

Lower Mill Creek Stream Restoration Project

The Anne Arundel County Bureau of Watershed Protection and Restoration (BWPR) identified the Lower Mill Creek Project in the comprehensive assessment of the Magothy River Watershed as an excellent opportunity for stream restoration. The site has a drainage area of 934.3 acres, 222 acres (23.8%) of which is impervious. Through the stabilization of 2,369 linear feet of stream and planting of 4,000 trees, the Lower Mill Project created wetlands and aquatic habitat, recharging groundwater, providing flood attenuation, enhancing riparian buffers, and maximizing sediment and nutrient reductions. The enhanced habitat and optimized water quality credit generated from this project upholds the County's regulatory obligations for the County's National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit and the Chesapeake Bay Total Maximum Daily Load (TMDL).

The cumulative effects of urban development coupled with insufficient stormwater management control infrastructure and channel alteration for the construction of roads and utilities resulted in degraded habitat, channel incision, bank erosion, and irregular planform geometry among other signs of instability within the project site's watershed. Additionally, in December 2005, a 36-inch wastewater main collapsed approximately 2,500 linear feet upstream of the Mill Creek tidal headwaters. Nearly three million gallons of wastewater and 1,700 cubic yards of soil slurry were discharged directly into the project area, impacting the floodplain, stream, and tidal headwaters of Mill Creek. Immediately after the spill, DPW contracted BayLand for technical and permitting assistance for the emergency restoration of the blocked stream channel and adjacent floodplain. DPW also contracted BayLand to provide monitoring and assessment of the wastewater and soil slurry overflow. Following a year-long comprehensive monitoring effort, BayLand was retained for design and permitting services to remove the remaining accumulated sediment from the tidal headwaters and restore natural habitat functionality at the tidal interface, immediately downstream of the project area. In response to the unstable conditions, Mill Creek was targeted for restoration to improve hydrologic, hydraulic, geomorphic, water quality and biological functionality.

The bed scour, vegetation destruction, and reduced groundwater integration observed at the site prior to restoration had weakened the ecological functions responsible for water clarity, nutrient cycling, and temperature control. The existing stream did not provide adequate fish passage or habitat features. There was a significant drop in elevation between the outfall draining from upstream portions of Mill Creek that created a barrier to safe fish passage. A series of gabion baskets installed at the upper reaches of the project were undermined by erosion, creating a cascade of stormwater flow that also prevented fish passage. Through floodplain reestablishment and stabilization of bed features in this project, both aquatic and terrestrial habitat quality and complexity was significantly enhanced.

A "Valley Restoration" approach was utilized to encourage high frequency, high duration, and large extent of surface and groundwater exchange between the channel and floodplain and promote the retention of organic matter, sediment, nutrients, and water. The restored existing channel was raised to reconnect the floodplain and reduce shear stress. Riffle grade control structures and coarse woody material were placed in the undersized channel to further protect from incision during storm events.

The design created a highly-connected wetland system that spreads energy across a wide floodplain during most runoff events. The riparian wetland floodplain system is maintained through the project reach, and a stable restored stream channel was created that enhances water quality and wildlife habitat. The holistic design approach connects the extensive riparian wetland vegetation to groundwater, retains carbon sources to benefit water quality and habitat, promotes filtration of surface water nutrients through the expanded wetland system, enhances the hyporheic exchange zone to improve groundwater treatment, provides ecological uplift, and yields cost-effective TMDL credits. Pollutant load removal rates are 310,200 pounds/year Total Suspended Solids (TSS), 71.9 pounds/year Total Phosphorus (TP), and 597.5 pounds/year Total Nitrogen (TN).

The base of the stream was elevated to meet the base of the outfall, creating a more continuous path for fish passage into the stream. The implemented SPSC structure involved installation of stable, shallow pools (max depth ~1ft) that, along with adequate tree canopy cover, created habitat where fish and other aquatic species can safely thrive. It should also be noted that the swimming performances of the most populous fish in Maryland, the blacknose dace, was utilized as a baseline to ensure that the proposed constructed riffles would not create supercritical flow conditions under base flow conditions or influence fish swimming performance.

Anne Arundel County conducted pre-restoration monitoring at four (4) sites along Mill Creek to develop a baseline for aquatic biological community and habitat conditions. The effort consisted of benthic macroinvertebrate

sampling, physical habitat assessment and geomorphology assessment. Post-construction monitoring is being conducted to compare habitat conditions before and after restoration. Success of the project will be based on measuring the resulting bank height ratio and expected increased water table that will help establish and support riparian and floodplain plant communities while providing a high capacity to store sediment.

BWPR's Ecological Assessment & Evaluation Program maintains a long-term biological monitoring program and routinely collects biological, habitat, and geomorphological data from local streams throughout Anne Arundel County. Sites are assessed using methodologies based on the Maryland Biological Stream Survey (MBSS) and BWPR Sampling protocols (AAC, 2017). Mill Creek has been a target for biological monitoring since 2010.

There are four (4) sites near the proposed project site in Mill Creek that the County has monitored for biological health and aquatic habitability via the MBSS Fish/Benthic Index of Biotic Integrity (FIBI/BIBI), the U.S. EPA Rapid Bioassessment Protocol (RBP) method for low-gradient streams, and the Maryland DNR Physical Habitat Index (PHI). These assessments establish a baseline for future comparison with post-construction data.

The average BIBI scores over the monitoring period ranged between a "poor" and "fair" benthic macroinvertebrate community. The results are indicative of poor water quality since Ephemeroptera are sensitive to water quality conditions and decrease in number and percentage as water quality degrades. Additionally, percent intolerant urban increases as water quality decreases.

The RBP scores were determined from a variety of parameters including epifaunal substrate/available, pool substrate characterization, pool variability, sediment deposition, channel flow status, channel alteration, channel sinuosity, bank stability, vegetative protection, and riparian zone width. The average RBP scores over the monitoring period range from "non-supporting" to "partially supporting". Overall, the riparian zone width was rated highly at all sites although bank stability and sediment ratings were very low.

The PHI score were based on instream habitat, epifaunal substrate, velocity/depth diversity, pool/glide/eddy quality, riffle/run quality, bank stability, embeddedness, shading, riparian buffer zone width, remoteness, aesthetic rating (trash) and a number of woody debris and root wads. Average PHI scores over the monitoring period ranged from "degraded" to "partially degraded". Generally, the PHI score was very low due to low bank stability ratings. All three (3) of these measurements (BIBI, RBP, and PHI) suggested that Mill Creek was not providing stable habitat or effective stormwater treatment, and therefore, should be a priority for restoration.

A major initiative of BWPR is to increase the environmental literacy of Anne Arundel County by identifying opportunities for citizen engagement and public involvement. Throughout the restoration process, BWPR invited the Harting Farm HOA and all other community members within a 300-foot radius of the project to meetings that explained the scope, impact and progress of the project. The project is situated along the new extension of the Broadneck Trail built in 2020, and therefore highly visible and accessible, which significantly increased the educational and demonstration value of the restoration work.

The BWPR partnered with the Anne Arundel County Public Schools Office of Environmental Literacy (Arlington Echo) to bring nearby schools, including Magothy River Middle School and Belvedere Elementary School, to the project to plant vegetation and educate them in environmental issues. Many projects performed by the County are used as sampling sites for in-depth scientific monitoring efforts by non-profits and universities to further advance knowledge in the field of stream and wetland restoration. Mill Creek will be open to any group interested in performing such analysis and extensive post construction monitoring.

The restored ecology, stability, and accessibility of the Lower Mill Stream Restoration Project inspires ecological stewardship that extends far beyond the boundaries of the watershed. Wildlife habitat and water quality have dramatically improved since construction completion. Riparian wetlands have expanded with pocket wetlands and backwater areas evident. Several significant storm events occurred during construction and in the months that followed, and these flood events spread storm flows across the site and through the installed woody debris reaches as designed, reducing velocities and dropping sediment throughout the site and confirming that shear stresses have been managed. This project represents the ideal "Stream Restoration" and receiving recognition through the Chesapeake Network's BUBBA program would help further Anne Arundel County's efforts to collaborate with the environmental community in restoring the Chesapeake region's waterways.