PROJECT CONCEPT
TOWN OF BRIDGEWATER
COOKS CREEK ARBORETUM STREAM BANK STABILIZATION

Location Description
38.38646, -78.95052
Cooks Creek Arboretum on the western side of the Town of Bridgewater along Cooks Creek (**Figure 1**). The Arboretum is located within the FEMA floodplain.

Project Purpose
Stabilize eroding stormwater channel (Phase 1) and Cooks Creek banks (Phase 2) at the Arboretum using low-profile, naturalistic approaches consistent with the Arboretum's floodplain character and aesthetic.

Additional Information Needed
- Evaluation of erosion extent and rate
- Presence and location of utilities

Background
At the parking area for the Arboretum, a stormwater conveyance ditch has begun to erode (**Figure 2**). Stormwater from the adjacent residential development outfalls into the stormwater conveyance, flows through a culvert under the Arboretum's entrance road, and joins Cooks Creek at the southern end of the Arboretum. Erosion has left nearly vertical banks along an approximately 150 foot long gully, which becomes progressively deeper as it approaches Cooks Creek, up to approximately 3 feet deep. In the upper portion of the stormwater conveyance channel, the banks have become undercut at least one foot into the bank (**Figure 3**).

In multiple locations within the Arboretum, the stream banks along Cooks Creek are bare and steep, making them susceptible to erosion (**Figure 4**, **Figure 5**). The Arboretum is within the floodplain of Cooks Creek, and the creek naturally overtops its banks during significant events. Left untreated, the current erosion could worsen and lead to bank instability and mass wasting. This would potentially endanger infrastructure in the park and would send large amounts of sediment into Cooks Creek, which currently has an approved TMDL for excessive sediment and phosphorus. The site could benefit from stabilization along the banks to address these issues and ensure the condition does not degrade.



Figure 1. Site map of Cooks Creek Arboretum, noting important existing infrastructure within the property.



Figure 2. Erosion along stormwater channel leading to Cooks Creek on the south side of the Arboretum. Left image taken from the Arboretum entrance road facing southeast towards the stormwater outfall and upstream stormwater channel. Right image shows channel below the entrance road, with Cooks Creek visible in background (facing northwest).



Figure 3. Undercut bank along stormwater conveyance channel, between stormwater outfall and entrance road to the Arboretum. Undercut estimated at least 1 foot into the bank. Parking lot for the Arboretum visible in background.



Figure 4. Steep, erodible bank of Cooks Creek with the Arboretum trail and grounds visible in background. Photograph taken facing north from near the parking lot.



Figure 5. Steep, erodible bank of Cooks Creek near northern stormwater outfall with residential development visible in background. Photograph taken facing northwest from walking trail in the Arboretum.

Conceptual Design and Planning-Level Cost Estimate

As **Phase 1**, the erosion of the stormwater conveyance and outfall near the parking lot would be addressed by converting the channel into a regenerative stormwater conveyance (RSC) or similar outfall stabilization effort (**Figure 6**) to both control erosion and generate sediment and nutrient reduction credits, which the Town can use to address their MS4 permit requirements. The channel is partially pre-excavated due to the erosion, reducing the additional excavation needed to install the filter media and stone weirs. RSCs are designed to convey, infiltrate, and treat stormwater before entering the creek by routing flow through a sequence of riffles and shallow pools filled and underlaid by a sand and wood chip filter media (with a ratio of 4:1) that dissipate energy and detain and infiltrate stormwater (**Figure 7**). Native herbaceous and woody vegetation are also included in the design, improving function and nutrient removal. RSCs are often constructed with a sediment forebay for the first pool to initially store the water and allow for sediment to settle, before leading to the riffles and filter media. The overall volume of the RSC would be based on the drainage area leading to the structure and a volumetric runoff coefficient based on land cover. The drainage area will need to be field-verified as the layout of the stormwater system connections can create more complex drainage systems than would be assumed based strictly on topography, though it appears highly unlikely that the drainage area would exceed the recommended upper threshold of 50 acres. The cross section of the RSC should be designed to convey the 100-year storm event without overtopping the banks of the pools or riffles. The cobbles in the riffles should

be sized in such a way that the flow velocity from the 100-year storm does not exceed the maximum allowable velocity of the cobble.

The nearby parking lot for the Arboretum could be used during construction for access and the staging of materials. RSCs also require regular monitoring and maintenance of the vegetation and structure after construction. For example, this may include pruning vegetation, adding additional plants to maintain desired density, ensuring riffles and pools are in good condition, and removing accumulated sediment from pools and inflow points.

There is an additional stormwater outfall entering Cooks Creek in the Arboretum further north which appears to be stabilized with riprap. There does not appear to be any active erosion present. The condition at this location should be monitored and addressed if conditions change. If erosion issues develop, this northern outfall and channel could also be evaluated for stabilization strategy implementation.

A streambank restoration project could be implemented for Cooks Creek as part of **Phase 2** efforts, targeting the unstable banks found throughout the park. Given the generally low bank heights and mature trees in the vicinity, increased bank stability could be achieved with plantings of native live stakes and tubelings along the stream bank and edge without major grading. Establishing vegetation on exposed banks will provide stability to the soil and slow the velocity of water flowing through the channel. Species should be selected based on aesthetics for the Arboretum and ability to stabilize the soil. Native vegetation would also enhance the ecosystem function and habitat value at the Arboretum. Some example species are noted in **Table 1** below. The spacing of vegetation is included in the table. Typically, the tubelings are placed with three feet of space between the stems for streamside plants and 15 feet for the riparian plantings. Live stakes are typically planted at a rate of one stake per linear foot. Herbaceous vegetation supplements the woody plantings and provides additional habitat and forage for wildlife. The plantings should occur throughout the site, along both banks. The streamside planting zone, including stream edge and stream bank plantings, should be rooted immediately adjacent to the Cooks Creek, creating a 6-ft wide planted strip along the stream. The riparian planting zones extend an additional 30 feet on the upland side of the streamside plantings, establishing a more resilient buffer (**Figure 6**). Invasive vegetation should be removed and managed within these zones. Information on the spacing and planting process for these tubelings, live stakes, and seeds are included in the sample construction details in **Figure 8**.

With the establishment of a healthy vegetated riparian buffer, it is often useful to protect vegetation from disturbance by directing foot traffic to specific locations along the stream. This allows and encourages the enjoyment of the streamside area without wholesale degradation of the vegetation that keeps the area stable. A set-aside is included in the cost estimate for additional lengths of trail to connect the existing trail to pockets of streamside access.

The work done in the park should be completed with limited disturbances to the infrastructure and activities at the park. The Arboretum focuses on growing and preserving the trees and vegetation within the park. The condition of the trails and stormwater infrastructure on the site should be maintained. The design should also be completed with aesthetics consistent with the current state of the park. These considerations on the site would limit certain design alternatives, such as a full stream restoration, that require heavier construction and an increased disturbance.

Table 1. Sample species recommended for establishing healthy riparian vegetated buffer along Cooks Creek.

Planting Zone	Scientific Name	Common Name	Spacing/Seeding Rate
Streamside	*Alnus serrulata*	Brookside alder	3’ on center
	Cephalanthus occidentalis	Buttonbush	3’ on center
	Cornus amomum	Silky dogwood	1 per LF, staggered (live stakes)
	Ilex verticillata	Winterberry	3’ on center
	Salix nigra	Black willow	1 per LF, staggered (live stakes)
Riparian Plantings	*Asimina triloba*	Pawpaw	15’ on center
	Cercis canadensis	Eastern redbud	15’ on center
	Lindera benzoin	Northern spicebush	15’ on center
	Viburnum prunifolium	Black-haw	15’ on center
Riparian seeding	*Carex squarrosa*	Squarrose sedge	0.20 lbs/ac
	Dichanthelium clandestinum	Deer tongue grass	10.00 lbs/ac
	Elymus riparius	Riverbank wild rye	10.00 lbs/ac
	Eupatorium perfoliatum	Common boneset	0.10 lbs/ac
	Juncus tenuis	Path Rush	0.20 lbs/ac
	Lobelia cardinalis	Cardinal Flower	0.10 lbs/ac
	Senna hebecarpa	Wild Senna	0.10 lbs/ac
	Solidago speciosa	Showy goldenrod	0.10 lbs/ac
	Symphyotrichum pilosum	White Oldfield American Aster	0.10 lbs/ac
	Verbesina alternifolia	Wingstem	0.20 lbs/ac
	Vernonia noveboracensis	New York ironweed	0.10 lbs/ac



Figure 6. Approximate locations of proposed planting zones and regenerative stormwater channel in Cooks Creek Arboretum.

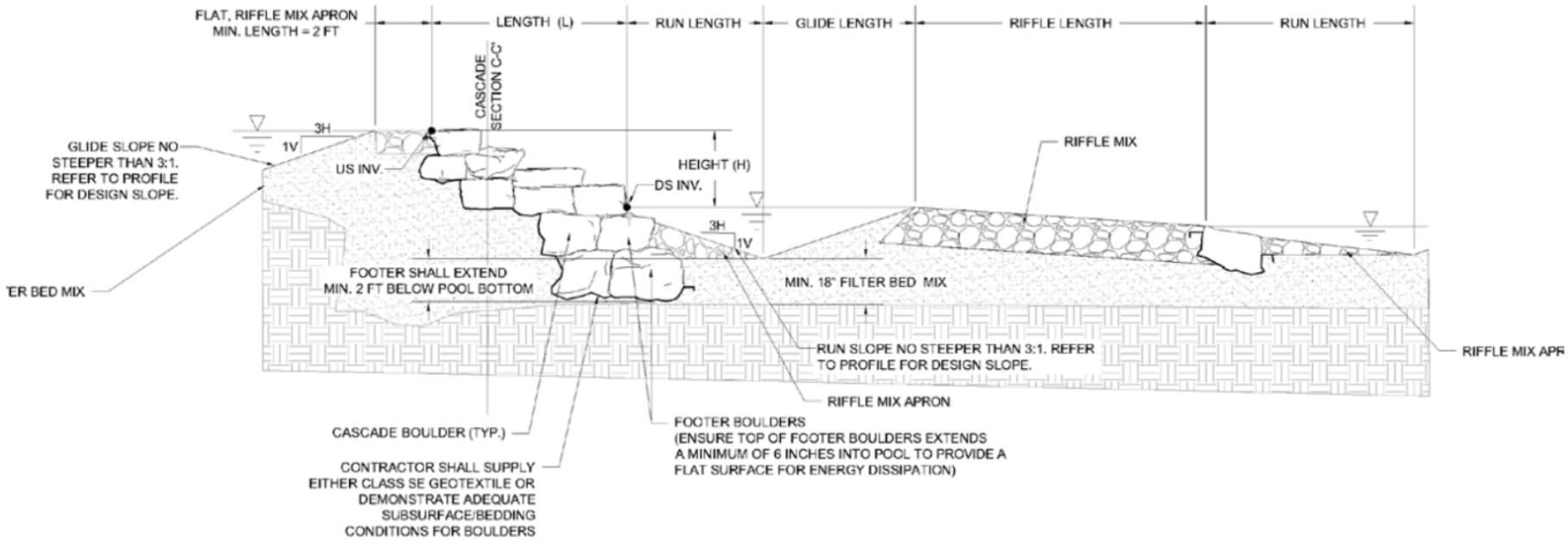

Figure 7. Typical construction profile for a regenerative stormwater channel (VA DEQ, 2025).

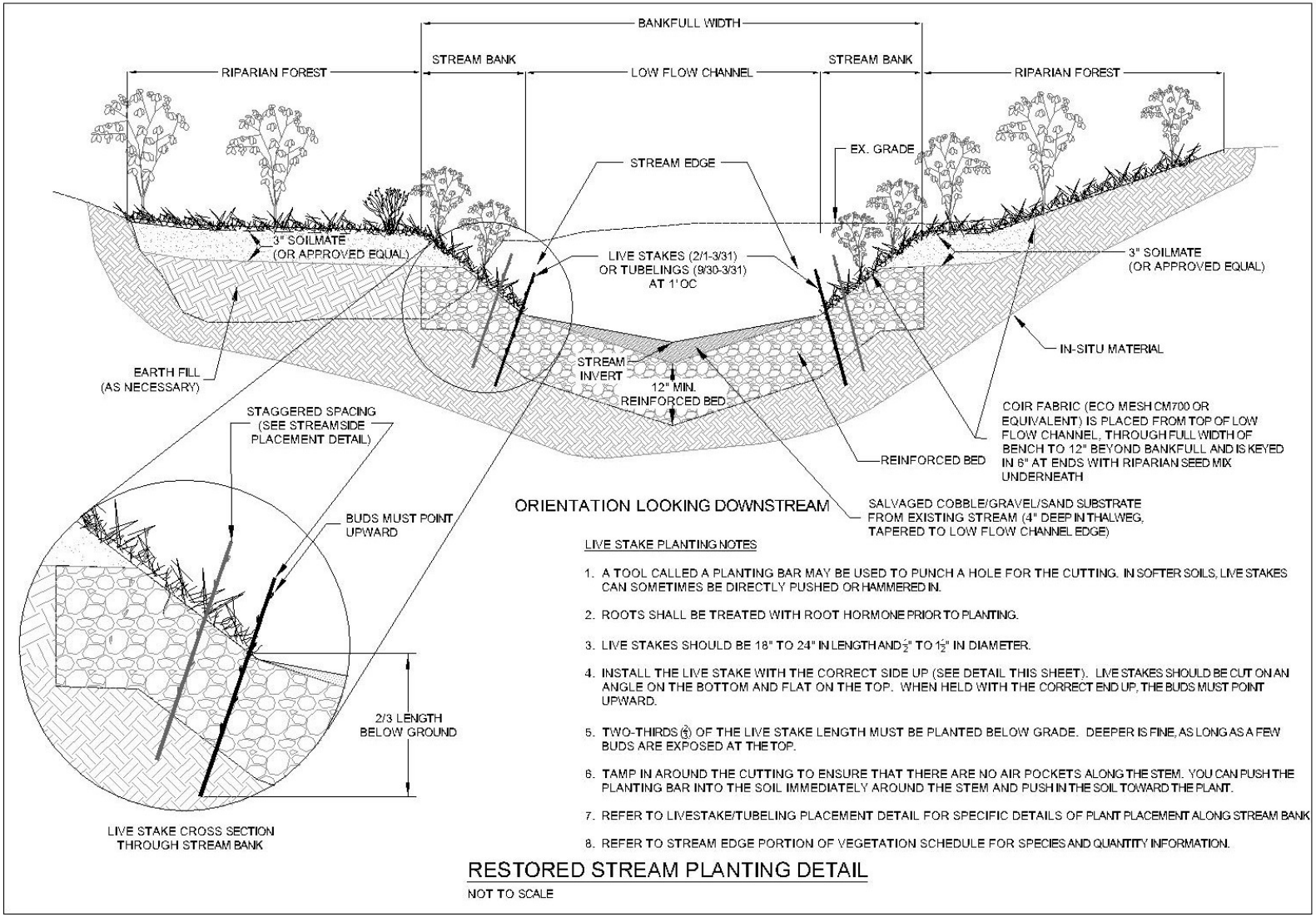

Figure 8. Typical construction details for plantings along a stream.

ITEM/DESCRIPTION	QTY	UNIT	UNIT COST	ITEM SUB-TOTAL	EXTENDED SUB-TOTAL
Phase 1: Stormwater Channel Stabilization					**$413,738**
Survey and Design					**$69,000**
Survey	1	LS	$15,000	$15,000	
Design	1	LS	$40,000	$40,000	
Permitting	1	LS	$14,000	$14,000	
Construction Administration and Oversight					**$15,000**
Construction Oversight	1	LS	$15,000	$15,000	
Access and Erosion/Sediment Control					**$8,100**
Temporary Construction Entrance	1	EA	$4,500	$4,500	
Super Silt Fence	400	LF	$9	$3,600	
Construction: Stormwater Conveyance					**$226,160**
Stakeout	1	LS	$15,000	$15,000	
As-Built Survey	1	LS	$15,000	$15,000	
Mobilization	1	LS	$10,000	$10,000	
Clearing	0.1	AC	$30,000	$3,000	
Grading	0.2	AC	$9,000	$1,800	
Excavation	800	CY	$20	$16,000	
Excess Haul Offsite	800	CY	$45	$36,000	
Class II Riprap	500	TON	$180	$90,000	
Geotextile Fabric	170	SY	$5	$850	
Filter Bed Media Sand	400	CY	$80	$32,000	
Filter Bed Media Wood Chips	100	CY	$60	$6,000	
Permanent Seeding and Straw	170	SY	$3	$510	
Phase 1 Contingency (30%)					**$95,478**
Phase 2: Cooks Creek Bank Stabilization					**$189,982**
Survey and Design					**$30,000**
Survey	1	LS	$10,000	$10,000	
Design	1	LS	$20,000	$20,000	
Construction Administration and Oversight					**$5,000**
Construction Oversight	1	LS	$5,000	$5,000	
Access and Erosion/Sediment Control					**$1,700**
Orange Safety Mesh	200	LF	$4	$800	
Super Silt Fence	100	LF	$9	$900	
Plantings and Construction - Cooks Creek					**$109,440**
Mobilization	1	LS	$5,500	$5,500	
Trail Construction	100	SY	$84	$8,400	
Riparian Buffer Seed and Straw	1,900	SY	$3	$5,700	

ITEM/DESCRIPTION	QTY	UNIT	UNIT COST	ITEM SUB-TOTAL	EXTENDED SUB-TOTAL
Live Stakes	2800	EA	$10	$28,000	
Stream Edge Planting (tubelings)	2800	EA	$8	$22,400	
Stream Bank Planting (tubelings)	3700	EA	$8	$29,600	
Riparian Planting (30' buffer, tubelings)	1,230	EA	$8	$9,840.00	
Phase 2 Contingency (30%)					**$43,842**
TOTAL ESTIMATED BUDGET					**$606,957**

Some cost savings on items such as survey and mobilization could be realized by not separating the timeline of the two phases, though estimates are presented assuming the phases will be separate endeavors.

Assumptions

- Watershed of Cooks Creek (via StreamStats 8/20/2026) is 20.8 square miles, taken from the project coordinates
- 1400 linear feet of Cooks Creek assumed to receive riparian plantings. RSC channel assumed 150 feet long and 30 feet wide.

Recommended Next Steps

Assess the need for additional nutrient reduction credits to achieve MS4 permit requirements and general interest in the project(s).

References

USGS. StreamStats v4.33.0. Accessed online 20 August 2026.

Virginia Department of Environmental Quality. 2025. *Virginia Stormwater Management Handbook*. Version 1.2. https://www.deq.virginia.gov/water/stormwater/stormwater-construction/handbooks.