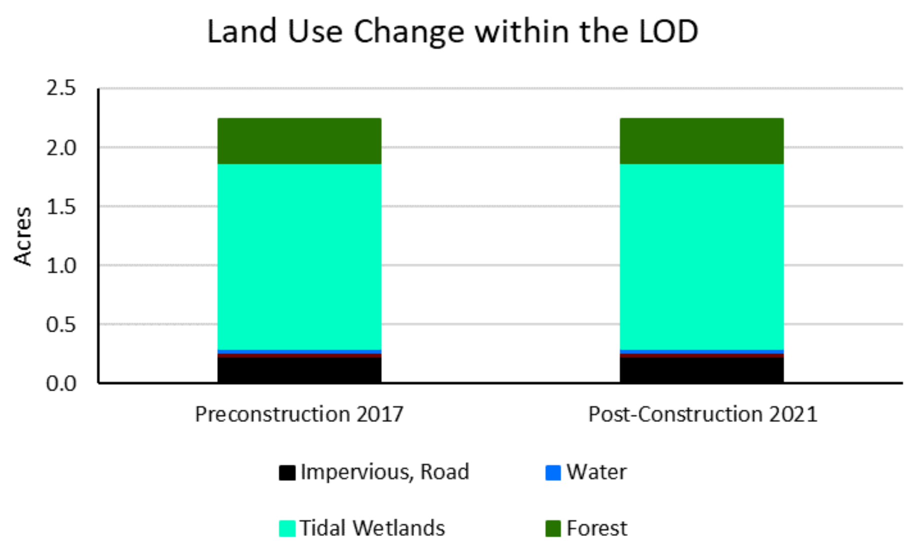


Figure 11. Land use change within the Cowhide Branch Lower limits of disturbance.

The post-construction vegetation monitoring plan involved sampling of fixed 1/50th acre plots for a representative sample of approximately 8% of the restored non-tidal forested wetland area. The primary purpose of monitoring of woody vegetation was to ensure that the Nationwide Permit 27 requirements for plant viability were met. Community occurrence monitoring which looks at the vegetative cover for all species (woody and herbaceous) was also conducted for the purposes of examining changes over time in the plant community, and for identifying any non-native or invasive plant species that may impact the project.

The overall survival rate of woody vegetation, including both planted and native volunteers, ranged from 145% to 167%[6] during the first 3 years of post-construction monitoring, exceeding the 85% required by the Nationwide Permit 27. Except for autumn olive, black cherry, tulip poplar, and black locust, all observed volunteer woody species are regionally native and typical of bottomland habitat.

Competition from climbing hempweed resulted in mortality of planted trees along the northern boundary of the planting area. This is particularly evident where protective tree cages were installed, as hempweed vines utilized the cages as a trellis and fully engulfed planted specimens. Non-native/invasive species of note which were observed within the project area (both inside and outside of monitoring plots) include Chinese bushclover, common reed, small carpetgrass, Japanese stiltgrass, and to a lesser extent, English ivy and Japanese honeysuckle. These species are all aggressive colonizers with the ability to outcompete and displace native vegetation, and negatively affect ecosystem function and resiliency.

In September 2021, climbing hempweed was both manually removed and herbicidally treated in areas where it was observed having detrimental effects on planted trees. All tree cages were removed from the project site to discourage the growth of climbing hempweed and other vines. Rank grasses and other vegetation were cut in the immediate vicinity of some planted woody specimens to reduce competition and encourage growth of trees and shrubs. Additionally, common reed within the project site was treated herbicidally.

Water Quality Impacts

Changes in TN, TP, and TSS loads associated with both the land use conversion pre- to post-restoration and the stream restoration project are provided in Table 9. Stream restoration reductions using both the CBP stream restoration planning rate and the crediting protocols are provided for comparison. No land use conversion occurred and therefore there are no associated load changes.

Table 9. Load change comparison for TN, TP, and TSS (lbs/yr) of land use conversion and stream restoration.

Edge-of-Stream (EOS) Load (lbs/yr)	Change in Load from Land Use Conversion Pre- to Post-Restoration[1]	Load Reduction from Stream Restoration (Planning Rate)	Load Reduction from Stream Restoration (CBP Crediting Protocols)[2]
TN	0	-71	-255
TP	0	-64	-
TSS	0	-233,120	-

[1] No land use conversion occurred.
[2] CBP Crediting Protocol 2.

Summary

The Cowhide Branch stream restoration was a regenerative stormwater conveyance project constructed in 2018 in a suburban area. No land use conversion occurred and therefore there are no associated load changes.

[6] Calculated as the percentage of total woody specimens (including volunteers) observed compared to the total woody specimens planted.

Preconstruction	Post-Construction
	

Figure 12. Pre- and post-construction photos of Cowhide Branch.

Furnace Creek Stream Restoration Phase 2
Anne Arundel County, MD
Maintaining Forests in Stream Corridor Restoration Case Study

Project Background

This project involved the restoration of approximately 3,700 linear feet of Furnace Creek and approximately 200 linear feet of a tributary to Furnace Creek in the Patapsco River Tidal Watershed. The project objectives were to provide ecological enhancement, support requirements of the National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit, and to help meet pollutant load reductions associated with Chesapeake Bay Total Maximum Daily Load (TMDL). The restoration involved the conversion of 1,000 linear ft of trapezoidal, concrete-lined channel to a floodplain wetland complex with a base flow channel. An additional 1,500 linear feet were filled to raise the existing stream and create a new shallow baseflow channel with increased sinuosity and floodplain reconnection.

A map of the stream restoration project site is provided in Figure 13 and the key background information is included in Table 10.

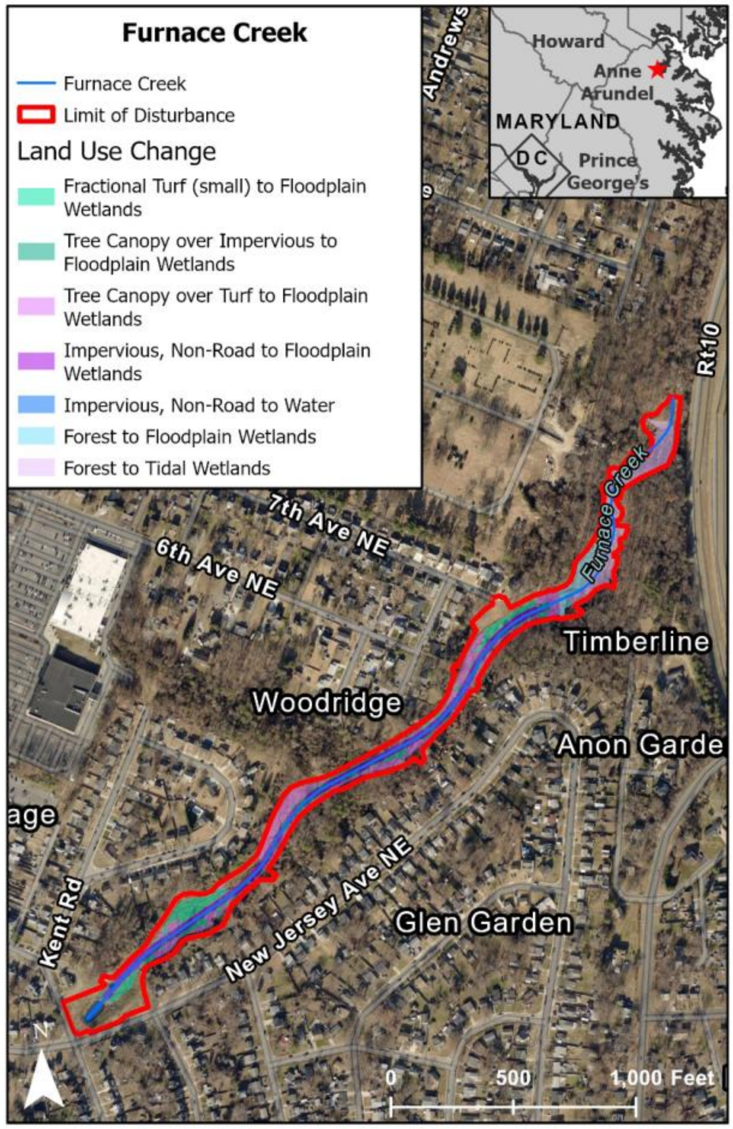


Figure 13. Furnace Creek pre- to post-restoration land use change shown with post-restoration 2021 aerial imagery.

Table 10. Background information about the Furnace Creek stream restoration project in Anne Arundel County, MD.	
Address	South of Glen Haven Memorial Gardens Cemetery, intersection of Kent Rd & New Jersey Ave NE
Restoration Design Type	Floodplain Reconnection
Year Completed	2020
Physiographic Region	Western Coastal Plain
Watershed Land Use	Suburban
Project Length	3,900 feet

Regulatory Requirements

Nationwide Permit 27 applies to this project. Requirements include 3 years of monitoring for success and report vegetation species richness and cover in monitoring reports. In addition, wetland vegetation dominance must be achieved, where more than 50% of all dominant plant species are rated obligate, facultative wet, or facultative.

MDE issued a §401 Water Quality Certification that requires wetland monitoring on years 1, 3, and 5 following project completion, including vegetation viability measurements. The project is required to result in at least 15,513 square feet of nontidal wetland creation to offset permanent wetland impacts. The wetland creation must be monitored in year 5 to show it is meeting the following project standards:

- Wetland hydrology, as defined in the Regional Supplement of the U.S. Army Corps of Engineers wetland delineation manual
- Minimum of 85% native (indicator status of FAC or wetter) species
- Native wetland plant density of at least 435 living trees/shrubs with a minimum height of 10 inches per acre (FAC or wetter)

Riparian Vegetation Change

Land use changes within the Furnace Creek project's Limits of Disturbance (LOD) are summarized in Figure 14. Prior to restoration, most of the land use within the Furnace Creek LOD was a combination of tree canopy over turf, forest, fractional turf, and impervious (associated with the concrete-lined channel). Construction resulted in the conversion of approximately 1.9 acres of forest, 1.6 acres of impervious, and 0.9 acres of fractional turf to tidal and floodplain wetlands.

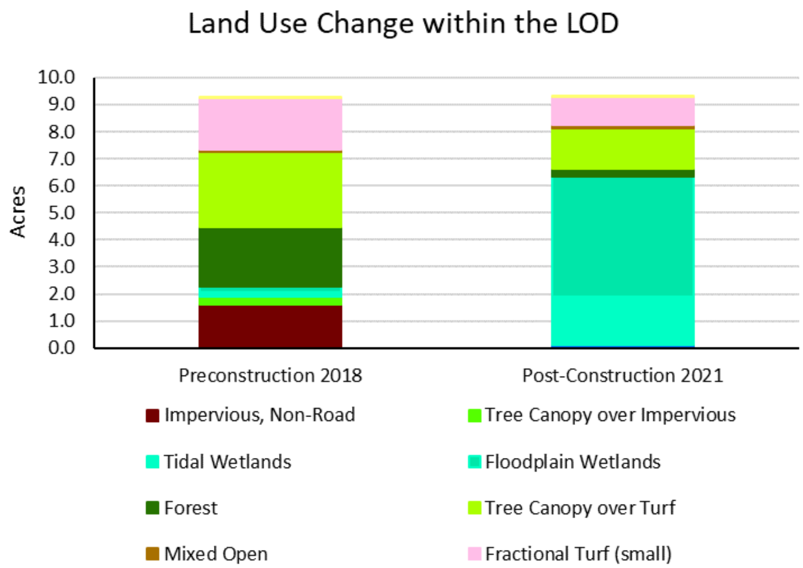


Figure 14. Land use change within the Furnace Creek stream restoration limits of disturbance.

A pre-restoration specimen tree inventory counted 25 trees with a Diameter at Breast Height (DBH) measure of greater than 30 inches, ranging from poor to good condition.

The Anne Arundel County Bureau of Watershed Protection and Restoration monitored performance of the project site following a rapid assessment protocol based on the Stream Functions Pyramid developed by StreamMechanics, PLLC (Harman et al., 2012[7]) and the Function-Based Rapid Field Stream Assessment Methodology (Starr et al., 2015[8]). The first year of post-construction monitoring found the riparian vegetation parameter to be "Functioning at Risk," which was as expected based on design due to the urban location with residential homes on either side of the project site. It was noted that a good stand of vegetation was present and comprised of an appropriate community based on the project planting plan. A post-restoration wetland delineation will be performed in monitoring year 5.

[7] Harman, W. R. Starr, M. Carter, K. Tweedy, M. Clemmons, K. Suggs, C. Miller. 2012, A Function-Based Framework for Stream Assessment and Restoration Projects. U.S. Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Washington, D.C. EPA 843-K-12-006.

[8] Starr, R., W. Harman, S. Davis. 2015. FINAL DRAFT Function-Based Rapid Field Stream Assessment Methodology. U. S. Fish and Wildlife Service, Chesapeake Bay Field Office, Annapolis, MD. CAFE S15-06.

Water Quality Impacts

Changes in TN, TP, and TSS loads associated with both the land use conversion pre- to post-restoration and the stream restoration project are provided in Table 11. Stream restoration reductions using both the CBP stream restoration planning rate and the crediting protocols are provided for comparison. Both the land use conversion and stream restoration result in load reductions. The land use load reductions are the result of conversion of the pre-restoration impervious stream channel and turf with higher loading rates to post-restoration wetlands with lower loading rates. The stream restoration results in higher load reduction than the land use conversion.

Table 11. Load change comparison for TN, TP, and TSS (lbs/yr) of land use conversion and stream restoration.

Edge-of-Stream (EOS) Load (lbs/yr)	Change in Load from Land Use Conversion Pre- to Post-Restoration[1]	Load Reduction from Stream Restoration (Planning Rate)	Load Reduction from Stream Restoration (CBP Crediting Protocols)[2]
TN	-43	-278	-1,683
TP	-2	-252	-167
TSS	-1,699	-917,600	-114,000

[1] Loads from land use conversion were calculated from loading rates obtained from CAST using the P6 land-river segment where the project is located and the progress scenario of the year prior to completion of the stream restoration project.
[2] CBP Crediting Protocols 1, 2, and 3.

Summary

The Furnace Creek stream restoration was a floodplain reconnection project constructed in 2020 in a suburban area. Predominant riparian vegetation change was the conversion of approximately 1.9 acres of forest, 1.6 acres of impervious, and 0.9 acres of fractional turf to tidal and floodplain wetlands. Both the land use conversion and stream restoration result in load reductions, with higher reductions for the stream restoration. Results from the first year of post-construction monitoring found the riparian vegetation to be "Functioning at Risk," which was as expected due to the urban location with residential homes on either side of the project site.

Preconstruction

PHOTO 4: LOWER PROJECT SUBREACH

PHOTO 7: CONCRETE CHANNEL IN UPPER PROJECT SUBREACH

Post-construction


Figure 15. Pre- and post-construction photos of Furnace Creek.

Project Background

This project involved the restoration of approximately 1,500 linear feet of North Branch Muddy Creek located on property owned by the Smithsonian Environmental Research Center (SERC) in Edgewater, MD. The restoration included a regenerative stream channel design to fill the incised channel with a layer of gravel topped with a mixture of sand and wood chips to raise the channel to the legacy fill terrace. The fill was stabilized with a series of rock weirs and berms to deflect stream flow out onto the floodplain. This design aimed to increase residence time of water and encourage frequent flooding of the floodplain to increase sediment deposition and nutrient removal via biological uptake.

A map of the stream restoration project site is provided in Figure 16 and the key background information is included in Table 12.

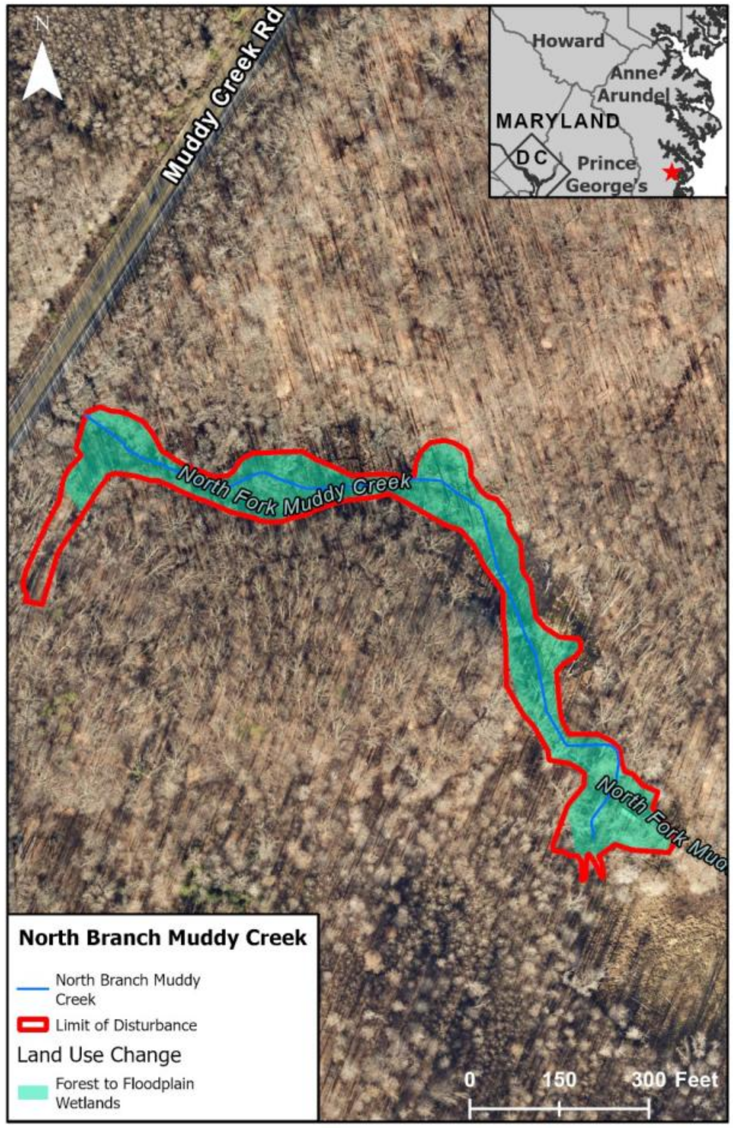


Figure 16. North Branch Muddy Creek pre- to post-restoration land use change with post-restoration 2021 aerial imagery.

Regulatory Requirements

Nationwide Permit 27 applies to this project. Requirements include 5 years of monitoring for success and report vegetation species richness and cover in monitoring reports. In addition, >80% vegetative cover is required within the limit of disturbance.

MDE Authorization from the Water Management Administration was also issued but did not include specific vegetation requirements.

Table 12. Background information about the North Branch Muddy Creek stream restoration project in Edgewater, MD.

Address	3924 Muddy Creek Rd, Edgewater, MD 21037
Restoration Design Type	Regenerative Stormwater Conveyance
Year Completed	2016
Physiographic Region	Coastal Plain
Watershed Land Use	Agricultural
Project Length	1,500 linear feet

Riparian Vegetation Change

Land use changes within the North Branch Muddy Creek project's Limits of Disturbance (LOD) are summarized in Figure 17. Prior to restoration, the land use within the North Branch Muddy Creek LOD was almost entirely forested. Construction resulted in the conversion of about 2.5 acres of forest to floodplain wetlands.

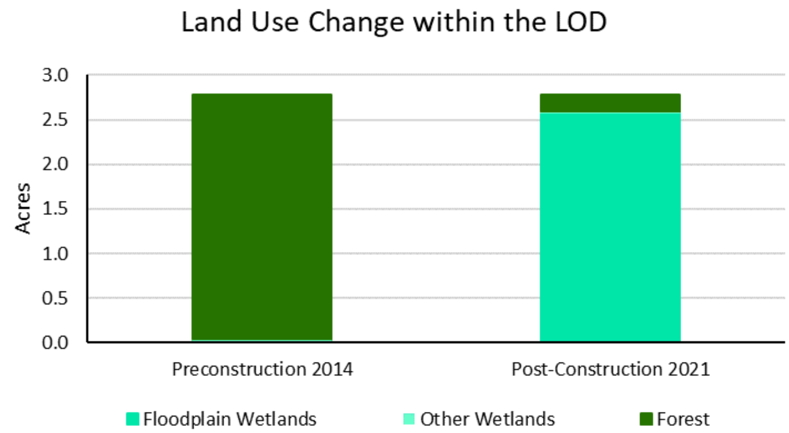


Figure 17. Land use change within the North Branch Muddy Creek stream restoration limits of disturbance.

The U.S. Fish and Wildlife Service conducted a pre-restoration function-based geomorphic assessment of the project. Prior to restoration, the vegetation included a dense canopy, with trees approximately 40 to 60 years old. Species included sweet gum, sycamore, box elder, tulip poplar, and maple. There was minimal understory, and the groundcover consisted of wild multiflora rose and other annual vegetation. The riparian vegetation was classified as "Not Functioning" according to the Stream Function Pyramid Framework (Harman et al., 2012[9]).

Pre- and post-restoration vegetation monitoring was also done as part of the project by the Smithsonian Environmental Research Center (SERC) to evaluate the growth of trees at the restoration site. Dendrometer bands were put on the trees and the distance between two points on the bands was measured on a weekly basis for three years. Growth was calculated as a percentage of the increase from the first to the last measurement for each year. Figure 18 shows the pre- and post-restoration mean values for trees growing on the edge of the stream (mostly *Liriodendron tulipifera*) versus trees on the floodplain but closer to the border with the upland.

[9] Harman, W. R. Starr, M. Carter, K. Tweedy, M. Clemmons, K. Suggs, C. Miller. 2012, A Function-Based Framework for Stream Assessment and Restoration Projects. U.S. Environmental Protection Agency, Office of Wetlands, Oceans, and Watersheds, Washington, D.C. EPA 843-K-12-006.

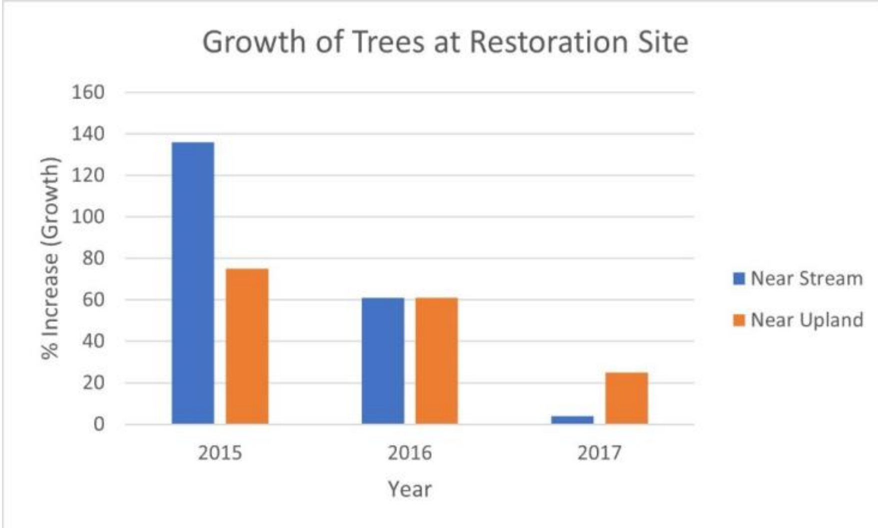


Figure 18. Tree growth at the North Branch Muddy Creek restoration site.[10] *Growth in 2015 was measured pre-restoration and growth in years 2016 and 2017 were measured post-restoration.*

The data clearly show that raising the water level resulted in decreased growth and the decrease was greatest near the creek bank where all but one of the *Liriodendron* were located. Because *Liriodendron* don't survive or grow very well in wet habitats, these results were expected and not viewed as a negative result of the restoration.

Table 13 shows a comparison provided by Dennis Whigham at SERC between the number of trees and shrubs found in 2015 versus 2022 at three study 10' X 10' plots established in three transects at the stream restoration site. The transects run from the top of the restoration (Transect 1) to the bottom (Transect 3). At the time of the examination in 2022 it was reported that the plots associated with Transect 3 were mostly water covered, plots associated with Transect 2 were partially water covered, and Transect 1 plots were not water covered (other than water in a few low spots).

Table 13. Results from tree plots at North Branch Muddy Creek project site.

Transect #	Vegetation Type	Number near the creek		Number away from the creek	
		Pre-restoration 2015	*Post-restoration 2022*	*Pre-restoration 2015*	*Post-restoration 2022*
Transect 1	Trees	4	1	4	3
	Shrubs	21	20	13	22
Transect 2	Trees	4	1	7	5
	Shrubs	10	10	13	22
Transect 3	Trees	3	2	2	0
	Shrubs	21	0	11	0

Water Quality Impacts

Changes in TN, TP, and TSS loads associated with both the land use conversion pre- to post-restoration and the stream restoration project are provided in Table 14. Stream restoration reductions using both the CBP stream restoration planning rate and the crediting protocols are provided for

[10] Figure provided by Dennis Whigham (Smithsonian Environmental Research Center).

comparison. There was no change in load associated with land use conversion because the project involved the conversion of forest to wetland, which have the same loading rates.

Table 14. Load change comparison for TN, TP, and TSS (lbs/yr) of land use conversion and stream restoration.

Edge-of-Stream (EOS) Load (lbs/yr)	Change in Load from Land Use Conversion Pre- to Post-Restoration[1]	Load Reduction from Stream Restoration (Planning Rate)	Load Reduction from Stream Restoration (CBP Crediting Protocols)[2]
TN	0	-113	-1,691
TP	0	-102	-243
TSS	0	-372,000	-458,880

[1] Loads from land use conversion were calculated from loading rates obtained from CAST using the P6 land-river segment where the project is located and the progress scenario of the year prior to completion of the stream restoration project.
[2]The CBP crediting protocols were followed, but the specific CBP protocols were not reported.

A study conducted by Thompson et al. (2018)[11] of the North Branch Muddy Creek site found that at the reach scale, the restoration enhanced stream function, removing 44.8% of the phosphate, 45.8% of the total phosphorus, 48.3% of the ammonium, 25.7% of the nitrate, 49.7% of the total nitrogen, and 73.8% of the suspended sediment. However, due to hydrological variance, monitoring stations farther downstream suggested no detectable changes at the larger spatial scale relative to a reference stream, which highlights the challenges of detecting watershed-scale responses to small-scale stream restoration projects.

Summary

The North Branch Muddy Creek stream restoration was a regenerative stormwater conveyance project constructed in 2016 in an agricultural area. Predominant riparian vegetation change was the conversion of approximately 2.5 acres of forest to floodplain wetlands. There was no change in load associated with land use conversion due to forest and wetlands having the same loading rates. Raising the water level resulted in decreased tree growth on the site, which was an expected outcome of the project.

Preconstruction	Post-Construction
	

Figure 19. Pre- and post-construction photos of North Branch Muddy Creek.

[11] Thompson, J., Pelc, C.E., Brogan, W.R., and T.E. Jordan. 2018. The multiscale effects of stream restoration on water quality. *Ecological Engineering* 124(2): 7-18.

Big Rocky Run
Fairfax County, VA
Maintaining Forests in Stream Corridor Restoration Case Study

Project Background

This project involved the restoration of approximately 2,450 linear feet of unnamed intermittent stream channels in Ellanor C. Lawrence Park using natural channel design within the Big Rocky Run watershed. The objective of the project was to restore/enhance/stabilize the degraded stream channel and bank to provide aquatic habitat benefits, grade control, energy dissipation and improve aesthetics. Restoration included installation of in-stream structures (rock cross vanes, j-hook rock vanes, and in-stream habitat logs), and stabilization of stream banks and channel to include reinforced bed material, and rock structures. The project also restored native vegetation along the riparian corridor, as well as created floodplain habitat features in some abandoned channel reaches.

A map of the stream restoration project site is provided in Figure 20, and the key background information is included in Table 15.

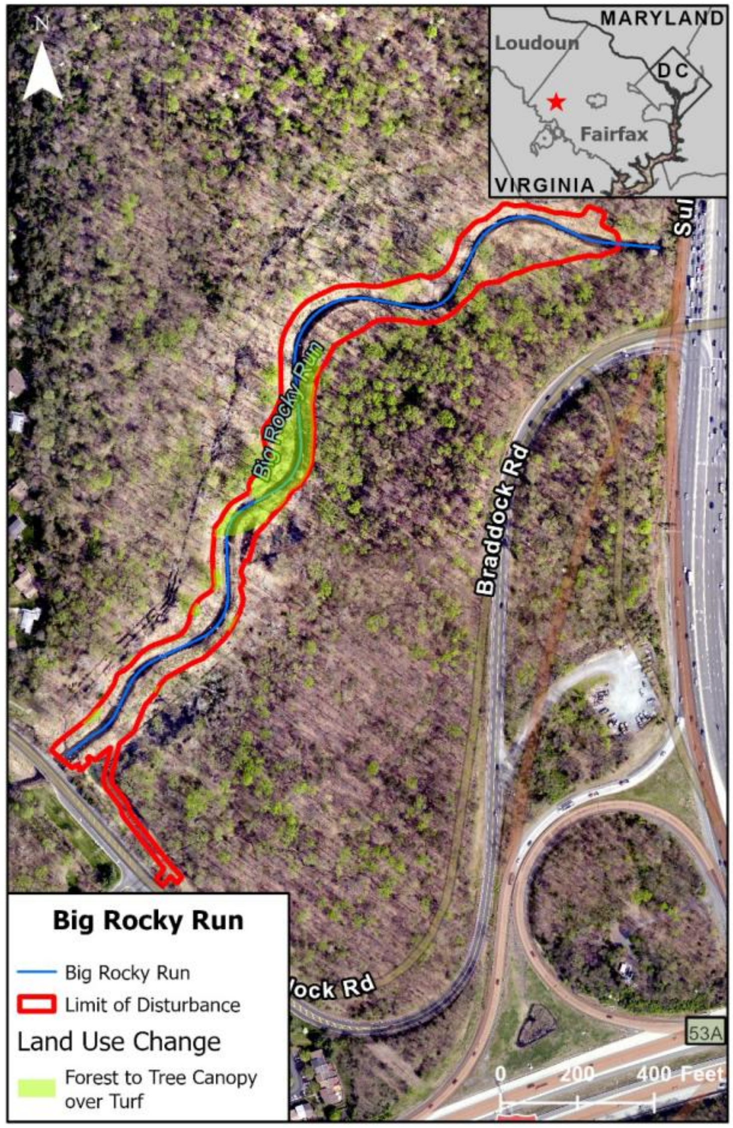


Figure 20. Big Rocky Run pre- to post-restoration land use change with post-restoration 2016 aerial imagery.

Regulatory Requirements

Nationwide Permit 27 applied to this project. Requirements included 5 years of monitoring for success unless success is achieved prior to 5 years (with Corps approval). All temporarily impacted areas were required to be restored and/or replanted to their preconstruction contours within 30 days following construction. The Chesapeake Bay Program Preservation Ordinance Chapter 118 and Fairfax County's Tree Conservation Plan required replanting in the disturbed areas of 100 overstory trees, 200 understory trees and 1,089 shrubs per acre of disturbance.

Table 15. Background information about the Big Rocky Run stream restoration project in Fairfax County, VA.

Address	Braddock Road west of Route 28
Restoration Design Type	Natural Channel Design
Year Completed	2014
Physiographic Region	Triassic
Watershed Land Use	Suburban
Project Length	2,450 ft

An individual Department of the Army Permit was not required. In addition, the Virginia Department of Environmental Quality provided conditional §401 Water Quality Certification for Nationwide Permit Number 27.

Riparian Vegetation Change

Land use changes within the Big Rocky Run project's Limits of Disturbance (LOD) are summarized in Figure 21. Prior to restoration, the land use within Big Rocky Run's LOD was predominantly forested. Construction resulted in a conversion of about 1 acre of forest to tree canopy over turf.

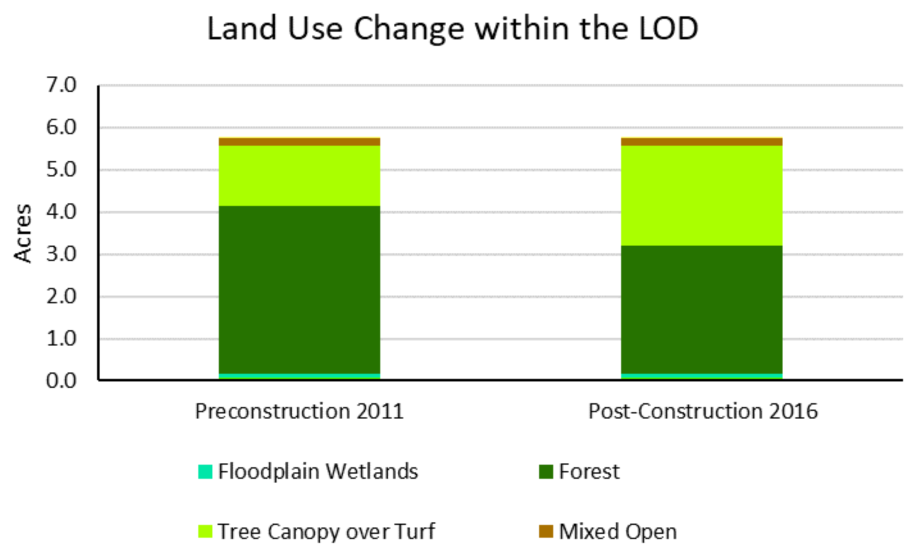


Figure 21. Land use change within the Big Rocky Run stream restoration limits of disturbance.

Prior to restoration, a variety of large and small native trees were dispersed throughout the stream corridor, with the understory layer dominated by herbaceous invasive species. Many trees were falling into the channel due to streambank erosion. All areas disturbed during the restoration were replanted to establish a native riparian buffer. The total planting area was 3.6 acres and included more than 50 varying species of plants and shrubs. Almost 1,000 trees were planted in 4 zones (streambank, floodplain, upland riparian forest, and floodplain wetland), as well as more than 3,500 shrubs.

Monitoring was conducted with the Warranty Monitoring Protocol (pre-2016). A further protocol, Fairfax County's Ecological Monitoring Protocols (2018), captured additional forest metrics. Results from the first year of post-construction monitoring in 2014 indicated an estimated 483 woody stems per acre, with greater than 50% invasive cover. A 2015 survey found 83% total woody plant success rate, with 2.19 acres in forest. Herbaceous cover was 85% – 95%, with 40% found to be invasive. Management actions including additional planting and treatment of invasive species occurred from 2015 – 2018. Monitoring in 2018, following the Fairfax County Ecological Monitoring Protocol, estimated 1,885 trees per acre (including seedlings) with an average of 8.4 tree species per plot identified and an estimated 77.2% overstory cover. Approximately 736 shrubs per

Figure 22. Big Rocky Run conditions during March 31, 2022 field visit. Photo provided by Brock Reggi (VA DEQ).

acre with an average of 5.8 shrub species per plot were identified. Non-native invasive plant cover was 46%. The plant community was a mixture of planted species and volunteers.

Brock Reggi from VA DEQ conducted a field visit in March 2022 and noted that Big Rocky Run is a mature stream restoration project with multiple success parameters. It is bordered by mature buffers and wetland dominated floodplains without a clear break in habitat types. Understory canopy with maturing planted species along the valley was noticeable with few areas of lower species diversity.

Water Quality Impacts

Changes in TN, TP, and TSS loads associated with both the land use conversion pre- to post-restoration and the stream restoration project are provided in Table 16. Stream restoration reductions using both the CBP stream restoration planning rate and the crediting protocols are provided for comparison. The increase in load from land use change is less than 1% of stream restoration load reductions calculated using both the planning rate and CBP crediting protocols.

Table 16. Load change comparison for TN, TP, and TSS (lbs/yr) of land use conversion and stream restoration.

Edge-of-Stream (EOS) Load (lbs/yr)	Change in Load from Land Use Conversion Pre- to Post-Restoration[1]	Load Reduction from Stream Restoration (Planning Rate)	Load Reduction from Stream Restoration (CBP Crediting Protocols)[2]
TN	2	-184	-628
TP	0.5	-167	-117
TSS	126	-607,600	-40,328

[1] Loads from land use conversion were calculated from loading rates obtained from CAST using the P6 land-river segment where the project is located and the progress scenario of the year prior to completion of the stream restoration project.
[2]Specific CBP crediting protocols not provided.

Summary

The Big Rocky Run stream restoration was a natural channel design project constructed in 2014 in a suburban area. Predominant riparian vegetation change was the conversion of approximately one acre of forest to tree canopy over turf. The increase in loads associated with this land use change are minimal compared to the load reductions from the stream restoration project. Plantings in the disturbed areas followed Fairfax County's Tree Canopy Conservation Plan requirements and results from monitoring conducted four years post-construction determined them to be successful.

Preconstruction	Post-Construction
	

Figure 23. Pre- and post-construction photos of Big Rocky Run.

Project Background

This project involved the restoration of approximately 6,400 linear feet of stream channel within the Flatlick Branch watershed using natural channel design. It was Phase II of a three-phase effort, with a total of 11,910 linear feet projected to be restored when all three Phases are complete. The objective of the project was restoring/ enhancing/ stabilizing the degraded stream channel bed and bank to provide aquatic habitat benefits, grade control, energy dissipation, and prevent further erosion. The restoration included the installation of in-stream structures, a reinforced bed, log and rock structures for stabilization, minor channel realignment and enhancement, and wetland and riparian corridor enhancement.

A map of the stream restoration project site is provided in Figure 24 and the key background information is included in Table 17.

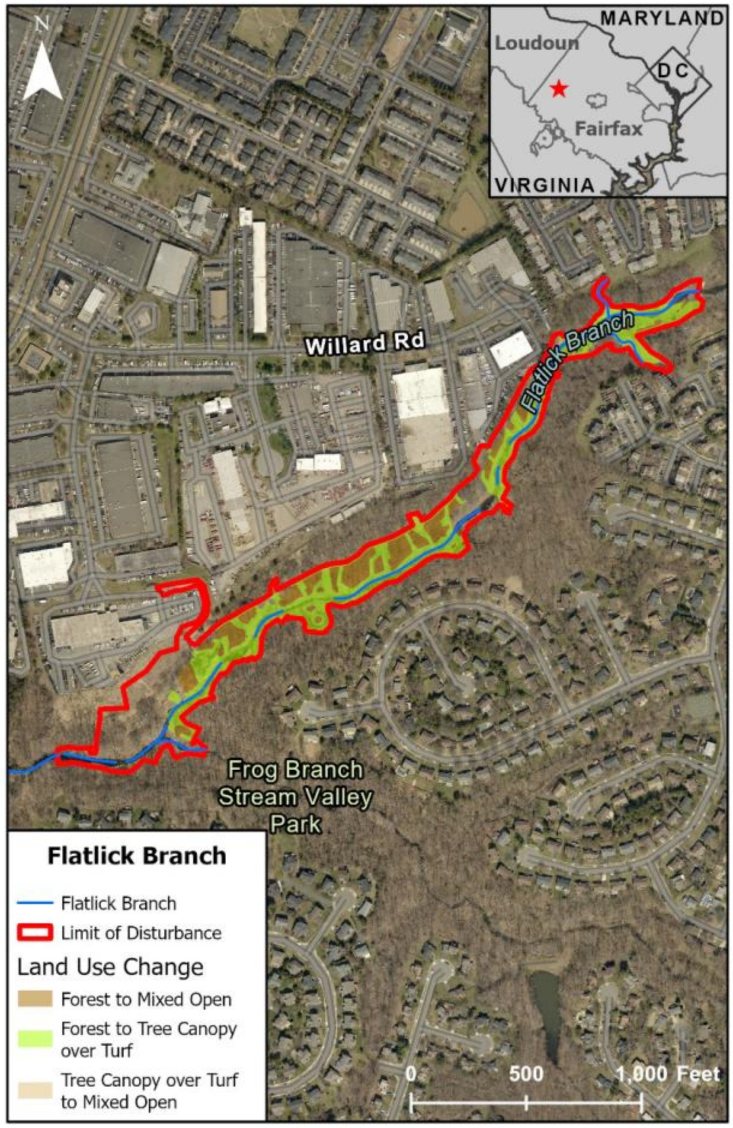


Figure 24. Flatlick Branch pre- to post-restoration land use change with post-restoration 2019 aerial imagery.

Regulatory Requirements

Nationwide Permit 27 applied to this project. Requirements included 5 years of monitoring for success, with the site released after 3 years with Corps approval. The Chesapeake Bay Program Preservation Ordinance Chapter 118 and Fairfax County's Tree Conservation Plan required replanting in the disturbed areas of 100 overstory trees, 200 understory trees and 1,089 shrubs per acre of disturbance.

An individual Department of the Army Permit was not required. In addition, the Virginia Department of Environmental Quality provided conditional §401 Water Quality Certification for Nationwide Permit 27.

Table 17. Background information about the Flatlick Branch Phase II stream restoration project in Fairfax County, VA.

Address	Henninger Court and Lee Jackson Memorial Highway (Route 50)
Restoration Design Type	Natural Channel Design
Year Completed	2018
Physiographic Region	Triassic
Watershed Land Use	Suburban
Project Length	6,400 ft

Riparian Vegetation Change

Land use changes within the Flatlick Branch project's Limits of Disturbance (LOD) are summarized in Figure 25. Prior to restoration, the land use within Flatlick Branch's LOD was predominantly forested. Construction resulted in the conversion of approximately 9 acres of forest to tree canopy over turf and mixed open.

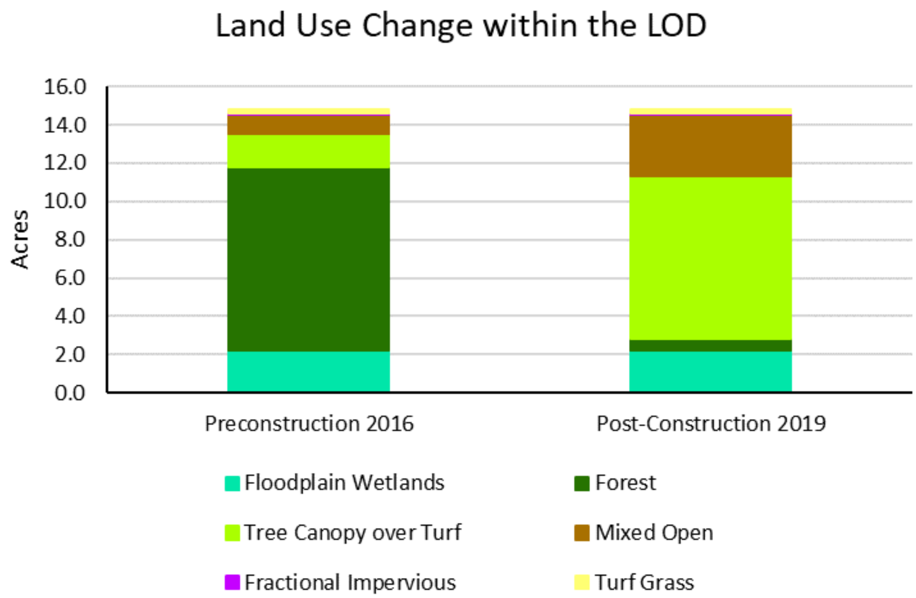


Figure 25. Land use change within the Flatlick Branch stream restoration limits of disturbance.

Pre-restoration canopy cover was 93.9%, with 2,953 trees per acre (including seedlings) consisting of 8 species. In addition, there were 10,337 shrubs per acre consisting of 5 species, 2 of which were invasive. In total, 21.8% was of the vegetation community was invasive.

The restoration project involved the removal of 218 trees and the non-disturbance of 1,712 trees. The total planting areas totaled about 8.5 acres and included about 30 varying species of plants and shrubs. Over 10,000 trees were planted in the stream side and riparian forest zones, as well as more than 25,000 shrubs. The replanting of this site was atypical of other County projects and followed an experimental protocol using only bare root seedlings. The first bare root survival inspection is scheduled for 2022.

Monitoring in 2021, following the Fairfax County Ecological Monitoring Protocol, estimated 1,608 trees per acre (including seedlings) with an average of 7.5 tree species per plot identified and an estimated 85.6% overstory cover. Approximately 1,203 shrubs per acre with an average of 3.25 shrub species per plot were identified. Non-native invasive plant cover was 72.9% (mostly a single species, stilt grass). The plant community was a mixture of planted species and volunteers.

The Fairfax County Recovery Wheel, which is used to illustrate holistic stream corridor ecological conditions, can be seen in Figure 26, with both a pre-restoration condition and the condition as assessed 3 years post-restoration. The Recovery Wheel includes 24 metrics across 6 interdisciplinary subject areas, including biological categories such as riparian structural diversity (stream corridor condition), aquatic structural diversity (stream condition) and species composition (biodiversity). Riparian structural diversity includes measures of the native woody species planted and naturally occurring in the area immediately adjacent to the stream and across the width of the floodplain as described above. This metric is associated with ecosystem functional traits related to bird habitat, floodplain sediment trapping efficiency, and forest health and succession; that is, more shrub and tree stems (up to a certain point) are correlated with higher ecosystem function. Although in general, stream corridor vegetation condition scores are lower at 3 years when compared to pre-restoration conditions, many of the other metrics at Flatlick Branch are showing improvement over the pre-restoration condition.

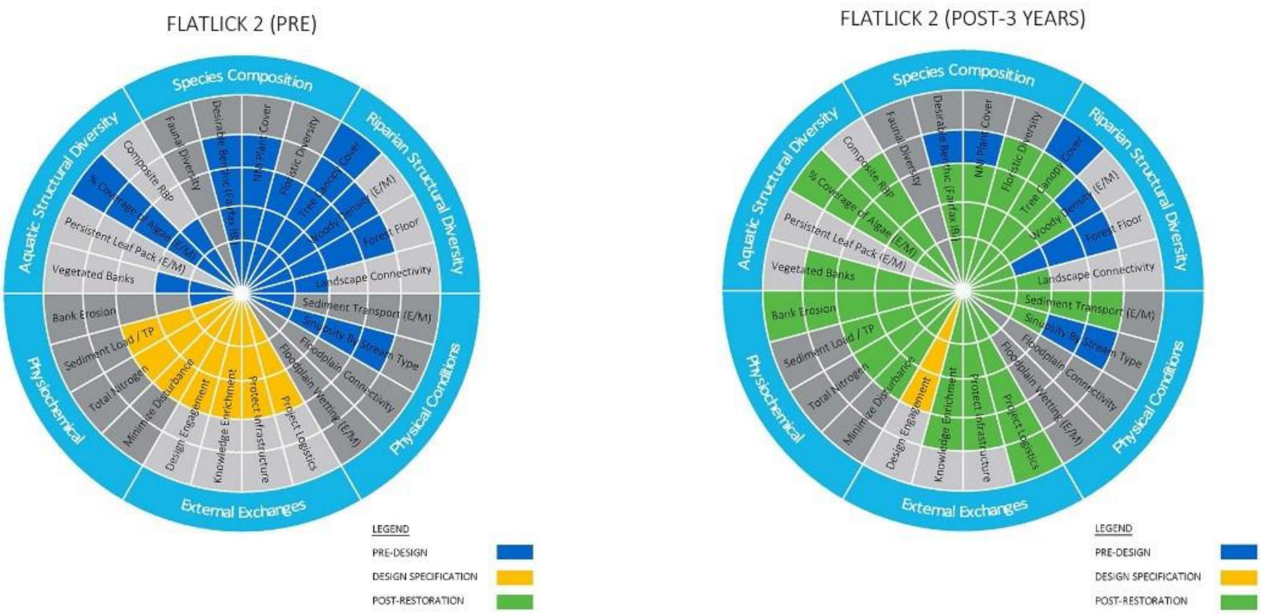


Figure 26. Fairfax County Recovery Wheels for the Flatlick Branch stream restoration project.

Brock Reggi from VA DEQ conducted a field visit in March 2022 and noted that Flatlick Branch was designed with diverse habitat areas. The site contains a mature outer canopy, and the understory layer of the buffer is still developing in a heavily matted grass layer.

Figure 27. Flatlick Branch conditions during March 31, 2022 field visit. Photo provided by Brock Reggi (VA DEQ).

Water Quality Impacts

Changes in TN, TP, and TSS loads associated with both the land use conversion pre- to post-restoration and the stream restoration project are provided in Table 18. Stream restoration reductions using both the CBP stream restoration planning rate and the crediting protocols are provided for comparison. The increase in load from land use change is less than 3% of stream restoration load reductions calculated using both the planning rate and CBP crediting protocols.

Table 18. Load change comparison for TN, TP, and TSS (lbs/yr) of land use conversion and stream restoration.

Edge-of-Stream (EOS) Load (lbs/yr)	Change in Load from Land Use Conversion Pre- to Post-Restoration[1]	Load Reduction from Stream Restoration (Planning Rate)	Load Reduction from Stream Restoration (CBP Crediting Protocols)[2]
TN	15	-480	-3,258
TP	4	-435	-379
TSS	2,517	-1,587,200	-91,926

[1] Loads from land use conversion were calculated from loading rates obtained from CAST using the P6 land-river segment where the project is located and the progress scenario of the year prior to completion of the stream restoration project.
[2] CBP Crediting Protocols 1 and 2.

Summary

The Flatlick Branch stream restoration was a natural channel design project constructed in 2018 in a suburban area. Predominant riparian vegetation change was the conversion of approximately 9 acres of forest to tree canopy over turf and mixed open. The increase in loads associated with this land use change are minimal compared to the load reductions from the stream restoration project. Plantings in the disturbed areas followed Fairfax County's Tree Canopy Conservation Plan requirements and results from monitoring conducted three years post-construction determined them to be successful.

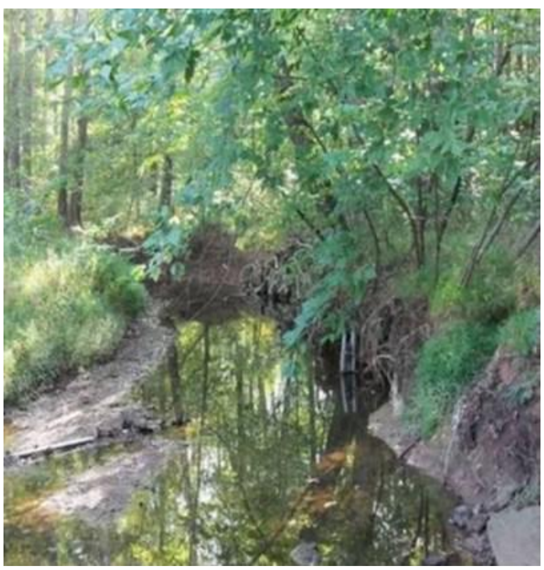
Preconstruction	Post-Construction
	

Figure 28. Pre- and post-construction photos of Flatlick Branch.

Paul Spring Branch
Fairfax County, VA
Maintaining Forests in Stream Corridor Restoration Case Study

Project Background

This project involved the restoration of approximately 600 linear feet of stream channel within the Paul Spring Branch watershed using natural channel design. The objective of the project was to restore/enhance/stabilize the degraded stream channel and bank to provide aquatic habitat benefits, grade control, energy dissipation, aesthetic improvements, and to prevent further erosion. The restoration included the installation of in-stream structures (cross-vanes, step pools, rock sills, rock toes, root wads, J-hook vanes, and riffles with log sills), the realignment of a portion of the stream and filling and planting of that portion of the stream, and associated work to restore the stream to a more natural and stable condition.

A map of the stream restoration project site is provided in Figure 29, and the key background information is included in Table 19.

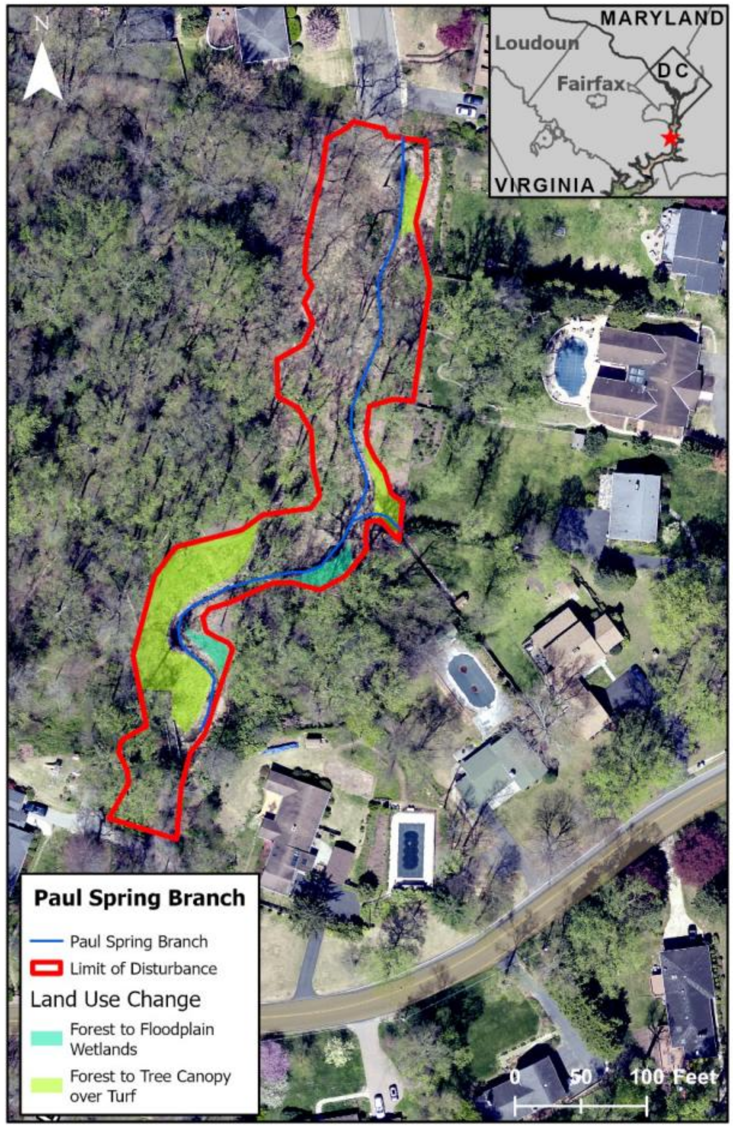


Figure 29. Paul Spring Branch pre- to post-restoration land use change with post-restoration 2017 aerial imagery.

Regulatory Requirements

Nationwide Permit 27 applied to this project. Requirements included 2 years of monitoring for success, with the site released after one year with Corps approval. All temporarily impacted areas were required to be restored and/or replanted to their preconstruction contours within 30 days following construction. The Chesapeake Bay Program Preservation Ordinance Chapter 118 and Fairfax County's Tree Conservation Plan required replanting in the disturbed areas of 100 overstory trees, 200 understory trees and 1,089 shrubs per acre of disturbance.

An individual Department of the Army Permit was not required. In addition, the Virginia Department of Environmental Quality provided conditional §401 Water Quality Certification for Nationwide Permit Number 27.

Table 19. Background information about the Paul Spring Branch stream restoration project in Fairfax County, VA.

Address	Gilbert McCutcheon Park, 7509 Fort Hunt Rd
Restoration Design Type	Natural Channel Design
Year Completed	2015
Physiographic Region	Coastal Plain
Watershed Land Use	Suburban
Project Length	600 ft

Riparian Vegetation Change

Land use changes within the Paul Spring project's Limits of Disturbance (LOD) are summarized in Figure 30. Prior to restoration, the land use within Paul Springs's LOD was predominantly forested. Construction resulted in the conversion of approximately 0.2 acres of forest to tree canopy over turf and floodplain wetlands. Land use remained relatively the same four years after construction, with only a change of 0.1 acres from tree canopy over turf back to forest.

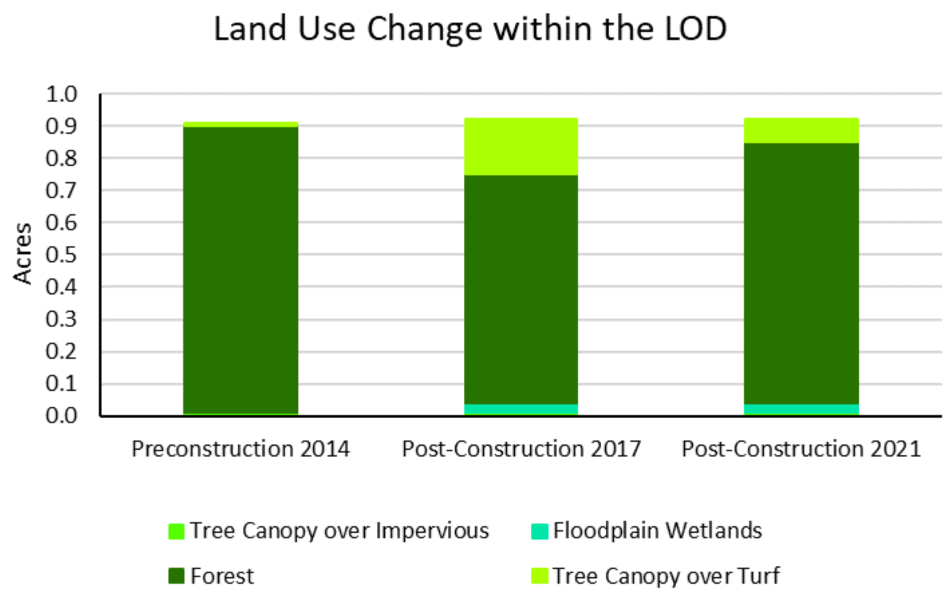


Figure 30. Land use change within the Paul Spring stream restoration limits of disturbance.

Restoration of the site was done with about 21 varying species of native trees, herbaceous plants, and grasses to promote natural reforestation. The design plan indicates that about 29 trees were removed for the project. The total planting areas equaled 0.77 acres, with 80 canopy trees, 156 understory trees, 840 shrubs, and 577 live stakes planted. An invasives control plan was also drafted for the site due to the presence of multiple invasive species including English Ivy and Multiflora Rose.

Monitoring was conducted using two different Warrant Monitoring Protocols (pre-2016 and post-2016). A further protocol, Fairfax County's Ecological Monitoring Protocols (2018), captured additional forest metrics. Woody plant success rate was calculated as the percentage of total woody specimens (including volunteers) observed compared to the total woody specimens planted. Results from the first year of post-construction monitoring in 2016 indicated an 87% total woody plant success rate during the first growing season, with 0.77 acres in forest. A second survey later in the Fall indicated a total woody plant success rate of 99%, with a 120% success rate for overstory trees and a 110% success rate for understory trees. The percentage of herbaceous invasives decreased from June (49%) to September (2.6%), suggesting that the invasive species control plan had been effective. Invasive control treatment continued in 2017. Monitoring in 2018, following the Ecological Monitoring Protocol, estimated 8,375 trees per acre (including seedlings) with an average of 17.6 tree species per plot identified and an estimated 93.6% overstory cover.

Figure 31. Paul Spring Branch conditions during March 31, 2022 field visit. Photo provided by Brock Reggi (VA DEQ).

Approximately 1,842 shrubs per acre with an average of 6.6 shrub species per plot were identified. Non-native invasive plant cover was 13.4%. The plant community was a mixture of planted species and volunteers.

Brock Reggi from VA DEQ conducted a field visit in March 2022 and noted that Paul Spring Branch was stable with a thick understory and diverse mature canopy. Located on the outer limits of a multi-acre park, the stream buffer is noticeably thicker than adjacent woodlands. There were minimal invasives identified, with 15% honeysuckle and a small patch of ornamental bamboo along the buffer.

Water Quality Impacts

Changes in TN, TP, and TSS loads associated with both the land use conversion pre- to post-restoration and the stream restoration project are provided in Table 20. Stream restoration reductions using both the CBP stream restoration planning rate and the crediting protocols are provided for comparison. The increase in load from land use change is less than 1.5% of stream restoration load reductions calculated using both the planning rate and CBP crediting protocols.

Table 20. Load change comparison for TN, TP, and TSS (lbs/yr) of land use conversion and stream restoration.

Edge-of-Stream (EOS) Load (lbs/yr)	Change in Load from Land Use Conversion Pre- to Post-Restoration[1]	Load Reduction from Stream Restoration (Planning Rate)	Load Reduction from Stream Restoration (CBP Crediting Protocols)[2]
TN	0.6	-45	-187
TP	0.1	-41	-41
TSS	27	-148,800	-4,600

[1] Loads from land use conversion were calculated from loading rates obtained from CAST using the P6 land-river segment where the project is located and the progress scenario of the year prior to completion of the stream restoration project.
[2] CBP Crediting Protocols 1 and 2.

Summary

The Paul Spring Branch stream restoration was a natural channel design project constructed in 2015 in a suburban area. Predominant riparian vegetation change was the conversion of approximately 0.2 acres of forest to tree canopy over turf and floodplain wetlands. The increase in loads associated with this land use change are minimal compared to the load reductions from the stream restoration project. Plantings in the disturbed areas followed Fairfax County's Tree Canopy Conservation Plan requirements and results from monitoring conducted three years post-construction determined them to be successful.

Preconstruction	Post-Construction

Figure 32. Pre- and post-construction photos of Paul Spring Branch.

Project Background

This project involved the restoration of approximately 1,314 linear feet of unnamed intermittent stream channels within the Pohick Creek watershed (1,250 linear feet of an unnamed tributary to Pohick Creek and 64 linear feet of an unnamed tributary). The objective of the project was to restore/enhance/stabilize the degraded stream channel and bank to provide aquatic habitat benefits, grade control, energy dissipation, and aesthetic improvements. The restoration included relocation of the intermittent stream channel, raising the streambed to reconnect the stream channel with the floodplain, installation of in-stream structures, and stabilization of stream banks and channel to include reinforced bed material, and rock structures. An existing stormwater management pond was also cleaned, and an emergency spillway was repaired.

A map of the stream restoration project site is provided in Figure 33 and the key background information is included in Table 21.

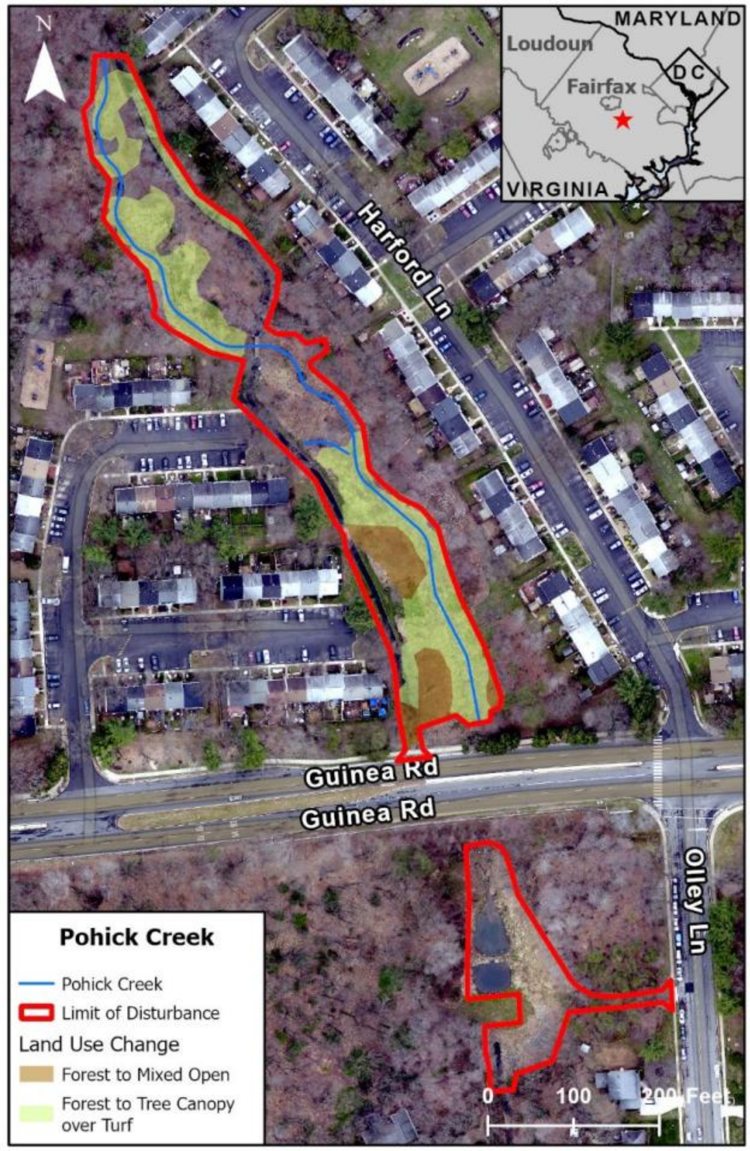


Figure 33. Pohick Creek pre- to post-restoration land use change with post-restoration 2014 aerial imagery.

Regulatory Requirements

Nationwide Permits 27 and 3 applied to this project. Requirements included 5 years of monitoring for success, with the site released after three years with Corps approval. All temporarily impacted areas were required to be restored and/or replanted to their preconstruction contours within 30 days following construction. The Chesapeake Bay Program Preservation Ordinance Chapter 118 and Fairfax County's Tree Conservation Plan required replanting in the disturbed areas of 100 overstory trees, 200 understory trees and 1,089 shrubs per acre of disturbance.

Table 21. Background information about the Pohick Creek stream restoration project in Fairfax County, VA.

Address	Guinea Road and Harford Lane, Burke, VA 22015
Restoration Design Type	Natural Channel Design
Year Completed	2014
Physiographic Region	Piedmont
Watershed Land Use	Suburban
Project Length	1,314 ft

An individual Department of the Army Permit was not required. In addition, the Virginia Department of Environmental Quality provided conditional §401 Water Quality Certification for Nationwide Permit Number 27.

Riparian Vegetation Change

Land use changes within the Pohick Creek project's Limits of Disturbance (LOD) are summarized in Figure 34. Prior to restoration, the land use within the Pohick Creek LOD was predominantly forested. Construction resulted in the conversion of about 1 acre of forest to tree canopy over turf and mixed open. Land use remained relatively the same four years after construction, with only a slight change of 0.02 acres of mixed open to turf.

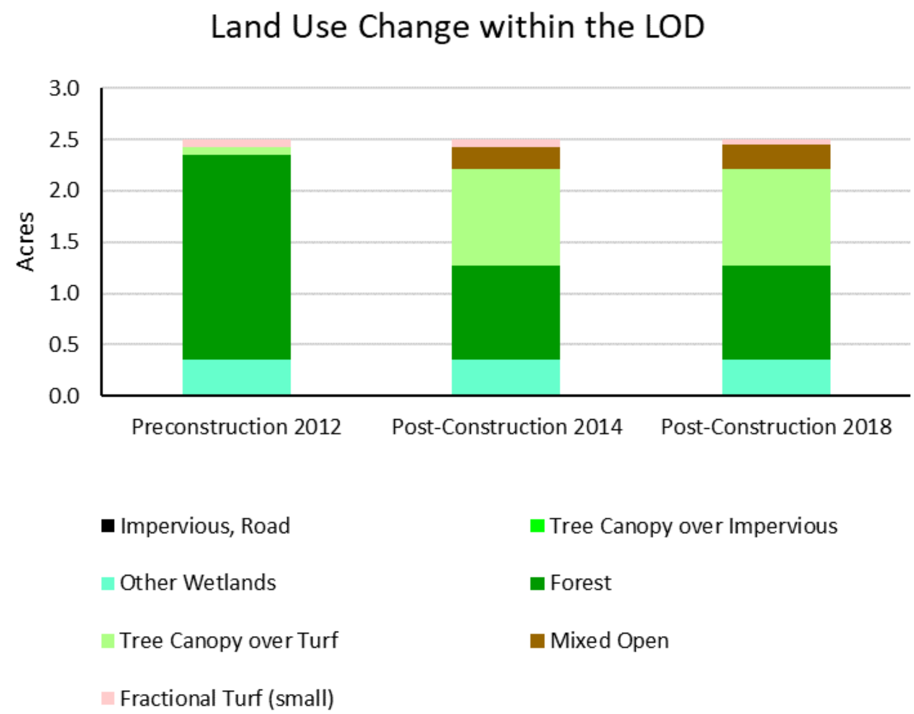


Figure 34. Land use change within the Pohick Creek stream restoration limits of disturbance.

Restoration of the site was done with about 20 varying species of native trees, herbaceous plants, and grasses to promote natural reforestation. The design plan called for a total of 89 trees to be removed (18 of which were dead), with 587 not to be disturbed. The total planting areas equaled about 1.1 acres, with over 500 trees to be planted (either bare root or live stakes) in the stream side and riparian forest zones. In addition, more than 3,000 shrubs were planted.

Monitoring was conducted with the Warranting Monitoring Protocol (pre-2016). A further protocol, Fairfax County's Ecological Monitoring Protocol (2018), captured additional forest metrics. Woody plant success rate was calculated as the percentage of total woody specimens (including volunteers) observed compared to the total woody specimens planted. Results from the first year of post-construction monitoring in 2015 indicate a 366% total woody plant success rate, with 0.88 acres in forest. Herbaceous cover was 80% – 100%, with up to 10% found to be invasive. In 2016, the number of trees per acre was estimated at 1,076, including seedlings. The percentage of invasive increased slightly to 17% in 2016. Monitoring in 2017, following the Ecological Monitoring Protocol, estimated 1,052 trees per acre (including seedlings) with an average of 5 tree species per plot identified and an estimated 90.4% overstory cover. Approximately 1,828 shrubs per acre with an average of 5 shrub species per plot were identified. Non-native invasive plant cover was 11.3%. The plant community was a mixture of planted species and volunteers.

Brock Reggi from VA DEQ conducted a field visit in March 2022 and noted that the restoration project was a stable system integrated seamlessly into the adjacent neighborhoods (Figure 22). The riparian buffer included a diverse understory with mature canopy lined by the limits of the neighboring properties. There were minor areas with concentrated invasive species through the reach but totaling less than 35% of the overall buffer area. Invasive species included honeysuckle, English ivy, multiflora rose and devils walking stick.

Figure 35. Pohick Creek conditions during March 31, 2022 field visit. Photo provided by Brock Reggi (VA DEQ).

Water Quality Impacts

Changes in TN, TP, and TSS loads associated with both the land use conversion pre- to post-restoration and the stream restoration project are provided in Table 22. Stream restoration reductions using both the CBP stream restoration planning rate and the crediting protocols are provided for comparison. The increase in load from land use change is less than 6% of stream restoration load reductions calculated using both the planning rate and CBP crediting protocols.

Table 22. Load change comparison for TN, TP, and TSS (lbs/yr) of land use conversion and stream restoration.

Edge-of-Stream (EOS) Load (lbs/yr)	Change in Load from Land Use Conversion Pre- to Post-Restoration[1]	Load Reduction from Stream Restoration (Planning Rate)	Load Reduction from Stream Restoration (CBP Crediting Protocols)[2]
TN	3	-99	-426
TP	1	-89	-23
TSS	488	-325,872	-8,097

[1] Loads from land use conversion were calculated from loading rates obtained from CAST using the P6 land-river segment where the project is located and the progress scenario of the year prior to completion of the stream restoration project.
[2]Specific CBP crediting protocols not provided.

Summary

The Pohick Creek stream restoration was a natural channel design project constructed in 2014 in a suburban area. Predominant riparian vegetation change was the conversion of approximately one acre of forest to tree canopy over turf. The increase in loads associated with this land use change are minimal compared to the load reductions from the stream restoration project. Plantings in the disturbed areas followed Fairfax County's Tree Canopy Conservation Plan requirements and results from monitoring conducted three years post-construction determined them to be successful.

Preconstruction	Post-Construction
	

Figure 36. Pre- and post-construction photos of Pohick Creek.

Appendix E. State Webcast Summary

Maintaining Forests in Stream Corridor Restoration

State Webcasts

Introduction and Purpose

With growing interest and implementation of stream restoration in the Chesapeake Bay Watershed, there is an increasing need for research about how to protect riparian buffers and minimize their impact during stream restoration construction. The Center for Watershed Protection (CWP) conducted three half-day state-focused webcasts (one each in PA, MD, and VA) to support the project "Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned," a collaborative effort with the Chesapeake Bay Program (CBP) and stakeholders to evaluate impacts of stream restoration projects on existing riparian ecology and forest buffers in Pennsylvania, Maryland, and Virginia. The webcasts were intended for Bay partners, stream restoration practitioners, and local officials involved with stream restoration at the state and local level.

The purpose of the webcasts was to present the current project findings and discuss how to improve stream restoration practices to minimize impacts to habitat and maximize water quality benefits. In addition, representatives from state agencies, local governments, and practitioners provided their perspectives on how riparian vegetation, including forest buffers, are considered as part of stream restoration projects.

The agenda for each webcast was similar, with the state agency, local government, and practitioner presentations focused on the state in which each webcast was held and included the following:

- Welcome and Project Overview
- State Agency, Local Government, and Practitioner Presentations
- Presentation of Project Results
- Facilitated Discussion
- Wrap Up and Next Steps

Discussion and lessons learned from the webcasts will be used in the development of guidance for local governments on the best practices to minimize unintended adverse outcomes to riparian forests and help improve selection, permitting, and funding processes for stream restoration projects in the Chesapeake Bay watershed.

Webcast Planning

Webcasts were planned in coordination with the project's Stakeholder Team, who provided input on potential speakers, attendees, and discussion topics. Speakers that provided state agency perspectives included members from the Stakeholder Team that represented the PA Department of Environmental Protection (PA DEP), MD Department of the Environment (MDE), and VA Department of Environmental Quality (VA DEQ). Local government speakers represented the County in each

This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement CB96374201 to the Chesapeake Bay Trust. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document.

state that was selected as a focal area for the project's recently completed case study analysis and included Lancaster County, PA, Anne Arundel County, MD, and Fairfax County, VA. These three counties were identified to represent each of the three states, and a variety of physiographic regions and stream restoration design types. The counties were selected based on the availability of stream restoration projects, feedback from a Stakeholder Team survey, and available monitoring data. Speakers providing the practitioner perspective were those identified as that have implemented multiple stream restoration projects within the focus state of each webcast.

Webcasts

Links to the information for each state webcast are provided in Table 1. The webcast recording links are for the Zoom recordings of each webcast[1]. The summary links go the webcast summaries within this document, which include information on the agenda, speakers, and meeting minutes.

Table 1. Webcasts

State	Webcast Date/Time	Webcast Recording Link	Webcast Summary Link
Pennsylvania	May 18, 2022 9 AM – 12 PM	PA Webcast Recording	PA Webcast Summary
Maryland	May 20, 2022 1 PM – 4 PM	MD Webcast Recording	MD Webcast Summary
Virginia	May 18, 2022 1 PM – 4 PM	VA Webcast Recording	VA Webcast Summary

Key Discussions and Lessons Learned

The key discussion and lessons learned from the state webcasts are summarized below.

Defining Stream Restoration and Appropriate Restoration Targets

The definition of restoration varies among the states and consistent terminology is important for processing permits. For PA DEP, restoration addresses the underlying causes of resource degradation within the modern constraints and acceptable vegetative outcomes are driven by addressing the underlying cause of degradation. Targeting symptoms of degradation would not be considered restoration under this definition. MD DNR adopted guiding principles related to stream restoration in June 2015 that defines and reviews distinct criteria for various types of stream treatments (e.g., restoration, rehabilitation, engineering, reclamation, stabilization, and enhancement) and noted that not all projects should be considered stream restoration. Historic or predevelopment conditions for setting vegetation restoration goals do not play a major part in MDE's considerations, which instead evaluates projects based on the value of current conditions. In VA, the definition of stream restoration is the process of converting an unstable, altered, or degraded stream corridor, including adjacent areas and floodplains to its natural conditions.

Community Engagement

Landowner engagement and public outreach/education are essential components of stream restoration projects and should be done early in the project process prior to the submission of permit applications to the state. Many community concerns are related to tree loss and Impacts to the terrestrial system in public areas where larger floodplain reconnection projects are proposed. It's

[1] A transcript of the webcast is included with the recording, but please note that the transcript has not been edited for grammatical correctness.

important to understand what the public wants and then balance whether that is appropriate for the site or not within the regulatory requirements. It's also important that the community be involved in reviewing project documents and assisting with decision making.

Monitoring and Maintenance

Monitoring and maintenance were noted as a critical components of stream restoration projects that are often overlooked. Incorporating maintenance into the project design and having it contracted is encouraged because landowners are unlikely to conduct maintenance themselves. One of the challenges identified was a lack of trained professionals that can conduct community classification and condition assessments. Performance-based contracting and warranty monitoring for plant survival and contractual requirements were noted as options to increase successful projects. An additional recommendation was that municipalities set aside 10% of project costs for monitoring and maintenance post-construction.

Another difficulty with maintenance and monitoring programs is not having an agreed upon functional metric to define a healthy forest. Developing regionally specific riparian monitoring protocols and forest quality indices was suggested. With advances in technology, remote-sensing tools are also useful for broad scale monitoring to supplement on-the-ground investigations.

Stream restoration projects can open space for invasive encroachment, with invasive species growth common in the first 2 years post-construction. Development of invasive species control plans using appropriate methods are an important part of maintenance (hand pulling or cutting, mechanical controls, prescribed fire, grazing/goats, and/or chemical applications). Forest mitigation plans often required of stream restoration projects can eliminate invasives and plant native vegetation improving the ecological health of the riparian area.

Effects on Stream Temperature

Increased stream temperature is also a concern because forest cover is important for cold water refugia. There is currently a STAC report under development on this topic. One problem is that many stream systems are driven by stormwater with limited groundwater-based flow. Microtopography is an important consideration and several speakers noted that substantial groundwater connection is a driver of cooler stream temperature. This is inconsistent with findings from the STAC report but is dependent on multiple factors and can be a complicated modeling problem that requires further investigation.

Consideration of Upland Stormwater Controls

There are many older developed areas that have minimal or no stormwater management. We are looking back at the last 50 years with hindsight and still catching up. Upland stormwater controls were questioned as a potential alternative option to conducting stream restoration projects that hasn't been properly explored. The difficulty with this approach alone is that that even if the stormwater flows are reduced, degradation to the stream systems has already occurred and will continue. While the retrofit of existing facilities can be beneficial, the area benefitted is often small and localized. Implementing enough stormwater controls at the watershed scale to be effective is challenging and depending on the watershed may not be feasible due to property ownership and enforcement concerns. A comprehensive review of the scientific and gray literature on this subject was recommended.

Summary of Webcast Evaluations

Attendees were asked to complete a survey to provide feedback after each webcast. A total of 13 responses were provided. Overall, the webcast was well-received by attendees, with all survey respondents indicating they were satisfied or very satisfied with the webcast. Most of the attendees rated the material covered in the webcasts as good or excellent and appreciated that there was ample time during the discussion to bring up individual perspectives and ideas. One recommendation for improvement was to include non-governmental organizations, landowner, and concerned citizens groups in the presentations. An additional recommendation was to include more discussion of a holistic approach that includes upland treatments before stream restoration and what can be done in more urban settings.

The webcast survey report is included at the end of this document and can also be accessed by the link below.
Webcast Survey Report

PA Webcast Summary

State Webcast Information
Pennsylvania
May 18th, 2022

CENTER FOR WATERSHED PROTECTION

Agenda

Date/Time	Wednesday, May 18, 2022, 9:00 AM – 12:00 PM	
Webcast Recording Link	https://us06web.zoom.us/rec/share/eGZW2snheEGyA4eue5MKnR-MW2xgYAqa2kbIUPD3gI5PI3T8_301raTccAfJQRWw.9FZcYmKGp5KMf7te	
Link to PDF of slides	https://www.cwp.org/wp-content/uploads/2022/05/Maintaining-Forests-Webcast-Presentation-Pennsylvania-final.pdf	
Time	**Agenda Item**	**Presenter**
9:00 AM – 9:20 AM	Welcome and Project Overview	Lisa Fraley-McNeal, CWP
9:20 AM – 10:20 AM	State Agency, Local Gov, and Practitioner presentations	Dave Goerman, PA DEP
		Charity Burkhart, David Miller/Associates
		Mike LaSala, LandStudies
10:20 AM – 10:25 AM	Break	
10:25 AM – 11:05 AM	Presentation of Maintaining Forests Project Results	Lisa Fraley-McNeal, CWP
		Chris Swann, CWP
		Alexandria Wilkins, CWP
11:05 AM – 11:10 AM	Break	
11:10 AM – 11:50 AM	Facilitated Discussion	Lisa Fraley-McNeal, CWP
11:50 AM – 12:00 PM	Wrap up and Next Steps	Lisa Fraley-McNeal, CWP

Presenters

Presenter	Biography
	**Dave Goerman, Pennsylvania Department of Environment Protection** David Goerman is a Water Program Specialist at the PA Department of Environmental Protection in the Division of Wetlands, Encroachment and Training, Bureau of Waterways Engineering and Wetlands. He's responsible for providing permitting and technical expertise on a wide range of issues involving waterways, wetlands, floodplains and stormwater management. His most recent worked has focused on aquatic resource headwater research, restoration and compensatory mitigation banking. David has worked in the Division since 1993 and has a B.S. Degree in the Biological Sciences from Clarion University, Clarion, PA.
	**Charity Burkhart, David Miller/Associates** Charity Burkhart is a 2009 graduate of Penn State University and is a Registered Landscape Architect with David Miller Associates, Inc., located in Lancaster Pennsylvania. She is the MS4 Program Manager for the 6 municipalities that the DM/A Municipal Group represents, assisting those municipalities in all aspects of permit management and project design. She is a member of the Lititz Borough Zoning Hearing Board and the Lititz Borough Parks Committee, as well as the St. John Neumann Catholic School

Presenter	Biography
	PTO. Charity also enjoys spending time with her family (Scott, Eva, Olivia, Carter, Linnea, and Daniel) at their beach house near Cape May, NJ.
	**Mike LaSala, LandStudies** Michael LaSala is a Specialist and Analyst who handles multi-disciplinary and special projects generally involved with implementation of Economic Ecology concepts. He develops and manages Stormwater Management Programs (SWMPs) required for NPDES Permit compliance. He has assisted in the Countywide Action Plan (CAP) development and implementation for multiple counties as part of the Pennsylvania Chesapeake Bay Phase III Watershed Implementation Plan. He provides assistance, primarily for MS4 Permits and watershed health, to LandStudies clients across the mid-Atlantic region. Additionally, he provides unique experience in municipal operations, including intergovernmental cooperation, integrated planning, ordinance development, and utility fee development through his time as the Executive Director of the Lancaster Inter-Municipal Committee (LIMC).
	**Lisa Fraley-McNeal, Center for Watershed Protection, Inc.** Lisa is a Sr. Watershed & Stormwater Research Specialist for the Center. Lisa has been working on urban watershed and stormwater management since 2006. Her areas of expertise include GIS and field methods for watershed assessment, watershed planning, stream restoration, Chesapeake Bay TMDL crediting, and applied research on topics related to watersheds and stormwater. She has a B.S. degree in Geography and Environmental Systems, with a writing minor and cartography certificate from the University of Maryland, Baltimore County. Lisa also has a M.S. degree from the University of Maryland, Baltimore County in Marine and Estuarine Environmental Science.
	**Chris Swann, Center for Watershed Protection, Inc.** Chris is a Watershed Planner & Environmental Analyst for the Center. Chris has been a watershed planner at the Center since 1997. His work time is split between two responsibilities; researching and writing technical guidance on watershed management issues and trying to keep the Center's technology in check and functioning properly. Since joining the Center, Chris has contributed in the writing of numerous Center publications, including the Urban Subwatershed Restoration Manual series and the Better Site Design Manual. Chris has a B.S. in Natural Resources Management from the University of Maryland, as well as a B.S. in Biology from James Madison University.
	**Alexandria Wilkins, Center for Watershed Protection, Inc.** Alexandria is a Watershed planner for the Center. A recent graduate with a Master of Environmental Science and Management (MESM) degree – specializing in water resource management – and a background in environmental stewardship and education, Alexandria contributes her knowledge and experience to support the Center's mission to protect and restore water resources. She brings skills in project management, geographic information systems (GIS), and data analysis to the team. In addition, she is interested in stakeholder engagement and the collaborative management of natural resources.

Registrants

Webcast Attendance Total Number of Registrants: 24 Total Number of Webcast Attendees: 17		
Name	**Email Address**	**Webcast Attendance**
Alexandria Wilkins	ajw@cwp.org	**Y**
Alison Herman	aherman@lyco.org	**Y**
Charity Burkhart	cburkhart@dmai.com	**Y**
Charles Smith	Charles.Smith@fairfaxcounty.gov	**Y**
Chris Swann	cps@cwp.org	**Y**
Dave Goerman	dgoerman@pa.gov	**Y**
Helen Golimowski	helen@devereuxconsulting.com	**N**
Jamie Eberl	jeberl@pa.gov	**Y**
Jason Swartz	jzs7093@psu.edu	**N**
Jordan Fox	jf@cwp.org	**Y**
Katie Brownson	katherine.brownson@usda.gov	**Y**
Kristen Wolf	kwolf@pa.gov	**N**
Lisa Beatty	elbeatty@pa.gov	**N**
Lisa Fraley-McNeal	lfm@cwp.org	**Y**
Liz Feinberg	liz.feinberg63@gmail.com	**Y**
Mary Kate Gallagher	marykate.gallagher@lccd.org	**Y**
Matt English	matthew.english@dc.gov	**Y**
Mike LaSala	mike@landstudies.com	**Y**
Rebecca Lauver	rlauver@allianceforthebay.org	**N**
Rebecca Napier	rnapier@wetlands.com	**Y**
Ruth Cassilly	rcassilly@chesapeakebay.net	**N**
Sally Claggett	sally.claggett@usda.gov	**Y**
Steve Putt	stputt@pa.gov	**N**
Suzanne Trevena	trevena.suzanne@epa.gov	**Y**

Summary of Key Discussion Points

One of the key regulations in Pennsylvania is 25 Pa. Code § 105.15. Environmental Assessment, which requires the cause of degradation to be identified. An acceptable vegetative outcome is driven by addressing the underlying cause of degradation. Restoration definitions are challenging, and PA DEP is hoping to standardize the terminology because it can affect how the department processes permits. For PA DEP, restoration addresses the underlying causes of resource degradation within the modern constraints. Targeting symptoms of degradation would not be considered restoration under this definition.

Project locations are identified based on input from 1) industry professionals and interested individuals, 2) indirect individuals and entities, and 3) the public. Understanding the public's perception about a project location and desires for that location is important. Insights from the public must be balanced with what techniques are appropriate to address the underlying causes of degradation at the site within the applicable regulatory requirements.

Maintenance was agreed upon as a critical component of stream restoration projects. Incorporating maintenance into the project design and hiring a contractor to conduct that maintenance is encouraged since landowners are typically unlikely to conduct maintenance themselves. Municipalities that David Miller/Associates Group represents are typically taking on maintenance responsibilities for a period of 3 to 5 years when property owners contribute land for a restoration project.

Additionally, non-native invasives are a concern with stream restoration projects in Pennsylvania. PA DEP has noted that sites are full of invasives at first, but once plantings are established and invasive treatments are implemented, issues with invasive vegetation are typically resolved.

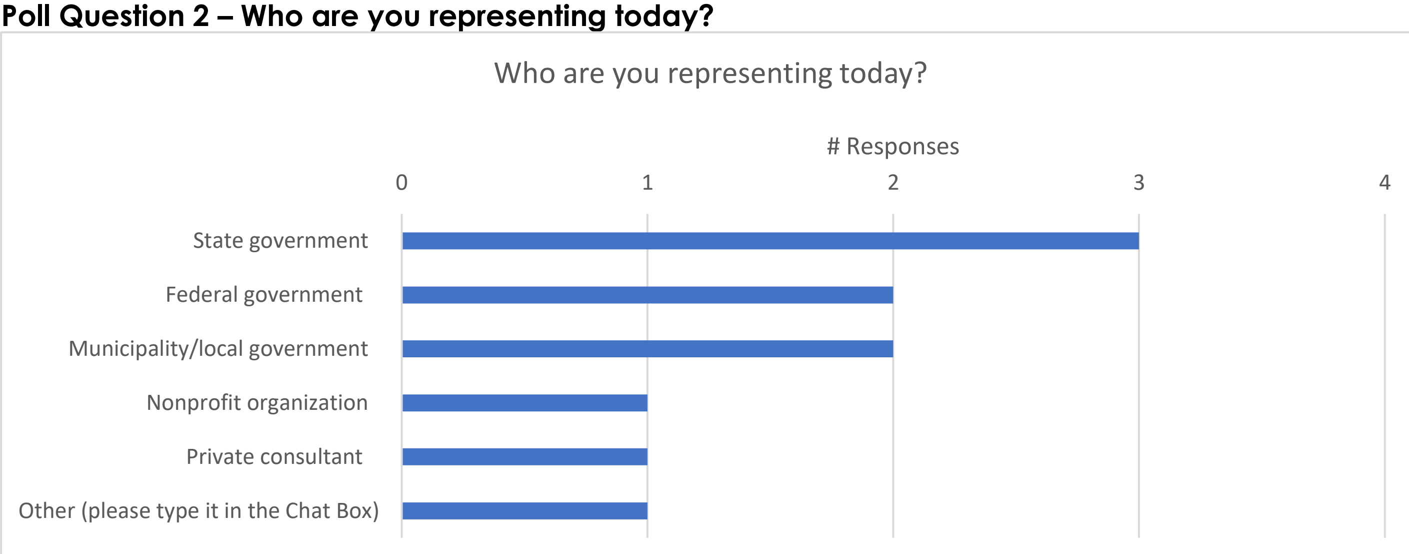
Increased stream temperature is also a concern because forest cover is important for cold-water refugia. There is currently a STAC report under development on this topic. PA DEP is finding that even without tree cover, the stream restoration sites are still covered in vegetation and the substantial groundwater connection is the primary driver of stream temperature. This is inconsistent with findings from the STAC report, but it is dependent on multiple factors and can be a complicated modeling problem.

Meeting Notes

Welcome and Project Overview

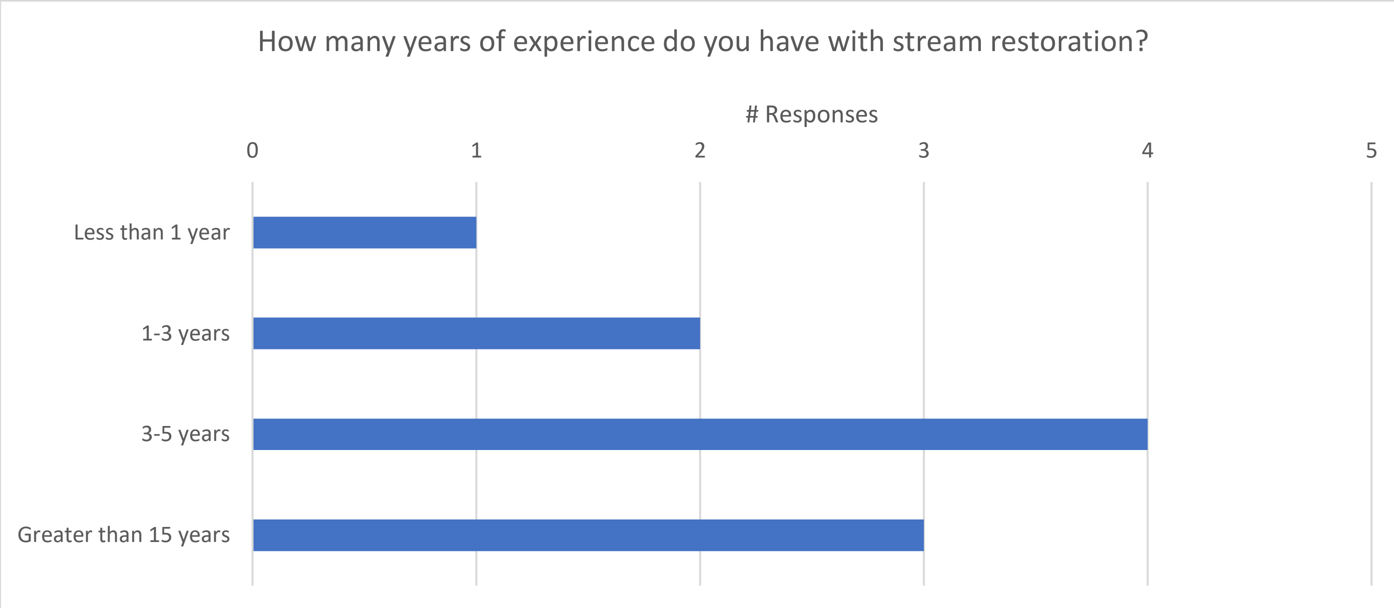
Poll Question 1 – How many people are participating in the webcast today at your location?
All but one attendee joined the webcast individually; one attendee indicated joining in as a group of 2 – 5.

Poll Question 2 – Who are you representing today?



Mike LaSala responded "Other," as he considers his role to be a combination of private consulting, non-profit, and local government.

Poll Question 3 – How many years of experience do you have with stream restoration?



Lisa Fraley-McNeal (CWP) – Overview of the Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned Project

Given the concern over the potential negative impacts of stream restoration, CWP received a grant from the Chesapeake Bay Trust to evaluate how these unintended outcomes can be minimized in the riparian area, including forest buffers, to improve riparian and stream habitat quality.

A Stakeholder Team was formed to provide input and help guide the project.

Background Information

- The CBP Stream Restoration Expert Panel Crediting Protocols were finalized in 2014. The credits contributed as a driver for implementation of stream restoration projects. Other benefits and considerations of projects beyond nutrient and sediment load reduction were often lost.
- The updated CBP stream restoration protocols based on recent workgroup updates help to address stream health more comprehensively.
- With sediment being one of the main stressors of biological impairment, there is a regulatory incentive to address it. Stream restoration is being done to meet local TMDLs in addition to the Bay TMDL.
- The rapid increase in stream restoration projects throughout the Chesapeake Bay watershed has led to growing concern and controversy about their effects on whole-ecosystem health and services.
- One of the arguments against stream restoration is that we should be looking upstream to implement BMPs instead. However, some considerations of this approach are 1) that it can take years before an effective geomorphic change is identified due to changes in the flow regime, and 2) Implementing enough upstream BMPs to create a response at the watershed scale is often not feasible depending on the watershed conditions.

Completed project tasks include: 1) project planning and preparation, 2) QAPP, 3) policy/document review and interviews, and 4) case study analysis.

The webcast task is currently in progress and will be completed by 5/31/2022.

The next task is to synthesize results from the completed project tasks into a final project report that includes recommendations on opportunities to improve consideration of riparian forests in stream corridor restoration projects to minimize unintended consequences. Recommendations from the project report will be used to update and finalize a best practices guidance document for local governments.

State, Local Government, and Practitioner Presentations

Dave Goerman (PA DEP) – Considering Forests in Stream Corridor Restoration
Dave represents the Bureau of Waterways Engineering and Wetland perspective but does not represent the perspective of all PA DEP depts.

Regulatory Requirements

- All projects that involve waterways and wetlands require a vegetative assessment with several modules.
- The Level 2 Rapid Assessment, which is a requirement of 25 Pa. Code § 105.15. Environmental Assessment that aims to characterize current conditions, can be waived by writing, and, in many instances, those requirements are waived.
- The program recognizes equivalency in establishing the vegetative form that is most appropriate given the site conditions.
- 25 Pa. Code § 105.15. Environmental Assessment requires that stream degradation is demonstrated and that the underlying cause of degradation is identified. The definition of an acceptable vegetative outcome is driven by what approach addresses the underlying cause of degradation. Topology, soils, and hydrology all influence what type of vegetation should be present at a site.

The current regulatory standard for compensatory mitigation site design uses all vegetative structure types and focuses on creating a heterogenic structure on-site. This gives all vegetation a chance to establish itself with an approach that highlights design over planting. PA DEP is in the process of shifting to a "restoration community design targeting approach," which targets specific community types that are suitable for the site to inform/direct practitioner approaches to planting design.

Key requirements for projects in PA include:

- Chapter 105 Dam Safety and Waterway Management [25 Pa. Code § 105.12(16)]. Waiver of permit requirements, which follows a specific assessment designed for restoration activities, although they are undergoing change.
- Chapter 102 Erosion and Sediment Control [25 Pa. Code § 102.5(i)]. Permit requirements would be exempt from ESC and NPDES permits when Section 404 permit coverage is required.

Restoration
In the past, what constitutes "restoration" has been pretty broadly interpreted, and many use the term "restoration" as a blanket term to cover a variety of different stream activities. PA DEP is shifting from a traditional environmental assessment to one that is specifically targeted for restoration activities. Additionally, PA DEP is working to establish a comprehensive training on restoration where they hope to standardize use of the terminology—these should be finalized in late 2022 or early 2023. If a proposed project is evaluated as a restoration or a "manipulation of the degraded riverine environment," it can influence permit requirements and the entity responsible for

reviewing the application. For PA DEP restoration addresses the underlying causes of resource degradation within modern constraints. Targeting symptoms of degradation would not be considered restoration under this definition.

Some successful restoration project examples include:

- Project with legacy sediment removal and headcut restoration; mass-wasting and the runoff of legacy sediment were the underlying causes of degradation.
- Early successful legacy sediment removal at Lititz Run – LandStudies (10- to 12-years-old)
- Mitigation bank site with multiple headwater tributaries; legacy sediment was removed within an existing perched wetland system (some of which are dominated by hillslope process). The stream was draining the wetland and exfoliating the bedrock—the vegetation structure is advancing at this site.
- Project with 4 – 5 feet of legacy sediment—some of the wetlands were left perched on the legacy sediment. The legacy sediment was determined to be the underlying cause of degradation at the site.

Guidance

The purpose of the project or program may dictate the use of specific guidance.

- Act 162 Riparian Forest Buffers Act
- 25 Pa. Code § 102.14. Riparian Buffer Requirements
- Agency-specific guidance from PA DCNR, PA DEP, PFBC, CREP, etc.
- 25 Pa. Code §105.15. Environmental Assessment
- PA Function-Based Compensation Protocol
- PA Resource Condition Level 2 Rapid Assessments
- PA Community Prediction Tool for Site Restoration (in development)

Questions

Sally Claggett – I would be interested in hearing more about the extent of invasive species control required for compensatory mitigation.

Response – We have a total percent cover for the site (10%) and an individual location percent cover (5%), I believe those are the numbers if my memory serves me correct.

Sally Claggett – Is Section 105 (Envi Assessment) what you said is often waived?

Response – We can waive the requirements that are in the EA, such as assessment, alternatives analysis.

Mike LaSala (LandStudies) and Charity Burkhart (David Miller/Associates) – A Perspective on Stream Restoration in Lancaster County

Their presentation focused on the County and local perspective of stream restoration. Charity discussed the thoughts and actions of local municipalities and Mike's portion of the presentation emphasized communication and the Lancaster County-Wide Action Plan (CAP)—Mike is the CAP Coordinator for Lancaster County.

Lancaster County, PA Overview

The area is known as an eclectic mix of agriculture and urban with 5,500 farms and 52 MS4 areas. 50% of their streams are listed as impaired.

Typical Stream Projects

- Floodplain Restoration (includes stream and floodplain area, legacy sediment removal)

- Direct Restoration (regrade streambanks, channel realignment)
    - A direct restoration is a broad category and a common approach that's relatively easy to meet from a permitting standpoint.
- Augmented Restoration or Manipulation (fish passage or habitat; selective streambank stabilization and restoration techniques)

Project locations are identified in three main ways: 1) industry professionals and interested individuals, 2) indirect individuals and entities, and 3) the public.

- Identified projects are often systems that could use some attention.
- Projects choice really comes down to the aesthetics, whether it's appropriate for the system or not
- One of the key goals is to understand what landowners/stakeholders/the public want in terms of aesthetics at a site, and then to balance that with what the regulations require.

Lancaster Clean Water Partners (LCWP) focuses on education and outreach to achieve clean and clear Lancaster streams. This led to the development of the Countywide Action Plan (CAP) to achieve the collective goals.

- CAP funding contributes to a variety of projects in the Lancaster area, most of which are stream restoration projects.

Riparian vegetation considerations during site assessment:

- What vegetation currently exists?
- Is the vegetation worth saving?
- Can they overplant elsewhere?
- Will the buffer be a traditional woody buffer or something different?
- Does it currently provide some other type of benefit?
- Along with long term maintenance considerations for overall success – Does the property owner have those resources?

There are challenges with property constraints and property owner willingness to install projects of reasonable size, etc.

<u>Regulations</u>

The goal is to abide by all applicable regulations holistically.

- Municipal Conservation Easement requirements
- DEP & Army Corps requirements
- Cost benefits or challenges to the installation process (the project requires justifications)
- How to encourage these to be municipally valuable to meet other requirements (MS4, etc.)? Is the buffer valuable to them?
    - Municipalities want multiple benefits or the most beneficial project so that it is justifiable.

Current project design proposals include:

- Traditional woody buffers (tree tubes and stakes bordering creeks and streams)
- Grass buffers (stabilization seed mixes)
- Hybrid approaches (tailored to bankside constraints)

<u>Installation & Design</u>

Design and implementation is informed by what's feasible and maintainable for the clients and what can get done through permits.

- For example, Plain Sect communities equated stream bank restoration with a traditional woody buffer that they didn't like because the woody buffers bring more wildlife and more invasives into the area. Work with the community involved educating them about the different types of restoration projects and what they might prefer over a woody buffer.

Example Projects

- Lime Spring Square Project (Municipal)
  - A Legacy Sediment Removal project – legacy sediment was the true impairment (lack of ecosystem and ecology, flooding, and infrastructure damage)
  - wide open herbaceous floodplain community historically and what's observed from a flooding and flow standpoint
  - The client was really interested in the co-benefits of the project.
  - The project resulted in a paradigm shift in the train of thought to looking at the extent of the watershed.

Questions/Comments

Sally Claggett - Agree that maintenance should be part of every contract or don't do project.

Response - Agreed with Sally, our municipalities enter a maintenance agreement with the property owner prior to installation of any projects on private property. We typically have a written maintenance plan as well.

Sally Claggett - @Charity-- we have moved away from requiring/requesting landowners to do maintenance (not likely to happen) but are strongly encouraging it to be wrapped into the project design and have it contracted.

Response - @sally, we are too. Our municipalities which are asking property owners to contribute land for a restoration are typically taking on maintenance responsibilities for a period of 3-5 years.

Sally Claggett – For what it's worth (FWIW), we feel that the full 5 years is often necessary.

Liz Feinberg - generally, can you speak to cost effectiveness, or best approaches, when sewer line/utility is in floodplain/valley

Response - Liz, I know mike has more experience in floodplain restoration as it relates to utilities. Ours are typically on the fringe of the extent of a buffer or restoration project, so they can be worked around. Banta Site on Lititz Run – runoff finds the least path of resistance often where there is a utility line – once restored, the stream was moved about 100 yards from where it was found and the sewer line placement wasn't an issue. Development of walking trails over sewer lines has been a creative way to work around these challenges. Sometimes they just need to be relocated.

Katie Brownson - What sort of resources are available to assist landowners with maintenance? And what sort of follow-up happens to ensure the landowner is following the maintenance agreement/plan?

Response - @kate, our follow up from the municipality requires inspection of installed BMPs every 5 years and a yearly maintenance inspection by the property owner. This is followed up on in our MS4 program. Also our CAP team tries to help facilitate funding for buffer maintenance as well.

Sally Claggett - its good to know that the municipality is responsible for the maintenance for the first 3-5 years.

Response - @sally, we figure that the critical failures (aside from crazy 100 yr+ rain events) will happen generally within 3-5 years. And from mikes perspective, landstudies also is able to contract maintenance with property owners through their field ops division. But while these are best case scenarios we understand not all of them are able to do this.

Project Results Presentation

Chris Swann (CWP) – Policy/Document Review and Interviews
Policy/document review: The goal was to better understand the requirements of each state for protecting and mitigating damage to stream buffers associated with stream restoration projects. A total of 40 regulatory and 78 technical/guidance documents were reviewed.

Interviews: The goals were 1) to better understand how the requirements identified from the review of regulatory and policy documents are (or are not) implemented in each jurisdiction and 2) to identify and refine best practices to minimize adverse impacts to riparian forests. A total of 19 individuals were interviewed, representing state and local governments, as well as practitioners.

Chris provided an overview of how forests are defined for this project and the key federal policies reviewed. He also summarized the key findings and identified best practices related to site selection and planning, design and permitting, implementation, and post-construction monitoring.

The deliverable for this task was a technical memo that will be included in the final project report.

No questions on the Policy Review & Interview presentation

Alexandria Wilkins (CWP) – Case Study Analysis
Reviewed 10 stream restoration projects in Lancaster County, PA, Anne Arundel County, MD, and Fairfax County, VA to determine the extent to which requirements are implemented and quantify the impacts stream restoration has on riparian vegetation.

Utilized loading rates from CAST to determine changes in nutrient and sediment loading from the stream restoration projects and impact to the riparian vegetation due to project implementation.

Alexandria walked through 5 case study example projects and summarized the key findings.

Case study results were summarized in 3- to 5-page summaries for each site that will be included in the final project report.

<u>Case Study Analysis Questions</u>
Sally Claggett - interesting that Muddy Ck project also seemed to add a road to the floodplain

Katie Brownson – There is a pretty big difference between the load reductions calculated using the planning rates and the CBP Crediting protocols- could you say a little more about why this is the case?

Lisa clarified that the planning rates were used so a consistent credit estimate could be obtained across all of the case study projects because it is a lbs reduction per linear foot. The reductions based on the crediting protocols were included as they were provided without further verification. Depending on how the protocols were calculated there could be different results. Generally, the planning rate was designed to be more conservative, and it was anticipated that results from the crediting protocols would result in higher load reductions.

Dave Goerman - How is there an increase in TSS when you go from ag pasture to wetland (non-pastured)? There should be a net decrease.

Lisa noted that this was due to loading rates in CAST being slightly higher for wetlands than for agricultural pastureland.

Facilitated Discussion

Sally Claggett – Prehistoric condition analysis of what "should" be present, do other state's do this? Doesn't know how researched that it or if it's at all controversial. Mike mentioned it being about aesthetics. How do the various drivers…what % of projects are based on each driver for both project selection and design?

Dave – underlying science is very robust, no question in their program for the benefits and rewards for this approach. Massive projects, zero failures as far as success, diverse and resilient conditions – way more that he anticipated. For compensatory mitigation, they are very strict about what they allow and don't allow. These projects are very resilient to climate change, etc. Very low maintenance projects. They are curious why people have fought this for so long

Sally – surprised they're don't have issues with invasives

Dave – sites are full of invasives at first but once plantings are established and with invasive treatments the plantings thrive.

Sally – Lime Spring Square – poor habitat before restoration. Where there are similar studies after restoration to show that the fish and mayflies came back?

Mike – higher level/ anecdotal assessment. Pre-construction they didn't notice any evidence of macros (fish or wildlife)

Charity – the municipality still gets to see those monitoring reports from year to year even if they are from a high viewpoint.

Sally Claggett – Clear and clean criteria, MD has a problem with stream temp TMDL on the rise – opening up and slowing down streams can warm them up but also the importance of forest cover for cold water refugia. Feels like this should be something that should be really important to weigh in on these designs.

Dave – it's a settled issue in their minds. Without tree cover, much of the streams are completely covered in vegetation. The amount of groundwater connection is substantial and that's what's driving the stream temperature.

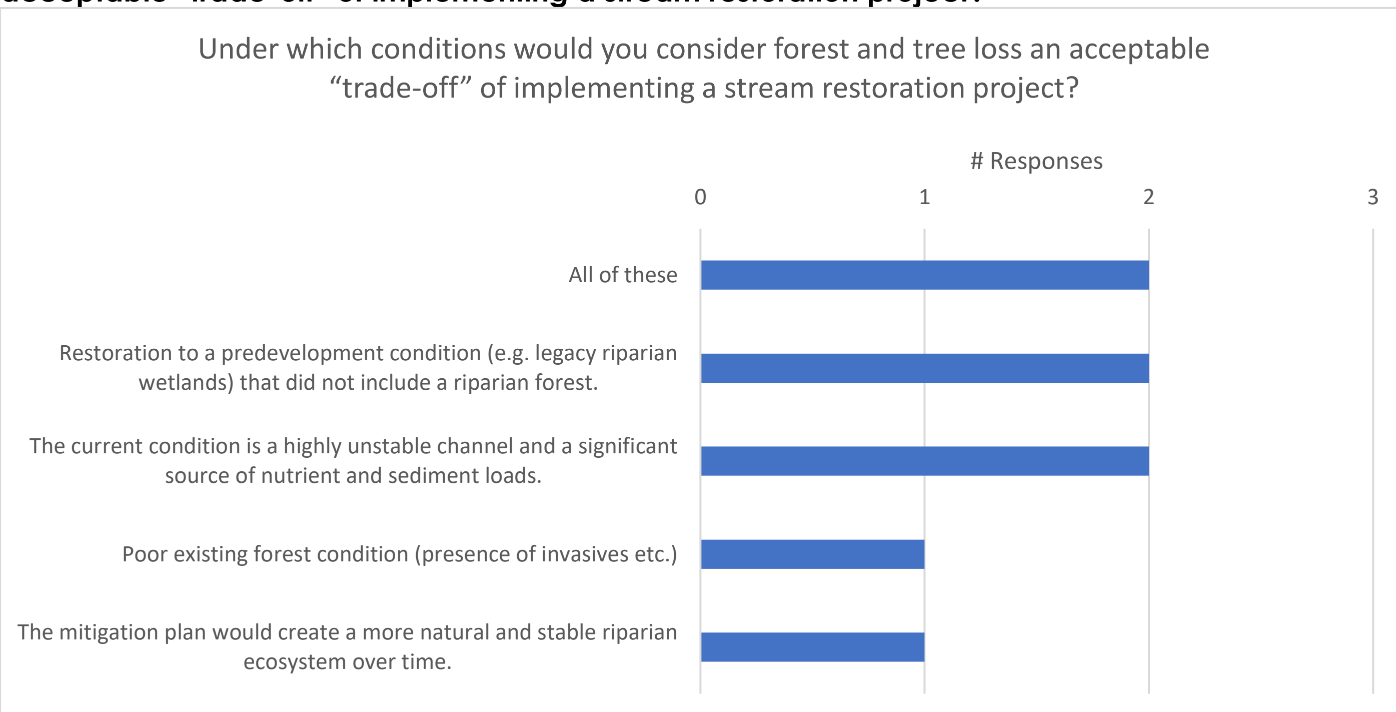
Sally – is there data? They are in the process of writing a STAC report and are finding that groundwater doesn't affect the stream temperature as much as previously thought.

Dave – would argue that groundwater thermal refugia is more important that headcut bank shading(?). Provides more consistent thermal regulation but it can depend on the size of the stream and other factors. It's a complicated modelling problem. In our observations and work we don't see it as an issue.

Sally – If you have any of those papers that talk about that, it's a good time to contribute those to the STAC report. It's been debated amongst the scientists, so if you have any support for your stance that would be appreciated.

Mike – Lititz Run has consistently seen the temperature maintained with that groundwater connection. It is complicated. At a new site, you have to change how you're thinking. We have to stop trying to create one checkbox for every situation. He will do some digging to find resources and data to help the STAC conversation.

Discussion Question 1 – Under which conditions would you consider forest and tree loss an acceptable "trade-off" of implementing a stream restoration project?



Sally Claggett – In MD, poor forest condition is often a reason for development

Katie Brownson – Struggled with the question, where she felt that one condition alone doesn't make it an acceptable trade-off; Doesn't always feel that reestablishing pre-historic conditions is realistic since things have changed.

Sally – most project do not look at the system holistically; how does the predevelopment condition act as a driver? Lititz Run is an impressive really holistic project.

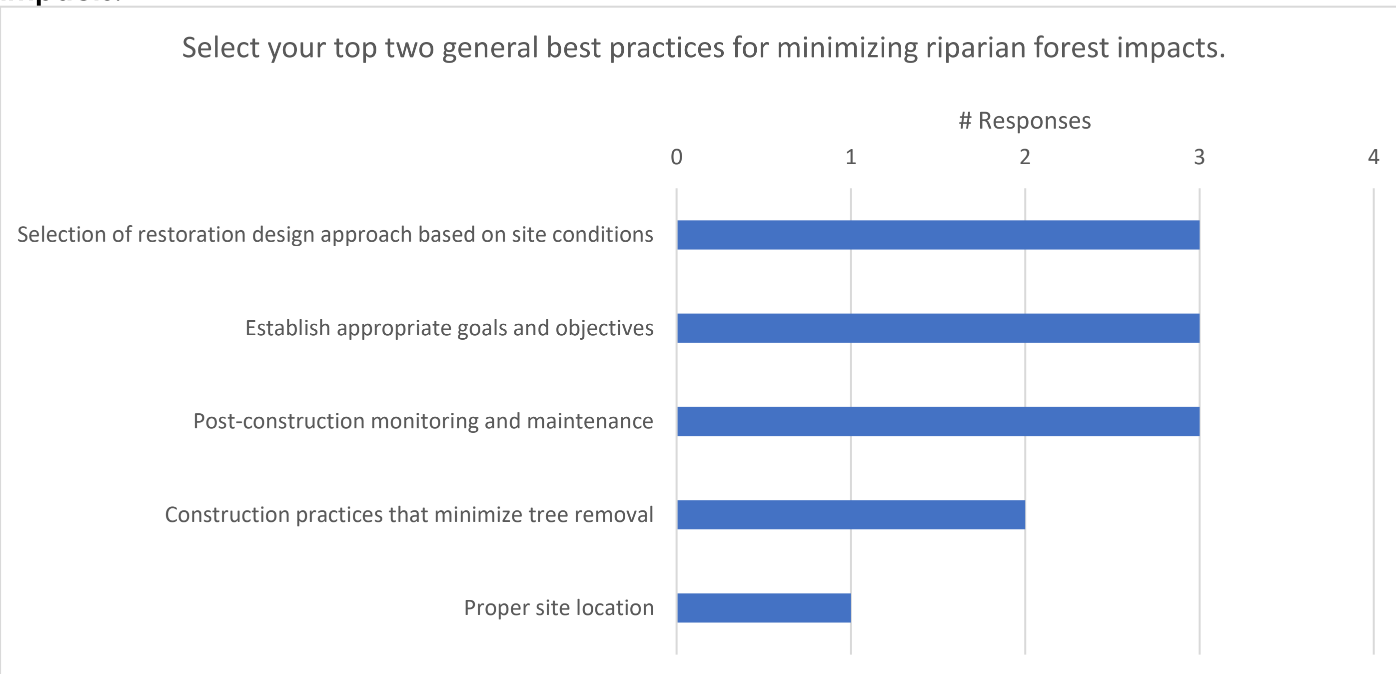
Dave – what they call restoration and what everyone else calls restoration is the difference between the hodge-podge vs the holistic view of the stream and floodplain system.

Mike - Rock Lititz is an example of a full scale restoration approach; an opportunity because of development – primary driver was Agnes in 1972 (from a down stream flood control standpoint). There's a difference between restoration and "manipulation"

Dave – biggest project in PA, mitigation bank that restored over 100,000 ft of stream restoring wet swales to a 30 sq mi drainage area with alluvial fans in between (Robinson Fork mitigation bank in southwest PA)

Mike – Lititz Run still have riparian corridors where it makes sense.

Discussion Question 2 – Select your top two general best practices for minimizing riparian forest impacts.



Top 3: Establish appropriate goals and objectives, selection of restoration design approach based on site conditions, post-construction monitoring and maintenance.

Sally – planting plans and techniques aren't needed if you have appropriate goals and objectives.

Mike – monitoring and maintenance is probably the most important because if you don't prioritize this all the other work tends to be a waste.

Discussion Question 3 – How should we take into consideration forest health decline that is occurring due to numerous factors (even without effects from stream restoration projects)? These factors include dominance by invasive and native vines, loss to invasive diseases/pests, competition from non-vine invasives, excess herbivory, and climatic-induced loss.

Sally – A lot of money is going into these opportunistic stream restorations – Invest some of that money in forest health and do both.

Dave – In PA, they are throwing money away on riparian buffers and spending oodles of money on forest health. Plantings on incised streams and have no effect on erosion, etc. Nobody assesses geomorphic conditions or if that's the appropriate tool for the site or situation.

Mike – People are rewarded for buffers. The accounting system is setup from a singular standpoint where the buffer counts the same no matter where you put it and the same applies to stream restoration. There are assumptions that we need to revisit in CAST, especially on BMP performance.

Sally – There are multiple issues with CAST and the expert panel reports are not perfect. The opaqueness of the stream restoration credits is a constant complaint. It is a very difficult process getting to the point that we are in. Credits applied to stream restoration were not at all conservative, and project were not put in the right places or weren't big enough. State agencies are pushing back…would like to hear if people find them understandable.

Dave – Agrees that they are complicated, but we are talking about complicated natural resources and the effort was trying to take account for those when being applied. Conservative approach in sediment reductions and there's still a lot to be learned in sediment credits. The stream crediting protocols that were recently revised was the best attempt at evidence based.

Sally – very complicated to try to find the multiple landowners to get these big projects done. State agencies are saying wait a minute…habitat isn't improving.

Dave – they don't have appropriate assessments to assess the restored system correctly. It may not be improvement based on macroinvertebrate data because you shift the food chain in these projects, but it's a more health redundant system from another standpoint. These are complicated difficult projects especially in the urban and suburban area. There is an abundance of sites but it is hard to find willing landowners. When you say stream restoration, we are likely not talking about the same thing.

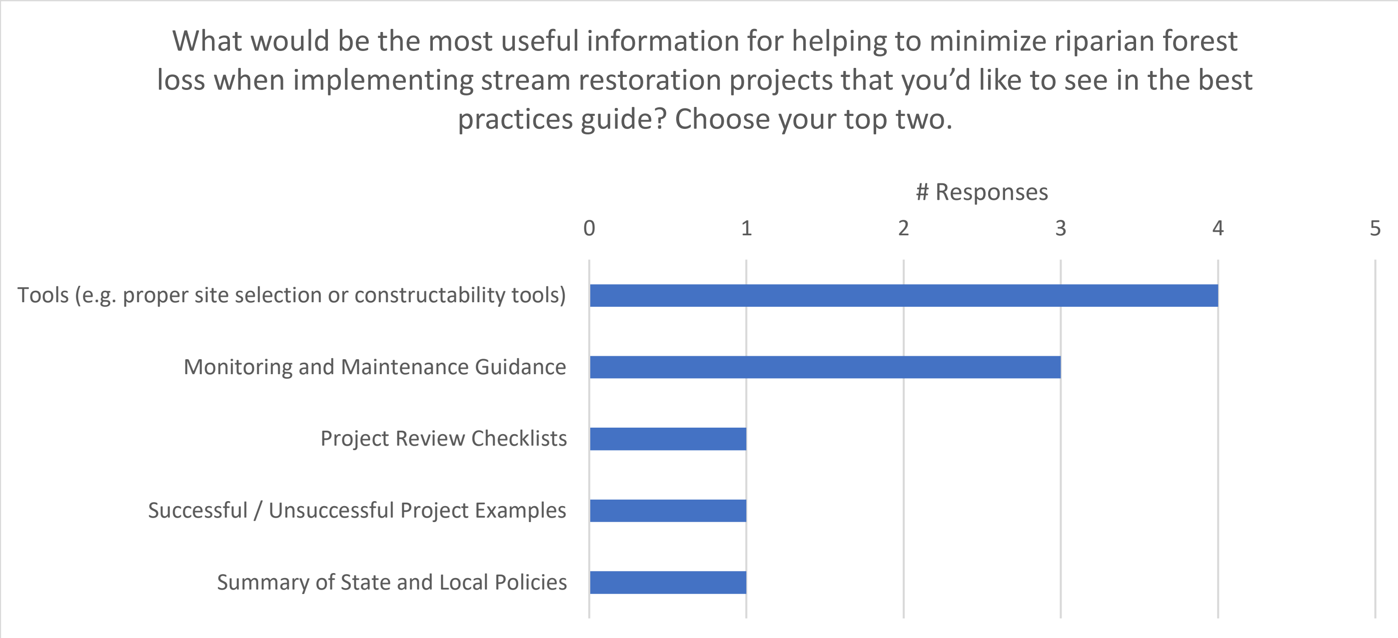
Mike – It might be helpful to better classify or delineate stream restoration into more helpful buckets. We just lump stream restoration into one bucket but not all restorations are the same, and that's the case with a lot of BMPs.

Dave – consistent use of terminology is an important factor

Discussion Question 4 – How can monitoring efforts for riparian forests that are part of stream restoration mitigation plans be improved?

Since we are short on time, the attendees are asked to email Lisa or Chris with thoughts they would like to share regarding question 4.

Discussion Question 5 – What would be the most useful information for helping to minimize riparian forest loss when implementing stream restoration projects that you'd like to see in the best practices guide?



Webcast Chat Log[2]

00:58:51 Chris Swann: Hi Everyone,

01:02:44 Mike LaSala: Private, non-profit, and local government

01:22:31 Sally Claggett: I would be interested in hearing more about the extent of invasive species control required for comp mitigation

01:38:47 Sally Claggett: Is Section 105 (Envi Assessment) what you said is often waived?

01:40:34 Dave Goerman: We can waive the requirements that are in the EA, such as assessment, alternatives analysis.

01:42:45 Dave Goerman: We have a total percent cover for the site (10%) and an individual location percent cover (5%), I believe those are the numbers if my memory serves me correct.

[2] Note that the chat log was copied directly from the webcast and has not been edited for grammatical correctness.

01:54:47 Sally Claggett: "clean and clear and cold"

02:00:02 Sally Claggett: Agree that maintenance should be part of every contract or don't do project.

02:06:31 Liz Feinberg: generally, can you speak to cost effectiveness, or best approaches, when sewerline/utility is in floodplain/valley.

02:11:17 Charity Burkhart: Agreed sally, our municipalities enter a maintenance agreement with the property owner prior to installation of any projects on private property. We typically have a written maintenance plan as well.

02:12:24 Katie Brownson: What sort of resources are available to assist landowners with maintenance? And what sort of follow-up happens to ensure the landowner is following the maintenance agreement/plan?

02:13:25 Charity Burkhart: Liz, I know mike has more experience in floodplain restoration as it relates to utilities. Ours are typically on the fringe of the extent of a buffer or restoration project, so they can be worked around.

02:13:42 Sally Claggett: @Charity-- we have moved away from requiring/requesting landowners to do maintenance (not likely to happen) but are strongly encouraging it to be wrapped into the project design and have it contracted.

02:17:55 Charity Burkhart: @sally, we are too. Our municipalities which are asking property owners to contribute land for a restoration are typically taking on maintenance responsibilities for a period of 3-5 years.

@kate, our follow up from the municipality requires inspection of installed bmps every 5 years and a yearly maintenance inspection by the property owner. This is followed up on in our MS4 program. Also our CAP team tries to help facilitate funding for buffer maintenance as well.

02:19:23 Sally Claggett: @Charity - Thanks!

02:20:01 Sally Claggett: its good to know that the municipality is responsible for the maintenance for the first 3-5 years.

02:30:18 Sally Claggett: thanks again Charity. FWIW, we feel that the full 5 years is often necessary.

02:56:48 Sally Claggett: interesting that Muddy Ck project also seemed to add a road to the floodplain

02:57:24 Katie Brownson: There is a pretty big difference between the load reductions calculated using the planning rates and the CBP Crediting protocols- could you say a little more about why this is the case?

02:58:23 Dave Goerman: How is there an increase in TSS when you go from ag pasture to wetland (non-pastured)? There should be a net decrease.

02:59:22 Charity Burkhart: In the projects detailed have you noticed if any invasive species have worked their way in or are those spot maintained as part of the maintenance program?

03:00:11 Dave Goerman: Big Spring run has some but they are minor and it has not been maintained.

03:02:30 Charity Burkhart: @dave thanks! I was kind of assuming that there was so much native material that it was choking out invasives but I've seen enough phragmites in wetland areas that I didn't know if things like that were an issue with these.

03:04:36 Dave Goerman: Typically they are vary diverse and with significant micro-topography and are self protecting from invasive species.

03:22:30 Katie Brownson: Do you have any published studies or reports you could share on the impacts of legacy sediment removal projects on temperature? That would be very helpful for the STAC report Sally mentioned.

03:47:21 Sally Claggett: too bad no one from DCNR is on

03:56:30 Sally Claggett: thanks for the discussion! I gotta run

03:57:48 Katie Brownson: Yes- some of this nuance in restoration design/impacts is important to capture when thinking about how to minimize unnecessary forest loss.

04:01:07 Dave Goerman: As far as monitoring EPA just came out with guidance on developing better monitoring and data management. BWEW is going to look at it for both compensation and grant restoration work.

04:01:43 Dave Goerman: thanks!

MD Webcast Summary

State Webcast Information
Maryland
May 20th, 2022

Agenda

Date/Time	Friday, May 20, 2022, 1:00 PM – 4:00 PM	
Webcast Recording Link	https://us06web.zoom.us/rec/share/7MpSzg26koCGWuuIyQ3n2gTVI3LgG5Yf-Mv_x98Nj6Z5Twsn_F9TK0F8GDnSJ7Mg.M_wLMwfhDPujDymU	
Link to PDF of Slides	https://www.cwp.org/wp-content/uploads/2022/05/Maintaining-Forest-Webcast-Presentation-Maryland-final.pdf	
Time	**Agenda Item**	**Presenter**
1:00 PM – 1:20 PM	Welcome and Project Overview	Lisa Fraley-McNeal, CWP
1:20 PM – 2:20 PM	State Agency, Local Gov, and Practitioner presentations	Denise Clearwater, MDE Tony Redman, MD DNR Marian Honeczy, MD DNR
		Erik Michelsen, Anne Arundel County
		Bryan Seipp, Ecotone
2:20 PM – 2:25 PM	Break	
2:25 PM – 3:05 PM	Presentation of Maintaining Forests Project Results	Lisa Fraley-McNeal, CWP
		Chris Swann, CWP
		Jordan Fox, CWP
3:05 PM – 3:10 PM	Break	
3:10 PM – 3:50 PM	Facilitated Discussion	Lisa Fraley-McNeal, CWP
3:50 PM – 4:00 PM	Wrap up and Next Steps	Lisa Fraley-McNeal, CWP

Presenters

Presenter	Biography
	**Denise Clearwater, Maryland Department of Environment** Denise Clearwater is the special projects coordinator in the Wetlands and Waterways Program in the Maryland Department of the Environment. She has a background in developing and implementing programs in wetland regulation, wetland training, and mitigation, as well as managing special projects for grants and program improvement and assisting in policy development. She has represented the MDE's Wetlands and Waterways Program on numerous interagency work groups for regulatory, wetland monitoring, restoration, preservation, and stream health and as an at-large Board member of the National Association of Wetland Managers. She is also a member of the Society of Wetland Scientists. Denise has a B.S. in zoology from the University of Maryland and an M.S. in wildlife management from Frostburg State College (now University).

Presenter	Biography
	**Erik Michelsen, Anne Arundel County, MD** Erik is currently a Deputy Director for Anne Arundel County's Department of Public Works, heading its Bureau of Watershed Protection and Restoration. He works to facilitate the recovery of the Chesapeake Bay and its tributaries through supporting robust restoration projects and rigorous scientific monitoring efforts, bolstered by diverse stakeholder partnerships. Erik has an extensive background as a project manager for an environmental consultant then as the Executive Director for a non-profit, the Arundel Rivers Federation (formerly the South River Federation), and working for Anne Arundel County since 2014, as the County builds up the environmental assessments, restoration implementation, and ecological evaluation to support the County's clean water obligations under the Municipal Separate Storm Sewer System (MS4) permit and the Chesapeake Bay Total Maximum Daily Load (TMDL).
	**Bryan Seipp, Ecotone** Bryan Seipp is Director of Project Development for Ecotone, LLC. a design-build ecological restoration firm located in Forest Hill, Maryland. Bryan is a licensed registered forester in Maryland with over 20 years of experience in the forestry and watershed management field. Bryan has worked in the forestry, agriculture, stormwater, and land protection sectors and has managed the implementation of a wide variety of water quality improvement projects, including stream restoration, throughout the Chesapeake Bay Watershed. Bryan currently serves as the chair of the Maryland Sustainable Forestry Council and president of the Catoctin Land Trust. In his free time Bryan enjoys spending time with his family and mountain biking.
	**Lisa Fraley-McNeal, Center for Watershed Protection, Inc.** Lisa is a Sr. Watershed & Stormwater Research Specialist for the Center. She has been working on urban watershed and stormwater management since 2006. Her areas of expertise include GIS and field methods for watershed assessment, watershed planning, stream restoration, Chesapeake Bay TMDL crediting, and applied research on topics related to watersheds and stormwater. She has a B.S. degree in Geography and Environmental Systems, with a writing minor and cartography certificate from the University of Maryland, Baltimore County. Lisa also has a M.S. degree from the University of Maryland, Baltimore County in Marine and Estuarine Environmental Science.

Presenter	Biography
	**Chris Swann, Center for Watershed Protection, Inc.** Chris is a Watershed Planner & Environmental Analyst for the Center. He has been a watershed planner at the Center since 1997. His work time is split between two responsibilities: researching and writing technical guidance on watershed management issues and trying to keep the Center's technology in check and functioning properly. Since joining the Center, Chris has contributed to the writing of numerous Center publications, including the Urban Subwatershed Restoration Manual series and the Better Site Design Manual. Chris has a B.S. in Natural Resources Management from the University of Maryland, as well as a B.S. in Biology from James Madison University.
	**Jordan Fox, Center for Watershed Protection, Inc.** Jordan is a Watershed & Stormwater Research Specialist for the Center. She joined the Center full-time nearly 5 years ago after graduating from Washington College in Chestertown, MD with a B.S. in Environmental Science, a B.S. in Biology, and a minor in chemistry. Her areas of expertise include GIS, field methods for watershed assessment and monitoring, and research on diverse watershed- and stormwater-related topics. Her favorite projects involve spatial analysis, data-driven deliverable creation, technical writing, and both desktop and field research.

Registrants

Webcast Attendance
Total Number of Registrants: 73
Total Number of Webcast Attendees: 54

Name	Email Address	Webcast Attendance
Alexander Bratchie	abratchie@howardcountymd.gov	**N**
Alexandria Wilkins	ajw@cwp.org	**Y**
Alison Santoro	alisona.santoro@maryland.gov	**Y**
Amanda Bland	abland@allianceforthebay.org	**N**
Amanda Pollack	ahp@cwp.org	**Y**
Amy Reed	amelia.reed@delaware.gov	**Y**
Anne Hairston-Strang	Anne.Hairston-Strang@maryland.gov	**Y**
Ari Engelberg	ari.engelberg@maryland.gov	**N**
Aubin Maynard	amaynard@mwcog.org	**Y**
Bel Martinez da Matta	maria.martinezdamatta@maryland.gov	**Y**
Bertha Berrios	pwberr30@aacounty.org	**Y**
Bill Stack	bps@cwp.org	**Y**
Brenda Morgan	pwmorg63@aacounty.org	**N**
Bryan Seipp	bseipp@ecotoneinc.com	**Y**
Carol Wong	ckw@cwp.org	**Y**
Carrie Decker	carrie.decker@maryland.gov	**Y**
Charles Smith	Charles.Smith@fairfaxcounty.gov	**N**
Chris Swann	cps@cwp.org	**Y**

Webcast Attendance Total Number of Registrants: 73 Total Number of Webcast Attendees: 54		
Name	**Email Address**	**Webcast Attendance**
Christina Lyerly	christina.lyerly@maryland.gov	**Y**
Christopher Victoria	pwvict16@aacounty.org	**Y**
Christy Ciarametaro	christy.ciarametaro@montgomerycountymd.gov	**Y**
Claudia Donegan	claudia.donegan@maryland.gov	**N**
Darian Copiz	darian.copiz@montgomerycountymd.gov	**N**
Debbie Herr Cornwell	deborah.herrcornwell@maryland.gov	**Y**
Denise Clearwater	denise.clearwater@maryland.gov	**Y**
Doug Streaker	dstreaker@biohabitats.com	**Y**
Douglas Griffith	pwgrif04@aacounty.org	**Y**
Emily Trethewey	est@cwp.org	**Y**
Erik Michelsen	pwmich20@aacounty.org	**Y**
Ginger Ellis	pwelli16@aacounty.org	**Y**
Greg Golden	greg.golden@maryland.gov	**Y**
Heather Ambrose	heather.ambrose@fairfaxcounty.gov	**N**
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Iris Allen	iris.allen@maryland.gov	**Y**
Janis Markusic	pwmark02@aacounty.org	**Y**
Jeff Sweeney	sweeney.jeff@epa.gov	**Y**
Jeff White	Jeff.White@Maryland.gov	**N**
Jim George	jim.george@maryland.gov	**Y**
Jordan Fox	jf@cwp.org	**Y**
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Karl Berger	kberger@mwcog.org	**Y**
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Kenneth Bawer	kbawer@msn.com	**N**
Laura Callens	lcallens@res.us	**Y**
Laura Kelm	laura@greenvestus.com	**N**
Laura Todd	ltodd@allianceforthebay.org	**N**
Lindsay DeMarzo	ldemarzo@howardcountymd.gov	**Y**
Lisa Fraley-McNeal	lfm@cwp.org	**Y**
Marian Honeczy	marian.honeczy@maryland.gov	**Y**
Mark Hoffman	mhoffman@chesbay.us	**Y**
Mark Symborski	mark.symborski@montgomeryplanning.org	**N**
Matt English	matthew.english@dc.gov	**N**
Matt Stover	matthew.stover@maryland.gov	**Y**
Megan Fitzgerald	fitzgerald.megan@epa.gov	**Y**
Meghan Fellows	meghan.fellows@fairfaxcounty.gov	**Y**
Melissa Chatham	melissa.chatham@maryland.gov	**Y**
Miranda Reid	miranda.reid@montgomerycountymd.gov	**Y**
Natasha Shangold	nlshangold2014@gmail.com	**N**
Nathan Forand	nforand@baltimorecountymd.gov	**Y**

Webcast Attendance Total Number of Registrants: 73 Total Number of Webcast Attendees: 54		
Name	**Email Address**	**Webcast Attendance**
Neely Law	neely.law@fairfaxcounty.gov	**Y**
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Paul Pitera	ppitera@res.us	**Y**
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Sara Weglein	sara.weglein@maryland.gov	**Y**
Sarah Hilderbrand	sarah.hilderbrand@maryland.gov	**Y**
Sophia Grossweiler	sophia.grossweiler@maryland.gov	**Y**
Tony Redman	tony.redman@maryland.gov	**Y**
Travis Cooke	tcooke@res.us	**N**

Summary of Key Discussion Points

MD DNR adopted guiding principles related to stream restoration in June 2015 that defines and reviews distinct criteria for various types of stream treatments (e.g., restoration, rehabilitation, engineering, reclamation, stabilization, and enhancement) and noted that not all projects should be considered stream restoration.

Historic or predevelopment conditions for setting vegetation restoration goals do not play a major part in MDE's considerations, which instead evaluates projects based on the value of current conditions. Priority areas and their desirable characteristics are described in other State references, regulations, and goals.

Many stream restoration projects are not affecting forest loss; rather, they are converting a mature forest to a young forest. This is not an advocation for clear-cutting, but it's important to note that young forests are important habitat for certain species like golden-winged warblers and others. Stream temperature is an important consideration of stream restoration design. While shading is one component, restored groundwater hydrology is also important for stream cooling. One problem is that many stream systems are driven by stormwater with limited groundwater-based flow. Microtopography is an important consideration.

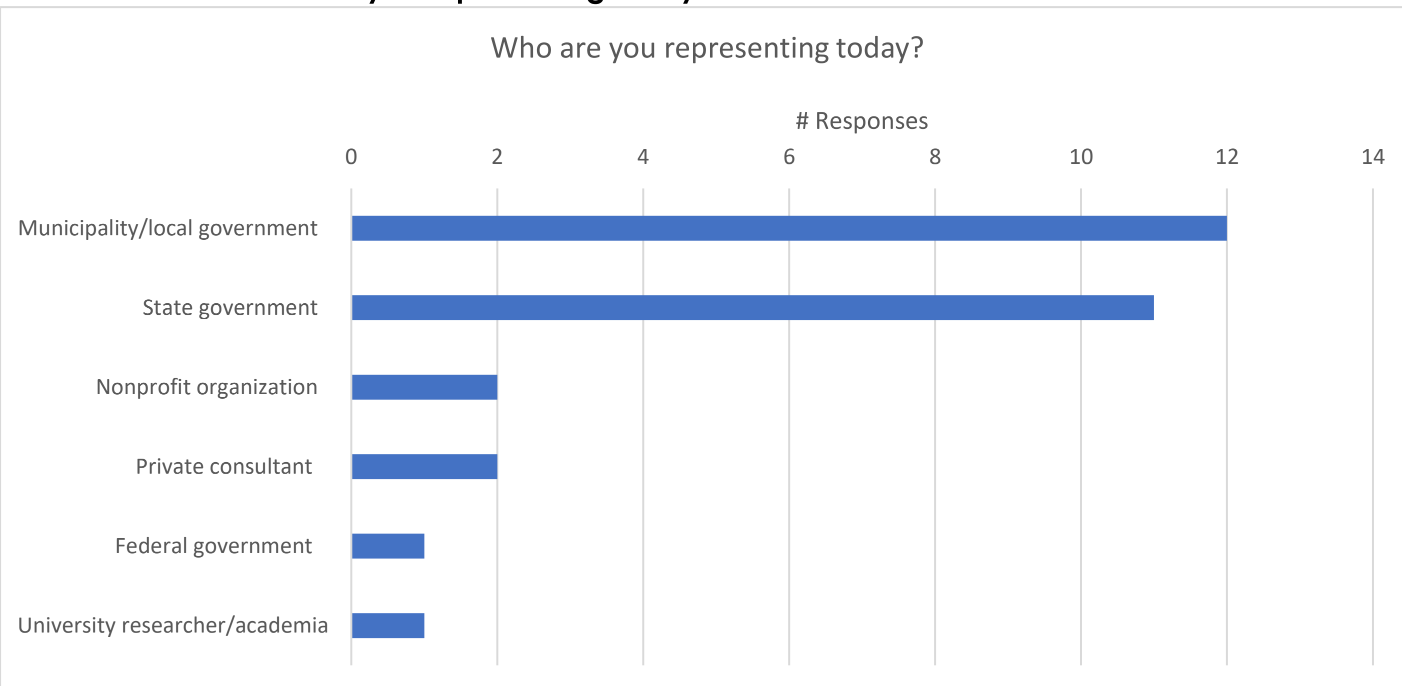
Landowner engagement and public outreach/education are important components of stream restoration projects. Many community concerns are in public areas where larger floodplain reconnection projects are proposed. Outreach and education to the public prior to the submission of permit applications to the state should be done to help to reduce community concerns.

One of the difficulties with monitoring programs is not having an agreed upon functional metric to define a healthy forest. Developing regionally specific riparian monitoring protocols and forest quality indices was suggested. With advances in technology, remote-sensing tools are also useful for broad scale monitoring to supplement on-the-ground investigations.

Meeting Notes

Welcome and Project Overview
Poll Question 1 – How many people are participating in the webcast today at your location? All attendees joined in individually except for one group of 2 – 5

Poll Question 2 – Who are you representing today?



Poll Question 3 – How many years of experience do you have with stream restoration?

Lisa Fraley-McNeal (CWP) – Overview of the Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned Project

Given the concern over the potential negative impacts of stream restoration, CWP received a grant from the Chesapeake Bay Trust to evaluate how these unintended outcomes can be minimized in the riparian area, including forest buffers, to improve riparian and stream habitat quality.

A Stakeholder Team was formed to provide input and help guide the project.

Background Information

- The CBP Stream Restoration Expert Panel Crediting Protocols were finalized in 2014. The credits contributed as a driver for implementation of stream restoration projects. Other benefits and considerations of projects beyond nutrient and sediment load reduction were often lost.
- The updated CBP stream restoration protocols based on recent workgroup updates help to address stream health more comprehensively.
- With sediment being one of the main stressors of biological impairment, there is a regulatory incentive to address it. Stream restoration is being done to meet local TMDLs in addition to the Bay TMDL.
- The rapid increase in stream restoration projects throughout the Chesapeake Bay watershed has led to growing concern and controversy about their effects on whole-ecosystem health and services.
- One of the arguments against stream restoration is that we should be looking upstream to implement BMPs instead. However, some considerations of this approach are 1) that it can take years before an effective geomorphic change is identified due to changes in the flow regime, and 2) Implementing enough upstream BMPs to create a response at the watershed scale is often not feasible depending on the watershed conditions.

Completed project tasks include: 1) project planning and preparation, 2) QAPP, 3) policy/document review and interviews, and 4) case study analysis.

The webcast task is currently in progress and will be completed by 5/31/2022.

The next task is to synthesize results from the completed project tasks into a final project report that includes recommendations on opportunities to improve consideration of riparian forests in stream corridor restoration projects to minimize unintended consequences. Recommendations from the project report will be used to update and finalize a best practices guidance document for local governments.

State, Local Government, and Practitioner Presentations

Denise Clearwater (MDE) – Maintaining Forests in Stream Restoration: Maryland Department of the Environment, Water and Science Administration, Wetlands and Waterways Program

There are a variety of different types of stream restoration implemented in MD, including natural channel design, RSCs, beaver dam analogs, and legacy sediment removal. The types vary by jurisdiction, but the most common types are natural channel design followed by RSCs.

While MDE recognizes that some vegetation may need to be removed during construction, concerns from the public and others about the extent of forest loss and wetland conversion have led us to require a closer examination of forest losses, including requesting additional justifications and minimization efforts. We're also working on determining the extent of change, and we've begun recommending new practices.

MDE is a state agency that implements the following statutes: Waterways & Floodplain (1933) and Nontidal Wetlands (1989). MDE also has a role in federal licensing and permitting and coastal zone management requirements—DNR also shares coastal zone management responsibilities. Decisions made under the statutes that MDE oversees/implements must weigh public advantages and disadvantages and be in the best public interest.

There are specific water quality criteria for Use III waters that indicates that riparian forest buffers adjacent to Use III waters must be retained whenever possible to maintain necessary temperatures to meet this criterion.

A new checklist for riparian areas was developed in 2021, which expands on previous assessments and requires additional information, like forest stand delineation, marking trees to be removed, and more. There is also new detailed assessment and guidance (funded by EPA) for the upper coastal plain, including upper coastal plain wetlands, in association with stream restoration projects. There is a similar effort underway for the Piedmont and the lower shore coastal plain (which should be completed at the end of 2023). Key wildlife habitat types are a consideration in the assessments.

MDE is required to produce a new study on ecological restoration and permitting by June 2024, to evaluate existing laws/regulations, the permit process, opportunities for public comment, defining ecological restoration, possibly developing a separate permit process for ecological restoration projects, conducting a holistic permit review, and evaluating whether additional staff and resources may be necessary.

Tony Redman (DNR) – Maintaining Forests in Stream Restoration: Maryland Department of Natural Resources
DNR adopted guiding principles related to stream restoration in June 2015; this policy guides actions to support, fund, construct, or review stream restoration project proposals in MD. The policy defines and reviews distinct criteria for various types of stream treatments (e.g., restoration, rehabilitation, engineering, reclamation, stabilization, and enhancement). Not everything should be called a stream restoration project. We're seeing increasing concern about the degree of clearing associated with stream projects. Impacts to existing trees must be avoided or minimized to the maximum extent practicable with ample justification in order for a project to receive DNR support; additionally, all unavoidable impacts to riparian trees must be compensated for/mitigated through afforestation when on-site restoration is not an option.

Marian Honeczy (DNR) – Maintaining Forests in Stream Corridor Restoration & Forest Conservation Act
The compliance requirements for the Forest Conservation Act are: 40,000 sq ft or greater of area disturbed and required grading, sediment control, or subdivision approval. If the project doesn't meet the exception requirements (or a local jurisdiction does not have exceptions for FCA ordinances), then full compliance is required.

The exception criteria indicate that a binding maintenance agreement of at least 5 years must be signed by the affected property owners. Additionally, the stream restoration project must avoid impacts to forests and provide on-site an equivalent number of trees to the number removed by the project. A tree is defined as a woody stem here.

Erik Michelsen (Anne Arundel County) – Forest Impacts in Stream Corridors as a Result of Restoration: Perspectives from Anne Arundel County
In Anne Arundel County (AACo), the following types of stream and wetland restoration are conducted: RSC, legacy sediment removal, valley restoration, beaver dam analogs. We try to duplicate the features that you may get through a legacy sediment removal project, but we're really aiming for integrated stream and wetland complexes as opposed to armored ditches.

These sites are identified through watershed assessments, concerns identified and shared by constituents, staff discovery, remote sensing tools, or some combination of the above methods. High-resolution lidar imagery is also used.

Erik showcased a variety of different projects completed by AACo, including some that were designed to be colonized by beavers.

County regulations and permitting requirements related to riparian forests and stream restoration projects were discussed, including the Forest Conservation Act (FCA). This aligns with what Marian presented. Erik also described the importance of working with the state early in the project development process (e.g., holding pre-permit application meetings). This gives applicants the opportunity to present the project to the regulatory staff, ask questions, and ensure sufficient time for feedback from the regulatory review staff to be incorporated into the project's design before unavoidable time and cost constraints arise later in the project's timeline.

Erik then reviewed some successful projects. The first project (Wilelinor completed about 15 to 17 years ago) included planting a host of Atlantic white cedar trees. Another project, Furnace Branch, is located in an urban part of the state and used to be a lined concrete swale; it has since been replanted as a stream/wetland complex. Post-construction photos showing vegetation establishment at Cat Branch (on the Magothy River) were presented. The Dairy Farm Outfall project was presented (tributary to the Little Patuxent); this is not classified as a stream since it's basically ephemeral due to very sandy underlying soils. For this project, the stream bed was raised during a valley restoration approach.

Bryan Seipp (Ecotone) – Riparian Vegetation Impacts from Stream Restoration
Bryan offers a unique perspective as a forester. While it's important to minimize tree loss, some trees do need to come down in the process of stream restoration projects; those removed trees are needed and are used as part of the project. One of Ecotone's goals is to create not only healthy streams but healthy floodplains that can deal with the watershed's hydrology.

Ecotone is able to work with many private landowners to come up with agreements on projects. Ecotone also works with a lot of folks who do grant-funded projects. Ecotone also does a lot of work in agricultural settings.

It's also important to consider the impacts of riparian forest threats like the Emerald Ash Borer, which is bringing down large swaths of trees.

Impacts of degraded streams on trout passage are also something that Ecotone considers. Bryan highlighted a project in New Jersey that aimed to remove blockages for trout.

Bryan raised the point that "young forests aren't bad"—many stream restoration projects are not affecting forest loss; rather, they are converting a mature forest to a young forest. This shouldn't be mistaken for advocating for clear-cutting, but there is not a lot of young forest in most of the center/western portions of the state. Young forests are important habitat for certain species like golden-winged warblers and others.

Bryan presented a selection of successful stream restoration projects, including those with beaver populations.

Bryan also mentioned the importance of using the wood from any removed trees. If this wood cannot be used on-site for some reason, it can be used by people in the community (for example, artisan woodworkers creating live-edge tables).

Project Results Presentation

Chris Swann (CWP) – Policy/Document Review and Interviews

Policy/document review: The goal was to better understand the requirements of each state for protecting and mitigating damage to stream buffers associated with stream restoration projects. A total of 40 regulatory and 78 technical/guidance documents were reviewed.

Interviews: The goals were 1) to better understand how the requirements identified from the review of regulatory and policy documents are (or are not) implemented in each jurisdiction and 2) to identify and refine best practices to minimize adverse impacts to riparian forests. A total of 19 individuals were interviewed, representing state and local governments, as well as practitioners.

Chris provided an overview of how forests are defined for this project and the key federal policies reviewed. He also summarized the key findings and identified best practices related to site selection and planning, design and permitting, implementation, and post-construction monitoring.

The deliverable for this task was a technical memo that will be included in the final project report.

Jordan Fox (CWP) – Case Study Analysis

Reviewed 10 stream restoration projects in Lancaster County, PA, Anne Arundel County, MD, and Fairfax County, VA to determine the extent to which requirements are implemented and quantify the impacts stream restoration has on riparian vegetation.

Utilized loading rates from CAST to determine changes in nutrient and sediment loading from the stream restoration projects and impact to the riparian vegetation due to project implementation.

Jordan walked through 5 case study example projects and summarized the key findings.

Case study results were summarized in 3- to 5-page summaries for each site that will be included in the final project report.

Questions from the Policy Review & Interviews or Case Study Analysis presentations were addressed and/or discussed during the facilitated discussion.

Facilitated Discussion

Question from Anne Hairston-Strang: Are there trends for more designs with shading in mind for wetland complexes (stream temperature considerations)?

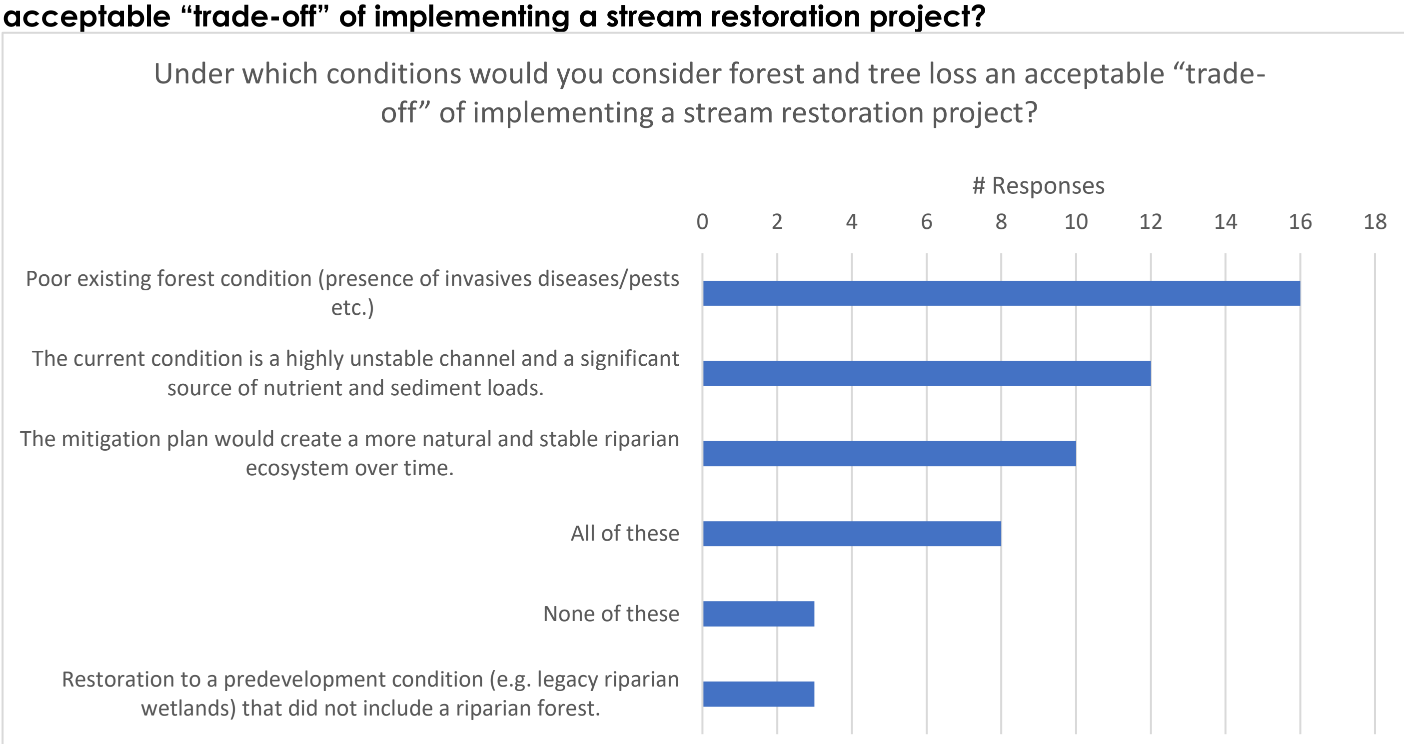
Response from Erik Michelsen: It's also important to consider how well these systems are able to handle flashy flows. In terms of temperature, while shading is certainly component, I think that we underestimate the value of restored groundwater hydrology on cooling these systems. I think a problem that we run into is that many of these systems are driven by stormwater with maybe a small trickle of groundwater-based flow.

The group discussed how micro-topography is considered and how that relates to temperature impacts in restored streams. In natural systems (including those with wetland complexes), you see a lot of topographic diversity within a site—for example, some sections of the stream may be open, and others may have islands and pools. Recreating this kind of micro-topographic diversity may be difficult from a maintenance perspective, but in terms of mimicking natural systems (specifically with the goal to recreate natural thermal regimes), it may be necessary. Erik Michelsen described the importance of creating a "mosaic" of microhabitats rather than an entirely uniform stream system. Anne Hairston-Strang elaborated further on the importance of temperature and its impacts on trout populations. While groundwater inputs are essential for maintaining trout habitat, shading those areas to maintain colder temperatures is also important. There appears to be unresolved discussion on whether groundwater inputs or in-stream shading are most important for maintaining temperatures suitable for trout populations.

In response to the case study analysis portion of the presentation, Denise Clearwater commented that forest and floodplain wetland areas are not mutually exclusive. Lisa Fraley-McNeal explained that we used the land use classifications from the 2013/2014 Chesapeake Conservancy dataset.

Greg Golden commented that it seems like 80% of concerns voiced by the public are in public areas where larger restoration/floodplain connections are proposed. Erik Michelsen commented that the public should be hearing about these projects way before permit applications get into the state's hands. The group discussed the importance of landowner engagement and public outreach/education.

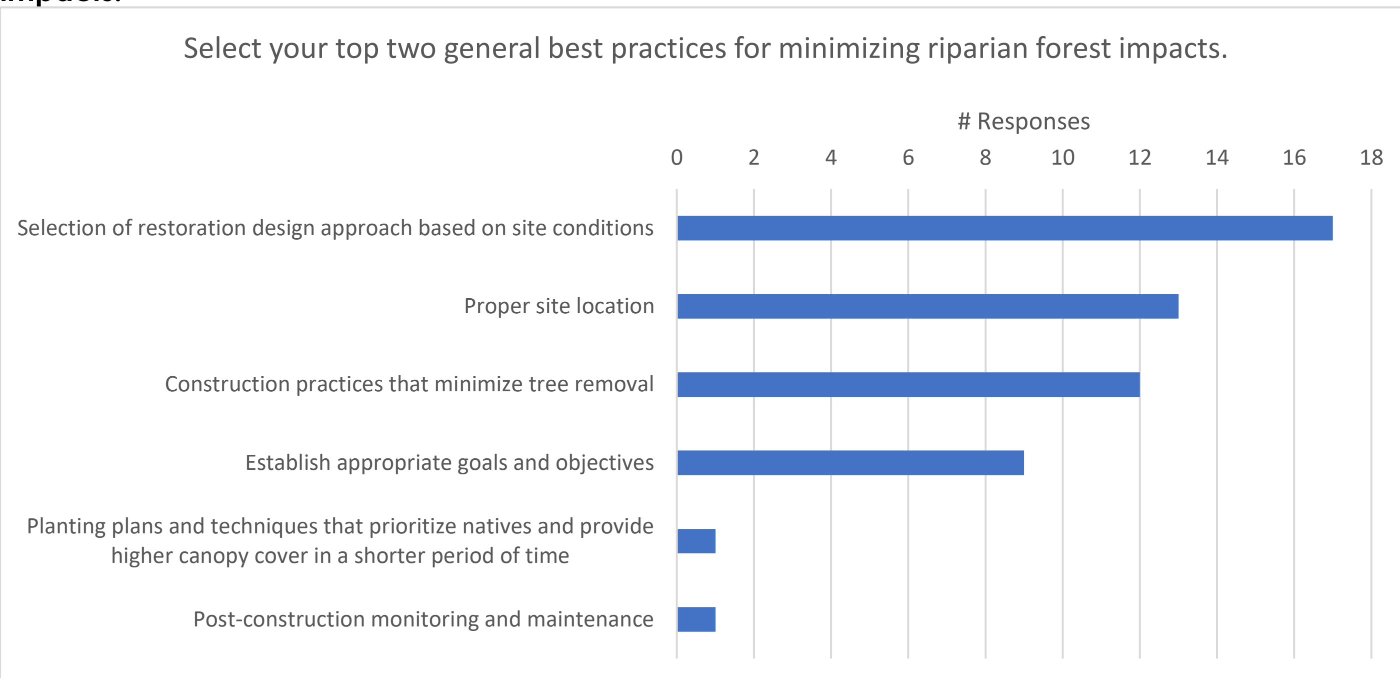
Discussion Question 1 – Under which conditions would you consider forest and tree loss an acceptable "trade-off" of implementing a stream restoration project?



The group discussed the poll results from the first facilitated discussion poll question, which showed that many consider poor existing forest condition to be a good reason to remove trees during restoration.

Tony Redman mentioned that he's not seeing much good documentation on the biological lift from stream restoration projects as they would like/need to see. The group discussed biological/functional uplift and water quality benefits (and, in some cases, decreased water quality) from stream restoration projects. In many cases, folks involved with stream restoration are focused on water quality solely from a TMDL crediting perspective, but the importance of also considering effects on habitats, regimes, and macrobiota was emphasized.

Discussion Question 2 – Select your top two general best practices for minimizing riparian forest impacts.



The group discussed the poll results from the second facilitated discussion poll question, which showed that many consider proper site selection and proper restoration type selection to be the best practices for minimizing riparian tree impacts. Aubin Maynard commented that site selection is not necessarily a choice in a lot of jurisdictions due to constraints from property ownership and utilities. A comment from the chat box indicated that post-construction monitoring and maintenance is often overlooked. Bryan Seipp mentioned performance-based contracting as well.

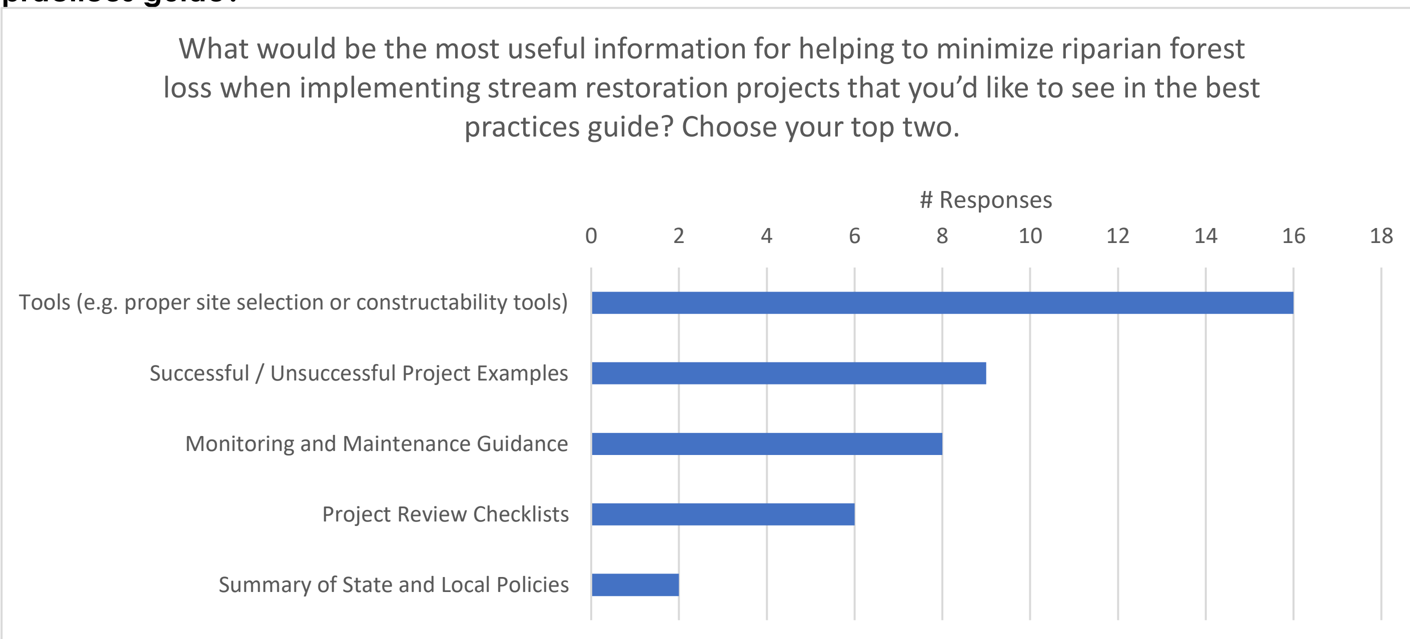
Discussion Question 3 – How should we take into consideration forest health decline that is occurring due to numerous factors (even without effects from stream restoration projects)? These factors include dominance by invasive and native vines, loss to invasive diseases/pests, competition from non-vine invasives, excess herbivory, and climatic-induced loss.

Bryan Seipp discussed how watershed hydrology and other regime-level characteristics can affect riparian forests/trees, and he mentioned threats from invasive insects and plants. The importance of maintenance was discussed.

Discussion Question 4 – How can monitoring efforts for riparian forests that are part of stream restoration mitigation plans be improved?

Erik Michelsen mentioned that remote-sensing tools (particularly some of the lidar and multi-spectral imaging) gives us an opportunity to look at changes in the plant community over time. These tools aren't that expensive and could be used on a broad scale. This, of course, is a supplement to on-the-ground examination, not a replacement for it. Meghan Fellows mentioned that one of the difficulties with monitoring programs is not having an agreed upon functional metric to define a healthy forest—green does not always mean good when looking at aerial imagery because of invasives. Douglas Griffith commented that developing regionally specific riparian monitoring protocols would be a start.

Discussion Question 5 – What would be the most useful information for helping to minimize riparian forest loss when implementing stream restoration projects that you'd like to see in the best practices guide?



The group discussed the poll results from the final facilitated discussion poll question about what the most useful information for would be for helping to minimize riparian forest loss during stream restoration projects (i.e., what do you want to see in the best practices guidance document?). Tools for proper site selection, followed by examples of successful and unsuccessful projects, followed by monitoring and maintenance guidance were the top three choices. Denise Clearwater added to the list specific performance standards and conditions since that was not a poll option.

Webcast Chat Log[3]

00:18:04 Chris Swann: Hi Everyone

00:53:47 Denise Clearwater: Lost audio will call in

01:20:12 Neely Law: Great presentation, Erik. This question is for Denise as well. Based on the research Erik presented on County projects and elsewhere by others, how do you define

[3] Note that the chat log was copied directly from the webcast and has not been edited for grammatical correctness.

historic or predevelopment conditions for setting vegetation restoration goals (forested vs scrub-shrub wetland)?

01:23:06 Bill Stack: Yes great presentation Erik and question Neely.

01:23:35 Denise Clearwater: Historic condition from hundreds of years ago does not play a major part in MDE's considerations. We evaluate based on how we value current conditions, among other requirements. Priority areas and their desirable characteristics are described in other State references, regulations, and goals.

01:25:09 Erik Michelsen: Neely. Thanks for the feedback. We're planting these system generally to function as forested wetlands with a mosaic of other, wetter, wetland types.

01:25:50 Erik Michelsen: As well as planting more upland species on the periphery, generally on the edges of the valleys.

01:37:48 Anne Hairston-Strang: Today's designs have to function with post-development hydrology and effects of rising temperatures. Stream temperatures are rising even more than air temperatures in many areas with changes in land use. Are there trends for more designs with shading in mind for the wetland complexes? And considering the watershed context for where other forest cover exists? Vigorous complaints are coming from areas where little other natural forest remains.

01:43:19 Greg Golden: Would like to ask a question based on where many concerns come from: urban / suburban forest corridors, publicly owned, where larger restoration or floodplain connections might be proposed. This seems to be where 80% of voiced concerns first get informed. I learn something each presentation, but the thought does come up, maybe we aren't going to the next step of analyzing and solving this concern, and potential solutions.

01:49:27 Denise Clearwater: I agree with Anne regarding temperatures-both shade and groundwater are important. Also, a riparian forest can still be a mosaic with microtopography, fine elevation changes, vernal pools, etc while still being shaded.

01:52:29 Erik Michelsen: Hey Greg,

01:53:32 Erik Michelsen: I know Lisa said she'll take your question up later, but I'll just say that the public should be hearing about these projects way before permit applications get into the State's hands. That's on the applicants.

02:03:21 Greg Golden: Good point Erik, I have been saying in the past couple months, there is always a landowner involved (or more than one), and some have larger interest groups, some have fewer. I know it's much more complex than that, but we are agreeing at this basic key starting point.

02:21:30 Denise Clearwater: "Forest" and "floodplain wetland" are not mutually exclusive areas. Tulip poplar are frequently found in floodplains, if not in very wet areas.

02:24:09 Alison Santoro: Denise, I agree. We need to differentiate between upland forest, forested wetlands, and emergent wetlands.

02:28:19 Denise Clearwater: There were other water quality impacts (e.g. lower DO) as a result of restoration in some early monitoring reports.

02:30:23 Meghan Fellows: Was there a change in NNI?

02:34:21 Jordan Fox (CWP): Hi Meghan -- for most of the case study locations, the post-construction monitoring indicated that non-native invasives were being adequately managed; although, they were observed at certain locations. Where that invasives monitoring data was present, those results are summarized in the case study memo.

02:38:04 Erik Michelsen: Groundwater DO at SERC increased after restoration, per the following presentation: https://cbtrust.org/wp-content/uploads/SERC-T.Jordan-RSC-Performance-6-29-18.pdf

02:53:31 Douglas Griffith: I'm not seeing the pop up box, but I'll use both of my two votes on F

02:56:41 Douglas Griffith: I'm having microphone issues - but the reason for my answer is that I feel it's an often overlooked facet of restoration. I've seen countless reforestation/planting efforts "fail" because of lack of post-construction/post-planting maintenance.

03:10:28 Douglas Griffith: I think developing regionally specific Riparian monitoring protocols would be a start, such as those that exist in the western states.

03:11:00 Douglas Griffith: As well as a regionally specific FQI

03:14:01 Anne Hairston-Strang: A forest health index from Vermont: index from indicator dashboard (https://www.uvm.edu/femc/indicators/vt)

03:14:41 Denise Clearwater: Specific performance standards and conditions

03:16:13 greg Golden:Adaptive Mgt is a very important tool, but how to optimize that.....is a whole conversation on its own. It is relatively early stages of optimizing for stream restoration

03:16:42 Erik Michelsen: Thanks

VA Webcast Summary

State Webcast Information

Virginia

May 18th, 2022

Agenda

Date/Time	Wednesday, May 18, 2022, 1:00 PM – 4:00 PM
Webcast Recording Link	https://us06web.zoom.us/rec/share/27q0QY6U9OW6mX4RV9spb-4zxZ_w3S65fOxtA0E4-nYUxH8g40FNOZvY_ZLLE-sz.8xJwCDIV1IL_IbM2
Link to PDF of slides	https://www.cwp.org/wp-content/uploads/2022/05/Maintaining-Forests-Webcast-Presentation-Virginia-final.pdf

Time	Agenda Item	Presenter
1:00 PM – 1:20 PM	Welcome and Project Overview	Lisa Fraley-McNeal, CWP
1:20 PM – 2:20 PM	State Agency, Local Gov, and Practitioner presentations	Brock Reggi, VA DEQ
		Charles Smith, Fairfax County
		Josh Running, Stantec
2:20 PM – 2:25 PM	Break	
2:25 PM – 3:05 PM	Presentation of Maintaining Forests Project Results	Lisa Fraley-McNeal, CWP
		Chris Swann, CWP
		Alexandria Wilkins, CWP
3:05 PM – 3:10 PM	Break	
3:10 PM – 3:50 PM	Facilitated Discussion	Lisa Fraley-McNeal, CWP
3:50 PM – 4:00 PM	Wrap up and Next Steps	Lisa Fraley-McNeal, CWP

Presenters

Presenter	Biography
	**Brock Reggi, VA Department of Environmental Quality** Brock has over 22 years working in the stream industry. He graduated from West Virginia University with a BS in environmental science and a minor in microbiology. Prior to working for the VDEQ, Brock began as an intern at West Virginia University where he spent multiple summers assisting in stream restoration short courses. From there Brock worked two years in West Virginia working with stream mitigation in the mining industry. He then worked for approximately 13 years for Williamsburg Environmental Group now Stantec where he conducted stream assessments, designs, and construction oversight.

Presenter	Biography
	**Charles Smith, Fairfax County** Charles Smith grew up in Arlington, VA. He is a naturalist and ecologist with 30 years of experience in natural resource and wildlife inventory, planning, restoration, management and monitoring. He is currently a branch chief for Fairfax County's Stormwater Planning Division, focusing on stream and natural area restoration. Charles is a veteran of the United States Army, a board member of the Virginia Native Plant Society, a Certified Ecological Restoration Practitioner with the Society for Ecological Restoration and an instructor for Virginia Master Naturalists, Virginia Master Gardeners and the Audubon Society of Northern Virginia.
	**Josh Running, Stantec** Josh Running is the National Technical Lead for Ecosystems Restoration for Stantec. He has been working in consulting for over 22 years, 19 + focused on stream restoration and water quality. His experience spans multiple stream restoration techniques, with project locations throughout Virginia's varied geology. Josh has proficiency in designing projects in both rural and urban settings. He received his BS in Watershed Management from UW – Stevens Point and lives with his wife (Amanda) and two sons (Porter and Sullivan) in Williamsburg, VA.
	**Lisa Fraley-McNeal, Center for Watershed Protection, Inc.** Lisa is a Sr. Watershed & Stormwater Research Specialist for the Center. Lisa has been working on urban watershed and stormwater management since 2006. Her areas of expertise include GIS and field methods for watershed assessment, watershed planning, stream restoration, Chesapeake Bay TMDL crediting, and applied research on topics related to watersheds and stormwater. She has a B.S. degree in Geography and Environmental Systems, with a writing minor and cartography certificate from the University of Maryland, Baltimore County. Lisa also has a M.S. degree from the University of Maryland, Baltimore County in Marine and Estuarine Environmental Science.
	**Chris Swann, Center for Watershed Protection, Inc.** Chris is a Watershed Planner & Environmental Analyst for the Center. Chris has been a watershed planner at the Center since 1997. His work time is split between two responsibilities; researching and writing technical guidance on watershed management issues, and trying to keep the Center's technology in check and functioning properly. Since joining the Center, Chris has contributed in the writing of numerous Center publications, including the Urban Subwatershed Restoration Manual series and the Better Site Design Manual. Chris has a B.S. in Natural Resources Management from the University of Maryland, as well as a B.S. in Biology from James Madison University.

Presenter	Biography
	**Alexandria Wilkins, Center for Watershed Protection, Inc.** Alexandria is a Watershed Planner for the Center. A recent graduate with a Master of Environmental Science and Management (MESM) degree – specializing in water resource management – and a background in environmental stewardship and education, Alexandria contributes her knowledge and experience to support the Center's mission to protect and restore water resources. She brings skills in project management, geographic information systems (GIS), and data analysis to the team. In addition, she is interested in stakeholder engagement and the collaborative management of natural resources.

Registrants

Webcast Attendance
Total Number of Registrants: 46
Total Number of Webcast Attendees: 32

Name	Email Address	Webcast Attendance
Alexandria Wilkins	ajw@cwp.org	**Y**
Allie Wagner	awagner@novaregion.org	**N**
Bill Gillespie	bgillespie70@hotmail.com	**N**
Brock Reggi	brock.reggi@deq.virginia.gov	**Y**
Brooke Perrigo	brooke.perrigo@fairfaxcounty.gov	**N**
Caroline Johnson	johnson.caroline@epa.gov	**Y**
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Josh Running	josh.running@stantec.com	**Y**
Katie Brownson	katherine.brownson@usda.gov	**N**
Katie Talley	ktalley@biohabitats.com	**Y**
Kenneth Bawer	kbawer@msn.com	**Y**
Kevin McLean	kevin.mclean@deq.virginia.gov	**Y**
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Summary of Key Discussion Points

In terms of monitoring and assessment, there are a lack of trained professionals that can conduct community classification and condition assessments. Additional funding was also recommended for monitoring budgets, and it was suggested that municipalities set aside 10% of project costs for monitoring and maintenance post-construction.

The community is concerned about habitat and viewshed disruption. Community inclusion is an important component of restoration and should be done early in the project process and often. The community should be involved in reviewing documents and assisting with decision-making.

Stream restoration projects can open space for invasive encroachment, with invasive species growth common in the first two years post-construction. Development of invasive species control plans using appropriate methods are an important part of maintenance (hand pulling or cutting, mechanical controls, prescribed fire, grazing/goats, and/or chemical applications).

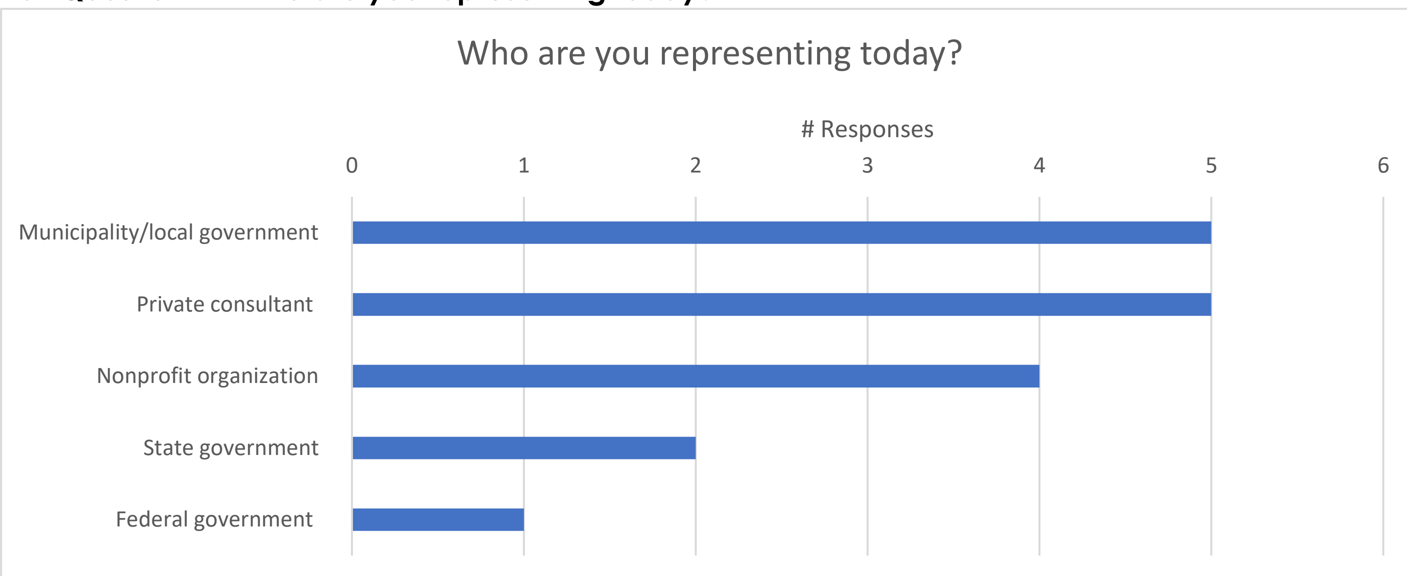
There are many older developed areas that have minimal or no stormwater management. Despite looking back at the last 50 years with hindsight, practitioners and regulators are still catching up. Upland stormwater controls were questioned as a potential alternative option to conducting stream restoration projects that hasn't been properly explored. The difficulty with this approach alone is that that even if the stormwater flows are reduced, degradation to the stream systems has already occurred and will continue to occur. While retrofitting existing facilities can be beneficial, the area benefitted is often small and localized. Implementing enough stormwater controls at the watershed level to be effective is challenging and, depending on the watershed, it may not be feasible due to property ownership and enforcement concerns. A comprehensive review of the scientific and gray literature on this subject was recommended.

Meeting Notes

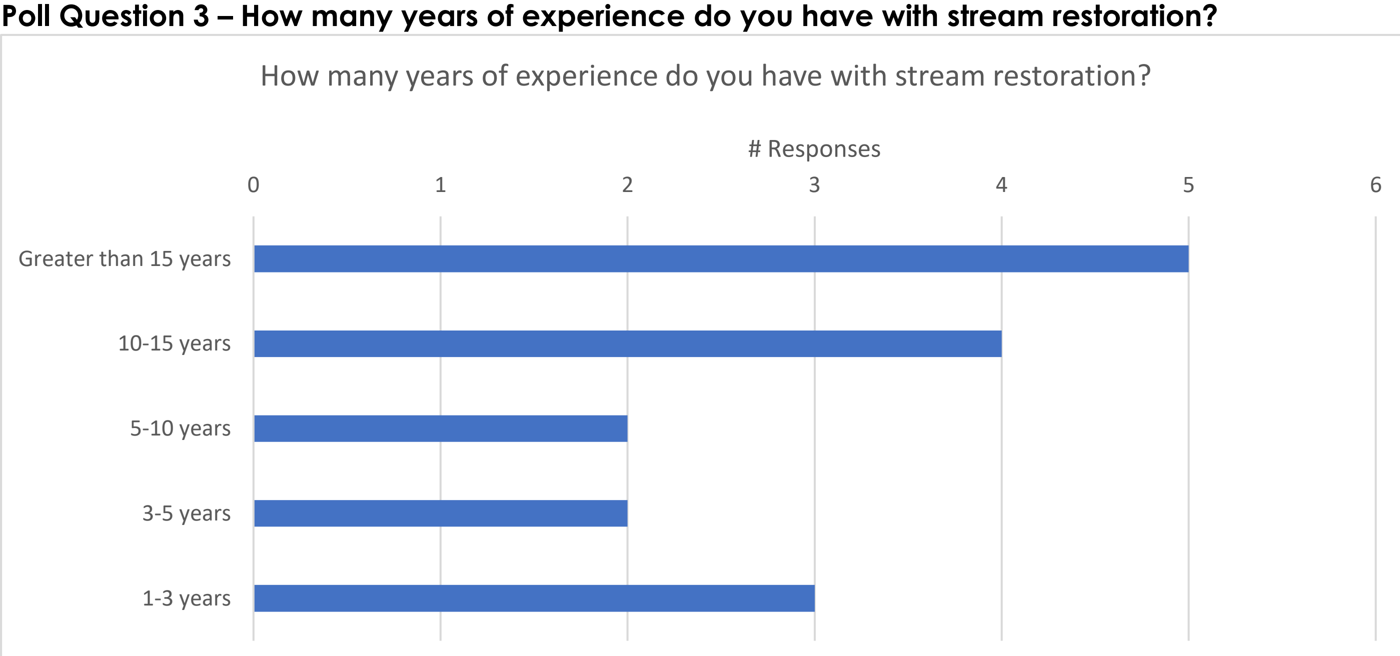
Welcome and Project Overview

Poll Question 1 – How many people are participating in the webcast today at your location?
All attendees joined individually.

Poll Question 2 – Who are you representing today?



Poll Question 3 – How many years of experience do you have with stream restoration?



Lisa Fraley-McNeal (CWP) – Overview of the Maintaining Forests in Stream Corridor Restoration and Sharing Lessons Learned Project

Given the concern over the potential negative impacts of stream restoration, CWP received a grant from the Chesapeake Bay Trust to evaluate how these unintended outcomes can be minimized in the riparian area, including forest buffers, to improve riparian and stream habitat quality.

A Stakeholder Team was formed to provide input and help guide the project.

Background Information

- The CBP Stream Restoration Expert Panel Crediting Protocols were finalized in 2014. The credits contributed as a driver for implementation of stream restoration projects. Other benefits and considerations of projects beyond nutrient and sediment load reduction were often lost.
- The updated CBP stream restoration protocols based on recent workgroup updates help to address stream health more comprehensively.
- With sediment being one of the main stressors of biological impairment, there is a regulatory incentive to address it. Stream restoration is being done to meet local TMDLs in addition to the Bay TMDL.
- The rapid increase in stream restoration projects throughout the Chesapeake Bay watershed has led to growing concern and controversy about their effects on whole-ecosystem health and services.
- One of the arguments against stream restoration is that we should be looking upstream to implement BMPs instead. However, some considerations of this approach are 1) that it can take years before an effective geomorphic change is identified due to changes in the flow regime, and 2) Implementing enough upstream BMPs to create a response at the watershed scale is often not feasible depending on the watershed conditions.

Completed project tasks include: 1) project planning and preparation, 2) QAPP, 3) policy/document review and interviews, and 4) case study analysis.

The webcast task is currently in progress and will be completed by 5/31/2022.

The next task is to synthesize results from the completed project tasks into a final project report that includes recommendations on opportunities to improve consideration of riparian forests in stream corridor restoration projects to minimize unintended consequences. Recommendations from the project report will be used to update and finalize a best practices guidance document for local governments.

State, Local Government, and Practitioner Presentations

Brock Reggi (VA DEQ) – Stream Restoration Buffers in Virginia

The most common types of stream restoration projects in Virginia are Natural Channel Design (NCD) and Regenerative Stormwater Conveyance (RSC).

VA DEQ (9VAC25-210-10) defines stream restoration as "…the process of converting an unstable, altered, or degraded stream corridor, including adjacent areas and floodplains, to its natural conditions."

- Dave Rosgen's NCD approach defines river restoration as restoring "the physical, chemical, and biological functions of the river [… and it] includes not only the river channel but also its related components, including adjacent floodplains, flood prone areas […] wetlands, and associated riparian communities."

Brock described the four different priority types for stream restoration (developed by the North Carolina Stream Restoration Institute, 2003). The majority are Priority I Restoration (where the channel is raised and connected to the floodplain) and Priority II Restoration (where a new channel is created, and the floodplain is lowered). Priority III and IV Restoration are seen less often, and they involve creating a new channel under modified equilibrium and implementing bed/bank armoring, respectively.

- Big Rocky Run project (NCD wide buffer design; 2010)
- Paul Springs (NCD one-sided buffer; 2015)
- Pohick (NCD narrow buffer – 150 ft; most invasives but they were isolated; 2013)
- River Run (NCD below bankfull; 2019)
- James Terrace (RSC step-pool stormwater conveyance; 2016)

<u>Virginia's Perspective on Riparian Vegetation Changes</u>

- Recommended methods protocol for surveying pre-construction and identifying trees that should be saved
- Chesapeake Bay TMDL Special Condition Guidance – Section V.K. Outfall and Gully Stabilization
    - The goal is to maintain or improve existing native riparian vegetation to the maximum extent practicable.
- Virginia Water Protection (VWP) Permit Regulations
    - The goal is to promote no net loss of wetland acreage and function, as well as stream functions and water quality benefits.
- Mitigation Banking (9VAC25-210-116F2)
    - This is the final protective mechanism for the compensation of sites, including all surface waters and buffer areas.

The 404/401 mitigation requirement is 50 to 100 feet of riparian buffer in mitigation. Additionally, the seed source must be free of invasives. Forested conditions are not necessarily required since emergent or scrub-shrub vegetation may be appropriate for some project sites.

Successful projects are first-and-foremost those that meet their monitoring requirements. When performance standards are met, site visits are conducted, as-builts are created, and compliance inspections are passed, then a project site is considered successful. Some specific projects that are considered successful are:

- NCD VARTF site (Goose Creek, 2007)
- Less than Bankfull Nutrient Bank (Mossy Creek, 2018)
- NCD (Snakeden)
- RSC (James Terrace)

In terms of best practices, nothing is explicitly documented at the state level. Recommendations from the stream restoration crediting protocols are the best sources. The following are also helpful resources:

- Riparian Buffers Guidance Manual
- Mitigation Banking Selection Criteria Guidance
- County-specific guidance

Charles Smith (Fairfax County) – Maintaining Forests in Stream Corridor Restoration
We are focused on urban stream systems with a low level of retention that causes significant outflows and stream erosion. Ability to address problems at the source is limited.

The biggest threats to natural communities and streams are land conversion and fragmentation (and associated runoff from impervious surfaces), invasive species, deer herbivory, climate change, and compound effects like the urban heat island effect.

Fairfax County is largely residential and 80% of streams are impaired. They have mostly achieved their Chesapeake Bay Crediting goals and are now focusing on TMDL goals.

Regulations & Permit Requirements

- Clean Water Act (CWA) Sections 401 (state) and 404 (federal)
- Chesapeake Bay Preservation Ordinance requires protection/restoration of Resource Protection Areas (RPAs)and regulates impacts to vegetation. This may not apply to localities without tidal waters.
- Stormwater ordinances are required in all VA localities.
- VA Marine Resources Commission
- Local Stormwater and Land Disturbance
- VW DEQ General Discharge Permit
- VDOT Land Use Permit

Project drivers in Fairfax County are permit compliance, flood control/conveyance, stability/erosion, functional lift, aquatic biological impairment, and pollution prevention.

Tree loss and impacts to terrestrial systems are two of the most commonly raised concerns about stream restoration (based on data or perception). There are also concerns about stability/erosion, appropriate methodology, restoration planting and invasives control, wildlife impacts, cost, need for the project, influence of industry, questions on benefits, and not controlling the source.

Project selection is based on watershed plans, recommendations from staff and residents, desktop and field review, project ranking (access, land ownership, etc.) – merit and funding availability make the final decision.

Trying to move towards Priority 1 Restoration, but primarily involved in Priority III Restoration projects. Priority 4 Restoration is traditionally seen as armoring the stream banks, but that's not always the case.

The paradigm of stream restoration started with Lane's Balance Equation (1955), and it evolved to the Stream Function Pyramid (2012) and further evolved to the Stream Evolution Triangle (2019). Varying parameters determine what dominates the system.

- Refers to any NCD, RSC, LSR or other restoration project that meets the qualifying conditions for credits, including environmental limitations and stream functional improvement.

The following are important for restoration planning in Fairfax County:

- Expressing the "why" of the restoration
- Drafting an ecological description of the site
- Establishing clear and measurable goals and objectives, as well as performance standards and accompanying monitoring protocols to evaluate project success
- Having plans/schedules/budgets for site prep/restoration/monitoring/adaptive management

- Having strategies for long-term protection and maintenance

Old Courthouse Spring Branch – Tysons Corner

Below the project area, there was a stable system, but at the lower end of the project area, there was degraded forest on one side and stable forest on the other side of the stream channel.

- Riparian Corridor Vegetative Community Assessment (community type classification as a departure from a reference condition)
- Projects should target fair or poor-quality vegetative communities and avoid good or excellent quality communities.
- Not many are trained to conduct community classification and condition assessments well

Stream buffer forest systems in poor or fair conditions (examples shown from photos); plantings were not planned or maintained to support the growth/development of a multi-tier forest system – there are likely other considerations as well.

Community inclusion is also important. There should be early and frequent communication with the community, and members of the public should be on the team to review documents and assist with decision-making.

Importance of community inventory (vegetative community mapping), creating a resource map to guide decisions based on what is important to the community to assist in determining where to avoid impacts, and designing based on function.

The Fairfax County Recovery Wheel tool is used to establish goals, target project potential based on site conditions, ensure goals reflect stakeholder values, create metrics to measure outcomes, and track progress.

Restoration Design and Implementation

- Importance of plant selection – use locally common plants, plant palettes by community type, plant size, quality, and source
- Nucleation – woody plants grow better when clustered together; this has shown increased plant survival.
- Deer browse is the major limiting factor after human impacts, so there is the need to plant with deer in mind by using pot stock rather than seedlings to discourage deer browse.

Development of invasive species control plans using appropriate methods (hand pulling or cutting, mechanical controls, prescribed fire, grazing/goats, and/or chemical applications)

They have three distinct monitoring programs:

1. Basic (Determine if site is stable/performing – once every 5 years, if not more)
2. Warranty (Identify needed remediation – once or twice)
3. Ecosystem (Determine system functions/trajectory – 2 to 3 times over 10 years)

Stream maintenance and condition score cards are used during basic monitoring to track whether the system is performing or not—this prompts further investigation as necessary.

Warranty monitoring for plant survival and contractual requirements has shown an increase in plant survival overall. Monitoring = better success!

Ecosystem monitoring using the "plot method" looks at the effect on the ecosystem, the condition of the ecosystem before construction/restoration, a reference ecosystem, post-restoration, and multi-year recovery.

Other types of monitoring include: Functional Ecosystem Recovery and Microbial Community Assessment.

Necessary Improvements

- More qualified staff to conduct natural community mapping and condition assessment
- To include funding for monitoring in project budgets
- Education of designers and managers
- Adding ecology to the design process

Josh Running (Stantec) – Practitioner Presentation

Community Concerns

- No one wants to remove a mature tree; it's not an inexpensive task.
- The community is concerned about habitat loss and viewshed disruption.
- Additionally, stream restoration projects can open up space for encroachment from non-native invasive species.
- There is an overall lack of communication with the community.
- Design considerations are not often explained to the community effectively.
- Best engineering and best natural design principles come together to create the best project design.
- Designs should be right on the "edge-of-failure." - Making sure projects can be successful, but also taking into consideration that there is an intricate balance between incorporating natural design/processes versus incorporating access and safety into the design.

Stream Restoration Evolution

- In the past, there was more of an emphasis on short-term stabilization and a lack of stream geomorphic knowledge, which resulted in unnatural riffle-pool sequences and structure placements.
- Today, practitioners have access to an abundance of resources, references, and experiences. Today's stream restoration projects typically use of multiple techniques and materials, provide better access to the floodplain, and they increase the emphasis on water quality, habitat, and long-term stabilization.
- For the future, climate change adaptation is important. There is an estimated 20% increase in storm intensity predicted over the next 20 years. We need to factor this into project design and model multiple scenarios to ensure projects are resilient.
- DEQ Flooding Resiliency Grant

Types of Projects

- Variables that impact project types are:
    - Project goals and objectives (404/404, mitigation bank, TMDL, habitat, infrastructure protection, etc.)
    - Project outcomes (flooding, habitat, green space, education and outreach, water quality)
    - Project location (urban vs. rural, confined vs. open)

Riparian Vegetative Changes

- The vegetation does take a hit after restoration, but if done right, it will come back. How long does it take? Post-construction planting plans are important, and it is a long-term consideration dependent on soil quality, climate, sun exposure, etc.
- Typically, it takes around 10 years to see the multi-tier community developing if the deer browse is low.
- Invasive species growth is common during the first 2 years post-construction.
- Municipalities should set aside 10% of project costs for monitoring and maintenance post-construction

Elements of a Successful Project

- Meets project goals and objective
- Provides additional benefits
- Approved by the client and community
- Ensures long-term success

Project Results Presentation

Chris Swann (CWP) – Policy/Document Review and Interviews
Policy/document review: The goal was to better understand the requirements of each state for protecting and mitigating damage to stream buffers associated with stream restoration projects. A total of 40 regulatory and 78 technical/guidance documents were reviewed.

Interviews: The goals were 1) to better understand how the requirements identified from the review of regulatory and policy documents are (or are not) implemented in each jurisdiction and 2) to identify and refine best practices to minimize adverse impacts to riparian forests. A total of 19 individuals were interviewed, representing state and local governments, as well as practitioners.

Chris provided an overview of how forests are defined for this project and the key federal policies reviewed. He also summarized the key findings and identified best practices related to site selection and planning, design and permitting, implementation, and post-construction monitoring.

The deliverable for this task was a technical memo that will be included in the final project report.

Alexandria Wilkins (CWP) – Case Study Analysis
Reviewed 10 stream restoration projects in Lancaster County, PA, Anne Arundel County, MD, and Fairfax County, VA to determine the extent to which requirements are implemented and quantify the impacts stream restoration has on riparian vegetation.

Utilized loading rates from CAST to determine changes in nutrient and sediment loading from the stream restoration projects and impact to the riparian vegetation due to project implementation.

Alexandria walked through 5 case study example projects and summarized the key findings.

Case study results were summarized in 3- to 5-page summaries for each site that will be included in the final project reports.

No questions for the Policy Review & Interviews or Case Study Analysis presentations.

Facilitated Discussion

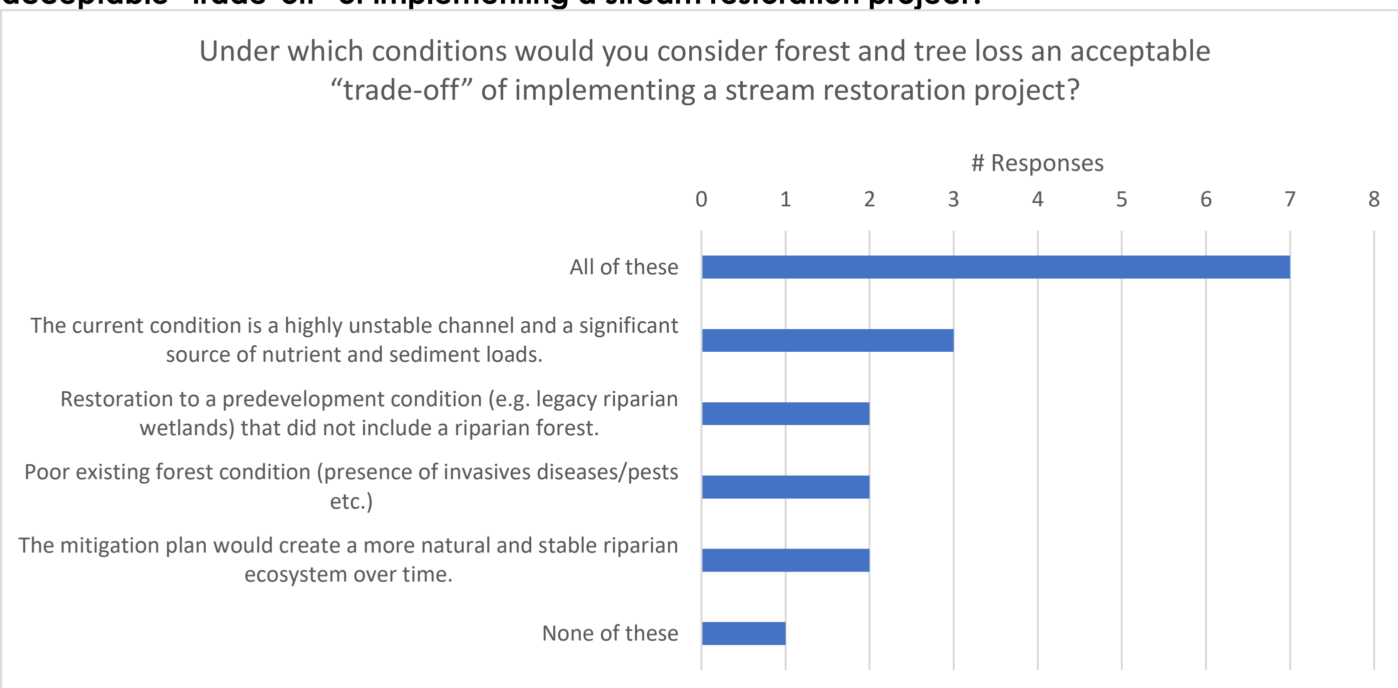
Kenneth Bawer – These discussions are based on the false premise that a “stream restoration” should and will be done, and now how do we save a few trees. The better discussion should be why are these “stream restorations” even done rather than upland stormwater control to fix the source of the problem. The excuse that you just can’t do upland control is always arm-wavey and never proven.

Bill Stack – Stream restoration should be done when stream bank erosion is a major stressor to aquatic life. It is often a stop-gap measure to restore some function to the stream while watershed controls are being implemented which in many watersheds can take years for enough watershed controls to be installed to restore the flow regime.

Rebecca Hanmer - Is any water quality evaluation performed pre- and post-construction for parameters relevant to local aquatic life like dissolved oxygen, temperature and not just the Bay pollutant loads TN, TP and TSS?

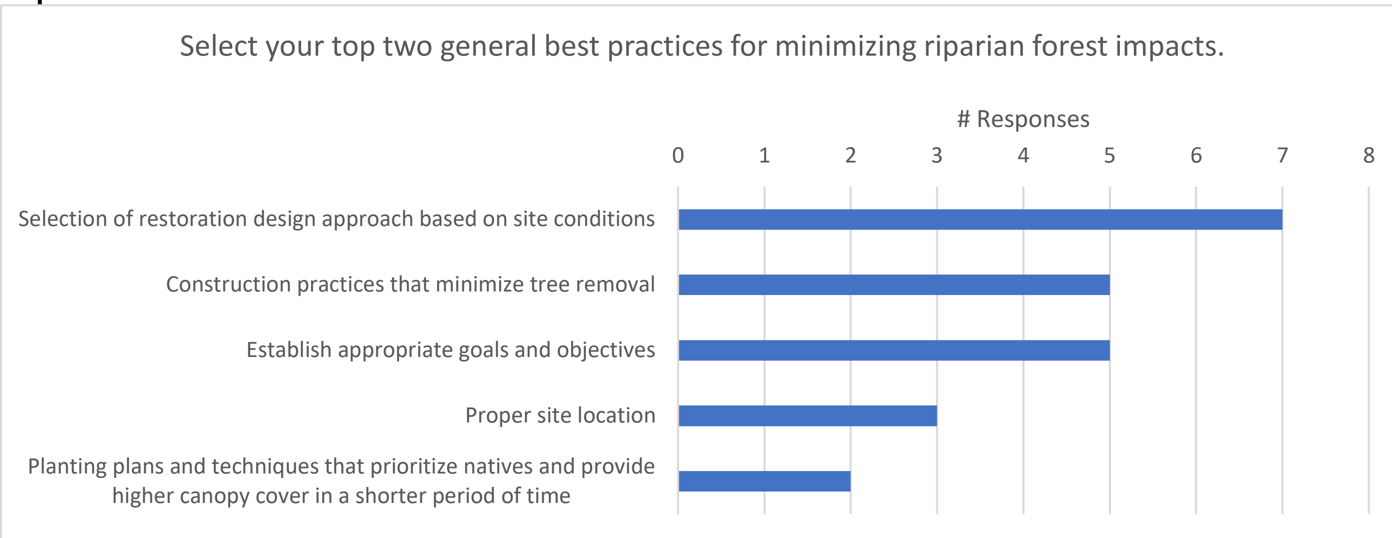
Response (Josh) – Isco samplers were set up in James City County where 5 stream restoration projects are going to be implemented to evaluate sediment loading rate and other constituents pre- and pos-restoration.

Discussion Question 1 – Under which conditions would you consider forest and tree loss an acceptable “trade-off” of implementing a stream restoration project?



Rebecca Hanmer noted that the design of the question asked about the reasons for tree loss that led almost everyone to vote for "all of the above". The way the question was posed would inevitably generate that answer, given the list of reasons why trees might be taken down in one project or another. Aren't all those reasons why trees might have to be removed a question of nuance? Is there anything in the project requirements that would require extreme prudence in removing the trees even if conditions exist that could be used as an excuse? It's going to be a judgment call. Unless there is a natural habitat reason to remove the trees, then all other removals need to be compensated in some way.

Discussion Question 2 – Select your top two general best practices for minimizing riparian forest impacts.



Discussion Question 3 – How should we take into consideration forest health decline that is occurring due to numerous factors (even without effects from stream restoration projects)? These factors include dominance by invasive and native vines, loss to invasive diseases/pests, competition from non-vine invasives, excess herbivory, and climatic-induced loss.

Josh – A lot can be done in terms of maintaining projects. Invasives can be dealt with by physical or chemical means; deer population control methods can be effective.

Charles – Watershed scale question; the significant fragmentation of natural areas; something that has to be addressed at the watershed scale more; Trying to expand urban tree canopy on private lands as well as public to address heat island effects; It goes back to that assessment of the community (good, fair, poor, etc.); looked at both the watershed and project scale.

Discussion Question 4 – How can monitoring efforts for riparian forests that are part of stream restoration mitigation plans be improved?

Charles – Programmatic and funding challenges. Within localities, there is a need for long-term programs with appropriate funding to keep trained staff available. Periodic monitoring to see if its functioning is important; canopy closure by simple survey or using aerial imagery remotely could be helpful as well.

Discussion Question 5 – What would be the most useful information for helping to minimize riparian forest loss when implementing stream restoration projects that you'd like to see in the best practices guide?

<u>Other Responses</u>

Charles - Site level community mapping and condition assessment is the best method of determining where higher quality resources are that should be avoided and lower quality resources that could benefit from restoration.

Ken Bawer – To minimize forest loss is not to do the stream restoration. Should it be done compared to upland control

Josh – There are a lot of issues; moving from one subwatershed to another but what happens to the subwatershed that's not being treated. The concern is the drive on the CB if you control the stormwater coming in it will reduce the degradation, but it is already happening and will continue. Additionally, upland is often privately-owned and you run into many issues there.

Kenneth – private land ownership is a key comment, I'm not naïve to think that it is easy or cheap but what do we do about the private land? Take the money for stream restoration projects and tell owners that they will put a bioretention or a rain garden on their land for free.

Josh – we are currently trying to mitigate the sins of the past

Brock – One size fits all; a lot more effort needs to put into regulating the releases to the streams especially on the soil and substrate types. Putting thought into the design of outfalls

Charles – retrofit of existing facilities which can be beneficial but is often small and localized. But we are looking at the large scale, we can't go back and force retrofit private properties. Right now we depend on redevelopment. Facilities that seem to work best were localized ponds that we have gotten away from. It's a really hard thing to address.

Josh – we really need to take into account the channel substrate and its ability to mobilize

Charles – everyone recognizes the intensity of flows is increasing and there's been a massive increase in flooding. The balancing act in long-term budgeting between safety and environmental degradation.

Kenneth – We're asking out natural areas to bear the brunt to fix the sins of our allowing over development without adequate stormwater control. We're sacrificing out local ecosystems and local areas to save the Bay. Not enough mindpower has been spent to try to figure out upland stormwater control. Pictures he's seen in this presentation would never look natural; it's a red herring. What was the environmental damage done to the original ecosystem? It's disingenuous.

Charles – we need to be better about describing the systems and the functions they perform to better inform the decision about whether the project gets done and what it needs to be restored back to. It should be based on a functions-based analysis.

Rebecca – Fredericksburg project and development in the next 10 years. How is upstream development taken into account for downstream restoration projects?

Charles – there is the responsibility of the design consultant to anticipate changes in that watershed. If it's a new development, permit requirements are likely to cause less of an impact than developments from the past.

Josh – MS19, water must be released from new developments at the same rate of the current/ pre-development land use. We are looking back at the last 50 years with hindsight and we are grappling with it. The reality is that we can do better and this is where we sit now. We are still catching up.

Brock – Reviewing plan sets, its increasingly obvious the amount of wood incorporated into projects. There's a lot of loss that's still yet to come and that's what the stream restoration is meant to avoid. There's more of a trend toward a more natural system at project completion than there was in the past

Kenneth – Can Lisa speak a bit more about the project in Carroll County? Of future plans?

Lisa – That study was wrapped up in the past 2 years. It was focused in the headwaters and involved sand filter retrofits of older ponds to reduce stormwater runoff. We did see a positive response in hydrology as a statistically significant result between pre- and post- treatment, including reduced flow and flashiness. Geomorphic indicators were trending toward stability but not with any significance in the limited amount of post-construction monitoring time included in the project. Most of the drainage area was treated by the sand-filter retrofits, but its not directly transferable because you'd have to find a way to treat the majority of the drainage area in a larger watershed which may not be feasible. We've applied for grant funding to continue monitoring and Carroll County may continue monitoring on their own.

Brock – VA is also open for questions, concerns, and comments. He is always looking for ways to improve. It's valuable to have more insight.

Charles – The industry is data driven if we get more tools and better tools over time that are data driven, they will be used especially if they are lower impact and lower cost.

Charles – VA is the same way. The updated priority 1 is more based on empirical data which will hopefully prove that we are helping with those sediment and nutrient reductions.

Kenneth – How the states allocate MS4 credits. In MD there is a huge emphasis on stream restoration vs upland projects. So I would argue that that is an artificial tipping of the scales.

Webcast Chat Log[4]

00:37:06 Chris Swann: Hi Everyone
00:39:35 Carter Henderson: B
00:39:47 Doug Streaker: D
00:40:27 Doug Streaker: F
02:22:30 Kenneth Bawer: These discussions are based on the false premise that a "stream restoration" should and will be done, and now how do we save a few trees. The better discussion should be why are these "stream restorations" even done rather than upland stormwater control to fix the source of the problem. The excuse that you just can't do upland control is always arm-wavey and never proven.

02:32:45 Bill Stack: Stream restoration should be done when stream bank erosion is a major stressor to aquatic life. It is often a stop-gap measure to restore some function to the stream while watershed controls are being implemented which in many watersheds can take years for enough watershed controls to be installed to restore the flow regime.

02:34:37 Kenneth Bawer: The science shows that "stream restorations" rarely if ever result in biological uplift (see Hilderbrand, Palmer, etc.)

02:45:08 Josh Running: We do a lot of retrofits and improvements related to stormwater facilities. Issues related to who owns the facilities are problematic...often controlled by an LLC that went out of exitance decades ago. Enforcement is a problem given the stormwater guidelines have advanced over time, as many communities are grandfathered. We have worked on purchasing homes and using the area (s) for treatment. However, not everyone likes using eminent domain or being forced to move in order to take houses and buildings to make SW facilities. Agree that stormwater treatment are important for instream WQ and mitigation against poor performing SW networks.

02:47:47 Rebecca Hanmer: Is any water quality evaluation performed pre- and post-construction for parameters relevant to local aquatic life like dissolved oxygen, temperature and not just the Bay pollutant loads TN, TP and TSS?

02:48:07 Bill Stack: I think there should be a comprehensive review of the scientific and gray literature on this subject. I have observed improvements in Baltimore City Steams while I was working there. However, stream restoration can stop the unzippering of streams and the transport of sediments to receiving waters. Hopefully, the implementation of a comprehensive watershed plan will be done concurrently but I know from experience how long this can take especially in a built environment.

[4] Note that the chat log was copied directly from the webcast and has not been edited for grammatical correctness.

02:48:41 Jason Papacosma: Right, @Bill Stack. We also think about it as a 'both and' dynamic. Work in the upland and creating resiliency in the stream valley. Time and space constrain the delivery of the former and costs of inaction (infrastructure risk, erosion, environmental impacts) require the latter. But both are needed.

02:54:01 Kenneth Bawer: Every vendor and government official says we have space constraints, but they never prove it. Plus, if a subwatershed has upland constraints, you can do the upland control in a different subwatershed to meet the MS4 Permit.

03:04:03 Charles Smith: Site level community mapping and condition assessment is the best method of determining where higher quality resources are that should be avoided and lower quality resources that could benefit from restoration.

03:33:34 Jason Papacosma: Well done speakers and good discussion. Thanks.
03:34:03 Suzanne Trevena: Can you put the link in the chat for the evaluation?
03:34:59 Chris Swann: https://lp.constantcontactpages.com/sv/T6klneS

Webcast Survey Report

Constant Contact Survey Results

Campaign Name: Maintaining Forests Webcast Survey May 2022

Survey Starts: 48

Survey Submits: 13

Export Date: 05/24/2022 08:07 AM

OPEN QUESTION

Name (optional)
greg golden
Charity Burkhart
Erik Michelsen
test
4 Response(s)

MULTIPLE CHOICE

1. Which state webcast did you attend?

Answer Choice	0%	100%	Number of Responses	Responses Ratio
Pennsylvania			2	15%
Maryland			10	76%
Virginia			1	7%
		Total Responses	**13**	**100%**

MULTIPLE CHOICE

2. Please identify the type of organization with which you work.

Answer Choice	0%	100%	Number of Responses	Responses Ratio
Federal government			1	7%
State government			5	38%
Local government (MS4)			4	30%
Local government (non-MS4)			0	0%
NGO			2	15%
Consultant			1	7%
No response			0	0%
Other			0	0%
		Total Responses	**13**	**100%**

NUMERIC SCALE

3. Please rate your overall satisfaction with the webcast.

Answer Choice	0% 100%	Number of Responses	Responses Ratio
1 (Very Unsatisfied)		0	0%
2		0	0%
3		2	15%
4		4	30%
5 (Very Satisfied)		7	53%
Mean	4.38		
Median	5.00		
	Total Responses	13	100%

MULTIPLE CHOICE

4. Please rate the material covered in the Introduction presentation

Answer Choice	0% 100%	Number of Responses	Responses Ratio
Excellent		6	46%
Good		6	46%
Average		1	7%
Poor		0	0%
No opinion		0	0%
Other		0	0%
	Total Responses	13	100%

MULTIPLE CHOICE

5. Please rate the material covered in the State govt., local govt., and practitioner presentations

Answer Choice	0% 100%	Number of Responses	Responses Ratio
Excellent		5	38%
Good		7	53%
Average		1	7%
Poor		0	0%
No opinion		0	0%
Other		0	0%
	Total Responses	13	100%

MULTIPLE CHOICE

6. Please rate the material covered in the Project Results presentation

Answer Choice	0% 100%	Number of Responses	Responses Ratio
Excellent		5	38%
Good		5	38%
Average		2	15%
Poor		0	0%
No opinion		1	7%
Other		0	0%
	Total Responses	13	100%

MULTIPLE CHOICE

7. Please rate the material covered in the Facilitated Discussion portion of the webcast

Answer Choice	0% 100%	Number of Responses	Responses Ratio
Excellent		8	61%
Good		5	38%
Average		0	0%
Poor		0	0%
No opinion		0	0%
Other		0	0%
	Total Responses	13	100%

MULTIPLE CHOICE

8. This 3-hour webcast was the right length?

Answer Choice	0% 100%	Number of Responses	Responses Ratio
Agree		9	69%
Too short		0	0%
Too long		3	23%
No opinion		1	7%
	Total Responses	13	100%

MULTIPLE CHOICE

9. Would you recommend this webcast to colleagues and coworkers?

Answer Choice	0% 100%	Number of Responses	Responses Ratio
Yes		11	84%
Only for some parts		2	15%
No		0	0%
Maybe		0	0%
No opinion		0	0%
	Total Responses	13	100%

OPEN QUESTION

10. What did you enjoy most about the webcast?

presentation of info and then ample time to discuss and bring up individual perspectives and ideas.

The project results and case studies portion.

The discussion was the most useful portion of the webcast. The rest was just advertising set in concrete positions for stream rehabilitation or that it needs to be more focused and better site selection to achieve goals.

test

6 Response(s)

OPEN QUESTION

11. What would you improve about the webcast?

I wouldn't call it improvement ideas because I think everything worked out fine. Follow up & next steps along the long journey is always needed in this topic. That can't always be done in the same call; thought process evolution & future discussions

3 hours is a little bit long with few breaks

Include NGO, landowner, and concerned citizen groups in the presentations.

test

5 Response(s)

OPEN QUESTION

12. Was there any information or topics you were hoping to see discussed that were not included?

I viewed it as pretty comprehensive. I thought the light amount of meeting moderating is a good idea, and was well done. Future discussions, same venue or different, can build on such discussions. Additional level of detail can always develop.

No

Site selection: how, why, where, key drivers was glossed over but it is the key. Also, no discussion of a more holistic approach that includes upland treatments before getting to stream rehabilitation and what can be done in more urban settings.

4 Response(s)

MULTIPLE CHOICE

13. Would you like to see additional webcasts on this topic in the future?

Answer Choice	0% 100%	Number of Responses	Responses Ratio
Yes		9	90%
No		0	0%
Maybe		1	10%
	Total Responses	**10**	**100%**

OPEN QUESTION

14. Any additional comments?

As above, a very useful mtg & some of these restoration related meetings & initiatives do seem to develop step by step. This was a productive meeting, I'm not saying it owes anything beyond its own goal;the topical discussion develops/evolves as well

Include a consultant and a citizen group representative that advocate for a more holistic approach that includes first addressing quantity and quality control in the uplands for all sites - urban, suburban and rural.

It was nice to have this as a webcast instead of in person. It makes it easier to attend.

3 Response(s)