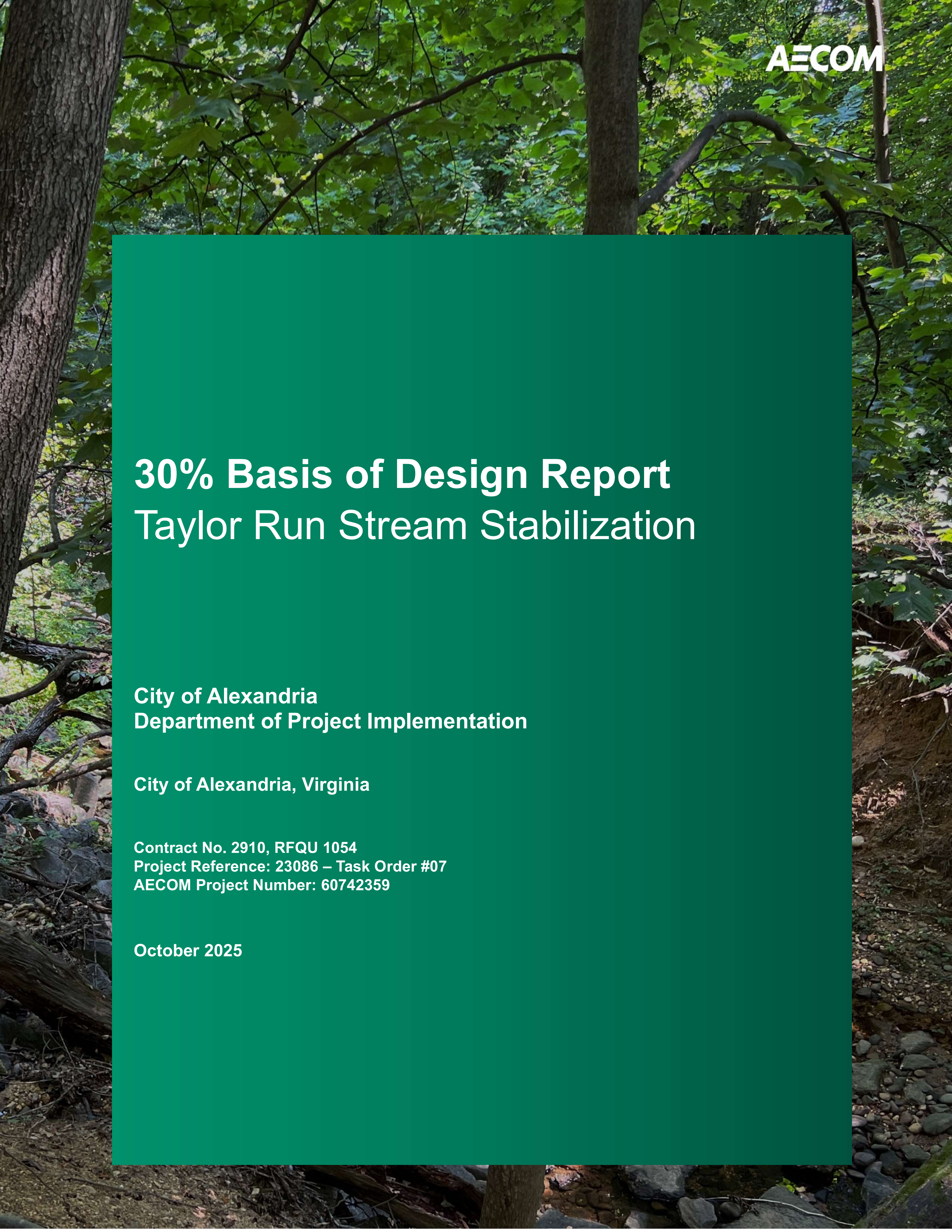

30% Basis of Design Report
Taylor Run Stream Stabilization

City of Alexandria
Department of Project Implementation

City of Alexandria, Virginia

Contract No. 2910, RFQU 1054
Project Reference: 23086 – Task Order #07
AECOM Project Number: 60742359

October 2025

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Executive Summary

The Taylor Run Stream Stabilization Design Project (Project) is located in the City of Alexandira, Virginia. The goal of the project is to implement a 'minimal stabilization' approach to protect at-risk infrastructure and provide stream stabilization along approximately 590 linear feet of non-continuous stream necessary to provide long-term infrastructure protection.

The project has been divided into four distinct areas, each addressing specific infrastructure vulnerabilities:

1. **Upstream Stormwater Outfall:** Currently in disrepair, surrounding stream banks are actively eroding, and outfall discharges into an undersized plunge pool causing excessive bed scour.
2. **Sanitary Sewer Crossing 1 and Stormwater Outfall:** Sanitary sewer crossing is at-risk of structural damage, adjacent stormwater outfall in deteriorating, contributing to eroding stream bed and banks.
3. **Exposed Sanitary Sewer Manhole:** Exposed sanitary sewer manhole is exposed and vulnerable to damage from storm flows or debris.
4. **Sanitary Sewer Crossing 2 and Retaining Wall:** The roots of a large Red Maple tree are exposed, putting the tree at risk of falling, stream bank and bed erosion has exposed an existing sanitary sewer crossing risking structural damage, and a nearby retaining wall is failing due to insufficient embedment depth.

Updated topographic and tree surveys were completed to ensure the most current site data was used in the design process. The project areas were evaluated during site visits, and items of note included erosion undermining trees, destabilizing stream banks, and threatening City infrastructure. Debris blockages occur throughout the stream and consist primarily of woody debris and concrete rubble. Stormwater and sanitary sewer infrastructure, including two stormwater outfalls, two exposed pipe crossings and an exposed sanitary sewer manhole, is susceptible to damage. To proceed with construction, a Nationwide Permit will be required for activities related to maintenance, bank stabilization, and utility line protection.

Taylor Run has a FEMA designated Zone A floodplain, necessitating that proposed solutions do not result in adverse impacts, such as increases downstream water surface elevations. A hydraulic analysis using FEMA effective flows has been completed to establish existing conditions. Proposed conditions will be modeled and submitted for review in future design phases.

Proposed stabilization measures include constructing gravity retaining walls to stabilize stream banks and protect the exposed sanitary infrastructure, replacement of deteriorated outfall headwalls, encasement of exposed sanitary sewer pipes, establishment of a plunge pool to comply with Virginia design standards and install boulder cascades to dissipate energy through the project areas supporting long term stability and reduced project grading extents.

The engineer’s Opinion of Probable Construction Cost (OPCC) at the 30% design phase is approximately $1,598,000. This estimate includes a 30% contingency to account for design uncertainties and a 4.3% escalation factor to reflect anticipated inflation between now and the mid-point to construction.

1 Introduction

The Taylor Run Stream Restoration Project, conducted during 2019–2020 under Task Order No. 22 of Contract No. 0000292, was initiated to stabilize the stream while generating nutrient and sediment reduction credits to support the City of Alexandria’s compliance with Chesapeake Bay cleanup mandates.

Following stakeholder engagement and evaluation of project goals, the decision was made to pursue a more ‘minimal stabilization’ approach, focusing primarily on the protection of at-risk infrastructure rather than broader ecological restoration goals and objectives.

AECOM, in collaboration with the City of Alexandria Department of Project Implementation and Transportation and Environmental Services, has prepared this 30% Design Report to document the development of the Taylor Run Stream Stabilization Design Project. The project focuses on implementing a minimal stabilization approach to protect at-risk infrastructure along Taylor Run. Designs for four key project areas emphasize targeted interventions to address exposed sanitary sewer infrastructure, deteriorating stormwater outfalls, eroding stream bed and banks, exposed critical root zone of a large Red Maple tree, deteriorating retaining wall, and an undersized plunge pool where the stream daylights.

Construction access and site disturbance will be carefully planned to minimize tree impacts and reduce disruption to the surrounding community. This minimal approach was selected over a more extensive stream restoration strategy based on stakeholder input favoring reduced environmental and community impacts.

The report and accompanying design documents outline recommended strategies to provide long-term stability to vulnerable infrastructure, maintain existing systems, and guide further design development and regulatory review.

1.1 Project Site Overview

Taylor Run is within the Mid-Atlantic Region within the Middle Potomac-Anacostia-Occoquan (HUC8: 02070010), Cameron Run-Potomac River (HUC10:0207001003), and Cameron Run (HUC12: 020700100302) watersheds. The stream discharges into Holmes Run, which ultimately flows into the Potomac River and then the Chesapeake Bay.

The project is situated in a developed urban area across two parcels owned by the City of Alexandria. The contributing drainage area encompasses approximately 333 acres of densely developed land. Surrounding the limits of disturbance (LOD) are residential neighborhoods, a community center, a school, open space, and forested buffers. The total watershed imperviousness is estimated at approximately 38%, contributing to increased runoff and deteriorating infrastructure conditions.

Four distinct project areas (**Figure 1**) were identified for necessary stabilization of at-risk infrastructure:

1. **Upstream Stormwater Outfall:** Currently in disrepair, surrounding stream banks are actively eroding, and outfall discharges into an undersized plunge pool causing excessive bed scour.
2. **Sanitary Sewer Crossing 1 and Stormwater Outfall:** Sanitary sewer crossing is at-risk of structural damage, adjacent stormwater outfall in deteriorating, contributing to eroding stream bed and banks.
3. **Exposed Sanitary Sewer Manhole:** Exposed sanitary sewer manhole is exposed and vulnerable to damage from storm flows or debris.
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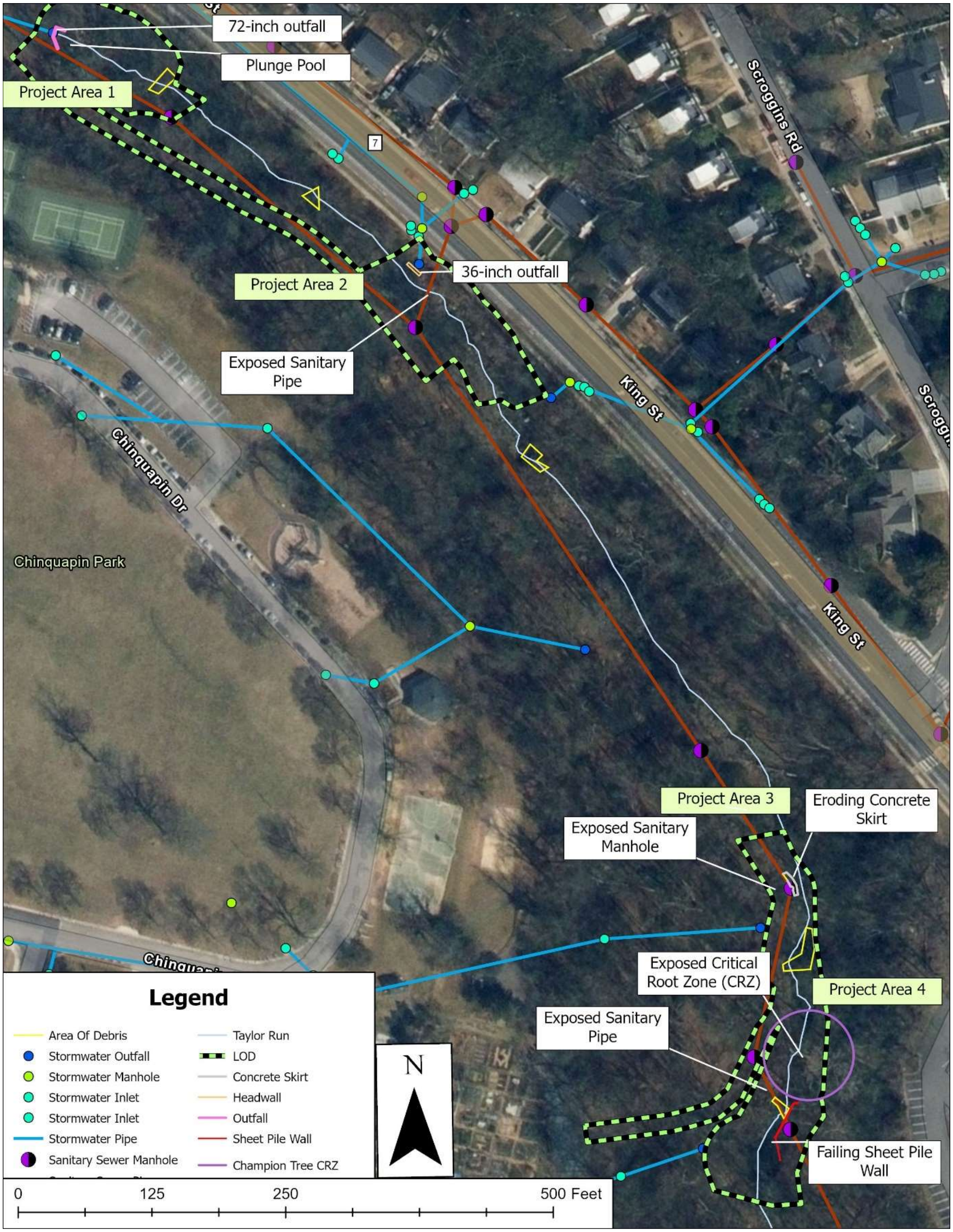


Figure 1: Taylor Run Project Location Map and LOD

1.2 Project Goals and Objectives

The Project is guided by a set of clearly defined goals and supporting objectives. These elements shape the conceptual design and ensure alignment with the City of Alexandria's priorities, as outlined in the Request for Qualifications (RFQ). The goals represent the overarching outcomes the project seeks to achieve, while the objectives define the specific actions and deliverables that support those goals.

1.2.1 Project Goals

The primary goals of the project are to:

1. Protect critical at-risk infrastructure from erosion and damage, including exposed sanitary sewer lines and stormwater outfalls.
2. Preserve and protect ecological features, such as the existing wetlands and mature trees within the park.
3. Stabilize streambanks to reduce excessive sedimentation and improve hydraulic function.
4. Minimize environmental and community impacts during construction and implementation.
5. Ensure cost-effective design and construction, aligned with budgetary and regulatory requirements.

1.2.2 Project Objectives

To achieve these goals, the project will:

- Develop fully engineered plans that meet all applicable regulatory and technical standards.
- Ensure design and construction costs remain within the awarded budget, maintaining fiscal responsibility throughout the project lifecycle.
- Create a phased construction plan that minimizes disruption to surrounding residential neighborhoods, schools, and public spaces.
- Design with minimal limits of disturbance, including access routes, to reduce vegetation removal and preserve site integrity.
- Implement stabilization measures that provide long-term protection for exposed infrastructure and sensitive ecological features.

The final design will deliver a balanced and sustainable solution that stabilizes the hydraulic function of Taylor Run, protects vulnerable infrastructure, and preserves the ecological integrity of the site. These goals and objectives collectively support the City's environmental, fiscal, and community engagement priorities.

2 Data Collection and Review

2.1 Topographic Survey and LiDAR

AECOM conducted a detailed topographic survey of approximately 1,450 linear feet of stream within an approximate 1.84-acre investigation area. The survey data was processed using Autodesk Civil 3D to generate 1-foot contour intervals, providing a high-resolution representation of existing site conditions.

The horizontal datum used for the survey is the Virginia State Plane Coordinate System (NAD83) in U.S. Survey Feet, and the vertical datum is the North American Vertical Datum of 1988 (NAVD88), also in U.S. Survey Feet.

To supplement the field-collected data and support the Hydrologic and Hydraulic (H&H) analysis, previously surveyed data from 2019 and Light Detection and Ranging (LiDAR) data was obtained from the U.S. Geological Survey (USGS). This additional data provided broader topographic context and enhanced the accuracy of watershed delineation and hydraulic modeling.

2.2 Soils

To characterize the soil conditions within the Project and contributing watershed, AECOM utilized data from the NRCS Web Soil Survey, developed by the U.S. Department of Agriculture Natural Resources Conservation Service (USDA NRCS).

Within the immediate project area, the dominant soil type is the Sassafras-Neabsco complex, which accounts for 100% of the surveyed area. These soils are typically well-drained and are commonly found on slopes, shoulders, and summits of marine terraces, making them suitable for stabilization efforts with minimal concern for poor drainage or high runoff.

To evaluate the broader drainage area, soils were classified into Hydrologic Soil Groups (HSGs), which provide an index of runoff potential based on infiltration characteristics:

- Group A soils (e.g., sand, loamy sand, sandy loam) have low runoff potential and high infiltration rates.
- Group D soils (e.g., clay, clay loam, silty clay) have high runoff potential and low infiltration rates.

The Taylor Run watershed is predominantly composed of Group B soils, which have moderate infiltration rates and low runoff potential, indicating favorable conditions for infiltration and reduced stormwater impacts.

The percent composition for each hydrologic soil group within the drainage basin is summarized in **Table 1** below. The results show that soils within the Project area are predominantly classified as hydrologic soil group B, or soils with a low runoff potential.

Table 1: Project Watershed Hydrologic Soil Group Summary

Percent Composition (%)			
HSG A	**HSG B**	**HSG C**	**HSG D**
0%	99.8%	0.2%	0%

This soil composition supports the selection of a ‘minimal stabilization’ approach, as the low runoff potential reduces the likelihood of severe erosive flows, allowing for targeted interventions focused on infrastructure protection and streambank stability.

2.3 FEMA Effective Data

Taylor Run is designated as a regulatory Zone AE stream, originally studied as part of the Cameron Run watershed analysis conducted by the Federal Emergency Management Agency (FEMA) in 2014. The most recent FEMA Flood Insurance Study (FIS) for the area was published on January 11, 2024, incorporating updated hydrologic and hydraulic data.

To support the design and regulatory compliance of the Project, a comprehensive hydrologic and hydraulic (H&H) assessment was performed. The hydrologic analysis was conducted using the U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Center – Hydrologic Modeling System (HEC-HMS) version 3.1.1, while the hydraulic modeling was completed using HEC-River Analysis System (HEC-RAS) version 3.1.1.

As part of the 2024 FIS update, flood hazard boundaries were re-delineated in 2020, reflecting changes in land use, hydrology, and topography. These updates are critical to ensure that proposed stabilization measures do not result in adverse impacts, such as increased water surface elevations downstream.

The effective Flood Insurance Rate Map (FIRM), illustrating the Taylor Run floodplain and regulatory boundaries, is provided in **Figure 2**.

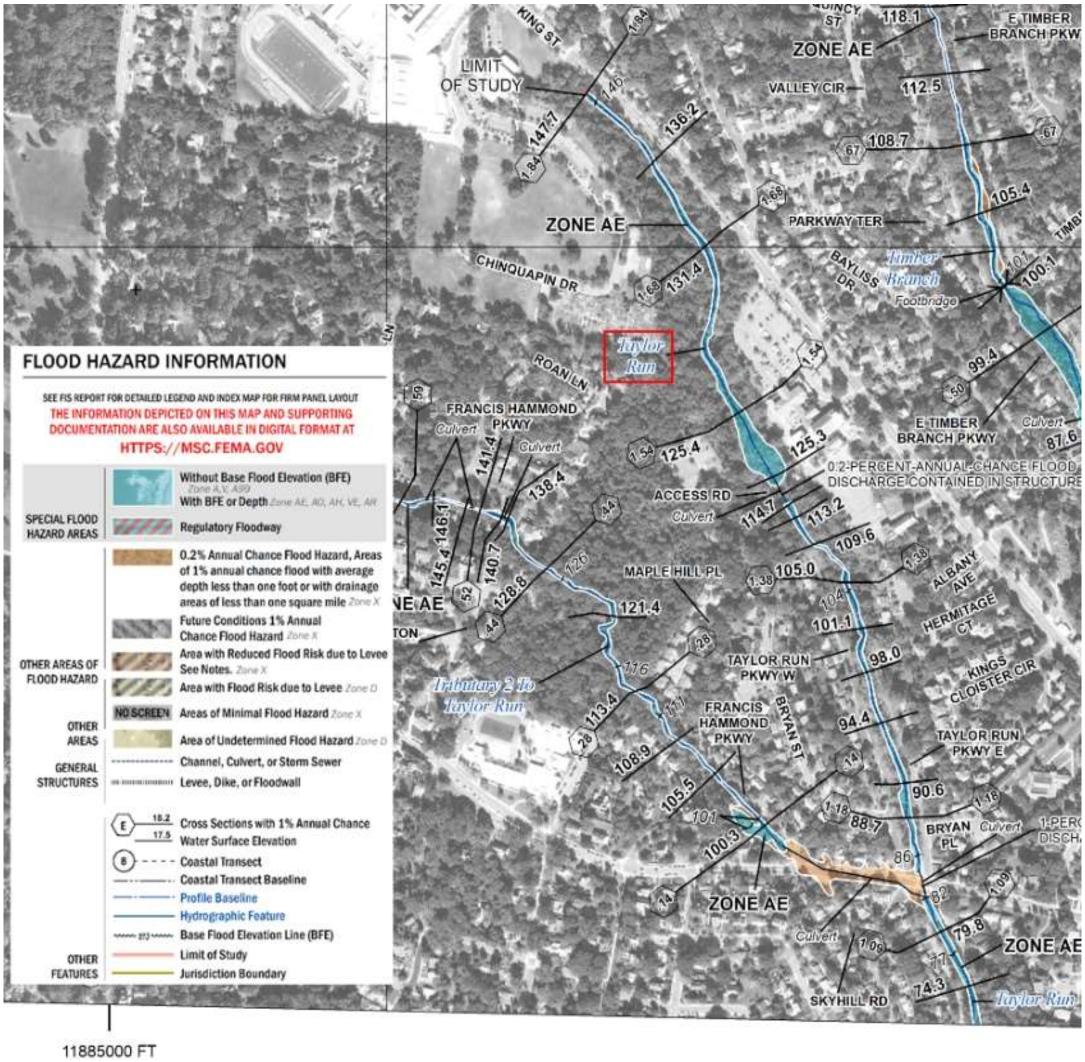


Figure 2: Effective FIRM of Taylor Run

2.4 Tree Inventory

Between May and July 2025, AECOM conducted field investigations to update and verify the existing tree inventory within the Project. The purpose of this effort was to identify any changes since the previous survey, including trees that had grown to significant size, fallen or died, and to ensure accurate documentation of current site conditions.

During the field survey, AECOM confirmed species identification, diameter at breast height (DBH) measurements, and health conditions of existing trees. Any new trees with a DBH of 12 inches or greater that were not included in the previous inventory were assigned unique identification numbers and geolocated using GPS technology.

A total of 749 trees were documented, of which 629 (approximately 84%) were living and 120 (approximately 16%) were dead. The most common species was Red Maple, with 152 trees recorded — 145 living and 7 dead. Other dominant species included Tuliptree (123 trees), Black Locust (80 trees), and Slippery Elm (54 trees), all of which contribute significantly to the canopy cover and ecological function of the stream corridor.

While the overall health of the tree population appears stable, certain species exhibited higher mortality rates. Notably, Black Locust had a mortality rate of approximately 32.5%. Additionally, 63 trees were classified as either Unknown Snag (24) or Unknown Tree (39), all of which were dead and in too poor of a condition to accurately identify. Although they may be outside the removal areas of any project impacts these trees may pose safety risks to the public while using the park and future considerations should be made to investigate if removal of these trees would improve park safety.

The inventory reflects a high diversity of tree species, with over 40 distinct types identified. This diversity enhances the ecological resilience of the area and contributes to the overall environmental value of the stream corridor.

The updated tree inventory provides critical data to inform design decisions, particularly in minimizing vegetation disturbance and protecting significant ecological features. Results from the survey are summarized in **Table 2** and further discussed in the Tree Inventory Memo (**Appendix A**).

Table 2: Tree Inventory Summary

Tree Type (Common Name)	Number of Trees	Status (Living | Dead)
American Beech	3	3 | 0
American Elm	31	30 | 1
American Holly	4	4 | 0
American Sycamore	4	4 | 0
Black Cherry	56	51 | 5
Black Locust	80	54 | 26
Black Oak	1	1 | 0
Black Walnut	10	10 | 0
Black gum	9	9 | 0
Boxelder	3	3 | 0
Chestnut Oak	6	6 | 0
Common Hackberry	1	1 | 0
Common Persimmon	3	3 | 0
Eastern Cottonwood	2	2 | 0

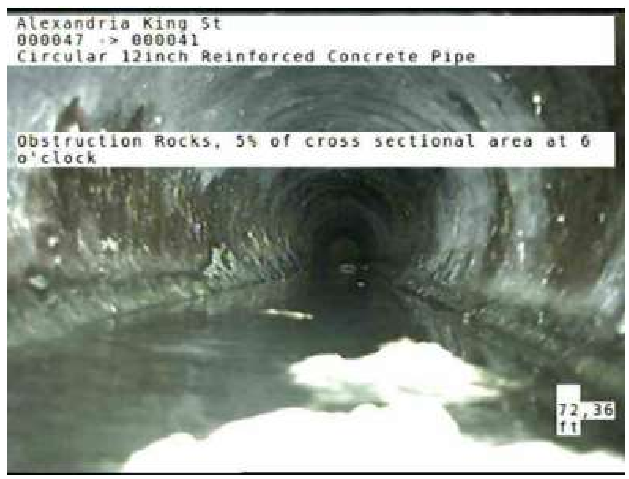
Tree Type (Common Name)	Number of Trees	Status (Living | Dead)
Green Ash	10	10 | 0
Hickory Species	2	2 | 0
Honey locust	1	1 | 0
Littleleaf Linden	1	1 | 0
Mimosa	1	1 | 0
Norway Maple	5	5 | 0
Pin Oak	1	1 | 0
Red Maple	152	145 | 7
Red Mulberry	2	1 | 1
Royal Paulownia	4	4 | 0
Sassafras	14	12 | 2
Scarlet Oak	1	1 | 0
Silver Maple	27	27 | 0
Slippery Elm	54	54 | 0
Southern Red Oak	3	3 | 0
Sugar Maple	2	2 | 0
Sweet Cherry	3	2 | 1
Sweet Gum	3	3 | 0
Tree of Heaven	25	21 | 4
Tuliptree	123	117 | 6
Unknown Snag	24	0 | 24
Unknown Tree	39	0 | 39
Virginia Pine	2	2 | 0
While Mulberry	25	25 | 0

Tree Type (Common Name)	Number of Trees	Status (Living | Dead)
White Oak	10	7 | 3
Willow Oak	2	1 | 1
Total	**749**	**629 | 120**

2.5 CCTV Condition Assessment

In July 2025 AECOM performed a CCTV inspection of the exposed sanitary sewer crossings in Project Area 2 and 4. Closed circuit video recording equipment was utilized to inspect the interior condition and generally, both pipe sections are in fair condition. The 12-inch, circular Reinforced Concrete Pipe (RCP) sanitary sewage pipe in Project Area 2 was assessed for approximately 97 linear feet between manhole ID 00047 and ID 00041. Sediment and rocks were present throughout the pipe and light cleaning is recommended. Observations of note include delaminating and discoloration of lining feature, and surface damage from spalling.

Spalling damage of pipe surface



Sediment and rock obstructions and discoloration of pipe lining.

The 18-inch circular cast iron sanitary sewage pipe in Project Area 4 was assessed for approximately 67 linear feet from manhole ID 007531 to ID 006571. There was evidence of a crown repair within the first foot of the upstream manhole (007531). The area shows minor deformation but there was no active infiltration observed during investigation. Additionally, medium joint separation and surface damage corrosion were noted. The CCTV Inspection reports can be found in **Appendix B**.

Point repair of pipe crown but has slight deformation

Pipe joint separation

2.6 Geotechnical Investigation

Between September and October 2025, AECOM conducted a geotechnical subsurface investigation. Four geotechnical soil borings were collected using the Standard Penetration Test (SPT). The surface fill (extending approximately 6 feet deep) is characterized as medium stiff to sandy clay and sandy silt with varying amounts of gravel. The underlying native soil (extending the maximum depth of the borings of 45 feet deep), consists of predominantly medium stiff to very stiff Potomac clay and thin embedded layers of well-graded sands. Very stiff Potomac clay soils are known to be susceptible to slope instability issues and are also known to have high shrink-swell properties. Collected materials from the borings were sent for laboratory testing to define material properties. Refer to **Appendix C** for the Geotechnical Investigation Memo.

3 Existing Stream Assessment

In May and August 2025, AECOM stream specialists conducted field investigations along approximately 1,500 linear feet of Taylor Run, with a focused assessment of approximately 590 linear feet within the four designated project areas. The purpose of these investigations was to evaluate previously identified impairments and determine appropriate minimal stabilization remedies for each area. Photographs documenting existing site conditions and photo descriptions can be found in **Appendix D.**

3.1 Project Area Descriptions

Four distinct project areas were identified for stabilization along Taylor Run. For clarity and consistency, each area has been assigned a unique identifier (Project Areas 1–4), ordered sequentially from upstream to downstream. The total stream length within these areas is summarized in **Table 3**.

Table 3: Project Area Name and Lengths

	Length (ft)
Project Area 1	129
Project Area 2	130
Project Area 3	70
Project Area 4	260
Total Length	589

3.1.1 Project Area 1

Project Area 1 originates from a 72-inch reinforced concrete pipe (RCP) outfall that conveys flow from Chinquapin Park, Alexandria City High School, surrounding residential neighborhoods, and a portion of Braddock Road.

Bank erosion has undermined many trees along the streambank slopes, causing them to fall into the channel and producing debris blockages. Evidence of stream head cut was noted next to the outfall right wingwall (looking upstream) where a gully has developed, contributing to the outfall being unstable. The plunge pool does not meet the most recent Virginia Department of Transportation (VDOT) standards. Large concrete debris was observed in the plunge pool and the immediate downstream section of stream.

Recently downed trees on the left bank, immediately downstream of the outfall

Debris accumulation obstructing flow downstream of the outfall

Erosion observed behind the right wingwall of the outfall (viewed looking upstream)

Deteriorating outfall and concrete debris in plunge pool

3.1.2 Project Area 2

Project Area 2 originates approximately 290 linear feet downstream of Project Area 1. Vertical and lateral erosion has lowered the streambed elevation, exposing an existing sanitary sewer putting the existing City infrastructure at-risk of damage. The exposed sanitary sewer line has no concrete encasement and acts as an inline weir for the upstream plunge pool. The exterior of the sewer line is undamaged, but with no concrete encasement it is susceptible to damage as debris has already accumulated on the crossing from fallen limbs and trees. Refer to **Section 2.5** for details on interior conditions.

Immediately downstream of the rock cascade, the left bank shows signs of significant erosion, including raw, vertical banks that exceed 6 feet in height. Lateral erosion of the left bank has exposed a dense clay layer and tree roots, which will cause the trees to fall into the channel and produce debris blockages. The erosion extends upstream where a 36-inch RCP outfall has an approximate 18-inch undercut that is eroding the headwall. Construction of the gravity wall may be more difficult where it intersects with dense clay layer. Extensive concrete and woody debris were noted in the channel, contributing to the development of mid-channel bars, increasing near bank stress and accelerating stream bank erosion rates.

Exposed sanitary sewer line vulnerable to erosion and structural damage

Severely eroded streambank with visible tree root exposure


36-inch stormwater outfall showing significant undercutting and headwall deterioration


Accumulation of woody debris contributing to channel instability and bank erosion

3.1.3 Project Area 3

Project Area 3 originates approximately 520 feet downstream of Project Area 2. On the right stream bank there is an exposed sanitary sewer manhole that sits on a concrete skirt. The concrete skirt has an undercut of approximately 24 inches. A large accumulation of woody debris in the channel has contributed to channel migration, bank stress and erosion which can cause root erosion and more trees to fall into the channel and compromise the park's trail network as a portion of the trail has collapsed into the stream.


Exposed sanitary sewer manhole with undercut concrete base, indicating potential structural vulnerability


Significant accumulation of woody debris contributing to channel migration and increased streambank erosion

3.1.4 Project Area 4

Project Area 4 originates approximately 25 feet downstream of the large accumulation of woody debris within Project Area 3. An undercut on the left bank has exposed the root mass of a large Red Maple tree putting it at risk of falling. Mid-channel bars are evident as the main flow path has migrated directly under the exposed roots.

Exposed sanitary pipe adjacent to a deteriorating sheet pile wall (left), with a riprap-lined channel bank providing erosion control on the right.

Directly downstream, the existing sheet pile retaining wall is failing from erosion and hydrostatic pressure. A sanitary sewer manhole behind the sheet pile wall risks damage once the wall collapses. The distance of the center of the manhole to the top of the wall is approximately 3 feet and the edge of the manhole is approximately 10 inches. The exposed sewer pipe crossing the channel has no concrete encasement, making it susceptible to damage. The exterior of the sanitary sewer pipe is intact and has accumulated leafy and woody debris behind the structure, acting as a channel blockage. Refer to **Section 2.5** for details on interior conditions.

Sanitary sewer manhole behind failing sheet pile wall

Lateral and vertical erosion of the channel banks is evident, exposing tree roots, causing them to fall into the channel and producing debris. There is evidence of bank stabilization efforts on the right bank, downstream of the sanitary sewer pipe.

3.2 Permitting Considerations

For wetlands and streams, the project is expected to meet the General and Regional Conditions of the U.S. Army Corps of Engineers (USACE)

- Nationwide Permit (NWP) 3 for maintenance,
- NWP 13 for bank stabilization, and/or
- NWP 58 for utility line activities for water and other substances under the Clean Water Act Section 404 and Section 401 authorization

Exposed roots of large Red Maple tree, looking upstream

A wetland/stream permitting analysis upon additional design milestones will be completed prior to permit application or pre-construction notification preparation. The NWP, among others', effective date ends March 14, 2026. There is often a one-year extension if the project is "under construction" but that is at the pleasure of USACE to authorize. New NWPs often have a period of validity under which the 401 conditions are not yet authorized, and 401 authorization is not guaranteed. If there are no applicable NWPs or 401 conditional authorization, individual coverage is often required. The regulatory bodies, such as the USACE are compelled to permit a project under the least burdensome permit for the applicant, i.e. the project proponent cannot compel the agency to initiate an individual permit when an NWP is appropriate, even when the expiration of the NWP draws near.

The USACE has replaced the Virginia Marine Resources Commission as the central clearinghouse for all Virginia wetland and stream permitting. Effective, September 2, 2025, the USACE new Regulatory Request System (RSS) or RSS portal is currently voluntary to use but will become the mandatory submittal mechanism before the end of 2025. The RSS is used to request pre-applications, jurisdictional determinations, pre-construction notifications, and permit applications (including VDEQ permits). The new system does not appear to allow these requests concurrently, nor does it allow an applicant to review the draft submittal for upload ahead of submittal. Therefore, increased communication ahead of any RSS submittal is likely required as the USACE and applicants/agent work through the new system.

4 Hydrology and Hydraulics

Effective FEMA hydrologic flows at Janneys Lane were utilized for the 10-, and 100-year, 24-hour storm events. As FEMA does not produce 1-, and 2-year flows, AECOM used flows calculated from HEC-HMS from the 2020 *Taylor Run Stream Restoration* project. The hydrologic analysis was performed by Wetland Studies and Solutions, Inc. Flows to be applied are provided in **Table 4**.

Table 4: Existing Conditions Peak Discharge at Outlet Point of Project Area

Scenario	Peak Discharge (cfs)
1-year	166
2-year	225
10-year	343
100-year	672

A previously completed one-dimensional Hydrologic Engineering Center River Analysis System (HEC-RAS) model from Task Order No 22 was reviewed and updated with recent survey data (Refer to **Section 2.1**). The existing conditions hydraulic analysis was performed to analyze changes in water surface elevations and shear stresses for the 2-, 10-, and 100-year storms using HEC River Analysis System (RAS) version 6.3.1. One-dimensional steady-state models were developed.

The HEC-RAS model includes areas outside of our Project. Stations 2304-1805 encompass the upstream portion of study (Project Area 1 and Project Area 2) and stations 1209-925 encompass the downstream protion of our study (Project Area 3 and Project Area 4). . Project results are within the red call out box. The results of the existing conditions hydraulic analyses are shown in **Table 5** for each storm event Comparisons between existing and proposed conditions will be provided in future submissions for all relevant parameters.

Table 5: Existing Conditions Results Comparison

Existing Station	Water Surface Elevation (ft)			Shear Stress (lb/sq ft)			Velocity (ft/s)		
	2-year	10-year	100-year	2-year	10-year	100-year	2-year	10-year	100-year
2304 10+27.24	148.85	149.38	150.46	7.02	7.88	9.68	1.26	1.4	1.94
2131 11+94.00	143.24	143.63	144.6	10.76	12.39	14.7	3.79	4.67	5.54
2065 12+60.00	143.34	143.9	144.99	6.17	7.21	9.7	1.05	1.27	1.83
2021 13+04.00	143.07	143.66	144.87	5.43	6.34	8.31	0.83	1.04	1.36
1925 14+00.00	141.73	142.24	143.41	7.16	8.21	10.16	1.45	1.66	1.98
1871 14+54.00	137.27	137.62	138.34	14.41	15.43	17.93	6.78	7.87	9.01
1805 15+20.00	134.81	135.34	136.26	9.57	10.59	13.51	2.84	3.23	4.81
1766 15+59.00	133.22	133.82	135.1	10.37	11.41	13.35	3.25	3.67	4.54
1725 16+00.00	131.72	132.03	132.8	9.85	11.83	14.92	3.21	4.35	6.17
1642 16+83.00	130.98	131.64	133.1	5.8	6.58	8.06	0.95	1.09	1.37
1585 17+40.00	130.59	131.29	132.81	5.45	6.17	7.51	0.83	0.99	1.32
1466 18+59.00	129.42	130	131.17	6.36	7.43	9.56	1.15	1.48	2.18
1425 19+00.00	129.25	129.82	130.96	5.23	6.28	8.43	0.75	1.03	1.71
1391 19+34.13	129.1	129.68	130.9	4.81	5.65	7.23	0.65	0.84	1.22
1320 20+05.00	128.18	128.69	129.81	6.52	7.35	8.88	1.29	1.54	1.99
1209 21+16.00	126.29	126.9	128.09	7.39	8.07	9.66	1.62	1.82	2.33
1164 21+61.00	126.01	126.74	128.3	2.92	3.5	4.59	0.2	0.27	0.33
1106 22+19.00	125.59	126.29	127.79	4.99	5.49	6.45	0.72	0.8	0.84
1060 22+65.00	124.6	125.2	126.49	7.48	8.34	9.85	1.67	1.94	2.43
981 23+44.00	122.78	123.15	123.98	8.11	9.62	12.18	2.1	2.78	4.01

Existing Station	Water Surface Elevation (ft)			Shear Stress (lb/sq ft)			Velocity (ft/s)		
	2-year	10-year	100-year	2-year	10-year	100-year	2-year	10-year	100-year
925 24+00.00	121.77	122.54	124.51	7.67	7.63	7.33	1.81	1.61	1.27
768 25+57.00	121.2	121.88	124.25	4.36	5.13	5.34	0.49	0.6	0.44
715 26+10.00	121.02	121.7	124.19	4.23	4.92	4.83	0.48	0.61	0.46

Results from the existing condition model reflect observations made during site investigations. As shown in **Table 5** the stream experiences high shear stress throughout the reach, with average calculated shear stresses of 6.78, 7.67 and 8.6 lb/sq ft for the 2-, 10- and 100-year storm events respectively. Increases in shear stress occur at both sewer sanitary sewer crossings within Project Area 2 (Station 1925-1871) and Project Area 4 (Station 10060-981). The results coincide with observed eroded stream banks and highlight the risk to the sanitary sewer infrastructure. See **Appendix E** for current model parameters and detailed results.

5 Proposed Minimal Intervention

The proposed design was guided by the Project goals and objectives, including long-term stream and bank stability, and protecting compromised infrastructure. The design implements a 'minimal stabilization' approach to reduce disturbance to the trees and community.

5.1 Outfall Stabilization

Project Areas 1 and 2 exhibit signs of outfall instability due to erosion. In Project Area 1, the right wingwall of the existing 72-inch reinforced concrete pipe (RCP) outfall will be replaced to match the specifications of the left wingwall, while the headwall and left wingwall will remain in place. In Project Area 2, the existing 36-inch RCP outfall will be replaced with a new cast-in-place endwall constructed in accordance with Virginia Department of Transportation (VDOT) standards. To mitigate future erosion during high-flow events, riprap will be installed around the headwall perimeter. The outfalls will feature a rock façade finish to match the gravity walls and blend with the natural environment.

Example of rock façade finish for outfalls

5.2 Channel Bank Stabilization

Gravity walls will be installed throughout the design areas to stabilize channel banks. This solution was selected over other alternatives due to its minimal disturbance footprint, ease of material handling, and expedited construction timeline, which collectively reduce tree clearing and minimize disruption to park activities. Sheet piles will be installed along the toe of the gravity walls to prevent erosion-related undermining from risk of excessive bed scour. These were chosen over deeper wall embedment depths due to the scour potential at the base of the boulder cascades and cost considerations. Specific embedment depths and sheet pile locations will be provided in future submissions. All gravity walls will feature a rock façade finish to blend with the natural environment. A one-foot freeboard above the proposed 100-year water surface elevation has been incorporated, as the walls are not intended to meet FEMA flood wall or load bearing wall accreditation standards, which would require a three-foot freeboard. This will allow for a shorter wall to be constructed in some areas reducing project costs. Due to the proximity of the high school and frequent community use, vertical gravity walls will be implemented in Project Areas 1, 2, and 4 to discourage climbing or sitting, thereby reducing the risk of injury and improving safety to the community. To further enhance safety, a railing will be constructed along the top of each gravity wall to prevent falls from elevated wall sections. This addition is especially important in areas with high pedestrian activity, such as near the high school, park trails, or sidewalks and bike lanes.

Example of gravity retaining wall with safety railing

In Project Area 1, gravity walls will be constructed on both banks, tying into the existing headwall at elevation 155.0 feet. On the left bank, the wall will reach a maximum height of approximately 7.5 feet over 38 linear feet, then taper down to elevation 149.17 feet over 55 linear feet. On the right bank, the wall will maintain elevation 155.0 feet over 39 linear feet, with wall heights ranging from 7.5 to 10.5 feet. The tallest section, at 10.5 feet, spans 13.5 linear feet, followed by a tapering segment ranging from 3 to 9.05 feet over 52 linear feet, tying into existing grade at elevation 150.5 feet.

In Project Area 2, the gravity wall will tie into the proposed headwall upstream at elevation 146.0 feet, with wall heights ranging from 9 to 10.5 feet over 47 linear feet. The wall will then transition to elevation 144.5 feet over 90 linear feet, with a maximum height of 12 feet spanning 69 linear feet.

In Project Area 3, following the removal of large woody debris, the banks will be stabilized using native plantings. Rock packing will be used to reinforce undercut roots and will extend through the critical root zone of the large Red Maple tree in Project Area 4. Additionally, 3'x2'x2' boulders will be placed at the toe of the bank to prevent future erosion beneath the tree.

Example of rock pack to support tree at the toe of the bank

In Project Area 4, the existing sheet pile wall on the left bank will be replaced with a gravity wall that ties into existing grade at elevation 130.0 feet. Wall heights vary from 3 to 12 feet over 35 linear feet, with the tallest section (12 feet) spanning 6 linear feet. The wall will then taper over 48 linear feet to tie into existing grade at elevation 125.5 feet, with wall heights ranging from 6 to 10.5 feet depending on base elevation.

5.3 Stream Bed Stabilization

Channel blockages, consisting mostly of woody and concrete debris, occur throughout the stream and were created from erosion of the City infrastructure and channel banks. Removal of the large debris blockages in Project Areas 2 through 4 will require the realignment of the thalweg towards the center of the channel and performing grading to stabilize the channel.

Example of plunge pool downstream of outfall

The plunge pool immediately downstream of the 72-inch outfall in Project Area 1 will be modified to meet Virginia Department of Environmental Quality (VDEQ) standards. The pool will be designed as a Type I plunge pool with dimensions of 36' L x 30' W, 3' H. Immediately downstream of the plunge pool, a boulder cascade (approximately 56 linear feet) will be used to quickly drop the stream down multiple feet (approximately 4 feet) to tie into the existing stream elevation at

Example of boulder cascade following Regenerative Step Pool Conveyance Design Guidelines

144.35’. Downstream of the 36-inch outfall in Project Area 2, a similar cascade will be implemented over approximately 95 linear feet. The stream elevation will rapidly drop 7.5 feet to tie into the existing stream elevation at 132.5’. A third boulder cascade will be installed in Project Area 4, downstream of the sanitary sewer pipe crossing. The cascade will extend approximately 73 feet and will lower the stream elevation 3.4 feet to tie into existing ground at elevation 120.66’. Boulder cascades will be constructed of strategically placed imbricated rocks, following Regenerative Step Pool Conveyance Design Guidelines, developed for the Anne Arundel County, Maryland Public Works Department.

5.4 Sanitary Sewer Infrastructure Protection

Portions of sanitary sewer pipes cross Taylor Run in Project 2 and Project 4. Both pipes will be encased in concrete. The boulder cascades, described in **Section 0**, will provide protection. No cover will be placed on top of the concrete encasements. The gravity walls, described in **Section 5.2**, will stabilize the banks and protect the sanitary manhole behind the existing sheet pile wall.

Example of sanitary sewer manhole protection

A gravity wall will be used to protect the exposed sanitary sewer manhole in Project Area 3. To meet the minimum radius recommended for convex curves (14.5 feet), the wall extends up and downstream of the sanitary sewer manhole. The wall ties into existing bank grade at elevations 133’ for approximately 38.5 linear feet, wall heights ranging from 5-9 feet. The maximum height of the wall is 9 feet for approximately 7.7 linear feet. The wall height steps down to tie into existing grade at elevation 130’, with wall heights ranging from 1.5-7.5 feet.

5.5 Cost Estimate

The estimated total cost for the Project is approximately $1,597,818. This figure reflects the scope and complexity of the stream stabilization work, including anticipated grading, material requirements, and site-specific conditions. The estimate incorporates a 30% contingency to account for unforeseen conditions and design refinements. Additionally, a 4.3% escalation factor has been applied to account for inflation between the present and the projected midpoint of construction in February 2027.

It is important to note that stream stabilization project costs can vary significantly based on factors such as project length, location, access constraints, and design complexity. The detailed cost breakdown is provided in **Appendix F**.

5.6 Construction Access and Scheduling

Multiple access points will be required for the project as the project areas span over 1,500 linear feet of stream. The Project will not be creating new paths for construction access to limit vegetation clear and disturbance to the community and park. Project Area 1 has access from the existing earthen park trail at most upstream extent of Taylor Run, at the 72-inch outfall. Minimal clearing will be required as many trees in this area have already died and fallen due to bank erosion or storm damage. Within Project Area 1 a total of 19 living trees will be impacted. Project Area 2 has access from the existing park trail and King Street with some moderate clearing of vegetation required. Within Project Area 2 a total of 2 living trees will be impacted. Project Areas 3 and 4 have access from the trail entrance near the community garden. Moderate clearing of vegetation will be required, for both of these areas a total of 5 living trees will be impacted.

The Virginia Department of Wildlife Resources (DWR) has designated no instream work between March 1 – June 30 due to general cold water species time of year restrictions. for DWR. Existing open areas adjacent to the stream have been identified for contractor stockpiling and staging to reduce vegetation impacts.

Although stream stabilization requires detail-oriented construction, implementation costs may be kept low by having contractors who specialize in gravity wall installation construct the Project. Experienced construction contractors can avoid mistakes that may compromise project function and extend the Project schedule. AECOM recommends that the City requires contractors to have an appropriate amount of experience in stream stabilization, wall construction, and utility protection for bid qualification or to be deemed the responsible bidder. AECOM also recommends that a stream restoration professional or engineer of record is also recommended to be on site during construction (full time or at minimum during Project critical times) to provide supervision and timely oversite to ensure a quality product.

6 Conclusion

The Project is designed to protect vulnerable infrastructure long-term while minimizing disturbance to surrounding trees and the local community. The project encompasses four distinct areas, each targeting specific stabilization needs, including exposed sanitary sewer infrastructure, deteriorating stormwater outfalls, actively eroding stream banks, a critical root zone of large Red Maple tree, and a degraded plunge pool. Future submissions will include hydraulic modeling of the proposed conditions using HEC-RAS to ensure the project does not adversely impact the regulatory Zone AE floodplain. Construction activities are expected to impact a total of 26 existing trees, of which 15 have diameters at breast height (DBH) less than 12 inches, 10 fall within the 13–24 inch range, and one tree measures between 25–54 inches DBH. The total estimated cost for the stabilization effort is $1,597,818, which includes a 30% contingency and a 4.3% inflation escalation factor based on a projected construction midpoint of February 2027.

Appendix A Tree Inventory

Appendix B CCTV Assessment Report

Appendix C Geotechnical Assessment Memo

Appendix D Site Photographs

Appendix E Hydrology and Hydraulics

Appendix F Cost Estimate

Appendix G 30% Stream Design Plans

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