Dynamics Between Riparian Buffers and Streambank Erosion Interventions
A Key Issues Report on Streambank Stabilization

May 2022

Developed by Dialogue + Design Associates for the James Riparian Consortium

Executive Summary

In spring of 2022, Christine Gyovai, Emily Carlson, and Lea Taylor of Dialogue + Design Associates, facilitators for the Middle and Upper James Riparian Consortium, conducted 16 interviews with key stakeholders (listed in Appendix A) to learn more about key challenges, concerns, resources, and future needs regarding streambank stabilization in the Chesapeake Bay watershed, particularly in the Middle and Upper James watershed. The highlights of the interviews are below, grouped thematically, with the most commonly shared ideas from interviewees listed first, and additional ideas following. The interview questions are listed at the end of this report. Information about the Riparian Consortium may be found at www.jamesriverconsortium.org. Consortium questions can be directed to Amber Ellis at aellis@thejamesriver.org, and Key Issues Report questions to Lea Taylor at lea@dialogueanddesign.com.

Streambank stabilization is a topic on which interviewees had strong opinions, variation in decision-making suggestions and differences in design considerations. One constant with interviewees is that when determining when and if to do streambank stabilization, "it depends" is an often used phrase. Across the board, the interviewees recognized streambank stabilization as an intervention that is sometimes necessary to protect human infrastructure threatened by severe erosion. Beyond this agreement, interventions in a stream's function for the sake of erosion management branch into a wide array of nuanced variables found in defining the objective, the cause, and designing an appropriate stream restoration response.

By nature and definition, fluvial systems are dynamic and multidimensional. Managing one symptom of dysfunction such as a single severely eroding streambank will seldom result in long-term improvement. From the perspective of a riparian buffer professional looking to ensure the long term viability of installing a buffer planting, understanding and navigating these layered objectives, systems processes and funding mechanisms provides a formidable yet intriguing challenge. Like any intervention in a complex system, increasing the overall knowledge of the stream or river system, the needs behind restoration, and how any solution might interface with the system over time will yield a clearer answer as to what kind of stream restoration approach is needed in a given scenario. Although a basic understanding of stream function will help with the decision-making process, the wisdom of experts is also crucial in restoring stream systems effectively and holistically. Defining the capacity and timing of experts remains a key challenge for addressing erosion issues.

This Key Issues Report includes many of the variables and nuances of the challenges and opportunities around streambank stabilization and stream restoration as a whole, as well as identifying needs, resources and possible ways forward. The **first phase of decision-making** is for core stakeholders to clearly define the objective(s) in addressing erosion in a given waterway. This phase overlaps with the **second phase,** which is to identify the cause and scale of the erosion in a comprehensive analysis, which may reframe the objectives moving forward. The **third phase** is to design an intervention based on the objectives, cause, funding, technical resources, and recognition of the stream's natural function and need to distribute energy through moving water and sediment for overall stream health.

Background

Context and Considerations

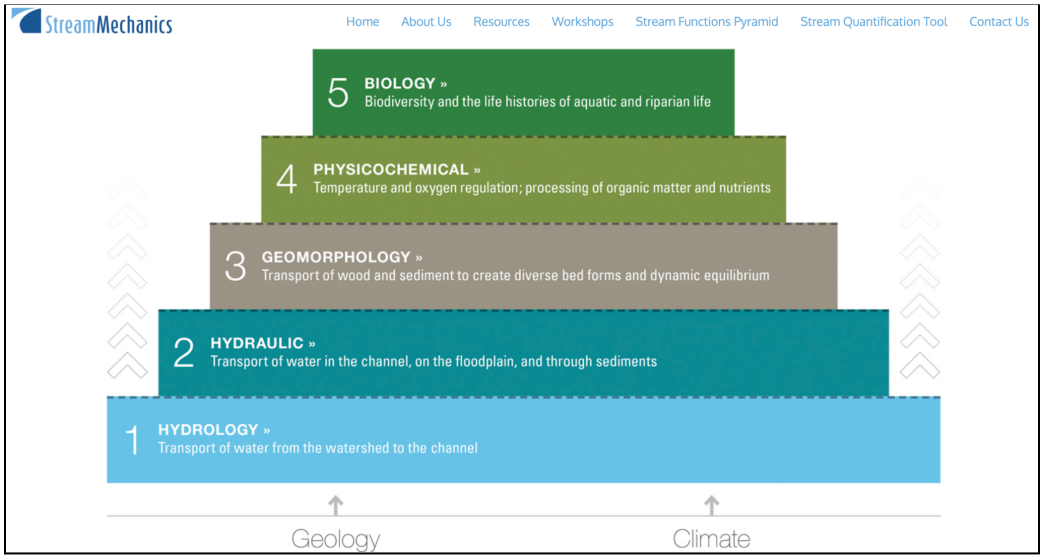
Streambank stabilization has been recognized as a practice used in tandem with riparian buffer related work. With the overall goal of increasing watershed health, streambank stabilization is a practice in the toolkit of many restoration practitioners, but it can often be costly and limited in scope. In order to better understand the objectives and implications of this practice in the James River watershed and beyond, interviews were conducted to gather the insights and knowledge of stream restoration practitioners and partners for the Upper and Middle James Riparian Consortium.

TMDL (The Total Maximum Daily Load)

Under the Federal Clean Water Act, states are required to identify and report impairments to rivers. The Total Maximum Daily Load must be calculated to determine the maximum amount of a pollutant for a particular waterway to determine a goal for reductions. In the United States, 46% of rivers and streams have excess nutrients. The Chesapeake Bay Program has a watershed-wide TMDL that was set in 2010, and a pollution diet was created including local TMDL plans and deadlines for load reductions allocated to the counties and municipalities. Stream restoration crediting is used as an approach to help meet TMDL targets, and is often used as a rationale for doing streambank stabilization projects.

Streambank Stabilization and Stream Restoration – key points

Interviewees recognize that streambank stabilization is a common objective for stream-restoration projects, especially where a stream reach is highly confined, or where infrastructure is threatened. Project designers' immediate objective is seldom to create a balanced ecological system. Stream restoration is the manipulation of the physical, chemical and biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded aquatic resource. Streambank stabilization is a vegetative, structural or combination treatment of streams designed to stabilize the stream and reduce erosion. Several more thoughts on the differences between streambank stabilization and stream restoration were shared, including:



- Several interviewees mentioned stream restoration in terms of the Stream Functions Pyramid developed by the Stream Mechanics group, which demonstrates a hierarchy of stream restoration and orders. The pyramid, shown here, is a hierarchical representation of stream functions with five levels: Hydrology, Hydraulics, Geomorphology, Physicochemical, and Biology.

- More than one interviewee cautioned that stream restoration should not just be about returning a stream to a historical context, but rather with the goal of bringing the stream back to ecological functioning within the current corridor constraints, important for both urban and rural settings.
- In contrast, stabilization is an intervention associated more so with localized erosion and to address localized conditions. Streambank stabilization will not address system-wide impairments. System-wide impairments are conditions that are pervasive throughout the stream corridor, where there is instability caused by watershed-wide conditions such as urbanization, mass-land clearing, or other historical impacts.
- Interviewees agreed that in most cases, stabilization is not going to be able to address system-wide impairments in a holistic way.
- Depending on a site assessment at a stream, practitioners will need to identify which practice (whether stabilization or restoration) is appropriate. Buffer plantings may be an appropriate intervention as part of stabilization, and other practices may be combined as well.
- Stream restoration is not a site-by-site fix, but rather requires a watershed approach. Restoration often stretches across several miles of stream reach and across multiple landowners.
- Multiple interviewees cautioned against using bank stabilization as a "band aid" solution to a larger problem, which may not last due to shortsightedness, and could even cause greater erosion problems downstream.
- The value of streambank stabilization varied among interviewees – some noted it is much easier to approach from a permitting perspective than stream restoration, and a few others regarded it as a very important approach for restoration.

Three Phases of Decision-making in Addressing Stream Erosion

When examining a site for a potential buffer planting that is exhibiting signs of erosion and stream channel migration, there are many variables and dynamics to consider in order to determine the best path forward. Sometimes, a stream stabilization project is the most effective way to protect the investment of a large buffer planting in order to keep the buffer from eventually falling into the stream. In some cases, planting a buffer alone may be enough to stabilize the banks over time. All the interviewees agreed that the decision making process is a complex one with many moving parts. A restoration project team will need to determine the objectives of the potential project, the local and watershed-level constraints, possible conflicts with infrastructure or land use, the agenda and desires of the landowner(s), and any implications the project may have downstream before determining which restoration approach to take.

1. Phase One – Defining the Objective

Many reasons exist to intervene in a stream's functioning. Before deciding on an intervention to stream erosion, a crucial first phase is to define the objective of the project. These objectives could be ecological or social/cultural in nature. This needs to be clearly defined and articulated before moving forward to make sure the return on investment is worthwhile, especially for streambank stabilization projects. Defining the co-benefits or ecosystem services of a project can also help define the need and method of intervention.

- For example, in considering the objectives of a project, a positive outcome of a stream restoration project in an urban area could be adding a trail to create a green space and

> "Consider the preponderance of evidence to ensure that the stream intervention is appropriate and will function. **Be comfortable with uncertainty**." -an interviewee

creating an amenity for a community, which could be one of the initial restoration objectives.

- In another example, funding from the Department of Wildlife Resources (DWR) for stream restoration was targeted at species that exist within certain watersheds such as the James spinymussel habitat in the James River upstream from and including the Rivanna River watershed.

Urban Considerations

For streambank stabilization efforts in urban and suburban areas, many more variables need to be taken into consideration. Urban areas are often more hydrologically challenging with more impervious surfaces, straightened and constrained channels, water quality issues, and a closer interface with human activity. Urban streams are seldom fully restored from an ecological standpoint, but buffers can often be replanted to increase community benefits such as aesthetics, health, education as well as for stream restoration.

- For example, the city of Richmond has had some streams that are extremely degraded, with eroded banks 20 feet deep, that pose a safety hazard to community members. One particular stream receives a lot of the runoff from the highway, and the stream is beyond typical ecological repair. When repairing this section of stream, the objective will be to address the water runoff rather than to restore the stream to a historic condition.
- Interviewees noted specific examples where contention has arisen surrounding the removal of existing trees and vegetation in the construction of some stream restoration projects. It is important to consider multiple, big picture perspectives and variables for these types of restoration projects.
- From a social justice standpoint, a question has arisen as to why streams in urban areas are not being addressed as much as in rural areas. Investing in streambank stabilization may include creating community access to a natural space; even if the desired ecological conditions aren't achieved, this could be considered its own success.
- It is important to address environmental justice considerations, such as targeting vulnerable areas for funding environmental work that would create a healthier and safer landscape.

2. Phase Two – Understand the Cause and Scale of the Erosion

Along with defining the objectives of a project, a critical second phase is determining the scale and dynamics of the erosion problem to determine a path forward. When considering a streamside project, the first step is to examine the site and understand if the identified erosion has a systemwide cause, a localized cause, or erosion resulting from both local and watershed-wide dynamics. The stream restoration practitioner, or whomever is designing the solution, will need to make the differentiation. The goal is then to discern which type of intervention is appropriate.

> **"A stream system is the best teacher,** and doing stream work is the best way to improve methods and learn from past mistakes."-an interviewee

For example, when considering if just planting a buffer is enough, it is crucial to consider what is going on upstream and how hydrological conditions have changed over the last couple of years. The practitioner should consider what may be affecting the shift in energies that are attacking a portion of streambank. A buffer may address stormwater that is coming over the bank, but the problem may stem from changing hydrological conditions and a shift in water forces that would require an intervention beyond planting trees.

Stream Function/Dysfunction

If there is unnatural, accelerated erosion, the next step is to understand its cause. Erosion is not always bad, but rather the **rate of erosion** associated with the change is where cause for concern stems from. One interviewee noted that humans seem to have an aversion to cut, vertical banks; in a forested watershed within a healthy system, however, these conditions can still be found, perhaps with roots in them. Erosion is part of natural stream functioning, illustrated by a stream's meander that erodes and deposits sediment to manage its fluvial energy. A stream migrates across the flood plain by distributing sediment. If this functioning is impaired, then both ecological and infrastructure problems can arise. The stream evolution model is useful to understand how streams naturally respond to disturbance. These disturbance cycles can take place over the course of decades or hundreds of years, and an assessment is merely a snapshot in time to draw conclusions about the stream process. One interviewee noted that if a stream is in a volatile state, and stabilization is occuring, the project designer should determine what can be done with the stream's new energy distributions. A healthy stream system can respond to changes in land use and storm intensity. A stream doesn't always look neat when it is changing. Stream restoration work may be appropriate, however, when there is active erosion. A site is considered to have active erosion if the streambank is eroding, and it is considered immediate if it has happened within the last 5-10 years.

One of the main rationales for implementing a stream stabilization project is to protect existing infrastructure that is threatened by stream erosion. Structural stabilization also has great value where the natural dynamic of a stream and its ability to move around a floodplain is not affordable. There are places for this type of intervention, for instance where there are structures and roads to protect and where the built environment requires structural support. If cropland along a stream is eroding, a farmer may have to consider when it makes sense to intervene based on the revenue that is lost due to eroding cropland. One consideration of note is that interventions can create hardpoints; stabilization is a lateral hard point. Stream channel reconstructions/stream restoration projects tend to change the elevation of the channel and both sides of the stream, which limits the ability of the stream to dynamically respond to a change in conditions. If the stream bed is too low (streambanks are too high), stabilization or restoration may be needed.

Another consideration regarding stream function is that water has a tendency to move depending on the water flow volume. The meander changes as the volume of water changes and water has a tendency to carry sediment. Mimicking this in nature is a complexity of doing this work in streambank stabilization.

The following table exhibits just a few of the considerations that interviewees suggested that can contribute to the decision making process.

Should a stream be stabilized?	MAYBE	UNLIKELY
Is there unnatural, accelerated erosion?	*If the erosion is not from natural stream functioning (such as a meander bend, a log jam, or a beaver dam) and from a recent or localized issue, stream bank stabilization may be an appropriate intervention.*	*If the problem is stemming from a watershed wide or upstream issue, a stabilization or restoration project will likely not resolve concerns.*

Is the erosion a localized issue and not a larger upstream or watershed-wide problem?	*If the erosion is unnaturally accelerated and threatening infrastructure, AND is a localized issue, bank stabilization may be an appropriate intervention.*	*If the site allows for the stream to correct itself, a buffer and floodplain protection could resolve the concern over time.*
Is infrastructure (such as a road or bridge) that can't be relocated threatened by stream erosion?	*If the erosion is threatening an important building or structure, it may be wise to consider stabilizing the bank, depending on the scale of cause.*	*If the infrastructure can be moved or the floodplain put into an easement, then a less invasive approach might be appropriate.*
Is the space available for the stream to correct itself in a protected floodplain?	*If the erosion is occurring in a constricted area such as an urban landscape, stabilization might be the proper recourse.*	*If the watershed is relatively intact, and the problem could fix itself with installing a buffer and fencing over time, stabilization might not be needed.*

Making the Most of a Site Visit

One interviewee shared their process for an initial site visit. During the initial site visit, it is critical to walk and assess conditions along an extensive reach upstream and downstream of the immediate area of concern. During this walk, the practitioner should look for indications of causes of instability or channel adjustment such as road crossings or other channel/floodplain constrictions, recent land clearing or development, channelization/straightening, floodplain-access restriction like berms or a deeply incised channel, extent of channel migration (vertical or lateral), highly erodible bank material, lack of forest buffer, livestock access, etc. Some of these indicators may not be blatantly obvious, requiring more subtle investigation. A localized cause of erosion could entail a farm with a cattle crossing, or where there is cattle access to other parts of the stream. Natural conditions like a debris jam that can cause erosion are localized in nature as well. One way of determining if the erosion is natural or not is to determine if there are long stretches of stream with erosion on both sides of the stream and if there is fine sediment. A successful streambank stabilization project needs to be implemented where the disturbance is local, such as fencing livestock out of streams. A steep streambank may also need to be regraded and planted with a robust riparian buffer.

The Bigger Picture Beyond the Site

Looking at the watershed holistically beyond the point of concern will help to understand what the overall stream and watershed stressors are. If a project's approach is not addressing the stressors, other types of practices may need to be conducted at a larger stream reach level or watershed level. Prior to an initial site visit, it is helpful to look at historic and current aerial photographs of the site itself and the upstream/downstream reaches. This provides a sense of land-use changes (such as agricultural use, urban development, deforestation, dam removal, bridge/road-crossing installation, etc.), rate of lateral channel migration, landscape-level channel geometry and valley characteristics.

This "big picture" view is critical in determining whether the site at hand is a discrete location of bank instability/erosion or whether there is a systemic problem that goes well beyond that site. This, in turn, informs the decision of whether to invest time and energy, and if so, the expected impact of the intervention. This thoughtful perspective can circumvent wasteful band-aid solutions to a larger problem.

First and second order streams, or "the headwater streams that constitute waterways in the upper reaches of the watershed (link to an article to learn more about stream orders)," are more resilient. In a first or second order stream without a pressing hydrological problem, the odds are that the vegetation can handle conditions on its own. 90% of stream miles are first or second order streams. In a system without trees, the stream is more mobile. For a stream of a larger size that has undergone impact and development, experienced watershed practitioners will oftentimes need to be involved to determine the best approach. It is also important to measure the watershed area of the site and to refer to the appropriate United States Geological Survey (USGS) regional curves to get a sense of stable channel dimensions to be expected.

3. Phase Three – Design the Intervention

The third critical phase of addressing erosion with designing for stream restoration is likely the most difficult. It requires taking into account the objectives of various stakeholders and understanding the scale and dynamics of the problem, as well as navigating funding structures, decades of evolving research and best practices, local materials, resources, permitting, and coordinating the process with a team of partners, unless it is a privately funded effort employing a consultant/contractor. The cost-to-benefit calculations of streambank stabilization contain variables that are unique to each site and can shift as the design phase progresses. Landowners often immediately turn away from streambank work due to the high costs, unless their property is immediately impacted by stream issues. The sections below illustrate various approaches and questions addressed in this phase of the work.

Alternatives to Traditional Streambank Stabilization

Several interviewees advocated for less aggressive interventions for stabilizing streambanks, especially in circumstances that allow for the stream to have more space to function. There are approaches to streams that work and aren't disproportionately expensive and time consuming. These look different in different places, as all states have different regulations for permits. Some of these interventions include bioengineering methods, such as planting forested buffers and integrating shrubs. These methods can do a lot of stabilization work, especiallyover time. With time, these bioengineered systems can change the streams. Hydrology and water force can undermine that process, but in smaller, second order streams, vegetation can often handle it unless there are significant hydrological issues such as extensive urban development.

> "A complex system has more variables than equations to solve it." -an interviewee

Stabilization practices such as root wad stabilization or large woody debris structures that mimic natural wood in streams are generally considered to be less aggressive practices. The Nature Conservancy and the U.S. Forest Service are advocating for these practices that are more commonly seen in the Pacific Northwest. The approaches of more intensive use of shrubs and live staking for immediate stability to slow down the migration of the channel are being used more. Methods specific to improving trout habitat or other habitat-motivated projects that include woody debris are becoming more sophisticated, moving beyond just thinking about modeled reductions in nutrients and sediment.

A bioengineering approach

One interviewee emphasized that it would be great to have more opportunities to implement stream restoration practices such as bioengineering that are softer in the intervention approach. These practices might still require permits, but they aren't as intensive (for example, woody debris placement). A bioengineering approach doesn't

have to include grading; it may be unnecessary, unless a landowner thinks it is necessary. Grading tends to be something that triggers permits as it is on the streambank. It may not help much, as the stream adapts and moves. Root wad work, large woody debris (even using Christmas trees), and revetments (sloping structures placed on banks or cliffs in such a way as to absorb the energy of incoming water) are considered bioengineering approaches, along with live stakes, posts, and other pieces that work through their roots and are durable. A bioengineering approach also entails considering what is acceptable from the practitioner's and landowner's perspectives over the course of time, even decades. It is an approach that requires patience for the landscape to heal itself over time.

When is planting a buffer enough?
General metrics are needed for deciding when it is appropriate to do a planting versus stabilization, based on factors such as bank height and the root depth of vegetation that is planted. The Bank Erosion Hazard Index (BEHI) has metrics to help determine bank stability, but they are relatively subjective. Determining if planting a buffer is a more appropriate practice than bank stabilization comes down to a bank's assessment based on how fast a bank is eroding or how bad the conditions are. Property owners have to be willing to allow the work as well.

One interviewee noted that banks are usually higher on the edge of the stream than they are in the floodplain (natural levees), and in order to decrease sediment loads, vegetated riparian forest buffers need to be along the upstream tributaries more so than along the main channel. Another interviewee shared that the input of sediment from an eroding stream is critical, even more impactful than what is happening upland in the watershed. When raw banks collapse, they cause more harm to the ecosystem and moving meanders will wipe out tree tubes. Buffers can have an enormous ecological and functional impact, especially when they reach maturity.

Another interviewee shared that if a stream has downcut or has legacy sediment deposits on the floodplain, causing it to be disconnected from the floodplain (the stream is too deep), streamside plantings may not work as the project could be compromised when the stream widens. Channel Evolution Models provide useful templates for understanding stream morphological responses to disturbance associated with lowering base level (incision), channelization or alterations to the flow and/or sediment regimes which often results in the widening of the channel (link to visual diagram and article here).

In considering buffer design, one participant shared that planting woody vegetation instead of grass on a streambank is an Eastern U.S. perspective where native trees and shrubs strengthen streambanks. They have roots that reinforce the soil against mass failures, such as landslides. Roots hold soil together, and roots exude organic material that act as soil glue. Shade is important, especially in upper reaches of streams where there are trout. Leaves are the primary source of food for the aquatic food chain. It is important that riparian plants are native, as their leaves are a food source for aquatic invertebrates in the waterway. The diversity of species is also important since leaves fall at different times, providing a consistent food supply throughout the year and decomposing at different rates. Plant diversity also makes buffers more resistant to pests and disease.

Specific site conditions and constraints
There may be specific site conditions or constraints that impact the undertaking of a streambank stabilization project. For instance, external factors such as a conservation easement may require the protection of a streambank. In tidal streambanks, there could be archaeological resources that would be lost due to erosion into

the Chesapeake Bay. Protecting the Bay then also becomes a matter of protecting these archaeological resources. Stream restoration projects may have endangered or critical species present on site, which could cause the Department of Wildlife Resources (DWR) to be involved. When evaluating whether streambank stabilization is appropriate, consideration should be given to factors such as landowner engagement, the site constraints for equipment access, availability and proximity of building materials, and site eligibility for trout habitat work and other funding programs through Soil and Water Conservation Districts (SWCDs) or the Natural Resources Conservation Service (NRCS). Another interviewee noted that in Virginia, some landscapes are old and don't move as much. Sediment moves downstream, but not far. It is only when the erosion is accelerated above natural erosion rates that there is a problem.

Role of the Landowner

Multiple interviewees mentioned the importance of the landowner in the overall success of a project. The landowner can make or break a project. Determining the landowner's objectives and desires will help the practitioner decide if the project is feasible or not. Property owners should be considered as a factor when deciding on the best sites for a restoration project. If the source of erosion is determined to originate from just one landowner's property, the level of communication is quite straightforward. Other times, the number of landowners involved is unwieldy or their varying land-use objectives are not aligned. "Walking away" from a potential project is a hard thing to do, but sometimes is the "right" thing given the limited resources of time and funding, the extent to which those resources are stretched, and the likelihood of a positive outcome when utilizing those resources.

Several times the landowner's commitment to stewardship of the project over time was mentioned as a determinant of project success. Landowners are a critical part of stream project efforts and have their own set of views, preferences and interpretations. There is a need to figure out how to communicate with landowners effectively. Part of this is figuring out how to have conversations with homeowners about resilience.

There is a need to find balance between what practitioners like to do, what they think is best, and how they can inform landowners on what is best. There needs to be sensitivity to the landowners and what they want from a project, as they are the decision-makers that allow practitioners on their land. Practitioners should be careful not to impose on farmers, who are often just getting by. In considering the role of landowners in stream work, one interviewee emphasized that landowners will reach out to the Virginia Department of Conservation and Recreation due to erosion issues on streambanks that are causing some risk to their property. It is worth noting that landowners will ask for help when the erosion is noticeable to them, which may be a point of erosion that is very advanced compared to the point at which practitioners may have flagged the erosion.

Additional considerations for working with landowners include:

- Is the landowner willing to accommodate necessary land-use changes to provide adequate floodplain access, bank slope, realignment, forest buffer width, etc.?
- Are they willing to make a long-term commitment and work through a lengthy process (assessment, design, funding, permitting, construction, and maintenance)?
- Are they willing to have "skin in the game" through either cost-share funds or in-kind contribution?
- Urban areas can struggle with streamfront properties that are not public land.
- Homeowners want a view of the river, and will actively remove mature vegetation to clear their view, compromising the streambank stability.

Funding the Work

Most practitioners understand that only certain types of projects are eligible for certain pots of money. Once the objectives and site dynamics are determined, the next challenge is finding an appropriate source of funding or other assistance. Many stream restoration practices are expensive and cost-prohibitive for a private landowner. The deciding factor may often be if there is money available and if there is a willing landowner.

In order to justify streambank stabilization project funding, many public funding sources need to see significant, active bank erosion in a stream. To take into account a project's credit-ability (ability to receive credits towards a TMDL), the problem would need to pose a compelling case of significant public risk or land loss – not just pinning the bank down to receive the credits. Funding and permitting agencies exert a lot of influence to get a project funded. There may need to be a strong rationale outside of the pounds of sediment and phosphorus reduction of a project. Funders often give higher priority to projects that serve another public purpose and have co-benefits, which can be biological or assets to the community.

Factors to consider for a project's funding feasibility include whether there is a critical species present, if there is a TMDL implementation plan for that watershed, and if there is a watershed group or other entity that might be willing to invest or seek funding for this site. A search of the Virginia Fish and Wildlife Inventory will also provide some insight into potential species of concern that might be present and that could influence potential funding, habitat needs, permitting requirements, and/or time-of-year construction restrictions should a project be warranted. Ideally for project funders, anything in and along the stream channel is not as much of a sole focus on downstream sediment load, but it is more about increasing stream health in that overall stream segment, including the aquatic habitat and aquatic ecosystems, especially that of benthic macroinvertebrates.

In agricultural regions, there are various partners that have funding and do work in streambank stabilization. Many of these partners tend to favor stabilization practices rather than the full restoration approach. There is no quantitative rubric to determine if a stabilization project is appropriate. Oftentimes, it depends on the availability of funding. In some cases, streams are stable enough that it is not worth the investment to conduct stabilization work.

Other challenges associated with funding stream work

Many aspects of stream work are constrained by funding limitations. A challenge with the maintenance of a project is that grant windows are short. Committing to a landowner that as a practitioner, they will check back in on a project yearly without established long-term funding entails betting on the future in a way that many organizations aren't comfortable with. Stream restoration work is often limited and slowed down by funding parameters, criteria, and gaps in understanding. Some of these criteria can make a project very costly. The more flexible the funding parameters in implementing projects, the more effective a design solution can be.

Cost-share funding considerations

Farmers can access funds through the NRCS or the Department of Conservation and Recreation's (DCR) cost-share funding, which is funneled through SWCDs. Funding for stream work projects is not differentiated based on whether the project is done from the perspective of preserving the Bay through load reduction or a landowner protecting their property from stream erosion. Stream work requires a permit from the Virginia Marine Resources Commission (VMRC) and the local Wetlands Board. Work most often takes place through a private contractor. DCR is a free resource for inspection of designs, and people often don't reach out to DCR for

this service. Most of these contractors do not report for credits, with the exception of big firms that have nutrient credit banks established. These entities might report sediment improvement without funds from a cost-share entity. It was very rare for landowners to follow up with DCR after the organization has done a site visit and provided a written report on the issue and resources on contractors and funding. For tidal streambanks, DCR will only hear back if a project is done through one of the funding programs. Cost-share funding from SWCD engineers is being utilized in projects to stabilize gullies, but they can't find contractors to adhere to the engineering specifications and standards. Even if a project is covered 75% by cost-share, a lot of out-of-pocket funding is often still needed.

Technical Assistance & Partners

Often the question arises about who the landowner should call if they have an erosion concern, as well as who else should be part of the analysis and design. If a riparian buffer practitioner has concerns about stream erosion compromising a project, they also need to know who to reach out to. There are various areas of expertise, and having a practitioner that understands stream systems, can identify underlying causes, and can recognize if an action on your property will have an effect elsewhere is important. Often, the objective of the project will help determine the funding options and involved partners. A major consideration is who already has a relationship with the landowner(s) in the region. The following list of technical assistance partners was suggested by interviewees, and includes several other considerations:

Public Resources

- Louise Finger with Virginia Department of Wildlife Resources (DWR) was mentioned several times as a respected resource of knowledge, but covers a large territory and is highly sought after.
- In terms of whom to call, if the site is in agricultural land, the United States Department of Agriculture (USDA) or the Natural Resources Conservation Service (NRCS) are organizations that can provide assistance on rural land.
- Soil and Water Conservation Districts (SWCDs) and their equivalent in other states will have broad hub knowledge about who to reach out to for stream work. Most don't have capacity to move a project forward, but they can make connections.
- It could be helpful to contact the Virginia Department of Environmental Quality (DEQ) and the Army Corps of Engineers to inquire about what they have seen that has worked, and what hasn't worked.
- The Department of Conservation and Recreation Shoreline Erosion Advisory Service (DCR-SEAS) is able to see where stormwater-caused erosion is taking place. An assessment of changes in upstream hydrology and energy requires a contractor.
    - If a farmer uses state cost-share funding from DCR, there is staff that can do this work, but mostly third-party design firms are relied on for an assessment. DCR is usually called on first when there is an erosion issue. DCR can do a preliminary assessment and make recommendations about riparian buffer plantings.

Private Resources

- Private consultants or engineering firms can be a great resource, but they often require payment up front from the landowner, especially if it is not on agricultural land, which may be eligible for some TMDL funding.

Non Profit Resources

- If the site in question involves native trout habitat, Trout Unlimited may make a site visit in partnership with the local SWCD.
- Land grant organizations such as The Nature Conservancy (TNC) can be helpful, especially concerning easements.

Other considerations

- Background, education, and experience are all important to the success of a project, but without a trusting relationship with the landowner, the project outcome will be at risk.
- When considering who to call for a project, consider that technical service providers see approaches to projects differently. Trusted organizations that have shepherded projects over time in a region have an irreplaceable sense of understanding.
- There is value in having volunteers doing livestaking to get more people involved and engaged in stream restoration work.

Creating the Biggest Impact

Interviewees were asked to share where they have found the greatest return or success on streambank stabilization projects. Several themes emerged about what types of projects effectively made the most impact. Restoring the floodplain functioning by giving the stream space to correct itself was one of the most-mentioned strategies. If stabilization work is done in a small order stream, in conjunction with clustered sites or in a small priority watershed, results seem to be a lot more effective. Similarly, project effectiveness is found to be a lot more likely where restoration partners have the most influence or control in the watershed. Effective design also was mentioned as an indicator of a successful project. Several interviewees noted that in many cases, multiple scales of intervention (such as at the local and watershed scale) are important for long term impact. Several interviewees also noted that there is a lot of value in addressing the problem where it starts instead of downstream.

Restoring floodplain functioning

Restoring floodplain functioning by giving the stream space to be a stream and correct itself over time can be a highly cost effective intervention, creating the best outcome in terms of revegetation and yielding benefits not only for water quality, but habitat and watershed impact. This can be seen as a more incremental approach with "softer" engineering such as adding woody debris. Floodplain reconnection is about changing the stream channel for increased frequency for stream conditions to reach the banks. The idea is to create a floodplain with benches and opportunities for the water to get up and out of the channel, onto the floodplain, so the water can spread out to slow down the water velocity. This allows the sediment to fall out, and let the plants use the nitrogen and other nutrients to grow.

The following are additional thoughts that were shared about restoring floodplain functioning:

- A contributor to success could include adequate area for the stream to access and expand or flood into the floodplain with minimal earthwork required (a function of watershed size, valley width, magnitude of entrenchment, land-use flexibility, etc.).
- An example of a project that could directly benefit from a low impact approach to streambank stabilization is a farm field with cows in the stream, where there is no buffer, but the watershed is relatively undeveloped. With interventions such as revegetation, fencing, and some grading, it presents

an opportunity for a project that costs less than traditional stabilization, simply giving the stream space to adjust itself properly. In this case, the stream project goes hand-in-hand with the floodplain or riparian project.

- If a stream is too disfigured, especially where a watershed is delivering ten times the flow it used to, an incremental approach won't address the erosion issues at one specific site.
- Increasing floodplain access and reattachment can be accomplished without holding the stream in place. There are places with a short reach that are disconnected from the floodplain, but with a longer reach, the cause of the erosion and floodplain disconnection is not always clear. It is expensive as it involves moving a lot of dirt, but doing it in the right places to reestablish wetlands value and function makes a lot of sense.
- "Espace de liberté" is an easement-related movement in France that allows the stream to have the space it needs to flood and migrate, which is a good example to learn from.

Working in Small, Upstream Watersheds

A small order stream, clustered sites, or a small, priority watershed (less than five square miles) can be an effective scale of targeted work, especially if it is not undergoing rapid development or land use changes. When most of the watershed includes mature forest cover along the banks upstream and downstream of the site, such as often found in small, upstream watersheds, a stabilization project is a lot more likely to be successful. These areas often allow for a better and more low impact approach – and one that builds more resilient ecosystems where there is space to plant a wide buffer and let the channel stabilize itself. The smaller order streams in the headwaters also tend to be where the trout are, and therefore where Trout Unlimited is able to assist with projects. Ecology-wise, aquatic organisms passage (AOP) projects produce the most dramatic and visual improvements.

A project has a higher chance of success where the factor(s) that are determined to have caused the instability are isolated and can be rectified (such as the presence of an undersized road-crossing, a channel impediment that can be removed, etc.) as opposed to systemic (watershed-level erosion issues, sediment/flow quantities are out of balance, etc.).

Clustered Sites

Project size is a factor in determining the effectiveness of the investment and impact. Spending money across multiple sites for habitat-focused partners such as Trout Unlimited is more helpful than spending a lump of money working on one site because the work is addressing a larger expanse of habitat and has more impact on sediment reduction. This depends on an organization's goal, as for some it may be more beneficial to work intensively on one site. Another case in which there is great return on streambank stabilization projects is when work is being done throughout a specific area. This entails focusing at a stream system scale, starting at the top and working down the stream to restore a whole stream complex. Working on random stream sections may fix sediment issues in a specific area, but it doesn't solve the issue in that drainage.

The Role of Effective Design

Effective design could be a catch-all for a project that considers all of the variables mentioned in this report, but many interviewees noted design as something that could be done well or badly. Since effective design is subjective, and based on both perspective and the defined objective, it is an evasive metric. One interviewee

noted that when the project is designed well to meet a specific objective, the outcome can be a good return on investment. Several times it was mentioned that effective design takes into account healthy streams that are supposed to move. By trying to hold the stream in place, we harm the ecosystem and create problems. It is good to have woody vegetation, but the stream needs to be able to move by eroding one bank and depositing sediment on the opposite bank. Other times, the objective dictates that it needs to be held in place to protect bridges or roads. One interviewee emphasized that a stream should be held in place only when necessary. High water events will test the system and design to show if it actually is resilient.

Sometimes planting a buffer is enough to stabilize the erosion over time. More often than not, planting a buffer with the right context can be very effective. There are innovative approaches for stabilization that have less opportunities for crediting such as live staking, which are low-impact, but could have high success rates. Redefining, scalping, and grading a streambank can have ecological impacts and be expensive. Many funders are more interested in less-engineered restoration approaches and in small-scale opportunities.

A buffer may be a viable option along a stream if the streambank height is considered. If there is a reasonable level of interchange with a tree root system, a root structure will form itself and a buffer project could be installed. Sites where planted trees can get access to the water table and flood plain are a good place for a buffer project. If a buffer is established on a stream in a meadow, the stream will start to widen and become shallower and more diverse as it matures into a young forest.

Importance of Maintenance

Several interviewees noted that it is important that the landowner or another third party has a high commitment to long-term stewardship and an appreciation of aquatic health. This includes the long term care for trees, planting them well in the first place, maintenance, protection from animals, and considerations of invasives. Several interviewees found that practitioners should assume responsibility for maintenance of a project, rather than leaving the responsibility to landowners. The success rate is much higher and the sales rate goes up for a firm when this assurance is given at the start. If practitioners are able to provide landowners a promise of maintenance commitment, landowners will interact more willingly.

One interview presented an example where when working in Maryland with Cooperative Extension, maintenance of buffers was a roadblock for agricultural landowners. Offering a five-year maintenance plan and helping with the plan would help immensely increase adoption of riparian buffers on agricultural land. It would be helpful to create a buffer package that includes maintenance. Maintenance is needed for stream projects with hard structures, which get undermined fairly quickly.

Influence in the Watershed

A practitioner's level of influence or control with partners and stakeholders in the watershed can determine where they will have the greatest return on investment with a streambank project. The more the watershed is thought of in the whole, using a holistic approach to the whole system, the more successful the work will be. Investments downstream may be irrelevant if upstream conditions are not addressed. One type of project that yields this level of control are source water protection plans.

For local governments, it is important to use a watershed approach that looks beyond TMDL credits and considers the health of the watershed to determine where to implement meaningful projects. Water quality

problems should always be addressed via a watershed assessment. If fine sediment is identified as a pollutant or problem and accelerated bank erosion (i.e. at rates above natural erosion rates) is identified as a source of fine sediment, the next step is to determine the underlying cause(s) of the bank erosion. Simply trying to stabilize eroding banks without understanding the underlying cause(s) may be a waste of money and time, and may not improve stream health.

A challenge in agricultural stream work is that work needs to be aggregated to have an impact. If a watershed that is HUC 14 (hydrologic unit code) in size, with one square mile or more of area, a lot of work can be done. If there are several problematic farms in the area, and work is not done on most or all of them, from an ecological perspective, the improvements can be undermined or lost entirely.

Stakeholder and Community Involvement in a Project

Projects that have involvement from multiple partners, such as the municipality and the community, are the most effective approach. There is often public contention about restoration and construction processes. When communities are on board, the project success and public perception is better. Education and outreach opportunities are important components. For example, having a project in a public space, such as near a soccer field, allows for an educational component. When there is only one entity that needs to provide easements for the work, it becomes easier and more feasible. Rich Starr is a restoration engineer and has done stream restoration crediting guidance. In his project feasibility assessment, easements are a factor to consider when deciding on whether to move forward with a project.

Other Examples and Variables of Successful Projects

- Designing with climate change in mind needs to account for hydrology or hydraulics and the selection of trees. The big question is will stream restoration structures such as root balls and cross vanes in streams hold up?
- Consider the climate resilience impact that stream work may have. Resilience and water quality will drive the work into the future. There is a role for the stream channel in the resilience picture as part of infrastructure. For example, there is an ability for stream corridors to be a floodplain to store water. The Bay model may not meet the 2025 goals, so there may need to be a shift in goals to focus on resilience. In considering resiliency and the climate – as we put limits around stream systems, they become less resilient.
- Short term construction projects can make a lot of sense for erosion control, such as hot spots in-stream, that are disproportionately impactful on the stream function.
- The convenience of site access and materials can greatly improve the project return on investment.
- Mitigation banking is an evolving discipline, and these projects are monitored heavily and are protected long-term. Protection of projects is really valuable, and it is needed in a mitigation scenario and less tenable in other situations. However, greater control or influence in the watershed will yield greater return in investments.
- One interviewee mentioned an example project near Charlottesville. Albemarle County was looking for stormwater retrofits possibilities and ended up restoring the stream ecosystem where there had been a dam that was breaching. The stream ran from the County to the City of Charlottesville, and the two entities had to work together. The County needed phosphorus credits and the City needed carbon credits; they worked out a deal in which they shared credits from the project, which was a mutual win.

- For example, sourcewater protection in the Catskills of New York or Harrisonburg in Virginia allows for a great deal of control in the headwaters which prevents many downstream problems.

Future Needs and Opportunities in the Upper & Middle James Watershed

When asked what interviewees see as the greatest future needs or opportunities around streambank stabilization in the Middle and Upper James watershed, several major themes emerged. Some were directed at the role of the Consortium, and others were more general.

Increased capacity of stream experts

In the James River watershed and beyond, several participants noted that the current and future need with regard to streambank stabilization is primarily additional staff with training and experience in stream processes and function to identify feasible project sites and implement restoration or stabilization efforts where appropriate. There is currently a very limited capacity of public agencies to provide expertise for preliminary assessments to start the process. The need across the state is greater than a few people can address, though one person dedicated to the Upper and Middle James would be a big step. Likewise, limited engineering capacity is a hurdle in the private sector, and especially at the state level. Access to funding in order to hire stream experts from the private sector was a commonly cited limitation both at the state level and in the private sector.

Practitioners that are not stream experts need to understand the projects first and to educate other staff to ensure that they are giving landowners good information. There is a lack of education on what assistance is available, what the first step is, what contacts exist beyond the private sector, and how to get a process started if an easement is in place for stream-related work. One interviewee noted that most SWCD employees in the state don't have this kind of knowledge. Only a small percentage of district and state employees have an idea of what a natural stream channel should look like and how humans have changed natural stream conditions. Due to the unknowns regarding permitting, costs, and what the right approaches are, many district staff have steered away from stream work. Districts get funding to do certain tasks, and there is limited capacity to do additional practices such as stream work.

Other thoughts concerning technical staffing capacity include:

- Some noted that there isn't a lack of engineers available, but there may be a lack of engineers available to work on these projects, in part because these projects might not be attractive to engineers. A log jam of projects sometimes ensues.
    - When approaching engineers for solutions, they often don't provide a nature-based approach. It is important to think about how technical expertise is part of the discussion.
    - Engineering firms often have the capacity to get stream projects in the ground, but ensuring cost-effectiveness can be a challenge.
    - Municipalities are sometimes doing this work at a scale that automatically precludes smaller firms, so restoration work will often be done by much larger firms. It would be helpful to identify other projects, possibly being managed by other partners to package smaller projects together.. If the small sizes of projects are an issue, the projects can be packaged together so a firm can address a handful of properties at once.
- Non-profit organizations often don't have engineers or dedicated hydrologists on staff. That perspective is needed, and often a private engineer is called on to solve the issue, but they often create a solution to maximize profit.

    - An example approach is that Trout Unlimited has an engineer working for the organization, but an external engineer is needed only to approve and put a professional engineering stamp on plans.
- Approaches to stream work have been geared towards private consultants and firms, which can be costly and intimidating to local organizations and agencies. Often, landowners do not know they can call state agencies or districts when their land is threatened by erosion. Landowners need help to walk through the process of stream work.
    - The guidance that state agencies and districts can offer is very limited. There are capacity gaps for public resources. Simple approaches such as planting trees and fencing livestock out of streams are not always the solution.

Role of the Consortium: Advocate for expanded capacity for technical assistance.

- The Consortium could document the need for and advocate to natural resource agencies (DCR, SWCD, DWR, etc.) that there is a need for expanded technical assistance in this effort.
- The Consortium could seek funding to train existing non-profit organization staff, such as at the James River Association, in these matters and hire a person with assessment, design, and implementation expertise to cover the Middle and Upper James.

Education for landowners, governments, and practitioners

Many interviewees agreed that practitioners, landowners, and local governments need to understand the basics of stream dynamics. Information could be made available through outreach efforts (such as roundtables) and for entitles like SWCDs and DEQ. Roundtables are great to disseminate information, and meetings need to be in-person in most cases as assumptions are made remotely. It is better to look at how to get information in the right people's hands instead of tracking down people with information to get the word out. It would be helpful to have resources throughout the state for different groups. Resources are needed that detail contacts, the streambank restoration process, how to oversee a small project, and steps to successfully write a grant. There has been a Virginia Agricultural Cost Share Manual Program (VACS) manual that includes information on the streambank stabilization process, but the associated costs and lack of clarity on what to do and how to do it remain a hindrance for state agencies.

Outreach to landowners

It would be beneficial to do an outreach education program for landowners to demonstrate that messy is good when it comes to streams, as messy streams are healthy streams. Specifically, people need to learn to stop removing beavers and wood debris from streams as they create habitat. Establish guidelines to differentiate between stream restoration and stabilization, as well as when it is appropriate to focus on one versus the other. Outreach is needed especially in agricultural areas. Information seems to often pass from person to person in these areas. For a landowner that does not know much about watershed restoration, they may be missing the information that an organization or agency will do work on their stream for them. There are programs to install fencing, a well, or a water source on a property in exchange for an agreement on behalf of the landowner to maintain the project.

Role of the Consortium: Create engaging learning opportunities.

There is a major gap in capacity and knowledge of what is available for stream work. A benefit of the Consortium is that people are brought together. The Consortium could facilitate a process to walk partners

through the options. There is a widespread lack of education among practitioners and the public. Stream work has become a daunting topic and a big undertaking, causing it to often be pushed aside by landowners and organizations. There needs to be better understanding about the cost-effectiveness of stream work. The development of assessment tools that could be used when assessing a site and to create a better understanding is needed.

- The creation of a program to learn from a stream, such as a walk-a-stream program, or a central database of information for landowners and riparian buffer practitioners on stream erosion interventions would be helpful.
- Encourage landowners and government agencies to increase awareness of best practices. The Consortium could work with local governments and help with education and to communicate with the public that streams should look messy, and to leave beaver and woody debris in streams.
- It would be helpful to have a consistent resource for information on stream work. All of the SWCDs need to be able to provide the same information to share with landowners. A uniform and consistent product to share with landowners would be helpful.
- The Consortium could organize a multi-day, in-person training session for site assessments to educate practitioners on what they're looking at. It would be helpful to do case studies and to visit failed projects to understand lessons learned as well.
- Demonstrate effective bioengineering approaches that have been done in the past, such as woody debris and planting shrubs. Landowners want to see something that is working before they buy into it, so demonstration projects are important, which could be on private property if the landowner agrees. The demonstration project should have a full stream and floodplain system with bioengineering solutions that may include a buffer.

Increased funding for high-impact projects

The risk and reward factors of dedicating large amounts of money to one project need to be considered. Identifying funding opportunities and pairing them with high-impact projects will lead to a higher chance of successful outcomes. Without funding to implement projects, having people to identify worthwhile sites will not result in significant change on the ground. The inverse is also true: increased funding for projects doesn't necessarily translate to more technical staff capacity to implement good projects. Sufficient funding will be needed to account for private-sector contracting for design and construction in order to effect large-scale change. A need is to ensure that funding programs are set up to fund the right practice at the right amount, as well as to provide the resources to do the project designs and work. Below are additional thoughts related to increasing funding:

- It is important to leverage partnerships to look at water quality issues. Funders are looking for projects that serve multiple organizations.
- Cost-share regulations may have to be built in to compensate for engineering staff. Cost-share rates have a cap of $8,000 for hiring engineers, no matter the size of the project. This is often prohibitive for private industry to get involved.
- A need is an ongoing source of funding from grant-giving entities. It would be helpful to create a shared pool for continued funding.
- In the Upper and Middle James watershed, the majority of land use is agricultural and forested, with fewer urban settings. It would be helpful to improve landowner access to funding such as the Virginia Agricultural Cost Share Manual Program (VACS) to help with those projects. There is recognition that agricultural and timber lands are a major contributor to sediment loads, and there is a push to install

more Best Management Practices (BMPs) in Virginia, which is increasing the amount of state funding available. These funds need to be made available to landowners.

- Streambank stabilization practices are eligible for cost-share funding and include armoring the toe, grading the bank, and adding vegetation to the bank. Stream restoration practices are not eligible for cost-share funding; restoration practices are eligible for refundable tax credits. It is often a more expensive project than streambank stabilization, as it requires work on both sides of the stream (with willing landowners on both sides) and upstream work.
- Identify future opportunities from the federal "infrastructure bill" (such as dam removals and road-crossing replacement opportunities), expanded funding for Chesapeake Bay water quality improvement efforts, funding of the Consortium, and other such efforts.
- There are funding options through NFWF and Small Watershed Grants, but getting access to funding is more complex than having Districts apply. Beyond the private sector, there aren't many free resources for local agencies and organizations. More needs to be done to provide access to public sector resources for stream work.
- SWCD employees often don't have the capacity to apply for small watershed grants across an entire district for landowners.

Role of the Consortium: Help secure funding for projects, and prevention through watershed work

- **Help secure funding for projects.**
    - The Consortium could seek funding that could be made available on a competitive basis for the private sector to design and implement stream projects.
- **Keep up the watershed-scale work and reduce the need for streambank stabilization projects.**
    - The Consortium could focus on reducing the need for this type of work by advocating for land conservation (especially forested land), improved road-crossing design requirements (regulatory level changes), improved stormwater management, mandatory livestock exclusion, and expansion of the Chesapeake Bay riparian-buffer ordinance throughout the James River watershed.

A Coordinated Watershed-Scale Approach

A coordinated watershed scale approach is key. Several interviewees shared the belief that large-scale changes are needed in order to truly address the causes of degraded stream morphology. These practices could include mandatory livestock exclusion, conservation of existing forest cover (not just riparian forest cover), low-impact development practices, stormwater attenuation, regulations that require adequately sized road crossings (both on private and state-owned roads), and other "big-picture" actions. Short of these practices, projects are in danger of focusing on the symptoms, but not the cause. For example, one interviewee noted that it doesn't make sense to do 1,000 feet of stream restoration between two degraded sections of stream; instead look at the entire watershed before jumping in to do piecemeal restoration.

Other opportunities in stream restoration and stabilization

- Stormwater management can be an effective venue for improving downstream erosion issues.
    - Urban areas in the watershed that could increase their efforts to manage stormwater runoff, which is often causing streambank erosion downstream.

- The permitting process for streambank stabilization work can be quite cumbersome and different depending on the lead agency or organization involved.
    - There is a limited number of people who can visit a site to approve permits for stream projects. It can be cumbersome and take a significant amount of time to complete the permitting process. In some instances, landowners or circumstances change because the permitting process takes too long, and it is important to begin a project once you have a cooperating landowner.
- Making a big impact in the agricultural sector with stream work is a big need.
    - There are creative ways to do it; for example, nutrient banking is a for-profit model, but often results in a bigger improvement than what is captured in the targeted nutrient offset.
    - Create restoration projects as touchstones in areas that may not see restoration projects otherwise for increased visibility.
- The watershed is a diverse region, with the Upper James being more focused on trout fisheries, and stream restoration approaches will look different in various parts of the watershed.
- More easements could provide long-term protection from development encroachment on streams in the future; for example, Federal Emergency Management Agency (FEMA) buy-outs protect sites that are routinely flooded.
- Virginia is enacting efforts for a statewide flood reduction plan. The Department of Conservation and Recreation has recently developed a coastal resilience master plan, and there is a goal to do a similar plan to address flooding issues in non-tidal regions. The focus of this work is on community protection and flood impacts, so it is unclear how much the plan will work with property owners in the Upper and Middle James watershed. Perhaps upstream restoration projects should be a focus; this would affect downstream hydrology conditions where the urban corridors are.
- Learn from other regional collaborative initiatives. Another potential opportunity to support streambank stabilization projects are large-scale collaborative efforts by groups like Chesapeake Conservancy and their effort in Pennsylvania to delist streams. They have identified stream catchments based on their specialized GIS analysis, and they see that with a certain amount of stream restoration work could be implemented to delist impaired streams with partners who are working at the catchment scale to do riparian and stream work, including on farms.

Role of the Consortium: Address roadblocks and important issues.

- **Help address bureaucracy roadblocks in state funding, programs, and permitting processes**. Bureaucracy can be a hindrance to flexible solutions. The Consortium could have a voice in pushing out the bureaucracy roadblocks and getting quality practitioners and contractors on board.
    - An interviewee shared the example that there was a project with vernal pools wherein a wealthy individual bought a property and wanted to improve the stream for fishing. The site was a channelized mess, but DEQ had very stringent criteria for how the stream needed to be remediated, which can make it difficult to accommodate the landowner's wishes. Part of the concern is that the funding source creates limitations and hoops to jump through. They were not allowed to put wood instream for habitat, which could have been a helpful solution. Agencies can at times become a bottleneck to restoration work or hold back progress if staff members don't have current knowledge of best management practices and opportunities.

- **Address issues related to DEIJ (Diversity, Equity, Inclusion, and Justice).**
    - The Consortium could come up with an approach for site evaluation and prioritization across the whole watershed, and include DEIJ factors as comparison criteria among sites. Information on what factors are used to assess stream sites would be helpful.
    - The RVAgreen 2050 is an equity and climate action plan developed by Richmond's Office of Sustainability, focused on flooding and stream health. Interviewees noted that there is a lot of great thinking going on about these topics in Richmond which could be an inspiration.

Concerns about Streambank Stabilization (things to watch out for)

Some of the main concerns shared around streambank stabilization relate to poor design, TMDL and credit-driven projects, unrealistic ideals about stream restoration, not accounting for downstream repercussions of stream restoration projects, and practitioners that adhere to narrowly prescribed methods. These concerns and beyond included the following:

Poor Design

Poor design in stream restoration can be either wasteful or contribute to the erosion problem, especially if it does not account for the scale of the erosion problem. Not accounting for the stream channel's need to be a dynamic system that can shift or adjust over time even within a natural range of pattern, profile, and dimension can contribute to the failure of a project. Other elements of poor stream design may include:

- The use of extensive channel armoring with rip-rap to hold a channel in an inappropriate pattern, dimension, or profile leading to increased downstream instability.
- Ignoring the importance of the floodplain connection is nearsighted and does not address the mid-scale potential for intervention.
- If a stabilization project is not done in a comprehensive context with what is happening upstream and downstream, it could just be a band aid solution that may end up failing or causing problems downstream. Projects need to be located in areas where they are actually needed. An issue with the construction of stream restoration projects can be the possibility that it is doing more harm than good and needs to be considered.
- When disturbing the floodplain, interventions often alter the peak flows of storm events.
    - In some areas, ponds were installed to mitigate floods and sediment retention. Restoration projects are attempting to take the dams out; the impacts of this need to be considered. Human-made interventions to influence the behavior of wetlands put increased management tasks on landowners.
- Creating a narrow ideal of how a stream should be could lead to overspending money on projects, implementing projects in the wrong settings, or a misunderstanding of how active a stream's change is or what the constraints are.
- Use caution to avoid installing an ineffective project that could cause more harm than good.
    - DCR has installed cedar revetments with cables in the bank that ripped out over a few major storm events and washed downstream which caused a flow restriction and even greater erosion problems.
- Straightening a stream often speeds up the water and creates a knickpoint or mini waterfall. That knickpoint will erode and move upstream, causing a deepening of the channel. When the channel is deepened, the streambanks become higher, which can cause bank erosion. If a stream is too deep, all the flow energy is in the channel and doesn't get a chance to slow down on the flood plain.

- DWR tries to collaborate on stream bank work after floods, when no permit is needed to address issues. DWR is trying to get experts involved before they start straightening channels. People should have more stream practitioners ready to present functional stream designs and grading protocols in case of an emergency to prevent future erosion issues.

TMDL-driven Crediting

Several interviewees noted the problems that arise when the work is being driven largely by Chesapeake Bay TMDL credits. This rationale for doing projects isn't always strong enough to justify the work. The protocols that drive crediting specify urban stream restoration. Many stakeholders have noted the need for credits that are specific to rural situations, as the urban credits don't apply to many areas of the watershed. However, project implementers and localities are often seeking a large number of credits, which streambank stabilization affords, and is driving a lot of work currently. The regulatory crediting and MS4 (municipal separate storm sewer systems) permits are driven by models of sediment load in the Chesapeake Bay that are often flawed and not comprehensivePotential changes in the system vary from state to state with individual regulatory structures. In Pennsylvania, there is pushback stemming from MS4 permits. Due to permitting constraints and associated investments, project approval and implementation are often not very effective..

The TMDL crediting approach has been a big driver in the Bay watershed for restoration work. There have been discussions of creating another crediting approach for stabilization of agricultural stream restoration. Establishing crediting protocols for agricultural areas that pertain to streambank stabilization work could be a big driver in the James watershed. The Chesapeake Bay Program has an Agricultural Workgroup that may have invested efforts in creating new protocols.

It is also worthwhile to explore crediting as a driver for the work and to get counties on board for more incentives. TMDL and Watershed Implementation Plan (WIP) are goals for nitrogen, phosphorus, and sediment load reductions. Some of this load is coming from non-tidal stream bank erosion. Streambank interventions may be appropriate to address water quality downstream, regardless of whether or not a landowner's property is at risk. A challenge is that if a project is done from the Bay-preserving, TMDL perspective, the Chesapeake Bay Program has specific protocols for streambank restoration projects to receive TMDL and WIP credit. The crediting may depend on where the funding for a project is coming from. There are a host of identified impaired streams in the Middle and Upper James that could benefit from a TMDL approach to restoration.

Other thoughts on TMDL-crediting

- It is key to locate stream restoration practices in the right places. Oftentimes, people implement practices for crediting purposes or the Bay TMDL, and so the project may not be implemented on the most degraded portion of the stream. It is important to take into consideration the different watershed characteristics, such as historic and future conditions, for a comprehensive approach and to ensure proper practices.

Other Concerns

- A lack of agreement and understanding on the importance or relevance of stream restoration work impacts the funding opportunities and success of projects.

    - There is a big disparity in the acceptance of stream work versus the money required to do these projects. There is a difference in opinions on the importance of streambank stabilization. Perspectives from the state or regional scale may hold the opinion that money is better spent planting more trees rather than working to restore a specific site.
        - There is a lot of funding for districts, Chesapeake Bay programs, and improvements. There is not a definitive consensus on how much priority should be given to stream work.
    - Designers will use a certain prescribed approach because they have invested a lot in training and developing an expertise for doing projects a certain way. It would be better to learn from past mistakes, improve the methods, tie the appropriate intervention to what is occurring, and avoid inappropriate practices for the conditions that are being addressed.
        - Practitioners from fisheries focus on building habitat within streams. In thinking about trout, when bigger structures are built, the benefit often moves away from local trout and more towards larger non-native fish.
    - Stream restoration has become more contentious among community members due to the disturbance and tree removal that is sometimes part of the construction.
- If landowners want to address erosion problems on their land, they are hesitant to call the Army Corps when applying for a grading permit, because they want to avoid creating permitting hassles or restrictions for themselves.
- Restoration practices should take into account research on the durability of restoration practices over time, including research by Margaret Palmer at the University of Maryland, Emily Bernhardt at Duke University, and research done through the Chesapeake Bay Program.
- When stream restoration projects are reported now, the land use changes (such as loss of trees) aren't reported. Usually, only the load reduction associated with crediting protocols are reported. The Chesapeake Bay Program has done work to quantify the benefit of trees and factors in the loss of trees in stream restoration work. Doing stream work in the middle of a pasture is easier and the math is more direct.
    - Consider if the forest is being impacted to do stream work. A good assessment process would take this into account. The considerations that determine if a process moves forward are often exclusive of the vegetation.
- Sometimes funding criteria perpetuate problems with stream design such as the United States Department of Agriculture (USDA) programs specificity on what is funded and how things have to be done. In many cases, funding was only provided for trees and not live staking. It complicated things to work outside these programs, so approaches tended to be more short-sighted in order to meet the program criteria.
    - The driving force for stream projects is watershed improvement, but projects are often approached through a one-step decision making process: if the site is in the watershed, the project will move forward, without much thought of what impact the project will have.

Resources

Interviewees were asked to share print or digital resources that they have found helpful and could provide others with information to learn about streambank stabilization. Several interviewees mentioned the Stream Functions Pyramid by Stream Mechanics, created by Will Harman and Rich Starr, as noted above as a model for addressing the whole stream systems instead of just one part. The pyramid is a hierarchy of stream restoration and orders. The National Fish and Wildlife Foundation (NFWF) uses this tool to build and communicate what is

possible, what the goals of an effort are, and how to stretch to get to the biological goals at the top. Several interviewees also noted that the Center for Watershed Protection (CWP) is involved in research on the topic. CWP is on the steering committee of a Science and Technology Advisory Committee (STAC) workshop submitted by the CBP Stream Health Workgroup that was recently approved. The workshop will be on the state of stream restoration science and looks at regulatory issues, the history of stream restoration, as well as what is to come to improve restoration outcomes in the future. There will likely be many informative presentations.

It was shared that the best information can be learned through first-hand experience. It would be helpful to walk a stream with practitioners to observe what is happening. The best teacher is the system itself. Residents can share knowledge about what they have experienced with a system, as they've lived with that system over time.

Interviewees noted that an analyzation of the Rosgen approach to streams is needed:

- Untangling prescriptive approaches like Rosgen is key – it is important to not assume what the stream needs to look like. We need to not think we can engineer ourselves out of the issues that are impacting the stream.
- The Rosgen approach worked in the western U.S., where the approach appeared compelling. It is worth investigating if the approach is the best one.

Understanding the Basics

Interviewees shared the following information regarding the basics of stream functions and assessments:

- Gaining a basic understanding about river processes, hydrology, and geomorphology is the first and vital step in addressing understanding what interventions might be appropriate with a degraded streambank. This is the foundation for recognizing the "natural" vs. the out-of-balance condition. It is a critical piece to attempting to identify the "why," and, thus, the "if" and the "how" to proceed.
- Basic fluvial geomorphology texts, such as Dunne and Leopold's early engineering textbook, *Water in Environmental Planning* and Rosgen's *Applied River Morphology,* are good starting points for a practitioner to gain a deeper understanding of stream systems.
- There is a dearth of information out there for the general public, such as YouTube videos. Greg Jennings has done a series of explanatory videos.
- Virginia Tech is a land grant institution, and through the extension service, the organization has created information for landowners. The extension in North Carolina has released informational and educational materials.
- Some of the materials on stream work are daunting. Conferences on the topic can be more approachable and helpful.
- There is a lot of guidance on stream restoration, it can be hard to sift through. Whichever guidance is most distilled and easily digestible would be best.

In-person Opportunities

- In-person training opportunities are available through:
    - Courses at North Carolina State University and the North Carolina Extension
    - Wildland Hydrology (Rosgen) courses
    - Utah State University, and other institutions
- Through a grant from the Chesapeake Bay Trust (CBT), work is being done to explore the topic of maintaining forests in stream corridor restoration. Case studies, a series of webinars on the topic, and a

best practices guide for local governments will be conducted. They are exploring how riparian vegetation changes and if there are trade-offs in the benefits of stream restoration practices in comparison to the associated land use changes.

Online and Additional Resources

Interviewees shared the following regarding general sources of information on streambank work:

- The Chesapeake Stormwater Network has a consolidated guidance for Crediting Stream and Floodplain Restoration Practices in the Chesapeake Bay Watershed. The CBP Protocol 1 (Prevented Sediment) Workgroup Update (2020) was specifically mentioned. There are eight protocols, both in-channel and side-channels.
- Chesapeake Bay Trust's Pooled Monitoring Advisory Committee (PMAC) has powerpoints that summarize research. Information about the Pooled Monitoring Forum: Restoration Research to make Science and Regulatory Connections, which can be found here.
- North Carolina Cooperative Extension publication titled Small-Scale Solutions to Eroding Streambanks
- Appendix B from NFWF is a resource around stream restoration goals and looking at the right intervention that lists stream restoration resources for applicants to familiarize themselves with as an attachment to small watershed RFP funding opportunity, which can be helpful to incorporate.
- Information about CBT's Restoration Research program can be found here.
- The Chesapeake Conservancy tool is helpful for the Consortium.
- The VA Streams public listserv (vastreams-g@vt.edu).
- The USDA U.S. Forest Service has done work on large woody debris with a team from New England, who create great materials and host helpful meetings on the topic. The USDA has provided helpful materials on root wads and woody debris for stability in a naturalized context.
- The Chesapeake Bay Program's Expert Panel Report came out in 2014; there have been workgroup updates to the report in recent years. The report has a lot of resources in the reference and appendix sections.
- The Chesapeake Bay Program's Agricultural Workgroup is a helpful resource.
- CBP Protocol 1 (Prevented Sediment) Workgroup Update (2020), which may be found here.
- Metropolitan Washington Council of Govts Stream Restoration Guidebook. This is currently a draft version, but is a good summary of stream restoration best practices.
- The notes that Keith provided after the March 8th Consortium Steering Committee meeting pertain to design and maintenance issues and can be relevant to this conversation.
- The Texas A&M AgriLife Extension Service works on agricultural non-point source pollution. The AgriLife Extension Service has an urban riparian and stream restoration program, which provides training, field guides, and stream health materials. These materials are useful for agricultural lands, and were designed for landowners and citizens.

Experts and Experienced Practitioners

Interviewees were asked to identify key stakeholders and regional actors in stream work. The following names and entities were mentioned:

- Louise Finger
- Trout Unlimited
- Kip Mumaw
- Matt Ehrhart

- At the Chesapeake Bay Trust, Sadie Drescher runs the research program. She can summarize what is happening with streambank restoration on the research side, which can tell us about the trade offs.
- It is important to get more perspectives from the rural agricultural setting.
- Tess Thompson
- Tom Benzing - James Madison University professor
- Art Perola is the director of the Stream Institute and a professor of civil and environmental engineering at the University of Louisville.
- Greg Jennings comes to Virginia occasionally and used to teach to the DEQ staff.
- Rich Starr used to work with NFWF and now works for EPR in Maryland. There is a collaboration on research and work on stream design.
- Joe Byrd at Biohabitats.
- The community of restoration practitioners is generous with their knowledge and tries to get information to others as well.
- Joe Wood at Chesapeake Bay Foundation has been advocating for less stream restoration, and can speak on when it is not appropriate to do restoration or what community concerns might be around restoration and tree removal.
- Ellen Wohl at Colorado State (American fluvial geomorphologist).
- Natural Resources Conservation Service (NRCS) provides support for agricultural landowners; perhaps someone at the state office would be helpful to reach out to.
- Environmental consulting firms that have experience with streambank stabilization and stream restoration.
- The Nature Conservancy in Pennsylvania and the Northeast think about stream systems. They tend to work on rural and agricultural systems and focus on the connection to land, but have had concerns about resiliency. As we lock stream systems into place, consider the long-term impact, which may be harmful.
- Shenandoah Streamworks does good work and has qualified contractors.
- Ecosystem Services
- Individuals from the DCR-SEAS program would be helpful to reach out to.
- Dave Hirschman
- Staff at DEQ are involved in permitting, which is a helpful angle to explore. There are new staff members in the wetlands permitting group who focus on streambank and restoration work.
- The Thomas Jefferson Soil and Water Conservation District has done streambank work.
- There are members from across the watershed that are a mix of universities, consultants, local govts, etc. on the Maryland Water Monitoring Council (MWMC) Stream Restoration subcommittee who may know of others to reach out to. It is a group that meets four times a year to discuss various topics and to organize an annual conference.

Interviewees

1. Keith Burgess, Monacan Soil and Water Conservation District (SWCD)
2. Dylan Cooper, Trout Unlimited
3. Matt Ehrhart, Stroud Water Research Center
4. Ari Daniels, Center for Watershed Protection (CWP)
5. Louise Finger, Department of Wildlife Resources (DWR)
6. Lisa Fraley-McNeal, Center for Watershed Protection (CWP)
7. James Fulcher, Soil Scientist at Field Works
8. Dave Hirschman, Hirschman Water and Environment
9. Grace LeRose, City of Richmond
10. Luke Longanecker, Thomas Jefferson Soil and Water Conservation District (SWCD)
11. Todd Lookingbill, University of Richmond
12. Kip Mumaw, Ecosystem Services
13. Jake Reilly, National Fish and Wildlife Foundation (NFWF)
14. Tess Thompson, Virginia Tech
15. Aaron Wendt, Virginia Department of Conservation and Recreation (DCR) Shoreline Erosion Advisory Service (SEAS)
16. Sammy Vest, Trout Unlimited

Interview Process

D+D conducted virtual interviews to collect the ideas, concerns and resources from key stakeholders, and developed this Key Issues Report in preparation for a General Consortium Meeting on May 19th, 2022. In March of 2022, Christine Gyovai, Emily Carlson, and Lea Taylor of D+D conducted 16 virtual interviews, covering the following questions:

1. When is it appropriate to do streambank stabilization -- when does it or doesn't it make sense to do a streambank stabilization project (when is just planting a buffer enough, or what should practitioners look for)? Then, if streambank stabilization is needed, who should a practitioner call?
2. Where have you found the greatest return on streambank stabilization projects?
3. What do you see as the greatest future needs or opportunities around streambank stabilization in the Middle and Upper James watershed?
4. What are the greatest concerns you have about streambank stabilization in general, or related to specific streambank circumstances?
5. What are the most helpful resources (in print or digital) for others to learn about streambank stabilization?
6. Who else should we potentially reach out to potentially reach out to (who else is key to the field; but likely not for an interview)?
7. What else would you like to share regarding streambank stabilization?
8. *Additional question asked if time allowed*: In your experience, do most of the stream bank stabilization projects you have installed involve a watershed approach or are your designs pinpointing the eroding section of focus?
9. *Additional question asked if time allowed*: What can the Riparian Consortium do to make more streambank stabilization projects possible? It seems like even without their great expense, there aren’t enough engineers or practitioners available to help with SS projects.