Piney Run Tributary

Stream Restoration

Prepared for:

WEFTEC

Student Design Competition

Environmental Category

August 27, 2021

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PROJECT ABSTRACT FORM

WEFTEC® 2021 STUDENT DESIGN COMPETITION

……………………………………………………………………..

Project Title: _____Piney Run Tributary Stream Restoration___________________________________

University: ____George Mason University____

Faculty Advisor: ______Matthew Doyle, PE, CCM____

Team Members: _____Grace Morrissey, Romelia Belteton, Nasima Sadr, and Camille Fulton________

Abstract (not to exceed 200 words) – failure to comply to fully detail project description can result in rejection of abstract. Abstracts will be used in marketing materials for the competition.

EXECUTIVE SUMMARY OR IN-PROGRESS REPORT SUBMISSION

WEFTEC® 2021 STUDENT DESIGN COMPETITION

………………

The Executive Summary or In-progress Report will be reviewed by the WEF® SDC Subcommittee to determine placement of each team in the most appropriate competition category. Content included in either the Executive Summary or In-progress Report draft should be sufficient to demonstrate the progress of the team as well as the scope of the project. Page requirements and limits are as follows:

If an Executive Summary is submitted to meet this requirement, it should be no less than 2 pages and no more than 5 pages, including figures.

If an In-progress Report draft is submitted to meet this requirement, it has no page restrictions but should be submitted without appendices. The In-progress report is intended to be a copy of the design report at the time of entry material submission.

Abstract

Fairfax County has hundreds of miles of streams, many of which are in pristine condition. However, due to urban development, several streams have been suffering. Urban development plays a significant role in disturbing hydrologic balance. Impervious surfaces such as rooftops and asphalt roads replace the groundcover and increase surface runoff.

The runoff causes stream channels to erode and become deeper and wider, ultimately disconnecting from their natural flood plain. One such stream suffering from urban development is a small tributary to Piney Run. The tributary is a small section of stream that has had its channel eroded away and is now starting to cause infrastructure and property damage.

To solve this problem, our team will classify the stream using the Rosgen Classification Method, make site visits to assess the geomorphic patterns, and conduct sediment assessments. We will work with Fairfax County to understand their restoration priority and other goals. Using the Natural Channel Design (NCD) method we will develop multiple design alternatives to be screened in a decision matrix. Once the alternatives are screened we will make a recommendation and further develop the alternative to include additional details, permitting, cost, and a construction schedule.

GMU Design Team and Responsibilities

Jonathan Parker: Project Manager - Potential Improvements and Alternatives, Decision Analysis, Recommended Alternative (VWEA Member #: 17987431)

Romelia Belteton: Site visit, Appendices and Conclusion (VWEA Member #: 18040419)

Grace Morrissey: Assessment of Current Facilities, Computations, Site Visit (VWEA Member #: 18024129)

Camille Fulton: Selected Alternative, Construction Constraints, and Construction Methods (VWEA Member #: 18040447)

Nasima Sadr: Site visit, Project Overview, Editor (VWEA Member #: 18040538)

Jenny Eid: Site visit, Computations, Decision Analysis (VWEA Member #: 18040877)

Aivan Estacio: Site visit, Project Schedule, Project Costs, Constraints (VWEA Member #: 18040905)

1.0 Project Overview

1.1 Background and Location

Over the last few decades, there has been a major increase in urban development around the Washington Metropolitan area. As shown in Appendix A, Figure 1, the Piney Run tributary is located in Reston, Virginia and was planned under the Garden City Movement. This movement is a method of urban planning in which the territory has equal parts residential, industrial, and agricultural zone. Although this plan was intended to enable self-contained communities that minimize environmental impacts, it resulted in rapid development which has had various impacts on the hydrological region due to changes in land usage. As the city has developed and more buildings and roads were constructed, the change in surface has resulted in damage to various streams in the area.

One stream in particular that is suffering from this rapid urban development is a tributary of Piney Run. This 1,300-foot tributary serves as an outflow for a 46-acre watershed that has since been developed from temperate deciduous forest into large, single-family home communities. This tributary has faced serious erosion that has disconnected it from its natural floodplain and caused various other issues including widening, root exposure, risk of damage on nearby infrastructure, and even the exposure of sanitary mains.

1.2 Project Overview and Client Goals

The goal of this stream restoration project is to protect the exposed gravity sewer and the trees near the stream, enhance the habitat of diverse wildlife to increase the population, mitigate erosion, and improve the water quality while restoring the stream. Ideally, this project would minimize impact to the surrounding system while working on restoring the stream.

The overall summary of the project goals and objectives considered in this stream restoration and rehabilitation projects include:

- Protect the exposed gravity sewer
- Protect private property from flood
- Protect trees and existing vegetation
- Improve connectivity to the floodplain
- Reduce long term maintenance
- Improve wildlife habitat
- Improve water quality
- Improve aesthetics

2.0 Assessment of Current Facilities

The first step in any stream restoration process is to complete an existing conditions survey. A complete understanding of the stream's form and structure is a key component of the survey and includes a review of its cross-sectional area, pattern, profile, and substrate materials. Once the existing conditions are known, a recommendation plan can be developed. To accomplish an existing survey, both quantitative and qualitative investigations of the stream and the watershed will be conducted.

2.1 Watershed Drainage Area

The project watershed boundary was delineated using geographic information system (GIS) information provided by Fairfax County. The total area of the watershed was found to be around 46 acres. The watershed delineation is provided in Appendix A, Figure 2.

2.2 Land Use Survey

Piney Run is located in an urban residential area and will continue to be in an urban residential area for many years to come. There are no commercial or industrial zones in the watershed and the soil has moderately high runoff potential. With this, the soil is classified as soil group C when calculating the CN. The runoff curve number is calculated to be 88 and the calculations are shown in the Appendix A, Figure 3.

2.3 Dimension

The existing-condition survey was done on March 7th, 2021 by measuring channel dimensions at several cross sections located along the stream, and especially at riffles and pools. Temporary wooden stakes were driven into the ground at the banks as markers for cross-section endpoints. The zero end of a measuring tape was then attached to the stake that is on the left when looking downstream, and tightly stretched above the level of water to the cross-section endpoint. Measurements were then obtained and recorded for the widths and depths at those locations. The stream dimensions were found using the measured average cross-sectional dimensions. The channel was found to have an average width of 10 feet, with an average depth of 6 feet, along the 1,300 foot length of the stream.

2.4 Pattern

The Piney Run Stream has a very low sinuosity of 1.08 (calculation shown in Appendix A, Figure 4). A natural stream should have a sine wave shape to it, however, this stream is very straight. It does not have a distinct pattern. This causes the stream to have a faster velocity because it does not have curves to maneuver around. When restoring the stream, the stream can be shaped to be less straight to slow down the velocity of the water.

2.5 Profile

The existing-condition survey included a longitudinal-profile survey. The importance of generating the profiles lies in determining the depths and slopes of all the stream features, especially at riffles, pools, and runs. The stream has high slopes at many riffle sections, which reach values of 3% and lead to increased velocities. Piney Run Stream, as discussed above, has a low sinuosity, and thus the stream should be restored in a way that considers shaping its pattern sinusoidally and lowers the slope for all stream features.

2.6 Substrate Analysis

The Piney Run soil is classified as marine clay. The bed of the stream has a lot of pebbles, so a quantitative description of the bed material was done by a method of pebble count. The wetted perimeter cross-section substrate analysis method was used. 100 pebbles were collected from the wetted perimeter at normal flow. It was found that the majority of the pebbles were 3 cm long by 2 cm wide. Since the stream has a fast velocity, the sediment transport is high which causes erosion.

2.7 Estimating Discharge and Velocity

The discharge is the volume of water that flows per unit of time. The discharge, Q, during peak flow, through the stream channel's cross section per unit time is calculated using Manning's equation (1) and the associated formulas in Appendix A, Figure 5, and was found to be about 17.68 cubic feet per second.

2.8 Assessing Riparian Condition

The land surrounding the stream consists of private property. There are big trees and a gravity sewer that needs to be protected throughout the stream restoration process. This riparian zone is approximately 50 feet in width on either side of the stream. It should be noted that if the bed of the stream is raised it could flood the backyards around the stream. The gravity sewer, big trees, and floodplains are 3 factors that need to be taken into consideration while restoring the stream.

2.9 HEC-RAS Existing Conditions Model

The stream valley was modeled using the most recent version of the Hydrologic Engineering Center's, River Analysis System (HEC-RAS 5.0.7). This software was selected because this is the software Fairfax County is most familiar with. The GIS shapefiles (contours, stream, structures and parcels) were imported into the software and set the projections to the Virginia State Panel coordinate system. Using the GIS data allowed the team to trace over the steam channel. Each of the eight major cross sections were hand measured and recorded via field measurements and applied to the model. Each cross section was approximately 50 feet wide. From the site visits, the roughness of the stream was classified and the "Manning's n" was found to be 0.035. The sewer crossing was added to the model from field measurements collected from a site visit. Using the hydraulic analysis noted above, the flow data and boundary conditions were added to the model. The model was run under a subcritical flow regime and adjusted to match the existing conditions of the stream. The model showed the aerial sewer crossing was creating a blockage in the natural flow of the stream. At the sewer crossing, the condition changes to rapid varied flow (RVF) as water cascades over the pipe. The cascading water continues to create a larger scour pool under the pipe. Appendix A, Figure 6 shows the RVF over the sewer crossing at Station 04+60.

2.10 Rosgen Stream Classification System

Using the Rosgen Stream Classification, shown in Appendix A, Figure 8, the Piney Run Stream is classified as an F6b. The stream is a single-thread channel, is entrenched, has moderate to high width/depth ratio, moderate sinuosity, and about a 2% slope. These factors classify Piney Run as F6b.

3.0 Evaluation of Potential Areas of Improvement

Based on the clients goals and the existing conditions of the tributary, seven key areas were determined for potential improvement. These potential improvements set the basis for the potential solutions and will later be considered in the decision analysis.

3.1 Protect Gravity Sewer

One of the main considerations made in developing potential solutions was the dire need in protecting an 8” sewer main that has become exposed. During development, the pipe was placed at the stream invert instead of the required 3’ depth. Due to the major erosion the stream has faced, the pipe is now aerial and at very high risk of damage. Damage to this pipe can result in sanitary sewer overflow that would cause widespread exposure and extensive environmental damage.

3.2 Protect Private Property

Due to the close proximity of the tributary to residential neighborhoods, protection of private property is a vital consideration in necessary improvements. In some cases the tributary is within 30 feet of residence. Running nearby the tributary is a trail and bridge that is owned by Reston Association. Avoiding damage to either of these was a concern raised by the client and therefore considered a priority in design. A challenge that became apparent during a site visit was the lack of access for construction vehicles or equipment.

3.3 Protect Tree Vegetation

A major goal set by the Reston Association is to protect the existing vegetation and to minimize future impacts. Due to the stream bed widening and the increased root exposure, many trees are no longer stable and are at risk of collapse. Besides damage done from the widening stream bed, the client has also expressed interest in minimizing impact from any potential solutions proposed. As a desired buffer for the adjoining residential zones and a key component of the highly-trafficked community nature trails, the protection of the old-growth trees is of high importance to the community.

3.4 Improve Connectivity

The major erosion of the tributary has caused incised channelization that continues to face degradation and widening. A potential area of improvement is in connecting the tributary back to the floodplain. This would help prevent continued erosion, mitigate further flood damage, and enable the restoration of wildlife habitat.

3.5 Reduce Long Term Maintenance

A factor in the design was to reduce the need for maintenance. Under current conditions, the need for tree removal, culvert repairs and maintenance, and bridge repairs, has been a significant challenge for the client. The design will aim to reduce the need for such frequent maintenance and provide a more sustainable system.

3.6 Better Habitat for Wildlife

During a site visit, it became apparent that there is a major opportunity to improve the local ecosystem. Currently, the stream experiences massive fluctuations in flow depending on the weather. Without a rain event, the flow is virtually non-existent, and during a rain event, the flow is too fast. Neither of these conditions allow wildlife to thrive. The local ecosystem can be improved by designing a system that allows more stable flow or creates a pool in which aquatic animals can survive.

3.7 Improve Water Quality

The water quality of the tributary is an area with major potential improvements. From any given rain event, the turbidity of the water is significantly increased due to the increased flow rate eroding the channel and suspending clay and silt that is then carried off into Piney Run. This high turbidity not only prevents the stream from being habitable but it also reduces the aesthetic pleasure of the highly frequented trail.

3.8 Improve Aesthetics

Under the existing conditions, the stream banks have suffered erosion which have caused vegetation to be removed and sediment to move downstream. The current conditions of the stream is very poor and has dramatically increased the stream's importance as an aesthetically pleasing backdrop that people can enjoy as they go about their daily business. Trail networks, parks, and open spaces are important in establishing and maintaining the quality of life for a community. And as part of a highly-trafficked trail and bridge network, there is a lot of area for improvement to make the tributary and surrounding area more appealing to the community, thereby improving the overall well-being of the community. Increasing vegetation, improving water quality, establishing wildlife habitats, and protecting, while also hiding, the sewer main, will all aid in restoring the aesthetics of this tributary.

4.0 Potential Solutions and Opportunities

4.1 Alternative #1 - Priority 1 Restoration

Description

The Priority 1 alternative would be to replace the existing incised channel with an entirely new channel. The depth of this new channel is determined by using flow from the existing channel to develop a bankfull stage. By excavating a new channel with the appropriate dimension, pattern, and profile to fit the watershed and valley type, the tributary will be reconnected to the floodplain which raises the water table and restores the wetlands. In adding more curvature to this new channel the rate of slope decline can be decreased thereby reducing the flow rate and preventing future erosion. After construction of the new channel is complete, the old channel is to be filled.

Advantages

The advantages for this alternative includes: protection of the gravity sewer, reconnection of the floodplain, improved wetlands, reduced maintenance, increased water quality, improved habitat for wildlife, and improved aesthetics.

Disadvantages

The largest disadvantage to this alternative is the need for significant space which is unavailable due to the adjacent residential neighborhoods. In addition to the lack of space, this alternative would also require the removal of trees and vegetation which is against the client's goal. Given the old channel would need to be filled, the cut from the proposed channel would not be enough to fill the old channel and would require a significant amount of fill to be brought in. In addition to the cost from fill, this alternative would also require the demolition and reconstruction of the existing paved trail which would drive costs further. Overall, Priority 1 restoration is typically a go-to solution but in this case is not viable due to the aforementioned constraints.

4.2 Alternative #2 - Priority 2 Restoration

Description

The Priority 2 alternative is using the existing channel-bed elevation and lowering the floodplain to a bankfull stage height. While excavating this new floodplain, a new channel can be designed with the appropriate dimension, pattern, and profile to fit the watershed and valley type and be constructed to prevent degradation and widening in the future.

Advantages

The advantages of the Priority 2 alternative includes: reconnection to floodplain, reduced maintenance, and increased water quality.

Disadvantages

Priority 2 does not protect the exposed gravity sewer and would in fact cause further exposure. In addition, it would require major tree and vegetation removal, demolition and reconstruction of the paved trail, and removal of vast amounts of fill.

4.3 Alternative #3 (Priority 3 Restoration)

Description

Similar to Priority 2, Priority 3 restoration aims to use the existing channel-bed elevation. The key difference is that instead of lowering the entire floodplain, Priority 3 would be to excavate a narrow bankfull bench on either side of the channel that would help to reduce the flow.

Advantages

The advantages of the Priority 3 alternative includes: reconnection to floodplain, reduced maintenance, and increased water quality. Additionally, this alternative would require less cut than in Priority 2. This alternative would be more manageable with constraints such as the adjoining neighborhoods.

Disadvantages

Like Priority 2, Priority 3 does not protect the exposed gravity sewer and would in fact cause further exposure. In addition, it would require significant tree and vegetation removal.

4.4 Alternative #4 (Priority 4 Restoration)

Description

Priority 4 restorations utilizes various techniques to armor the existing bank in place. Through the use of riprap, concrete, gabions, or various other structures working in combination, the bank is hardened to prevent further damage.

Advantages

The main advantages of Priority 4 restoration include: streambank stabilization, protection of the sewer main, no impact on existing vegetation, no impact on flooding potential, and reduced maintenance. This alternative, if utilized with other stream restoration methods, can provide various other benefits.

Disadvantages

The main disadvantage to the Priority 4 restoration is that it doesn't completely reconnect the stream to the floodplain. Priority 4 also will not correct any of the problems with the stream dimensions and profile of curvature.

5.0 Decision Analysis

To evaluate which alternative would be best, a Multi-Attribute Decision Model (MADM) will be utilized to examine a Tradeoff Analysis to determine the best possible course of action to address the appropriate project selection. To properly determine the best course of action, criteria have been developed to support interpretation of the key outcomes required to achieve the best solution. Based on such interpretation, criteria were weighed on a scale to accurately represent their importance to the solution.

The team met with engineers from Fairfax County and discussed what should be used for evaluation criteria. Using the team's best engineering judgement, the advice provided by the Fairfax County engineers, and the clients goals for the area, the four potential design solutions were evaluated using a decision matrix to determine the optimal design solution as seen in Appendix B, Table 1. The alternatives were assigned point values (0 = poorest, 5 = best) depending on their effectiveness in solving the particular goal. The sum of the points for each alternative were then calculated, and the highest scoring solution was selected as the recommended alternative.

In creating the MADM, each alternative was given a weight relative to the importance of the goal to the client with the top two scoring categories being protecting the sewer main and protecting the trees which combined, hold a total of 50% of the weight.

6.0 Recommended Alternative

6.1 Selected Alternative

Based upon the Multi-Attribute Decision Model discussed in the previous section, the optimal alternative was found to be a **Priority 4 Restoration** with a score of 4.20**.** This option was chosen as it was the only alternative that can both protect the sewer main and protect the majority of old-growth trees and existing vegetation. Priority 1 restoration was close with a total score of 3.75, but was not selected as it would require the removal of many trees in construction of the new channel.

Upon design of the alternative it was found that to maximize the goals achieved, various restoration techniques could be implemented in conjunction with or in place of an armored bank. The other techniques proposed include:

1. Cross vane created step pools which slow down velocity of the stream during storm events. This technique requires minimal vegetation loss and increases the aesthetics of the stream.

These step pools would also improve wildlife habitat and water quality. Additionally, this technique will reduce the amount of riprap needed.

2. Cut stream side slopes to 45° for riprap installation in areas that step pools are unable to be utilized.

3. Plant trees and vegetation that will help stabilize the stream bed and reduce flow. This measure also increases the aesthetic of the restoration as well as the ecological health of the region.

The proposed site plan can be seen in Appendix A, Figure 17. The proposed design would result in the stream bed to be elevated by an average of 3 feet which would provide roughly 6 inches of cover to the sewer main. The riprap installed on top will provide future protection against erosion that caused the sewer exposure.

6.2 Construction Constraints

Construction constraints determined for the project consisted of an existing bridge, erosion and sediment control, and environmental and social factors. The existing bridge will have to be inspected before proceeding with any construction activity surrounding it. An erosion and sediment control plan will need to be put in place as well because of the amount of erosion expected during the construction process. There are also environmental constraints that include trees that cover large amounts of the land area. Since tree preservation is an important goal of the project, they should not be removed during the construction process. There are some social constraints due to the restoration site's location being near a residential area. Additional potential issues involve coordination with the HOA of the affected residential area and possible public hearings for the project. These factors will also pose difficulty in access, staging, and other construction processes.

6.3 Construction Methods

The construction method for the proposed design will involve accessing the site, transporting materials to the site, and finally conducting excavation to begin construction. The construction site is located in a residential area, so accessing the site will take place using private vehicles to transport the workers and materials needed for construction. With all materials and workers present at the work site, the process of construction can begin. The chosen plan for stream restoration is to raise the channel bed in order to reshape and add materials to prevent possible erosion.

7.0 Other Considerations

7.1 Permits

VDOT Permit: Most of the work will be in the stream valley, however access will be gained from the VDOT right-of-way. A VDOT Land Use Permit Application will be needed.

Virginia Pollutant Discharge Elimination System (VPDES) Permit: Due to the work within and around the stream channel, disturbance can be expected well over one acre of land. The team expects the need for a VPDES Permit for Discharges of Stormwater from a Construction Activities (VAR 10).

Joint Permit Application: A Joint Permit Application (JPA) will be necessary. The JPA is used to apply for permits for work in the waters of the United States (including wetlands) within Virginia. The JPA is also used to apply for corresponding permits from the Virginia Marine Resources Commission, the Virginia Department of Environmental Quality, and/or Local Wetlands Boards.

Fairfax County Land Disturbance Permit: Since the land disturbance for this project is over 1200 sq. ft, a Fairfax County Land Disturbance permit will be necessary. Since the project also includes above ground structures, a County Building permit will be needed.

7.2 Other Considerations

Easements: Since much of the work will be on the Home Owners Association, both temporary and permanent easements from various land owners is expected.

Resource Protection Area (RPA): According to the Fairfax County Digital Map Viewer, an RPA encompasses most of the project area. The RPA's include perennial streams and their associated wetlands, land within 100 feet of these features, and land within a major floodplain whichever is the most landward. In this case the floodplain appears to be the most landward of most the RPA features.

Bypass Pumping of the Stream: A pump-around diversion is a dewatering practice for temporarily pumping flow around segments of the stream channel during construction. This practice involves installing a temporary pump-around system and in-stream barriers to delivery flow around sections or reaches of the stream. Appendix A, Figure 15 is the standard detail for a pump-around diversion design.

Public Outreach: Reston Civil Association is a very involved community and will want to be involved in every phase of this project. Providing virtual community meetings, a website and a project sign is recommended.

Chesapeake Bay Nutrients and Sediment (MS4 Program): This project would comply with the Chesapeake Bay Nutrients and Sediment (MS4 Program). During construction the site stormwater runoff and pollutants would be controlled.

7.3 Opinion of Project Cost

From the interview with Fairfax County engineers working on this project, the estimated capital costs for this project are $1000 per L.F. of the stream, design cost of $350 per L.F. of the stream, and restoration planning cost that are about 10% of the total cost.

RSMeans Online was used to develop a detailed construction cost estimate for the chosen alternative solution of the project as seen in Appendix B Table 2. The cost estimate for alternative #4 are construction costs of $949 per L.F. of the stream, design cost of $285 per L.F. of the stream, and restoration planning cost of about 10% of the total cost.

A value engineering alternative cost proposal was also developed using RSMeans Online in Appendix B Table 3. This cost alternative would save $154 per LF by using concrete shaped into gabions instead of using gabions. The VE cost estimate for alternative #4 includes the construction cost of $795 per L.F. of the stream, the design cost of $238 per L.F. of the stream, and the restoration planning cost of about 10% of the total cost.

7.4 Estimates of Operation and Maintenance Costs

There will only be minimal operation, maintenance, and life cycle cost for the project as the alternative chosen is restoring the stream naturally and this will allow nature to heal and maintain the rest.

It is imperative that the plant density or no excessive loss of trees and/or vegetation is maintained; the design dimensions (Width-Depth Ratio, Bank Height Ratio, and Radius of Curvature) do not increase/decrease by 20% of the as-built dimensions; and the Step-pool structure is maintained during scheduled regular maintenance inspection.

Construction Procurement Methods: The success of a construction project is tied to the proper project delivery method. With this in mind, several construction procurement methods including design-bid-build (DBB), design build (DB), and construction management at risk (CMAR) were evaluated.

Comparing the familiarity of the owner to the procurement methods and evaluating which is most appropriate for the size and type of this project, it is found that DBB is the most common procurement method used by the county, CMAR is also used but mostly for projects over $10 million, and DB is rarely used. Since the Design-Bid-Build method is what the county staff is most familiar with, it will be easier for the county to manage and staff can be more active with the construction administration aspect of the project so the design intentions can be carried throughout construction. DBB will also allow the County to receive competitive bids and separately interact with the designer and the construction contractor. Using the Design-Bid-Build procurement method is recommended for this particular project.

Implementation Plan/Scheduling: Because easements are needed for the construction, a design and permit phase of about 2 years is expected. In addition, a total construction duration of about 1.5 years can also be expected for the scope of this project based on comparison from previous projects of the county engineers.

8.0 Conclusion

Based on in-depth analysis and the utilization of the Multi-Attribute Decision Model, a Priority 4 Restoration would provide the best solution for this particular tributary of Piney Run. The implementation of an armoured bank in conjunction with cross vane created step pools, 45° sidebank slopes, and planting of additional trees and vegetation, would fulfill important aspects of the project goals. Figure 17 in Appendix A displays the aforementioned proposed site plan. These stream restoration measures would provide sewer main protection, public safety, tree and existing vegetation protection, private property protection, reduced long term maintenance, and improve water quality, wildlife habitat, and aesthetics. The proposed solution would resolve each of the problems and fulfill all the clients goals.

List of Appendices

Appendix A - List of Figures

Figure 1 - Project Location

Appendix B - List of Tables

Appendix C - Acknowledgments

Ingrid Davis-Colato, Michael Baker International

Lilantha Tennekoon, Michael Baker International

Shannon Bell, Fairfax County Government

Charles Smith, Fairfax County Government

Matthew Doyle, Fairfax County Government

The team would also like to specifically express our gratitude to Holly Anne Mattel from HRSD for organizing the 2021 VWEA Student Design Competition.

Appendix D - Technical References

Fairfax County Geographical Information System (GIS) Data (17 different layers)

Guidance for Stream Restoration, May 2017, United States Department of Agriculture

Hydraulic Design of Stream Restoration. Sept 2001, US Army Corps of Engineers

Natural Channel Design Dave Rosgen, 2011

Natural Channel Design for River Restoration Dave Rosgen, 2019

Stream Corridor Restoration (National Engineering Handbook 653) United States Department of Agriculture

The Virginia Stream Restoration & Stabilization Best Management Practices Guide Department of Conservation and Recreation 2004

Stream Corridor Restoration, Princeales, Processes and Practices, Federal Interagency Stream Restoration Working Group 1998

Stream Restoration Handbook, North Carolina Stream Restoration Institute

Stream Restoration Design (National Engineering Handbook 654) United States Department of Agriculture

Virginia Erosion and Sediment Control Handbook Third Edition 1992

APPENDIX A - FIGURES

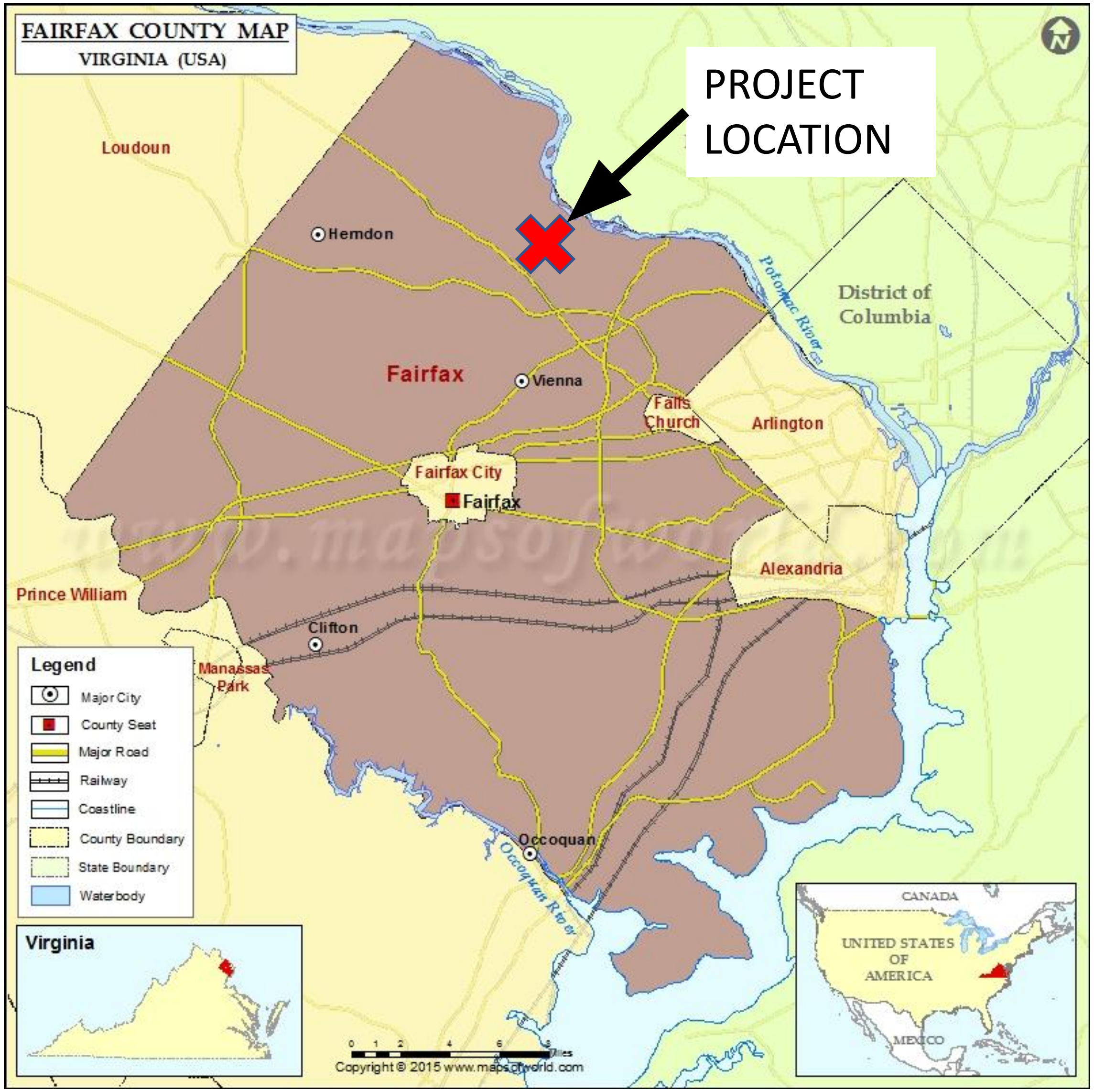

Figure #1
Project Location

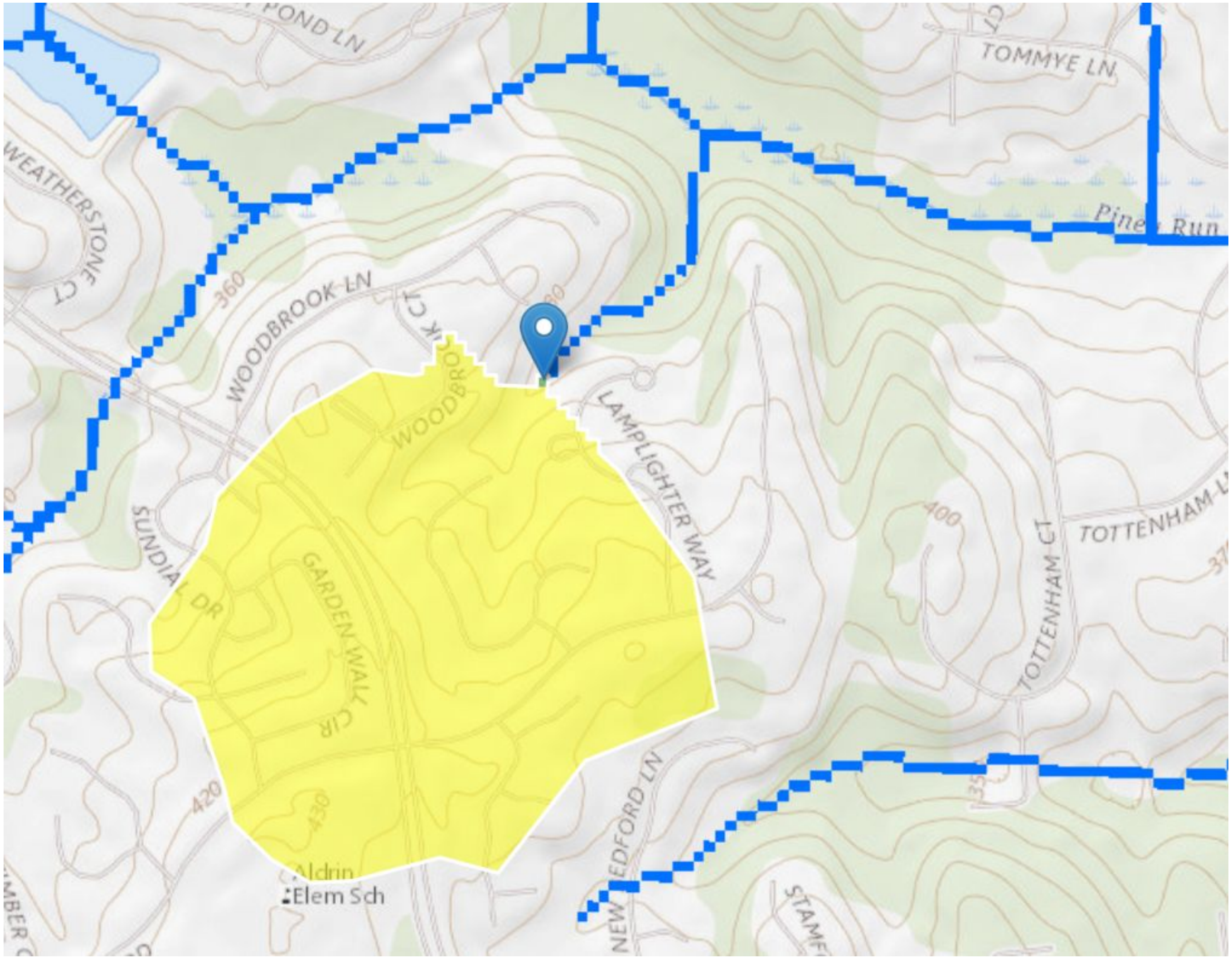

Figure #2
Watershed Delineation

Piney Run Tributary Stream Restoration Reston Virginia
Student Design Competition – Environment Team
Student Activities Committee Virginia Water Environment Association

TR 55 Worksheet 2: Runoff Curve Number and Runoff

Project: Piney Run Stream Restoration Designed By: Grace Morrissey Date: 3/17/2

Location: Reston, VA Checked: Jonathan Parker Date: 3/18/2

Check one: ☐ Present ☐ Developed

1. Runoff curve number (CN)

** Note: Calculations may run a step behind. **
Type in a text field and press "Tab" to update.

Soil name and hydrologic group (Appendix A)	Cover description (Cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN [1/] Table 2-2	Fig. 2-3	Fig. 2-4	Area ▣ acres ☐ mi^2 ☐ %	Product of CN x area
C	Tree Coverage	86			16.0	1,376.0
C	Roof Tops	98			7.6	744.8
C	Grass / Yards	79			15.0	1,185.0
C	Roads / Driveways	98			7.4	725.2
				Totals =	46.0	4,031.0

[1/] Use only one CN source per line.

CN (weighted) = total product / total area = 4,031.0 / 46.0 = 88 Use CN = 88

(If CN is less than 30, further calculations will not be made)

2. Runoff

	Storm #1	Storm #2	Storm #3
Frequency .... years			
Rainfall, P (24 hour) .... in.			
Runoff, Q .... in. (Use P and CN with Table 2-1, Figure 2-1, or equations 2-3 and 2-4.)			

Figure #3
TR-55 CN Worksheet

$$Sinuosity = \frac{channel\ length}{straight\ line\ valley\ length},\ where\ channel\ length = 1300ft\ and\ straight\ line\ valley\ length = 1200ft$$

$$Sinuosity = \frac{1300\ ft}{1200\ ft} = 1.08$$

Figure #4
Sinuosity

$$A = by\ ,where\ b = 10\ and\ y = 0.5$$

$$A = 10 * 0.5 = 5\ ft^2$$

$$WP = b + 2y\ ,where\ b = 10\ and\ y\ = 0.5$$

$$WP = 10 + 2 * 0.5 = 11\ ft$$

$$R = \frac{A}{WP}\ ,where\ A = 5, WP = 11$$

$$R = \frac{5}{11} = 0.45\ ft$$

$$Q = \frac{1.49AR^{\frac{2}{3}}S^{\frac{1}{2}}}{n},\ where\ n = 0.035,\ A = 5, R = 0.45, S = 2\ \%\ or\ 0.02$$

$$Q = \frac{1.49 * 5 * 0.45^{\frac{2}{3}} * 0.02^{\frac{1}{2}}}{0.035} = 17.68\ ft^3/s$$

$$V\ = \frac{Q}{A}\ ,where\ Q = 17.68\ and\ A = 5$$

$$V = \frac{17.68}{5} = 3.54\ ft/s$$

Figure #5
Discharge Cals

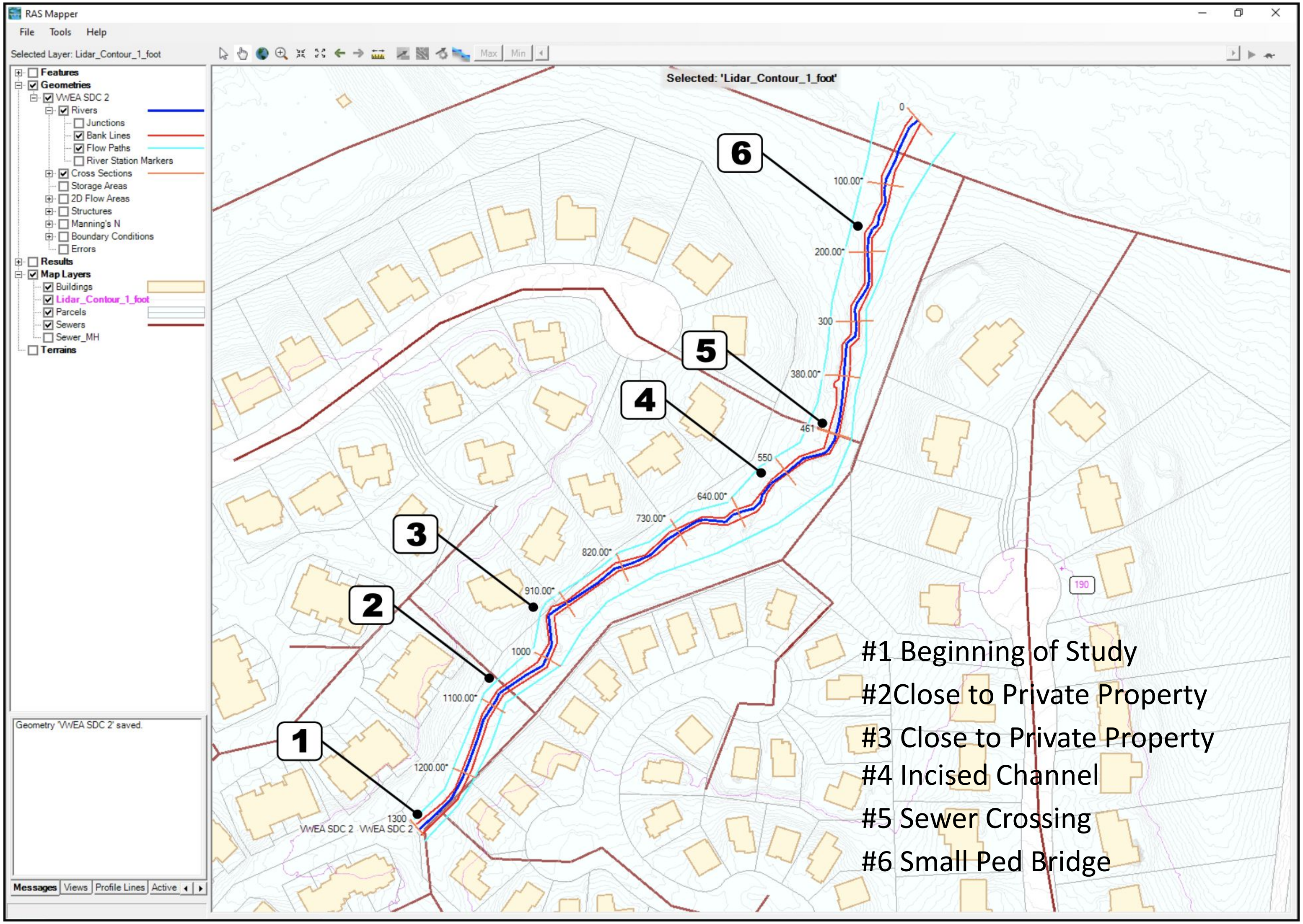

Figure #6 HEC-RAS
MODEL Existing
Conditions Plan

Piney Run Tributary Stream Restoration Reston Virginia
Student Design Competition – Environment Team
Student Activities Committee Virginia Water Environment Association

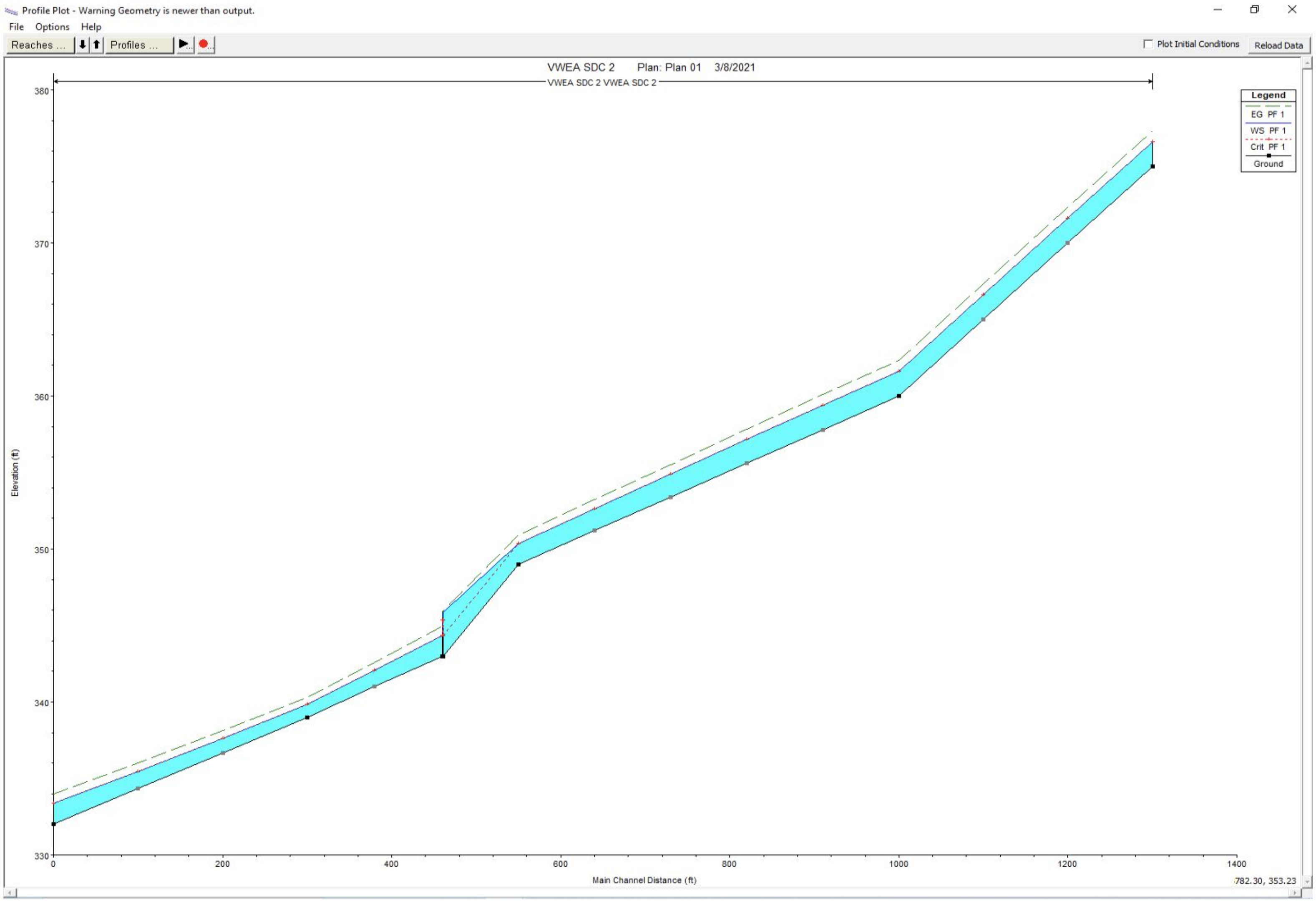

Figure #7 HEC-RAS MODEL Existing Conditions Profile

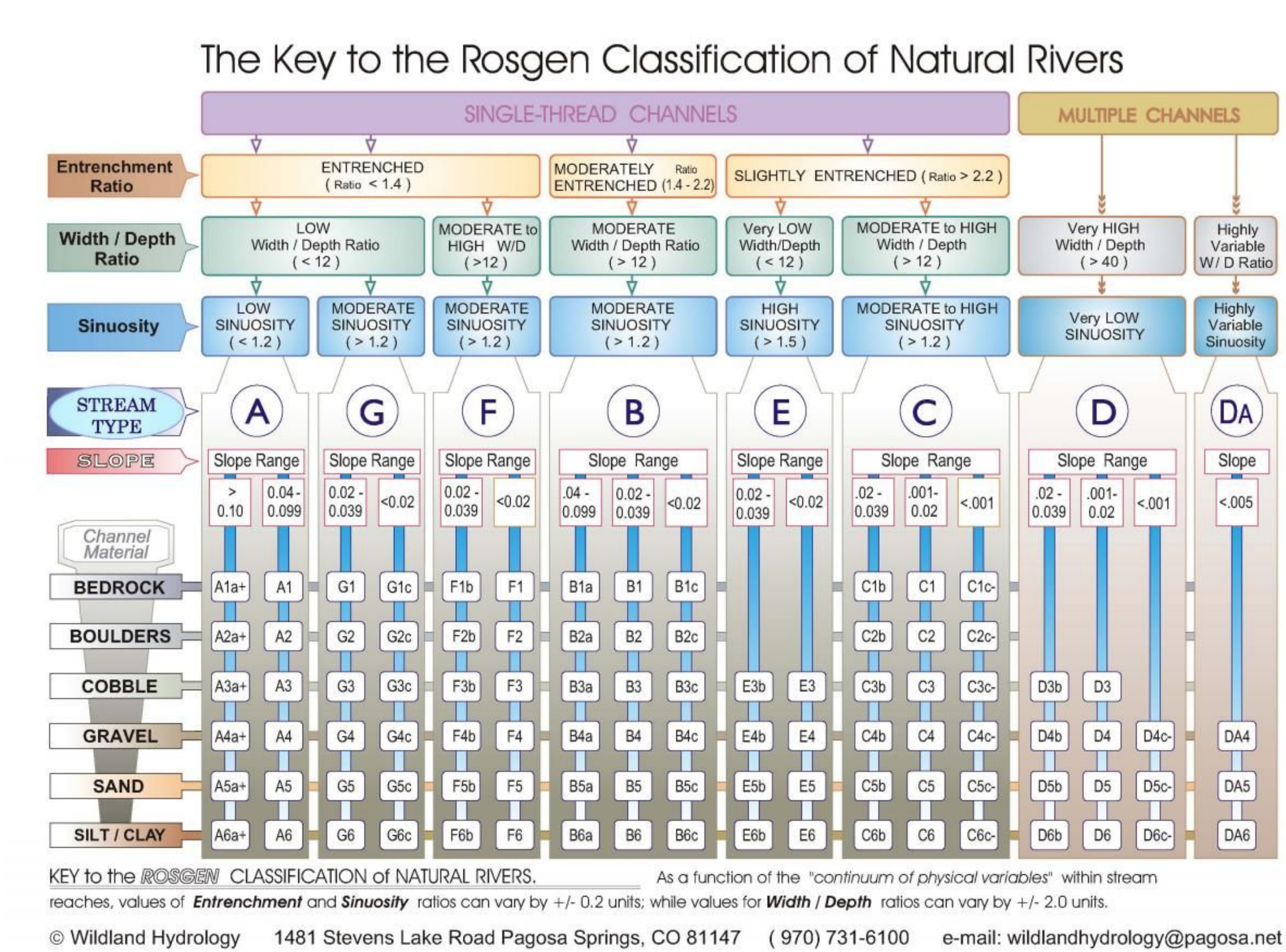

Figure #8
Rosgen Class Chart

Piney Run Tributary Stream Restoration Reston Virginia
Student Design Competition – Environment Team
Student Activities Committee Virginia Water Environment Association

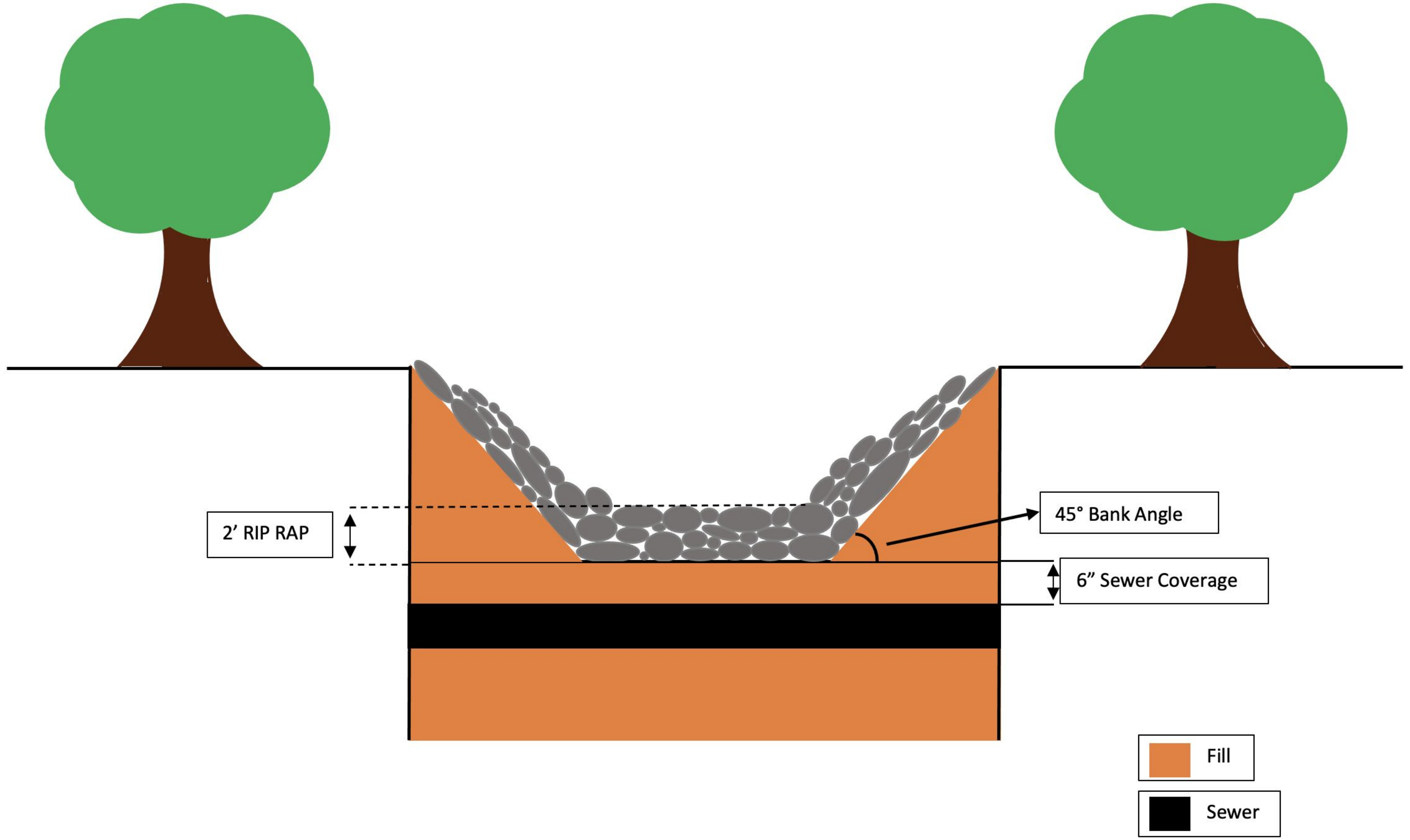

Figure #9 Proposed Conditions Plan

Piney Run Tributary Stream Restoration Reston Virginia
Student Design Competition – Environment Team
Student Activities Committee Virginia Water Environment Association

VWEA
Virginia Water Environment Association

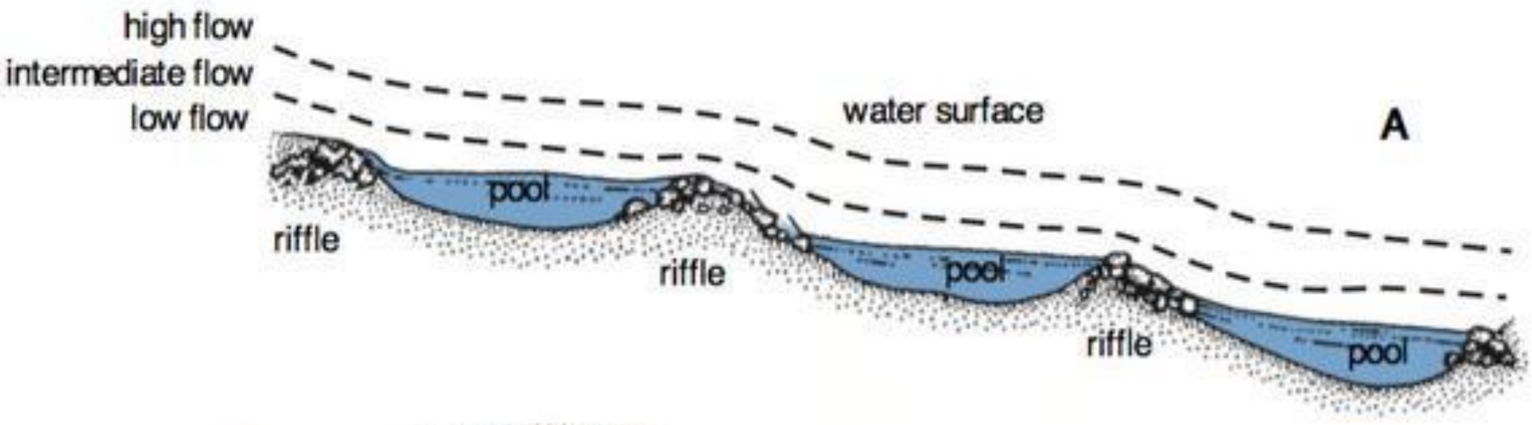

Figure #10
Proposed
Conditions Profile

Piney Run Tributary Stream Restoration Reston Virginia
Student Design Competition – Environment Team
Student Activities Committee Virginia Water Environment Association

VWEA
Virginia Water Environment Association

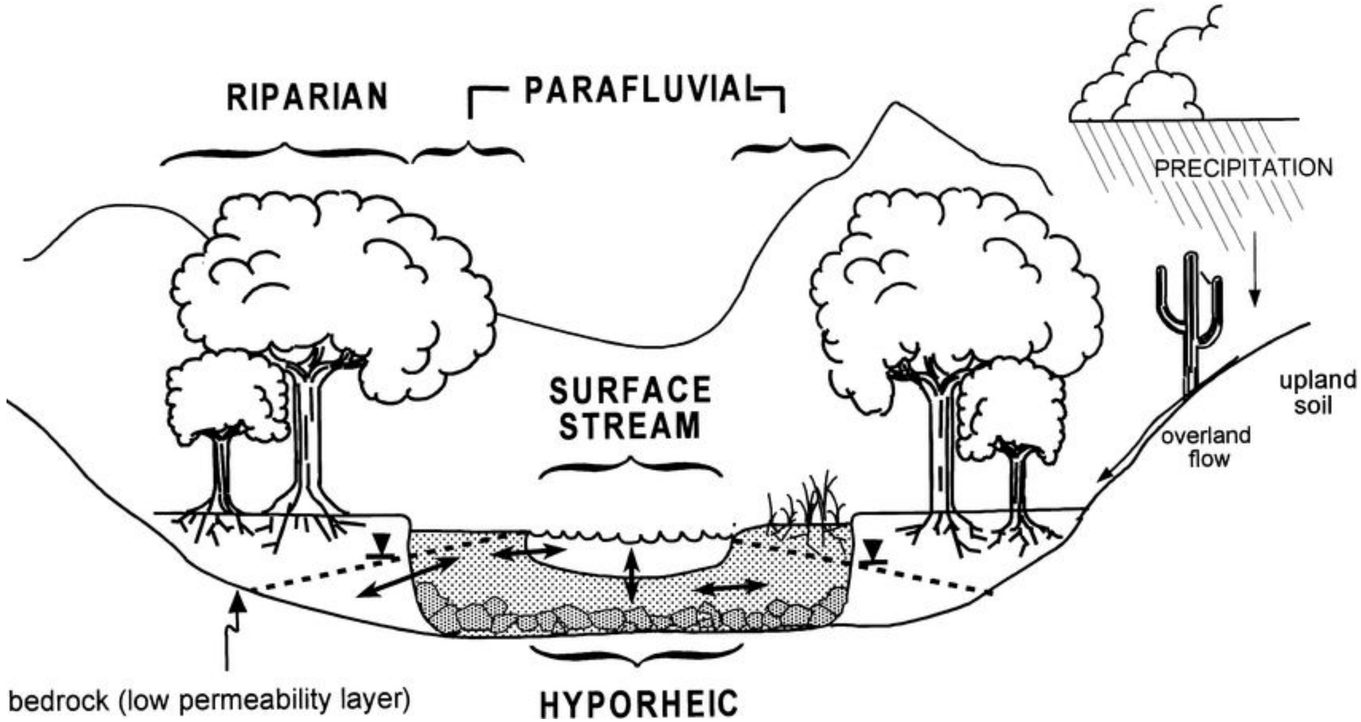

Figure #11 Cross Section Infill

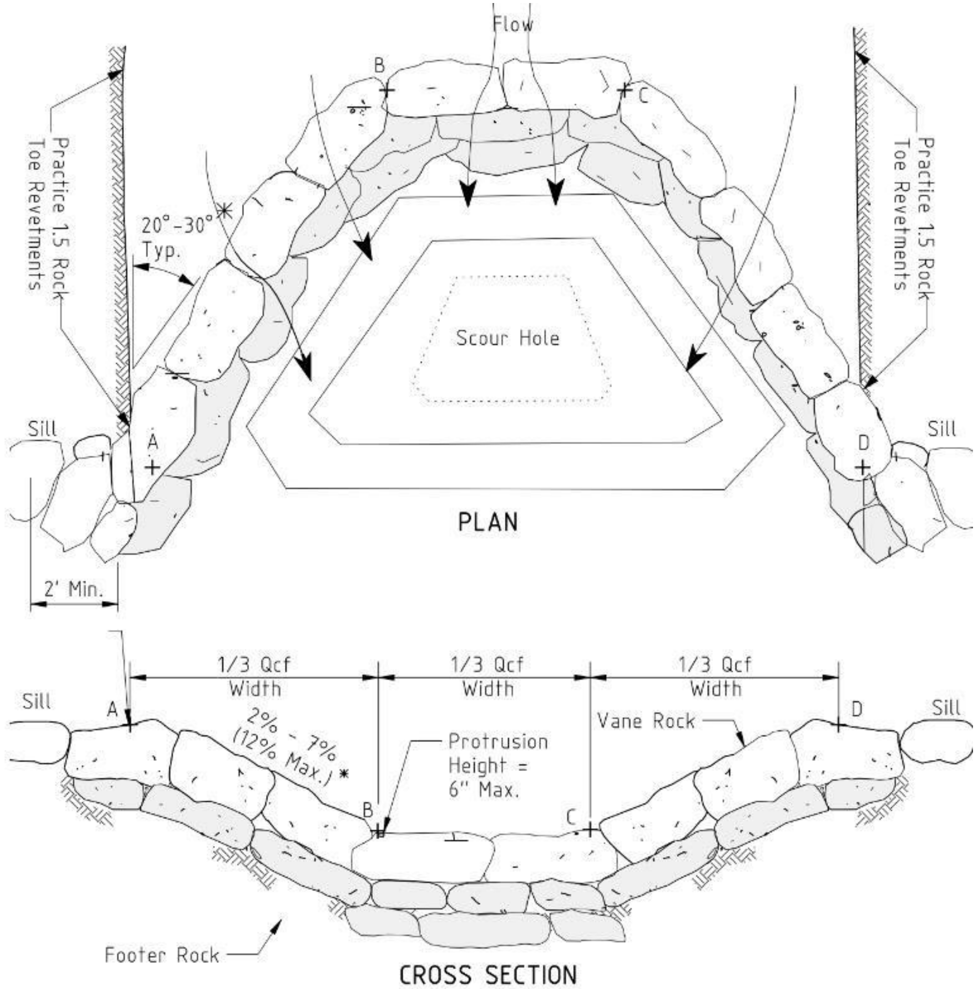

Figure #12 Cross Vane Diagram

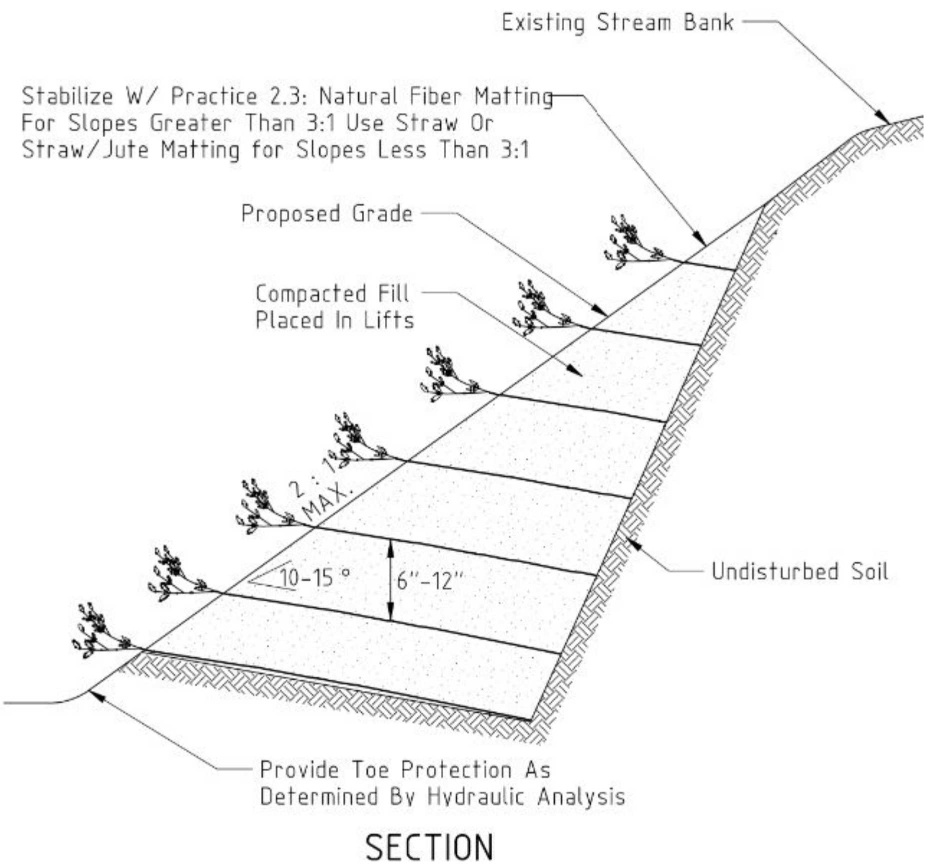

Figure #13 Stream Bank Stabilization
Using Soil

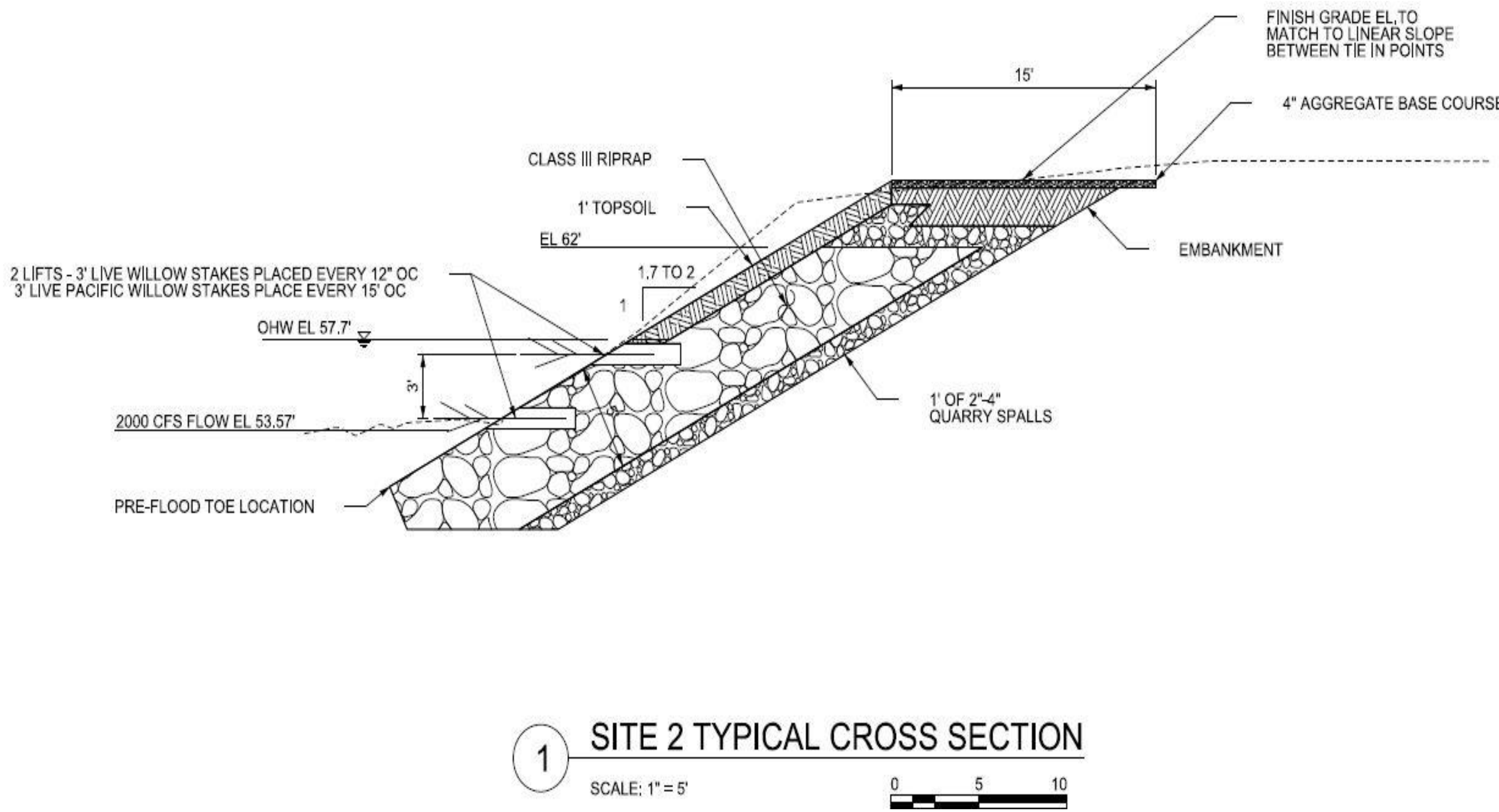

Figure #14 Stream Bank Stabilization
Using RIP RAP

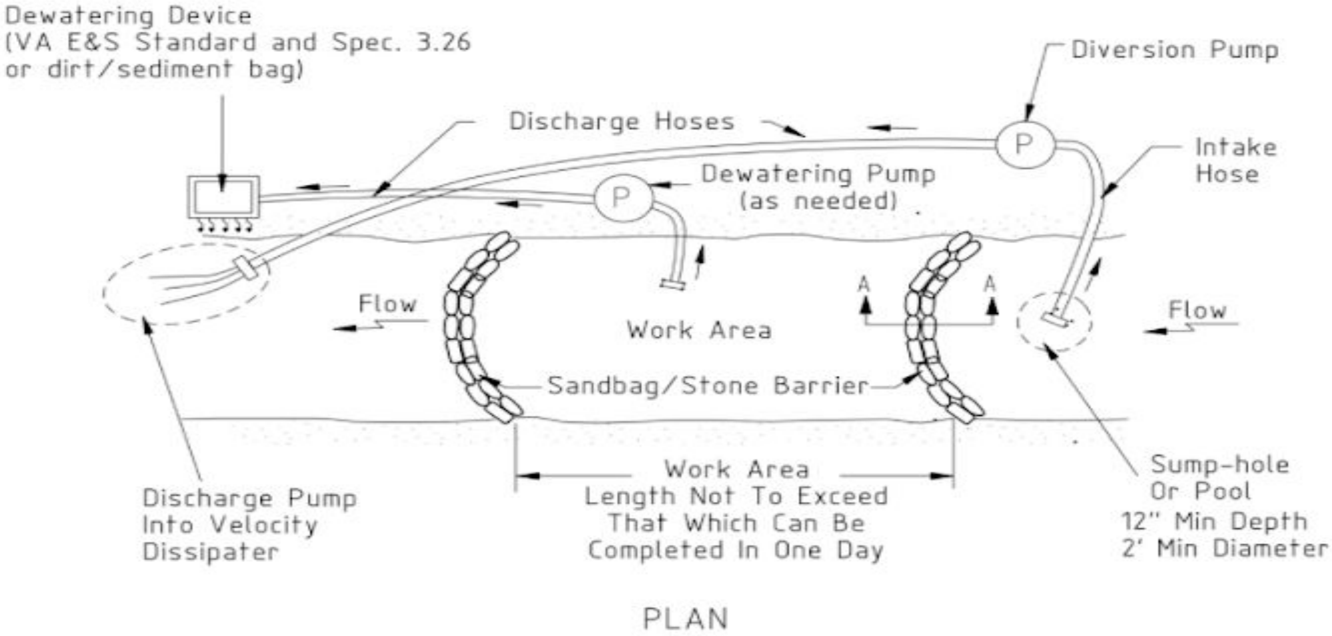

Figure #15
Bypass Pumping of the Stream

ID		Task Name	Duration	Start	Finish	Predecessors
1		Design Phase	370 days	Tue 3/23/21	Mon 8/22/22	
2		Task 1 - General Design Services	250 days	Tue 3/23/21	Mon 3/7/22	
3		Task 2 - Value Engineering	60 days	Tue 3/8/22	Mon 5/30/22	2
4		Task 3 - Bid Phase	60 days	Tue 5/31/22	Mon 8/22/22	3
5						
6		Permit Phase	90 days	Tue 8/23/22	Mon 12/26/22	4,1
7						
8		Construction Phase	355 days	Tue 12/27/22	Mon 5/6/24	6
9		Mobilization	30 days	Tue 12/27/22	Mon 2/6/23	6
10		Erosion and Sediment Control	20 days	Tue 2/7/23	Mon 3/6/23	9
11		Excavation	45 days	Tue 3/7/23	Mon 5/8/23	10
12		Dewatering	20 days	Tue 5/9/23	Mon 6/5/23	11
13		Yard Piping	45 days	Tue 6/6/23	Mon 8/7/23	12
14		Equipment Installation	60 days	Tue 8/8/23	Mon 10/30/23	13
15		Stream Restoration	60 days	Tue 10/31/23	Mon 1/22/24	14
16		Demobilization	15 days	Tue 1/23/24	Mon 2/12/24	15
17		Site Restoration	15 days	Tue 2/13/24	Mon 3/4/24	16
18		Contingency	45 days	Tue 3/5/24	Mon 5/6/24	17

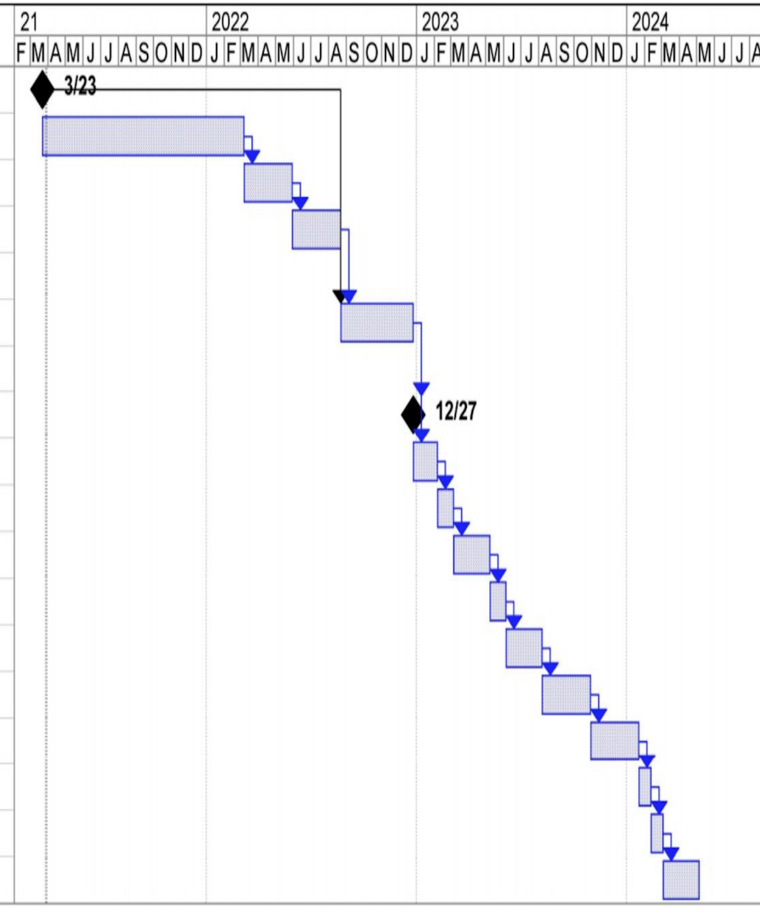

Figure #16
Overall Project Schedule

Piney Run Tributary Stream Restoration Reston Virginia
Student Design Competition – Environment Team
Student Activities Committee Virginia Water Environment Association

Figure #17
Proposed Site Plan

APPENDIX B - TABLES

			Courses of Action							
		Weight	1		2		3		4	
Criteria		1.00	Priority 1 Restoration		Priority 2 Restoration		Priority 3 Restoration		Priority 4 Restoration	
1	Protect the sewer main	0.25	5	1.25	0	0.00	0	0.00	5	1.25
2	Protect the trees	0.25	3	0.75	1	0.25	1	0.25	5	1.25
3	Protect private property	0.10	3	0.30	4	0.40	4	0.40	5	0.50
4	Reconnect floodplain	0.10	5	0.50	5	0.50	5	0.50	0	0.00
5	Reduce maintenance	0.10	3	0.30	3	0.30	3	0.30	4	0.40
6	Improved water quality	0.10	3	0.30	4	0.40	4	0.40	4	0.40
7	Improve wildlife habitat	0.05	3	0.15	2	0.10	2	0.10	4	0.20
8	Improve aesthetics	0.05	4	0.20	2	0.10	2	0.10	4	0.20
		TOTAL		**3.75**		**2.05**		**2.05**		**4.20**
									Best	

Table #1
Multi-Attribute Decision Model (MADM)

ENGINEER'S ESTIMATE FOR LITTLE PINEY RUN TRIBUTARY STREAM RESTORATION

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	MOBILIZATION	1	LS	$70,000.00	$70,000.00
2	CLEARING & GRUBBING INCLUDING MINIMAL TREES	1	ACRE	$20,000.00	$20,000.00
3	TEMPORARY SAFETY FENCE AND TREE PROTECTION	2,600	LF	$5.00	$13,000.00
4	SILT FENCE, SYNTHETIC E&S	2,600	LF	$15.00	$39,000.00
5	TEMPORARY CONSTRUCTION ENTRANCE (WITHOUT WASH RACK)	1	EA	$5,000.00	$5,000.00
6	VEHICLE WASH RACK	1	EA	$400.00	$400.00
7	DEWATERING	3,000	SY	$50.00	$150,000.00
8	2" TOPSOIL	1,500	SY	$10.00	$15,000.00
9	EXCAVATION	3,000	BCY	$12.00	$36,000.00
10	BACKFILL & FILL , 300' HAUL, AIR TAMPED COMPAC	30,000	LCY	$12.00	$360,000.00
11	RIPRAP	5,000	SY	$80.00	$400,000.00
12	GENERAL CONDITIONS	1	EA	$100,000.00	$100,000.00
13	O&P	1	EA	$25,000.00	$25,000.00
	Total Construction Cost				$1,233,400.00
	Design Cost (30% of total construction cost)				$370,020.00
	Restoration planning cost (10% of project cost)				$160,342.00
	TOTAL COST (Rounded)				$1,764,000.00

Table #2
Alternative #4 Costs

Piney Run Tributary Stream Restoration Reston Virginia
Student Design Competition – Environment Team
Student Activities Committee Virginia Water Environment Association

VWEA
Virginia Water Environment Association

ENGINEER'S (VE) ESTIMATE FOR LITTLE PINEY RUN TRIBUTARY STREAM RESTORATION

ITEM NO.	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	AMOUNT
1	MOBILIZATION	1	LS	$70,000.00	$70,000.00
2	CLEARING & GRUBBING INCLUDING MINIMAL TREES	1	ACRE	$20,000.00	$20,000.00
3	TEMPORARY SAFETY FENCE AND TREE PROTECTION	2,600	LF	$5.00	$13,000.00
4	SILT FENCE, SYNTHETIC E&S	2,600	LF	$15.00	$39,000.00
5	TEMPORARY CONSTRUCTION ENTRANCE (WITHOUT WASH RACK)	1	EA	$5,000.00	$5,000.00
6	VEHICLE WASH RACK	1	EA	$400.00	$400.00
7	DEWATERING	3,000	SY	$50.00	$150,000.00
8	2" TOPSOIL	1,500	SY	$10.00	$15,000.00
9	EXCAVATION	3,000	BCY	$12.00	$36,000.00
10	BACKFILL & FILL , 300' HAUL, AIR TAMPED COMPAC	30,000	LCY	$12.00	$360,000.00
11	CONCRETE SHAPED RIPRAP ALTERNATIVE	5,000	SY	$40.00	$200,000.00
12	GENERAL CONDITIONS	1	EA	$100,000.00	$100,000.00
13	O&P	1	EA	$25,000.00	$25,000.00
	Total Construction Cost				$1,033,400.00
	Design Cost (30% of total construction cost)				$310,020.00
	Restoration planning cost (10% of project cost)				$134,342.00
	TOTAL COST (Rounded)				$1,478,000.00

Table #3

Alternative #4 Value Engineering Costs